Rome, 28.05.2019

Authors:

VERSUS 5.1.9

User Manual

INDEX

LIST OF FIGURES

INTRODUCTION

The purpose of this manual is to provide with guidelines in using and managing VERSUS features. VERSUS is a GUI based software which loads observation and model data and performs various types of Verifications

SOFTWARE REQUIREMENTS

For information about software requirements see VERSUS - Technical Manual and SW Installation Step-by-step

INSTALLATION

For information about installation see VERSUS - Technical Manual and SW Installation Step-by-step

WEB GUI

VERSUS is a system with a web GUI dynamically created with PHP code.

In order to better utilize all system features, JavaScript has to be enabled on your browser. Please follow the instructions below for JavaScript activation on your computer.

Internet Explorer 5.0 and above

1. Go to Tools > Internet Options > click on the Security tab
2. Click on the Custom Level button and scroll towards the bottom of the list
3. Make sure Active Scripting is enabled
4. Save the settings and refresh the page

Mozilla Firefox 1.0 and above

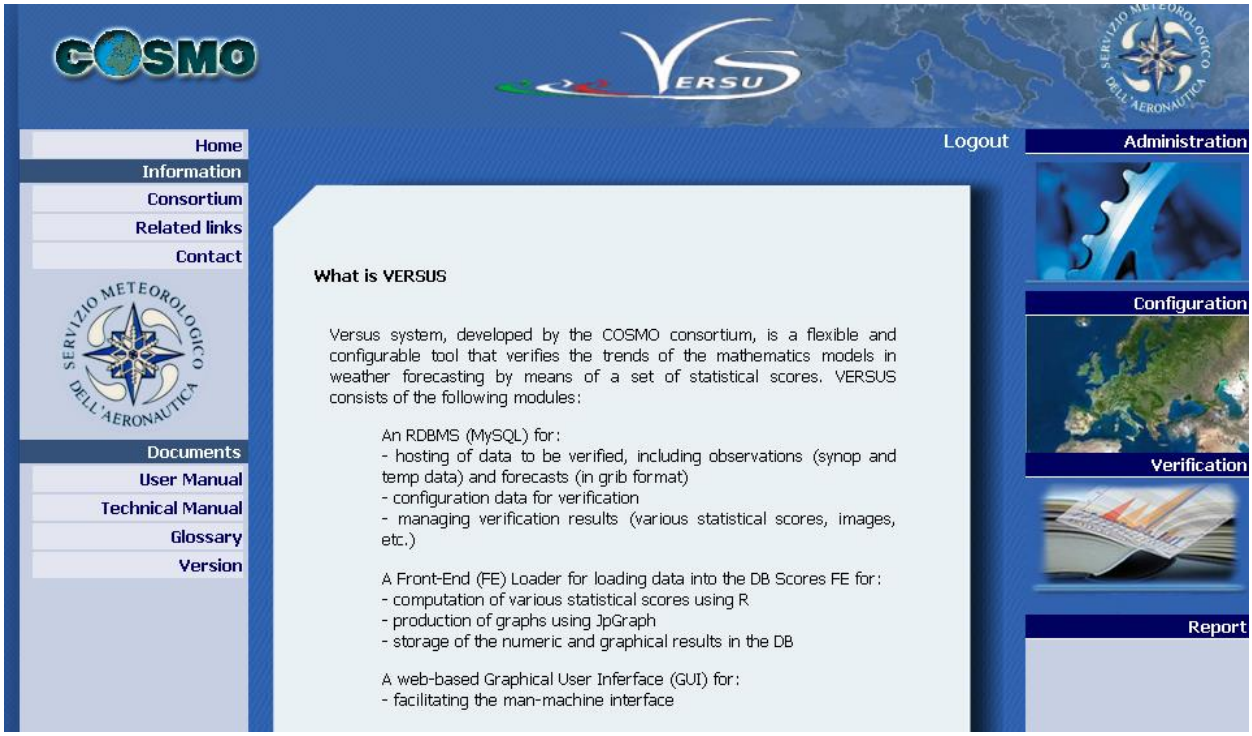
1. Go to Tools > Options > click on the Content tab
2. Check the box, Enable JavaScript
3. Save the settings and refresh the page
4. It is necessary to enable pop-ups from VERSUS address.

Firefox
Go to the Edit->Preferences menu and select the Content icon at the top of the dialog. If "Block pop-up windows" is checked, add www.nanohub.org to the Exceptions list. Firefox also uses plug-in to filter pop-ups. The most common plug-in is NoScript. To enable pop-up for a particular page, select the highlighted "S" icon at the bottom of the browser to guideNoScript to allow the pop-up.

InternetExplorer
Go to Tools->Internet Options menu. Click on the Privacy tab. Uncheck the field 'Block pop-ups' ('Turn on Pop-up Blocker' in IE 7.x). This will unblock pop-ups from all sites. To only allow pop-ups from nanoHUB, check 'Block pop-ups' and click on Settings. Enter nanohub.org in the field 'Address of Web site to allow:' and click Add. Close all windows.

The GUI is optimized for 1280x1024 resolution with last versions of Internet Explorer (7.x) and Mozilla Firefox (3.x).

Note.*To change zoom with Firefox Mozilla 3 and to maintain an optimized GUI it is necessary to control that menu 'View → Zoom →Zoom Text Only' is not selected.*



It is not recommended to change zoom with Internet Explorer because in some cases this browser does not ensure an optimized resolution for text modified using CSS.

Figure 1 VERSUS Home page

On the left shoulder on VERSUS home page there are useful links to User Manual, Technical Manual and Version information.

In the Version link the following information is shown:

Version Number: VERSUS Version installed

Release Date: Official Date release

Installation Date: Installation date on the machine

Figure 2 VERSUS Version information

Once logged into VERSUS system by user name and password, the system displays the following message:

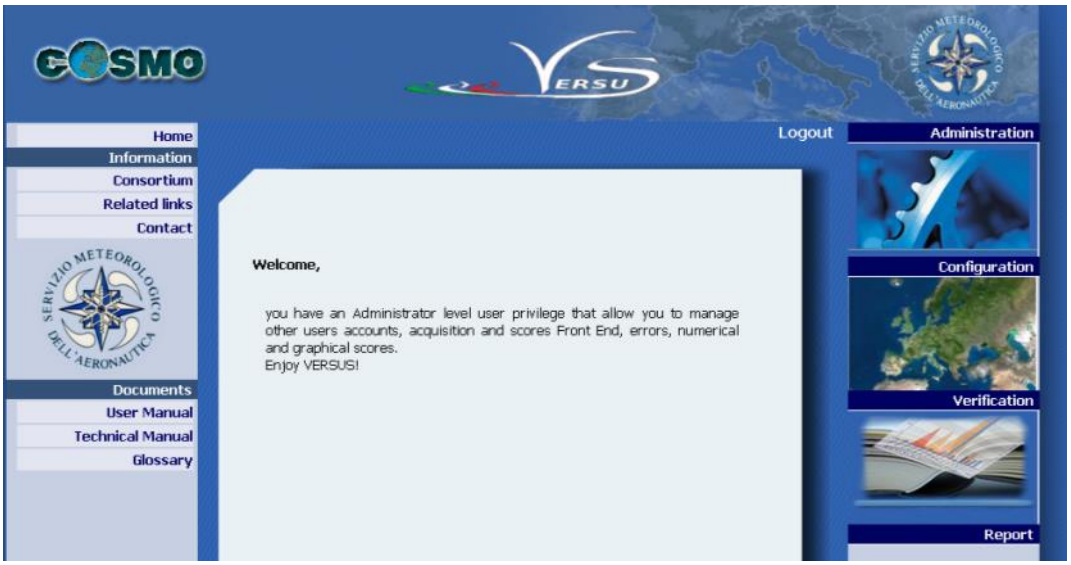
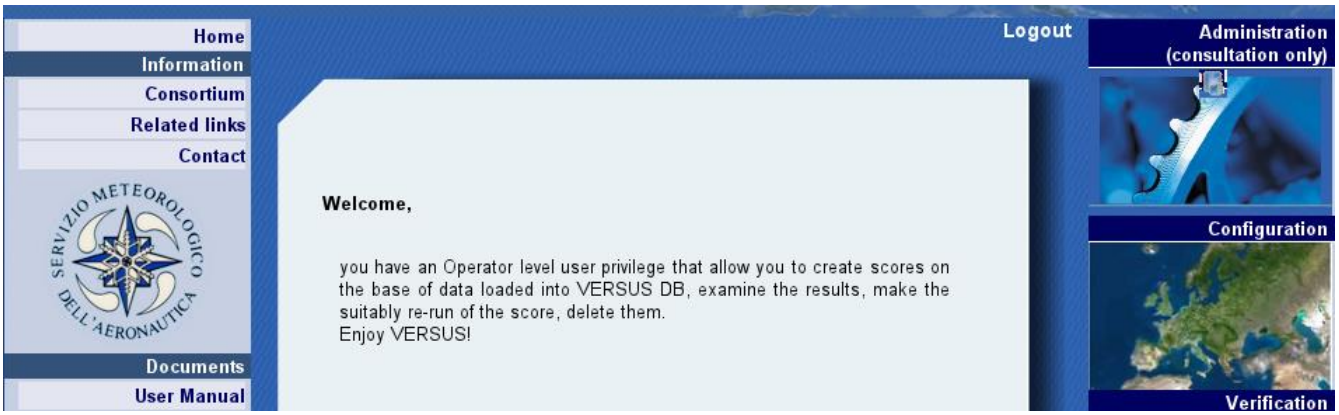


Figure 3 VERSUS login (Administrator)

Figure 4 VERSUS login (Consultant)



MENU

Once logged, the right shoulder shows VERSUS Navigation Menu. The following sections are displayed:

Administration: the general administration management of the system, reserved to the Administrator user

Configuration: the general system registry configuration, reserved to Administrator and Operator

Verification: option for Verification configuration, reserved to Administrator and Operator

Report: Results and data analysis reports, available to all users.

Versus manages three types of users:

Administrator user can manage data acquisition and Front End loaders, errors, users, numerical and graphical scores. He has the highest level of user privileges.

Operator user is able to create scores on the database loaded into VERSUS DB, look at the results, perform the appropriate re-run of the scores, and eventually delete them. He has the medium level of privileges.

Consultant user can only look at the score results. He has the lowest level of privileges.

This table displays the different users privileges

MENU	*ADMINISTRATOR*	*OPERATOR*	*CONSULTANT*
Administration	X		
Verification	X	X	
Configuration	X	X	
Report	X	X	X[1]

4.1 ADMINISTRATION MENU

Currently, the system has only one administrator user with: User name: versus- Password: versus (the password is versus)

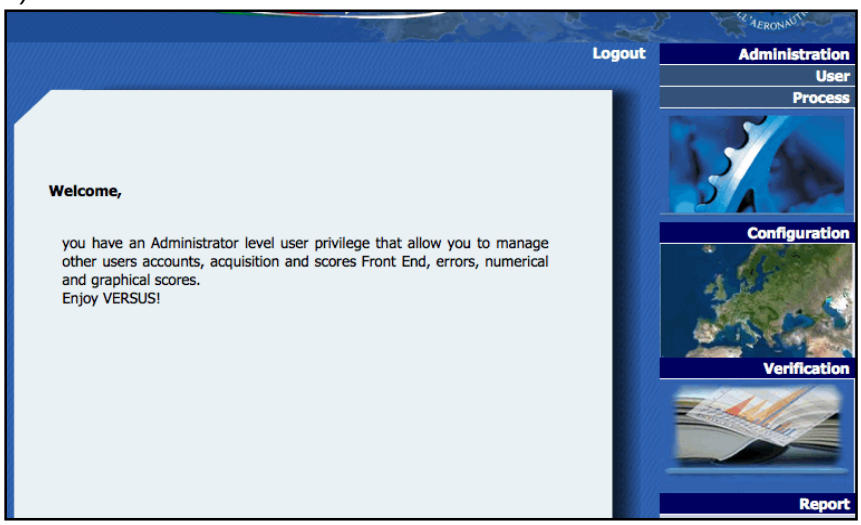


Figure 5. Administration Menu

By clicking on “Administration” option, the system displays the sub-menus User and Process. Administrator user can manage both of them.

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4.1.1 USER ADMINISTRATION

By clicking on User sub-menu the system displays the following:

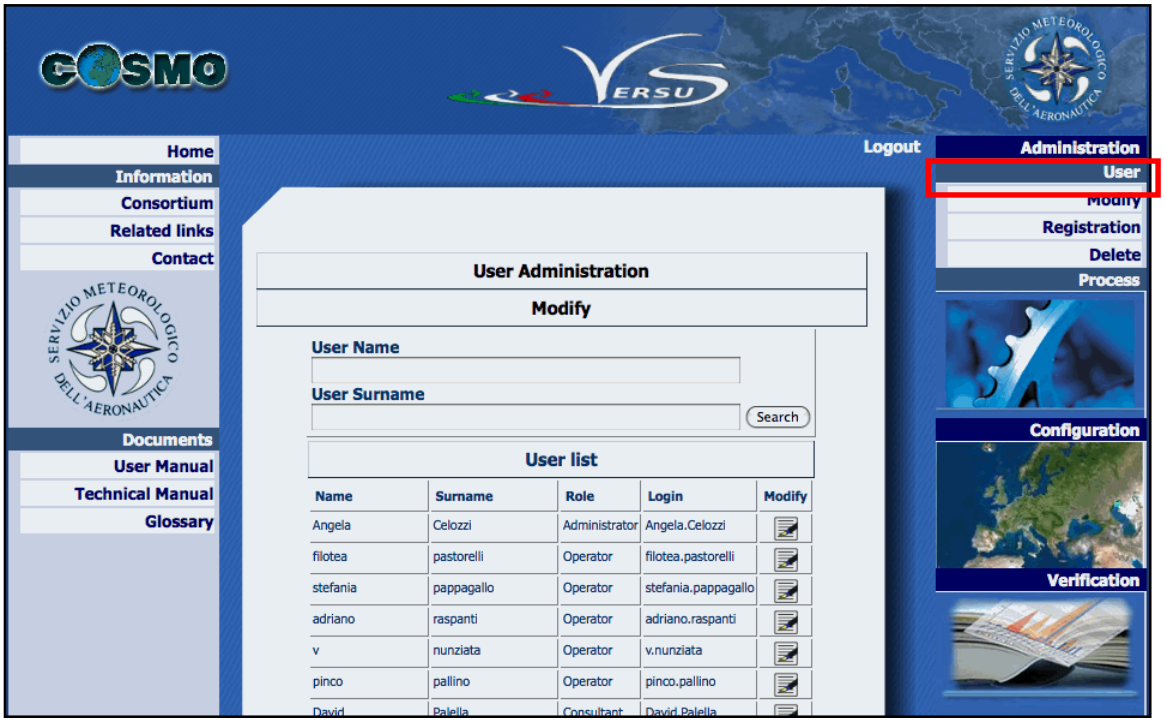


Figure 6 User Menu

The Administrator can create new users by clicking on “Registration” option of the “User” menu (Fig. 5):

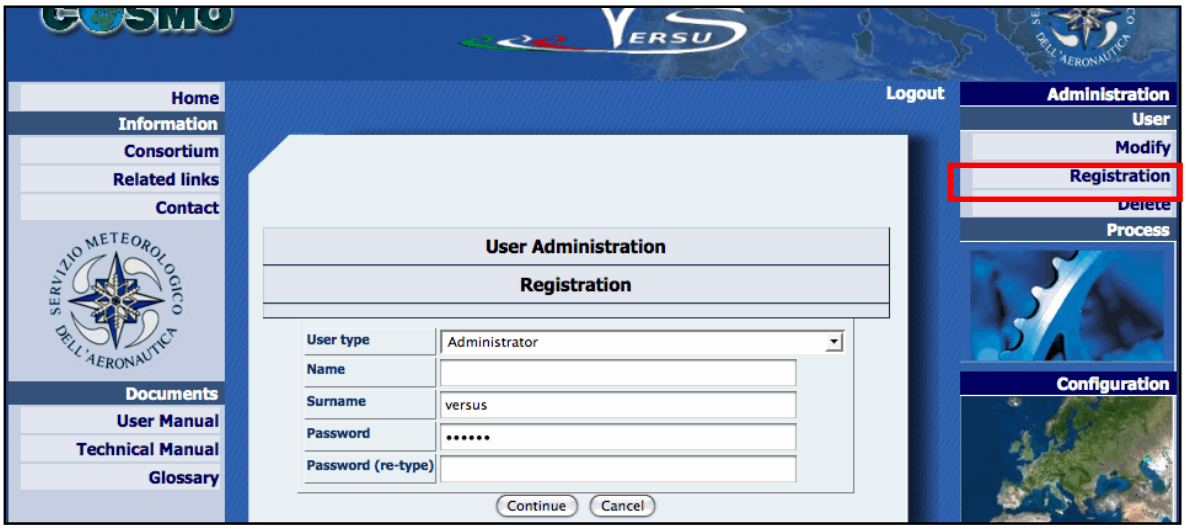


Figure 7 User Registration

The new users can login using the user id with the following syntax: ***name.surname***.

The Administrator:

✓can change a user's name, surname and password;

✓cannot change the user role

✓can delete one or more users

When a user wants to leave the system, he must click on link Logout, so the session will be reset.

Administrator user can modify a user by clicking on "Modify" option of the "User" menu:

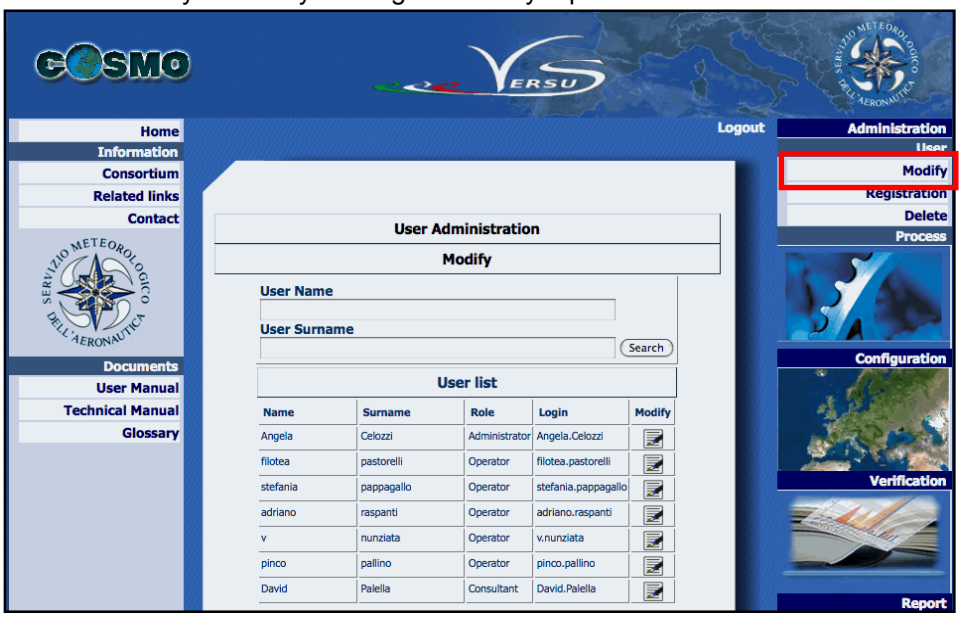


Figure 8 User Modify

Administrator user can delete a user by clicking on "Delete" option of the "User " menu:

Figure 9 User Delete

4.1.2 PROCESS ADMINISTRATION

There are five main procedures in the menu Administration->Process:

Figure 10 Administration ->Process

- **Acquisition Manager**. This FE manages data loading into database, surface observations, upper (BUFR or ASCII format), feedback files data in netcdf format (TEMP from radiosonde and AIREP from aircraft including AIREP report, AMDAR and ACARS.) and forecasts (GRIB format). Only the Administrator can create a new Front End through the Web GUI.
- **Acquisition Registration** Administrator can create new FE (Front Ends)
- **Scores Manager**. This FE manages the production of numerical and graphical scores. The front-end scores are previously configured into the system and users are not allowed to create new ones.
- **Batch Execution** This procedure allows monitoring of the status of periodical verifications (Monthly or Seasonal) and running a set of verifications.
- **Queue Manager** This procedure checks the verifications that are running, to be executed (pending) or in error. The icon will  be present in case there are verifications in queue in any of the possible states

4.1.2.1 ACQUISITION MANAGER

Clicking on “Process” menu item, the system displays the FE loader monitoring form:

Figure 11 Monitoring loader FE

In the above GUI, the following information for each loading Front-End (FE) is displayed:

Name: the unique name of the FE

Process: the status of the process that can be either ‘Stopped’ or ‘Started’

Status: the status of the FE that can be either ‘Online’ or ‘Stand-by ’.An FE is Online when it is ready to ingest data. Ingestion is possible when the Acquisition Manager is in START mode.

Acq. Files: the number of files that are ready to be acquired

Error Files**:** the number of files that have been rejected from the system

Backup Files: the number of backup files

Report: the link to the FE report

Modify: the link to FE modification Form

Logs: the link to the list of log files (files with information on the execution) related to the FE

Delete: Delete a FE from the VERSUS DB

Loader FE To start it up through the WEB GUI, the user should click on Start Button. Alternatively, he can run the script ‘/home/versus/VERSUS/sviluppo/classes/loader.php’ from VERSUS server To stop it through the WEB GUI, user should click on Stop button.

It is also possible to start up the FE by command line editing in the file: VERSUS_HOME/sviluppo/classes/phpversusFE.php. This way of starting-up the acquisition process is highly recommended when the system has problems on ingestion phase.

By clicking on  icon of the “Acquisition Manager” form, the system opens the GUI that displays the report of the related FE:

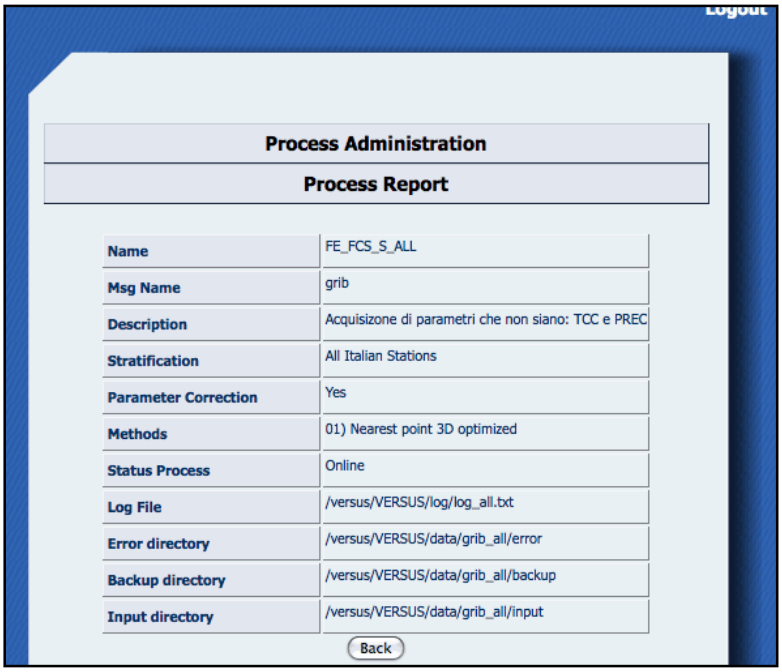


Figure 12 Process Report

The displayed information is the following:

Name: the FE name

Msg Name: the type of data that the FE manages (for example, grib, bufr)

Description: the FE description

Stratification: the related stratification

Parameter Correction: if the FE parameter correction is active or not

Methods: the list of interpolation methods that the FE manages.

Status Process: if the FE is in stand-by or online

Log File: the path and name of the log file with the process information

Error directory: the directory where the FE moves the error files

Backup directory: the directory where acquired files are backed-up

Input directory: the directory where files to ingest are copied

By Clicking on icon of the “Acquisition Manager” form, the system opens the GUI for FE modification:

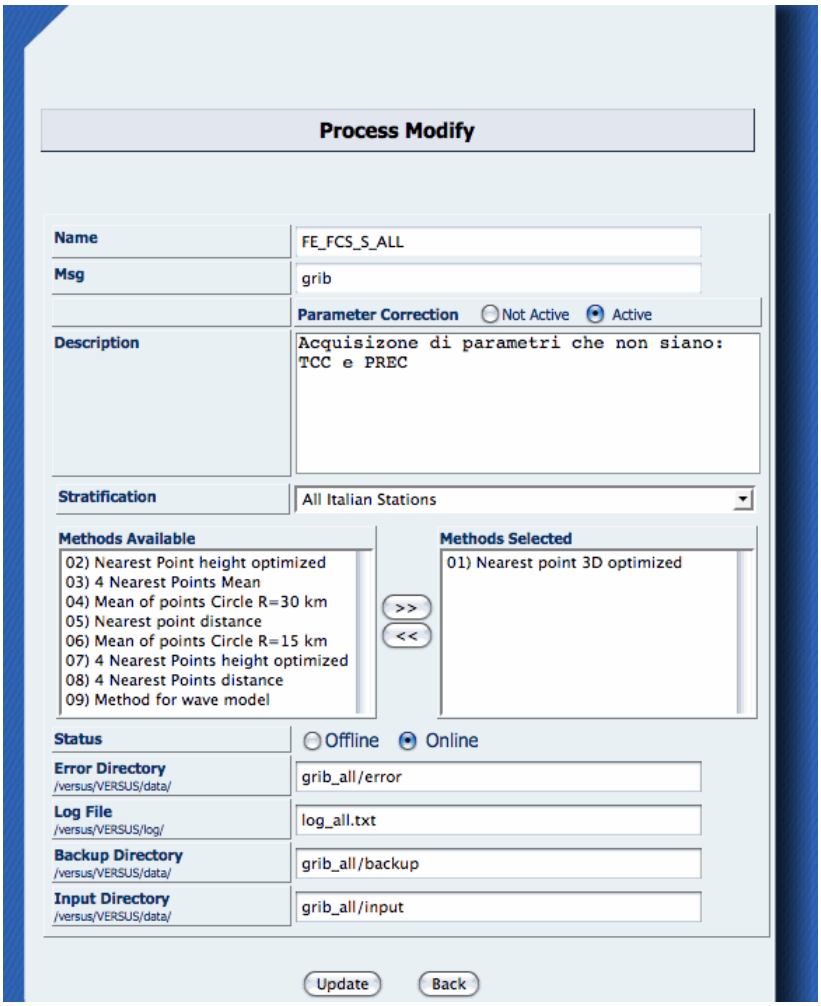
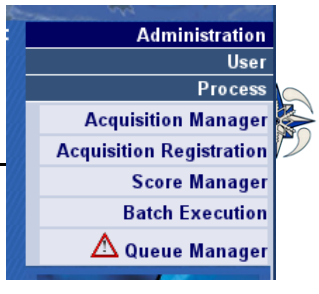


Figure 13 Process Modify

The information that can be modified for each FE is: Parameter Correction (Active or not), Description, Stratification, Methods, Status, Log File, Error directory, Backup directory, Input Directory.

By Clicking on icon of the “Acquisition Manager” menu or on “Log Manager” menu, the system opens the GUI that displays the list of LOG Files of the FEs sorted by date.



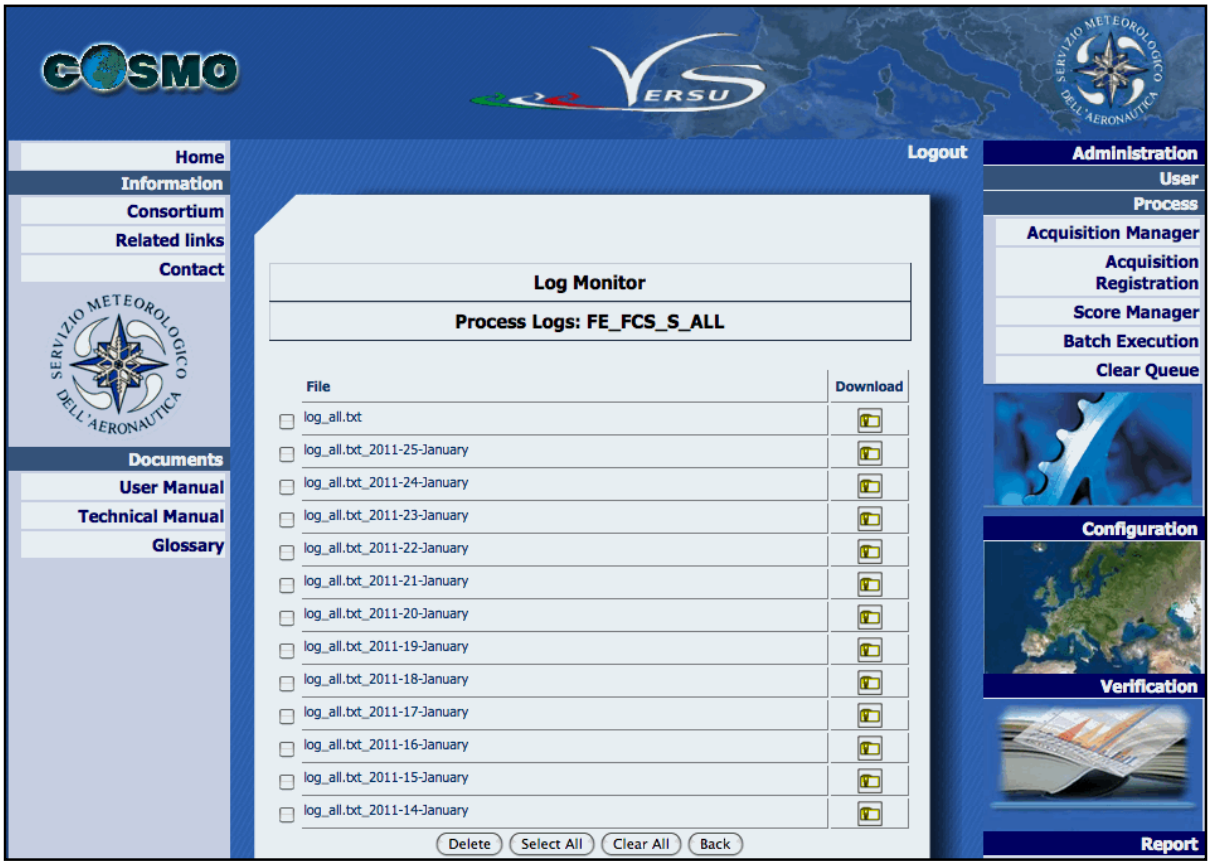


Figure 14 Log Monitor

Administrator can download the selected log files and look at them. When the Acquisition Manager is in START MODE, VERSUS creates a log file for each day The log file contains the eventual errors. The obsolete log files can be deleted from the system.

4.1.2.2 Front-End ACQUISITION REGISTRATION

Only the Administrator can create an acquisition Front End (FE), by clicking on “Acquisition registration” option of the “Process Administration” menu.

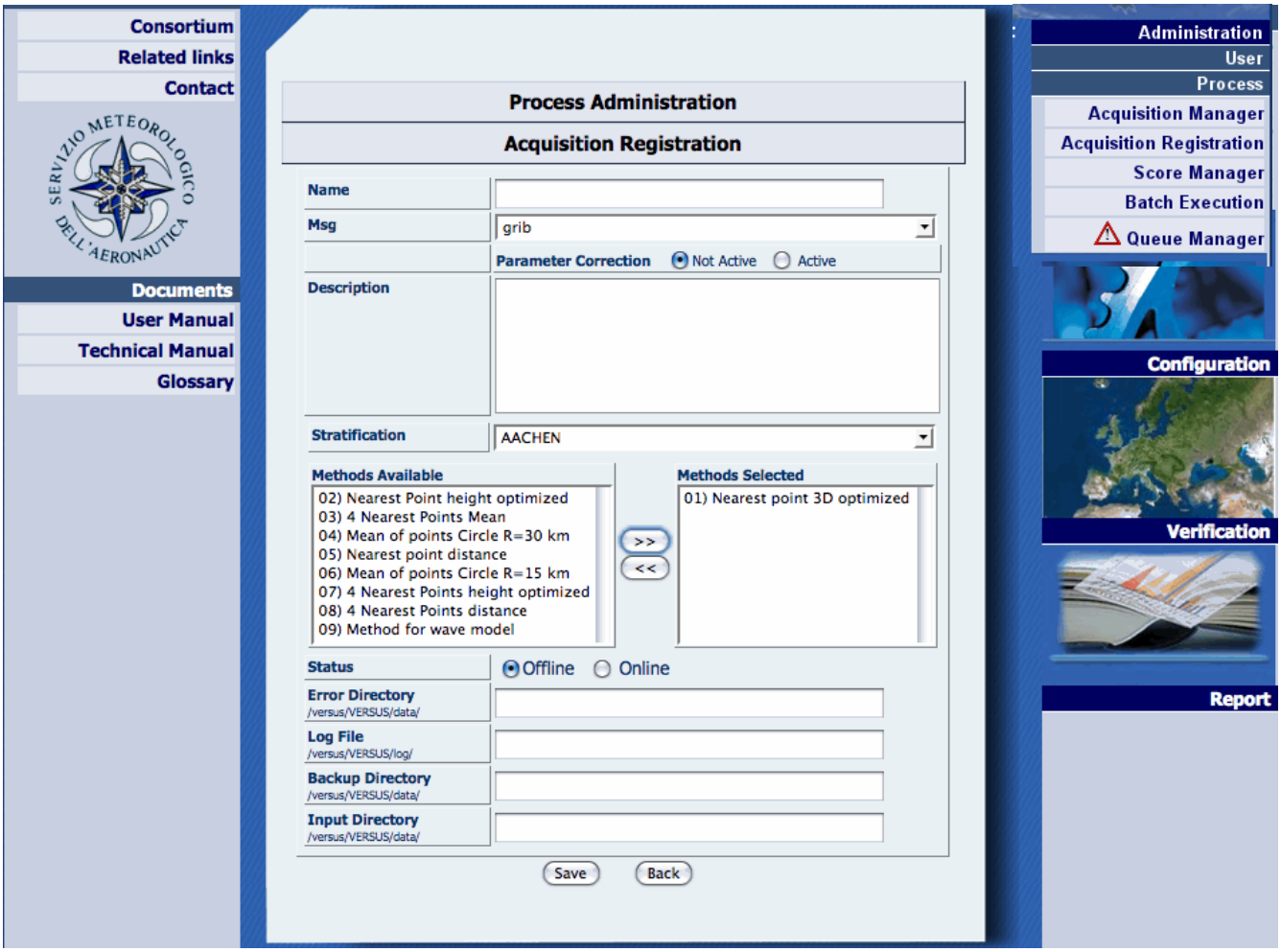


Figure 15 Acquisition Registration

To Register a new loader FE, the following information is needed :

Name: the unique name of the FE

Msg: the type of loaded data. It is ‘grib’ for model data,’bufr_synop’ for synop data in bufr format, ‘bufr_temp’ for temp data in bufr format,‘ synop’ for synop data in ASCII format, ‘temp’ for temp data in ASCII format, ‘solar_obs’ for solar radiation data in ASCII format, ‘xml’ for XML files (see Apprendix II for xml format), ‘feedbackfile temp‘ for FF TEMP, feedbackfile airep’ for FF AIREP (netcdf) and ‘area_grib’ for grib data when verification is based on analysis data. The FE area_grib data do not need stratification and method specification because they are ingested in gridded format..

Parameter Correction: If parameter correction is active or not, (when Msg is grib)

Description: meaningful description

Stratification: the stratification the FE has to deal with. It is not specified in area_grib FE message type.

Methods: the list of FE grib data methods for model value interpolation at the observation point.

Status: if the FE is in stand-by or online

Log File: the log directory where log files are written

Error directory: the directory where the FE moves the error files

Backup directory: the directory where acquired files are backed-up

Input directory: the directory where files to ingest are copied

To load an ASCII text SYNOP observation file the following format is needed where the fields are tab separated:

1.id_station: the id that VERSUS provides

2.dt_validity : in the format yyyy-mm-dd

3.Step

4.Ceiling

5.Visibility

6. total cloud

7.wind direction

8.wind speed

9.T2m

10.Td

11.Mslp

12. pressure tendency

13.pressure change

14. Precipitation

15. precipitation type (1 if 13021 2 if 13022)

EXAMPLE:

20286 2010-01-01 00 24 5 5 180 5 5 5 1000 1 1 10 1
20286 2010-01-01 03 24 5 5 180 5 5 5 1000 1 1 10 1
20286 2010-01-01 06 24 5 5 180 5 5 5 1000 1 1 10 1
20286 2010-01-01 09 24 5 5 180 5 5 5 1000 1 1 10 1

Note that VERSUS does not create accumulation precipitation values from hourly data, so the data should be preprocessed before being loaded.

Ingested grib data are coded with different TRI (Time Range Indicators) depending on the value that is represented each time. According to WMO the TRI values are defined as follows:

0 Forecast product valid at reference time + P1 P1>0), or Uninitialized analysis product for reference time (P1=0). Or Image product for reference time (P1=0)

1 Initialized analysis product for reference time (P1=0).

2 Product with a valid time ranging between reference time + P1 and reference time + P2

3 Average(reference time + P1 to reference time + P2)

4 Accumulation (reference time + P1 to reference time + P2). Product considered valid at reference time + P2

5 Difference(reference time + P2 minus reference time + P1) product considered valid at reference time + P2

To load Feedback files : Two feedback files acquisition FE types can be created. The data types that VERSUS can ingest are the following:
- TEMP from radiosonde
- AIREP from aircraft including AIREP report, AMDAR and ACARS.

The GUI that manages the FE for FF TEMP ingestion is provided by clicking on “Administration->Process->Acquisition Registration” and choosing the “feedbackfile temp” in Msg option menu

Figure 16 FE Acquisition Registration for TEMP Feedback files

For TEMP FE, the main difference from other FE is the possibility to select the “State of Observation”.

The stratification for TEMP FE can be a group of stations, similarly to other types.

"State of observation" is an attribute that can also be selected in the verification configuration phase. Nevertheless it is preferable to make the data discrimination at this point of the loading phase , in order to avoid ingestion of useless for verifications data that will impact the DB size.

Similarly to TEMP data GUI that manages the FE for FF AIREP ingestion is provided by clicking on:"Administration->Process->Acquisition Registration" and choosing the "feedbackfile airep" in Msg option menu: The option 'State of Observation' is also provided

Note !! The stratifications that are possible to select for FF AIREP are registered as " Area Feedbackfile type "(defined by only area boundaries in terms of lat1/lon1 and lat2/lon2 (see Stratification Configuration Chapter for details)

The FE registration for XML files is similar. The XML input files observation and model structure is described in Apprendix II**.** The corresponding model type, mentioned in the XML file, should be registered as well, (See Model Registration) before trying to ingest the files.

The general procedure for input files ingestion is that they should be put under the "input" directory, defined in the corresponding FE, for while the ingestion process is stopped. Then the "Start" button should be pressed, to start the ingestion process. The file(s) will then move to the "error" subdirectory, from which they will be read by the system. On a successful ingestion, each file is moved to "backup" subdirectory of the corresponding FE; on error in processing, the file will remain in the "error" subdirectory. The corresponding log file will be generated.

4.1.2.3 SCORE MANAGER

By clicking on "Score Manager" option of the "Process" menu, the system displays the following GUI for score management.

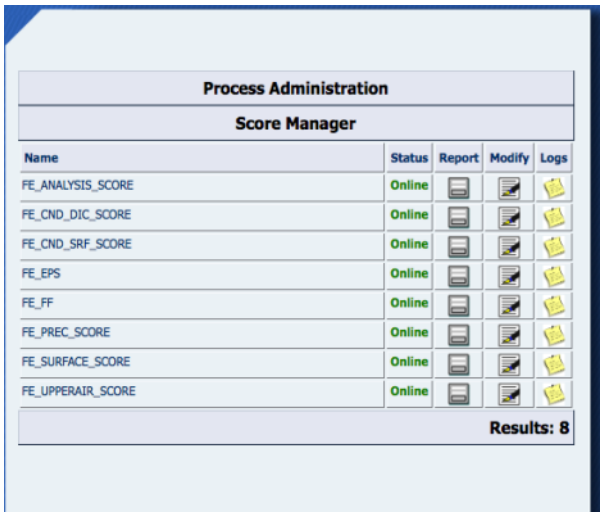


Figure 17 Score manager

Currently, VERSUS has the following score processes:

FE_ANALYSIS_SCORE: Process for computing analysis scores

FE_CND_DIC_SCORE: Process for dichotomous scores on surface data for conditional verifications

FE_CND_SRF_SCORE: Process for continuous scores on surface data for conditional verifications

FE_EPS : Process for probabilistic scores on surface data for standard Ensemble Prediction System (EPS)

FE_PREC_SCORE: Process for dichotomous scores on surface data for standard verifications

FE_FF: Process for continuous scores on Feedback Files data for standard verifications.

FE_SURFACE_SCORE: Process for continuous scores on surface data for standard verifications

FE_UPPERAIR_SCORE: Process for continuous scores on upper air data for standard verifications

By clicking on icon of the “Score Manager” form, the system opens the GUI that displays the report of the related FE.

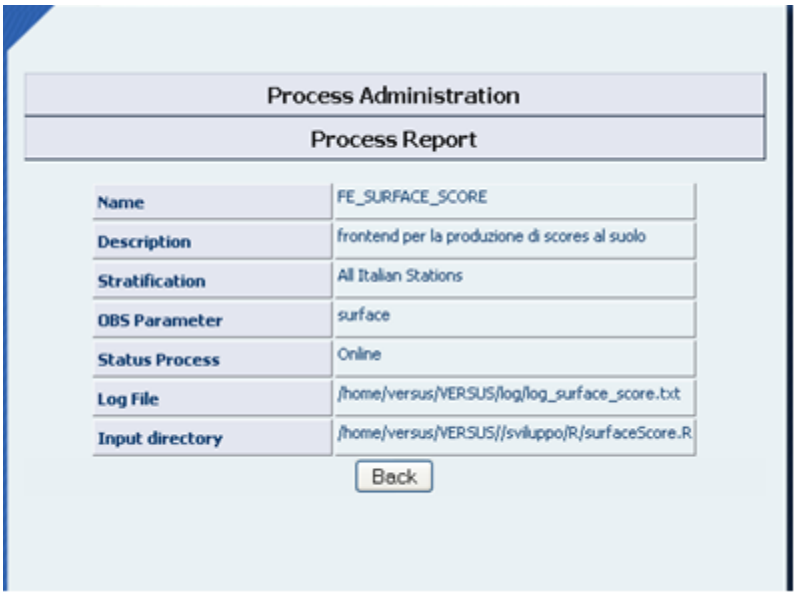


Figure 18 Process Report

By clicking on icon of the “Score Manager” form, the system opens the GUI that displays the form for FE modifying. It indicates the directories and the names of the log files and the R code files for scores calculations.

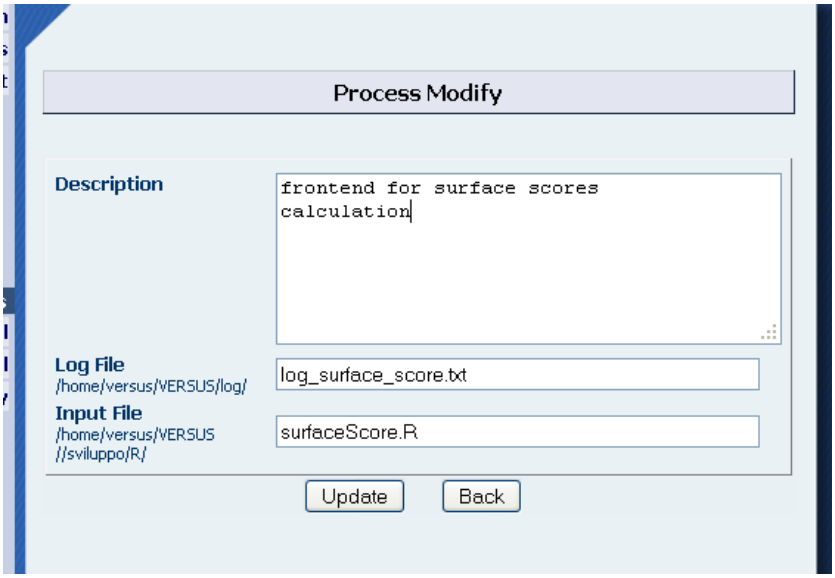


Figure 19 Process Modify

By clicking on  icon of the “Score Manager” menu, the system opens the GUI that displays the list of LOG Files, produced by the FE sorted by date.

4.1.2.4 BATCH EXECUTION

By clicking on “Batch Execution” option of the “Process” menu, the system displays the GUI for Verification Periodical Monitoring selection. (It is recommended that user should read the Verification Menu first)

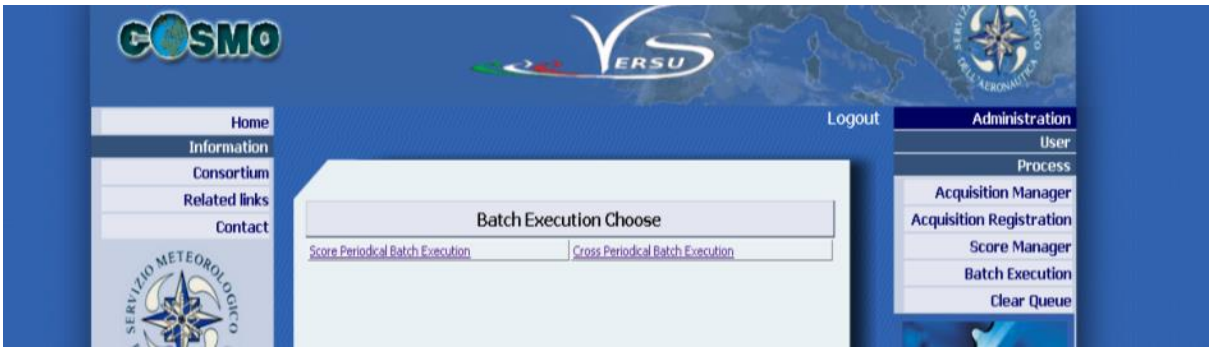


Figure 20 Batch Execution Selection

User can select Score Periodical Batch Execution or Cross Periodical Batch Execution.

The **Score Periodical Batch Execution** GUI allows definition of the verification process which can be Monthly or Seasonal, and gives the possibility of running sets of verifications.

Figure 21 Score periodical Batch Execution

The Score periodical Batch Execution form includes two sections.

The first section defines the verification parameters , and the following information is needed:

Model Process: the model process to be verified

Type: Monthly or Seasonal

Year: the verification year

Month or Season: if the Type field is set to “Monthly” the system displays the list of months. If the Type field is set to “Seasonal” the system displays the list of seasons DJF, MAM, JJA, SON.

By Clicking on “Search” the system displays in the second section, the status of verifications for execution giving the capability to run them, either separately or together.

The verification information section includes the following:

Verification Type: this field displays the number of available verification types (monthly or seasonal) grouped for “Continuous standard criteria for surface data, Continuous standard criteria for upper air data, Dichotomous standard criteria, Continuous conditional criteria for surface data, Dichotomous conditional criteria for surface data, Time series, Daily cycle, Scatter plot, surface continuous EPS, surface dichotomous EPS, Standard Surface Analysis, Standard upper air Analysis”.

Status: It displays the number of verifications that have already been executed.

Execute: It allows execution of pending only verifications per block

Force Execution: It forces execution of all verifications per block

Finally the button “Execute All” tells the system to execute all the pending verifications in the GUI and the button “ Force execute All” forces execution of all verifications.

The system also allows execution of individual selected verifications. By clicking on Verification Type link the system displays a form listing the configured criteria of each block. As an example for Surface Monthly Verifications the following report is displayed:

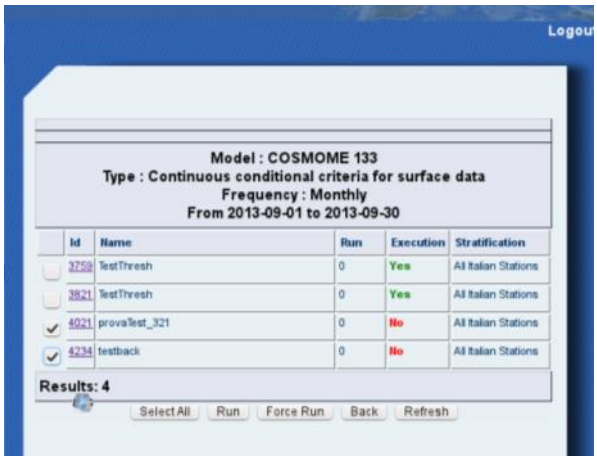


Figure 22 Batch Execution

The Batch execution Report displays:

- **Id**: the id of verification , which is a link to the criteria report
- **Name**: the description of the verification
- **Run**: the configured run
- **Execution**: if the verification has been executed or not
- **Stratification**: the related stratification

User can now select the Verifications to be executed by ticking the box of each one or select all of them by clicking on “Select All” button. By clicking on ‘Run” button only the pending verifications will be executed, while by clicking the Button “Force Run” all the verifications will be executed anyway.

By running a verification in batch mode the plot of the verification is also executed, with the condition that the plot has already been configured and executed at least once.

By running verification from the VERSUS Batch Execution functionality, the GUI is automatically redirected to the **Queue Manager** (see chapter) where all the selected process are listed with description of their state.

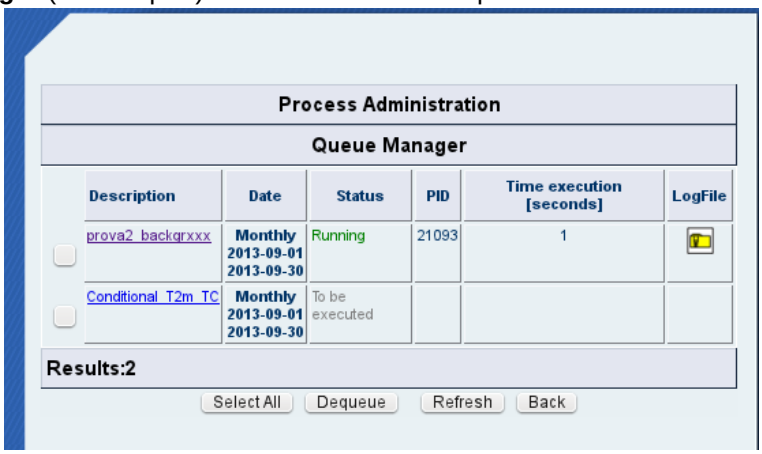


Figure 23 Queue Manager (Redirected from Batch Execution)

The **Cross periodical Batch Execution** GUI allows execution of cross model verifications.

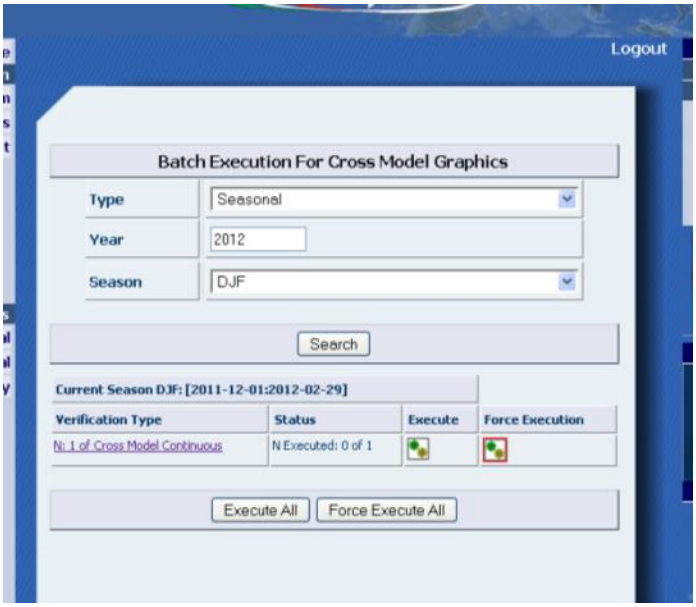


Figure 24 Cross Periodical Batch Execution

The Cross periodical Batch Execution form includes two sections

The first section defines the verification parameters and the following information is needed:

Type: Monthly or Seasonal

Year: the verification year

Month or Season: if the Type field is set to “Monthly” the system displays the list of months. If the Type field is set to “Seasonal” the system displays the list of seasons DJF, MAM, JJA, SON.

By Clicking on “Search” the system displays in the second section, the status of verifications for execution giving the capability to run them, either separately or together

The verification information section includes the following:

Verification Type: this field displays the number of available verification types (monthly or seasonal) grouped for Cross model continuous standard/conditional/weather type criteria for surface data ,Cross model continuous standard criteria for upper air data, Cross model dichotomous standard/conditional/weather type criteria for surface data, Cross model dichotomous standard criteria for upper air data,

Status: It displays the number of verifications that have already been executed.

Execute: It allows execution of pending only verifications per block

Force Execution: It forces execution of all verifications per block

It is also possible to execute individual selected verifications by the same procedure already mentioned for Score periodical Batch Execution.

All the scores executed by this GUI have log filenames as follows:

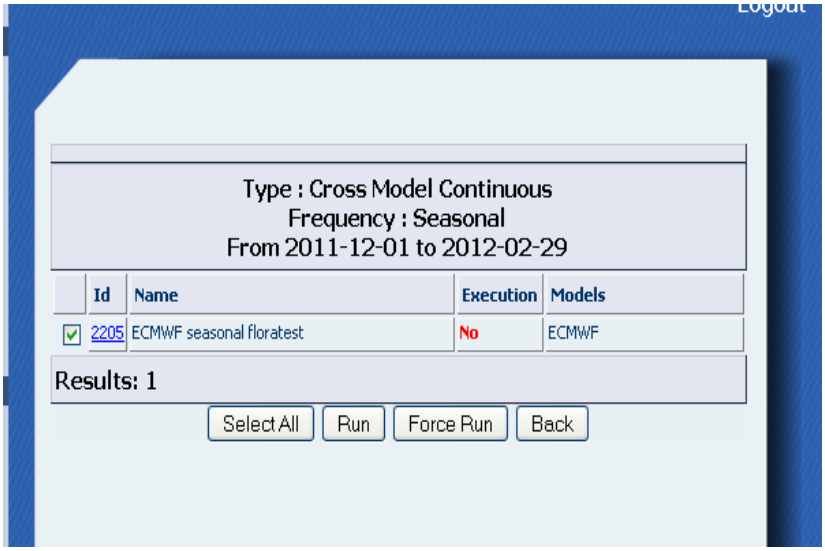


Figure 25 Cross periodical Batch Execution Selection

log_file_name.txt_yyyy-dd-CurrentMonth-ID_SCORE_ScoreMonth for monthly

or

log_file_name.txt_yyyy-dd-CurrentMonth-ID_SCORE_ScoreSeason for seasonal

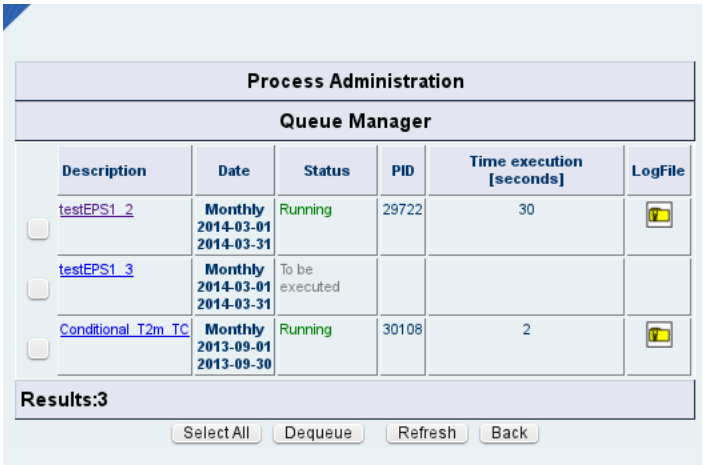
By clicking on Score Manager->FE_SURFACE_SCORE the system displays:

Figure 26 Log Monitor

The log files can be downloaded.

4.1.2.5 QUEUE MANAGER

By clicking on “Queue Manager” option of the “Process” menu, the system displays a GUI In order to get in real time information about the state of active or ended process, The Queue Manager page shows a summary of the



currently VERSUS active processes. In the following examples are reported Queue Manager information in case of ‘Running’, ‘To be executed’ and ‘Error’ processes.

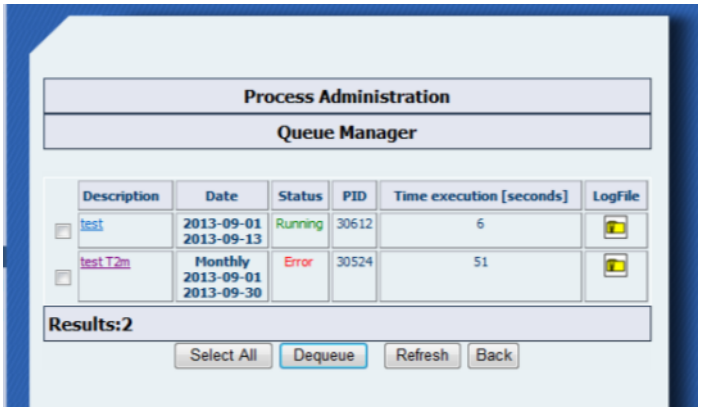


Figure 27 Queue Manager Example 1

Figure 28 Queue Manager Example 2

The page includes a table described hereafter :

Description	Text description of verification (link)
Date	starting date and ending date
PID	System process identifier
Time execution	Time in seconds from the start of execution
File log	Access to log file

These features give the possibility to:

- Check the scores activated and their state (Error, Running or waiting for execution)
- Clear the error queue
- Stop active processes
- Download the log file for each verification

- *Select All*-> Select all processes
- *Dequeue* -> remove process from queue
- *Refresh* -> force the page refresh (the page is automatically reloaded every 30 seconds)
- *Back* -> back to the previous page

This page is also partially accessible to consultant/operator users, only as a report of processes. In this case the actions of select and dequeue are disabled.

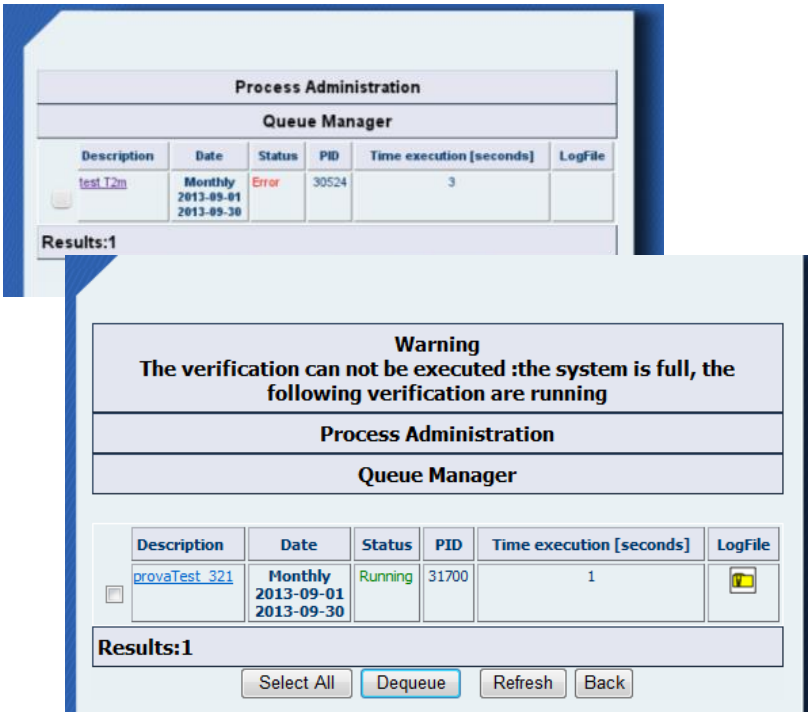


Figure 29 Queue Manager for Consultants

Figure 30 Queue Manager Warning Message

Redirection to the Queue Manager is performed in the following cases:

- If the system has already reached the maximum number of possible DB connections the execution of a new verification is inhibited. The page is redirected to the Queue Manager with a Warning message

Note: *It must be noted that for EPS verification execution, at the moment it is not possible to run additional scores simultaneously in order not to overcome the maximum number of DB available connections (defined in the my.cnf and currently fixed to 100).*

This value must be tuned based on the results of a test phase and of the current hardware features.

- If a user tries to run a verification already running for the same period, the system redirects to the Queue Manager with a warning message and the verification execution will not restart.

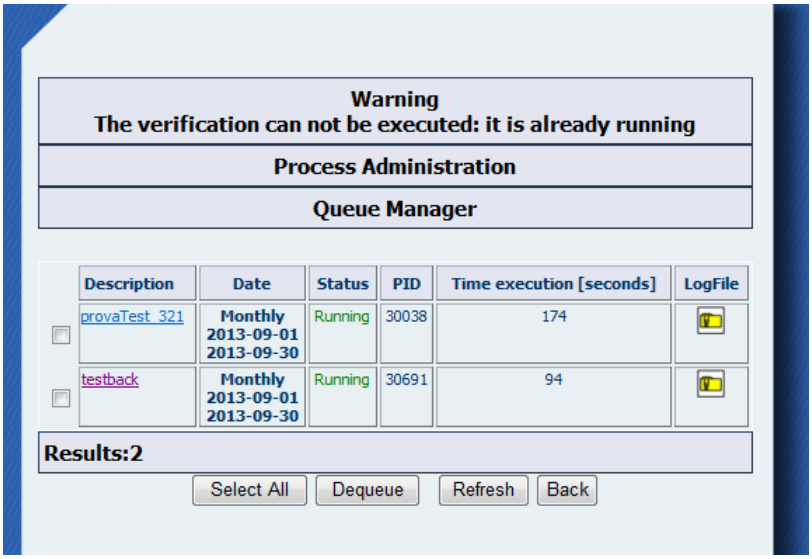


Figure 31 Warning for already Running verification

For each verification running a unique log file is created (stored in the directory $VERSUS_HOME/log). The file is not overwritten if a new verification is launched except for the case of ID and verification period being the same.

The first part of log filename is associated to the type of score based on the rules already defined for VERSUS and described in the technical documentation. At the end of the string is appended ID and start - end date of the current verification, as shown in the example below.

log_surface_score.txt_2015-3-Mar_4272_20130901-20130930

Reference to the type of score

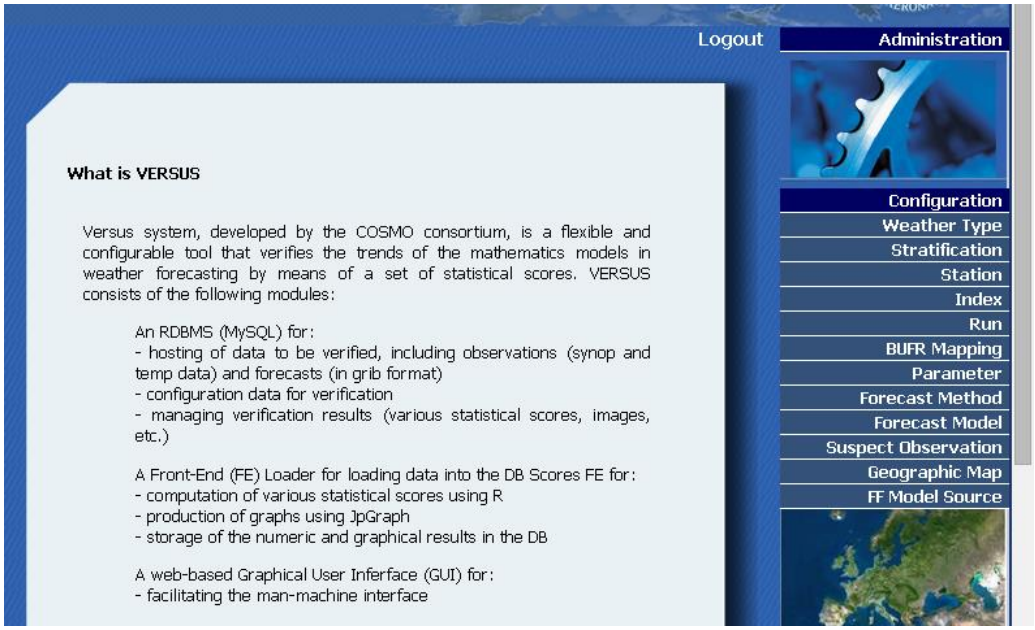
date of execution

Start date – end date

4.2 CONFIGURATION MENU

This menu allows configuration of the system procedures features. By clicking on configuration menu the system displays :

Figure 32 Configuration menu



The features that can be set are:

WEATHER TYPE

STRATIFICATION

STATION

INDEX

RUN

BUFR MAPPING

PARAMETER

FORECAST METHOD

FORECAST MODEL

SUSPECT OBSERVATION

GEOGRAPHIC MAP

FF MODEL SOURCE

4.2.1 WEATHER TYPE (DEPENDENT)

It is the system section for setting weather type dependent features.

4.2.1.1 WDT REGISTRATION

By clicking on Weather type option the system displays the following form:

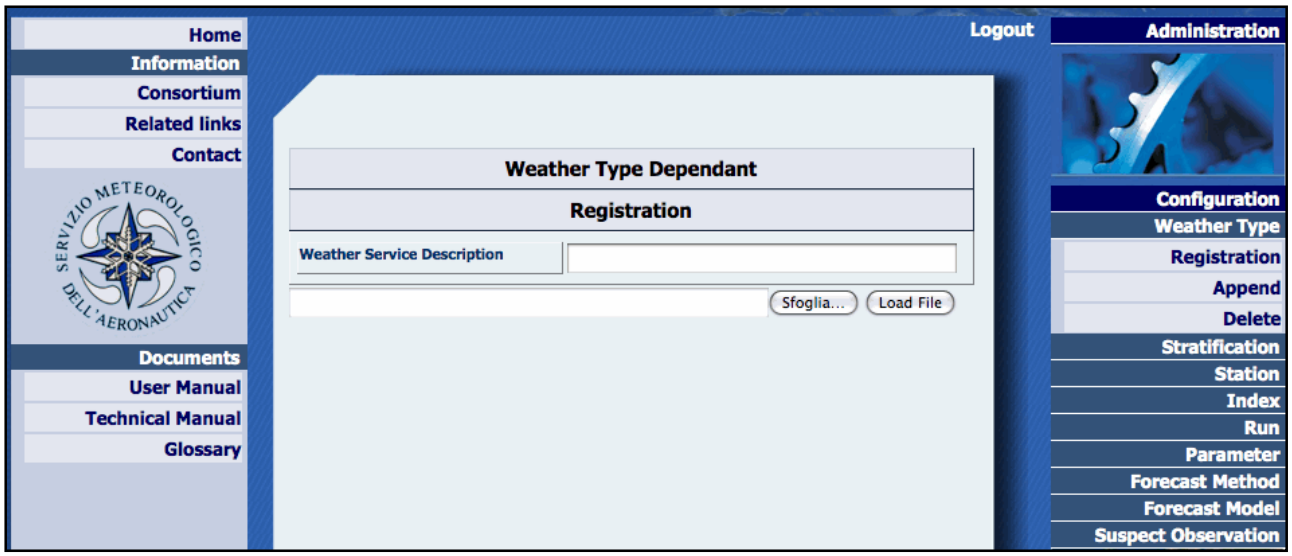


Figure 33 WTD Registration

At this point it is possible to upload a Weather type file for a specific Weather Service location (WTD) by means of browse button, locate it the local directory and click on 'load file'

A WDT file should be a txt file written in the following way: The first part is the Weather Class description, written as follows:

1 Zonal cyclonic ZN

2 Zonal anticyclonic ZA

3 N-NW cyclonic NNWC

4 N-NW anticyclonic NNWA

etc.

The first field is the class number, the second field the class description and the third field an abbreviation. The fields must be separated by tab and each class must be defined on a single line.

The second part is the Weather Class description for each date. The word "Start" indicates the point where the date description starts . For example:

1 Zonal cyclonic ZN

2 Zonal anticyclonic ZA

3 N-NW cyclonic NNWC

4 N-NW anticyclonic NNWA

Start

2010-01-01 1

2010-01-02 2

2010-01-03 1

etc.

The date and related class definition number, separated by tab are required.. The date must be given yyyy-dd-mm format. When the WDT file is ready the system can be acquire it into its DB by clicking on 'load file' button:

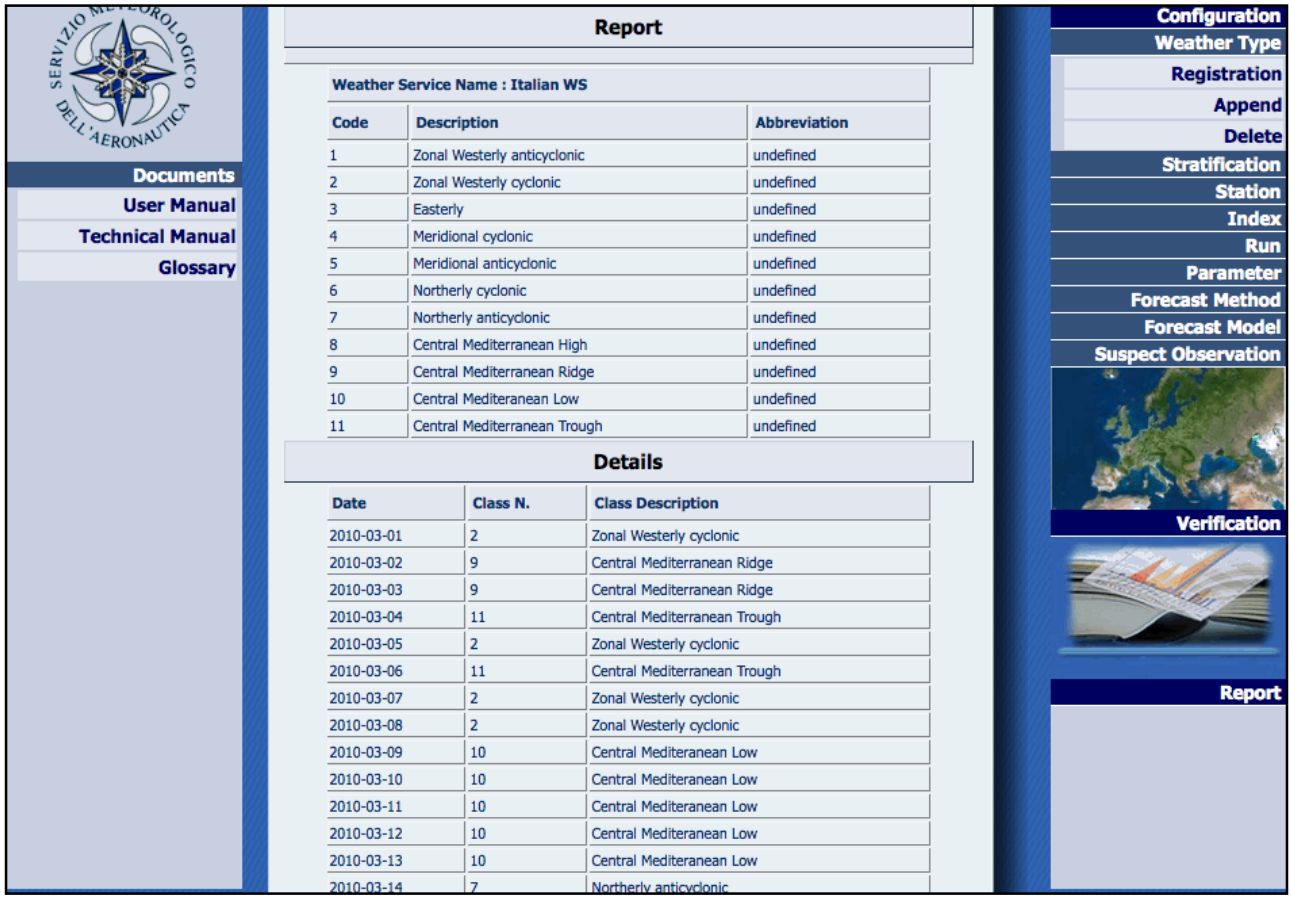


Figure 34 WTD Report

The system then displays a page with the information of the created WTD file .

4.2.1.2 WDT APPEND

It is also possible to edit an existing WTD file and add new dates by inserting data in the following way:

Start

2010-02-01 1

2010-02-02 2

2010-02-03 1

The system will append the new dates in the WTD file.

By clicking on Weather Type->Append option (right menu) , the system displays:

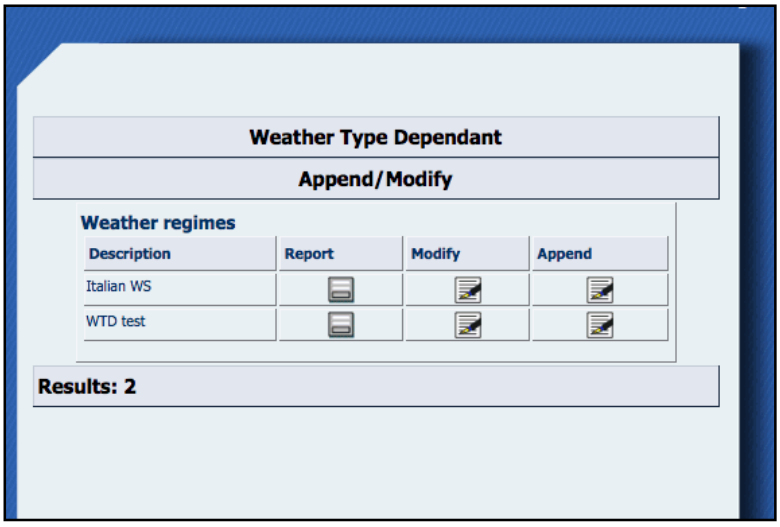


Figure 35 WTD Append/Modify

The list of reports for each Weather Service location is displayed. By clicking on icon “Report” the system displays the information of each WTD. By clicking on icon “Modify” the system displays a form where user can modify class description and add/edit an abbreviation for each one.

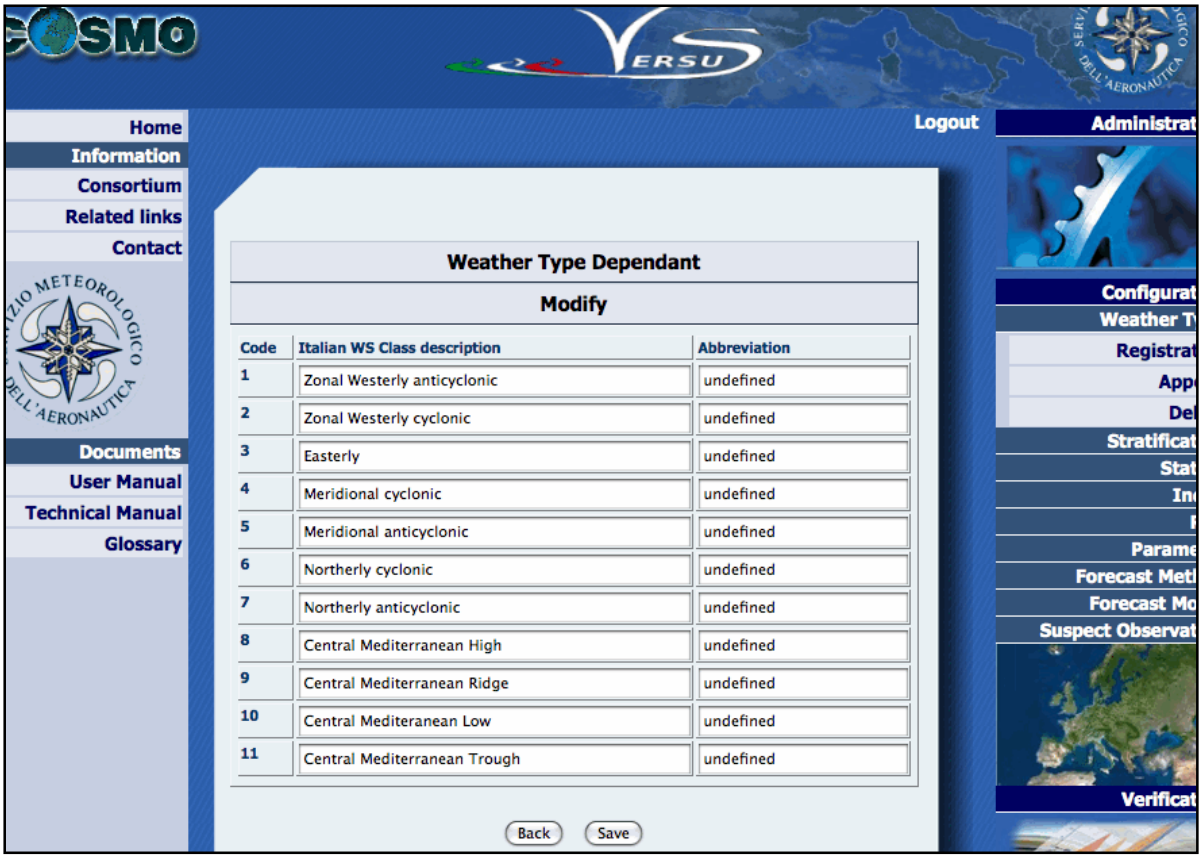


Figure 36 WTD Modify

By clicking on "Append" and then on 'Browse' the system displays:

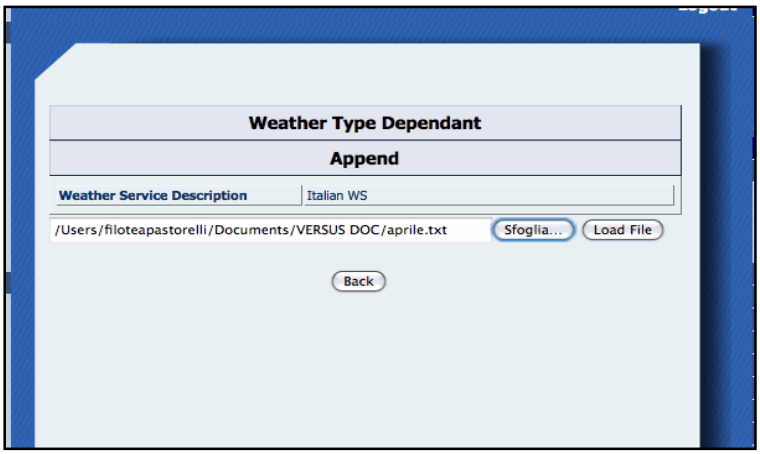


Figure 37 WTD Append

The user can append further date classification on existing Weather Service by adding a txt file

4.2.1.3 WDT DELETE

It is also possible to delete to an existing WDT, by clicking on Weather Type->Delete, and the system displays:

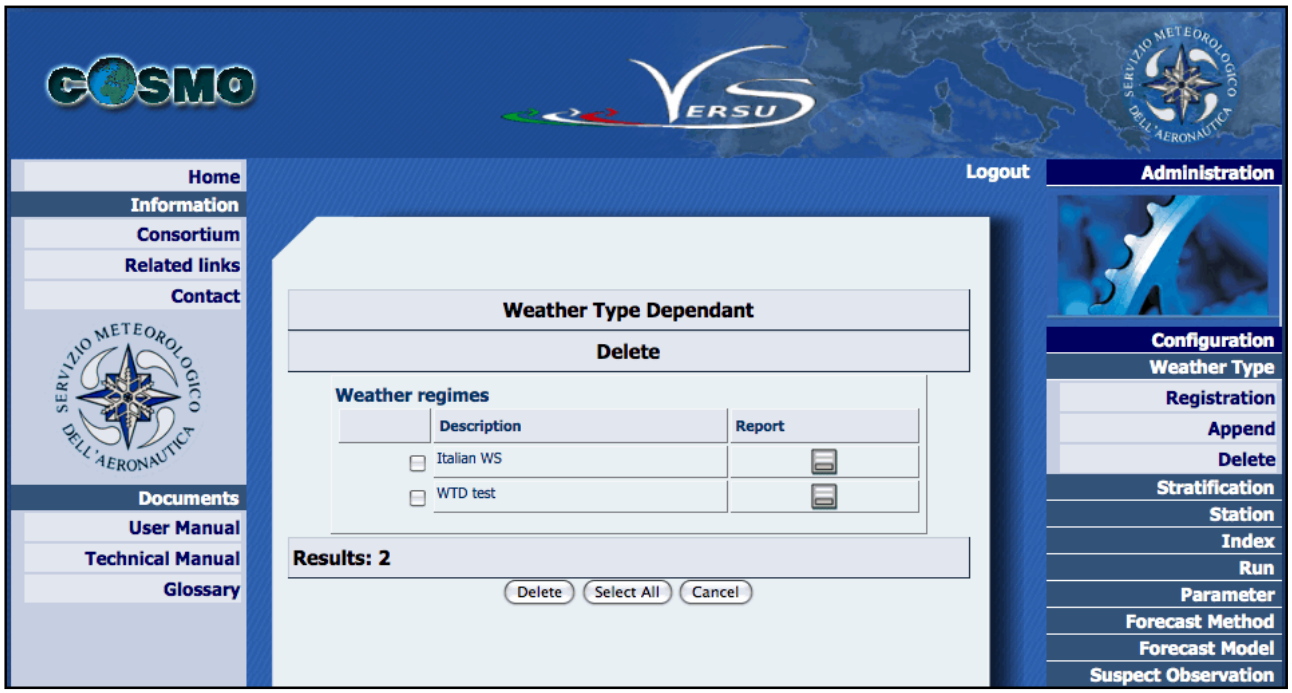


Figure 38 WDT Delete

The system shows all the existing WDT and user can select the ones to be deleted.

4.2.2 STRATIFICATION

The stratification menu is the part of the system that manages stratifications. A stratification groups a set of stations. User can create a new stratification, modify or delete it. To create a stratification, user should click on 'Registration' of the Stratification menu, specify the stratification name and select the stations

4.2.2.1 STRATIFICATION REGISTRATION

To select the stations of a new stratification, two methods are possible. By Country or by Area.

To select the stations by country user must select 'Country' on the ' Stratification type' menu and select one of the available countries.

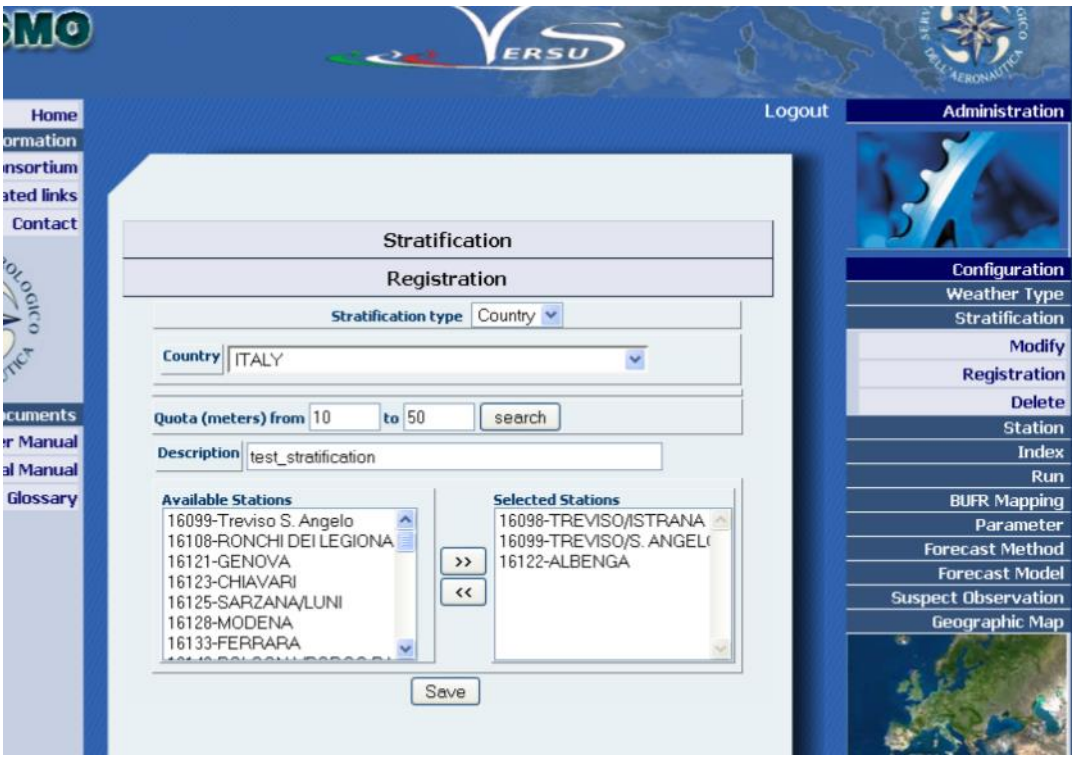


Figure 39 Stratification Registration by Country

The altitude limits of the stations is possible by entering a minimum and maximum height on " Quota (meters) from/to". (If * is left, no height selection is performed)

Description: A name of the stratification

By clicking on Search, the available stations are displayed on the left window, and user can add/remove selected stations on the right window with the arrows.

The new stratification is saved by clicking on 'Save'.

To select the stations by Area user must select ‘ Area’ on the Stratification Type’ menu and specify the latitude and longitudes of the lower left point of the area (LAT P1/LON P1) and the upper right one (LAT P2/LON P2). The next steps are the same as for the previously described country selection method.

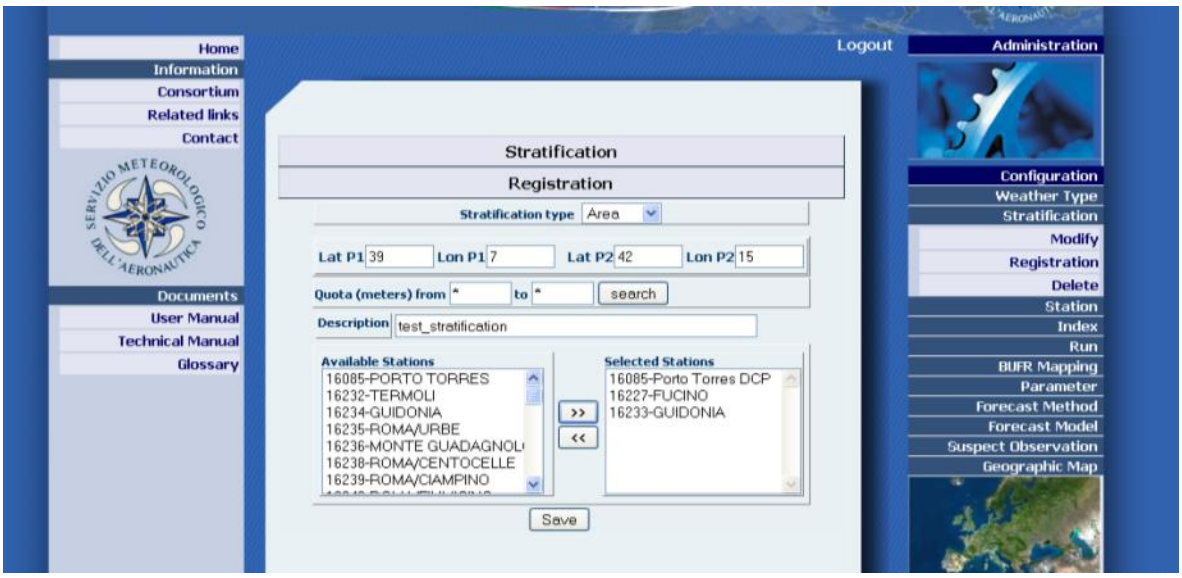


Figure 40 Stratification Registration by Area

For FF AIREP data the stratification is NOT connected to a list of fixed on-site points related to meteorological stations or buoys, but the observations are intercepted at different, longitude, latitude and pressure levels encountered along the route. So, FF stratification is an extended area that includes all the data along the route. So, for AIREP data, the “Stratification type” option is “Area Feedbackfile”, with specification of lat/lon parameters.

Figure 41 FF Stratification Registration

By clicking on 'Save', the registered stratification report is displayed

Figure 42 FF Stratification Report

4.2.2.2 STRATIFICATION MODIFY

On "Stratification" menu the option 'Modify' leads to GUI which allows stratification modification .

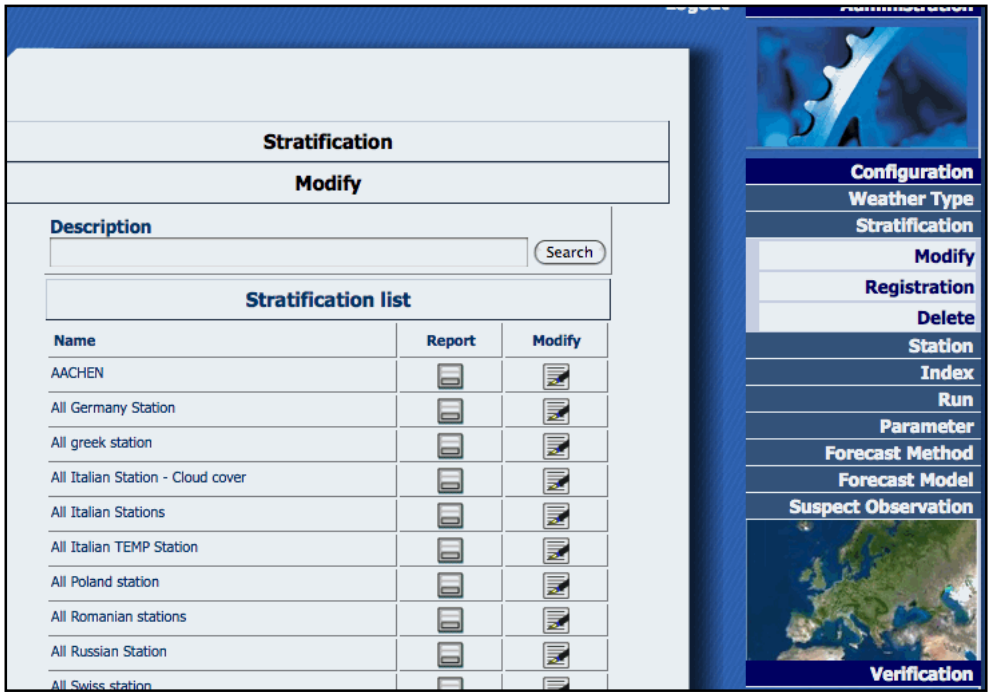


Figure 43 Stratification Selection and Modification

The form displays the stratification description, An icon linking to the related report, and an icon allowing stratification modification. The report icon displays the following GUI :

Figure 44 Stratification report

The modification icon of Fig. 43 displays the following GUI :

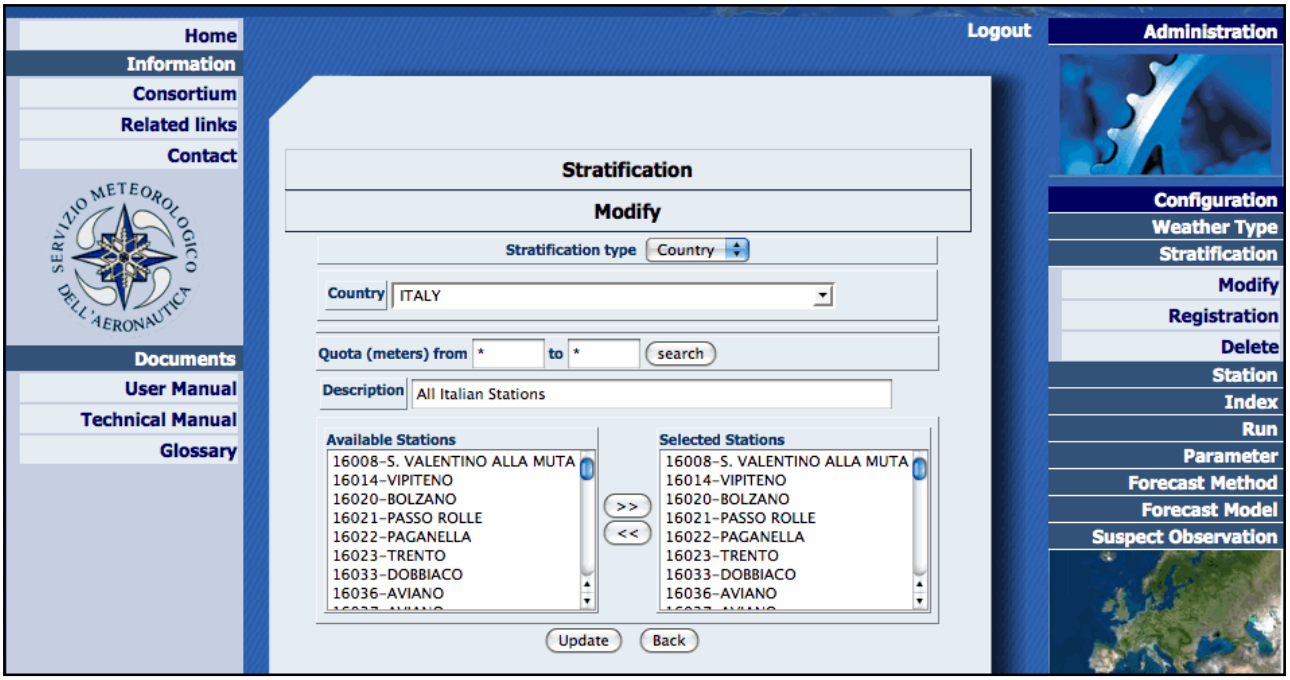


Figure 45 Stratification Modify

To create a stratification with stations of two different countries, user must first create a stratification by selecting stations of the first country and save it with a specific name. Then by locating its name on the stratification list and clicking on “Modify”, stations from a second country can be added.

4.2.2.3 STRATIFICATION DELETION

On Stratification menu the Delete option displays the following form:

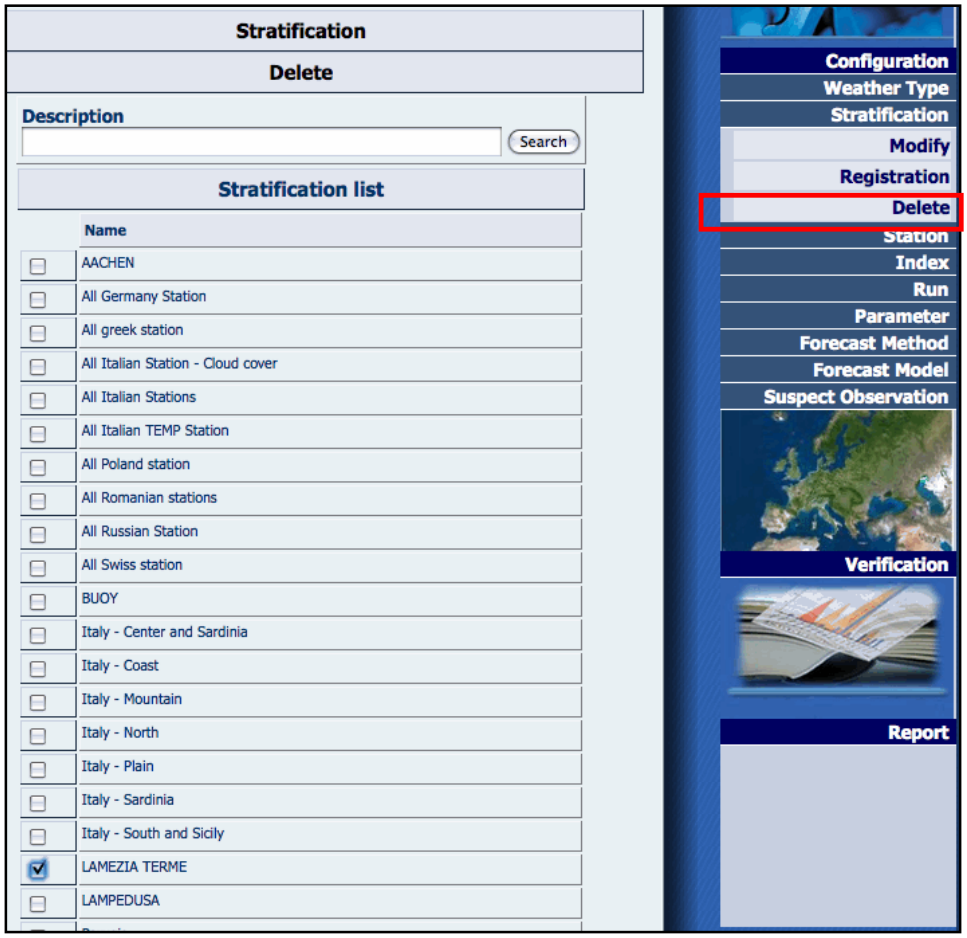


Figure 46 Stratification Delete form

There are two methods of deleting a stratification:

Delete: delete the stratification only if it is not linked to products such as: verification, graphs, scores

Force Delete: delete the stratification and all related links

For example, on selecting Stratification “Delete” and clicking on Delete, the system displays

Figure 47 Stratification Delete Error

all configured products related to the stratification and deletion is not performed.

However, by clicking on “Force Delete” button, the stratification and all related products are deleted.

4.2.3 STATION

The station menu manages the registry that contains information about WMO stations. User can add a new station, modify or delete it. Alternatively user can load an ASCII file formatted according to specific requirements.

4.2.3.1 STATION REGISTRATION

By clicking on Registration item of the Station menu, the system displays the following GUI:

Figure 48 . Station Registration

By Clicking on Registration option, the system displays the GUI that allows insertion of a single Station into VERSUS DB.

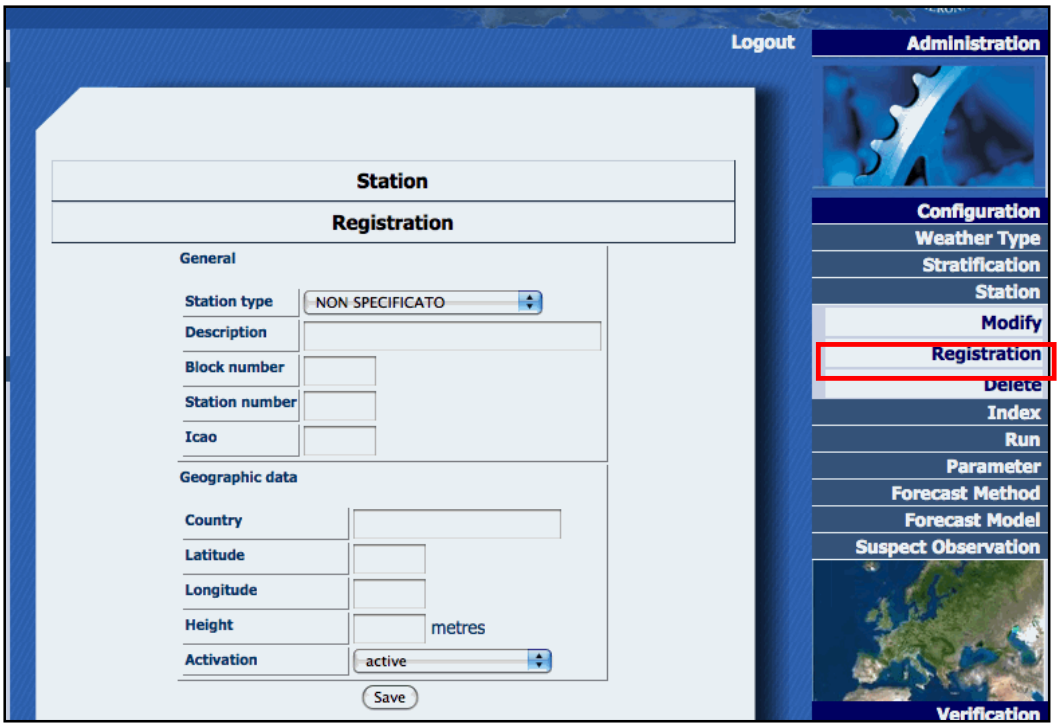


Figure 49 Single station registration

The parameters to specify on inserting a new station are:

Station type: the type of the station e.g. DCP

Description: a station description

Block number: WMO block number code of the station

Station number: WMO station number code of the station

ICAO: the ICAO code

Latitude: latitude of the station in geographical coordinates

Longitude: longitude of the station in geographical coordinates

Height: station elevation in meters

For entering stations data written in an ASCII file, the user should click on Browse of the Station Registration menu, select the file, with the stations information, and click on 'Load stations' option .

When the file is loaded, assuming there are no errors, all loaded stations information is displayed on a page for checking.

The file format used is the **MASTER FLAT FILE for** WMO Publication No. 9 Volume A – Observing Stations.

4.2.3.2 STATION MODIFY

By clicking on Modify option of the Station menu, the system displays the following GUI (Fig. 81):

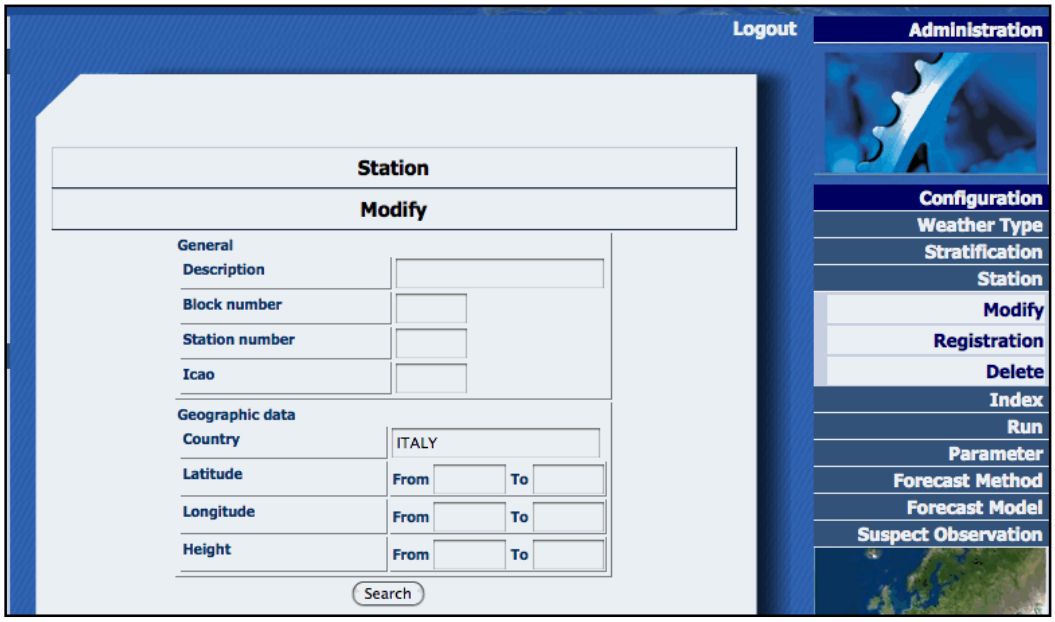


Figure 50 Station Modify

In the form above is possible to search for stations by filling in one or more fields, A list of stations is displayed with their information (missing figure). By clicking on 'Modify' icon user can make modifications on each station.

4.2.3.3 STATION DELETE

By clicking on delete option of the Station menu, the system displays the following GUI:

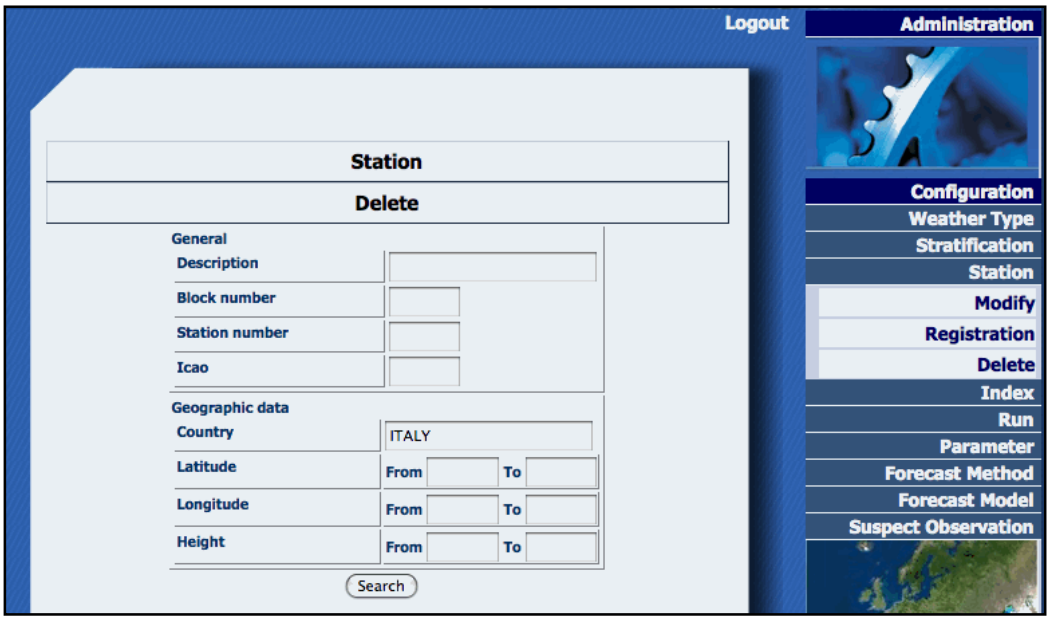


Figure 51 Station Searching for Delete

A search of stations is again performed by filling in the appropriate fields, and the system displays the following GUI:

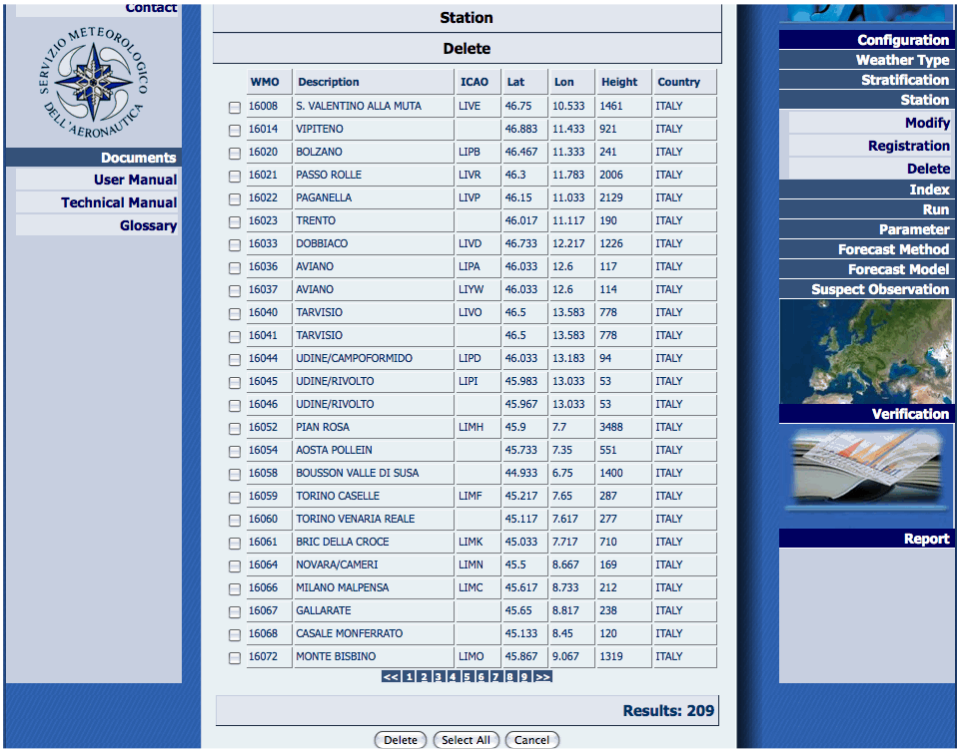


Figure 52 Station Delete

Stations can be deleted by checking their names on the GUI above and clicking on Delete button.

4.2.4 INDEX

This part of the system manages the index scores definition.

The index scores that Versus manages are continuous or dichotomous. Every index score contains its algorithm written in R code.

User can create a new index, modify or delete it.

4.2.4.1 INDEX REGISTRATION

By Clicking on option registration of the “Index” menu, the system displays the following GUI:

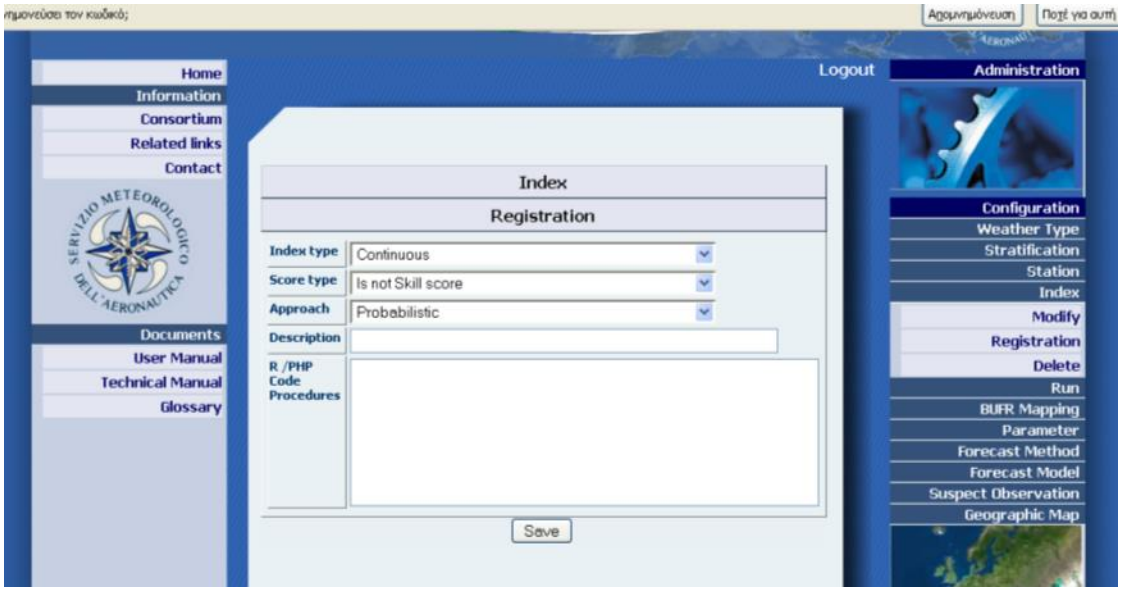


Figure 53 Index Registration

The user has to specify:

Index type: continuous or dichotomous

Score type: if the index is s skill score or not (is compared to persistence/climatology or not)

Approach: Deterministic or probabilistic

Description: a short description

R/PhP Code Procedure: a piece of R code that will be executed from the system. Note that the variables that the system uses for continuous indexes are:

fcs: to identify the forecast array

obs: to identify the observation array

persistence: to identify the persistence/climatology (reference) array of obs (for skill scores)

wind_d: the forecast – observation array of the wind direction correctly adjusted

u_d: the forecast -observation difference array of the u-component parameter

v_d:the forecast -observation difference array of the v-component parameter

persistence_u: array to identify the persistence/climatology (reference) of the u-component parameter

persistence_v: array to identify the persistence/climatology (reference) of the v-component parameter

The variables that the system uses for dichotomous indexes are A,B,C,D resulting from the contingency tables. A is the number of hits, B is the number of false alarms, C is the number of misses and D the number of correct rejections.

4.2.4.2 CONFIDENCE INTERVALS INDEX REGISTRATION

If user wants to calculate Confidence intervals for continuous scores (by bootstrap method, see Apprendix I for details) (note that ONLY EPS scores are automatically calculated) he needs to register CI High and CI low for each score via web GUI by writing code in the R/PhP window. The setup changes for different scores but the pattern is the following (for high CI):

```
require(verification)
booter <- function(d, i) {
A<-verify(d[i, "surface_value"], d[i,"grib_value"],frcst.type="cont", obs.type="cont")
return(c(A$MAE))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300);score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1)
high_ci <- score_ci[[4]][5];index <- high_ci
```

For low CI the last line should be replaced with

```
low_ci <- score_ci[[4]][4];index <- low_ci
```

The confidence level can be changed by setting up conf option. Here, the most widely used percentile method is used (type=c(“perc”)) but several other options are available, e.g., BCa method (type=c(“bca”)). (also “norm”, ”basic”, ”stud”). Here **300** is the number of resamplings and **0.99** the confidence level. These values can be changed by user. In Apprendix III there are code examples for all confidence indexes

An example of MAE CI Low registration is shown below. By clicking on “Configuration->Index->Registration” fields should be filled in the R/PhP window:

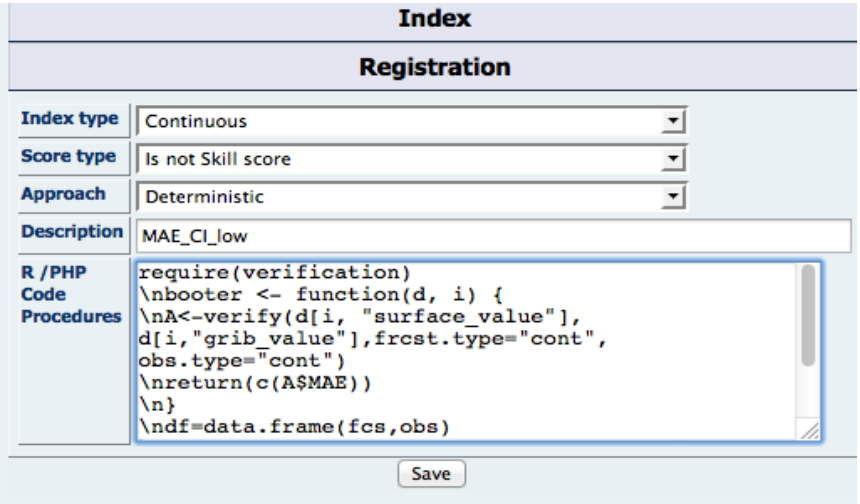


Figure 54 Index CI registration

By clicking on ‘Save’, the following report is displayed and the CI_low index is available to be selected.

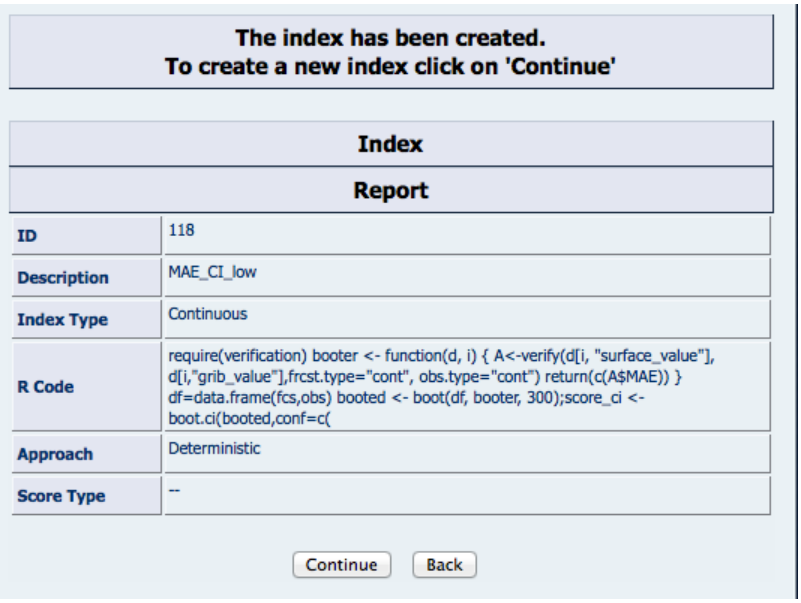


Figure 55 MAE_CI Low Report

To calculate Confidence intervals for most dichotomous scores (namely EDS, ETS, F, FAR, HSS, KSS, ORSS, PC, POD, and TS) (normal distribution see Apprendix I for details) registration of CI High and CI low for each score via web GUI by writing code in the R/PhP window. The setup changes for different scores but the pattern is the following (eg. For ETS high):

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(1-0.01/2)# For 99% higher CI

index <- A$ETS+B*A$ETS.se

The user can easily change the confidence level by writing, e.g., qnorm(1-0.05/2) for higher 95% confidence level. Note that for the lower 95% CI, one should type qnorm(0.05/2), and for the lower 99% CI: qnorm(0.01/2). Note that FBI CI are calculated using bootstrap and PAG CI with Wilsons method. The codes for all scores CIs are given in Apprendix III.

4.2.4.3 INDEX MODIFY

The system gives the possibilities to modify an existing index. By Clicking on option modify of the “Index” menu, the following GUI is displayed:

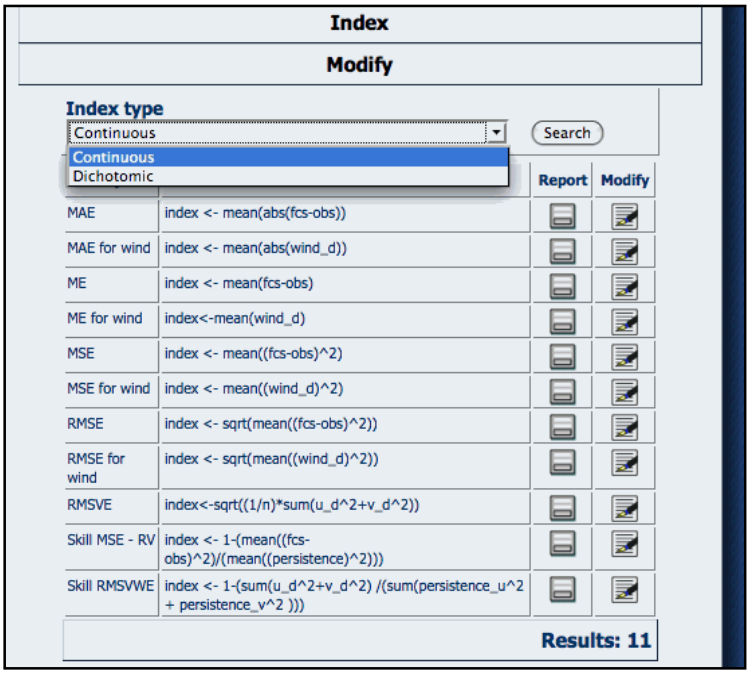


Figure 56 Index Search

The user can select the type of index to modify: Continuous or Dichotomous. By clicking on Modify icon the following GUI is displayed:

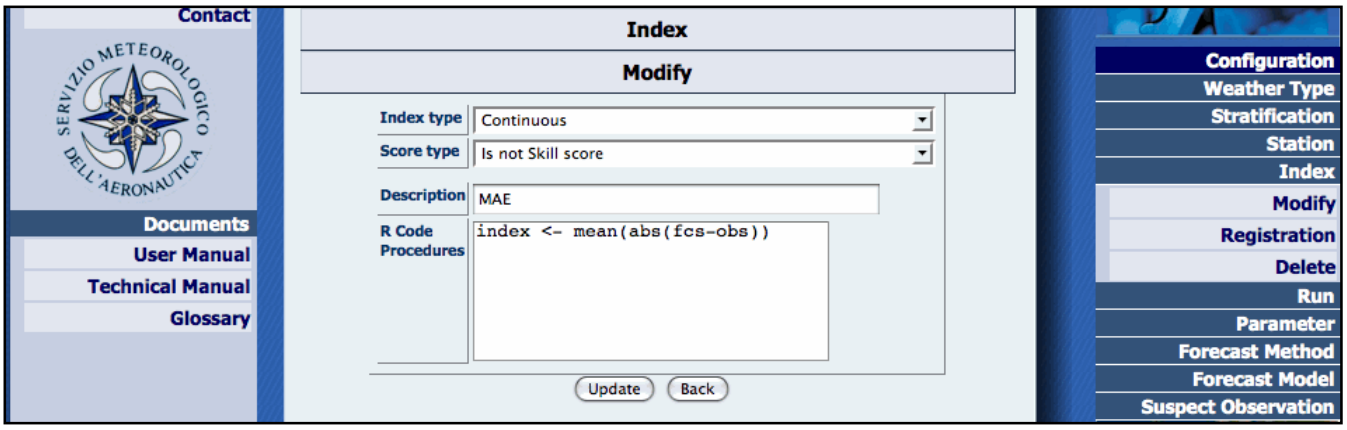


Figure 57 Index Modify

4.2.4.4 INDEX DELETE

By clicking on Index->Delete option the system displays the following GUI, where user can select indexes for deleting.

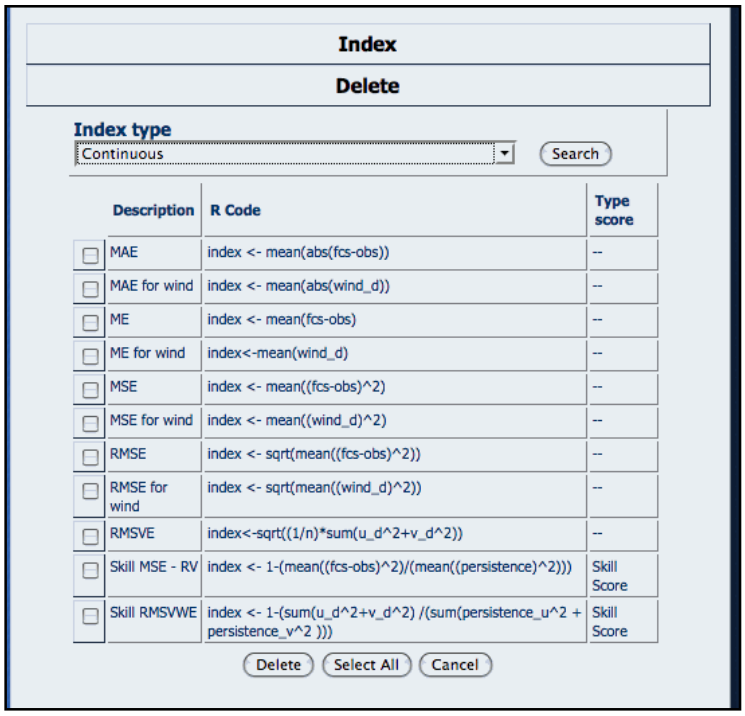


Figure 58 Index Delete

4.2.5 RUN

The run section deals with the model run (initial time) used by the system. User can register a run or delete existing ones by selecting from the menu..

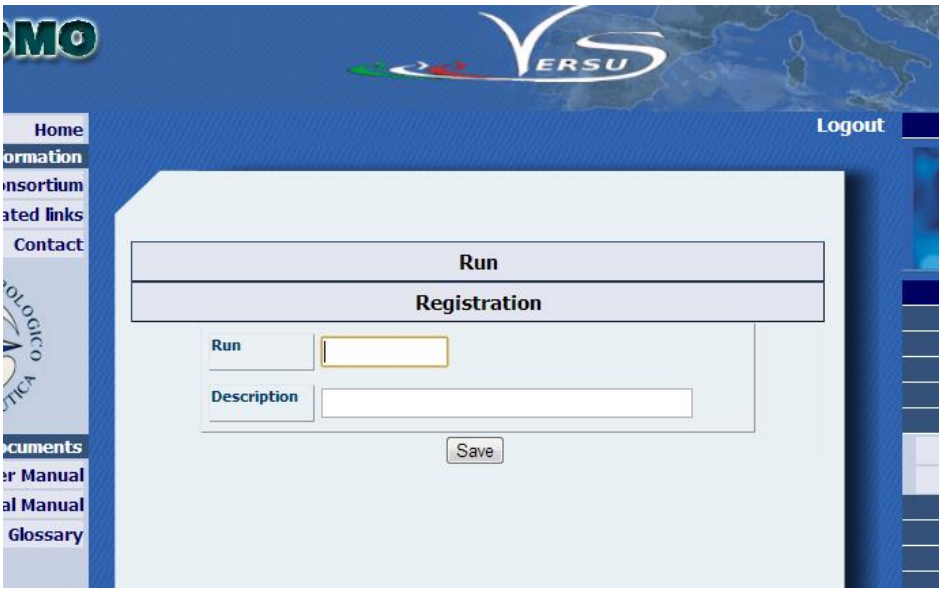


Figure 59 Model Run Registration

Figure 60 Model Run Delete

4.2.6 **BUFR MAPPING**

The BUFR mapping is the part of the system that handles BUFR observation data that are coded according to WMO rules, by keeping ECMWF rules . User can register a new WMO BUFR coded parameter, modify or delete an existing one.

4.2.6.1 BUFR MAPPING PARAMETER REGISTRATION

By clicking on 'Registration' option of 'BUFR Mapping menu', a new WMO BUFR coded parameter can be registered and the following information is needed:

ECMWF code : Select the parameter with its ECMWF BUFR code.

WMO code: Input the WMO BUFR code of the parameter.

Sensor height and Displacement. By clicking on 'Save', the registration is saved.

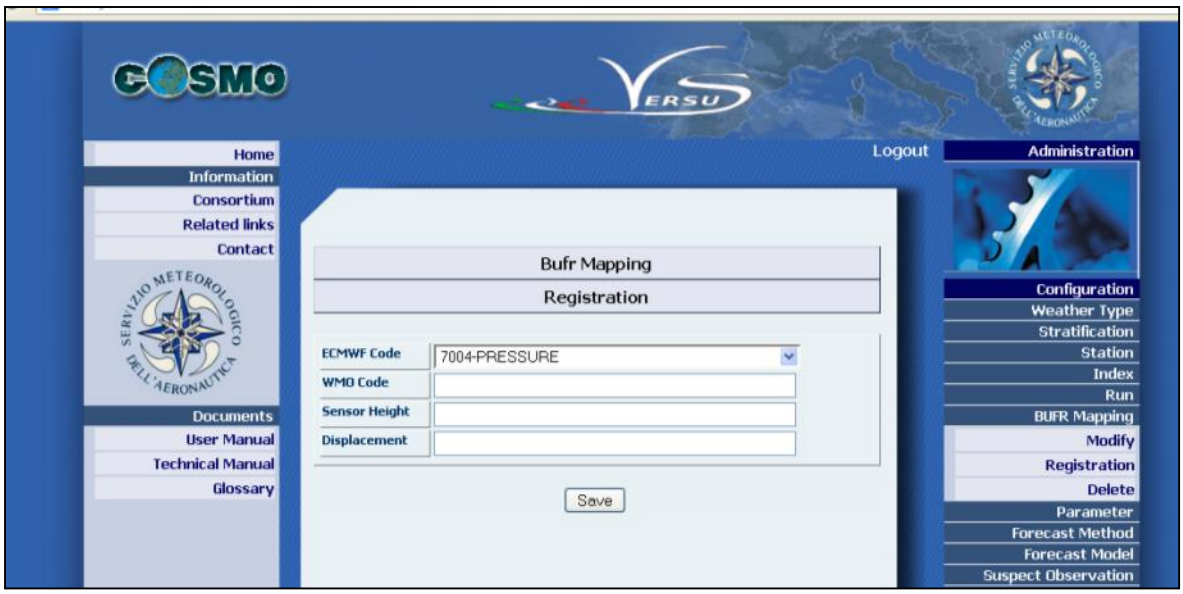


Figure 61 BUFR Mapping Parameter Registration

4.2.6.2 BUFR MAPPING PARAMETER MODIFY

By clicking on ' Modify of the BUFR Mapping menu, a GUI with the ECMWF description, ECMWF code, WMO code, Sensor Height (expressed in metres) and Displacement (expressed in minutes) of all registered observation parameters is displayed.

Figure 62 BUFR Mapping Modify

By clicking on' Report' icon on the right of each parameter, the information on each of them appears.

Figure 63 BUFR Mapping Parameter Report

By clicking on 'Modify' icon on the right of each parameter the relative coding information can be modified by inserting the WMO code, sensor height and displacement and clicking on ''Update".

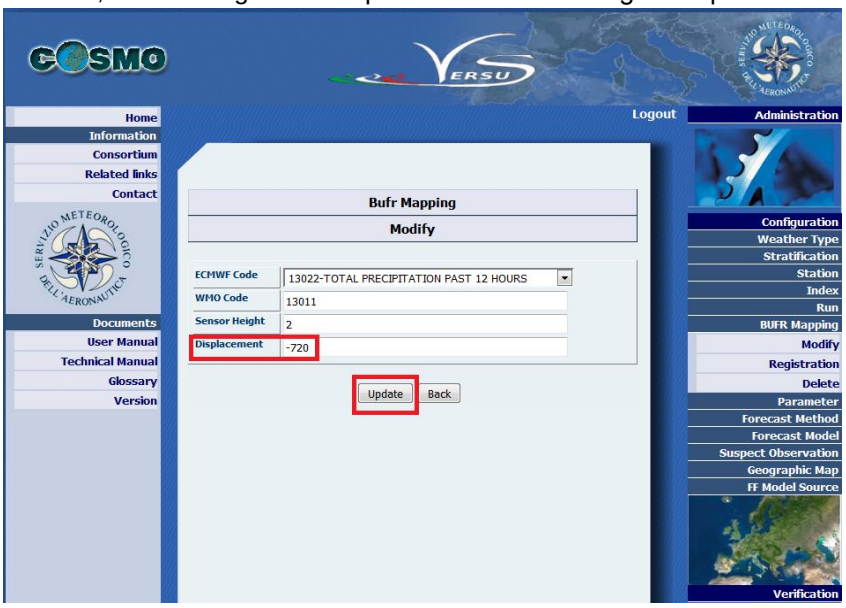


Figure 64 BUFR Mapping Parameter Modify

WARNING: Versus version 5.1.6 manages the new BUFR format of the synop messages. In this type of format cumulated/averaged fields (as windgust over 3 hours for example) are defined by the "time period" descriptor, wich Versus compares with the "displacement" chosen for the relative observed parameter, in the bufr mapping section.

If new BUFR synop messages are used as input for verifications:

- in the case of parameter "windgust" assure that loaded grib files interval period is consistent with the corrispondent observed period which it is necessary to verify (the system does not distinguish this forecast parameter according to the cumulation period but only to the grib code 187 and code table 201). The time interval parameter used to calculate the maximum windgust in the COSMO model is "hincmxt" (&RUNCTL namelist parameter in INPUT_ORG).

- In the case of other cumulated/averaged parameters (as precipitation for example) it is mandatory to define the "displacement" field in the bufr mapping window, otherwise the observed values will not be loaded into the DB.

- In the case of windspeed parameters (for example 011002 or 011012) the field "displacement" must be left empty, because it is not associated to any time period inside bufr files.

If new BUFR temp messages (usable from version 5.1.9) are used as input for verifications:

- If inside the new bufr temp template are present descriptors already in use in the Versus machine and registered as "surface" parameters, it is necessary to configure a bufr-mapping corrispondence between the old and new bufr descriptors (for example, let's assume that the "Temperature" field is, in the old temp template, associated to the descriptor 12001 and registered as "upperair"; that "Temperature" field is, in the new temp template, associated to the descriptor 12101 and that this descriptor is already in use for the parameter "Temperature at 2m", thus registered as "surface" parameter; the bufr-mapping will be configured using "wmo code" = 12101 – "ecmwf code" = 12001).

4.2.6.3 BUFR MAPPING PARAMETER DELETE

To delete a BUFR mapping parameter user must click the option 'Delete' from the BUFR Mapping menu and the following GUI is displayed.

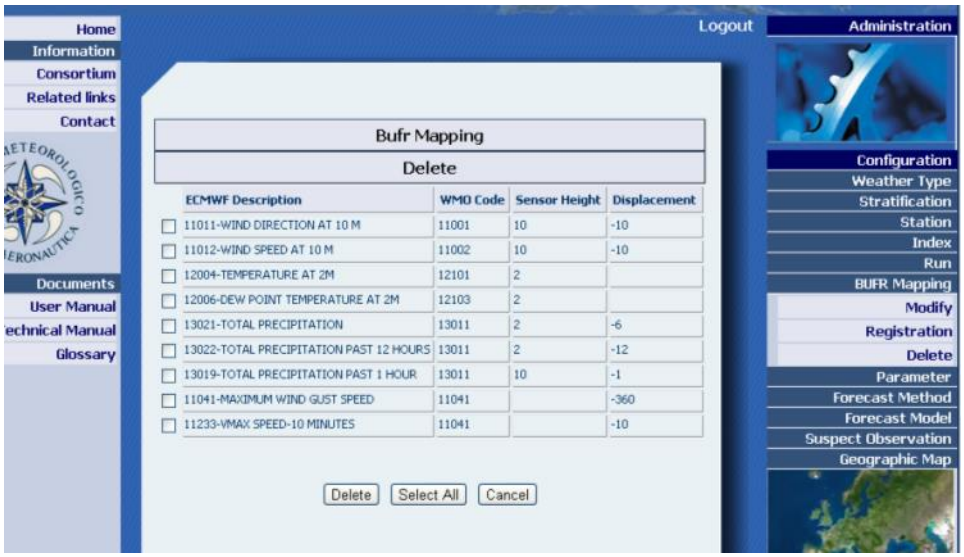


Figure 65 BUFR Mapping Parameter Delete

User should then select the mapping parameter to be deleted by ticking on the appropriate boxes or clicking on 'Select All' to select all of them. They can be removed by clicking on the 'Delete' button.

4.2.7 PARAMETER

There are three types of parameters in the VERSUS DB: the observation parameters (OBS), the forecast parameters (FCS) and the Feedback files (FF) parameters. The identification of the observation parameters is based on the bufrtables code. The identification of the forecast parameters is based on field code tables and forecast parameters in grib standard code. Users can create a new parameter, modify or delete existing ones.

4.2.7.1 REGISTER A NEW PARAMETER

The registration of a new parameter is different for the two parameter types OBS and FCS. Therefore, in the subsequent sections, the two procedures are described separately.

1) Register an observation Parameter

The VERSUS system loads all registered observation parameters in a given bufr file using the bufr-decoder of ECMWF. The list of registered parameters can be checked by choosing "Parameter" -> "Modify" from the VERSUS menu and selecting as Parameter type "OBS". In case the desired parameter is not in the list, the user needs to register the parameter via the web browser.

By clicking on option "registration" of the menu "Parameter" the system displays the following GUI:

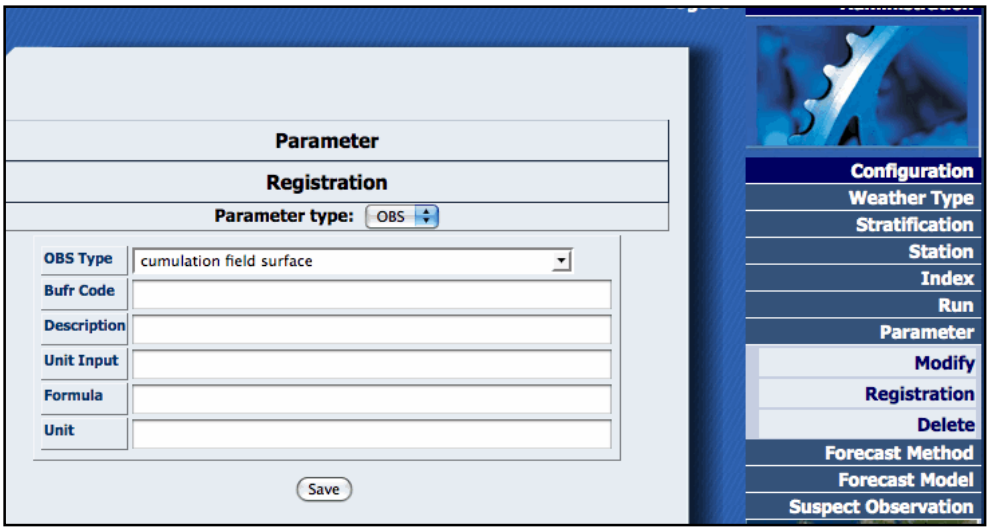


Figure 66 OBS Registration

The information to be filled in is:

OBS Type: select accumulation surface parameter, surface, upper air, or wind direction type parameter

Bufr Code: the BUFR code that can be found in BUFR TABLES

Description: the parameter description usually found in BUFR TABLES

Unit Input: bufr unit of the parameter

Formula: a formula to apply for unit conversion, e.g. K is converted into °C. This field is written in php code. The formula must end with the character ";"

Unit: parameter unit after formula application

In case of no unit conversion, the formula field is left empty and the Unit is the same as the Unit Input.

To finish this procedure, the parameter registration needs to be saved. In order to verify whether the registration of the new parameter was successful, new parameter type observation data should be uploaded for a test time period and then data availability should be verified for the same time period.

2) Register a forecast parameter

The list of registered parameters can be checked by selecting "Parameter" -> "Modify" from the VERSUS menu and selecting as Parameter type "FCS". In case the parameter of interest is not in the list, it needs to

be registered. Unlike the registration of an observation parameter, it is not entirely web GUI based but requires first the extension of the configuration xml file located at HOME/VERSUS/conf/grib1.xml.

Step 1: add new parameter in the file HOME/VERSUS/conf/grib1.xml

The file has the following structure:

<fields>

<!-- LM -->

To add a single field parameter (for example, Temperature) the code is the following:

<field name="temp">
<element name="t" unit="°C">
<codeTable>69</codeTable>
<parameter>11</parameter>
</element>

</field>

To add a parameter composed by two fields (Wind with u and v coordinates), the code is:

<field name="wind">
<element name="u" unit="m/s">
<codeTable>2</codeTable>
<parameter>33</parameter>
</element>
<element name="v" unit="m/s">
<codeTable>2</codeTable>
<parameter>34</parameter>
</element>
</field>

The above is an example of wind field definition where the wind forecast parameter is given in u and v coordinates. The system automatically calculates wind speed and wind direction. However, in case the wind speed and wind direction are also included in the forecast data and need to be ingested in the DB, the code is the following:

<

<field name="wind">
<element name="u" unit="m/s">

<codeTable>2</codeTable>
<parameter>33</parameter>
</element>
<element name="v" unit="m/s">
<codeTable>2</codeTable>
<parameter>34</parameter>
</element>
</field>
<field name="wind_ff">
<element name="ff" unit="m/s">
<codeTable>2</codeTable>
<parameter>32</parameter>
</element>
</field>
<field name="wind_dd">
<element name="dd" unit="degree true">
<codeTable>2</codeTable>
<parameter>31</parameter>
</element>
</field>

So, for any new parameters, the related entry has to be added defining the field name, the element name, the unit, the code table and the parameter following the xml format.

Step 2: upload a grib file containing the new parameter via the appropriate front end

In the updated grib1.xml file, the system is able to identify it via the code table and the parameter identifier. Note that a new grib file needs to be ingested into the DB in order to put this new entry into the parameter list in the web GUI.

Step 3: modify the description of the new parameter via the GUI

When the system identifies a new forecast parameter (i.e. after a grib file with the new parameter has been uploaded), the entry “TBD” (To Be Defined) appears in the description field indicating that a description has to be defined. To do this, user should click on option “Modify” of the Parameter menu and select ‘FCS’ on the Parameter Type menu. The available forecast parameters are displayed in the following GUI:

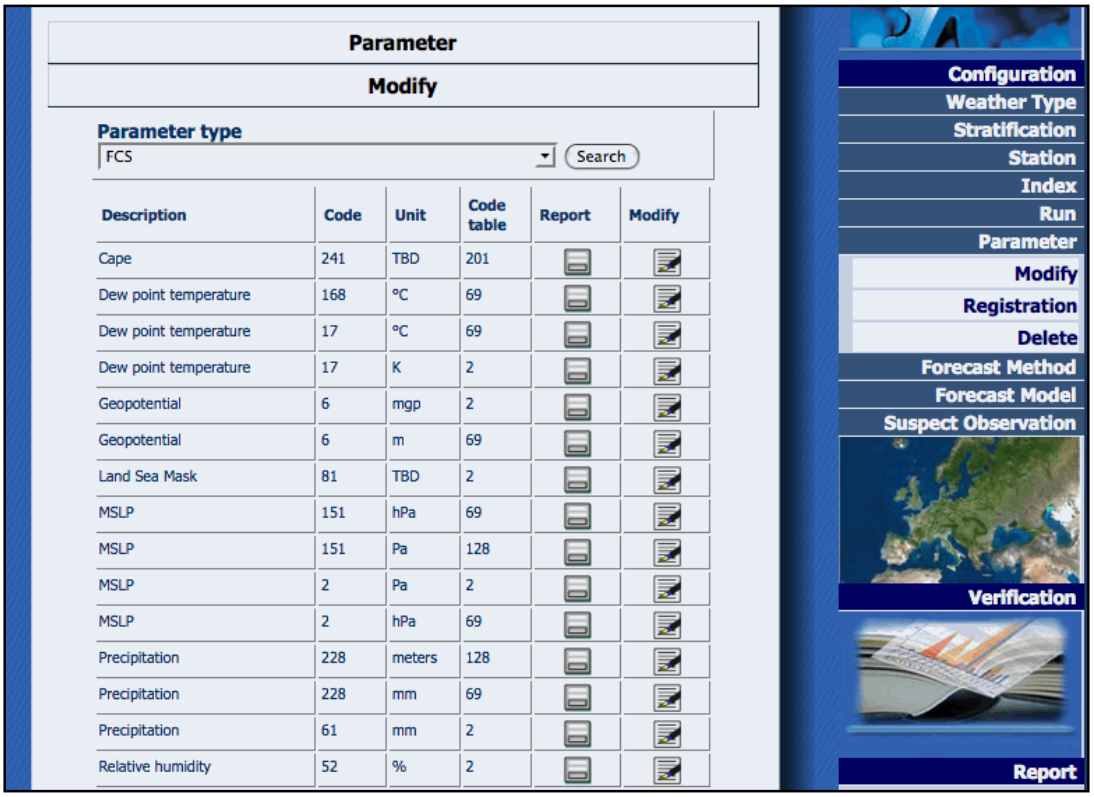


Figure 67 List of FCST Parameters to Modify

By selecting the parameters with the description and unit set to “to be defined” (TBD), and clicking on the modify icon, the GUI displays:

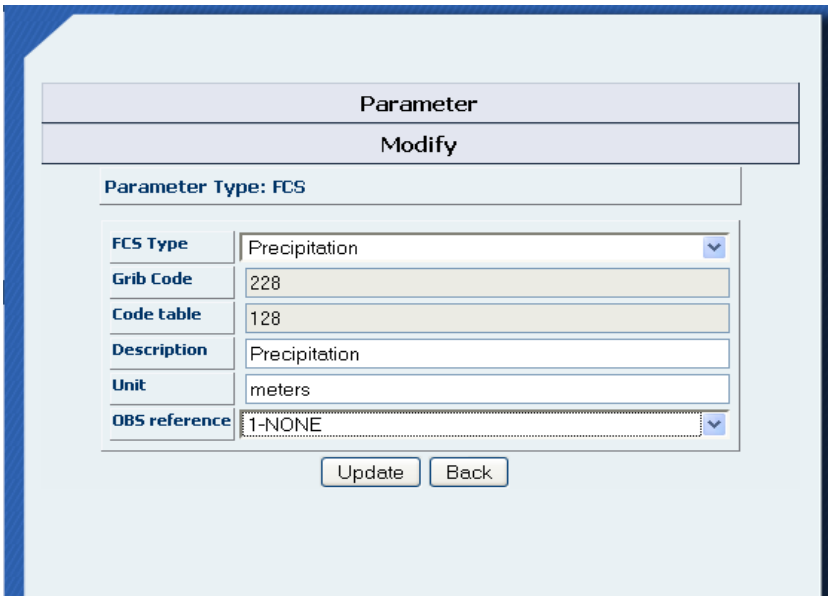


Figure 68 FCS Parameter Modify

In this example, the code table 128 and grib code 228 refer to the precipitation parameter. So the user has to fill in the description and units of the parameter to replace “TBD”. The OBS reference option refers to the corresponding observation parameter.

- For model data used for Analysis verification, the path of the configuration file is VERSUS_HOME/conf/grib1.xml

☞ **NOTE: There is no registration procedure for FF data The parameters that are automatically loaded from the FF files are : Geopotential, Relative Humidity, Upper air Temperature, u and v wind components.**

4.2.7.2 MODIFY A PARAMETER

Registered parameters descriptions and units can be also modified (e.g. in case of typos or more suitable descriptions etc). This is possible both for observation and forecast parameters.

☞ **Modification of an observation parameter**

By clicking on item “Modify” of the Parameter menu and selecting ‘OBS’ on the Parameter Type menu the available observation parameters are displayed on the following GUI:

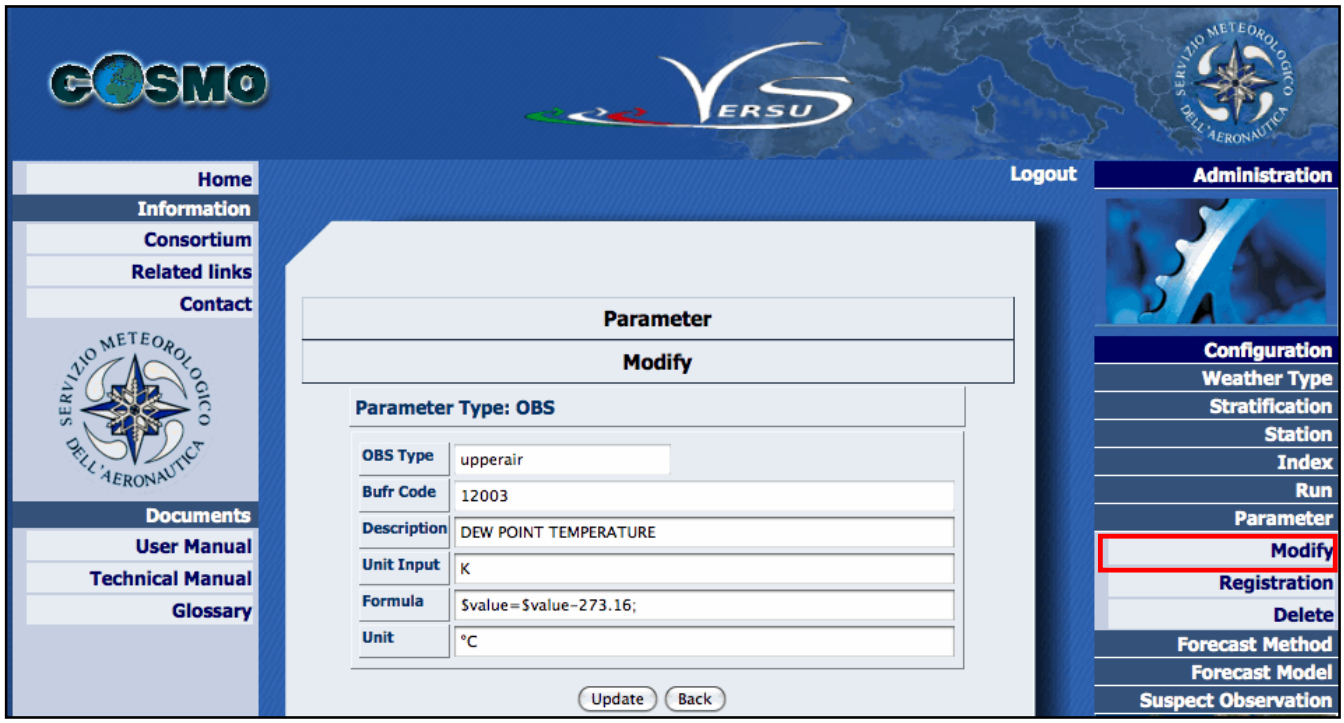


Figure 69 OBS Parameter Modify

The user may now modify:

Description: the parameter description

Unit Input: parameter unit before conversion

Bufr Code: bufr code parameter

Formula: a unit conversion formula, e.g. in this case the K is converted into °C. This field is written in php code. Make sure that the formula ends with the ";" character.

Unit: parameter unit after formula application

Modification of a forecast parameter

User can modify by GUI the forecast descriptions and units but cannot perform unit conversions as for observation parameters. To do that, code needs to be added in the file HOME/VERSUS/conf/griboper.xml which is the file that deals with parameter calculations.

For example: For Temperature conversion from K to °C, the following code has to be added in the file griboper.xml :

<dfield name="tCelsius" operation ="gribConstantSum" unit="°C" missingValue="9999.90">

<coding>

NEW CODE

<gribTablesVersionNo>69</gribTablesVersionNo>

<indicatorOfParameter>11</indicatorOfParameter>

</coding>

ORIGINAL CODE

<elementname ="t" >

<codeTable>2</codeTable>

<parameter>11</parameter>

</element>

<constant name ="absZero">-273.16</constant>

</dfield>

It is also necessary to add the following code in grib1.xml in order to allow ingestion of the calculated temperature data.

<field name="temp">

<element name="t" unit="°C">

NEW CODE
<codeTable>69</codeTable>

<parameter>11</parameter>

</element>

</field>

☞ Modification of a feedback file parameter

To modify an FF parameter, user must select “Modify” on the Parameter menu and selecting ‘FF’ on the Parameter Type menu. The available observation parameters are displayed on the following GUI

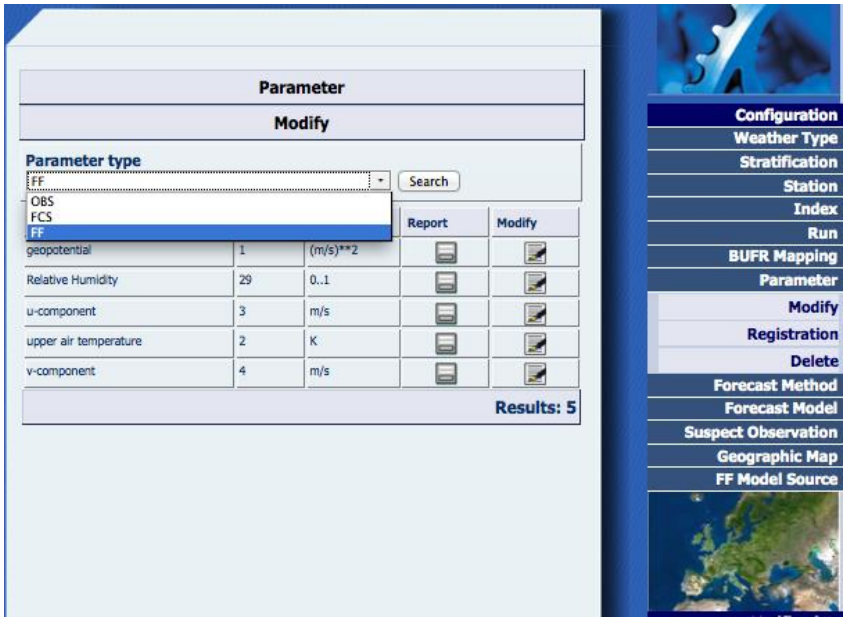


Figure 70 List of FF Parameters to modify

4.2.7.3 DELETE A PARAMETER

Configured parameters can be removed from the VERSUS DB by clicking on option “Delete” in the Parameter menu:

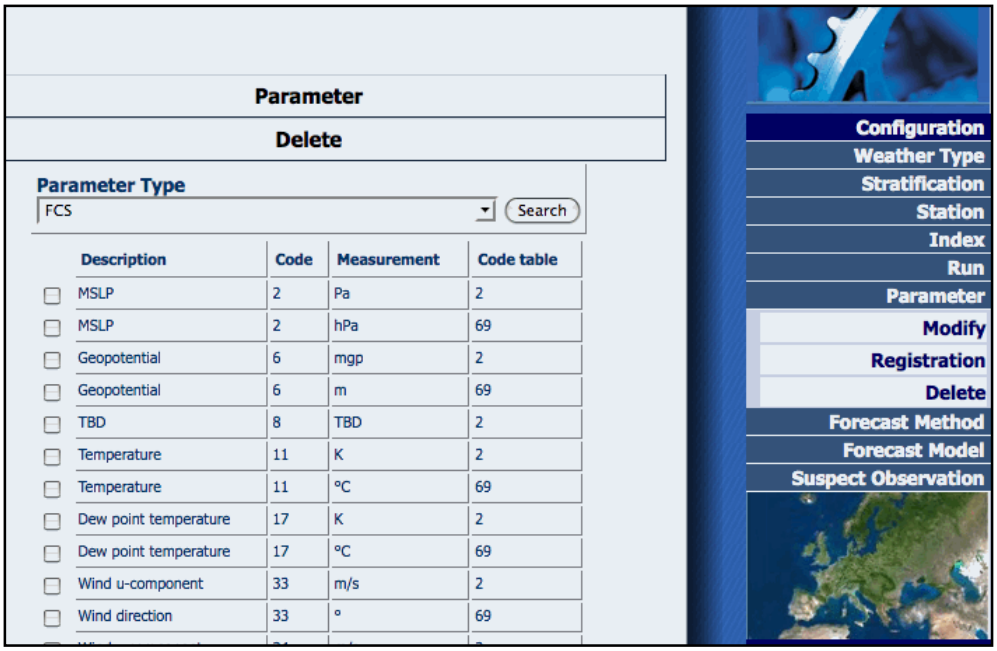


Figure 71 Parameter Delete

After having selected the parameter type (forecast, observation or FF), the list of available parameters is displayed. By checking the ones the user wants to delete, and clicking on ‘delete’ on the bottom of the form, the parameters are deleted. However, the user should double-check that the parameter has been deleted by displaying again the parameter list.

4.2.8 FORECAST METHOD (INTERPOLATION METHOD)

The forecast method is the algorithm used to calculate by interpolation a forecast value at the observation location. User can create a new method, modify or delete an existing one**.**

Currently the available methods are:

1) Nearest point 3D optimized
2) Nearest Point height optimized
3) 4 Nearest Points Mean
4) Mean of points with R=30 km
5) Nearest point distance
6) Mean of points Circle with R=15 km
7) 4 Nearest Points height optimized
8) 4 Nearest Points distance
9) Method for wave model

Registration of a new forecast interpolation method is only possible by GUI only for the case of Mean of Points of a circle, where user can define a Radius value. To do so, user should click on' Registration' Option of the Forecast Method menu and add a description of the method, for example . 06) Mean of Points Circle R=15km, Algorithm= Mean Radius, and Parameter the value of the Radius of the circle (eg. 15) . For any other method user has to enter in the Phoenix Code.

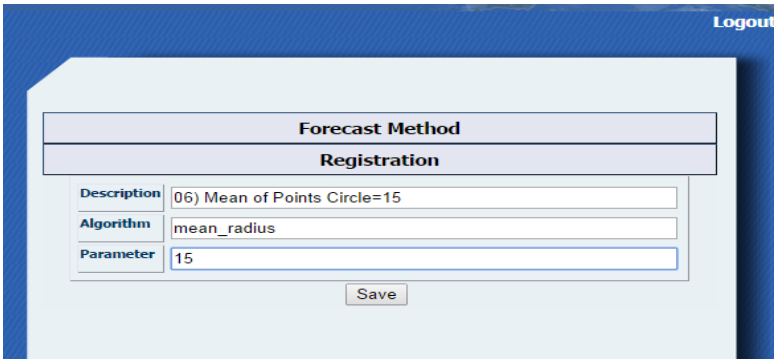


Figure 72 Forecast Method registration

The "method for wave model" has the following principle of operation: for each observation point, in terms of latitude and longitude, the method searches for the 4 neighboring points in the grid (are taken into account only points over the sea, according to the land-sea fraction provided); the best point corresponds to the one with minimum spherical distance from the observation point.

4.2.9 FORECAST MODEL

The forecast model is the part of the system that deals with the meteorological models that VERSUS uses .User can register a new model, modify or delete the parameters of an existing one.

4.2.9.1 MODEL REGISTRATION

Model type: It is the model type which contains the topography information.

By clicking on "Registration" option of the Forecast Model menu and then on **(…)** on the right of ' Model Type' line the system displays a window where the Model Type Selection GUI appears:

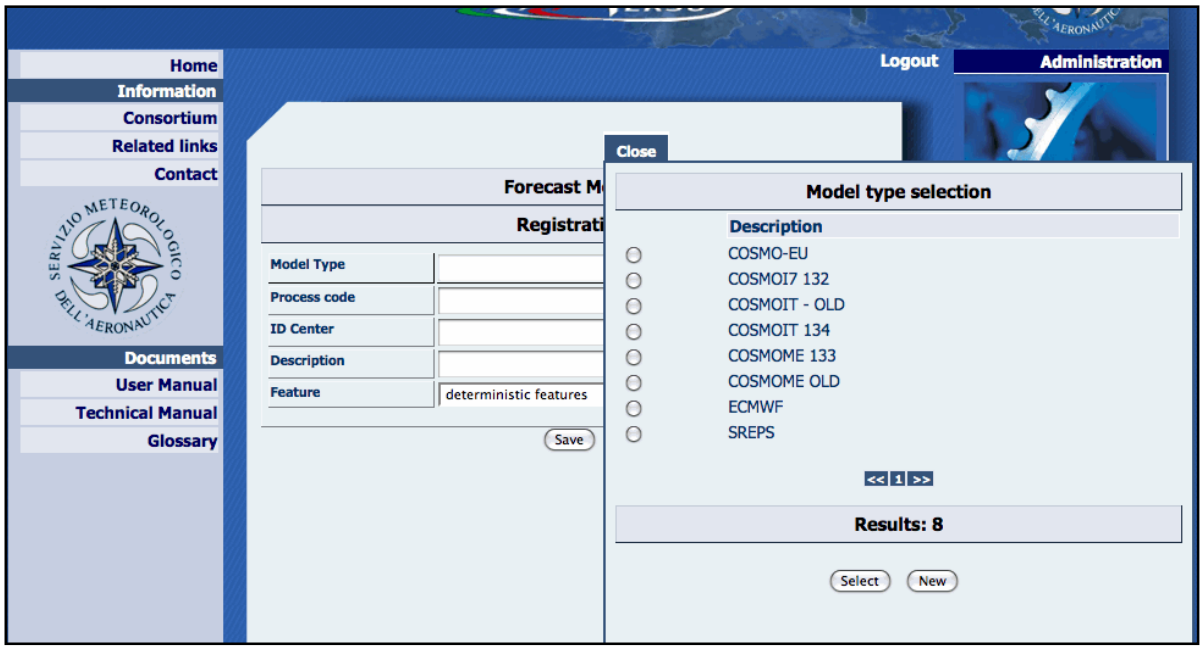


Figure 73 Forecast Model Registration

The user can select the type of model via the Model type selection menu:

The user should click on “New” option of Model type selection panel to create a new one, in case there is not a valid type model in the selection menu:

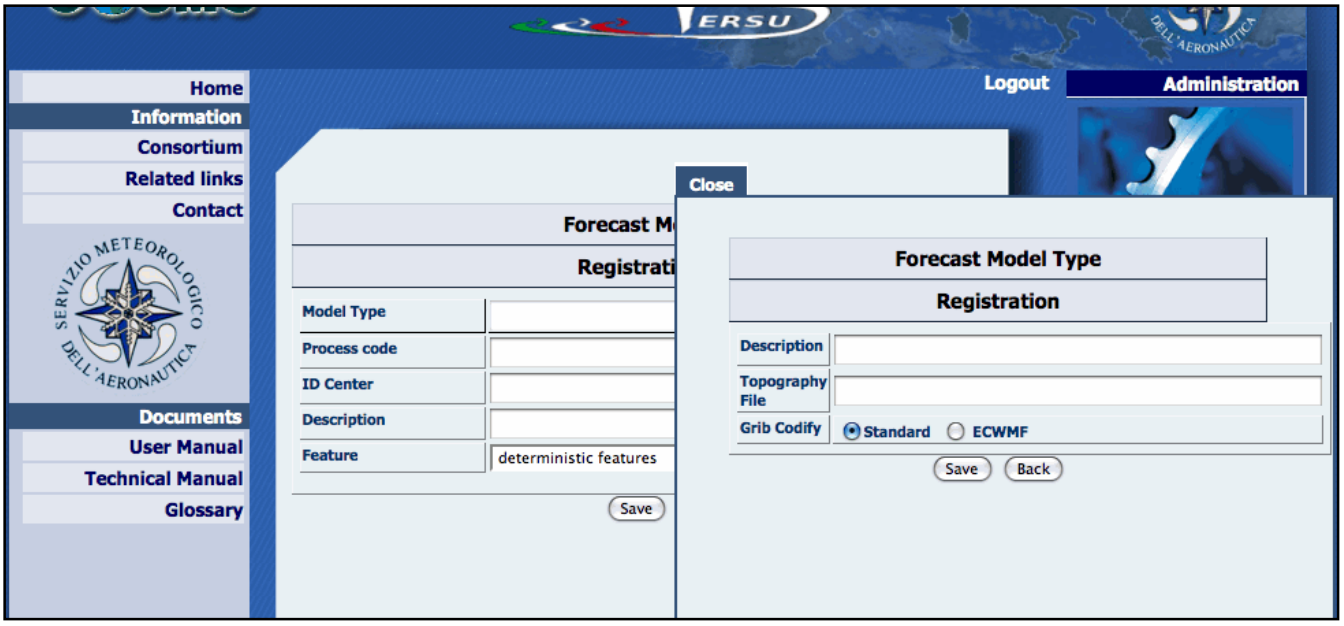


Figure 74 Forecast Model type registration

For registration of a new Forecast Model Type the system needs the following data:

Description: a description of the model type

Topography File: the path+filename of the GRIB format topography file to be decoded. This file should contain the land sea mask (FR_LAND) and geopotential heights.(FIS) in the same dimension/resolution as the grib files that will be loaded.

Grib Coding: the user should specify if the grib format is standard or ECMWF one (normally if the precipitation fields are coded as time range indicator 4, is standard, otherwise is the ECMWF one)

Process code ID : is the process code of the forecast to decode

ID Center: is the numeric code of the origin center of the forecast

Description: a meaningful description of forecast model

Feature: if the forecast is probabilistic or deterministic

Number of FCS Ensemble: the number of the included members for probabilistic forecasts

- **To load model data other than COSMO** in VERSUS database, (**with standard "grib codify**") the model grid should be in spherical coordinates (or spherical coordinates with rotated pole) and the next steps should be followed:

a) Make a topography file with variables :

Code: Select all

```
GP:sfc:kpds=6,1,0:anl:winds in grid direction:"Geopotential [m^2/s^2]
LAND:sfc:kpds=81,1,0:anl:winds in grid direction:"Land cover (land=1;sea=0)
[fraction]
```

And place it with other topography files, it will be needed on step b.

ONLY for WAVE models - it is necessary to include a land-sea fraction grib file, with the following codification: land = 0 ; sea = 1.

b) Create new model type in VERSUS GUI (Configuration - Forecast Model - Registration - Model type selection - New). Set path to the new Topography File.

c) Create Forecast Model with the new Model type using appropriate Process code and ID Center. After that data could be loaded as usual. For example, this command can be used to convert EPS data:

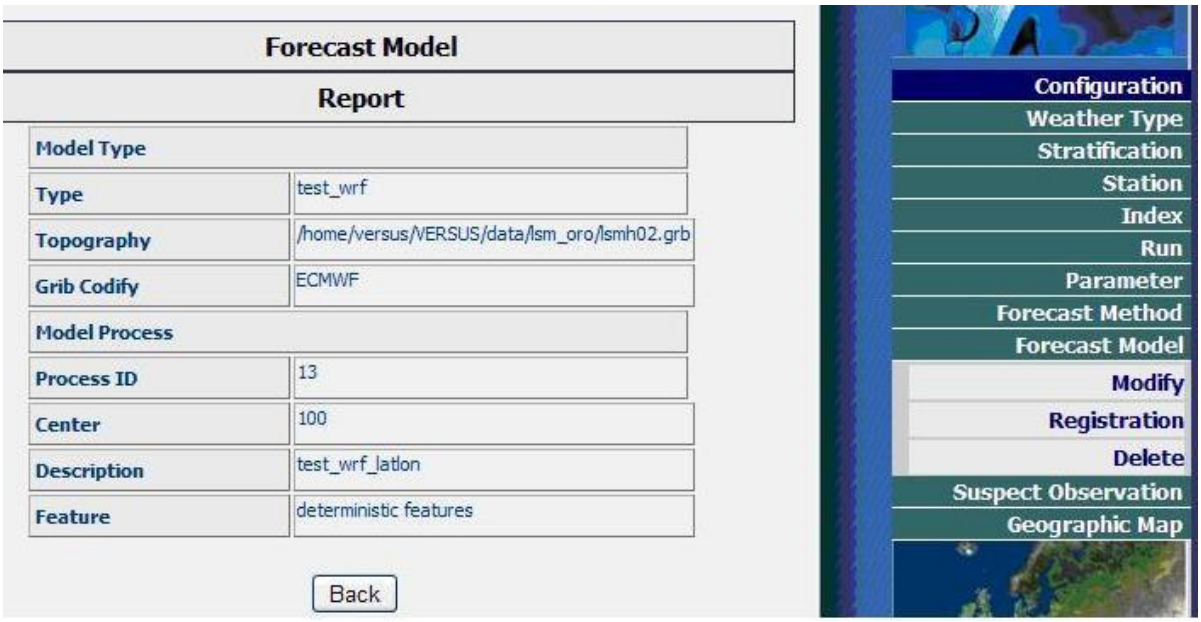
```
centre=4,subCentre=98,setLocalDefinition=28,localDefinitionNumber=28,marsCla
ss=co,marsType=pf,marsStream=enfo,experimentVersionNumber=0009,
perturbationNumber=$imem,numberOfForecastsInEnsemble=$NMEMS $FILEOUT
$FILEOUT1
```

For WRF model registration (ECMWF codify)

a) Switch to WRF UPP postprocessing option: outputs gribs instead of NetCDF (standard WRF ARW post postprocessing outputs NetCDF files).

b). Create orography file as usually.

c). Transfer this file into lat-lon projection using copygb utility (part of UPP) (code 0 in grib).



d). Register a new model in VERSUS GUI as usually. To choose Grib codify ECMWF. To change the process number and centre number using grib_set command, as in the previous example.

Figure 75 Example of WRF model registration

4.2.9.2 MODEL MODIFY

By clicking on item “Modify” of Forecast Model menu the system displays the following GUI:

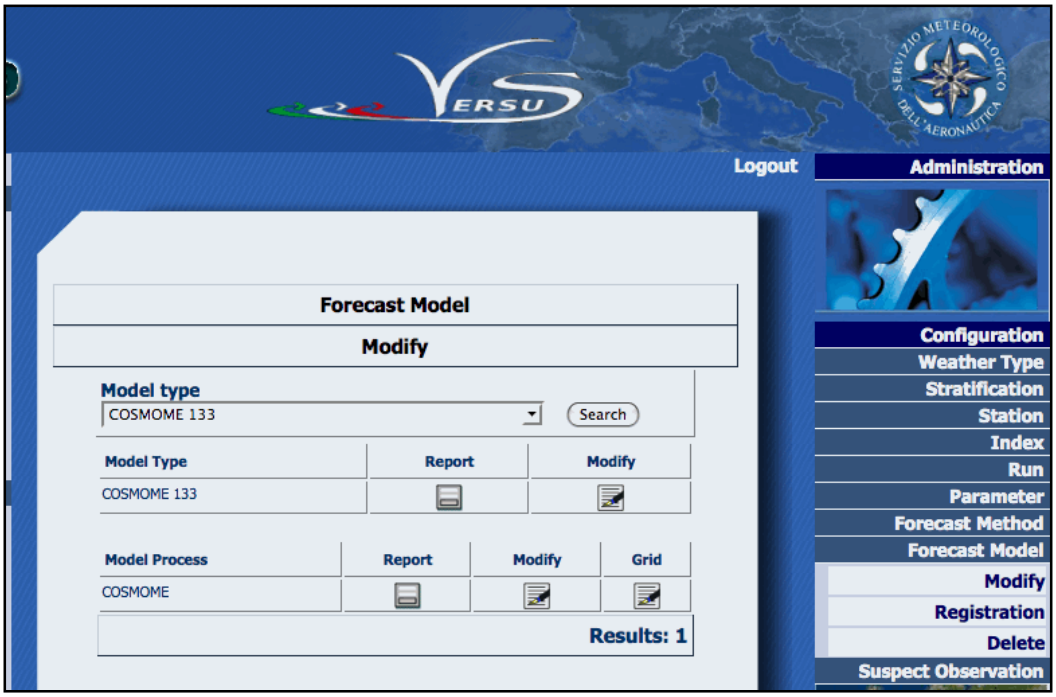
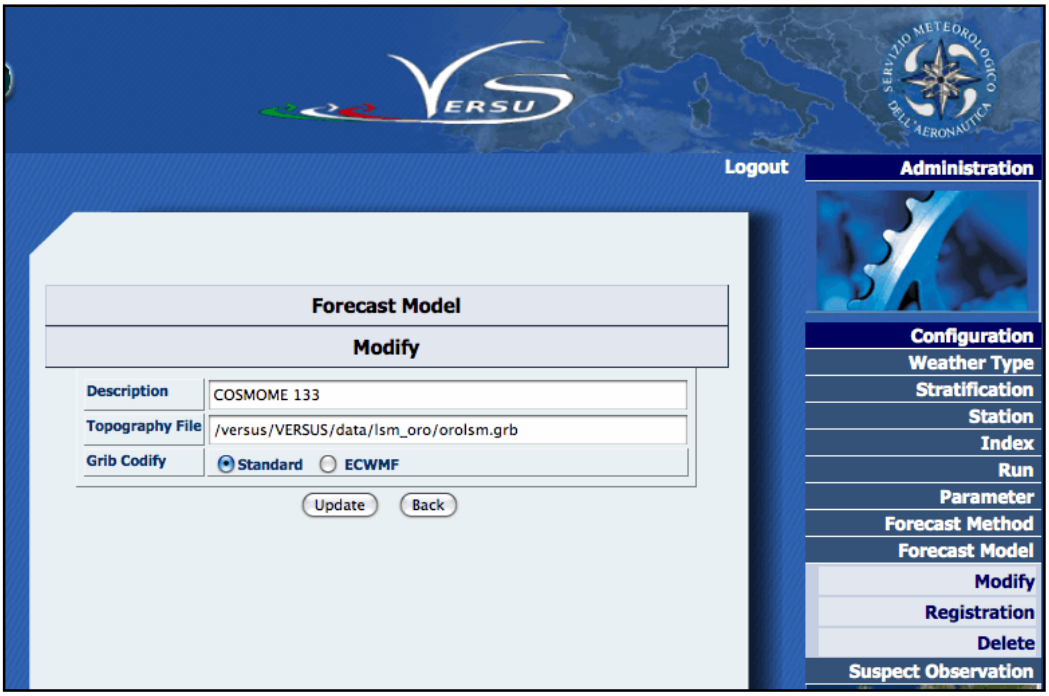


Figure 76 Forecast Model Modify

By clicking on 'Search' on the right of the model type to modify, the system displays model type and model process information. By clicking on Report icon the related data information is displayed. By clicking on Modify



icon of model type, it is possible to modify related information. For model type modification the system displays the following GUI:

Figure 77 Model type Modify

By clicking on Modify icon of Model Process menu, (Fig.58) it is possible to modify model process information. For model process modification the system displays the following GUI:

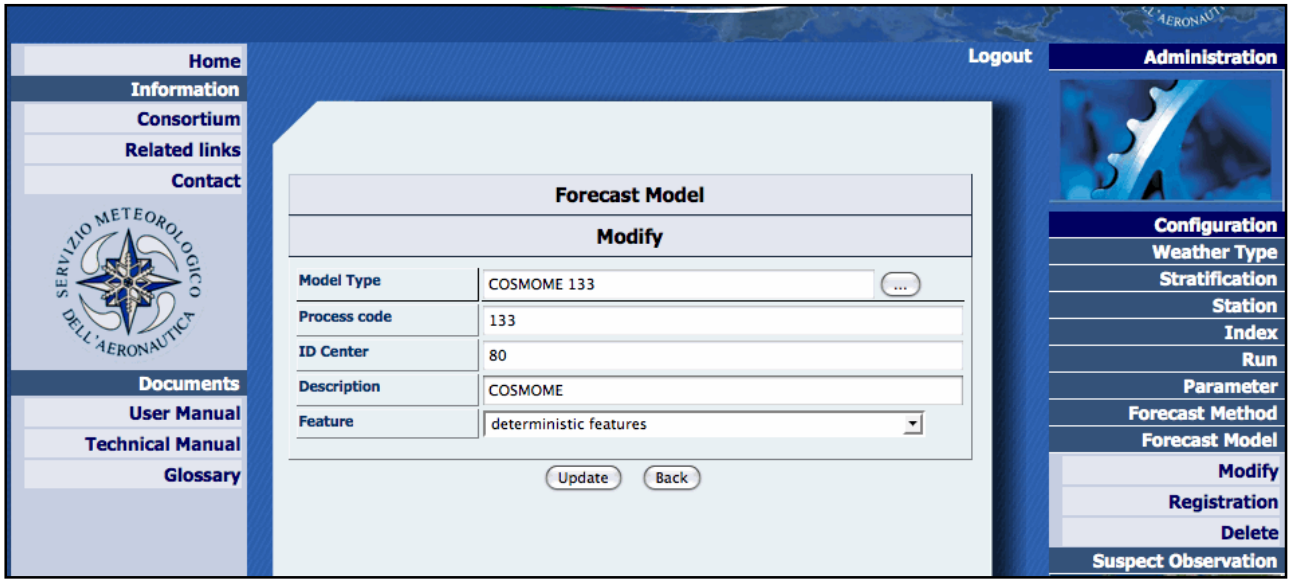


Figure 78 Deterministic Model Process Modify

For probabilistic models the number of ensemble members should also be specified.

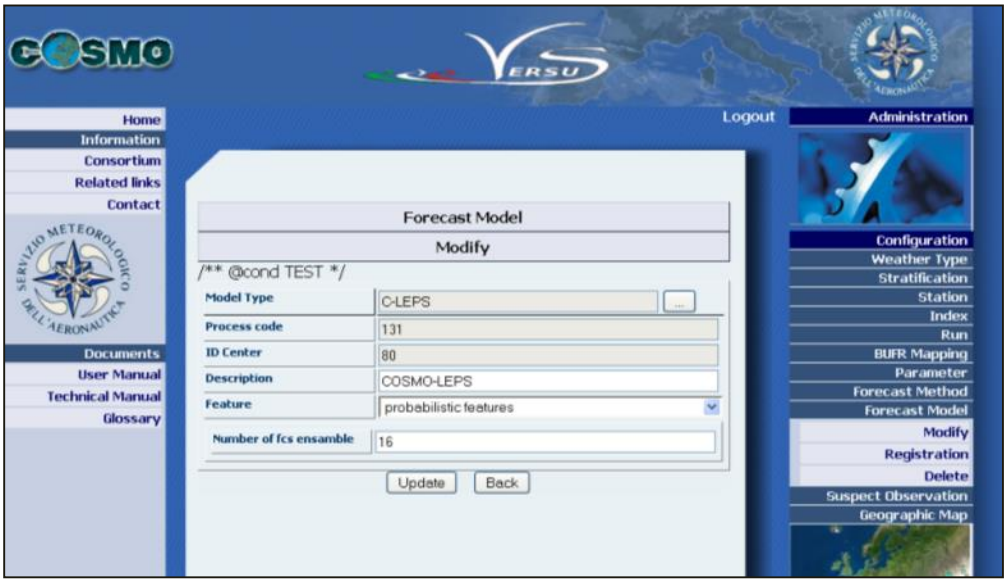


Figure 79 Probabilistic Model Process Modify

By clicking on Grid icon of model process menu, it is possible to modify grid data . For grid modification the system displays the following GUI:

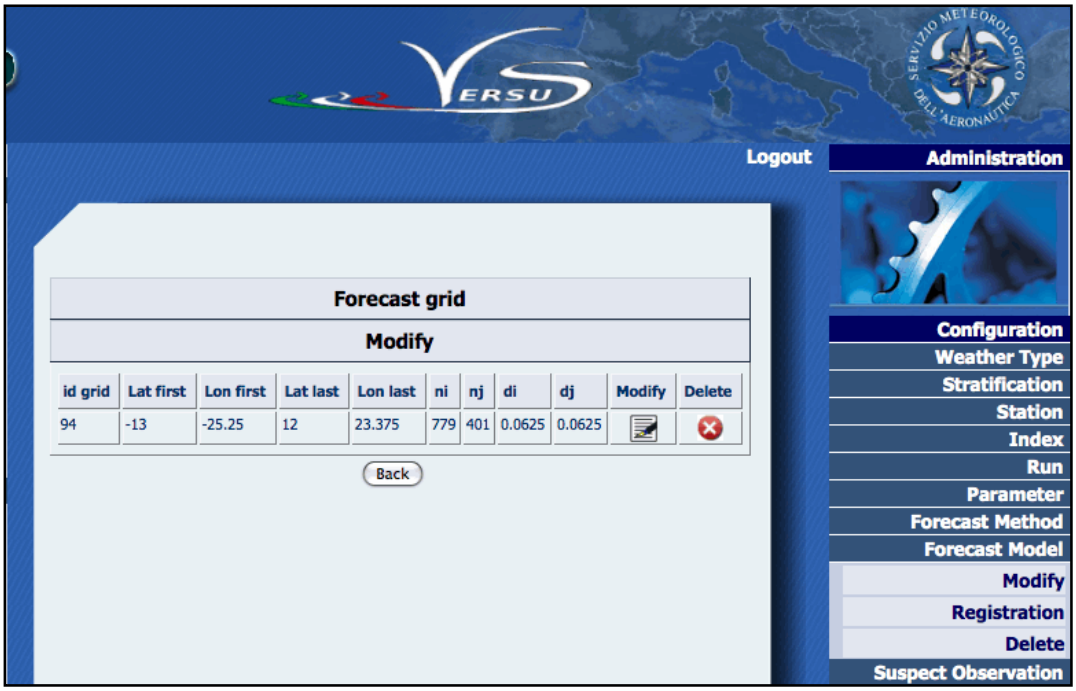


Figure 80 Grid information

The user can delete or modify the grid. By clicking on Modify icon, the system redirects to the following form:

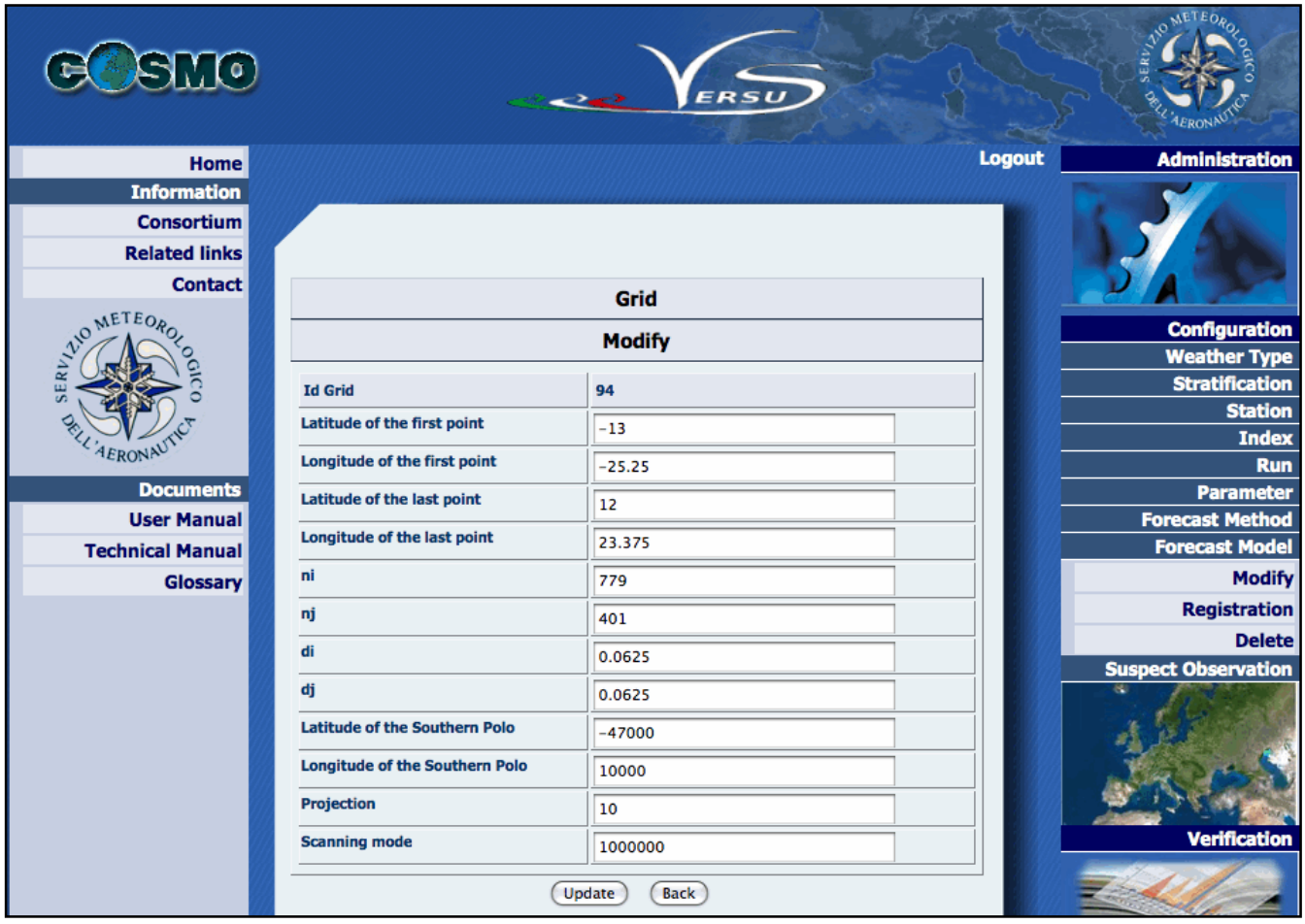


Figure 81 Grid modify

The grid fields that can be modified are:

Latitude of the first point

Longitude of the first point

Latitude of the last point

Longitude of the last point

Ni number of grid points on x-direction

Nj number of grid points on y-direction

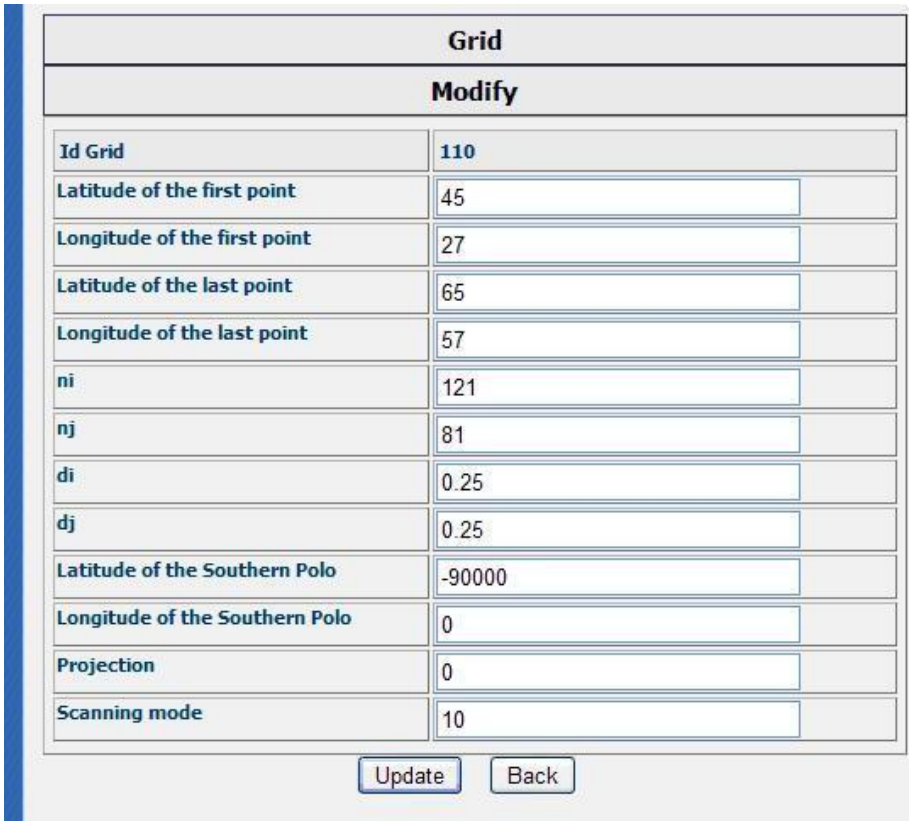
Di x-grid spacing (degrees)

Dj y-grid spacing (degrees)

Latitude of the South Pole

Longitude of the South Pole

Grid Projection number



Scanning mode

Figure 82 Example of Grid Modify for WRF Model

4.2.9.3 MODEL DELETE

By clicking on "Delete" of the Forecast Model menu the system displays the following GUI:

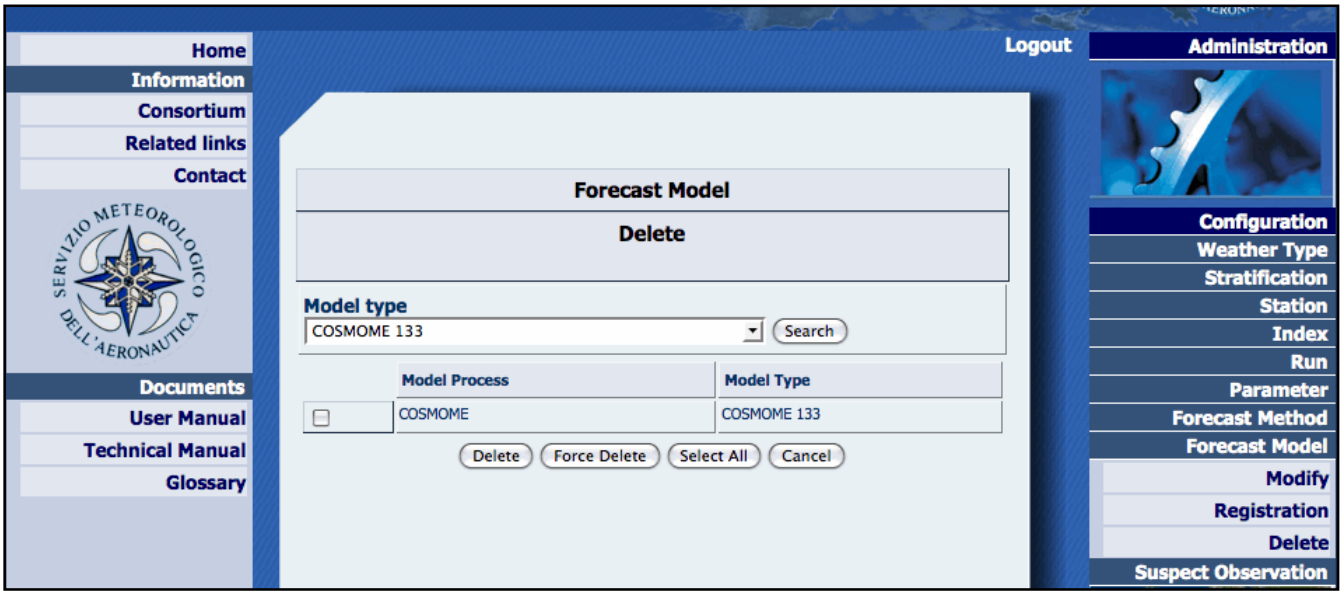


Figure 83 Model Process Delete

There are two ways of deleting a model:

Delete: deletes the model only if it is not linked to products such as: verifications, graphs, scores

Force Delete: delete the model and all related products.

4.2.10 SUSPECT OBSERVATION

The suspect value configuration can eliminate pairs of observation/model data causing problems during calculation of scores. User can create a new suspect value condition, modify or delete it. By clicking on Suspect Observation -> Registration user can set limits to the absolute value of forecast- observation difference. Suspect values can be retrieved and saved in text files (see Report Menu).

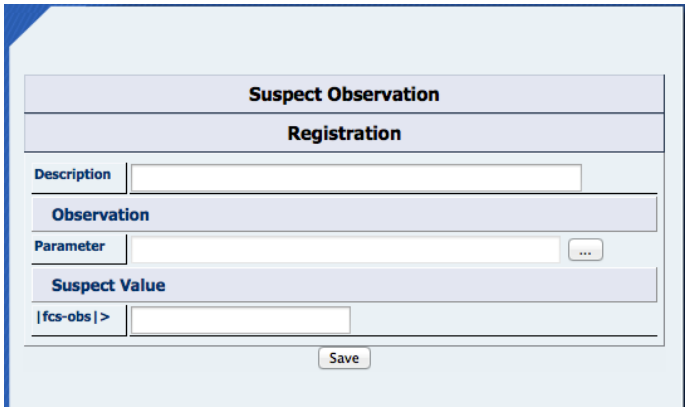


Figure 84 Suspect observation Registration

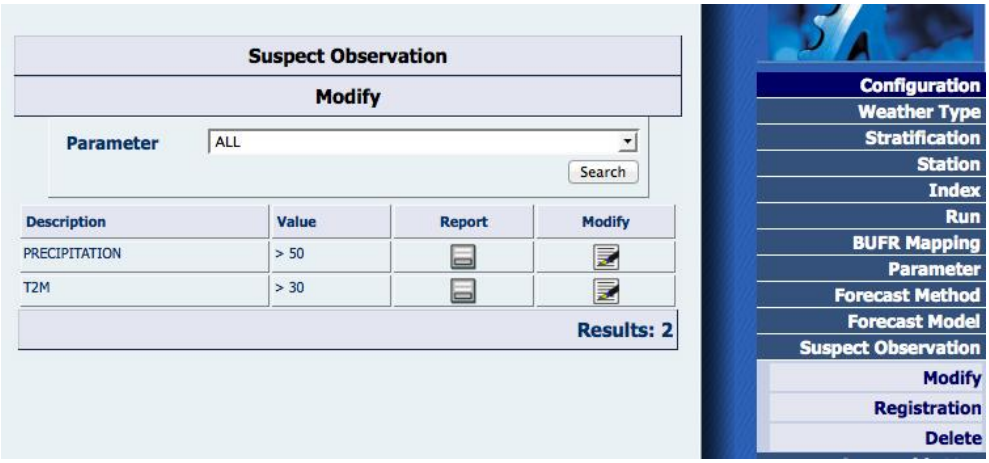


Figure 85 Suspect Observation Modify List

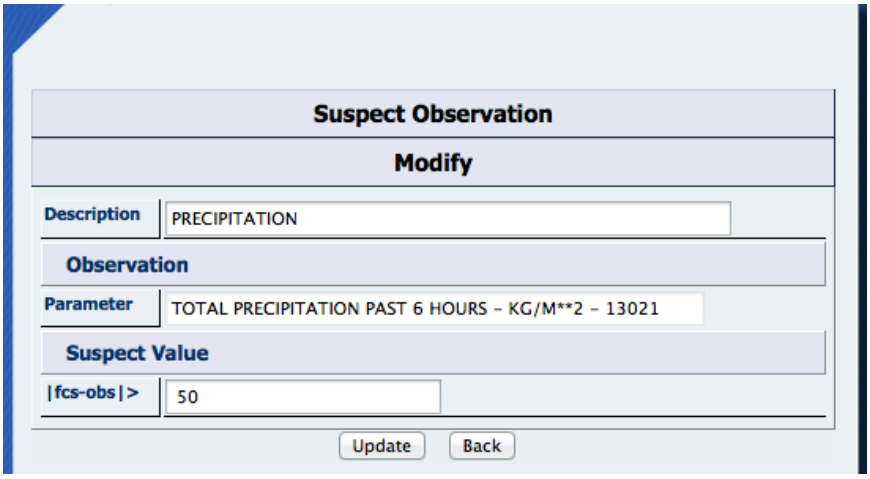


Figure 86 Suspect Observation Modify menu

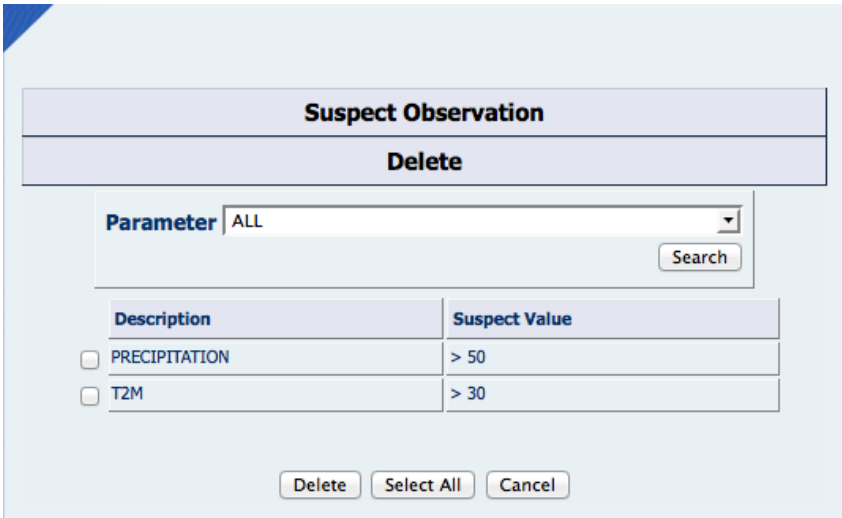


Figure 87 Suspect Observation Delete Menu

User can modify or delete a suspect observation value.

4.2.11 GEOGRAPHIC MAP

The Geographic map menu is used to configure the plotting of graphics related to verifications based on geographical scores calculation. To configure a geographic map the system needs the map in **png** format and the related graphic information. By clicking on Geographic map the system automatically displays the GUI for map modifying:

Figure 88 Geographic Map Modify

VERSUS system includes a set of maps created for every COSMO partner. Each map information can be displayed by clicking on report icon, or modified by clicking on Modify icon‘.

For example:

1) by clicking on report icon of Italy Map the system displays:

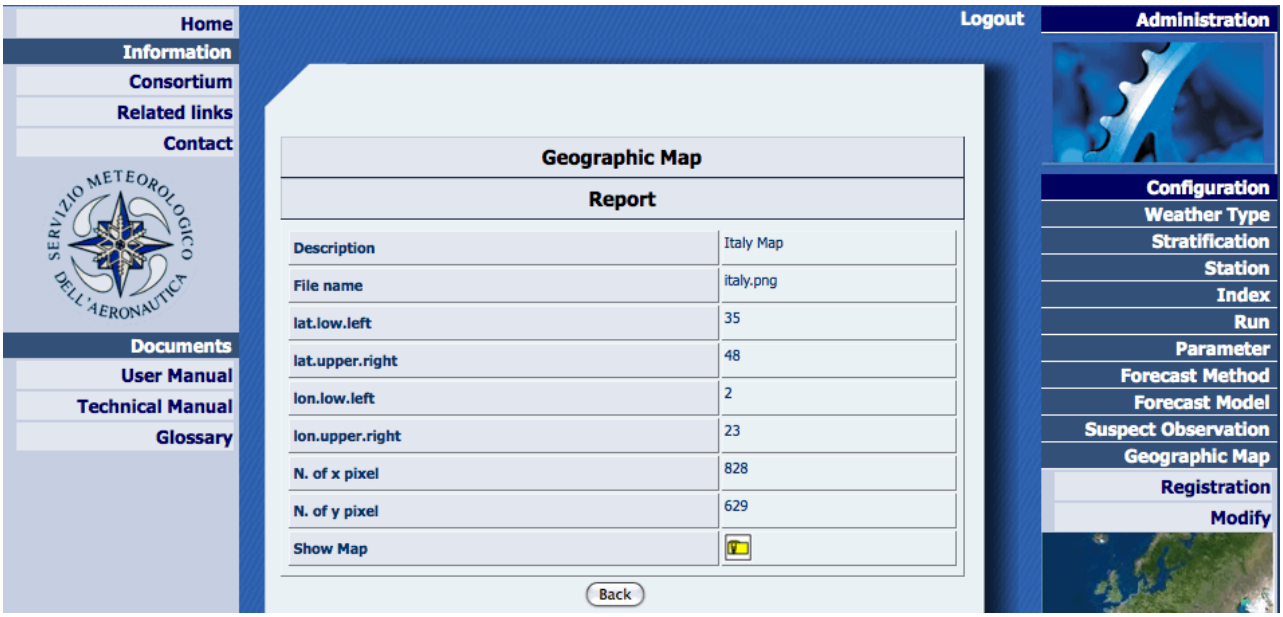


Figure 89 Geographic Map Report

The available information is:

Description: The name of the map

File name: the name of the uploaded map file

lat.low.left: latitude of the lower left boundary of the map

lat.upper.right: longitude of the upper right boundary of the map

lon.low.left: longitude of the lower left boundary of the map

lon.upper.right: longitude of the upper right boundary of the map

N. of x pixel: number of the x-pixels of the map

N. of y pixel: number of the y-pixels of the map

Show Map: by clicking on this icon, downloading of the map for viewing is possible

2) By clicking on Modify icon of Italy Map the system displays:

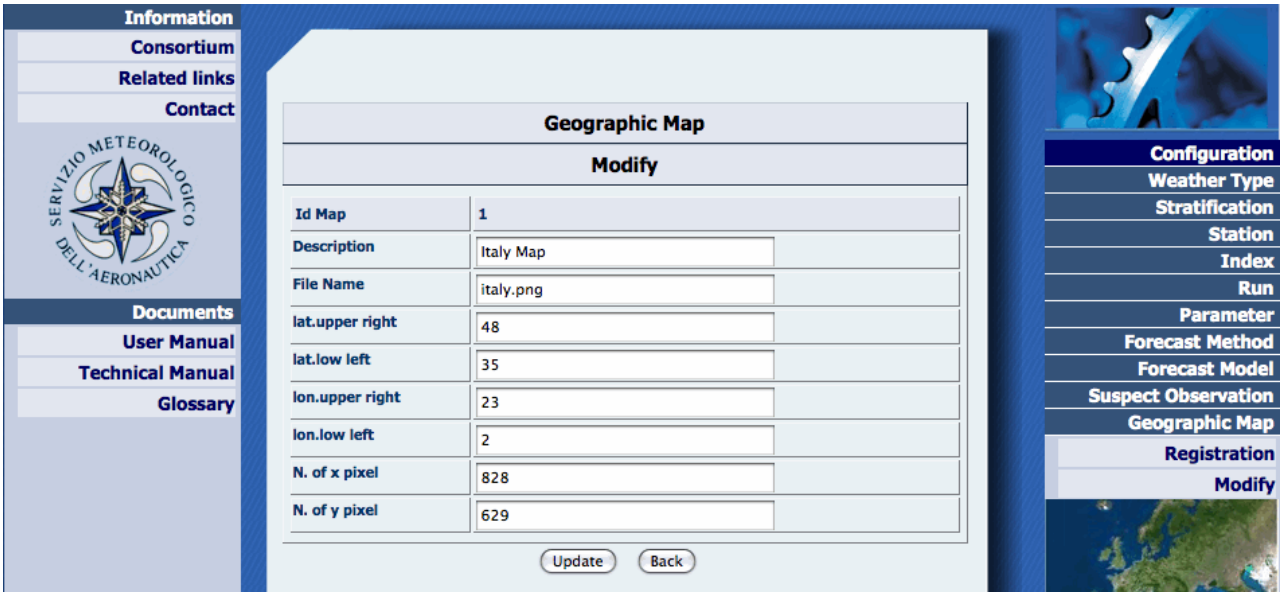


Figure 90 Geographic Map Modify

On this form it is possible to modify the information previously set. New settings will be registered by clicking on 'Update'.

3) By Clicking on Delete icon of Italy Map the system deletes the related map.

To register a new map, user should Click on Geographic map->Registration and the system displays the following form for map registration. The required information is:

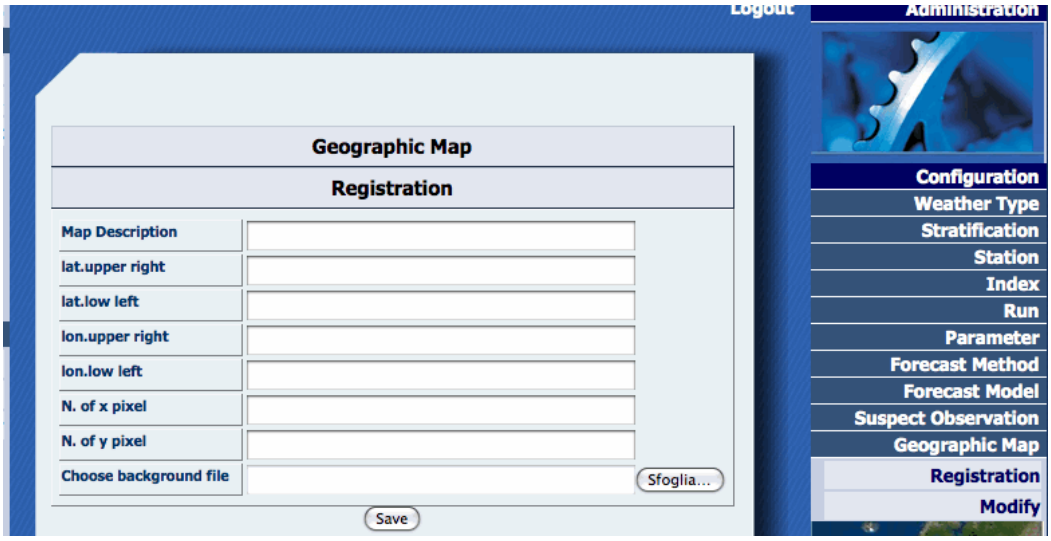


Figure 91 Geographic Map Registration

Map Description: A generic description of the map

lat.low.left: latitude of the lower left boundary of the map

lat.upper.right: longitude of the upper right boundary of the map

lon.low.left: longitude of the lower left boundary of the map

lon.upper.right: longitude of the upper right boundary of the map

N. of x pixel: number of x-pixels of the map

N. of y pixel: number of y-pixels of the map

Select background file: By clicking on this icon, the system gives the capability to upload a map (in png format) with the features described in the above fields .

☞ The map should be in cylindrical projection.

Currently in VERSUS there are available maps for each COSMO partner.

4.2.12 FF Model Source

In the FF the model concept is expressed as a simple description of it. Therefore, no model configuration is required into VERSUS. The system automatically loads into the database the model described in FF. Clicking on Configuration->FF Model Source, the system displays the list of models that have been dealt with by the loader FE

Figure 92 FF Model Source List

By clicking on “Configuration->FF Model Source->Delete” the system shows the following check list.

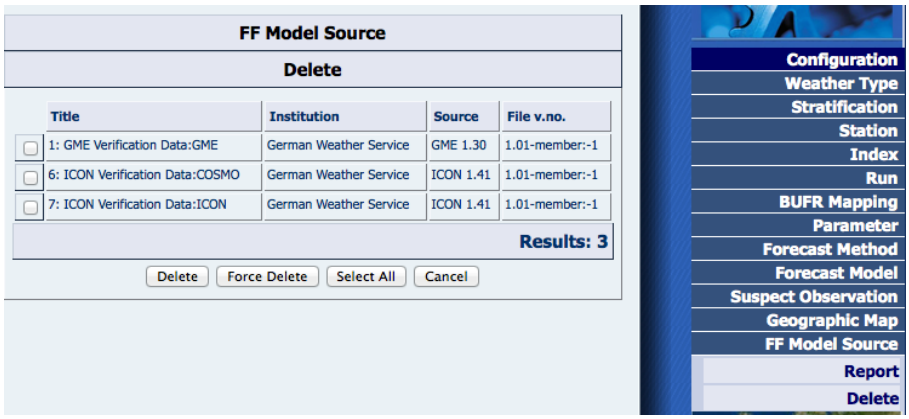


Figure 93 FF Model Delete

To delete an FF model the user can select one or more models from the list:

Clicking on “Delete” button, the system remove the model if no connected information are present;
Clicking on “Force Delete” button, the system remove the model and all connected information except the configured verifications which shall be searched and removed by the user clicking on “Report->Verification Removal”.

4.3 VERIFICATION MENU

It is the menu for the system verification configurations. By Clicking on “Verification” menu option the system displays:

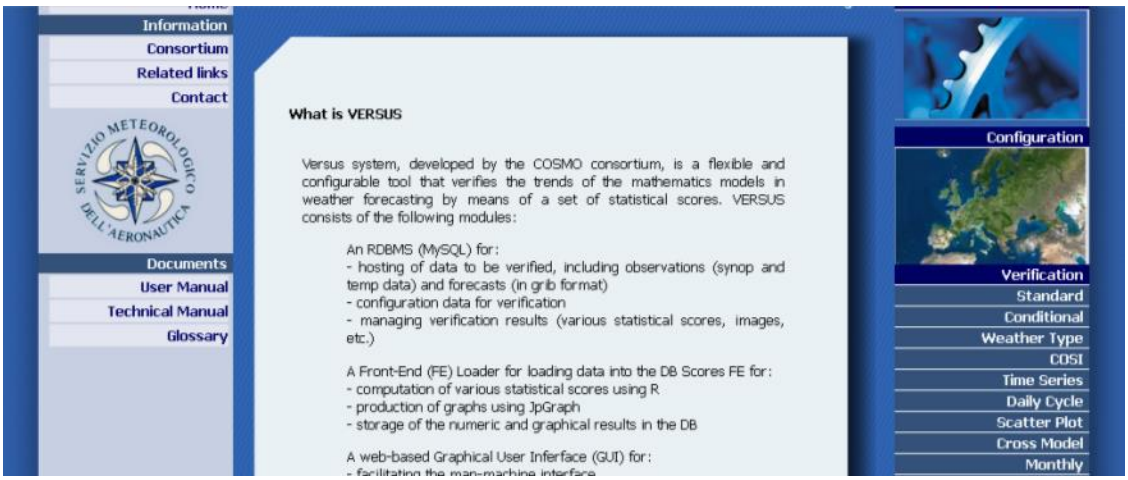


Figure 94 Verification Menu

This menu block allows configuration of the verifications that VERSUS manages.

4.3.1 STANDARD VERIFICATION

Verification is the process to identify the quality of a forecast, when compared, or *verified*, against the corresponding observations or model analysis data.

Versus creates four types of standard verifications for forecast comparisons with:

- on-site station observations (on site)
- model analysis gridded data (Analysis)
- Ensemble Probability Scores (EPS)
- Feedback files Verifications. (FeedBackfile)

4.3.1.1 STANDARD VERIFICATION on-site

To create a standard verification using a group of on-site station observations (stratification), the user has to click on option “Standard” ->On-site of Verification menu, and the system displays the following form:

Figure 95 On-site Standard Verification Registration

To create an on-site standard verification, the following information is needed:

Criteria Type: it can be Surface or Upper air.

Description: a name to identify the verification.

Stratification: the ensemble of stations for scores calculation.

Date/Frequency: a data time series defined either by start and end date or by a periodical timescale which can be ‘monthly’ or ‘seasonal’, and is based either on observations or on forecasts.

Steps: start, end and interval step for verifications. The interval step must be consistent with the frequency of available model outputs and observations.

In particular for precipitation verifications the steps must be the following:

For 24hourly precipitation: start=24, end=end of simulation, step=24

For 12hourly precipitation: start=12, end=end of simulation, step=12

For 6hourly precipitation: start=6, end=end of simulation, step=6

By clicking on **(….)** information on initial Run time of mostly used models is displayed together with precipitation time steps

Observation: observation parameter.(parameters with different TRI are available)

Model: the model to verify

Run: the model run

Grid: the latitude and longitude boundaries of the selected model grid **.**

Parameter: The forecast parameter

Method: selection of the model interpolation method ex. : nearest point or average value of points within a circle of radius R.

Index: Versus manages two kinds of variables : continuous and dichotomous. By selecting '**continuous**' or '**dichotomic** ' index a list of scores appear by for each case by clicking on (….) and selection can be performed. If CIs are inserted by user (see index menu) they also will appear on this lists.

Figure 96 Indexes for Continous/ Dichotomous variables

For dichotomous parameters, a set of thresholds also needs to be specified, and the system calculates the scores for each of them. Performance diagrams are also automatically produced

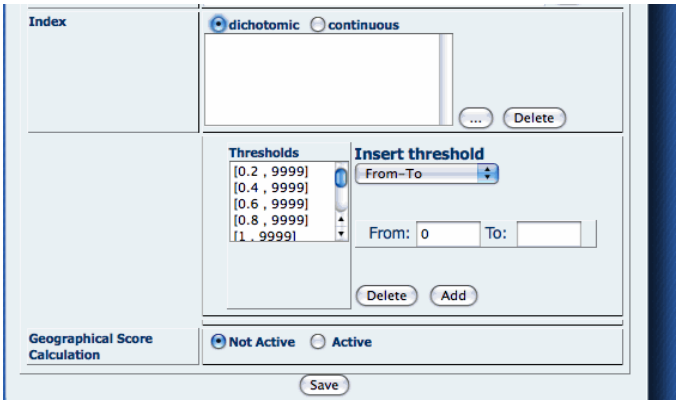


Figure 97 Thresholds for dichotomous variables

Suspect Value: if continuous index is selected, the option for suspect values detection can be activated..

Geographical Score calculation: if the box is checked the system calculates the scores for every station included in the stratification and gives the possibility to plot the results in the already configured map. It may take a little longer for the verification to be created. Option available only for surface data.

Example.

To create a Data interval verification **on Temperature surface data from 01 August 2011 to 31 August 2011** user needs first to check data availability for both forecast and observation surface data of that time period (see Data Availability Menu)

After checking forecast data availability it is important to select the same interpolation method of the dataset on the verification registration form.

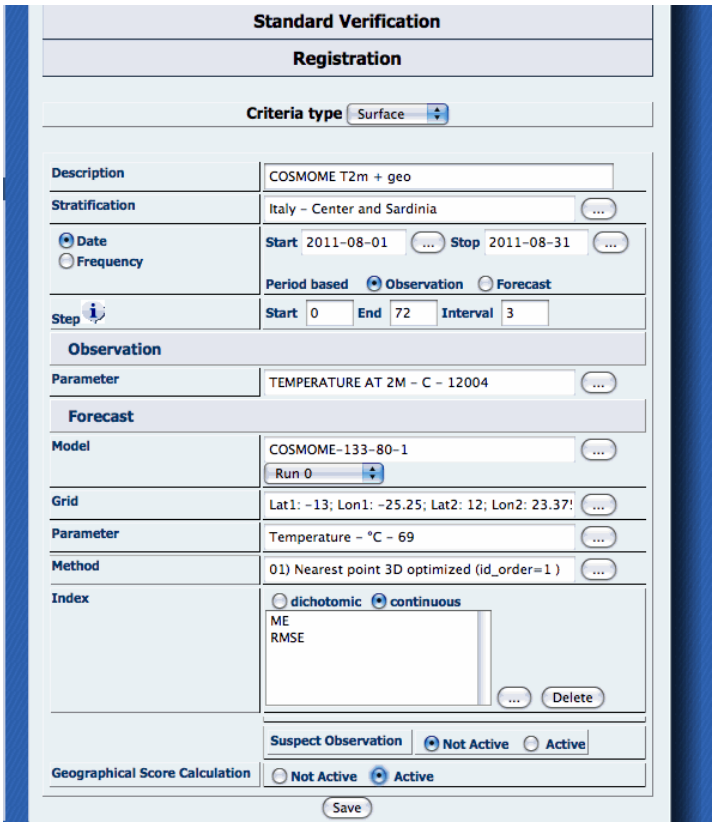


Figure 98 Standard Verification - continuous index - geographical distribution

Data availability check is done also automatically when a verification is created, ONLY for verifications of specified time period(like this example) and NOT for periodical ones (monthly or seasonal).

Standard Verification Report	
Id	3034
Name	COSMOME T2m + geo
Criteria Type	Surface
Dichotomic	No
Run	0
From	2011-08-01
To	2011-08-31
Period Based	Observation
Steps	START: 0 END: 72 INTERVAL: 3
Stratification	Italy - Center and Sardinia
Geographical Distribution	Yes
OBS	
Parameter	TEMPERATURE AT 2M - C - 12004
Suspect Value	No
FCS	
Model	COSMOME
Grid	Lat first:-13; Lon first:-25.25; Lat last:12; Lon last:23.375
Parameter	Temperature - °C - 69
Scores	ME RMSE
Method	01) Nearest point 3D optimized Algoritm:id_order=1

Figure 99 Verification Report

The system displays the related report with all the verification information. **It is recommended to retain the number id of each created verification in order to search it faster when you need to retrieve it.**

The 'Execute' button appears only when data are available and only if the verification is Date Interval (like this example). If the verification is periodical, the report can be saved in 'Verification Archive, where it can be retrieved in order to run the scores for each month or season (See Report menu). By clicking on "Execute" button at the bottom of the page, the system runs the scores By clicking on 'Duplicate' button a new Verification GUI with the already set parameters opens, so the user can create a similar verification by changing only few parameters.

The calculated scores are displayed on a new page, so user can save them in an ASCII file or in an Excel file.

From: 2011-08-01 To: 2011-08-31

Step	Index Value	Number Value
From: 2011-08-01 To: 2011-08-31		
0	2.76083	813
3	2.71805	603
6	2.38327	1043
9	1.5237	847
12	2.05437	1046
15	1.95221	862
18	2.03128	1015
21	1.80368	648
24	2.48531	813
27	2.69815	603
30	2.43402	1043
33	1.59206	847
36	2.14304	1046
39	1.98464	862
42	1.99717	1015
45	1.78304	648
48	2.55933	813
51	2.7633	603
54	2.54093	1043
57	1.69752	847
60	2.31176	1046
63	2.08958	862
66	1.99909	1015
69	1.80489	648
72	2.61468	813

Save Excel | Save Text | Save Text Geo | Configure | Back

Figure 100 Score Report

If the geographical distribution box is checked, the system calculates the scores for each individual station. (See also Report Menu-> Standard Verification Search)

☞ Versus is able to configure the verification plot by clicking on “Configure” button.

To configure the plot Versus displays different web GUI related to the type of data and index.

- ✓ Surface data with continuous index
- ✓ Surface data with dichotomous index
- ✓ Upper air data with continuous index

If user re-runs the scores, the previous scores are deleted and recalculated.

For periodical verifications, the user should first check if there are available data for each timescale (month or season), by the Data Availability option of the Report menu.

Periodical verifications (monthly or seasonal) can be executed in two ways:

- ✓ **by means of batch execution**
- ✓ **on-demand** through Web GUI .

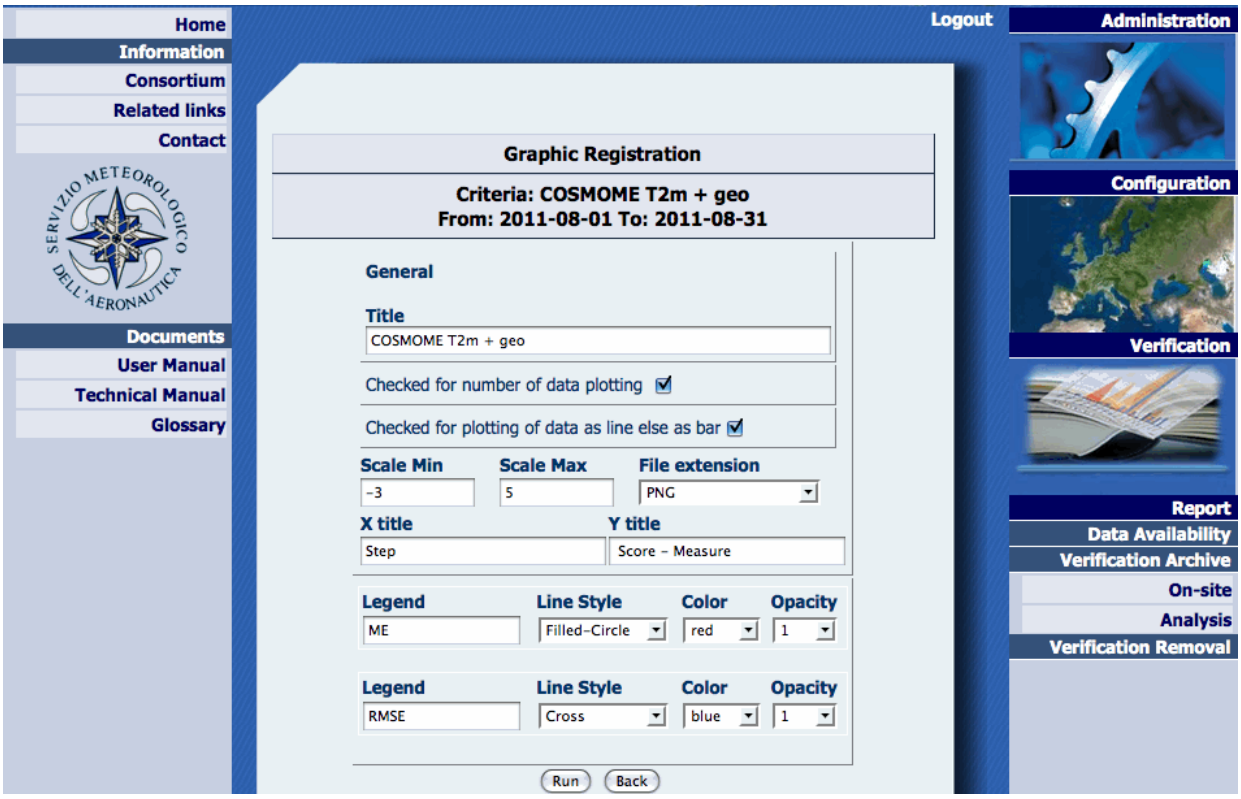


Figure 101 Graphic configuration for Verification with Continuous index

Continuous scores graphics

For graphic configuration of **continuous index** user can select:

- The generic title
- if check for plotting the number of paired data
- if check for plotting data as line or bar
- A data range
- A title for x axis
- A title for y axis
- Color and style for each line in the plot

Finally, by clicking on Run button the graph is created as shown in the following figure:

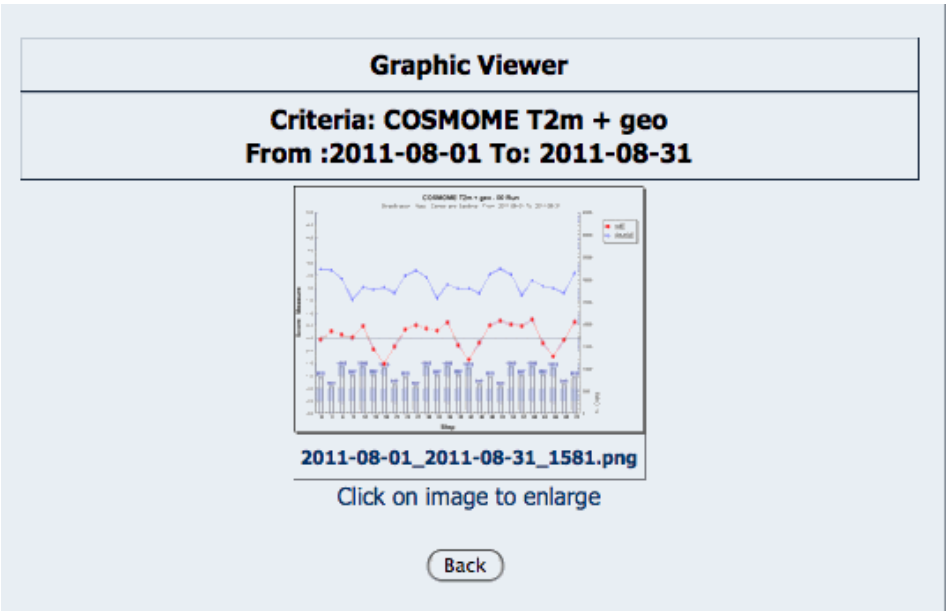


Figure 102 Preview of Verification Plot with Continuous index

Confidence Levels for continuous scores are plotted on the same graph

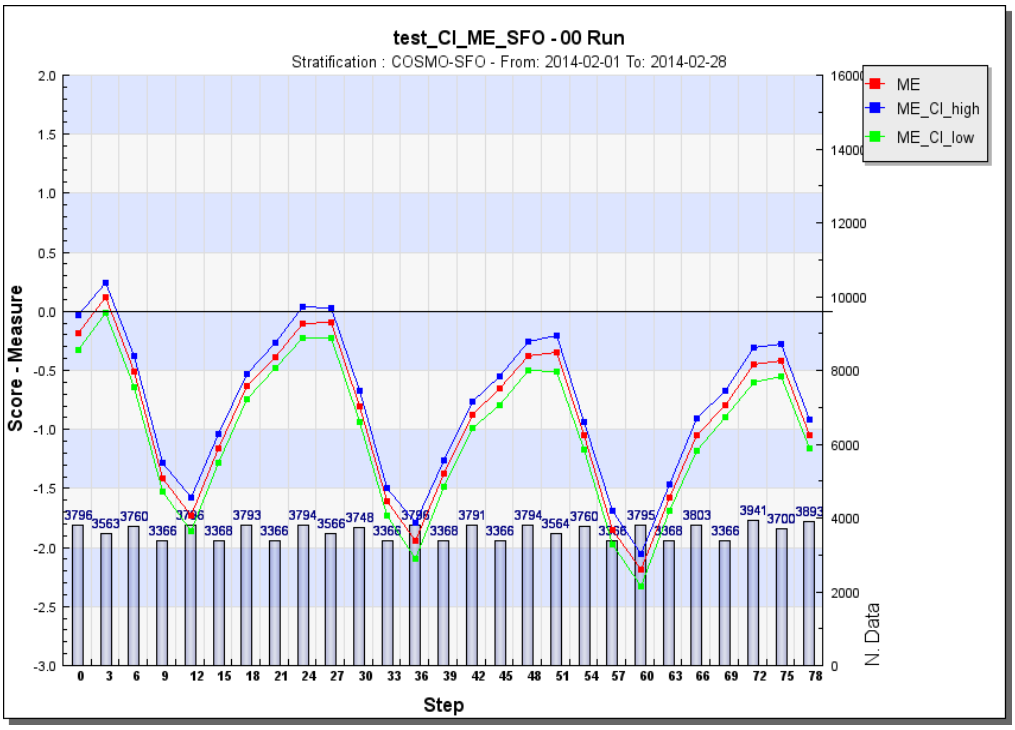


Figure 103 Example of Continuous score plot with CIs (plotted on the same graph)

Dichotomous scores graphics: Two types of dichotomous scores can be created::

By step, where x-axis represents time steps and lines or bars are plotted for different thresholds.

By threshold, where x-axis represents threshold values and lines or bars are plotted for different timesteps

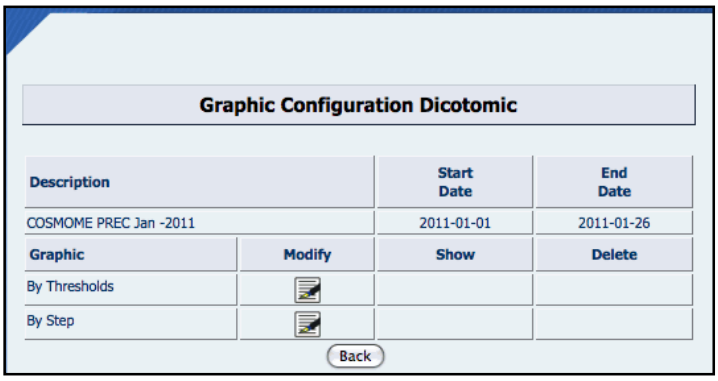


Figure 104 Dichotomous graphic configuration

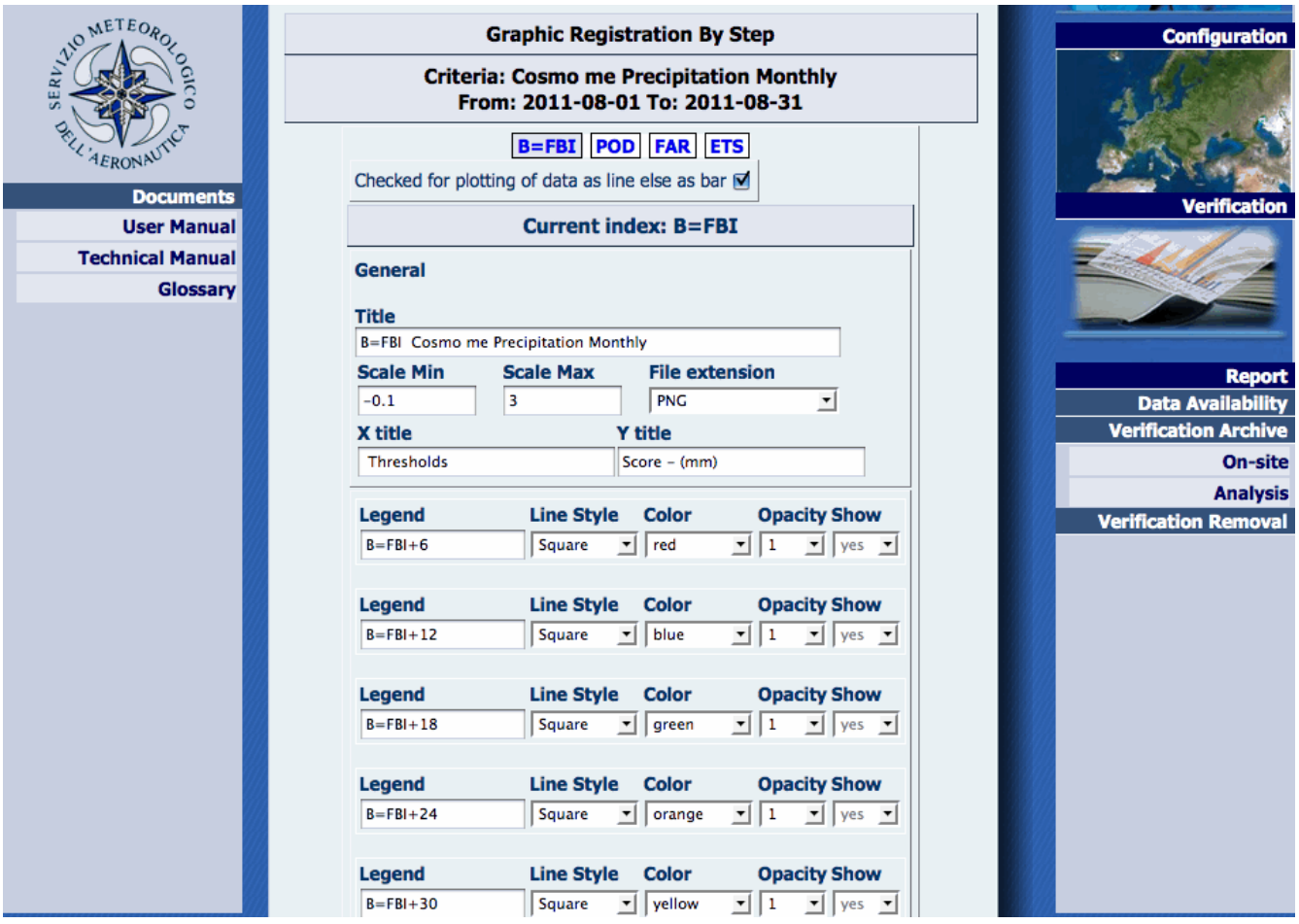


Figure 105 Graphic configuration By Threshold

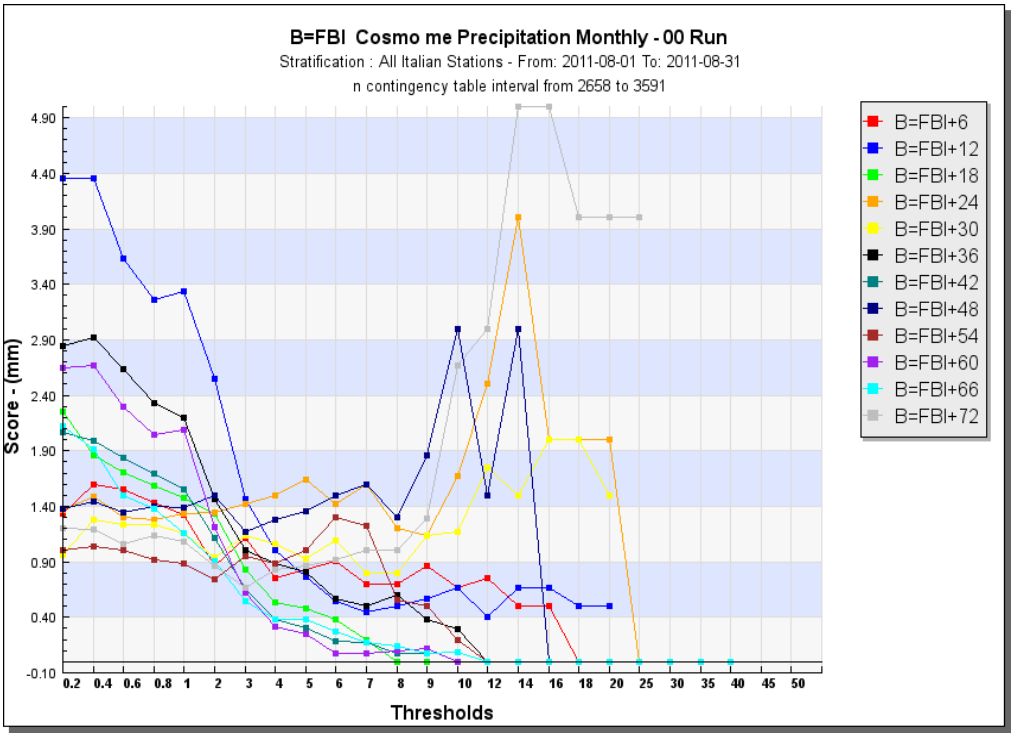


Figure 106 Example of line graphic by threshold

Figure 107 Graphic Configuration by Step (bar)

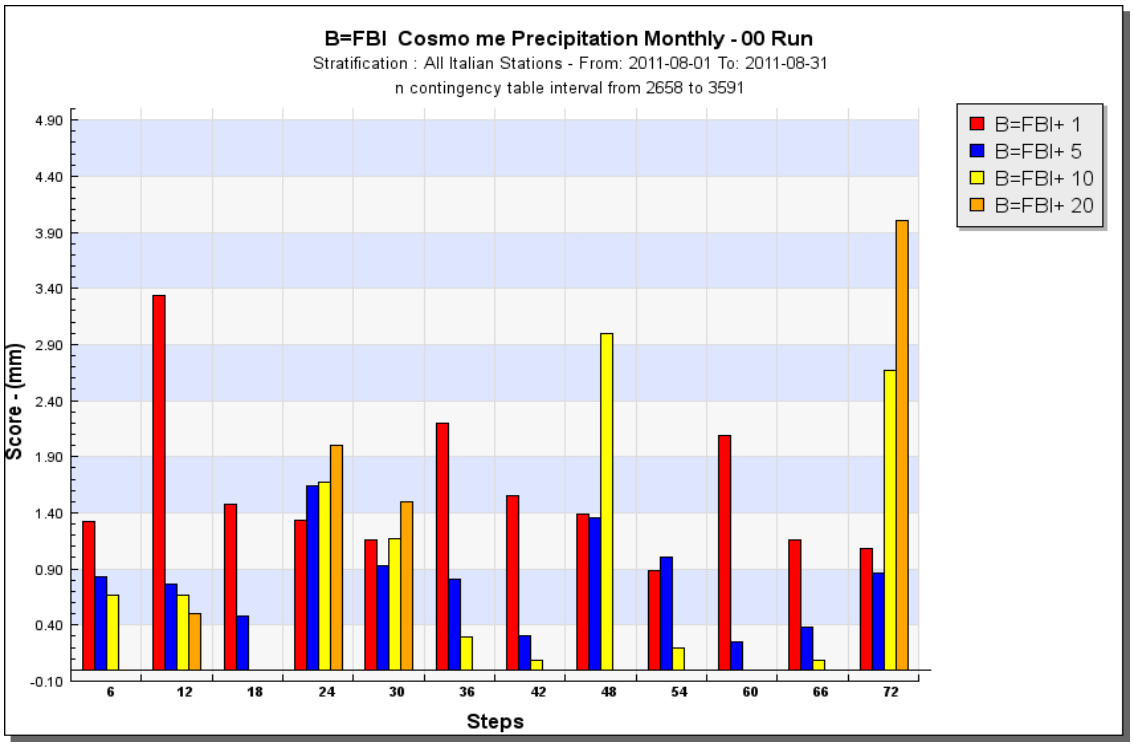


Figure 108 Example of bar graphic by step

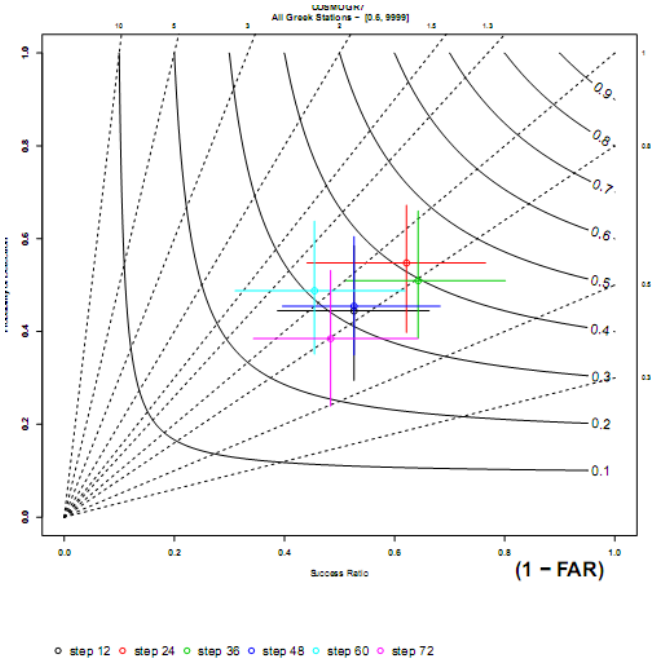
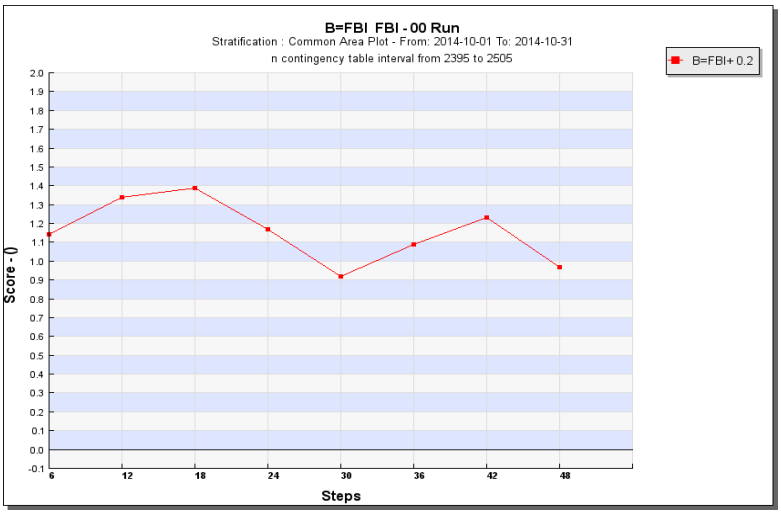
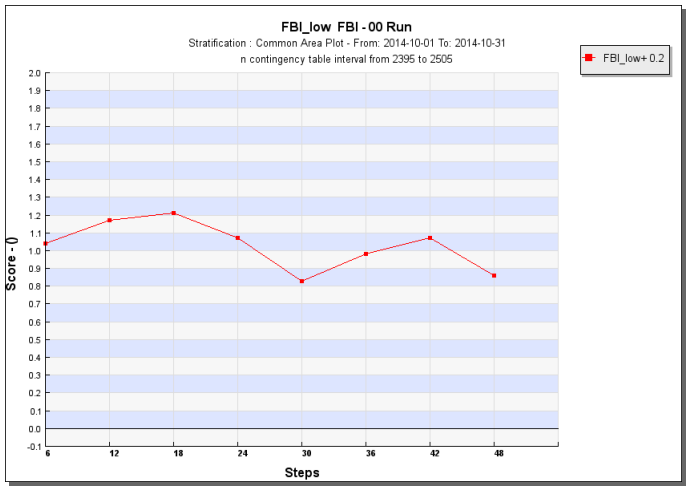


Figure 109 Example of Performance Diagram

Performance Diagrams for each threshold are automatically calculated and can be downloaded by retrieving the Verification (see Report Menu)

The confidence levels for dichotomous scores are calculated in different plots





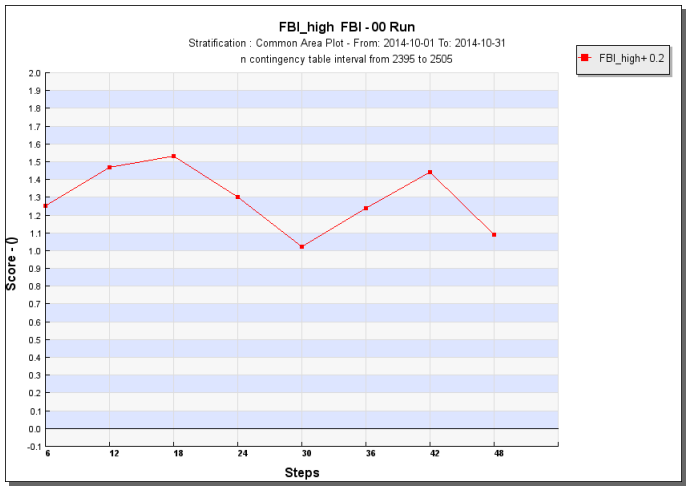


Figure 110 FBI, FBI high, FBI low

For probabilistic models the system configures automatically as many verifications as the members the user selects. By selecting a probabilistic model the system enables the member selection menu as follows:

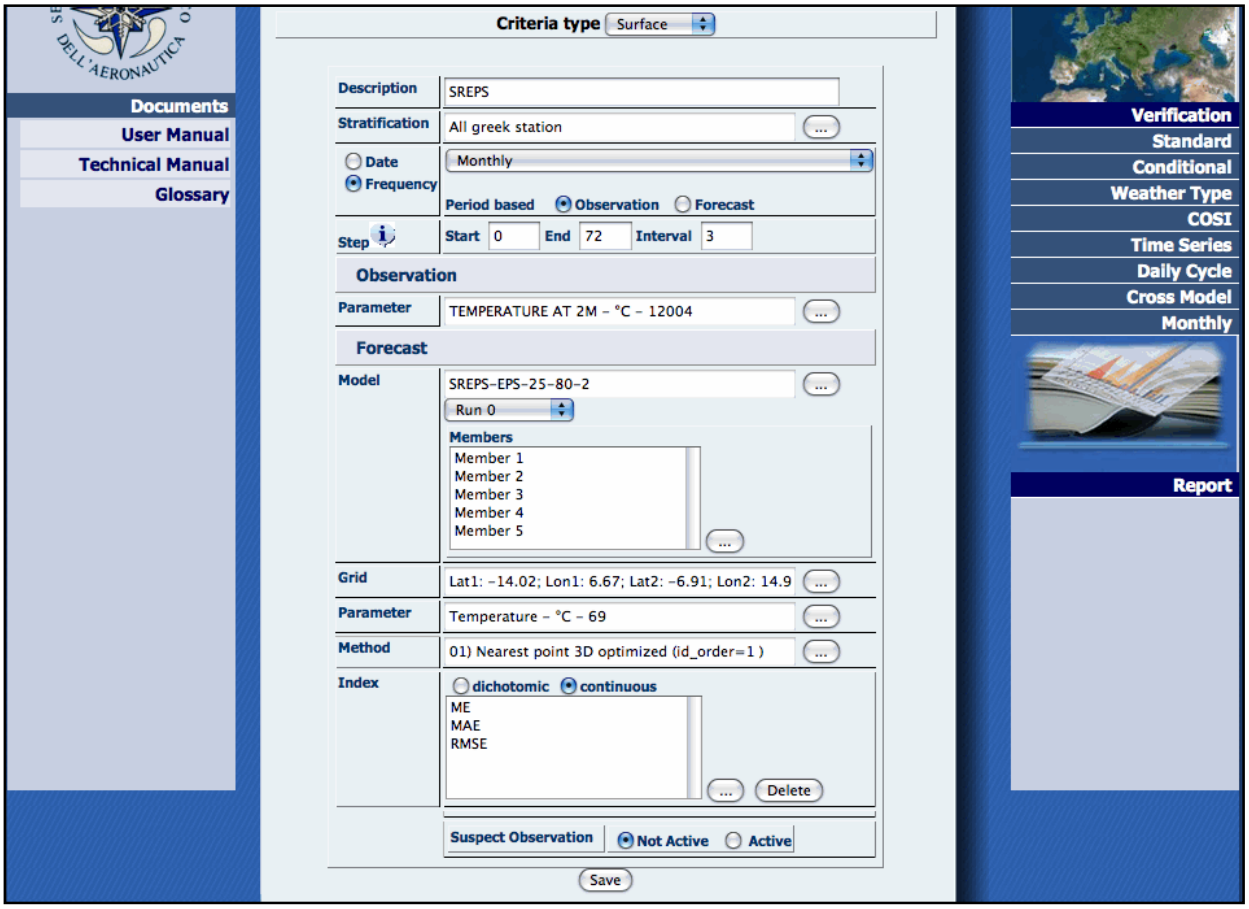


Figure 111 Standard Verification Registration for probabilistic model

By clicking on ‘Save’ the system displays the reports of the created verifications :

Figure 112 Standard Verification Report for probabilistic model

For Upper air type criteria the system displays the following form:

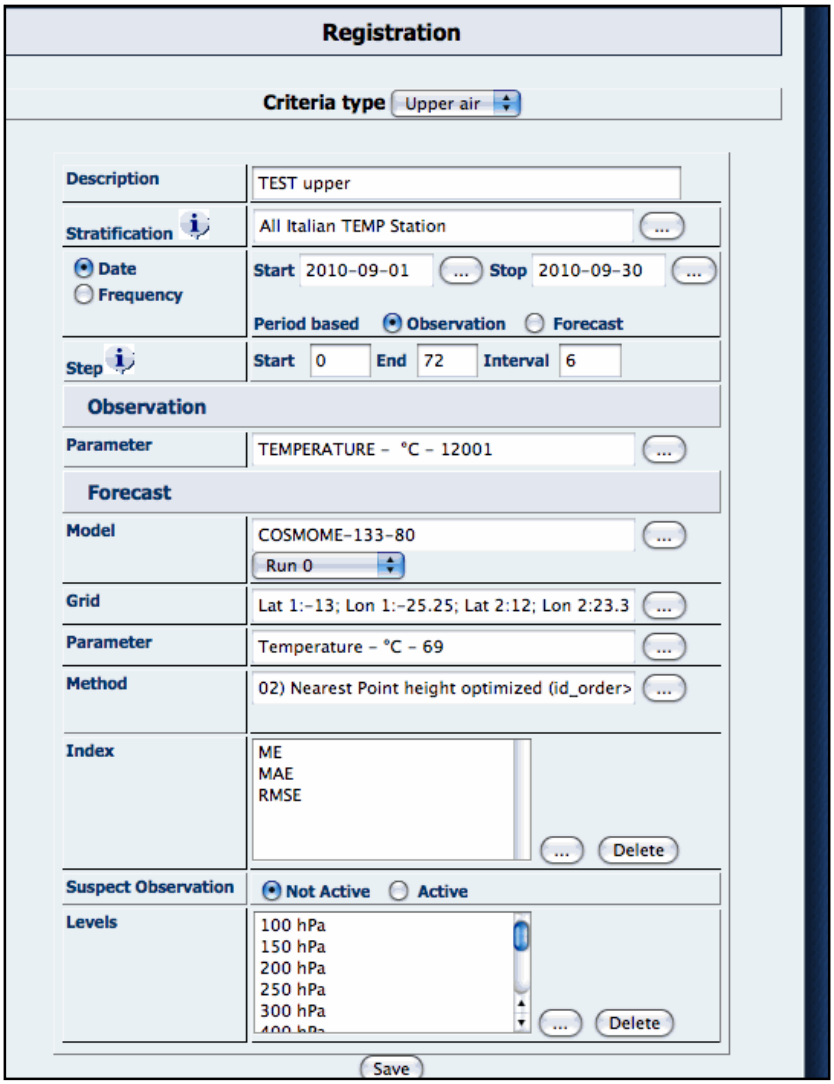


Figure 113 Standard Verification Registration for upper air data

To configure a Standard verification on upper air data the user needs to enter the same information as for the surface data, change the Criteria Type field to “Upper air” and select the levels of interest. The verification is performed between radiosonde data in BUFR format and model data on pressure levels.

By clicking on ‘Save’ button, and assuming that data are available to calculate the scores, the system displays the following GUI for this data interval example.

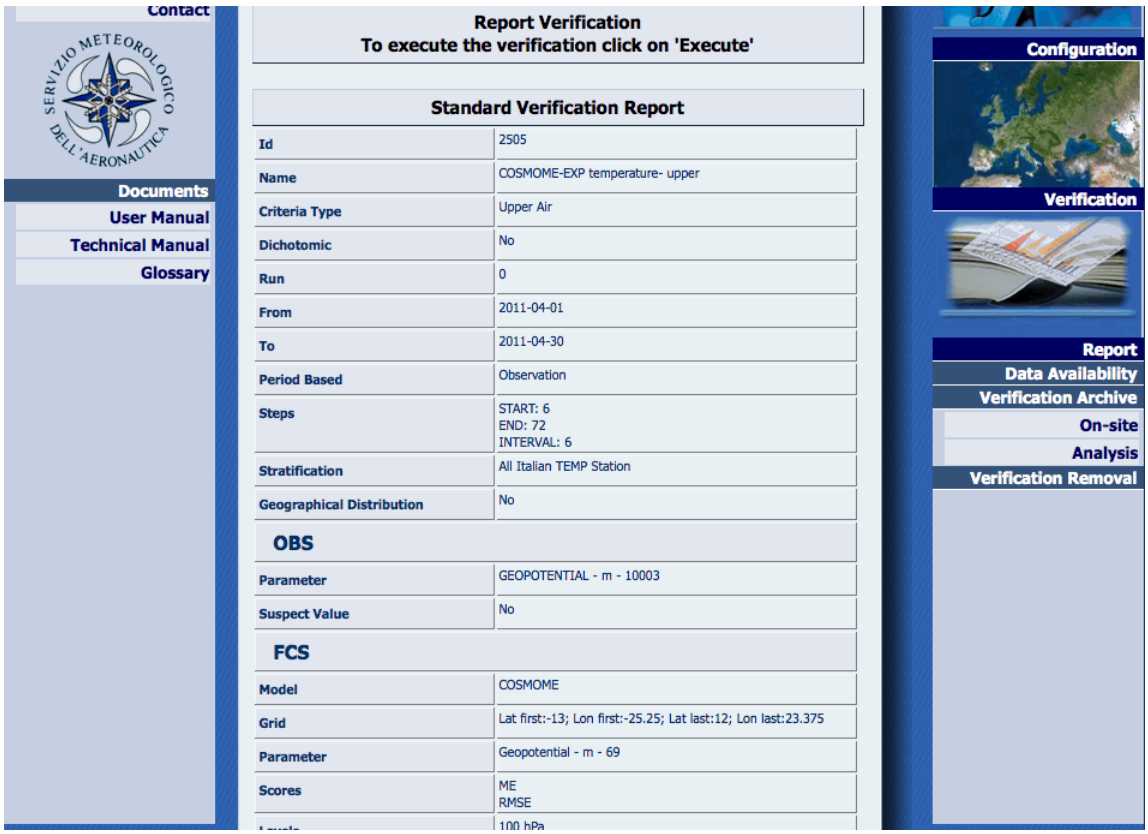
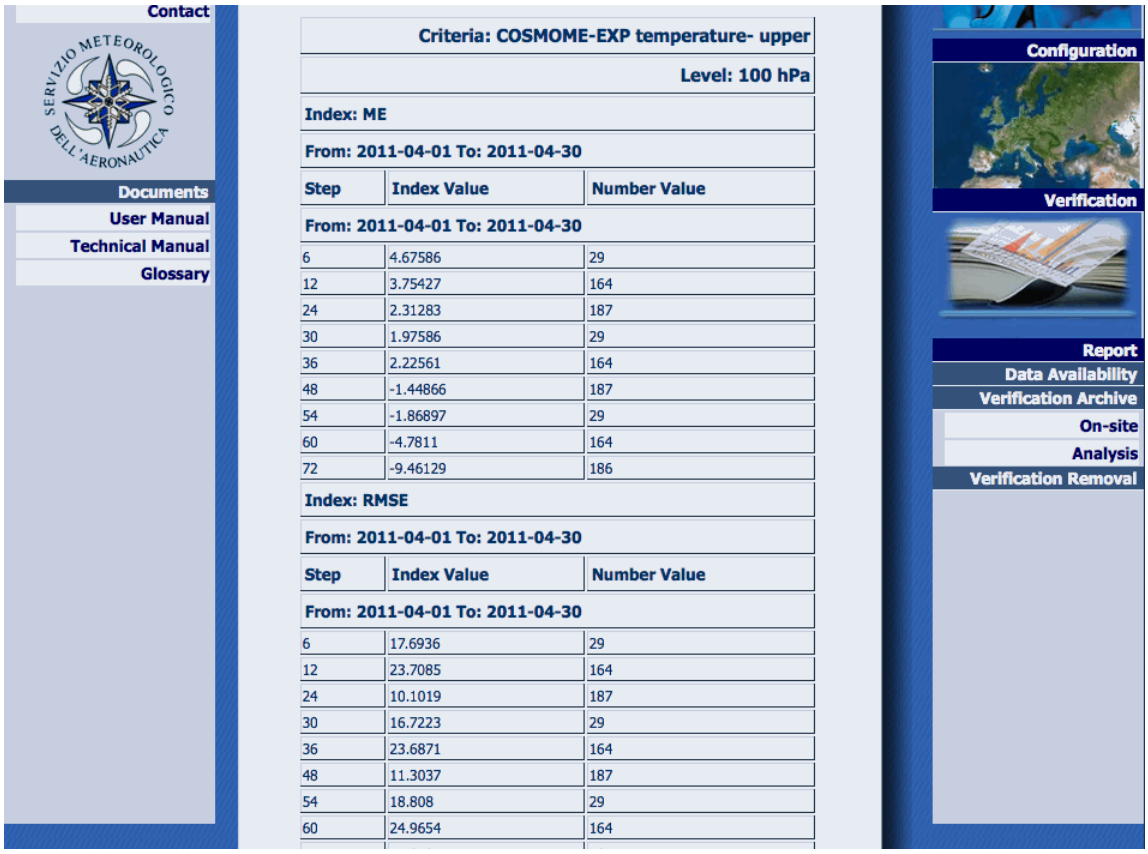


Figure 114 Standard Verification Report for upper air data

By clicking on Execute button the system runs the scores and a GUI appears, displaying the results which can be saved in text or excel format:



Criteria: COSMOME-EXP temperature- upper		
Level: 100 hPa		
Index: ME		
From: 2011-04-01 To: 2011-04-30		
Step	Index Value	Number Value
From: 2011-04-01 To: 2011-04-30		
6	4.67586	29
12	3.75427	164
24	2.31283	187
30	1.97586	29
36	2.22561	164
48	-1.44866	187
54	-1.86897	29
60	-4.7811	164
72	-9.46129	186
Index: RMSE		
From: 2011-04-01 To: 2011-04-30		
Step	Index Value	Number Value
From: 2011-04-01 To: 2011-04-30		
6	17.6936	29
12	23.7085	164
24	10.1019	187
30	16.7223	29
36	23.6871	164
48	11.3037	187
54	18.808	29
60	24.9654	164

Figure 115 Standard Verification Score for upper air data

If the Verification is configured for Date Interval at the end of the page it is possible to configure the plot by clicking on Configure button, and the system displays the following GUI:

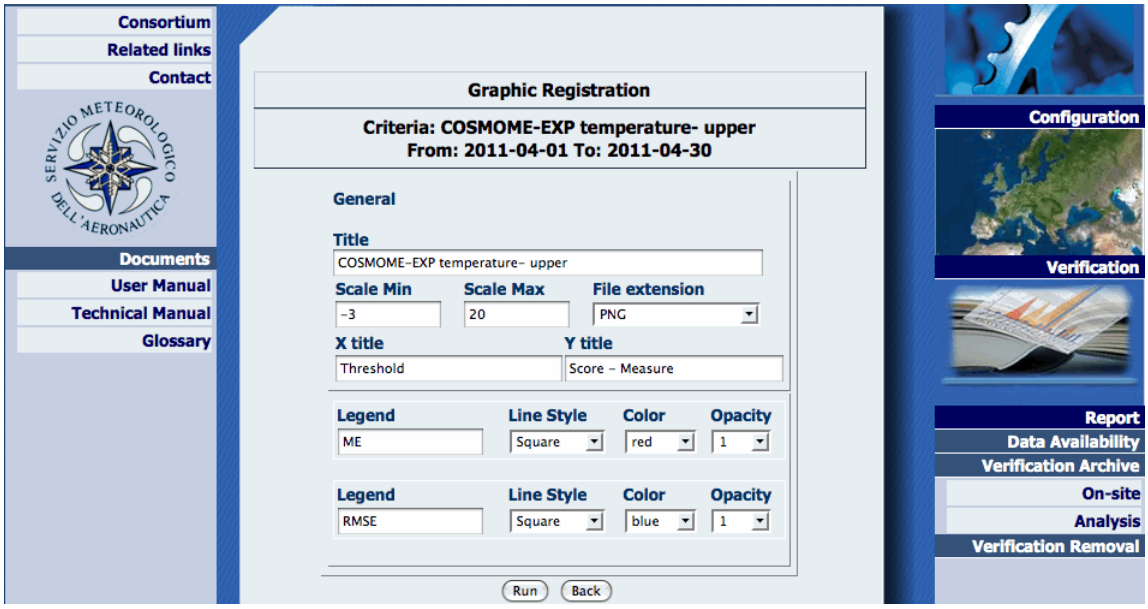


Figure 116 Standard Verification Graphic Configuration for upper air data

By clicking on Run button the system displays a graph that contains all steps plotted at the same time, and a list of individual plots for each step configured in the verification:

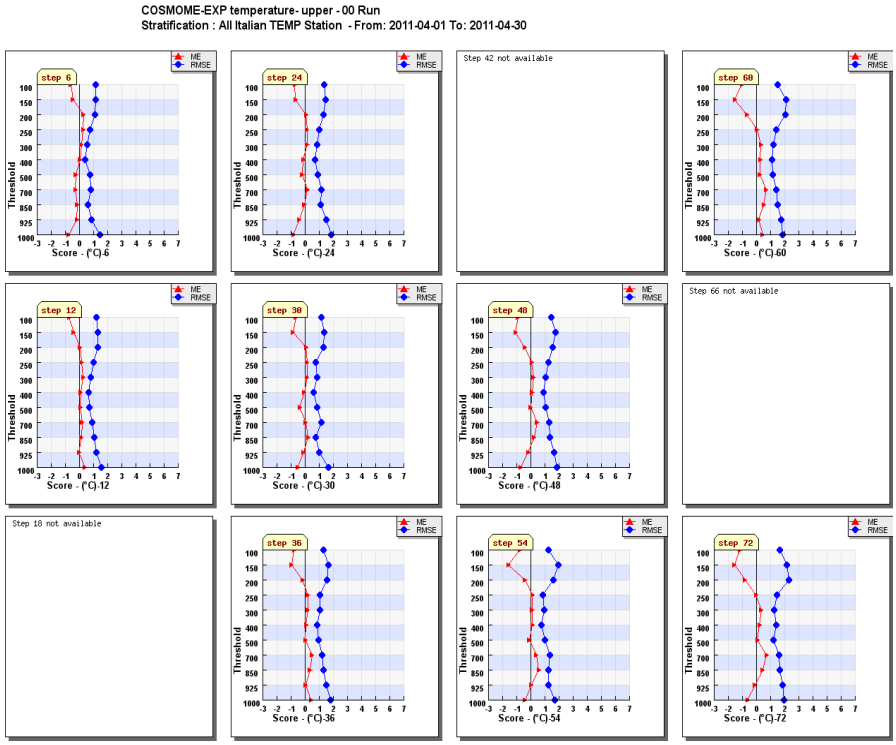


Figure 117 Standard Verification Graphic for upper air data-global plot

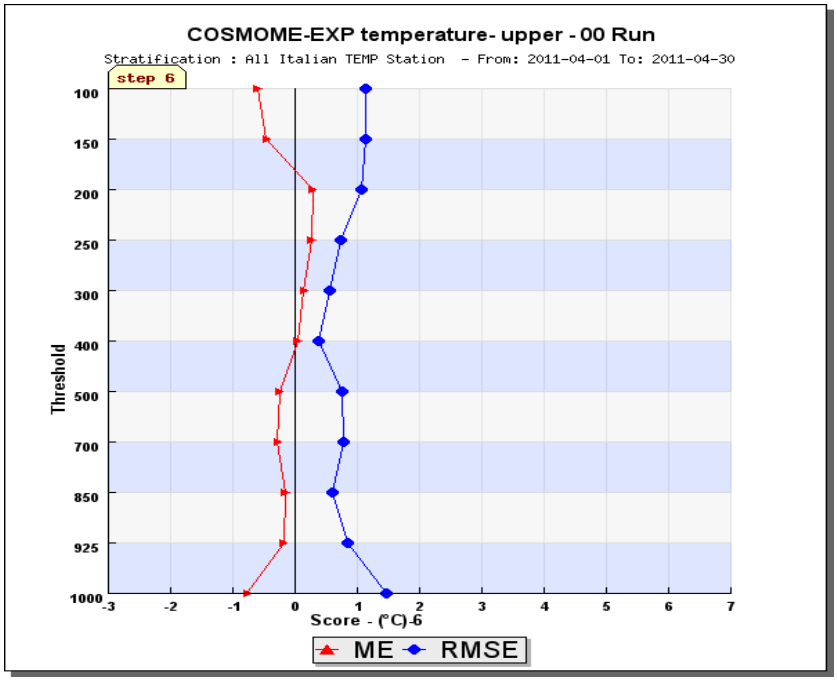


Figure 118 Standard Verification Graphic for upper air step-6

4.3.1.2 Analysis STANDARD VERIFICATION

To create a standard verification using analysis data , the user must click on option “Standard” ->Analysis on verification menu, and the system displays the following GUI:

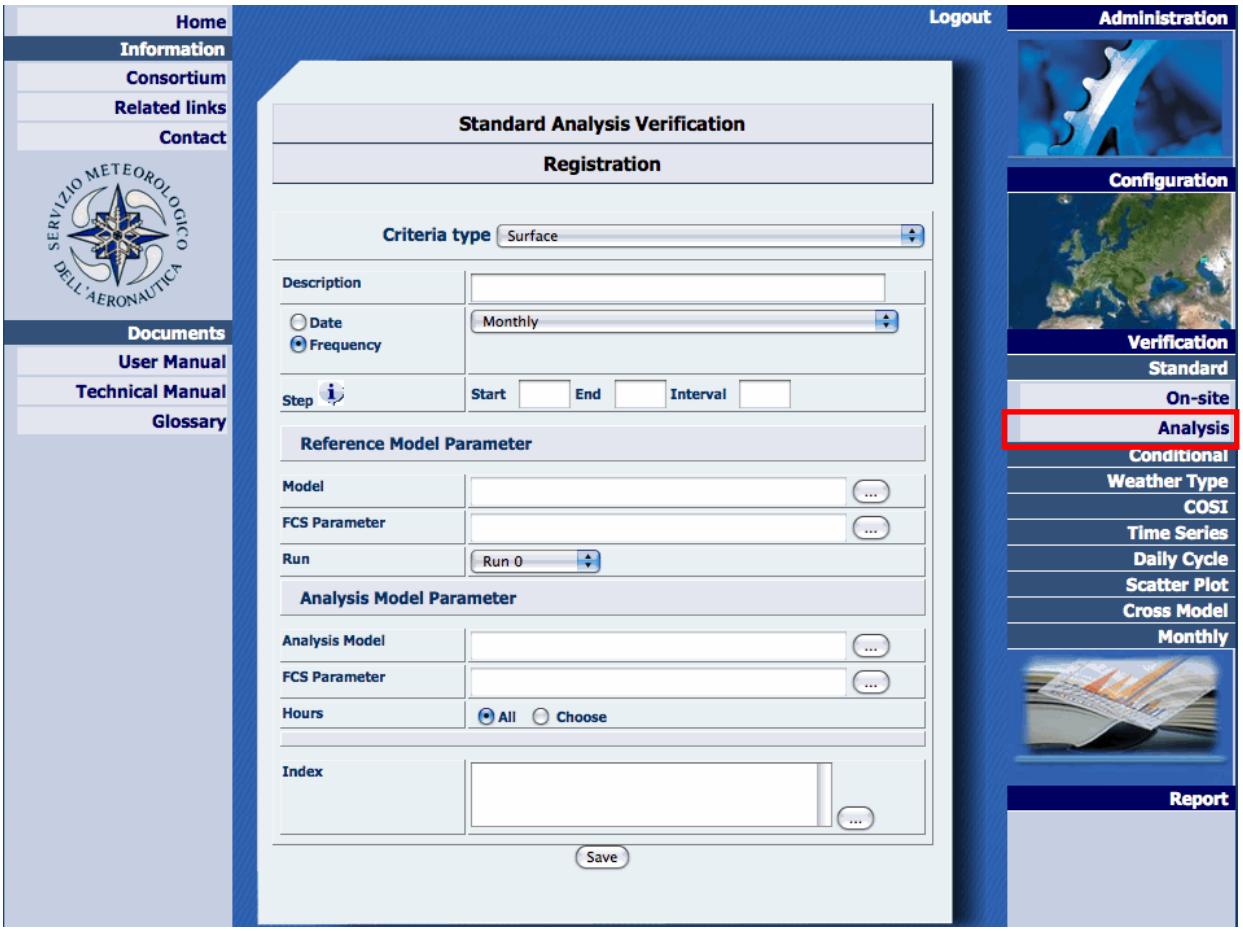


Figure 119 Analysis Standard Verification Registration

To create a standard verification based on gridded data , the following information is needed:

Criteria Type: it can be Surface or Upper air.

Description: a name to identify the verification.

Stratification: the ensemble of stations for scores calculation .

Date/Frequency: a data time series defined either by start and end date or a periodical timescale that can be ‘Monthly’ or ‘Seasonal’.

Steps: start, end and interval time step for verifications.

Steps: start, end and interval step for verifications. The interval step must be consistent with the frequency of available model outputs

In particular for precipitation verifications the steps must be the following:

For 24hourly precipitation: start=24, end=end of simulation, step=24

For 12hourly precipitation: start=12, end=end of simulation, step=12

For 6hourly precipitation: start=6, end=end of simulation, step=6

Reference Model Parameter options concern data related to model to be verified:

Model: the model to be verified

FCS Parameter: the reference model forecast parameter

Run: the reference model run

Analysis Model Parameter: Contains information on analysis gridded data which are used instead of observations:

Model : the analysis model name

FCS Parameter: the analysis model parameter

Hours: By selecting 'All', all the available hours are taken into account for comparison with the reference model run, otherwise the user can select the ones he wants.

Index: the selection is among the continuous indexes ME,MAE,MSE,RMSE

Example.

Creation of a verification **on surface Analysis data from 01 August 2011 to 31 August 2011:**

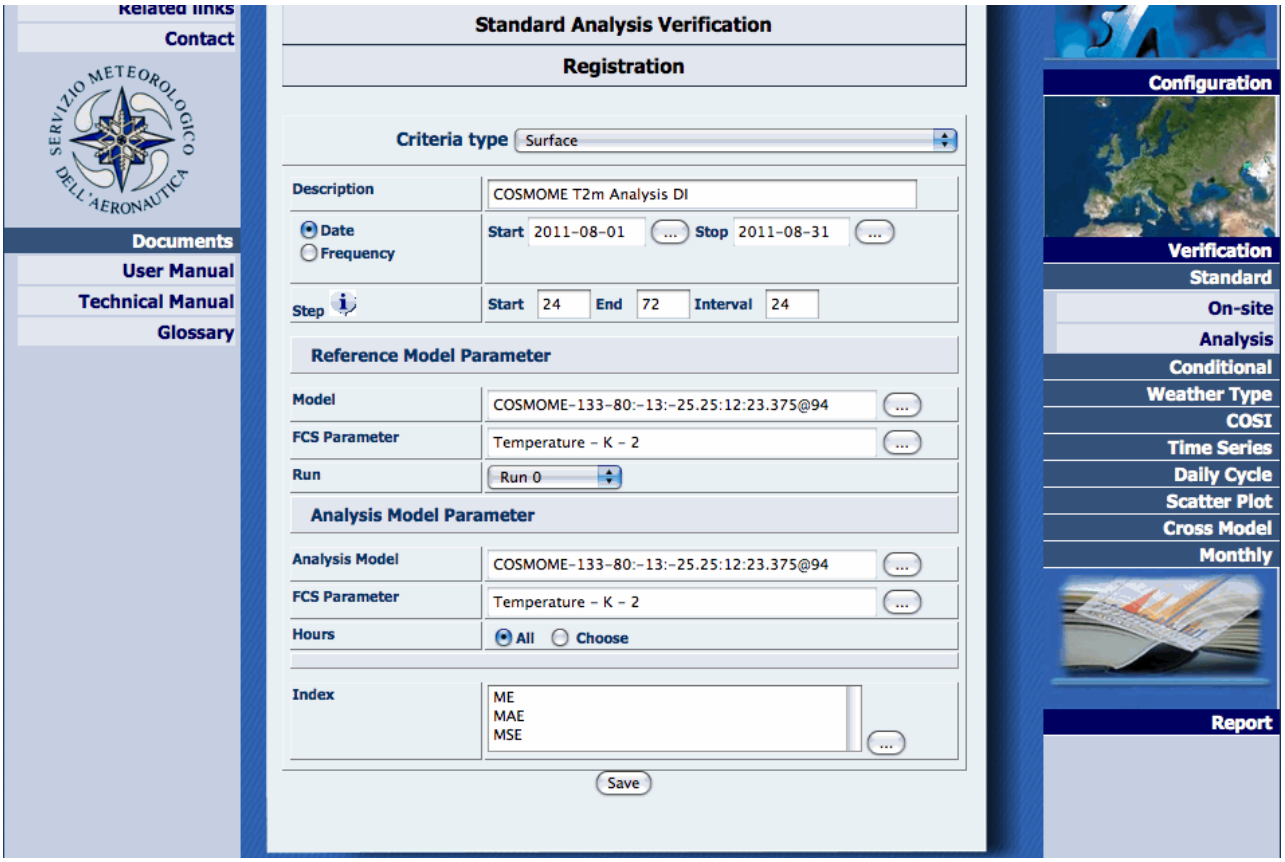
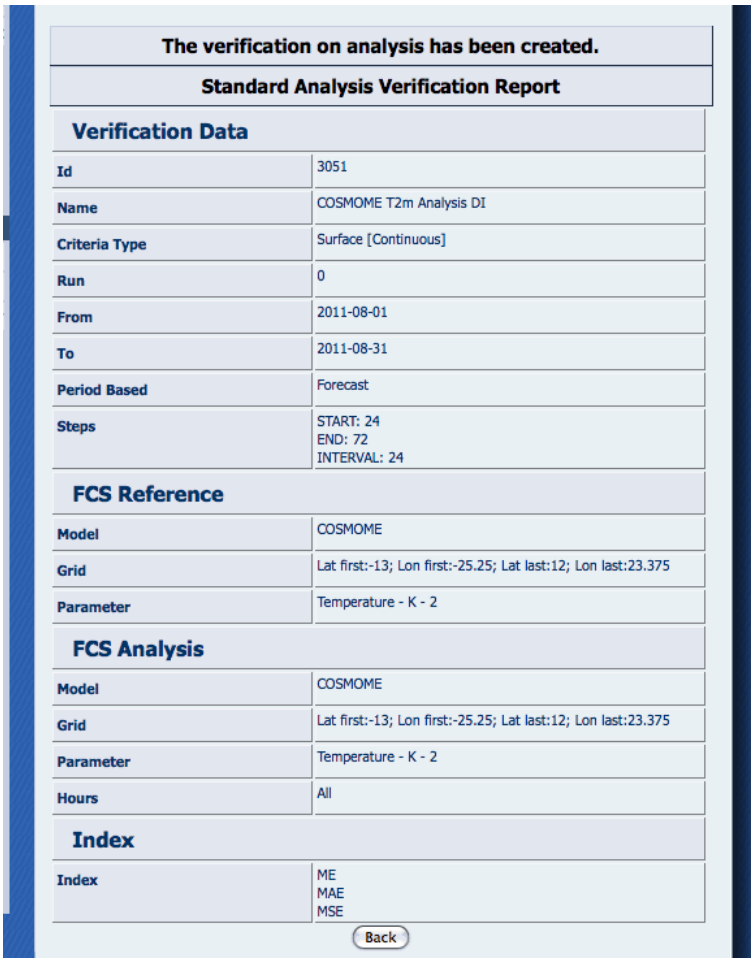


Figure 120 Surface analysis Standard Verification

By clicking on ‘Save’, the system displays the new verification report. .



The verification on analysis has been created.

Standard Analysis Verification Report

Verification Data

Id	3051
Name	COSMOME T2m Analysis DI
Criteria Type	Surface [Continuous]
Run	0
From	2011-08-01
To	2011-08-31
Period Based	Forecast
Steps	START: 24 END: 72 INTERVAL: 24

FCS Reference

Model	COSMOME
Grid	Lat first:-13; Lon first:-25.25; Lat last:12; Lon last:23.375
Parameter	Temperature - K - 2

FCS Analysis

Model	COSMOME
Grid	Lat first:-13; Lon first:-25.25; Lat last:12; Lon last:23.375
Parameter	Temperature - K - 2
Hours	All

Index

Index	ME MAE MSE

Back

Figure 121 Analysis surface Standard Verification report

By selecting Report ->Verification Archive->Analysis, it is possible to find the created verification and run it:

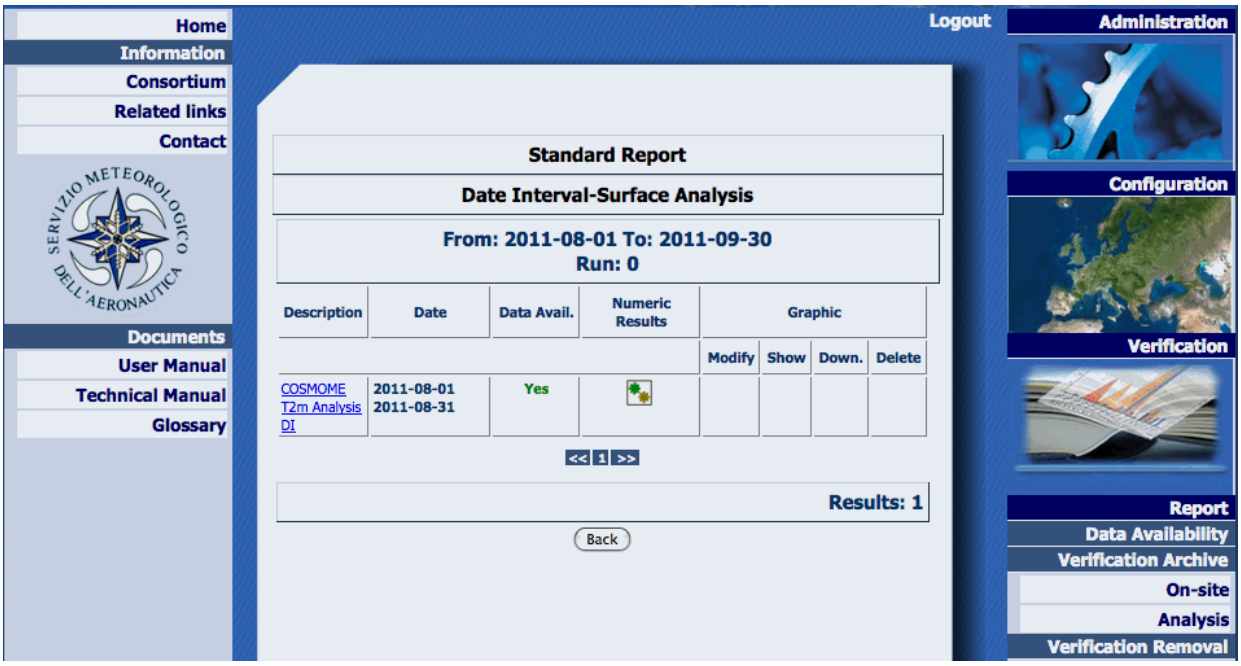


Figure 122 Analysis surface Standard Verification list

The graphic related to this verification is:

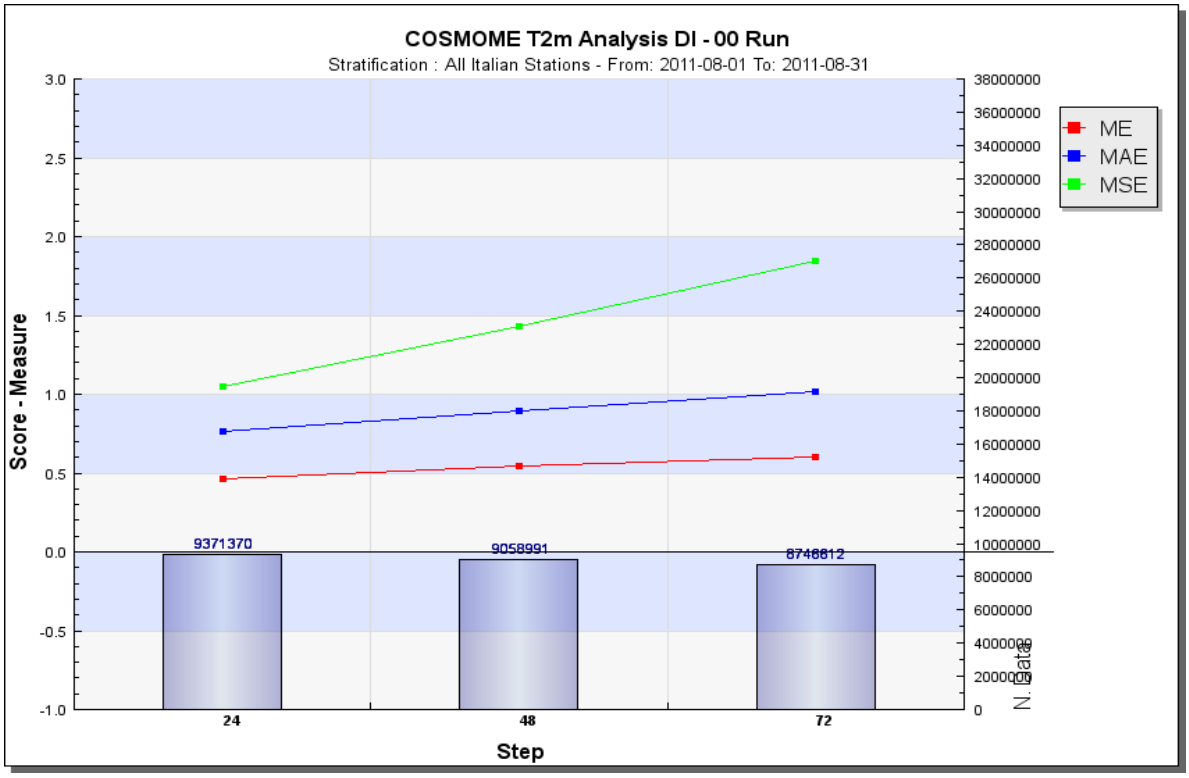


Figure 123 Analysis surface Standard Verification graphic

It is also possible to create verifications on Upper Air data, but in this case pressure levels must be selected.

4.3.1.3 Standard Verification for ENSEMBLE PREDICTION MODEL SYSTEMS

A Standard EPS Verification calculates probability statistical scores and diagrams for Ensemble Prediction model Systems.

To register a new Standard EPS Verification, user should click on option Standard (EPS) of the Verification Menu, and the system displays the following form:

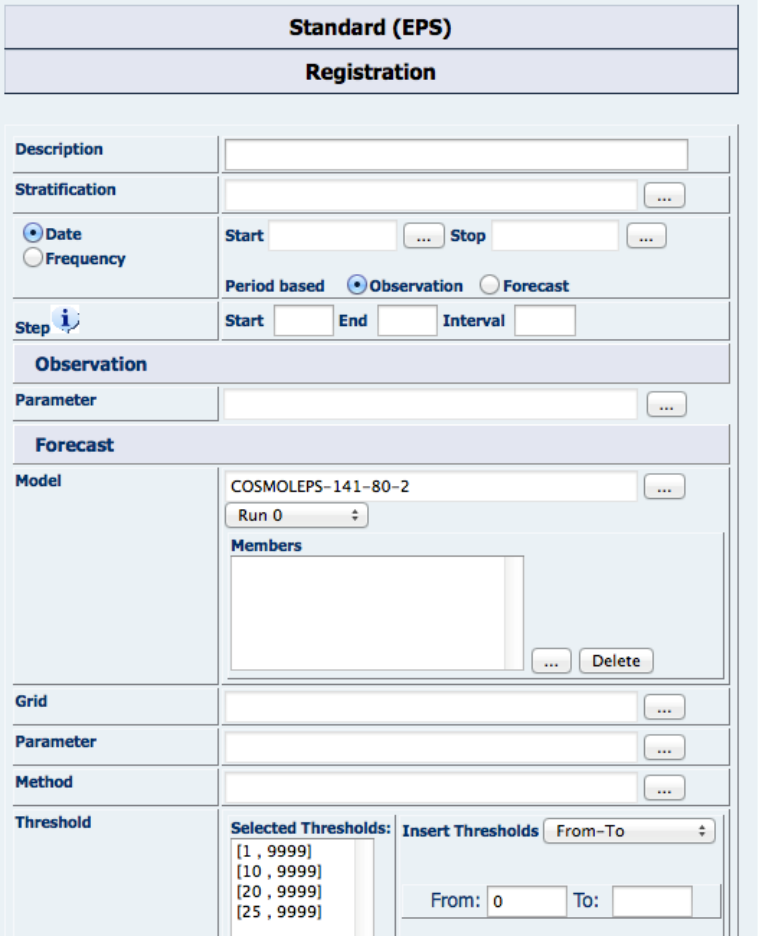


Figure 124 EPS Verification Registration

To create an EPS Standard Verification the following information is needed:

Description: a name to identify the verification.

Stratification :the ensemble of stations for scores calculation.

Date/Frequency :a data time series defined either by start and end date or by a periodical timescale which can be 'monthly' or 'seasonal'.

Period Based: On Observations or forecasts.

Step: start, end and interval step for verification. For dichotomous parameters it is also possible to verify the day/night cycle. For example the night cycle is configured by setting start=0, interval=12.

Observation: observation parameter .(Precipitation for this example)

Model: the probabilistic model to verify

Run: the model run

Members : the selected model members Selection of Member 0 is also possible.

Grid: the latitude and longitude boundaries of the selected model grid **.**

Parameter: Forecast parameter to verify

Method : the model interpolation method

Thresholds: Specify the Thresholds for scores calculation. User can specify and insert/delete thresholds

The calculated EPS scores are BRIER, BRIER Skill, Brier Decomposition (Reliability, Resolution, Uncertainty), RPS (Rank Probability Score), RPSS (Rank Probability Skill Score), RPS climatology, CPRS (Cumulative Probability Skill Score), CPRSS (Cumulative Probability Skill Score), SPREAD, ERROR, ROC Area and Outliers.(See Apprendix for short descriptions). Confidence intervals of scores are also calculated.

The EPS diagrams are ROC, Reliability, Cost Loss and Rank. T**here is no possibility for selection of EPS scores and diagrams, they are all calculated for each verification.** RPS and RPSS scores are consistent only with MECE (Multi Category Probability Forecasts) thresholds.

By clicking on 'Save' the verification is created and saved in the Verification Archive., The system checks what type of intervals are configured. If intervals are not MECE (as is in the above example) the system converts them into MECE for the RPS, RPSS, RPSS.cli calculation. The created verification report is the following:

Grid	Lat first:-16.125; Lon first:-15.75; Lat last:9.75; Lon last:16.125
Parameter	Precipitation - mm - 2
EPS Diagrams	ROC, Reliability, Cost-Loss, Rank
Scores	BRIER BRIER-CI.High BRIER-CI.Low BRIER-reliability-CI.High BRIER-reliability-CI.Low BRIER-reliabily BRIER-resolution BRIER-resolution-CI.High BRIER-resolution-CI.Low BRIER-SKILL BRIER-SKILL-CI.High BRIER-SKILL-CI.Low BRIER-unc-CI.High BRIER-unc-CI.Low BRIER-uncer CRPS-CI.High CRPS-CI.Low CRPSS ERROR Outliers RMSE3 ROC area RPS RPS-CI.High RPS-CI.Low RPS-clim-CI.High RPS-clim-CI.Low RPS.clim RPSS RPSS-CI.High RPSS-CI.Low SPREAD
Thresholds	[1 , 9999] [10 , 9999] [20 , 9999] [25 , 9999]
RPS/RPSS Thresholds	[-9999 , 1] [1 , 10] [10 , 20] [20 , 25] [25 , 9999]
Members	Member 1

Figure 125 Standard EPS Verification Report

The system converts the intervals used for the EPS verification into adequate intervals for RPS calculation.

Similarly to the Standard Verification, the system displays the related report with all the verification information. In case of a DATE INTERVAL verification, an availability check is performed automatically and if the specified data are available, “Execute” button appears and the system can run the scores.

If the verification is periodical (Monthly or Seasonal), the report is saved in ‘Verification Archive’, and needs to be retrieved in order to run the scores, See Report Menu- EPS Verification Search).

In the above example (Monthly Verification) after retrieving the Verification from the archive, the following menu for graphic configuration appears:

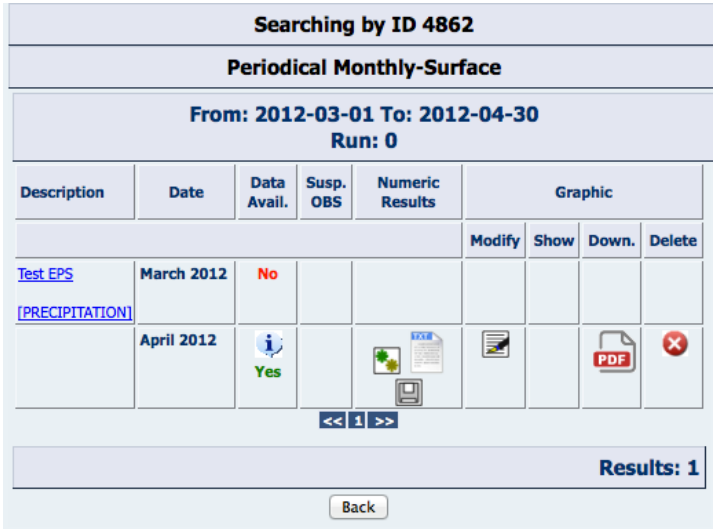
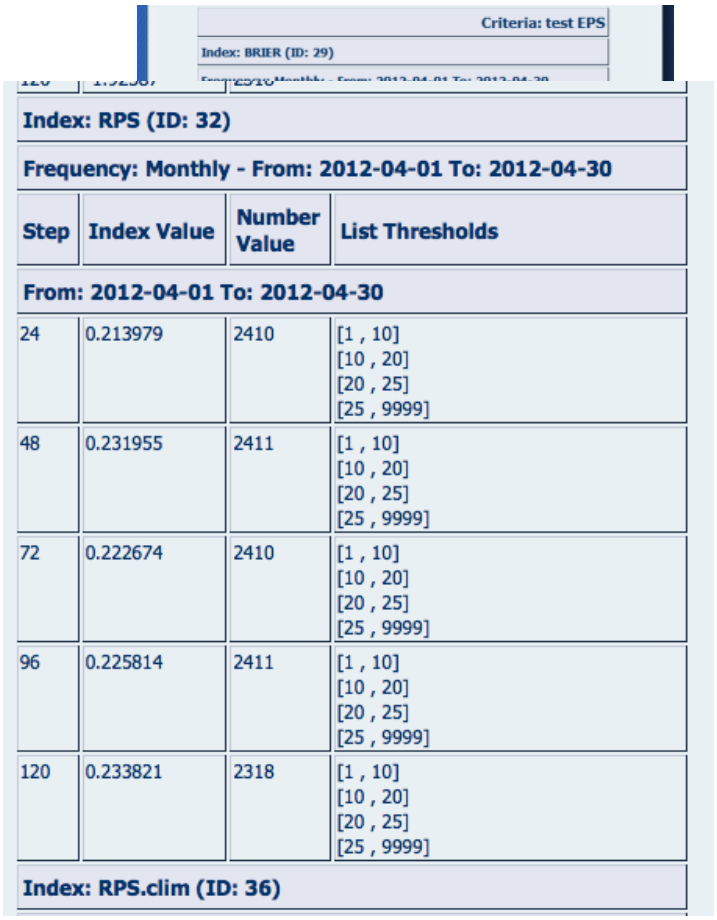


Figure 126 EPS Graphic tools menu

After clicking on ( )'Execute', the calculated scores are displayed , and the user can view them ( ) (Score Report) and save them in an ASCII file or in an Excel file.



Criteria: test EPS

Index: BRIER (ID: 29)

Index: RPS (ID: 32)

Frequency: Monthly - From: 2012-04-01 To: 2012-04-30

Step	Index Value	Number Value	List Thresholds
From: 2012-04-01 To: 2012-04-30			
24	0.213979	2410	[1 , 10] [10 , 20] [20 , 25] [25 , 9999]
48	0.231955	2411	[1 , 10] [10 , 20] [20 , 25] [25 , 9999]
72	0.222674	2410	[1 , 10] [10 , 20] [20 , 25] [25 , 9999]
96	0.225814	2411	[1 , 10] [10 , 20] [20 , 25] [25 , 9999]
120	0.233821	2318	[1 , 10] [10 , 20] [20 , 25] [25 , 9999]
Index: RPS.clim (ID: 36)			

Figure 127 Score report example for BRIER scores

Figure 128 Score report example for RPS score.

By clicking on ( )'Configure' option of the menu, the graphic Configuration menu appears and user can select configuring the graphic either by thresholds or by steps. **RPS, RPS.clim and RPSS values are plotted only by steps**

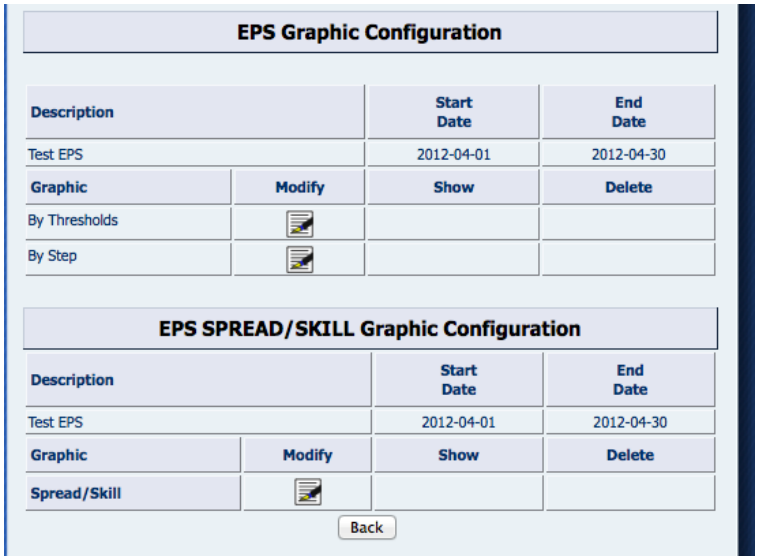


Figure 129 Graphic configuration menu

By clicking on 'modify' icon the following GUI appears where user can configure each score plot separately by selecting the desired one at the top of the page, specifying the y axis scale and the plot features.

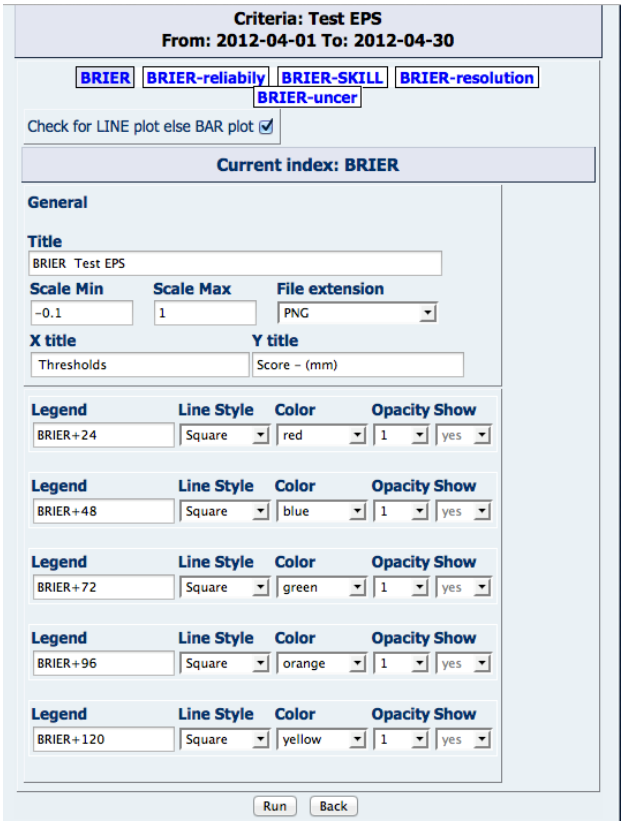


Figure 130 EPS Graphic Configuration by threshold (the possible scores that can be configured by threshold are shown on top of the form)

In this graph there is no possibility to activate the ‘Show Option’. The ‘Run’ button plots the scores

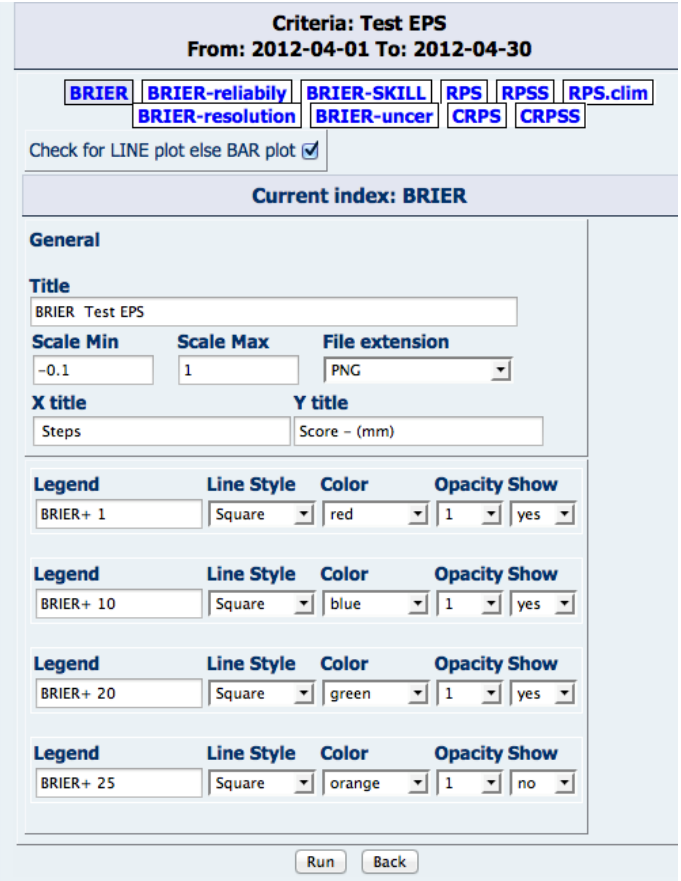


Figure 131 EPS Graphic Configuration by step (the possible scores that can be configured by step are shown on the top of the form)

In this graph there are the options “Show” for drawing or not the connected line and user can select ‘yes’ or ‘no’. In the graphic configuration of RPS, RPSS, RPS.clim, CRPS, CRPSS scores the option “Show” is disabled as in the following example for RPSS.

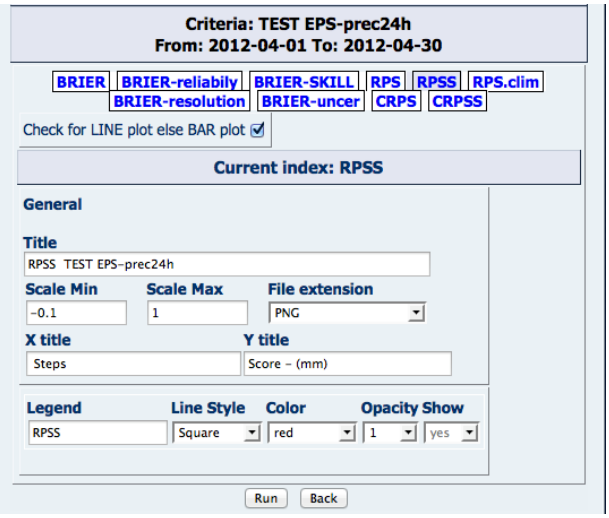
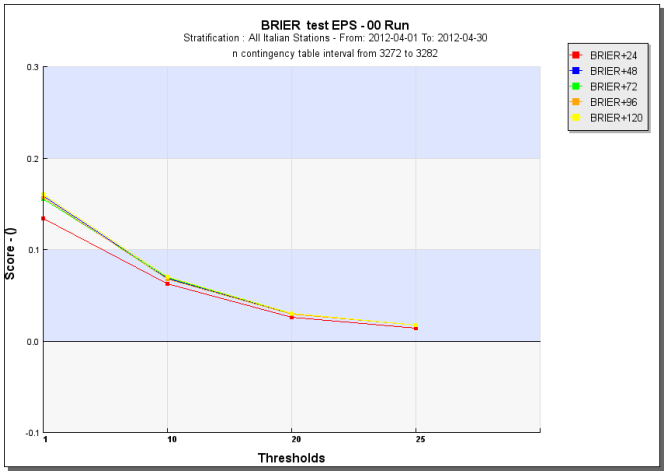


Figure 132 RPSS Graphic Configuration by step

For SPREAD/SKILL scores configuration. the menu is the following:

Figure 133 SPREAD/SKILL Graphic Configuration (Option "Show" does not appear)

Examples of line plots of EPS Scores line plots are given below:



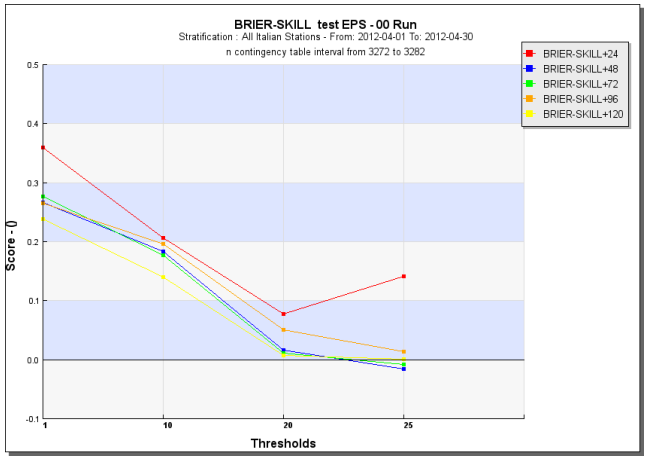
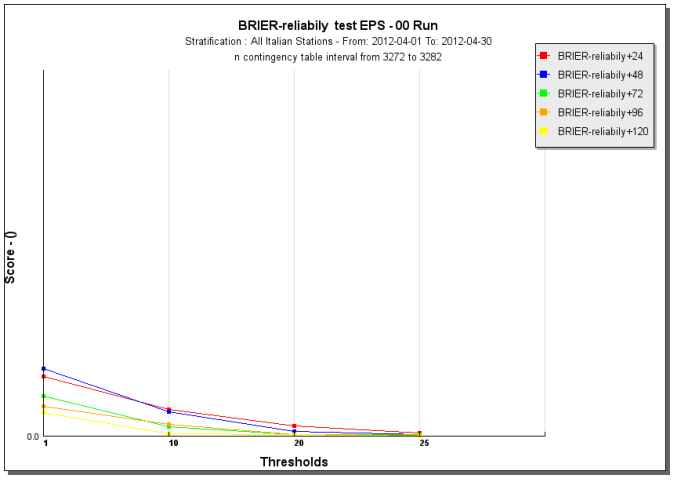


Figure 134 Brier and Brier Skill Scores Plots by Thresholds



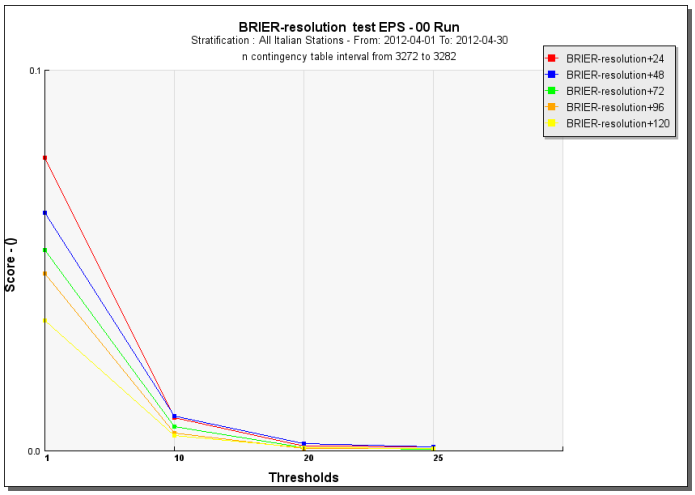
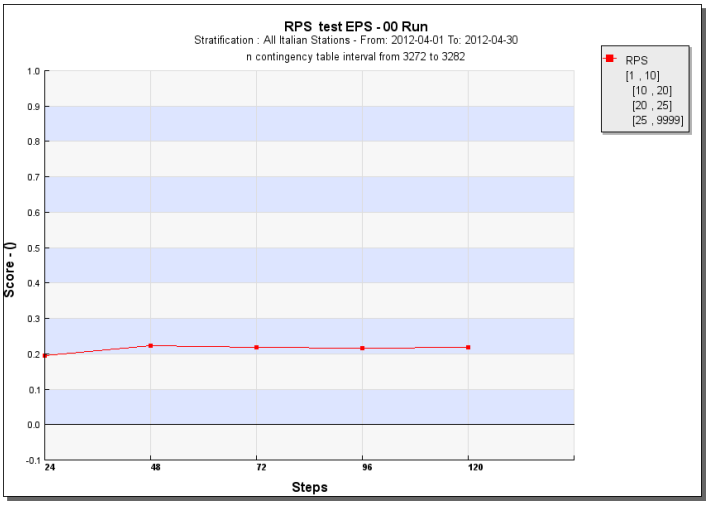


Figure. 135 Brier Reliability and Resolution by Thresholds



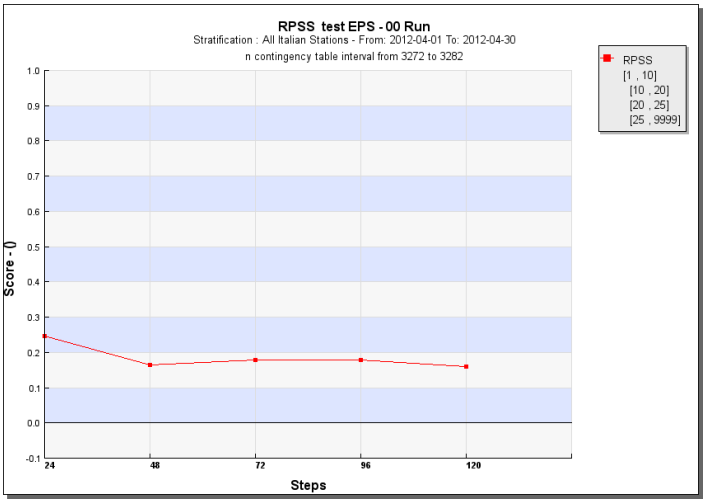


Figure 136 RPS and RPSS plots by steps

Figure 137 SKILL-SPREAD Graphics

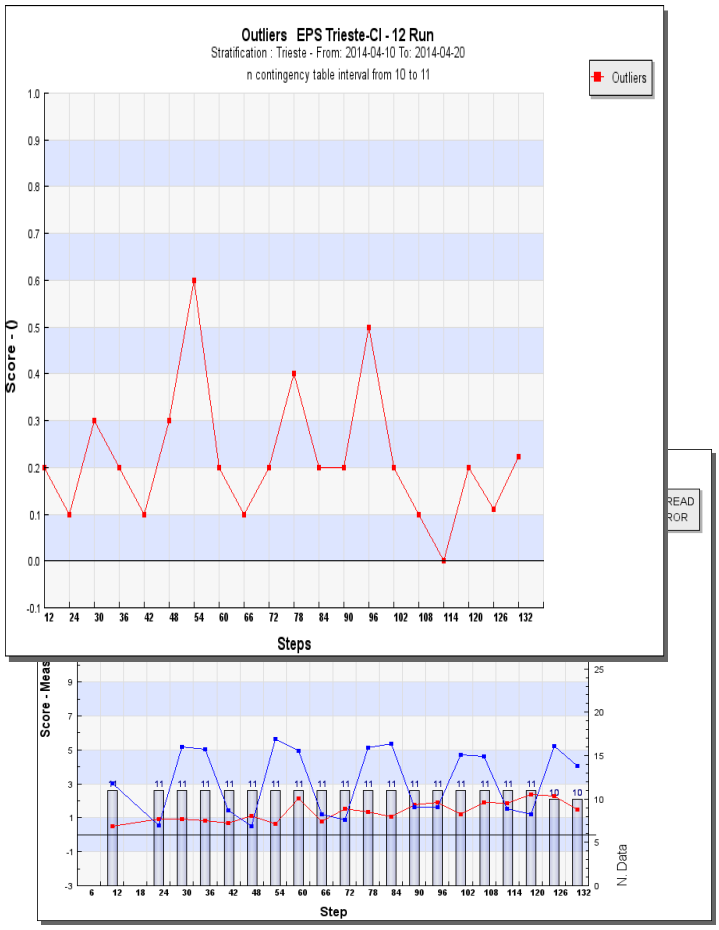
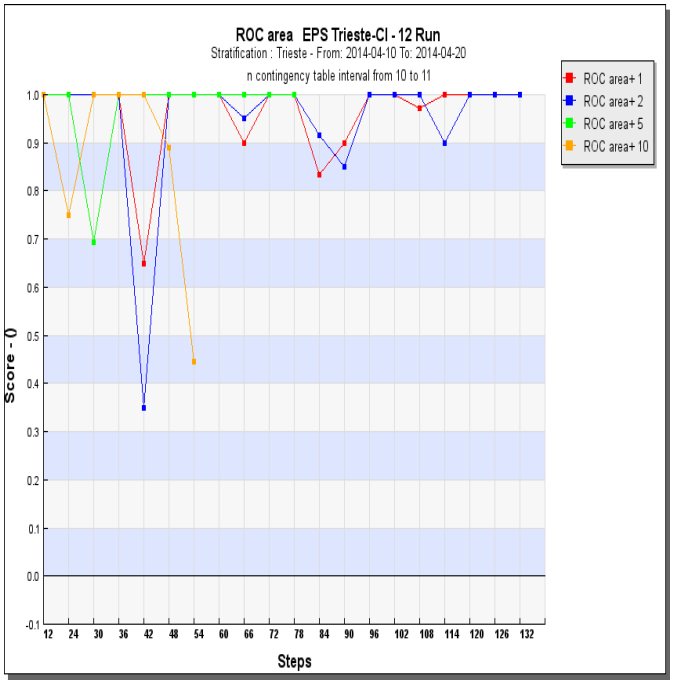


Figure138 Outliers score graphic

Figure 139 ROC Area score Graphic



Note that for Confidence Intervals of EPS scores, the plots of Ci_high, CI_low are NOT plotted on the same graph, but in different ones (like in the case of dichotomous scores).

The EPS diagrams are created automatically and can be downloaded by retrieving the Verification (see Report Menu)

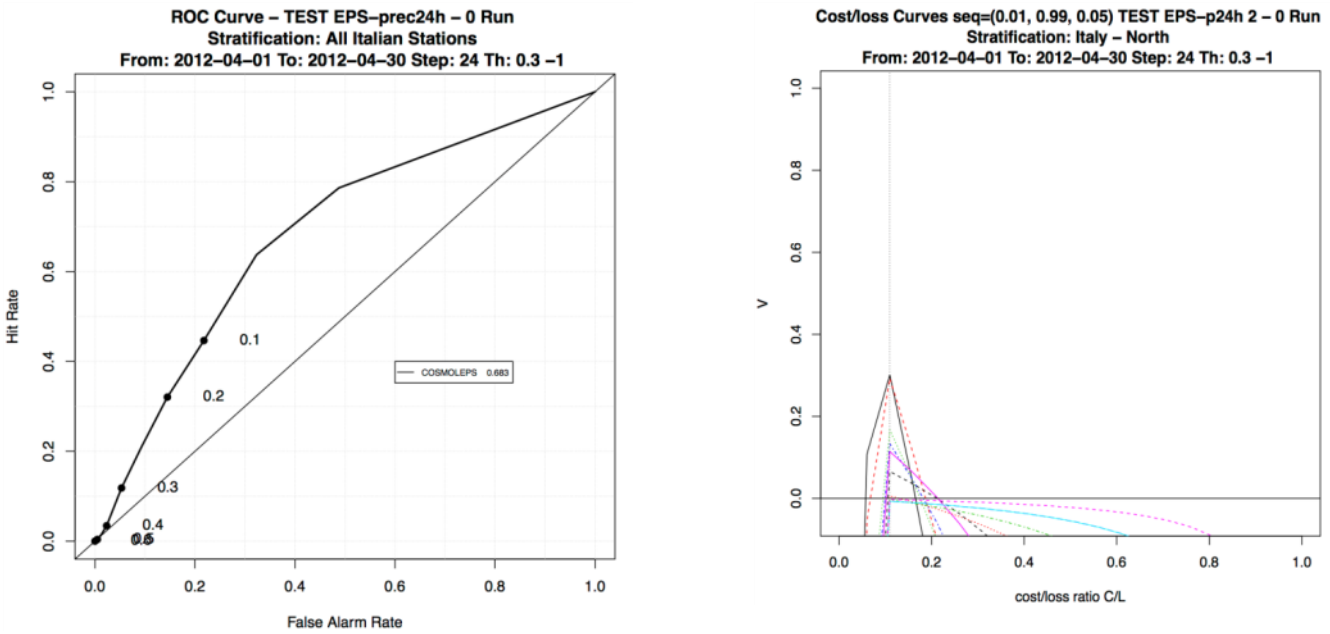


Figure 140 Examples of ROC and Cost-Loss Diagrams

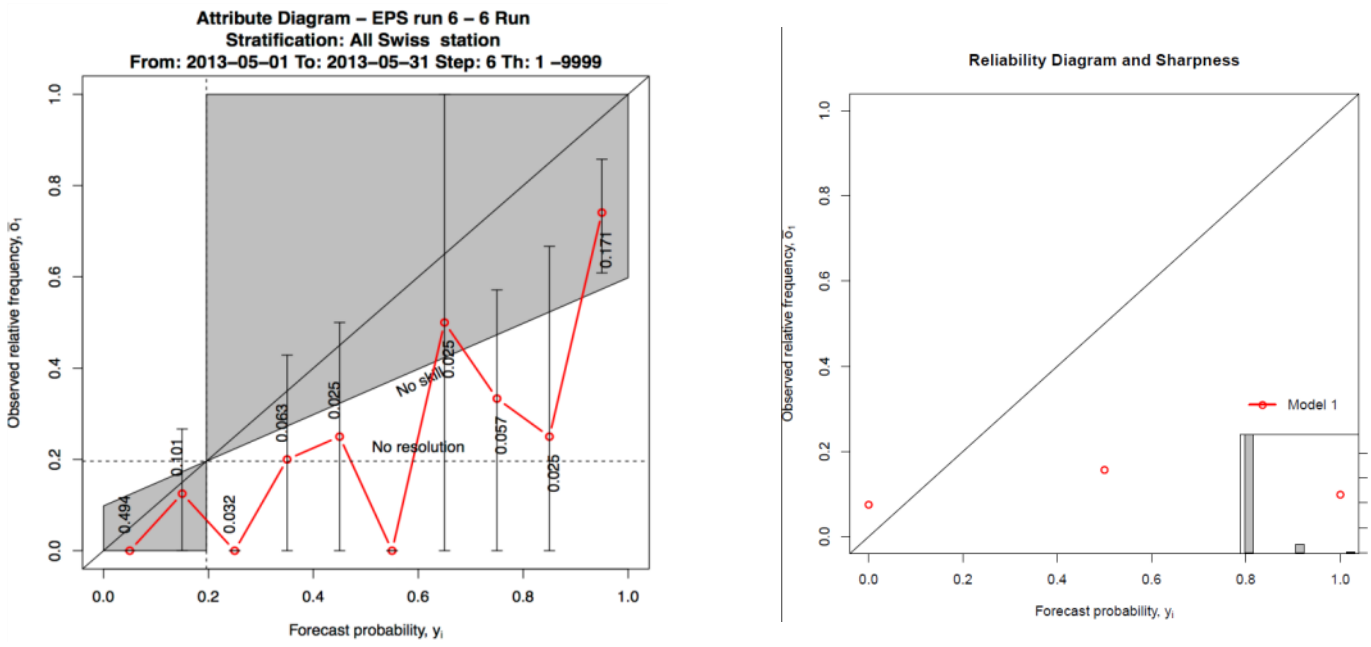


Figure 141 Attribute Diagrams with confidence interval/ Reliability-Sharpness Diagram

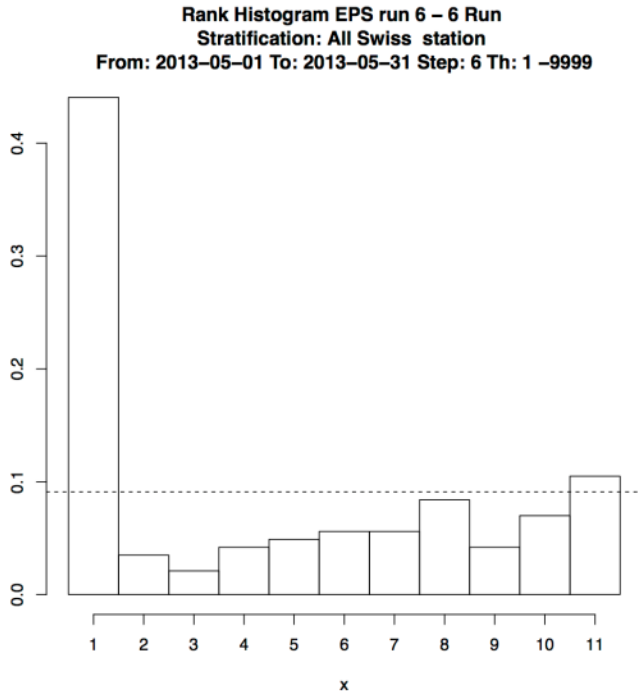


Figure 142 Rank Histogram

4.3.1.4 FEEDBACK FILES Verification Registration

The configuration of a verification based on FF data follows the same rules as the other configurations implemented into VERSUS. In order to configure a FF verification the user has to click on Verification->Standard->FeedbackFile menu, and the following GUI is displayed:

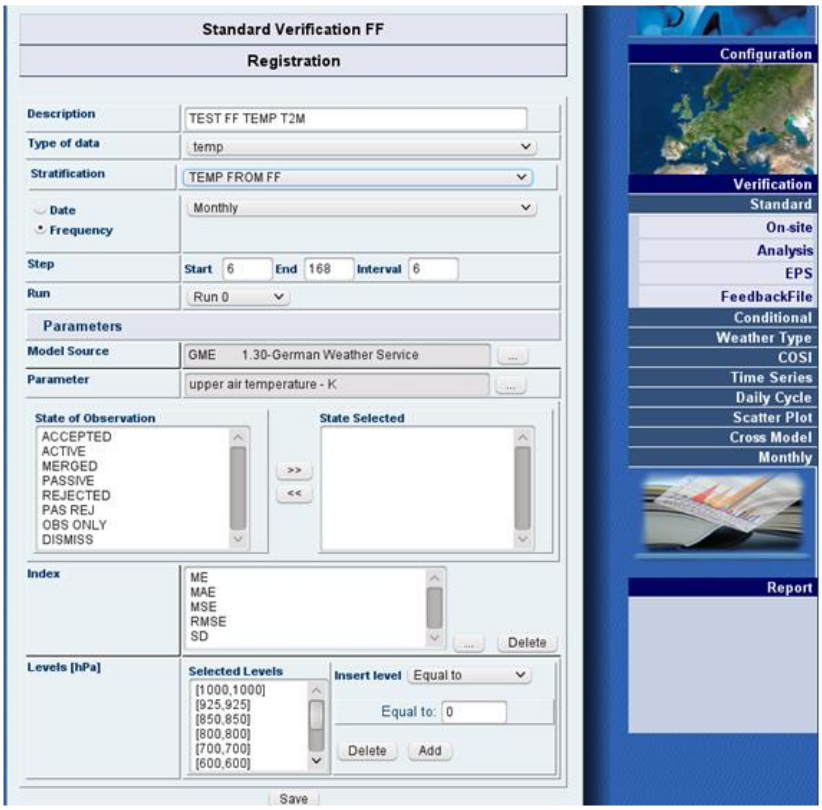


Figure 143 Standard FF Verification Registration

In order to configure the FF verification the following fields should be filled in:

Description: a brief description of the verification;

Type of Data: this field can be TEMP if the verification deals with TEMP data or AIREP if the verification deals with AIREP data. According to this selection different list of stratifications will appear in the corresponding section. Stratification by stations for TEMP or by area for AIREP;

Stratification: the stratification on which the verification will be performed;

Date or frequency: the fixed time period or frequency of the verification;

Step: the start, end and interval step fields;

Run: the run of the model;

Model Source: Selection of the available model sources loaded into the system;

Parameter: the selection of the available configured parameters;

State of observation: the state of observation that the verification will take into account during the score execution. If no state is selected the verification shall take into account all the available states; (It is better to select the state of observation during the FE loading phase)

Index: the scores to compute (only continuous) which can be ME, MAE, MSE, RMSE, STDE;

Levels[hPa]: the levels expressed in hPa, on which the scores will be computed.

These levels can be set as “fixed pressure levels” or “level bins layers”. In this last case every layer is defined as an interval of pressure levels.

The multi value field “Selected Levels” is pre-filled with default levels and the user can modify according his needs both in single number and layer values by the “Insert level” as detailed below:

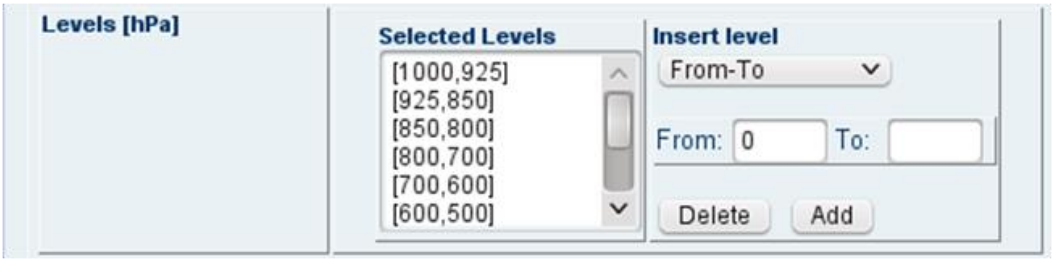


Figure 144 FF Pressure Levels Configuration

The selection “**Equal to**” **on the ‘Insert level’ menu allows to** define a single value level (default **selection** for TEMP) while the selection “**From-to**” allows to define an air layer (default choice for AIREP) through the setting of the lower and upper limit respectively

The graph configuration follows the rules of the upper air Verification and (see also report menu), and the produced graphics are similar to the ones produced by Standard Verification-Upper Air.

The system provides a panel with a general overview including graphics for all steps and simultaneously the single graphic for each step as represented in the following example:

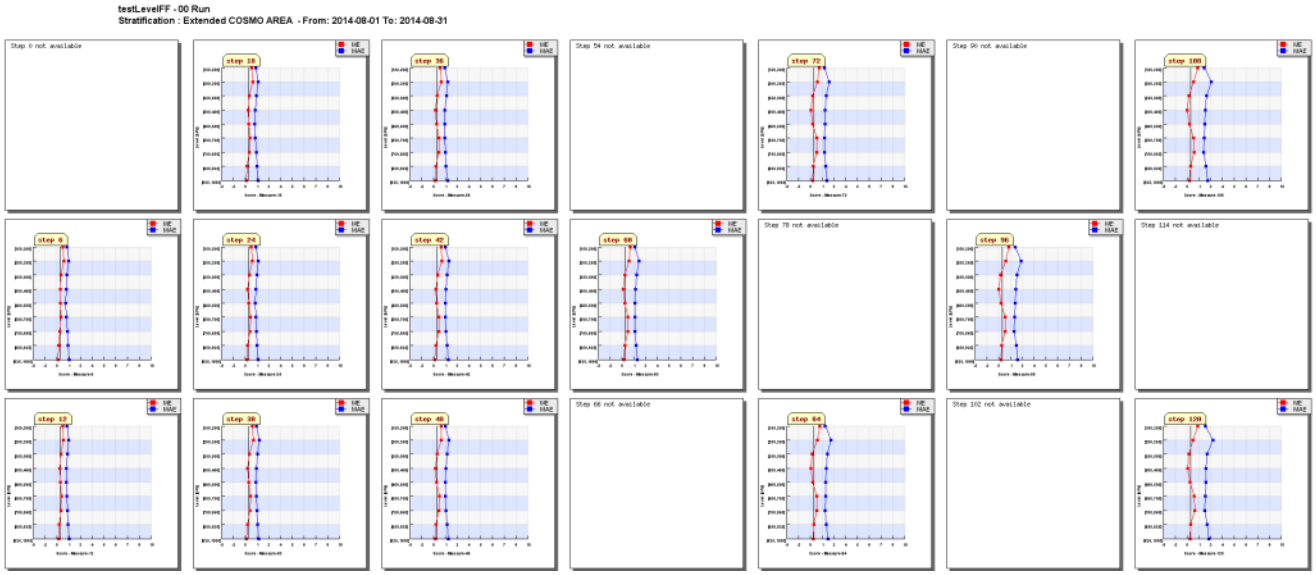


Figure 145 FF Graphics Panel Overview

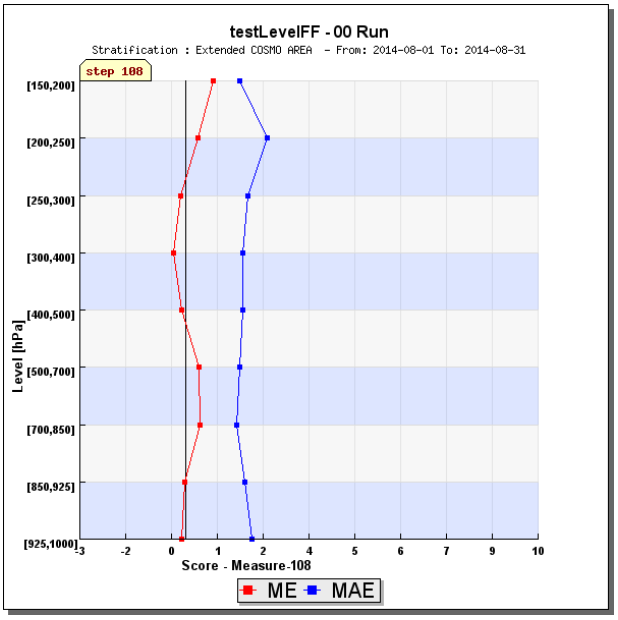


Figure 146 FF step 6 zoomed Graphic

4.3.2 CONDITIONAL VERIFICATION

A *conditional verification* is defined as the verification, against a set of observations when specific conditions on observations or/and forecasts are applied .simultaneously or independently.

VERSUS creates two types of conditional verifications:

- on surface data with continuous scores
- on surface data with dichotomous scores

☞ ***It is not possible to create a conditional verification for upper air data, EPS and FF***

To create a conditional verification the user has to provide the information specified in the standard verification in addition to the conditions on:

- **Observation Data**
  - by Value
  - by Function
- **Forecast Data**
  - by Value
  - by Function
- **Both Observation and Forecast Data**
  - by Value
  - by Function

In this last case, by default, the menu opens with the option ‘By Value’ for both observation and forecast data at the same time and the user can combine ‘By Value’ and ‘By Function’ options for each of them independently.

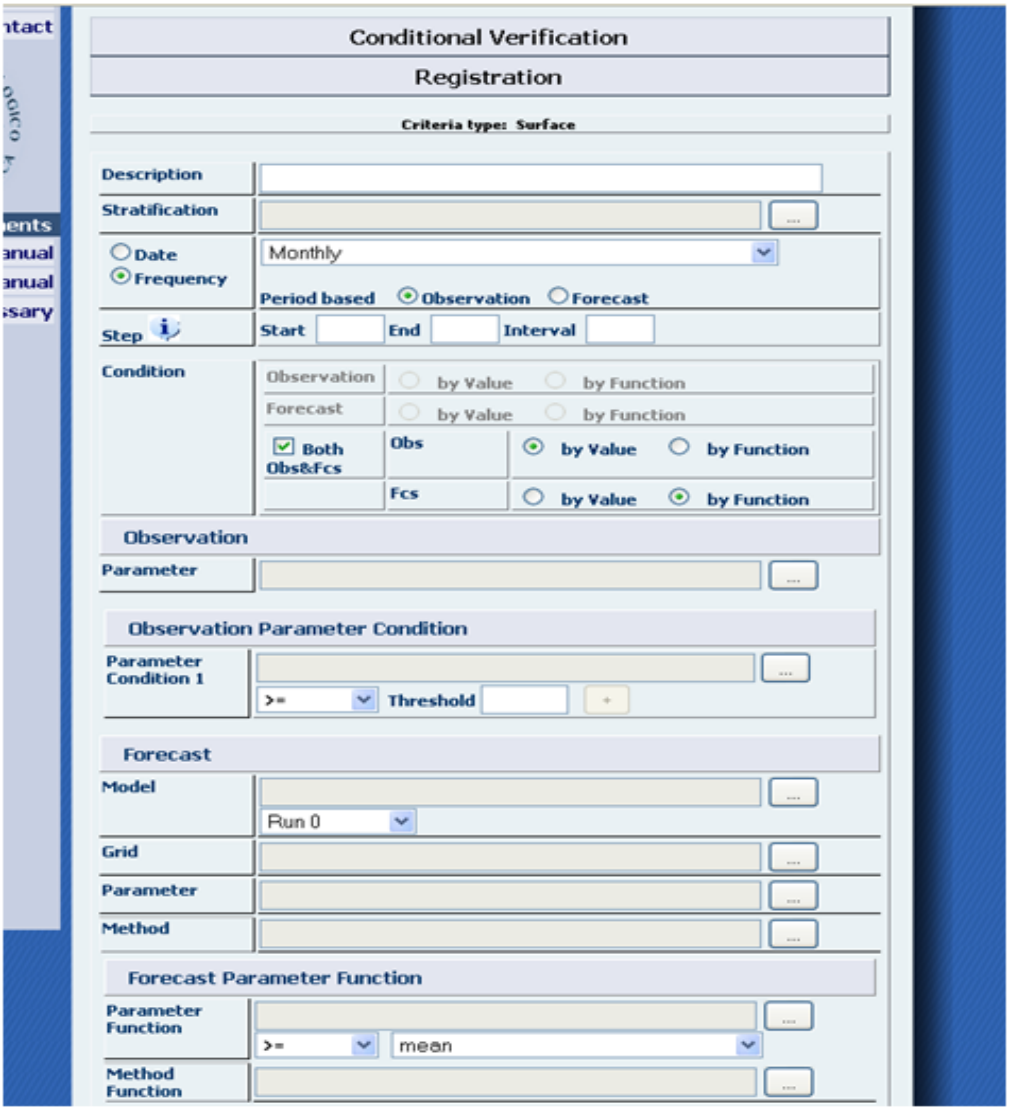


Figure 147 Definition of conditions

Condition by Value

To define a condition on a parameter value lying within a specified window , the user must define one condition with “=<>=” (AND).

To define a condition on parameters lying outside a specified window, two conditions must be specified, the first with “=<” and the second with “>=”(OR). To apply a condition on wind direction two ‘OR’ conditions are needed in order to specify the direction range. The second condition appears by clicking on button (+)

Condition by Function

The user can define conditions on parameter functions , for example the values average.

If the condition applies to the forecast parameter it is also necessary to define the interpolation method.

- There is no possibility of conditional Verification for Feedback files and EPS.

4.3.3 WEATHER TYPE DEPENDENT VERIFICATION

A weather type dependent verification is a verification performed on specified weather class.

This type of verifications are performed based on:

- onsite observations
- analysis data

4.3.3.1 ON SITE WEATHER DEPENDENT VERIFICATION

To create a WDT Verification the user selects on Weather- type menu->Onsite, and the system displays the GUI. The configuration of this type of verification is identical to a Standard one, with the addition of the Weather Type option:

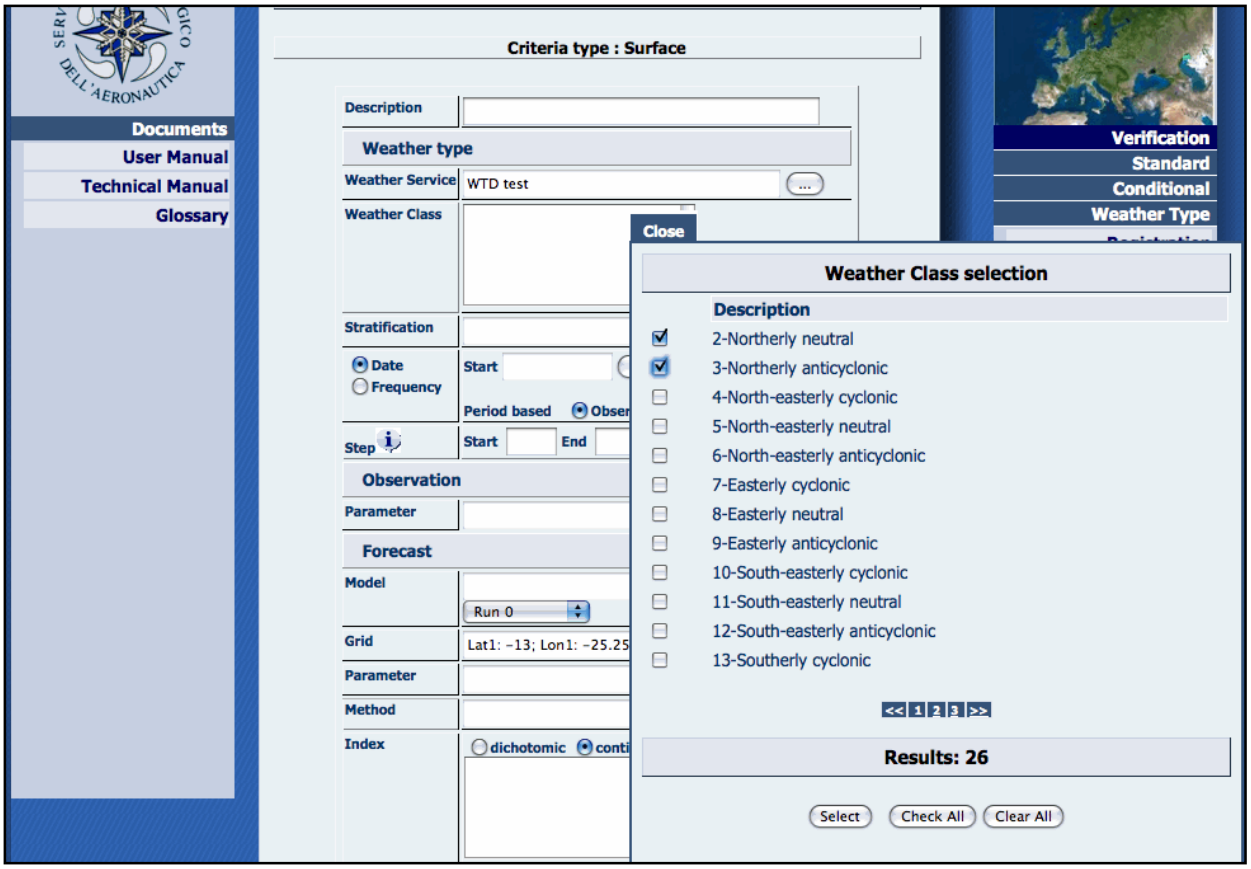
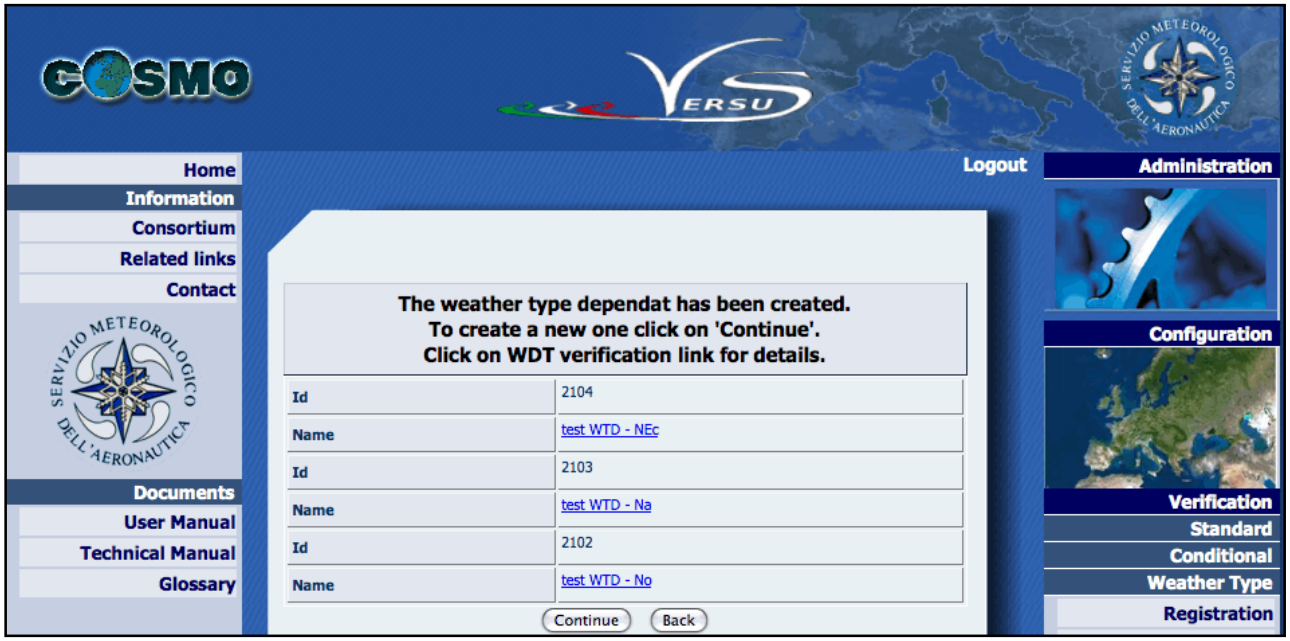


Figure 148 WDT Verification Registration

The user must select the weather services that are already configured and related weather classes he wants the verification for. By clicking on button save, the system configures automatically as many verifications as the number of weather classes he selects. The report related to WDT Verification registration is:

Figure 149 On-site WDT Verification Report



4.3.3.2 ANALYSIS WEATHER TYPE VERIFICATION

To create a WDT Verification the user selects on Weather- type menu->Analysis, so the system displays the GUI. The configuration of this type of verification is identical to an analysis Standard one, with the addition to a new section Weather Type:

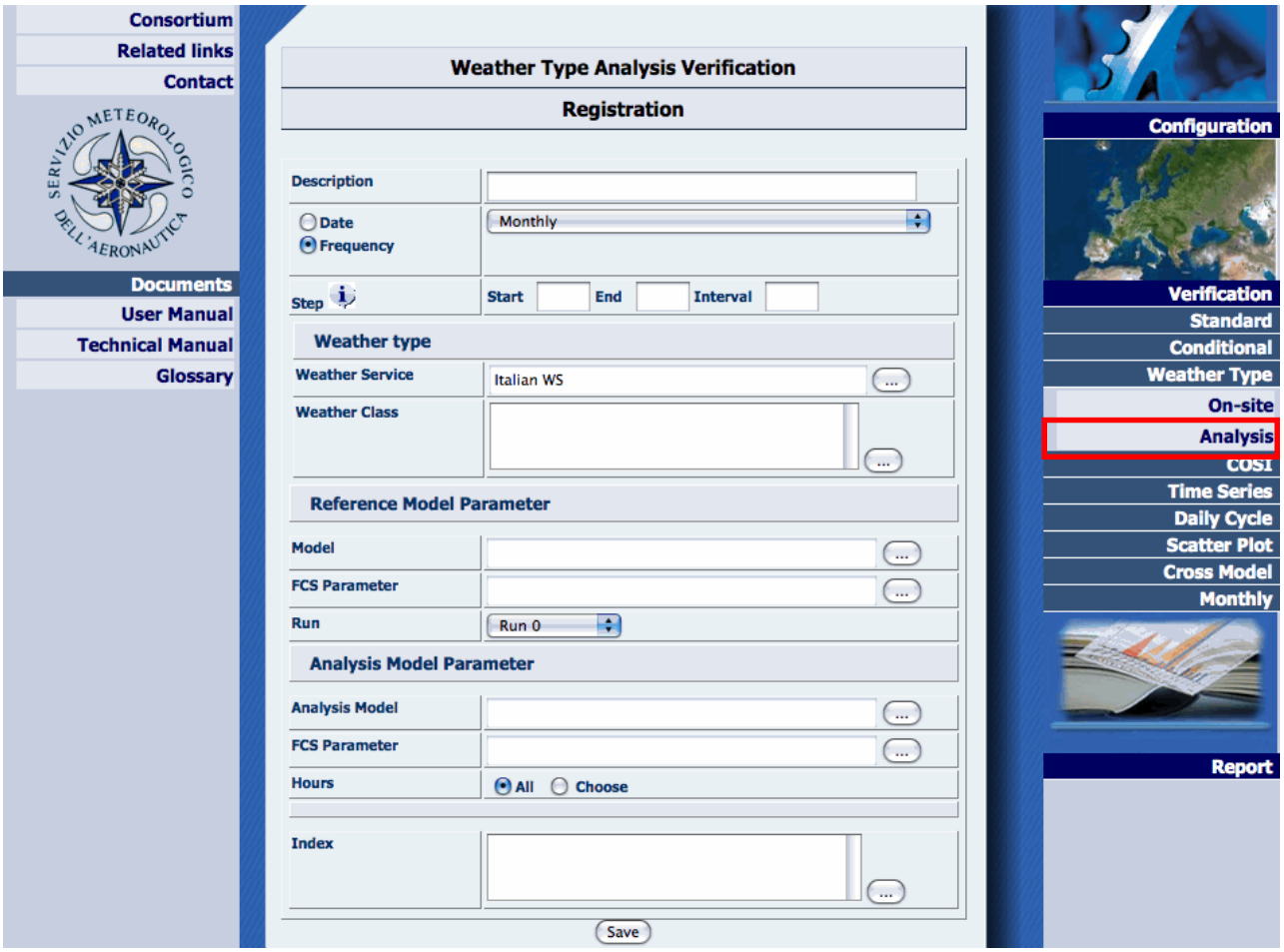


Figure 150 Analysis WDT Verification

4.3.4 TIME SERIES

The time series plot displays the trend of observations, forecasts and scores data in a pre-determined time period. Multiple model forecast trends can be displayed on the same graph.

By clicking on “Time Series” menu the system displays the GUI for Time Series registration.

The following information is needed:

Description: a name to describe the verification.

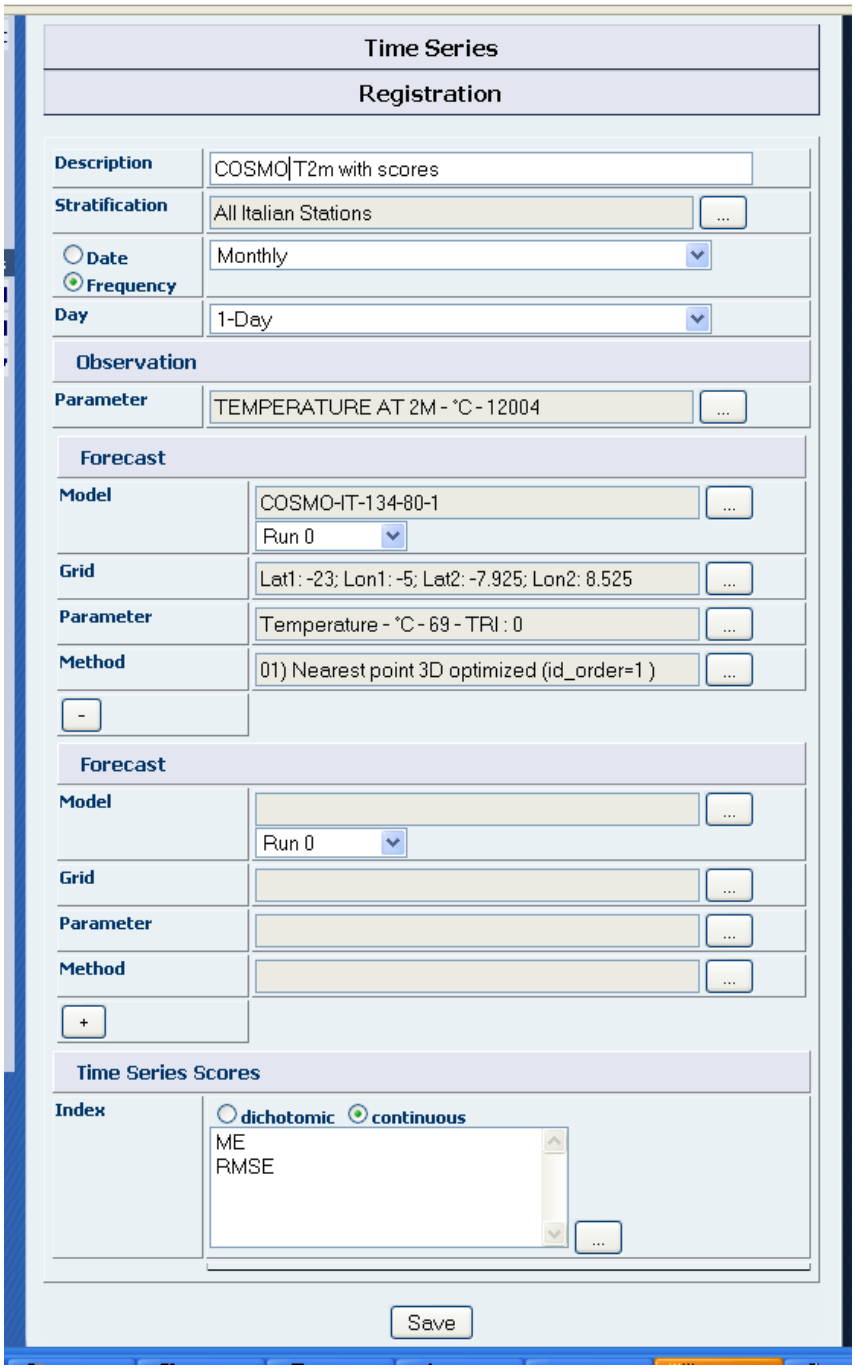


Figure 151 Time Series Registration

Stratification: the ensemble of selected stations for scores calculation.

Date / Frequency: a data time series range defined either by start and end date or by a periodical timescale that can be ‘monthly’ or ‘seasonal’.

Day : 1-day, 2- day or 3 forecast day average data.

Observation: observations parameter.

Model: the first model to verify

Run: the model run

Grid: the latitude and longitude boundaries of the selected model grid.

Method: list of methods of model value interpolation at the observation point such as nearest point, average value of grid points within a circle of radius R

☞ In case of adding a new model user should click on **'+'** button on the left bottom of the forecast menu and a new forecast menu section appears for a new model configuration. The user can repeat the action for the desired number of models.. With the button **'-'** user can remove a model from the configuration.

Index: the list of scores to be plotted as time series. This is an optional field.

Concerning the accumulated parameters, the system automatically takes into account the accumulation of the previous 24 hours, while for the others parameters the 00 hour value is taken.

Clicking on save button the system displays:

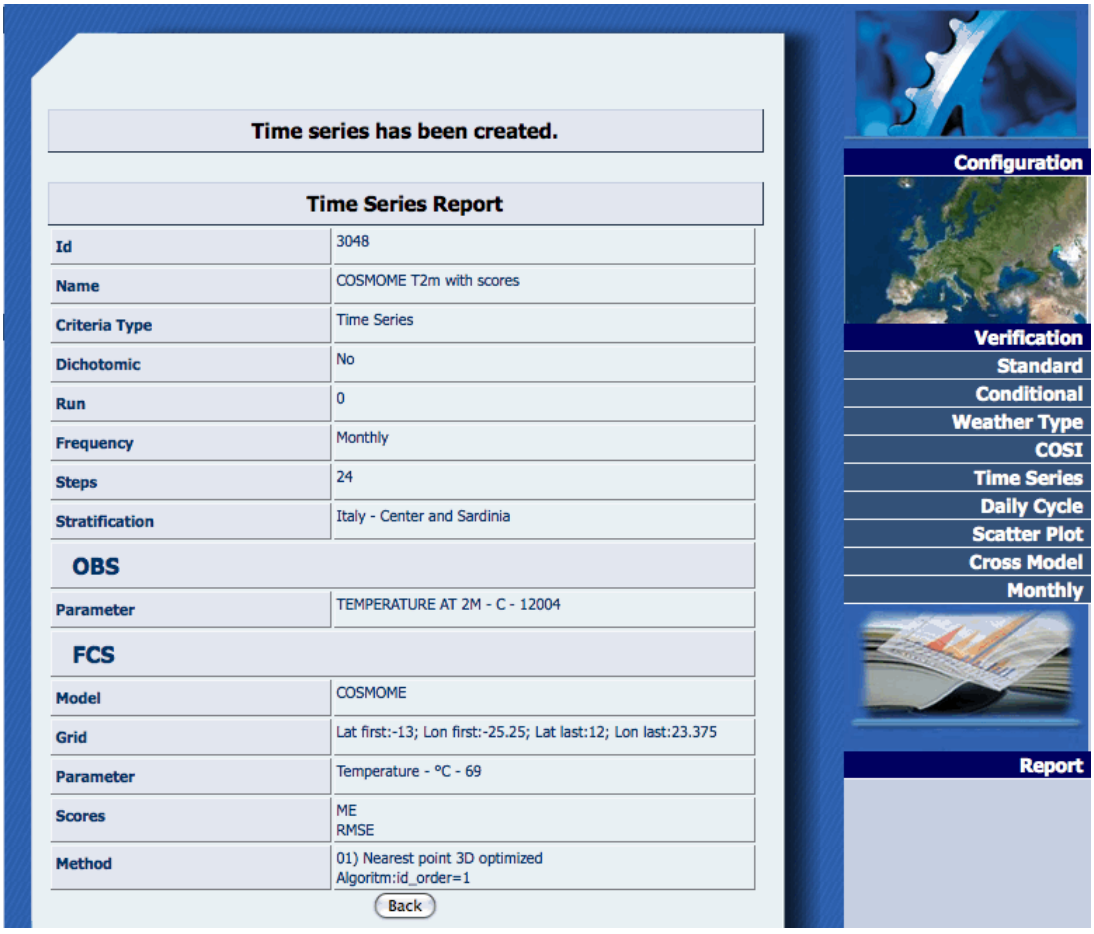
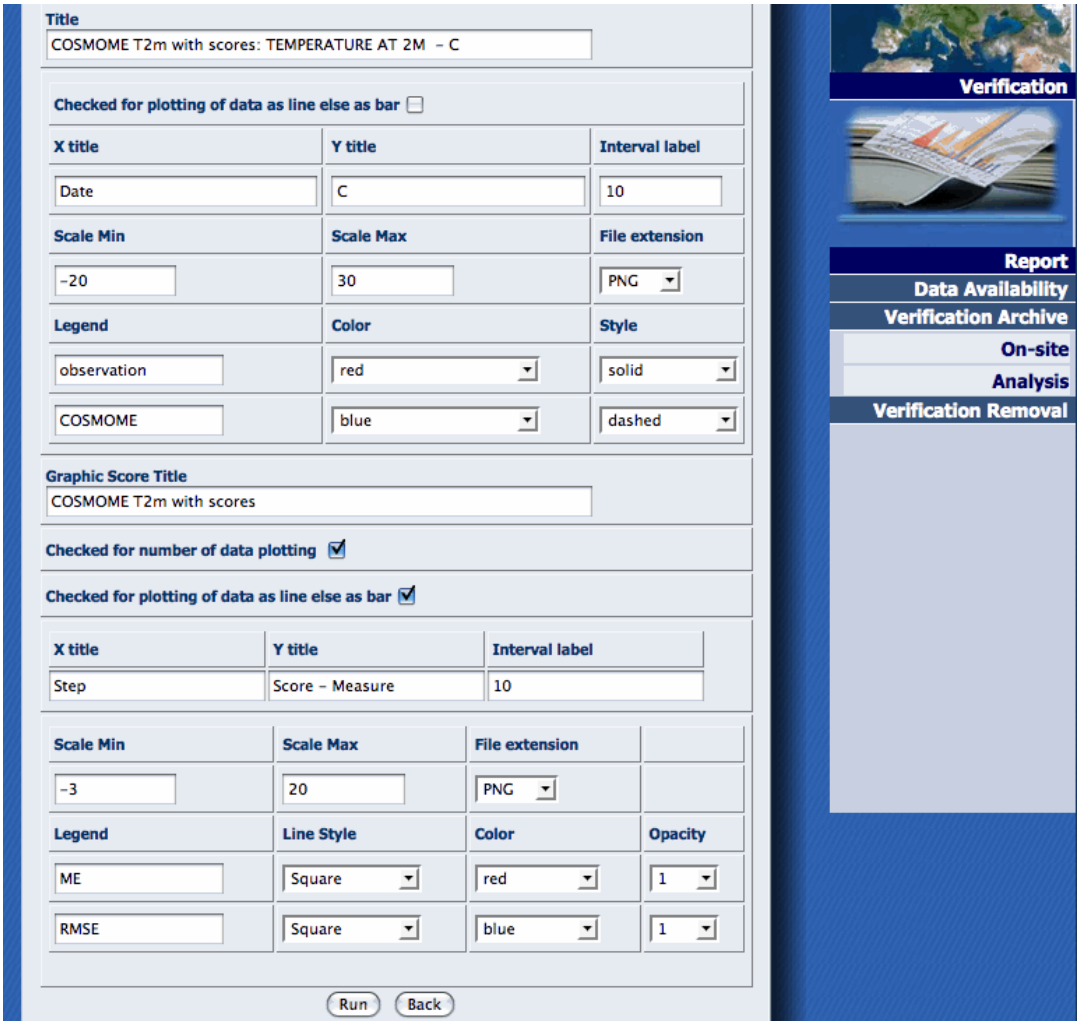


Figure 152 Time Series Report Monthly

If the created Time Series report is based on start and end date and data are available in the DB the system can configure the plot . Data availability can be verified as an option of the Report menu.

Once saved in the system, the report can be found by searching in the Verification archive menu, and the



graphic configuration has the following options:

Figure 153 Time Series graphic configuration

The configuration of time series plots consists of two parts :

- the first part set ups the options for plotting observations and model forecasts
- the second part sets up the options for plotting scores.

By clicking on Run button the system displays the two following graphs:

The possibility of downloading the observations and forecast values at each time step is also possible. (See Time Series Verification Searching on Chapter 4.3-Report Menu)

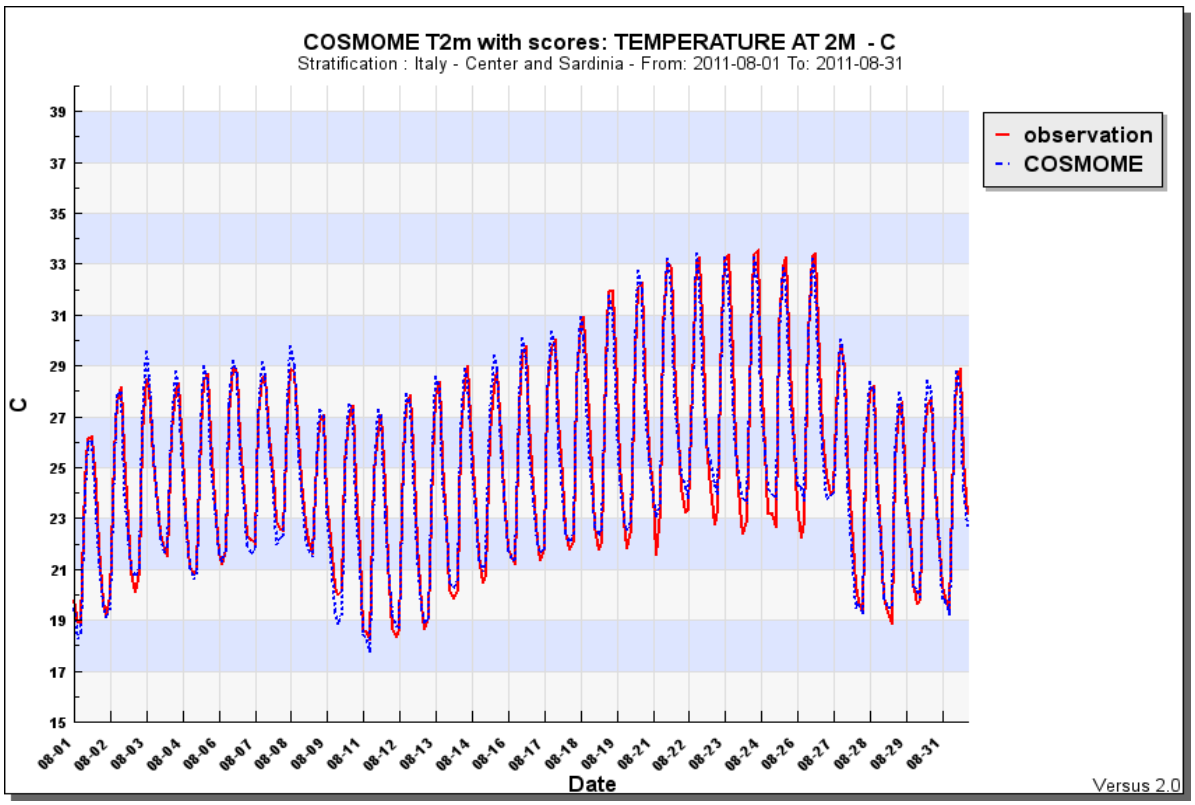


Figure 154 Time Series graphic

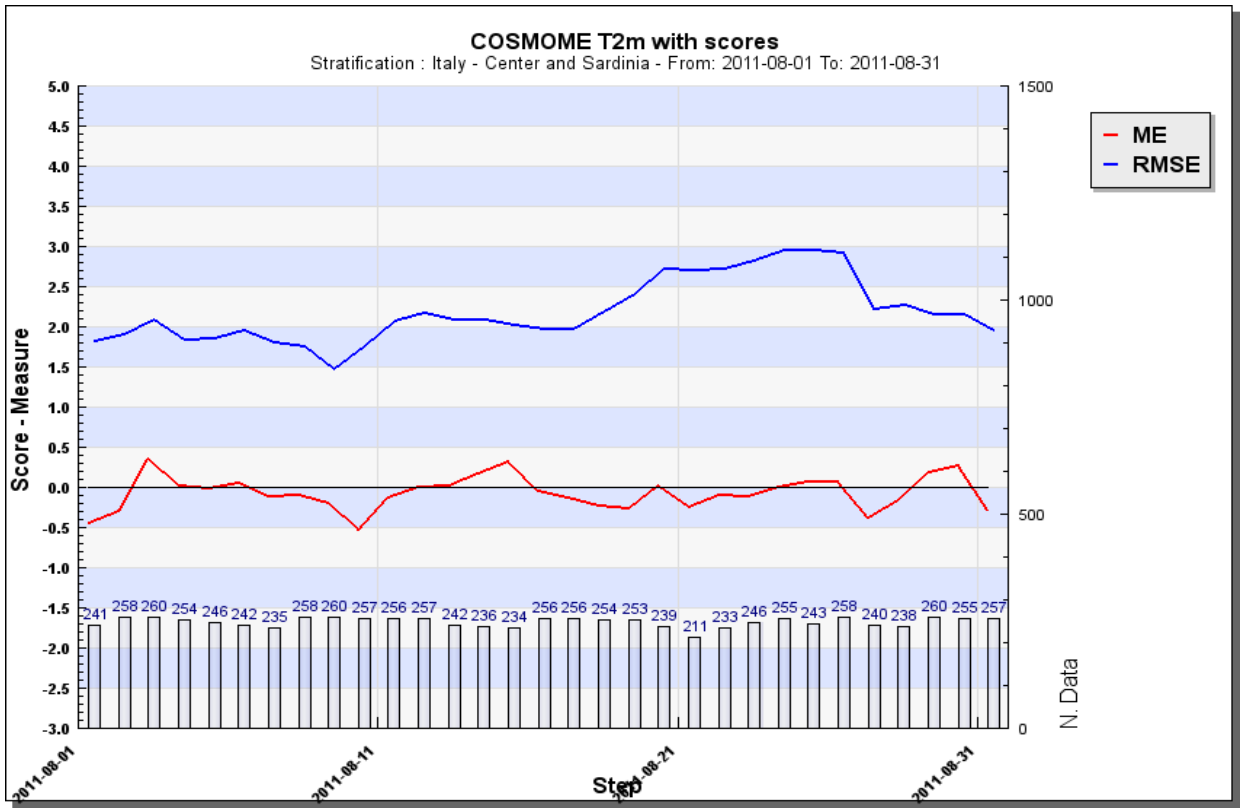


Figure 155 Time Series scores graphic

4.3.5 DAILY CYCLE

The daily cycle graphic depicts the trend of observation and model forecast data on a monthly basis by daily time steps. Parameter settings are identical to a time series graphic without the index configuration option. Multiple model forecasts can be plotted on the same graph. Daily Cycle Registration and report creation procedure is the same as for the Time Series one.

4.3.6 SCATTER PLOT

The scatter plots depict the relationship between two sets of data: observation and forecast.

Clicking on “Scatter Plot” menu the system displays the GUI for Scatter Plot registration.

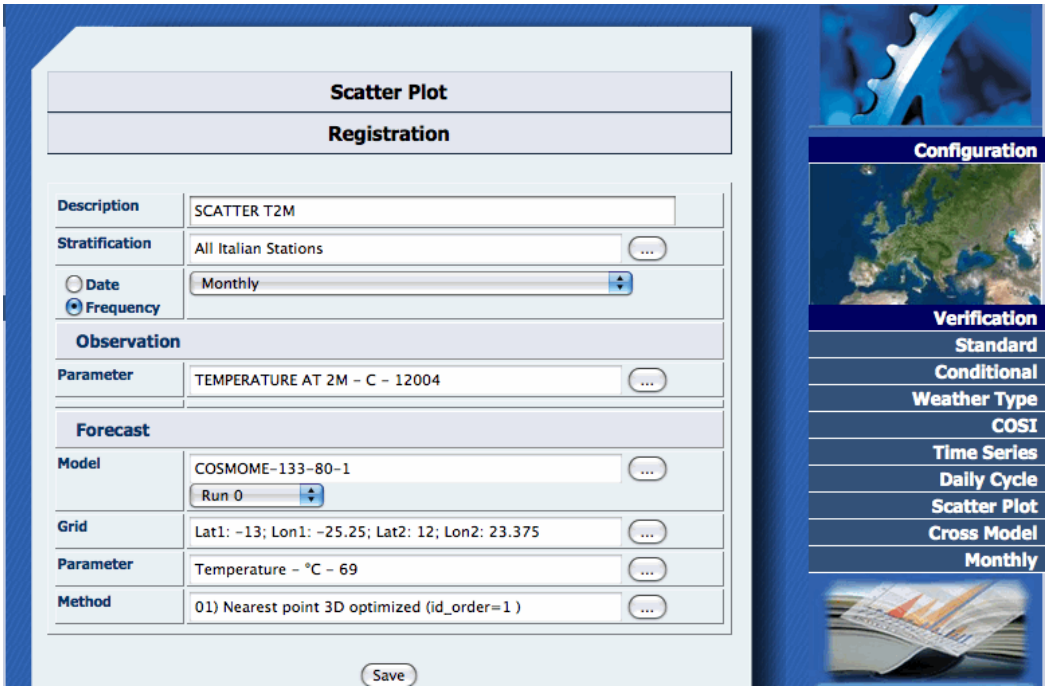


Figure 156 Scatter plot registration

The information needed is:

Description: a name to describe the verification.

Stratification: the ensemble of selected stations for scores calculation.

Date / Frequency: a data time series defined either by start and end date or by a periodical timescale that can be ‘monthly’ or ‘seasonal’.

Observation: observation parameter.

Model: the model to verify

Run: the model run

Grid: the latitude and longitude boundaries of the selected model grid.

Method: list of methods to use for model value estimation at the observation point.

A graphic is plotted, for each model step

By clicking on save the system displays the following report:

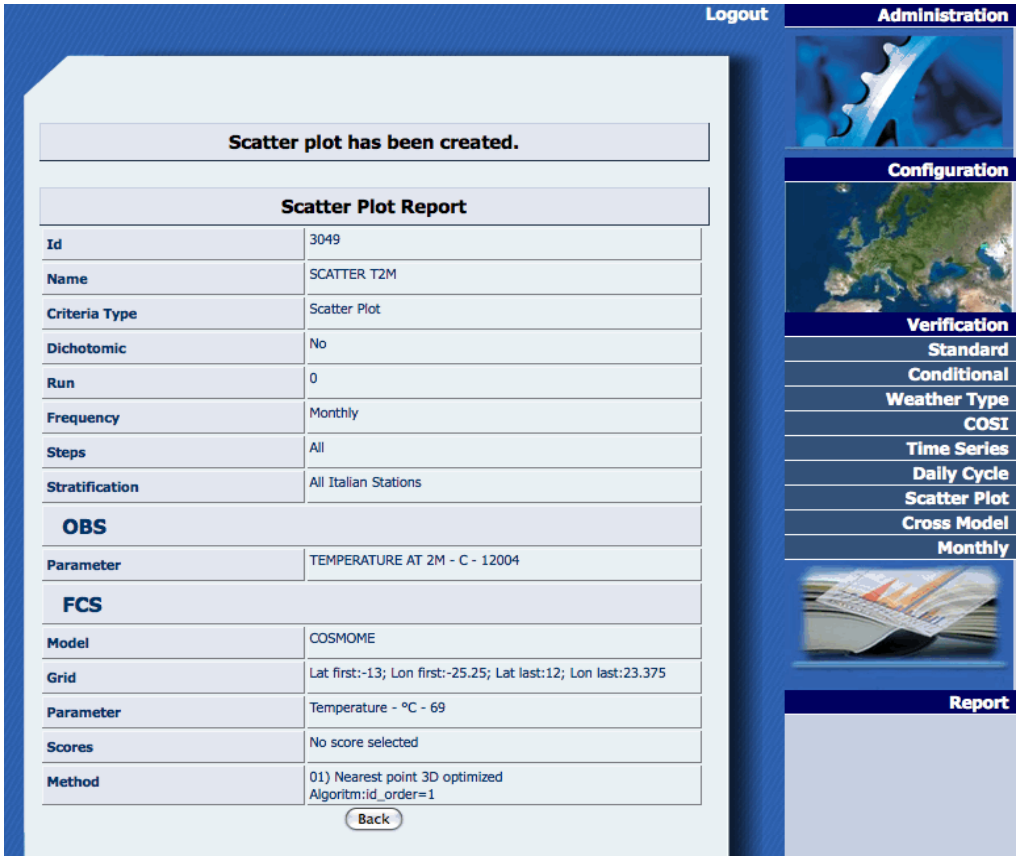


Figure 157 Scatter plot report

The report can be found in the Verification Archive and the graphic settings are the following:

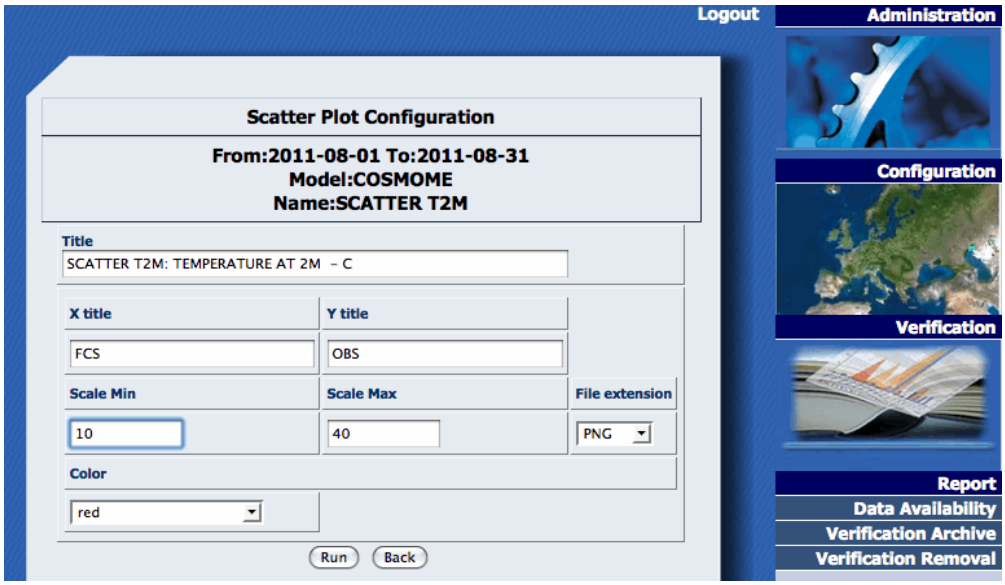
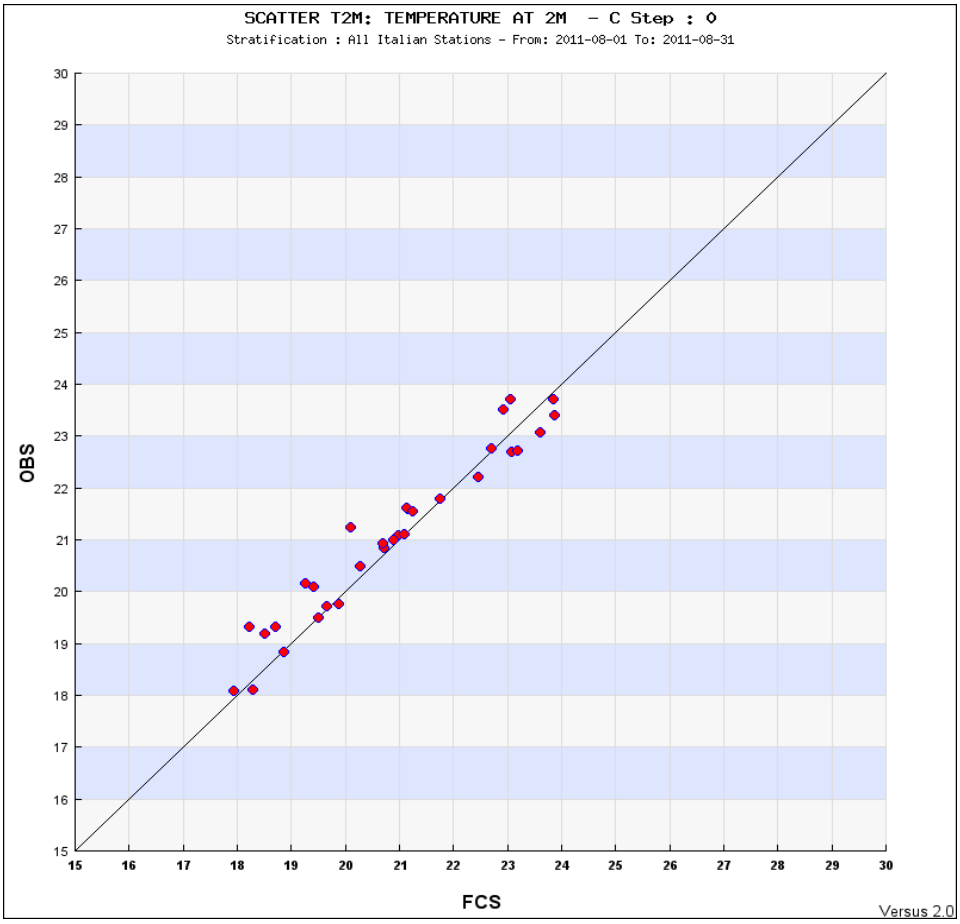


Figure 158 Scatter plot graphic configuration

The number of produced plots is equal to the number of model steps:

Figure 159 Scatter plot graphic results-step 0



4.3.7 COSI

The COSMO Index (henceforth called COSI) is a measure of the forecasting skill of the different COSMO models implemented in COSMO consortium.

For more information about COSI see COSI COSMO Index Document.

Clicking on COSI menu the system displays the following GUI:

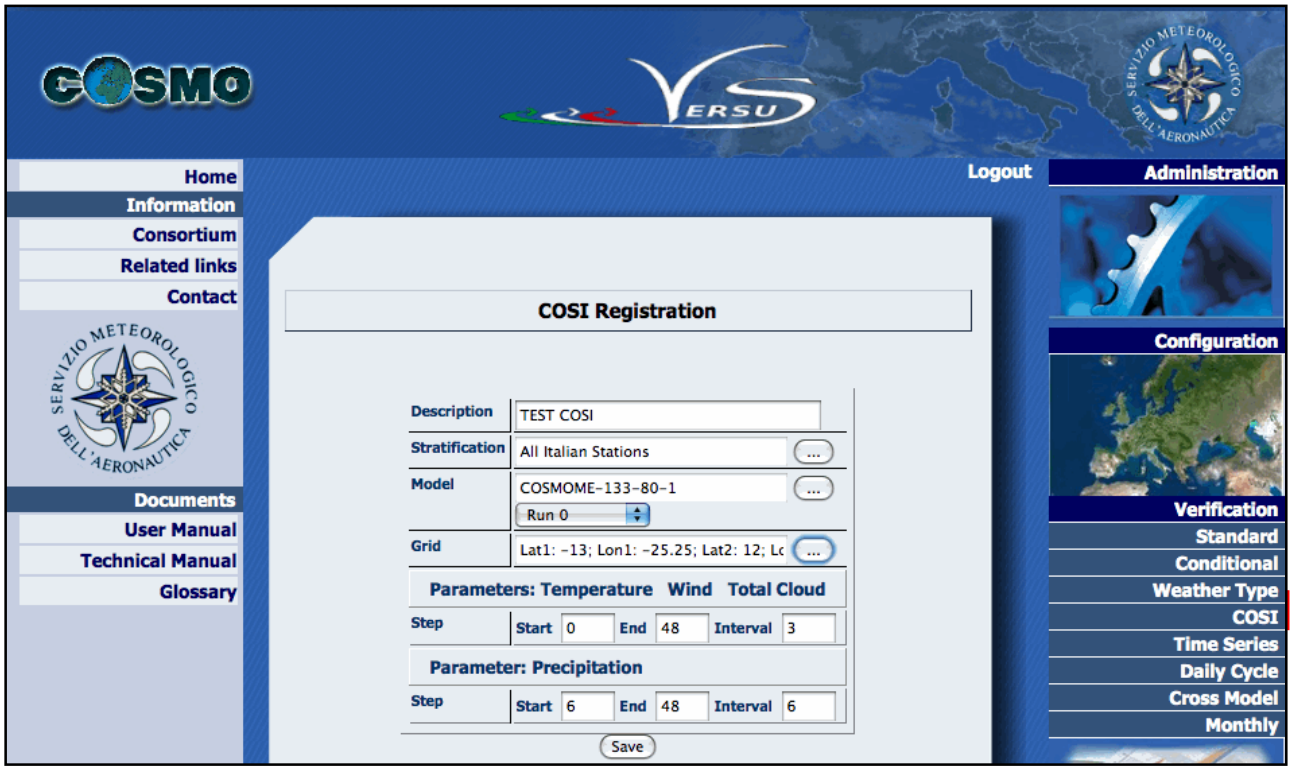


Figure 160 COSI Registration

To register a new COSI verification the following information is needed:

Description: a name to identify the verification

Stratification: the stratification for COSI calculation

Model: forecast model name and run

Grid: the latitude and longitude boundaries of the selected model grid

Steps for index calculation of Temperature, Wind, Total Cloud Step. (Start, end, interval)

The interval of the Precipitation Step refers to precipitation accumulation hours

By clicking on button “Save” the system displays the report of the created COSI:

Figure 161 COSI Definition Report

The report displays links to each COSI parameter verifications that compose the index.

4.3.8 CROSS MODEL

The system can also create cross model graphics for all types of verifications. The aim is to group in a single plot two or more scores obtained from different meteorological models. Graphics for probabilistic models can are also be produced. By clicking on “Cross Model” menu the system displays the following GUI verificare:

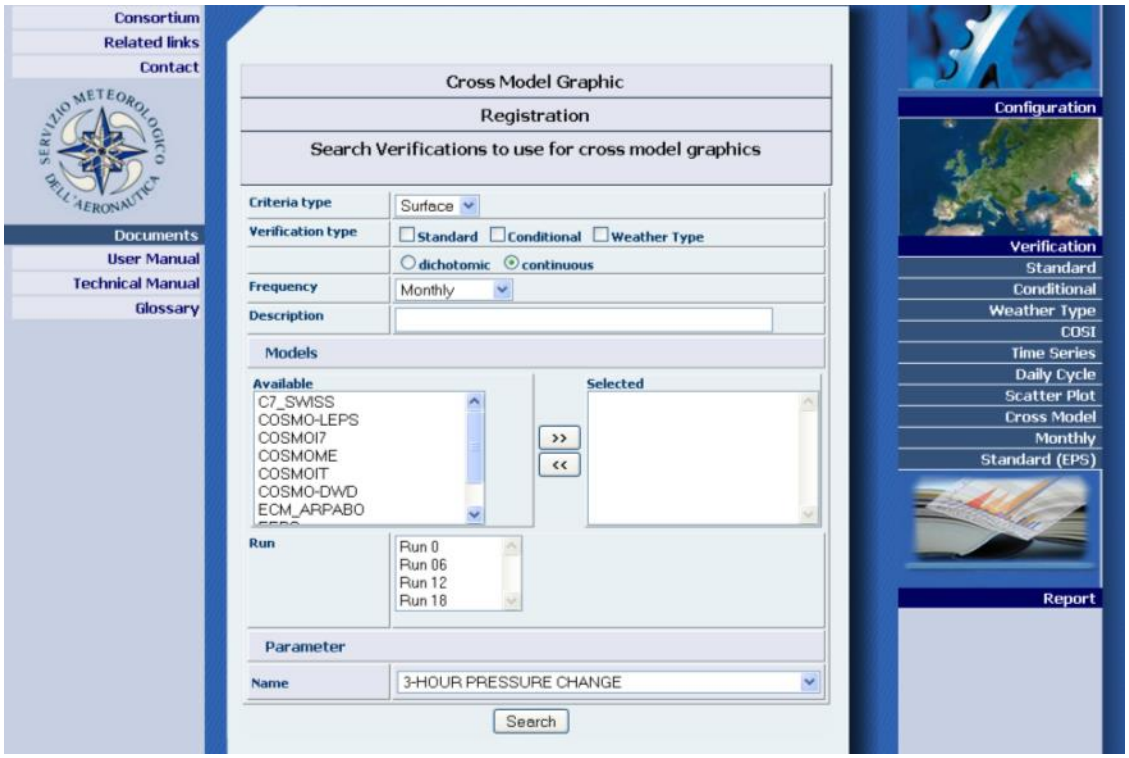


Figure 162 Verification request for cross model graphics

Cross Model Graphic needs a registration procedure where the information needed is the following:

- type of data, surface or upper air;
- Verification type, standard, conditional or Weather Type,
- type of score, continuous or dichotomous;
- list of models;
- run;
- parameter.

Cross Model graphics are plots showing index scores from different models. By submitting “Search” the system shows all the configured verifications which apply to the request:

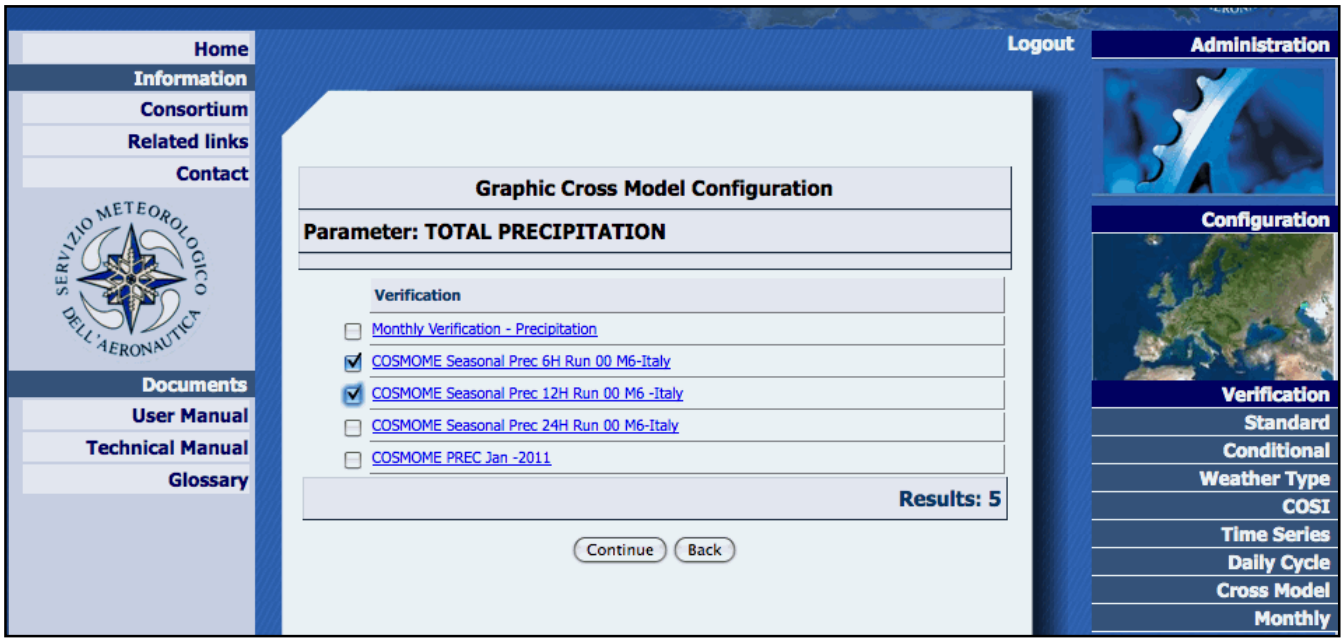
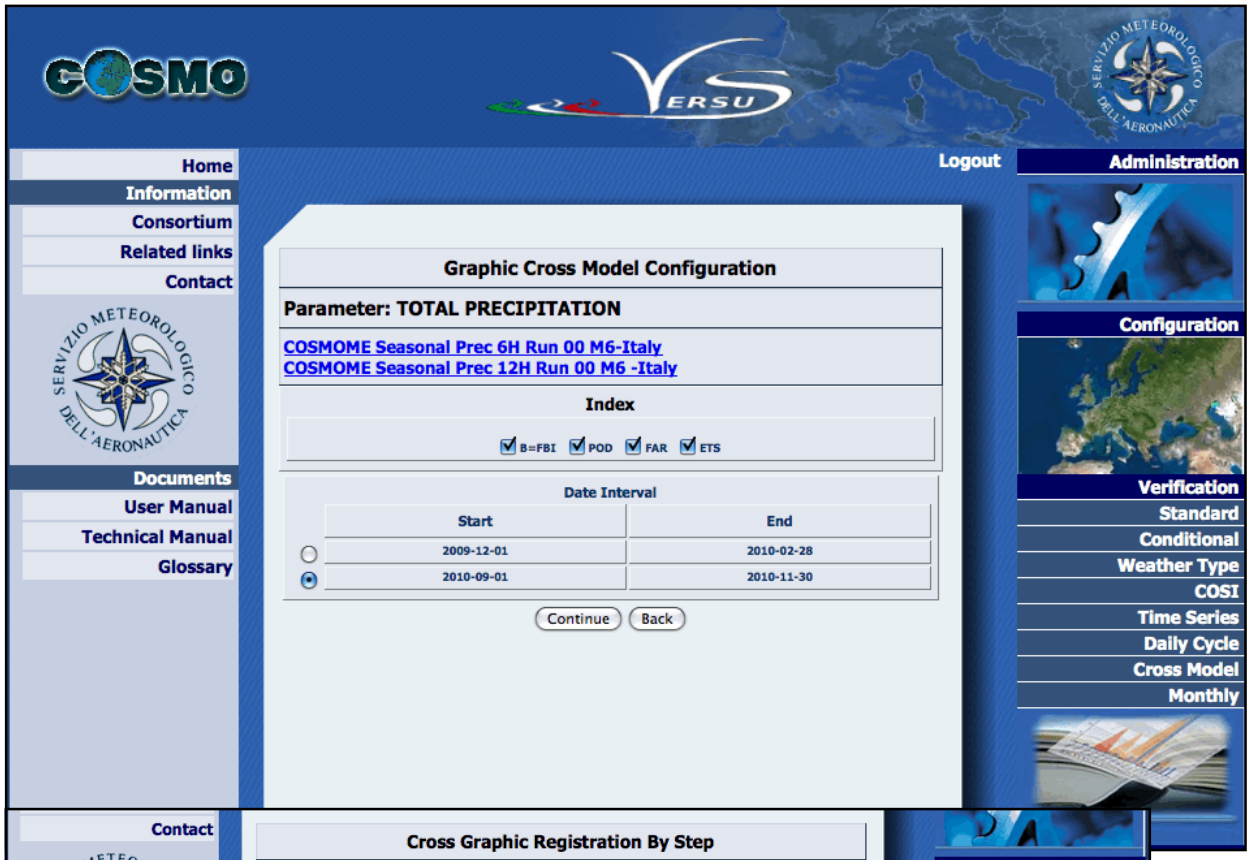


Figure 163 Graphic Cross Model configuration

In the GUI above the user can select from a list of available configured verifications.

By clicking on “Continue” button the system displays the list of time periods of the verifications, and a list of calculated indexes. The next step is selection of time periods ,and indexes. By clicking on “Continue”, the following GUI is displayed. (Figure 62) which is an example of registration for dichotomous index plots


COSMO
VERSU
Home
Information
Consortium
Related links
Contact
Documents
User Manual
Technical Manual
Glossary
Logout
Administration
Configuration
Verification
Standard
Conditional
Weather Type
COSI
Time Series
Daily Cycle
Cross Model
Monthly
Graphic Cross Model Configuration
Parameter: TOTAL PRECIPITATION
COSMOME Seasonal Prec 6H Run 00 M6-Italy
COSMOME Seasonal Prec 12H Run 00 M6 -Italy
Index
B=FBI POD FAR ETS
Date Interval
Start
End
2009-12-01
2010-02-28
2010-09-01
2010-11-30
Continue
Back

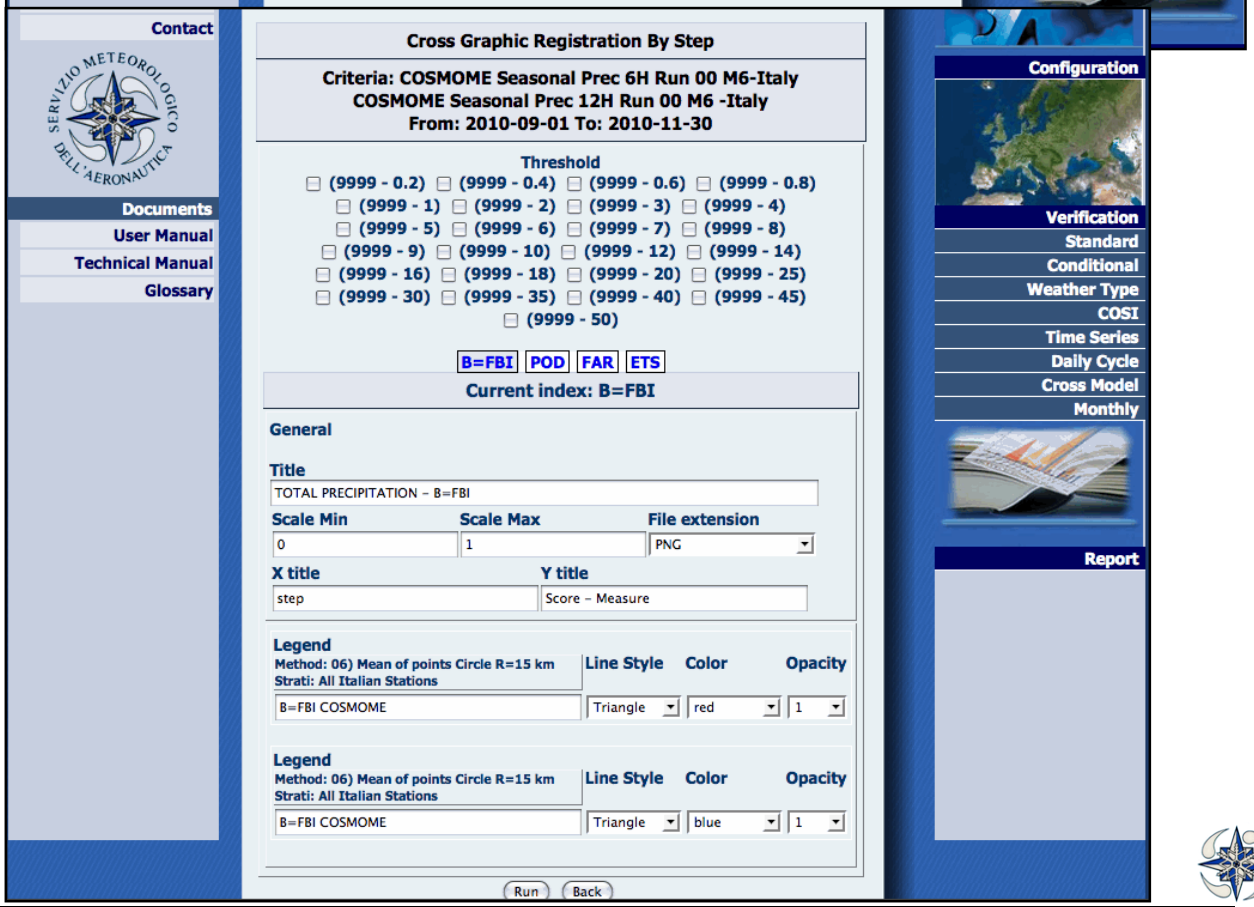

Contact
Documents
User Manual
Technical Manual
Glossary
Configuration
Verification
Standard
Conditional
Weather Type
COSI
Time Series
Daily Cycle
Cross Model
Monthly
Report
Cross Graphic Registration By Step
Criteria: COSMOME Seasonal Prec 6H Run 00 M6-Italy
COSMOME Seasonal Prec 12H Run 00 M6 -Italy
From: 2010-09-01 To: 2010-11-30
Threshold
(9999 - 0.2) (9999 - 0.4) (9999 - 0.6) (9999 - 0.8)
(9999 - 1) (9999 - 2) (9999 - 3) (9999 - 4)
(9999 - 5) (9999 - 6) (9999 - 7) (9999 - 8)
(9999 - 9) (9999 - 10) (9999 - 12) (9999 - 14)
(9999 - 16) (9999 - 18) (9999 - 20) (9999 - 25)
(9999 - 30) (9999 - 35) (9999 - 40) (9999 - 45)
(9999 - 50)
B=FBI POD FAR ETS
Current index: B=FBI
General
Title
TOTAL PRECIPITATION - B=FBI
Scale Min
Scale Max
File extension
0
1
PNG
X title
Y title
step
Score - Measure
Legend
Method: 06) Mean of points Circle R=15 km
Strati: All Italian Stations
Line Style
Color
Opacity
B=FBI COSMOME
Triangle
red
1
Legend
Method: 06) Mean of points Circle R=15 km
Strati: All Italian Stations
Line Style
Color
Opacity
B=FBI COSMOME
Triangle
blue
1
Run
Back

Figure 165 Graphic Cross Model graphic configuration

By clicking on “Run“ the plots of the selected indexes are created.

4.3.9 MONTHLY GRAPHIC

This type of graphic depicts the trend of the monthly scores. By clicking on “Monthly” option of the “Verification” menu the system displays the following GUI:

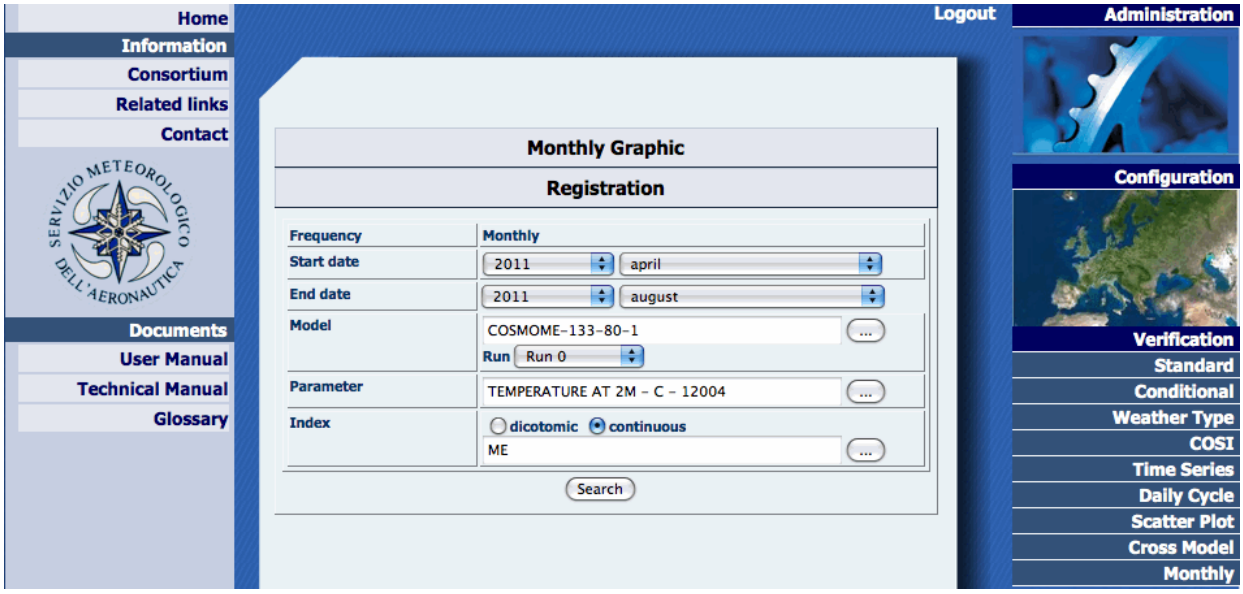


Figure 166. Monthly graphic registration

The scores search is performed by entering the desired period (start and end month). To refine the request, the model, its run, the parameter and index can be selected. By clicking on “Search” the system displays the requested information.:

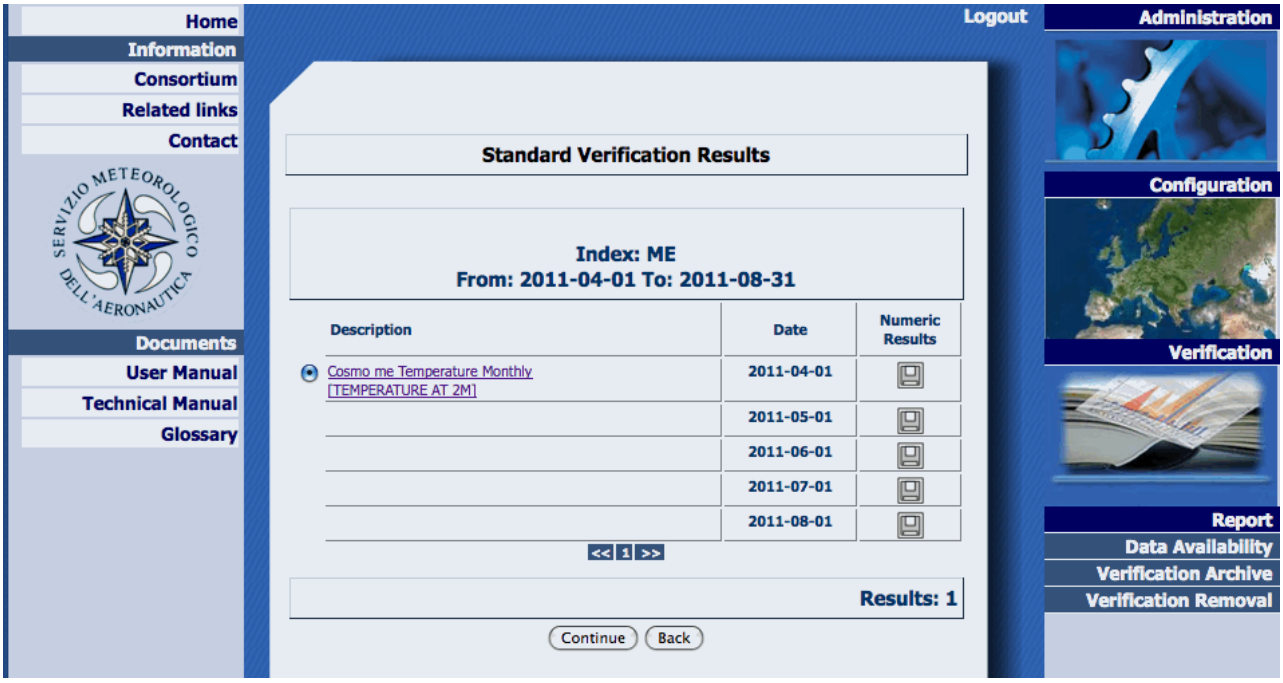


Figure 167 Score request results.

By entering "Continue" the system displays the GUI for monthly plots configuration:

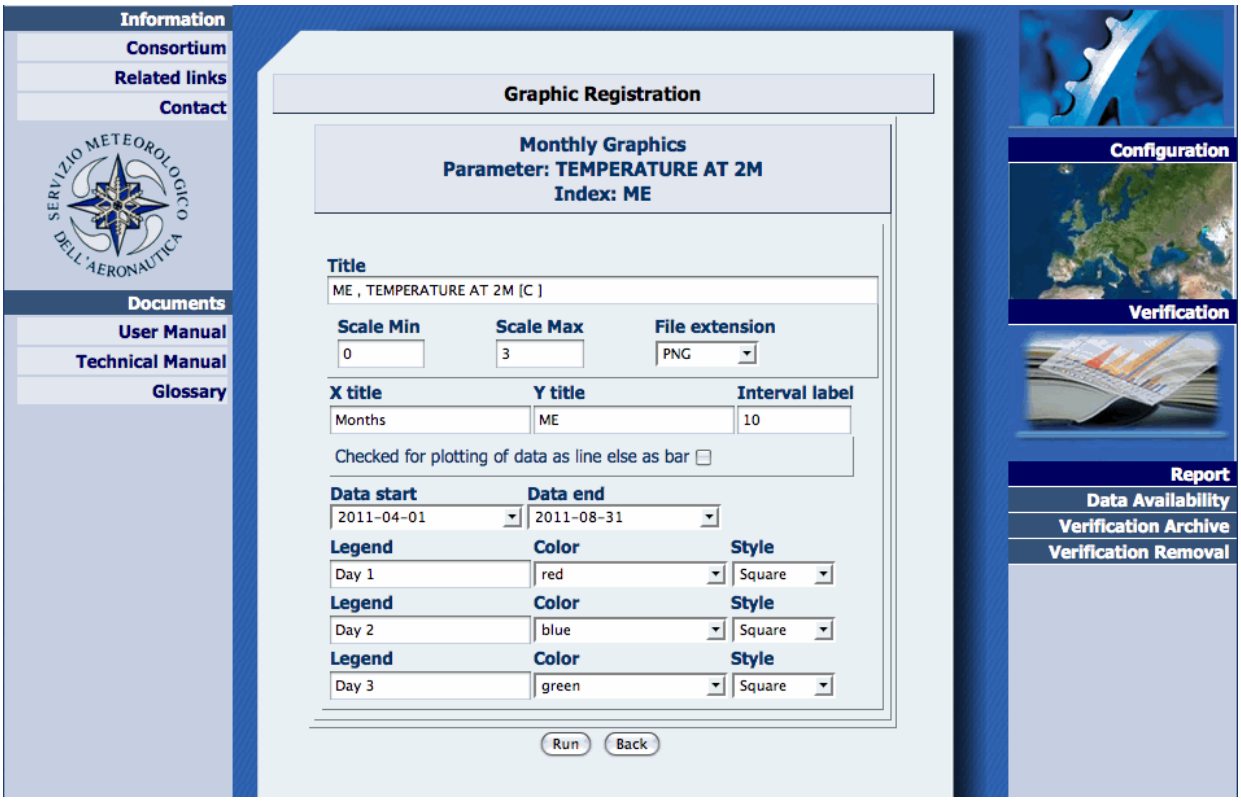
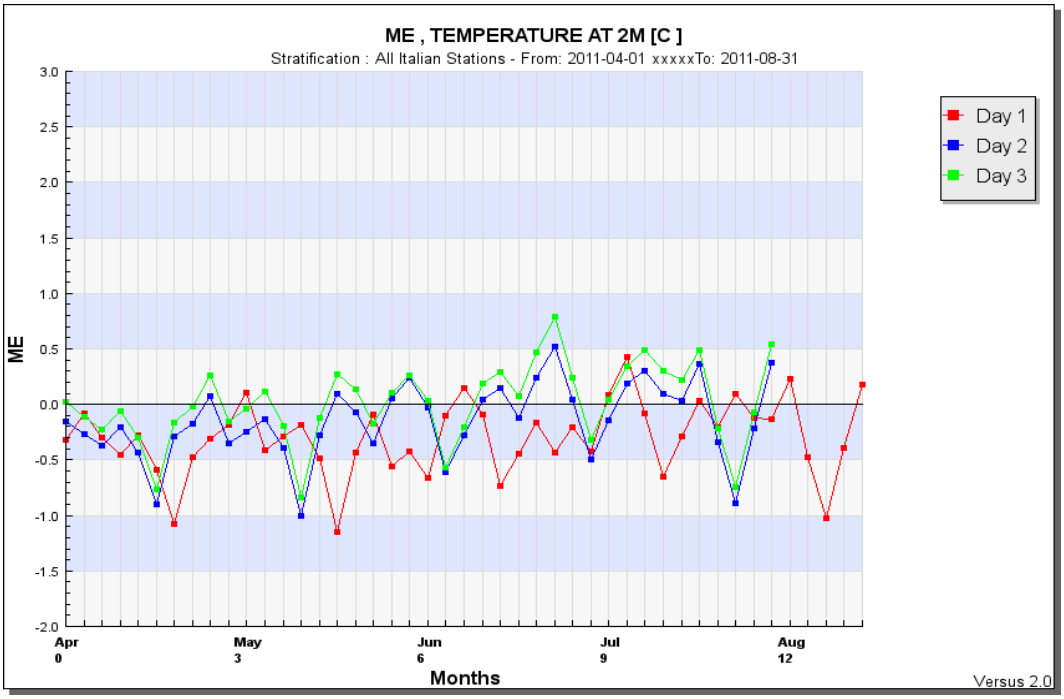


Figure 168 Monthly graphic configuration

By entering ‘Run’the plots foreach forecast day are displayed:

Figure 169 Monthly graphic



4.4 REPORT MENU

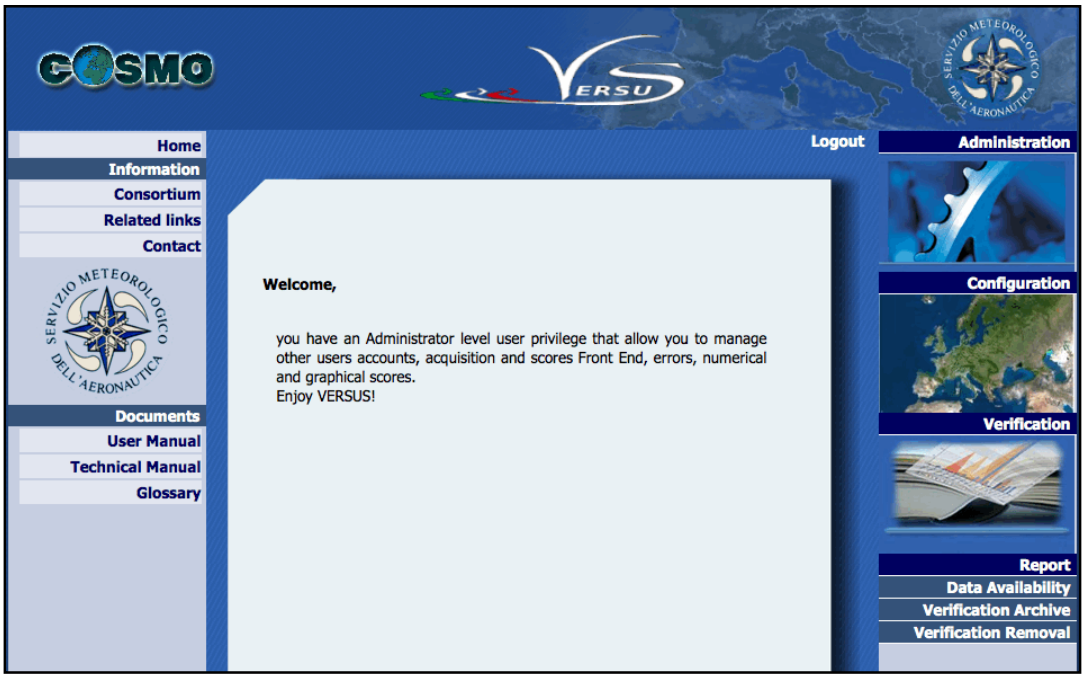


Figure 170 Report menu

The Report Menu manages all data and graphical reports available in VERSUS system.

4.4.1 DATA AVALIABILITY

It is possible to check the availability of data (forecasts and observations) and download them in ASCII, Excel, or grib1 format

By clicking on Data Availability option the system opens two sub-menus:

1) On-Site: for checking the data availability related to Front End that deals with bufr and ASCII synop, buf rand ASCII temp formats, and forecast model data on specified stratification

2) Analysis: for checking analysis data availability related to Front End that deals with grib in raw format (area_grib)

4.4.1.1 DATA AVALIABILITY On-Site

By clicking on Data Availability On-site, the system displays:

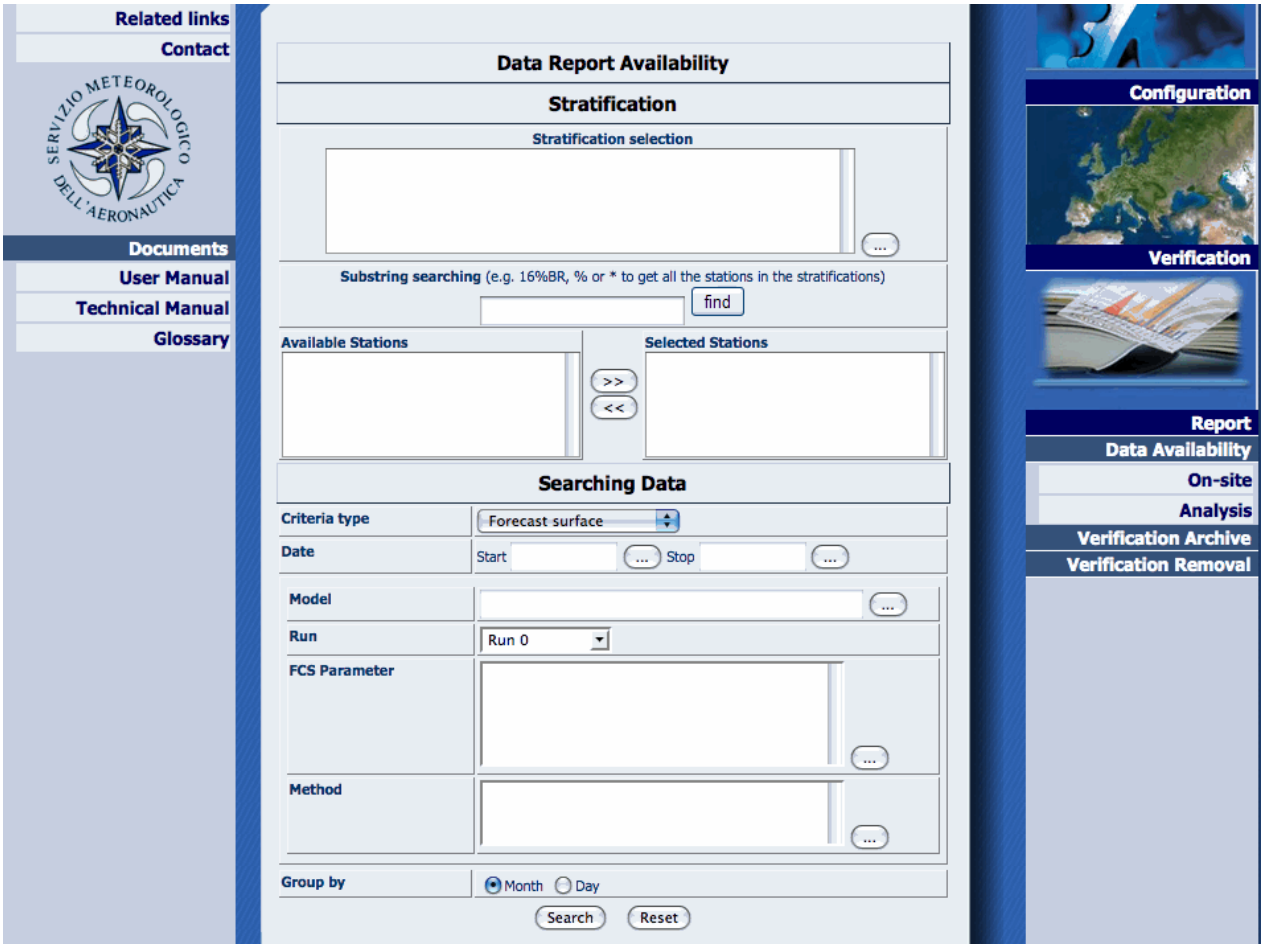


Figure 171 FCS Data availability on-site search All Italian stations

Stratification: User can search for data of a specific stratification or a set of stations inside a set of stratifications. To search for stations that match a specific criteria the field "Substring searching" should be filled in. In the form above a search on the "All Italian stations" stratification is performed and the criteria of station sub-search is "16%BR"**.** By clicking on 'find' the system displays on "Available Stations" field the list of stations that match the substring. The user can now select the stations he needs in the data availability query by clicking on >> button.

Criteria Type: User can check the data availability for forecast data, surface or upper air observation data.

Data: start date and end date of the time period of interest. In case these fields are empty, the system displays all available data without taking into account time range.

Model: Only for forecast data. The user needs to specify the model and it is the only mandatory field. If the model is probabilistic, the system displays the list of its members, and user can select one or more.

Run: Only for forecast data. It is the model run

FCS Parameter: only for forecast data. The list of parameters that are checked for availability

Method: Appears only for forecast data. Selection from list of interpolation methods of the model data

Group by: the data can be grouped by day or month

By changing criteria type to "Upper air Observation" the system displays the following GUI:

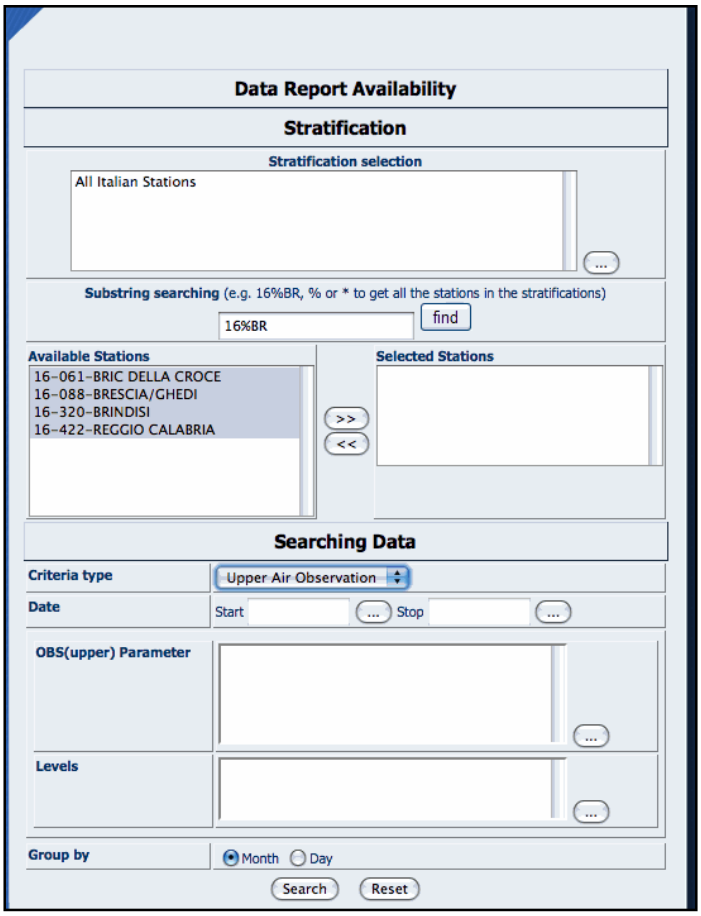


Figure 172 OBS Data availability request

Then, user can select the options for observation search.

By clicking on 'Search' button of an FCS criteria type, the system makes a query in the database to verify the model data availability..

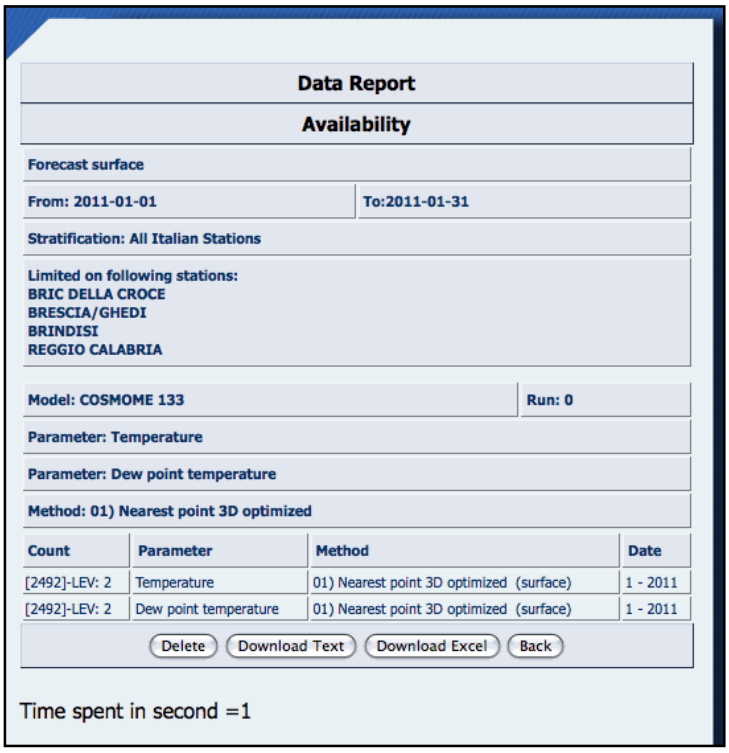


Figure 173 FCS Data Report: Availability

From this GUI it is possible:

- ✓ To delete selected data by clicking on “Delete” button
- ✓ To download the data in Text or Excel format

A special attention should be given to the observed precipitation parameter. A download request of precipitation observation implies that the system automatically gets 6,12, or 24 hours accumulated precipitation .

- ✓ Search for FF data loaded into VERSUS DB, is done by clicking on “Report->Data Availability->FeedbackFile”. The GUI that appears is:

Figure 174 FF Data Availability Search

The GUI gives the possibility to select:

Criteria type: if data to search are TEMP or AIREP;

Stratification: the stratification of the data;

Data: the reference date interval

Source Model: the FF source model description;

OBS parameter: The list of parameters that are checked for availability

Group by: the data can be grouped by day or month

Clinking on the “Search” the system displays the following GUI: Data can be downloaded in text files or deleted.

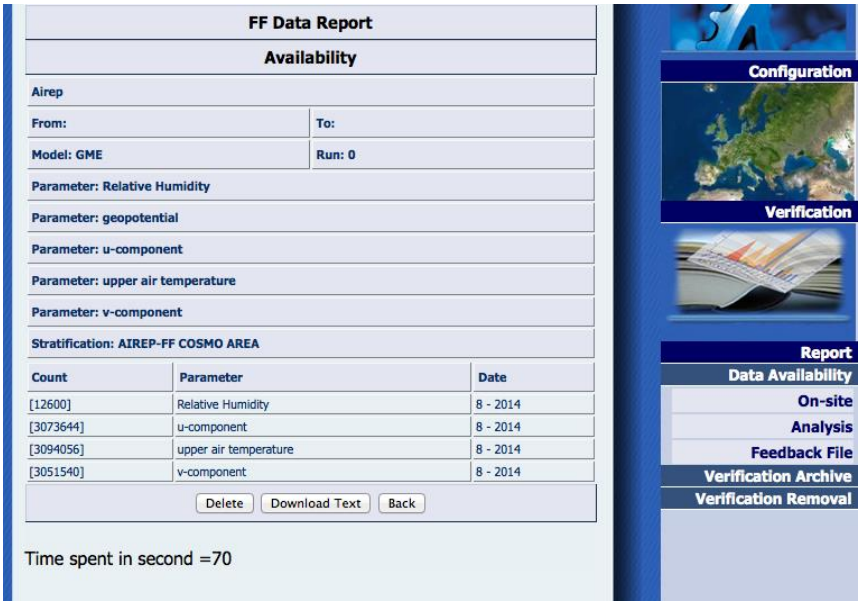


Figure 175 FF Data availability Report

4.4.1.2 DATA AVALIABILITY Analysis

By Clicking on Data Availability On-site, the system displays the form for searching data related to the ingestion of grib data useful for analysis verification.

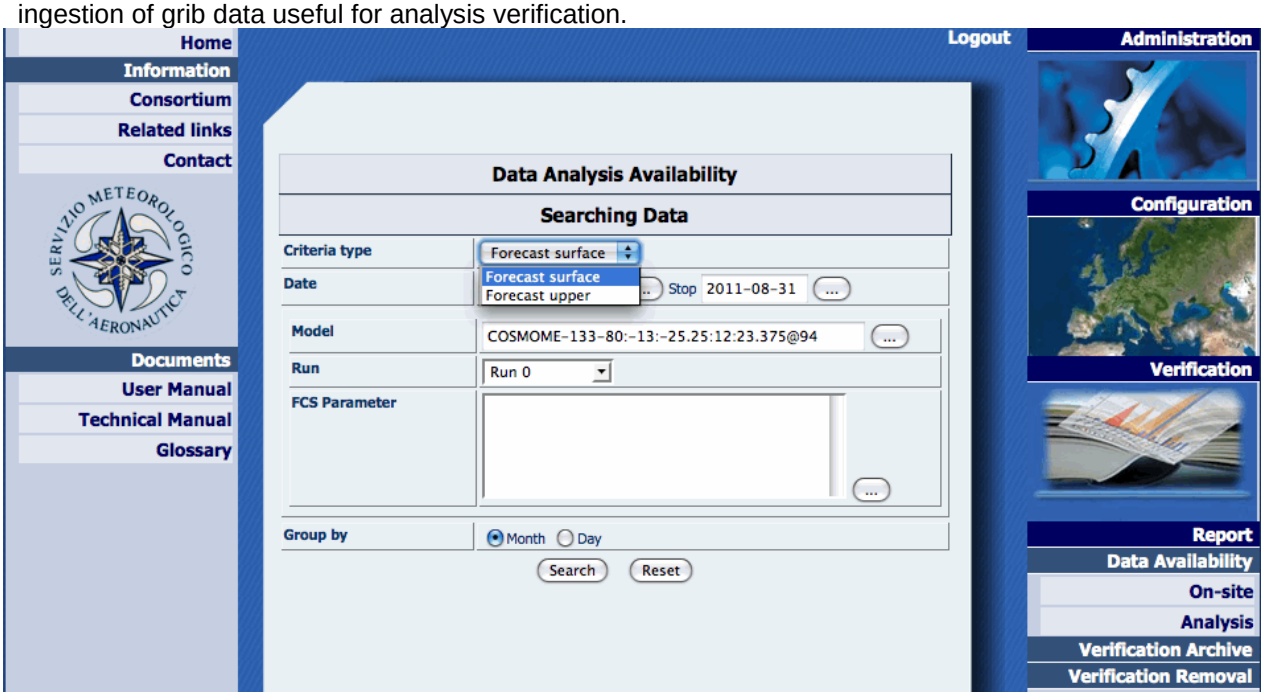


Figure 176 FCS Data availability analysis searching

Criteria Type: User can check the data availability for surface or upper model data.

Data: start and end date of the period of interest, In case the fields are left empty, system shows all available data without taking into account time range.

Model: The user must specify the model and this is the only mandatory field.

Run: the model run

FCS Parameter: The list of parameters that user wants to check for availability

Group by: the data can be grouped by day or month

By clicking on search button the following form is displayed:

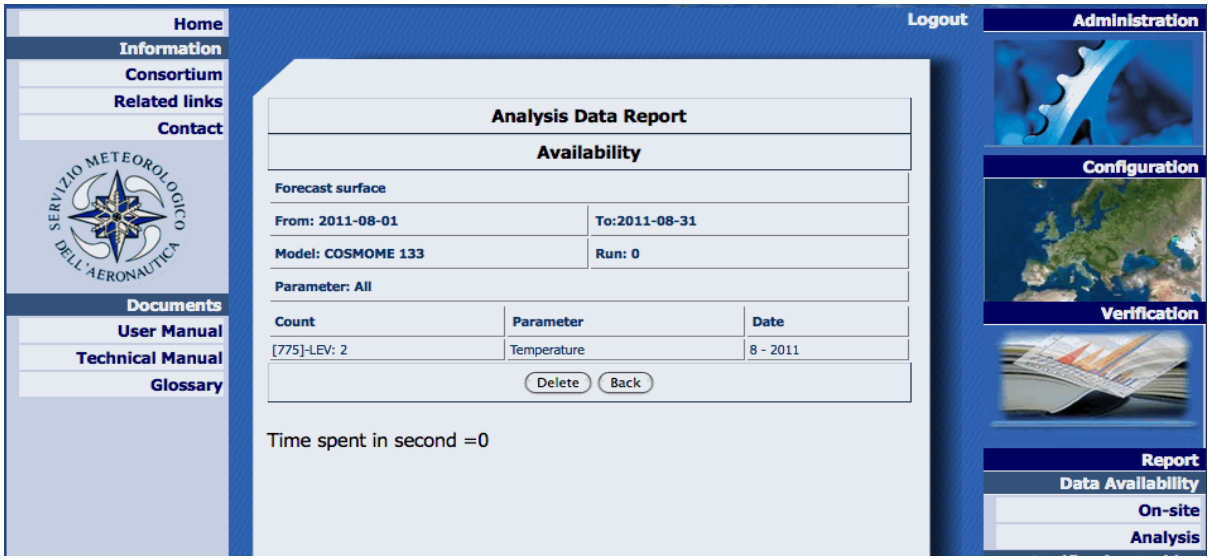


Figure 177 FCS Analysis Report: Availability

From this GUI it is possible to delete selected data by clicking on “Delete” button.

4.4.2 VERIFICATION ARCHIVE

The menu “Verification Archive” manages the scores and graphics results of all the verifications that VERSUS has carried out. Verification archive menu consists of two sub-menus:

On site: for submitting a request for verifications based on on-site stations.

Analysis: for submitting a request for verifications based on gridded data.

4.4.2.1 VERIFICATION ARCHIVE On-site

By Clicking on “Verification Archive”->On-site the system displays :

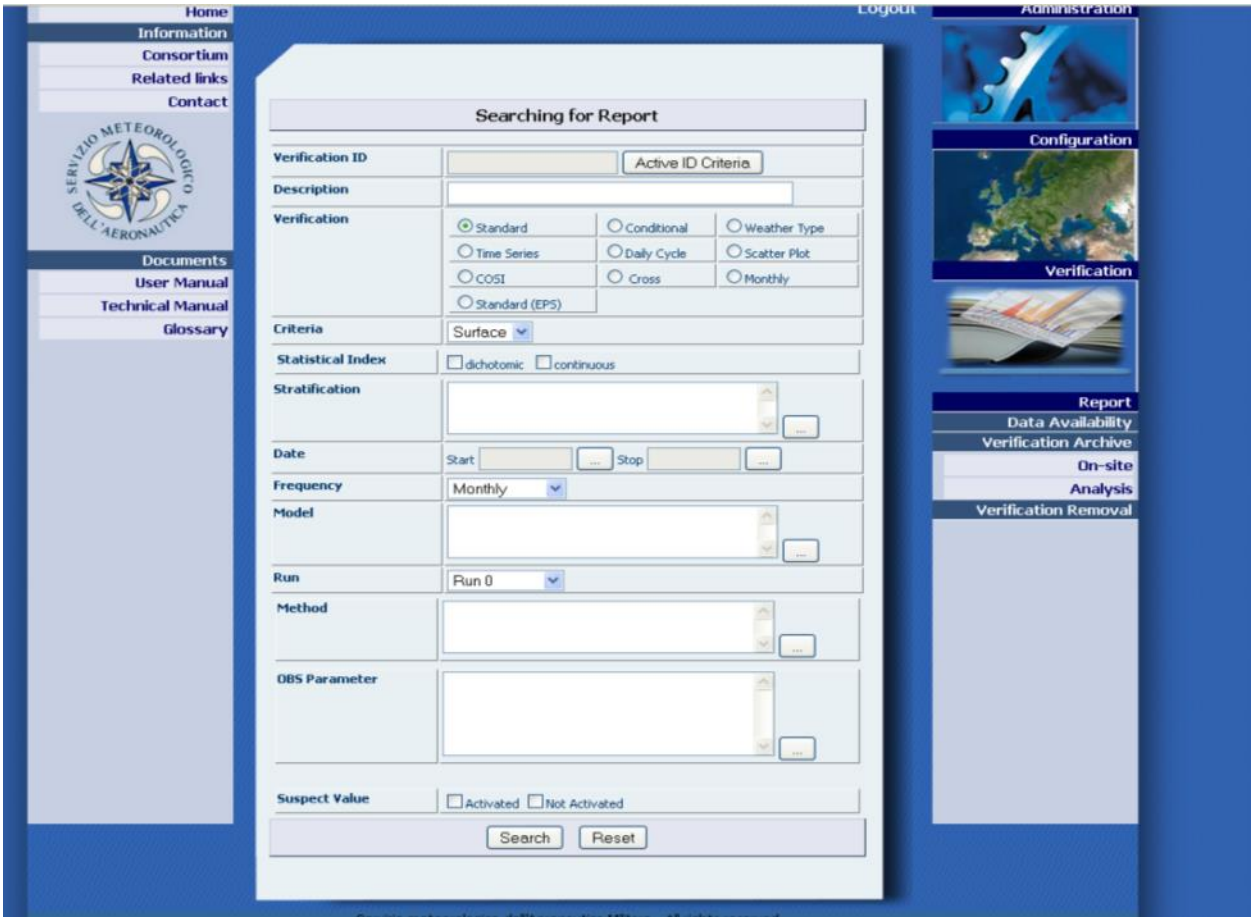


Figure 178. Verification Archive on-site

The GUI above can search for verifications in two different ways:

- ✓ by Verification ID: on this type of request the user must click on “Active ID Criteria”, fill in the field Verification ID, and the fields related to the time period. The verification ID can be found in the report form. This kind of request can locate a specific verification independently of the type (Standard, Conditional, Weather Type, Time Series, Daily Cycle, Scatter plot, COSI, Cross, Monthly, Standard (EPS))
- ✓ by Field: on this type of request, the user has to fill in the fields appearing on the GUI which depend on of the type of verification checked.

All verifications requests have in common the following fields to specify:

Description: a verification can also be searched with a substring contained in its configuration description.

Verification: it is a mandatory field in which the user must specify the kind of verification he wants to search for., The values are Standard, Conditional, Weather Type, Time Series, Daily Cycle, COSI, Cross, Monthly.

Criteria: the user has to specify if the verification is on Surface or Upper air data. The whole set of verifications is defined on surface data except for Standard and Cross which can be defined in upper data also.

Stratification: this field is needed for specifying one or more stratifications for verification search. If left empty the system will perform the search for all the available stratifications.

Date: the time interval on which to perform the verification search. It is mandatory if frequency is set to Monthly or Seasonal.

Frequency: this field can be set to Monthly for a request of verifications configured as Monthly, Seasonal for verifications configured as Seasonal or Date interval for verifications configured in a defined time period.

Model: this field is needed to select one or more models used for the verifications. If left empty the system will perform a search for all the available models.

Run: this field refers to the model run

OBS Parameter: (except for COSI) this field is for selecting one or more parameters for verification search. If left empty the system will perform a search for all the available parameters.

At the end of form there are two options :

- Search: for submitting the search request
- Reset: for resetting the fields previously set.

4.4.2.1.1 Standard Verification Searching

Additional fields for this type of query are:

Statistical Index: this field can be set as dichotomous or continuous or both

Method: this field is for selecting one or more interpolation methods. If left empty the system will perform the search for all the available methods.

Suspect Value: if the option 'Activated' is checked the search will include only verifications configured with the option of the suspect value control. If 'Not Activated' is checked, the search will include only verifications configured with the option not to have the suspect value option. To check both options is equivalent to uncheck both.

An example of GUI settings for searching a standard verification is given below:

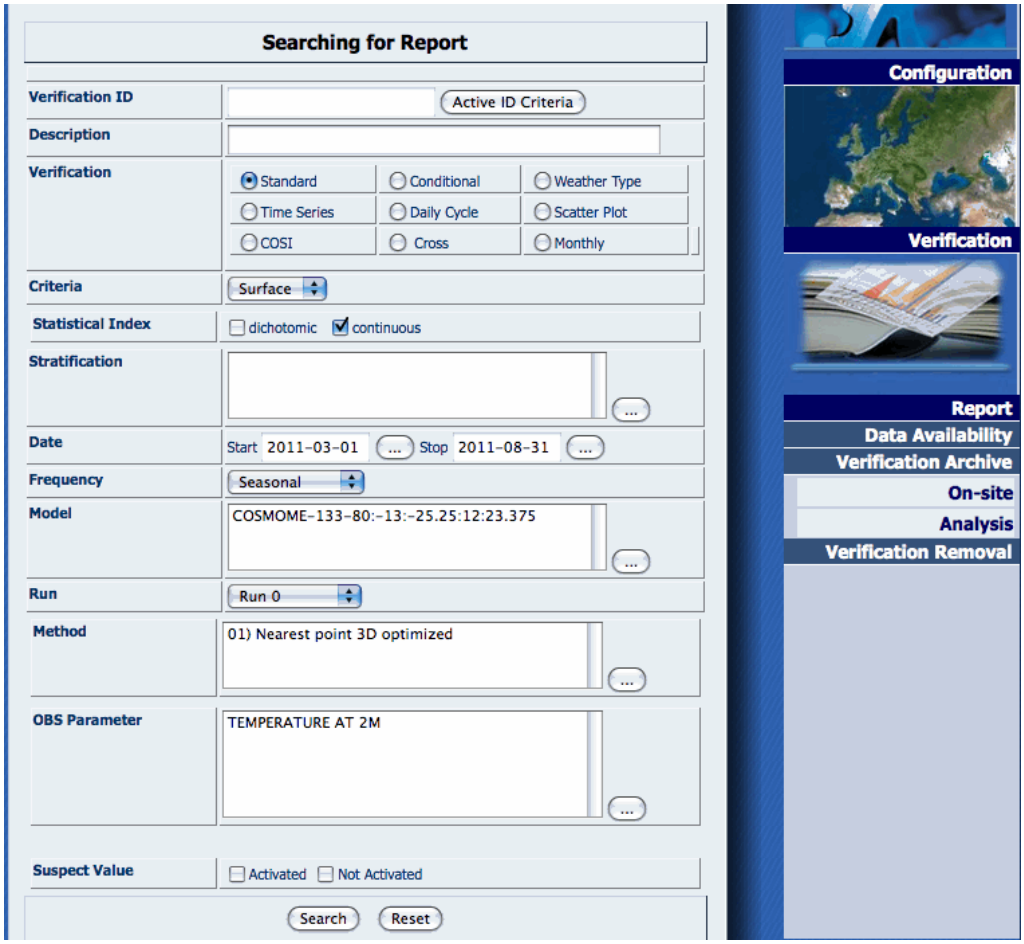


Figure 179 On-site Standard Verification Search

This standard verification search is performed by specifying the following fields:

Description: not specified.

Verification: Standard.

Criteria: Surface.

Statistical index: continuous

Stratification: All Italian Stations

Date: from 2011-03-01 to 2011-08-31

Frequency: Seasonal.

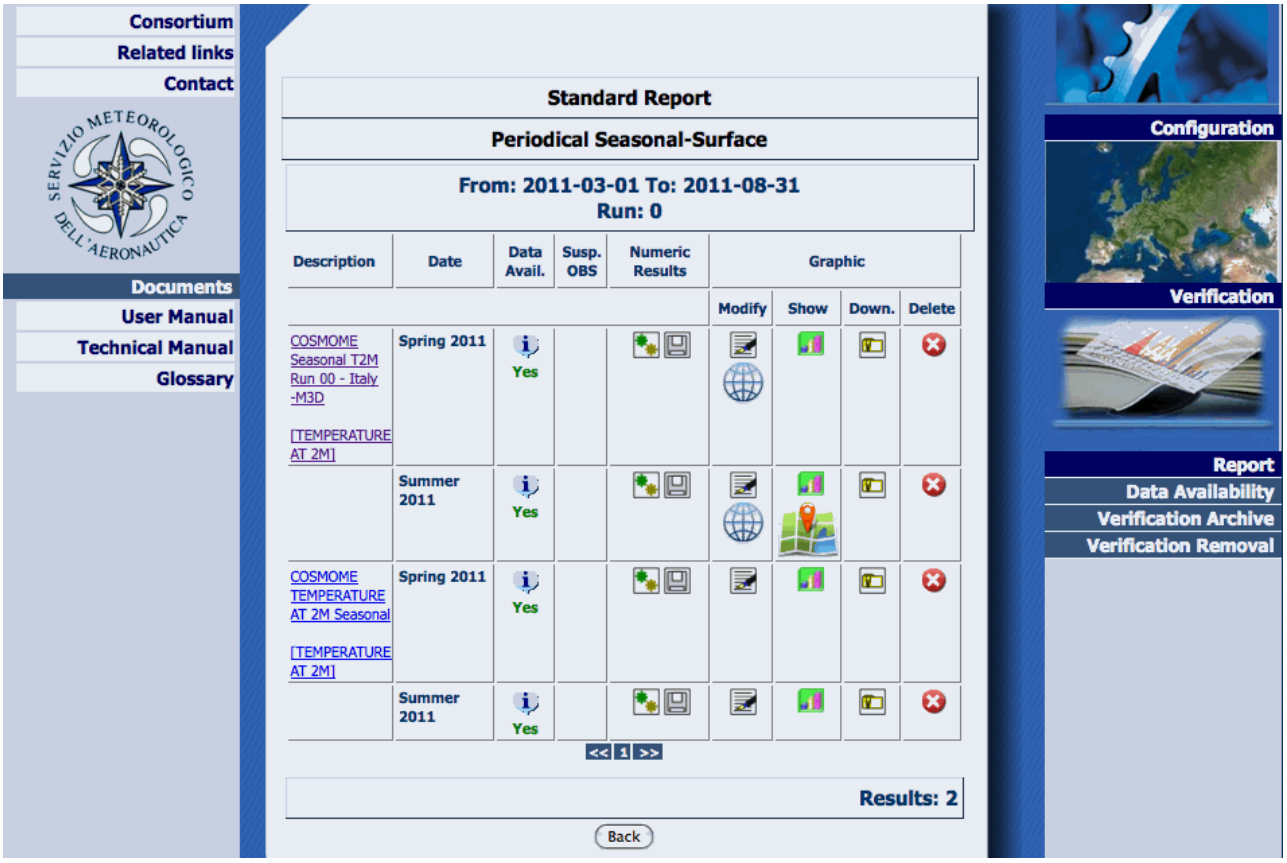
Model: COSMOME

Run: 00

Method: 1) Nearest Points 3D optimized

OBS Parameter: 2 Meters Temperature

Suspect Value: both



By Clicking on Search button the system displays the following web GUI:

Figure 180 On-site Standard verification list

For each verification found, the system builds the seasons (or months) and for each of them the following information is available:

- ✓ Description: It is the description of the verification found and it is a link to its complete report
- ✓ Date: the calculated date automatically build from the system
- ✓ Data Avail. To get information concerning the number of matching data (obs fcs). By clicking on this icon the system automatically calculates the number of matching pairs.

- ✓ Suspect Obs: in case of suspect observations ,is a link to them in order to visualize them and download them by clicking on 'Save Text'

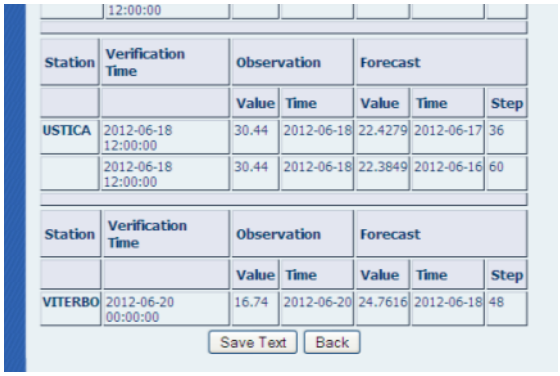


Figure 181 Suspect Observations

Numeric Results: Click on this icon for running or rerunning the scores, if data is available and only if the current user is not a consultant

When running a verification, from **Report->Verification Archive,** the link appears. This icon indicates that the verification is in the process of computing the scores.

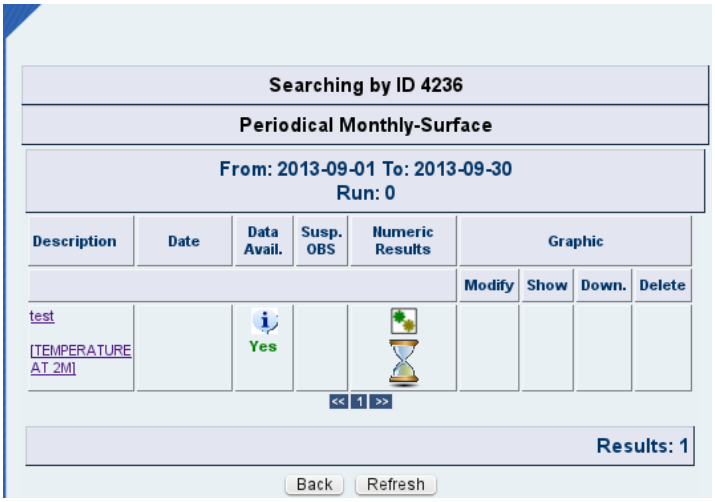


Figure 182 Process of Running a Verification

- ✓ The refresh of this GUI can be forced by clicking on the "Refresh" button, In any case, the page is automatically reloaded after 60 seconds. If the verification has correctly ended the traditional Versus view will appear.
- ✓ During the execution clicking on the icon the system redirects to the Queue Manager page, with the details of the current verification and of the ones that are currently running.
- ✓ Numeric Results: for analyzing or saving the calculated score
- ✓ Graphic-Modify: for configuration of the plot as standard graph and for geographical graphical distribution

- ✓ Graphic-Show: for displaying the standard plot for showing the geographical plotting
- ✓ Graphic-Delete: for deleting the plot, only if the current user is not a consultant
- ✓ Graphic-Download for downloading all plots either standard or geographical (.png format)The files are stored in the Verification Archive critera_ID.zip where ID is the Verification ID number. The files can be alternatively downloaded directly from the file system from the path $HOME_VERSUS/html/versus

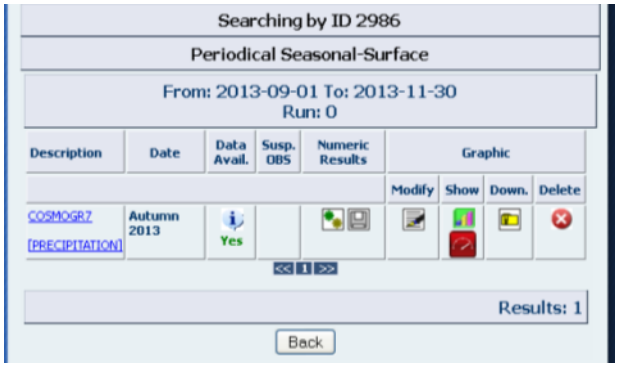


Figure 183 Standard Verification list for dichotomous parameters with Performance Diagrams

For dichotomous parameters, performance diagrams (PD) are also produced. By clicking on a list of PD for each threshold is available and can be downloaded in PDF format.

To configure a geographical plot of a verification, it needs to have been created with “Geographical distribution ” option set to on. In the list of verifications, the icon of the geographical distribution appears.

By clicking on icon the system displays :

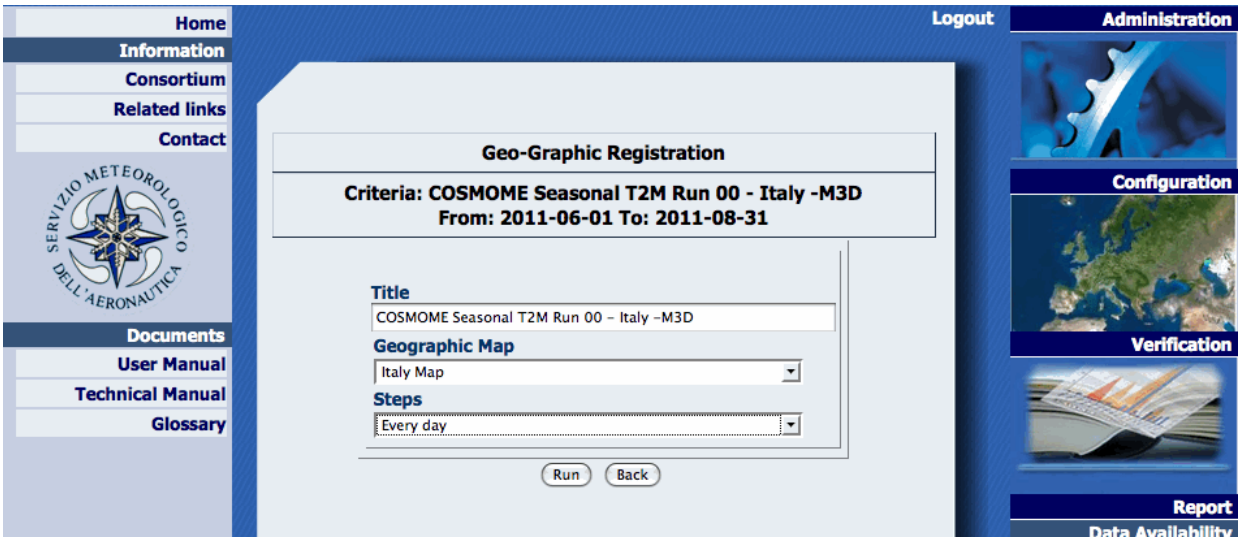


Figure 184 Geographic plot configuration

The information needed is:

Title: the title of geographical map distribution

Geographic Map: the geographic map on which the scores will be plotted

Steps: day or night/day cycle

By running the registration the system displays as many graphics as the days of the model for each configured score, The figure below displays a graph of ME index geographical distribution of the first day (0-24 steps) . X-axis represents longitude values, and y-axis latitude values, :

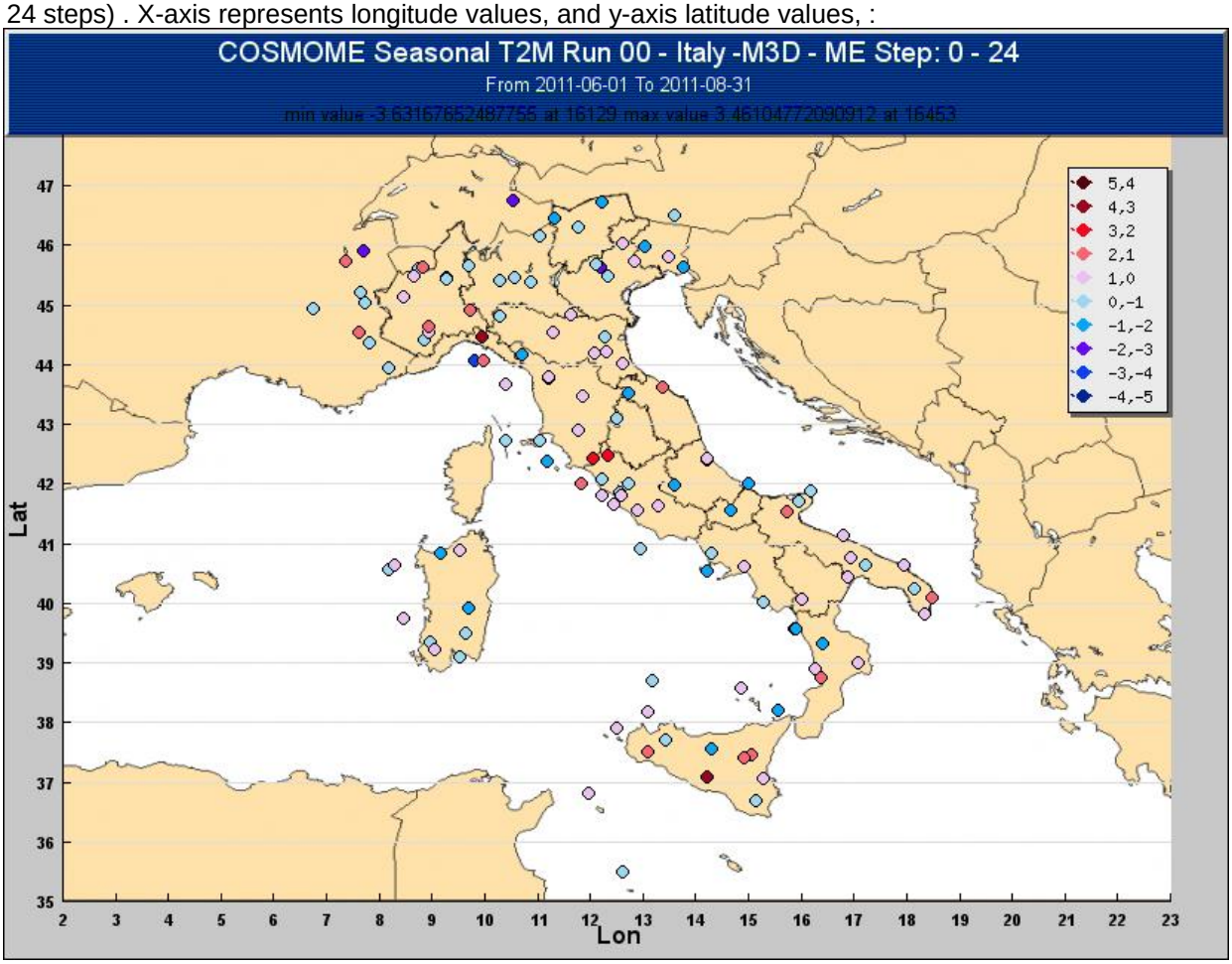


Figure 185 Geographic distribution graph

The graphic colors and legends can be changed by editing the file RGBdefine.php located in the directory:

${VERSUS_HOME}/html/versus/

For each score and for each parameter there are two variables to edit:

global $COLOR_XXXXX_SCORE; It is the colors array that contains the colors coded into RGB code.

global $LEGEND_XXXXX_SCORE; It is the legend array that contains the intervals of legends.

XXXXX is the bufr code of the parameter and **SCORE** is the name of the score.

When the variables are not specified the system uses the default option:

global $COLOR_OTHER;

global $LEGEND_OTHER

Referring, as an example, to continuous scores, in the file “RGBDefine.php” disseminated with the VERSUS packages, default color and legend for ME of Temperature (bufr code 12004), are configured through the variable $COLOR_12004_ME and $LEGEND_12004_ME. The graphic for the other continuous scores are, also produced based on the general variables described above.

A detailed procedure to configure these properties for a new index follows, using as an example, configuration of color and legend array for the Standard Deviation (SD) of the Temperature. According to this procedure the user can configure any other “parameter-index” couple (continuous or dichotomous).

In general the user can change color or legend, but in order to make the changes operational, in any case, he must define both arrays.

The steps are the following:

1. Edit the file “RGBDefine.php”

2. To configure the legend arrays: add two rows in the file, the first declaring the variable name and the second filling the array with the user requested values, as follows

```
global $LEGEND_12004_SD;
$LEGEND_12004_SD=array("2.1,2.0","2.0,1.9","1.9,1.8","1.8,1.7","1.7,1.6","1.5,1.6","1.5,1.4","1.4,1.3","
1.2,1.3","1.3,1.2");
```

3. To configure the color arrays: add two rows in the file, the first one declaring the variable name and the second filling the array of colors with the user requested values, as follows

```
global $COLOR_12004_SD;
$COLOR_12004_SD=array(array(84,3,11),array(255,255,0), array(248,6,31) ,array(246,102,117),
 array(235,193,239),array(156,215,241) ,array(9,166,248), array(103,6,249), array(13,63,243), array(5,36,148));
```

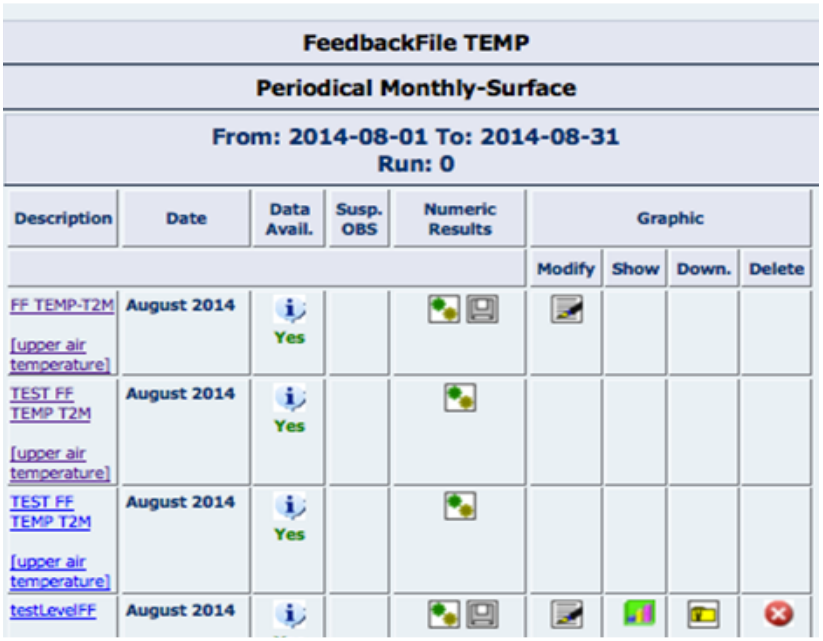
In this simple example the arrays have been changed with respect to those initially defined for ME, in order to have a legend ranging between 1.2 and 2.1 with steps of 0.1 and the color array has been changed to associate the colour yellow RGB “255 255 0” to the interval [2.0,1.9].

4.4.2.1.2 Feedback files Verification Search

To search a FF Verification, the procedure is similar to a standard Verification, with selection of “Report->Verification Archive” menu. Feedback File button should be selected on the Verification menu and criteria fields :are TEMP or AIREP. According to the fields, the stratification type is different (stations or area defined):

Figure 186 FF Report Search

Clicking on Search Button the GUI is displayed and the scores can be plotted in the same way as standard verification.



FeedbackFile TEMP

Periodical Monthly-Surface

From: 2014-08-01 To: 2014-08-31
Run: 0

Description	Date	Data Avail.	Susp. OBS	Numeric Results	Graphic			
					Modify	Show	Down.	Delete
FF TEMP-T2M [upper air temperature]	August 2014	Yes						
TEST FF TEMP T2M [upper air temperature]	August 2014	Yes						
TEST FF TEMP T2M [upper air temperature]	August 2014	Yes						
testLevelFF	August 2014							

Figure 187 FF Verification Search Report

4.4.2.1.3 Conditional Verification Search

Additional fields for this kind of search are:

Statistical Index: this field can be set as dichotomous or continuous or both

Method: this field is for selecting one or more interpolation methods. If left empty the system will perform the search for all available methods.

Condition: a verification can be searched for condition on Observation (based on value or function) or Forecast(based on value or function) or both. In this last case user should check the “Condition Obs&Fcs”.

Suspect Value: if ‘Activated’ is checked, the search will locate only the verifications configured for suspect value. If‘ Not Activated’ is checked, the search will locate only the verifications configured not to have the suspect value. Checking both is equivalent to uncheck both.

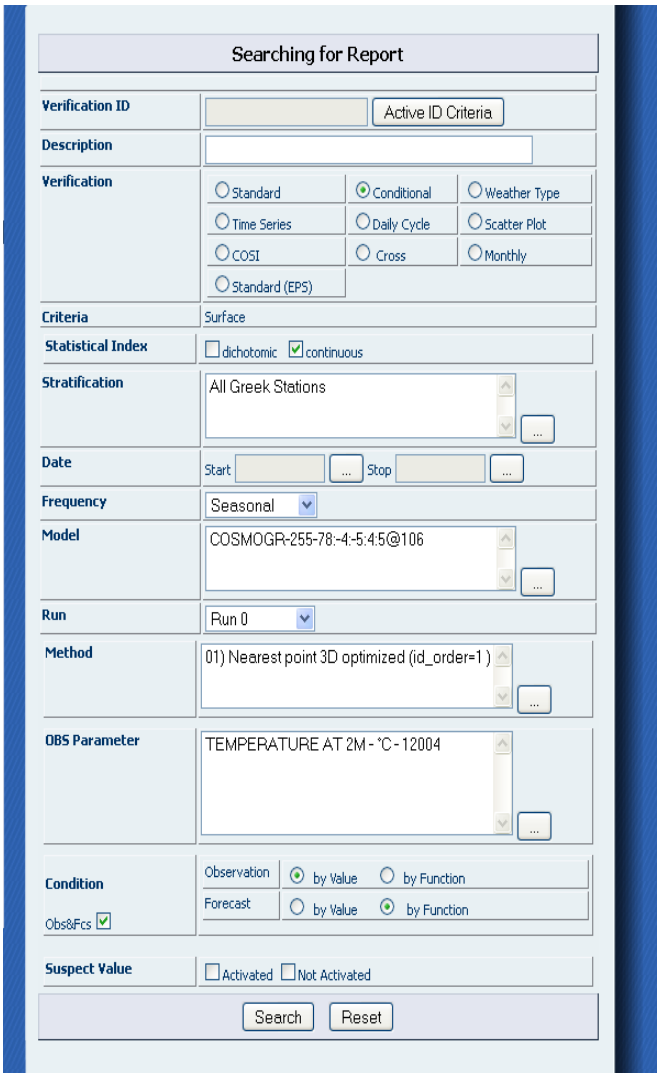


Figure 188 Conditional Verification Search

An example of GUI settings for a conditional verification search is given below:

This conditional verification search is performed by specifying following fields:

Description: not specified.

Verification: Conditional.

Criteria: Surface (it is fixed).

Statistical index: continuous

Stratification: All Italian Stations

Date: from 2010-09-01 to 2011-01-31

Frequency: Seasonal.

Model: COSMOME

Run: 00

Method: 1) Nearest Points 3D optimized

OBS Parameter: T2m, TD2m

Condition: on Observation by value

Suspect Value: both

By Clicking on Search button the system displays a web GUI similar to that described for standard verification.

4.4.2.1.4 Weather type Verification Searching

The fields for this kind of search are the same as the ones of standard verification in addition to the following:

Weather Service: select a weather service

Weather Class: select one or more weather classes of the weather services . If left empty the system will configure the research for all the weather classes

An example of GUI settings for a request of a weather type verification is the following:

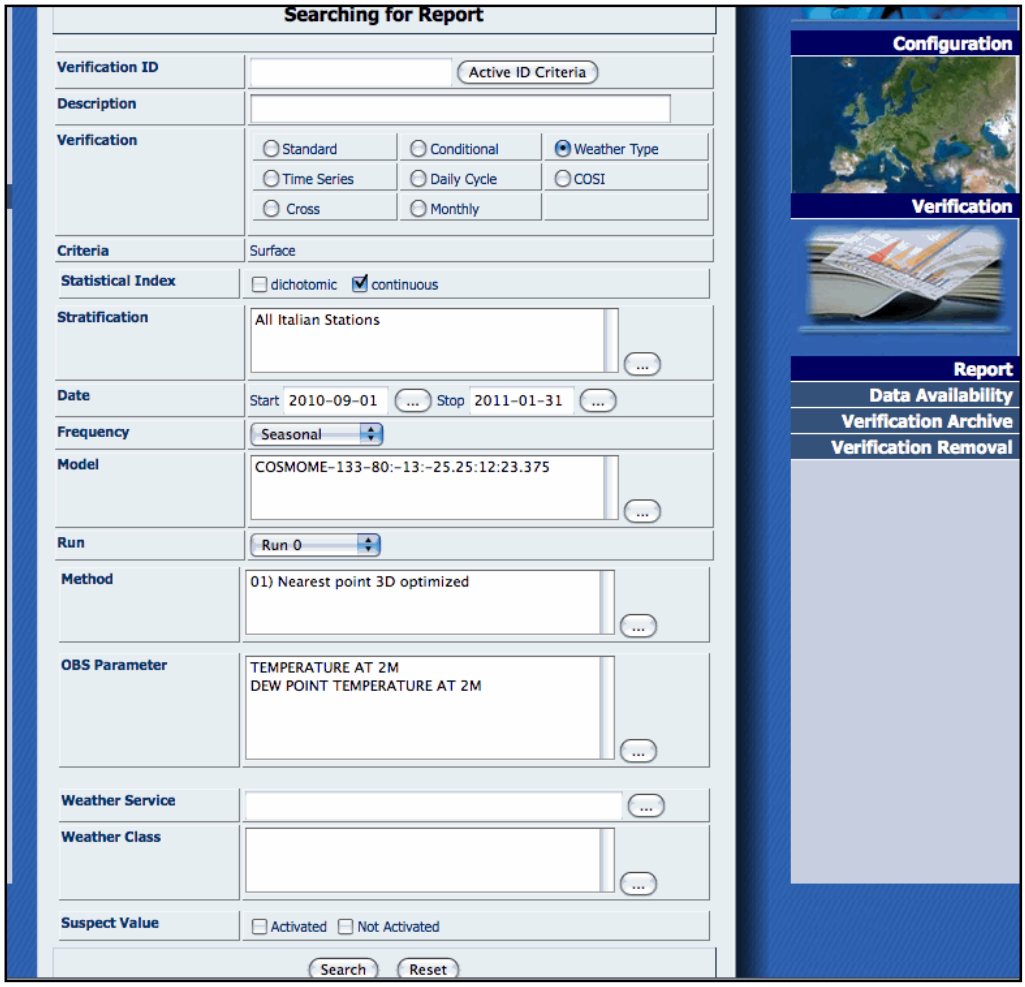


Figure 189 WTD Verification Searching

By Clicking on Search button the system displays a web GUI similar to that described for standard verification.

4.4.2.1.5 Time Series Searching

The fields for this kind of search are the same as the ones for standard verification without the specification of the statistical index. When the verification is retrieved, and executed, by clicking on  besides the graphic .png files, a .csv file stores the values of observations and forecast values for each time step for all models (in case of multiple models time series). The files are stored in the Verification Archive critera_ID.zip where ID is the Verification ID number.

4.4.2.1.6 Daily Cycle Searching

The fields for this kind of search are the same as the ones for time series verification

4.4.2.1.7 Scatter plot Searching

The fields for this kind of search are the same as the ones for time series verification

4.4.2.1.8 COSI Searching

By Checking COSI on field verification of Verification Archive, the fields for COSI search are displayed...

.

An example of GUI settings for searching a COSI verification with the minimum possible input fields is given below:

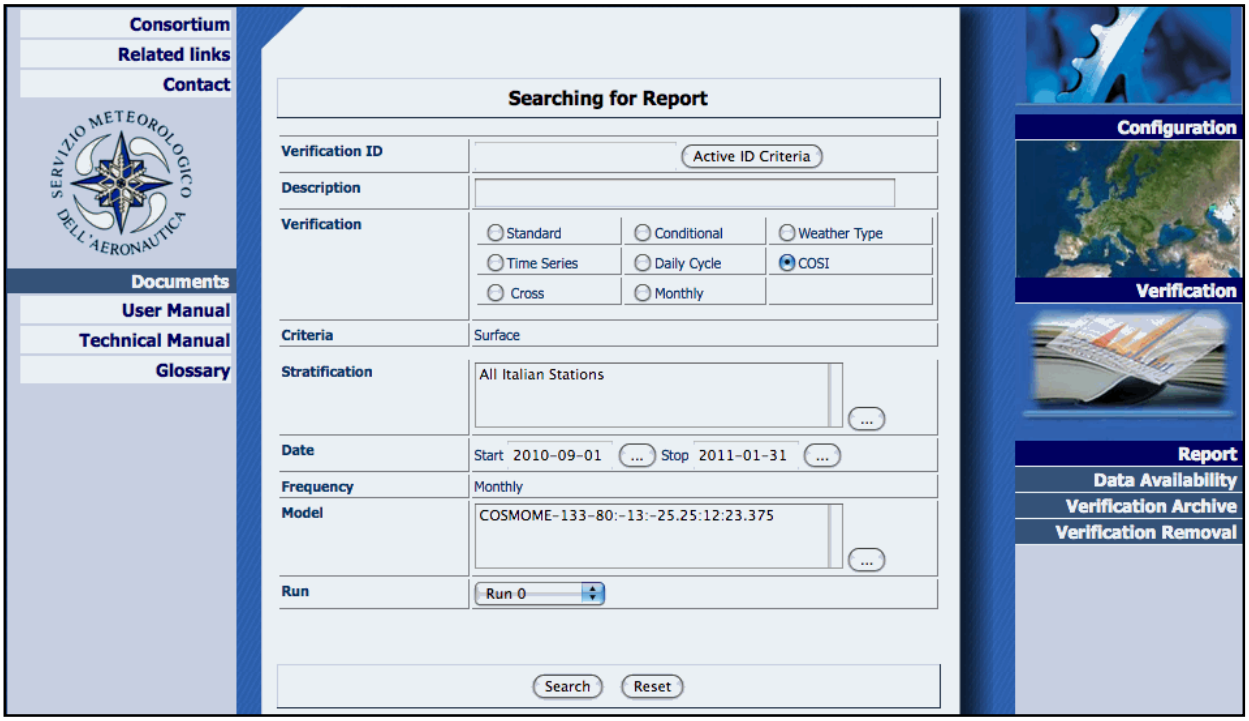


Figure 190 COSI Verification Searching

The user needs to specify:

Stratification

Start date: the initial year and month of COSI calculation

End date: the final year and month of COSI calculation

Model: the process model and related run

By Clicking on Search button the system displays all the COSI that apply , displaying the following form:

Figure 191 Search COSI Index Results

On the above form it is possible to do the following:

To View the COSI Index definition by clicking on COSI Description

In the GUI above all data are available but no scores have been executed, For each month the system shows if scores and data are available. It is possible to view or execute the monthly scores by clicking on link "Scores". In this case, clicking on link "Scores" of the month of September the system displays:

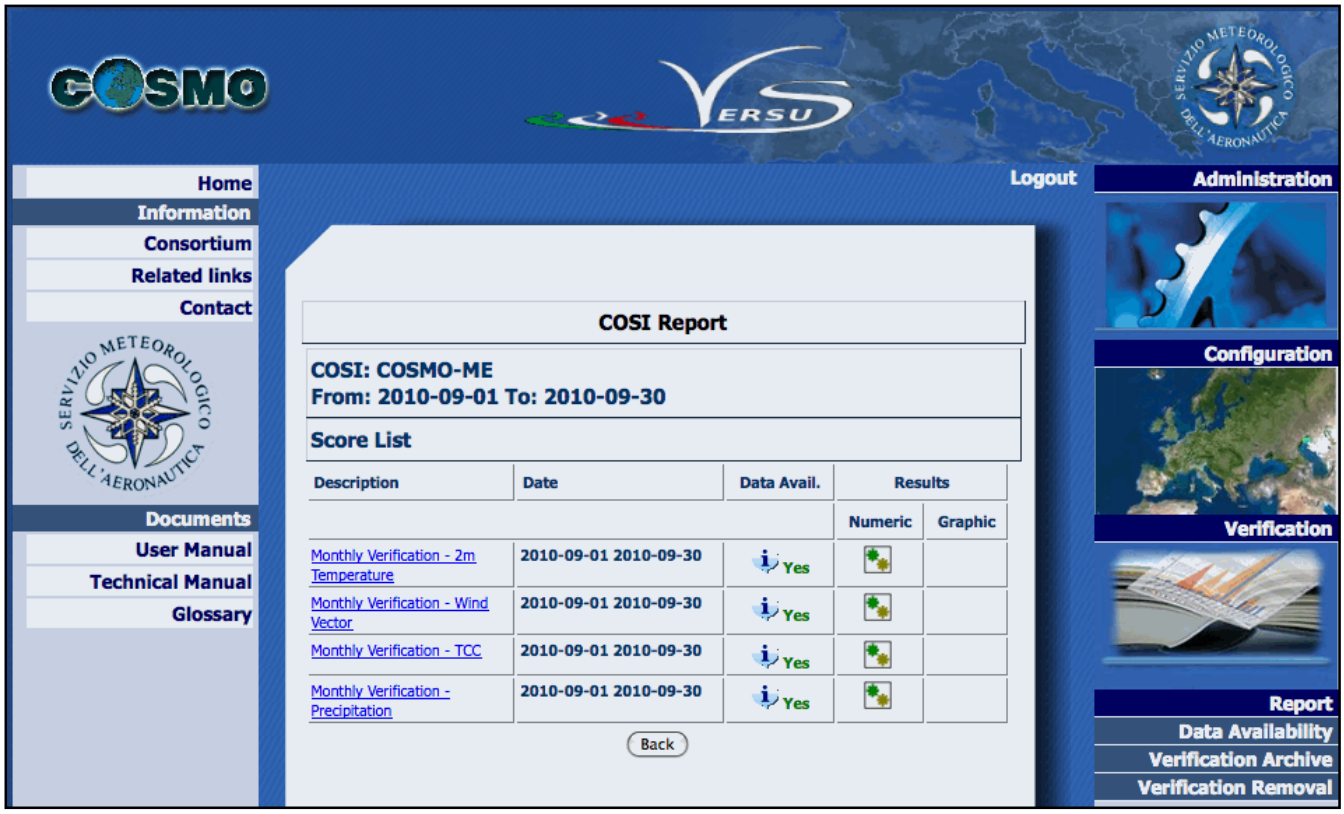


Figure 192 COSI Scores execution

From the above form it is possible to run a single score, or rerun an existing one.

By Clicking on “Trend” link of the Figure 139 the system displays:

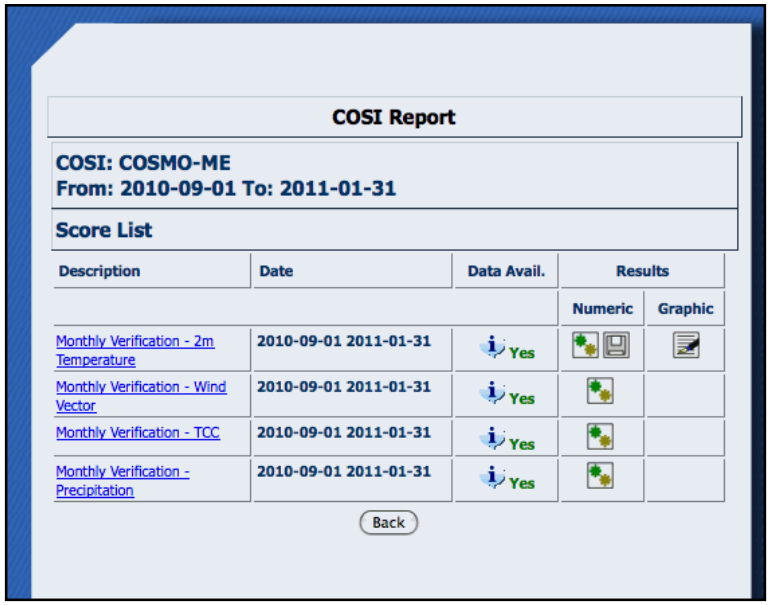
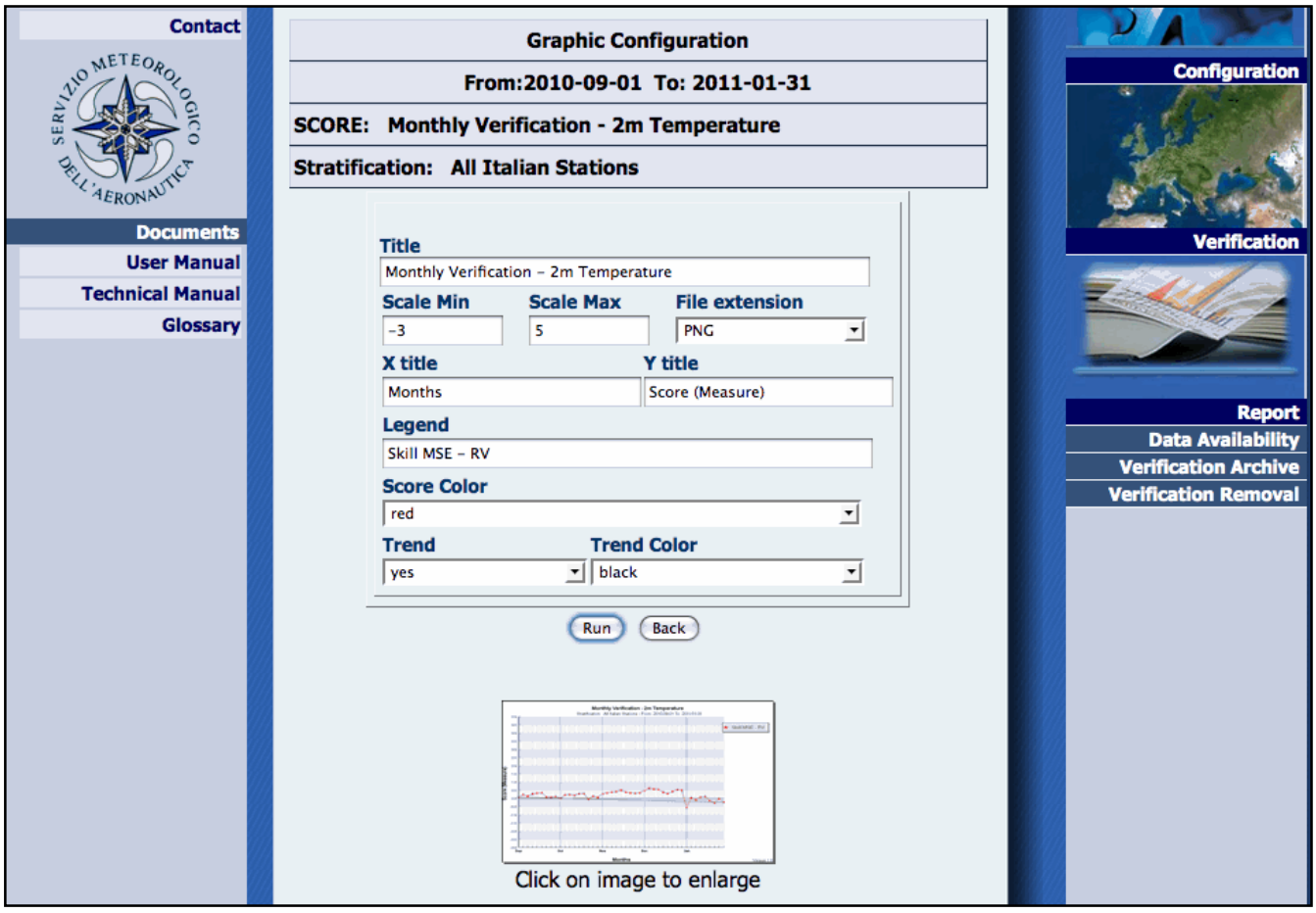


Figure 193 COSI Trend execution

From the above form it is possible to execute the missing score on the configured date by clicking on icon. Moreover it is possible to get the trend graphic clicking on icon. For example by clicking on Temperature scores the system displays:

Figure 194 COSI Trend graphic configuration



By Clicking on the image the system displays the index trend:

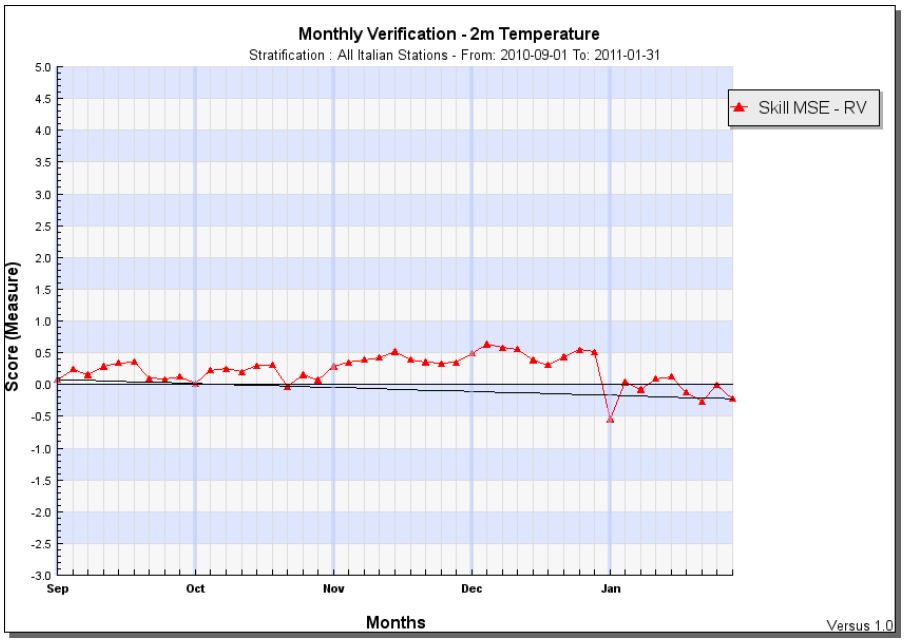


Figure 195 COSI Trend graphic

It is possible to run the complete COSI execution by clicking on  of the Figure 139.After execution, by clicking on  icon the system displays numeric COSI results, as follows:

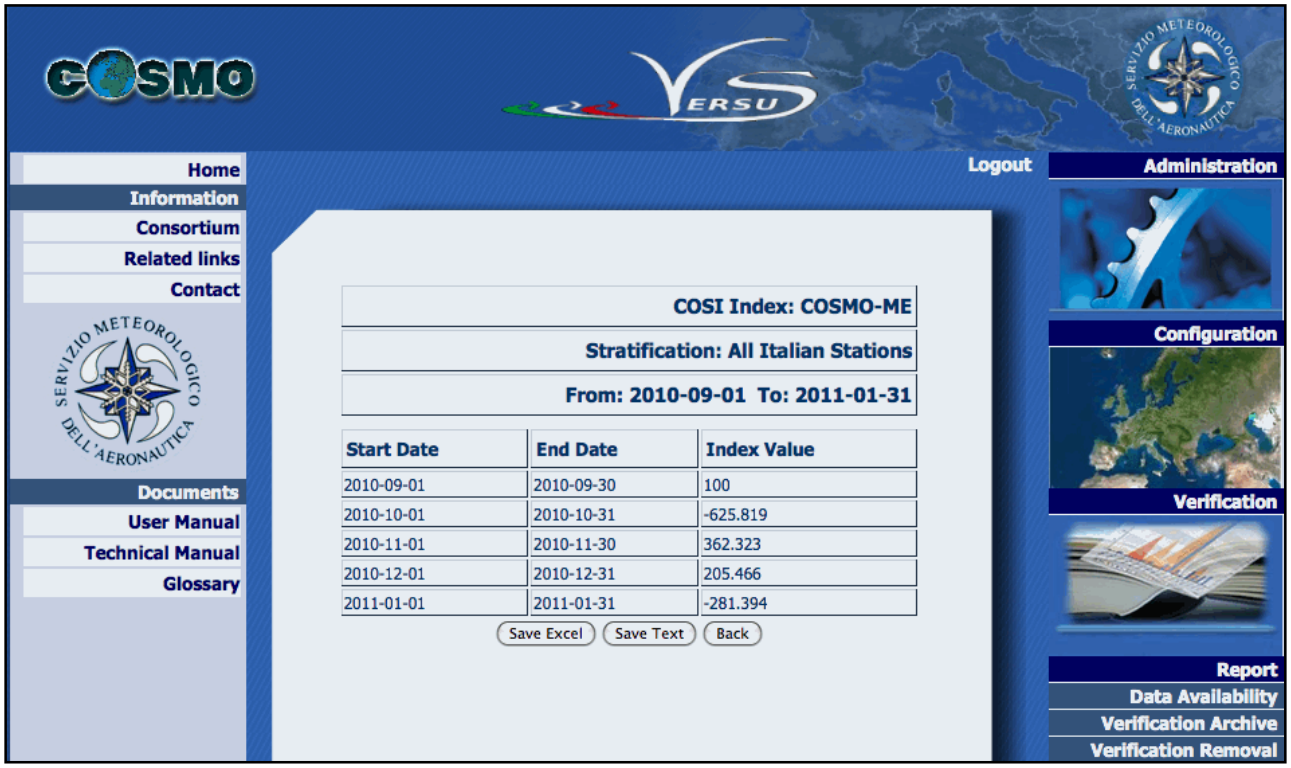


Figure 196 COSI numeric results

For graphic configuration the user must click on  icon of the Figure 139.

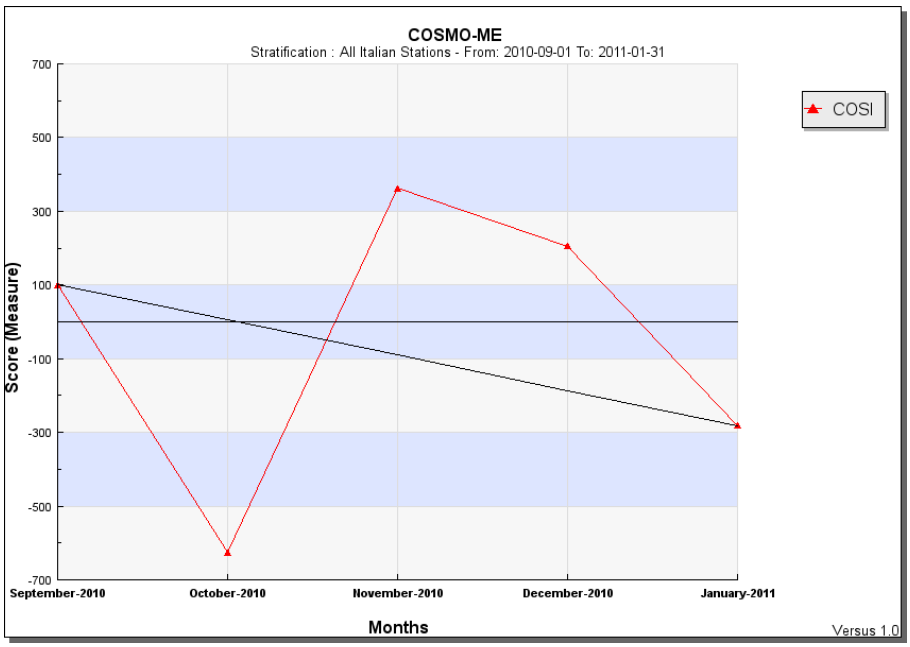


Figure 197 COSI graphic

4.4.2.1.9 CROSS Search

By selecting ‘Cross’ on field Verification of Verification Archive, the fields for Cross search appear.

An example of GUI settings for a Cross verification search with minimum input fields is given below:

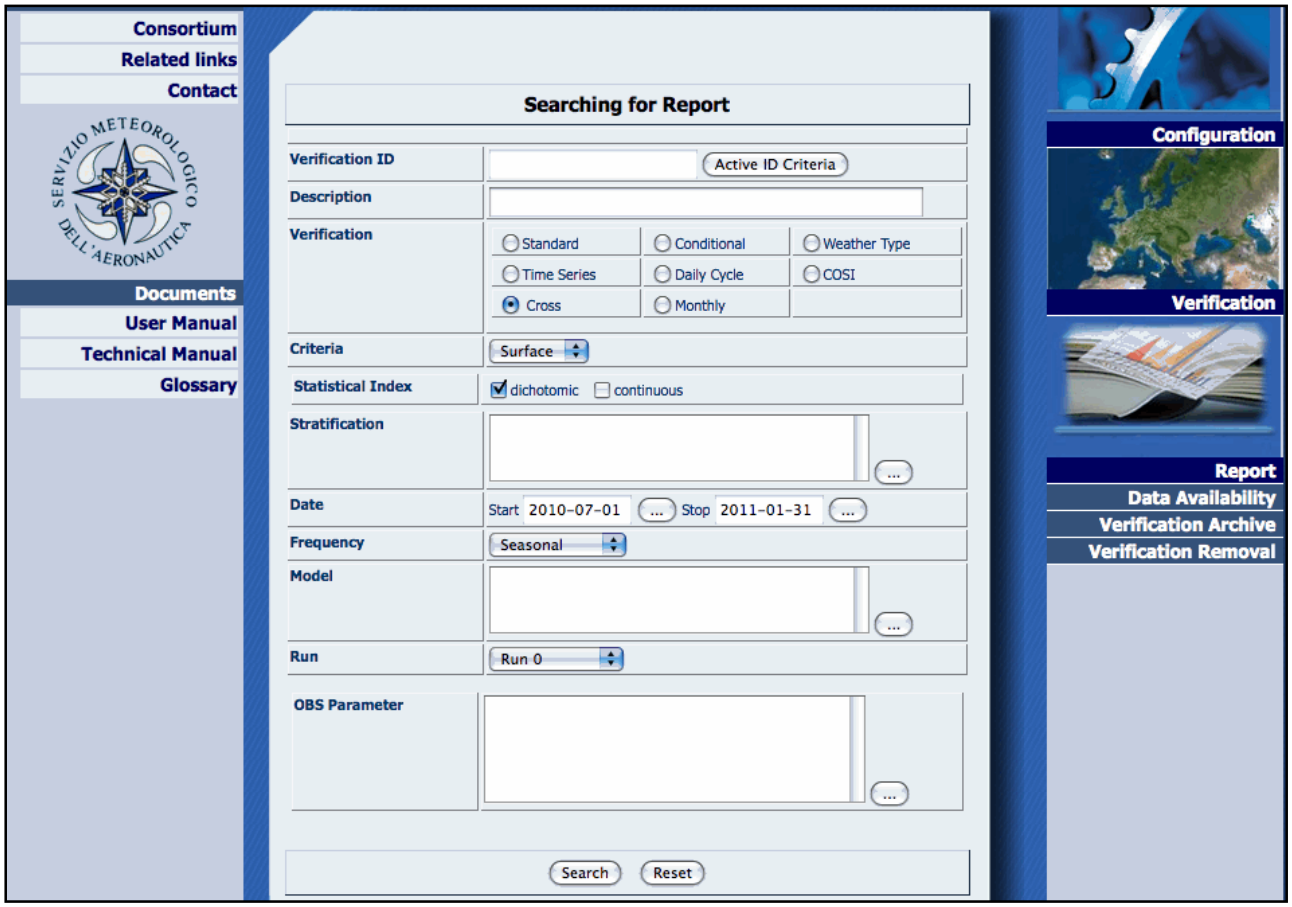


Figure 198 CROSS Searching

By Clicking on Search button the system displays all the defined Cross model graphics that apply, displaying the following form:

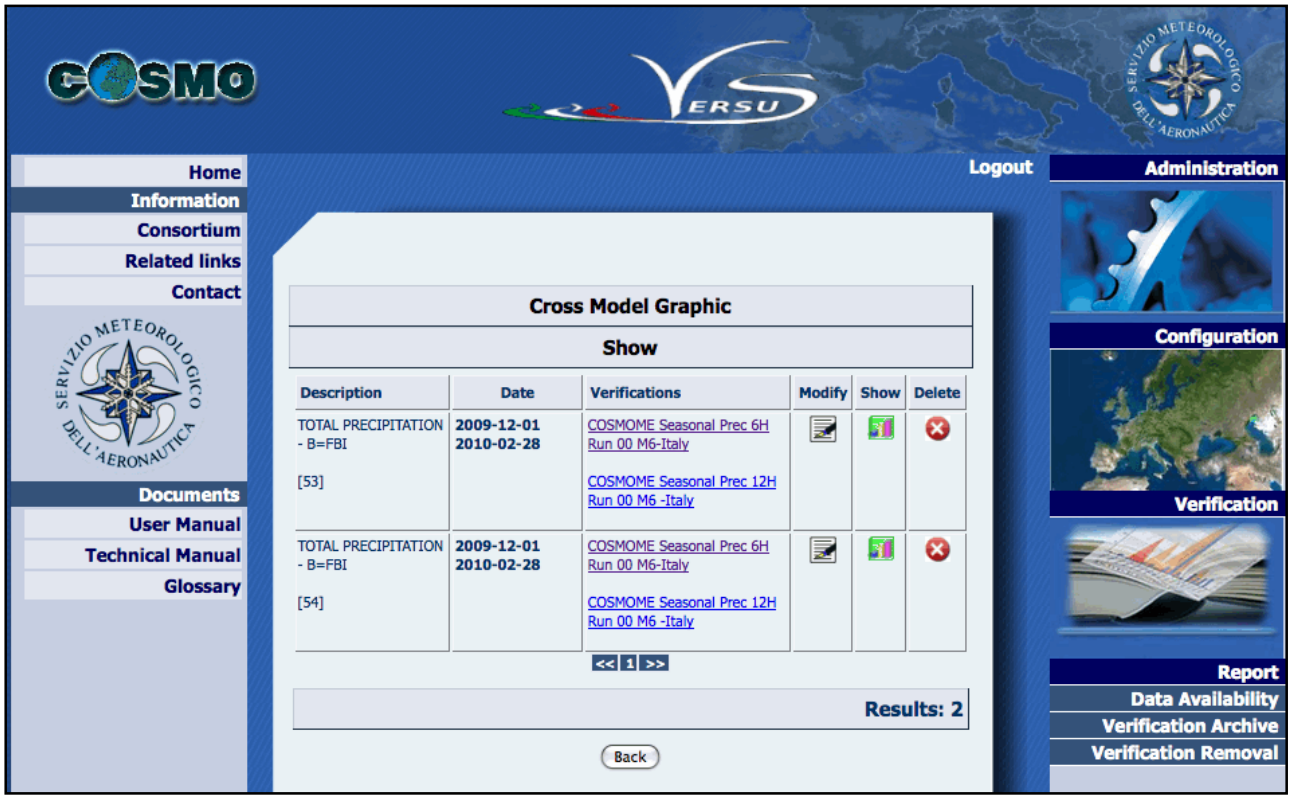


Figure 199 CROSS Model Graphic Show

Moreover, for each CROSS graphic it is possible:

- ✓ To modify the plot
- ✓ To show the plot
- ✓ To delete the plot

4.4.2.1.10 Monthly Report Search

By selecting 'Monthly' on field Verification of Verification Archive, Monthly Report fields appear.

An example of GUI settings for a Monthly graphic request with minimum input fields is given below:

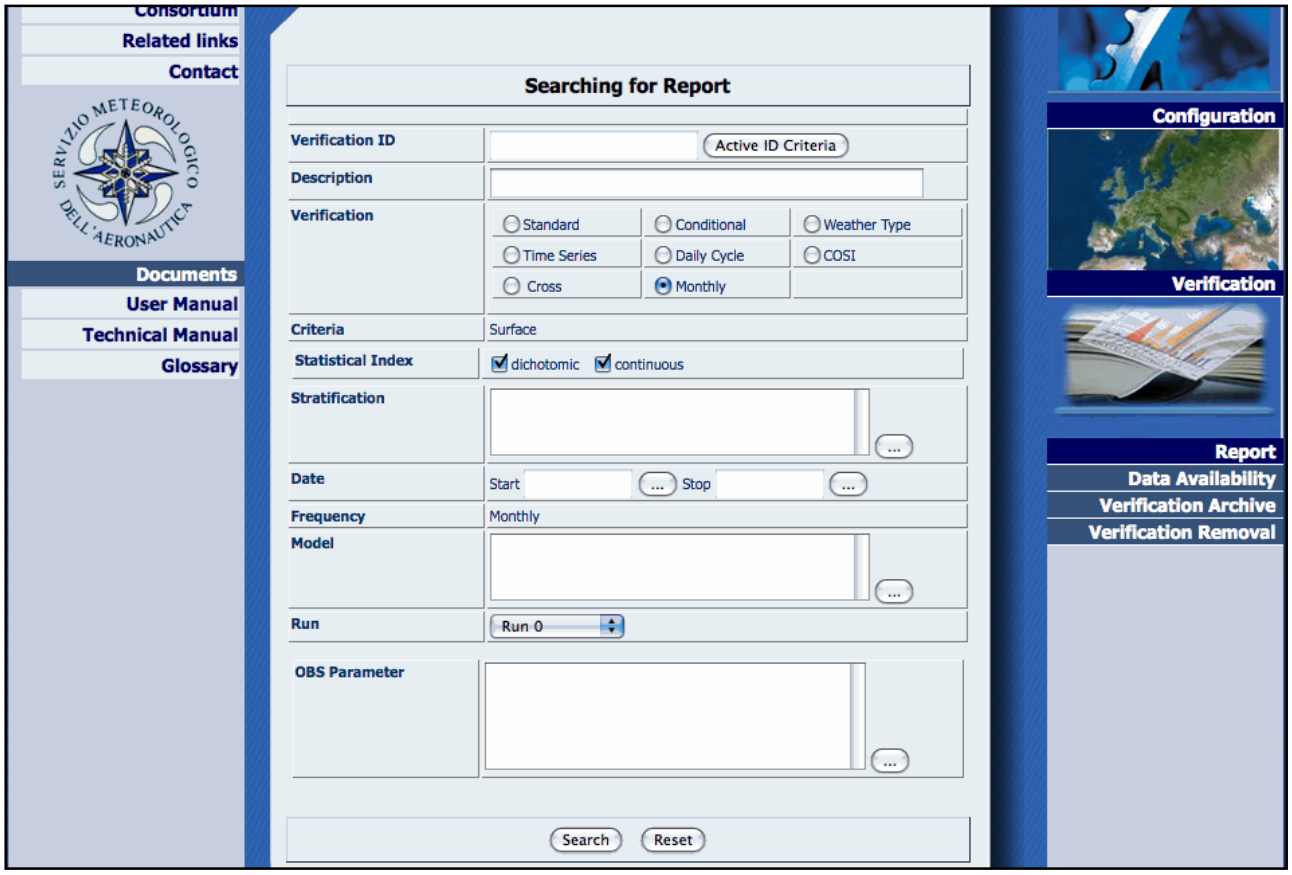


Figure 200 Monthly Graphic Search

By clicking on Search button the system displays all the defined Monthly graphics that apply, displaying the following form:

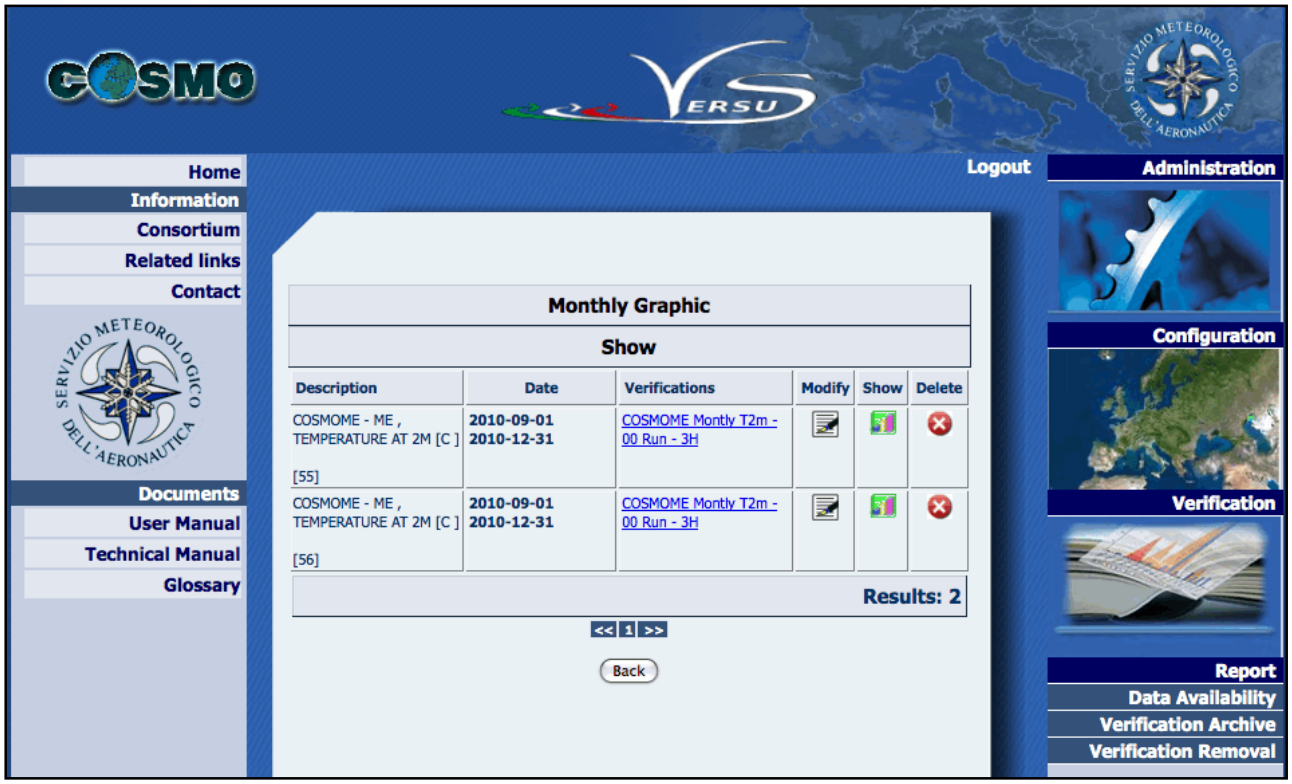


Figure 201 Monthly Graphic Search

For each monthly graphic the system displays the following information:

- ✓ The monthly description
- ✓ The date the graphic refers to
- ✓ The standard verifications involved in the plot

Moreover, for each monthly graphic it is possible:

- ✓ To modify the plot
- ✓ To show the plot
- ✓ To delete the plot

4.4.2.1.11 EPS Standard Verification Search

By Clicking on “Verification Archive”->On-site the system displays the following GUI for Report Search. The user must specify ‘Standard EPS’ on the Verification Menu, the date interval for the Verification Search and the model run. The remaining fields are optional.

An example of GUI settings for an EPS Verification request with minimum input fields is given below:

Figure 202 EPS Report Search

By clicking on Search button the system displays all the configured EPS Verifications that apply, displaying the following form:

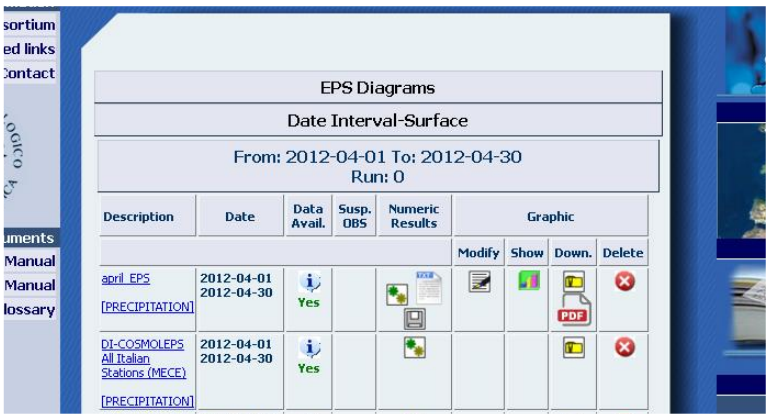


Figure203 List of available EPS Verifications

Similarly to the previous Verifications, the following options are displayed:

- ✓ Numeric Results: for running or rerunning the scores, if data is available and only if the current user is not a consultant
- ✓ Numeric Results: for analyzing or saving the calculated scores including also ROC Curve, Reliability diagram, rank histogram and cost-loss curve. (The txt box saves them in txt format)

- ✓ Graphic-Modify: for configuration of the plot as standard graph
- ✓ Graphic-Show: for displaying the standard plot .
- ✓ Graphic-Delete: for deleting the plot, only if the current user is not a consultant
- ✓ Graphic-Download for downloading all score plots
- ✓ By clicking on "PDF' icon the EPS diagrams (ROC, Reliability etc) can be downloaded in .pdf format.

4.4.2.2 VERIFICATION ARCHIVE Analysis

By clicking on "Verification Archive"->Analysis the system displays the GUI for searching the verification based on analysis data. VERSUS is able to create Standard (surface or Upper) and Weather type surface) verification.

The GUI can search verifications in two different ways:

- ✓ by Verification ID: for this kind of search the user must click on "Active ID Criteria", fill in the field Verification ID, and the fields related to the time period. The verification ID can be found in the report form. This kind of search aims to find a specific verification independently of the type (Standard, Weather Type)
- ✓ by Field: for this kind of verification the user has to fill in the fields of the GUI that are specific of the type of verification checked.

4.4.2.2.1 STANDARD VERIFICATION on Analysis

The search for analysis standard verification is performed by the following GUI:

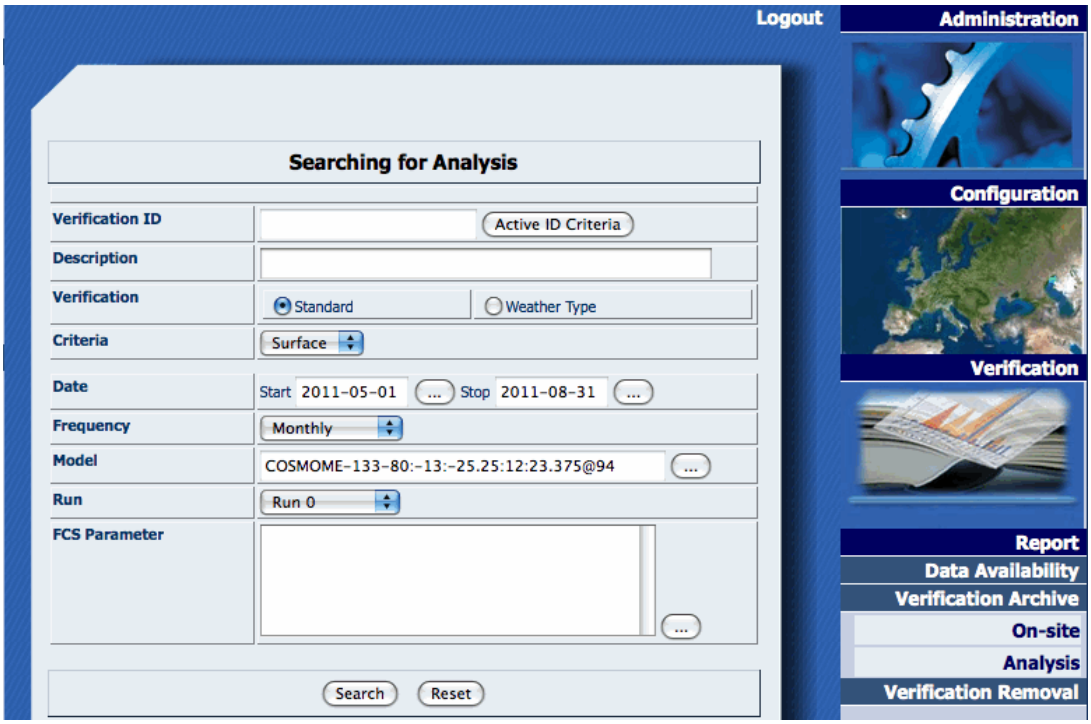


Figure 204 Analysis Standard Verification Search

The following fields must be set:

Verification: Standard or Weather type

Description: a verification can also be searched by a substring contained in the configuration description .

Criteria: the user must select if the verification is on Surface or Upper air data. All the verifications are defined on surface data except for Standard and Cross.

Date: the interval data on which search for the verification. It is mandatory if frequency is set to Monthly or Seasonal.

Frequency: this field could be set to Monthly for searching verification configured as Monthly, Seasonal for searching verification configured as Seasonal or Date interval for searching verification configured in a defined time period.

Model: this field aims to select one or more models for verification search. If left empty the system will configure the research for all the existing models

Run: this field refers to model run

FCS Parameter: for selection of one or more parameters for verification search. If left empty the system will perform a search for all the parameters.

At the end of form there are two buttons:

- ✓ Search: for submitting the query.
- ✓ Reset: for resetting of the specified fields .

By clicking on Search the system displays:

Figure 205 Analysis Standard Verification List

The operations that can be executed are the same as the ones for a verification defined on on-site data. The calculated grib files with the scores for each step and index are downloadable by clicking on the 'Down.' icon. They can then be plotted with appropriate tools. By clicking on Download icon the system displays a GUI, where grib files for each score and step can be downloaded together with their usual graphic plot.

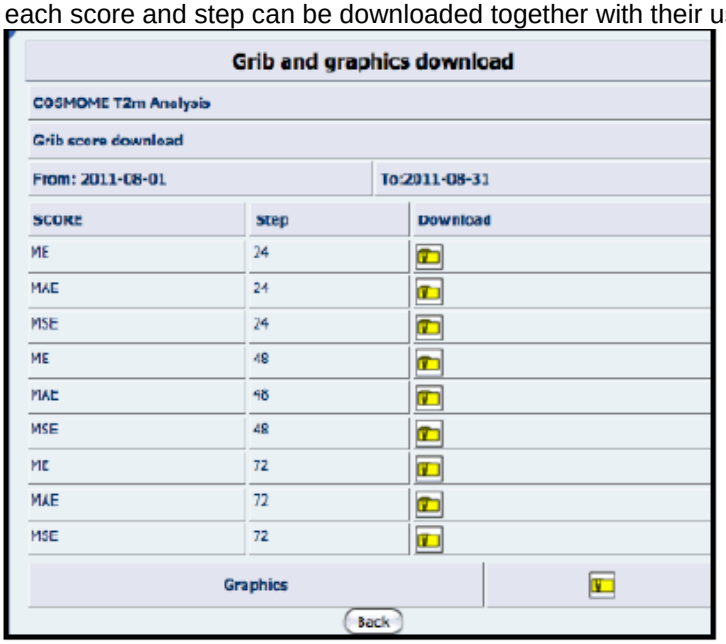


Figure 206 Grib files and graphic download.

4.4.2.2.2 WEATHER TYPE VERIFICATION on analysis

By selecting 'Weather type verification' the following GUI is displayed:

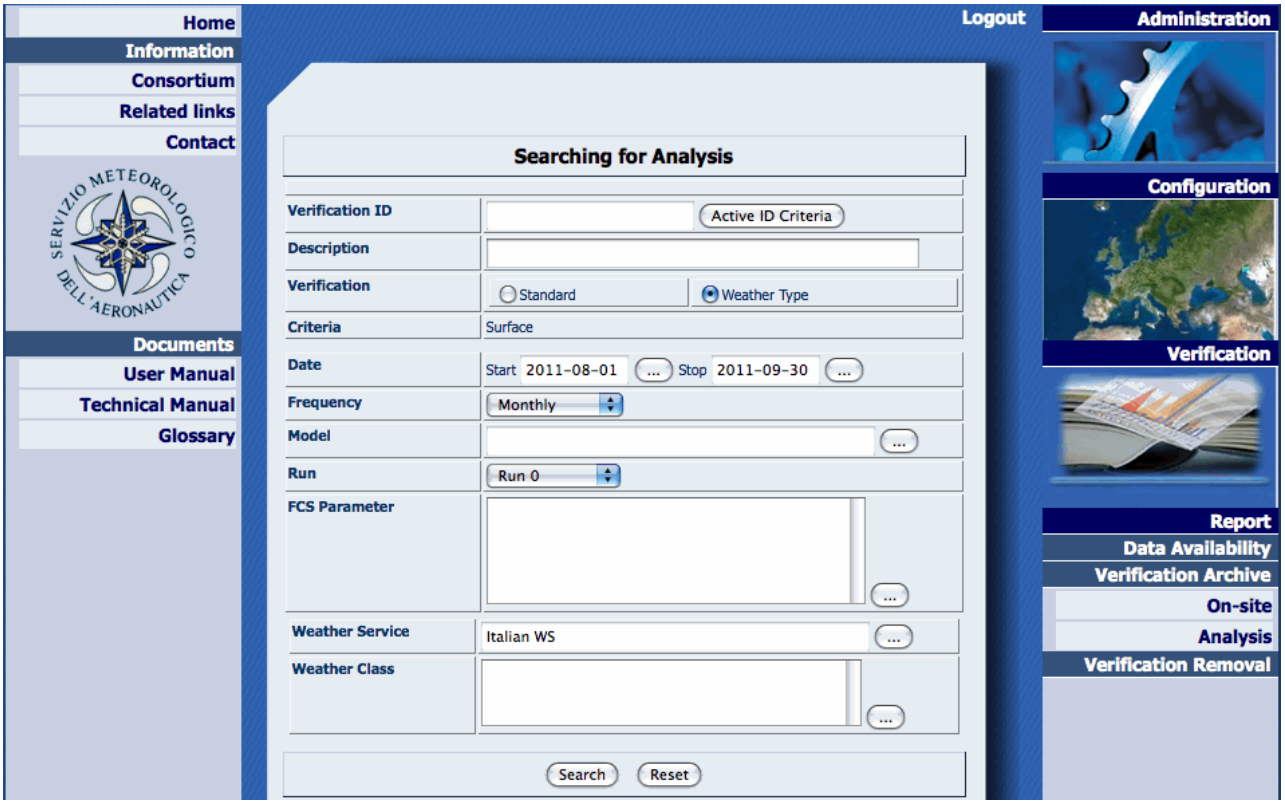


Figure 207 Analysis Standard Verification Search

By Clicking on Search button the system displays a web GUI similar to that described for standard verification in addition to the weather type information.

The menu “Verification Removal” manages the scores and graphics removal of all the verifications that VERSUS carried out. Verification Removal menu consists of two sub-menus:

On site: for managing the search and deletion of the verifications based on on-site stations.

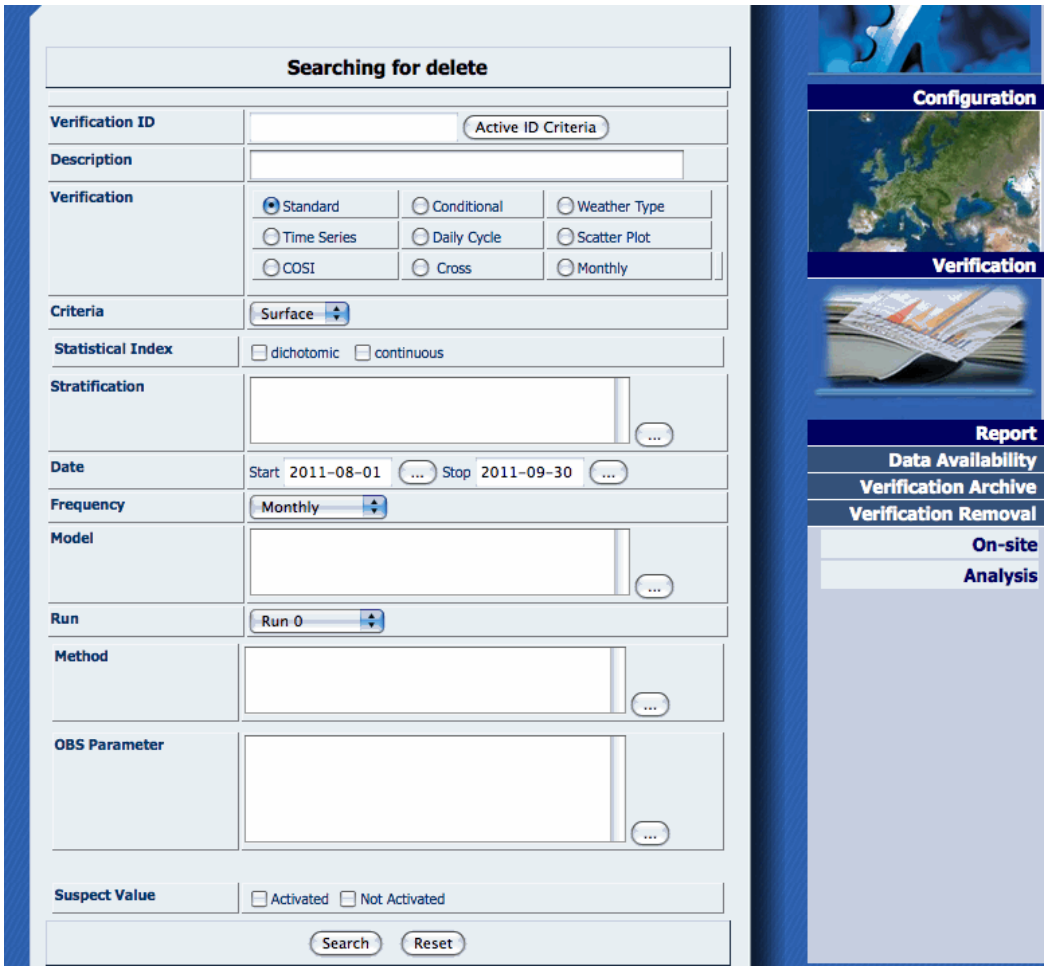
Analysis: for managing the search and deletion of the verifications based on gridded data.

4.4.3 VERIFICATION REMOVAL

4.4.3.1 VERIFICATION REMOVAL On-site

By clicking on “Verification Removal”->On-site the system displays:

Figure 208 On-site Verification Search for Removal



The GUI above follows the same searching rules of the “Verification Archive” menu. The main difference is the output of the search, which is the following:

Figure 209 Verification Delete

The user can check the verification he wants to delete and click on "Delete" button .the system, then asks for a confirmation of the delete operation, and if the answer is OK, the system removes all the verifications checked and their related scores and graphics definitively from the database. Similarly to the standard on-site Verification Deletion the deletion of the other Verification types is performed. For example :

4.4.3.2 VERIFICATION REMOVAL Analysis

By clicking on "Verification Removal"->Analysis the system displays:

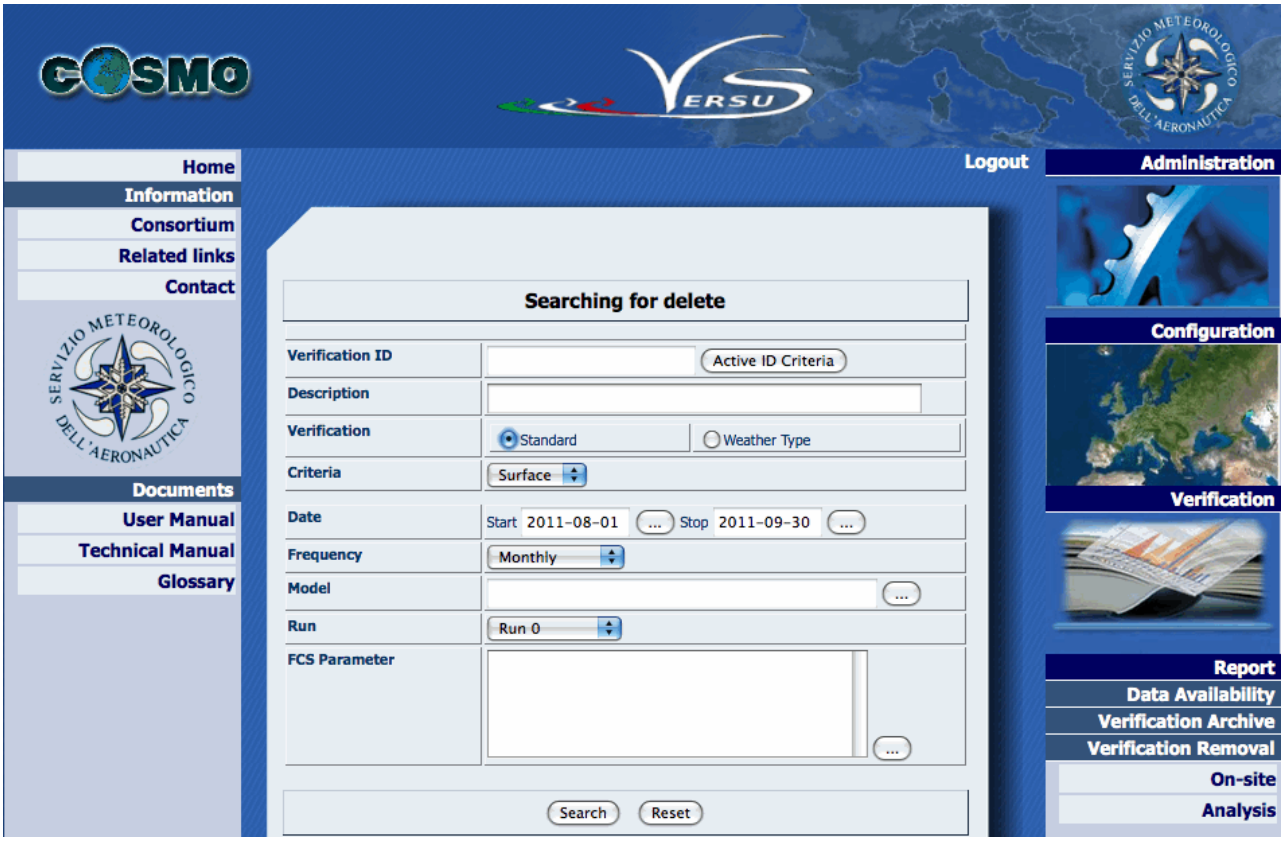


Figure 210 Analysis Verification Search for Removal

The GUI above follows the same searching rules of the “Verification Archive” menu. The main difference is again the output of the search, which is similar to the one described for on site verification removal.

5 *FILE NAMES SCHEMAS*

The Verification graphics files are automatically stored in the system by the filename criteria_ID.zip and the file names are based on the following rules.

For continuous scores :

SCORE_C_(ID_Verification)_STEP_(G).png

For dichotomous scores:

D_SCORE_(ID_Verification)_STEP_(G)/TH/ST.png

Where G= Geographic Map distribution (if applicable)

ST=Plot for step

TH=Plot for Thresholds

Files with .csv extension contain observations and model outputs from time series Verifications.

For Performance Diagrams: PD_(ID_Verification)_TH.pdf

For EPS scores

E_(ID_Verification)_STEP/TH/ST.png

STEP is applicable only for the SCATTER PLOT/Geographical Distribution

EPS verification produces also diagrams in pdf

The pdf file names schema is E_ID_Verification_STEP_startth_endth_pdf

Where statth and endth indicate the threshold limits.

6 SRNWP DATA POOL– SHORT REFERENCE

6.1 INTRODUCTION

This brief guide describes how to load obs data from SRNWP data pool project and the correspondent fcs from COSMO model.
At the moment, only radiation and fluxes parameters have been taken into account and all the usual functionalities of VERSUS have been implemented (standard and conditional verification, scatter plots, time series and daily cycle).

6.2 DATA SETUP

The observations datasets are available on the COSMO website in a self-descriptive Ascii format, that has been adopted as a standard for the dedicated VERSUS Front-End. Nine (9) stations are available in the SRNWP data pool Exchange project but only the following have been taken into account as they fall inside the COSMO-ME area and/or the datasets are almost complete: Lindenberg, S. Pietro Capofiume, Cabauw, Debrecen, Payerne and Fauga-Mauzac. Other stations whose data are available and coded with the same ASCII file format can be added easily in VERSUS following the usual procedure. At the moment observation data are available up to 2012.
In order to have the corresponding forecast parameters for comparison, you have to setup the Namelist of your model, unless they are already available.
A table comparing observations and forecasts is given below:

OBS data	**FCS data**
RSWD: incoming solar radiation	ASWDIR_SAvrg direct downward SW rad Surface
RSWU: reflected solar radiation	ASWDIFD_S Avrg diffuse downward SW rad Surface
	Avrg Balance of SW
RLWD: incoming thermal radiation	ALWD_S Avrg downward LW radiation at the surface
RLWU: outgoing thermal radiation	ALWU_S Avrg upward LW radiation at the surface
	Avrg Balance of LW
HS: sensible heat flux	ASHFL_S: averaged sensible heat flux
LE: latent heat flux	ALHFL_S: averaged latent heat flux

NOTE 1: Balance of SW and LW radiation for observation is internally calculated and stored
NOTE 2: Forecasts for each step are averaged from the beginning of the run (internally calculated on 1 hour interval). Time Range Indicator for this kind of averaged data in GRIB files is 3.

6.3 MODEL FORECASTS UPLOADING

Grib files have to be loaded from an ad hoc FE created with the usual rules.

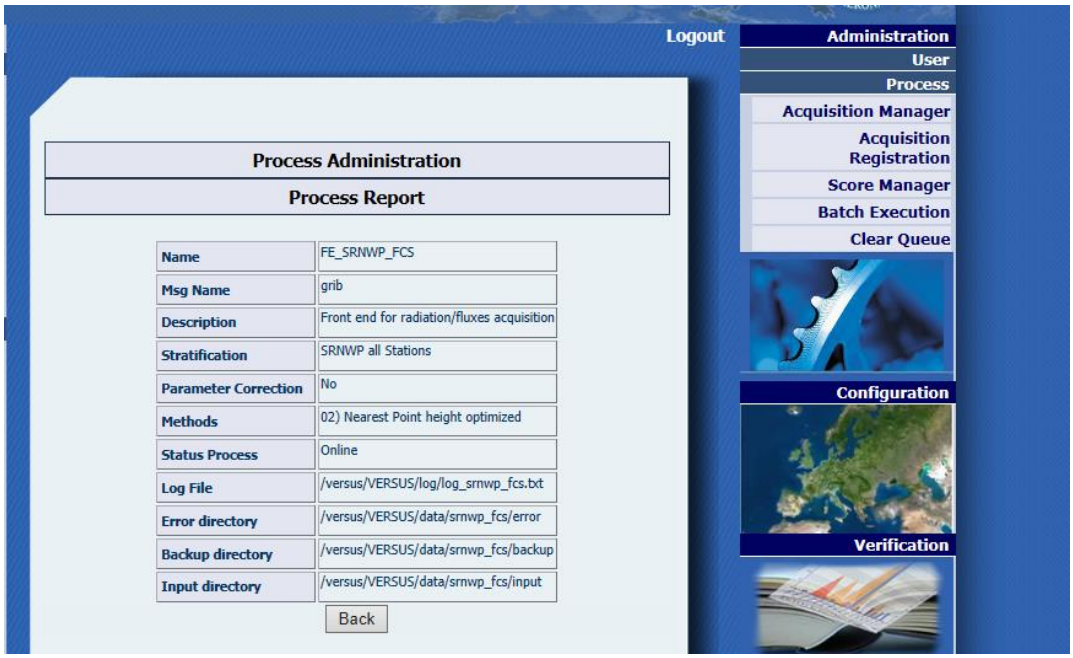


Figure 211 FE Forecast Data acquisition process

Any algorithm for point extraction can be used (mean over a radius around the station is suggested).
Before uploading grib files, radiation and fluxes fcs parameters should be added. The usual rule to add a new fcs parameter in VERSUS has to be used editing grib1.xml file and griboper.xml, by adding the following lines respectively.

GRIB1.XML:

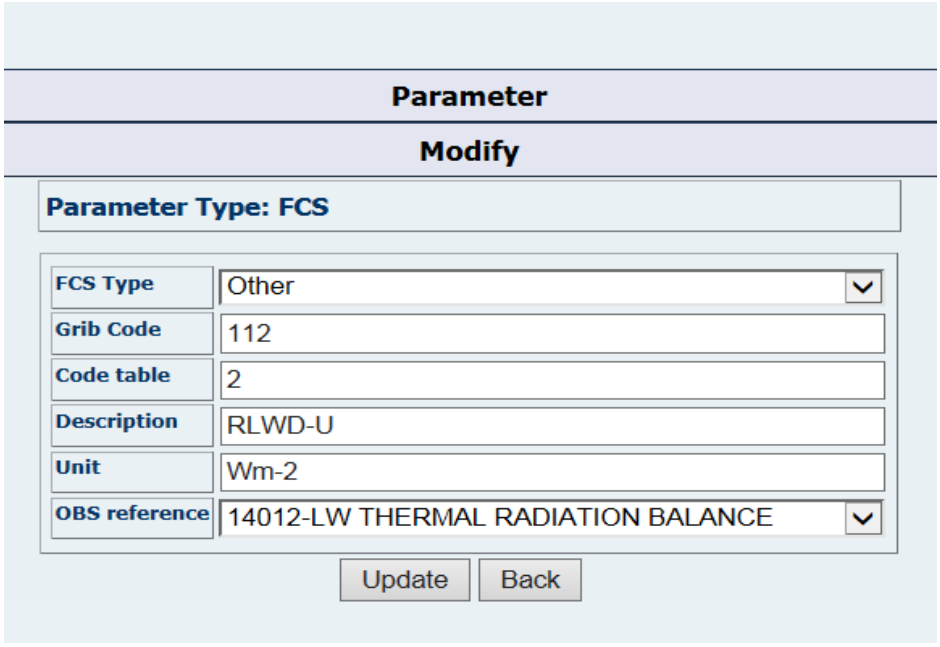
```
-<field name="rswdu">
        -<element name="rswdu" unit="rswdu">
        <codeTable>2</codeTable>
        <parameter>111</parameter>
```

```
        </element>
</field>
-<field name="rlwdu">
        -<element name="rlwdu" unit="rlwdu">
        <codeTable>2</codeTable>
        <parameter>112</parameter>
        </element>
</field>
-<field name="sshf">
         -<element name="sshf" unit="sshf">
        <codeTable>69</codeTable>
        <parameter>122</parameter>
        </element>
</field>
-<field name="slhf">
        -<element name="slhf" unit="slhf">
        <codeTable>69</codeTable>
        <parameter>121</parameter>
        </element>
</field>

GRIBOPER.XML:
-<dfieldmissingValue="9999.90" unit="sshf" operation="gribConstantMultiply" name="sshf">
-<coding>
        <gribTablesVersionNo>69</gribTablesVersionNo>
<indicatorOfParameter>122</indicatorOfParameter>
</coding>
-<element name="sshf“>
        <codeTable>2</codeTable>
        <parameter>122</parameter>
</element><constant name="var">-1.</constant>
</dfield>

-<dfieldmissingValue="9999.90" unit="slhf" operation="gribConstantMultiply" name="slhf">
-<coding>
        <gribTablesVersionNo>69</gribTablesVersionNo>
<indicatorOfParameter>121</indicatorOfParameter>
</coding>
 -<element name="slhf">
        <codeTable>2</codeTable>
        <parameter>121</parameter>
</element>
<constant name="var">-1.</constant>
</dfield>
```

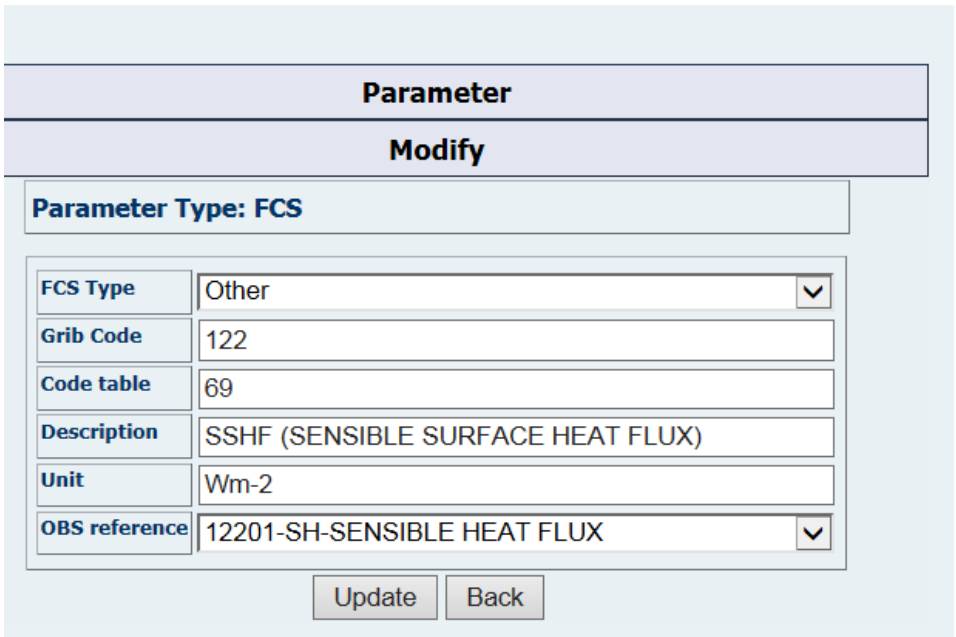
Once the first set of gribs has been uploaded it is useful to modify forecasts Parameter information from



VERSUS menu as in the following examples

Figure 212 Parameter Modify for LW forecast radiation (similar for SW)

Figure 213 Parameter Modify for forecast Sensible Heat Flux (similarly for Latent Heat)



6.4 OBSERVATION UPLOADING

ASCII files have to be loaded from an ad hoc FE created with the usual rules with ‘ SolarObs’ option at ‘Msg Name’.

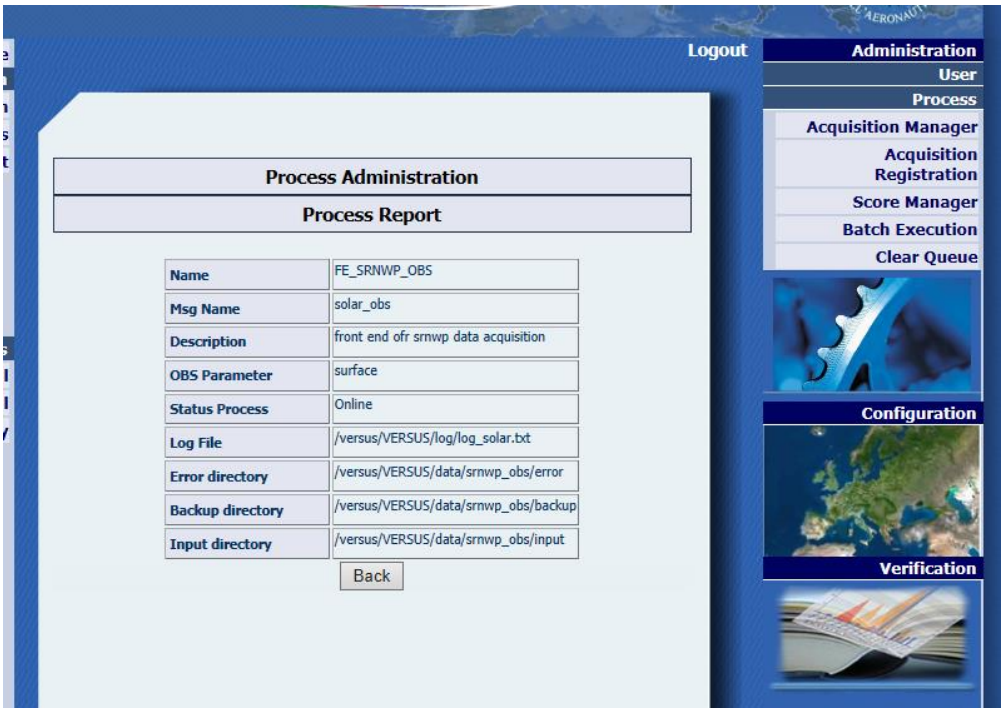


Figure 214 Observations Data FE Uploading

ASCII files can be downloaded from COSMO website and they have to be edited in order to add the WMO code to the SRNWP data pool stations used. Note that Fauga-Mauzac has no WMO code anda fake one has been used (VERSUS uses WMO code as a primary key). See the figure below.

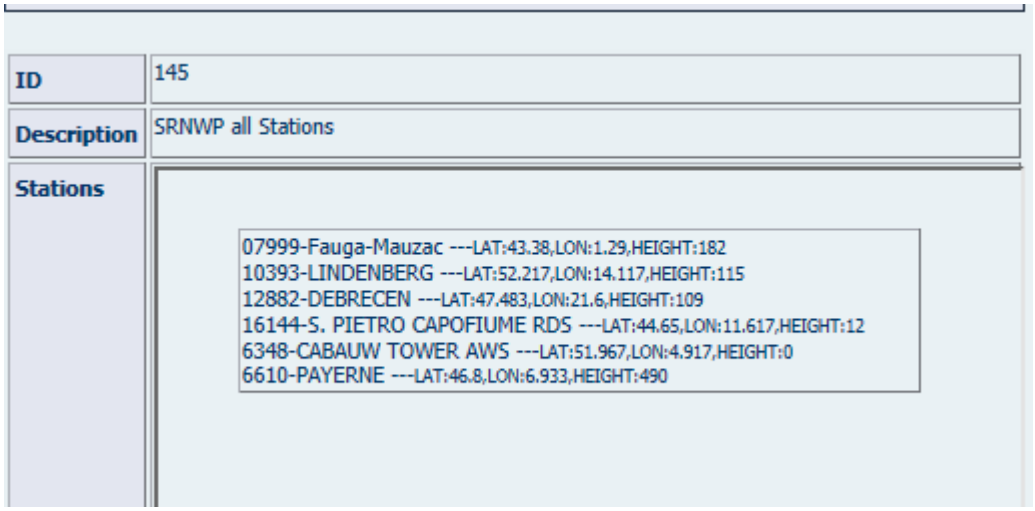
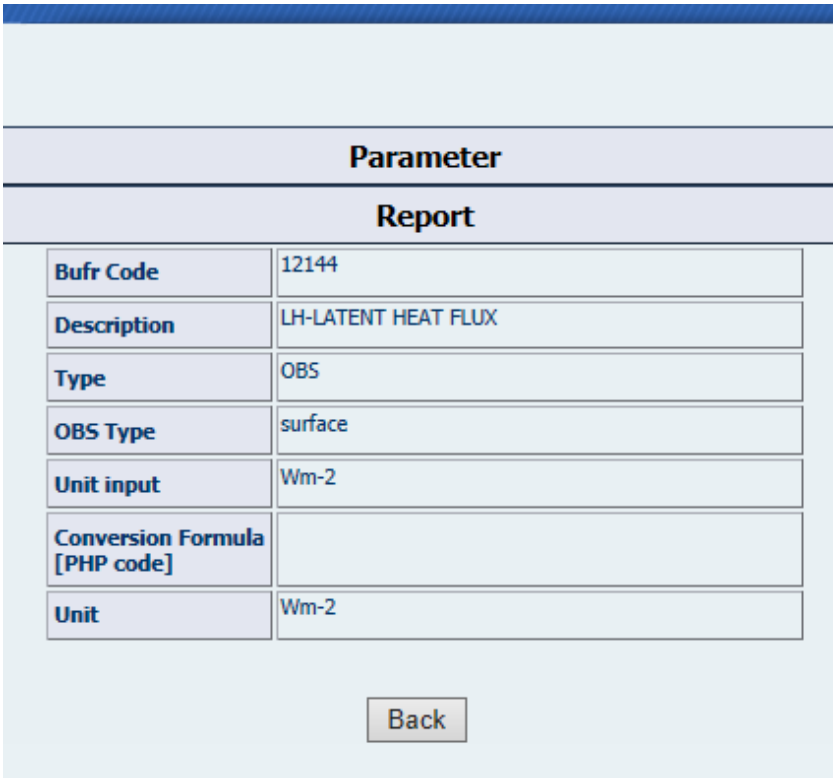


Figure 215 SRNWP stations

The WMO code has to be added in the following way in each first record of the ASCII file containing the observation:

#SRNWP data exchange action
#**06610**Payerne 46.8137°N 6.9425°E 20110501 00:10 - 20110601 00:00 UTC DATE;

Before the ASCII files are uploaded you need to add Observation Parameters information from VERSUS menu as in the following examples:



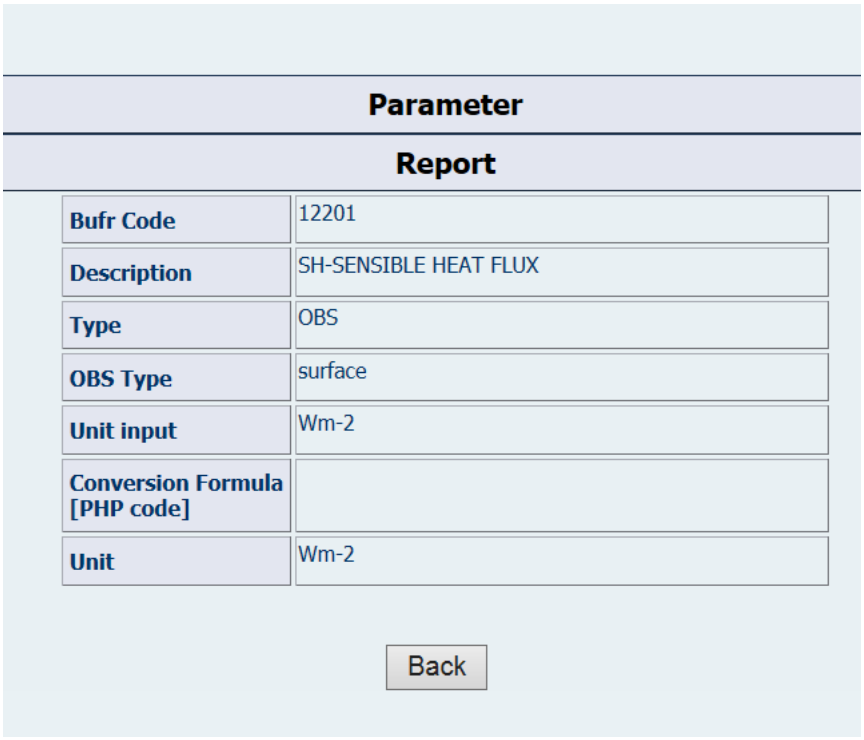
Parameter

Report

Bufr Code	12144
Description	LH-LATENT HEAT FLUX
Type	OBS
OBS Type	surface
Unit input	Wm-2
Conversion Formula [PHP code]	
Unit	Wm-2

Back

Figure 216 Latent Heat Observation Parameter Definition



Parameter

Report

Bufr Code	12201
Description	SH-SENSIBLE HEAT FLUX
Type	OBS
OBS Type	surface
Unit input	Wm-2
Conversion Formula [PHP code]	
Unit	Wm-2

Back

Figure 217 Sensible Heat Observation Parameter Definition

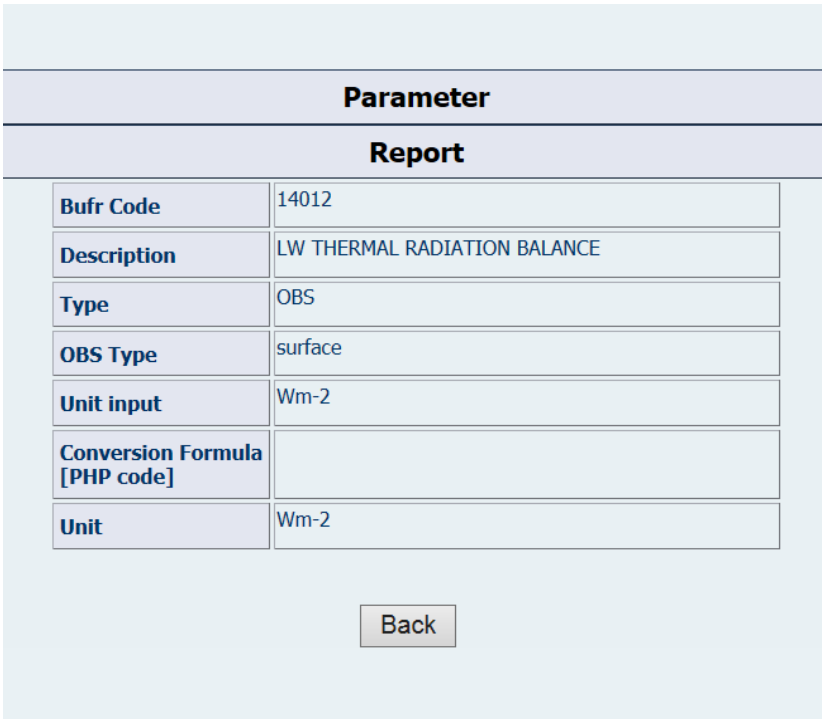
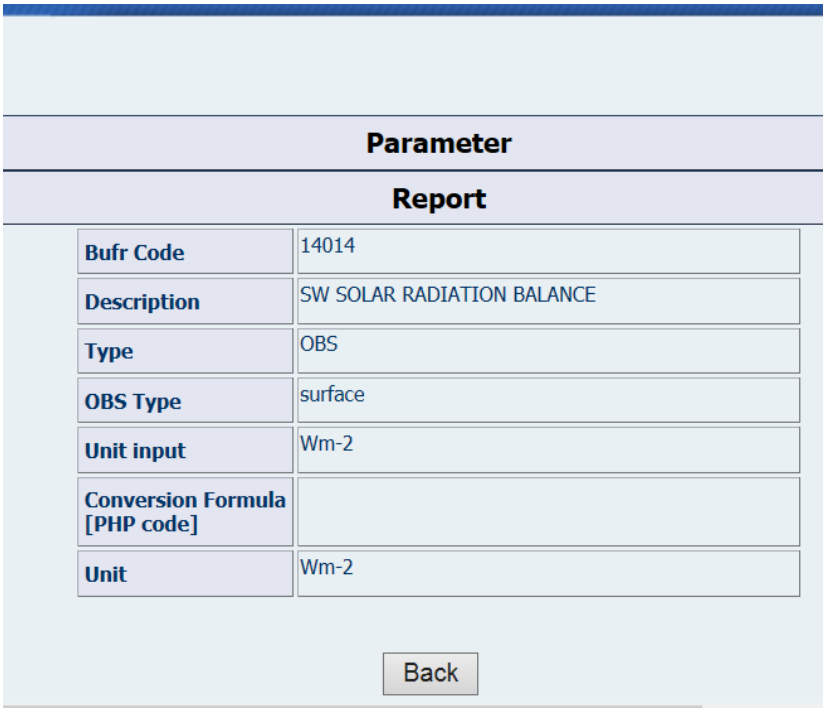
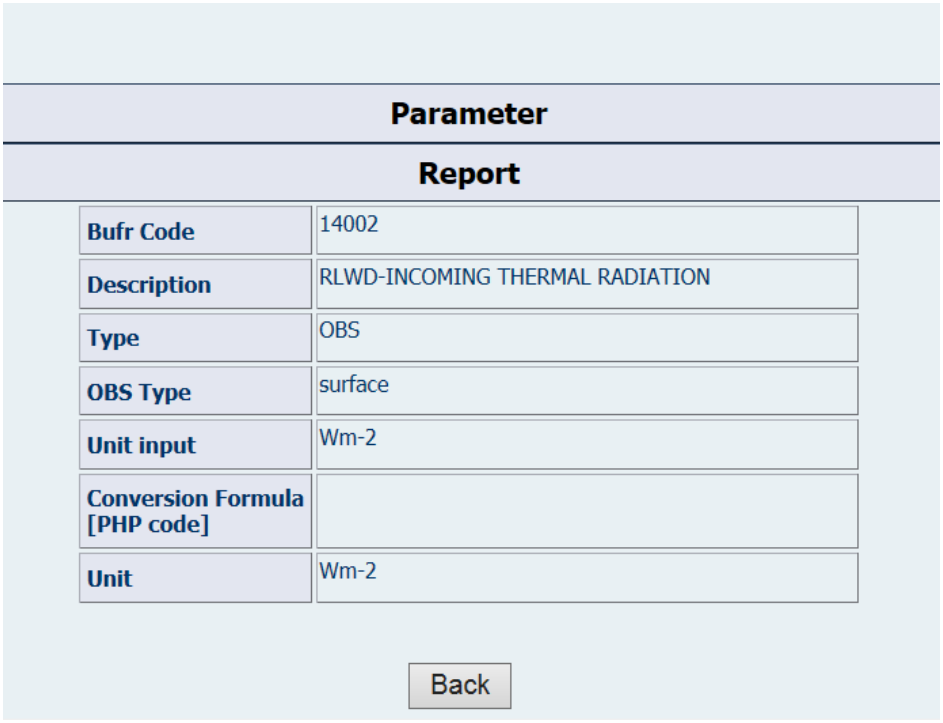


Figure 218 LW Thermal radiation Balance Observation Parameter Definition

Figure 219 SW Solar Radiation Balance Observation Definition





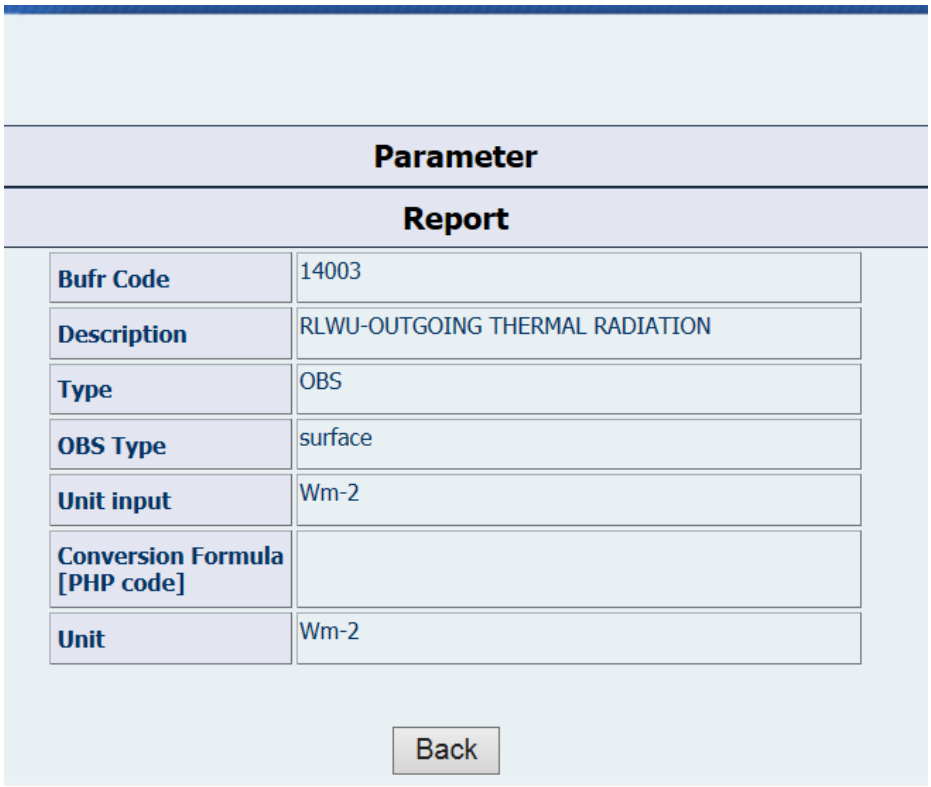
Parameter

Report

Bufr Code	14002
Description	RLWD-INCOMING THERMAL RADIATION
Type	OBS
OBS Type	surface
Unit input	Wm-2
Conversion Formula [PHP code]	
Unit	Wm-2

Back

Figure 220 LW Incoming Thermal Radiation Observation Definition



Parameter

Report

Bufr Code	14003
Description	RLWU-OUTGOING THERMAL RADIATION
Type	OBS
OBS Type	surface
Unit input	Wm-2
Conversion Formula [PHP code]	
Unit	Wm-2

Back

Figure 221 LW Outgoing Thermal Radiation Observation Definition

Figure 222 Incoming Solar Radiation Observation Definition

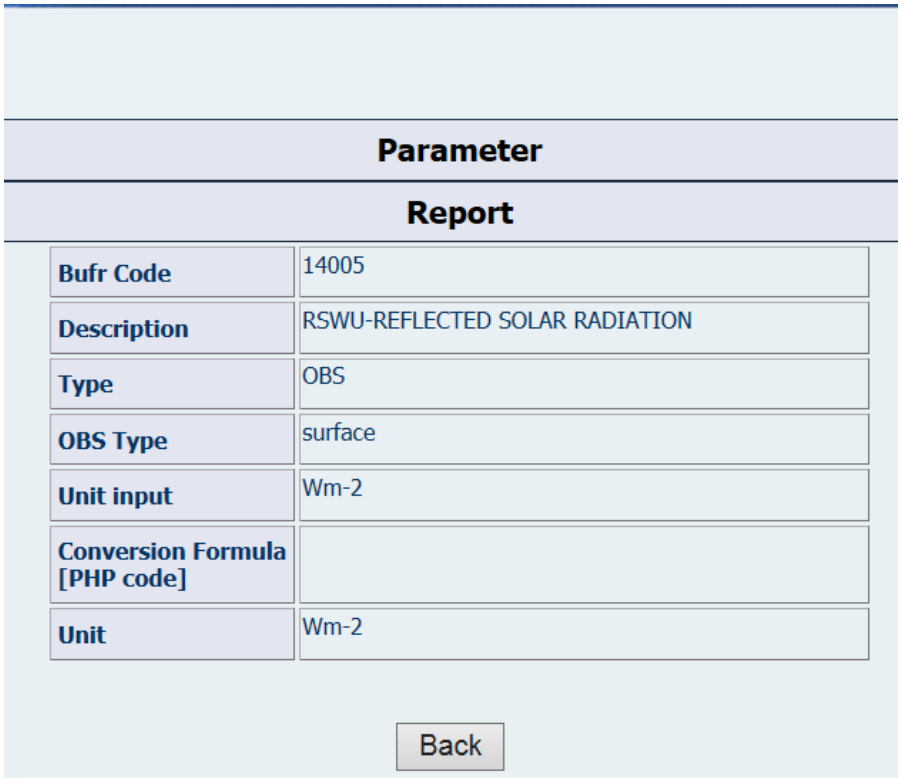


Figure 223 Reflected Solar Radiation Observation Definition

7 USEFUL internal Links to VERSUS Software Information

For information on VERSUS schema, tables and memory allocations

http://localhost/versus/report

For information on VERSUS classes

http://localhost/versus/html/classes.html

APPRENDIX I (Scores Description)

A short description of most common score indexes that VERSUS calculates is given below.

DETERMINSTIC FORECASTS

CONTINUOUS SCORES

Mean Error (ME) The average value of differences between forecast and observed values which calculates trend of overestimation or underestimation (Values from -∞to +∞, desired value 0 ME > 0 Overestimation, ME< 0 Underestimation)

$$\mathrm{ME} = \frac{1}{n}\sum_{k=1}^{n}\left(f_k - o_k\right)$$

Mean Absolute Error (MAE) The average absolute value of the differences between forecast and observed values. It gives an estimation of the absolute error (Values from 0 to +∞, desired value 0. The smaller the MAE the better the forecast)

$$\mathrm{MAE} = \frac{1}{n}\sum_{k=1}^{n}\left|\left(f_k - o_k\right)\right|$$

Root Mean Square Error (RMSE) The average absolute value of the root of the squared differences between forecast and observed values. It gives an estimation of the absolute error with a positive weight to higher differences (Values from 0 to +∞, desired value 0.The smaller the RMSE the better the forecast)

$$\mathrm{RMSE} = \sqrt{\left(\frac{\sum_{k=1}^{n}(f_k - o_k)^2}{n}\right)}$$

All the above are also adequately calculated for wind direction (ME, MAE, RMSE for Wind)

DICHOTOMOUS SCORES (based on contingency tables)

Probability of detection (POD): The number of times an event is correctly forecast divided by the total number of observations of that event (Values from 0 to 1, desired value 1)

False alarm ratio (FAR): The number of times an event is forecast but not observed, divided by the total number of forecasts of that event.(Values from 0 to 1, desired value 0) The opposite of FAR ,(1-FAR) is the Success Ratio (SR)

Frequency Bias Index (FBI): The number of times an event is forecast,divided by the total number of observations of that event.(Values from 0 to +∞ :FBI> 1 indicates overestimation, FBI< 1 underestimation, desired value 1)

Threat Score (TS): The number of correct forecasts of an event (hits), divided by the total number of forecasts of the event (Values from 0 to 1, desired value 1)

Equitable threat score (ETS): The *threat score* (*critical success index*) adjusted for the number of correct forecasts expected by chance. The score is intended to offset the sensitivity of the TS to the underlying climatology of the event.(Values from 0 to 1, desired value 1)

The Proportion Correct (PC) score gives the fraction of all correct forecasts (event and non-event). It is a simplistic and misleading measure since it rewards equally correct 'yes' and uninteresting 'no'.

Heidke Skill Score (HSS). It is a more accurate mesure of the PC, adjusted to eliminate correct forecasts due to random chance

False Alarm rate (F) mesures the False Alarms given the observed non-events.

Hanseen-Kuipers Skill Score (KSS) is defined as POD-F and it is a measure of skill a forecast to distinguish the 'yes' cases from the 'no' cases.

Odds Ratio Skill Score (ORSS) is a scaled score with values from -1 to =1 of the OR (odds ratio) which measures the forecasting system's probability to score a hit as opposed to the probability of making a false alarm.

PAG Score is the ratio of hits to the total number of YES forecasts. So it shows the proportion of correct forecasts of an event in the total number of forecasts of this event.

Extreme Dependency Score (EDS) is a score for prediction of rare events.

Performance Diagram

On this diagram is possible to exploit the geometric relationships between four measures : POD (y axis), SR (1-FAR) (x-axis) TS (curves) and FBI (dashed axial lines).. For good forecasts, POD, SR, FBI and TS approach unity, such that a perfect forecast lies in the upper right of the diagram. Deviations in a particular direction calculate relative differences in POD and SR and consequently FBI and TS An immediate visualization of differences in performance are thus obtained. Sample uncertainity is given by the crosshairs.

PROBABILISTIC FORECASTS

Brier Score (BS): The Brier Score (BS) measures the average square error of a probability forecast. It is analogous to the mean square error of a deterministic forecast, but the forecasts, and hence error units, are given in probabilities

$$BS = \frac{1}{N}\sum_{i=1}^{N}(p_i - o_i)^2$$

N is the number of points in the domain (spatio-temporal)

Oi =0 or 1 depending on occurrence or not of the event

Pi= the probability of occurrence according to the forecast system (the fraction of the ensemble members that forecasted the event)

The Brier score can be represented as the sum of three terms relevant for interpretation of

$$BS = \frac{1}{N}\sum_{k=1}^{K} n_k(p_k - \overline{o}_k)^2 - \frac{1}{N}\sum_{k=1}^{K} n_k(\overline{o}_k - \overline{o})^2 + \overline{o}(1-\overline{o})$$

reliability *resolution* *uncertainty*

sources of errors: Reliability, Resolution and Uncertainity

The verification sample is partitioned into bins according to the forecast. There are *K* bins, and *K* is often 10. That is, the verification sample is divided into deciles of forecast probability, all the 0 to 10% forecasts are put together with their corresponding observations, 11 to 20% in another group and so on. o_k is the observed frequency of occurrence of the event in bin *k*.

The **Reliability term** is thus the sum of the squared differences between the forecast probability value for bin *k* and the observed frequency of the event in bin *k*. One wishes this term to be small for a good Brier score, which will happen when the forecast probability equals the observed frequency for all probability forecast bins. This forecast is said to be reliable.

The **Resolution term** is the difference between the observed frequency in bin *k* and the overall sample average frequency, the *base rate*, represented by ŏ. This term measures the ability of the forecaster to define his forecast bins in such a way so as to separate situations into different types, The resolution term is subtracted, so this is a desirable situation.

The **Uncertainty term** is a measure representing if an event is common or rare, and ranges from 0 (very common or very rare event) to 0.25 (the climatological probability is near 0.5). This latter case introduces more uncertainty in the forecasting situation.

Brier Skill Score (BSS): Measures the relative skill of the probabilistic forecast over that of a reference forecast in terms of predicting whether or not an event. Skill scores have a range of -∞ to 1. Negative values indicate that the forecast is less accurate than the reference forecast. "Reference" forecast can be any unskilled forecast; the two most often used are climatology and persistence..

$$BSS = \frac{BS - BS_{ref}}{BS_{perf} - BS_{ref}}$$

Where BS_{ref} is the Brier Score of the Reference Forecast and BS_{perf} is the Brier score of the perfect forecast. Since the perfect Brier score is 0, the BSS can be written

$$BSS = 1 - BS / BS_{ref}$$

Rank probability score (RPS): For multi-category probability forecasts (MECE), a measure of the difference between the cumulative distribution of forecasts and the observation, summed over all categories. Measures the ability of the probability forecast to predict the category in which the observation fell into. (Accuracy).

$$RPS = \frac{1}{M-1}\sum_{m=1}^{M}\left[\left(\sum_{k=1}^{m} p_k\right) - \left(\sum_{k=1}^{m} o_k\right)\right]^2$$

M=the number of forecast categories (eg. Rainfall bins 0-1mm, 5-10mm, etc).

O_k if the event occurs of not in category k (1 or 0)

P_k the probability of occurrence in category k

RPS.climis computed from the climatological probabilities

Rank probability skill score (RPSS): For multi-category probability forecasts,(MECE) the difference in the *rank probability score* for a standard unskilled forecast such as *climatology* or *persistence* and the *rank probability score* for the forecast, divided by the *rank probability score* for the *standard forecast*.

$$RPSS = \frac{\overline{RPS} - \overline{RPS}_{reference}}{0 - \overline{RPS}_{reference}} = 1 - \frac{\overline{RPS}}{\overline{RPS}_{reference}}$$

$$CRPS(forecast) = \frac{1}{ncases}\sum_{i=1}^{ncases}\int_{x=-\infty}^{x=-x}\left(F_i^f(x) - F_i^o(x)\right)^2 dx$$

CRPS (Continuous Rank Probability Score) It is similar to the rank probability score, but compares a full distribution with the observation, where both are represented as *cumulative distribution functions* (cdfs). The equation for calculation of the CRPS is,

Where $F_i^f(x)$ is the forecast probability cdf for the ith forecast case and $F_i^o(x)$ is the observation, expressed as a cdf. If the observation is of a specific value, then the corresponding cdf is a single step-function with the step from 0 to 1 at the observed value of the variable.

The CRPSS (Continuous Rank Probability Skill Score) is a skill score based on the CRPS, and has the normal skill score format,

$$CRPSS = \frac{\overline{CRPS}_{forecast} - \overline{CRPS}_{reference}}{\overline{CRPS}_{perfect} - \overline{CRPS}_{reference}}$$

Where the overbars refer to averages over a preferably large sample. The reference forecast is usually climatology or persistence. The skill score measures the improvement over the standard forecast, normalized to the total possible improvement. The range is -∞ to 1. Since the perfect CRPS score is 0, the skill score can be rewritten as,

$$CRPSS = \frac{\overline{CRPS_{ref}} - \overline{CRPS_{forecast}}}{\overline{CRPS_{ref}}}$$

SKILL/SPREAD relationship. The SKILL (RMSE of the ensemble mean) is plotted against the SPREAD (standard deviation of the ensemble). When the spread line is below and far from the skill line then the ensemble is considered underdispersive.

The diagrams that VERSUS performs are the following:

Reliability or Attribute diagram: A plot of the observed frequency of an event (y axis) vs. the forecast probability of the event (x-axis). The forecast-observation dataset is binned according to the forecast probability in order to obtain estimates of the observed frequency. In a perfect system the graph is a straight line oriented at 45º to the axes. Below this line the probabilities are overestimated and above it underestimated. (mesure of Reliability). A dashed horizontal line represents climatology (position of graph mesures Resolution) and a diagonal line between climatology and pefect reliability is the 'no skill' line.

Sharpness diagram: A histogram plot of the number of forecasts vs. forecast probability of each bin. Usually used as an inset to a *reliability diagram*. Forecast systems that are capable of predicting events with probabilities different from the observed event frequency are said to have 'sharpness'.

Relative operating characteristic (curve) (ROC): It is a plot of the *hit rate* vs. the *false alarm rate* obtained by building a contigency table for each probability class. It measures the quality of a binary prediction or decision based on the forecast probability, based on different probability thresholds defining the prediction of the occurrence or non-occurrence of the event.

Rank diagram: It depicts how well the ensemble spread of the forecast represents the variability of the observations. The N ensemble members are classified from lowest to highest and N+1 bins are created. The observations fall into bins and the number of observations into each bin is shown in the figure.

Cost Loss diagram: The improvement of economic value of the forecast is measured relative to the climatology forecast and is plotted as a function of the Cost/Loss ratio. For probabilistic forecasts the curve of interest is an envelope of curves representing each of the probability values allowed by the forecast. The lighter curves represent the relative value as a function of the cost-loss ratio using each of the probabilities as a yes/no threshold for the forecast, while the heavy curve is the outer envelope representing the maximum possible value.

Confidence intervals: The CIs in VERSUS enable estimating sampling uncertainty. There are two main types of CIs in VERSUS: parametric and non-parametric.

The non-parametric techniques utilize the bootstrap resampling,which does not rely on any distributional assumptions for the sample; the only assumption is that the sample is representative of the population. The effect

of dependence of the sample is equal to sample volume decrease. For most of the scores available with VERSUS, CIs are calculated using the bootstrap method, which was proven to have good accuracy.

All the parametric intervals in VERSUS rely on the underlying sample to be at least approximately independent and normally distributed. Most of the dichotomous scores resulting from the outcomes of contingency table have binomial distribution, which tends asymptotically to the normal distribution. Thus, the CIs based on the assumption of normal distribution are calculated for most of the dichotomous scores, namely EDS, ETS, F, FAR, HSS, KSS, ORSS, PC, POD, and TS.

They are calculated in the following way:

$\theta \pm z_{\alpha/2} \cdot V(\theta)$,

where $z_{\alpha/2}$ is the α-th quantile of the standard normal distribution, and $V(\theta)$ is the standard error of the statistic (or parameter) θ. Standard errors of most of dichotomous scores can be obtained from R *verify* function,

The FBI CIs are calculated using bootstrap (function table.stats.boot) as FBI's SE is not present in *verify* function (Note that it is possible to calculate CIs in a similar way also for POD, FAR, and ETS).

PAG is calculated using Wilson's method suitable for proportions (Gilleland 2010) as its SE is not present in *verify* function:

$$\frac{\hat{p} + \frac{z^2_{\alpha/2}}{2n} \pm z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p}) + \frac{z^2_{\alpha/2}}{4n}}{n}}}{1 + \frac{z^2_{\alpha/2}}{n}}.$$

For more information on the scores and diagrams visit the website

http://www.cawcr.gov.au/projects/verification

APPRENDIX II XML file Structure and examples

- **XML Stucture: Every xml file can contains different <fcs></fcs> tags. The tags are explained in the related comment <!--xxx -->. Parentheses describe the value to be replaced**.

<fcs gribEditionNumber=1> <!--related to one model on a specific grid -->

<model> <!--model information-->

<cd_model_process> (generating Process Identifier) </cd_model_process>

<!-- it should be fictitious value. It is necessary to classify the origin of the information -->

<origination_centre> (identification Of Originating Generating Centre) </origination_centre>

<!-- it should be fictitious value. It is necessary to classify the origin of the information -->

<n_fcs_ensemble> <model>ensemble_size:model_name=cosmo-7 </model> </n_fcs_ensemble>

</n_fcs_ensemble>

<missing_value_code><model>missing_value_code :model_name=cosmo-7</model></missing_value_code>

```
</model>
<list_element><!-- this tag can be multiple, one for each parameter field of the model-->
        <fcs_element>
                <code_table> (grib Tables Version No) </code_table>
                <cd_parameter> (indicator Of Parameter) </cd_parameter>
                <id_level> (indicator Of Type Of Level) </id_level>
                <level1> (level1) </level1>
                <level2> (level2) </level2>
                <time_range_ind> timeRangeIndicator </time_range_ind>
                <base_date><model>base_date:format=xsd,model_name=cosmo7</model></base_date>
                <!-- equivalent to dt_validity and run -->
                <id_method> TBD </id_method>
                <!--it should be fictitious value. It is necessary to classify the origin of the information-->
        </fcs_element>
        <product><!-- this tag can be multiple, one for each station point-->
        <point_reference>
                        <wmo_block> (wmo block number) </wmo_block>
                        <wmo_station>(wmo station number)</wmo_station>
                        <lat><model>grid_point_latitude:location_name=06610,
                        location_group=wmo,model_name=cosmo-7</model></lat>
                        <lon><model>grid_point_longitude:location_name=06610,
                        location_group=wmo,model_name=cosmo-7</model></lon>
                        <height><model>grid_point_height:location_name=06610,
                        location_group=wmo,model_name=cosmo-7</model></height>
                       <lsm><model>field:tag=FR_LAND,level=-1, level_class=slev,
                model_name=cosmo-7, location_group=wmo,location_name=06610, lead_time_idx=1 </model>
                </lsm>
        </point_reference>
        <grib _data> <!-- this tag can be multiple, one for each validation date and perturbation number-->
                <grib_value><model>field:tag=T_2M,level=2,level_class=z,model_name=cosmo-7,
                location_group=wmo,location_name=06610,lead_time_idx=2</model></grib_value>
        <validation_date><model>validation_date:lead_time_idx=2,format=xsd,
                        model_name=cosmo-7 </model>
                </validation_date>
                <perturbation_number><model>ensemble_member_id:model_name=cosmo-7          </model>
```

```
        </perturbation_number>
        <n_fcs_ensemble> <model>ensemble_size:model_name=cosmo-7 </model>
        </n_fcs_ensemble>
        </grib_data>
    </product>
    </list_element>
</fcs>
```

- ## XML Examples

- **Example of XML template corresponding to the minimal solution that is already supported by fieldextra 11.3 (all model and parameter information provided manually):**

```
<fcs gribEditionNumber=1> <!--related to one model on a specific grid -->
<model> <!--model information-->
    <cd_model_process> 107</cd_model_process>
    <origination_centre> 215 </origination_centre>
    <n_fcs_ensemble> <model>ensemble_size:model_name=cosmo-7 </model> </n_fcs_ensemble>
    <missing_value_code><model>missing_value_code :model_name=cosmo-
7</model></missing_value_code>
</model>
<list_element><!-- this tag can be multiple, one for each parameter field of the model-->
    <fcs_element>
        <code_table> 2</code_table>
        <cd_parameter> 11 </cd_parameter>
        <id_level> 105 </id_level>
        <level1> 0 </level1>
        <level2> 2 </level2>
        <time_range_ind> 0 </time_range_ind>
        <base_date><model>base_date:format=xsd,model_name=cosmo7</model></base_date>
        <!-- equivalent to dt_validity and run -->
        <id_method> 09 </id_method>
    </fcs_element>
    <product><!-- this tag can be multiple, one for each station point-->
    <point_reference>
```

<wmo_block> (wmo block number) </wmo_block>

<wmo_station>(wmo station number)</wmo_station>

<lat><model>grid_point_latitude:location_name=06610,
location_group=wmo,model_name=cosmo-7</model></lat>

<lon><model>grid_point_longitude:location_name=06610,
location_group=wmo,model_name=cosmo-7</model></lon>

<height><model>grid_point_height:location_name=06610,
location_group=wmo,model_name=cosmo-7</model></height>

<lsm><model>field:tag=FR_LAND,level=-1, level_class=slev,

model_name=cosmo-7, location_group=wmo,location_name=06610, lead_time_idx=1 </model>
</lsm>

</point_reference>

<grib _data> <!-- this tag can be multiple, one for each validation date and perturbation number-->

<grib_value><model>field:tag=T_2M,level=2,level_class=z,model_name=cosmo-7,
location_group=wmo,location_name=06610,lead_time_idx=2</model></grib_value>

<validation_date><model>validation_date:lead_time_idx=2,format=xsd,

model_name=cosmo-7 </model>

</validation_date>

<perturbation_number><model>ensemble_member_id:model_name=cosmo-7 </model>
</perturbation_number>

<n_fcs_ensemble> <model>ensemble_size:model_name=cosmo-7 </model>
</n_fcs_ensemble>

</grib_data>

</product>

</list_element>

</fcs>

- **Example XML template with new keys for the dynamic generation of model and parameter information with fieldextra (choice of key names only preliminary):**

<fcs gribEditionNumber=1> <!--related to one model on a specific grid -->

<model> <!--model information-->

<cd_model_process><model>generating_process_id:model_name=cosmo-7</model></cd_model_process>

<origination_centre><model>originating_center:model_name=cosmo-7</model></origination_centre>

<n_fcs_ensemble> <model>ensemble_size:model_name=cosmo-7 </model> </n_fcs_ensemble>

<missing_value_code><model>missing_value_code :model_name=cosmo-7</model></missing_value_code>

</model>

<list_element><!-- this tag can be multiple, one for each parameter field of the model-->

<fcs_element>

<code_table><model> table_number :tag=T_2M</model></code_table>

<cd_parameter><model>parameter_id:tag=T_2M </model></cd_parameter>

<id_level><model>level_type:tag=T_2M</model> </id_level>

<level1> <model>level_value1:tag=T_2M</model></level1>

<level2> <model>level_value2:tag=T_2M</model> </level2>

<time_range_ind><model>time_range_indicator:tag=T_2M</model></time_range_ind>

<base_date><model>base_date:format=xsd,model_name=cosmo7</model></base_date>

<!-- equivalent to dt_validity and run -->

<id_method> 09 </id_method>

</fcs_element>

<product><!-- this tag can be multiple, one for each station point-->

<point_reference>

<wmo_block> (wmo block number) </wmo_block>

<wmo_station>(wmo station number)</wmo_station>

<lat><model>grid_point_latitude:location_name=06610,
location_group=wmo,model_name=cosmo-7</model></lat>

<lon><model>grid_point_longitude:location_name=06610,
location_group=wmo,model_name=cosmo-7</model></lon>

<height><model>grid_point_height:location_name=06610,
location_group=wmo,model_name=cosmo-7</model></height>

<lsm><model>field:tag=FR_LAND,level=-1, level_class=slev,

model_name=cosmo-7, location_group=wmo,location_name=06610, lead_time_idx=1 </model>
</lsm>

</point_reference>

<grib _data> <!-- this tag can be multiple, one for each validation date and perturbation number-->

<grib_value><model>field:tag=T_2M,level=2,level_class=z,model_name=cosmo-7,
location_group=wmo,location_name=06610,lead_time_idx=2</model></grib_value>

<validation_date><model>validation_date:lead_time_idx=2,format=xsd,

```
                model_name=cosmo-7 </model>
            </validation_date>
            <perturbation_number><model>ensemble_member_id:model_name=cosmo-7 </model>
            </perturbation_number>
            <n_fcs_ensemble> <model>ensemble_size:model_name=cosmo-7 </model>
            </n_fcs_ensemble>
            </grib_data>
        </product>
        </list_element>
</fcs>
```

- **Example of a T2M of COSMO-7 forecast model connected to Pratica di mare WMO Station:**

<fcs gribEditionNumber=1> <!--related to one model on a specific grid -->
<model_info> <!--model information-->
<cd_model_process>107 </cd_model_process>
<origination_centre> 215 </origination_centre>
<n_fcs_ensemble> -9.E9 </n_fcs_ensemble>
<missing_value_code>-9.E9</missing_value_code>
</model_info>
<list_element><!-- this tag can be multiple, one for each parameter field of the model-->
<fcs_element>
<code_table> 2 </code_table>
<cd_parameter> 11 </cd_parameter>
<id_level> 105 </id_level>
<level1> 0 </level1>
<level2> 2 </level2>
<time_range_ind> 0 </time_range_ind>
<base_date>2014-05-19T12:00:00+00:00</base_date>
<!-- equivalent to dt_validity and run -->
<id_method> 09 </id_method>
</fcs_element>
<product><!-- this tag can be multiple, one for each station point-->
<point_reference>
<wmo_block> 16 </wmo_block>
<wmo_station>245 <wmo_station>
<lat>48</lat>
<lon>12</lon>
<height >18</height>
<lsm>1</lsm>
</point_reference>
<grib _data> <!-- this tag can be multiple, one for each validation date and perturbation number-->
<grib_value>295.30<grib_value>
<validation_date>2014-05-19T13:00:00+00:00</validation_date>
<perturbation_number>-9.E9 </perturbation_number></grib_data>

```
        </product>
        </list_element>
</fcs>
```

APPRENDIX III CODE FOR CONFIDENCE INTERVALS

MAE_CI_low

```
require(verification)
booter <- function(d, i) {
A<-verify(d[i, "surface_value"], d[i,"grib_value"],frcst.type="cont", obs.type="cont")
return(c(A$MAE))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300);score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);low_ci <- score_ci[[4]][4];index <- low_ci
```

MAE_CI_high

```
require(verification)
booter <- function(d, i) {
A<-verify(d[i, "surface_value"], d[i,"grib_value"],frcst.type="cont", obs.type="cont")
return(c(A$MAE))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300);score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);high_ci <- score_ci[[4]][5];index <- high_ci
```

RMSE_CI_low

```
require(verification)
booter <- function(d, i) {
A<-verify(d[i, "surface_value"], d[i,"grib_value"],frcst.type="cont", obs.type="cont")
return(c(sqrt(A$MSE)))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300);score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);low_ci <- score_ci[[4]][4];index <- low_ci
```

RMSE_CI_high

```
require(verification)
booter <- function(d, i) {
A<-verify(d[i, "surface_value"], d[i,"grib_value"],frcst.type="cont", obs.type="cont")
return(c(sqrt(A$MSE)))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300);score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);high_ci <- score_ci[[4]][5];index <- high_ci
```

MSE_CI_high

```
require(verification)
booter <- function(d, i) {
A<-verify(d[i, "surface_value"], d[i,"grib_value"],frcst.type="cont", obs.type="cont")
return(c(A$MSE))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300);score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);high_ci <- score_ci[[4]][5];index <- high_ci
```

MSE_CI_low

```
require(verification)
booter <- function(d, i) {
A<-verify(d[i, "surface_value"], d[i,"grib_value"],frcst.type="cont", obs.type="cont")
return(c(A$MSE))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300);score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);low_ci <- score_ci[[4]][4];index <- low_ci
```

ME_CI_high

```
require(verification)
booter <- function(d, i) { A<-verify(d[i, "surface_value"], d[i,"grib_value"],frcst.type="cont", obs.type="cont") return(c(A$ME)) } df=data.frame(fcs,obs) booted <- boot(df, booter, 300);score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][5]
```

ME_CI_low

```
require(verification)
booter <- function(d, i) { A<-verify(d[i, "surface_value"], d[i,"grib_value"],frcst.type="cont", obs.type="cont") return(c(A$ME)) } df=data.frame(fcs,obs) booted <- boot(df, booter, 300);score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);low_ci <- score_ci[[4]][4];index <- low_ci
```

ETS_CI_low

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(0.01/2)# For 99% CI low
index <- A$ETS+B*A$ETS.se
```

PAG_CI_low

```
if((a+b)>0){
P <-a/(a+b)
Z=qnorm(0.01/2)# 99%CI
N=a+b+c+d
A=(P*(1-P)+Z^2/(4*N))/N
index <- (P+Z^2/(2*N)+Z*sqrt(A))/(1+Z^2/N)}else{index<-9999}
```

ETS_CI_high

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(1-0.01/2)# For 99% CI high
index <- A$ETS+B*A$ETS.se    2          2          NULL    1
```

EDS_CI_high

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(1-0.01/2)# For 99% CI high
```

index <- A$EDS+B*A$EDS.se

EDS_CI_low

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(0.01/2)# For 99% CI low

index <- A$EDS+B*A$EDS.se

F_CI_high

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(1-0.01/2)# For 99% CI high

index <- A$F+B*A$F.se

F_CI_low

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(0.01/2)# For 99% CI low

index <- A$F+B*A$F.se

FAR_CI_high

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(1-0.01/2)# For 99% CI high

index <- A$FAR+B*A$FAR.se

FAR_CI_low

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(0.01/2)# For 99% CI low

index <- A$FAR+B*A$FAR.se

HSS_CI_high

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(1-0.01/2)# For 99% CI high

index <- A$HSS+B*A$HSS.se

HSS_CI_low

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(0.01/2)# For 99% CI low

index <- A$HSS+B*A$HSS.se

KSS_CI_high

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(1-0.01/2)# For 99% CI high

index <- A$KSS+B*A$KSS.se

KSS_CI_low

require(verification)

obs <- c(a,b,c,d)

A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")

B=qnorm(0.01/2)# For 99% CI low

index <- A$KSS+B*A$KSS.se

ORSS_CI_high

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(1-0.01/2)# For 99% CI high
index <- A$ORSS+B*A$ORSS.se
```

ORSS_CI_low

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(0.01/2)# For 99% CI low
index <- A$ORSS+B*A$ORSS.se
```

POD_CI_high

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(1-0.01/2)# For 99% CI high
index <- A$POD+B*A$POD.se
```

POD_CI_low

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(0.01/2)# For 99% CI low
index <- A$POD+B*A$POD.se
```

PC_CI_high

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(1-0.01/2)# For 99% CI high
index <- A$PC+B*A$PC.se
```

TS_CI_high

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(1-0.01/2)# For 99% CI high
index <- A$TS+B*A$TS.se
```

TS_CI_low

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(0.01/2)# For 99% CI low
index <- A$TS+B*A$TS.se
```

PC_CI_low

```
require(verification)
obs <- c(a,b,c,d)
A<- verify(obs, pred = NULL, frcst.type = "binary", obs.type = "binary")
B=qnorm(0.01/2)# For 99% CI low
index <- A$PC+B*A$PC.se
```

PAG_CI_high

```
if((a+b)>0){
P <-a/(a+b)
Z=qnorm(0.01/2)# 99%CI
N=a+b+c+d
A=(P*(1-P)+Z^2/(4*N))/N
index <- (P+Z^2/(2*N)-Z*sqrt(A))/(1+Z^2/N)}else{index<-9999}
```

FBI_high

```
CT <- matrix(c(a,c,b,d),ncol=2) # a-c-b-d order!
C <- table.stats.boot(CT, R=100,alpha=0.01)
```

```
index <- C[[5]]
```

FBI_low

```
CT <- matrix(c(a,c,b,d),ncol=2) # a-c-b-d order!
C <- table.stats.boot(CT, R=100,alpha=0.01)
index <- C[[6]]
```

ME_wind_CI_high

```
require(verification)
booter <- function(d, i) {
A<-mean(d[i,"wind_d"])
return(c(A)) }
df=data.frame(wind_d)
names(df)<-c("wind_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][5]
```

ME_wind_CI_low

```
require(verification)
booter <- function(d, i) {
A<-mean(d[i,"wind_d"])
return(c(A)) }
df=data.frame(wind_d)
names(df)<-c("wind_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][4]
```

BRIER_CI_high

```
require(verification)
booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)
return(c(A$bs, A$bs.reliability, A$bs.resolution, A$bs.uncert, A$ss))
}
df=data.frame(Obs, Prob)
```

```
names(df)<-c("Obs","Prob")
booted <- boot(df, booter, 300);bs_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- bs_ci[[4]][5]
```

COR_CI_high

```
require(verification)
booter <- function(d, i) {
A<-cor(d[i,"grib_value"], d[i,"surface_value"])
return(c(A))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][5]
```

COR_CI_low

```
require(verification)
booter <- function(d, i) {
A<-cor(d[i,"grib_value"], d[i,"surface_value"])
return(c(A))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][4]
```

MAE_wind_CI_high

```
require(verification)
booter <- function(d, i) {
A<-mean(abs(d[i,"wind_d"]))
return(c(A)) }
df=data.frame(wind_d)
names(df)<-c("wind_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][5]
```

MAE_wind_CI_low

```
require(verification)
booter <- function(d, i) {
A<-mean(abs(d[i,"wind_d"]))
return(c(A)) }
df=data.frame(wind_d)
names(df)<-c("wind_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][4]
```

BRIER_CI_low

```
require(verification)
booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)
return( c(A$bs, A$bs.reliability, A$bs.resolution, A$bs.uncert, A$ss))
}
df=data.frame(Obs, Prob)
names(df)<-c("Obs","Prob")
booted <- boot(df, booter, 300);bs_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- bs_ci[[4]][4]
```

BRIER_reliability_CI_high

```
require(verification)
booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)
return(c(A$bs, A$bs.reliability, A$bs.resolution, A$bs.uncert, A$ss))
}
df=data.frame(Obs, Prob)
names(df)<-c("Obs","Prob")
booted <- boot(df, booter, 300);bs.reliability_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=2);index <- bs.reliability_ci[[4]][5]
```

BRIER_reliability_CI_low

```
require(verification)
booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)
return(c(A$bs, A$bs.reliability, A$bs.resolution, A$bs.uncert, A$ss))
}
```

df=data.frame(Obs, Prob)

names(df)<-c("Obs","Prob")

booted <- boot(df, booter, 300);bs.reliability_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=2);index <- bs.reliability_ci[[4]][4]

BRIER_resolution_CI_high

require(verification)

booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)

return(c(Abs, Abs.reliability, A$bs.resolution, A$bs.uncert, A$ss))

}

df=data.frame(Obs, Prob)

names(df)<-c("Obs","Prob")

booted <- boot(df, booter, 300);bs.resolution_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=3);index <- bs.resolution_ci[[4]][5]

BRIER_resolution_CI_low

require(verification)

booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)

return(c(Abs, Abs.reliability, A$bs.resolution, A$bs.uncert, A$ss))

}

df=data.frame(Obs, Prob)

names(df)<-c("Obs","Prob")

booted <- boot(df, booter, 300);bs.resolution_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=3);index <- bs.resolution_ci[[4]][4]

BRIER_uncert_CI_high

require(verification)

booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)

return(c(Abs, Abs.reliability, A$bs.resolution, A$bs.uncert, A$ss))

}

df=data.frame(Obs, Prob)

names(df)<-c("Obs","Prob")

booted <- boot(df, booter, 300);bs.uncert_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=4);index <- bs.uncert_ci[[4]][5]

BRIER_uncert_CI_low

```
require(verification)
booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)
return(c(A$bs, A$bs.reliability, A$bs.resolution, A$bs.uncert, A$ss))
}
df=data.frame(Obs, Prob)
names(df)<-c("Obs","Prob")
booted <- boot(df, booter, 300);bs.uncert_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=4);index <- bs.uncert_ci[[4]][4]
```

RMSE_wind_CI_high

```
require(verification)
booter <- function(d, i) {
A<-sqrt(mean((d[i,"wind_d"])^2))
return(c(A)) }
df=data.frame(wind_d)
names(df)<-c("wind_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][5]
```

RMSE_wind_CI_low

```
require(verification)
booter <- function(d, i) {
A<-sqrt(mean((d[i,"wind_d"])^2))
return(c(A)) }
df=data.frame(wind_d)
names(df)<-c("wind_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][4]
```

BRIER_skill_CI_low

```
require(verification)
booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)
return(c(A$bs, A$bs.reliability, A$bs.resolution, A$bs.uncert, A$ss))
```

```
}
df=data.frame(Obs, Prob)
names(df)<-c("Obs","Prob")
booted <- boot(df, booter, 300);bs.ss_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=5);index <- bs.ss_ci[[4]][4]
```

BRIER_skill_CI_high

```
require(verification)
booter <- function(d, i) { A<-brier(d[i, "Obs"], d[i,"Prob"],bins=FALSE)
return(c(A$bs, A$bs.reliability, A$bs.resolution, A$bs.uncert, A$ss))
}
df=data.frame(Obs, Prob)
names(df)<-c("Obs","Prob")
booted <- boot(df, booter, 300);bs.ss_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=5);index <- bs.ss_ci[[4]][5]
```

SD_CI_high

```
require(verification)
booter <- function(d, i) {
A<-sd(d[i,"grib_value"]-d[i,"surface_value"])
return(c(A))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][5]
```

SD_CI_low

```
require(verification)
booter <- function(d, i) {
A<-sd(d[i,"grib_value"]- d[i,"surface_value"])
return(c(A))
}
df=data.frame(fcs,obs)
booted <- boot(df, booter, 300)
```

```
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][4]
```

Skill MSE - RV_CI_high

```
require(verification)
booter <- function(d, i) {
A<- 1-(mean((d[i,"fcs"]-d[i,"obs"])^2)/(mean((persistence)^2)))
return(c(A))
}
df=data.frame(fcs,obs)
names(df)<-c("fcs","obs")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][5]
```

SKILL MSE - RV_CI_low

```
require(verification)
booter <- function(d, i) {
A<- 1-(mean((d[i,"fcs"]-d[i,"obs"])^2)/(mean((persistence)^2)))
return(c(A))
}
df=data.frame(fcs,obs)
names(df)<-c("fcs","obs")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][4]
```

MSE_wind_CI_high

```
require(verification)
booter <- function(d, i) {
A<-mean((d[i,"wind_d"])^2)
return(c(A)) }
df=data.frame(wind_d)
names(df)<-c("wind_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][5]
```

MSE_wind_CI_low

```
require(verification)
booter <- function(d, i) {
A<-mean((d[i,"wind_d"])^2)
return(c(A)) }
df=data.frame(wind_d)
names(df)<-c("wind_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][4]
```

Skill RMSVWE_CI_high

```
require(verification)
booter <- function(d, i) {
A<- 1-(sum(d[i,"u_d"]^2+d[i,"v_d"]^2)/(sum(persistence_u^2+persistence_v^2)))
return(c(A))
}
df=data.frame(u_d,v_d)
names(df)<-c("u_d","v_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][5]
```

Skill RMSVWE_CI_low

```
require(verification)
booter <- function(d, i) {
A<- 1-(sum(d[i,"u_d"]^2+d[i,"v_d"]^2)/(sum(persistence_u^2+persistence_v^2)))
return(c(A))
}
df=data.frame(u_d,v_d)
names(df)<-c("u_d","v_d")
booted <- boot(df, booter, 300)
score_ci <- boot.ci(booted,conf=c(0.99),type=c("perc"),index=1);index <- score_ci[[4]][4]
```