INSPECT - INtercomparison of SPatial vErification methods for COSMO Terrain

HNMS Involvement

2a. Policy for model output and observation data format standards before entering verification chain (preprocessing) based on existing COSMO data processing software (coordination with Fieldextra SCA).

2b. Adaptation of existing verification packages (in particular, SpatialVx and VAST) to COSMO data and development of local tools with the aim to provide scripts for applying the most widely used spatial methods, that will be utilized in Tasks 3 and 4. The adaptation will mainly concern MesoVICT experiment datasets to be utilized from verification software and scripts that will facilitate the application of R libraries (SpatialVx) for a large variety of methods

3d: Application of SAL verification methods (over Italy, and for the core MesoVICT case)

3f: Application of traditional categorical scores and spatial verification methods to analyze extreme precipitation events based on MesoVICT cases

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Communication with Fieldextra SCA for input file definition for VAST software (exploring all capabilities of Fieldextra software for gridded forecast/obs) preprocessing required by VAST.

- ***After final approval from the STC of strategy for I/O of verification software tools, written policy will be prepared for describing common exchangeable format for Input files***

2b. Adaptation of existing verification packages (in particular, SpatialVx and VAST) to COSMO data and development of local tools with the aim to provide scripts for applying the most widely used spatial methods, that will be utilized in Tasks 3 and 4. The adaptation will mainly concern MesoVICT experiment datasets to be utilized from verification software and scripts that will facilitate the application of R libraries (SpatialVx) for a large variety of methods

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1. SpatialVx : Just started: basic libraries application on test datasets
2. VAST: Preparation/Adaptation of MesoVICT datasets as input for VAST

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2. VAST: Preparation/Adaptation of MesoVICT datasets as input for VAST

MesoVICT datasets

Forecast Data:

1. Model Data interpolated on the VERA grid (resolution 8 km)

ASCII format on a Cartesian grid (non regular)

Models available:
COSMO-2 (old runs – version of model):
COSMO-1 (new runs)
CMC-GEM (Canadian model)

Preparation of script to extract precipitation values and produce a CSV file in VAST format (Lon, Lat, Value, SW corner moving to the N) from fcs and obs files *veraMergeValsToCoords.sh* available in ftp meteoam

- VAST can process only regular lat-lon files so these data will have to be interpolated for a second time (!) on a regular grid, to be usable by software (Opinion?)
- SpatialVx input file format not decided yet

2. "Raw" Model GRIB1 files (not available for all cases/models)

Core Case: COSMO-2 (old runs,GRIB1)

FILES	19-06-2007								20-06-2007								21-06-2007								22-06-2007								23-06-2007	
	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC
145.grb									24																									
146.grb										24																								
148.grb														30																				
149.grb													24																					
151.grb																	30																	
153.grb																	24																	
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156.grb																						30												
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161.grb																									24									
162.grb																										24								
164.grb																														30				
165.grb																													24					
167.grb																																	30	
169.grb																																	24	
170.grb																																		24

Parameters	1h preci	2mT

Data currently processed for 00UTC runs (20, 21,22/06/2007)

Through this application, the necessity to better define input file names for VAST was profound (Cycle info, start date, reference date)

Core Case: COSMO-1 (new runs,GRIB1)

FILES	20-06-2007								21-06-2007								22-06-2007								23-06-2007		
	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC	06UTC
2007062006.grb											24																
2007062006.grb																			24								
2007062006.grb																											24

Parameters	1h preci	2mT	MSLP	wind u,v

Data NOT processed yet

Core Case: CMC GEMH (GRIB1)

FILES	20-06-2007								21-06-2007								22-06-2007								23-06-2007		
	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC	06UTC	09UTC	12UTC	15UTC	18UTC	21UTC	00UTC	03UTC	06UTC
2007062006.grb									18																		
2007062106.grb																	18										
2007062206.grb																									18		

Parameters	1h preci	?	?	?

Data NOT processed yet

Observations: JDC

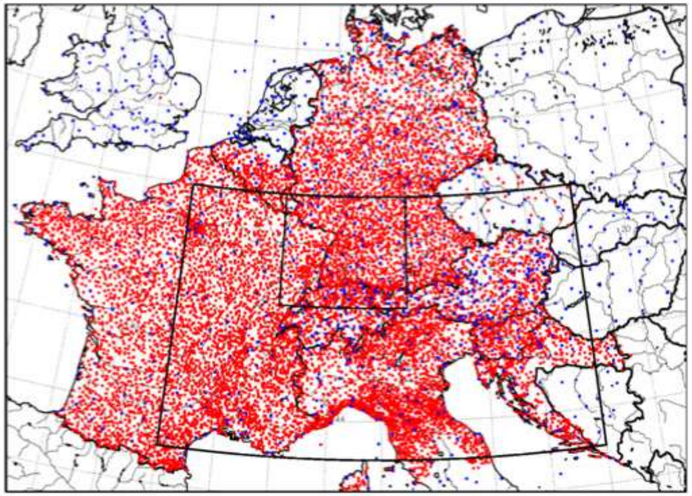

Figure 1: GTS (blue) and non-GTS (red) station distribution. Data from these stations have been collected for the whole year 2007 (partly only for the period 6-11/2007). Smaller frame – COPS area, larger frame – D-PHASE area.

FORMATS:

1. VERA Data in ASCII format on a Cartesian grid. Domain is 1664 km in W-E direction and 1536 km in S-N direction (resolution of 8 km).
2. BUFR datasets created using VERA files (M.S.Tesini) for easier use with VAST

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Not started yet – only in place of ARPA-PT

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Approach

Questions addressed:

✓ How far ahead can the signal of a potential large scale flooding event be detected from a NWP?

✓ How skillful are convection permitting NWP forecasts in providing guidance on convective systems that can cause intense precipitation events?

Various methods are utilized (spatial and point) to deal with the problematic characteristics of precipitation.

Categorical score suitable for heavy rainfall events to be used:

1. Symmetric external dependence index (SEDI)

-Equitable score
-Suitable for low base rate (rare events)
-Non-fixed range

$$SEDI = \frac{\log F - \log H - \log(1-F) + \log(1-H)}{\log F + \log H + \log(1-F) + \log(1-H)} \quad (2)$$

where H is the hit rate,

$$H = \frac{a}{a+c} \quad (3)$$

and F is the false alarm rate,

$$F = \frac{b}{b+d} \quad (4)$$

Task prerequisite

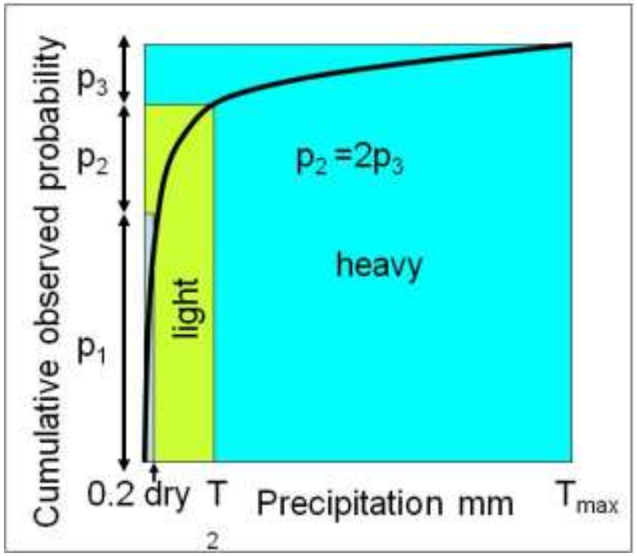
Score will be added to VERSUS for easier Application – Oct 2015

Approach

Categorical score suitable for heavy rainfall events to be used:

2. Stable Equitable Error in Probability Space (SEEPS)

- Dry, light , heavy based on observed climatology (24h) at station – p_1 , p_2 , p_3
- Contingency table probabilities based on these categories
- Scoring matrix – stable, equitable
  - SEEPS=0 (perfect) , =1 (no skill - , e.g. constant)



-Equitable
-Can be averaged over locations with different climates
-More stable to sampling uncertainty (for sufficiently skilful systems) and better for trend detection than other scores.
-Robust to skewed distribution because the error is measured in probability space.
-Adapts to assess prominent aspects of local weather.
-Inhibits hedging (for reasonable systems). It is generally not possible to reduce SEEPS without some physical insight.
-SEEPS can identify key forecasting errors including **failure to predict heavy large-scale precipitation, incorrect location of convective cells and overprediction of drizzle.**

Status

Categorical score suitable for heavy rainfall events to be used:

2. Stable Equitable Error in Probability Space (SEEPS)

For SEEPS calculation is necessary to include:

1. weights of the SEEPS scoring matrix and percentiles for each station for the 30-yr period 1980-2009. Data was given by ECMWF – **Available**
2. Code prototype in C language was rewritten in Fortran – **Done**
3. Adaptation to 24h forecast precipitation datasets – **Ongoing**

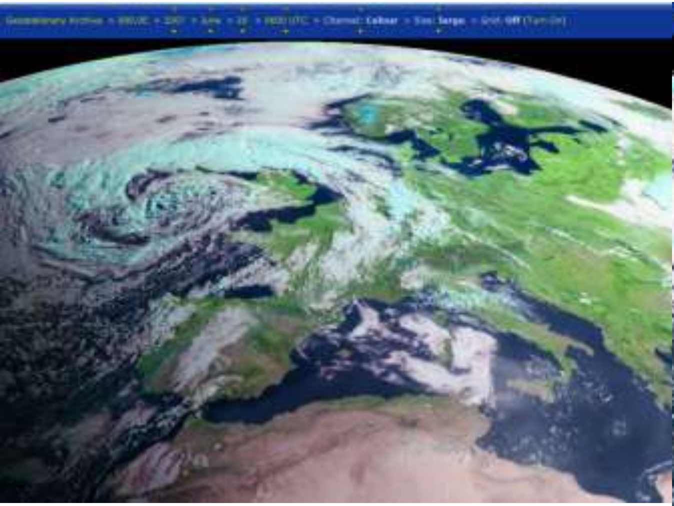
Next Steps:

- Calculate SEEPS over two different geographic areas (Common Area and Greece) with COSMOGR7 for a 12 month period (permitting for seasonal analysis)
- Calculate SEEPS derived by COSMOGR2 over the same experimental period
- Apply SEDI score for both regions/models and all seasons
- Explore the possibility to apply varying thresholds based on seasonal/station climatology to better indentify extreme events on SEDI calculations

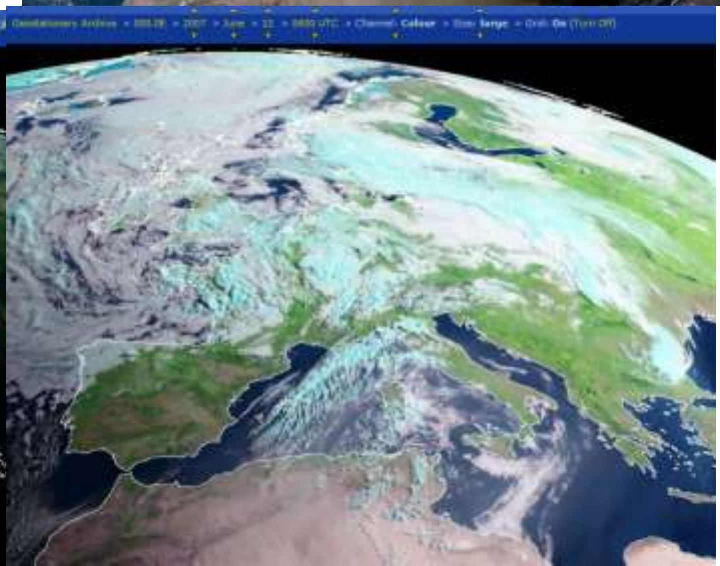
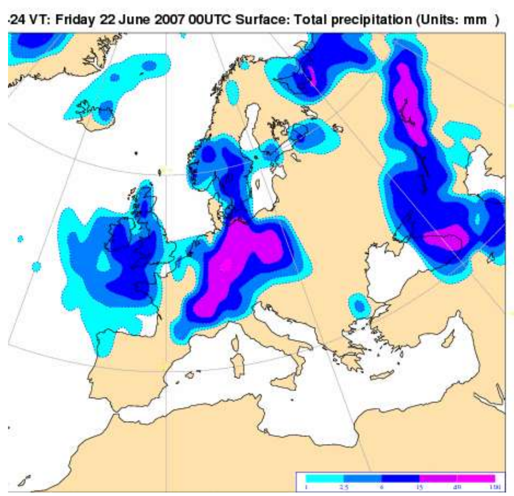
- Analyze the impact of season, resolution, lead time, precipitation threshold on the identification of extreme events

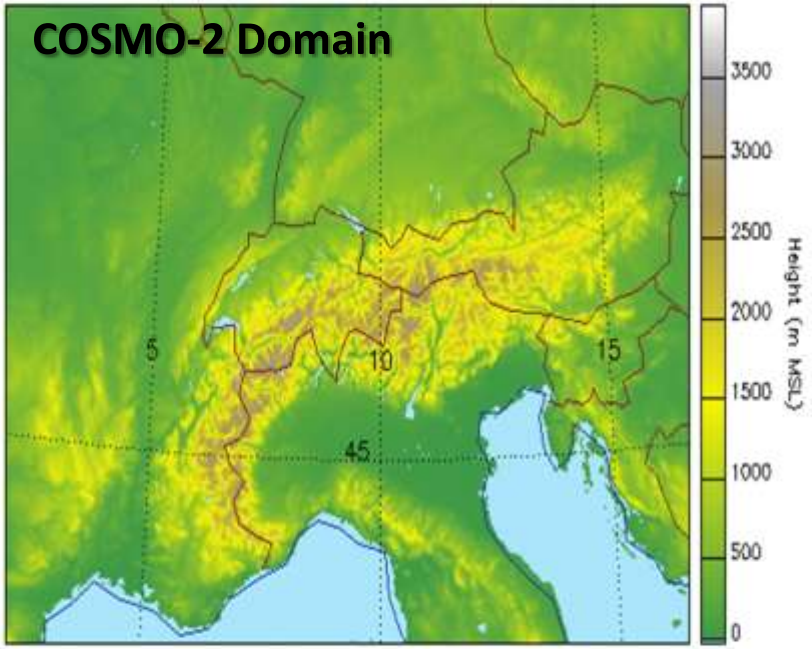
Case 1 (core case): 20-22 June 2007

"Ahead of a trough, located over the British Isles, warm moist air is advected towards the Alpine Region. This leads to strong convective events in the evening of 20 June, in the area north of the main mountain range. On the next day (21st) a cold front is reaching the Alps from the west and moves to the east rather quickly. Ahead of the front again convective events are observed. With the passage of the front strong westerly winds occurred."







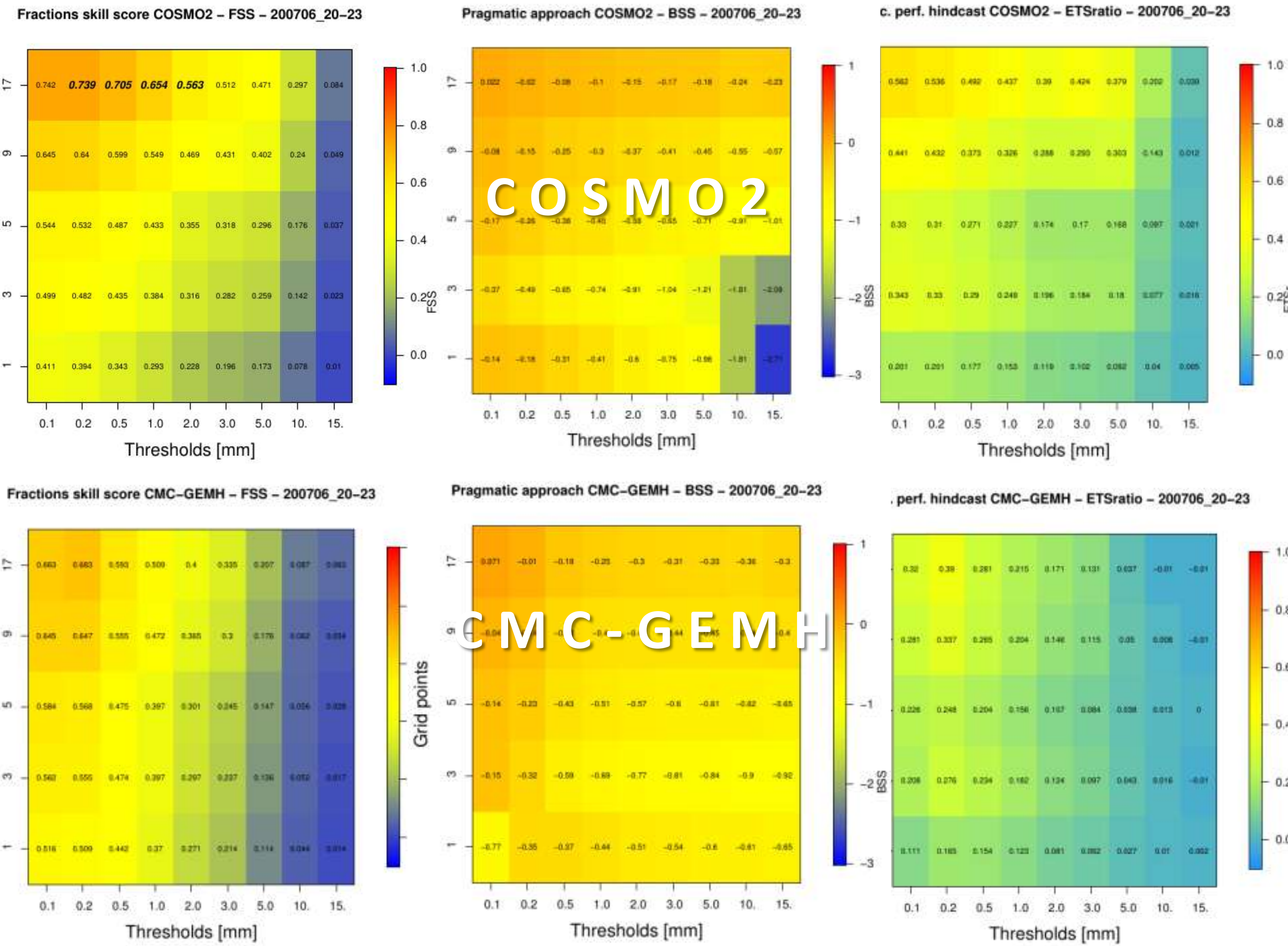
MesoVict Core case

Forecast model used:
1. COSMO-2 extrapolated to ~7km resolution
Data:20, 21,22.06.07:00-24UTC
Precipitation, 1h accumulation

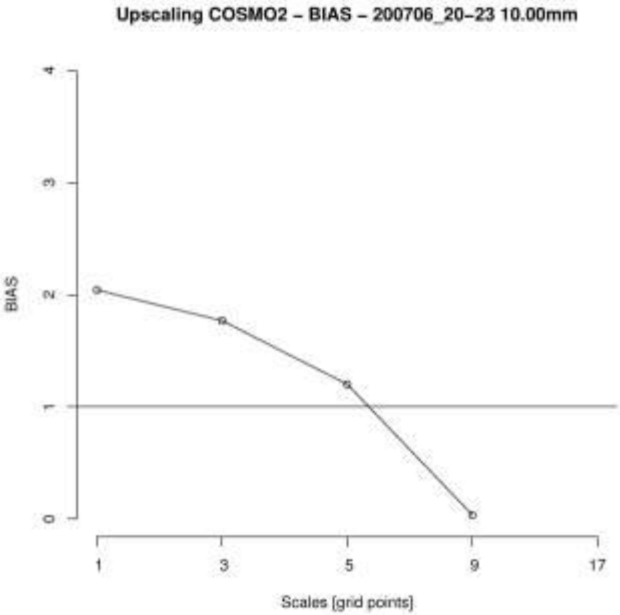
2. CMC GEMH: in VERA resulution
Originally 2.5 km (0.0225 X 0.0327)
Data:20, 21,22.06.07: 06-18UTC
Precipitation, 6h accumulation

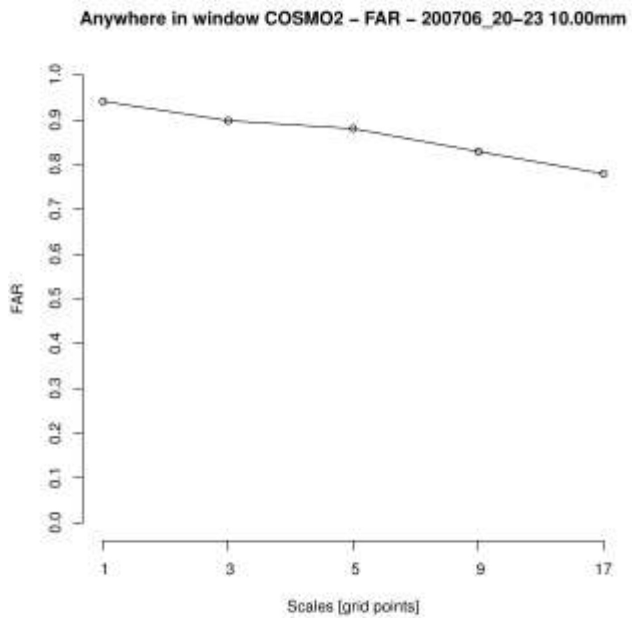
Observation data used: VERA analysis in ~7km resolution resolution

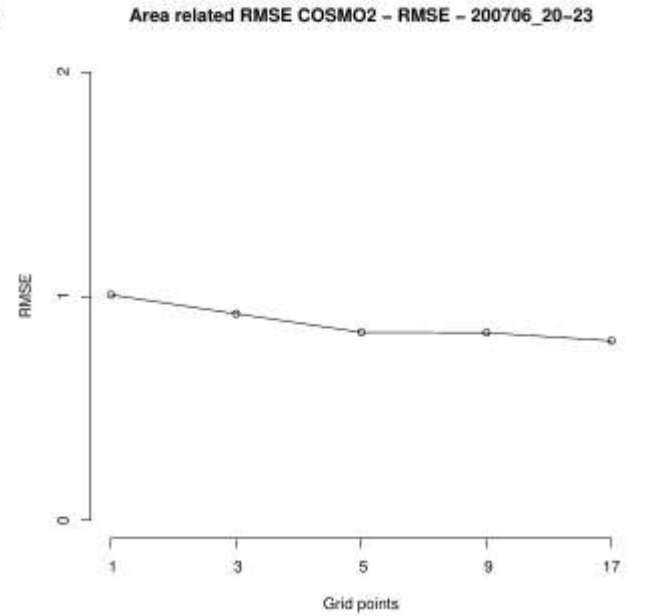
Data adapted by N.Vela and M.S.Tesini

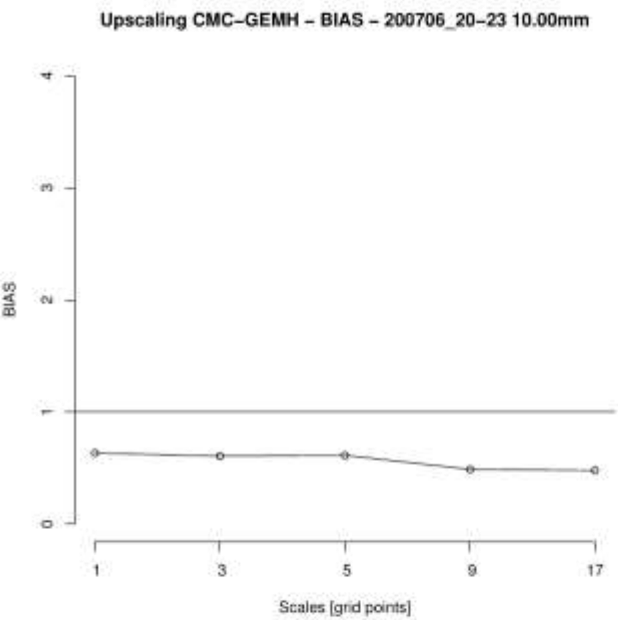


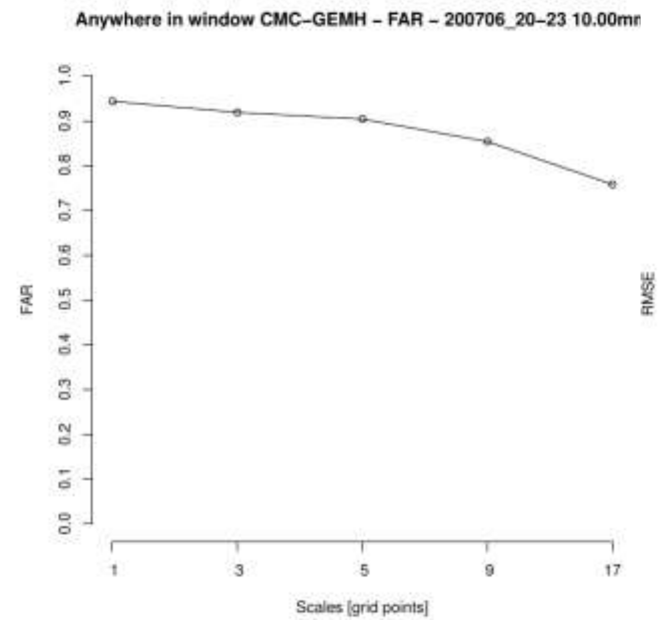
Fractions skill score COSMO2 – FSS – 200706_20–23
Pragmatic approach COSMO2 – BSS – 200706_20–23
c. perf. hindcast COSMO2 – ETSratio – 200706_20–23
COSMO2
FSS
BSS
Thresholds [mm]
Fractions skill score CMC–GEMH – FSS – 200706_20–23
Pragmatic approach CMC–GEMH – BSS – 200706_20–23
. perf. hindcast CMC–GEMH – ETSratio – 200706_20–23
CMC-GEMH
Grid points
BSS
Thresholds [mm]


Upscaling COSMO2 – BIAS – 200706_20–23 10.00mm
BIAS
0
1
2
3
4
1
3
5
9
17
Scales [grid points]


Anywhere in window COSMO2 – FAR – 200706_20–23 10.00mm
FAR
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1
3
5
9
17
Scales [grid points]


Area related RMSE COSMO2 – RMSE – 200706_20–23
RMSE
0
1
2
1
3
5
9
17
Grid points


Upscaling CMC–GEMH – BIAS – 200706_20–23 10.00mm
BIAS
0
1
2
3
4
1
3
5
9
17
Scales [grid points]


Anywhere in window CMC–GEMH – FAR – 200706_20–23 10.00mm
FAR
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1
3
5
9
17
Scales [grid points]

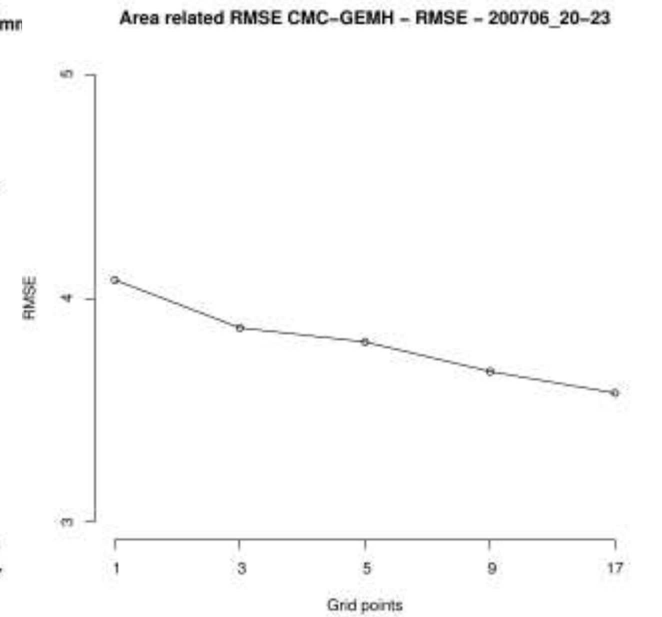

Area related RMSE CMC–GEMH – RMSE – 200706_20–23
RMSE
3
4
5
1
3
5
9
17
Grid points

Table 1. Characteristics of several fuzzy verification methods. A decision rule of ' – ' indicates that the method does not use neighbourhood events. The metrics are defined in the Appendix unless otherwise indicated.

Fuzzy method	Matching strategy[a]	Decision model	Quantities compared	Decision rule for event $\langle I \rangle_s$	Original metrics
Upscaling (Zepeda-Arce *et al.*, 2000; Weygandt *et al.*, 2004; Yates *et al.*, 2006)	NO-NF	Useful forecast resembles the observations when averaged to coarser scales	$\langle I_x \rangle_s, \langle I_y \rangle_s$	$\langle I \rangle_s = \begin{cases} 0 & \langle \overline{Y} \rangle_s < \text{threshold} \\ 1 & \langle \overline{Y} \rangle_s \geq \text{threshold} \end{cases}$	BIAS, TS, ETS
Minimum coverage (Damrath, 2004)	NO-NF	Useful forecast predicts the event over a minimum fraction of the region of interest	$\langle I_x \rangle_s, \langle I_y \rangle_s$	$\langle I \rangle_s = \begin{cases} 0 & \langle P \rangle_s < P_e \\ 1 & \langle P \rangle_s \geq P_e \end{cases}$	POD, FAR, ETS
Fuzzy logic (Damrath, 2004), joint probability (Ebert, 2002)	NO–NF	Useful forecast is more correct than incorrect	$\langle I_x \rangle_s, \langle I_y \rangle_s$	$\langle I \rangle_s = \langle P \rangle_s$	POD, FAR, ETS
Multi-event contingency table (Atger, 2001)	SO-NF	Useful forecast predicts at least one event close to an observed event	$I_x, \langle I_y \rangle_s$	$\langle I \rangle_s = \begin{cases} 0 & \langle P \rangle_s < P_e \\ 1 & \langle P \rangle_s \geq P_e \end{cases}$	ROC, V
Intensity-scale (Casati *et al.*, 2004)	NO-NF	Useful forecast has structure that is more accurate than a random arrangement of the observations	I_x, I_y	–	SS
Fractions skill score (Roberts and Lean, 2007)	NO-NF	Useful forecast has similar frequency of forecast events and observed events	$\langle P_x \rangle_s, \langle P_y \rangle_s$	–	FSS (refer to text)
Pragmatic (Theis *et al.*, 2005)	SO-NF	Useful forecast has a high probability of detecting events and non-events	$I_x, \langle P_y \rangle_s$	–	BS, BSS
Practically perfect hindcast (Brooks *et al.*, 1998)	SO-NF	Useful forecast resembles one that would have been issued by a forecaster given perfect knowledge of the observations beforehand	$I_x, \langle I_y \rangle_s$ $I_x, \langle I_x \rangle_s$	$\langle I \rangle_s = \begin{cases} 0 & \langle P \rangle_s < \langle P \rangle_{s,optimal} \\ 1 & \langle P \rangle_s \geq \langle P \rangle_{s,optimal} \end{cases}$	TS_x, TS_y
Conditional square root of RPS (Germann and Zawadzki, 2004)	SO-NF	Useful forecast has a high probability of matching the observed value	$I_x, \langle P_y \rangle_s$	–	CSRR (refer to text)
Area-related RMSE (Rezacova *et al.*, 2007)	NO-NF	Useful forecast has a similar distribution of intensities as the observations	ordered X, ordered Y	–	RMSE

[a] NO-NF, 'neighbourhood observation-neighbourhood forecast'; SO-NF, 'single observation-neighbourhood forecast'.