# National Report - ITALY

- Highlights on
  - ✓ Operations
  - ✓ Research activities
- Target on
  - ✓ Consolidation of the national partnership
  - ✓ COSMO evolution


***Antonio VOCINO, the CNMCA NWP group and the "Italian COSMO family"***

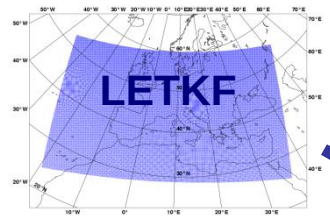
*antonio.vocino@am.difesa.it*

ITAF Met · CIRA · ARPAE · ARPA Piemonte · CMCC · CIMA · CETEMPS

# ItAF Met Service COSMO suites

## Ensemble Data Assimilation:

Operational since June 2011




3h cycle
7 km
49 v.l.
40+1 m.

Operational since nov 2018


1h cycle
2.2 km
65 v.l.
40+1 m.

## Observations

RAOB (also descent), PILOT, SYNOP (also non-GTS), SHIP, BUOY, Wind Profilers/Radars, AMDAR-AIREP, Mode-S, Meteosat AMV, Metop scatt. winds, NOAA/Metop AMSUA/MHS and NPP/NOAA ATMS radiances

ECMWF EUROPEAN CENTRE FOR MEDIUM RANGE WEATHER FORECASTS

## Boundary Conditions

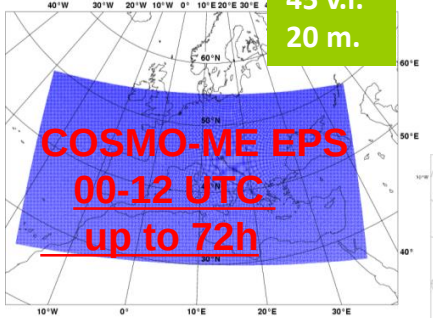
(HRES, ENS)

Ensemble Analysis

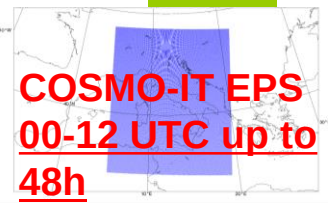
Deterministic Analysis

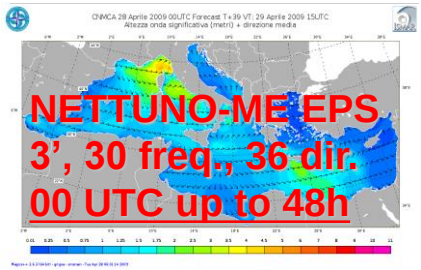
## Ensemble Prediction System:

7 km
45 v.l.
20 m.




2.2 km
65 v.l.
20 m.

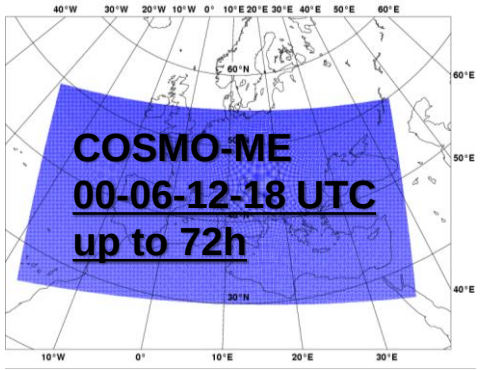


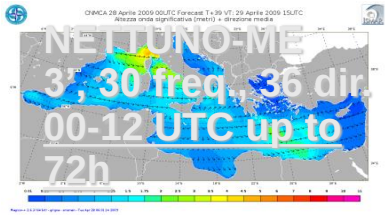




## Local Area Modeling:

5 km
45 v.l.

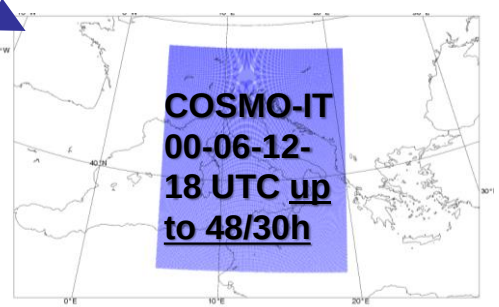
- parameterized convection

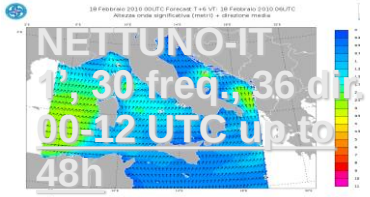



2.2 km
65 v.l.

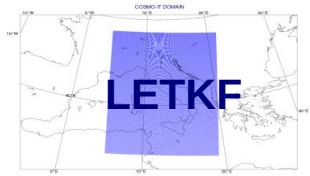
- explicit convection



# The ICON Model

**Ensemble Data Assimilation:**




**1h cycle**
**2.2 km**
**65 v.l.**
**40+1 m.**

Observations

RAOB (also descent), PILOT, SYNOP (also non-GTS), SHIP, BUOY, Wind Profilers/Radars, AMDAR-AIREP, Mode-S, Meteosat AMV, Metop scatt. winds, NOAA/Metop AMSUA/MHS and NPP/NOAA ATMS radiances

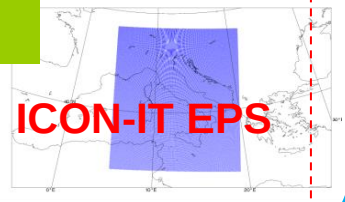
ECMWF Boundary Conditions (HRES, ENS)

Ensemble Analysis

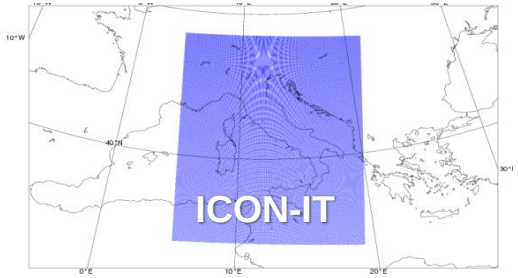
Deterministic Analysis

Suite on hold*
* with/without GPUs

**2.2 km**
**65 v.l.**
**20 m.**



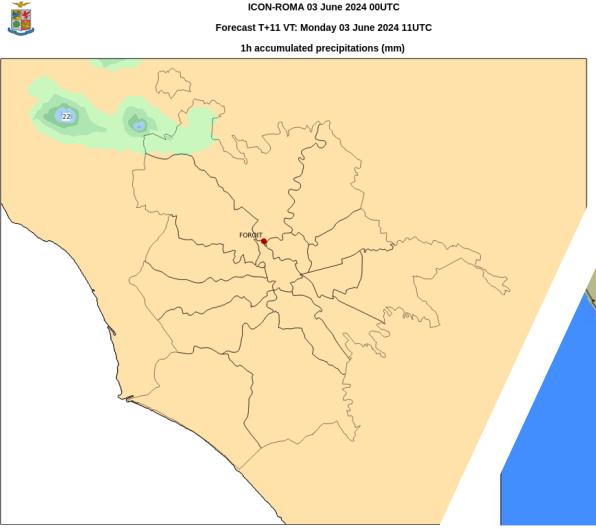

**Ensemble Prediction System:**

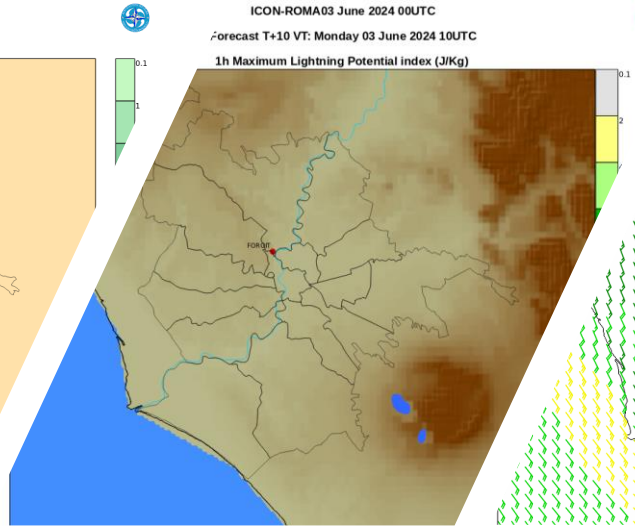


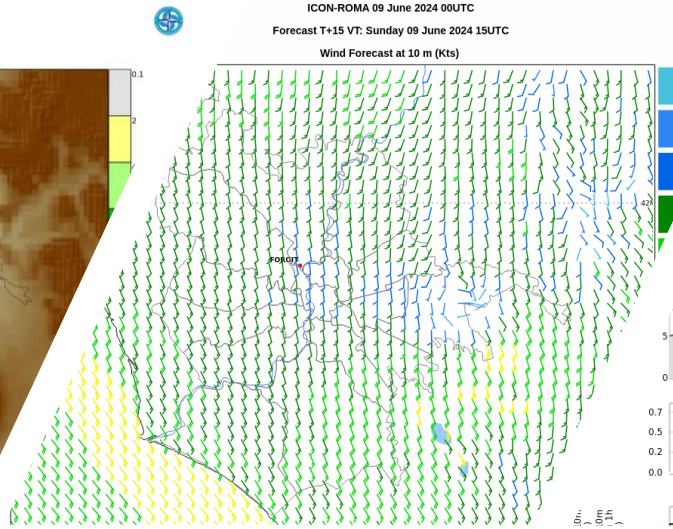

**2.2 km**
**65 v.l.**

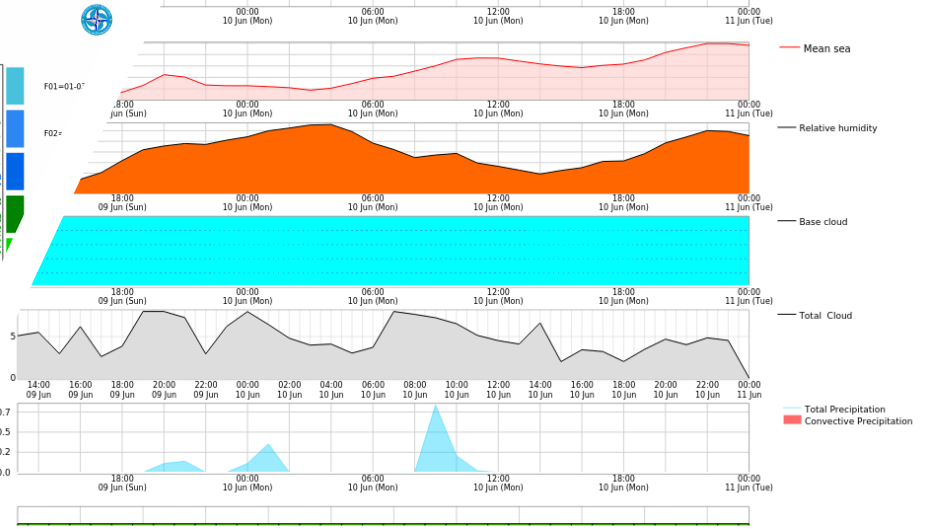
explicit convection

**Local Area Modeling:**



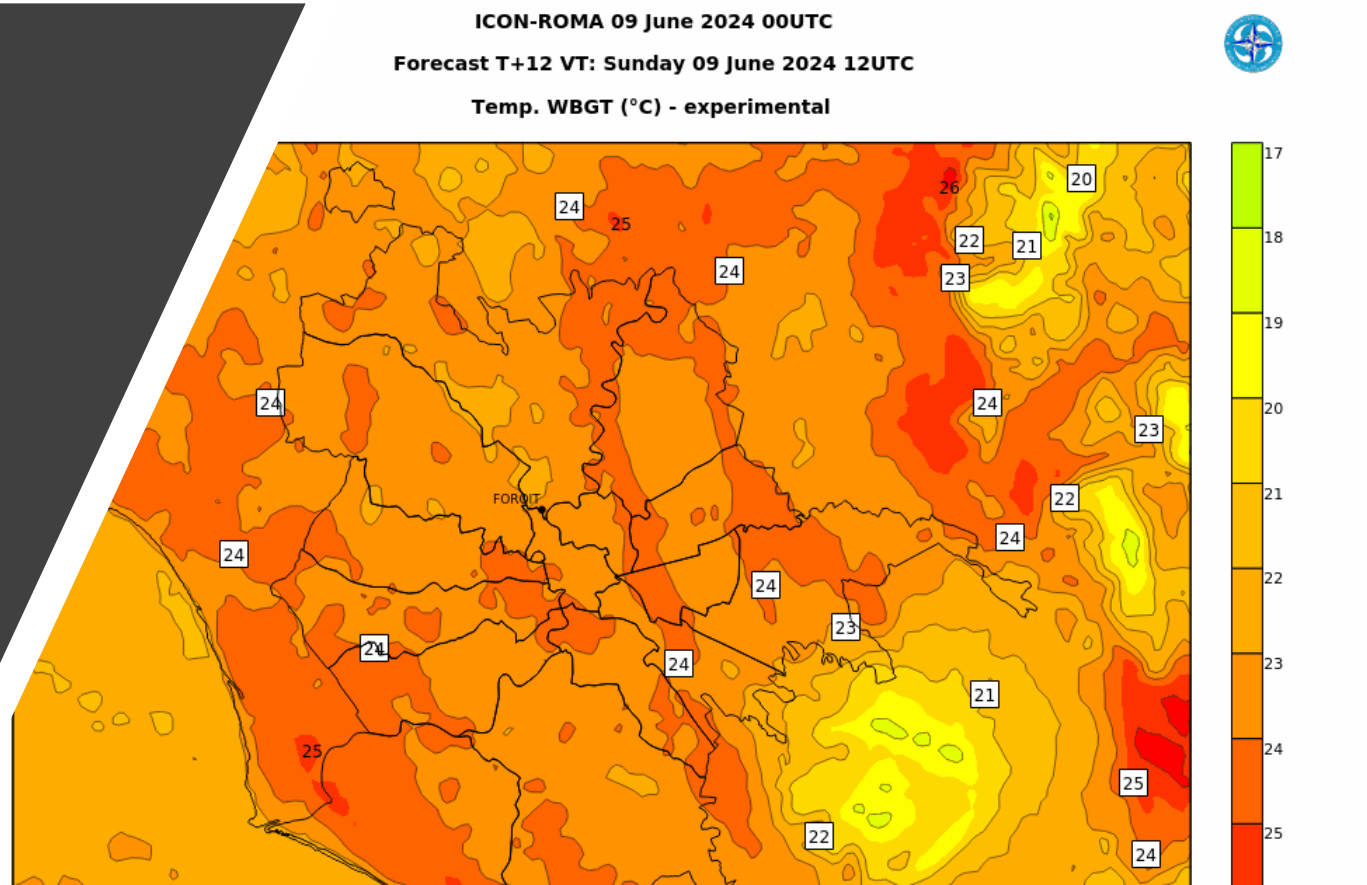




# *Running ICON model at sub-kilometric scales*

*EXPERIMENTAL*
*2way nesting @500m*
*00/12UTC run up to +36h*

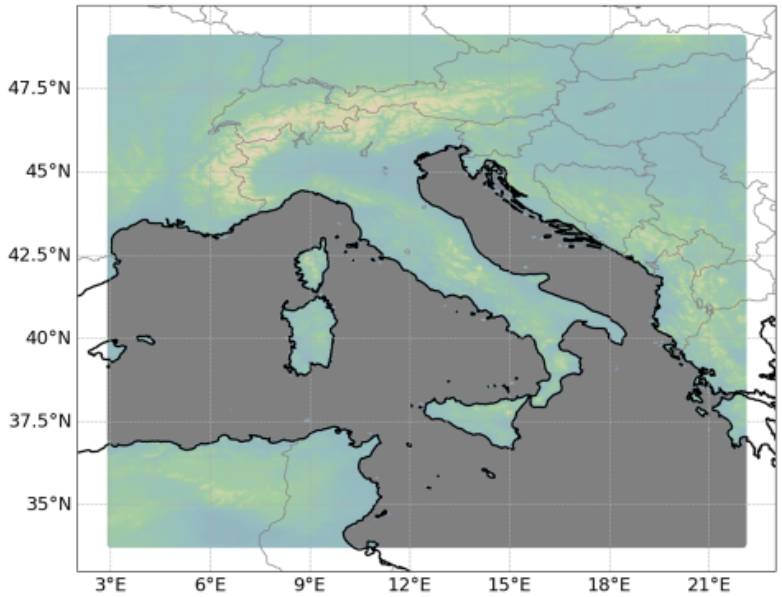



CONSORTIUM FOR SMALL SCALE MODELING
COSMO
ICON

# NWP for National Civil Protection System

ICON-2I model fully operational since 18/06/2024.

**Model domain:**




**Model version:** 2.6.5.1

**Horizontal resolution:** 2.2 km

**NWP system:**

| Model | Forecast type | Forecast range | Initial time (UTC) |
|---|---|---|---|
| ICON-2I | deterministic | +72h | 00, 12 |
| ICON-2I-RUC | deterministic | +24h | 03, 06, 09, 15, 18, 21 |
| ICON-2I-EPS | ensemble, 20 members | +51h | 21 |

Currently, the maintenance and development of the ICON-2I model is under responsibility of Arpae, with ItaliaMeteo collaborating on these tasks. From 2025, the roles will be reversed.

WG3b COSMO CONSORTIUM FOR SMALL SCALE MODELING

## WG3b Priority Project CITTA' : City Induced Temperature change Through A'dvanced modelling

ArpaP is currently involved in **Task 3. Numerical experiments**

*Subtask 3.2: Turin*

TERRA_URB in ICON-LAM was tested on the heat wave that Turin experienced in June 2022. Different experiments were performed in hindcast mode at 500 m resolution in order to better reproduce the UHI effect. The results have been compared to those provided by the COSMO model including TERRA_URB.

ArpaP is also involved in the project Urban Forestry

https://www.regione.piemonte.it/web/temi/ambiente-territorio/green-economy/urban-forestry

TERRA_URB in COSMO is used to simulate the Urban Heat Island effect in different cities of the Piedmont region and to identify the most vulnerable areas.

# Research activities within the CORDEX community

## CORDEX Flagship Pilot Studies

- **Convection Permitting Model (CPM):** investigating the CPM added value for heatwaves, Multi-tracker, Lightning, Snow cover, extreme precipitation. CMCC is the contact point of CLM-Community for this activity and it's providing climate data, produced with COSMO model, through the ESGF nodes.
- **Land use classes across the scales (LUCAS):** CMCC is performing the downscaling of GCM MPI-ESM-HR (CMIP6), historical and SSP 1-2.6 scenario to assess the effects of the time-varying land use classes on atmospheric variables.
- **Urban environments and Regional Climate Change (URB-RCC):** understand the effect of urban areas on the regional climate, as well as the impact of regional climate change over these complex areas. CMCC coordinates the protocol for CLM-Community to perform the experiment with urban schemes/parametrizations.

## EURO-CORDEX

- Development of CMIP6 converter tool to prepare the boundaries for COSMO and ICON. Several GCMs (CMCC-CM, MPI, EC-EARTH etc ..) are ready to be downscaled in the EURO-Cordex community.
- Testing of COSMO-clmv6.00 configuration in the COPAT2 Evaluation Working group
- Running the scenario experiment with COSMO-CLM, driven by GCM CMCC-CM2-SR5 (CMIP6), ssp1-2.6 and ssp3-7.0

## … other projects

**The GLORI Digital Twin** is a configurable on-demand global-to-regional short-range high resolution digital twin based on the prediction capability of ICON. In this framework, CMCC is examining the possibility of developing a coupled (atmosphere-ocean) model using ICON and the ocean model (NEMO or CMCC-OM), including an assimilation of the already available ocean data, to have a Mediterranean digital twin including the ocean component.

# Evaluation of high-resolution ICON-LAM over Sardinia for application in the lower stratosphere

Centro Italiano Ricerche Aerospaziali

***D. Cinquegrana (1), M. Montesarchio (1), A.L. Zollo (1), E. Bucchignani (1)***

*(1) CIRA , Italian Aerospace Research Center, Meteo System & Instrumentation Laboratory, Capua, Italy*

ICCARUS 2024

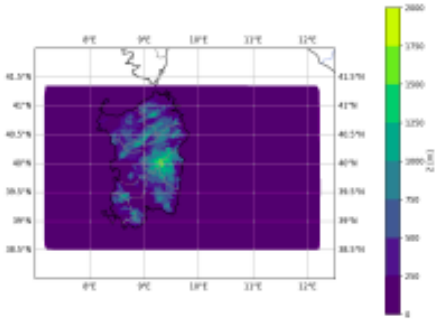
25th ICON/COSMO/CLM/ART User Seminar,
*4 - 6 March 2024*
*DWD Offenbach (Germany)*

## Introduction

In the last decades, there has been a renewed interest in the commercial usage of the stratosphere, since it is possible to use less expensive and high-resolution Earth monitoring services with respect to satellites, covering four times the areas of standard aircraft. Being the horizontal motion of stratospheric balloons associated with winds, it is evident the importance of accurate wind forecasts in this part of the atmosphere [1]. In order to support a future mission of the stratospheric platform developed at the Italian Aerospace Research Center (CIRA), scheduled in October 2024 at the Tortoli military airport (Sardinia, Italy), the CIRA meteorological Lab has developed a specific configuration for ICON over Sardinia with the aim of testing the capabilities of the model in reproducing the main atmospheric variables over the considered domain, especially at altitudes between 15 and 20 km.

## The computational domain and the test case considered

The climate in Sardinia is Mediterranean, with mild, short and fairly wet winters and hot, long and sunny summers, occasionally sultry but fed by breezes. Sardinia is one of the warmer regions in Italy, with an average daily temperature of 22 degrees. For 6 months, the average temperatures are over 25 degrees. The computational domain considered and its orography (Z[m]) is shown in the figure below.



**Set up:**

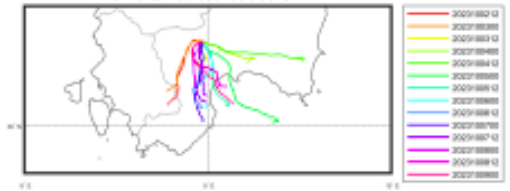
- Domain: 7.2-12.2E/ 38.5-41.3N
- Grid R2B11, ~1.1 km
- Forcing data: ECMWF IFS (0.075° resolution)
- Time step: 12 s

Daily simulations performed with ICON-LAM were analyzed, from 2nd October 2023 to 8th October 2023. For each day, three simulations were performed, respectively starting at 00 UTC (24 hours lead time), at 18 UTC of the previous day (30 hours lead time) and at 12 UTC of the previous day (36 hours lead time) in order to investigate the sensitivity of the model to the spin-up time.

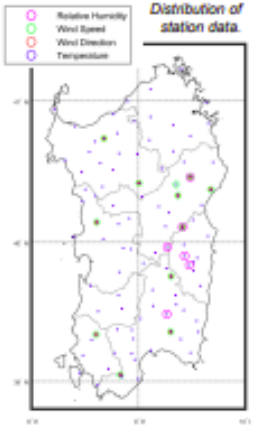
The boundary conditions were updated every 3 h.
The model configuration assumes that only the shallow convection parameterization is active. Moreover, a single moment cloud microphysics scheme and a diagnostic Kohler cloud cover scheme are employed. The 1D COSMO model for diffusion and transfer is chosen for this configuration.

Model evaluation has been performed by means of a comparison with a combination of ground observations downloaded from the Meteo Italian Supercomputing portal [2], where data provided by Italian Environmental Protection Agencies (ARPA) are collected. Moreover, a detailed evaluation of the wind profiles has been performed against radio sounding data in Decimomannu (CA) being the only stratospheric observational values available over the domain considered. Radiosonde data collected by ECMWF in the WMO BUFR format and archived at NOAA NCEI (National Centers for Environmental Information) have been used. This dataset, among parameters and metadata captured at each level, includes time, latitude and longitude displacement.

*Horizontal radiosonde tracks.*



*Distribution of station data.*



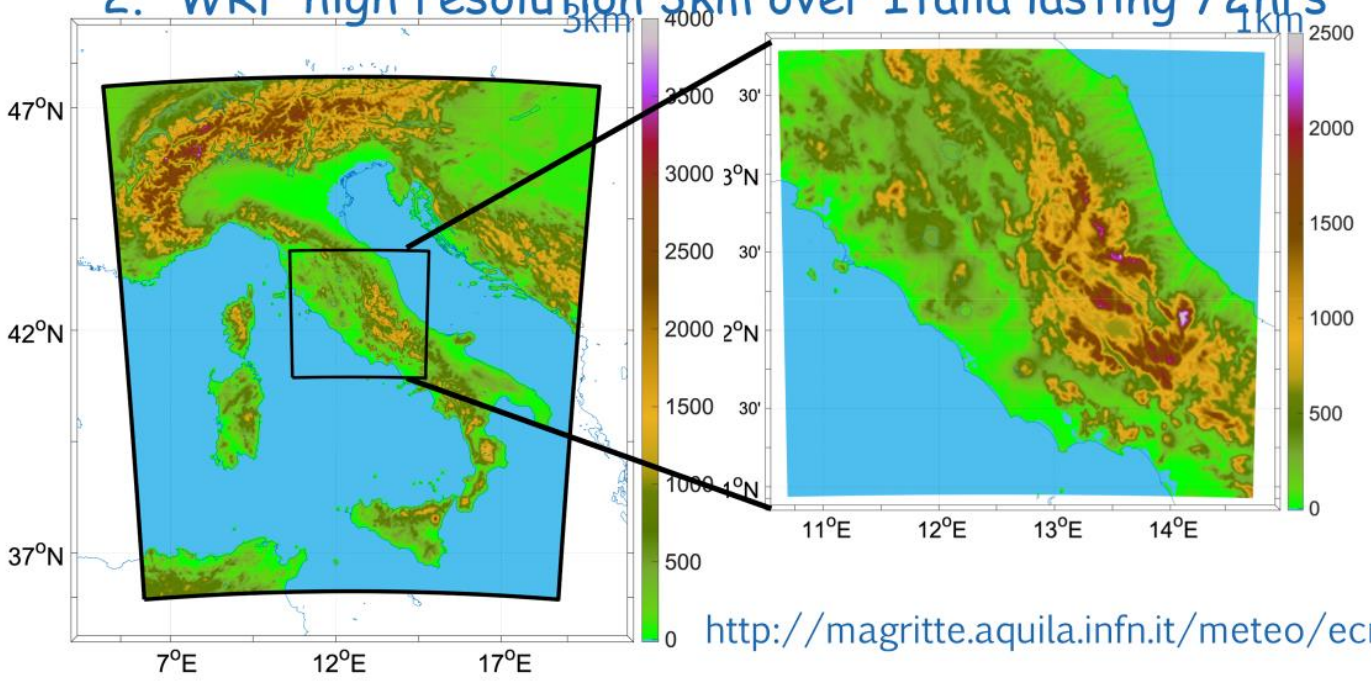

For each day, data at 00 and 12 UTC were considered, according with sounding data availability. Considering the typical drift distance of the radiosonde observation in the stratosphere (i.e. 50 km), and the high grid resolution (1 km), during the comparison with observed data, the drift in space and time has been taken in account.

The main CIMA tasks are:

- WG6 coordination (MM) which includes:
  - ❑ PP C2I4LC (lead by NMA under the umbrella of WG6) devoted to the ICON user support
  - ❑ Transition to ICON-LEPS in stand-by (waiting for Ines Cerenzia to come back from maternity leave)
  - ❑ NWP Test Suite work on going
  - ❑ Technical Reports editorial work
  - ❑ Also, in the framework of WG6, PP IMPACT (transition of ICON to GPU) is proceeding, an online meeting is scheduled on 5th September
- Participation in PT EPOCS about crowdsourced data (lead by IMGW in the framework of WG5). The work concerns the use of a free library (TITANLIB) for data quality control of precipitation (EO) and the possible use of Personal Weather Stations (MM)
- Still working on PP CITTA', testing ICON with TERRA_URB parametrization (case studies only). Results will be shown during the WG3b parallel session on Tuesday 12 September (MM)

# Meteorological Modelling: Ferretti, Ricchi, Falcione and others during the years

- Operation Forecast: DETERMINISTIC
  1. **WRF high resolution 3km over Italy and 1km over center of Italy**
  2. WRF high resolution 3km over Italia lasting 72hrs




Monte midia Radar data assimilation operational production of the BE every 15 days

http://magritte.aquila.infn.it/meteo/ecmwrf-2way/

# The way ahead

- Setting the scene for new challenges HERE and NOW
- Strengthening the national partnership

  +synergies +communication
  -duplications -autarchy
- Facilitating the evolution of COSMO
  - ✓new structure and management of WGs
  - ✓COSMO-ICON special partnership
  - ✓open-science and open-mind