RECCO

REgional Climate in Complex Orography

Development of ensembles of regional climate change scenarios, with focus on variability, extremes and uncertainties in areas of complex topography

NextData
un sistema nazionale per la raccolta, conservazione, accessibilità e diffusione dei dati ambientali e climatici in aree montane e marine

Unit 1 :
Institute of Atmospheric Sciences and Climate (ISAC),
(CNR coordinating Institute)

Silvia Trini Castelli and Antonio Parodi

Unit 2:
Abdus Salam International Centre for Theoretical Physics (ICTP)

Filippo Giorgi

Unit 3:
Cineca

Giovanni Erbacci and Piero Lanucara

Unit 4:
Institute of Methodologies for Environmental Analysis (IMAA)

Fabio Madonna

The AIM

improving the physical understanding of the changes in climatological regimes over the NextData regions of interest, with the support of their meteorological characterization.

The RATIONALE

The variability and uncertainties of climate and meteorology of the interest areas (Hindu-Kush Karakorum, Alps and Mediterranean region) will be studied with a suite of regional climate models (RCMs) integrated with mesoscale meteorological models.

Each modelling system will be used at different spatial scales, from regional to local, yielding a unique multi-scale modelling framework.

The MODELS

The ICTP RegCM: will produce ensembles of regional scenarios using different model configurations, resolutions, driving GCMs and greenhouse gas scenarios, which will allow a characterization of different sources of uncertainty.

The WRF model: will allow dynamical downscaling at the mesoscale of scenarios provided by the EC-EARTH global model. These will be compared with and integrate the ICTP RegCM ensemble.

The RAMS model: will be used to perform high-resolution (cloud-resolving) simulations for specific complex topography areas to investigate relevant physical and dynamical processes.

The results will be evaluated using available observations and released to the NextData databank.

More details for ICTP RegCM

An uncertainty analysis of climate scenarios will be attained through the completion of an ensemble of simulations with the ICTP RegCM.

Emphasis will be on changes in climate variability, hydroclimatic regimes and extremes, and on the characterization of primary sources of uncertainty in the scenarios. This is an essential aspect for the application of the results to impact assessment studies.

More details for WRF model

A more in-depth analysis of changes in variability and extreme events, such as flood, drought, and heat waves, will be attained through the completion with the WRF model of mesoscale dynamical downscaling of emission scenarios produced with the EC-Earth global model.

The focus will be on events that are the most important in determining impacts on a wide variety of sectors in environmental and health protection.

More details for RAMS model

An identification and thorough analysis of critical issues related to the simulation of physical processes in very complex orography settings will be attained through high-resolution simulations with the RAMS model over the mountainous areas of the Hindu-Kush Karakorum and Italian Alps and Apennines.

This goal will be achieved on the basis of a sensitivity analysis of the model performance versus observed data.

Benchmark scenarios to provide reference case studies will be delivered.

The WPs

WP1 RegCM modelling activities

WP2 WRF modelling activities

WP3 RAMS modelling activities

WP4 Evaluation and joint analysis of simulation results

Over common study regions and time-slices an intercomparison will be carried out between the RegCM and WRF dynamical downscaling results for a range of variables and statistics. The WRF results will be compared with the RAMS simulations in the common subareas through graphical and statistical analyses. All simulations will be compared to observed data where available. Results obtained for the Apennines will also be compared with remote sensing observations. The purpose of the intercomparison will be to identify the added value of increased resolution, particularly in terms of representation of dynamical processes in complex topography regions, and to explore methods to account for such processes in climate projections (e.g. regression techniques).

Main result and deliverable

The project will result in an unprecedented set of regional climate model simulations for the Alpine and Mediterranean regions, Hindu-Kush Karakorum, and possibly other areas of interest, obtained using a chain of modelling systems operating at different scales.

The end deliverable of the project is the inclusion of the output from these scenarios and meteorological simulations into the NextData data repository, following the NextData data format, and therefore making them available to the scientific community.

Who is doing what

Unit 1:
ISAC-CNR performs WRF and RAMS meso- to local-scale simulations.

Unit 2:
ICTP carries out and analyses ensembles of regional simulations using the model RegCM in its latest version RegCM4 over all interest areas.

Unit 3:
CINECA provides access to its supercomputing facilities (FERMI among the others, equipped with 163840 cores) to Units 1 and 2 of the project.

Unit 4:
IMAA-CNR provides in-situ data and ground based and satellite remote sensing observations, to cross-check the outcome of the modelling activities.

Who is doing what – up to 12 11 2013

Unit 1: ISAC-CNR

- Review of literature on high-resolution simulations in highly complex terrain

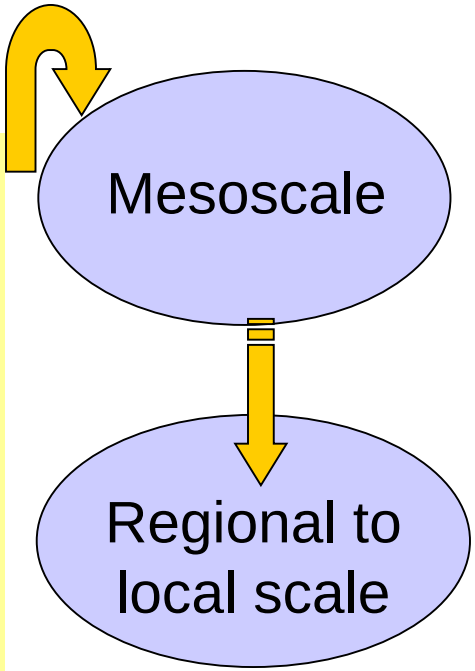
- Collection and analysis of past RAMS simulations in the Italian Alps for guiding lines: the Frejus and Brenner areas

- Identification of input datasets apt at high-resolution simulations:

http://eros.usgs.gov/elevation-products; http://eros.usgs.gov/land-cover
http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php
http://due.esrin.esa.int/globcover/

Unit 1: ISAC-CNR

Simulation of the meteo fields using the prognostic code RAMS up to 1 km resolution, 4 nested domains



grid 1: 1088 lon x 1088 lat km^2 — 64 km horizontal resolution
grid 2: 562 lon x 464 lat km^2 — 16 km horizontal resolution
grid 3: 197 lon x 132 lat km^2 — 4 km horizontal resolution
grid 4: 101 lon x 81 lat km^2 — 1 km horizontal resolution

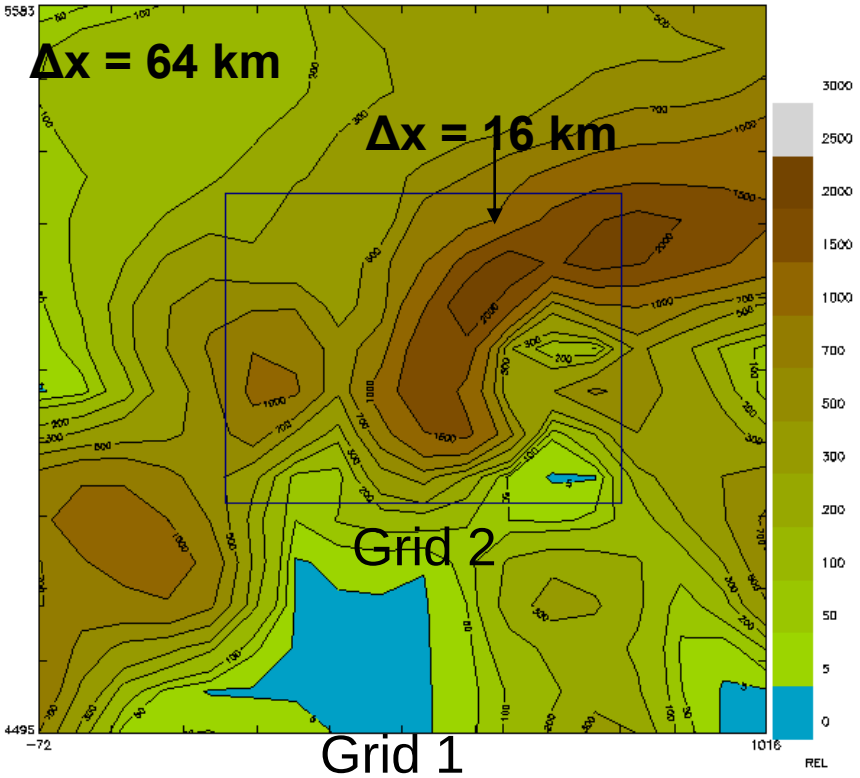
Vertical grid: 27 vertical stretched layers (0 –17500 m),
first layer 50 m depth (first level at 24 m)

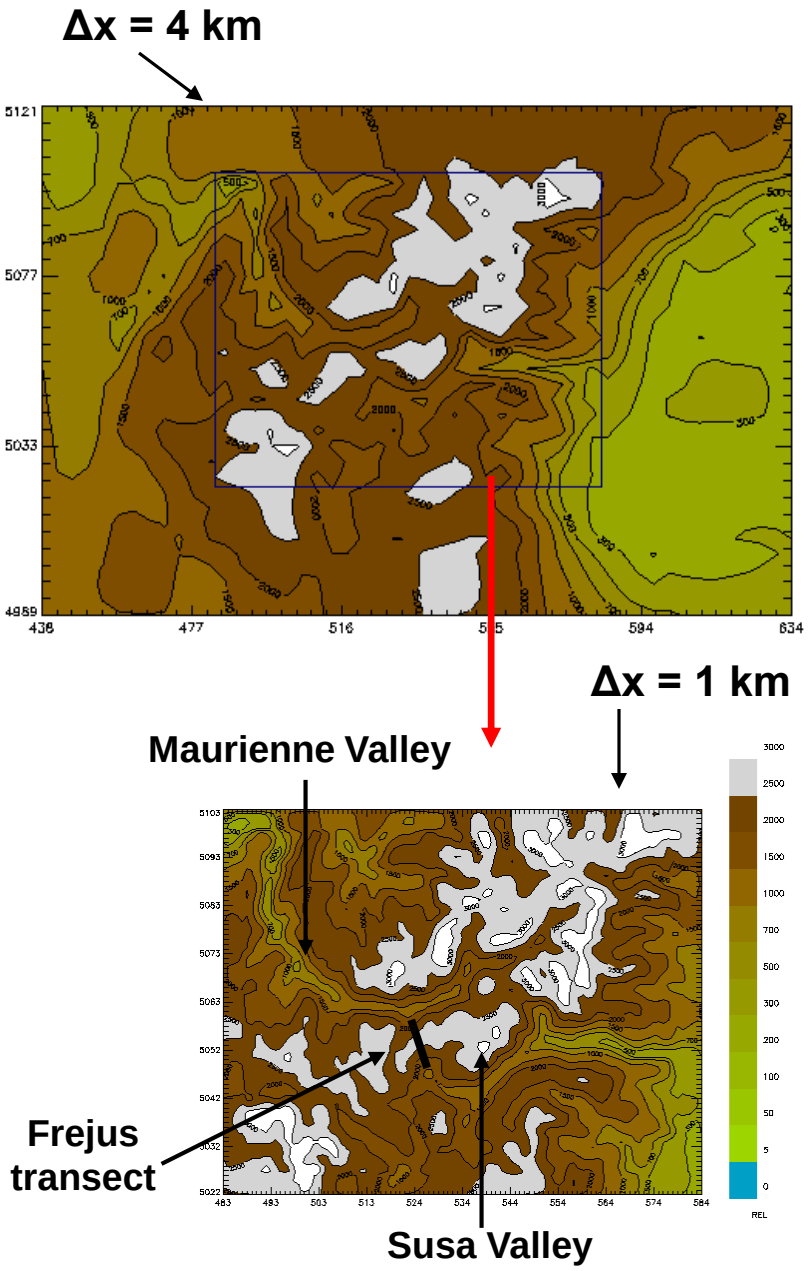
RAMS is initialised with the ECMWF (0.5^o lat/lon) analysis fields.

Nudging at the lateral boundaries of the outer grid every 6 hours.

Who is doing what – up to 12 11 2013

Unit 1: ISAC-CNR



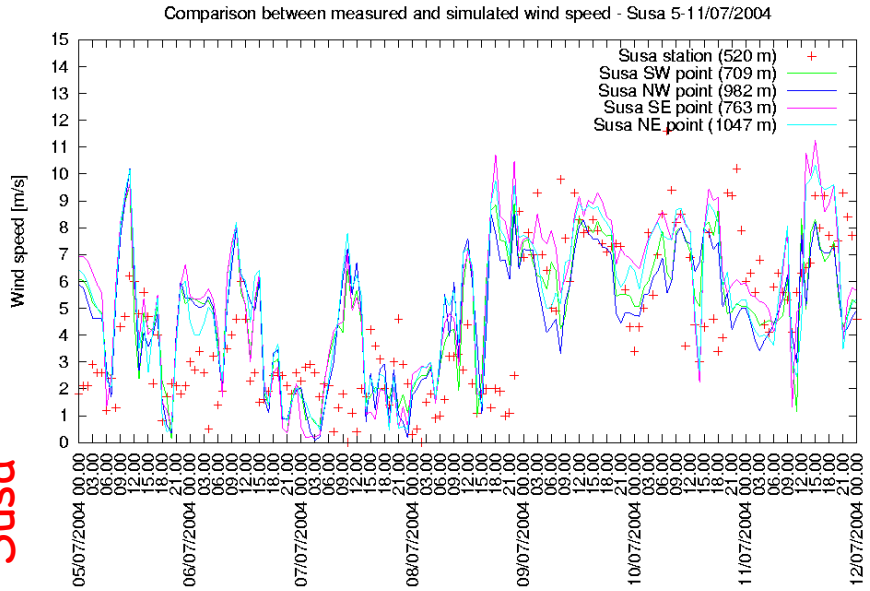


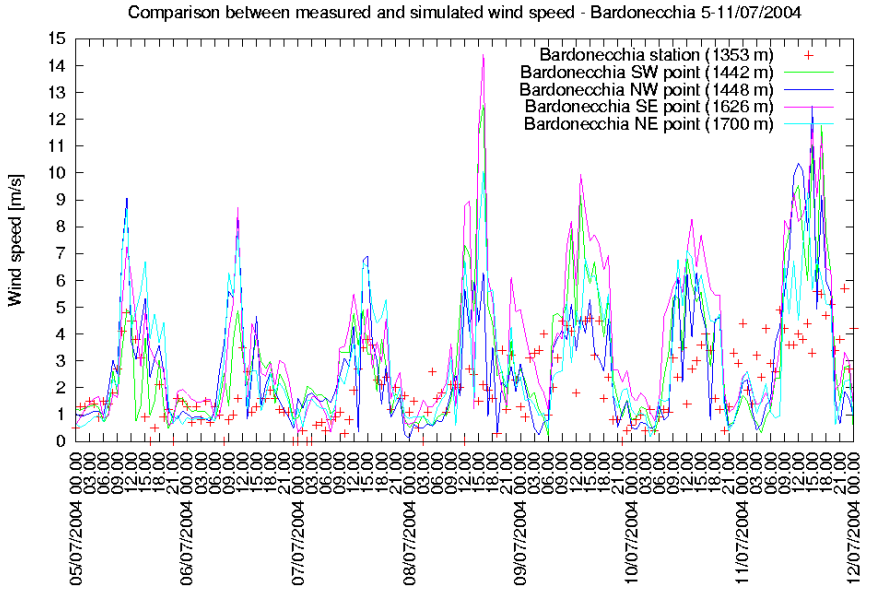
Example: Frejus Transect

Who is doing what – up to 12 11 2013

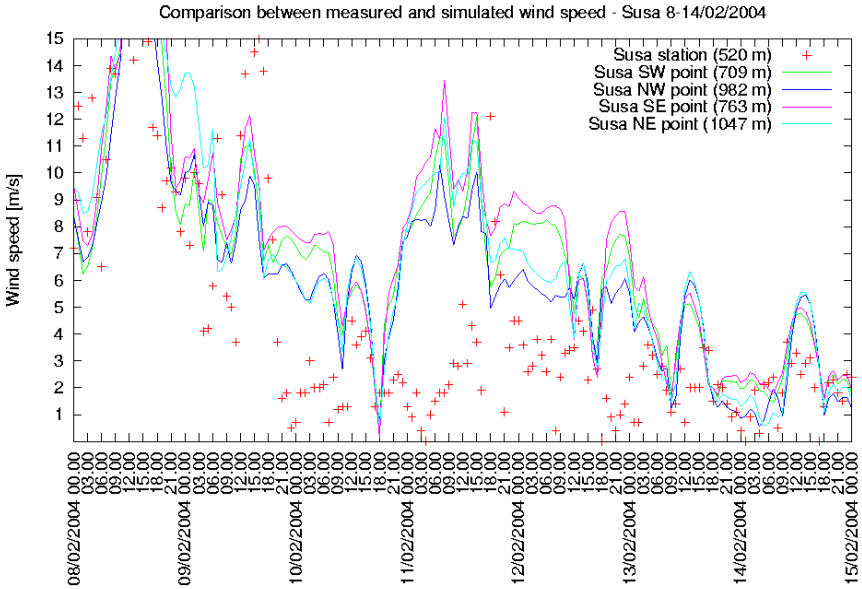
Unit 1: ISAC-CNR

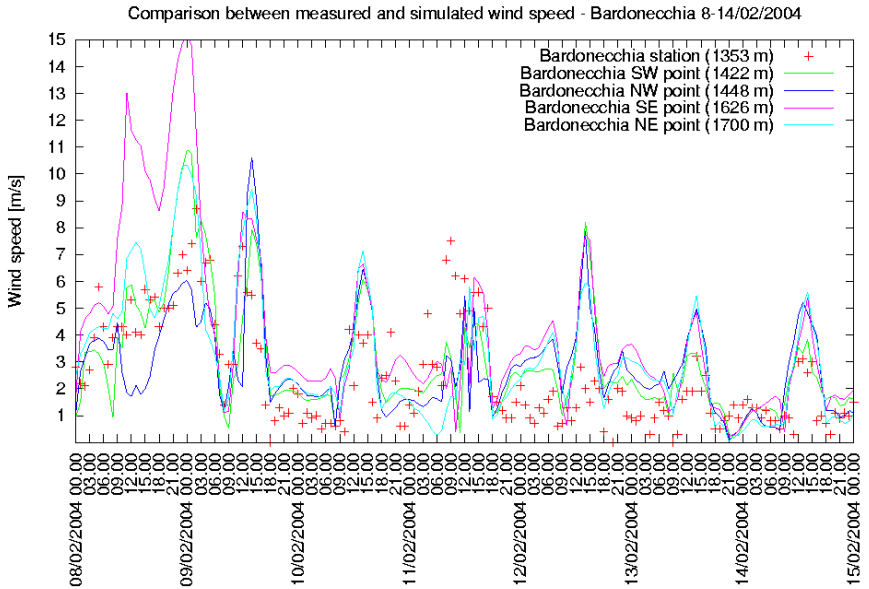
Susa





Bardonecchia





Who is doing what – up to 12 11 2013

Unit 1: ISAC-CNR

Sensitivity of the simulations to a proper modelling of the surface temperature in highly complex terrain, especially in Winter time.

The initial profile of temperature and humidity in the soil represent the triggering-start of the soil model, part of the 'engine' of the surface layer and boundary layer physical processes.

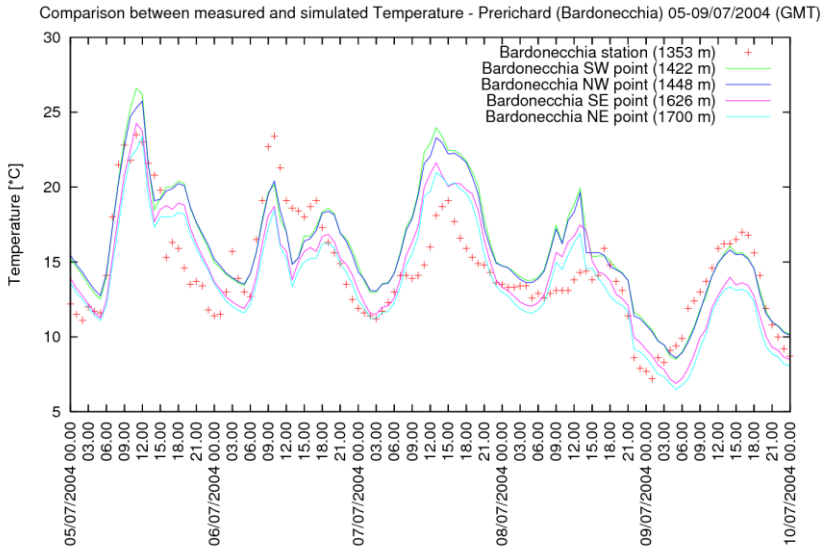
Lack of observed data and information about the soil thermodynamical variables is one of the limits which can affect the performances of the numerical models: more 'dramatic' for Winter periods, not yet optimal information on snow coverage

1st try: initial soil profiles of temperature and humidity the values extracted by the ECMWF analyses,

2nd try: using a constant profile of humidity with lower values than the ECMWF ones (ex. RH = 25 %)

Who is doing what – up to 12 11 2013

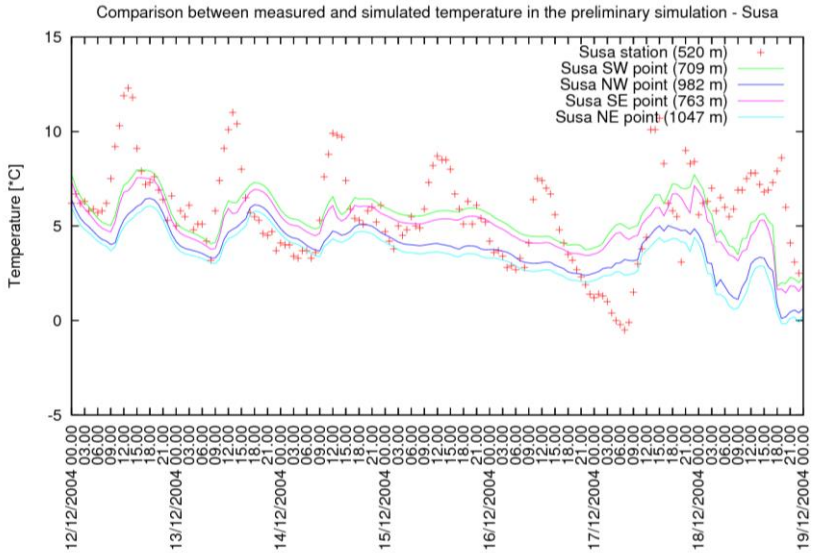
Unit 1: ISAC-CNR

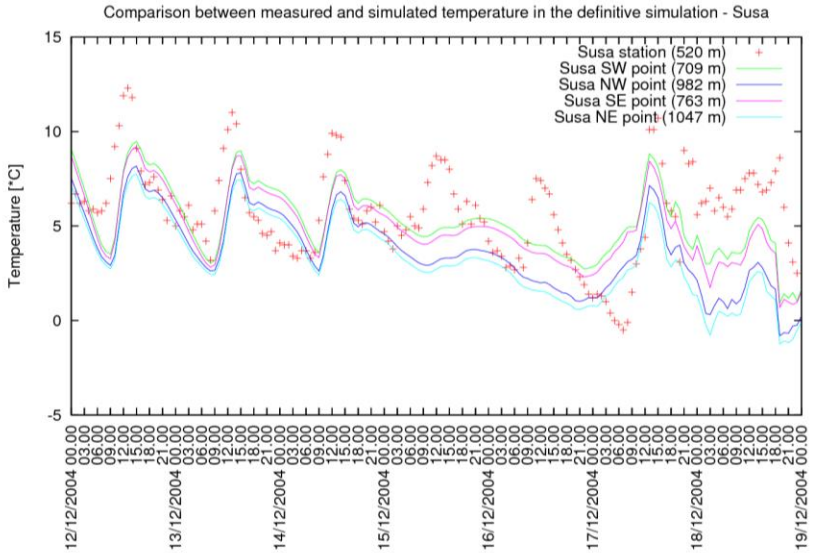


July

December 1st try

December 2nd try

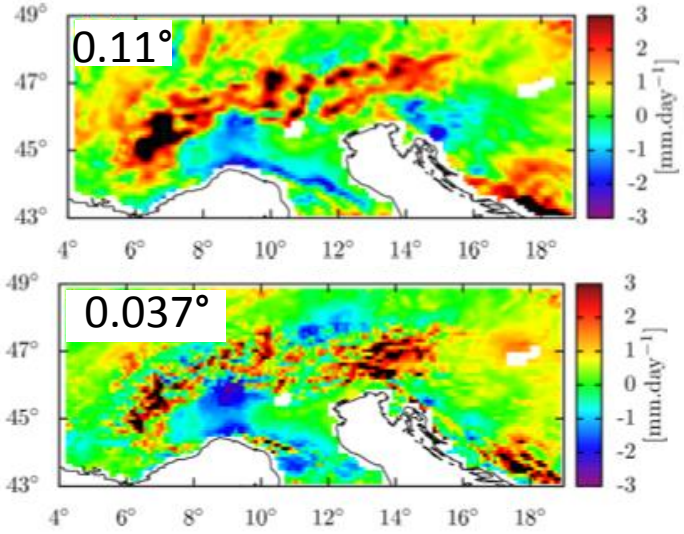




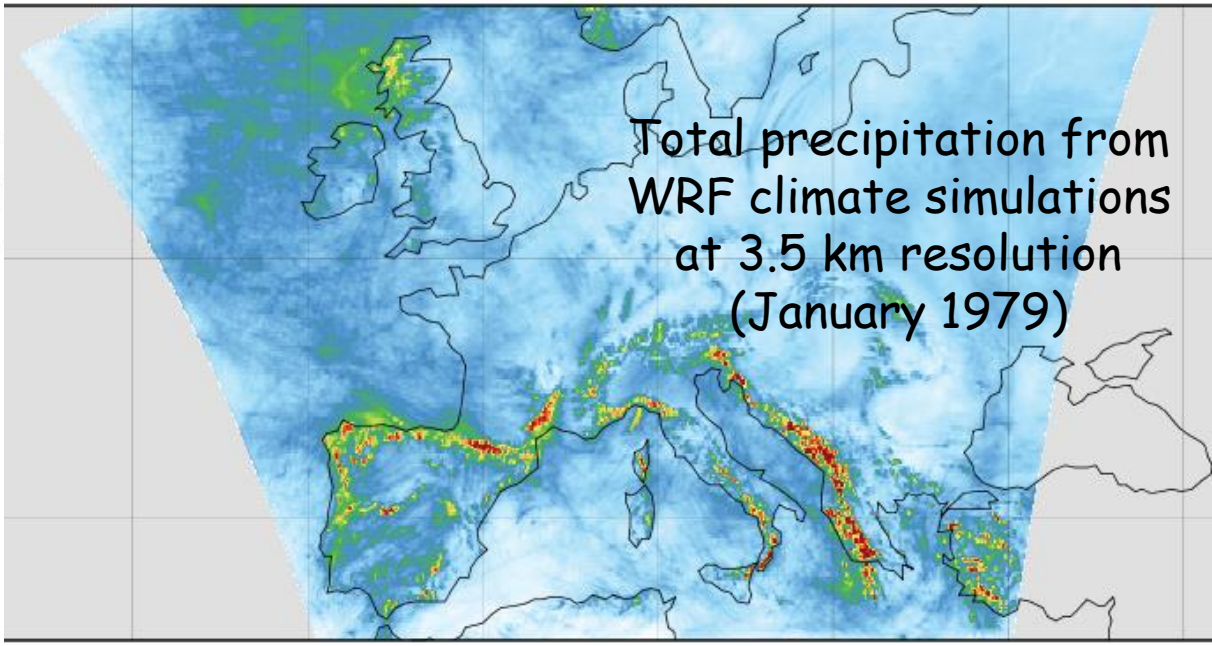
High-resolution (3.5 km) dynamical downscaling of global scenarios over Europe

- 30-yr present (1979-2008). Large scale drivers EC-Earth and ERA-Interim (30 years with ERA-Interim done)
- 30-yr projection (2021-2050 RCP 4.5) large scale driver EC-Earth, to be completed by May 2014.

WRF-HISTALP



Precipitation January 1979



Simulations @ LRZ/SuperMUC, Munich, computing project EXPRESS-Hydro

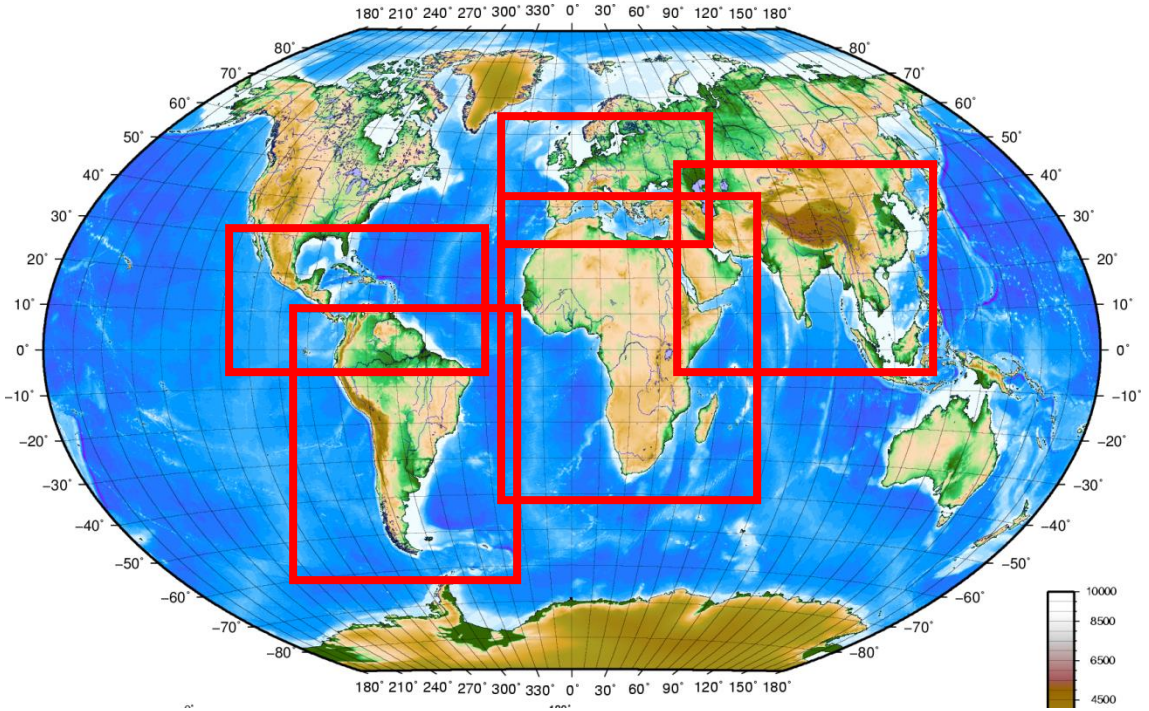
Who is doing what – up to 12 11 2013

Unit 2: ICTP

- ✓CORDEX RegCM4 hyper-Matrix (CREMA) experiment
  - Basic experiments (50 km, CORDEX domains) being analysed
  - Higher resolution experiments (25 km, 12 km) being tested over the South Asia and Africa domains

- ✓High resolution (12 km) scenario simulation (1970-2100)
  - Completed until 2085 and continuing

The CREMA Phase I Experiment



Contribution to the Coordinated Regional Downscaling Experiment (CORDEX) by the RegCM community

Collaboration with
U. San Paolo (Brazil)
CICESE (Mexico)
Indian Institute of technology
DHMZ (Croatia)

Special Issue of
Climatic Change

34 Scenario simulations (1970-2100) over 5 CORDEX domains with RegCM4 driven by three GCMs, 2 GHG scenarios (RCP4.5/8.5) and different physics schemes

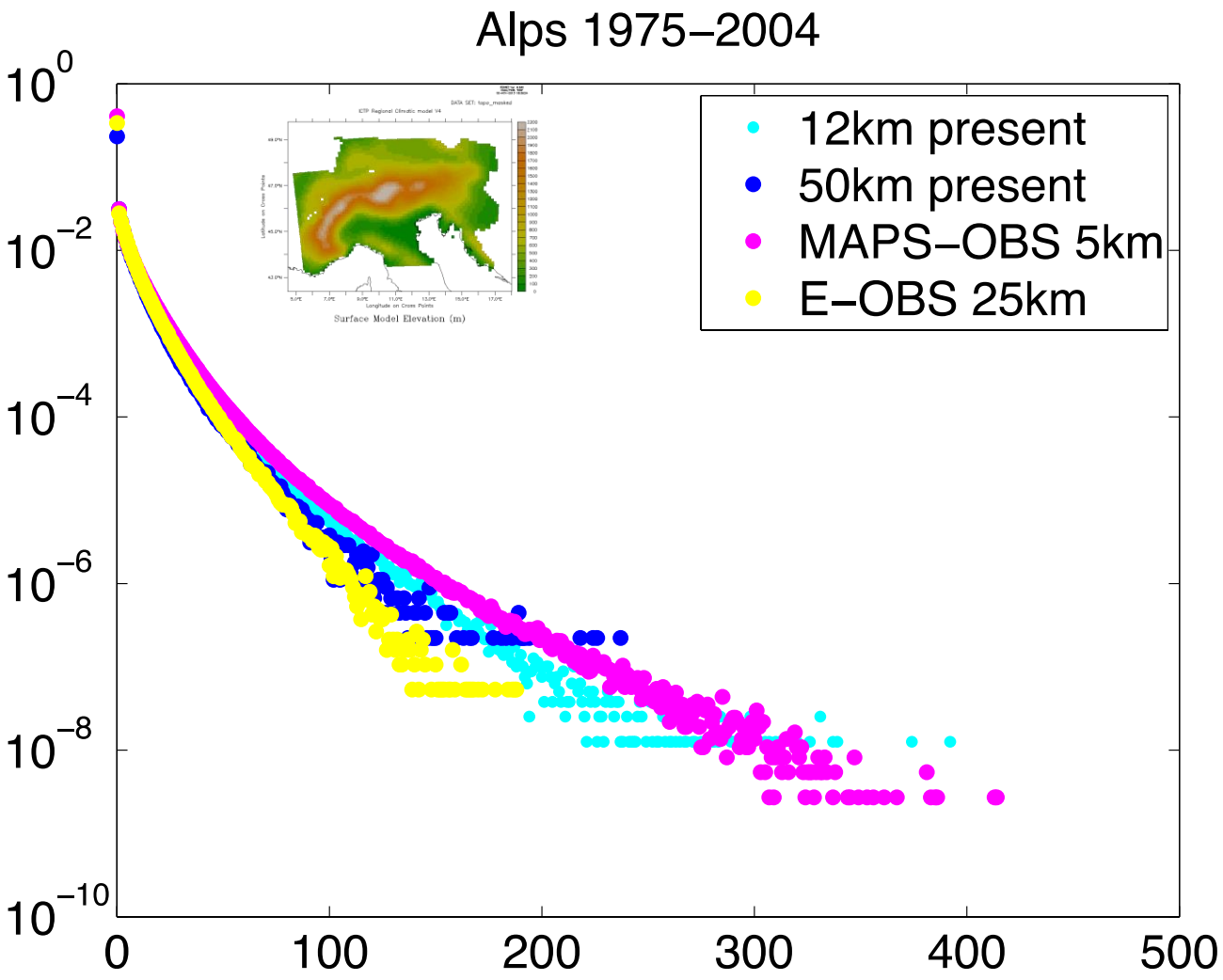
3 months dedicated time on ~500 CPUs at the ARCTUR HPC
~200 Tbytes of data produced

The CREMA Phase I Matrix

	Africa	C America	India	Med	S. America
HAD-CLM-GE	2			1	
HAD-CLM-E		2			2
HAD-BATS-G		2		3	
HAD-BATS-GE				3	2
MPI-CLM-E		1	1		1
MPI-BATS-G	1	1		3	
MPI-BATS-GE				3	
MPI-CLM-GE				1	
GFDL-CLM-E			2		1
GFDL-CLM-EG			2		

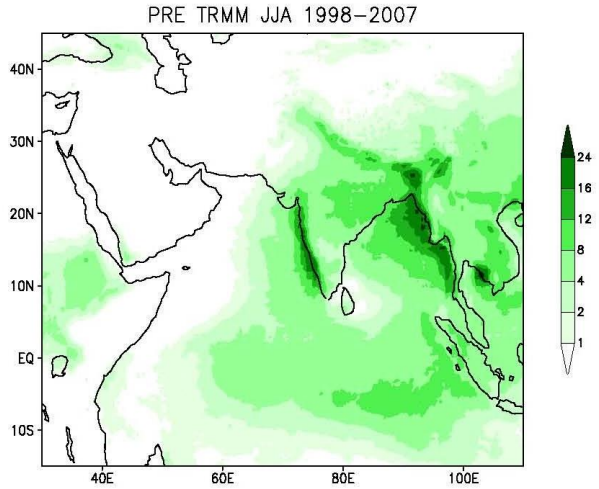
Table 1 The CREMA simulation ensemble divided by land-surface (CLM or BATS) and convection scheme (G=Grell, E=Emanuel, GE=Grell over land-Emanuel over ocean, EG=Emanuel over land Grell over ocean). 1 indicates only the RCP 8.5 scenario was completed, 2 indicates that both the RCP 8.5 and 4.5 scenarios were completed.

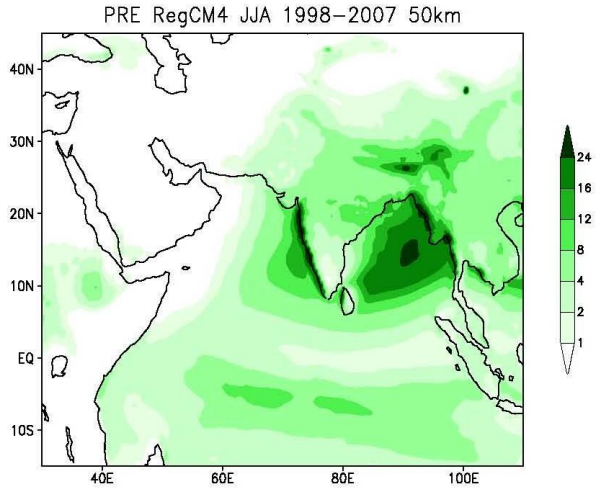
Simulated and observed daily precipitation PDFs at different resolutions (RegCM driven by HadGEM)



Tests of RegCM4 at different resolutions over the South Asia domain 1998-2007, ERA-Interim Boundary Conditions

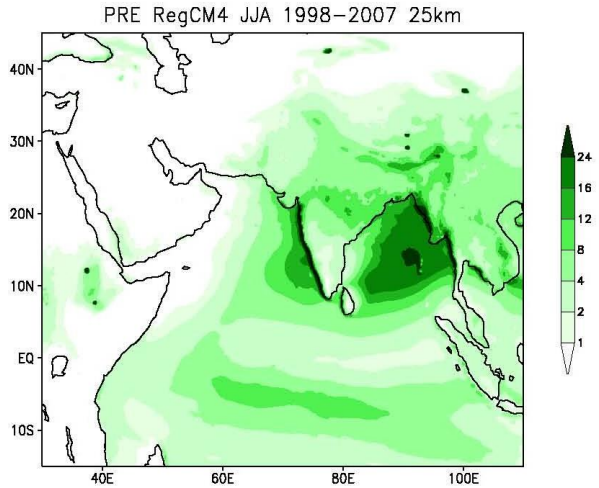
TRMM (25 km)

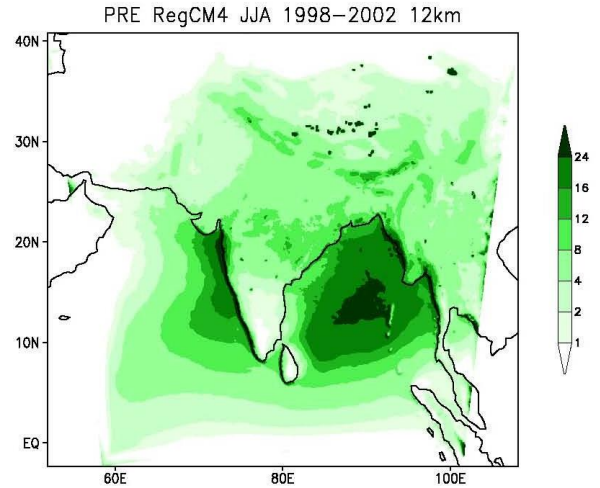




RegCM4 (50 km)

RegCM4 (25 km)





RegCM4 (12 km)

Who is doing what – up to 12 11 2013

Unit 3:

CINECA provides access to its supercomputing facilities to Units 1 and 2 of the project. GRANT SUBMISSION "B" – grand challenges: December 2013; "C" – ordinary runs: every month

Who is doing what – up to 12 11 2013

Unit 4: IMAA – CNR

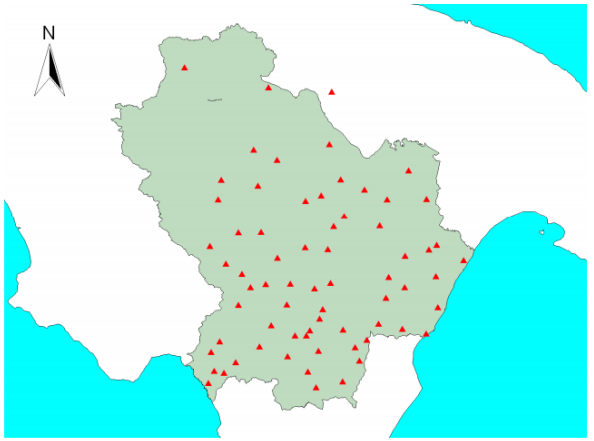
ground based observations and modelling evaluation

- Ground based observations of Essential Climate Variables for the study of aerosol, clouds, precipitation and radiation (available since 2004).

- Output of main European mesoscale weather models retrieved over the CNR-IMAA Atmospheric Observatory (CIAO), in cooperation with Cloudnet (www.cloud-net.org).

- Routine in-situ radiosounding with the retrieval of the uncertainty budget using the data processing of GRUAN (GCOS Upper-Air Reference Network).

- Rain gauge data provided by CIAO station and by the whole network available in Basilicata region (waiting for the data from the regional agency ALSIA) for the validation model output over the Appennino region).

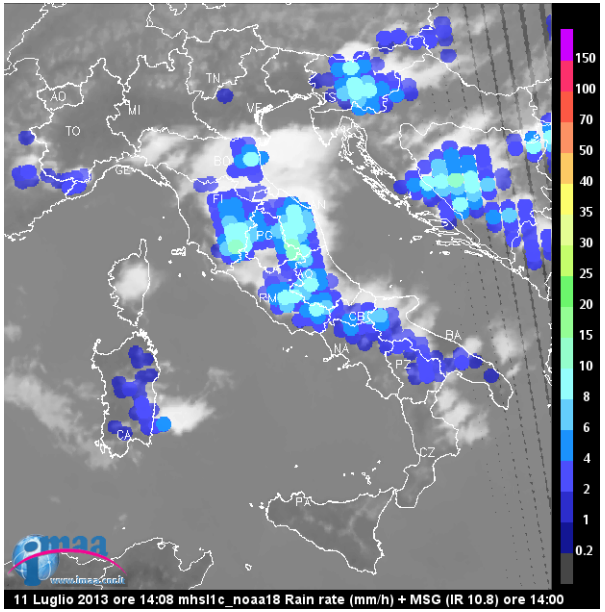


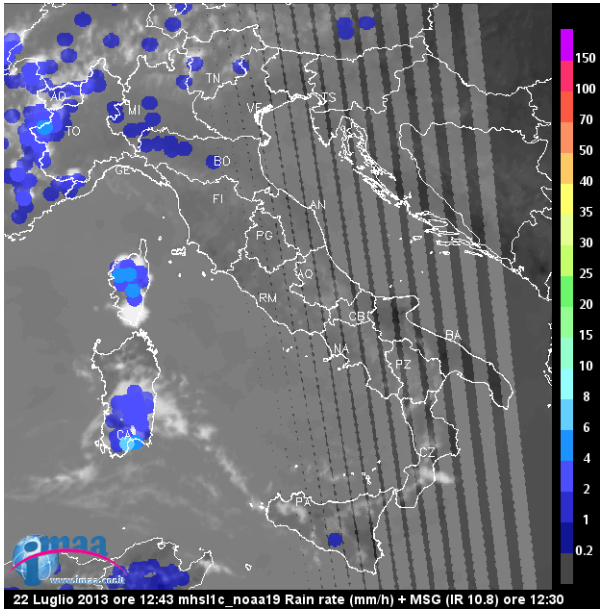
Rete pluviometrica operativa in Basilicata

Madonna, F., Amodeo, A., Boselli, A., Cornacchia, C., Cuomo, V., D'Amico, G., Giunta, A., Mona, L., and Pappalardo, G.: CIAO: the CNR-IMAA advanced observatory for atmospheric research, Atmos. Meas. Tech., 4, 1191-1208, doi:10.5194/amt-4-1191-2011, 2011.

Unit 4: IMAA-CNR

Rain Rate estimation from satellite observations





Rain rate estimation have been retrieved for all AMSU passages over Italy since 2009 and available for the project activities.

Di Tomaso, E., Romano, F., and Cuomo, V.: Rainfall estimation from satellite passive microwave observations in the range 89 GHz to 190 GHz, J. Geophys. Res., 114, D18203Di Tomaso, E., Romano, F., and Cuomo, V.: Rainfall estimation from satellite passive microwave observations in the range 89 GHz to 190 GHz, J. Geophys. Res., 114, D18203

D. Cimini, F. Romano, E. Ricciardelli, F. Di Paola, M. Viggiano, F. S. Marzano, V. Colaiuda, E. Picciotti, G. Vulpiani, and V. Cuomo, "Validation of satellite OPEMW precipitation product with ground-based weather radar and rain gauge networks of satellite OPEMW precipitation product with ground-based weather radar and rain gauge networks", Atmospheric Measurement Techniques

Work in process