NextData model data and simulations:

an outlook on the possible future climate for the Italian Peninsula and the Mediterranean basin

Silvio Gualdi

and the NextData WP2.5 team

CLIMATE ACTION IN SUPPORT OF THE PARIS AGREEMENT
BOLOGNA, 26-27 OCTOBER 2017

NextData Side Event at SISC,
Friday 27 October, 13:30 – 15:30, Bologna

Società Italiana per le Scienze del Clima
SISC
Program at a glance

"NextData model data and simulations"

WP2.5

Digital archive of numerical climate simulations and predictions → **Future climate change projection in mountain regions**

CMCC, ENEA, ISAC-CNR

- Building of an archive containing output data from global, regional and local climate simulations either already existing or conducted during the project.

- Produce climate change projections at high and very–high spatial resolution with different downscaling techniques (dynamical, statistical, stochastic).

- Make available and accessible the climate data through a (homogeneous) system of archives and thematic data portal lined to the Project General Portal.

WP2.5 sub-project

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 orography

Unit1 (ISAC-CNR, coordinator): **Silvia Trini Castelli** and Antonio Parodi
Unit2 (ICTP): Laura Mariotti, Filippo Giorgi
Unit3 (Cineca): Giovanni Erbacci
Unit4 (IMAA-CNR) Fabio Madonna

Aim: **improving the physical understanding of the changes in climatological regimes in the Alpine regions**, with the support of their meteorological characterization.

Scope: investigate the variability and uncertainties of climate and meteorology in the areas of interest (Alpine regions) with **a suite of regional models integrated with mesoscale meteorological models**. Each modelling system will be used at different spatial scales, from regional to local, yielding a unique multi-scale framework .

"NextData model data and simulations"

So far:

- **Survey** of the available global and regional numerical simulations to be included in the NextData archive.

- Definition of **common protocols of data archiving and access**.

- Definition and preparation of **coordinated numerical experiments** to be conducted within NextData aimed at addressing specific **Scientific Questions**

- **Production of coordinated global and regional numerical simulations**.

- implementation of **non-hydrostatic, limited area numerical models** aimed at reproducing the **climatic and environmental dynamics** in mountain regions with **complex orography**.

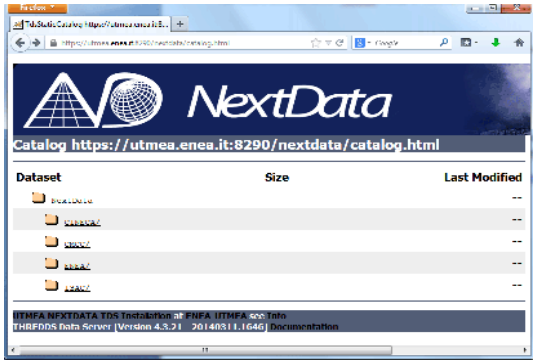
- Production of climate change scenarios at very–high resolution over areas of interest, through **statistical and stochastic downscaling**.

- Building of a **numerical data archive**, including both global and regional simulations, with a **focus on the Mediterranean and Alpine regions.**

- Preliminary version of **numerical model output data archives and access portals**. The data archives include outputs from global and regional models with resolutions from about 120 to about 4 km and for different emission scenarios (RCP4.5, RCP8.5).

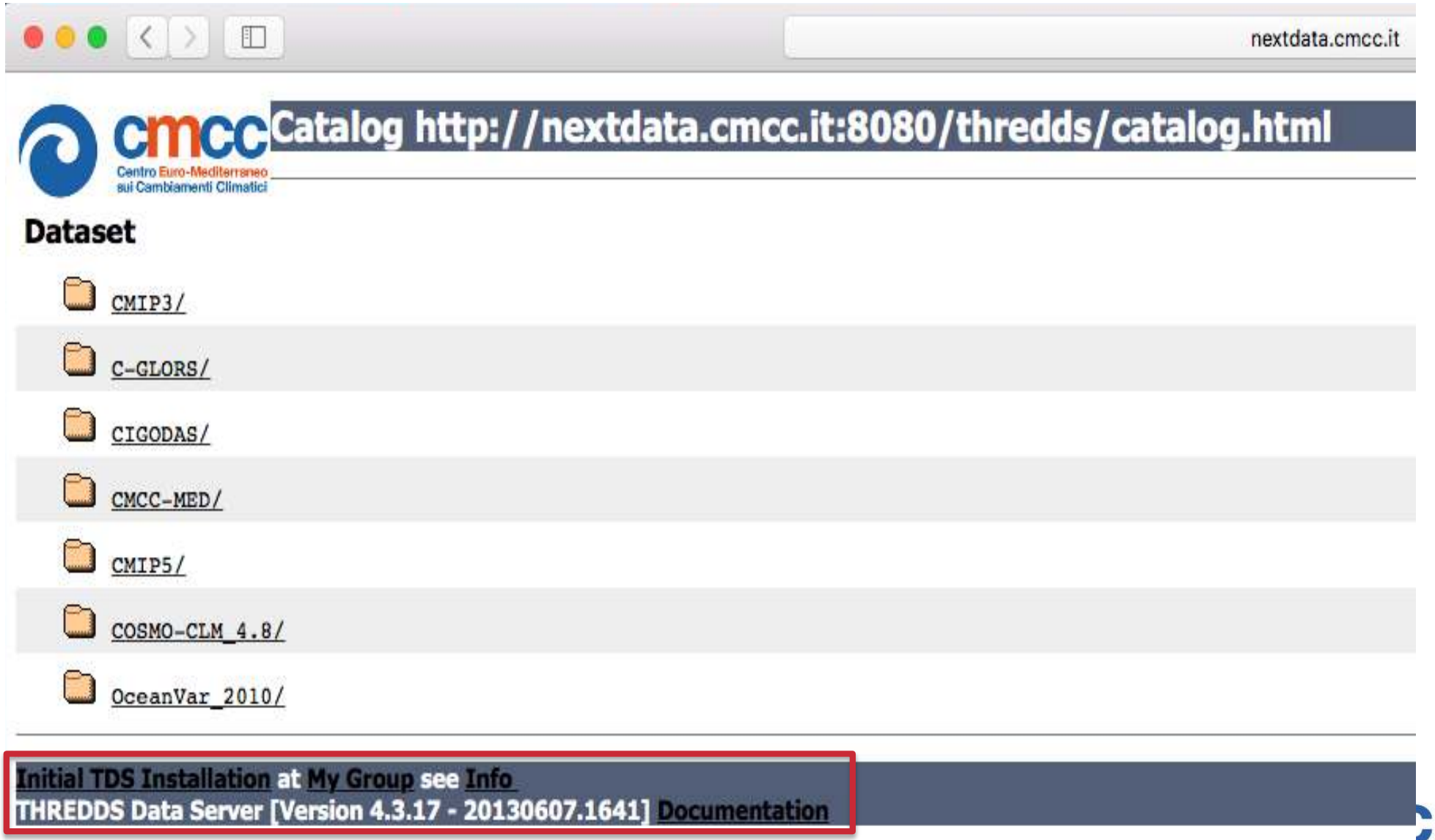
Data archives and access to numerical simulation outputs

Make available and accessible the climate data through a (homogeneous) system of archives and thematic data portal lined to the Project General Portal.



CMCC Thredds server

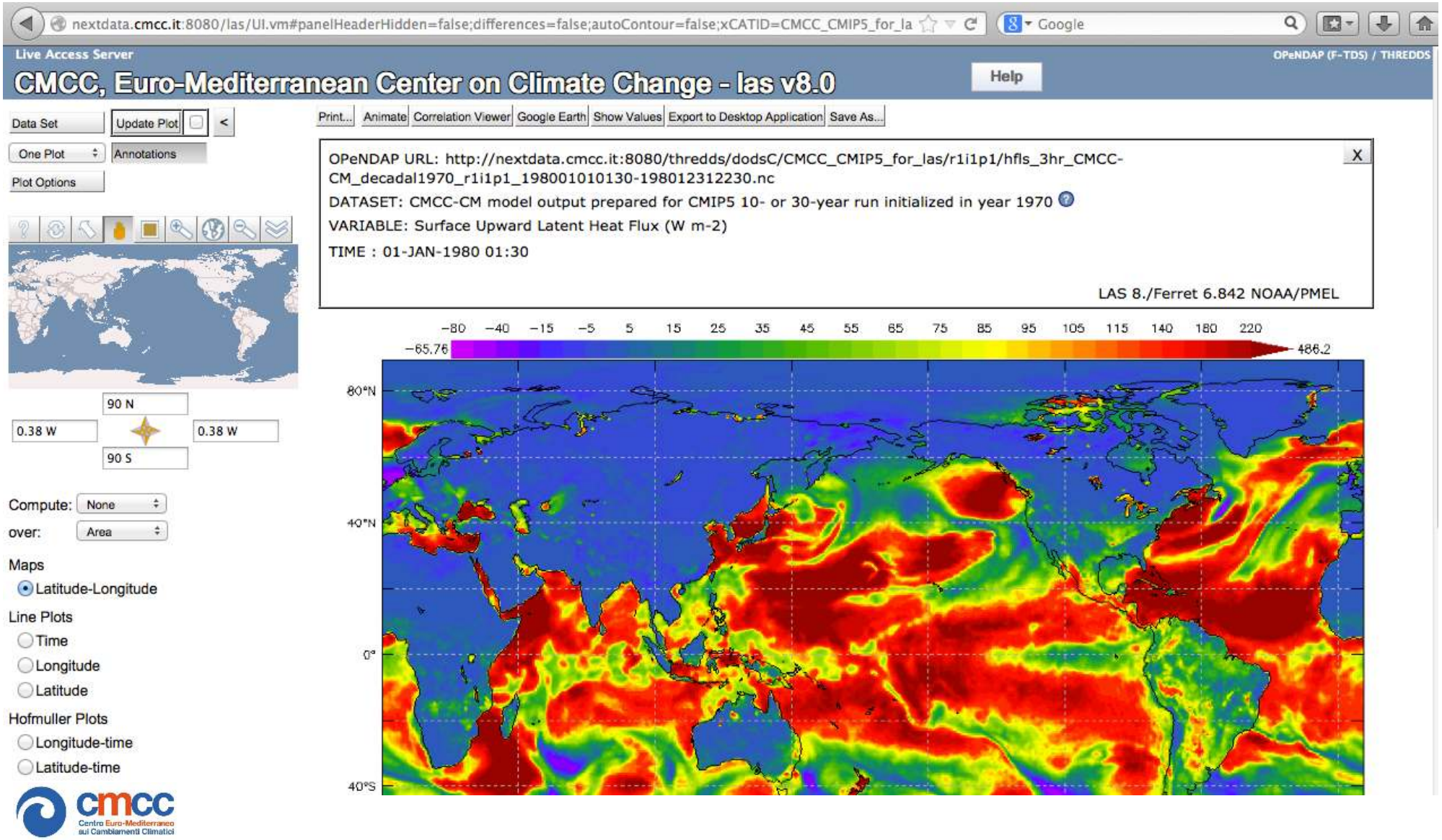
Osvaldo Marra @ CMCC Lecce



http://nextdata.cmcc.it:8080/thredds

Centro Euro-Mediterraneo sui Cambiamenti Climatici

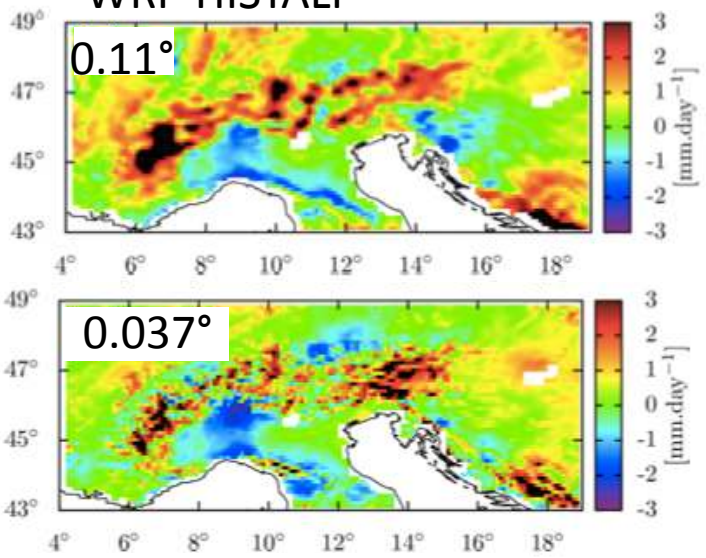
CMCC LAS server: overview

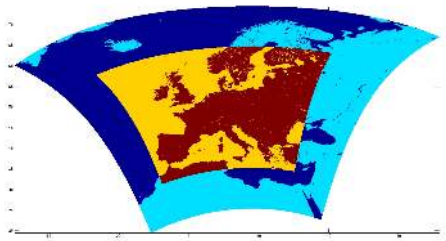


High-resolution (3.5 km) dynamical downscaling of global scenarios over Europe

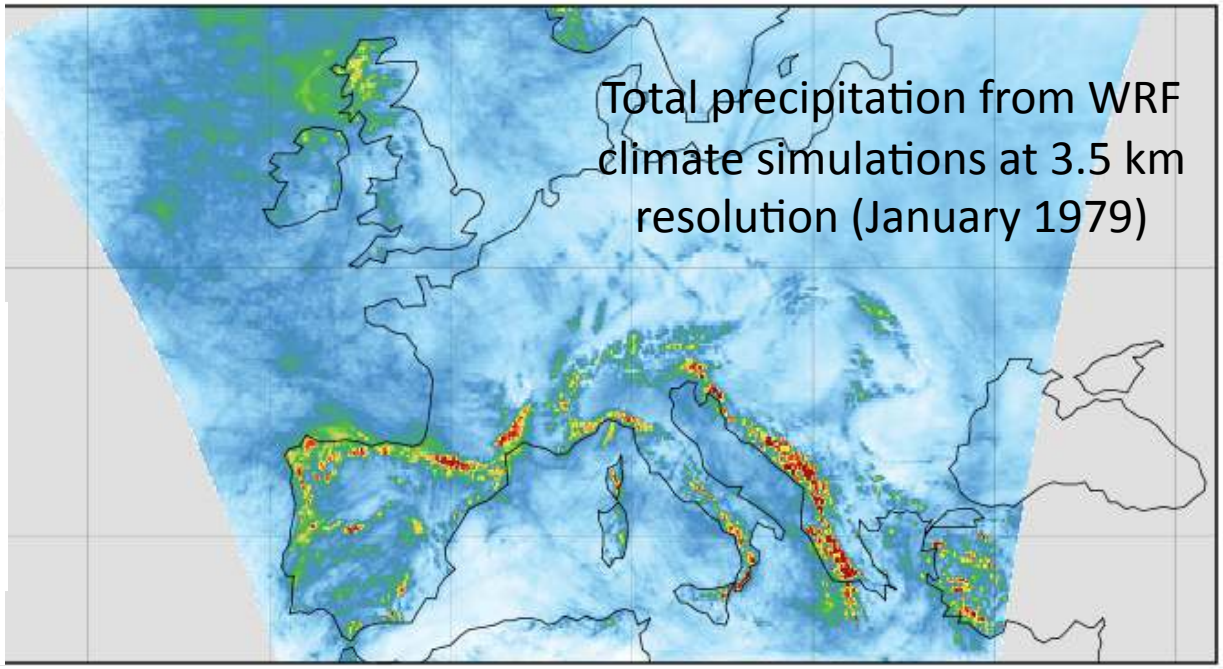
- 30-yr present (1979-2008). Large scale drivers EC-Earth and ERA-Interim
- 30-yr projection (2021-2050 RCP 4.5) large scale driver EC-Earth.

WRF-HISTALP



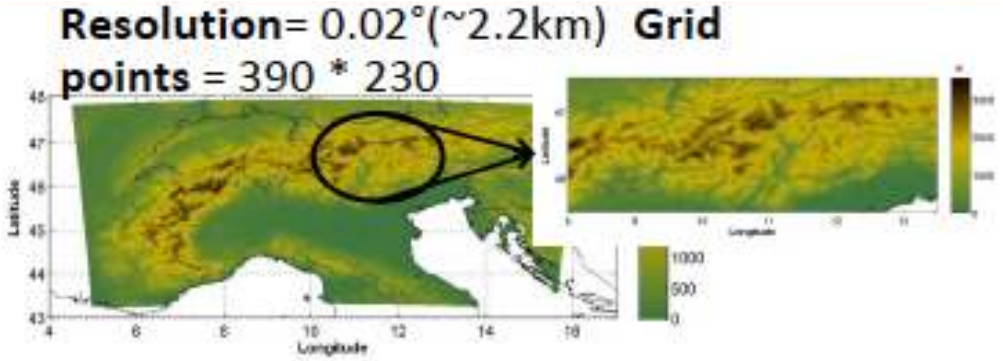


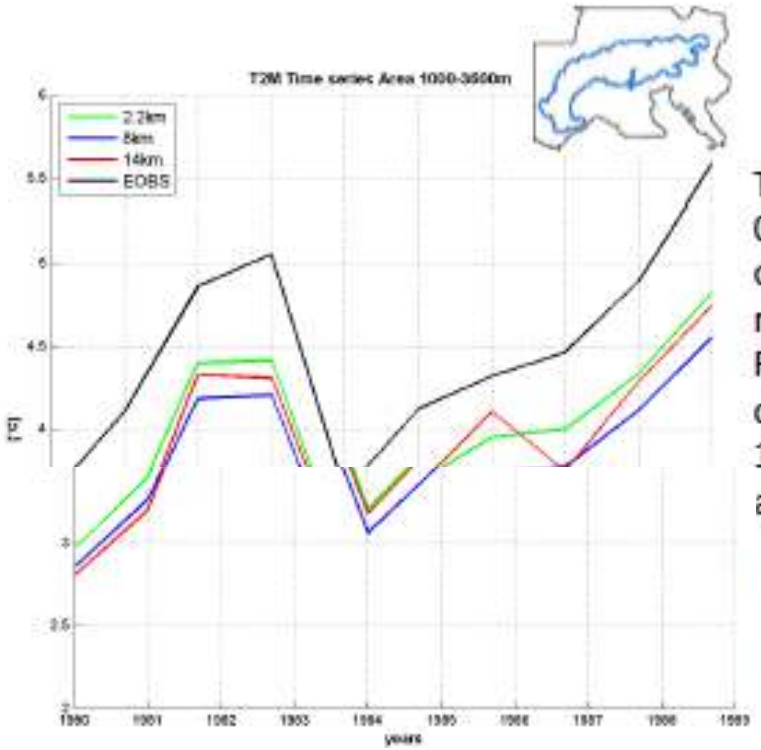
Precipitation January 1979



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

High and Very–High resolution simulations in the Alpine region





The 0.02° simul
0.0715° (about
order to assess
resolution.
Figure on the le
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agreement with

High (0.07° → ~8 km) and Very–High (0.02° → ~2.2 km) horizontal resolution simulations over the Alpine region for the period 1979–1990 conducted with the **COSMO-CLM regional climate model**.

High and very–high **simulations compared with the results obtained from a 14 km resolution** and with different **observational data sets** (e.g., E-OBS, EURO4M-APGD, etc.

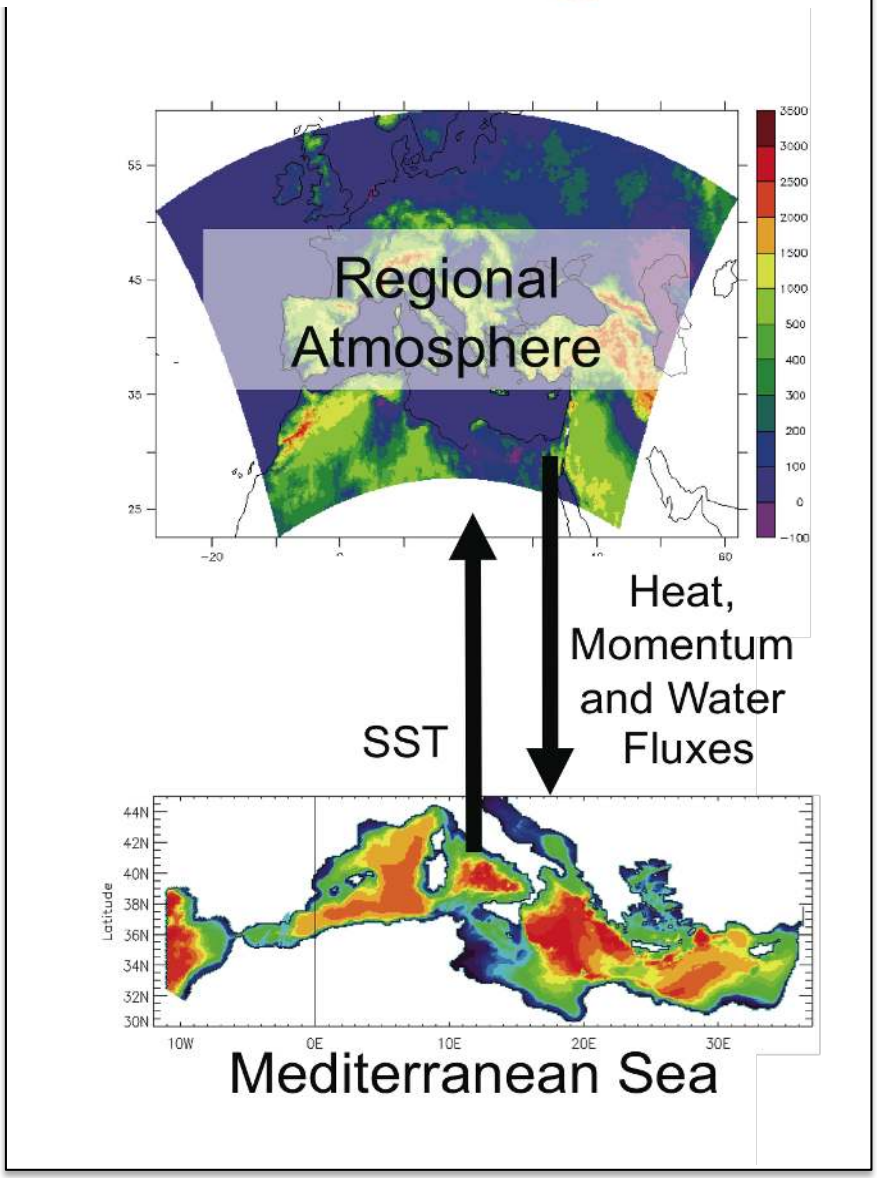
cmcc
Centro Euro-Mediterraneo sui Cambiamenti Climatici

Coupled Modelling in the Mediterranean

Cosmo-CLM 4.8
horizontal resolution ~44 km
deltat=240"
vlevs=40
MEDCORDEX domain+atlantic box

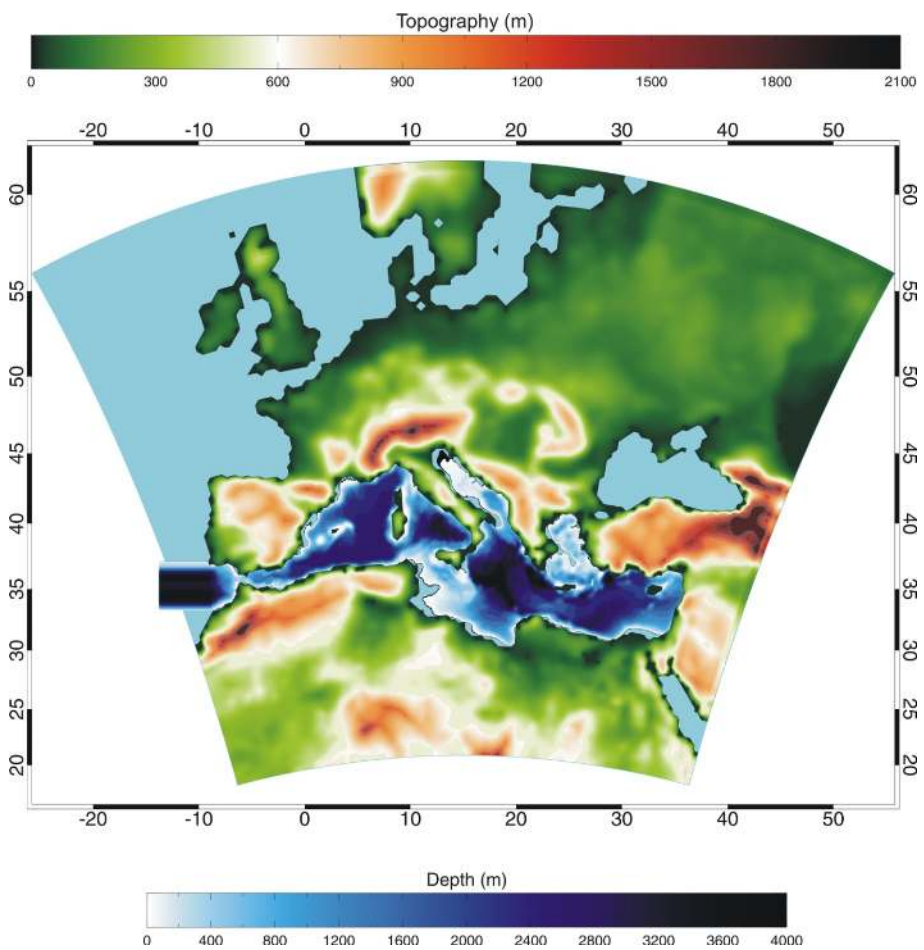
Oasis 3 CMCC parallel version
coupling frequency 4800"

Nemo 3.4 (MFS)
horizontal resolution 1/16
deltat=600"



Coupled Modelling in the Mediterranean

ENEA-PROTHEUS 1.0



Model components

RegCM3

18 sigma vertical levels

30 Km horizontal resolution

BATS + IRIS

BATS: Biosph.-Atmosph. Transfer Scheme

IRIS: interactive RIvers Scheme

SST

OASIS 3

Freq. 6h

HF-WF-Wind

MedMIT

42 zeta vertical levels (partial cell)

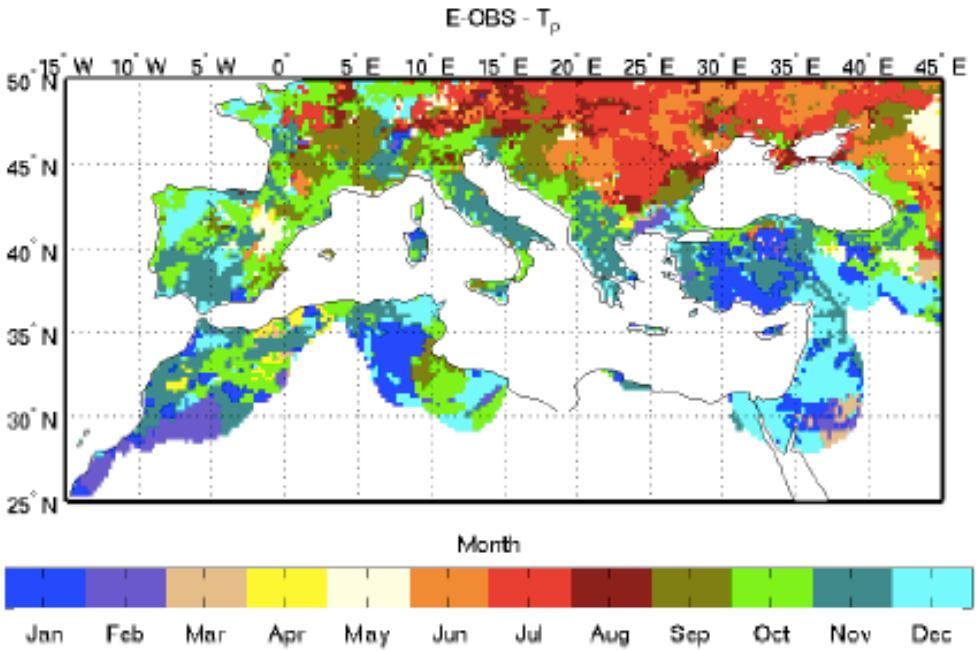
1/8° x 1/8° horizontal resolution

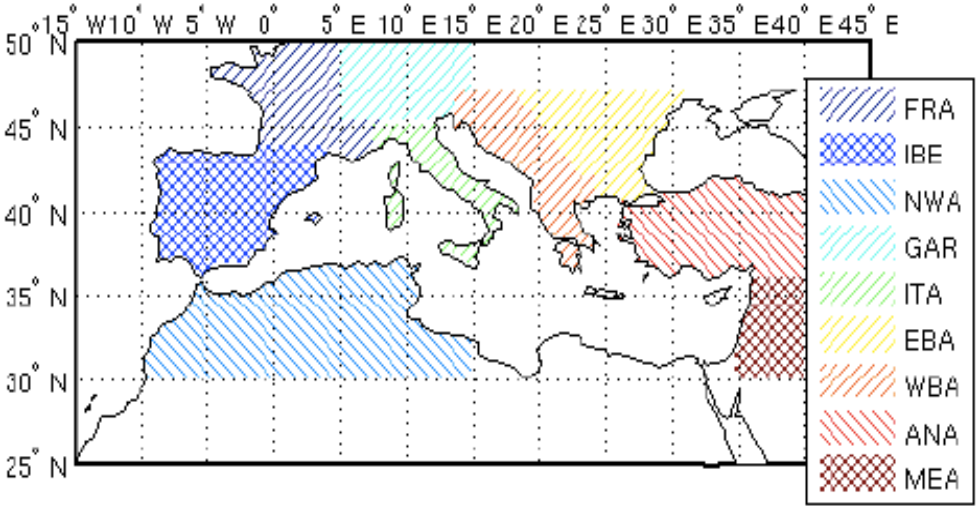
P99 timing

• Is computed from the histogram of all the values in the time series such that P>P99, selecting the most populated monthly bin in the histogram.

• In **Central and Eastern Europe** most of the extreme events in **summer**.

• In **Western and Southern Europe** maximum during **autumn and winter**.





• It can be used to infer physically-based criteria to divide the domain in coherent sub-regions

(Cavicchia et al. Clim. Dyn. 2017)

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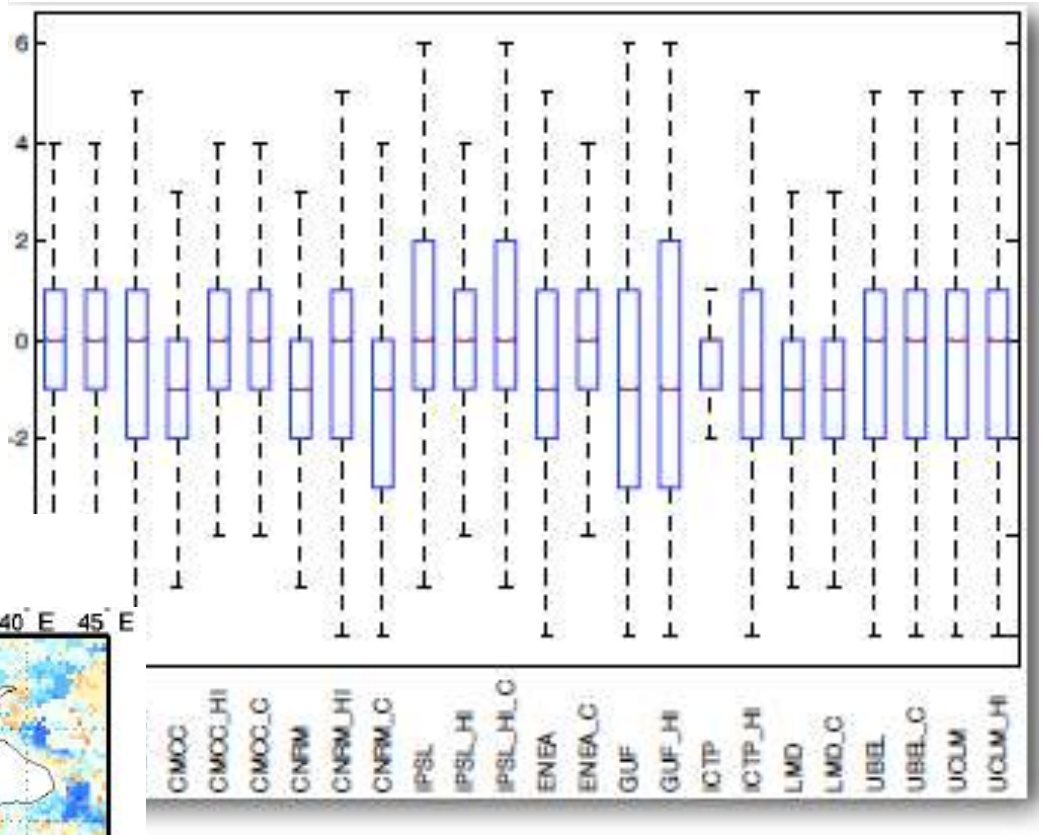
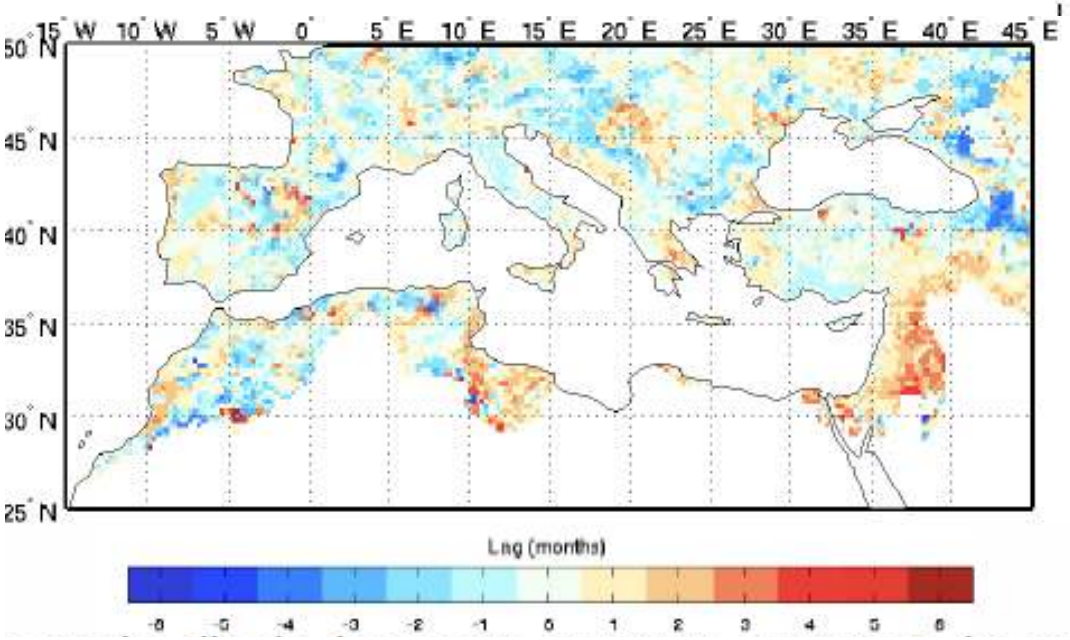
Overall, the main dipole between summer extremes in Central Europe and winter-autumn extremes in South/West Europe **well captured by all models**.

T_{P99} Lag between models and E-OBS



Ensemble mean – T_{P99} Lag difference



Locally, shifts of up to 2-3 months can be noticed between different models.

(Cavicchia et al. Clim. Dyn. 2017)

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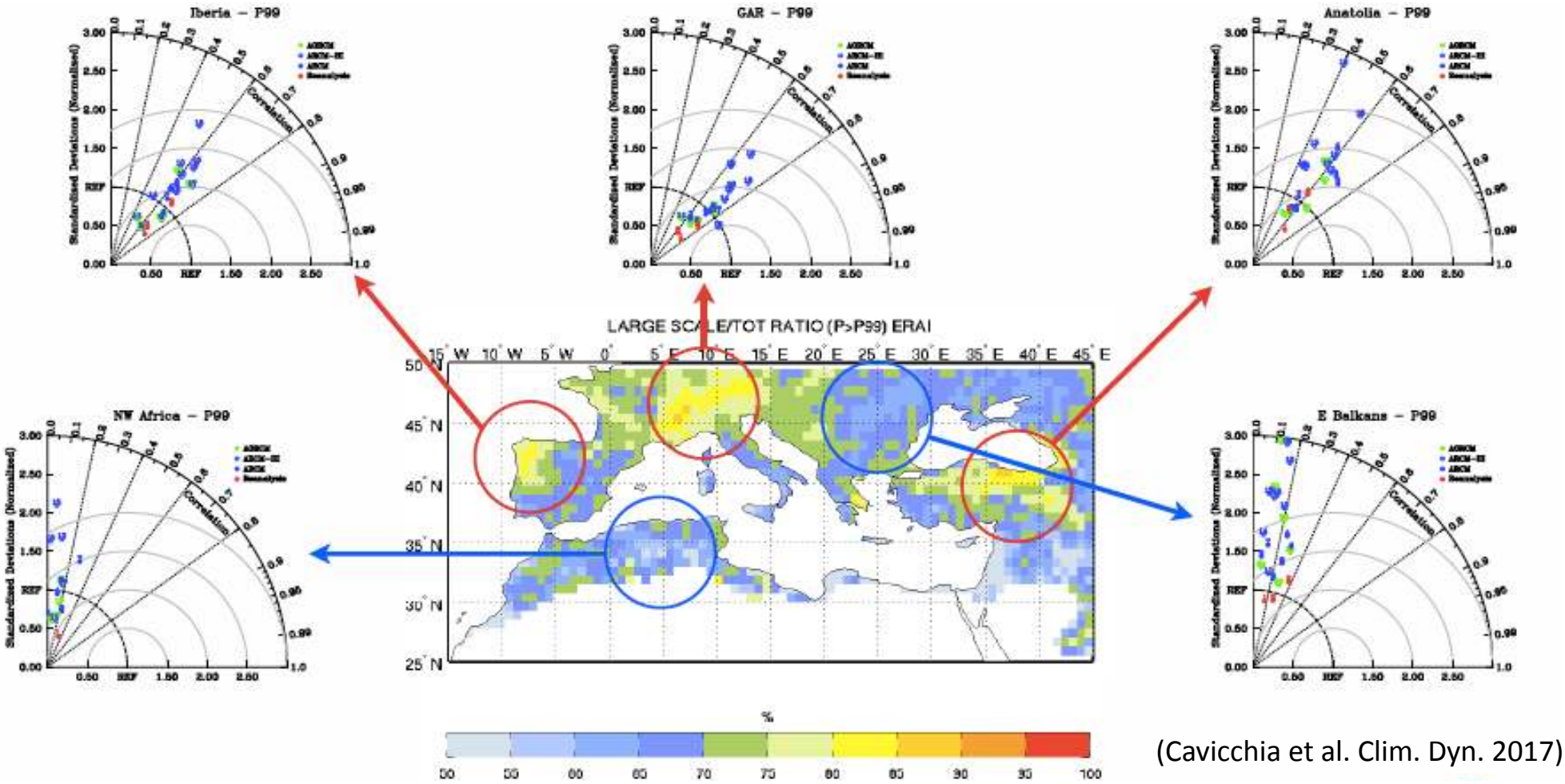
• In the regions where all models tend to show a **better performance** extreme events are **dominated by large scale precipitation**.

• In the regions where all models tend to show **bad performance,** large scale precipitation provides a **smaller contribution to extremes**



(Cavicchia et al. Clim. Dyn. 2017)

Work plan 2017-2018

- Complete the production of climate change scenarios at very-high resolution using different downscaling tools (dynamical, statistical, stochastic)

- Complete the implementation of data portal and their accessibility via the project General Portal.

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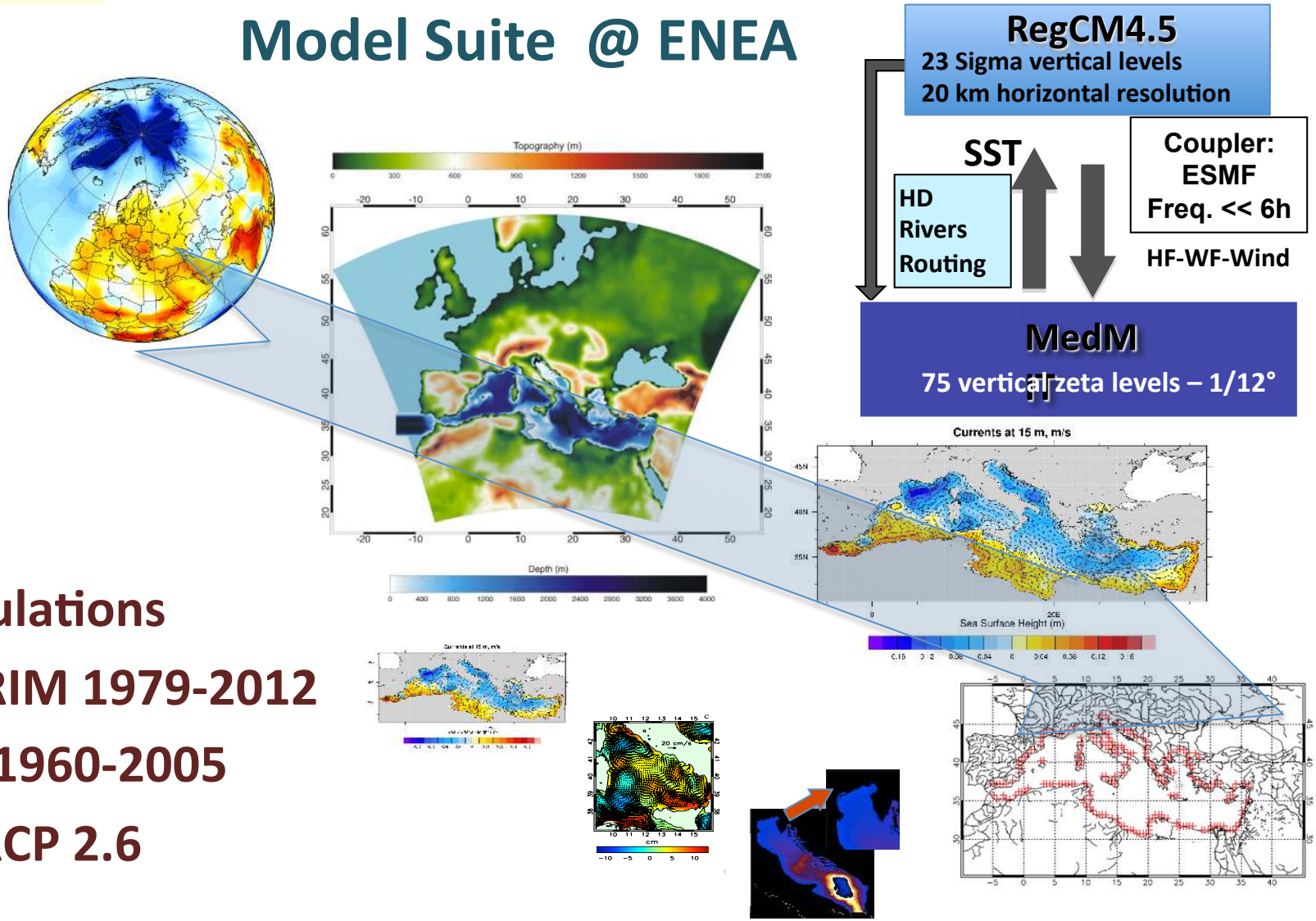
Model Suite @ ENEA



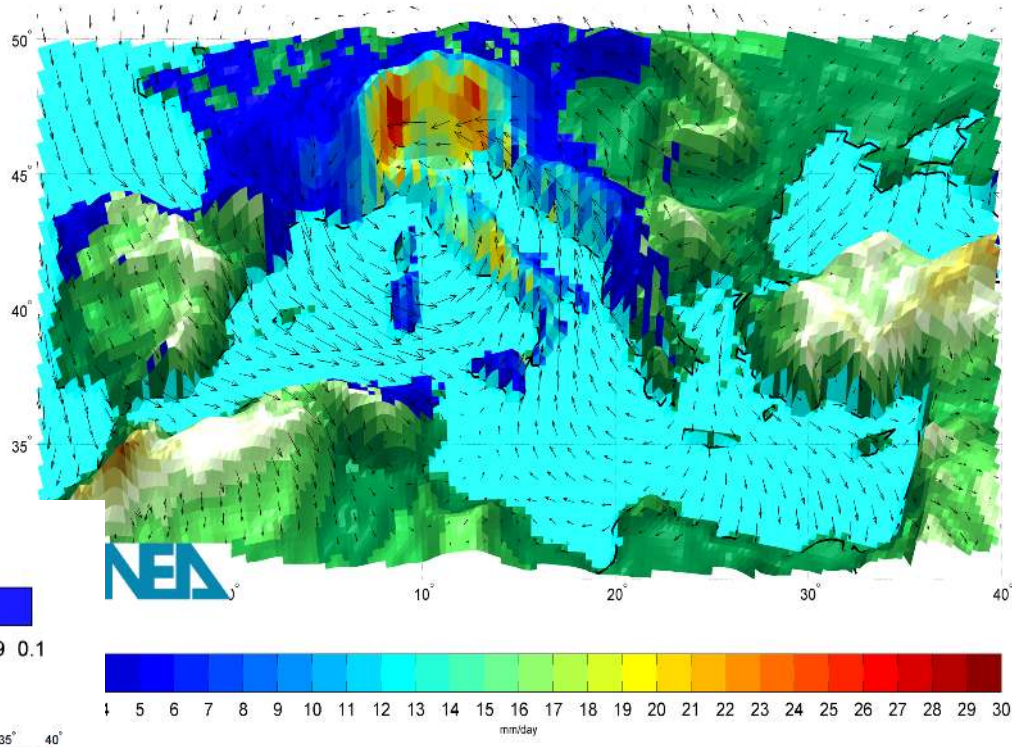
Planned Simulations

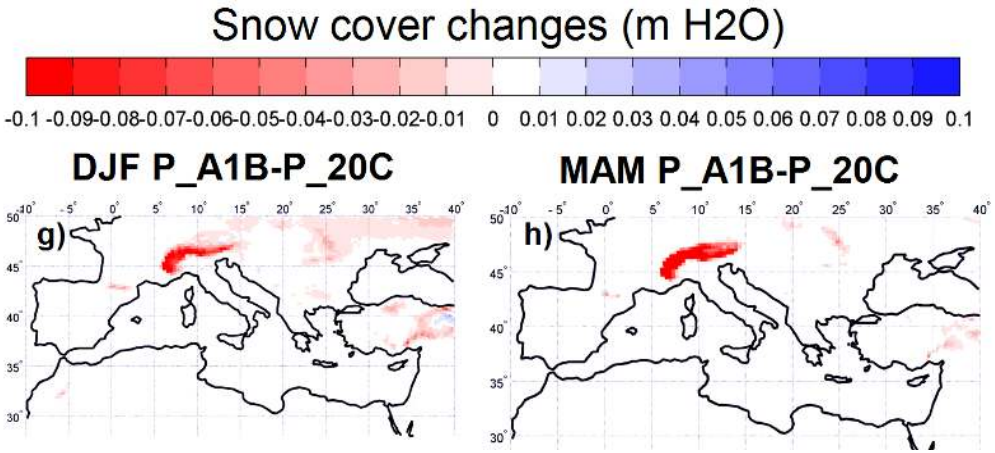
- ERA-INTERIM 1979-2012
- Historical 1960-2005
- RCP 8.5 /RCP 2.6

Scientific Objectives

- Analysis of extreme events with a special focus on **severe impact events associated with air – sea interaction** → cyclogenesys, intense precipitation on the Alpine area

- Snow cover change due to a change in the Mediterranean cyclogenesys.





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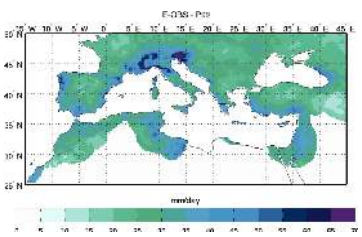
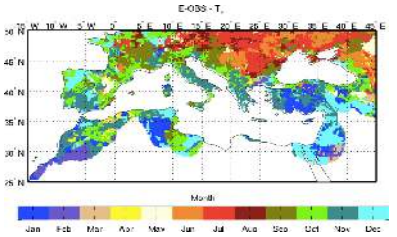
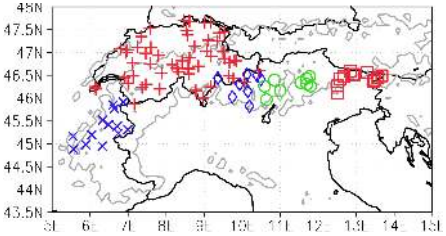




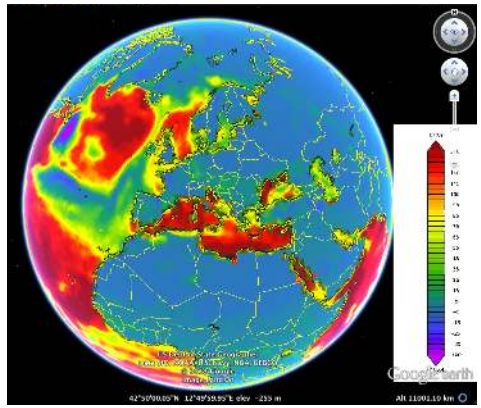


- An ensemble of high resolution simulations (from 100 km to 25 km) performed with the (global) CMCC climate model (HighResMIP).

- **Enlarge the climate change projection ensemble over the Mediterranean region** produced with the **coupled regional climate model**: RCP4.5 and **RCP2.6**.

- **Analysis of the 2.2 km simulation over Alpine area** over a reference period (1979-1990)
  - evaluation of the performances for sub daily precipitation and related specific features (e.g. duration, inter time events).

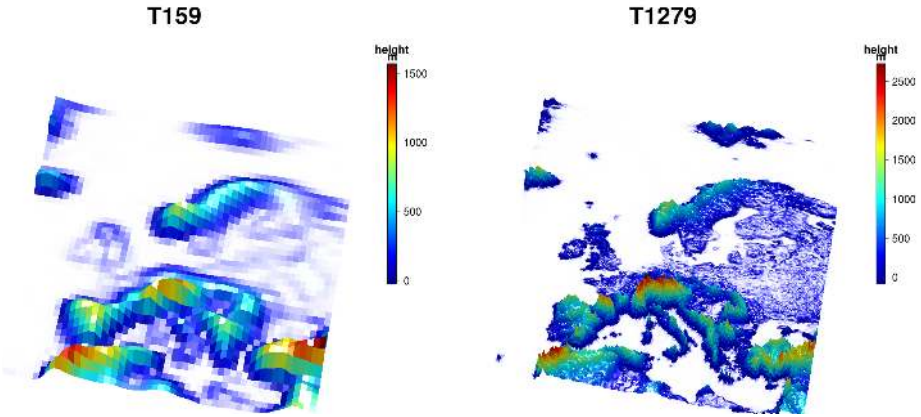
- Assessment of the **sub daily precipitation variation** over the period 2021-2050, using IPCC scenario RCP4.5, with respect to a reference period.
  - future scenarios of sub daily precipitation will be produced with stocastic disaggregation (Ciervo et al., 2016) of the regional climate simulations at 8 km over the Alpine region. This method will be based on the statistical parameters obtained using sub daily precipitation available over the reference period from the 2.2 km configuration.



High-resolution climate projections

Inclusion in the archive of projections from the global climate model **EC-Earth 3:**

- a large ensemble (up to **10 members** per resolution) of very high resolution AMIP simulations (**from 125km to 16km**) performed in the PRACE EU projects (2015-2017) Climate SPHINX and Climate SPHINX reloaded.
- High-resolution projections performed using **stochastic physics.**
- High-resolution coupled simulations (up to 40km) following **HighResMIP** specification.



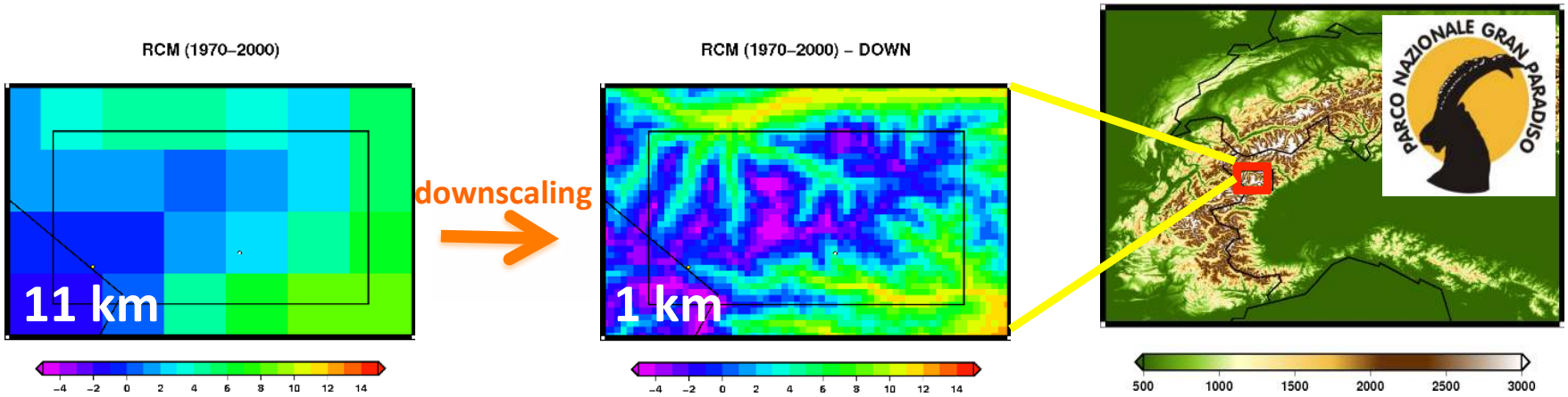
In collaboration with the EUDAT pilot Data-SPHINX led by ISAC-CNR

Orographic downscaling of temperature

Method: large scale temperature fields are downscaled by applying a simple orographic correction based on a annual or monthly adiabatic lapse rate (known from the literature or previous studies, e.g. *Rolland 2003*).

Case study: downscaling of EOBS gridded observations and EURO-CORDEX regional climate models (0.11° resolution) to 1 km over the area of Gran Paradiso National Park, Italy.

Software: open-source command line tools developed by ISAC-CNR, made available on GitHUB.

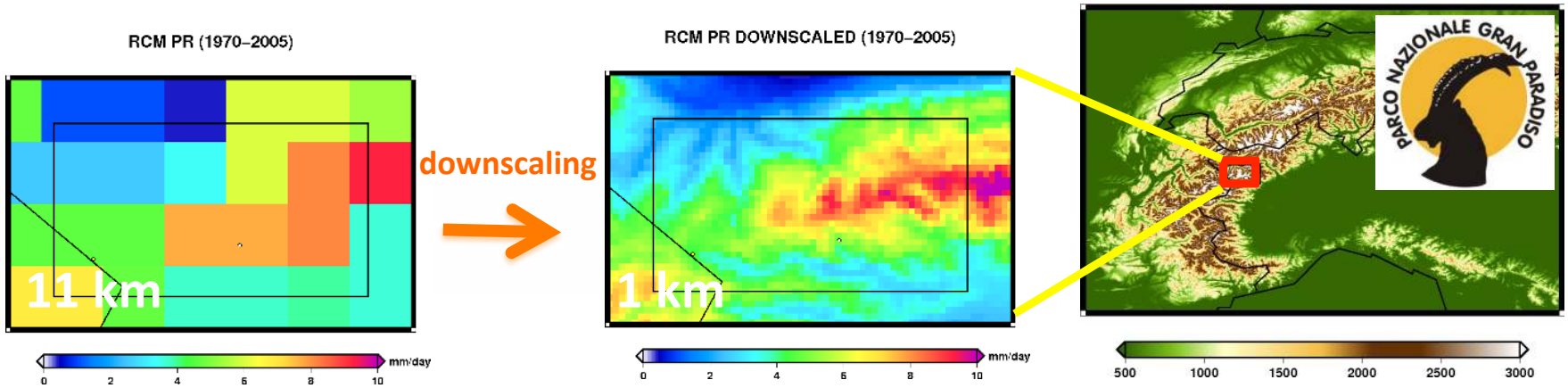


Rolland C., 2003: Spatial and Seasonal Variations of Air Temperature Lapse Rates in Alpine Regions. J. Climate, 16, 1032–1046, doi: 10.1175/1520-0442(2003)016<1032:SASVOA>2.0.CO;2.

Orographic downscaling of precipitation

Method: a reference fine-scale climatology from gridded observations or high resolution simulations is used to derive corrective weights which are applied to realisations of stochastic fields generated with the RainFARM stochastic downscaling technique (*Rebora et al., 2006; D'Onofrio et al., 2014*)

Software: open-source command line tools developed by ISAC-CNR, made available on GitHUB

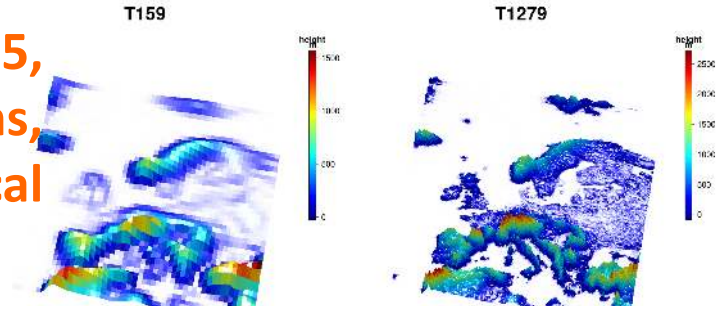


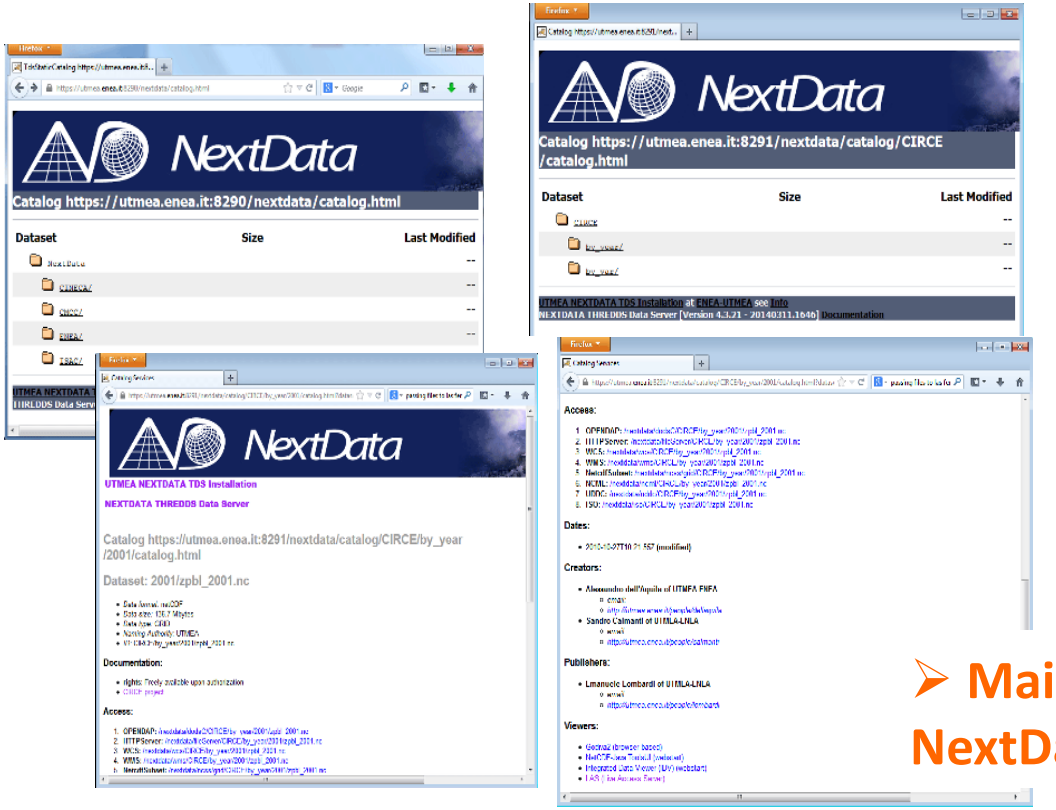
Rebora, N., L. Ferraris, J. von Hardenberg, and A. Provenzale, 2006: RainFARM: Rainfall downscaling by a filtered autoregressive model. J. Hydrometeor., 7, 724–738, doi:10.1175/JHM517.1

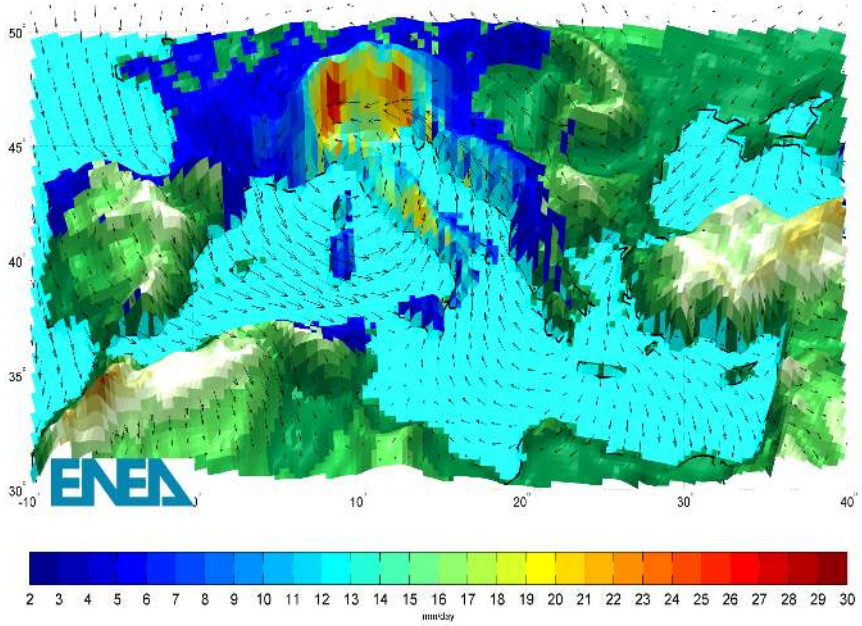
D. D'Onofrio, E. Palazzi, J. von Hardenberg, A. Provenzale, and S. Calmanti, 2014: Stochastic Rainfall Downscaling of Climate Models. J. Hydrometeor., 15, 830–843, doi: 10.1175/JHM-D-13-096.1.

Summary

- **Significant extension of the archive, beyond CMIP5, with state-of-the-art, very high-resolution simulations, useful for modelling and studying the hydrological cycle, resources and ecosystems in mountain areas.**







- **Maintenance and up-grade of the NextData thredds server**

Thank you!


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


Società Italiana per
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