Climate projections for the XXI century over the Mediterranean area with COSMO-CLM and induced variations on hydraulic and geological hazards

Edoardo Bucchignani

and CMCC ISC Division Team

cmcc
Centro Euro-Mediterraneo
sui Cambiamenti Climatici

OUTLOOK

Introduction

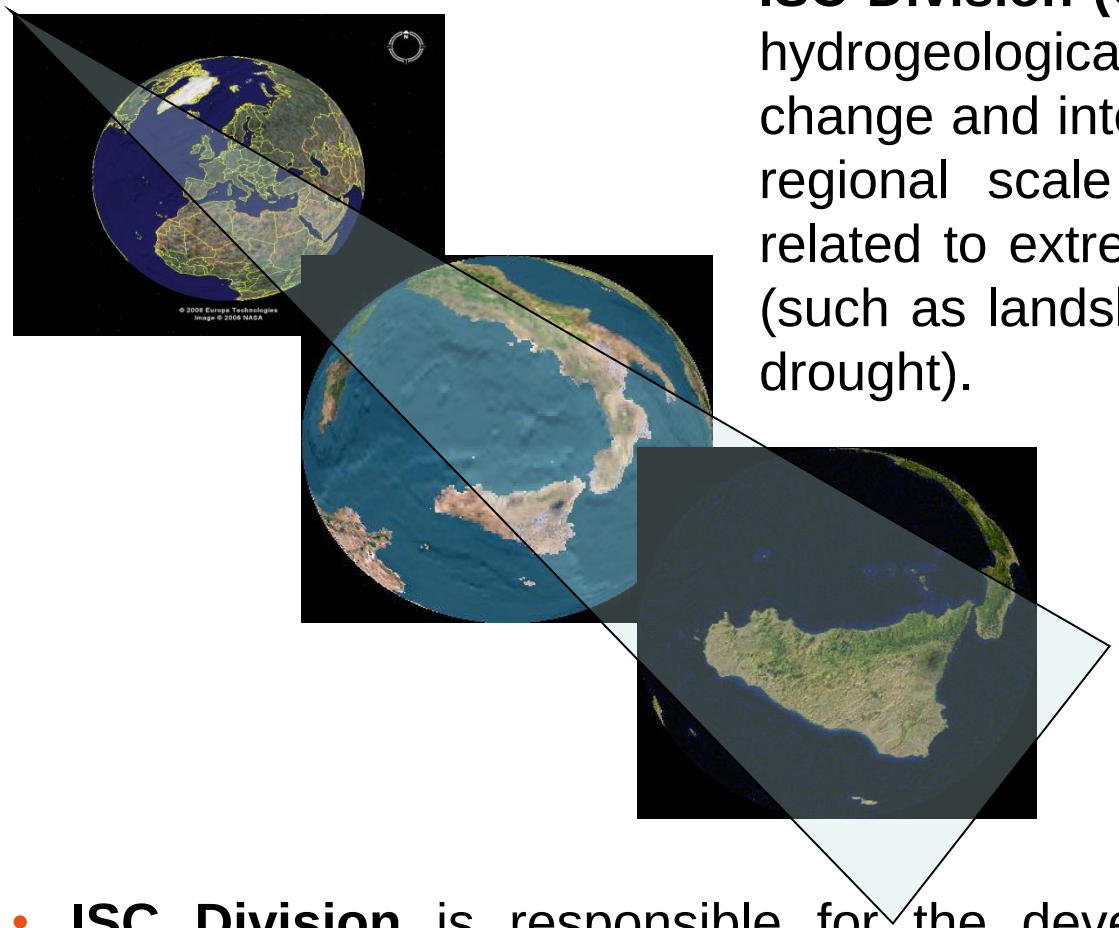
The COSMO-CLM model

Model Evaluation

Climate Projections

Geological hazards

The CMCC ISC Division



- **ISC Division (Capua Team)** focuses on the hydrogeological risks connected with climate change and integrates climate models at the regional scale with the analysis of risks related to extreme events and their impacts (such as landslides, floods and hydrological drought).

- **ISC Division** is responsible for the development of the **regional climate model COSMO CLM**, being involved since 2008 in the activities of the CLM Community.

The COSMO-CLM regional climate model

- The COSMO-CLM is the Climate Mode of the COSMO model system.
- It is a non hydrostatic regional climate model atmospheric prediction system, developed by the CLM-Community.
- It is designed for simulations on time scales up to centuries and spatial resolutions down to 1 km.
- It is the only limited area numerical model system in Europe which has a range of applicability encompassing:

1. operational numerical weather prediction (COSMO)
2. regional climate modelling of past, present and future (CLM),
3. the dispersion of trace gases and aerosol (ART) and
4. idealized studies (ITC)

- It is applicable for downscaling in all regions of the world and of most of the Global Climate simulations available.
- It is fully documented.

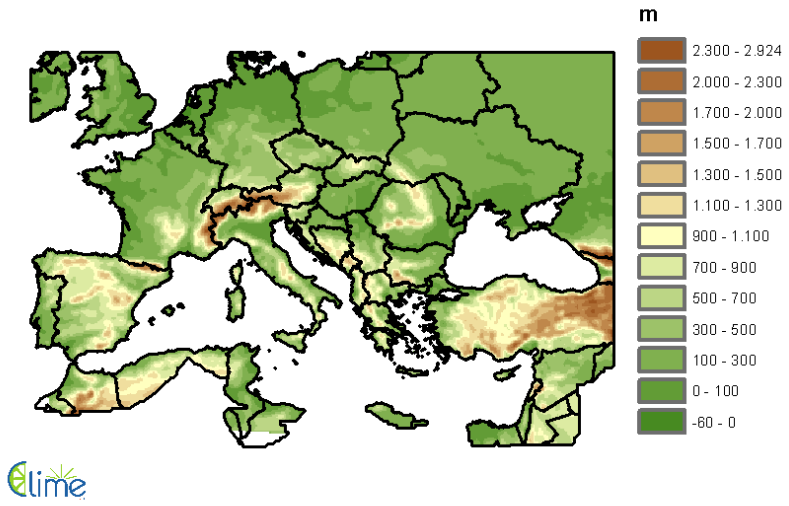
Climate Limited-area Modelling Community

Numerical simulations over Europe

The numerical simulations, at **0.125º** (about 14km) of horizontal resolution, are driven by:

1. **ERA-Interim** reanalysis (horizontal resolution of 0.703˚) for the period **1979-2011**.
2. **CMCC-CM** "sub-optimal" forcing following the IPCC 20C3M protocol, for the period 1971-2005.
3. **CMCC-CM** for the period 2006-2100, under the IPCC RCP4.5 and RCP8.5 emission scenarios.

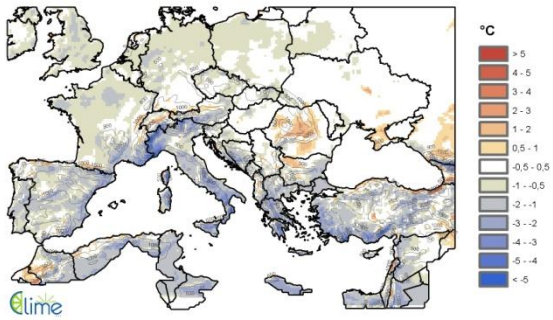
Evaluation performed using **E-OBS** dataset (vsn. 9) for temperature and precipitation.



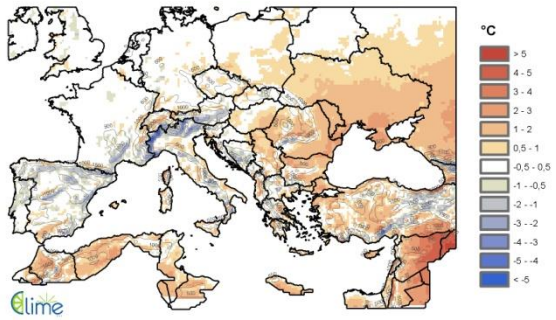
Horizontal resolution	0.125˚
Num. of grid points	385 x 265
Model versions	INT2LM: 1.10_clm2 / COSMO: 4.8_clm19
Num. of levels	40 vertical and 7 soil
Time step	100 s

Temperature validation: COSMO vs E-OBS (°C) 1971-2000

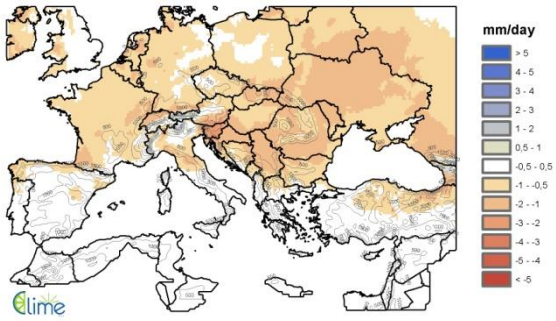
DJF



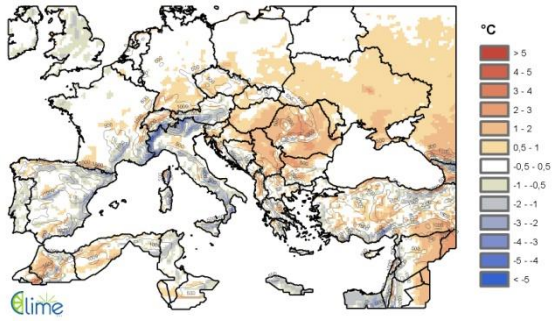
MAM



JJA



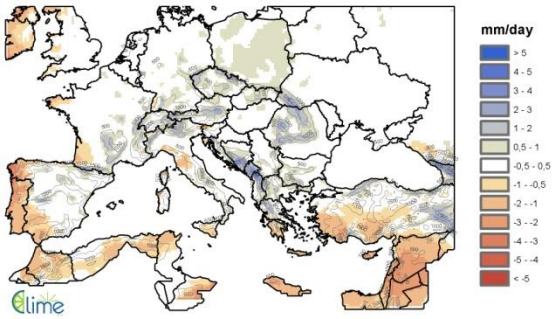
SON



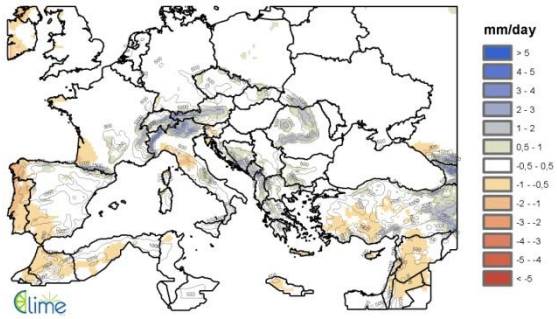
Good agreement in spring and autumn: the bias never exceeds 2° C, with the exception of some regions in eastern area; bias close to 0° C In the northern part of the domain, (e.g in France, Germany, UK). Winter is interested by a general cold bias (with peaks of 4° C over Alps); in summer a general hot bias occurs, especially in the eastern part of the domain.

Precipitation validation: COSMO vs E-OBS (mm/d) 1971-2000

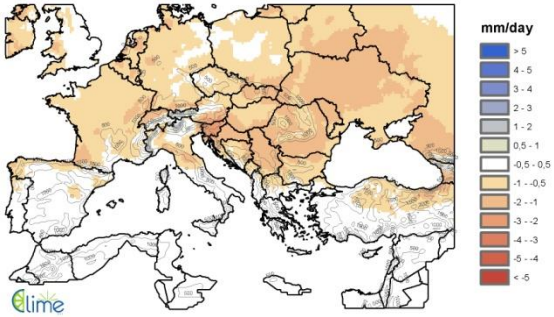
DJF



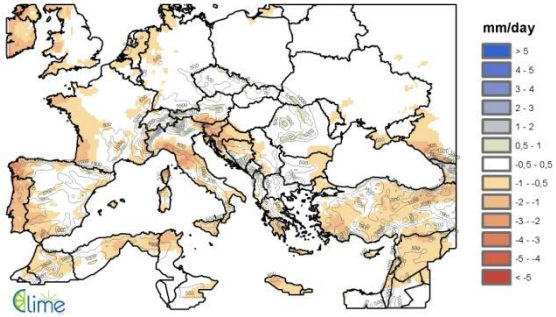
MAM



JJA



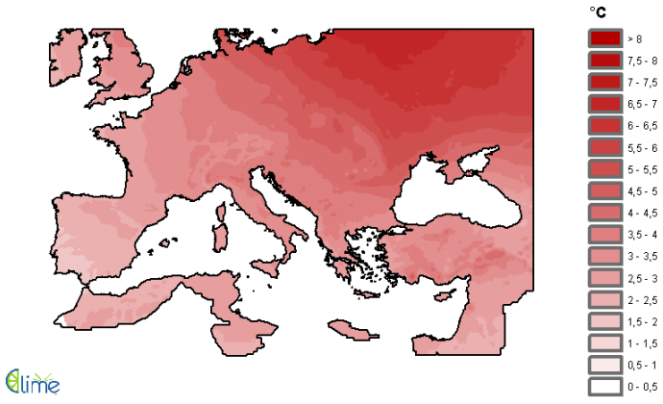
SON



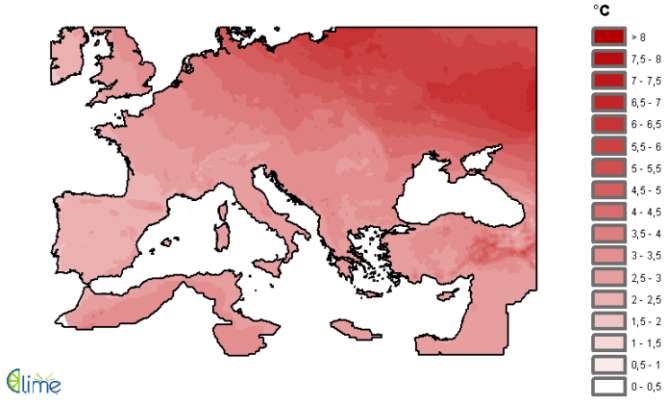
Good agreement in wide areas (bias between 0.5 and -0.5 mm/day). General underestimation occurring in summer in almost the whole domain. High correlation between model bias and elevation contour lines, especially over Alps, Carpathians and Caucasus Mountains; the mountain chains are interested by a general overestimation of precipitations,

Temperature projections: 2071-2100 vs 1971-2000 RCP4.5

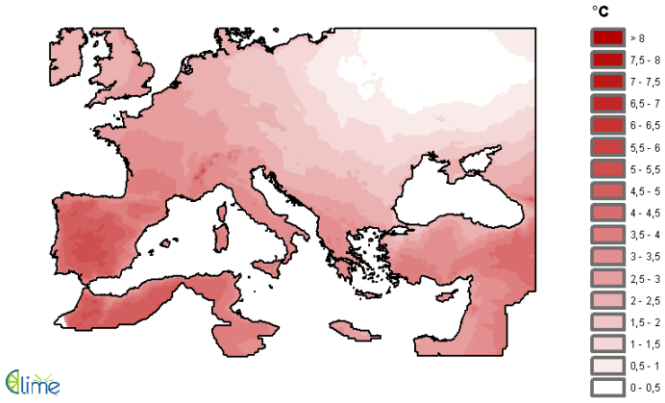
DJF



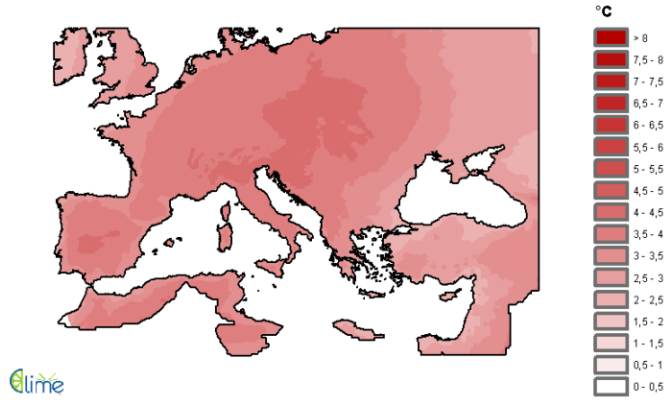
MAM



JJA



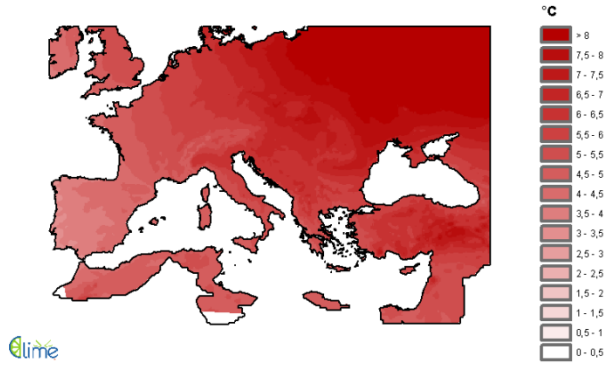
SON



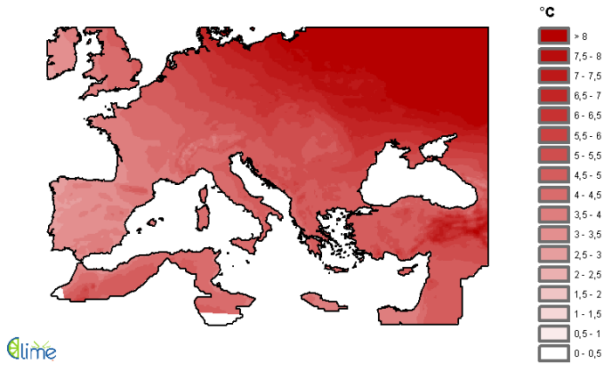
A general warming is projected in the future: the increase is more pronounced in DJF and MAM. SON is characterized by a more homogeneous warming, while in JJA the North-East part of the domain is characterized by negligible variations.

Temperature projections: 2071-2100 vs 1971-2000 RCP8.5

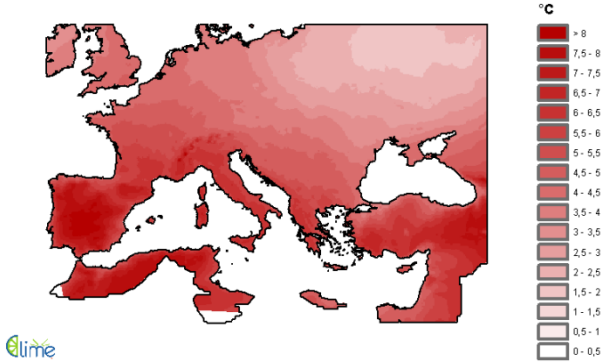
DJF



MAM



JJA



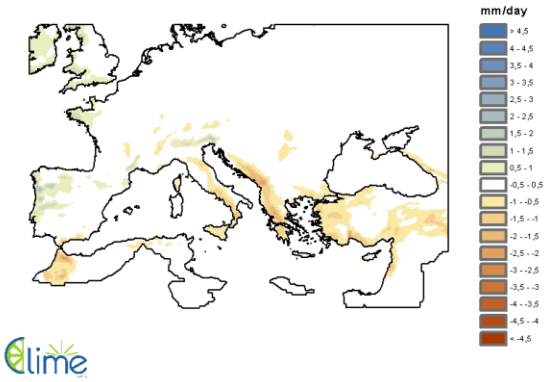
SON

Distribution anomalies similar to those observed for RCP4.5, but with larger increases of temperature. Peaks of 8˚ C are observed in DJF and MAM.

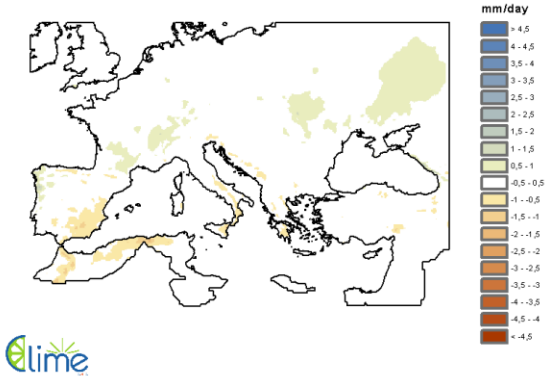
Good agreement with Jacob et al (2013), EURO-CORDEX simulations.

Precipitation projections: 2071-2100 vs 1971-2000 RCP4.5

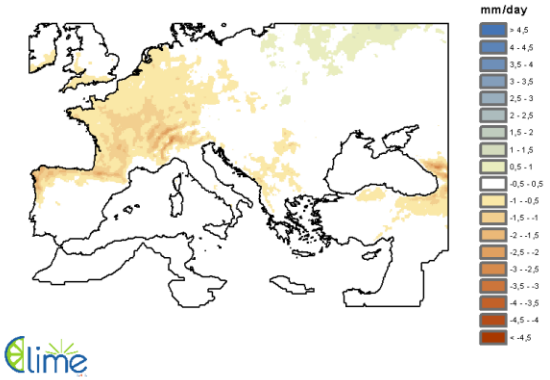
DJF



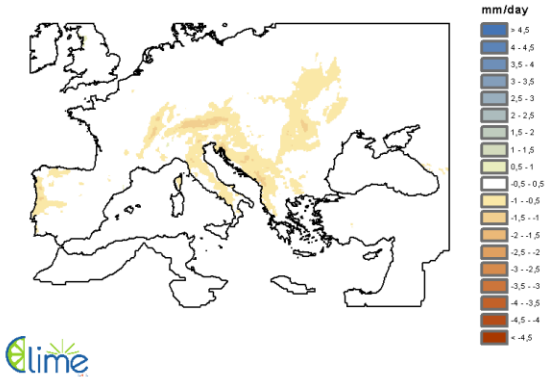
MAM



JJA



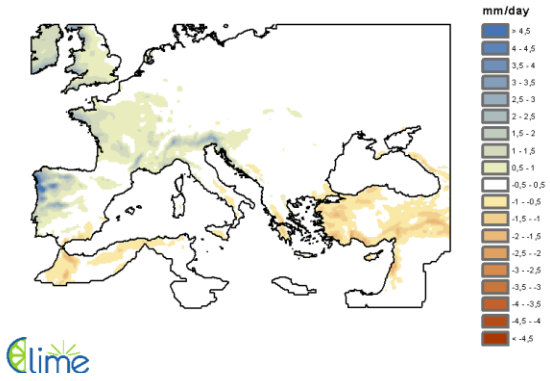
SON



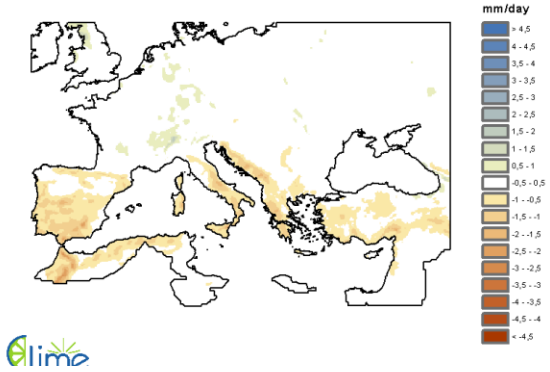
In DJF, precipitation reductions are projected in Italy, Greece and Turkey. In JJA, significant reductions projected in north-center Europe. In SON, precipitation reductions are projected in Italy and central Europe.

Precipitation projections: 2071-2100 vs 1971-2000 RCP8.5

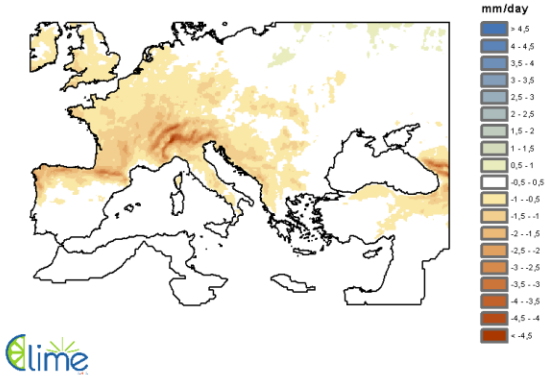
DJF



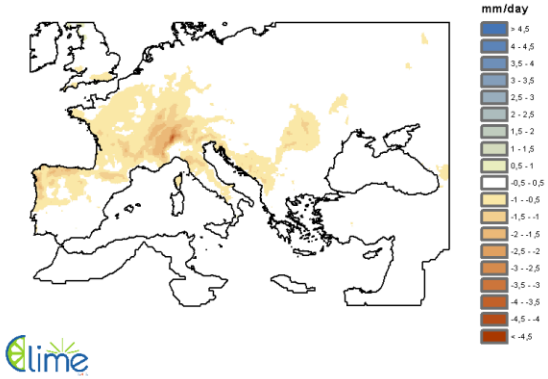
MAM



JJA



SON



Significant precipitation reductions are projected in JJA and SON over North-Center Europe. Precipitation increases expected in DJF over France, Spain and South UK .

Good agreement with Giorgi and Lionello (2008) (A1B emission scenarios).

Geological Hazards …