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Simulating the time evolution of weather events in Italy in the framework of climate change

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BACKGROUND

- Climate change is responsible for the intensification of extreme weather events (e.g., floods, heat waves, prolonged periods of drought)
- The Mediterranean area is a hot spot for the climate change (*Lionello and Scarascia, 2018*)
- Italy needs site-specific adaptation solutions to climate change due to its orographic variability
- Four "Representative Concentration Pathways (RCP)", characterized by increasing severity, have been proposed by the Intergovernmental Panel on Climate Change (IPCC).

METHODOLOGY

WORKFLOW

Preparation of the numerical setup
- Installation of WRF (v4.4.2)
- Identification of the initial and boundary condition dataset for the simulations
- Identification of calculation domains (Figure I and Table I)
- Definition of the physical configuration of the runs (Table II)

WRF runs
- Test for evaluating the numerical configuration of the model
- Simulations for the year **1997**
- Simulations for the year **2050** based on IPCC RCP4.5 and RCP8.5 scenarios
- Simulations for the year **2100** based on IPCC RCP4.5 and RCP8.5 scenarios

Post-processing
- Computation of summer days (Table III) for the years 1997 and 2100- scenario RPC8.5 in Rome
- Computation of tropical nights (Table III) for the years 1997 and 2100- scenario RPC8.5 in Rome
- Representation of spatial distribution of temperaure at 2 meters over Italy in two of the five cases considered

Table III - Extreme temperature indices (*Fioravanti et al., 2016*)

Index	Definition	Units
Summer days (SU25)	Annual count of days when daily maximum temperature (TX) >25 °C	Number of days
Tropical nights (TR20)	Annual count of days when daily minimum temperature (TN) >20 °C	Number of days

The Weather Research and Forecasting (WRF) model

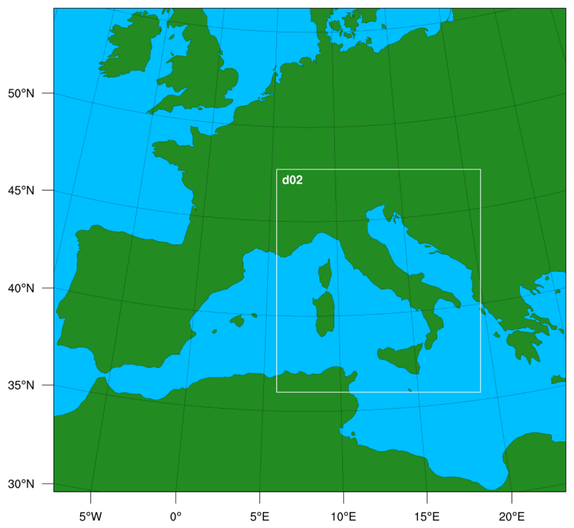

Figure I - WRF Pre-Processing System (WPS) domains configuration

Table I – Horizontal resolution and size of the domains

ID Domain	Geographic area	Horizontal resolution [km]	Number of Cells (lon x lat)
d01	Europe	27	108 x 102
d02	Italy	9	129 x 141

Table II – Physics options of WRF runs

Physical category	Selected option
Planetary Boundary Layer	Assymetric Convective Model Version 2 (ACM2)
Land-surface	Noah Land-Surface
Surface-layer	Monin-Obukhov Similarity
Microphysics	WSM 6-class graupel
Short wave radiation	RRTM
Long wave radiation	Dudhia
Land use dataset	MODIS

RESULTS

Spatial distribution of TEMPERATURE at 2 meters [°C]

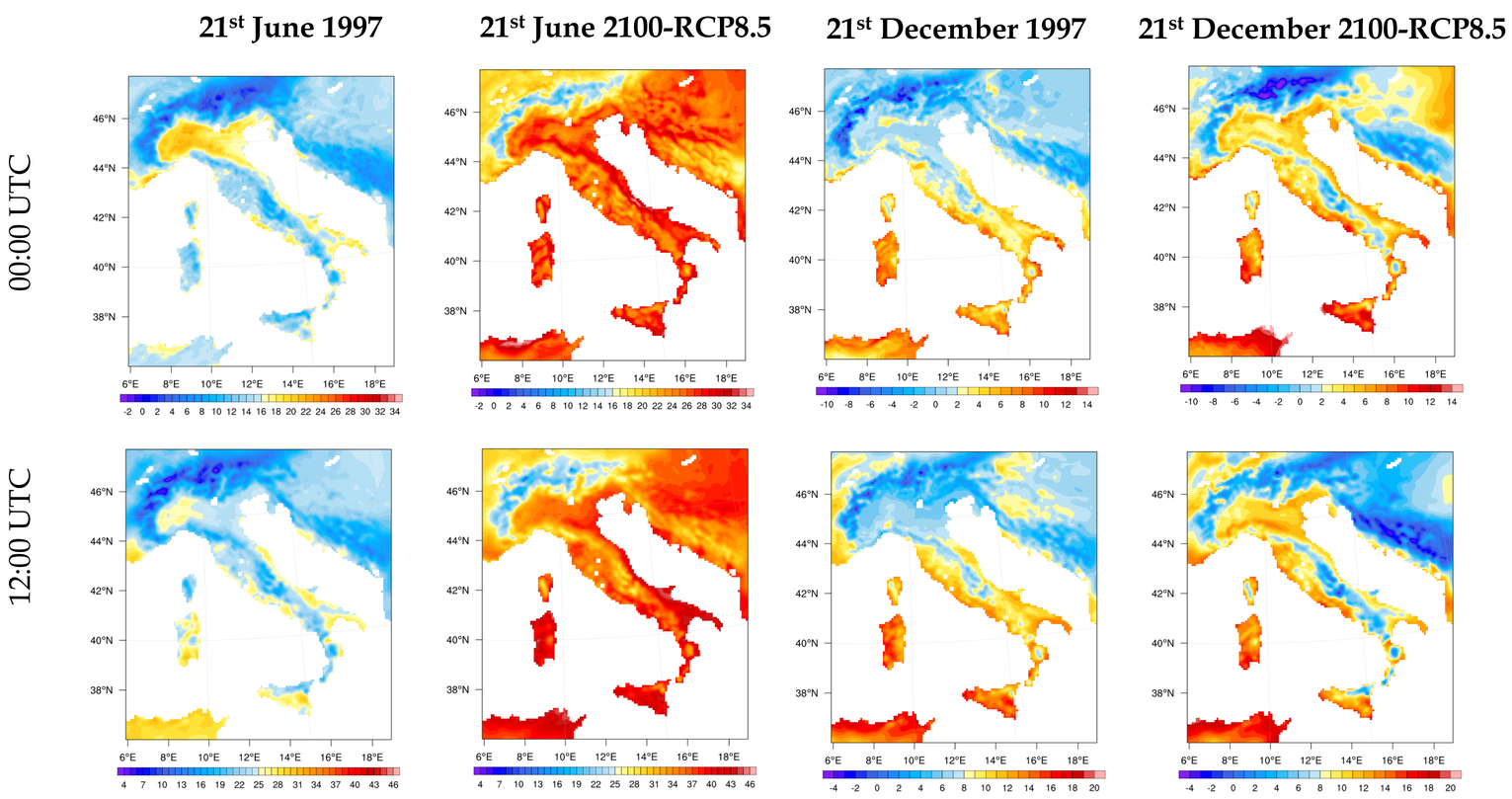

Figure II - Spatial distribution of air temperature at 2 meters over Italy in the years 1997 (reference case) and 2100 (according to the IPCC RCP8.5 scenario) at 00:00 UTC and 12:00 UTC

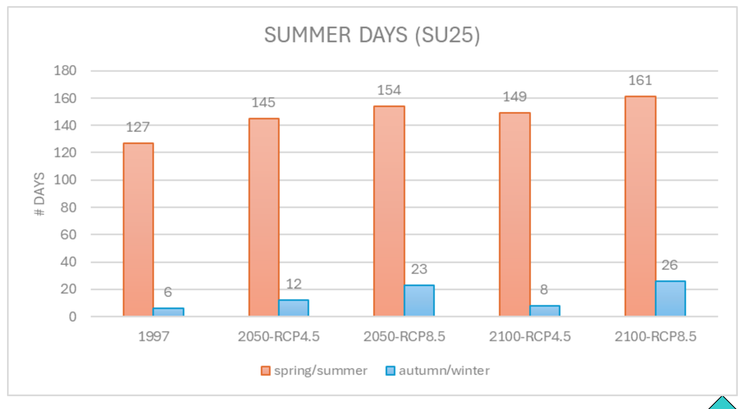

Figure III - Number of summer days (SU25) in Rome

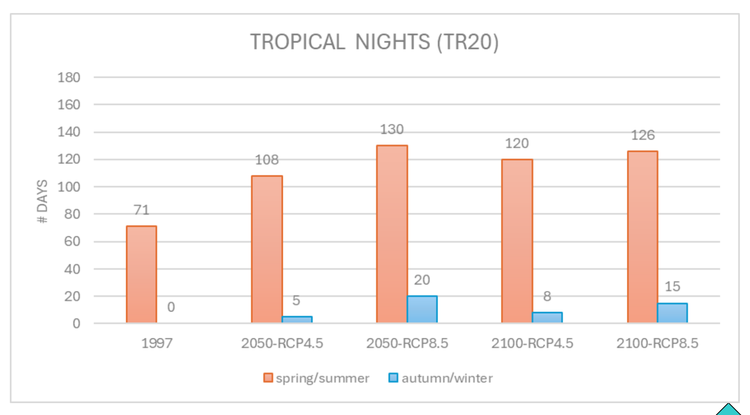

Figure IV - Number of tropical nights (TR20) in Rome

CONCLUSIONS

- The future evolution of the thermo-dynamic fields over Italy is simulated by means of WRF simulation. Extreme temperature indices, such as SU25 and TR20 (Table III) are computed for the city of Rome
- The increase in SU25 is high especially in winter. In the 2100-RCP8.5 winter such increase reaches almost 80% of the 1997 value
- The evolution of TR20 suggest a notable rise in the minimum temperatures. In the 2050-RCP4.5 case, the highest number of TR20 is counted, both in summer (130) and in winter (20).

References

- Fioravanti et al., 2016. Recent changes of temperature extremes over Italy: an index-based analysis. Theor Appl Climatol (2016) 123:473–486 DOI 10.1007/s00704-014-1362-1
- Lionello, P., & Scarascia, L. (2018). The relation between climate change in the Mediterranean region and global warming. Regional Environmental Change, 18, 1481-1493

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