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# Impacts of climate change in Italy

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# *Ricerca sul Sistema Energetico*

develops applied researches in the electro-energetic sector



[www.rse-web.it](http://www.rse-web.it)

In the Sustainable Development and Energy Sources Department (SFE) some activities involve:

- application of meteorological modeling to assess renewable energy capability;
- forecast of the meteorological variables influencing short and long term management of the electrical system;
- application of meteorological and chemical modeling for the assessment of the electricity system's impact on the air quality;
- *climatic changes analysis to investigate their impacts on the electro-energy system.*



# Outline

- Climate Changes (CC): what is happening?
- Monitoring Green-House-Gases (GHGs)
- Analyzing CC: Variables and Data-sets
- Elaborating Future projections over Italy



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# References

**Intergovernmental Panel of Climate Change (IPCC)**

<http://www.ipcc-data.org/>

**Copernicus Climate Change Service (C3S)**

<https://climate.copernicus.eu/about-c3s>

## **EU Reports**

## **Regional Climate Model (RCM) results (EU Projects)**

**PRUDENCE**                      **2001-2004**

**ENSEMBLES**                      **2004-2009**

**CIRCE**                              **2007-2010**

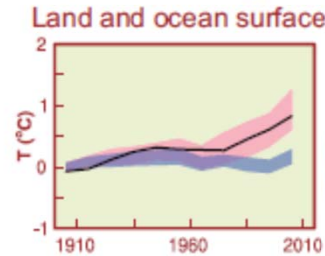
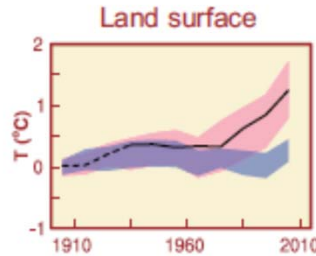
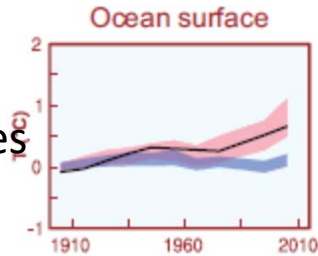
**ACQWA**                              **2008-2012**

**CORDEX (Euro-CORDEX, Med-CORDEX)**



# IPCC AR5 (2013)

Global Averages

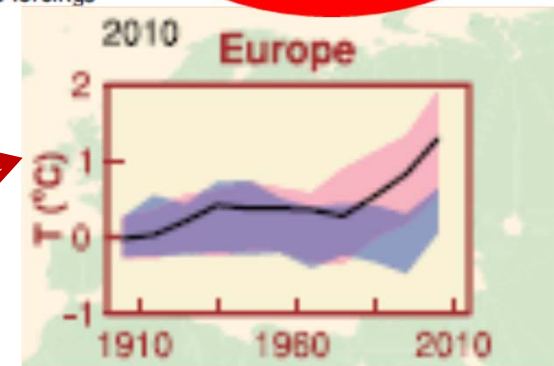


≡ Observations

Models using only natural forcings

Models using both natural and anthropogenic forcings

**Mediterraneo  
Hot Spot**



European Environmental Agency

EEA, 2012: 2002–2011

+ 0.77°C (T global)

+1.3 °C (T Europe)

EEA, 2015: 2005–2014

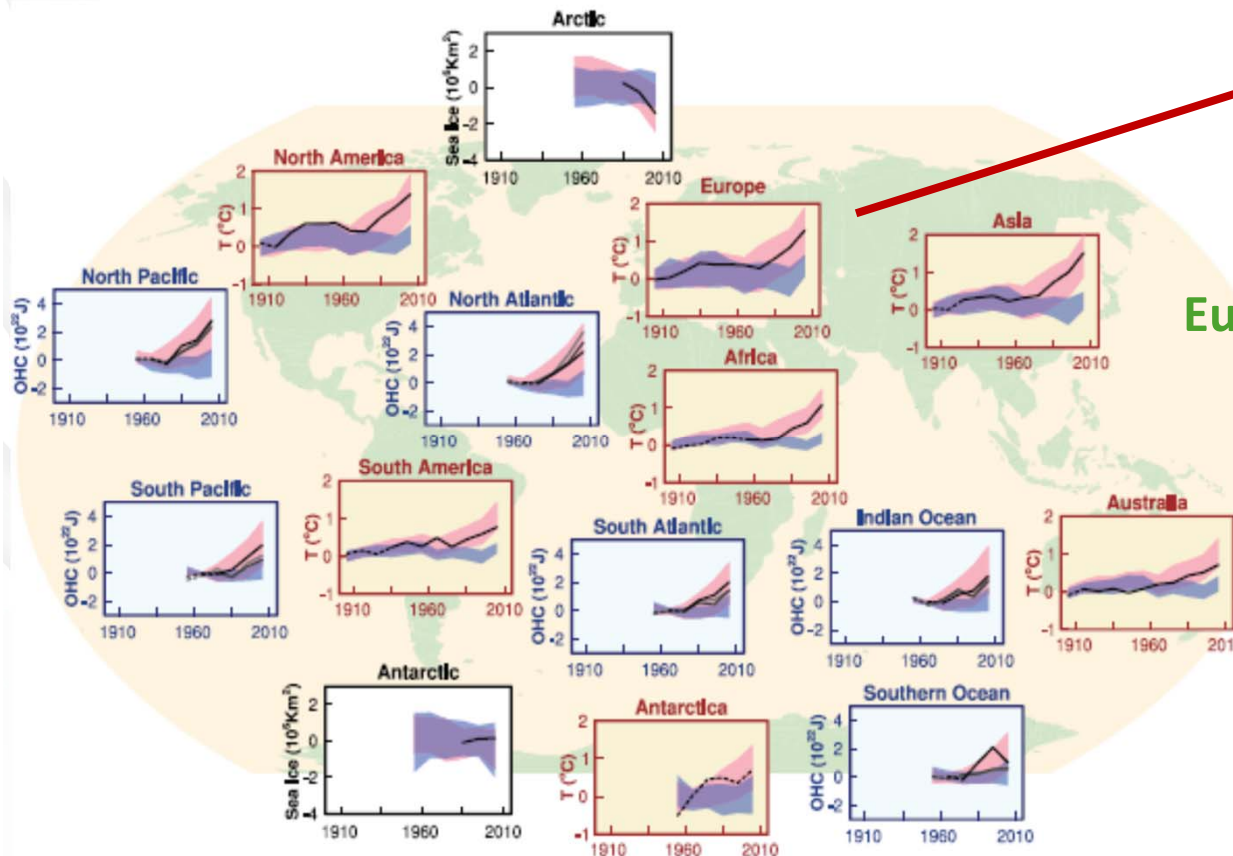
+ 0.82°C (T global)

+1.5 °C (T Europe)

EEA, 2017: 2007–2016

+ 0.9°C (T global)

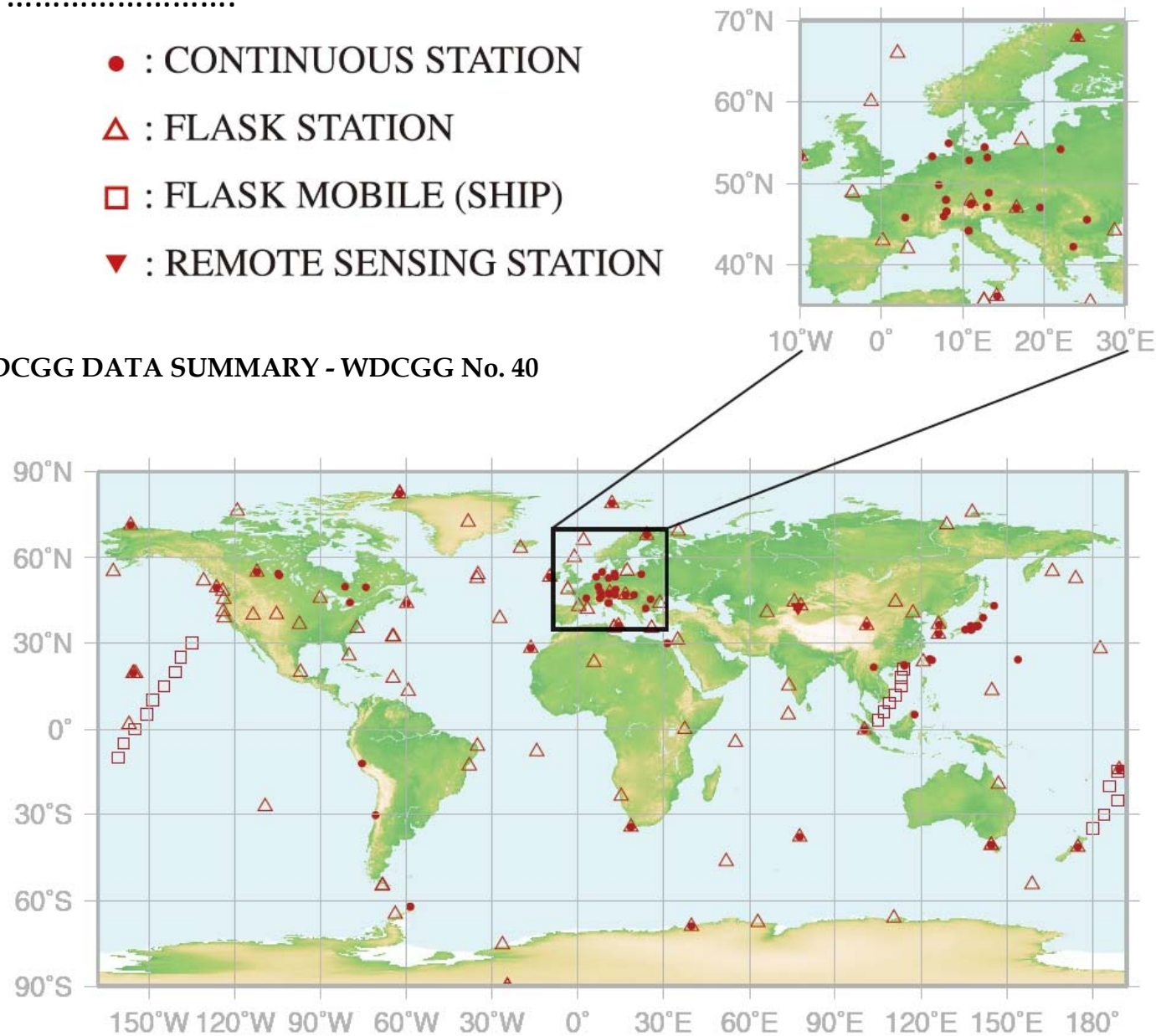
+1.6 °C (T Europe)



# Monitoring GHGs : The Global Atmosphere Watch (GAW)

- .....
- : CONTINUOUS STATION
  - △ : FLASK STATION
  - : FLASK MOBILE (SHIP)
  - ▼ : REMOTE SENSING STATION

WMO WDCGG DATA SUMMARY - WDCGG No. 40





# Plateau Rosa Station

OASI <http://oasi.rse-web.it/>



Selected greenhouse gas observatories



The Plateau Rosa (45.93°N, 7.71°E, 3480 m a.s.l.) is one of the highest GAW Regional stations in Europe. It is located near the Matterhorn, on the Italian side of the Alps (operated by the Turin section of the National Institute for Astrophysics). Its position in the free troposphere upon a large snowfield located over a bare mountain plateau and far from urban and polluted zones makes it appropriate for background measurements of greenhouse gases. The measurements of the main greenhouse gases ( $\text{CO}_2$  and  $\text{CH}_4$ ) and tropospheric ozone have been regularly carried out by the Research on Energy Systems (RSE). The longest time series is for  $\text{CO}_2$  currently covering more than 20 years (discrete sample measurements from 1989 to 1997, and continuous measurements from 1993 to present).

WMO Greenhouse Gas Bulletin, 2013. The State of Greenhouse Gases in the Atmosphere Based on Global Observations through 2012, No. 9, 6 November 2013.

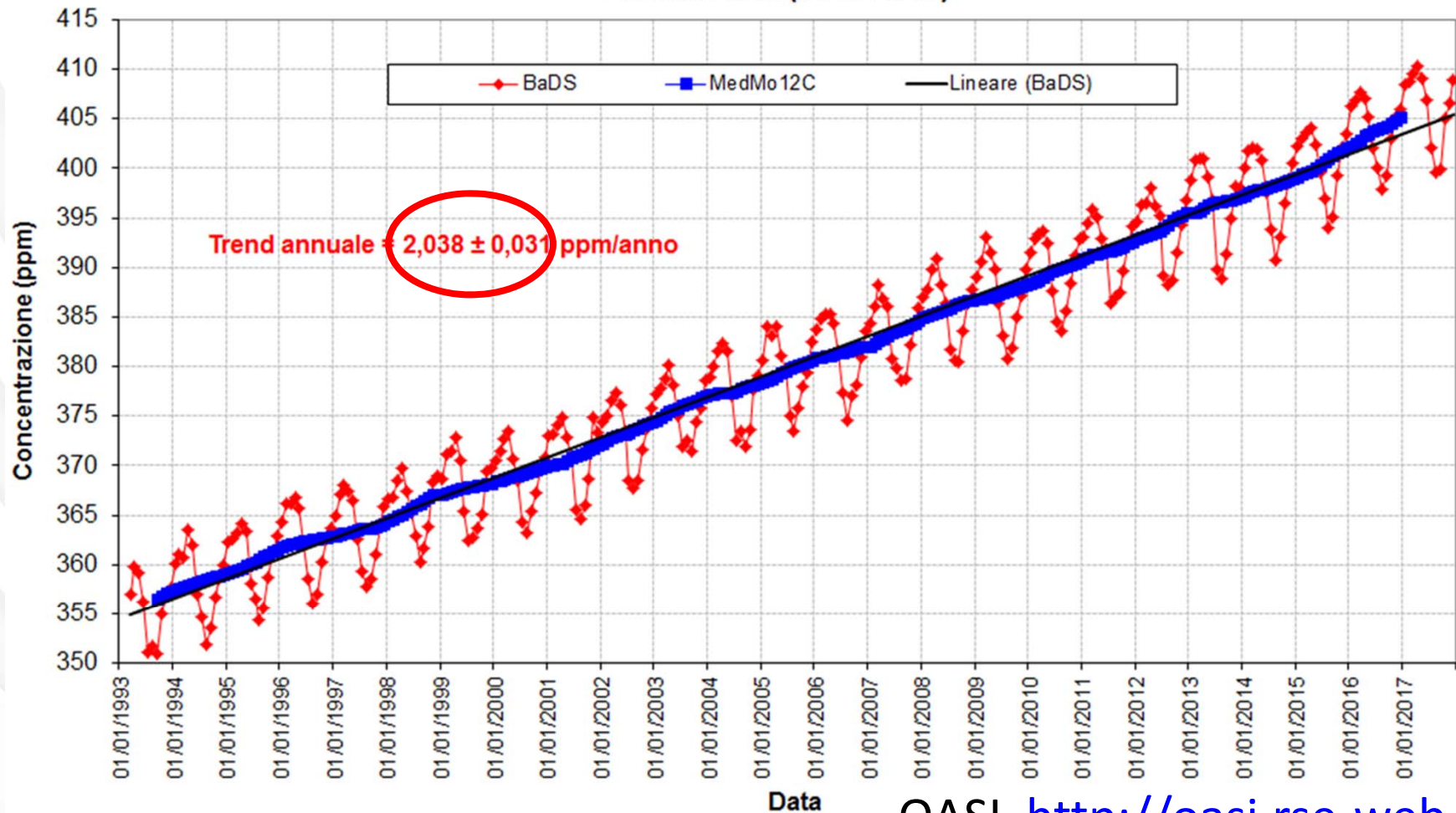


Plateau Rosa station (WMO ID Code: PRS, 45.93°N, 7.71°E, 3480 m a.s.l.)  
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# Monitoring Station Plateau Rosa

## CO2 BaDS (Background Data Selection)

Andamento del valore medio mensile della concentrazione atmosferica di fondo  
Plateau Rosa (1993-2017)

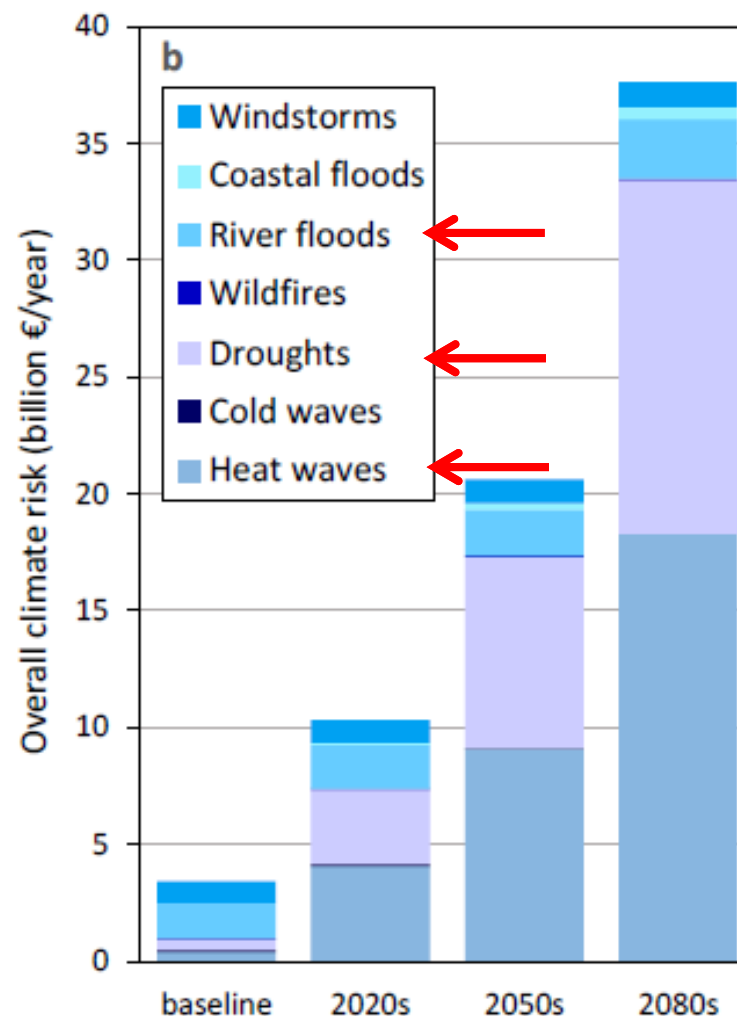
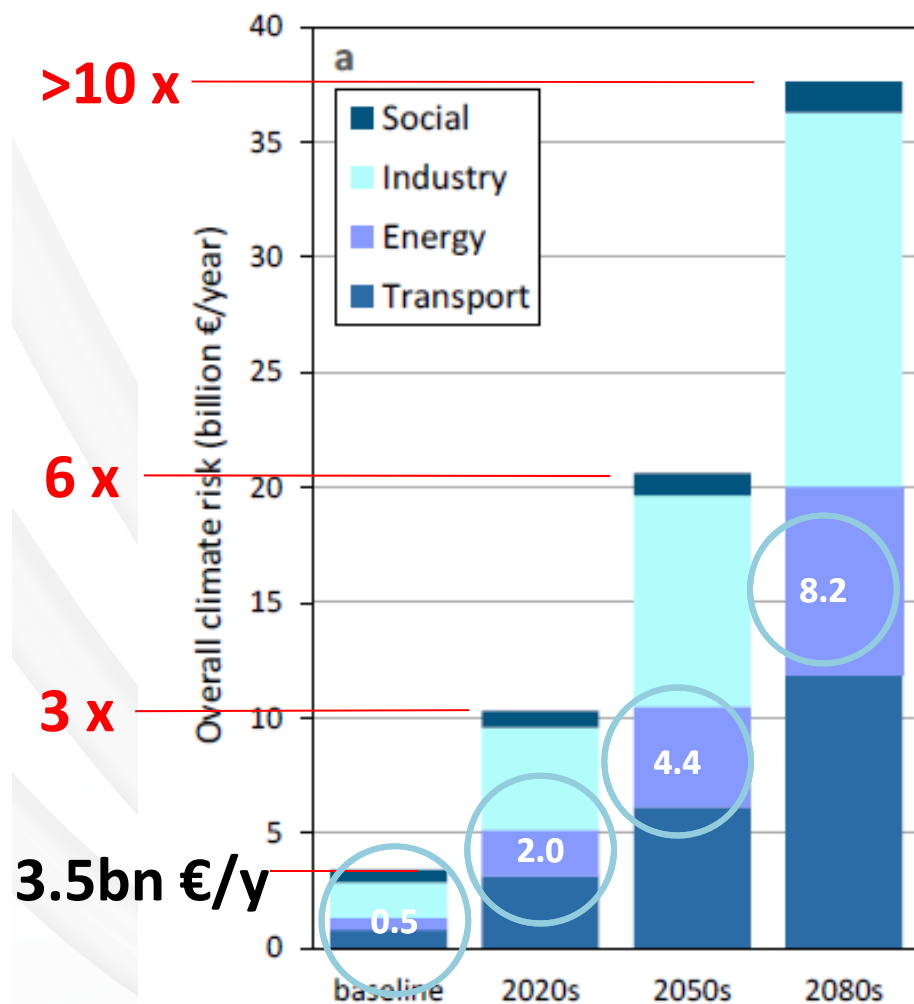


OASI <http://oasi.rse-web.it/>

GAW: The annual average increase for the past decade is **about 2.1 ppm/year**



## Resilience of large investments and critical infrastructures in Europe to climate change



*Sharp decrease of return periods of multiple extreme weather events (e.g. a current 100-year heat wave or 20-year flood may occur every 1 or 2 years under future climate conditions)*

**EEA, 2016: "The projected damage costs from climate change are highest in Southern Europe"**

# ***Energy Sector:***

## ***infrastructure vulnerable to climate impacts***

- **Fossil power generation** (loss of efficiency if temperature increases)
- **Hydroelectric generation** (loss of water supply if drought periods increase)
- **Renewable power generation** (loss of production in case of extreme weather events)
- **Energy distribution system** (reduced network distribution capacity if temperatures and storminess increase)
- **Infrastructures** (they could be damaged if a fire breaks out)
- **Energy power demand** (linked to weather variables, particularly to daily temperature)

# • Analysing CC: Data-sets

## Variables

Air Surface Temperature

Total precipitation

Wind speed

## Reference data (from obs)

### **E-OBS**

<http://eca.knmi.nl/dailydata>

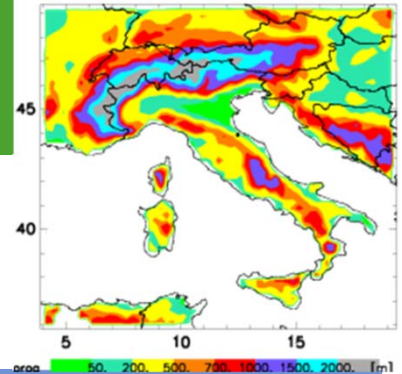
0.25 x 0.25 deg, from 1961

### **MESAN** (*MESocale ANalysis system*)

<https://ecds.se/dataset>

5 km, 1979÷2013

### **SYNOP**



## Model Data: GCMs, RCMs

### **CMIP3**

<http://www.pcmdi.llnl.gov>

~100 km, 1961÷2050 (SRES A2, A1B, B1)

### **ENSEMBLES**

<http://www.ensembles-eu.org>

25 km, 1961÷2050 (SRES A1B)

### **Med-CORDEX**

<https://www.medcordex.eu/>

0.11 deg (~12km), 1961÷2050 (RCP4.5, RCP8.5)

0.44 deg (~50km), 1961÷2100 (RCP4.5, RCP8.5)

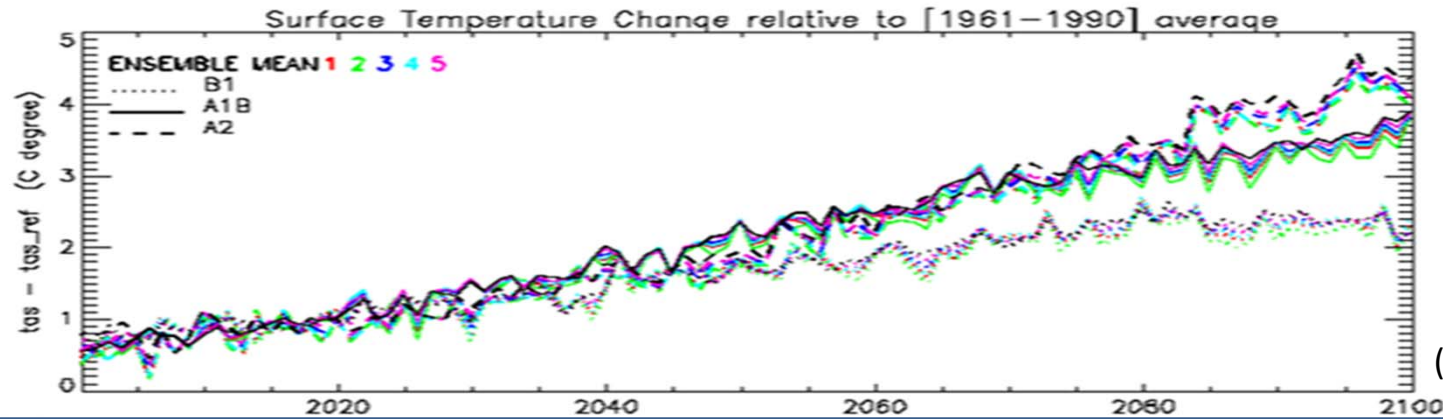
### **Euro-CORDEX**

<http://www.euro-cordex.net/>

0.11 deg (~12km), 1961÷2100 (RCP8.5)

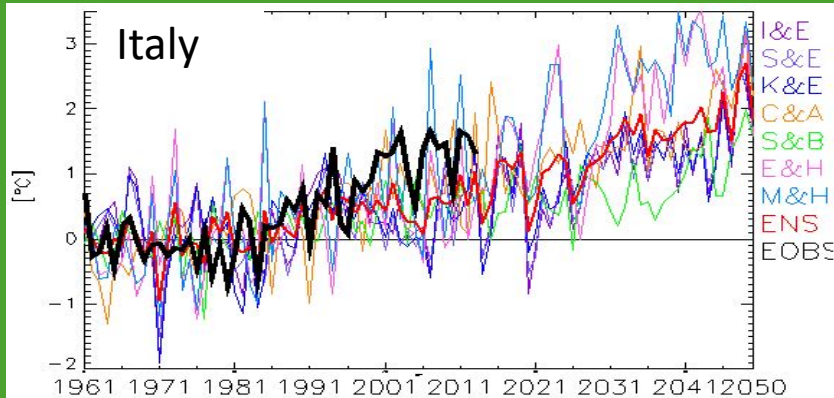


## Italian Region



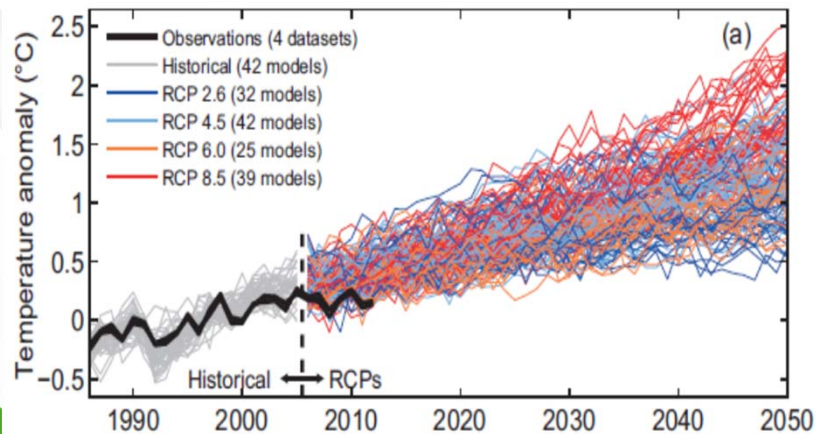
GCMs: CMIP3

(Faggian, 2007)



RCMs: ENSEMBLES A1B

Global mean temperature near-term projections relative to 1986–2005



IPCC, AR5

# Elaborationg Future projections over Italy

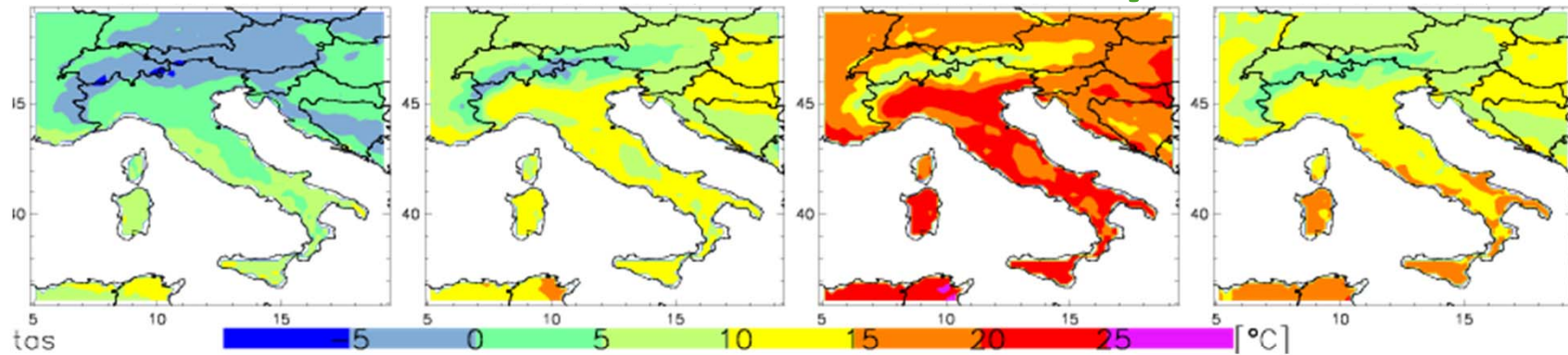
**REF: 1961-1990 or 1971-2000**

**FUT: 2021-2050 , 2071-2100**

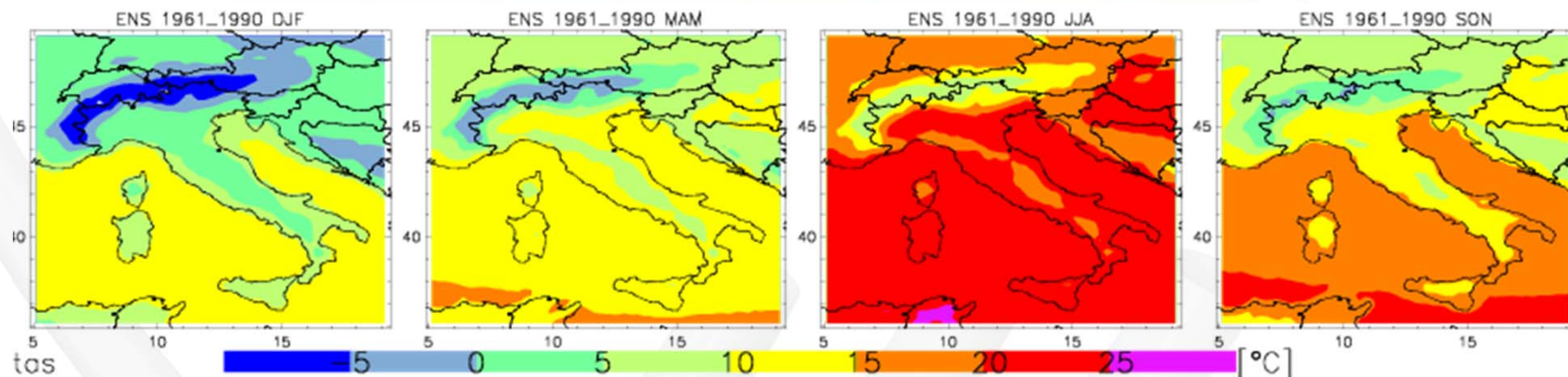
- Scenarios in REF period: **V(REF)**
- Scenarios in FUT periods: **V(FUT)**
- Anomalies:  **$V(FUT) - V(REF)$**
- Anomalies (%):  **$100 * V(FUT) - V(REF) / V(REF)$**

# Reference Scenarios – mean *temperature*

E-OBS

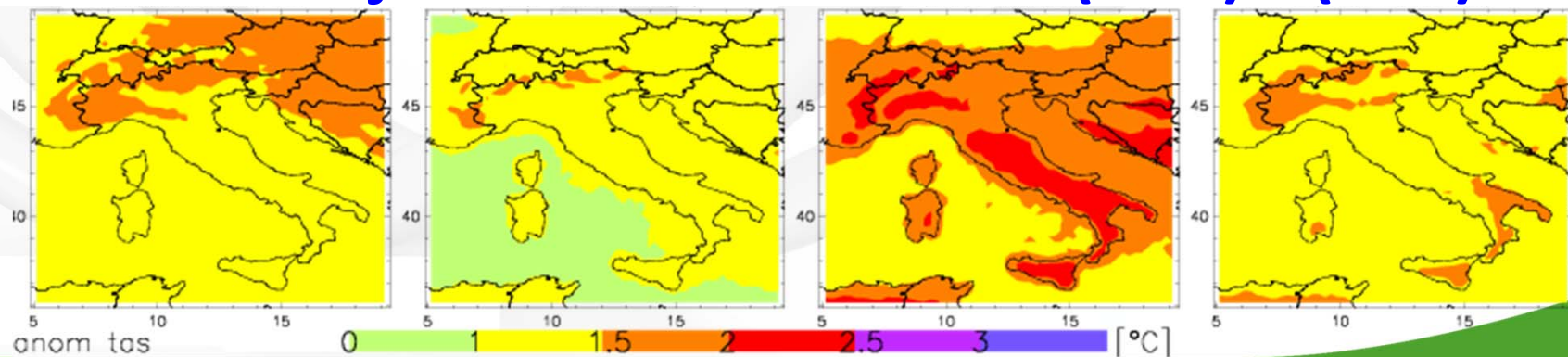


ENS



## Future Projections: Anomalies $T(FUT)-T(REF)$

ENS





Winter

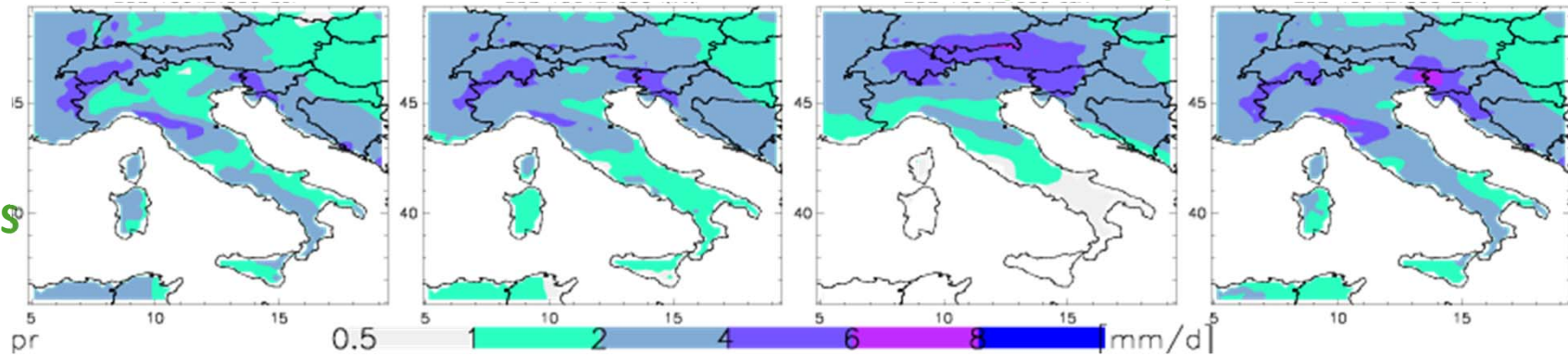
Spring

Summer

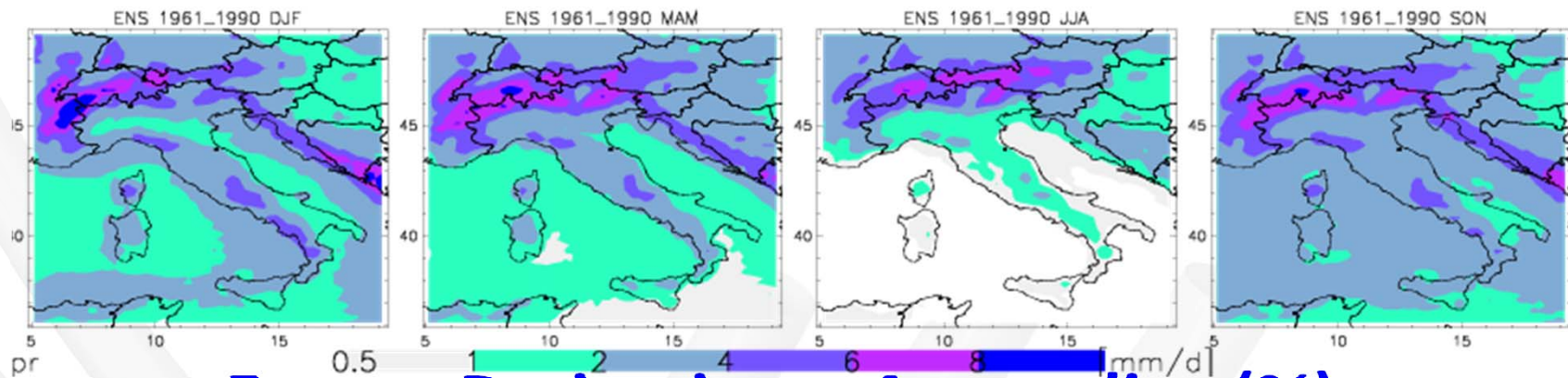
Autumn

## Reference Scenarios – total *precipitation*

E-OBS

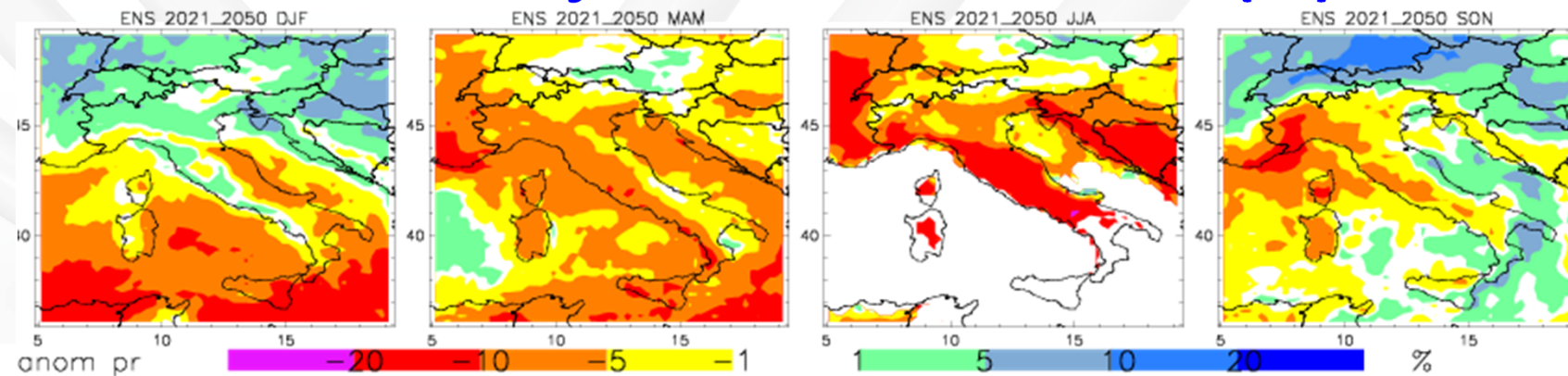


ENS

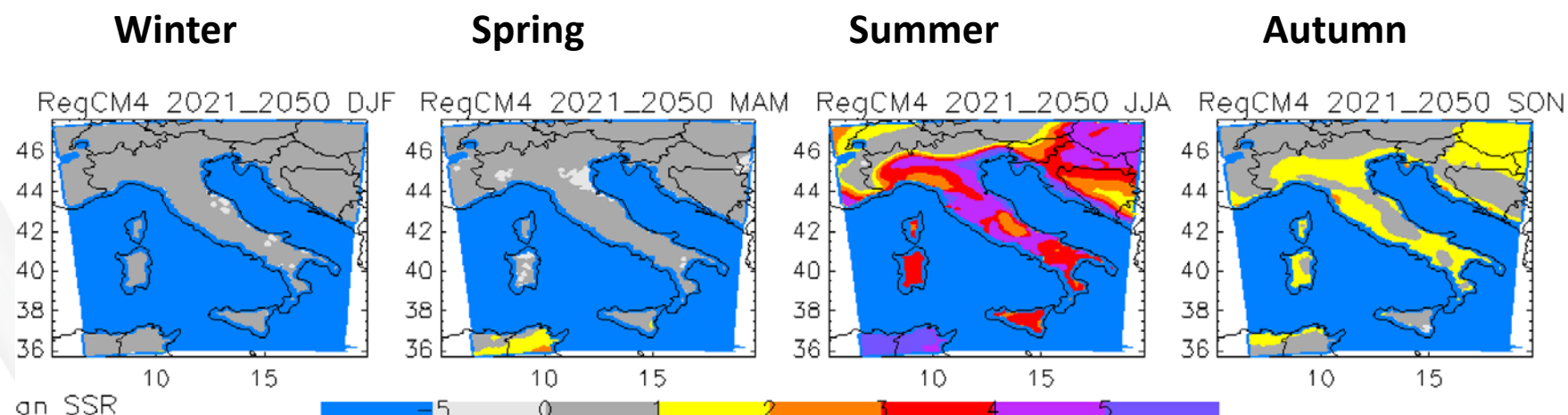


## Future Projections: Anomalies (%)

ENS



## Estimating fire danger over Italy in the next decades



Seasonal changes of the Seasonal Severity Rating (SSR, from the Forest Fire Weather Index FWI), projected by 2021–2050 relative to 1971–2000 according RegCM4 (Med-CORDEX model) in RCP 8.5

(Faggian, 2018)

# ETCCDI indices (WMO,2009)

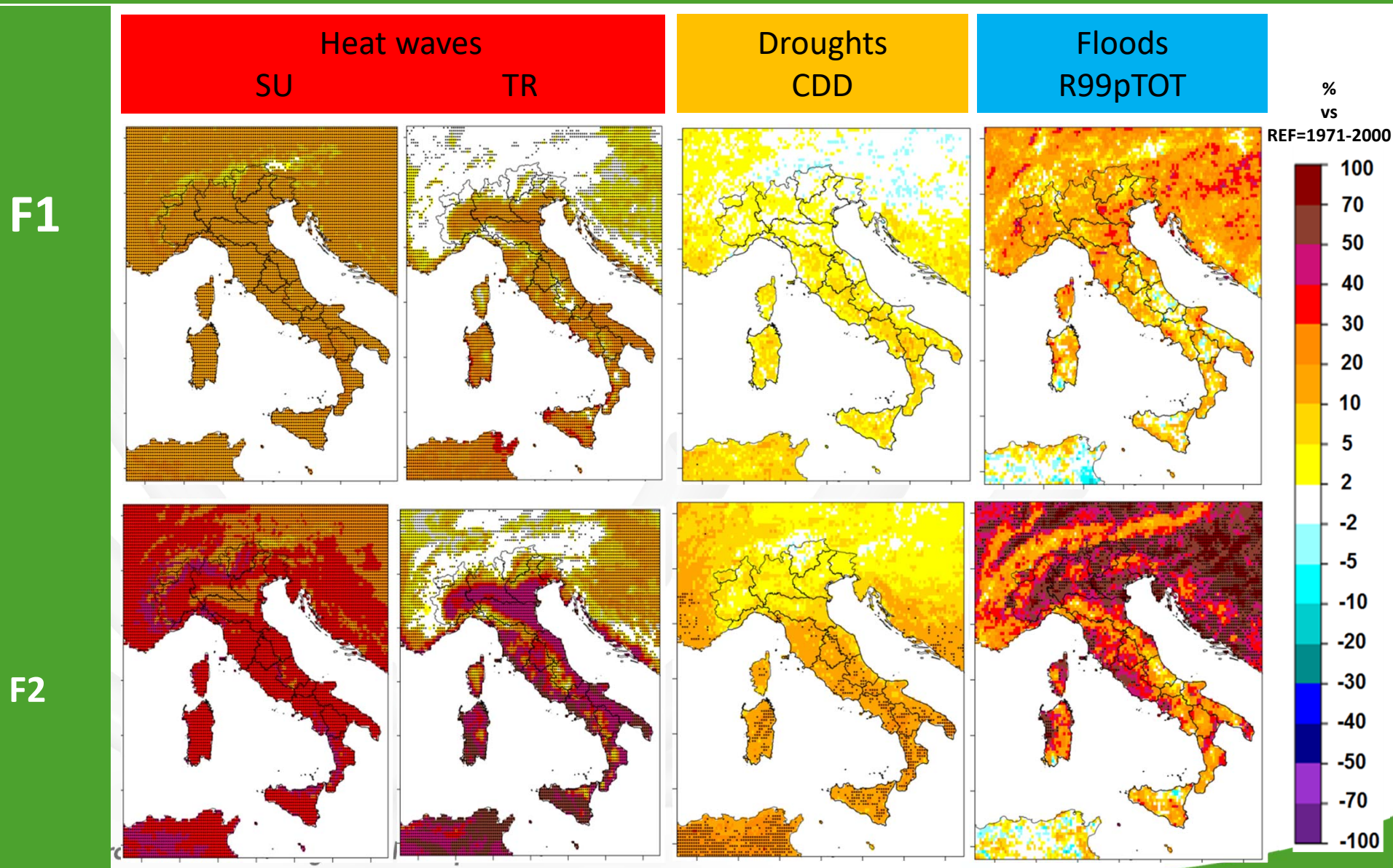
defined by the World Meteorological Organization Expert Team on Climate Change Detection and Indices

Hazard	Index	Description	
Heat Waves	SU	Summer days. Annual count of days when TX (daily maximum temperature) > 25°C.	E T C C D
	TR	Tropical Night. Annual count of days when TN (daily minimum temperature) > 20°C.	
Drought	CDD	Maximum length of dry spell. Maximum number of consecutive dry days	
Severe Thunderstorms	R99pTOT	Annual total PRCP when RR > 99p. Annual total precipitation when daily wet day amount >99 <sup>th</sup> percentile	
Floods			



# Future projections over Italy

## F1=2021-2050 , F2=2071-2100



# CONCLUSIONS

- Climate change projections over the Mediterranean region (with focus over Italy) point out a significant warming and drying, especially in the warm season.
- By 2050 it is expected:
  - a) a mean warming of 1-1.5°C in winter , ~ 2°C in summer
  - b) a warming over 2°C in extreme temperature values
  - c) an increases in droughts, floods and wind storms
- an exacerbation of the hazards , projected to become more serious in the second part of the century

CLIMED <http://climed.rse-web.it>

# *Thank you*

## ***Acknowledgement***

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