

Analisi degli indici estremi derivati dalle simulazioni del modello regionale RegCM4 a 50km per la regione europea

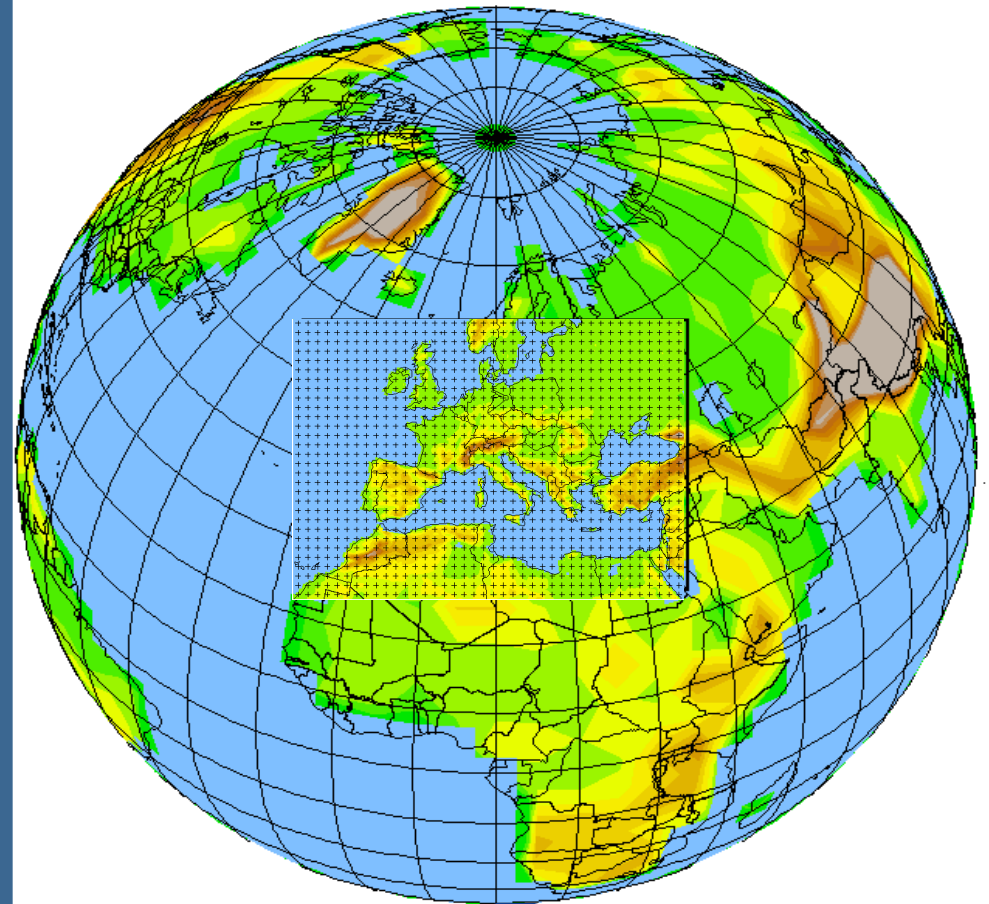
Erika Coppola

Abdus Salam International Centre for Theoretical Physics, Trieste, Italy

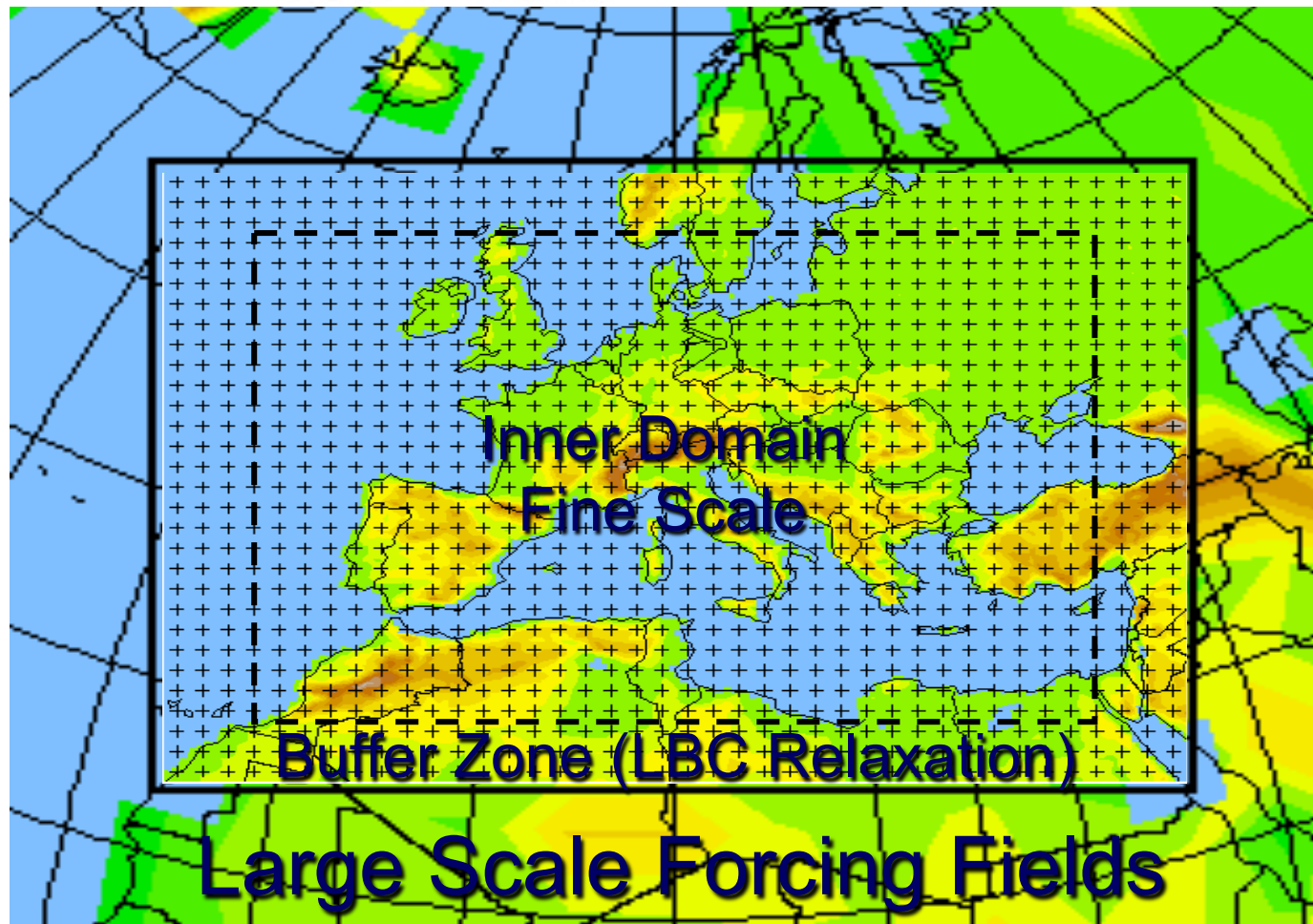


“Nested” Regional Climate Modeling: Technique and Strategy

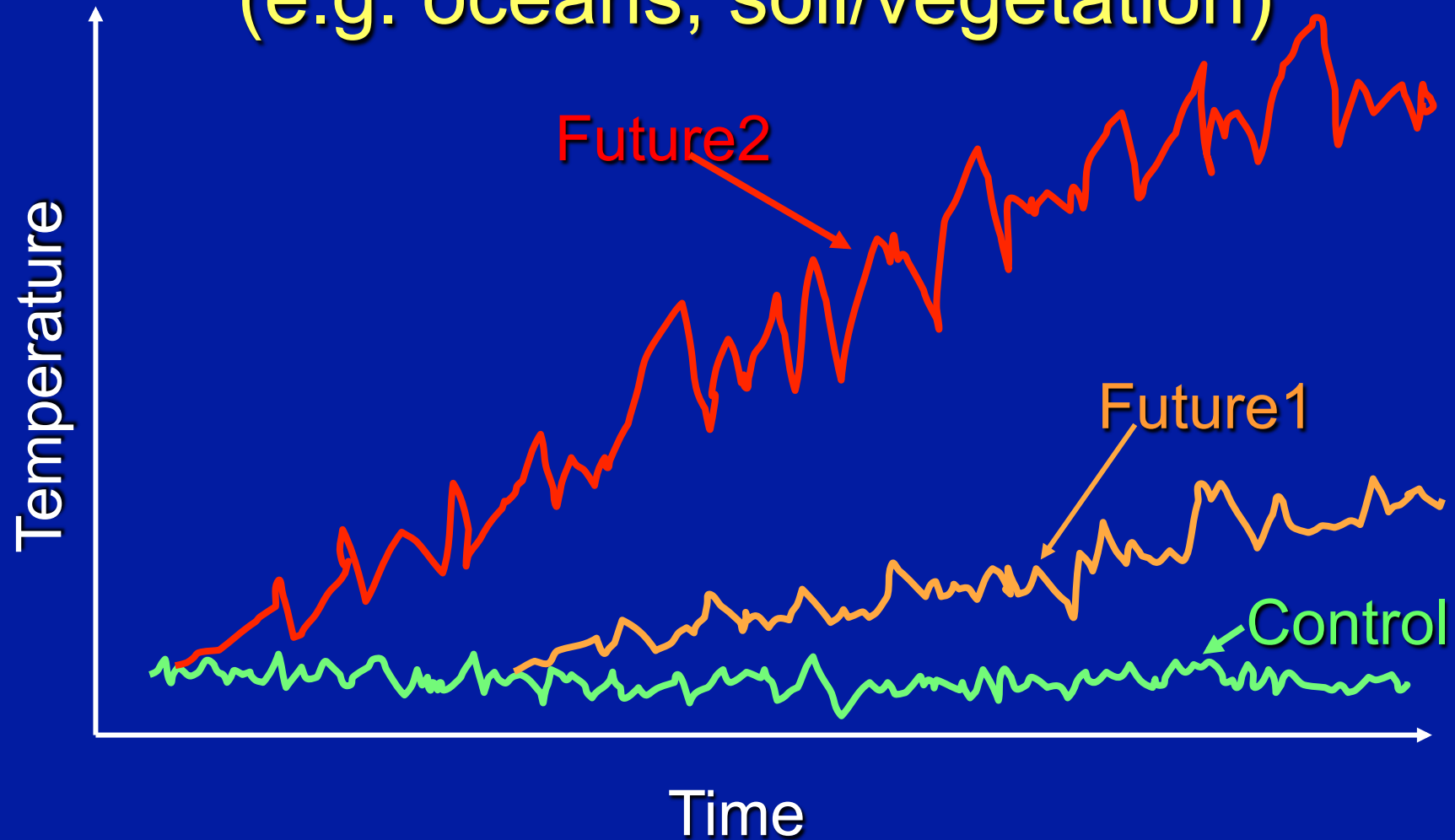
- **Motivation:** The resolution of **GCMs** is still too coarse to capture regional and local climate processes
- **Technique:** A **Regional Climate Model** (RCM) is “nested” within a GCM in order to locally increase the model resolution.
 - Initial conditions (IC) and lateral boundary conditions (LBC) for the RCM are obtained from the GCM (“**One-way Nesting**”) or analyses of observations (**perfect LBC**).
- **Strategy:** The GCM simulates the response of the general circulation to the large scale forcings, the RCM simulates the effect of sub-GCM-grid scale forcings and provides fine scale regional information
 - **Technique borrowed from NWP**



RCM Nesting procedure



Climate can evolve differently depending on the initial conditions of its slow components (e.g. oceans, soil/vegetation)



Irreducible Uncertainty of Climate Change

A1: Rapid economic growth, population 9B in 2050 then decline, quick spread of efficient technologies, convergent world

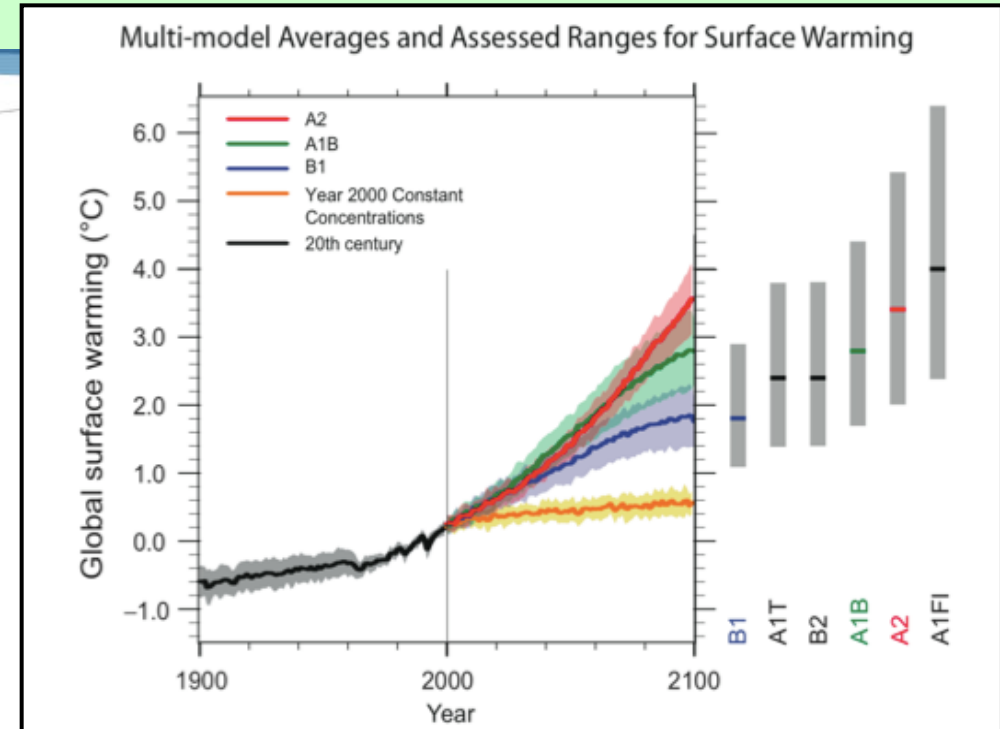
A1F: fossil fuels

A1B: mix of fuels

A1T: non-fossil fuels

A2: more divided/diverse world, continual population increases, regional economic development, slower and fragmented technological and economic gains

B1: Same as A1, but change toward service and information economies, reductions in material intensity

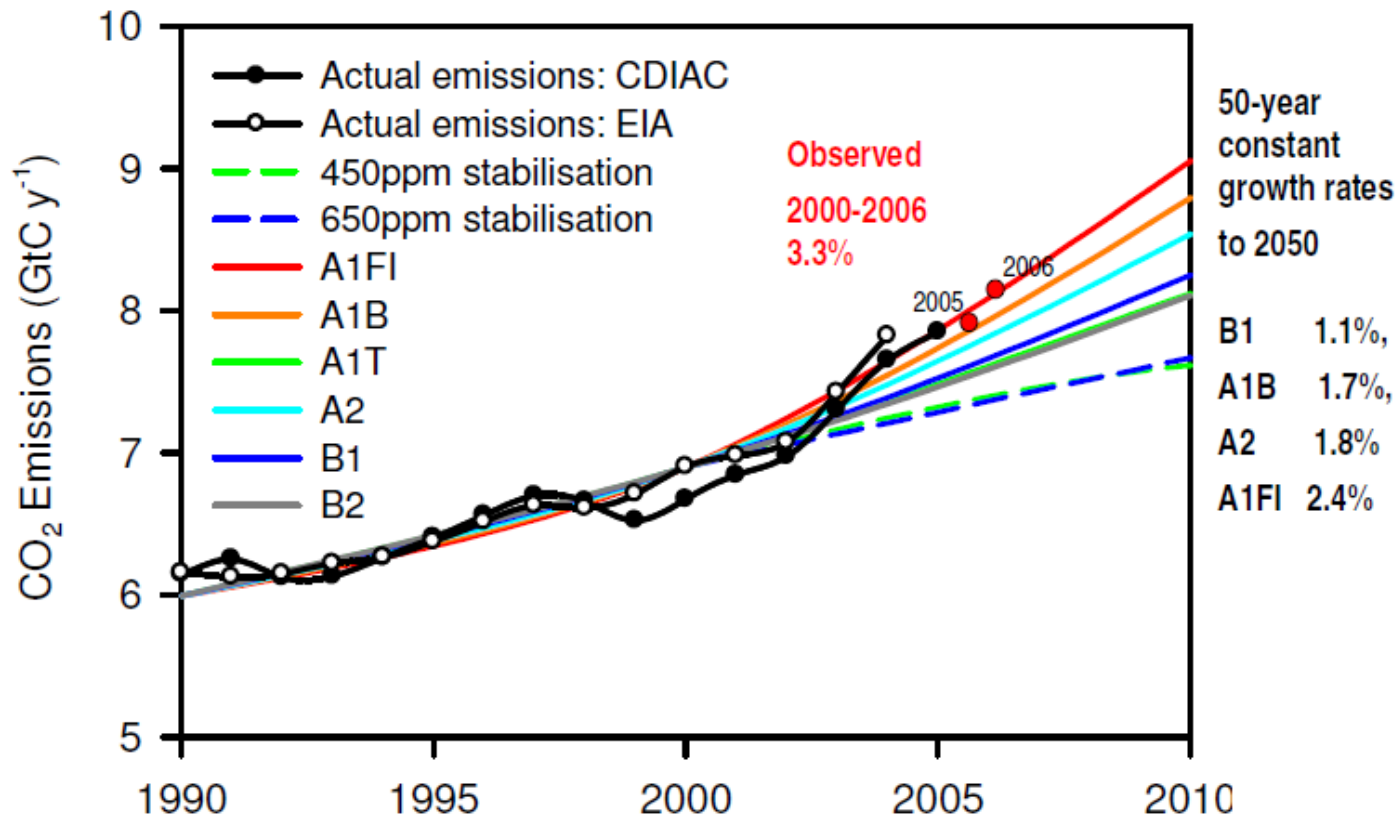


IPCC Fourth Assessment Report May 2007

B2: More divided world but ecologically friendly, slower population growth than A2, intermediate economic development, less rapid technological change, more fragmented change at more local level

Moving Beyond IPCC 4 Scenarios

Trajectory of Global Fossil Fuel Emissions



Raupach et al. 2007, PNAS

Liverman et al., 2009: planning should consider 4 deg C rise by 2060

Moving Beyond IPCC 4 Scenarios

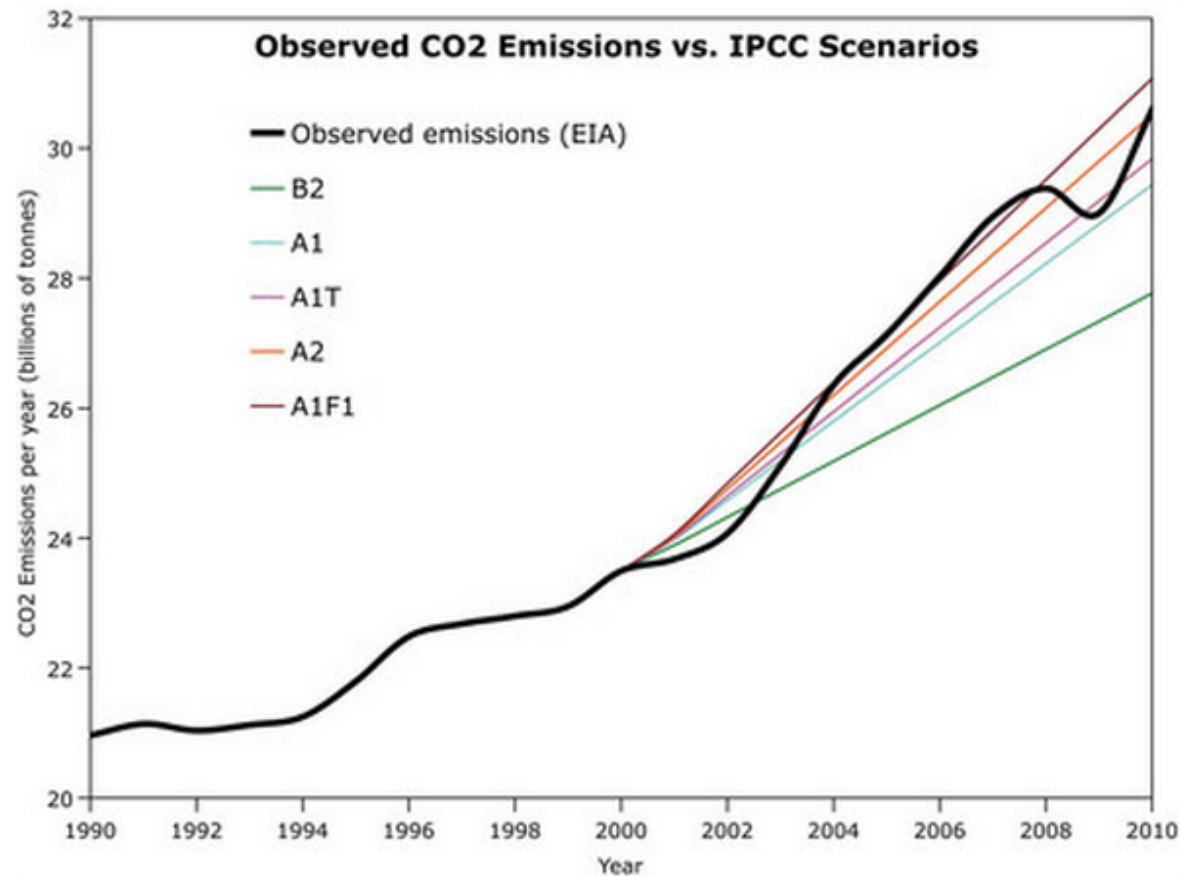
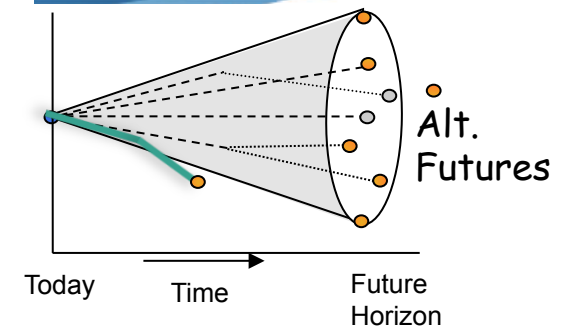


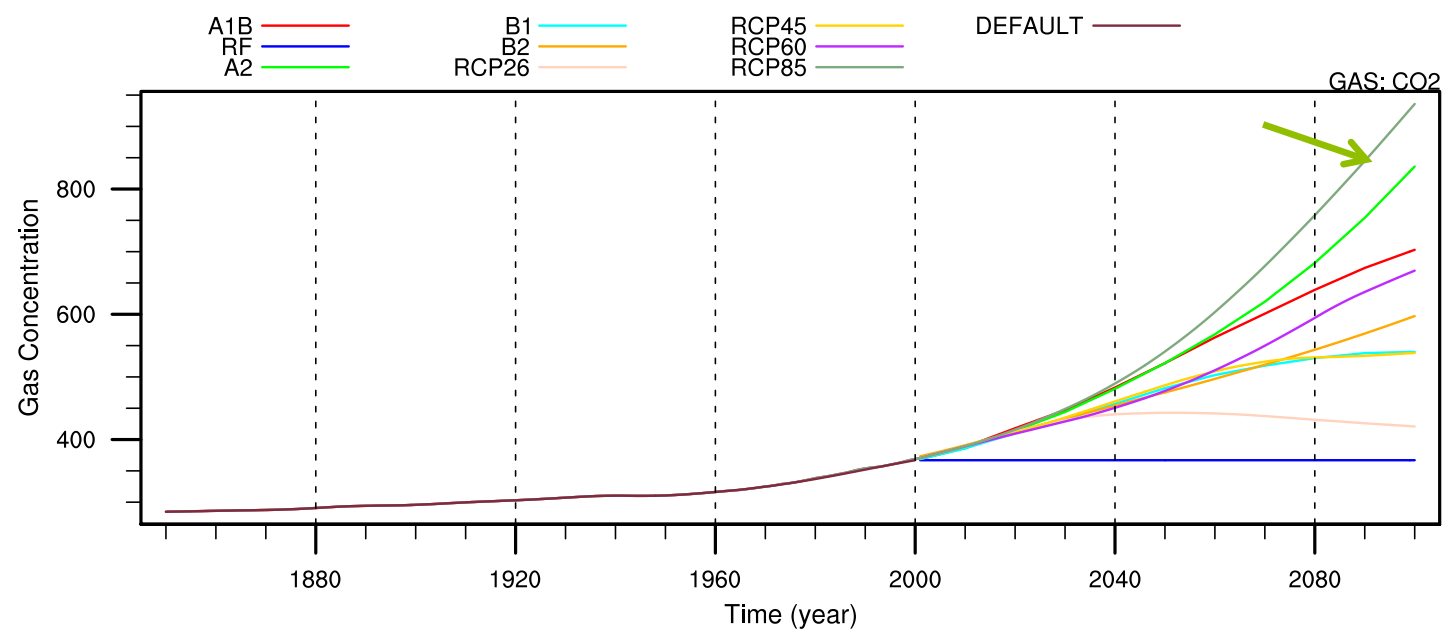
Figure 1: US Energy Information Administration (EIA) global human CO₂ annual emissions from fossil fuels estimates vs. IPCC SRES scenario projections. The IPCC Scenarios are based on observed CO₂ emissions until 2000, at which point the projections take effect.



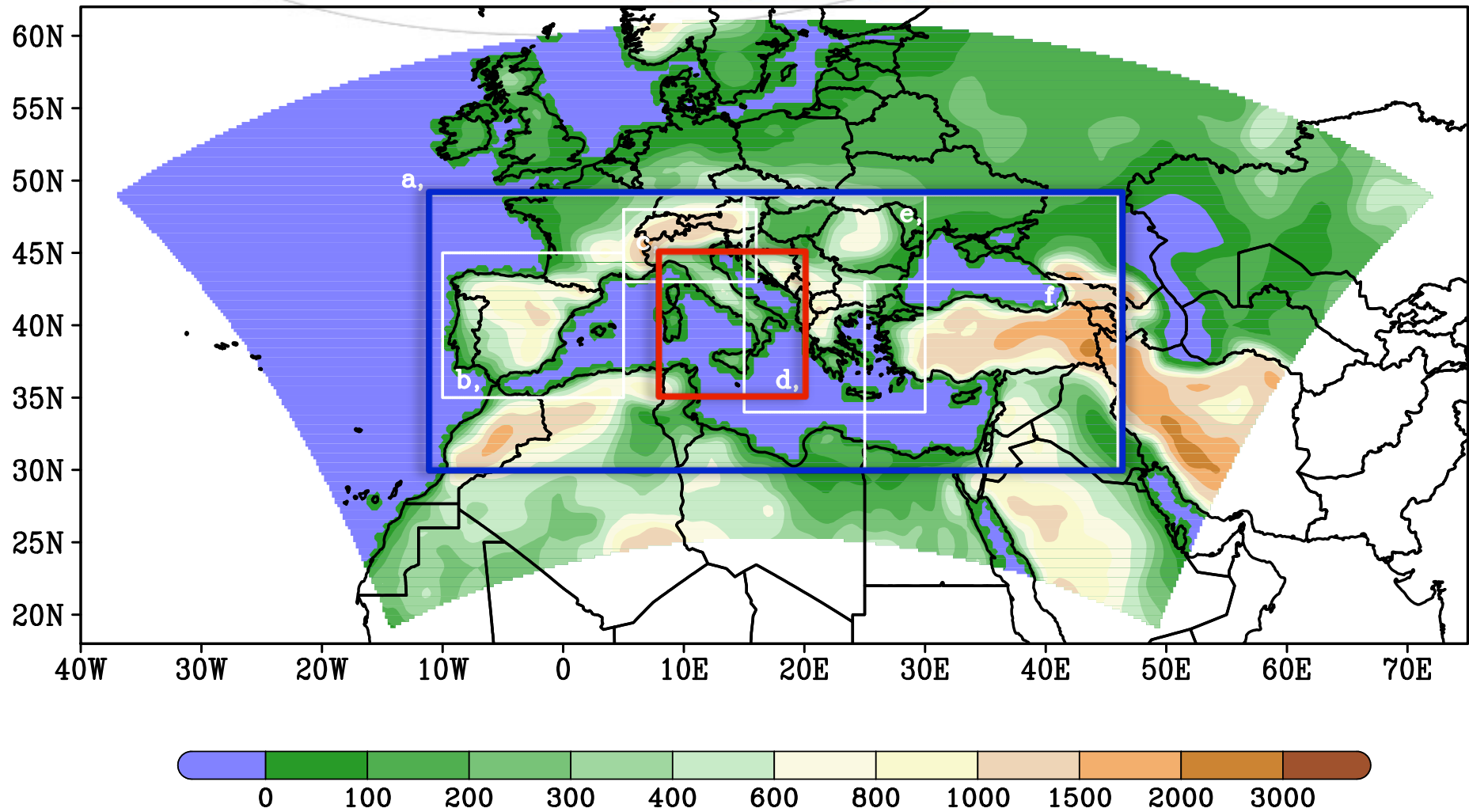
Abraham, 2012, <http://theconversation.edu.au>

Liverman et al., 2009: planning should consider 4 deg C rise by 2060

Vecchi IPCC4 scenari + nuovi RCP usati nel prossimo IPCC5

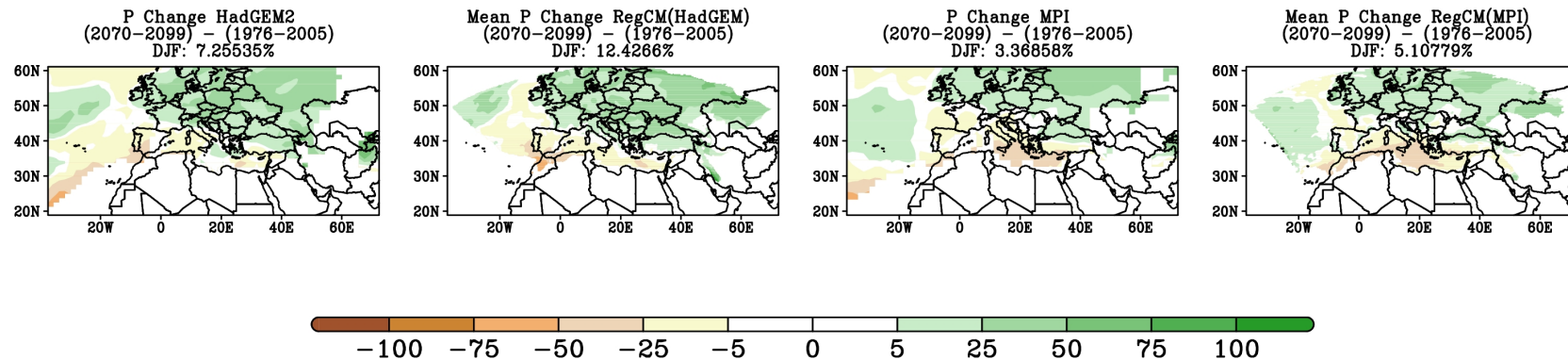


CORDEX domain Europe

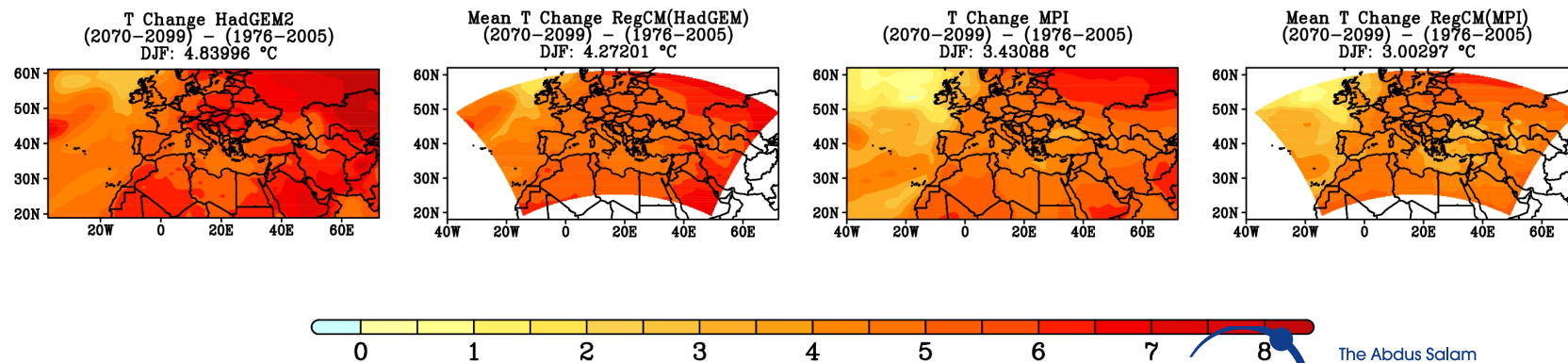


Inverno

Pioggia: differenza percentuale del periodo 2070-99 rispetto al presente

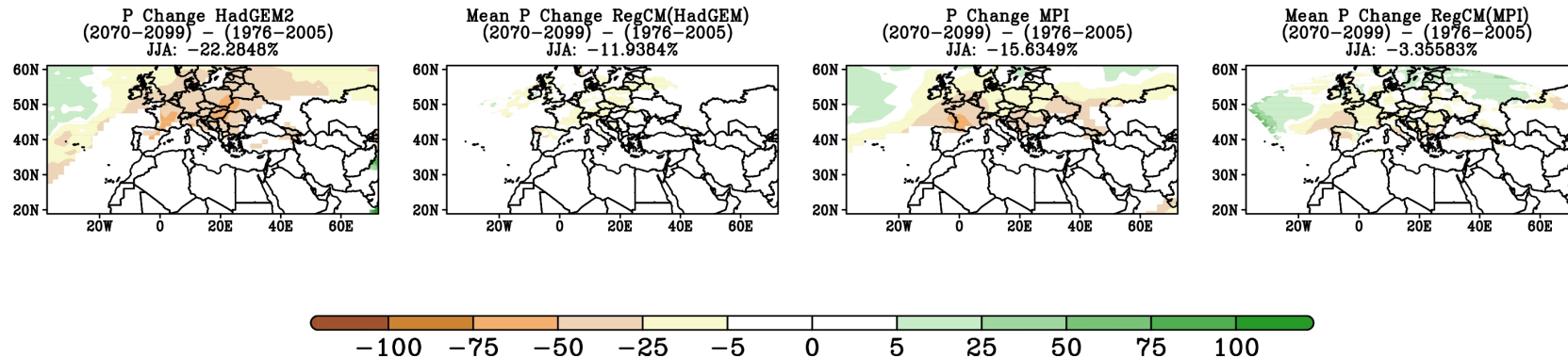


Temperatura: differenza percentuale del periodo 2070-99 rispetto al presente

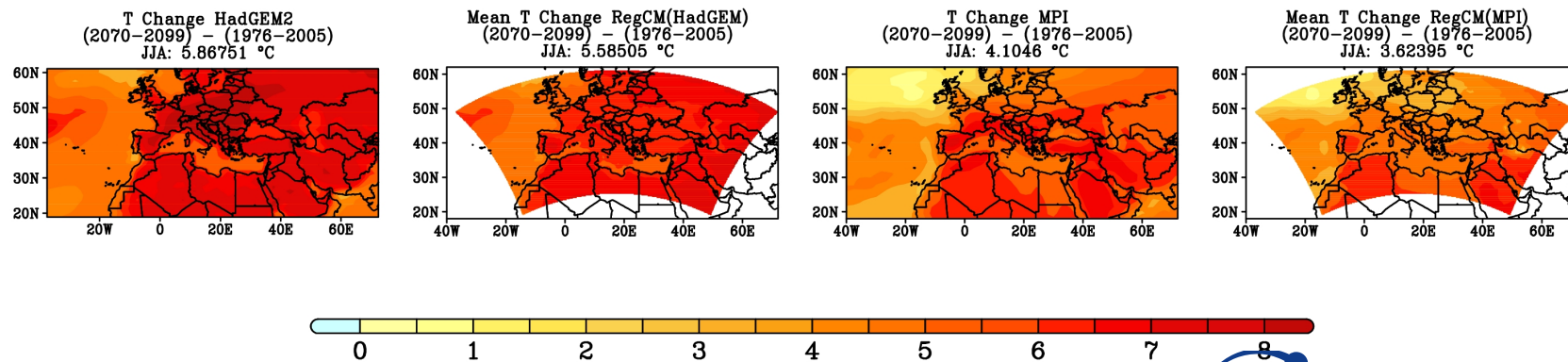


Estate

Pioggia: differenza percentuale del periodo 2070-99 rispetto al presente

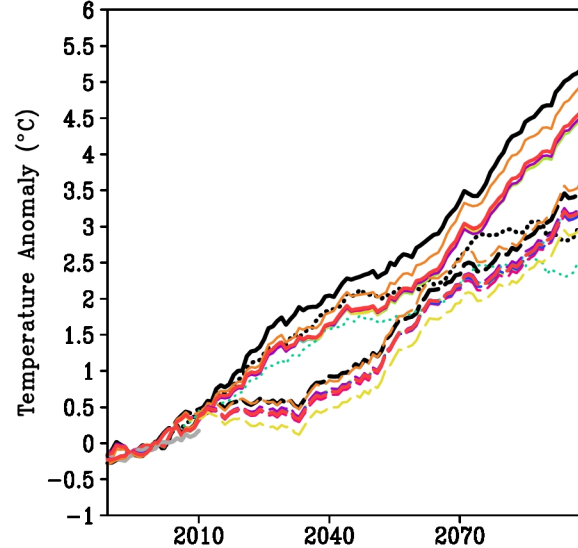


Temperatura: differenza percentuale del periodo 2070-99 rispetto al presente

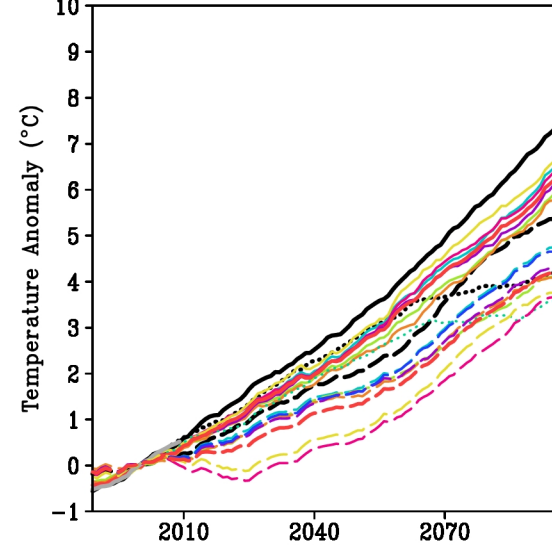


Anomalia di temperatura

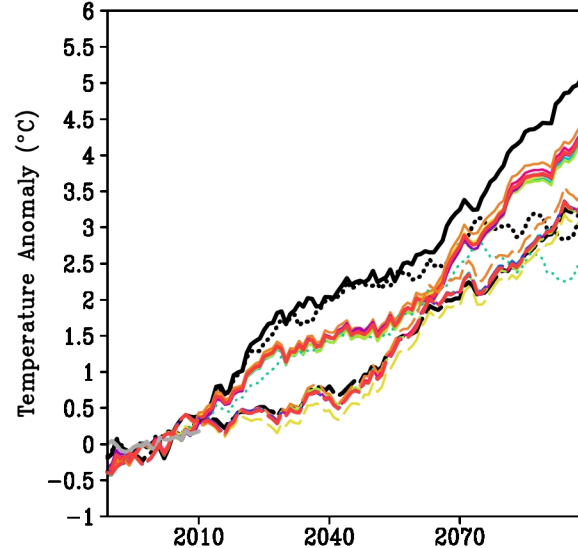
DJF 1970–2099 Mediterranean



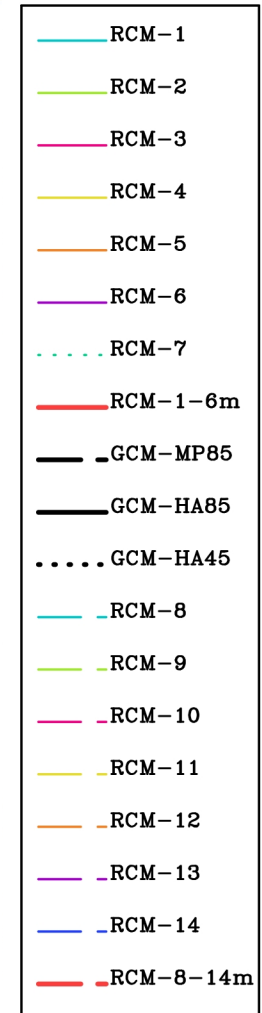
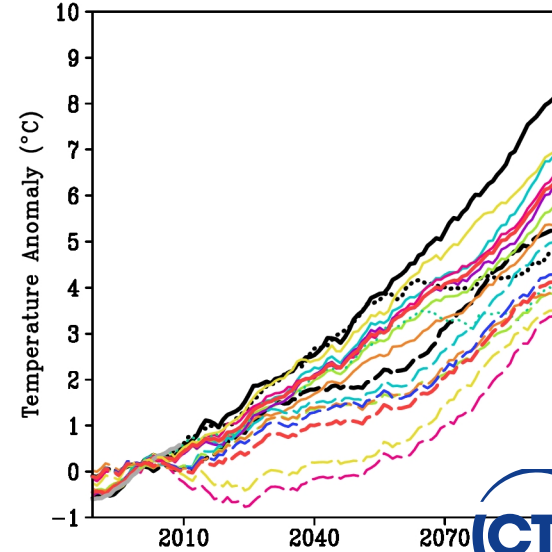
JJA 1970–2099 Mediterranean



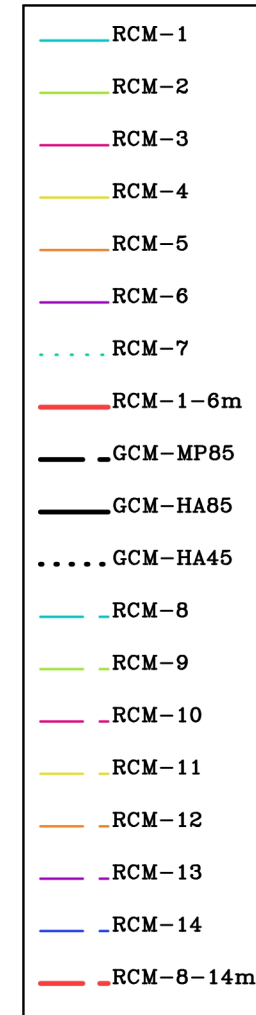
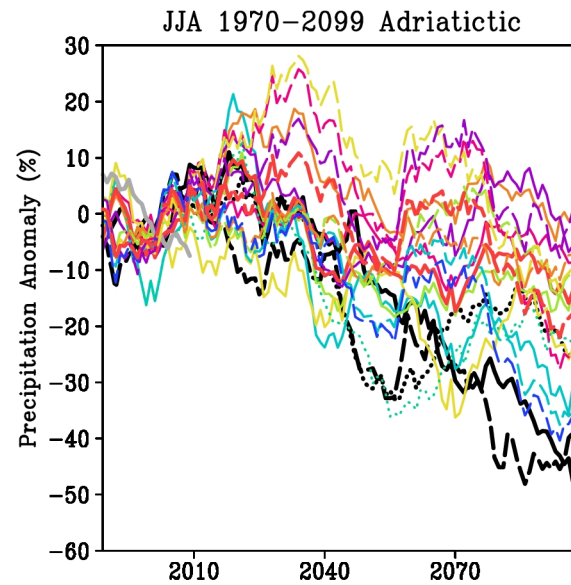
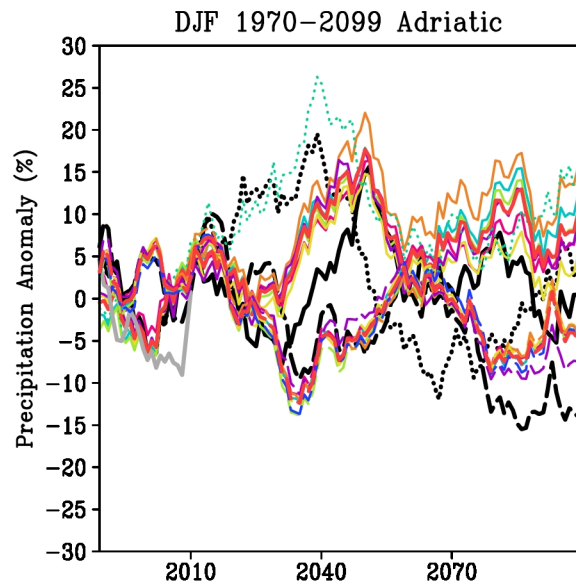
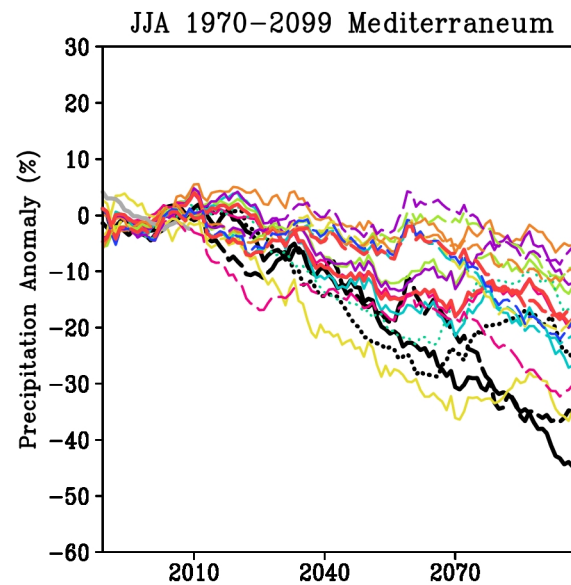
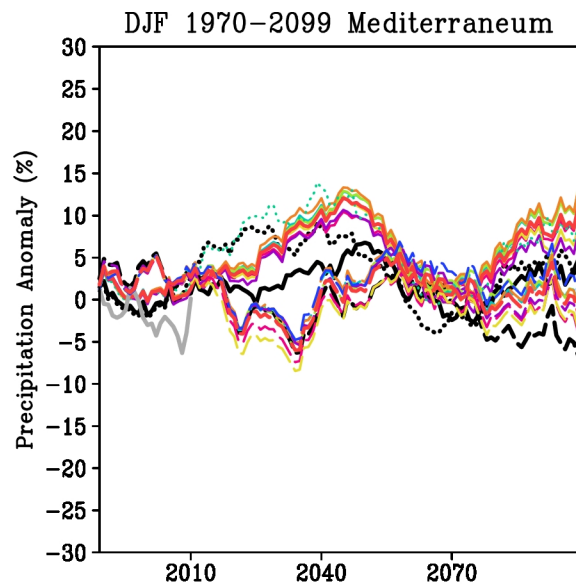
DJF 1970–2099 Adriatic



JJA 1970–2099 Adriatic



Anomalia di precipitazione



Un Po' di nomenclatura

Ondate di calore

Heat Wave Day Index (HWD): Number of heat wave days, where a heat wave occurs when for at least N_d consecutive days the daily maximum temperature exceeds the long term average by at least N_t degrees.

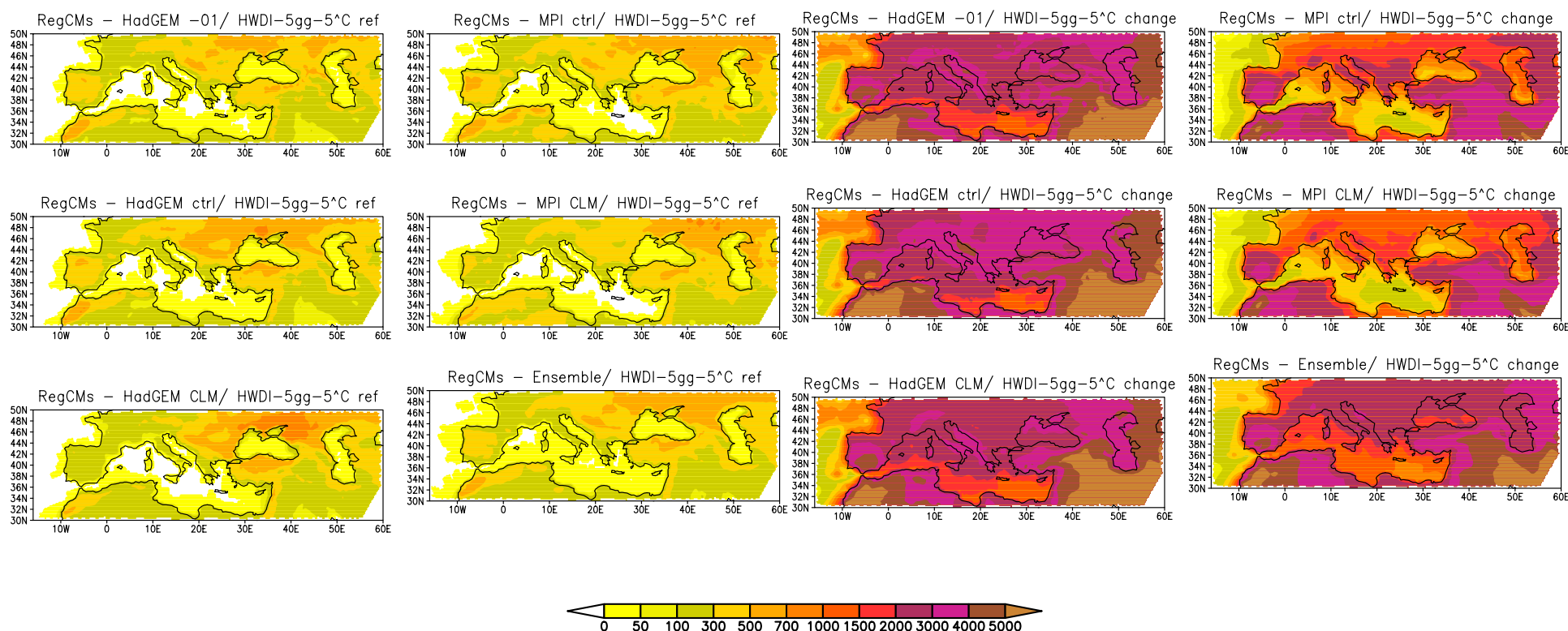
Siccita'

Dry Spell Length Index (CDD): Maximum number of consecutive dry days, where a dry day is defined as having precipitation below 1 mm/day.

Eventi estremi di precipitazione

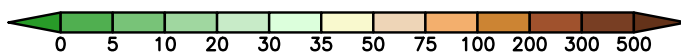
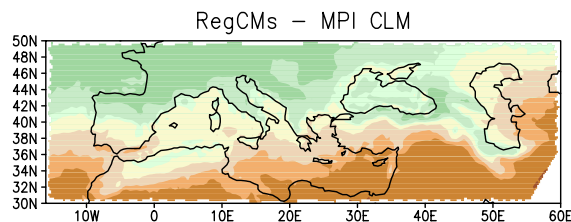
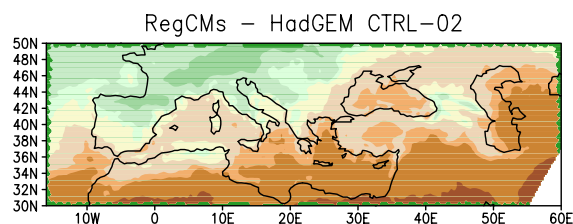
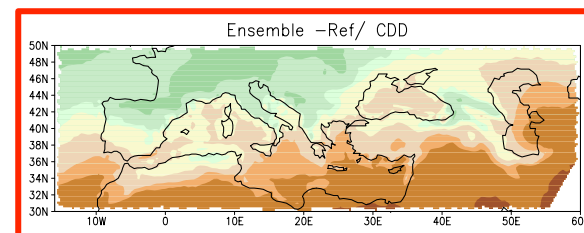
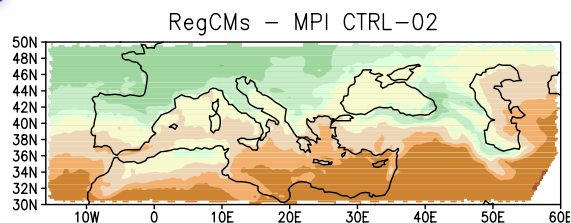
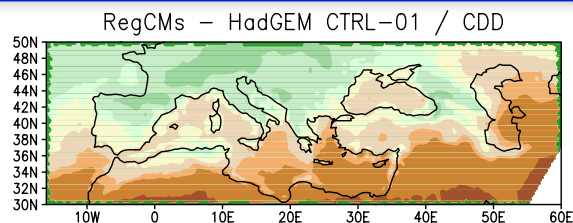
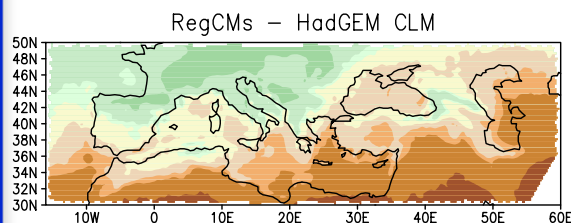
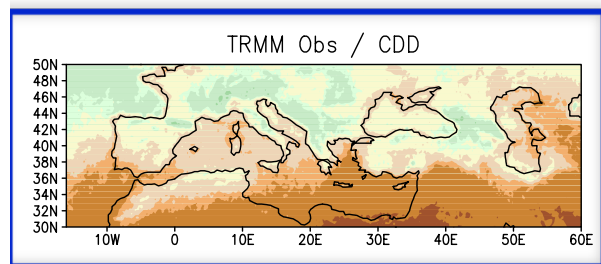
Heavy precipitation Index (R95): Percent of total precipitation above the 95% percentile

Ondate di calore *Heat Wave Day Index (HWD)*



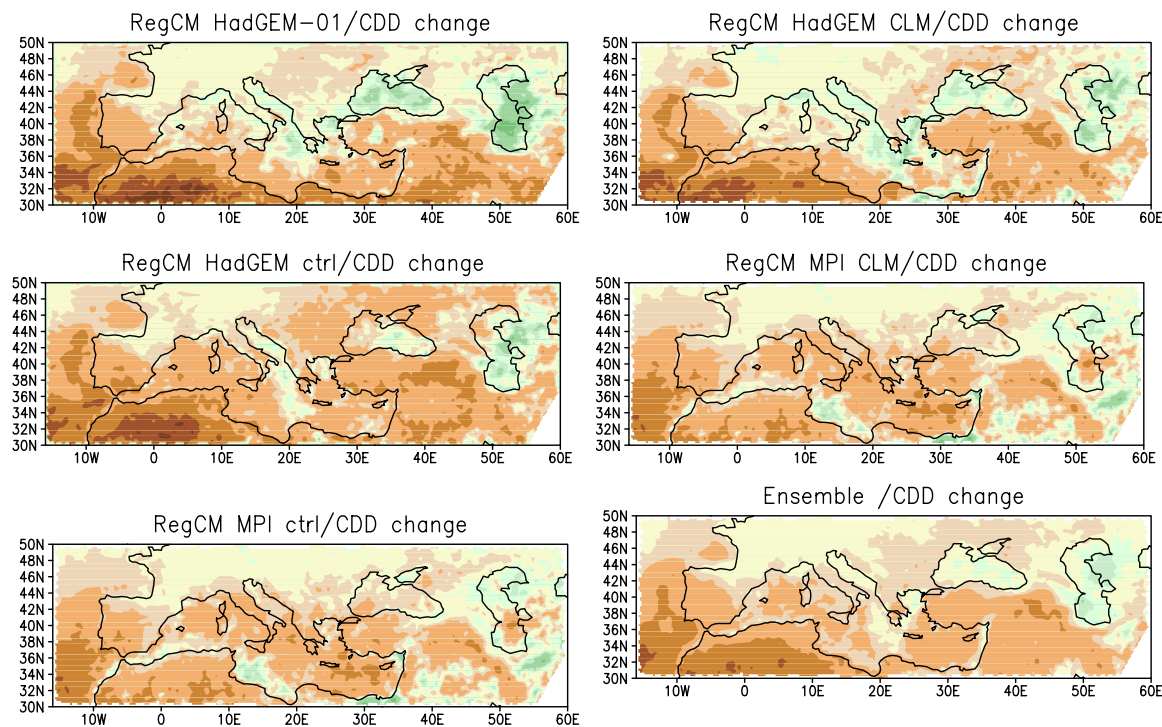
Siccita': Dry Spell Length Index (CDD)

Presente

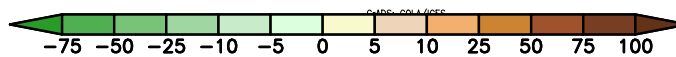


Siccita': Dry Spell Length Index (CDD)

Futuro



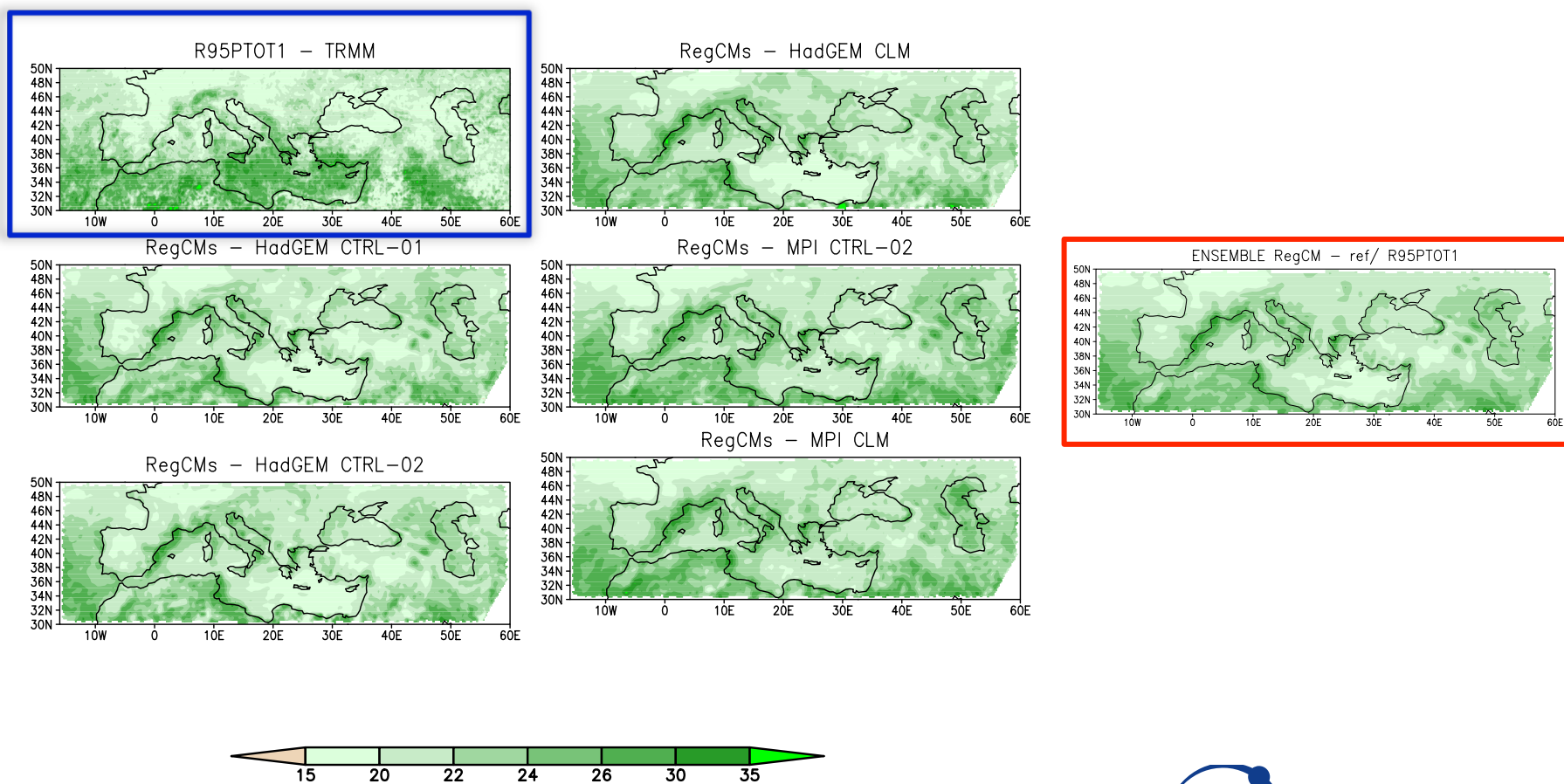
GRADS: COLA/IGES



The Abdus Salam
International Centre
for Theoretical Physics

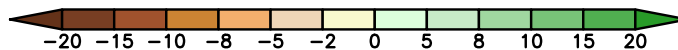
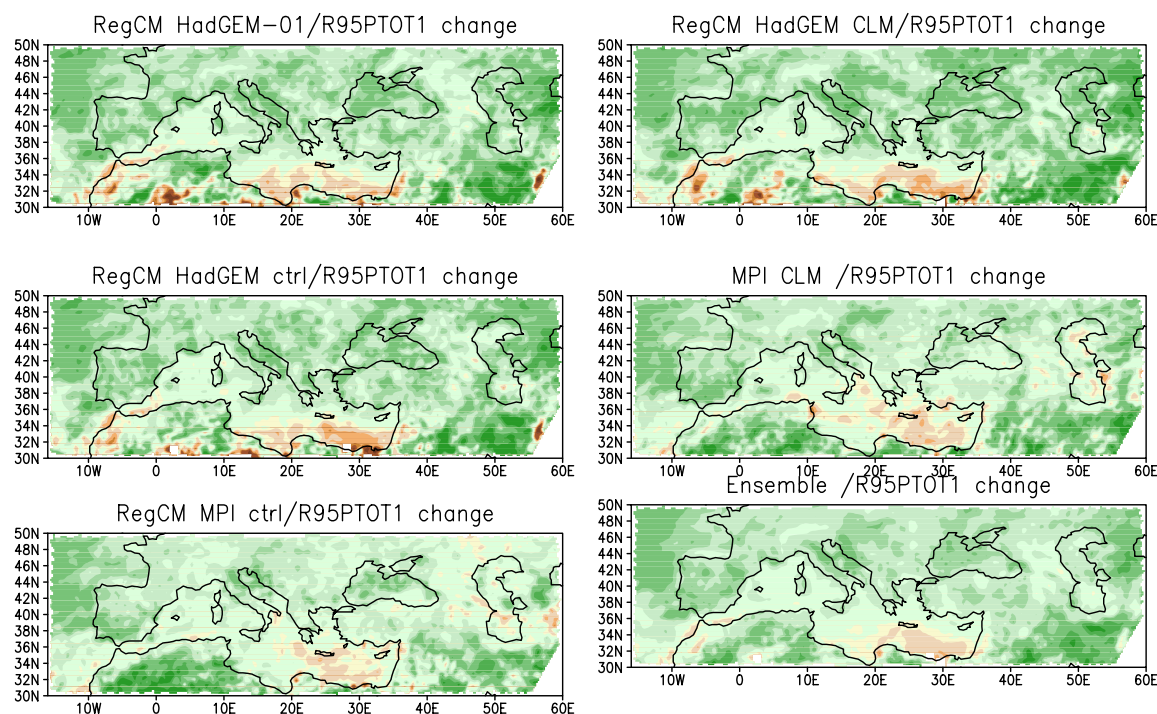
Eventi estremi di precipitazione *Heavy precipitation Index (R95)*

Presente



Eventi estremi di precipitazione *Heavy precipitation Index (R95)*

Futuro



The Abdus Salam
International Centre
for Theoretical Physics



The IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

Projected 'S Europe and Mediterranean' changes in temperature and precipitation extremes, including dryness. For 2071-2100 (wrt 1961-1990) or 2080-2100 (wrt 1980-2000) - GCMs/RCMs and A2/A1B.

<i>Tmax (warm days WD & cold days CD) and Tmin (warm nights WN & cold nights CN)</i>	<i>Heat waves/warm spells</i>	<i>Heavy precipitation (heavy precipitation days HPD, percentage of days > 10mm %DP10, 20-year return value RV20HP)</i>	<i>Dryness (consecutive dry days CDD, soil moisture anomalies SMA & PDSI)</i>
<p>High confidence WD/ WN very likely to increase and CD/CN very likely to decrease.</p> <p>High confidence: number of days with combined hot summer days & tropical nights very likely to increase.</p>	<p>High confidence: likely more frequent &/or longer heat waves & warm spells (also increases in intensity).</p> <p>Likely largest increases in SW, S and E.</p>	<p>Low confidence: Inconsistent changes in HP intensity and %DP10; increase in HP intensity in all seasons except summer over parts of the region, but decrease in other parts, e.g. Iberian Peninsula.</p> <p>Low confidence in RV20HP changes</p>	<p>Medium confidence: Increase in dryness (CDD, SMA) in Mediterranean. Consistent increase in area of drought.</p>

See IPCC SREX Table 3.3 for all three European regions and full details.
Very likely = 90-100% probability. *Likely* = 66-100% probability.



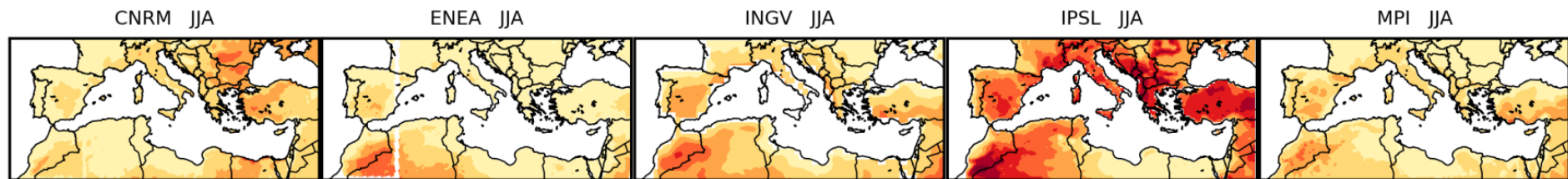
Using RCMs we can look at changes in extreme weather events across the Mediterranean



This example is for maximum Warm Spell Duration (WSDI)

- Defined as sum of days in a span of ≥ 6 days above a threshold (the 90th percentile)
- 5 RCM runs from the CIRCE project (25-80km resolution, A1B)
- Consistent increase – but magnitude varies spatially and from model to model

Climrun Index wsd
2021-2050 average minus 1971-2000 average

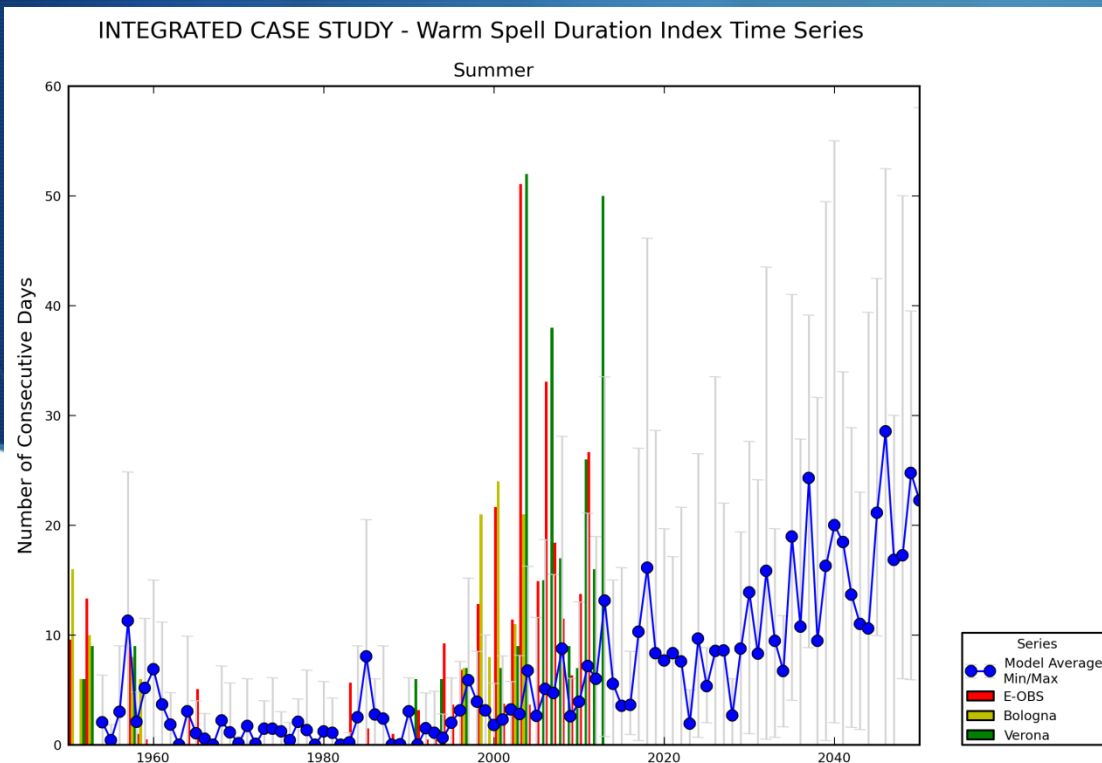




More useful to look at changes averaged over the study area



- RCMs reproduce WSDI fairly well in the first few decades – but underestimate the large observed increase over the last decade.
- All RCMs show a continuing increase. For 2021-2050 minus 1971-2000, the ensemble mean change is +11 days (model range is + 4 days to + 19 days)
- 2003 is a very extreme year in the observations and only a few simulated future years are similar in magnitude



Blue is average of the 5 RCMS
Grey lines show minimum/maximum range across the 5 models each year
Red bars are gridded 25 km observations – more directly comparable with RCMs than station series
Green bars are two station series



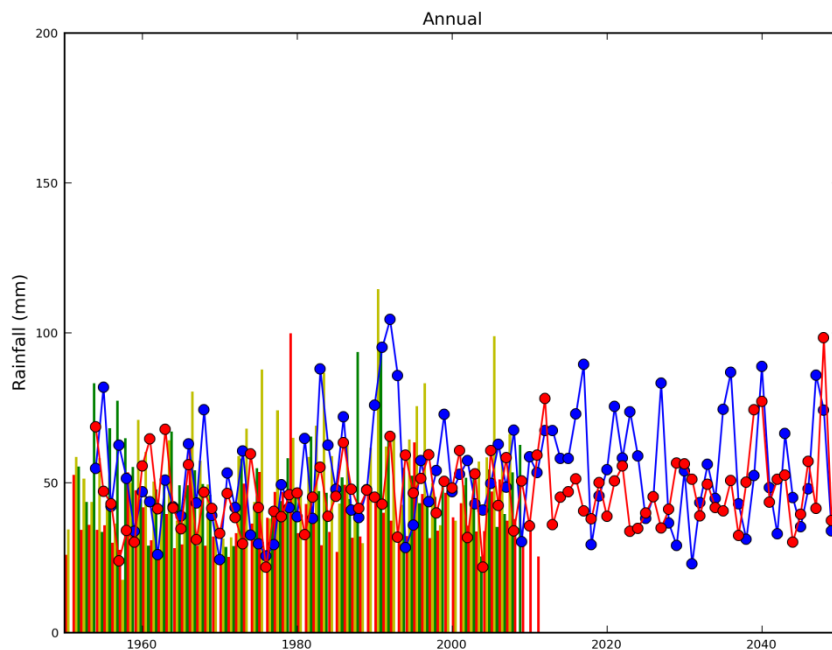


We have also looked at changes in maximum 1 day and 5 day rainfall

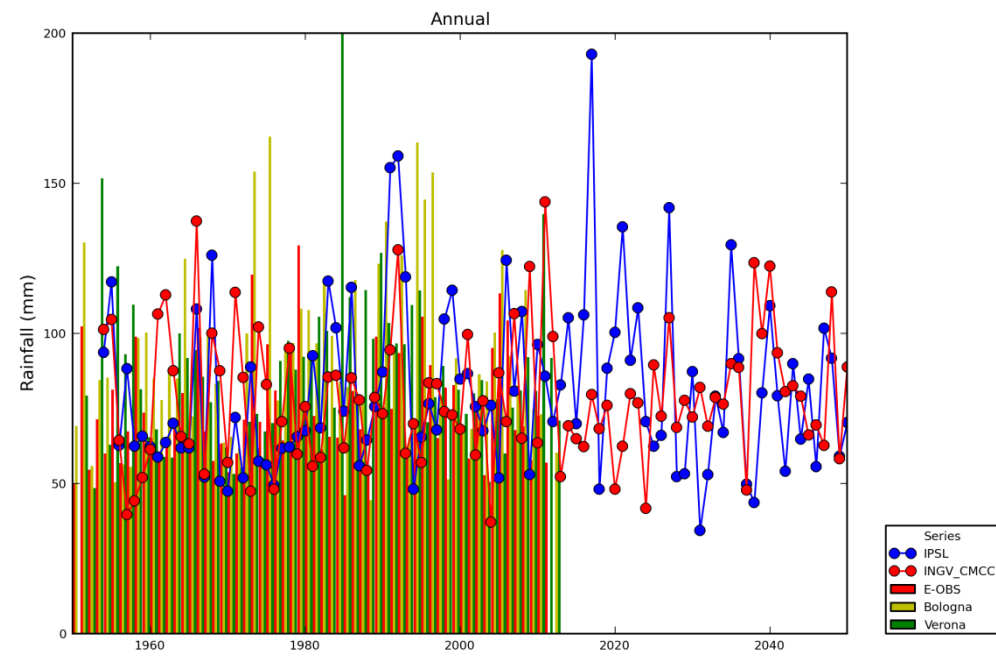


- But only for two RCMs (red and blue)
- Although the two RCMs don't capture the largest observed values and one of them severely underestimates summer events, they generally perform quite well for the present day – especially for 1 day maximum and when compared with the gridded observations
- All series are dominated by year-to-year variability
- No indication of any observed or simulated trends
- Annual values are shown here – but similar conclusions for all seasons

INTEGRATED CASE STUDY - Maximum 1-day Rainfall



INTEGRATED CASE STUDY - Maximum 5-day Rainfall



Grazie

