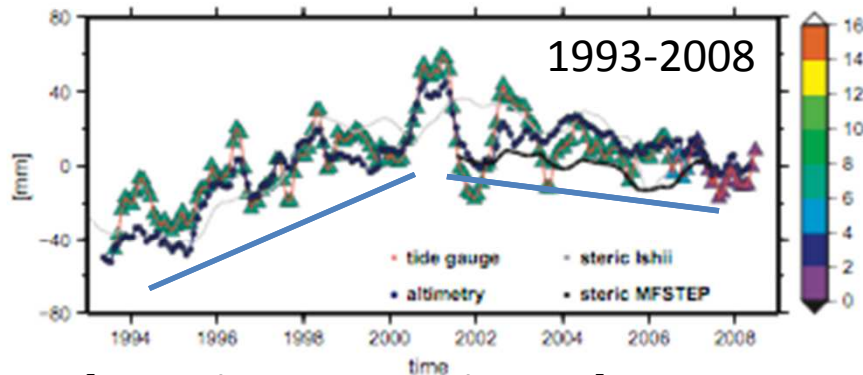


# Sea-level rise in the North Adriatic basin: Observations

Trend osservato di sea-level nell'Adriatico (mm/yr) nel periodo recente.



[Fenoglio-Marc et al. 2012]

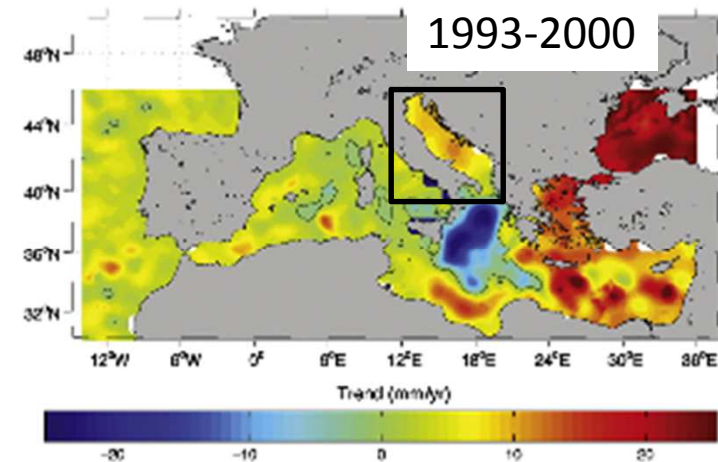


Fig. 7. Sea level trends (mm/yr) from the multisensor altimetry product for the period 1993–2000.

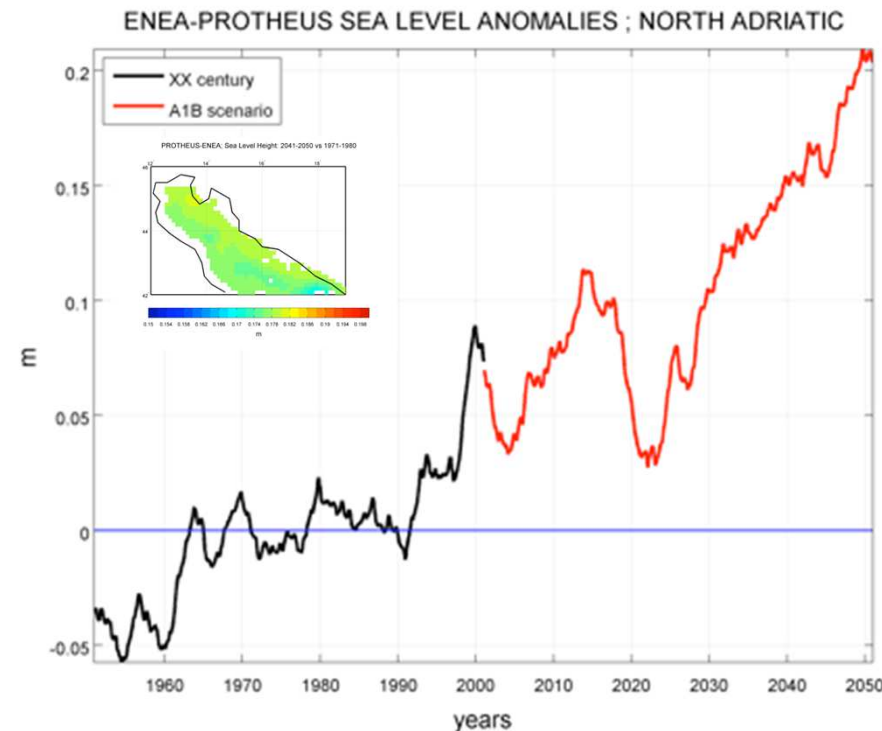
[Tsimplis et al. 2009]

Forte variabilit  del trend del SLR nel NA:

1993-2000 : positivo (+8 mm/yr)

2000-2008 : negativo (-5 mm/yr)

# Sea-level rise in the North Adriatic basin: Model-based estimates

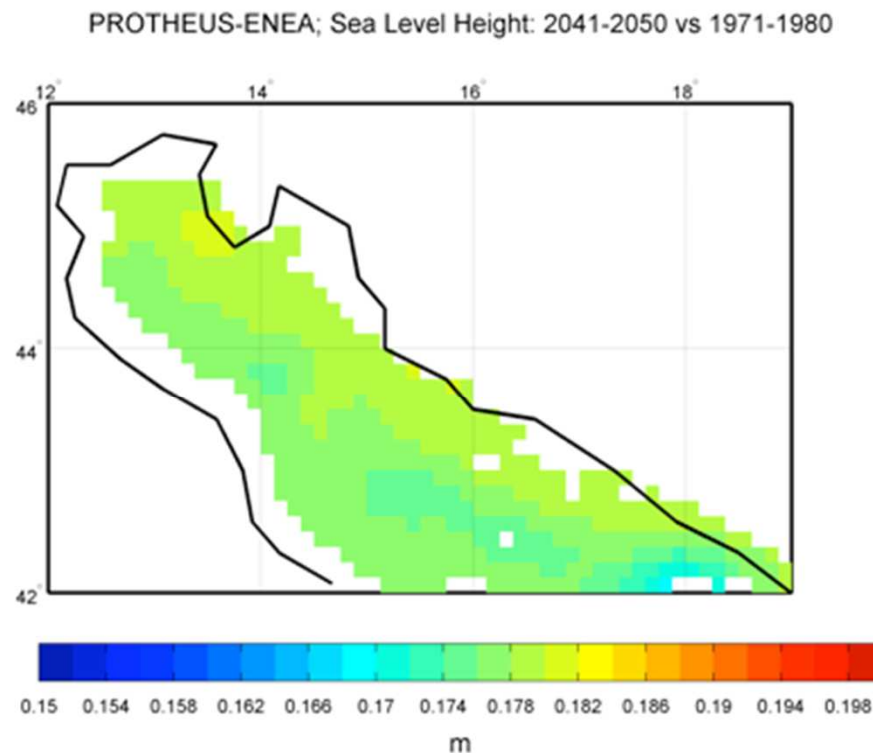


Trend (2000-2050):  
2.8 mm/yr

Anomalie di sea-level nel bacino Adriatico (metri; effetto termosterico calcolato per l'intero bacino Mediterraneo + componente dinamica nell'Adriatico ) calcolate rispetto alla media climatologica per il periodo 1960-1990, da una simulazione effettuata con il modello ENEA-PROTHEUS per il periodo 1951-2050 (IPCC scenario SRES A1B, dal 2000 al 2050).

La serie temporale e' calcolata come media sulla regione [12° -19° E; 42N-45N] (vedi box piccolo).

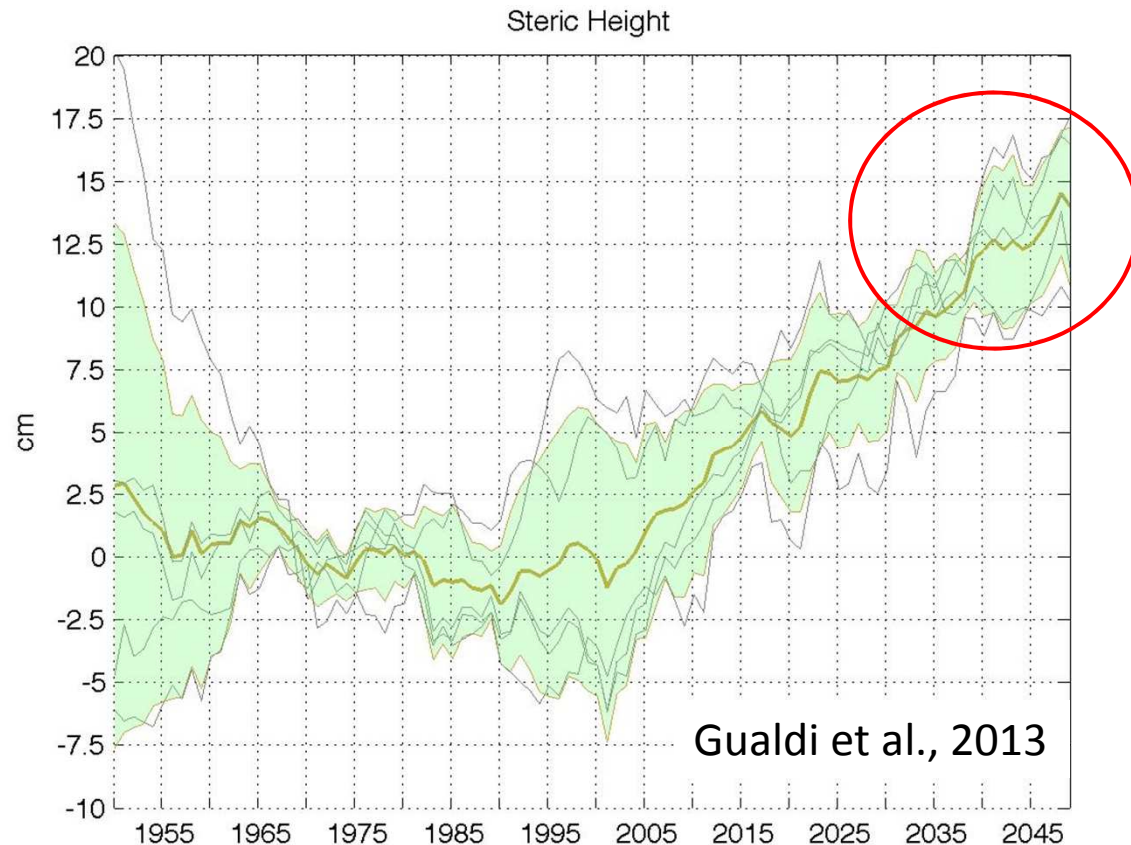
# Sea-level rise in the North Adriatic basin: Model-based estimates



Mappa di anomalie di sea-level (in metri) calcolate come **differenza tra il periodo 2041-2050 e il periodo 1971-1980**, utilizzando il modello ENEA-PROTHEUS. Nel calcolo del sea-level sono stati inclusi l'effetto termosterico (media sull'intero dominio del Mediterraneo) e la componente dinamica (anomalie di circolazione nel bacino Adriatico).

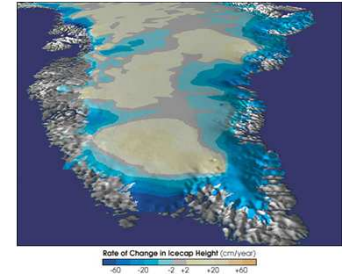
# SLR: Uncertainty estimates (1): Model uncertainty

2021-2050 MSLR  
CIRCE (2013): +7/+12 cm  
CMIP3 (Marcos & Tsimplis,  
2008): -22/+18 cm



Anomalie di SL (effetto sterico sul Mediterraneo) nei modelli CIRCE, calcolate rispetto al periodo di riferimento 1960-1990. Differenze tra modelli (risoluzione, Parametrizzazioni, etc) determinano risultati diversi. Una stima dell'incertezza nelle proiezioni di SLR deve basarsi sull'utilizzo di più modelli.

# SLR: Uncertainty estimates (2): The impact of land ice-melting



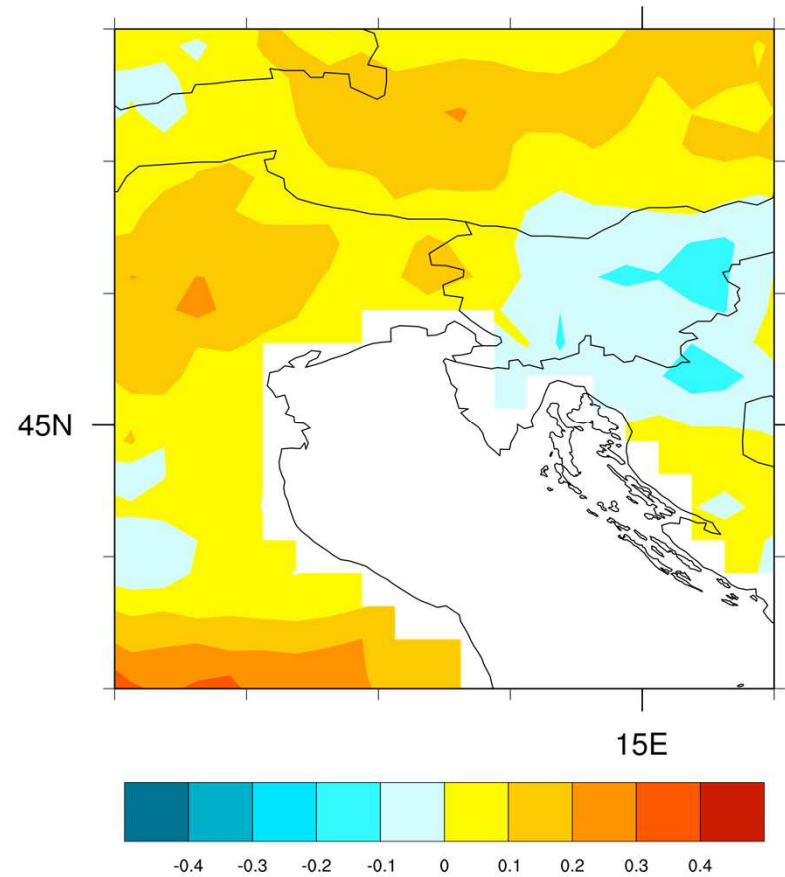
I modelli di ultima generazione (CMIP5) non contengono una rappresentazione dei ghiacciai continentali.

La sorgente principale di massa per il SL globale, deriva dallo scioglimento dei ghiacci artici (Groenlandia)

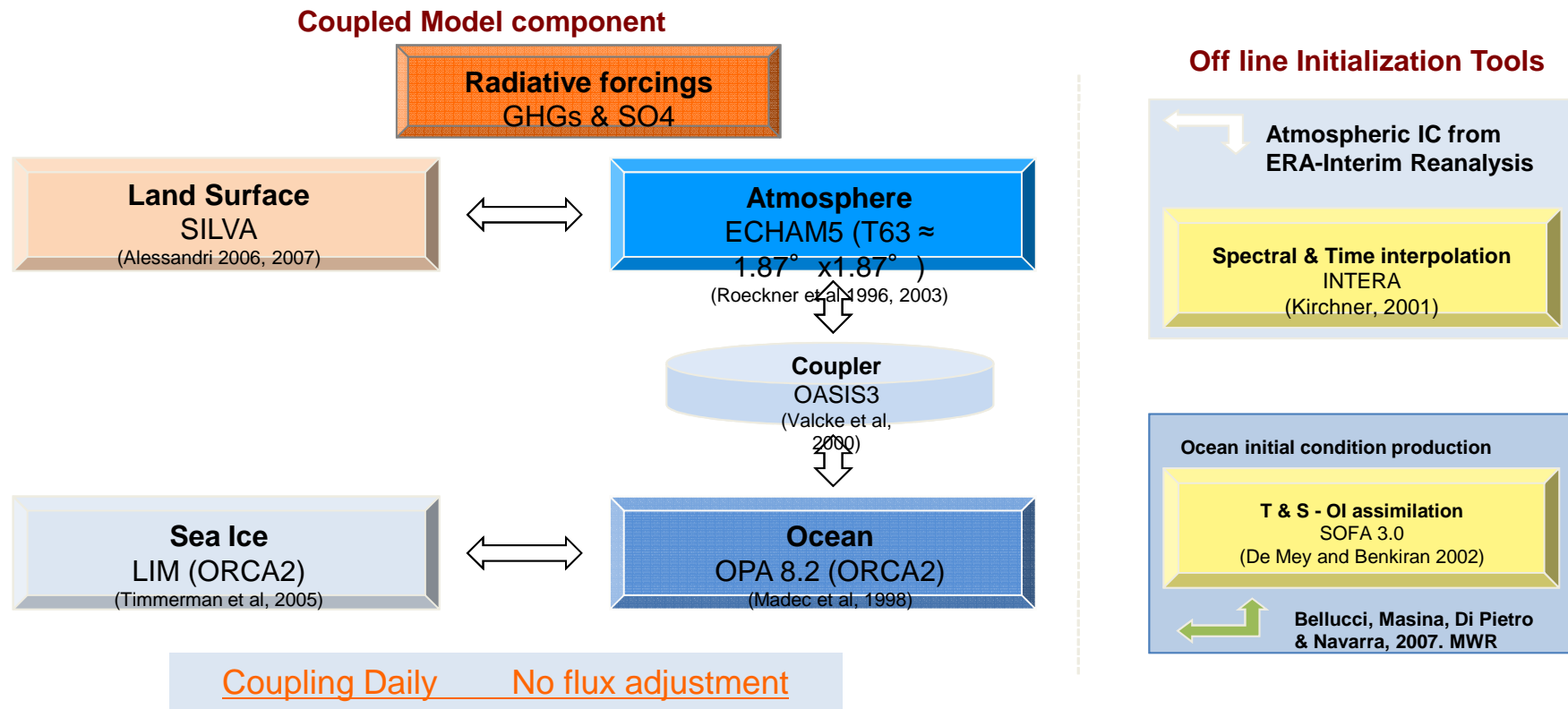
Studi recenti mostrano che l'influenza dello scioglimento dei ghiacciai artici rimarrebbe probabilmente confinata al solo bacino del Nord Atlantico (Subpolar Gyre) e ai Mari Nordici a causa dell'effetto della circolazione oceanica (Marsh et al. 2010)

L'effetto sul Mediterraneo potrebbe essere marginale (effetto sterico dominante).

# Previsioni stagionali di eventi estremi (precipitazioni)



# Il sistema di previsioni stagionali del CMCC (CMCC-SPS)

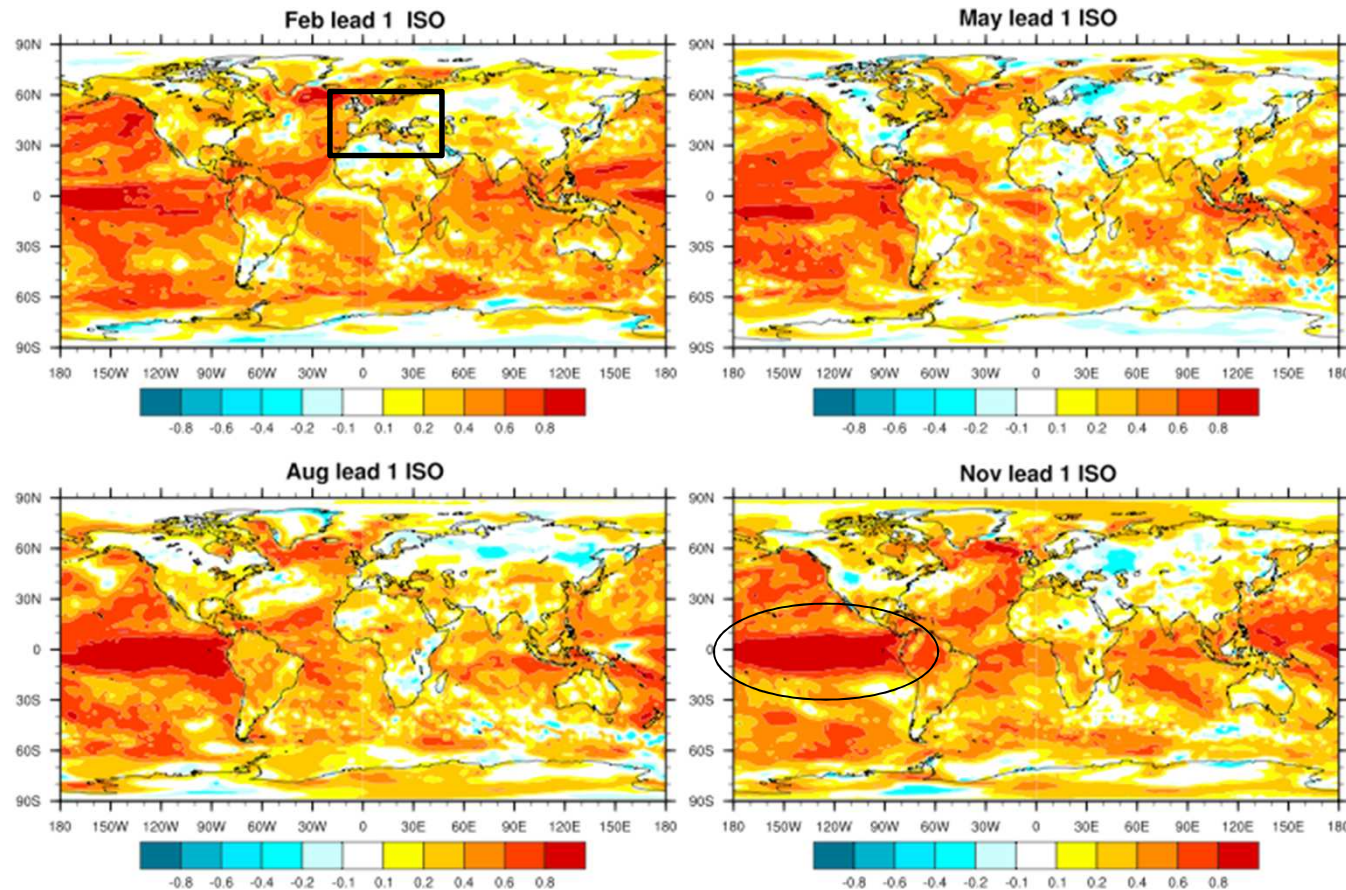


Specification of initial conditions allow the model to evolve from a state which is the “reality” measured at the time of the forecast.



# “Skill” predittivo del CMCC-SPS

tsurf Anomaly Correlations (ACC)

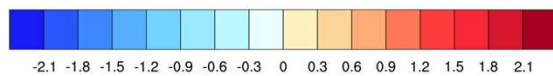
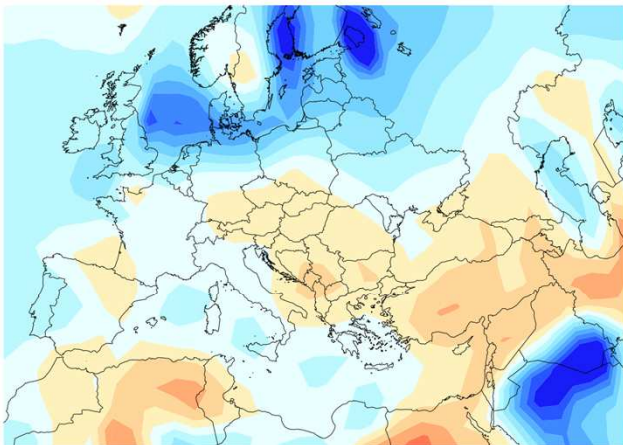


- Predictability is generally higher on the ocean than on land (red areas indicate larger association between model results and observations), and in the Tropics than at mid latitudes.
- In a few areas the predictability is high during the whole year

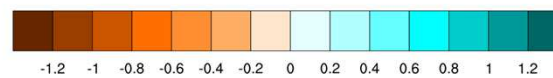
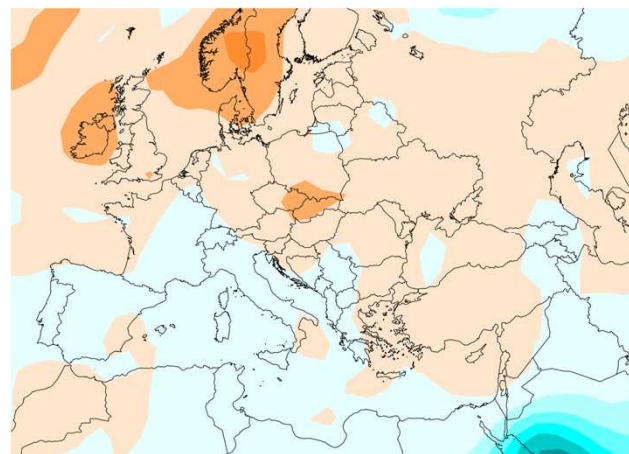


## Previsioni stagionali: JJA 2013

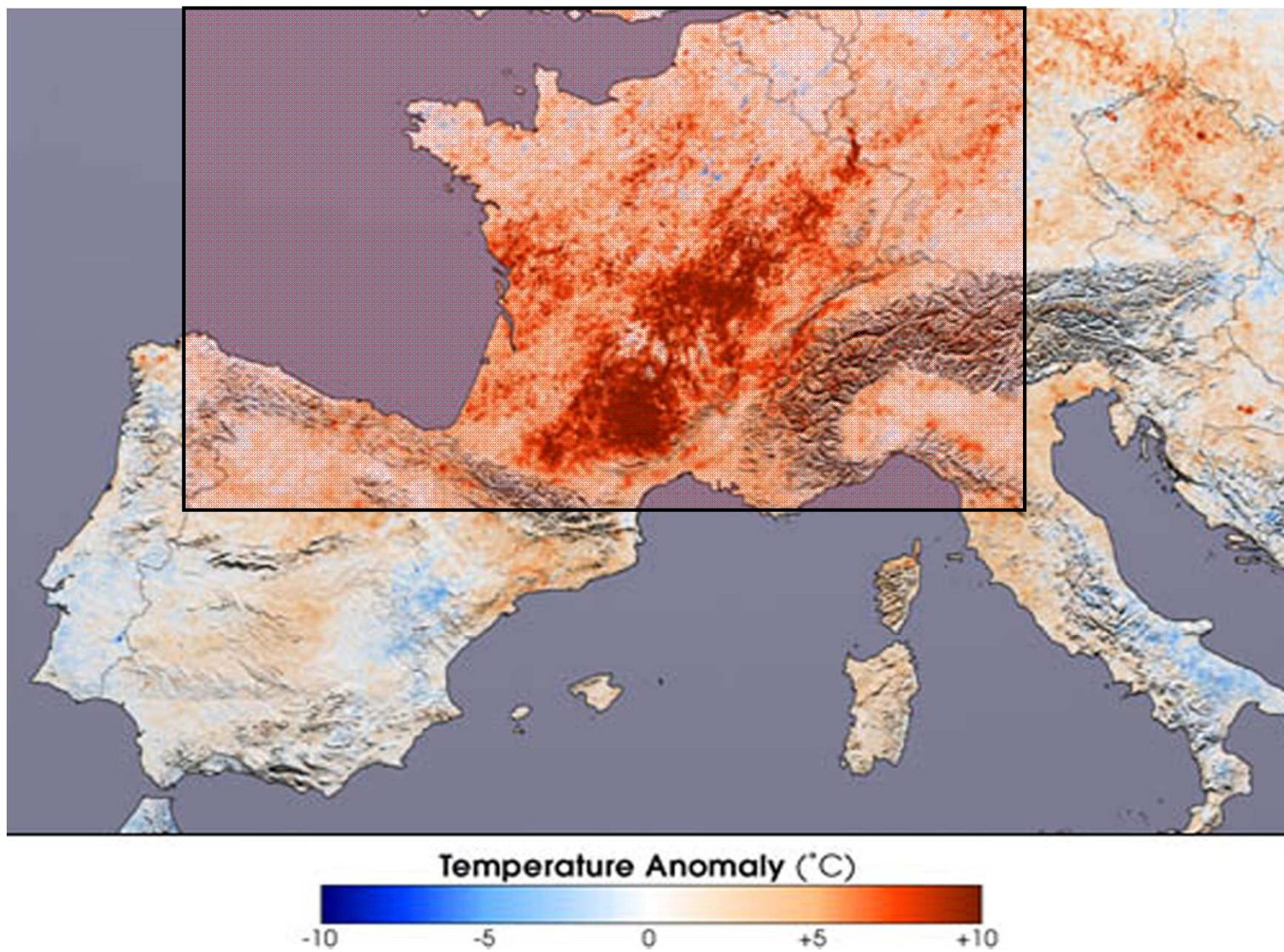
201304 jja Temperature anomalies (°C)



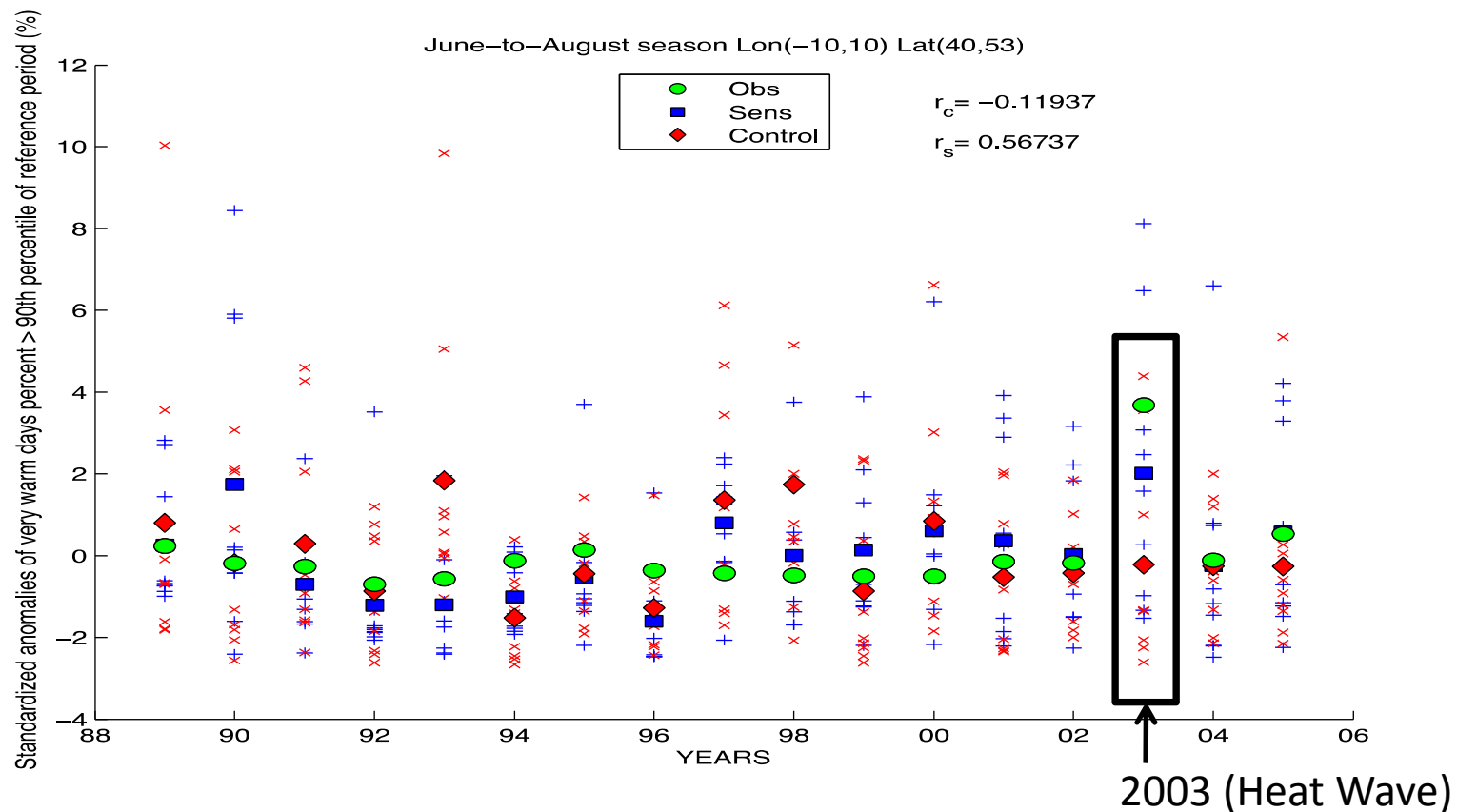
201304 jja Precipitation anomalies (mm/day)



## Eventi estremi: Heat wave del 2003



# No. warm days ( $>90^{\circ}$ percentile) in JJA over Europe



● OSSERVAZIONI

■ PREVISIONI

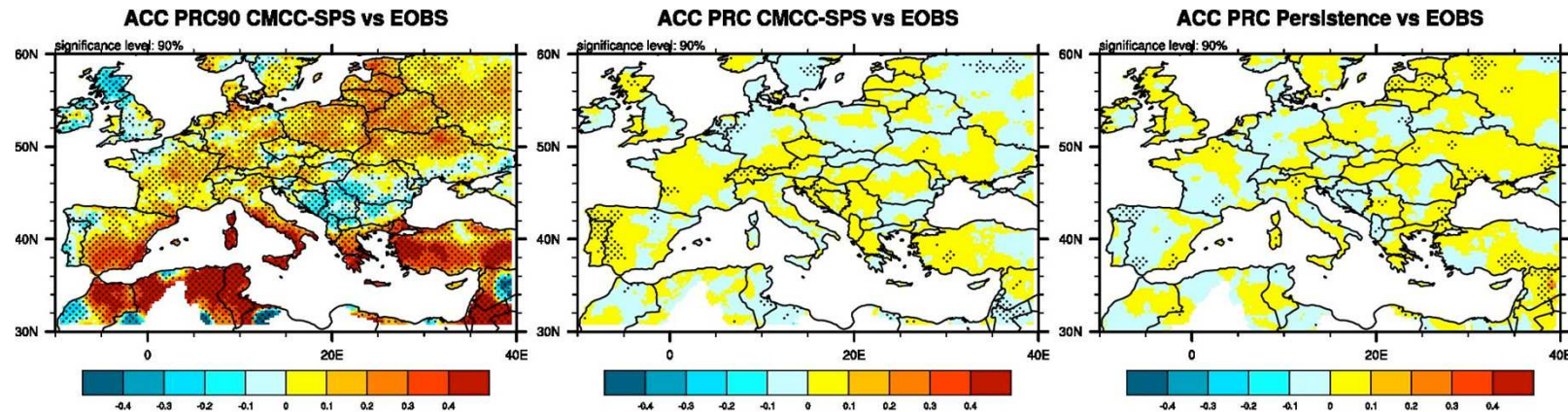
◆ CONTROLLO

$$R_c = -0.119$$

$$R_p = +0.567$$

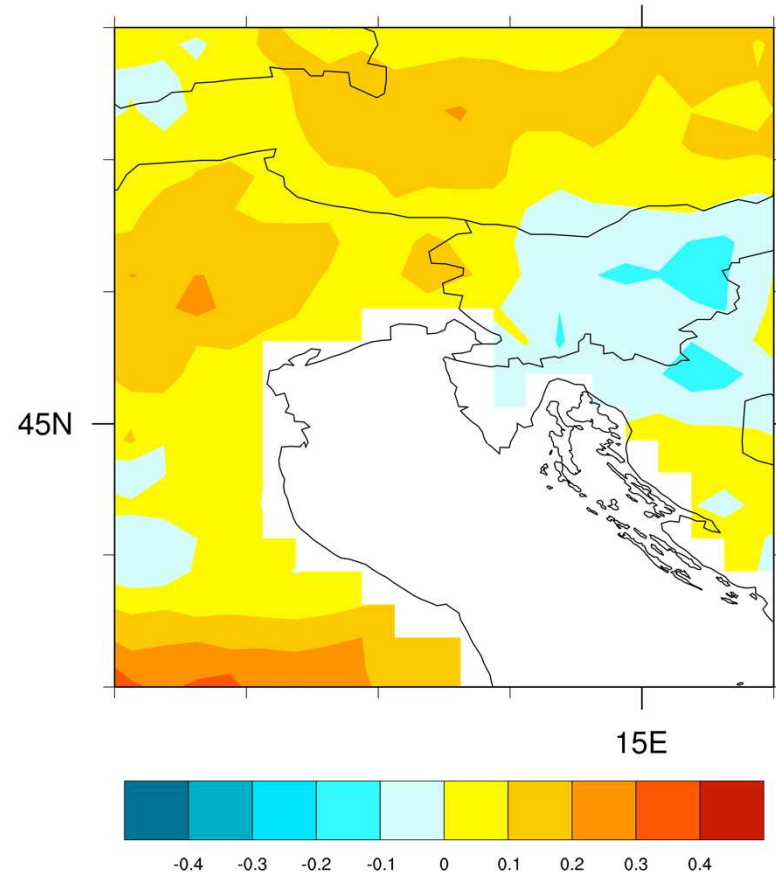


# Previsioni stagionali di precipitazioni estreme: "heavy rain" events (precip >90° percentile)



Indice di skill predittivo modesto sull'Europa centro-settentrionale (0.2-0.3). Valori piu' elevati sul bacino del Mediterraneo (0.4). No skill sui Balcani.

## ACC PRC90 CMCC-SPS vs EOBS



Nell'area del Nord Adriatico, lo skill predittivo presenta ancora valori molto bassi (benche' positivi). Risoluzione modesta dei modelli di previsione stagionale (~100-200 Km) non adeguata alla risoluzione di processi a scala regionale → possibile soluzione : downscaling statistico



## 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>T<sub>max</sub></i> (warm days WD & cold days CD) and <i>T<sub>min</sub></i> (warm nights WN & cold nights CN)	<i>Heat waves/warm spells</i>	<i>Heavy precipitation</i> (heavy precipitation days HPD, percentage of days > 10mm %DP10, 20-year return value RV20HP)	<i>Dryness</i> (consecutive dry days CDD, soil moisture anomalies SMA & PDSI)
<p><b>High confidence</b> WD/WN <b>very likely</b> to increase and CD/CN <b>very likely</b> to decrease.</p> <p><b>High confidence:</b> number of days with combined hot summer days &amp; tropical nights <b>very likely</b> to increase.</p>	<p><b>High confidence:</b> <b>likely</b> more frequent &amp;/or longer heat waves &amp; warm spells (also increases in intensity).</p> <p><b>Likely</b> largest increases in SW, S and E.</p>	<p><b>Low confidence:</b> 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><b>Low confidence</b> in RV20HP changes</p>	<p><b>Medium confidence:</b> 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.



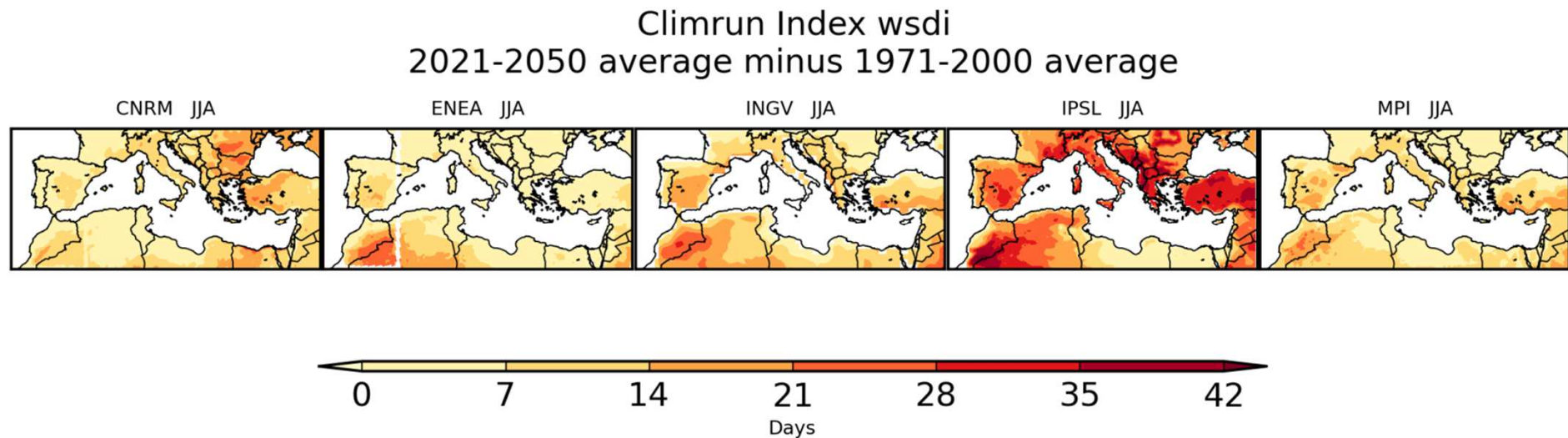


## Using RCMs we can look at changes in extreme weather events across the Mediterranean



This example is for maximum Warm Spell Duration (WSDI)

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



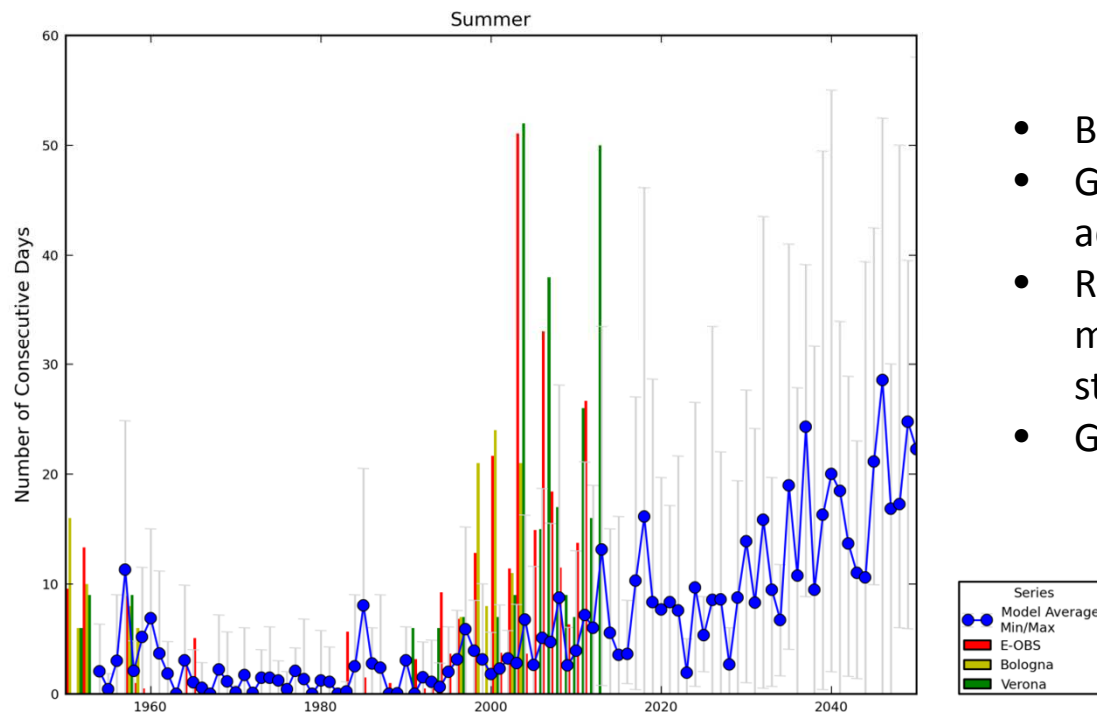


## More useful to look at changes averaged over the study area



- 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

INTEGRATED CASE STUDY - Warm Spell Duration Index Time Series



- 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

