

# The summer NAO in CMIP3 models and related uncertainties in precipitation projections in the Euro-Mediterranean region

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- Bladé et al. 2011 (Climate Dynamics)
- Bladé et al. 2012 (in press, JGR-Atmospheres)



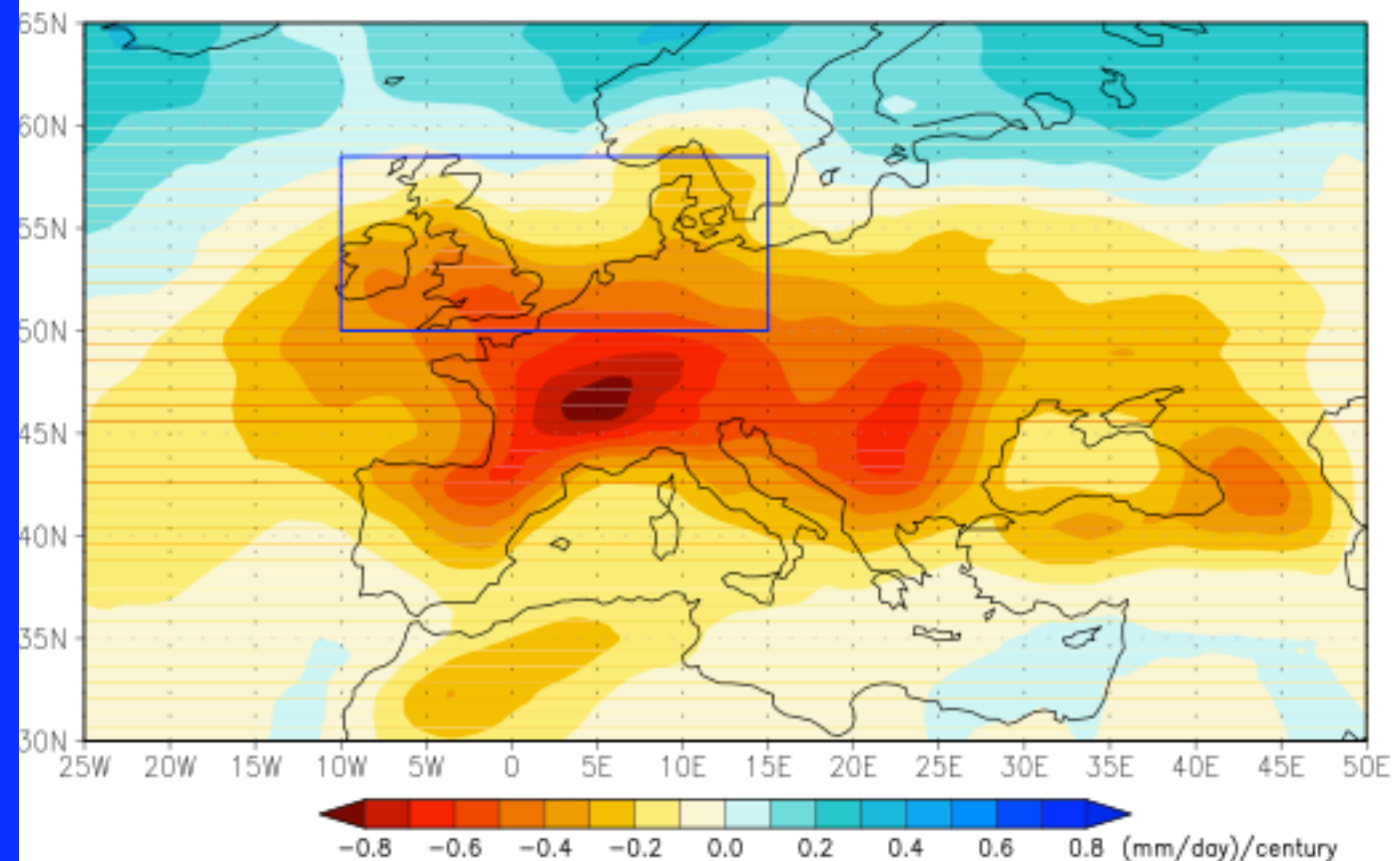
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**Motivation:** models predict substantial summer precipitation reductions in Europe and the Mediterranean

## IPCC-AR4 :

PREDICTED  
ENSEMBLE-MEAN  
RELATIVE CHANGE IN  
PRECIPITATION  
FROM 1980-1999  
TO 2080-2099

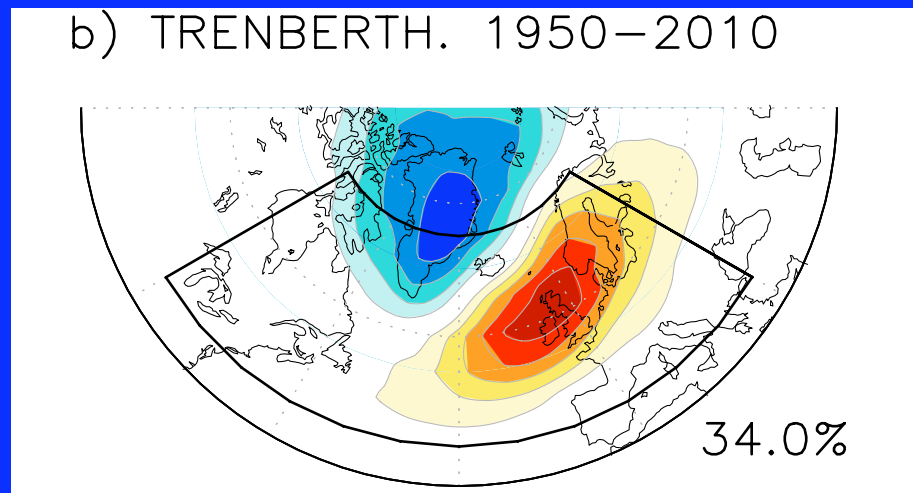
(a) MULTI-MODEL MEAN PRECIPITATION TREND



BY

# The summer NAO

- defined as the leading EOF of July-August SLP in the domain  $[40^{\circ}\text{N}-70^{\circ}\text{N}; 90^{\circ}\text{W}-30^{\circ}\text{E}]$ , following Folland et al. 2009 and Greenbath and Rong (2006)



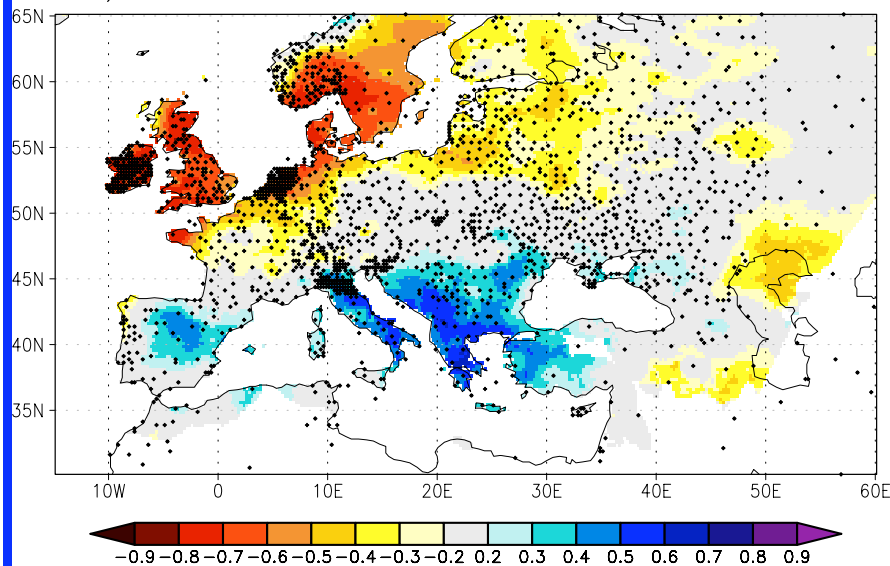
- dominant dynamical pattern of summer precipitation variability in the Euro/Mediterranean area (Bladé et al. 2011)

# SNAO in observations

(Bladé et al. 2011)

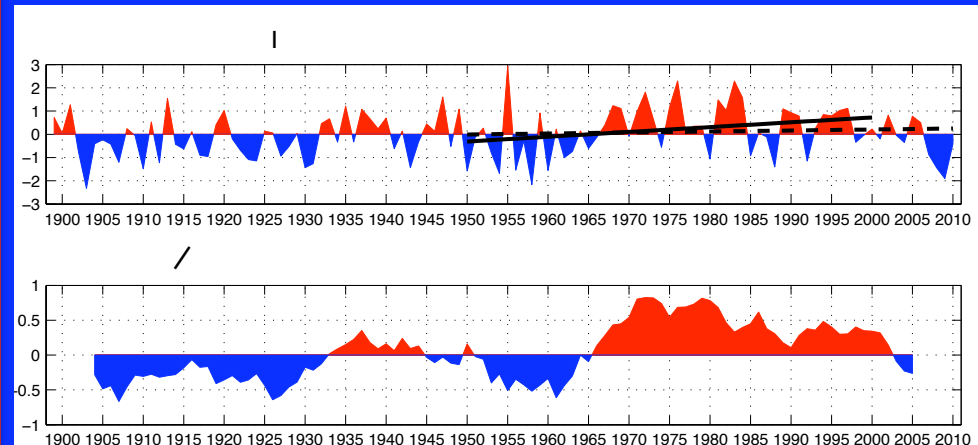
## PRECIP CORRELATIONS (E-OBS)

a) SUMMER NAO: CORRELATION WITH PRECIPITATION



SNAO is negatively correlated with precipitation in northern Europe, positively correlated with precipitation in Mediterranean

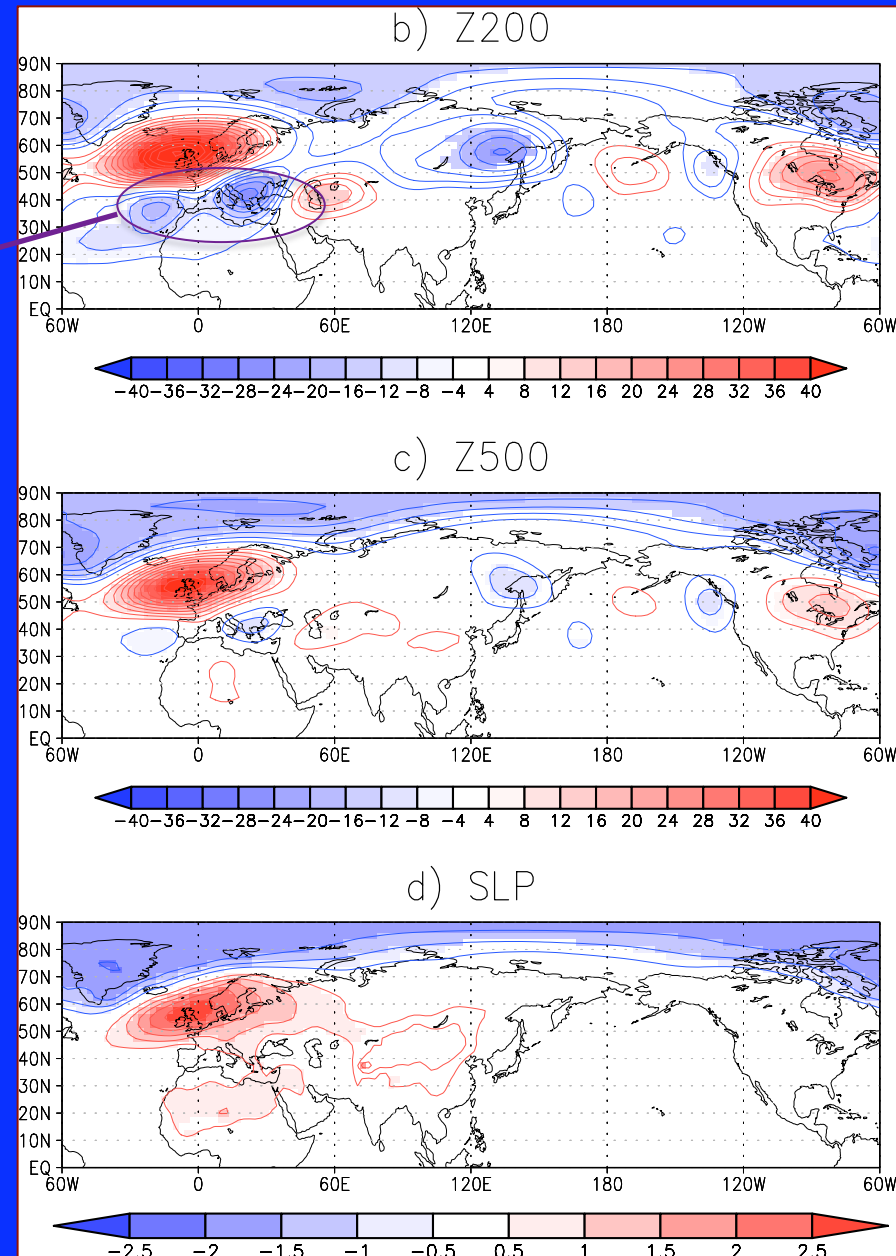
## SNAO time series



SNAO time evolution is dominated by multidecadal fluctuations ..... but no significant long-term trend

# SNAO impact over the Mediterranean is related to an upper level trough which is part of a hemispheric pattern of anomalies

Upper-level trough implies  
mid-tropospheric cooling and  
thus potential instability  
-> favors summer convection



(Bladé et al. 2011)

## OBJECTIVES

To attempt to validate climate model projections by

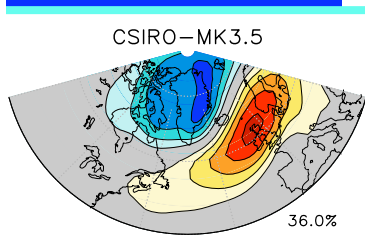
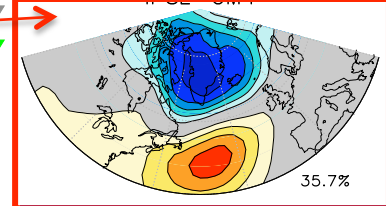
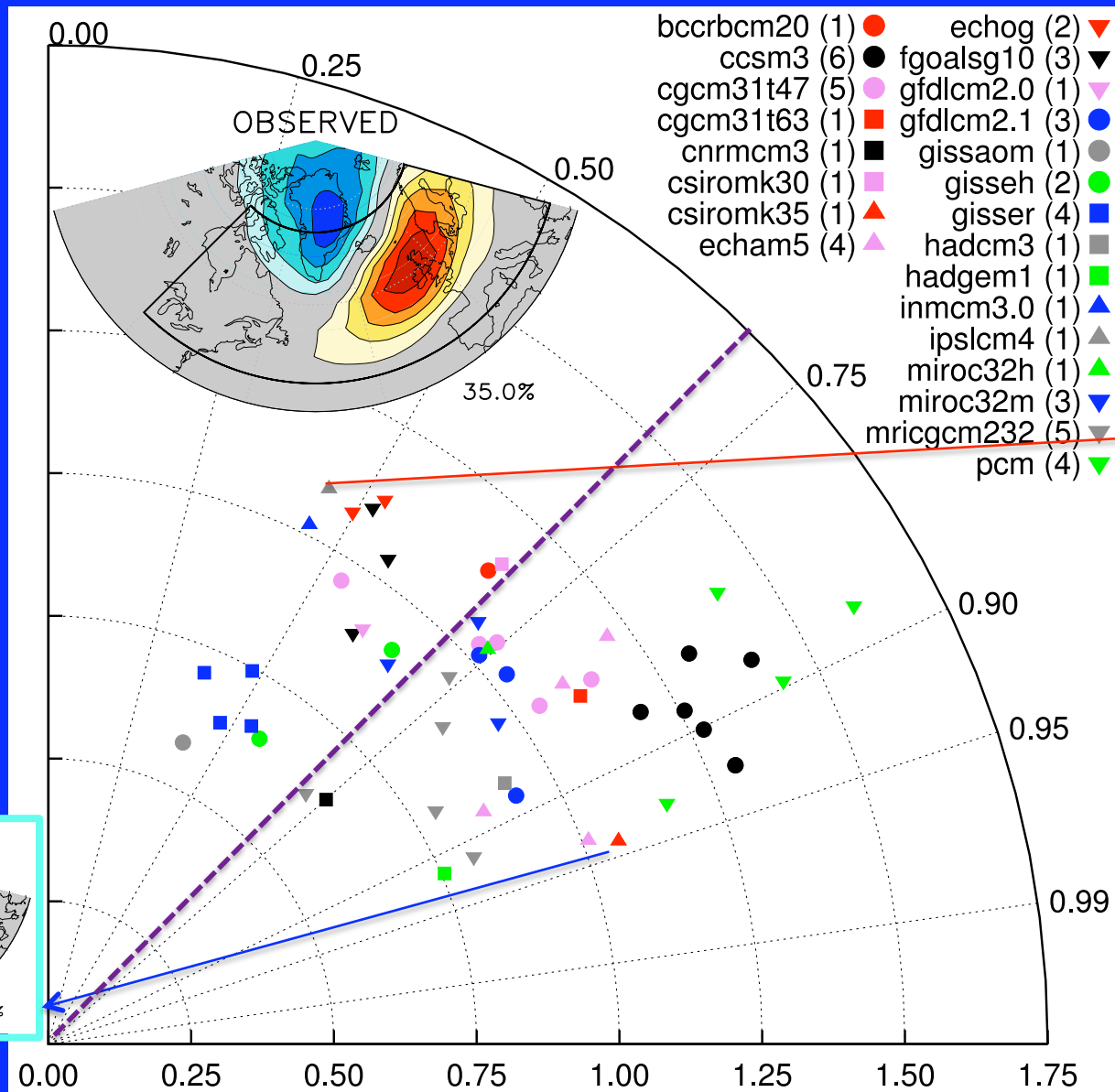
- documenting CMIP3 model performance with regards to the SNAO
- assessing the contribution of the SNAO in the projected summer drying in the Euro/Mediterranean region in the CMIP3 simulations

# Most CMIP3 models reproduce the spatial pattern of the SNAO

Taylor-like plot  
comparing  
simulated  
and  
observed  
SNAO

a “good”  
model

a “bad”  
model



(Bladé et al. 2012)

To be fair to the models we project the observed SNAO onto the SLP field ...

And discard those that just don't seem to have a SNAO (4 out of 24)

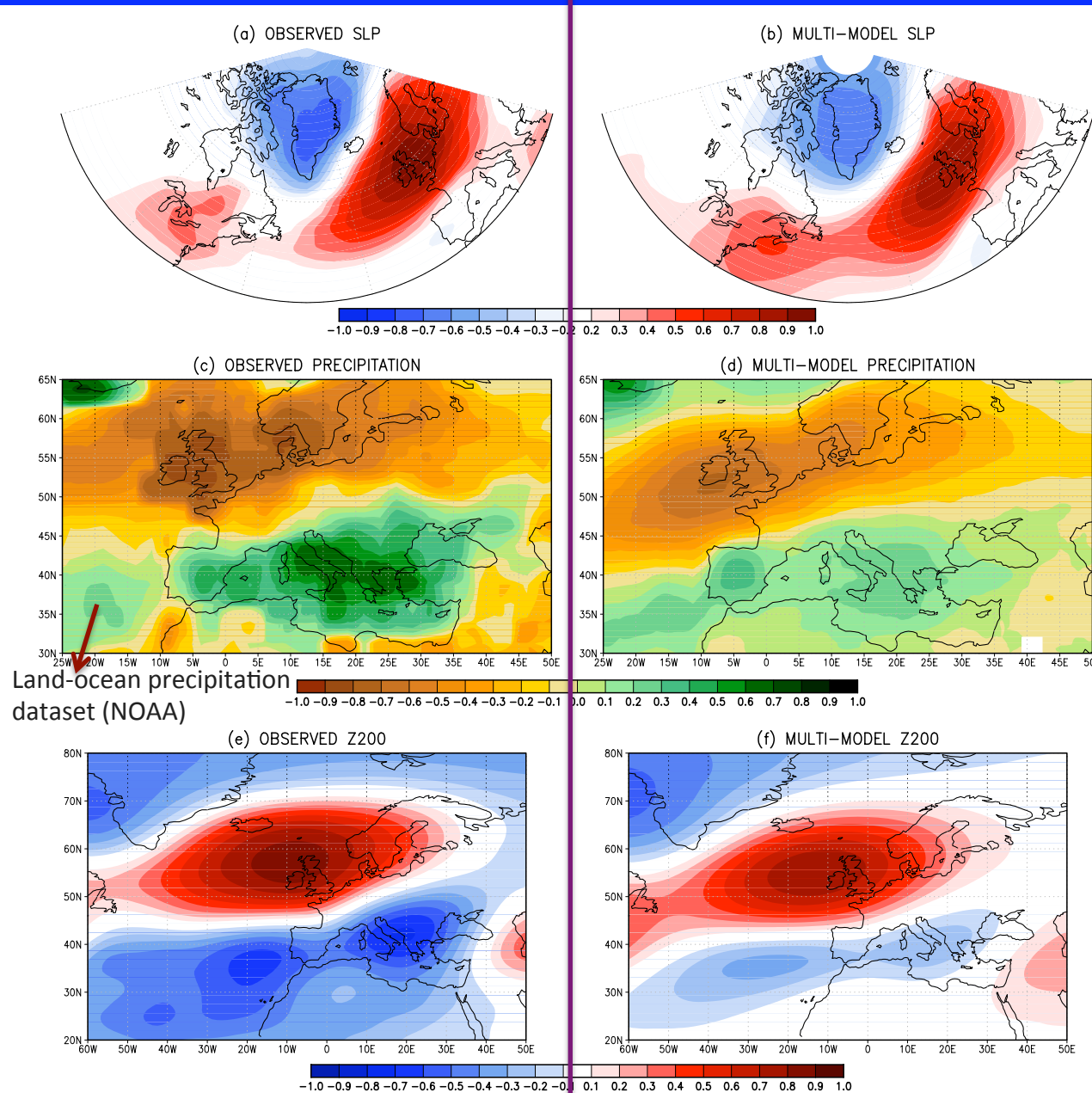
We are left with 20 models and 44 simulations (1950-2100 period)





## OBSERVATIONS

## MULTIMODEL ENSEMBLE



CMIP3 models  
also reproduce  
the broad-scale  
dipolar  
precipitation  
signature

but the signal in  
the Mediterranean  
is too weak ....

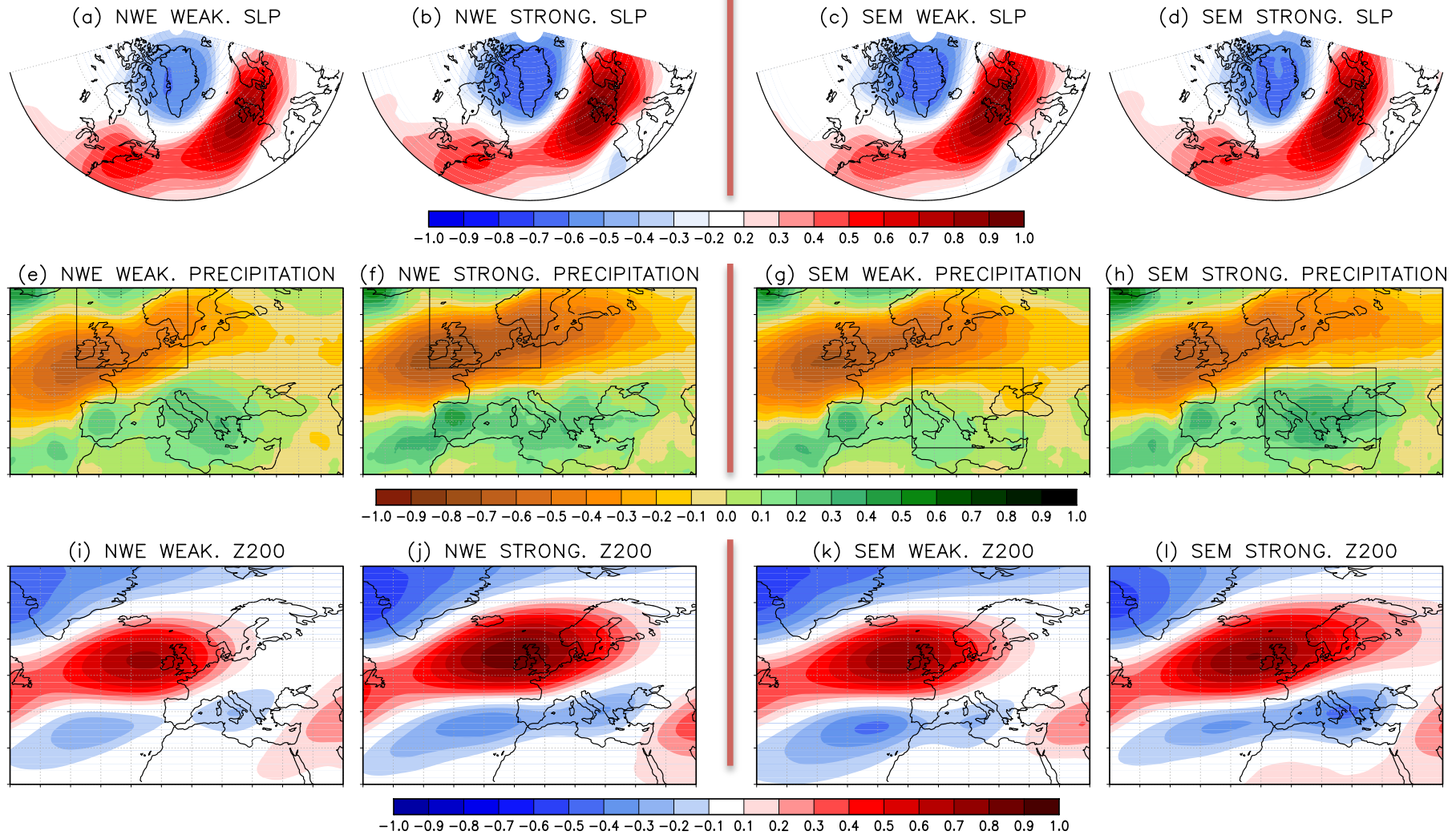
which is related  
to weak troughs  
at 200 hPa

(Bladé et al. 2012)

# WE STRATIFY PRECIPITATION RESPONSES AND SHOW HIGH END /LOW END RESPONSES (9 out of 44)

## NORTHWEST EUROPE

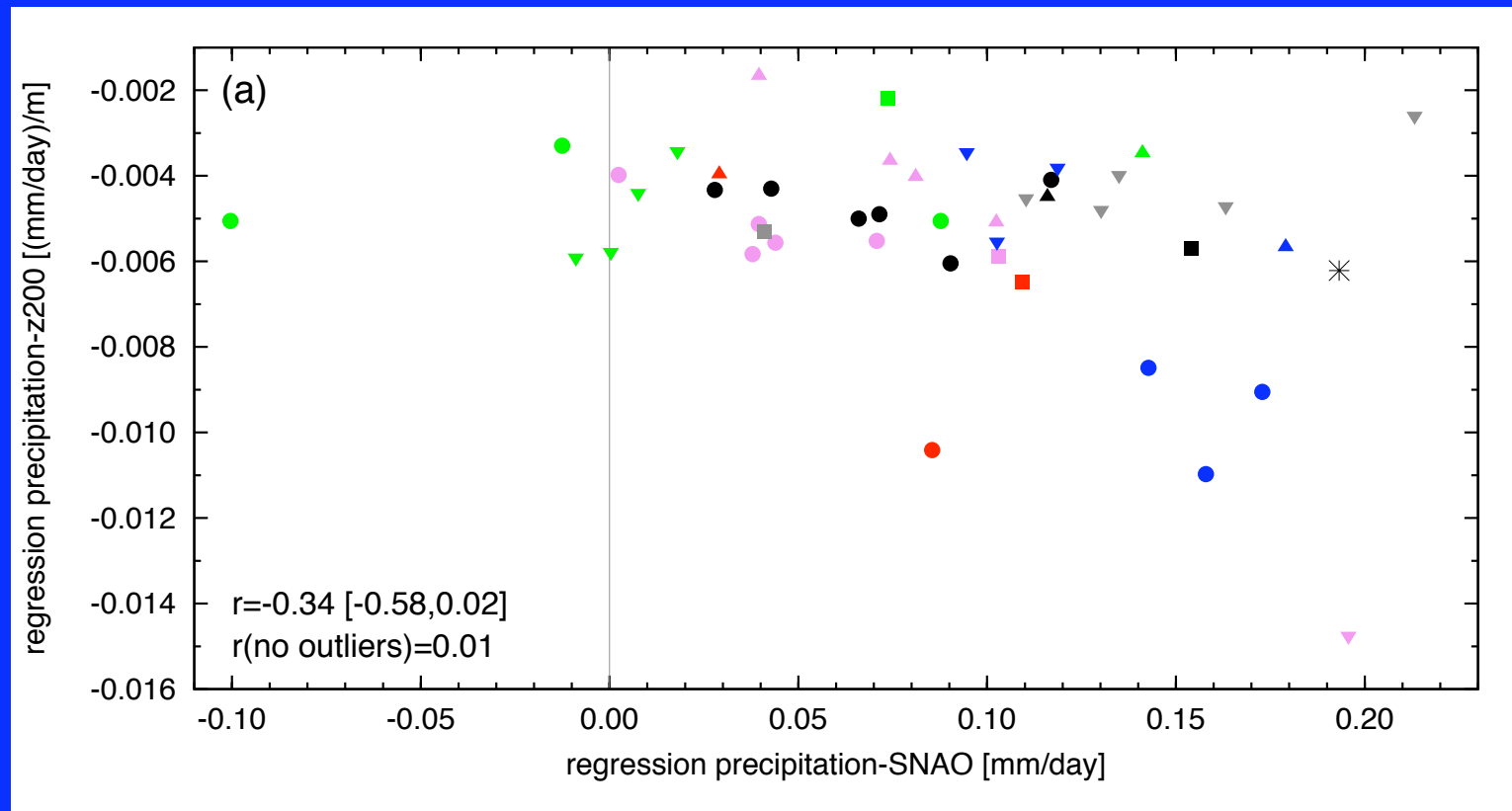
## SOUTHEAST EUROPE/MEDITER.



even the "best" models are too weak in the Mediterranean ...

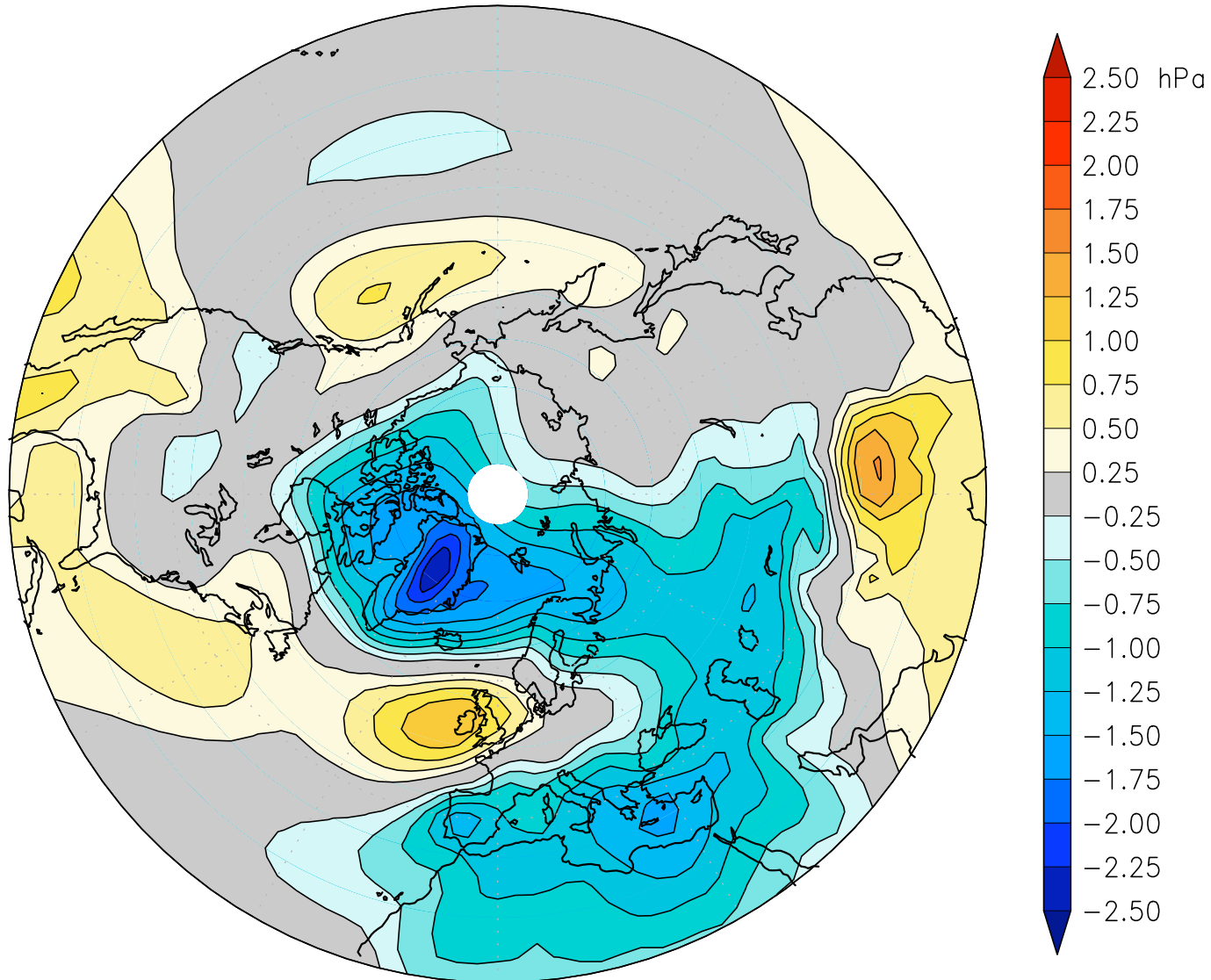
Weak response to SNAO in the Mediterranean is not due to too weak precipitation in response to an upper level trough but to the weak SNAO-related trough in the models

Regression of precipitation onto Z-200 trough  
versus regression of precipitation onto SNAO



## 21<sup>st</sup> century: CMIP3 models project an upward SNAO trend

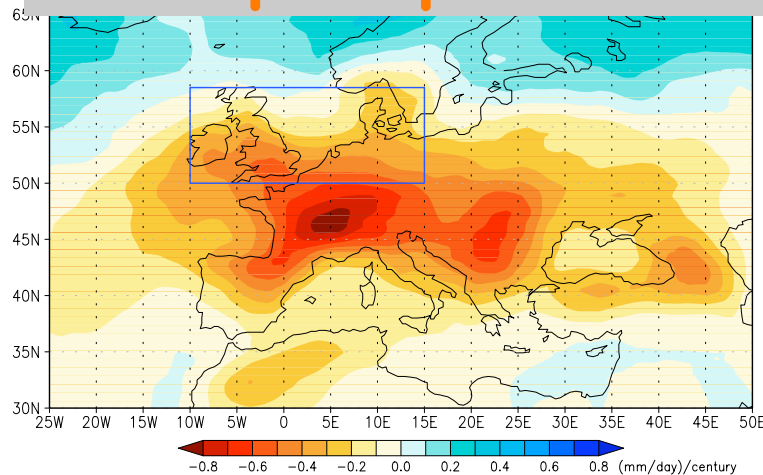
MULTI-MODEL MEAN SLP (2050–2099)–(1950–1999)



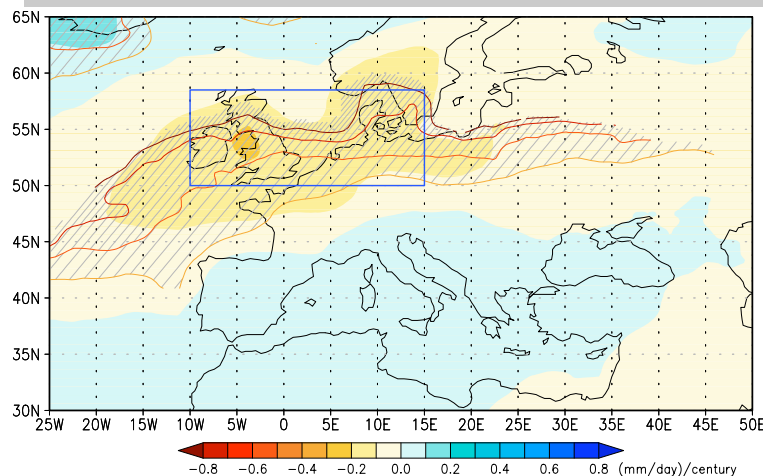


# The SNAO trend accounts for 50% of the ensemble-mean drying in NW Europe

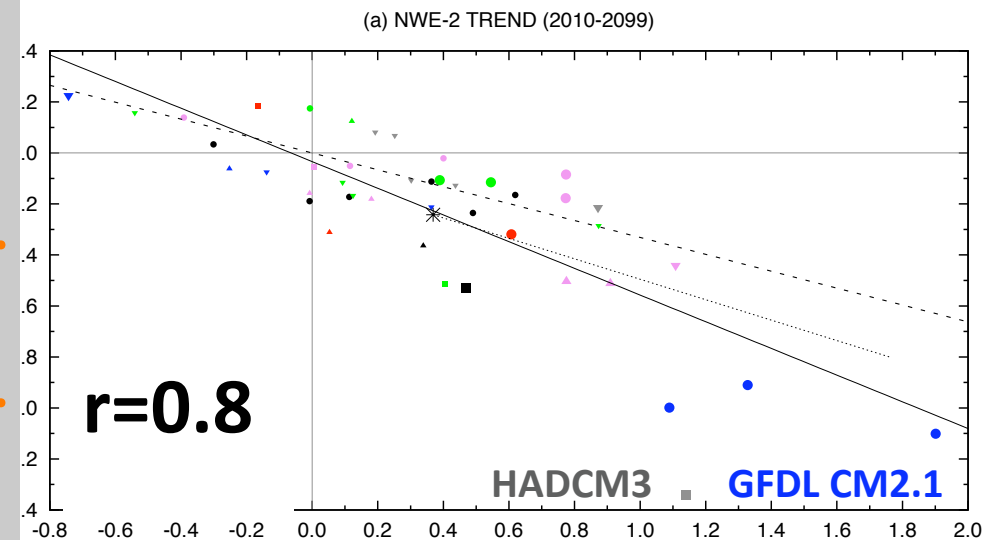
## MME precip trend



## SNAO contribution



## NW precip trend



## SNAO trend

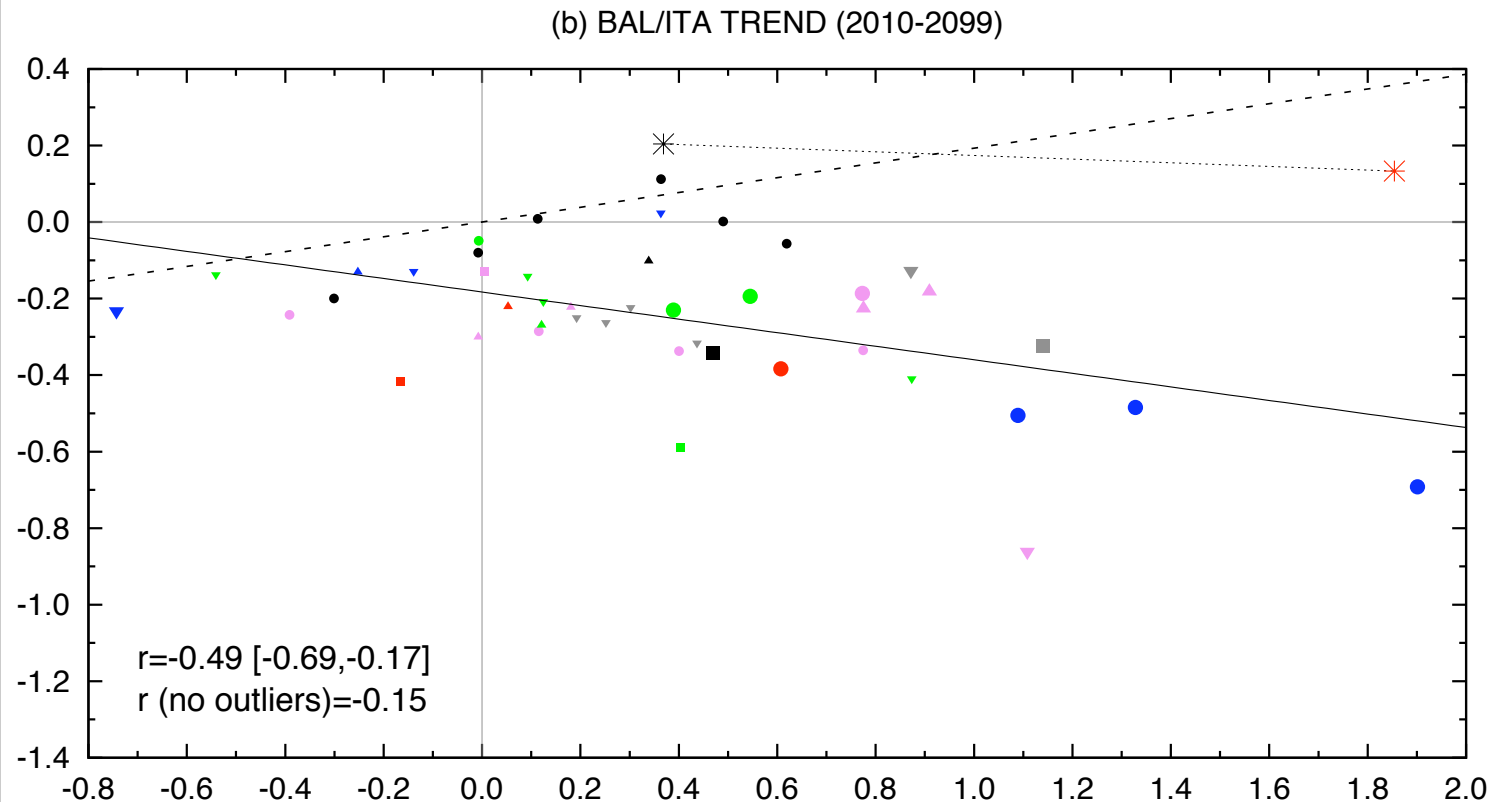
and also for 64% of the spread (uncertainty) in the magnitude of this drying

(Bladé et al. 2012)



But in the Mediterranean, where the model's impact on precipitation is too weak, the upward SNAO trend is inconsistent with observations (no precipitation decreases)

Mediterranean precip trend



SNAO trend



(Bladé  
et al.  
2012)

# CONCLUSIONS

- CMIP3 models reproduce the spatial SLP signature of the SNAO and the broad-scale dipolar pattern of precipitation over Europe, but the precipitation impact over the Mediterranean is too weak. The model error is related to their inability to reproduce the observed upper-level trough that favors convection in observations.
- Many CMIP3 predict an upward SNAO trend in the XXI<sup>st</sup> century. This trend accounts for 50% of the mean projected precipitation decrease in NW Europe. However, the large uncertainty in the SNAO trends results in a very large large uncertainty in the magnitude of this drying (64%).
- The corresponding expected increase in Mediterranean precipitation that would partially offset the drying due to other processes does not occur in CMIP3 models.
- Because the Mediterranean drying feedbacks on the circulation in central Europe via the local heat low, the model biases in the Mediterranean due to the missing SNAO teleconnection may lead to excessive drying over central Europe also.