# Seasonal Predictability of European Wind Storms

## The North Atlantic and European Area

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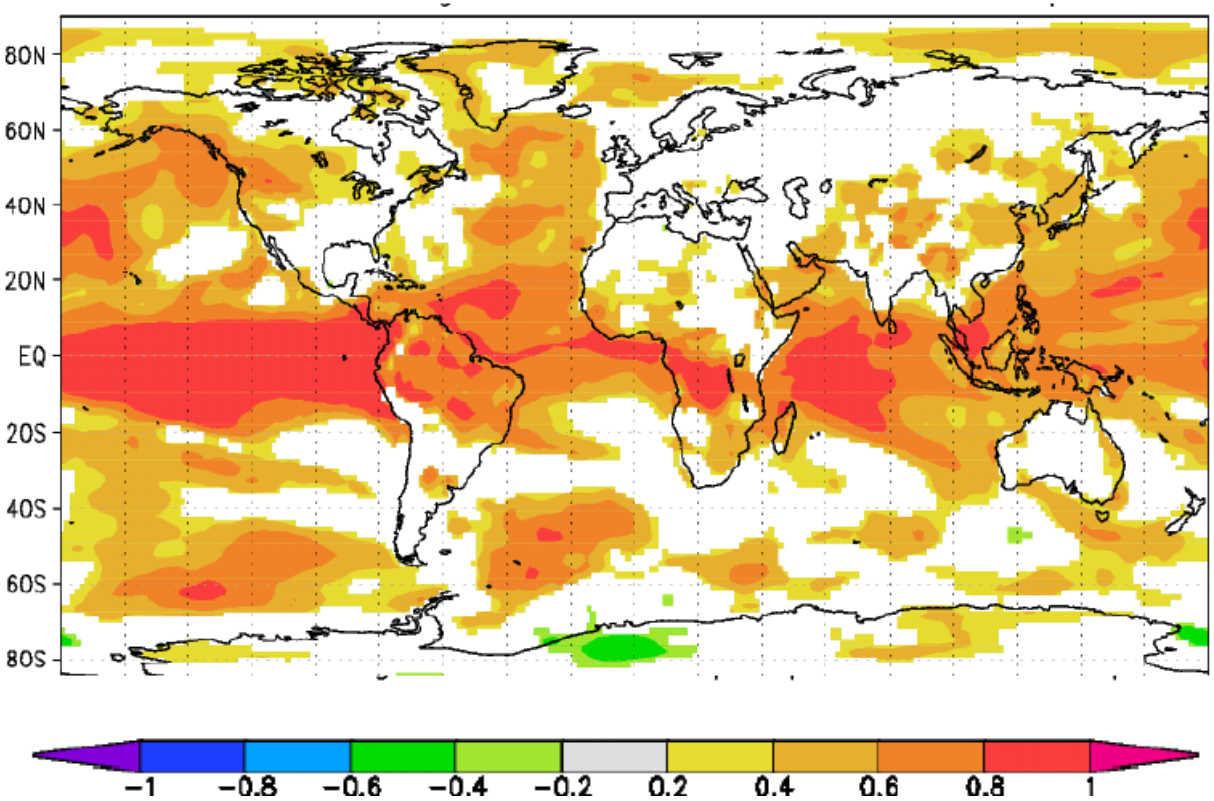
Main Source: PhD thesis of Dominik Renggli, 2011

# Operational Seasonal Predictions

Correlation of ECMWF System 3
Seasonal Temperature Forecasts wrt GHCN 1981-2005.

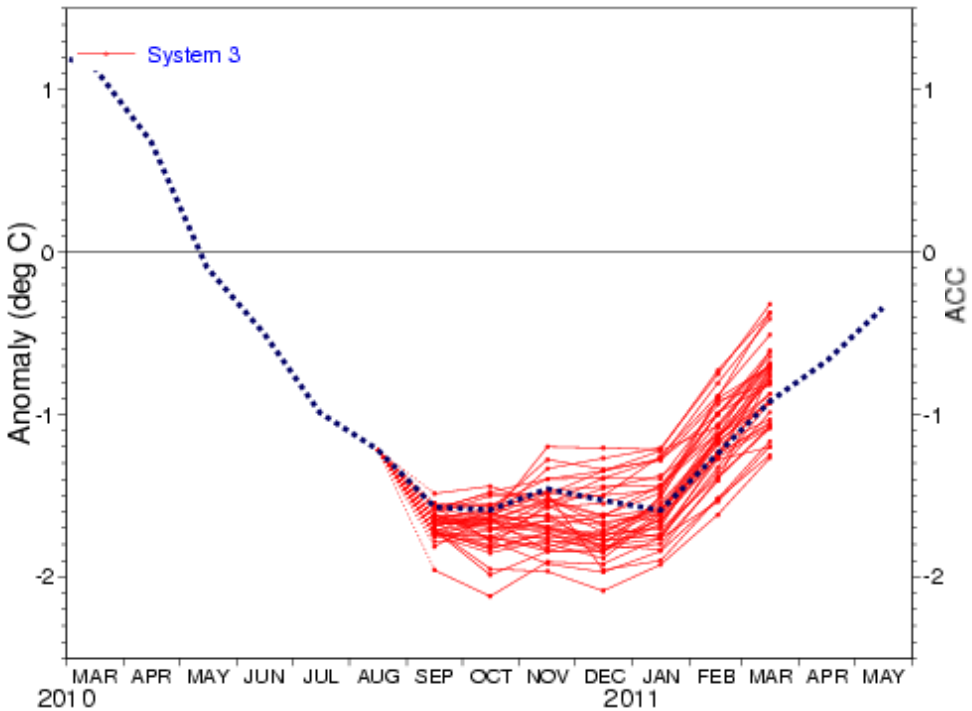



**DJF, T2m**

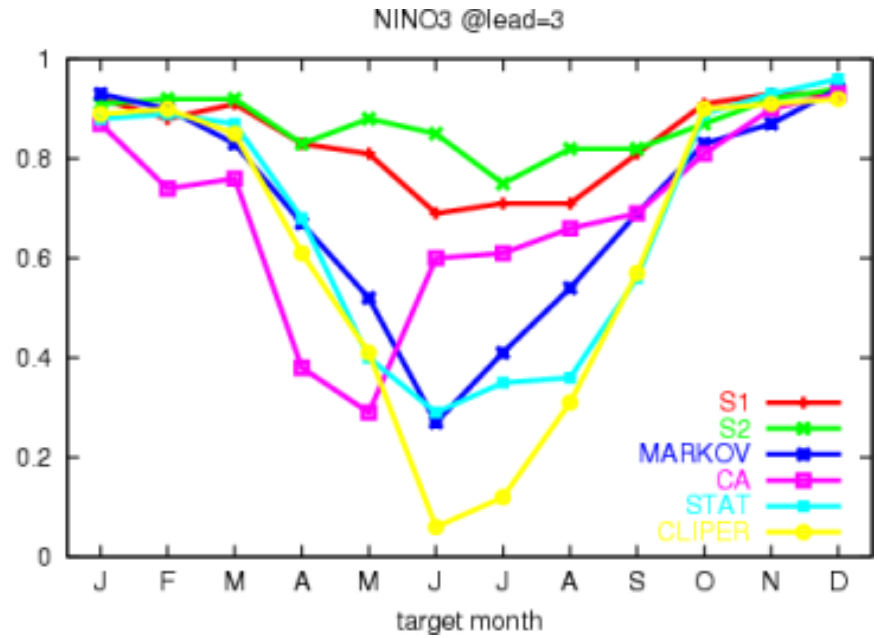
From
Doblas-Reyes (2010):
ECMWF Seminar
Seasonal Prediction over
Europe

# Seasonal Forecasts: El Niño

ECMWF-FCST
Niño3.4-Index, Sep 2010




3-month lead ECMWF FCST
compared to statistical models




Oldenborgh et al., J. Climate 2005

# Outline

1. Defining a wind storm
2. Mechanisms steering storm frequency according to observational data
3. Seasonal hindcast results
4. Conclusions and Outlook

# 1. How do we define a wind storm?

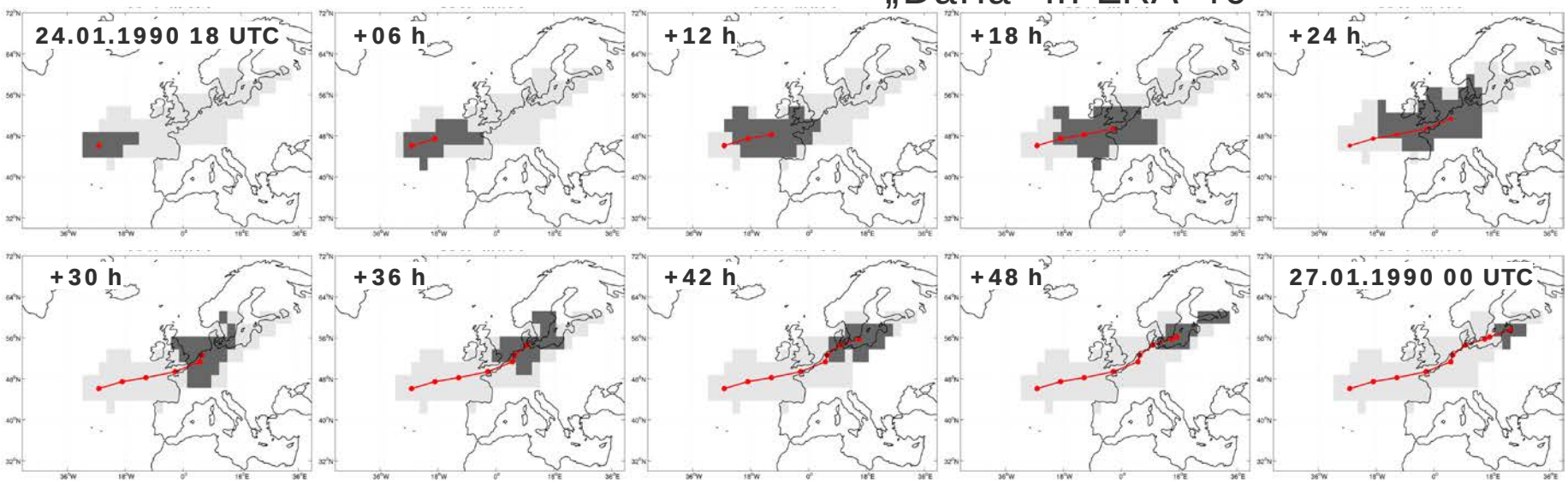
**Idea:** A large scale storm is characterized by

extreme (> 98%) wind speeds over a large area

lasting over at least 18 hours (three 6-hourly archiving steps)

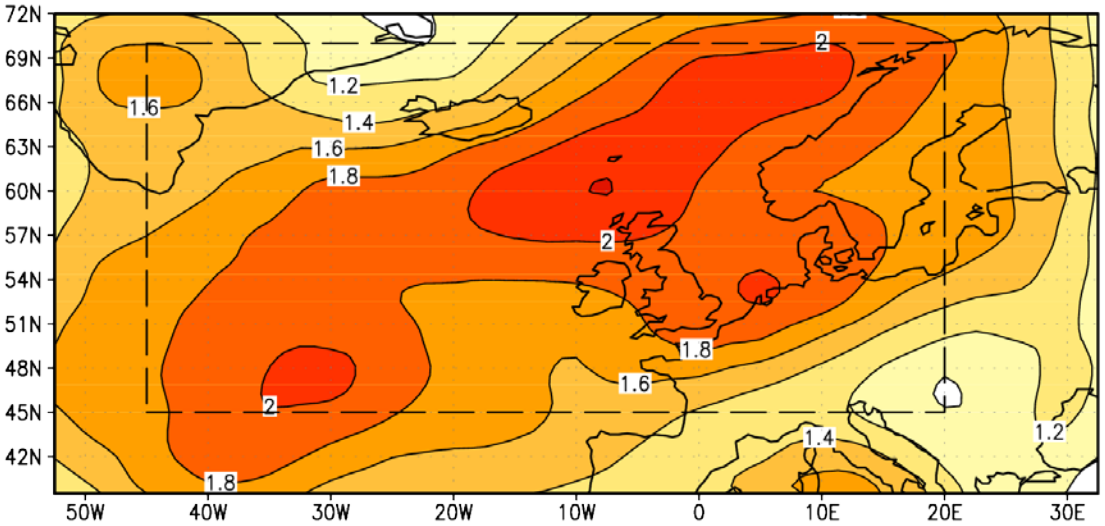
(Leckebusch et al., Meteorol. Z, 2008)

„Daria“ in ERA-40

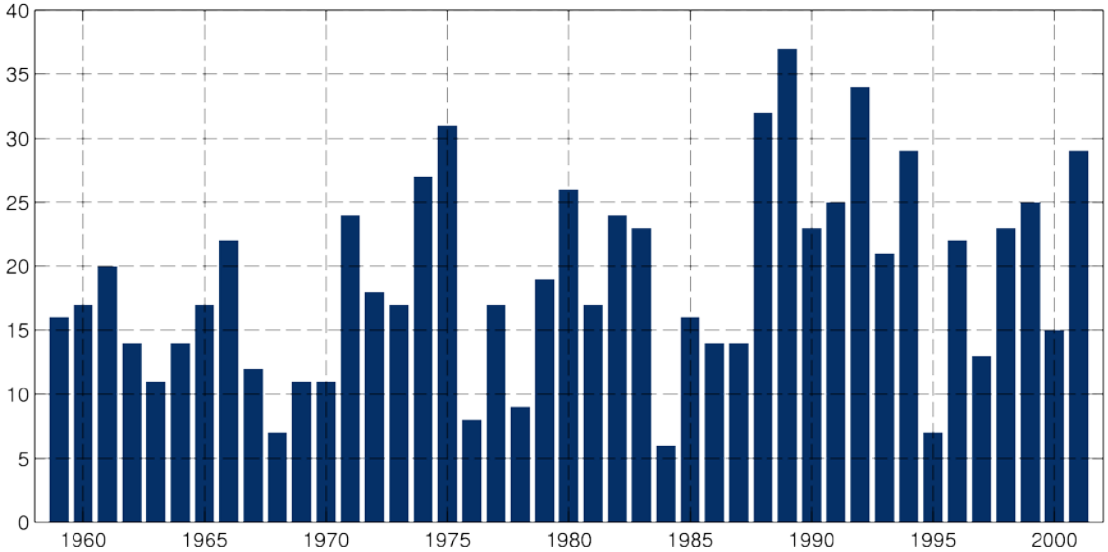


# 1. Wind Storm Track Densities

**Wind Storm Track densities**
(per DJF and area)
1959-2001, ERA-40




(Renggli et al., MWR accepted 2011)




**Number of Wind storm events**
DJF affecting the North Atlantik-European box, ERA-40

# 2. Potential Mechanisms: NAO

- **NAO** influences **storm risk** (Pinto et al., 2009)

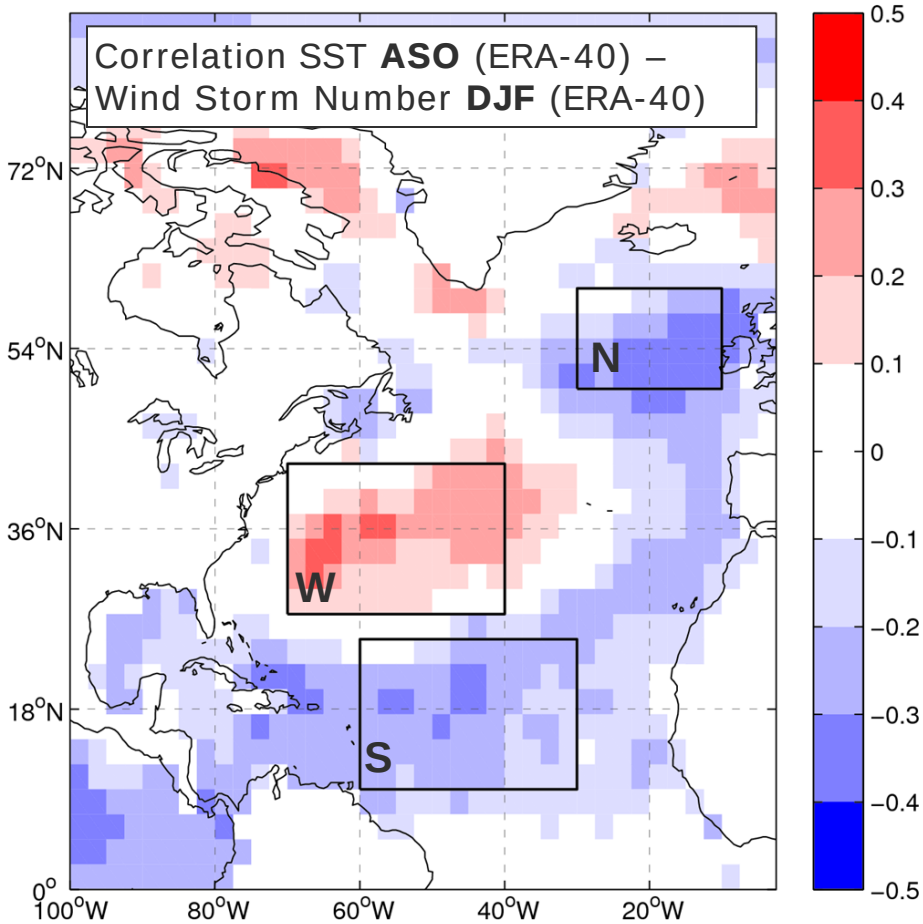
- **Seasonal predictability of the NAO** (Müller et al., 2005) for 1987–2001 („15% relative to a climate prediction“), but not for 1959–2001.
- Summer **SST Horseshoe** related to early winter NAO (Czaja and Frankignoul, 1999)

**Idea of a mechanism:**

**Ocean -> Baroclinicity -> (Cyclone Growth) -> storm occurrence**

→ Consider Ocean influence in **observational data**

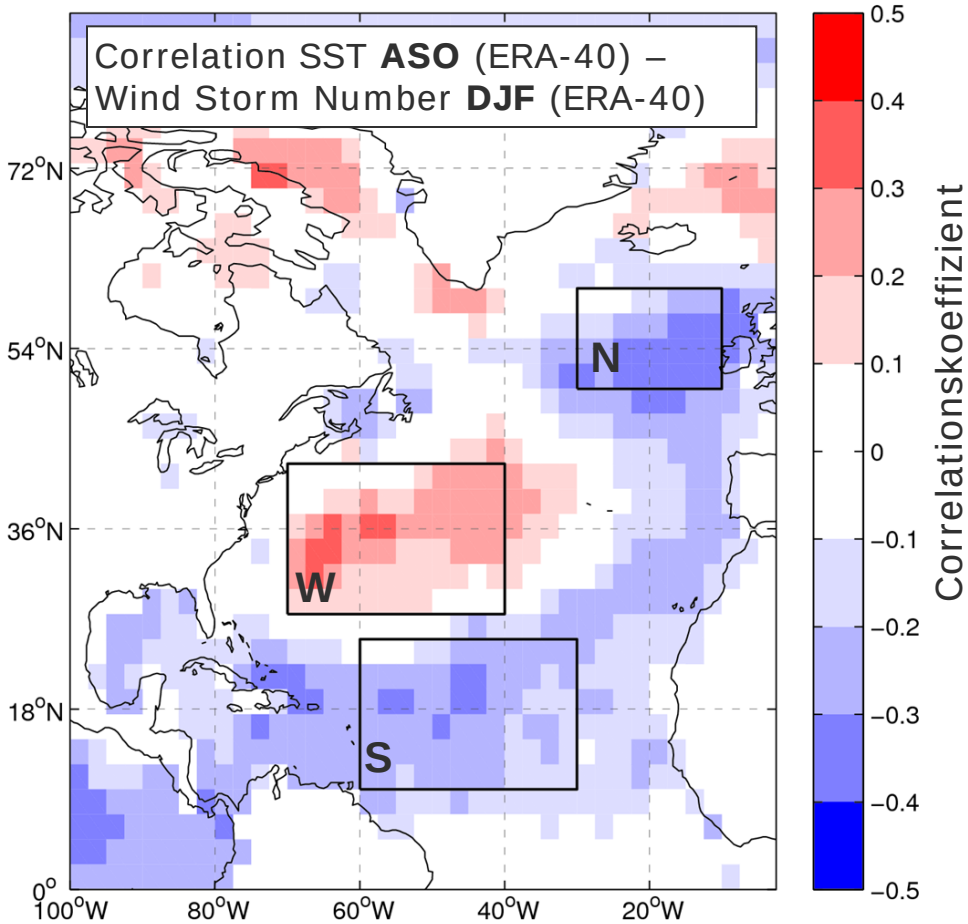
# 2. Number Wind storms -> SST

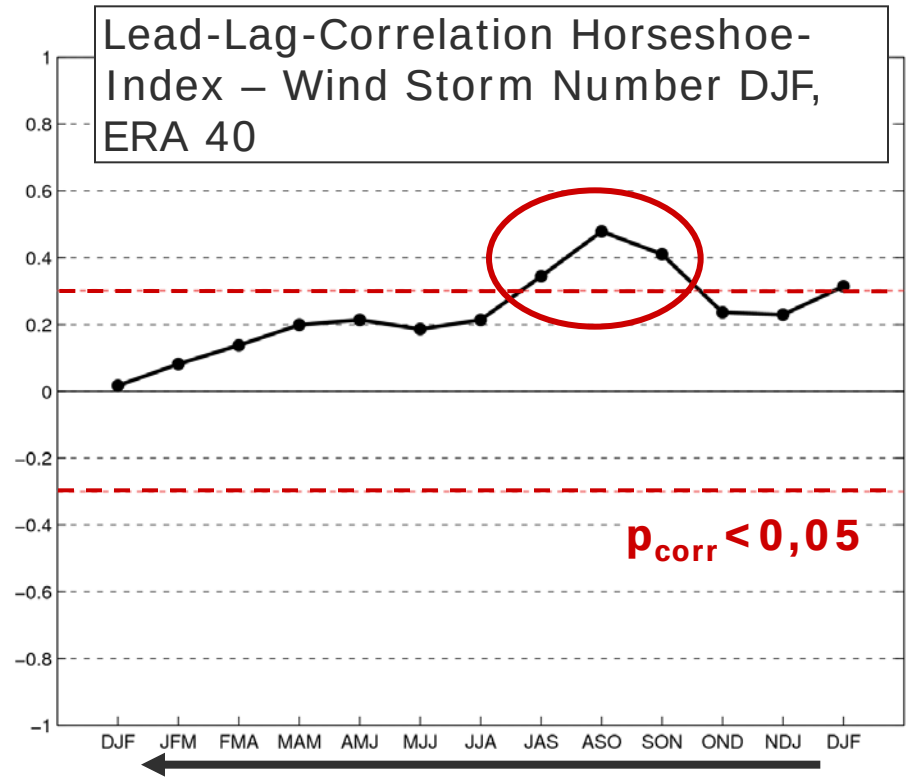



→ Definition **Horseshoe-Index**:

$$HSI = \overline{SST_W} - \frac{1}{2}(\overline{SST_N} + \overline{SST_S})$$

# 2. Horseshoe Index -> Number of Wind Storms




Snow ☑ NAO ☑ Sea ice ☑

→ Definition **Horseshoe-Index**:

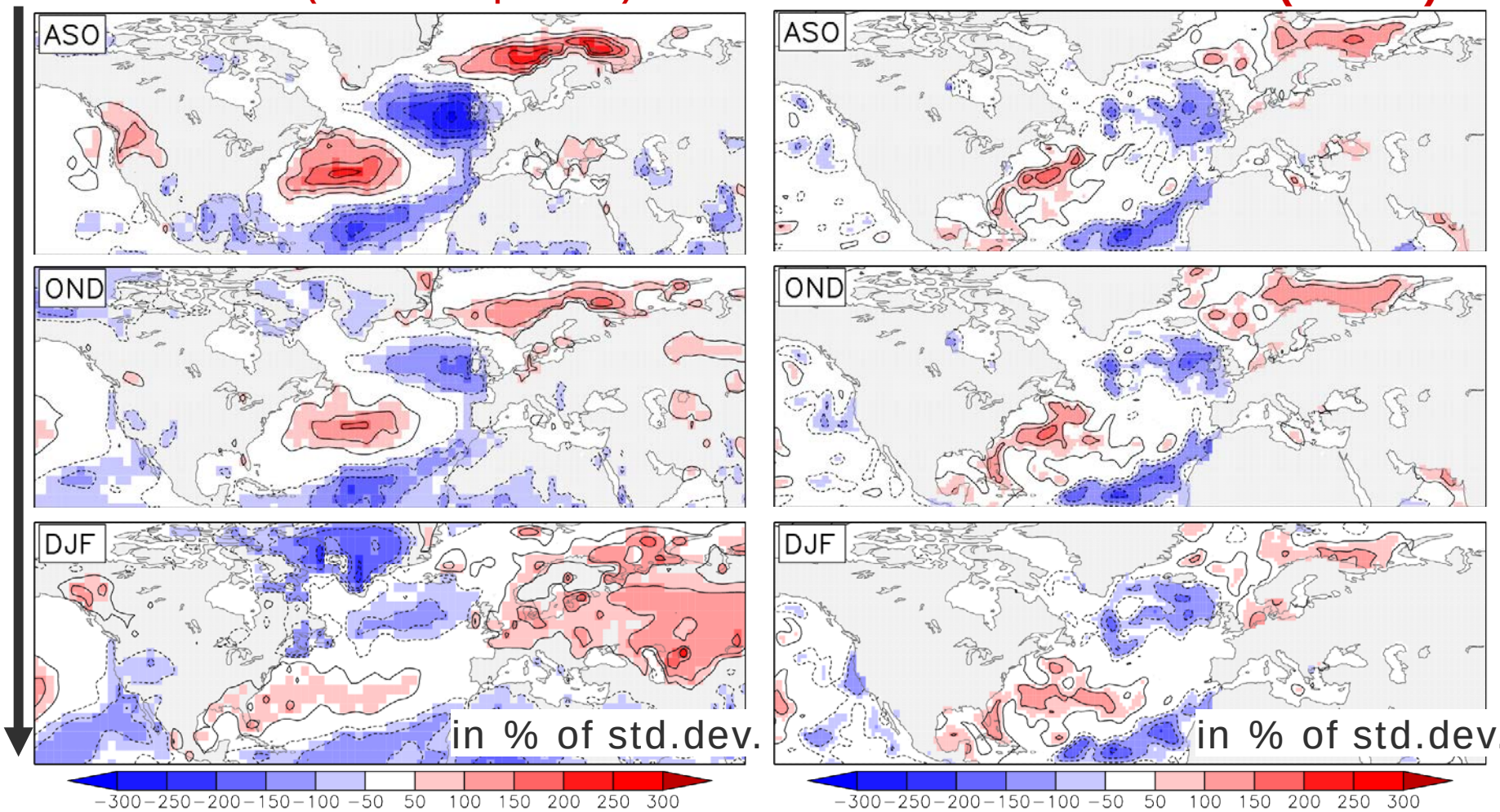
$$HSI = \overline{SST_W} - \frac{1}{2}(\overline{SST_N} + \overline{SST_S})$$

**Significant correlation on the seasonal time scale**

# 2. Potential Mechanisms: Developement of horse shoe

Composites for Horseshoe ASO$^{++}$ minus Horseshoe ASO$^{--}$

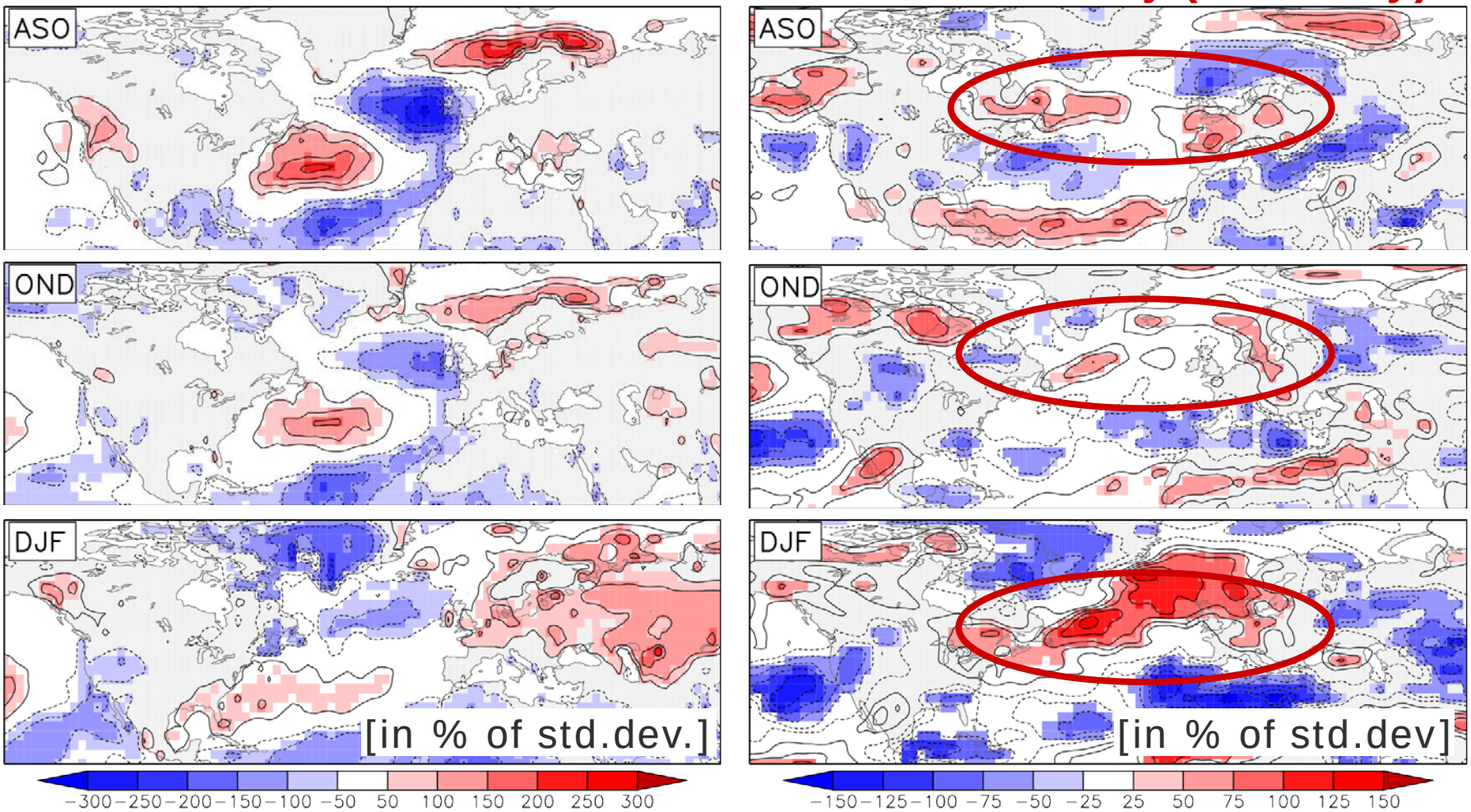
ERA-40 **SST (surface temperature)** **Ocean-heat content (300m)**



# 2. Potential Mechanisms: Baroclinicity

Composites for Horseshoe ASO++ minus Horseshoe ASO--

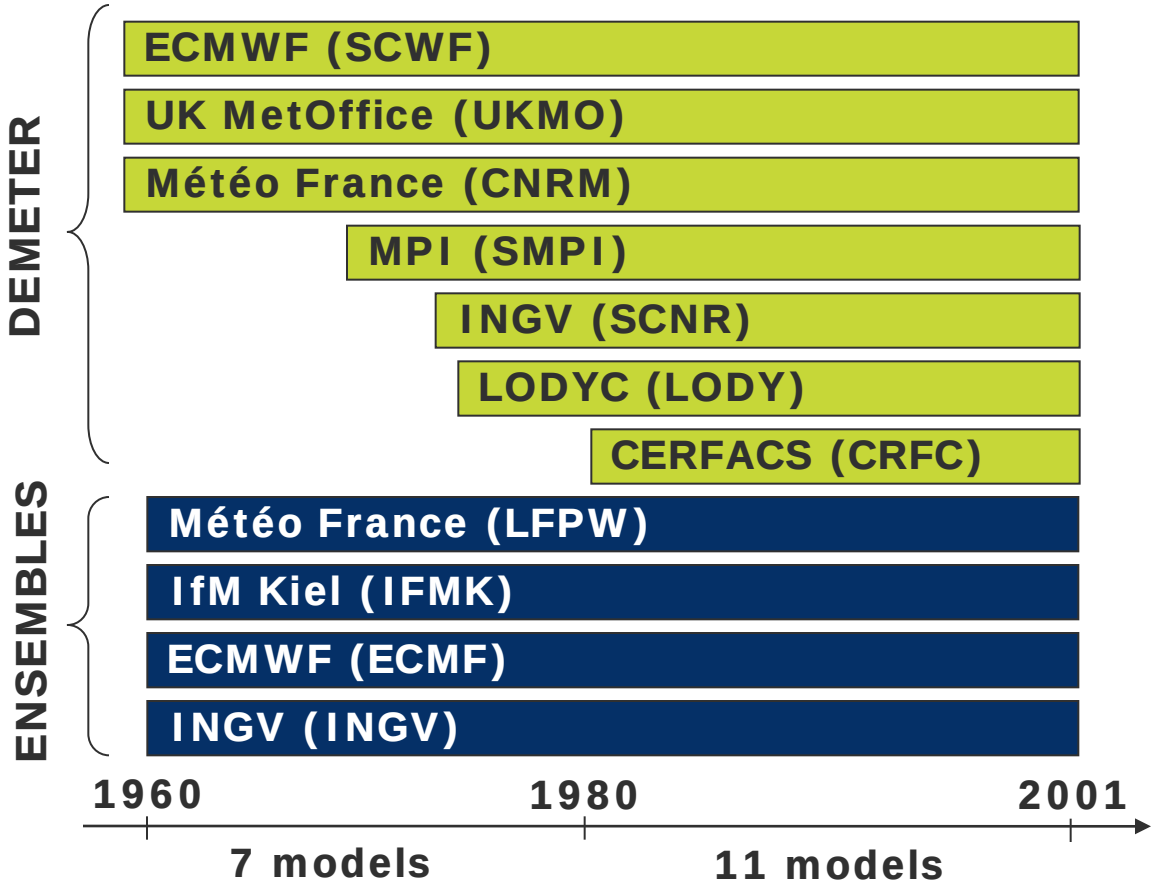
ERA-40 **SST (surface temperature)** **Baroclinicity (Max Eady)**



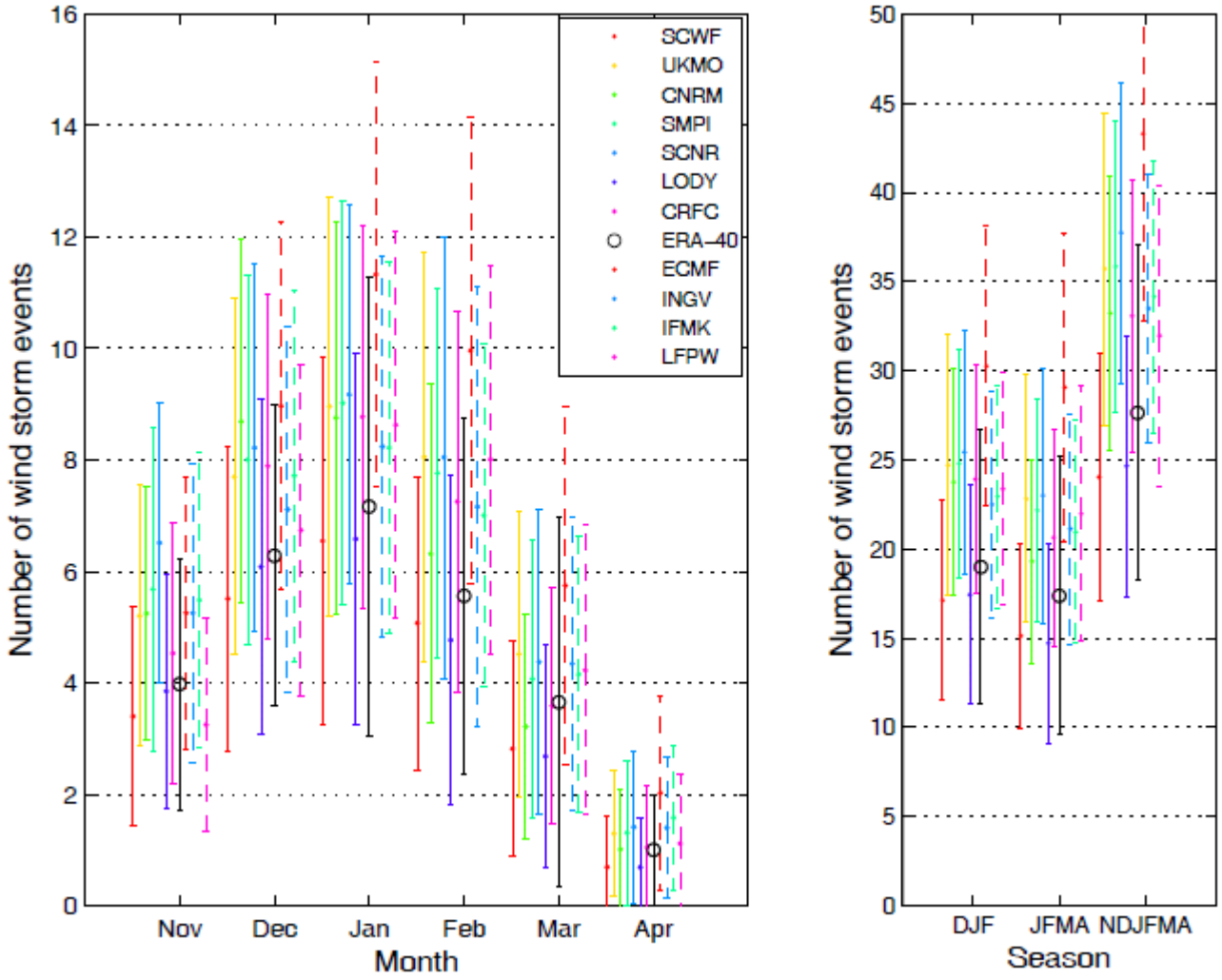
# 3. Seasonal hindcasts based on numerical models

- 11 OA models (DEMETER, ENSEMBLES) (Palmer et al. 2004, Weisheimer et al. 2009)

- Seasonal Hindcasts 1980-2001
- August-Hindcasts: August → January
- November-Hindcasts: November → April
- 9 ensemble-runs for each model

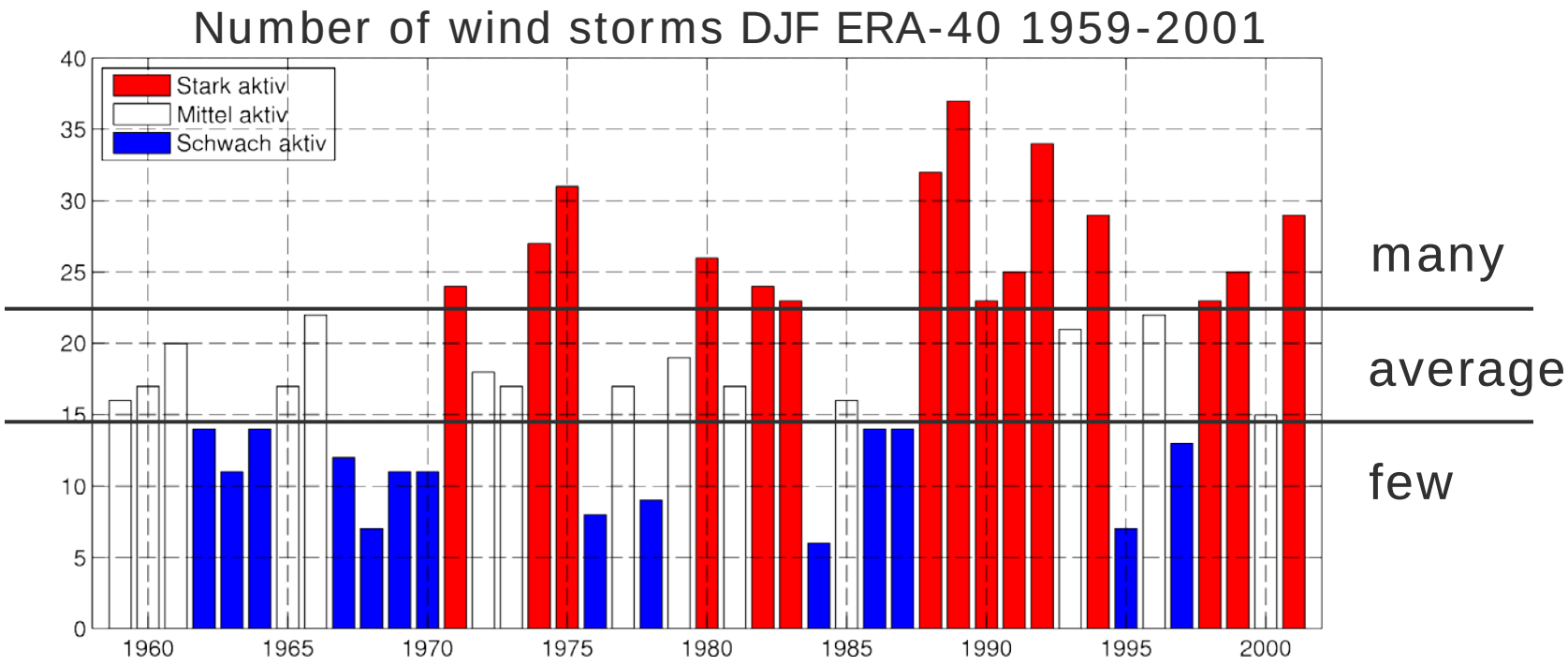


# 3. DEMETER and ENSEMBLES storm count climatologies



# 3. Testing the skill: November forecasts

- Predictant: Probability of 3 Storm Number Classes

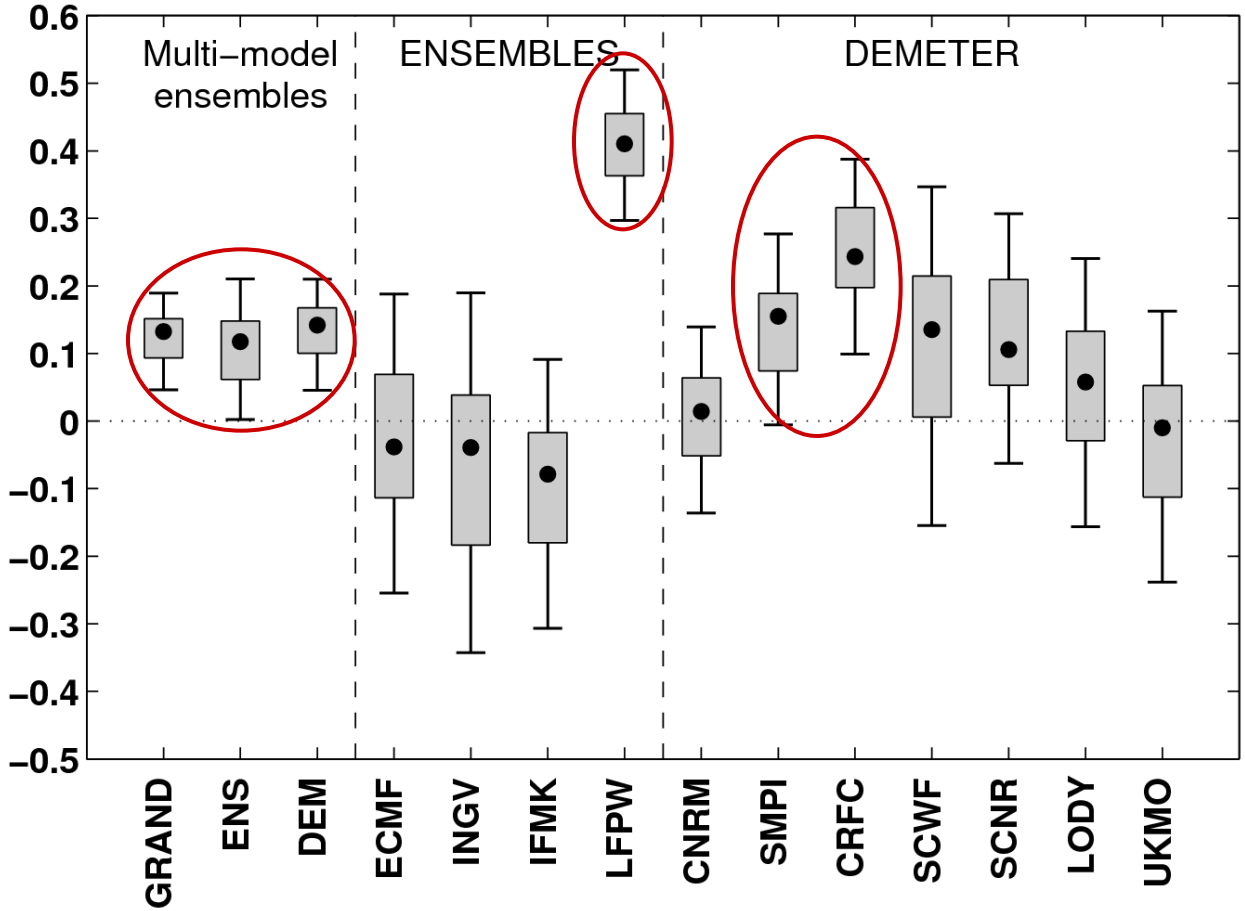



- **Ranked Probability Skill Score (RPSS)**
  RPSS=1: perfect forecast;
  RPSS>0: fcst better than climatology)

(Weigel et al. 2007)

# 3. Skill of November hindcasts

RPSS of **November-forecasts** of **DJF storm counts** (1-3 Monate forecasts) **1980-2001**

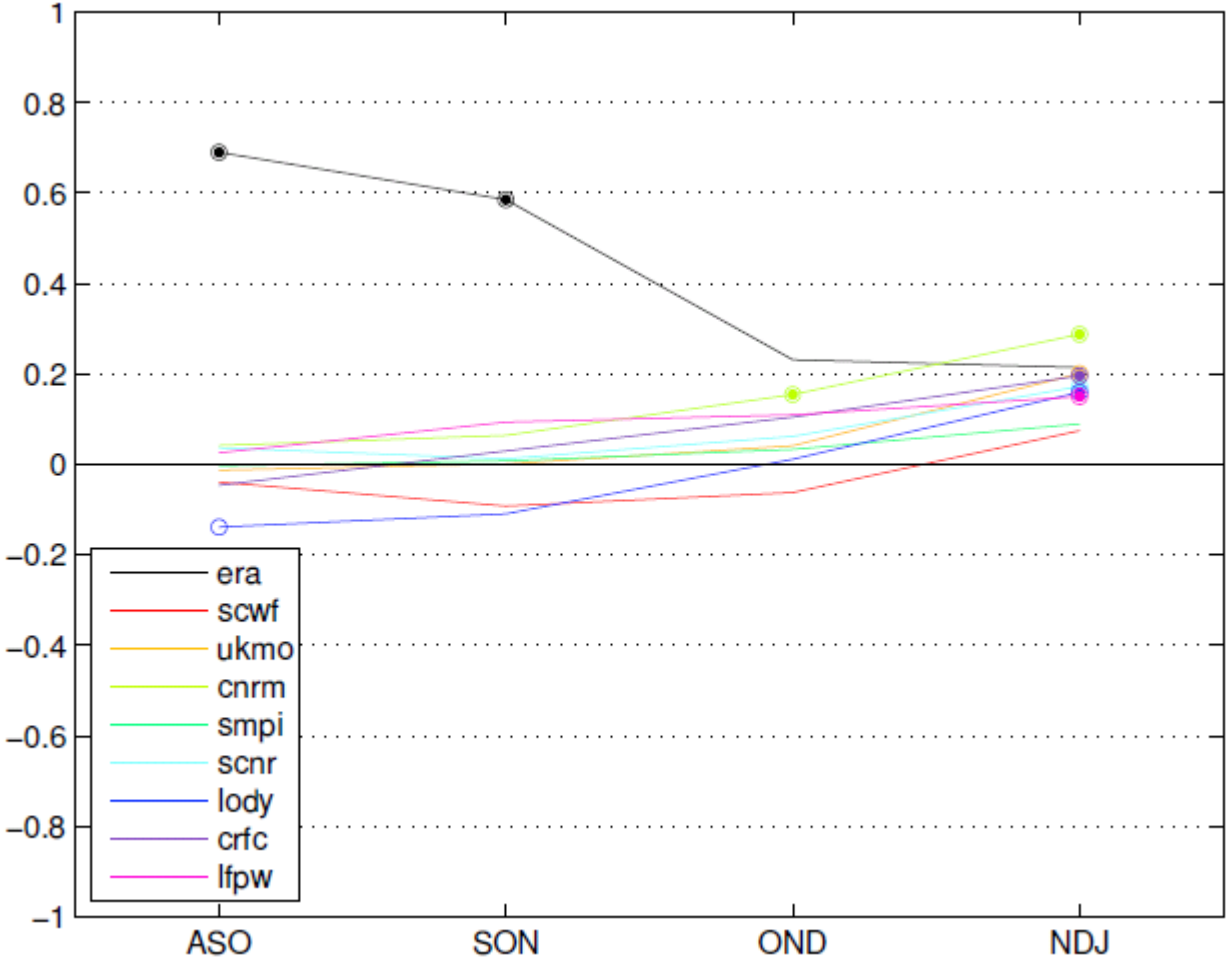



(Renggli et al. 2011)

Note:

- Skill 1980-2001 > 1960-1980!
- Skill high storm activity > skill average storm activity!

# 3. August Hindcasts: Horse shoe and wind storms



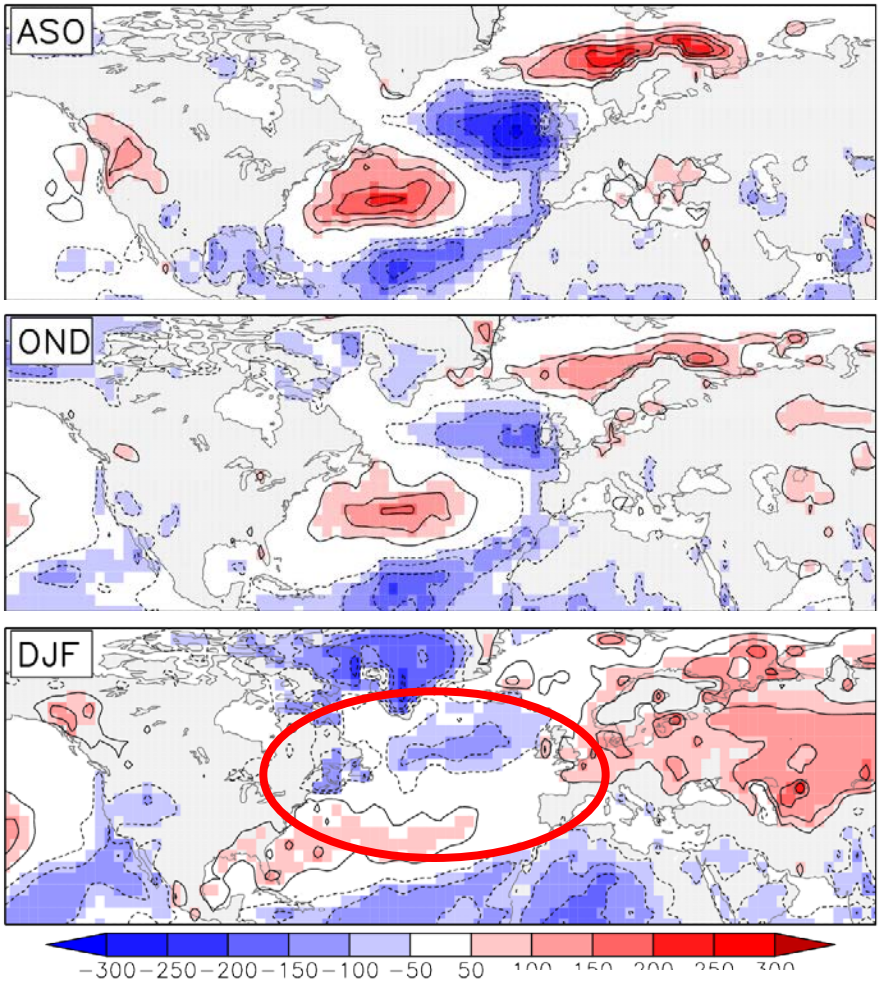

Spearman Lead-Lag-Correlation:

3-monthly Horseshoe-Index vs windstorm number during subsequent Dec-Jan, 1980–2001

Circles: 10% significance level

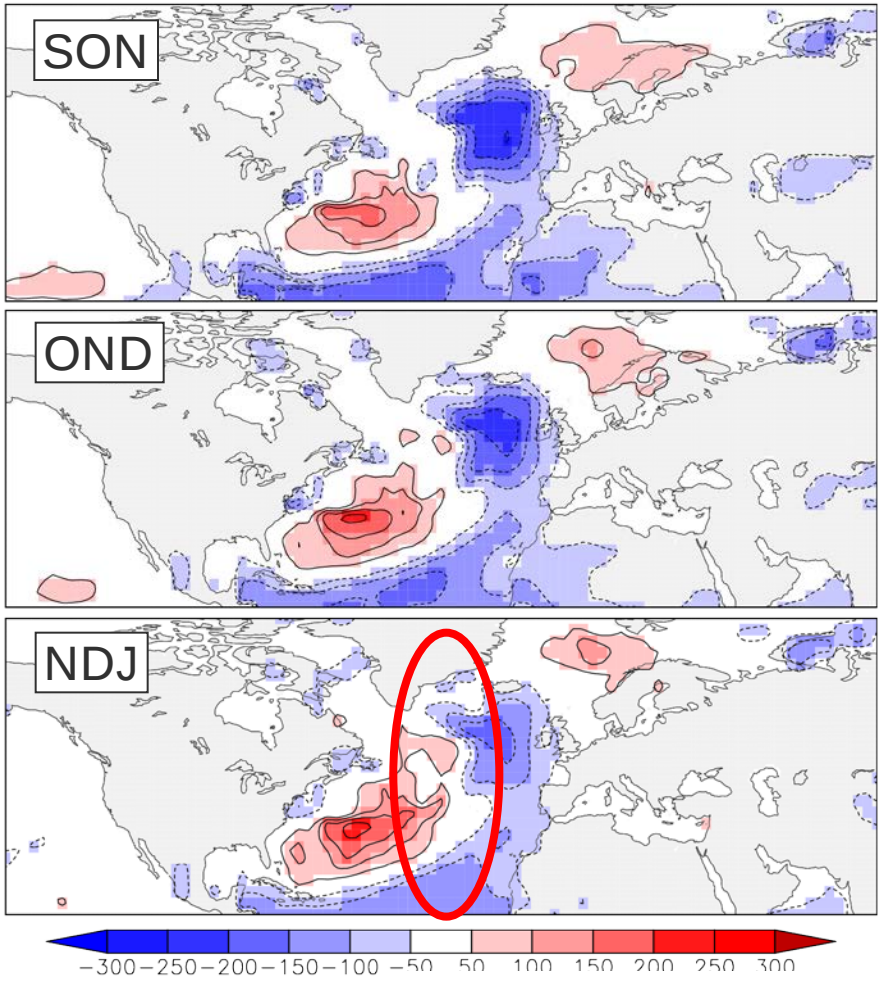
# 3. Horseshoe-Composites from August-Hindcasts

ERA-40 **SST**




[in % of std.dev.]

SCNR **SST**



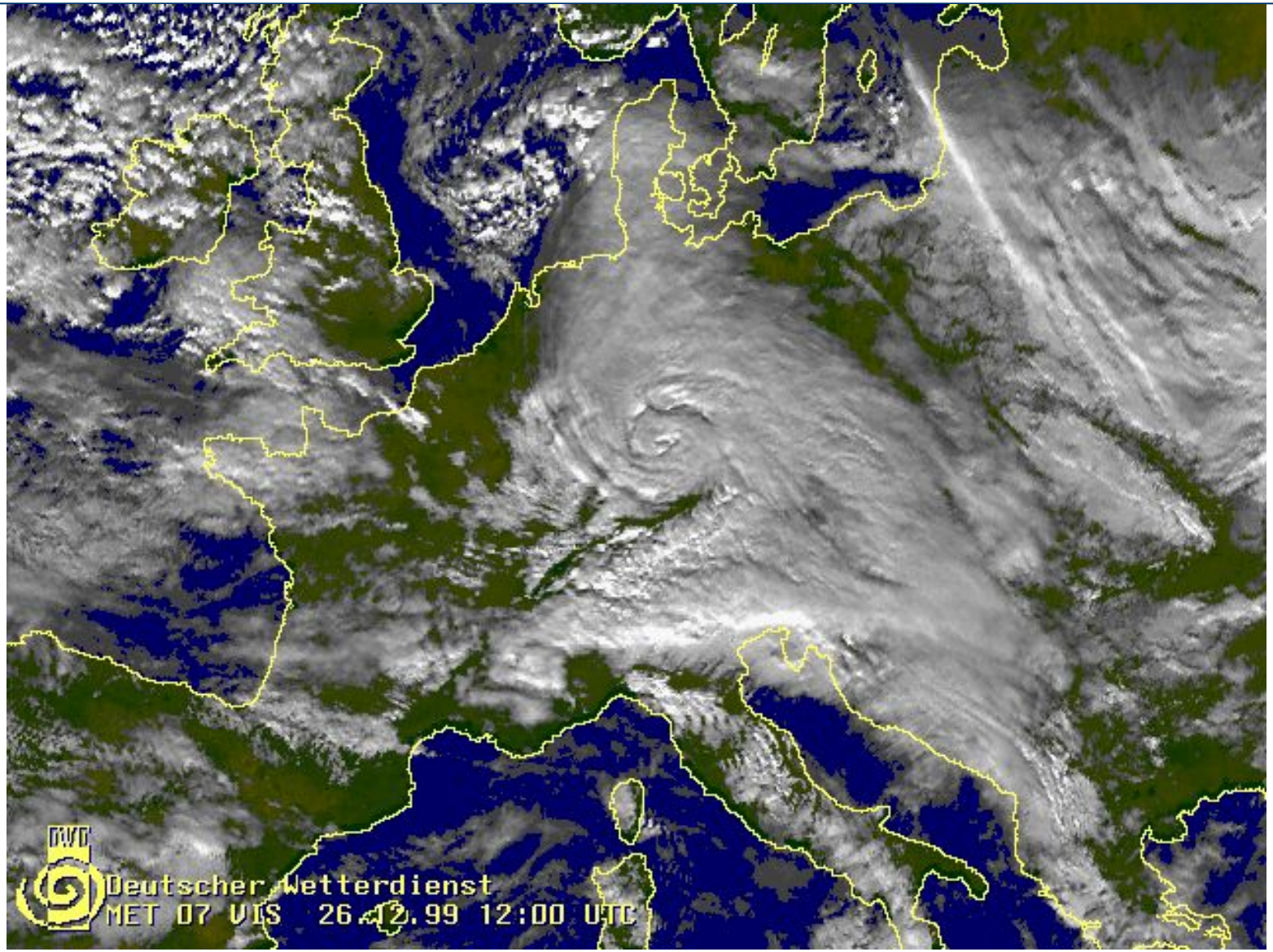

[in % of std.dev.]

# 4. Conclusions

- The Number of Atlantic-European **storms** is related with summer **horseshoe** pattern in Atlantic SSTs according to **observational data**
- Potential mechanisms:
  Signals in Upper Ocean Heat content could contribute to enhanced **baroclinicity** in the Eastern North Atlantic.
- Not shown: NAO also has an influence statistically independent from horseshoe.
- Numerical **seasonal forecast models** starting in August do not reproduce this pattern well,
  or quickly develop towards their climatology.
- Improvements of the models, with respect to **ocean-atmosphere interaction**, could be promising.

# 4. Outlook

- **Decadal forecasts** based on coupled AO-models are currently considered at several research institutions.

- Could improvements with respect to **seasonal forecasts** be the way to make progress with decadal forecasts?

# Thank you for your attention !