Seasonal predictability of European wind storms

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Outlines

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  - Special definition and identification of wind storms related to model data
  - Intraseasonal cycle of wind storm frequency
- **Wind storm frequency and hemispheric scale factors in ERA40**
  - Eurasian snow cover extent
  - North Atlantic SST gradients
- **Summary and Outlook**

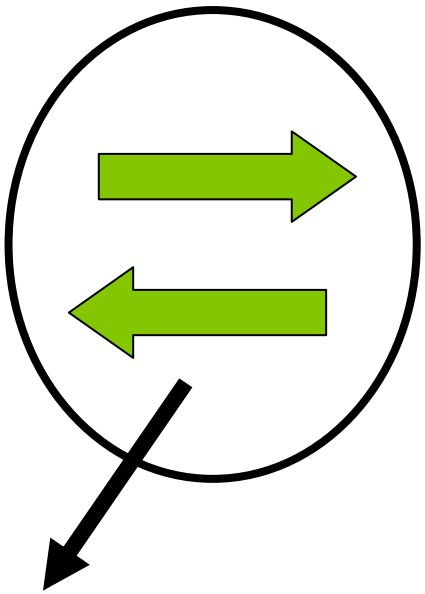
Rationale

Variability of wind storm frequency

seasonal timescale!

Hemispheric scale factors (>5000 km, weekly to seasonal timescale), e.g.

- Snow cover (Qian and Saunders, 2003)
- SST gradients
- NAO (Palutikof et al. 2003)



Synoptic to mesoscale factors (100-5000 km, 2-8 day):

- Baroclinicity
- Upper tropospheric divergence
- Latent heat

(Ulbrich et al., 2001; Pinto et al., 2008)

physical mechanisms ↔ predictability?

Data used in the study

- ERA40:
  - 6 hourly instantanous 10m wind speed (code 165/166), 2.5° spatial resolution
- DEMETER:
  - Multi model ensemble, consisting of 7 coupled models with 9 ensemble members each
  - Models considered so far (run from 1959-2001):
    - ECMWF (SCWF)
    - UK MetOffice (UKMO)
    - MeteoFrance (CNRM)
  - November hindcasts, run from 1 November to 30 April (thus, winter defined as November to April, NDJFMA)
  - Wind speed data as for ERA40

"Wind storms" in model data: Definition

- Climate models systematically underestimate wind speeds, especially over land

- Considering model's local wind speed climatology

- **Local 98th percentile of 10m wind speed** (threshold for damage inducing wind speeds, cf. Klawa and Ulbrich, 2003; Leckebusch et al., 2007)

- Wind storm is a **spatially** and **temporally coherent exceedance** of the local 98th 10m wind speed **percentile**.

Wind storms in model data: Identification

1) Identification of **spatially coherent exceedances** of the local 98th percentile:
   - Exceedances at adjacent gridboxes ("cluster")
   - Minimum area per time step: ~ 350 x 350 km^2

which must be

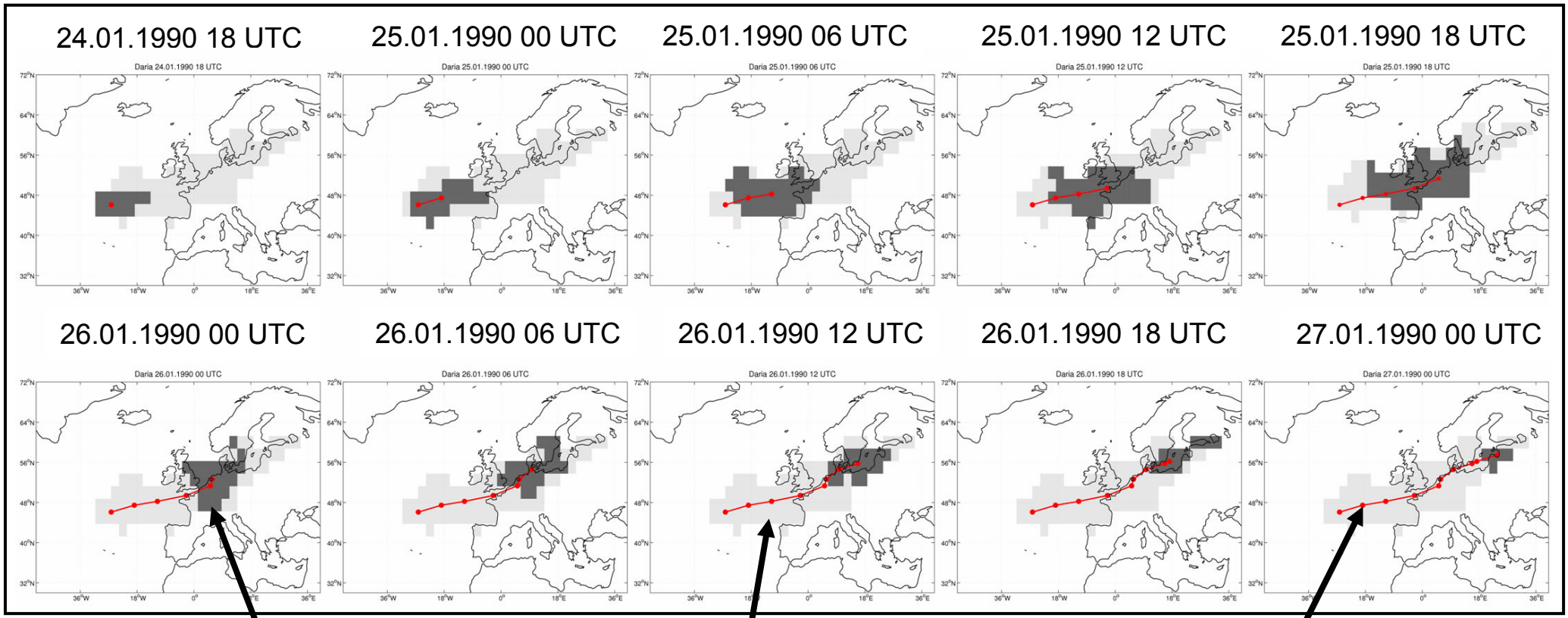
2) **Temporally coherent**:
   - "cluster" can be tracked in the next timestep via nearest neighbour tracking
   - minimum lifetime: 24h (4 time steps)

- **Event based** identification (date, lifetime, position etc. is known)

- Identification method applied on ERA40 and DEMETER data
  (Leckebusch et al., submitted)

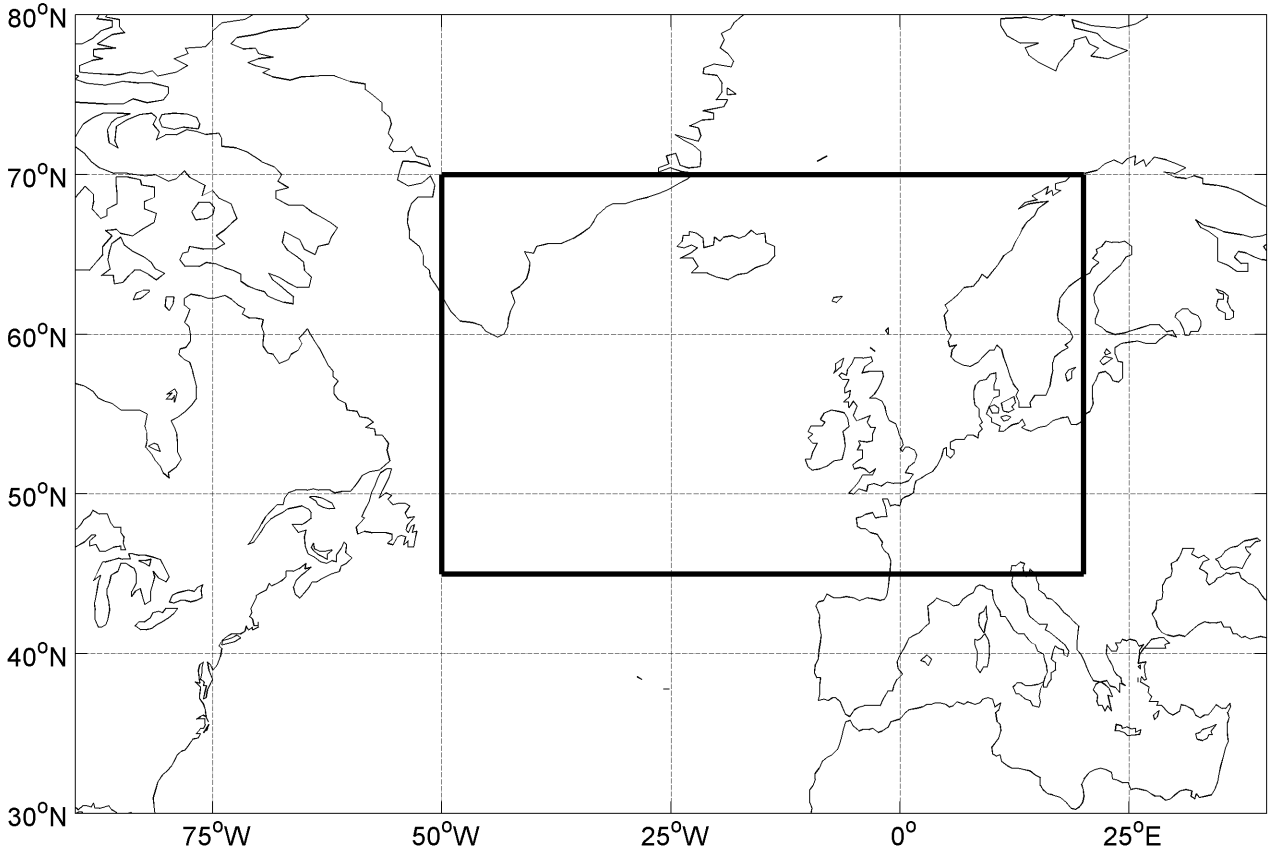
Wind storms in model data

Illustrative example: Track and footprint of **wind storm "Daria"**, 24.-27.01.1990, as identified in **ERA40**



Intraseasonal cycle of wind storm frequency

- **Wind storm frequency** defined as **number of events per month crossing a predefined box** over the North Atlantic and Western Europe

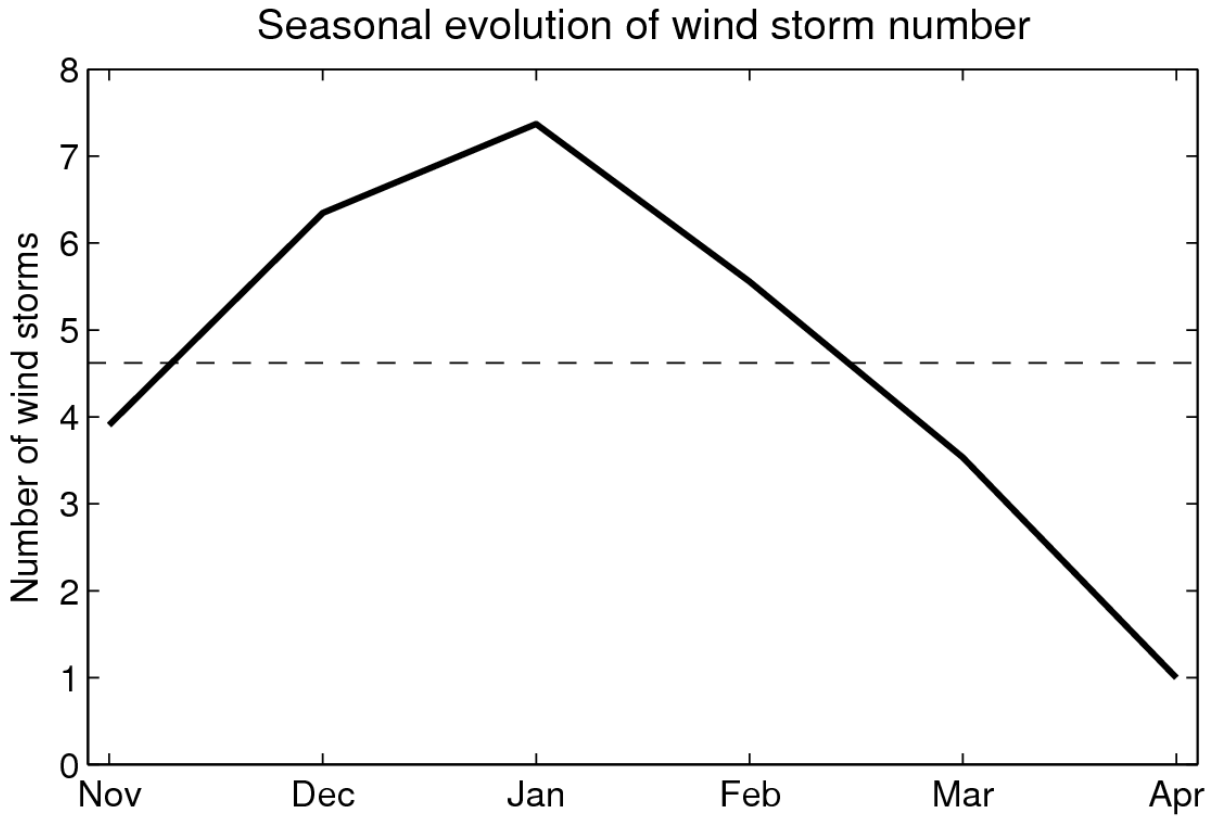


Intraseasonal cycle of wind storm frequency

- Monthly mean wind storm frequency:
  - ERA40: 4.6
  - SCWF: 3.8 (83%)
  - UKMO: 5.5 (119%)
  - CNRM: 5.2 (113%)
- **DEMETER data scaled** by the relative difference to ERA monthly mean frequency (intraseasonal cycle: only relative performance relevant!)
- Note: DEMETER results based on **mean of all 9 ensemble members**

Intraseasonal Cycle in ERA40:

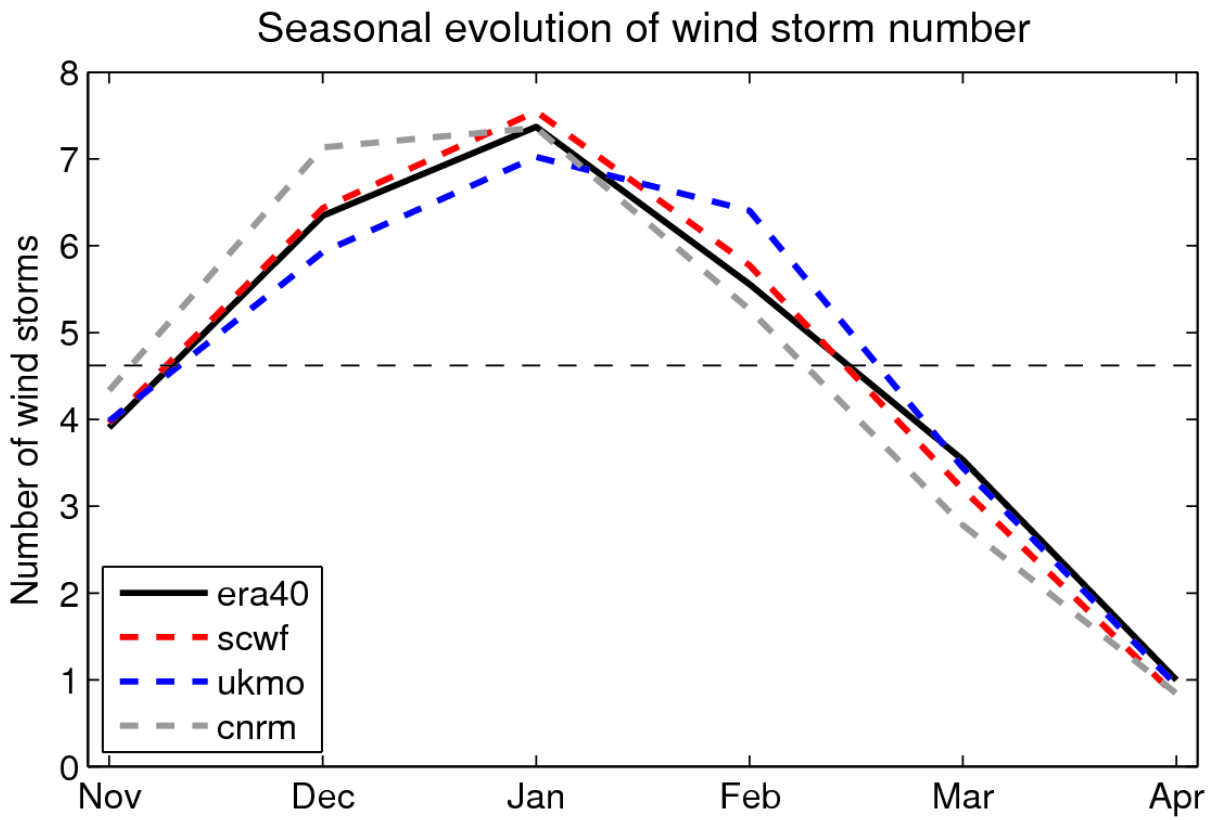
- Increase from November to January
- Decrease from January to very few in April
- Seasonal mean: 4.6



Intraseasonal Cycle in DEMETER:

- Overall good representation of the intraseasonal cycle
- Deviations in the order of 10%
- RMSE:
  - SCWF: 4.3%
  - UKMO: 9.0%
  - CNRM: 10.7%
- Significant deviations exist (Student's t-test)

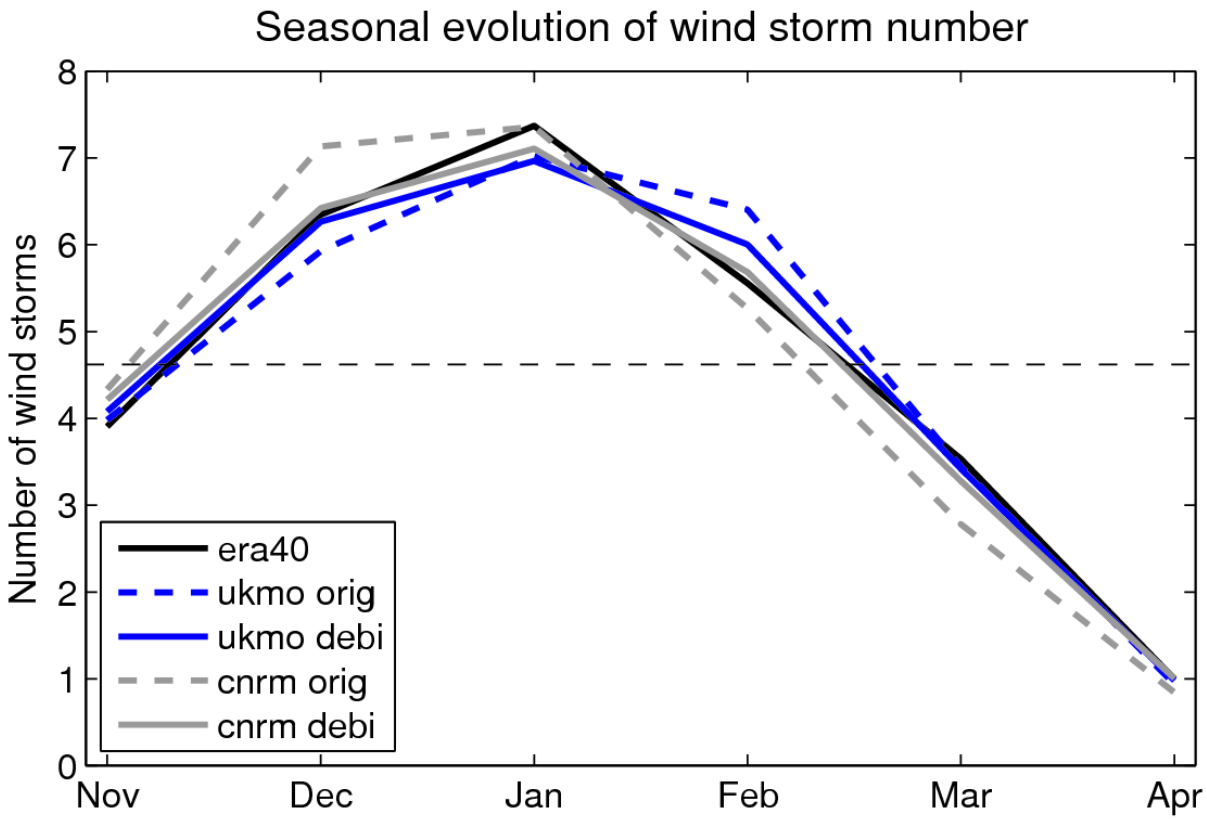
➡ **Debiasing scheme**



Sig (%)	Nov	Dec	Jan	Feb	Mar	Apr
SCWF	10.7	15.9	21.2	34.0	50.0	75.7
UKMO	15.6	68.9	41.6	***91.5***	14.4	31.3
CNRM	74.1	***93.6***	1.7	45.4	***86.5***	68.1

Intraseasonal Cycle in DEMETER: debiased

- Overall cycle fits better to ERA40
- RMSE markedly reduced for all models
- Remaining deviations **not significant**



	RMSE original	RMSE debiased	Difference
SCWF	**4.3%**	**3.4%**	**-21.5%**
UKMO	**9.0%**	**5.7%**	**-36.7%**
CNRM	**10.7%**	**4.4%**	**-58.7%**

Hemispheric scale factors and wind storms

- Analysis of relations between hemispheric scale factors and wind storm frequency **in ERA40**

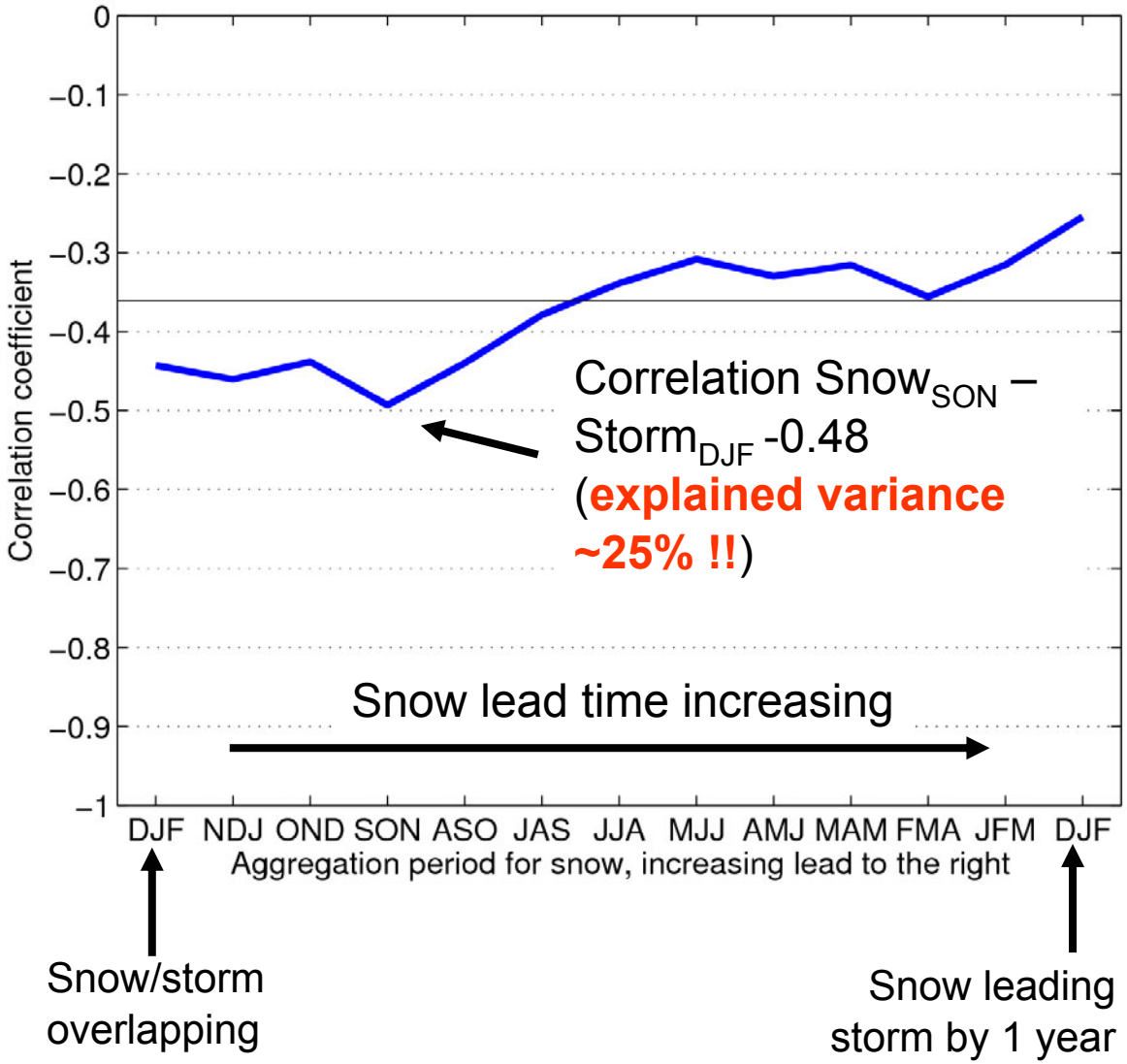
- **lead/lag correlation** between factor and wind storm frequency (**factor leading** by up to 1 year)

- Eurasian snow cover extent
- North Atlantic SST gradient

Snow cover extent

- Observed snow cover extent over Eurasian continent 1972-2001 (Robinson et al., 1993)
- Generally negative correlation
- **Highest correlation for preceding autumn snow cover**
- 95% confidence level indicated by horizontal black line (-0.36)

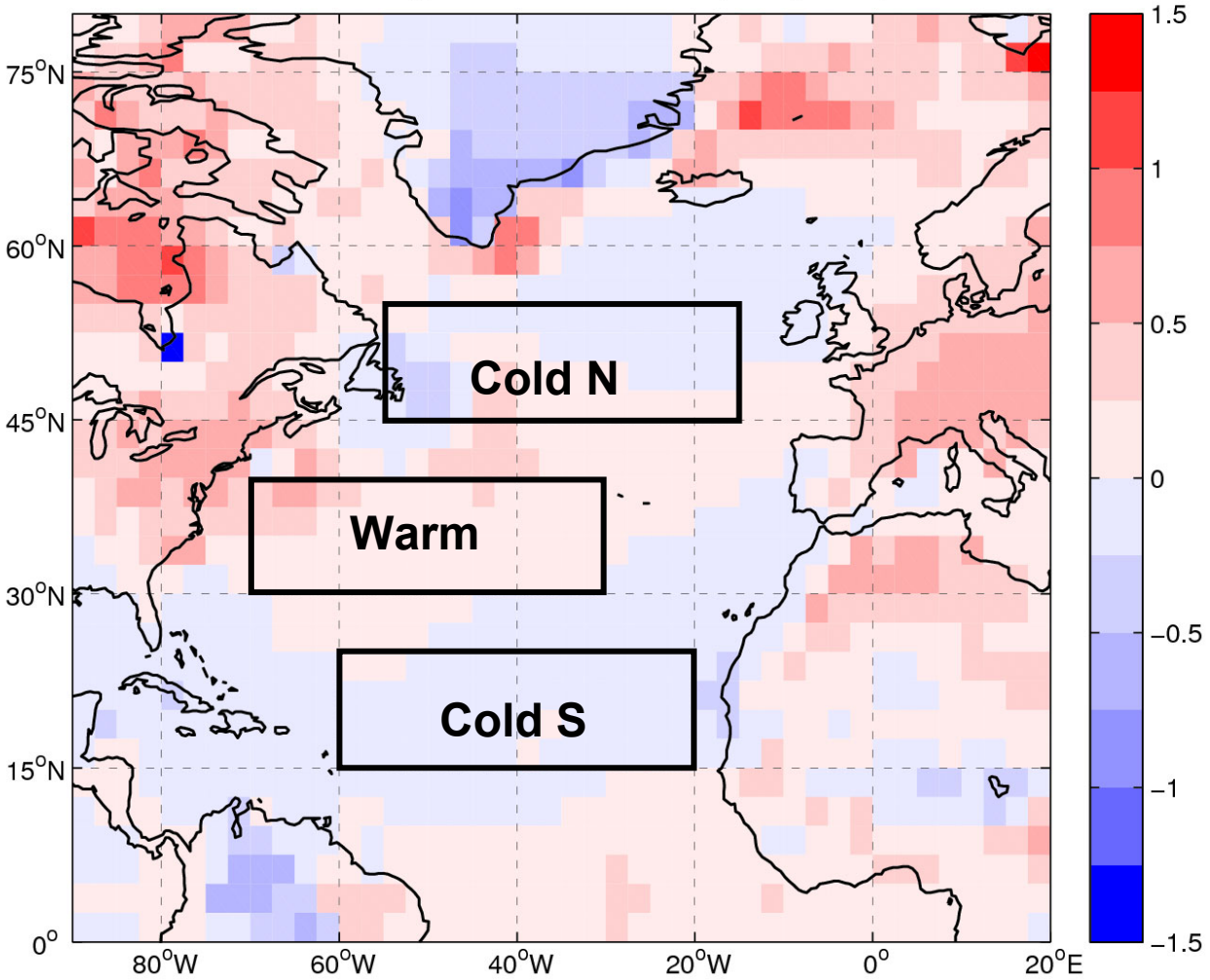
Correlation wind storm frequency DJF ERA40 with 3 monthly mean Eurasian snow cover extent



SST: Composite

- ERA40 SST (code 139) 1959-2001
- Horseshoe-like pattern in high/low frequency composite difference
- SST gradient index defined accordingly, based on monthly and spatial means over the 3 boxes:

Difference SST composite for 20 high/low wind storm frequency seasons

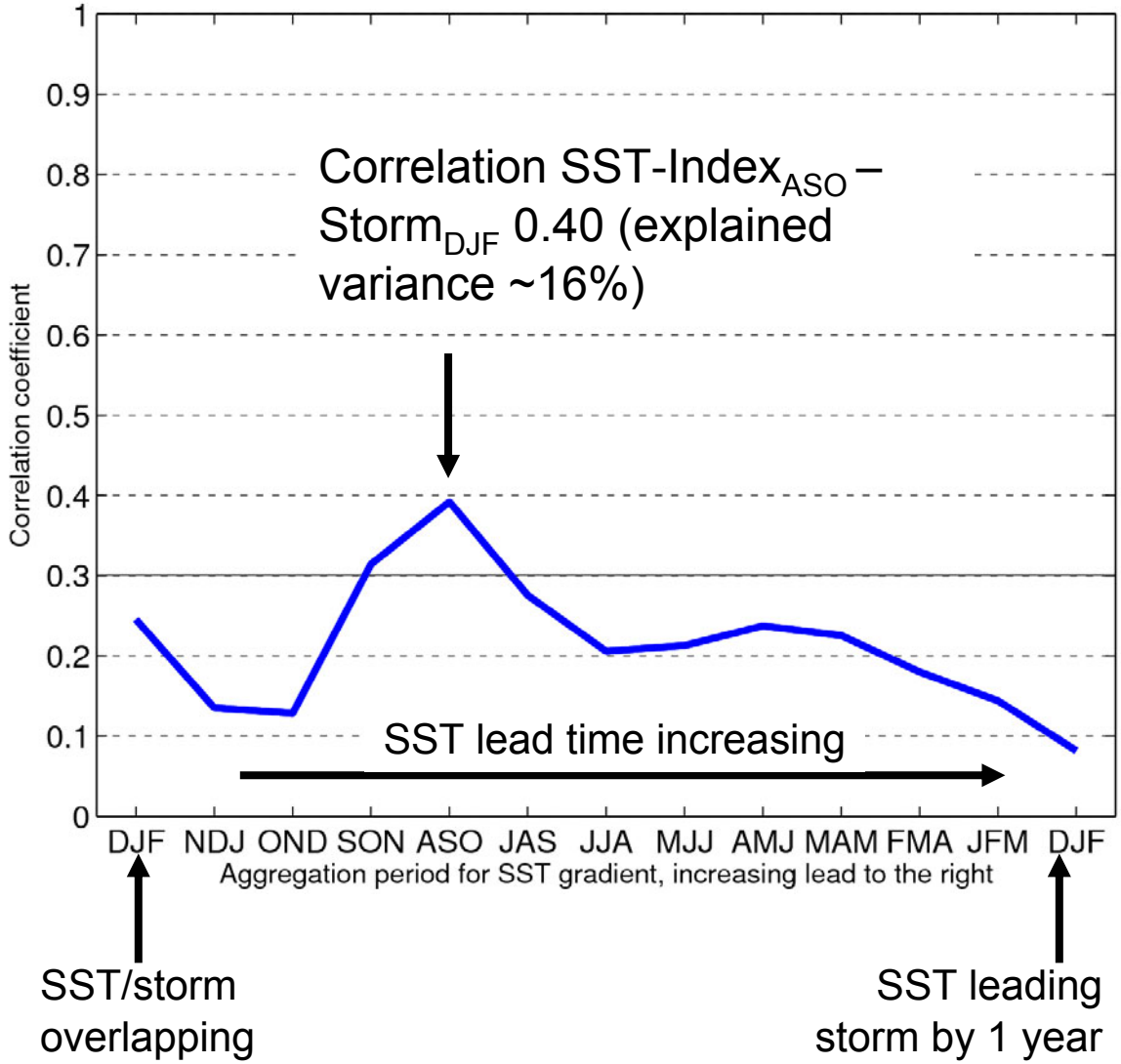


Grad = Warm – 0.5 x (Cold N + Cold S)

SST gradient index

- Generally positive correlation
- **Highest correlation for SST gradient index in the preceding summer/autumn**
- 95% confidence level indicated by horizontal black line (0.30)

Correlation 3 monthly mean NA SST gradient index with DJF wind storm frequency



Summary and Outlook

- Identification of wind storms in model data
- DEMETER models reproduce intraseasonal cycle of wind storm frequency reasonably well.
- Significant correlations of wind storm frequency with Eurasian snow cover extent and North Atlantic SST gradient

→ Analysis of relation of other hemispheric scale factors (e.g. NAO, sea ice, Stratosphere) and synoptic to mesoscale factors

→ Analysis of the representation of these relations in DEMETER

→ Skill scores (dynamical predictability) of the DEMETER single and multi model ensembles