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ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

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Using NWP to assess the influence of the Arctic atmosphere on mid-latitude weather and climate

Questions

- By how much could weather forecasts in the Northern mid-latitudes be improved if we had perfect knowledge of the Arctic?
- How can Arctic conditions influence northern mid-latitudes in a climatological sense?
- Under which large-scale circulation conditions is the influence strongest?

Method

- IFS experiments started on the 1st and 15th of each month from 1979 to 2012 without and with relaxation towards ERA-Interim applied from 75 N to 90 N
- 204 start points for each season
- Error reduction due to relaxation evaluated

Averaged root mean square error (RMSE) reduction Z500

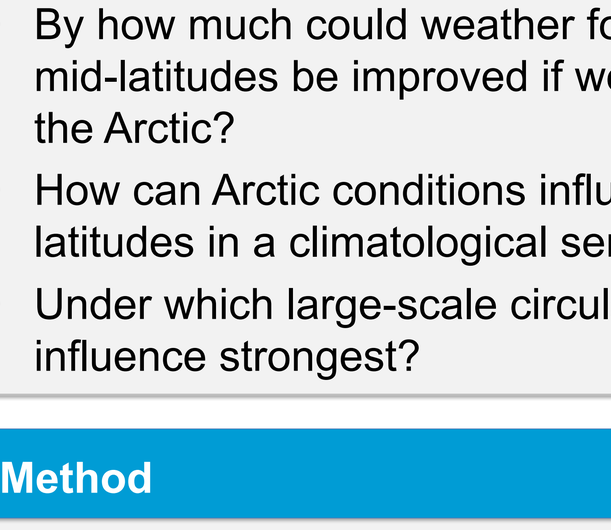

Fig. 1: *RMSE reduction (%) of Z500 forecasts due to Arctic relaxation.*

Forecast error reduction relatively little over mid-latitudes

But: clearly stronger effect over Northern Asia

Composites

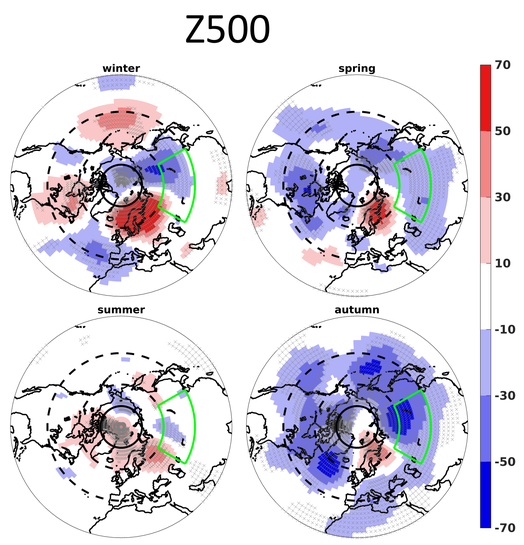

Fig. 5: *Z500 difference (m) between composites for improved and neutral forecasts with Arctic relaxation for Northern Asia (green box) considering forecast lead times 1 to 7 days. Stippled areas indicate areas significant according to a Wilcoxon test.*

Strongest forecast improvement over northern Asia in situations with northerly flow anomalies – especially in winter (in summer hardly visible).

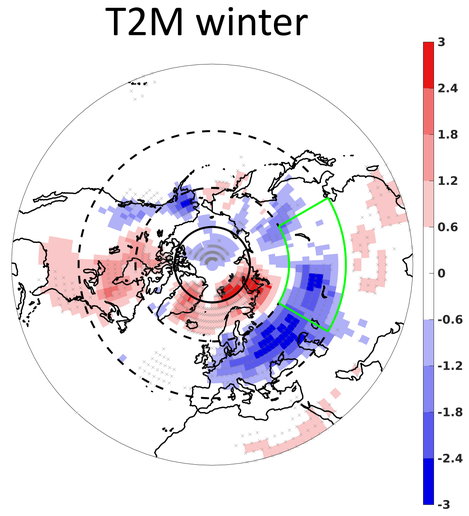

Fig. 6: *2 m temperature difference (K) between composites for improved and neutral forecasts (with respect to Z500) with Arctic relaxation for Northern Asia (green box) in winter considering forecast lead times 1 to 7 days.*

Cold anomalies up to 3 K over north-western Asia, eastern and Central Europe in cases of strongly improved forecasts, i.e. poor representation of such cold conditions without relaxation.

Z500 ERA-Interim

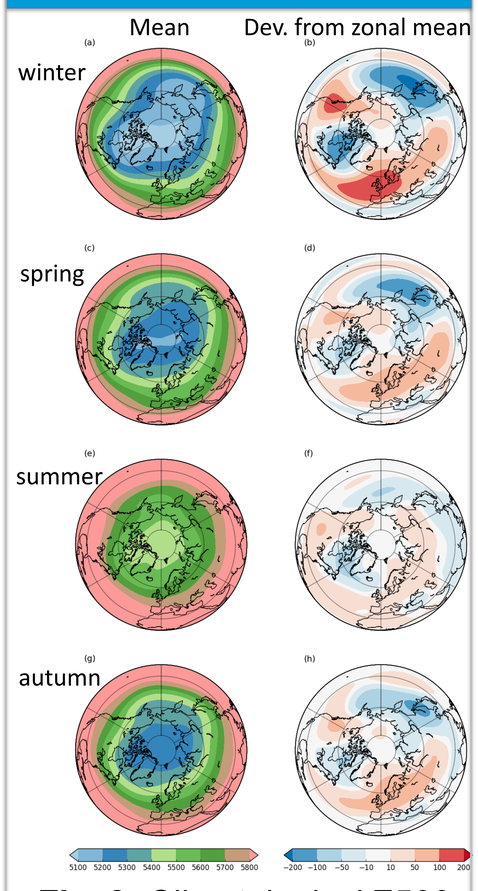

Fig. 2: *Climatological Z500 (m) from ERA-Interim by season*

North component over land

South component over sea

Spatial RMSE reduction Z500

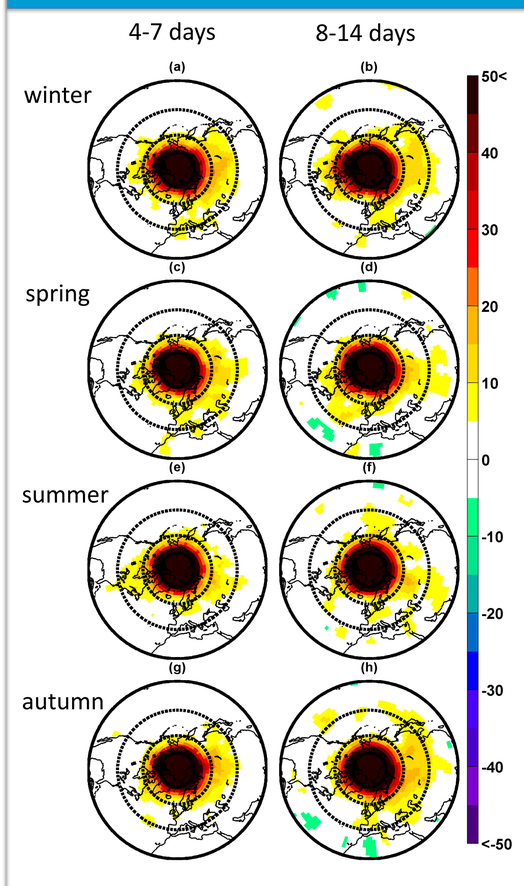

Fig. 3: *RMSE reduction (%) of Z500 depending on the forecast lead time*

Strongest reduction in winter and autumn

Spatial RMSE reduction T2M

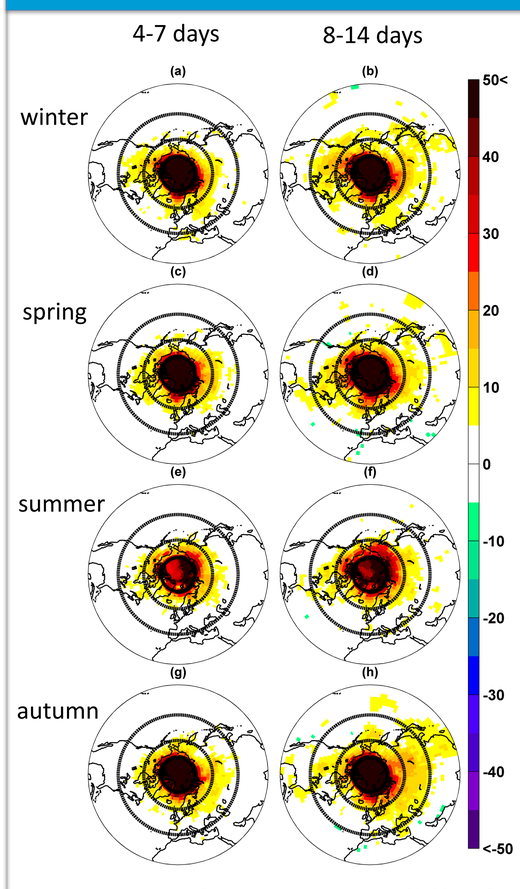

Fig. 4: *RMSE reduction (%) of 2 m temperature depending on the forecast lead time*

Generally similar picture close to the surface and in mid-troposphere

Conclusions

- Strongest forecast improvements and therefore Arctic – northern mid-latitude linkages from Kara Sea area into northwestern Asia
  - Main pathways consistent with previous studies
- Cold anomalies over western Asia, eastern and central Europe in cases of anomalous northerly flow: indicating poor representation of such events in model?
- No trend in Arctic influence over the investigated 34 years

References:

- **Semmler, T., T. Jung, M. A. Kasper, and S. Serrar (2017):** Using NWP to assess the influence of the Arctic atmosphere on mid-latitude weather and climate. *Advances in Atmospheric Sciences*, doi: 10.1007/s00376-017-6290-4
- **Jung, T., M. A. Kasper, T. Semmler, and S. Serrar (2014)**: Arctic influence on subseasonal mid-latitude prediction. *Geophysical Research Letters,* doi: 10.1002/2014GL059961

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