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

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Fast atmospheric response to a sudden thinning of Arctic sea ice

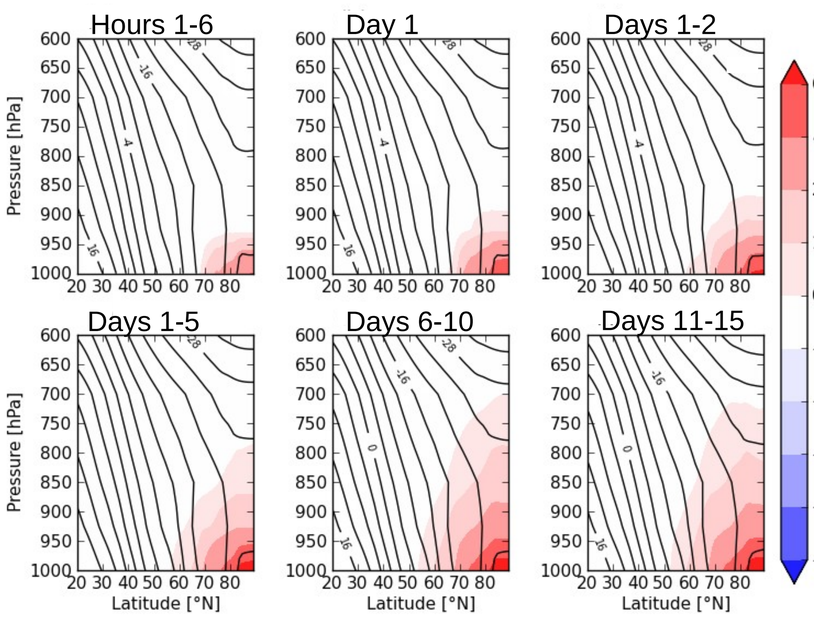
Motivation

Not only dramatic decrease in Arctic sea ice extent but also in Arctic sea ice thickness. What are the impacts on the atmospheric large-scale circulation?
Aim: disentangle processes that lead to atmospheric large-scale circulation changes

Method

Investigate fast response to sudden thinning of Arctic sea ice with an atmosphere-only NWP model
~400 pairs of 15-day and 90-day experiments (one control: CTL, one with about 50% less sea ice thickness) with IFS (Integrated Forecast Model) of ECMWF initialized at different winter start dates between 1979 and 2012

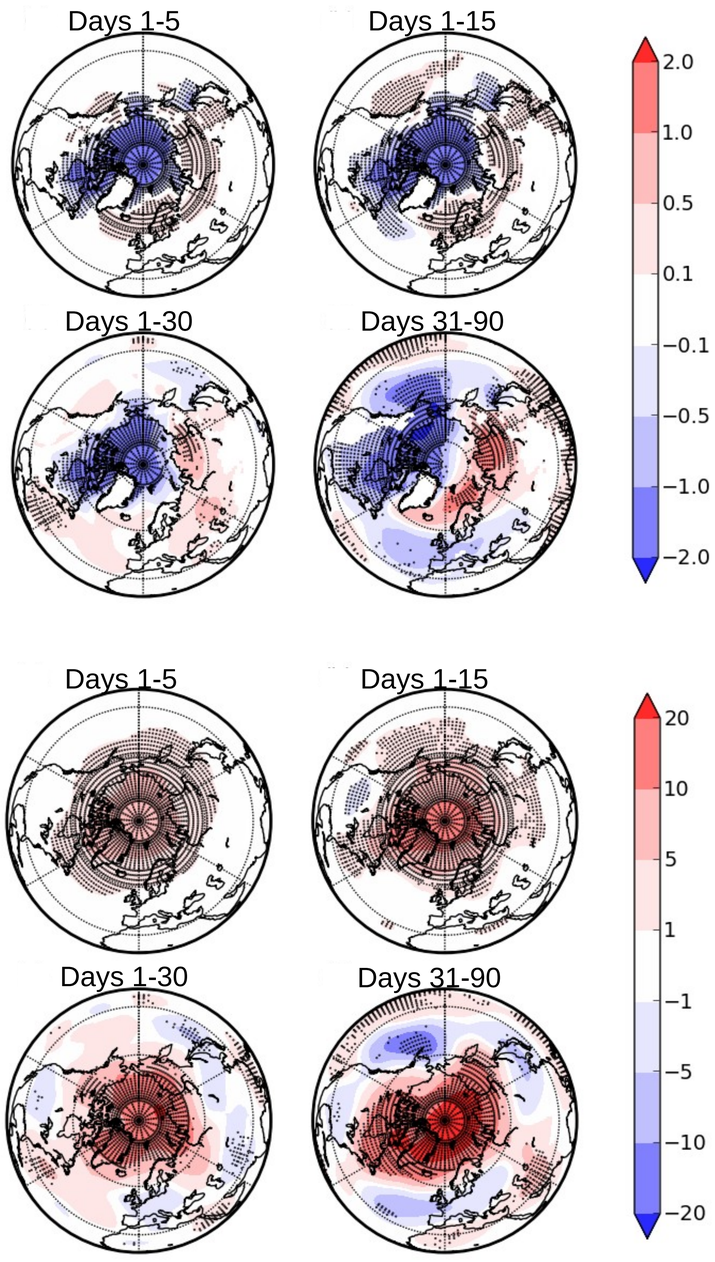
Temperature and pressure response



Mean vertical temperature profiles for CTL (black contour lines, interval 4°C) and response (colour shading)

Temperature response largely restricted to boundary layer and high latitudes!

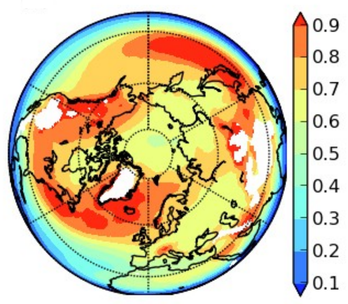
MSLP response (hPa)



Baroclinic response over entire Arctic (due to pan-Arctic forcing not restricted to ice edge) and barotropic response over north-western Siberia / north-eastern Europe already after a few days!
Barotropic response generally for entire 3 months!
Reason could be reduced synoptic wave energy propagation.

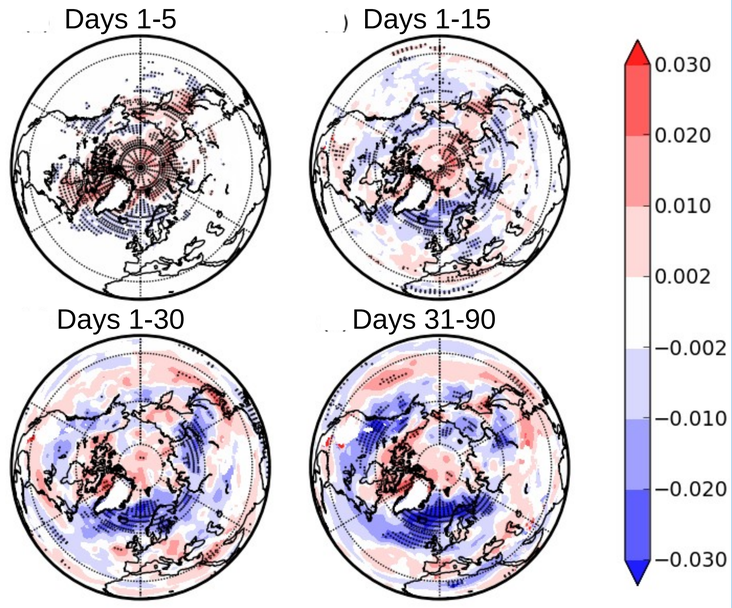
Z500 response (m)

Synoptic activity and maximum eady growth rate

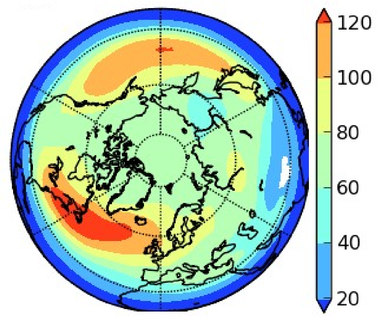


Maximum eady growth rate (day^{-1}) between 500 and 850 hPa in CTL

Maximum eady growth rate response (day^{-1}) between 500 and 850 hPa

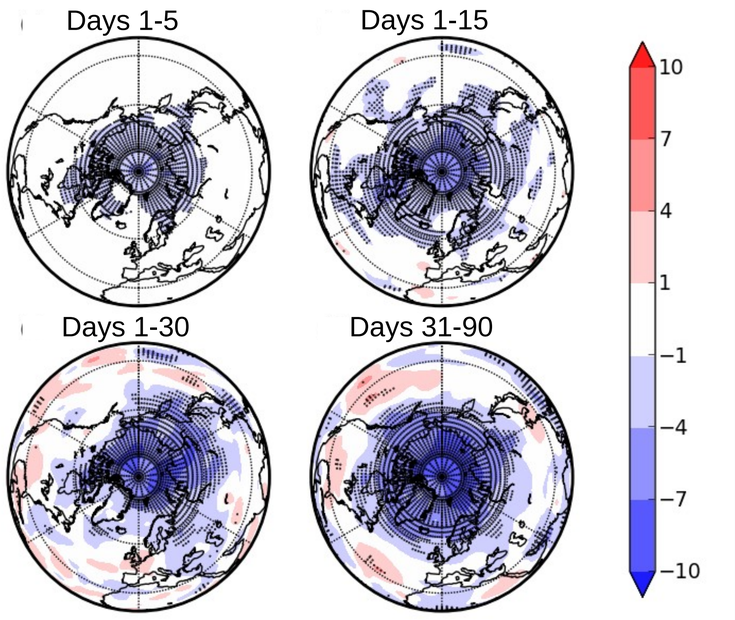


First days: increase over Arctic.
Entire three months: decrease over north-eastern North Atlantic



Synoptic activity (m) in 500 hPa in CTL

Synoptic activity response (%) in 500 hPa



Decrease over entire Arctic and adjacent areas!!!

Discussion and conclusions

- Fast response to reduced Arctic sea ice thickness largely restricted to boundary layer and high latitudes
- Temperature response saturates as early as a few days into the integration
- Meridional temperature gradient reduction restricted to area north of 60°N
- Large-scale circulation response to such a strong pan-Arctic surface forcing rather limited
- Already present after a few days (troposphere-stratosphere interaction not necessary)
- Position of major storm tracks largely unaffected
- Increase in maximum eady growth rate not reflected in synoptic activity, instead a decrease can be seen!

References
Semmler, T., T. Jung, and S. Serrar (2015), Fast atmospheric response to a sudden thinning of Arctic sea ice, Climate Dynamics, submitted.
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