The Role of Intense Cyclones for Precipitation, Sea Ice and Snow Cover Distribution in the Nordic Seas

E.M. Knudsen[1]*, K.I. Hodges[2], A. Rinke[3] and S. Crewell[1]

[1] Institute of Geophysics and Meteorology, Univ. of Cologne (Germany), [2] Institute for Department of Meteorology, Univ. of Reading (UK), [3] Climate Sciences, Alfred Wegener Institute (Germany)

Research Questions

Main:

- What role do cyclones play in the rapidly changing Nordic Seas with regards to precipitation, sea ice and snow cover?

Secondary:

- Is there a significant trend in cyclone-associated precipitation?
- Which cyclones contribute the most to overall precipitation, and why?
- How is sea ice loss linked to intense cyclones?

Motivation

- Arctic warming at twice the rate of global average (Arctic amplification)[i].
- Barents Sea sea ice trend anomalous for Arctic average, with significant retreat also in winter (Fig. 1)[ii].
- Marked positive trend in wintertime atmospheric moisture over Ny-Ålesund[iii].
- Even so relatively little focus on late fall/early winter compared to summer[iv,v,vi].

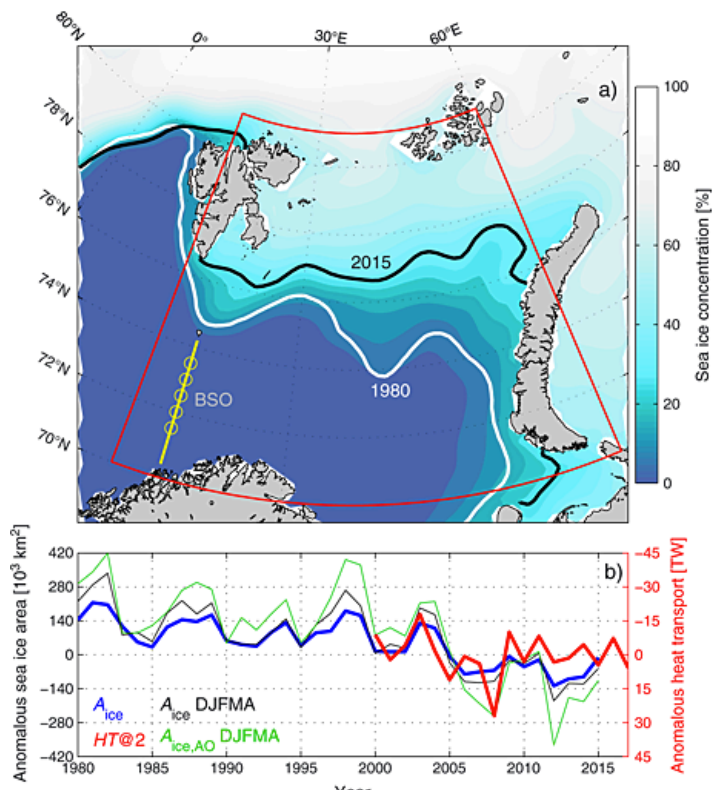

Fig. 1: (a) Sea ice concentration DJFMA 1980-2015. (b) Time series of Barents Sea (red box in (a)) interannual sea ice area (SIA) July-June [blue] and DJFMA [black], Arctic Ocean interannual SIA DJFMA [green] 1980-2015, and Barents Sea Opening (BSO; yellow line in (a)) heat transport (2 year lag relative to SIA) July-June 1997-2015 [red]. From Onarheim et al. (2015)[ii].

Preliminary Results

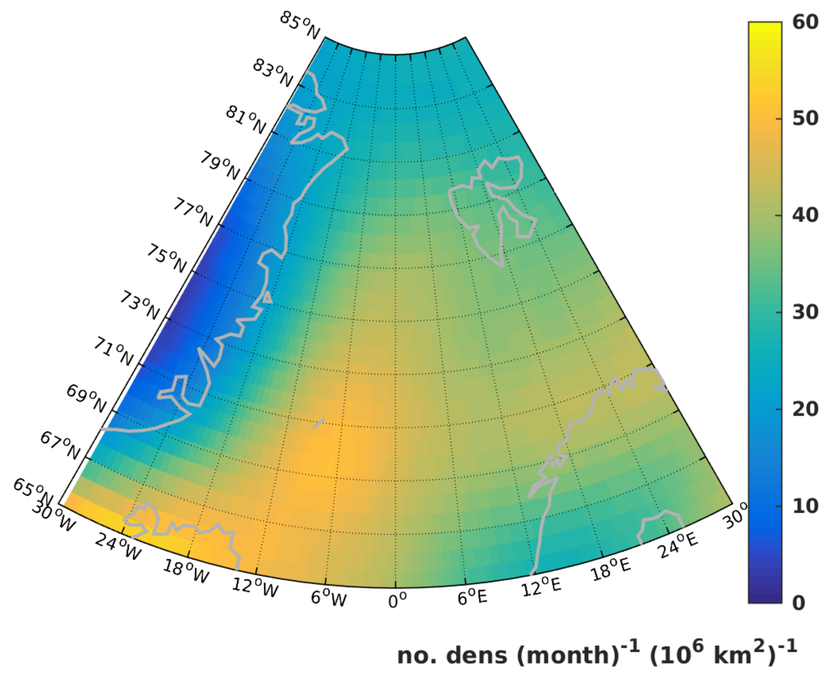

Fig. 2: Cyclone frequency OND 1979-2014.

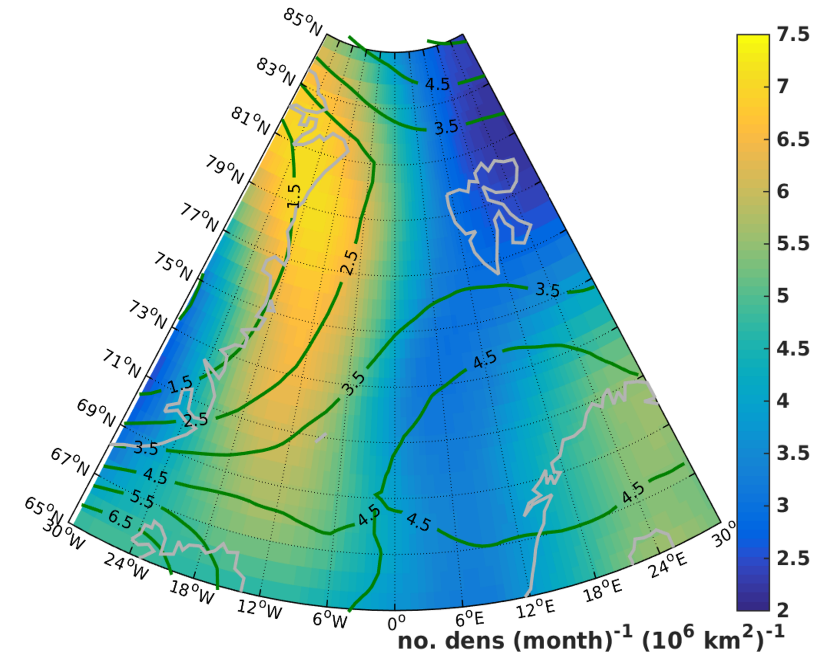

Fig. 3: Cyclone formation (shading) and dissipation (contours) OND 1979-2014.

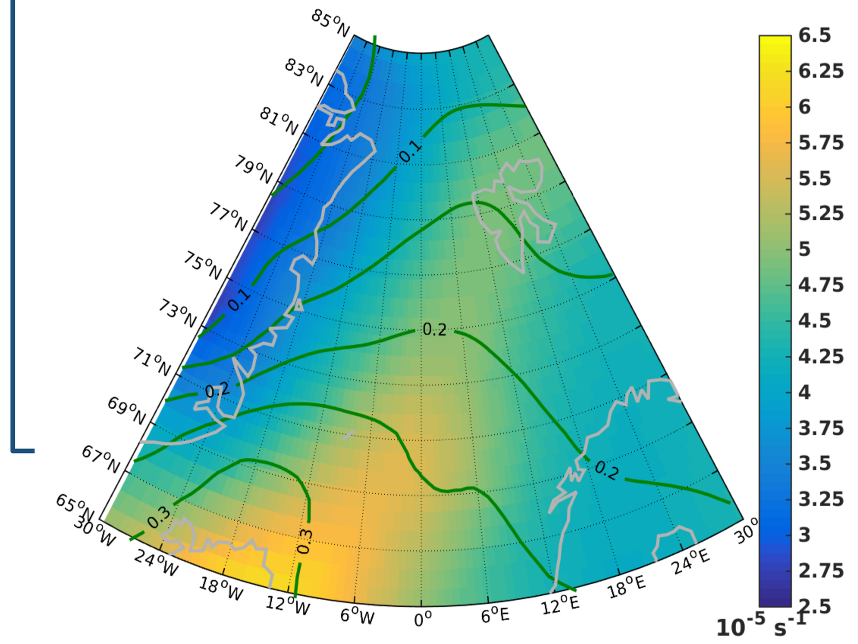

Fig. 4: Cyclone intensity (shading) and cyclone-associated precipitation intensity (contours) OND 1979-2014.

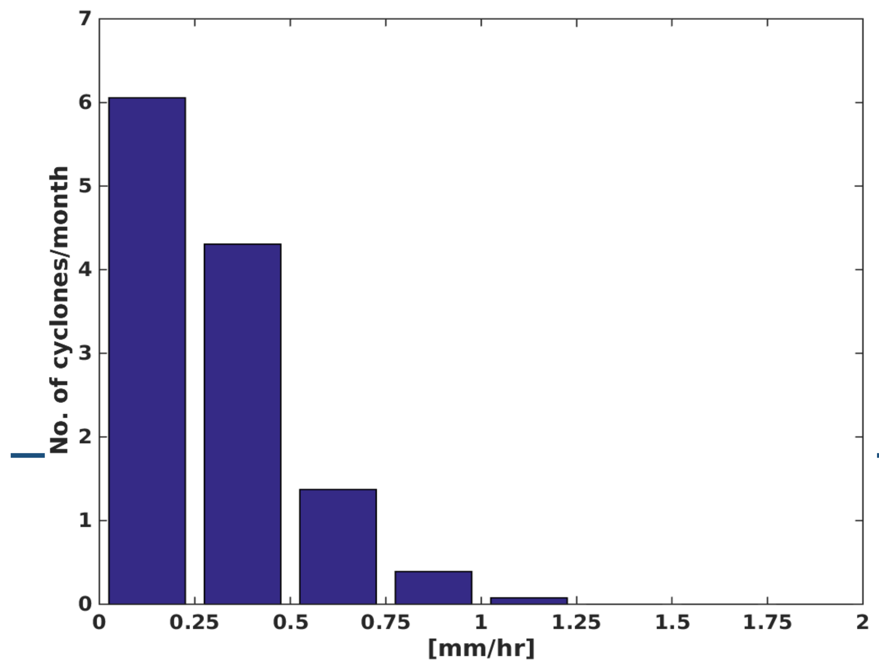

Fig. 5: Cyclone-associated precipitation intensity histogram averaged over the Nordic Seas OND 1979-2014.

Cyclone frequency (Fig. 2):

- Region a prolongation of the N. Atlantic storm track.

Cyclone formation and dissipation (Fig. 3):

- Cyclones develop downstream of the Greenland Ice Sheet and partly along the sea ice edge.
- Cyclones die out when reaching land, but not particularly over sea ice.

Cyclone and cyclone-associated precipitation intensities (Figs. 4 and 5):

- Cyclone intensity distributed in a meridional band relative to the more zonally precipitation intensity.
- Mostly light rain cyclones in the region.

Data Set and Methods

Data set:

- ERA-Interim reanalysis OND 1979-2014.

Method:

- 6-hourly cyclone and cyclone-associated precipitation tracking and statistical calculation (TRACK)[vii].

Next Steps

1. Identification of anomalous high and low cyclone-associated precipitation intensity seasons.
2. Composite analysis from 1 for precipitation amount and phase, sea ice, snow cover and surface temperature.
3. Comparison to HIRHAM5 regional climate model.
4. Case study on an extreme case also including Ny-Ålesund weather station and radiosondes, CloudSat satellite and Global Precipitation Climatology Centre gauge-analysis data.

References

[i] Cohen, J., Screen, J. A., Furtado, J.C., Barlow, M., Whittleston, D., Coumou, D., Francis, J. A., Dethloff, K., Entekhabi, D., Overland, J., & Jones, J. Recent Arctic amplification and extreme mid-latitude weather. *Nat. Geosci.* **7**, 627–637 (2014).
[ii] Onarheim, I. H., Eldevik, T., Årthun, M., Ingvaldsen, R. B. & Smedsrud, L. H.. Skillful prediction of Barents Sea ice cover. *Geophys. Res. Lett.* **42**, 5364–5371 (2015).
[iii] Maturilli, M. & Kayser, M. Arctic warming, moisture increase and circulation changes observed in the Ny-Ålesund homogenized radiosonde record. *Theor. Appl. Climatol.*, 1–17 (2016).
[iv] Screen, J. A. & Simmonds, I. Declining summer snowfall in the Arctic: causes, impacts and feedbacks. *Clim. Dyn.* 38 2243–2256 (2012).
[v] Knudsen, E. M., Orsolini, Y. J., Furevik, T. & Hodges, K. I. Observed anomalous atmospheric patterns in summers of unusual Arctic sea ice melt. , *J. Geophys. Res. Atmos.* **120**, 2595–2611 (2015).
[vi] Knudsen, E. M., & Walsh, J. E. Northern Hemisphere storminess in the Norwegian Earth System Model (NorESM1-M). *Geosci. Model Dev.* **9**, 2335–2355 (2016).
[vii] Hodges, K.I. TRACK. http://www.nerc-essc.ac.uk/~kih/TRACK/Track.html (2016).

Acknowledgements

This work was supported by the German Research Foundation through the Transregional Collaborative Research Centre TR 172 – "Arctic Amplification: Climate Relevant Atmospheric and Surface Processes, and Feedback Mechanisms (AC)³".

* Correspondence to: eknudsen@uni-koeln.de

1st (AC)³ Science Conference on Arctic Amplification, 26-28 March 2017, Bremen, Germany