New view of Arctic cyclone activity from the Arctic System Reanalysis

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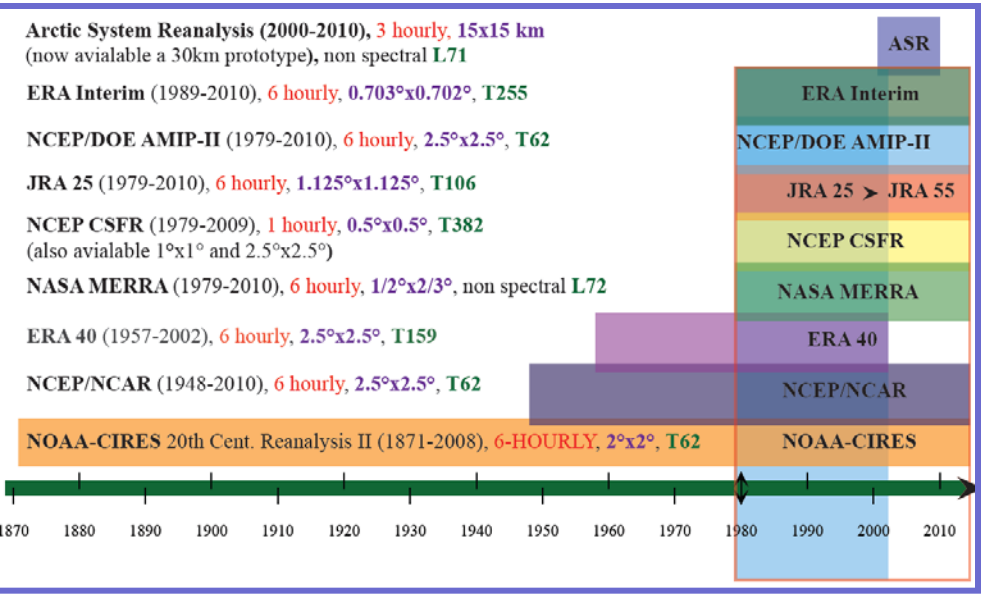
MOTIVATION

- Key role of cyclone activity in the Arctic energy and hydrological cycles
- Cyclones impact on sea ice changes and respond to the diabatic processes in the Arctic
- Cyclones bridge Atlantic climate signals with Arctic climate variability

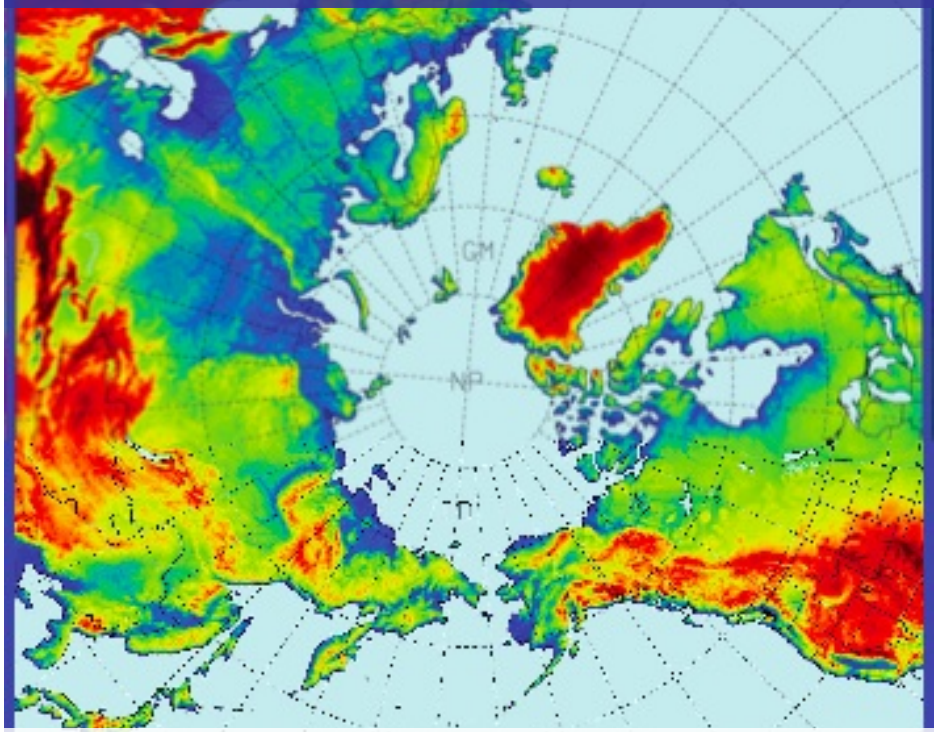
Arctic cyclones compared to midlatitudinal ones:
- smaller in size,
- shorter living,
- more frequently experience rapid deepening

More difficult to identify and track



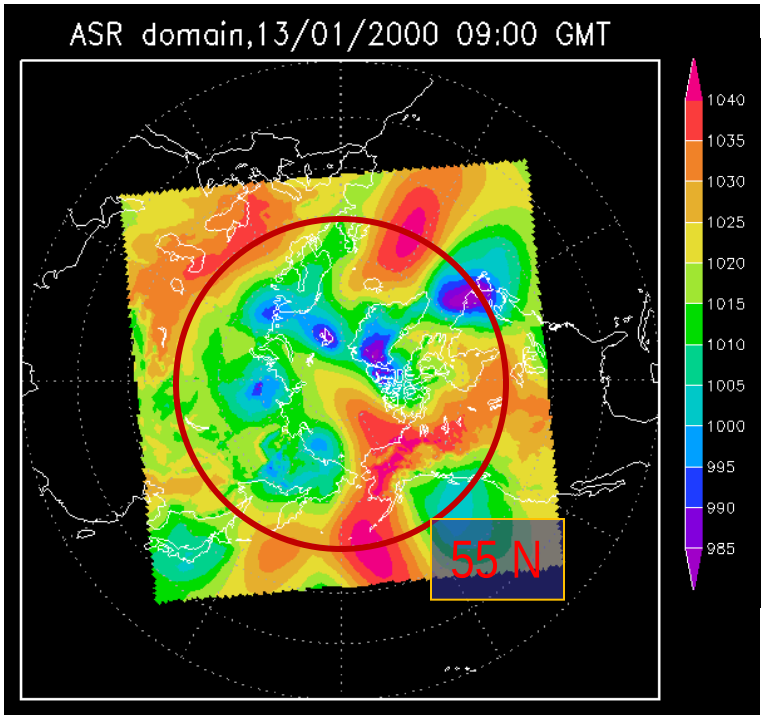
Arctic System Reanalysis

ASR, [Bromwich et al., 2010]

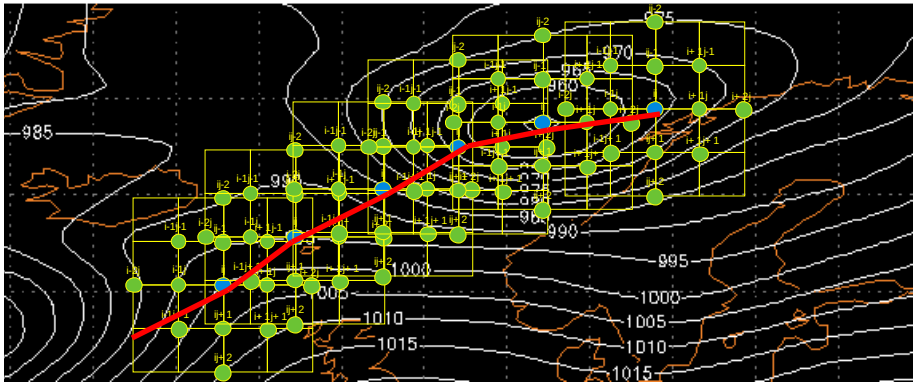


- Polar WRF (Weather Research and Forecasting)
- 10x10 km (2014), now 30x30 km, 3 hourly
- 2000 – 2010 period covered
- ERA-Interim as lateral boundary conditions
- 3 times more data assimilated than in ERA Interim

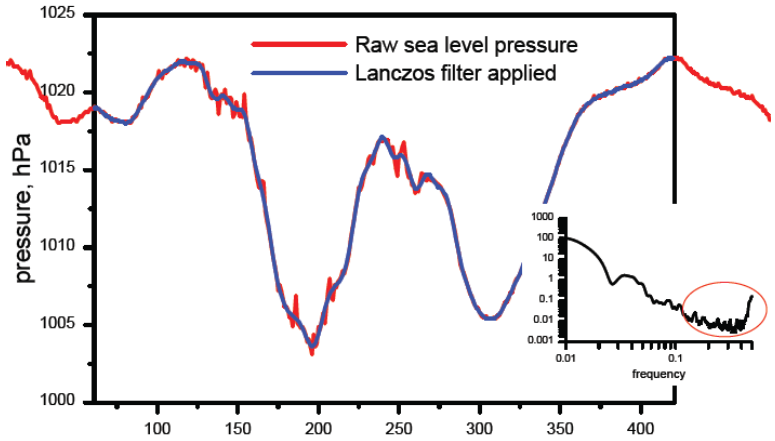
Tracking, limited area problem



Cyclone tracking – sea level pressure



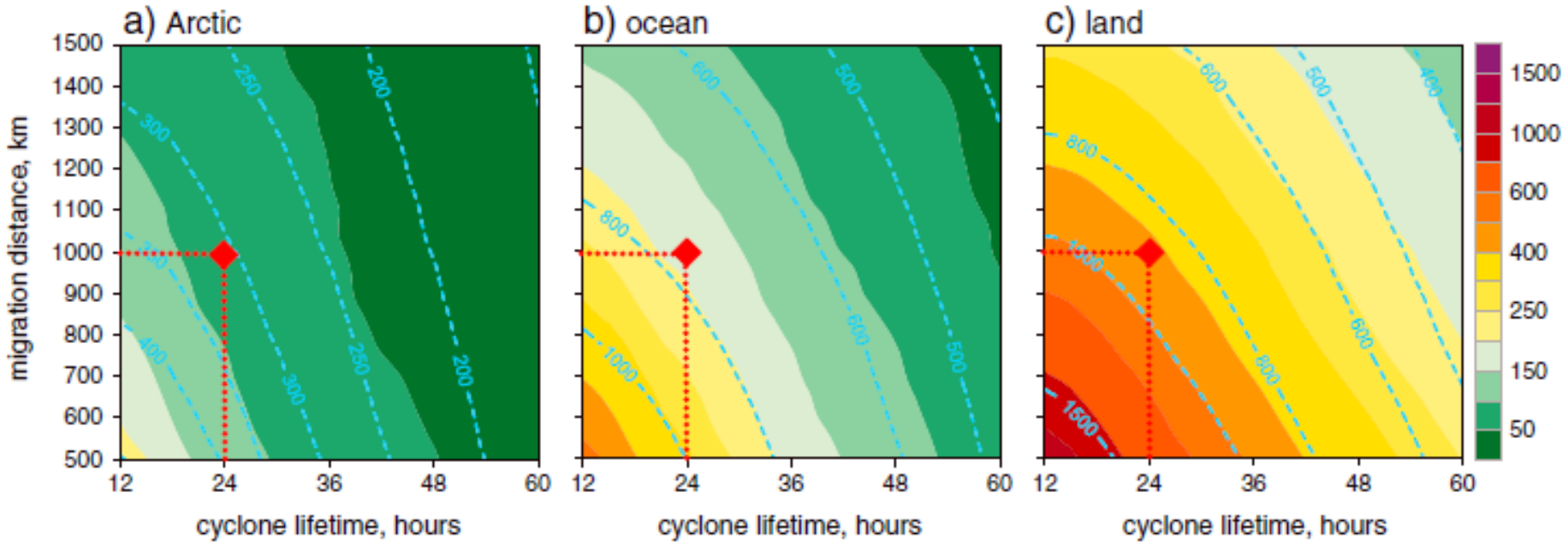
Zolina and Gulev (2002), Rudeva and Gulev (2007), Neu et al. (2013),Tilinina et al. (2013)



- Tracking is performed at the ASR grid (360x360)
- To minimized entry-exit problem for limited area tracking analysis is performed for the area north of 55N
- Post-processing (elimination of short-living, very shallow and not propagating systems)
- ERA Interim, NCEP CFSR, MERRA for comparisons

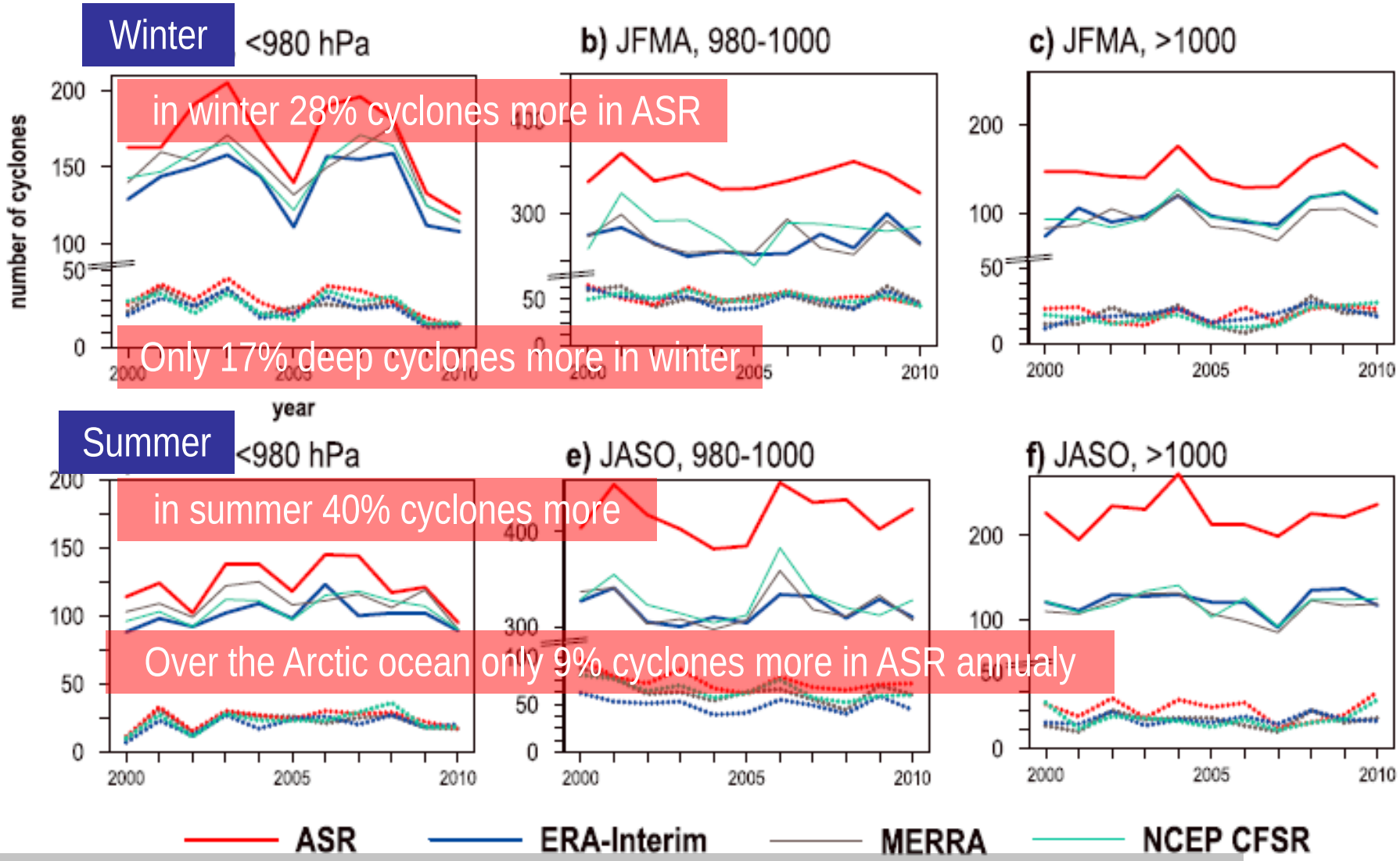
A choice of threshold on cyclone lifetime and migration

Number of cyclones in ASR – blue lines



- ASR everywhere reports more cyclones, even for the very strict thresholds
- Difference in the total cyclone counts between ASR and ERA-Interim increases with the decrease of lifetime and migration
- Final choice was 24 hr and 1000 km (as in Hodges et al.,2011 and Tilinina et al., 2013)

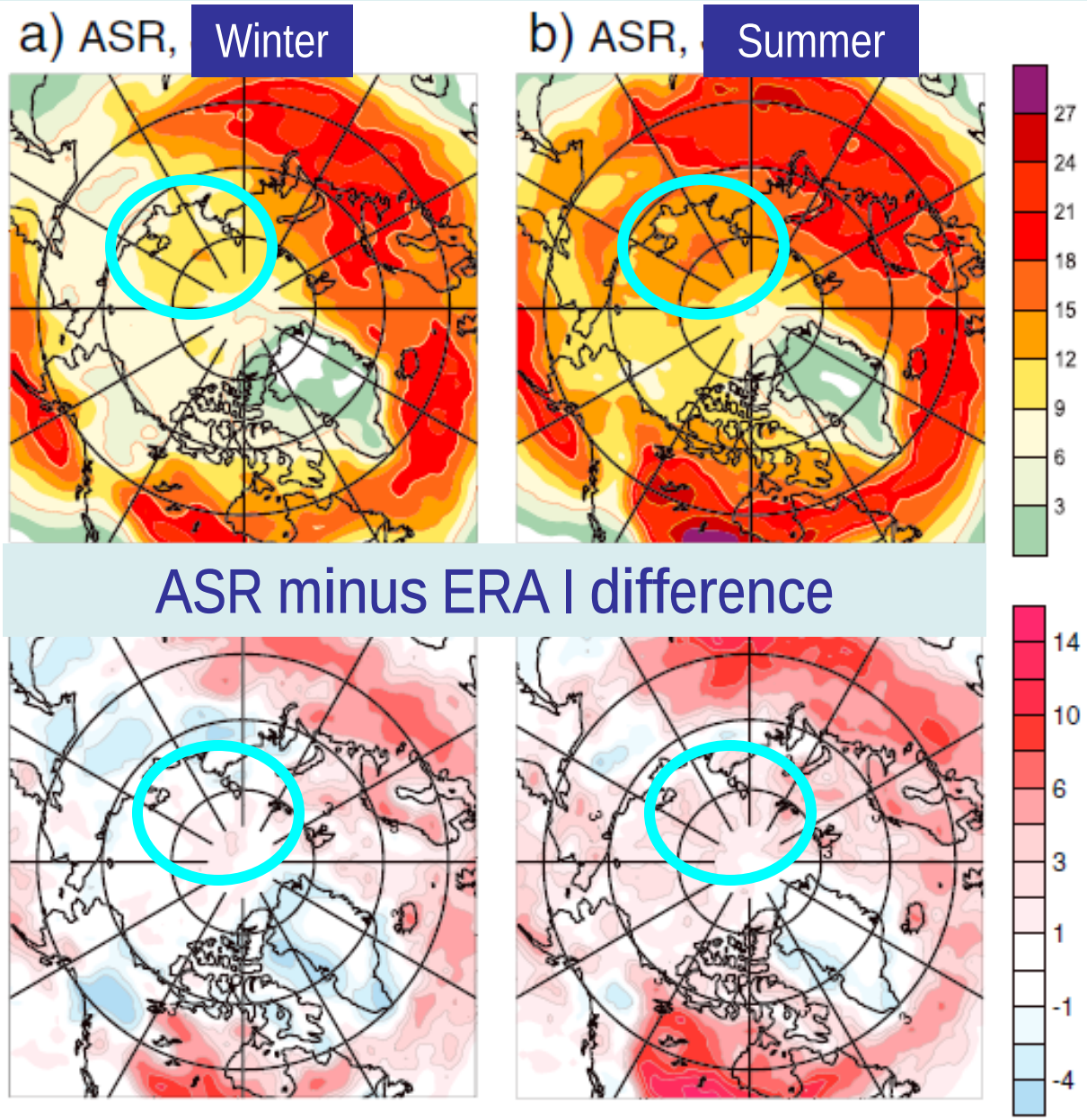
Annual number cyclones in ASR and different reanalyses



Bold lines: number of cyclones, entering 55N, dotted lines: number of cyclones over the Arctic Ocean

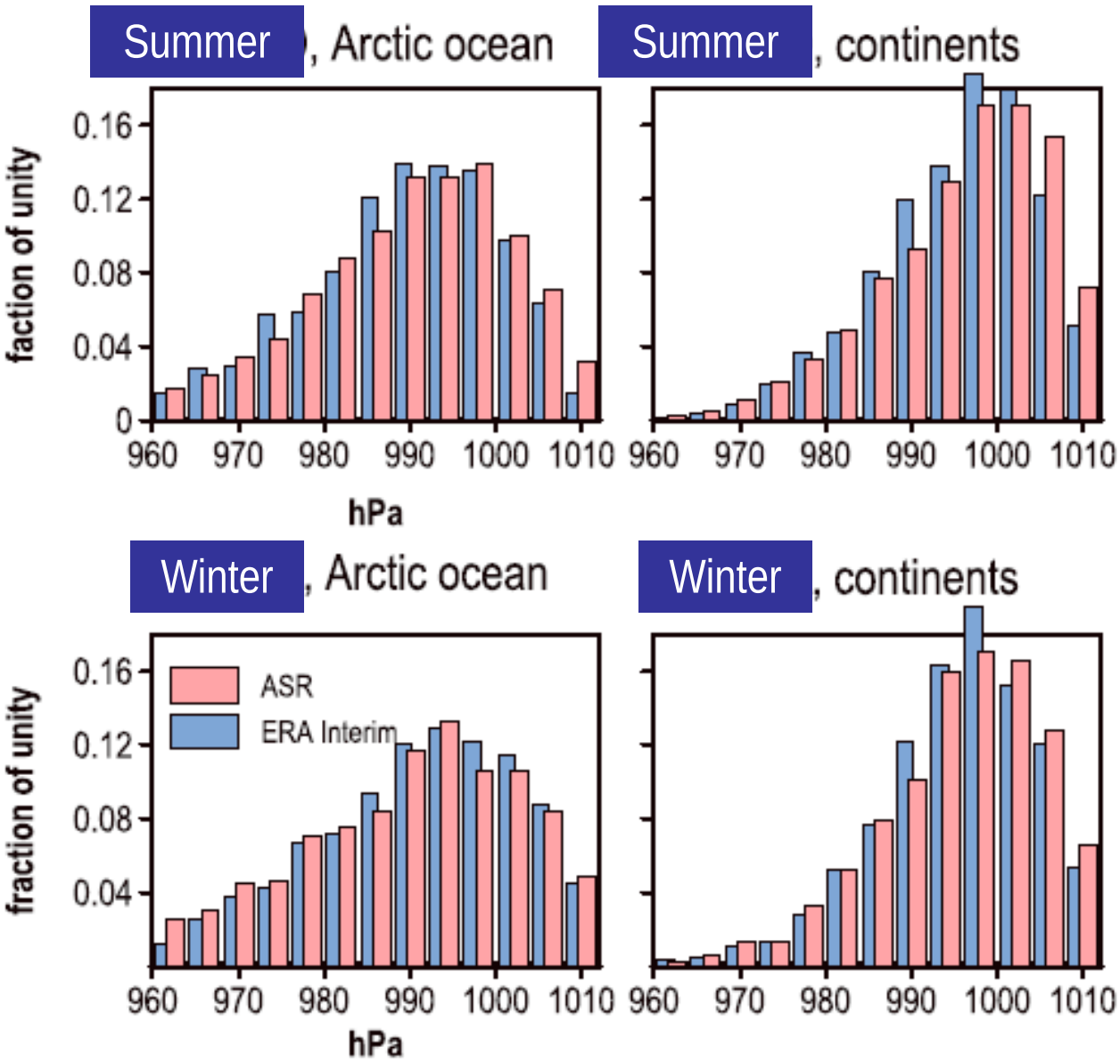
Differences are formed mostly by moderately deep and shallow cyclones over the land

Climatology of cyclone numbers, 2000 - 2010



- 35-40 % more cyclones in ASR in summer over the continents
- Up to 30% more cyclones in ASR over the ocean
- Summer cyclone maximum in the eastern Arctic in ASR

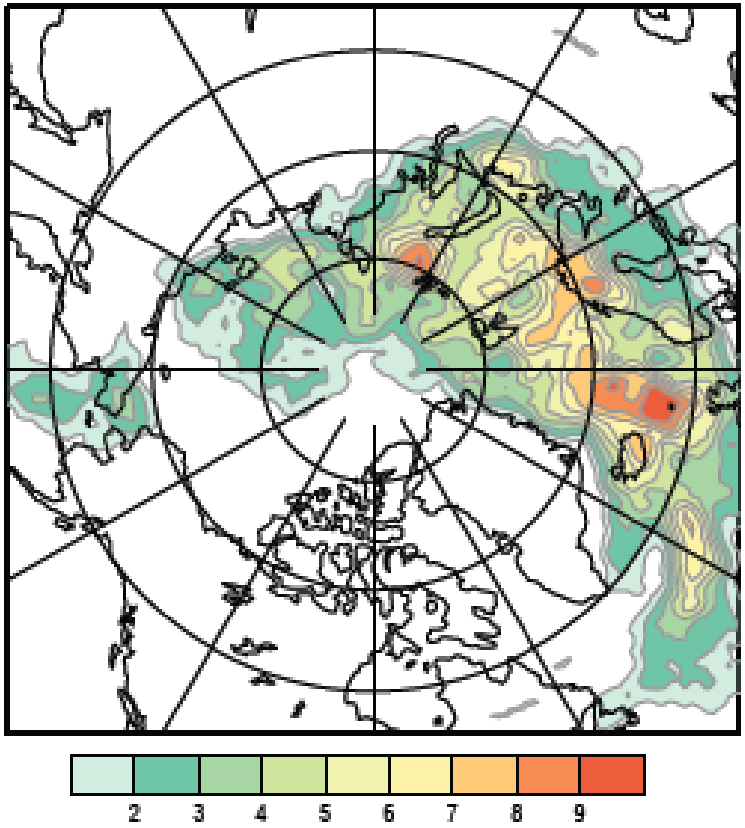
Climatological occurrence histograms of the min cyclone central pressure



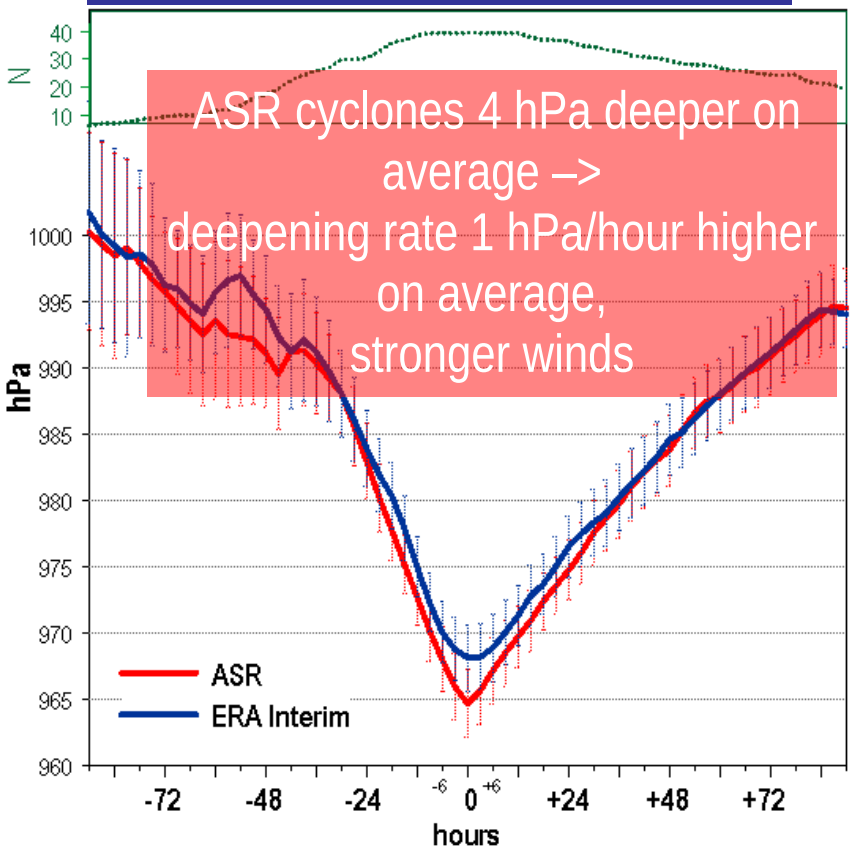
- On average ERA-Interim cyclones are deeper compared to ASR → larger population of shallow and moderately deep cyclones in ASR
- The fraction of intense events (< 980 hPa) in ASR is smaller than in ERA-Interim for the same reason
- Over the Arctic ocean probability distributions of life cycle parameters are close to each other

Life cycle of the most intense cyclones in ASR a ERA-Interim

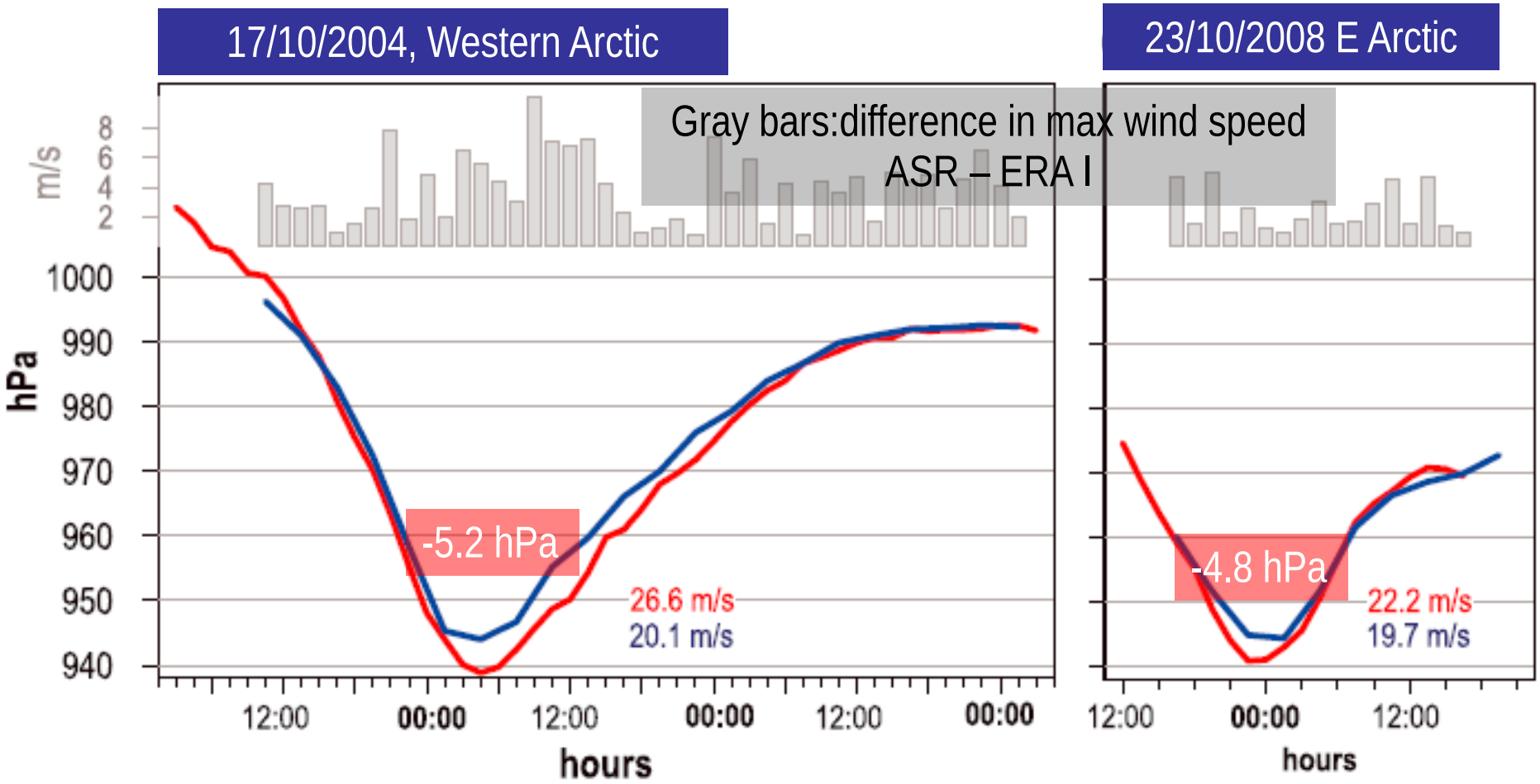
40 deepest summer cyclones



Averaged SLP profile



Case studies



Wind speed at the most intense cyclone phase higher by 4 and 3 m/s in ASR

Conclusions

ASR shows that the Arctic is more densely populated with cyclones (35% more), especially in summer, than suggested by the modern era global reanalyses. This is mostly due to shallow and moderate cyclones over the highlatitude continents

ASR captures summer maximum of cyclone activity in the eastern Arctic which is hardly detectable in global reanalyses (ERA-I reports 30% less cyclones here).

The most intense cyclones in ASR are ~4 hPa deeper than in ERA-Interim, they also show stronger deepening and higher maximum wind speeds

Outlook

The role of ASR model formulation and data assimilation input - the current resolution of ASR (30 km) is comparable to ERA-Interim (0.75°) → the richer data assimilation input is primarily responsible for a better of cyclone activity and cyclone life cycle in ASR (to test in the future)

Association of cyclone dynamics with ice cover and air-sea interactions

Revisit with the full ASR version (~15 km) – polar lows and more

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Tilinina, N., S. K. Gulev, and D. H. Bromwich (2014), New view of Arctic cyclone activity from the Arctic system reanalysis, *Geophys. Res. Lett.*, 41, doi:10.1002/2013GL058924.

Thank you for the attention!

Zimbabwe Star

From Zambezi to Limpopo

Zimbabwe Star http://www.zimbabwestar.com 1:56 PM Wednesday 22 January 2014 Volume 22/2014

Arctic storms more rampant than previously believed

Zimbabwe Star (ANI) Friday 17th January, 2014

A new study suggests that about 1,900 cyclones churned across the top of the world each year from 2000 to 2010, leaving warm water and air in their wakes - and melting sea ice in the Arctic Ocean.

That's about 40 percent more of these Arctic storms than previously thought, according to the study of vast troves of weather data that previously were synthesized at the Ohio Supercomputer Center (OSC).