Larcform2 and other future possible community activities

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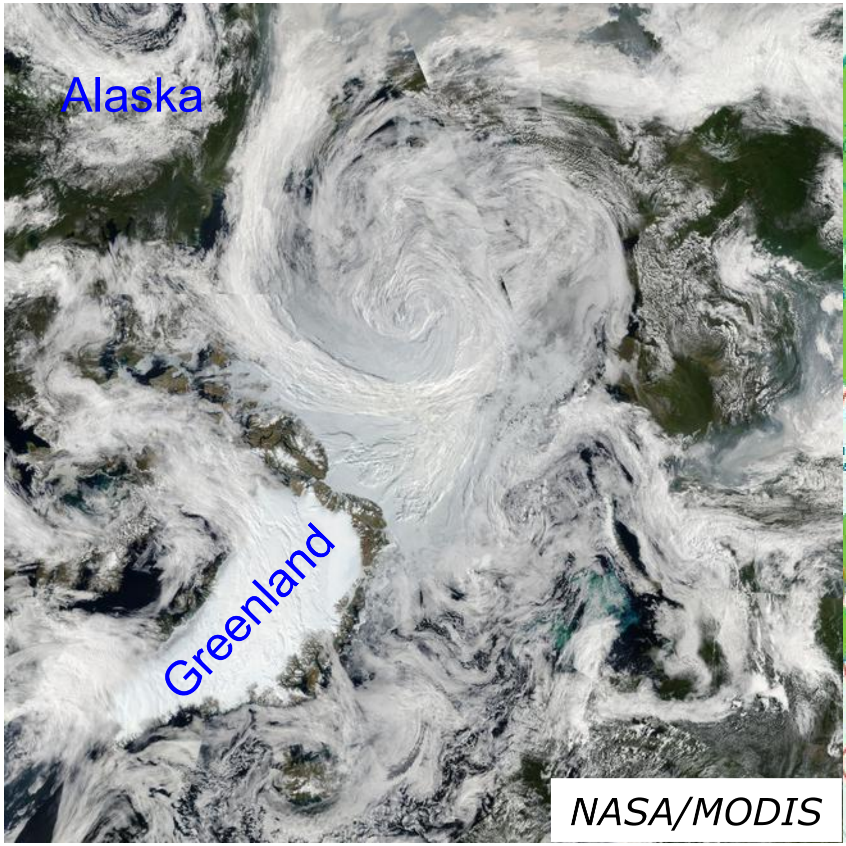
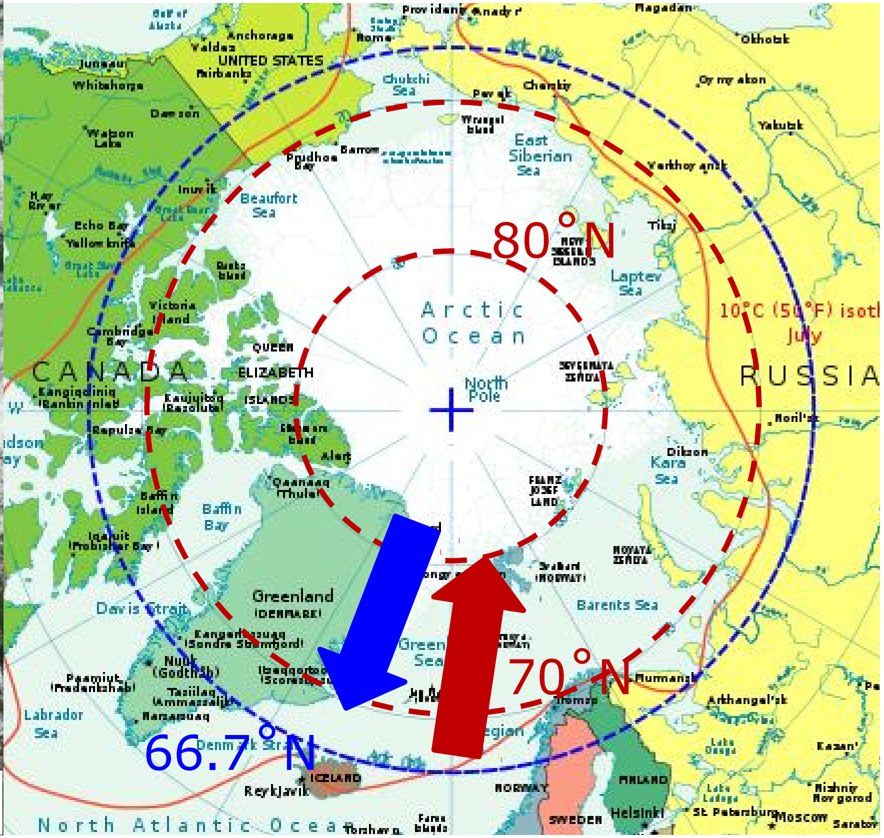
What is so special in polar regions? Why is it so hard for models to get it right?



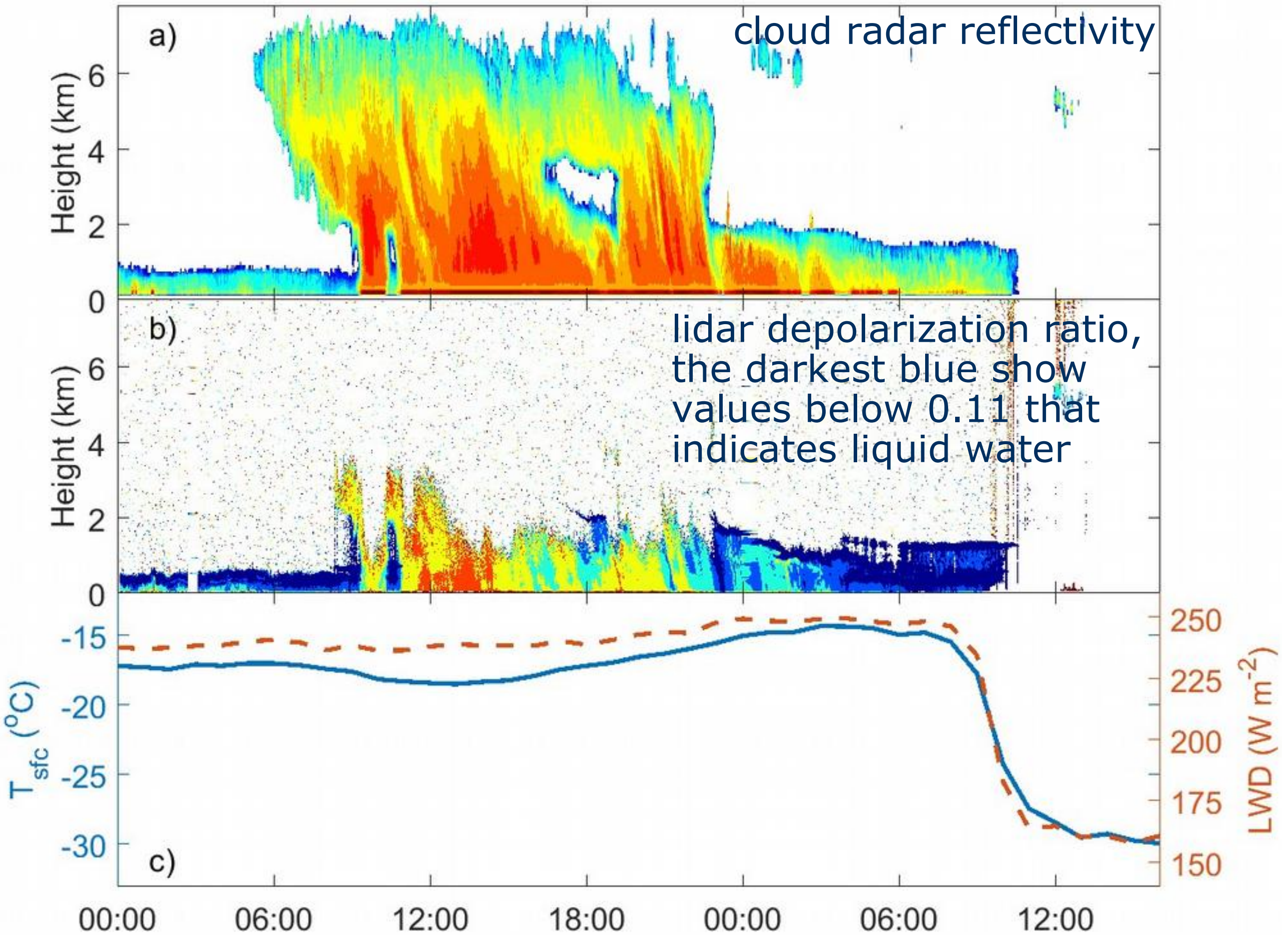
NASA/MODIS



- Small diurnal cycle, large annual cycle, i.e. less frequent “reset button”
- Advection and coupling to surface
- Clouds are frequently of mixed phase, low CCN & IN concentrations
- Processes are active in shallow layers
- Limited amount of observations to test the coupled system in models

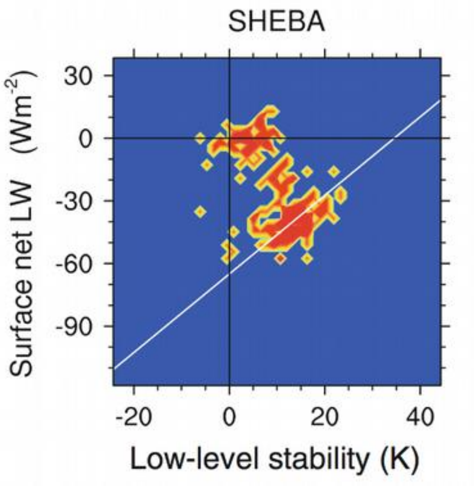
Importance of clouds over sea ice

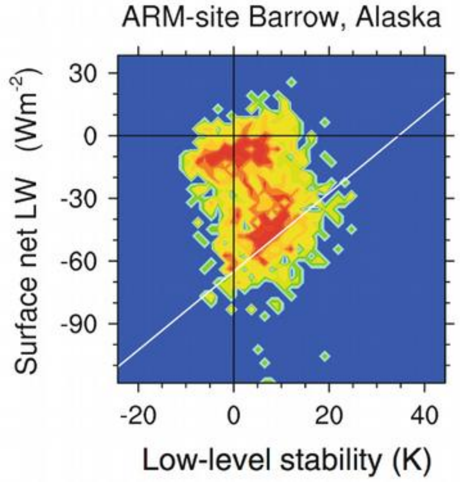
SHEBA Nov 23-24 1997



cloud radar reflectivity

lidar depolarization ratio, the darkest blue show values below 0.11 that indicates liquid water

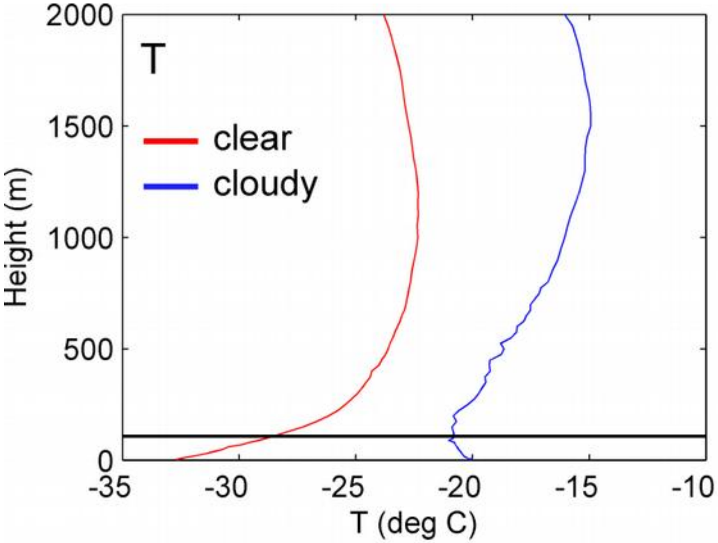


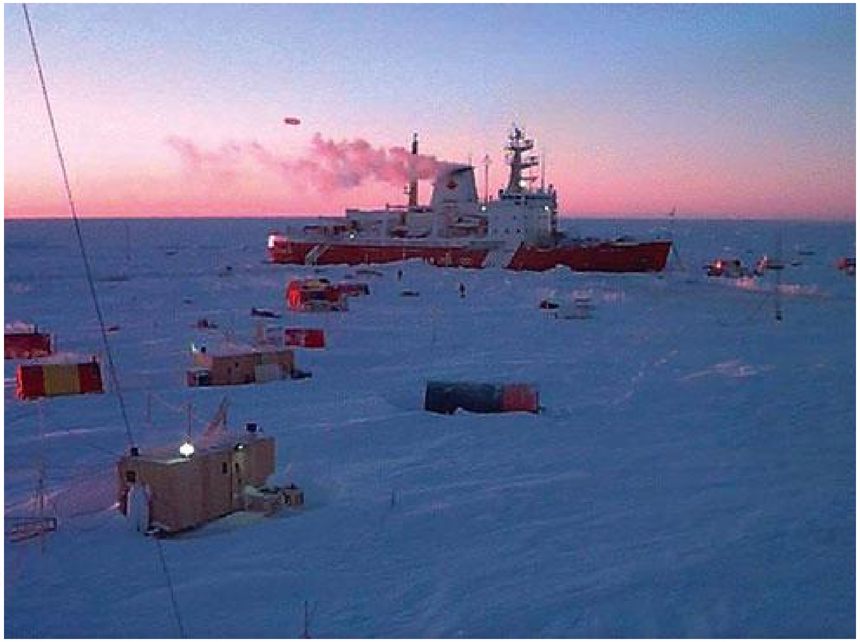


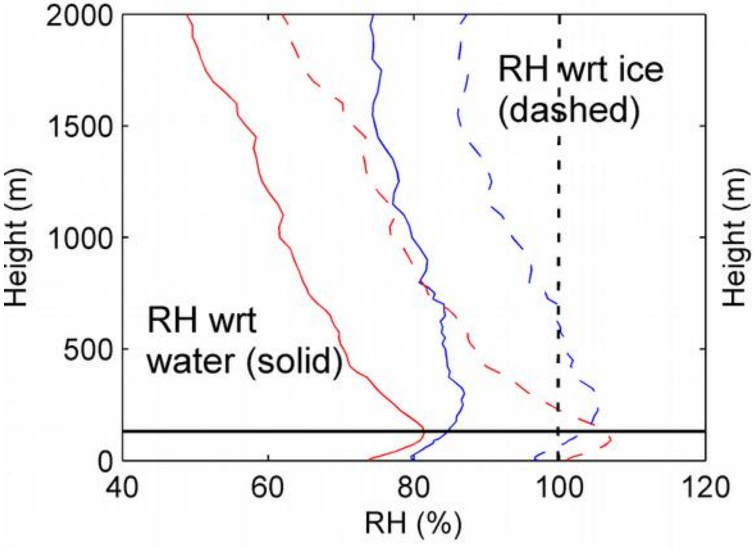
Persson et al 1999; Pithan et al 2013

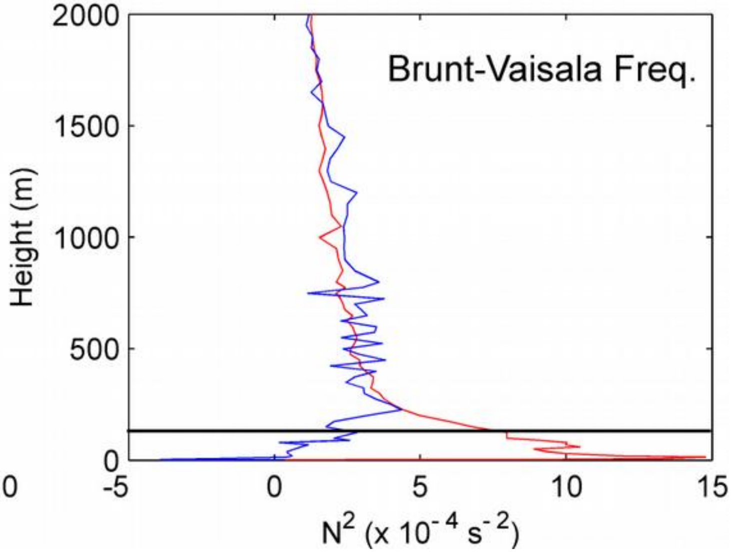
Vertical structure in winter

Mean profiles @ SHEBA







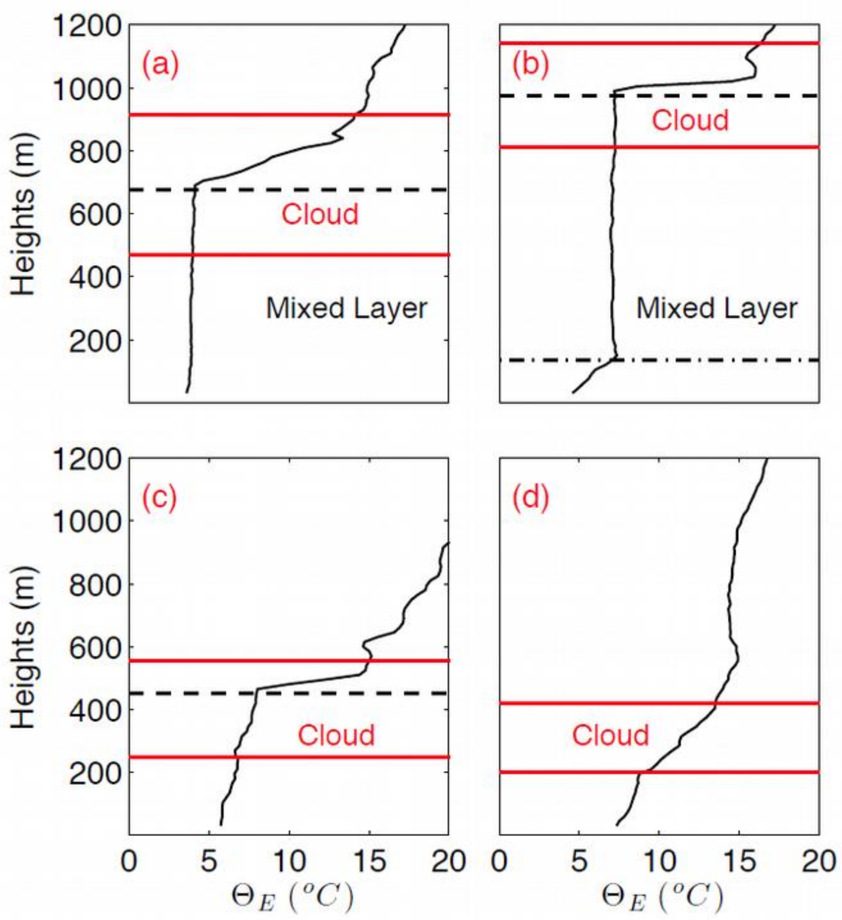


Courtesy of Ola Persson

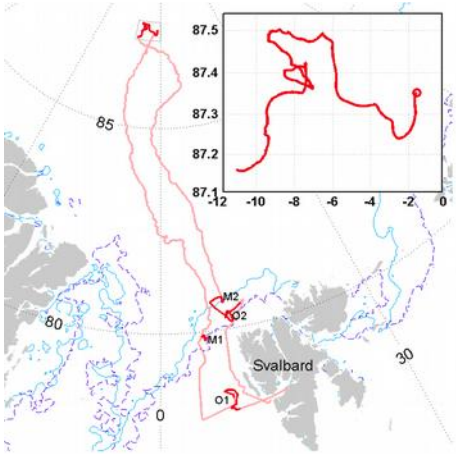
Cloud statistics from observations
ASCOS summer 2008

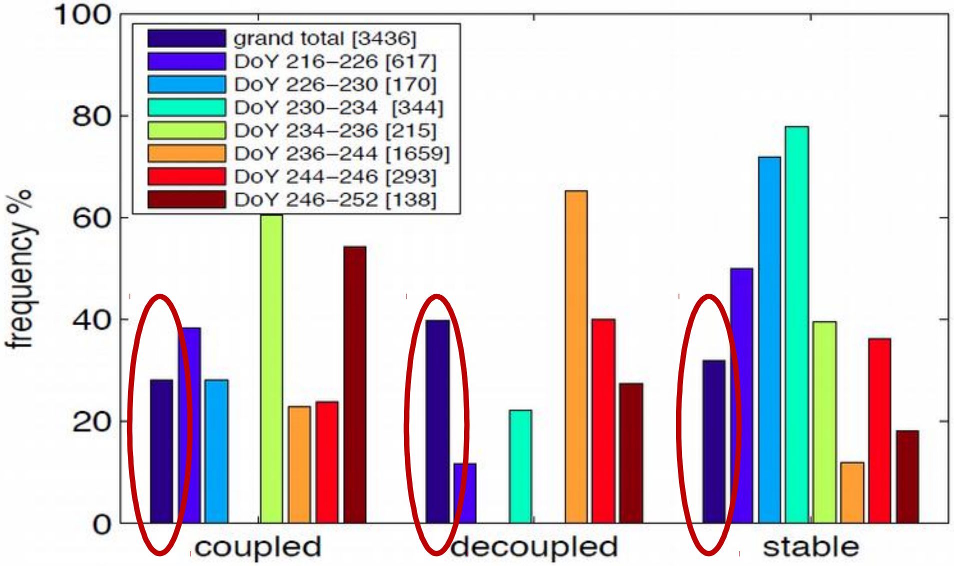
ASCOS cruise

Coupled **Decoupled**



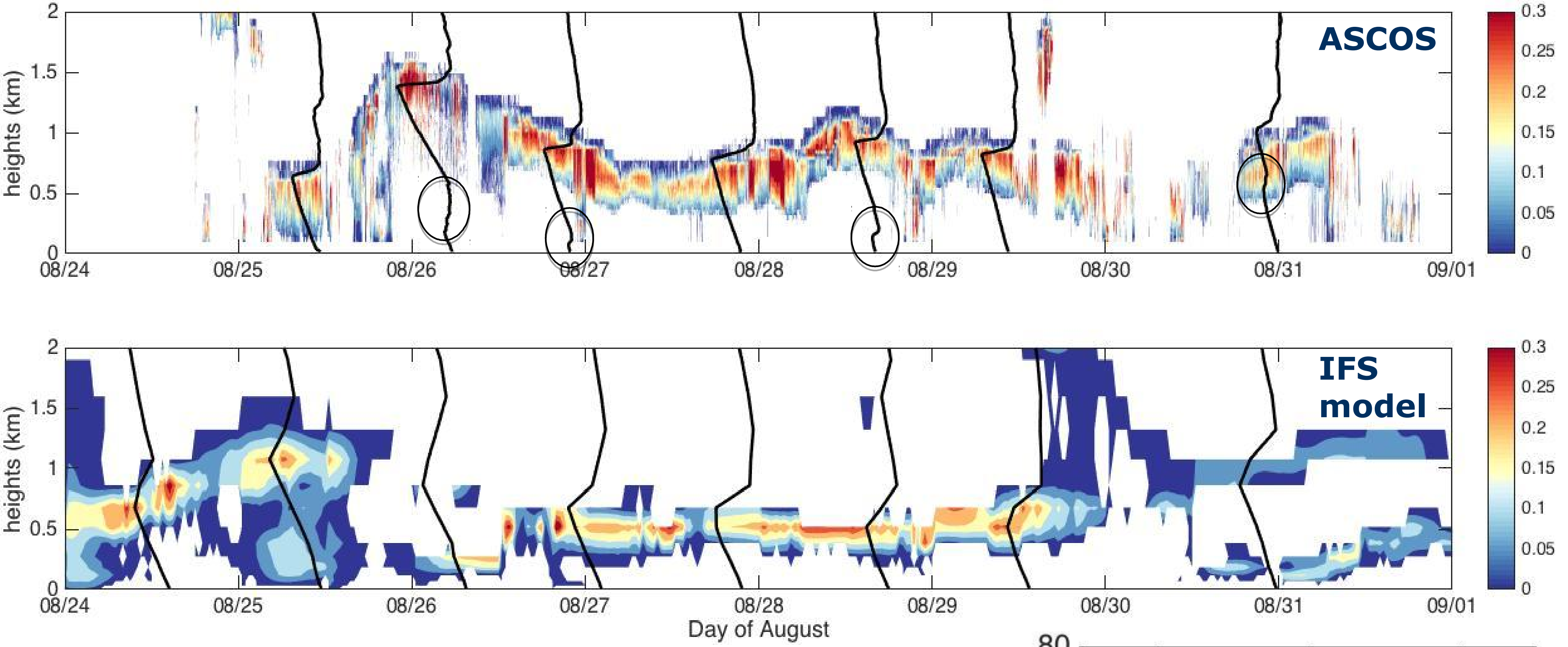
Stable

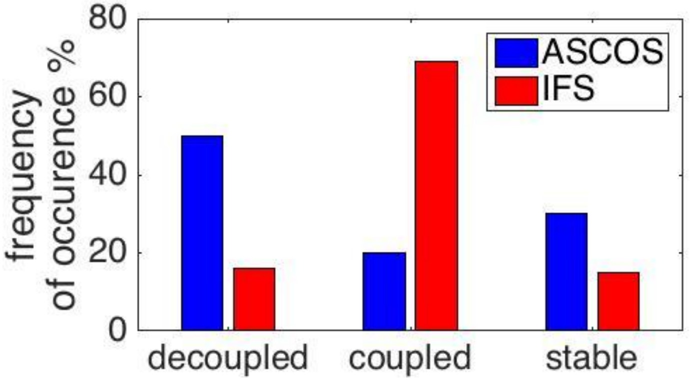




Sotiropoulou et al., 2014

Vertical structure in observations and model



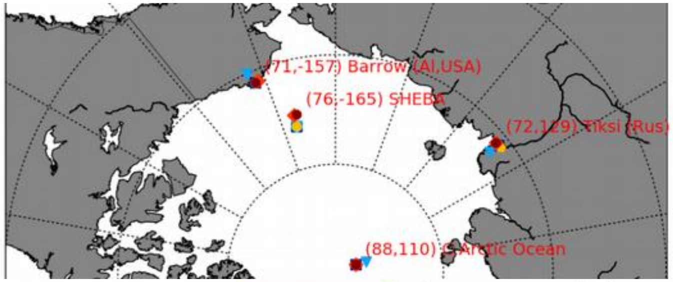


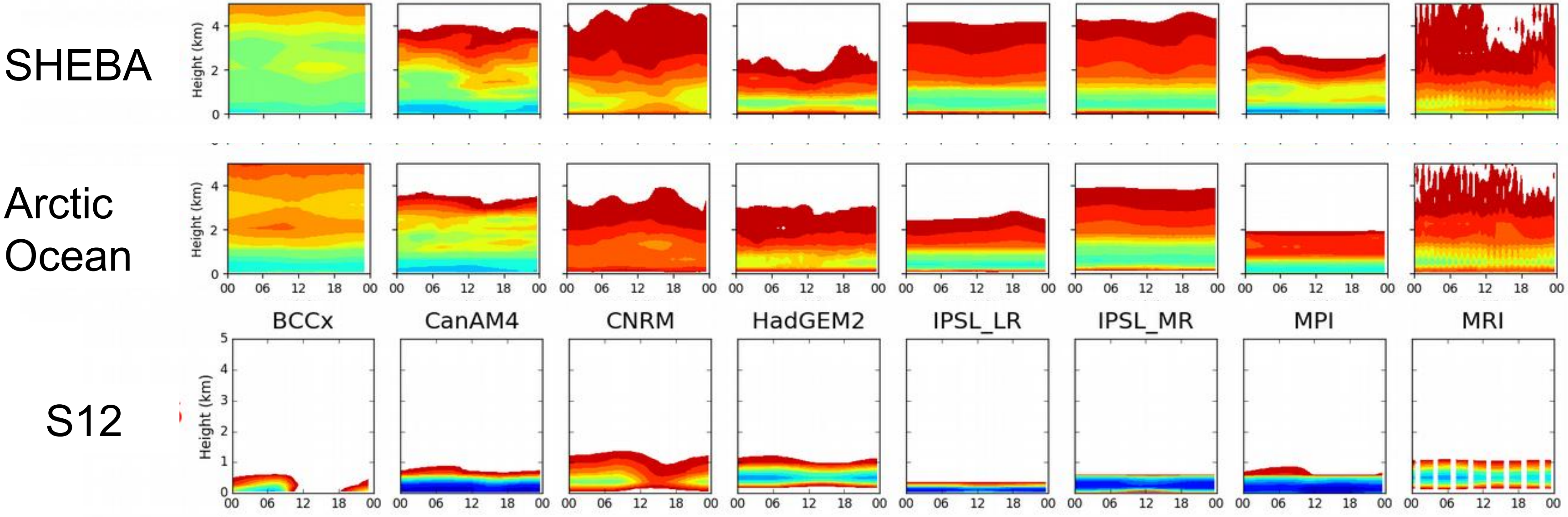
Clouds in the stable regime are more often liquid with less water content and fewer droplets

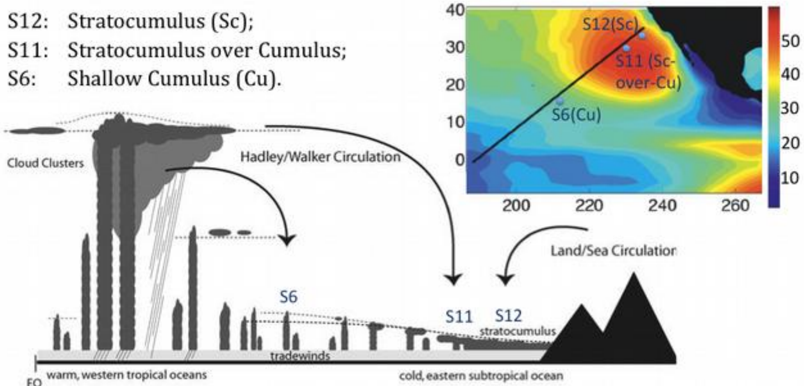
Sotiropoulou et al. 2014

CMIP5 models, CFMIP supersite data

Summer (JJA) mean diurnal cycle of cloud water (clw)







S12: Stratocumulus (Sc);
S11: Stratocumulus over Cumulus;
S6: Shallow Cumulus (Cu).

Nygren and Svensson, in preparation

Airmass transformation

Transport in over sea ice, Lagrangian perspective

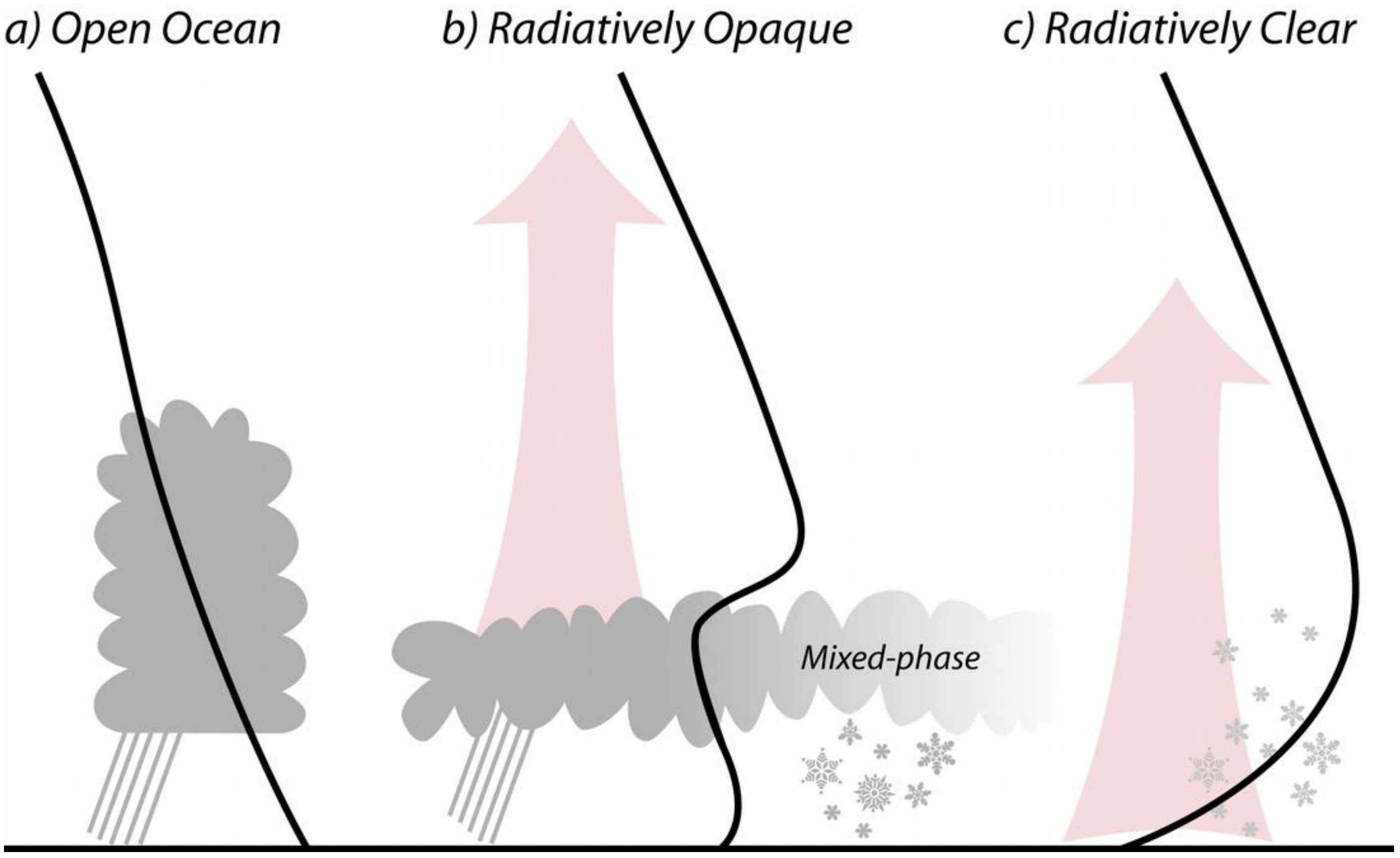


Figure by T. Mauritsen

What determines their lifetime?

Airmass transformation

Transport in over sea ice in winter

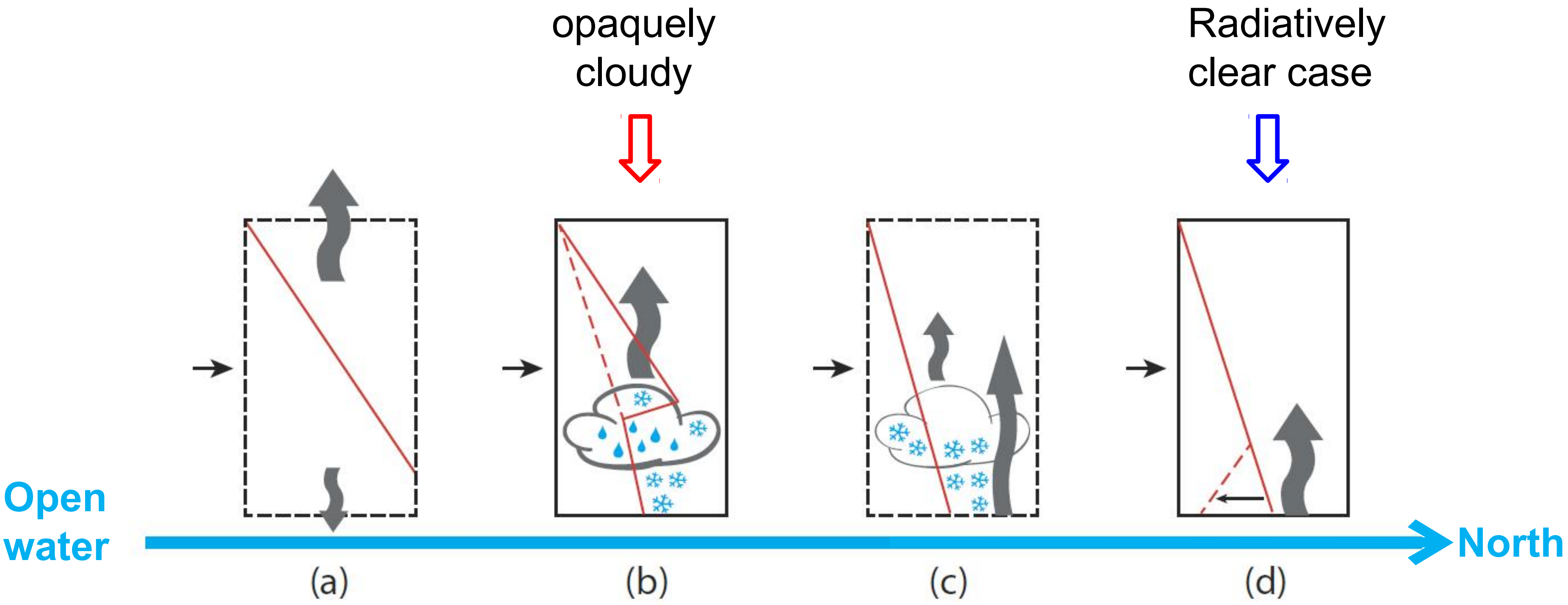
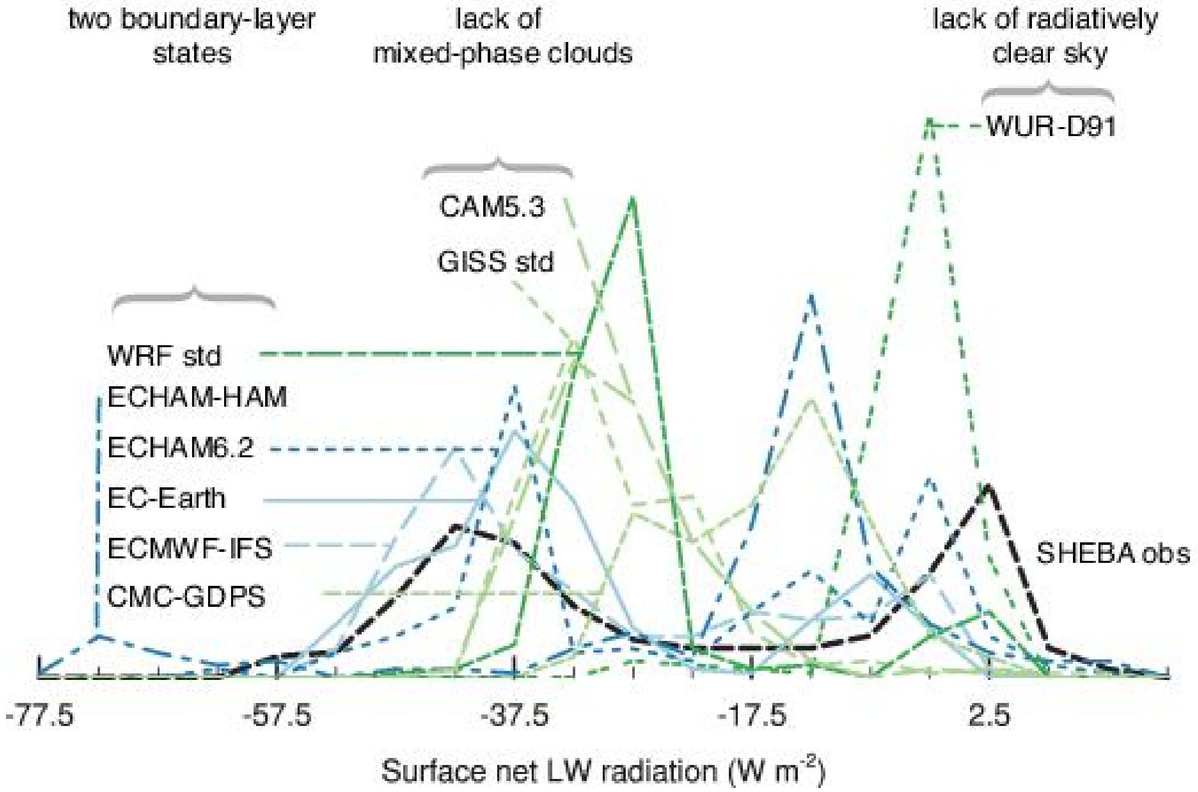


Fig. 6 Sketch of the formation of Arctic air. Dashed boxes mark unstable transition states.

Pithan et al., 2013

Polar airmass transition

Larcform1



Pithan et al., 2016

Polar airmass transition

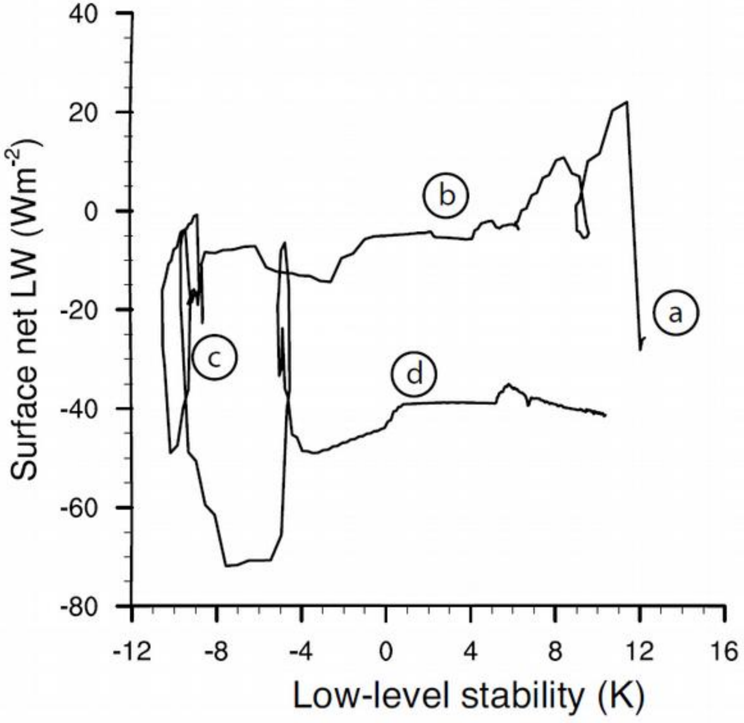
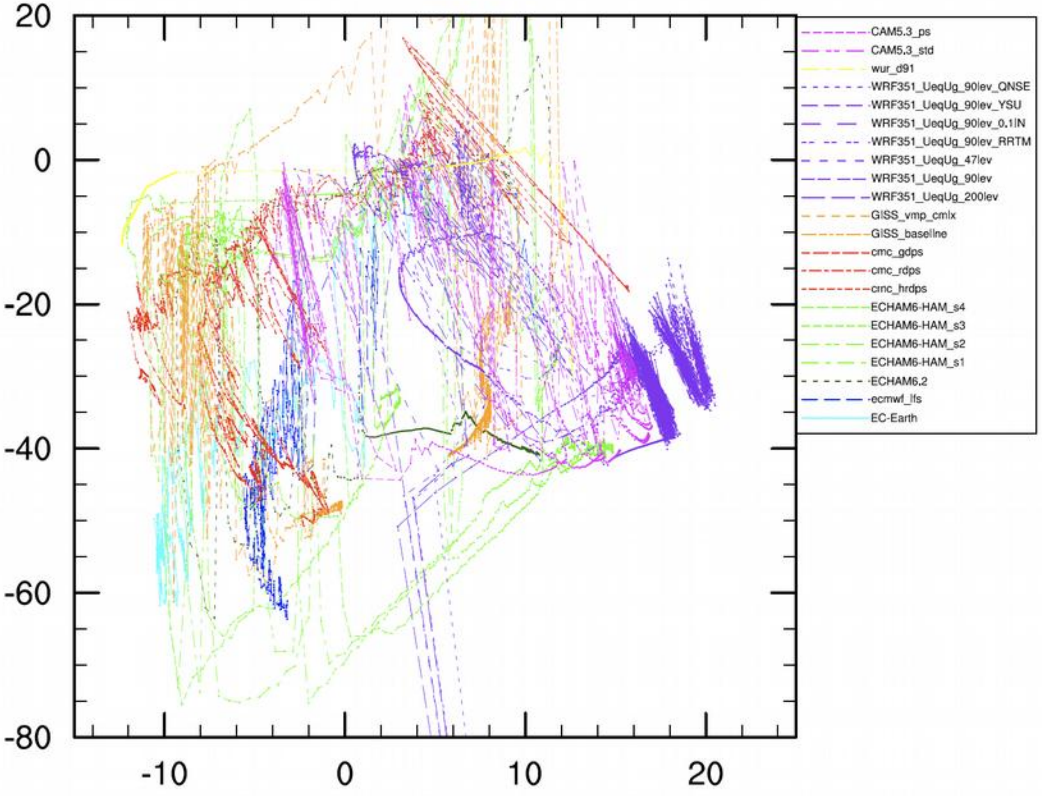


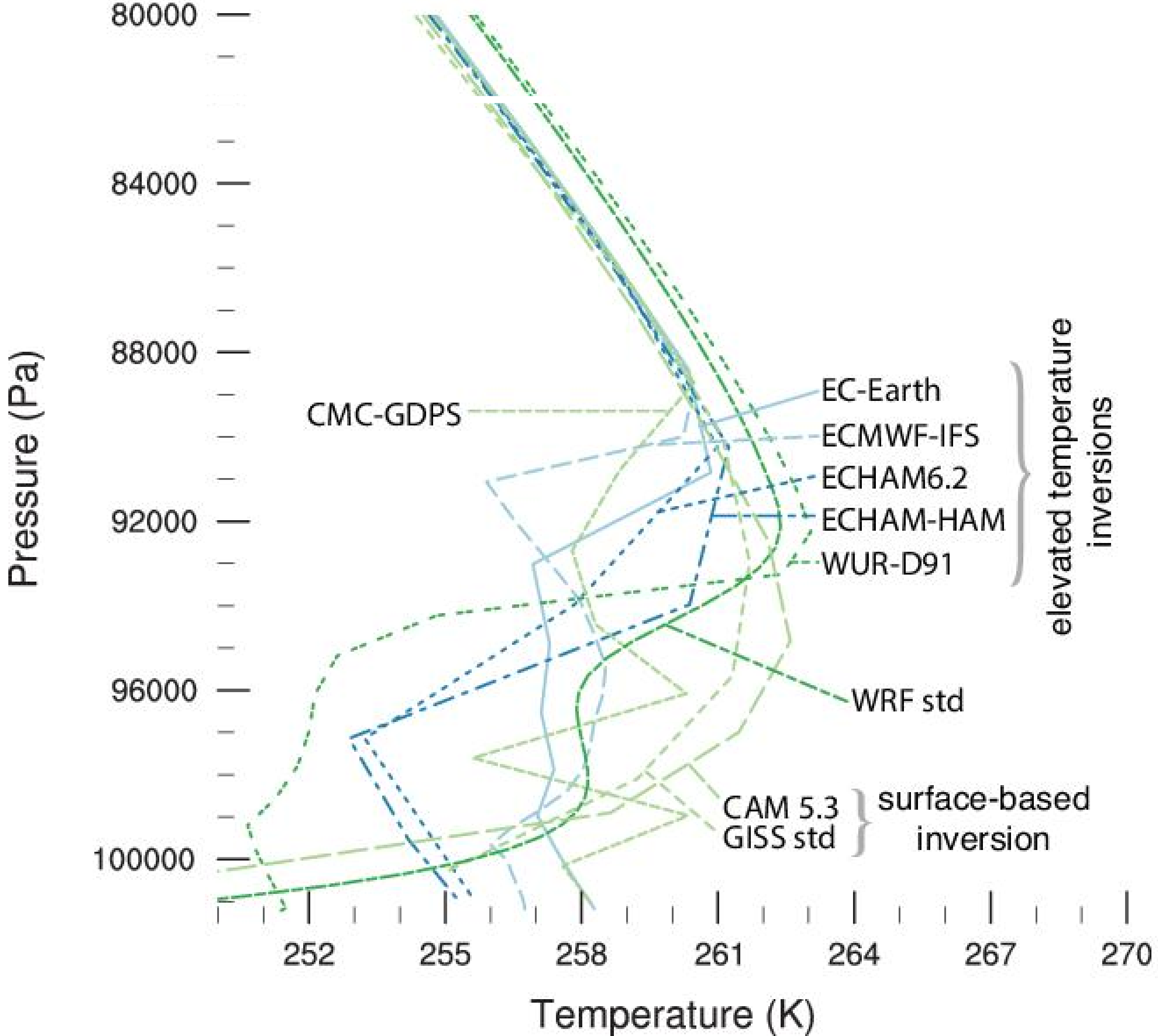
Fig. 7 Trajectory of low-level stability against surface net longwave radiation in idealized SCM experiment of Arctic air formation (section 2.1), hourly averages.



Pithan et al., 2013

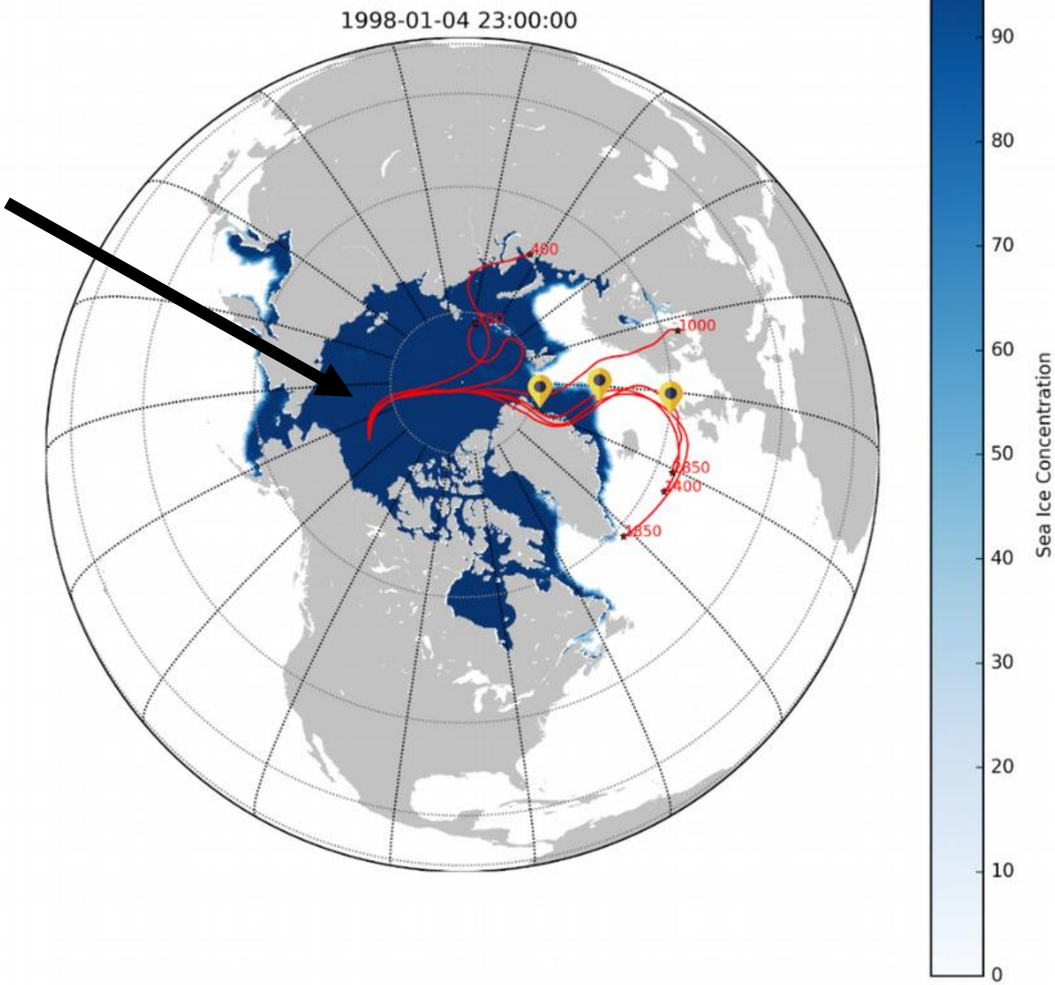
Polar airmass transition

GASS SCM model intercomparison



Pithan et al., 2016

Airmass passing over observational locations – Possible Larcform2 case?

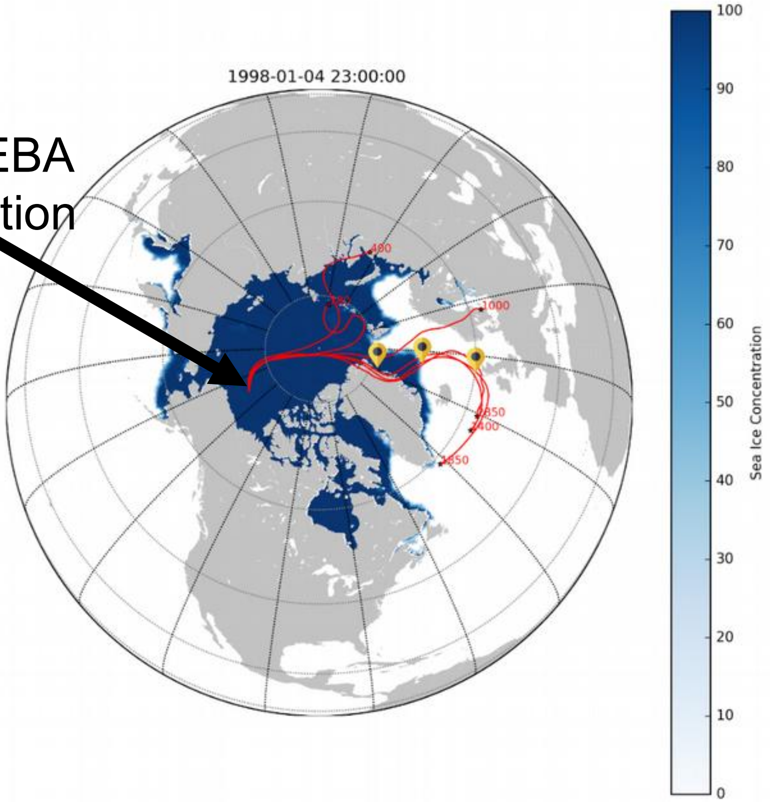


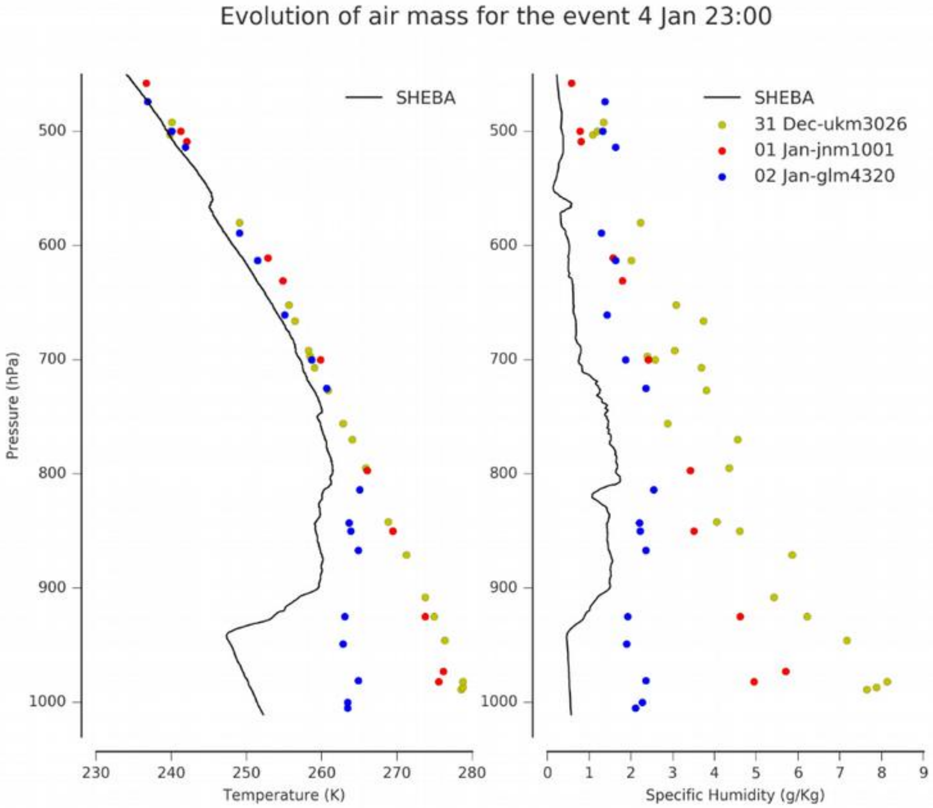
SHEBA location

Courtesy: Felix Pithan and Master student

Airmass passing over observational locations – Possible Larcform2 case?

SHEBA location





Courtesy: Felix Pithan and Master student

Mixed-phase clouds

Delicate balance between many processes

Stockholm University

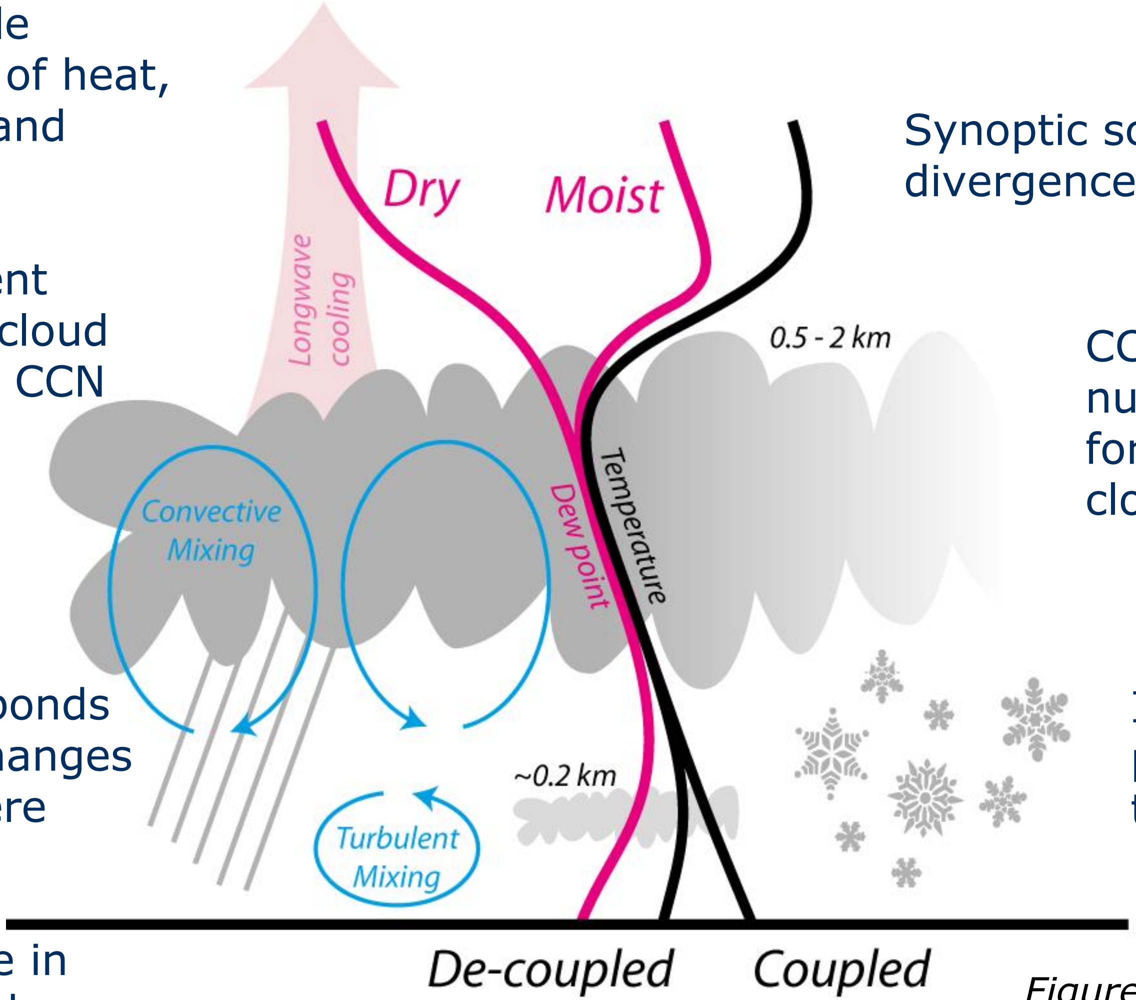


Figure by T. Mauritsen

Large-scale advection of heat, moisture and aerosols

Synoptic scale divergence

Entrainment source of cloud water and CCN

CCN (cloud droplet number) important for lifetime of liquid clouds

Surface responds rapidly to changes in atmosphere

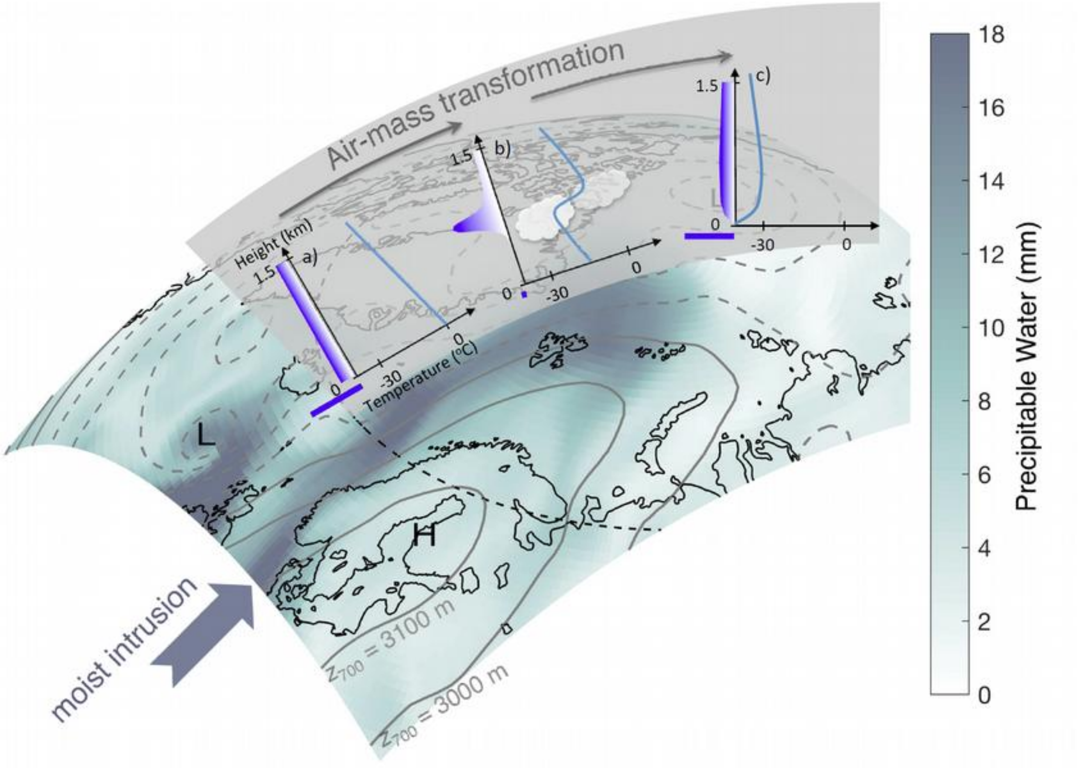
Ice particles precipitate out of the liquid cloud

Temperature in winter, albedo during melt

Surface fluxes mostly small and less important

Lagrangian case before MOSAiC

Further motivate Lagrangian observations



https://www.mosaic-expedition.org

Pithan, Svensson et al., 2018
Nature Geoscience, accepted

Year of Polar Prediction
–
Supersite evaluation and verification

Gunilla Svensson, Stockholm University

Barbara Casati, Environment Climate Change Canada

and many more …

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale

YOPP
YEAR OF
POLAR
PREDICTION

Process-based evaluation at supersites

- Inspired by GASS (GEWEX) model intercomparison studies such as GABLS1&4 and LARCFORM

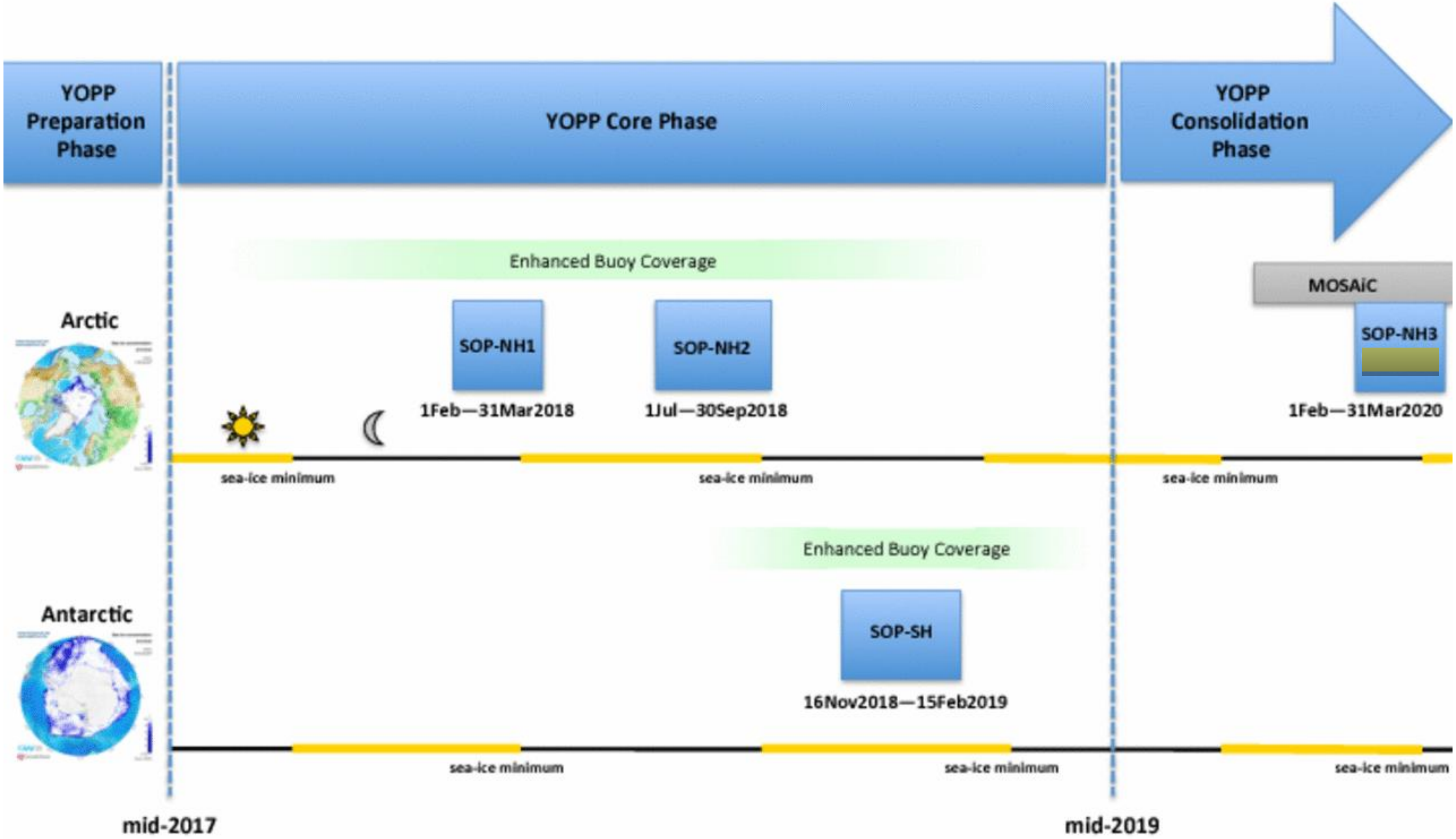
- Target processes under selected regimes – ensure close ties to certain parameterizations

- Find cases of special interest for further modeling, involving the community in intercomparisons

- Use observations in comparison with models in novel ways to aid in parameterization development

Year of Polar Prediction

Special Observing Periods (SOPs)



YOPP Preparation Phase

YOPP Core Phase

YOPP Consolidation Phase

Arctic

Enhanced Buoy Coverage

MOSAiC

SOP-NH1

1Feb—31Mar2018

SOP-NH2

1Jul—30Sep2018

SOP-NH3

1Feb—31Mar2020

sea-ice minimum

sea-ice minimum

sea-ice minimum

Antarctic

Enhanced Buoy Coverage

SOP-SH

16Nov2018—15Feb2019

sea-ice minimum

sea-ice minimum

sea-ice minimum

mid-2017

mid-2019

polarprediction.net

YOPPsiteMIP – Polar supersites

The Arctic supersites include the International Arctic Systems for Observing the Atmosphere (**IASOA,** https://www.esrl.noaa.gov/psd/iasoa/dataataglance) stations at Barrow, Oliktok Point, Eureka, Alert, Summit, Ny-Ålesund/Zeppelin, Pallas-Sodankylä, Tiksi, Cherskii, Cape Baranova, as well as the **ECCC** sites Iqaluit and Whitehorse (ecpass.ca).

The Antarctic supersites include Alexander Tall Tower, Casey, Davis, Dome-C, Dumont D'Urville, Halley IV, Jang Bogo, King George Island, Georg Von Neumayer, Mawson, Syowa, Amundsen-Scott South Pole, Byrd, Rothera, Vostok, McMurdo, Troll.

A few points at the third pole also…

Supersite and model output

Initially for SOPs but likely for the whole of YOPP

- IASOA data team is working on providing observational data in specially prepared files
- NWP centres (ECMWF, ECCC, MeteoFrance, Russia NWP, MetNo, FMI…) are working on providing high-frequency model (preferably time-step, 15 min or 1 hour) data on model levels

Both communities are to use identical variable names (using naming convention when they exist conforming with e.g. CMIP), aiming for one-to-one comparison

Data contain standard variables (Tier 1) for verification and more specialized output (Tier 2) for more advanced process evaluation and model-to-model intercomparison

Document available at:
https://www.polarprediction.net/yopp-activities/yopp-task-teams/yopp-modelling-task-team/

Interaction between the PBL and the large-scale circulation

How can we use observations to better constrain PBL drag in models?

- Lack of direct global measurements of surface drag
- Over ocean, there are scatterometer data that provides the low-level winds, however, these observations rely on similarity theory to get the stress vector
- Over land there are local observations of the surface friction, but no area coverage – and there are more processes (surface heteorogeneity, orography, gravity waves, etc)
- Wind-turning over the boundary layer, the cross-isobaric angle, can be analyzed as a measure of the ageostrophic flow in the PBL

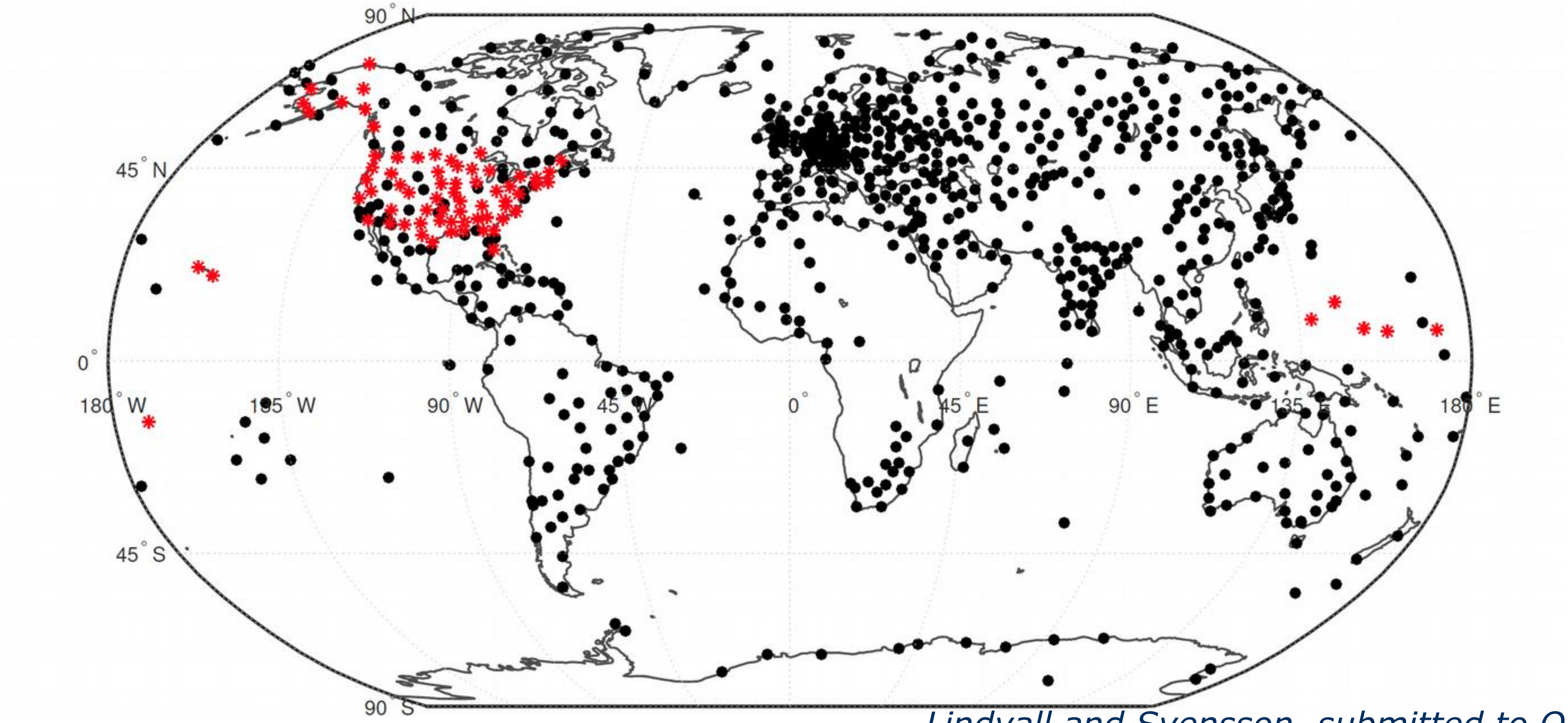
Observations

IGRA

- Soundings at over 1000 locations (681 included)
- Limited vertical resolution
- PBLH from Seidel et al, 2010 (1971-2010)

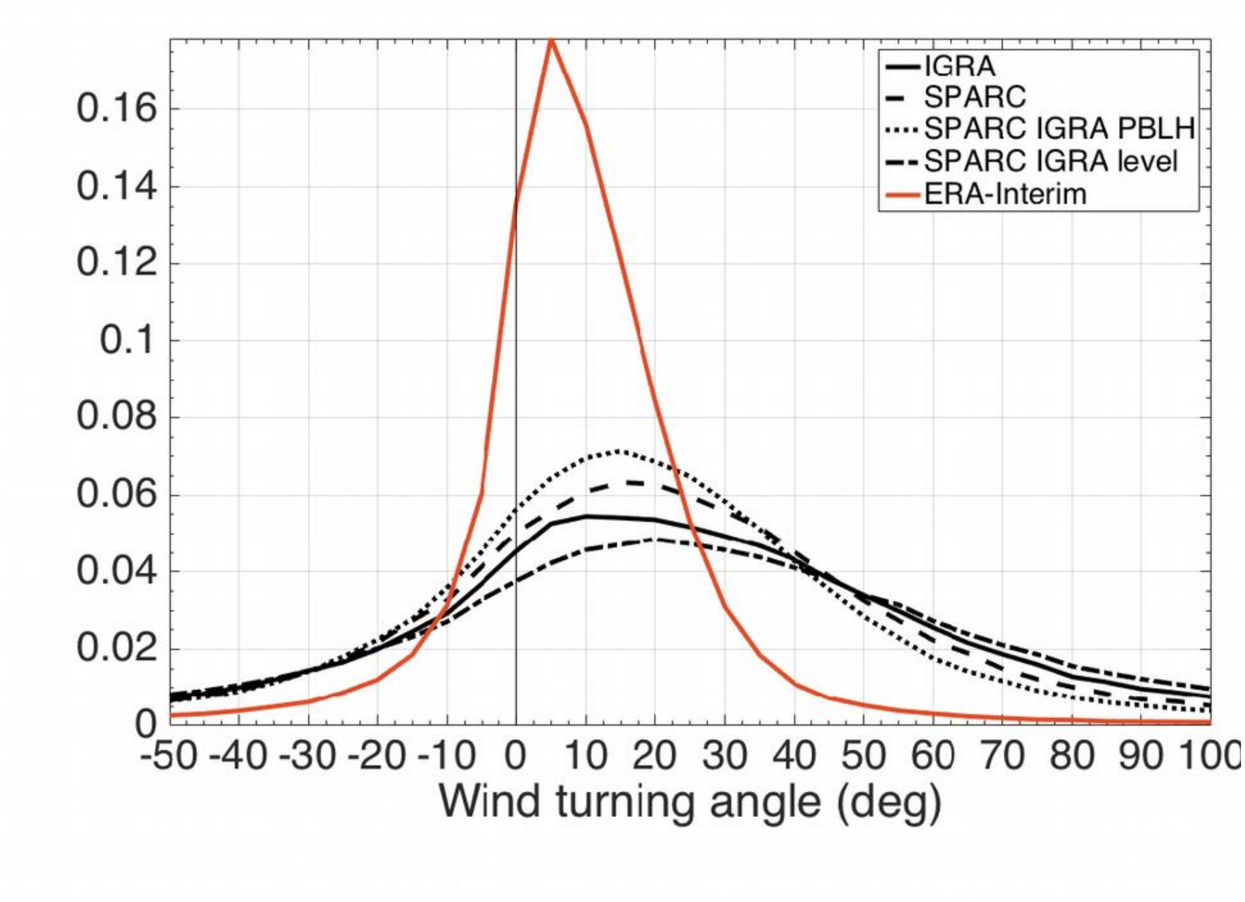
SPARC

- High vertical resolution (6 or 1 s)
- Fewer points (US only)
- 1998-2011



Lindvall and Svensson, submitted to QJRMS

Wind turning over the PBL



Lindvall and Svensson, submitted to QJRMS

Wind turning over PBL

Annual mean

Stockholm University

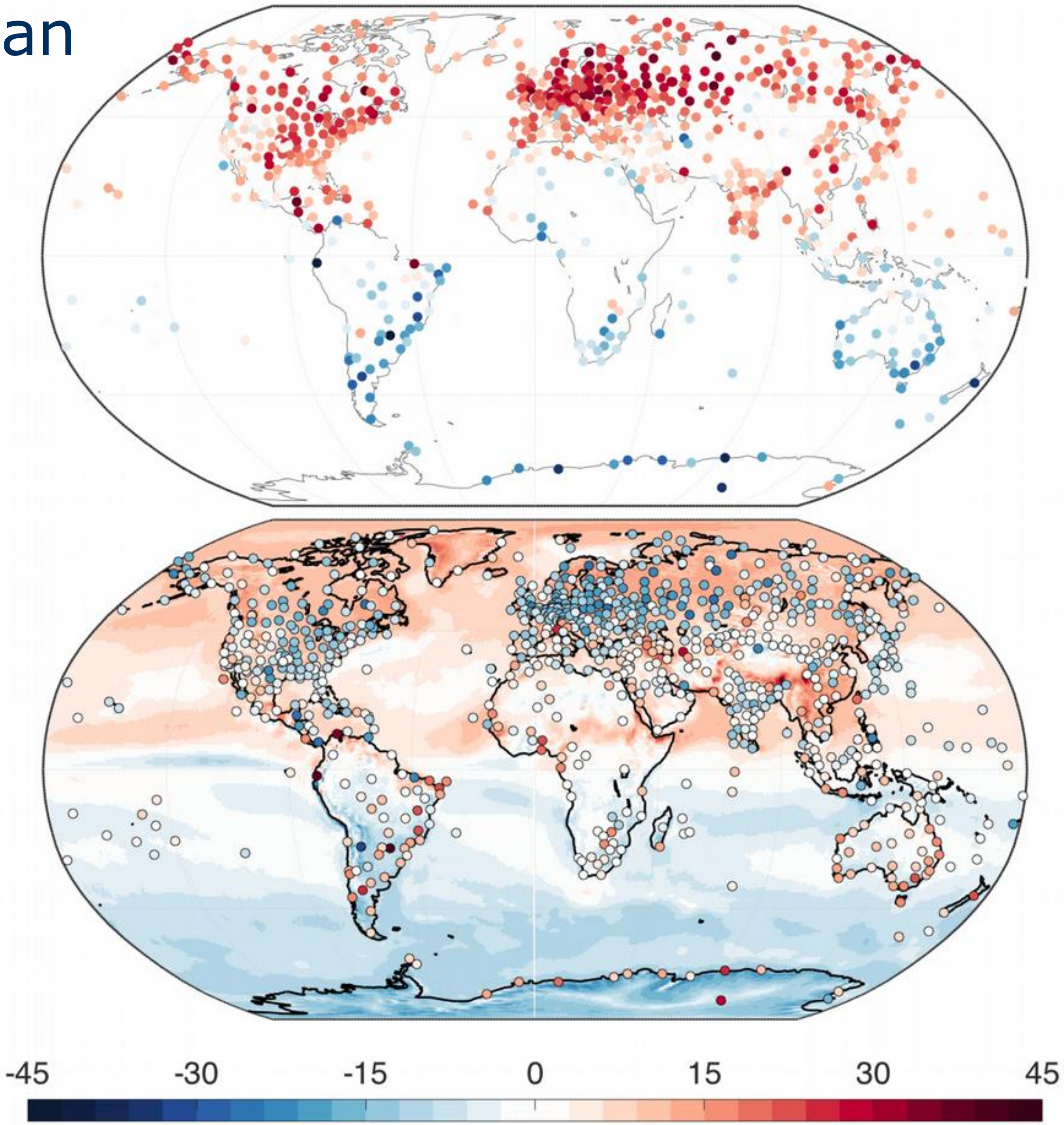


FIG. 3. Maps of the median angle of wind turning from a) the IGRA radiosonde archive (1981-2005) and b) ERA-Interim (years 2001-2005) with the bias in the mean wind-turning angle represented by dot symbols.

Lindvall and Svensson, submitted to QJRMS

Cross-isobaric angle

Era-Interim and CMIP5 models