Symptoms of Arctic Amplification observed in Ny-Ålesund

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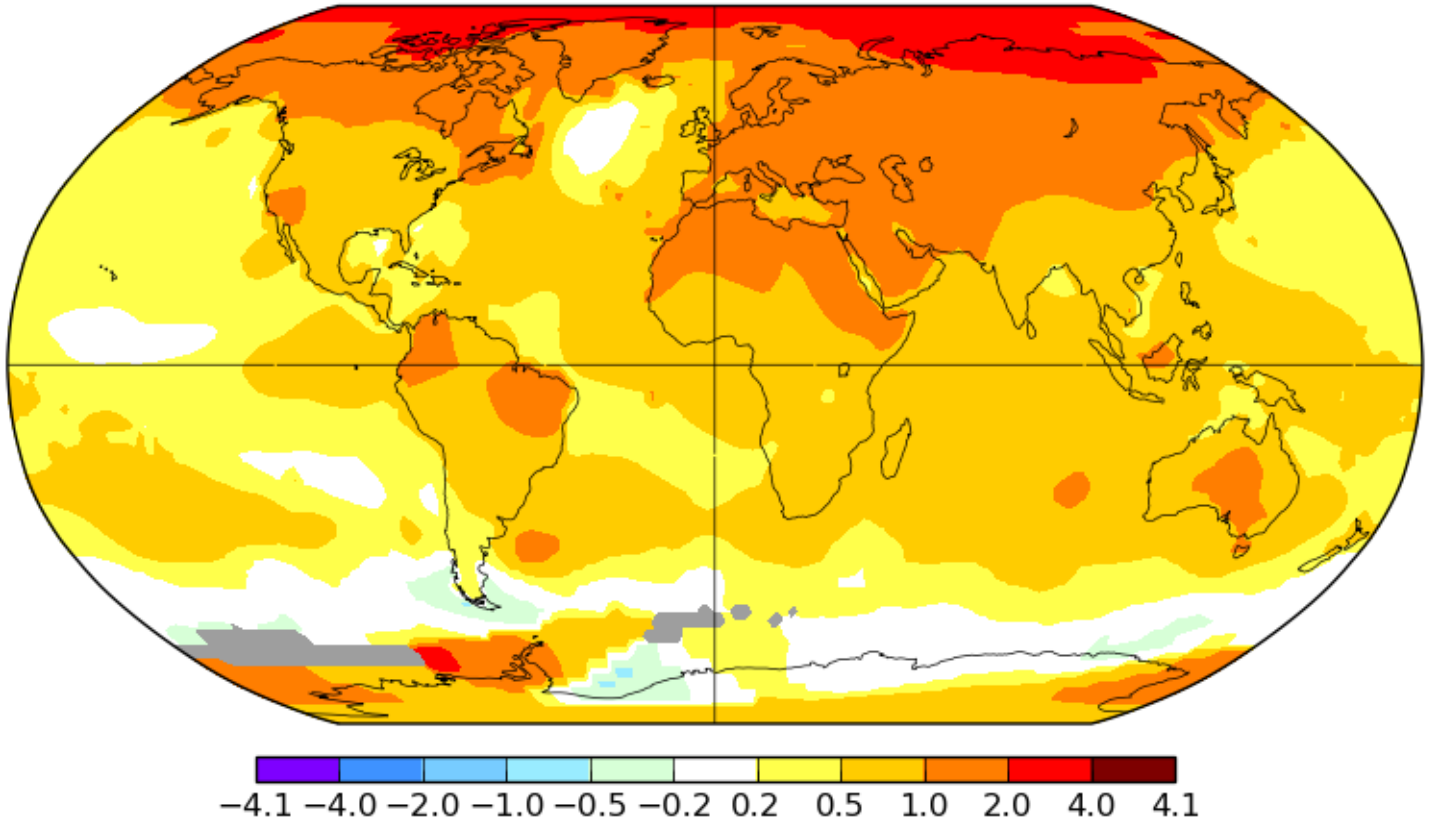
ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Svalbard Science Conference, 6-8 Nov 2017, Oslo

Arctic Warming

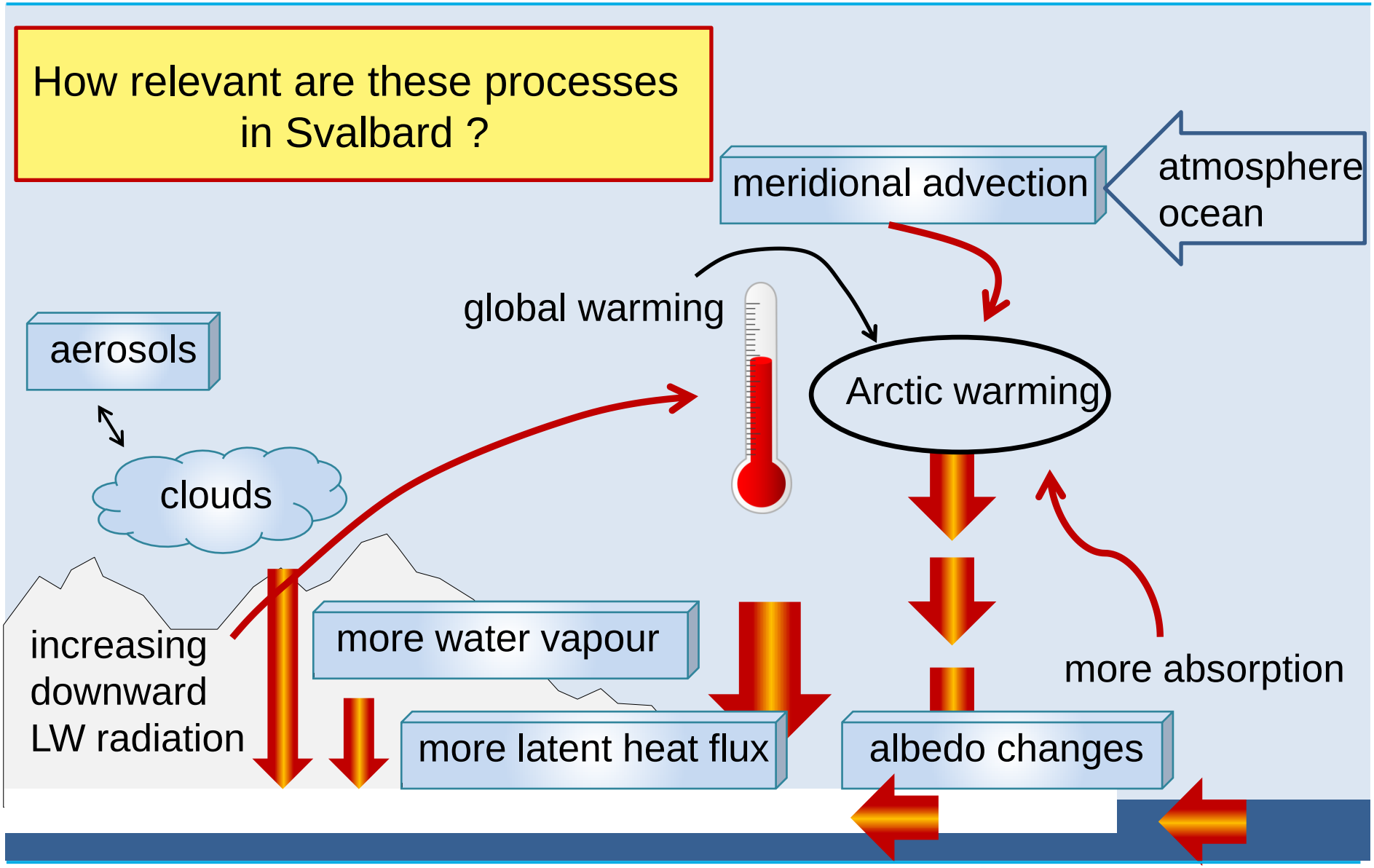
annual mean T [2007-2016] anomaly vs. [1951-1980]



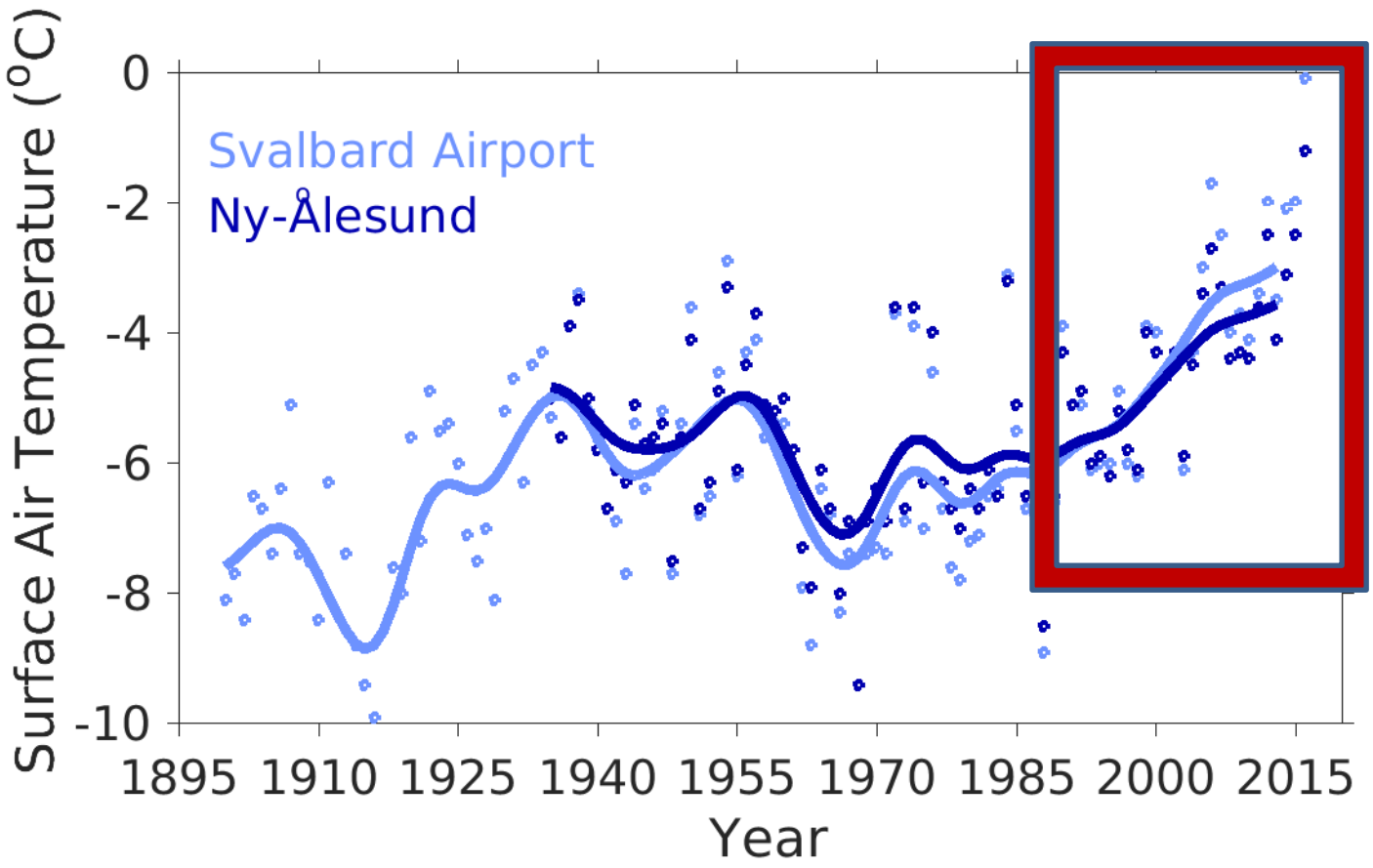
GISS Surface Temperature Analysis

source: https://data.giss.nasa.gov/gistemp/maps/

Arctic Amplification

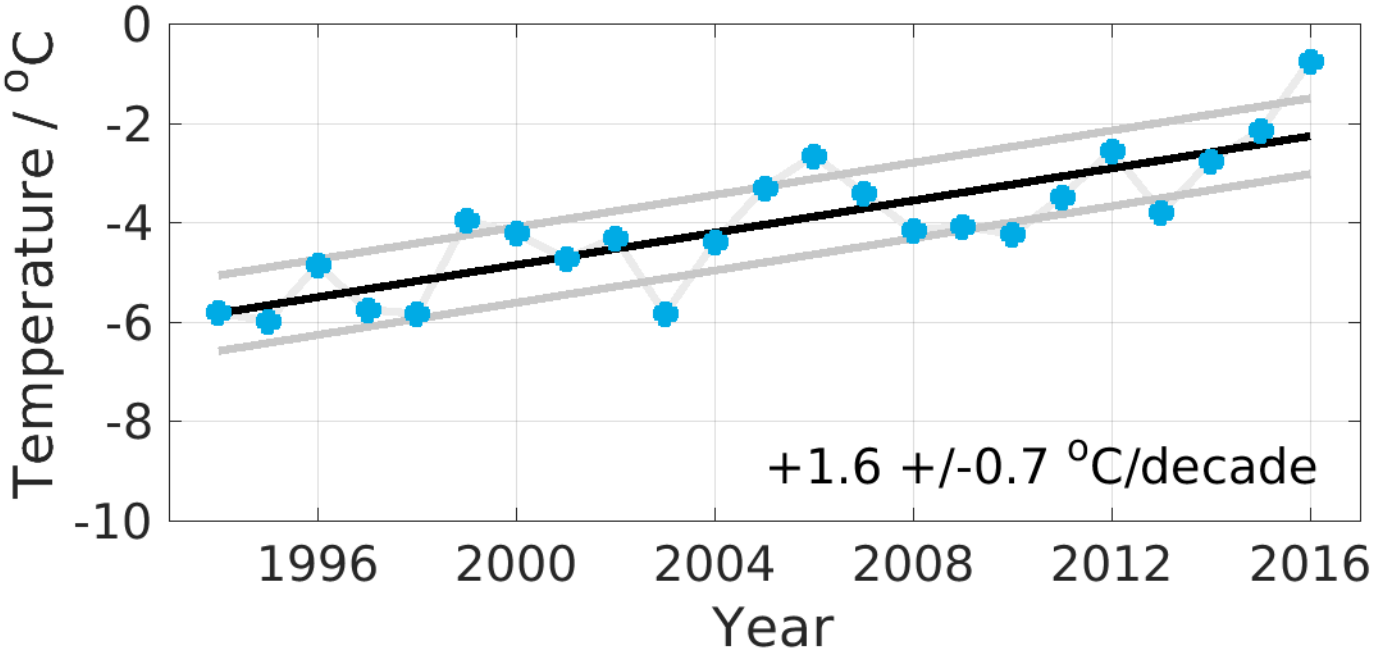


Svalbard Temperatures



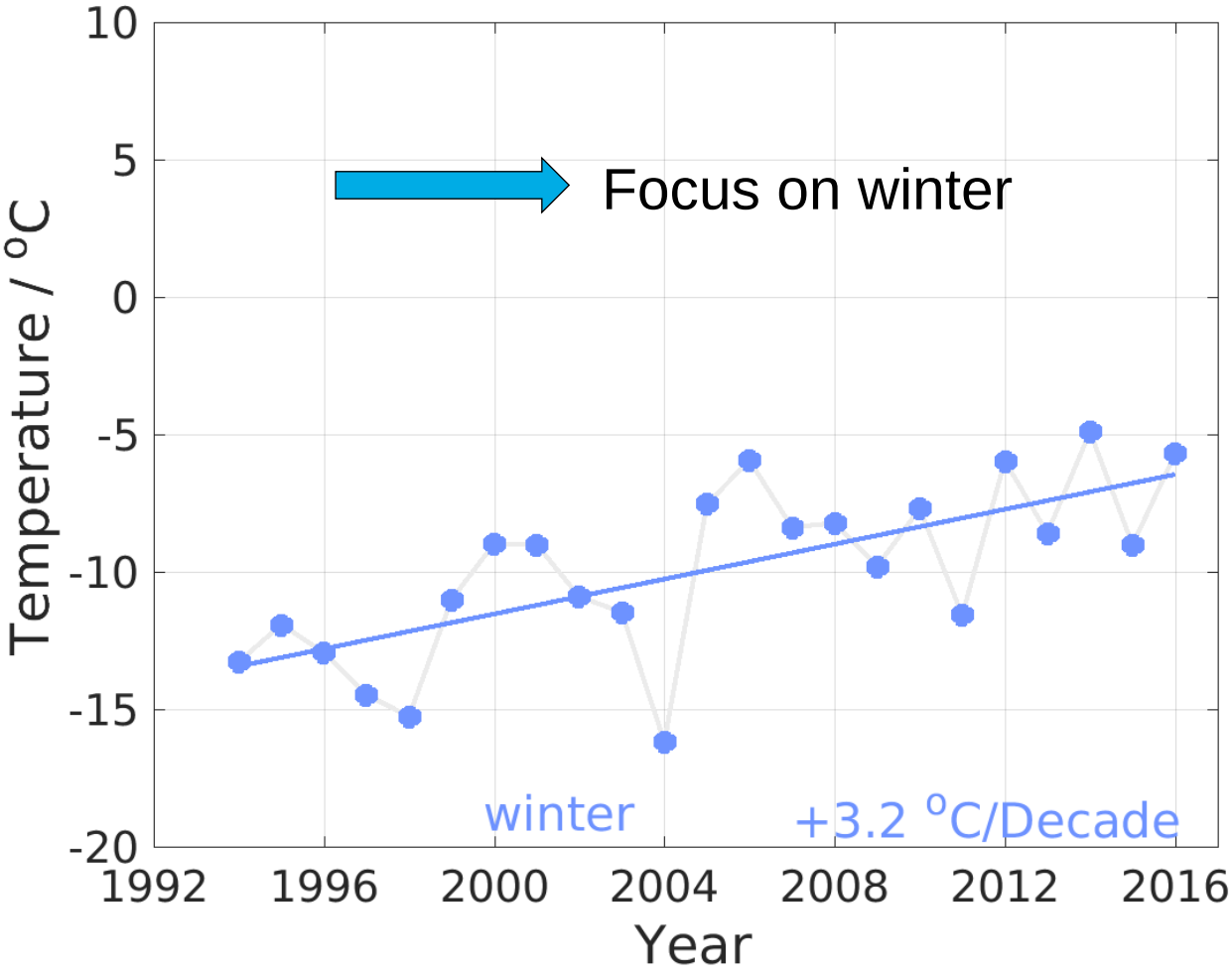
data: homogenized by Øyvind Nordli,
provided by Inger Hansen-Bauer, met.no

Annual Mean Temperature



Update of Maturilli et al. (2013), doi:10.5194/essd-5-155-2013

Seasonal Mean Temperature



Update of Maturilli et al. (2015), doi: 10.1007/s00704-014-1173-4

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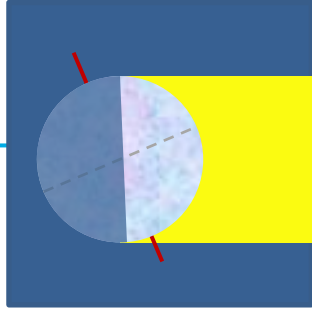
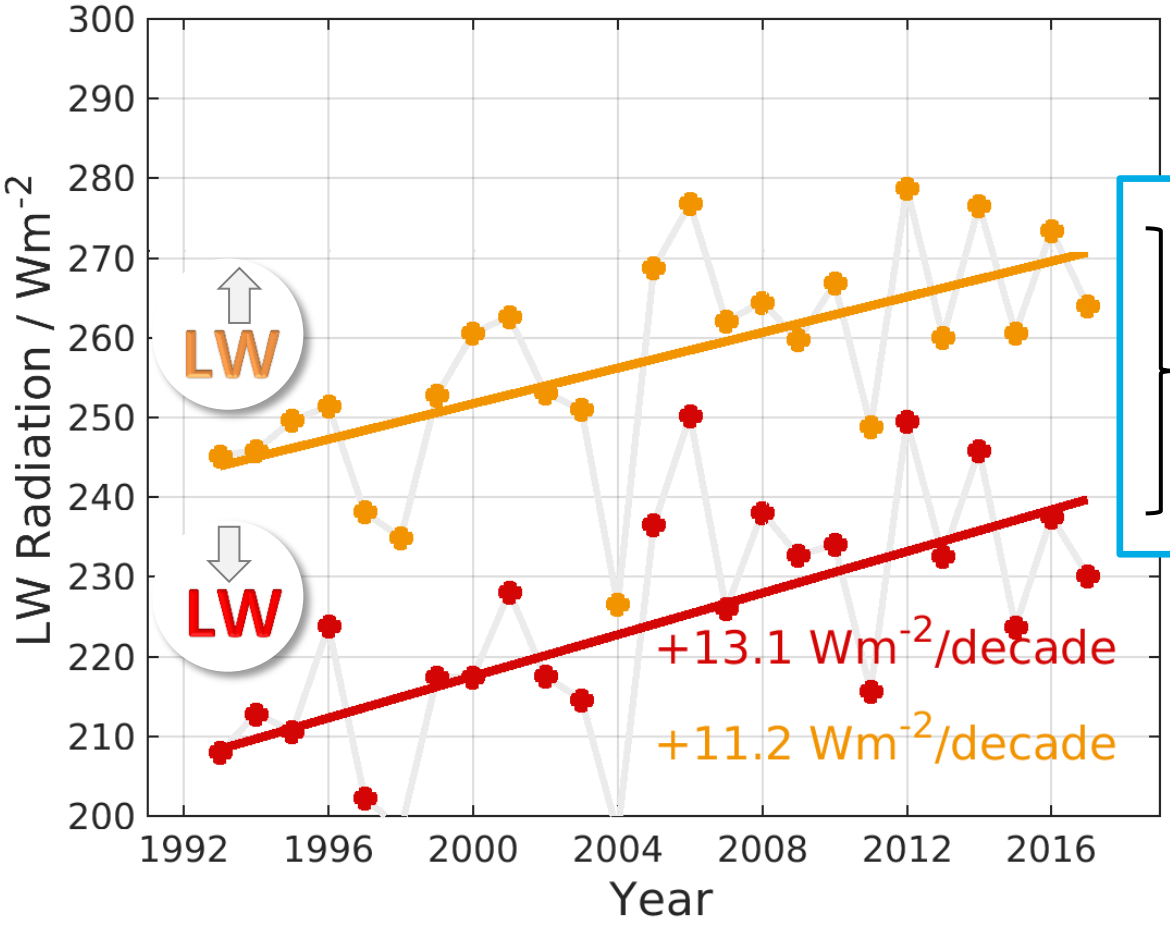
Longwave Radiation



near-surface warming ⟶ increase in thermal emission

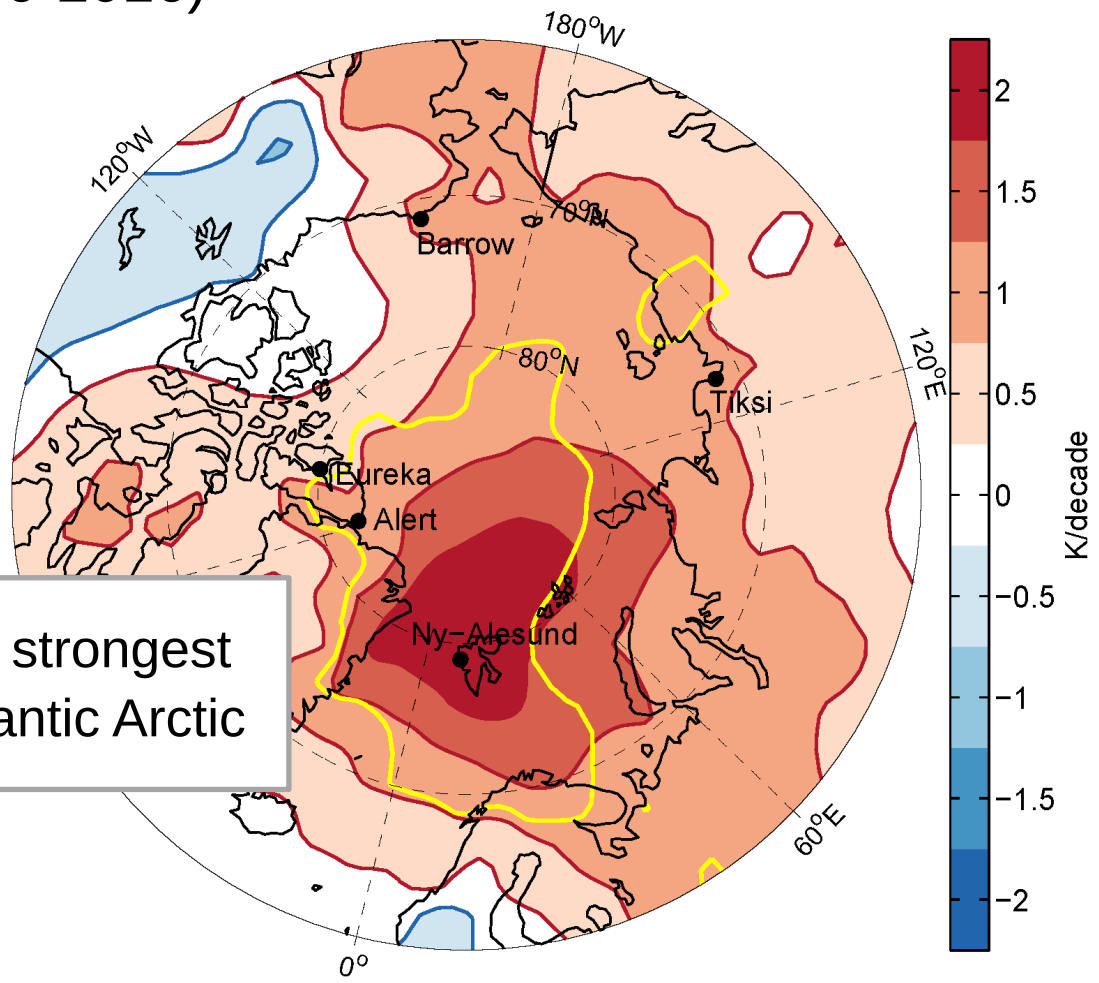


increase in LW_{net}

Update of Maturilli et al. (2015), doi: 10.1007/s00704-014-1173-4

Recent Arctic Winter Warming

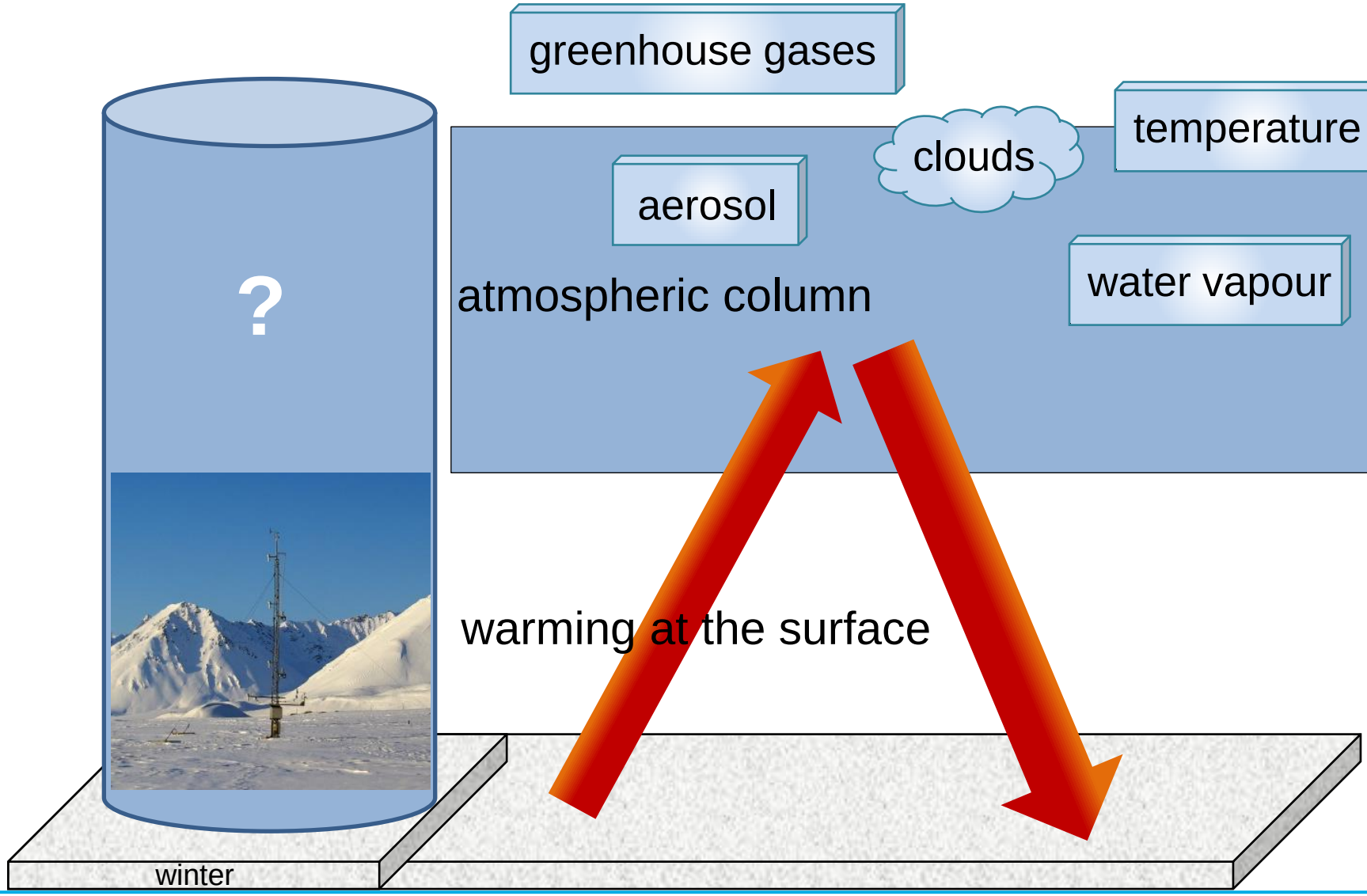
Dec-Jan-Feb mean decadal temperature trend at 850 hPa
(ERA-Interim 1996-2016)



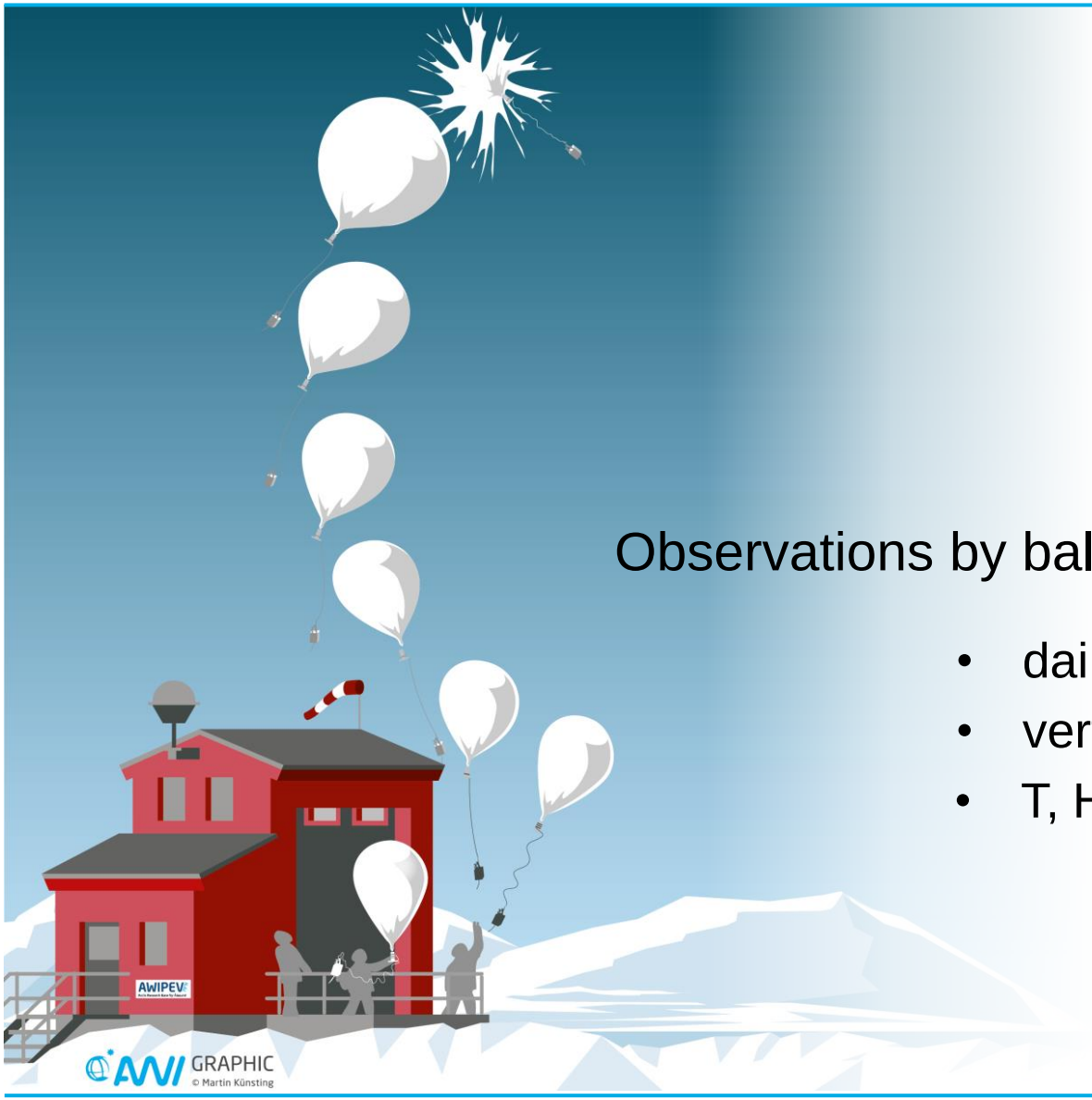
winter warming strongest
in the North Atlantic Arctic

from Dahlke and Maturilli (2017), in press

Surface → Upper Air



Surface → Upper Air



temperature

water vapour

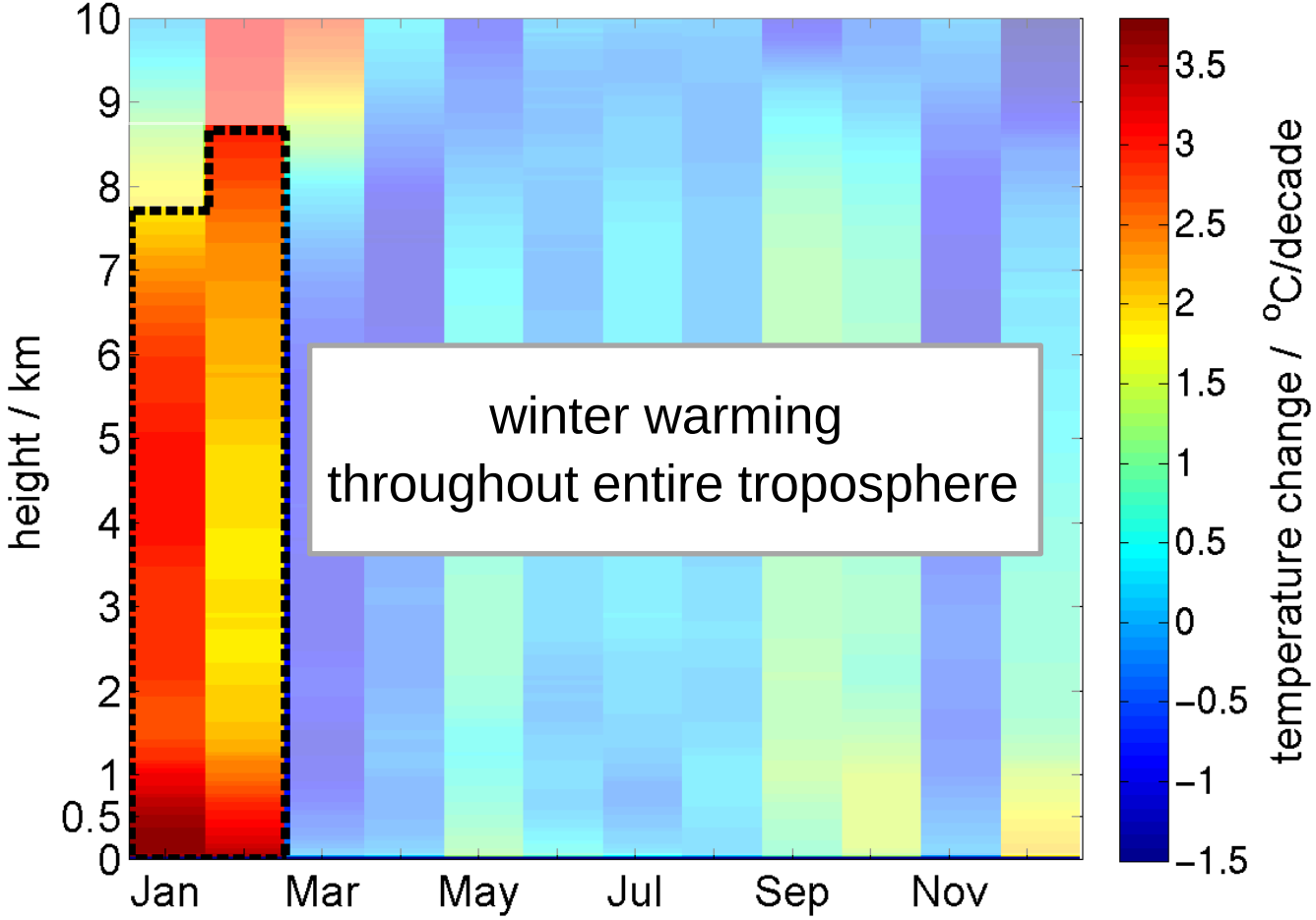
Observations by balloon-borne radiosondes

- daily soundings since 1993
- vertical profiles up to 30 km
- T, H_2O, wind, pressure

Upper-Air Observations

temperature

Change in Temperature

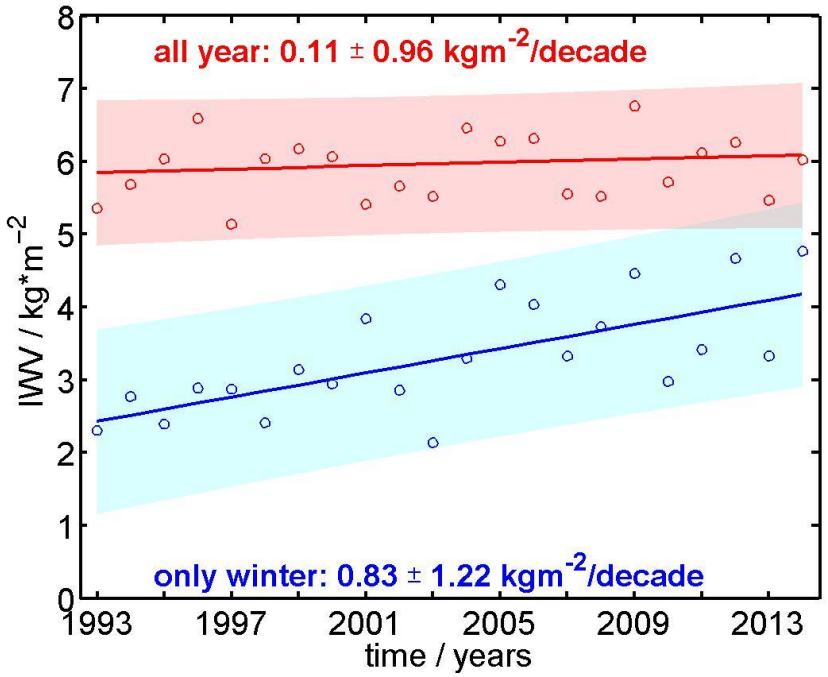


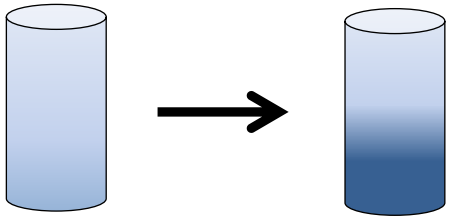
from Maturilli and Kayser (2016), doi:10.1007/s00704-016-1864-0

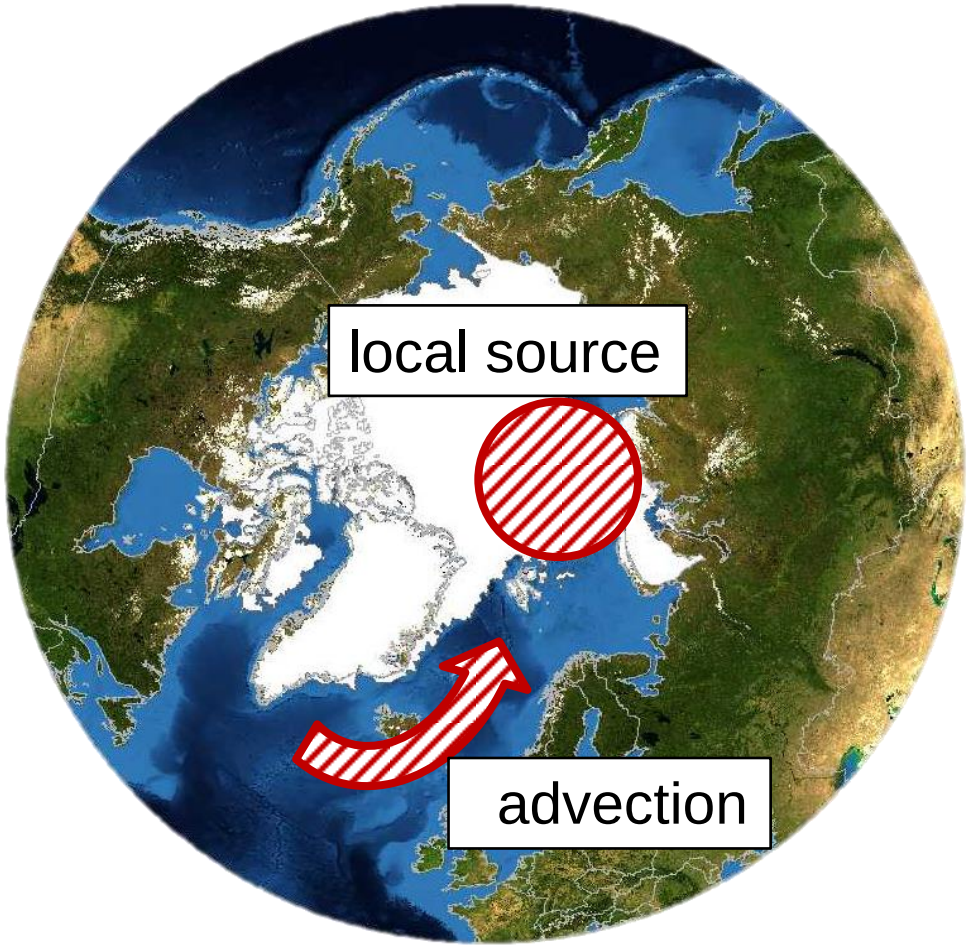
Upper-Air Observations

water vapour

Change in Atmospheric Moisture







from Maturilli and Kayser (2016), doi:10.1007/s00704-016-1864-0

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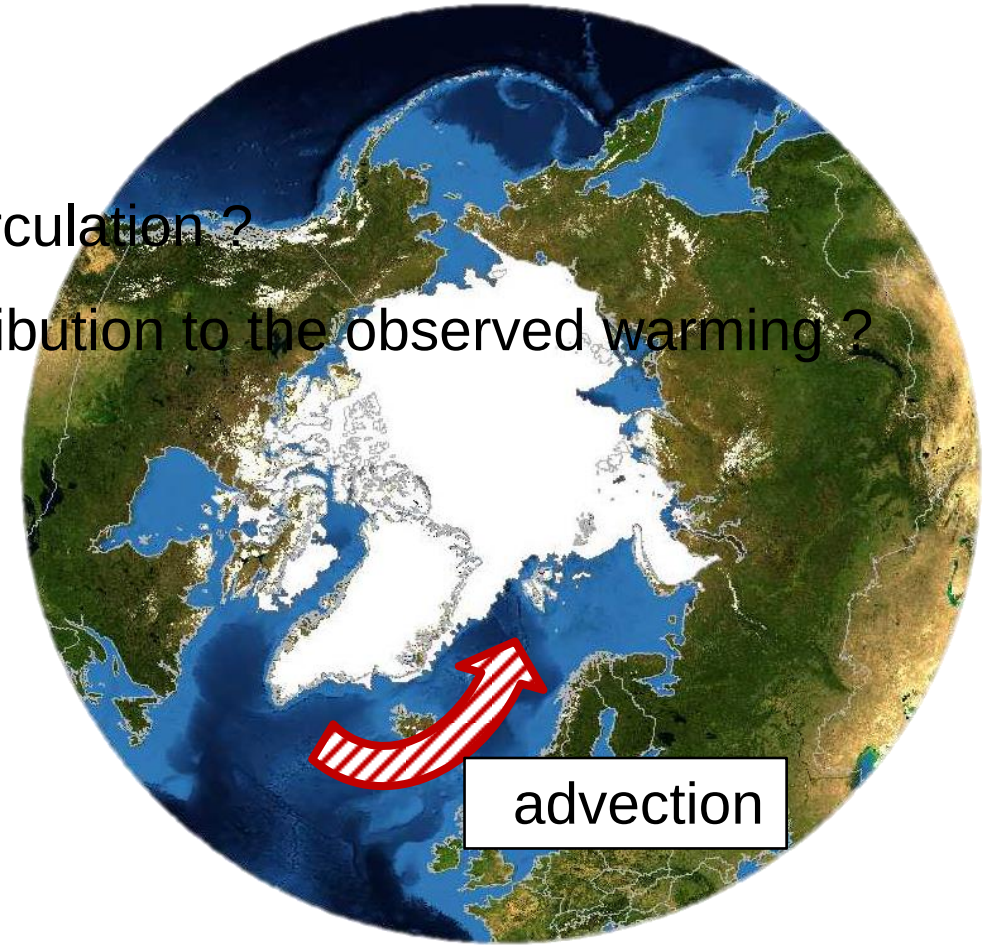
Upper-Air Observations

Change in Synoptic Wind Direction:

In recent winters, synoptic flow
is more frequent from SOUTH.

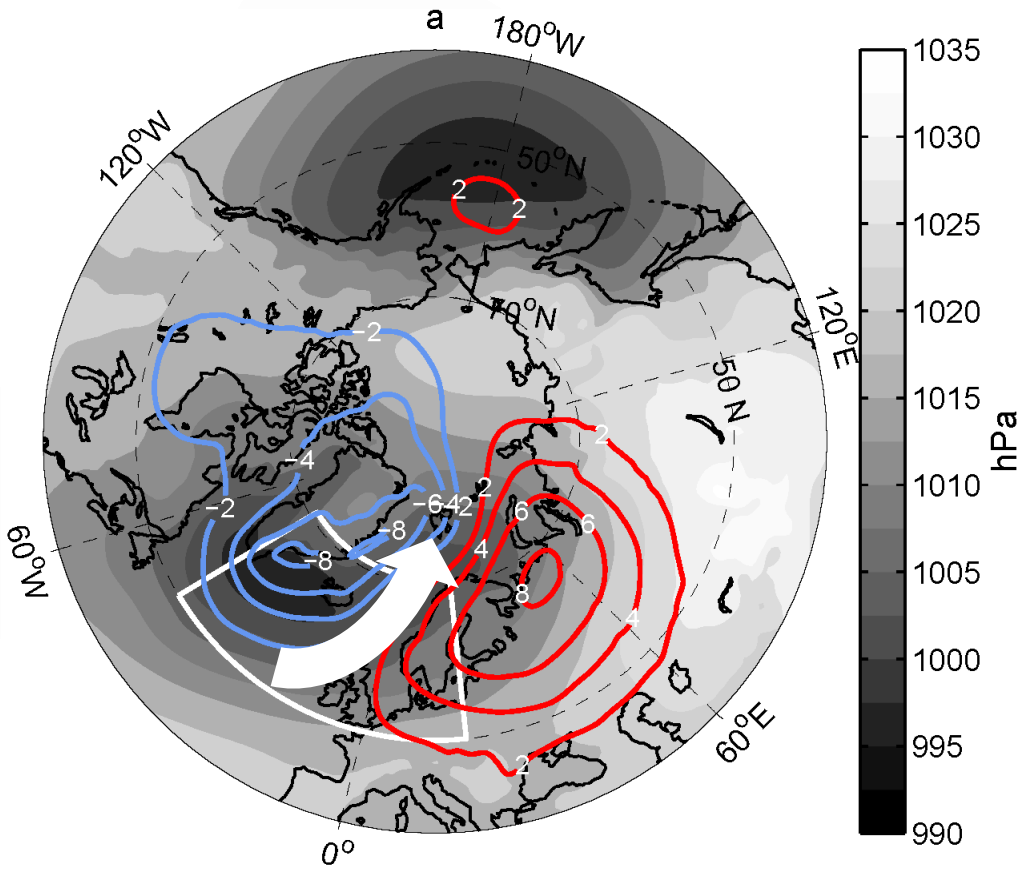
➡ Changes in atmospheric circulation ?

➡ What is the advective contribution to the observed warming ?



from Maturilli and Kayser (2016), doi:10.1007/s00704-016-1864-0

Circulation Changes



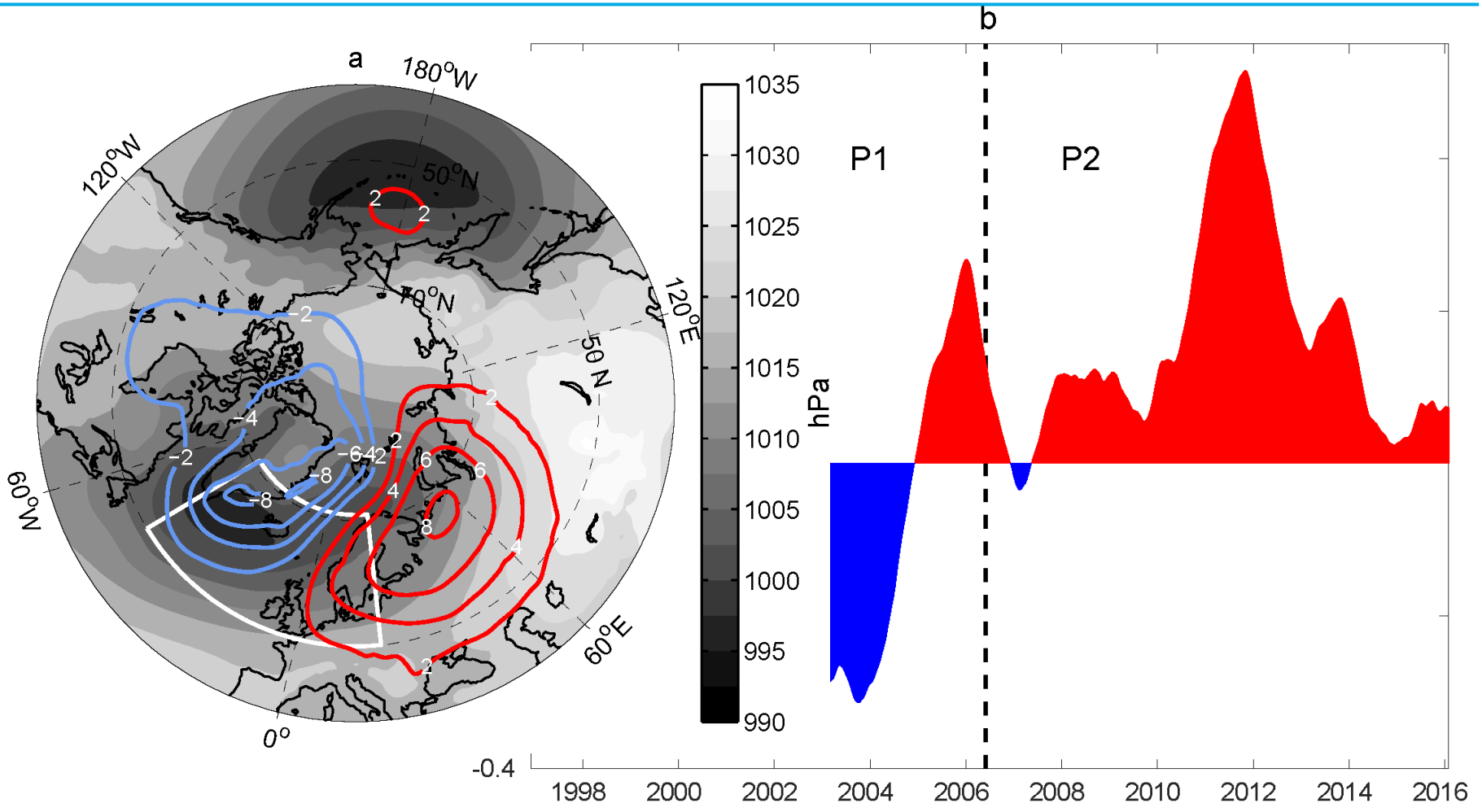
Sea-level Pressure Anomaly Pattern

related to increased advection from Atlantic region

meridional advection

from Dahlke and Maturilli (2017), Adv.Met., in press

Circulation Changes

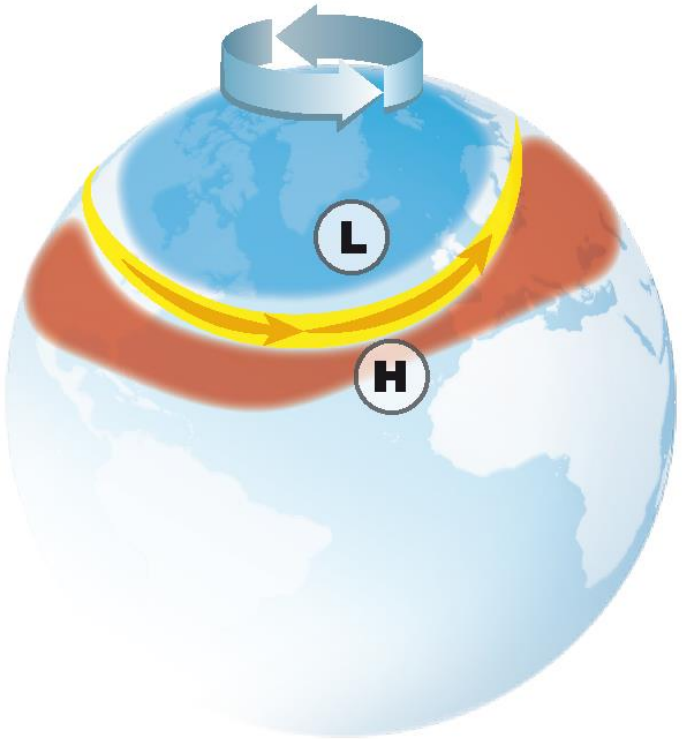


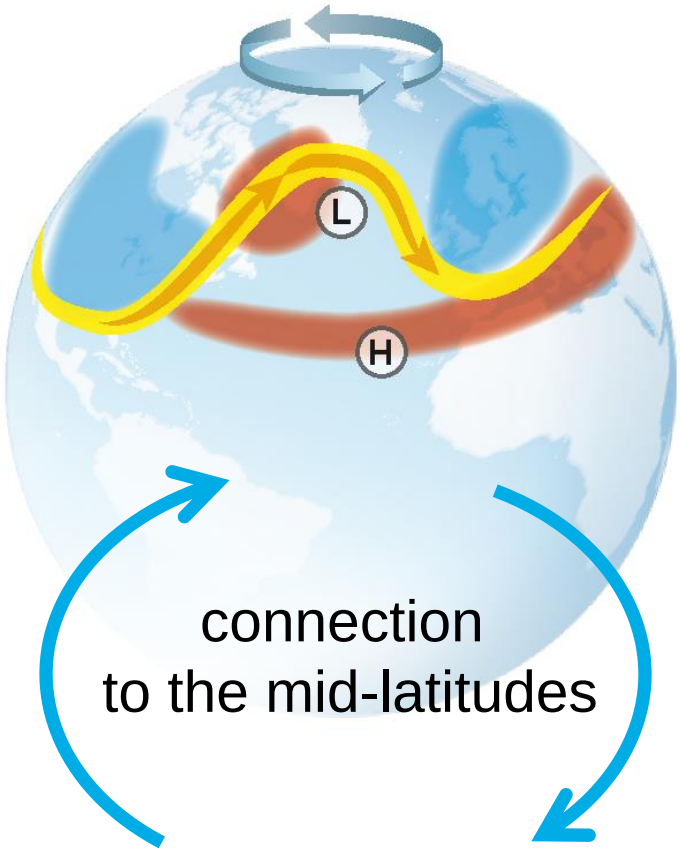
normalized time series of the DJF SLP composite pattern

from Dahlke and Maturilli (2017), Adv.Met., in press

Circulation Changes

zonal flow → meridional flow





Atmospheric Circulation in the Mid-Latitudes

Polar Jet Stream at about 10km

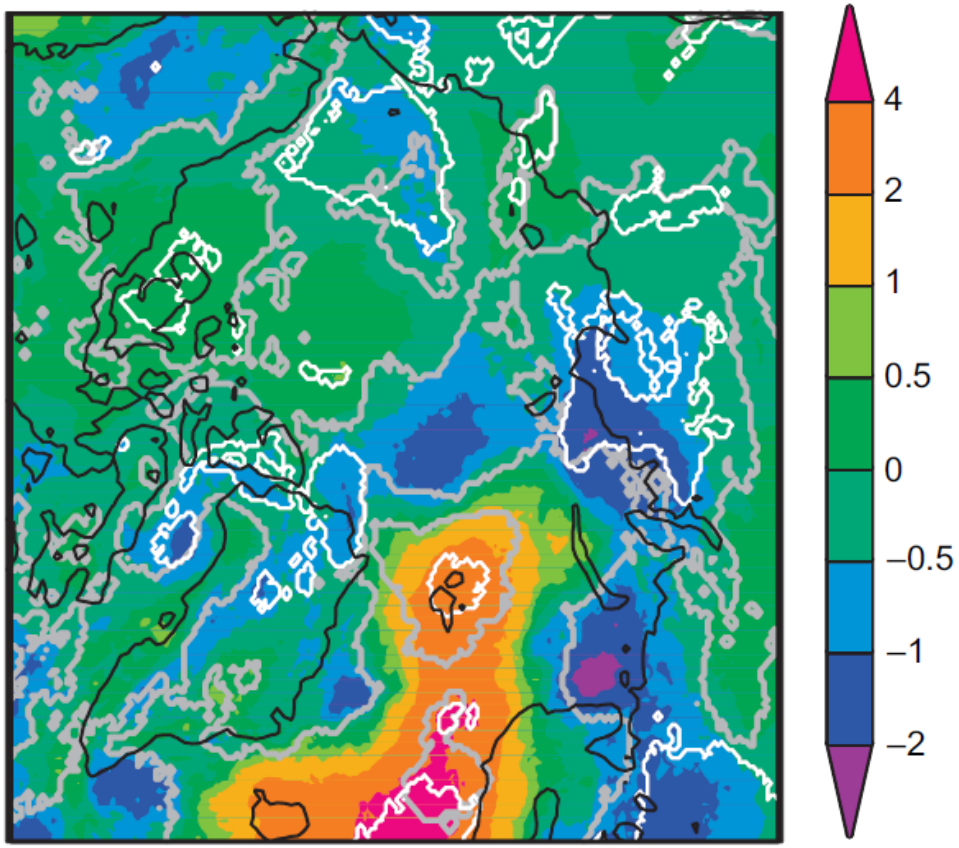
MERRA data, Jan. 2012, NASA

Color: wind speed

movie from https://svs.gsfc.nasa.gov/3864

Extreme Cyclone Events

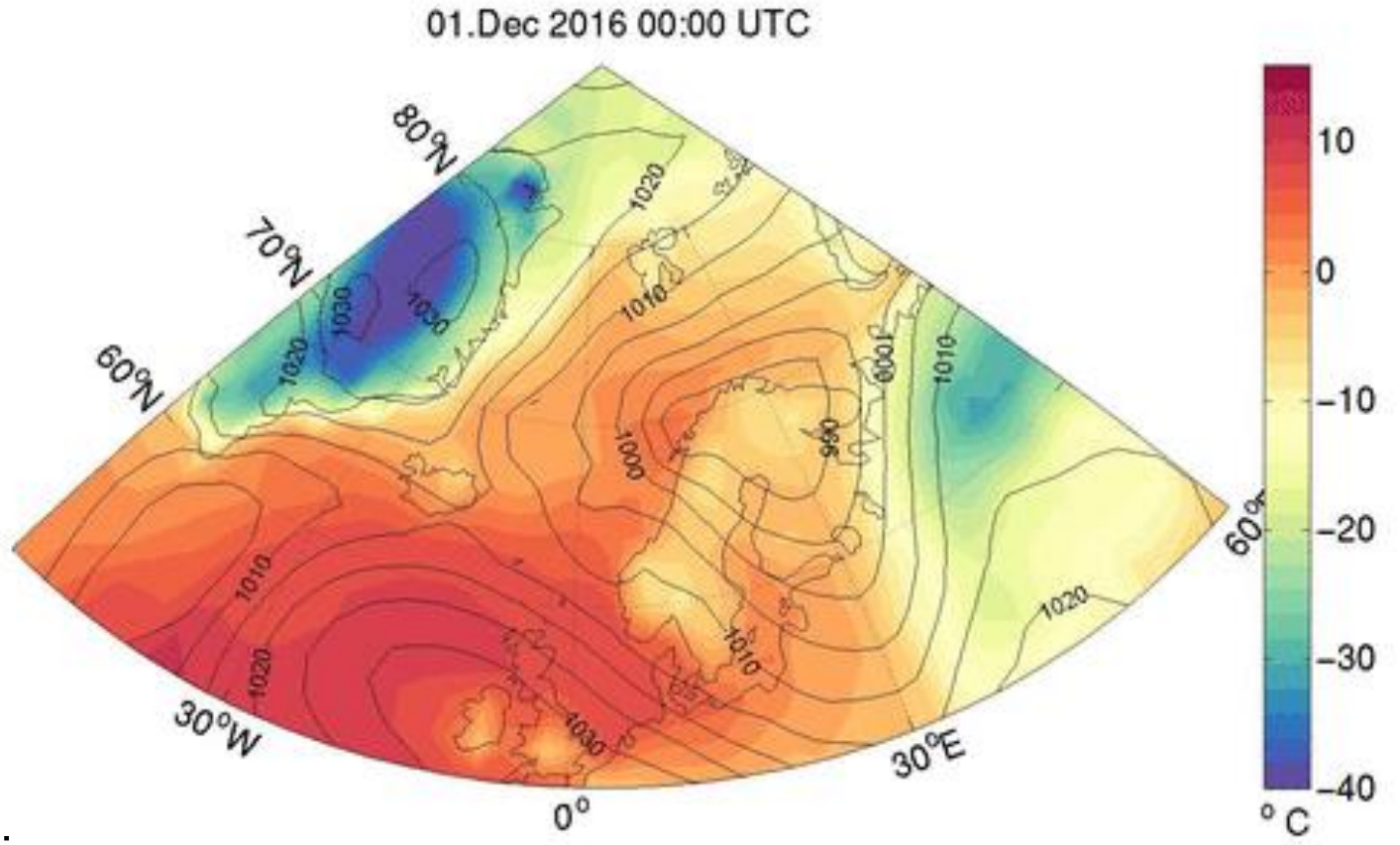
Increase in early winter, here: December



Trend of frequency of extreme cyclone events [6h-events/decade] based on ERA-Interim data, 1979–2015.

from Rinke et al. (2017), doi:10.1088/1748-9326/aa7def

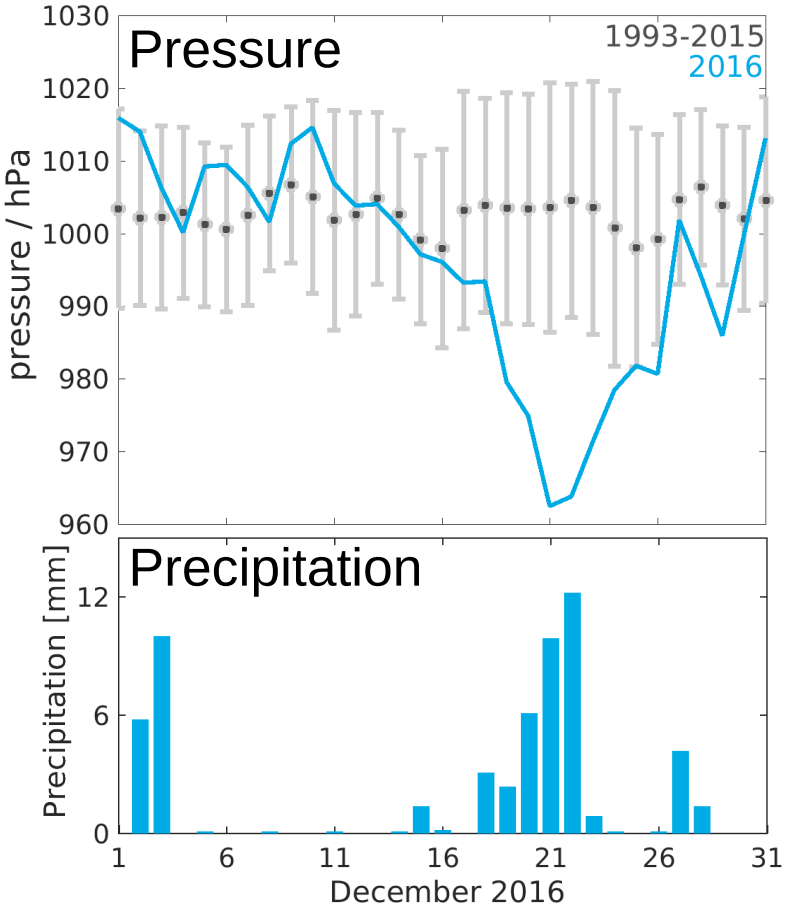
Example: December 2016

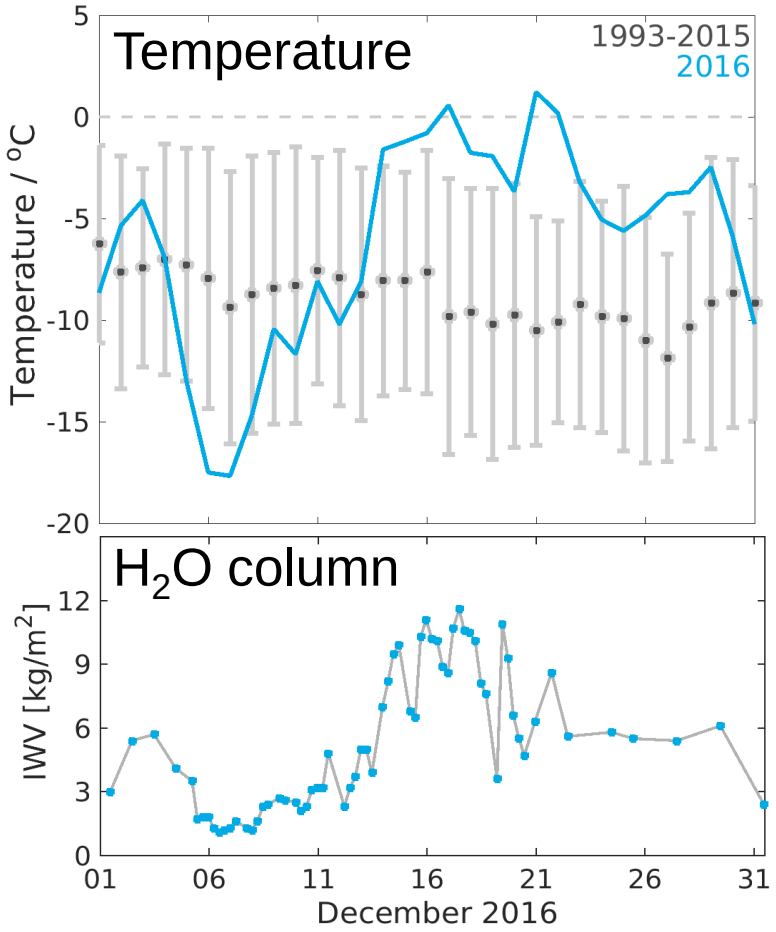


ERA-interim
surface pressure [hPa] (contour lines)
and temperature [°C] (color-coded)

December 2016, Ny-Ålesund

Atmospheric Observations





data from AWIPEV Meteorological Observatory;
precipitation data from met.no

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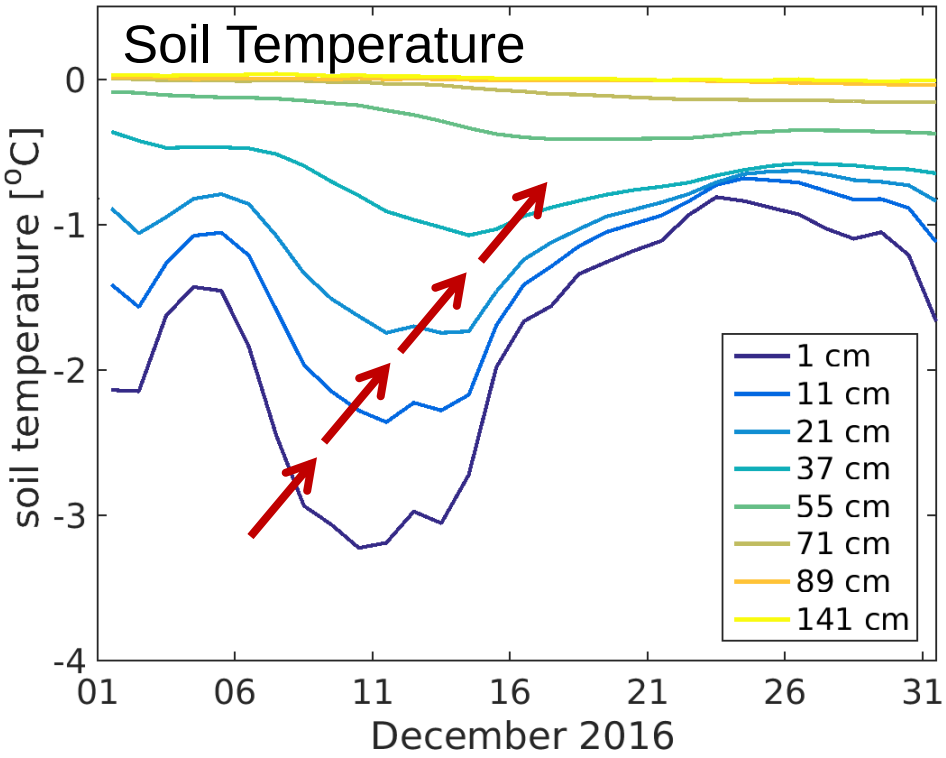
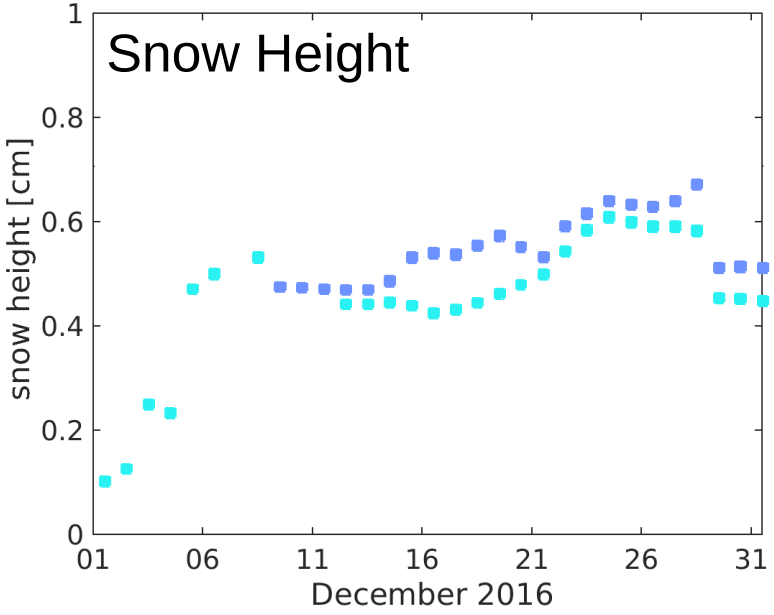
Terrestrial Observations



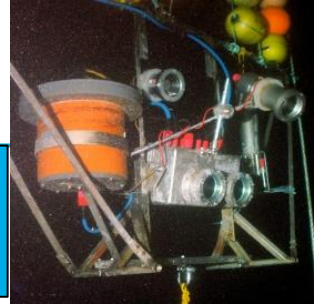


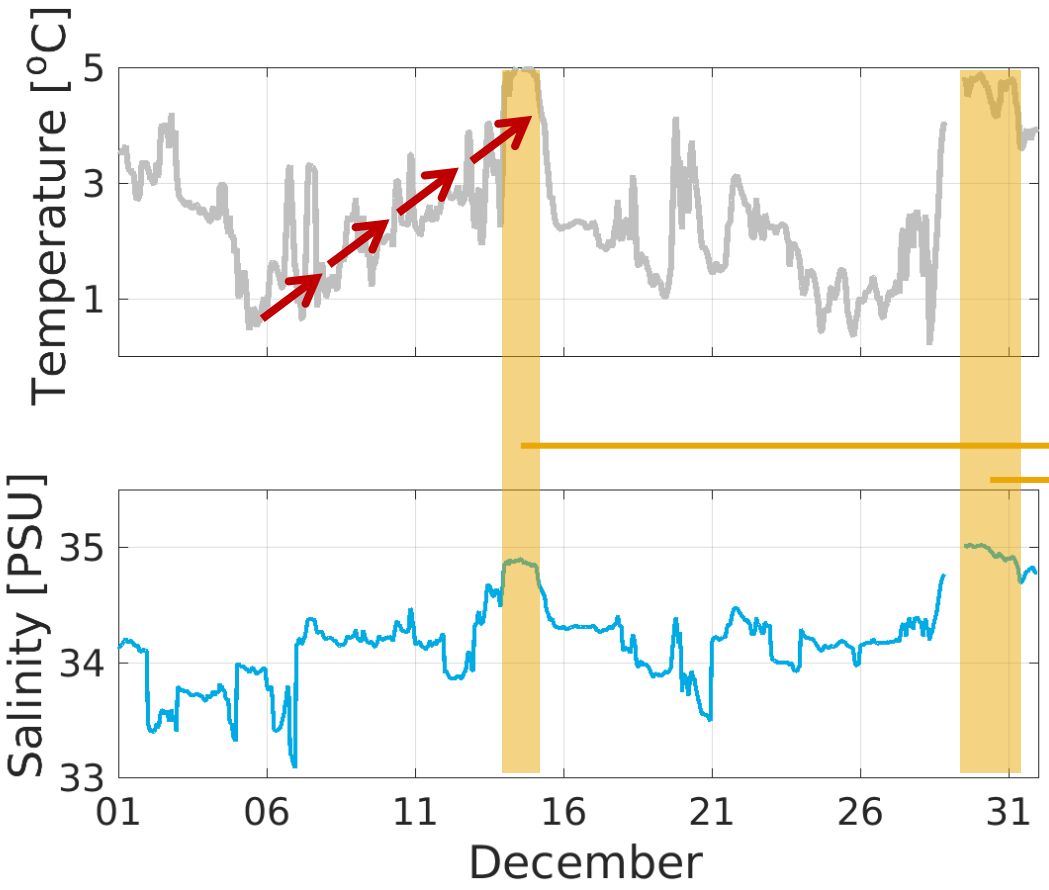
➡ warming of the active layer

data from AWIPEV Permafrost Observatory

December 2016, Ny-Ålesund

Marine Observations





Kongsfjord hydrography dominated by

- Arctic water in winter
- Atlantic water in summer

[*Svendsen et al., 2002*]

Atlantic water inflow

related to turbulence and mixing induced by geostrophic wind forcing

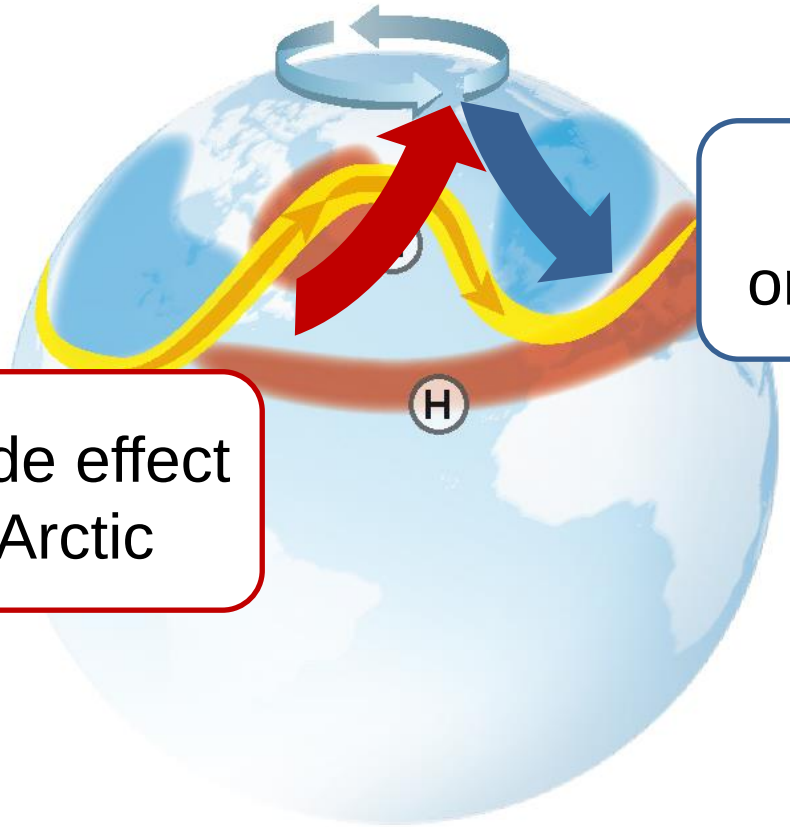
"Atlantification"

affects marine ecosystem

data from AWIPEV Underwater Observatory

Connecting Svalbard to the World

Among other factors of Arctic Amplification, cyclonic activity plays a prominent role for the warming of the Svalbard region, affecting the atmospheric, terrestrial and marine subsystems.



Arctic effect
on mid-latitudes

next presentation

mid-latitude effect
on the Arctic