Water vapour in the Arctic: Future plans and MOSAiC

Ana Radovan,University of Cologne

G-VAP Workshop

25-27, Oct, 2017, Leicester

MOSAiC The International Arctic Drift Expedition

FLUXES CLOUDS TRANSPORT SURFACE ARCTIC AMPLIFICATION (AC)3

TRANSREGIO TR 172 | LEIPZIG | BREMEN | KÖLN

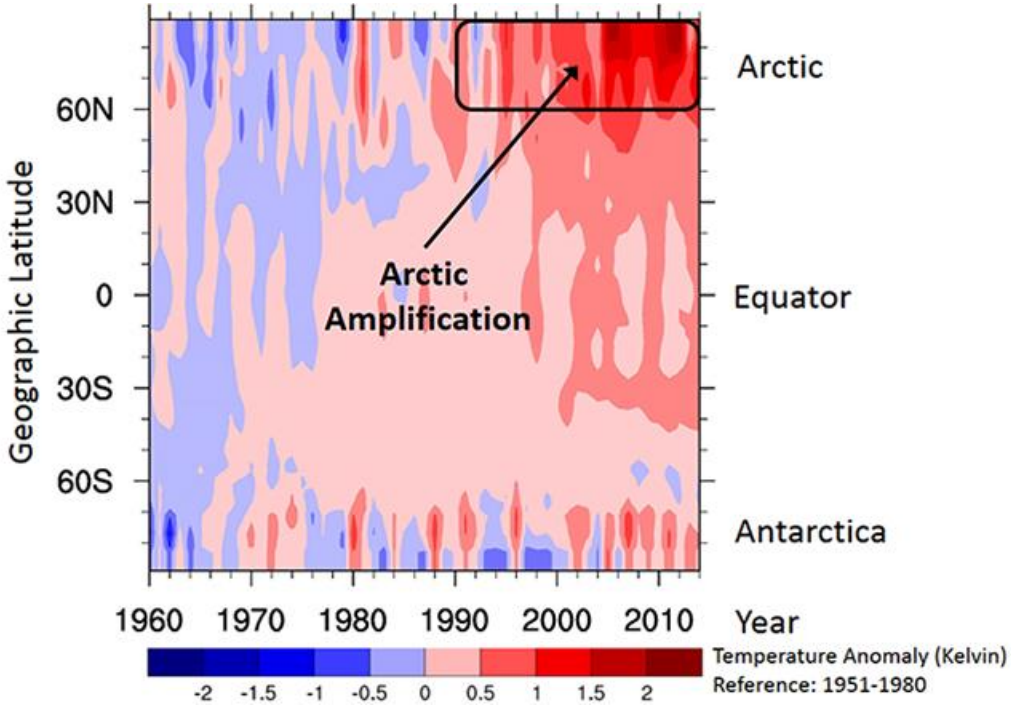
UNIVERSITÄT LEIPZIG

Universität Bremen

Universität zu Köln

TROPOS Leibniz Institute for Tropospheric Research

Arctic Amplification



Changes in surface air temperature are more than **twice the global average**

Wendisch, M., et al. (2017)

Water vapour in the Arctic

- **Positive WV trends are found in most studies:** *Ross and Elliot (2000), Trenberth (2005), Serreze et al. (2012), Mieruch et al. (2014), Wang et al. (2016)*
- **Different studies → different result**

author	data	region	period	trend
Trenberth, Fasullo (2005)	SSM/I	global oceans	1988-2003	0.41 mm/decade
Mieruch et al. (2014)	HOAPS	oceans (60°N/S)	1996-2005	0.53 kg/m2 decade
Wang et al. (2016)	MWR	global oceans	1995-2011	0.34 mm/decade

Water vapour in the Arctic

- surface humidity inversions → high importance in the cloud formation and their maintenance
  - highest occurrence during winter > 50%
  - strength of between 0.3-0.7 x 10^{-3} kg/m^3

Devasthale et al., 2011

- WV surface intrusions – increase PW above climatological mean for ≈ 30% during winter

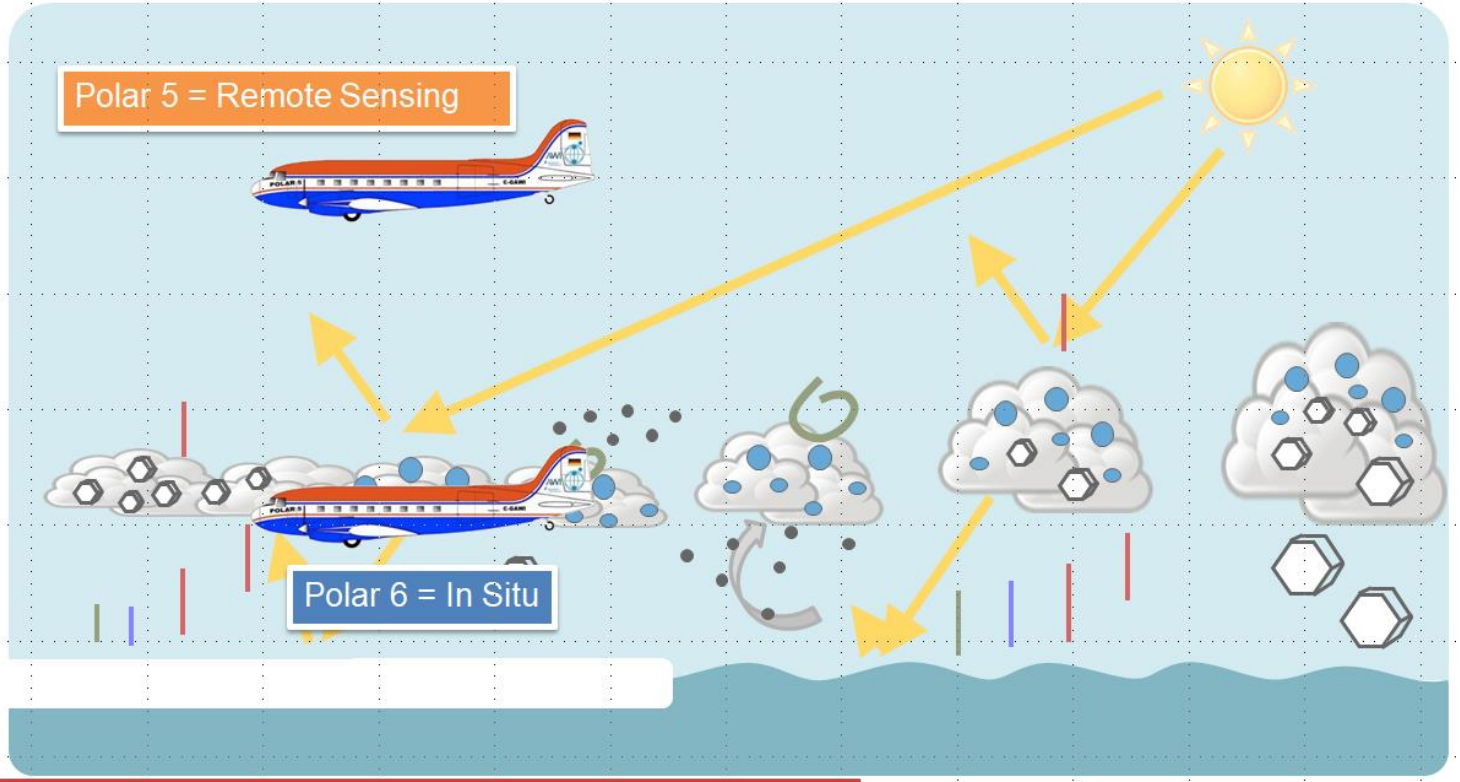
Doyle et al., 2011

- climate models project → strong warming and increasing of the precipitation, **but**

different models → different results for changes in cloud cover

- largest differences in months of minimum sea ice cover.

ACLOUD - Arctic Cloud Observations Using airborne measurements during polar Day

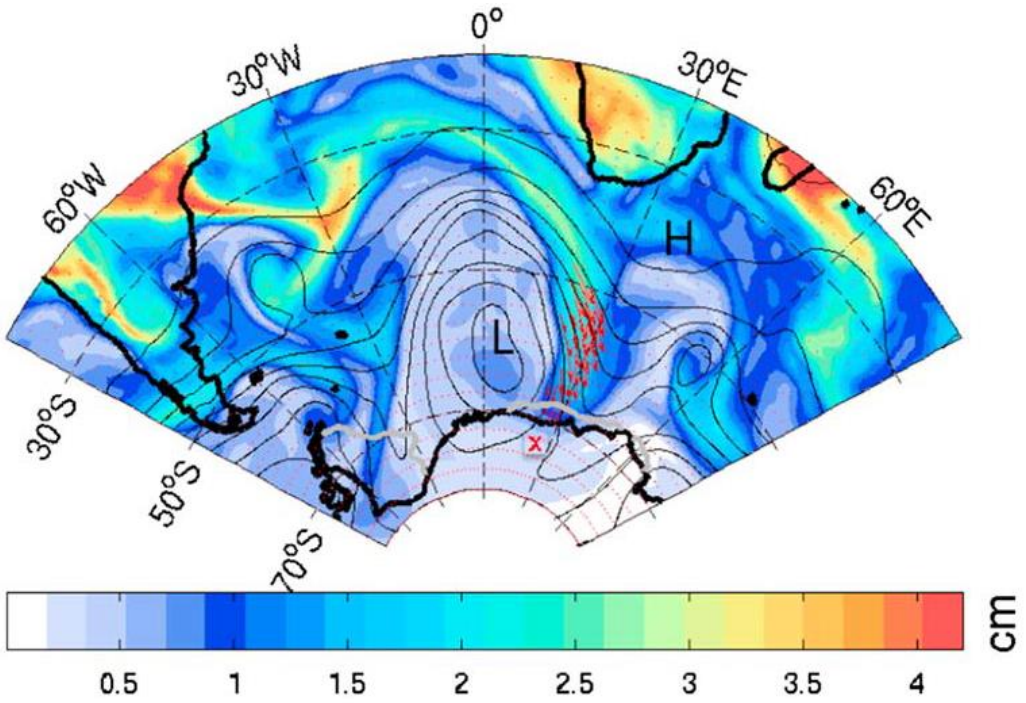


Collocated Measurements

ACLOUD - Arctic Cloud Observations Using airborne measurements during polar Day

Collocated Measurements

Atmospheric river/s (AR)



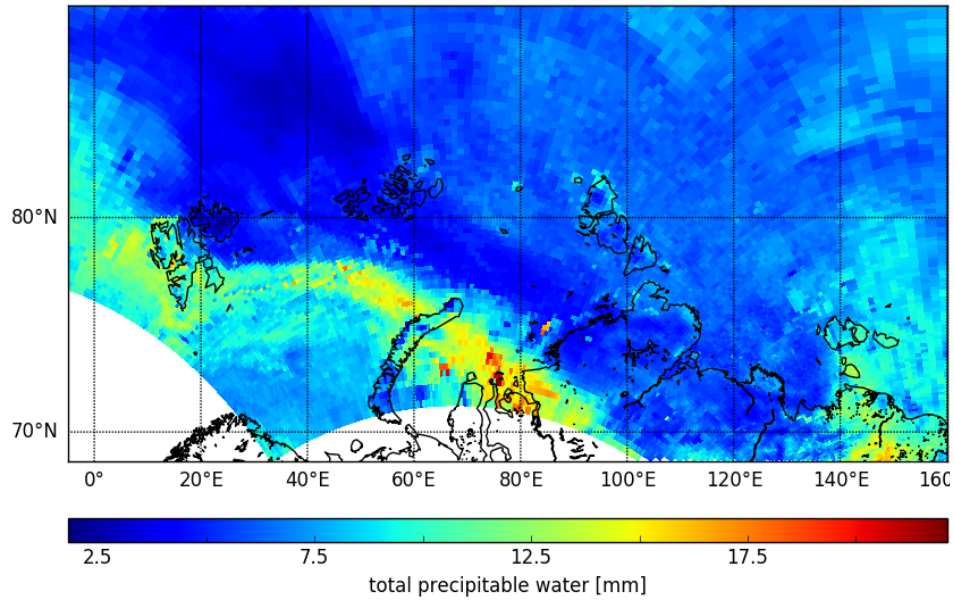
- narrow → less than 1000 km wide
- elongated → more than 2000 km long region of moisture
- take up 10% of the zonal circumference
- responsible for 90% of the total mid-latitude vertically integrated water vapour transport (IVT)

- connected with extreme precipitations and flooding

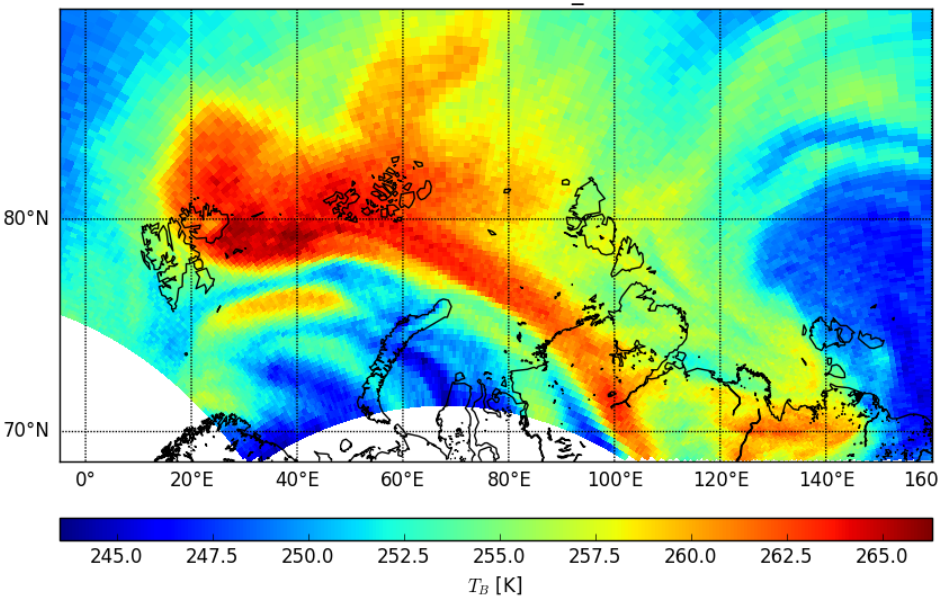
Ralph and Neiman (2004), Lavers et al. (2013), Gorodetskaya et al. (2014)

Atmospheric River from MIRS & MHS

29, May, 2017 at 10:07 UTC
TPW



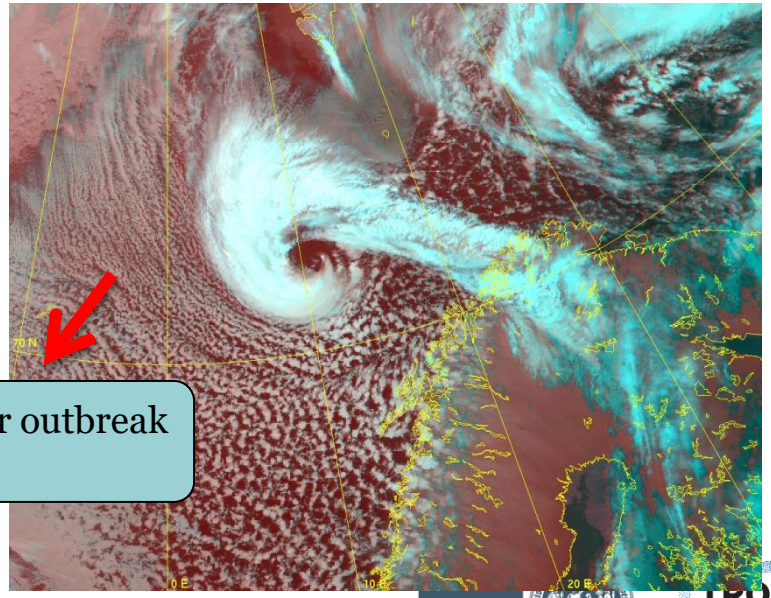
29, May, 2017 at 10:07 UTC
BT @ 183 ± 3 GHz



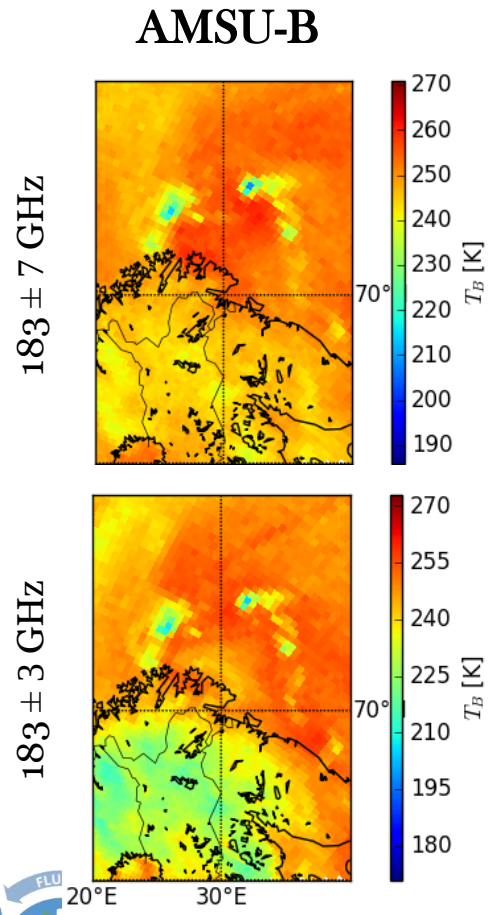
Polar lows

- small (diameter < 600 km)
- intense maritime cyclone (winds > 15 m/s)
- short-lived (3-72h)
- bring large amounts of precipitations

- **CHARACTERISTICS:**
  - spiral of clouds
  - clear eye (in the center of the cloud vortex)
  - usually warm core
  - generally well-defined fronts



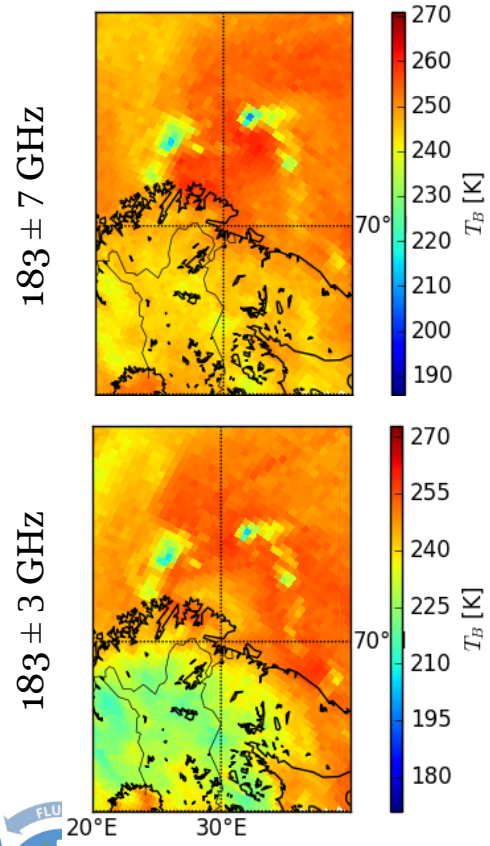
Polar low case on 07-Jan-2009 at 09:00 UTC



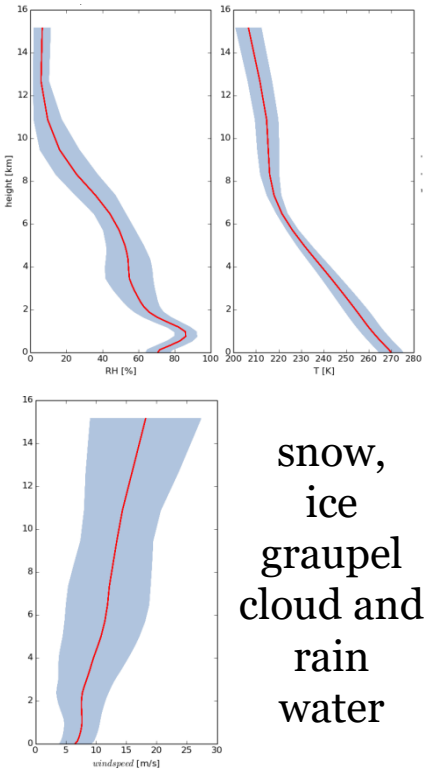
AMSU-B –Advanced Microwave Humidity Sounder – B

Polar low case on 07-Jan-2009 at 09:00 UTC

AMSU-B



ASR



snow,
ice
graupel
cloud and
rain
water

AMSU-B –Advanced Microwave Humidity Sounder – B

ASR – Arctic System Reanalysis v1

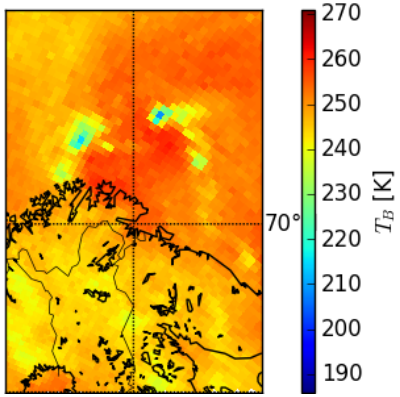
Polar low case on 07-Jan-2009 at 09:00 UTC

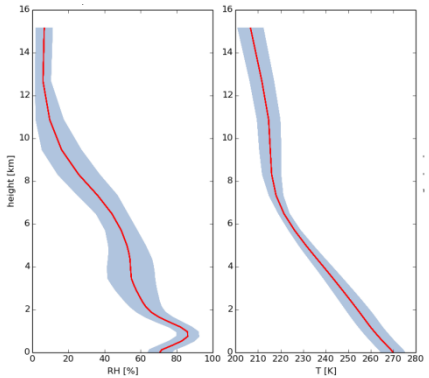
AMSU-B

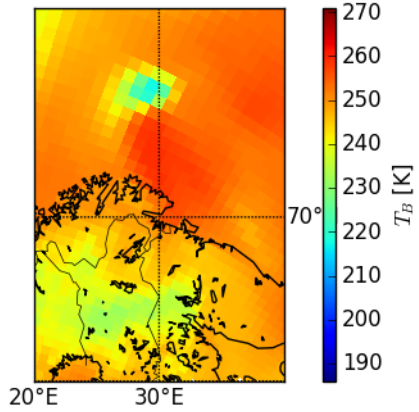
ASR

ASR using **PAMTRA** forward operator

183 ± 7 GHz

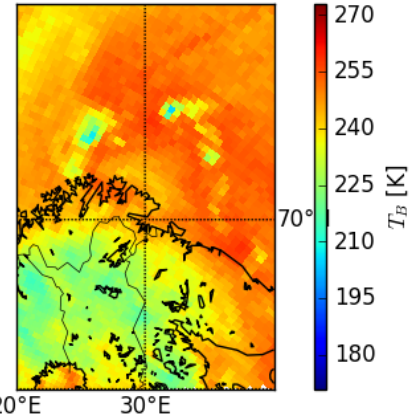


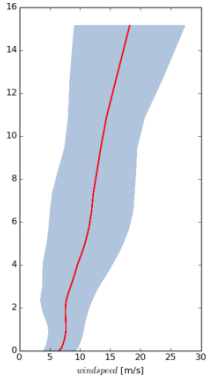




183 ± 7 GHz

183 ± 3 GHz





snow,
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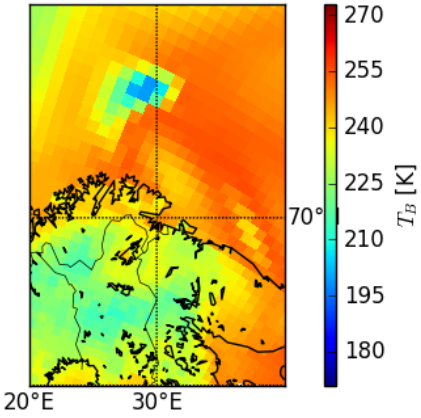
RT model
PAMTRA



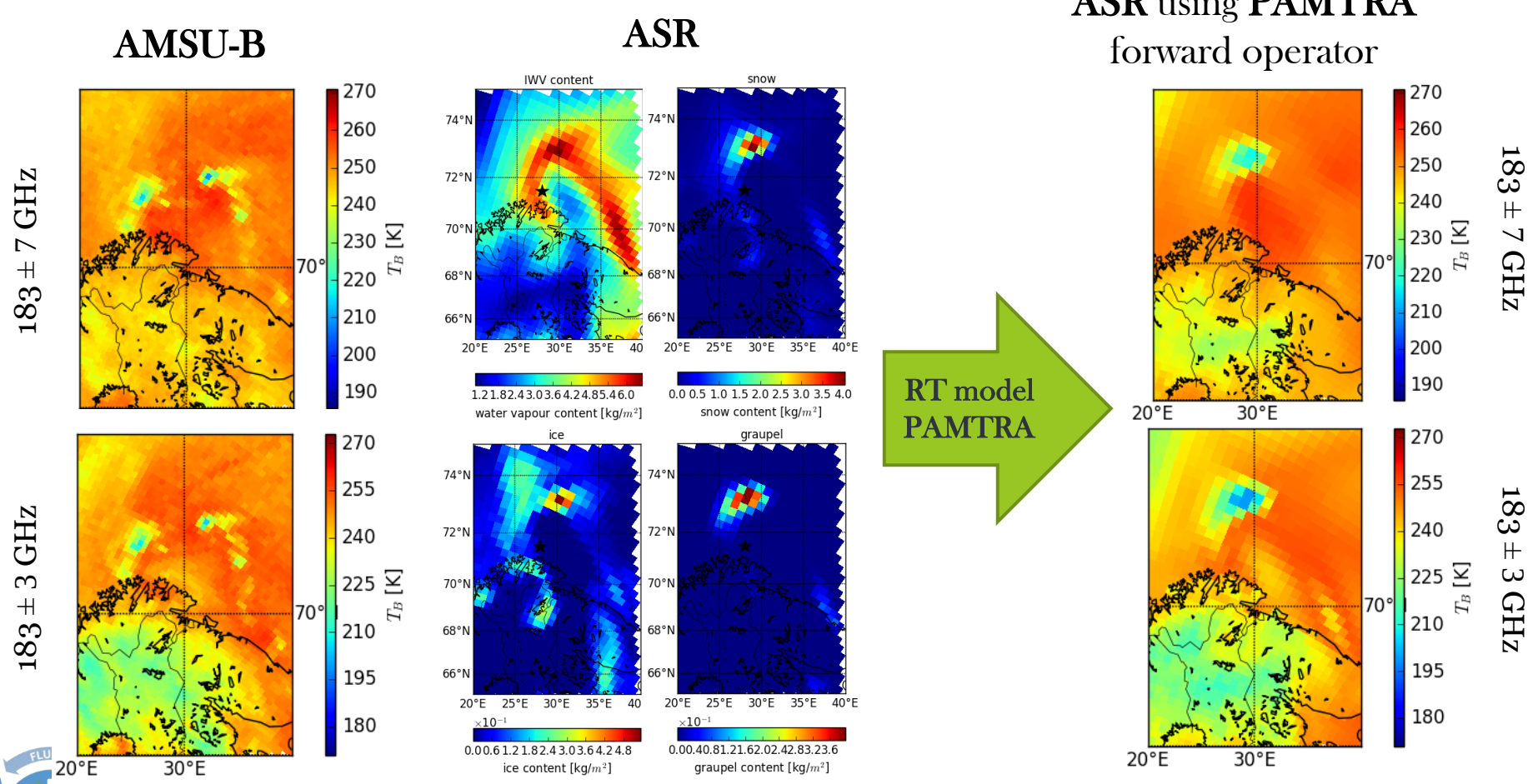
183 ± 3 GHz

AMSU-B –Advanced Microwave Humidity Sounder – B

ASR – Arctic System Reanalysis v1

PAMTRA - Passive and active microwave radiative transfer model

Polar low case on 07-Jan-2009 at 09:00 UTC



AMSU-B –Advanced Microwave Humidity Sounder – B

ASR – Arctic System Reanalysis v1

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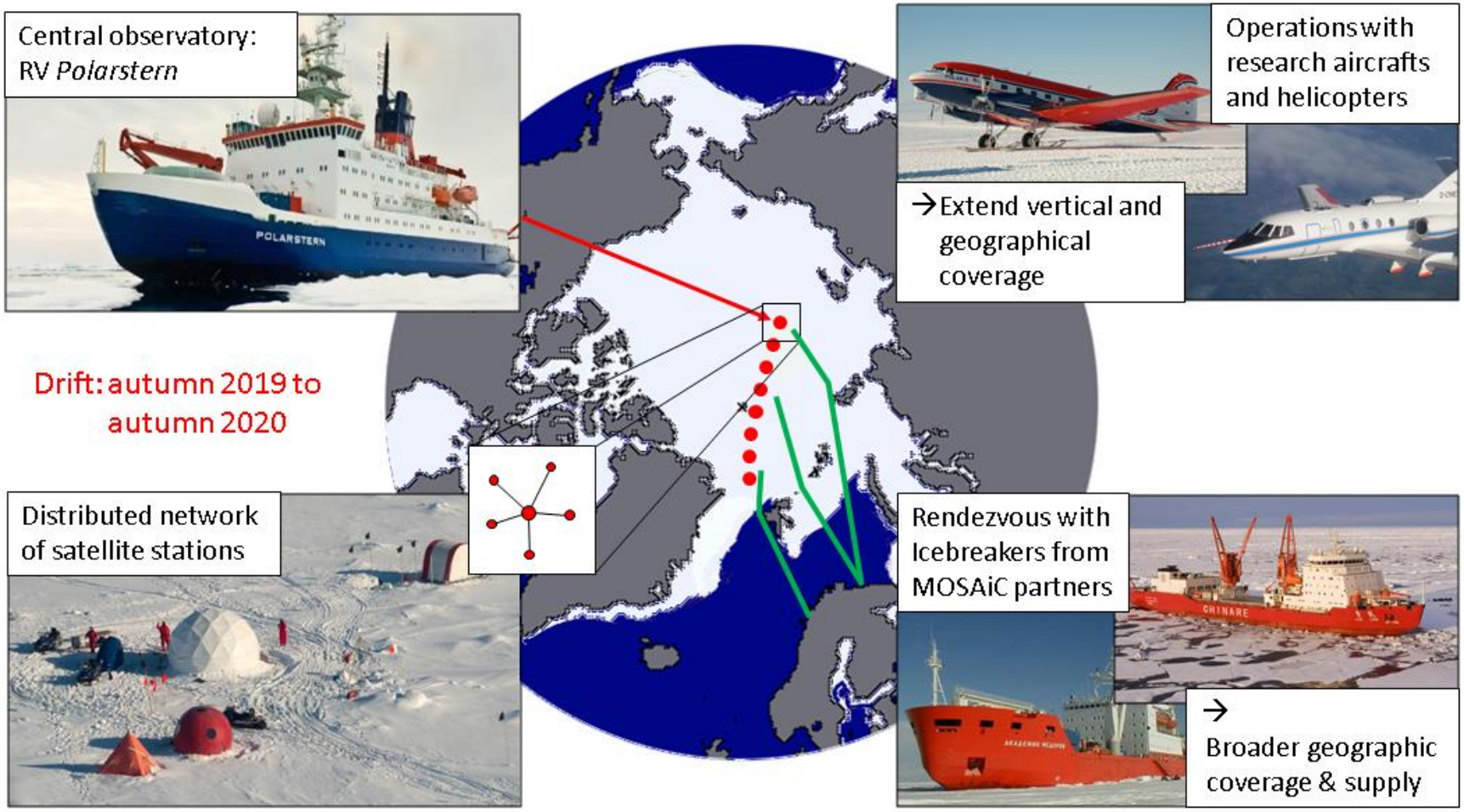
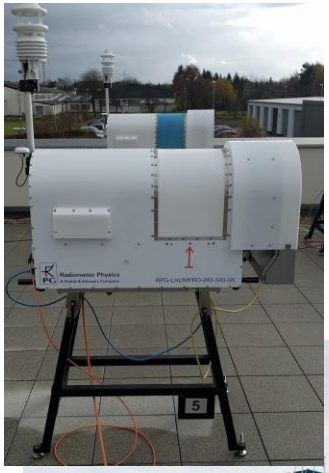
MOSAiC

The Multidisciplinary drifting Observatory for the Study of Arctic Climate



MIRAC-P on Polarstern

- **M**icrowave **R**adar/Radiometer for **A**rctic **C**louds



RPG-LHUMPRO-243-340-G4:

- **Passive channels overlapping with Ice Cloud Imager ICI: 6 DSB at 183 GHz H_2O** line for humidity profiling**, 243 and 340 GHz** for opacity estimation and ice cloud observation
- Absolute **brightness temperature accuracy 1.0 K**
- Channel bandwidth 200 MHz @ 183 GHz, 4 GHz @ 243 and 340 GHz
- Optical resolution HPBW 1.3°
- Integration time ≥ 0.4 seconds
- Absolute calibration with internal ambient & external cold load
- Stability better than 0.03 K over full operating temperature range
- Ground operation on stand

Thank you for your attention !

contact: aradovan@uni-koeln.de

Links

- **ACLOUD** – https://acloud2017.blogspot.co.uk/
- **MOSAiC** – http://www.mosaicobservatory.org/