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Assimilation of MW low-peaking channels in HARMONIE-AROME at high latitudes

Stephanie Guedj, Jostein Blyverket, Roger Randriamampianina

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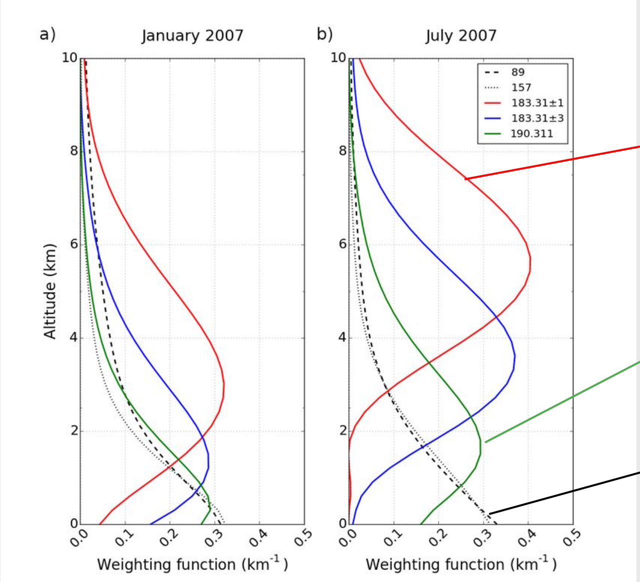
Assimilation of MW channels

What is a low peaking channel & what information does it contain?

MHS (Arctic)

Weighting function



Edel et al., 2019

High-peaking channel: emission from the atmosphere

Low-peaking channel: mixed signal coming from both the atmosphere and the surface

Window channel: Information on the surface

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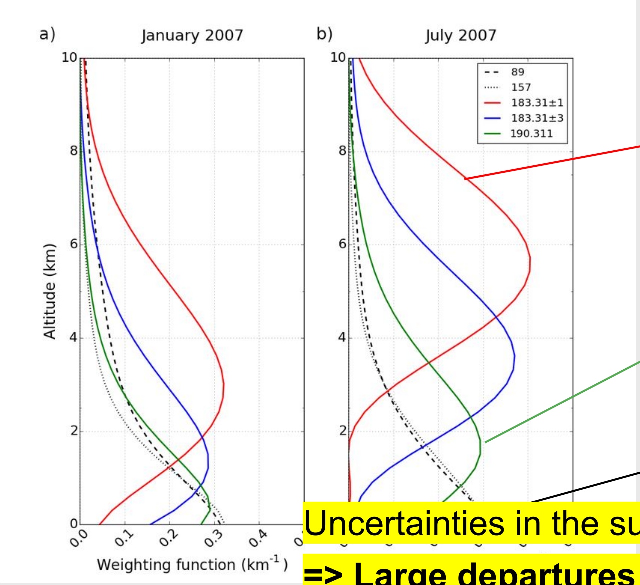


Edel et al., 2019

High-peaking channel: emission from the atmosphere

Low-peaking channel: mixed signal coming from both the atmosphere and the surface

Window channel: Information on the surface

Uncertainties in the surface modelisation for radiances **over land & sea-ice**

=> Large departures to observations for surface-sensitive channels

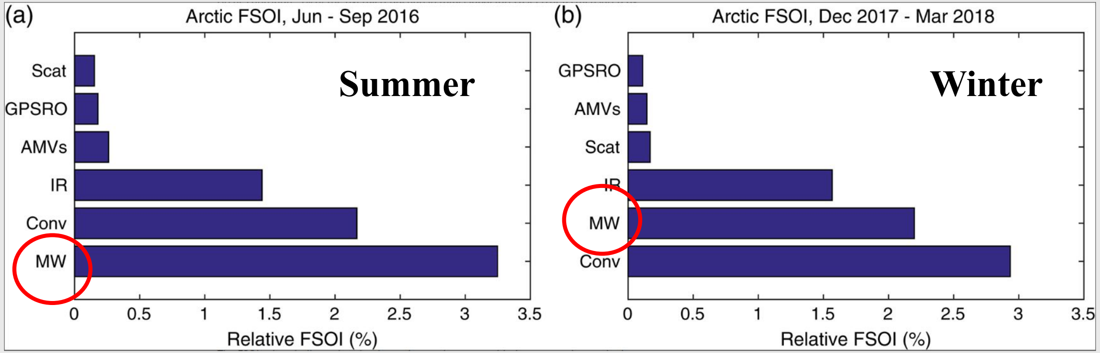
low-peaking channels remain blacklisted or in passive mode over complex surfaces

NWP in Polar regions

Given the high availability of satellite data over the poles that have large impact despite a limited usage (Lawrence et al., 2019)

=> Potential for reducing forecast errors if we use better MW low-peaking channels

Especially, on estimating the surface emission (surface temperature, emissivity …)



(Lawrence et al., 2019)

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Data & Forecast systems

MW instruments: AMSU-A, MHS, ATMS & MWHS-2

3D-Var LAM NWP systems over Northern latitudes

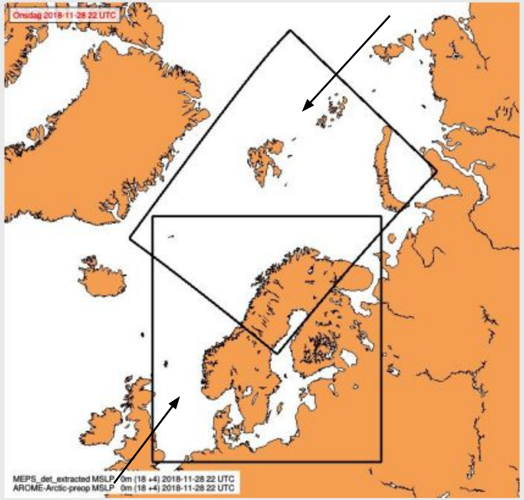
2.5 km horizontal resolution

65 level vertical levels

AROME-Arctic: **Sea-ice**
METCOOP: **land**

<u>Objective</u> => Enhance the assimilation of low-peaking channels over difficult surfaces

AROME-Arctic



METCOOP

(Reima's poster)

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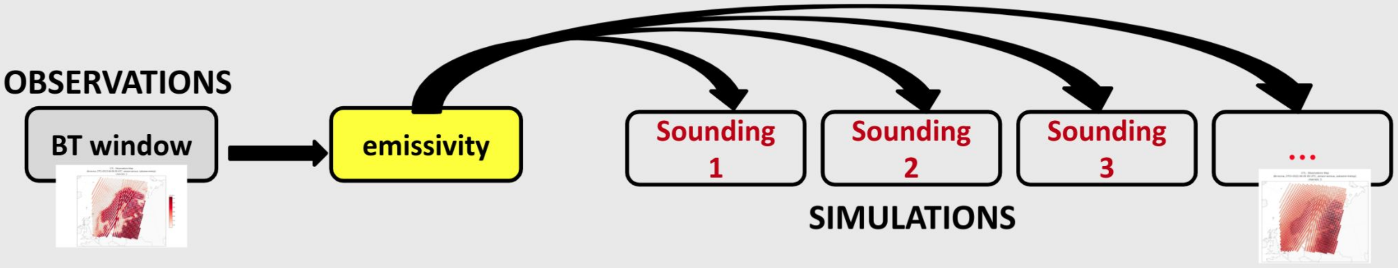
Method

<u>Dynamic emissivity method</u>: Retrieve the surface emissivity from a window channel & allocate it to adjacent sounding channel (Karbou et al., 2006)



Assumption: non-scattering & plane parallel atmosphere, specular surface, the medium emits at the temperature of the surface skin & **the variability of emissivity with frequency is low**.
=> OK over land surfaces but more complex over snow and sea-ice (Karbou et al, 2014) …

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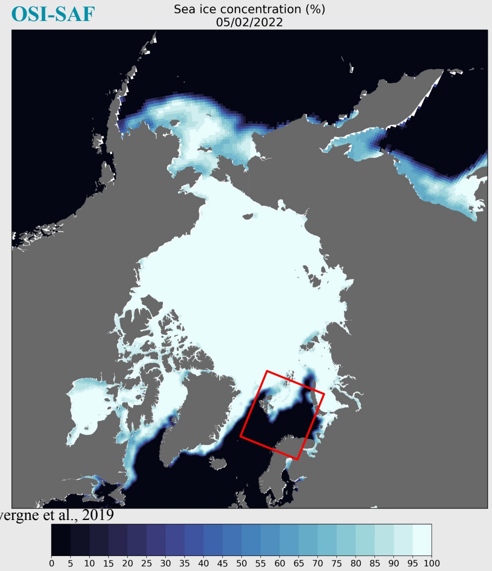
LDYN over sea-ice

FG departures (in Kelvin)
of ATMS T channels over Sea-ice
(no change over open ocean / FASTEM)

Case study: 05/02/2022

=> valid for MHS Q channels

OSI-SAF



Lavergne et al., 2019

Courtesy of Palerme C.

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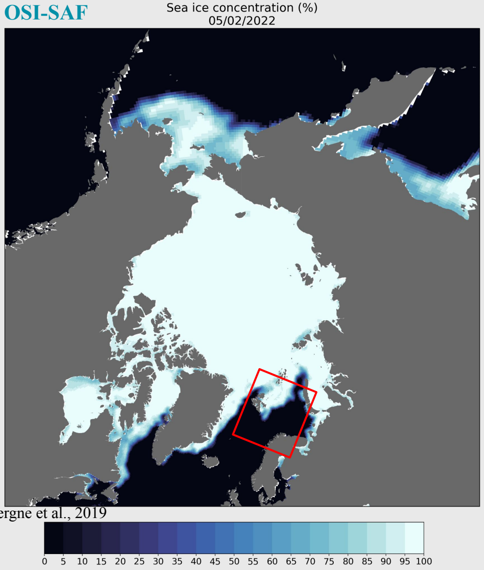
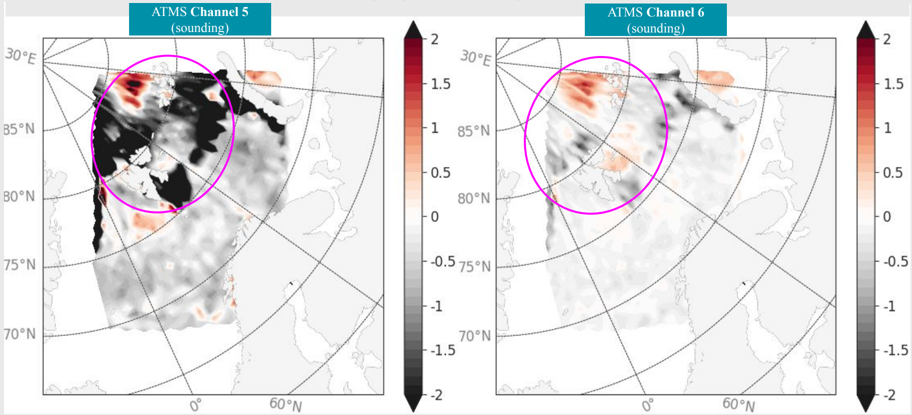


Courtesy of Palerme C.

CONTROL



LDYN over sea-ice

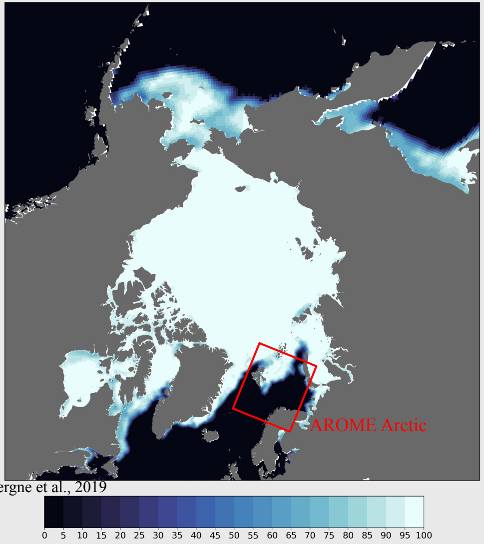
Emissivity & FG departures (in Kelvin) of ATMS T channels over **Sea-ice**
(no change over open ocean / FASTEM)

Case study: 05/02/2022

=> valid for MHS Q channels

OSI-SAF

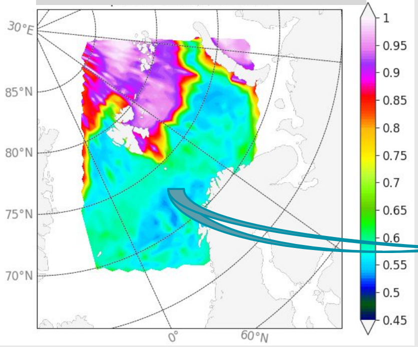
Sea ice concentration (%)
05/02/2022

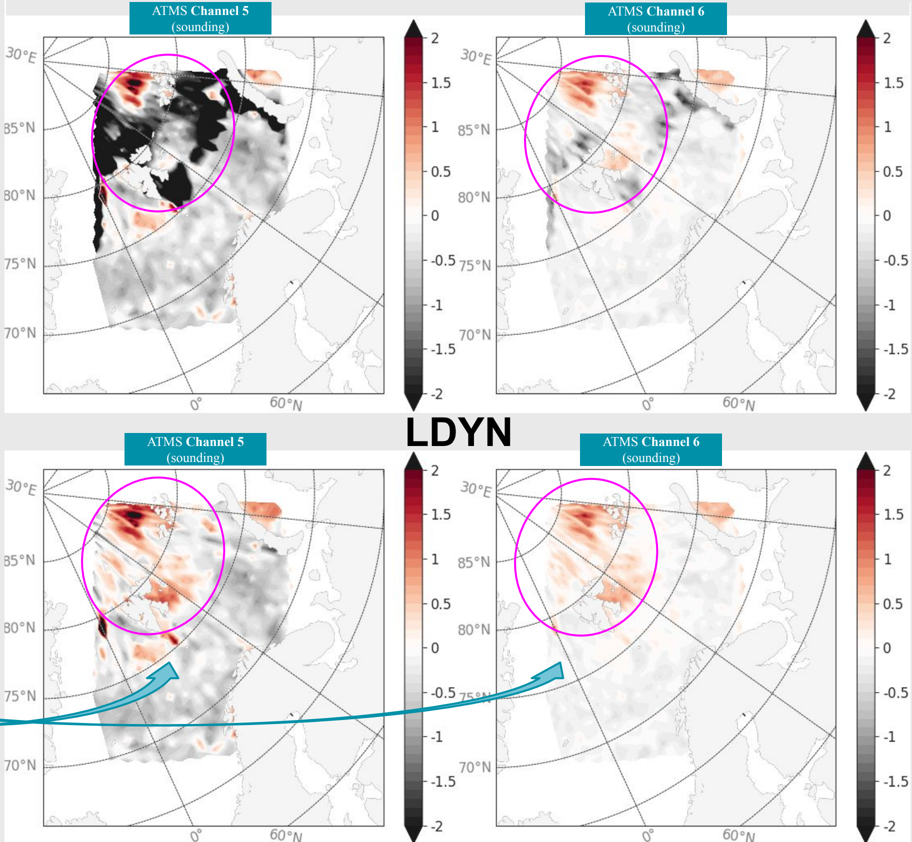


Lavergne et al., 2019

Courtesy of Palerme C.

Retrieved emissivity
Channel 3 (50.3 GHz)



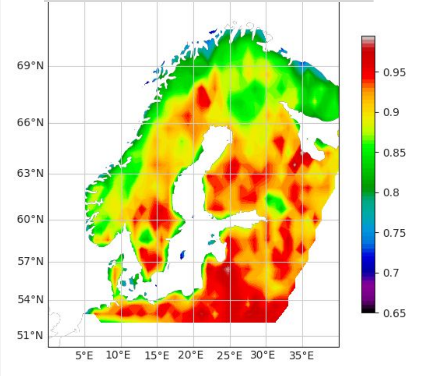


LDYN over land

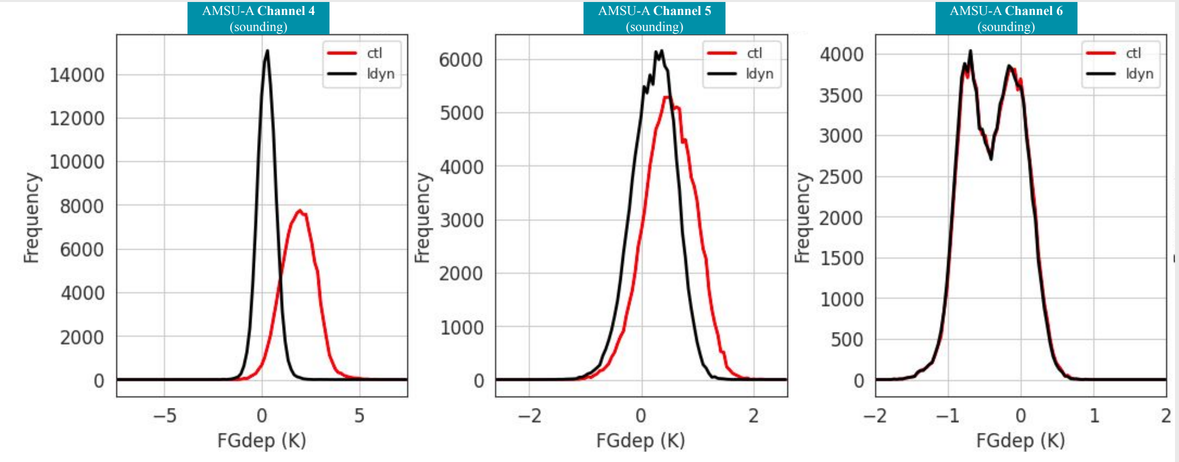
CONTROL
LDYN

Emissivity & FG departures (in Kelvin)
of AMSU-A channels over **land**
Period: 20210201-20210315

Retrieved emissivity
Channel 3 (50.3 GHz)



Snow-free



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LDYN over land

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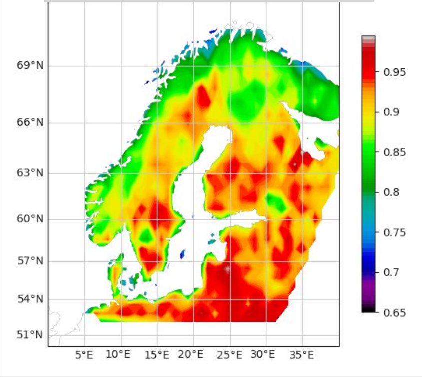
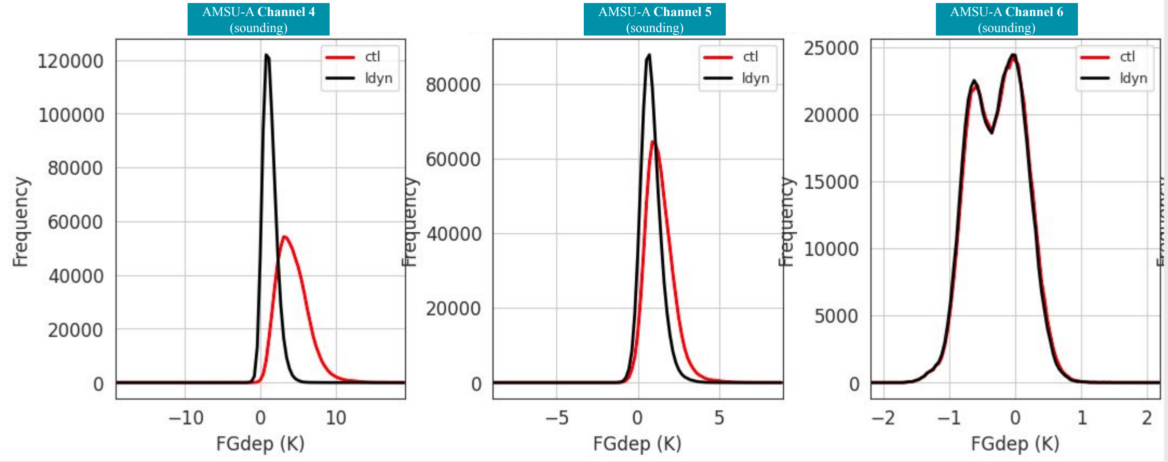
Emissivity & FG departures (in Kelvin)
of AMSU-A channels over land
Period: 20210201-20210315

Retrieved emissivity
Channel 3 (50.3 GHz)



Snow



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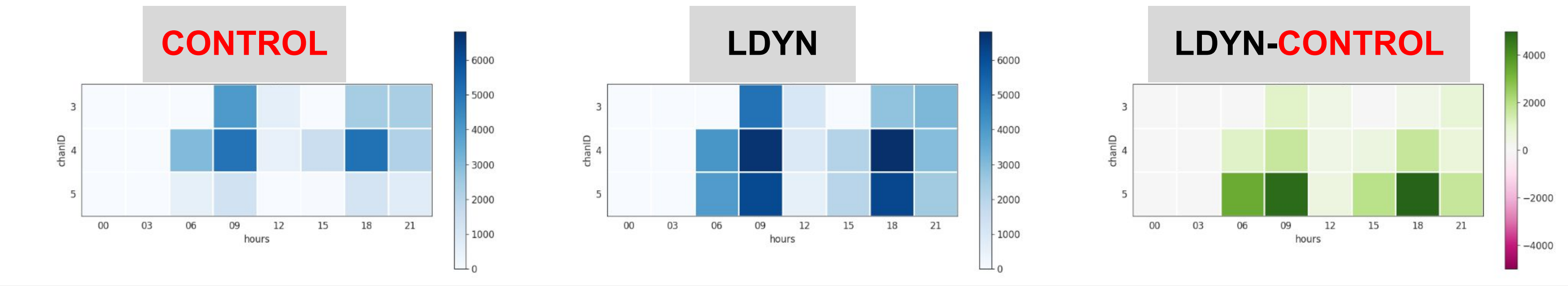
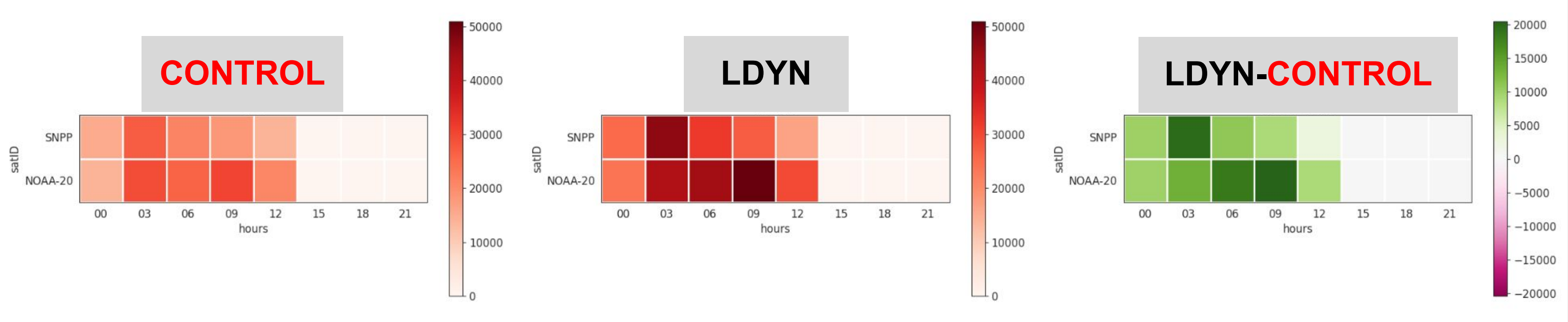
Changes in active data

MHS over land



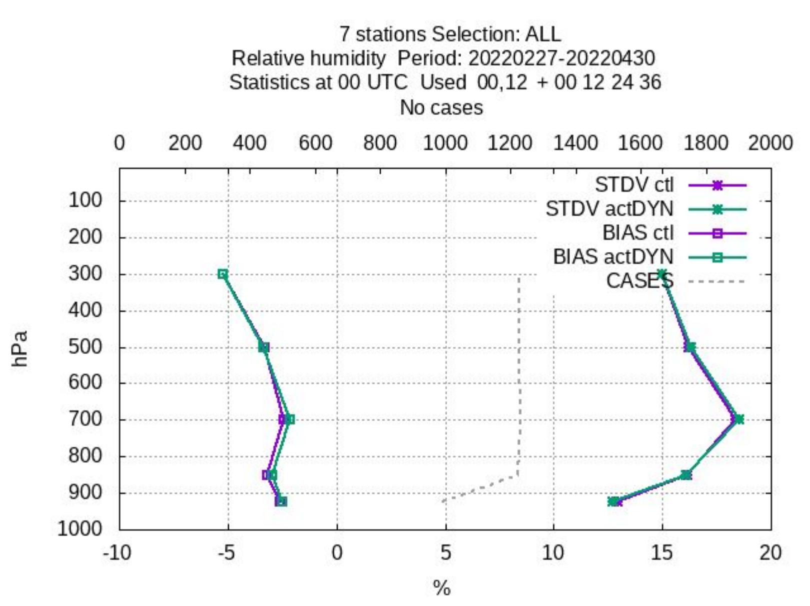
ATMS over sea-ice

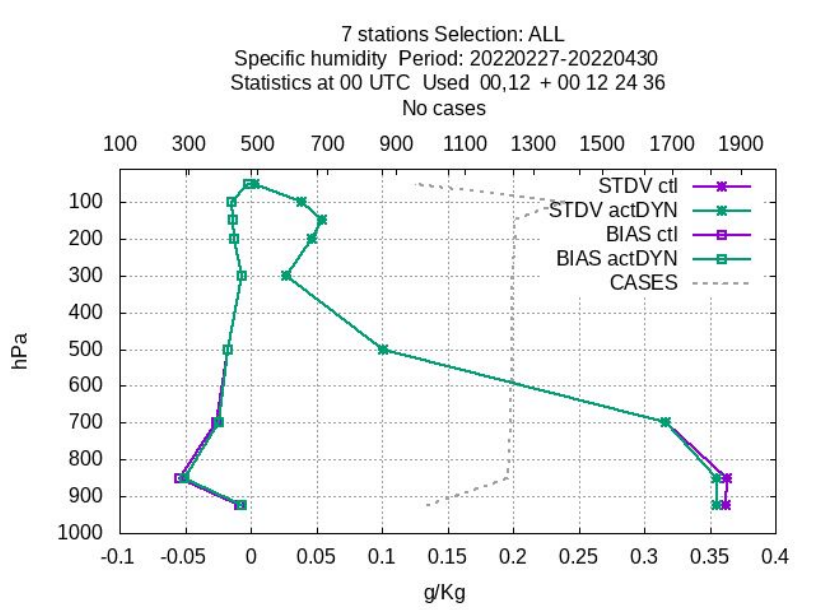


Forecast scores

Assimilation of ATMS low-peaking channels over AROME-Arctic domain (winter):

Positive impact on humidity profiles vs radiosondes but rather neutral for other parameters

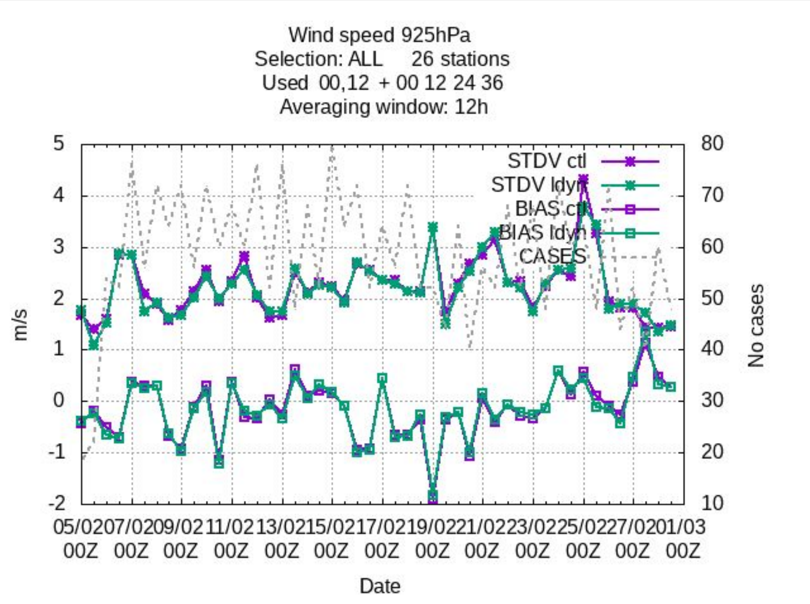


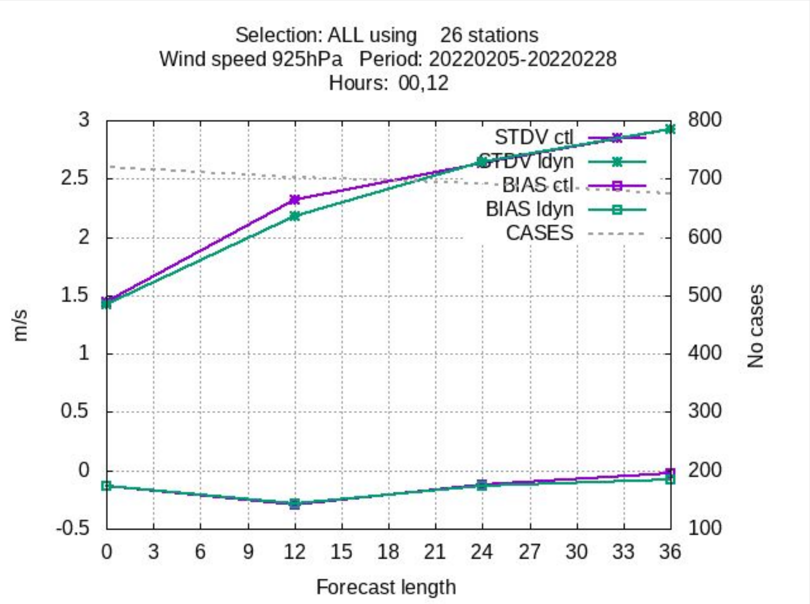


Forecast scores

Assimilation of AMSU-A & MHS over METCOOP domain (winter):

Positive impact on wind speed and humidity vs radiosondes but rather neutral for other parameters





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Conclusion

- Polar regions benefit from a high-density coverage of satellite observations but their usage are still limited over complex surfaces due to large uncertainties in the emissivity and temperature.
- Following “LDYN” Karbou’s method, the surface emissivity has been updated to assimilate low-peaking channels
- Better BT simulations, increase of active assimilated data & neutral to positive impacts on forecast :)

Operational implementation of “LDYN”:

- June 2022: ATMS low-peaking added to AROME-Arctic (+ MWHS-2 ongoing)
- Feb 2023: AMSU-A & MHS low-peaking channels added to MEPS (Reima’s poster)
- March 2023: ATMS & MWHS-2 in MEPS Preop
- Baseline of the 3D & 4D-Var experiment for the ESA-AWS mission preparation (Magnus’ presentation)

<u>Future plans</u>:

- Improve the QC over mixtes surfaces (Alan Geer TN) + Footprint operator (Maté’s talk)
- Retrieval of skin temperature instead of emissivity (“LSKIN”)
- Lambertian assumption over snow-covered surface in regional system (Global tested in Bormann, 2022)
- A machine learning approach for estimating snow and sea-ice emissivity in Arctic NWP (Jostein’s poster) (EUMETSAT Fellowship)

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Thank you

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References

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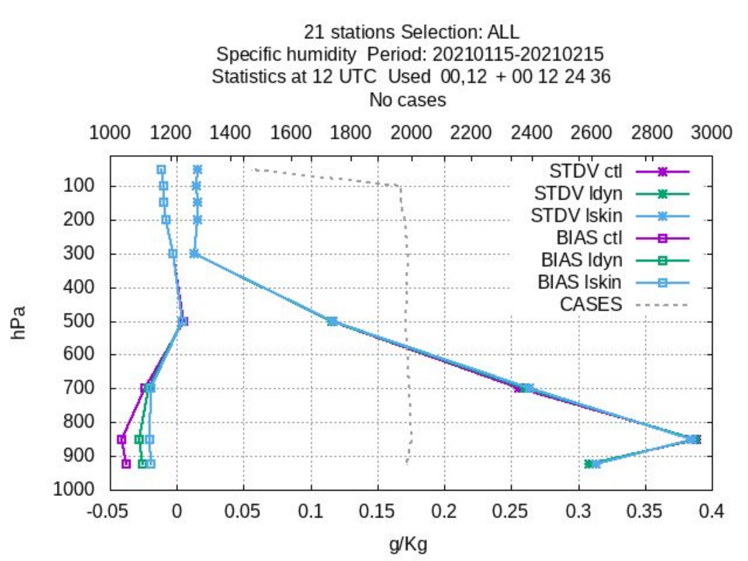
What about the skin temperature ?

Idea: Retrieve & allocate the skin temperature (Karbou et al., 2006)

=> Use of emissivity atlas (averaged retrievals)



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