

A Consortium for COnvection-scale modelling
Research and Development

**Impact of Assimilating AMSU-A Microwave Radiances with a
high-resolution Data Assimilation System over different Surface.**

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5th All Staff Workshop, 31 March - 4 April 2025, Zalakaros

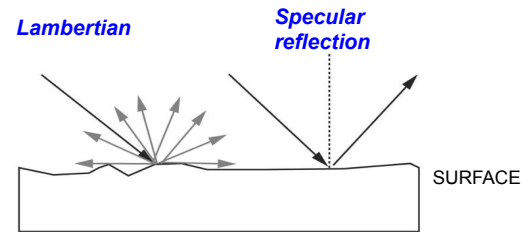
OUTLINE:

- **Introduction:** The Advanced Microwave Sounding Unit (**AMSU-A**) and experiment setup.
- This study examines simulation results across different weather seasons to capture varying atmospheric conditions.
- Multiple experiments using 3D-Var assimilation across various seasons assess the impact of Lambertian (**LAMB**) and specular (**SPEC**) reflections.
- Surface emissivity is dynamically retrieved using the **RTTOV** model and **window channels**.
- By analyzing reflection assumptions over **land, snow, and sea ice**, this study improves the use of microwave radiance.

Advanced Microwave Sounding Unit (AMSU-A)

The Advanced Microwave Sounding Unit (AMSU-A), a 15-channel microwave sounder designed primarily to obtain temperature profiles in the upper atmosphere and to provide a cloud-filtering capability for tropospheric temperature observations.

- 15 channel microwave sounder with a frequency range of 15-90 GHz.
- Provides atmospheric temperature measurements from the surface up to 40 km.
- It provides a nearly all weather temperature sounding capability in complement to the infrared sounding measurements.
- IFOV size of about 48 km near nadir.



@ Guedj et al, 2010

Experiment setup:

Model: Harmonie-Arome

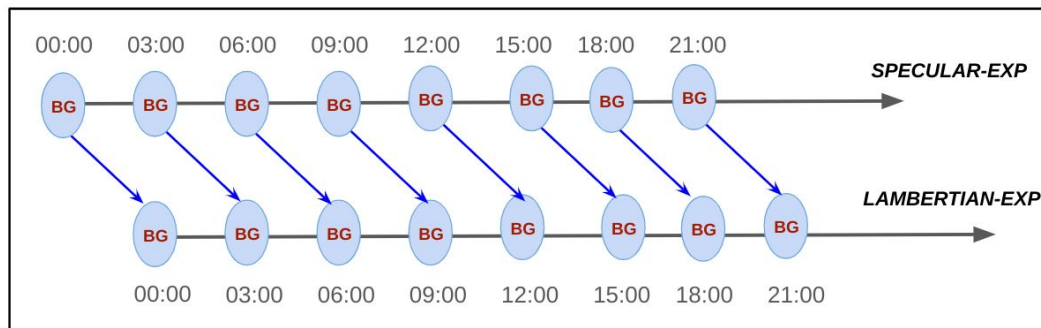
Horizontal Resolution: **2.5 km**

Grid Points: **960x1080**

Vertical levels : **65**

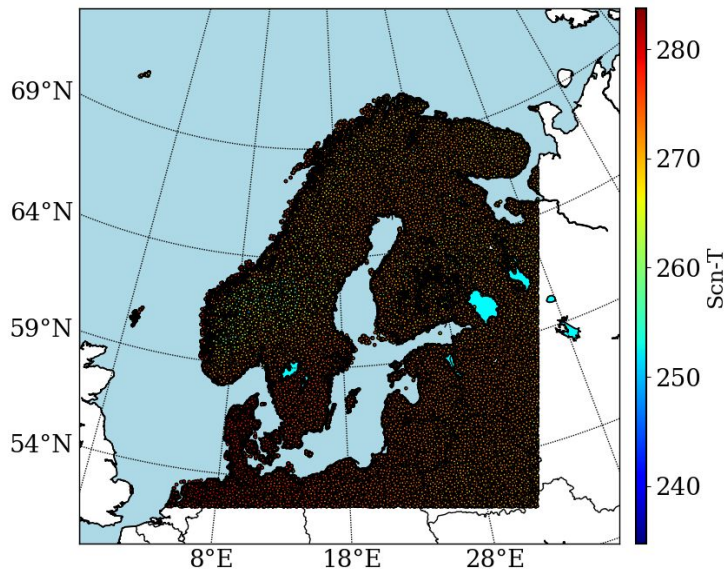
DA: **3D-VAR** system

IC/BC: MetCoOP operational run, Satellite bias corrected files

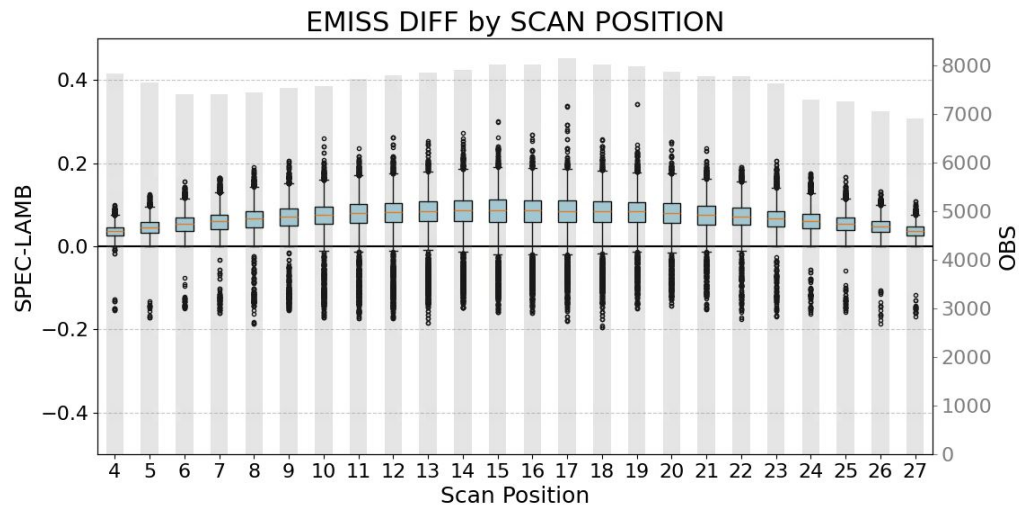


Impact over Land: January 2024

OBS count = 183994; MIN = 234.73 ; MAX = 283.79



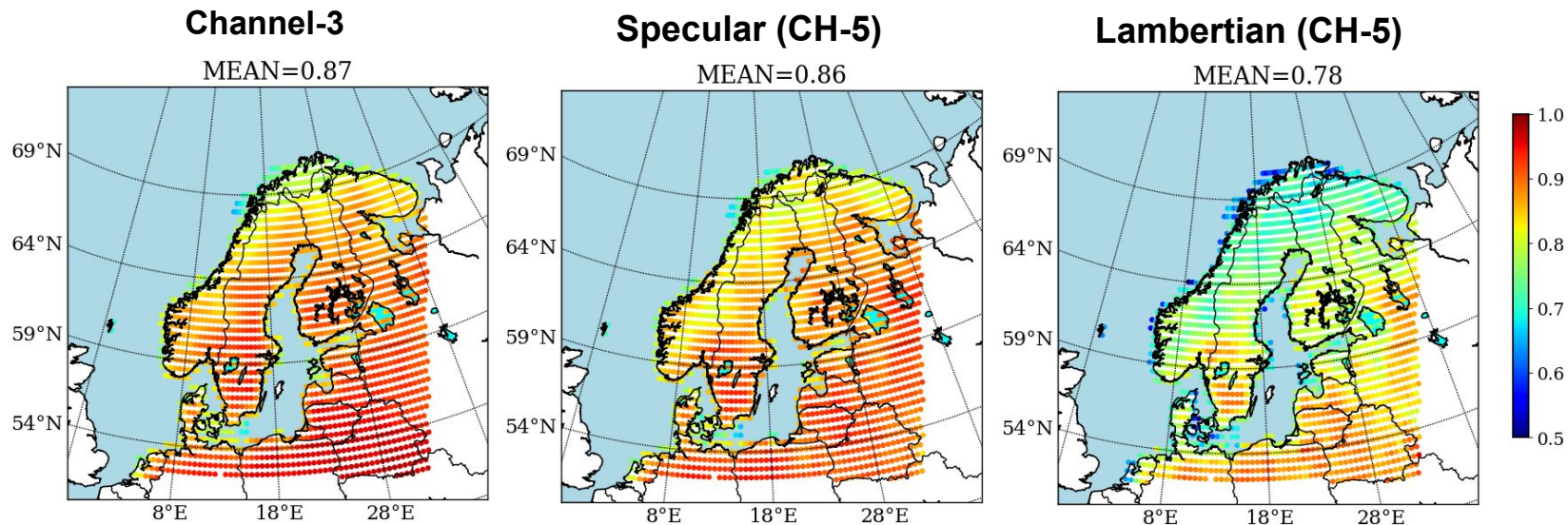
Location of the available LAND observed values for all the month of January 2024 and for all assimilation cycle



The figure illustrates the differences in surface emissivity calculated using specular and Lambertian experiments for various scan positions during January 2024. The Lambertian effect is a function of zenith opacity, which influences the spectral shape of the retrieved surface emissivity.

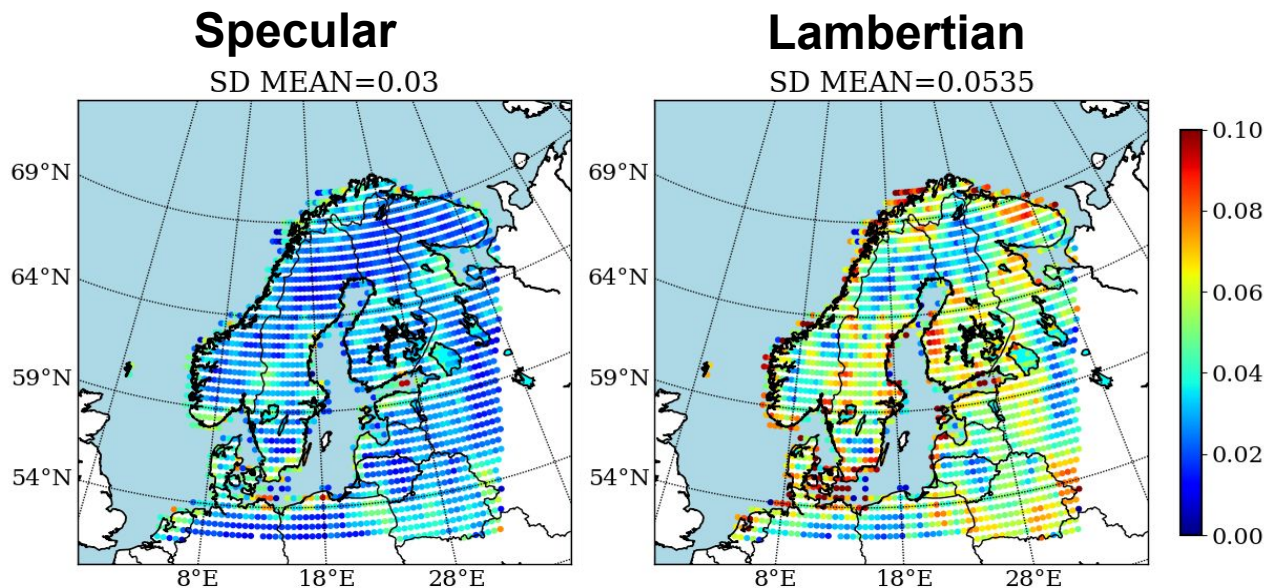
Impact over Land: January 2024

Surface emissivities calculated at AMSU-A Channel 3 were used as inputs for RTTOV.



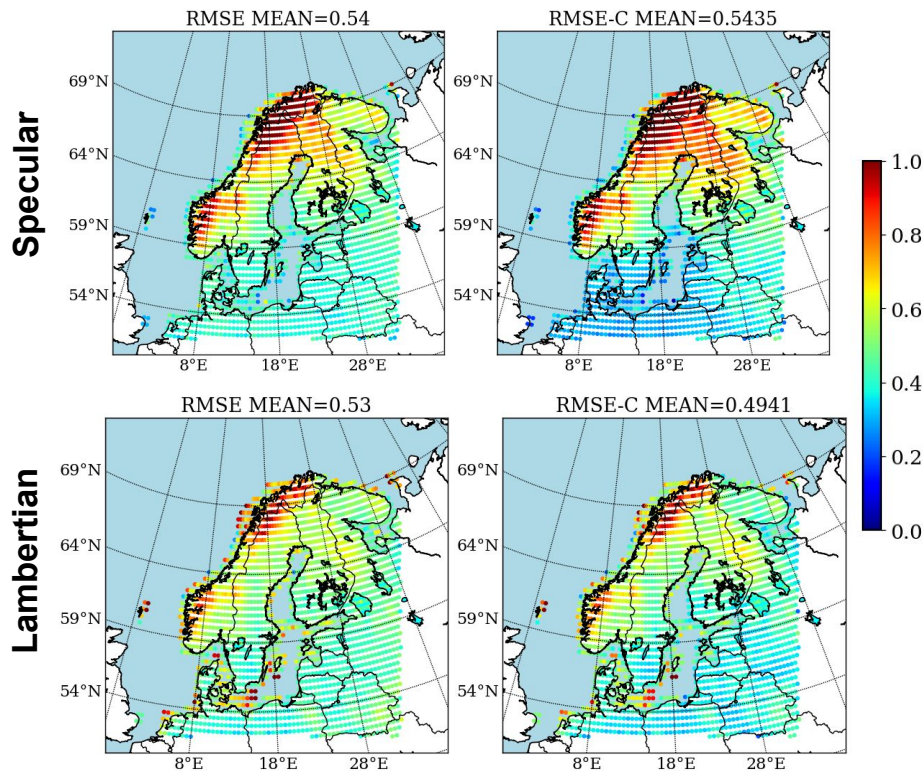
Spatial distribution of gridded (0.5x0.5) mean surface emissivity from AMSU-A channel-3 and from two different scenario Lambertian and Specular reflection of AMSU-A channel-5

Impact over Land: January 2024



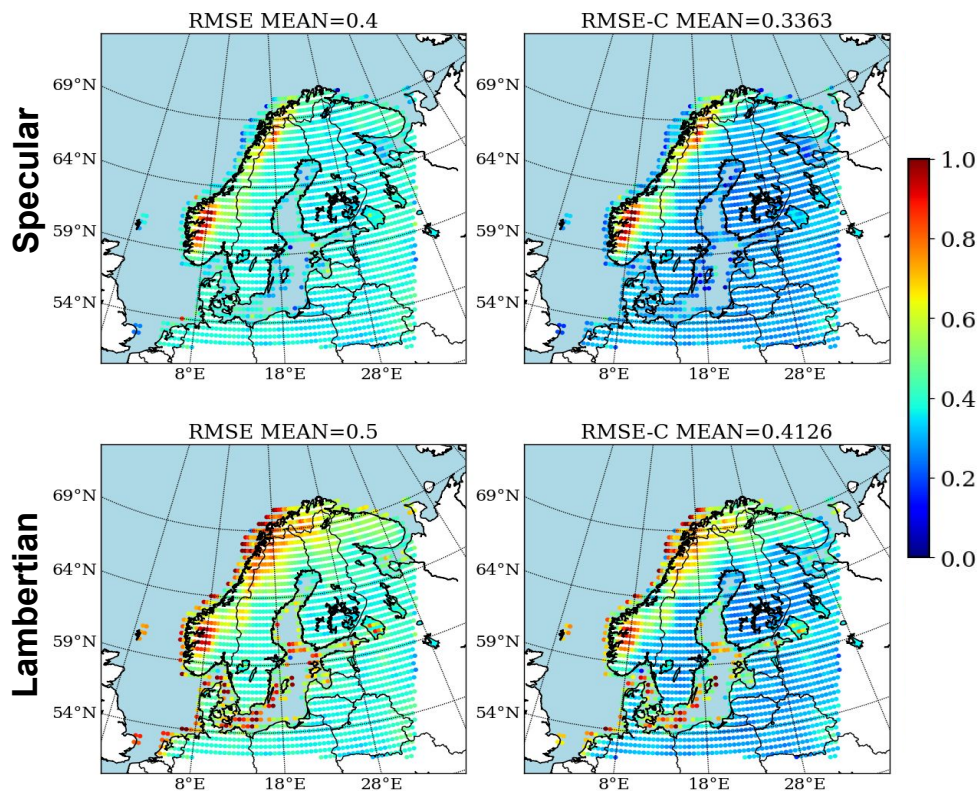
The spatial distribution of the gridded (0.5x0.5) standard deviation (SD) of retrieved emissivity for two different scenarios—Lambertian and specular reflection—of AMSU-A channel 5 is presented. The image clearly indicates that the uncertainty in emissivity is significantly higher in Lambertian reflection, whereas in specular reflection, the standard deviation (uncertainty spread) is much lower and more uniform.

Impact over Land: January 2024



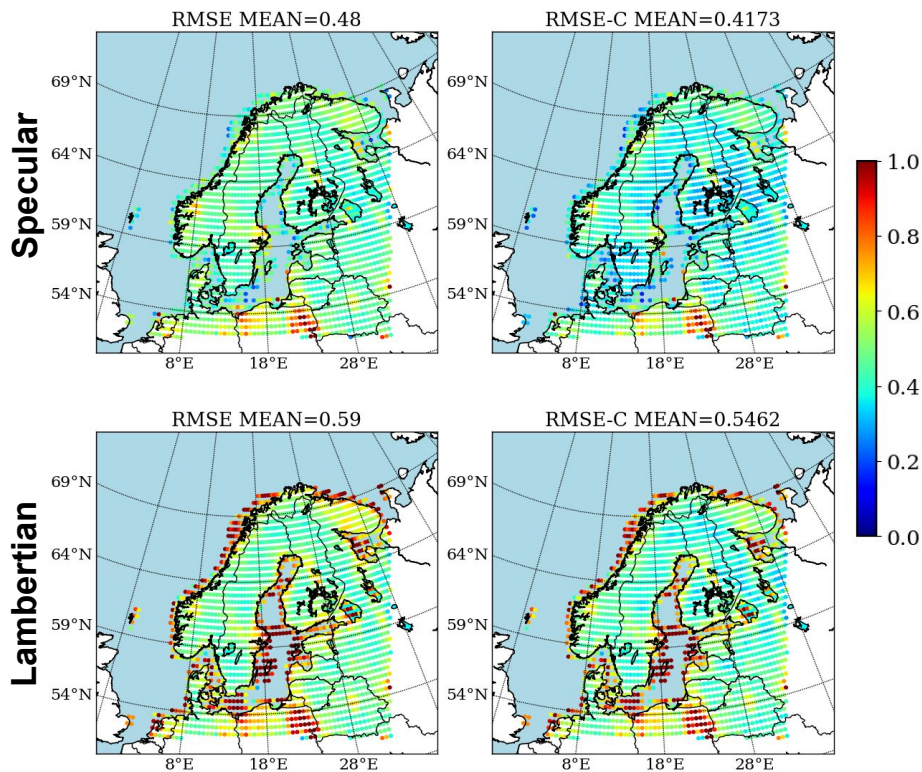
Spatial distribution of gridded (0.5x0.5) root mean square error (RMSE) of brightness temperature (in K) for two different scenario Lambertian and Specular reflection before bias correction of AMSU-A channel-5.

Impact over Land: April 2024



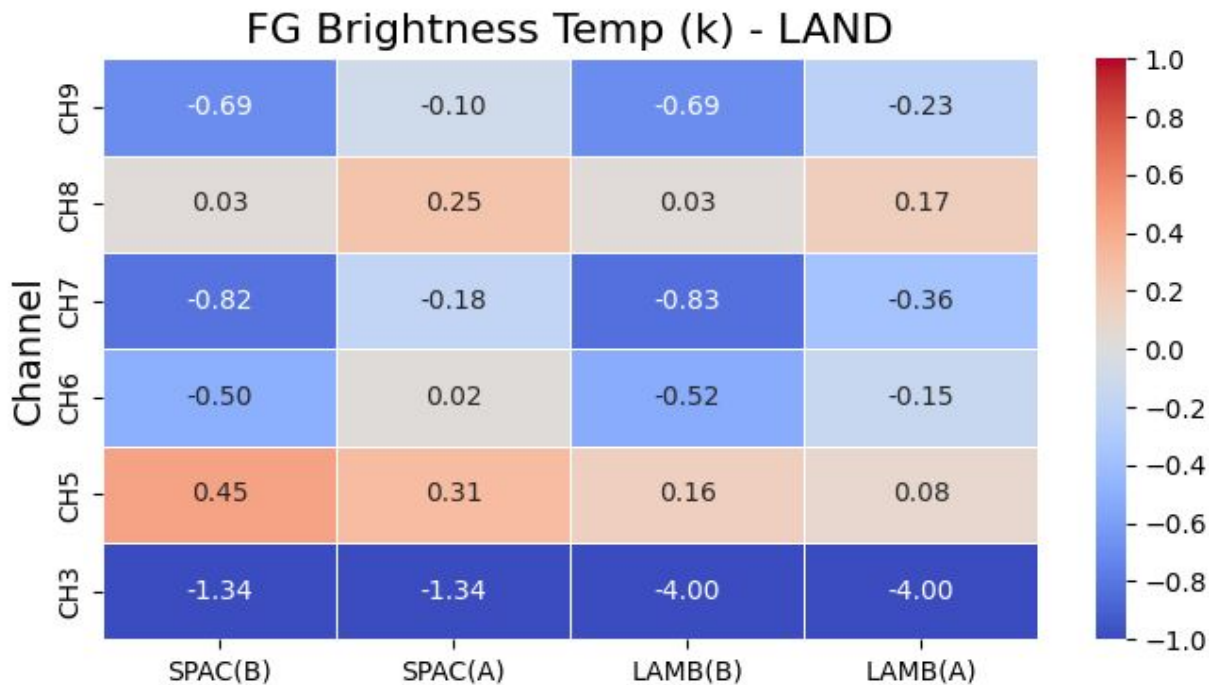
Spatial distribution of gridded (0.5x0.5) root mean square error (RMSE) of brightness temperature (in K) for two different scenario Lambertian and Specular reflection before bias correction of AMSU-A channel-5.

Impact over Land: June 2024



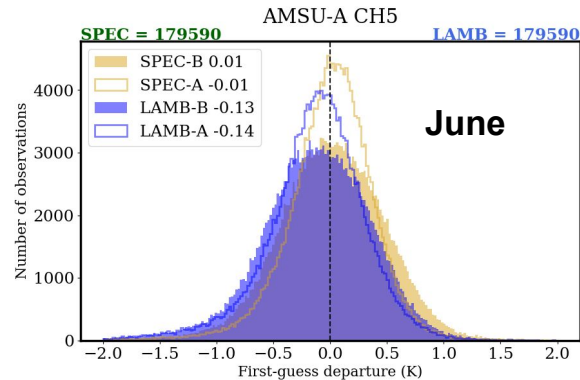
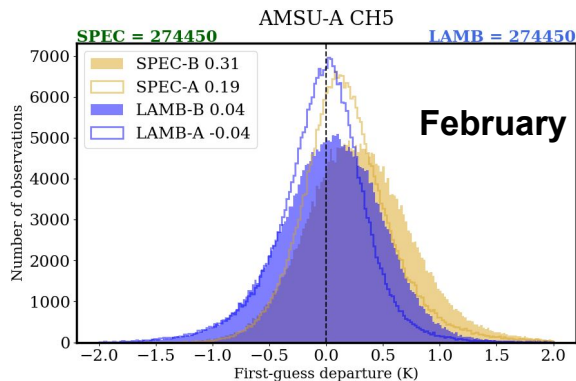
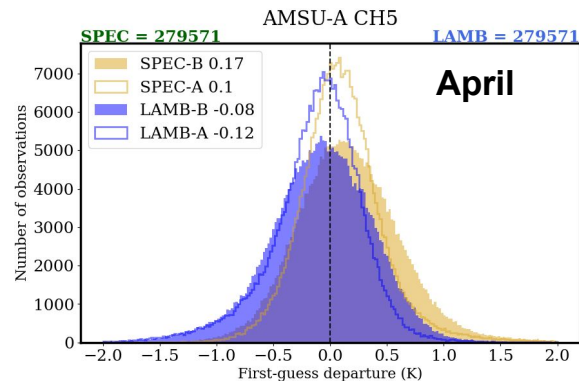
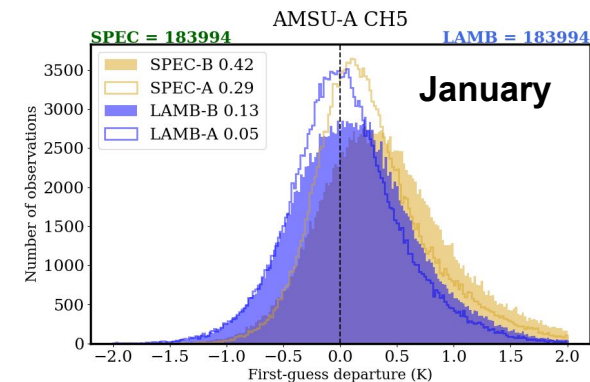
Spatial distribution of gridded (0.5x0.5) root mean square error (RMSE) of brightness temperature (in K) for two different scenario Lambertian and Specular reflection before bias correction of AMSU-A channel-5.

Impact over Land: January 2024



First-guess departure (FG) of brightness temperature (k)

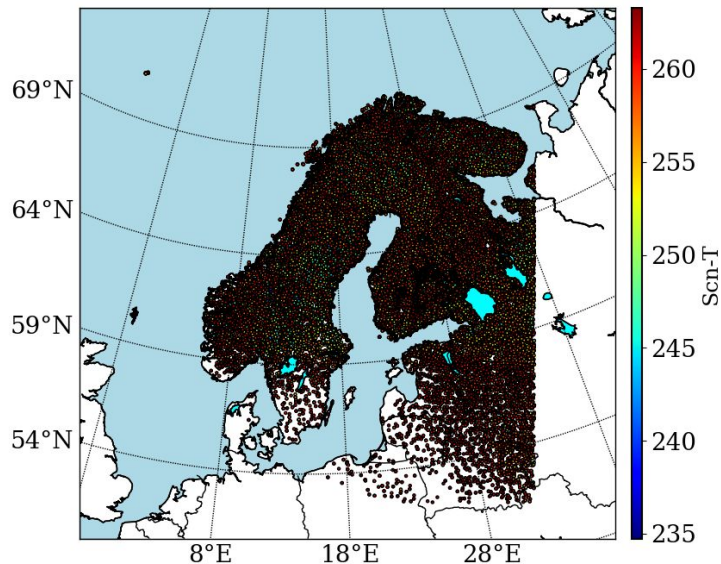
First-guess departure (FG) of brightness temperature (k)



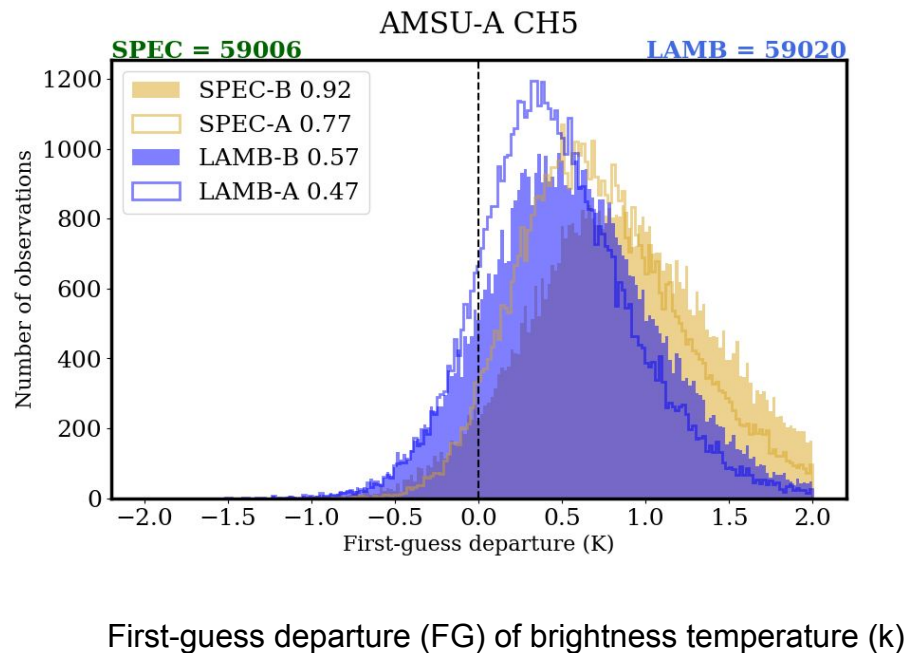
First-guess departure (FG) of brightness temperature (k)

Impact over Snow: January 2024

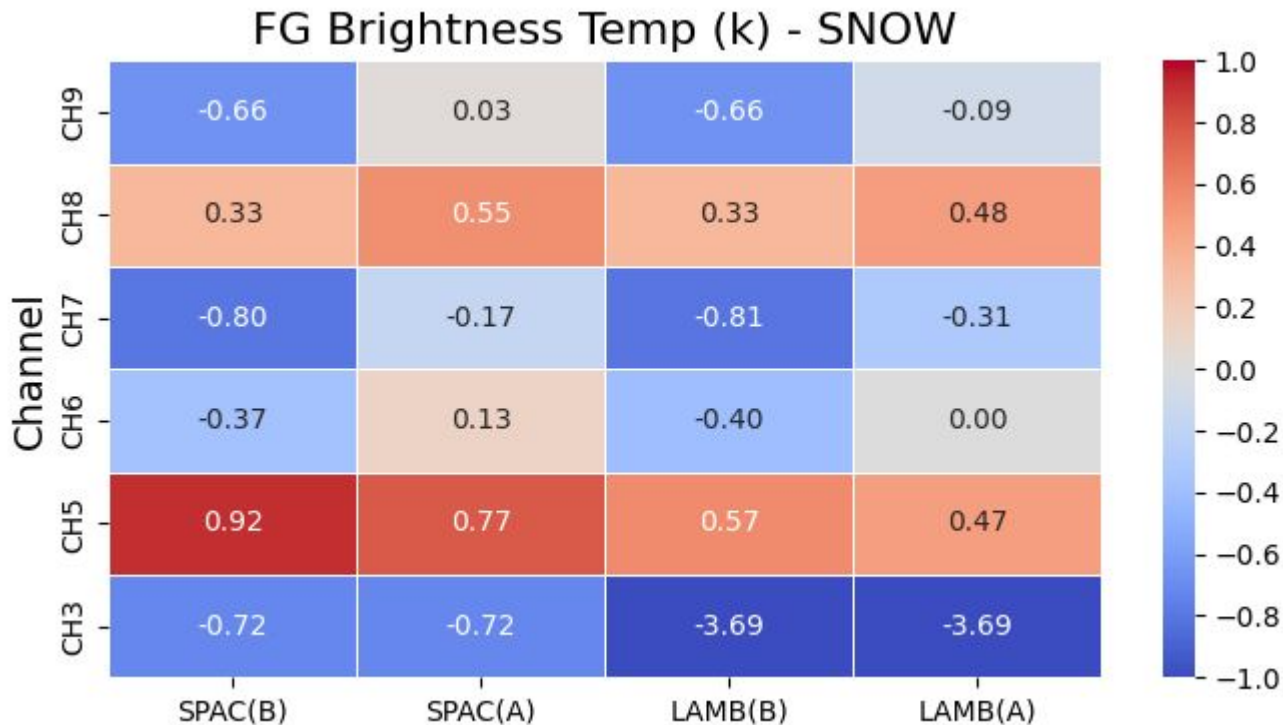
OBS count = 59006; MIN = 234.73 ; MAX = 263.3



Location of the available SNOW observed values for all the month of January 2024 and for all assimilation cycle

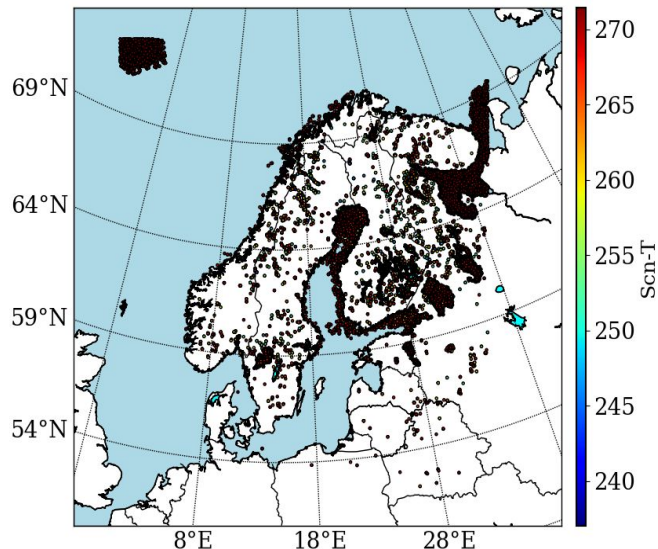


Impact over Snow: January 2024



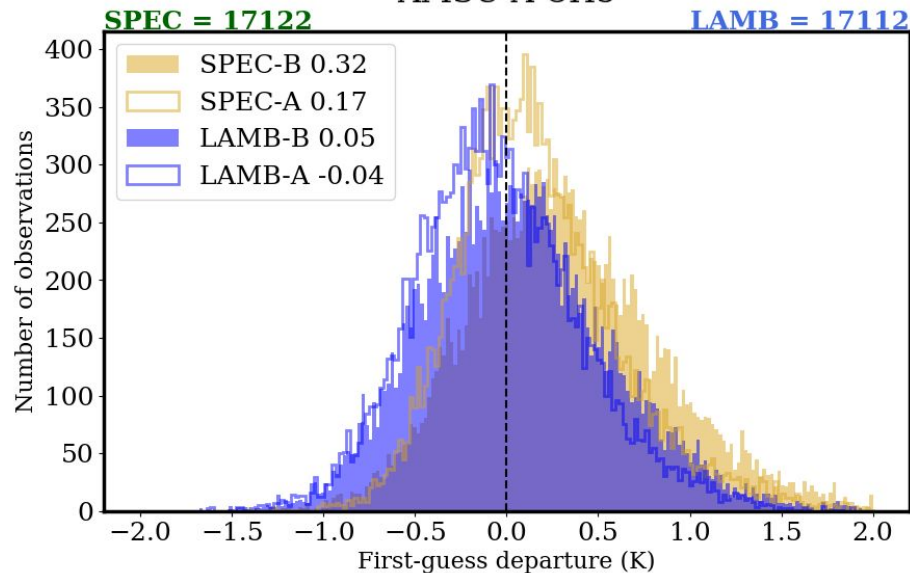
Impact over Sea-Ice: January 2024

OBS count = 17122; MIN = 237.02 ; MAX = 271.46



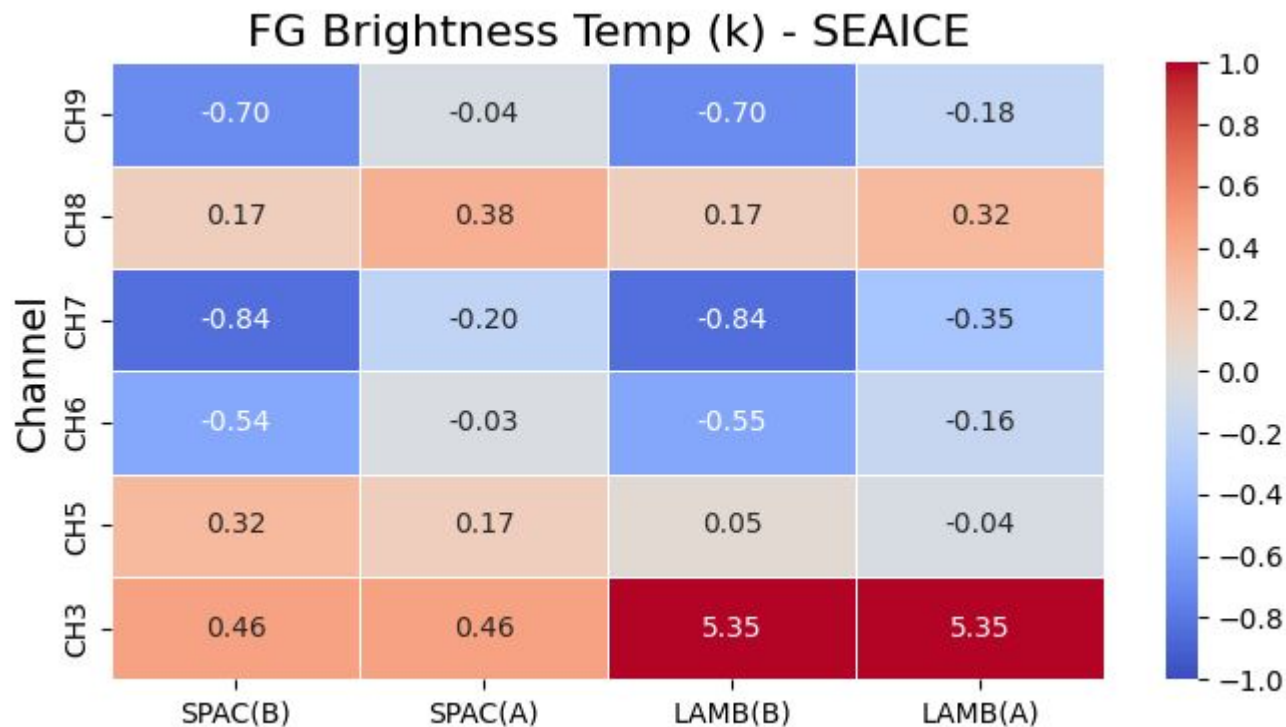
Location of the available Sea-Ice observed values for all the month of January 2024 and for all assimilation cycle

AMSU-A CH5



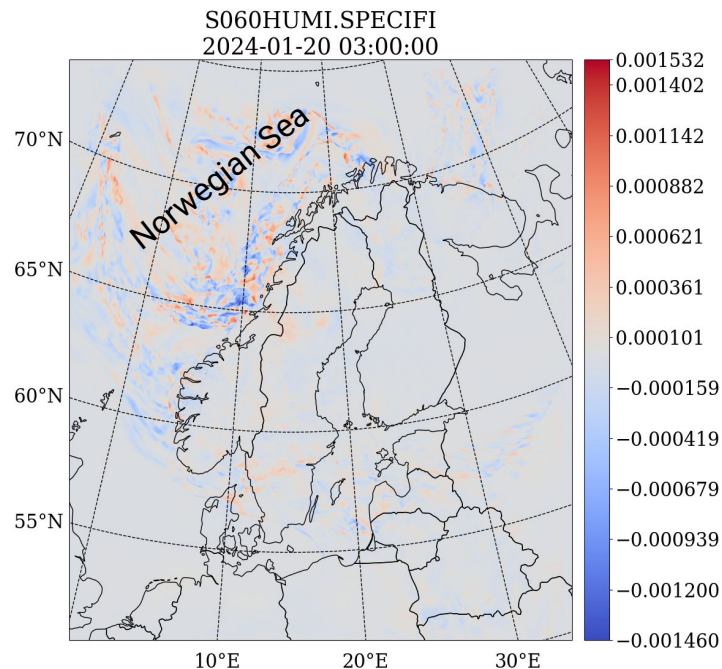
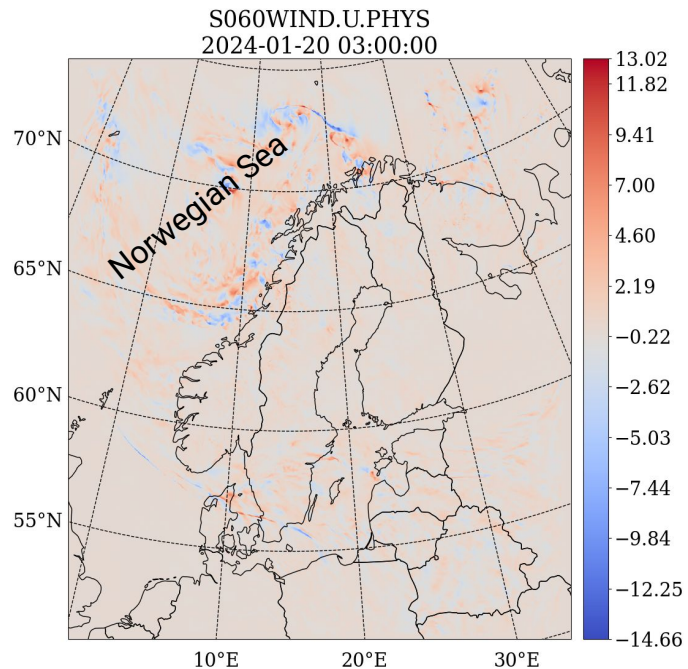
First-guess departure (FG) of brightness temperature (k)

Impact over Sea-Ice: January 2024



3-HR Forecast Difference (Lambertian - Specular)

Valid on 20 January 2024 at 00 UTC



Summary:

- During the winter months (January and February), the specular reflection method exhibits a higher root mean square error (RMSE) than the Lambertian method over land. In the summer months, the specular reflection method outperforms the Lambertian reflection method over land.
- During the winter months, the background error in brightness temperature (k) is consistently positive over snow-covered areas for both the LAMB and SPEC experiments.
- Uncertainty in surface emissivity, measured in terms of standard deviation (SD), is higher in Lambertian reflection. In contrast, specular reflection exhibits a much lower and more uniform standard deviation, indicating a narrower spread of uncertainty.
- A more in-depth study will explore the significance of the weighted mean of various types of reflection on different surfaces and across different seasons.

Thank you for your attention