Plan for All-sky Radiance Assimilation over Land in the NCEP Global Model

Azadeh Gholoubi [1], Emily Huichun Liu [2], Andrew Collard [2], and Daryl Kleist [2]

[1]AXIOM at NOAA/NWS/NCEP/EMC, [2]NOAA/NCEP/EMC/Modeling and data Assimilation branch

Email: azadeh.gholoubi@noaa.gov

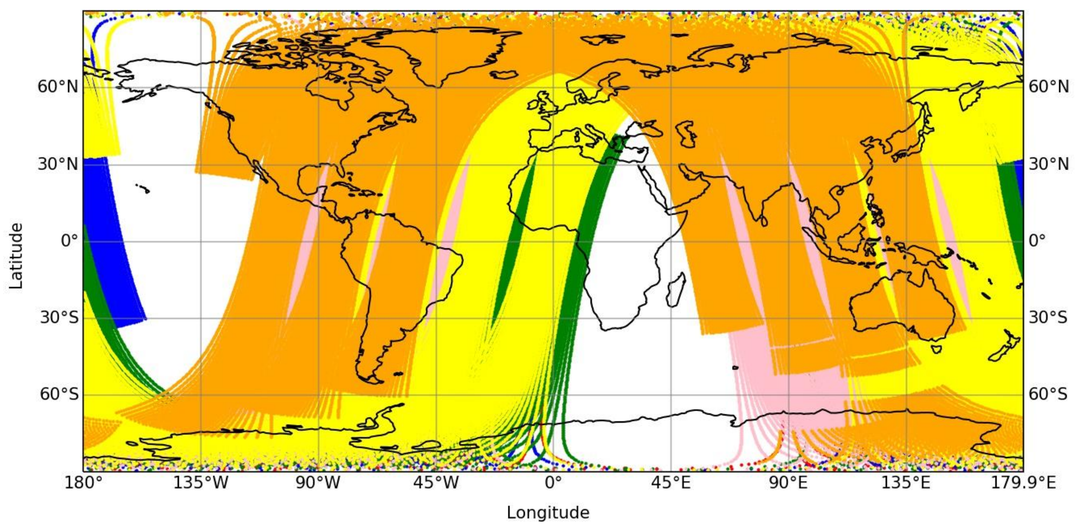
Introduction

The all-sky assimilation of microwave observation in the NCEP Global Forecast Model (GFS) is limited to observations over the ocean. This is because, over the ocean, fast and accurate emissivity models have been developed for NWP that allow the assimilation of channels with strong surface sensitivity. In contrast, the microwave signal emerging from land surfaces depends on frequency, polarization, and incidence angle. It is also affected by surface types and conditions, making it challenging to model surface emissivity accurately. The complexity of modeling the interaction between all these surface parameters and the microwave radiation has generally restricted the use of observation to temperature and humidity channels, which receive a weak contribution from the surface over land.

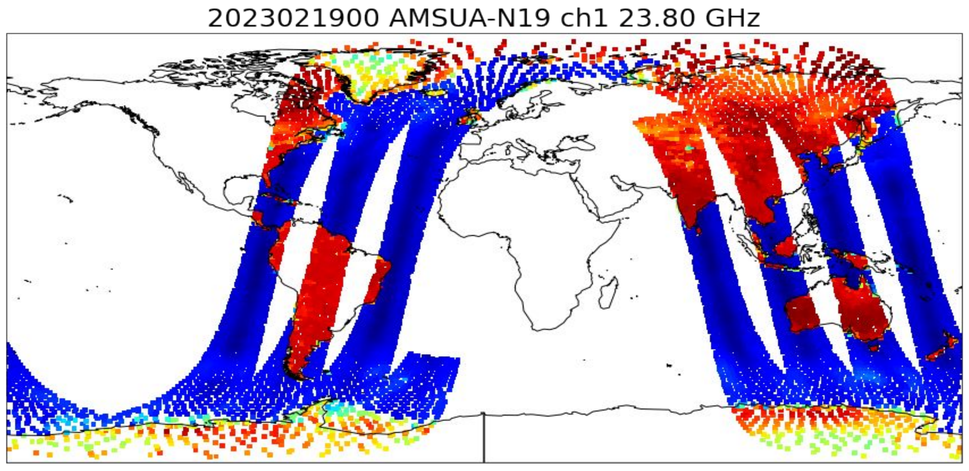
All-sky Framework - Current Status

- All-sky assimilation over ocean only
- Clear-sky assimilation over non-ocean area
- Sensors in all-sky are MW sounders
- We need to explore MW imager

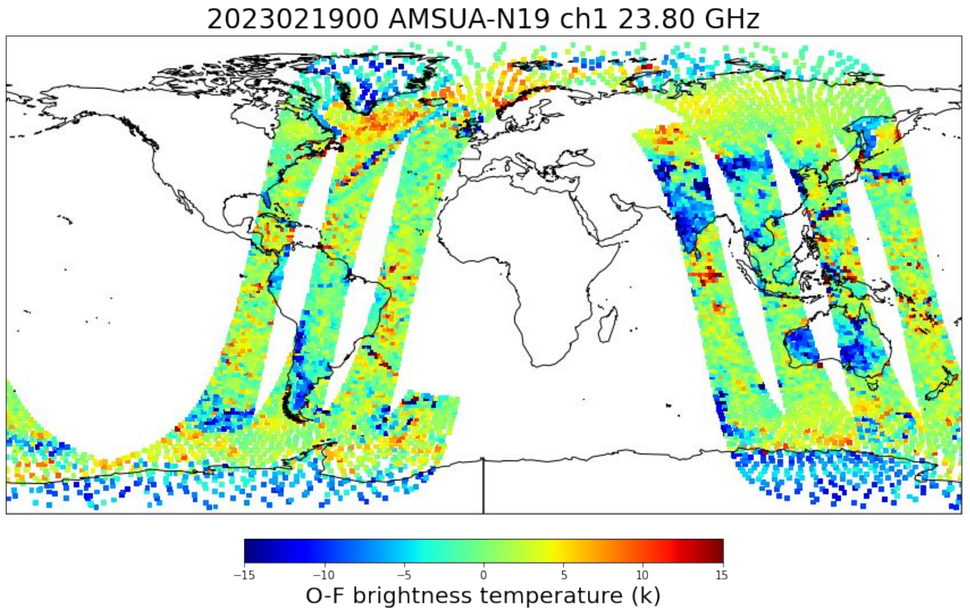
GSI observation data: AMSU-A



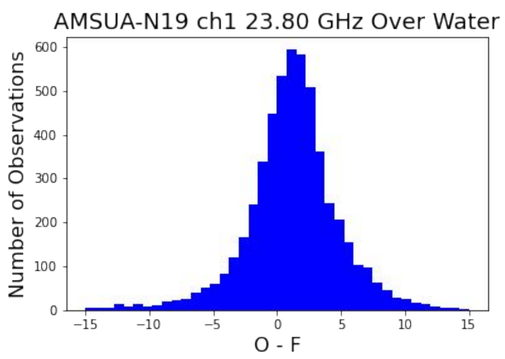
2023021900 AMSUA-N19 ch1 23.80 GHz



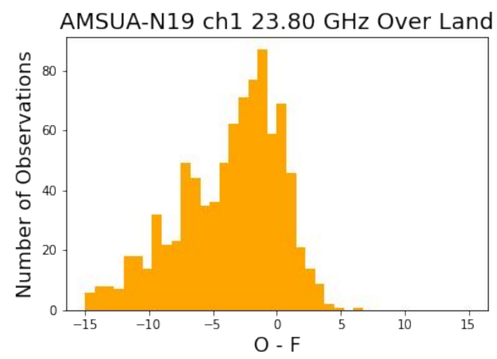
2023021900 AMSUA-N19 ch1 23.80 GHz



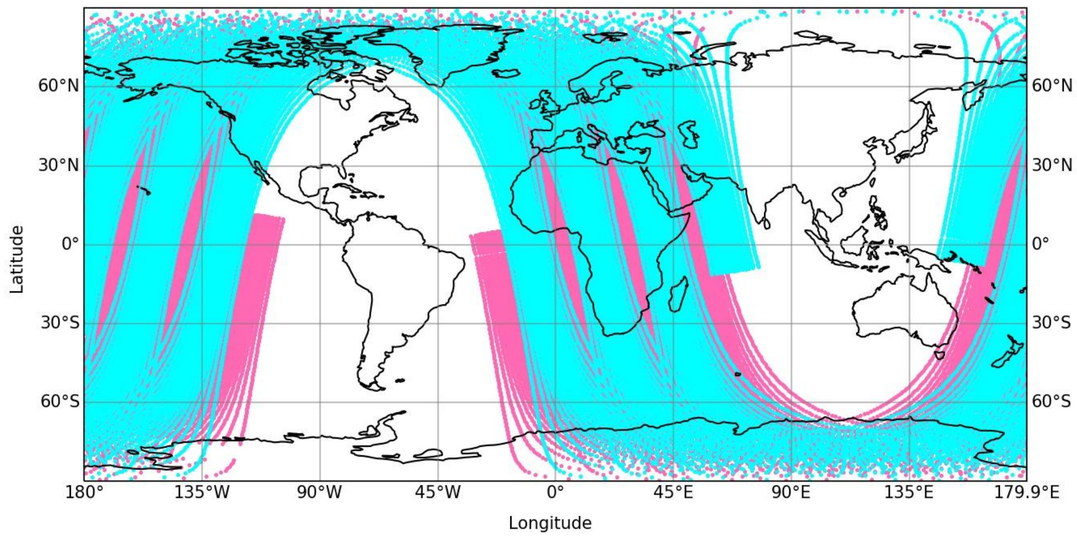
AMSUA-N19 ch1 23.80 GHz Over Water



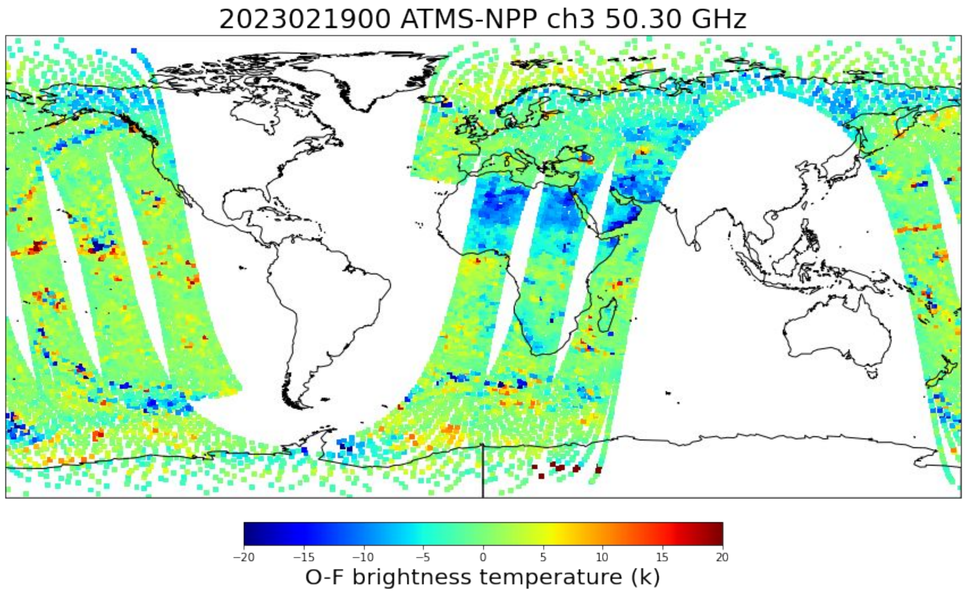
AMSUA-N19 ch1 23.80 GHz Over Land



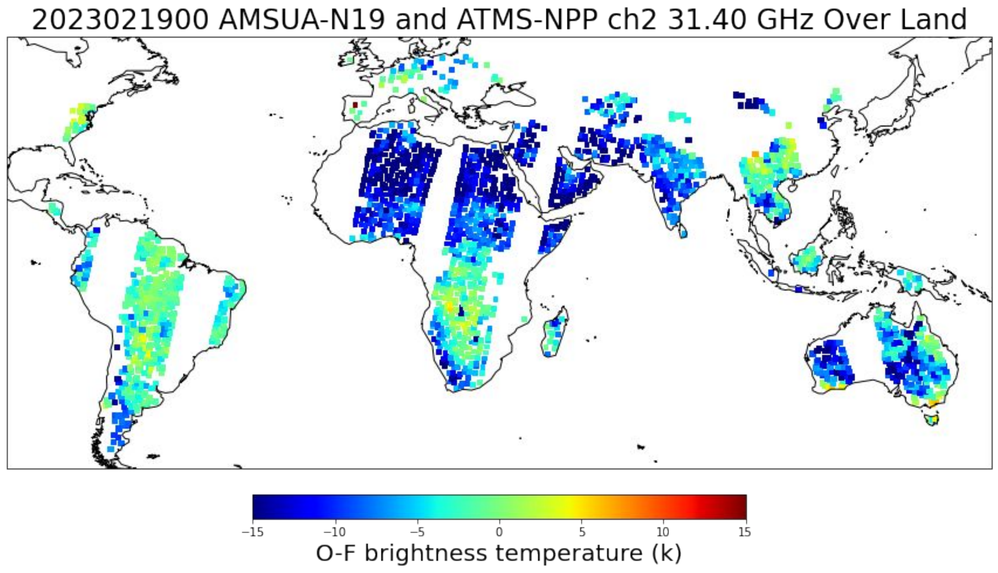
GSI observation data: ATMS



2023021900 ATMS-NPP ch3 50.30 GHz



2023021900 AMSUA-N19 and ATMS-NPP ch2 31.40 GHz Over Land



Future Plan

First step towards using observation over land surfaces is obtaining more reliable surface emissivity estimates. Following the footsteps of ECMWF, the use of an instantaneous emissivity retrieval from MW surface-sensitive channels will be explored along with an emissivity atlas. In addition, the use of soil moisture and soil temperature from the NCEP global surface model in the Community Radiative Transfer Model (CRTM) will be investigated.

Instantaneous emissivity retrieval:

$$T_b = \varepsilon_{(\theta,\vartheta)} T_s \tau_{(\theta,\vartheta)} + \left(1 - \epsilon_{(\theta,\vartheta)}\right) T^{\downarrow}_{(\theta,\vartheta)} \tau_{(\theta,\vartheta)} + T^{\uparrow}_{(\theta,\vartheta)}$$

$$\varepsilon = \frac{T_b - (1-C)\left(T^{\uparrow}_{clr} + T^{\downarrow}_{clr}\tau_{clr}\right) - C\left(T^{\uparrow}_{cld} + T^{\downarrow}_{cld}\tau_{cld}\right)}{(1-C)\left(T_s - T^{\downarrow}_{clr}\right)\tau_{clr} + C\left(T_s - T^{\downarrow}_{cld}\right)\tau_{cld}}$$

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