Using skin temperature increments from microwave observations in a coupled atmosphere-ocean model

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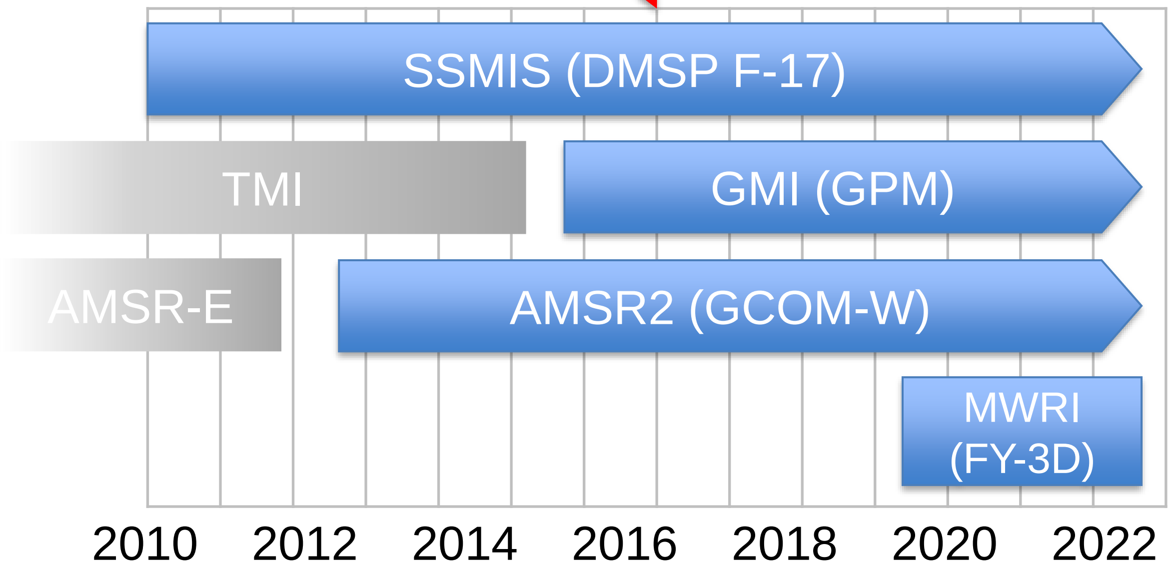
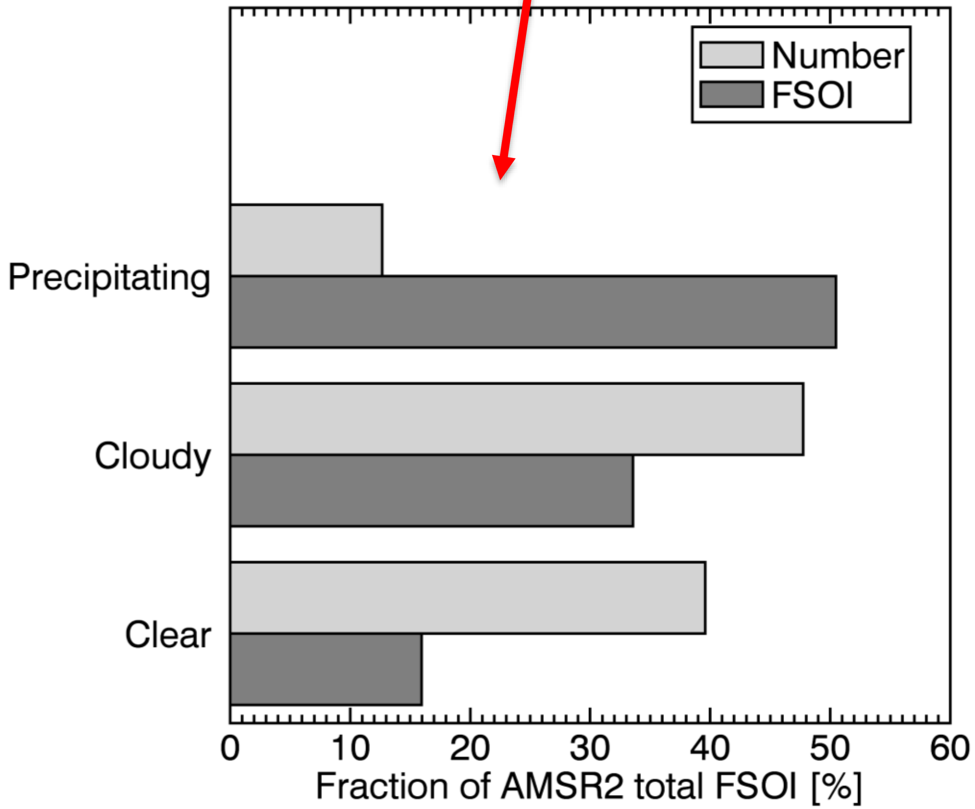
Microwave Imagers at ECMWF

All-Sky Assimilation of Microwave Imagers

- ECMWF uses 4D-Var for initial conditions for the medium range weather forecast.
- Microwave imager data helps to improve atmospheric humidity, cloud and precipitation analyses.



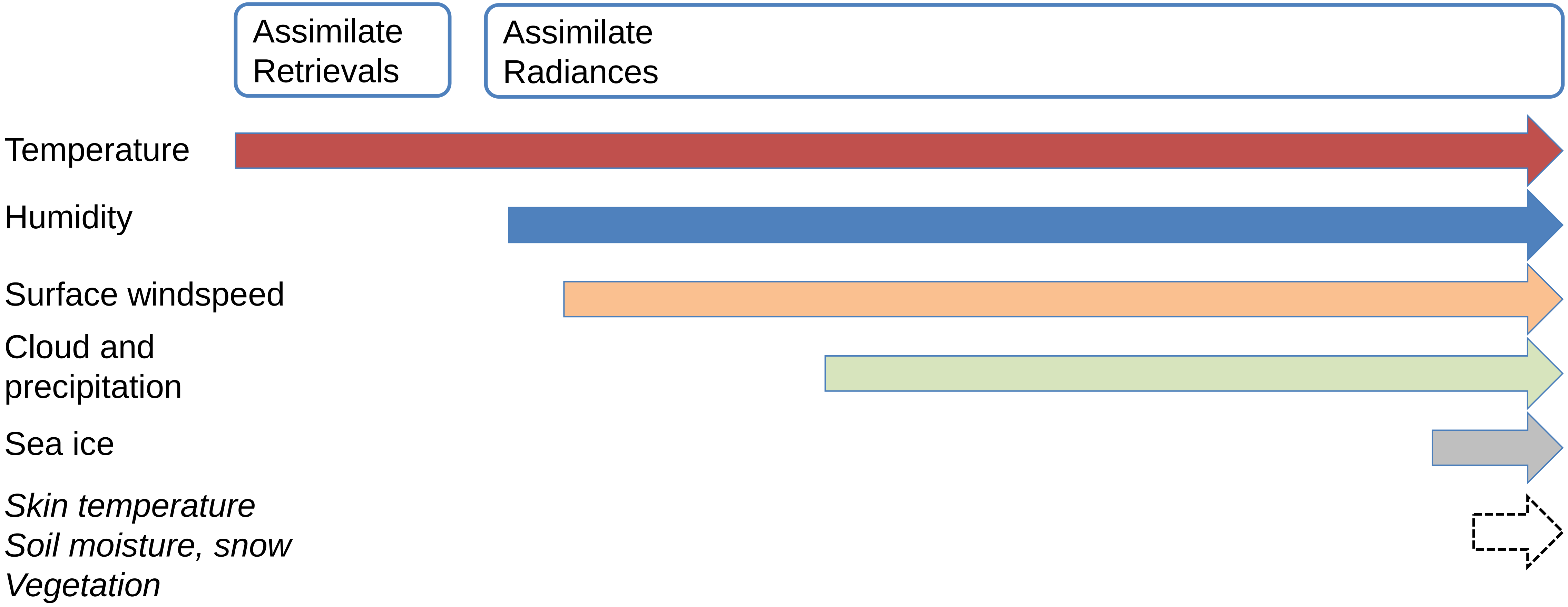
Microwave imagers give their largest forecast impact from a small fraction of precipitating scenes.



FSOI for AMSR2 (July – August 2016) split by clear, cloudy and precipitating conditions.

FSOI - Forecast Sensitivity to Observation Impact – an adjoint approach to measure the impact of observations on the short-term forecast *(see Dahoui et al. (2017))*

History of All-Sky Assimilation at ECMWF



Rough history and future plans for all-sky / all-surface assimilation at ECMWF

direct radiance assimilation (late 1990s)

all-sky radiance assimilation (~2010)
(see Bauer et. al. 2010, Geer et al., 2010, Geer and Bauer, 2010 and 2011)

all-sky all-surface radiance assimilation (2025)

Background

Introduction

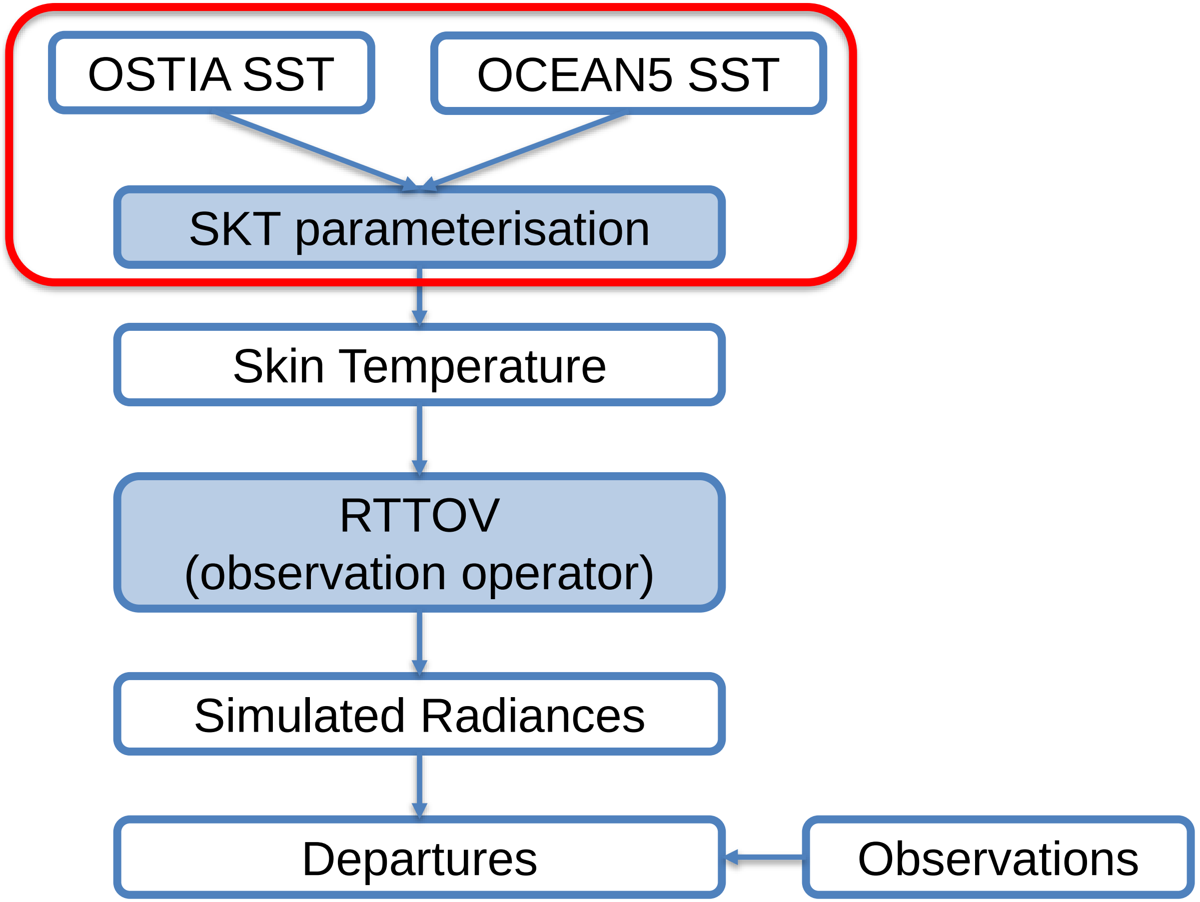
- In the near future, ECMWF plans to move towards a coupled atmosphere-ocean system.

- Information from microwave imagers can be exploited over oceans to help drive the ocean model.

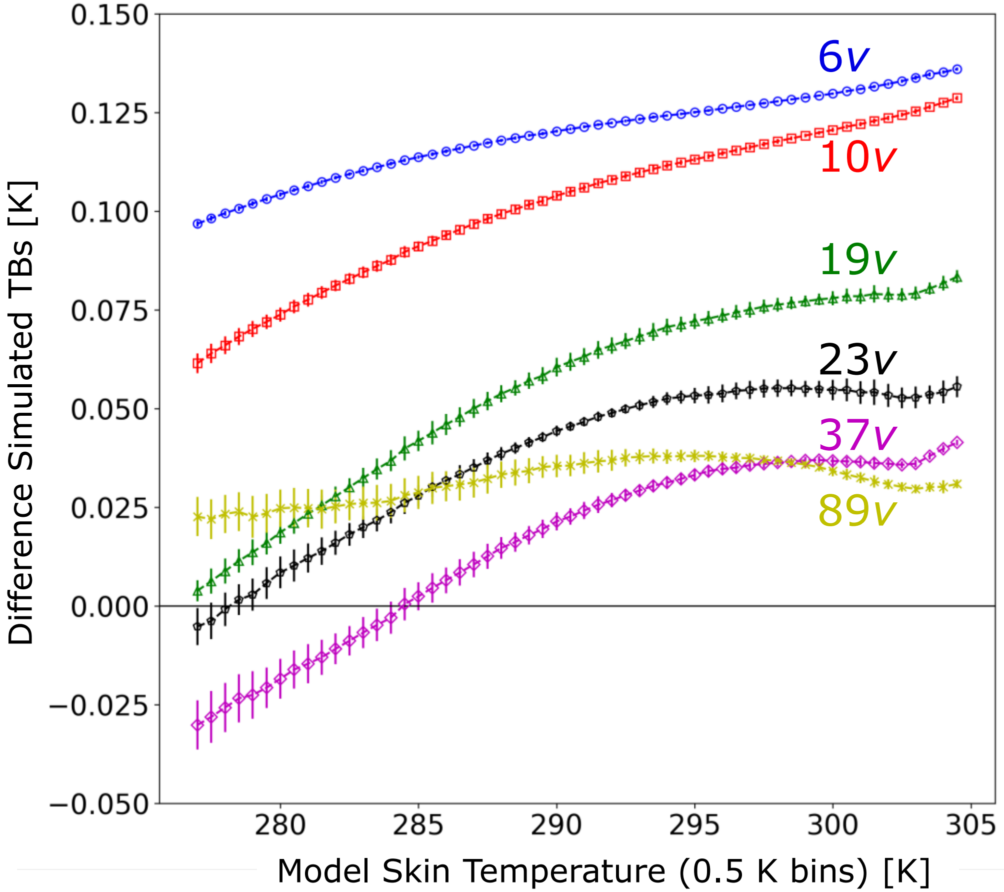
- To do this, low frequency (6 and 10 GHz) channels are required with appropriate QC.

- Important for upcoming missions carrying low-frequency channels, such as CIMR.

Why is skin temperature important?

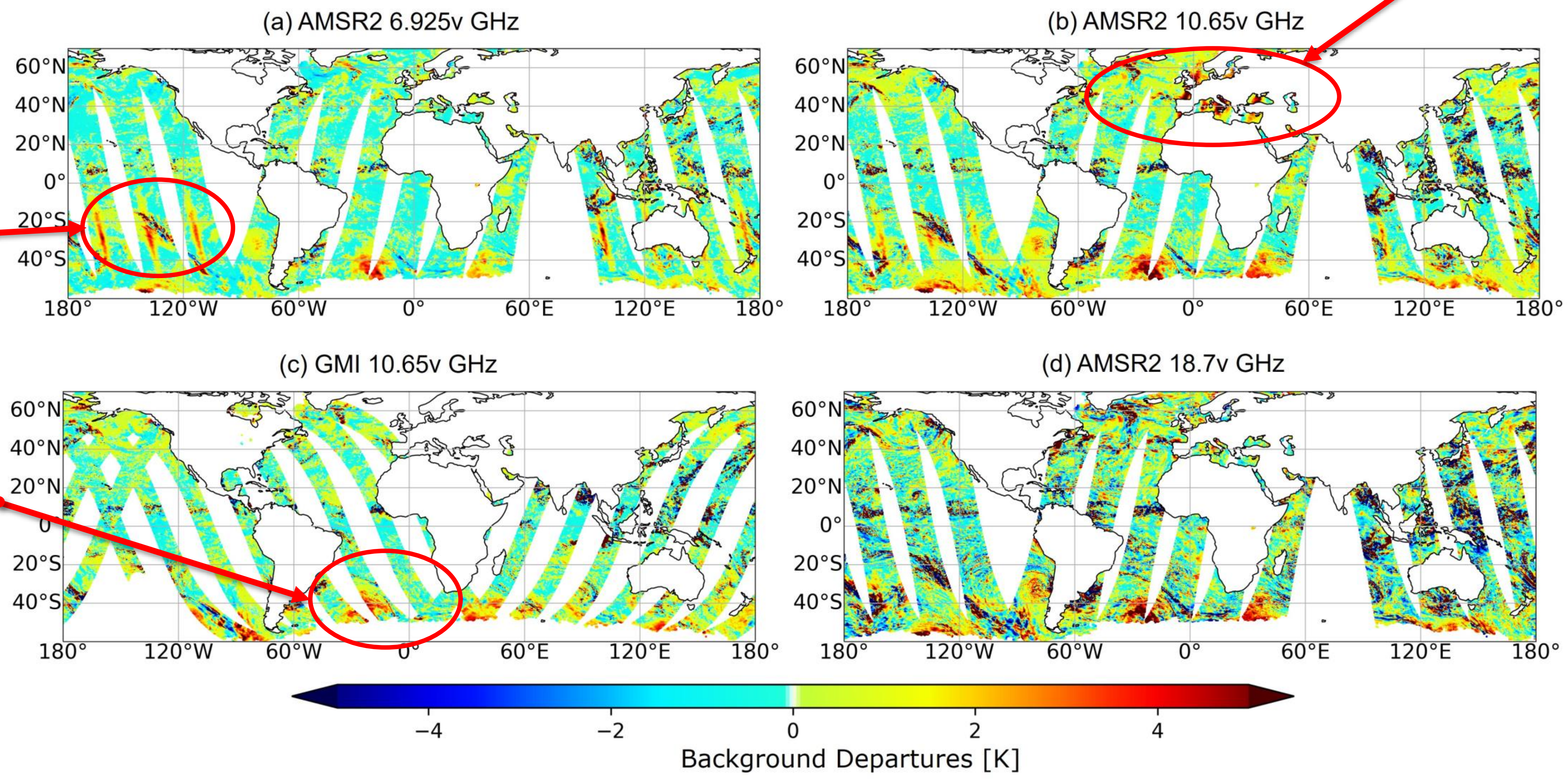


Adding 0.2 K to the input SKT under clear sky conditions



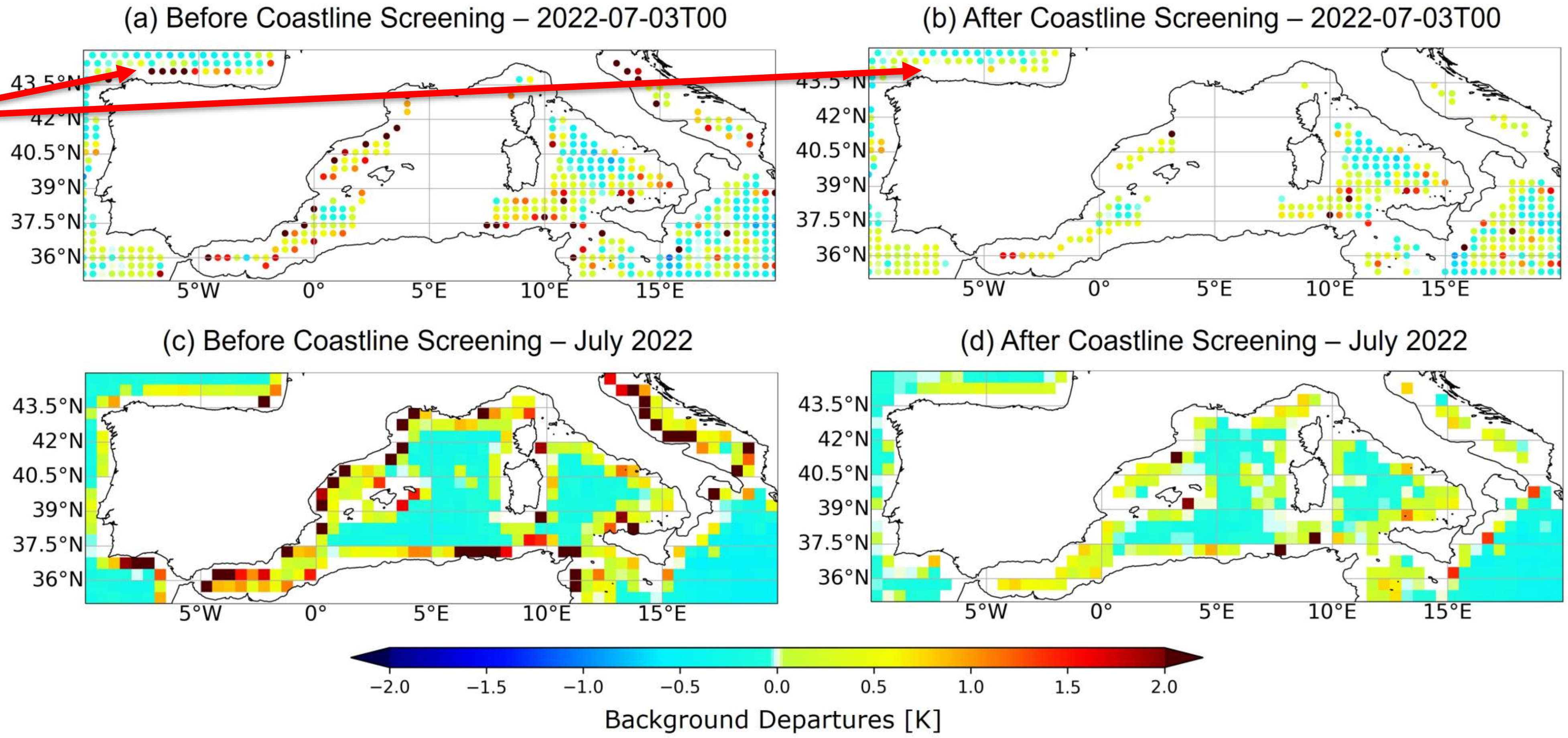
Adding 6 and 10 GHz to the NWP System

Quality Control at 6 and 10 GHz – Before Screening

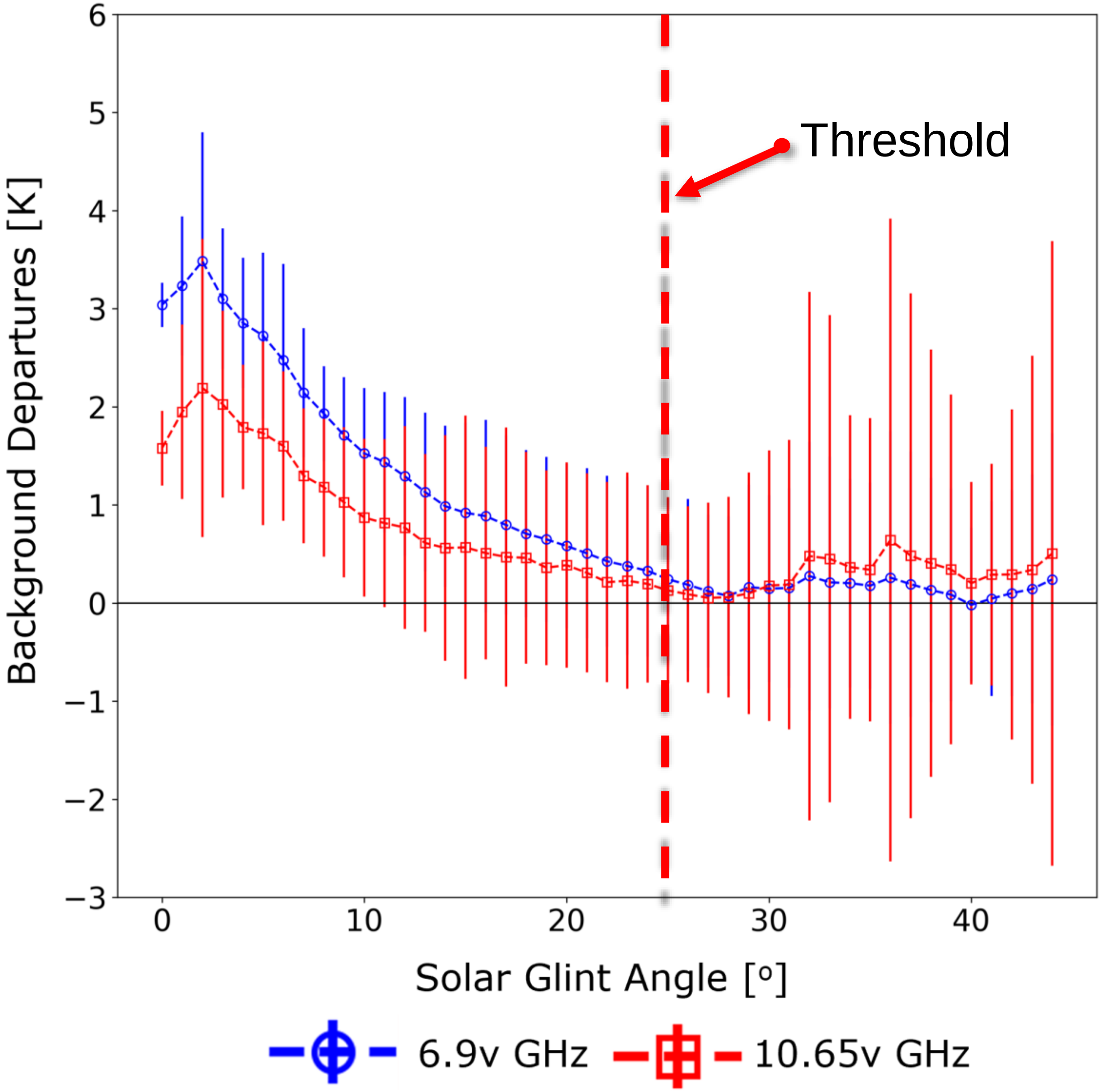


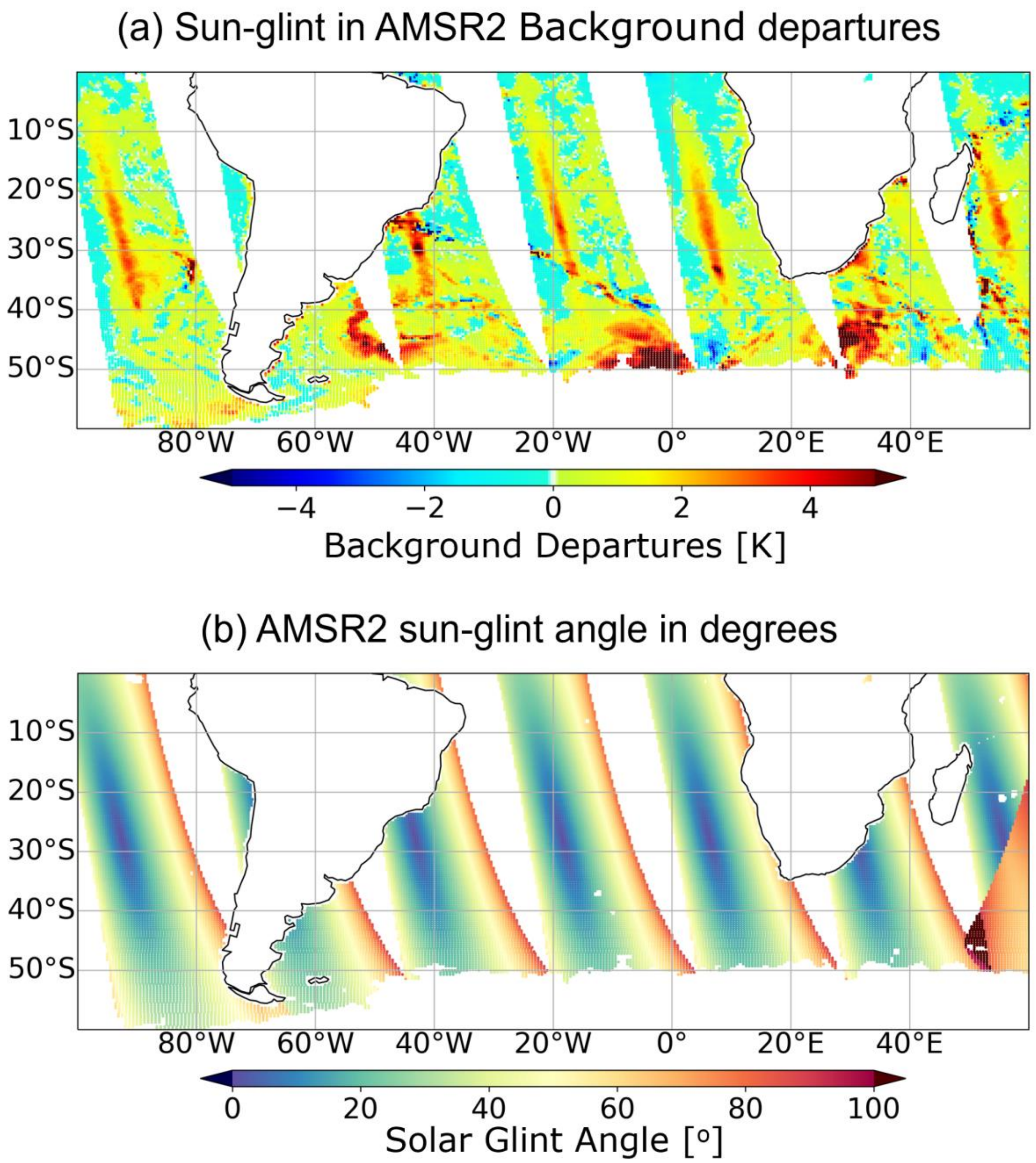
Coastline Screening at 6 GHz

Removal of high background departures



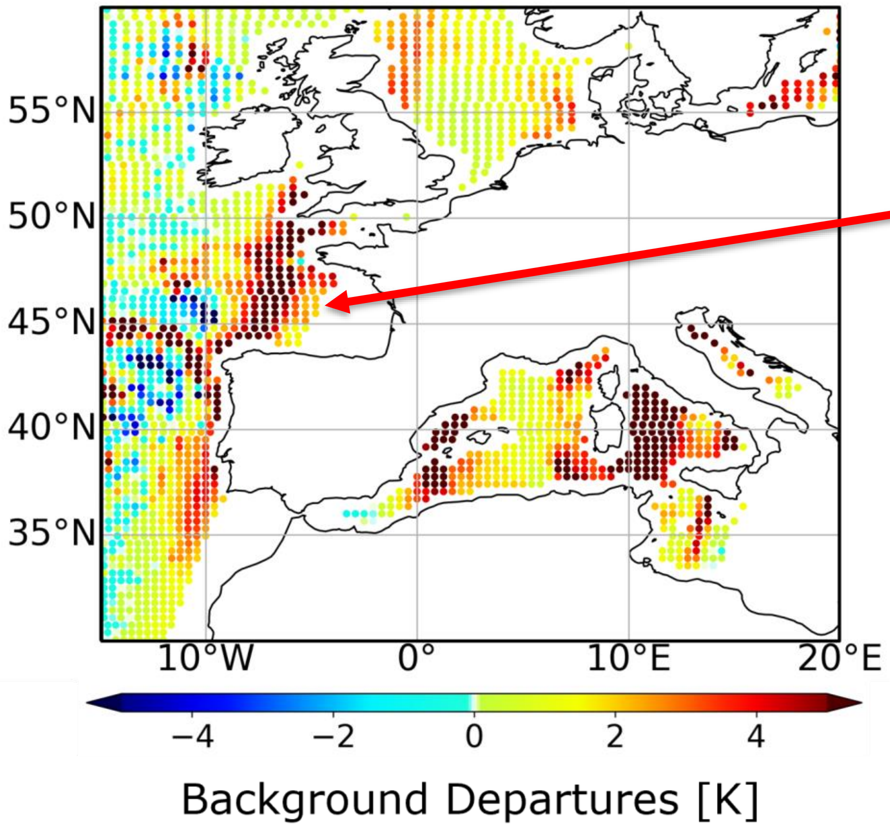
Sun-Glint Screening

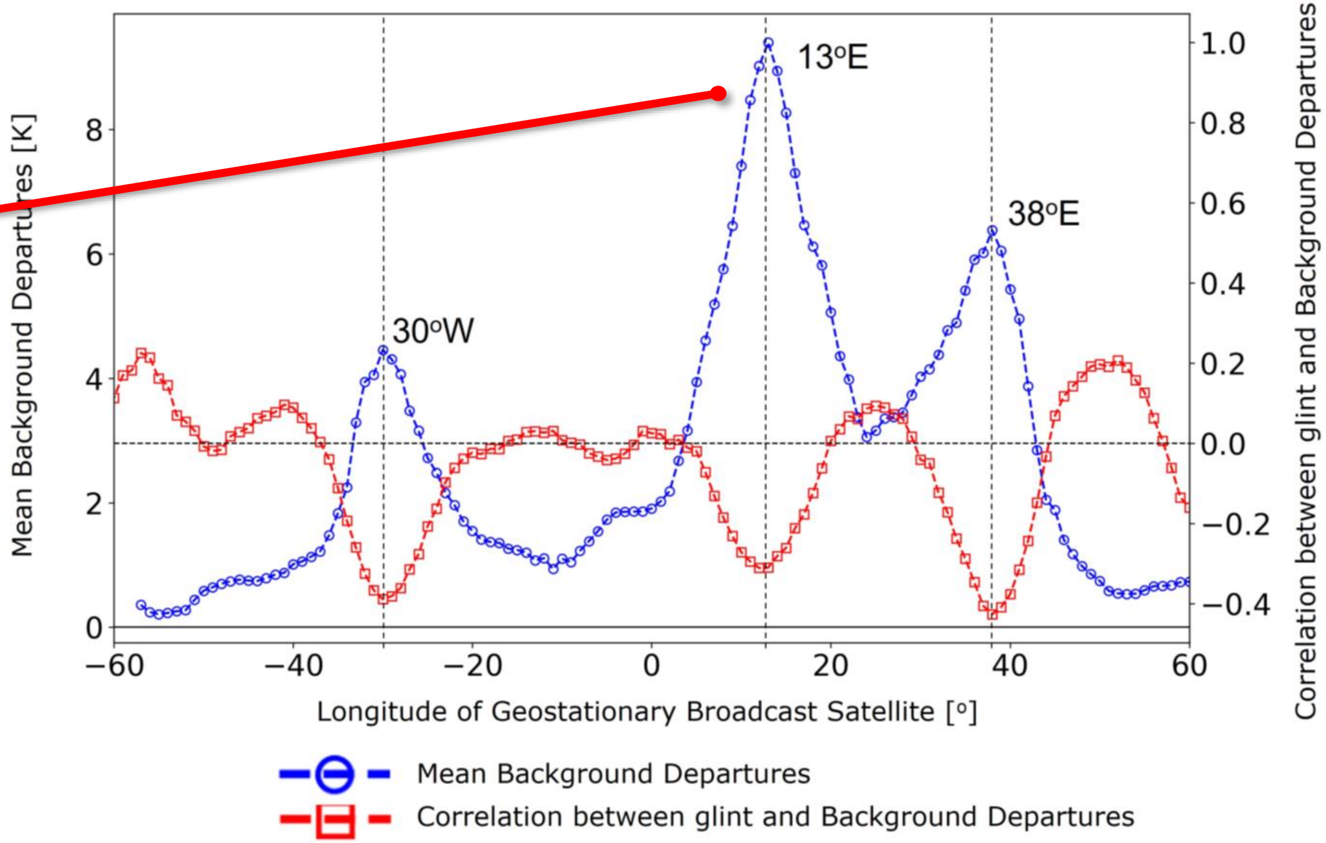




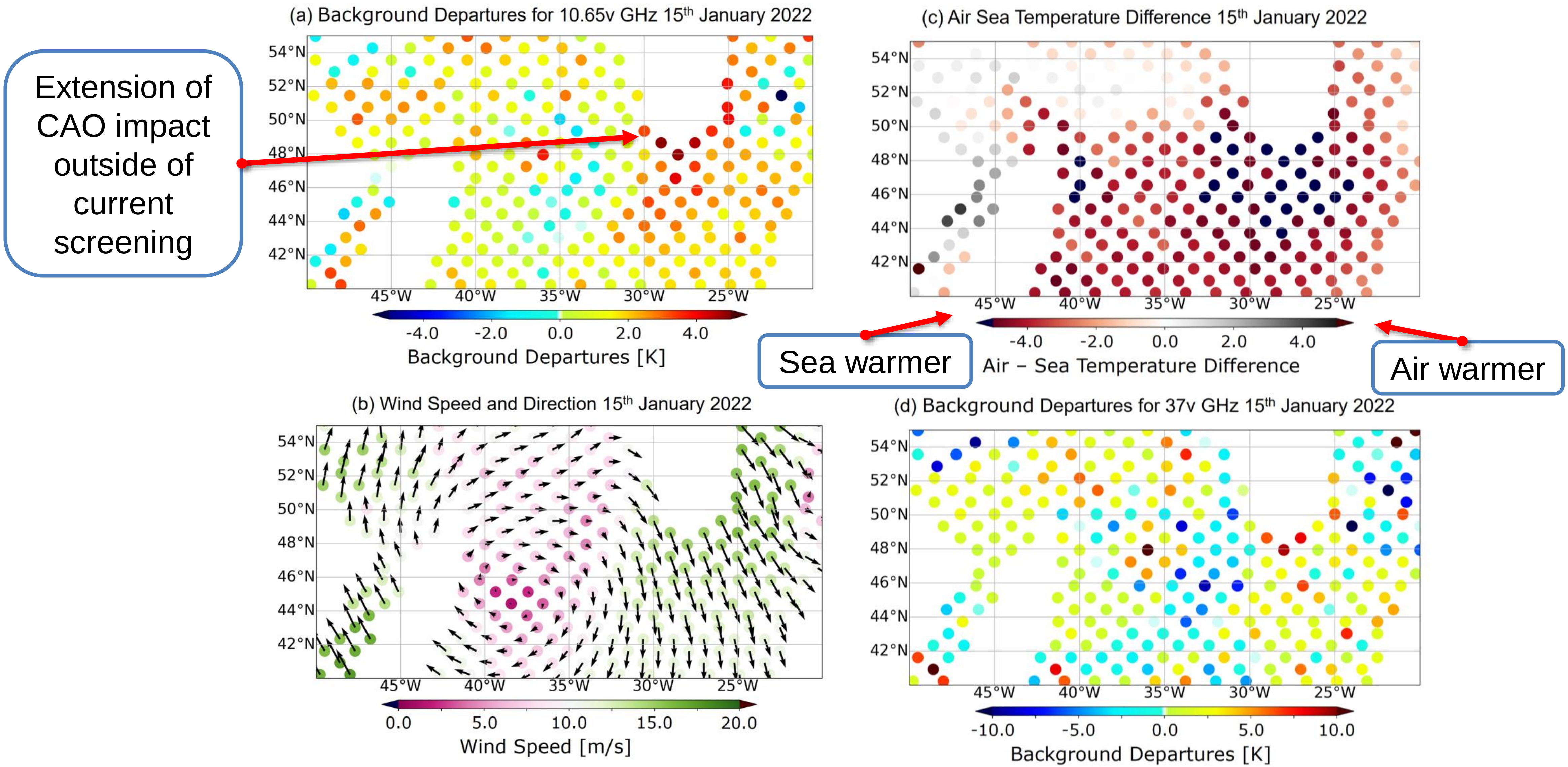
RFI Screening for 10 GHz on AMSR2

Sources identified by placing satellites in theoretical orbits, calculating the glint and comparing this with background departures.

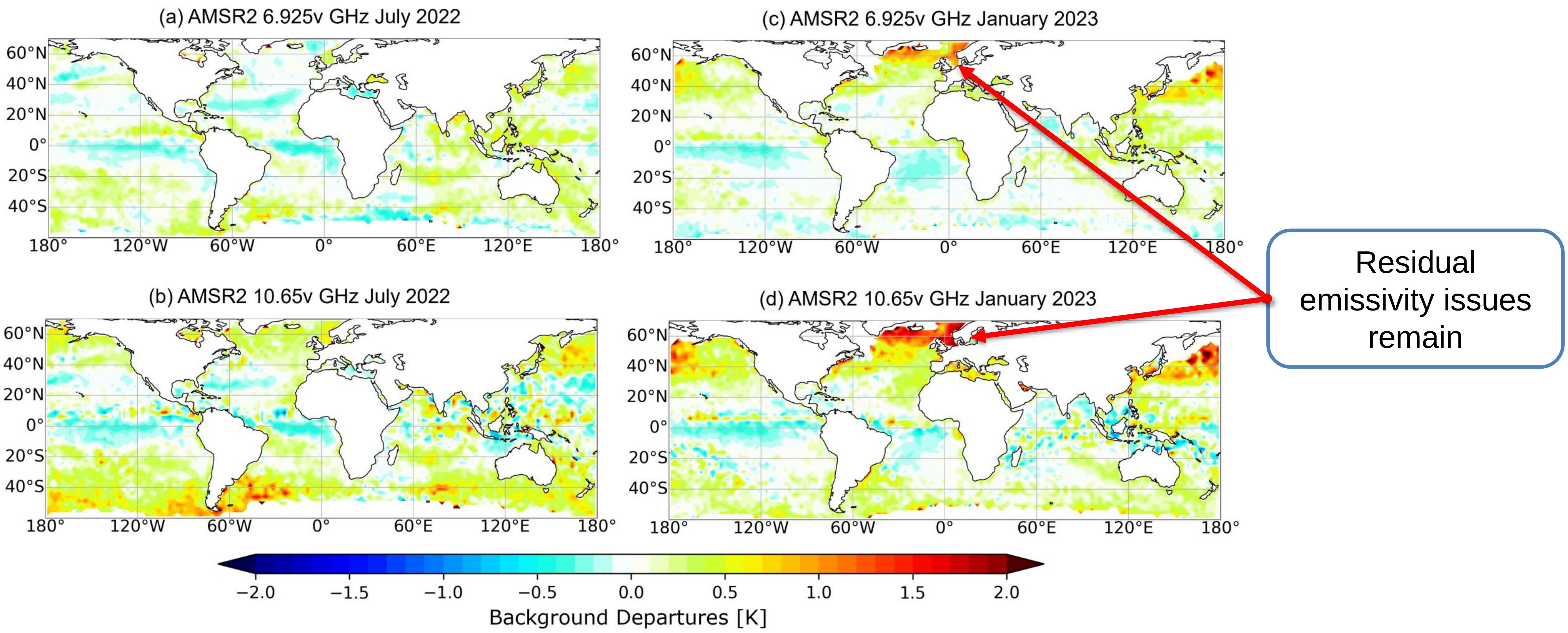




Cold Air Outbreaks at 6 and 10 GHz



Background Departures After Screening – Monthly averages



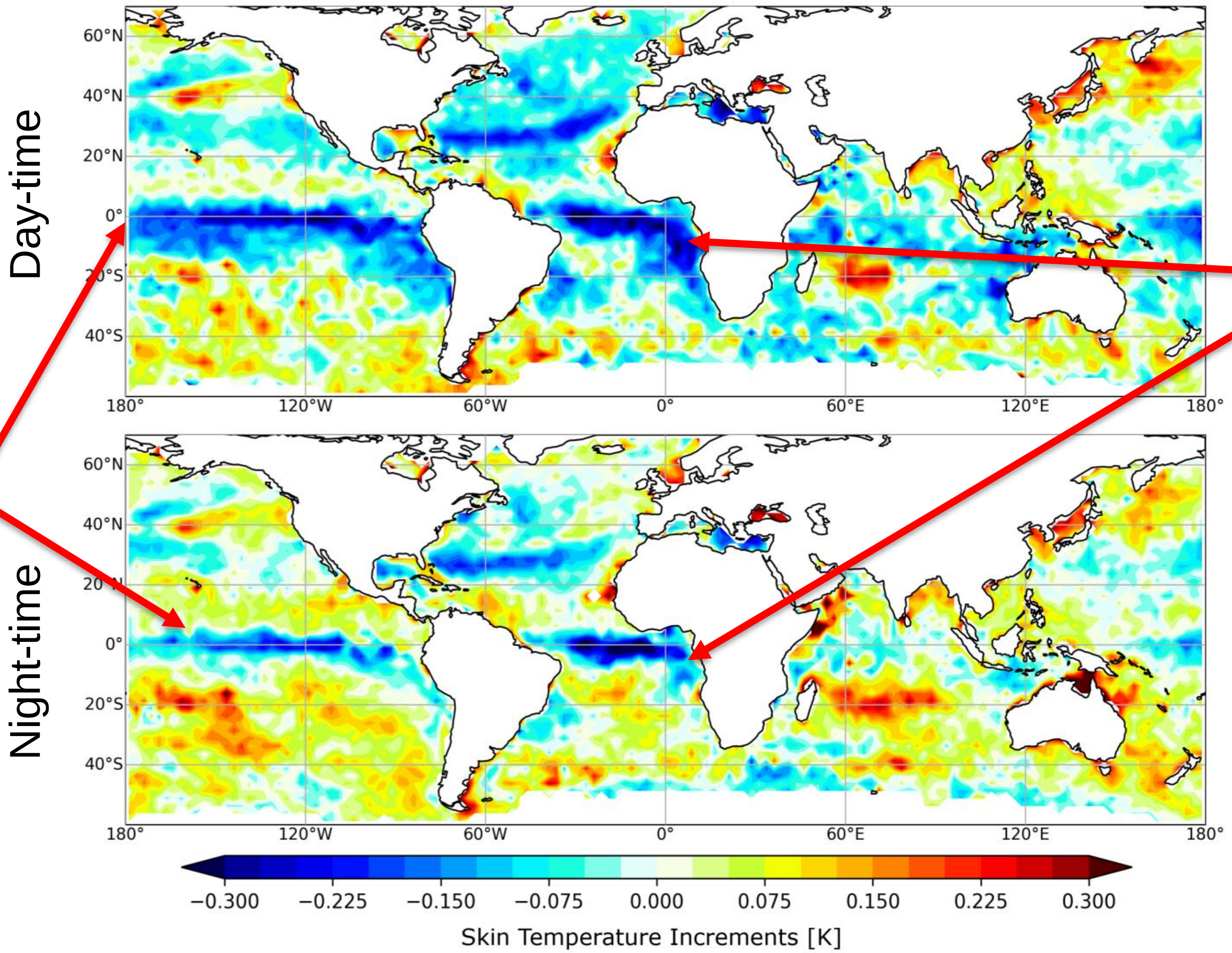
Generating Skin Temperature Increments

Skin Temperature Increments for July 2022

Linked to diurnal effects from SKT parameterisation

Cooling in the ETP both day and night

Linked to foundation input products



Large scale cooling, but not present in January (next slide)

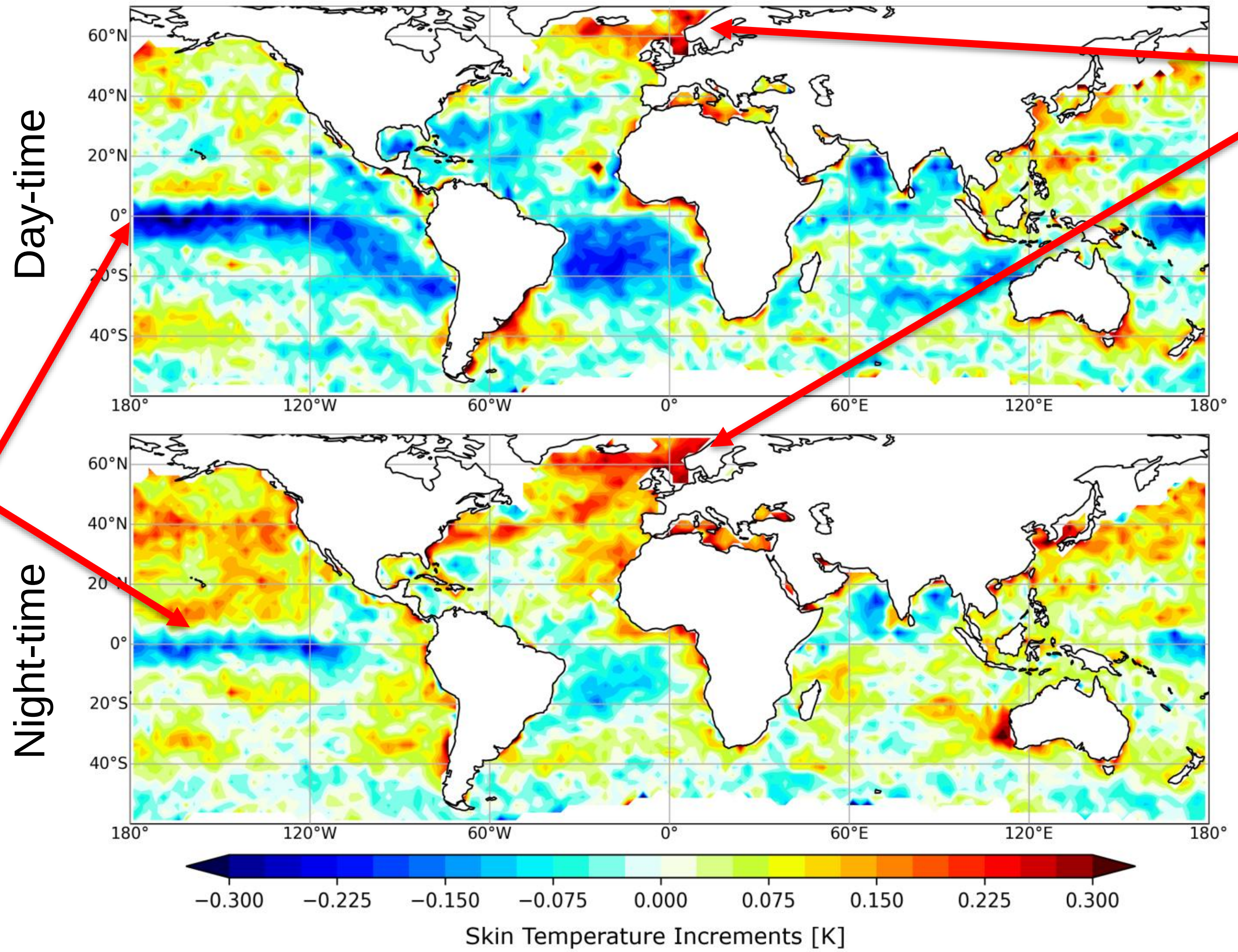
Skin Temperature Increments for January 2023

Linked to diurnal effects from SKT parameterisation

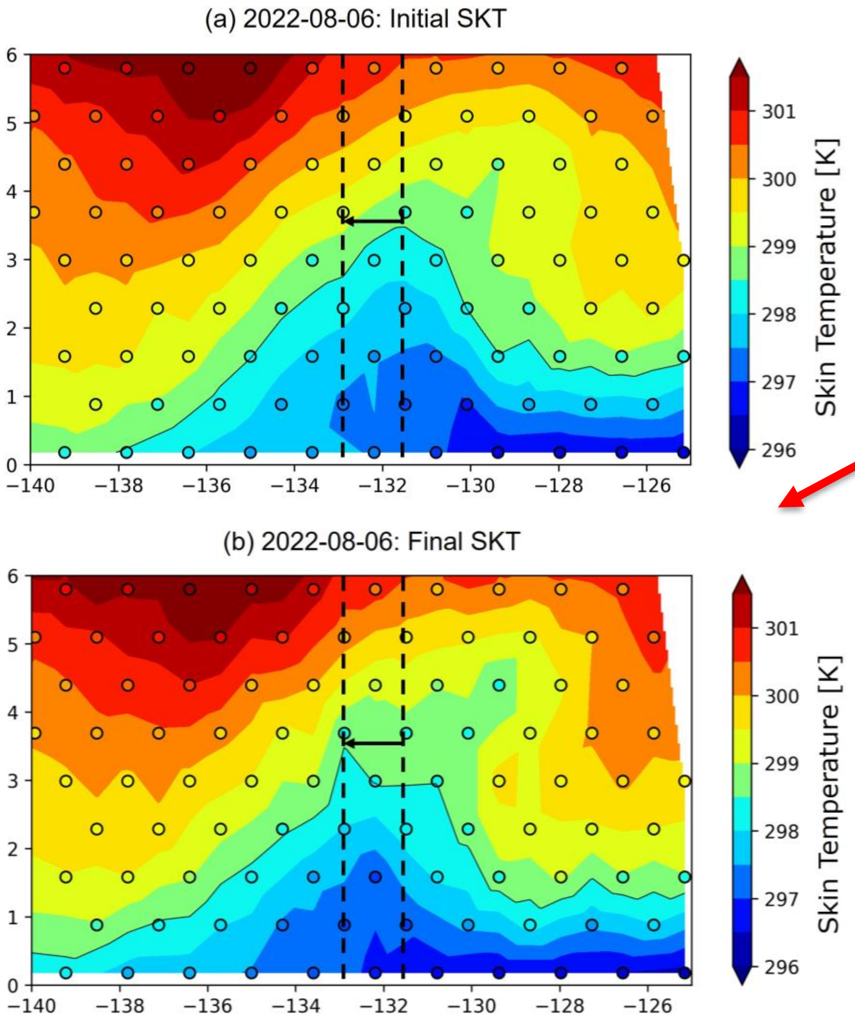
Cooling in the ETP both day and night

Linked to foundation input products

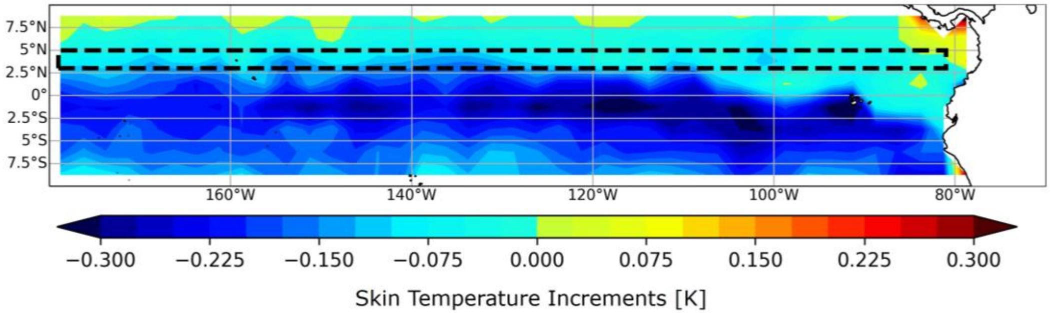
Residual effects related to model errors

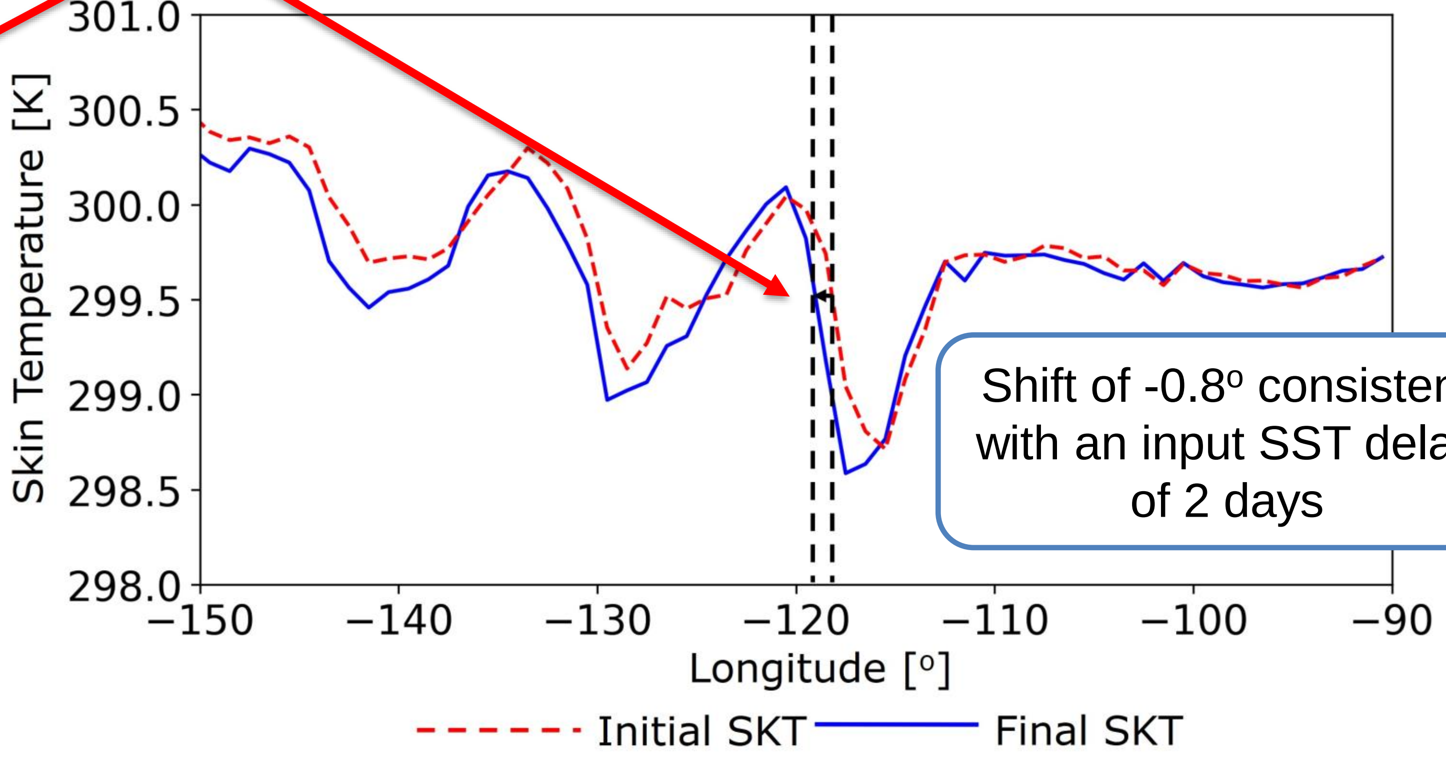


Correcting the Propagation of Tropical Instability Waves



Crests of waves moving between background and analysis





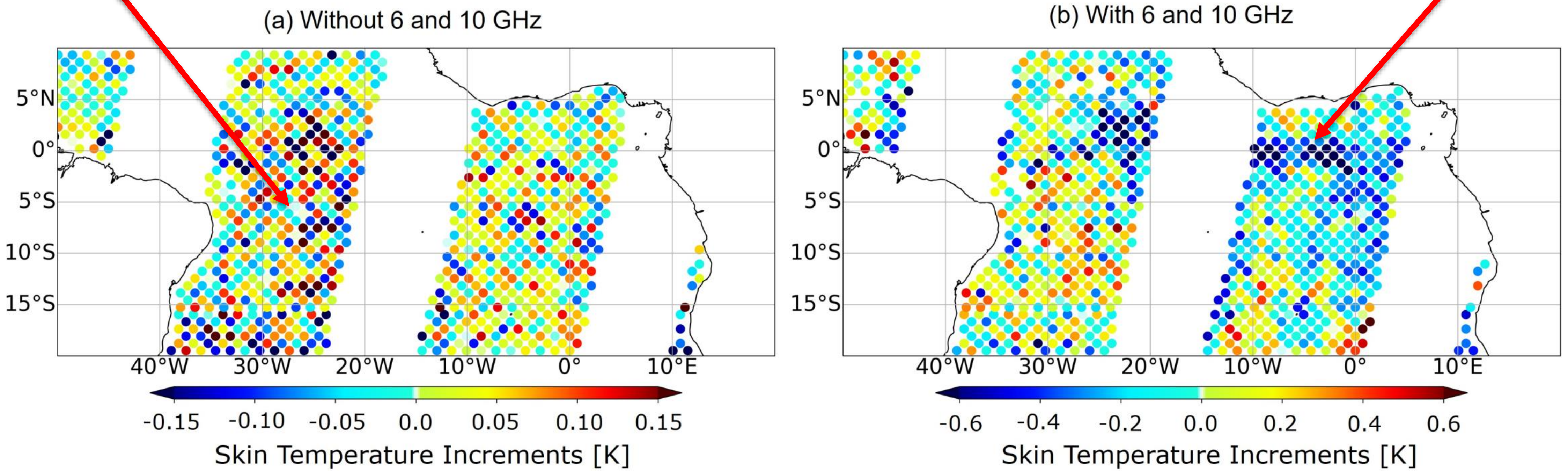
Shift of -0.8º consistent with an input SST delay of 2 days

Sensitivity of SKT increments to 6 and 10 GHz

Low magnitude increments with no pattern

Baseline channels included in both: 18.7, 23.8, 36.5, 89.0 GHz

Discernable patterns and larger magnitude



Skin Temperature Increments in the Coupled Atmosphere-Ocean System

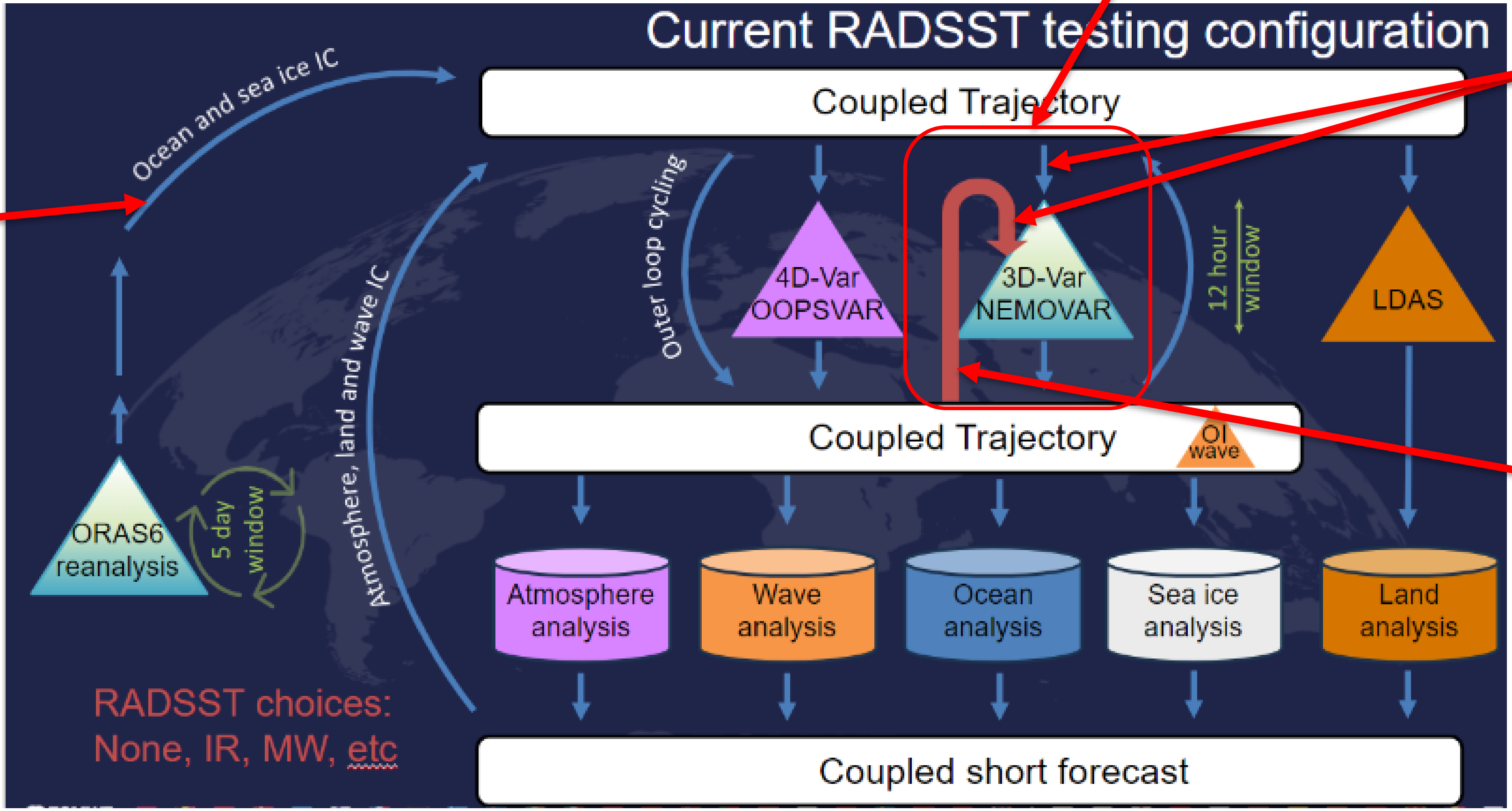
The Coupled System

Coupled ocean model

In-situ and altimeter observations

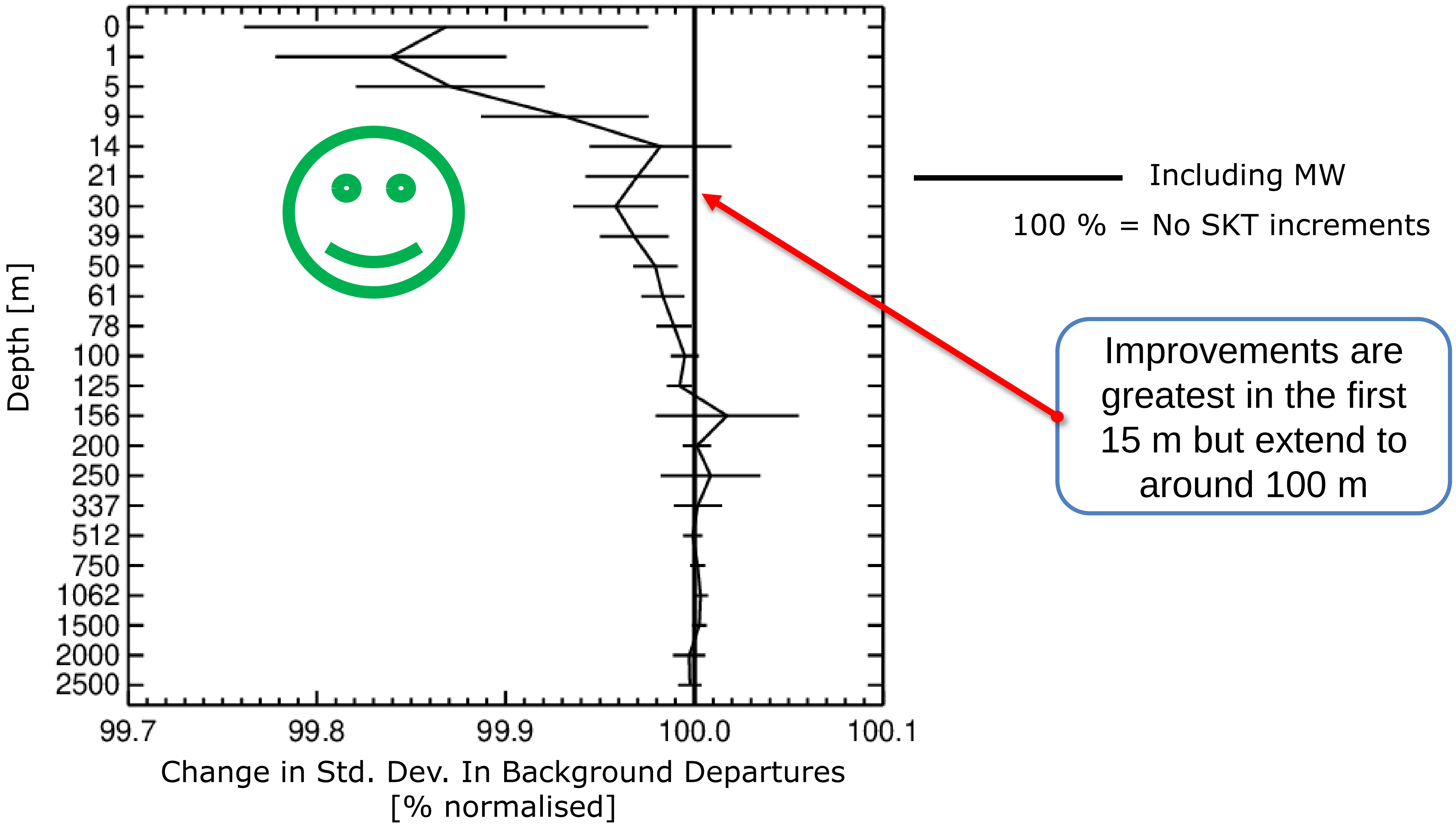
Controls re-initialisation

SST information from MW imagers added at second loop



Courtesy of Philip Browne (ECMWF)

Impact of MW on Fit of In-Situ Ocean Observations



Summary

- Microwave observations with primary sensitivity to the surface are being used for the first time.

- Meaningful skin temperature increments can be generated using microwave observations.

- Use of these increments in the coupled system result in a better fit to in-situ ocean observations.

- The following changes will become operational at CY50R1:
  - Activation of 6 and 10 GHz from AMSR2 and GMI.
  - Activation of skin temperature increments from these sensors.
  - Use of the skin temperature increments in the coupled system.

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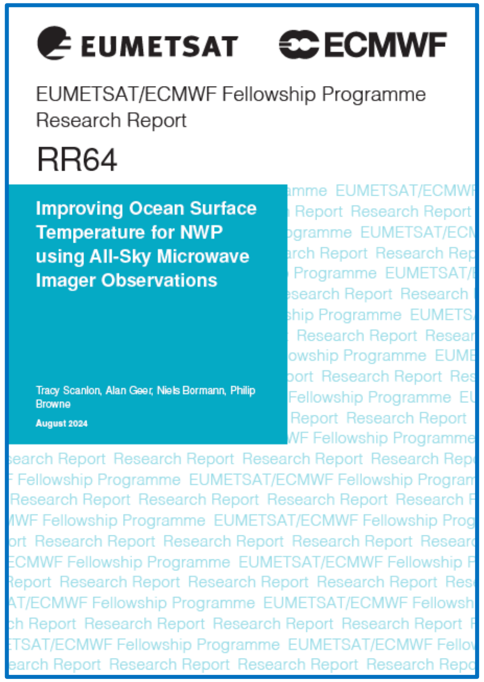
EUMETSAT ECMWF

EUMETSAT/ECMWF Fellowship Programme
Research Report

RR64

Improving Ocean Surface Temperature for NWP using All-Sky Microwave Imager Observations

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August 2024

Scanlon, T., Geer, A., Bormann, N. and Browne, P. (2024). Improving ocean surface temperature for NWP using all-sky microwave imager observations. Technical Report RR64, doi:10.21957/c16be07b23