

The GAIA-CLIM project at ECMWF and the Met Office

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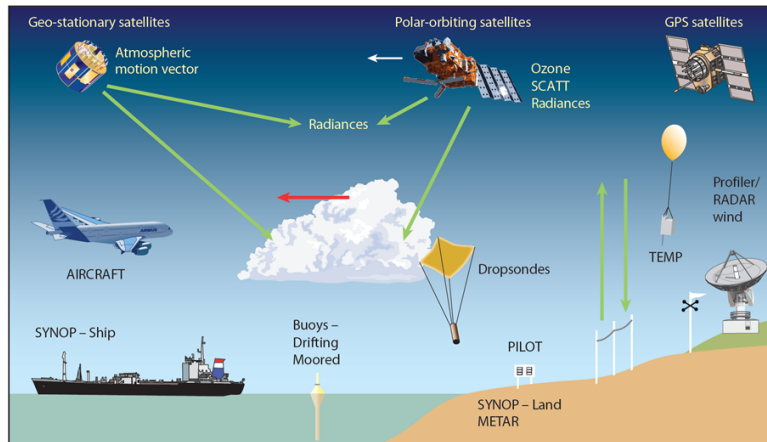
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 640276.

Background: ECMWF Numerical Weather Prediction System

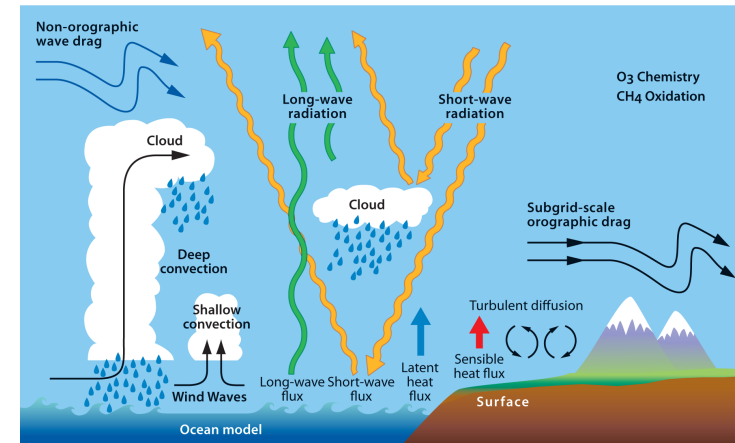
Numerical Weather Prediction at ECMWF

Providing global weather forecasts to member states since 1975

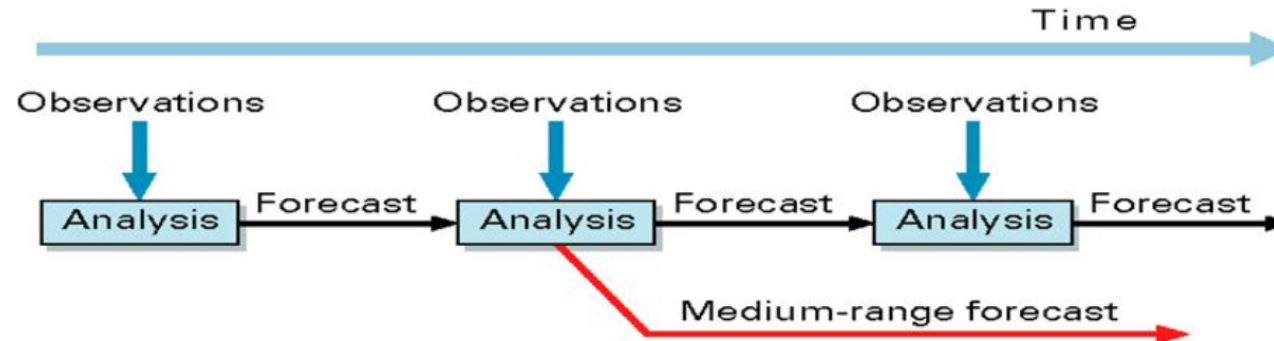
Observations



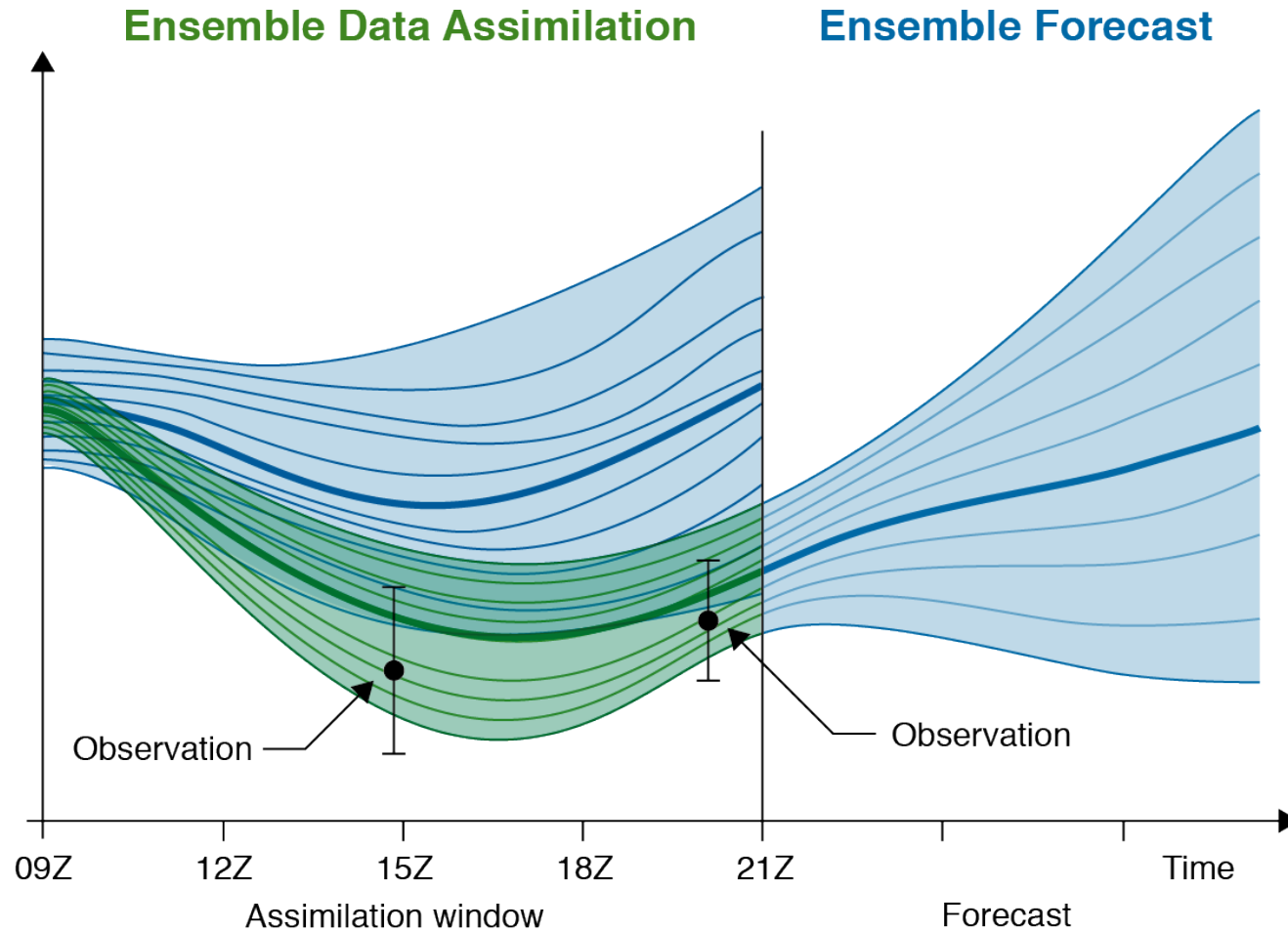
Model (atmosphere, ocean, wave, land)



Data assimilation scheme



Handling uncertainty in data assimilation



Random Errors

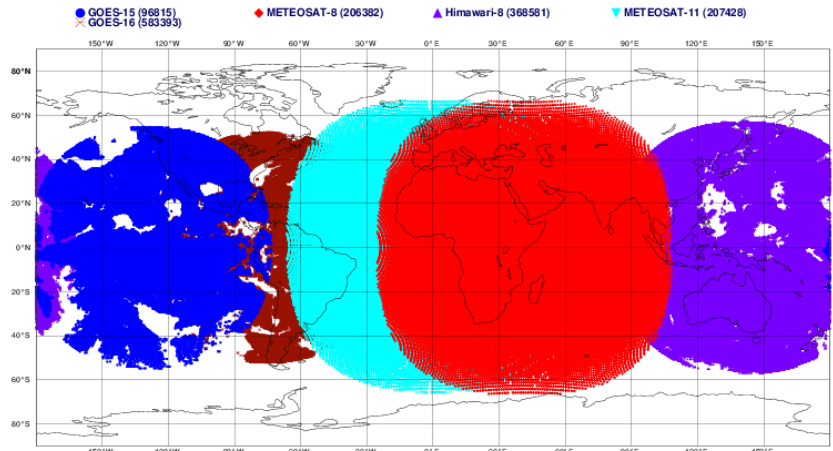
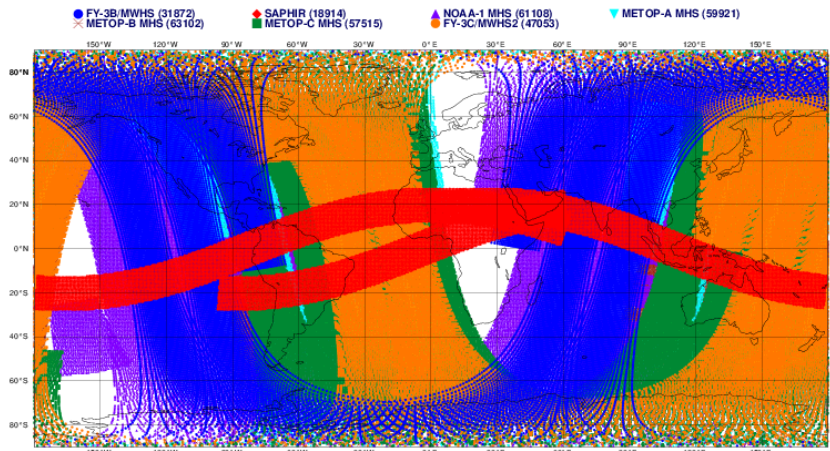
- Specified error covariance matrices **B** and **R**
- Ensemble Data Assimilation

Systematic Errors

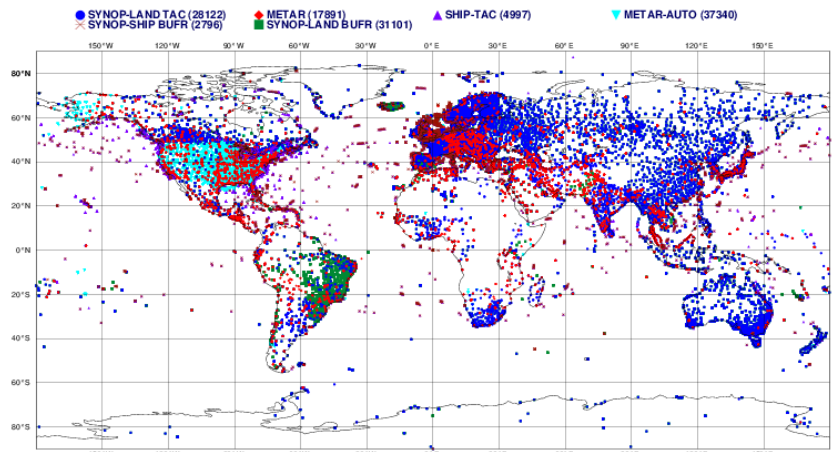
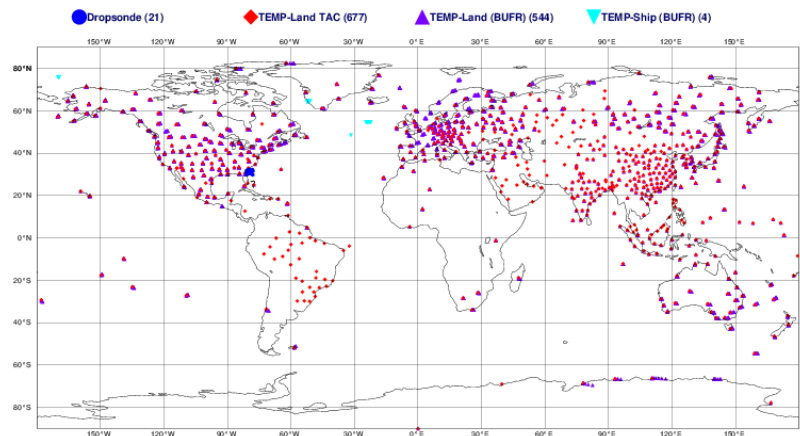
- Bias correction for observations
- Weak constraint for forecast model error (ongoing work)

Observations used at ECMWF for weather and climate

Temperature, Wind, and Humidity observations are key



*Particularly large impacts from **microwave data** (SHEM) and in-situ data (NHEM)*



*Bormann et. al. Tech Memo 839
www.ecmwf.int/publications/*

GAIA-CLIM activities: Satellite Cal/Val using NWP and GRUAN radiosondes

February 2015 – February 2018



EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

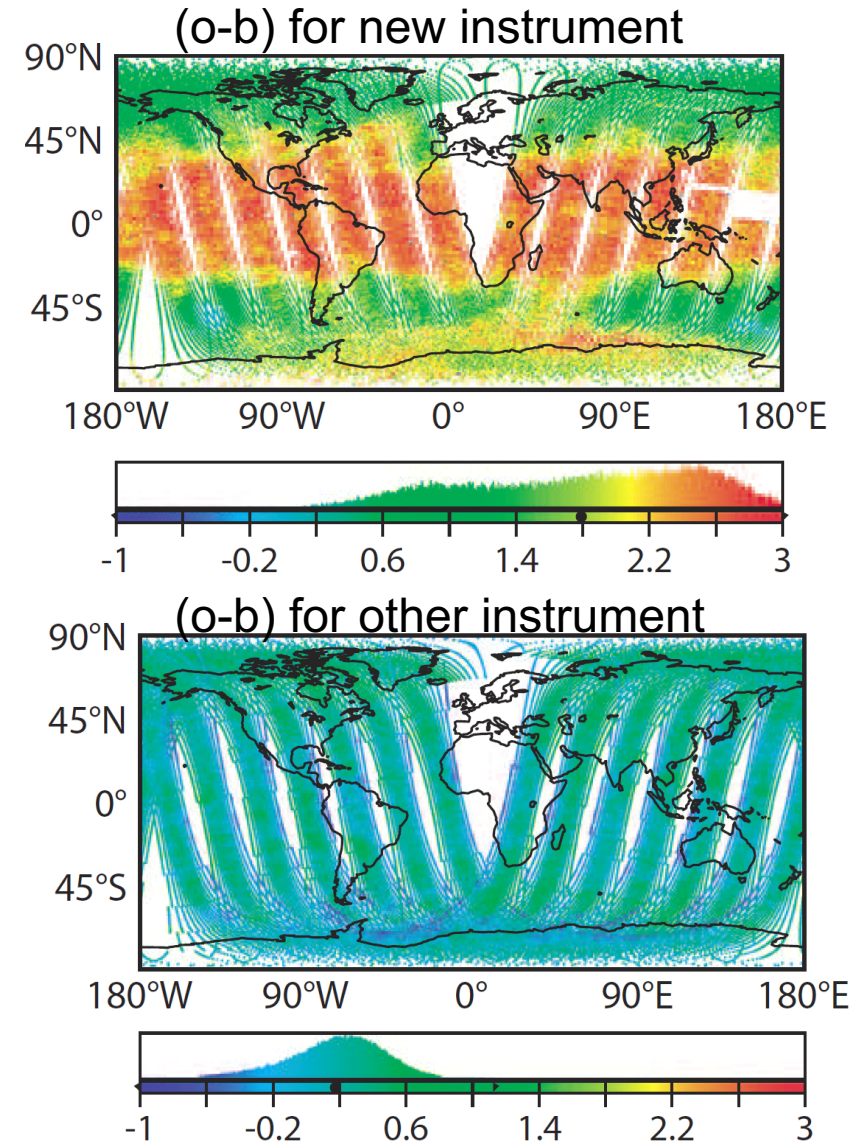


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Evaluating satellite data with NWP short-range forecasts

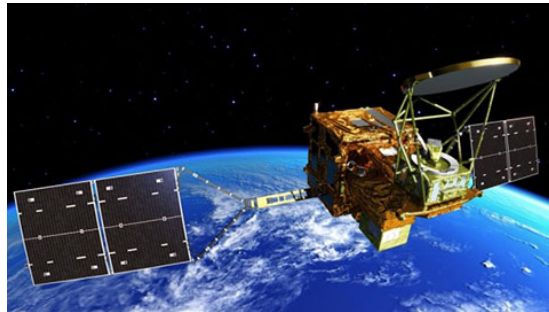
General idea:

- Compare observations (“o”) against a stable, global background (short-term forecast, “b”)
- Quality of background ensured through assimilation of a wealth of other observations
- Allows cross-comparisons to similar instruments, without collocation
- Use the background from the Met Office and ECMWF to gain an idea of forecast uncertainty

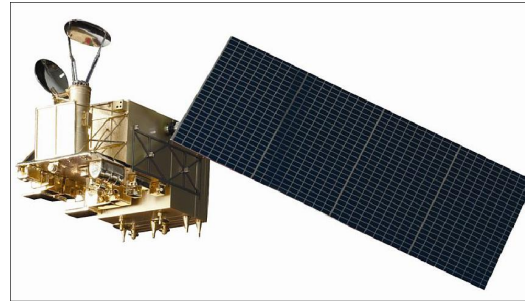


Satellite Instruments evaluated

GCOM W1 AMSR-2



FY-3C MWRI & MWHS-2



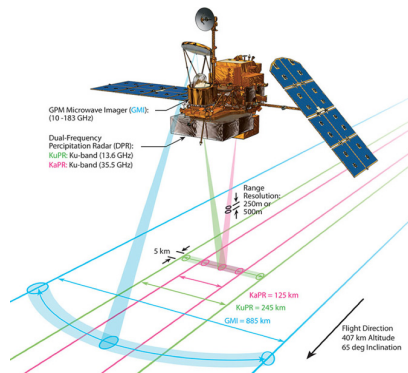
Atmospheric Temperature
and Humidity sensitive
instruments

Reports Available:

ECMWF Tech. Memo. 798

GAIA-CLIM deliverable D4.6
<http://www.gaia-clim.eu/system/files/document/d4.6.pdf>

GPM GMI

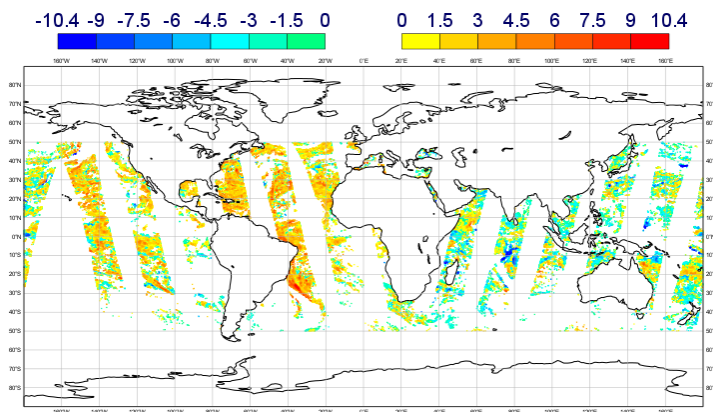


Meteor MTVZA-GY

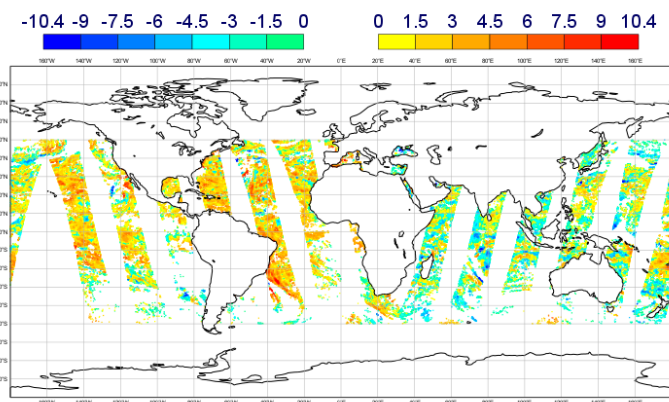


Satellite data evaluated during GAIA-CLIM: FY-3C MWRI

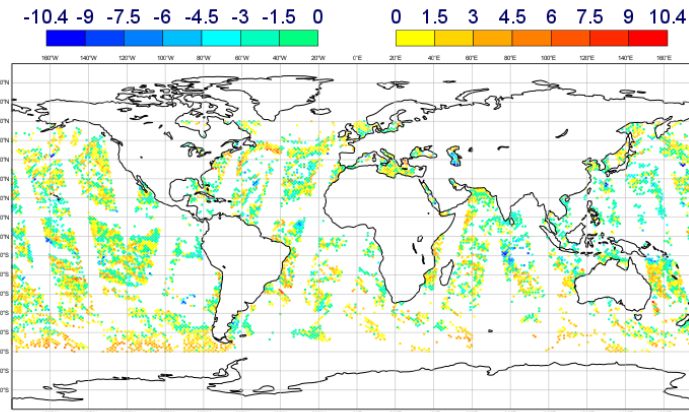
ECMWF O – B minus global average: 23V channel



Met Office O – B minus global average: 23V channel

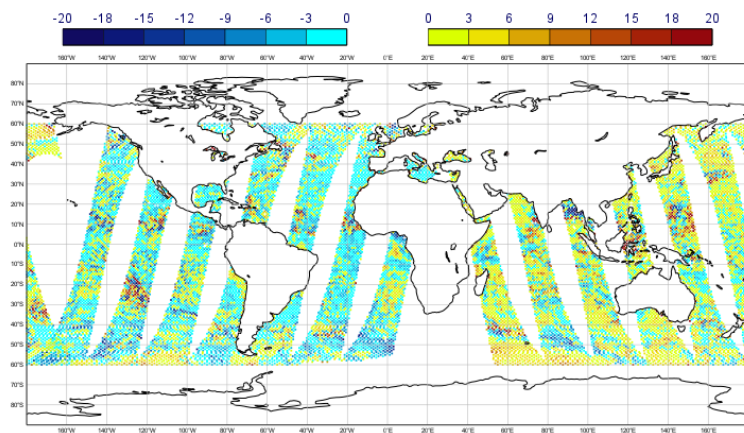


ECMWF AMSR-2 O – B minus global average:
23V channel



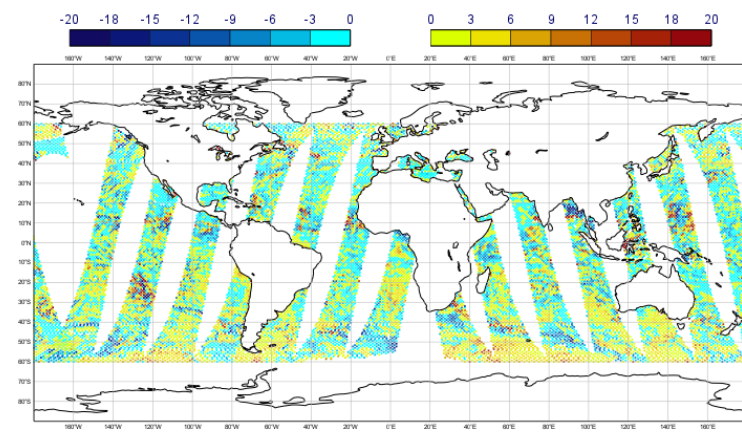
Current MWRI 37V

37V channel: O - B (K) minus global average



Test MWRI 37V

37V channel: O - B (K) minus global average

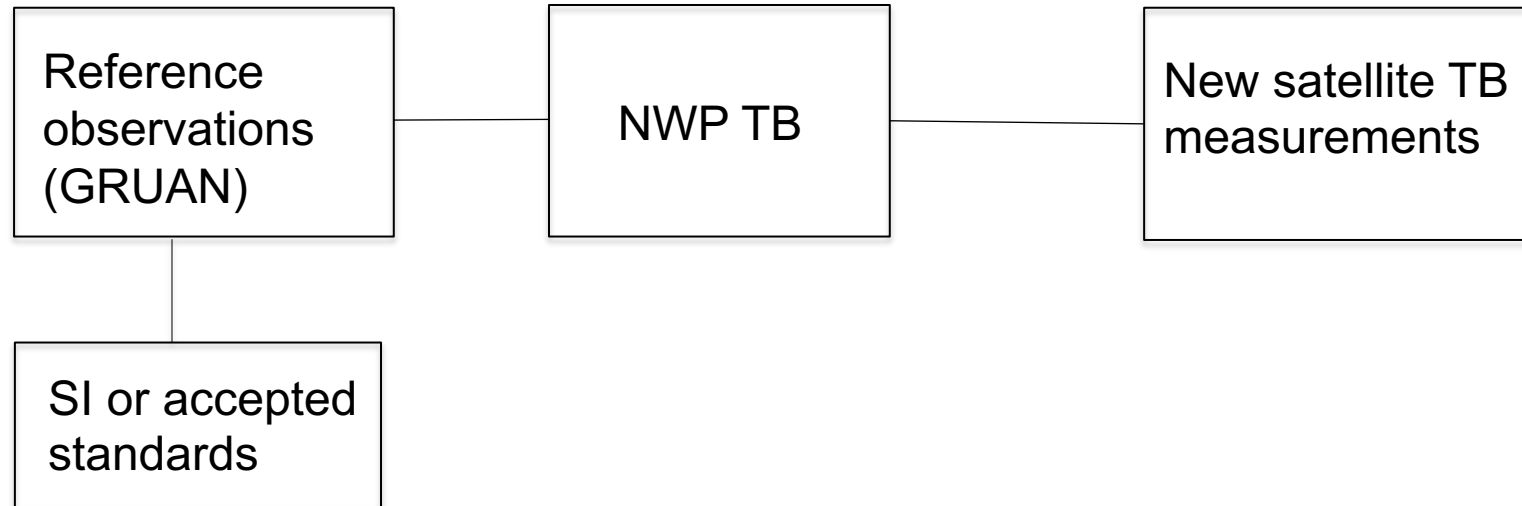


Correction developed:

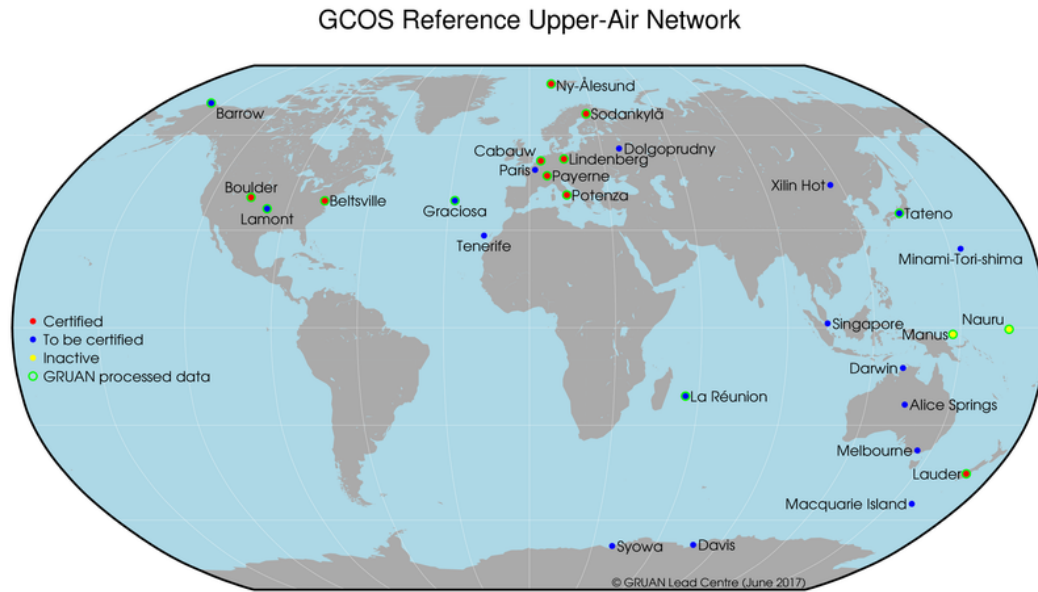
Xie et. al. IEEE TGRS 2018

Linking NWP to reference standards

1. Explore using NWP as a reference for validating new satellite data



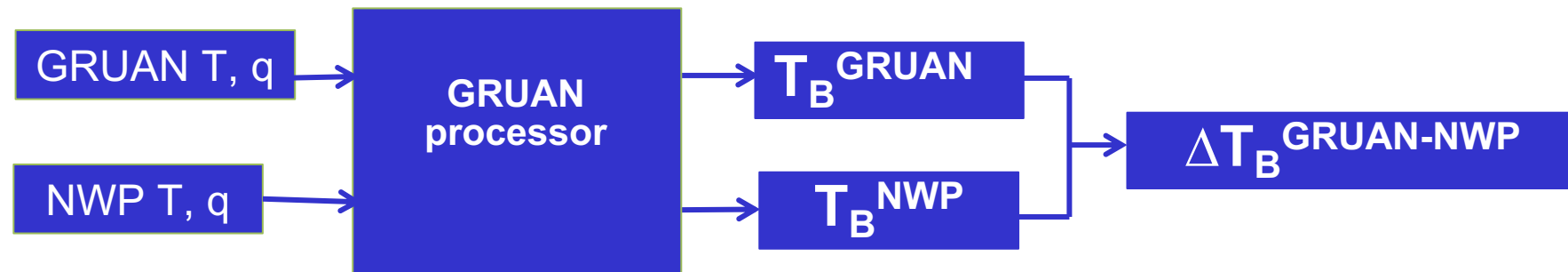
Compare GRUAN reference radiosonde data to NWP forecasts



Dirksen et al 2014:

- RS92 reprocessed radiosonde observations
- Comprehensive uncertainty budget
- Validated with dual launches

The GRUAN processor (Carminati et al, 2018):

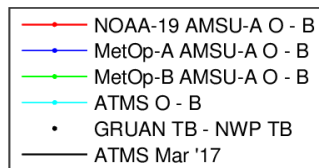
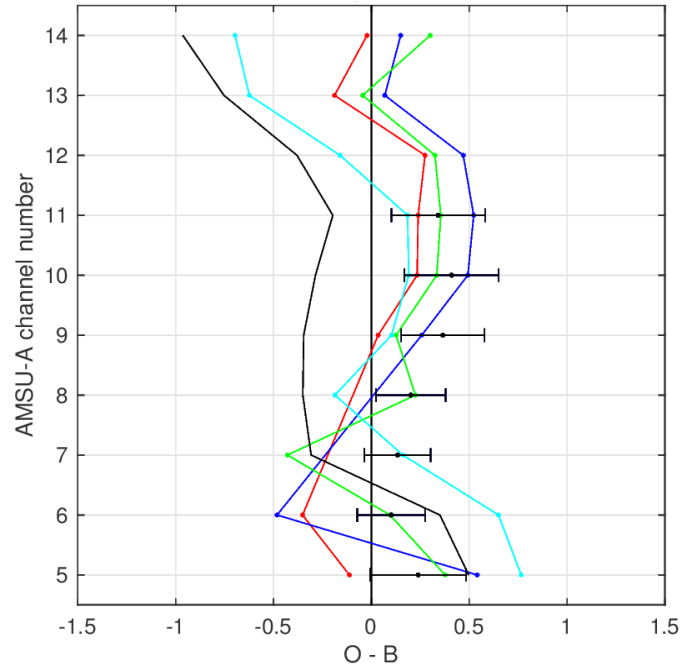


Results presented by Fabien Carminati

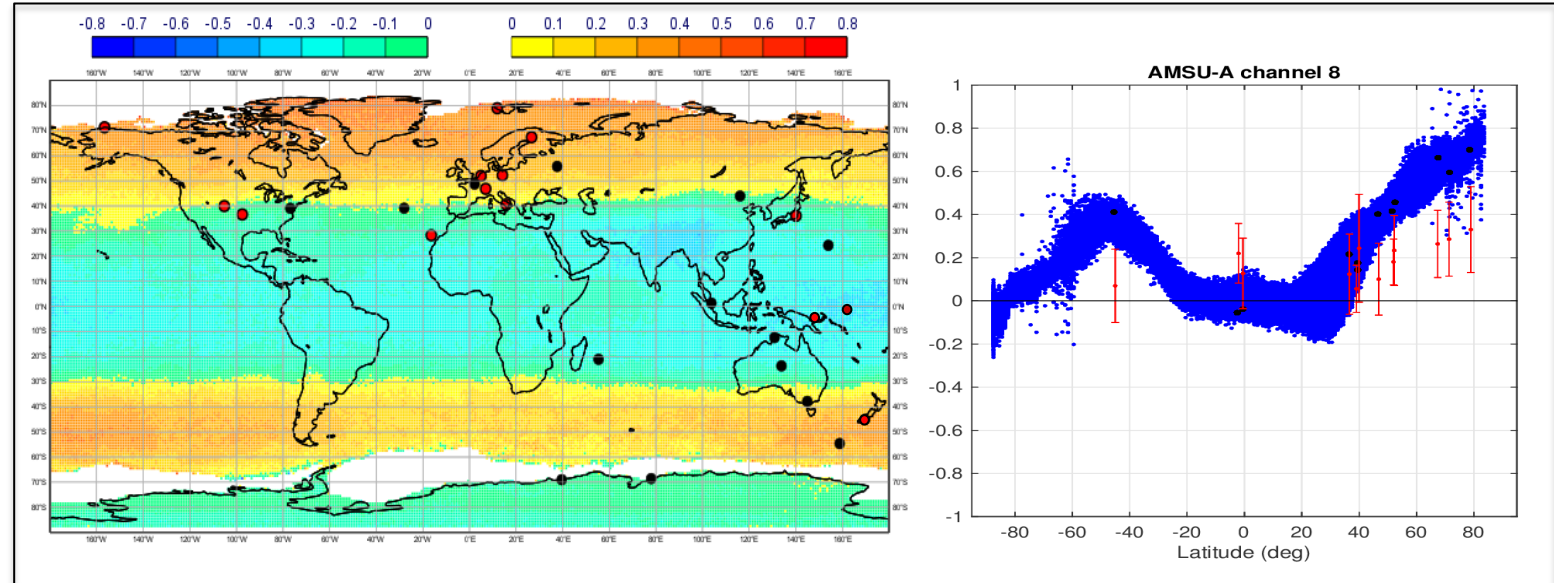
First Steps in evaluating satellite data to reference standards

AMSU-A Global and Geographical Mean O - B

AMSU-A/ATMS global biases



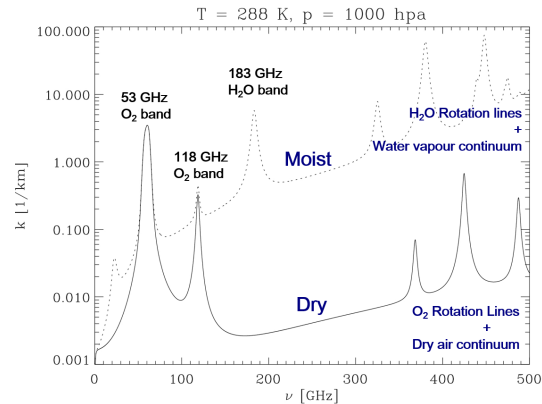
MetOp-B AMSU-A channel 8 July 2016



Forecast bias can explain some of the mean O – B but not all

Instrument error? Forward model error? Representation error?

GAID document: Gaps in validating satellite data to reference standards



RTTOV uncertainties

Estimate sources of uncertainty in AMSUTRAN

(e.g. applying method of Domenico Cimini et al, *Atmos Chem Phys*, 2018)

Ocean emissivity uncertainties:

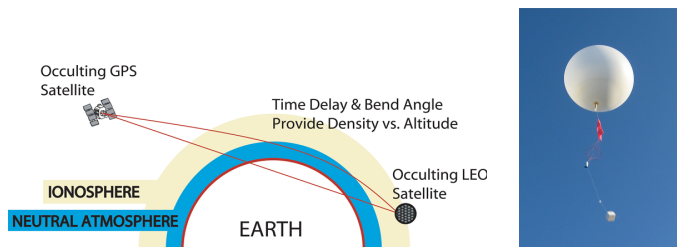
Lack of ocean emissivity reference model

Uncertainties in FASTEM emissivity model are needed:

Permittivity + rough surface and foam effects

Expansion of reference data networks

- More GRUAN sites (Southern Hemisphere) with better characterised systematic/random uncertainties
- GPSRO?



Summary

- NWP short-range forecasts provide global, accurate fields which are able to identify instrument anomalies but are not linked to reference standards
- In GAIA-CLIM the GRUAN data were used to link NWP to reference standards for atmospheric temperature and humidity
- Recommendations were made for further work including estimating forward model uncertainties, expanding reference networks
- A better knowledge of uncertainties in random and systematic errors could be used in bias correction and observation error models in data assimilation

See e.g. Bill Bell's presentation