TROPICS for global weather forecasting

TROPICS applications telecon, 21st December 2017

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Thanks to: Heather Lawrence, Niels Bormann

ECMWF

Overview

- Current impact of microwave radiance observations at ECMWF
  - All-sky assimilation
  - Great benefits from 183 GHz

- Experience with 118 GHz observations from MWHS-2

- Objectives for TROPICS assimilation at ECMWF:
  - Learn how to use smallsat missions in global NWP
  - NRT data required

Current impact of microwave observations at ECMWF

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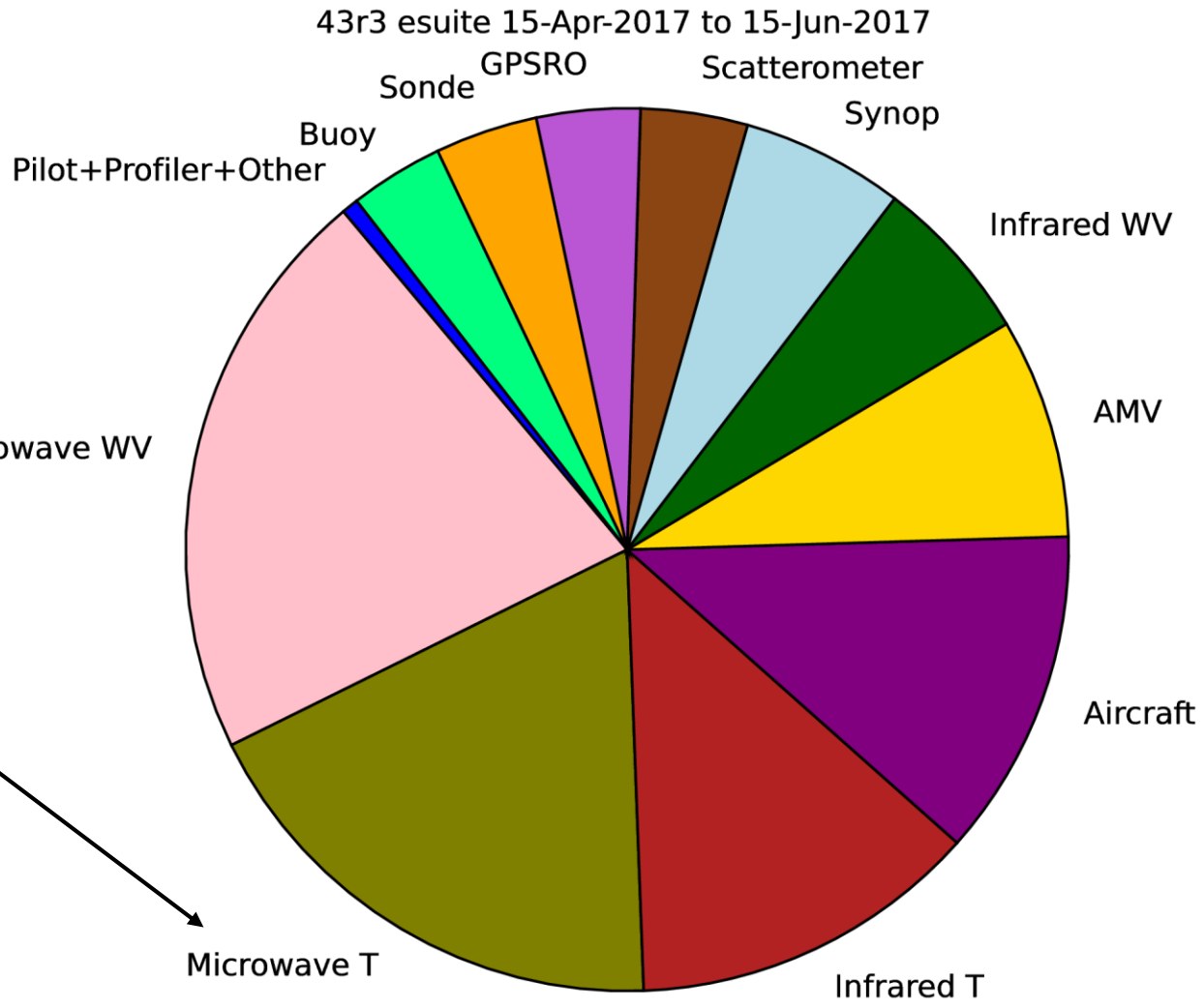
Relative FSOI (forecast sensitivity to observation impact)



Microwave radiance observations dominate, providing around 40% of observation impact

How?

- All-sky, all-surface assimilation
- Many sensors assimilated
- 4D-Var tracing of humidity, cloud and precipitation
- High accuracy T channels

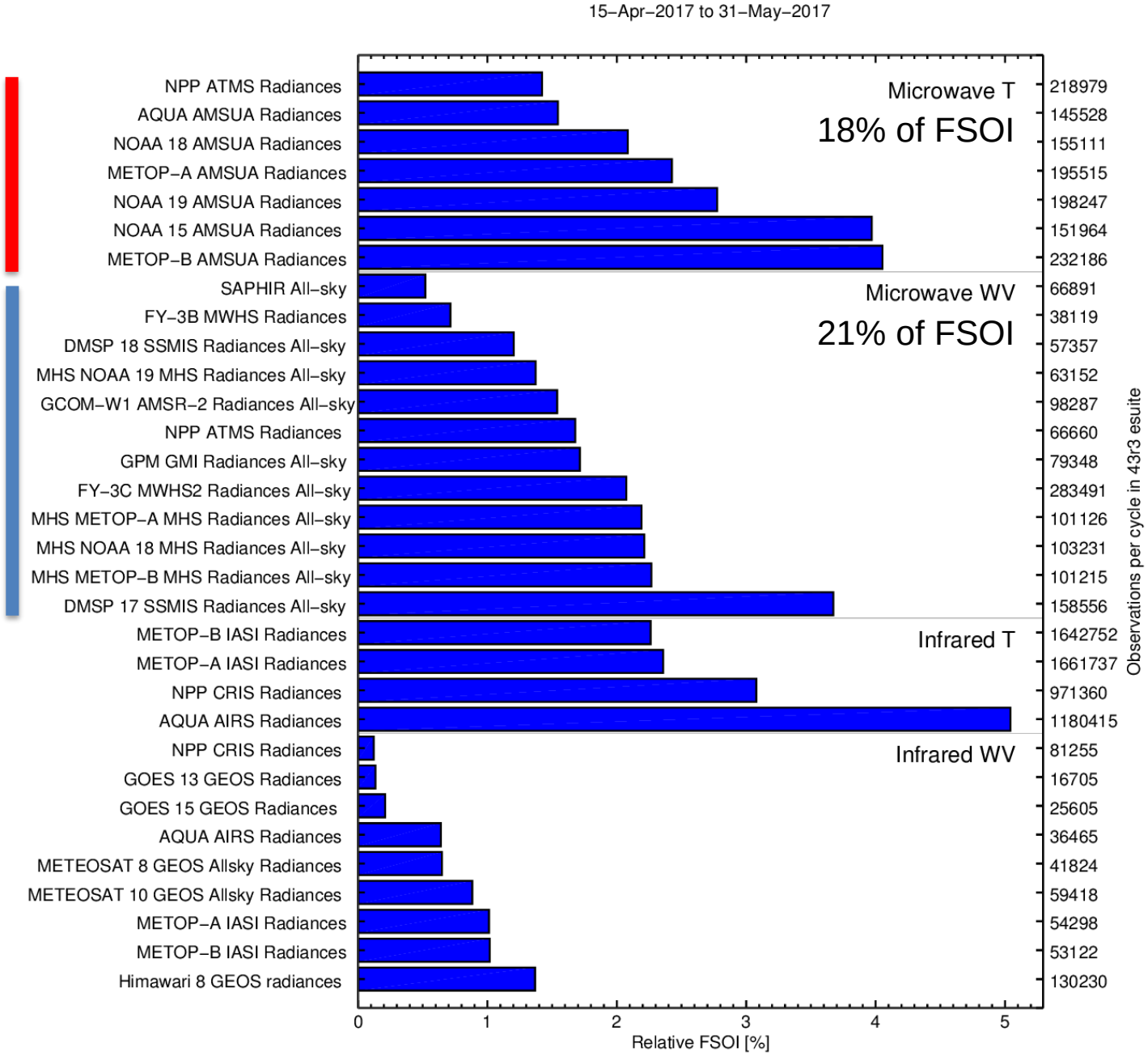
Relative FSOI by satellite and instrument

AMSU-A and ATMS temperature channels (50 GHz)

- Ocean, land, snow and sea-ice
- But not yet all-sky

Humidity, cloud and precipitation sensitive channels

- Imager channels (19 – 90 GHz) over non-polar oceans
- WV sounding channels (183 GHz) over ocean, land, snow and sea-ice
- Almost everything assimilated in all-sky conditions



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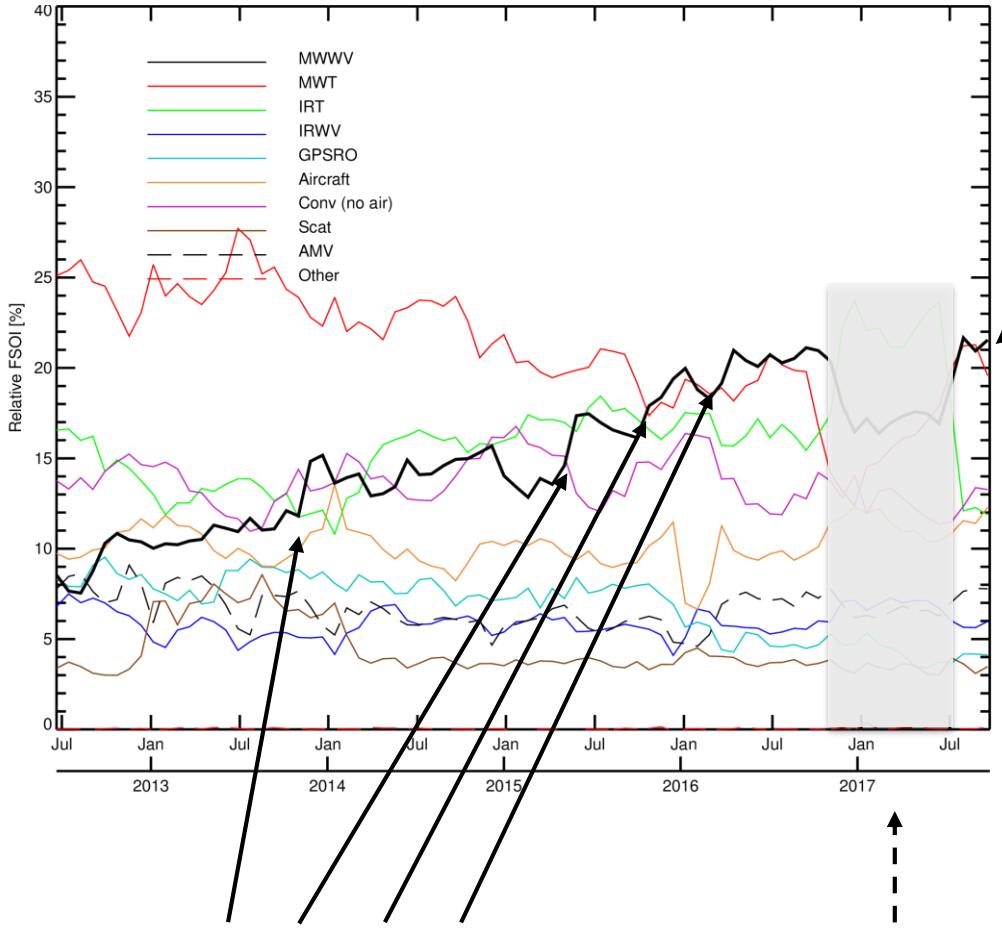
The recent development of all-sky microwave humidity assimilation

Relative FSOI from different observing system components
(FSOI = adjoint-based measure of short-range forecast impact)



Microwave water vapour, cloud and precipitation radiances from **12 sensors**

Addition of more all-sky microwave data

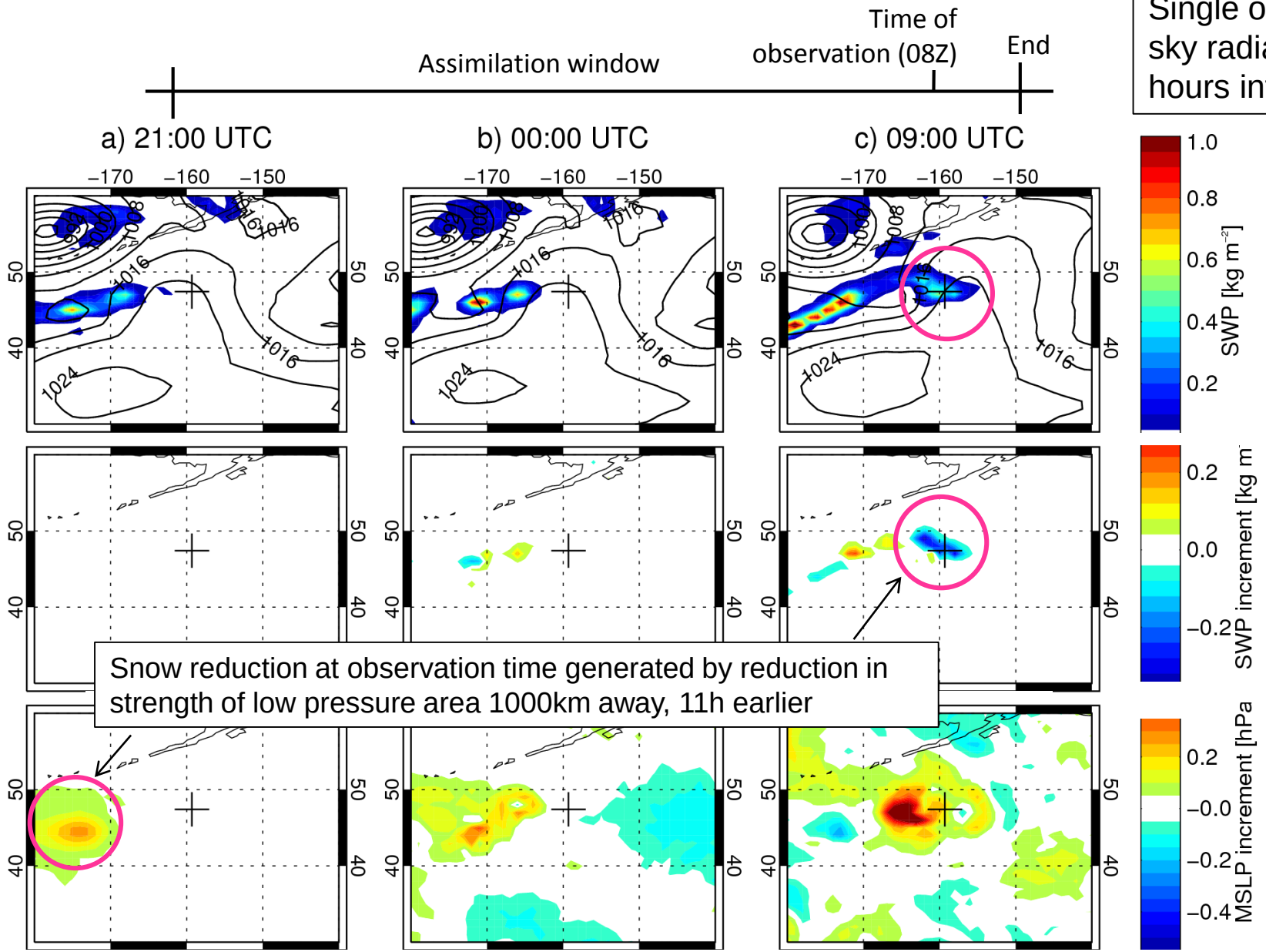
(cycle 43r1 relative FSOI is incorrect due to correlated IR errors)

For more information see very recent 2017 papers:

- Review of ECMWF developments: DOI:10.1002/qj.3172
- Overview of all-sky assimilation at NWP centres: DOI:10.1002/qj.3202
- ECMWF strategy for all-sky assimilation: ECMWF TM 815

All-sky mechanism: generalised “tracer effect” in 4D-Var

Single observation test case: all-sky radiance observation valid 11 hours into the 4D-Var window



Experience with 118 GHz channels of MWHS-2

See “Evaluation and assimilation of the microwave sounder MWHS-2 onboard FY-3C in the ECMWF numerical weather prediction system”, Lawrence et al., 2018, accepted TGRS

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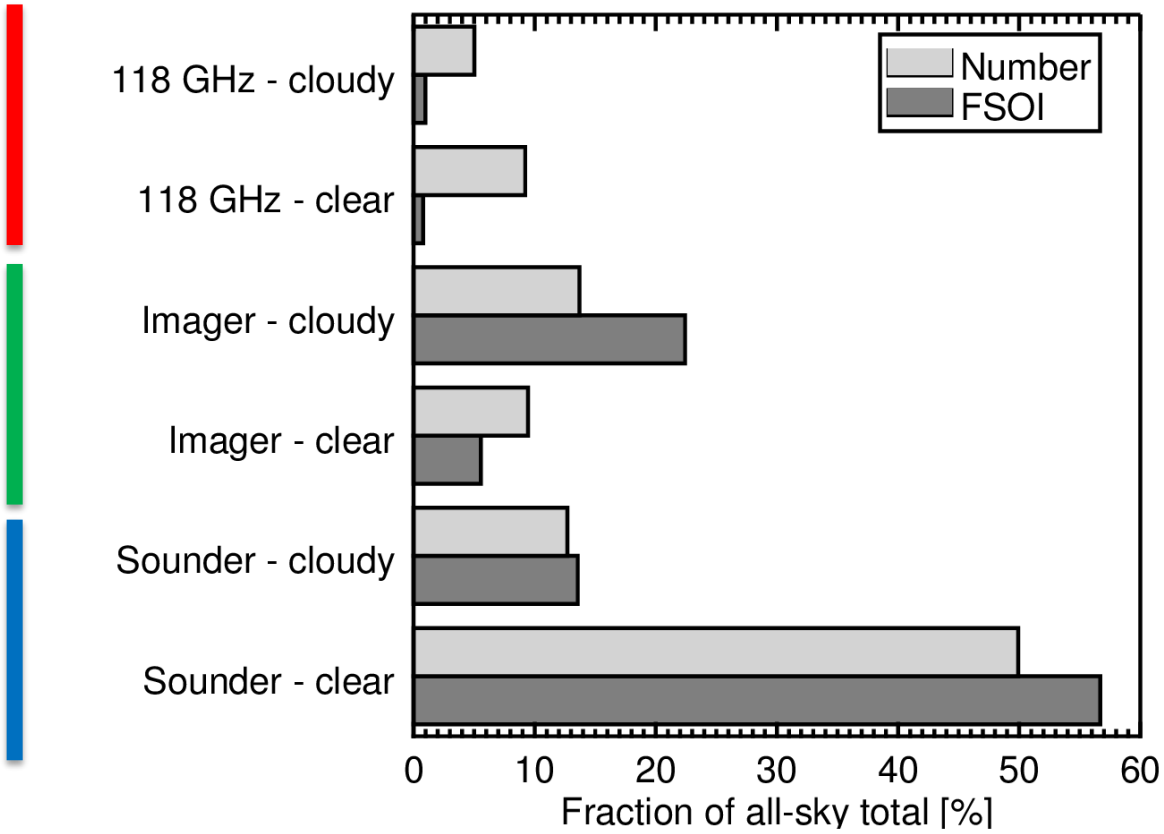
Impact of MWHS-2 channels 2-7 (118 GHz temperature channels)

MWHS-2
118 GHz

SSMIS, GMI,
AMSR2
19 - 90 GHz

2xSSMIS,
4xMHS,
MWHS-2
183 GHz



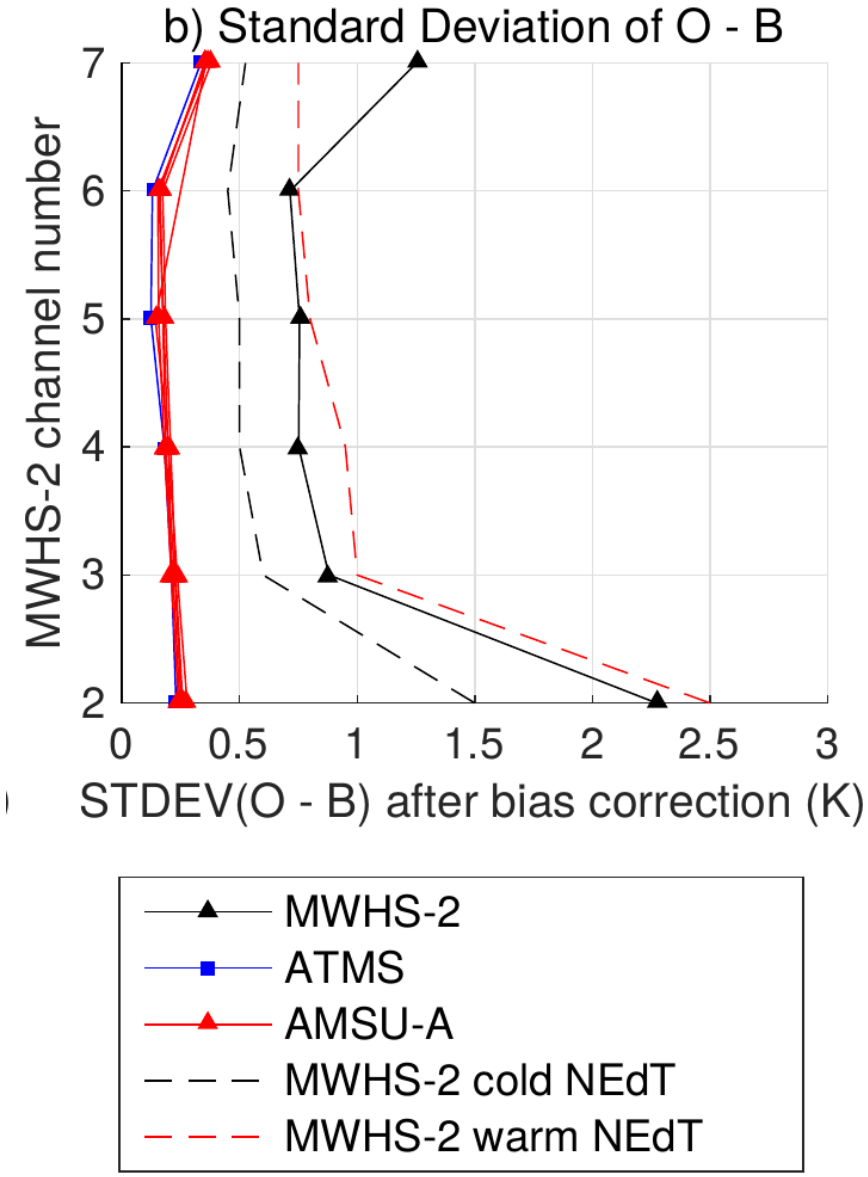
Breaking down the “microwave water vapour” relative FSOI by channel type

Per-observation impact of 118 GHz is currently small – why?

NEdT is large compared to equivalent AMSU-A channels

Relative errors

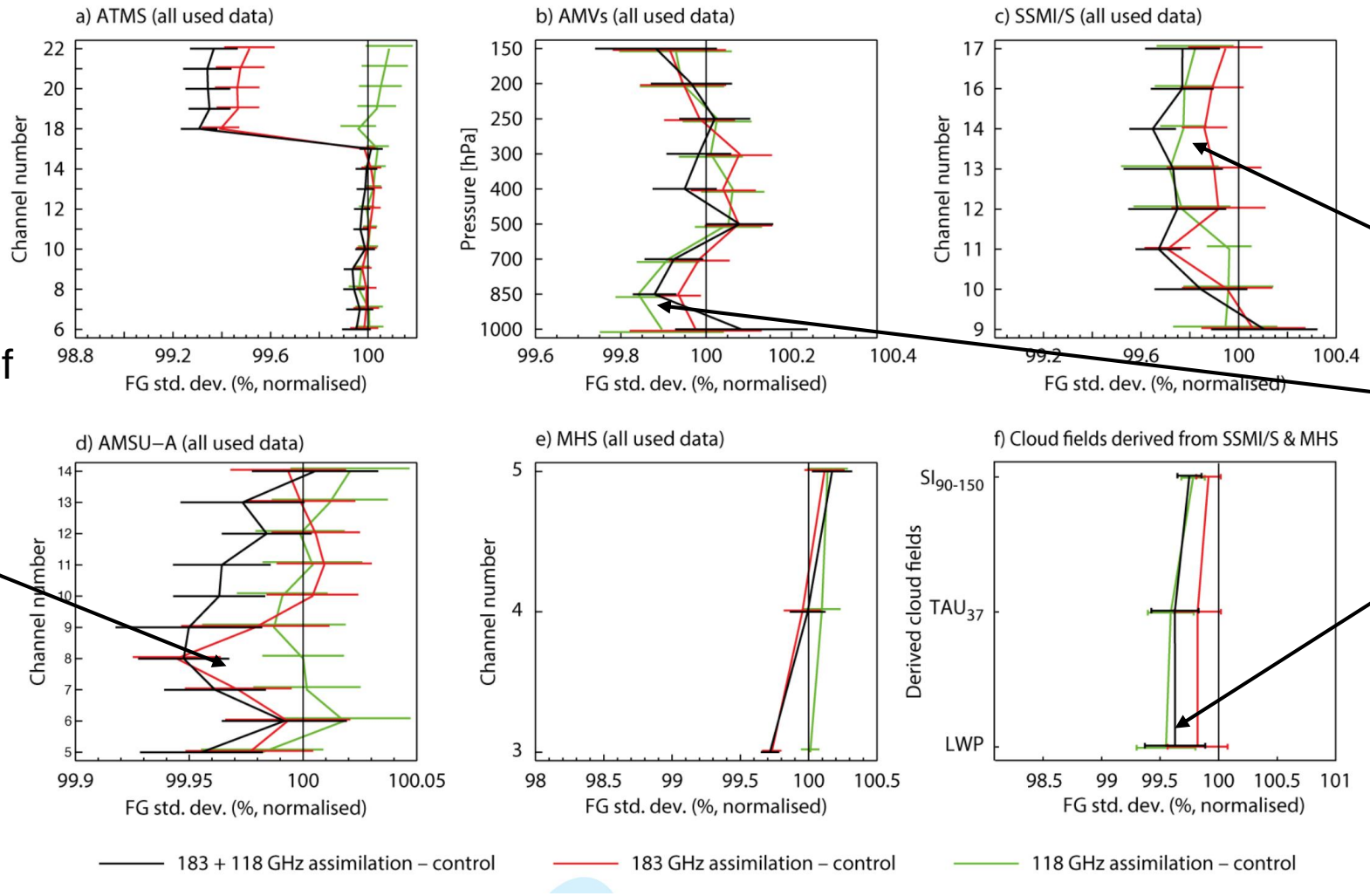
- Temperature forecast errors: 0.1K
- AMSU-A NEdT: 0.15 – 0.4 K
- MWHS-2 NEdT: 0.5 – 1.0 K



Impact of MWHS-2 183 and 118 GHz channels

Measured by first-guess fit to other observations

183 GHz channels improve forecasts of upper-tropospheric temperature



118 GHz channels improve forecasts of low-level water cloud and wind

Objectives for TROPICS data in global weather forecasting

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Possible impacts

Expected impacts (based on existing examples):

- 183 GHz data will improve global forecasts as does existing data
- 118 GHz data should improve low-level cloud, moisture and winds

Speculative impacts:

- Tropical cyclones, tropical convection diurnal cycle, equatorial waves?
- Benefit from 90 GHz and 220 GHz channels as for microwave imagers?
- Frequent coverage may reduce 118 GHz effective noise, boosting the temperature information content

Using smallsat data operationally

Will the data be available in near-real time (NRT)?

- This is critical for the engagement of operational forecasting centres

Can we update our operational processing infrastructure quickly enough?

- A typical research mission may only become operational at weather centres 1 – 2 years after launch. This is (already) not good enough.

Calibration stability and accuracy

- Inter-satellite calibration is not a big concern: we will use adaptive bias correction (VarBC) to correct satellite-specific biases
- But complex time-dependent biases are harder to deal with – e.g. orbital-dependent biases

Summary

- Current impact of microwave radiance observations at ECMWF
  - Around 40% of all impact comes from microwave satellite radiances
  - All-sky, all-surface assimilation
  - Great benefits from 183 GHz

- Expected impact from TROPICS in global forecasting
  - 183 GHz channels key
  - 118 GHz cloud, low-level moisture, (?) temperature

- Objectives for TROPICS assimilation at ECMWF
  - Learn how to use smallsat missions in global NWP
  - **NRT data required**