Global observing system experiments in the ECMWF assimilation system

Niels Bormann, Heather Lawrence, David Duncan, Fernando Prates, Jacky Farnan

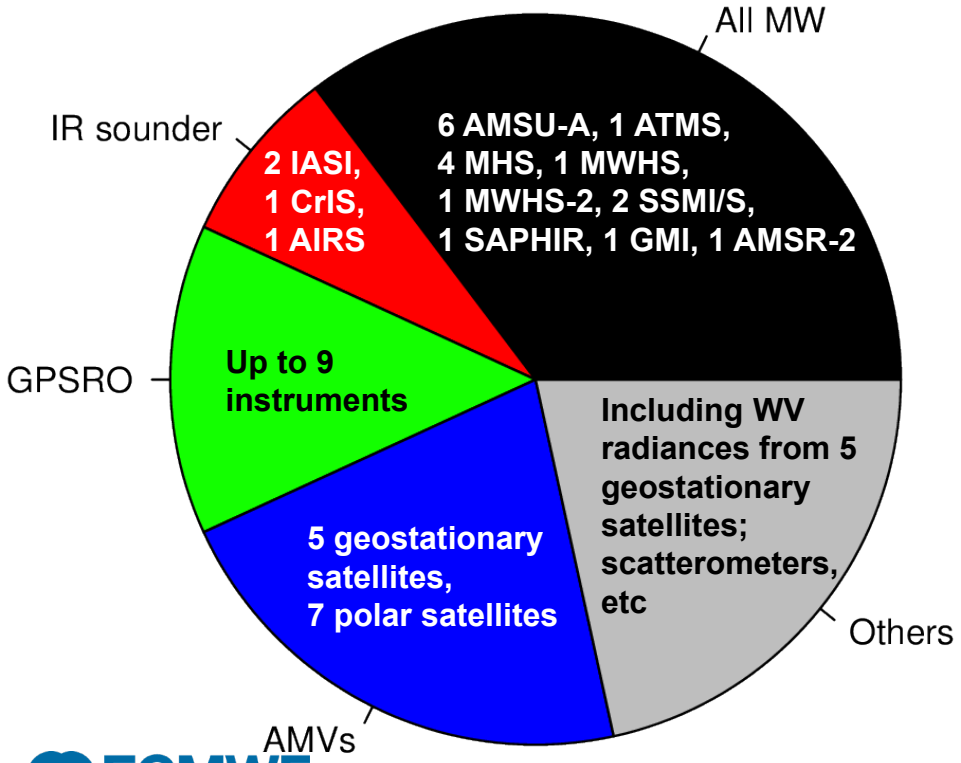
ECMWF

Observing system experiments

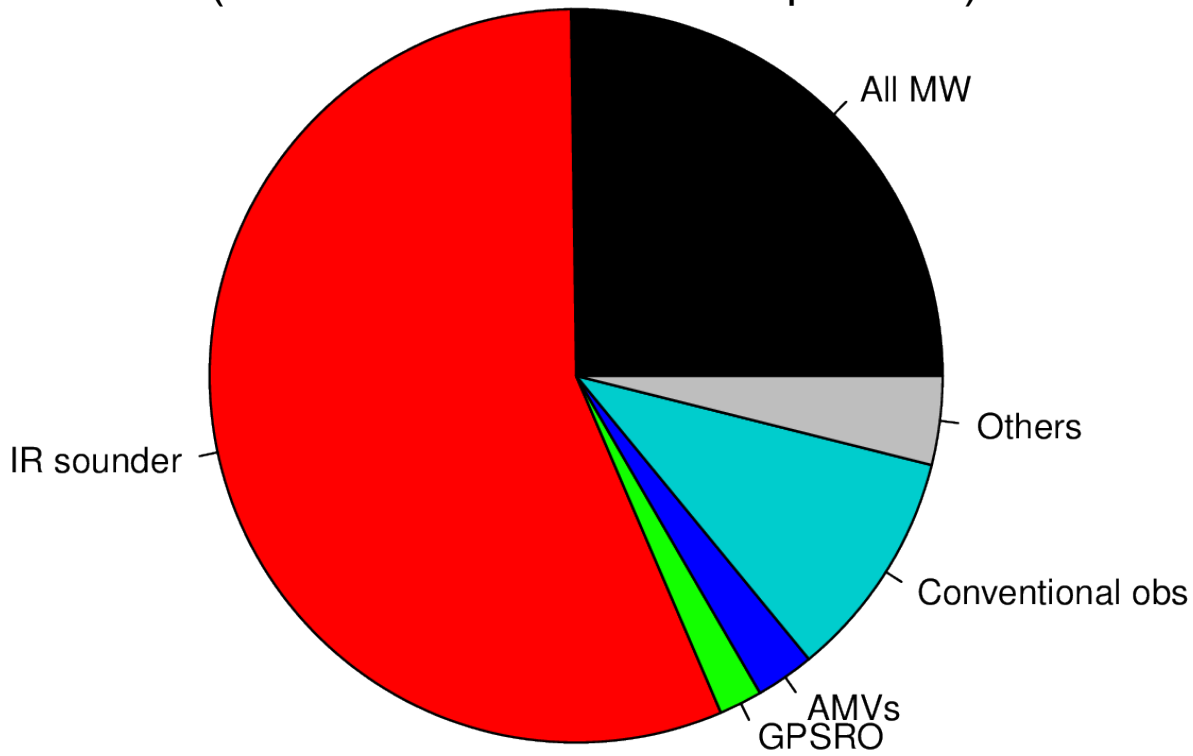
(Bormann et al. 2019, ECMWF Tech Memo 839)

- Denial experiments compared to a full system for:
  Conventional observations, MW radiances, AMVs, IR sounders, GPSRO
- Periods: 1 June – 30 September 2016; 1 December 2017 – 31 March 2018; (ie 2 x 4 months)

Assimilated satellites/ instruments

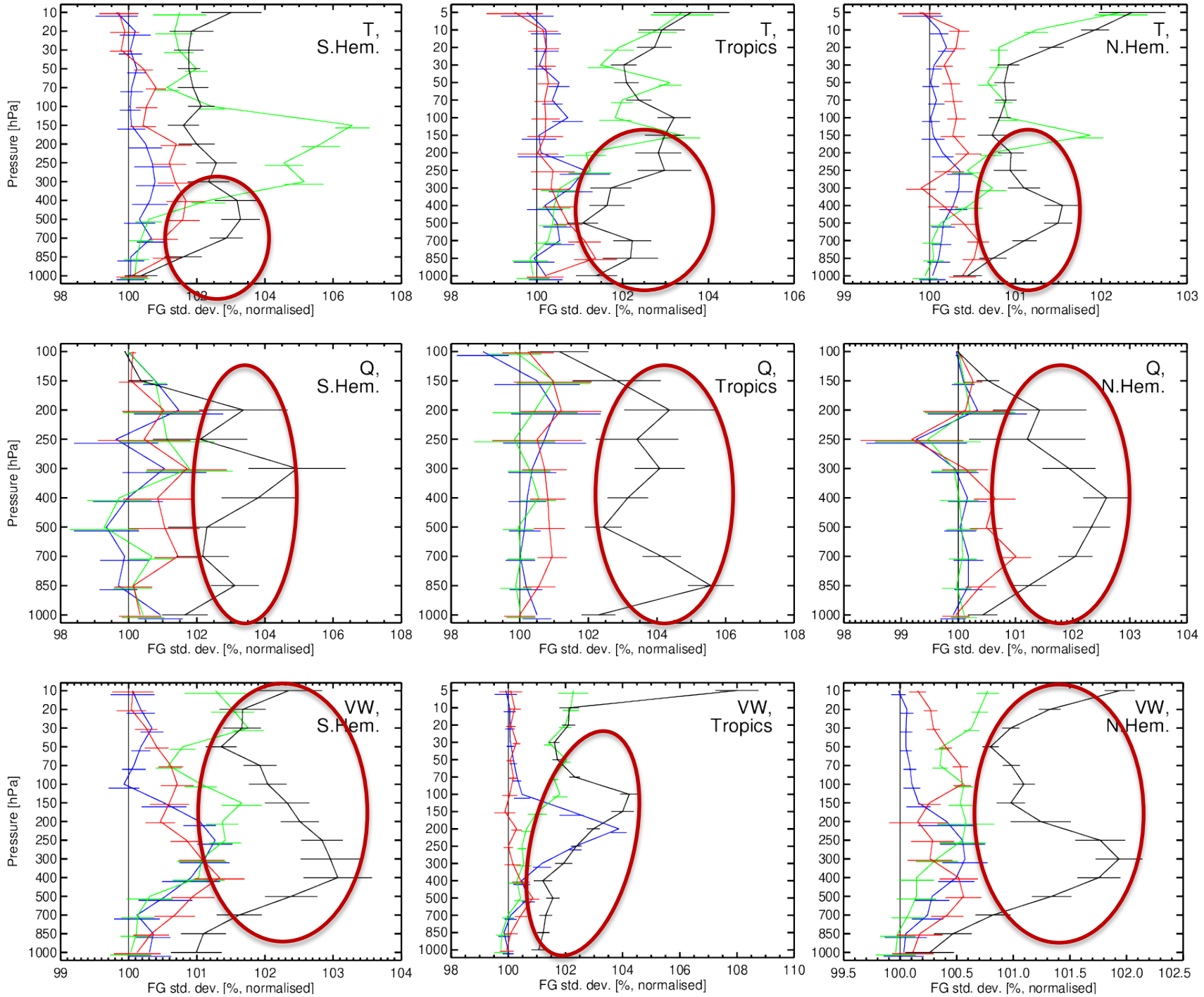


Assimilated observations
(Total number: ~ 20 Million per 24 h)



Short-range forecast impact vs radiosondes

- **Strong impact from MW**



MW denial – Control
IR sounder denial – Control
GPSRO denial – Control
AMV denial – Control

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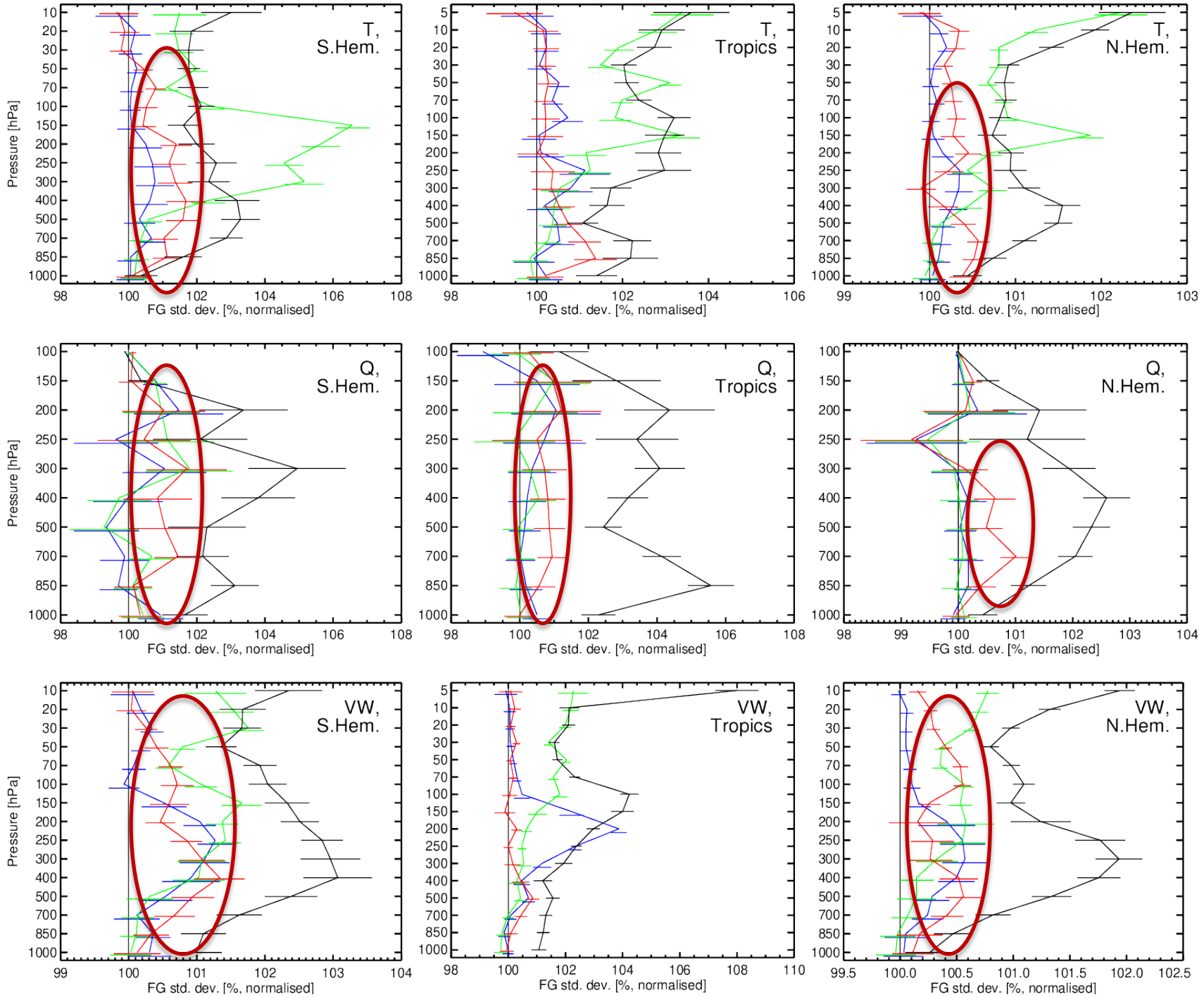
- **Significant impact from IR sounders**



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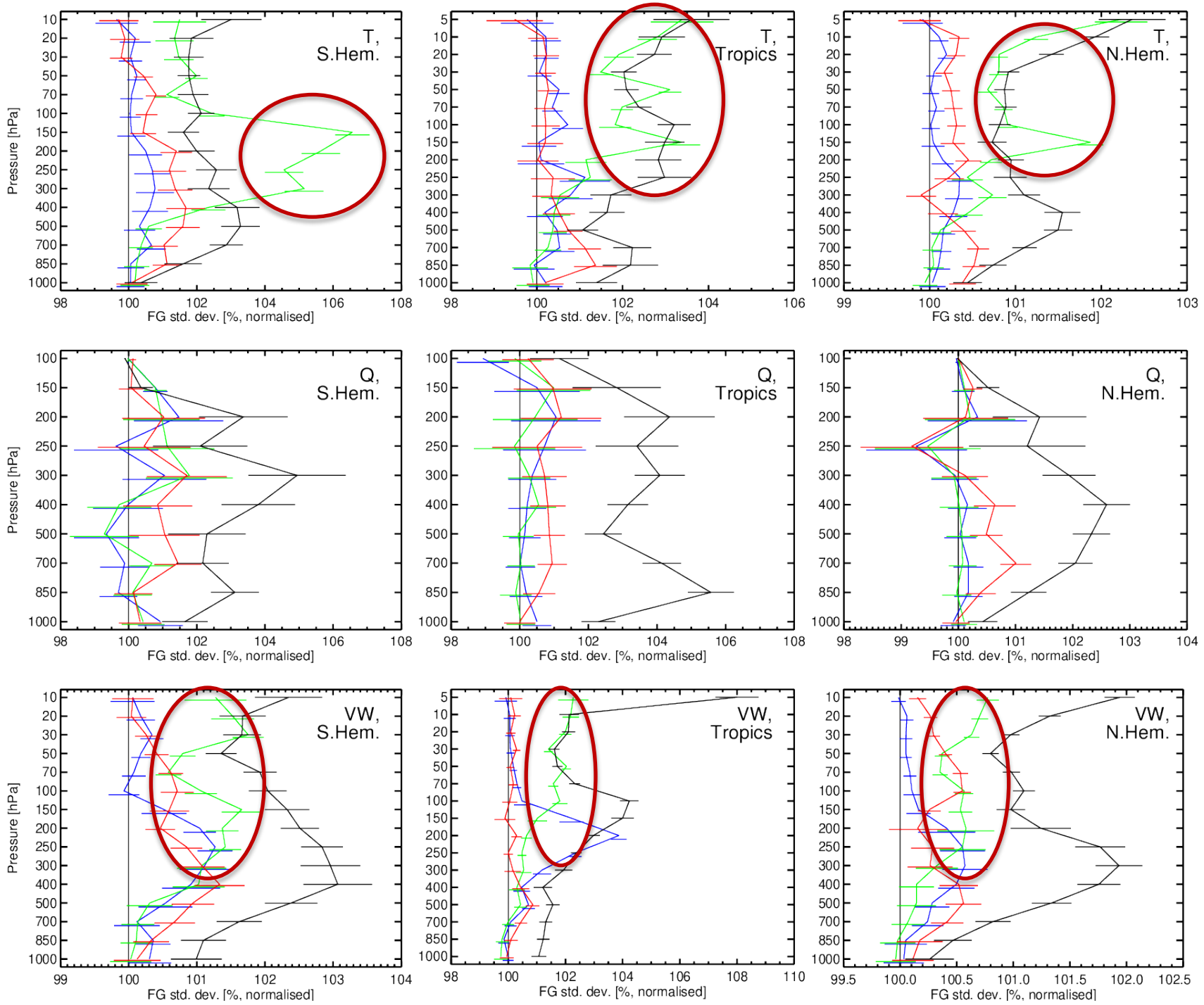
- **Strong temperature impact from GPSRO in UTLS**



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Short-range forecast impact vs radiosondes

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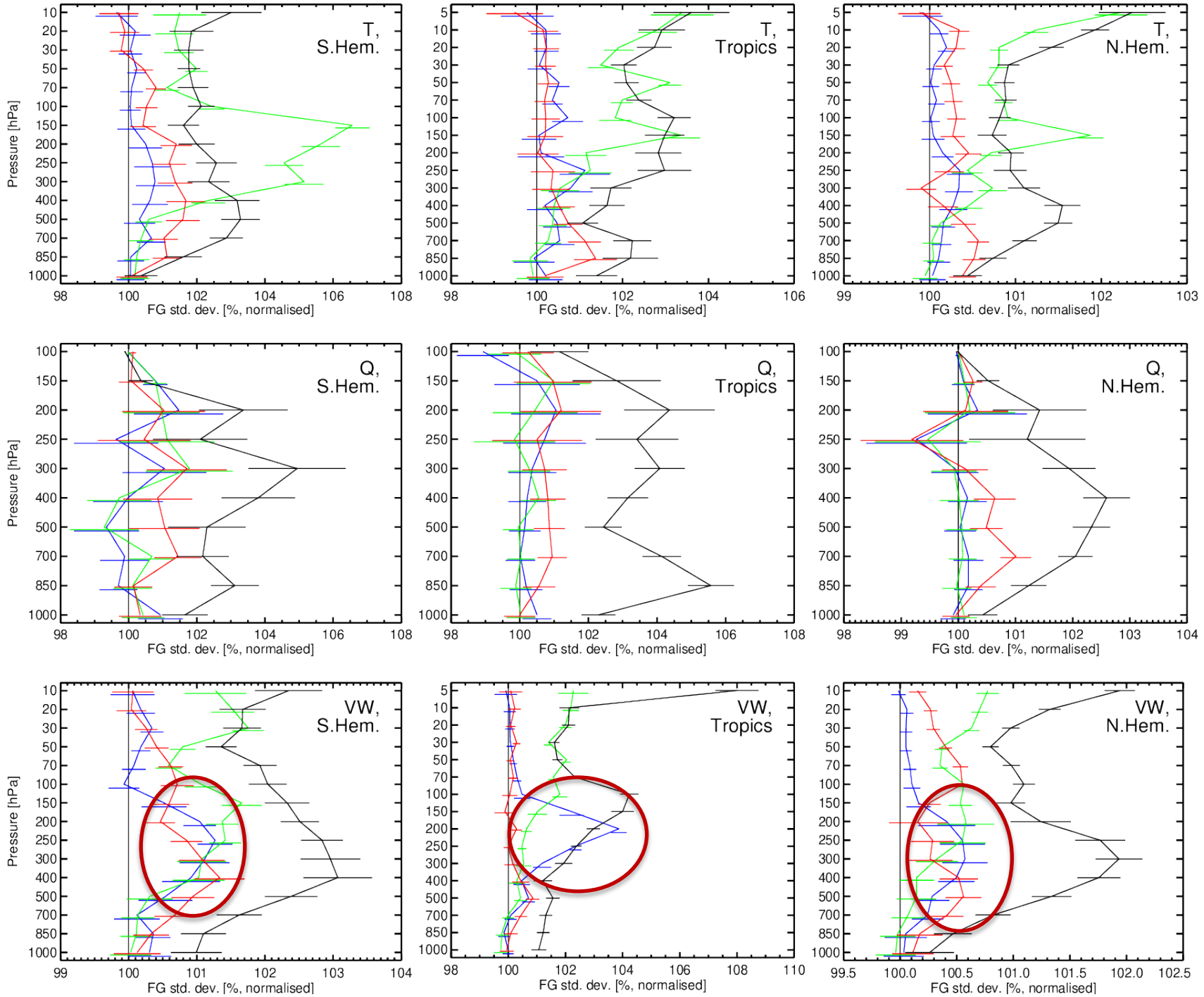
- Strong temperature impact from GPSRO in UTLS
- **Strong wind impact from AMVs, esp tropics**



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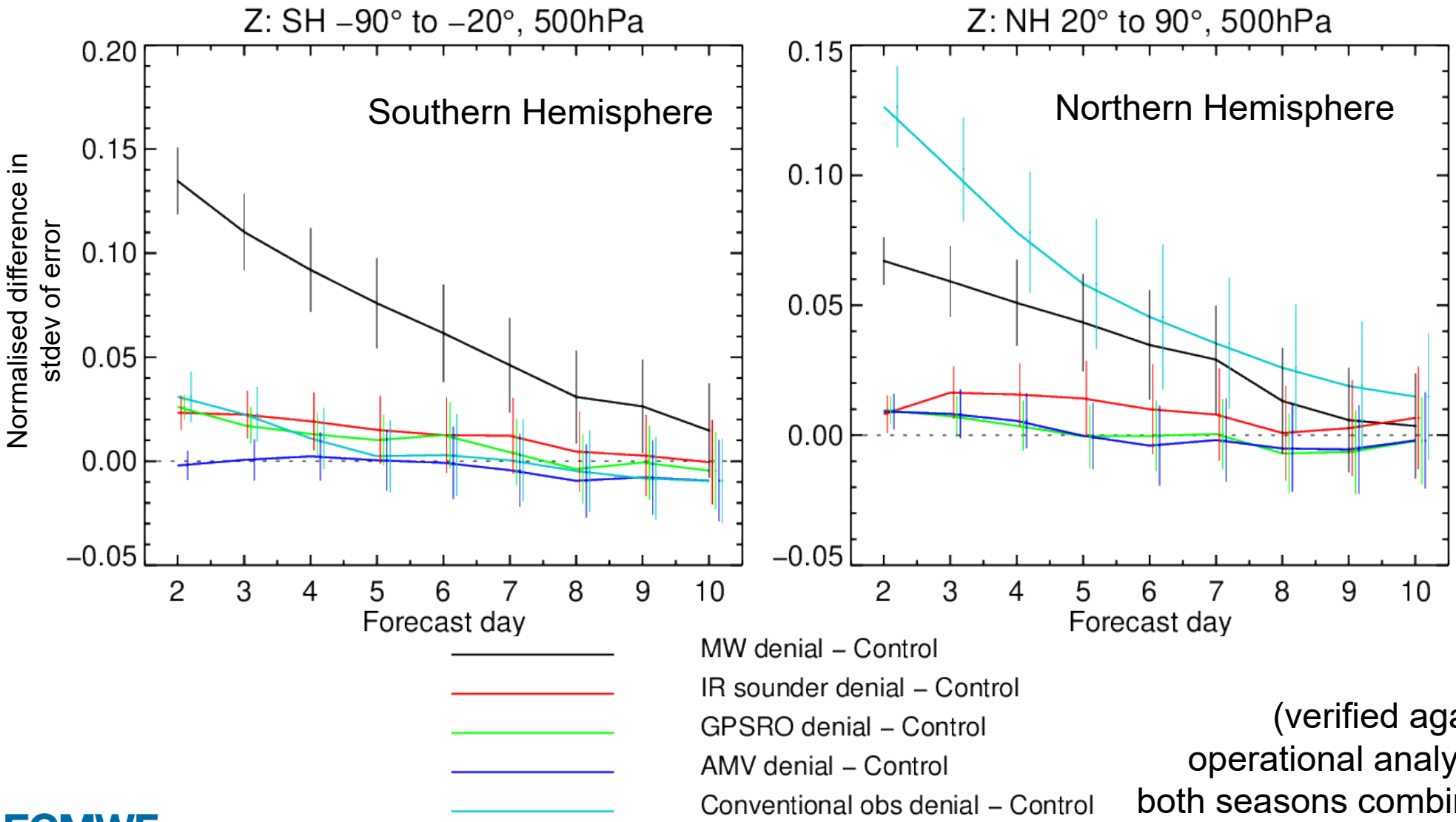
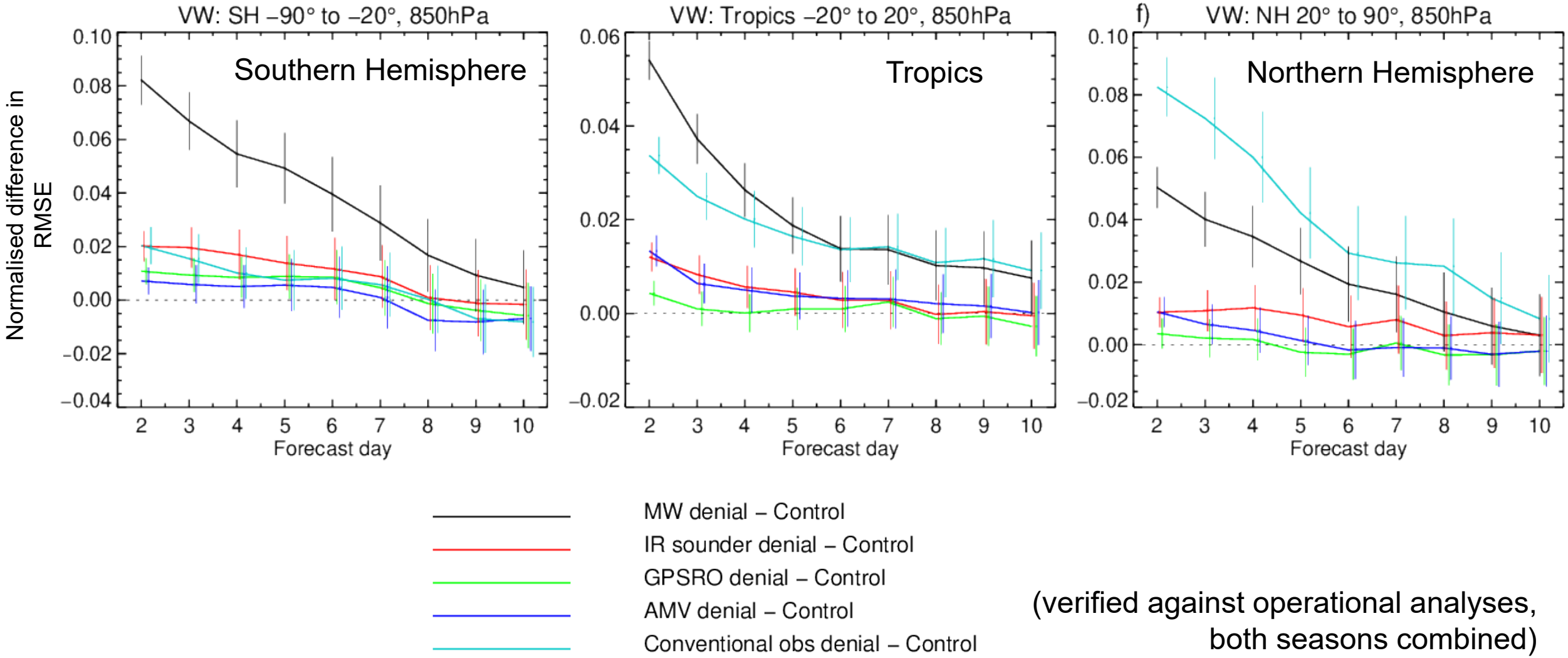
Medium-range impact: Z 500 hPa



(verified against operational analyses, both seasons combined)

Medium-range impact: Wind at 850 hPa



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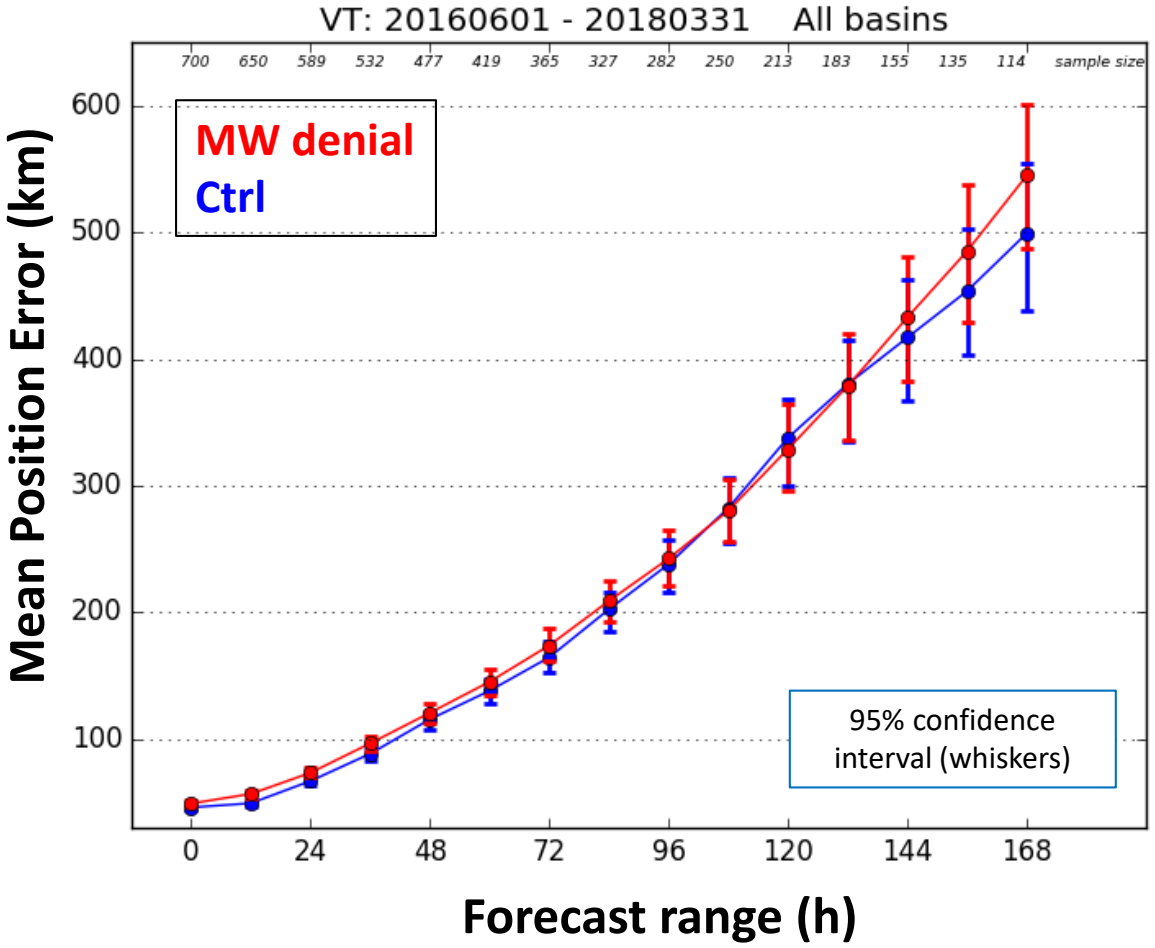
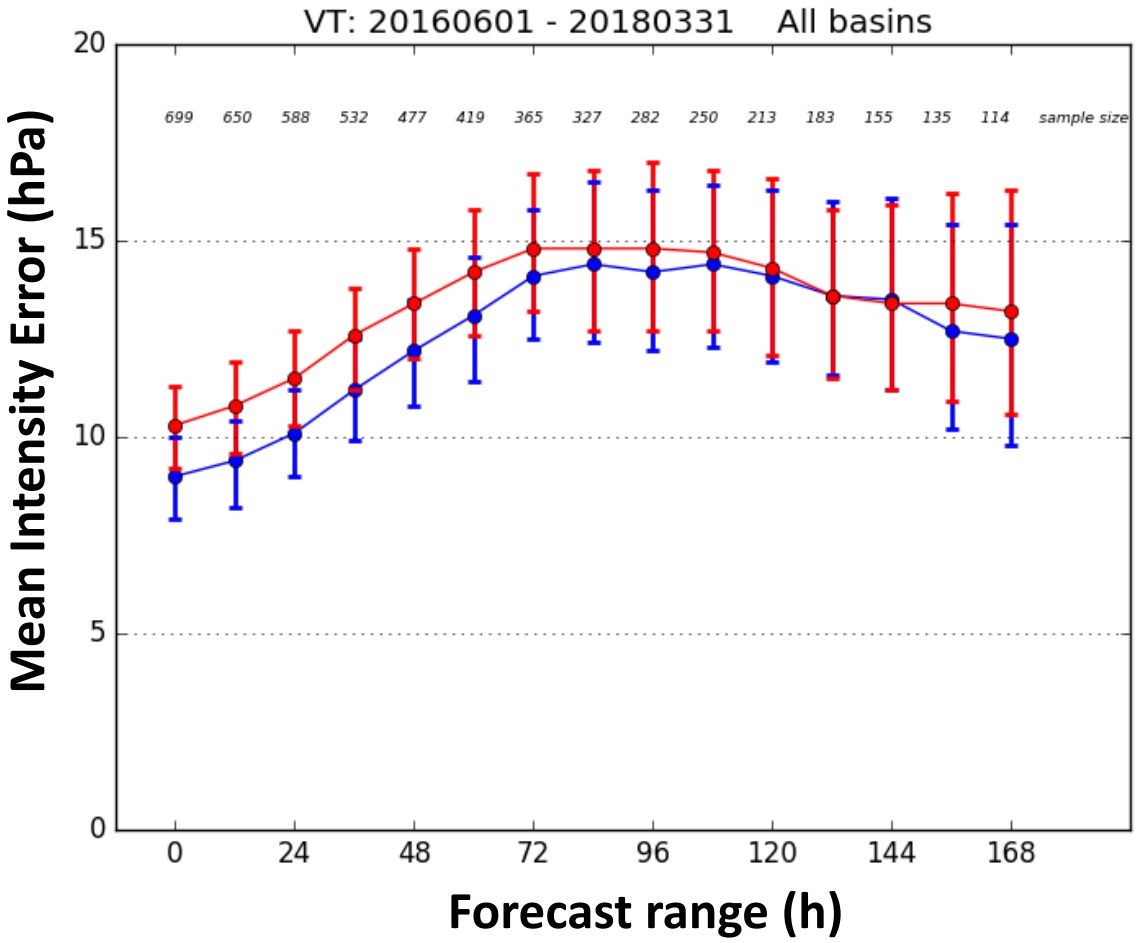
Impact of MW radiances on tropical cyclone forecasts

(Fernando Prates)

All basins, homogeneous samples,
1 June – 30 September 2016; 1 December 2017 – 31 March 2018; (ie 2 x 4 months)
Note: Spatial resolution TCo399 (~28km) much lower than operations





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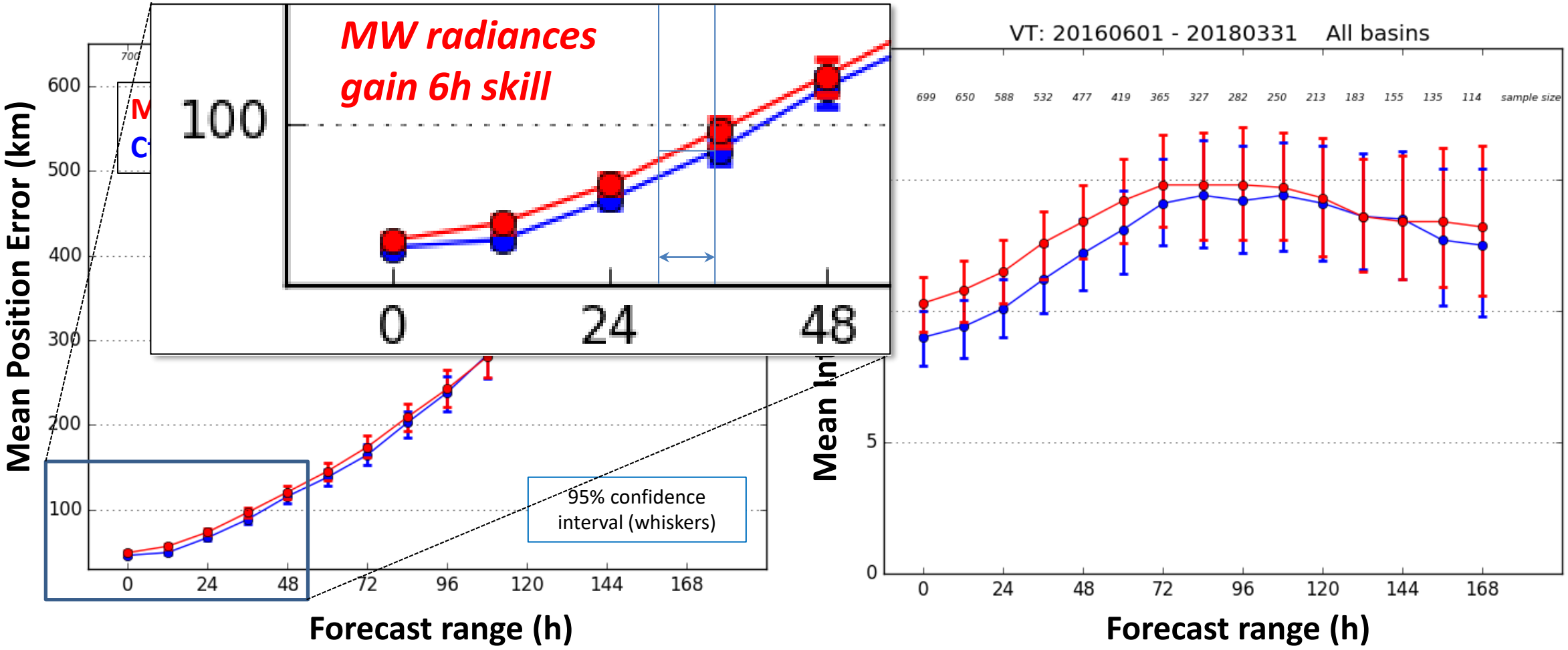


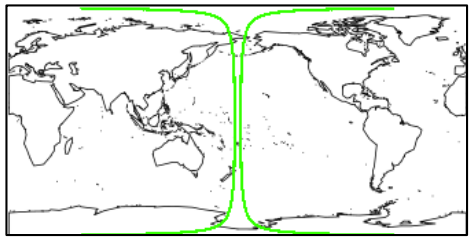
Why do we see so much impact from the MW?

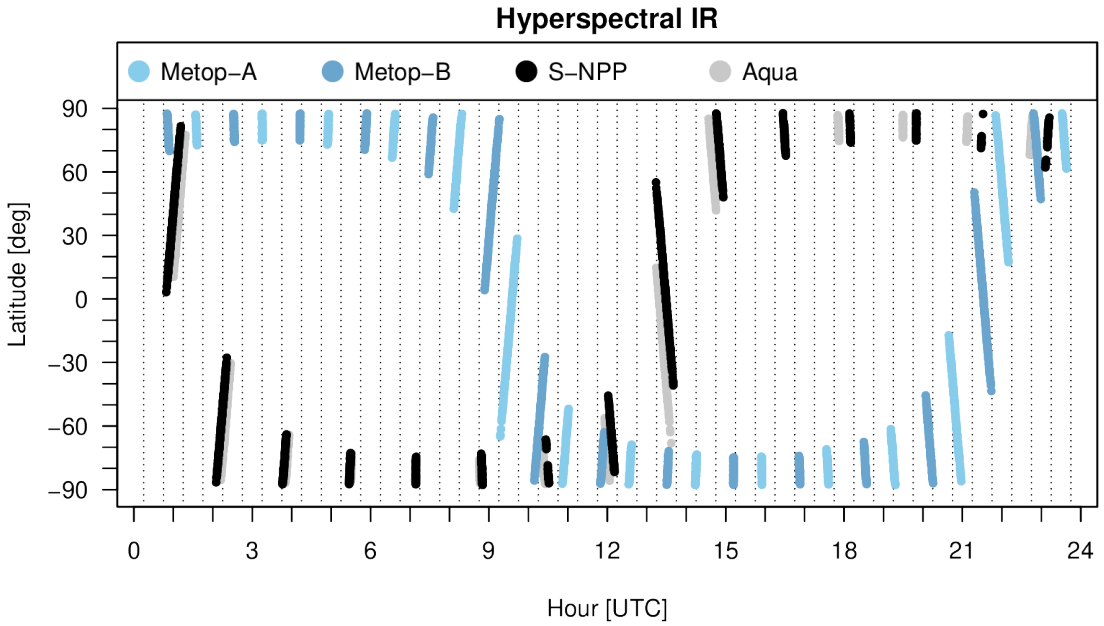
Better coverage presently from MW:

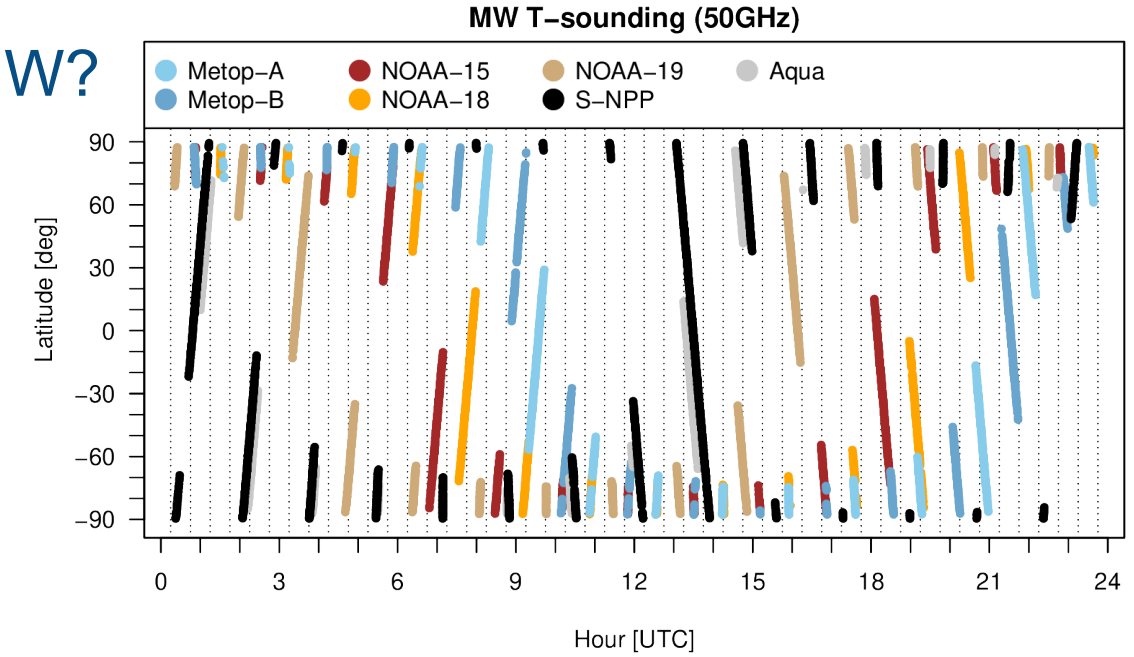
- More orbits
- All-sky and all-surface use for many channels

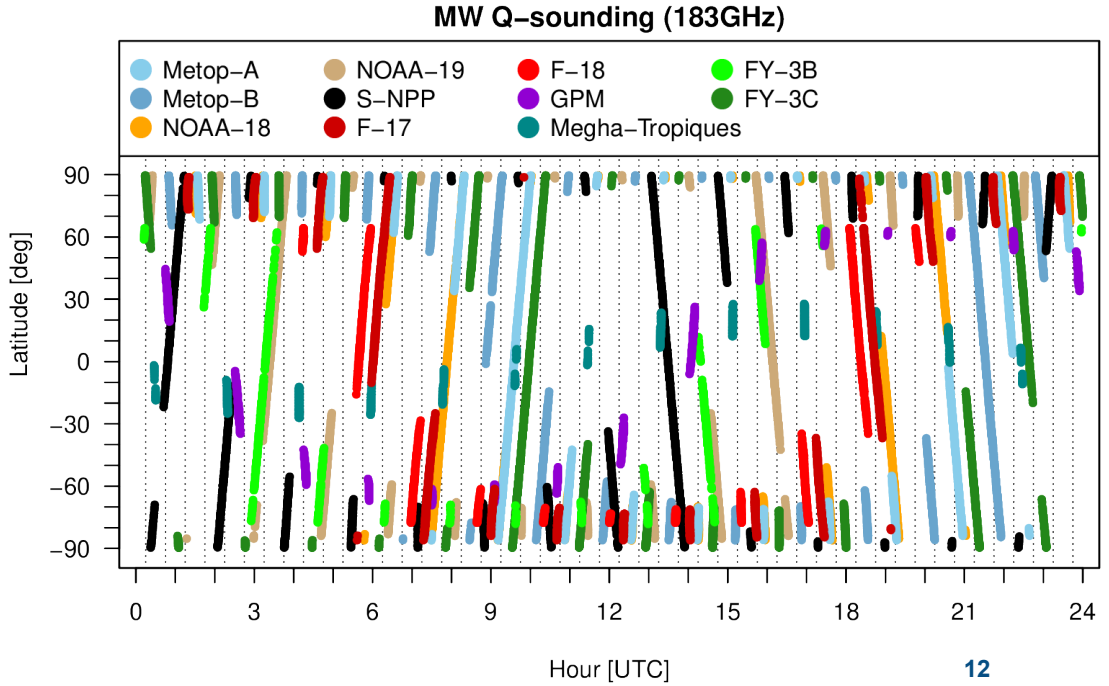
“Cleaner” errors for MW T-sounding.

Temporal coverage over 500 km stripe around 180º meridian on 15 Feb 2018.









How much incremental benefit does each MW sounder provide?

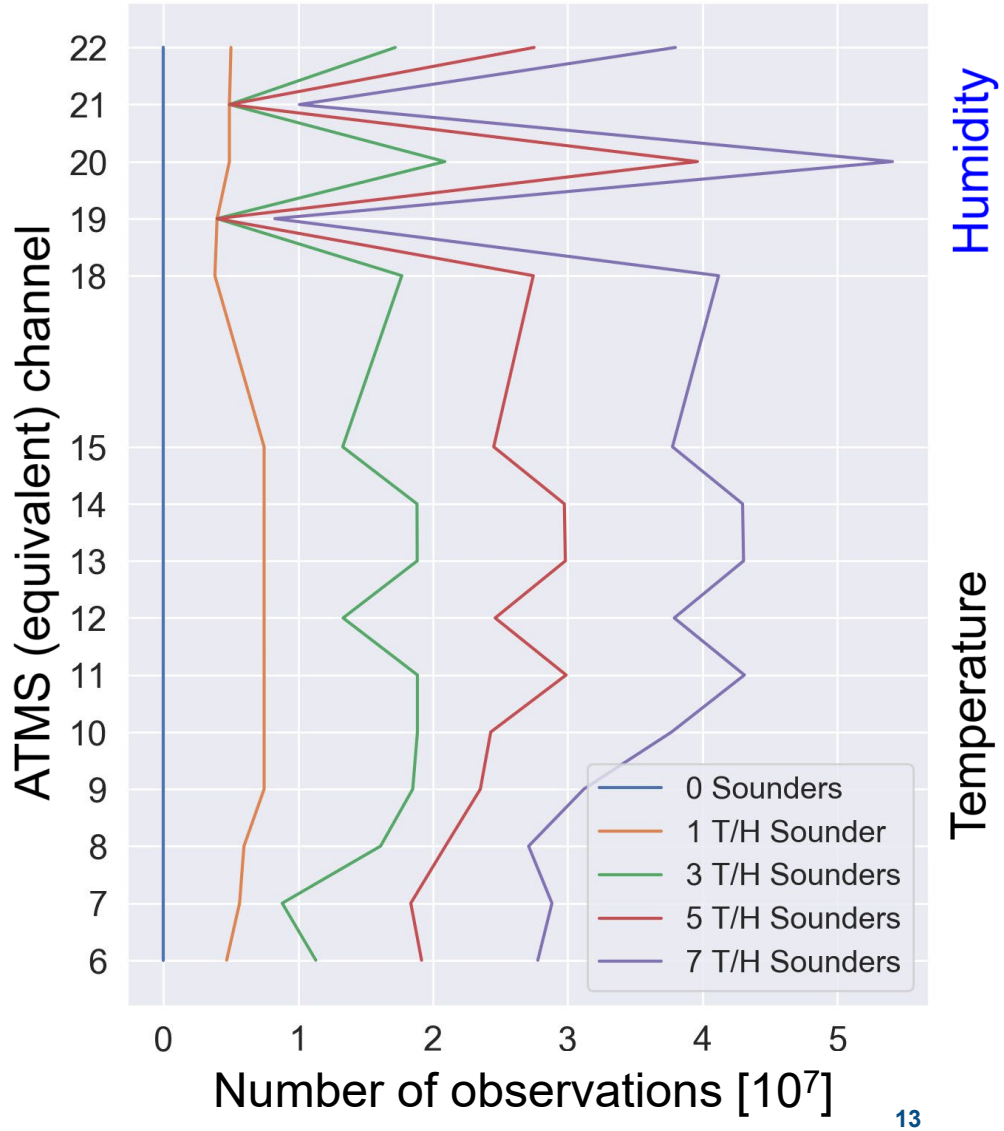
(David Duncan)

Control: No MW sounding data assimilated (from AMSU-A, MHS, ATMS, SSMIS, GMI, MWHS, MWHS-2, SAPHIR), otherwise full observing system

Experiments with data from 1/3/5/7 polar-orbiting MW temperature/humidity sounders added back to Control

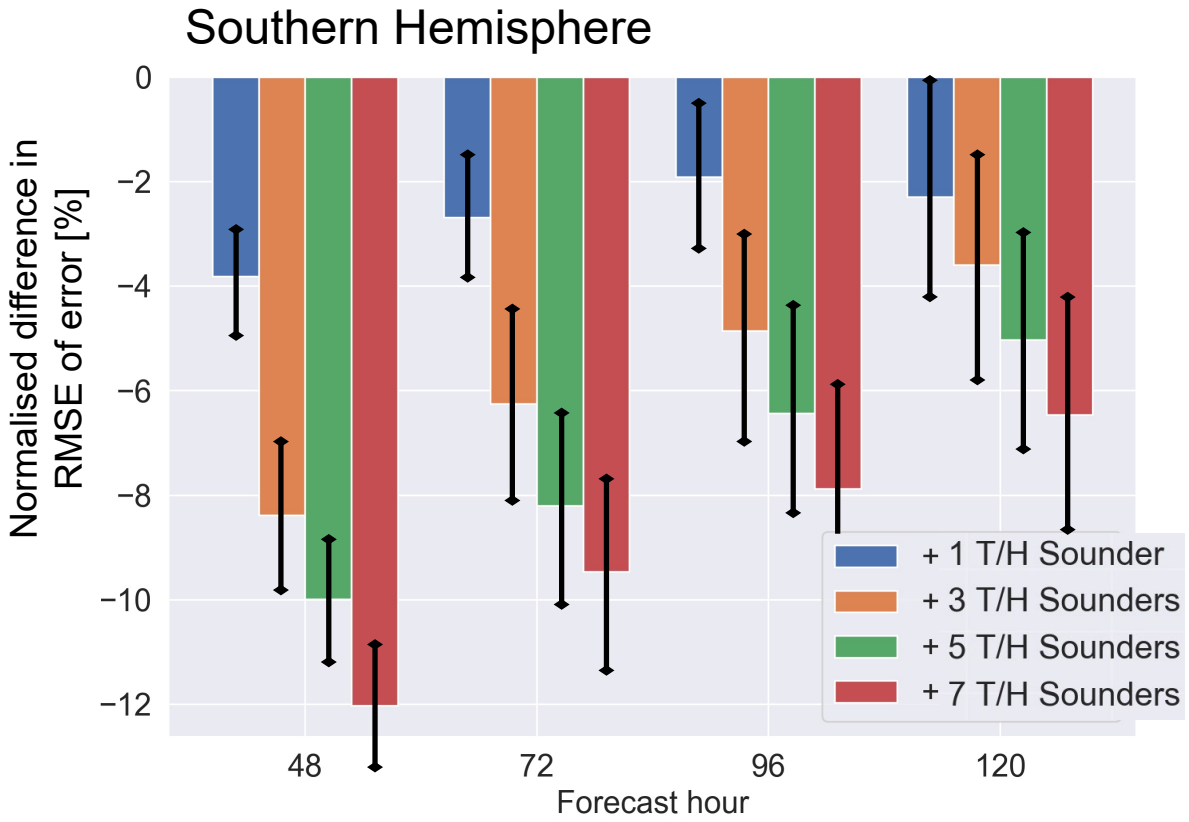
Note: Not all MW sounders are the same - different instrument capabilities/health, different treatment in assimilation (clear-sky/all-sky, etc), etc

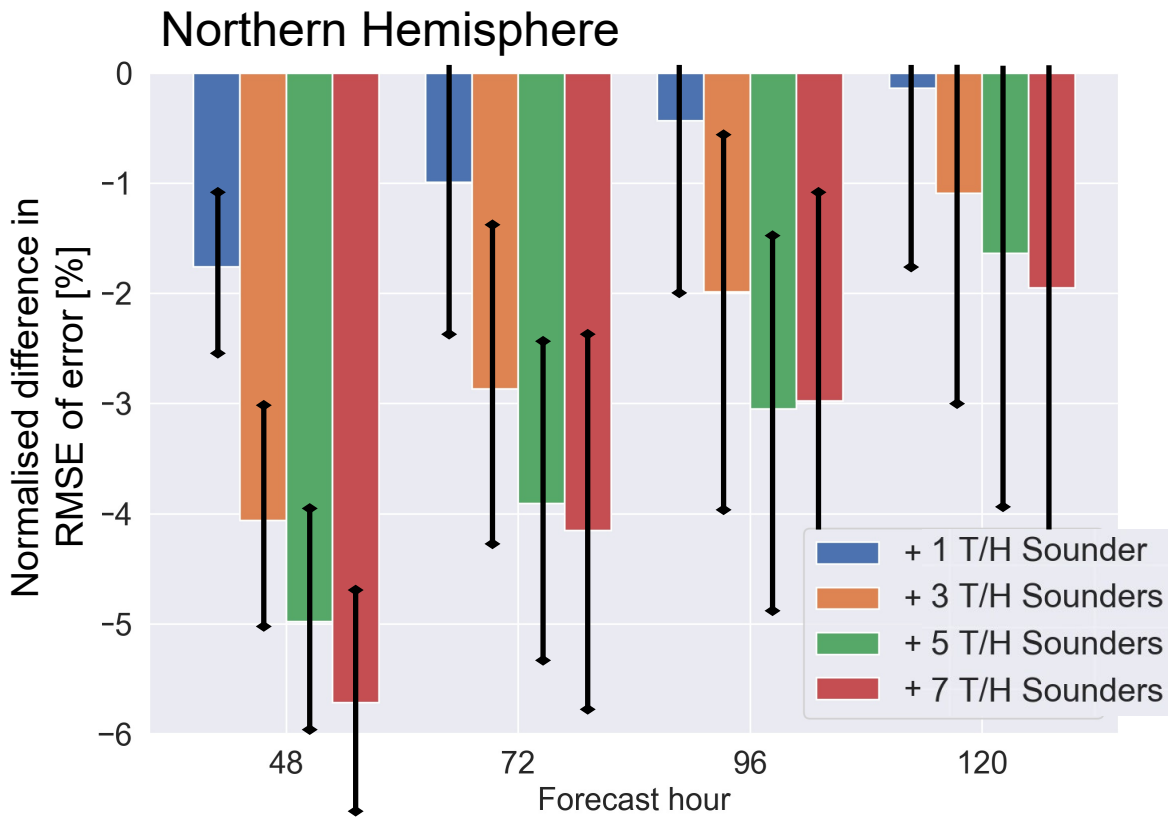
Period: 1 June – 15 September 2018



Medium-range impact from adding MW temperature/humidity sounders: Z 500 hPa RMSE

(David Duncan)





→ **No indication of saturation.**

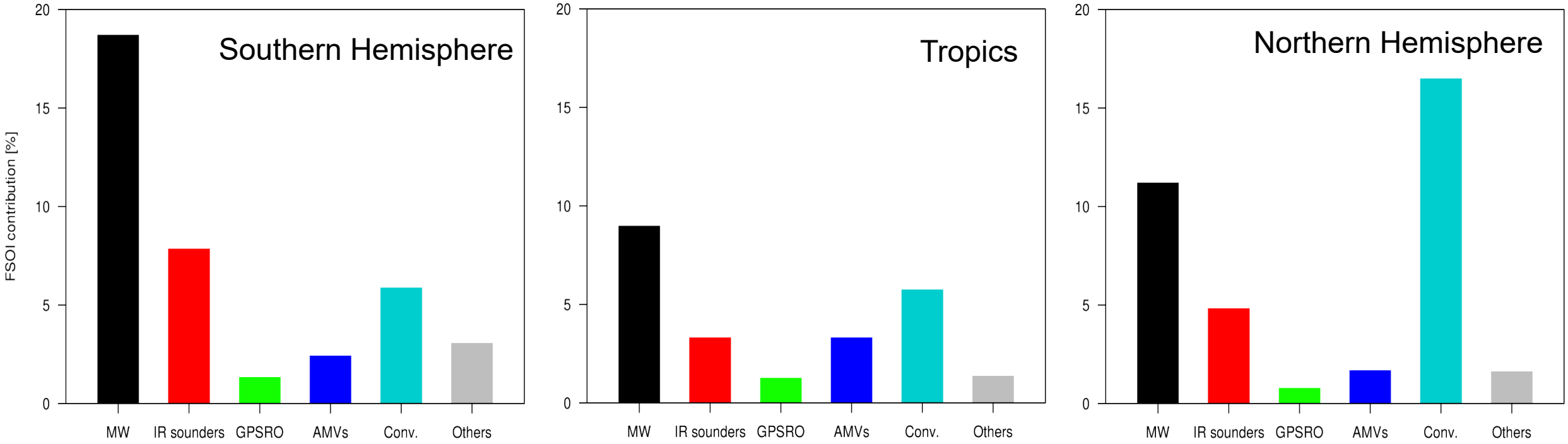
Conclusions

- Conventional observations and microwave radiances are presently the main drivers of headline scores in the ECMWF system, with infrared sounders adding further robustness for a wide range of geophysical variables.
  - MW sounding data benefit from present good spatial/temporal coverage and all-sky/all-surface use for many channels.
  - No indication that impact from MW sounders is saturated after 7 orbits.
  - Benefits for tropical cyclone forecasts from MW radiances.

- GPSRO shows significant impact in the upper troposphere/lower stratosphere, particularly temperature.
- Atmospheric Motion Vectors add benefits for tropospheric wind, particularly in the tropics and at the short range

Contribution in terms of total FSOI

(if you really need to know)



(100% = total global FSOI)

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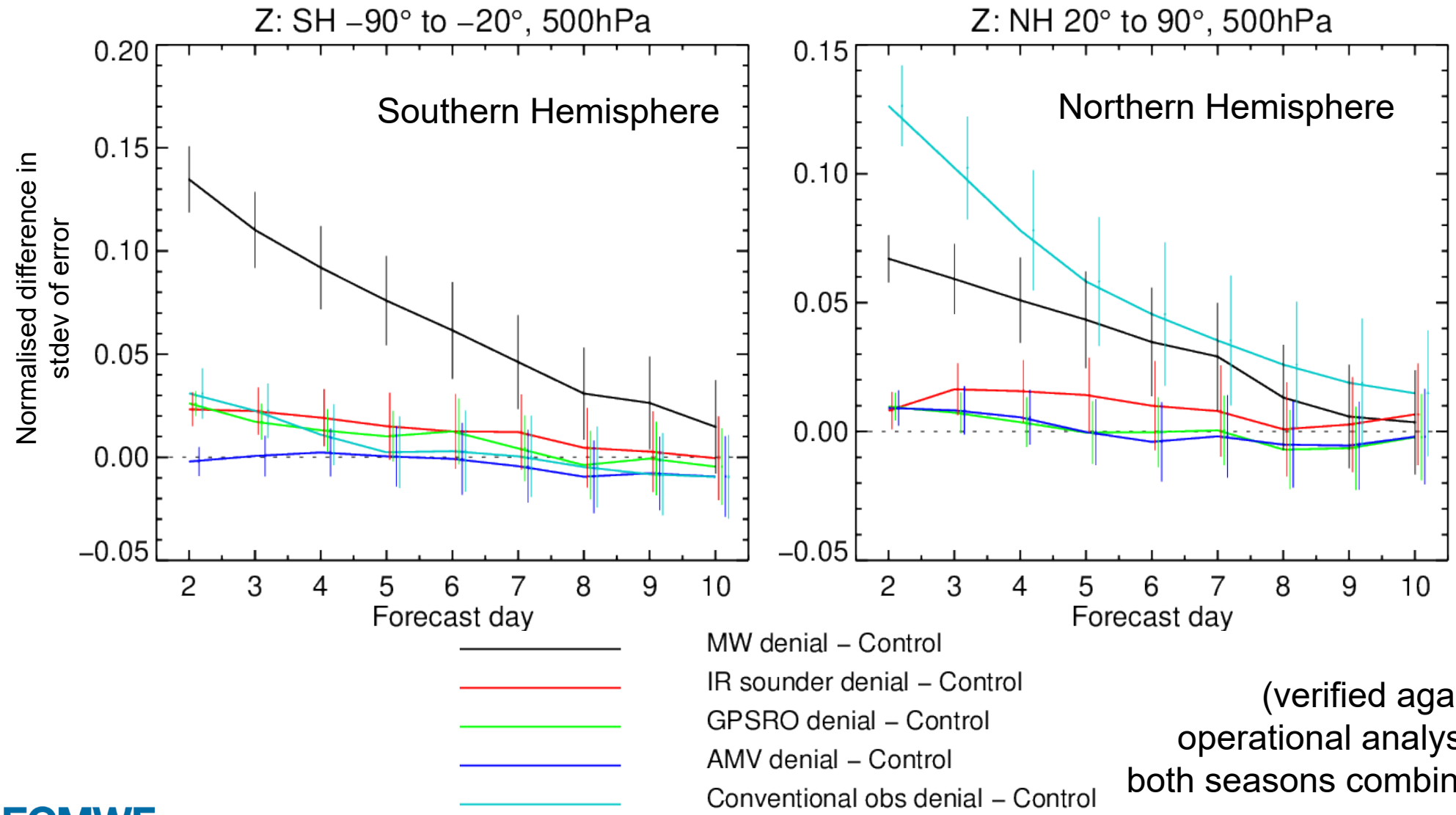

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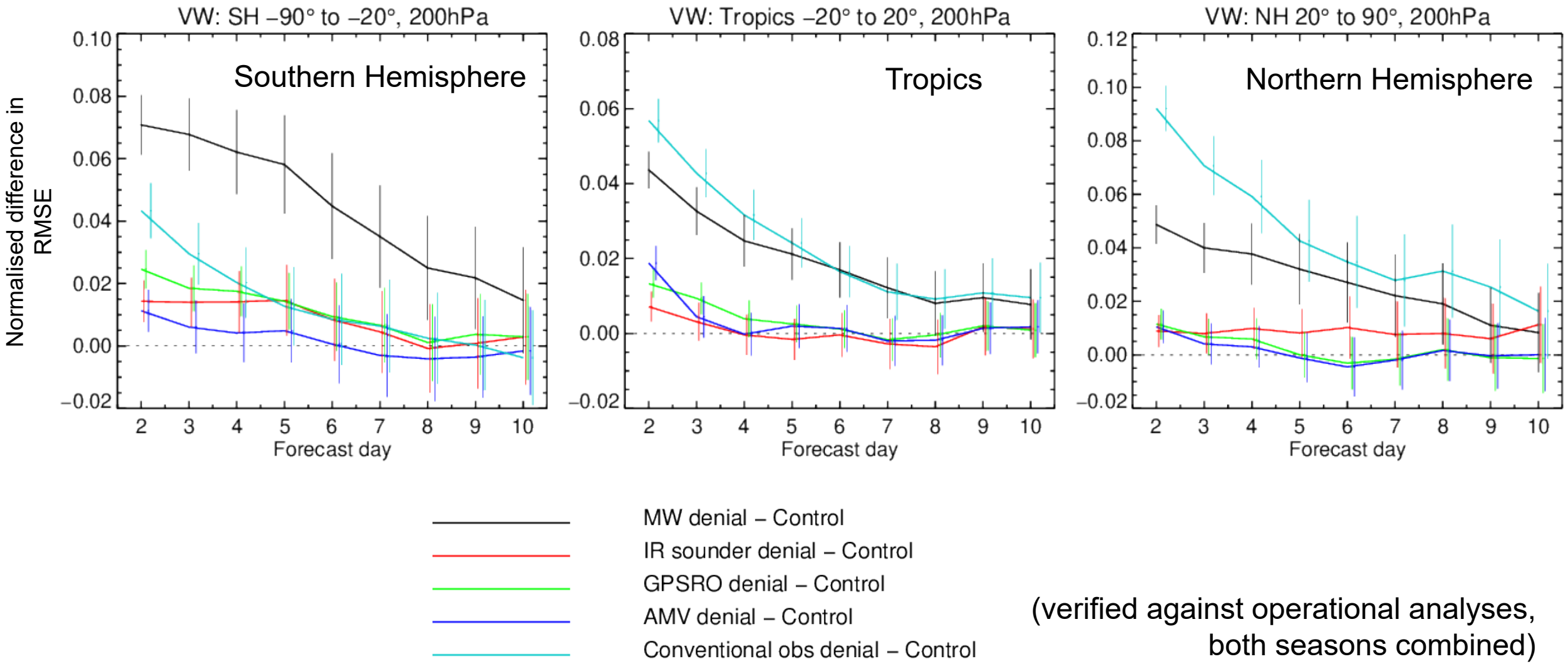
Current impact of various observing systems: Wind at 200 hPa



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