# Infra-red soundings in NWP at the Met Office: experience and suggestions for future systems

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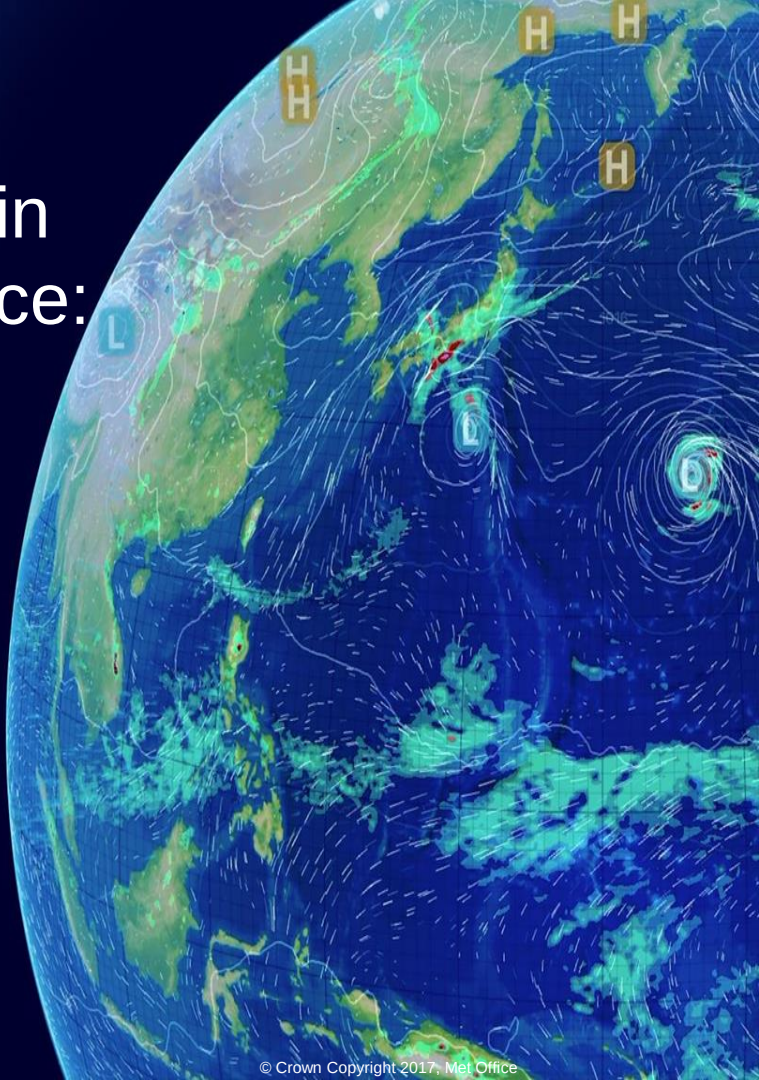
www.metoffice.gov.uk



# Infra-red soundings in NWP at the Met Office: experience and suggestions for future systems

- Met Office use of IR sounder data in NWP
  - Observations used
  - Impacts
  - Monitoring
- Future IR sounding systems
  - What's important?
- Comments on NOAA requirements
- Conclusions

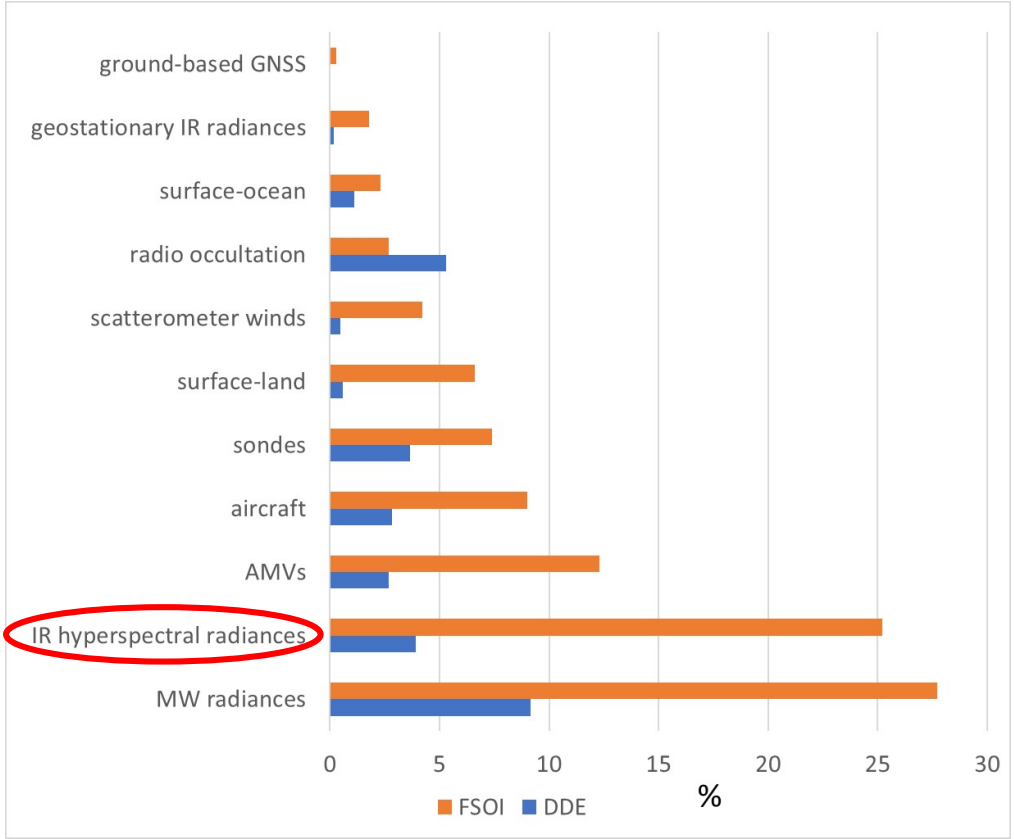
# Infra-red soundings in NWP at the Met Office: instruments used

- IASI Metop(-A), -B, -C
- CrIS Suomi-NPP, NOAA-20
- AIRS Aqua

Also investigated:

- HIRAS FY-3D

# Infra-red soundings in NWP at the Met Office: impact (1)




Data denial experiments

Aug-Oct 2019

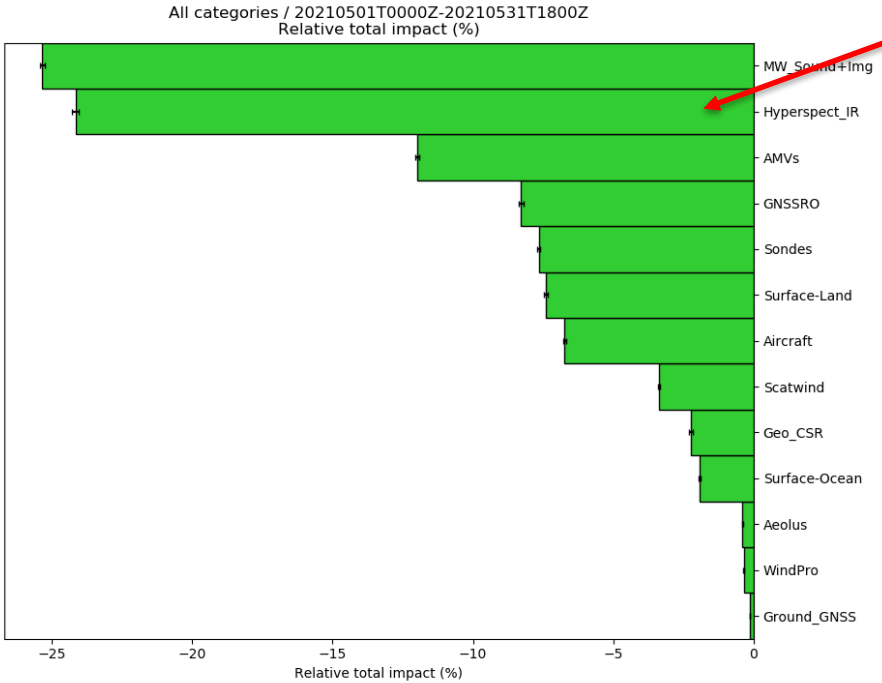
%impact on error variance of 24h forecast

- by DDE
- by FSOI

Candy B et al., 2021
Met Office FRTR 641

Eyre J, 2021. QJRMS
DOI: 10.1002/qj.4123

# Infra-red soundings in NWP at the Met Office: impact (1)



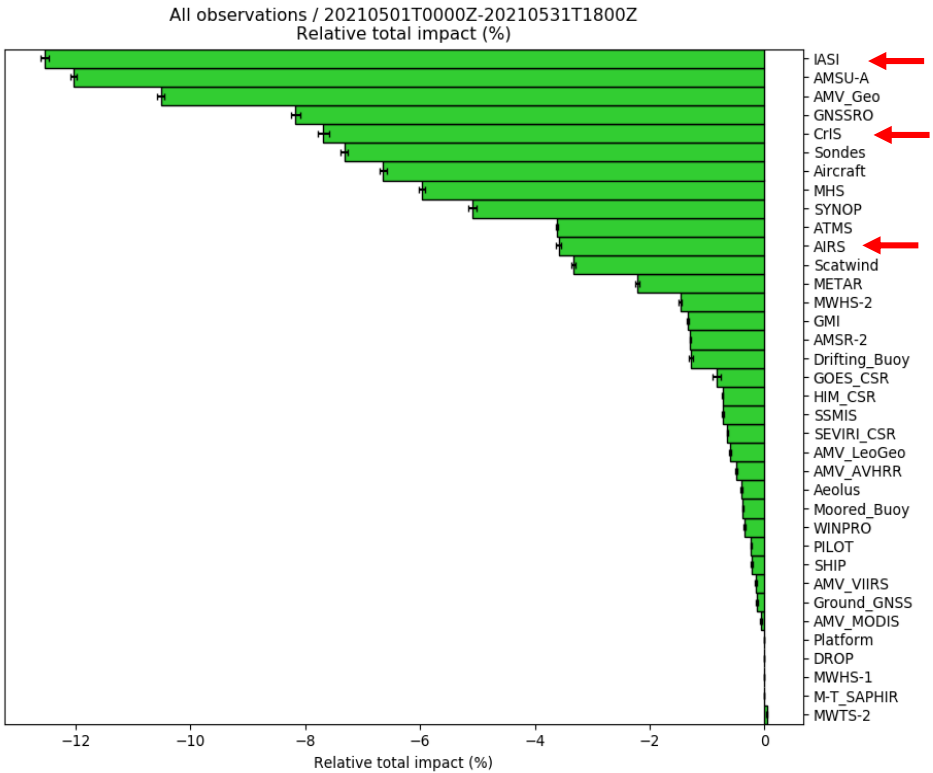

Hyperspectral IR sounders

FSOI impacts

by technology type

May 2021

# Infra-red soundings in NWP at the Met Office: impact (2)




IASI

CrIS

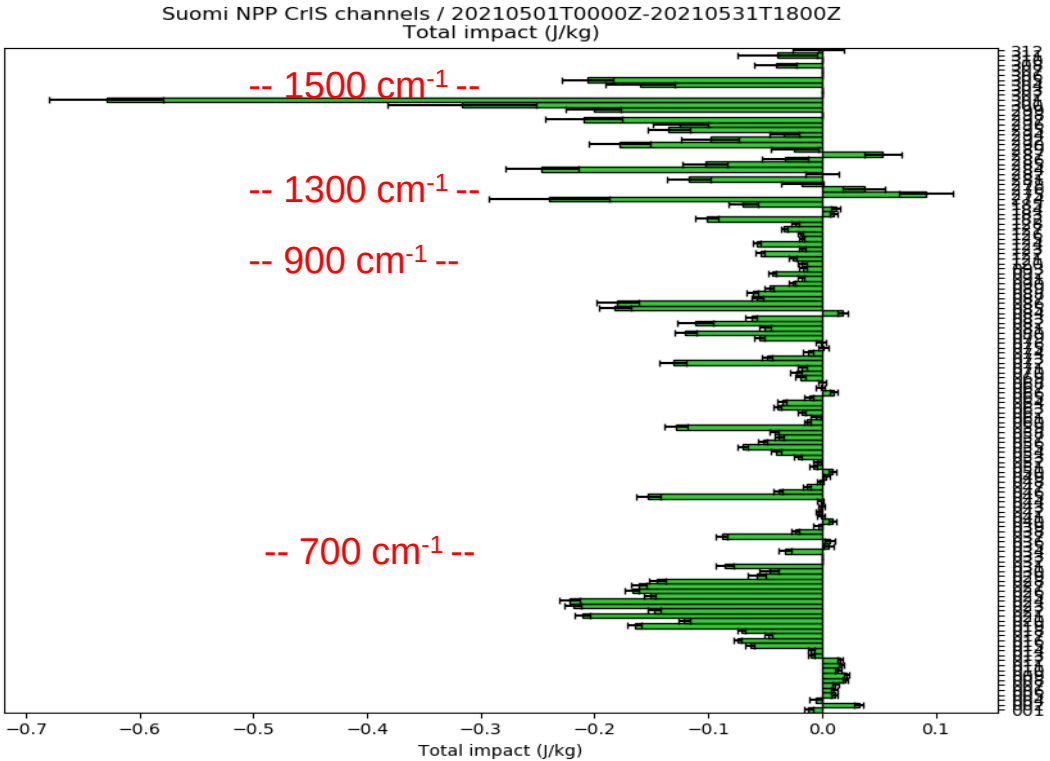
AIRS

FSOI impacts

by instrument

May 2021

# Infra-red soundings in NWP at the Met Office: impact (3)




FSOI impacts

by IR channel

Suomi-NPP / CrIS

May 2021

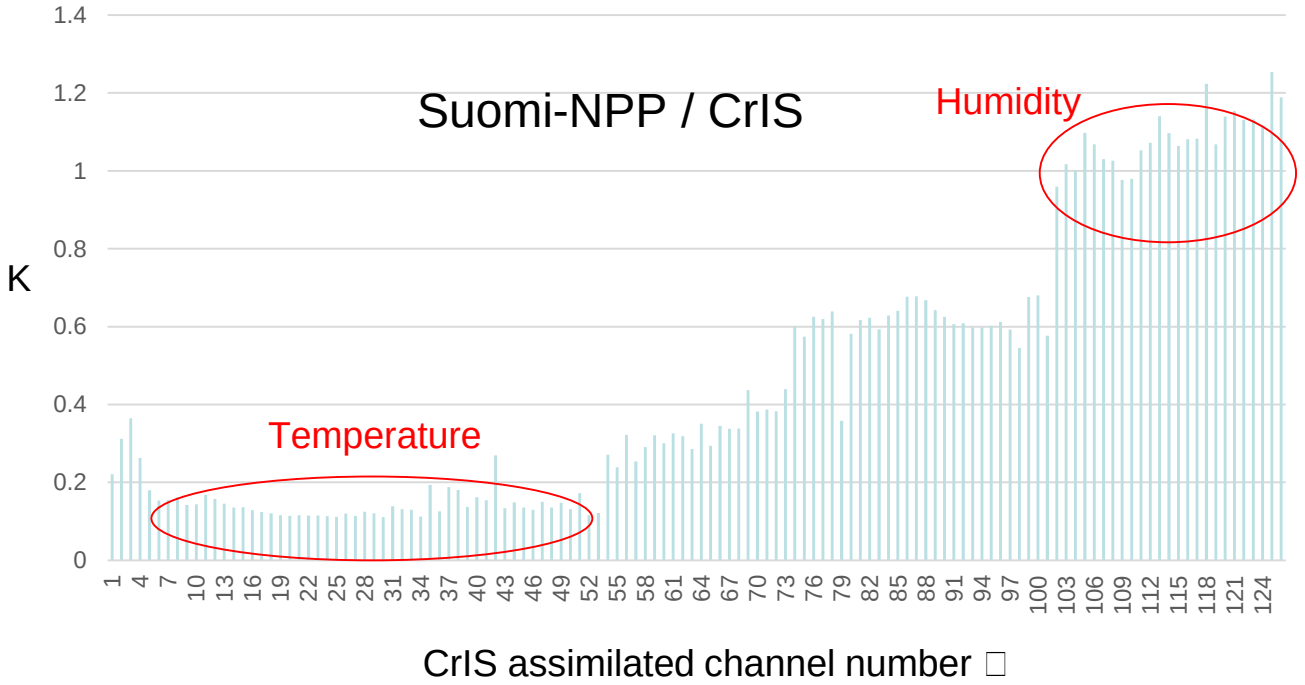
# Microwave soundings in NWP at the Met Office: monitoring (1)

Routine monitoring includes:

- mean and standard deviation of observed-minus-forecast brightness temperatures, “O-Bs”
- for each channel
- for each assimilation cycle

Following data are averages for 2 weeks in June-July 2021

# Standard deviations of observed-minus-forecast brightness temps: monitoring (2):



# Infra-red soundings in NWP at the Met Office: monitoring (3)

- For key tropospheric temperature sounding channels, SD of (O-B) is 0.1-0.2 K
- For key tropospheric humidity sounding channels, SD of (O-B) is ~1.0 K
- These values include:
  - measurement error (NEdT) and
  - RT model error and
  - pre-processing error and
  - forecast error!

# Future IR sounding systems: what's important? (1)

## Temperature sounding

- Low NEdT: < 0.2 K
- Complication: effects of high spectral resolution on noise requirements needs careful study

- As for MW, calibration stability should be better than this
- … particularly around orbit, and over periods of 1-2 days.
- NWP bias correction (VarBC) can handle changes on slower time scales, and the occasional jump

# Future MW sounding systems: what's important? (2)

## Temperature sounding

Horizontal resolution – 25-50 km is OK for assimilated data

- because of limited vertical resolution and the aspect ratio of atmospheric features

but

- higher resolution/sampling needed for cloud problem
- coincident imagery also useful for cloud problem
- … and see on (humidity sounding)

# Future MW sounding systems: what's important? (3)

## Temperature sounding

Longwave CO2 or Shortwave CO2 or Both ?

- Longwave CO2 preferred at present
- More work needed to improve impact of shortwave
  - improved RT modelling

# Future MW sounding systems: what's important? (4)

## Humidity sounding

- 6 micron band: longwave side, shortwave side or both?
  - Both preferred
  - If only one, choose side with least contamination from other species, … assuming NEdT is adequate
- NEdT requirements more relaxed than for temperature
- Higher horizontal resolution more useful for humidity
- Also, for GEO sounder, tracking humidity features gives information on wind

# Comments on NOAA requirements and questions (1)

- Selection of channels: “target” as CrIS; priority to longwave
- Spectral resolution (SR): “target” as CrIS, “improved” as IASI
- NEdT: CrIS should be “target”, at CrIS spectral resolution
- □ SR and NEdT should be considered together
- Spatial resolution (fov size): “target” as CrIS; improvements welcome, but not at expense of NEdT
- □ SR, NEdT and fov size should be considered together
- Spatial sampling: “target” as CrIS. Increases should be considered, but beware unmanageable/unaffordable data rates
- Calibration accuracy is important and calibration stability is very important

# Comments on NOAA requirements and questions (2)

- Backbone – as WIGOS 2040 Vision
- Geo hyperspectral IR
  - specification – MTG-IRS is a good target
  - applications – focus on hi-res NWP and nowcasting
  - also for winds
- Collocation – on same platform as MW sounder?
  - desirable, but not essential
- Timeliness – every minute of reduced delay is useful for NWP
- Data form for assimilation
  - now – radiances or reconstructed radiances

# Comments on NOAA requirements and questions (3)

- Other factors?
  - Consider where information from hyperspectral IR is crucial – i.e. better than MW or RO – e.g. high vertical resolution for temperature in the lower troposphere
  - Don’t spend all available money on hyperspectral IR (and other mature technologies) - deliver same capability for less cost - spend money saved on meeting other aspects of user requirements – wind, soil moisture, etc., etc.

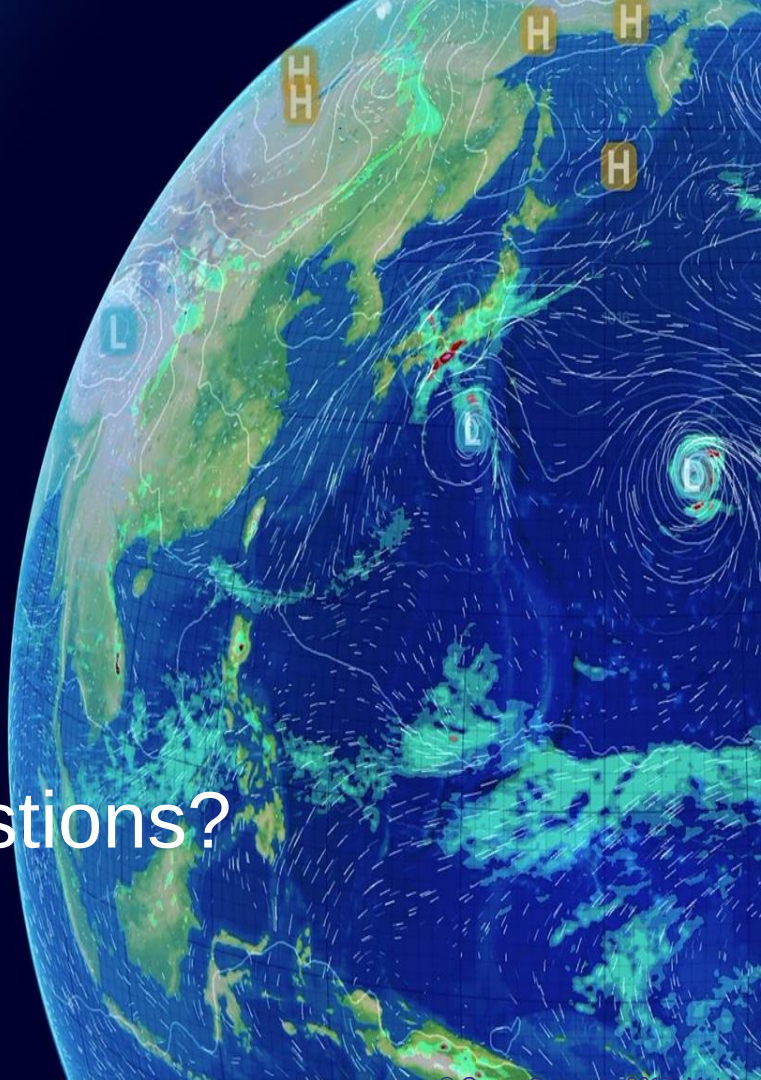
# Conclusions

- Infra-red sounding radiances are very important for operational NWP performance

- Backbone of high-quality instruments will remain important – as WMO “Vision for WIGOS in 2040”

- Low NEdT with high spectral resolution and calibration stability are crucial for temperature sounding

Met Office




# Thank you! Questions?