Initial assessment of GIIRS on board FY-4B

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Introduction

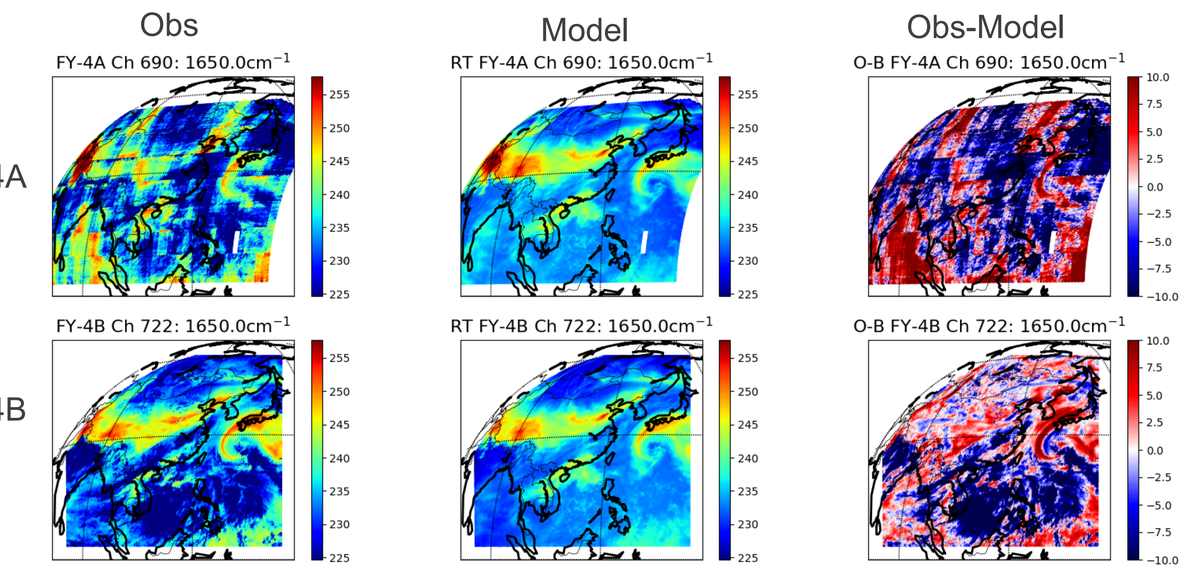
Following the launch by CMA of FY-4A, an improved GIIRS instrument was included as part of the payload of FY-4B, and has become the first operational hyperspectral infrared instrument on a geostationary platform.

For NWP, we are keen to exploit these observations, and it is also an opportunity to learn how best to exploit observations of this kind ahead of the European mission MTG-S IRS.

The assessments presented here have been performed by comparing FY-4A GIIRS radiances to both co-located IASI observations and ECMWF model simulations.

First impressions comparing FY-4A and FY-4B (ECMWF)

Here, observations of a mid-wave infrared (MWIR) water-vapour channel for a single scan are compared to clear-sky model simulations.



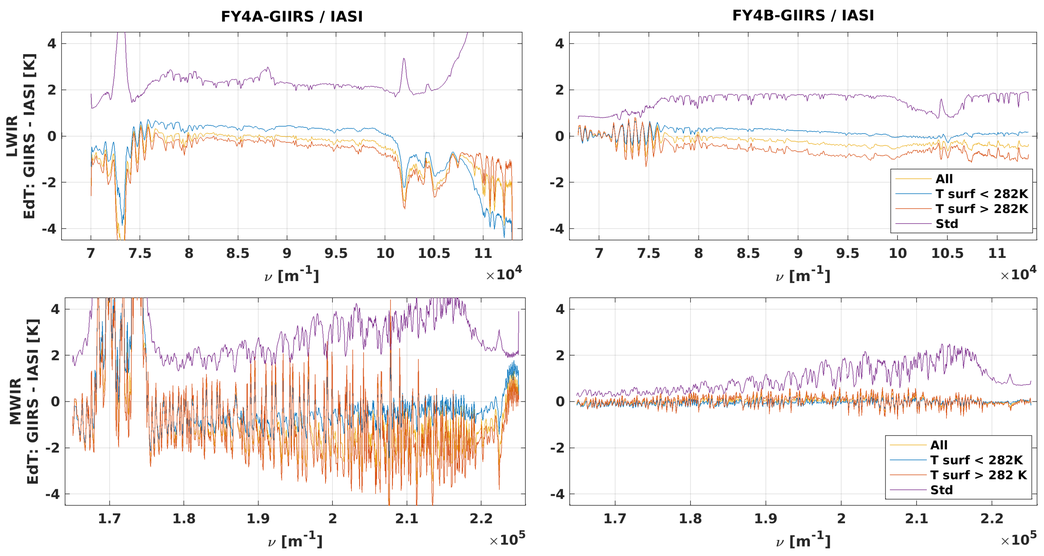
Clearly, many of the systematic issues present in the MW band of FY-4A have been largely corrected for FY-4B.

The “blocky” artefacts significantly reduced the scope for effectively assimilating FY-4A GIIRS in both the LWIR and MWIR bands, so from an NWP perspective it is encouraging that this improved for FY-4B (the LWIR band is also improved – results not shown here).

Spectral and radiometric cross-calibration using IASI (EUMETSAT)

Approximately 30.000 colocations with the Metop-B and C IASI have been studied to estimate the radiometric calibration of each GIIRS instrument for January 2023.

The calibration is assessed as a function of the window channels temperature (above or below 282K). The FY-4B GIIRS instrument is performing much better, in particular, there are no more signs of instrument contamination.

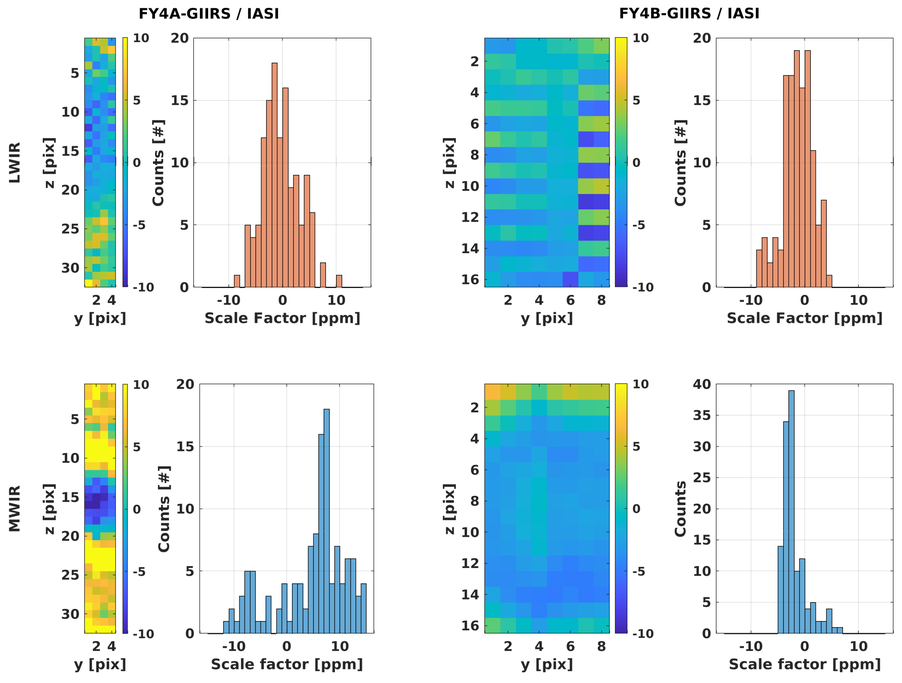


The fact that the cold scenes are measured too hot and the hot scenes too cold in long wave infrared (LWIR) could be associated with straylight effects (see limbs below).

To the right are estimates of the spectral calibration in ppm for the LWIR and MWIR detectors of FY-4A and FY-4B GIIRS as calculated from IASI co-locations.

The layout of the GIIRS focal plane array of FY-4B is changed with respect to FY-4A from 32x4 to 16x8, but the total number of pixels remains the same.

In general the performance of FY-4B GIIRS is much better, particularly in the MWIR band. However, the “checkerboard” pattern persists in the LWIR band. Also, in the MWIR band, a ”bullseye” pattern exists, although it is less pronounced in FY-4B.



Model comparisons (ECMWF)

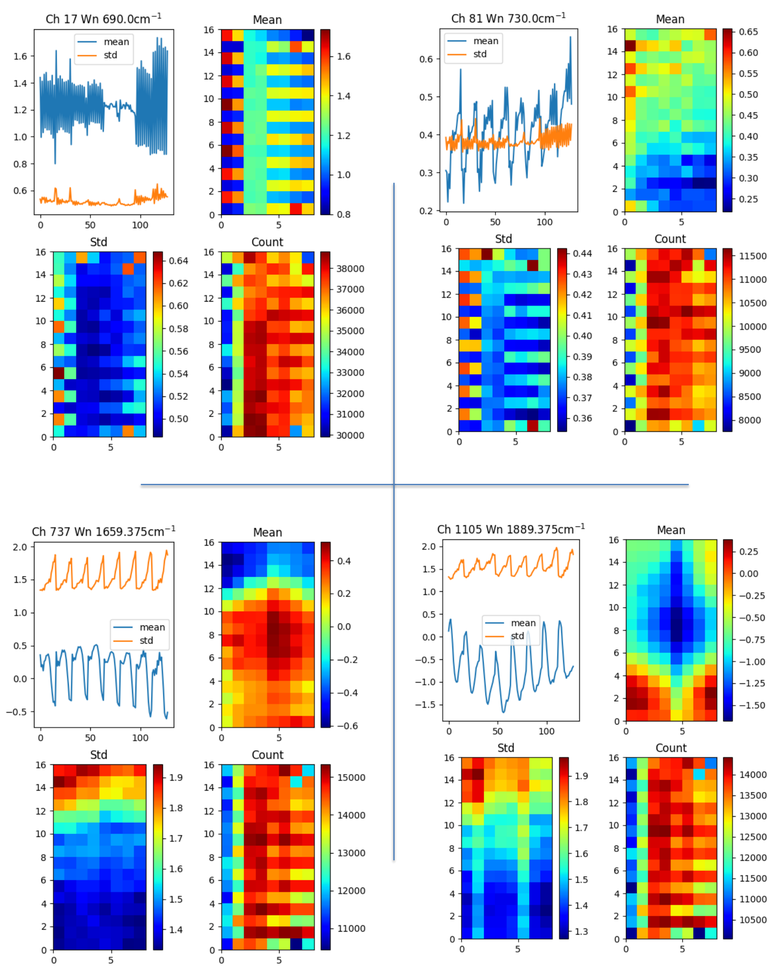
Although performing comparisons with collocated IASI observations is a valuable approach, using model simulations is complementary as the solar time is not a limitation for the simulations. This means that the model simulations provide a much larger sample. However, the downsides are that the model itself is subject to biases, and cloud is not simulated as part of the radiative transfer.

Here are shown mean, standard deviation of clear-sky O-Bs of FY-4B GIIRS, for a set of four channels after cloud-screening has been applied.

A number of patterns are present, both in terms of biases between pixels, and also the noise characteristics

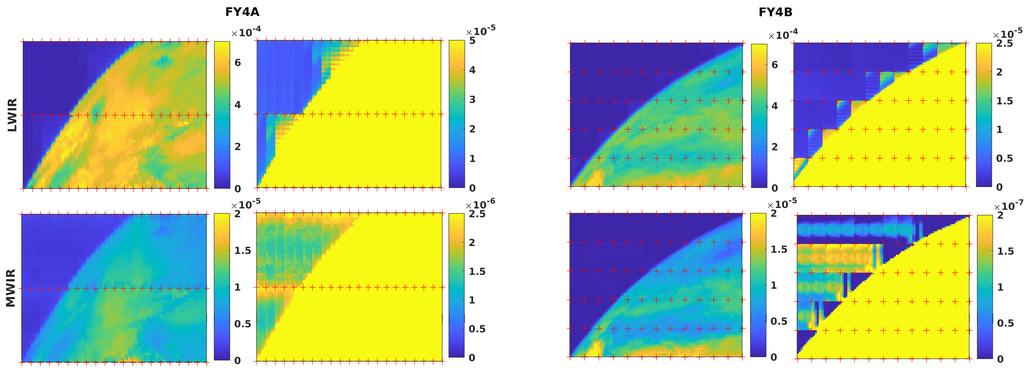
The patterns generally match the spectral calibration ones assessed with the comparisons to IASI.

The inter-pixel variability will influence decisions regarding which pixels to include/exclude in assimilation experiments.



Limb measurements (EUMETSAT)

By examining measurements at the limb, it is possible to witness effects such as straylight. This is achievable because of the stark contrast between the terrestrial and space portions of the field of regard when the plotted dynamic range is modified.
Here we see in the LWIR band evidence of excessive radiation in the space portion which is consistent with flaring inside the optical components (spurious reflections creating symmetrical ghosts). The MWIR pattern is not understood.



Note the colour scales; FY-4B is significantly better than FY-4A.

Summary/plans

ECMWF and EUMETSAT will continue to analyse FY-4B GIIRS observations. An approach being pursued by EUMETSAT is to investigate whether remaining systematic deficiencies could be corrected as a post-processing step. Also, assimilation experiments will be run, and ECMWF plans to routinely monitor the quality of FY-4B GIIRS observations.

Acknowledgements

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References

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