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Use of geostationary imager clear-sky radiances in Met Office Global NWP

R.B.E. Taylor & P.N. Francis

Clear-sky radiance (CSR) information from geostationary imagers has been used in the Met Office's global 4D-Var system since 2010, starting with the SEVIRI instrument aboard Meteosat-8 and since extended to use products from an equatorial ring of five platforms.

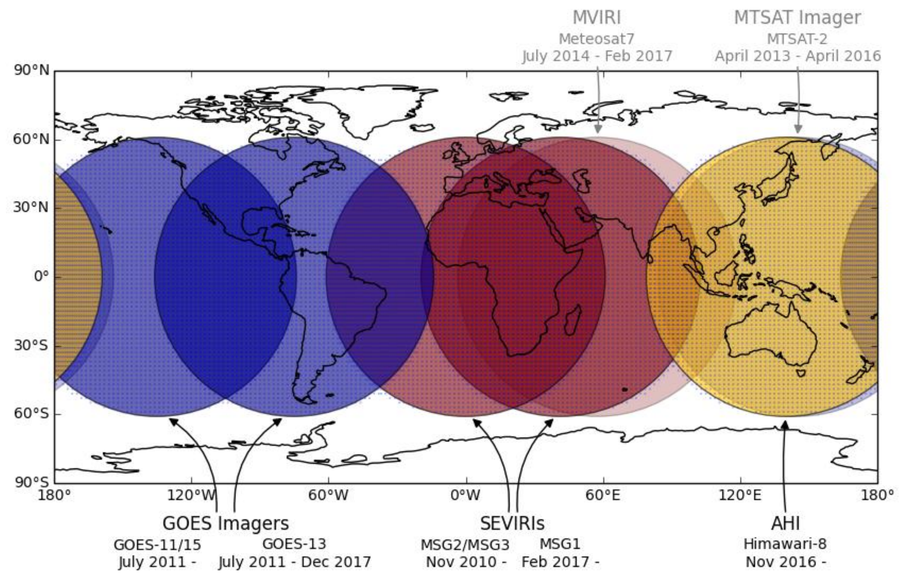
A typical assimilation configuration uses :

- hourly data (GOES 3-hourly)
- spatially aggregated product – typically 16x16 pixels ~ 60x60km at sub-satellite point (AHI 32x32km)
- cloud-free obs (no constituent pixels affected by cloud)
- data thinned to 120km
- WV channels, + surface-sensitive IR over sea for SEVIRI & AHI
- extra window-channel O-B threshold test for undetected cloud
- 4K obs error for WV channels, 1.5K for window channels
- eclipse blacklisting around local midnight (GOES)
- higher-peaking WV channels (SEVIRI & AHI) used over low cloud (see below)
- variational bias correction

Channel summary

SEVIRI	MVIRI	GOES Imager	MTSAT Imager	Advanced Himawari Imager
IR 3.9		IR 3.9	IR 3.8	IR 3.9
WV 6.2	WV 6.3	WV 6.5		WV 6.2
			WV 6.8	WV 6.9
WV 7.3				WV 7.3
IR 8.7				IR 8.6
IR 9.7				IR 9.6
IR 10.8		IR 10.7	IR 10.8	IR 10.4
	IR 11.5			IR 11.2
IR 12.0			IR 12.0	IR 12.4
IR 13.4		IR 13.3		IR 13.3

All surfaces + low cloud; all surfaces; sea only; monitored; not used

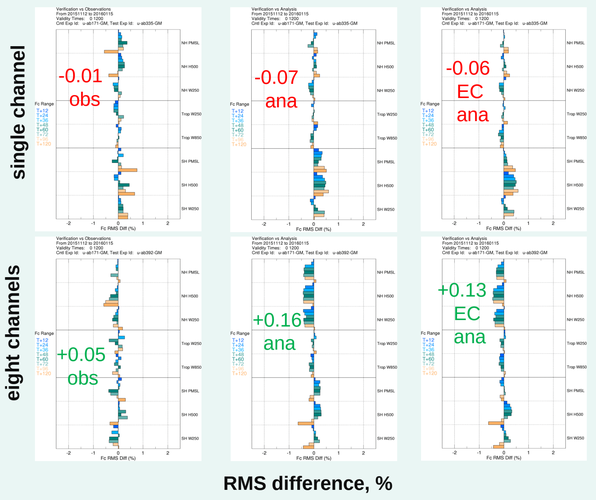


MTSAT-2 Imager → Advanced Himawari Imager (November 2016)

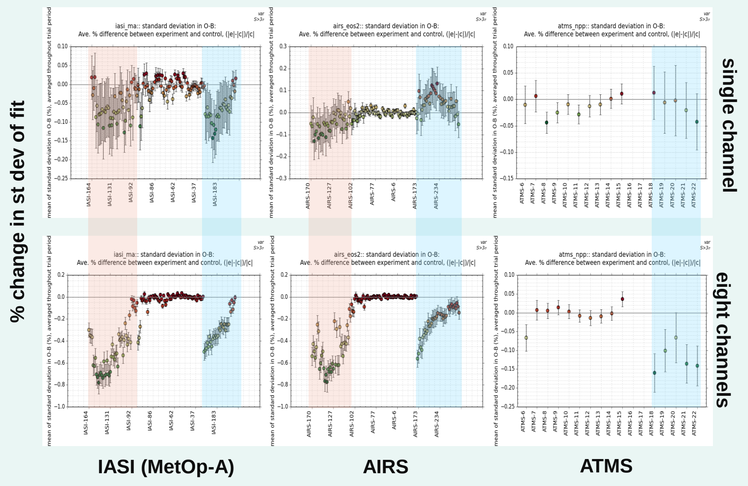
The AHI, aboard Himawari-8, which replaced MTSAT-2's Imager over the western Pacific in Spring 2016, has three channels providing water-vapour information and five surface-sensitive channels. Trials were run both for a "like-for-like" single-channel replacement configuration and for a set-up using all available channels (similar to that for SEVIRI). Results shown are for a winter season experiment.

NWP forecast impact results (right) are small but consistent. The statistics of O-B fits (far right) demonstrate the impact of using extra AHI data on the short-term forecast. The channel sets shaded in blue show the impact of additional water-vapour channels whilst the channels shaded in pink suggest the surface-sensitive channels influence tropospheric temperature profiles. This latter result is also seen in the withdrawal experiment below.

Index impact (trial − control, with plots of RMS changes):



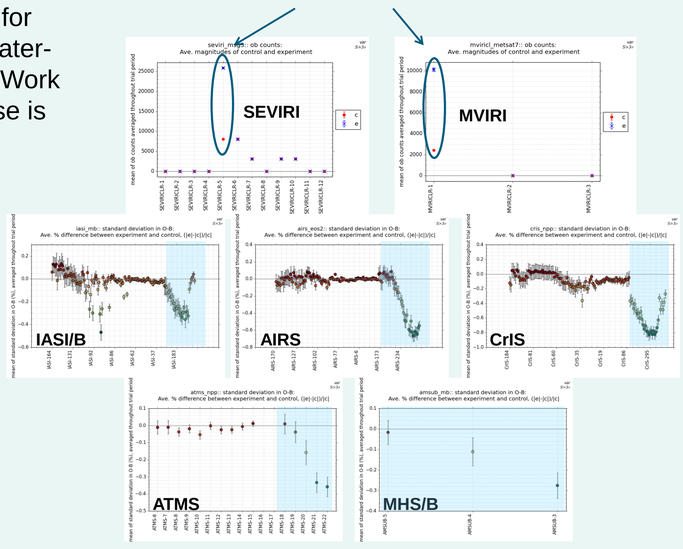
Impact on O-B fits for other satellite instruments:



Use of higher-peaking water-vapour channels over low cloud (November 2016 onwards)

Most geostationary imager CSR products are now supplied with cloud masks which differ by channel. Higher-peaking water-vapour channels are insensitive to low cloud, so their radiances can be accurately forward-modelled in its presence, and assimilated as "clear-sky". Trialling of these additional observations showed a modest impact on the NWP index and consistently significant improves RMS O-B fits for other instruments (below).

JMA supplies AHI data with a cloud mask for each of its three water-vapour channels. Work to optimise their use is now in progress.



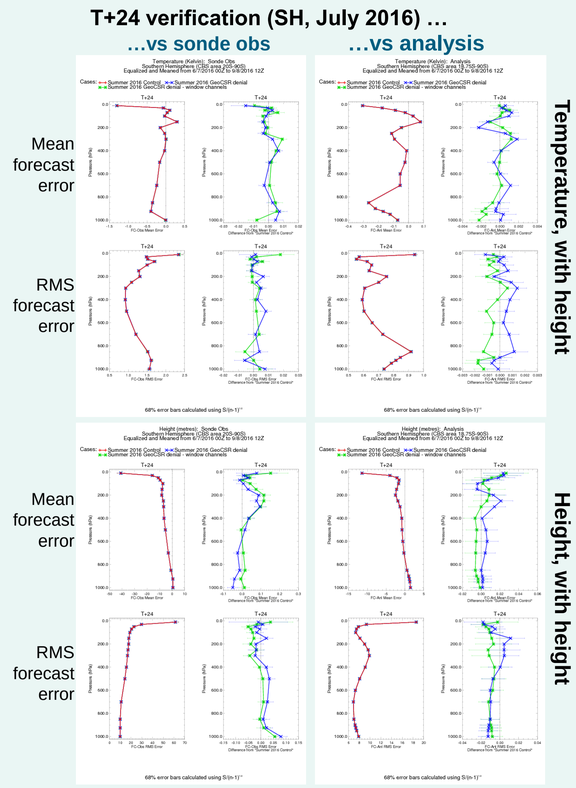
Geostationary imager denial experiment (work in progress)

Adding or altering the assimilation of a single geostationary imager typically has only a modest impact on the NWP index. Experiments (summer & winter) are in progress to show the effect of withdrawing all geostationary imager data and surface-sensitive channels only.

Verification plots for the first month (right) show some indication of benefit from these data. Clearer signals come from the improved RMS O-B fits for other instruments (below), where only the full denial experiment shows the characteristic WV-channel signal.

(Note that for denial experiments, an increased RMS indicates data is of benefit.)

T+24 verification (SH, July 2016) …



Blue = no GeoCSRs, Green = no surface-sensitive channels

Met Office FitzRoy Road, Exeter, Devon, EX1 3PB United Kingdom
Tel: +44 1392 885680 Fax: +44 1392 885681
Email: ruth.taylor@metoffice.gov.uk