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Assessment & Assimilation of FY-3D HIRAS in the Met Office System

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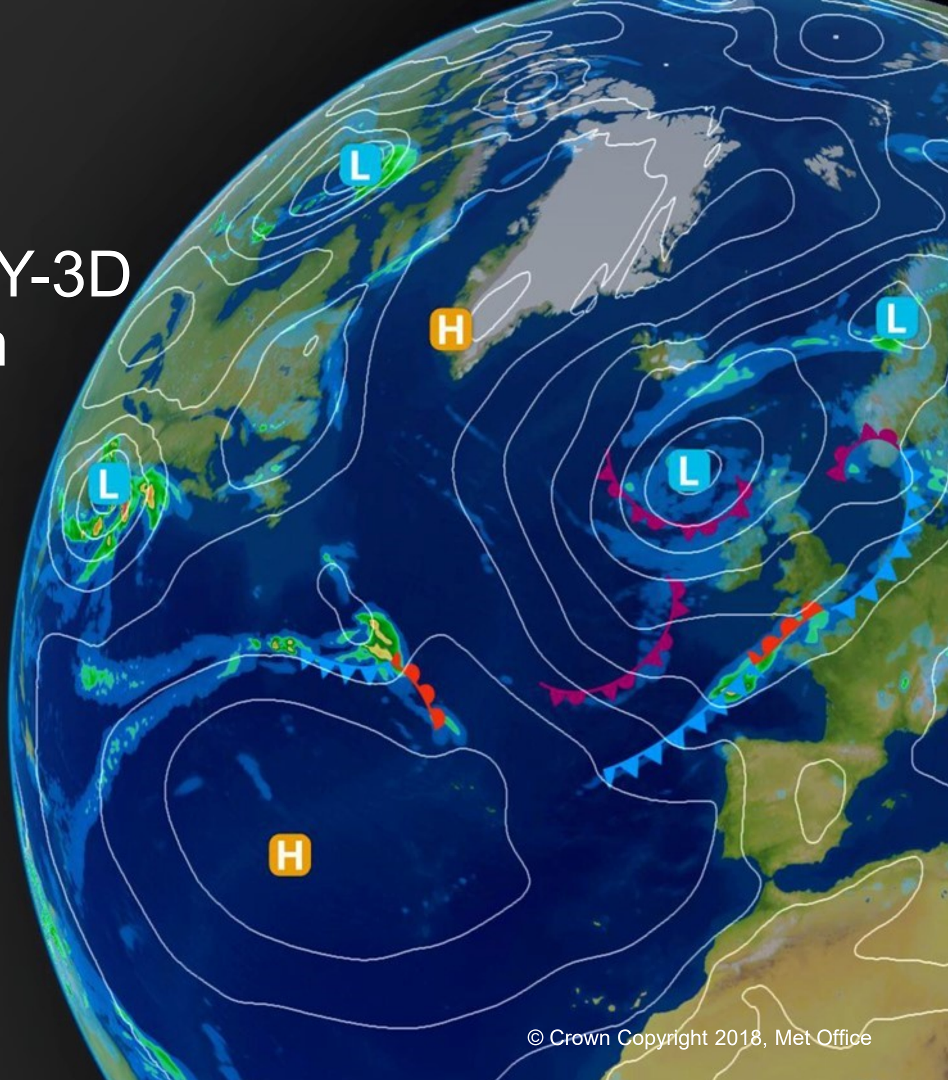

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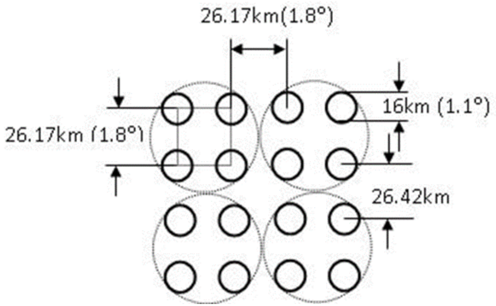
Specifications

Hyperspectral Infrared Atmospheric Sounder (HIRAS)

Parameters	Specification
Scan Period (s)	10
View angle (°)	1.1
Scan angle (°)	± 50.4
Radiative calibration accuracy (K)	0.7
Spectral calibration accuracy (ppm)	7
Direction pointing bias (°)	± 0.25
Pixels per scan	116



	Band	Spectral Range (cm^{-1})	Spectral Resolution (cm^{-1})	No of channels
FSR	Long-wave	650 - 1136	0.625	777
	Mid-wave	1210 - 1750	0.625	865
	Short-wave	2155 - 2550	0.625	633
NSR	Long-wave	650 - 1136	0.625	777
	Mid-wave	1210 - 1750	1.25	432
	Short-wave	2155 - 2550	2.5	158

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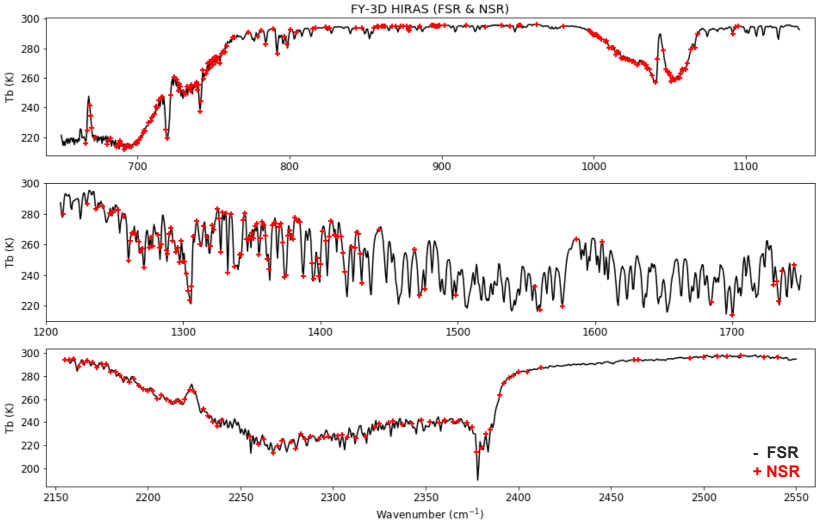
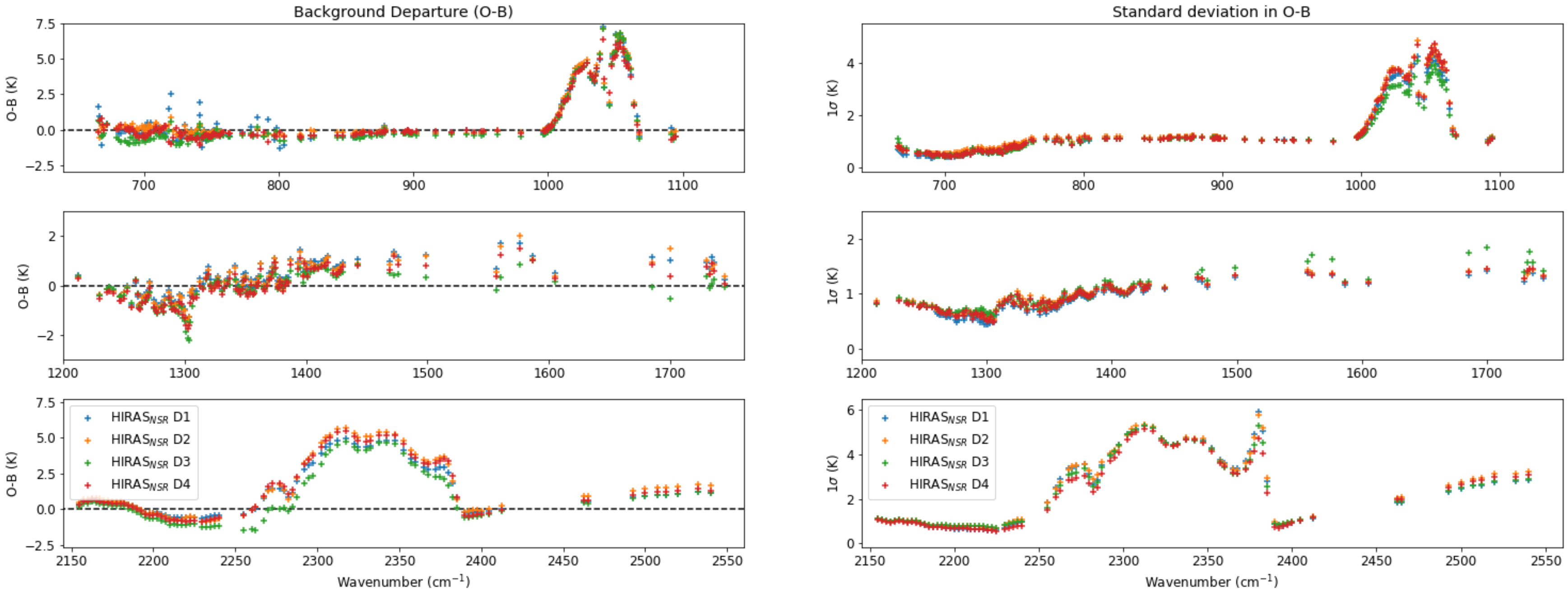
Pre-processing



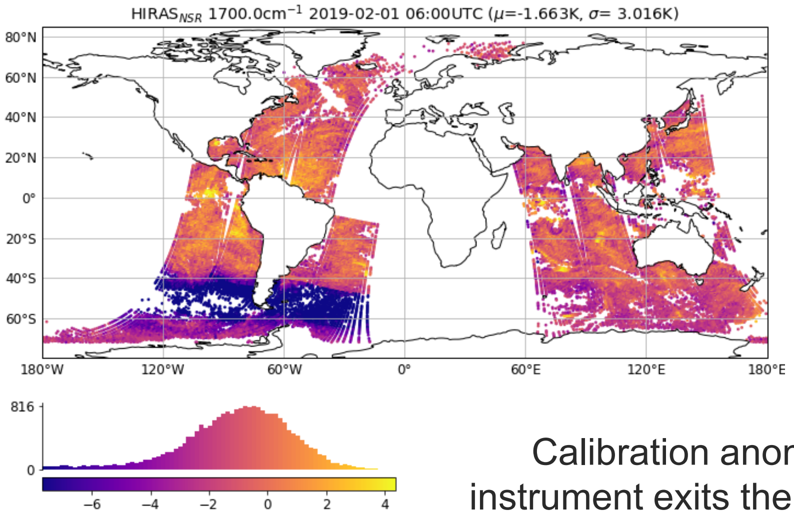
- 2 months (Feb-Mar 2019) of HIRAS FSR (2275 channels) data prepared by CMA in HDF5 format.
- Ingestion in the AAPP version 8.4 [1] and conversion to level 1c binary format using the tool *hiras_sdr* (incl. Hamming apodization).
- Degradation to NSR (1367 channels) using the AAPP tool *hiras_degrade_fsr.*
- Channel selection (399 channels) identical to that currently used for CrIS [2, 3].
- Conversion to BUFR format using a locally-defined BUFR sequence (available through AAPP) and stored in the Met Office's observation database.

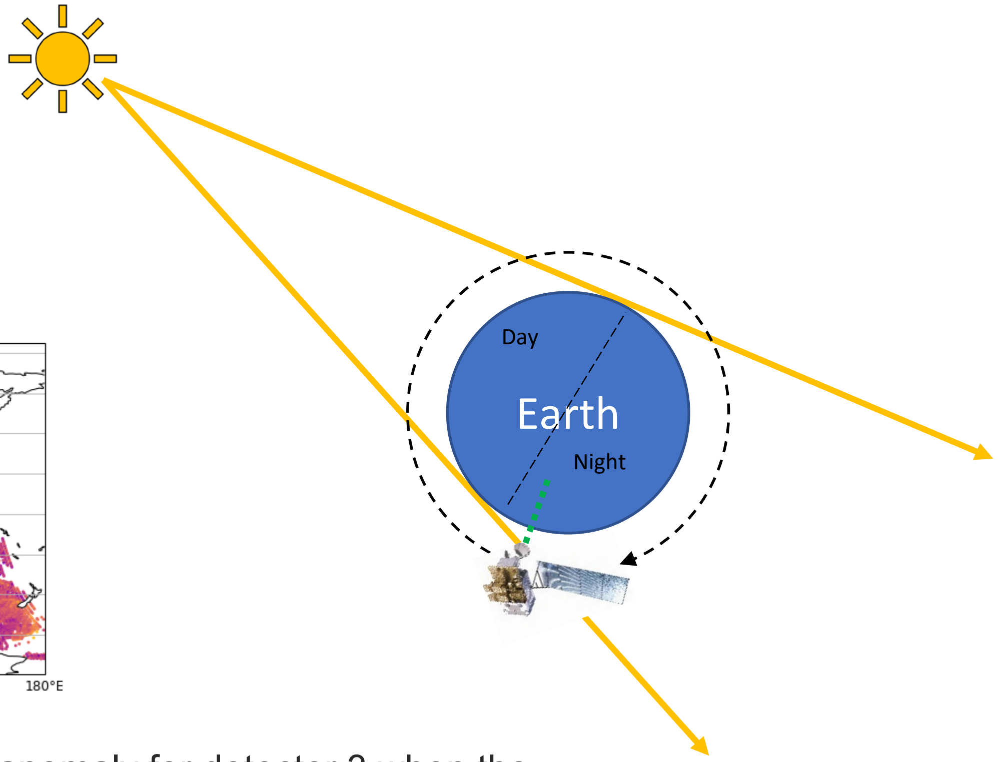
Clear-Sky / Ocean Only

Background Departures



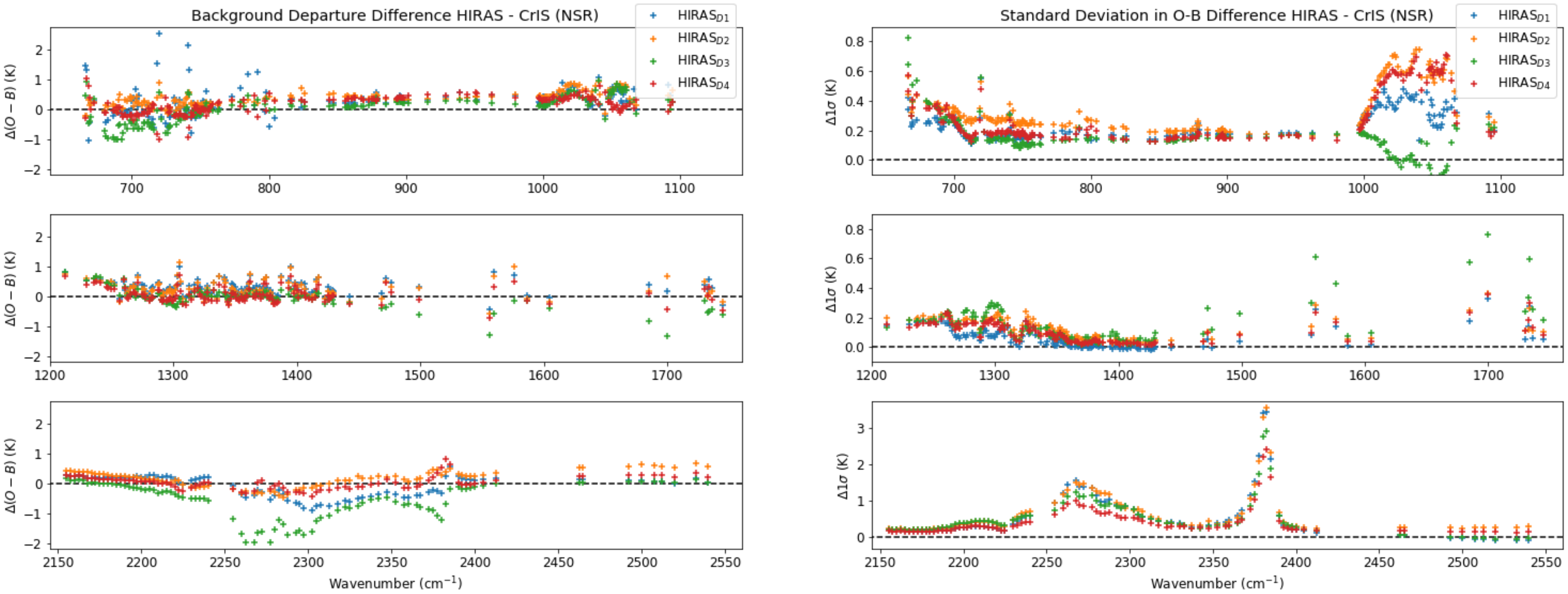
Calibration Anomaly





Calibration anomaly for detector 3 when the instrument exits the shadow of Earth at solar zenith angle ~ 100-120°. Possible contamination of the cold calibration view by direct of reflected sunlight.

Double Difference Against CrIS



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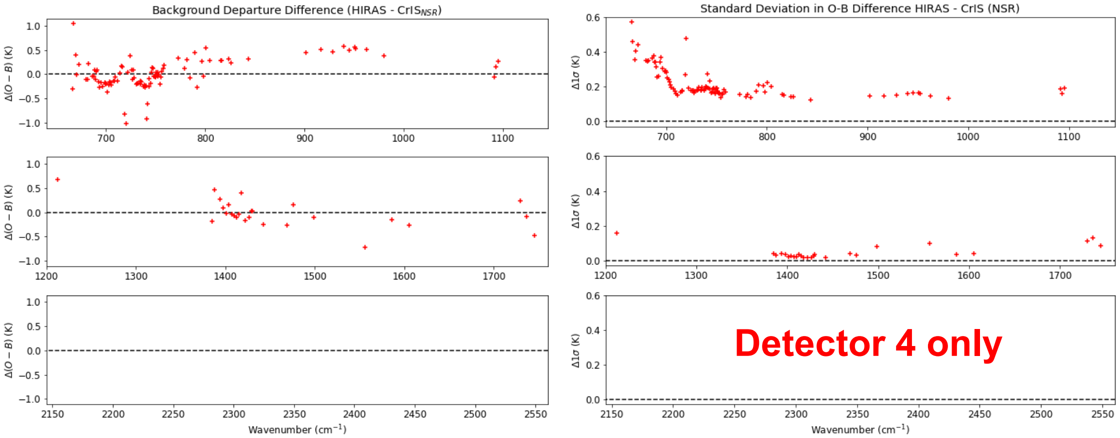
Assimilation Experiments

- Low resolution N320L70 UM, N108/N216 4D-Var uncoupled hybrid assimilation full global system.
- Thinning and channel selection are similar to those used for CrIS (**but ocean only**).
- Observation covariance matrix estimated for 1D-Var (and used in 4D-Var as a day-1 approach) following a similar methodology used by [4].
- Variational bias correction coefficients have been spun up off-line with a low resolution 4D-Var cycling suite for two months.



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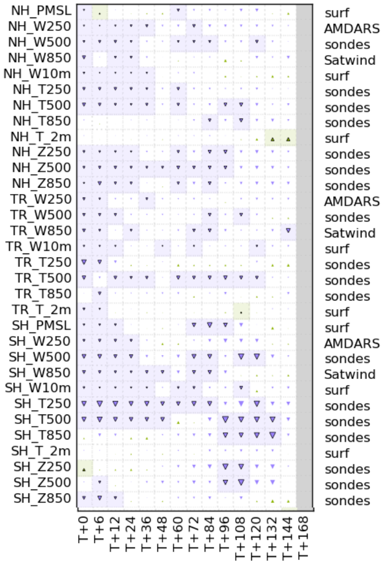
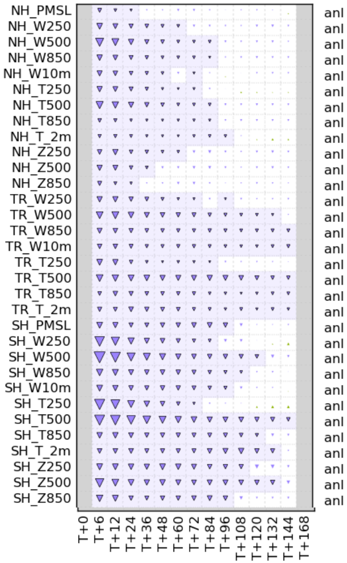
Assimilation Experiments

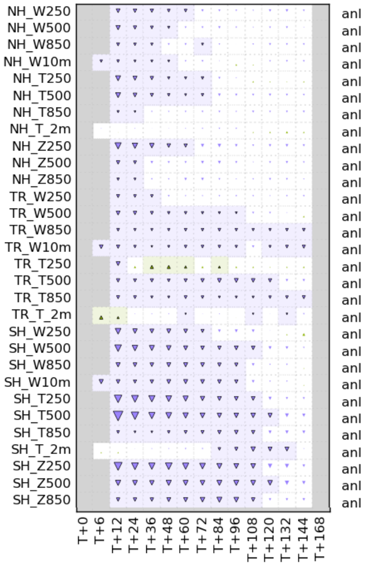
-0.31% RMSE difference against observations



-1.06% RMSE difference against MO analyses



-0.56% RMSE difference against ECMWF analyses



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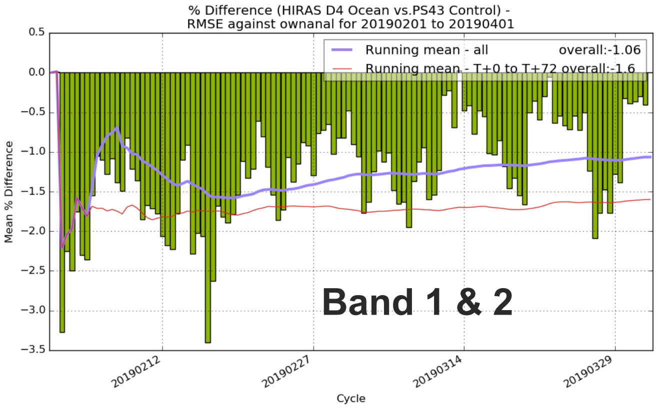
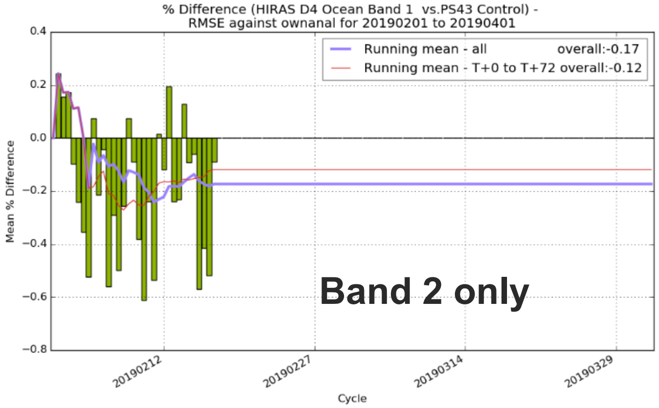
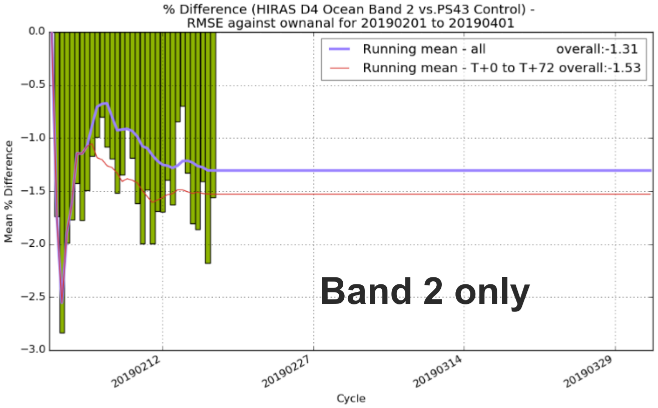
Assimilation Experiments

Time series of RMSE difference against MO analyses







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Summary

- HIRAS (det. 4) compares generally well to CrIS at NSR:
  - O-B are on average within ±0.1 K across the 399 channels,
  - but up to 1 K for high peaking temperature channels in the long-wave band,
  - and up to 0.7 K for humidity channels in the mid-wave band.
  - HIRAS standard deviation is on average 0.2 K larger than CrIS.
- Probable sunlight contamination of detector 3 deep space view affects band 2.
- Preliminary assimilation experiments (det. 4 over ocean) yield negative results when using CrIS channels selection (especially in band 2).
  - HIRAS-dedicated channel selection is under investigation.
- Complete assessment to be submitted to *Remote Sensing.*

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References

[1] Labrot , T., Atkinson, N. and Roquet, P., “AAPP documentation software description”, NWPSAF-MF-UD-002, version 8.1, 2019, https://www.nwpsaf.eu/site/software/aapp/documentation/

[2] A. Gambacorta and C. D. Barnet, "Methodology and Information Content of the NOAA NESDIS Operational Channel Selection for the Cross-Track Infrared Sounder (CrIS)," in IEEE Transactions on Geoscience and Remote Sensing, vol. 51, no. 6, pp. 3207-3216, June 2013. doi: https://doi.org/10.1109/TGRS.2012.2220369

[3] Smith, A. , Atkinson, N. , Bell, W. and Doherty, A. (2015), An initial assessment of observations from the Suomi-NPP satellite: data from the Cross-track Infrared Sounder (CrIS). Atmos. Sci. Lett., 16: 260-266. doi: https://doi.org/10.1002/asl2.551

[4] Weston, P. P., W. Bell, and J. R. Eyre, 2014: Accounting for correlated error in the assimilation of high-resolution sounder data. *Quart. J. Roy. Meteor. Soc.*, 140, 2420–2429, doi: https://doi.org/10.1002/qj.2306.

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Questions ?

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