Himawari-8 AHI Radiance Assimilation with GSI at JCSDA

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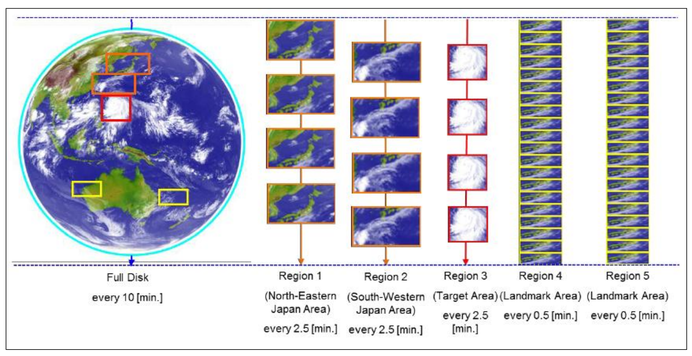
1. Introduction

A new era in environmental satellites began in October 2014 when Japan's Himawari-8 attained geostationary orbit. Main instrument of the satellites is the Advanced Himawari Imager (AHI) which is comparable to the Advanced Baseline Imager (ABI) on board the U.S. GOES-R class satellites.

Efforts are currently ongoing at the NOAA/NESDIS Center for Satellite Applications and Research (STAR) to assimilate Himawari-8 AHI radiance measurements in the NOAA Global Data Assimilation System. All plumbing in the Grid-point Statistical Interpolation (GSI) system to allow assimilation of Himawari-8 AHI radiance has been completed, and the impact of the real AHI observations is determined in the global framework at JCSDA. All sky (clear, cloudy, and precipitation) IR radiance of Himawari-8 will be expanded beyond the assimilation of only clear sky IR channels. It is toward the ultimate goal to routinely assimilate these data to improve global weather forecasts as well as to improve global cloud and precipitation analyses. The cycling experiments with/without real H8 AHI have been performed to assess its Analysis/Forecast impacts. The preliminary scientific results about the ingestion of Himawari-8 AHI data and the impact on the NOAA GFS model forecast will be presented in this Conference.

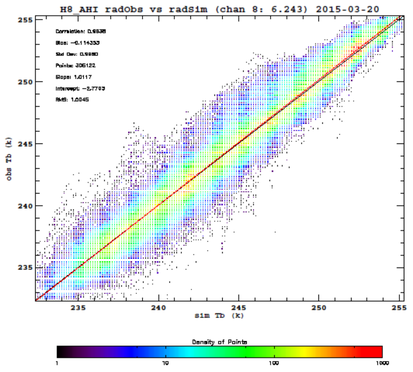
2. Himawari-8 AHI



Band		Central Wavelength (μm)	Spatial Resolution
1	VIS	0.46	1 km
2		0.51	
3		0.64	0.5 km
4	NIR	0.86	1 km
5		1.6	2 km
6		2.3	
7	IR	3.9	
8		6.2	
9		7.0	
10		7.3	
11		8.6	
12		9.6	
13		10.4	
14		11.2	
15		12.3	
16		13.3	

3. Pre-Assimilation Assessment

COAT: Clear data (Split-window SST threshold)/sat zenith limit < 60

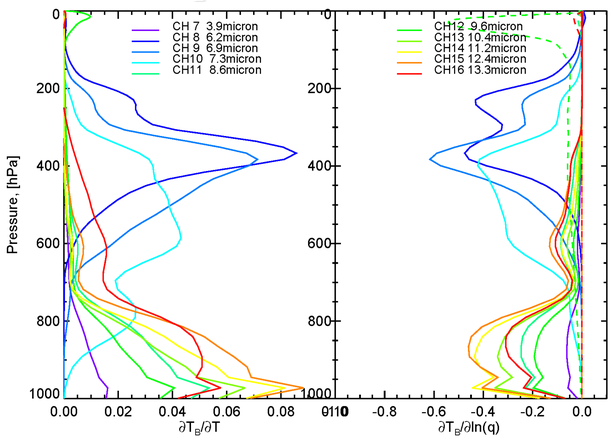


H8 AHI All Clear-Sky Cases (Ocean Only)

Chan	Freq, [μm]	Bias, [K]	Std. Dev., [K]	RMSE, [K]	Corr.	No of Cases
7	3.885	1.10	2.03	2.31	0.82615	305122
8	6.243	0.11	1.00	1.00	0.98380	305122
9	6.941	0.04	1.00	1.00	0.98550	305122
10	7.347	-0.20	0.94	0.96	0.98206	305122
11	8.593	-0.65	0.92	1.12	0.93633	305122
12	9.637	0.10	0.71	0.72	0.98399	305122
13	10.407	-0.49	0.93	1.05	0.92869	305122
14	11.240	-0.36	1.08	1.14	0.90715	305122
15	12.381	-0.68	1.30	1.46	0.89117	305122
16	13.281	-0.92	1.03	1.38	0.92990	305122

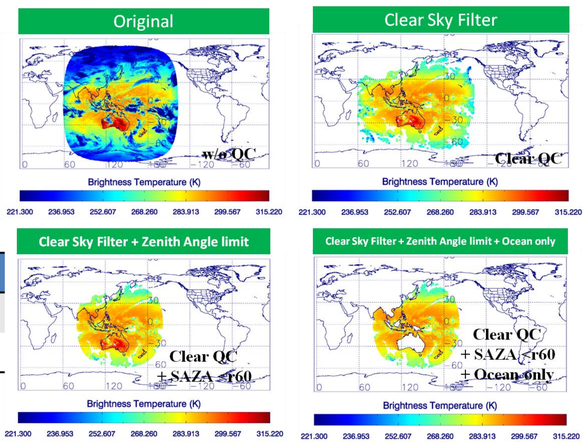
AHI IR Channel *T(p)* (left), $H_2O(p)$ (solid right) and $O_3(p)$ (dashed right) Jacobians:

Computed using ECMWF collocated to clear-sky, night-time, near nadir, tropical ocean, AHI observation as input to CRTM v2.2.1.



4. AHI Readiness in GSI

- Developed AHI ingest codes and QC procedures.
- AHI observation errors statistics.



Channel	7	8	9	10	11	12	13	14	15	16
Freq.	3.8μm	6.2μm	6.9μm	7.3μm	8.6μm	9.6μm	10.4μm	11.2μm	12.4μm	13.3μm
Obs. Error	1.40	0.95	0.95	0.90	0.80	0.70	0.90	1.00	1.30	1.00

5. Experiment Setup

Model:

– T670L64 Semi-Lagrangian GFS, operational observations, GFS/GDAS cycles;

– Hybrid 3D EnVar: 80 member T254L46 ensemble with fully coupled (two-way) EnSRF update

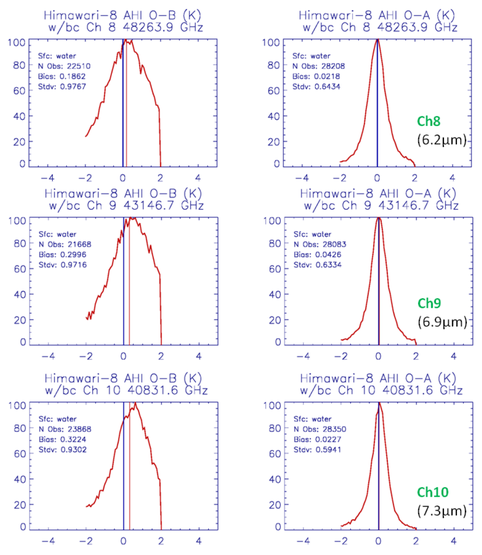
Two cycling experiments on 6/1/2015 – 6/29/2015:

– **CTRNL**: Current observing system

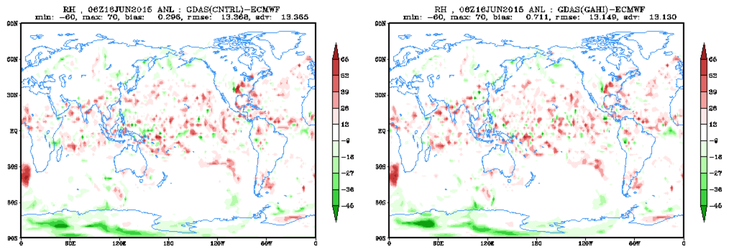
– **AHI:** Current observing system + AHI from water vapor channels (*WV6.2, WV6.9 and WV7.3*)

6.1 Assessment Impact on the Analysis

Reduced Bias and Std. Dev.



Chan	N obs (O-B)	N obs (O-A)	Bias w/bc (O-B)	Bias w/bc (O-A)	Stdv (O-B)	Stdv (O-A)
7(3.8μm)	23,760	23,937	0.50	0.46	0.83	0.82
8(6.2μm)	22,510	28,208	0.19	0.02	0.98	0.64
9(6.9μm)	21,668	28,083	0.30	0.04	0.97	0.63
10(7.3μm)	23,868	28,350	0.32	0.02	0.93	0.59
11(8.6μm)	23,283	26,268	0.03	-0.03	0.73	0.68
12(9.6μm)	26,256	26,713	0.04	0.01	0.71	0.64
13(10.4μm)	24,870	24,999	-0.02	-0.03	0.75	0.72
14(11.2μm)	24,377	24,555	-0.04	-0.03	0.78	0.73
15(12.4μm)	23,264	23,621	0.01	-0.02	0.85	0.77
16(13.3μm)	24,806	25,008	0.03	-0.04	0.78	0.69

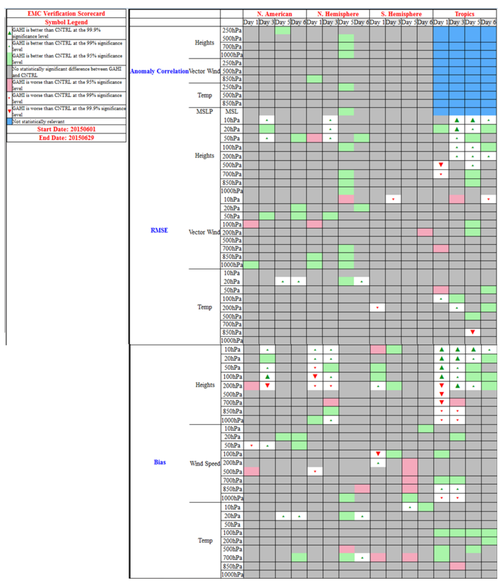


Reduced upper tropospheric RH uncertainty with AHI after two weeks of cycling.

6.2. Assessment Impact on the Forecast

Scorecard for verification:

Anomaly correlation, bias and root mean-squared error differences between CNTRL and AHI for forecast days 1–6 verified against ECMWF operational analyses. Green indicates improvement over current GFS/GDAS while red indicates a degradation at T670/T254 resolution.



Summary:

- Developed AHI ingest codes and QC procedures in GSI.
- Performed the preliminary assessment for H8 real data in active assimilation of water vapor channels.
- Preliminary assessment of the assimilation of AHI water channels on analysis and forecast (radiometric and geophysical) skill shows neutral to marginal positive impact relative to assimilation without AHI.

Future Work:

- Data Thinning – exploit high temporal and spatial resolution sampling of data
- Optimize observation error/bias correction.
- Extend data assimilation to more channels (chns 7-16)
- Assessment of AHI in the upcoming NOAA 4D-hybrid system