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Monitoring of IR Clear-sky Radiances over Oceans for SST (MICROS): Near-Real Time, Web-Based Tool for Monitoring CRTM – AVHRR Biases

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1. Introduction

Monitoring of IR Clear-sky Radiances over Oceans for SST (MICROS) is a web-based Near-Real Time (NRT) tool which monitors the Model (Community Radiative Transfer Model, CRTM) minus Observation (AVHRR) (M-O) biases in clear-sky brightness temperatures (BT) over oceans, produced by the newly developed Advanced Clear-Sky Processor for Oceans (ACSPO). MICROS system which has been in routine use since July 2008 with AVHRR data from NOAA-16, -17, -18 and MetOp-A.

2. Objectives

This paper documents the MICROS system and discusses the effects of three ACSPO versions on the global M-O biases. It also demonstrates the utility of MICROS to monitor satellite radiances over clear-sky global ocean in NRT for stability and cross-platform consistency.

3. ACSPO versions tested in MICROS since July 2008

- ACSPO v.1.0 (operational May 2008) uses: CRTM r577 in conjunction with Reynolds 1° weekly SST and NCEP/GFS 1° 6hr fields to produce model BTs; Fresnel's surface emissivity model, and ordinary CRTM coefficients.
- ACSPO V.1.02 (implemented in MICROS on 4 September 2008) use Reynolds 0.25° daily SST and CRTM v.1.1, Wu-Smith emissivity model and Planck-Weighted CRTM coefficients.
- ACSPO V.1.1 (implemented in MICROS 12 November 2008) uses flexible BT and SST bias filters for different bands and sensors (Petrenko et al., 2009). Also, day/night flag switches now at solar zenith angle of 90° (v.1.0/1.02: 85°)

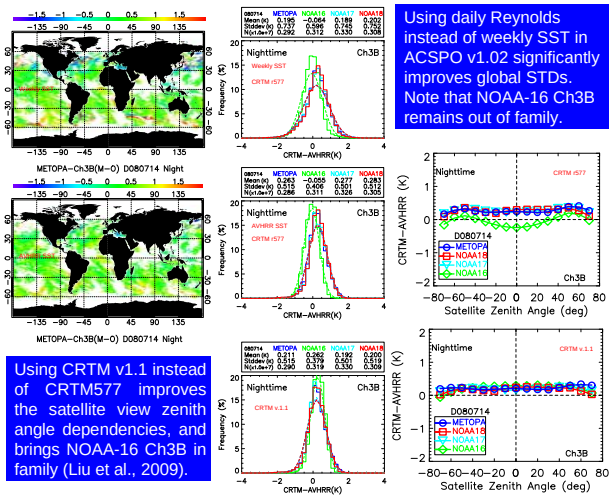
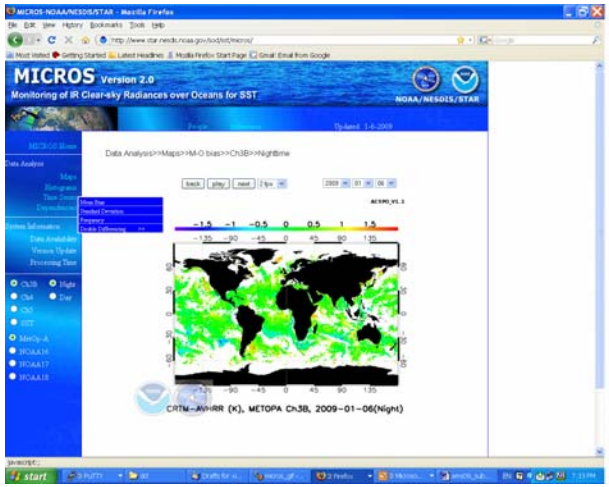


Figure 1. Global distributions and histograms of the M-O biases and their view zenith angle dependencies for one day of nighttime data (14 July 2008) for MetOp-A Ch3B.



MICROS: www.star.nesdis.noaa.gov/sod/sst/micros

4. Nighttime global mean M-O and SST biases

- NOAA16 Ch3B was out of family before September 4, 2008, due to effect of out-of-band contribution in NOAA-16 Ch3B special response function. (Liu et al., 2009). This problem was fixed in CRTM v.1.1.
- The warm M-O biases are due to a combined effect of not included aerosols, using bulk SST (instead of skin), and using "daily-mean" Reynolds SST to represent the nighttime SST, which is cooler due to the effect of the diurnal cycle.
- Short-term variability in the M-O biases likely arises from the instabilities in the Reynolds SST input.

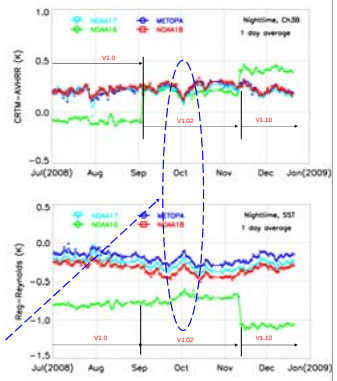


Figure 2. (Top) Global M-O biases in Ch3b, 4, 5 for NOAA-16, -17, -18, and MetOp-A from 1 July to 20 December, 2008. (Bottom) Corresponding SST biases wrt Reynolds SST (weekly 1° before 4 September and daily 0.25° AVHRR-based after that date). Each point in the graph is a global average over all nighttime observations (SZA>90°) within a 24-hour period (~3 mln/day; cf. Fig. 1).

5. Nighttime global STDs of M-O and SST biases

- Global STDs of both M-O and ΔT_S have significantly reduced when ACSPO was upgraded from v.1.0 to v.1.02 (due to the use of more accurate daily SST as reference) and further decreased in v.1.10.
- Before September 4, the STDs of both M-O and ΔT_S show a prominent weekly cycle. This is an artifact of using weekly SST in ACSPO v.1.0. It was resolved in ACSPO v.1.02. where daily SST was employed.

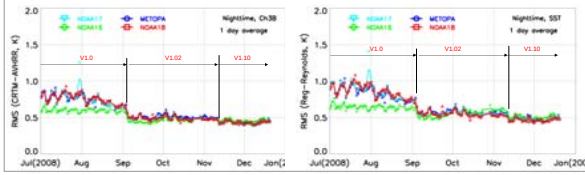


Figure 3. Same as in Figure 2 but for the global STD for Ch3B and SST.

6. Cross-platform and day-night consistency using Double-Differencing (DD) technique

- Fig. 4 shows cross-sensor DDs. All BTs are consistent except for NOAA18 Ch4. NOAA-16 is unstable in all three bands.
- The D/N DD (Fig. 5) became more realistic in ASCPO v1.10 Afternoon platforms are slightly warmer during daytime whereas morning platforms are slightly cooler.

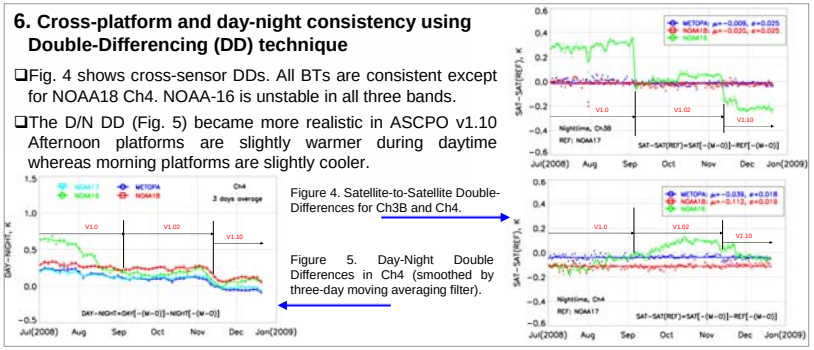


Figure 4. Satellite-to-Satellite Double-Differences for Ch3B and Ch4.

Figure 5. Day-Night Double Differences in Ch4 (smoothed by three-day moving averaging filter).

7. Conclusion and Future Work

- The "out-of-family" anomaly in NOAA16 Ch3B in ACSPO v.1.0 was uncovered by MICROS and fixed. However, NOAA16 are unstable in all bands and all ACSPO versions. This instability is being analyzed.
- The nighttime global mean M-O biases have been stable from July-December 2008 (except NOAA16). The corresponding STDs have significantly improved when ACSPO was upgraded to v.1.02 and v.1.10.
- A double-differencing technique used in MICROS can contribute to establishing cross-sensor CAL links within the Global Satellite Inter-Calibration System (GSICS).
- Improvements to CRTM In ACSPO are underway. Those include accurate modeling daytime BTs, and testing the Jacobian / tangent linear for physical SST retrievals and improved cloud masking.
- Work is underway to extend MICROS functionality to include monitoring of BTs from MSG/SEVIRI. Data from NPOESS/VIIRS and GOES-R ABI will be added when become available.

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