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http://gsics.wmo.int *Dr. Fangfang Yu, Editor*

Potential of Highly Elliptical Orbit for Observing Polar Regions and Satellite Inter-Calibration

The Highly Elliptical Orbit (HEO) has recently drawn significant attention in the meteorological community due to its unique ability for observing Polar Regions (Trishchenko and Garand, 2012). The HEO orbit, called Molniya, has been employed intensively for communication and some other purposes for nearly half of a century by Russia, US and other countries. Despite this successful record, it has never been used for regular meteorological observations similar to those from the Low Earth Orbit (LEO) polar satellites and Geostationary (GEO) satellites. The World Meteorological Organization (WMO) initiated work a few years ago to include the HEO spaceborne system as part of the Global Observing System (GOS) (WMO, 2009). In particular, the HEO system equipped with Vis/IR imagers can provide valuable observations of atmospheric motion vectors (AMV), clouds, surface albedo, radiative fluxes, sea ice, snow cover, vegetation and wildfires, among other parameters.

Continuing the pioneering work of Kidder and Vonder Haar (1990), Trishchenko and Garand (2011) conducted a detailed study of the 12-h Molniya HEO orbit, and concluded that a two-satellite constellation in one orbital plane could provide continuous coverage of the region 60°-90° for each hemisphere. Thus, two pairs of HEO satellites (one pair for each hemisphere) in combination with a GEO constellation could effectively provide continuous coverage of the whole globe as shown in Figure 1. The labelled contour lines in Figure 1 denote temporal coverage from a two-satellite HEO system expressed as % of time for specific location observed over 24 hr interval. Arcs of different color denote the area coverage for various GEO satellites. All results correspond to the Viewing Zenith Angle (VZA) limit 70°.

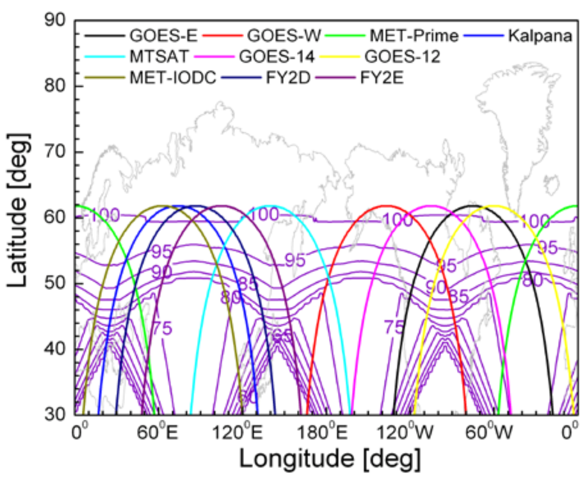

Figure 1. Map of temporal coverage (%) over 24-hr period for GEO and HEO systems over Northern latitudes. Picture for South Hemisphere (not shown) is similar.

A drawback of the Molniya orbit is its exposure to high levels of ionizing radiation, including a considerable amount of high-energy protons with energy E > 10 MeV (Trishchenko *et al.*, 2011). This represents a high degree of risk and decreases the expected lifetime of the meteorological imaging payload, solar panels and other electronic equipment To address this problem, Trishchenko *et al.* (2011) conducted an orbit optimization exercise and designed the 16-hr orbit, termed the Three Apogee (TAP) orbit, which significantly reduces the total dose of high energy protons and makes the radiation environment for the HEO system somewhat similar to GEO satellites. The eccentricity of the TAP orbit, which determines the dwelling time over the Polar Regions, could be as high as 0.55.

The TAP orbit with critical inclination i=63.4° ensures stability of the line of apsides and provides 100% temporal coverage for all latitudes above approximately 63°N and 98% temporal coverage at 60°N. This somewhat smaller coverage is due to the smaller eccentricity for the TAP orbit (e=0.55) than for a classical Molniya orbit (e>0.7). To compensate for the smaller eccentricity and to improve coverage at 60°N to 100%,

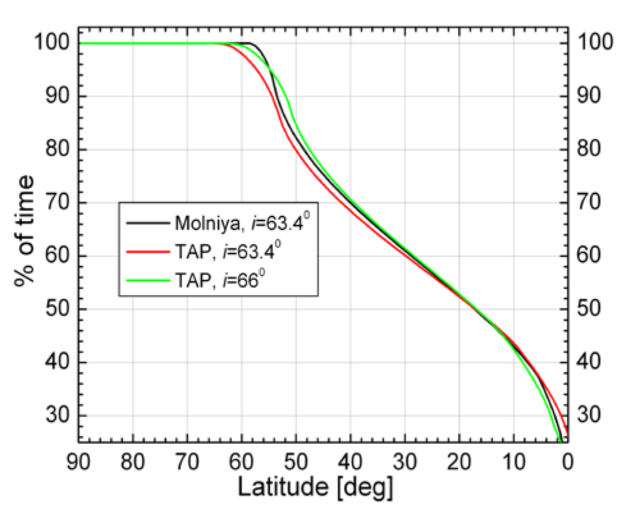

Figure 2. Zonal mean temporal coverage for 12-h Molniya and 16-h TAP orbit with inclination 63.4° (critical value) and 66°).

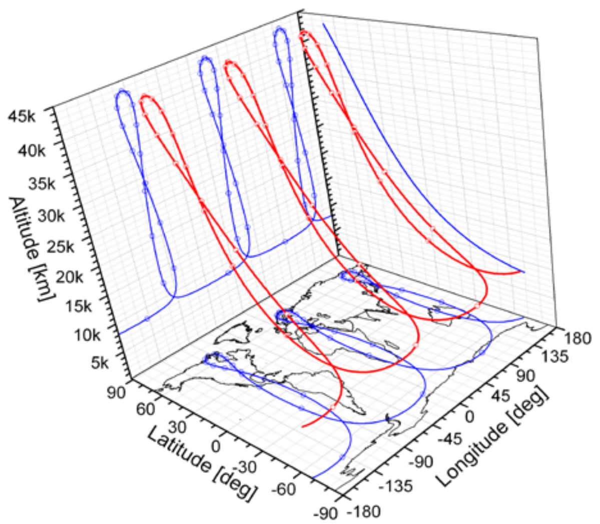

Figure 3. 3-D view of 16-hr TAP orbit showing geographical location and altitude of satellite trajectory. Small circles denote position of satellite at 1-hr time intervals.

one can increase the inclination of the TAP orbit to 66°. Figure 2 compares the zonal mean temporal coverage of the 16-hr TAP orbit for two values of inclination (critical value 63.4° and 66°) and the classical 12-hr Molniya orbit at critical inclination.

The departure of inclination from a critical value means that orbit maintenance necessary to keep the apogee location at the required latitude with argument of perigee equal to 270° will require more propellant for orbit correction. Values of inclination between critical value 63.4° and 70° represent a feasible scenario and practical trade-off space for 16-hr TAP orbit.

The HEO Earth imaging system could be a valuable component of the Global Satellite Inter-Calibration System (GSICS) due to its unique orbital geometry features, such as wide range of altitudes, latitudes and longitudes covered by the satellite trajectory. A 3-D view of a 16-hr TAP HEO orbit is shown in Figure 3. The TAP orbit has three apogees separated by 120°. Trishchenko et al. (2011) suggested the following central longitudes for apogees: 95°W (North America), 25°E (Europe), 145°E (Eastern Siberia). The working range of satellite altitudes for regular image acquisition operations extends from about 24,000 km to 43,500 km and corresponds to satellite latitude positions north of 30°N.

HEO-LEO geometry matching. The HEO orbit design provides numerous opportunities for intercalibration with LEO polar orbiters due to frequent geometry matching with polar LEO scanning systems for both observational angles: Viewing Zenith Angle (VZA) and Relative Azimuth (RAZ). This is possible owing to continuous coverage of high latitudes from HEO and frequent passes of the LEO satellites over this region.

An example of matching geometry with difference in VZA less than 5°, and difference in RAZ less than 10° is presented in Figure 4 for the Suomi NPP VIIRS imager and 16-hr HEO TAP orbit described by Trishchenko et al. (2011). Results are shown for a 16-day interval that represents a complete ground track repeat cycle for the SNPP satellite. Numerous coincident observations occur within the latitude band 20°N-77°N for a wide range of VZA angles – from near nadir to close to 55° – within every 24-hr time interval. The RAZ angular range covers an angular sector of about 60°. Thus, unlike Simultaneous Nadir Overpass (SNO) events used for LEO-LEO inter-calibration, the LEO-HEO satellite inter-calibration may occur on a daily basis over a wide range of geometrical conditions. The geometry matching may also occur in the tropical zone and the Southern Hemisphere where a HEO system built for the Northern Polar Region is not normally expected to provide regular image acquisitions.

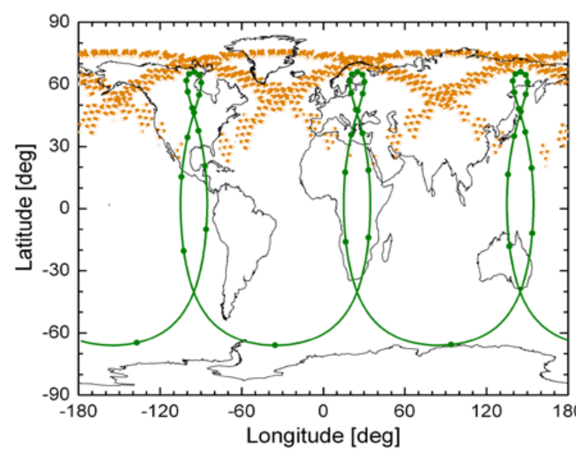

Figure 4. An example of matching geometry for LEO (VIIRS/SNPP) and 16-hr TAP orbit over 16-day repeat cycle of LEO orbit. ΔVZA<5^0, ΔRAZ<10°.

HEO-GEO geometry matching. The inter-calibration between GEO and HEO systems with matching geometry for both VZA and RAZ angles is possible for those GEO satellites that are at a longitude close to the HEO ground track (in our case the difference in longitude should be approximately <25°). This is a consequence of the relatively high altitude of the HEO system which is comparable to GEO altitudes. If two platforms are far away and both have similar altitudes, they simply cannot observe the same point on the Earth along the same direction. This makes HEO-GEO inter-calibration dependent upon GEO relative location with respect to the HEO ground track. For the HEO TAP orbit described above and ten GEO operational satellites presented in Figure 1, the geometry matching for VZA and RAZ is possible only for the four GEO platforms: METEOSAT (0°E), GOES-East (75°W), MTSAT (140°E) and GOES-14 (105°W). A map with matching points for HEO and GEO shown as coloured areas is

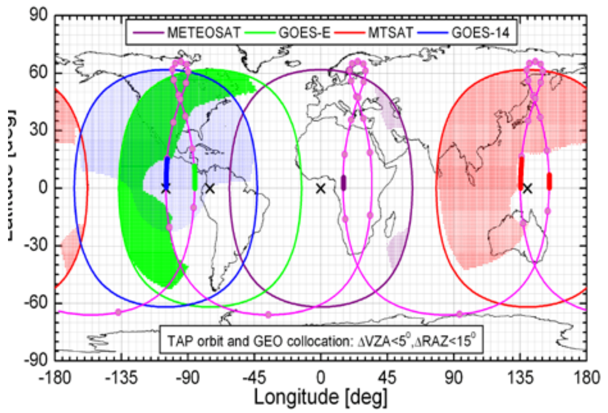

Figure 5. An example of matching geometry for GEO satellites and 16-hr TAP orbit. $\Delta VZA<5^0$, $\Delta RAZ<15^0$. HEO orbit is purple. Only 4 out of 10 GEO satellites identified in Figure 1 are suitable for inter-calibration with selected HEO orbit. Inter-calibration may only occur outside of HEO regular operational interval over the parts of orbits shown as thick coloured lines.

presented in Figure 5. We slightly extended the RAZ angular range to $\Delta RAZ<15^\circ$ to include some points for HEO - METEOSAT geometry matching. There are no collocated points for this satellite pair, if the $\Delta RAZ<10^\circ$ condition is used. Note that due to the altitude factor mentioned above, no geometry matching occurs for the regular operational coverage of the HEO system, i.e. when the satellite is located above 30°N. To obtain some matching pairs between HEO and GEO, the HEO image acquisition interval should be extended to the equator. The parts of the HEO orbit suitable for geometry matching with GEO are marked by thick lines of the same color as the 70° VZA limit zone plotted for each GEO. The locations of GEO sub-satellite points are marked by crosses. If geometry matching condition for relative azimuth could be relaxed to a larger angle difference or completely removed, which is sometimes employed for the thermal IR inter-calibration, then HEO-GEO inter-calibration could be conducted with all GEO satellites within the regular HEO operational interval.

Summarizing the above, one can conclude that the Highly Elliptical Orbit (HEO) represents a unique opportunity for continuous observation of Polar Regions from space. Two pairs of satellite (one pair for each hemisphere) can provide continuous coverage of the latitude region 60°-90°. In combination with GEO constellation this will enable continuous observations of weather around the globe and contribute to the WMO strategic vision for the development of a global satellite observing system. The HEO observing system will provide frequent and diverse opportunities for inter-calibration with polar LEO systems. The inter-calibration between HEO and GEO is also possible; however, it is dependent upon the relative position of the longitude of GEO locations and the HEO ground track and only occurs outside of HEO's operational coverage area, thus requiring special extended image acquisition, when the satellite passes over the tropical zone. If the relative azimuth matching condition is relaxed or removed, HEO-GEO inter-calibration is possible for all GEO satellites within the operational HEO coverage area.

(By Drs. Alexander P. Trishchenko and Louis Garand, [CCRS/NRCan and Louis Garand, AS&T/Environment Canada]).

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Monitoring IR Clear-sky Radiances over Oceans for SST (MICROS)

The STAR Sea Surface Temperature (SST) Team is responsible for producing SSTs from AVHRR, VIIRS and ABI sensors onboard the NOAA/Metop, SNPP/JPSS, and future GOES-R satellites, respectively. Terra/Aqua MODIS observations are also processed for consistency analyses. In May 2008, NESDIS launched its Advanced Clear-Sky Processor for Oceans (ACSPO) system into operations. The main ACSPO products are clear-sky radiances over ocean in all AVHRR-like bands, and derived SST and aerosol. The fast Community Radiative Transfer Model (CRTM) is employed in ACSPO to simulate top-of-atmosphere (TOA) clear-sky brightness temperatures (BT) in three bands centered at 3.7 (IR3.7), 11 (IR11), and 12 µm (IR12), using daily 0.25° Reynolds SST and 6 hourly 1° NCEP Global Forecast System (GFS) upper-air data as input (Liang *et al.*, 2009). Model ("M") BTs are used in ACSPO in conjunction with observed ("O") BTs for improved cloud detection and physical SST retrievals. In July 2008, a web-based near-real time Monitoring IR Clear-sky Radiances over Oceans for SST (MICROS, www.star.nesdis.noaa.gov/sod/sst/micros/) system was established, to check the M-O biases for stability and cross-platform consistency (Liang and Ignatov, 2011). Initially, MICROS monitored M-O biases from GAC (Global Area Coverage, 4 km) data of NOAA-16, -17, 18 and Metop-A. NOAA-19 was added following its launch in February 2009, and monitoring of NOAA-17 discontinued after failure of its AVHRR scan motor in February 2010. Following launch of the VIIRS instrument onboard SNPP in October 2011 and the opening of its cryoradiator doors on 19 January 2012, its monitoring commenced on 21 January 2012 along with the two MODIS instruments onboard Terra and Aqua.

All analyses in MICROS are performed in 24 hour intervals, separately for day and night. Currently, only nighttime analyses are used for sensor monitoring. Daytime M-O biases are less accurate, due to solar reflection not fully accounted for in the CRTM, and the diurnal cycle, which is not resolved in the first-guess SST (Liang and Ignatov, 2011). Global statistics of M-O biases are calculated in the full clear-sky ocean domain, including full sensor swath up to ~±68°. All results are displayed in MICROS with no exemption or additional quality control other than the ACSPO clear-sky mask (Petrenko *et al.*, 2010). An example of global nighttime histograms from the four AVHRR GAC data is shown in Fig. 1.

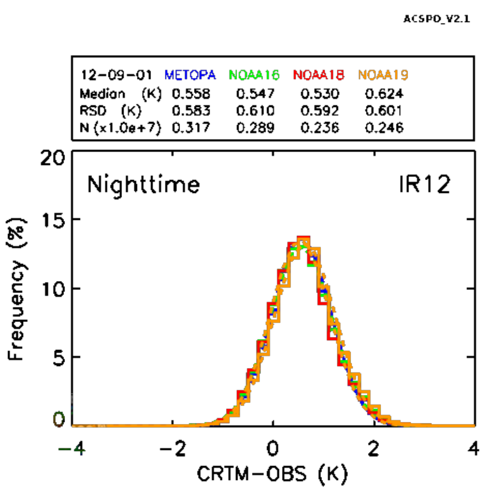


Figure 1. Global nighttime histograms of M-O biases @12μm from NOAA-16, -18, -19, and Metop-A GAC data for 1 September 2012. Note a near-Gaussian shape, narrow width, and close cross-platform consistency. Each histogram is based on approximately 2.8 million clear-sky ocean GAC pixels, resulting in a very accurate estimate of the global mean M-O biases of (+0.58±0.04) K. A positive bias is due to missing aerosol in CRTM input; using daily average bulk Reynolds SST (instead of diurnal-cycle adjusted nighttime skin SST); and residual cloud contamination in ACSPO clear-sky BTs.

Gaussian parameters shown in Fig.1 are trended in MICROS in time as shown in Fig.2.

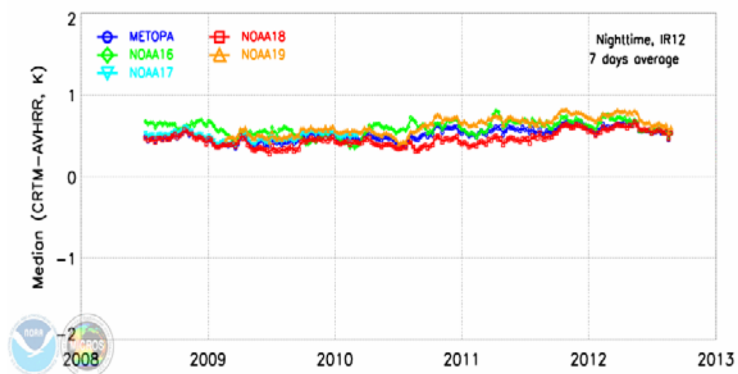


Figure 2. Time series of global nighttime M-O biases @12μm from NOAA-16, -17, -18, -19, and Metop-A GAC data. Note that M-O biases change in time, due to instabilities in both model and sensor BTs. However, different platforms closely track each other, due to the common origin of model errors resulting from temporal instability of the Reynolds SST (Liang and Ignatov, 2011).

The double-differencing (DD) technique is widely employed in GSICS to minimize the effects of time-variable factors, including errors in reference SST and/or in the GFS upper air data; missing inputs in the CRTM (such as aerosol); possible systemic biases in the CRTM forward model; and periodic updates in ACSPO cloud mask. The DDs largely cancel out these unknown, uncertain, or unstable factors and thus are more effective to cross-compare different sensors (*e.g.*, Wang *et al.*, 2008; Strow *et al.*, 2008; Wu *et al.*, 2008). An example of DDs derived from Fig. 2 with Metop-A GAC as reference is shown in Fig. 3.

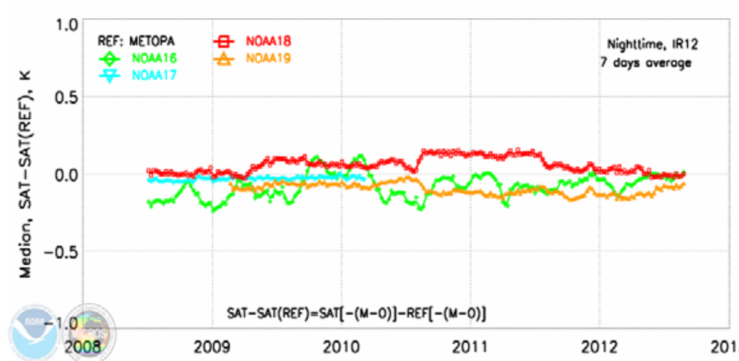
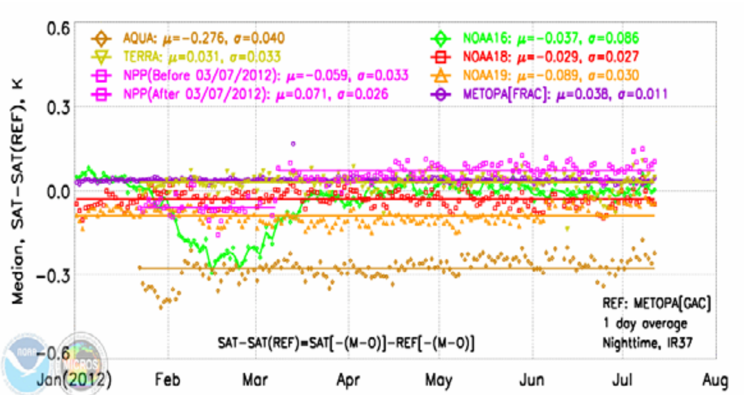
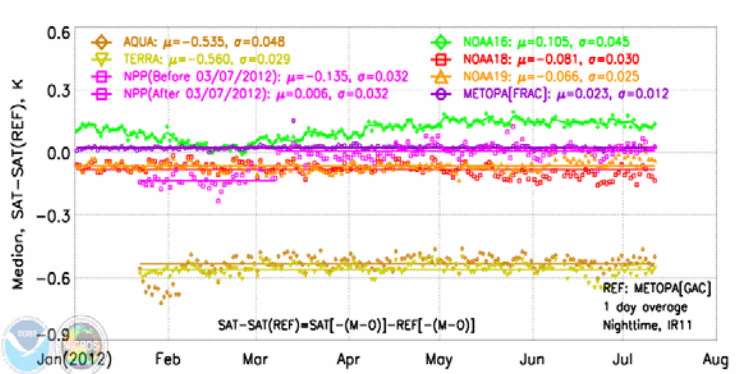
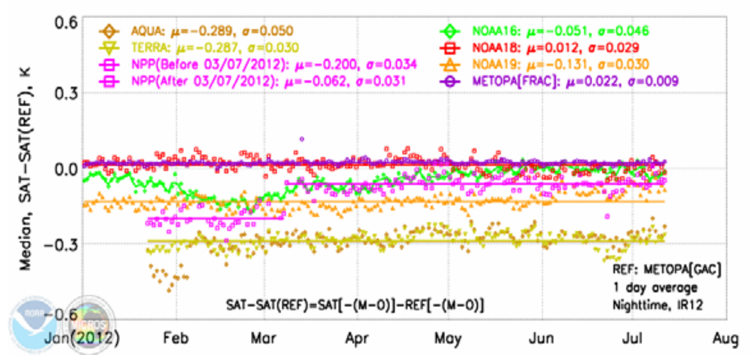


Figure 3. Time series of Double Differences (DD) derived from Fig. 2. Metop-A is selected as a reference platform. Note that NOAA-17 overpass time is close to that of Metop-A @9:30pm. The BTs on the two platforms are very consistent, as expected. NOAA-18 and -19 overpass at ~1:30am and are also expected to be consistent, both being slightly cooler than Metop-A and NOAA-17, due to the diurnal cycle in SST. However, they are inconsistent with each other, with NOAA-18 being warmer than NOAA-17 and Metop-A. NOAA-16's observation times drifted from 4-7am over a 4 year period, and its AVHRR measurements are unstable, likely due to the twilight orbit affecting its calibration.

Fig. 4 shows DDs for AVHRRs, MODISs and VIIRS with Metop-A GAC as the reference. The cross-platform biases are within ±0.1 K for all three window bands of VIIRS and all AVHRRs, with the exception of NOAA-16, which is unstable and out of family due to calibration problems. All AVHRRs and MODISs are stable in time, but VIIRS BTs show a +0.14K jump on 7 March 2012. On that day, the calibration in VIIRS thermal bands was fine tuned (C. Cao and F. LeLuccia, personal communication). As a result, all VIIRS BTs are now consistent with AVHRRs to within ±0.1 K. The regression SSTs (based on regressing the satellite radiance observations against buoy observations of SST) were consistent to within ±0.1 K before VIIRS recalibration. They increased by +0.1 K due to recalibration, taking the VIIRS SST out of family. It took until 3 May 2012 to accumulate sufficient number of new match-ups with *in situ* SSTs, calculate new VIIRS SST coefficients and thus bring VIIRS SSTs back into the AVHRR/MODIS family. Figure 4 also shows MODIS (collection 5) DDs. In IR11and IR12, Terra and Aqua show high cross-platform consistency, but both MODIS instruments are outside the AVHRR/VIIRS cluster by ~ 0.6 K and ~ 0.3 K, respectively. This is due to the suboptimal MODIS transmittance and spectral coefficients in the CRTM v2.02 currently used in ACSPO (and not due to problems with MODIS sensors). The new CRTM v2.1 released as of this writing is being explored to reconcile MODIS with AVHRR and VIIRS. The Terra IR3.7 is well within the AVHRR/VIIRS family, whereas Aqua is biased − 0.3 K low. Work is underway with the NASA MODIS calibration support team to understand and resolve this Terra-Aqua inconsistency.







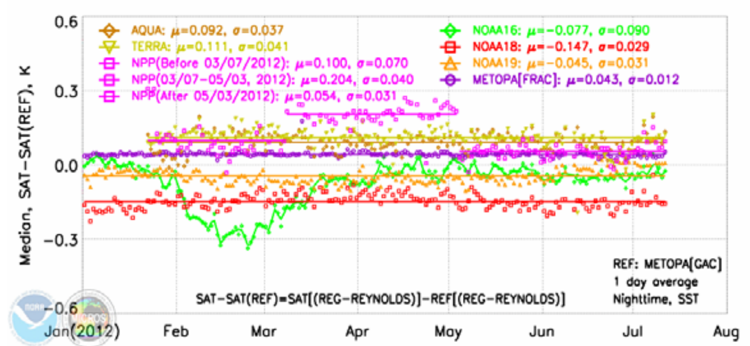


Figure 4. Nighttime DDs in IR37, IR11, IR12 and SSTs from AVHRR (NOAA-16, -18, -19, Metop-A), MODIS (Terra, Aqua), and VIIRS (SNPP). Each point is calculated from median M-O biases over 24 hours of global clear-sky ocean data (~2.8, 45, 35, and 90 million clear-sky ocean observations for AVHRR GAC, FRAC (Full Resolution Area Coverage, 1 km), MODIS, and VIIRS, respectively). Metop-A (GAC) data are used as reference.

The MICROS DD technique may be compared to the simultaneous nadir overpasses (SNO) technique used in GSICS (Cao *et al.*, 2004; Tobin, 2008). Note that cross-platform consistency in MICROS is monitored in the full global domain and sensor swath, thus resulting in much larger statistics (~2.8, 45, 35, and 90 million nighttime observations for AVHRR GAC, FRAC, MODIS, and VIIRS, respectively, per 24 hr period), whereas the SNO technique is based on only a handful of match-up nadir looks per day. Also, the DD statistics are derived from the deviations of clear-sky BTs and SSTs from their respective reference states, and follow the narrow Gaussian distributions shown in Fig. 1, whereas the SNO statistics for BTs are collected in a wide range of all-sky conditions, illumination geometries, and over different types of underlying surface (ice, land, water). As a result, the SNO distributions are wide and strongly asymmetric, which, along with the relatively small samples, leads to greater uncertainties in the results. Unique to the DD technique is that it takes into account the differences in spectral response functions between the two sensors, whereas the SNO technique measures a combined effect of sensor calibration and spectral response differences. Finally, since SNO data are mostly collected in the polar areas, monitoring of IR3.7 may be problematic during extended periods of polar days, due to solar contamination. The MICROS DD technique has no problem monitoring this band, using global nighttime ACSPO data.

On the other hand, the DD technique does include sources of error not relevant to the SNO method. The model BTs may not be consistently calculated for the reference satellite and the satellite of interest (as e.g. was the case for MODIS in CRTM 2.02), and this may lead to uncertainty in the results. Also, small systematic errors in the CRTM, while they cancel out in the DD technique applied to a single satellite, can lead to spurious cross-satellite biases if the satellite instruments are not identical. However, as examples with MODIS show, such biases are detectable and can be minimized.

Another implementation of the DD technique in GSICS is based on using measured (rather than RTM modeled) high-resolution AIRS or IASI spectra and convoluting them with the sensor spectral response functions (*e.g.*, Hewison and König, 2008; Wang and Cao, 2008; Wang and Wu, 2008). It would be instructive to compare MICROS DDs with those calculated against hyper-spectral data. However this would require establishing long-term systematic monitoring for the SST bands and sensors similar to MICROS. In summary, the DD technique employed in MICROS is an effective supplement to the SNO and hyper-spectral methodologies adopted in GSCIS for sensor inter-calibration.

The MICROS DDs suggest that once CRTM coefficients are corrected, cross-platform biases for all AVHRR (except NOAA-16), MODIS (except IR3.7) and VIIRS sensors in SST bands will be within several hundredths to ~0.1K. Work is underway towards reconciliation of CRTM and sensor BTs, and minimizing cross-platform biases, through improvements to ACSPO algorithms, CRTM and its inputs, satellite radiances, and skin-bulk and diurnal SST modeling. However, the achieved uncertainty envelope is already deemed to be within the potential of the MICROS DD technique, which relies on not necessarily accurate, but at least consistent CRTM characterization of different sensors and bands. (MODIS is an example where such characterization was done inconsistently in CRTM v2.02, and fixed in v2.1). For high-accuracy SST applications, these remaining small cross-platform biases will likely need to be adjusted empirically.

Work is also underway to include in MICROS Metop-B, launched on 17 September 2012, (A)ATSRs onboard ERS and ENVISAT, and geostationary sensors such as MSG/SEVIRI and GOES-R/ABI. We will also explore the possibility of using global model aerosol fields (Goddard Chemistry Aerosol Radiation and Transport, GOCART, and Navy Aerosol Analysis and Prediction System, NAAPS, www.nrlmry.navy.mil/aerosol/) in conjunction with the CRTM aerosol module, to more accurately model TOA BTs and minimize M-O biases. Work is underway with the MODIS sensor calibration team to resolve the cross-platform inconsistency between IR3.7 channels of Terra and Aqua. We also plan to improve the MICROS DD accuracies by using a more accurate CRTM and selecting optimal input SST and upper air fields.

In the future, we will extend the MICROS DDs to include solar reflectance bands. The GOCART and NAAPS models will be used in conjunction with the CRTM to generate first-guess TOA reflectances, which will be used to evaluate the M-O biases and DDs for solar reflectance bands.

(By Drs. Alexander Ignatov and Xingming Liang, [NOAA])

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NOAA Report on Satellite Calibration Anomalies and Significant Instrument Events

The NOAA Integrated Calibration and Validation System (ICVS) for monitoring instrument performance and radiance quality of NOAA operational satellite instruments continues to evolve. It plays a key role in detecting calibration anomalies, diagnosing their root causes, and assessing the impacts of anomalous events. The following is a summary of the significant instrument events and calibration anomalies detected and assessed with the NOAA ICVS in the past year. (Yu *et al.*, 2012):

- GOES-15 replaced GOES-11 as the GOES-West on 5 December 2011. GOES-15 Imager is implanted with NOAA corrected spectral response functions to improve the radiometric calibration accuracy for Ch3 (6.5µm) and Ch6 (13.3µm).
- GOES-12 Imager radiometric calibration anomaly occurred from ~1930UTC on 12 December 2011 to ~1500UTC on 13 December 2012.
- GOES-15 Imager radiometric calibration anomaly occurred from 2045UTC on 12 March 2012 to 2045UTC on 16 March 2012. Anomaly was caused by the change of SPS for GOES-15 at the ground station.
- GOES-13 Sounder long-wave infrared (IR) channels had abnormal radiance from 20 June 2012 to about 24 June 2012, resulting from a filter wheel anomaly.
- GOES-13 Sounder short-wave IR channels experienced increased noise beyond specifications from mid-July 2012.
- GOES-13 Imager and Sounder were shut down on 23 September 2012. During the instruments' recovering period, GOES-14 was operated as GOES-East.
- GOES-15 Sounder IR radiance accuracy of long-wave channels degraded from 21 September 2012 to 25 September 2012 and from 29 September 2012 to 1 October 2012.
- NOAA-19 AMSU-A Ch7 has an increasing noise beyond the specification since *spring* 2012. Root cause to this anomaly is under investigation.

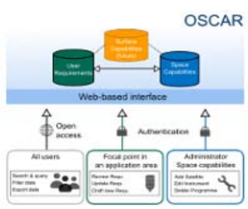
(By F. Yu, N. Sun, T. Chang, M. Grotenhuis, X. Wu, C. Cao and F. Weng, [NOAA]).

REFERENCES

Yu, F., N. Sun, T. Chang, M. Grotenhuis, X. Wu, C. Cao, F. Weng, 2012: NOAA report on satellite calibration anomalies and significant instrument events. *CGMS meeting*, Lugano, Switzerland, 5-8 November 2012.

News in this Quarter

Observing System Capability Analysis and Review Tool (OSCAR)



The World Meteorological Organization's (WMO) recently announced Observing System capability Analysis and Review Tool (OSCAR) is now live at: http://www.wmo-sat.info/oscar/ OSCAR is a resource developed by WMO in support of Earth Observation applications, studies and global coordination. It contains quantitative user-defined requirements for observation of physical variables for WMO applications. It also provides detailed information on all earth observation satellites and instruments, and expert analyses of space-based capabilities.

Successful 4th GSICS Users' Workshop

The 4th GSICS Users' Workshop was successfully held in Sopot, Poland on 4 September 2012 during the EUEMETSAT 2012 Conference.

GSICS Vision Survey

The GSICS Executive Pane wishes to consult space agencies and user communities on the Vision of GSICS in five to ten years. As a representative of either a satellite operator and/or a satellite data user application, you are invited to provide input to this consultation by responding to the few questions in the survey, which is available at:

http://www.star.nesdis.noaa.gov/smcd/GCC/vision_survey.php

Heads Up: Next GSICS Users' Workshop

During the 4th GSICS Users' Workshop in 4 September 2012, it was announced that the next GSICS Users' Workshop will take place in conjunction with the first NOAA Satellite Conference which will be held in College Park, Maryland, USA from April 8-12, 2013.

Just Around the Bend …

GSICS-Related Meetings

- The 40th Coordination Group for Meteorological Satellites (CGMS) meeting will be held in Lugano, Switzerland on 5-8 November 2012.
- The annual GRWG and GDWG joint meeting will be held in Williamsburg, Virginia, USA on 4-8 March 2013.

GSICS Publications

Dinapoli, S. and M. Bourassa, 2012: Uncertainty and intercalibration analysis of H*Wind, *Journal of Atmo. Ocean. Technol.*, **29**, 822-833.

Han, H., H. Lee, 2012: Inter-satellite atmospheric and radiometric correction for the retrieval of Landsat sea surface temperature by using Terra MODIS data, *Geosciences Journal*, **16(2),** 105-204..

Li, J. et al. 2012: A twin-channel difference model for cross-calibration of thermal infrared band, *Science China Technical. Sciences*, **55(7)**, 2048-2056.

Uprety, S. and C. Cao, 2012: Radiometric and spectral characterization of comparison of the Antarctic Dome C and Sonoran Desert sites for the calibration and validation of visible and near-infrared radiometer, *Journal of Applied Remote Sensing*, **6,**.doi:10.11171/1.JRS.6.063541.

Verspeek, J. et al. 2012: Improved ASCAT wind retrieval using NWP ocean calibration, *IEEE Trans. Geosci. Remote Sensing*. **50(7)**, 2488-2492.

Kroodsma, R. et al. 2012: Inter-calibration of microwave radiometers using the vicarious cold calibration double difference method, *IEEE J. Selected Topics in Applied Earth Obs. Remote Sens.* **5(3)**, 1006-1013.

With Help from our Friends:

The *GSICS Quarterly* Editor would like to thank those individuals who contributed articles and information to this newsletter. The Editor would also like to thank Dr. George Ohring for careful proofreading and editing assistance, our European Correspondent, Dr. Tim Hewison of EUMETSAT, and Asian Correspondent, Dr. Yuan Li of CMA, in helping to secure and edit articles for publication.

Submitting Articles to GSICS Quarterly: The *GSICS Quarterly* Press Crew is looking for short articles (<1 page), especially related to cal/val capabilities and how they have been used to positively impact weather and climate products. Unsolicited articles are accepted anytime, and will be published in the next available newsletter issue after approval/editing. **Please send articles to Fangfang.Yu@noaa.gov.**