Status of Metop First Generation SST Products at NOAA

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EUMETSAT EPS AND NOAA JPSS: SYNERGY

- Three Metop First Generation satellites (Metop-FG), Metop-A, -B and -C (launched on 19 October 2006, 17 September 2012, and 7 November 2018, respectively) form the current EUMETSAT Polar System (EPS).
- The EPS contributes to the EUMETSAT/NOAA Initial Joint Polar System (IJPS), along with the NOAA Joint Polar Satellite System (JPSS), which succeeded the NOAA heritage Polar Operational Environmental Satellites (POES) system.
- JPSS covers afternoon (PM) orbit, with local equator crossing time 1:30pm/am, while EPS flies a mid-morning (AM) orbit @9:30am/pm. The two orbits complement each other, covering SST diurnal cycle at approximately 4 points separated by ~4/8 hours.
- JPSS SST is derived from the new-generation VIIRS sensor with ~3,000 km swath at 0.75km@nadir/1.5km@swath edge resolution, while Metop-FG still carries a heritage NOAA sensor, AVHRR (although with an improved capability to store onboard and transmit to the ground high-resolution Full-Resolution Area Coverage (FRAC) data 1.1km@nadir/6km@swath edge in a ~2,800km swath.
- The Metop-FG will be succeeded by Metop Second Generation (Metop-SG). The first satellite in the SG series is expected to be launched in late 2022 and will carry a new generation sensor onboard, METimage. NOAA plans to process Metop-SG data and generate a wide suite of geophysical products, including SST.

Platform/Sensor	Metop-A, -B and -C / AVHRR-3
Sample Filename	L2P: 20190809200000-OSPO-L2P_GHRSST-SSTsubskin-AVHRRF_MA-ACSPO_V2.70-v02.0-fv01.0.nc L3U: 20190809200000-OSPO-L3U_GHRSST-SSTsubskin-AVHRRF_MA-ACSPO_V2.70-v02.0-fv01.0.nc
Processing Level	L2P and L3U
Spatial Coverage	Global: 180W-180E; 90N-90S
Temporal Coverage	2-week rotated
Latency	Metop-A/B: L2P: 3 hours ; L3U: 3 hours ; Metop-C: L2P and L3U: 6 hours
Resolution	L2P: 1km @Nadir; ~6km @swath edge ; L3U: 0.02°
Projections	L2P: Satellite native swath (WGS84); L3U: Equal-grid 0.02°
Swath Width	~2,800 km
Sample Frequency	6 scan lines per 1 second
Orbital Period	101 Minutes
Orbit	Sun-synchronous mid-AM stable @9:30am/pm; Metop-A is not stabilized after Sep 2016

CURRENT ACSPO METOP-FG SST PRODUCTS AND USERS

- NOAA produces SSTs from two VIIRSs onboard NPP and N20, and from three AVHRR FRACs onboard Metop-A, -B, and -C, in L2P and 0.02º gridded L3U (U=uncollated) formats, using its Advanced Clear Sky Processor for Oceans (ACSPO) enterprise system. All products are reported in 10min granules, 144 files per day, with a total data volume of 8GB/day for L2P and 0.4GB/day for L3U.
- Maximally consistent cloud masking (Petrenko et al., 2010), SST retrieval (Petrenko et al. 2014) and Sensor-Specific Error Statistics (SSES; Petrenko et al., 2016) algorithms are applied to the data of VIIRSs and AVHRR FRACs.
- NPP/N20 and Metop-A/B are operationally processed at NOAA OSPO and made available with a ~3hrs latency. Metop-C is processed at STAR in a "best effort" mode and available to users with a ~5hrs latency. While VIIRS SSTs are archived at PO.DAAC & NCEI, Metop SSTs are only available via NOAA PDA and Coast Watch website *https://coastwatch.noaa.gov/cw/satellite-data-products/sea-surface-temperature/acspo-avhrr-frac.html* as a 2-week rotated buffer.
- The major users of the JPSS and Metop SST products include two ACSPO gridded super-collated products, L3S-PM (produced from two VIIRSs) and L3S-AM (produced from three Metops) (Jonasson et al., 2020) and the geo-polar blended L4 analysis (Maturi et al., 2018).

VALIDATION AND MONITORING OF METOP PRODUCTS

- Metop SSTs are validated against QC'ed SSTs from the *in situ* SST Quality Monitor (*i*Quam; *www.star.nesdis.noaa.gov/sod/sst/iquam/*; Xu and Ignatov, 2014).
- Results of global monitoring are published in another NOAA system, SST Quality Monitor (SQUAM; *www.star.nesdis.noaa.gov/sod/sst/squam/*; Dash et al., 2010).
- Regional monitoring is performed in the ACSPO Regional Monitor for SST (ARMS; *www.star.nesdis.noaa.gov/sod/sst/arms/*; Ding et al., 2017)
- BTs are monitored in the Monitoring of IR Clear-sky Radiances over Ocean for SST (MICROS; *www.star.nesdis.noaa.gov/sod/sst/micros/*; Liang and Ignatov, 2011).

TOWARDS 1ST ACSPO AVHRR FRAC REANALYSIS (RAN1)

- At present, there is no full-mission reprocessed AVHRR FRAC SST dataset from all three Metops. Work commenced at NOAA towards consistent first reprocessing (Reanalysis-1, RAN1) of full AVHRR FRAC record, from three Metop-FG satellites (-A, -B, and -C), from 2006-present.
- The motivation is three-fold:
  1. Supplement the AVHRR GAC RAN record going back to 1981 but becoming unusable in recent years, due to orbital degradation of the latest NOAA-18 and -19 satellites, with high-resolution FRAC continuation and overlap;
  2. Create a long-term high-resolution L3S-AM record, from MODIS-Terra (launched in Dec 1999) and Metop-FG (and Metop-SG moving forward);
  3. Provide high-quality input into geo-polar blended L4 analysis
- It is also planned to reprocess all FRAC data in STAR, back to 2006, and create ACSPO AVHRR FRAC SST RAN1.

PRELIMINARY RESULTS

- Fig. 1 shows results of the initial pass through the Metop-A, -B and -C data with a set of fixed NLSST regression coefficients. The "satellite minus *in situ*" bias is well within NOAA ±0.2 K specs, there is likely an artificial trend and residual inconsistencies between the three Metops.

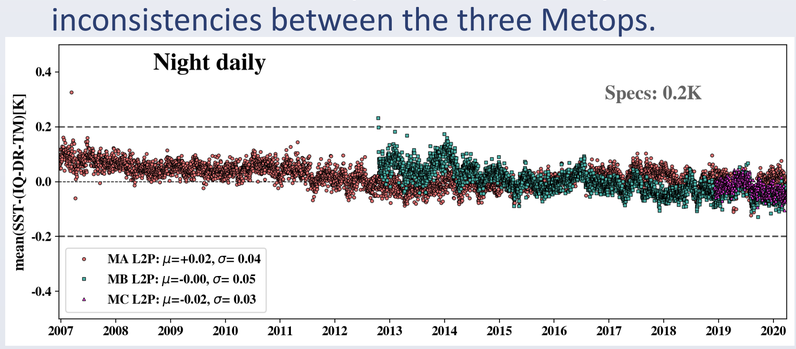

Fig.1. Nighttime Sub-Skin SST vs. iQuam in situ SSTs: Daily Bias for Metop A/B/C, using fixed set of regression coefficients.

- Fig. 2 shows the time series from Fig. 1 replotted using variable coefficients (calculated consistently with how this is done in the AVHRR GAC RAN).
- Recall that AVHRRs were not designed for long-term climate applications. Calibration artifacts and orbital drift problems are largely mitigated on large & stable Metops, compared to smaller and NOAA satellites flying unstable orbits, but empirical adjustments against *in situ* data may still be needed.

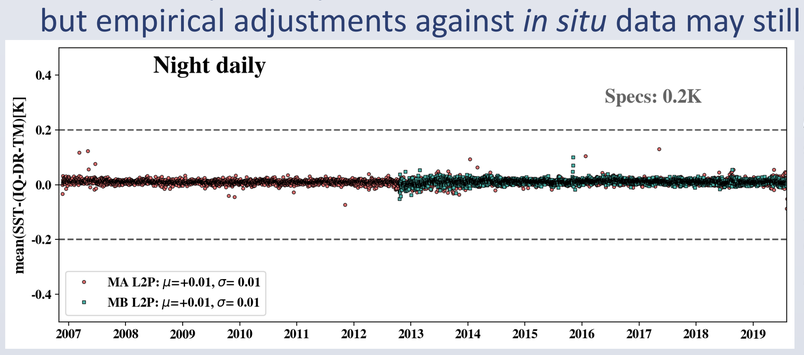

Fig.2. Same as in Fig.1, but produced using variable SST coefficients (recalculated daily using sliding time windows 1±45 days for GR SST). Metop-C and dates after Aug 2019 are not processed yet.

FUTURE WORK

- We plan to consistently reprocess all Metop AVHRR FRAC SST data from Metop-A/B/C, archive and make available to NOAA (NOAA L3S super-collated product, L4 blended analysis, CPC) and other interested national and international users.
- In order to produce long-term consistent SST time series from Metop AVHRR FRACs, we will explore variable SST coefficients, extend the methodology to the preset time, include Metop-C, eliminate remaining small inter-satellite biases, and release AVHRR FRAC RAN1.
- Consistency w/historical AVHRR GAC RAN2 and current JPSS VIIRS SSTs will be verified.

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