MEMORANDUM FOR:	The JPSS Program Record
SUBMITTED BY:	JPSS VIIRS ACSPO SST Team: Alexander Ignatov, Lead
CONCURRED BY:	JPSS Algorithm Management Project Lead Arron Layns
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APPROVED BY:	JPSS Program Scientist Mitch Goldberg

SUBJECT:	N20 VIIRS ACPO SST Full Maturity Status
DATE:	05/16/2019

Full Maturity Status Declaration for VIIRS ACSPO SST

Maturity Review Date:	**05/16/2019**
Effective Date:	**05/16/2019**
Operational System:	**NDE**

The Joint Polar Satellite System-1 satellite (JPSS-1) was successfully launched on 18 Nov 2017 and renamed NOAA-20 (hereafter, N20) after reached the polar orbit. With the same design as the Suomi NPP Visible Infrared Imaging Radiometer Suite (VIIRS), the N20 VIIRS is a cross-track scanning radiometer with 22 channels with wavelengths ranging from 0.41 to 12.5µm, enabling global measurements of ocean, atmosphere and land characteristics, including sea surface temperature (SST).

On 3 Jan 2018, the N20 VIIRS started providing earth scene measurements for the mid-wave and thermal infrared bands. By 5 Jan 2018, the data quality enabled the generation of the VIIRS SST. On 7 Nov 2018, operational production of SS commenced at NDE with the Advanced Clear-Sky Processor for Ocean version 2.60 (ACSPO 2.60). On 23 Apr 2019, the ACSPO in NDE was upgraded to 2.61. Complete time series of N20 SST from 5 Jan 2018 – present have been consistently reprocessed with ACSPO 2.61 in STAR, and archived at PO.DAAC and NCEI. Based on evaluation presented to the NOAA JPSS program, the N20 VIIRS ACSPO SST products are now considered to have Full Maturity.

1. **Maturity stage definition**

The definitions of maturity stages are available at the JPSS Algorithm Maturity Matrix webpage: www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php. Full Maturity means that the product meets the following criteria

- Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal)
- Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level.
- Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
- Product is ready for operational use based on documented validation findings and user feedback.
- Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.

2. Algorithm Description

ACSPO is the NOAA enterprise SST system, employed to process multiple polar (VIIRS, AVHRR GAC and FRAC, and MODIS) and geostationary (ABI on GOES-R, and AHI on Himawari) sensors onboard US and international satellites. Two major functions of ACSPO are identifying clear-sky high-quality ocean pixels, suitable for SST retrievals, and calculation of SSTs (from measured brightness temperatures in several window bands, including M12, 14, 15, and 16 centered at 3.7, 8.6, 11 and 12 µm, respectively). Two reflectance bands, M5 and M7, are also used during the daytime to improve clear-sky masking. SST is calculated using empirical Multi-Channel and Non-Linear SST regressions, separately for nighttime (Solar zenith angle >90°) and daytime (Solar zenith angle <90°). Error characterization is appended to each valid SST retrieval (called Single-Scanner Error Statistics, SSES), with two layers providing an estimate of the expected bias and noise (standard deviation) in the retrieved SST. Two products are produced: L2P (swath projection; ~26 Gb/day) and its 0.02° gridded version, L3U, ("U" meaning "uncollated", i.e., no aggregation, or collation in time is applied) (0.45 Gb/day). Both are in reported in Group for High Resolution SST (GHRSST) Data Specification version 2 (GDS2) NetCDF4 format, in 10-min granules, 144 granules per day.

Detailed information about the algorithms and the content of the netCDF4 data file is available in the ACSPO SST ATBD at www.star.nesdis.noaa.gov/jpss/sst.php. See also "Data availability" below.

Product requirements/Exclusions (L1RDS)

VIIRS SST requirements are documented in the JPSS Level 1 Requirements Supplement (L1RDS) and in the JPSS ESPC Requirements Document (JERD) Volume 2: Science Requirements Version 2.0.The current version of the L1RDS is available at http://www.jpss.noaa.gov/technical_documents.html. The VIIRS ACSPO SST product meets the full set of JPSS Level 1 requirements.

Product evaluation/validation

- Global comparisons with several high-quality L4 SST analyses;
- Validation vs. global QC'ed drifters & tropical moorings, and ARGO Floats from the NOAA in situ Quality Monitor (iQuam; www.star.nesdis.noaa.gov/sod/sst/iquam/);
- Comparisons w/NPP, Aqua/Terra MODIS, Metop-A/B/C AVHRR FRAC..

Product availability

- https://coastwatch.noaa.gov/cw/satellite-data-products/sea-surface-temperature/acspo-viirs.html
- https://podaac.jpl.nasa.gov/dataset/VIIRS_N20-OSPO-L2P-v2.61
- https://podaac.jpl.nasa.gov/dataset/VIIRS_N20-OSPO-L3U-v2.61
- https://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.nodc:GHRSST-VIIRS_N20-OSPO-L2P
- https://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.nodc:GHRSST-VIIRS_N20-OSPO-L3U.

Product reliability

Multiple users of ACSPO SST product confirm that the product is stable, dependable and reliable. It is served via NOAA PDA, PO.DAAC, NCEI, NOAA CoastWatch, and EumetCast. ACSPO SST is monitored in the SST Quality Monitor for SST (SQUAM; www.star.nesdis.noaa.gov/sod/sst/squam/), including validation against iQuam (www.star.nesdis.noaa.gov/sod/sst/iquam/) QC'ed in situ data, and in the ACSPO Regional Monitor for SST (ARMS; www.star.nesdis.noaa.gov/sod/sst/arms/).

Algorithm performance dependence

The performance of the VIIRS SST product largely depends on the performance of the VIIRS SDR product. VIIRS SDR team worked closely with SST Team, to address all our concerns, including initial instabilities in the thermal IR bands of N20 VIIRS; quarterly warm-up cool-down (WUCD) exercises (currently frequency reduced to annual), and operational correction of remaining WUCD biases in thermal bands (correction algorithm delivered to operations). ACSPO processing also employs first guess SST (currently, Canadian Met Center product, CMC L4) and GFS atmospheric profiles, which are input into CRTM simulations. Graceful degradation uses closest in time CMC and GFS data, if current are not available. Sensitivity is very minor and do not result in measurable errors in SST product or clear-sky masking.

Known errors/issues/limitations

The product fully meets and exceed L1RDS requirements and users expectations. However, future work (pattern recognition, thermal fronts' detection, and data fusion) requires minimization of residual cloud leakages and residual regional, angular, cross-satellite biases in retrieved SST.

3. **Changes since last maturity stage**

   New ACSPO v2.61 has replaced 2.60 delivered to the NDE at the time of provisional review. No code change, but LUTS have been recalculated using a larger match-up data set, which helped mitigate the initially observed high-bias in the high latitudes.

4. **Review board recommendations**

   Declare ACSPO SST Fully Validated as of the date of this review, 16 May 2019.

5. **Path Forward/Future Plan**
   - Address residual cloud leakages, and derive ocean patterns and thermal fronts;
   - Address more fundamentally cloud leakages and SST biases, and work towards data fusion.

6. **Additional Items to note**

   The VIIRS SST product is widely used nationally and internationally. There are many positive feedbacks from users. No negative feedback or complaints received so far. Users wanted thermal fronts, and fused (collated) SST product, from multiple passes and sensors. Work is underway towards those objectives.

Additional information is available at: www.star.nesdis.noaa.gov/jpss/Docs.php

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