ACSPO VIIRS SST Reanalysis 2 (RAN2)

Olafur Jonasson[1,2], Alexander Ignatov[1]

1. NOAA STAR, 2. GST Inc.

Background & Objectives of VIIRS SST Reanalyses (RANs)

- Suomi NPP launched 28 Oct 2011; Cryoradiator door opened 18 Jan 2012.
- N20 (aka "J1") launched 18 Nov 2017; Cryoradiator door opened 3 Jan 2018.
- VIIRS SST produced 1-2 days after opening the cryoradiator doors using NOAA Advanced Clear Sky Processor for Ocean (ACSPO) enterprise system.
- This poster summarizes SST Reanalysis 2 (RAN2), from NPP & N20.
- L2P (swath) & L3U (0.02º; gridded) data reported in 10-min granules (144/day).
- Regression ('sub-skin') SST & SSES (used to derive 'depth' SST) are reported.
- Cal/Val is performed using match-ups with *in situ* data from NOAA *in situ* SST Quality Monitor (*i*Quam; www.star.nesdis.noaa.gov/sod/sst/iquam)
- Quality Control and Cal/Val statistics are published in the NOAA SST Quality Analysis Monitor (SQUAM; www.star.nesdis.noaa.gov/sod/sst/squam)
- ACSPO Regional Monitor for SST (www.star.nesdis.noaa.gov/sod/sst/arms/; ARMS) monitors regional performance of VIIRS SST imagery, and compares it with other polar AVHRR/MODIS and geostationary ABI/AHI SST products.
- Monitoring IR Clear-sky Radiances (www.star.nesdis.noaa.gov/sod/sst/micros/; MICROS) compares measured brightness temperatures (BTs) in VIIRS SST bands to simulations using the Community Radiative Transfer Model (CRTM)
- Data in GDS2 format archived in NASA PO.DAAC & NOAA CoastWatch/NCEI.

VIIRS SST Reanalysis 1 (RAN1; NPP only)

- RAN1 was performed in 2015 in conjunction with U. Wisconsin CSPP Team, using ACSPO v2.40, and covered a period from Mar'2012-Dec'2015. Period from Dec'2015-on was supplemented from NRT processing (ACSPO v2.41/2.60/2.61).
- Results of NPP RAN1 are available on the NOAA CW website. Its monitoring was included in SQUAM and MICROS.
- Fig. 1 show results of validation of RAN1 'sub-skin' and 'depth' L2P SSTs vs. *i*Quam *in situ* SSTs (drifters + tropical moorings). Each point represents 24hr global statistics. Statistics for the full period are summarized in Table 1.
- Global mean biases 'Sub-skin minus *in situ* SST' and 'Depth minus *in situ* SST' in Figs. 1a-b are fairly stable in time, with residual seasonal variations up to ~0.1 K (more during the daytime, likely due to increased skin-depth SST difference).
- The standard deviations are larger for 'sub-skin' SST (Fig. 1c), especially during the daytime, due to increased skin-depth differences. The standard deviations and day-night differences, are reduced for 'depth' SST (shown in Fig. 1d).

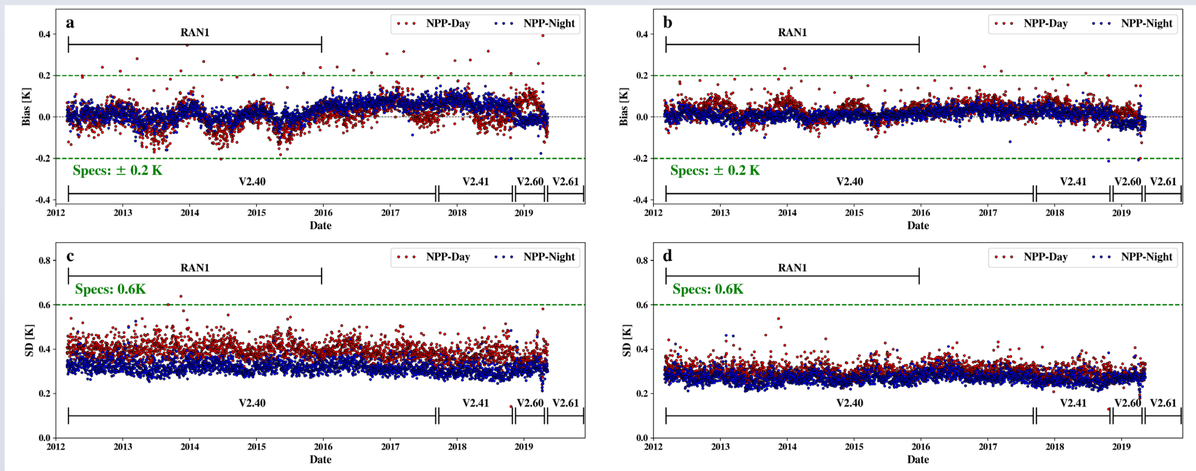

Figure 1. Daily statistics of global (a-b) mean biases and (c-d) standard deviations (SDs) of ACSPO L2P minus iQuam SSTs. From mid-Dec'2015 – Apr'2019, NPP RAN1 (Mar'2012 – mid-Dec'2015) is supplemented by operational data. (Left) Global Regression (GR; proxy for 'sub-skin' SST); (right) Piece-Wise Regression (PWR; proxy for 'depth' SST).

- All biases in Figs. 1a-b are well within ±0.2K specs, except for quarterly spikes of ~+0.25K in daytime SSTs, due to black body warm-up cool-down (WUCD) calibration exercises. These artifacts have been addressed in RAN2.
- The average standard deviations (SDs) for sub-skin SST (Fig. 3) are ~0.32K at night, and ~0.39K during the daytime. Both are well within the 0.6K specs.
- The SDs for 'depth' SST (Fig. 4; 0.27K at night & 0.30K during the day, respectively) are smaller than for 'sub-skin' SST, and beat the JPSS specs by a wider margin.
- Table 1 summarizes biases and SDs from the full time series, for "sub-skin" and "depth" SSTs, for both L2P and L3U.
- Note that users prefer L3U data, due to a factor ~60 smaller data volume, with very comparable performance statistics.
- L3U biases slightly differ from L2P, due to outlier removal/suppressed residual cloud, but most importantly, different representation in the high latitudes.

RAN1 (NPP)	L2P ('sub-skin')	L3U ('sub-skin')	L2P ('depth')	L3U ('depth')
Bias (night) [K]	+0.029	+0.045	+0.012	+0.017
Bias (day) [K]	+0.014	+0.009	+0.032	+0.027
SD (night) [K]	0.32	0.32	0.27	0.27
SD (day) [K]	0.39	0.39	0.30	0.30

Table 1: NPP VIIRS RAN1 SST biases and standard deviations (SD) from 1 Mar 2012 – 30 Apr 2019. "L2P 'sub-skin' minus in situ" statistics are from Fig. 1a,c and "L2P 'depth' minus in situ" from Fig. 1b,d. Corresponding statistics for L3U (not shown in Fig. 1) are also included in the Table.

VIIRS SST Reanalysis 2 (RAN2; NPP & N20)

- ACSPO v2.60 became operational on 7 Nov 2018. On 23 Apr 2019, it was replaced by v2.61, which employs the same ACSPO code, but with new look-up tables (LUT), updated to mitigate high-latitude biases found in v2.60 data, and to recalculate N20 LUTs using longer time series.
- Compared with v2.40/2.41, v2.60 in addition to the support of N20, adds two improvements: 1) improved BT and SST imagery, using the resampling algorithm which minimizes the effect of bow-toes distortions and deletions; and 2) added 8.6 µm band to the retrieval algorithms.
- The goal of RAN2 is to backfill NPP/N20 records prior to Apr 2019, back to the beginning of both missions, and to provide consistent ACSPO v2.61 time series.
- For RAN2, we start from L0 (RDR) data and work with the NOAA calibration team to improve calibration and minimize the effects of WUCD on SDRs & SST.
- As of this date, all N20 SST data (Jan 2018 – Apr 2019) have been reprocessed, and part of NPP from Jan 2013 to Apr 2019, with only 2012 remaining.
- Archival with NASA PO.DAAC and NOAA CoastWatch/NCEI is in progress.
- Fig. 2 shows RAN2 validation statistics (similar to those for RAN1 in Fig. 1).
- Figs. 2a-b, show that daytime quarterly WUCD bias spikes have been significantly minimized, suggesting an improved L1b calibration.
- For 'sub-skin' SST, bias is within JPSS specs (0.2K) with the exception of 4 days. The standard deviation is within specs (0.6K) for all days, except two. For depth SST, both bias and SD are well within the specs for the whole time series.
- NPP & N20 SSTs are consistent for the overlapping period (Jan 2018 - Apr 2019).

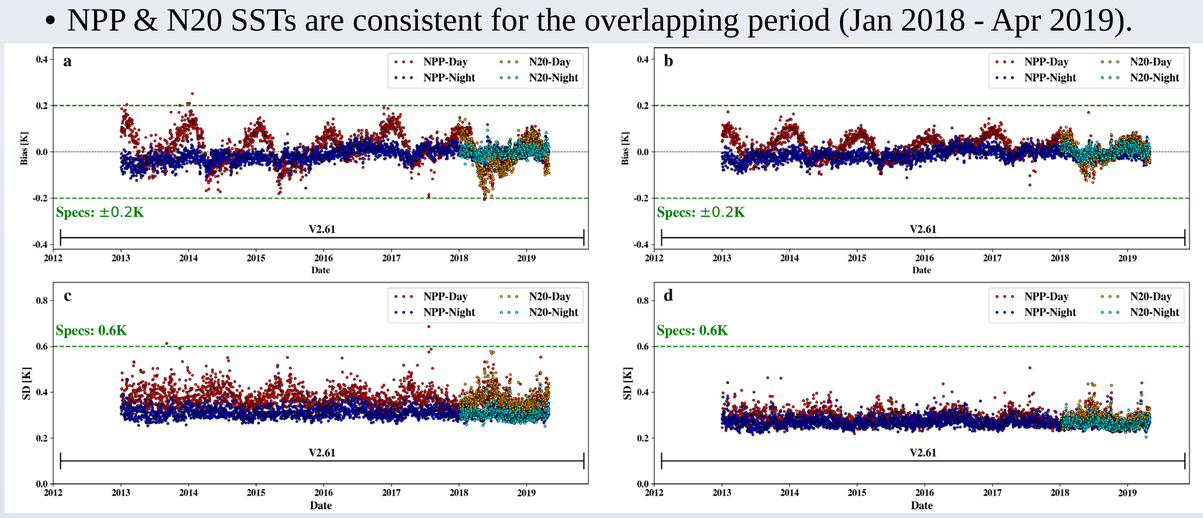

Figure 2. NPP/N20 VIIRS L2P RAN2 minus in situ SST global statistics. Mean bias for (a) GR 'sub-skin' and (b) PWR 'depth'. Standard deviations for (c) GR 'sub-skin' and (d) PWR 'depth'.

- Tables 2 and 3 summarize biases and SDs from the full time series (NPP & N20), for 'sub-skin' & 'depth' SSTs, for both L2P and L3U.
- RAN2 results are comparable or superior to RAN1 (cf. Table 1).
- L2P and L3U statistics are comparable for both NPP and N20.

RAN2 (NPP)	L2P ('sub-skin')	L3U ('sub-skin')	L2P ('depth')	L3U ('depth')
Bias (night) [K]	-0.014	+0.002	-0.013	+0.001
Bias (day) [K]	+0.017	+0.003	+0.022	+0.016
SD (night) [K]	0.31	0.31	0.27	0.27
SD (day) [K]	0.37	0.37	0.29	0.29

Table 2: NPP VIIRS RAN2 SST biases and standard deviations (SD) from 1 Jan 2013 – 30 Apr 2019. L2P statistics for sub-skin SST are from Fig. 2a,c and for depth SST are from Fig. 2c,d. Corresponding statistics for L3U (not shown in Fig. 2) are also provided.

RAN2 (N20)	L2P ('sub-skin')	L3U ('sub-skin')	L2P ('depth')	L3U ('depth')
Bias (night) [K]	+0.001	+0.019	+0.003	+0.010
Bias (day) [K]	-0.013	-0.026	+0.006	+0.003
SD (night) [K]	0.30	0.30	0.27	0.27
SD (day) [K]	0.37	0.37	0.29	0.29

Table 3: N20 VIIRS RAN2 SST biases and standard deviations from 5 Jan 2018 – 30 Apr 2019. L2P statistics for 'sub-skin' SST are from Fig. 2a,c and for 'depth' SST are from Figs. 2b,d. Corresponding statistics for L3U (not shown in Fig. 2) are also provided.

RAN2 Summary & Remaining Work

- NPP RAN1 (L3U and part of L2P) SST data, supplemented by NRT data from Dec 2015-on, are available from 1 Mar 2012 on the Coast Watch SST website.
- RAN1 employed ACSPO v2.40 and supplemented with real-time data after Dec'2015, using ACSPO versions 2.40/2.41/2.60/2.61.
- The goal of RAN2 is to provide a consistent time series with ACSPO v2.61.
- Quarterly spikes in day SST due to the WUCD events are addressed in RAN2.
- N20 SST data processing is completed with only 2012 remaining for NPP. We estimate that the full RAN2 dataset will be complete in 2019.
- The RAN2 data are being archived at NASA PO.DAAC and NOAA CW/NCEI.

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olafur.jonasson@noaa.gov