Towards Second SNPP VIIRS SST Reanalysis (RAN2)

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Objectives of VIIRS SST reanalysis (RAN)

- Reprocess SNPP and N20 VIIRS SST data from the start of L1b records with available thermal bands information (SNPP: Jan 2012; N20: Jan 2018), to the present time.
- Produce 10min granules (144/day) of L2P (swath; 26GB) and L3U (0.02º; 0.5GB) data.
- Produce Regression (proxy for "subskin") & SSES-bias corrected ("depth") SSTs.
- Make all data available to users in GDS2 format on the NOAA Coast Watch SST (CW; coastwatch.noaa.gov/cw_html/sst.html).
- Create match-ups with *in situ* data from NOAA *in situ* SST Quality Monitor (*i*Quam; www.star.nesdis.noaa.gov/sod/sst/iquam).
- Perform quality analysis and publish results on the NOAA SST Quality Analysis Monitor (SQUAM; www.star.nesdis.noaa.gov/sod/sst/squam).
- Monitor IR Clear-sky Radiances (MICROS) by comparing measured brightness temperatures (BTs) in VIIRS SST bands to simulations using the Community Radiative Transfer Model (CRTM). Publish results at www.star.nesdis.noaa.gov/sod/sst/micros/.

SNPP VIIRS SST Reanalysis 1 (RAN1)

- SNPP RAN1 was performed in 2015 in conjunction with U. Wisconsin CSPP Team and covered Mar'2012-Dec'2015, with Dec'2015-on supplemented from NRT processing.
- Results of SNPP RAN1 available on the NOAA CW website & in SQUAM / MICROS.
- Figs. 1-4 show results of validation of RAN1 "subskin" and "depth" L2P SSTs vs. *i*Quam *in situ* SSTs (drifters + tropical moorings). Each point represents 24hr global statistics.
- Table 1 summarizes validation statistics for both L2P and L3U SST data.

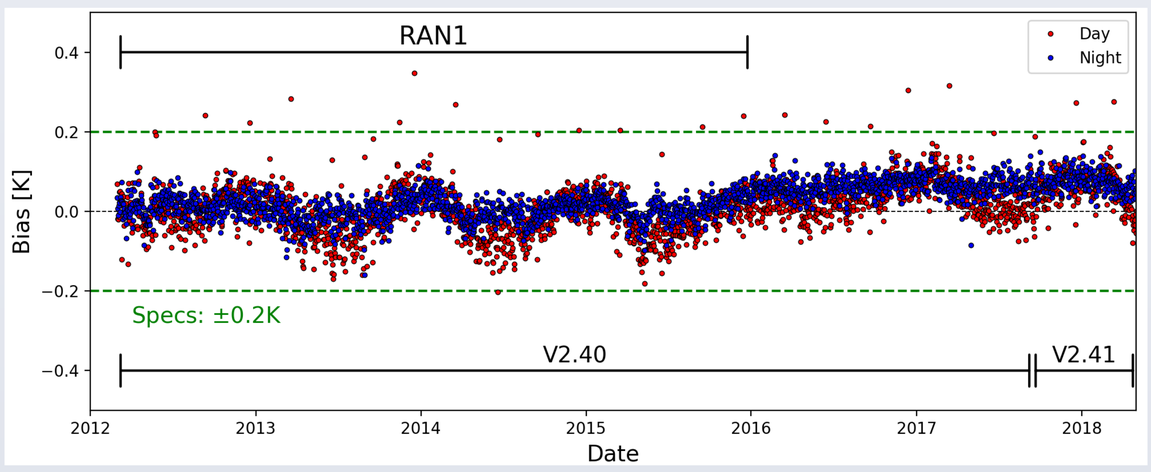

Fig. 1: "SNPP VIIRS L2P – in situ SST" bias

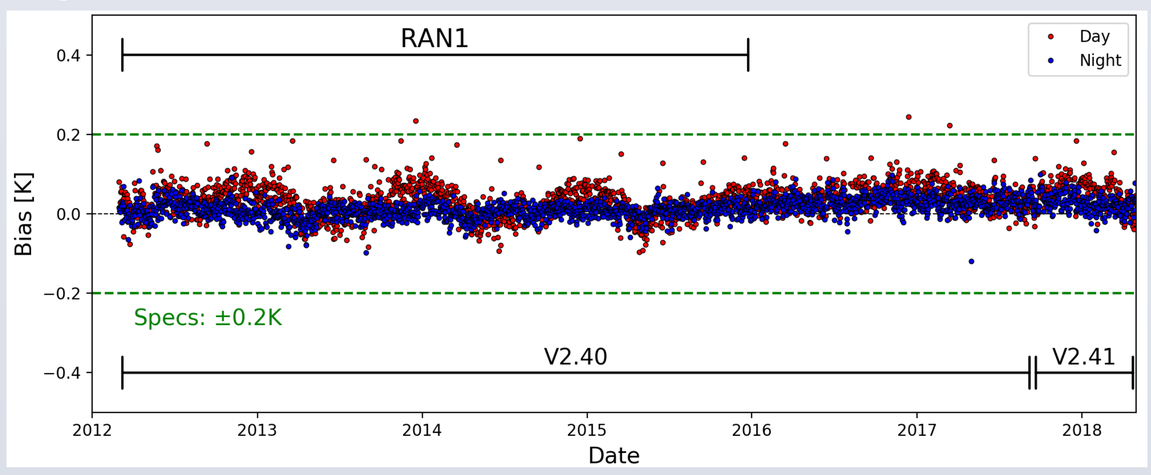

Fig. 2: "SNPP VIIRS SSES bias corrected L2P – in situ SST" bias

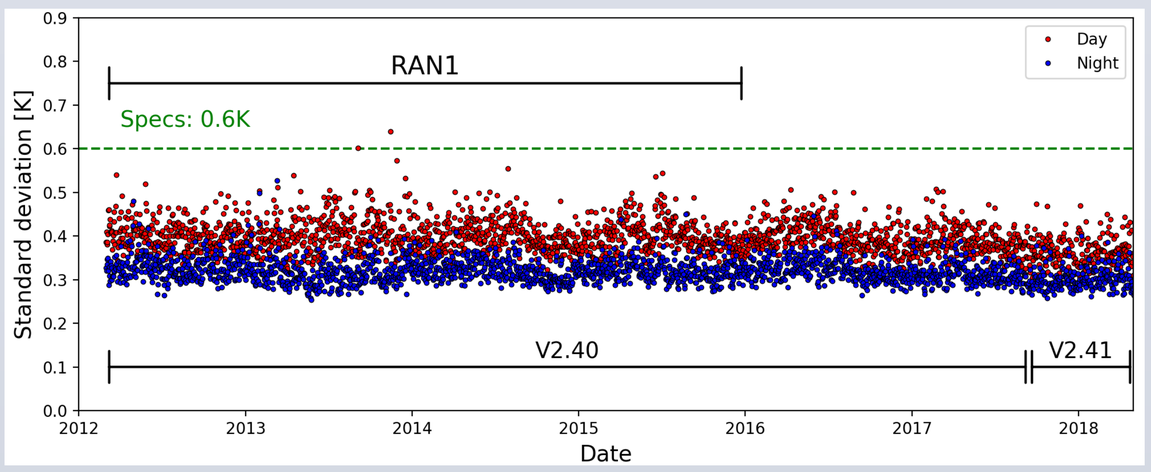

Fig. 3: "SNPP VIIRS L2P – in situ SST" standard deviation

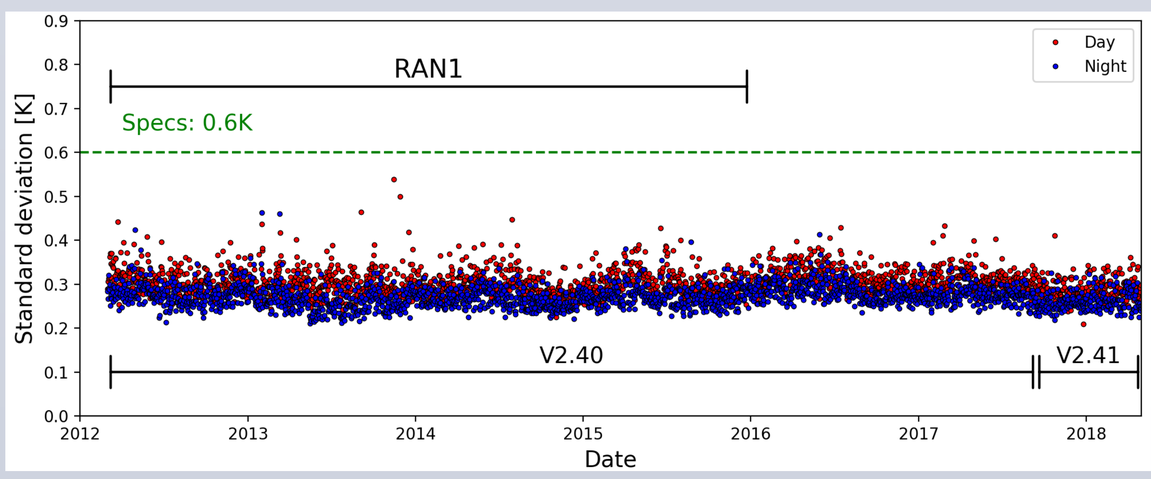

Fig. 4: "SNPP VIIRS SSES bias corrected L2P – in situ SST" standard deviation

- Biases w.r.t. *in situ* SST for global (Fig. 1) and piece-wise regression (PWR shown in Fig. 2 = SSES bias corrected) are fairly stable in time, with residual seasonal variations of up to ~0.1 K throughout the mission. For day SST, the variations in time (including seasonal cycle) are larger than at night, likely due to increased skin-bulk difference.
- The biases are significantly reduced in the SSES bias corrected SSTs (Fig. 2), because the PWR is a better proxy for *in situ* SST. Both products are within ±0.2K specs, except for quarterly ~+0.25K spikes, due to black body warm-up cool-down (WUCD) events.
- Fig. 3 shows standard deviations (SD) w.r.t. *in situ* for the "skin" SST (currently produced with a global regression). The time series of the SDs are stable, with average 0.32K for night and 0.40K for day, both well within the 0.6K specs. The larger SD during the day is at least in part due to the increased diurnal thermocline.
- The SSES bias correction (Fig. 4) results in smaller SDs (0.27K for night and 0.30K for day, respectively) and beat the JPSS specs with a larger margin. The contrast between the day and night SDs is reduced, because the PWR is a better proxy for depth SST, in both cases and partially accounts for the variable diurnal thermocline.
- Table 1 shows biases and SDs from the full time series, for "skin" & "depth" SSTs, both L2P and L3U. The L3U data volume is smaller than L2P, with comparable statistics.

	L2P	L3U	L2P (deb.)	L3U (deb.)
Bias (night) [K]	+0.030	+0.045	+0.014	+0.018
Bias (day) [K]	+0.011	+0.004	+0.034	+0.029
SD (night) [K]	0.32	0.32	0.27	0.27
SD (day) [K]	0.40	0.39	0.30	0.30

Table 1: SNPP VIIRS SST biases and standard deviations (SD) from 1 Mar 2012-30 Apr 2018. "L2P" statistics are for "subskin" SST from Figs. 1,3 and "L2P (deb.)" are for PWR "depth" SST from Figs. 2,4. Corresponding statistics for L3U (not shown in Figs. 1-4) are also given.

Motivation for RAN2

- The quarterly WUCD events degrade quality of day SST, for up to two-day periods. The degradation of night SST is less pronounced, due to the use of M12 band @3.7µm, which is less affected by the WUCDs. We are working with the NOAA calibration team to improve L1b data and minimize the effects of WUCD on SSTs in RAN2.
- RAN1 was performed using ACSPO V2.40 and the time series have been supplemented with V2.41 since mid-Sep 2017. In RAN2, ACSPO V2.60 will be consistently used, which contains important updates such as improved imagery, new SST algorithms, improved clear-sky mask and new ocean fronts product.
- RAN1 biases (Fig. 1) exhibit slow seasonal variations of ~0.1 K throughout the mission. The effect is less pronounced in the SSES bias corrected result in Fig. 2, but still visible during daytime. In RAN2, we will explore variable regression coefficients to minimize spurious temporal variations, and better link VIIRS SST to *in situ* SST.

Preliminary Results

The proposed WUCD correction was tested for a typical event, when VIIRS black body (BB) was first warmed up and then cooled down. VIIRS calibration should account for these BB changes & result in accurate BTs & SSTs. However, Fig. 4 shows that the warm-up phase (i.e., when BB temperature is set above the 292.5K norm) results in a cold dip of ~-0.05K, whereas the cool-down phase (when BB temperature is set below its 292.5K nominal setting) causes a ~+0.25K warm anomaly. The green curve shows the expected residual SST bias in the proposed RAN2, with a magnitude <0.03K.

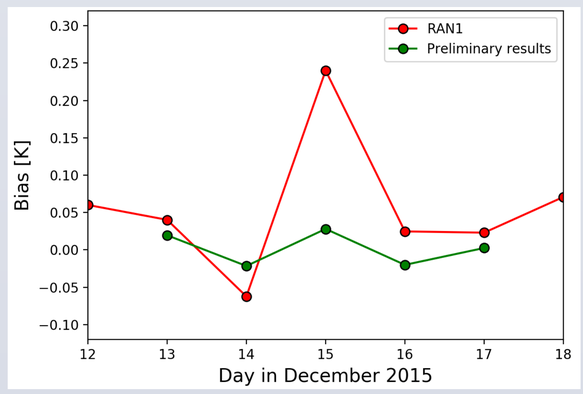

Fig. 5: Daytime SST bias with respect to in situ SSTs for the WUCD event on 15 Dec 2015.

Conclusion and Future Work

- SNPP RAN1 L3U (and part of L2P) SST data are available from 1 Mar 2012 to present on the Coast Watch SST website (coastwatch.noaa.gov/cw_html/sst.html)
- Match-ups with *i*Quam *in situ* data have been created and displayed in NOAA SQUAM system. Corresponding radiances are monitored in MICROS. Filling data in ARMS is underway.
- The RAN1 data show seasonal variations and unexplained trends. We will explore variable SST regression coefficients in RAN2, to better link VIIRS to *in situ* SSTs.
- Quarterly spikes in day SST due to the WUCD events will be addressed in RAN2.
- RAN2 will commence after ACSPO V2.60 is finalized (June 2018).
- RAN2 will be an iterative process. Several passes through historical data with possible recalculations of SST regression coefficients are expected.
- ACSPO V2.61 might be needed if issues with 2.60 are encountered.
- We expect to significantly advance RAN2 by the end of 2018.
- RAN2 data will be made public, when we are confident in its quality.

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