The near real-time web-based SST Quality Monitor (SQUAM)

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Abstract

- SST Quality Monitor (SQUAM) is a web-based near real-time (NRT) tool used to monitor NESDIS satellite SST products for stability and cross-platform consistency.
- SQUAM analyzes statistics of deviations in satellite SST (T_S) with respect to several global reference SST fields (T_R), *e.g.*, Reynolds SST, RTG, OSTIA and ODYSSEA.
- Currently, SQUAM monitors two AVHRR products: the heritage Main Unit Task (*MUT*) and the new Advanced Clear-Sky Processor for Oceans (*ACSPO*), from five platforms: NOAA-16, -17, -18, -19 and MetOp-A.
- SEVIRI SST for two months have also been tested for GOES-R preparedness.

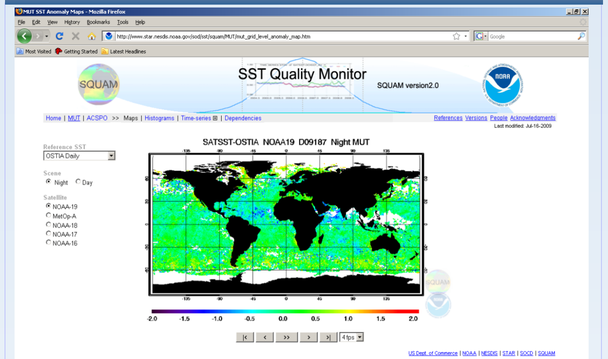
1. The SQUAM Concept

- Customarily, satellite SSTs are validated against *in situ* SSTs. However, *in situ* data are sparse, geographically biased, of non-uniform quality, and have limited availability in NRT.
- SQUAM employs global analyses or climatological SST fields as a reference. These fields cover full retrieval domain with a more uniform quality, and are available in NRT.
- Monitoring of SST is done in "difference space". Global *SST difference* between satellite SST (T_S) and a global reference SST (T_R) is given as: $\Delta T_S = T_S - T_R$.
- Probability density functions of ΔT_S are near-Gaussian (even though T_S and T_R are highly skewed). Fig. 1 shows example ΔT_S map for NOAA-19 MUT minus OSTIA SST.
- Outliers are handled using robust statistics (Dash *et al.*, 2009).
- Fig. 2 shows ΔT_S histograms before and after removing outliers.

2. Input data: operational and test

- Satellite SSTs: NOAA-16, 17, 18, 19, MetOp-A, & MSG:
  - MUT SST from 2004 to present (*e.g.*, Ignatov *et al.*, 2004)
  - ACSPO SST from September 2008 (*e.g.*, Liang *et al.*, 2009)
  - 2 months of SEVIRI SST (June 2008, January 2009)
- Reference SSTs:
  - Global analysis fields: Reynolds (weekly and daily), RTG (low and high resolution), OSTIA, ODYSSEA
  - Climate: Pathfinder (ACSPO), Bauer-Robinson 1985 (MUT)
  - *In situ* bulk (*http://www.star.nesdis.noaa.gov/sod/sst/calval/*)

3. SQUAM Webpage



http://www.star.nesdis.noaa.gov/sod/sst/squam/

Fig. 1: Difference between NOAA-19 MUT night SST and OSTIA (see web for more analyses).

4. Outliers and histograms

- Global distribution of ΔT_S is near-Gaussian. First 4 moments (Mean, Standard deviation, Skewness, Kurtosis) are used for monitoring (*cf.*, Fig. 3).
- The outliers are removed based on "Median ± 4×RSD" criterion.

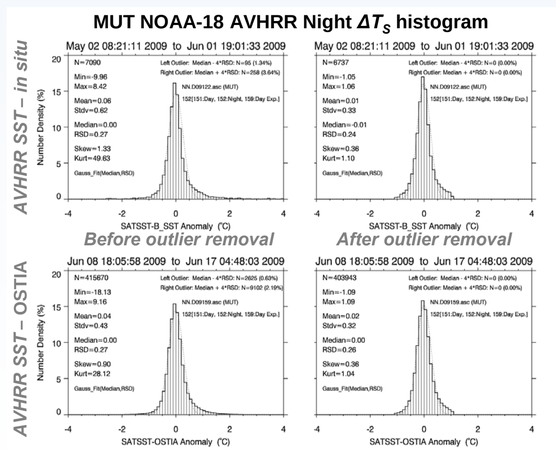


Fig. 2: Probability function of MUT NOAA-18 AVHRR night ΔT_S. Statistical parameters annotated are trended in time.

5. NRT diagnostics: AVHRR SST

(1): Trend statistical parameters in time

(check satellite SST stability and cross-platform consistency)

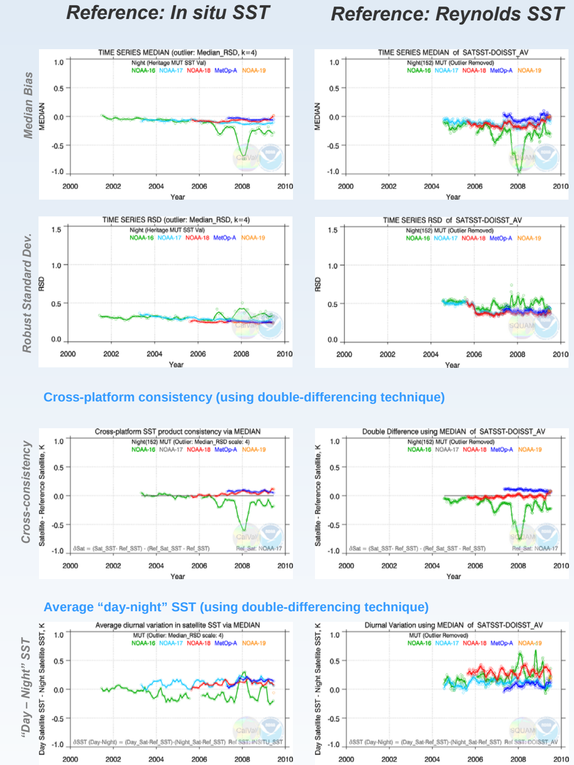


Fig. 3: Time-series of statistical parameters in ΔT_S. A double-differencing technique (bottom two panels) is used to check satellite SSTs for cross-platform and "day-night" consistency.

(2): Plot mean SST difference *vs.* observational parameters

(check satellite SST for self-consistency)

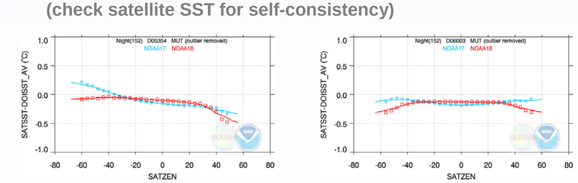


Fig. 4: MUT night ΔT_S *vs.* view zenith angle (SATZEN) for two periods. The misallocation in SATZEN before January 2006 was detected (left) and corrected (right) using the methodology employed in SQUAM.

6. Preliminary analyses: SEVIRI

SEVIRI SSTs were tested as a proxy for GOES-R ABI. For SEVIRI, two more products are generated in addition to regression SST: *physical SST based on Bayesian inversion* (Merchant *et al.*, 2009) and a *hybrid* SST (Ignatov *et al.*, 2009).

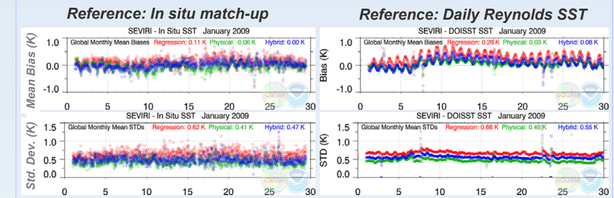


Fig. 5: Validation of SEVIRI SST *vs. in situ* and *Reynolds SST*.

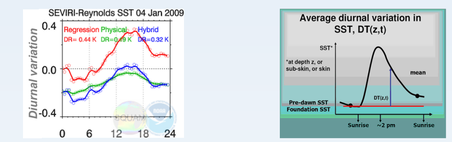


Fig. 6: Left: A typical diurnal variation (DV) of SST derived from SEVIRI. The diurnal range (DR) values are annotated. Right: An expected ideal DV plot (courtesy: www.ghrsst-pp.org).

Summary

- SQUAM performs statistical analyses on differences between satellite SST (T_S) and several global reference SST fields (T_R), such as, Reynolds, RTG, OSTIA and ODYSSEA SSTs.
- SQUAM is fully operational with two AVHRR SST products, the heritage *MUT* and the newer *ACSPO,* from five platforms (NOAA-16, -17, -18, -19, and MetOp-A).
- MSG SEVIRI SST products are also tested as a step towards GOES-R ABI preparedness.

Future work

- Apply diurnal model and extend for GOES-R and NPOESS.

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