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NESDIS AVHRR Sea Surface Temperature Calibration/Validation: Results for NOAA 16–18 from 2001–2007

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Introduction

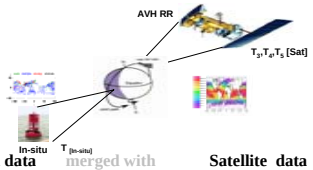
NOAA satellites provide repetitive daily global coverage of Earth. For over two decades, the National Environmental Satellite, Data, and Information Service (NESDIS) has been generating sea surface temperature (SST) products operationally from the Advanced Very High Resolution Radiometer (AVHRR). Global AVHRR SSTs are merged with in situ SSTs and organized into monthly matchup files, which are used to calibrate SST algorithms (early in satellite mission) and then to routinely validate SST products (for the lifetime of a platform). Ancillary data from both satellite and in situ files are also available on the matchup files (Pichel, 1991; Walton, et al., 1998).

Objective

Describe and document calibration/validation (Cal/Val) results of the heritage operational SST products from NOAA16–18 AVHRRs against in situ SST from 2001 to 2007.

Generation of Matchup Files

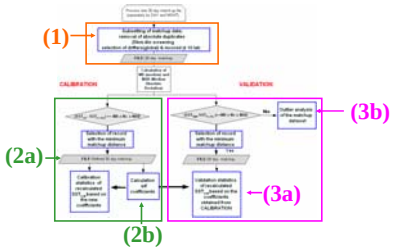
AVHRR brightness temperatures (T_3,T_4,T_5) are routinely merged with in situ SST within a 50 km/8 h space-time window. The matchup files are archived every 30 days.



In situ data merged with **Satellite data**

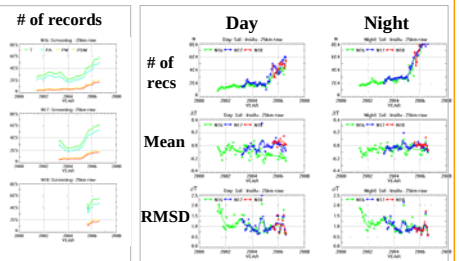
ID	Time	Lat/ Long	In situ SST	Climate Temp	Time	Lat/ Long	T_{clr}	T_3	T_4	T_5	Sat(θ)

AVHRR SST Cal/Val Flowchart



Removing outliers (Wadsworth, 1998) is a critical step of Cal/Val. The current system allows different screenings at the "Cal" and "Val" stages. Results shown in this presentation are screened using median ± 2 MAD/0.6745 and median ± 4 MAD/0.6745 of **($T_{sat} - T_{in\ situ}$)** for Cal and Val, respectively.

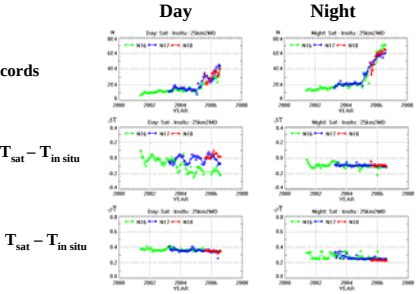
(1) Subsetting and QC of Matchup Data



T = Total number of records.
PA = Post absolute duplicates.
PW = Post 25 km/4 hr screening.
PDM = Post selection drifters (global) and moored (± 10° lat).

Global matchup statistics of **($T_{sat} - T_{in\ situ}$)** for NOAA 16–18 after the **PDM** screening. Each point represents one month.

(2a) CAL: Input: (After median ± 2MAD screening)



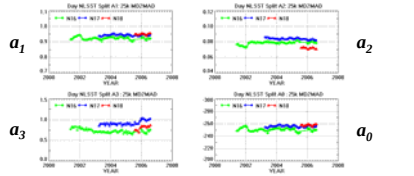
Statistics of $T_{sat} - T_{in\ situ}$ after using a median ±2MAD screening criterion.

(2b) CAL: Day SST Coefficients

The matchup data after a median ±2MAD screening are used to obtain coefficients of daytime and nighttime SST regression equations.

Day: Split-window NLSST

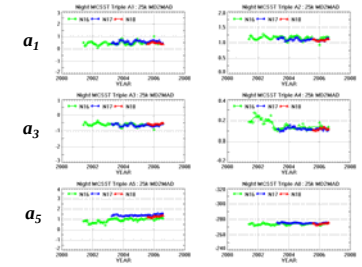
$$T_{in\text{-}situ} = a_o + a_1 T_4 + a_2 T_{sfc} (T_4 - T_5) + a_3 (T_4 - T_5)(\sec\theta - 1)$$



(2b) CAL: Night SST Coefficients

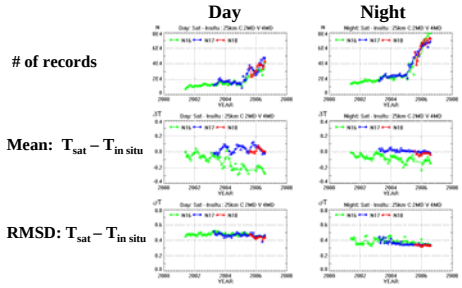
Night: Triple-window MCSST

$$T_{in\text{-}situ} = a_o + a_1 T_4 + a_2 T_3 + a_3 T_5 + a_4 (T_3 - T_5)(\sec\theta - 1) + a_5 (\sec\theta - 1)$$



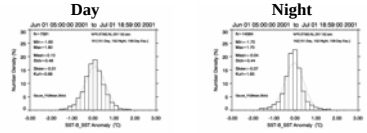
(3a) VAL: Statistics

Matchup data after outlier removal are used to assess the accuracy of operational SST. The validation statistics verify the product quality and consistency over the history of the satellites.



Statistics of $T_{sat} - T_{in\ situ}$ using the first month's coefficients (first point in the time series shown in section 2b). The validation dataset has been screened using the median ± 4 RMSDs (MAD/0.6745) criterion.

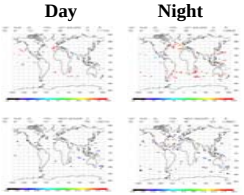
VAL: Histograms of $T_{sat} - T_{in\ situ}$



Example histograms of $T_{sat} - T_{in\ situ}$ for a 30-day matchup file for day and night. Number of observations, minimum, maximum, mean, RMSD, skewness, and kurtosis are annotated on the histograms.

(3b)VAL: Mapping Outliers

At the validation stage the data (from section 1) are screened for outliers using the median ± 4 RMSDs (MAD/0.6745) criterion.



Geographical locations of the left and right outliers for one 30-day matchup data file. The temporal maps of outliers representing each of the 30-day matchup files are used to create time-series animations.

Conclusion

The AVHRR SST Cal/Val system monitors the accuracy and stability of SST algorithms (coefficients) and the derived satellite SST relative to in situ measurements. The quality of the in situ data is critically important for SST Cal/Val. The validation bias is within ±0.2°C, and RMSD is from 0.38 to 0.53°C during the day and 0.32 to 0.48°C at night.

Future Work

Explore
- Global QC/QA of in situ SSTs using anomalies of in situ SST minus global reference field.
- SST from moored buoys (global) and ships for the use in Cal/Val.
- In situ data from other sources such as FNMOC/GODAE (currently, only NCEP in situ data are used at NESDIS).

Test out improved Cal/Val with
- Newly developed ACSPO system while preparing for NPOESS/VIIRS.
- MSG/SEVIRI, while preparing for GOES-R/ABI.

Acknowledgement and Disclaimer

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Literature

- Pichel, W.G. (1991). Operational production of multichannel sea surface temperatures from NOAA polar satellite AVHRR data. Palaeogeography, 90, 173–177.
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