The NOAA Daily Optimum Interpolation SST: Status and Planned Improvements

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What is the DOISST?

The National Climatic Data Center routinely produces the ¼ ° NOAA Daily Optimum Interpolation Sea Surface Temperature (or DOISST; Fig. 1). DOISST anomalies (Fig. 2) are used to study climate phenomena like El Niño (Fig. 3). The DOISST version 2 (V2) methodology requires three inputs (Fig. 4) and is described in Reynolds et al. (2007) and Reynolds (2009).

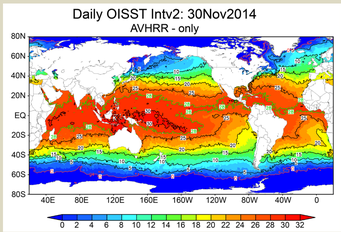

Fig. 1. Example of DOISST.v2.

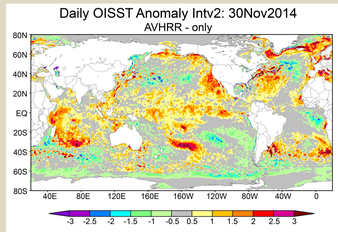

Fig. 2. Example of a DOISST anomaly map (DOISST minus 1981–2000 climatology).

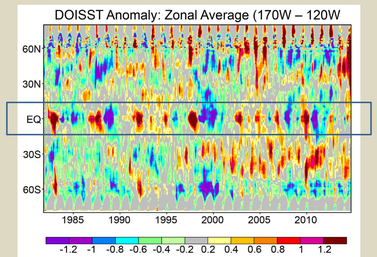

Fig. 3. Hovmoller diagram of the zonal average (monthly; 120°–150°W) DOISST anomalies. The equatorial region (box) shows extreme warm and cold events associated with El Niño/La Niña. Note that in 2014, the anomalously warm conditions occur north of the equatorial region.

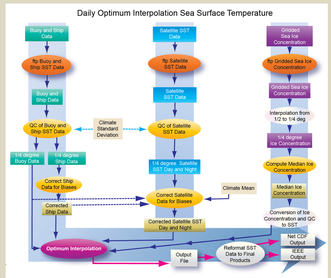

Fig. 4. Operational processing flow for DOISST has three input streams:1) satellite SSTs, 2) in situ data, and 3) sea ice concentrations.

Objectives

This poster describes the ongoing effort to modernize DOISST code to meet the Climate Data Records Program's standards, that in the long run, will facilitate updates to the product and reduce maintenance costs.

What makes DOISST a Climate Data Record?

The DOISST that uses satellite SSTs solely from the Advanced Very High Resolution Radiometer (AVHRR) is considered a Climate Data Record (CDR) because it extends over thirty years (1981 to present) and has been processed to be as consistent as possible across sensors. As a CDR, DOISST has to meet Full Operational Capability requirements:

- Sustained, systematic, reliable, robust production
- Algorithm and software fully documented
- Meets the CDR Program's coding standards
- Results are independently reproducible
- Reprocessed for entire period of record

Why was the DOISST code refactored?

DOISST is based on work by Richard W. Reynolds and Tom Smith that started in the 1980s. With the retirement of Reynolds, code refactoring was needed:

- To enable long-term maintenance and sustainability in operations
- To ensure the transparency of the code

NOAA operational goals are shown in Fig. 5.

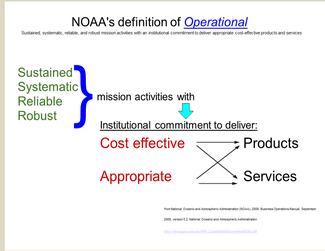

Fig. 5. NOAA Operational Requirements.

Refactoring is a disciplined approach to improve the internal design of the code without changing the functionality. It is performed to improve reliability, readability, and maintainability. Figure 6 shows sample code before and after the refactoring.

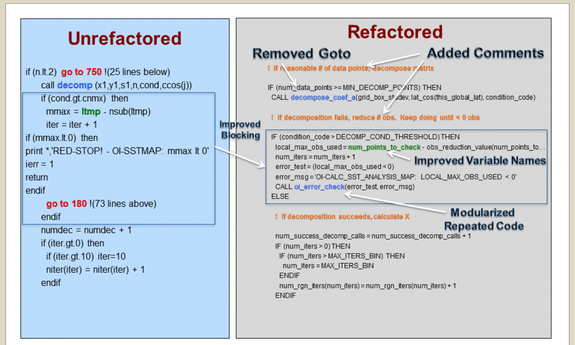

Fig. 6. Example of DOISST code before and after refactor

Overall, refactoring increased code readability. In terms of metrics, it:

- Reduced the number of lines of FORTRAN source code by 30% (not counting variable declarations that were added)
- Reduced the lines of code in scripts by 50%
- Reduced cyclomatic complexity in terms of Vg = # unique paths (Table 1).

Routines with Highest Cyclomatic Complexity (Vg)			
Routine	Vg Before	Vg After	% Change
buoy_ship (main)	53	47	11%
ncep_ice2sst (main)	43	38	12
oi (main)	85	37	56
satellite_navy (main)	41	35	15
sstmap subroutine	39	33	15
intrp subroutines (2)	46	13	72
Project Total	2127	902	58

Table 1. Cyclomatic complexity (Vg) before and after refactoring of DOISST routines

What are the planned changes in DOISST?

The three main inputs to DOISST have been temporally extended or rereleased. All updated inputs will be used in the next DOISST version.

The biggest change will be the AVHRR SST dataset. Pathfinder version 5.2 provides a skin SST, while the previous version 5.0/5.1 is a bulk SST , typically ~0.2 warmer than skin (Fig. 7). An adjustment may have to be made to be consistent with buoy/ship SSTs. As before, operational SSTs will be used to extend DOISST to the present, as shown in Fig. 8.

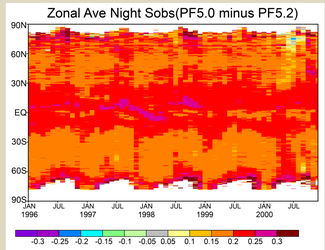

Fig. 7. Difference between old and new (version 5.2) Pathfinder AVHRR SSTs.

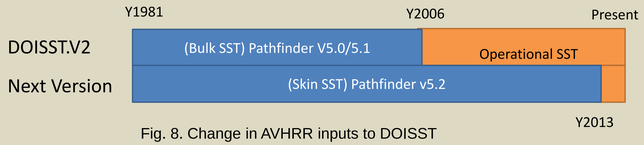

Fig. 8. Change in AVHRR inputs to DOISST

Changes to other DOISST.v2 inputs include:

- Updated in situ dataset (currently ICOADS release 2.5; Woodruff et al., 2011)
- Sea ice concentrations (GSFC/NASA Team algorithm; Cavalieri et al. 1996) extended to 2013

Following these changes, the other type of DOISST that includes microwave (called AVHRR+AMSR) will be updated as well.

SUMMARY

DOISST updates consist of three steps:
PHASE 1: Code rejuvenation (almost completed)
PHASE 2: AVHRR_only reprocessing (by end of 2015)
PHASE 3: AVHRR+AMSR reactivation (by end of 2015)

References

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3. Reynolds, R. W., T. M. Smith, C. Liu, D. B. Chelton, K. S. Casey and M. G. Schlax, 2007:Daily High-resolution Blended Analyses for sea surface temperature. J. Climate, 20, 5473-5496.
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