Pathfinder AVHRR Sea Surface Temperature 4 KM Climate Data Record

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Abstract

The NOAA National Centers for Environmental Information (NCEI) develops and maintains the high resolution, long-term, climate data record (CDR) of global satellite sea surface temperature (SST) called Pathfinder SST. These SST values are generated at approximately 4 km resolution using Advanced Very High Resolution Radiometer (AVHRR) instruments aboard NOAA polar-orbiting satellites going back to 1981. The Pathfinder SST algorithm is applied consistently over the full time period (August 1981 - December 2014) and is based on the Non-Linear SST algorithm using the modernized NASA SeaWiFS Data Analysis System (SeaDAS). Coefficients for this SST product were generated using regression analyses with co-located in situ and satellite measurements based on Kilpatrick, Podesta and Evan (2001). Notably, the data were processed in the Amazon Web Service cloud and are made available through all of the modern web visualization and subset services provided by the THREDDS Data Server, the Live Access Server, and the OPeNDAP Hyrax Server. Building on the long historical aspect of Pathfinder SST (Casey et. al., 2011), quarterly updates will be maintained to continue this long (>33 years), consistently processed, global high-resolution SST climate data record.

The SST Pathfinder 5.3 CDR uses the NOAA -7, -9, -11, -14, -16, -17, -18, -19 AVHRR sensors and maintains both wet and dry coefficients to improve accuracy of retrievals. Updates include

- L2P, L3U, and L3C products **(Figures 1.A through C**) and SST values of all quality levels (**Figures 1C versus 1D**), giving the user more SST pixels to work with and the option to apply their choice of cloud-masking procedures.;
- Better identified and flagged anomalous hotspots at landwater boundaries;
- Updated land mask (based on Global Lakes and Wetlands Database) and sea ice data over the Antarctic ice shelves masked as ice;
- Improved handling of sun glint areas (no longer masked out);
- Consistent cloud tree tests for NOAA07 and NOAA-19 with respect to other sensors;
- NetCDF file format improvements to ensure consistency with the Group for High Resolution SST (GHRSST) requirements;
- Processing done using Amazon Web Service cloud computation (**Figure 2**) under NOAA cloud pilot project.

Overall, the SST Pathfinder 5.3 compares well with other GHRSST products (**Figures 3 and 4**).

Overview

Figure 1. Pathfinder SST products: (A) Level 2P and (B) Level 3U products from large orbit files will be available to users in the release of version 5.3, in addition to the (C) Level 3C product. The old Pathfinder SST product 5.2 (D).

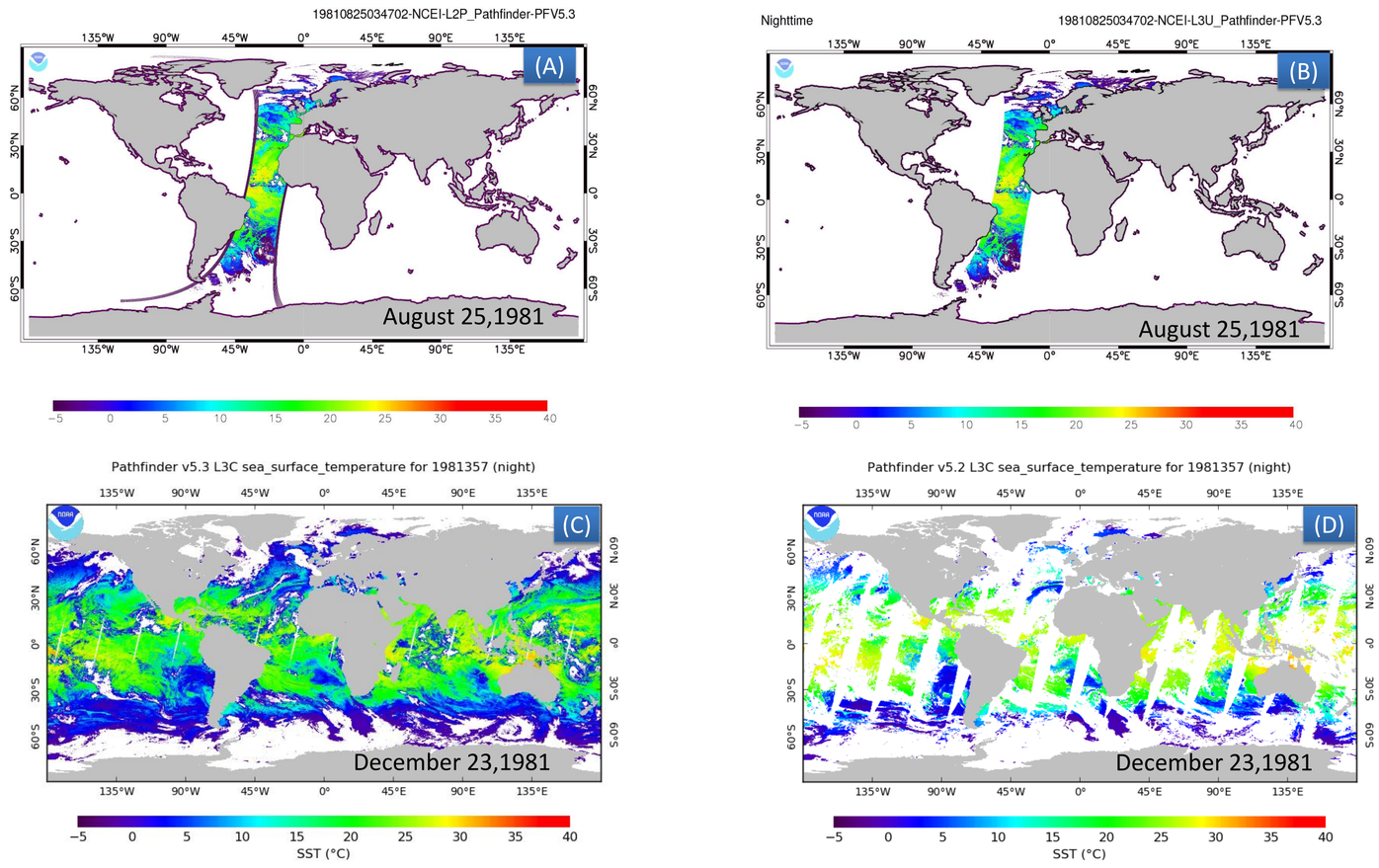


Figure 2. Cloud Pilot Project flowchart for Pathfinder SST version 5.3. (Acronyms: AWS, Amazon Web Service; EC2, Elastic Compute Cloud; S3, Simple Storage Service.)

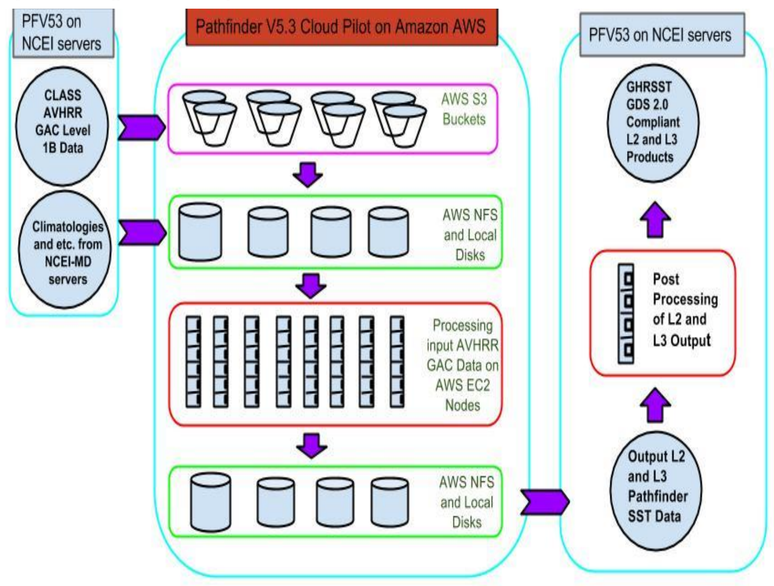


Figure 3. PFSST (5.2 & 5.3) data compare well to the CMC0.2 Global Foundation SST, but differs as expected for a skin SST measurement. Day and night binning to be resolved.

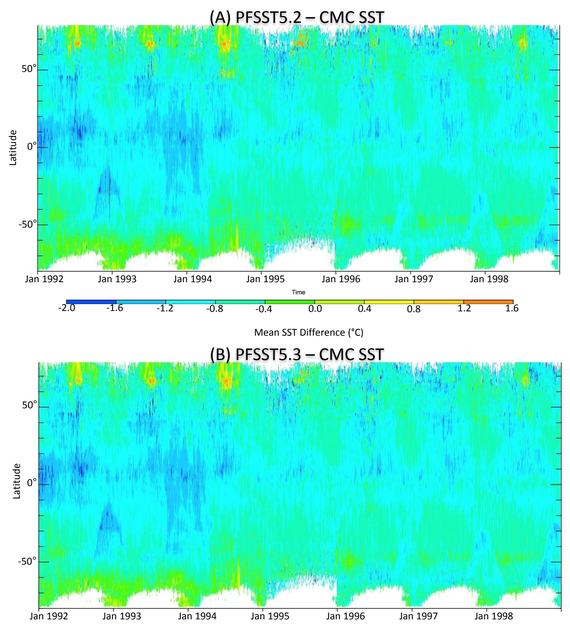
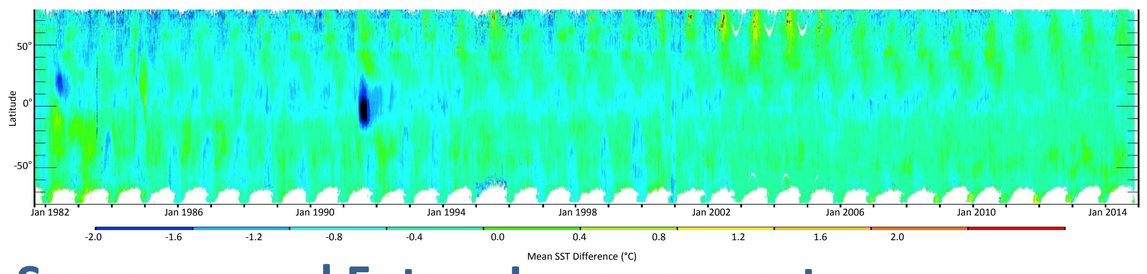


Figure 4. Differences between PFSST 5.3 and the daily OISST fall within the range of ± 2°C.



Some Current Applications of the Pathfinder SST CDR

The Pathfinder SST CDR is recognized and utilized by users as an authoritative source of SST and contributes to the international effort on quality controlled SST field through GHRSST. This CDR is a primary source of information for numerous regional and global marine resource efforts, e.g., local habitat characterization, coral reef stress monitoring by Coral Reef Temperature Anomaly Database (CoRTAD, **Figure 5),** and El Niño events. NCEI provide long-term preservation and access to data and metadata for data discovery: enhanced access to data, supporting functions such as on-line visualization and subsampling. Additional applications include

- Input to produce a collection of sea surface temperature (SST) and related thermal stress metrics, developed specifically for coral reef ecosystem applications (CoRTAD: Coral Reef Temperature Anomaly Data Base);
- Input source of AVHRR data for the Danish; Meteorological Institute L4 reanalysis (**Figure 6**);
- AVHRR input to MGDSST (level 4) developed by Japanese Meteorological agency (JMA) reanalysis dataset (1982-current);
- Used in the Italian National Research Council (CNR) Reanalysis over the Mediterranean region.
- Acts as a reference climatology to OSTIA SST by UK Met office;
- Used in reanalysis for NOAA/NCEI OISST.

Figure 5. CoRTAD Version 5 Thermal Stress Anomalies (SST minus Maximum of Weekly Mean Climatological SST) during an El Niño year.

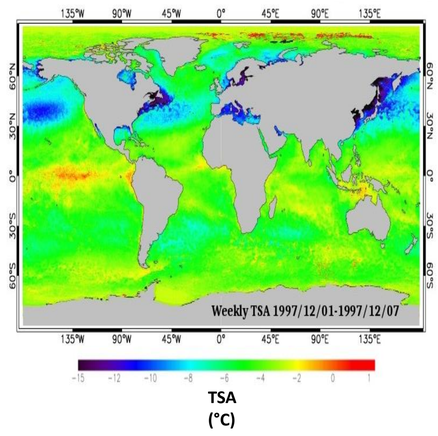
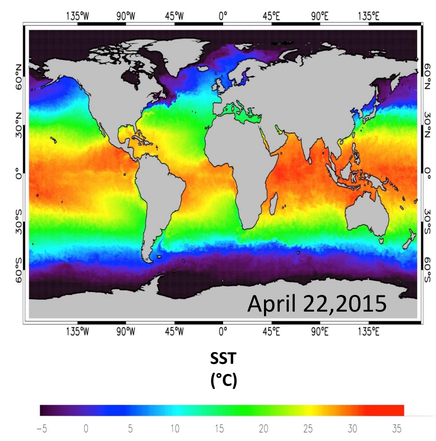


Figure 6. GHRSST-Danish Meteorological Institute OI level 4 global SST field.



Summary and Future Improvements

The Pathfinder SST CDR products are improved with scientific quality assessments through rich inventory analysis and in situ data matchups. Future improvements:

- Provide quarterly updates to extend the record forward;
- Apply Climate Data Assessment Framework (CDAF) based on the GHRSST community standards;
- Investigate how to improve the pathfinder “dt_analysis”;
- Improved quality assessment: compare Pathfinder version 5.3 with a different CDR, e.g., ARC, and explore uncertainties in the SST based on FIDUCEO (Fidelity and Uncertainty in Climate data Records from Earth Observation) project;
- Populate the SSES_bias and SSES_standard_deviation variables for pathfinder v6 to make it 100% GDS2 compliant;
- Resolve binning problem of mixed day and night granules at high latitudes (see **Figure 3**).

References

1. Casey, K.S., T.B. Brandon, P. Cornillon, and R. Evans (2010). "The Past, Present and Future of the AVHRR Pathfinder SST Program", in *Oceanography from Space: Revisited*, eds. V. Barale, J.F.R. Gower, and L. Alberotanza, Springer. DOI: 10.1007/978-90-481-8681-5_16.
2. Kilpatrick, K. A., G. P. Podesta, and R.H. Evans. 2001. "Overview of the NOAA/NASA Pathfinder algorithm for Sea Surface Temperature and associated Matchup Database." *J. Geophys Res.,* 106: 9179-9198. 13497- 13510.

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