

4 km AVHRR Pathfinder Project

*****ANNOUNCEMENT September 14: NCEI releases AVHRR Pathfinder Version 5.3 for August 1981 through December 2014*****

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). 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 data set (PFV53) is the newest release of the PF SST products. This is a step forward in preparation for the future Version 6 (PFV6) data set. (No release date has yet been established). The Pathfinder SST data set is based on the Non-Linear SST algorithm using the modernized NASA SeaWiFS Data Analysis System (SeaDAS). Coefficients for the regression analyses with co-located in situ and satellite measurements based on Kilpatrick, Podesta and Evan (2001) and Baker-Yeboah, Saha, Zhang, Casey, Evans, and Kilpatrick (in progress). 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 TDS 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 year) resolution SST climate data record.

Consistent with 52, PF53 is provided in netCDF-4 (classic model, with internal compression and chunking) and are nearly 100% compliant with the [GHRSSST Data Specification Version 2.0](#) (provided: L2P and L3U products). These data deviate from that standard only in that the sses_bias, sses_standard_deviation, and sst_dtime variables are empty. Data for 1981-2014 are available through NCEI's ftp, http, OPeNDAP, and THREDDS access systems:

- HTTP: <http://data.nodc.noaa.gov/pathfinder/Version5.3/L3C>
- FTP: <ftp://ftp.nodc.noaa.gov/pub/data.nodc/pathfinder/Version5.3/L3C>
- OPeNDAP: <http://data.nodc.noaa.gov/opendap/pathfinder/Version5.3/L3C>
- THREDDS: <http://data.nodc.noaa.gov/thredds/catalog/pathfinder/Version5.3/L3C/catalog.html>

This [SST PF53 Climate Data Record](#) uses the NOAA -7, -9, -11, -14, -16, -17, -18, -19 AVHRR sensors and maintains both wet and dry coefficients to improve accuracy of retrieval

- Included all SST values of all quality levels (**Figures 1 for PF53 versus Figure 2 for PF52**). The user can turn off the lowest quality level of pixels, when comparing the old version 5.3 (Figure 3).
- 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 NOAA-07 and NOAA-19 with respect to other sensors;
- Improved flagging of a very small percentage of pixels with SST values > 39.8 degrees C (see l2p_flags).
- NetCDF file format improvements to ensure consistency with the Group for High Resolution SST (GHRSSST) requirements;
- Processing done using Amazon Web Service cloud computation under NOAA cloud pilot project.

Overall, PF53 compares well with other GHRSSST products (see **Figures 4 and 5**) and validation results corresponding to Pathfinder Level 3 skin SST minus sub-surface buoy SST show a standard deviation of 0.5 K (Baker-Yeboah, Saha, Zhang, Casey, Evans, and Kilpatrick, 2016: AGU Poster and manuscript in progress).

Figure 1-3 Pathfinder SST examples from (A) version 5.3 with all pixel values available for the user, (B) version 5.2, which did not have all pixels available for the user, and (C) version 5.3 with zero quality level pixels removed..

Figure 1. Pathfinder SST version 5.3 with all pixel values available for the user.

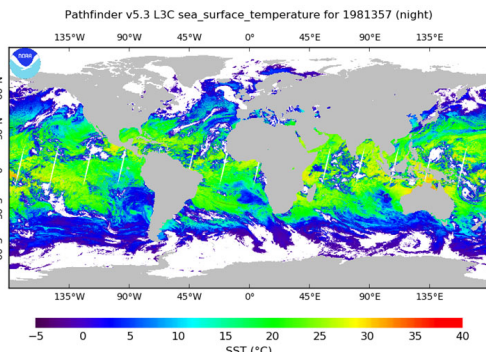


Figure 2. Pathfinder SST version 5.2 did not have all pixels available for the user.

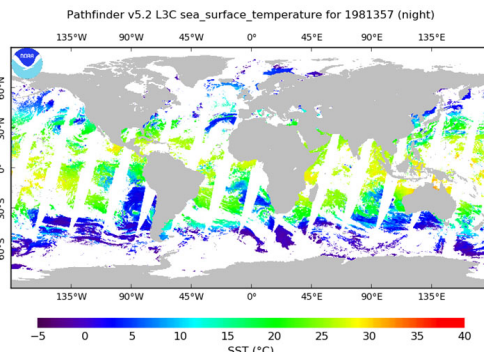
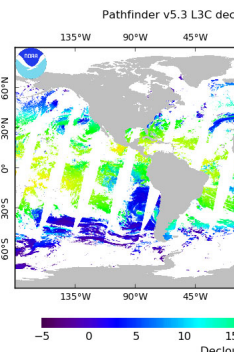


Figure 3. Pathfinder SST version 5.3 with zero quality level pixels removed.



The following table lists known issues with the PFV53 data set:

Known Issue	Comments
A code error in the NASA SeaDAS package spatial binning software used to create daily PF53 L3C (collated) data and MODISV5 products has been identified. This day/night spatial binning problem was corrected in 2015 by NASA in SeaDAS7.2 for MODIS SST data but not for AVHRR SST algorithms.	NCEI will work toward making needed updates to address this problem. A correction will be implemented in PFV6. In global maps of Pathfinder V5.2 and V5.3 high latitude SST's in months near the summer (June) solstice and winter (December) solstice are often incorrect above 50 degree latitude, due to improper splitting of the mixed night and day granules due to NASA SeaDAS package.
Updates beyond 2014 to the products are needed.	NCEI is in the process of addressing this need. Quarterly updates will be implemented as soon as

	possible in 2017.
PFV53 are not fully GDS2.0 compliant: sses_bias, sses_standard_deviation, and sst_dtime variables are empty.	These empty variables are a known issue and were not possible to include in PFV53. The plan is to include them in a future PFV6 data set.
Currently, a major gap exists from 1994275 to 1995017. In the original PFV50 processing, these data were available from RSMAS and PFV50 has been used to temporarily fill that gap, as in PF52.	Level 0 GAC data from NOAA-9 have been located and provided to the National Centers for Environmental Information. These data will be included in PFV6.
The aerosol_depth_indicator variable is sub-optimal, as in PF52 since it relies on a two fairly different sources of aerosol data.	The aerosol data community is improving its datasets so we hope by the time of a future PFV6 data set to have available a consistent aerosol product available for the entire Pathfinder period.
Aerosols missing from primary and fallback sources for Sep 1994 - Feb 1995, as in PF52.	Corrected for now by using the previous year's aerosol values for the missing days (as in PF52).
Sea ice missing from primary and fallback sources for 1987 day 340 through 1988 day 10.	We resolved this for now by using the previous year's ice. For example, for 1988 day 001, we used 1987 day 001 sea ice. However, the source attribute does not appear to properly reflect this correction. NCEI is investigating missing sea ice in the DOISST for this period and will also work with our sea-ice data providers to improve coverage in the early years of their data sets.
Both PF5.2 and PF53 reveal a very small percentage of pixels with SST values > 39.8 degrees C (see l2p_flags) and a need to investigate other high SST values.	Improved flagging of a very small percentage of pixels with SST values > 39.8 degrees C (see l2p_flags) has been implemented. Further analysis will be done to better quantify similarly high SST values in the PFSST products.

In the coming weeks, we will update these web pages to provide additional details on PFV53.

Figure 4. 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.

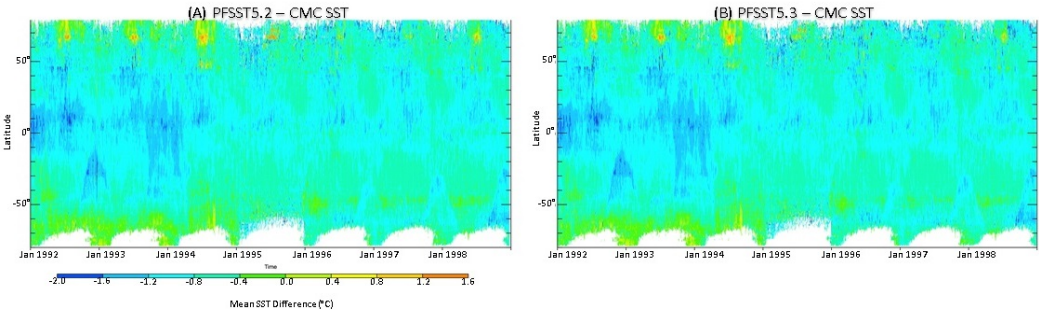
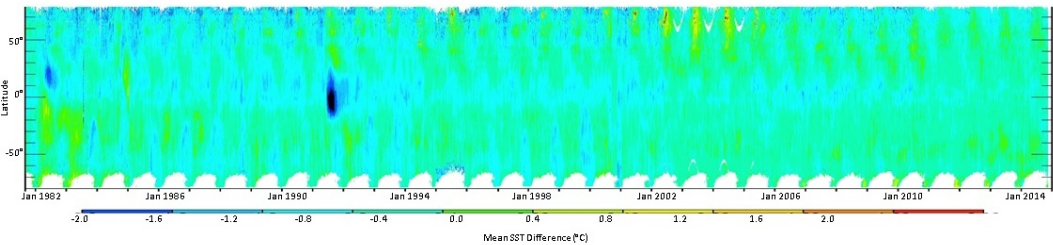


Figure 5. Differences between PFSST 5.3 and the daily OISST fall within the range of ± 2°C.



Acknowledgment & Citation:

If you use Pathfinder 4km data, please acknowledge the use of these data with the following statement: "These data were provided by GHRSSST and the US NOAA National Centers for Environmental Information. This project was supported in part by a grant from the NOAA Climate Data Record (CDR) Program for satellites". Please cite the following publication:

Baker-Yeboah, S., K. Saha, D. Zhang, K. S. Casey, R. Evans, and K. A. Kilpatrick (2016). "Pathfinder Version 5.3 AVHRR Sea Surface Temperature Climate Data Record", Fall AGU 2016.

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. Barth and R. Evans. Springer. DOI: 10.1007/978-90-481-8681-5_16. (Click here for a PDF copy).

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, 42, 46,191-46,200.

SST PF 5.3 Algorithm can be found on the CDR web page at http://www1.nodc.noaa.gov/pub/data/sds/cdr/CDRs/Sea_Surface_Temperature_Pathfinder/Algorithm

