Validation of AVHRR Pathfinder Version 5.0 Sea Surface Temperatures

Kenneth S. Casey * and Andrew D. Barton, NOAA/NODC; Edward J. Kearns, Univ of Miami/RSMAS; Richard W. Reynolds, NOAA/NCDC

ABSTRACT

An improved, 20-year long sea surface temperature (SST) data set based on NOAA Advanced Very High Resolution Radiometer (AVHRR) observations and an improved Pathfinder algorithm has been developed by the NOAA National Oceanographic Data Center (NODC) and the University of Miami Rosenstiel School of Marine and Atmospheric Science (RSMAS). This data set implements numerous improvements over the previously available version 4.x Pathfinder data sets, including a finer spatial resolution, use of sea ice masks in quality level determinations, and greater inclusion of coastal and inland waters. Validation studies conducted on this AVHRR Pathfinder Version 5.0 collection have been undertaken. Both quantitative and qualitative assessments of these SST observations are presented here, with an emphasis on the improved coastal coverage, reduced biases compared to operational AVHRR SSTs, enhanced climatologies, and refined high-latitude observations.

History of Pathfinder SSTs

The Pathfinder Version 5.0 Project is the successor to the NOAA/NASA AVHRR Oceans Pathfinder Program, which developed global SSTs at 9.28 km resolution throughout the 1990's and culminated in the Version 4.x (V4) dataset. The V4 dataset, distributed through the JPL's PO.DAAC (http://podaac.jpl.nasa.gov/sst/), found widespread use and was among their most popular products.

Despite its success, some problems with the V4 data set limit its use. For example, biases are known to exist in areas strongly impacted by atmospheric aerosols. Additionally, the relatively crude landmask creates significant problems for coastal applications and lack of sea ice information limits the use of the data in the ice-prone high latitudes. This new reprocessing by RSMAS and NODC seeks to correct these deficiencies and provide a higher resolution and ultimately more accurate SST product. This global 4 km resolution dataset is termed "Pathfinder Version 5.0 (V5)" since it builds directly on the V4 dataset, including the use of the same set of matchup coefficients.

This V5 reprocessing uses an improved version of the Pathfinder algorithm and processing steps to produce twice-daily global SST and related parameters back to 1985, at a resolution of approximately 4 km, the highest possible for a global AVHRR data set. Daytime and nighttime averages for Daily, 5-day, 7-day, 8-day, Monthly, and Yearly periods are produced, along with corresponding sets of climatologies. Current key improvements over the earlier 9 km V4 Pathfinder SST data set include a more accurate, consistent land mask, higher spatial resolution, and inclusion of sea ice information. Additional improvements including better flagging of aerosol-contaminated retrievals and the provision of wind and aerosol ancillary data are being implemented in the Version 6 reprocessing to take place during FY2005

Numerous advances have also been made to improve access to and use of the V5 Pathfinder data. These improvements include the creation of FGDC metadata records and full, online access to the entire data set through:

OPeNDAP - http://data.nodc.noaa.gov/cgi-bin/nph-dods/pathfinder
FTP - ftp://data.nodc.noaa.gov/pub/data.nodc/pathfinder

The V5 data are also being served in partnership through the NASA JPL PO.DAAC's POET interface (http://podaac.jpl.nasa.gov/poet).

Key Improvements: Finer Spatial Resolution and Better Coastal Coverage

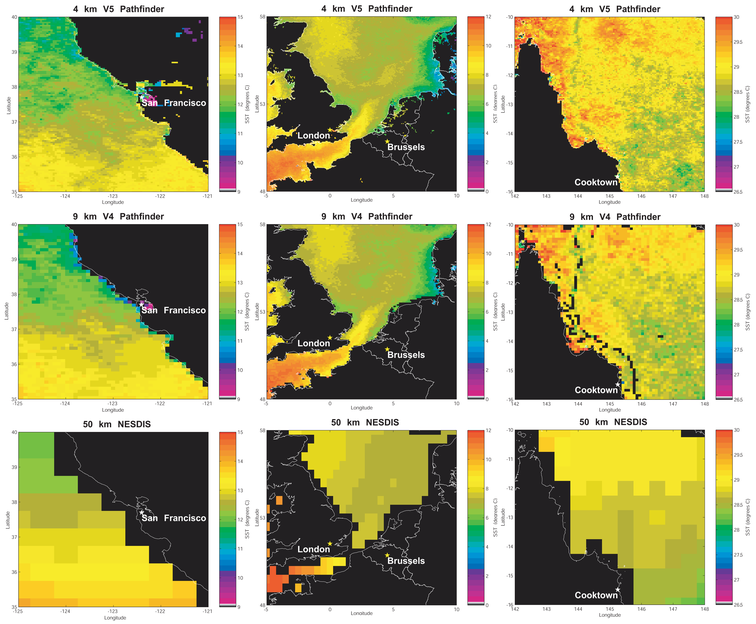


Figure 1 (above): The 9 panels above demonstrate the improvements achieved in V5 Pathfinder (first row) when compared to the older V4 Pathfinder (second row) and Operational NESDIS 50 km SST products (third row). The first column shows the California coast, around San Francisco. The second column shows the North Sea and surrounding land areas. The third colum shows the vicinity of the Great Barrier Reef off northeastern Australia. Black areas in the images are identified as land in the respective data sets. In all three regions, notice the finer detail and availability of SST observations immediately along the coasts, within bays, and in inland waters in the new V5 Pathfinder dataset. In the the third column, notice the band of pixels along the Great Barrier Reef incorrectly identified as land in the V4 Pathfinder data. Also notice the band of cooler waters along the Great Barrier Reef in V5, a feature not clearly seen in V4.

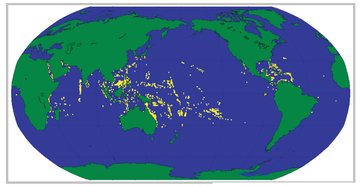


Figure 2: Of the approximately 7000 coral reef locations shown above in yellow, only 61% are covered directly by the old V4 Pathfinder data. In Pathfinder V5, the coverage is over 98%.

Key Improvements: Reduced Biases and Increased Consistency

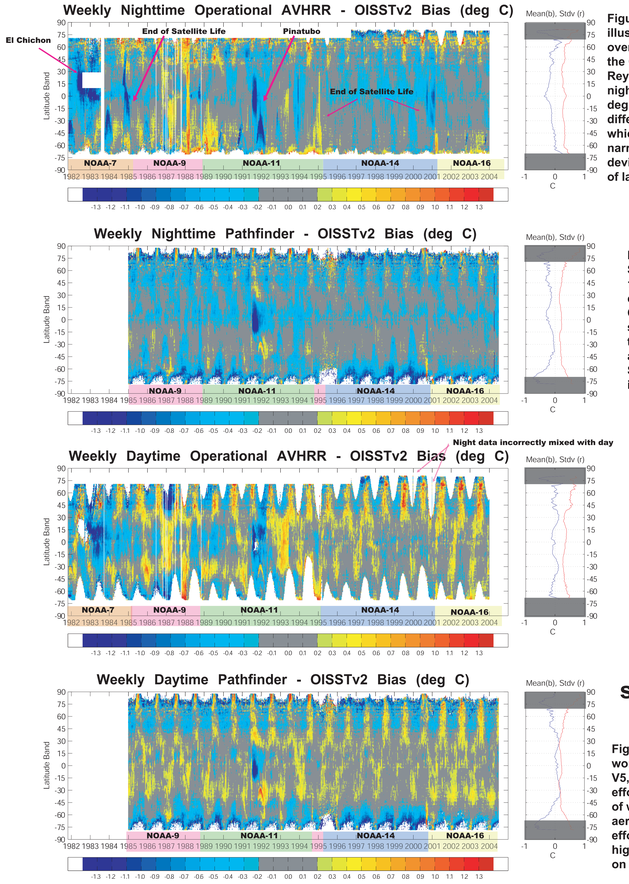
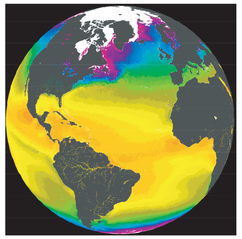


Figure 3 (left): The four panels to the left illustrate the greater consistency and lower overall biases in the Pathfinder V5 SSTs than in the Operational SSTs, when compared to the Reynolds OISSTv2 dataset. Both daytime and nighttime comparisons are shown for the 1-degree zonally averaged weekly mean differences. Colors on the time axis indicate which satellites where used for that time. The narrow panels show the average and standard deviation of the bias over all times for each band of latitude.



Key Improvements: Enhanced Climatologies

Figure 4 (above right): The SST globe depicts the typical SST for this week (climatological week 50), based on 1985-2001 Pathfinder V5 data. The Pathfinder climatologies have been tested using the method of Casey and Cornillon (1999), which compares ICOADS in situ against climatological SSTs. The climatology with the lowest standard deviation of the difference is best able to describe the mean SST state of the ocean. Summary results are shown in the table to the right, indicating better performance by the Pathfinder V5 SSTs.

Climatology	Number Obs.	STDV (deg C)
Pathfinder V4	~100 M	1.64
ERSSTv1	~100 M	1.65
COADS	~100 M	1.66
NESDIS Oper.	~86 M	1.78
NEDSIS Gap-Fill	~98 M	1.86

STDV differences of 0.01 are signifcant at > 99%

Key Improvements: Sea Ice Masking

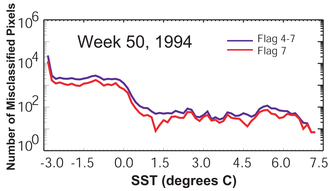
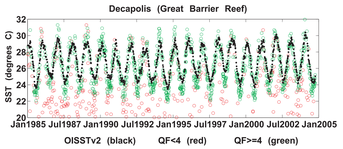


Figure 6 (left): The older V4 Pathfinder did not use a weekly-varying ice mask in its quality control procedures. The result was the possibility that some high latitude pixels could be misclassified as valid SSTs, despite being from ice-coverered ocean areas. This figure demonstrates the problem for week 50 from V4 1994 data. Even at the highest quality flagging (flag=7), many pixels are misclassified. All of these pixels are flagged as ice in V5.

Ongoing Efforts: In situ validation, aerosol flagging, and more...

Figure 7 (right): Numerous ongoing efforts are working to improve the usefulness of Pathfinder V5, and to make improvements for the Version 6 effort in 2005. Some examples are the provision of wind ancillary data and better flagging of aerosol-contaminated values. In situ validation efforts are also being conducted, especially in highly variable coastal regions such as this site on the Great Barrier Reef.



REFERENCES:

Casey, K.S. and P. Cornillon (1999). A comparison of satellite and in situ based sea surface temperature climatologies, Journal of Climate, vol 12, 1848-1863.

* NOAA National Oceanographic Data Center, 1315 East-West Highway, Silver Spring MD 20910, USA. Ken.Casey@noaa.gov, http://iwww.nodc.noaa.gov/sog/pathfinder4km