

# Extended Reconstructed Sea Surface Temperature Version 4

## 1. Intent of This Document and POC

**1a)** This document is intended for users who wish to compare satellite derived observations with climate model output in the context of the CMIP5/IPCC historical experiments. Users are not expected to be experts in satellite derived Earth system observational data. This document summarizes essential information needed for comparing this dataset to climate model output. References are provided at the end of this document to additional information.

Dataset File Name (as it appears on the ESGF):

--to be added once file is accepted-----

**1b)** Technical point of contact for this dataset:

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*[List a technical point of contact for this dataset, who is capable of fielding questions from users about all aspects of the dataset (i.e., how it was produced, its limitations and appropriate use, etc.) Include an email address for this person.]*

## 2. Data Field Description

CF variable name, units:	TOS, Kelvin
Spatial resolution:	2-degree in latitude and longitude
Temporal resolution and extent:	Monthly from January 1854 to December 2015
Coverage:	Global oceans from 88S to 88N.

## 3. Data Origin

ERSSTv4 is reconstructed based on in situ (ships and buoys) observations from ICOADS Release 2.5 (1854-2007) and NCEP GTS (2008-2015). Satellite observations are not included. However, the base function Empirical Orthogonal Teleconnection (EOT) are trained by Monthly (derived from weekly) OISST that include satellite observations.

The number of observations is shown in Figure 1.

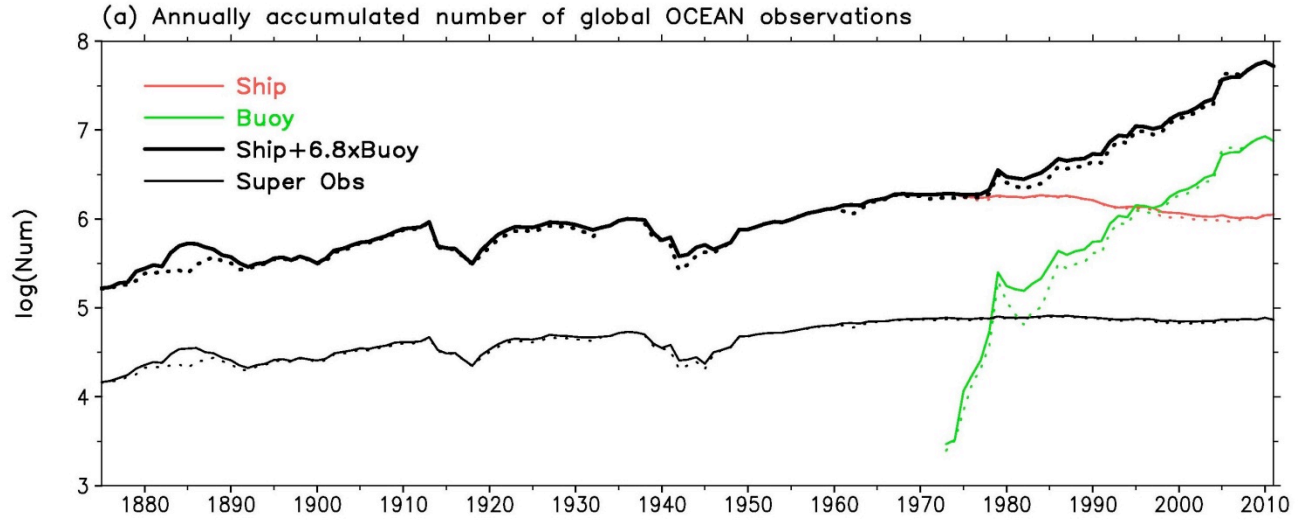


Figure 1. (a) Annually accumulated number (in log scale) of SST observations by ships (red line) and buoys (green line), equivalent number of combined ship and buoy observations (thick black line), and the number of superobservations on a  $2^{\circ} \times 2^{\circ}$  grid (thin black line). Solid and dotted lines represent observations selected from ICOADS R2.5 and R2.4, respectively. The factor of 6.8 is determined by the ratio of error variances of ship and buoy observations.

#### 4. Validation and Uncertainty Estimate

The ERSSTv4 are validated using “perfect observations” from coupled model simulations, other SST analyses, and independent satellite observations.

Figure 2 shows the validations of NINO3.4 index in updating the base function EOTs and their acceptance criterion Crit. In v4, the EOTs are trained use the longest data available (1982-2011) and lower Crit of 0.1.

Figure 3 shows the difference and STD of ERSSTv4 and other SST products in comparison independent ATSR observations.

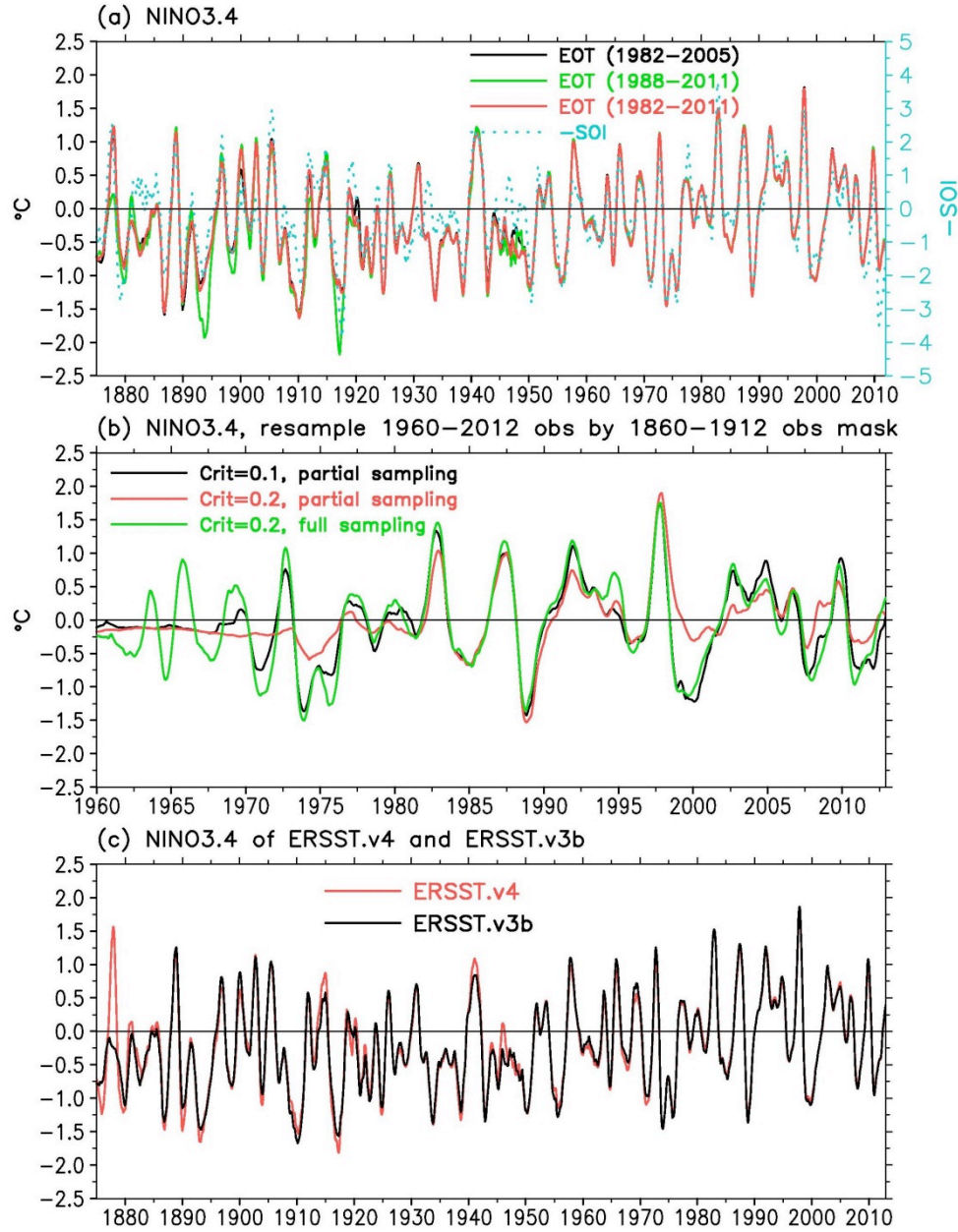


Figure 2. (a) NINO3.4 index (left axis) in test analyses using EOTs trained with 1982-2005, 1988-2011, and 1982-2011 data, overlapped with -SOI index (right axis). (b) NINO3.4 index from 1960 to 2012 in test analyses using Crit of 0.1 and 0.2 and using EOTs trained with 1982-2011 data, when observed data are resampled by observational mask from 1860 to 1912. The NINO3.4 in full sampled analysis is overlapped. (c) NINO3.4 index of ERSST.v4 and ERSST.v3b.

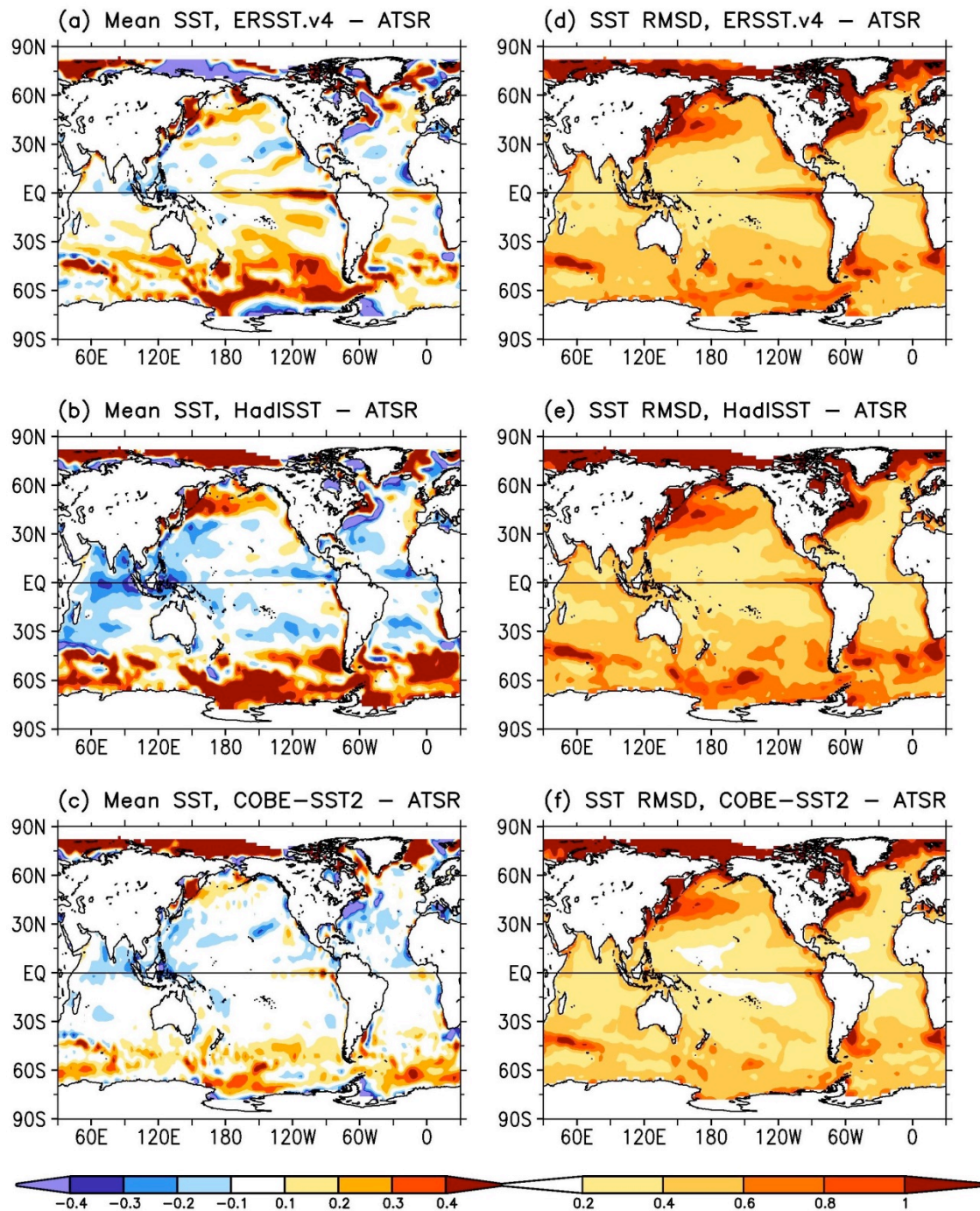


Figure 3. Collocated mean (1997-2011) difference of SSTs on  $2^\circ \times 2^\circ$  grid between (a) ERSST.v4 and ATSR, (b) HadISST and ATSR, and (c) COBE-SST2 and ATSR. (d), (e), and (f) are same as (a), (b), and (c) except for RMSD. The difference in the Arctic is blanked due to sparse observations. Contour intervals are  $0.1^\circ\text{C}$  in (a)-(c) and  $0.2^\circ\text{C}$  in (d)-(f).



The uncertainty of ERSSTv4 is estimated. The uncertainty is separated into reconstruction and parametric uncertainty. The reconstruction uncertainty is associated with the use of limited number (a maximum of 130) of EOTs, which is estimated using 32-member ensemble analysis. The parametric uncertainty is associated with changes of 24 parameter values, which is estimated using 1000-member ensemble analysis.

Figure 4 shows the globally averaged uncertainty of local SST and Figure 5 shows the uncertainty of globally averaged SST. The uncertainty from different SST products is compared in Figures 4 and 5.

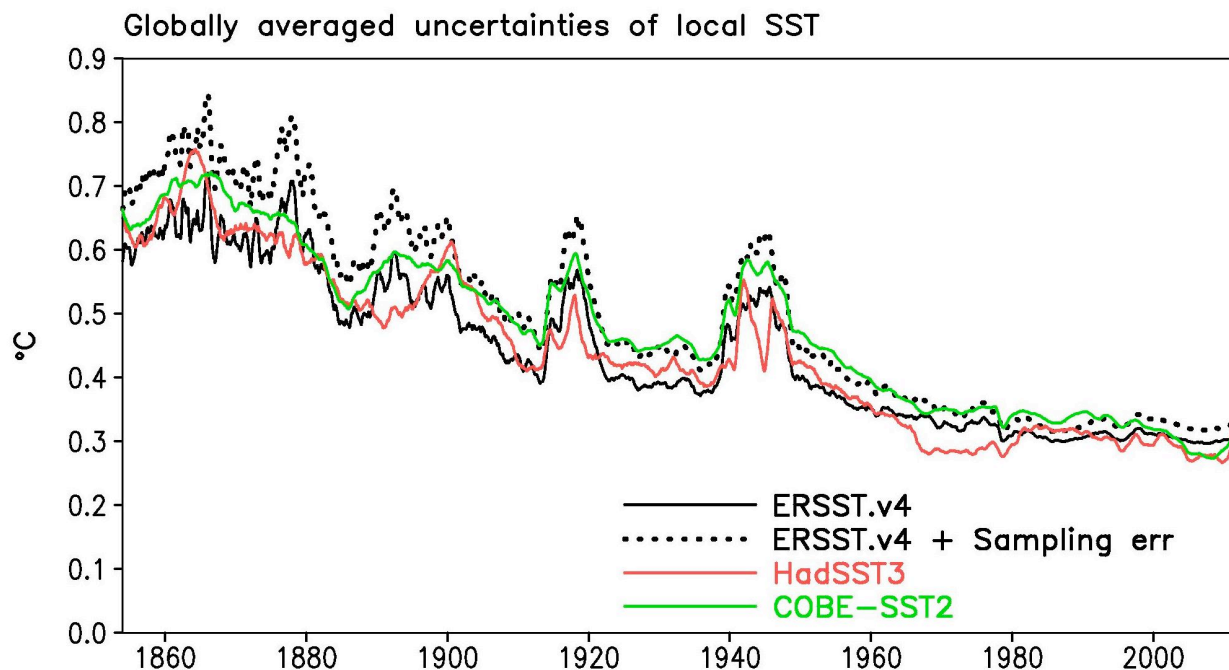


Fig. 4. Globally averaged total uncertainties ( $1\sigma$ ) of ERSST.v4 (black line), ERSST.v4 + Sampling error (black dotted line), HadSST3 (red line), and COBE-SST2 (green line). A 12-month running mean is applied.

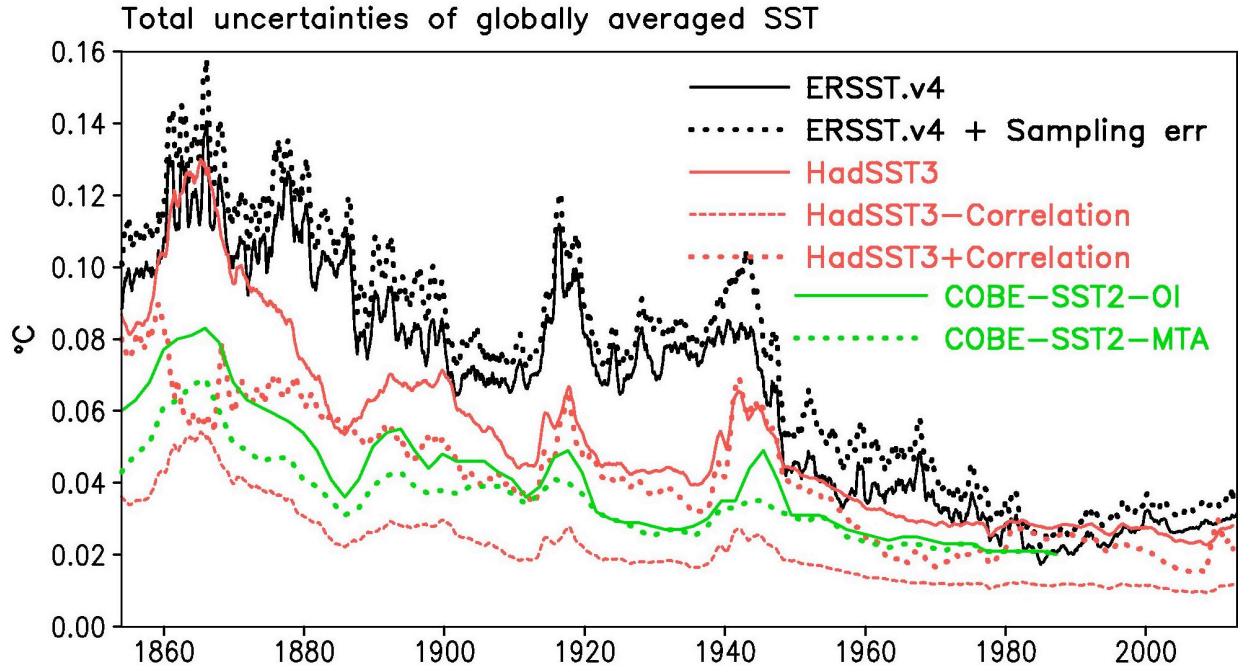


Fig. 5. Total uncertainties ( $1\sigma$ ) of globally averaged SST in ERSST.v4 (black line), ERSST.v4 + Sampling error (black dotted line), HadSST3 (red solid line), HadSST3-Correlation (red dashed line), and HadSST3+Correlation (red dotted line), overlapped with the sampling uncertainty in COBE-SST2-OI (green solid line), and COBE-SST2-MTA (green dotted line). A 12-month running average is applied except for COBE-SST2-OI and COBE-SST2-MTA that are adapted from Hirahara et al. (2014).

## 5. Considerations for Model-Observation Comparisons

- ERSSTv4 represent SST observation in the depth of 5-20 meters.
- The data before 1880 are very unreliable due to lack of in situ observations, particularly in the Pacific.
- The data in the high-latitudes (north of  $60^\circ\text{N}$  and south of  $50^\circ\text{S}$ ) before the 1950s are not reliable due to lack of observations.

## 6. Instrument Overview

The ERSSTv4 is a reconstructed SST product that based on in situ observations from ships and buoys. Ship observations are extended throughout the entire SST time period from 1854 to 2015, although the number of observations changes with time (Figure 1). The ship observations are from various buckets: Canvas buckets, wood buckets, insulated buckets, and engine-room intake (ERI) after 1940s. The buoy observations include drifting buoys, moored buoy (TAO, TRITON, PIRATA, RAMA, etc) after the later 1970s. The Argo observation is not included in v4.

## 7. References

Huang, B., V. F. Banzon, E. Freeman, J. Lawrimore, W. Liu, T. C. Peterson, T. M. Smith, P. W. Thorne, S. D. Woodruff, and H.-M. Zhang, 2015: Extended Reconstructed Sea Surface Temperature version 4 (ERSST.v4), Part I. Upgrades and intercomparisons. *J. Climate*, **28**, 911-930, doi:10.1175/JCLI-D-14-00006.1.

Huang, B., P. W. Thorne, T. M. Smith, W. Liu, J. Lawrimore, V. F. Banzon, H.-M. Zhang, T. C. Peterson, and M. Menne, 2016: Further exploring and quantifying uncertainties for Extended Reconstructed Sea Surface Temperature (ERSST) version 4 (v4). *J. Climate*, 29, 3119-3142, DOI: 10.1175/JCLI-D-15-0430.1.

## 8. Dataset and Document Revision History

ERSSTv4 remains without revisions.