Improvement and verification of high resolution of gridded SST

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Abstract

The quality and accuracy of a gridded field derived from observations depends upon, among other things, sufficient amount of observations with small biases and reliable error estimates. Quality control procedures are likely to detect observations with defects. The background (first guess) yields in general relatively small innovations and the estimate background covariances are reasonable. In this presentation we examine some of these elements. Satellite SST retrievals from AVHRR, GOES, AMSR2, and insitu SST observations are explored for use in real time RTOFS-Atlantic for SST data assimilation, and, in delayed mode, for daily SST analysis product. SST decorrelation time scales and seasonal variability can be studied from the SST analysis product. 2DVAR SST analysis with new covariance estimates are compared with other analysis, including MURSST, RTG-HR, and GEO Polar blended SST for verification purposes.

SST data treatment

SST observations: physical retrieval AVHRR, daily GOES (bias removed), AMSR2 (redistributed, compare well with AVHRR, no bias detected), and insitu (VIIRS coming soon)

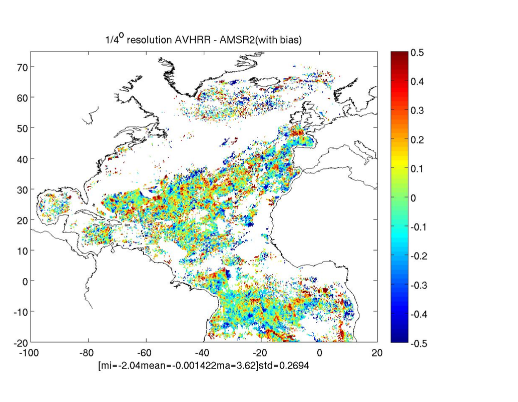
Quality control: Observation SST, is accepted if deviation from climatological mean (4km PATHFINDER version 5 monthly multi-year averages, provided by GHRSST and the US National Oceanographic Data Center) is within 2.3STD; and deviation from background (model estimate for assimilation, yesterday analysis for analysis) is within 2.3STD.

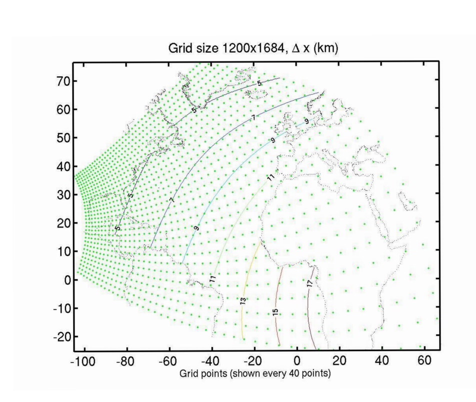
Incorporate superobs: The observations in a grid cell are weighted by their inverse error variance to yield at most one observation per grid cell. (Please see grid resolution in RTOFS view graph below)

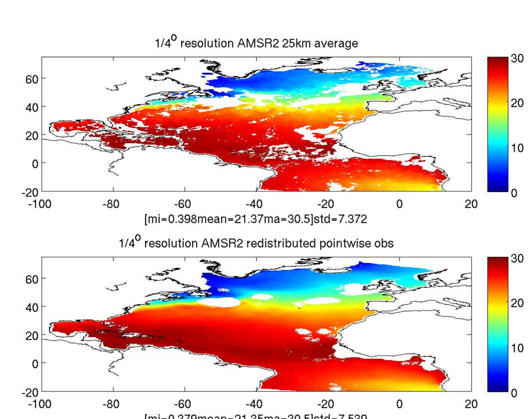
Observation operator: Mapping from gridded field to observation locations

Linear interpolation for AVHRR, GOES, and insitu

Average for AMSR2: the footprint is a 25x25 km square average SST. The observation operator has been modified since grid cells are smaller than the footprint. The right panel shows AMSR2 field using linear interpolation (top) and average (bottom),







Gridding of SST observations into RTOFS Grid

Observation SSTobs(x,τ), where τ=tobs-tcenter

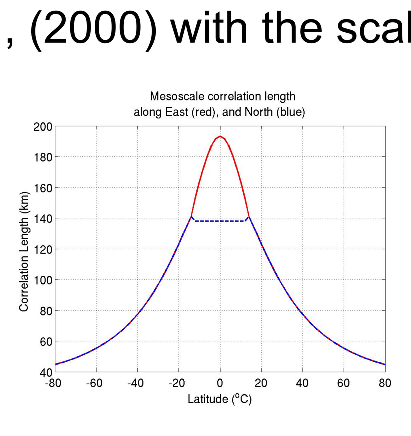
2DVAR (Purser et al., 2003) is set up for Gaussian anisotropic, inhomogeneous in space and homogeneous in time covariance matrix.

The **Gaussian covariance** used is:

cov=exp(-(x-xobs)'A(x-xobs))*exp(-(τ/td)^2)

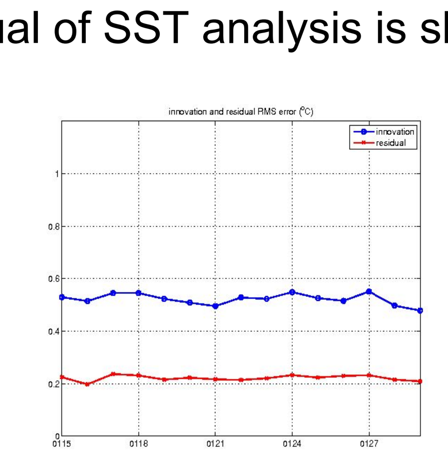
where A=diag((1/Least)^2,(1/Lnorth)^2), td is the time decorrelation scale, Least and Lnorth are the length scales in the east-west and north-south directions.

The mesoscale SST and SSH covariance in the deep ocean circulation are similar. Here we used Ducet et al., (2000) with the scales shown below.



Temporal correlation scale: one day before and one day after the center day

The innovation and residual of SST analysis is shown below.



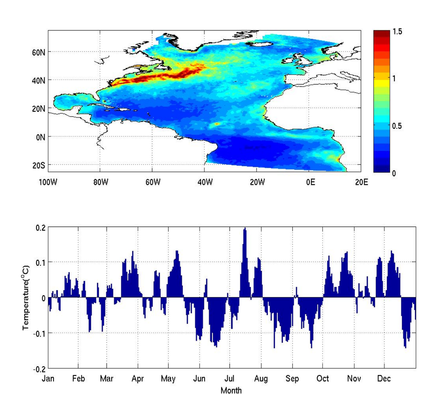
SST seasonal variability and decorrelation time scales

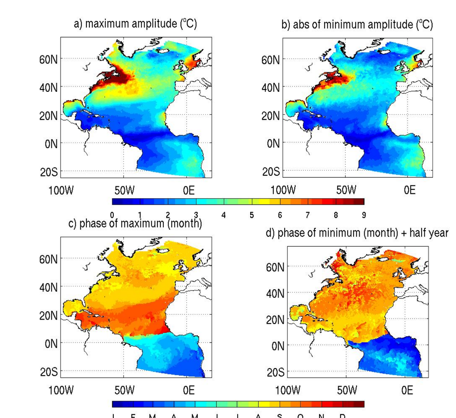
SST(x,t) variability can be written as

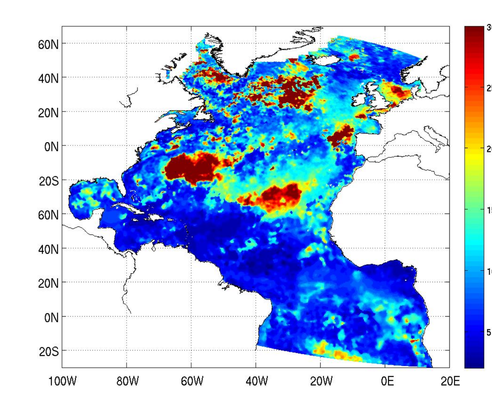
$$SST'(x,t) = a_0(x) + [a_{1/2}(x)\cos(0.5wt) + b_{1/2}(x)\sin(0.5wt)] + \sum_{p=1}^{m}[a_p(x)\cos(pwt) + b_p(x)\sin(pwt)] + R(x,t)$$

which contains a linear combination of a year harmonic and sub-harmonics. We refer to as the seasonal harmonic (mid Fig.). The terms R (left Fig.) will approximate the rapidly varying signals.

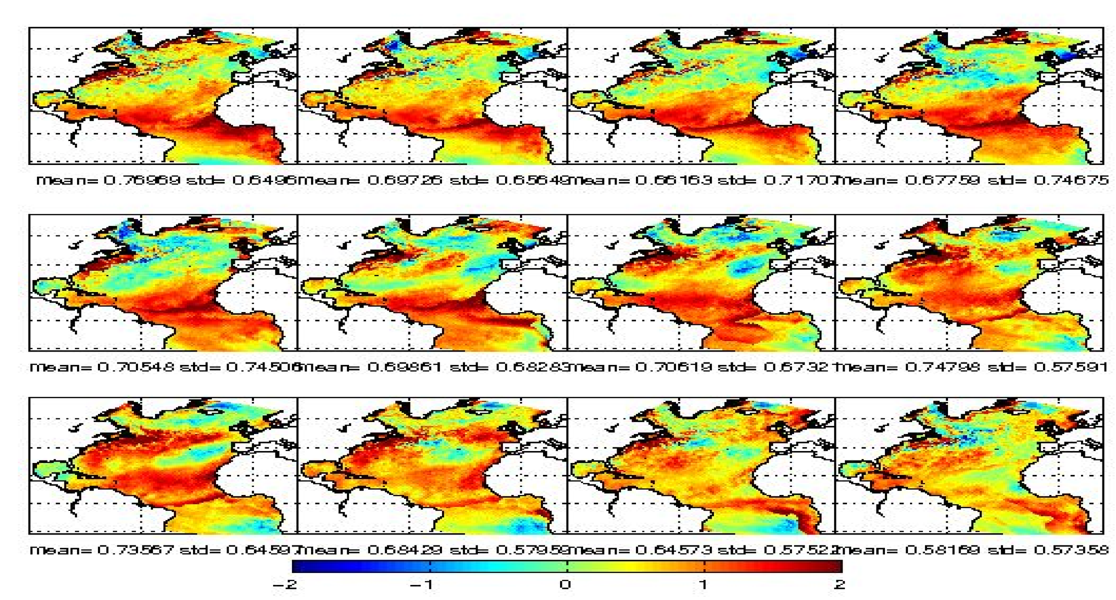
After removal of periodic signals on two year time series, the decorrelation time scale (right Fig.) computed from autocovariance of the rapidly varying signal is found to be nearly independent of the time of the year once four or more harmonics are used. The decorrelation is about 7 to 10 days in North Atlantic. Time decorrelation scale td is about half of the zero crossing length scales L.





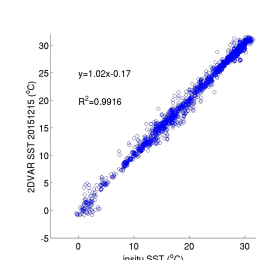


Comparison between seasonal cycle from harmonics approximation and PATHFINDER version 5 monthly climatology



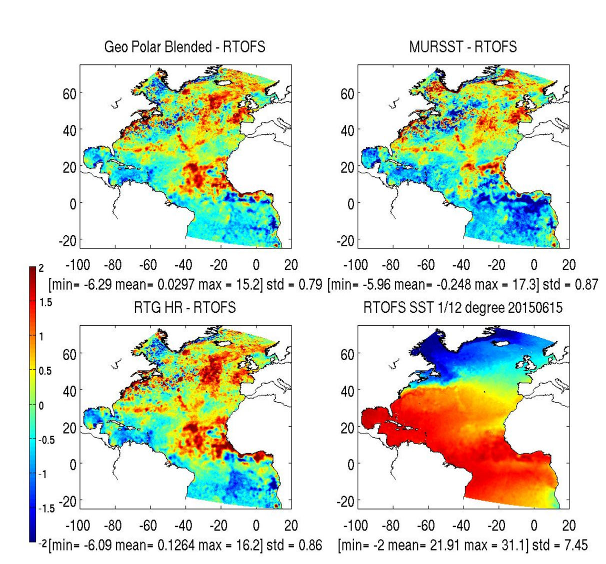
Validations

SST analysis using AVHRR&AMSR2 only, Verification with insitu data



	20150315	20150615	20150915	20151215
R^2	0.9924	0.9948	0.9936	0.9916

Verification with other products: MURSST(JPL), RTG-HR(NCEP), GEO_Polar_Blended SST(NESDIS)



[mean,STD]	20150315	20150615	20150915	20151215
MURSST-RTOFS	[-0.37,0.52]	[-0.24,0.87]	[-0.40,0.49]	[-0.42,0.52]
RTG-HR-RTOFS	[-0.14,0.59]	[0.12,0.86]	[-0.28,0.52]	[-0.24,0.57]
GEO Polar-RTOFS	[-0.18,0.55]	[0.02,0.79]	[-0.20,0.48]	[-0.45,0.49]

Conclusion

AMSR2 data has been successfully implemented with an average observation operator into SST analysis.

We have employed successfully mesoscale SST Gaussian covariance in time and space.

SST analysis product compares well with other available SST analysis products.

Reference

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