



ESA Climate Change Initiative Phase 1

Sea Surface Temperature (SST)

ESA SST CCI L4 reanalysis using the OSTIA system

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Outline

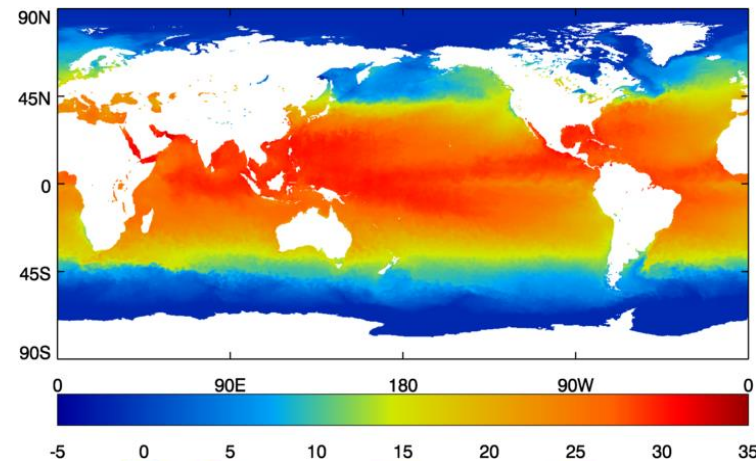


- Introduction
- ESA SST CCI satellite data
- SST CCI sea ice processing
- SST CCI L4 analysis system
- SST CCI L4 system improvements
- Verification results
- Summary

Introduction



- ESA SST CCI L4 analysis carried out using an improved version of the OSTIA reanalysis system.
- During phase 1 of project L4 products consist of long term reanalysis and two demonstration reanalyses.
- Long term product is daily, high resolution SST and sea ice product which runs from 1991-09 to 2010-12
- Uses data generated specifically for the SST CCI project
- No insitu assimilated, which provides independent data set for validation for full reanalysis time period.

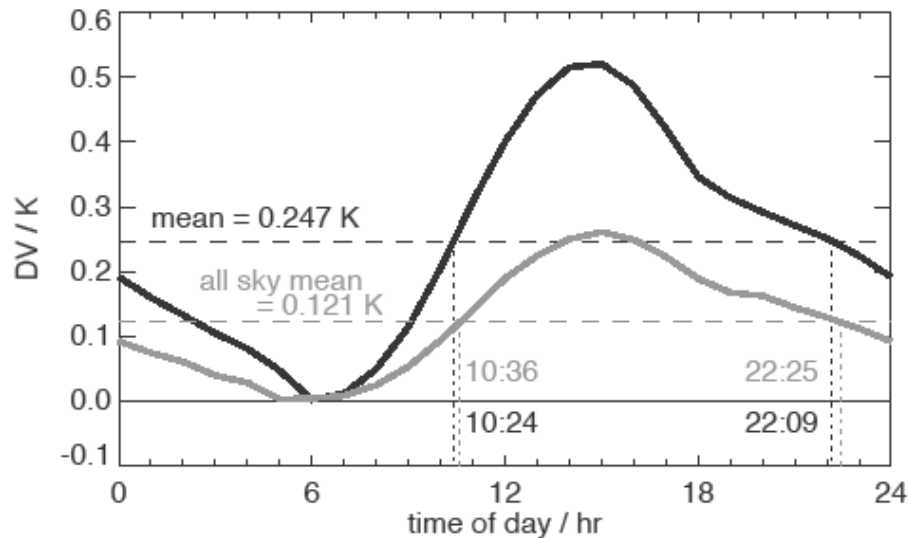


Introduction



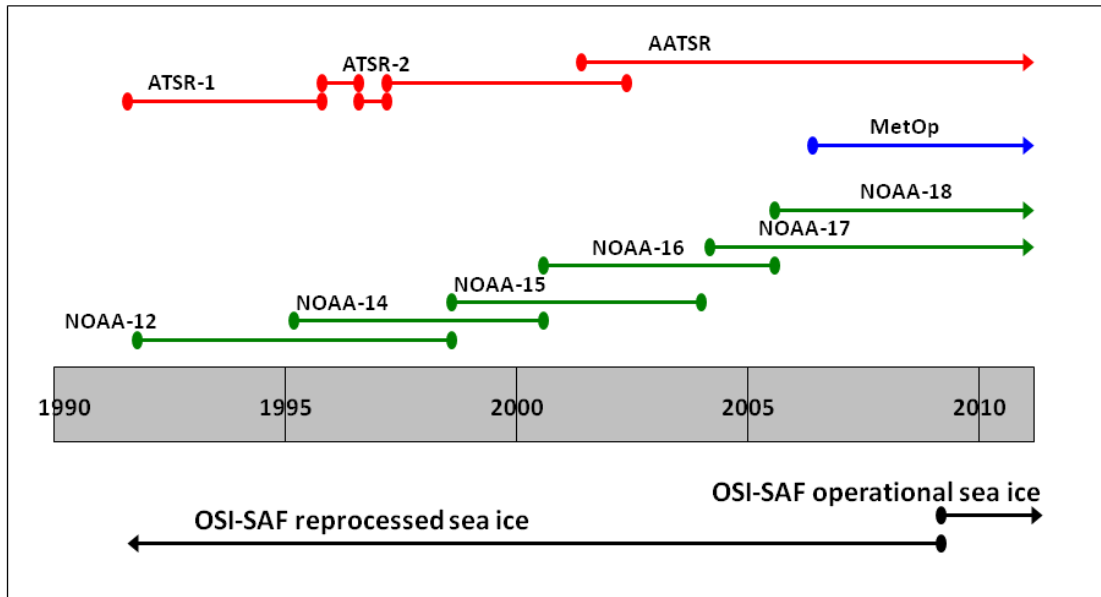
- SST CCI L4 is depth SST analysis (@20cm).
- This SST will contain diurnal signal.
- During production all observations are adjusted to 10.30 and 22.30 local time.
- These times were chosen so that the analysed SST can be considered as the daily average SST.

Mean diurnal cycle



Based on Filipiak model tuned to SEVIRI data and run from ECMWF NWP fields. (Chris Merchant)

ESA SST CCI satellite data



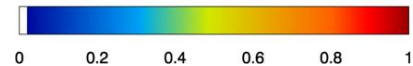
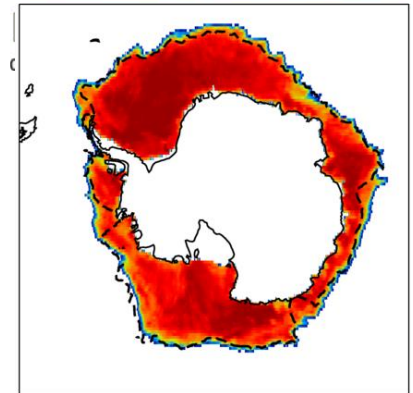
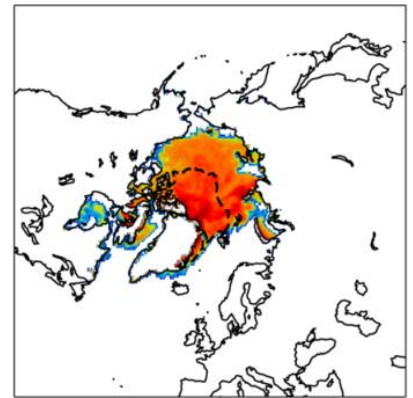
- All SST data used in the LT CCI L4 analysis has been consistently reprocessed for the CCI project.
- For NOAA AVHRR data use two NOAA satellites at a time.
- Introduce MetOp AVHRR when it becomes available in Nov 2006.
- For sea ice concentration data use the OSI-SAF reprocessed data when available, switch to operational product in Oct 2009

For details on the L2/L3 products see Chris Merchant's poster, **L2 and L3 products from the ESA CCI project**

ESA SST CCI sea ice processing



- The OSI-SAF reprocessed and operational sea ice concentration data is regridded and filled onto the L4 analysis grid and disseminated with the L4 SST product.
- To try and ensure consistency between the SST and sea ice fields the SST is relaxed to -1.8°C in the background creation step.
- Investigation carried out for the SST CCI project found tuning the parameters in this relaxation didn't improve consistency between the SST and sea ice fields.
- Sea ice concentration errors information provided with the OSI-SAF data (not available in the operational product) are now provided in the SST CCI L4 files.
- Data with the 2m air temp flag set (where $T > 10^{\circ}\text{C}$) are not included in the sea ice concentration field.

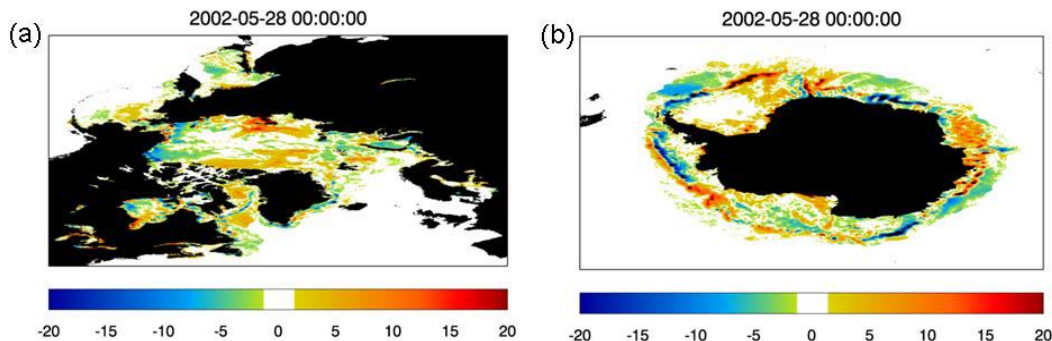


Northern and Southern hemisphere sea ice conc with freezing SST contour.

Pre-processing sea ice data



- Data gaps exist in the OSI-SAF sea ice data due to lack of available data, missing data within the ice field or rejection in our own QC.
- In the OSTIA reanalysis v1 in these gaps data was persisted from the previous day's ice concentration.
- Here a weighted linear temporal interpolation method is used to fill the gaps, the data either end of the gap is weighted according to the observational errors provided with the product.
- Experiments show this is an improvement over the persistence method.



Date	Northern Hemisphere		Southern Hemisphere	
	RMSE (mean error) of absolute concentration differences, %		RMSE (mean error) of absolute concentration differences, %	
	Interp – real	Persist – real	Interp – real	Persist – real
20020527	3.81 (2.22)	4.16 (2.39)	3.97 (2.50)	4.65 (2.80)
20020528	4.53 (2.76)	5.58 (3.32)	5.61 (3.46)	7.55 (4.34)
20020529	4.52 (2.71)	6.44 (3.83)	5.21 (3.27)	9.07 (5.11)
20020530	4.03 (2.20)	7.37 (4.37)	3.44 (2.20)	10.08 (5.48)

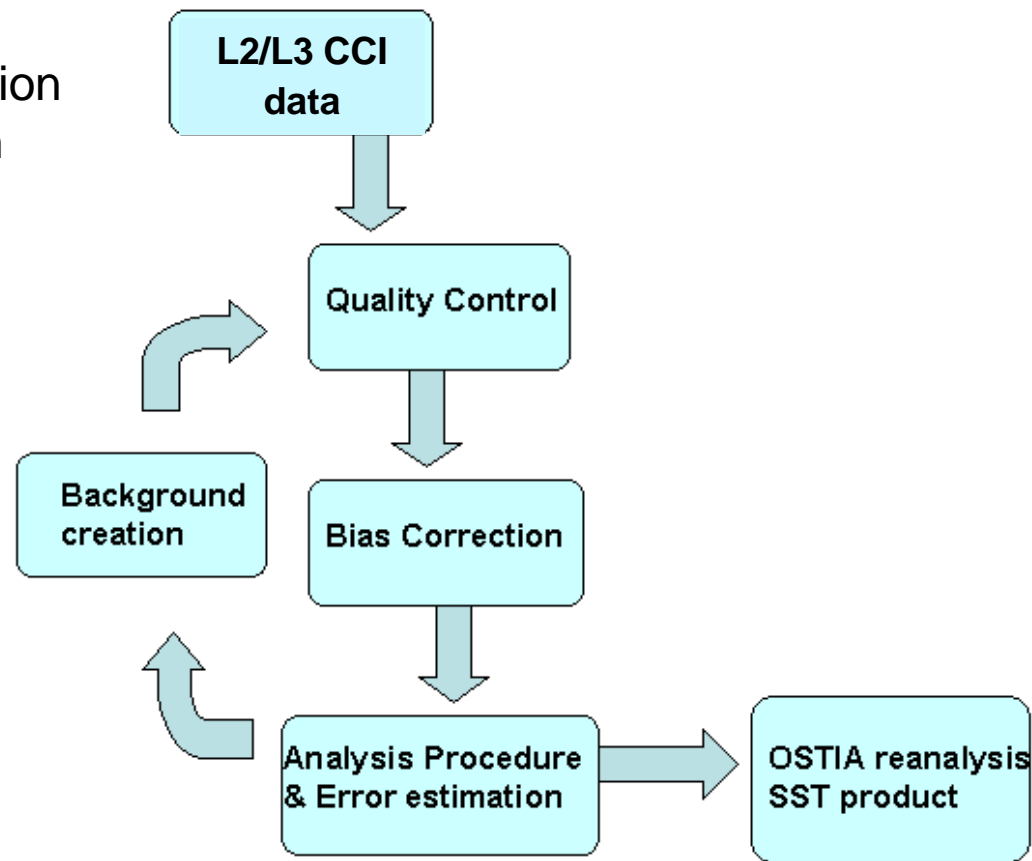
Interpolated minus real ice concentration field (%) on 28 May 2002, for (a) Northern and (b) Southern Hemisphere.

Ice conc difference stats for 2 filling methods over 4 day gap.

L4 SST analysis system



- Analysis is of depth SST rather than foundation => Change in our QC.
- No skin-bulk correction, no rejection of diurnally warmed obs based on windspeed.
- Bias correct NOAA and MetOp AVHRR obs to ATSR obs.
- Use 3 day assimilation window.

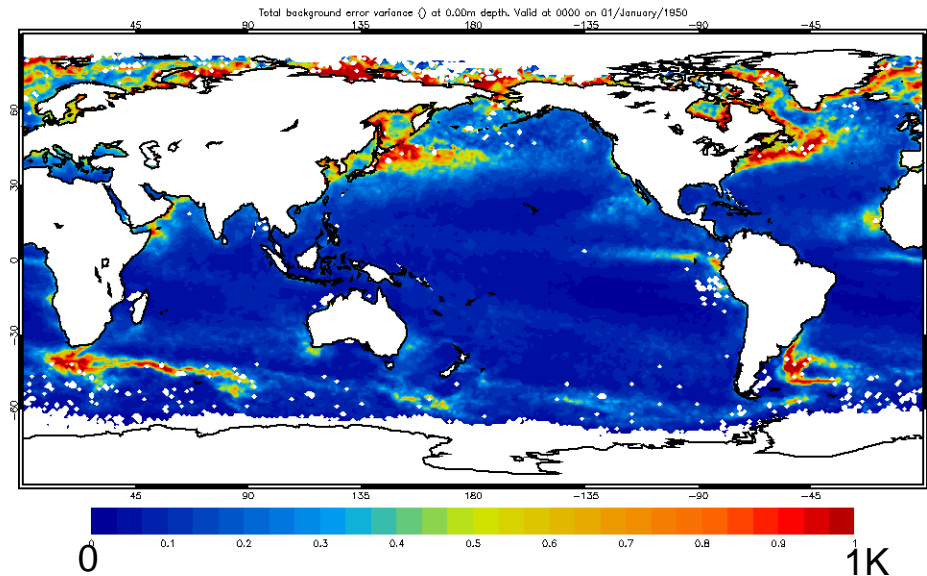
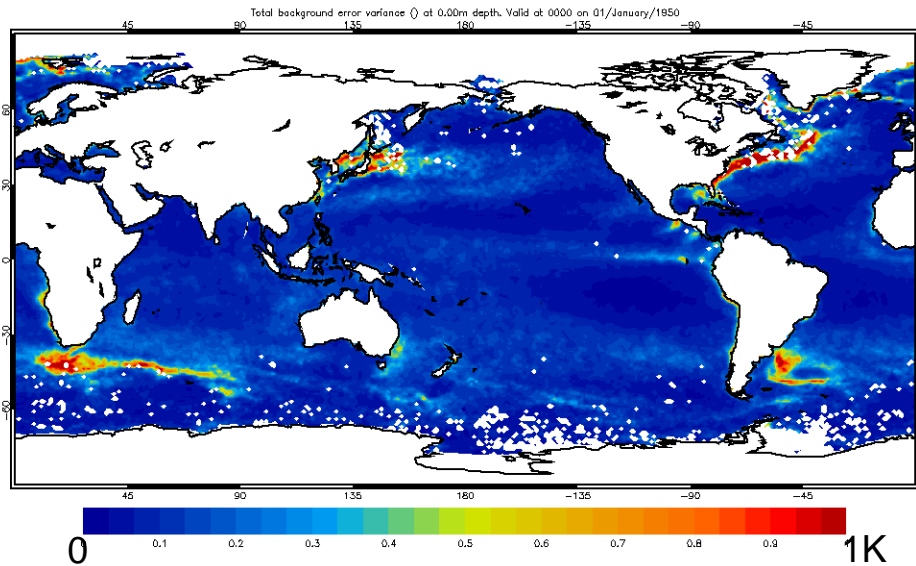


New background error covariances



DJF

JJA



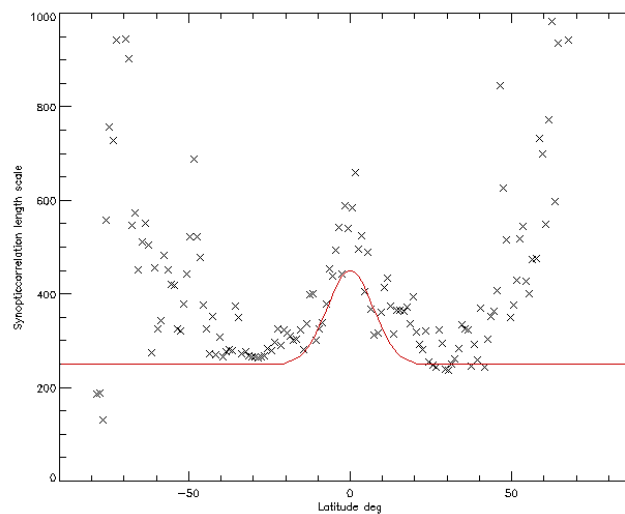
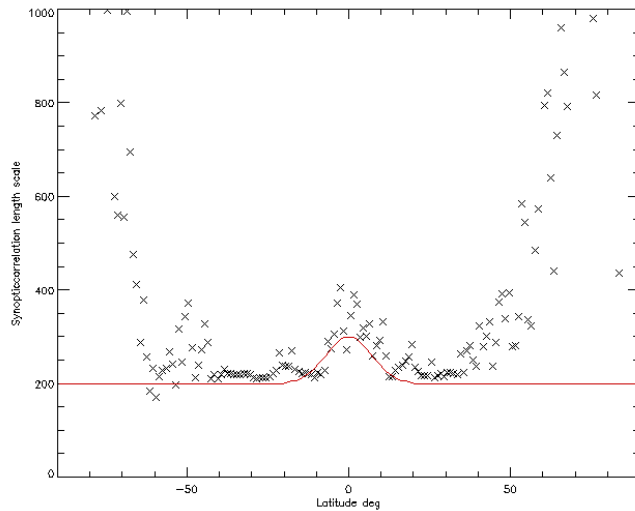
- Use new background error covariance parameterisations estimated using output from OSTIA reanalysis V1 using AATSR innovations.
- New seasonally varying background error variances have been estimated. For both mesoscale and synoptic scale components of the background error.
- New anisotropic latitudinally varying correlation length scales have also been estimated

New background error covariances



E/W scales

N/S scales



Synoptic scale

400km

200km

- Different correlation length scales exist in the East-West and North-South directions but both mesoscale and synoptic scale components showed latitudinal variability in length scales.
- Parameterisation shown has constant length scale up to 20° N and S of the equator.
- Symmetric exponential increase of length scale within 20° of equator.

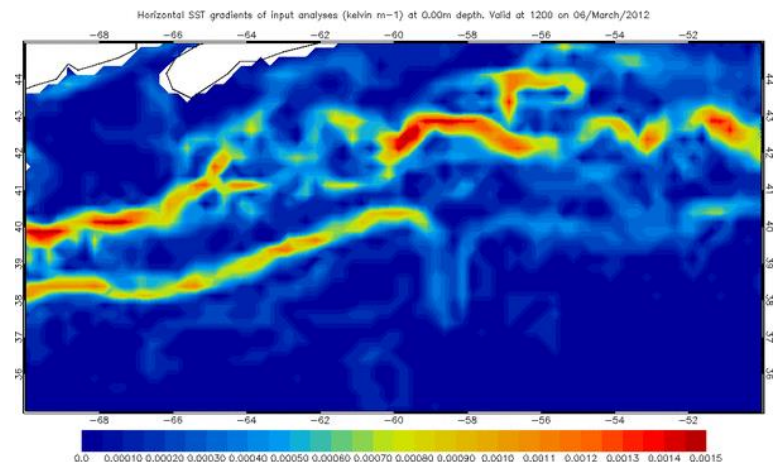
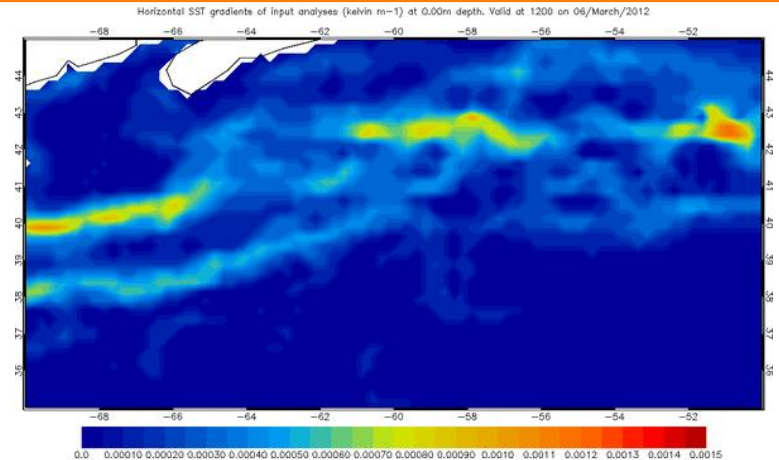
New background error covariances



- New background error variances and correlation length scales increased accuracy and feature resolution of the OSTIA analysis.

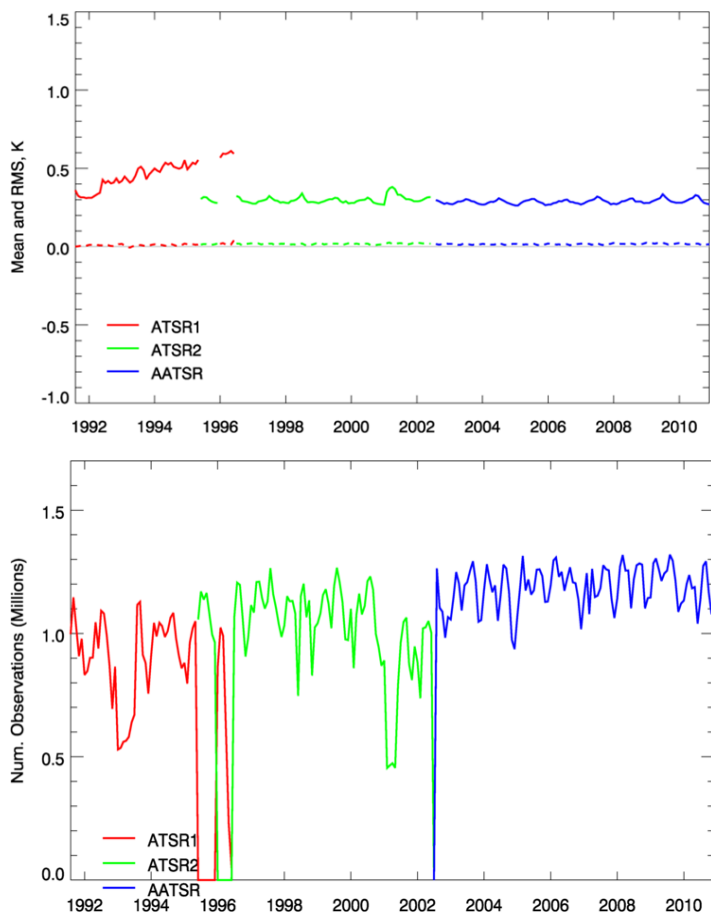
	Old OSTIA	Updated OSTIA
Drifter o-b	0.52(-0.01)	0.37(0.00)
AATSR o-b	0.45(0.04)	0.37(0.03)
ARGO o-a	0.47(0.03)	0.43(0.04)

Observation-minus-background/analysis RMSE (bias) calculated for March 2012.



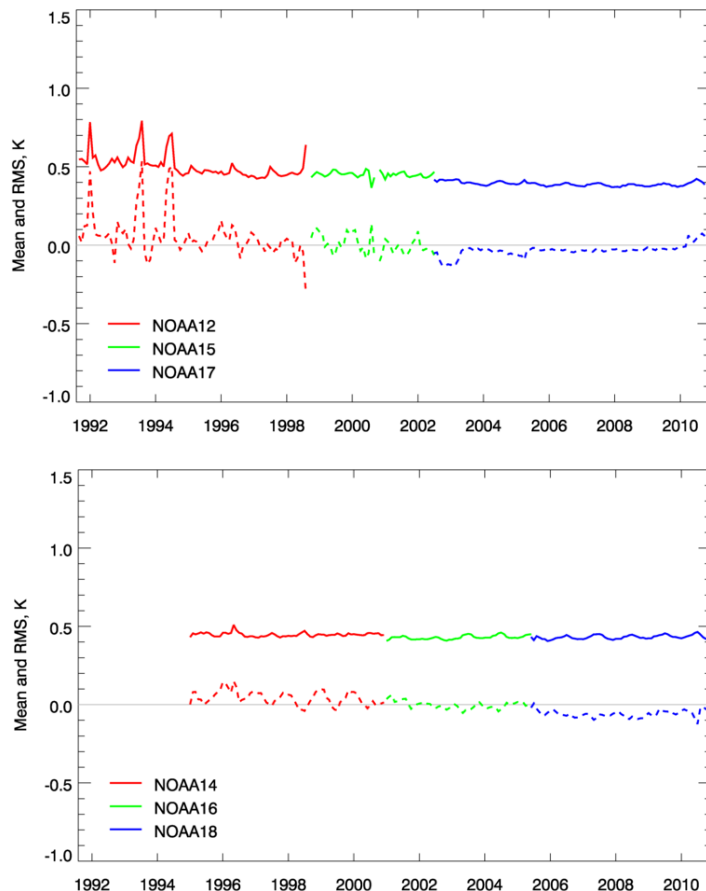
Horizontal SST gradients in the gulf stream in March 2012.

Results- ATSR obs-bg statistics



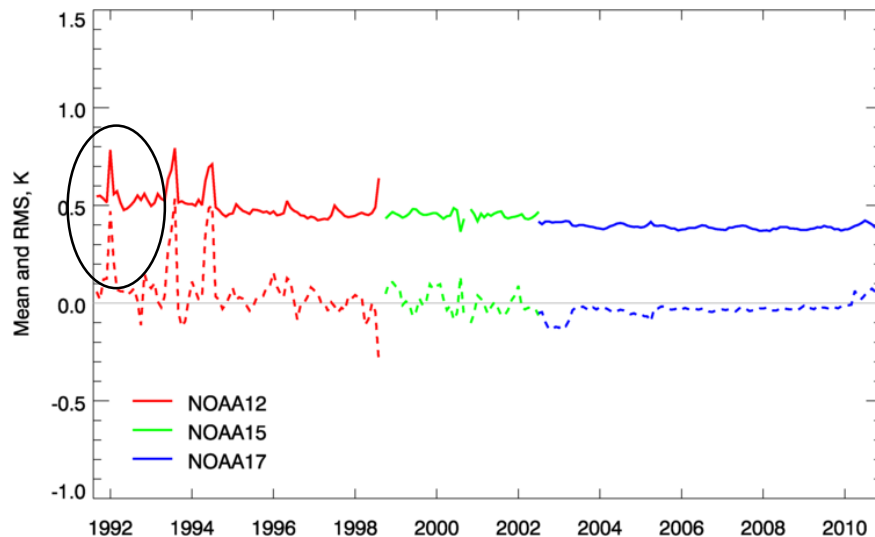
- Obs-bg RMSE is ~0.3K for ATSR-2 and AATSR data c.f. ~0.5K in the OSTIARAN v1.0.
- ATSR-1 data remains problematic, in situ validation required in the ATSR-1 period to assess the impact on the L4 product.
- Zero obs-bg bias due to the ATSR data being used as reference in the bias correction.
- Discernable seasonal cycle in the obs-bg RMSE.

Results- NOAA AVHRR obs-bg statistics



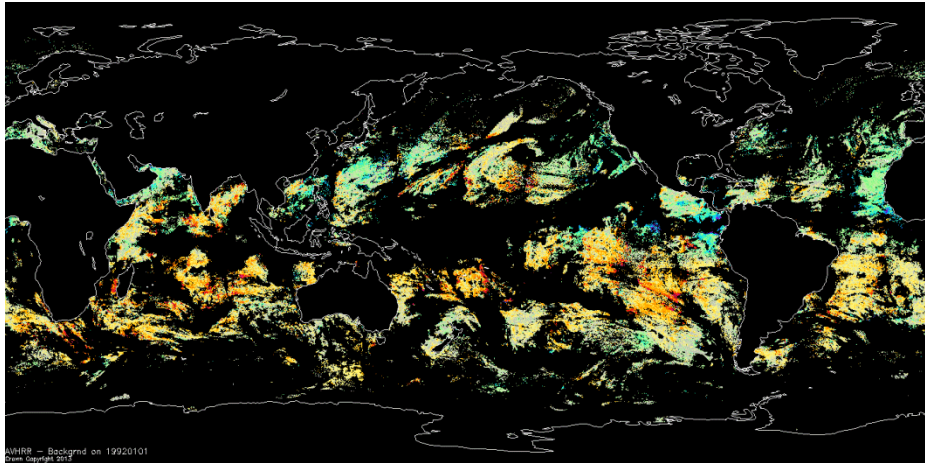
- Obs-bg stats show discernable differences between the individual NOAA missions.
- Obs-bg RMSE is $\sim 0.45\text{K}$ for NOAA 14,15,16,17,18 AVHRR data c.f. $\sim 0.5\text{K}$ for the AVHRR pathfinder data used in the OSTIARAN v1.0.
- NOAA 12,14,15 have seasonally varying obs-bg biases whilst a consistent negative bias is observed in the NOAA 17 and 18 data.
- Periodic problems in NOAA 12 data where spikes in the obs-bg RMSE and bias can be observed.
- Discernable seasonal cycle in the obs-bg RMSE.

Results- NOAA AVHRR obs-bg statistics

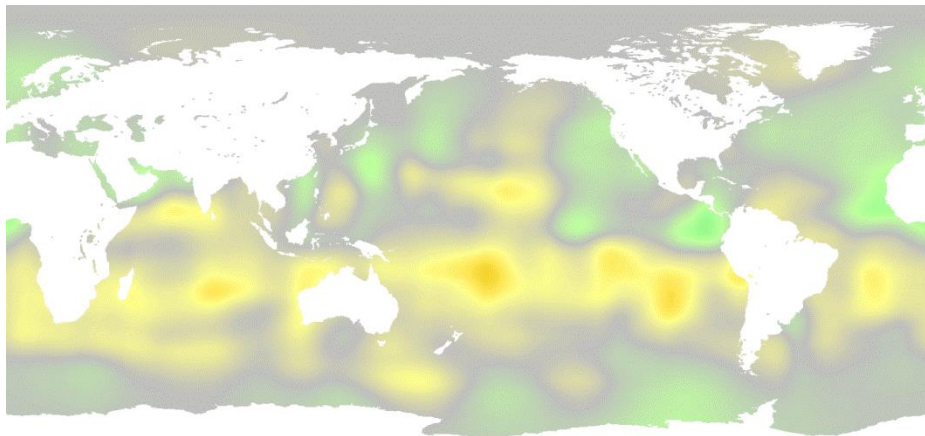


- 3 periodic spikes in obs-bg bias and RMSE observed in Jan 1992, Jun-Aug 1993 and May-Aug 1994 in the NOAA 12 AVHRR data.
- The large obs-bg biases are global in nature, the daily globally average bias can exceed 1K.
- The onset of these periods of large global bias are rapid.
- These may be caused by the instrument operating at temperature outside the range over which it was calibrated.
- The SST CCI L4 system seems relatively robust to these large biases as they are corrected out within our bias correction system.

Results- NOAA AVHRR obs-bg statistics



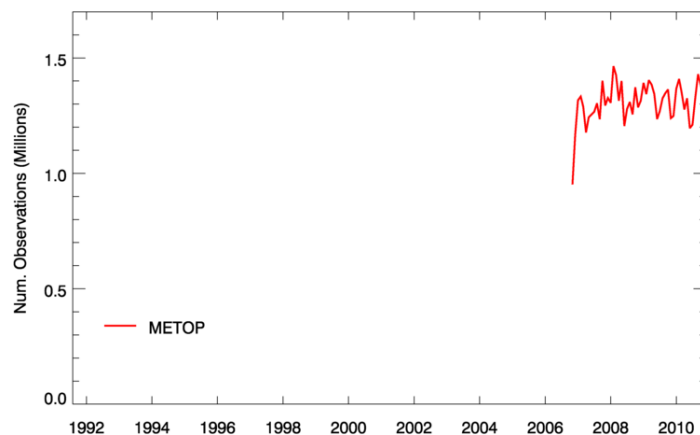
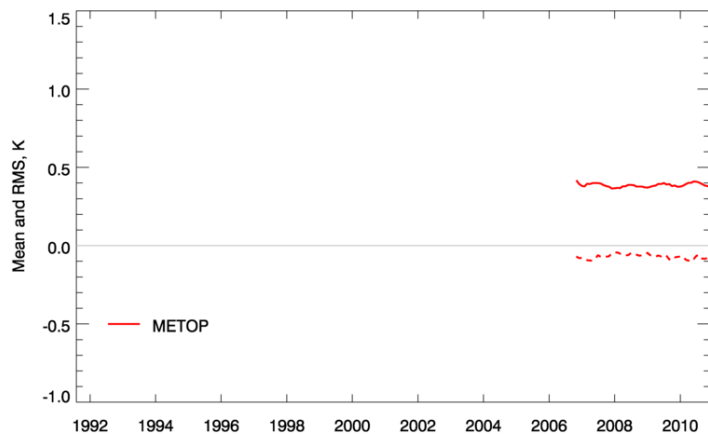
Jan 1992 daily NOAA 12 o-b biases



Jan 1992 daily NOAA bias correction.

- 3 periodic spikes in obs-bg bias and RMSE observed in Jan 1992, Jun-Aug 1993 and May-Aug 1994 in the NOAA 12 AVHRR data.
- The large obs-bg biases are global in nature, the daily globally average bias can exceed 1K.
- The onset of these periods of large global bias are rapid.
- These may be caused by the instrument operating at temperature outside the range over which it was calibrated.
- The SST CCI L4 system seems relatively robust to these large biases as they are corrected out within our bias correction system.

Results- MetOp AVHRR obs-bg statistics



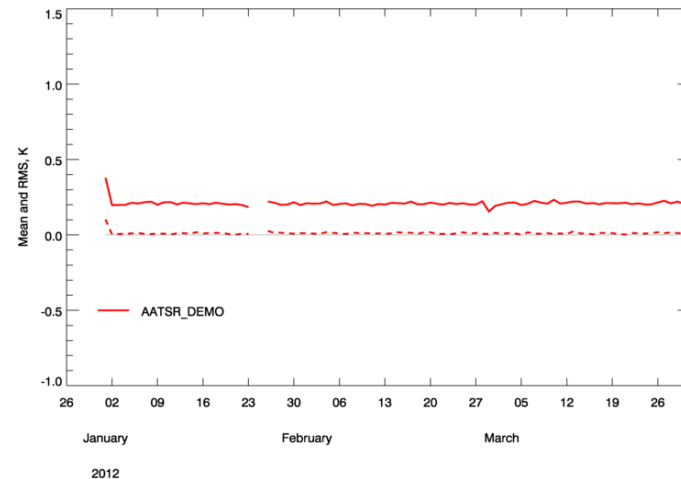
- Obs-bg RMSE is ~0.4K for MetOp AVHRR data.
- MetOp obs-bg bias is negative similar to the NOAA AVHRR 17 and 18 data available for the same period.
- Discernable seasonal cycle in the obs-bg RMSE.

ESA SST CCI demonstration analyses



- Two demonstration SST CCI analyses have been carried out in addition to the LT reanalysis using the same L4 system.
- Demo 1 runs from Jun-Aug 2006 and is to be used to assess the impact of MW data on the L4 analysis. Same satellite data used in the LT reanalysis but with the addition of AMSR-E and TMI data.
- Demo 2 runs from Jan-Mar 2012 and is used to assess the feasibility of running the reanalysis in delayed mode ingesting data volumes similar to those in the current NRT system. Is foundation SST analysis using AATSR, MetOp AVHRR and SEVIRI night-time data.

Demo 2 AATSR obs-bg stats. N.B.
RMSE is ~0.2K c.f ~0.3K for LT
reanalysis



Summary and ongoing work



- The SST CCI L4 analysis system has been presented.
- The updates to the L4 system have been described
- Initial verification is encouraging, obs-bg stats show improvement over those obtained from the OSTIA reanalysis v1.0.
- Independent validation using in situ data (both drifters and top-level ARGO data) to be carried out within the CCI project will further quantify the CCI L4 SST analysis accuracy and the accuracy of the analysis errors.
- Comparisons to other LT reanalyses will be carried out within the GHR SST multi-product ensemble (GMPE) framework. The ensemble will include LT SST CCI L4, SST CCI L4 Demo 1, OSTIA reanalysis v1.0, CMC reanalysis, MGD SST reanalysis, OI SST reanalysis.