

The ATSR SST Time Series

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Acknowledgement to the AATSR QWG and the NEODC Archive Team particularly:

Gary Corlett, David Llewellyn-Jones *et al.*, EOS, U. Leicester

Andrew Birks, Chris Mutlow, Dave Smith, Brian Maddison, Matt Pritchard, Jack Abolins *et al.*, RAL

Chris Merchant, Edinburgh

Roger Saunders *et al.*, Met. Office

Philippe Goryl *et al.*, ESA

Hugh Kelliher, Space Connexions

ATSR and Sea Surface Temperature records

- Skin SST is the fundamental quantity derived from the thermal (ocean) radiances measured by the ATSR instruments
- Skin SST drives the outgoing longwave radiation, along with the atmosphere.
- Skin SST is the boundary condition for the atmosphere, i.e., it is the interface temperature for ocean-atmosphere exchange of thermal heat fluxes and trace gases.
- Skin SST can be related to other “classes” of SST which are important for historical climate records, e.g., sub-surface temperatures measured by buoys.

Currently, the Essential Climate Variable (ECV) is “bulk” temperature.

The (A)ATSR mission from an SST perspective

■ ATSR-1

- Launched July 1991; data until May 1996
- Mount Pinatubo eruption June 1991 - a major influence on the early time series.
- 3.7 μm channel failed May 1992 so only 2 channel dual-view from that date
- Other issues: pickup noise from cooler; detector temperate

■ ATSR-2

- Launched April 1995; data until Feb 2008
- Scan mirror failure December 1995 to July 1996; ATSR-1 data available (for this analysis until end March)
- ERS-2 Gyro failure in January 2001
- Mid-January to mid-February 2001 no data; data distributed to June 2003

■ AATSR

- Launched March 2002; Data from August 2002

(A)ATSR data - Version 2

- First consistent processing of ATSR-1, ATSR-2, and AATSR data
- Coefficient based approach as first implemented for the ATSR-1 approach but coefficients refined to be much more robust to stratospheric aerosol (Merchant et al, 1999)
- Improved cloud detection
- Retrieval of 6 SST products
- Archive in consistent format of all ATSR data at NEODC



www.neodc.rl.ac.uk

ATSR Multi-mission
Archive



ATSR SST Products

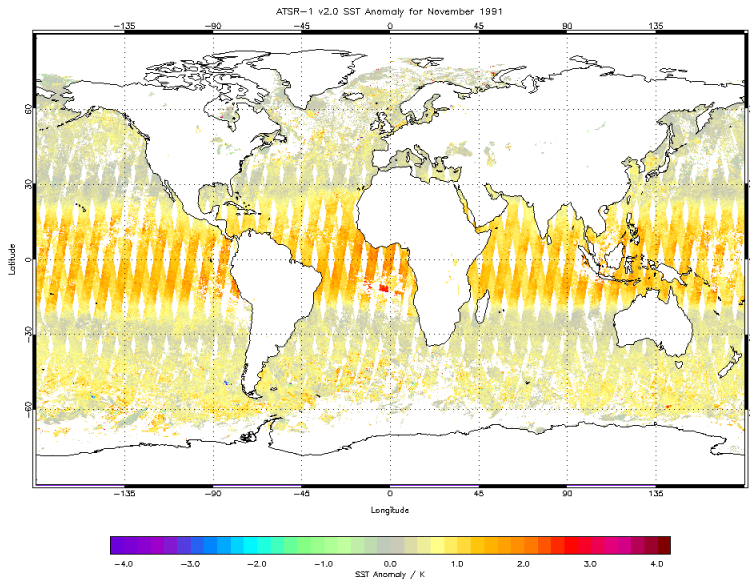
Retrieval	Characteristics	Issues
Night Dual 3 channel	Dual. Can use 3.7 μm channel;	Clouds – no visible channels
Night Nadir 3 Channel	Not dual but still 3.7 μm	Clouds – no vis. Use dual-view clouds etc.
Day Dual 2 Channel	Dual but no 3.7 μm channel	
Night Dual 2 channel	Dual but no 3.7 μm channel	Clouds – no vis.
Day nadir 2 Channel	The most limited retrieval: no dual, no 3.7 μm	
Night nadir 2 Channel	The most limited retrieval: no dual, no 3.7	Clouds - no vis. Use dual-view clouds etc.

Global mean SST time series

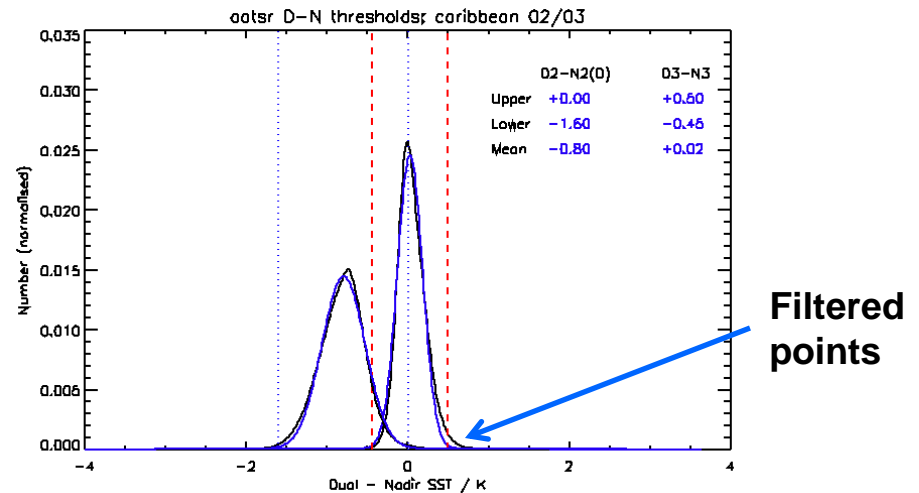
- Gridding to level 3
 - (A)ATSR version 2 Level 2 spatially averaged SST products, binned to level 3, 10 arc minute “daily” averages.
 - Data are separated into day and night
 - Data are “quality” filtered using dual-nadir SST differences [cold limit applied everywhere; warm limit $> 30^\circ$ latitude]

Dual-nadir filtering

- Difference between dual and nadir SST tells us about residual atmosphere errors (+instrument and retrieval errors)
 - Clouds
 - Mt Pinatubo aerosols (volcanic in the stratosphere)
 - Tropospheric aerosols: Saharan dust [ASDI – Good et al, submitted, 2009]



DUAL-NADIR SST; ATSR-1; 11/91



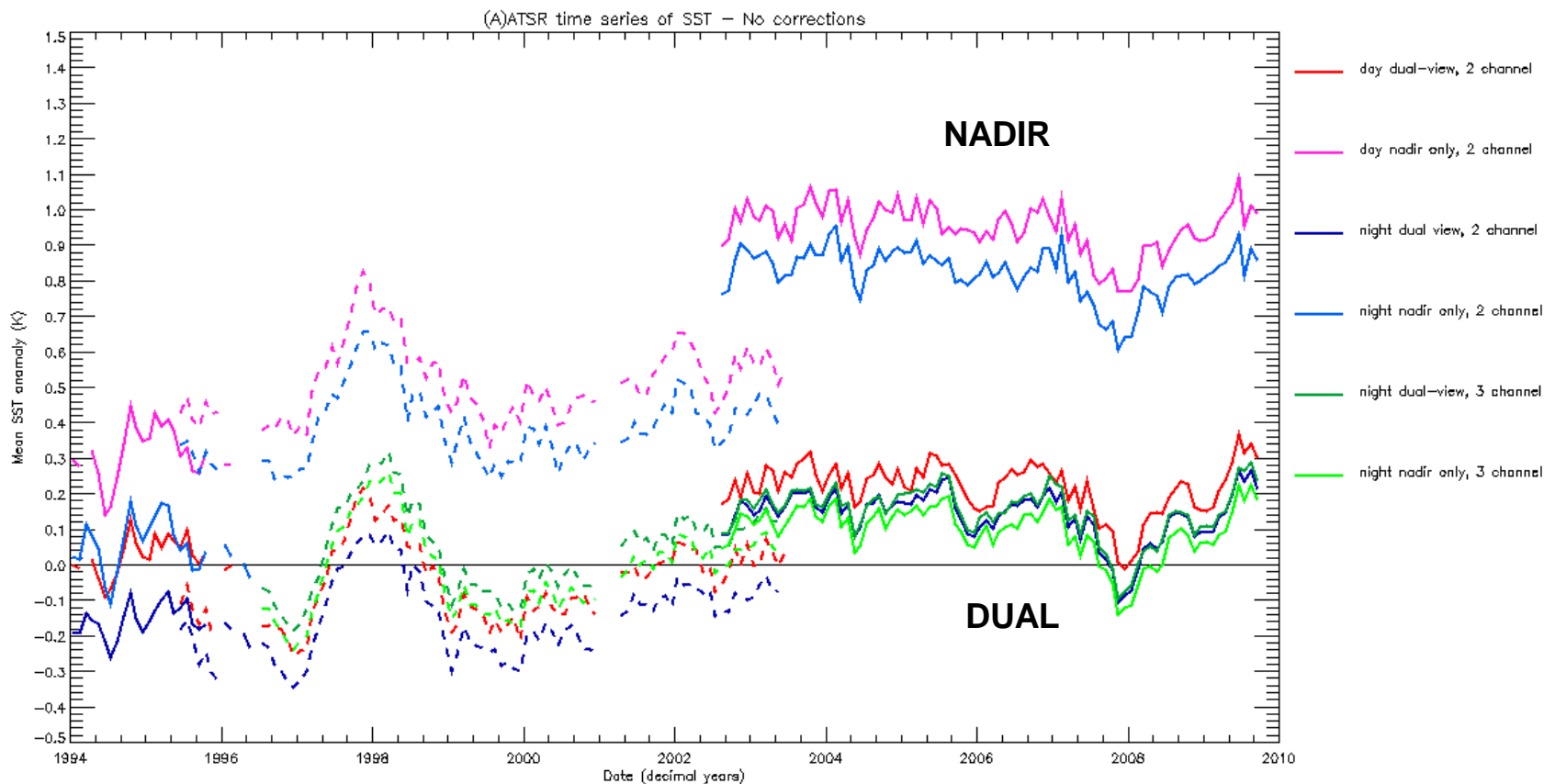
DUAL-NADIR SST; AATSR; 02/03

Global mean SST time series

- This talk – data from 1994 onwards; cloud-clearing during Pinatubo (our method; consistent sampling)
- All time series are constructed from:
 - Monthly data sets on a 5 degree lat/long grid.
 - Requires valid days at a grid point for a monthly average
 - Global/regional time series use only grid points where all monthly points are valid; area weighted average.
 - Anomalies with respect to Reynolds climatology (1971-2000)

V2 global time series: no bias corrections

6 SST products: nighttime



Overlap periods: empirical correction of inter-instrument bias

■ ATSR-1 / ATSR-2

- (06/1995 – 12/1995)
- Mean dual-2 differences: 0.13 K (day/night separately)

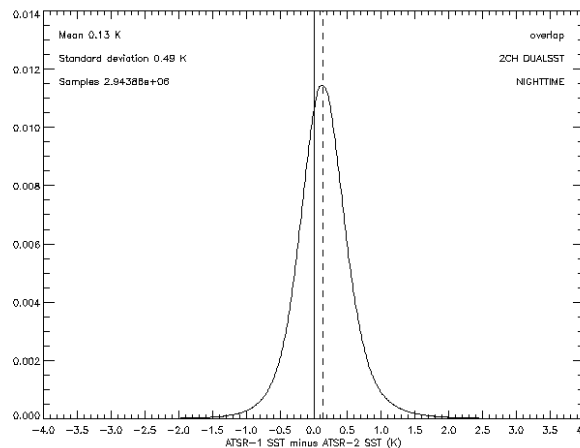
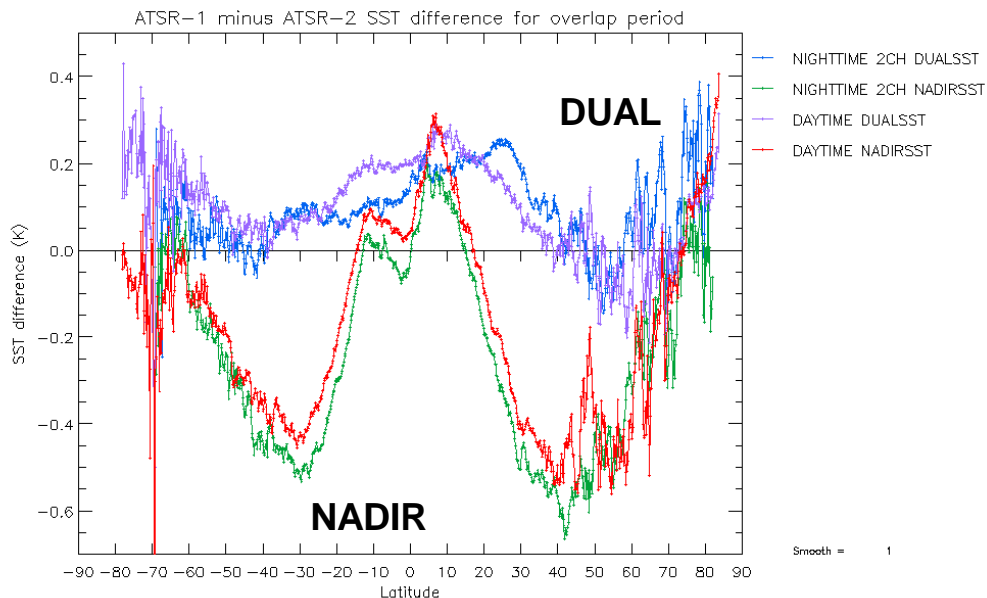
■ ATSR-2 / AATSR

- (07/2002 – 06/2003)
- Mean dual-3 difference: 0.03 K; mean dual-2 = 0.22K (night)



ATSR-1 vs ATSR-2

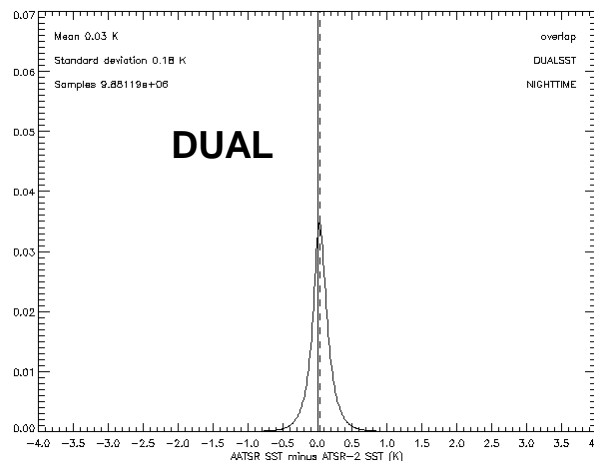
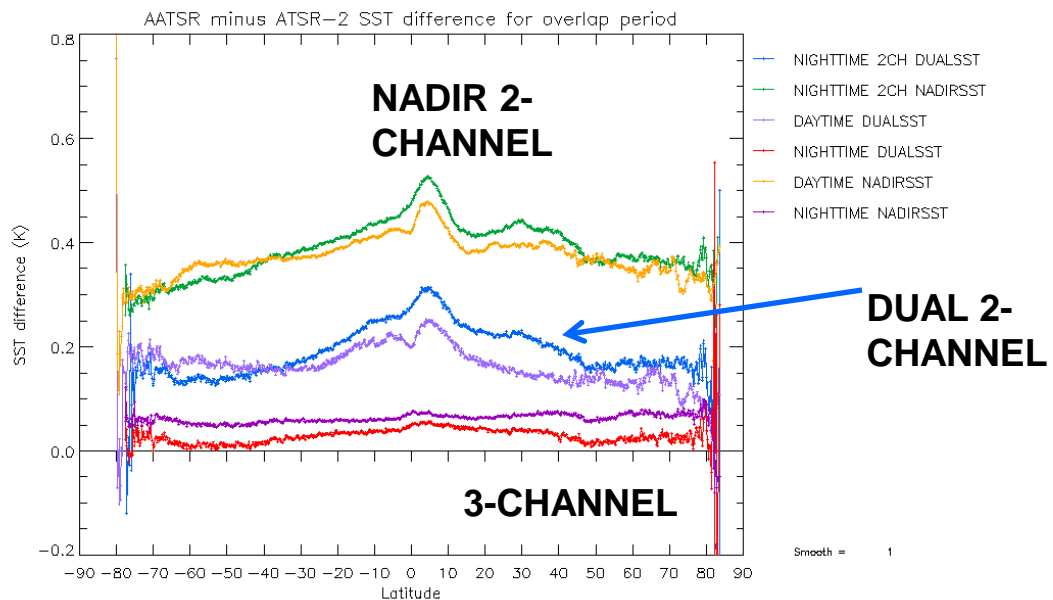
Retrieval	Mean	SD
Nadir day-time 2 Channel	-0.14	0.58
Nadir night-time 2 Channel	-0.22	0.57
Dual day-time 2 Channel	0.13	0.53
Dual night-time 2 Channel	0.13	0.49





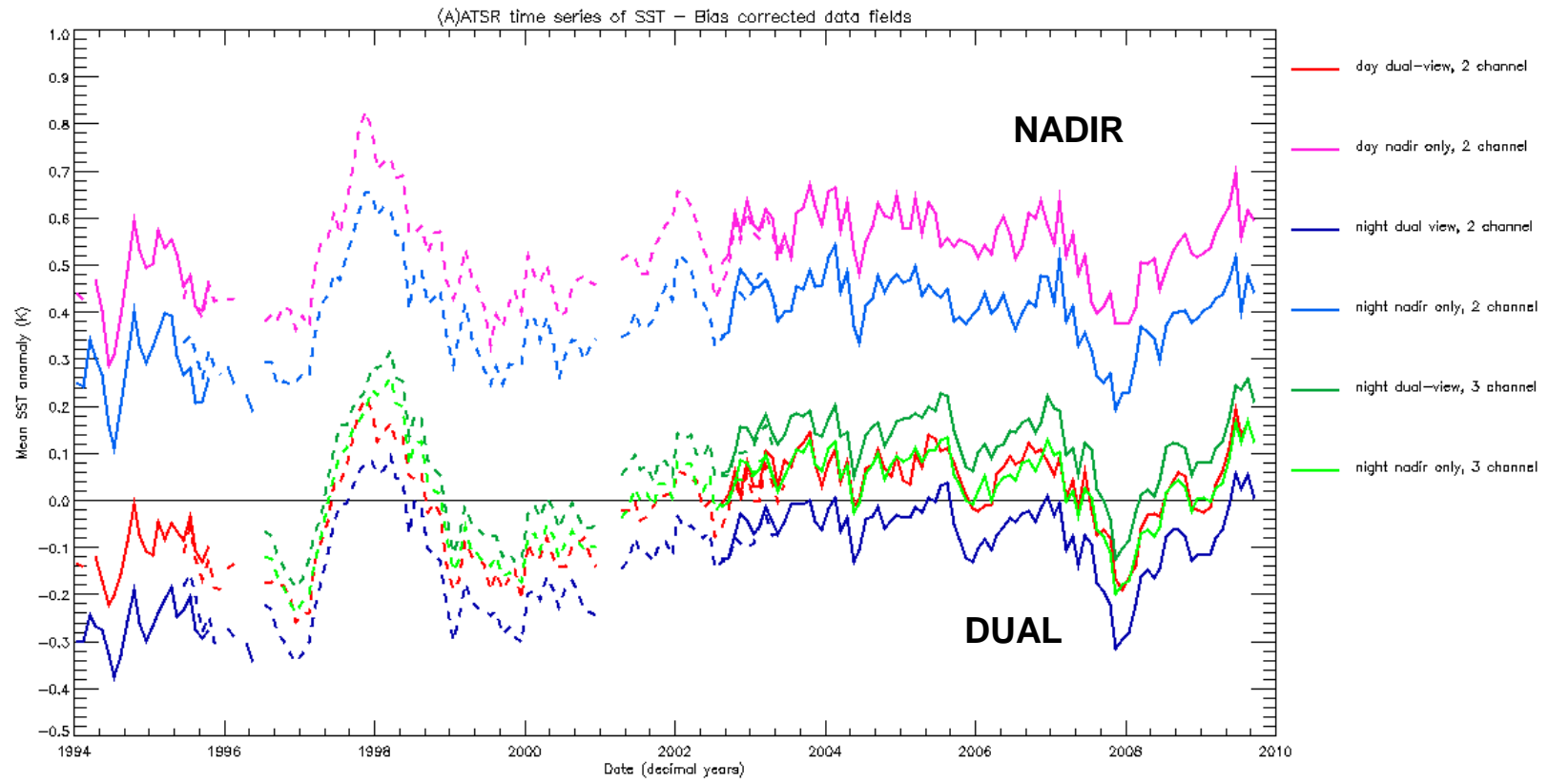
AATSR - ATSR-2

Retrieval	Mean	SD
Day Nadir 2 channel	0.39	0.15
Night Nadir 2 Channel	0.42	0.16
Night Nadir 3 Channel	0.06	0.11
Day Dual 2 channel	0.17	0.24
Night Dual 2 Channel	0.22	0.25
Night Dual 3 Channel	0.03	0.18



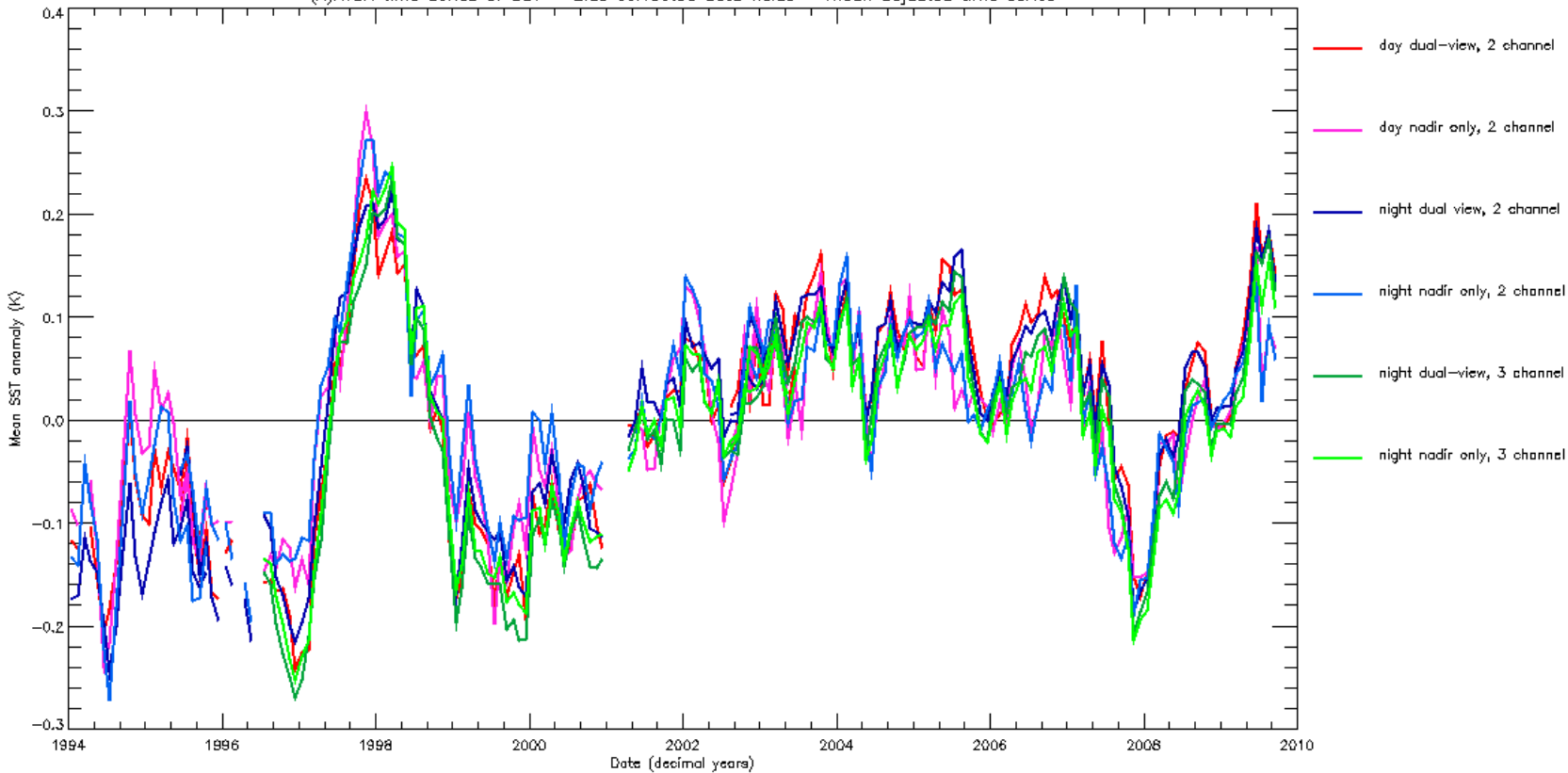


V2 global, multi-product, bias-corrected, anomaly time series: inter-instrument bias corrections (10 arc min level) 6 SST products, nighttime

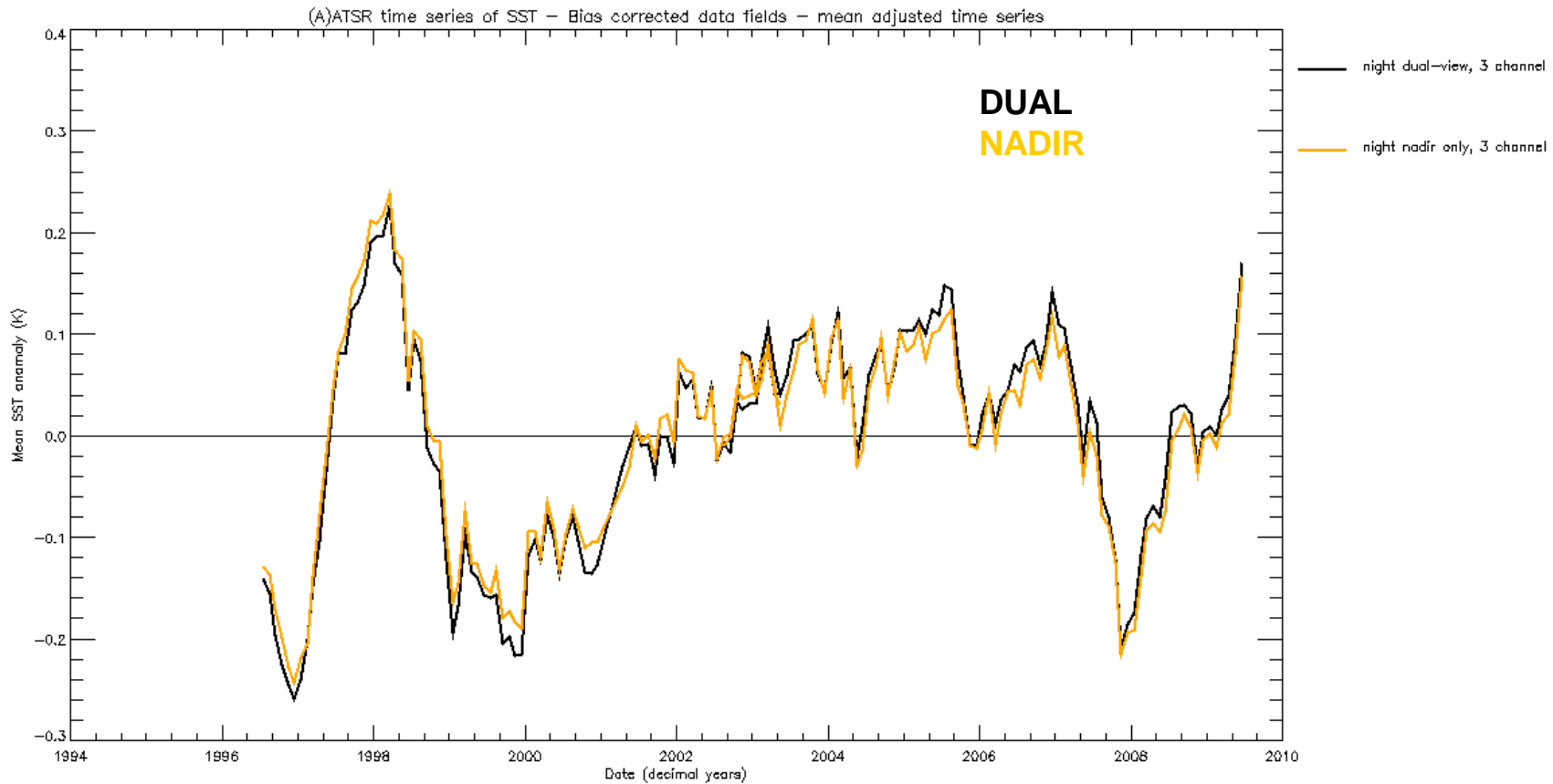


V2 global, multi-product, mean-adjusted anomaly time series: mean-adjusted, inter-instrument bias correction 6 SST products: nighttime

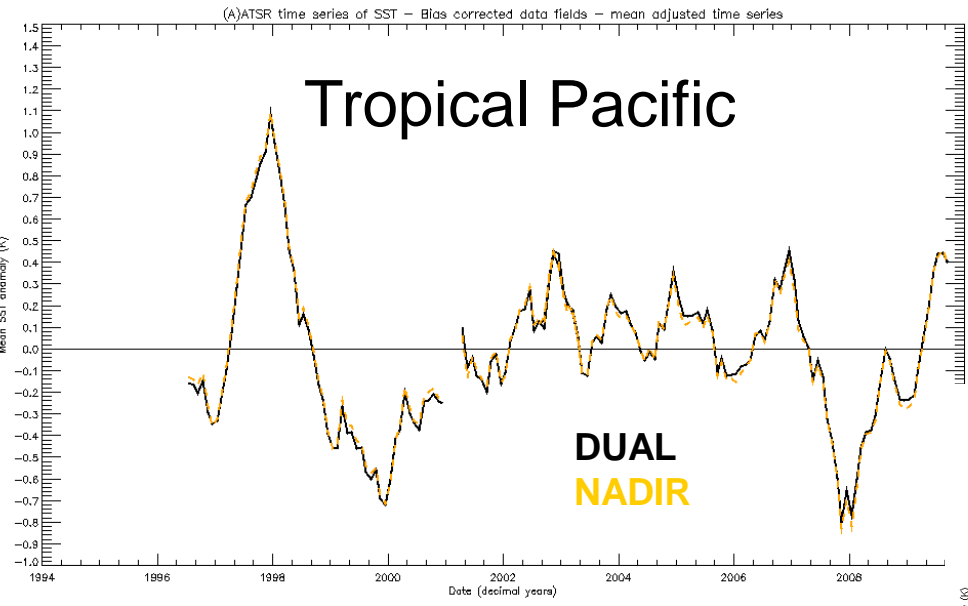
(A)ATSR time series of SST – Bias corrected data fields – mean adjusted time series



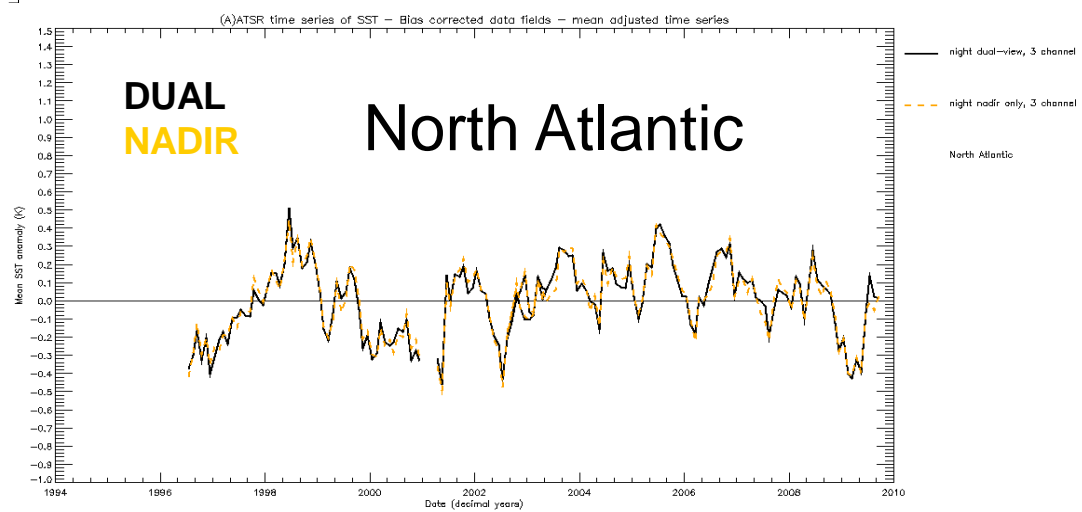
Most accurate V2 global anomaly time series: dual-3 night mean-adjusted, inter-instrument bias correction



V2 regional time series: mean-adjusted, bias correction Dual-view, 3 channel nighttime



— night dual-view, 3 channel
- - - night nadir only, 3 channel
Tropical Pacific



— night dual-view, 3 channel
- - - night nadir only, 3 channel
North Atlantic

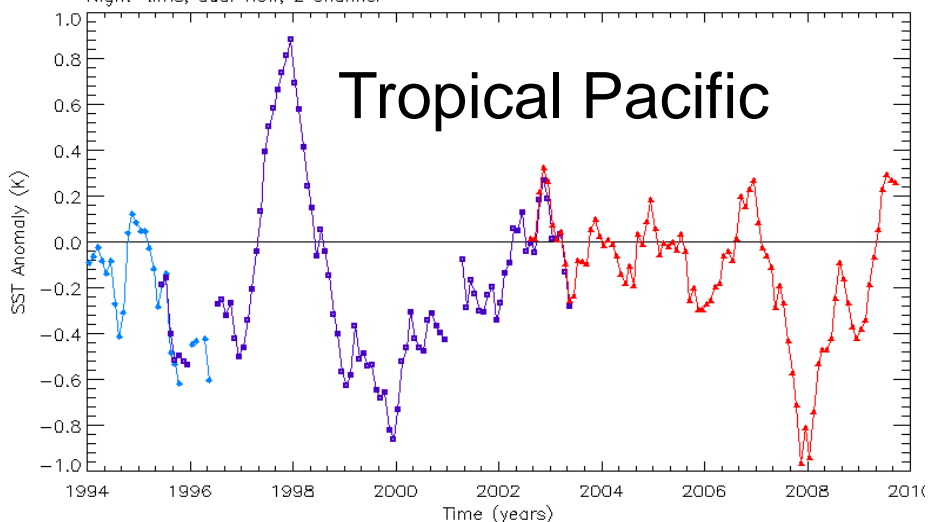
Summary

- Consistent SST record in archive
- Very good relative time series particularly in ATSR-2/AATSR period with excellent agreement between D3 and N3 [Filtering has to be applied]
- Validation evidence indicates very good stability and low mean bias (not shown).
- Influence of large El Nino, recent La Nina and El Nino evident modulating the underlying trend in temperature.
- (A)RC will make further improvements to cloud clearing and retrieval bias.

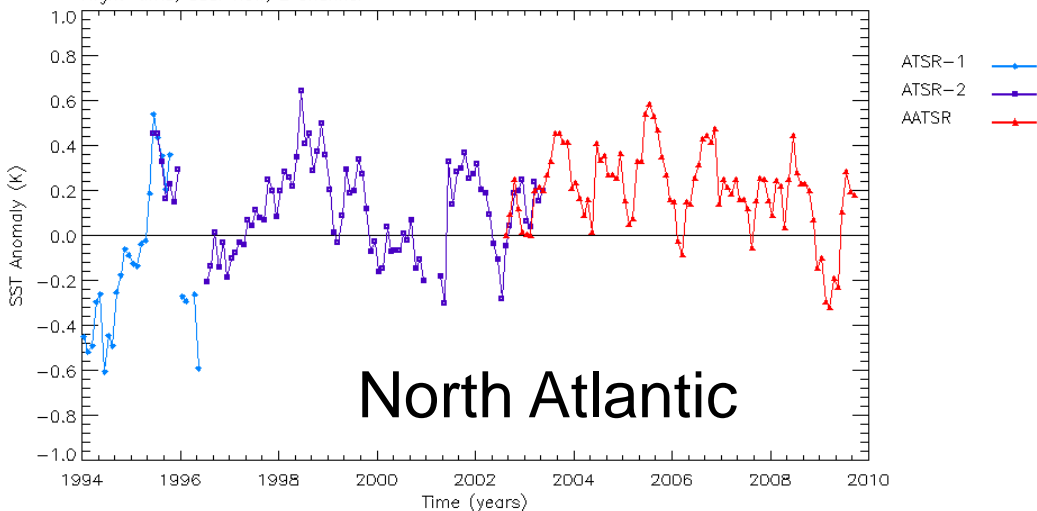
The time series work has been funded by DECC (formerly Defra)

V2 regional time series: inter-instrument bias correction Dual-view, 2 channel nighttime

Tropical Pacific Ocean Mean SST Anomaly : monthly averages on 5.0 degree grid
Night-time, dual view, 2 channel



North Atlantic Ocean Mean SST Anomaly : monthly averages on 5.0 degree grid
Night-time, dual view, 2 channel



The AATSR multi-product, relative anomaly time series