ESA Climate Change Initiative Phase-II

Sea Surface Temperature (SST)

www.esa-sst-cci.org

SST CCI trail blazer users: engagement and results

Nick Rayner and Chris Atkinson

SST CCI products

The three ESA SST CCI LT version 1.0 products assessed are:

- **ATSR**. SSTs from ATSR instruments in L3U format at 0.05° latitude by 0.05° longitude resolution covering 1991 – 2010. (Hereafter, SST CCI ATSR.)
- **AVHRR**. SSTs from AVHRR instruments in L2P format at Global Area Coverage (GAC) resolution covering 1991 – 2010. (Hereafter, SST CCI AVHRR.)
- **Analysis**. Satellite-only SST-depth L4 daily analysis created by OSTIA system from SST CCI ATSR and SST CCI AVHRR products at 0.05° latitude by 0.05° longitude resolution covering 1991 – 2010. (Hereafter, SST CCI analysis.)

These are utilised over the period 1991-2010.

Climate Assessment approach

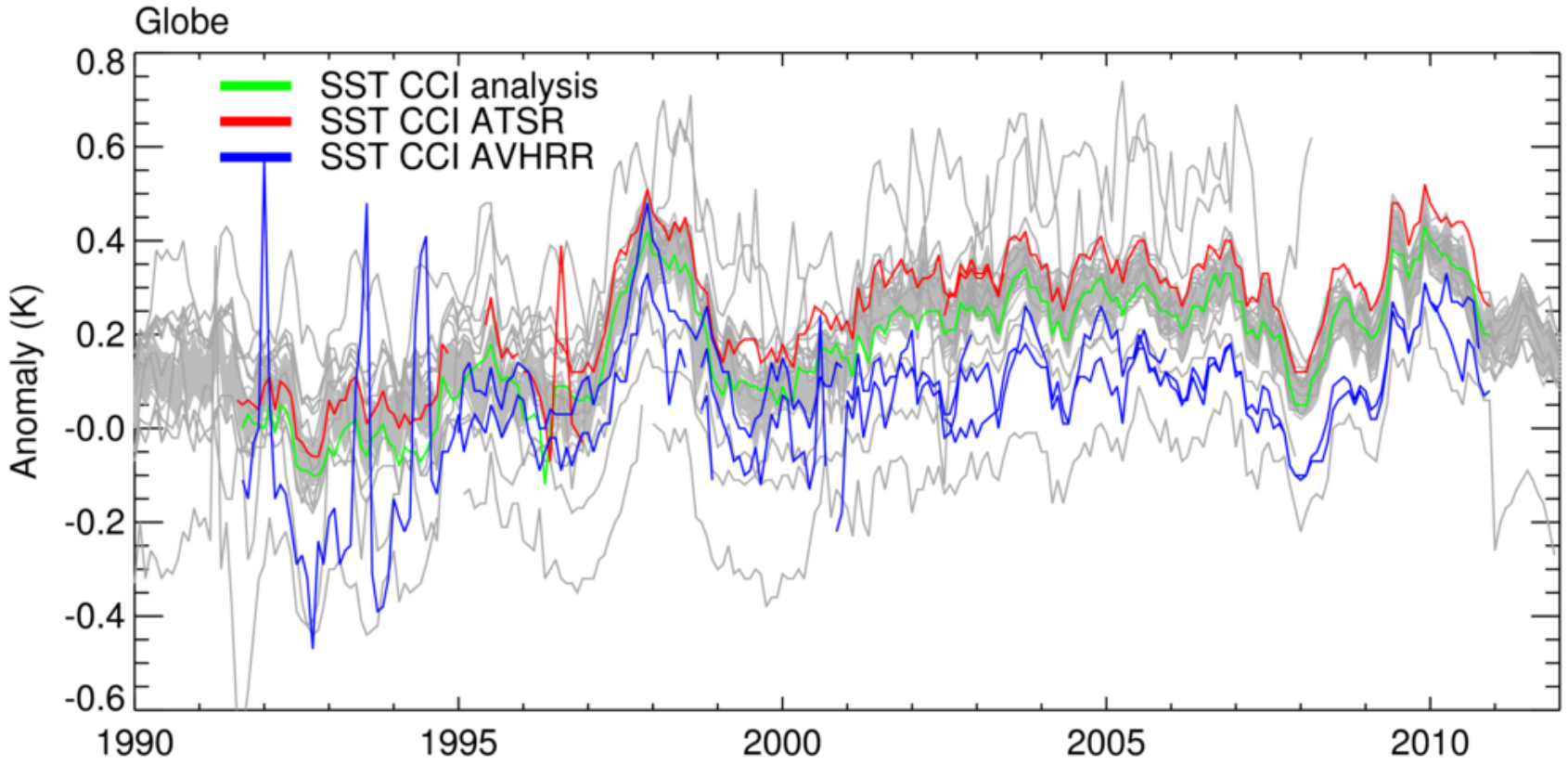
Three main components to the Climate Assessment:

- Assessment of trends and variability and comparison to other SST products
  - analysis of linear trends both globally and regionally;
  - the exploration of known inter- or multi-annual modes of variability, through calculation of standard indices ;
  - comparison of multi-annual or decadal averages; and
  - the calculation of autocorrelations in time
  - analysis of stability and GMPE from validation WPs
- Use in climate modelling and other applications
  - Use in model assessment framework at MOHC
  - *Use in other contributed applications*
- Comparison to other ECVs
  - Analysis of the representation of fronts in SST CCI and OC SST products cf precursors

Trail blazer users were invited to download the SST CCI products prior to general release and provide feedback on their use.

- Voluntary user reports included in the Climate Assessment Report alongside funded work

Global, monthly average SST anomaly
(relative to average for 1985-2007)

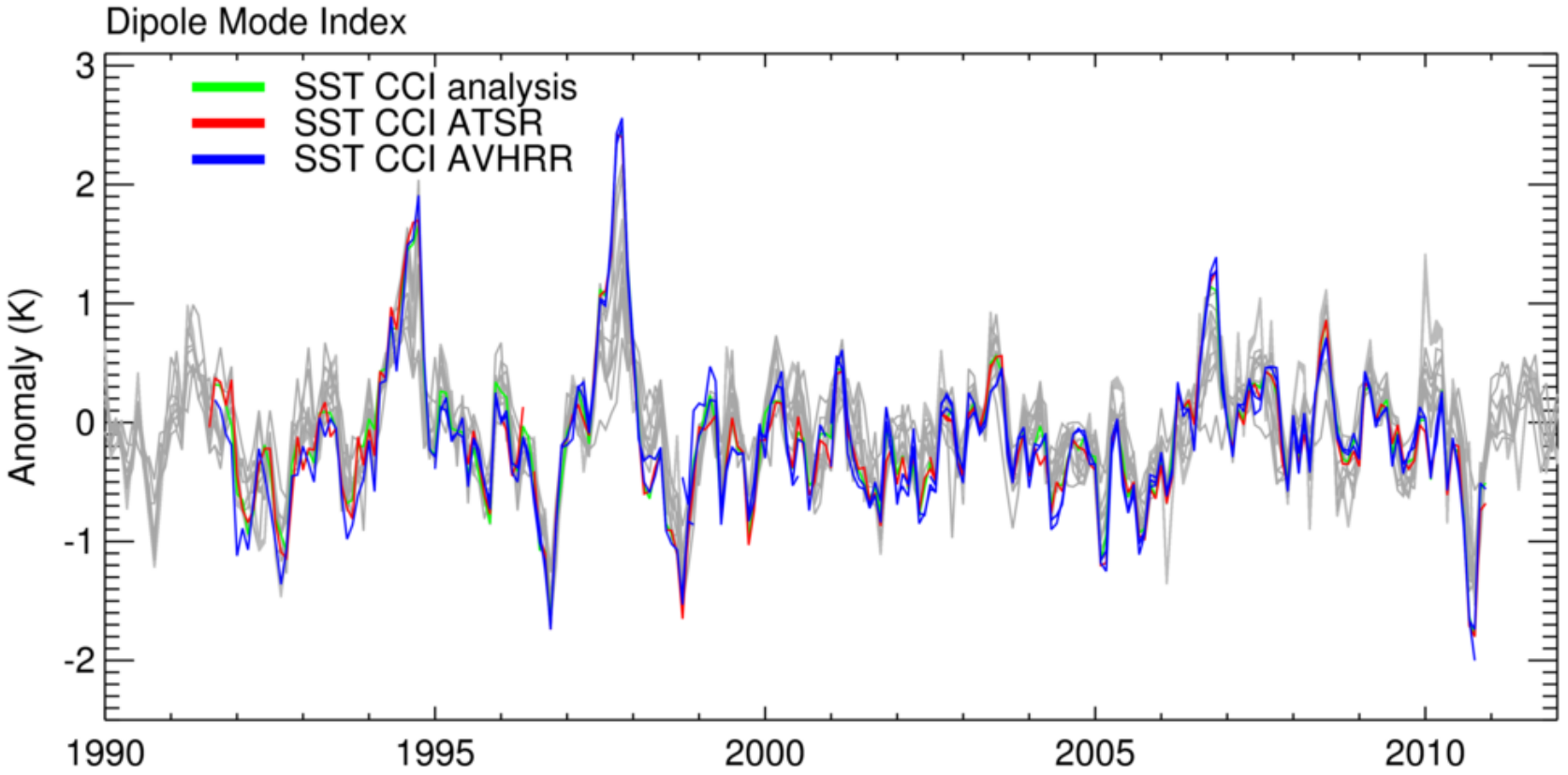


Overall variability is similar except for erroneous variability in the 1990s in the SST CCI AVHRR and ATSR products.

The SST CCI products are more consistent after 1996.

Trend of SST CCI products is at upper end of comparison range

Regional phenomena – Dipole Mode Index



Overall variability is similar in the SST CCI and comparison with some differences.

Peak seen in comparison data sets in 2009/10 missing in SST CCI products

Some peaks to trough variability higher in SST CCI products

Results – improved feature resolution

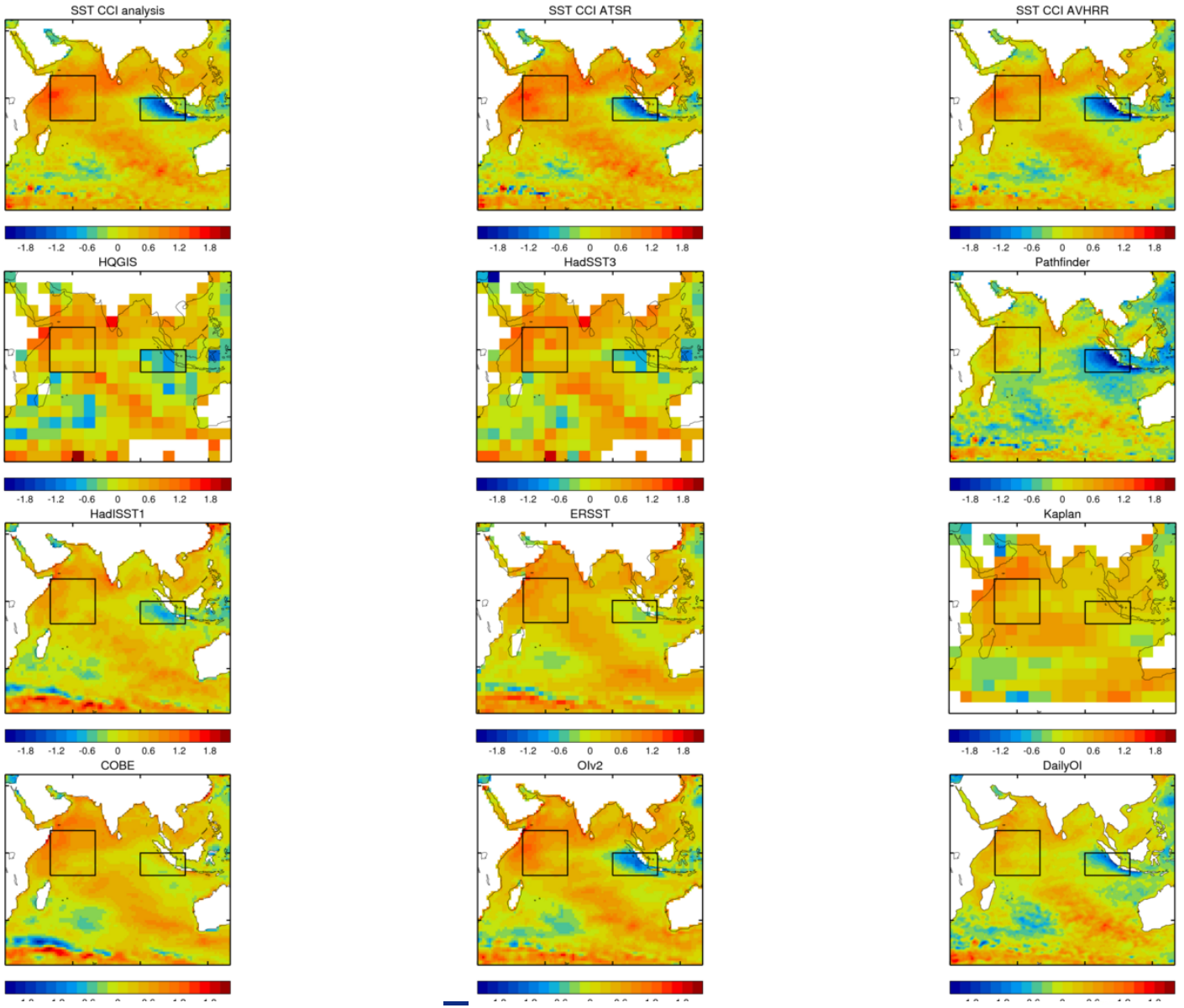
Jun–Dec 1997

Cold area off Indonesia is much colder in SST CCI products

In situ only data sets have much weaker cold anomaly:

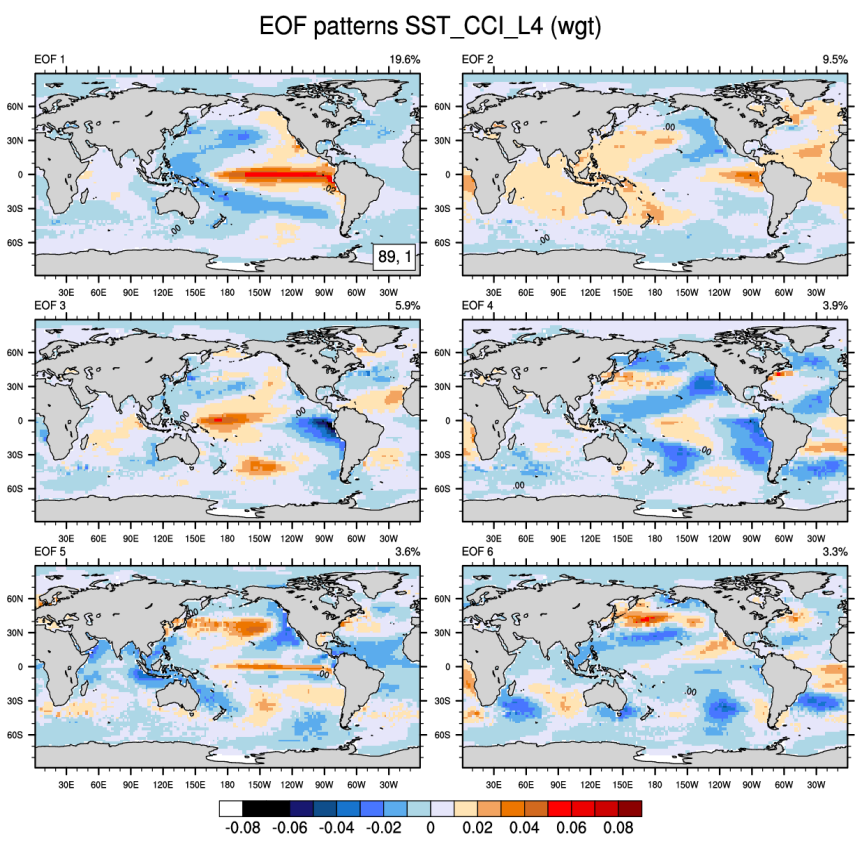
e.g. HadSST3, ERSST, Kaplan, COBE

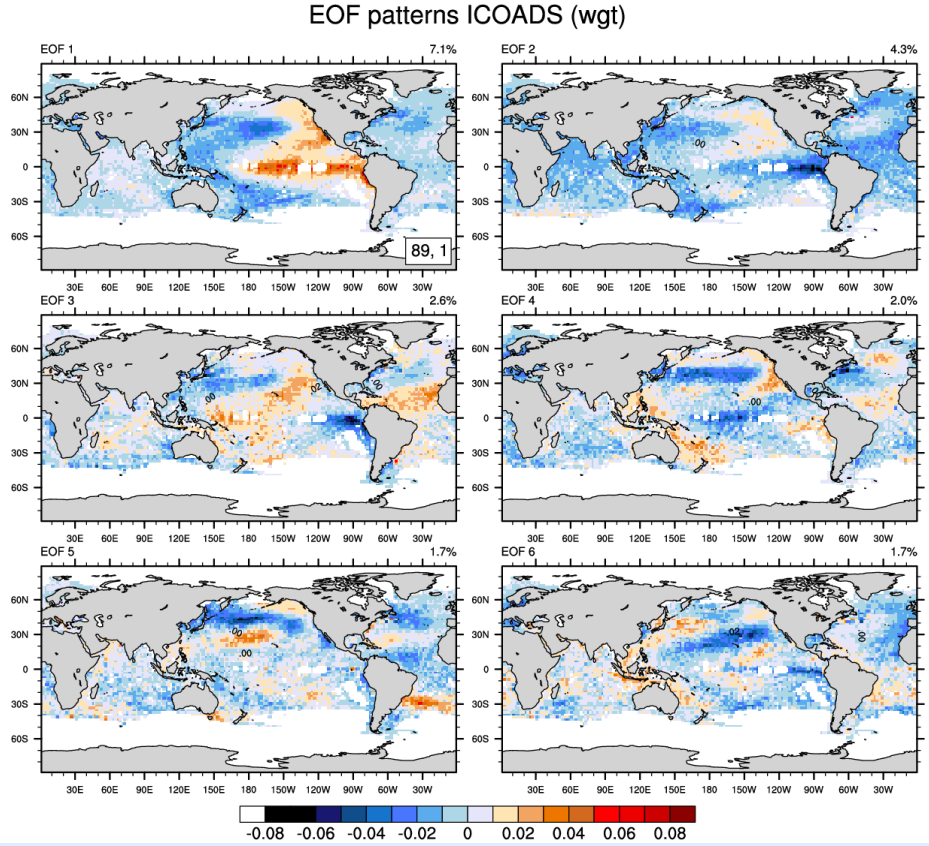
Similar improvements are seen in the Tropical Atlantic



Major EOF patterns: analysis vs ICOADS

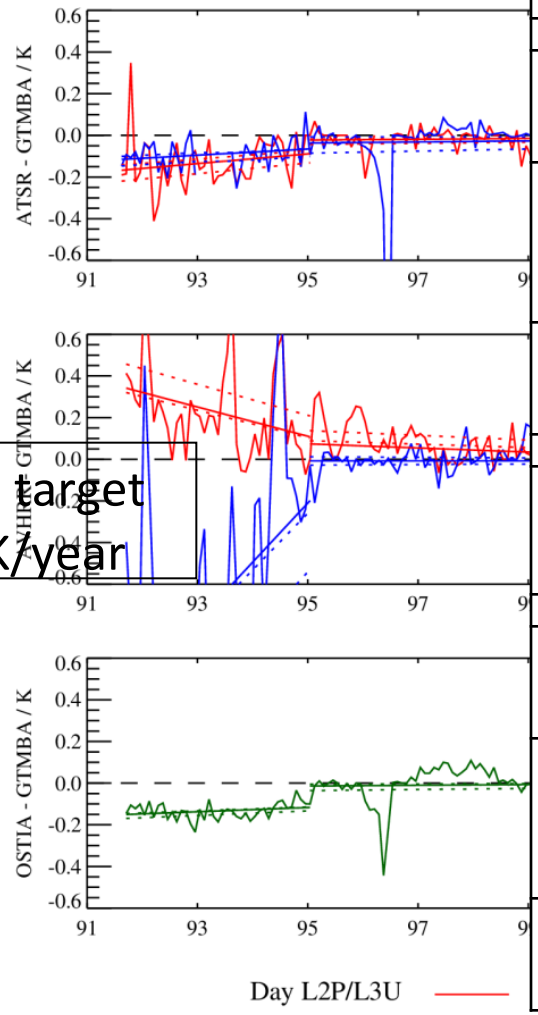
The same large-scale EOFs are seen in the independent satellite analysis and *in situ* gridded summaries: this confirms the large-scale variability is as expected. (Courtesy Simone Morak.)





Stability (courtesy Gary Corlett)

SST difference between SST CCI products and the GTMBA



GCOS target is 3mK/year

SST CCI 95% confidence interval (mK year^{-1}) for 1995 – 2005

	Day	Night	Both
SST CCI AVHRR	-137.9<trend<-2.4	105.9<trend<462.3	
SST CCI ATSR	-13.6<trend<60.1	-7.4<trend<36.8	
SST CCI analysis			-1.8<trend<22.1

SST CCI ATSR

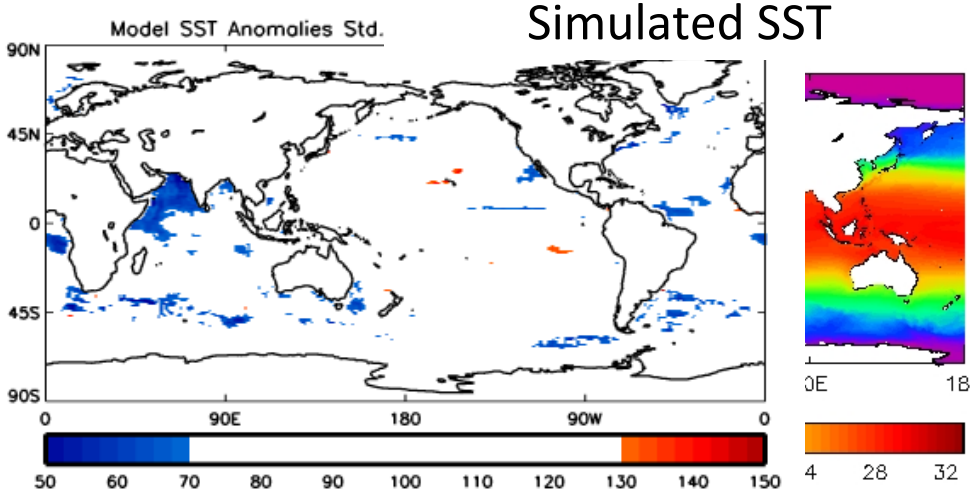
SST CCI AVHRR

SST CCI 95% confidence interval (mK year^{-1}) for 1995 – 2010

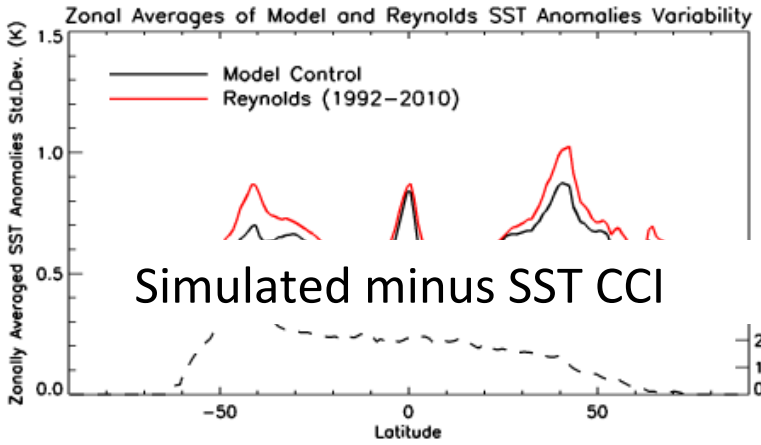
	Day	Night	Both
SST CCI AVHRR	-12.3 < trend < -7.4	-2.0 < trend < 2.0	
SST CCI ATSR	0.7 < trend < 3.2	-1.4 < trend < 6.4	
SST CCI analysis			0.1 < trend < 3.2

SST CCI analysis

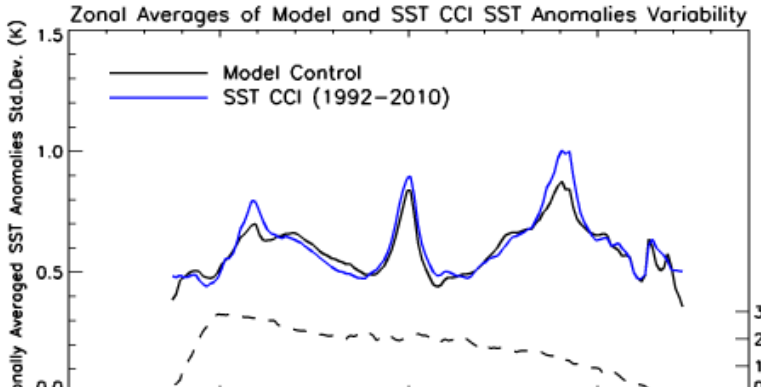
Coupled model evaluation

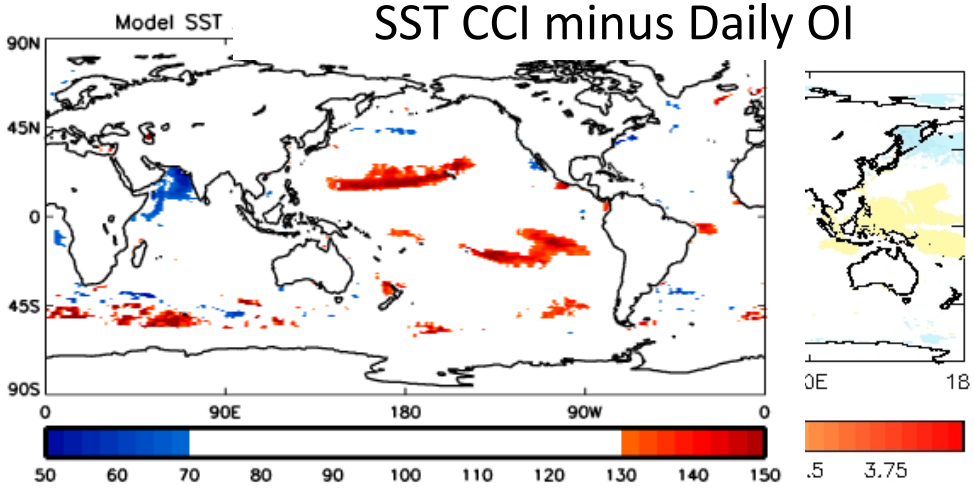


Simulated SST



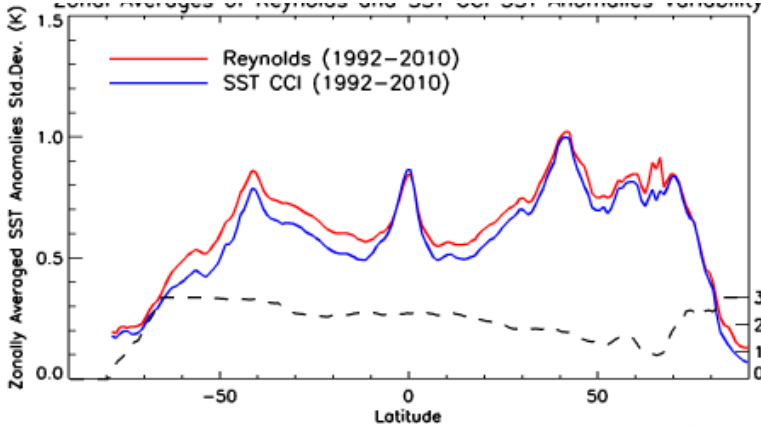
Simulated minus SST CCI



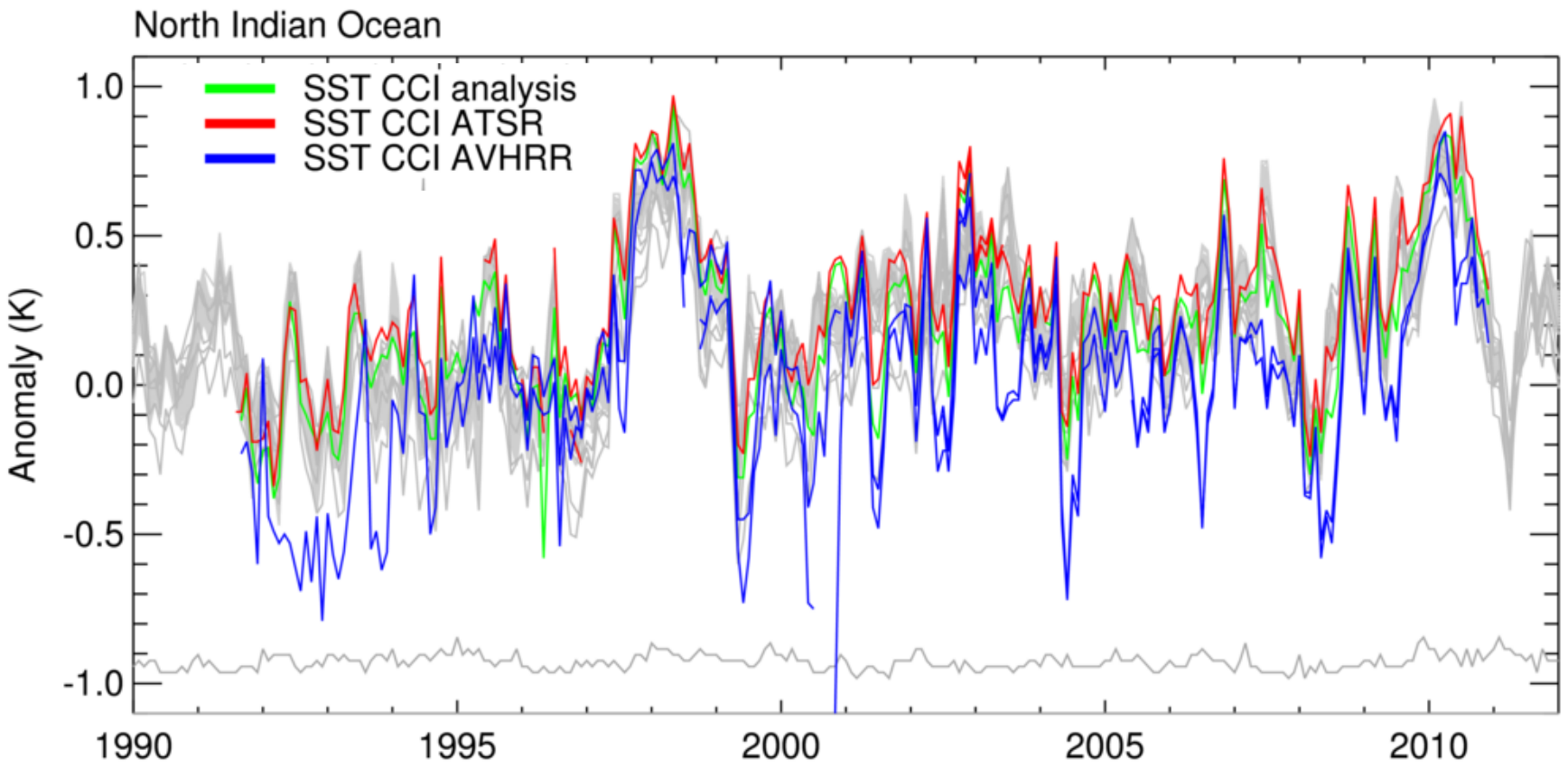


SST CCI minus Daily OI

Simulated minus Daily OI



North Indian Ocean



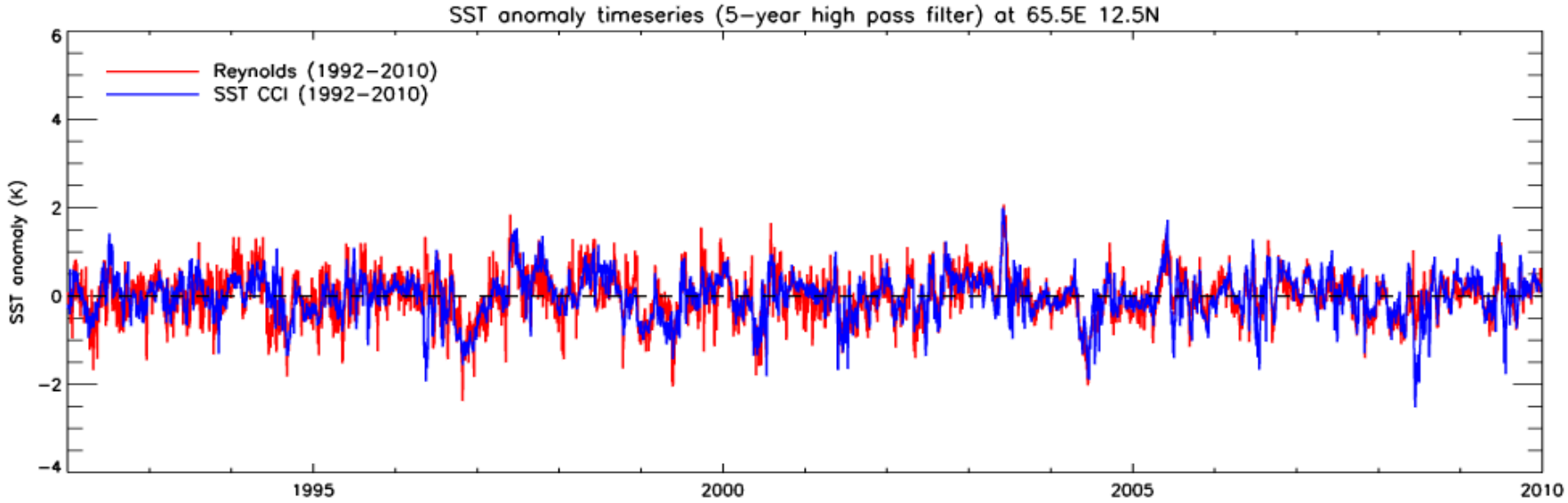
Spurious variability in North Indian Ocean in SST CCI AVHRR product

Thought to be due to CLAVR-X cloud detection passing desert dust

SST anomalies in the central Arabian Sea

Daily OI variability is enhanced relative to the SST CCI analysis prior to the introduction of AMSR-E data from 2003, and relatively reduced from 2003 onwards.

Apparent positive impact of the passive microwave data on the Daily OI suggests that Daily OI variability is exaggerated here prior to 2003, but also that SST CCI analysis variability may be overestimated here too.

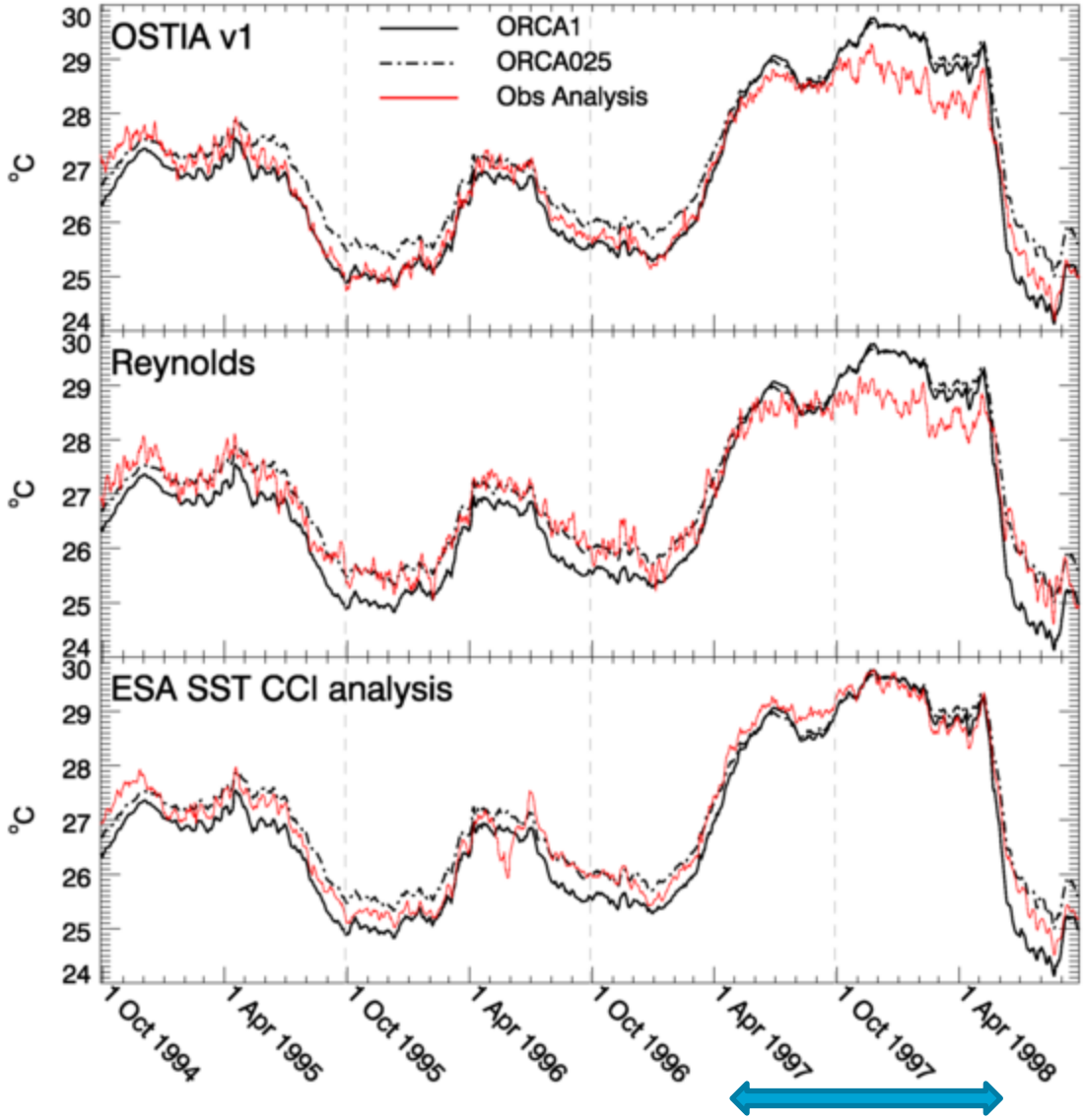


Exploration of heat transport in ocean models via Tropical instability Waves

Provision of daily mean information in SST CCI analysis is a better natural comparator to the simulated daily data than SST_{fnd} or the daily "means" provided in the Daily OI.

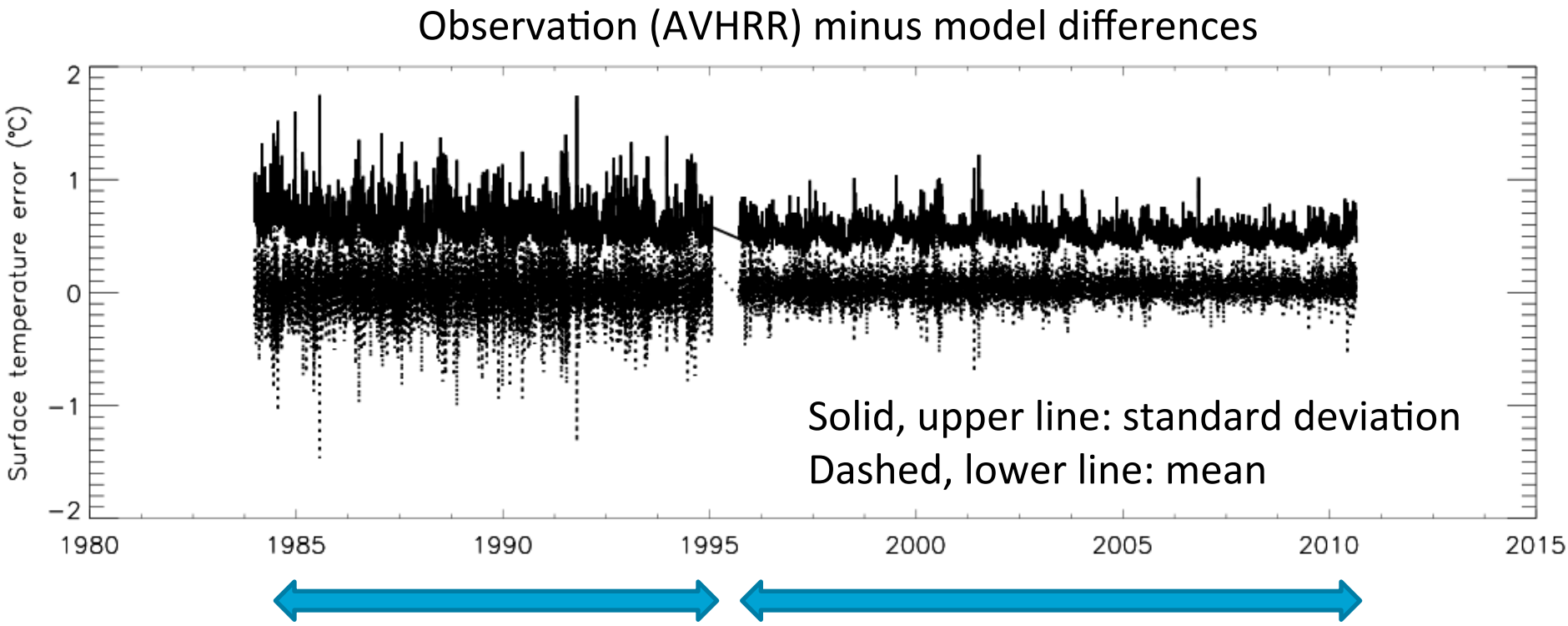
Courtesy Tim Graham (submitted to Ocean

Modelling)



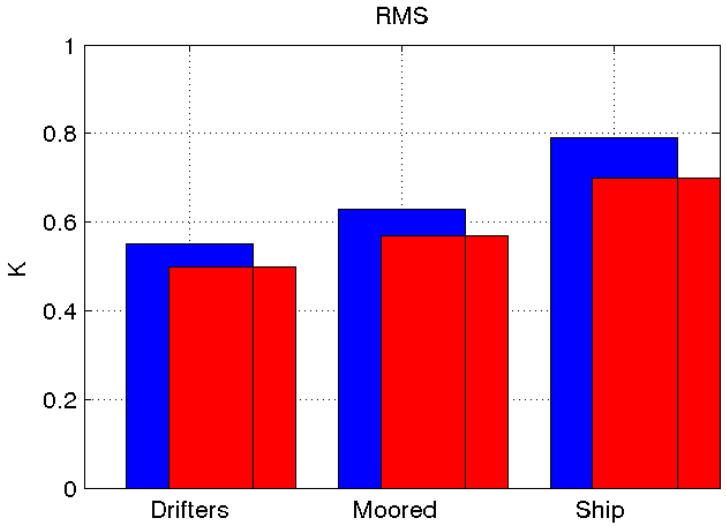
Improved agreement during the El Nino period

Assimilation of SST CCI AVHRR product into North-west Shelf Seas reanalysis (courtesy Robert King)



DMI Arctic L4 analysis, 2006-8, cf reference data (courtesy Jacob Hoyer)

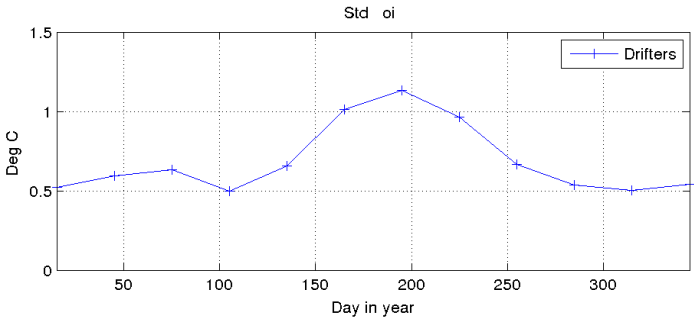
RMS difference



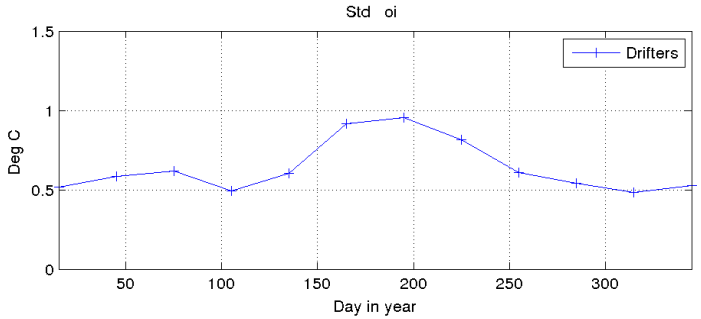
Using SST CCI AVHRR

Using Pathfinder AVHRR

Std. dev. of difference between Arctic L4 analysis and drifters through the year



Using SST CCI AVHRR

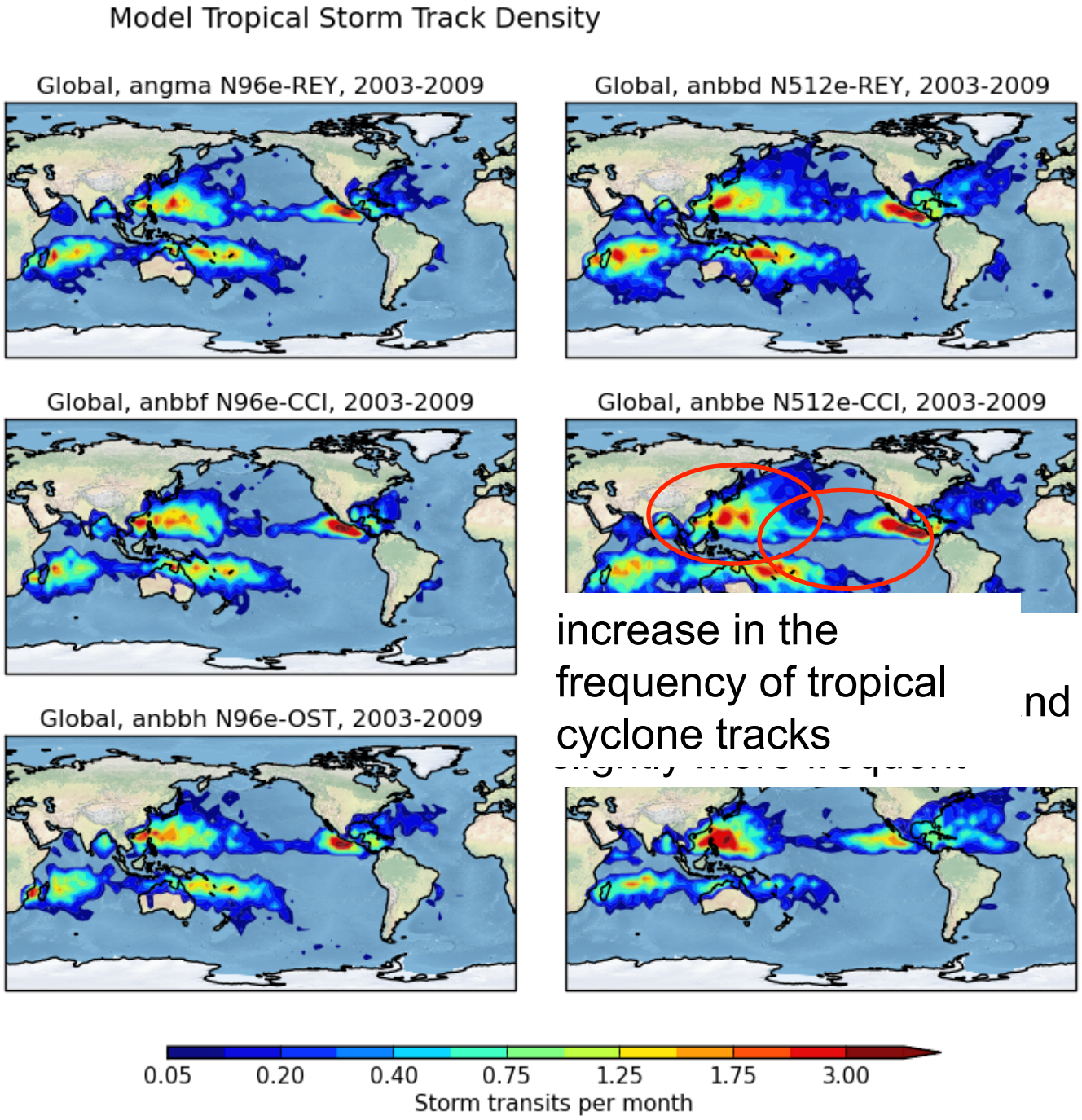


Using Pathfinder AVHRR

Simulation of tropical storm track density

The tropical cyclone tracks may be influenced by the higher SSTs in the SST CCI analysis compared to those in the Reynolds et al Daily OI.

Courtesy Malcolm Roberts (submitted to CLIVAR Exchanges)



increase in the frequency of tropical cyclone tracks

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Relationships between
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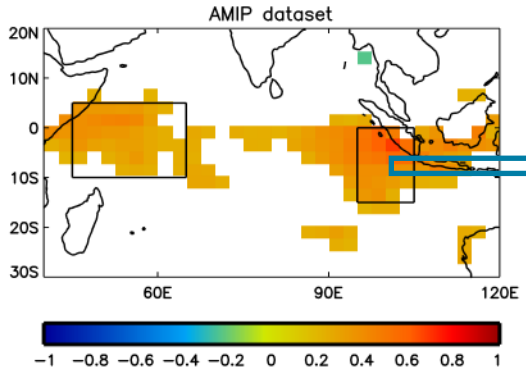

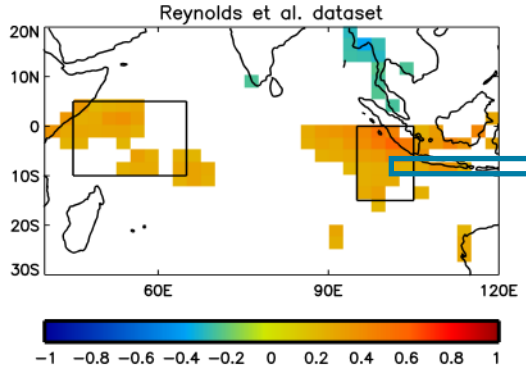

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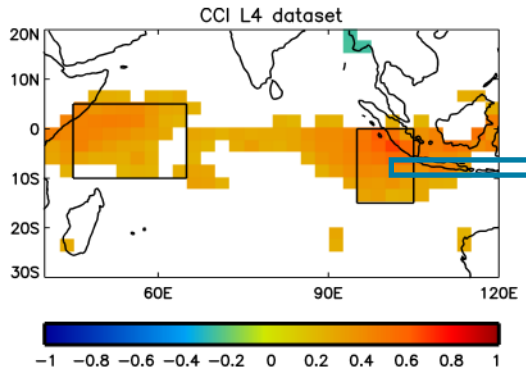
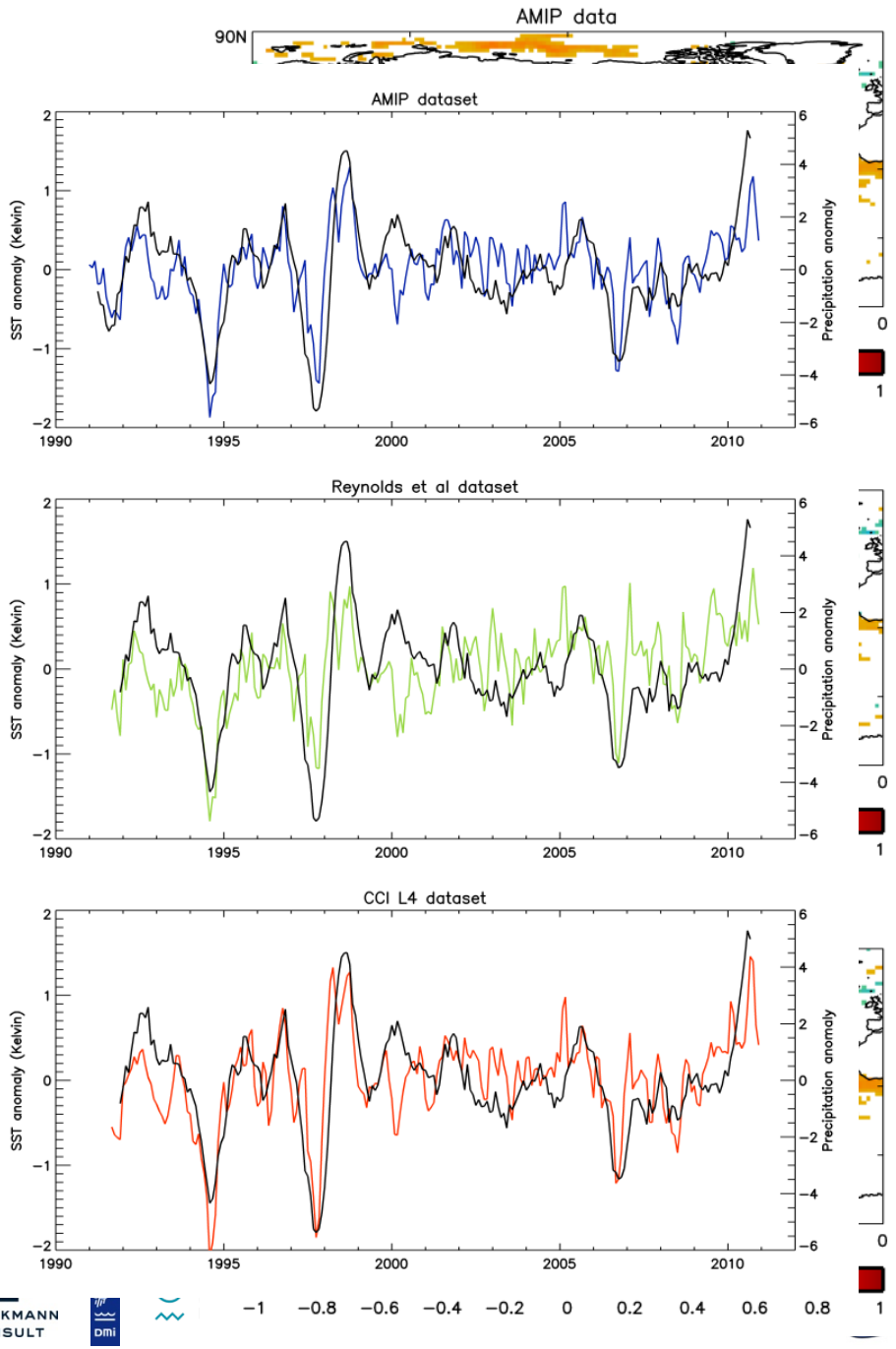




Key messages #1

Variability in AVHRR SSTs may be exaggerated in the Gulf of Arabia/ Arabian Sea due to biases from intermittent desert dust.

- Here the SST CCI analysis is up to 0.6 K cooler than some other datasets in JJA. Causes a significant reduction in the simulated Indian monsoon rainfall when used to drive a 25 km model, magnifying an existing model bias.
- Evidence that there may be a positive impact of the use of passive microwave data in this region

Daily mean SST data provided by the SST CCI analysis is more useful than foundation SST data for the purpose of evaluating model simulations of heat transport by tropical instability waves.

- daily mean SST CCI analysis is more comparable to simulated daily mean SSTs.

Surface temperature error in a reanalysis of shelf seas (assimilating only SST) markedly lower when SST CCI products were used, relative to the earlier period when Pathfinder data were assimilated.

- use of the newly developed SST CCI uncertainties gave a significant reduction in the RMS errors of the shelf seas reanalysis when compared to in situ observations.

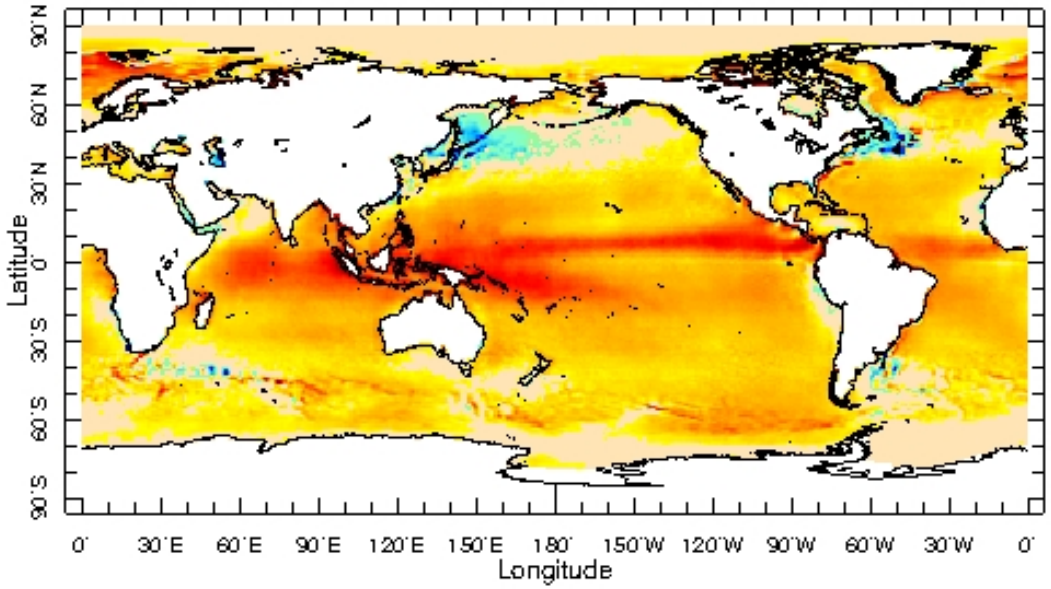
Key messages #2

Different SST datasets were used to force the same global atmosphere-land general circulation model at low (~130 km) and high (~25 km) resolutions. Several differences in the simulated mean state seem to be influenced by differences between the SST datasets, including the Indian monsoon rainfall and surface temperature differences over North America.

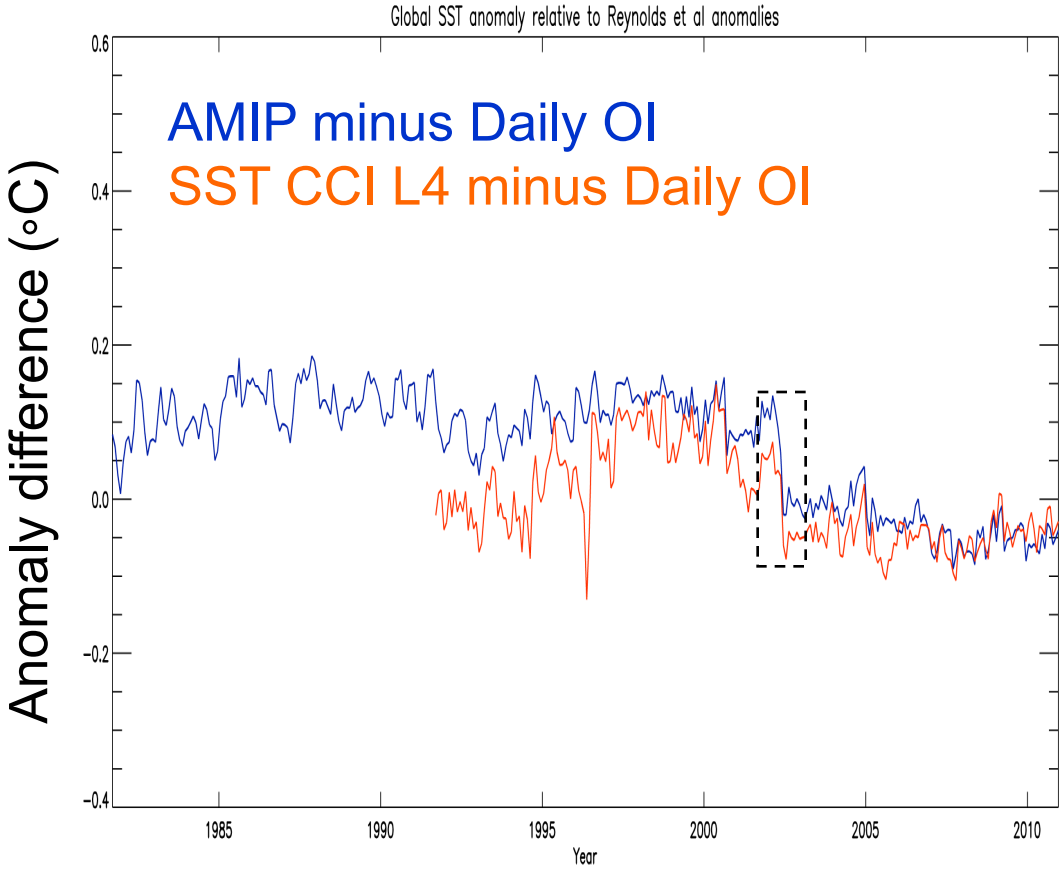
- Not clear whether due to the superior resolution of the SST CCI analysis, or due to other differences between data sets (e,g, in their relative biases)
- Tropical cyclone climatologies are also affected, particularly in the Eastern and Western Pacific regions.
- It is important to have a range of forcing datasets, e.g. through provision of an ensemble, so that model biases can be put into context compared to the model response to different forcing datasets.

Extra slides

Mean difference SST CCI L4 minus MyOcean OSTIA Reanalysis v1 (Sep 1991 to Dec 2010) Courtesy Alexey Kaplan



Discontinuities in Daily OI (courtesy Katie Brown)



AMIP and SST CCI analyses generally warmer than Daily OI pre-2002
Discontinuity in Daily OI when AMSR introduced, June 2002

Dudley's fig