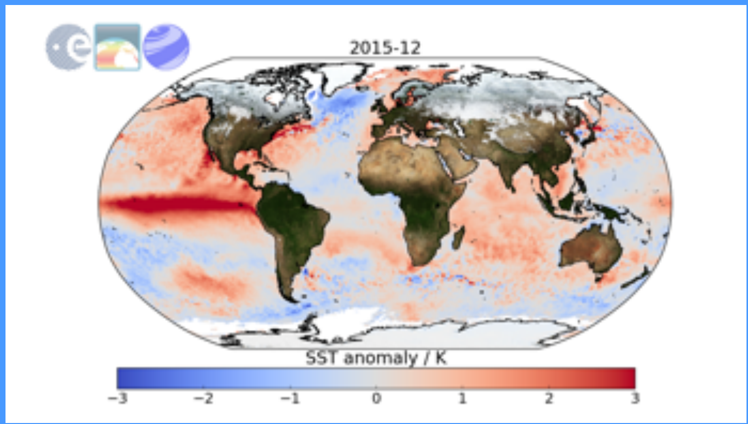
ESA Climate Change Initiative Phase-II

Sea Surface Temperature (SST)

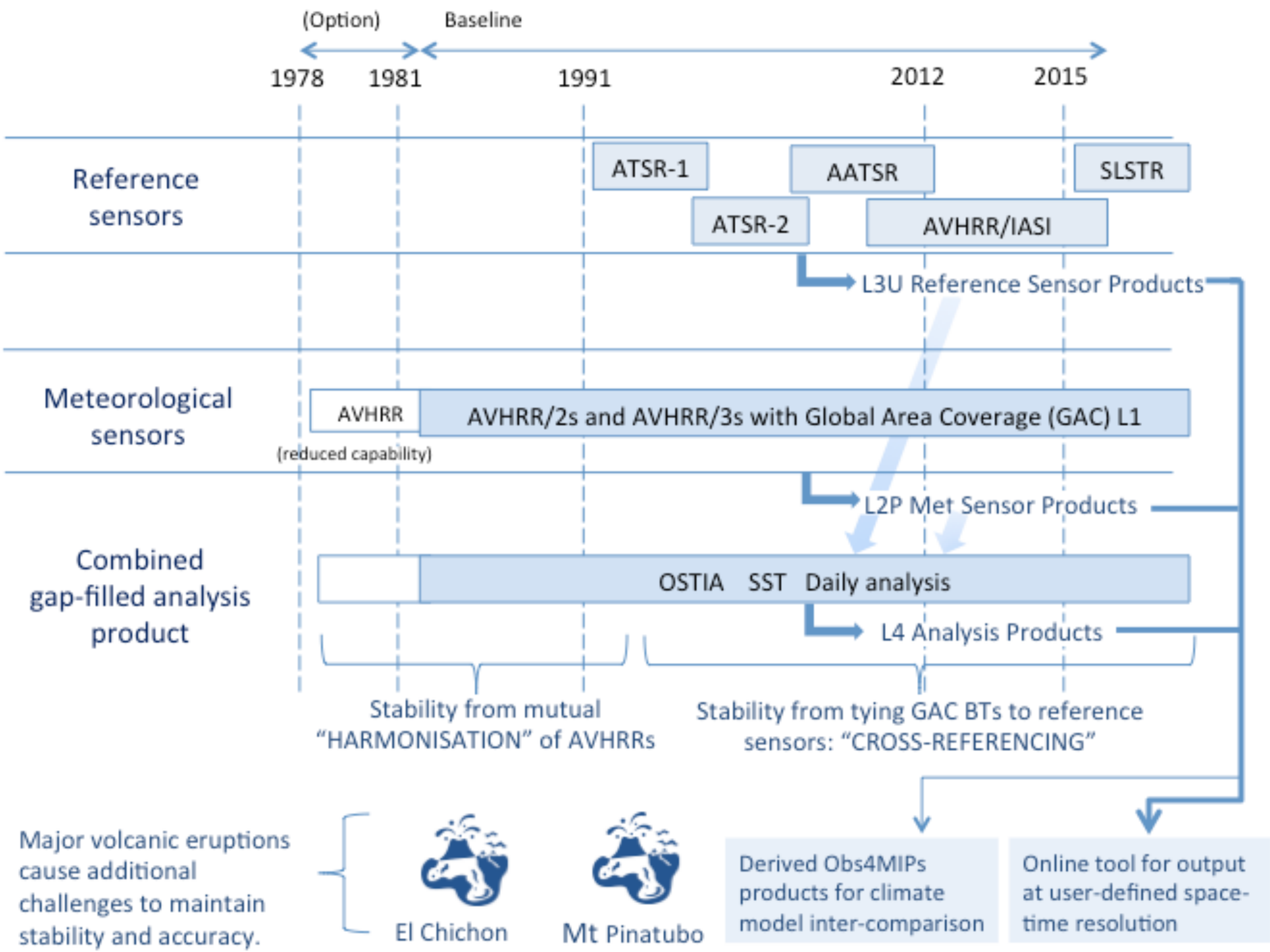
www.esa-sst-cci.org

SST Update for CMUG

Merchant and SST CCI team



R&D Passive Microwave Sensors



Principal EO challenges

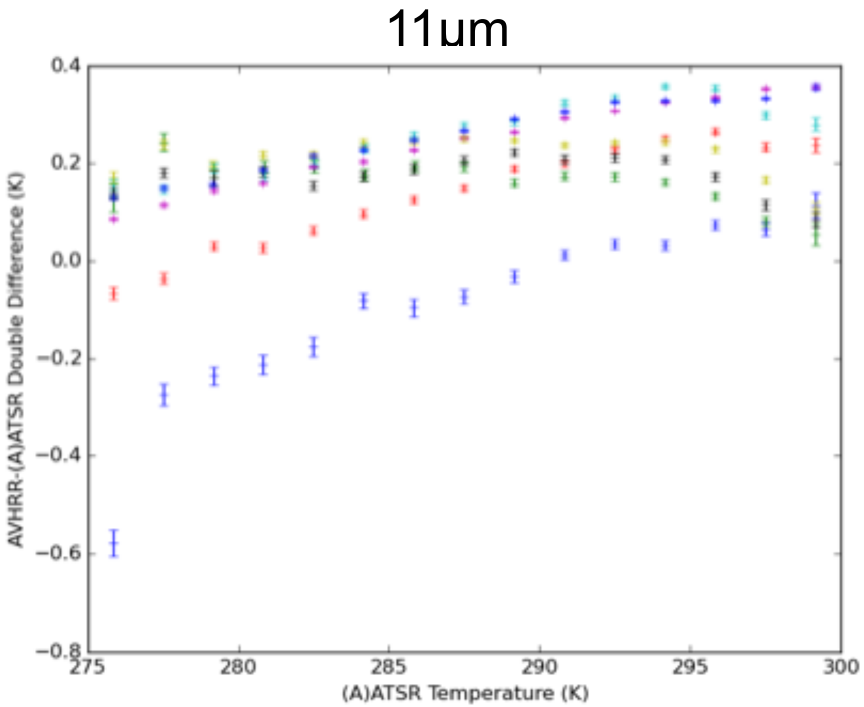
To extend the SST CCI climate data record (CDR) **before and after** the period of the Along-Track Scanning Radiometers (ATSRs)

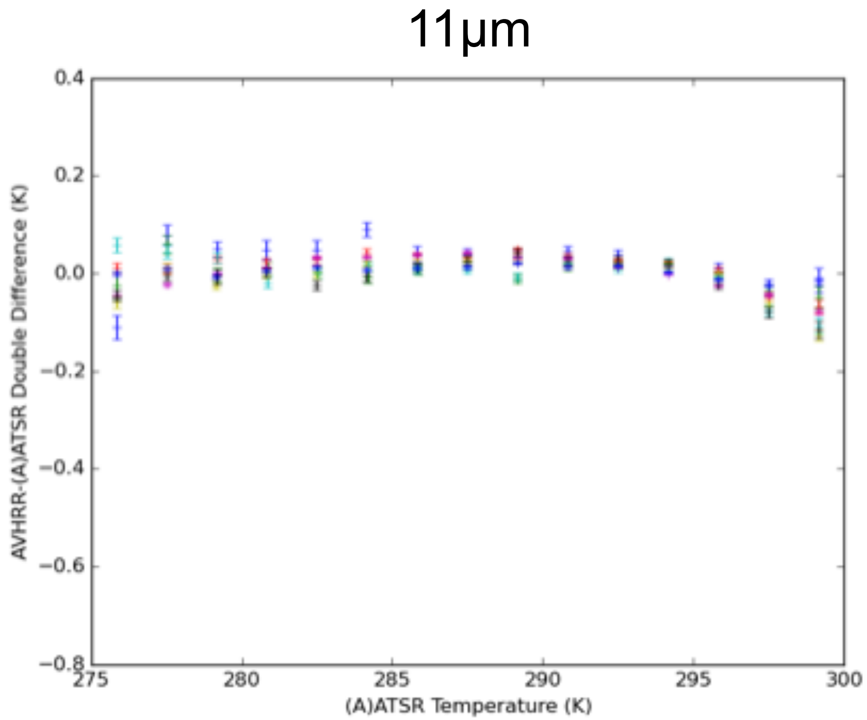
New EO science required to

- Harmonise and stabilise AVHRRs/ATSR1 pre-1996
- Improve cloud detection
  - during strat. aerosol periods
  - in general for AVHRR relative to “heritage”
- Achieve IR SST uncertainty
  - Smooth-atmosphere optimal estimation for AVHRRs
  - Coefficients / OE in presence of strat. aerosol

Scene temperature dependent biases

- For NOAA-12 to MetOp-A (RT-mediated difference from (A)ATSRs)

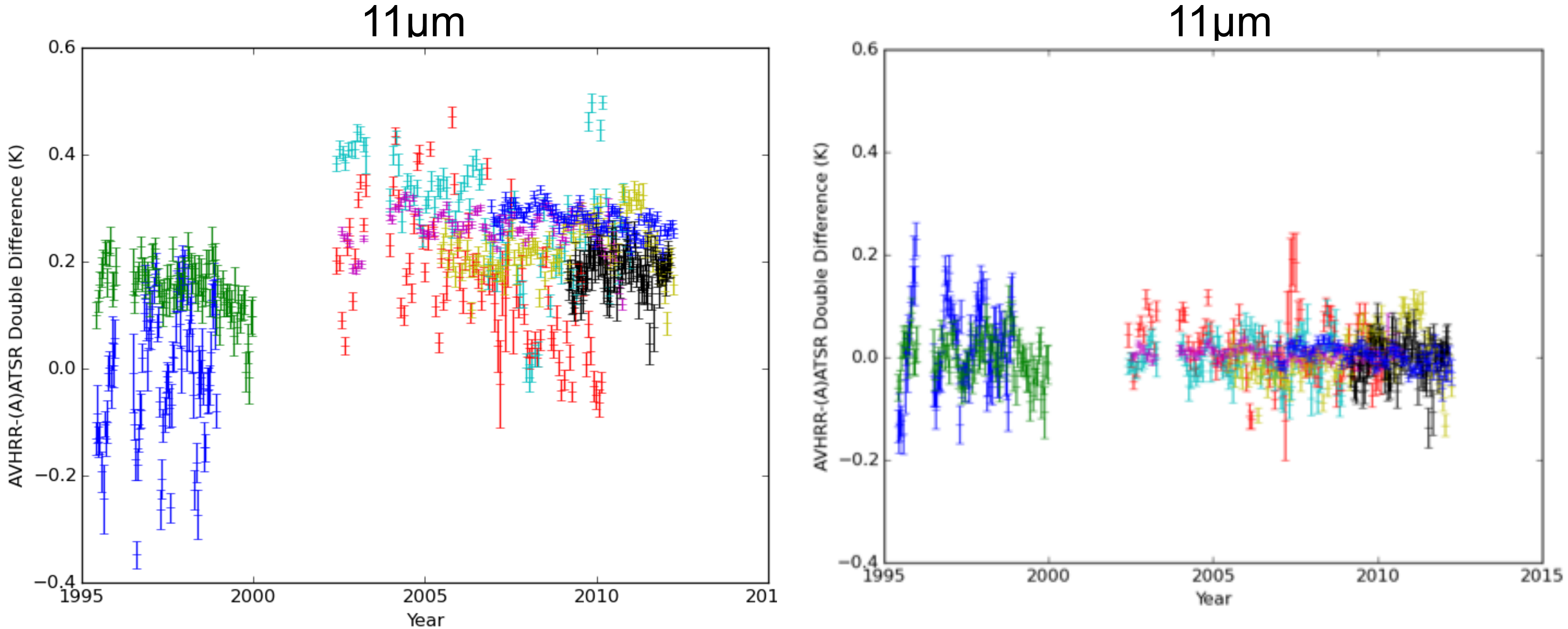




- Improvement with new calibration
  - Reduced biases and trends

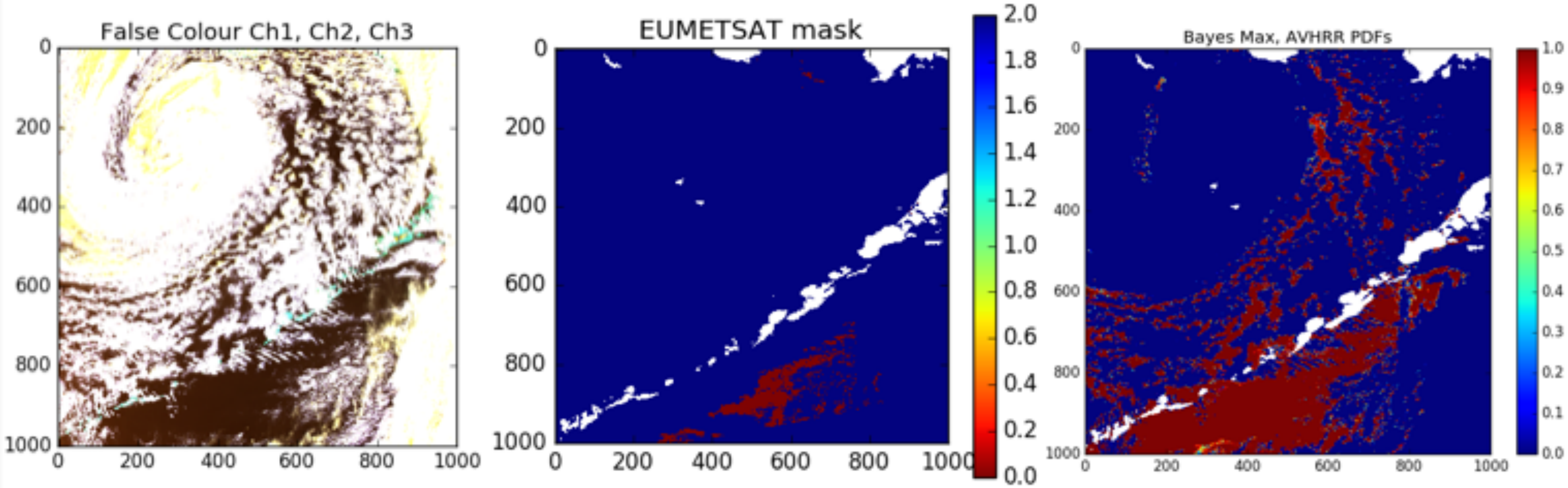
Time dependent biases

- Strong time dependent bias in original calibration (NOAA-12 to Metop-A) (not showing NOAA-14 vs AATSR and NOAA-15 vs ATSR-2 hence the gap)



- Reduced time dependent biases
  - Note NOAA-15 a lot better compared to 3.7µm channel but still worse than other sensors (8am orbit)
  - NOAA-12 still problematic (>0.1K bias) and may not be fully fixable with a simple model (more complex model out of scope)

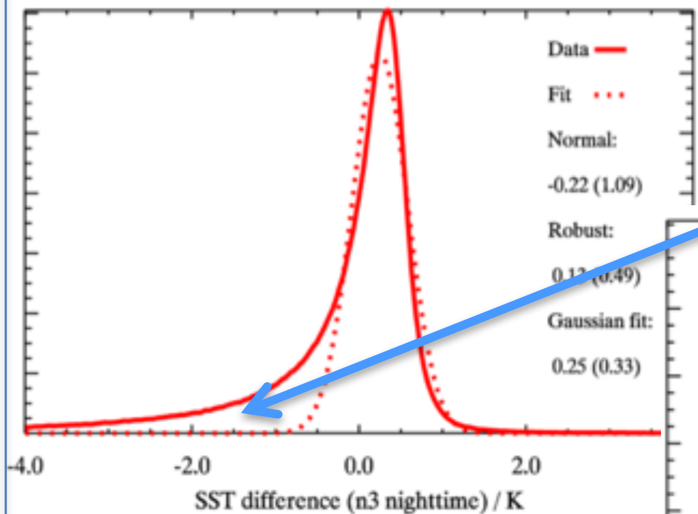
AVHRR FRAC Cloud Detection



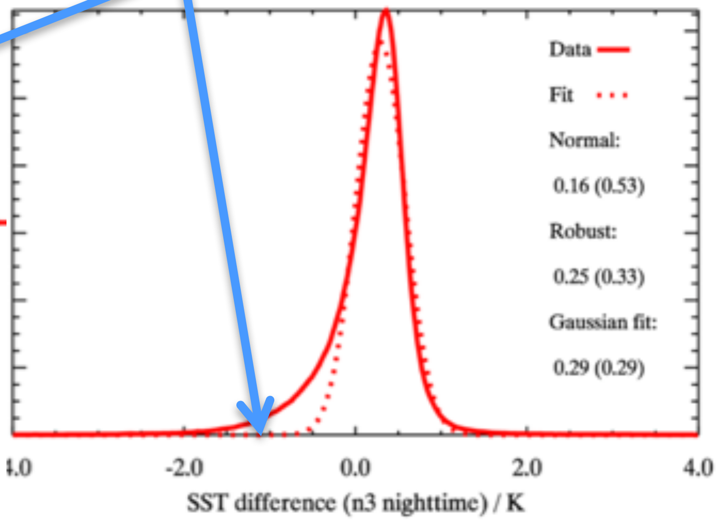
Improved cloud detection in comparison with EUMETSAT mask.

N3 Nighttime Retrieval

Cold tail in comparisons is reduced, and the spread in the fit is reduced.

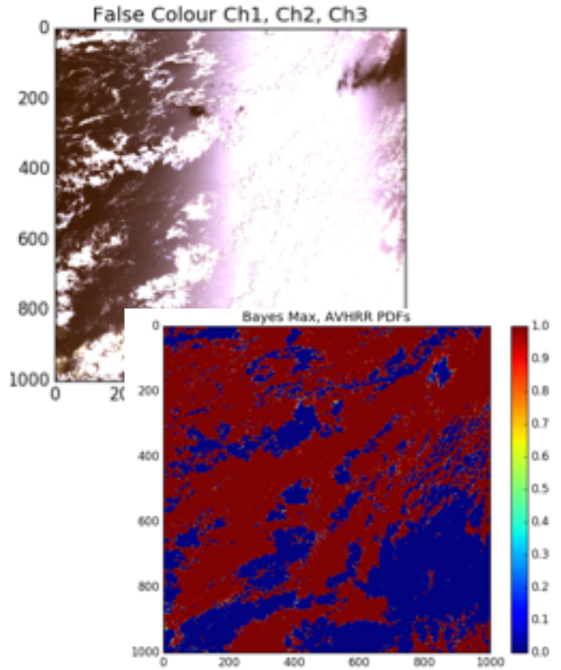


EUMETSAT Mask

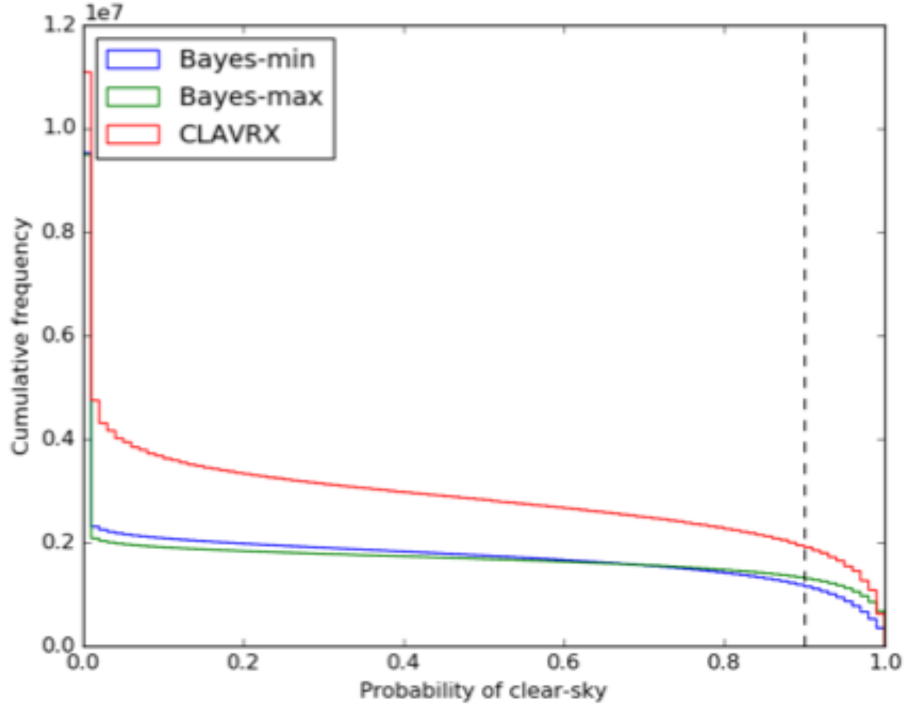


Bayes Mask

Good performance in sunglint regions.



AVHRR GAC Cloud Detection



METOP-A Cloud Detection Statistics:
Uses match-up database, comparisons with drifting buoys.

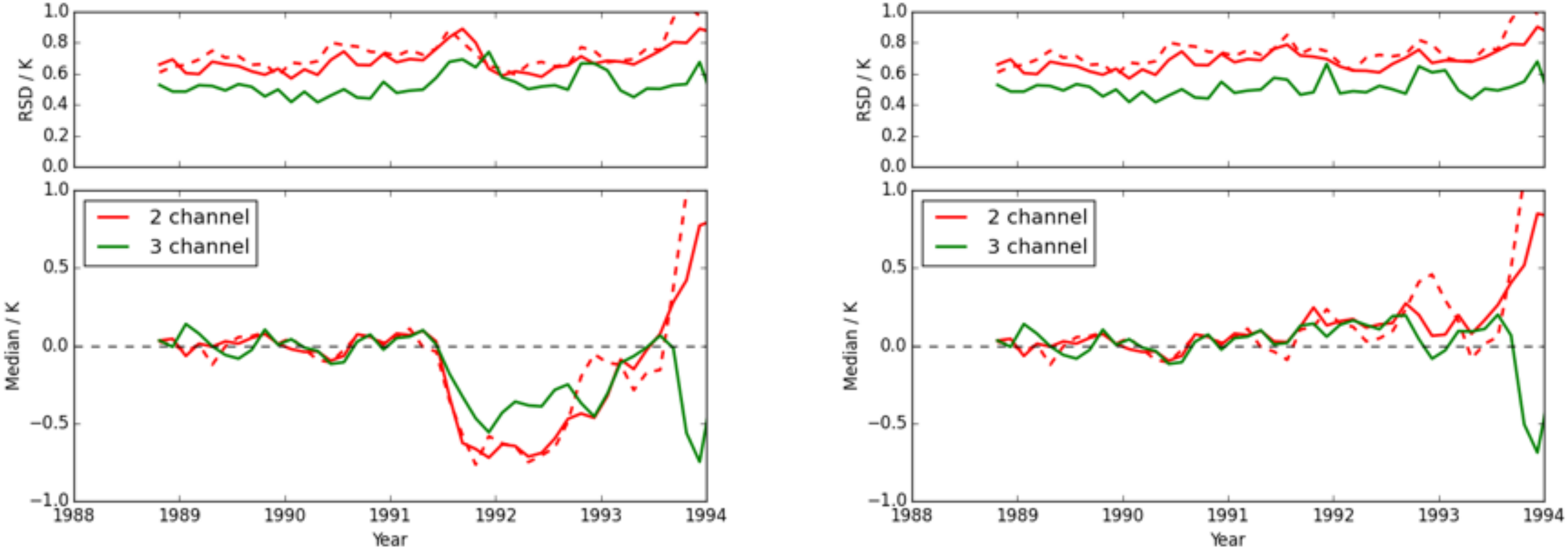
Day	**N**	**SD**	**RSD**
CLAVR-X	724444	0.933	0.473
CCI	583648	0.566	0.428
Night	**N**	**SD**	**RSD**
CLAVR-X	653789	0.825	0.342
CCI	393609	0.473	0.286

Bayesian cloud detection reduces the standard deviation of the drifter-satellite SST differences signifying a better cloud detection performance than CLAVR-X.

		N3	D2	D3
Number of matches				
Day	10312			
Night	12590			
Mean (Standard Deviation)				
Day			0.033 (0.296)	
Night		-0.004 (0.241)	0.003 (0.278)	0.044 (0.240)

AATSR – GTMBA difference statistics / K
CCI development coefficients
Atmospheric correction smoothing

Minimizing Pinatubo impact on AVHRR SST



Without (left) and with (right) stratospheric aerosol accounted for in SST retrieval

Strengths foreseen for SST CCI v2.0

- 35 year record
  - consistent across L2-L4
- Smaller uncertainties relative to precursors
  - using all AVHRRs as L4 input
  - better cloud detection and retrieval methods
- Uncertainties estimated per-datum
- Good temporal consistency ("clean signal")
- Relatively high "real" resolution in L4 product
- Respectable stability
  - TBQ for 1980s
  - harmonisation
  - stability through stratospheric aerosol events
  - aliasing of diurnal cycle removal

Importance of accurate SST observations

Very subtle errors (0.1 K) in SST matter

Relevant processes … some examples

- air-sea heat flux exchanges
- oceanic uptake of CO_2
- SST anomalies provide ‘memory’ for seasonal forecasting
- teleconnections through atmospheric circulation (e.g. ENSO)
- location and timing of tropical convection (e.g. MJO)

Sea surface temperature

- prescribed for atmospheric re-analyses
- key variable constraining coupled re-analyses
- prescribed for climate model investigations (e.g, AMIP)
- widely used in model evaluation

closely related *Isochrysis*. The more distant clade D comprises bacterial genes with ~30% identity to *Alma1*, but its relevance is yet to be determined. We synthesized five genes from across the phylogenetic tree and expressed them in *E. coli* (see the SM). Two genes, *E. huxleyi Alma2* (clade C) and *Symbiodinium*-A1 (clade A) were expressed at low levels, yet exhibited lyase activity upon feeding DMSP to *E. coli* culture (fig. S10). However, these two enzymes were not sufficiently stable to be purified.

The identification of the family members of the newly identified algal DMSP lyase in a wide range of marine organisms would enable better understanding of the physiological and signaling roles of DMS in algal resistance to viral infection, predation (*5*), and commensal (*14*) and symbiotic interaction (*31*). Although it is clear that DMS production by bacteria DMSP lyases has a fundamental role in the oceanic sulfur and carbon cycles, the newly revealed algal enzyme may allow quantification of the relative biogeochemical contribution of algae and bacteria to the global DMS production.

REFERENCES AND NOTES

1. W. Sunda, D. J. Kieber, R. P. Kiene, S. Huntsman, *Nature* **418**, 317–320 (2002).
2. E. Garcés, E. Alacid, A. Reñé, K. Petrou, R. Simó, *ISME J.* **7**, 1065–1068 (2013).
3. M. Garren *et al.*, *ISME J.* **8**, 999–1007 (2014).
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5. G. V. Wolfe, M. Steinke, G. O. Kirst, *Nature* **387**, 894–897 (1997).
6. A. J. Kettle, M. O. Andreae, *J. Geophys. Res. Atmos.* **105** (D22), 26793–26808 (2000).

CLIMATE CHANGE

Possible artifacts of data biases in the recent global surface warming hiatus

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Much study has been devoted to the possible causes of an apparent decrease in the upward trend of global surface temperatures since 1998, a phenomenon that has been dubbed the global warming "hiatus." Here, we present an updated global surface temperature analysis that reveals that global trends are higher than those reported by the Intergovernmental Panel on Climate Change, especially in recent decades, and that the central estimate for the rate of warming during the first 15 years of the 21st century is at least as great as the last half of the 20th century. These results do not support the notion of a "slowdown" in the increase of global surface temperature.

The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (*1*) concluded that the global surface temperature "has shown a much smaller increasing linear trend over the past 15 years [1998–2012] than over the past 30 to 60 years." The more recent trend was "estimated to be around one-third to one-half of the trend over 1951–2012." The apparent slowdown was termed a "hiatus" and inspired a suite of physical explanations for its cause, including changes in radiative forcing, deep ocean heat uptake, and atmospheric circulation changes (*2*–*12*). Although these analyses and theories have considerable merit in helping to understand the global climate system, other important aspects of the "hiatus" related to observational biases in global surface temperature data have not received similar attention. In particular, residual data biases in the modern era could well have muted recent warming, and as stated by IPCC, the trend period itself was short and commenced with a strong El Niño

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NATURAL ENVIRONMENT RESEARCH COUNCIL

Karl et al, Science, June 2015.

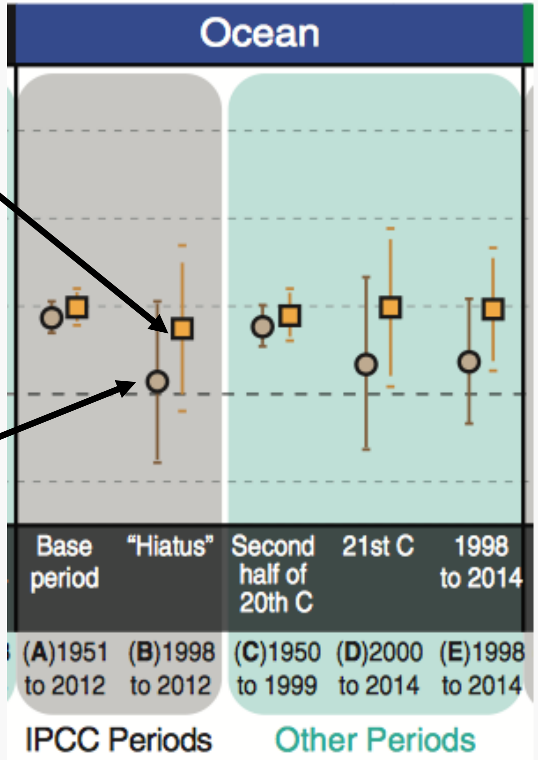
that is an underestimate because of incomplete coverage over the Arctic. Indeed, according to our new analysis, the IPCC's (*1*) statement of 2 years ago—that the global surface temperature "has shown a much smaller increasing linear trend over the past 15 years than over the past 30 to 60 years"—is no longer valid.

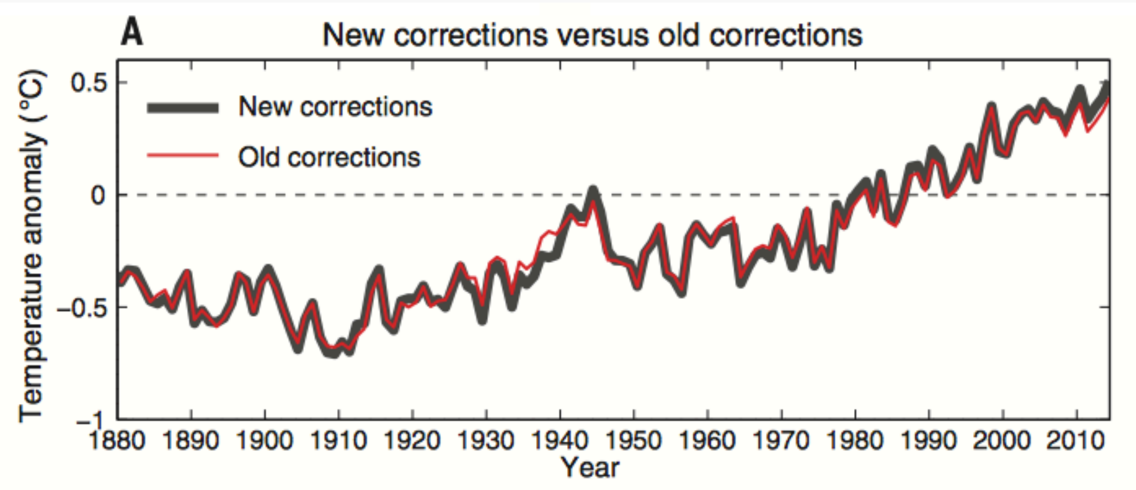
REFERENCES AND NOTES

1. IPCC, *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report*

New “Karl et al” global ocean temperature trend (98 to 12) 0.08 K/decade

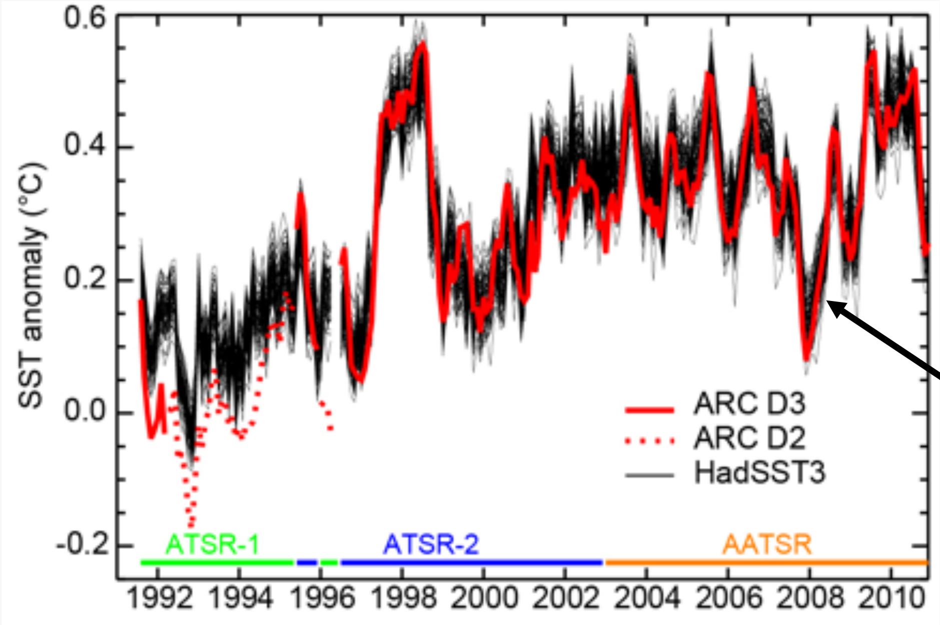
“IPCC” trend during “global warming hiatus” 0.01 K/decade





New assumptions about **in situ SST biases** in the NOAA ERSST dataset turn a “hiatus” (red) into a trend consistent with late 20th C trend

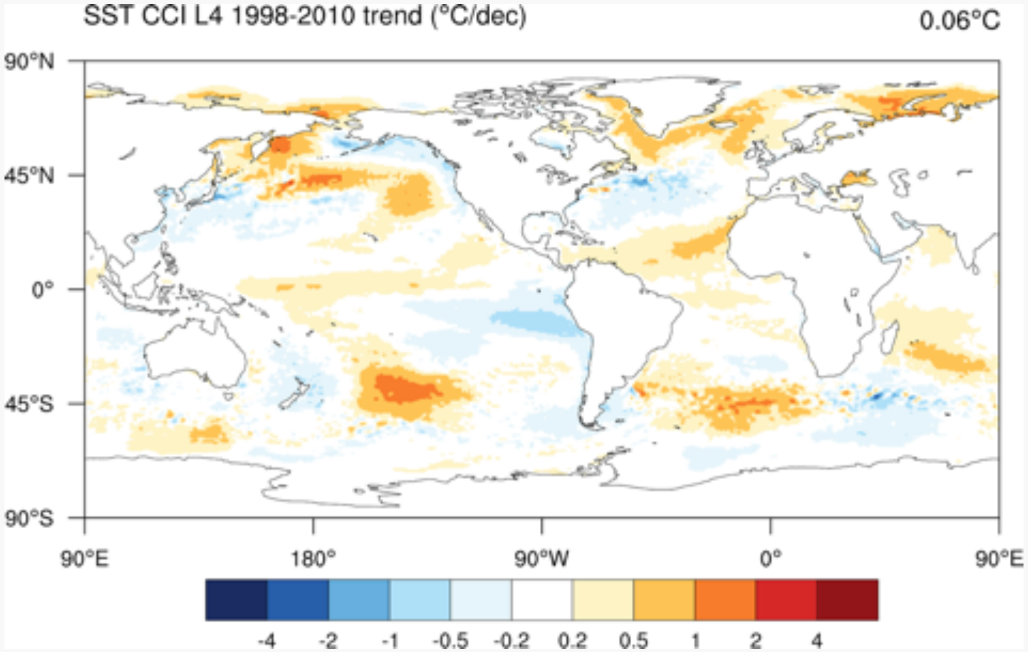
Last IPCC report also contained the first satellite-only SST CDR based on ATSRs



Solid red: best quality satellite SSTs

Trend in the ARC SST time series (1998 to 2012) is 0.06^{o}C/dec

SST CCI: Satellite only blend of ATSRs and AVHRRs gives consistent picture to ARC



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Science & Environment

Climate change: Fresh doubt over global warming 'pause'

By Matt McGrath
Environment correspondent

5 January 2017 | Science & Environment | Share

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Glaciers have continued to melt at increasing rates over the past 20 years despite the supposed pause

A controversial study that found there has been no slowdown in global warming has been supported by new research.

Many researchers had accepted that the rate of global warming had slowed in the first 15 years of this century.

But **new analysis in the journal Science Advances** replicates findings that scientists have underestimated ocean temperatures over the past two decades.

With the revised data the apparent pause in temperature rises between 1998 and 2014 disappears.

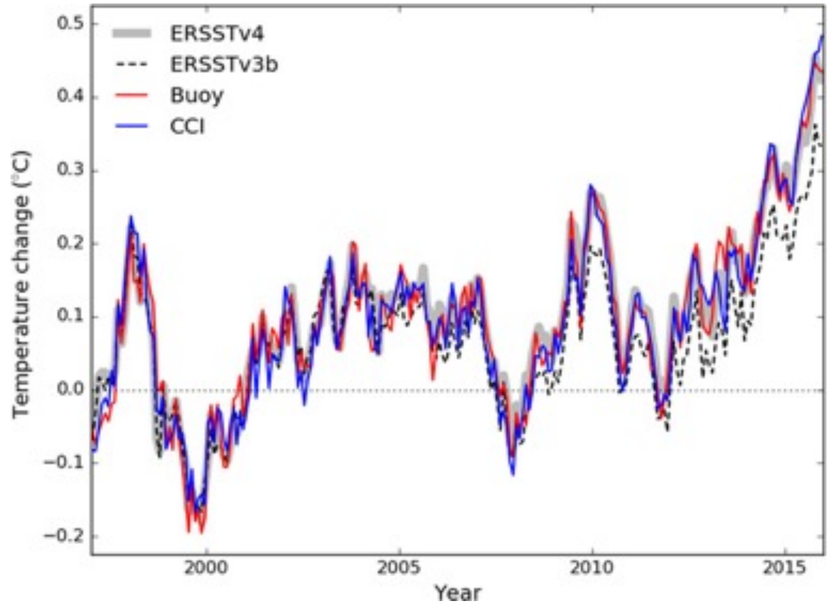
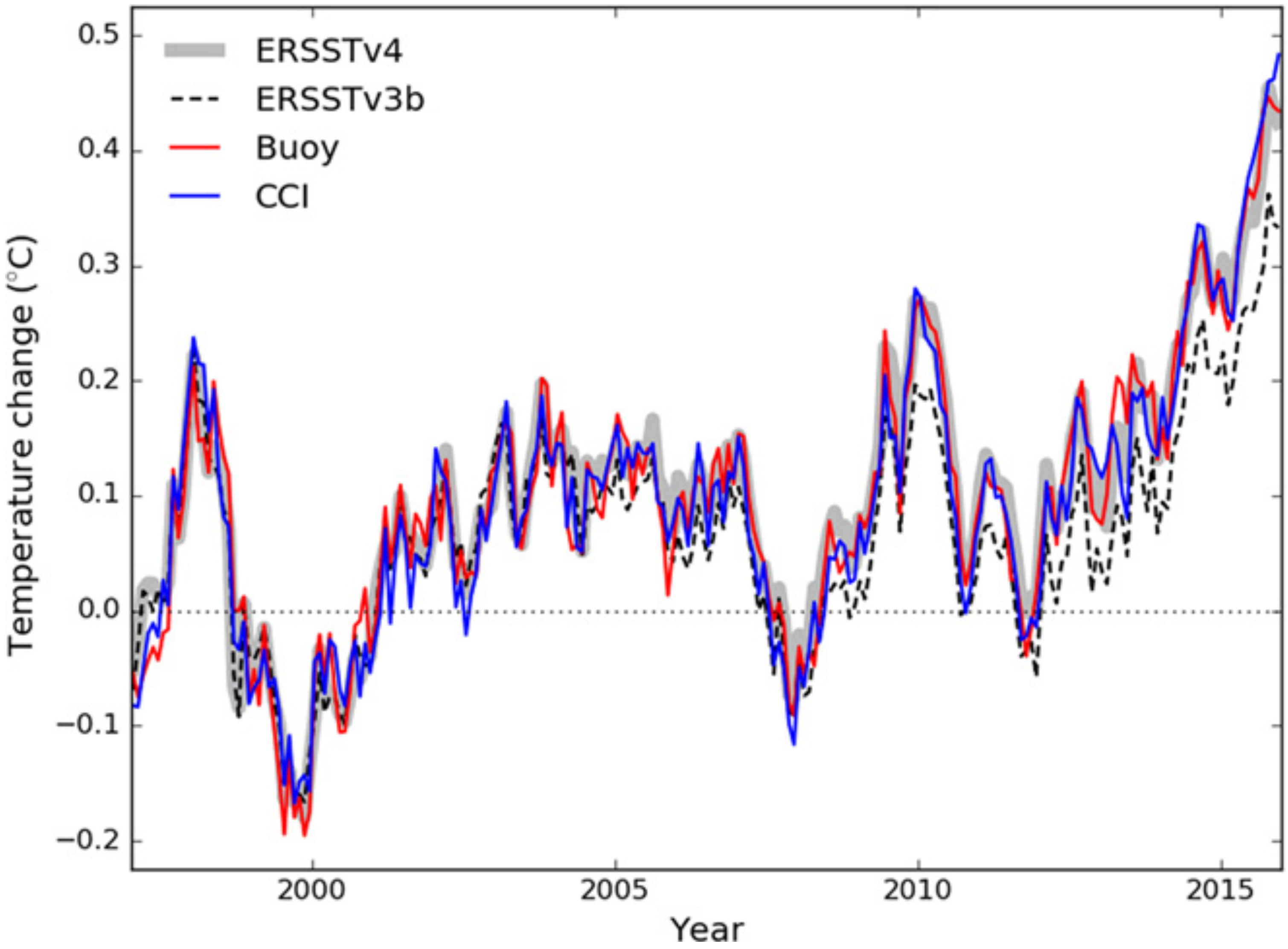


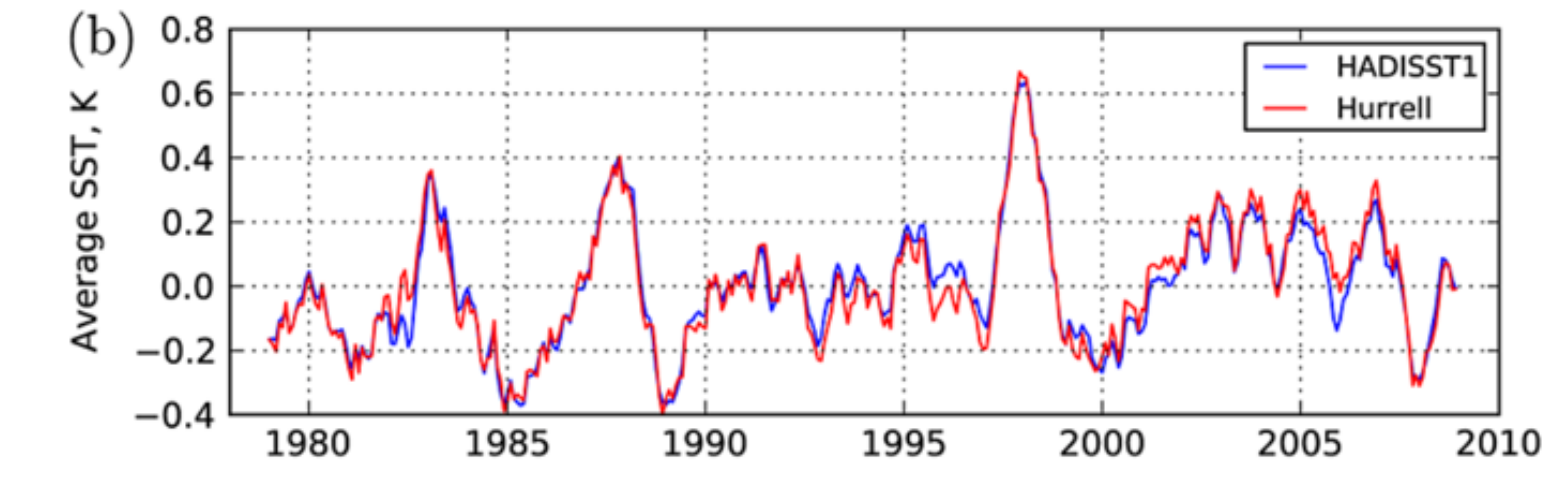
Fig. 1 Comparison of the different ERSSTv3b, ERSSTv4, buoy-only, and CCI SST monthly anomalies from January 1997 to December 2015, restricting all series to common coverage.



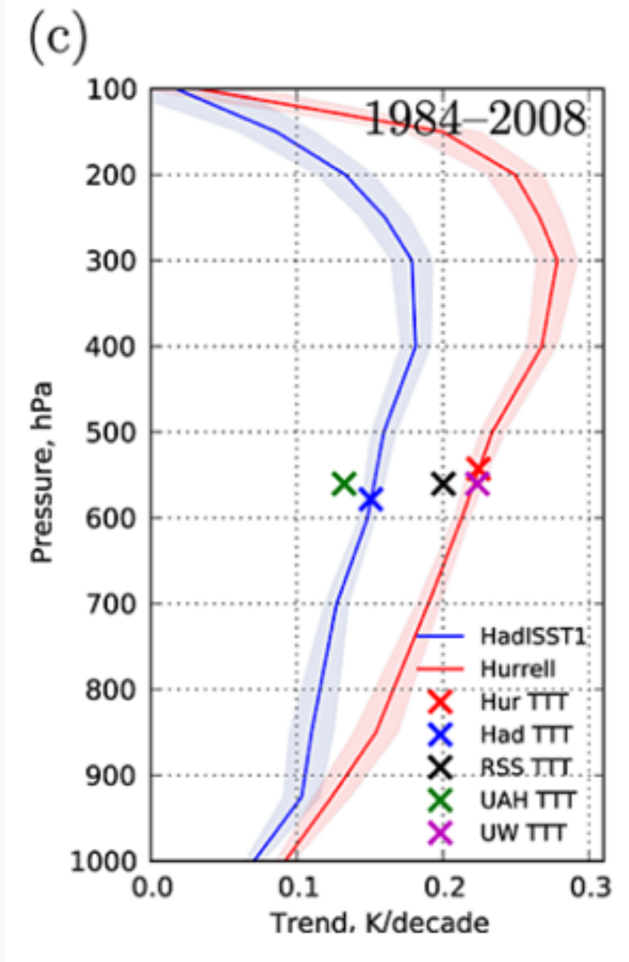
Zeke Hausfather et al. Sci Adv 2017;3:e1601207

Science Advances
AAAS

Published by AAAS



20°S to
20°N mean

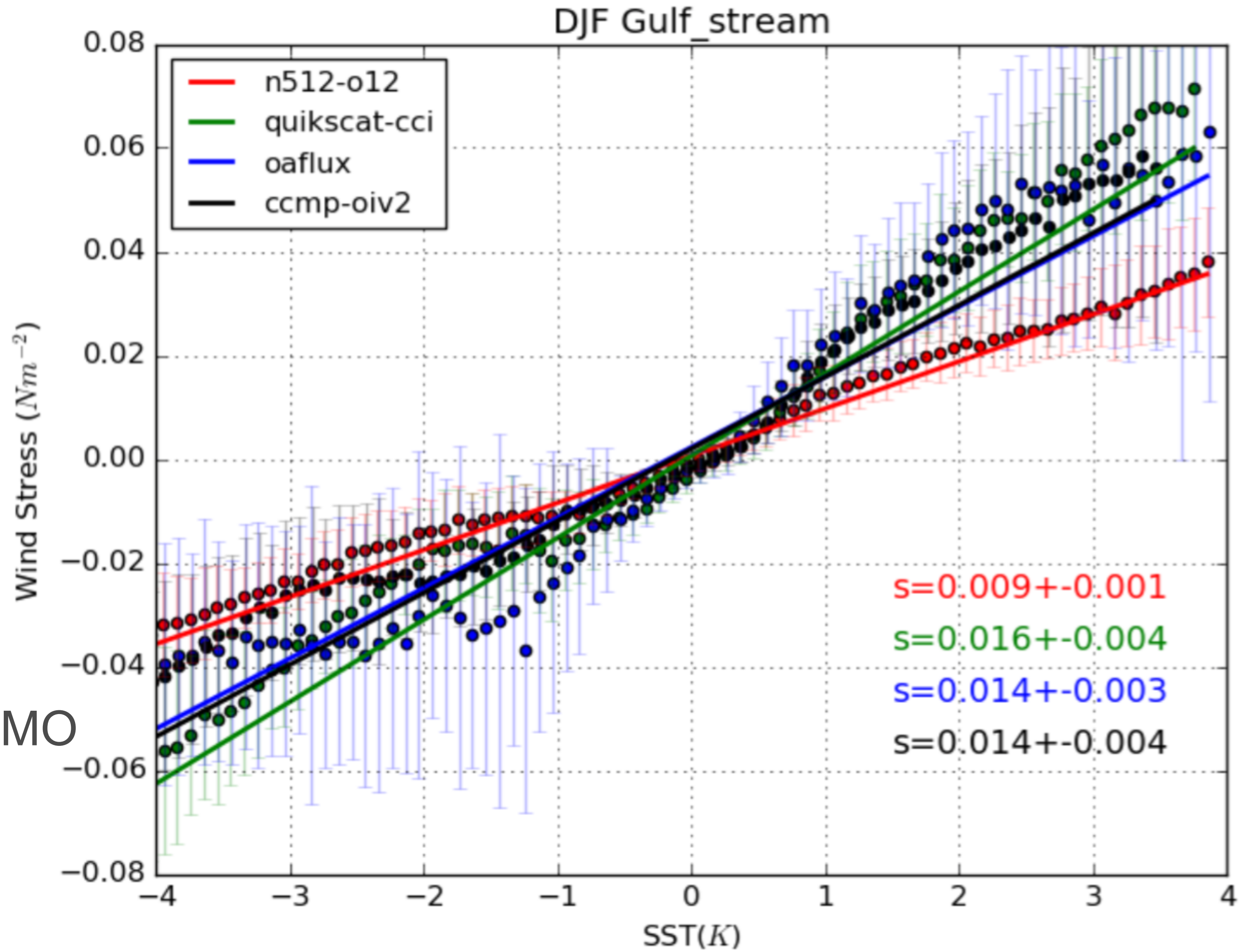


"The differences in simulated tropospheric temperature trends between model runs [forced with] HadISST1 and Hurrell [NOAA OI v2] are significant compared to the trends themselves, focusing attention on the uncertainty in the SST datasets."

Flanaghan et al., 2014
Journal of Geophysical Research: Atmospheres
Volume 119, Issue 23, pages 13,327-13,337, 11 DEC 2014 DOI: 10.1002/2014JD022365
http://onlinelibrary.wiley.com/doi/10.1002/2014JD022365/full#jgrd51871-fig-0004

Air-sea coupling strength

3 different pairs of observational data



Malcolm Roberts UKMO

Planned CCI work 2017 in SST CCI CRG

- Simulations
  - Run 25km global model (and lower resolution) with CCI SST product – 1981-2016
  - This in parallel to HighResMIP/PRIMAVERA simulation using HadISST2.2 ¼˚ daily SST for 1950-2014, and to CMIP6 simulations (using monthly 1˚ PCMDI)
    - Assess impact of SST forcing dataset
    - Assess impact of model resolution
    - To include consideration of mid-latitude storms, air-sea interaction, assessment of cold wakes from tropical cyclones
  - Coupled eddy-resolving simulations (1/12˚) from 4 PRIMAVERA groups may also help understand aspects of model SST variability
    - Look at air-sea coupling strength from ensemble
    - Compare to longer CCI-SST and other SST/windstress products
- Other analysis (outside CCI)
  - Continued evaluation of SST variability in observations and models, down to daily and sub-daily (Pat Hyder)
  - What aspects of model and observational variability agree/disagree

Where will SST CCI v2.0 go?

Beyond CEMS/doi and Portal:

CCI Toolbox – tools focussed on teleconnections

Climate Change Service (C3S)

- v2.0 CDR will be brokered once released
- Interim CDR hosted at C3S using SST CCI v2.0 processing chain will increase in timeliness progressively through pre-operational phase

Obs4MIPS

- ARC-based obs4MIPS SST was created in Phase 1, and this will be done again with v2.0

Marine Service

- Experimental v1.2 was taken up by CMEMS, and need to ensure a brokering arrangement for L4 can be established there too