Outline

Introduction

Hyperspectral IR measures both:

- Climate forcings (and other gas greenhouse effect)
- Earth system responses (temperature, humidity, clouds, surface properties)
- AIRS now 1 of 6 operational hyperspectral sounders
  - AIRS now up 17 years, IASI-1 12 years is next longest (9:30 orbit)
  - 17 years can be considered "long enough" for climate trending
  - AIRS record will be extended with CrIS (1:30 orbit)
- AIRS long time series makes it unique
- What limits climate-level trending with AIRS
  - Calibration stability
  - Retrieval algorithm limitations
  - Climate level measurements require frequent full-mission reprocessing

Climate Questions Relevant for IR Sounding

Language of Climate Research

- Atmospheric/surface anomalies (variations over time from the mean/baseline)
- Relationships between atmospheric variables undergoing climate forcings
- Improved understanding of dynamic processes possible via IR soundings
- Break into two categories, although they overlap.

General: Climate Data Records

- Temperature, Humidity, Ozone anomalies
- Minor gas trends
- Cloud anomalies
- Event detections: extrema, occurance of cloud types, volcanic events

Feedbacks: Climate Feedbacks

Climate Calibration Requirements

NASA: uncertainty is a requirement

1. Radiometric stability
2. Mult-instrument continuity
3. AIRS absolute radiometric accuracy is very good, but:
   - Grating spectrometer produces far greater radiometric variation with channel than interferometers
   - Accuracy is similar to Forward Model uncertainties
   - All retrieval approachs bias tune the radiometry in one form or another

AIRS Calibration Overview

Goal for climate measurements: small fraction of 0.01K/year

- Absolute accuracy is ~0.1-0.3K
- But with significant variations within this range with detector, module

However: AIRS is extremely stable

- The blackbody *may* be stable to $<$ ~0.004 K/year
- The individual channels are less stable, with considerable variability

Standards

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Weather Forecasts-Interim (ERA-I) reanalysis [*Dee et al.*, 2011]. Observed cloud fields were deemed too uncertain, and comparison with models too subjective, to be included. Surface air temperature and

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Journal of Geophysical Research: Atmospheres

RESEARCH ARTICLE
10.1002/2015JD023381

Key Points:

- Radiation, temperature, and water vapor relationships are explored
- CESM replicates many aspects of

Relationships among top-of-atmosphere radiation and atmospheric state variables in observations and CESM

Kevin E. Trenberth[1], Yongxin Zhang[1], and John T. Fasullo[1]

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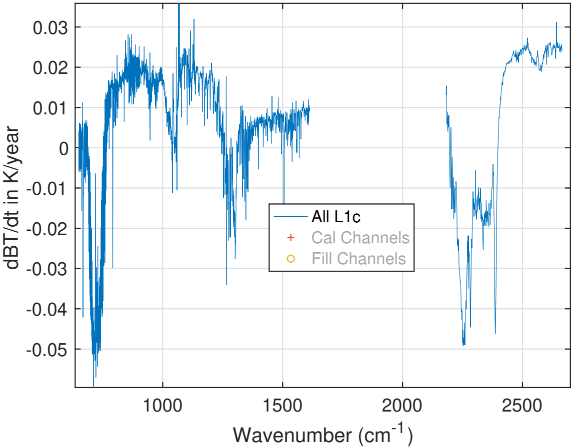

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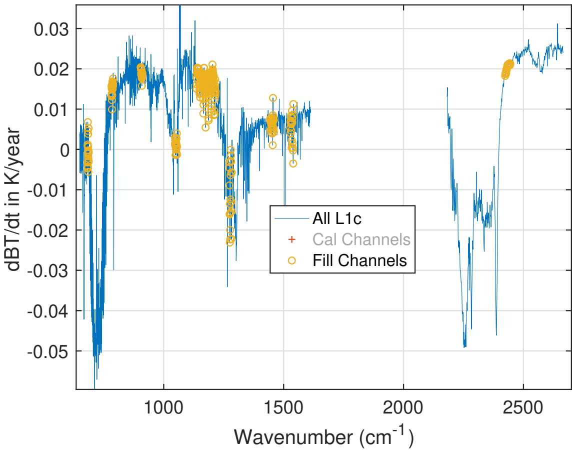

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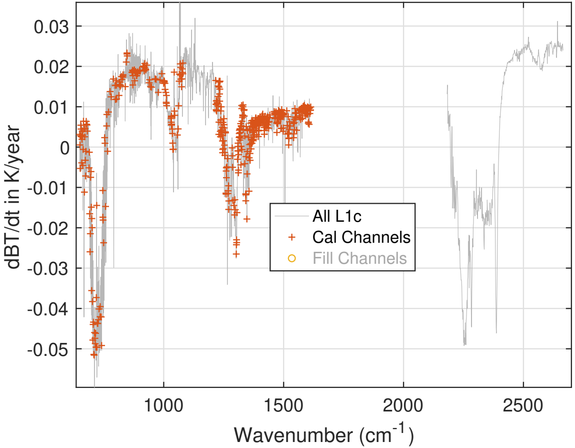

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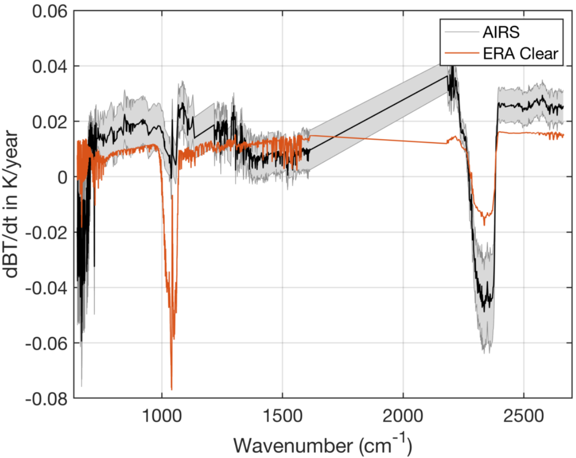

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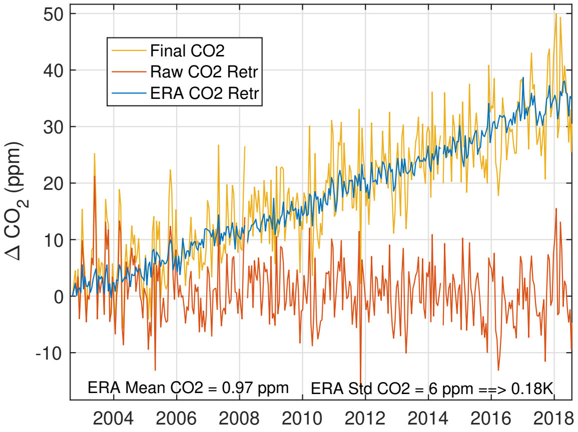

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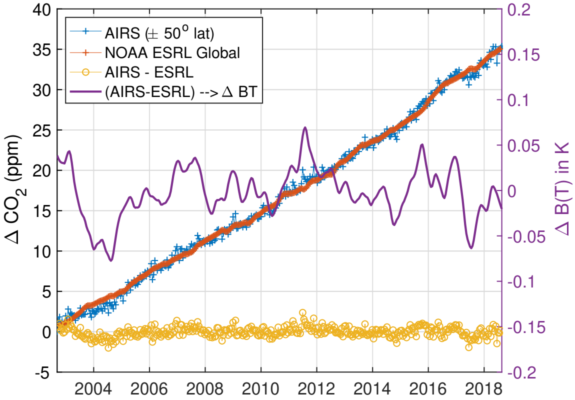

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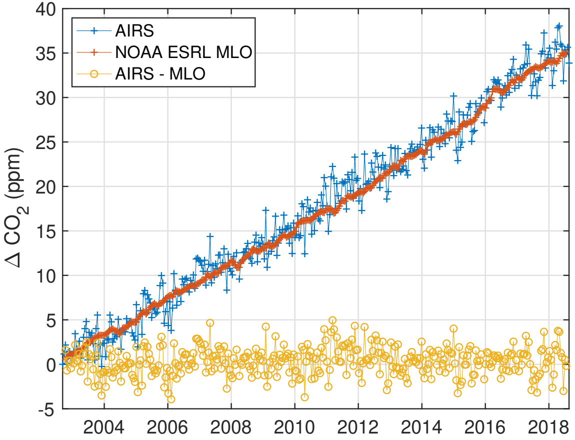

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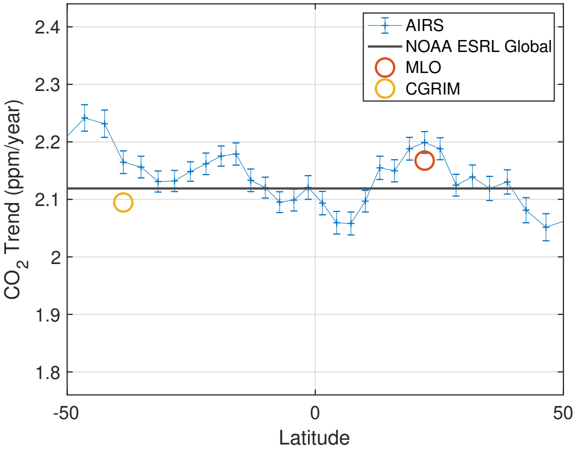

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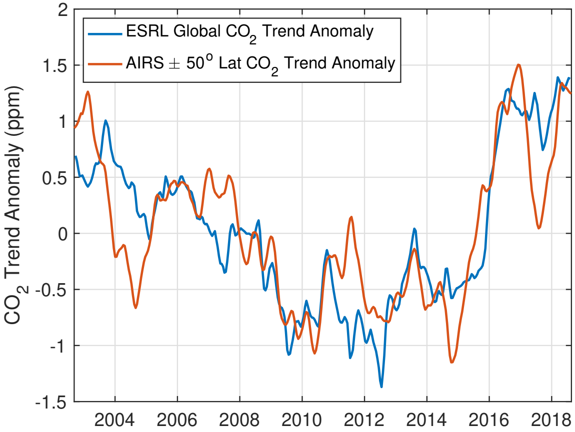

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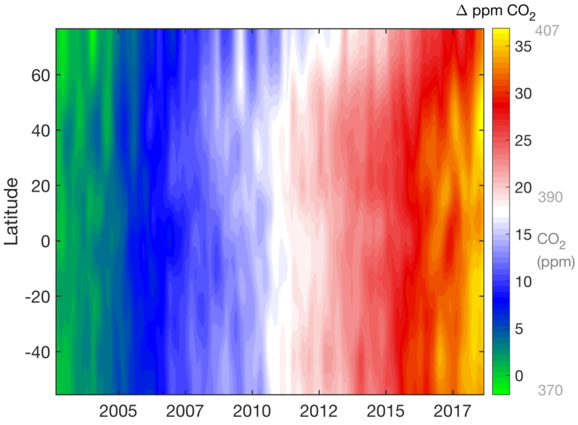

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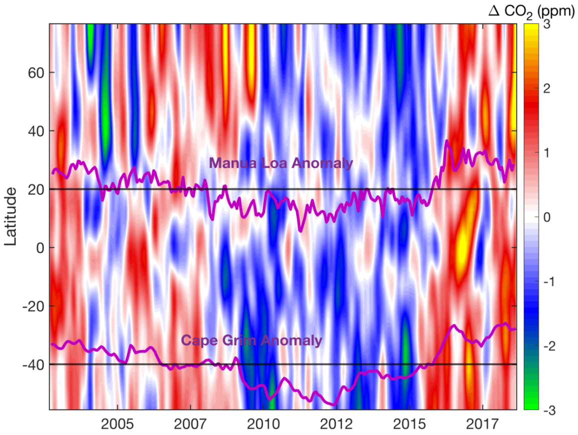

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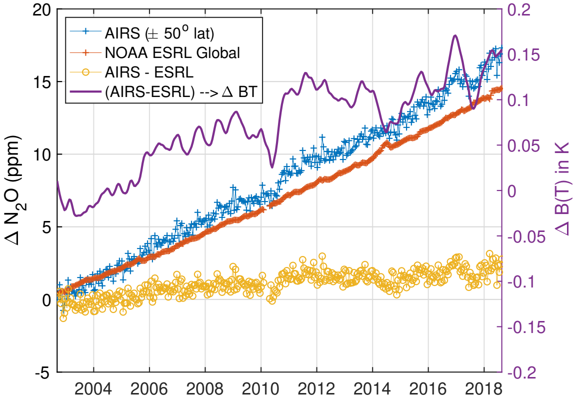

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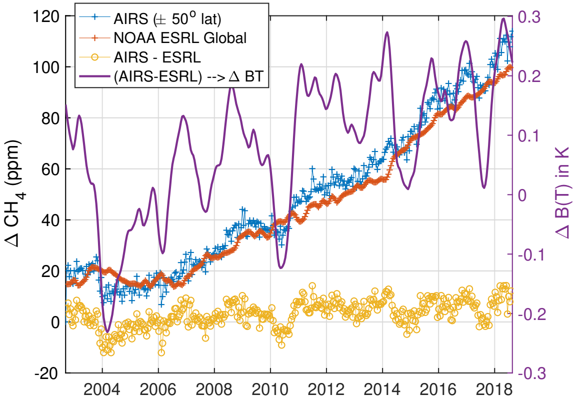

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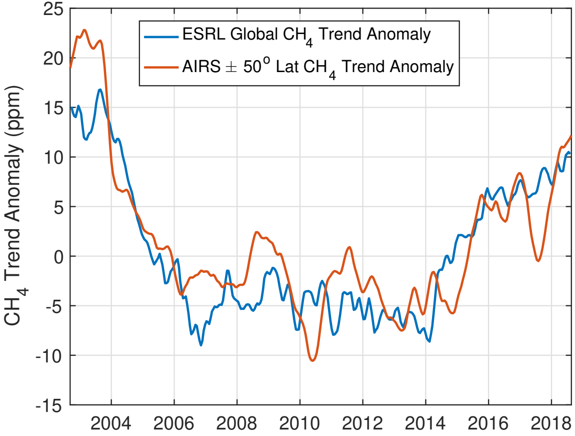

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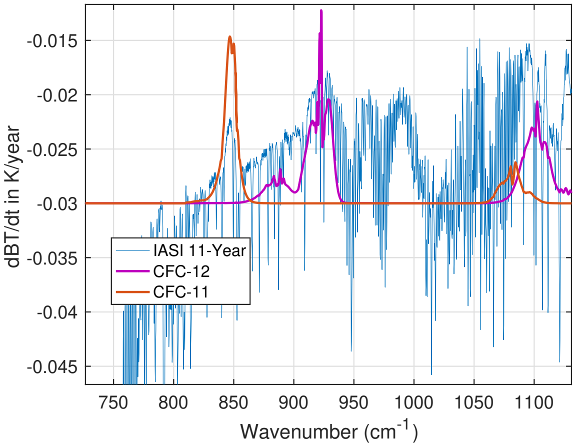

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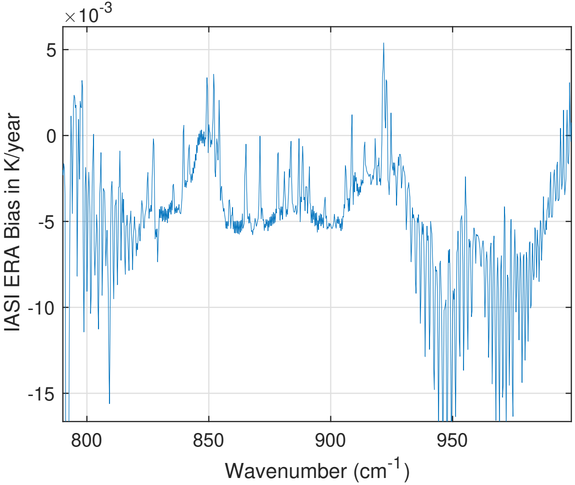

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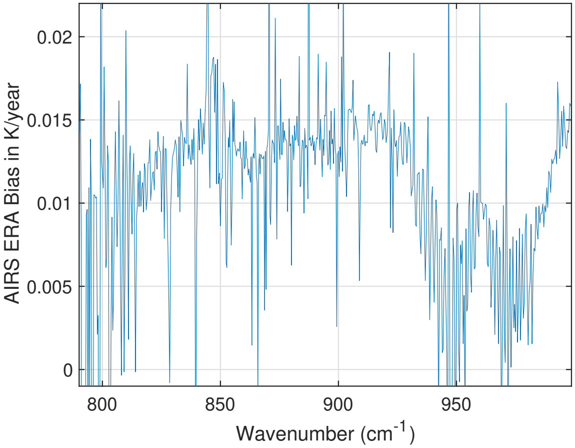

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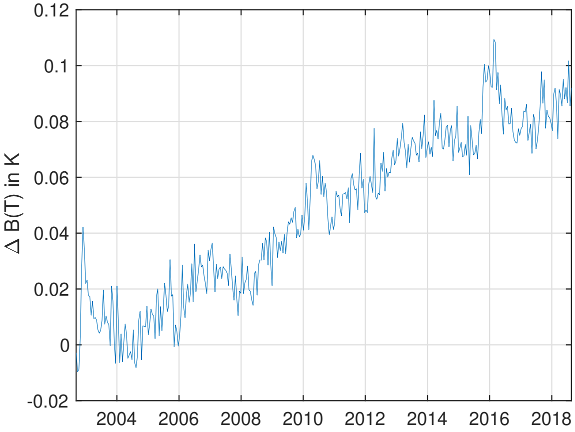

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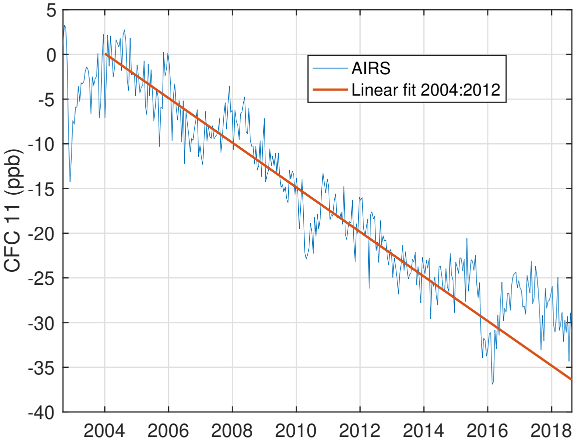

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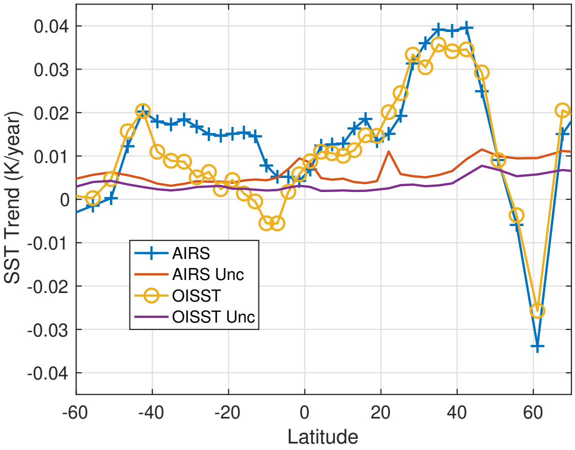

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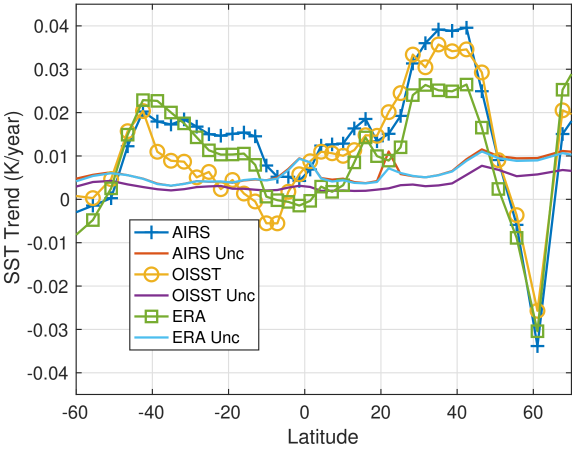

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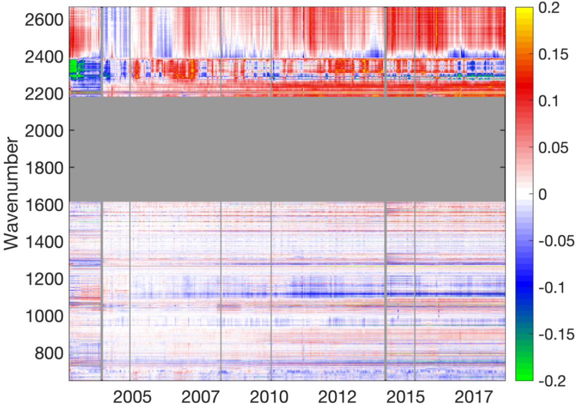

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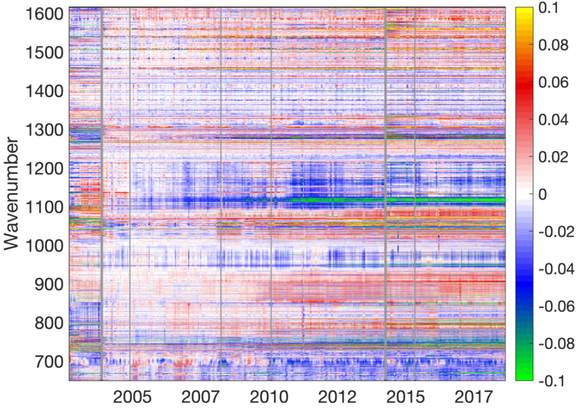

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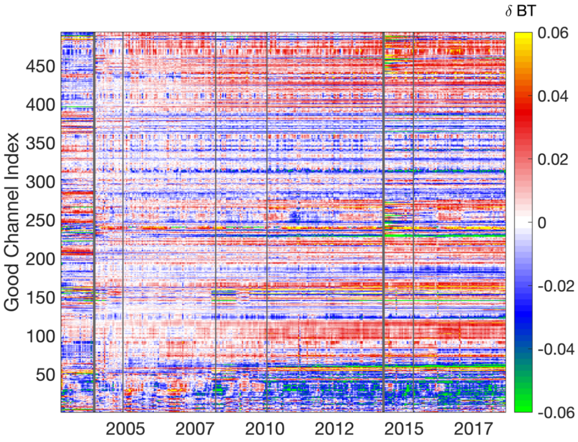

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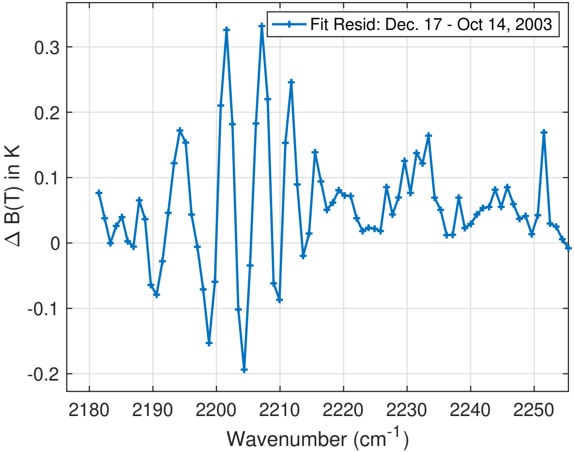

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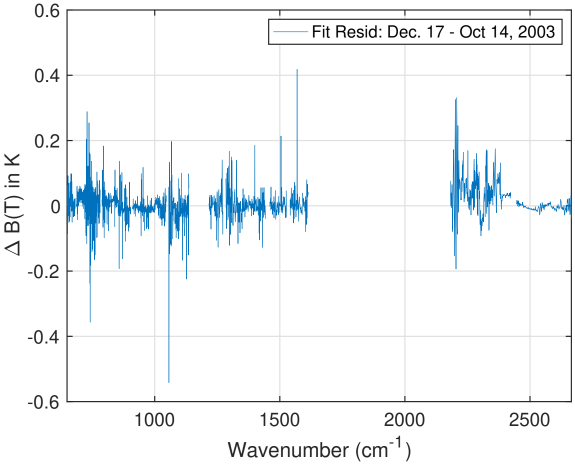

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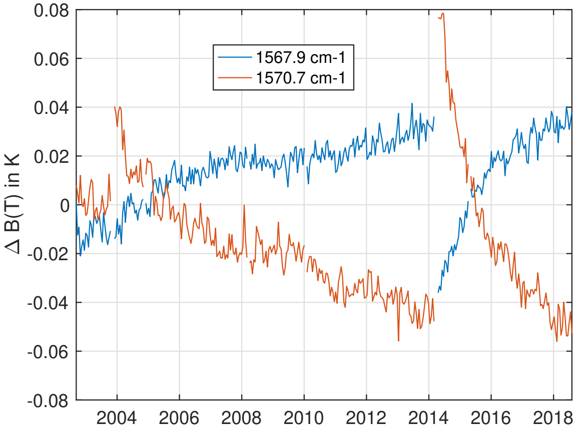

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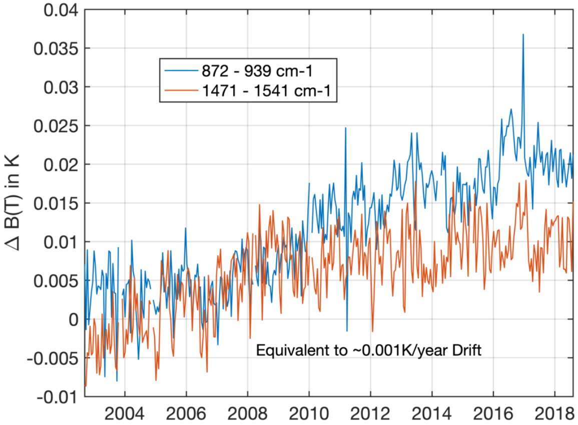

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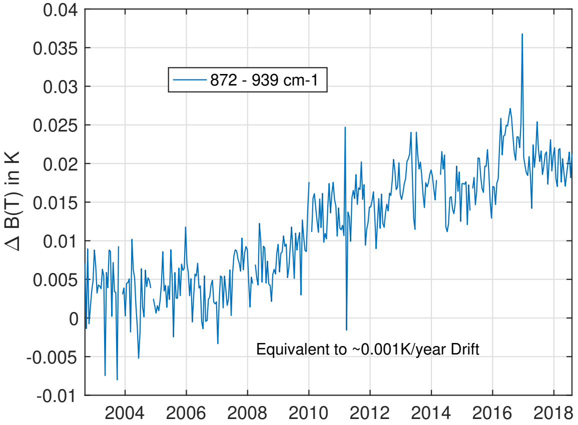

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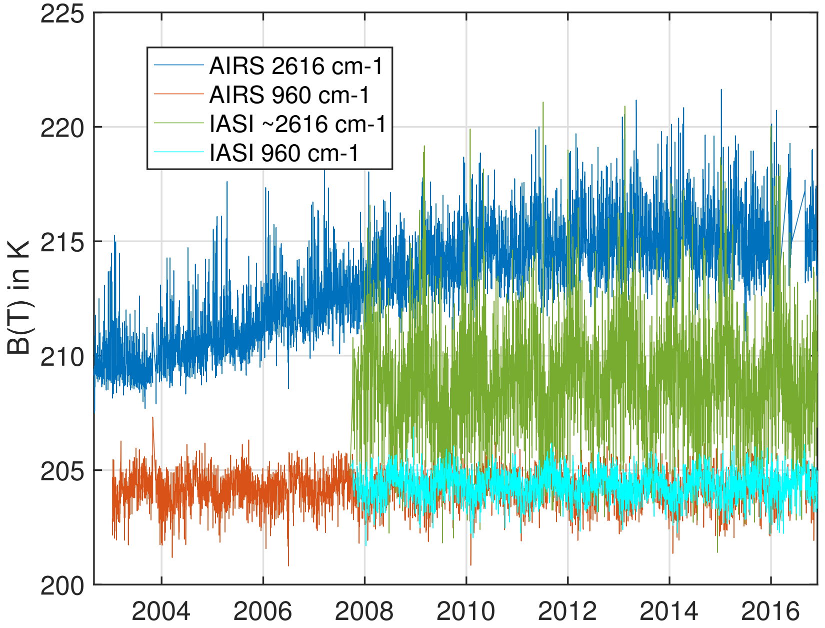
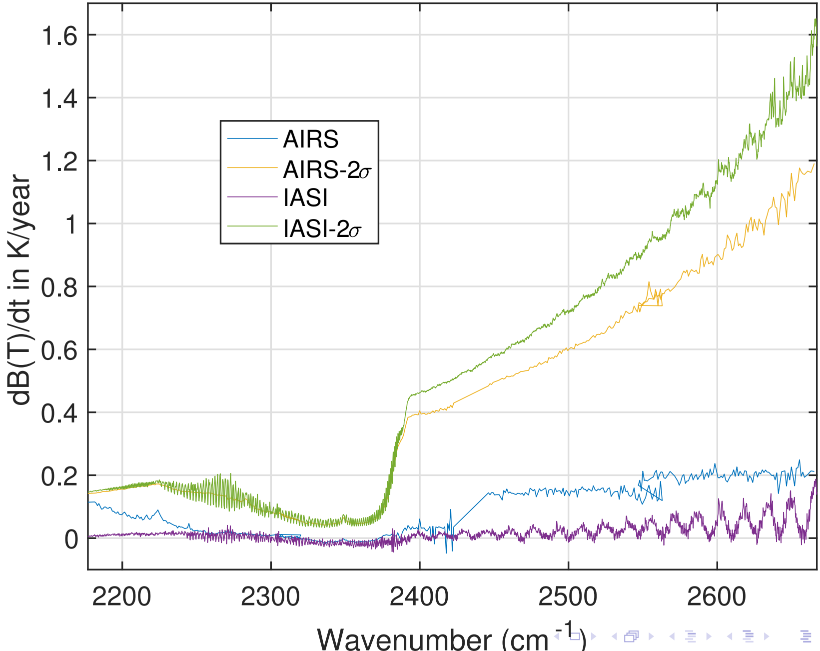


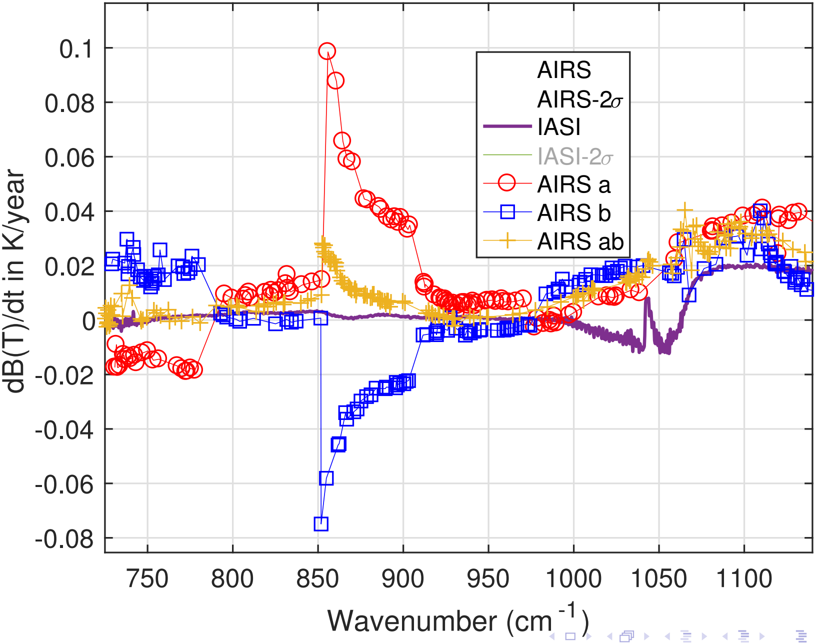
AIRS 2616 cm-1
AIRS 960 cm-1
IASI ~2616 cm-1
IASI 960 cm-1
B(T) in K
225
220
215
210
205
200
2004
2006
2008
2010
2012
2014
2016

DCC4



AIRS
AIRS-2σ
IASI
IASI-2σ
dB(T)/dt in K/year
Wavenumber (cm⁻¹)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2200
2300
2400
2500
2600

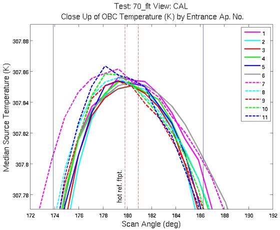
DCC6


AIRS
AIRS-2σ
IASI
IASI-2σ
AIRS a
AIRS b
AIRS ab
dB(T)/dt in K/year
Wavenumber (cm -1)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
750
800
850
900
950
1000
1050
1100

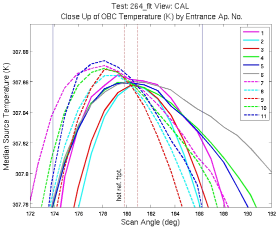
overroye_scan.pdf

Profiles with Expanded Temperature Scale

Test 70, July 2002



Test 264, April 2014

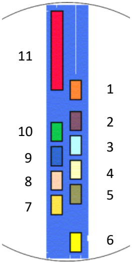


- Vertical blue lines define the limits of the normal calibration footprint
- Curvature within the limits probably indicate gradients within the OBC
- Some difference seen in the profiles, 2002 to 2014

overroye_map.pdf

C9 Test Differences (2002 - 2014) positions projected onto OBC Aperture

Aper.	Lt. Edge	Rt. Edge	Center	Width	
No.	(mm)	(mm)	(mm)	(mm)	Modules
	Right col. of apertures (in order of height position on FPA):				
1	-0.008	0.045	0.018	0.052	M9, M10
2	0.018	0.039	0.029	0.024	M2a
3	0.013	0.029	0.021	0.016	M2b
4	0.000	0.084	0.039	0.084	M4c, M4d
5	0.000	0.050	0.026	0.050	M4a, M4b
6	NaN	0.039	NaN	NaN	M5, M6
	Left column of apertures (in order of height position on FPA):				
11	-0.013	0.013	0.000	0.024	M11, M12
10	-0.024	0.018	-0.003	0.042	M3
9	NaN	0.005	NaN	NaN	M1b
8	NaN	0.005	NaN	NaN	M1a
7	NaN	0.052	NaN	NaN	M7, M8



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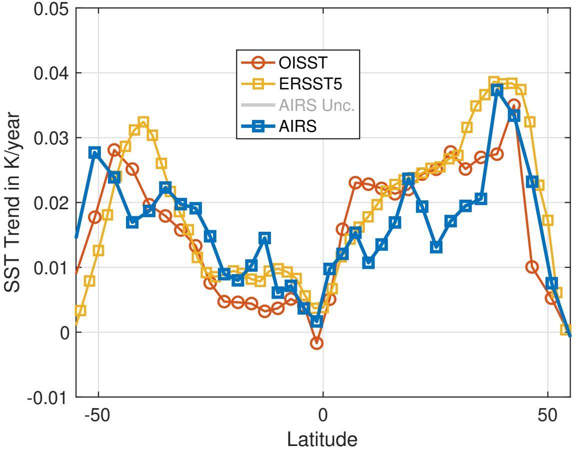

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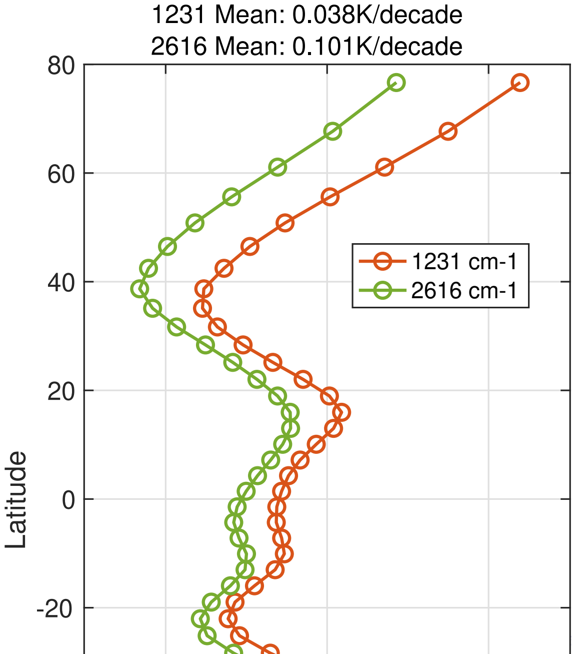

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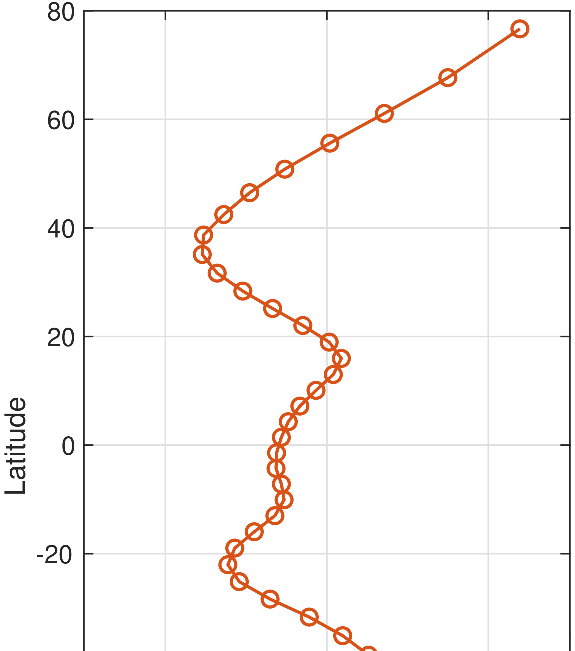

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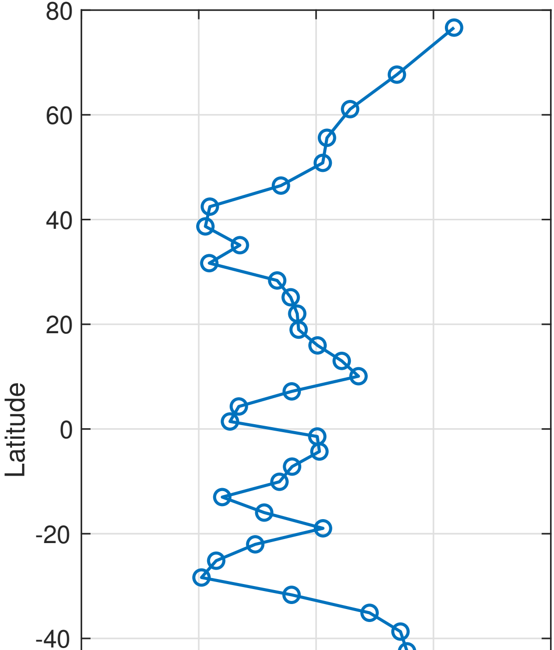

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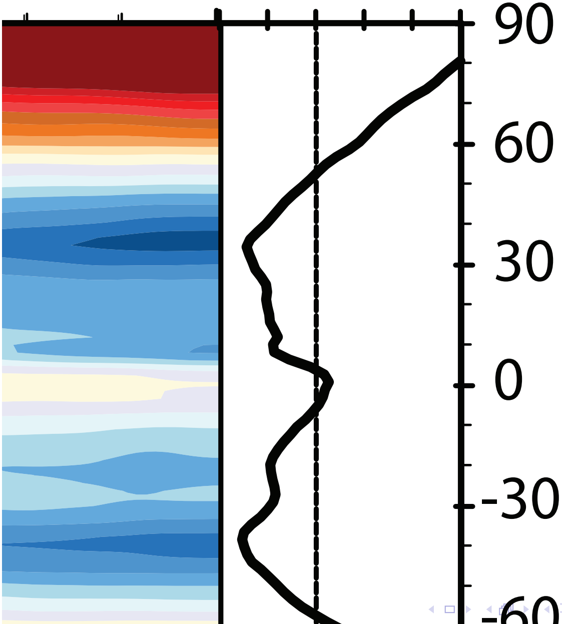

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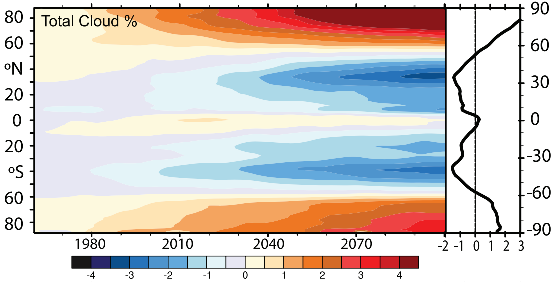

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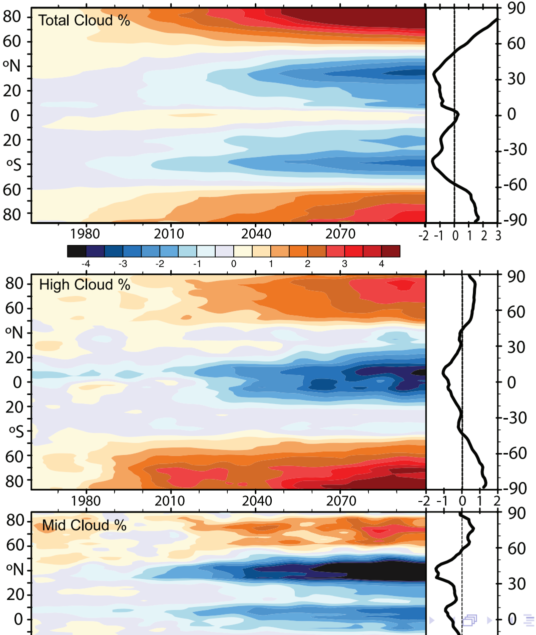

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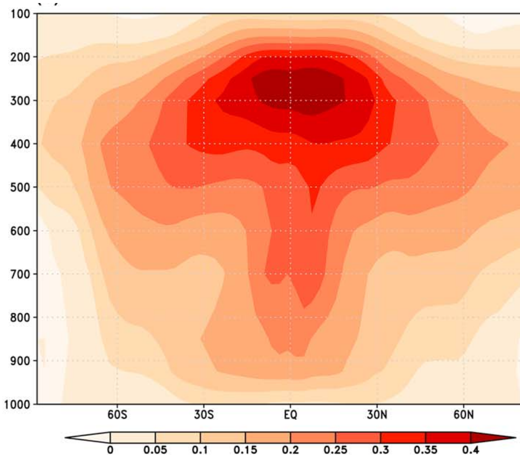

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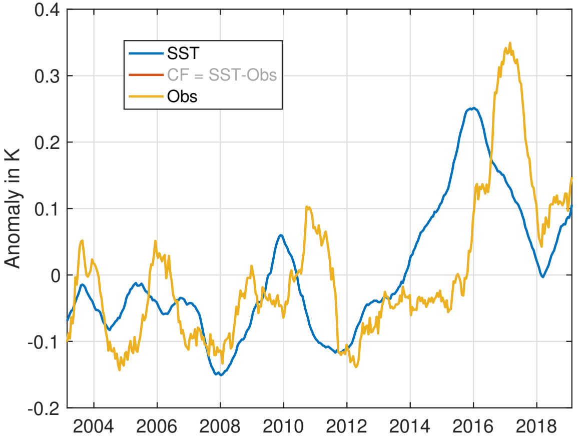

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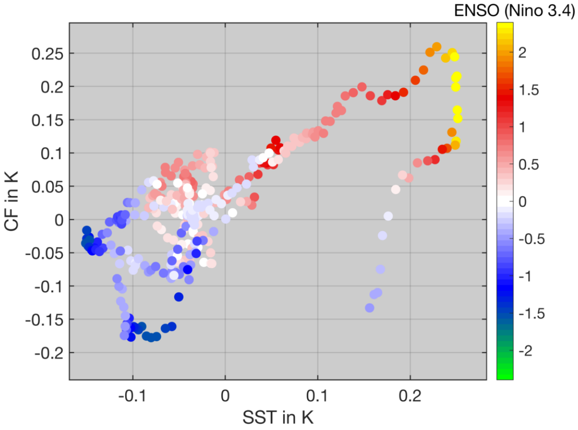

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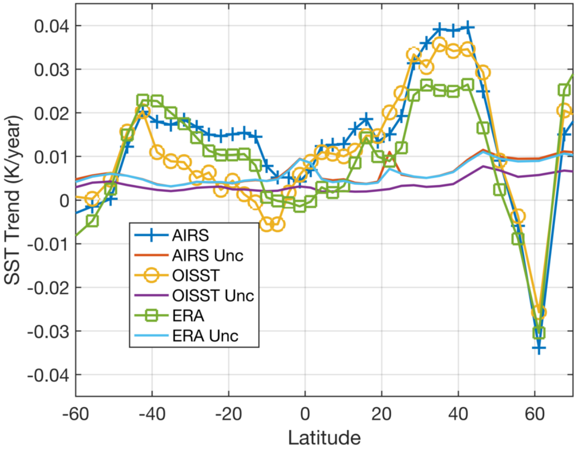

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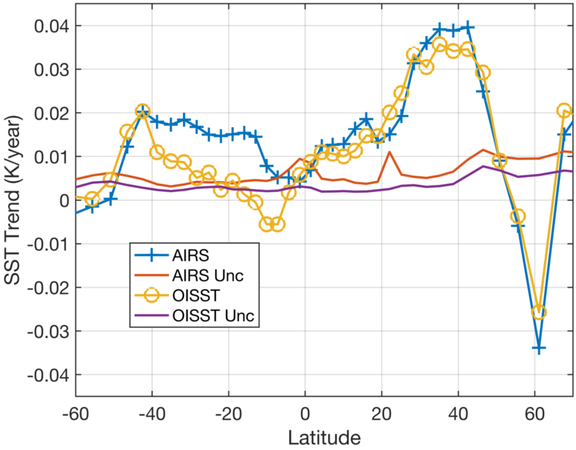

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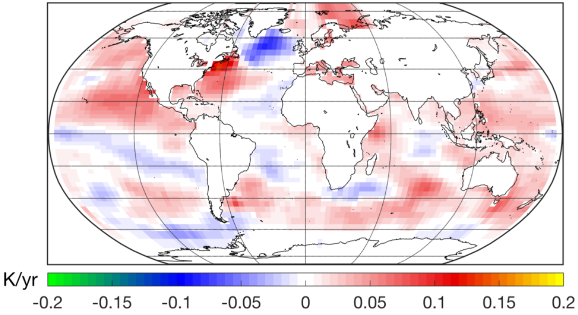

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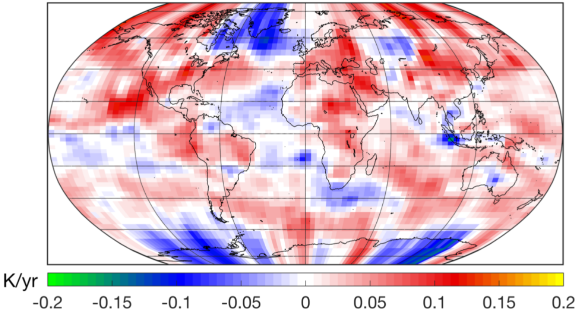

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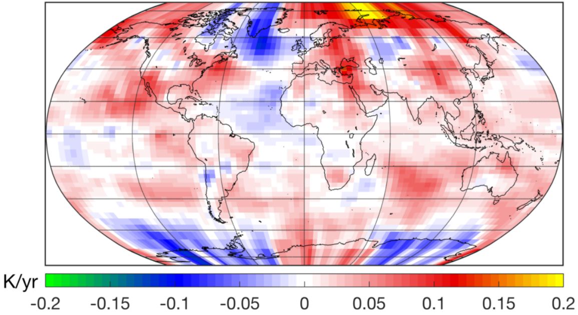

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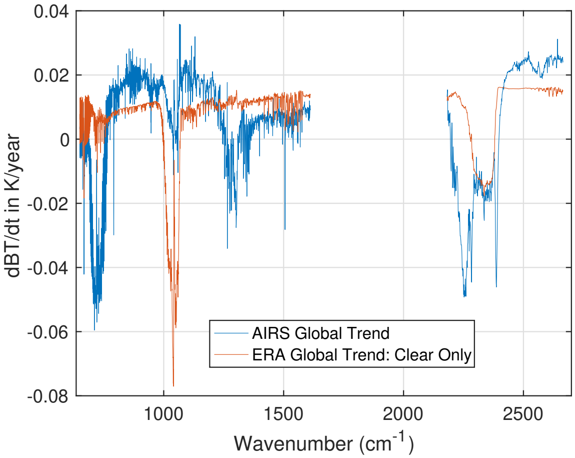

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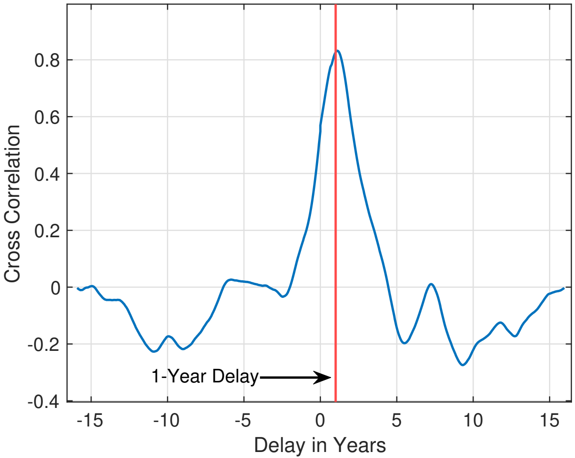

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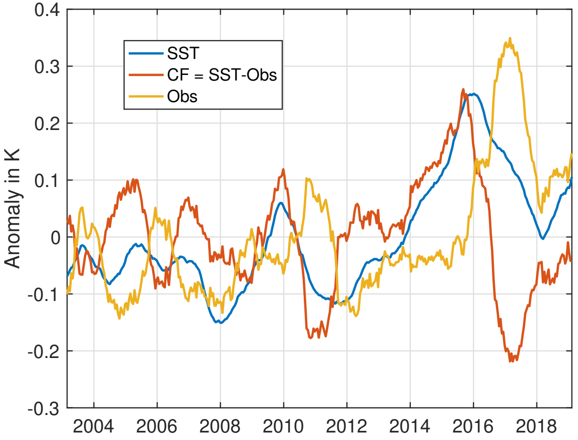

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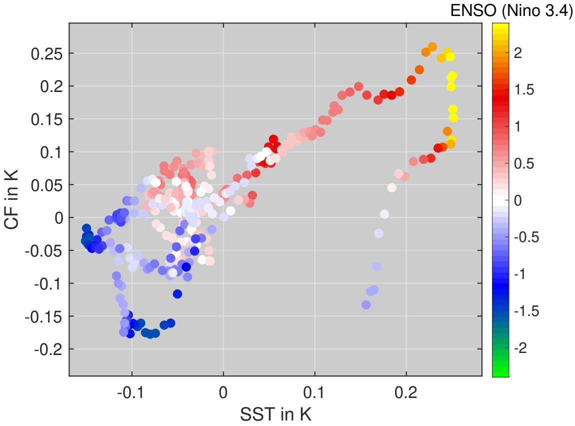

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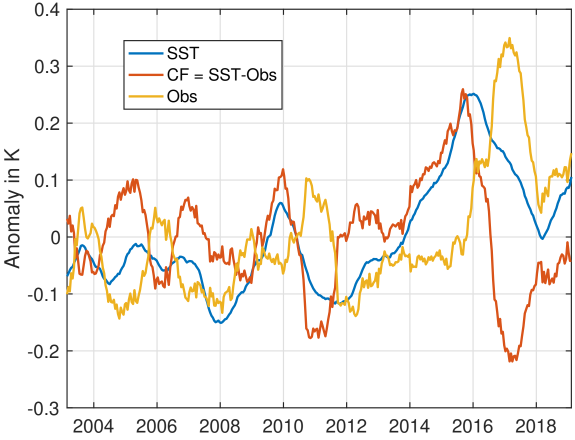

Png/water_chans_1400to1600_trend_vs_btobs_2dhist_glc