

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, occurrence of cloud types, volcanic events

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 approaches 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 $\sim 0.1\text{-}0.3\text{K}$
- ▶ But with significant variations within this range with detector, module

However: AIRS is extremely stable

- ▶ The blackbody *may* be stable to $< \sim 0.004\text{ K/year}$
- ▶ 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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RESEARCH ARTICLE

10.1002/2015JD023381

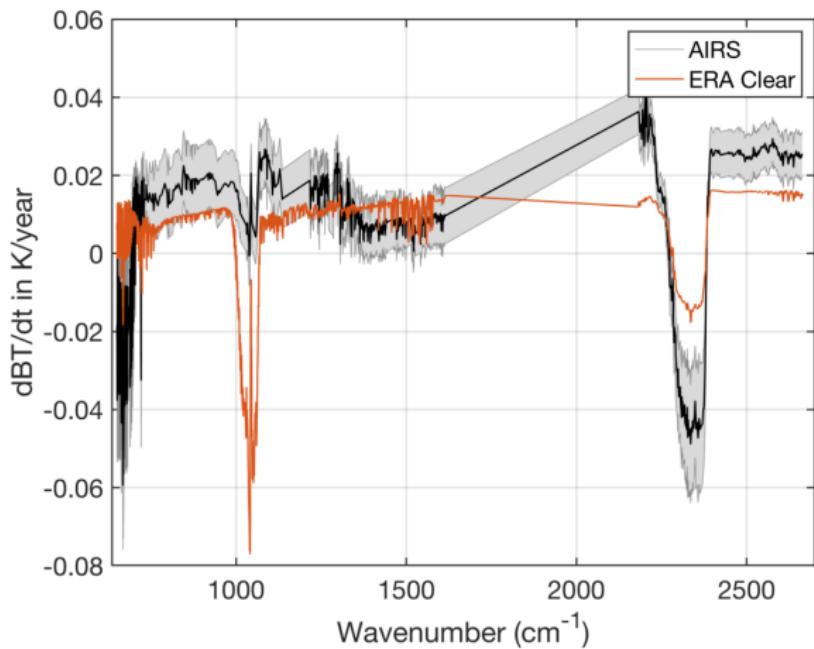
Key Points:

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

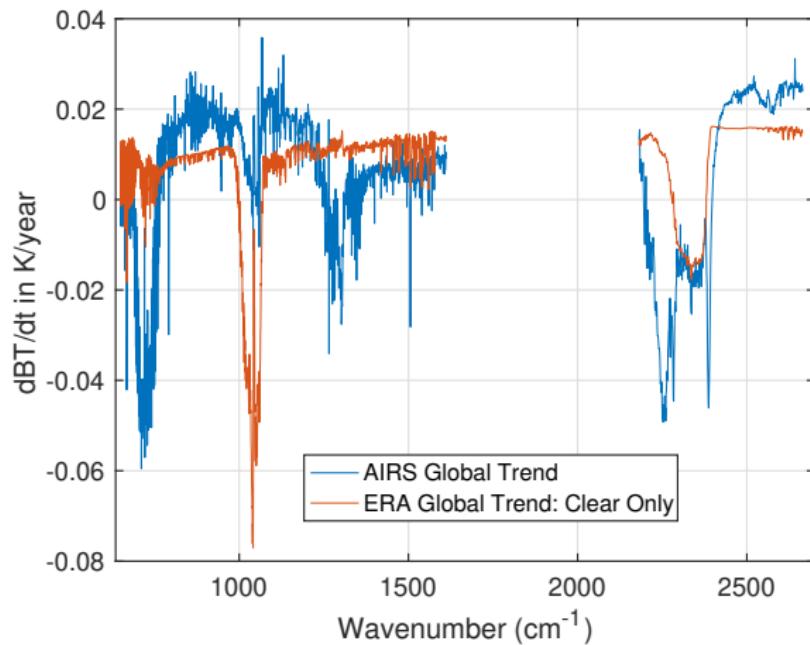
Relationships among top-of-atmosphere radiation and atmospheric state variables in observations and CESM

Kevin E. Trenberth¹, Yongxin Zhang¹, and John T. Fasullo¹

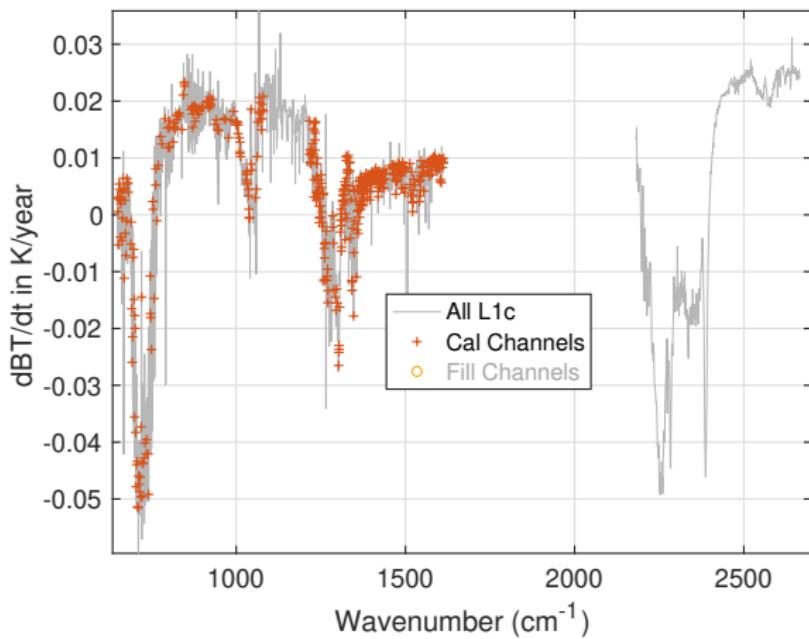
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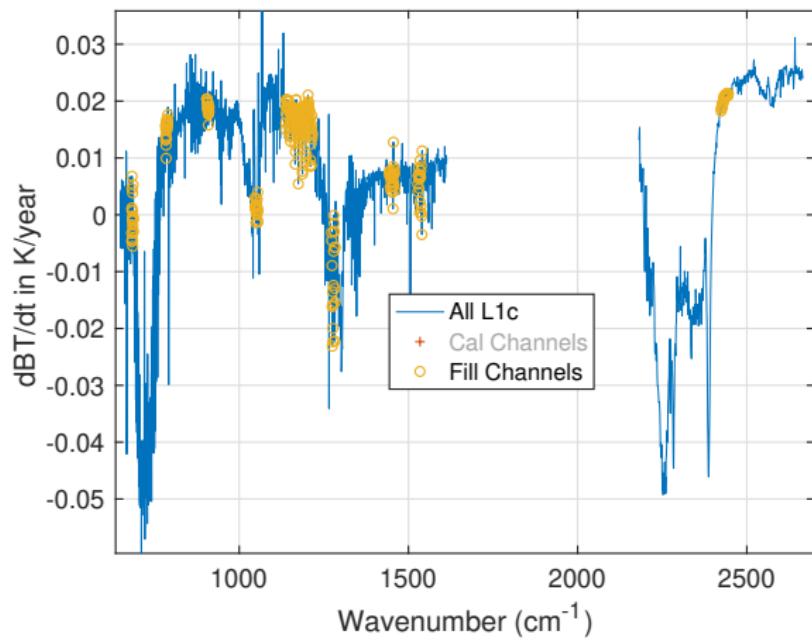
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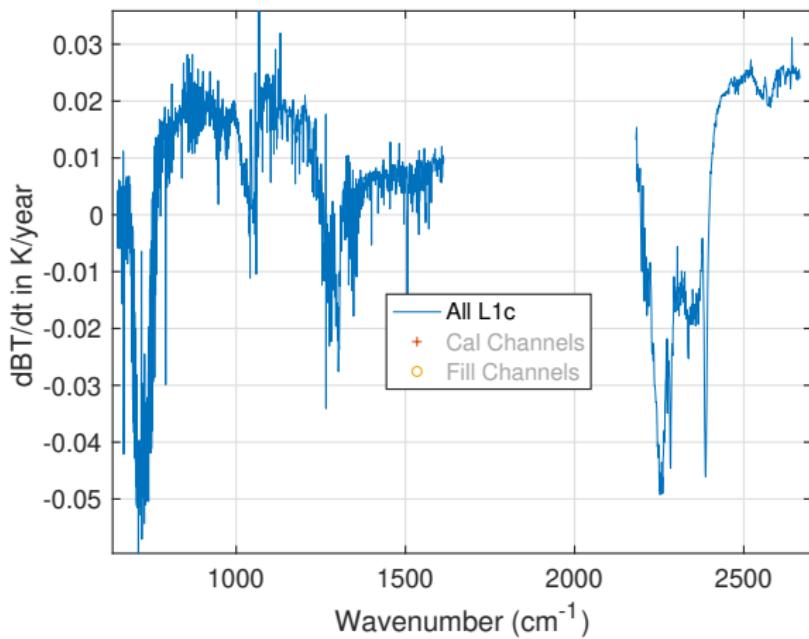
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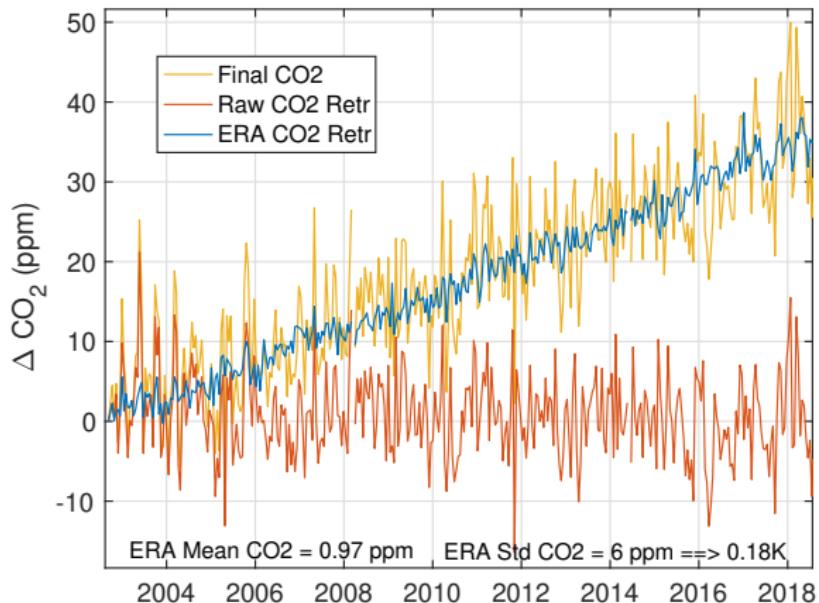
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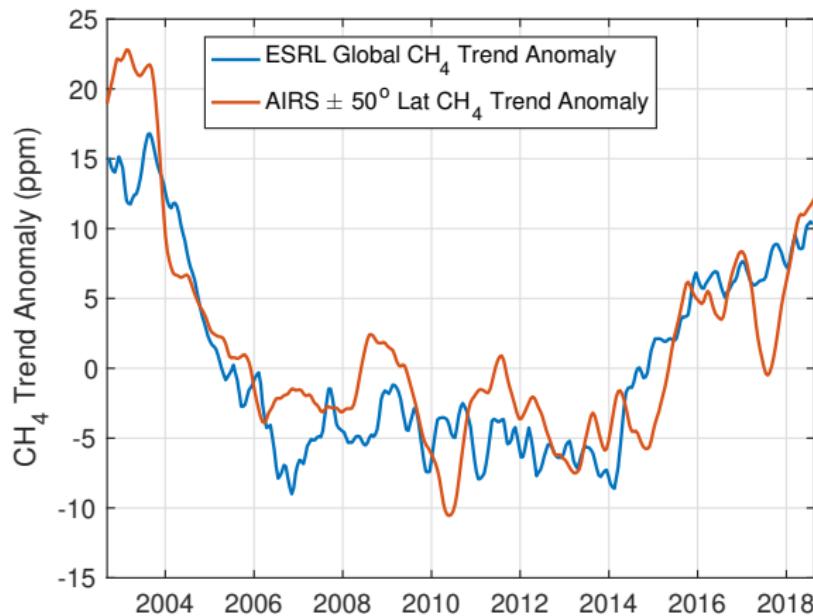
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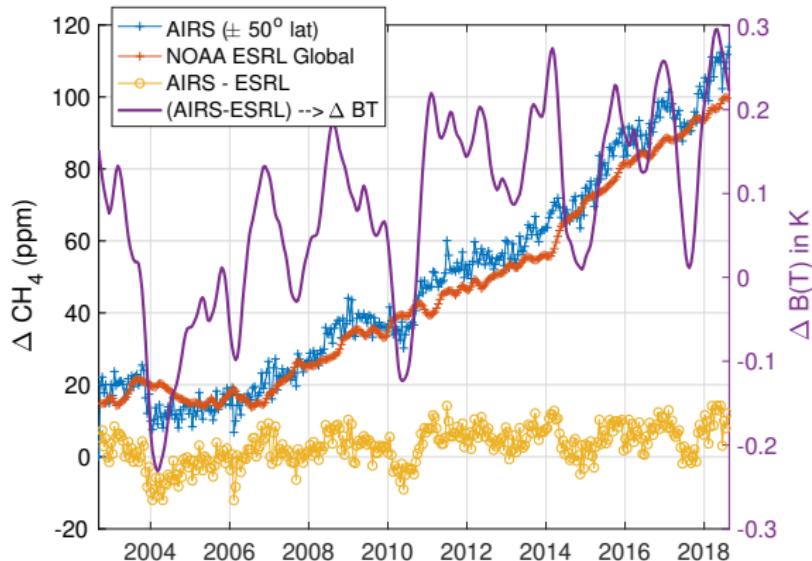
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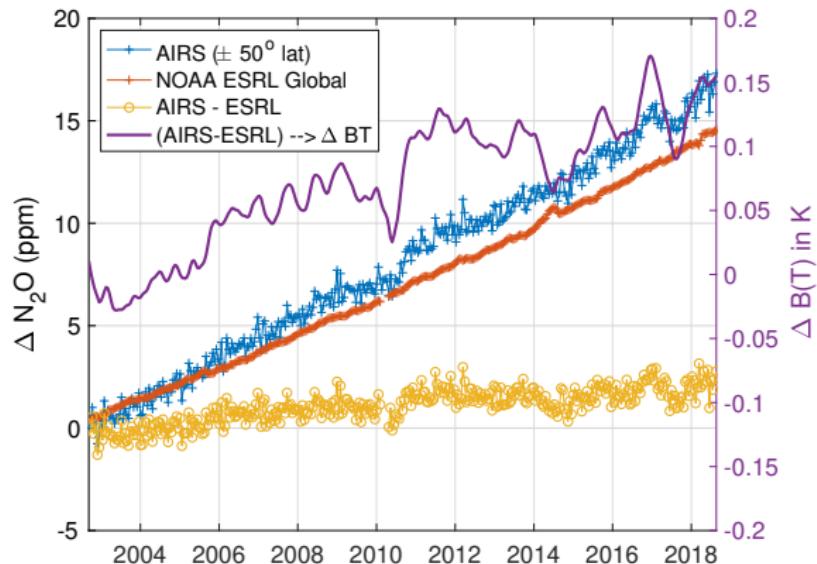
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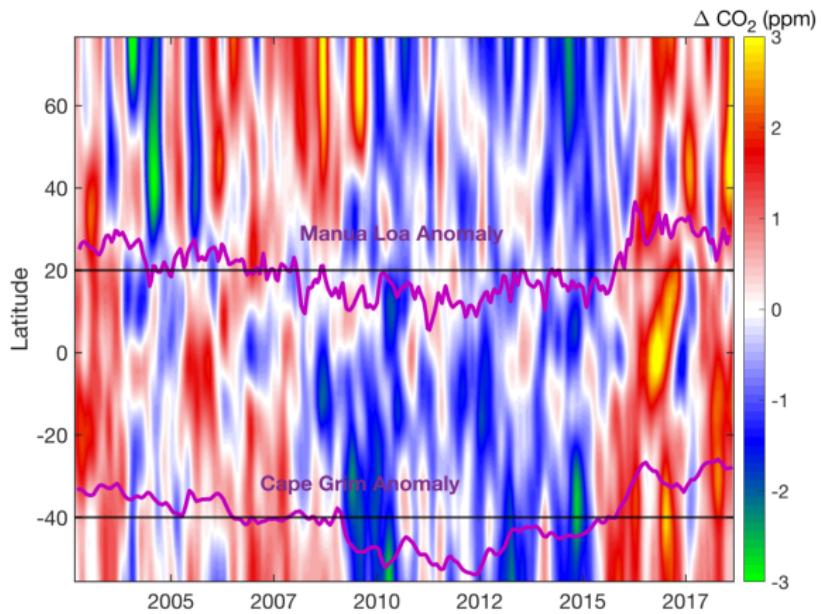
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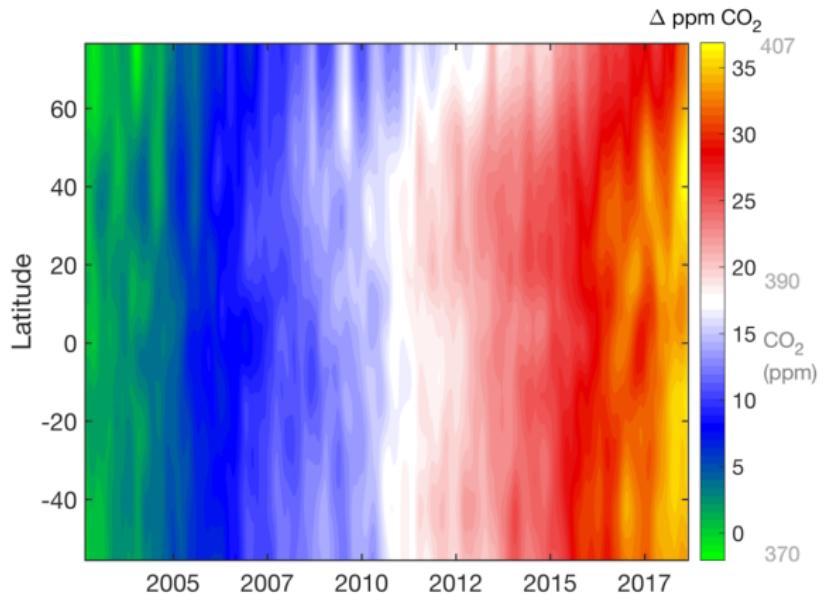
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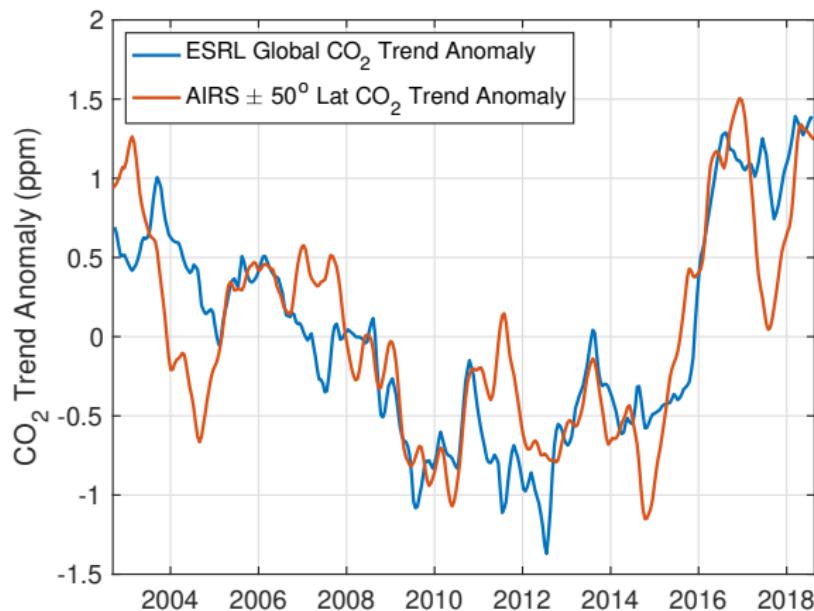
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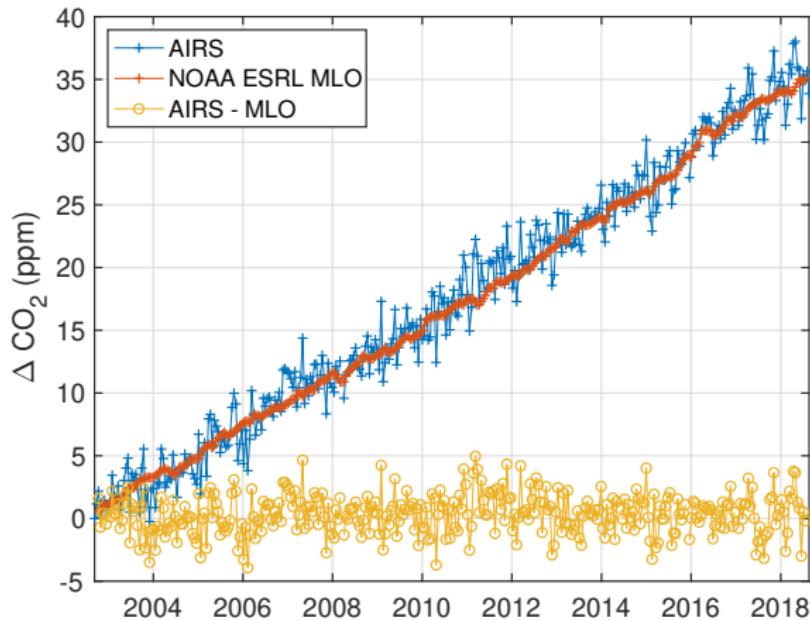
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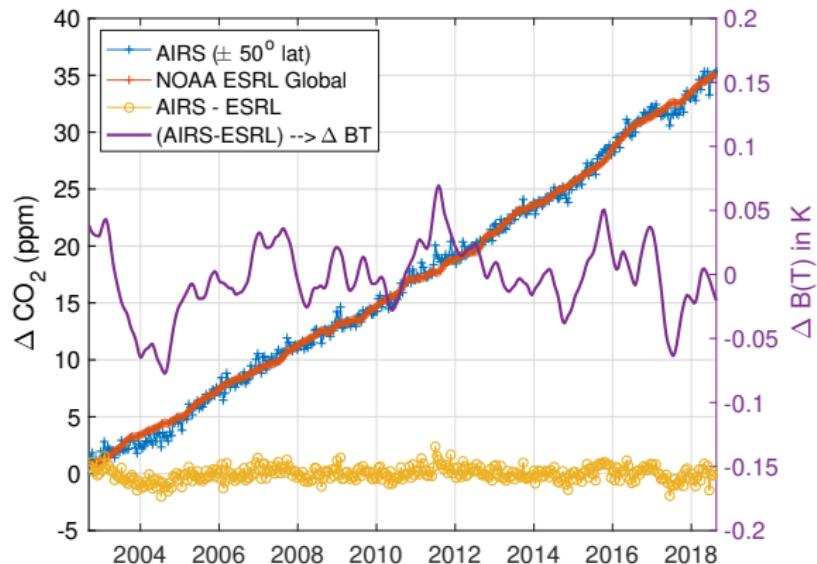
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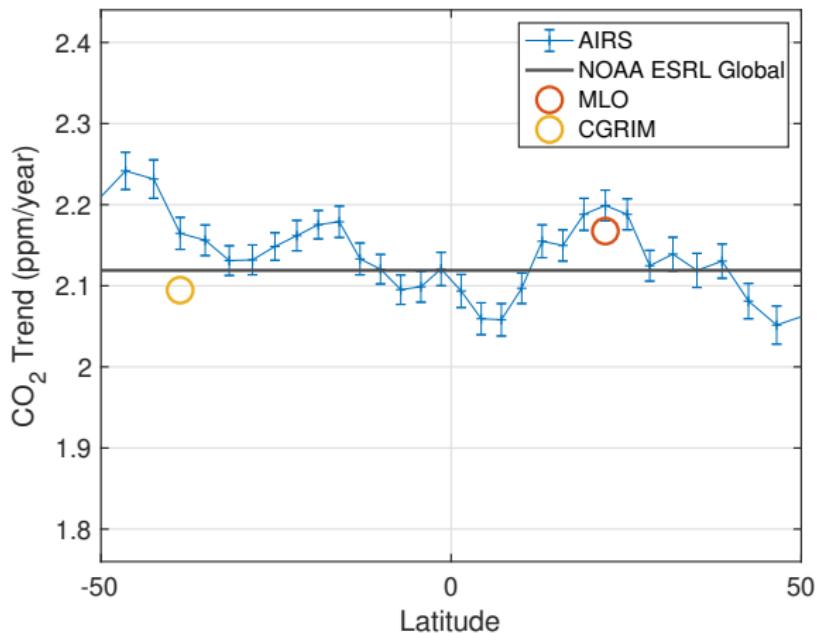
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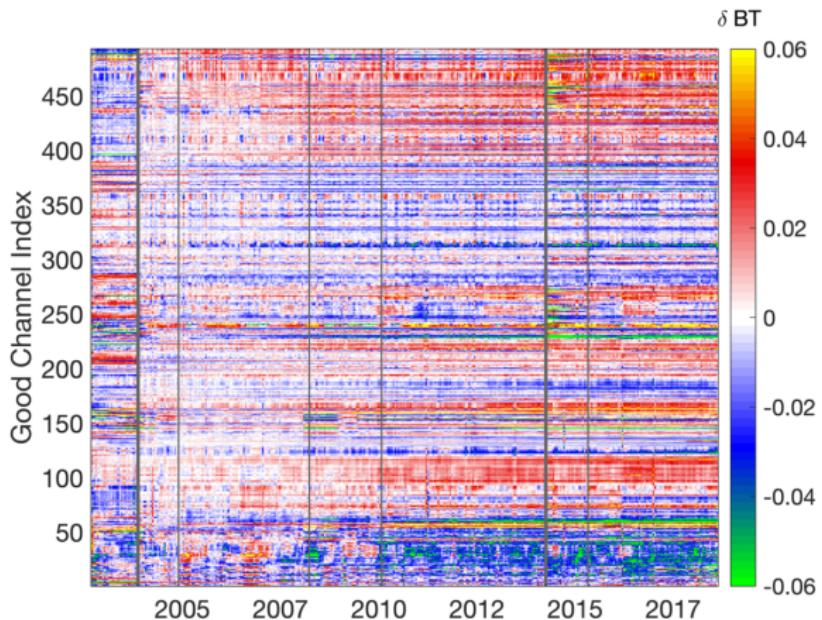
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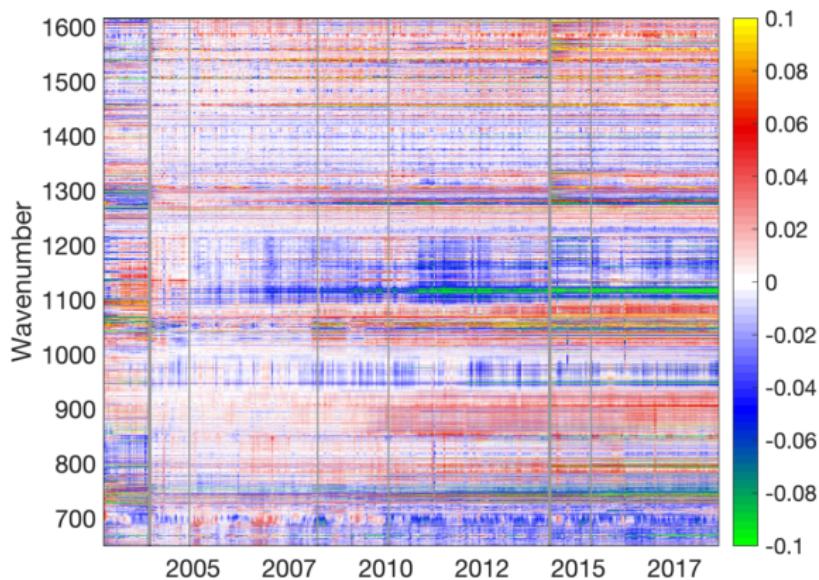
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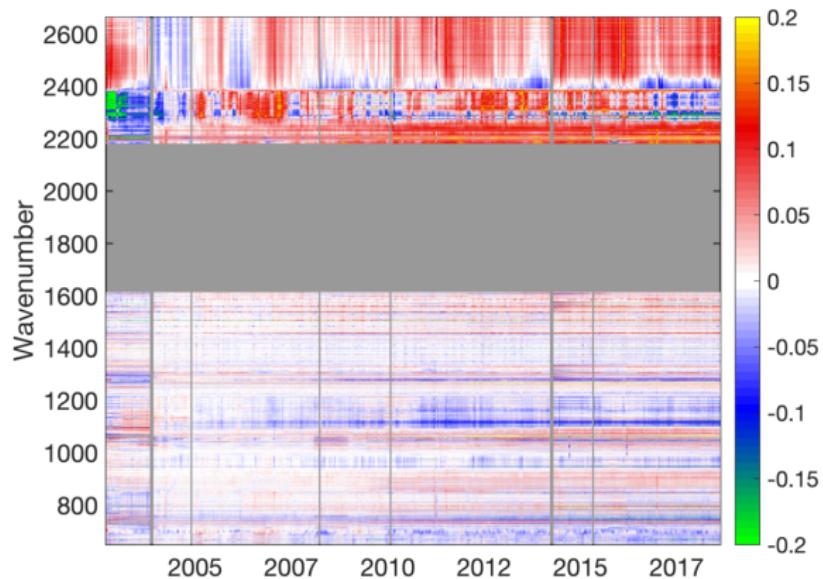
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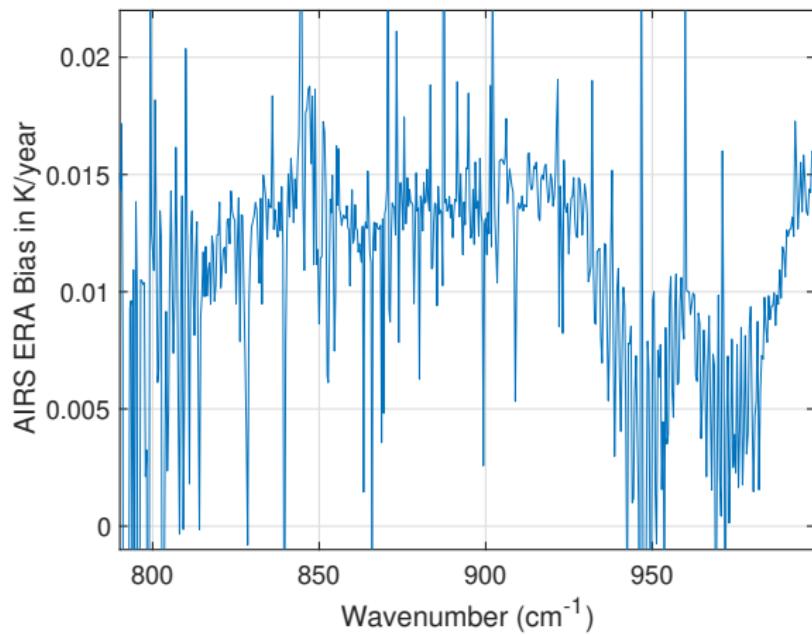
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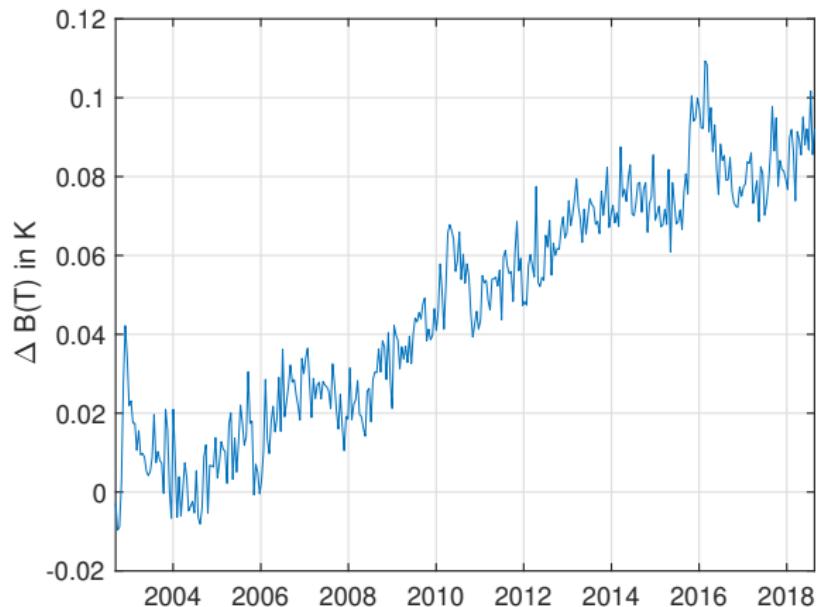
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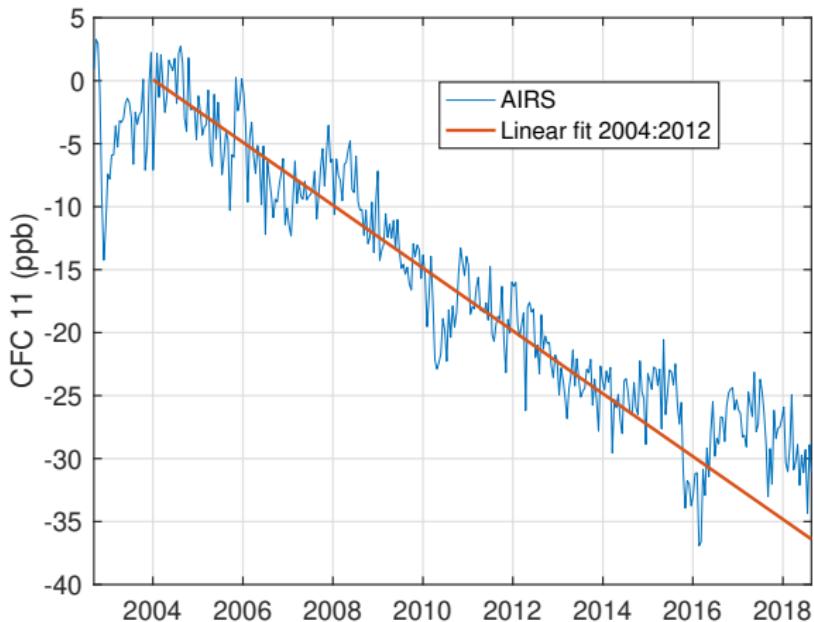
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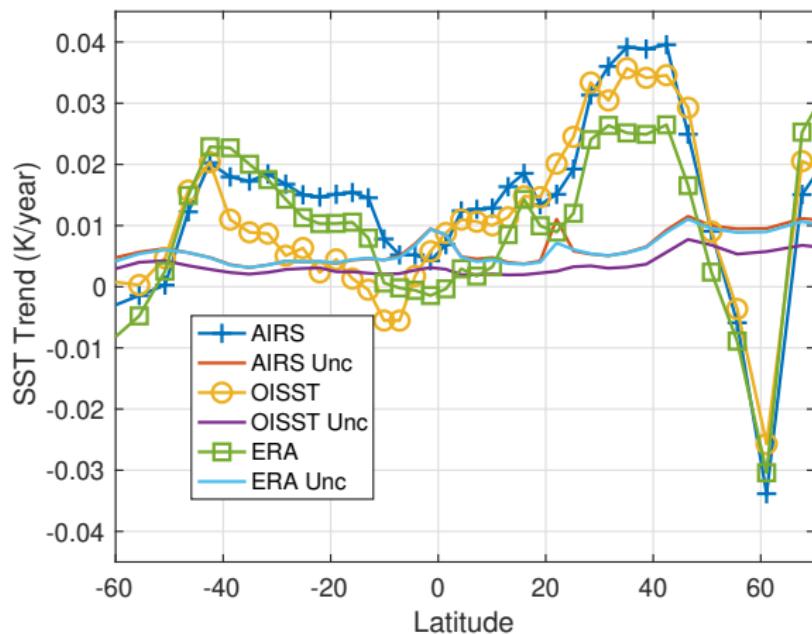
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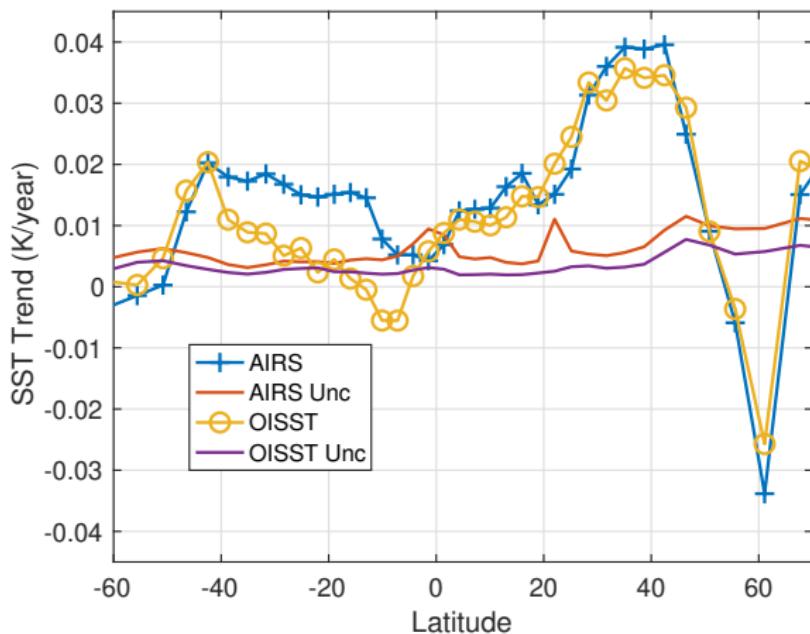
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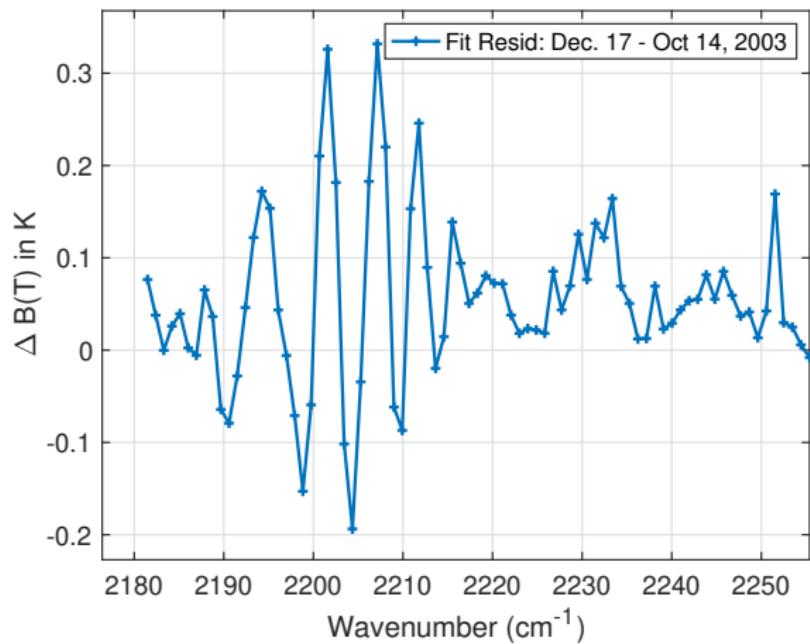
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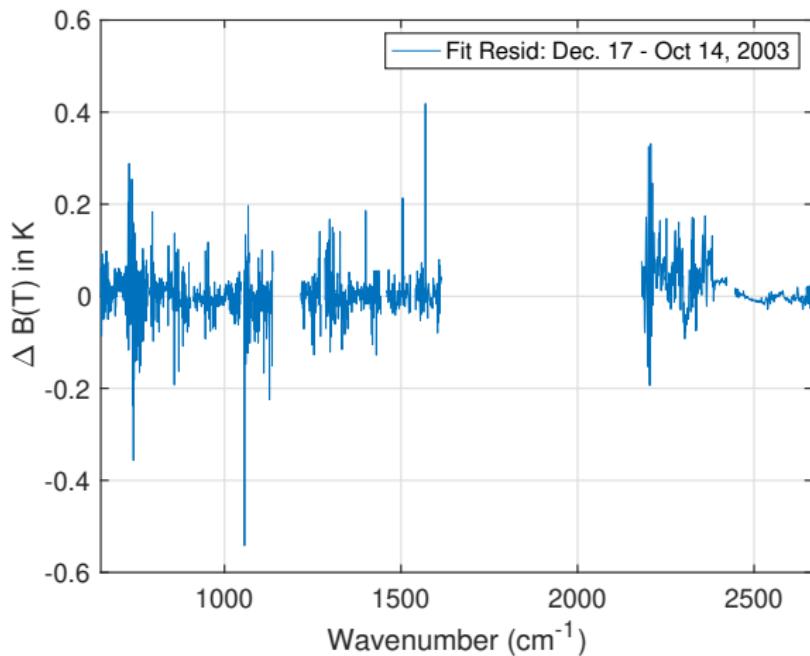
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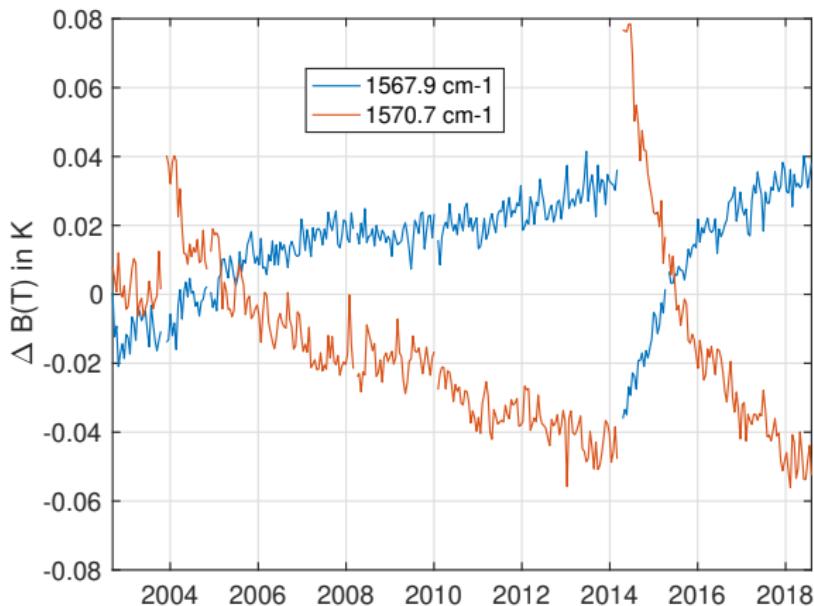
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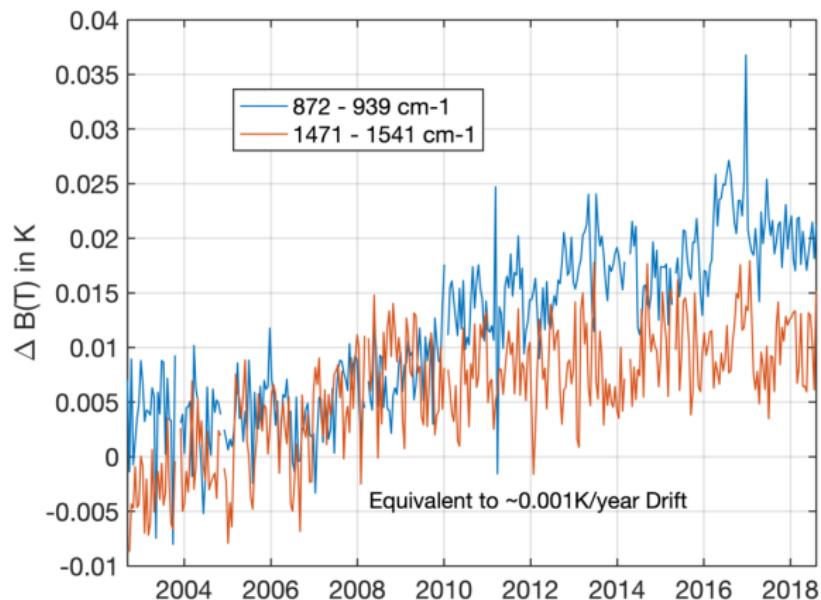
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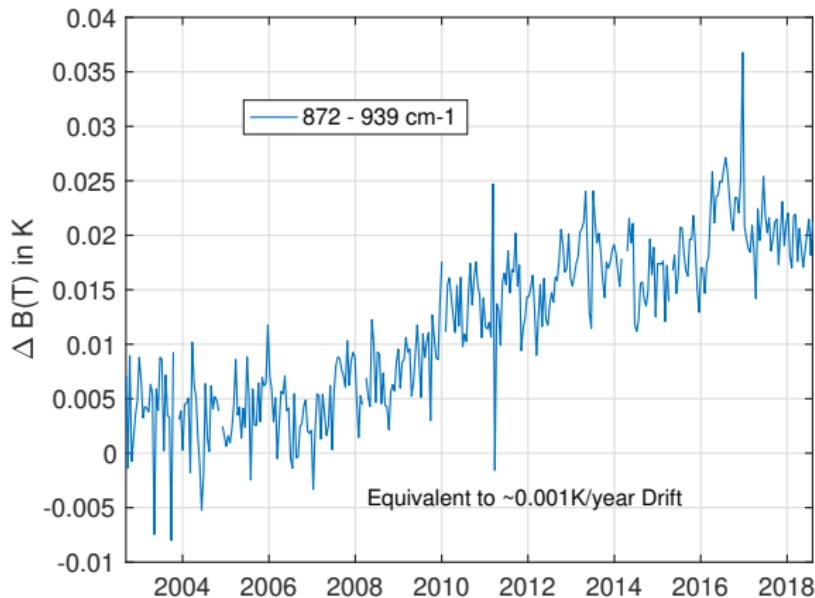
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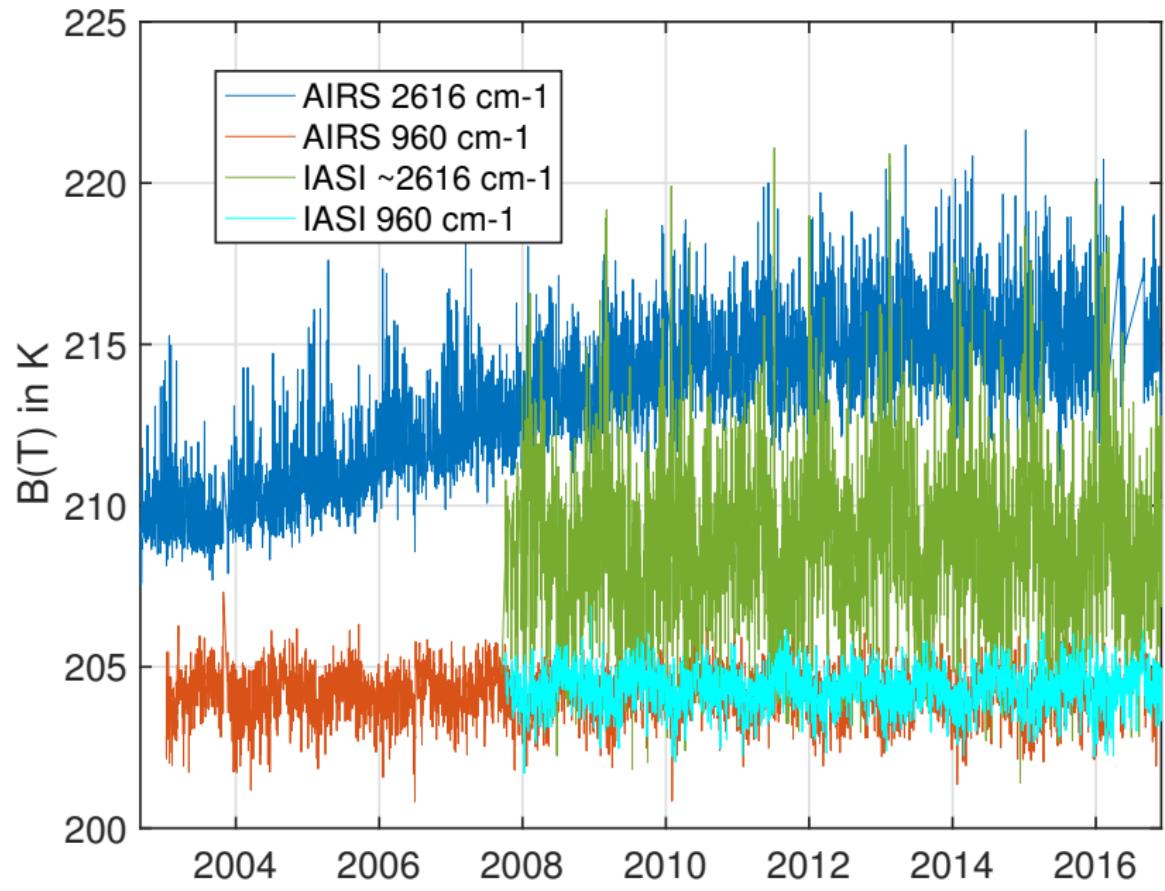
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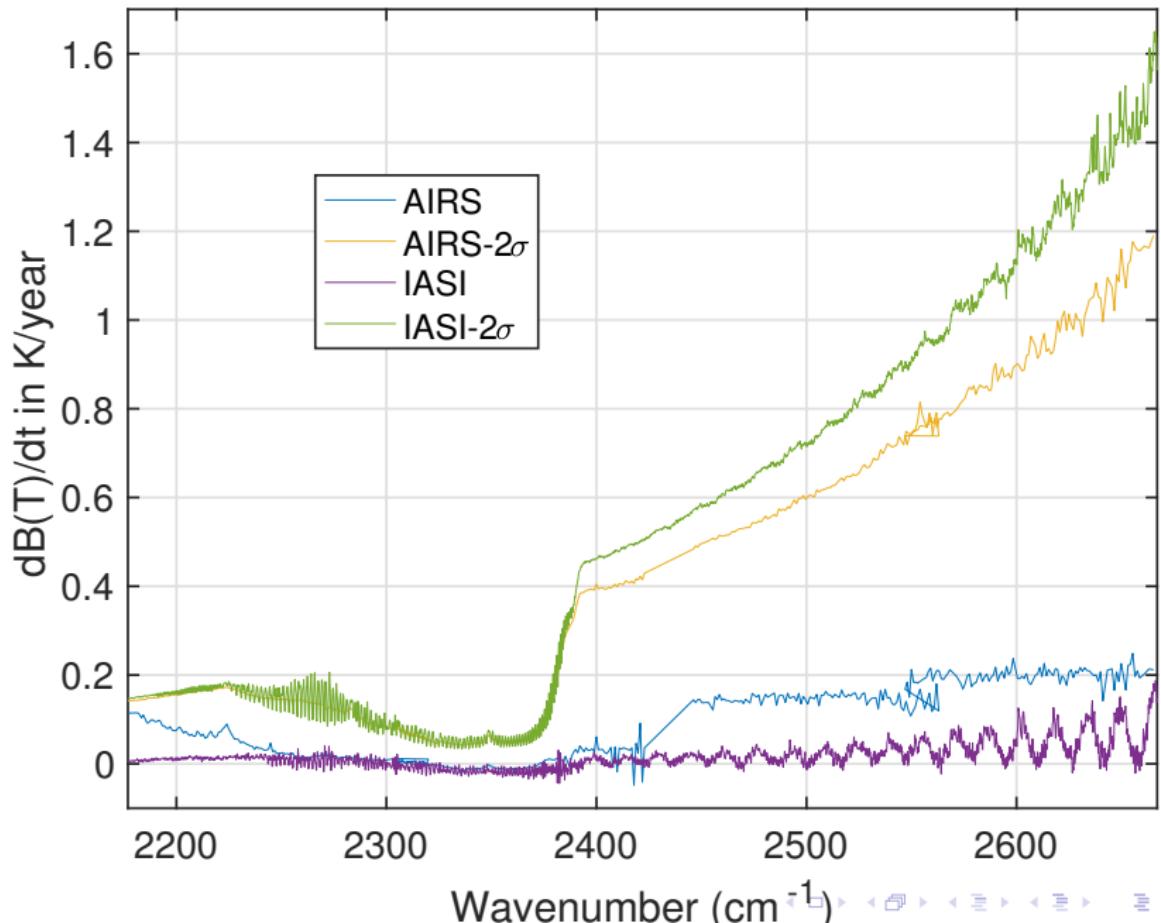
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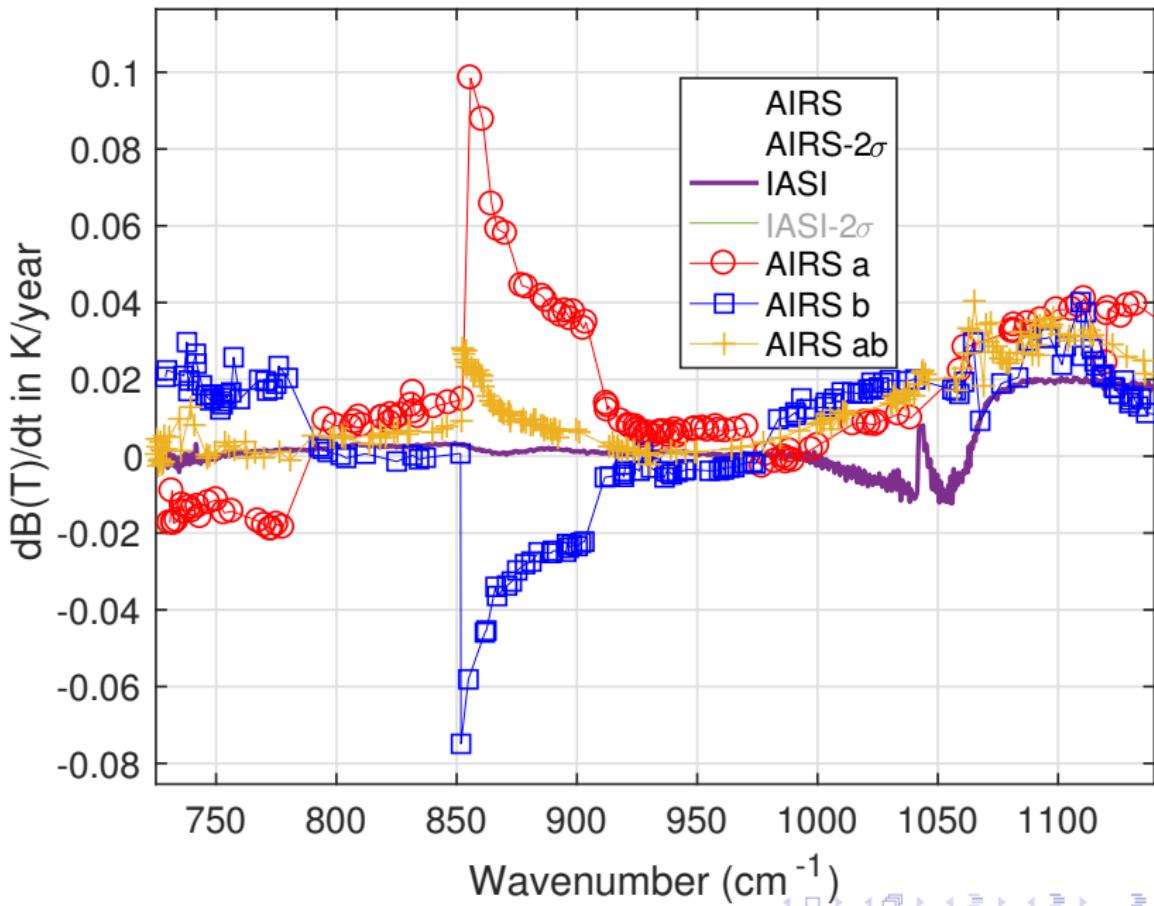
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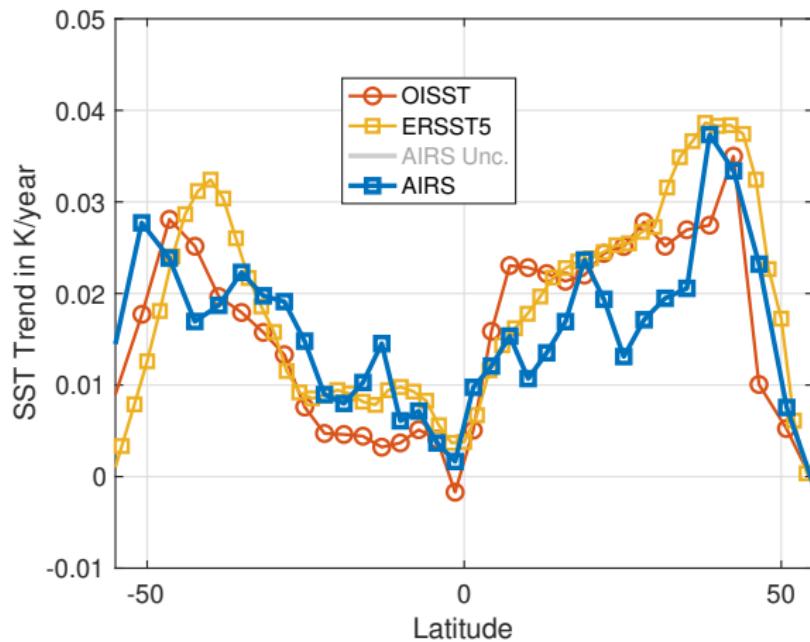
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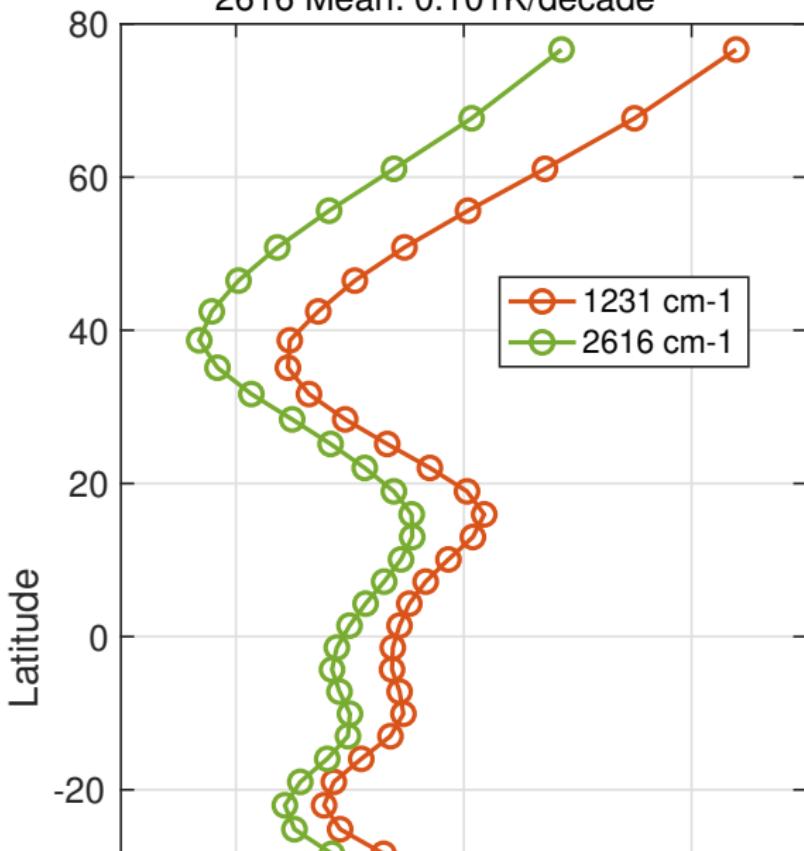
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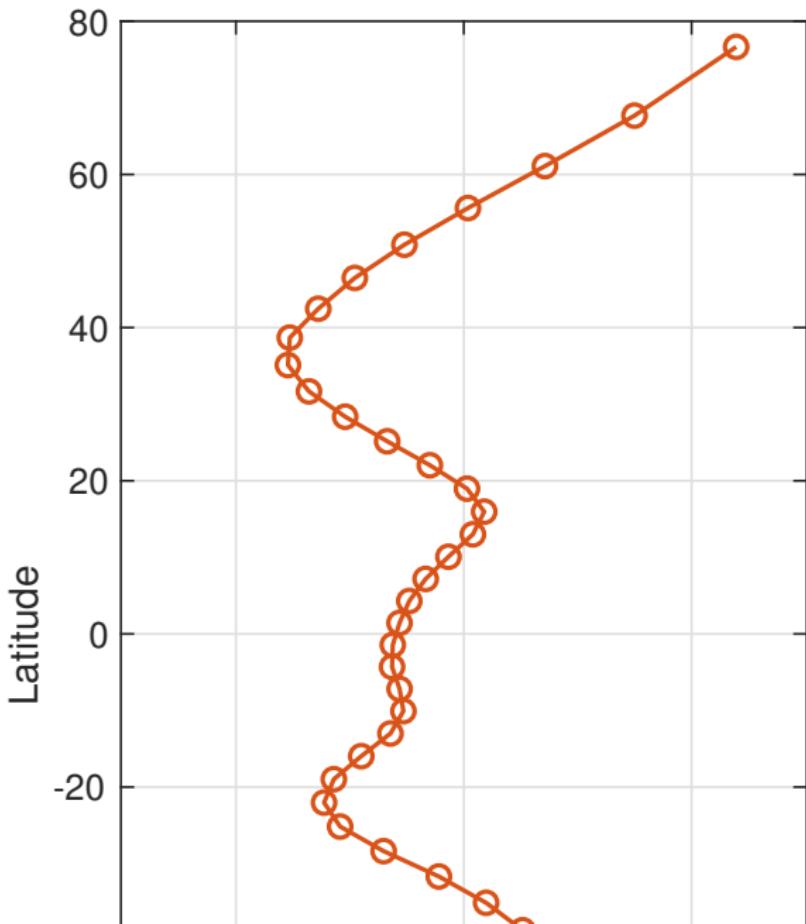
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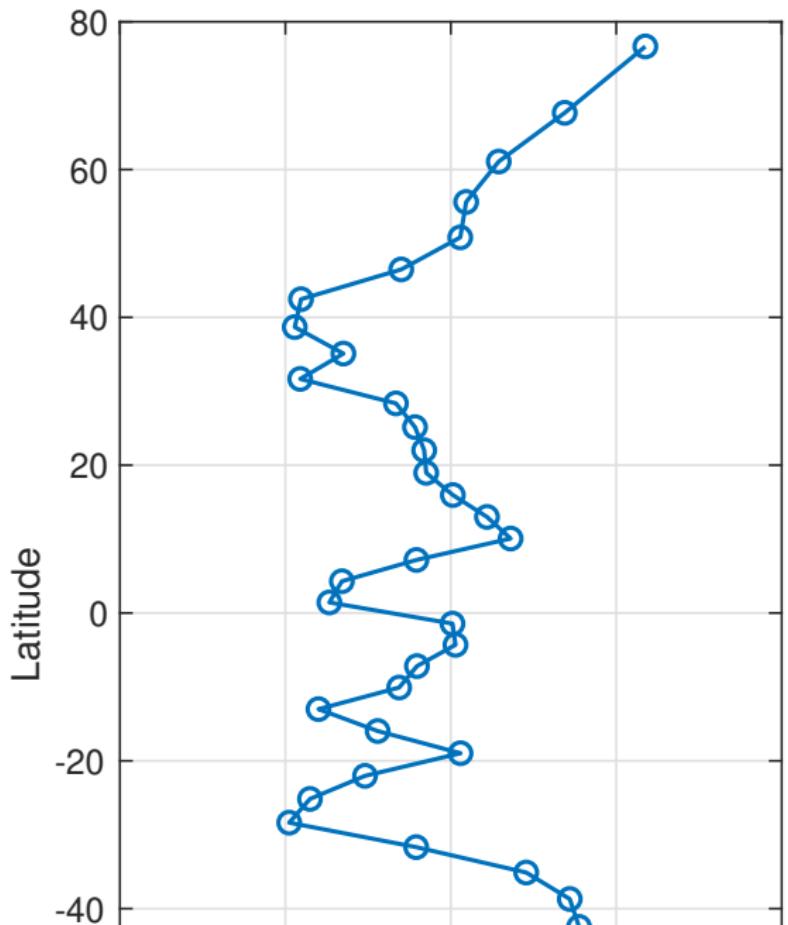
1231 Mean: 0.038K/decade
2616 Mean: 0.101K/decade



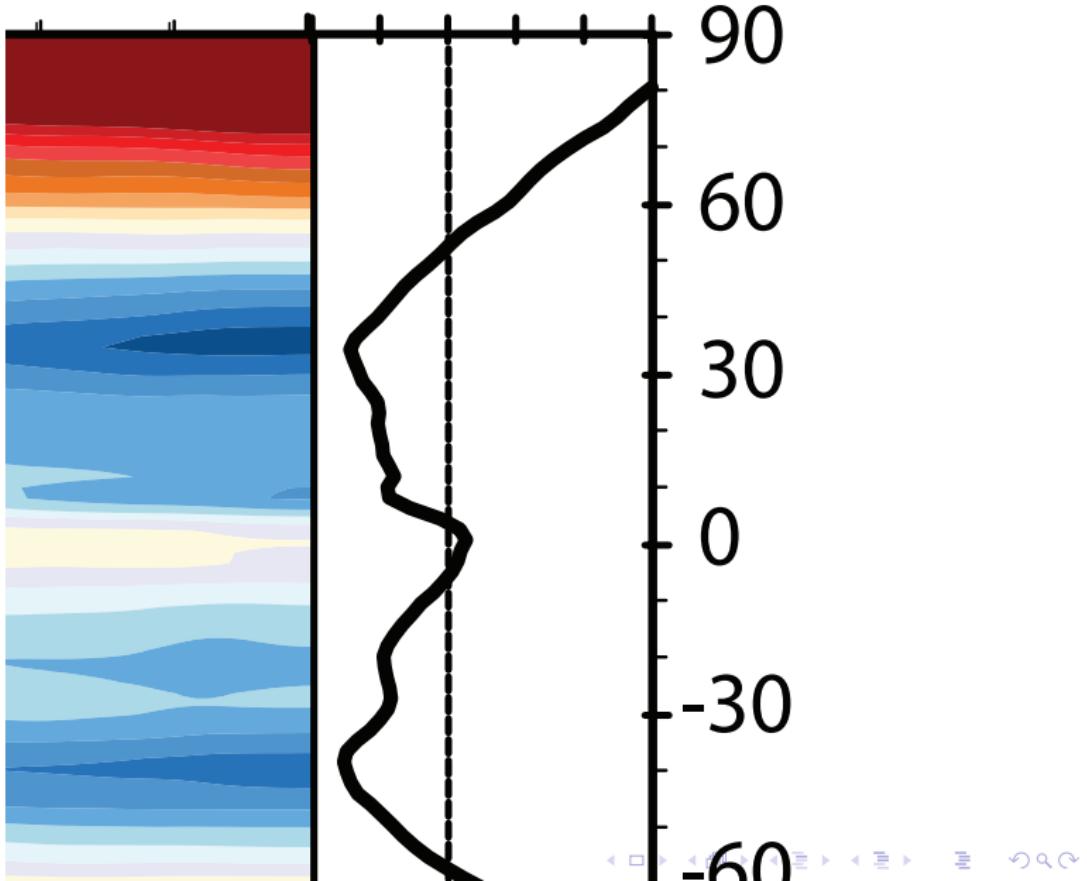
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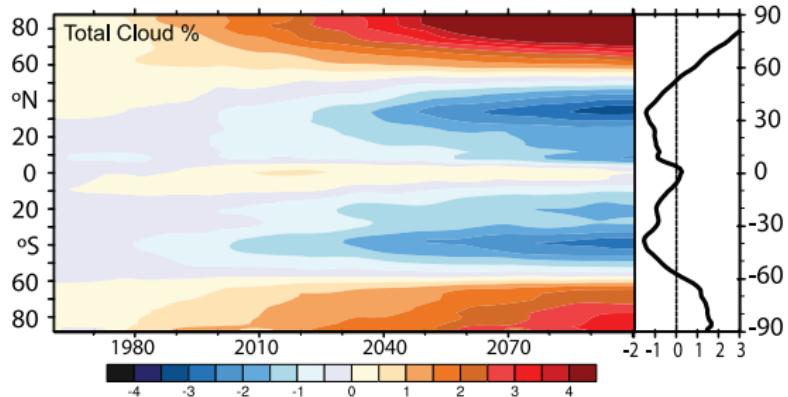
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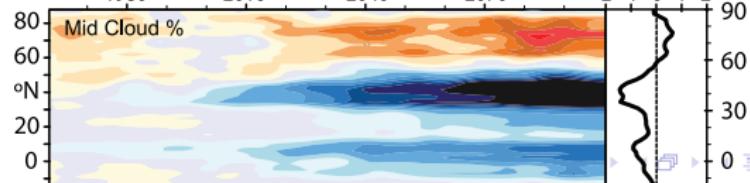
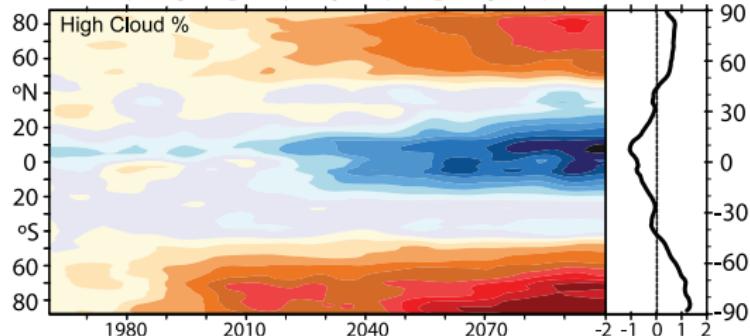
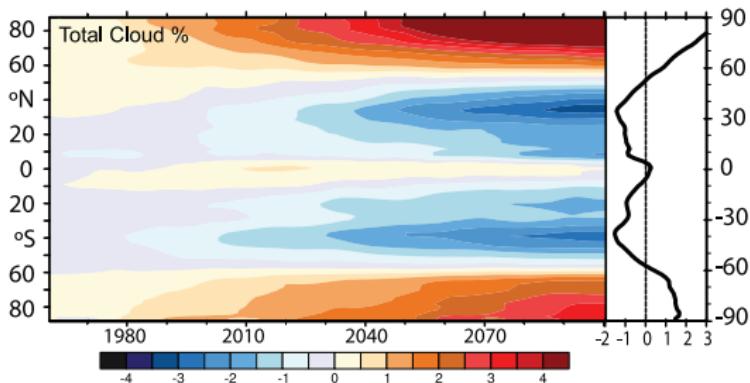
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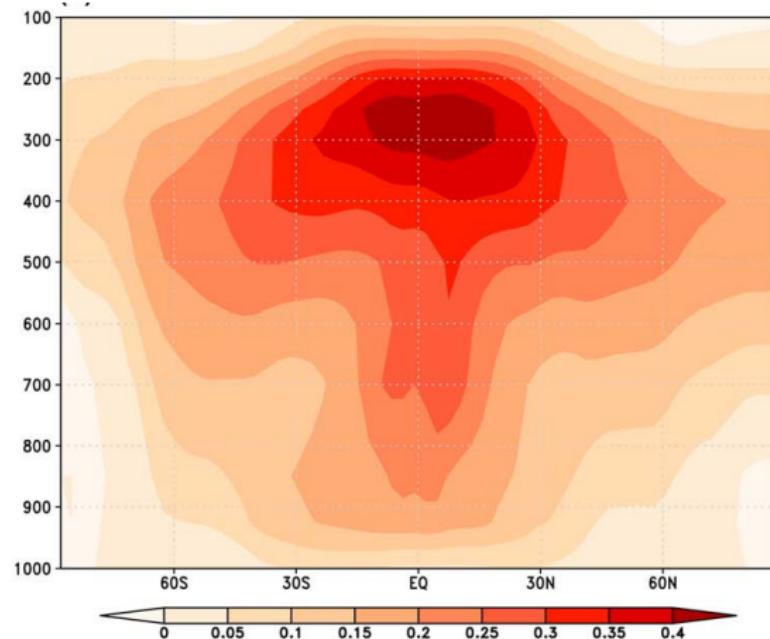
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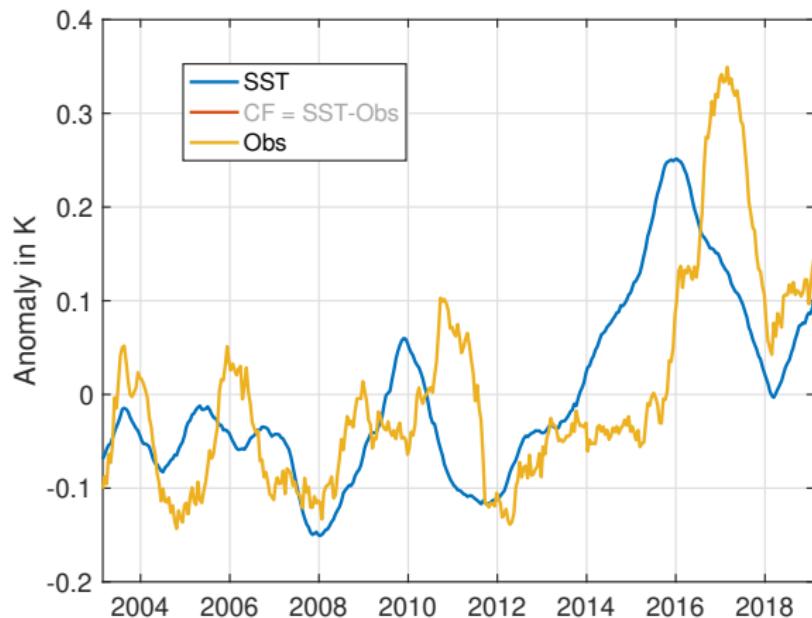
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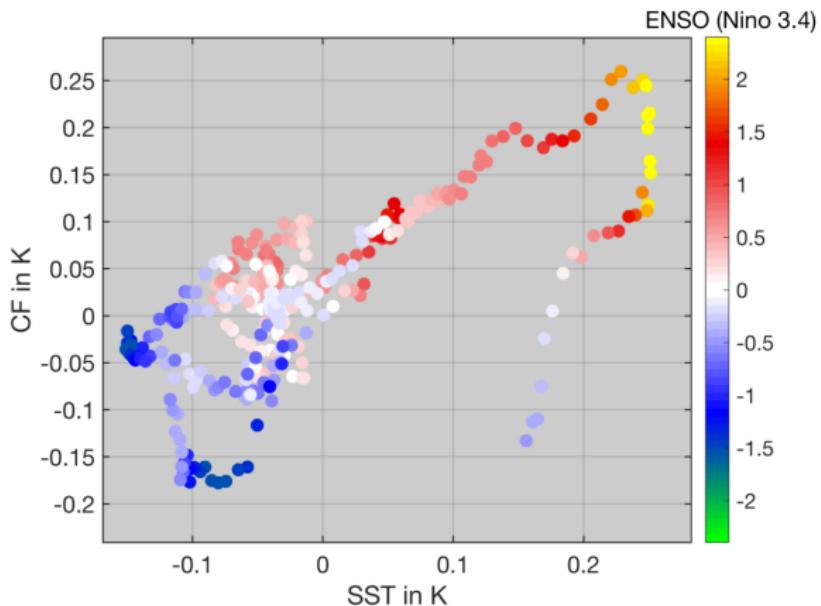
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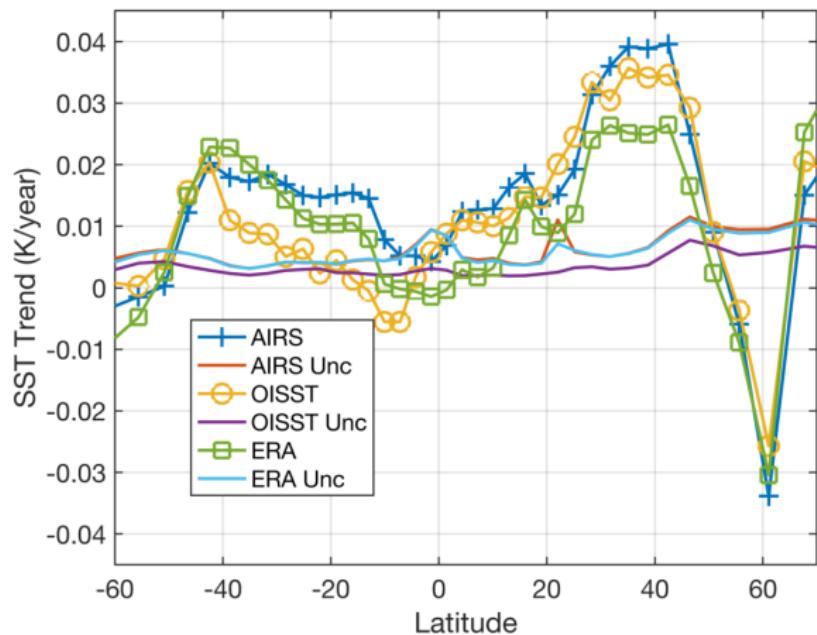
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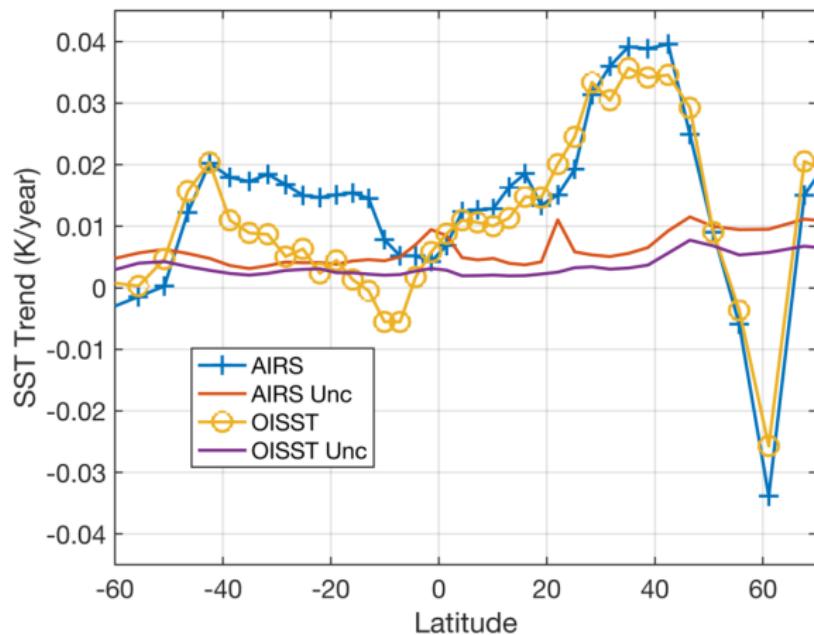
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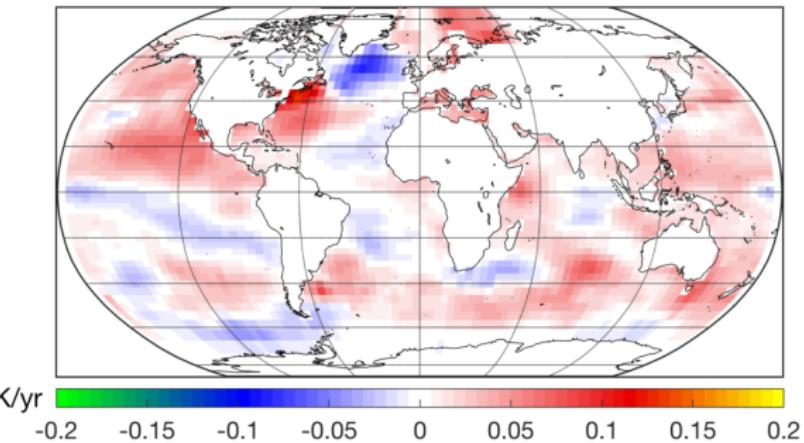
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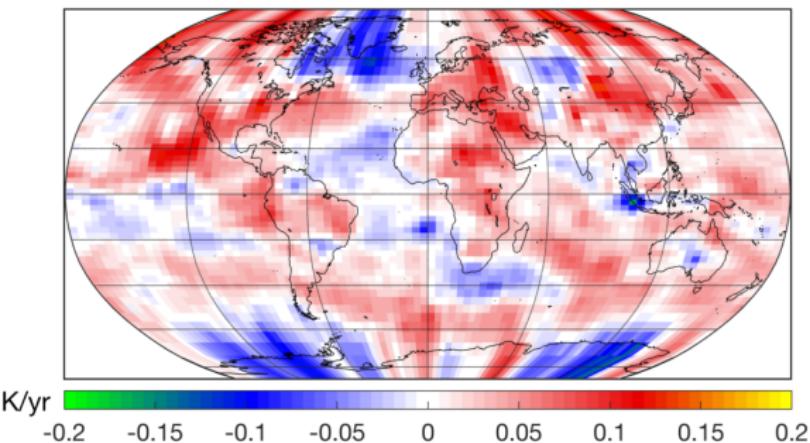
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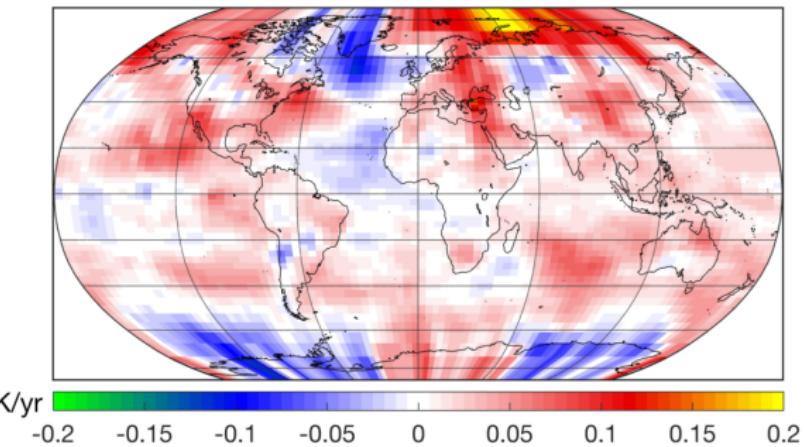
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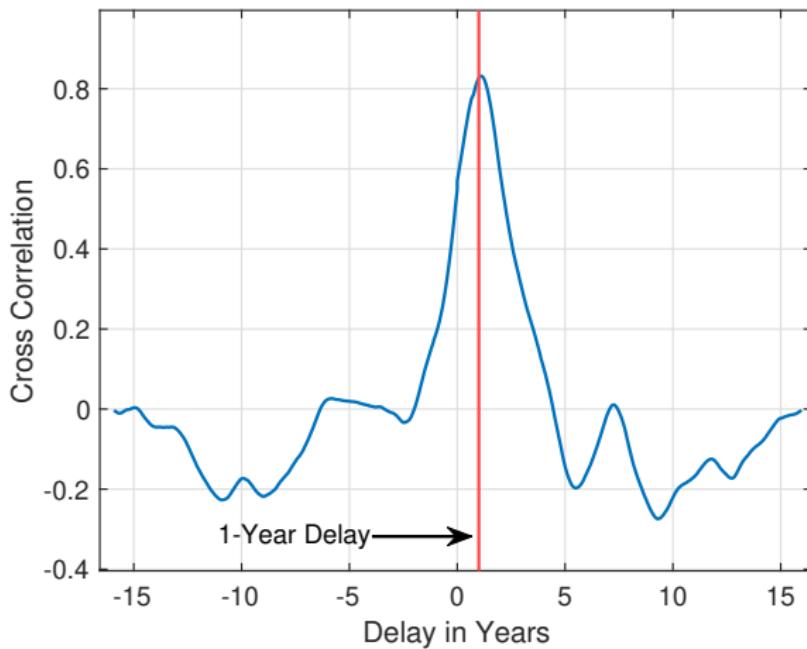
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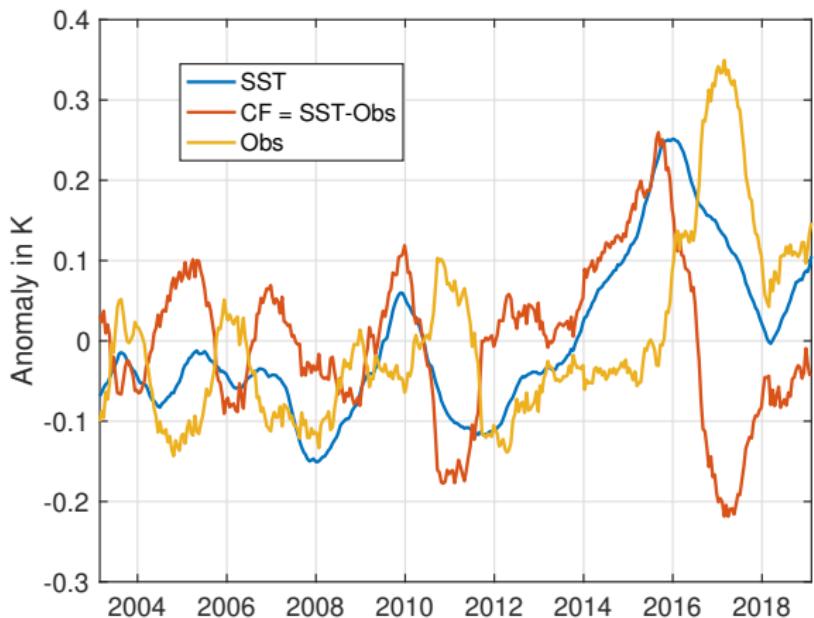
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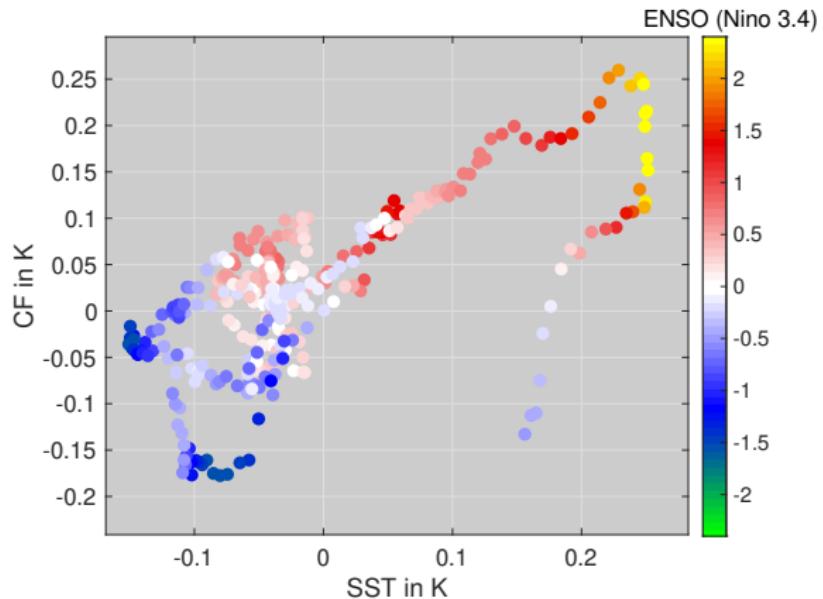
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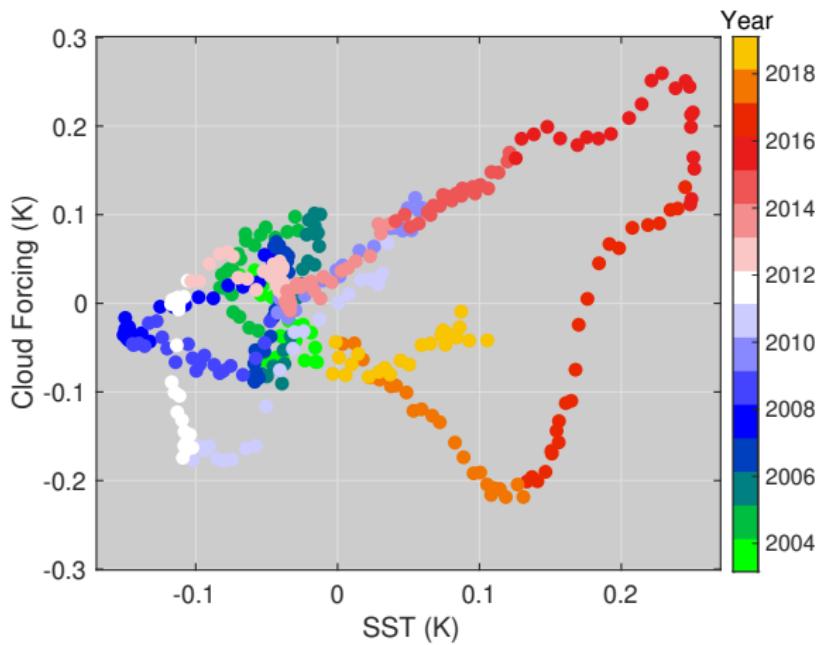
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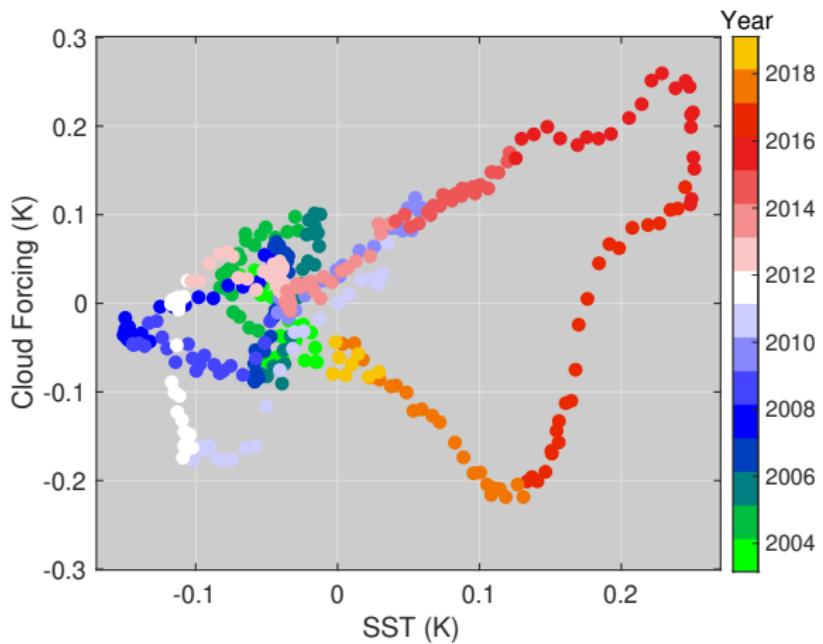
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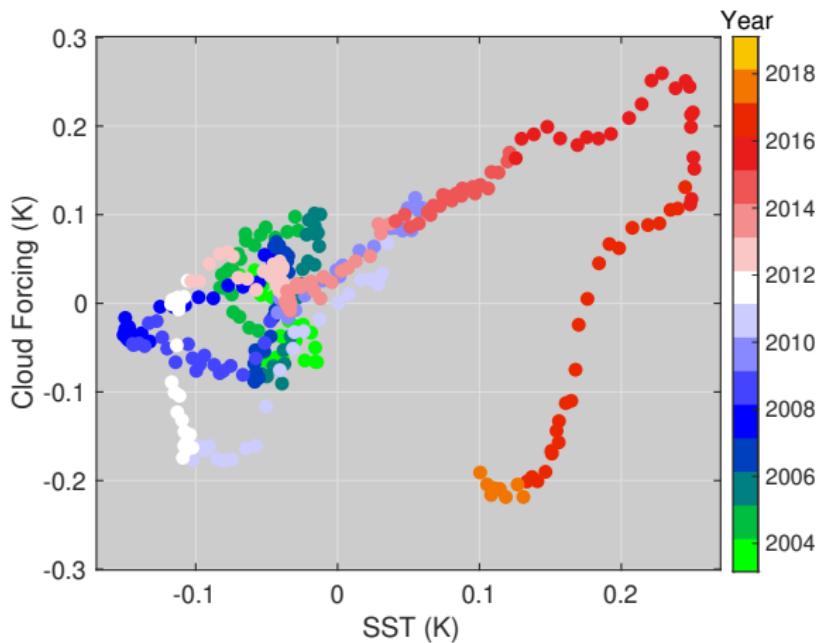
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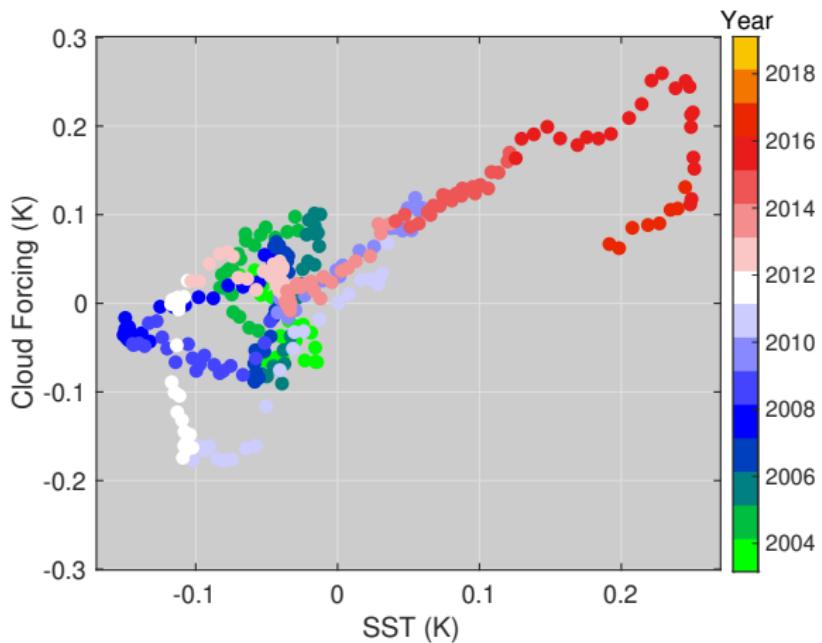
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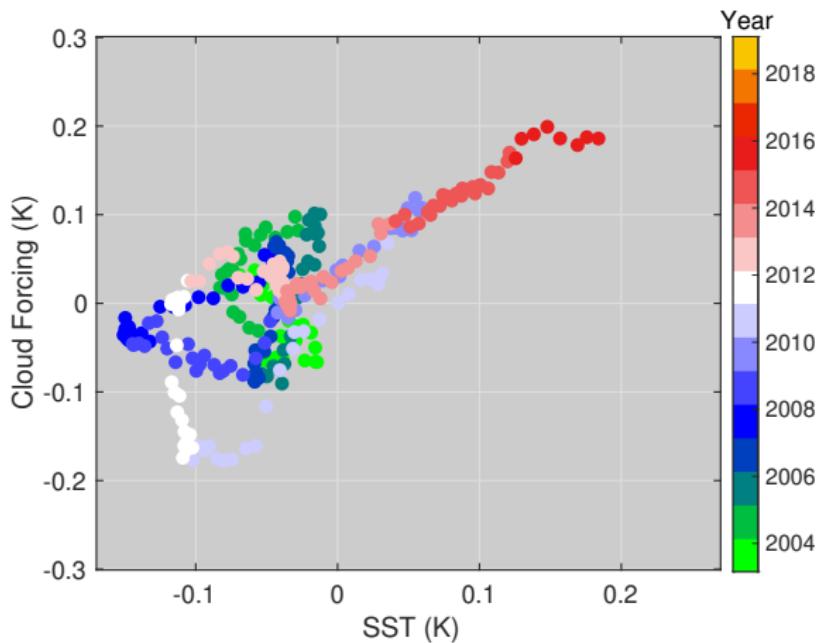
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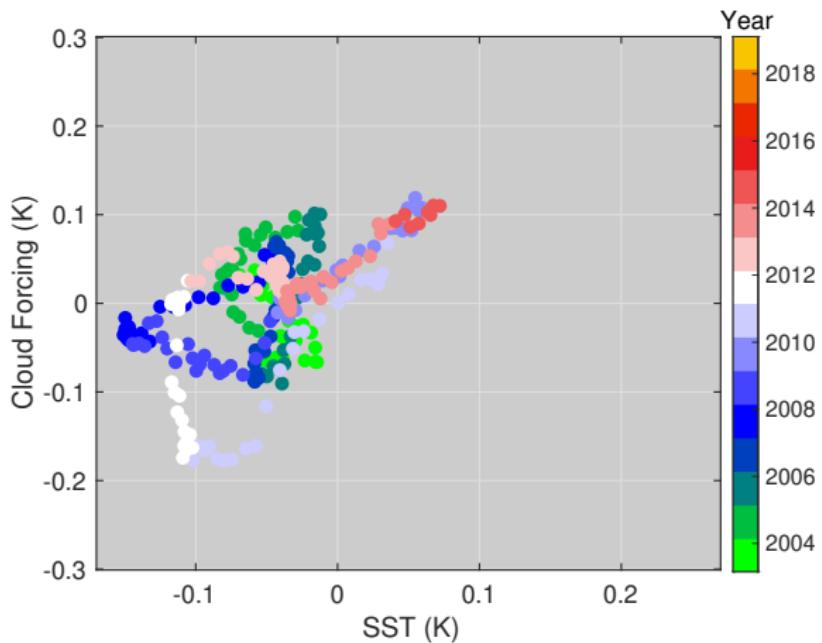
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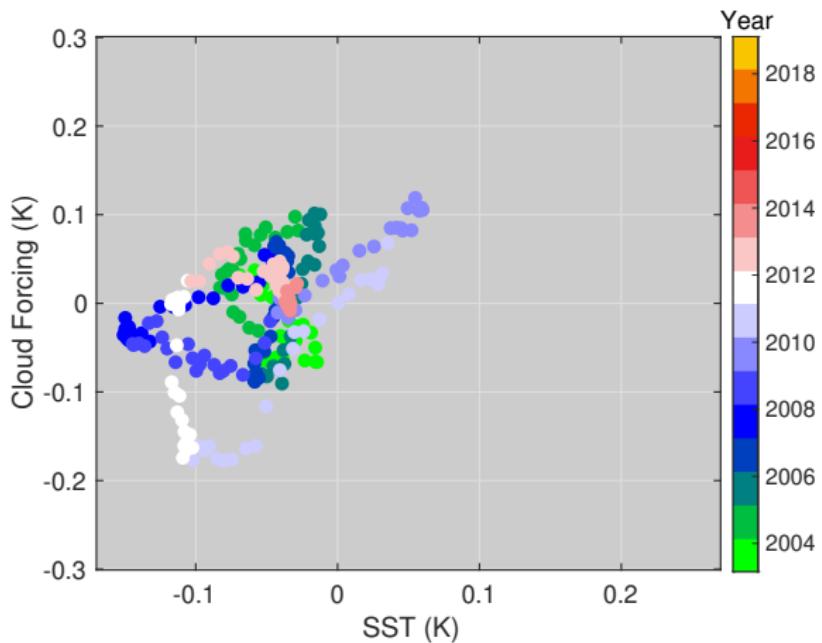
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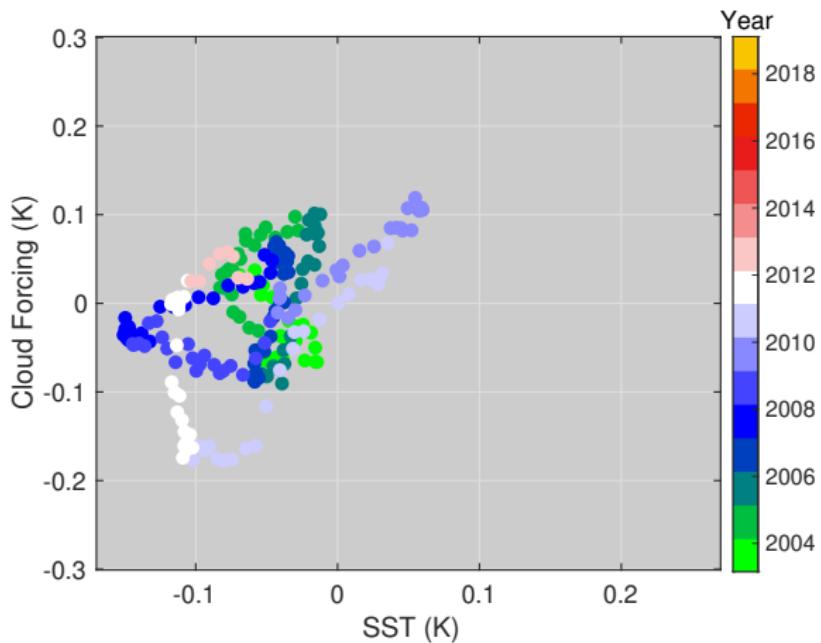
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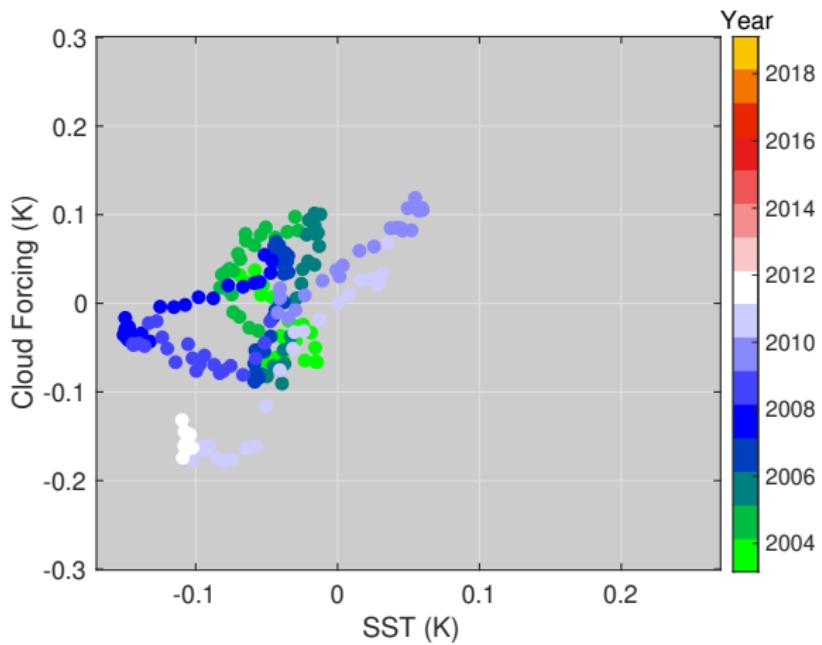
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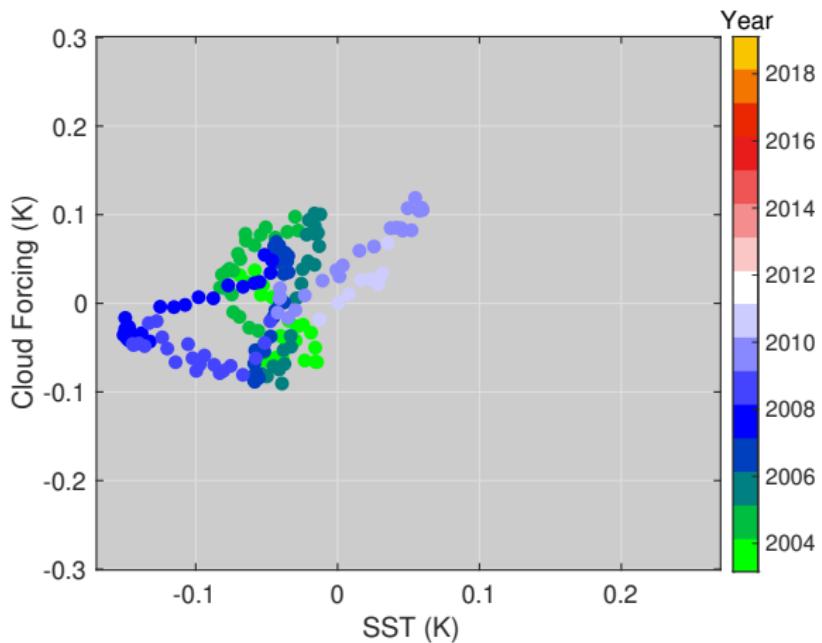
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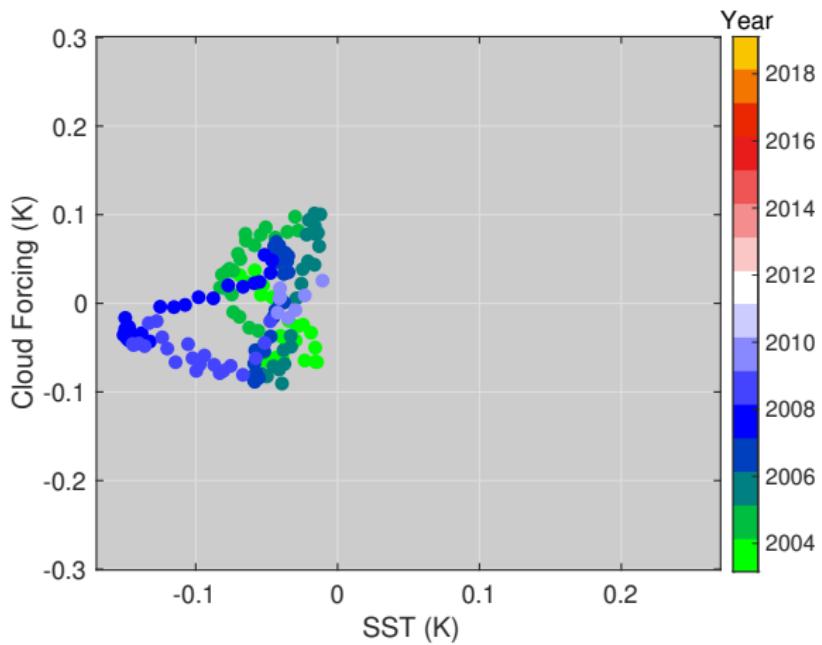
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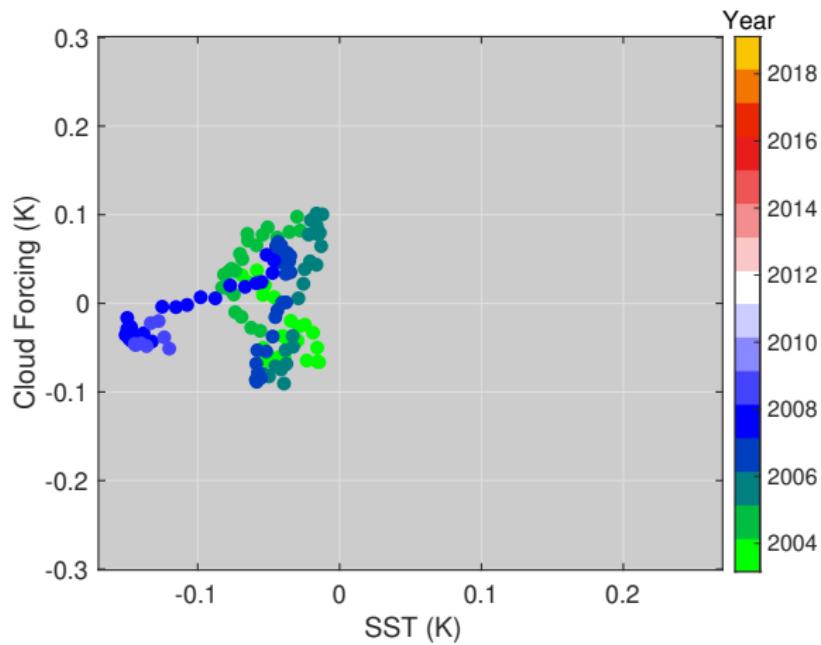
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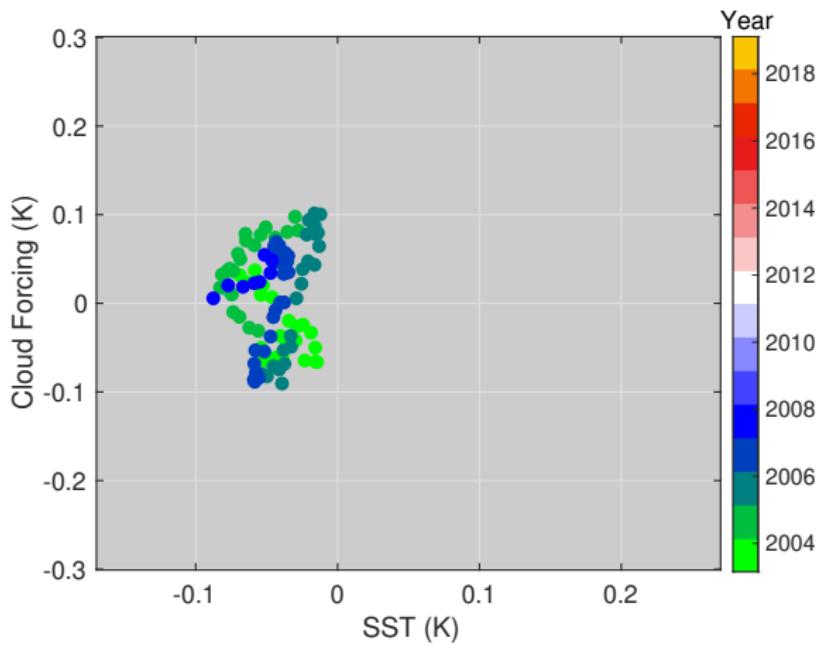
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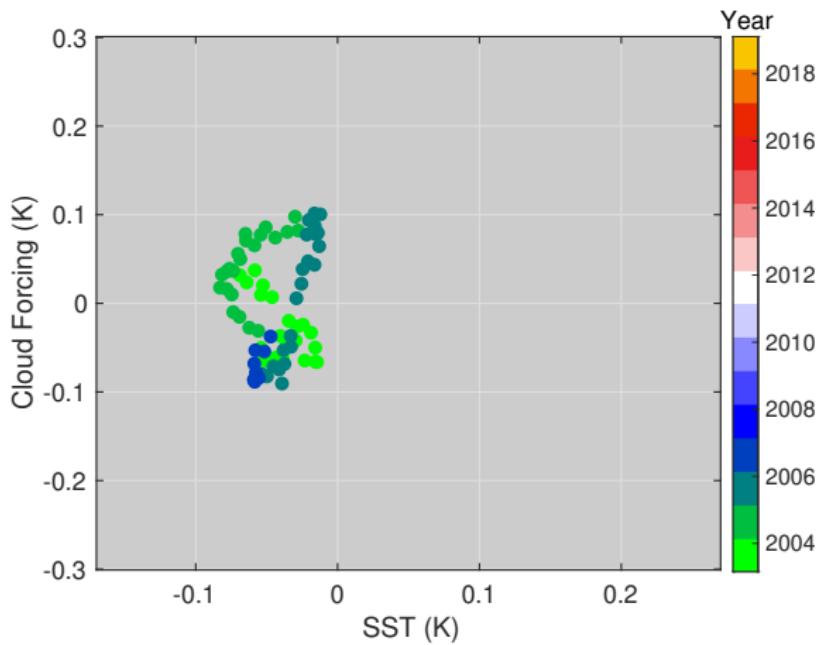
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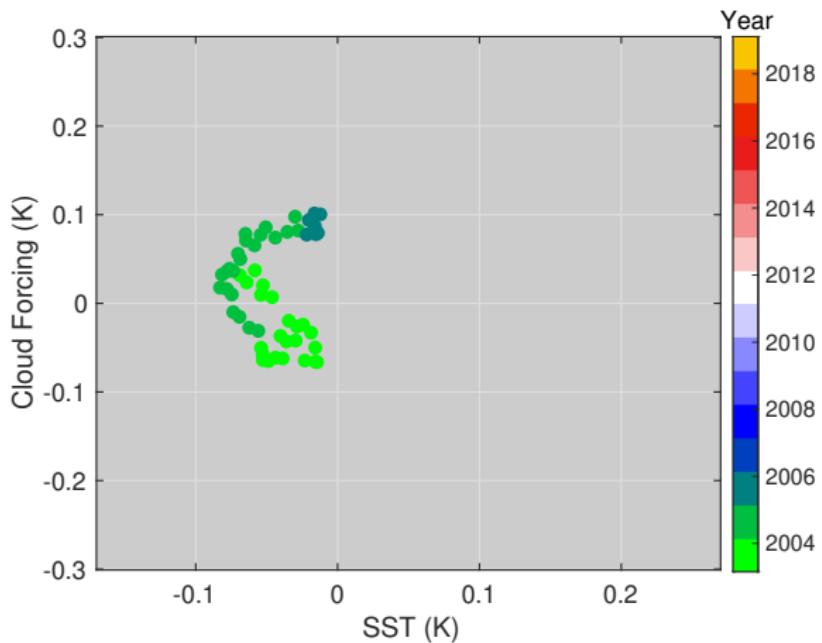
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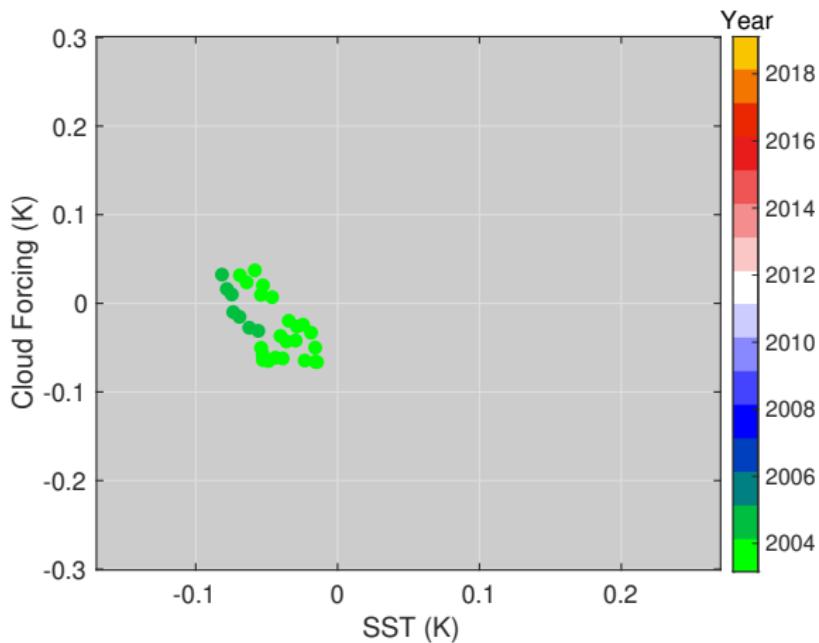
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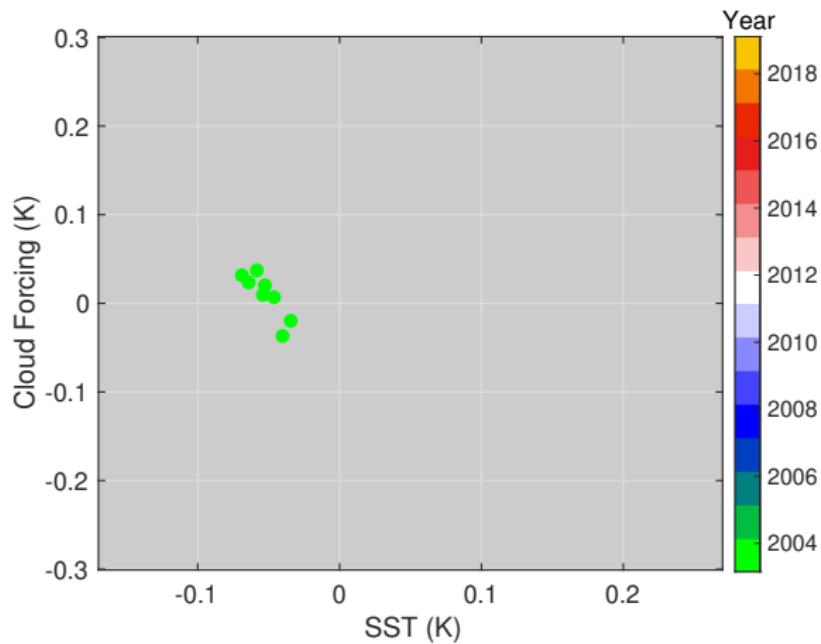
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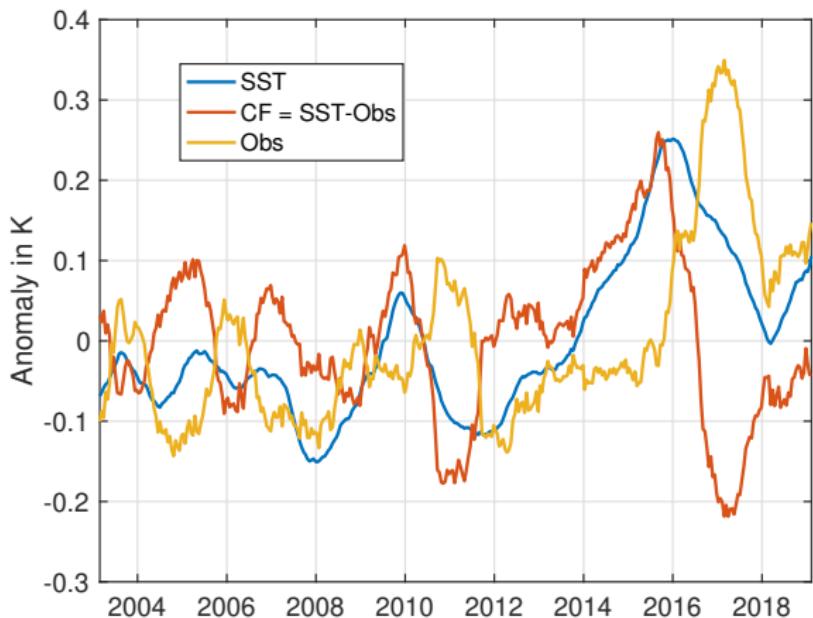
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