Observed Changes in Organized Tropical Deep Convection as Identified by Cloud Regime Analysis

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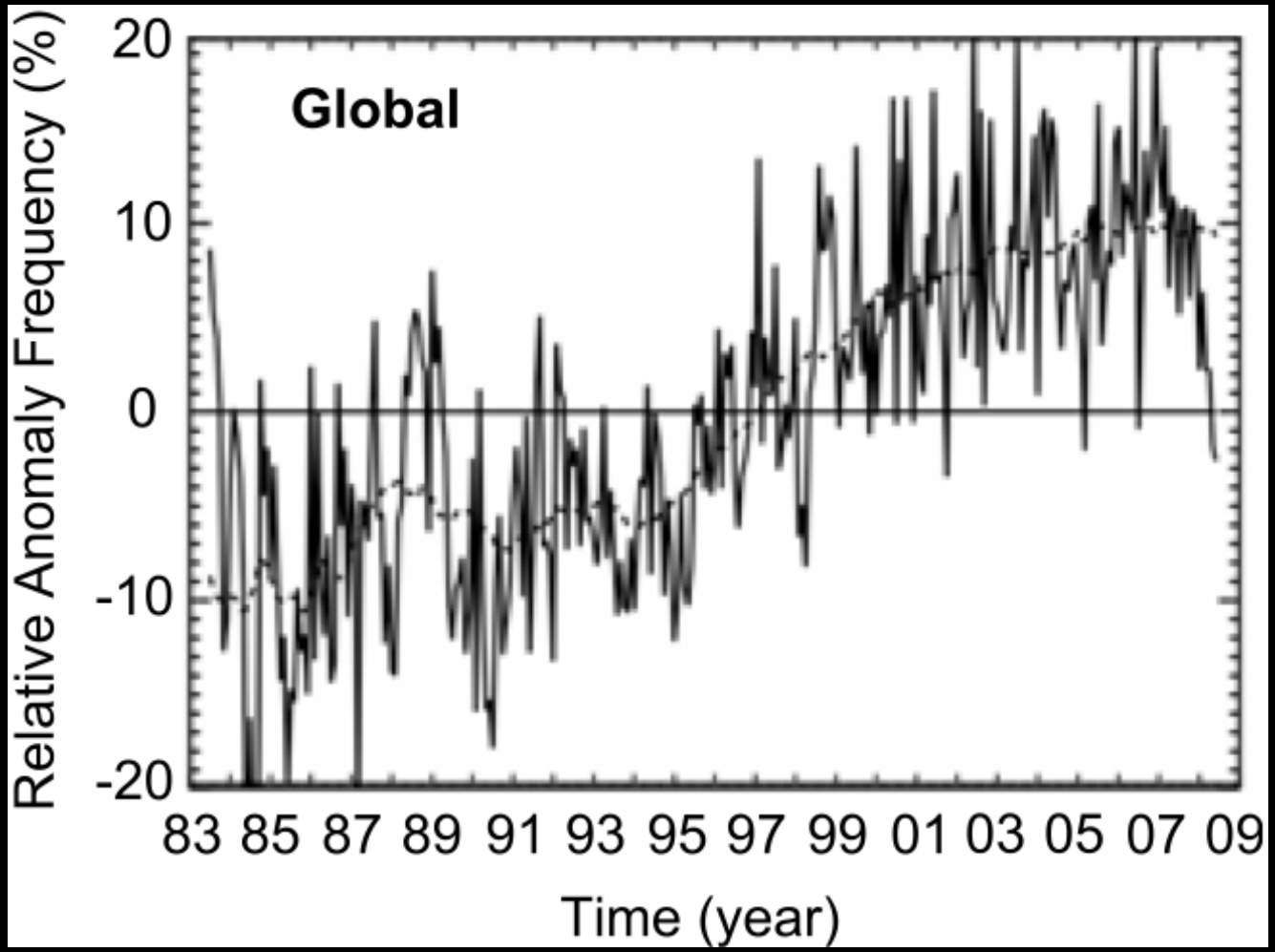
Motivation: Changes in Org. Deep Conv.

Motivation

Organized deep convection has a critical impact on the climate system, but we know little about how it has changed globally in the past and will change in a warming climate.

- GCMs cannot properly represent organized deep convection
- lack of observations that are both global and sufficiently long

Org. Deep Conv. Has Increased by 20%



(Tselioudis et al., 2010)

How do they represent organized deep convection?

Representing Org. Deep Conv. with Cloud Regime

- by cloud regimes (or weather states)
- classification of the **convective state** of the atmosphere
- one regime in particular characterizes an environment of **organised deep convection**

Aims: Changes in this Regime and Other Regimes

Aims

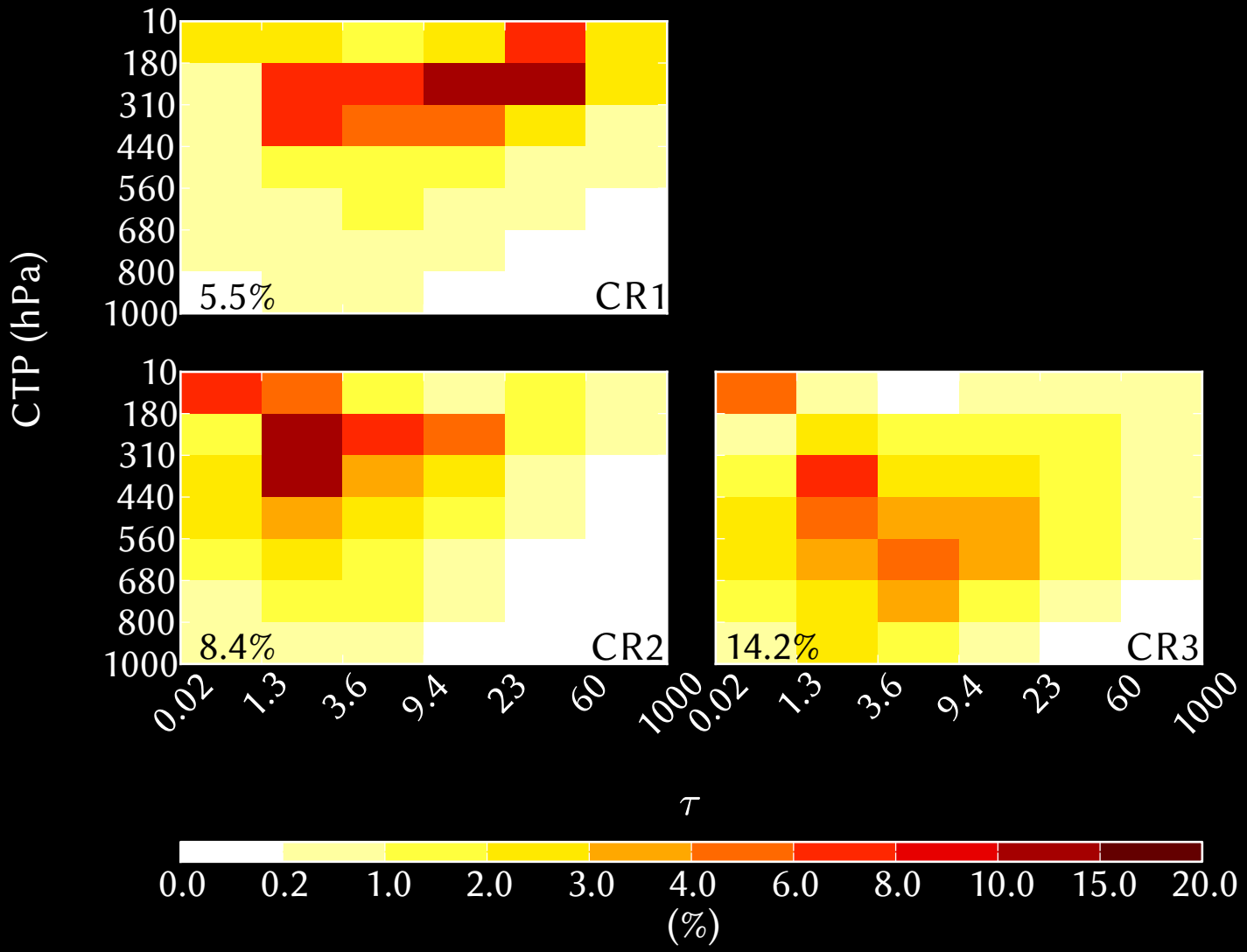
1. how has this organized deep convective regime changed **internally**?

2. how have **other regimes of less organized deep convection** changed?

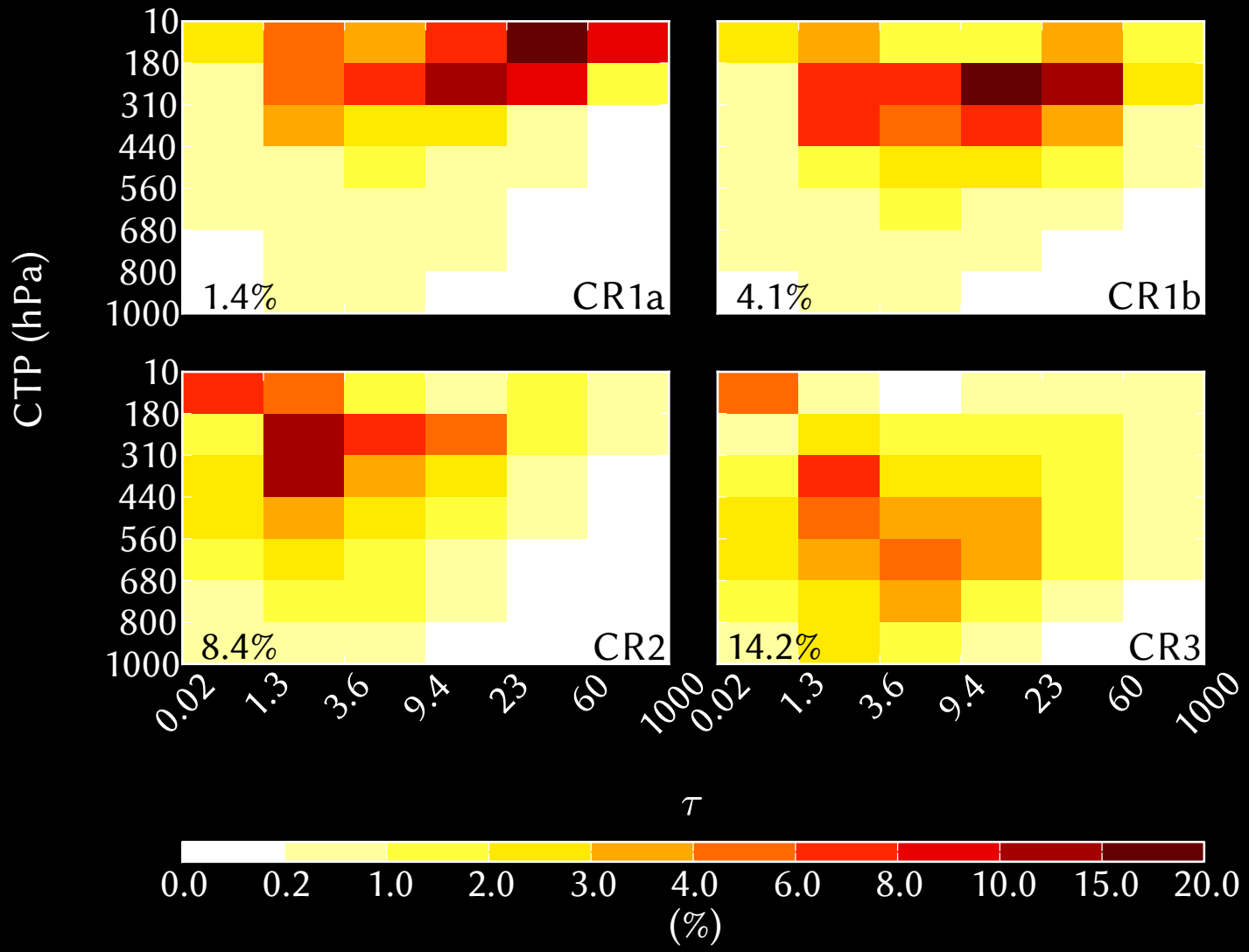
Cloud Regimes as Convective Indicators

- first proposed by *Jakob and Tselioudis (2003)*
- classification of cloud fields by k-means clustering of joint-histograms of CTP and τ
- 280 km $\times$ 280 km, daily time resolution, 35°N/S
- indicators of the convective state of the atmosphere

Three Regimes Describe Deep Convection



Re-clustering CR1 Gives Two Sub-Regimes



Caution in Using ISCCP in Trend Studies!

GEOPHYSICAL RESEARCH LETTERS, VOL. 34, L04701, doi:10.1029/2006GL028083, 2007

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Arguments against a physical long-term trend in global ISCCP cloud amounts

Amato T. Evan,[1] Andrew K. Heidinger,[2] and Daniel J. Vimont[3]

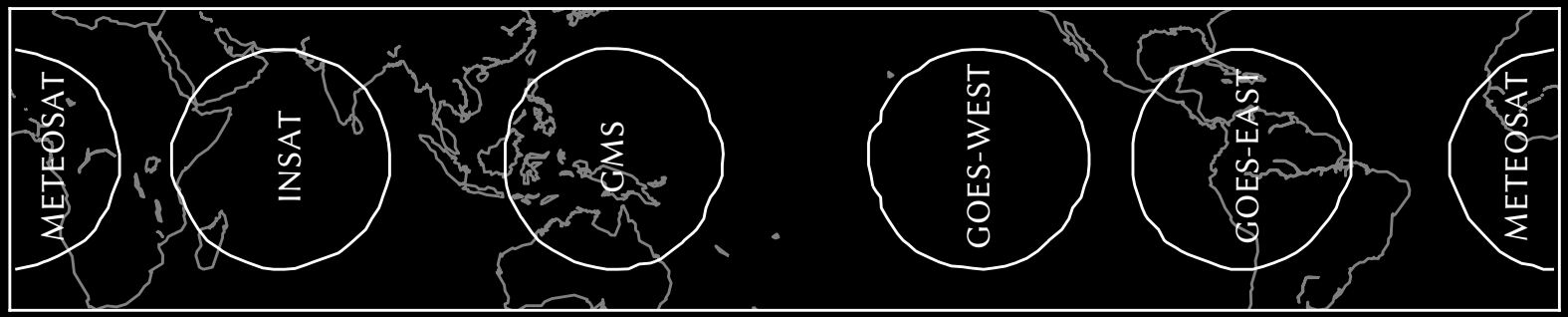
Received 11 September 2006; revised 8 January 2007; accepted 23 January 2007; published 17 February 2007.

[1] The International Satellite Cloud Climatology Project (ISCCP) multi-decadal record of cloudiness exhibits a well-known global decrease in cloud amounts. This downward trend has recently been used to suggest widespread increases in surface solar heating, decreases in planetary albedo, and deficiencies in global climate models. Here we show that trends observed in the ISCCP data are satellite viewing geometry artifacts and are not related to physical changes in the atmosphere. Our results suggest that in its current form, the ISCCP data may not be appropriate for certain long-term global studies, especially those focused on trends." **Citation:** Evan, A. T., A. K. Heidinger, and D. J. Vimont (2007), Arguments against a physical long-term trend in global ISCCP cloud amounts, *Geophys. Res. Lett.*, *34*, L04701, doi:10.1029/2006GL028083.

iness and other associated products. The spatial coverage of the data is extended by utilizing Advanced Very High Resolution Radiometer (AVHRR) data from polar orbiting satellite roughly at latitudes above and below 60N and 60S, respectively. The exception to this is a segment of the Indian Ocean where geostationary satellite coverage did not exist until the late 1990s and data from the AVHRR was employed. We explore the long term variability of the ISCCP data using the D2 monthly mean cloud product for the years of 1983–2006 [*Rossow and Schiffer*, 1999], the most recent release (data from the British Atmospheric Data Centre, http://badc.nerc.ac.uk, and the Langley Research Center EOS DAAC, http://eosweb.larc.nasa.gov/). While we only consider the infrared total clouds product from this data set, which uses radiance measurements at 11 μm, this

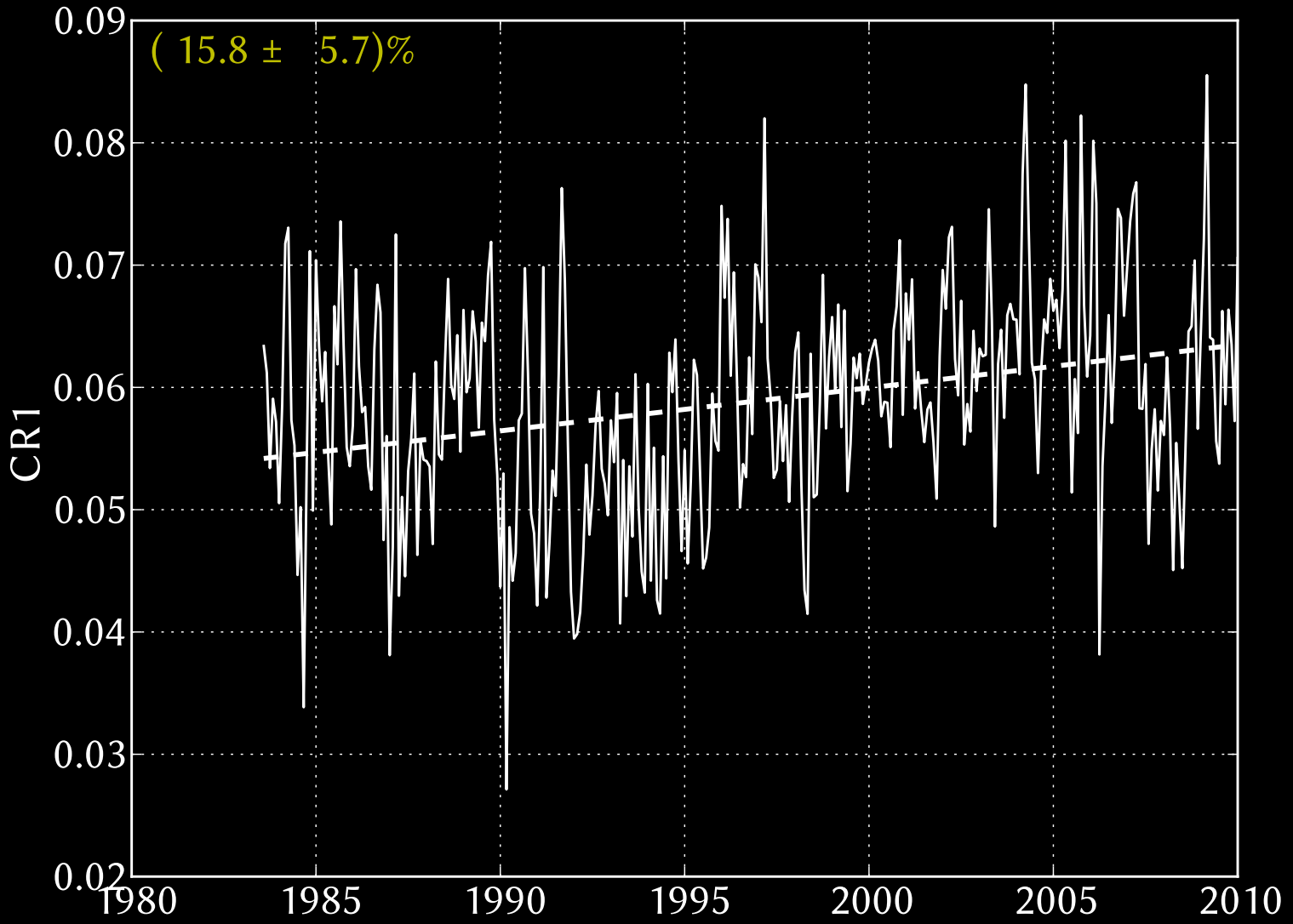
Minimize Artifacts by Zenith Angle Filter

- one main source of satellite artifacts due to **high satellite zenith angles** μ
- generally affects the threshold detection of optically thin clouds
- **set zenith angle filter** $\mu > 30^\circ$ to minimize such artifacts



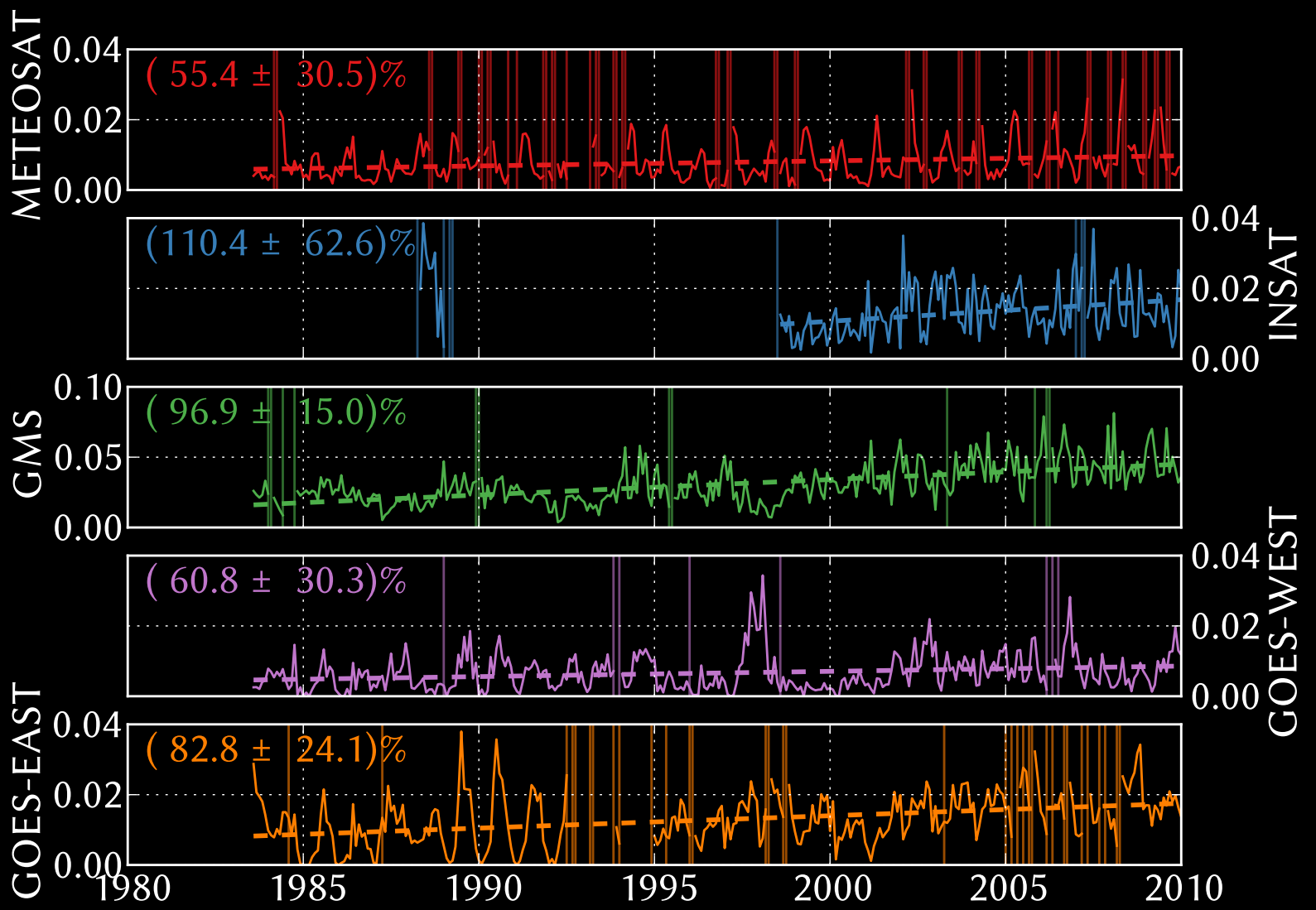
How does our approach compare with Tselioudis et al. (2010)?

Result Consistent with Tselioudis et al. (2010)



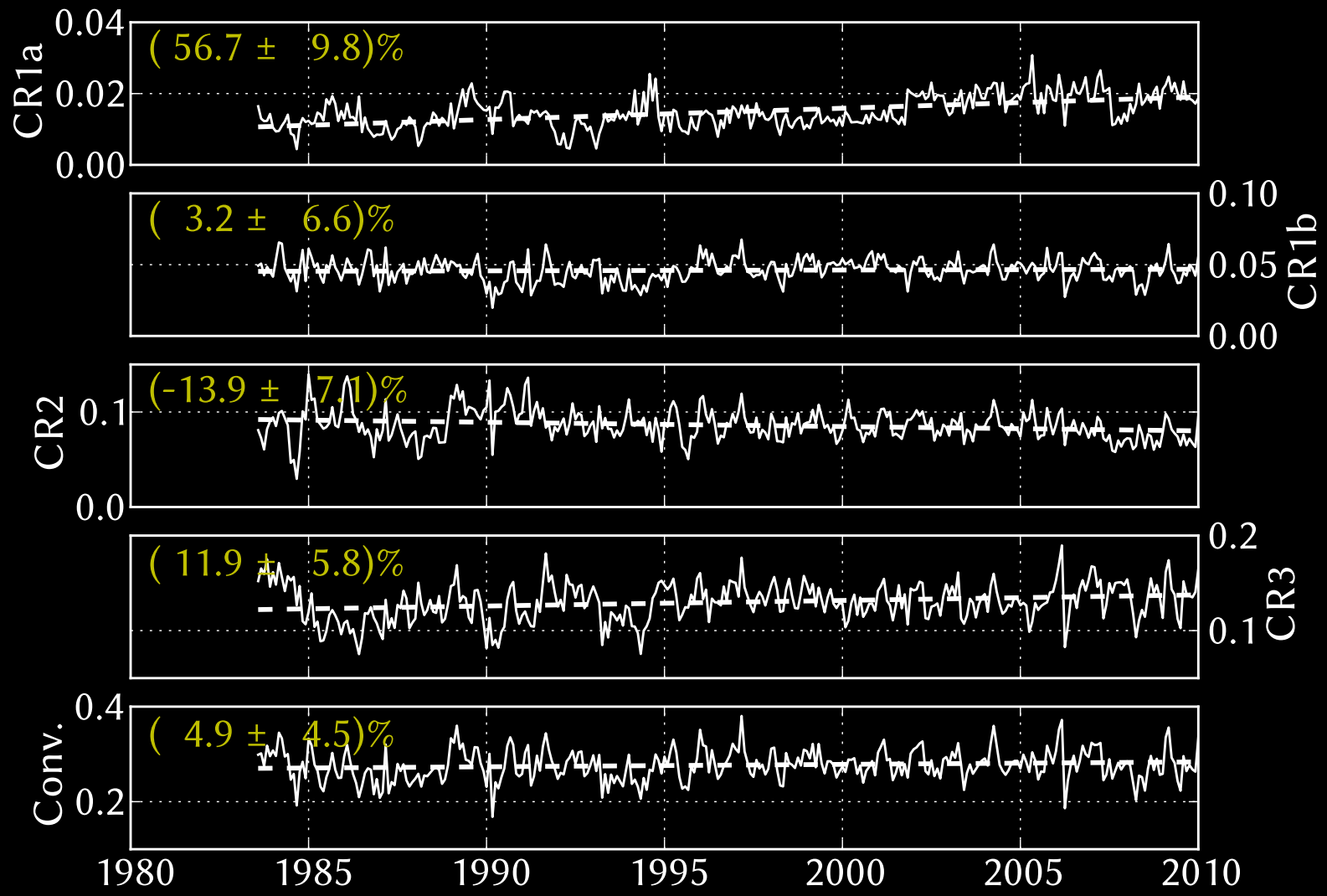
How has CR1a changed?

CR1a Increasing in Every Satellite Region

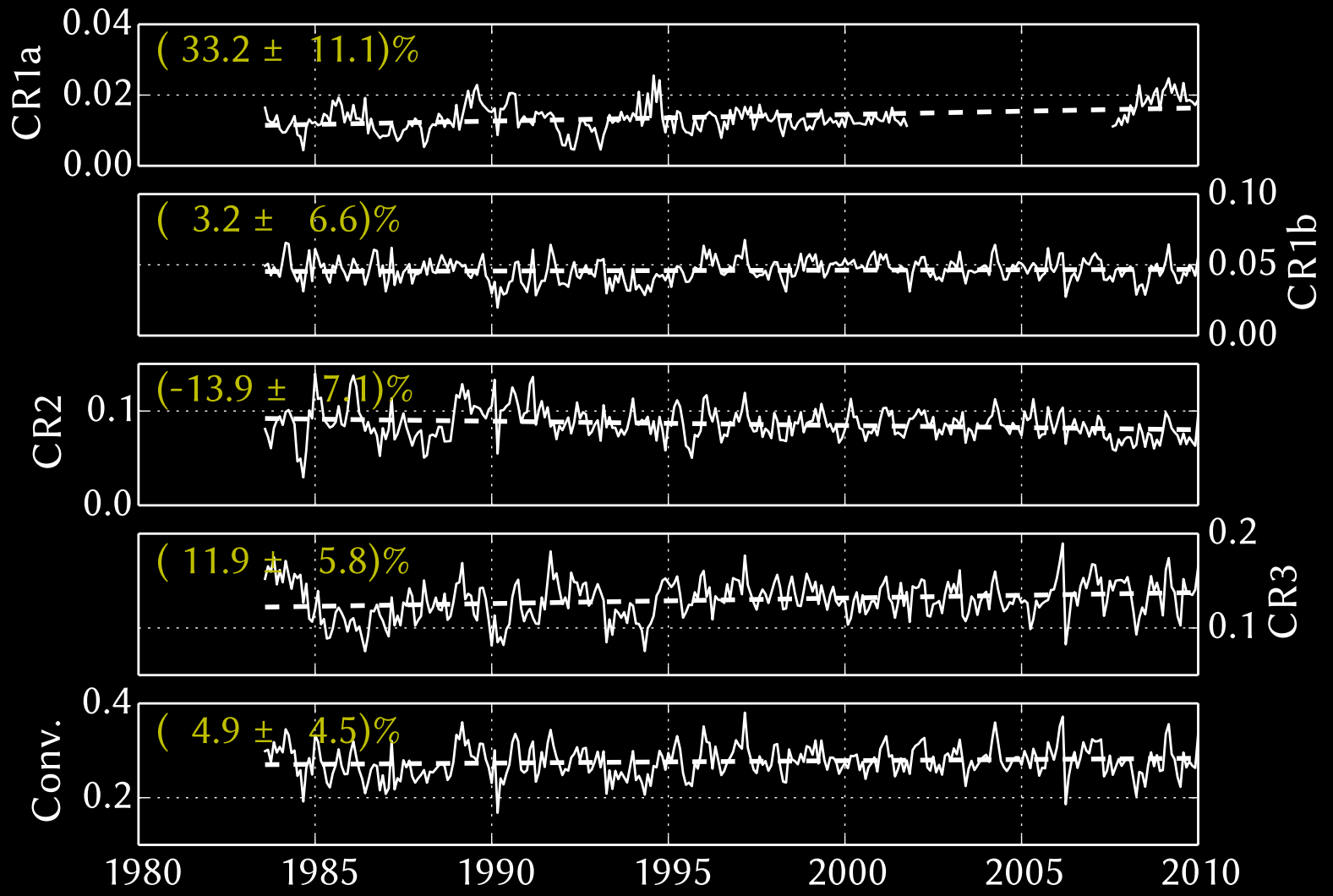


How has other regimes changed?

CR1a Increases But Convective Regimes Constant

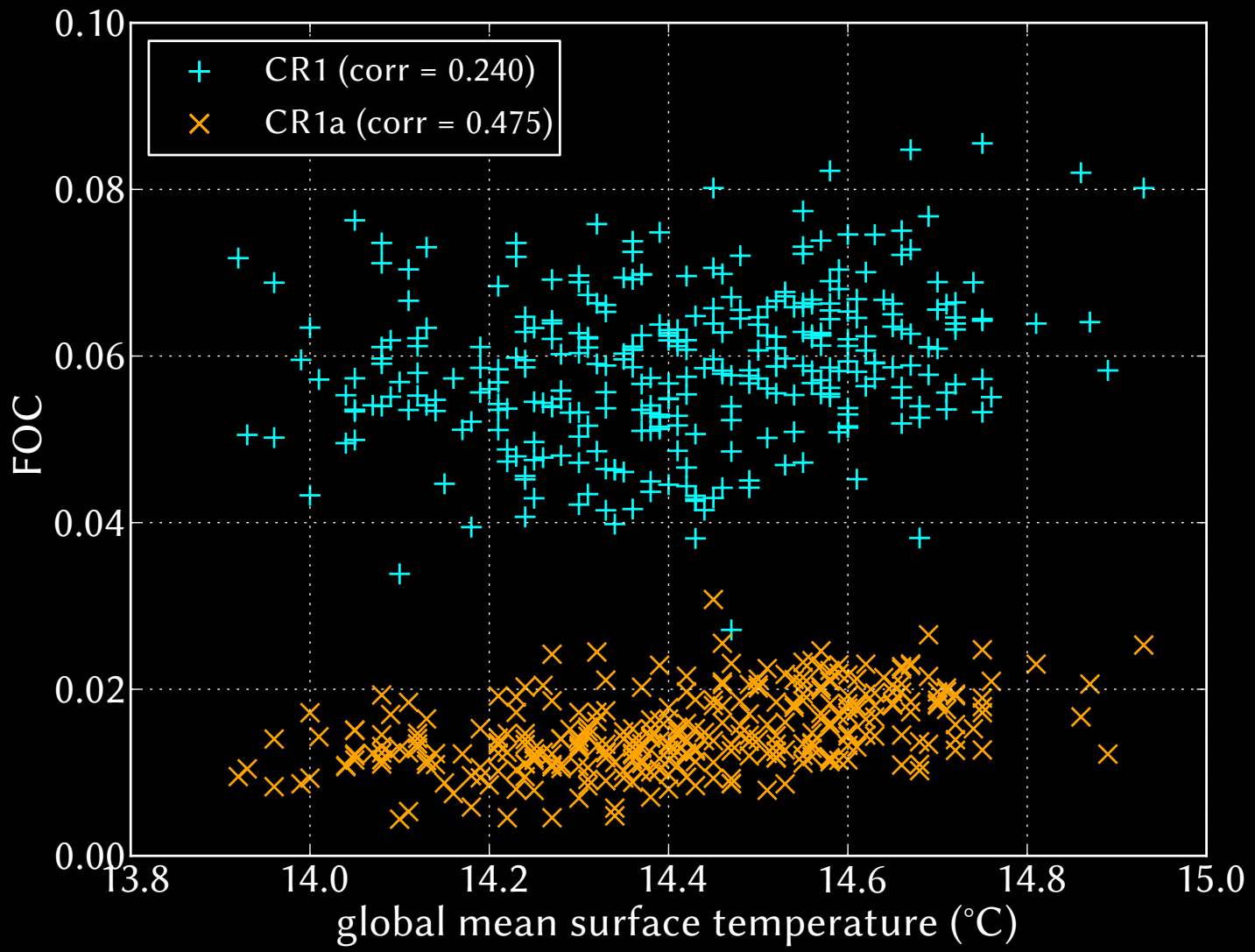


Still an Increase when Jumps are Removed



How will organised deep convection change in the future?

CR1a/CR1 May Increase in a Warming Climate



Conclusions

Conclusions

1. increase in organized deep convection is due **increase** in the more **intense** component
2. area of deep convection remained **constant** but has **intensified** into more organized modes
3. a warmer climate may have **more organised deep convection**

To Do

Address other sources of satellite artifacts, such as from polar-orbiting satellites