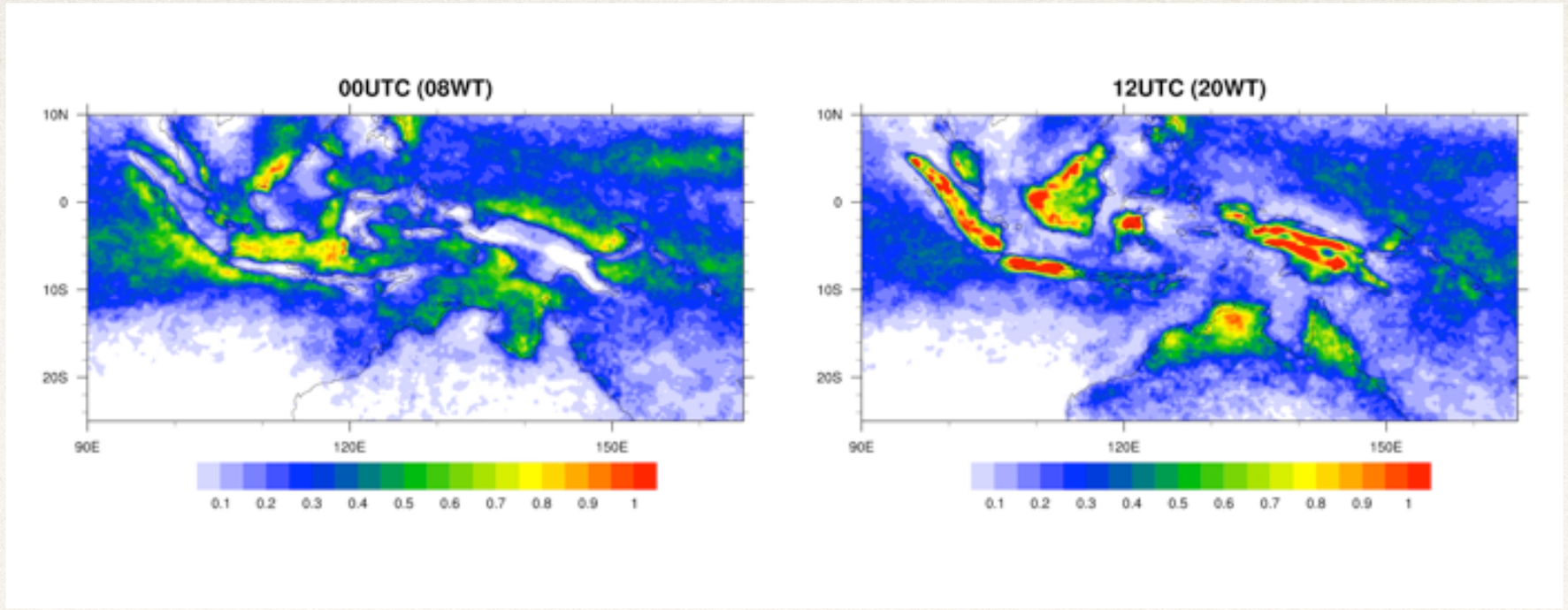


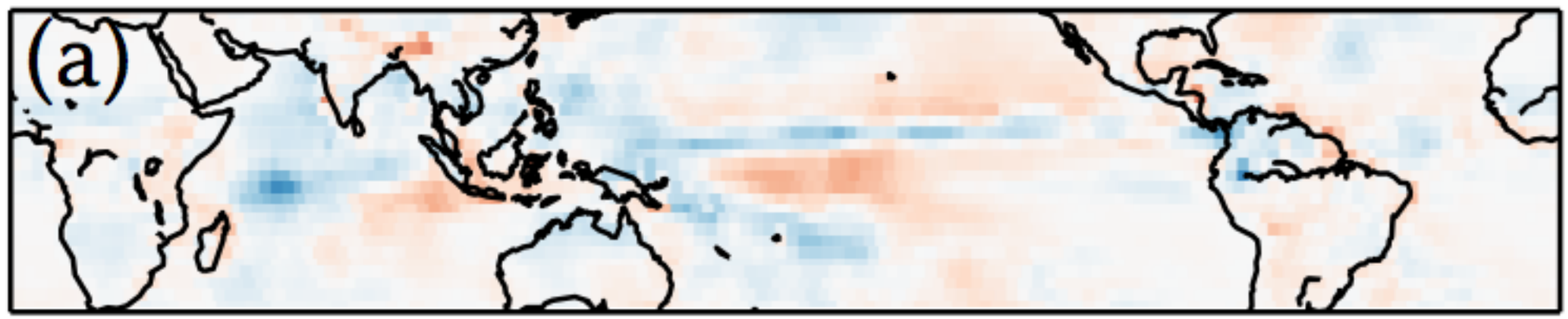
Increases in organised tropical convection as a driver of rainfall trends - how the rich get richer

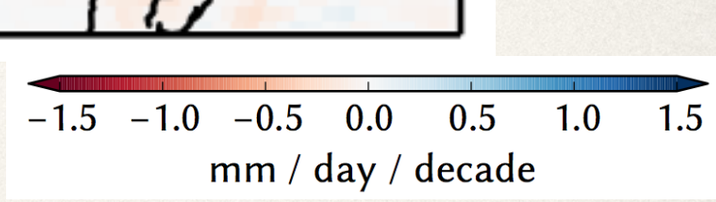
Jackson Tan[1], **Christian Jakob**[1], William Rossow[2], George Tselioudis[3]
[1]ARC Centre of Excellence for Climate System Science, School of EAE, Monash University;
[2]CCNY New York; [3]NASA GISS

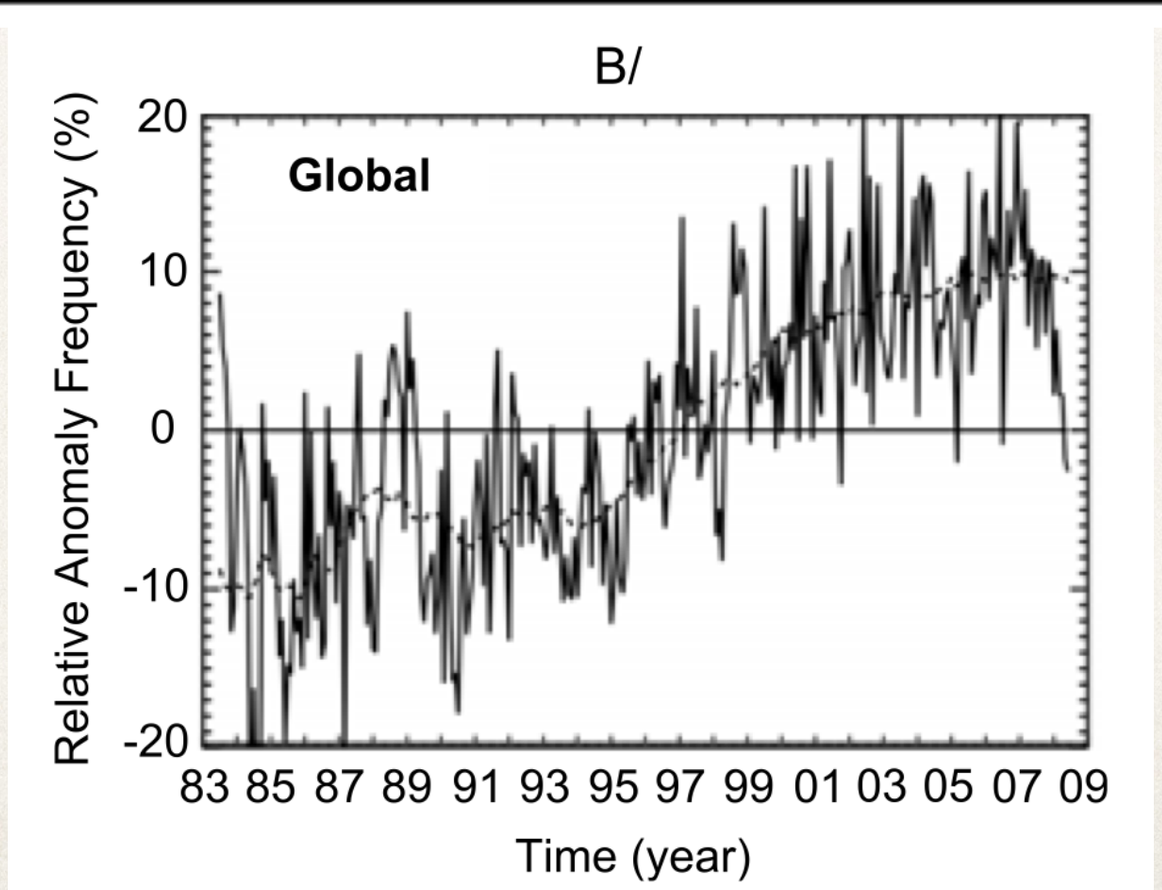
10 July 2014

Trends both in rainfall and the an convective cloud regime have been reported. Are they related?

GPCP linear rainfall trend - July 1983 – December 2009







Time evolution of CD regime anomaly ±15°

Tselioudis et al., 2010

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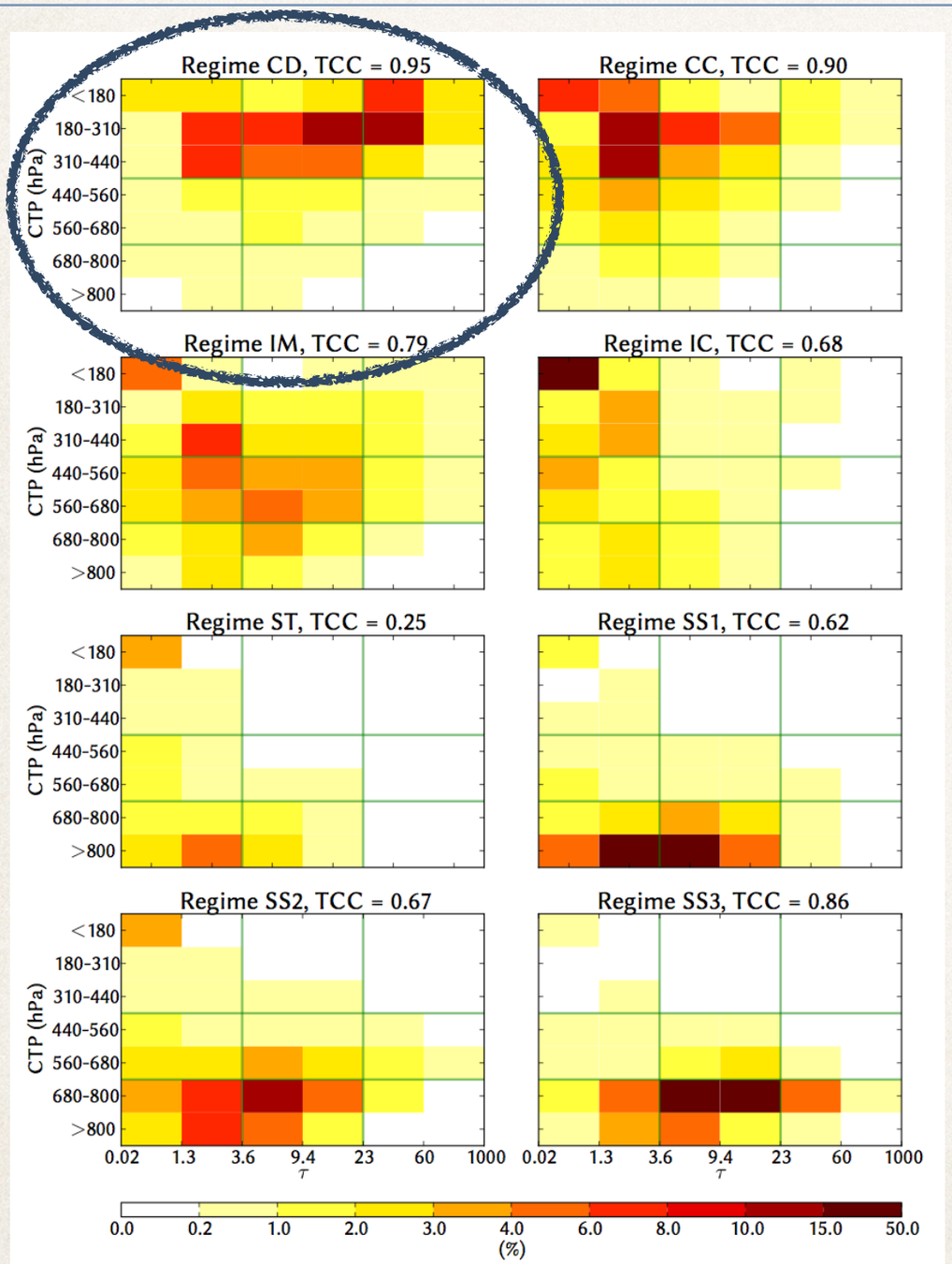
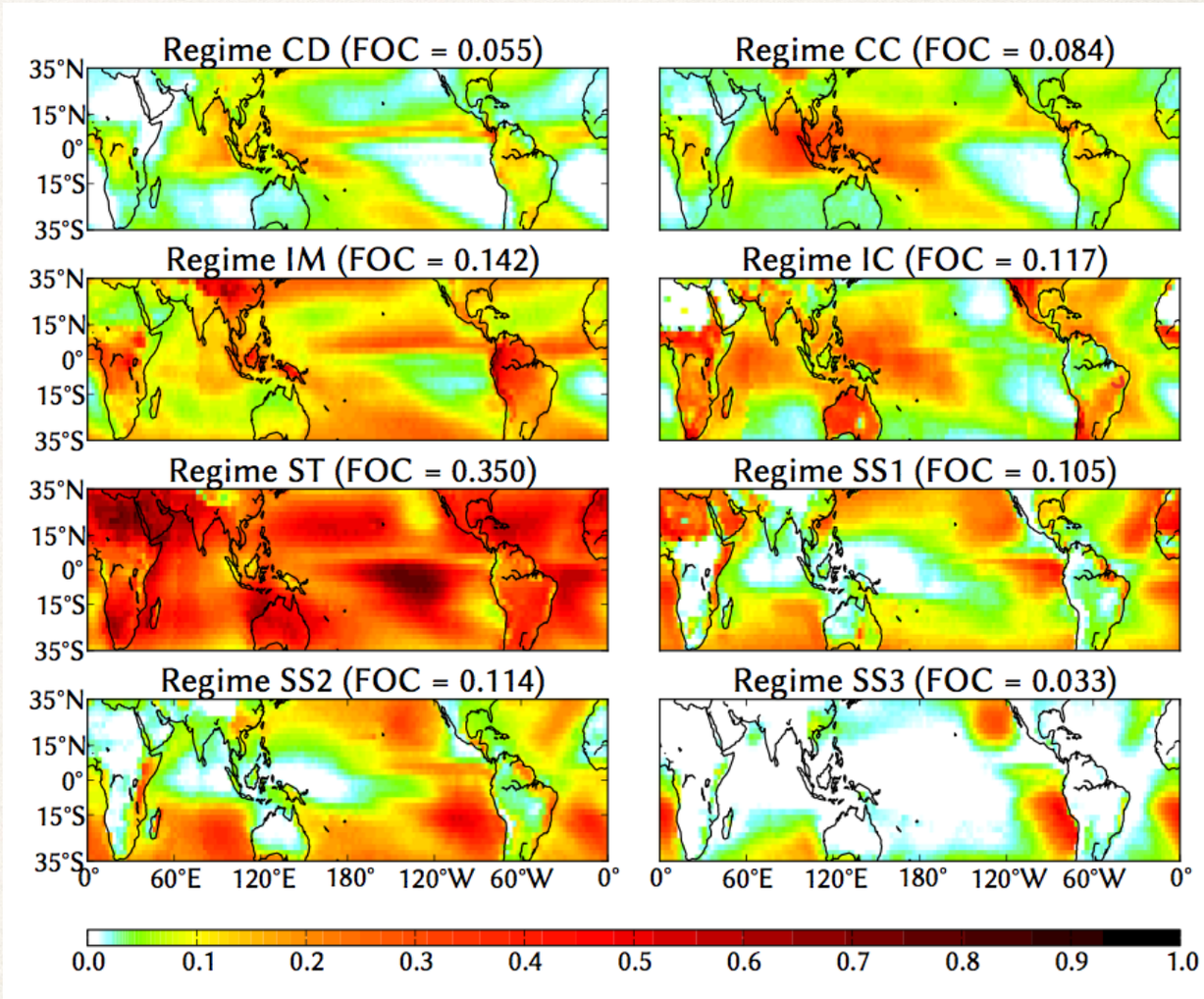
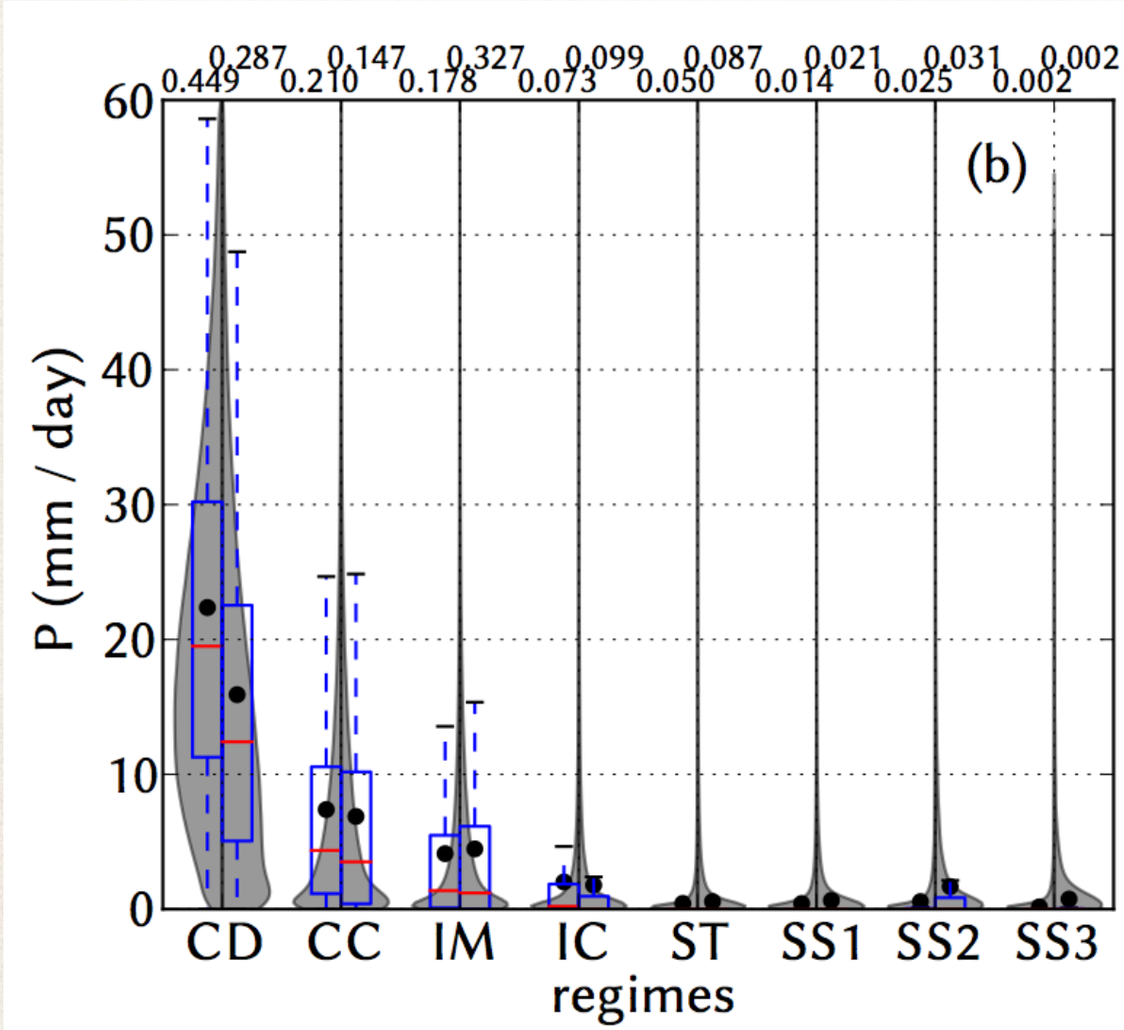
Cluster analysis of daily tropical (± 35°) histograms for 23 years reveals 8 recurring cloud states



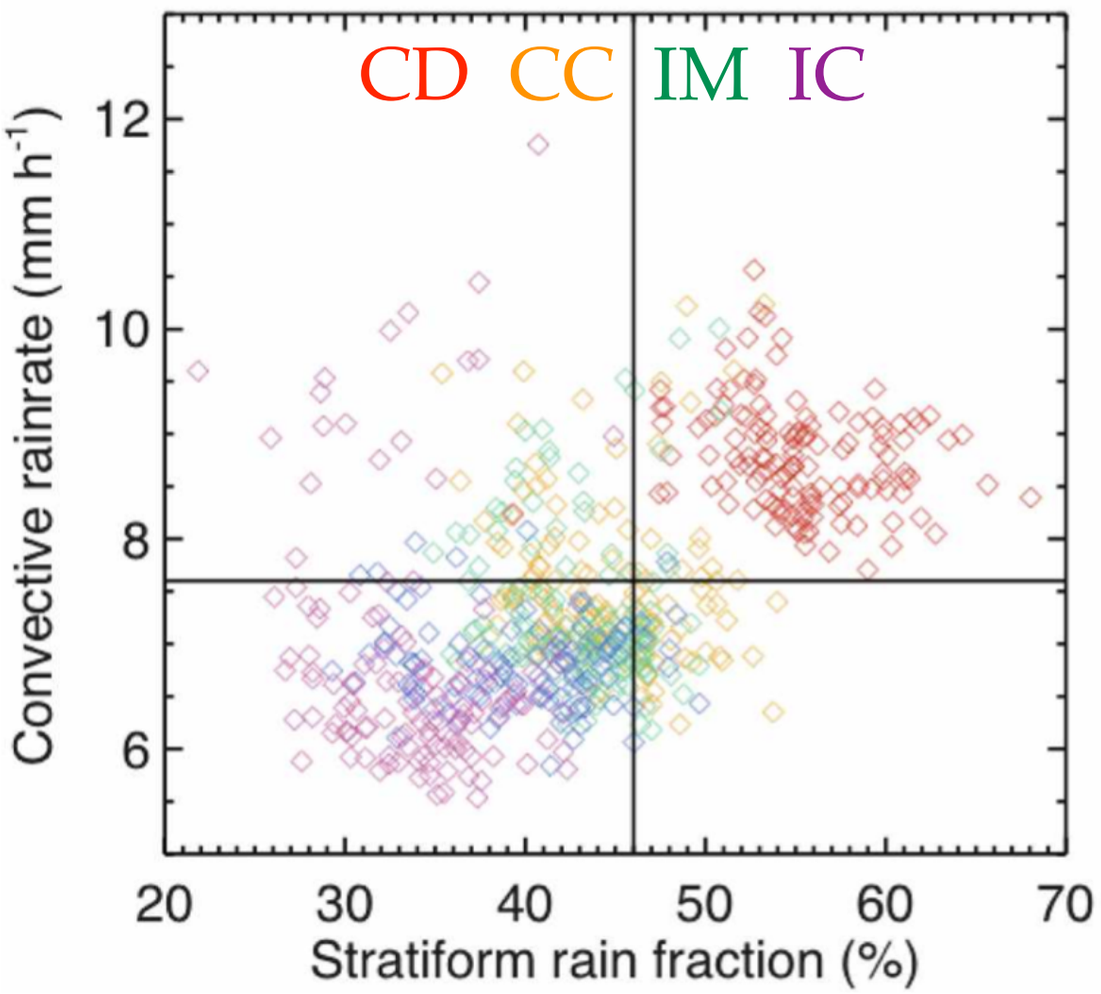


Jakob and Tselioudis, 2003, Rossow et al., 2005; Tselioudis et al., 2013; and many more

A careful analysis of their rainfall behaviour reveals one of the convective regimes (CD) to show strong signs of organisation

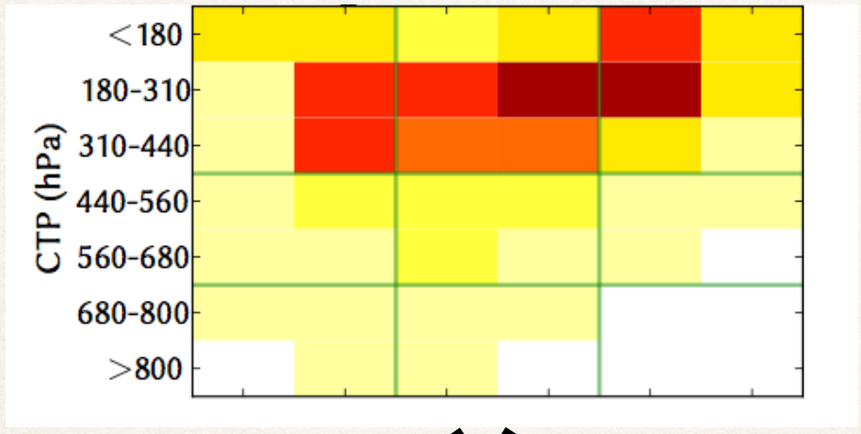


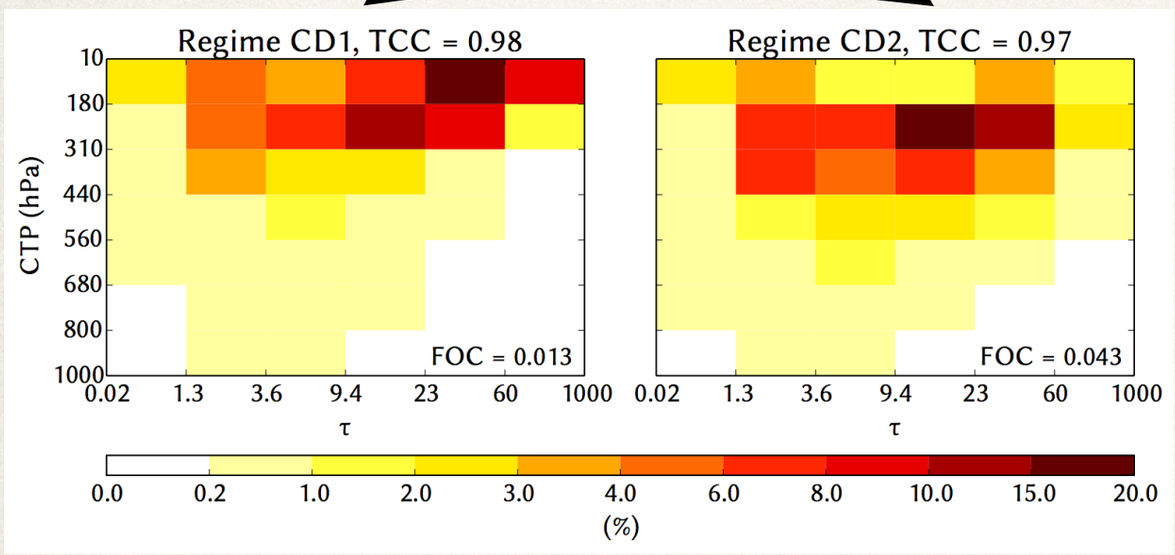
Tan et al, 2013

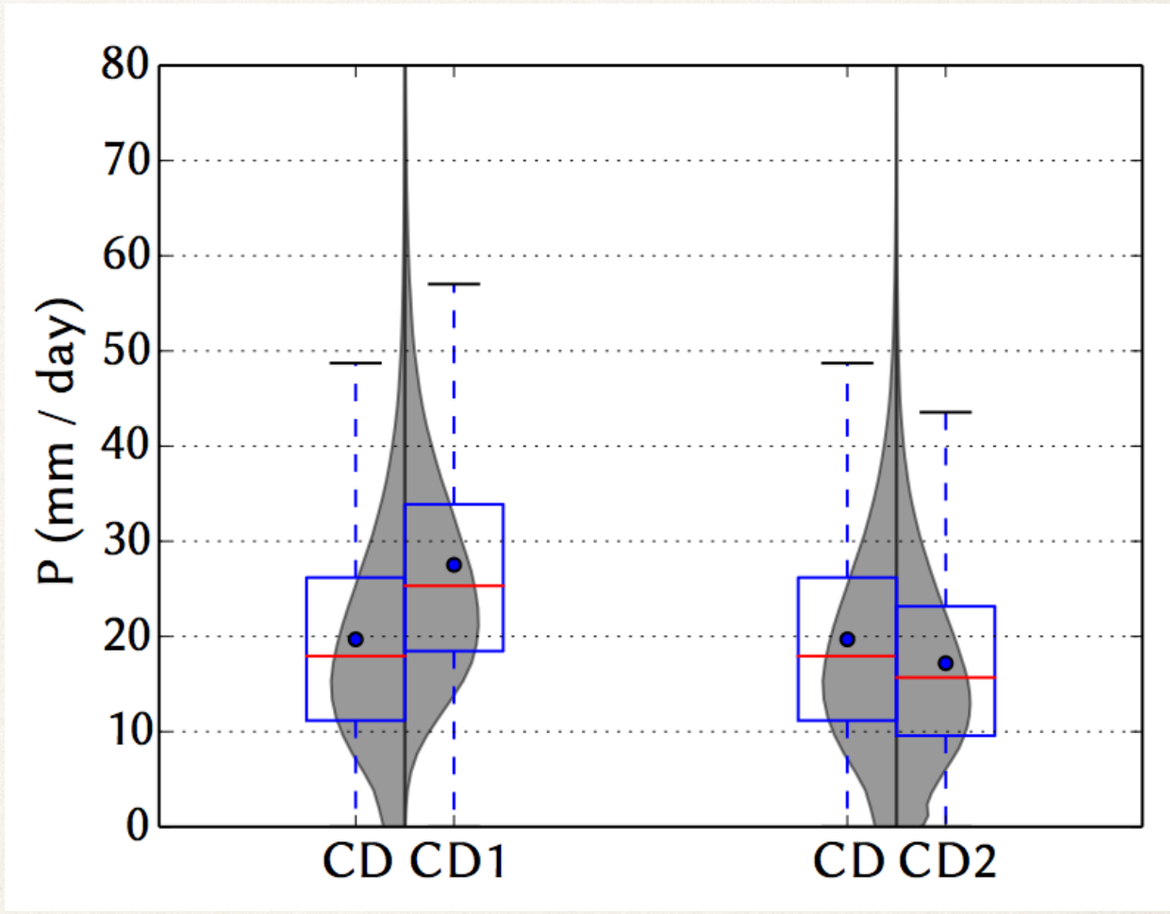


Jakob and Schumacher, 2008

A further decomposition of the CD regime proves useful to study its rainfall behaviour

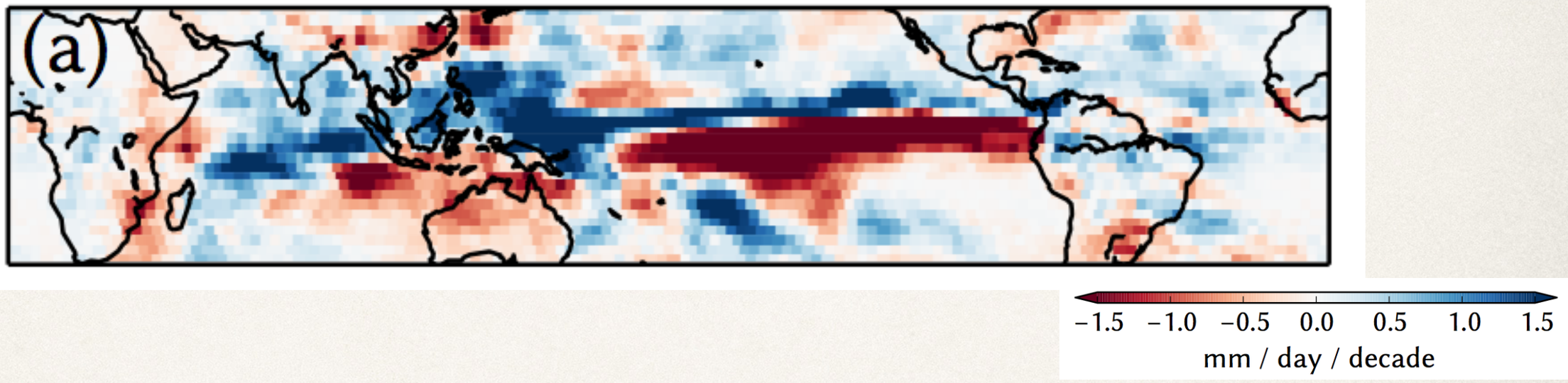






For a shorter record (since 1997) we can conduct a decomposition of the rainfall trend by cloud regime

GPCP linear rainfall trend - January 1997 – December 2009



At each point we write:

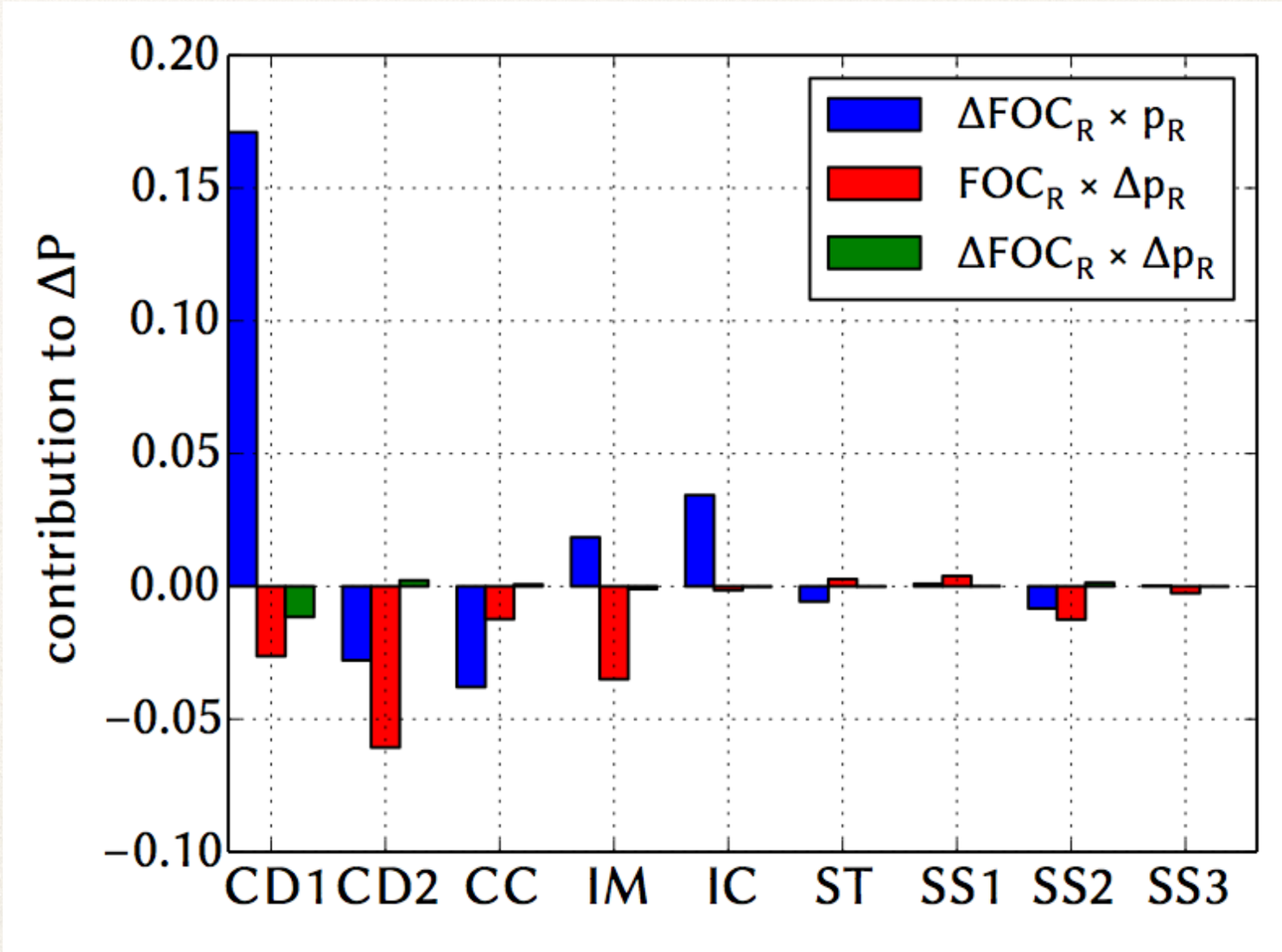
$$\overline{P} = \sum_{r=1}^{9} FOC_r \cdot P_r$$

Then at each point:

$$\Delta\overline{P} = \sum \Delta FOC_r \cdot P_r + FOC_r \cdot \Delta P_r + \Delta FOC_r \cdot \Delta P_r$$

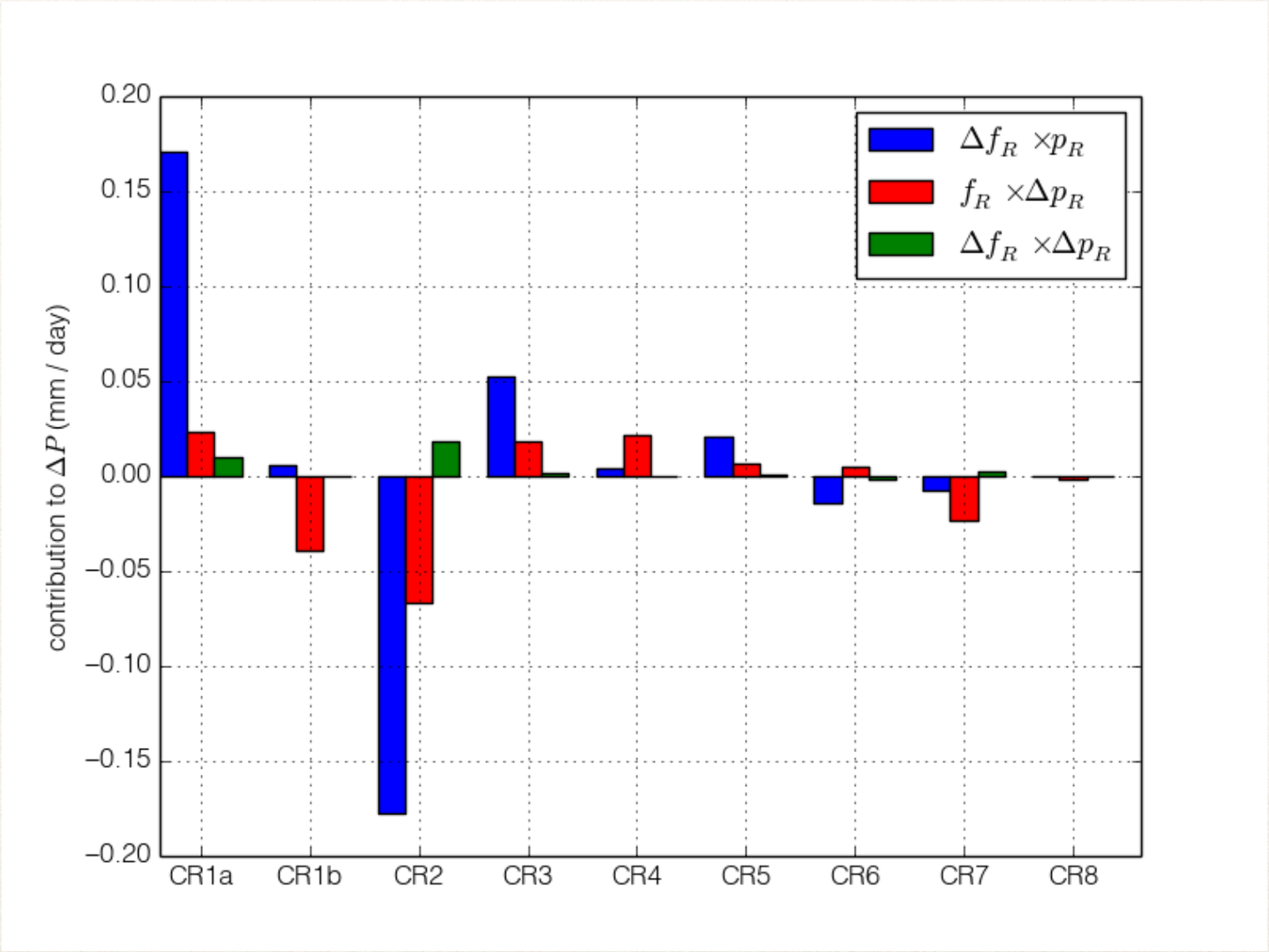
The decomposition of the rainfall trend by cloud regime reveals the main contributor to positive trends to be the CD1 regime

Tropical mean trend contributions by regime

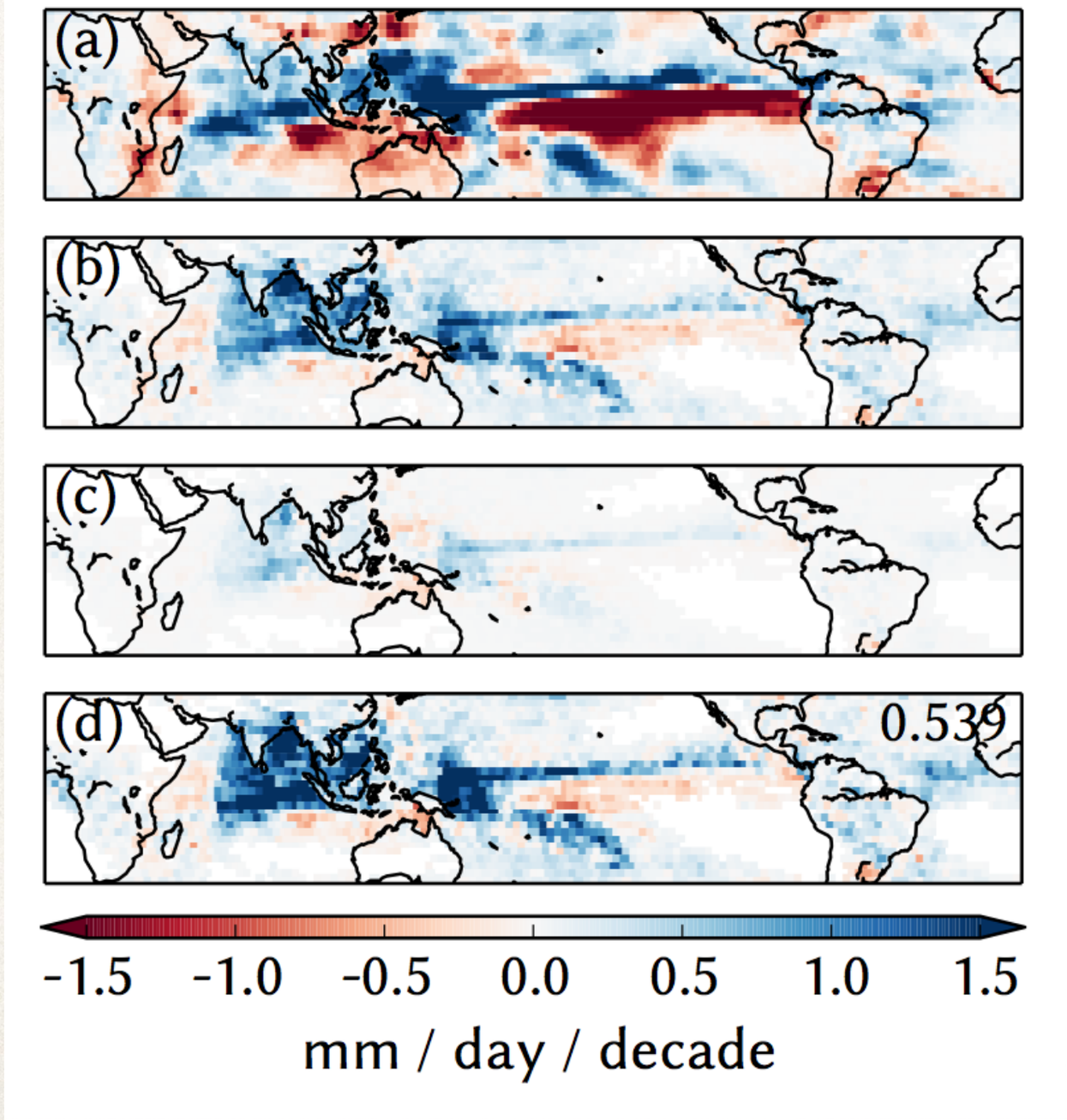


The decomposition of the rainfall trend by cloud regime reveals the main contributor to positive trends to be the CD1 regime

Same result but with 1983-2009 PERSIANN data set



Most of the 1997-2009 positive rainfall changes can be reconstructed using the CD1 regime alone!



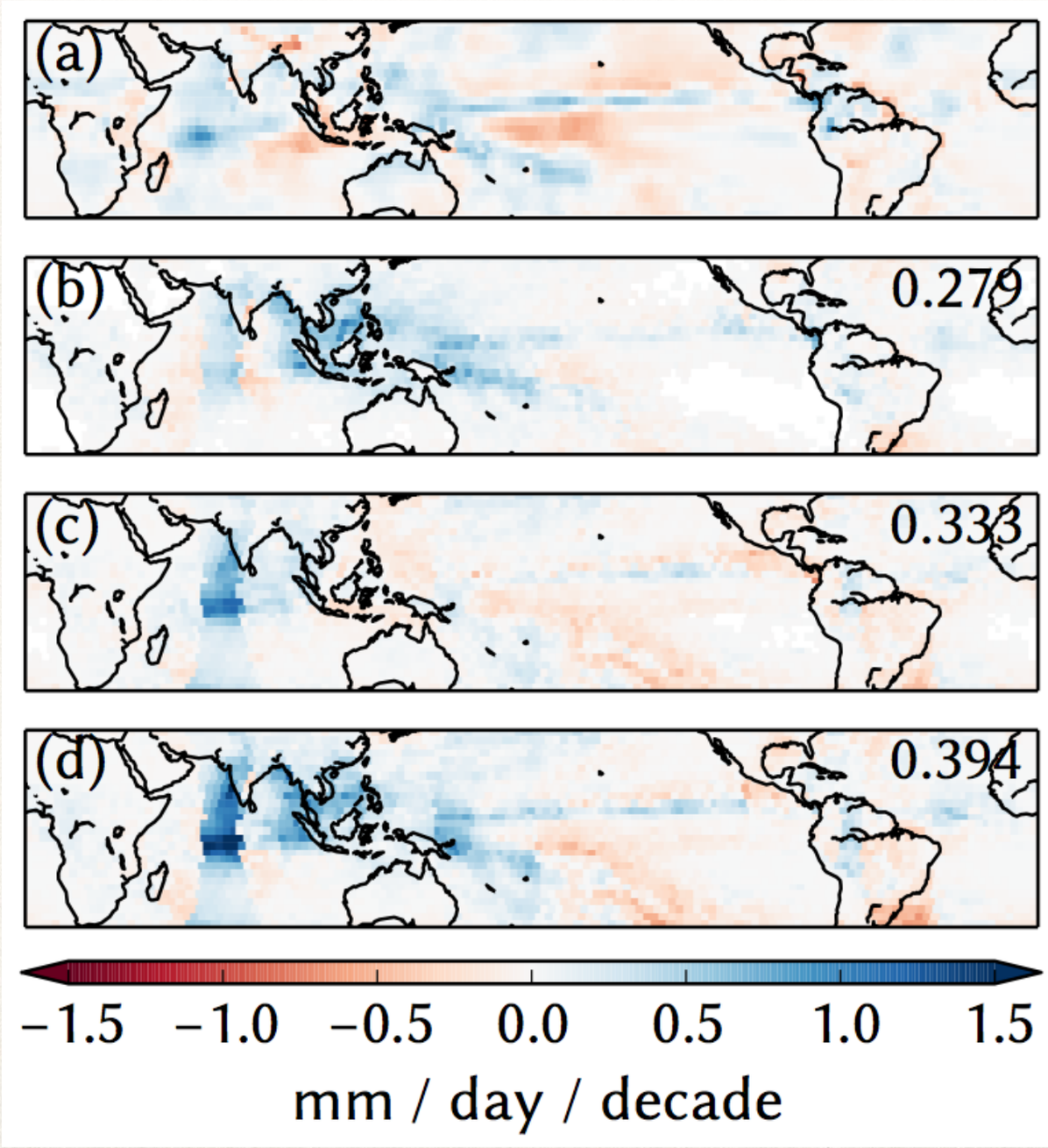
Total "trend" 1997-2009

$\Delta FOC_{CD1} \times P_{CD1}$

$FOC_{CD1} \times \Delta P_{CD1}$

All CD1 terms

(Wrongly) Assuming ΔP_r to be zero, even the longer term trends show a strong relationship to the CD1 regime



Total trend
1983-2009

$\Delta FOC_{CD1} \times P_{CD1}$

$\Delta FOC_{CD2} \times P_{CD2}$

All CD1 and CD2 terms

Conclusions

- Objectively identified tropical cloud states from ISCCP data provide good surrogates for the archetypal states of tropical convection.

- Much of the observed (and projected?) wet get wetter rainfall trend is the direct result of an increase in the occurrence of organised convection.

- Modern cumulus parametrisations must therefore include a description of organised convection.

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Thank you!