Reduced wet season length detected by satellite retrievals of cloudiness over the Brazilian Amazonia: a new methodology

Elisa Thomé Sena
Departamento Multidisciplinar
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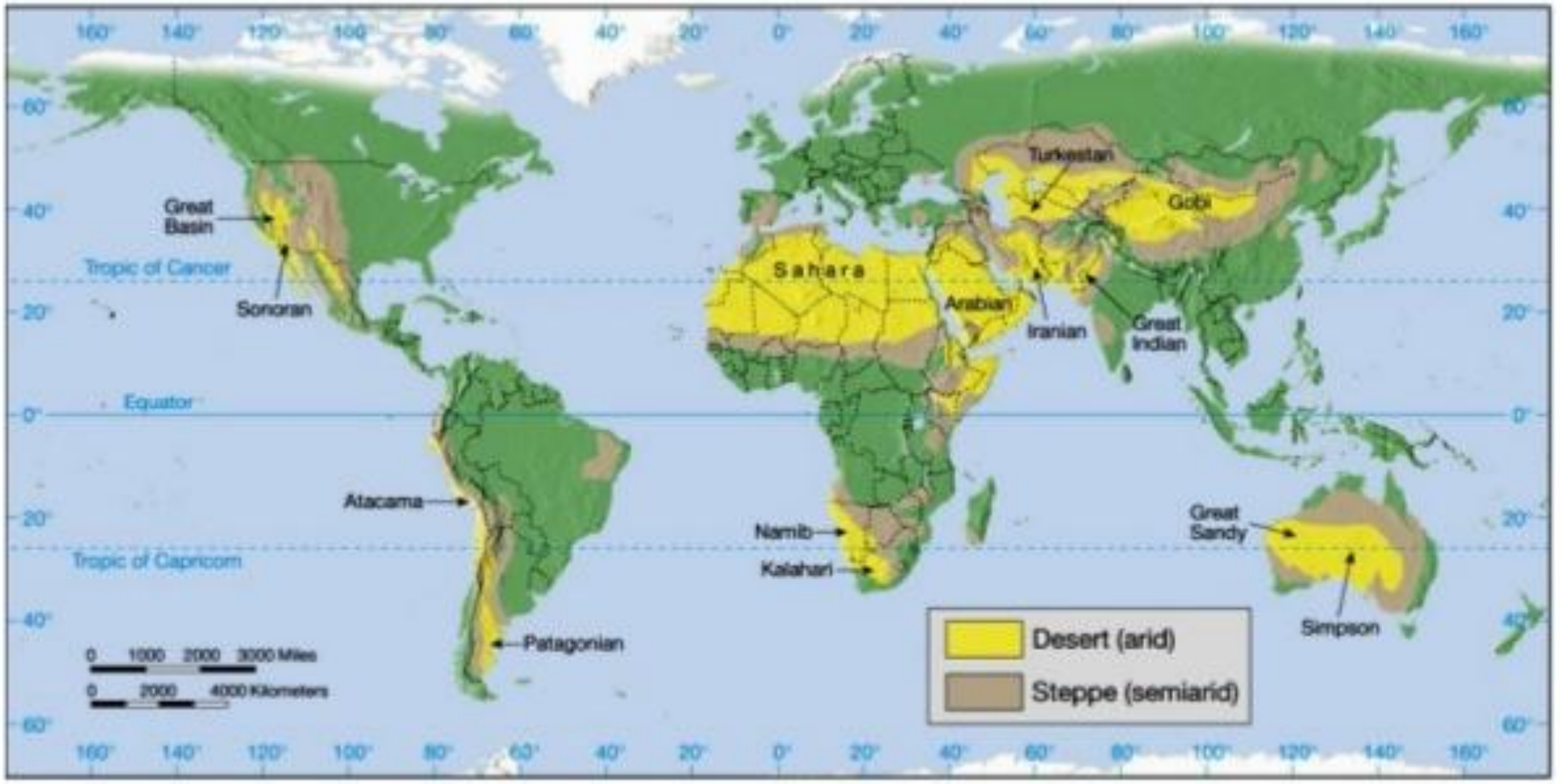
Why does the Amazon rainforest matter?

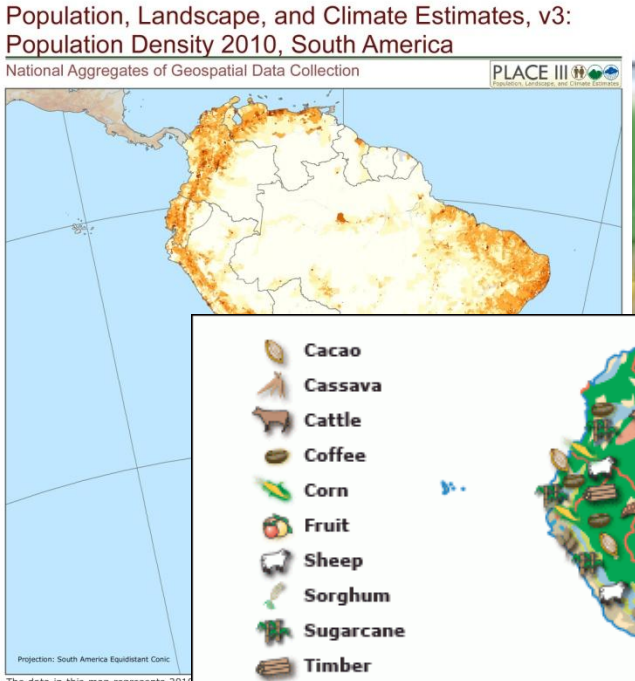
Largest deserts on Earth



Largest deserts on Earth

Population of the Southeast and South of Brazil: **108 million people.**

Largest deserts on Earth



Population of the Southeast and South of Brazil: **108 million people.**

South of Amazonia: agriculture and food security.

Largest deserts on Earth

What if Amazon's rainfall regime changes?

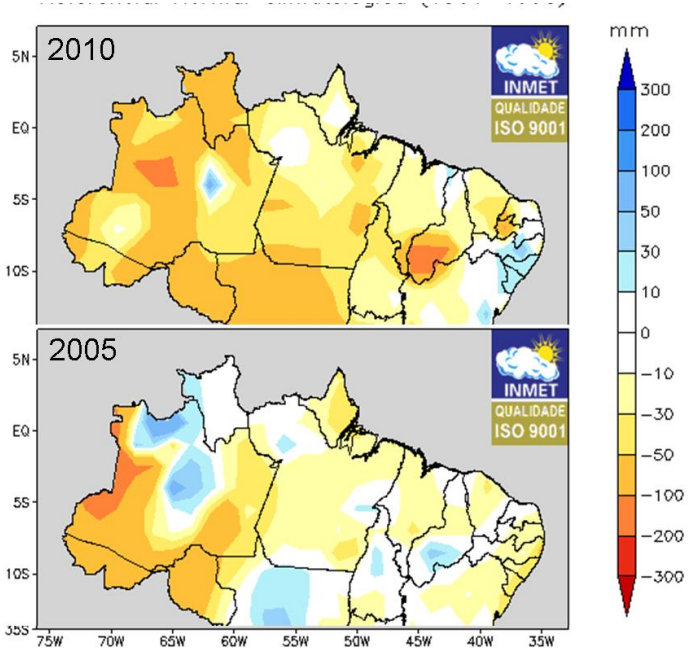
Population of the Southeast and South of Brazil: **108 million people.**

South of Amazonia: agriculture and food security.

Amazon rainforest hit by second 'once in a century drought' in five years

By DAVID DERBYSHIRE FOR MAILONLINE
UPDATED: 09:01 BST, 4 February 2011

Precipitation Anomaly –September



2010

2015

Goal:

Verify how Amazon's cloud life cycle and rainfall regime has changed over the years and explore the possible drivers and consequences of these changes.

Questions:

- What is happening to clouds in Amazonia?
- How are these variations linked to meteorological variables over the region?
- What is happening to the rainfall regime in Amazonia?
- What are some of the potential drivers of these changes?

Data

International Satellite Cloud Climatology Project (ISCCP)

- 27 years of Cloud fraction retrievals from Geostationary Satellites (1983 – 2009)
- One measurement every 3 hours
- Grid cell: 2.5^{o} x 2.5^{o}

Other data sources

- ERA-Interim and ERA Interim/Land Reanalysis
- Climate indices time series

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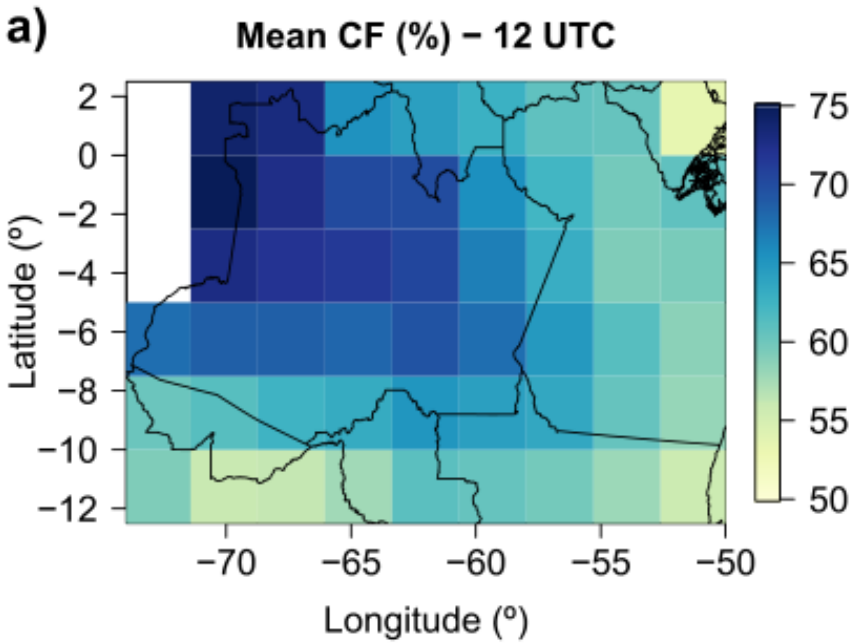
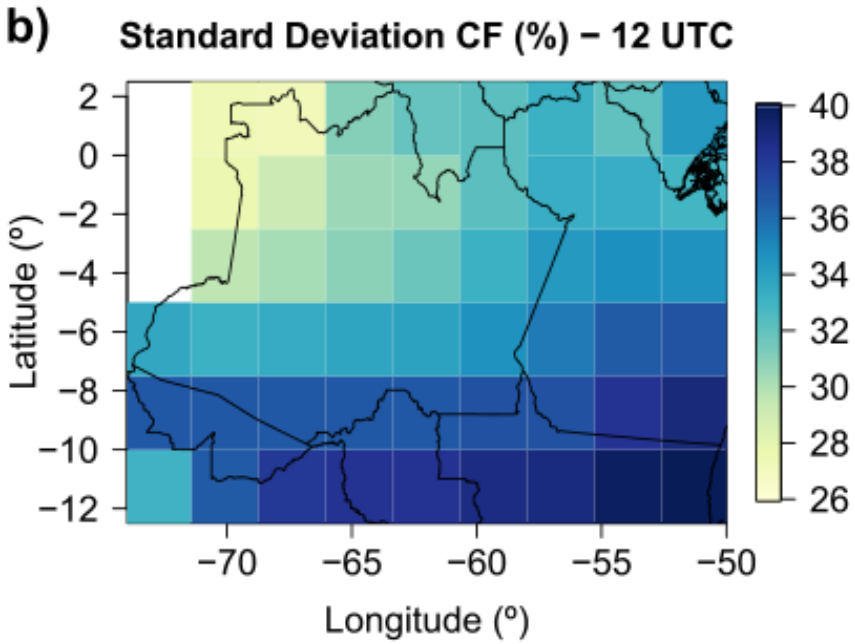
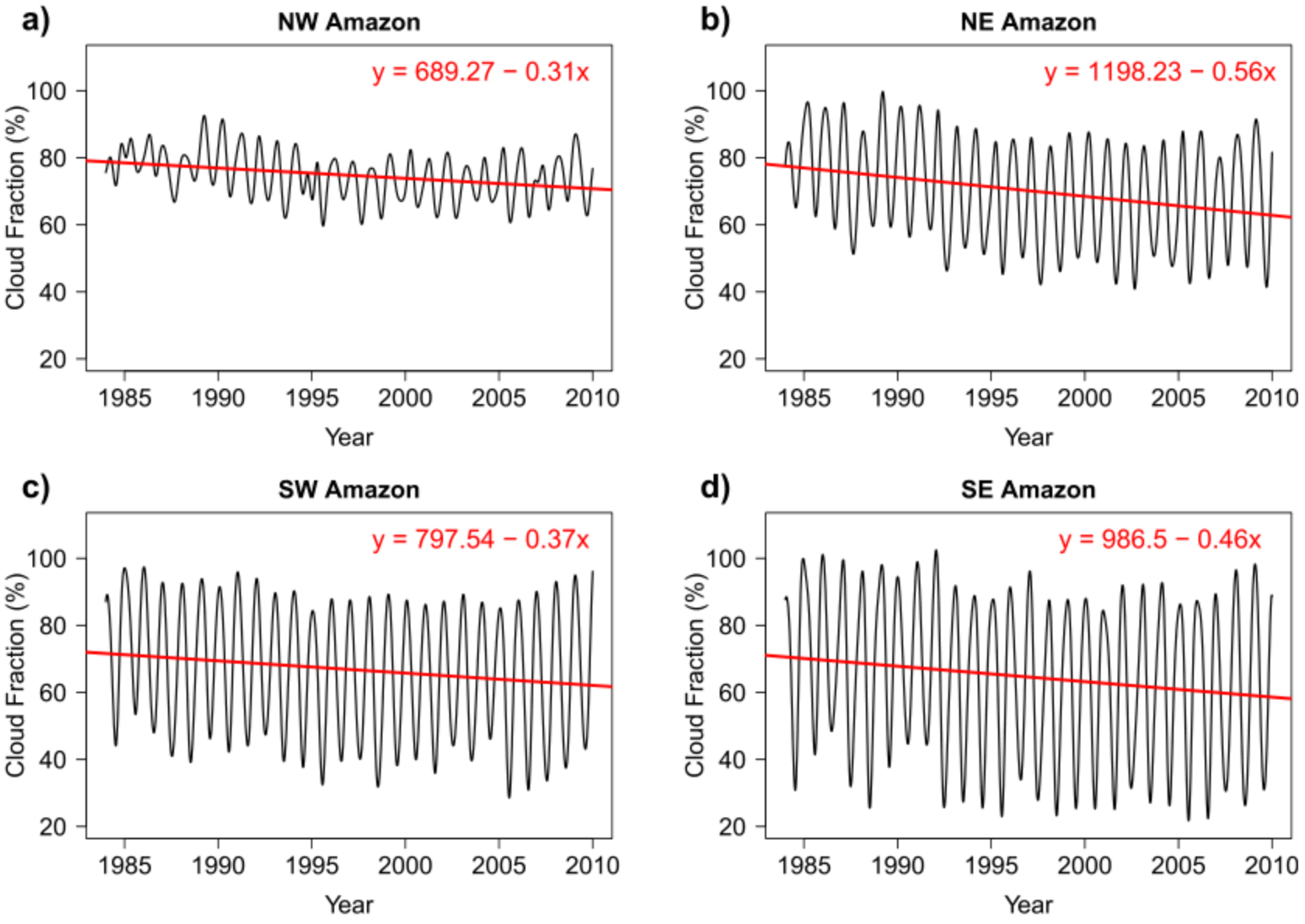
Mean and standard deviation of Total Cloud Fraction (1983 – 2009)

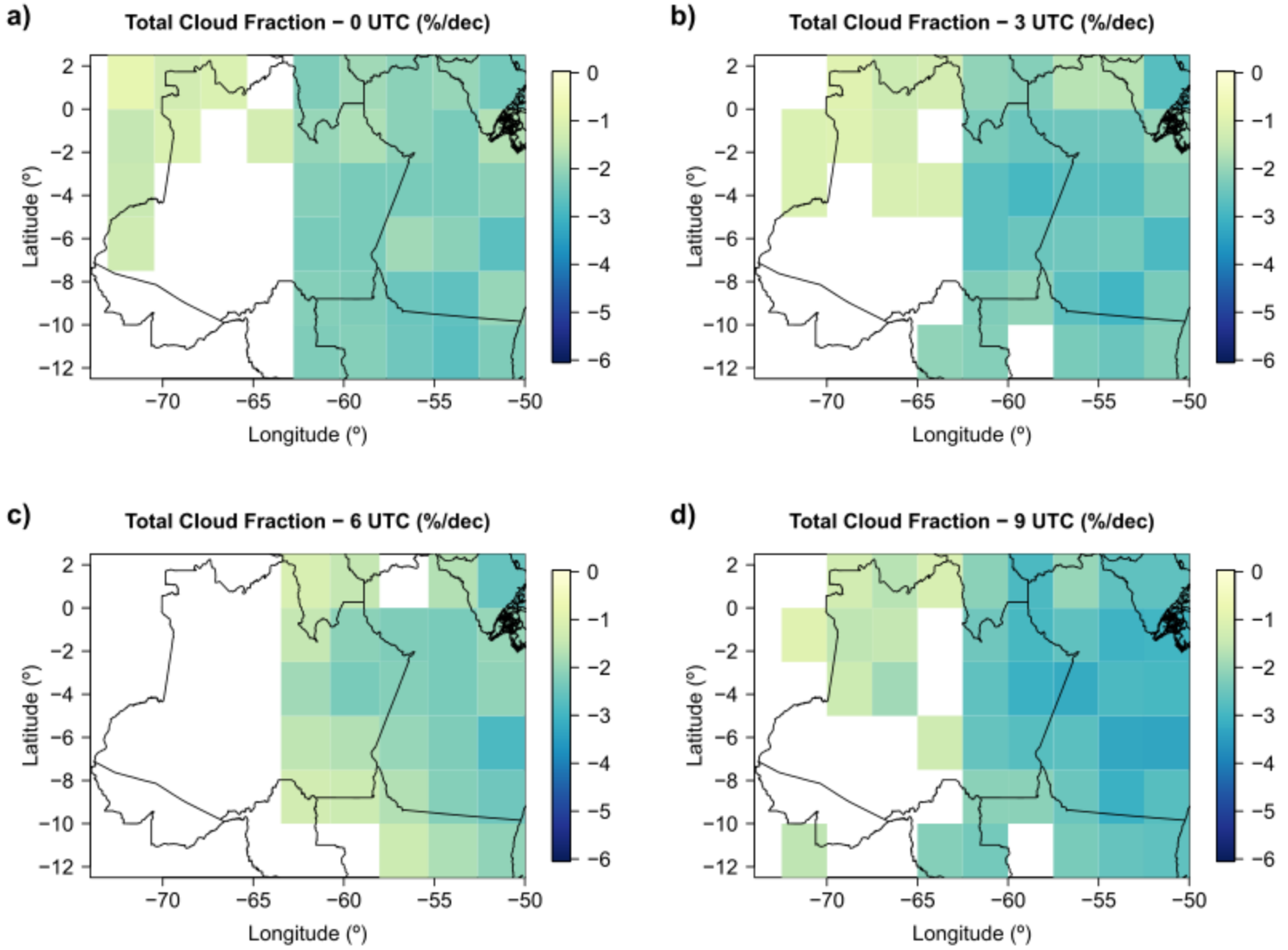




Time series of Total Cloud Fraction by region



Linear trends – Total CF (1983 – 2009)



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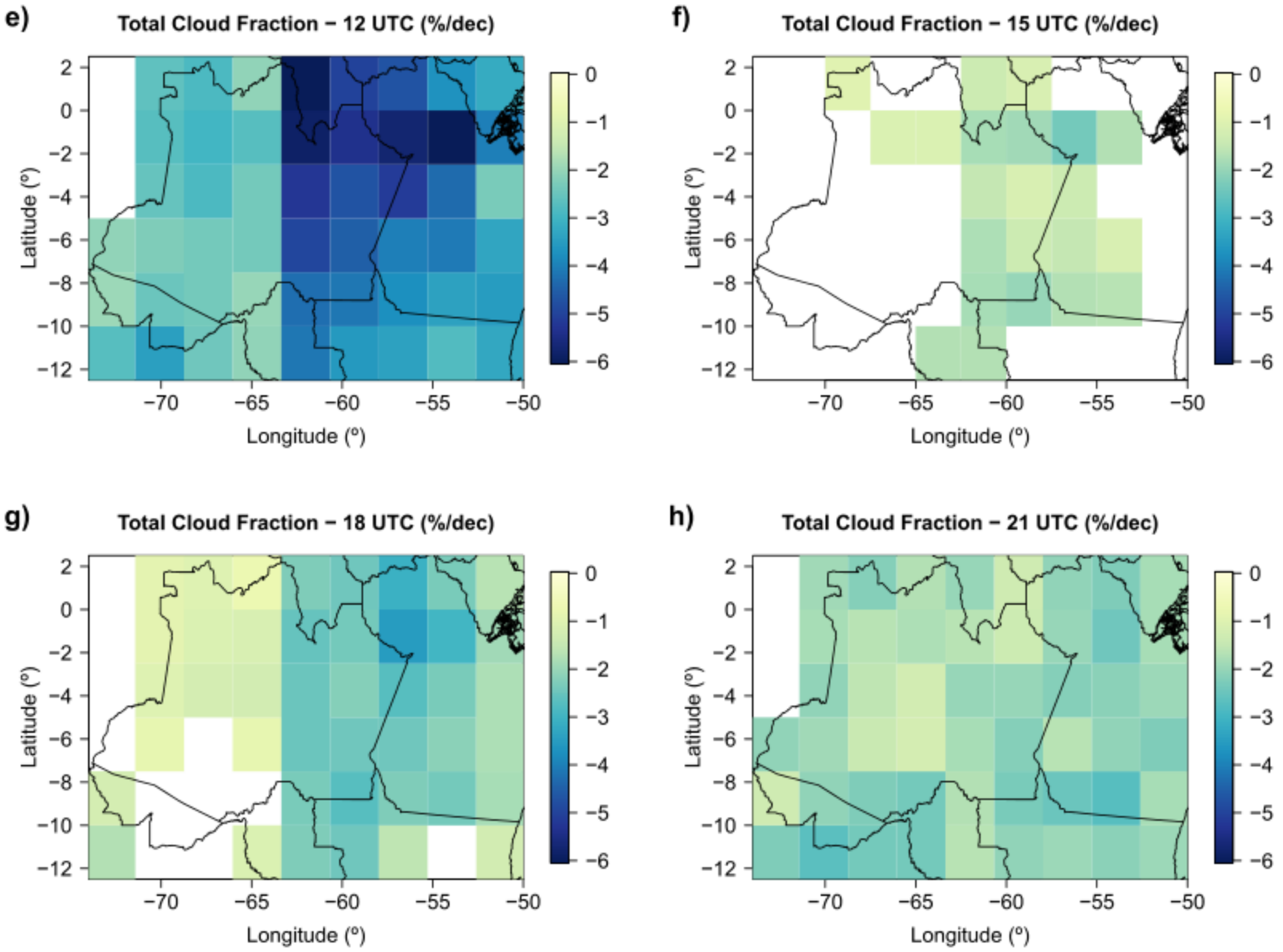
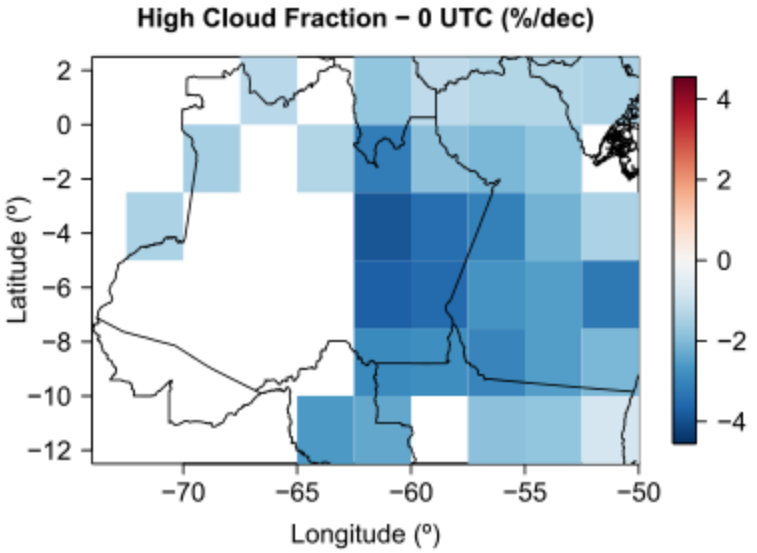
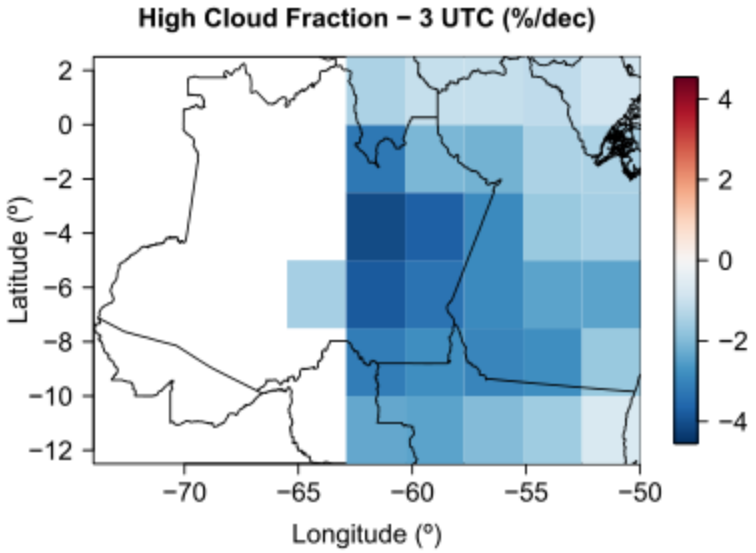
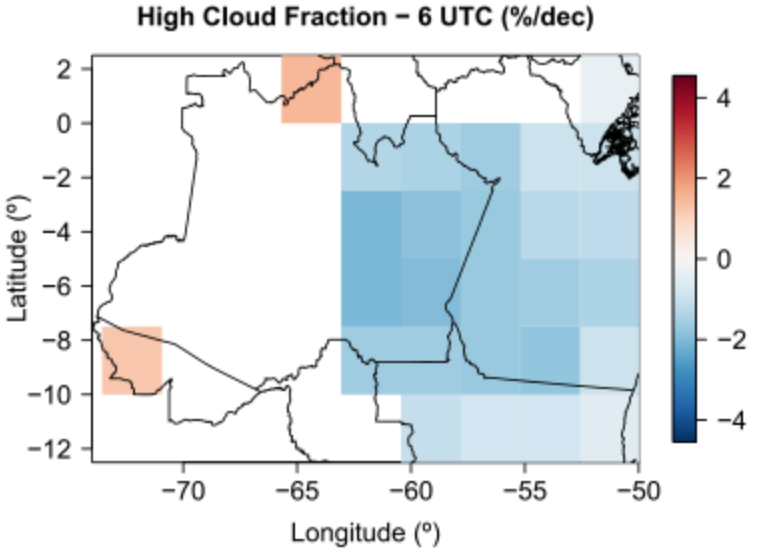
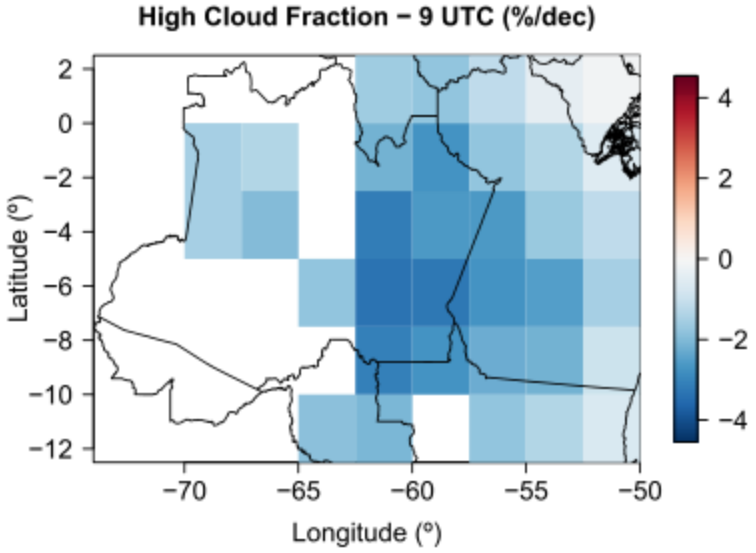


Linear trends – High CF (1983 – 2009)









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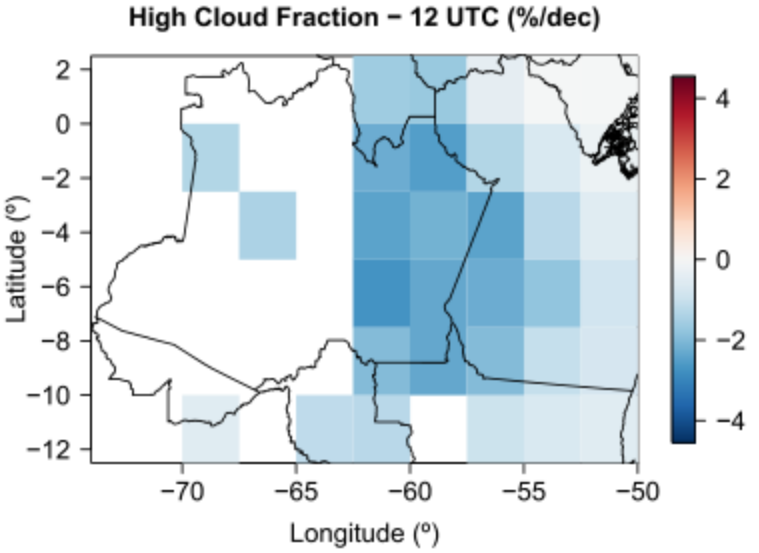
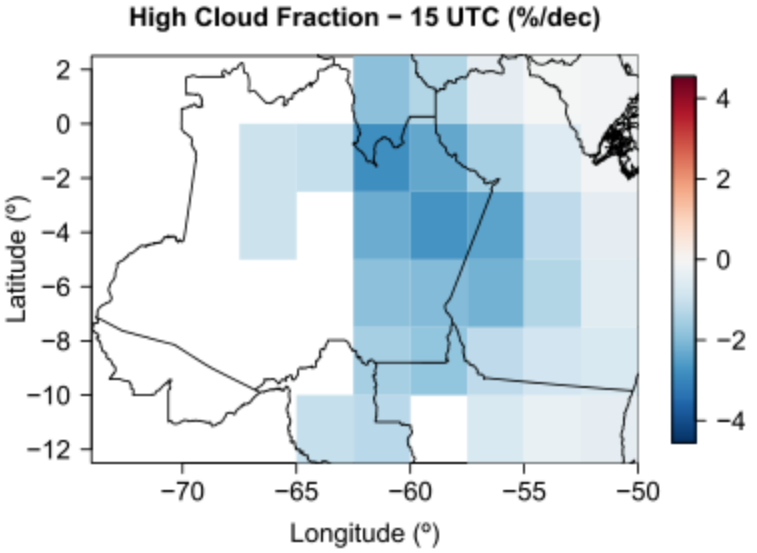
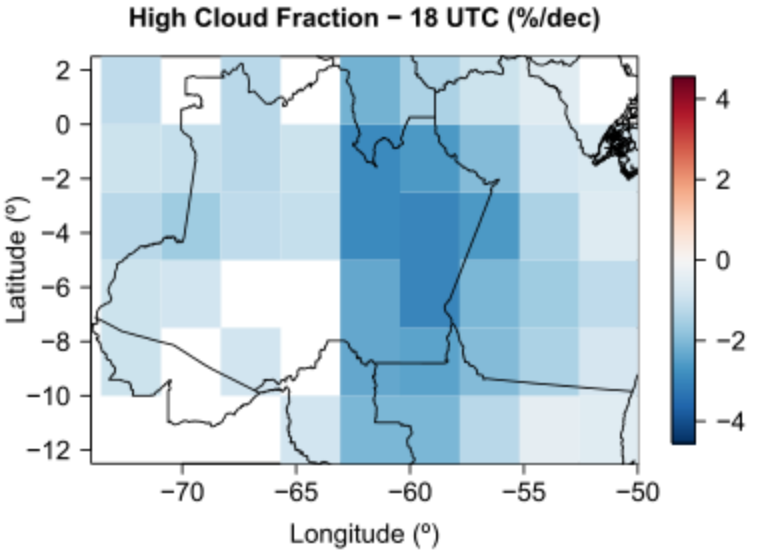
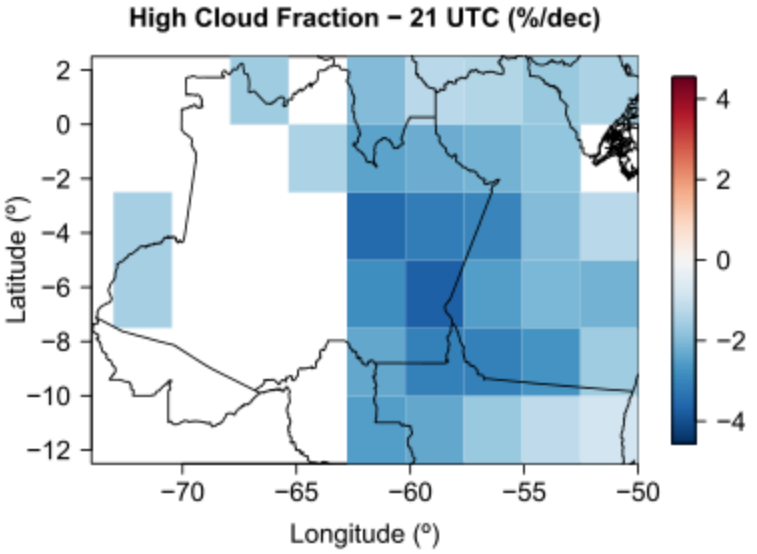
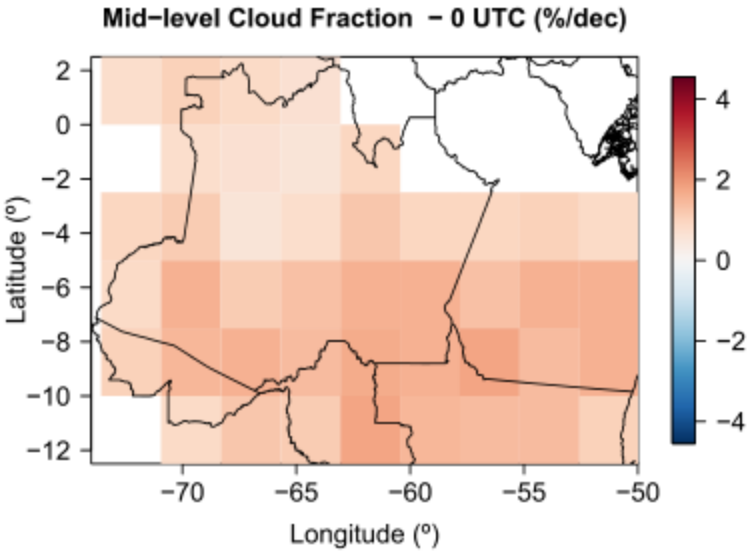


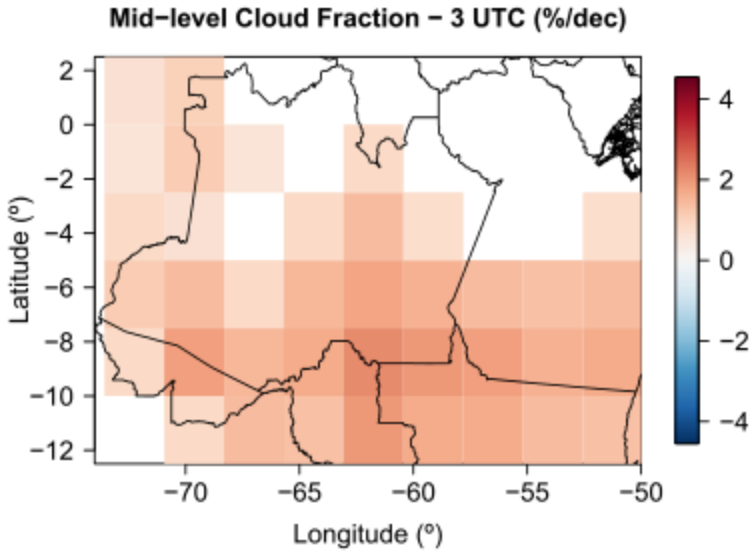


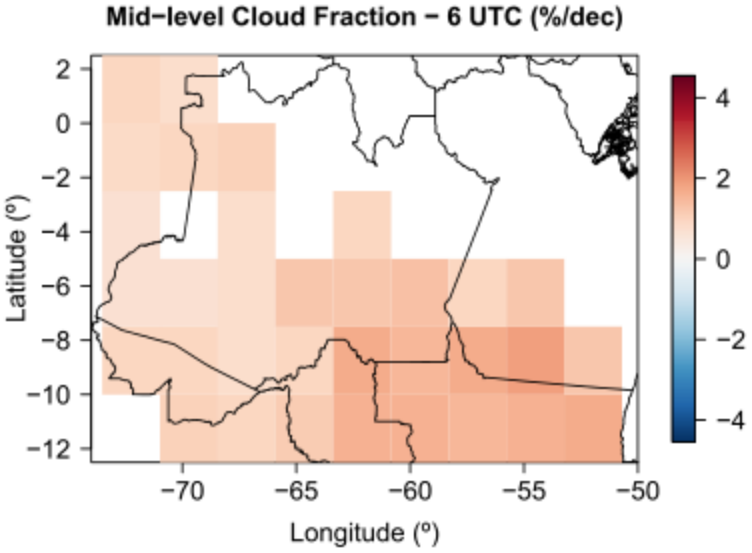


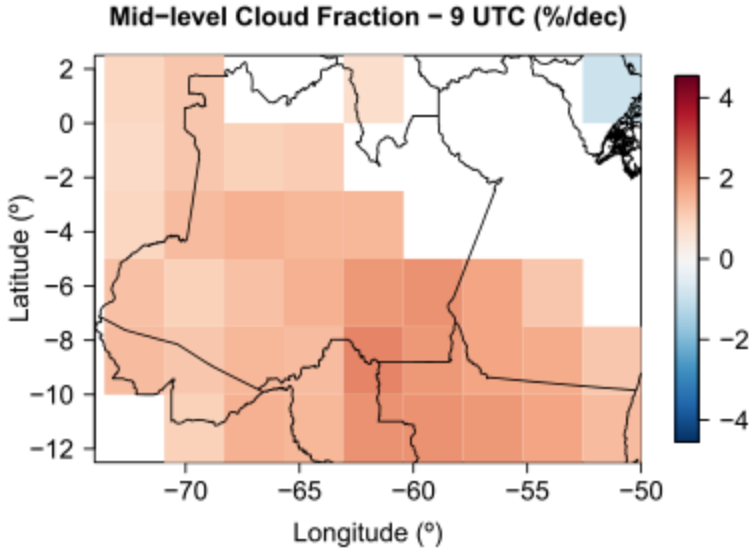


Linear trends – Mid-level CF (1983 – 2009)









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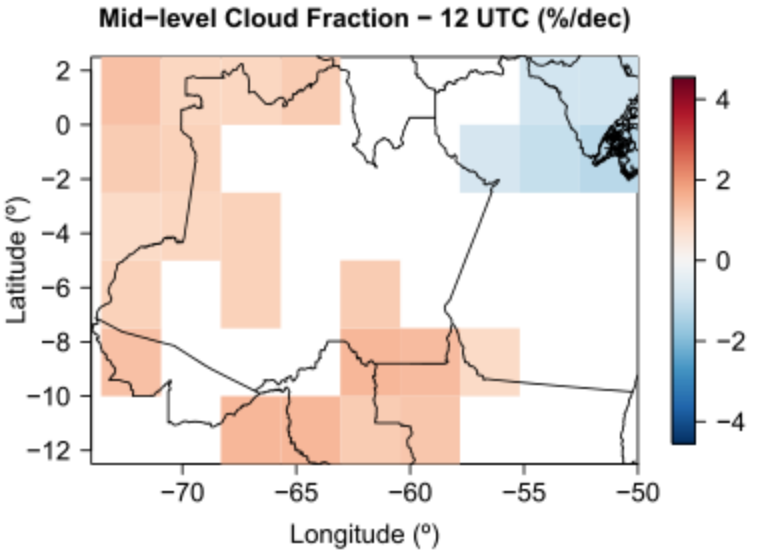
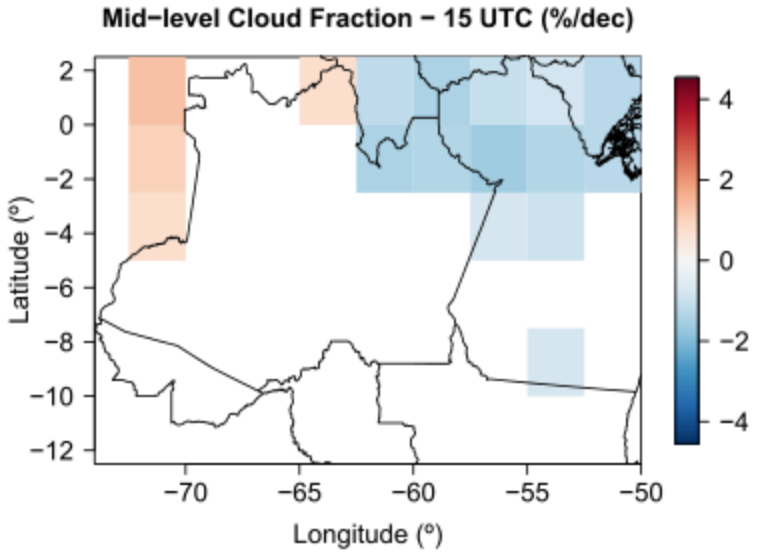
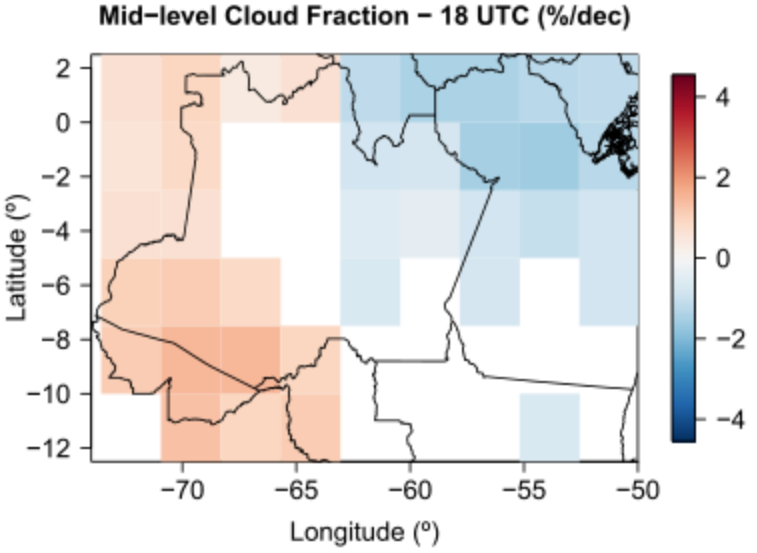
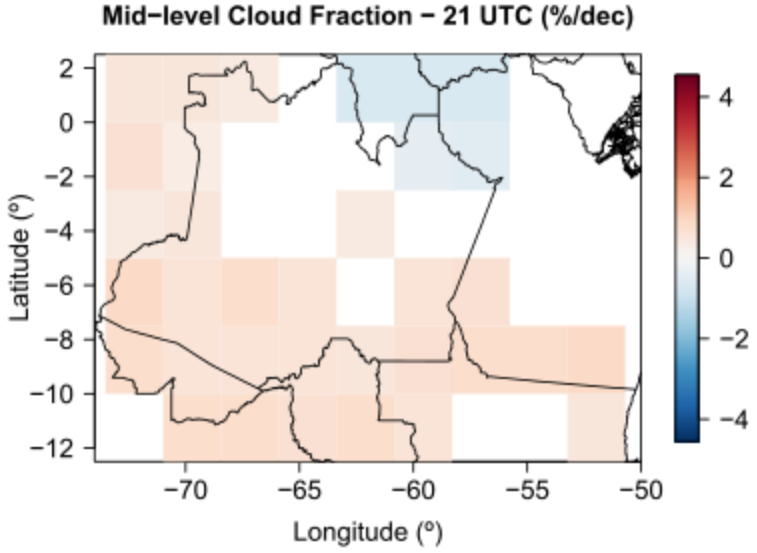
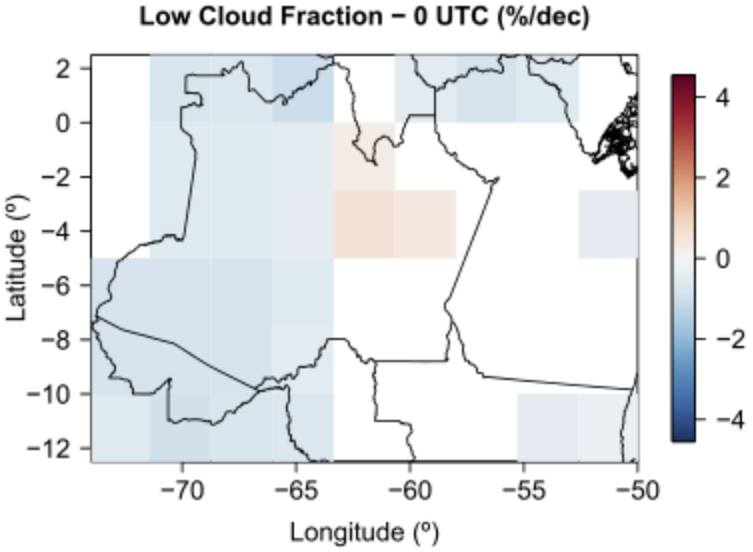


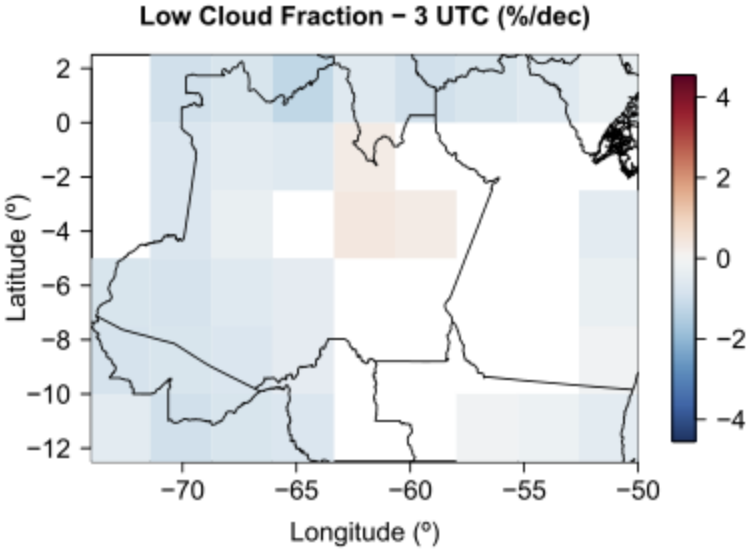


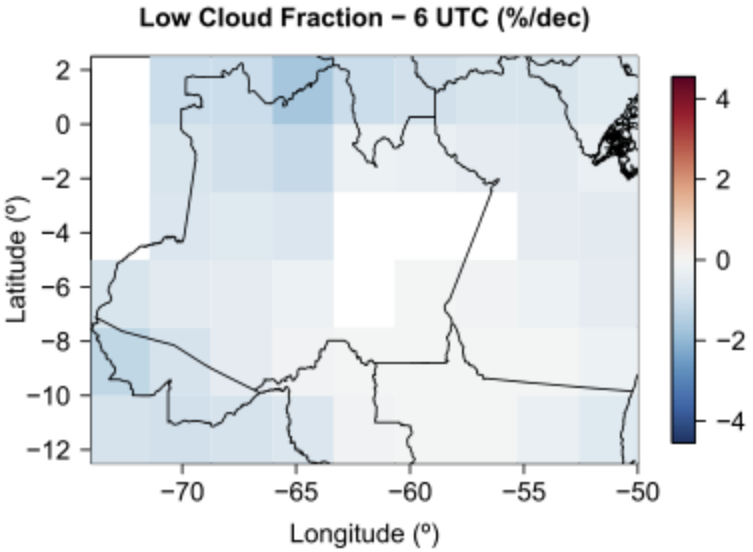


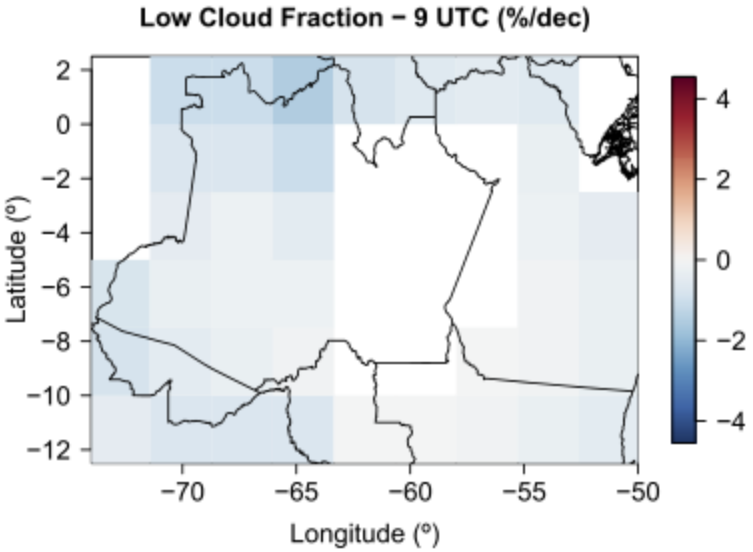


Linear trends – Low CF (1983 – 2009)









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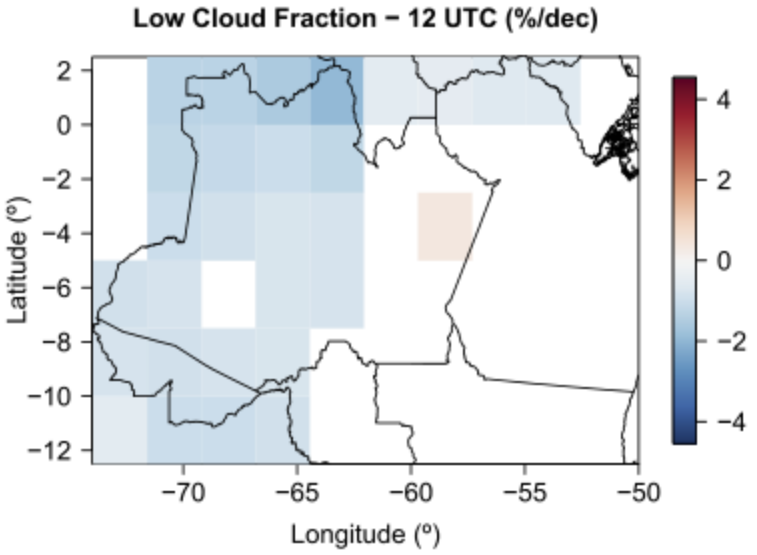
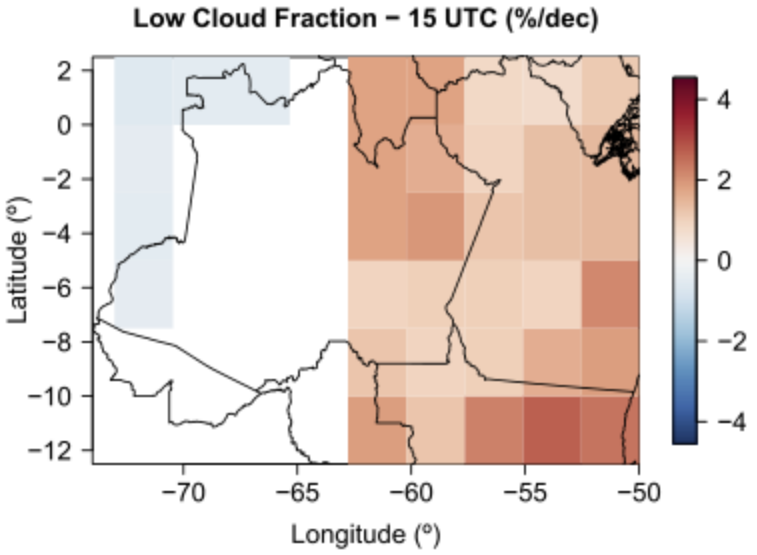
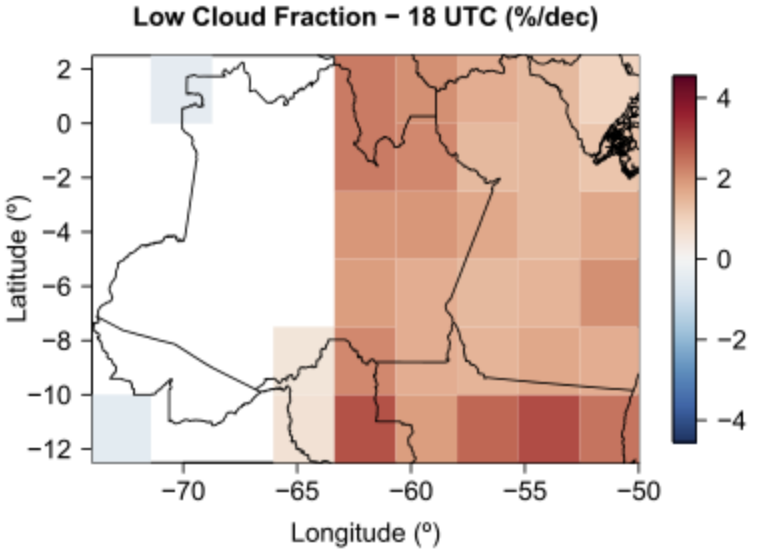
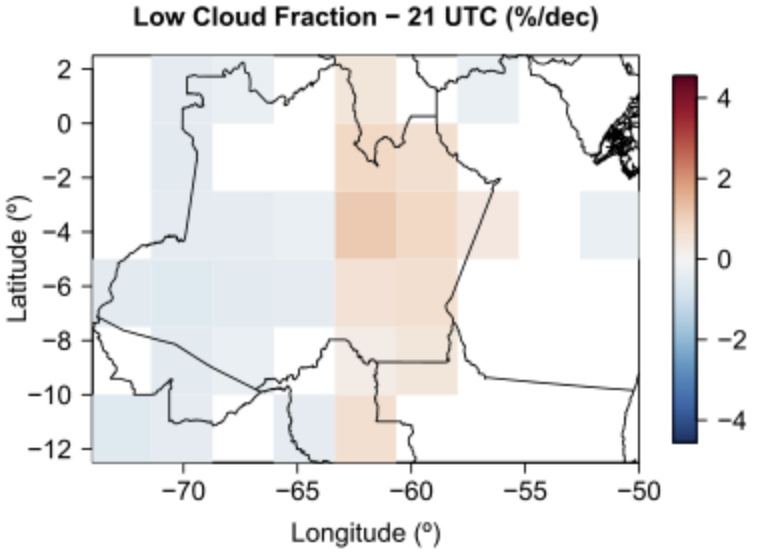
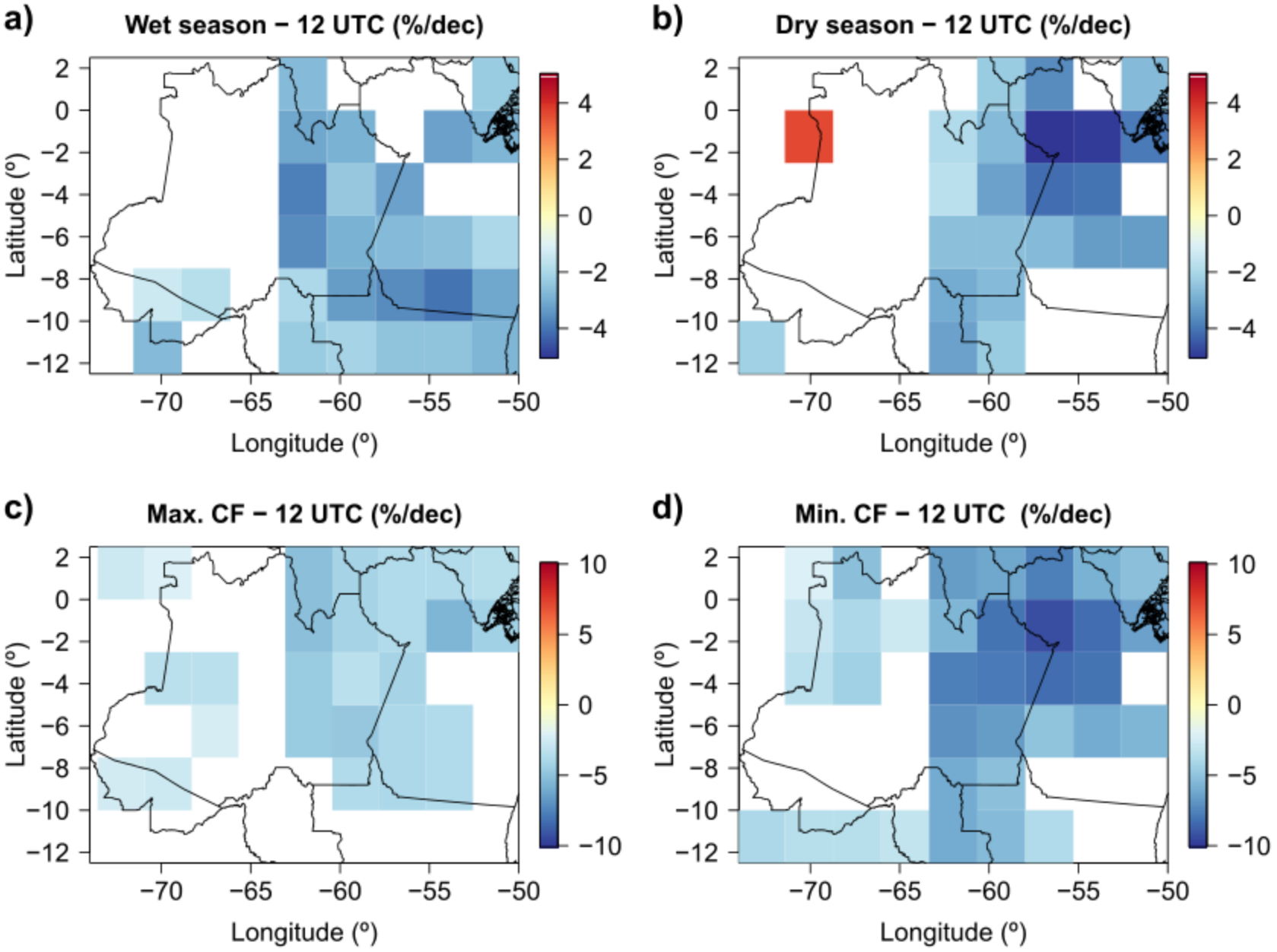








Linear trends (1983 – 2009)



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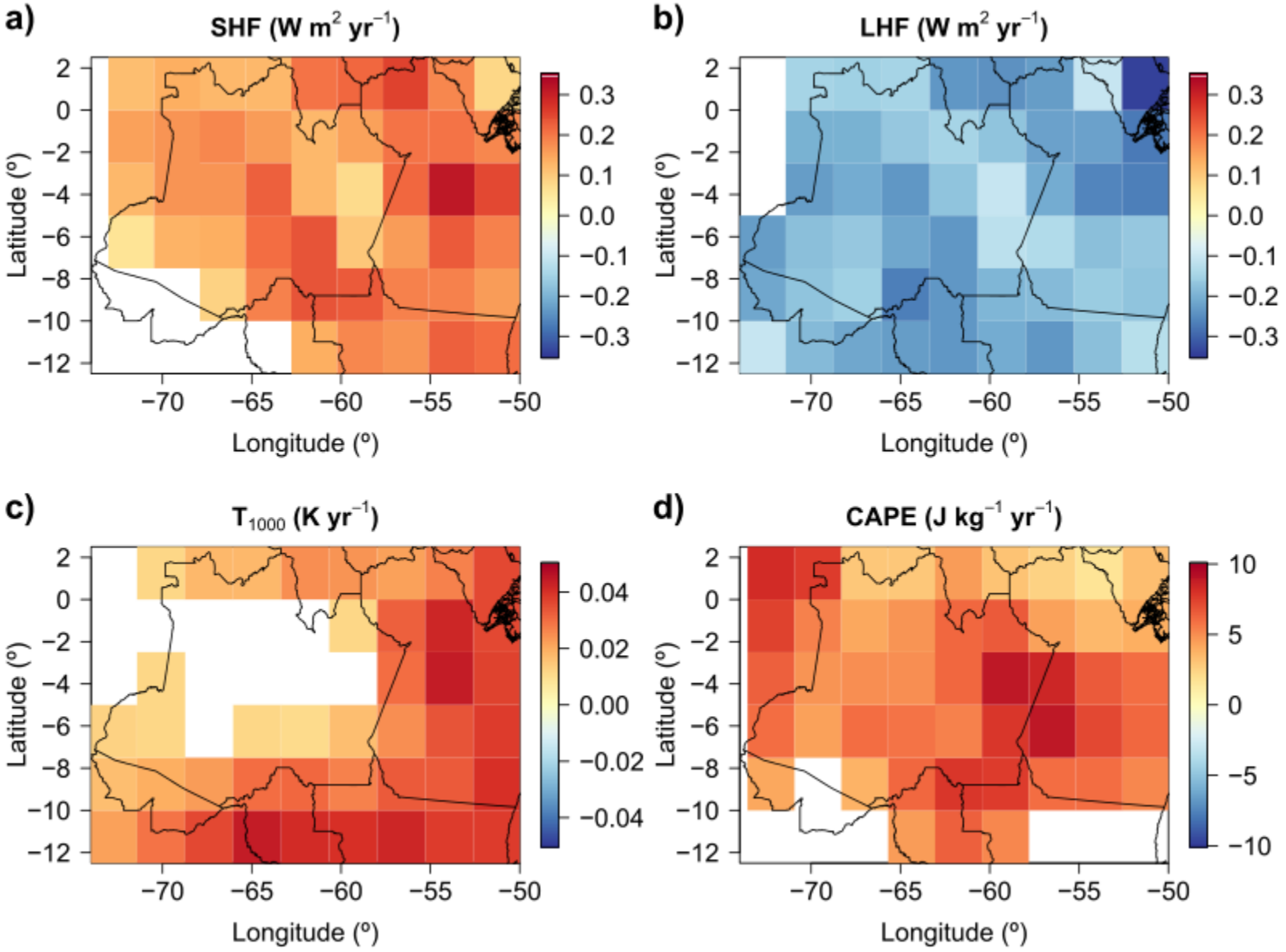
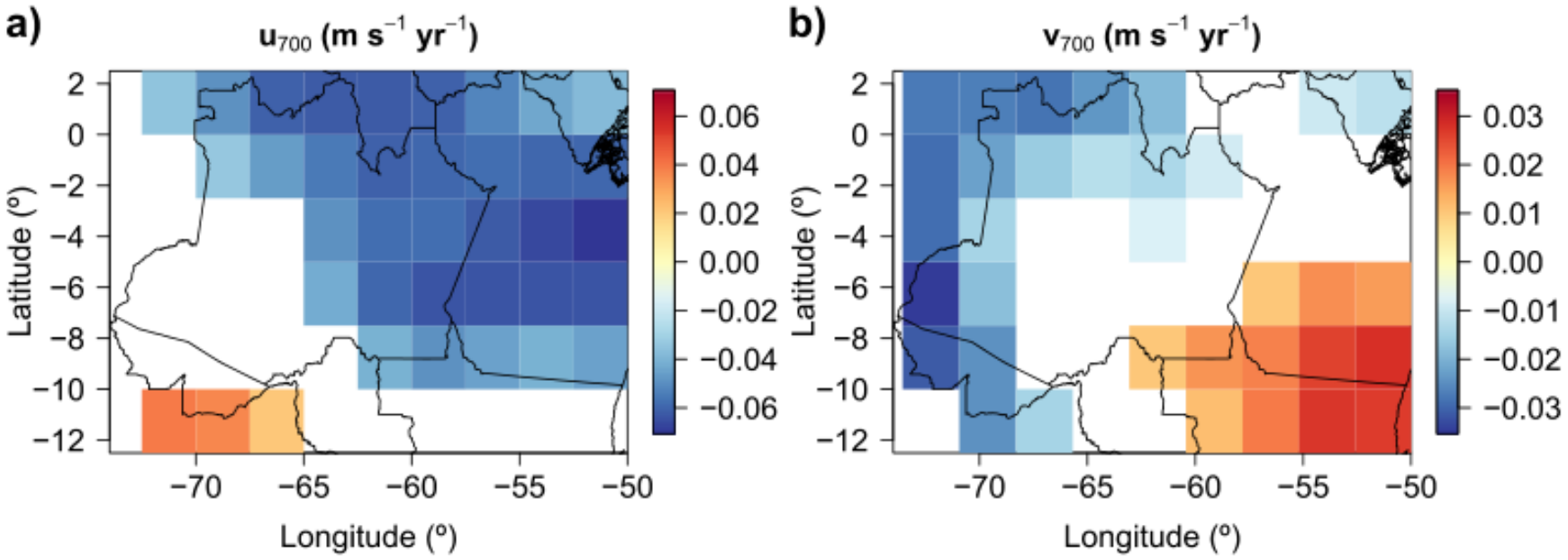


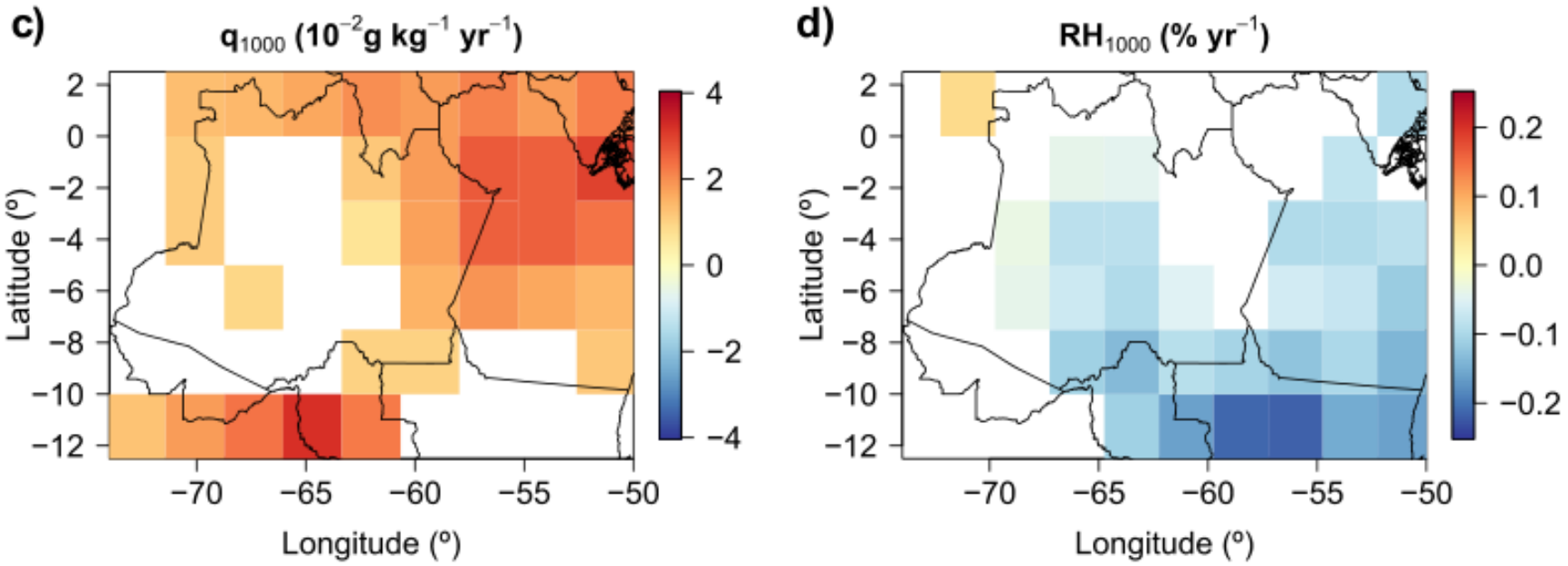
Consistent with decreased cloud fraction.

Linear trends (1983 – 2009)



- Intensification of easterly winds.
- Intensification of northerlies in the NW and weakening of northerlies in the SE.

Linear trends (1983 – 2009)



- Increased specific humidity due to moisture transport from the Atlantic ocean to Amazon.
- Decreased Relative Humidity.

Consistent with decreased cloud fraction.

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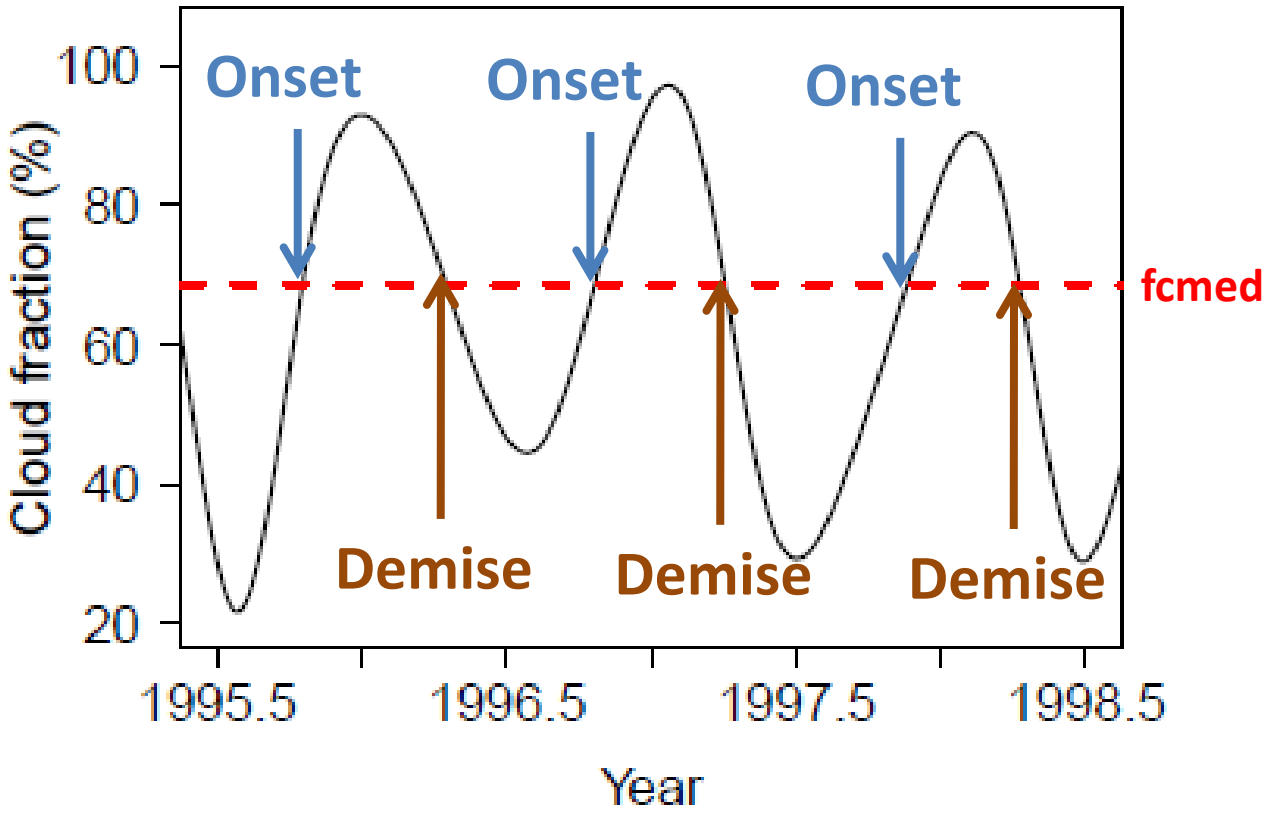
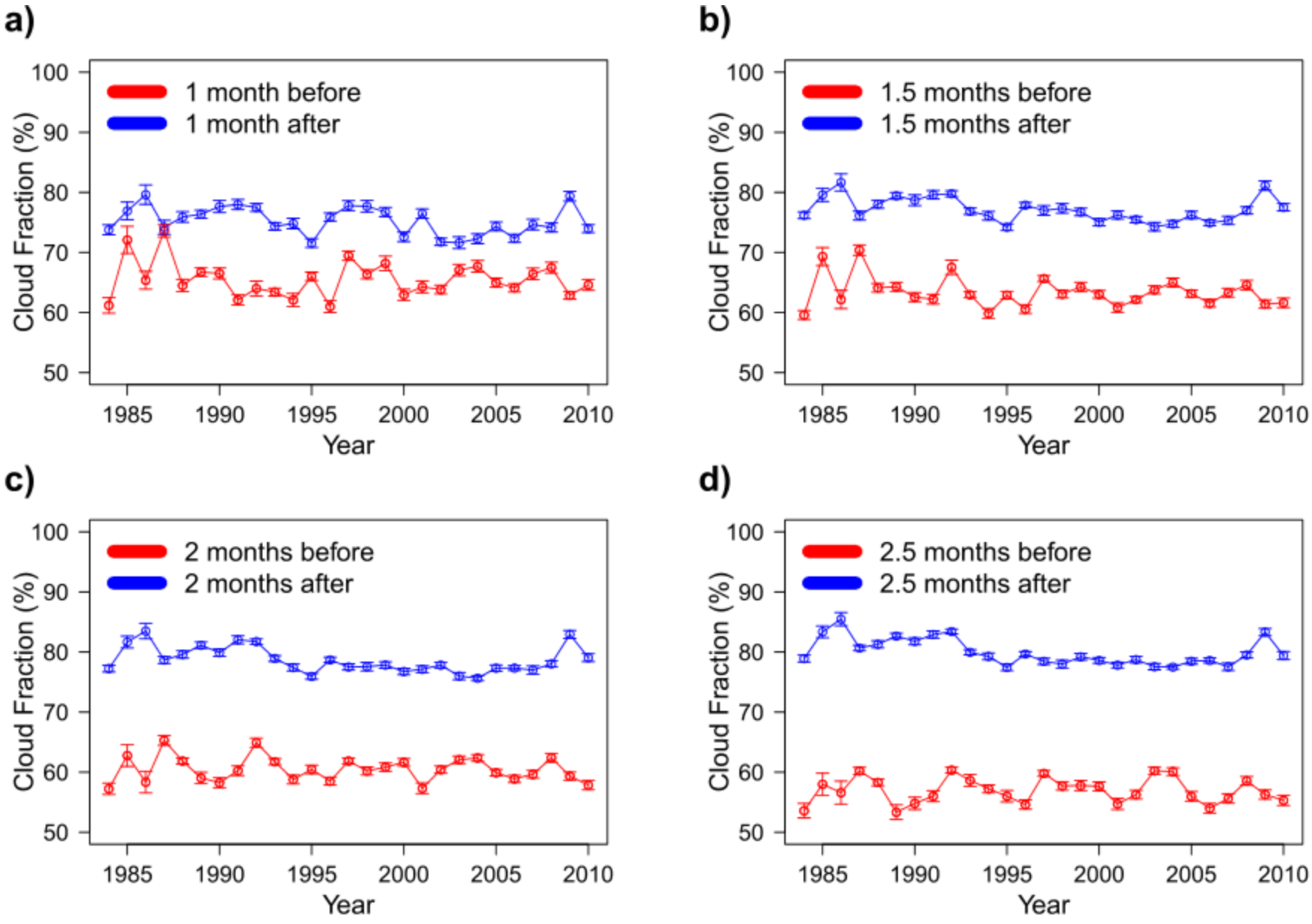
Methodology

New method to estimate wet season onset, demise and length in Amazon.

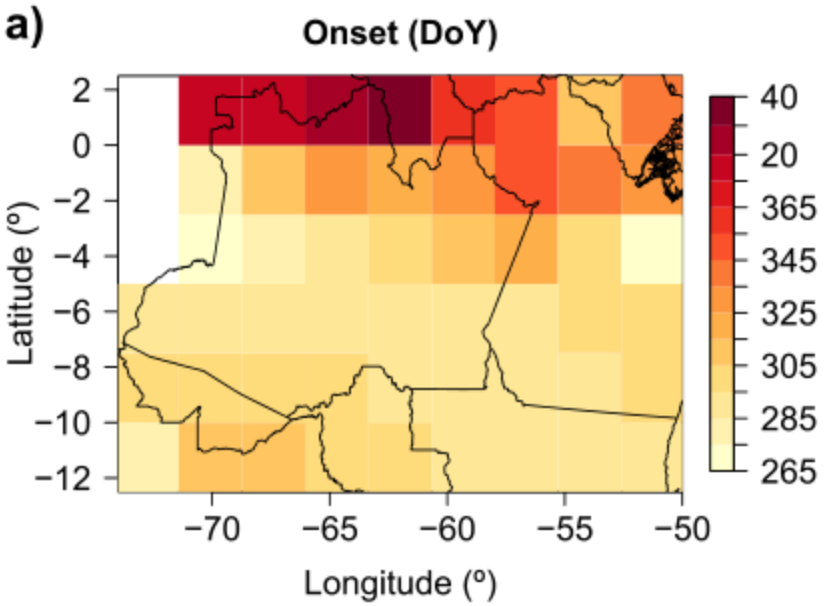
Example of smoothed cloud fraction

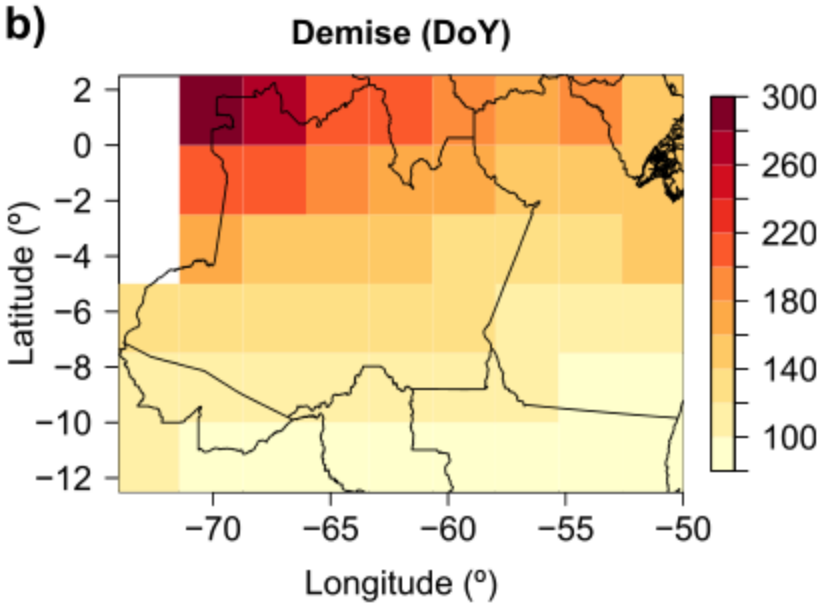
6.25°S, 56.25°W – 12 UTC (8 LT)

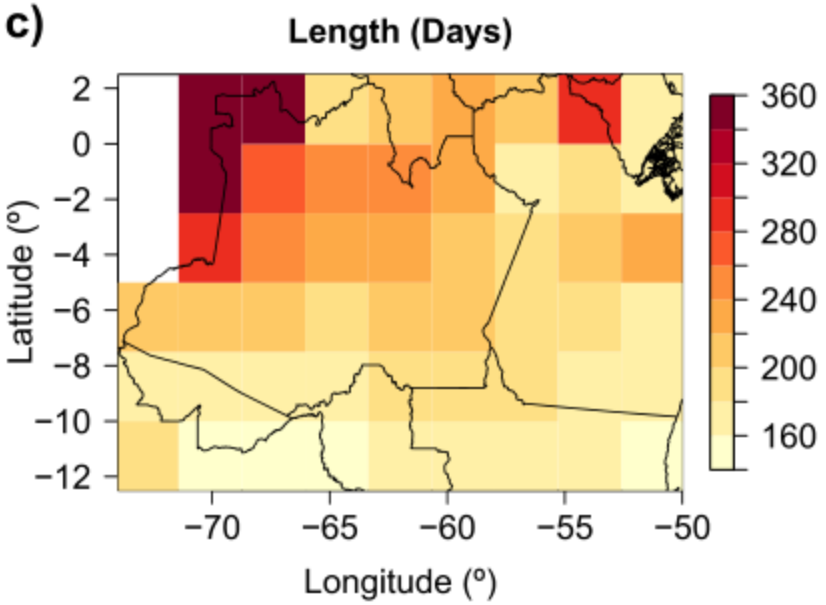



a)
1 month before
1 month after
b)
1.5 months before
1.5 months after
c)
2 months before
2 months after
d)
2.5 months before
2.5 months after
Cloud Fraction (%)
Year
100
90
80
70
60
50
1985
1990
1995
2000
2005
2010

Average (1983 – 2009)



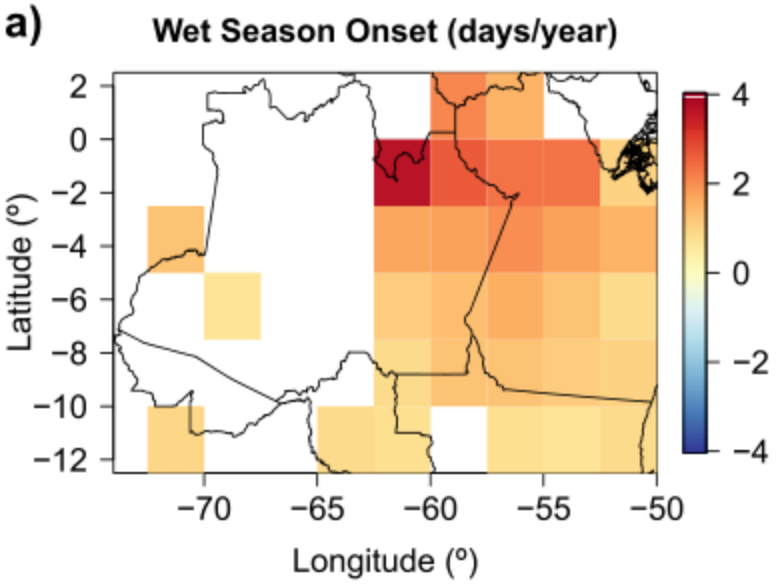


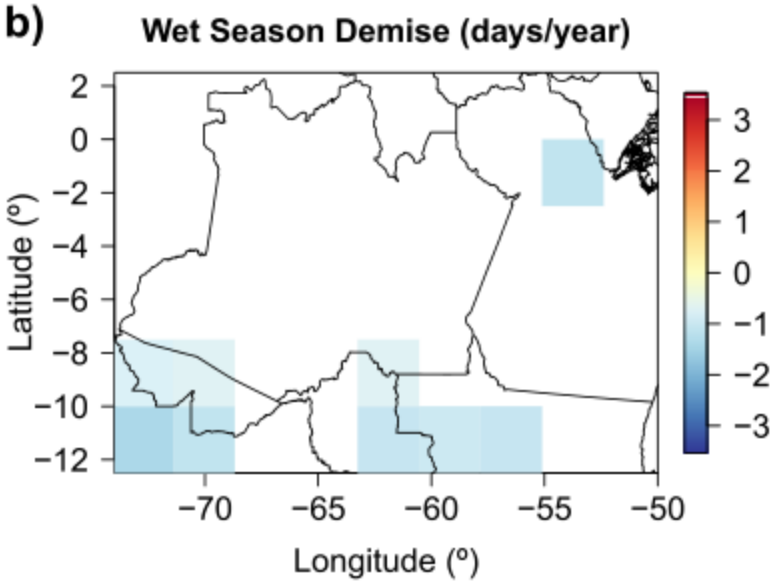


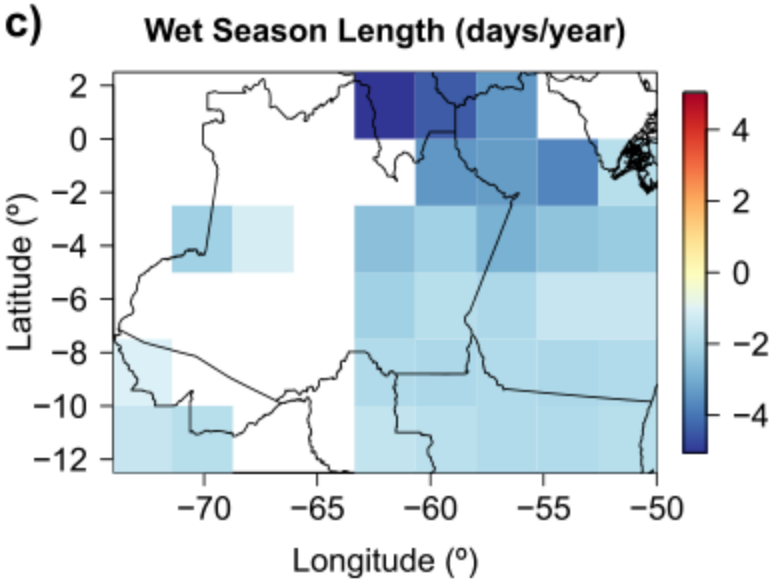
Consistent with previous approaches.

Advantage: Does not rely on rain gauges

Linear trends Onset, Demise and Length (1983 – 2009)







- Delayed onsets
- Earlier demises
- Shorter wet seasons

Large scale influence!!!

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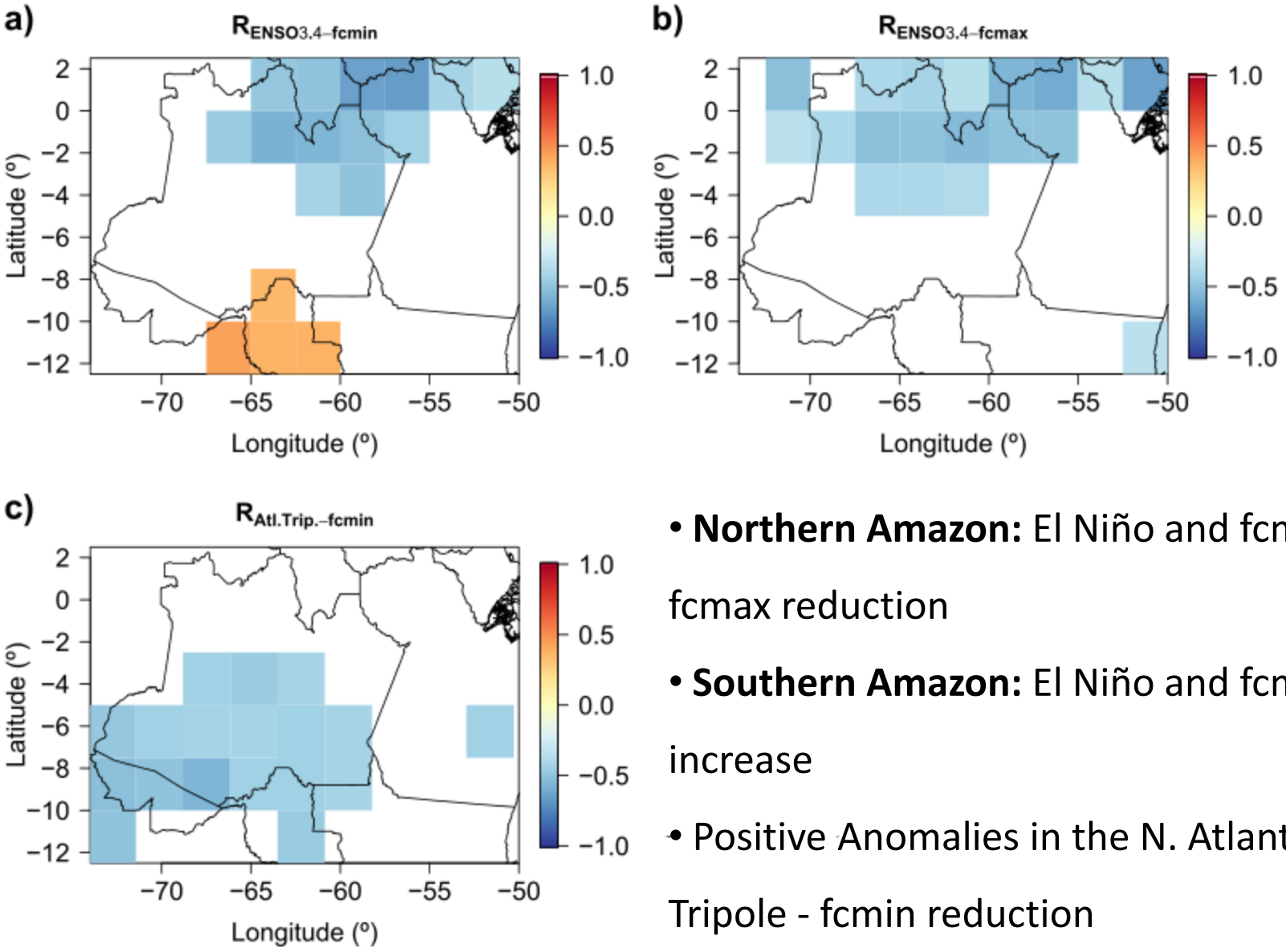
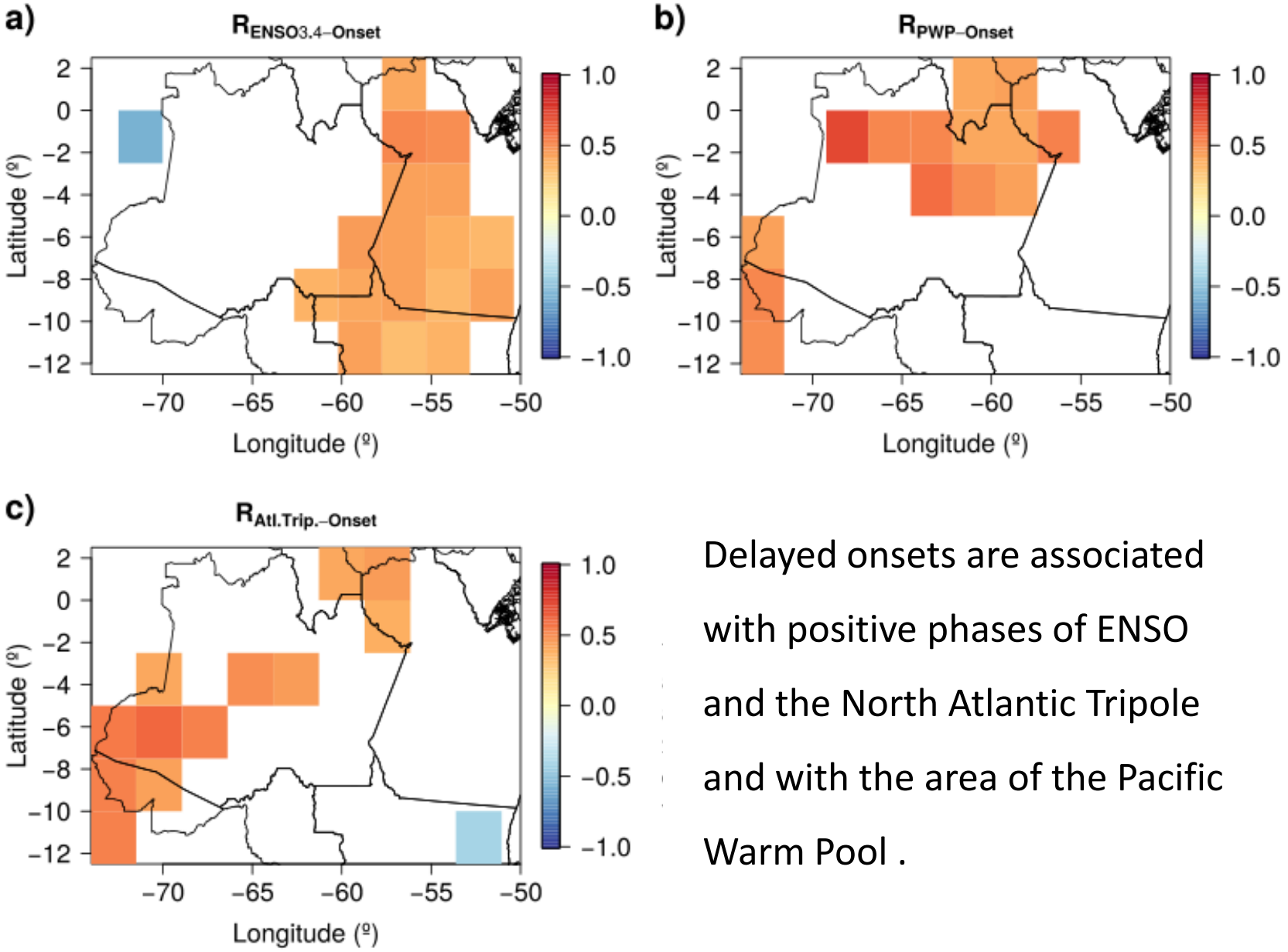
Correlation between detrended time series and CFmax or CFmin



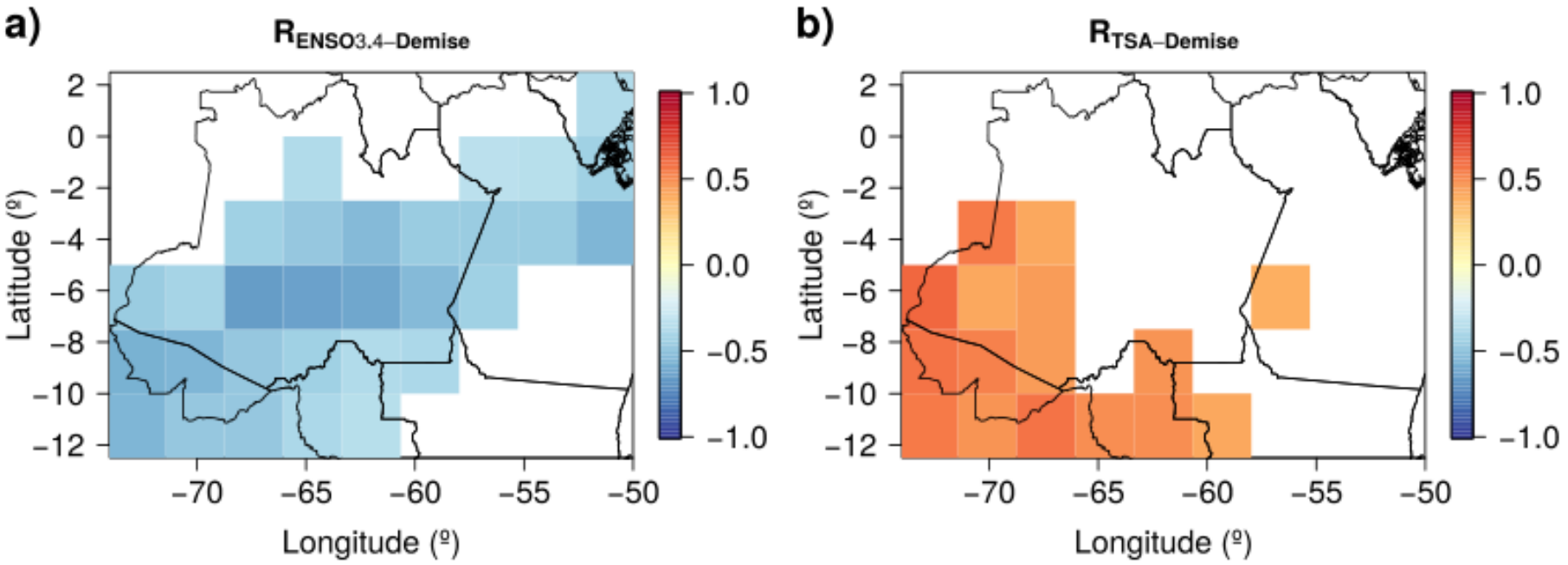
- **Northern Amazon:** El Niño and fcmin, fcmax reduction
- **Southern Amazon:** El Niño and fcmin increase
- Positive Anomalies in the N. Atlantic Tripole - fcmin reduction

Correlation between detrended time series
Wet season onset



Delayed onsets are associated with positive phases of ENSO and the North Atlantic Tripole and with the area of the Pacific Warm Pool .

Correlation between detrended time series
Wet season demise

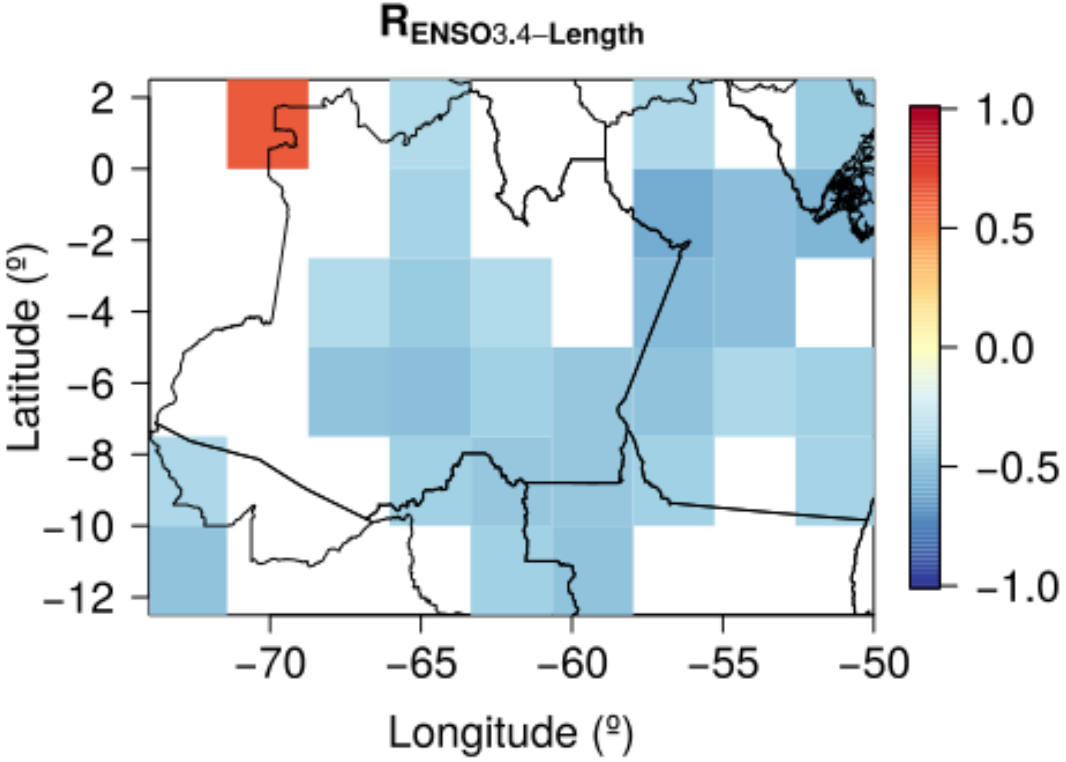


Links between:

- Earlier demises and El Niño.

- Delayed demises and positive anomalies of SST in the Tropical South Atlantic (TSA).

Correlation between detrended time series
Wet season length



Link between:

- Shorter wet seasons and El Niño.

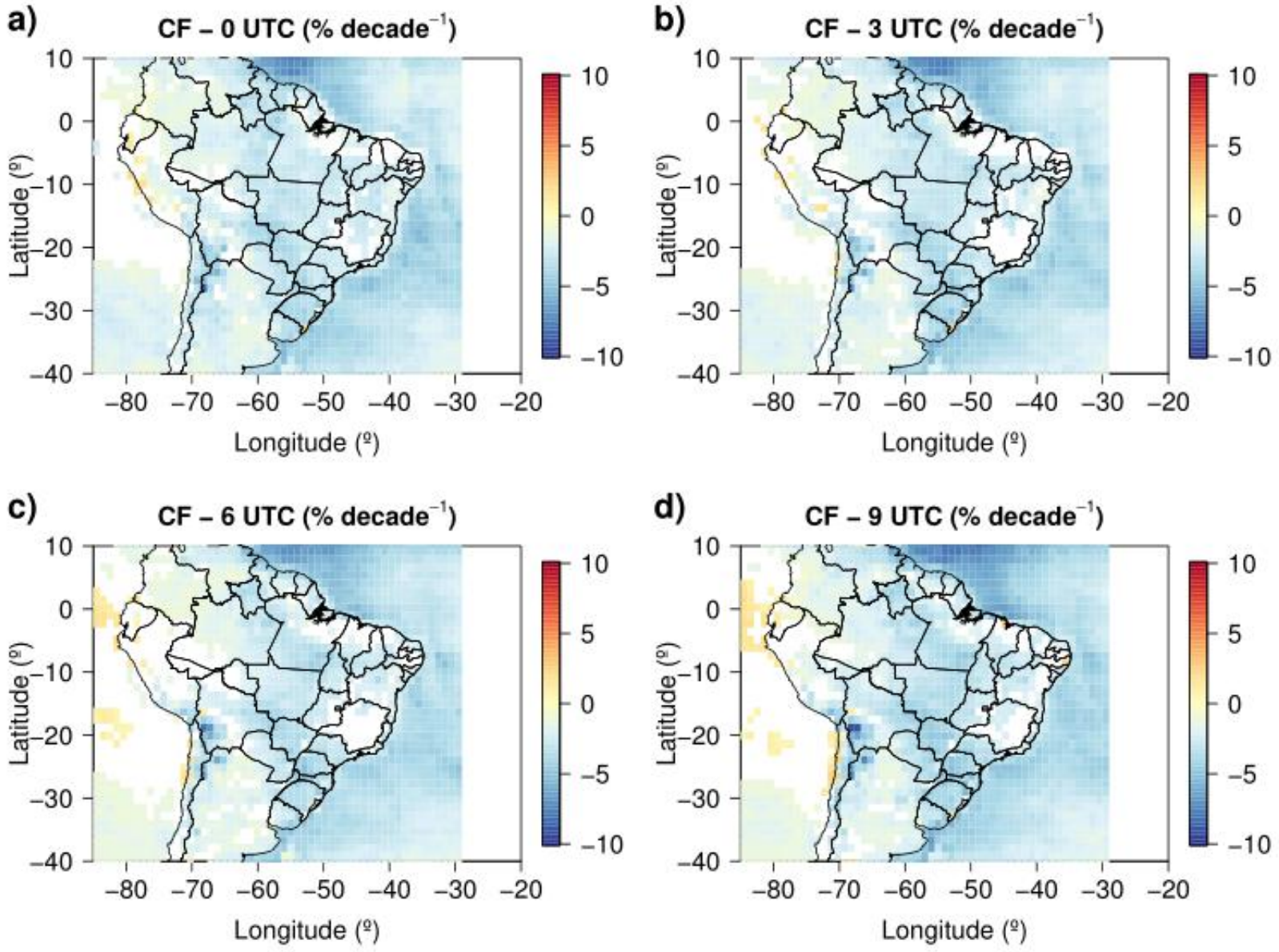
- **ENSO dominates interannual cycle of precipitation**
- **Modeling needed to understand long-term trends (AMO, PDO, etc.)**

Ongoing work:

CNPq Universal Project

Long-term variability of the cloud life cycle and their impacts on solar energy and water availability

Linear trends of total cloud fraction (1983 – 2015)



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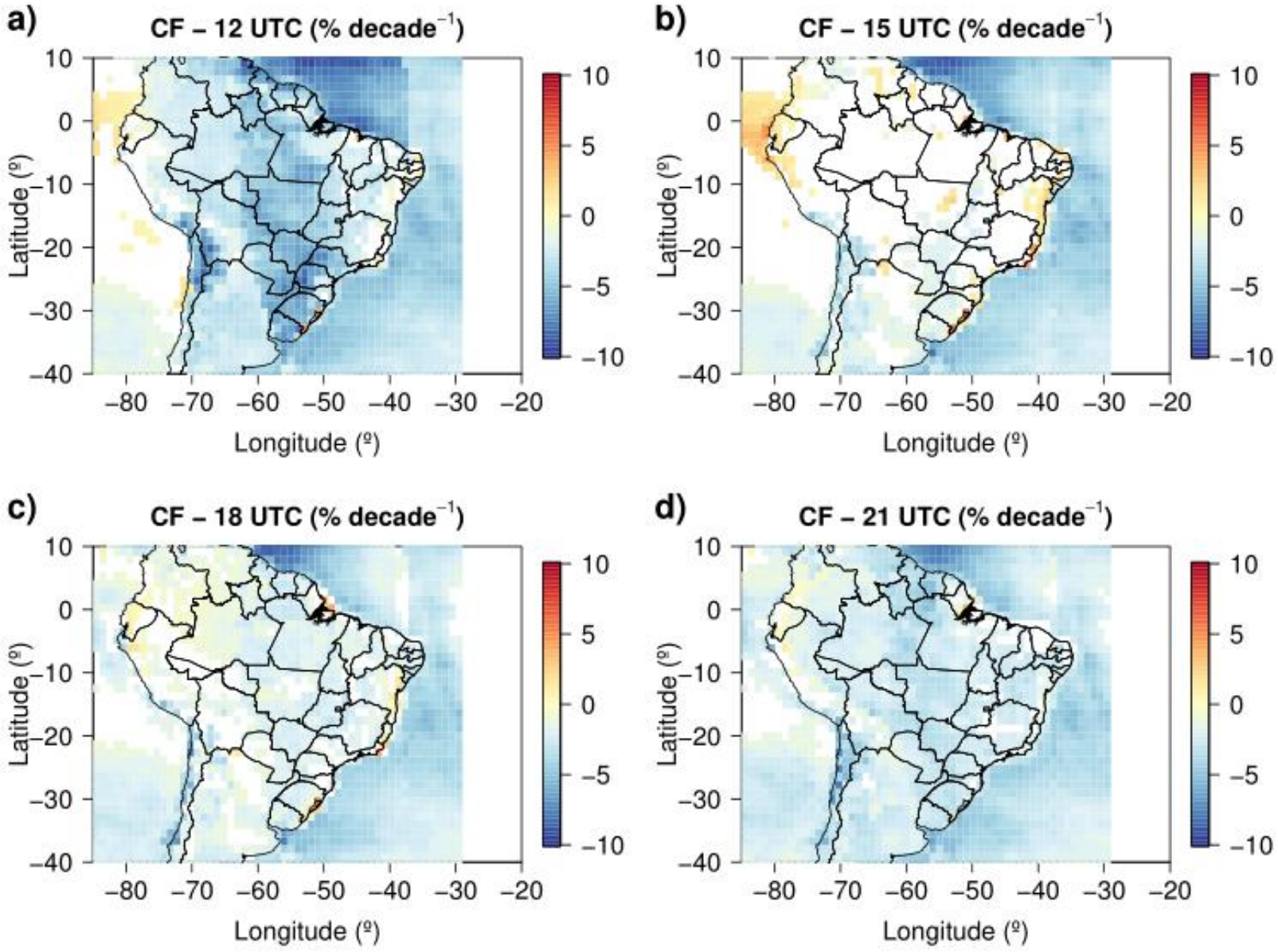
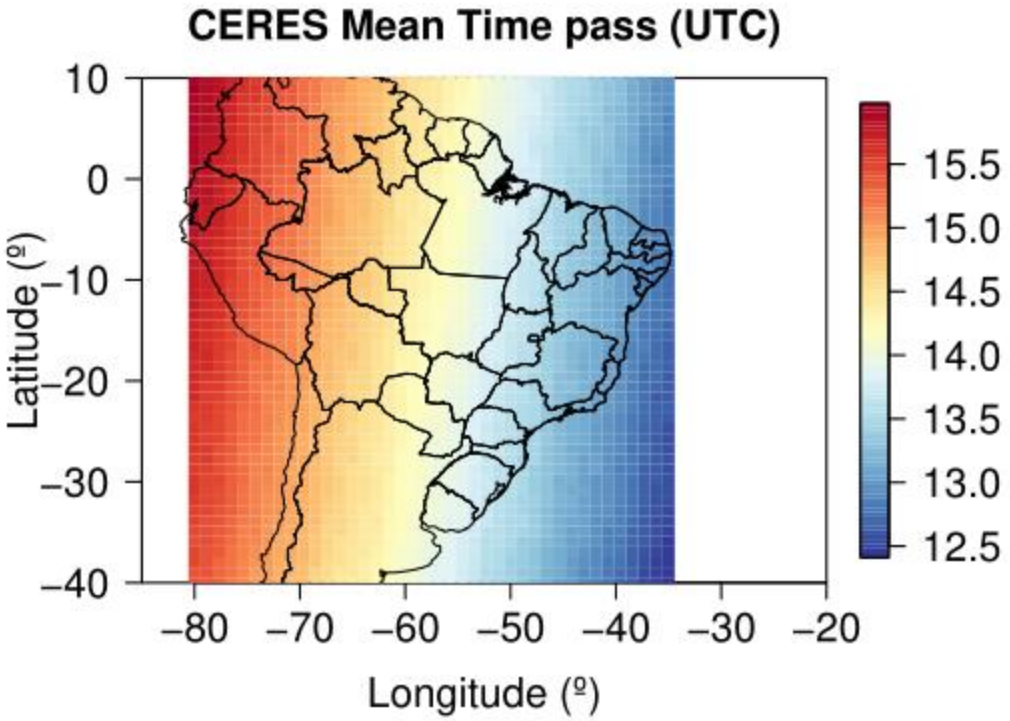
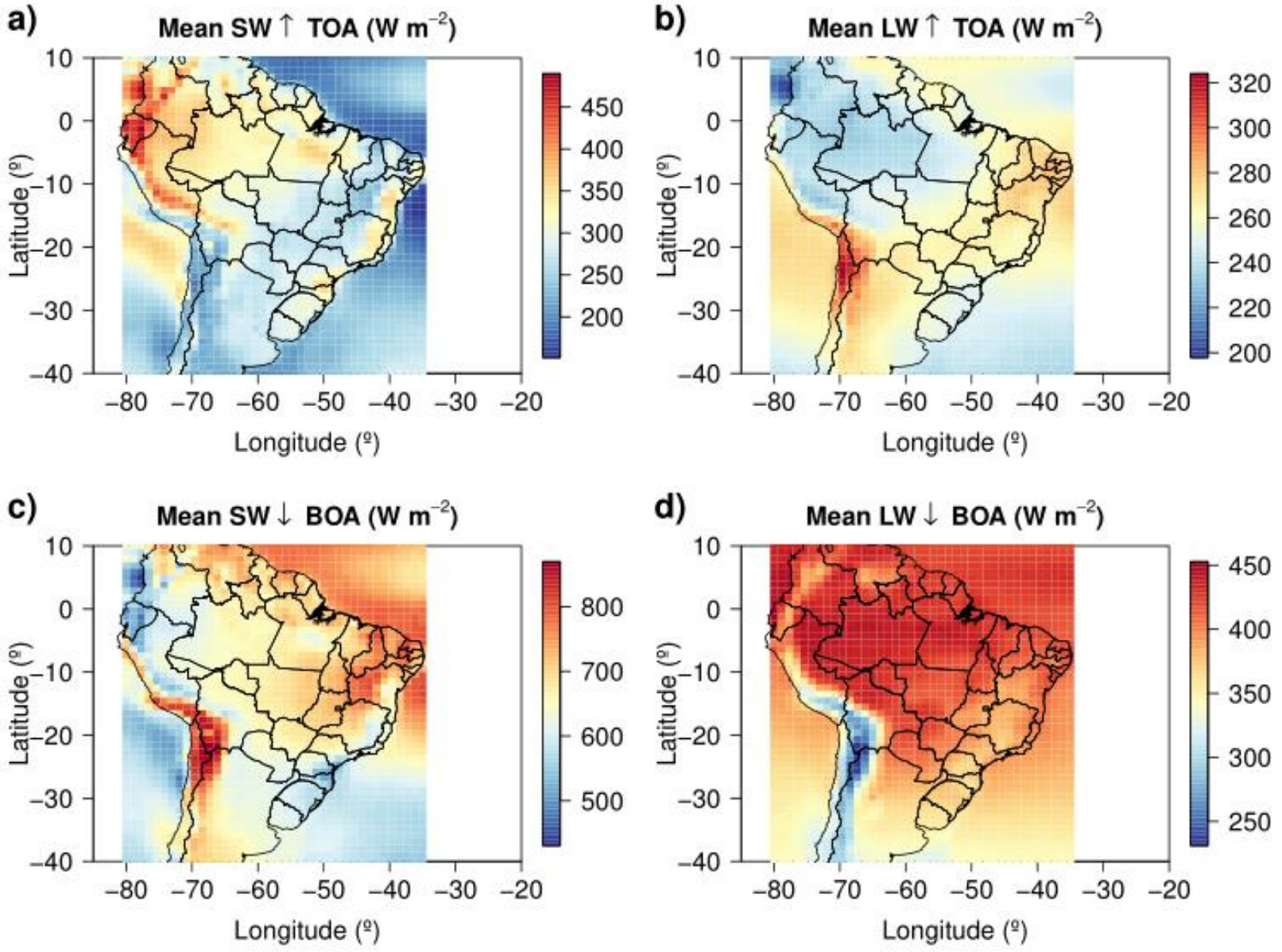


CERES (2000 – 2016)

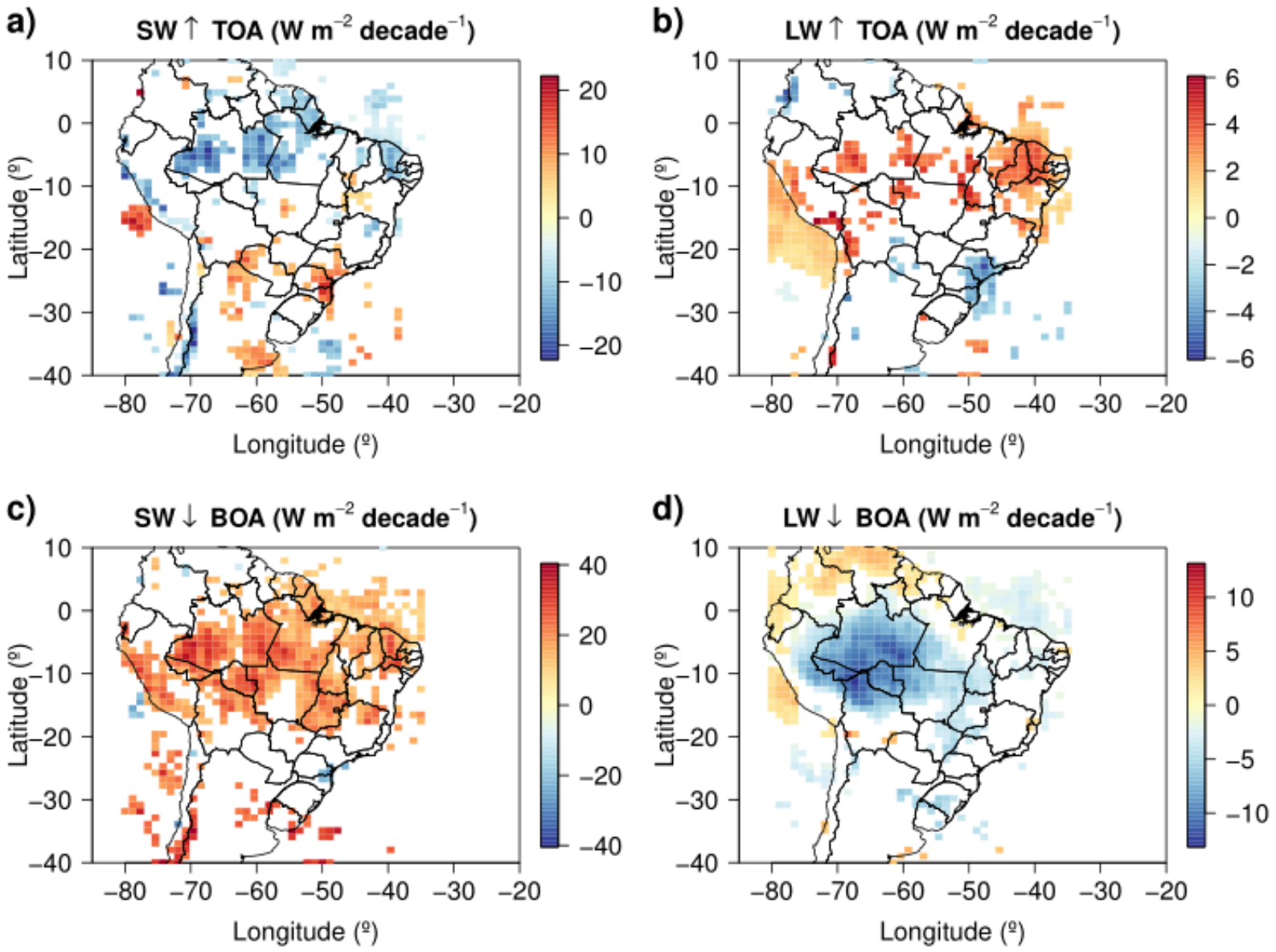


Trends at mean time pass ± 15 minutes

Mean Irradiances by CERES (2000 – 2016)



Linear Trends of Irradiances by CERES (2000 – 2016)



Summary

- A new methodology to assess the rainy season onset and length in Amazon is proposed.
- The results show shorter wet seasons and earlier onsets, especially in Eastern Amazon likely linked to large-scale phenomena.
- This study provides strong evidence of the influence of ocean-atmospheric interactions on Amazon's rainfall regime.
- There is a consistent reduction of cloud fraction over the study area which significantly modifies Amazon's energy balance and thermodynamics.

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Thank you!!!

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Reduced wet season length detected by satellite retrievals of cloudiness over the Brazilian Amazonia: a new methodology (2018), Journal of Climate
Sena, E. T., Silva Dias, M. A. F. , Carvalho, L. M. V., Silva Dias, P. L.