The influence of temperature–moisture coupling on the occurrence of compound dry and hot events over South America: historical and future perspectives

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1 Introduction

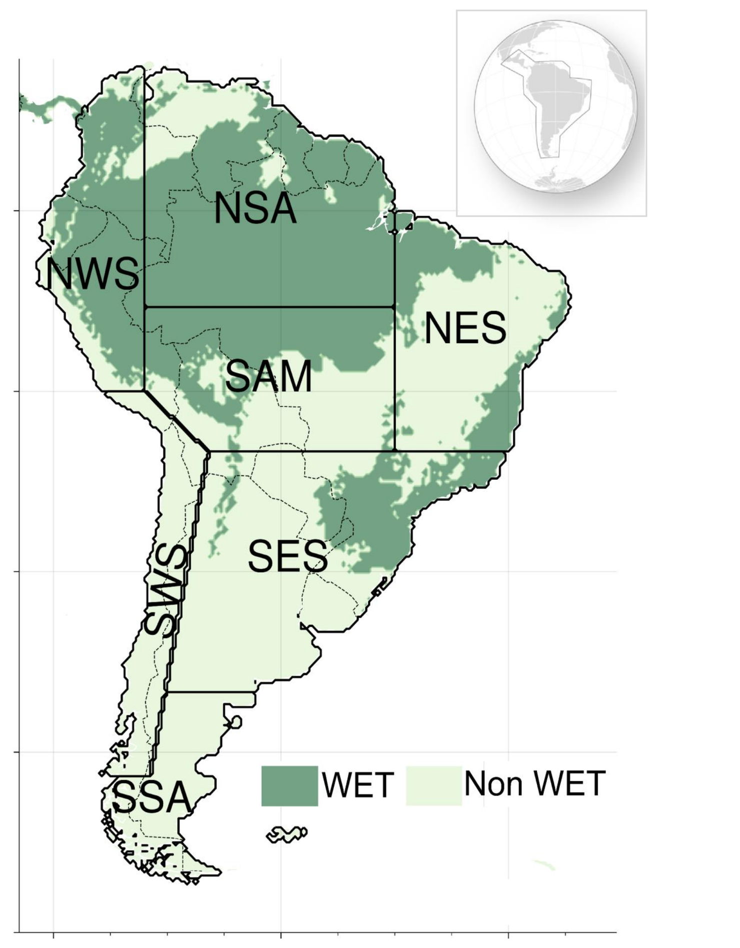


Fig 1. Geographical scope of South America (SA) with it's climatic sub-regions defined by [3] and the moist and non moist ecoregions defined by [4].

Changes in the relationship between temperature and moisture in S. America (SA) are foreseen in a climate change scenario due to a reshaping of temperature and precipitation distributions. This association resulting from the interaction between the **(i) atmospheric contribution (AC)**, evaluated here through the correlation between temperature and precipitation [1], and the **(ii) land–atmospheric contribution (LAC)**, conceptualized as the soil moisture–temperature coupling [2], modulates the occurrence of **compound dry and hot (CDH) extremes.**

2 Data and Methods

- **Data**

ERA5 reanalysis

Historic (1970-2005)

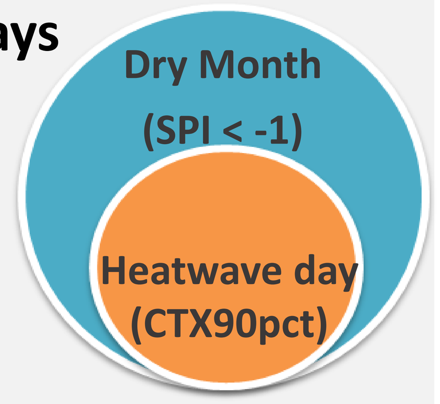
+

CORDEX (SAM22) multi-variable ensemble

Historic (1970-2005)

RCP2.6 + RCP8.5 (2006-2099)

- **CDH days**



- **Atmospheric Contribution (AC)** $\rho(P, T_{proxy})$
- **Land-Atmospheric Contribution (LAC)** $\Pi = \rho(Rn - \lambda E, T) - \rho(Rn - \lambda Ep, T)$

- **Multivariate Regression Analysis**

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

Y= Mean summer CDH days per year

$\beta_1 X_1 = \beta_{AC} AC \mid \beta_2 X_2 = \beta_{LAC} LAC$

3 AC and LAC over South America

Future changes in the bivariate distribution of AC and LAC levels are region dependent:

1. <u>AC strengthening</u>:
   - NWS non WET
   - NES WET
   - NES non WET
2. <u>LAC strengthening</u> :
   - NWS WET
   - NES WET
   - NES non WET
   - SAM WET
   - SAM no WET
3. (1) + (2):
   - NES WET
   - NES non WET

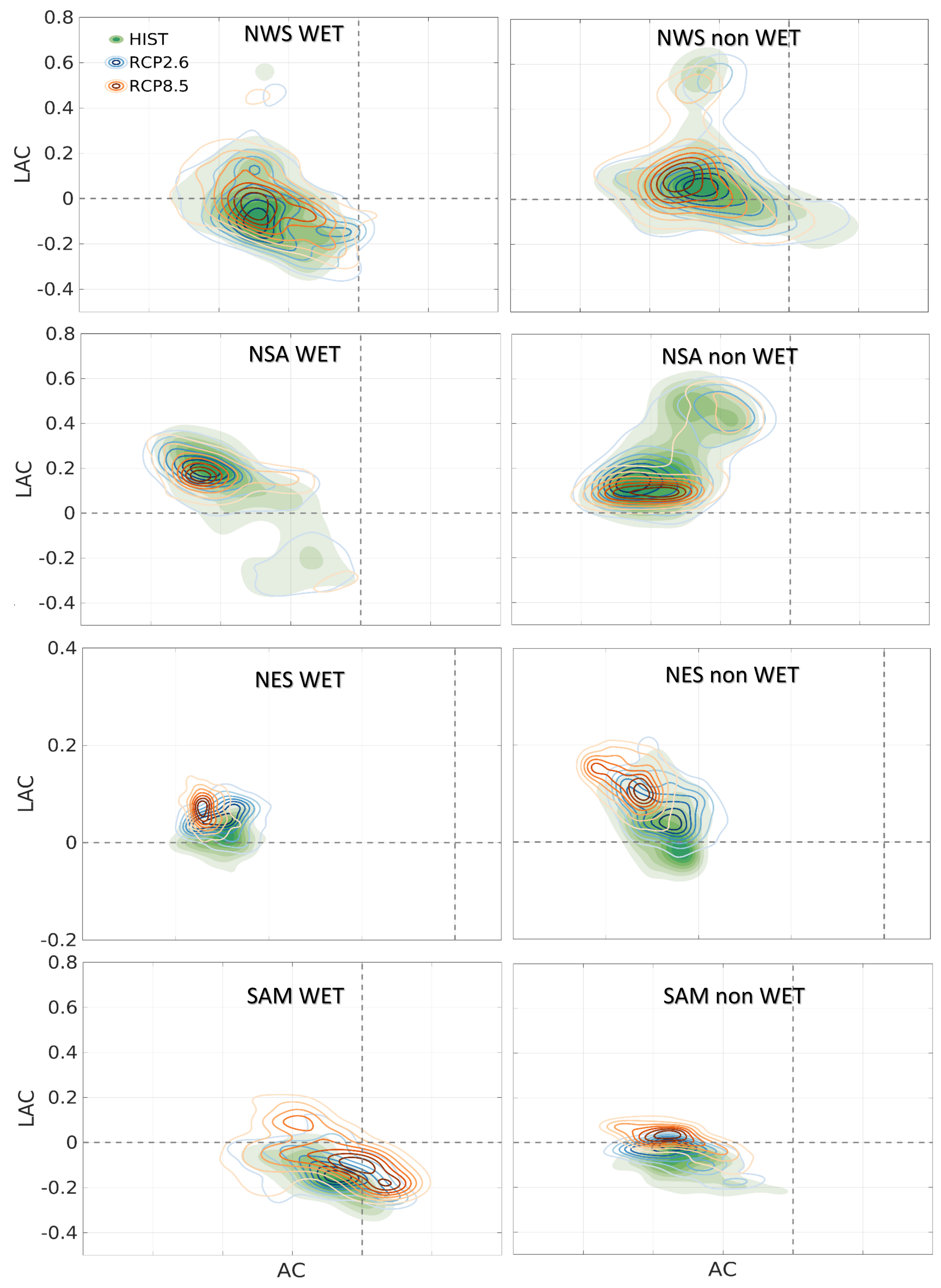


Fig. 2 Bivariate Kernel distributions of LAC and AC levels across different SA sub-region and within the respective Wet and non Wet ecoregions for the historical period (green shades), the RCP2.6 (blue contours) and the RCP8.5 (orange contours) experiments.

4 CDH conditions in South America

- All regions are expected to witness **an increase in the mean number of summer days under CDH conditions**, with particular emphasis to **NWS and NSA**.

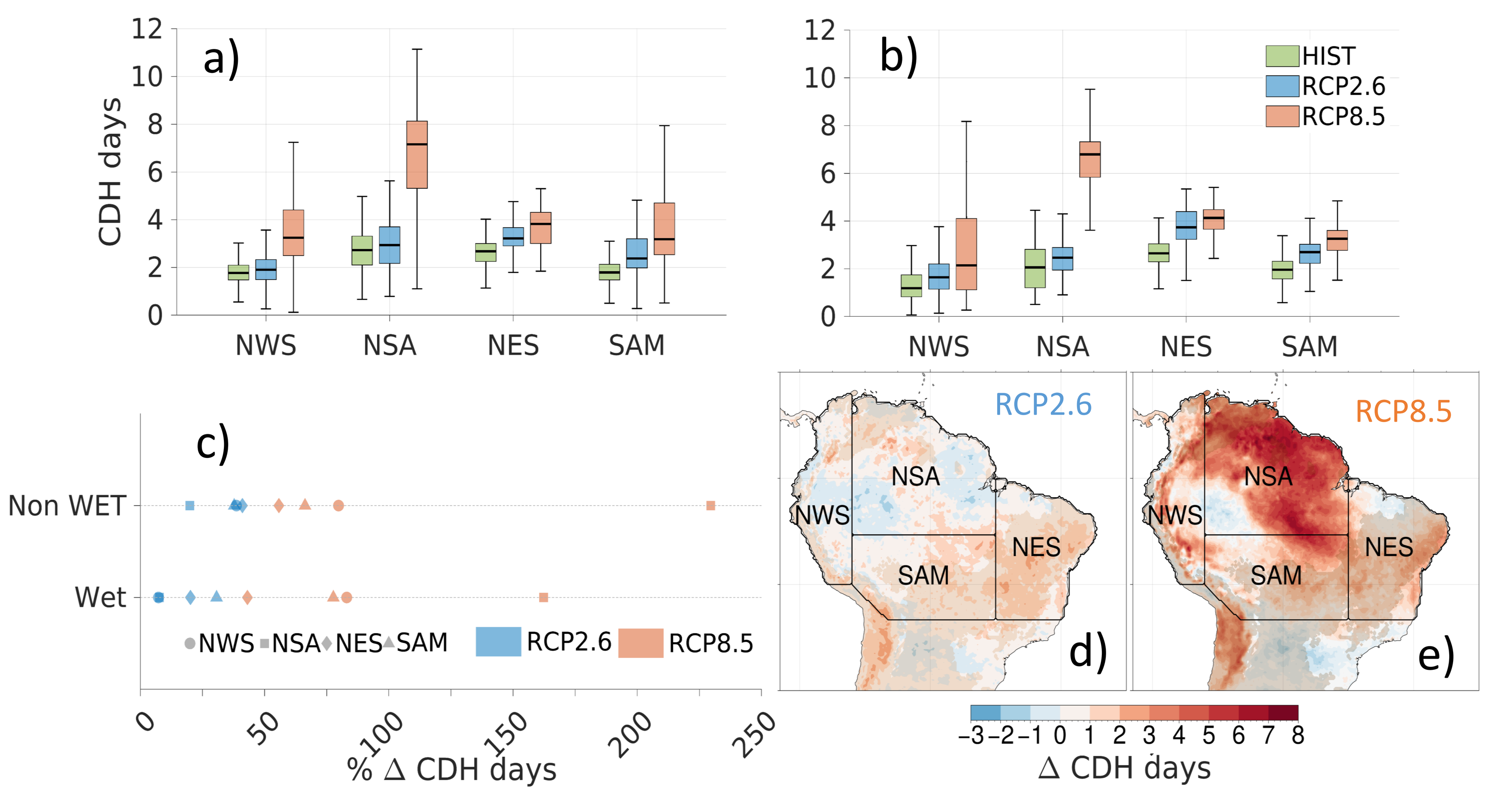


Fig. 3 a and **b** Boxplots depicting the statistical distribution of the mean summer CDH days per year over the SA sub-regions and within the respective Wet (**a**) and non Wet ecoregions (**b**). **c** Percentage of increase in the mean summer CDH days per year for RCP2.6 and RCP8.5 future scenarios in respect to the Historical period. **d and e** Spatial distribution over SA of the variation in the mean summer CDH days per year for the RCP2.6 and RCP8.5 in respect to the historic.

5 Influence of LAC and AC on CDH days

- In general, the level of influence of **soil moisture–temperature coupling** ($\beta(LAC) > 0$) on **summer CDH conditions** is expected to **increase in future for all regions**.
- A simultaneous strengthening of the influence of **soil moisture–temperature coupling** ($\beta(LAC) > 0$) and of **compound hot and low precipitation conditions** ($\beta(AC) < 0$) is only observed over NWS.

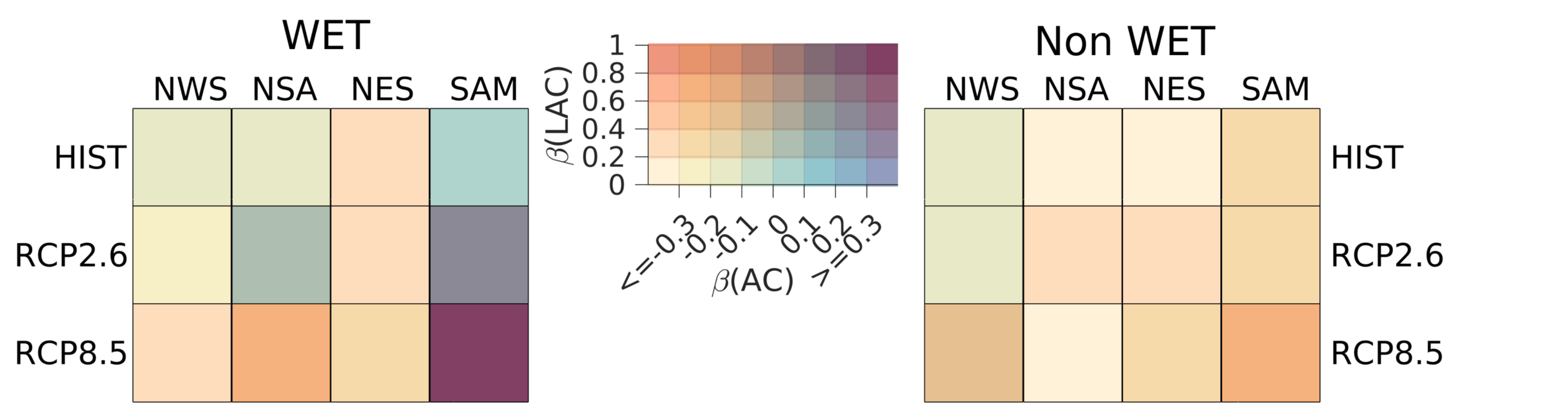


Fig. 4 Regression coeficients ($\beta \times 10^{-1}$) obtained from the multivariate regression models applied for the SA sub-regions and within the respective Wet (left panel) and non Wet (right panel) ecoregions for the historical, RCP2.6 and RCP8.5 experiments.

6 Summary

- A **high spatial variability** is expected in future **changes of the AC and LAC levels** over SA.
- The expected increase of CDH conditions is partially explained by the sum of two factors: **(1) increase in the AC and LAC levels and (2) changes in the influence of AC and LAC on the ocurrence of CDH events.**

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