Multi-model evidence of future tropical Atlantic precipitation change modulated by AMOC decline

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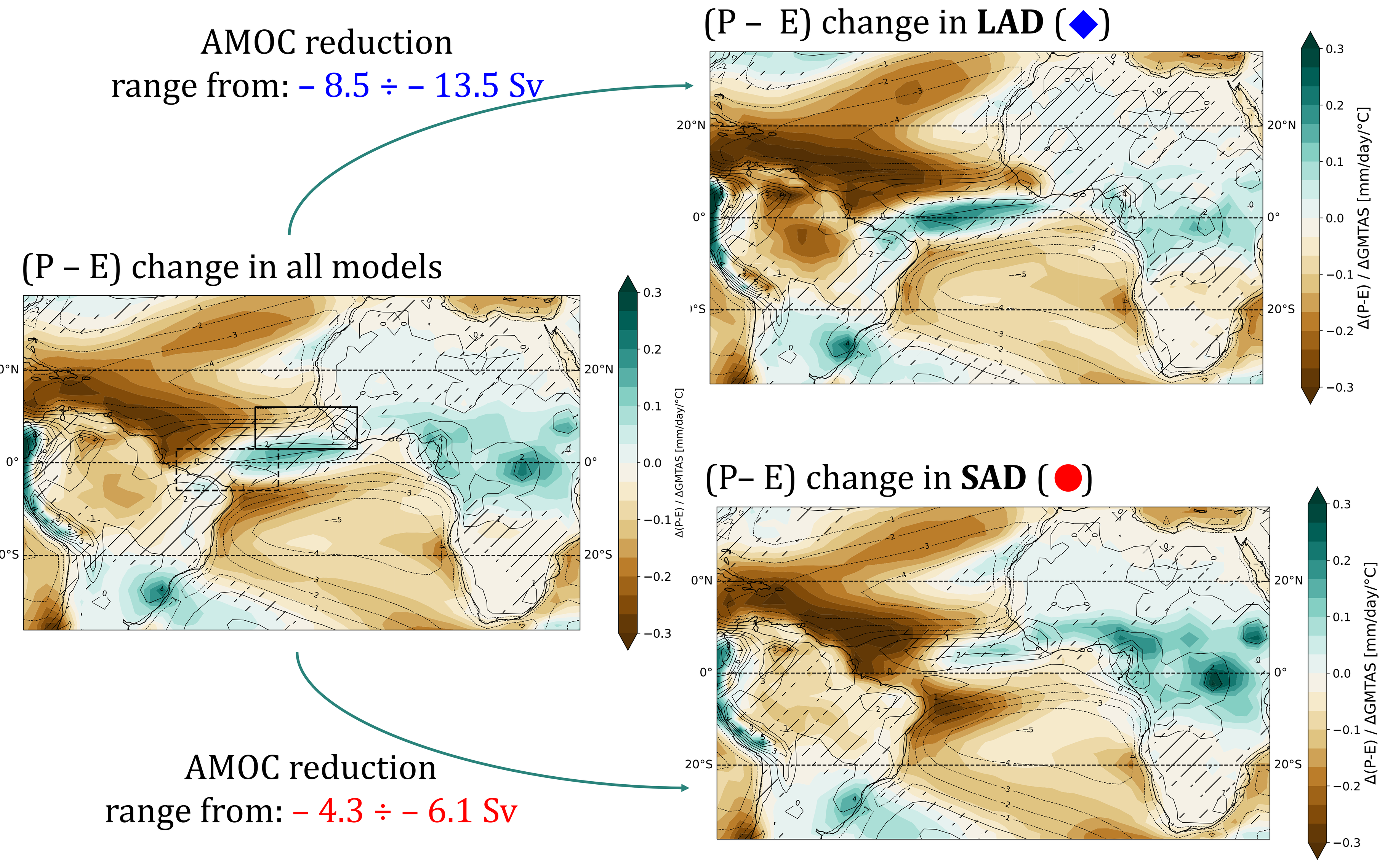
1. Introduction

Future climate projections of tropical Atlantic precipitation show considerable uncertainty [1]. The climate of the region is **strongly influenced** by the Intertropical Convergence Zone (**ITCZ**), whose meridional position is sensitive to the Atlantic Meridional Overturning Circulation (**AMOC**) transport of energy [2]. Here, we investigate the link between the large inter-model spread in **projections of the AMOC decline** [3] and those of the projected **mean annual position of the Atlantic ITCZ**.



2. Data and methods

- **3 precipitation observational datasets** (ERA5, MSWEP, IMERG)
- **30 CMIP6 models**: historical run + **ssp5-8.5** future projection

We divide the 30 models in 3 groups of 10 models each [3], based on the amount of AMOC decline under global warming: here evaluated as the difference between the ssp5-8.5 (years 1971-2100) and the historical experiments.

Mean AMOC strength (historical)	Projected AMOC decline (21st century)	
16.4 Sv	– 4.3 ÷ – 6.1 Sv	"Small AMOC decline" (**SAD**) ●
17 Sv	– 6.2 ÷ – 8.4 Sv	No group
21 Sv	– 8.5 ÷ – 13.5 Sv	"Large AMOC decline" (**LAD**) ◆

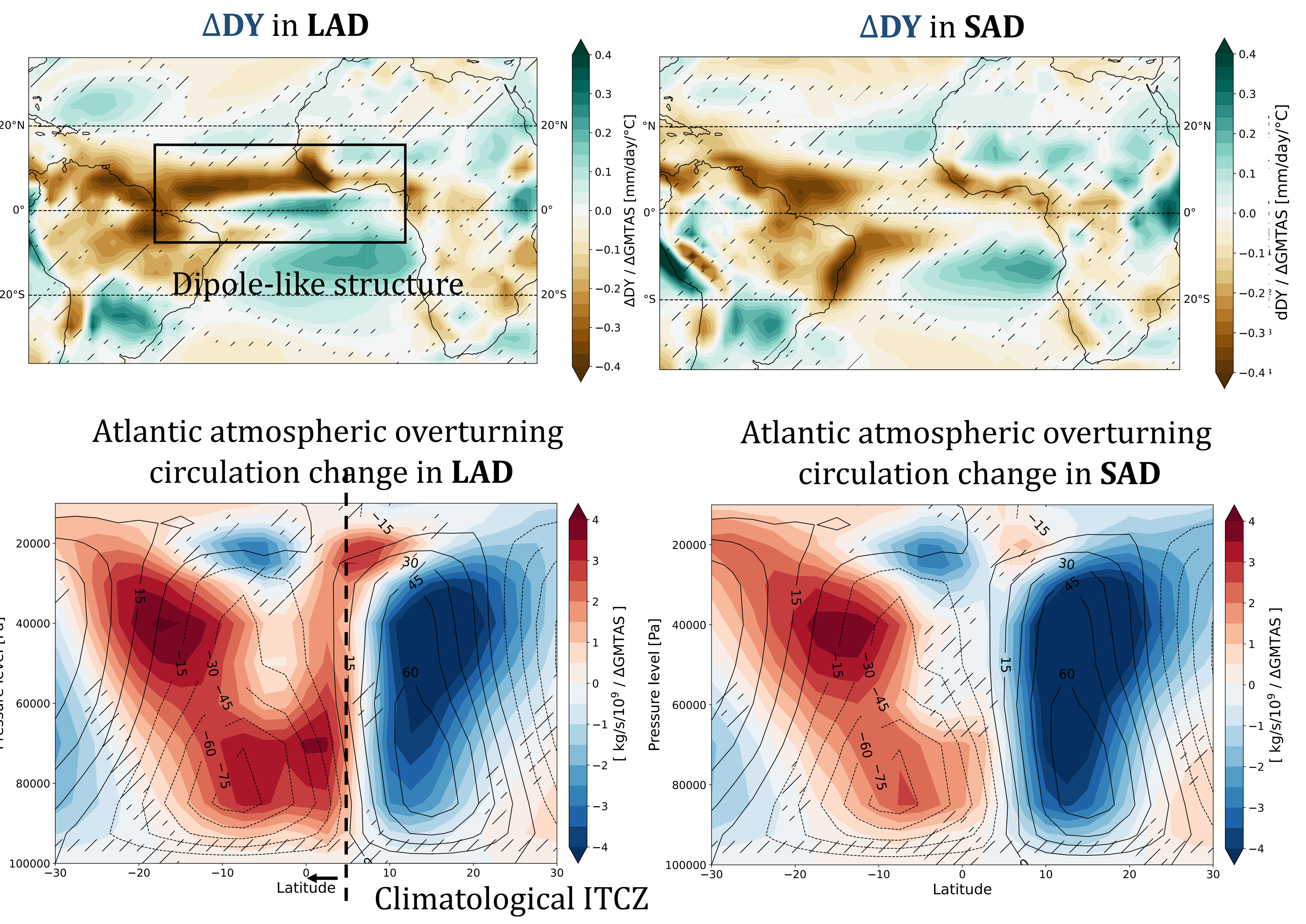
We attribute impacts to the AMOC decline by analysing differences in tropical precipitation changes between the **LAD** and the **SAD** groups.

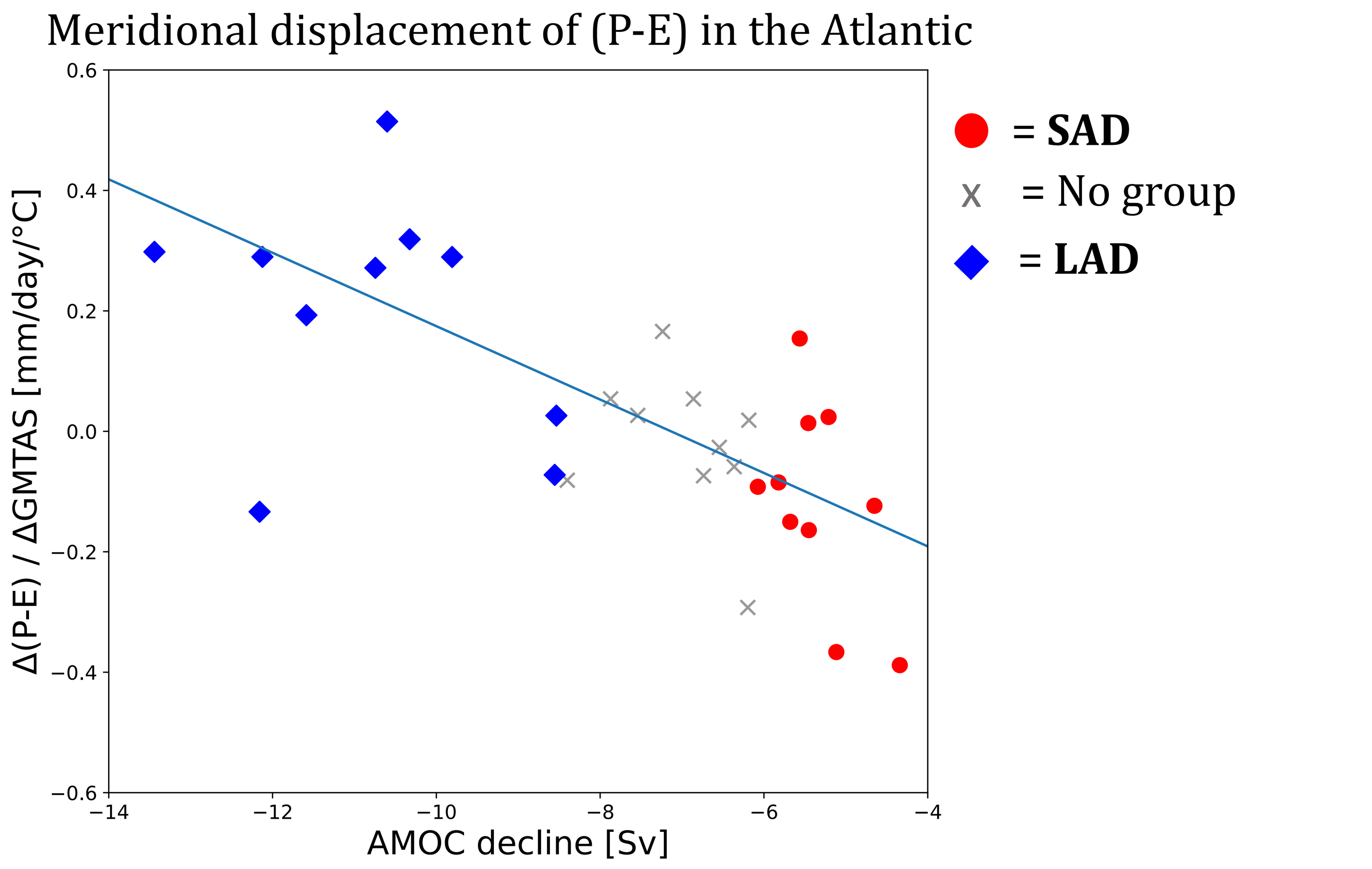
To investigate drivers of the **net precipitation (P – E)** change we compute the **moisture budget (1)** for the two groups [4].

$$\Delta(P-E) = \Delta TH + \Delta DY + \Delta TE + \Delta NL \quad (1)$$

- ΔTH: Good inter-model agreement
- $\Delta TE + \Delta NL$: Negligible effect
- ΔDY: Strong disagreement between **SAD** and **LAD**

3. Results





On the y axis: difference in average precipitation between the two boxes in figure *(P – E) change in all models:*

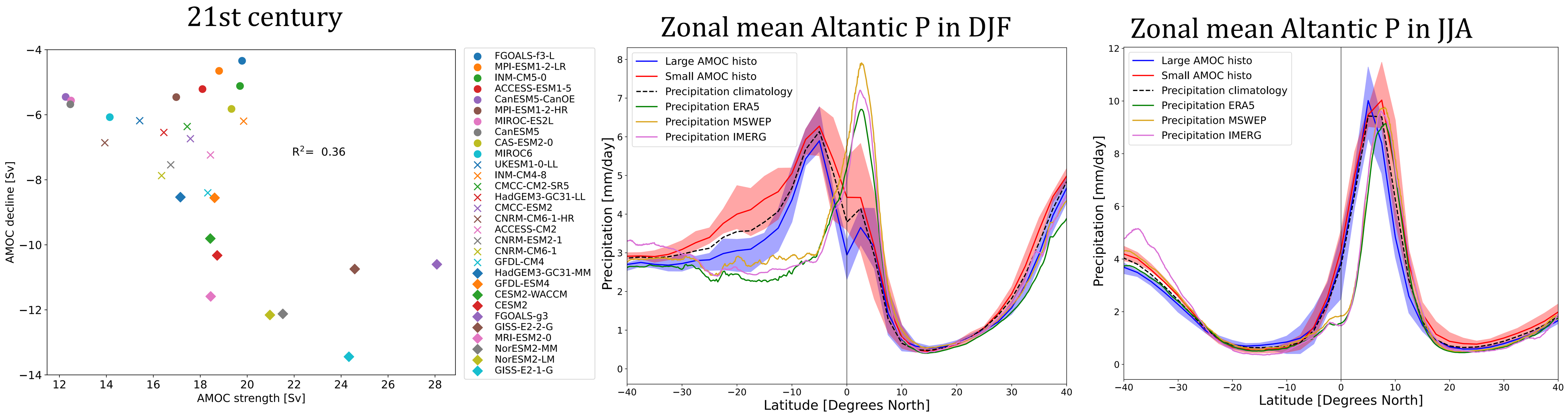
(P – E) change in Northern box – (P – E) change in Southern box

- Positive values: ITCZ southwards shift
- Negative values: intensification of current (P-E) distribution

4. Linkage with biases in the mean state

Models with a **stronger mean AMOC strength** in the historical experiment

- **Larger AMOC decline** in the 21st century
- **Less affected** by the **double-ITCZ bias**



5. Takeaways

- Inter-model spread in 21st century AMOC decline partly explains inter-model spread in Atlantic ITCZ meridional changes
- Models featuring a larger AMOC decline in the 21st century, also feature a stronger mean AMOC in the historical climate
- Models featuring a stronger mean AMOC in the historical climate are less affected by the double ITCZ bias in DJF
- Why do models featuring a stronger mean AMOC are less affected by precipitation biases, and does this influence their projection of future AMOC decline?

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References:
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[4] Seager et al. (2020). Thermodynamic and Dynamic Mechanisms for Large-Scale Changes in the Hydrological Cycle in Response to Global Warming, *Journal of Climate*, *23*(17)

Finanziato dall'Unione europea NextGenerationEU · Italiadomani · Ministero dell'Università e della Ricerca