The future of the low-level jets in northern South America and the Caribbean

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GIGA grupo de ingeniería y gestión ambiental

Introduction

- **What is the Choco jet?**

Westerly low-level circulation over the eastern tropical Pacific entering to western Colombia.

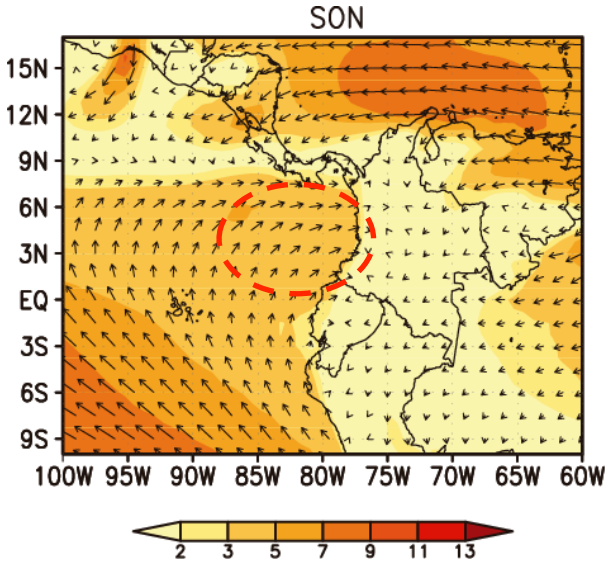


Fig.1 Seasonal climatology SON for 925hPa horizontal wind from ERA-Interim in m/s.

- **Why is it important?**

Influence on rainfall over western/central Colombia by:

-Moisture transport from the Pacific Ocean **(Poveda and Mesa, 1999; Arias et al. 2015)**

-Interaction with ITCZ, CLLJ, and EMEJ, inducing the formation of MCSs **(Sakamoto et al. 2011)**

The importance of the low-level jets for northern South America

2010-2012 wet season in northern South America

4 million people affected in Colombia

US$ 7 billion in damages and losts

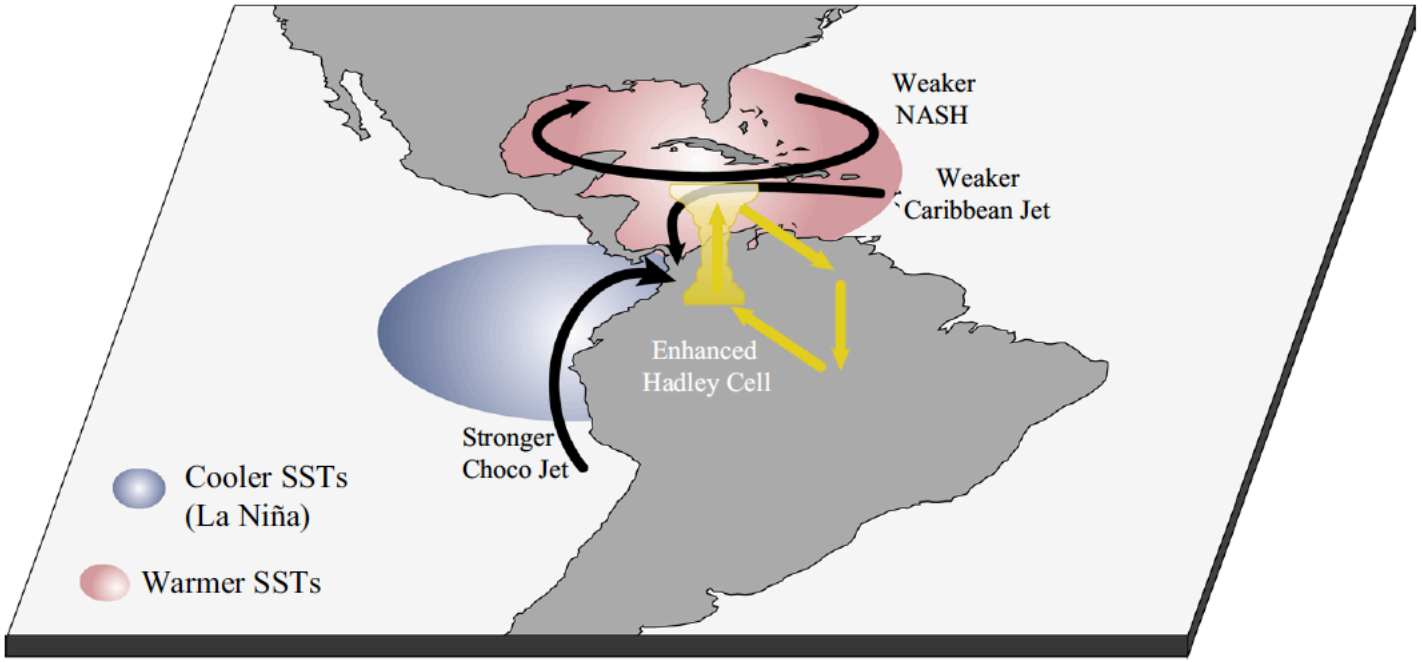
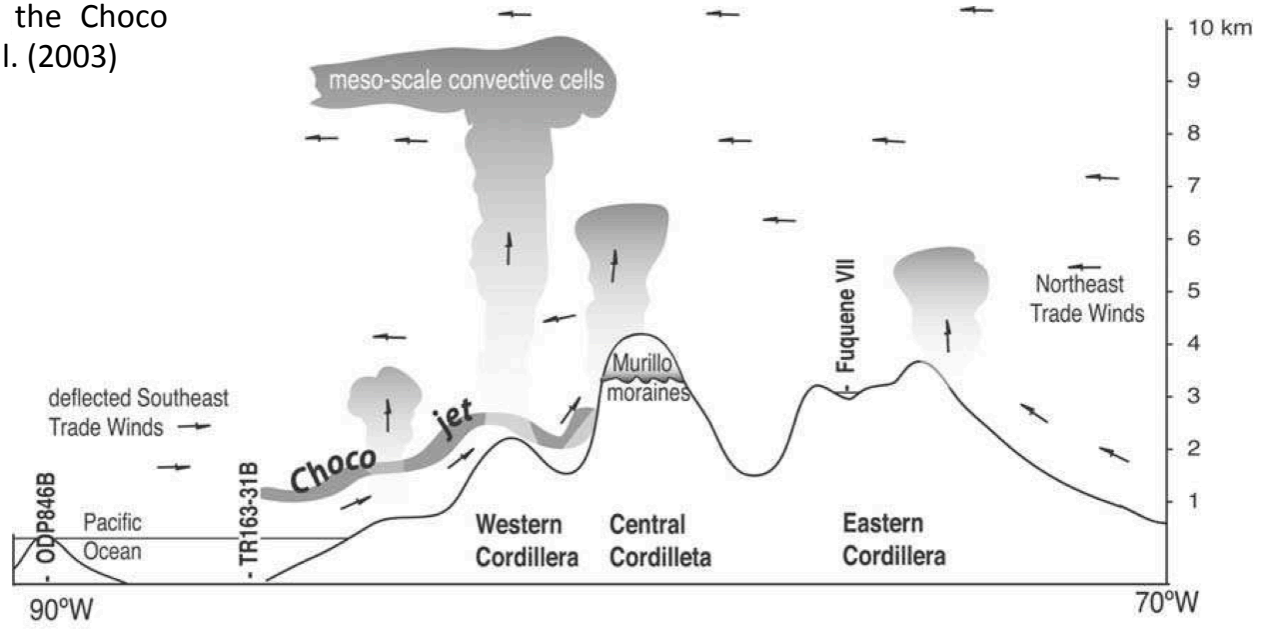


Fig.2 Moisture transport during the 2010-2012 anomalous wet season in northern South America. From Arias et al. (2015).

Past variability of the Choco jet

- Stronger jet during the Last Glaciation due to an increased inter-hemispheric SST gradient, turning western Colombia wetter **(Martínez et al. 2003).**

Fig.3 Cross-section of the Choco Jet. From Martínez et al. (2003)



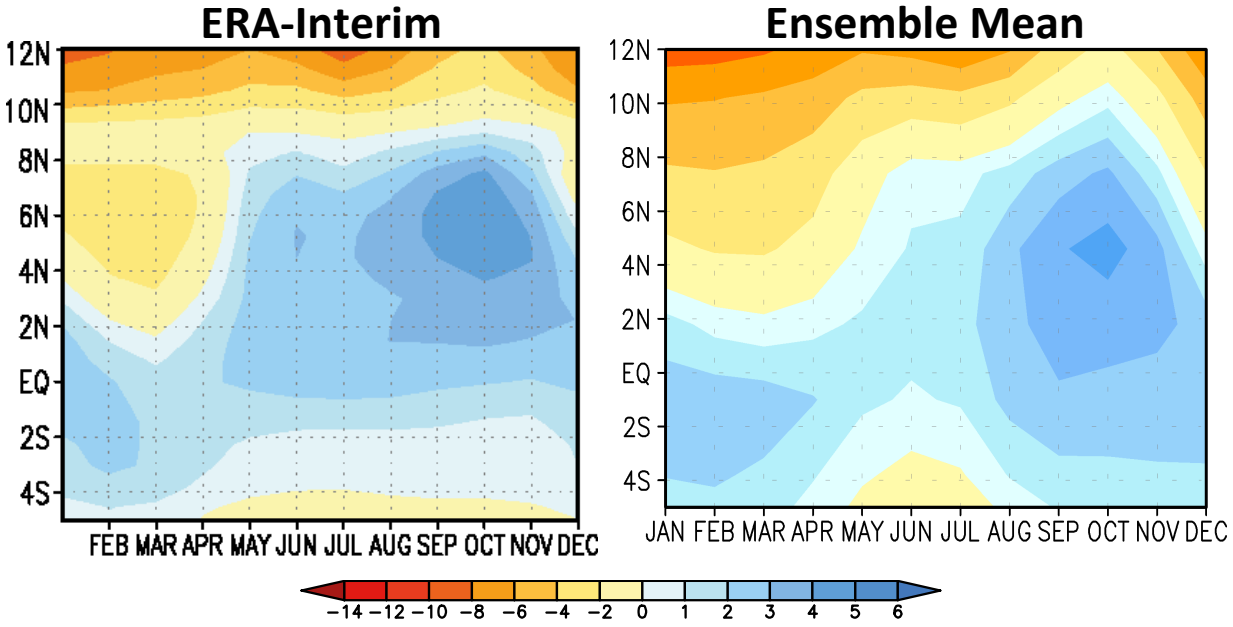
- **What could happen with the Choco jet under a warmer climate?**

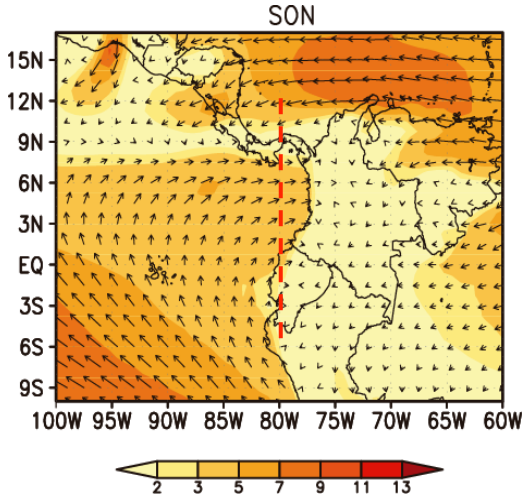
Datasets and methods

- ERA-Interim reanalysis **(Dee et al. 2011).**
- 5 Global Climate Models (GCM) from the CMIP5 Project selected based on **Sierra et al. (2015).**
- Original model resolution and bilinear interpolation for ensemble means (2.8°x2.8°).
- Use of the **historical** and **RCP85** experiments of the CMIP5 runs.
- Period of analyses: 1979-2005 (present) and 2006-2100 (future).
- Mann-Kendall test for trend identification **(Wilks, 2011).**

Present of the Choco jet

- Low-level westerly winds from the Pacific Ocean to Colombia.
- Jet core centered at 5°N and 80°W, 925hPa.
- Annual cycle with major (minor) activity during Oct-Nov (Feb-March) **(Poveda and Mesa, 2000).**



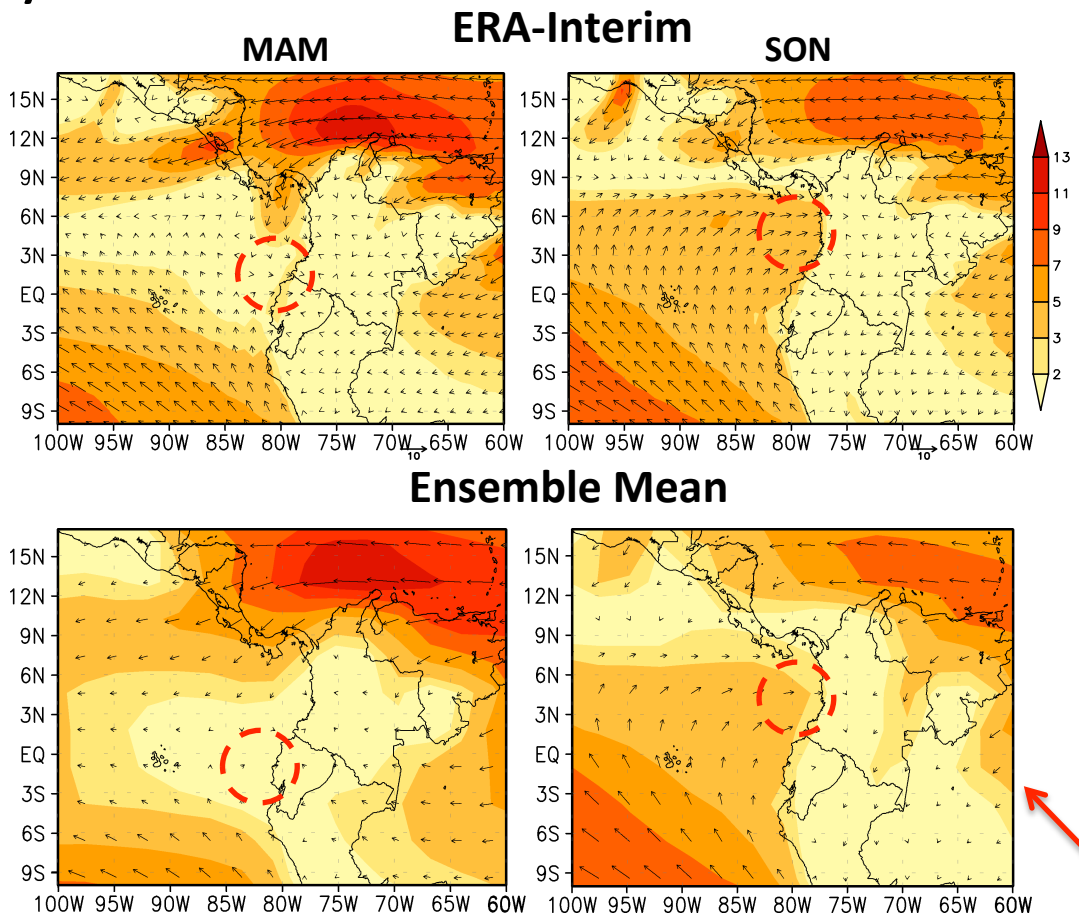


Reference figure

Fig.4 Latitude-time cross section of the monthly zonal wind climatology at 925hPa from ERA-Interim and the ensemble mean in m/s. **(Annual cycle).**

Present of the Choco jet

Latitudinal migration and **amplification** throughout the year.



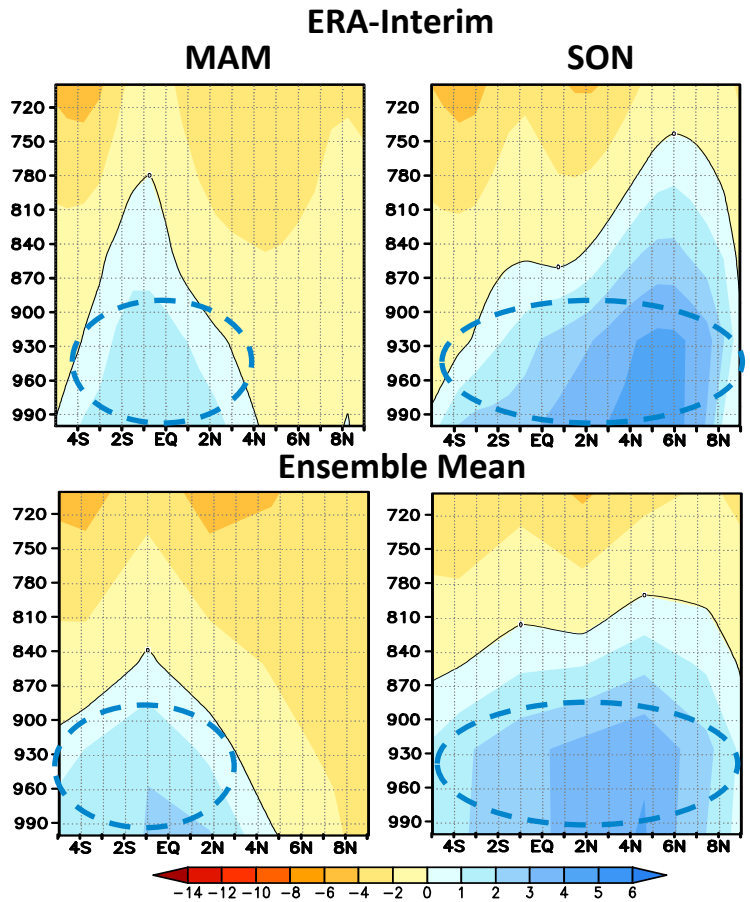


Fig.5 Latitude-height cross-section of the seasonal climatology of zonal wind from ERA-Interim and the ensemble mean in m/s. **(Vertical structure).**

Fig.6 Seasonal climatology for horizontal wind at 925hPa from ERA-Interim and the ensemble mean in m/s. **(Spatial distribution).**

Future of the Choco jet

- Choco jet index defined as the 925hPa zonal wind average at 80°W, between 5°S-7°N **(Poveda and Mesa, 2000).**

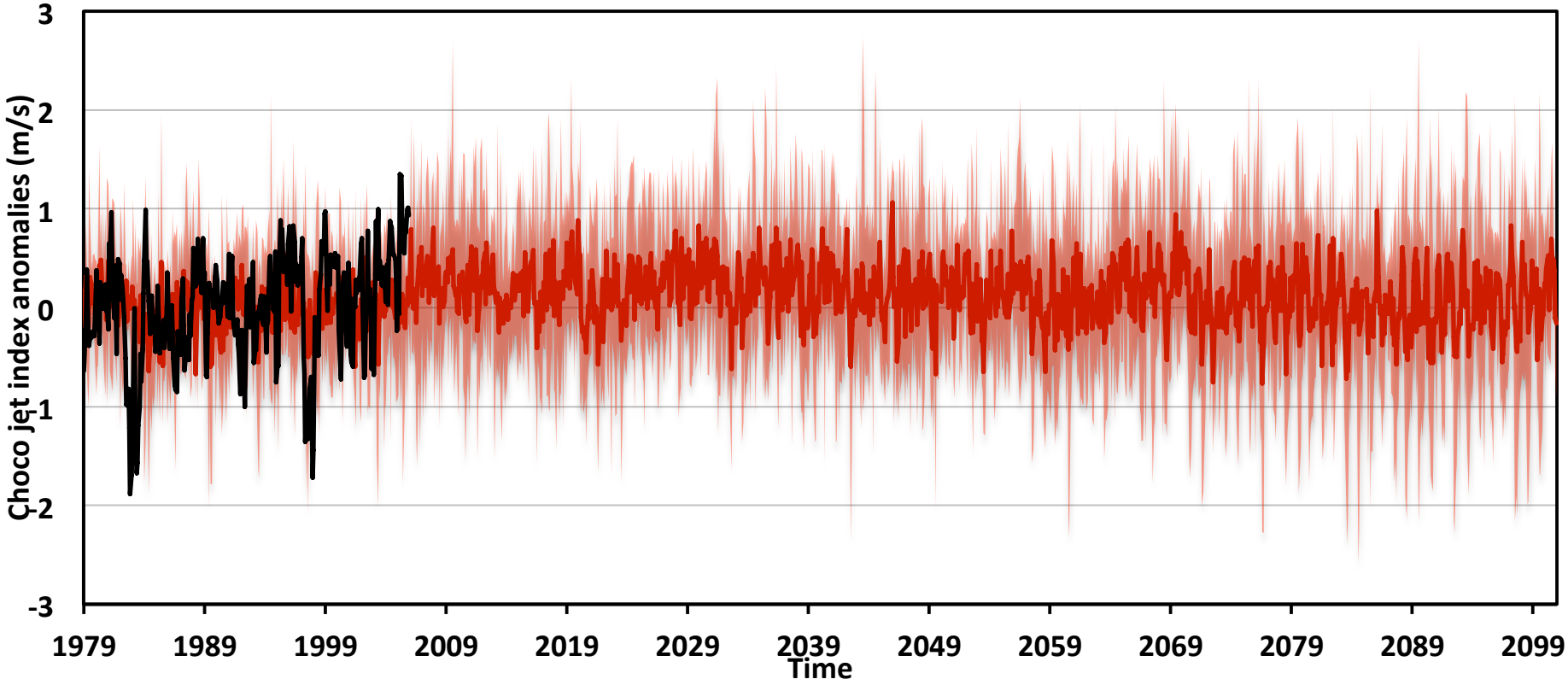


Fig.7 Time series of the Choco jet index monthly anomalies for the period 1979-2100. Data from ERA-Interim reanalysis and the ensemble mean of the GCM. Red lines correspond to the maximum and minimum values of the GCM time series.

Future of the Choco jet

- Ensemble mean (4 of 5 models) exhibits significant negative trends in the monthly index for the period 2006-2100.
- Trends start to be more significant after 2070.
- Negative significant trends in the ensemble mean in JJA and SON, with low agreement among modes (2 models).
- Major changes occur during JJA.

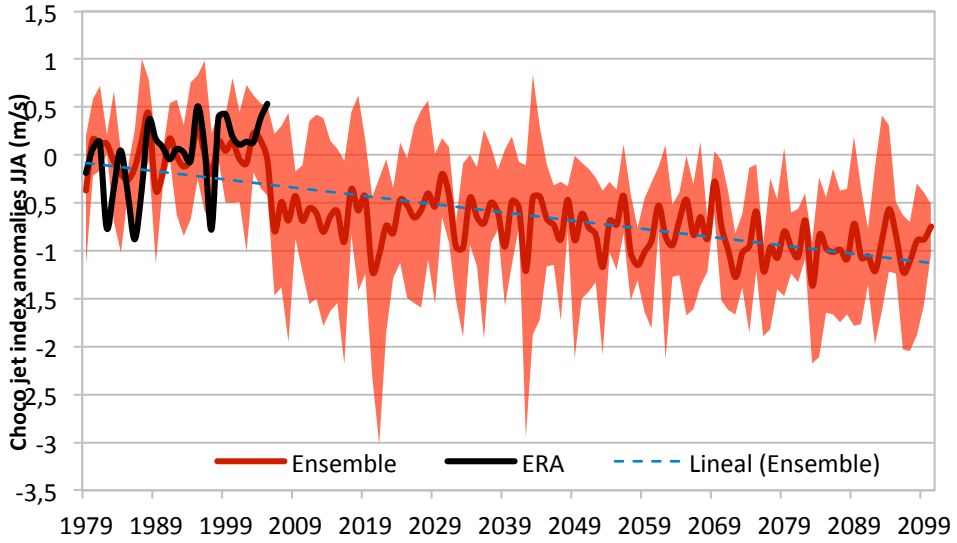


Fig.8 Seasonal anomalies of the Choco jet index in JJA for the period 1979-2100.

Future of the Choco jet

- Major weakening of the Choco jet during JJA and SON (strong agreement).
- Strengthening of the Caribbean low-level jet during JJA and SON (strong agreement). Results in agreement with previous works **(Taylor et al. 2013)**.
- Weakening of the winds over the eastern Pacific Ocean in JJA and SON (strong agreement).
- Shallower Choco jet during SON (strong agreement).

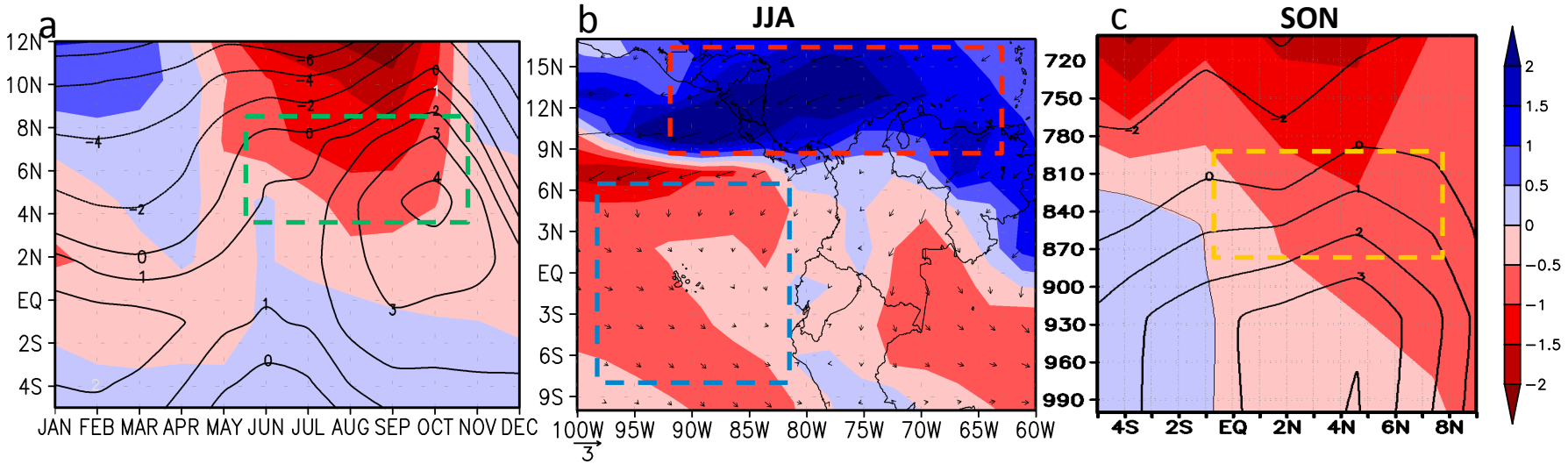


Fig.9 2070-2100 and 1979-2005 climatology differences of (a) anual cycle of zonal wind at 925hPa and 80°W, (b) horizontal wind at 925hPa for JJA, and (c) SON zonal wind at 80°W.

Mechanisms suggested to explain the Choco jet

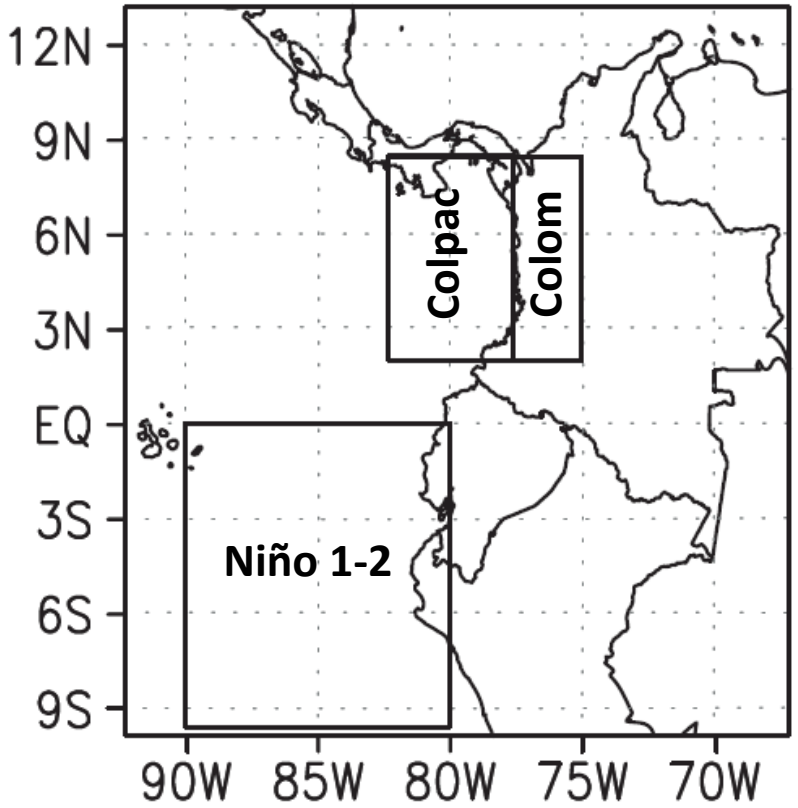


Fig.10 Key regions for temperature and sea level pressure gradientes involved in the mechanisms explaining the Choco jet **(Poveda and Mesa, 2000).**

- **Differences of temperture and sea level pressure among land/sea regions.**
- Topographic lifting.
- Interaction with the easterly winds.
- Change of Coriolis sign.
- Latent heat release in MCSs.

Future of the mechanisms involved in the Choco jet

- Positive trend **(weakening of the pressure gradient)** of the SLP difference between Colpac-Niño 1.2. All models agree.
- Similar results for the other regions but lower agreement.

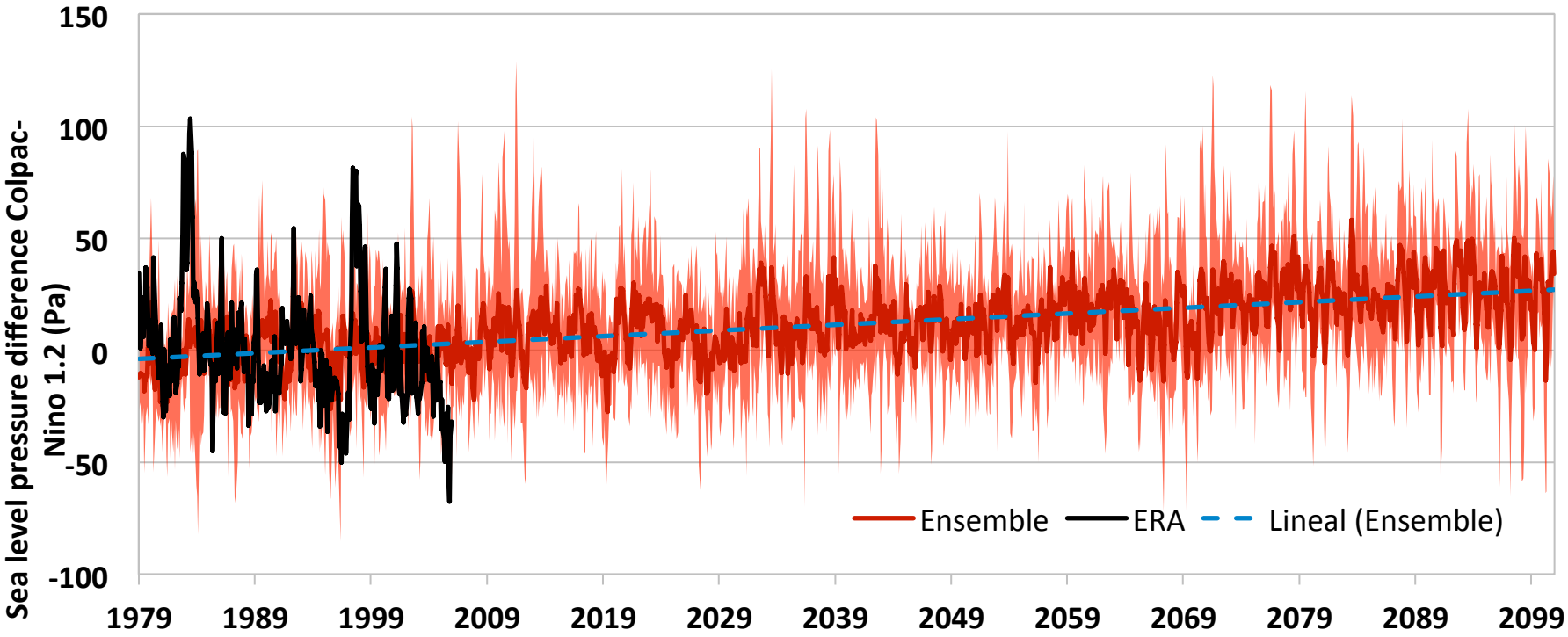
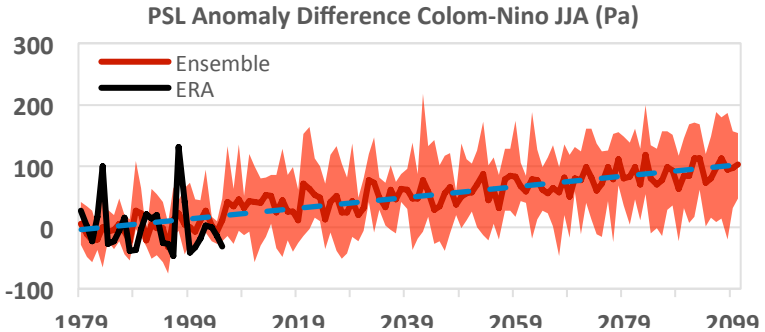
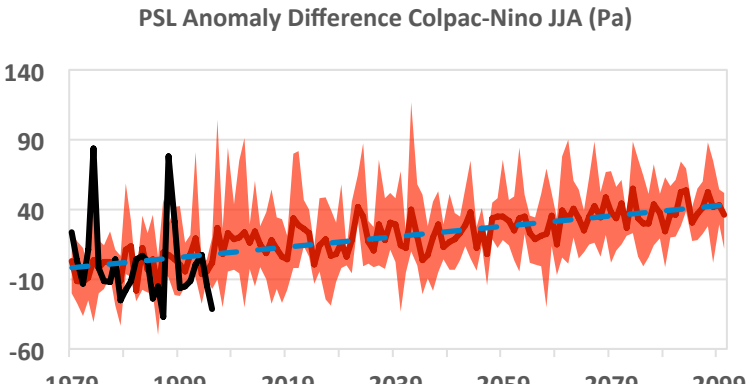
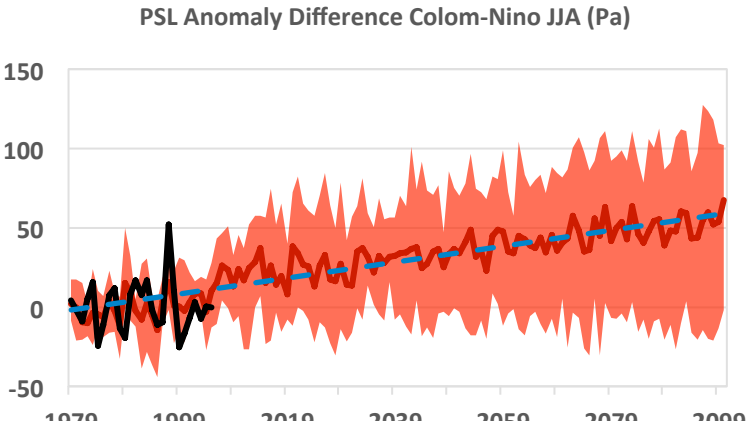


Fig.11 Monthly anomalies of the sea level pressure difference between Colpac-Niño 1.2 regions for the period 1979-2100.

Future of the mechanisms involved in the Choco jet







- Strongest trend and model agreement in JJA and SON.
- All models agree for the regions Colpac-Niño in JJA and SON, and Colom-Niño in JJA.
- Major changes during JJA.

Fig.12 Seasonal anomalies of the sea level pressure difference in JJA among regions for the period 1979-2100.

Future of the mechanisms involved in the Choco jet

- Negative trends related with a weakening of the temperature gradient among regions.
- Major changes and strongest agreement (all models) during JJA.

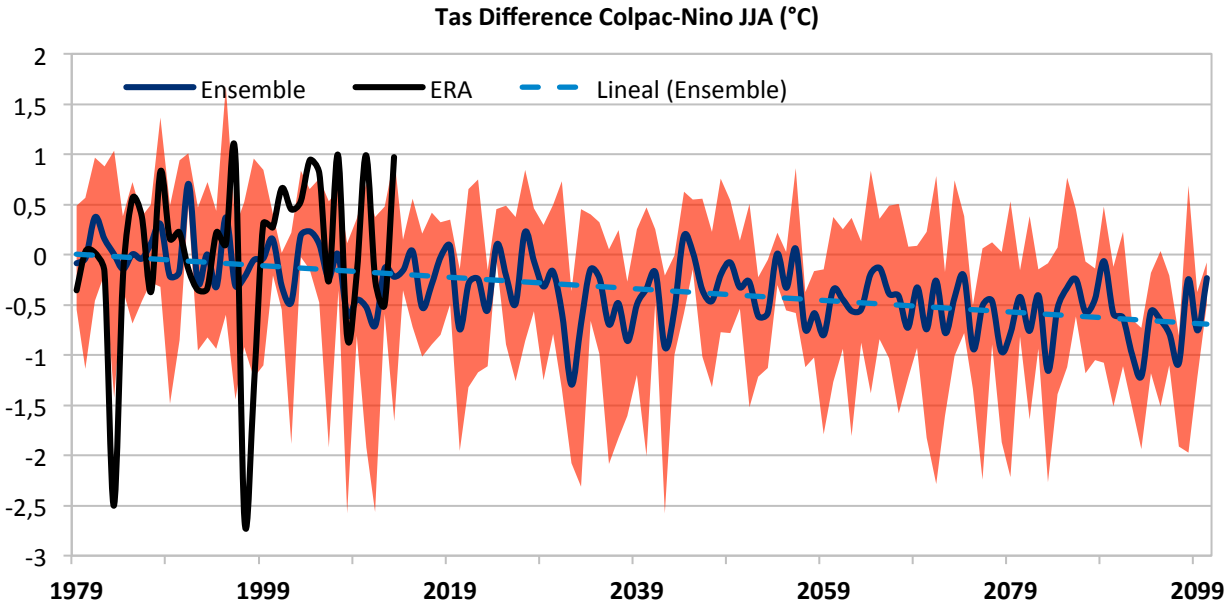


Fig.13 Seasonal anomalies of the sea level pressure difference in JJA between Colpac-Niño regions for the period 1979-2100.

Main points

- **Strong agreement** about a **weakening of the Choco jet** (4 from 5 models) for the 21st century.
- Major changes emerge **after 2070**.
- **Major changes** occur **during JJA and SON** (**weaker** and **shallower** low-level jet).
- Changes driven by **weaker land-sea surface pressure and temperature differences**.
- **Strenghtening** of the **Caribbean low-level jet** during **JJA** and **SON**.
- Possible **future changes of precipitation** linked to **changes ot low-level jets??**

Acknowledgments

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