CLARIS | LPB
HYDRO-CLIMATE AND SOCIETY IN LA PLATA BASIN

IMPRS-ESM International Max Planck Research School on Earth System Modelling

Max-Planck-Institut für Meteorologie

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Climate Service Center Germany 2.0
Eine Einrichtung des Helmholtz-Zentrums Geesthacht

Connections between low level jets and mesoscale convective systems in South America

Armelle Reca C. Remedio[1], Susanne Pfeifer[1], Daniela Jacob[1], Hartmut Graßl[2]

[1]Climate Service Center 2.0 – Helmholtz Zentrum Geesthacht, Hamburg, Germany; [2]Max Planck Institute for Meteorology, Hamburg, Germany

Introduction

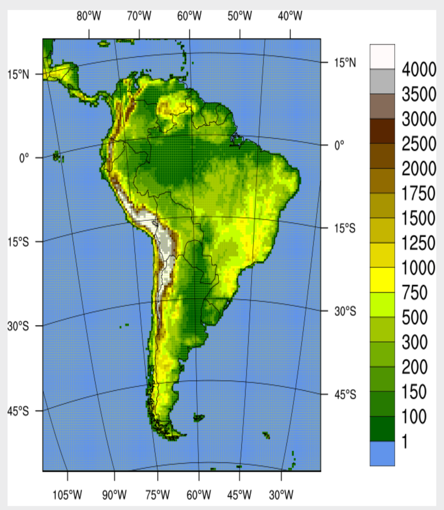
- The majority of the human population and socio-economic resources in South America are located in La Plata Basin
- During austral summer, large mesoscale convective systems (**MCSs**) are associated with strong low level jets (**LLJs**) that develop east of the Andes mountain range.
- Over the basin, the mature phase of **MCS** brings excessive amounts of rainfall that cause severe weather events such as thunderstorms, hail, and flooding.
- Due to its dire consequences, it is crucial to understand the relationship between **LLJs** and **MCSs**.

The study aims to assess the long term role of the **MCSs** and **LLJs** in South America by characterizing their spatial and temporal characteristics and quantifying the correlation between these two systems.

Research questions:

1. How are the daily precipitation distributed over different regions in South America? Are regional models able to reproduce the distribution?
2. What are the temporal and spatial characteristics of the South American **LLJs**? Are they represented in REMO?
3. How strong is the connection between **MCSs** and **LLJs** in South America?

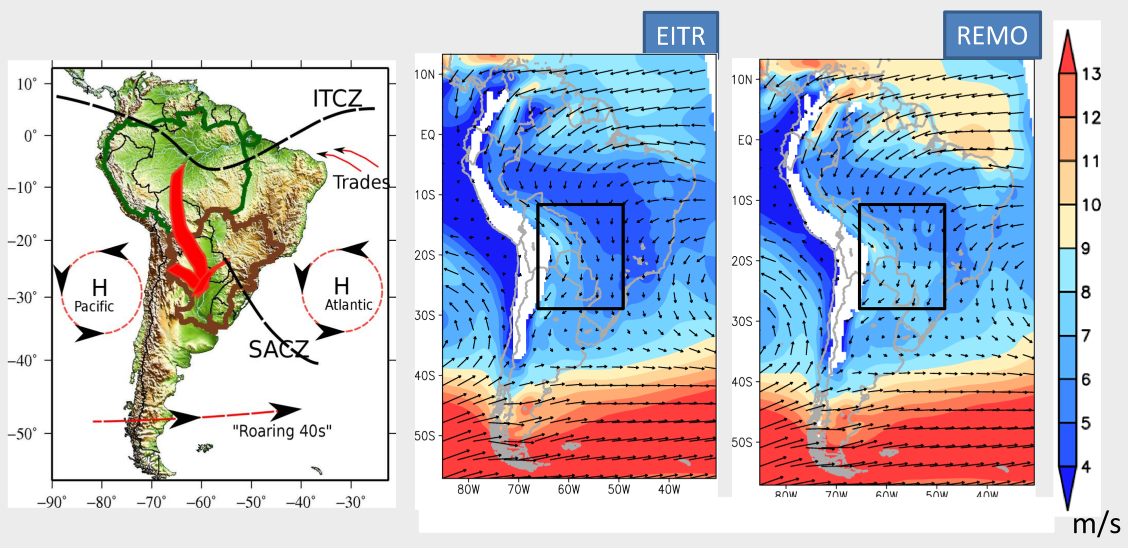
Data and Methods:

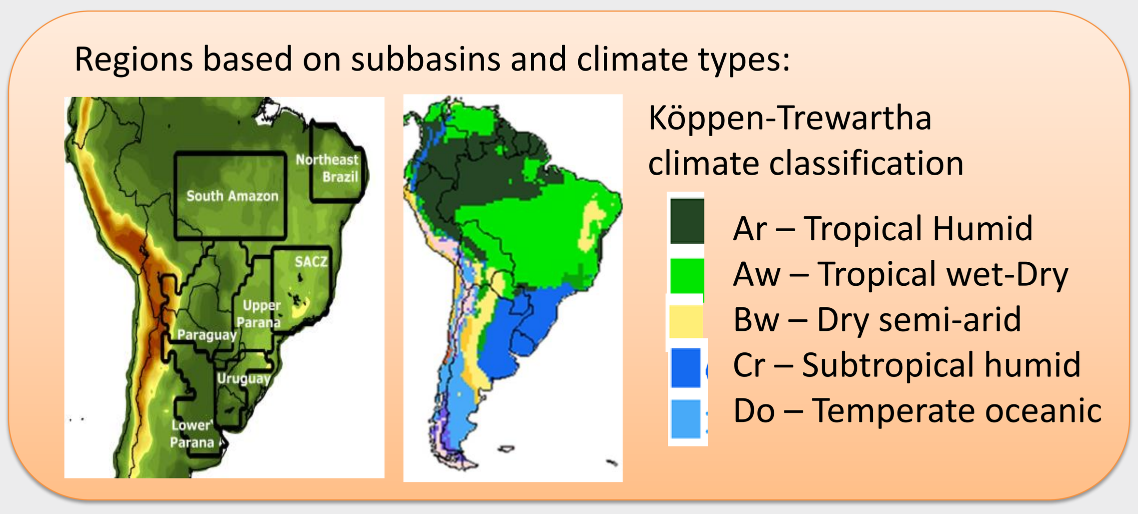


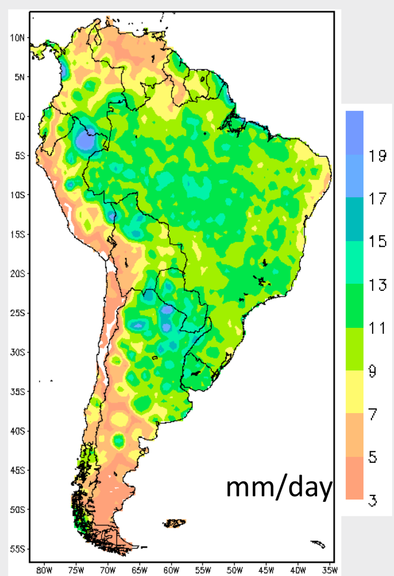
Dimensions:
151x181
31 vertical levels
0.44° x 0.44°

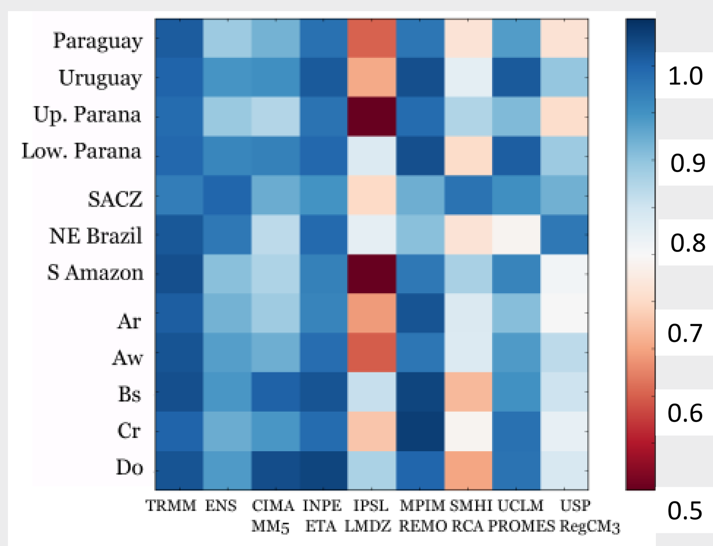
- REMO – the three-dimensional, hydrostatic, regional climate model used for analyzing the processes of **LLJs** and **MCSs**
- The model's horizontal grid resolution in the rotated coordinated system is 0.44° (about 50 km) and the domain covers the entire continent with 31 vertical levels
- The default model version is REMO2009, which has been modified due to the overestimation of the surface temperature over the Amazon basin during austral spring
- Short sensitivity tests are performed using REMO2009 with varying values and coverage of the permanent wilting point parameter, which influences the water holding capacity of the vegetation in the selected region
- The setup in which the permanent wilting point parameter is set to 10% in the forested regions exhibits the most realistic decrease of surface temperature (~3 K) in terms of affected regions. This modified REMO is able to simulate the climatic features of South America, thus it is used as a reasonable tool for the analysis.

Model evaluation: low-level circulation and daily precipitation distribution during summer







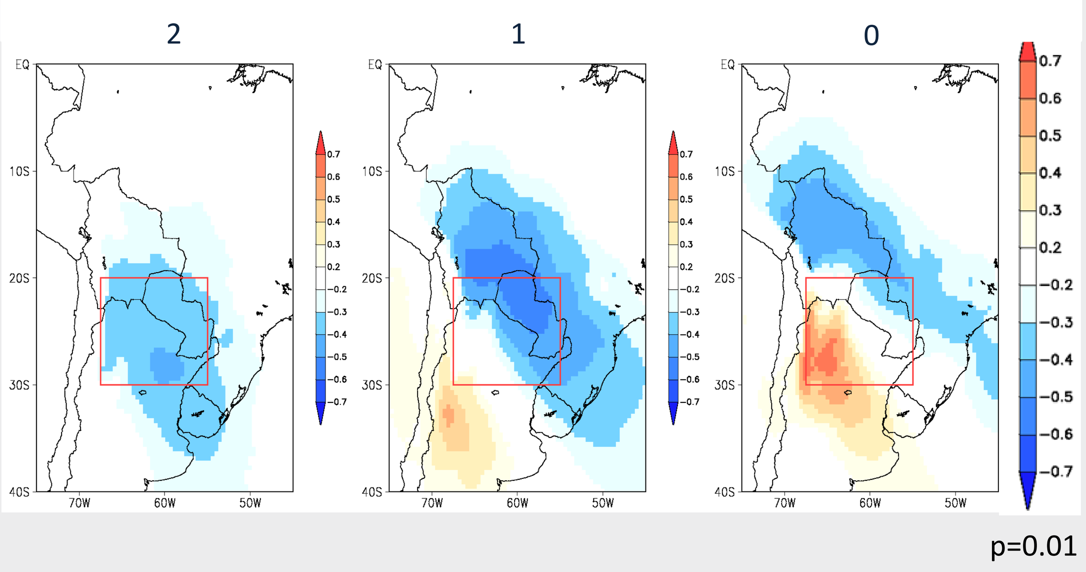


- The simulated atmospheric circulations at 300 hPa and 200 hPa are evaluated using the EITR reanalysis.
- The main circulations such as the Bolivian High and Nordeste Trough during summer, the low level jets, and the semi- permanent anticyclonic circulations over the Pacific and Atlantic oceans during summer and winter are generally represented in REMO.

- In the framework of the CLARIS-LPB Project, the uncertainties in simulating monthly temperature and precipitation using seven regional models including REMO are evaluated in several regions based on its hydrological and climate characteristics. In six out of the seven subregions, REMO is able to simulate the mean annual cycle of precipitation and temperature reasonably well compared to the other models.
- Over the South Amazon region, most models including REMO still exhibit the spring time warming. Possible reasons are the different land surface scheme of each model and an insufficient density of observations in the region.
- In the framework of the CORDEX initiative, the transferability of REMO to six CORDEX regions including South America are assessed for regions defined by the Koeppen-Trewartha climate classification types. Major climate types of South America are the tropical humid, tropical wet-dry, dry semi-arid, subtropical humid, subtropical summer-dry, and temperate oceanic climates. The skill of the model in simulating the observed precipitation and temperature within the 13 regions based on climate types is measured using probability density functions.
- Based on the skill scores relative to the CRU observations, relatively high scores are calculated over subtropical climate types including the La Plata Basin while relatively low scores are found in tropical climate types including the Amazon Basin.

Correlation:

REMO v_{850} and precipitation



Summary and conclusion:

- Using observational datasets from stations, reanalyses, and satellite estimates with varying horizontal resolution, and the high resolution REMO simulation data, the spatial and temporal characteristics of **LLJs** and **MCSs** are investigated.
- During austral summer, the **LLJs** modulate the climate by transporting warm and moist air from the Amazon to the La Plata Basin. At the exit region of the **LLJs**, the **MCSs** initiate and develop, which bring heavy precipitation events.
- Regions with high frequency of **LLJ** and **MCS** occurrences are identified and the mean contribution of **LLJs** and heavy precipitation events associated with MCSs are from 30–50% and about 30%, respectively, relative to the summer mean.
- Evaluating the lead-lag correlation between the meridional wind speed and area-averaged precipitation over the La Plata Basin for several summer periods (e.g. summers with normal years, ENSO warm, and cold phase years), a significant but weak negative correlation is calculated in both observations and simulation data two days before the anomalous rainfall.
- The negative correlation (~–0.6, p=0.01) located near Bolivia strengthens the day before (Day 1) while a positive correlation (~0.7, p=0.01) appears in central Argentina. These correlation values indicate a convergence of warm, moist air from the north and the cold, dry air from the southeast, which produce the heavy precipitation events the following day (Day 0). The significantly high correlation of anomalous meridional wind speeds the day before heavy precipitation events are good precursors for monitoring the severe weather events over the La Plata Basin.

Reference and acknowledgement

- A. R. C. Remedio. Connections of low level jets and mesoscale convective systems in South America. PhD thesis, Universität Hamburg, 2013.

- Thank you **Prof. Hartmut Graßl** for the fruitful panel meetings, useful insights, and guidance! Maraming maraming salamat po!

Climate Service Center 2.0 – Germany • Fischertwiete 1 • 20095 Hamburg
Phone +49 (0)40-226 338-451 • armelle.remedio@hzg.de

www.climate-service-center.de