CHANGES IN SUMMER PRECIPITACION IN SOUTHEASTERN SOUTH AMERICA BY THE WCRP/CMIP5 MODELS

Díaz, L.B*; Vera, C. S.

Centro de Investigaciones del Mar y la Atmósfera (CIMA), DCAO/FCEyN, UMI-IFAECI CNRS-CONICET-UBA, Buenos Aires, Argentina

***ldiaz@cima.fcen.uba.ar**

MOTIVATIONS AND GOAL

Southeastern South America (SESA) has experimented large positive precipitation trends during the 20th century that impacted many socio-economic sectors. There is a concern if this trend is due to the climate anthropogenic forcing and whether it will continue in the future or not. The fifth phase of the World Climate Research Program-Coupled Model Intercomparison Project (WCRP-CMIP5) Experiment currently provides the most comprehensive scenarios for studies of present and future climates.

The goal is to assess the skill of the WCRP/CMIP5 climate simulations in representing the mean, variability and trends of the austral summer precipitation in South America during the 20th century. In addition, an exploration of the precipitation trends in southeastern South America (SESA) and its possible causes is also made.

DATA

⋆ **CMAP** dataset (Xie and Arkin,1997) is used to describe the mean and variability conditions observed in the rainfall between 1979 and 2005.

⋆ **GPCC** dataset (Schneider et al, 2011) is used to describe the trend observed in the rainfall between 1902 and 2005.

⋆ Monthly means of rainfall of Historical (**H**), HistoricalNat (**HNat**) and HistoricalGHG (**HGHG**) runs were obtained from the set of simulations of 33 coupled general circulation of the WCRP/CMIP5 multi-model dataset (Taylor et al., 2011).

⋆ **HNat** simulations has been performed considering the natural forcing (volcanism, solar radiation variability, etc) only while leaving constant the Greenhouse gases (GHG) concentrations.

⋆ **HGHG** simulations has been performed considering the variations of the GHG forcing while leaving constant the natural forcing.

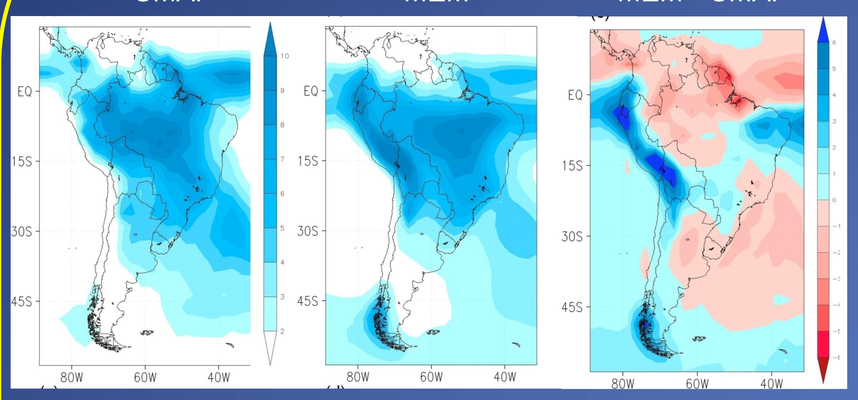
⋆ **H** simulations have been performed including variations in both GHG and natural forcing.

⋆ The multi-model ensemble mean (**MEM**) was obtained for each simulation averaging the available models.

VALIDATION OF CMIP5 HISTORICAL RUNS

MEAN DJF PRECIPITATION 1979-2005 (mm/day)

CMAP MEM MEM - CMAP

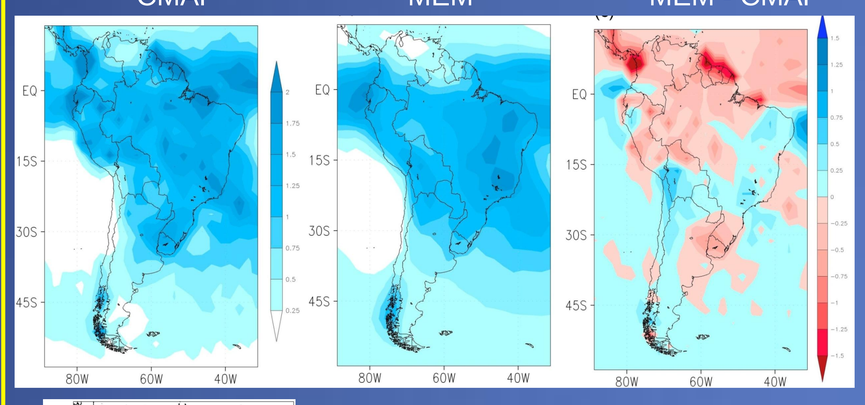


The MEM represents the main features of rainfall over ITCZ, SACZ and Southern Chile.

Underestimation:
Equatorial Zone, SAMS, SACZ and SESA.

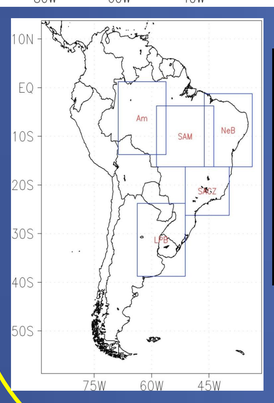
DJF PRECIPITATION STANDARD DEVIATION 1979-2005 (mm/day)

CMAP MEM MEM - CMAP



There is a general agreement between the MEM standard deviation spatial structure and the observed

In SESA, the MEM shows values almost half of the observed.

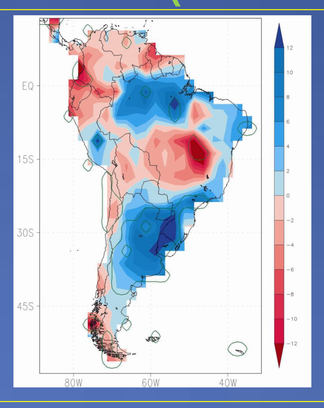


Region	Mean		Standard deviation	
	Mean Bias	Inter-model dispersion	Mean Bias	Inter-model dispersion
Am (Amazonia)	-0,93	1,23	-0,33	0,30
SAM (South American Monsoon)	0,21	1,22	-0,06	0,36
NeB (Northeastern Brazil)	1,33	1,43	0,03	0,38
SACZ (South Atlantic Convergence Zone)	-0,35	1,35	0,12	0,36
LPB (La Plata Basin)	-0,42	0,72	-0,14	0,17

Comparing with the CMIP3 results (Vera et al. 2009), there is a reduction of the mean bias in MEM precipitation over Am, SAM and LPB regions.

DJF RAINFALL LINEAR TREND 1902-2005 (mm/summer/decade)

GPCC



Positive trends:
SESA and northwestern Brazil

Negative trends
Southern Andes region and central Brazil

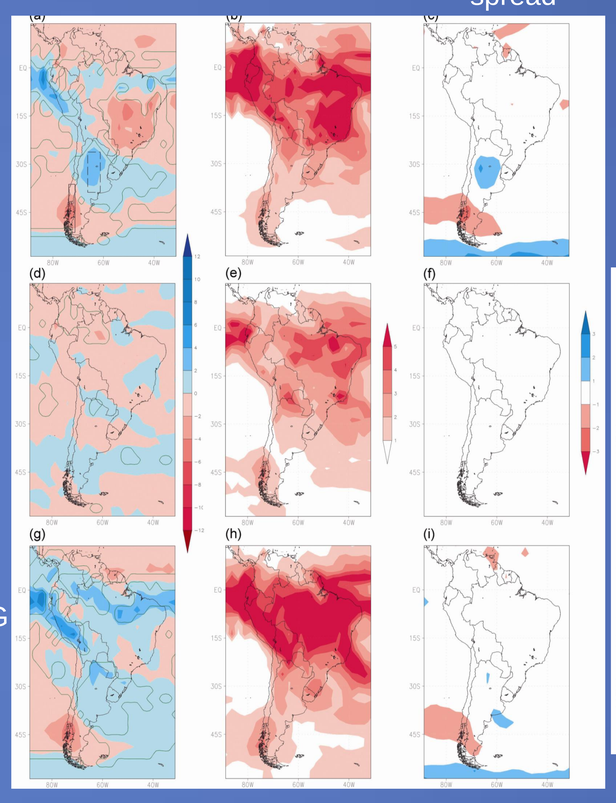
UNCERTAINTY ANALYSIS OF TRENDS

Mean trend | Model spread | Mean/Model spread

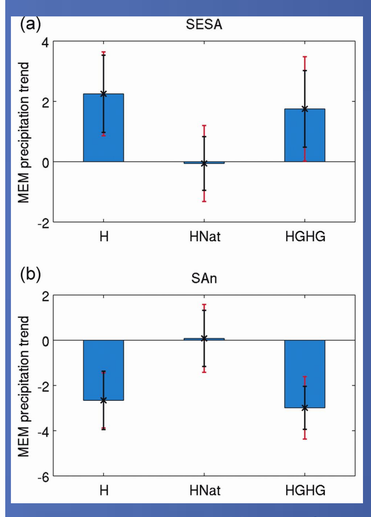
H

HNat

HGHG



Mean trends obtained for H experiment are able to reproduce observed precipitation changes although weaker.
The pattern of positive (negative) trends in SESA (SAn) are also discernible in some way in HGHG experiment, while they are not identifiable when natural forcing are only considered.

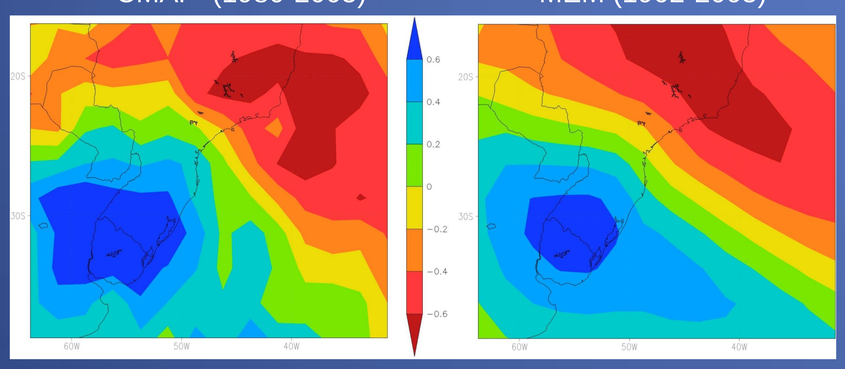


Mean trends for the H experiment are significantly different from those obtained for the HNat, which exhibit negligible mean values at both regions.

Uncertainty
Model
Internal Climate Variability

LEADING DJF PRECIPITATION INTERANNUAL VARIABILITY PATTERN (EOF1)

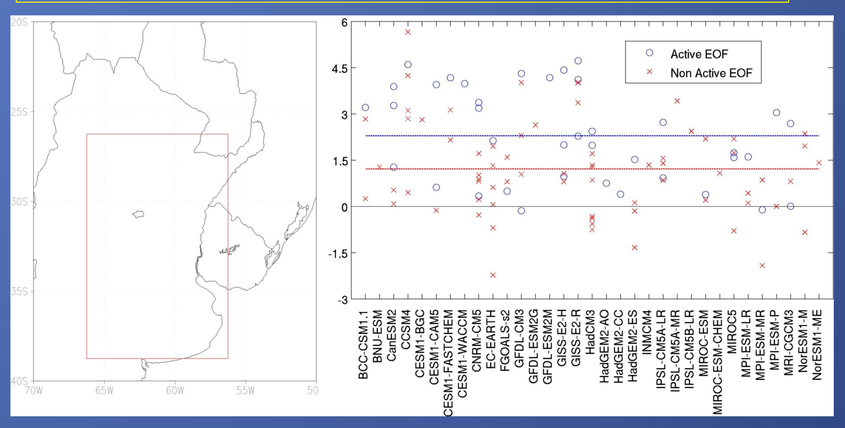
CMAP (1980-2005) MEM (1902-2005)



The CMAP and the MEM EOF show a dipolar pattern.

For most models individually, the correlation is found between 0.8 and 0.9. This result improves significantly the result of the CMIP3 models (Junquas et al, 2012).

INFLUENCE OF EOF1 ACTIVITY CHANGES ON THE SESA TREND



For most models, Active EOF model members have a larger trend than the non active EOF1 ones. The average of all Active EOF model members is larger than the average of all non active EOF model members.

INFLUENCE OF EOF1 ACTIVITY CHANGES ON THE TREND

⋆ **Positive EOF events (P) Wetter than normal conditions in LPB and dryer in SACZ.**

⋆ **Negative EOF events (N) Dryer than normal conditions in LPB and wetter in SACZ.**

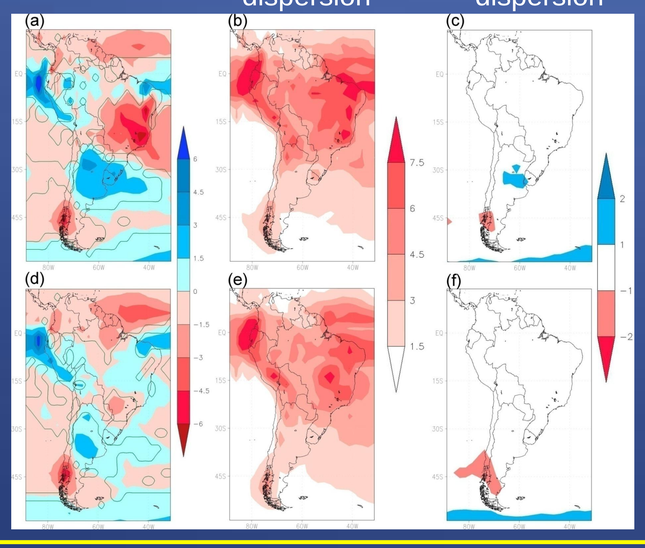
⋆ **Active EOF model members: Increase in P events and decrease in N events from 1902-1953 to 1954-2005.**

MEM was made pooling together all model members that satisfy the condition

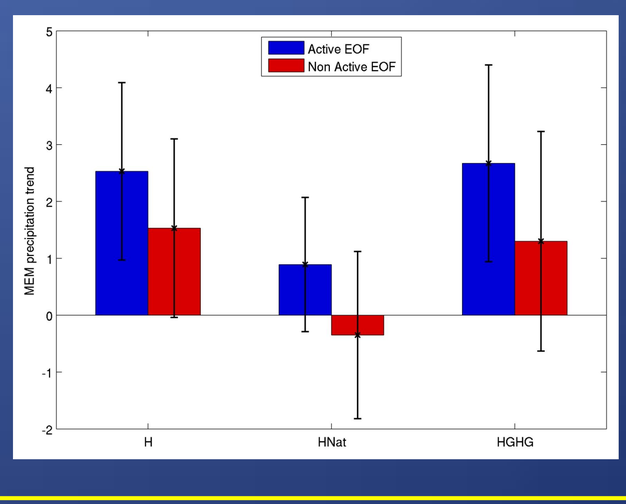
Mean trend | Ensemble dispersion | Mean/Ensemble dispersion

Active EOF ensemble

Non-Active EOF ensemble



Only the Active EOF ensemble show mean trend over SESA larger than the ensemble dispersion.



For the three simulations, the Active EOF MEM trend is larger than the correspondent to the Non-Active EOF MEM.

Only H and HGHG Active EOF MEM trend is superior than the correspondent ensemble dispersion.

CONCLUSIONS

DJF rainfall trends were computed over the 1902-2005 period. Most of the models show a significant positive trend over SESA in agreement with observations. However the simulated trend is much weaker. Moreover, the trend seems to be at least partially associated with a frequency increase of EOF1 positive events, which are characterized by precipitation increase (decrease) in SESA (SACZ). Precipitation trend from the multi-model ensemble mean is significantly different from inter-model dispersion over central-eastern Argentina. However, uncertainties related to internal variability (represented by model member dispersion) are large. Preliminary studies reveal that the anthropogenic forcing (associated to greenhouse gas concentration increase) seems to at least partially explain the positive rainfall trend.

ACKNOWLEDGMENTS

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