SSASE: A Regional Index for Assessing Severe Storm Environments in Subtropical South America

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The Abdus Salam International Centre for Theoretical Physics

IFAECI

cnrs

CONICET

IRD Institut de Recherche pour le Développement FRANCE

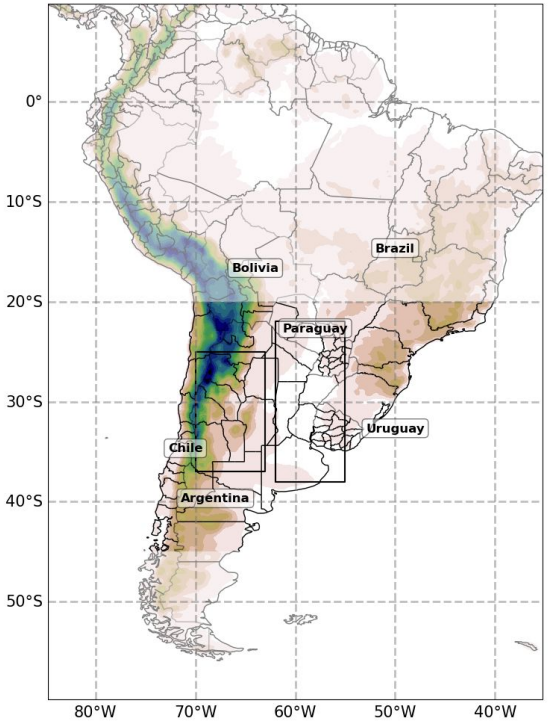
.UBA Universidad de Buenos Aires

Introduction I

- Severe storms (SS) are a particular class of convective storms associated with hail, strong winds, and tornadoes. The subtropical region of South America is one of the areas in the world where these storms are most intense and frequent, mainly during spring and summer months (Zipser et al. 2006).

- These high-impact storms cause severe socioeconomic damage, making it crucial to study their behavior in response to climate change, in order to provide elements that support decision-making and the design of adaptation policies.

  In Mendoza, where viticulture is the main economic activity, hail damage can lead to a loss of up to 22% of profits.(Van den Bosch, 2022)



Subtropical South America

Motivation

1

SS cause major socioeconomic damage; therefore, we are interested in studying their behavior under Climate Change.

2

Reports of SS events are scarce due to the spatial distribution of meteorological stations.

3

Satellite information has limitations due to its spatial coverage and instrumental defects.

4

The development of a tool capable of estimating the occurrence of SS.

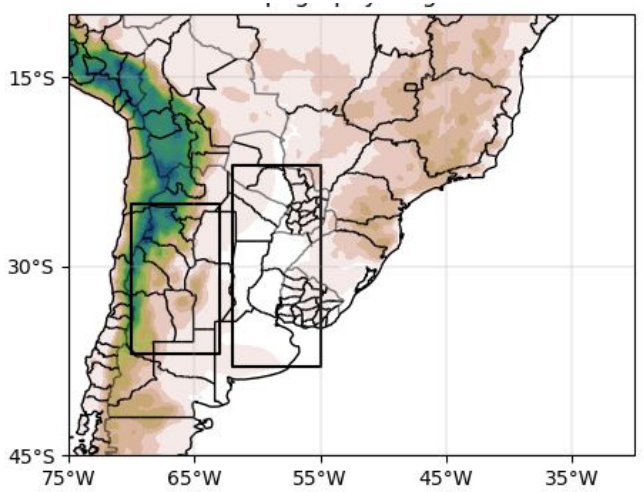
Introduction II

- One strategy to study the response of severe storms (SS) to climate change is the use of environmental indicators favorable to their occurrence, usually associated with CAPE and wind shear (Bruick et al. 2019; Allen 2018; Glazer 2021).

- It's of interest to represent the two main spots area of extremes events in our region

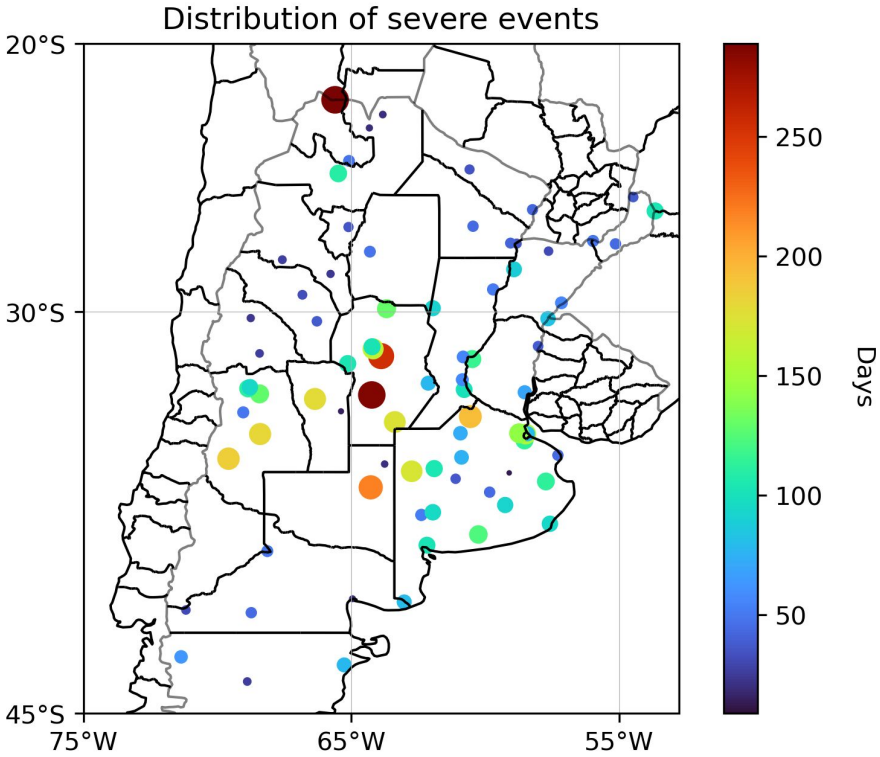
  East SSA

  West SSA

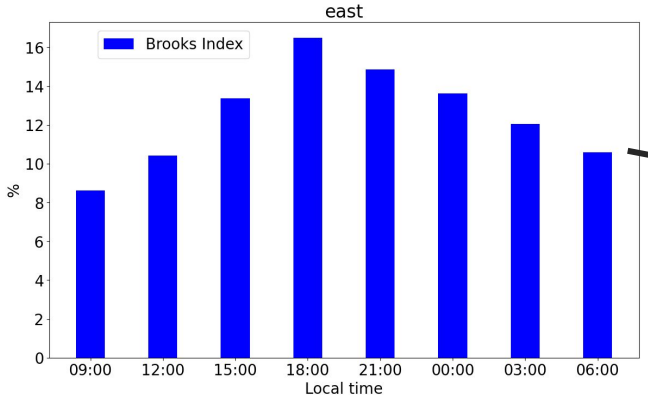


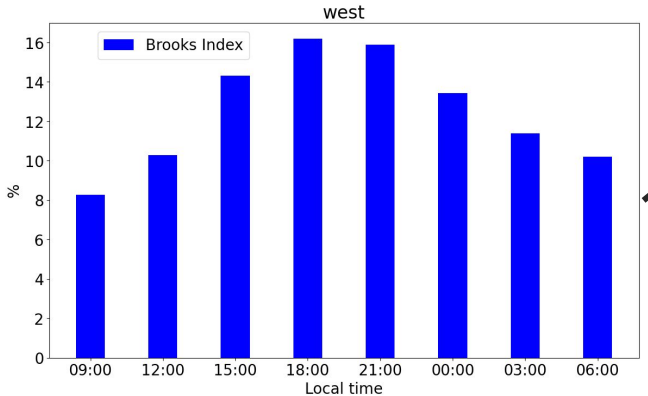
Introduction

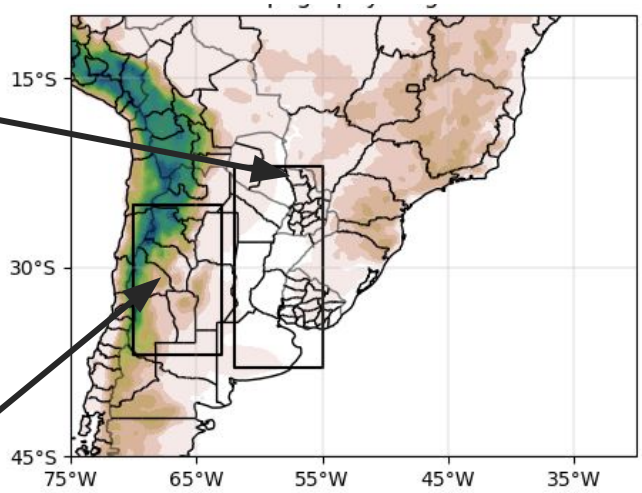
- Recompilation of SS Reports
- about 3000 SS reports
- Sample of non severe Storms
- Data from the environment: ERA 5 0.25x0.25, · hourly, 1990-2020



Severe Storm Index (Brooks, 2003)



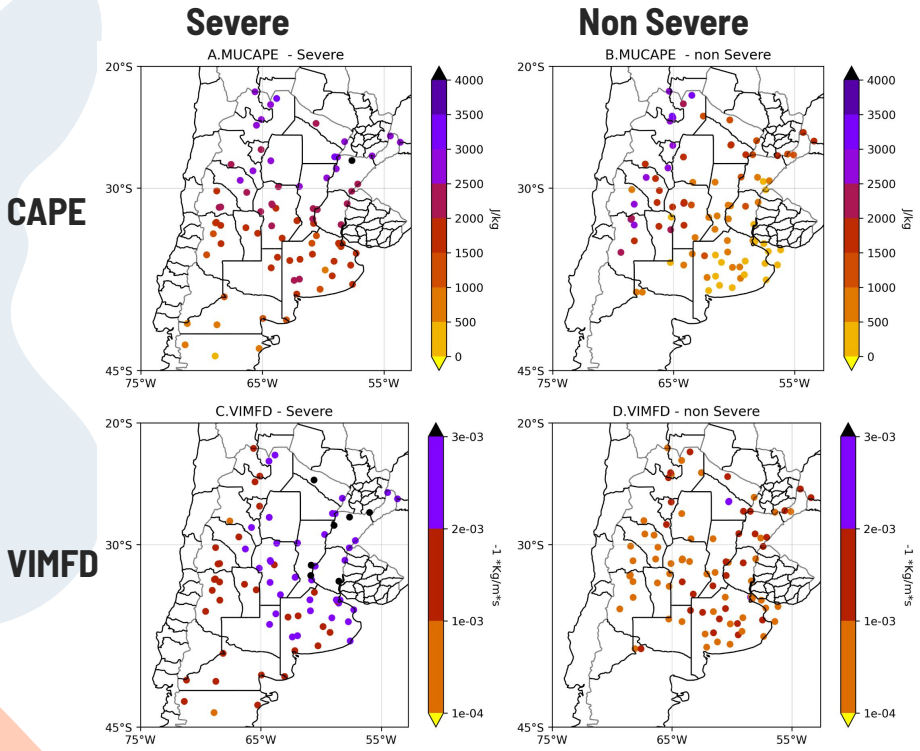




$$CAPE * S_{0-6}^{1.67} > \beta$$

Brooks et Al., 2003
Allen et Al, 2011
Glazer et Al, 2021

Index Construction



Add new Covariate

VIMFD: Vertically integrated moisture flux divergence

Ensure the best regional Representation

- To the east of Argentina, VIMFD prevails.
- To the west, CAPE prevails.

SASSE

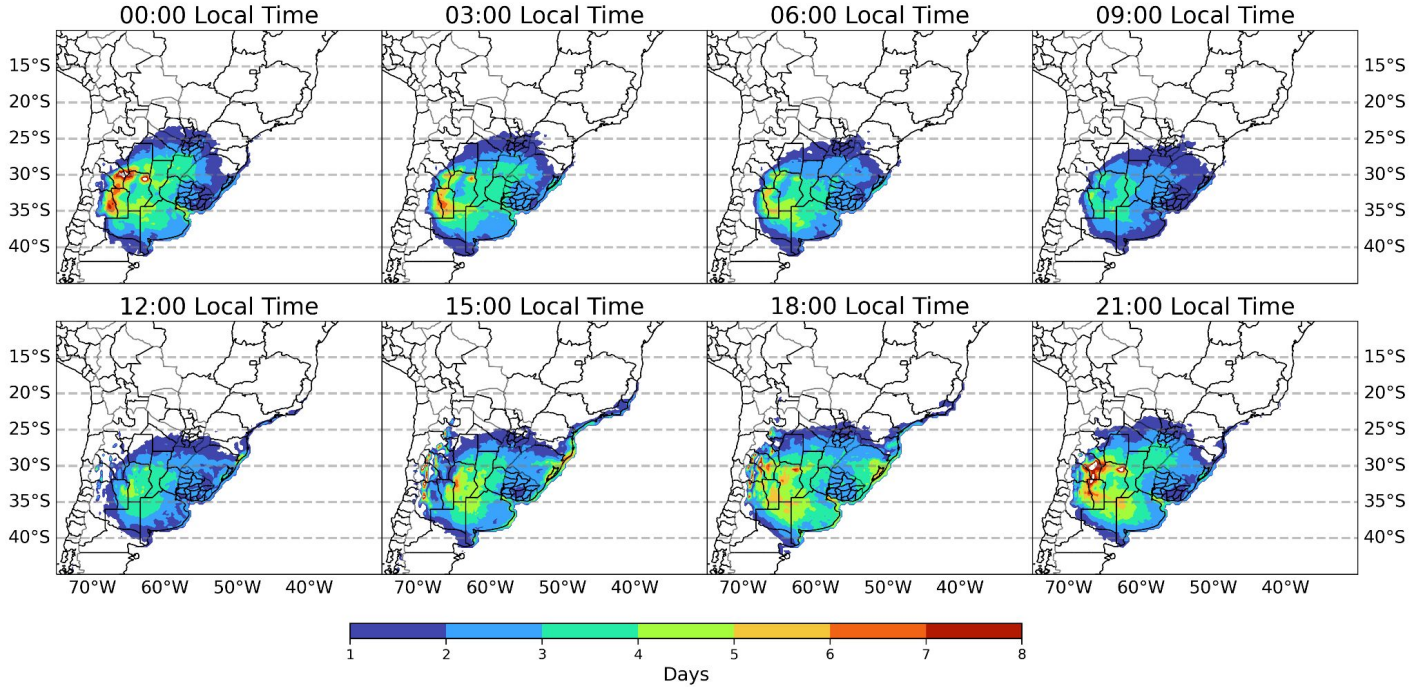
Subtropical **S**outh **A**merican **S**evere **I**ndex

$$1.6\log_{10}(MUCAPE) + 1.84\log_{10}(-VIMFD * 10^3) + 3.2\log_{10}(SHEAR) > 9$$

Linear discriminant analysis

Oruezabal, V. A., & Solman, S. A. (2025). Development of a Severe Storm Index Based on Environmental Conditions for Subtropical South America. Earth Systems and Environment. https://doi.org/10.1007/s41748-025-00686-z

SSASE: Summer (DJF)



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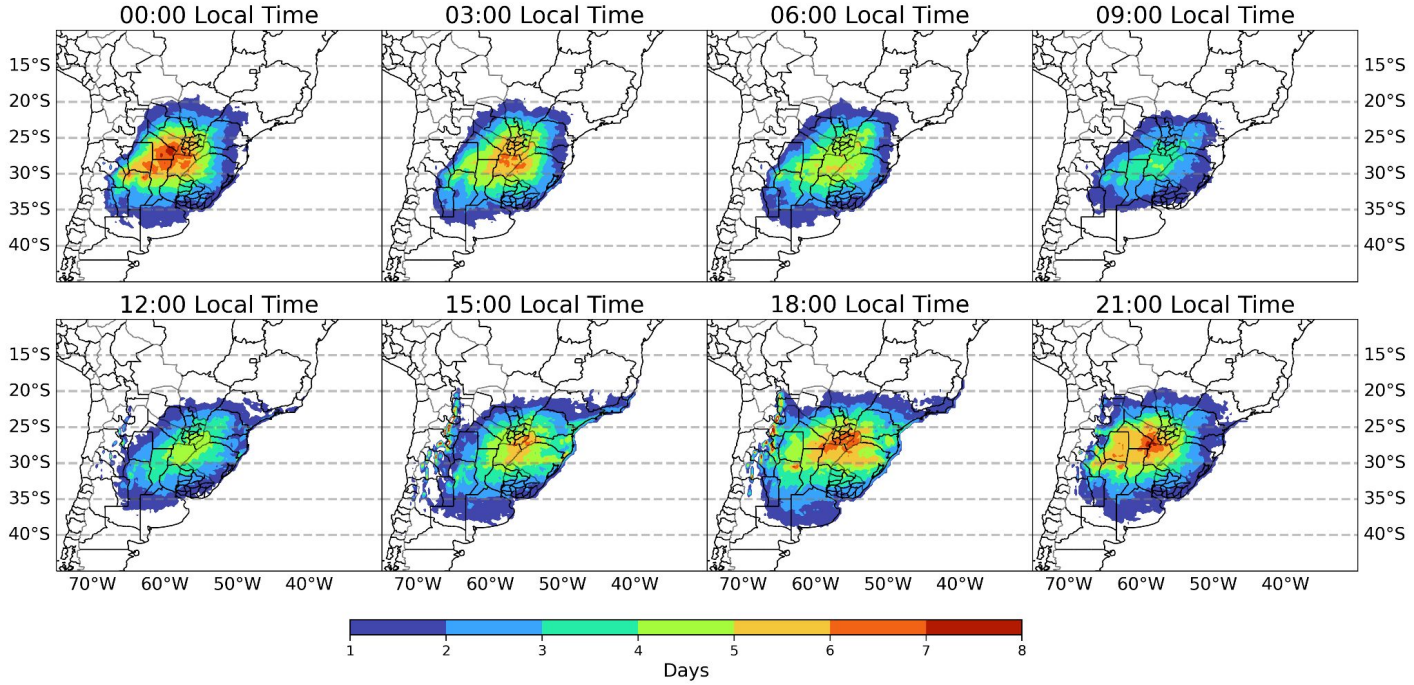
SSASE: Spring (SON)



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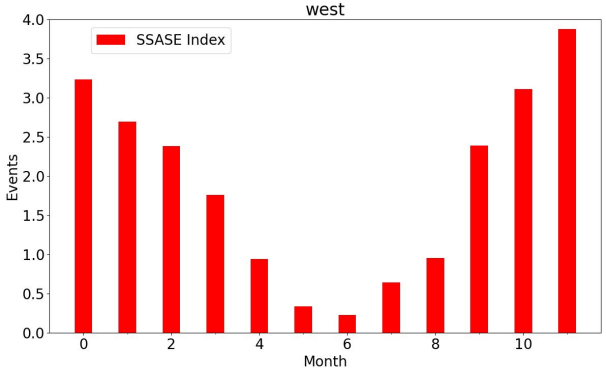
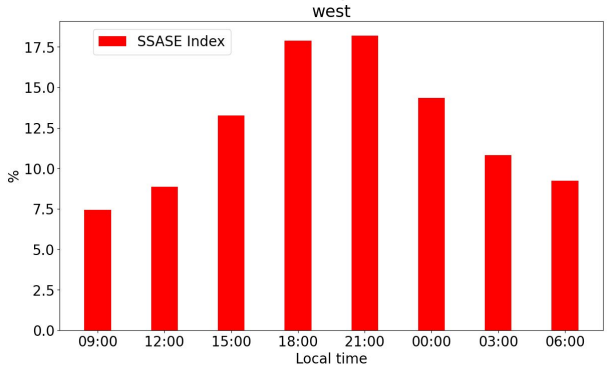
Diurnal and Annual Cycle

Annual

Daily

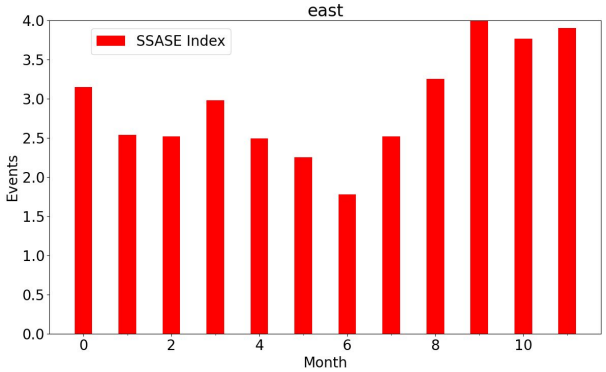
West

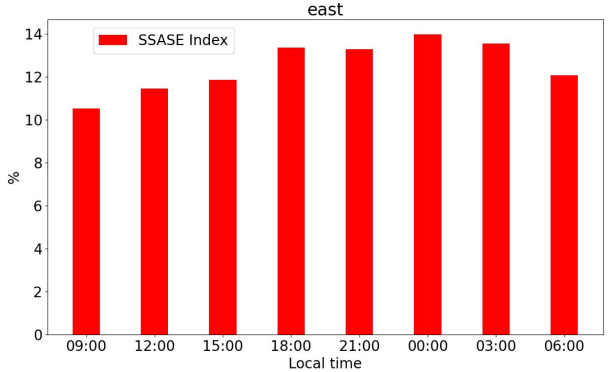




West Argentina has a peak in summer and through the afternoon

East





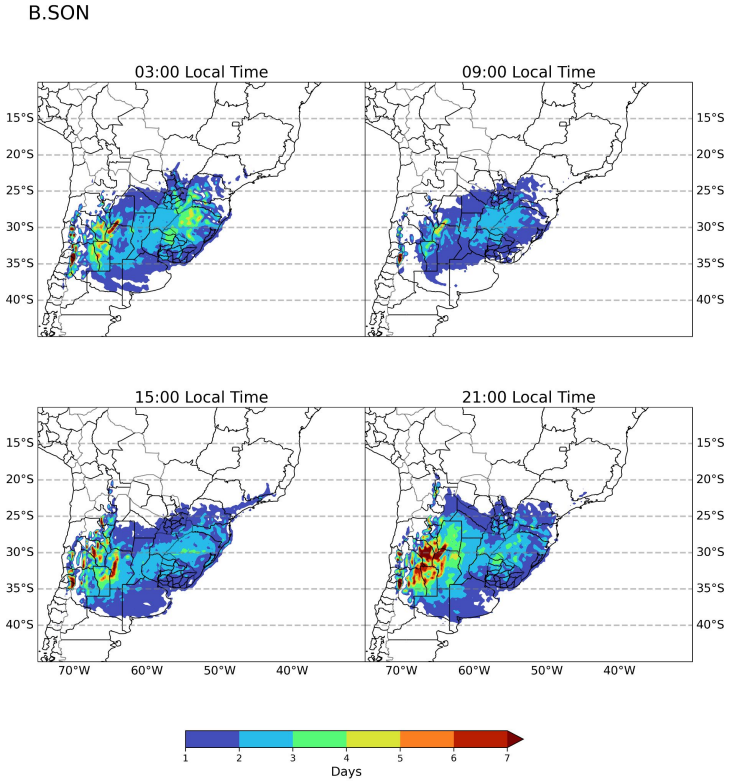
Eas Argentina has a peak in spring and through the night

Regional Model: Representation

Index Recalibration: Spring

Models Use

- -RegCM4.7(HadGEM)(ICTP)
- -RegCM4(HadGEM)(USP)
- -RegCM4.7(MPI)
- -RegCM4.7(NorESM1)

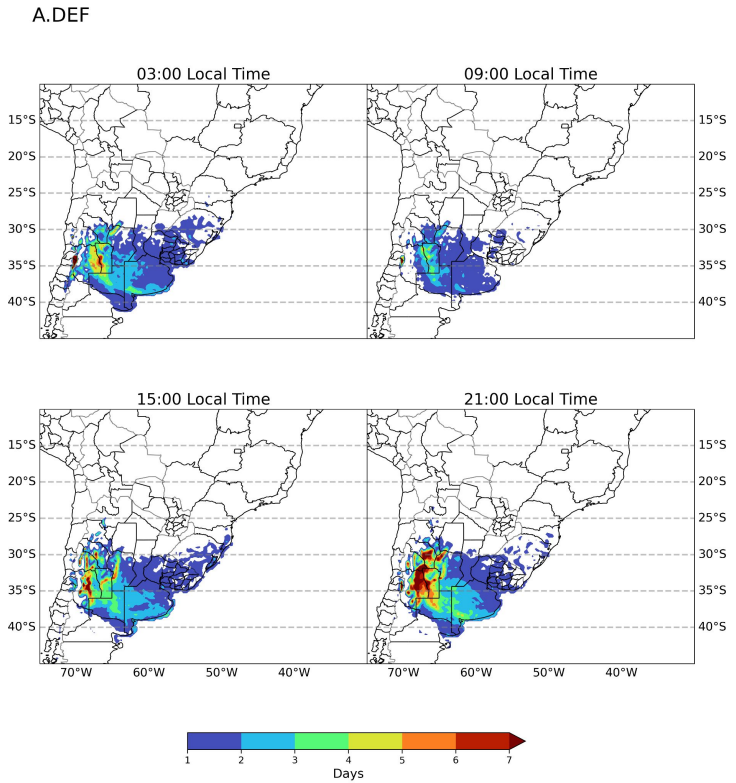


Index Recalibration: Summer

Calibration

Calculation of CAPE & VIMFD

with 8 Vertical levels



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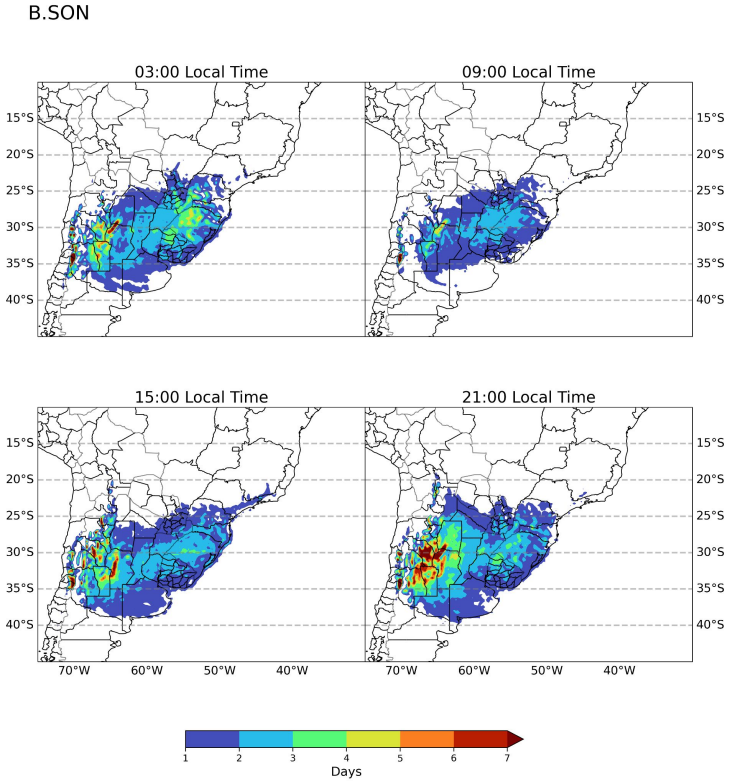
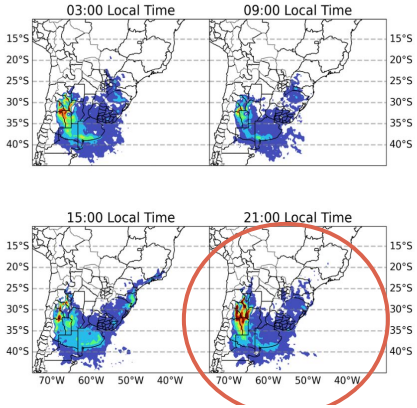
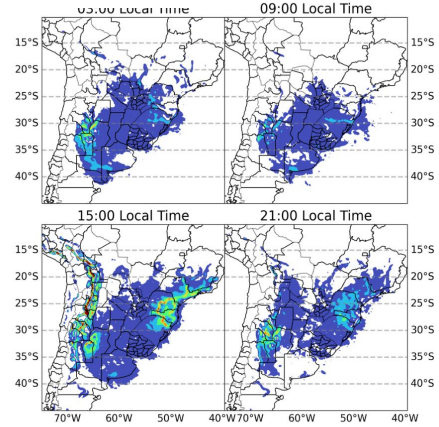


Summer representation

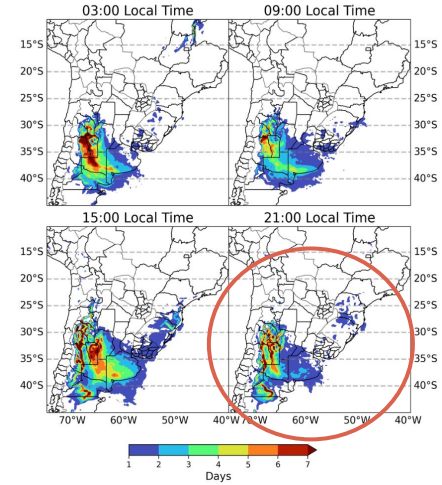
HadGEM-USP



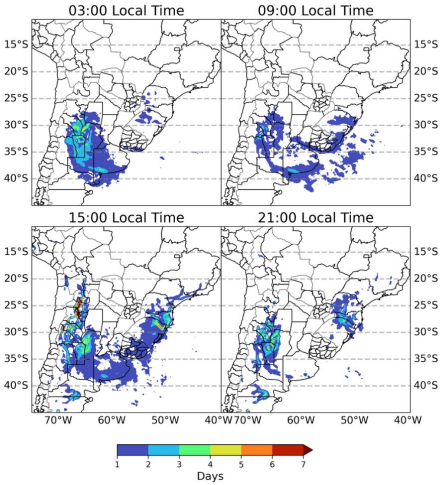
HadGEM-ICTP



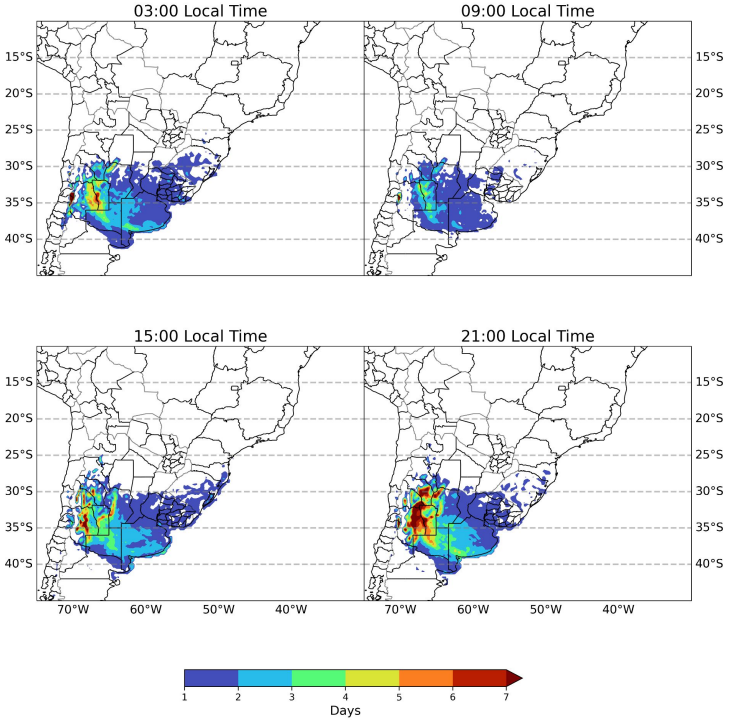
NorESM1



MPI

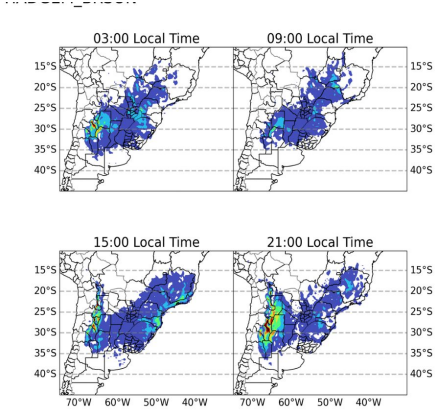


A.DEF

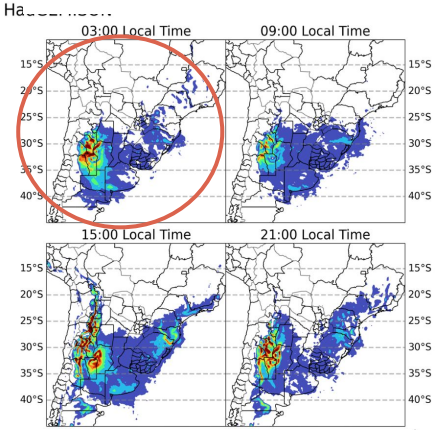


Spring representation

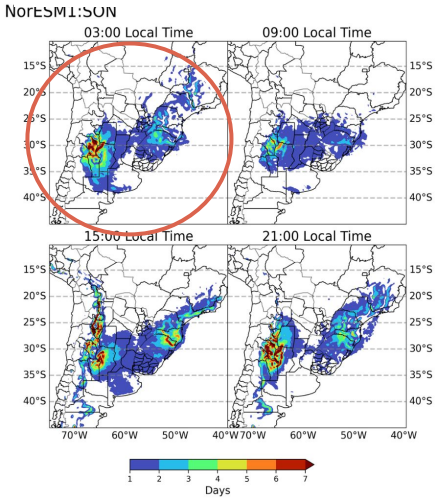
HadGEM-USP



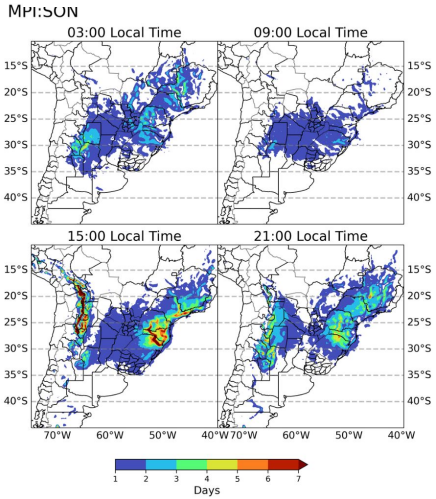
HadGEM-ICTP



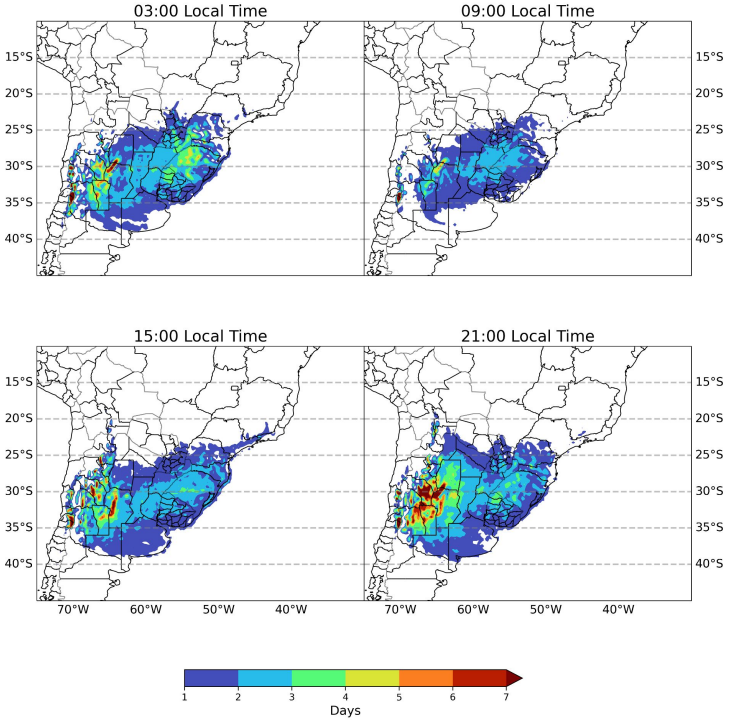
NorESM1



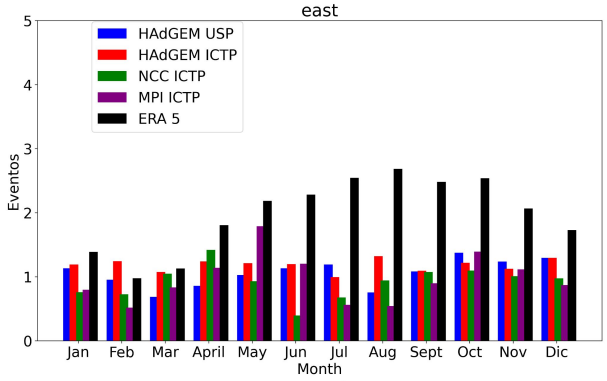
MPI

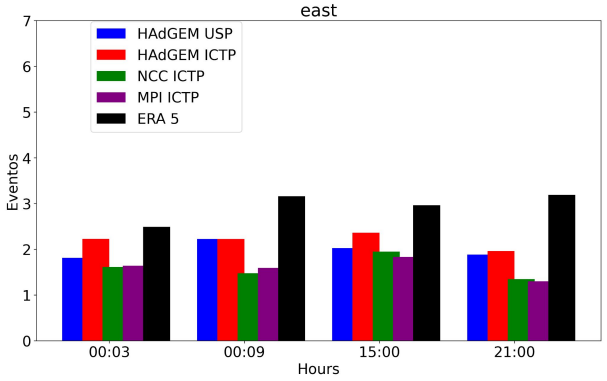


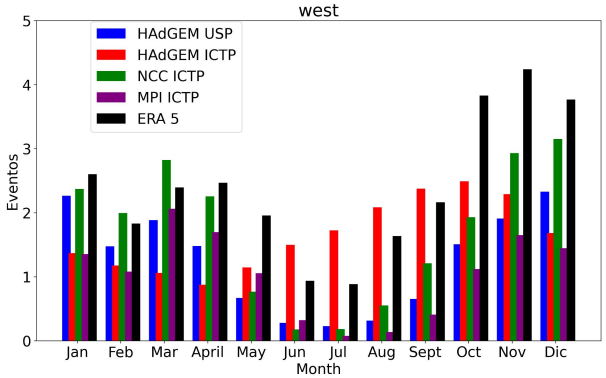
B.SON

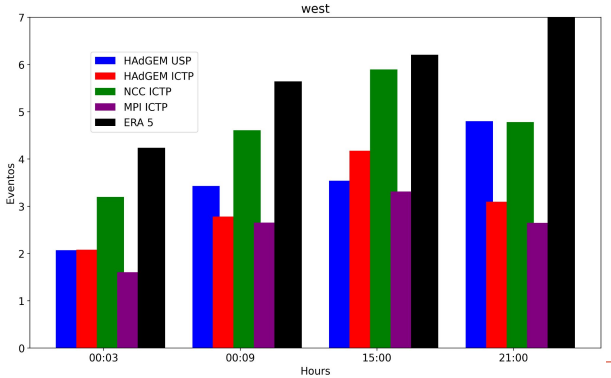


Annual and Diurnal Cycle



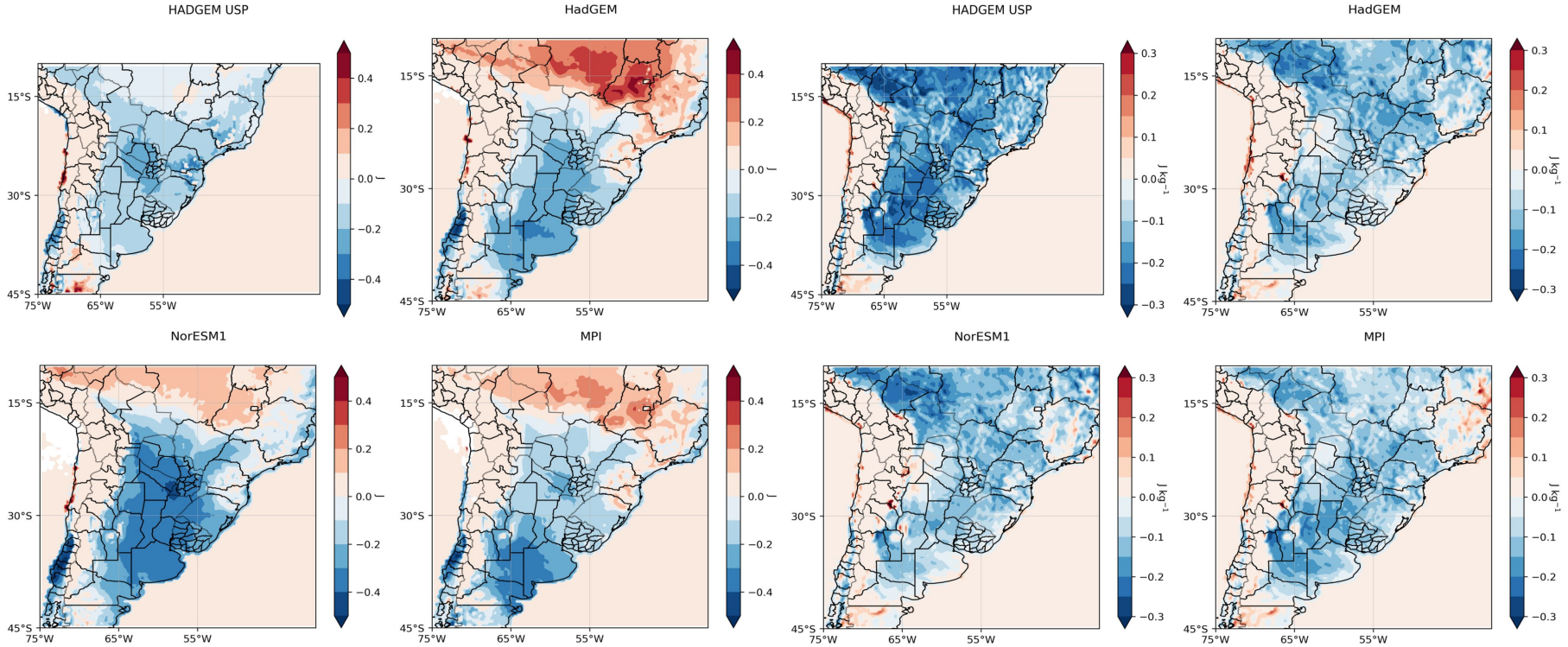






CAPE BIAS

VIMFD BIAS



Conclusions

- The index provides a reliable source of climatology
- The calibration for the model levels underestimates the climatology
- Regcm is a warmer and dryer model through all versions. Hadgem USP and NCC Shows better results
- Diurnal cycle is better represented than annual cycle
- Future work: Future projection and HighResMIP models

Thanks!

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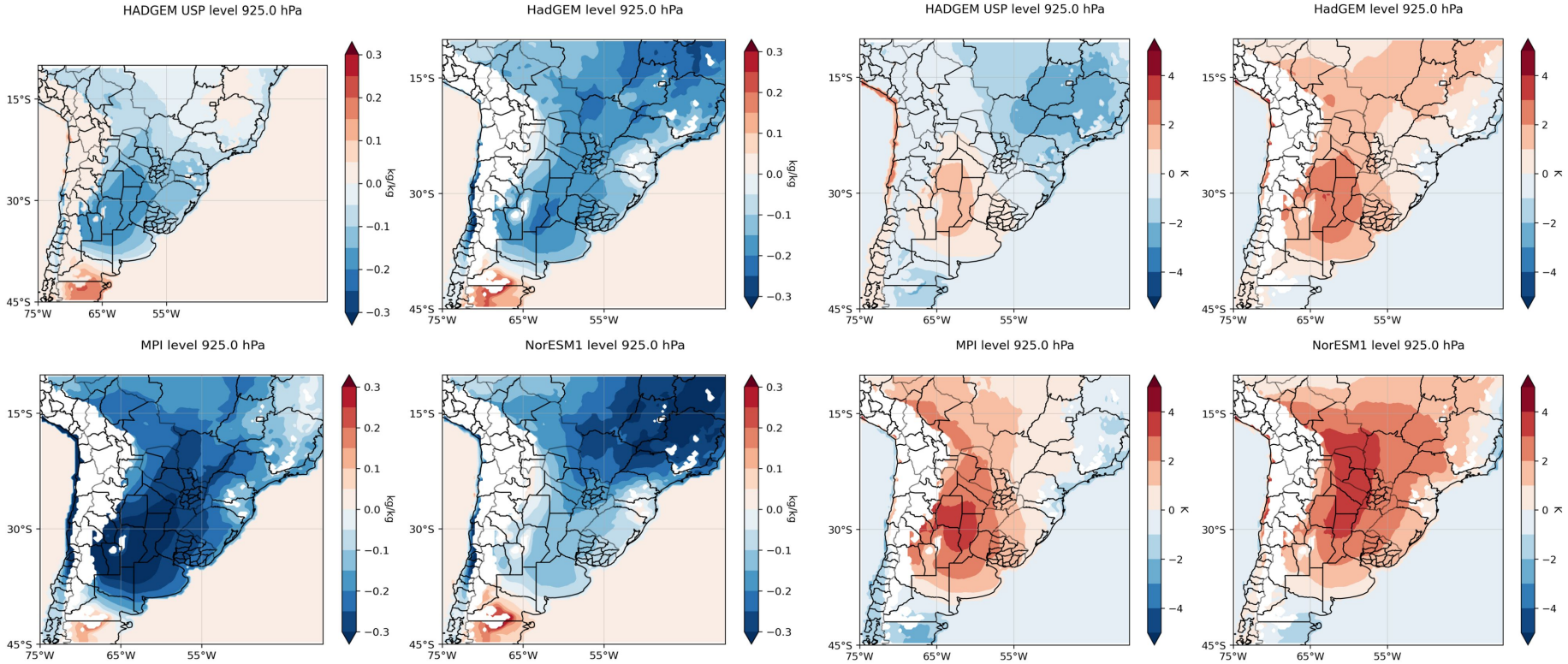
Specific Humidity / Temperature Bias



Specific Humidity / Temperature Bias