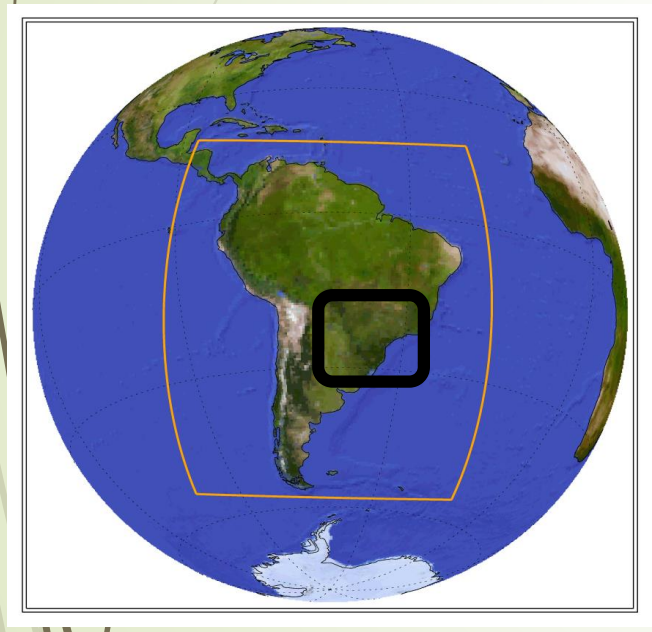
The CORDEX-FPS in Southeastern South America: a comparative study of statistical and dynamical downscaling models in simulating daily extreme precipitation events

Bettolli ML, Solman S, da Rocha RP, Gutiérrez JM, Llopart M, Fernández J, Lavín-Gullón A, Coppola E, Chou S, Doyle M, Feijoo M, Huth R, Barreiro M, Olmo M, Vianna Cuadra S, Machado L, Farneti R, Carneiro Rodrigues D

CORDEX-ICRC, Beijing 14-18 October 2019

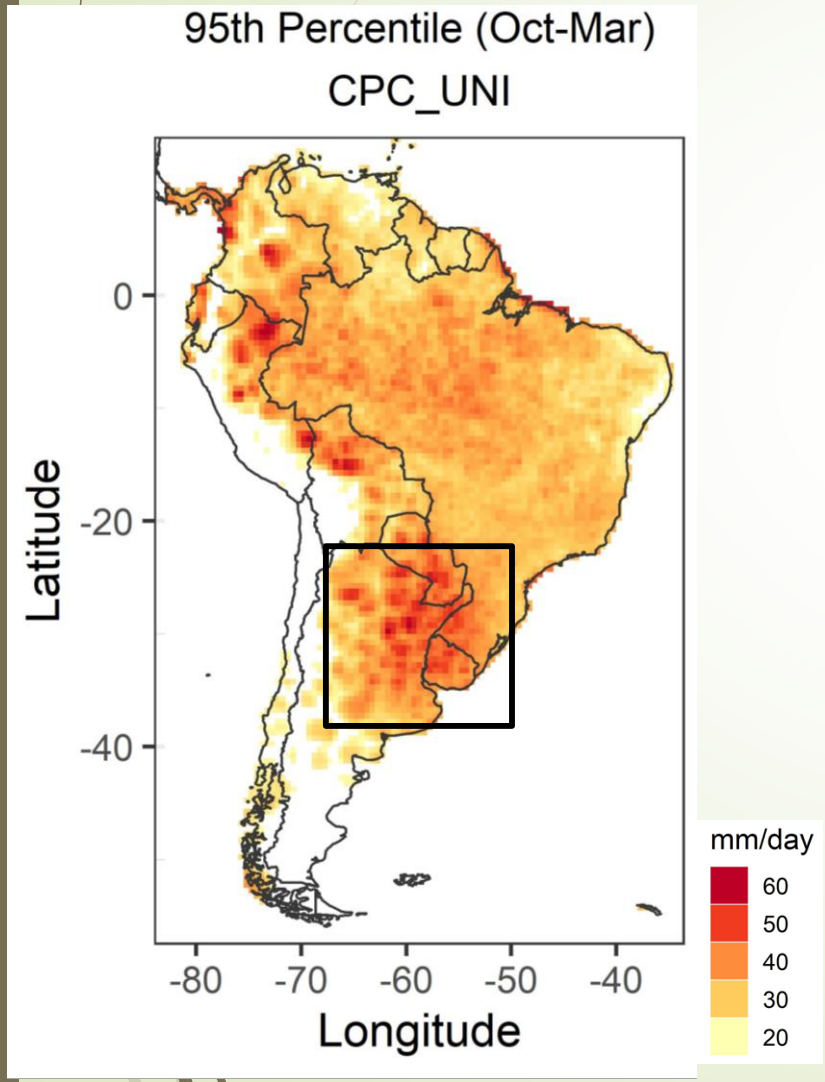
The FPS in SESA



SOUTHEASTERN SOUTH AMERICA (SESA)

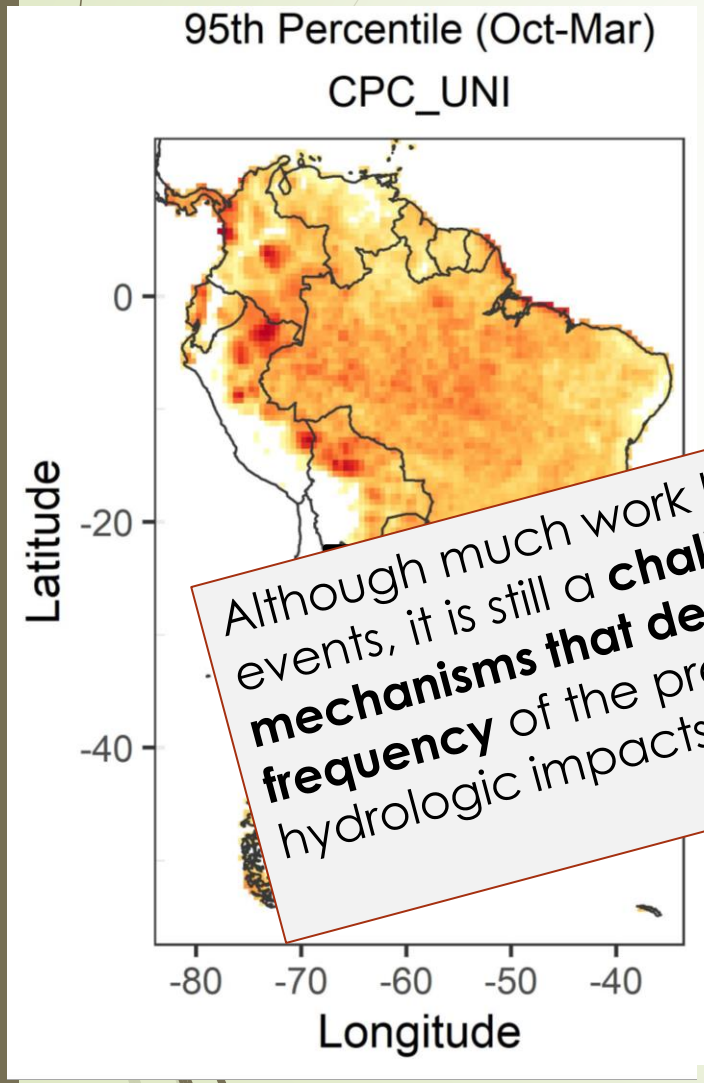
- Motivation
- Objectives
- Strategies
- Challenges
- Impact on regional networks
- Future steps.

Motivation



- In SESA, extreme precipitation events are:
  - **typical** features.
  - becoming **more frequent** and **more intense.**
- They have large **socio-economic** and **hydrologic impacts**.
- There are **limited ESD studies** in the region.
- There is a need for developing **RCM and ESD coordinated actions**.

Motivation



- In SESA, extreme precipitation events are:
  - **typical** features.
  - becomi… and
  …mic
  …dies in the
  …here is a need for developing **RCM and ESD coordinated actions**.

Although much work has been done to understand these events, it is still a **challenge to better identify the factors and mechanisms that determine the location, intensity and frequency** of the precipitation extremes and their large hydrologic impacts.

Objectives

- to **study multi-scale processes and interactions** that result in extreme precipitation events;
- to develop **actionable climate information from statistical and dynamical downscaling** based on co-production with the impact and user community

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Contributors

- **ARGENTINA**

DCAO-University of Buenos Aires

CIMA-CONICET

Argentine National Weather Service (SMN)

- **BRAZIL**

University of São Paulo (USP)

São Paulo State University (UNESP)

Center for Weather Forecasting and Climate Studies (CPTEC)

National Institute for Space Research (INPE)

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- **CZECH REPUBLIC**

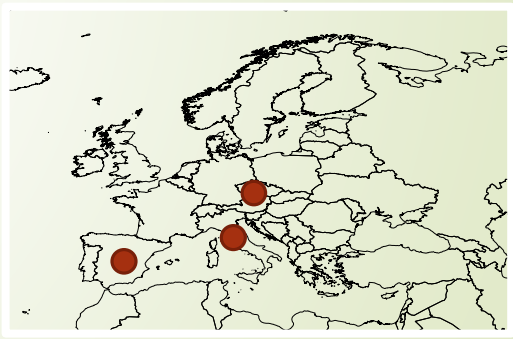
Charles University in Prague

- **SPAIN**

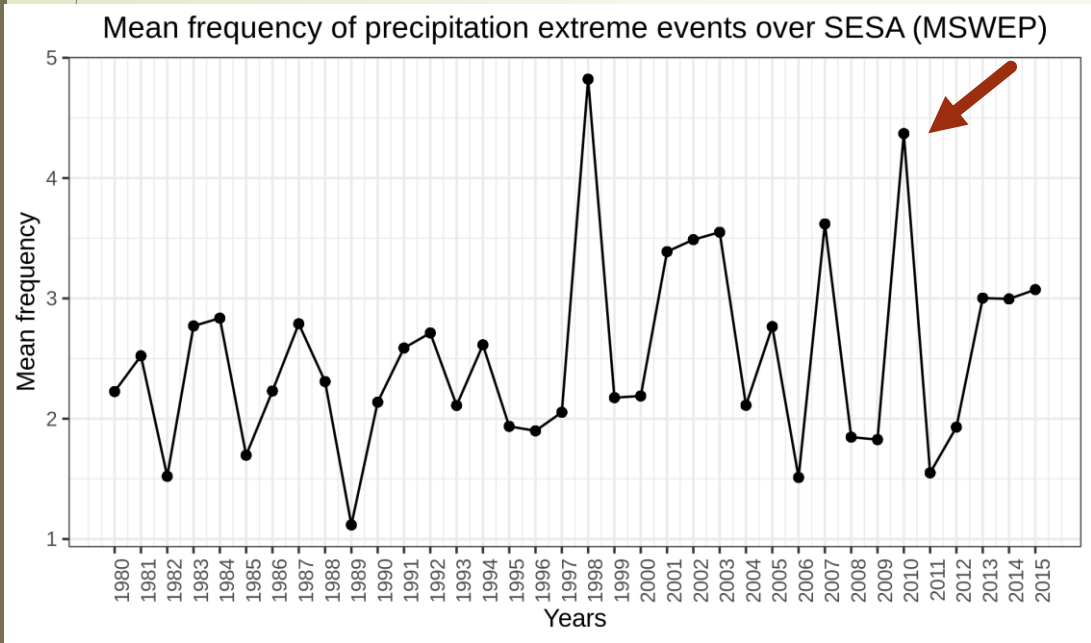
CSIC / University of Cantabria

- **ITALY**

Abdus Salam International Centre for Theoretical Physics (ICTP)

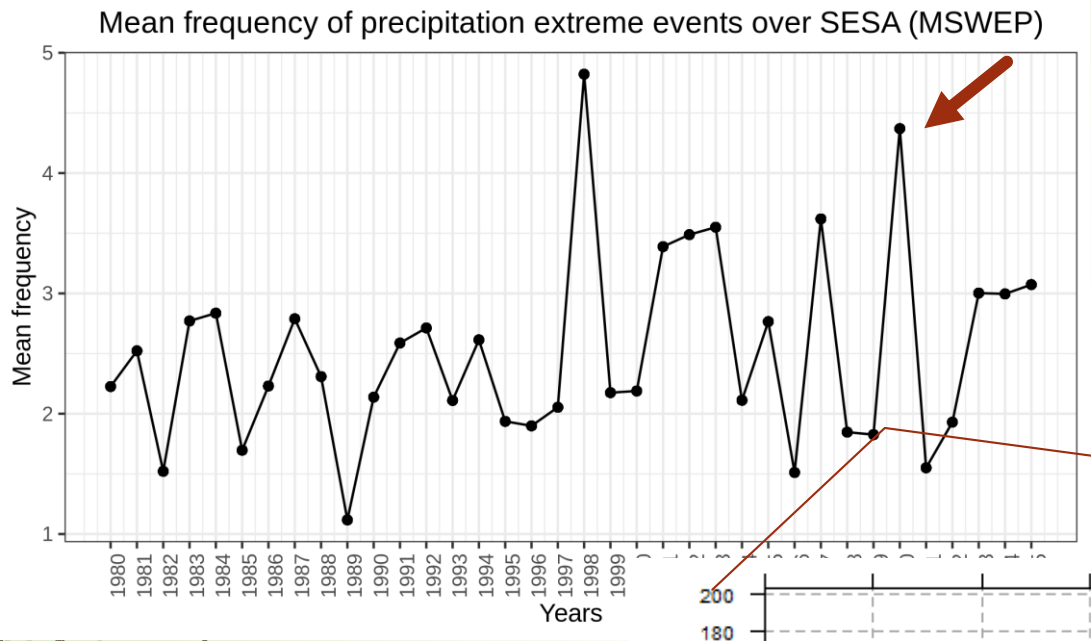


Strategy and experimental design



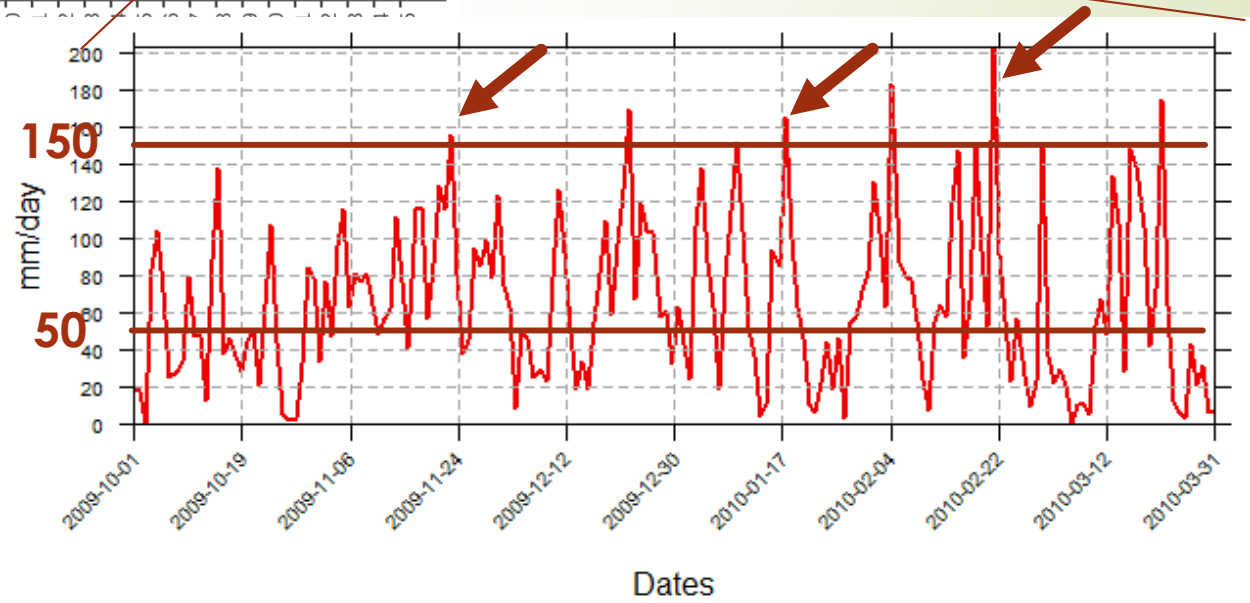
- High number of extreme events during **2009-2010 warm season** (October to March).
- **Three case studies** within that season were selected.

Strategy and experimental design



- High number of extreme events during **2009-2010 warm season** (October to March).
- **Three case studies** within that season were selected.

Maximum Daily Precipitation in SESA Station Data
2009-10 Warm Season Selected



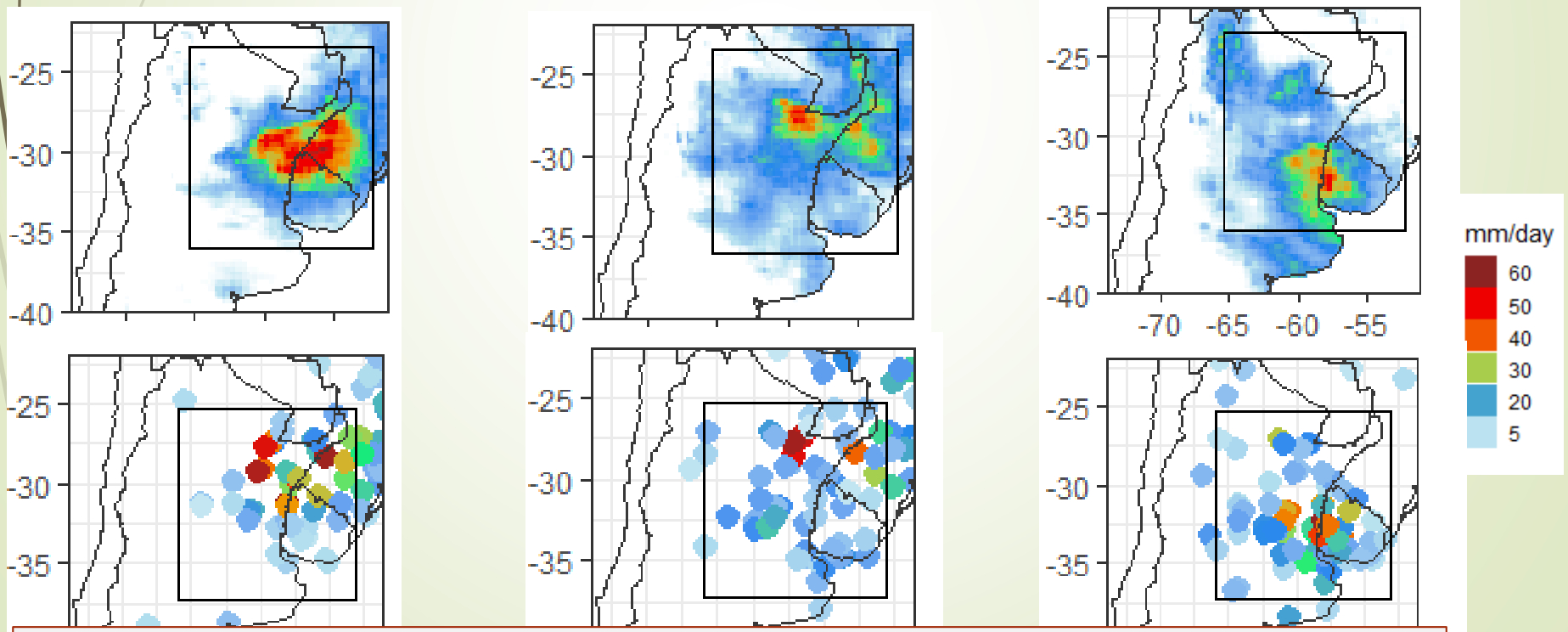
Strategy and experimental design

- **Case 1**
  3-day event: 2009-11-21 to 23
  event peak: 22-11-2009
  station max: 155 mm/day
- **Case 2**
  3-day event: 2010-01-18 to 20
  event peak: 19-01-2010
  station max: 165.4 mm/day
- **Case 3**
  3-day event: 2010-02-19 to 21
  event peak: 20-02-2010
  station max: 150 mm/day

3-day accumulated precipitation (mm/day)

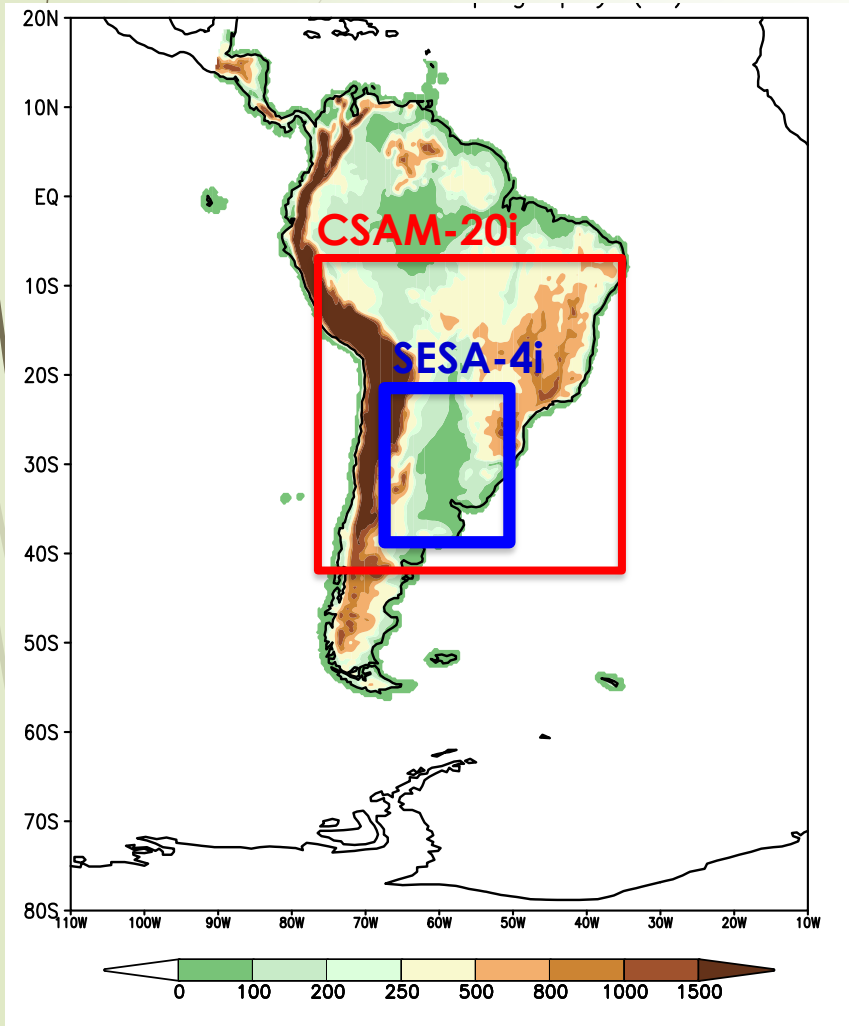
MSWEP

Station Data



The events selected have different **areal extensions and locations**

Strategy and experimental design



RCM Simulations

- **Two simulation types:**

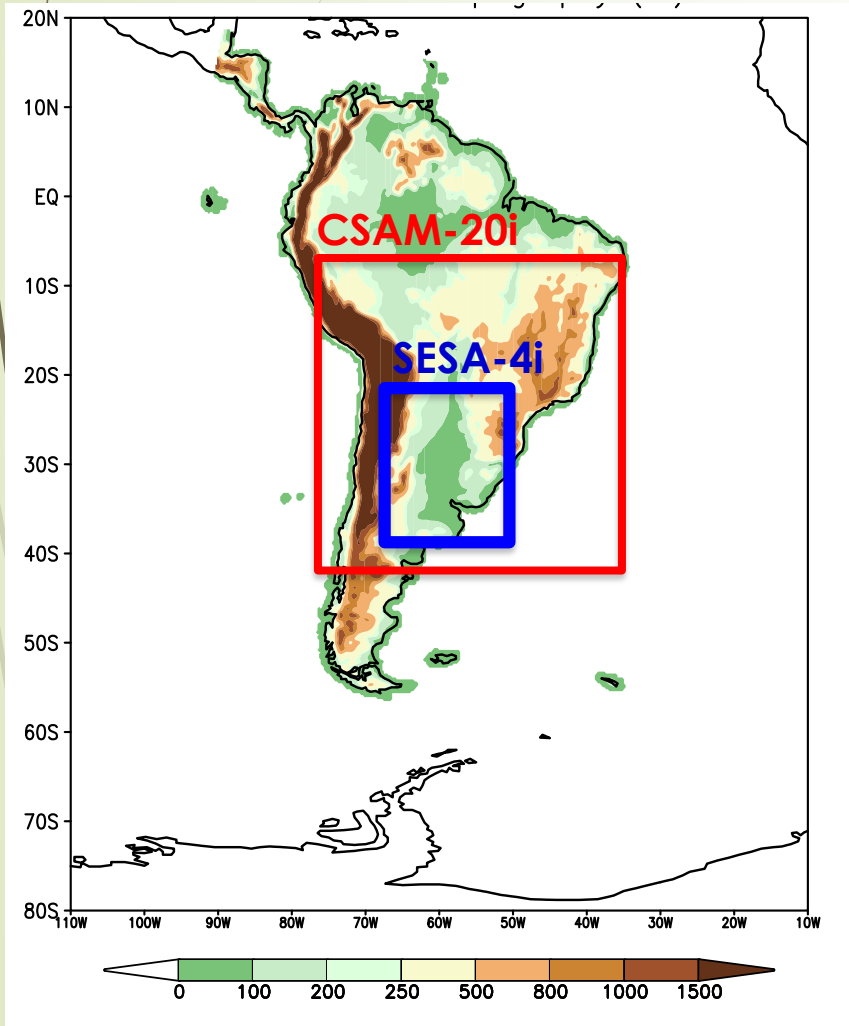
Weather like mode (WL): simulation starts ~12 hours before initial phase of each one of three extreme events;

Climate mode (CM): continuous simulation (seasonal) starting at 01-10-2009 ending at 31-03-2010.

- **Two domains**:

~ **20** (CSAM-20i) and **4** (SESA-4i) km of grid spacing

Strategy and experimental design



RCM Simulations

- **Initial and boundary conditions:**

CSAM-20i experiments are nested in ERA-Interim reanalysis;

SESA-4i experiments are nested in CSAMi-20i;

- **Models**:

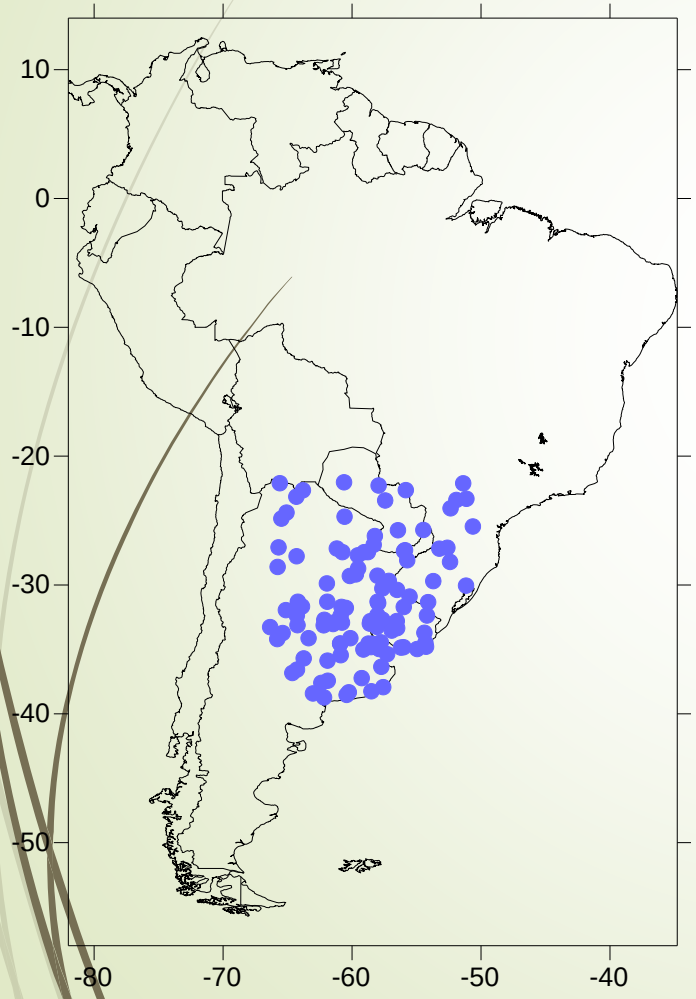
RegCM4 (USP-UNESP, Brazil)

WRF391 (CIMA, Argentina)

WRF381 (IFCA/UCAN, Spain)

ETA (INPE, Brazil)

Strategy and experimental design



ESD Simulations

- **Training and Test**

Training: 1979-2009

Test: 2009-2010

- **Predictors:**

ERA-Interim reanalysis

JRA reanalysis

- **Predictands**:

Station Data: daily Pr, Tx and Tn

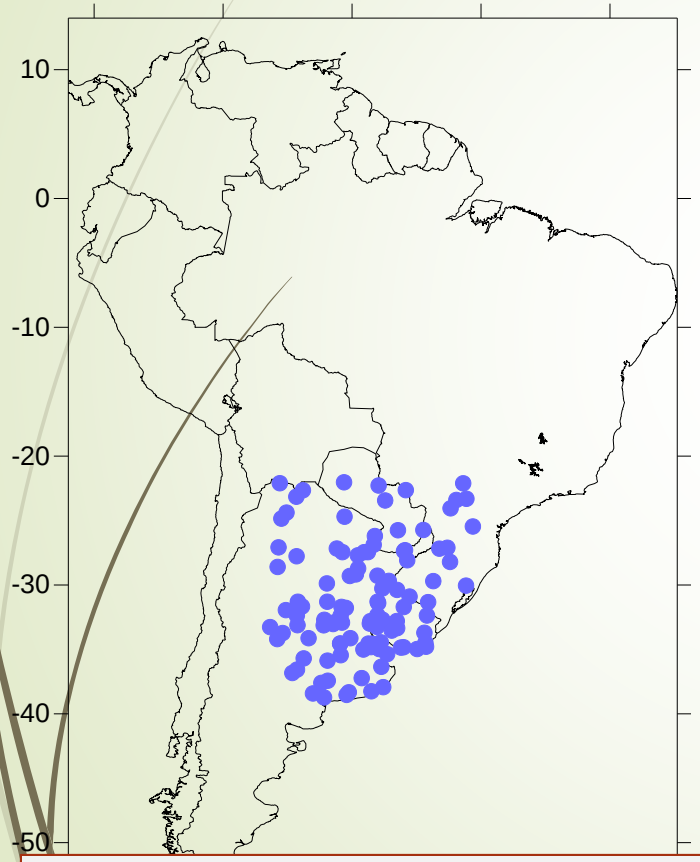
MSWEP: daily Pr

- **Models:**

GLM (4)

Analogs (3)

Strategy and experimental design



ESD Simulations

- **Training and Test**

Training: 1979-2009

Test: 2009-2010

- **Predictors:**

ERA-Interim reanalysis

JRA reanalysis

- **Predictands**:

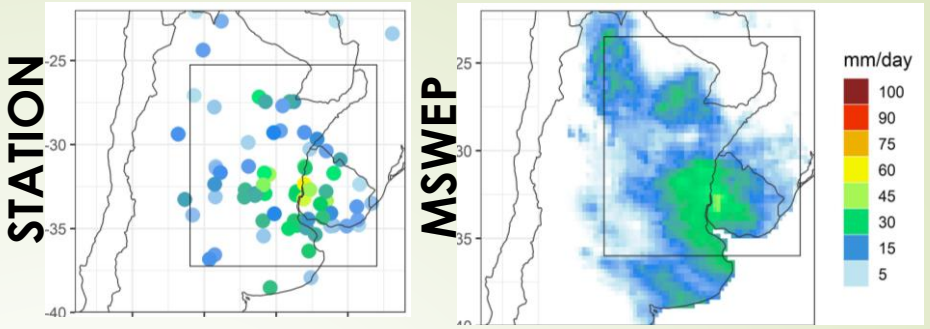
Station Data: daily Pr, Tx and Tn

MSWEP: daily Pr

- **Models:**

The ESD experiment was designed with the aim of **comparing the results with the RCM simulations** and **exploring the performance** of ESD in the region with focus on extreme events.

Case: 2010/02



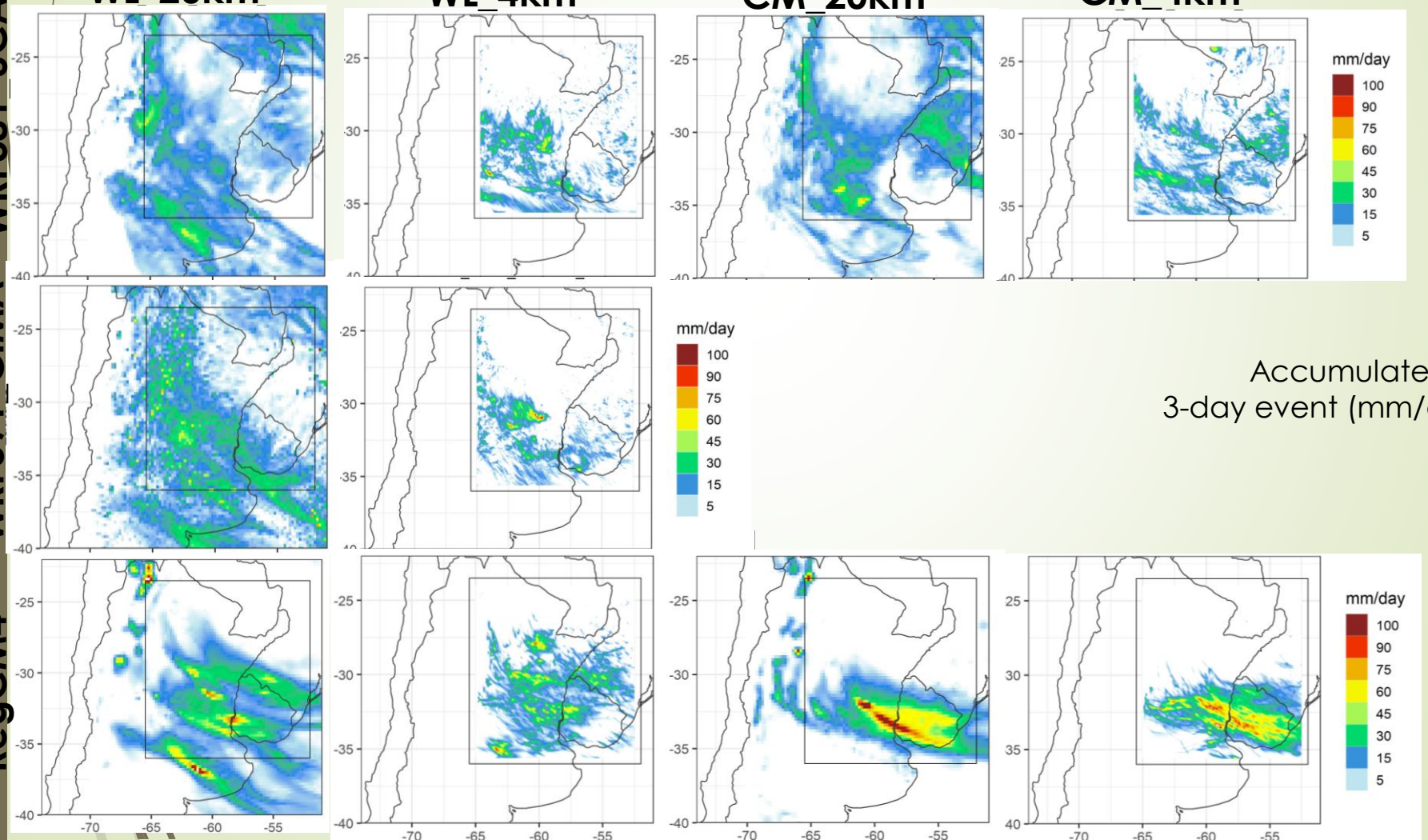
RCM

WL_20km | WL_4km | CM_20km | CM_4km

WRF381_UCAN

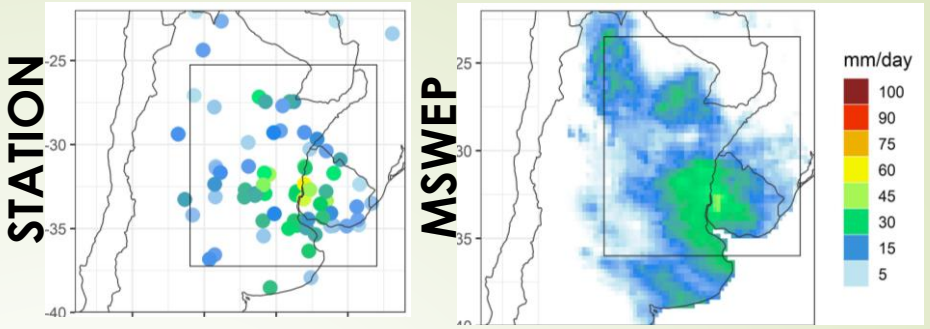
WRF391_CIMA

RegCM4



Accumulated Pr
3-day event (mm/day)

Case: 2010/02



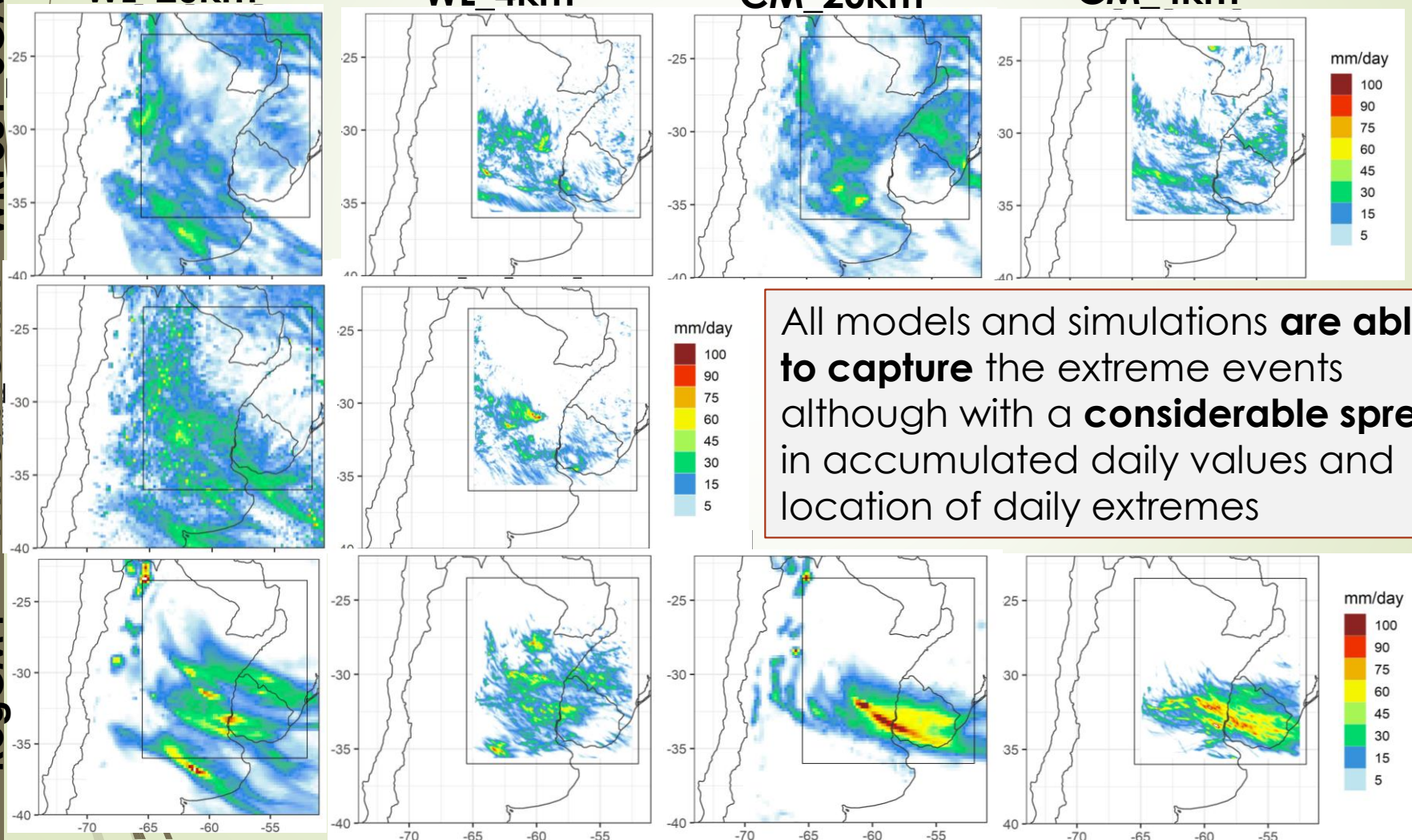
RCM

WL_20km | WL_4km | CM_20km | CM_4km

WRF381_UCAN

WRF391_CIMA

RegCM4



All models and simulations **are able to capture** the extreme events although with a **considerable spread** in accumulated daily values and location of daily extremes

Case: 2010/02

ESD.Station Data

ESD.MSWEP

ESD

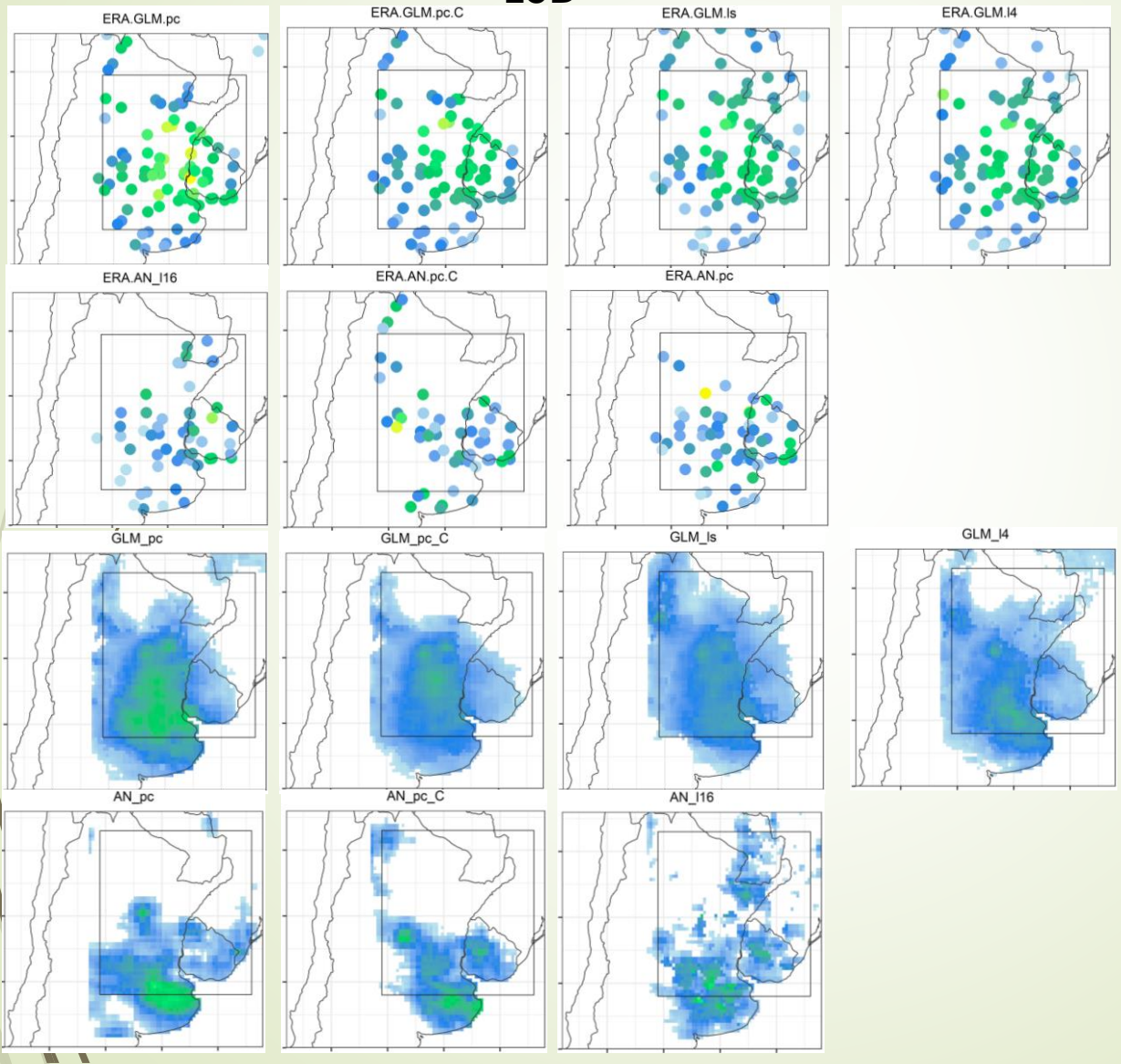
OBS

GLM

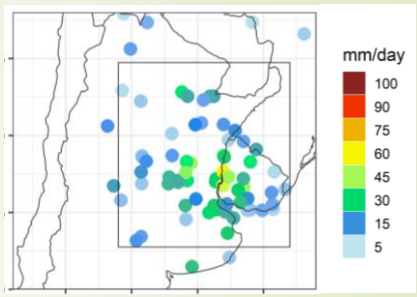
ANALOGS

GLM

ANALOGS

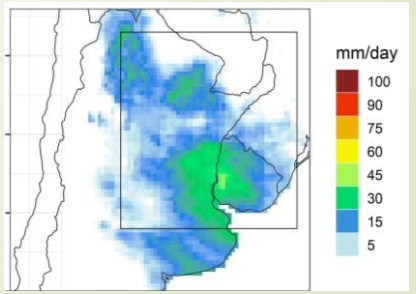


STATION



Accumulated Pr
3-day event (mm/day)

MSWEP



Objectives

- to **study multi-scale processes and interactions** that result in extreme precipitation events;
- to develop **actionable climate information from statistical and dynamical downscaling** based on co-production with the impact and user community

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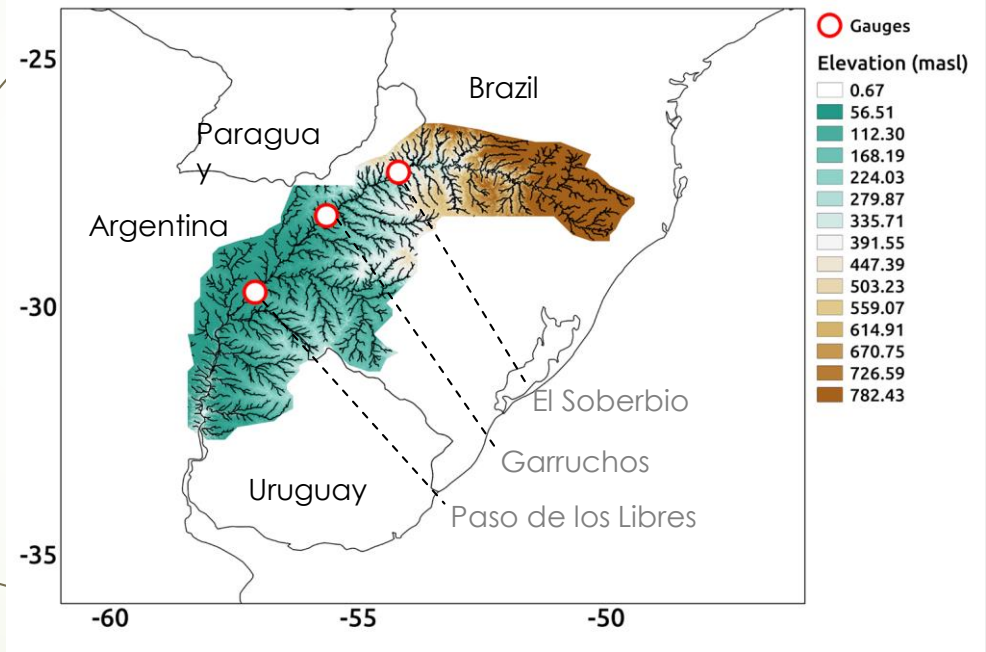
Actionable Climate Information

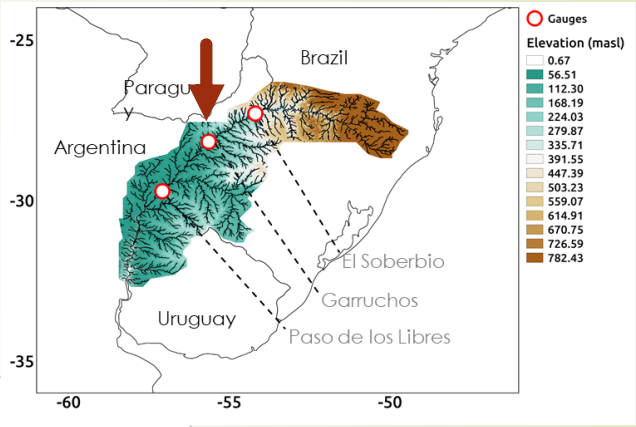
Uruguay River Basin



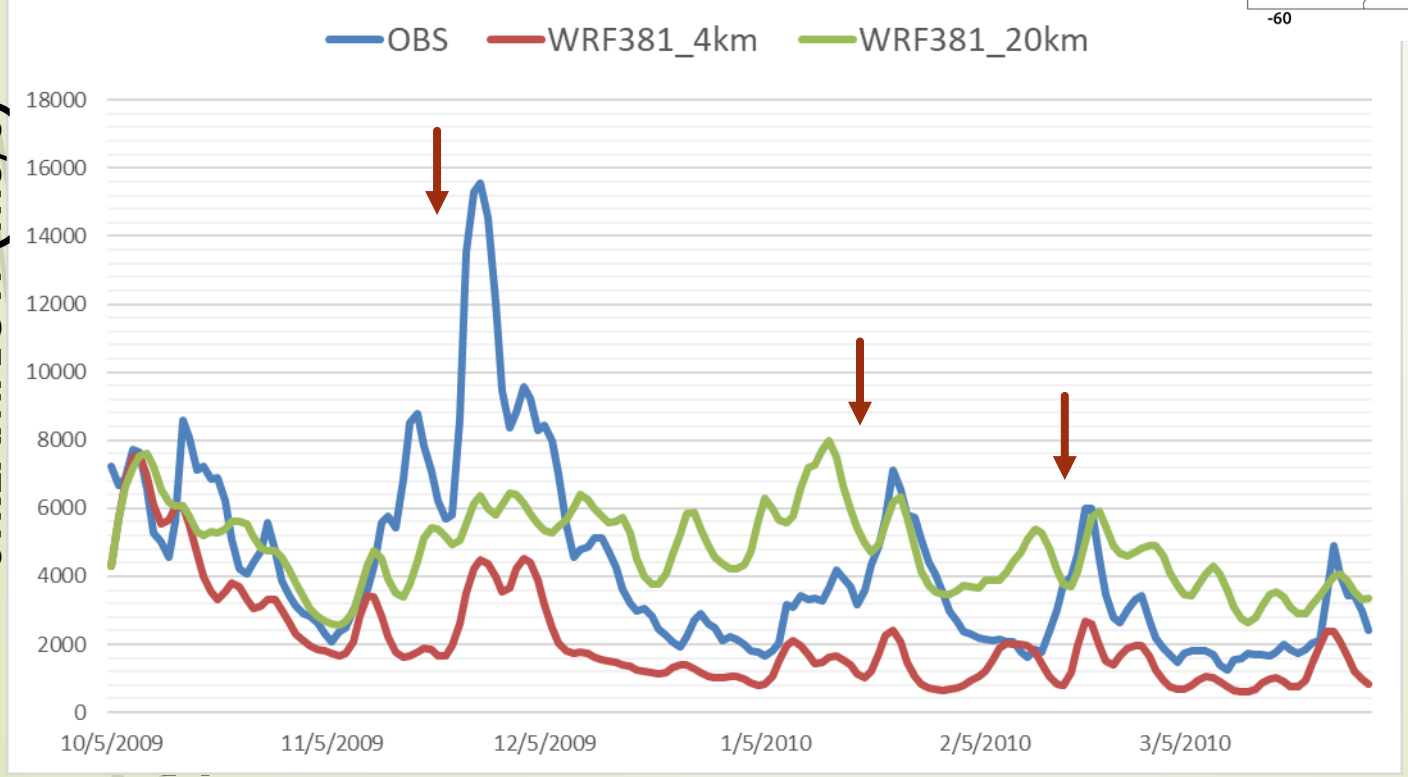
- Length ~ 1800 km
- Basin area ~ 365000 km^2
- Ave Discharge Paso de los Libres ~ 3000 m^3/s

Hydrological Model: VIC Variable Infiltration Capacity
Argentine National Weather Service-University of Buenos Aires

Actionable Climate Information



Garruchos



Challenges

- Financial Resources

  Low local financial support

  European financial support: visits and mobility

- Human Resources

  3 PhD students: 2 University of Buenos Aires
  1 Physics Institute of Cantabria

Impact on Regional Networks

- Enhanced regional networks
- Enhanced inter-institutional collaboration
- Data sharing
- Proposals submissions
- Capacity building activities
- CORDEX visibility

Future steps

- Finalize simulations and analysis of results
- Establish a protocol for ESD and RCM comparisons and validation framework
- Use of data in impact studies

Upcoming Activities

- ICTP Conference on Regional Climate Modeling and Extreme Events over South America: Results from the CORDEX-Flagship Pilot Study (SMR 3428): 17-19 November 2020, Buenos Aires, Argentina

Thanks!