6th Convective Permitting Modeling Workshop

A summary to PAIGH US National Section

Christopher L. Castro

Professor and Interim Head

Department of Hydrology and Atmospheric Sciences

University of Arizona

Geophysics Commission

ARIZONA

'Tom was beloved': Students, administrators remember UA professor killed in shooting

Jose R. Gonzalez
Arizona Republic

Published 9:54 a.m. MT Oct. 14, 2022 | **Updated 5:05 p.m. MT Oct. 14, 2022**

View Comments

7 Photos VIEW FULL GALLERY

Mourners come to pay condolences to the funeral of Thomas Meixner

Thomas Meixner, the head of the University of Arizona hydrology department, was shot and killed by a former student on Oct. 5.

What happened since October 5th

THE DAILY WILDCAT

DW NEWS SPORTS ARTS & LIFE OPINIONS SCIENCE CORONAVIRUS MULTIMEDIA PRINT EDIT

NEWS

'Oversight and response failure': UA faculty committee releases report on university safety

'SYSTEMIC ISSUES'

U. of Arizona Admits Failures Leading Up to Professor's Death

By Kate Hidalgo Bellows and Sarah Brown | MARCH 27, 2023

TERRY TANG, AP

A memorial for Thomas Meixner, a U. of Arizona professor killed on campus on October 5, 2022

GEWEX QUARTERLY

WCRP World Climate Research Programme

United Nations Educational, Scientific and Cultural Organization | Intergovernmental Oceanographic Commission

World Meteorological Organization | International Science Council

Vol. 32, No. 4 | Quarter 4 2022

GEWEX is a Core Project of the World Climate Research Programme on Global Energy and Water Exchanges

40 Years of the International Satellite Cloud Climatology Project

GEWEX

Convection-Permitting Modeling in South America and Beyond: A Summary of the 6th Convection-Permitting Modeling Workshop

Buenos Aires, Argentina
7–9 September 2022

Andreas F. Prein[1], Lluís Fita[2], Maria Laura Bettolli[3], and Roy Rasmussen[1]

[1]National Center for Atmospheric Research (NCAR), Boulder, CO, USA; [2]Centro de Investigaciones del Mar y la Atmósfera (CIMA), UBA-CONICET, CNRS IRL 3351 IFAECI, IRD, Buenos Aires, Argentina; [3]Departamento de Ciencias de la Atmósfera y los Océanos (DCAO), UBA-CONICET, CNRS IRL 3351 IFAECI, IRD, Buenos Aires, Argentina

In-person participants of the 6th CPM workshop

Workshop logistics and scope

- 70 in-person and 49 online participants from 19 countries
- Oral, poster sessions and panels
- Topics: advances in high resolution climate modeling, simulating extreme weather events, coordination of modeling efforts and connection to impact research. South American efforts emphasized
- Brought together members of ANDEX project, Coordinated Regional Climate Downscaling Experiment (CORDEX), a recent meteorological field campaign (RELAMPAGO – CACTI), and South American Affinity Group.
- Various sponsors, including National Center for Atmospheric Research, local universities within South America, and PAIGH.

Generating Climate change scenarios with high resolution modeling

- Direct downscaling of global or coarser-resolution regional models to kilometer scale, as applied in CORDEX and its Flagship Pilot Studies
  - Systematic improvement of extreme precipitation events with reduced uncertainty, larger increase in heat extremes

- Pseudo Global Warming (PGW) method: Historic atmospheric reanalysis data perturbed with climate change deltas derived from projections to generate future scenarios.
  - Computationally efficient
  - Biases from individual IPCC models do not affect the projection
  - Climate change attribution signal is clear.

Pseudoglobal warming approach to generate event storylines

- Storylines related to events such as tropical cyclones, derechos (straight-line winds), floods, extreme snowfall events
  - Emphasis on how these events would change if they would re-occur under future climate conditions or how historic climate change changed an event that occurred under present conditions.

- Improve understanding of process change in relation to climate change.

- Helpful in working with stakeholders who experienced a specific event and, therefore, can better relate with its changes in the future

Coupled high resolution modeling, to land surface or ocean

- Improving land surface model capabilities is an urgent need.
  - Lateral flow of shallow ground water must be represented in the Amazon for realistic climate simulation.
  - High rates of precipitation recycling in western Amazon related to the remote effects of deforestation
- Large benefits for simulating glaciers along the Andean Cordillera
- Accounting for human impact on water cycle highlighted as being critical.

Data Analysis and Sharing

- Large model domains, longer integrations, and larger ensembles with high resolution model require paradigm shift in how data is shared and analyzed
- Various platforms were presented, for example the Joint Analysis System Meeting Infrastructure Needs (JASMIN) system that allows researchers to perform analysis at the location of the data rather than download datasets to local servers
- Cloud storage and computing solutions mentioned as a future solution, but currently often prohibitive due to costs and inability to ensure long-term data access.

Data usability and impact

- World Meteorological Organization strategy for climate service delivery
  - Identify and engage users and understand their needs
  - Co-design service that fulfills their needs
  - Deliver the product
  - Evaluate and improve the products
- Developing relationship with users identified as worthwhile effort that takes years of continuous work
- Strategies of how to make high resolution modeling research more visible in in national and international climate assessments discussed
- Need strong focus on impacts, adaptation and vulnerability in next IPCC cycle, and this is where high resolution modeling is critically important.

Summary key message 1: Where the community is headed

- High resolution modeling community continuing to increase capabilities: domain size complexity, integration lengths.

- We've made the transition from a purely research focus to generating information that is valuable to impact researchers and stakeholders

- Building connections and collaborations with users has been highlighted as important to ensure usability of high resolution model output, but these relationships take time.

Summary key message 2: Earth-system thinking

- Coupling atmospheric models generally with other earth system components
- Advancing capabilities of existing components, such as convection and cloud schemes
- Land processes in South America are critically important to reduce biases, for example lateral groundwater flow and vegetation
- Additional of human impact on water cycle highlighted as urgent research need

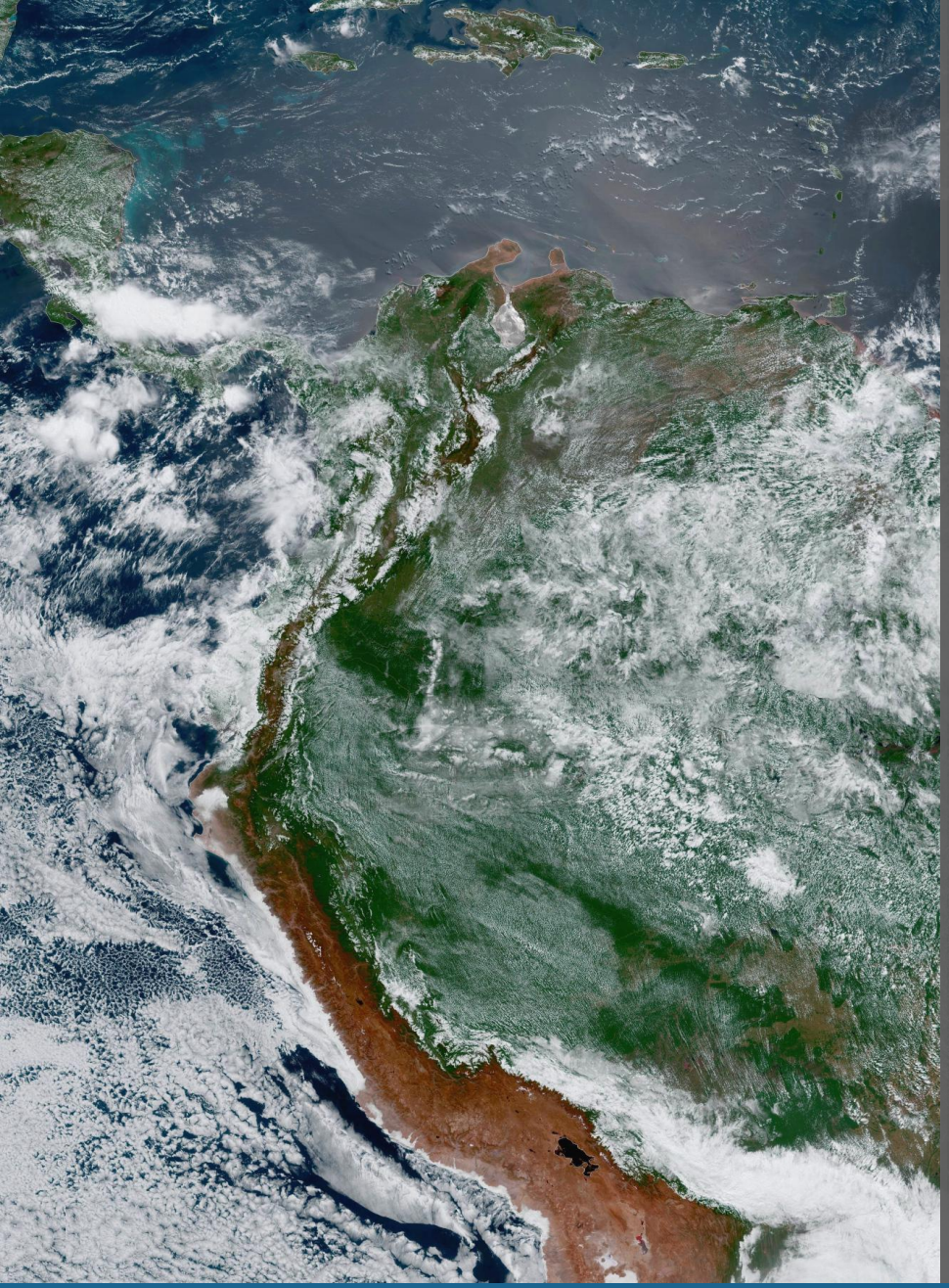
Summary key message 3: Variety of techniques to produce high resolution projections, no ‘right’ answer

- Direct dynamical downscaling
- Pseudoglobal warming
- Storylines

Each approaches have benefits and shortcomings. Research needed to intercompare these mehods

Summary key message 4: Data accessibility and equality

- Increasing data volume creases inequalities in data accessibility
- Particular problem in the Global South
- Initiatives have started to reduce inequalities by allowing researchers to analyze data at storage locations.



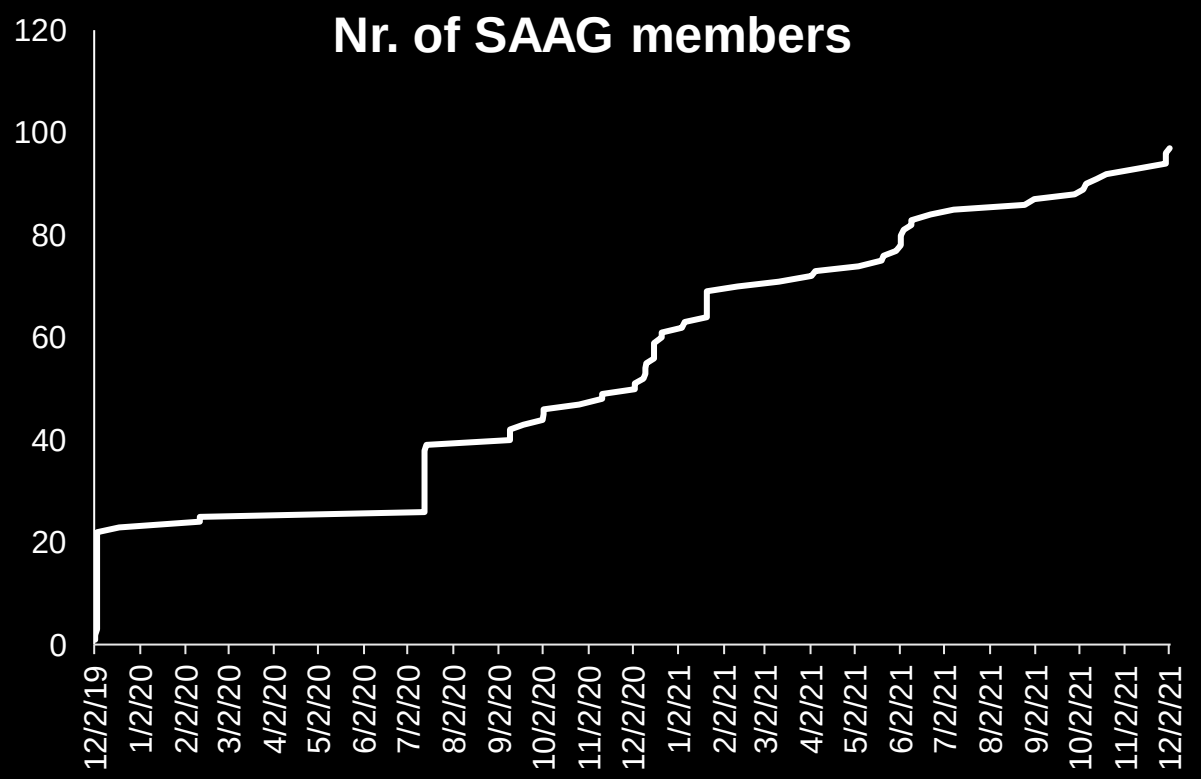
The use of Convective Permitting Modeling in South America Research

Andreas F. Prein (prein@ucar.edu), Roy Rasmussen, Changhai Liu, Kyoko Ikeda, Francina Dominguez

AGU 2021 Fall Meeting
Advancing Research on the Hydroclimate of South America
December 17, 2021

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

The South America Affinity Group



NCAR
UCAR

Generation of continental-scale convection-permitting climate simulation over South America

Perform Community Based Research

“**The whole is more than the sum of its parts**”

Urged need for improved predictability of South American water cycle

Why SAAG?

1. Mesoscale Processes in South America
- The Andes are the longest mountain range in the world
- Southern South America is home to some of the deepest thunderstorms on Earth
- Mesoscale convective systems dominate precipitation in many regions
- Strong land atmosphere coupling

2. Sparce observational networks

3. Large anthropogenic land-surface changes and climate change impacts

SAAG's goal is to improve the predictability of the South American water and energy cycle

How Does SAAG Coordinate

- Bi-weekly meetings focused on activity planning, knowledge exchange, and research coordination

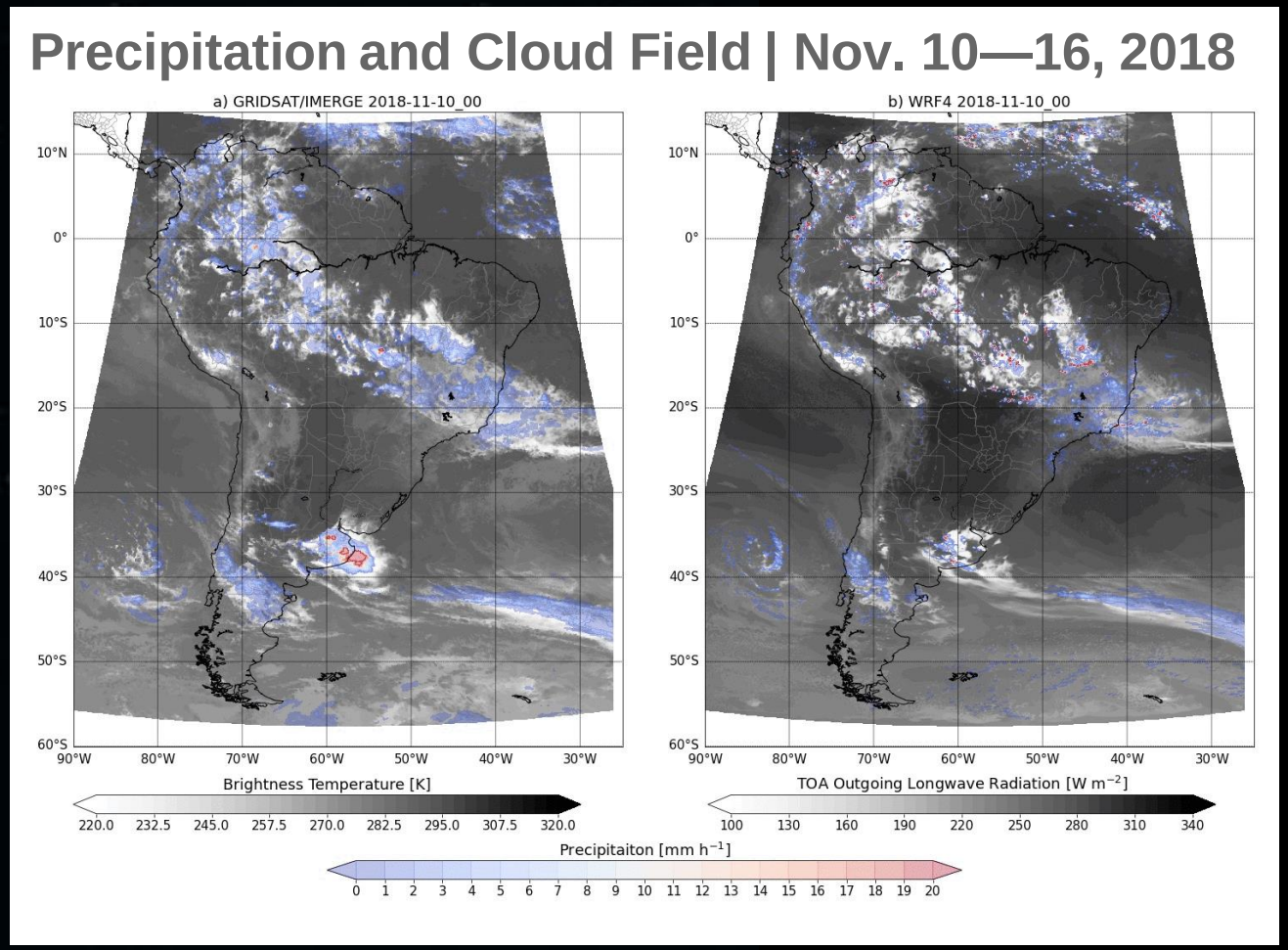
- Working groups focused on phenomenon
  - Convection and extreme precipitation
  - Orographic processes
  - Land-atmosphere coupling
  - Hydrology

- Web-based coordination
- https://ral.ucar.edu/projects/south-america

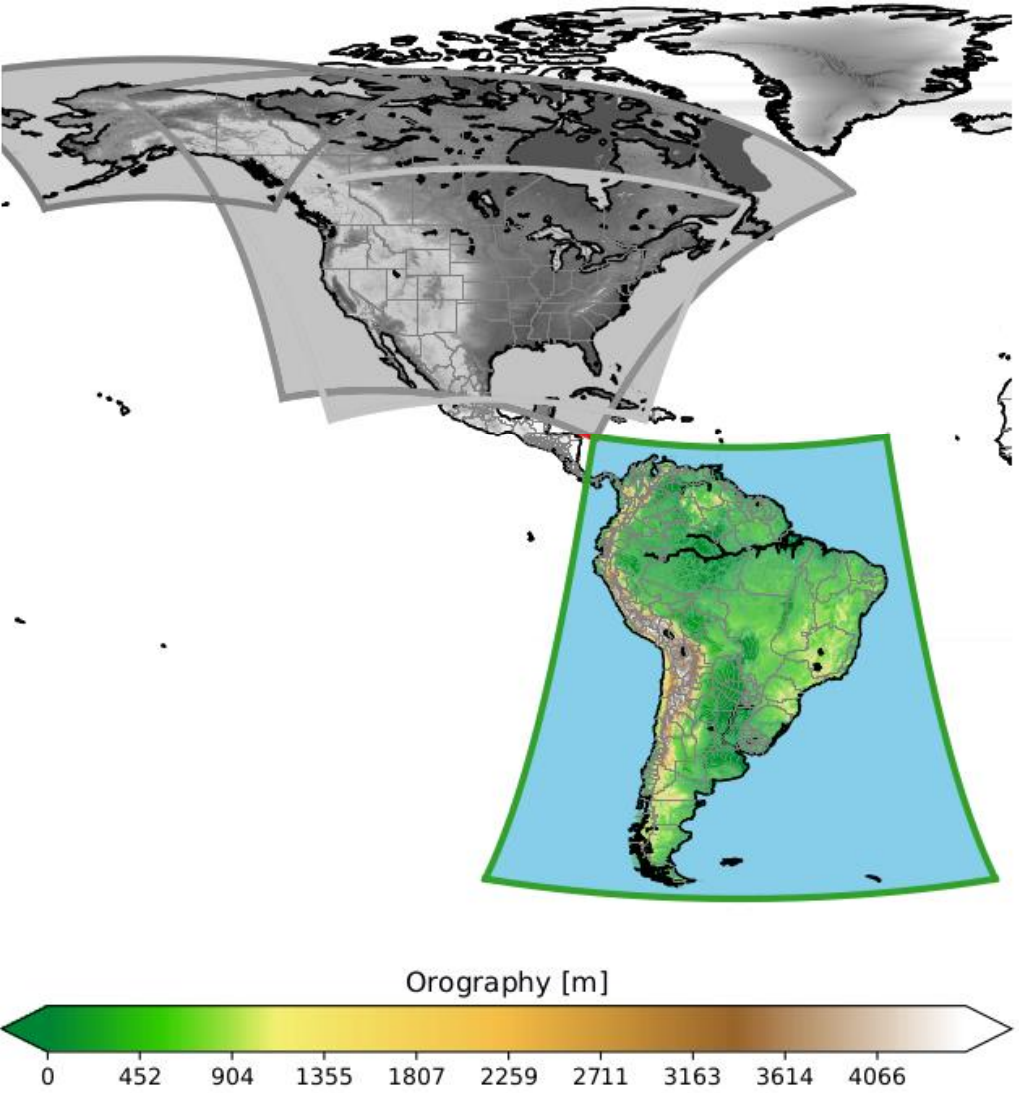
- Organization of Workshops and Meetings

What Does SAAG Do

Generation of climate model data at km-scale in support of scientific discovery and to build resilience against climate change



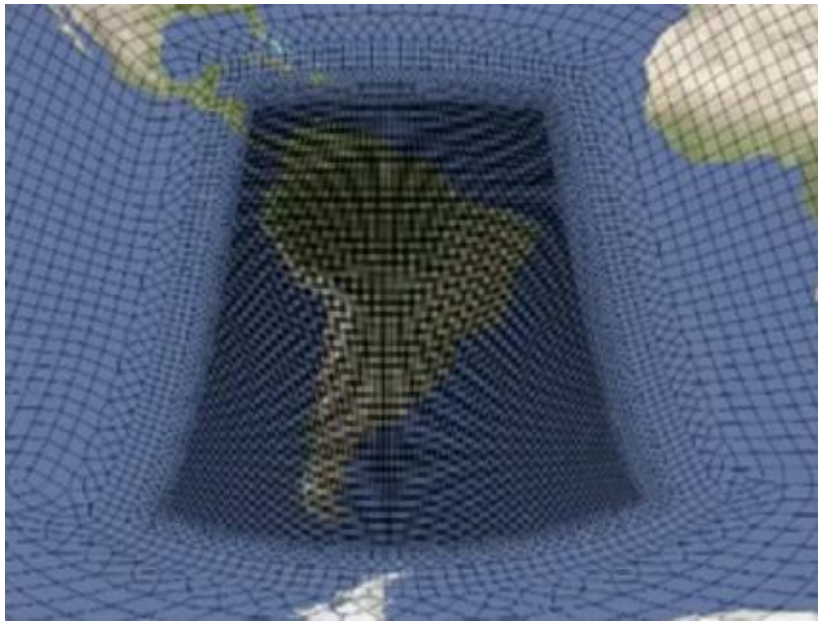
SAAG Simulations

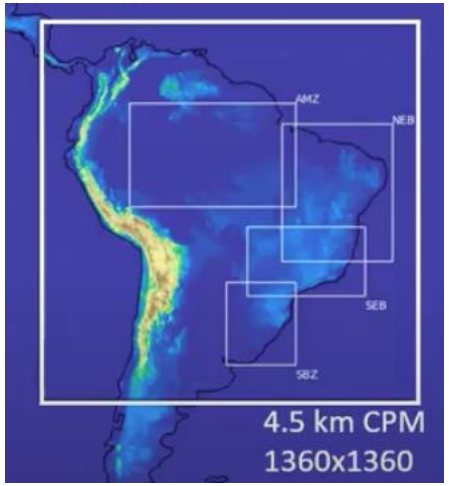


Weather Research and Forecasting model (WRF)

- 2000-2020 current climate simulation forced by ERA5 at 4 km grid spacing
- 20-year long future climate simulation (high-end scenario) using the PGW approach at 4 km grid spacing
- Hourly 3D model output for assessment of mesoscale phenomenon and targeted sub-domain simulations

SAAG Simulations





Weather Research and Forecasting model (WRF)

- 2000-2020 current climate simulation forced by ERA5 at 4 km grid spacing
- 20-year long future climate simulation (high-end scenario) using the PGW approach at 4 km grid spacing
- Hourly 3D model output for assessment of mesoscale phenomenon and targeted sub-domain simulations

System for Integrated Modeling of the Atmosphere (SIMA)

- 6 km simulation of 3-focus years based on ENSO cycle

UKMO Unified Model (UM)

- 1997-2007 ERA-Interim forced simulations at 4.5 km grid spacing
- Decadal-long GCM downscaled simulations in current and end-of-century (RCP8.5) climate

The whole is more than the sum of its parts

- Co-design of experiments
- Computer resource allocations
- Data storage
- Multi-model ensemble
- Observational datasets
- Connection to field campaigns (RELAMPAGO-CACTI, GoAmazon)
- Knowledge of South American partners
- Synergies across research efforts

Challenges

- Data Sharing and Analysis
- Computational Resources in South America
- Model validation particularly in Andes
- Sampling of future climate uncertainty space

Lessons Learned

- Community based research takes time
- Together we can go further & achieve more
- Regular engagements are key
- Every voice matters

How to get Involved

1. Reach out to SAAG coordination

   Roy Rasmussen (rasmus@ucar.edu)
   Andreas Prein (prein@ucar.edu)

2. Visit SAAG website to learn more

   https://ral.ucar.edu/projects/south-america

3. Participate in the 6th CPM Workshop

   Sept. 7-9, 2022, Buenos Aires, Argentina
   http://www.cima.fcen.uba.ar/cpcmw2022/

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.