



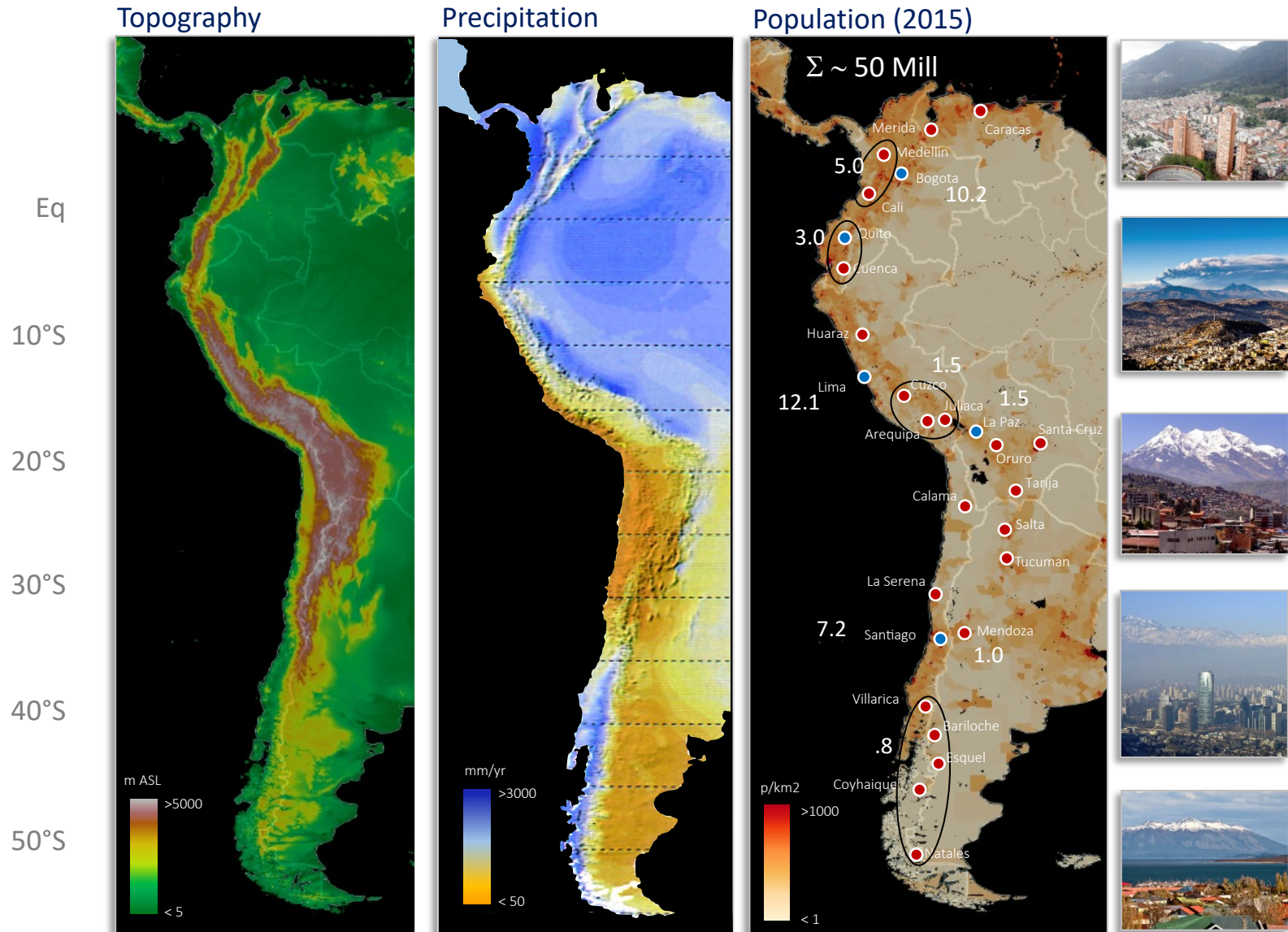
Hydroclimate Research Program for the Andes (ANDEX) and the connection with RfS

Germán Poveda
Universidad Nacional de Colombia,
Medellín, Colombia





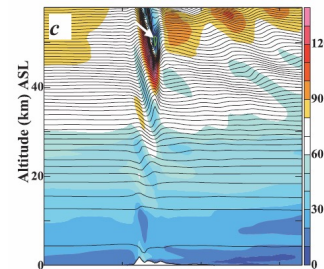
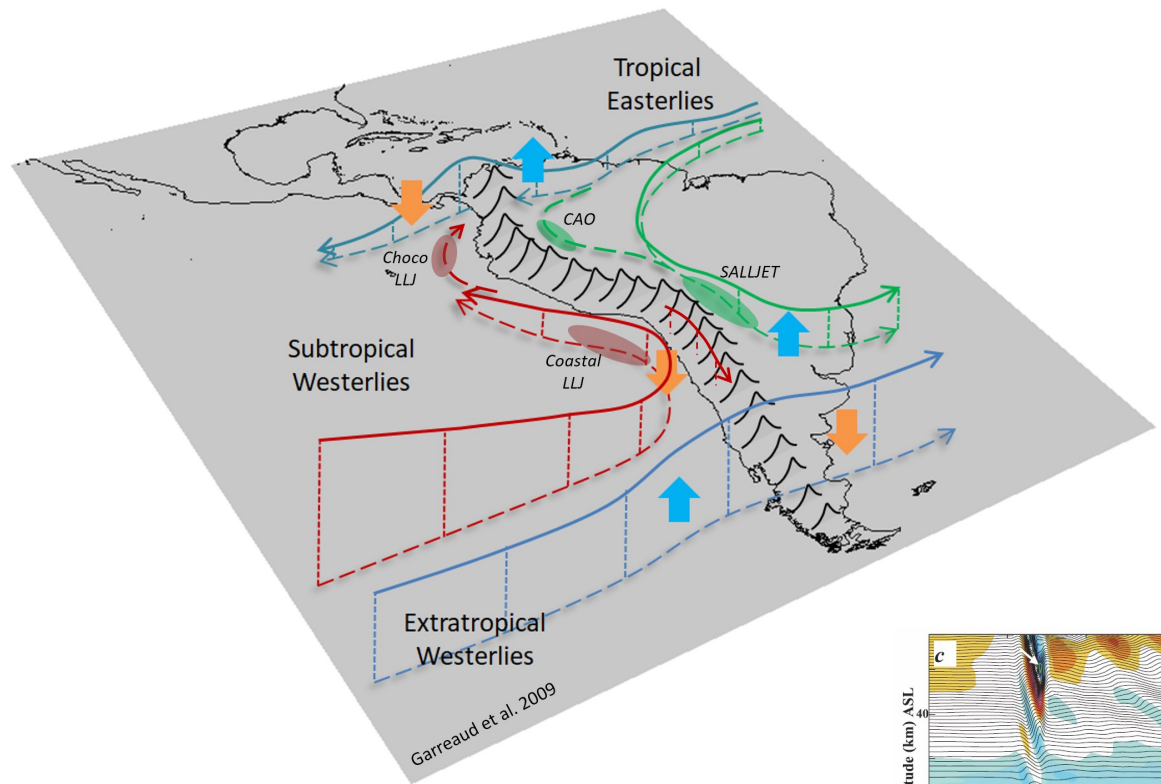
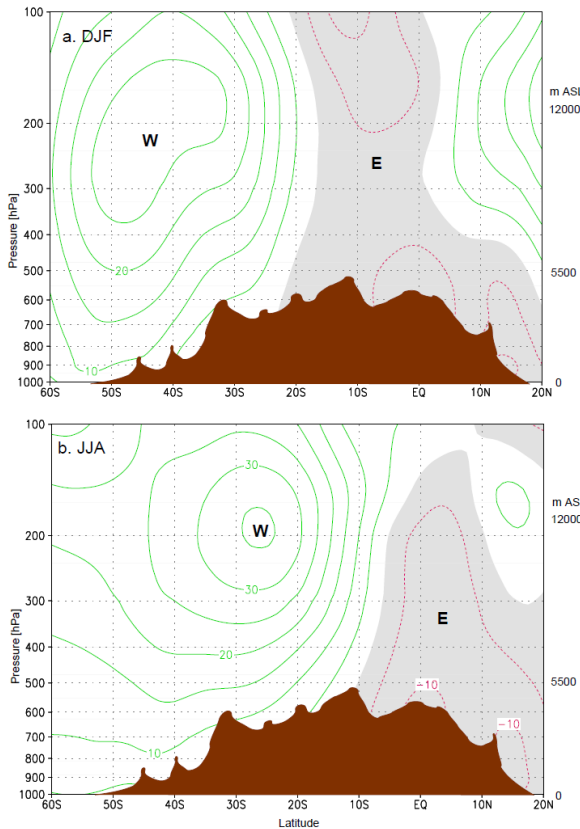
A REGIONAL HYDROCLIMATE INITIATIVE FOR THE ANDES





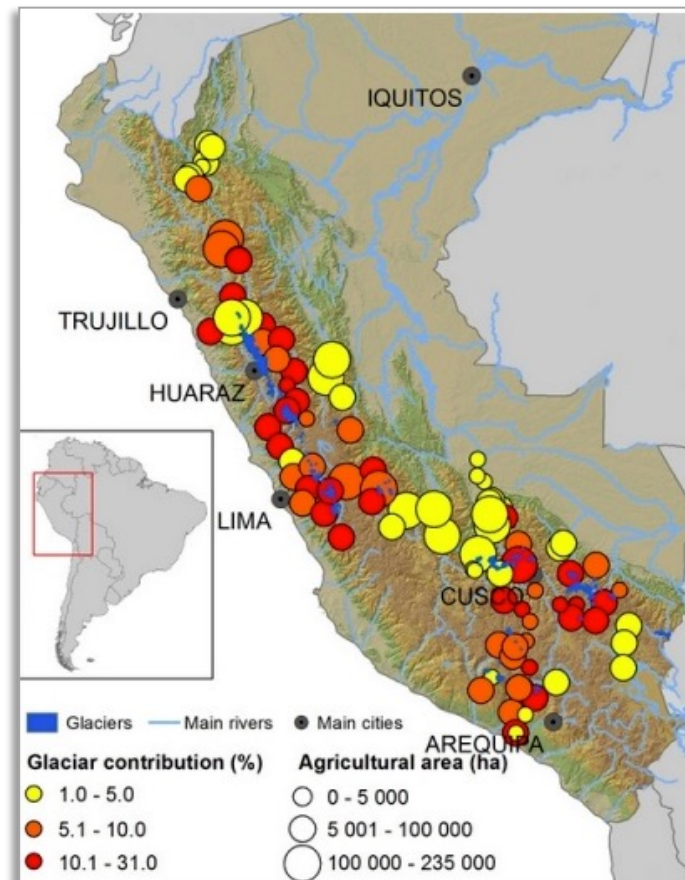
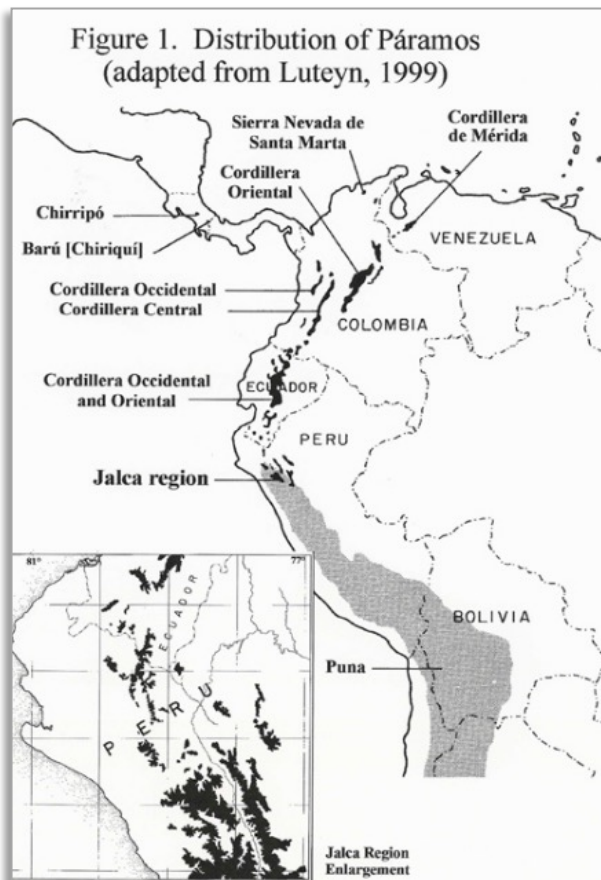
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The complex mid- and low-level atmospheric flows and systems in and around the Andes



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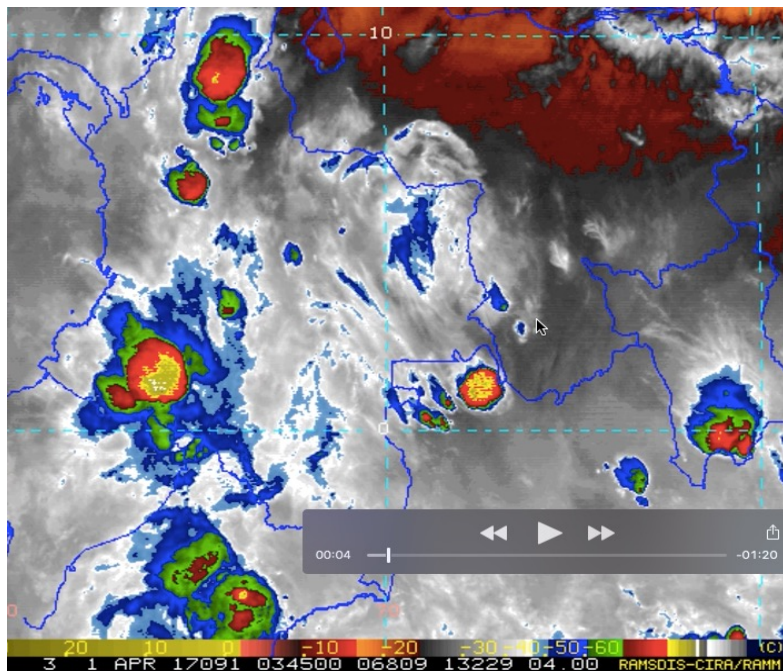
The Andean Credit





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Flooding and landslides also are recurrent along the tropical, subtropical and extratropical Andes (MCSs, Summer Convection, Atmospheric Rivers, etc.).

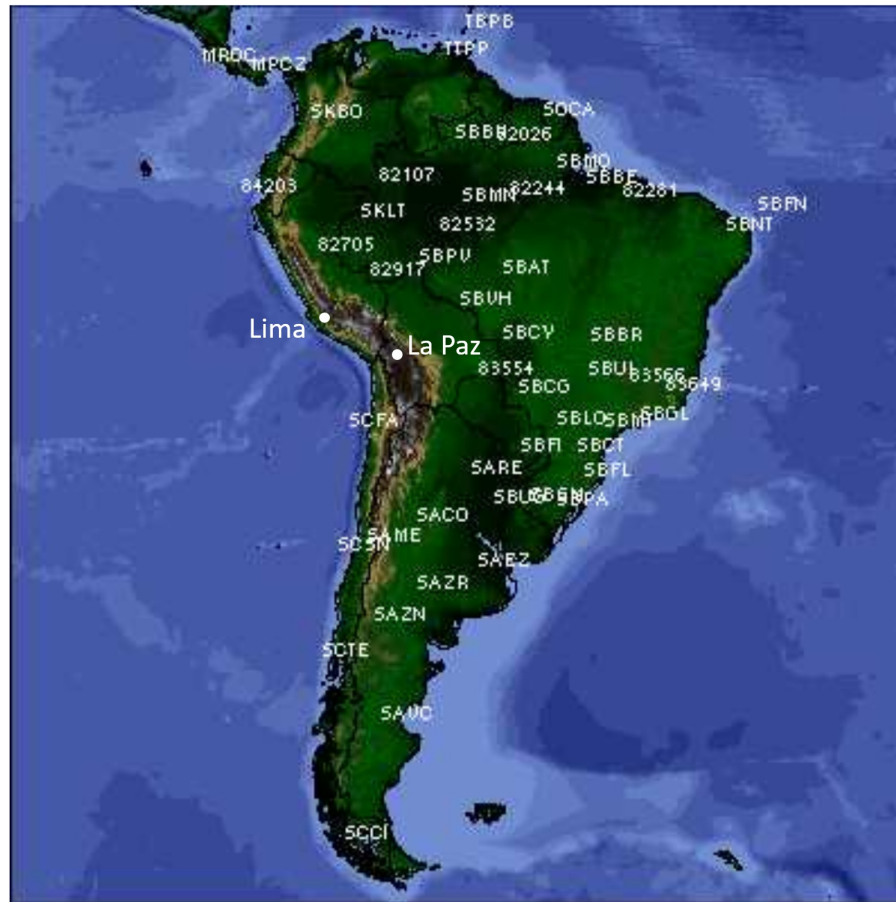


Intense storm triggered the flooding of Mocoa, Colombia, April 1, 2017, +400 deaths



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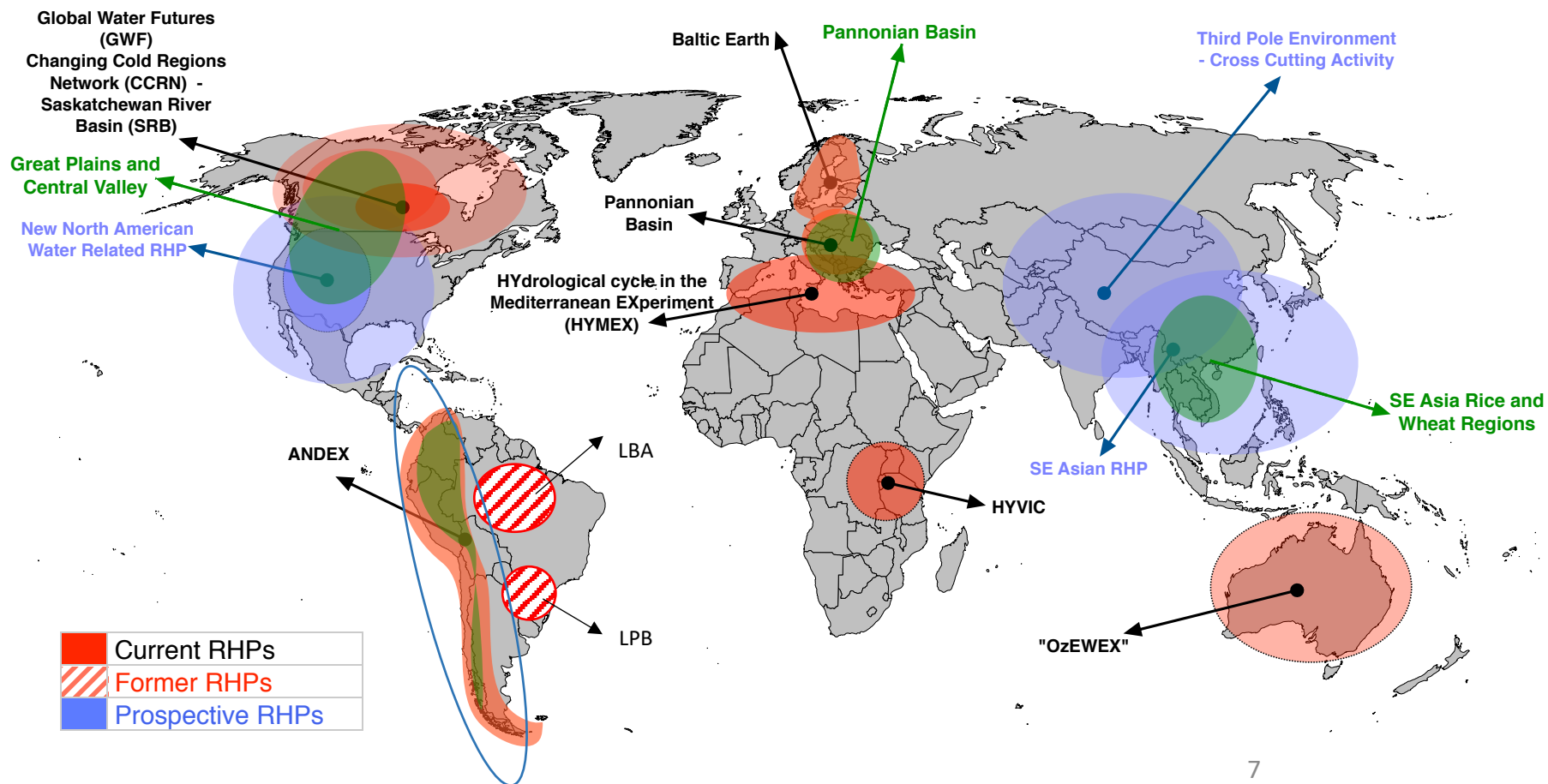
6-7 regular sounding stations in more than 7,000 km!!





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ANDEX – A Prospective Regional Hydroclimate Project (RHP) of GEWEX





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ANDEX Foundational Workshop

Medellin, Colombia, Dec. 4-7, 2017

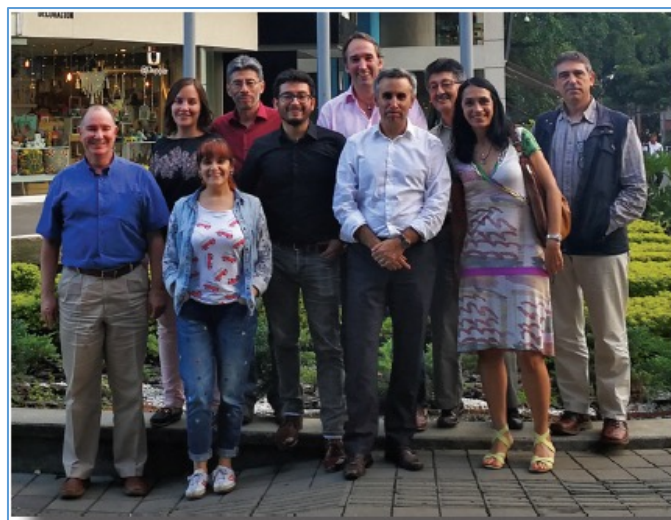
8 participants (LPC)



ANDEX: A Prospective GEWEX Regional Hydroclimate Project in the Andes

Germán Poveda¹, René Garreaud², Silvina Solman³, Jhan Carlo Espinoza⁴, Joan Cuxart⁵, Peter J. van Oevelen⁶, Paola A. Arias⁷, Jorge Molina⁸, José D. Pabón⁹ and Sara M. Vallejo¹

¹Universidad Nacional de Colombia, Medellín, Colombia; ²Universidad de Chile, Santiago, Chile; ³Universidad de Buenos Aires, Buenos Aires, Argentina; ⁴Instituto Geofísico del Perú, Lima; ⁵Universitat de les Illes Balears, Palma, España; ⁶International GEWEX Project Office, Washington DC, USA; ⁷Universidad de Antioquia, Medellín, Colombia; ⁸Universidad Mayor San Andrés, La Paz, Bolivia; ⁹International Research Centre on El Niño (CIIFEN), Guayaquil, Ecuador



Participants of the ANDEX Workshop.

First term co-chairs (3 years): Germán Poveda (Colombia) and René Garreaud (Chile).



A REGIONAL HYDROCLIMATE INITIATIVE FOR THE ANDES

1st ANDEX Meeting: Planning

Santiago, Chile, 22-24 Oct 2018

Ca. 30 participants

GEWEX NEWS

GEWEX is a Core Project of WCRP on Global Energy and Water Exchanges



Vol. 29 No. 4, November 2018

Trio of Meetings Highlights Potential of the Andes
for Continued Research



Participants of the 1st ANDEX Workshop

1st ANDEX Workshop

Santiago, Chile
22–24 October 2018

René Garreaud¹ and Germán Poveda², ANDEX Co-Chairs

¹Geophysics Department, Universidad de Chile and Center for Climate and Resilience Research (CR2), Santiago, Chile;

²Department of Geosciences and Environment, Universidad Nacional de Colombia, Medellín, Colombia

ANDEX, a scientific research program focused on the hydroclimatology of the Andes and a prospective GEWEX Hydroclimatology Panel (GHP) Regional Hydroclimate Project (RHP), held its first workshop in Santiago, Chile, from 22–24 October 2018. ANDEX is aimed at understanding, modeling, and predicting the dynamics of the water and energy cycles over the Andes cordillera, which runs from 10°N to 53°S and cross Colombia, Venezuela, Ecuador, Peru, Bolivia, Chile, and Argentina. More than 60 million inhabitants rely directly on the water resources provided by the Andes, but they are also exposed to a suite of natural hazards imposed by such impressive geography and climate, ranging from very humid conditions near the equator and western Patagonia to the hyper arid conditions in the subtropics. The Andes also face enormous challenges from human encroachment, urbanization, climate variability, climate change, land use changes, and massive deforestation.

The Santiago workshop was hosted by Prof. R. Garreaud and his team from the Geophysics Department of the Universidad de Chile, and received financial support from the World Meteorological Organization (WMO) through the GEWEX program, the Universidad de Chile, and the Center for Climate and Resilience Research (CR2). The meeting took place

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GEWEX

Meeting/Workshop Reports

Third ANDEX Workshop

Quito, Ecuador
21–24 April 2019

German Poveda¹ and René Garreaud²

¹Universidad Nacional de Colombia, Medellín, Colombia;

²Universidad de Chile, Santiago, Chile



Participants of the 3rd ANDEX Workshop in Quito. Left to right: P. van Oevelen, J.C. Espinoza, R. Garreaud, M. Masarikas, P.A. Arias, G. Poveda, J.D. Pabón and F. Vervoort

ANDEX is a prospective Regional Hydroclimate Project (RHP) of the GEWEX Hydroclimatology Panel (GHP). It aims to improve our understanding and prediction of climate and hydrology along the Andes cordillera. Three regional meetings have been held with the goal of identifying the research community, constructing a scientific agenda and defining preparatory implementation steps. The first meeting took place in Medellín, Colombia, from 4–6 December 2017. The main outcome of this meeting was to define a White Book with chapters focused on diverse hydroclimatic aspects of the Andes cordillera:

- Chapter 1. Introduction
- Chapter 2. Geographical Context of the Andes
- Chapter 3. Hydroclimate of the Andes
- Chapter 4. Cryosphere of the Andes
- Chapter 5. High Impact Events in the Andes
- Chapter 6. Observed and Projected Hydroclimatic Changes in the Andes
- Chapter 7. Observations and Data in the Andes
- Chapter 8. Science Underpinning Sustainable Development of the Andes
- Chapter 9. Challenges and Opportunities

The first ANDEX scientific workshop was held in Santiago, Chile, from 22–26 October 2018, and partly consisted of the joint ANDEX-GHP-International Network for Alpine Catchment Hydrology (INARCH) meeting. Scientists from all three events joined to discuss subjects of common interest, enhancing transregional scientific collaboration on mountainous terrain topics in manner consistent with the overall objectives of GHP. The first ANDEX workshop aimed specifically

to: (1) review the status of the ANDEX White Book; (2) identify overarching themes and major scientific questions; and (3) provide a first approach to an implementation plan.

The third meeting was held in Quito, Ecuador, from 21–24 April 2019, bringing together the lead authors of different chapters of the ANDEX White Book (R. Garreaud, G. Poveda, J.C. Espinoza, M. Masarikas, P. Arias, J.D. Pabón) and representatives of the International GEWEX Project Office (Peter van Oevelen and Fernando Vervoort). The main objective of this meeting was to assess the advancement of the White Book, entitled “ANDEX-A Regional Hydroclimate Project (RHP) on the Andes: Scientific Context, Challenges and Opportunities”. After an in-depth review on the status of the White Book, a timeline was defined with the first version of the book chapters prepared for peer-review on September 1, 2019. Other issues and further implementation steps were discussed during the Quito meeting, including:

1. Submission of a session proposal to the American Geophysical Union (AGU) Fall Meeting 2019, entitled “The Hydro-climate of the Andes: Current Understanding and Future Challenges”, convened by René Garreaud, German Poveda, Mathias Vuille and Ana P. Barros. The proposal was approved (session ID#: 78709) and 25 abstracts were received. Session details can be seen at <http://agu.confex.com/agu/fm19/webprogram/preliminary/Session78709.html>.
2. The planned submission of a session proposal to the 2020 European Geosciences Union (EGU) meeting
3. Discussion of initial ideas on setting up an ANDEX Open Scientific Conference for 200–300 participants in austral spring 2020
4. Design and construction of the ANDEX webpage and logo
5. Definition of the governance structure of ANDEX. The participants decided to start with a small coordinating and planning committee of dedicated individuals who will lead alongside the current co-chairs, G. Poveda and R. Garreaud. During the implementation phase, the final governance structure will be defined.
6. Submission of several chapters of the White Book as review papers to high-impact journals
7. Status of the ANDEX survey (<https://survey.monkey.com/1/XMHPRRM>). Responses are still welcome! If you would like to take the survey, please contact R. Garreaud (rgarreaud@def.uchile.cl).

The general consensus among the participants after this third workshop is that ANDEX is advancing at a good pace towards its establishment as a full GEWEX RHP. Ever since its inception in 2017, the ANDEX core group has identified and engaged a broad, diverse research network of scientists working in the seven Andean countries and relevant groups in North America and Europe. The ANDEX White Book will contain our current knowledge of the water and energy cycles along the Andes, and will conduct an in-depth analysis to identify the many gaps hindering our capacity to diagnose, model and predict the hydroclimate along this formidable mountain range. This will constitute a sound basis towards an implementation plan to be developed in the 2020–2025 timeframe.

ANDEX White Book Workshop

Quito, Ecuador, April 21–25, 2019

7 participants (LPC)



The Hydroclimate of the Andes: Current Understanding and Future Challenges

Tuesday 10 December 2019

A21U: Poster Session (16 papers)

A24K: Oral session (12 papers)

Primary Convener

[Rene Garreaud](#) University of Chile

Conveners

[Germán Poveda](#) Universidad Nacional de Colombia

[Mathias F Vuille](#) University at Albany, State University of New York

[Ana Paula Barros](#) Duke University



Recent progress in understanding the hydro-climate system of the Andes: Physical processes and resources for Andean populations

Tuesday 05 May 2020

CL2.10: 42 papers / online presentations

Convener: Jhan Carlo Espinoza

Co-conveners: Wouter Buytaert; Katja Trachte; Germán Poveda



Extreme weather events and their impacts in the Andes and surrounding regions: observational, paleoclimate and modeling perspectives

Convener: Paola Arias

Co-conveners: Wouter Buytaert, Francina Domínguez, Jhan Carlo Espinoza, Germán Poveda

Link: <https://meetingorganizer.copernicus.org/EGU21/sessionmodification/40697>

CL4.11: Papers / online presentations



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Main Overarching Scientific Questions

1. What are the main physical processes driving the water and energy budgets of the Andes at a broad range of spatial and temporal scales, and their interactions with the neighboring Pacific and Atlantic Oceans and major river basins of South America?
2. How climate change, deforestation and land use changes are affecting the hydroclimatological functioning of the Andes across the altitudinal gradients, from glaciers, to *páramos*, *punas*, cloud forests, rainforests, dry forests, deserts?
3. What is the scientific basis underpinning the sustainable development of the Andean region?



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On the previous basis, we have identified four science themes and two cross-cutting themes:

- Climate patterns and drivers
- Climate and environmental (LULC) changes
- High impact events
- Andean cryosphere
- Observations, data and modeling
- Science underpinning sustainable development

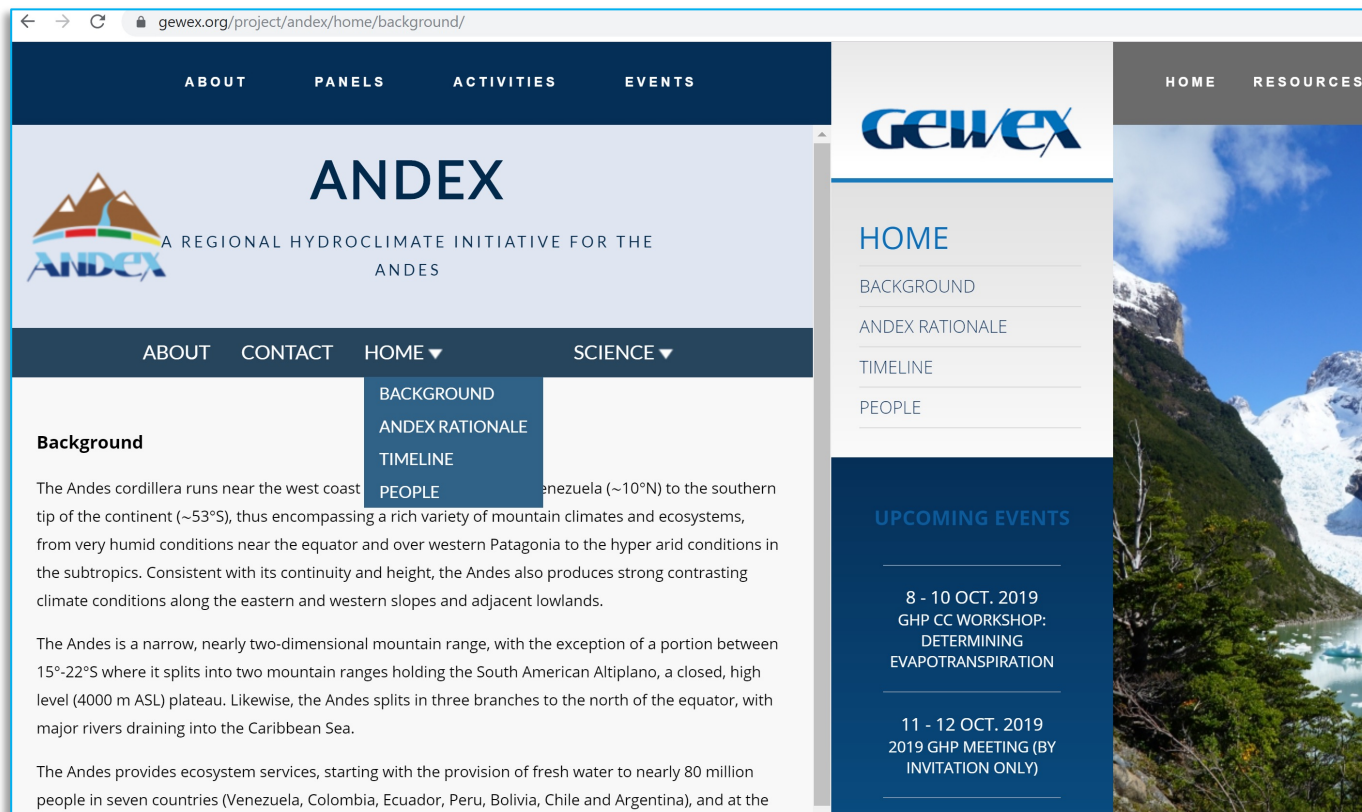


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ANDEX Web Page: Near Complete (as Sep-2021):

<http://www.gewex.org/project/andex/>

Thanks to Fernande Vervoort, Peter van Oevelen and their team
It was launched several months ago. ANDEX visibility!



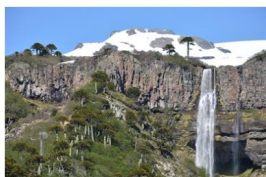


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ANDEX White Book Summarize Science / Identify Gaps

- 1: Introduction
- 2: Geographical Context of the Andes- R. Garreaud et al.
- 3: Hydroclimate of the Andes – R. Garreaud et al.
- 4: Cryosphere of the Andes – M. Masiokas
- 5: High Impact Weather Events in the Andes – G. Poveda et al.
- 6: Observed and Projected Hydroclimatic Changes in the Andes - J. Pabón et al.
- 7: Observations and Data in the Andes - R. Martínez et al.
- 8: Science Underpinning Sustainable Development of the Andes - G. Poveda et al.
- 9: Challenges and Opportunities – R. Garreaud, G. Poveda, P. van Oevelen et al.

All central chapters been peer-reviewed and published in Frontiers, Earth Sciences.



Research Topic

**Connecting Mountain Hydroclimate Through the
American Cordilleras**



A REGIONAL HYDROCLIMATE INITIATIVE FOR THE ANDES

ANDEX White Book

Summarize Science / Identify Gaps

<https://www.gewex.org/article-lander/>

ANDEX WHITE BOOK

Chapter 1. Introduction

Lead authors: René Garreaud and Germán Poveda

0 Comments

No comments found.

Add Your Comment

Chapter 2. Geographical Context of the Andes

Lead author: René Garreaud

0 Comments

No comments found.

Add Your Comment

Chapter 3. Hydroclimate of the Andes

- Espinoza JC, Garreaud R, Poveda G, Arias PA, Molina-Carpio J, Masiokas M, Viale M and Scaff L (2020). Hydroclimate of the Andes Part I: Main Climatic Features. *Frontiers in Earth Science* 8:64. [doi: 10.3389/feart.2020.00064](https://doi.org/10.3389/feart.2020.00064)
- Arias PA, Garreaud R, Poveda G, Espinoza JC, Molina-Carpio J, Masiokas M, Viale M, Scaff L and van



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On-line Form for Commenting White Book Chapters/Papers

<https://www.gewex.org/article/andex-white-book/>

Please
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[ABOUT](#) [PANELS](#) [ACTIVITIES](#) [EVENTS](#)

CHAPTER 3. HYDROCLIMATE OF THE ANDES

- Espinoza JC, Garreaud R, Poveda G, Arias PA, Molina-Carpio J, Masiokas M, Viale M and Scaff L (2020). Hydroclimate of the Andes Part I: Main Climatic Features. *Frontiers in Earth Science* 8:64. [doi: 10.3389/feart.2020.00064](https://doi.org/10.3389/feart.2020.00064)
- Arias PA, Garreaud R, Poveda G, Espinoza JC, Molina-Carpio J, Masiokas M, Viale M, Scaff L and van Oevelen PJ (2021) Hydroclimate of the Andes Part II: Hydroclimate Variability and Sub-Continental Patterns. *Front. Earth Sci.* 8:505467. [doi: 10.3389/feart.2020.505467](https://doi.org/10.3389/feart.2020.505467)

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Next Steps (Datelines)

1. WB Chapters are open for comments by the scientific community (Since April 2021).
2. To distill the synthesis of such comments.
3. To prepare the Implementation Plan.
4. To submit ANDEX as GEWEX RHP (November 2021).
5. To communicate and socialize ANDEX among Funding Agencies, Stakeholders, Interamerican Development Bank *et al.*
6. To hold ANDEX Open Science Conference and to launch the Implementation Plan (Early 2022).



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Many thanks!

Questions/Comments?