

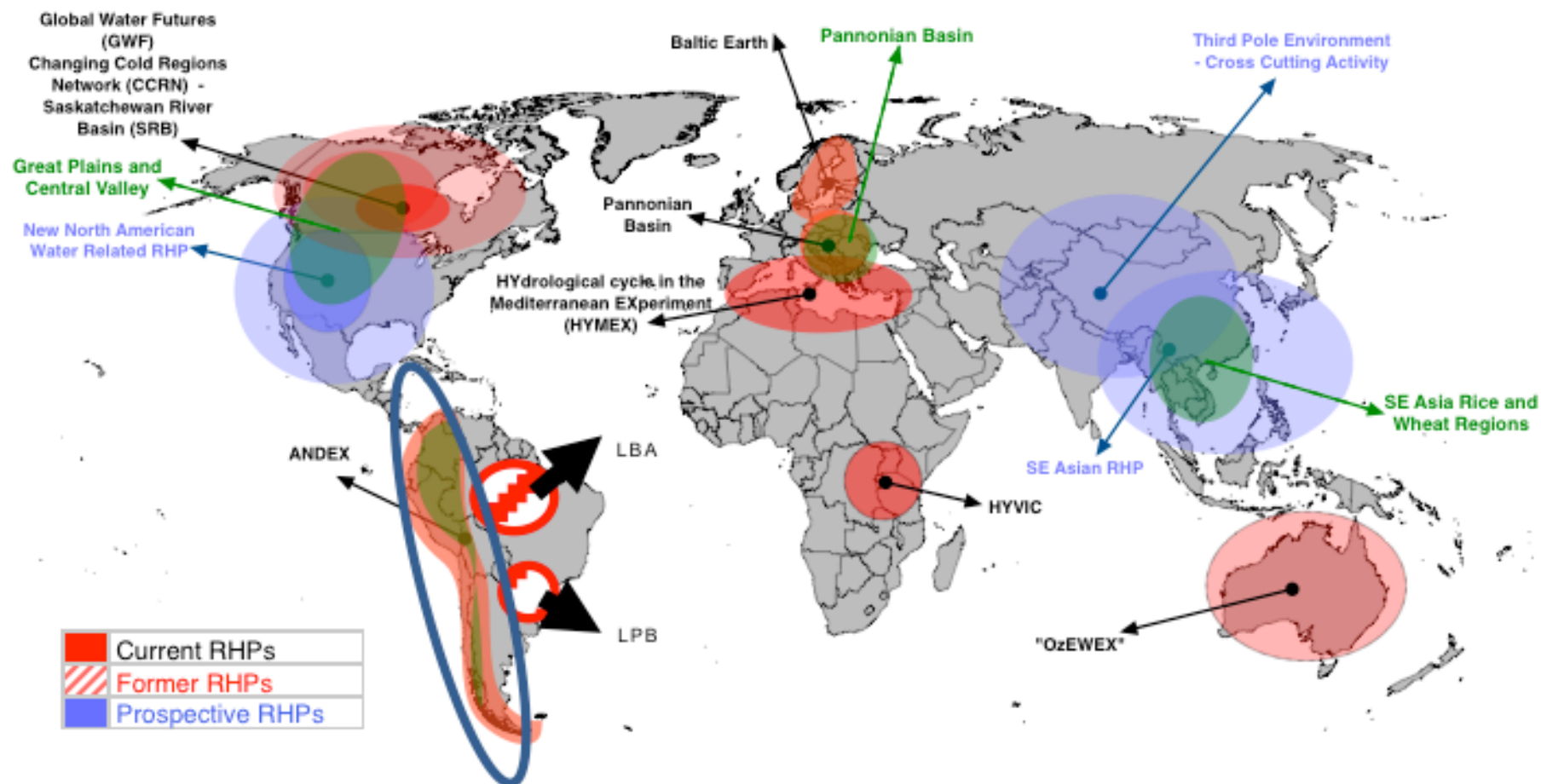
ANDEX - A Hydroclimate Research Program for the Andes and a Prospective GEWEX Regional Hydroclimate Project (RHP): Overarching Questions and Research Themes

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(2) Universidad de Chile

On behalf of the participants of the ANDEX meeting (Oct 22-23)



ANDEX as a prospective Regional Hydroclimate Project (RHP)



The Andes

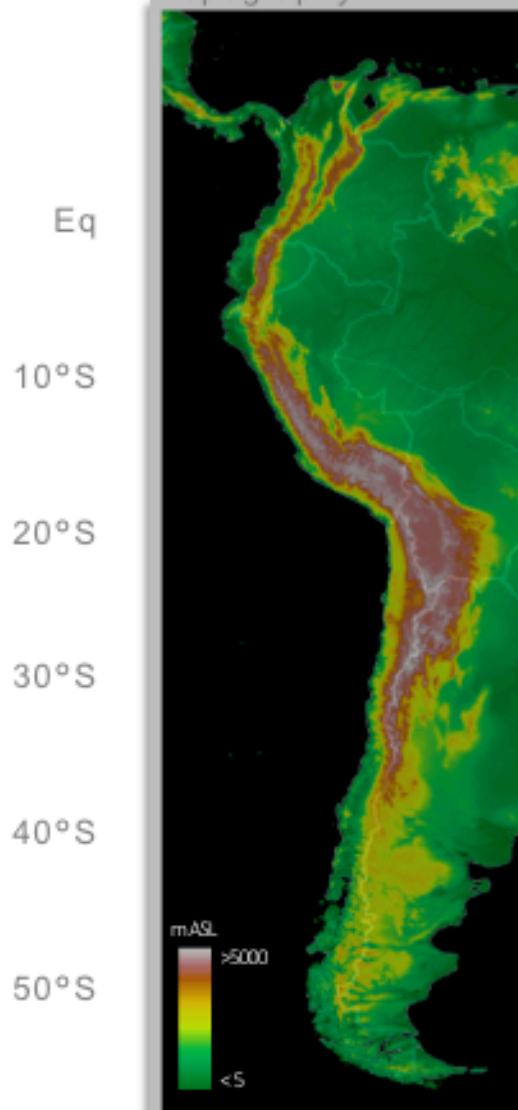


www.mapsofworld.com

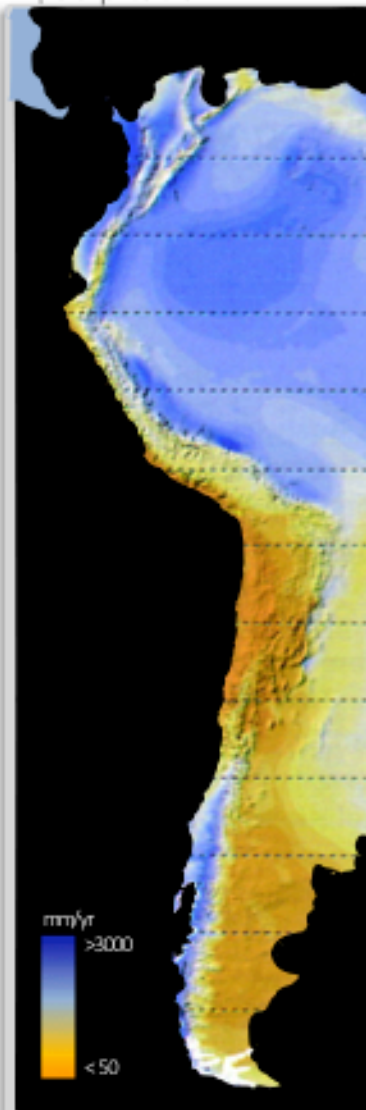
- World's longest mountain range: 7,242 km (10N to 46S).
- Seven countries: Colombia, Venezuela, Ecuador, Peru, Bolivia, Argentina and Chile.
- About 200 to 700 km wide (widest between 18°S-20°S), and average height 4,000 m. Aconcagua: 6,962 m.
- It contains glaciers, ice fields, volcanoes, deserts, high plateaus, lakes, *páramos*, *yungas*, *punas*, cloud forests, tropical rainforests, dry forests, savannas, and intra-mountainous valleys.
- Strong hydroclimatic variability associated with Latitude and Hemispheric location, but also with Aspect, Slope and Elevation.

Basic Features (1)

Topography



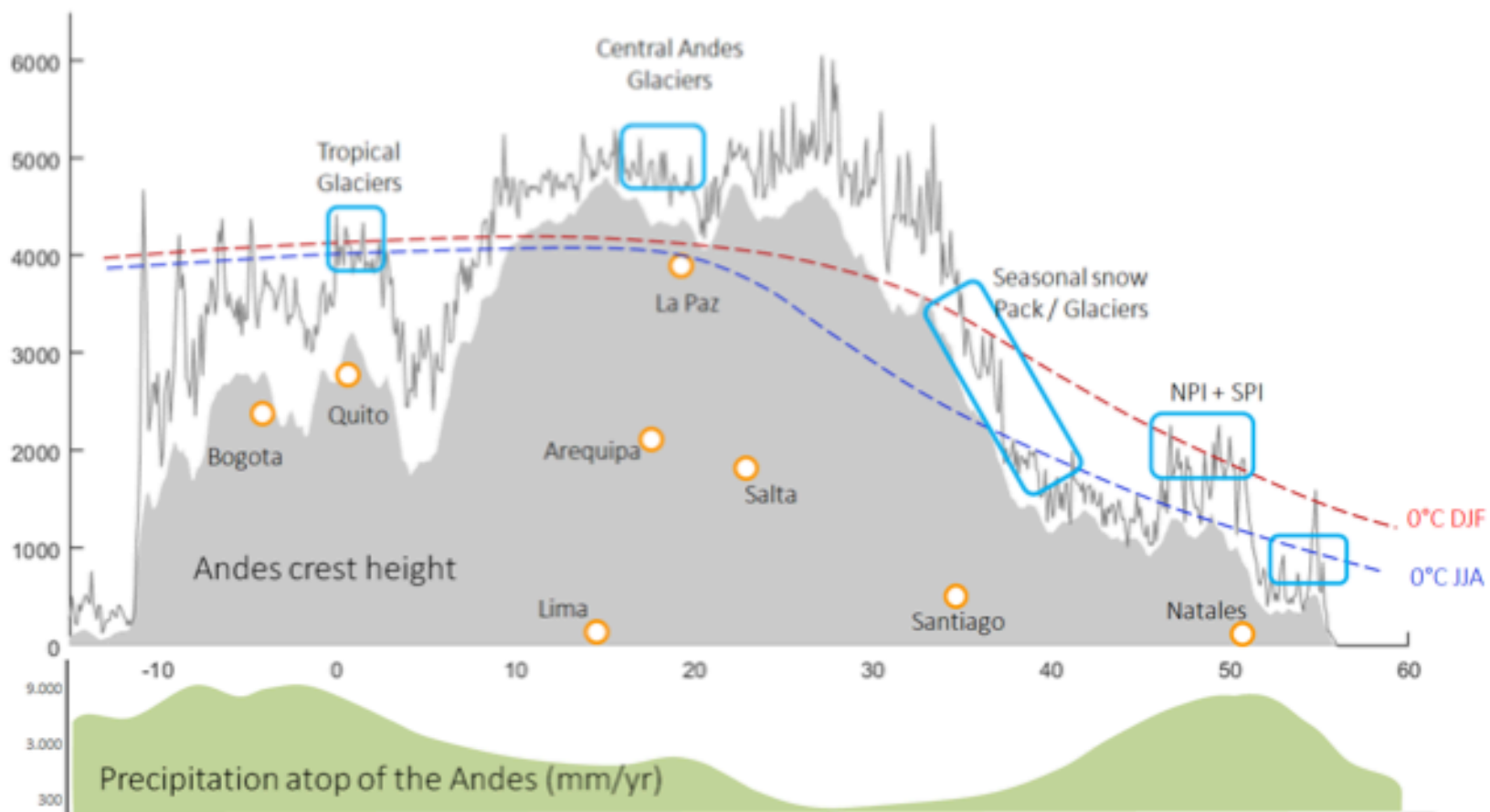
Precipitation



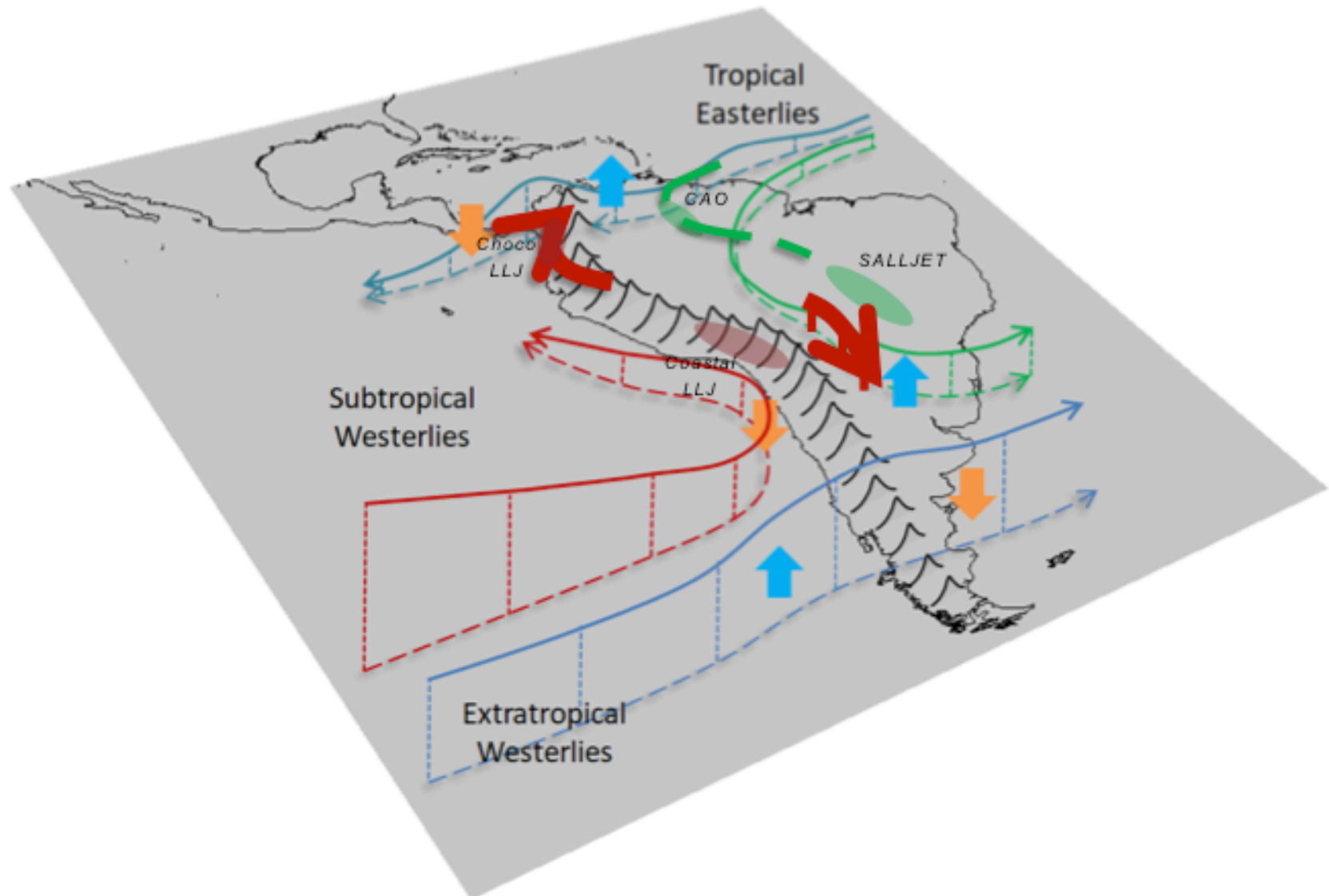
Population (2015)



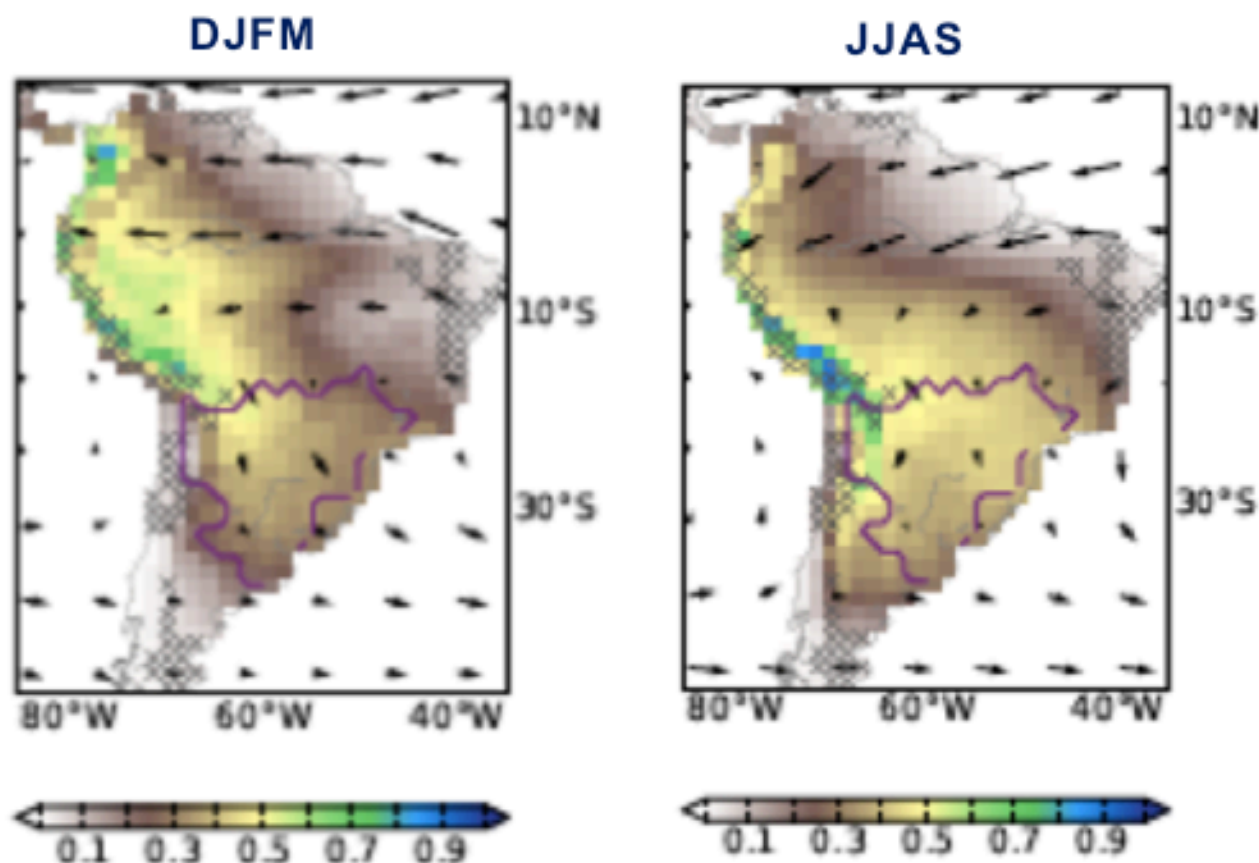
Basic Features (2)



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



Besides, Precipitation Recycling is Pretty Important along the North & Central Andes



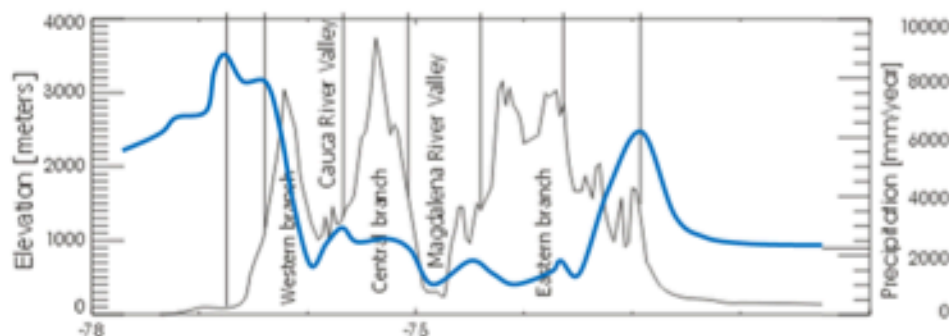
(d) ρ_c

(i) ρ_c

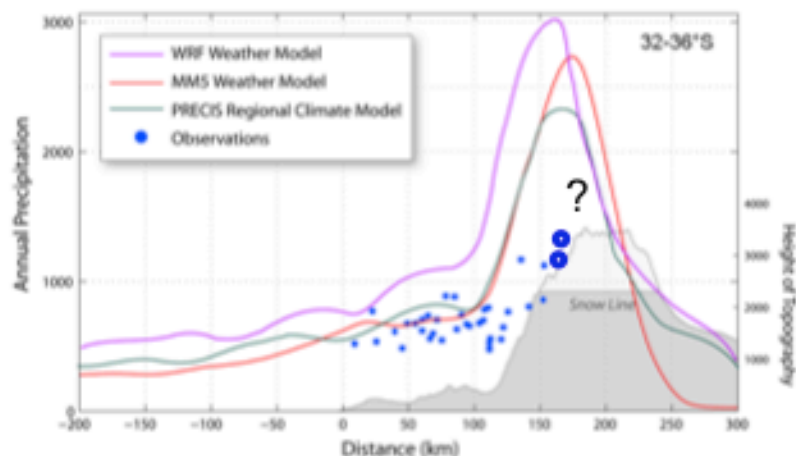
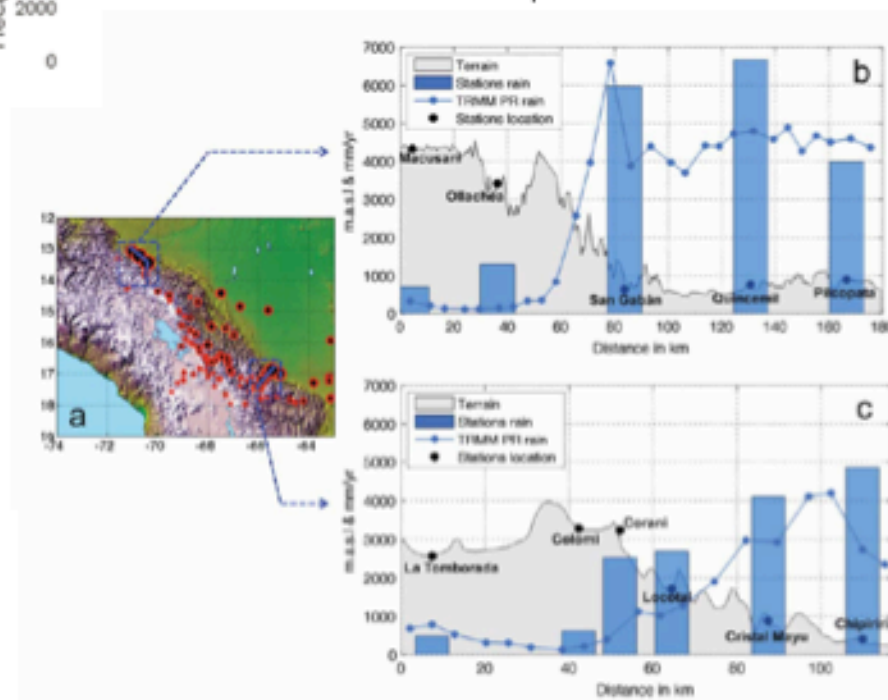
Extreme Precipitation

The elusive Orographic Precipitation Gradient (OPG(latitude))

Espinoza et al. 2015



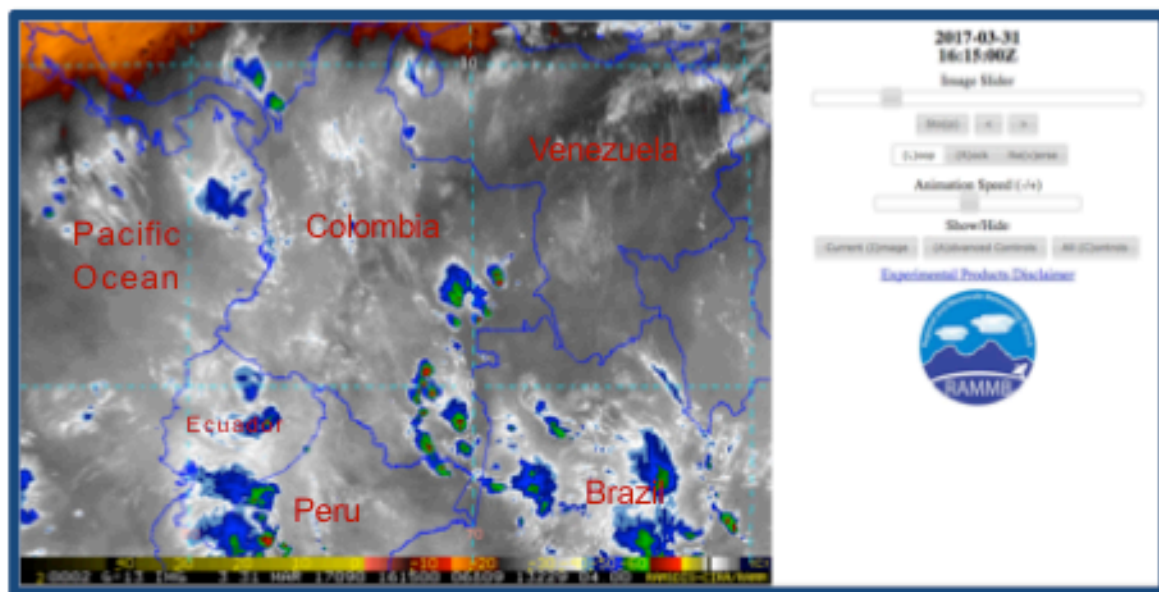
Distribution of mean annual rainfall over transect (around 6°N) along the three ranges of the Colombian Andes



Distribution of mean annual rainfall over transect (around 33°S) along the sub-tropical Andes

Threats from Climate Change and Hydroclimatic Variability and Deforestation Intensification of Storms and Floods

A MCS triggered the flooding that destroyed Mocoa, Colombia
April 1st, 2017 (+400 dead people)



The Andes are a formidable water tower... but people are subject to hazards & risks and strong vulnerability



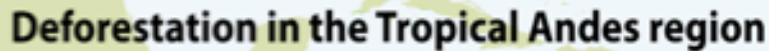
Flooding of Mocoa, Putumayo, Colombia,
on April 1st, 2017
At least **300** fatalities.



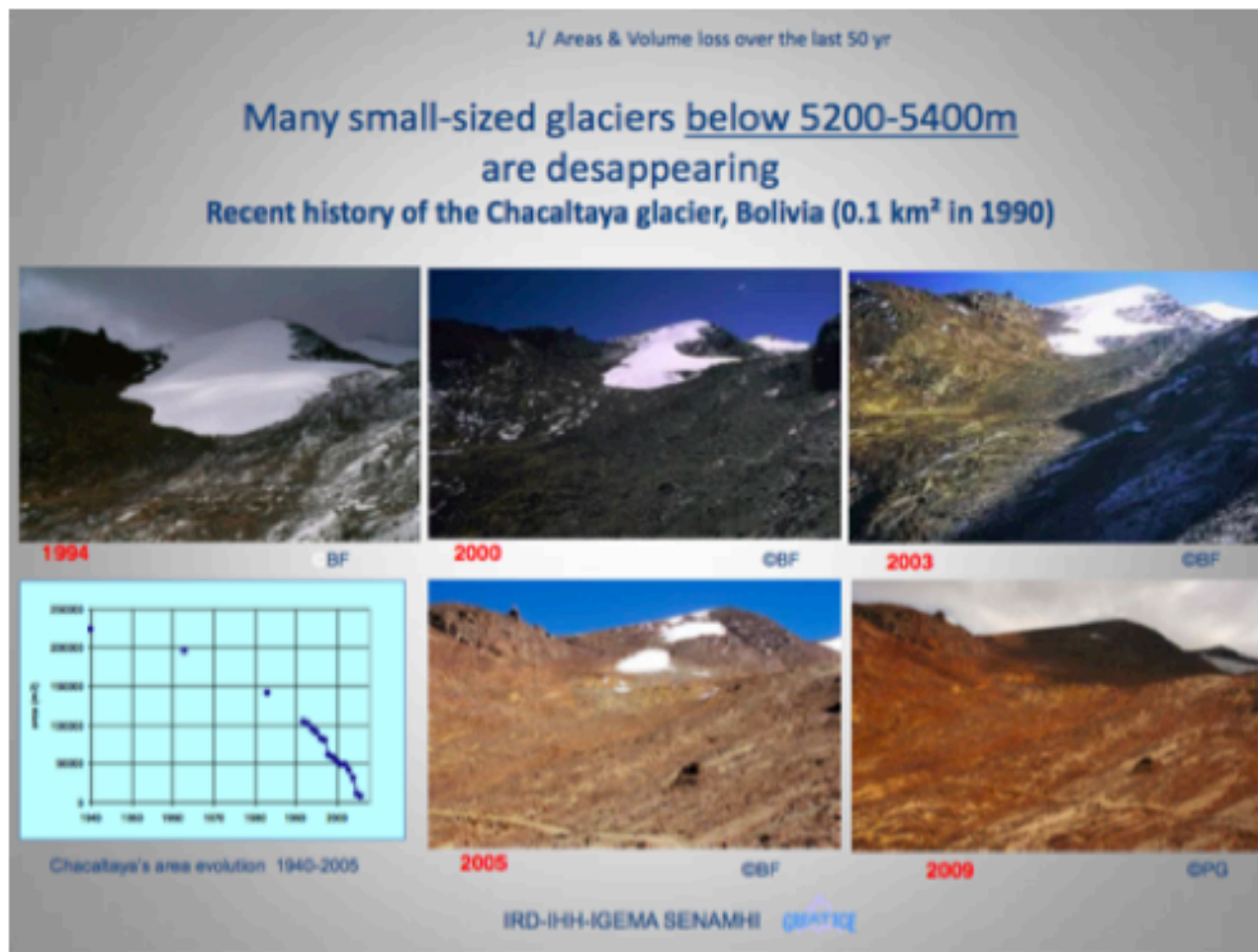
Landslide Santiago foothills, May 3, 1993
At least **100** fatalities.



Lahar from El Ruiz volcano eruption, Armero, Colombia,
November 13, 1985
At least **23,000** fatalities

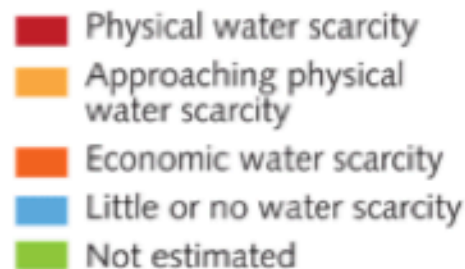
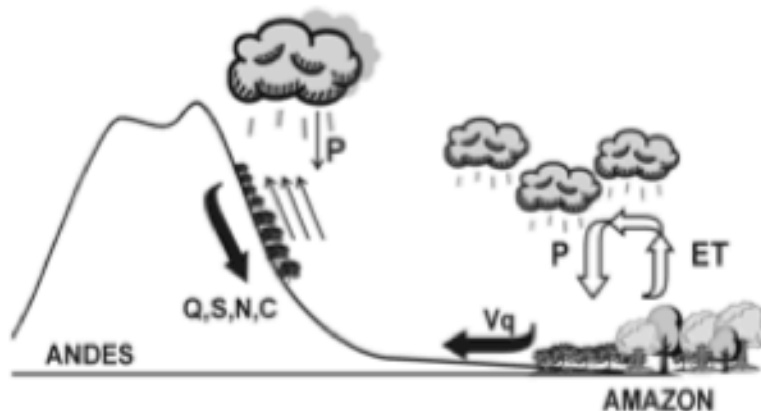


Andean Glaciers are Disappearing due to Global Warming

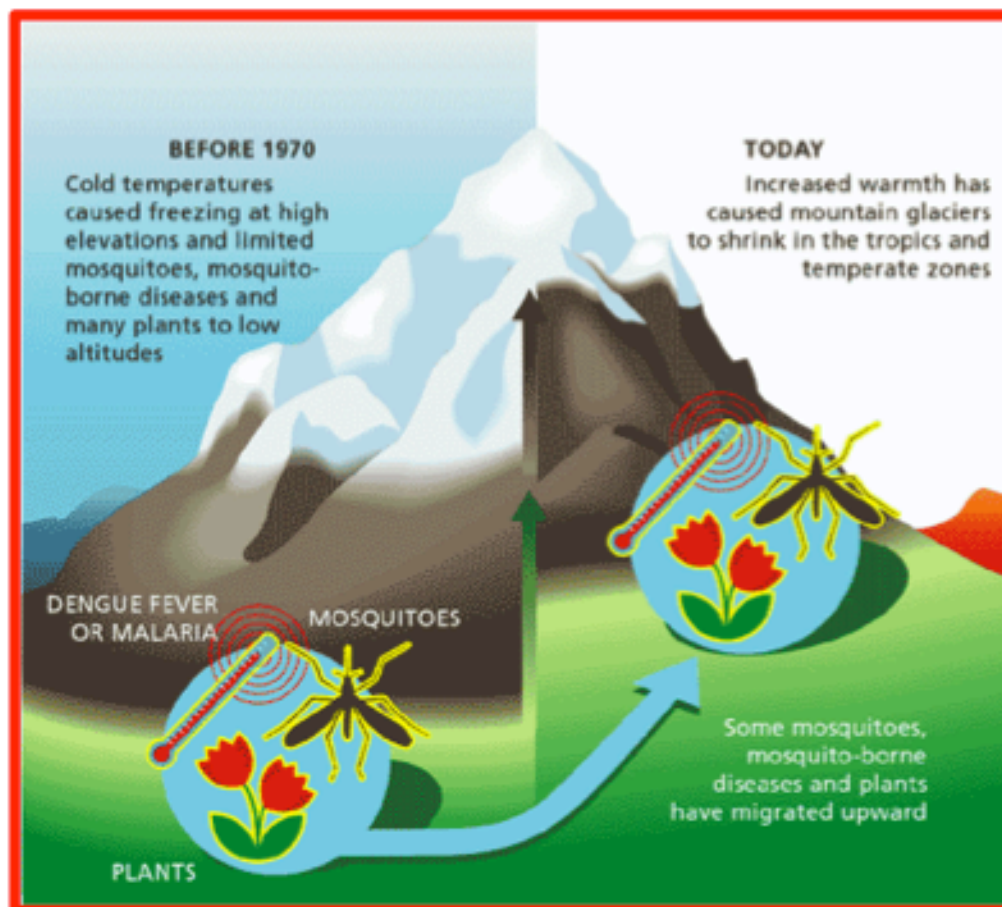


Water Scarcity in Latin-America

- How stable under climate change?
- How could it change?
- What is it that needs to be adapted to?
- What can be mitigated?



Mosquito-borne dengue (a urban disease) is migrating upward due to warming



ANDEX Start-Up Activity

Workshop held in Medellín, Colombia
December 4th-7th, 2017



ANDEX: A Prospective GEWEX Regional Hydroclimate Project in the Andes

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Participants of the ANDEX Workshop.

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

White Book – In Preparation (35+ co-authors)

- Ch. 1. Geographical Context
- Ch. 2. The Hydroclimate of the Andes
- Ch. 3: Climate and Environmental Change
- Ch. 4: High Impact Events
- Ch. 5: Cryosphere of the Andes
- Ch. 6. Observations and Data
- Ch. 7. Science Underpinning Sustainable Development
- Ch. 8. Actions and challenges



ANDEX activities during 2018

- May 7-11: ANDEX presentation at the 8th GEWEX Science Conference in Canmore, Alberta, Canada.
- June 11-15: R. Garreau and G. Poveda meet in Santiago, Chile.
- October: Five chapters of White Book drafts available (60-80%).
- Mid-September: Workshop agenda ready.
- October 22-23: 1st ANDEX (GHP) Workshop
- October 24 ANDEX-GHP-INARCH Joint meeting Santiago, Chile.

ANDEX

Main Overarching Scientific Questions

1. What are the main physical processes driving the water and energy budgets of the Andes (as a singular cordillera), at a broad range of spatial and temporal scales, and their interactions with the 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 and latitudinal gradients, from glaciers, to paramos, punas, cloud montane forests, rainforests, dry forests, and deserts?
3. What is the scientific basis underpinning the sustainable development of the Andean region?

Specific Research Questions (1)

1. What are the dynamical feedbacks between the Andes and the processes involved in the **hydrologic cycle** over the Andes (*Water Vapor, Precipitation, Evapotranspiration, Sublimation, Soil Moisture, Infiltration, Groundwater and River Flows*) at a wide range of spatial and temporal scales, for average and extreme conditions?
 - Water Vapor Sources, Precipitation Recycling, Pluviographic Optimum, Low-level Jets and Atmospheric & Aerial Rivers, the Bolivian High, the Amazon and La Plata River Basins, MJO, Tropical Easterly Waves, ENSO, et al.
 - Extreme Events: MCSs, Convective Storms, Floods, Droughts, Cold Spells, Hail Storms, Lightning, Fires, Zonda wind, Landslides.

Specific Research Questions (2)

2. What is the dynamics of processes involved in the **surface energy budget** over the Andes (*SWR*, *LWR*, *SHF*, *LHF*) across a wide range of spatial and temporal scales?
3. How is the dynamical coupling between 1 and 2 from Glaciers to Deserts?
4. What is the influence of the cryosphere on the surface hydrological cycle on the Andes and what is the influence of the atmospheric hydrological cycle on the Andean cryosphere?

Specific Research Questions (3)

5. What are the current and future human impacts from water diversion and pollution, deforestation, LU/LC, and climate change on the processes and variables involved in the water cycle and energy budget?
6. How to deal with them from a water (and other life support systems) management perspective?
7. How the current and future water and energy balances along the Andes (will) affect ecosystem services, water supply, hydropower generation, food production and food security, natural hazards, and human health?
8. What is the effect of the Andes on pollution in urban valleys and what are the risks for human health?

Other Activities (Oct 22-23)

- Initial discussions on existing and required projects, data sets, instrumentation and experiments.
- Initial discussions on methodological frameworks towards understanding, modelling and prediction.
- Initial discussions on agenda for 2018-2019. White Book, Next meeting? International Conference? Funding sources?
- Great atmosphere and networking!

ANDEX contribution to WCRP Grand Challenges on Water & UN Sustainable Development Goals

