



PERÚ

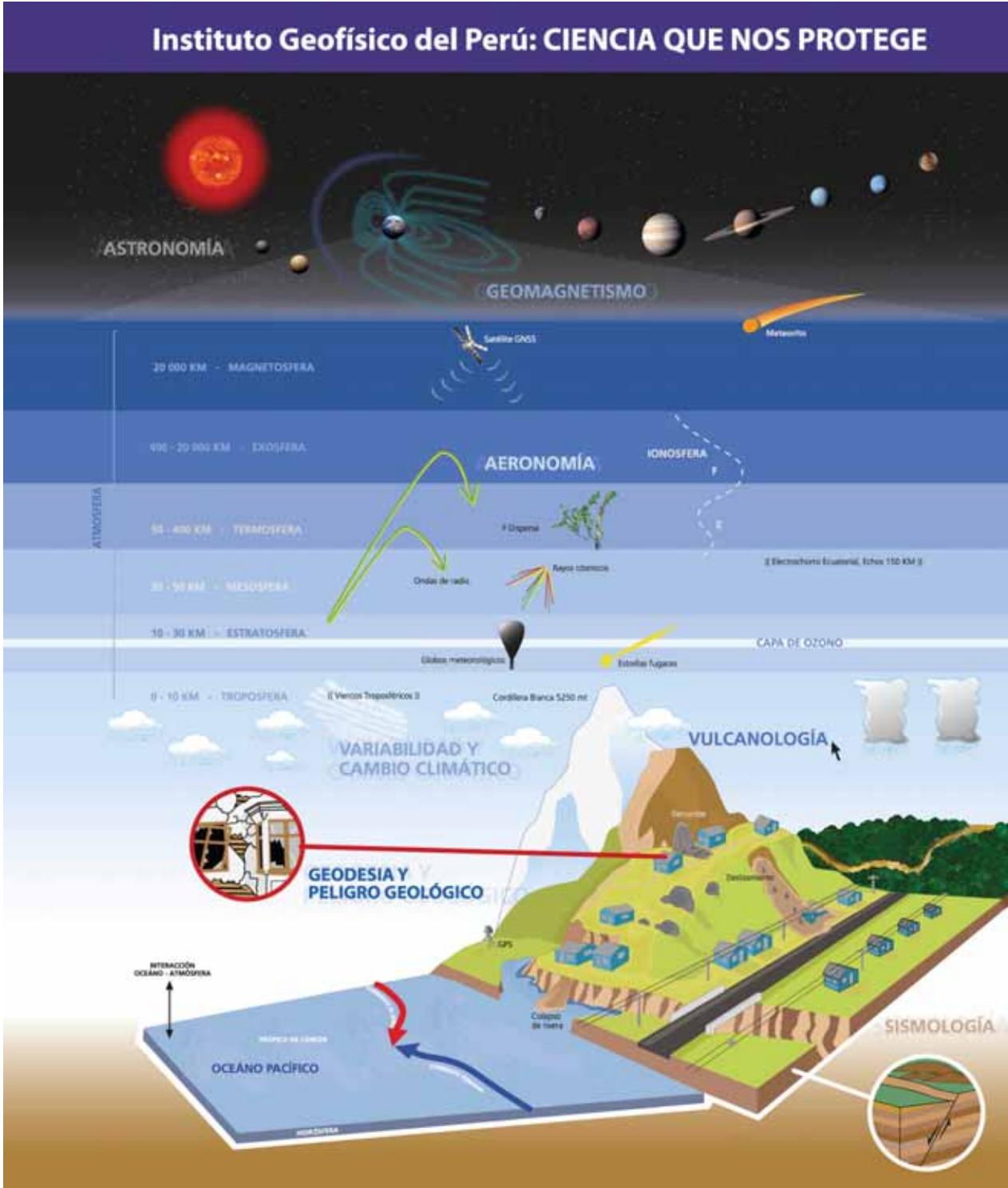
Ministerio
del Ambiente

Instituto
Geofísico del Perú



Andean climate research at the Geophysical Institute of Peru (IGP)

Ken Takahashi and collaborators
Instituto Geofísico del Perú



Research at IGP

Space

- Equatorial aeronomy
- Geomagnetism
- Radio Astronomy

Climate

- ENSO and climate variability
- Climate change
- Atmospheric physics
- Extreme meteorological events

Earth Sciences

- Seismology
- Space Geodesy
- Vulcanology
- Geophysical hazards

Geophysics and Society

- Socioeconomical impacts
- Outreach

IGP Climate Variability and Change Research Group

Research team

Ken Takahashi	Ph. D. Atmospheric Sciences (Head)
Jhan Carlo Espinoza	Ph. D. Environmental Sciences
Yamina Silva	Ph. D. Meteorology
Alejandra Martínez	Eco., M.Sc. Ecología y Gestión Ambiental <i>(IGP, Now head of the "Geophysics and Society" Group)</i>
Kobi Mosquera	M.Sc. Physics
Grace Trasmonte	Fluid Mechanics Eng., M.Sc. Ecology and Environmental Management
Jacinto Arroyo	Ing. Agrónomo
Luis Flores	Ing. Electrónica
Lucy Giraldez	Ing. Agrónoma
Emma Nuñez	Ing. Zootecnista
Julio Quijano	Ing. Mecánica de Fluidos
Berlin Segura	Lic. en Física
Juan Sulca	Lic. en Física
Ricardo Zubeta	Ing. Geógrafo
Steven Chávez	Bach. en Física
Jeffers Palacios	Bach. en Ing. Mecánica de Fluidos
Jorge Reupo	Bach. en Física
Miguel Saavedra	Bach. en Física

3 Ph.D., 3 M.Sc., 8 Ing./Lic., 4 Bachilleres

Active collaborators

Boris Dewitte	LEGOS/IRD, Francia
Katerina Goubanova	LEGOS, Francia
Dimitri Gutiérrez	IMARPE
Juan Carlos Gómez	IGP
Jean Loup Guyot	HYBAM/LEGOS, Francia
Pablo Lagos	MRI/IGP
Waldo Lavado	SENAMHI/UNALM
Mathieu Lengaigne	LOCEAN/IRD, Francia
Aldo Montecinos	U Concepción, Chile
Josyanne Ronchail	LOCEAN, Francia
José Rutllant	U. Chile/CEAZA, Chile
Fidel Villena	MINSA
Federico Velazco	IMARPE
Ronald Woodman	IGP

Current students

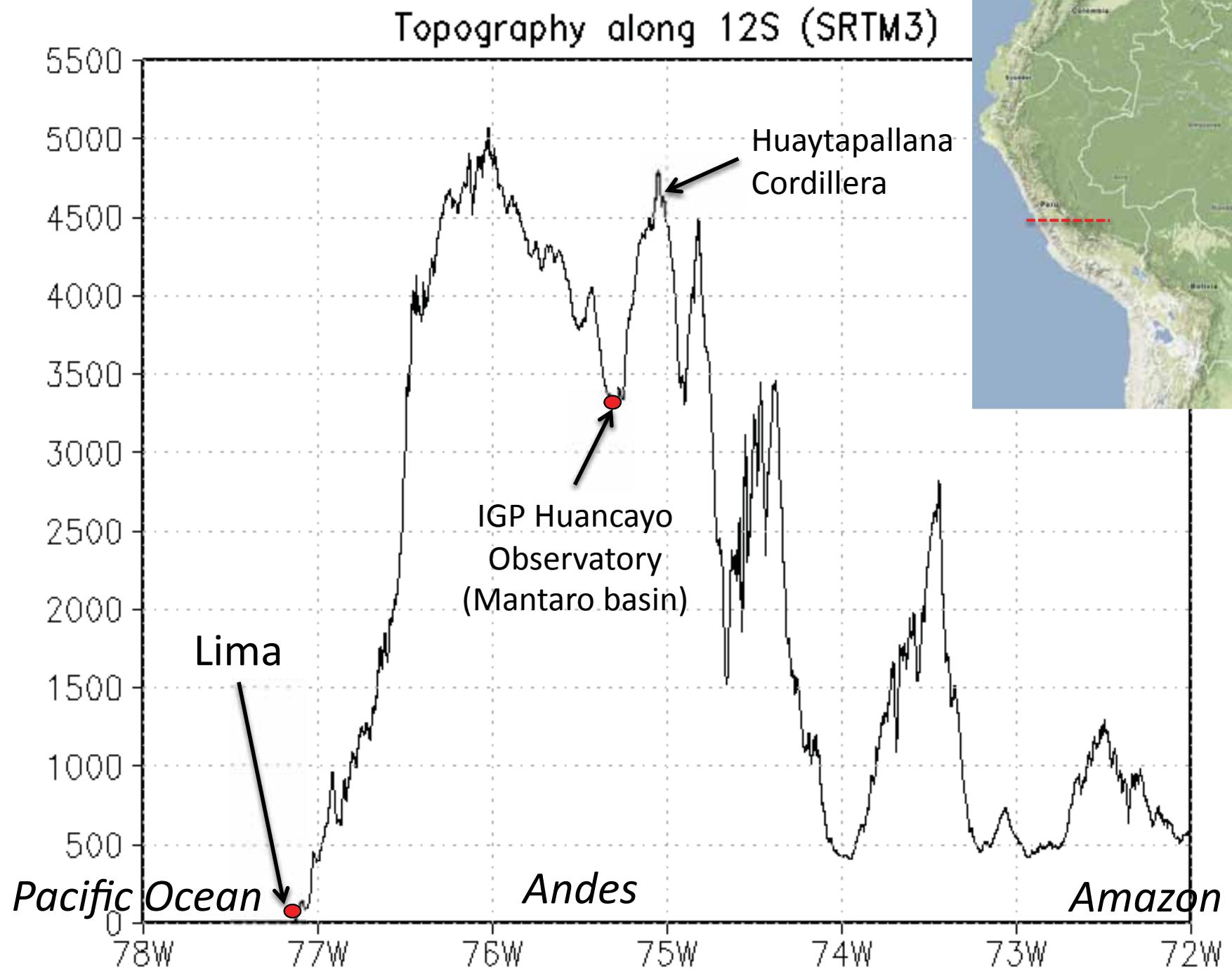
Sofía Endara	Física (UNMSM)
Jeancarlo Fajardo	Física (U. Callao)
Melissa Medina	Física (UNMSM)
César Sánchez	Física (UNMSM)
José Vásquez	Geografía y Medio Ambiente (PUCP)

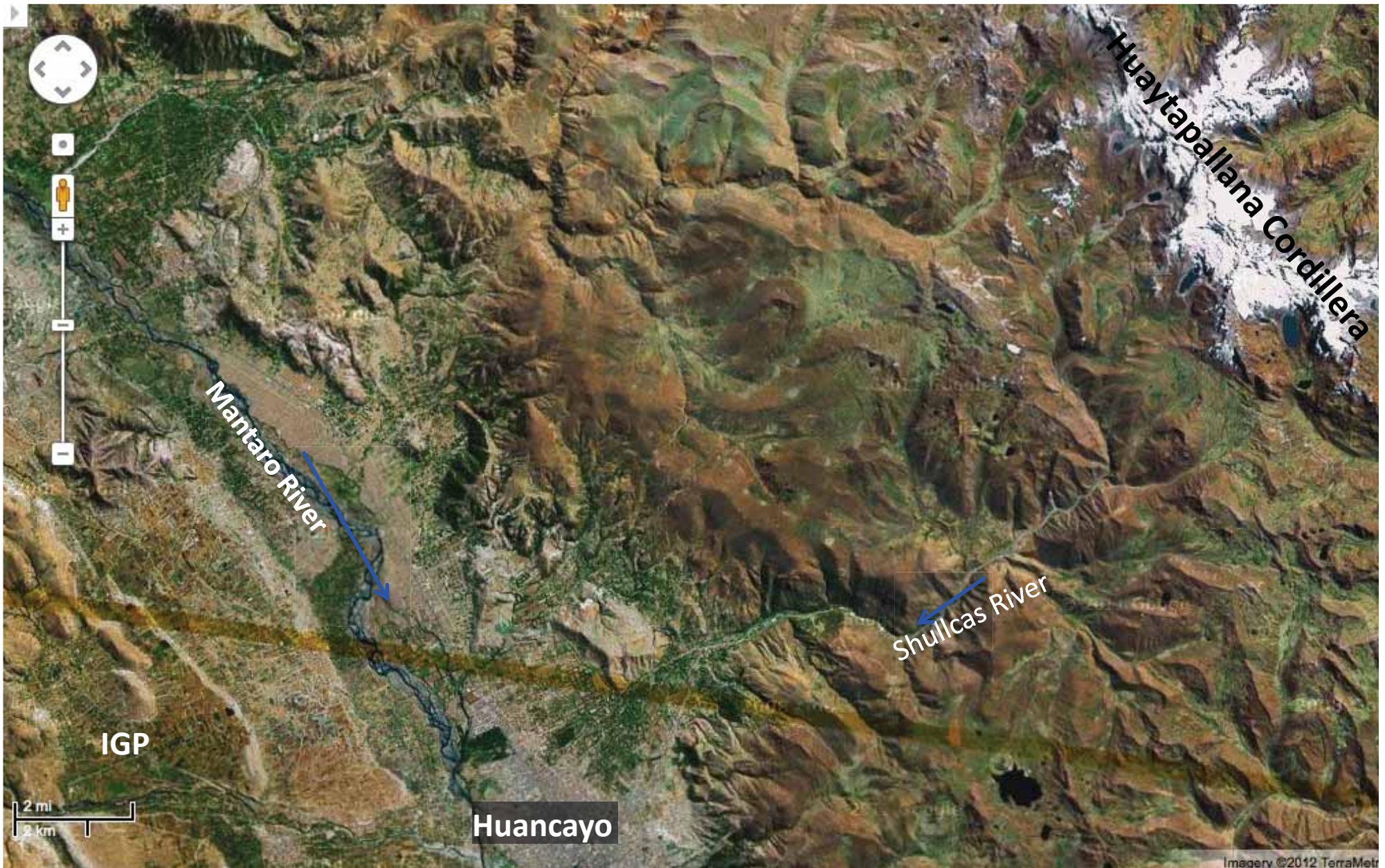
Support staff

Huber Gilt	Ing. Electrónica
Susana Huaccachi	Téc. Computación
Danny Pereyra	Téc. Computación



Huancayo Observatory (1921-present)
Birthplace of IGP





Boundary layer-Troposphere Radar

3D sonic anemometer



Meteorological station



177 m

Imagery Date: Jun 18, 2010

Aerosol sensors (NASA AERONET, to be installed)



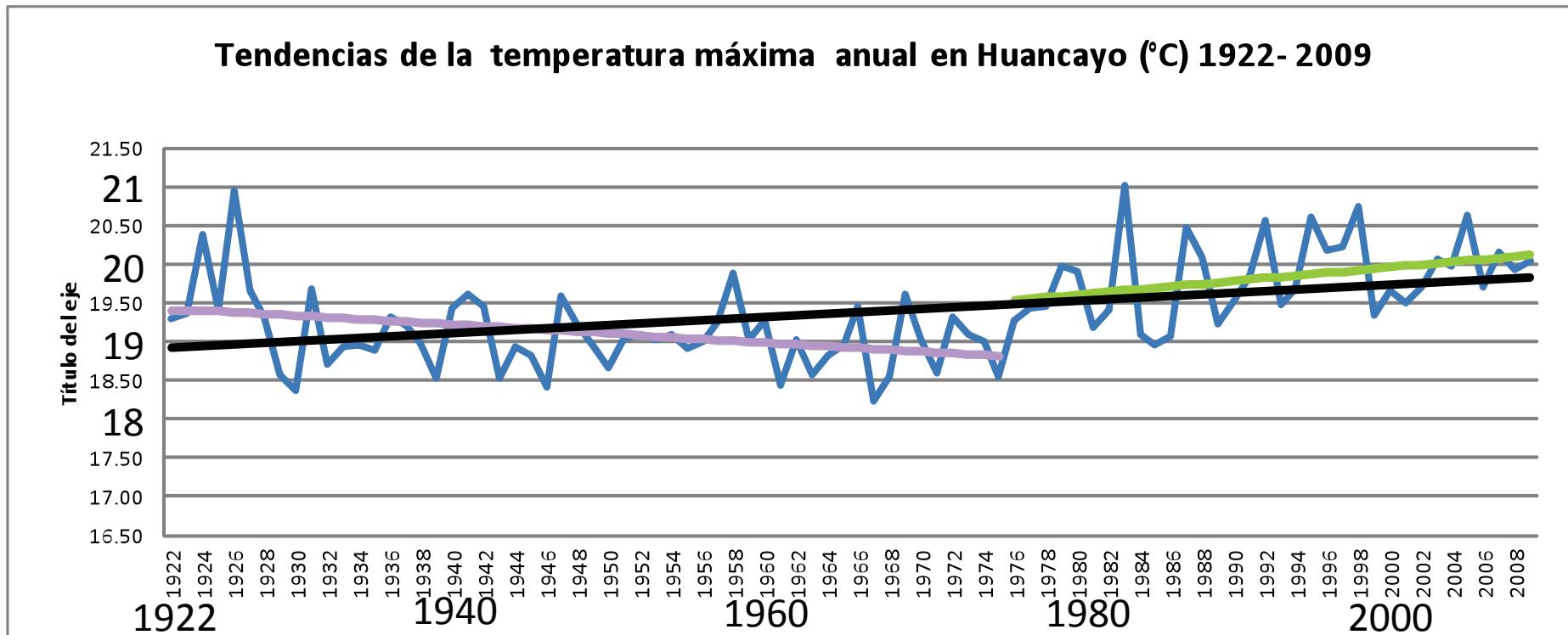
Observatorio de Huancayo Laboratorio de Micrometeorología y Radiación

Image © 2011 GeoEye

lat -12.041639° lon -75.319724° elev 3313 m

322 m

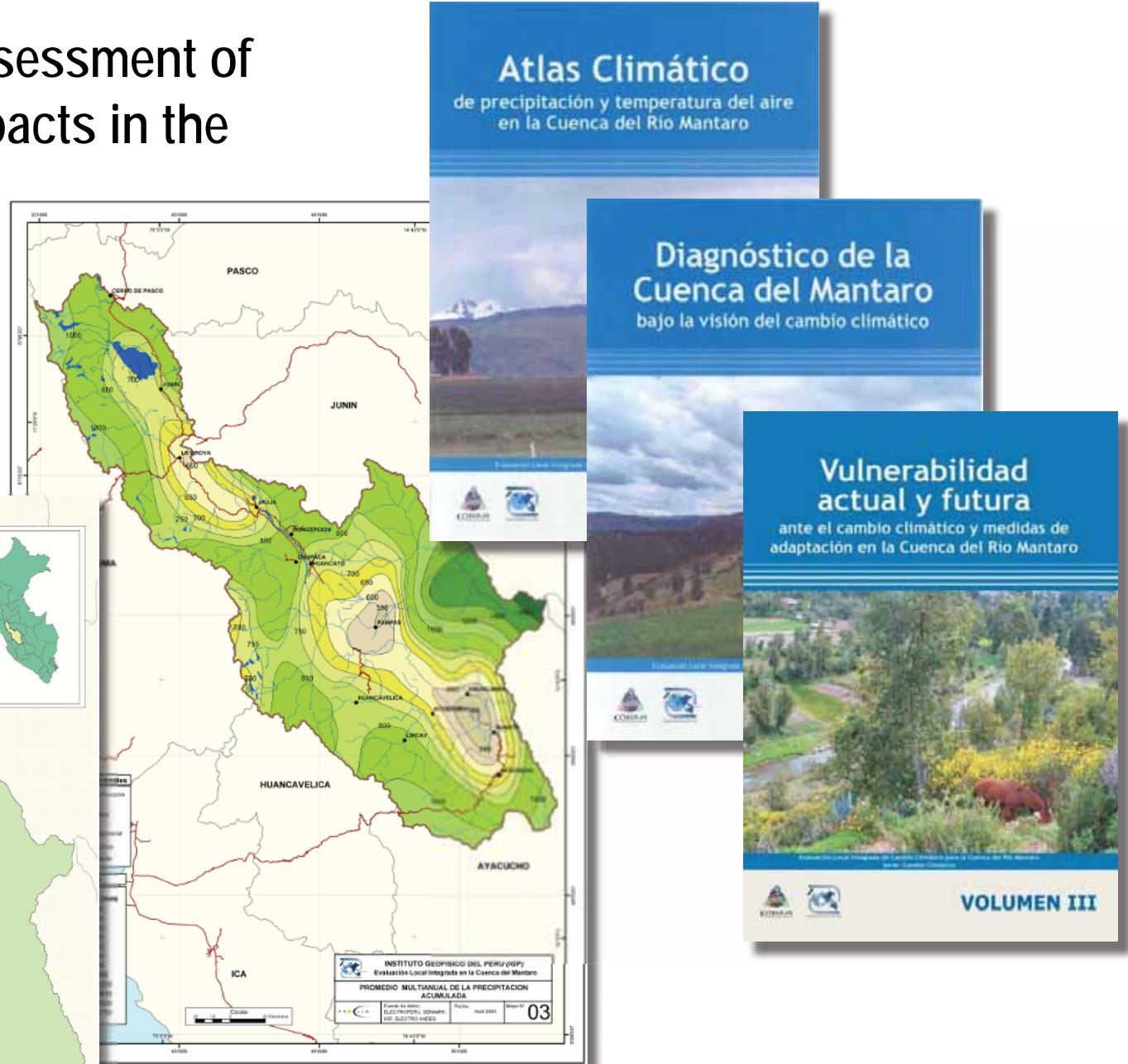
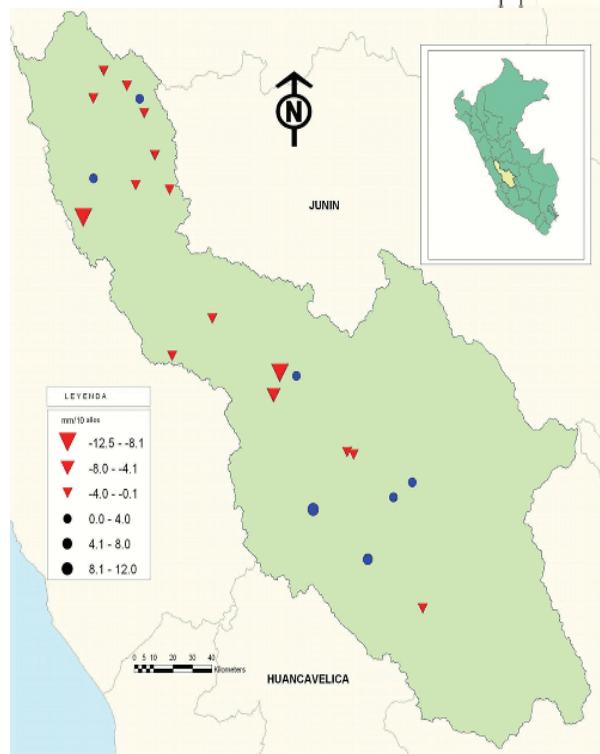
Trends in maximum temperature in the Huancayo Observatory (1922-2009)



1922-2009: 0.11 °C/decade	—
1922-1975: -0.10°C/decade	—
1976-2009: 0.18°C/decade	—

Local Integrated Assessment of Climate Change Impacts in the Mantaro Basin

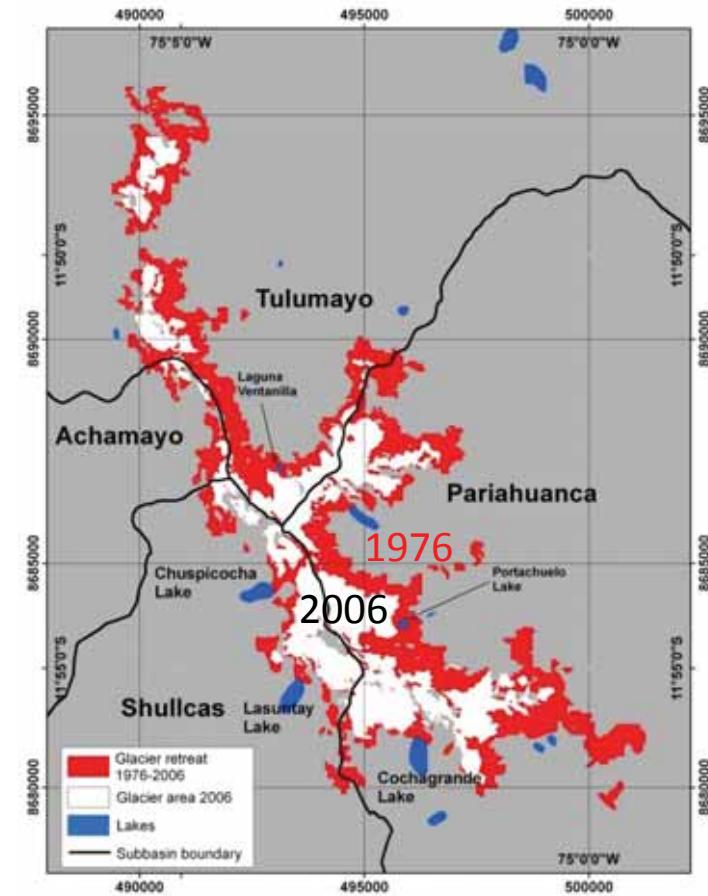
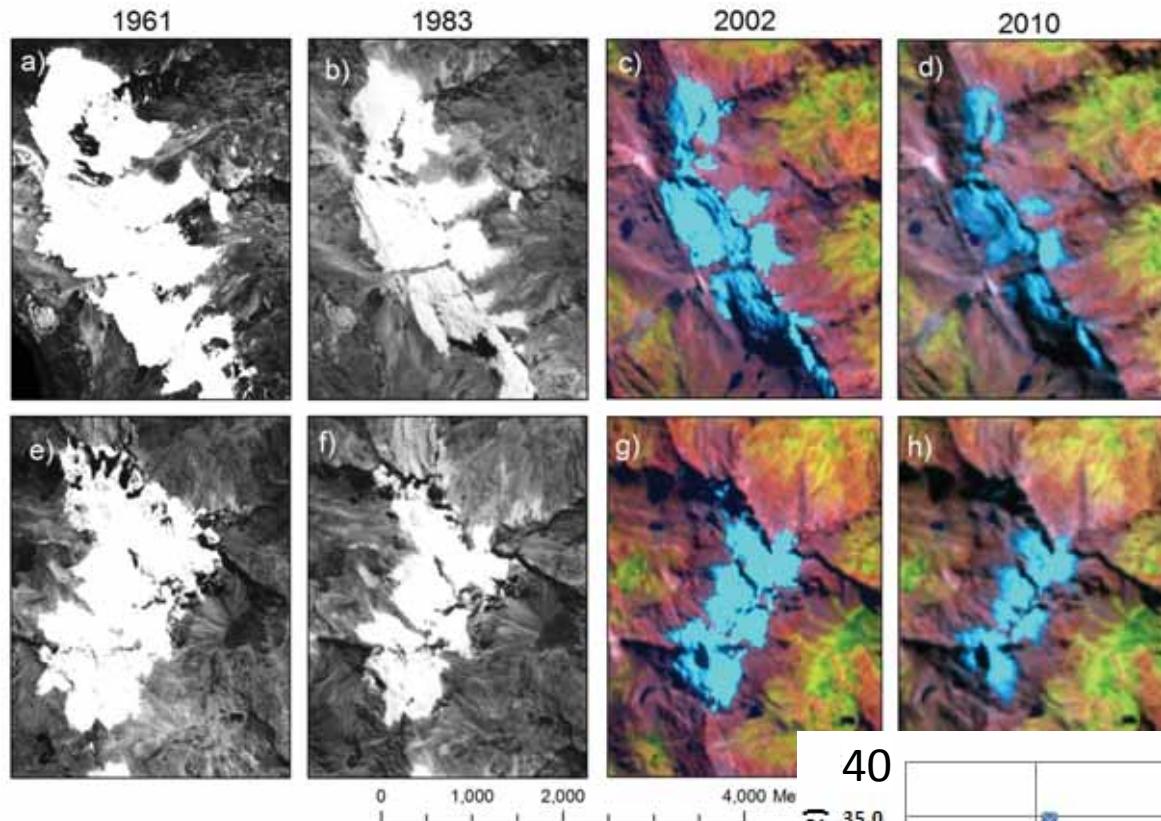
Annual precipitation trends (1950-2000)



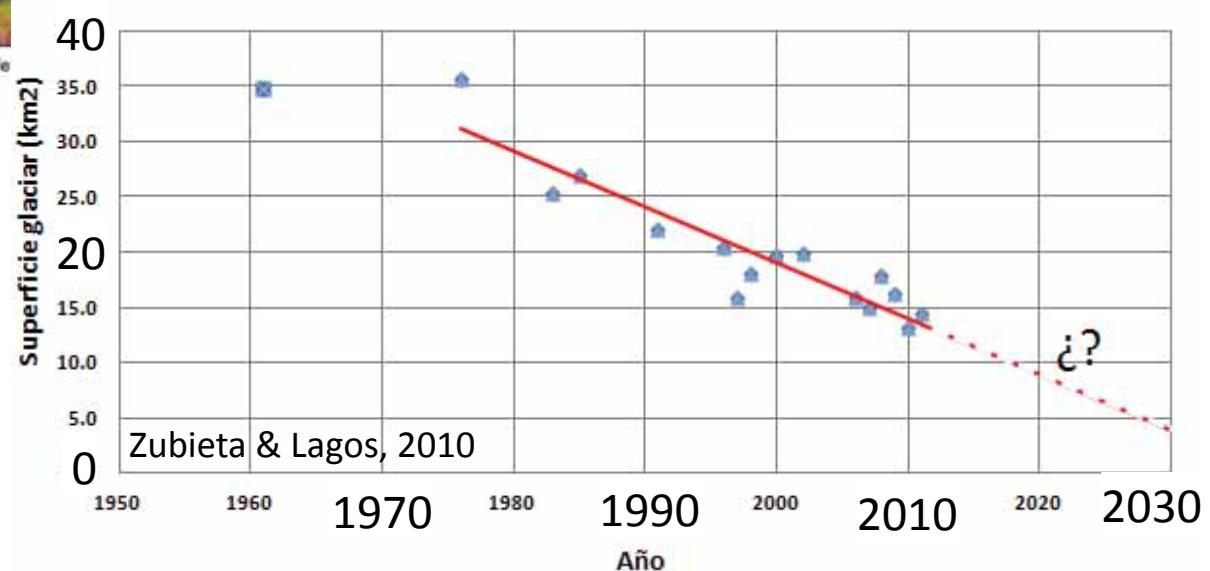
Annual precipitation climatology

IGP 2005

Changes in Huaytapallana glacier area

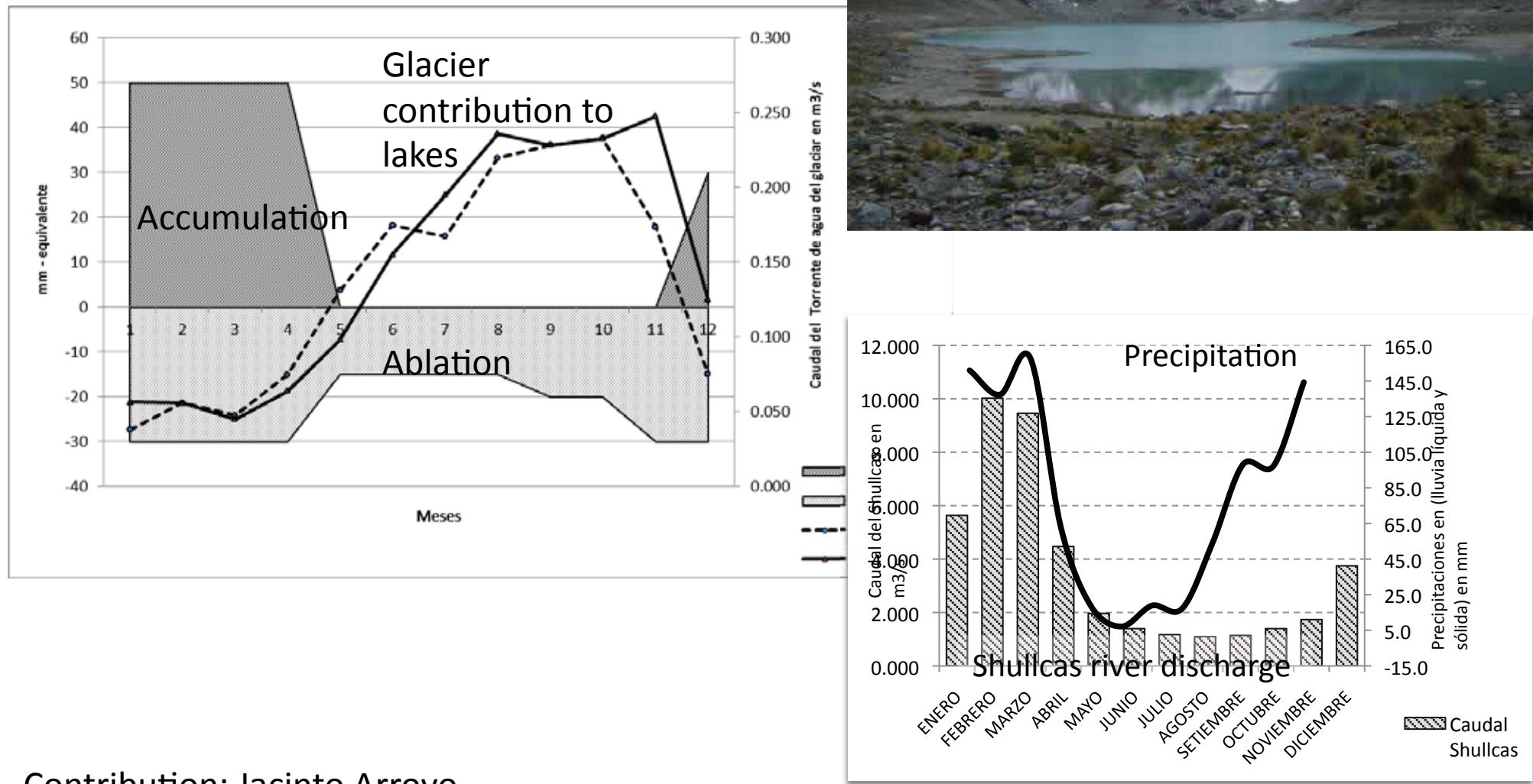


From the analyzed images(Satellite images and aerial photographs) we can conclude, that an important glacier retreat has been observed. Reaching its major loss in 2006, of up to 59.4% in the entire surface glacier.



Contribution: Ricardo Zubieta

Huaytapallana glacier and hydrology of lakes Lasuntay and Chuspicocha: Seasonal variations



Project (proposal)

Sustainability of water supply in the Mantaro valley under accelerating deglaciation

Activities:

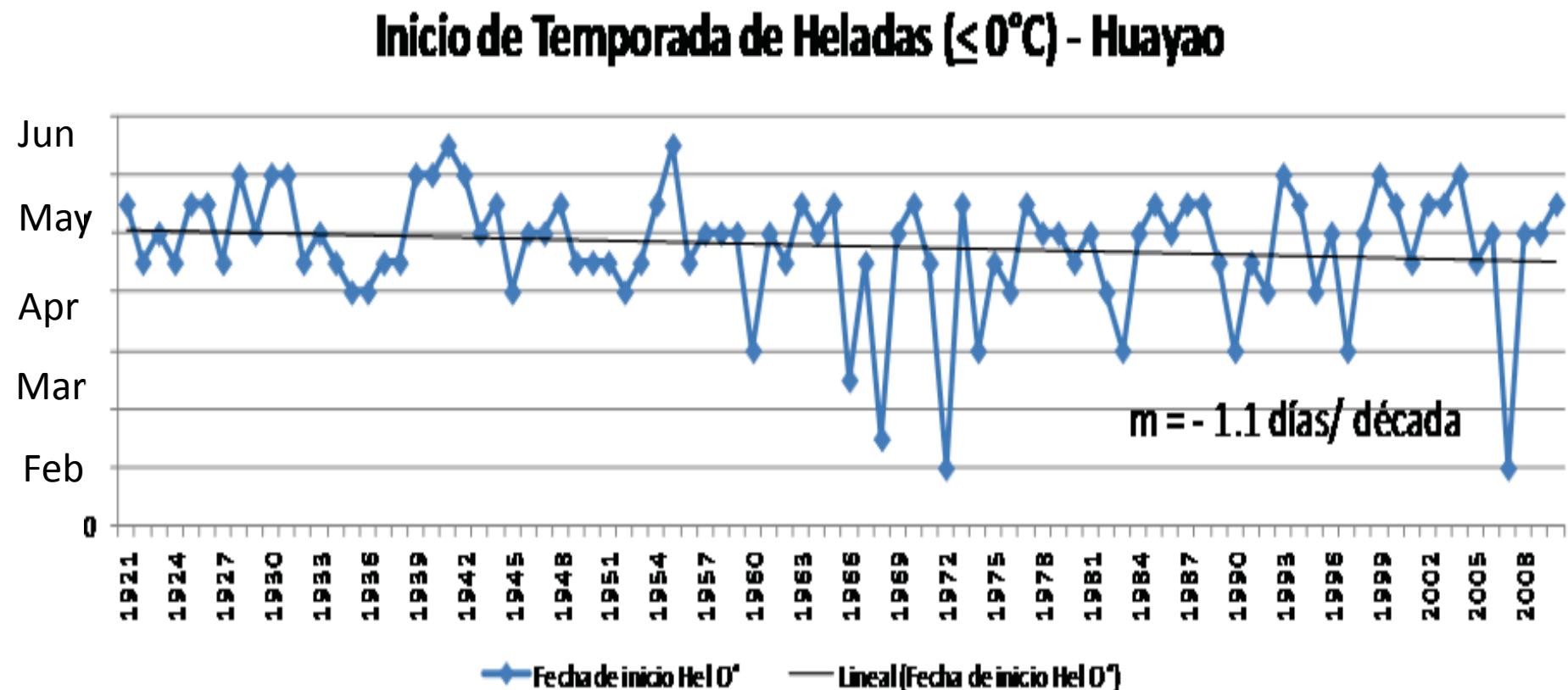
- Assessment of volume change of Huaytapallana glacier with LIDAR, isotopic and hydrochemical analysis and hydrological modeling.
- Scenarios of water availability by year 2050
- Assessment and prioritization of adaptation measures

Execution: Ohio State University/University of McGill/IGP Consortium

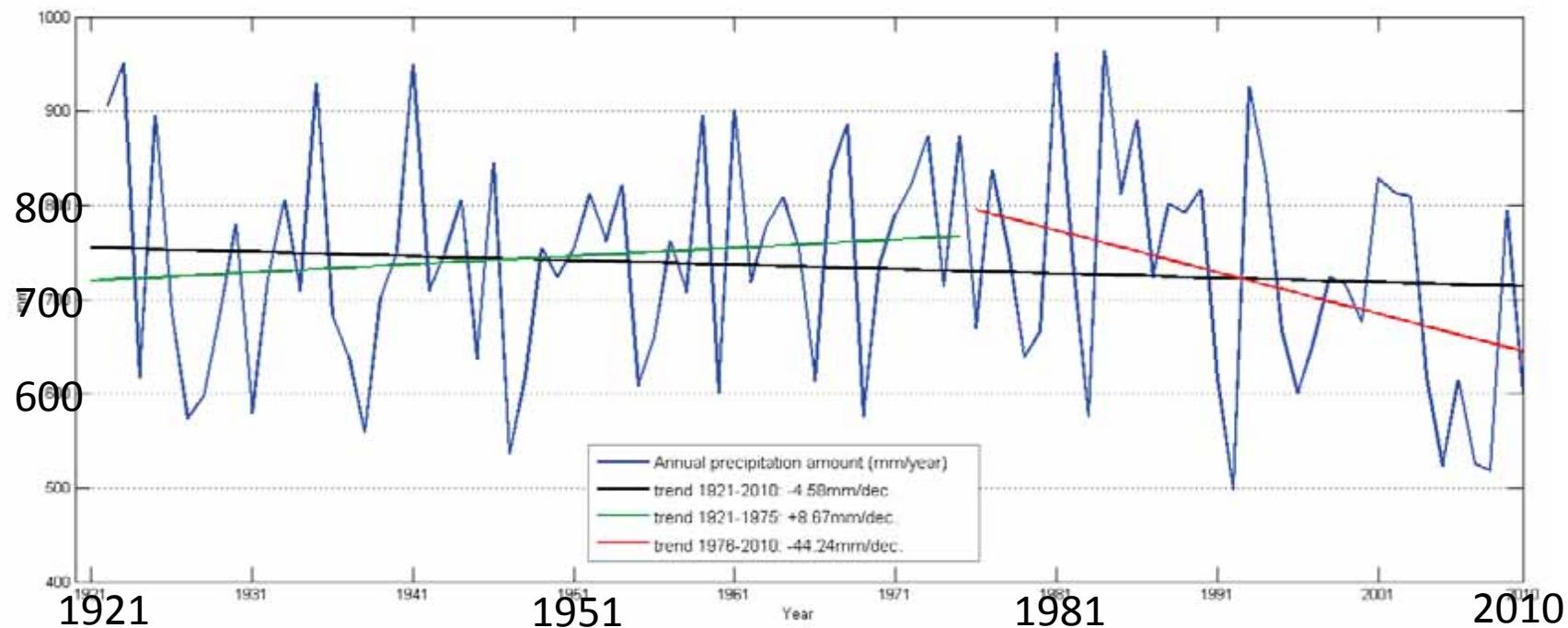
PIs: Bryan Mark (OSU), Jeff McKenzie (McGill), Pablo Lagos (MRI/IGP).

Expected funding: Regional Government of Junin/SEDAM/Consortium

Trend in the onset date of frost season



ANNUAL RAINFALL TRENDS (HUANCAYO OBS.)



1922-2010: -2.8 mm/decade

1922-1975: 16.0 mm/decade

1976-2010: -46.5 mm/decade

Project (closing soon)



MAnejo de **R**iesgos ante **E**ventos **M**eteorológicos **E**xtremos como medida de adaptación ante el cambio climático en el valle del **MANTARO** (2009-2012)

OBJECTIVES

INVESTIGACIÓN - ACCIÓN

Identificar los actores clave involucrados y evaluar las actuales capacidades de manejo del riesgo de desastres

Fortalecer y profundizar los estudios sobre los procesos físicos que rigen la ocurrencia de eventos meteorológicos extremos en la región

Evaluar la vulnerabilidad actual y elaborar planes participativos de manejo de riesgo local

Fortalecer las instituciones locales, sensibilizar a la población y difundir los resultados del proyecto

The main objective is to strengthen the capacity of risk management to extreme meteorological events by the population and the institutions that are in charge of the natural resources management, in order to reduce the vulnerability of the urban and rural population in the Mantaro valley to climate change. It's expected that the knowledge generated will serve as input into the preparation of local plans for adaptation.

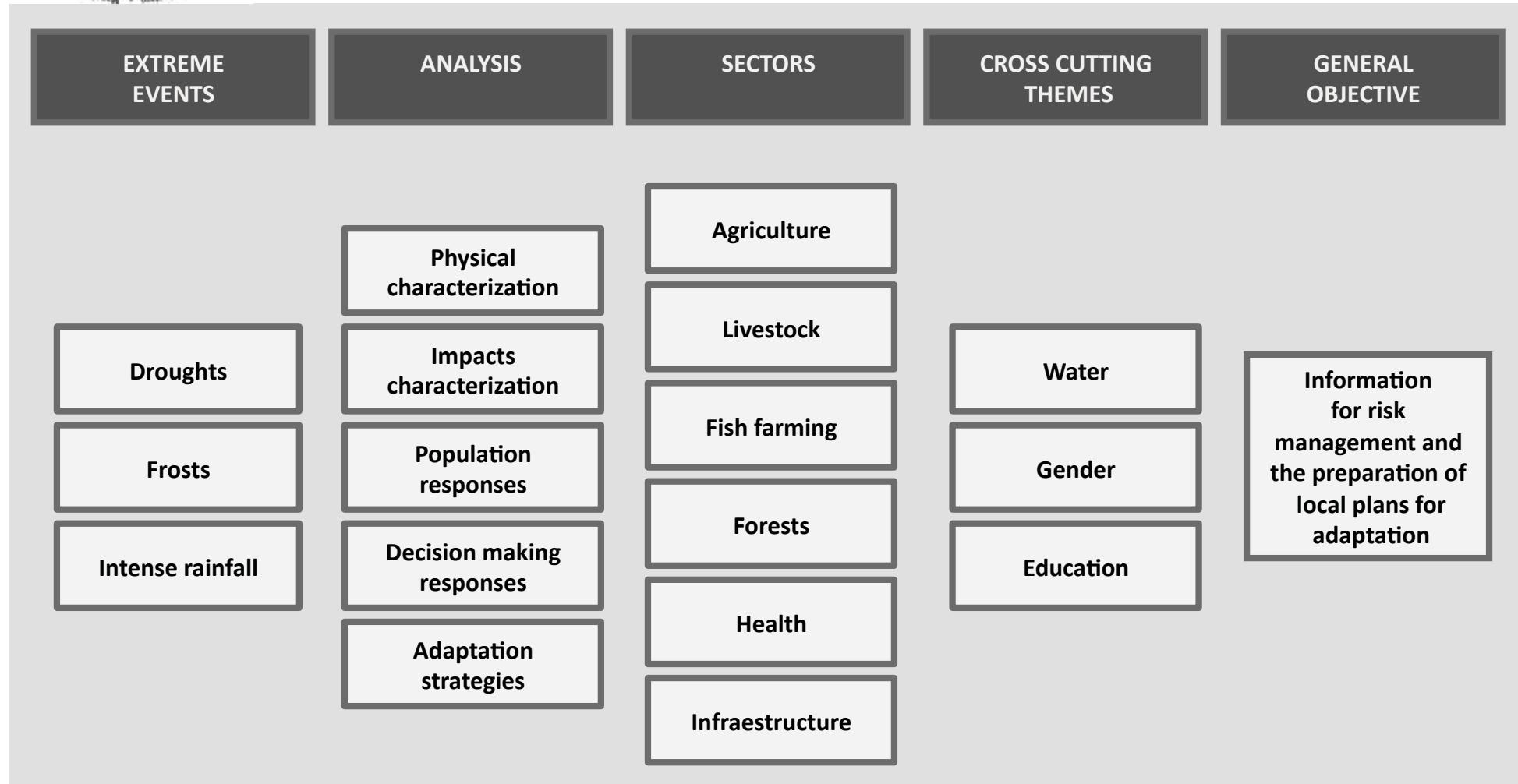
Execution: IGP

PI: A. Martínez

Funding: IDRC (Canada)

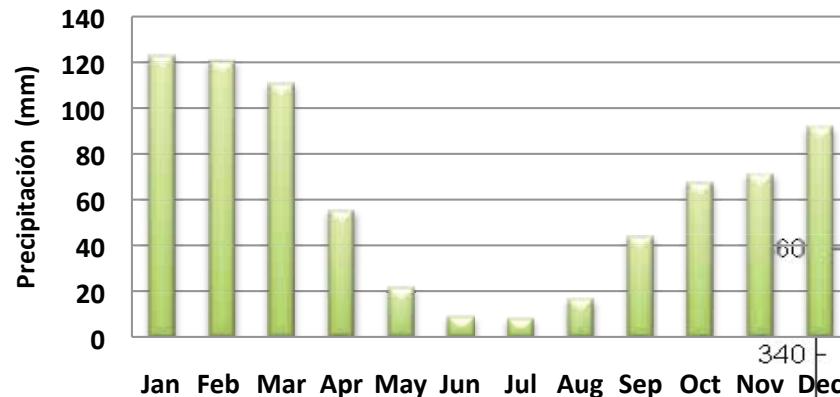


RESEARCH ORGANIZATION

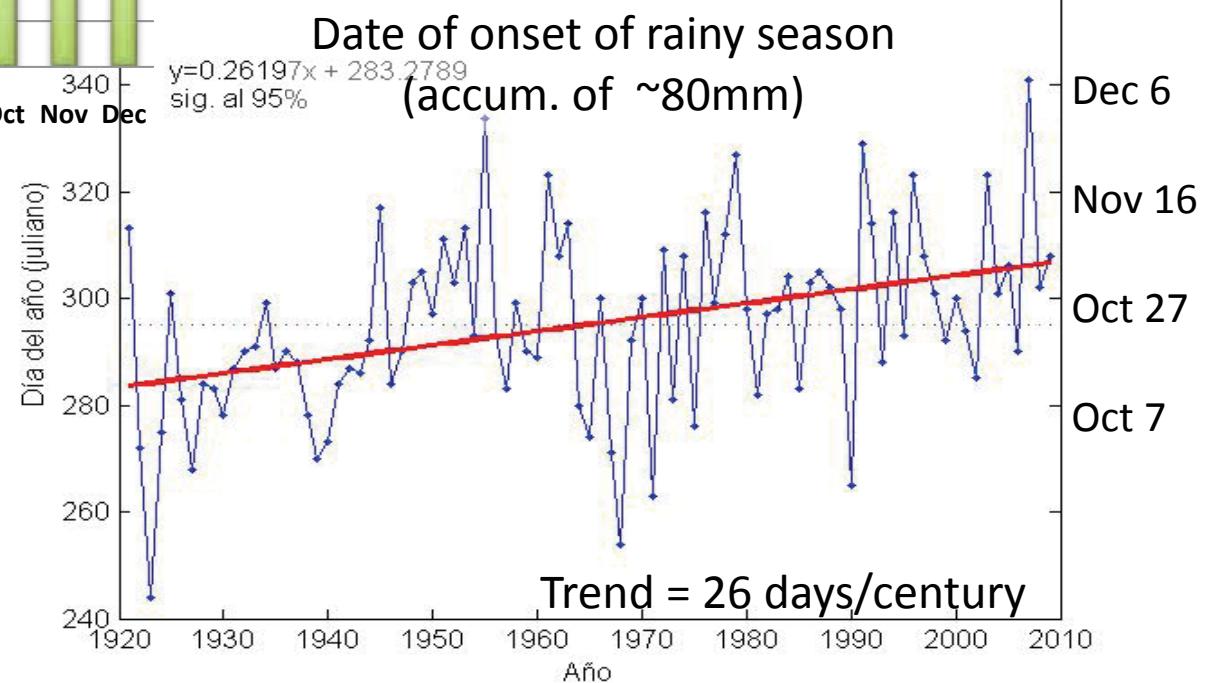


Delay in onset of rainy season (Huancayo)

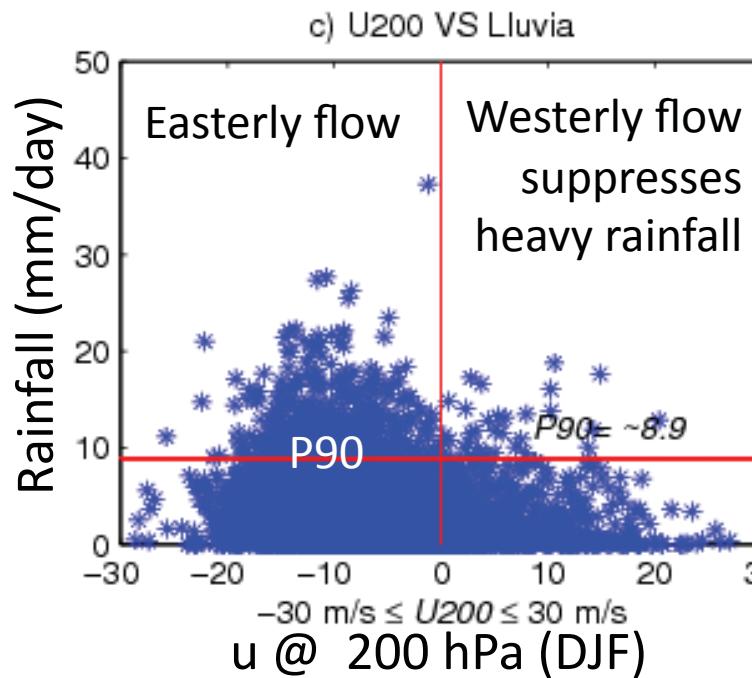
Monthly rainfall climatology in Huayao
(1921-2010)



Onset of rainy season =
Date in which soil is moist
enough for sowing of *tarwi*
(~80 mm of rainfall
accumulated in the season).



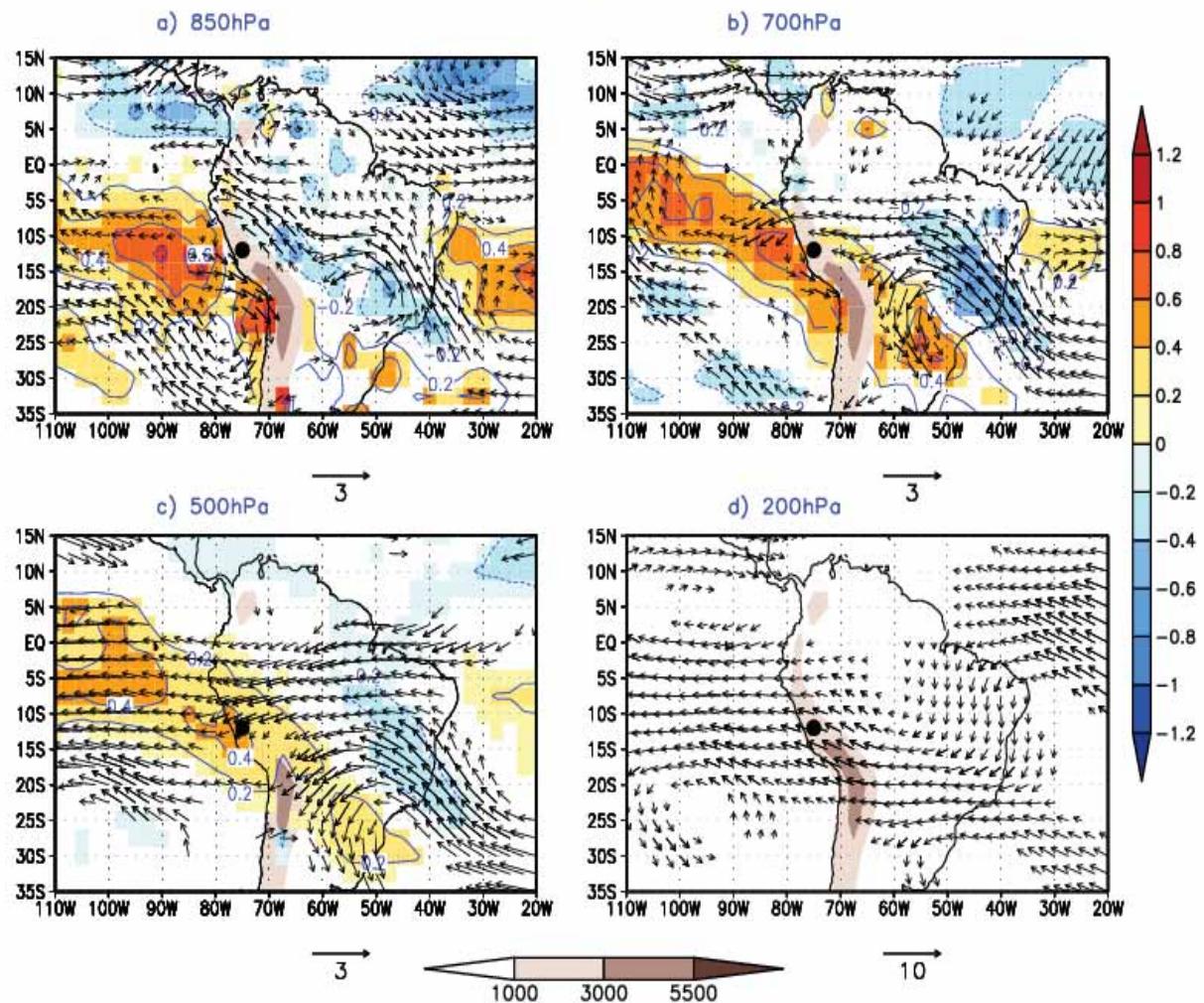
Atmospheric circulation and rainfall in the Mantaro basin



Outstanding question:
When wind is easterly, what determines whether rainfall will be intense?

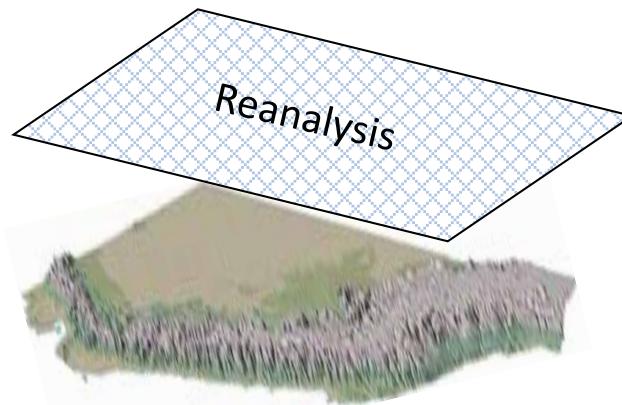


Mantaro heavy rain composite of wind (m/s) and specific humidity (g/kg) anomalies (DJFM)



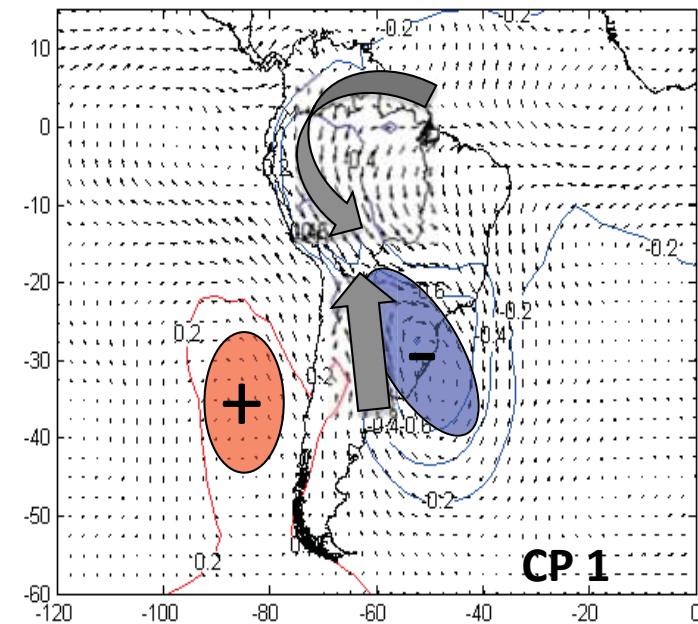
Definition of large-scale circulation patterns (CPs) in tropical South America using neural networks

Daily atmospheric inputs



||| Neural networks:
(Kohonen maps)

Total winds and geopotential at 850 hPa.
CP associated to extreme rainfall in south of Peruvian Amazon

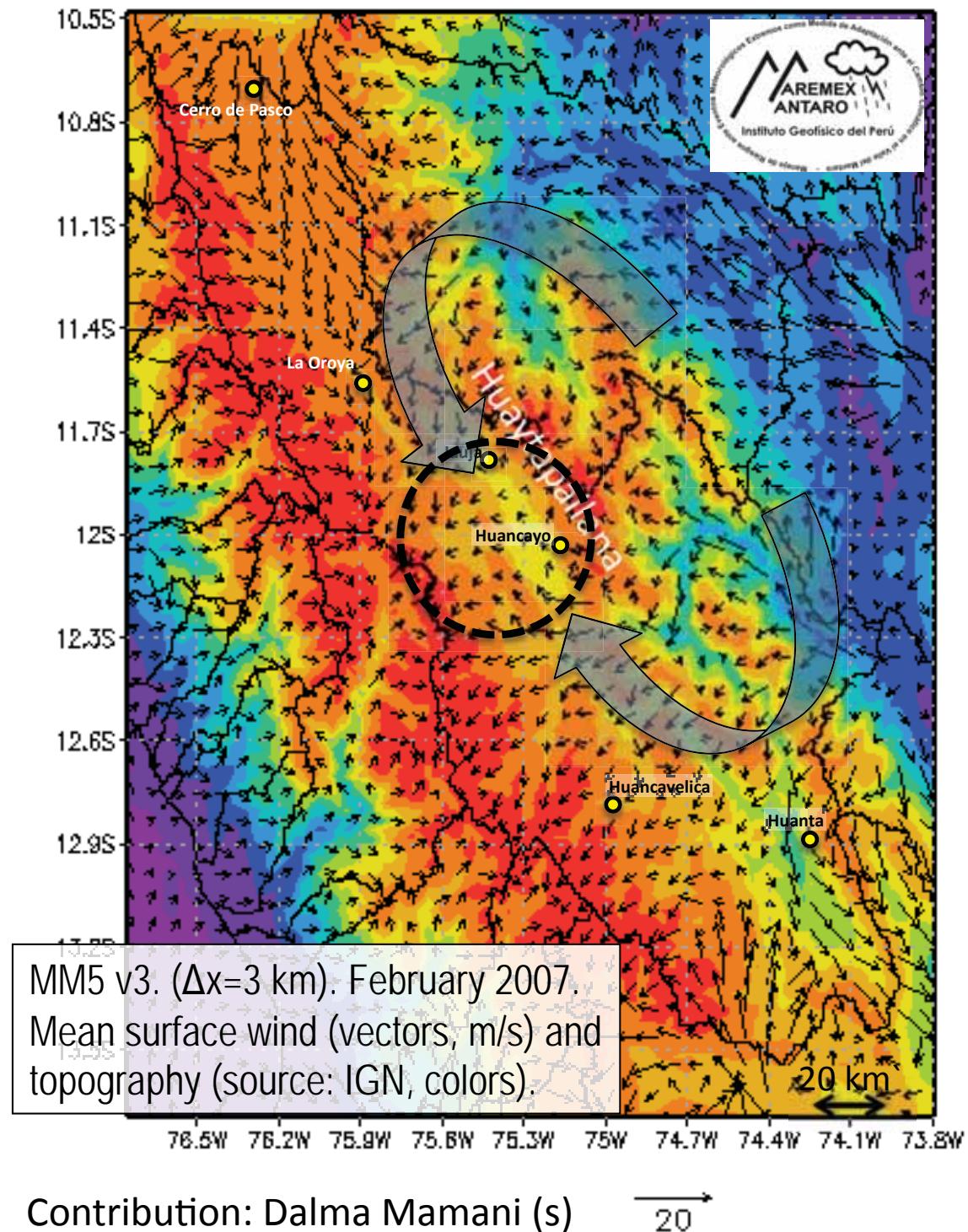


In the lowland, CPs are well related to:

- ✓ Extreme rainfall (Espinoza et al., 2011. Clim Dyn)
- ✓ Cold surges (Espinoza et al., submitted, Clim Dyn)

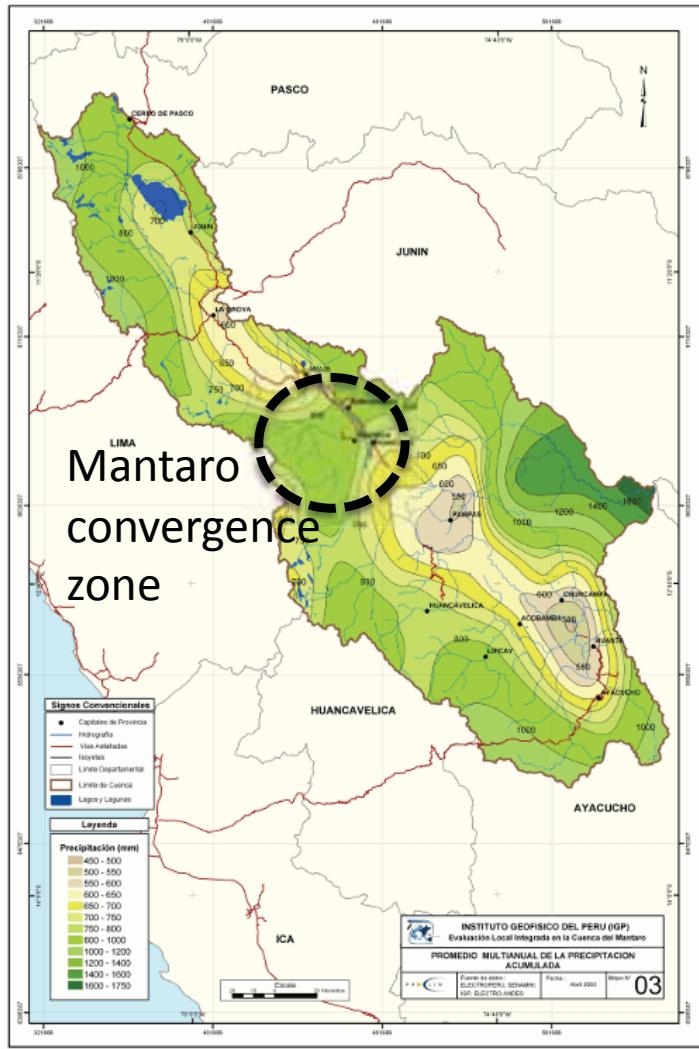
Definition of large-scale CPs in the middle and high troposphere and related to extreme rainfall and temperature in the Andes

Contribution: Dr. Jhan Carlo Espinoza



High-resolution atmospheric modeling in the Mantaro basin

Rain gauge climatology



Radiative frosts and surface energy budget

Field campaign:
July 15-18, 2010

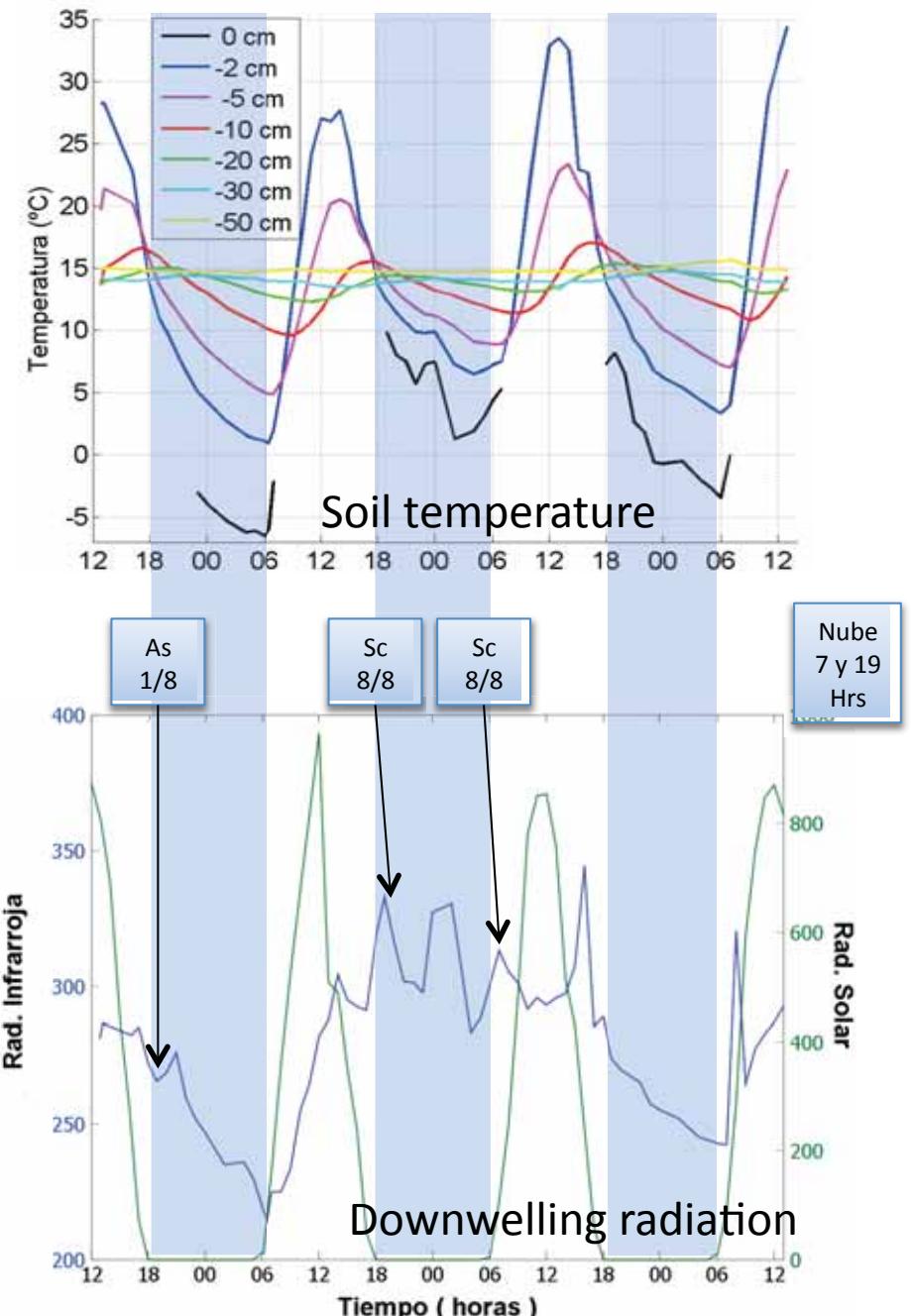
Measurements

- Soil temperature
- Downwelling shortwave and longwave radiation
- Standard meteorological measurements

Pyrgeometer



Geothermometers



Contribution: Miguel Saavedra (s)

Radiative frosts and surface energy budget



1. Model for surface temperature

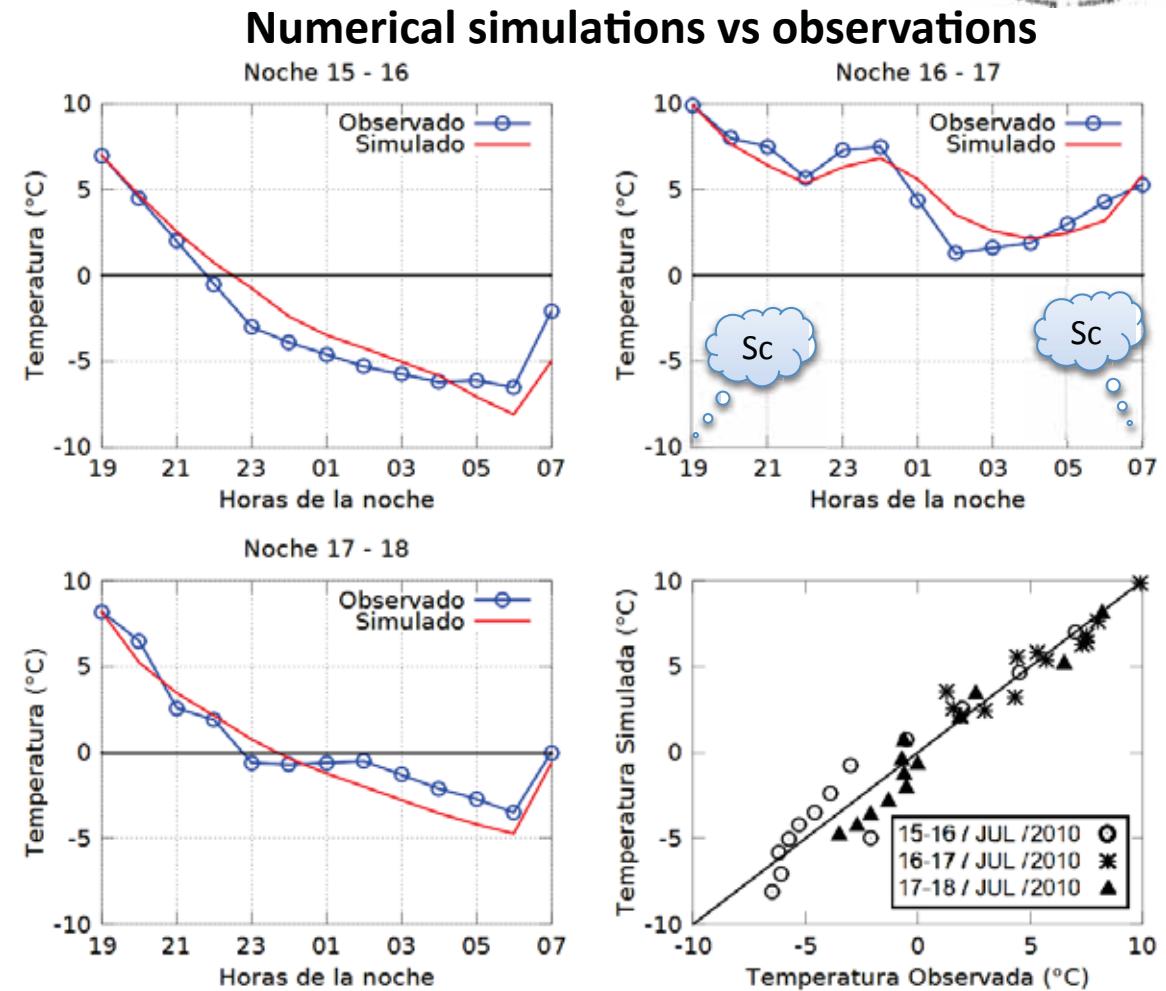
- Surface energy balance
- Multi-level soil heat diffusion

2. Radiative transfer model (SBDART)

To estimate $LW\downarrow$ and its sensitivities.

Conclusions

- Frosts are mainly determined by $LW\downarrow$, which in turn is controlled mainly by cloudiness, followed by air humidity and finally air temperature.
- Soil moisture can have a strong mitigating effect

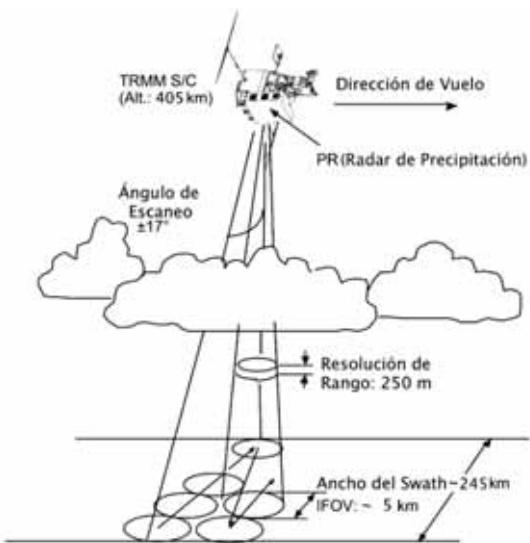


Perspectives

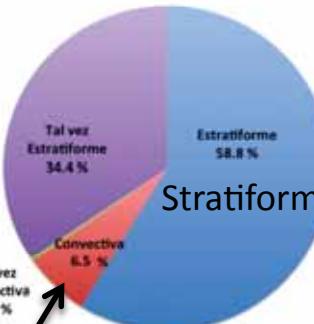
- Extend the validation period of the model.
- Characterize the behavior of the PBL and improve the modeling of $LW\downarrow$ with the radiative transfer model
- Study the seasonal cycle in temperature

Contribution: Miguel Saavedra (s)

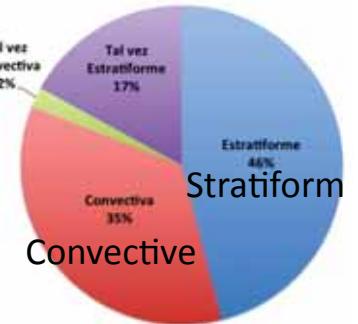
TRMM Precipitation Radar study of the Mantaro basin



rainy pixels



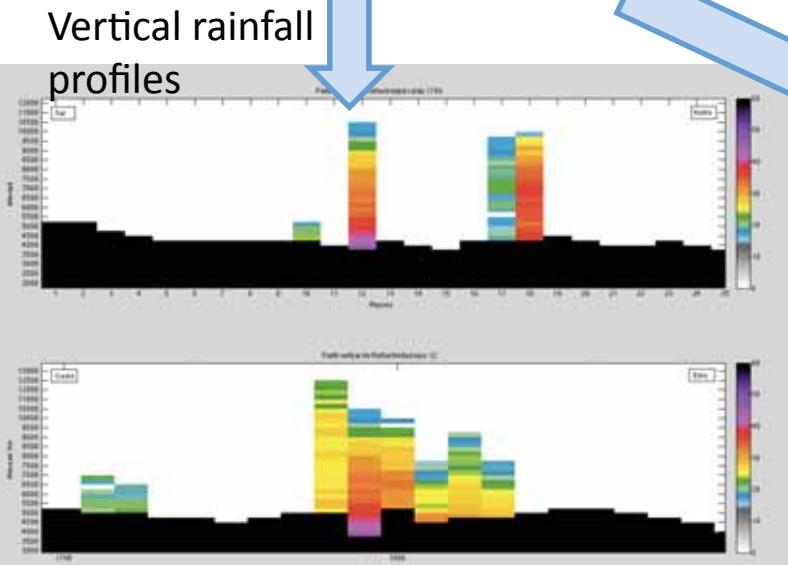
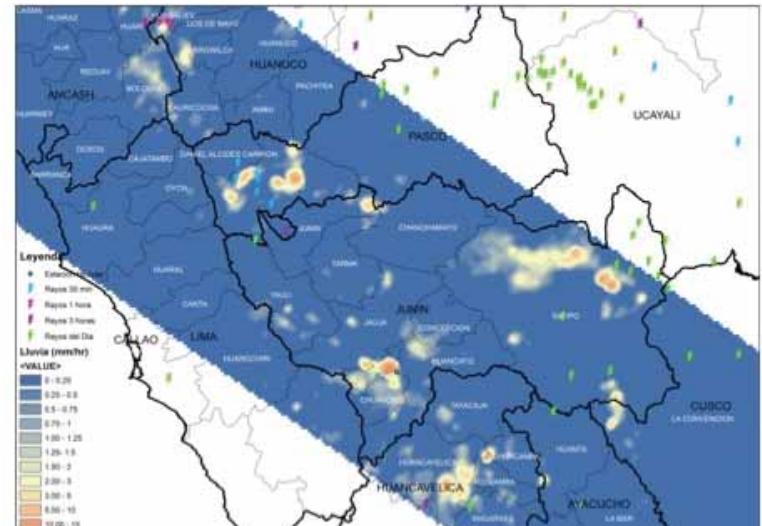
Surface rainfall



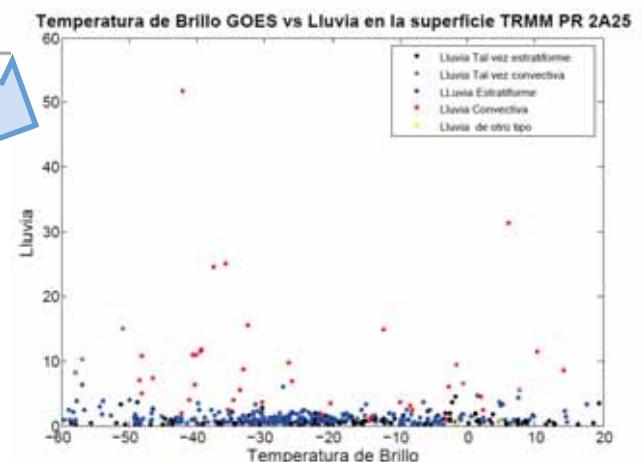
Rainfall-type classification
(importance of extreme events)

High resolution ($dx=5$ km)
TRMM rainfall & WWLLN lightning

Convective



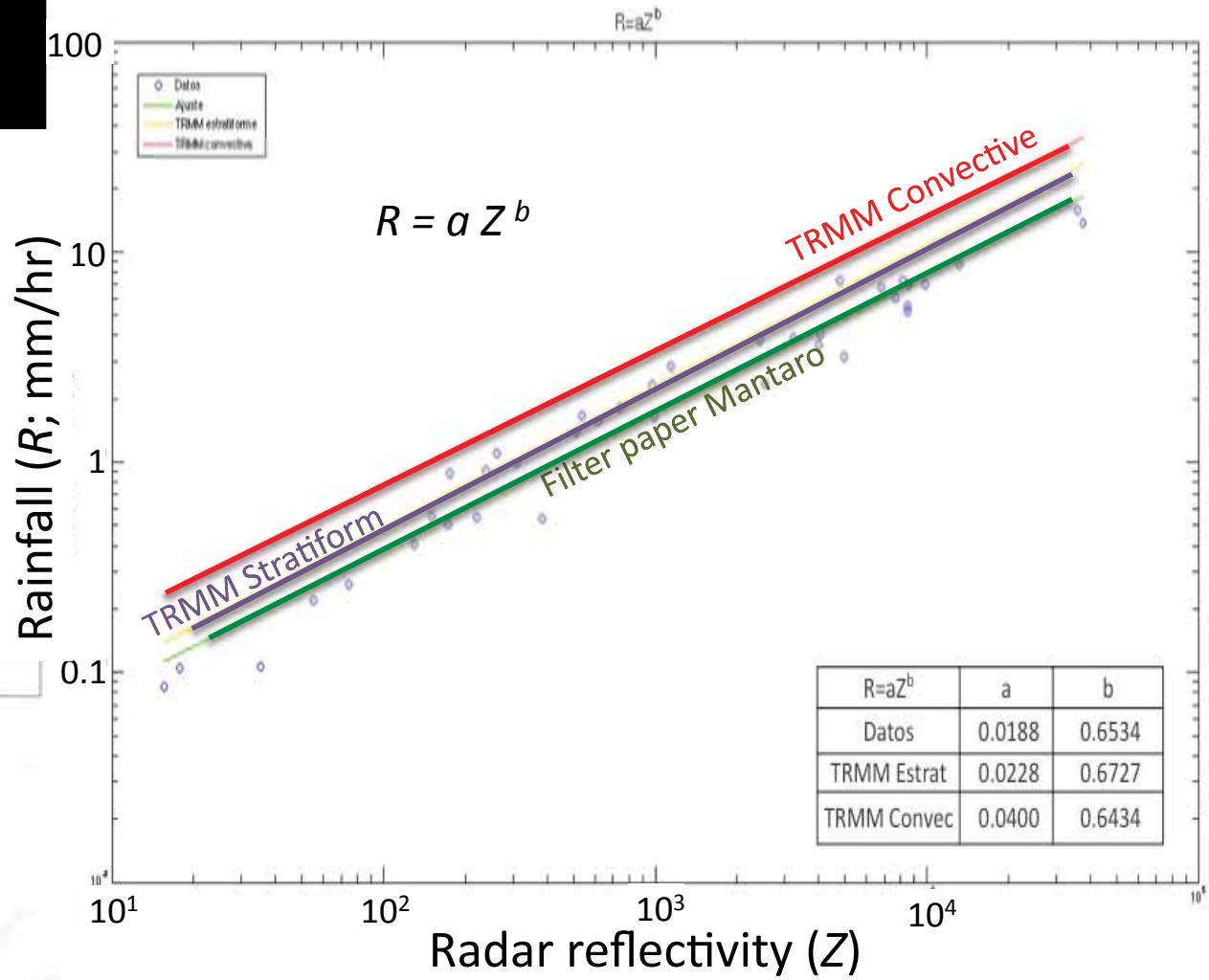
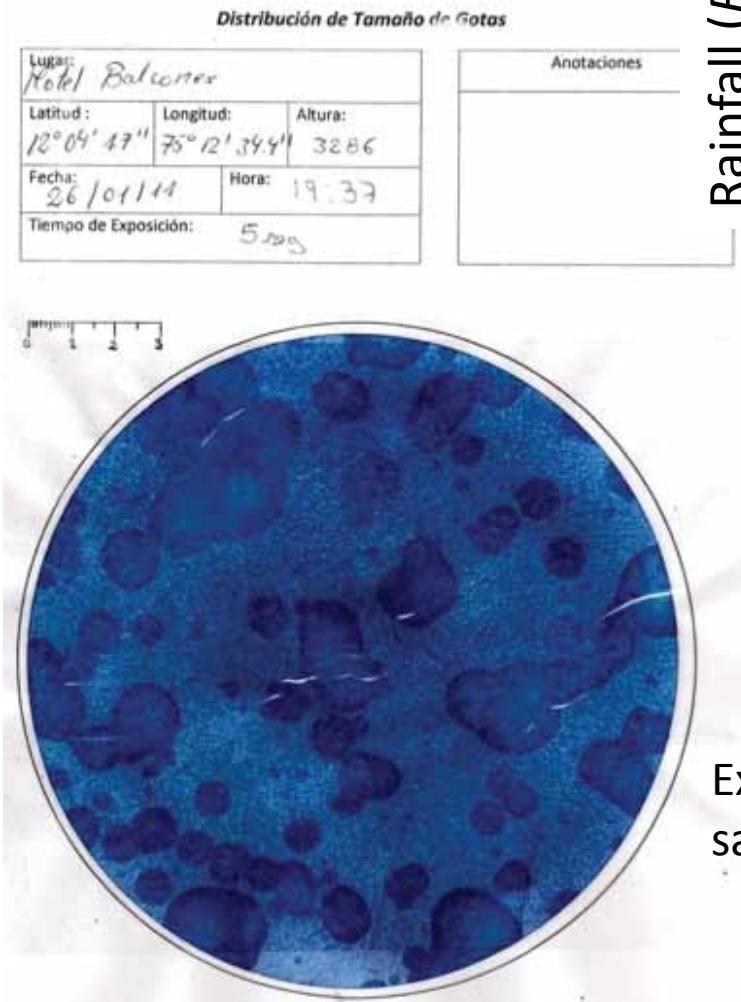
Little relation
between TRMM
rainfall and GOES IR
brightness
temperature



Contribution: Steven Chavez (s)

TRMM Precipitation Radar study of the Mantaro basin

Validation of the TRMM PR parameters in the Mantaro basin



Example of Drop Size Distribution sample with filter paper technique

Contribution: Steven Chavez (s)



Project (in review)

Rainfall hotspots in the eastern Peruvian Andes

Objective:

Understand the mechanisms that control the strong rainfall in the eastern Andes/western Amazon and estimate climate change scenarios for this region.

Principal investigators

Dr. K. Takahashi (IGP)

Dr. R. Houze (U. Washington)

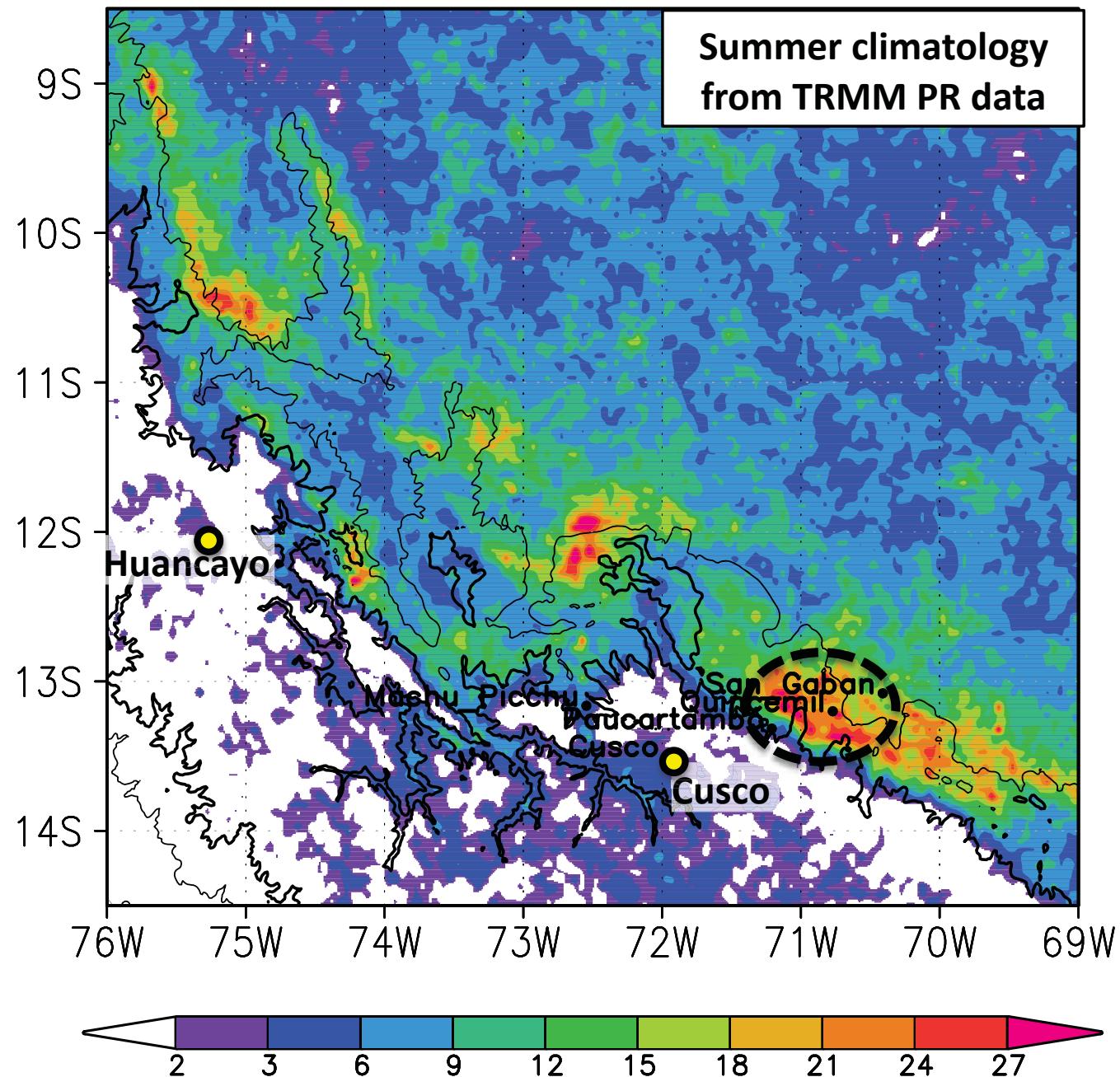
Collaborator:

Dr. J. C. Espinoza (IGP)

Expected funding:

PEER (NSF/USAID)

Rainfall climatology (Dec–Feb; mm/day) from TRMM precipitation radar (Nesbitt and Anders 2009) and topography contours (thin: 800 and thick: 3000 m; ETOP02)



Project (in preparation)

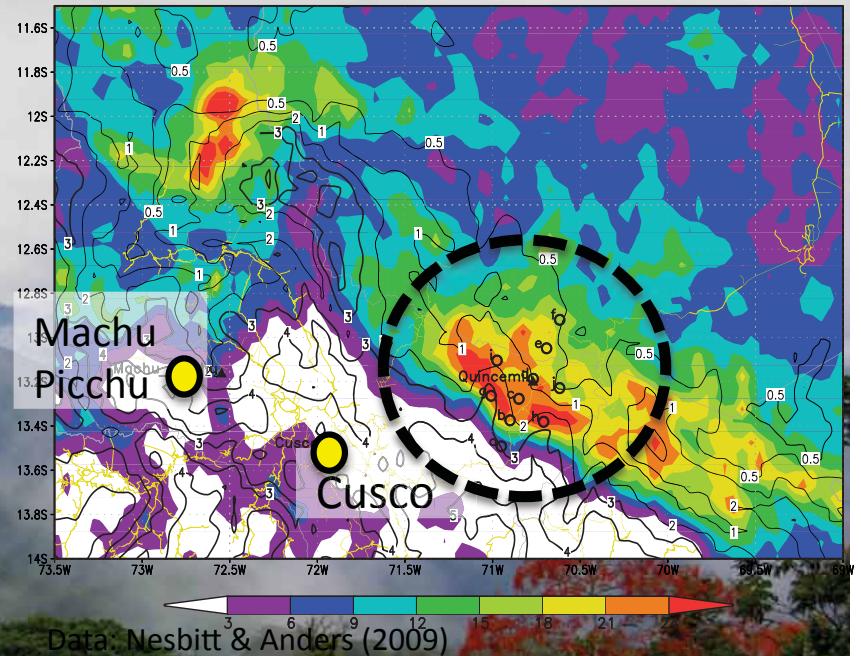
Hotspots Field Campaign

Period: 2012-2013 rainy season

Location: Quincemil hotspot, near Cusco



TRMM PR DJF rainfall climatology and proposed stations



Data: Nesbitt & Anders (2009)

Team: K. Takahashi (IGP), J. C. Espinoza (IGP), R. A. Houze (UW), A. Sifeddine (IRD), J. L. Guyot (HYBAM/IRD), J. Ronchail (LOCEAN), W. Lavado (SENAMHI)

Expected funding: IRD (France), NSF (USA)

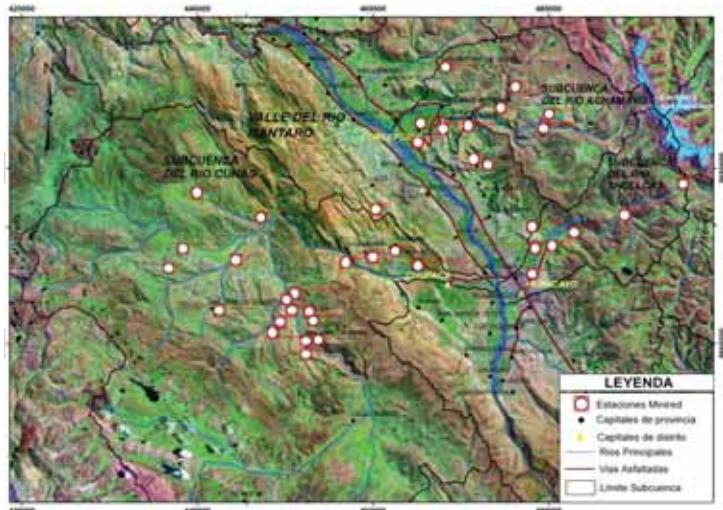
Photo of Quincemil area: www.danske-natur.dk

LINK BETWEEN PHYSICAL AND SOCIAL ASPECTS: COMMUNITY-BASED RAINGAUGE NETWORK

OBJECTIVES

- a) To have a basic rain gauge network of high density (but very low cost) and easy installation and use .
- b) Involve population in use and maintenance of this network, as a way to sensibilization in variability and climate change.

Emphasis in training and “appropriation” of the issue by the communities involved



Rain gauge
network



Training

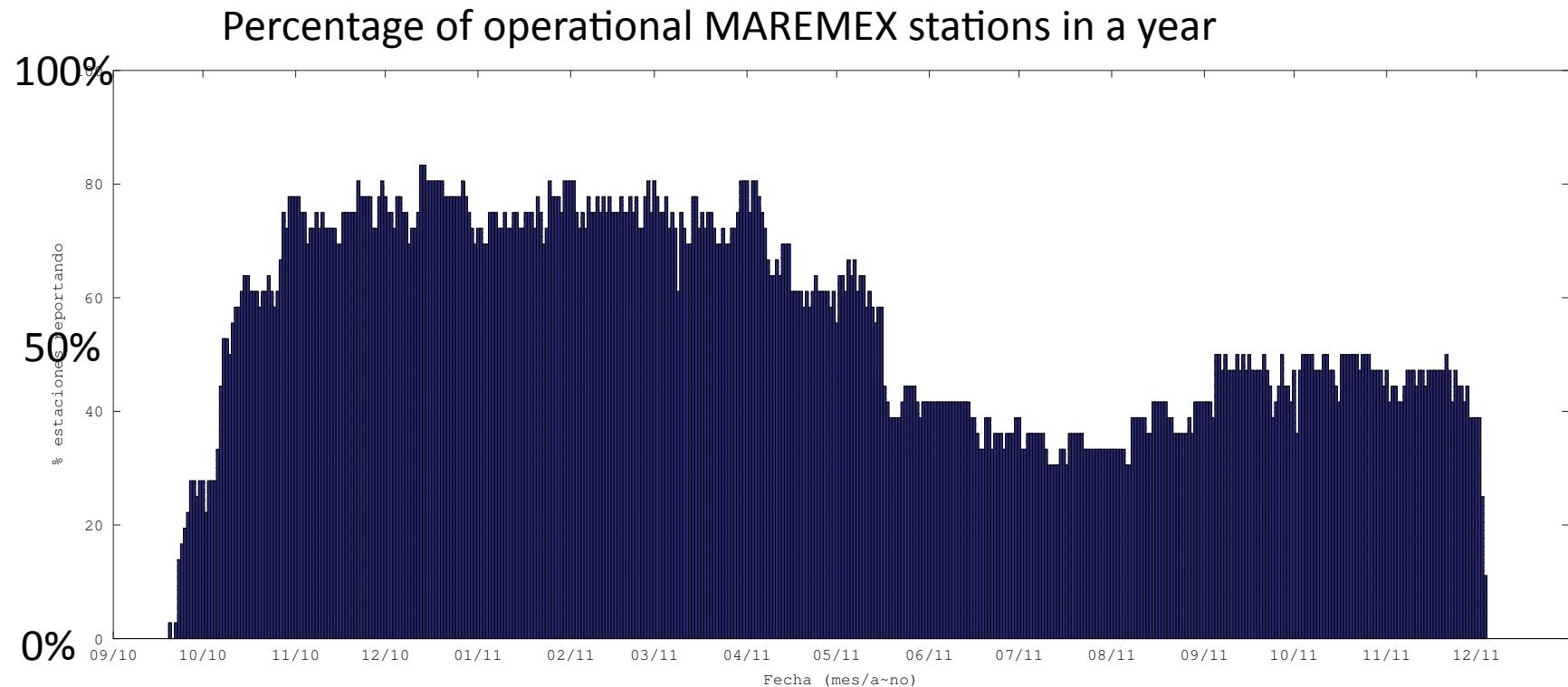


Daily
measurements



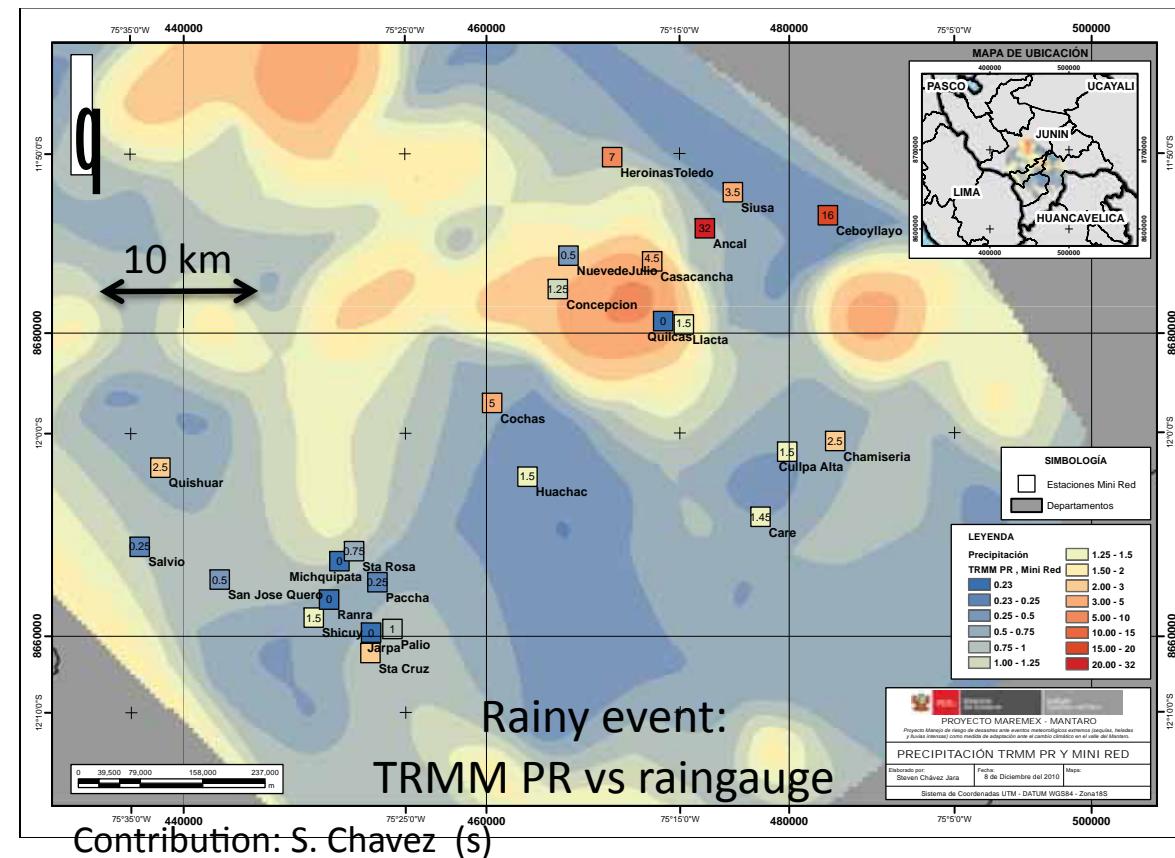
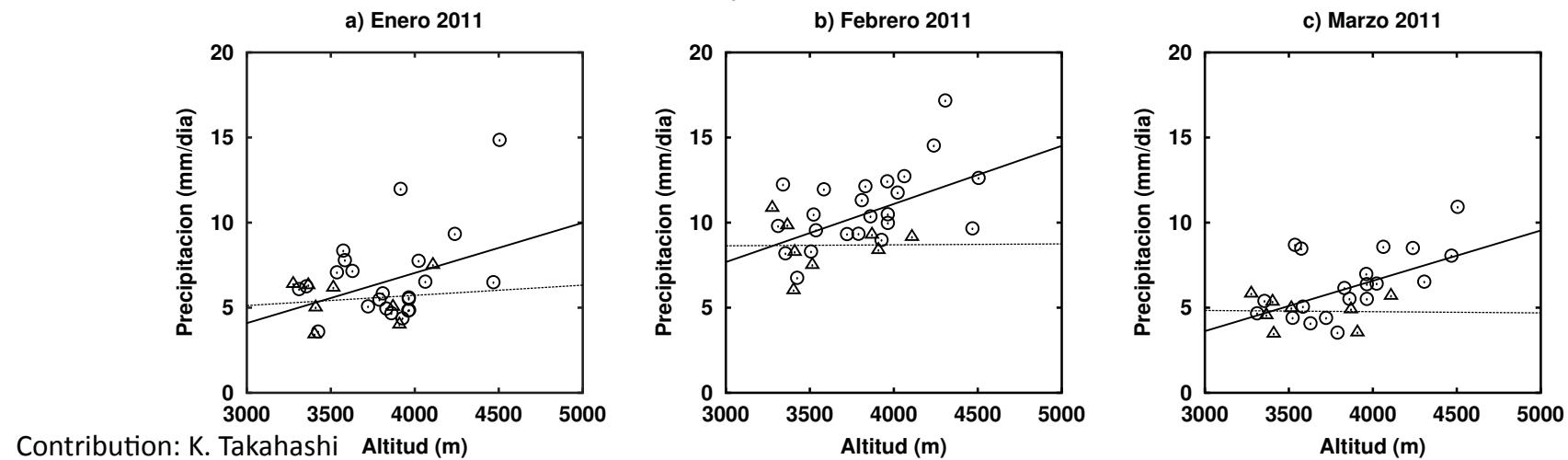
K. Takahashi & R. Orozco

LINK BETWEEN PHYSICAL AND SOCIAL ASPECTS: COMMUNITY-BASED RAINGAUGE NETWORK

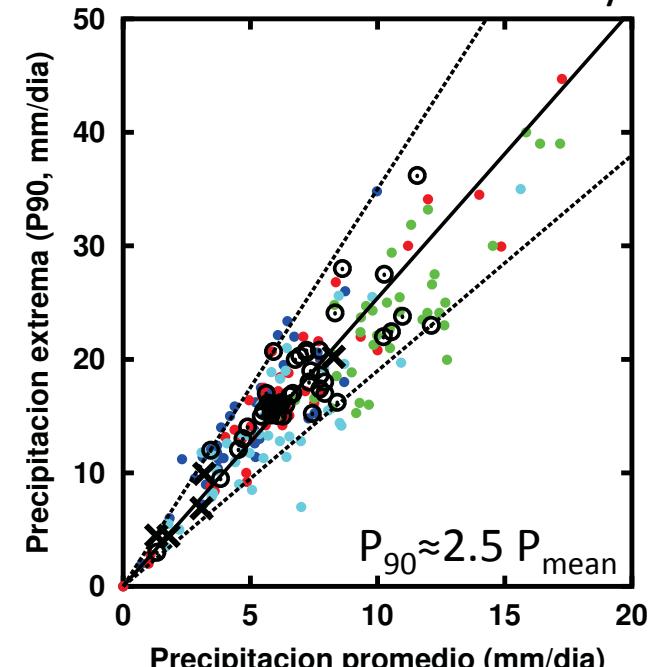


K. Takahashi

Monthly rainfall vs elevation

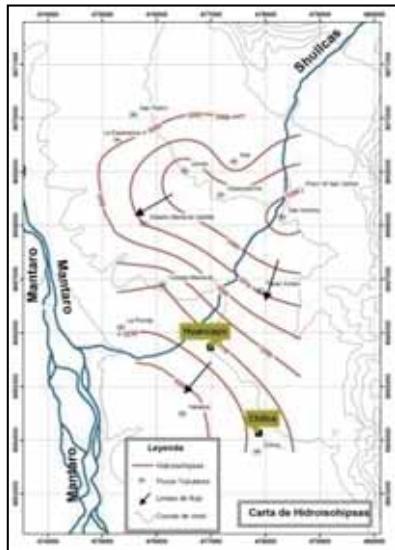


Extreme (P90) vs monthly mean rainfall in Mantaro valley



Contribution: K. Takahashi

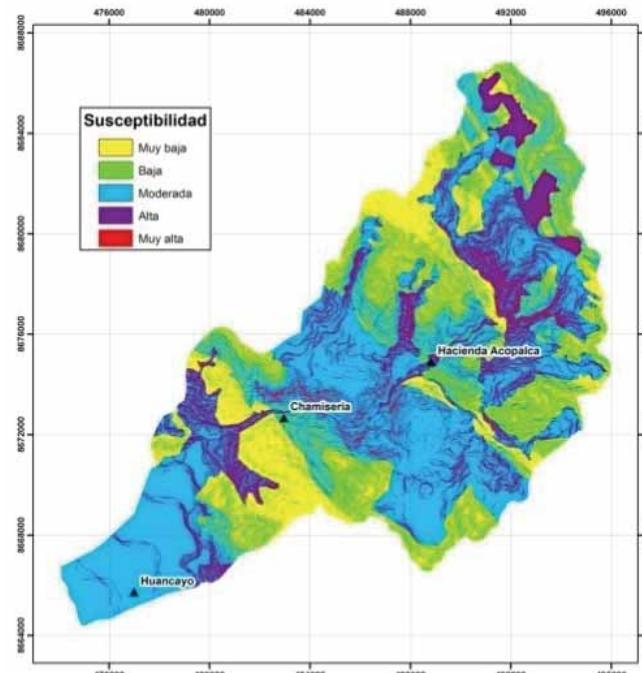
STUDIES RELATED TO PHYSICAL VULNERABILITY IN MANTARO VALLEY



Hydrogeological conditions – Franklin Blanco (s)



Flood zones assessment – Ricardo Zubieta



Susceptibility to landslides - Franklin Blanco (s)

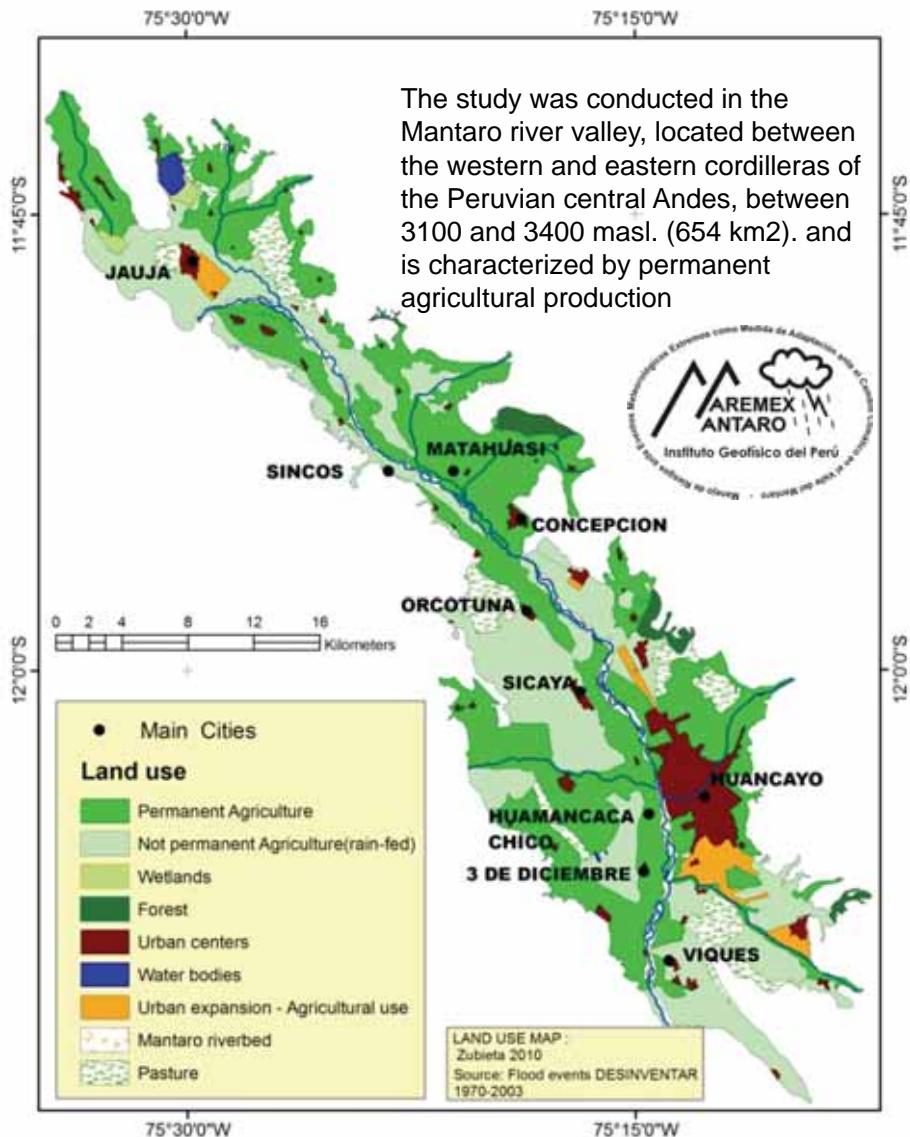


Physical vulnerability of rural and urban settlements - Luis Céspedes (s)



Rainfall thresholds for the determination of landslides - Marco Moreno (s)

ASSESSMENT OF FLOOD HAZARD IN THE CENTRAL ANDES OF PERU: HECRAS SIMULATION CONDUCTED IN MANTARO RIVER VALLEY



The objective of this study is to assess the floodplain hazard with maximum discharges and at different return periods, using the hydraulic model HECRAS (Hydrological Engineering Center - River Analysis System).

Contribution: Ricardo Zubieta

STUDIES RELATED TO SOCIO ECONOMIC VULNERABILITY IN MANTARO VALLEY



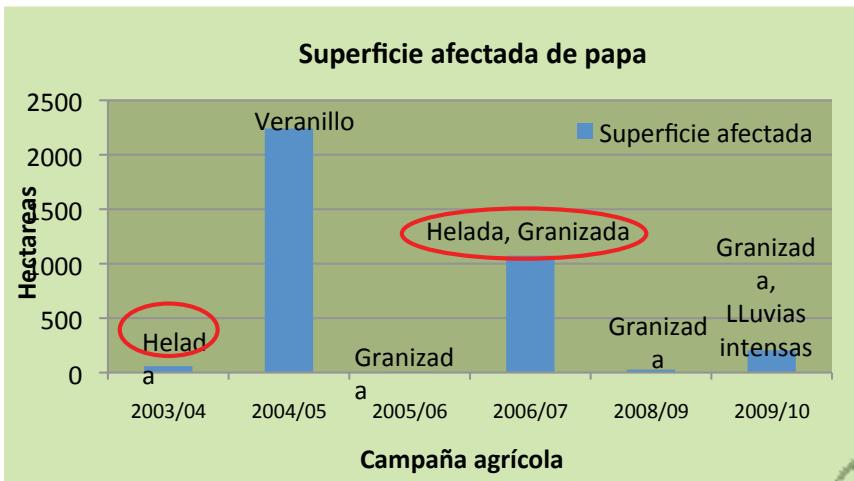
HEALTH
Lidia Enciso (s)



FORESTS
TU Dresden



LIVESTOCK
Enma Nuñez



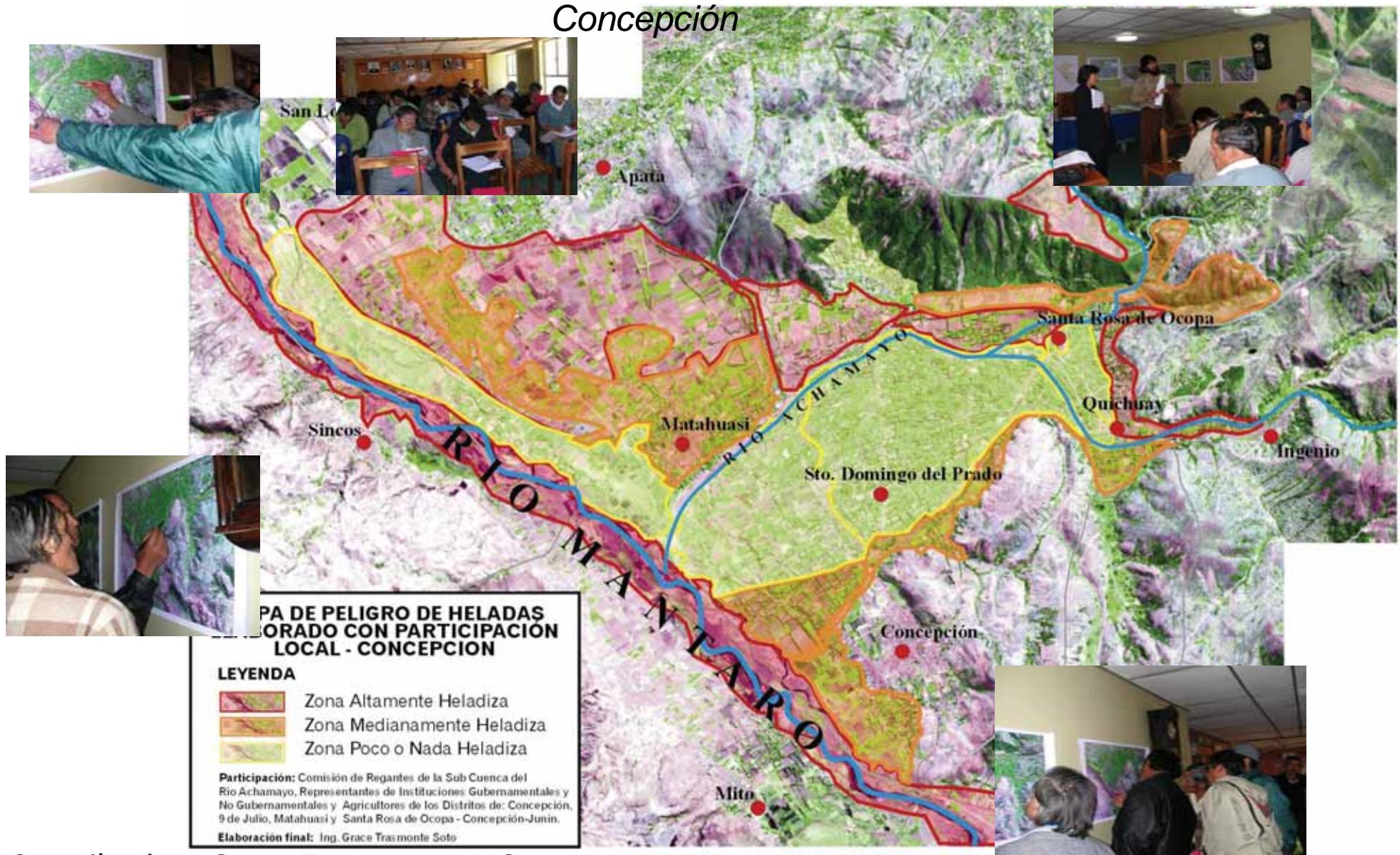
AGRICULTURE
Lucy Giraldez



FISH FARMING
Jahir Anicama (s)

Frost hazard mapping with local participation

Fuente: Trasmonte, 2009



Contribution: Grace Trasmonte, MSc

RESEARCH ON VULNERABILITY AND ADAPTATION: COLLECTION OF INFORMATION ON PERCEPTIONS AND TRADITIONAL KNOWLEDGE (1/3)

- a) Rural setting: Participative workshops in Quilcas (Achamayo sub-basin), Acopalca (Shullcas sub-basin) and San Juan de Jarpa (Cunas sub-basin)



- b) Urban setting: Participative workshops in Concepción (Achamayo sub-basin), Huancayo (Shullcas sub-basin) and Chupaca (Cunas sub-basin)



Contribution: A. Martínez and E. Núñez



RESEARCH ON VULNERABILITY AND ADAPTATION: COLLECTION OF INFORMATION ON PERCEPTIONS AND TRADITIONAL KNOWLEDGE (2/3)

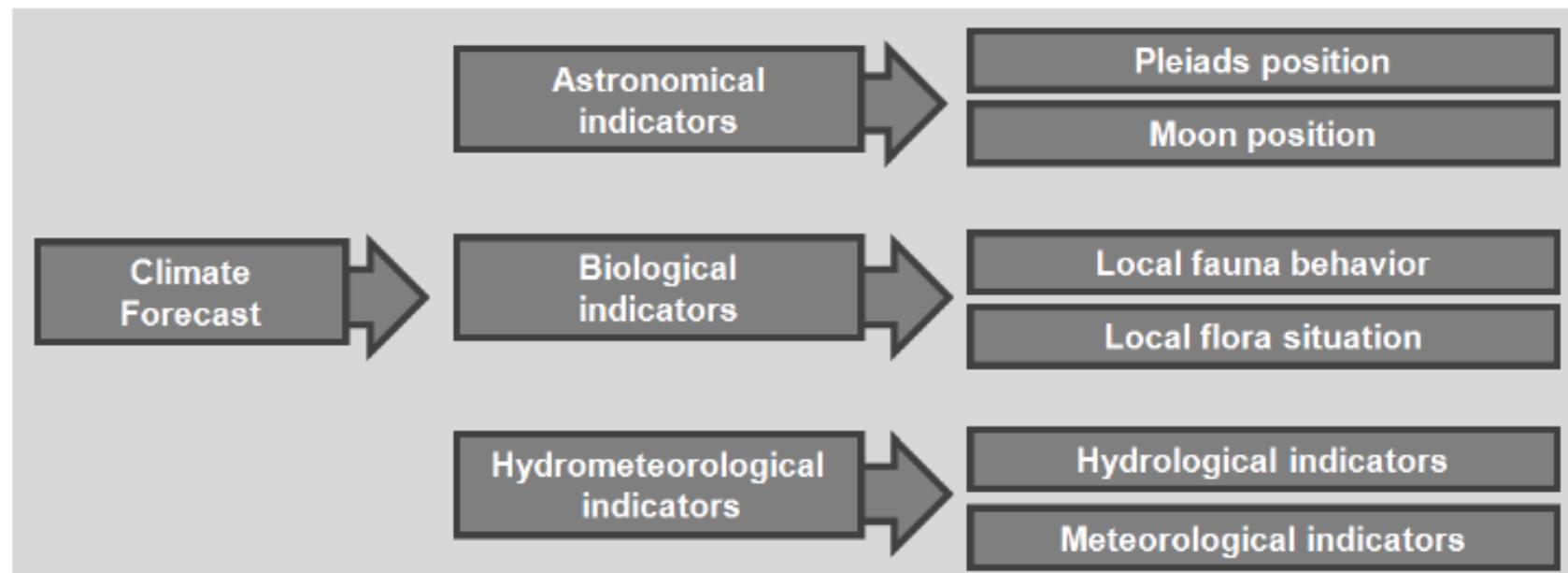


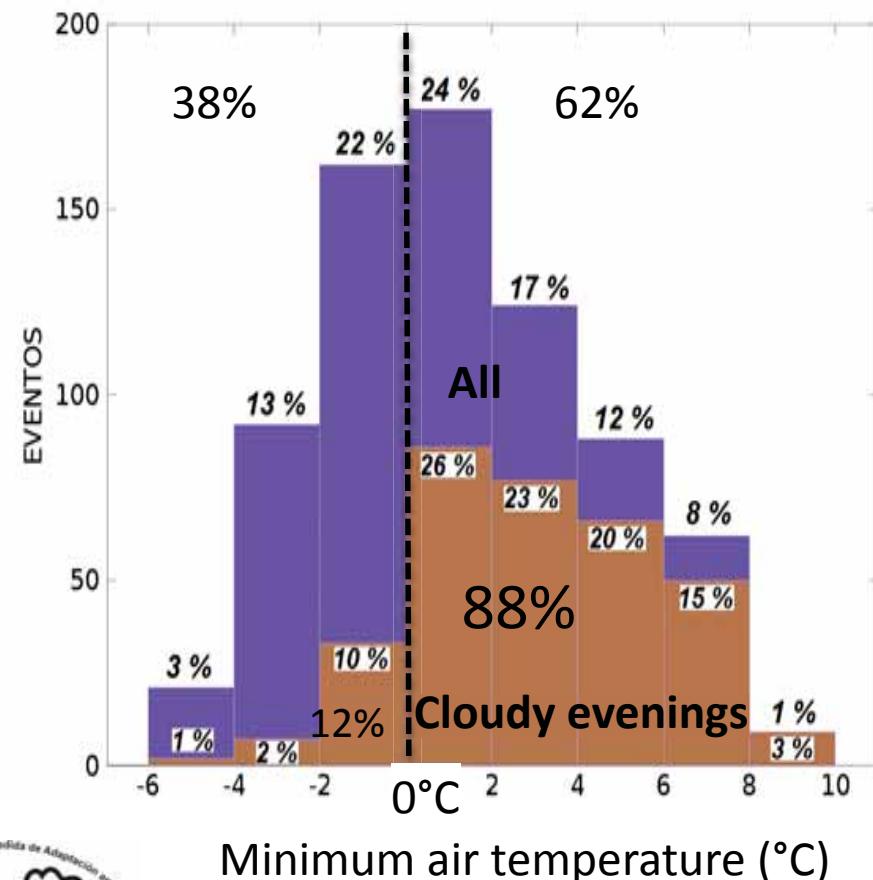
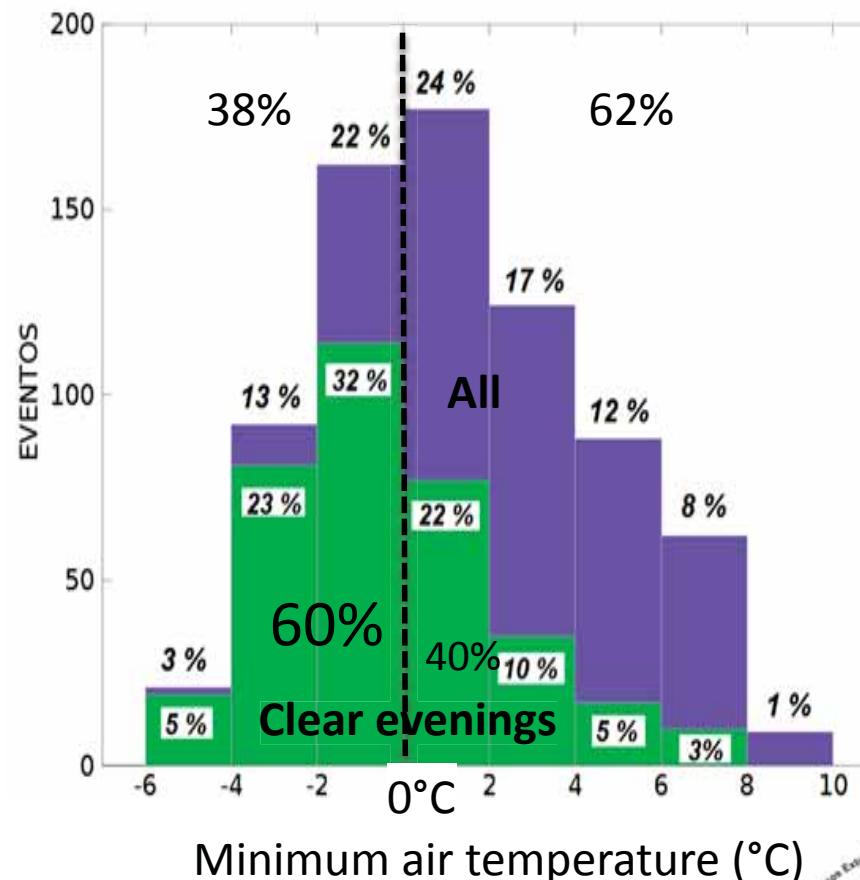
Figure 4 Local knowledge on climate forecast of "good year" in the Mantaro Valley



Contribution: A. Martínez and E. Núñez

RESEARCH ON VULNERABILITY AND ADAPTATION: COLLECTION OF INFORMATION ON PERCEPTIONS AND TRADITIONAL KNOWLEDGE (3/3)

Cloudiness observations at 7 pm as predictor of frosts
(Huancayo Obs., May-Aug 2003-2008)



Project (ongoing)

AndesPlus

Objective

Develop a methodological guide to formulate the scientific basis for the design and implementation of sustainable adaptation in mountain regions.

Execution: Consortium led by University of Zurich

Funding: PRAA project



AndesPlus Perú

2011-2012

Objective

Evaluation of methodologies and analysis elements for the development of projects of adaptation to climate change in high-altitude mountain regions based on the experience in the Shullcas river basin.

Execution: IGP

PI: Y. Silva, Ph. D.

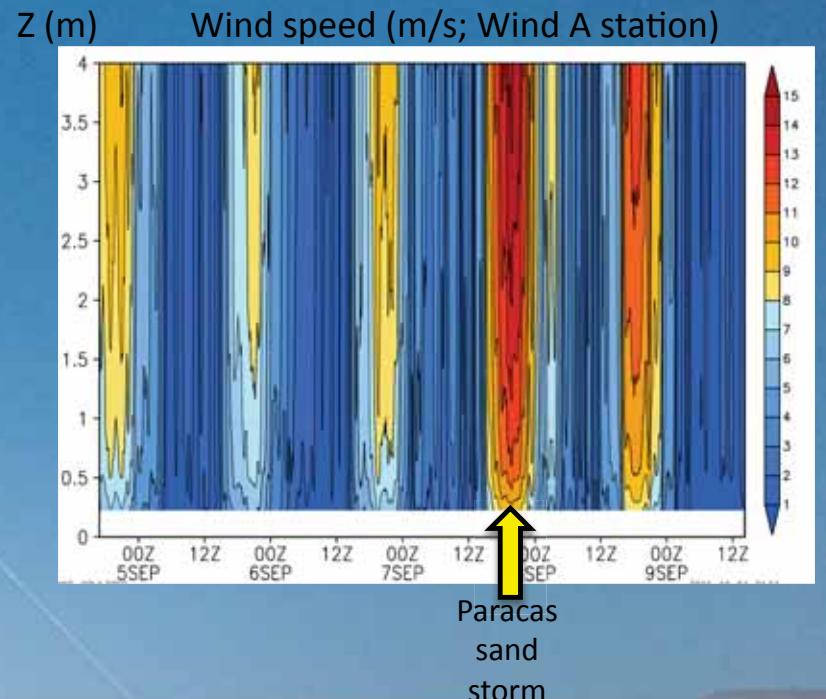
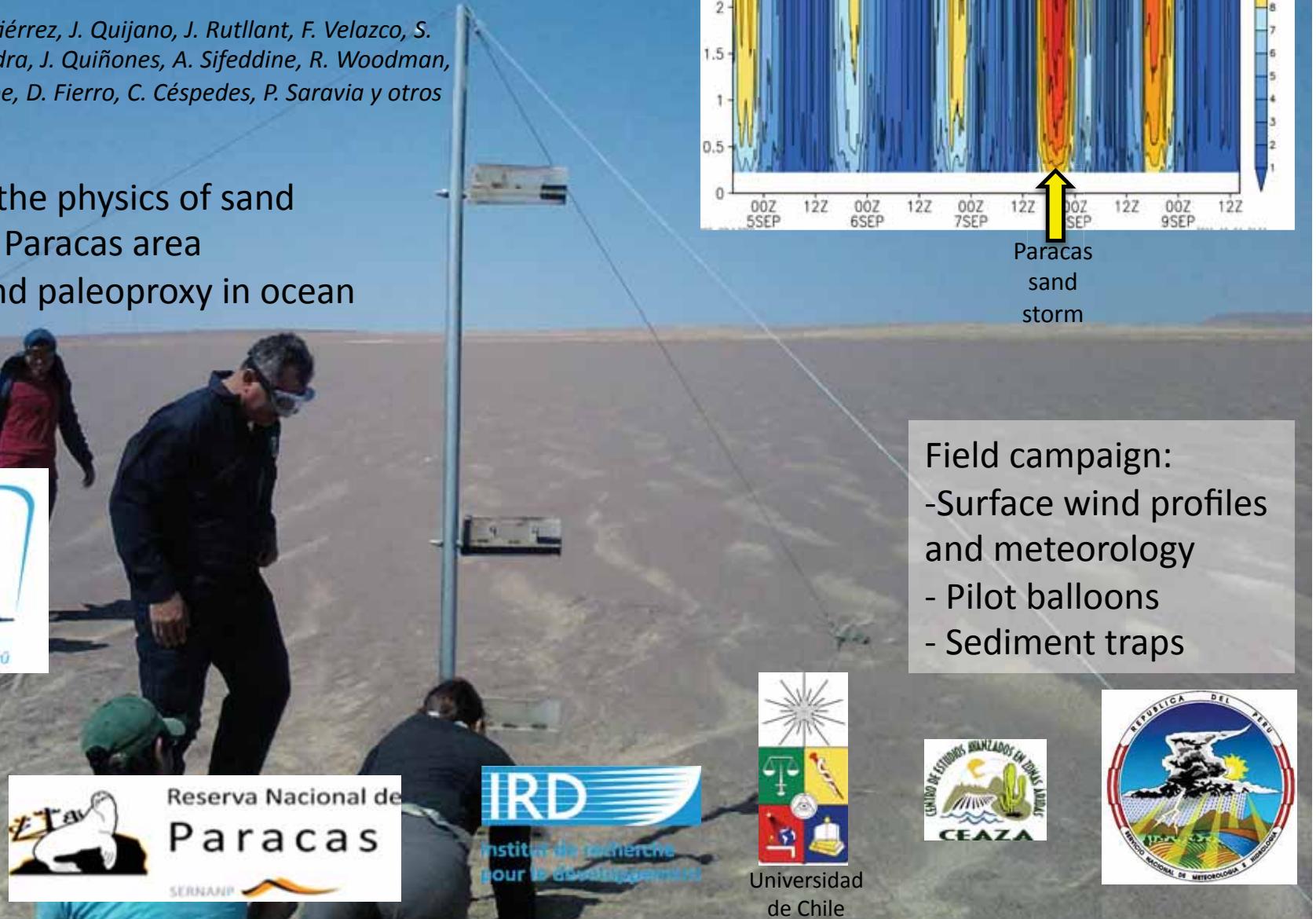
Project (ongoing)

Paracas Sand Experiment II *(ParaSEx II) 2011*

K. Takahashi, D. Gutiérrez, J. Quijano, J. Rutllant, F. Velazco, S. Caquineau, M. Saavedra, J. Quiñones, A. Sifeddine, R. Woodman, J. C. Gómez, N. Quispe, D. Fierro, C. Céspedes, P. Saravia y otros

Objetives

- Understand the physics of sand storms in the Paracas area
- Calibrate wind paleoproxy in ocean sediment



Field campaign:
-Surface wind profiles
and meteorology
- Pilot balloons
- Sediment traps



Universidad
de Chile



Project (active)

“Impact of climate variability and change on the mangrove ecosystem of Tumbes, Peru”

2011-2014

Main objective:

Strengthen the capacity for adaptation to climate variability and change in the mangrove ecosystem of Tumbes.

Some key issues:

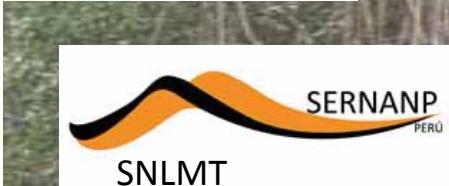
El Niño and other climate phenomena, precipitation processes, mangrove hydrodynamics, sediment dynamics, flood modeling, black conch and mangrove crab biology, mangrove dendrochronology, ecological communities, socioeconomical impacts.

PI: K. Takahashi, Ph. D.

Financiamiento:



Climate Change and Water Program



CGSNLMT

