



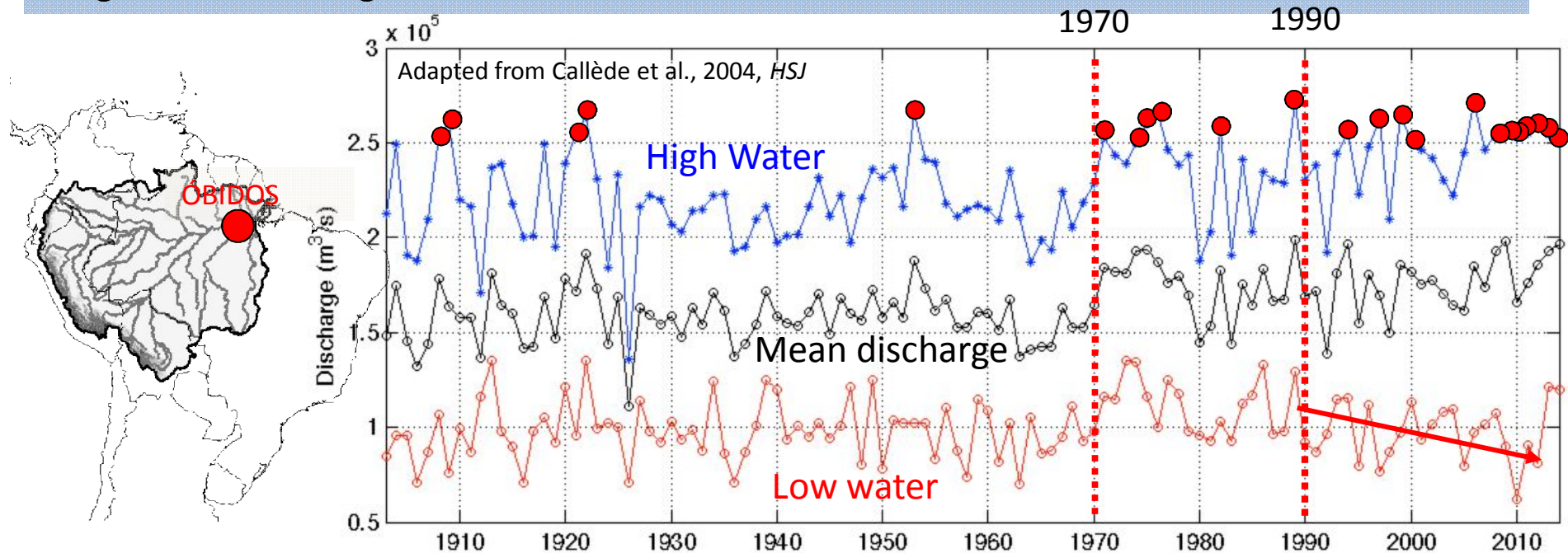
The extreme 2014 flood in South-Western Amazon basin

Jhan Carlo Espinoza
JA Marengo, J Ronchail, J Molina,
L Noriega, JL Guyot and
Collaborators from SO-HYBAM

VI HYBAM Meeting. Cusco - Peru 2015

Hydrological evolution in Amazon River at Óbidos (Brazil): 1903 - 2012

- High discharges during the 1970s.
- High frequency of strong flooding after 1970: 18 events higher than 250 000 m³/s after 1970 (only 5 between 1903 and 1970).
- Significant discharge diminution since 1990.



Extreme hydrological events are more frequent : Extreme drought in 2005 and 2010; historical flooding in 2009 and 2012.

04 extreme events in the last 10 years

The role of Tropical Atlantic and Pacific Oceans

Drought: Warm conditions in the tropical North Atlantic (April – August). Ej. 2010, 2005, 1995, 1963

Drought: Warm conditions in Central Pacific (Dec – Mar). Ej. 1926, 1998, 2010

Marengo et al. 2008, 2011, 2013
Espinoza et al. 2009; 2011; 2012; 2013
Zeng et al. 2008, Tomasella et al 2010,
Lewis et al., 2011; Yoon and Zeng, 2010

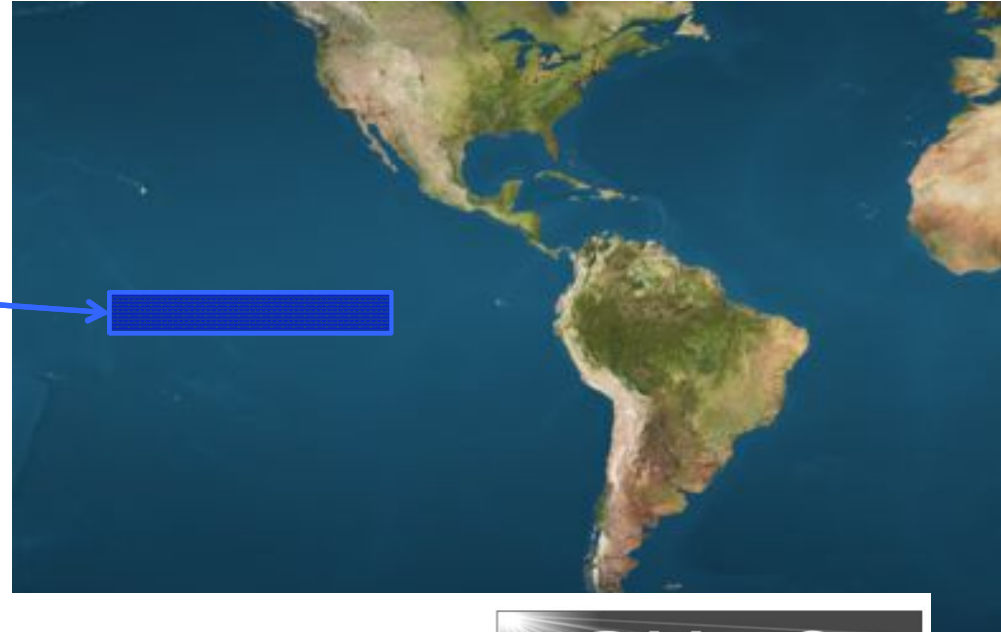


The major drought in Amazonia in 2010, has been related to
El Niño + Warm conditions in the NTA
(Marengo et al., 2011; Espinoza et al., 2011)

The role of Tropical Atlantic and Pacific Oceans

Floods: Cool conditions in central Pacific (Dec – Mar). Ej. 2012, 2011, 1999

Marengo et al. 2008, 2011, 2013
Espinoza et al. 2009; 2011; 2012; 2013
Zeng et al. 2008, Tomasella et al 2010,
Lewis et al., 2011; Yoon and Zeng, 2010



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Review

Extreme seasonal droughts and floods in Amazonia: causes, trends and impacts

J. A. Marengo^{a*} and J. C. Espinoza^b

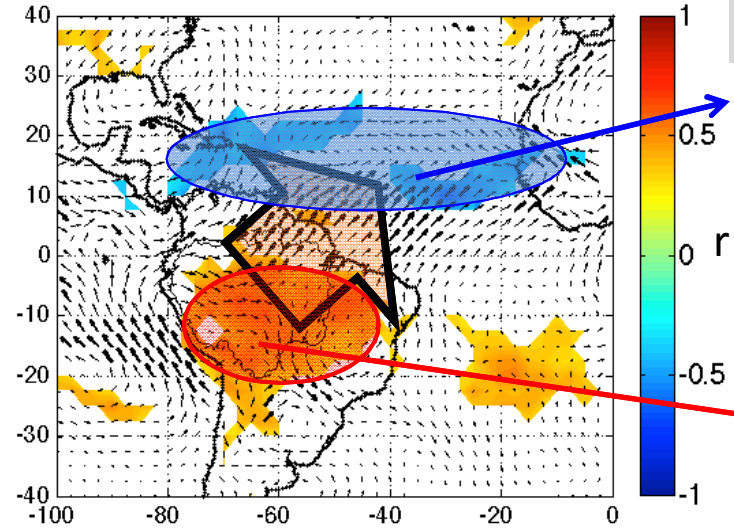
^a Centro Nacional de Monitoramento e Alerta de Desastres Naturais, Ministério da Ciência, Tecnologia e Inovação, Sao Paulo, Brazil

^b Department of Climate Variability, Instituto Geofísico del Perú, Lima, Peru

Impacts of North Tropical Atlantic over the Amazon basin during the dry season (JJAS, 1980-2010)



Correlation between: NATL & Humidity
transport flux (vectors) NATL & OLR (colors)



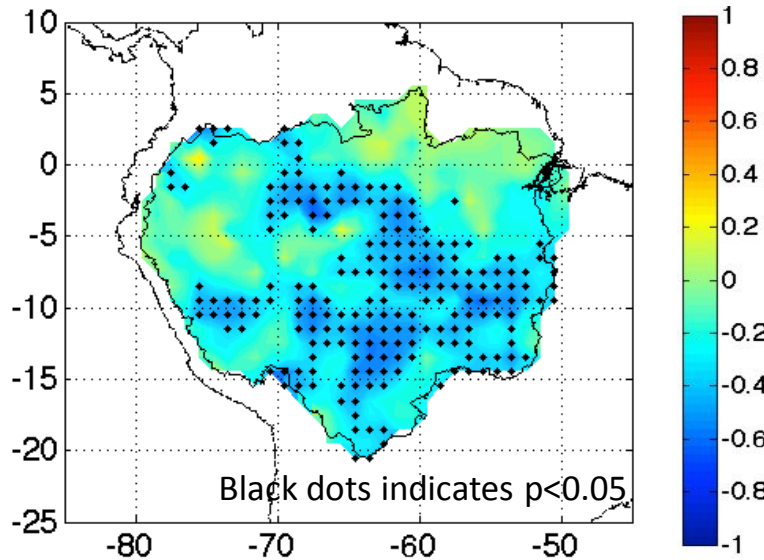
Warm conditions in the tropical Atlantic:

Enhanced convective activity

Deficit of humidity advection to Amazon basin

Weak convective activity

Correlation between NATL & Rainfall



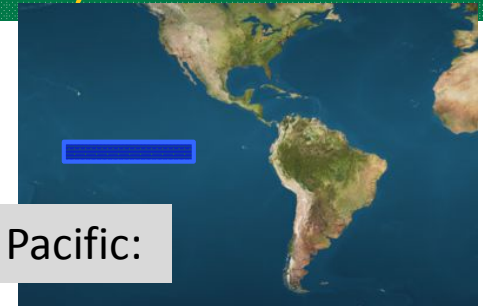
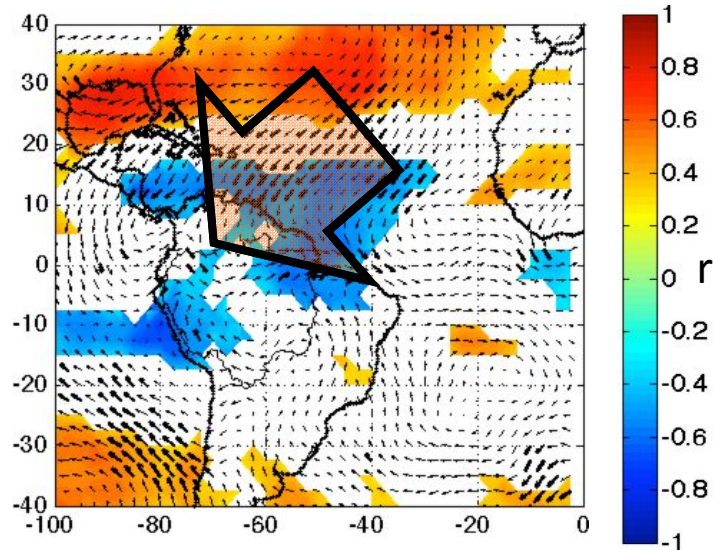
Warm conditions in the tropical North Atlantic:

Negative rainfall anomalies on the central and southern part of the Amazon basin

Extreme drought in 1964, 2005, 2010

Impacts of central La Niña over the Amazon basin during the wet season (DJFMA, 1980-2010)

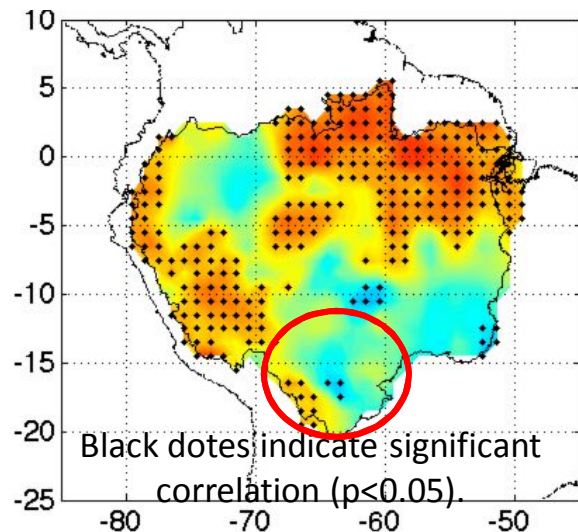
Correlation between: Niña C & Humidity transport flux (vectors). Niña C & OLR (colors).



Cool conditions in the Central Eq. Pacific:

Enhanced humidity advection to Amazon basin

Correlation between Niña C & Rainfall



Cool conditions in the Central Eq. Pacific:

Positive rainfall anomalies on the North Eastern and western Amazon basin.
Extreme floodings in 1999, 2012

Impacts of El Niño/La Niña are not clear over Bolivian Amazon: Opposition Andes-Lowland

2014: Extreme flood in the madeira basin

However, the tropical Atlantic and Pacific oceans do not explain
all the extreme events

For instance: the 2014 the historical flood in the Madeira River
(south-western Amazon basin)

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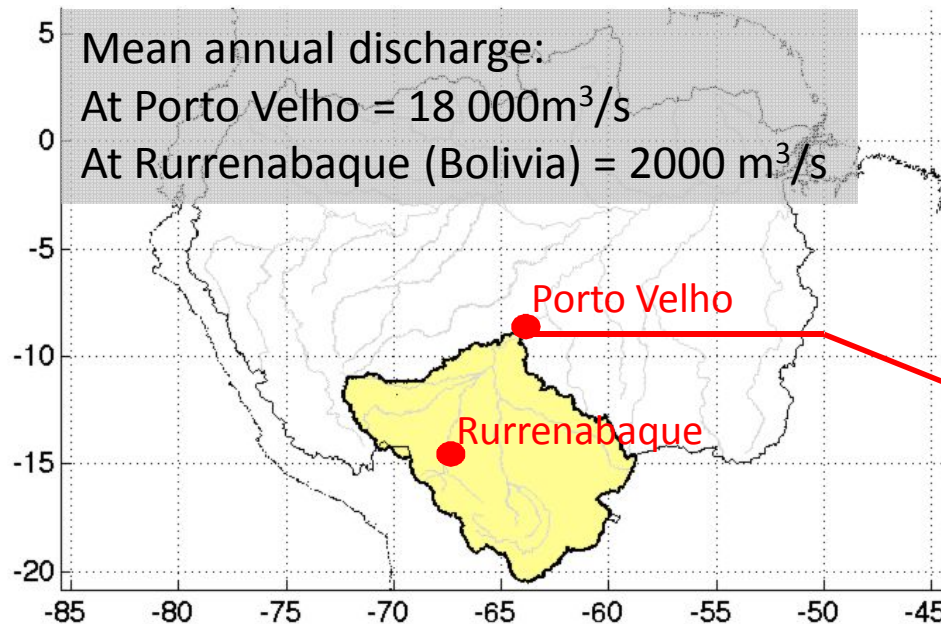
The extreme 2014 flood in south-western Amazon basin: the role of tropical- subtropical South Atlantic SST gradient

Jhan Carlo Espinoza¹, José Antonio Marengo², Josyane Ronchail³,
Jorge Molina Carpio⁴, Luís Noriega Flores⁵ and Jean Loup Guyot⁶

2014: Extreme flood in the Madeira basin

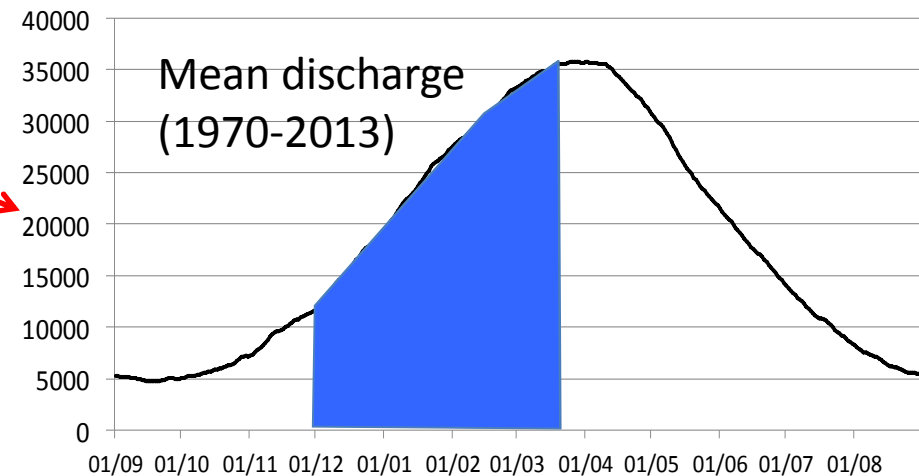
However, the tropical Atlantic and Pacific oceans do not explain all the extreme events

For instance: the 2014 the historical flood in the Madeira River (south-western Amazon basin)



Madeira River basin
at Porto Velho (Brazil) = 955 000 km²

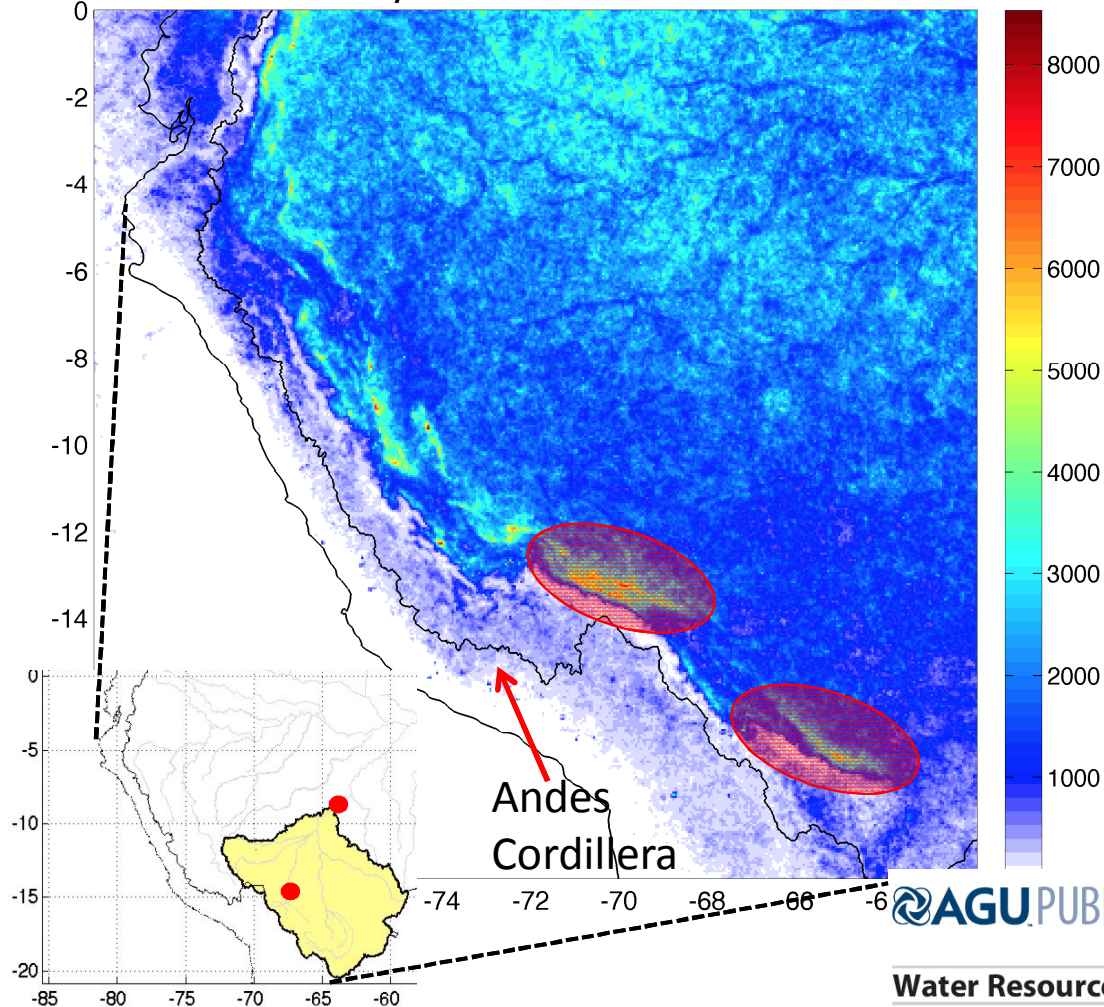
High water period (Mar-Apr) = 36 000 m³/s
Low-water period (Sept-Oct) = 5000 m³/s



Rainy season during austral summer (Dec-Mar) due to SA Monsoon System (Espinoza et al., 2009. J. Of Hyd.)

Mean Annual rainfall in western Amazon

Rainfall estimated by TRMM-PR 2A25



“Rainfall hotspots”
Maximum values of the
Amazon basin are reported
in the upper Madeira
~ **7000 – 8000 mm/yr**

Interactions between large-scale
circulation and the topography
determinate a very complex rainfall
distribution

For more details about extreme rainfall in
western Amazon see Espinoza et al., 2015, WRR

RESEARCH ARTICLE
10.1002/2014WR016273

Key Points:
• TRMM-PR and 95 stations describe
rainfall contrasts in Amazon-Andes
transition
• Rainfall hotspots over the southern
tropical Andes

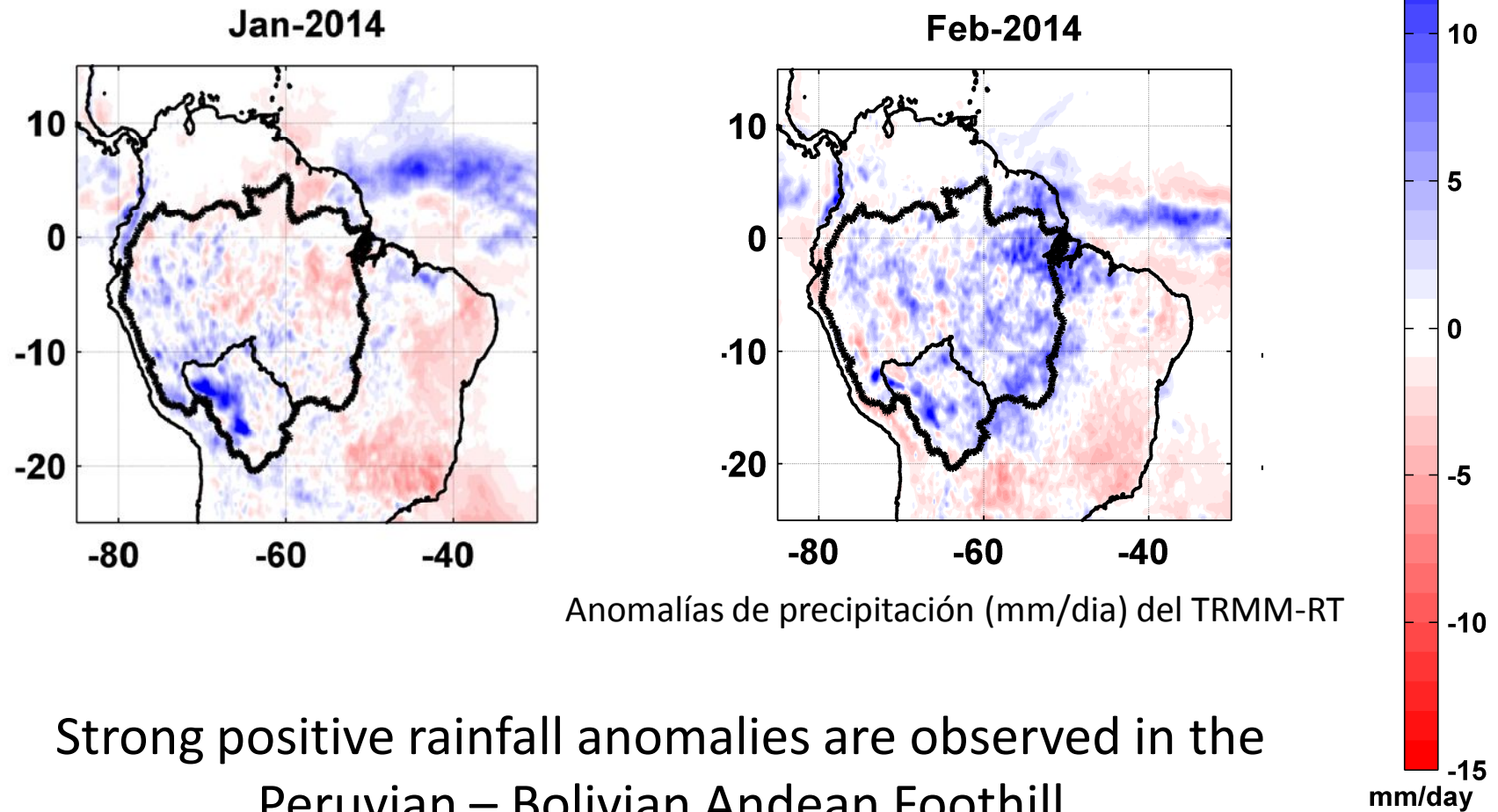
Rainfall hotspots over the southern tropical Andes: Spatial
distribution, rainfall intensity, and relations with large-scale
atmospheric circulation

Jhan Carlo Espinoza¹, Steven Chavez¹, Josyane Ronchail², Clémentine Junquas^{1,3}, Ken Takahashi¹,
and Waldo Lavado⁴



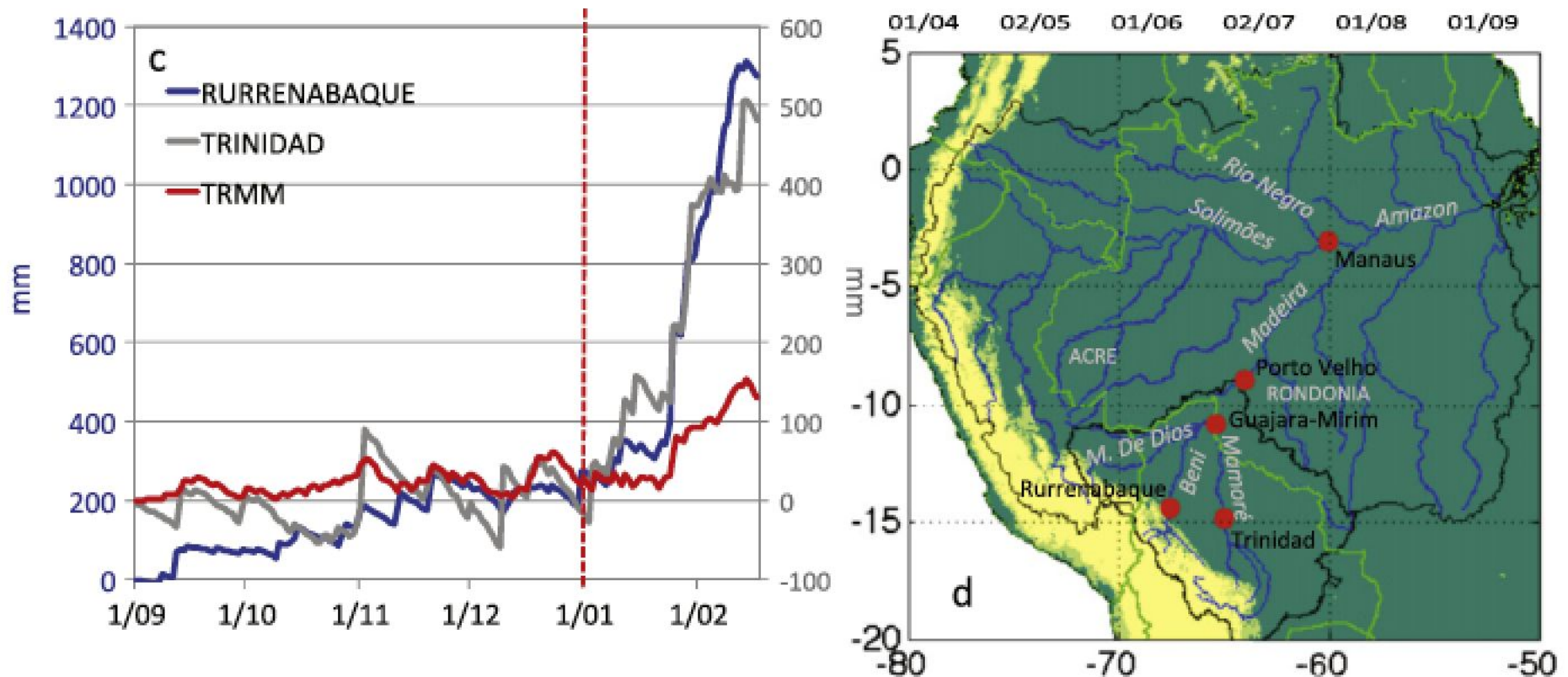
2014: Extreme flood in the madeira basin

Rainfall anomalies in the Andean foothill Jan-Feb 2014



2014: Extreme flood in the madeira basin

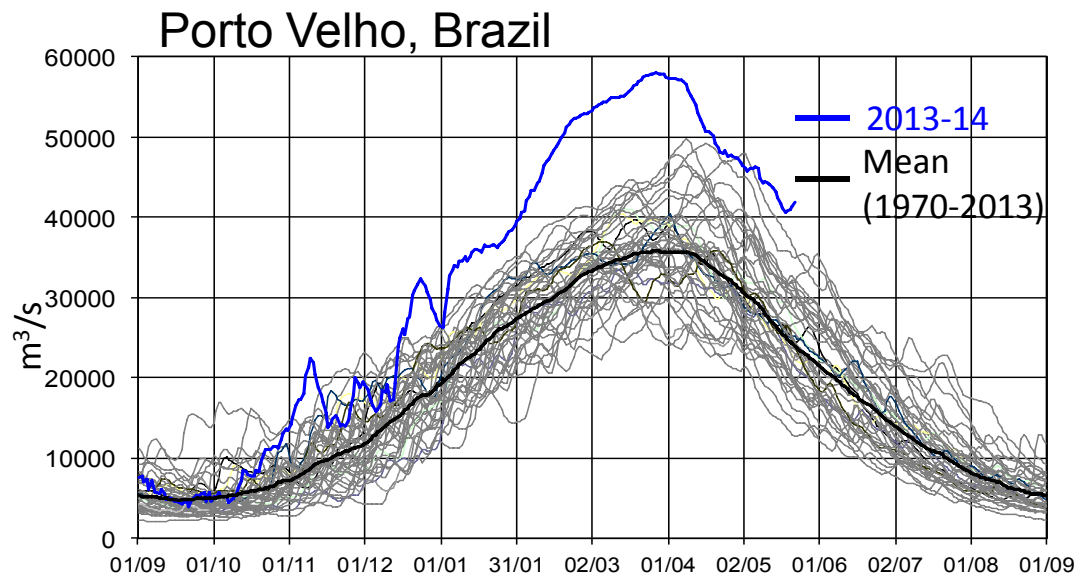
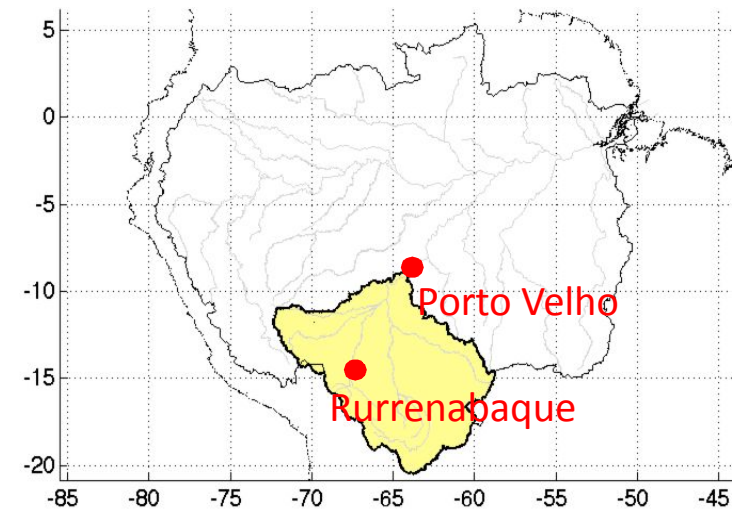
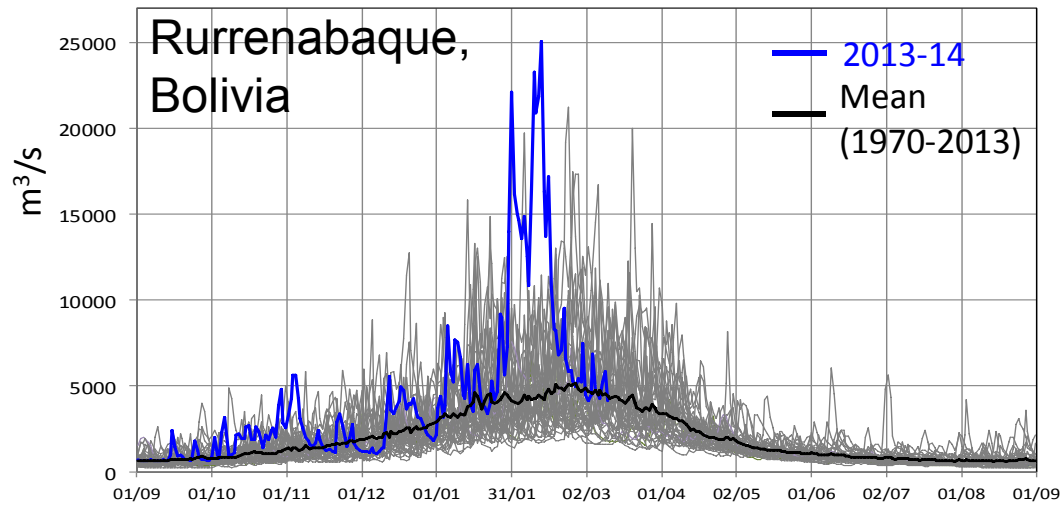
Accumulated rainfall anomalies in the Andean foothill
Sep 2013 - Feb 2014



At Rurrenabaque rainfall station:

1.100 mm between Jan 24th and Feb 10th. 4 times more than expected for this period

2014: Extreme flood in the madeira basin

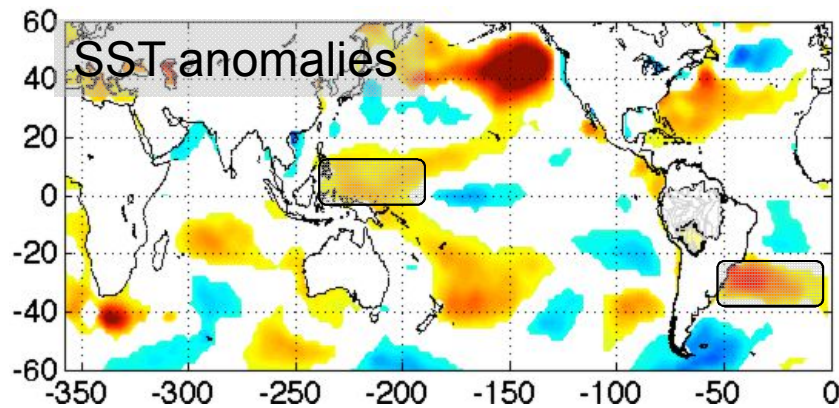


18 days with discharge above
10 000 m³/s

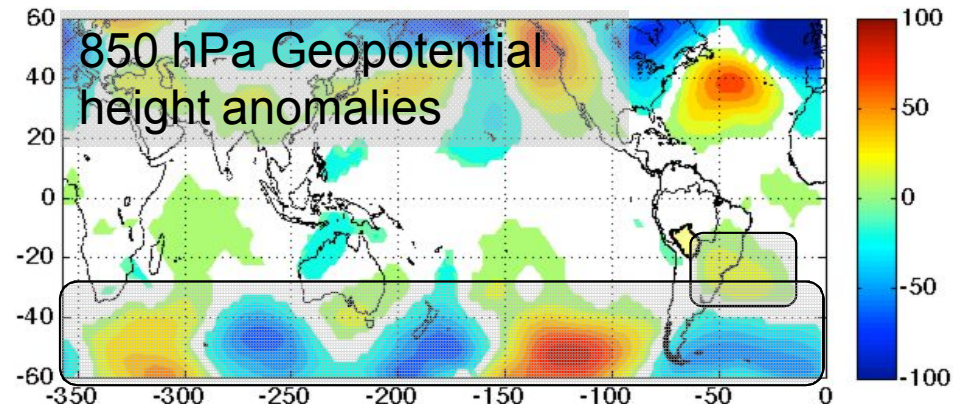
Historical discharge: 58 000 m³/s
Mean peak: 36 000 m³/s

A new extreme hydrological event in the Amazon basin. In this case, in absence of robust SST anomalies in tropical Pacific/Atlantic

Oceanic and Atmospheric conditions during 2014 austral summer



Warm conditions in: Indo-Pacific and Subtropical south Atlantic

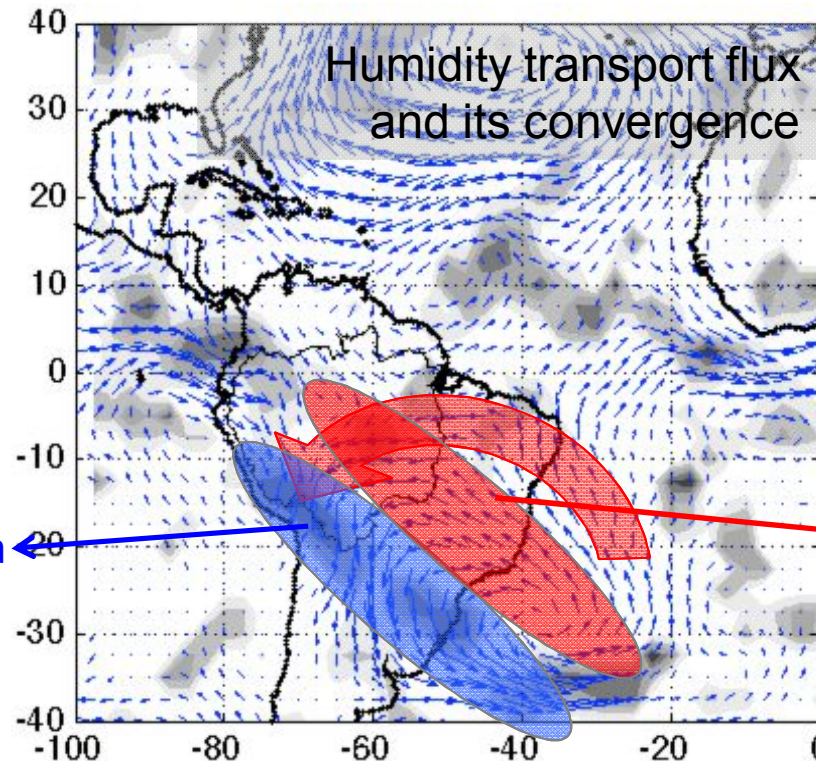


Train wave at mean latitudes

Intense moisture convergence over upper Madeira

Extreme dry conditions
 Southeastern Brazil
 (Marengo et al., 2015, BAMS
 Coelho et al., 2015, Cli Dyn)

Extreme wet conditions in upper Madeira and La Plata basins



2014: Extreme flood in the madeira basin

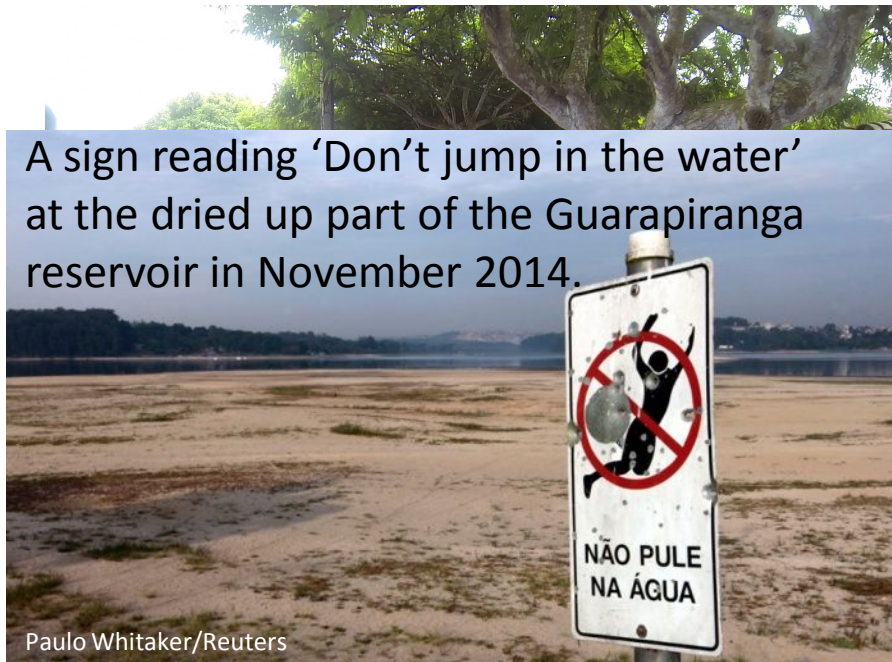
Flood in Puerto Siles (Bolivia) in March-2014



Some impacts of this historical flood

- 60 people dead
- About 40 000 hectares of crops was damaged.

A sign reading 'Don't jump in the water' at the dried up part of the Guarapiranga reservoir in November 2014.



In contrast, this climatic event produce a severe drought in Southeastern Brazil:

Rainfall in Southeastern Brazil during the December 2013-February 2014 was about 200-300 mm/month below normal

Economic Impacts of 2014 Extreme flood and drought



Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
1/1-4/30	Drought	Brazil	0	Unknown	4.3+ billion
2/15-3/31	Flooding	Brazil, Bolivia, Peru	0	29,500+	200+ million

Impact Forecasting | March 2014 Global Catastrophe Recap

The five largest natural catastrophes in 2014

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Ranking by overall losses

Date	Country/Region	Event	Fatalities	Overall losses US\$ m	Insured losses US\$ m
11-13.10.2014	India	Cyclone Hudhud	84	7,000	530
7-16.2.2014	Japan	Winter damage	37	5,900	3,100
3-15.9.2014	India, Pakistan	Floods	665	5,100	330
3.8.2014	China	Earthquake	617	5,000	-
2014	Brazil	Drought	-	5,000	-

Final Remarks

A new extreme flood is observed in Amazon (upper Madeira Basin)

This new exceptional flood in the Amazon in 2014 is related to warm condition in Pacific-Indian and Subtropical South Atlantic

Atmospheric conditions also produce an extreme drought in Southeastern Brazil

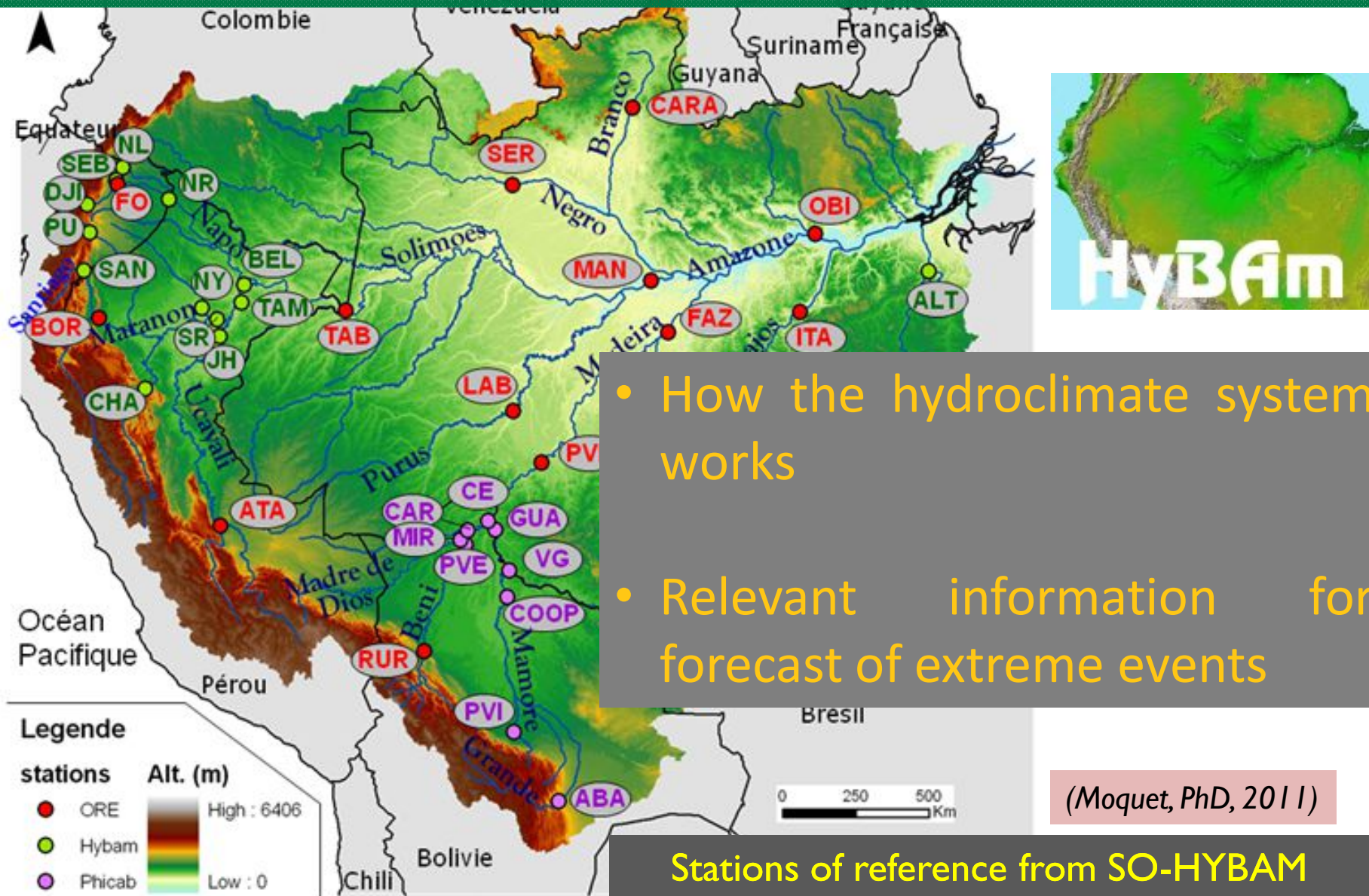
Final Remarks

A new extreme flood is observed in Amazon
(upper Madeira Basin)

Improve the forecast of extreme events is an
important challenge for the scientific
community of upper and lower
Amazonian countries

Atmospheric conditions also produce an extreme
drought in Southeastern Brazil

Information of Amazon Hydroclimate thanks to the observations





Thank you

Visit ORE-HYBAM web site for more information:

www.ore-hybam.org

And for forecast system in western Amazon:

www.igp.gob.pe/eventos-extremos-amazonia-peruana/

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