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Conceptual Model For Spillover Rain Formation In Lima, Peru

Piero Rivas

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Abstract

A composite analysis determined that spillover rain formation in Lima is driven mainly by systems in high levels which in turn fortify easterly winds that also bring moisture from the Amazon basin.

Introduction

Lima is a city located on a desert, which is why it hardly ever get rain. However, when it does, it can get up to a third of year's rainfall amount. Usually, rain clouds are transported by easterly winds. Nonetheless, as it is the predominant weather configuration during summer, it is rather problematic to make an accurate forecast.

A conceptual model of the predominant atmospheric features and variables during said events is a key factor to understand them better and to help up and coming forecasters in spillover rain forecast.

Data & Methods

Data: ECMWF reanalysis 0.5° South America.

Select day → Percentile 95* → (R>P95) → Selective daily means → Composites → Conceptual model**

Results

Chart 1. Spillover rain episodes (1980-1995). Rivas 2019

Year	Month	Day	OVH	MARTE	SPJC
1981	1	13	3.3	2.8	
1981	4	5	3.5	0.5	0
1983	1	17	0.8	0.2	0
1983	1	29	2.5	0.5	0
…	…	…	…	…	…
1990	12	26	1.4	0.2	
1992	1	1	0.7	0	0.1
1994	1	31	1.6		0.3
1994	3	5	2.1	0	0

Total of 286 spillover rainfall cases!

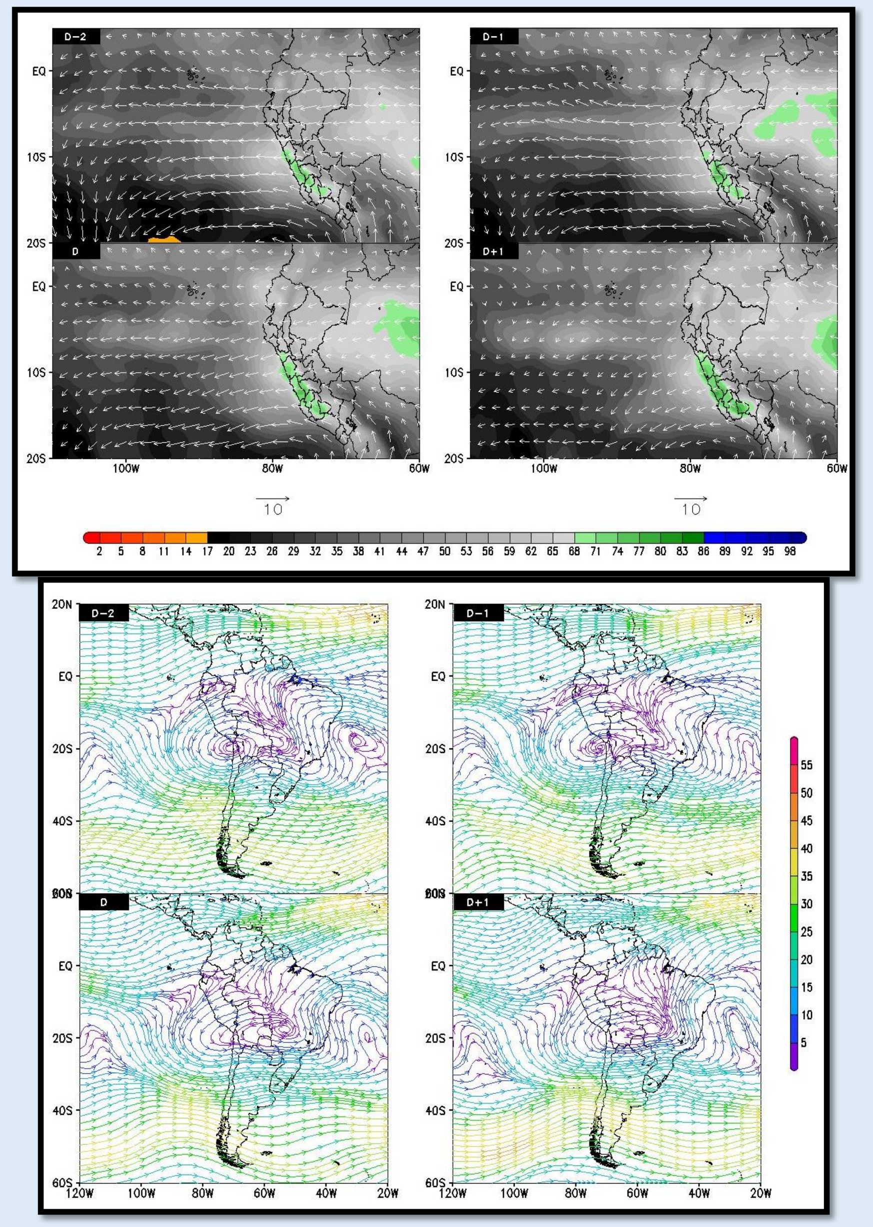


Figure 1. Composites of relative humidity and streamlines. Rivas 2019

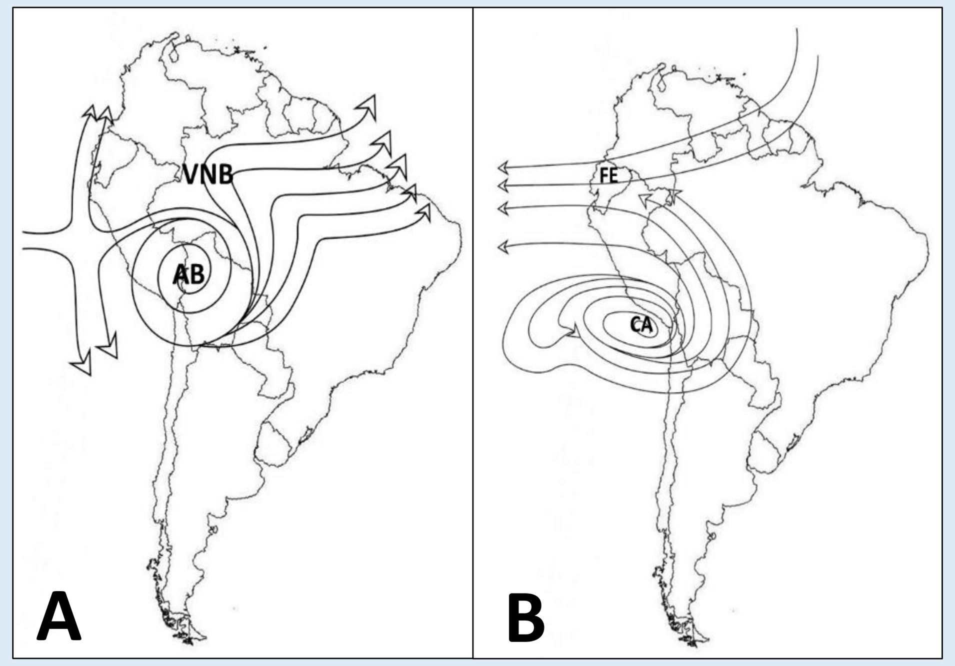


Figure 2. Conceptual model for spillover rain formation in three different atmospheric levels. (A) High levels (10 – 15 Km), (B) mid levels (6 – 7 Km). Rivas 2019.

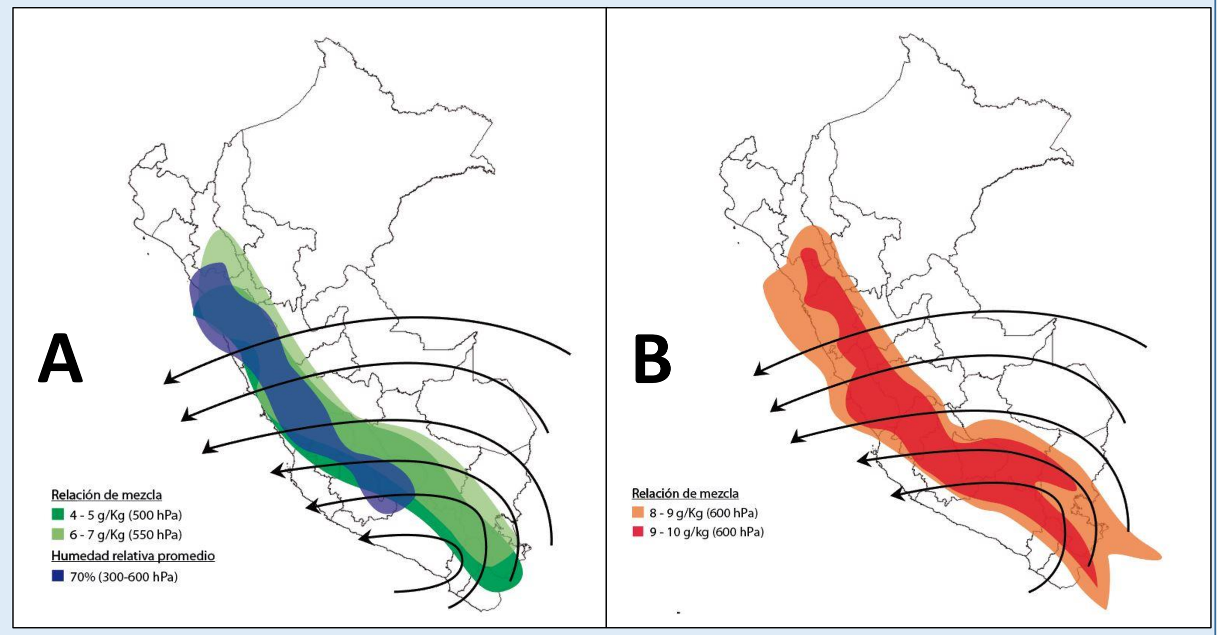


Figure 3. Conceptual model for spillover rain formation in mid levels. (A) Mixing ratio (Green: 6-7 g/Kg at 550 hPa; Blue: Mean RH 70%). (B) Mixing ratio (Orange: 8 – 9 g/Kg; Red: 9 – 10 g/Kg at 600 hPa). Rivas 2019

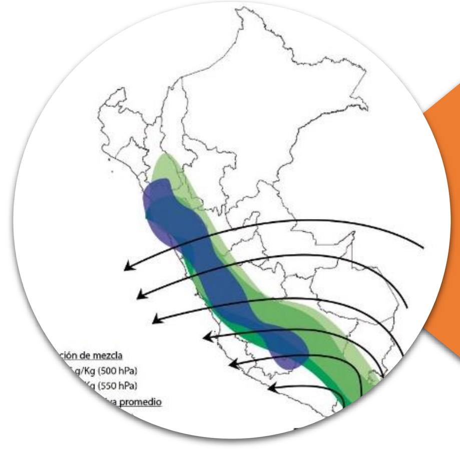
A high pressure system is very important on high levels because it drives easterly winds across the Andes. According to Underwood (2009), wind speed is a key factor for spillover rain formation. 5 – 10 m/s were found on mid levels. Givone and Meignen (1990) determined that wind direction is also crucial; it needs to be roughly perpendicular to the mountain barrier. It complies by having easterly/northeasterly winds in mid and high levels of the atmosphere. (Figure 2)

In figure 3, atmospheric moisture content is addressed. It is primarily studied on mid levels, where it was found that mixing ratios of at least 6 – 7 g/Kg in 550 hPa and 9 – 10 g/Kg in 600 hPa are needed for spillover rain formation. Also, a saturated atmospheric column is needed. A 70% relative humidity in 300 – 600 hPa column is the minimum value. Higher values would result in higher rainfall amounts.

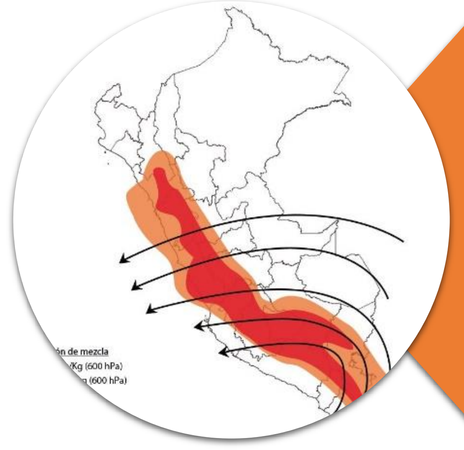
Conclusions

Spillover rain forms when:

High pressure system aloft



Moist atm. column with at least 70% RH.



Easterly/northeasterly winds (5 – 10 m/s) along with the mixing ratios detailed in figure 3; in mid levels.

Acknowledgements

- (*)Alfaro, L. 2014. Estimación de Umbrales de Precipitaciones Extremas Para la Emisión de Avisos Meteorológicos. Nota técnica 001-SENAMHI-DGM-2014. p. 5.
- (**)Nicholson, SE and Grisp, JP. 2001. A Conceptual model for Understanding Rainfall Variability in the West African Sahel on Interannual and Interdecadal Timescales. International Journal of Climatology 21:1733–1757.
- Underwood, J. S. et al. 2009. The Role of Upstream Midtropospheric Circulations in the Sierra Nevada Enabling Leeside (Spillover) Precipitation. Part I: A Synoptic-Scale Analysis of Spillover Precipitation and Flooding in a Leeside Basin. Journal of Hydrometeorology. 10:1309-1326.
- Givone, C. and Meignen, X. 1990. Influence of Topography on Spatial distribution of Rain. Hydrology of Mountainous Areas. 190:57-65.