



pour le développement







Influence of orography on spatial variability of precipitation in the tropical Andes

Clémentine Junquas K. Takahashi, S. Chavez, J-C Espinoza, T. Condom

WCRP VAMOS/CORDEX Workshop on Latin-America and Caribbean

Introduction

Introduction

- Validation
- Transport of humidity
- Diurnal cycle of the circulation
- Diurnal cycle of the precipitation
- Conclusions

Objective

- To understand the local mechanisms associated with the spatio-temporal variability of the precipitation in the tropical Andes
- Particular focus on local atmospheric mechanisms affecting the glaciers mass balance





Methodology

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Modelisation of the regional climate at hight resolution using the WRF model.

	Simulation 1	Simulation 2
	Regional simulation	One-way-nesting regional simulation
Domain	Domain 1 : Central tropical Andes	Domain 2 : Quelccaya-Zongo region
Horizontal resolution	27km	9km
Vertical resolution	27 levels	27 levels
Period	Sept 2009-Aug 2012	January 2010
Forcing	NCEP final Reanalysis (NCEP_FNL, 0.25°)	Simulation 1

	Parametrisations
Clouds microphysics	New Thompson et al scheme
Cumulus parametrization	Grell-Devenyi ensemble scheme
Planetary Boundary Layer	Yonsei University scheme
Land surface	Noah Land Surface Model
Surface Layer	MM5 similarity



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January of 2010 : Extreme rainfall and floods in Cusco region (e.g., Lavado et al 2010, El Comercio 2010)



Precipitation in the tropical Andes, 01-2010 Simulation 1 (27km)



Amazon monsoon over-estimated, but estructurally ok

Eastern slope of the Andes : too much hotspots modelised

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Precipitation in Cusco region, 01-2010 Simulation 1 (27km) and 2 (9km)

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- 27km –>9km : improvement of the structural representation of the hotspot
- But problems with rainfall in the valleys, and over-estimation of the rain in the hotspot and above 3500m.

Spatial structure of 2-m specific humidity Simulation 2 (9km) vs. observations, mean of January 2010

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Specific humidity seems to penetrate in the cordillera from the valleys
 Model too dry in the Pacific slide, too humid in the southeast

How such an incoming humidity flux from the Amazon toward the cordillera influences the rainfall in the Cusco region ?

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Analyse of the transport of humidity in WRF Simulation 2 (9km), mean of January 2010

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Convergence of two fluxes from the South and from the North
 Max convergence corresponds to max rainfall zone

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Diurnal cycle of the humidity flux Vertically-integrated humidity flux in Simulation 2 (9km, local hours), mean of January 2010

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Late night and morning : slow humidity fluxes, almost no convergence
Late morning : incoming flux from the Pacific ?

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Hours of maximum convergence : afternoon and early night

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Important diurnal variation in both case

- Afternoon : maximum rainfall situated in the West of the valleys
- Late afternoon : maximum displaced in the center of the cordillera
- Early night : precipitation maximum found in the valleys
- Same order of displacement of the maximum rainfall hour from afternoon to early night : western part of the cordillera – central part – valleys



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Diurnal maximum of snowfall above 4500m Simulation 2 (9km) vs observations

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- Hours of maximum snowfall in the model : between 1am and 4am
- In observations at the Zongo glacier: maximum between midnight and 3am

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- In the central tropical Andes the WRF model over-estimates the precipitation above 3500m and in the hotspot region, and under-estimates it in the valleys.
- The model is able to reproduce the observed incoming humidity flux from the Apurimac valleys, and also shows a second one situated in the region of La Paz (Bolivia).
- In the simulation, the spatial rainfall maximum in the Cusco region is due to a maximum convergence ocurring in majority between afternoon and early night.
- In the region of the Apurimac valleys, a West-East displacement of the maximum rainfall hour is found in both the model and TRMM, between afternoon and early night

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Perspectives

- Need to validate the TRMM products with observed rainfall data
- Is the afternoon incoming flux from the Pacific realistic ?
- Need to better understand the under-estimation of the rainfall in the Apurimac valleys, and the over-estimation above 3500m.
- Need to better understand the mechanisms of the humidity flux diurnal cycle and their influence over glacier mass balance
 -> 3-km and 1-km simulations are being displayed to understand local processes at the glaciers scales.