

Interactive comment on “The Medieval Climate Anomaly and the Little Ice Age in the Eastern Ecuadorian Andes” by M.-P. Ledru et al.

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Received and published: 18 September 2012

Reply to Vera Markgraf

1. Much detail is provided to explain different regional moisture regimes and their forcing, ENSO vs. South American summer monsoon. However, the basis for the interpretation of temperature changes is only presented in passing in the results.

Yes we agree. There is a lack of a good temperature pollen reconstruction because we were unable to obtain a good temperature pollen indicator. The only information about temperature available is based on the advance of the glaciers during the LIA. We will be able to improve this situation by employing a better calibration of the modern data as the top 20cm of the core present $\sim 1\text{cm/yr}$ sediment deposition rates. This is, however,

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work-in-progress and beyond the scope of the present study.

2. When using “rates” you actually mean conditions.

We agree that we used the term ‘rates’ in an inconsistent way. This will be changed in the revised manuscript.

3. “Water stock”: use water levels instead.

We have changed this term to ‘water storage’ as we refer to the total amount of water available and stored in the paramo, which is independent of the actual water level

4. “Cloud dripping”: cloud condensation. ok

Details: p. 2 line 5: .. between pollen transported upslope.. ok

line 7:..distinguish between precipitation and soil.. ok

p. 4 line 5: “Enso were weak” (state what you mean: low variability? Infrequent El Niño/La Niña?

We meant to say that ENSO events occurred with low frequency. This oversight has been corrected in the revised manuscript.

line 8: : : : showed that La Niñalike/El Niño-like:.. forcing was associated with MCA and LIA, respectively. ok

Line 12:..and complicate comparisons.. ok

Line 17: ? MCA colder? There is evidence from glacier studies in Colombia that the MCA was indeed cooler in the region (Jomelli, unpubl. data). This data however has not yet been published. We have therefore removed the first part of this statement.

Line 23: ..ability to expand new: : :practices to high elevations. ok

P. 5 line 6: .. dominant climate forcing systems ok

p. 6 line 9: .. cloud condensation (also p. 7 line 8 and p. 14 line 7) ok

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p.7 line 4: .. adiabatic lapse rate ok

line 15: .. of bog plants, paramo grassland.. ok

line 16: .. pinpinelifolia(?) (put colon after family name throughout) ok

p. 8 line 18: 9-m long core ok

p. 11 line 12: ? Each sample represents 14 years? The core was sampled at 2-cm interval (not 1-cm). 200 cm = 100 samples = 1100 years, minus the thickness of the tephra, sterile in pollen content.;Hence we calculated the mean value for the time represented by 2 cm of sediment deposition as ~14 years per sample.

p. 17 line 15: ..stopped abruptly as indicated by expansion.. (you derive climate from pollen changes not the other way around!) ok

line 18: .. "wet period; paramo drier" ..??? We changed this sentence as follows: '...return of convective moisture indicative of enhanced cloud condensation. However the soil of the páramo was drier and the grassland probably less extensive than previously.

Discussion p. 18: You describe precipitation "modes" for the two ENSO states, but your comparison between the Galapagos and your record falls back to ENSO variability to interpret the fact that their respective interpretation indicates contrasting modes. Not very satisfying.

Today, at an interannual scale, we know that during El Niño the mass balance of tropical Andean glacier is negative and during La Niña it is neutral or slightly positive. So in the past if we have warmer SSTs and more El Niños as during the Little Ice Age we should see a retreat of the glaciers. This is not what we observed. Then what means "more El Niño events" at a decadal scale? Is it just the frequency ? and what about the intensity? And if we have more El Niños, do we also get more La Niñas? Conroy wrote: "We therefore interpret larger T/E values to reflect higher lake level, increased precipitation and warmer EEP SST. However, given the temporal resolution of

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our record, we cannot separate El Niño-related changes from lower-frequency climate variability". Lower frequency SST variations in the eastern Pacific, not resolved by Conroy et al., may have contained significant ENSO-like interdecadal variability (e.g. Garreaud & Battisti, 1999), which would be more consistent with the glacial dynamics observed in our region. In our record we observe a good fit with the El Junco index that is not directly related to the ENSO modes we know today as we are dealing with decadal scales, so we preferred using "ENSO variability". However the question of the mechanism to relate SST variability to cloud condensation on the eastern cordillera is still poorly understood and needs further research.

Garreaud, R.D. & Battisti, D.S. (1999) Interannual (ENSO) and interdecadal (ENSO-like) variability in the Southern Hemisphere tropospheric circulation. *Journal of Climate*, 12, 2113-2123

Interactive comment on *Clim. Past Discuss.*, 8, 4295, 2012.

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