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Climate of the Past Discussions

Interactive comment on "Early Pliocene vegetation and hydrology changes in western equatorial South America" *by* Friederike Grimmer et al.

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TIAN This study generated new vegetation and climate record between 4.7 and 4.2 Ma by pollen analysis of 46 samples from ODP Site 1239A, which is located in the East Equatorial Pacific, a place suitable for investigating the precipitation-related fluvial runoff changes in northwestern South America, thus good for monitoring the past movement of the ITCZ. A major aim of this study is to clarify a mismatch about the ITCZ shift in the early Pliocene between the proxy records and the model simulation, that most proxy data supports a southward shift whereas numerical modelling suggests a northward shift in response to Central American Seaway closure and Andean uplift. Generally, this study fills the blank of well dated hydrological record of the early Pliocene in this region by pollen and spores studies from marine sediment. Generally,

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I agree with the comments posted by the other three referees and won't repeat it. Here are some minor suggestions, which I think should help the readers to better understand this research if considered.

Age model. How did the authors establish the age model for the study interval of Site 1239? From Tiedemann et al. (2007)? Why not add the benthic d18O record to the figures and sign labels of Marine Isotope Stages? You cannot just cite a reference to get all the necessary things done.

RESPONSE We'll add the d18OC.wuellerstorfi data of Tiedemann et al. 2007 to Figure 4 (see supplementary file AC2). However, in this part of the Pliocene the fluctuations in the stable oxygen values are small. Also in the stable oxygen data a gap is present around 4.5 Ma, because they have only been measured on sediments of Hole A (same as the pollen). In the results section, we will specify that we used the Tiedemann et al. (2007) age model.

TIAN Continuity of the record. Since other palynological studies of the region have been conducted for the mid-Pliocene to the Holocene, why not combine those records with the new record of the early Pliocene? Are they from the same marine core? The new record depends on 46 samples to cover the time interval of 4.7-4.2 Ma, with an average time resolution of 11 Kyr. In such a relatively short period and with a relatively low time resolution, the authors still recognize four major steps of the vegetation changes, and claim that all the vegetation belts as explained in Figures 3 and showed in Figure 4 display synchronous increase/decrease for each stage. If carefully examining figure 4, the features of the variability of the vegetation belts just constrainedly match those described in the text. The referee RC1 also pointed it out. Increasing the time resolution such as doubling, and filling the hiatus between cores 35X and 36X of Hole 1239A (there should be also vegetation change in this interval), something very different probably could happen. Also as indicated by Referee RC1, the unpublished data which is so important to support the author's conclusion of a low percentage of lowland rainforest before 4.7 Ma should be put together with the presented record of

this manuscript. I believe that all readers with interests for the ITCZ shift in the early Pliocene would like to see a continuous record since the early Pliocene rather than a segmented record in such a narrow period.

RESPONSE We think that 11 kyr sample resolution is not too bad for the Early Pliocene. Please, keep in mind that palynological analysis is very time consuming and needs a palynologist well trained in the specifics of the pollen flora under discussion.

We originally put a zone boundary at the coring gap, which in hindsight was unfortunate and, more important, not backed up by the cluster analysis. The CONISS cluster analysis groups samples from below and above the coring gap together suggesting no fundamental trend changes took place during the period in between as also indicated by the XRF-record. We correct this in the new version. Filling the coring gap would take several months of analysis and might not be strictly necessary.

To put the data in a better perspective and to present a more continuous record, we add analyses from the low-resolution pilot study, as also asked for by Carina Hoorn (Figure 4A in supplementary file AC2). We might draw your attention to the long-term development of the lowland forest.

To our knowledge the only published marine pollen diagrams from the region are those of ODP 677 and TR163-38 covering the past 40 and 15ka, respectively (González et al. 2006), and M772-056 covering the past 11ka (Seillès et al., 2016). There is overlap with the top three samples. We wrote on lines 255-257: “A Holocene pollen record from nearby core TR 163-38 has high similarity to the core top samples in its youngest part, showing increased open vegetation (Poaceae, Cyperaceae, Asteraceae), low percentages of Rhizophora, maximum percentages of fern spores, and low pollen and spores concentrations (González et al., 2006).” To which we’ll add: ”A pollen record closer to the coast - from the Bay of Guayaquil - also indicate relative open vegetation and drier mid- to late Holocene conditions (Seillès et al. 2015) as does the record of ODP Site 677 from the deep basin northwest of Carnegie Ridge (González et al. 2006).”

Detailed analyses for the mid-Pliocene are in progress and are hopefully published (at least submitted) next year. However, this work will focus on the mid-Piacenzian warm Period and on the intensification of the Northern Hemisphere Glaciations. Those are very different themes and beyond the scope of this paper.

TIAN About permanent Elño, closure of Central American Seaway and Andean uplift. My suggestion is weakening the discussion on these comprehensive topics but focusing on its significance in indicating the hydrological changes. The new pollen records are not strong evidences to support the so ambitious conclusions in the present manuscript.

RESPONSE We agree that the changes in the vegetation coupled to changes in hydrology is the core of our paper. We try to look at the hydrological changes from all perspectives as acknowledged by Carina Hoorn. We think that it is important to do so, because so many globally important drivers influence the hydrology of the region. We also are convinced that our Páramo record can be used as an argument that at least the Ecuadoran Andes were already high in the Early Pliocene (see also the responses to Flantua & Hooghiemstra). We'll check the phrasing of the discussion

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