Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2017-52-AC2, 2017

Earth System Dynamics
Discussions
Open Access
EGU

Interactive comment on "Atmospheric Torques and Earth's Rotation: What Drove the Millisecond-Level Length-of-Day Response to the 2015–16 El Niño?" *by* Sébastien B. Lambert et al.

Sébastien B. Lambert et al.

sebastien.lambert@obspm.fr

Received and published: 5 September 2017

Following the reviewer suggestion, we worked on improving the quality, the readability, and the scope of our paper in the new version of the manuscript. The manuscript was modified in consequence.

It is always difficult to reply to an evaluation about the interest or not of a paper, as part of it is a matter of point of view. We do consider, of course, that our work is new enough to deserve publication in a top-level journal such as ESD, as it bring new insight on how Earth and atmosphere exchange angular momentum during an ENSO event or, to be more specific, it shows that this exchange can differ to a considerable extent

Printer-friendly version

Discussion paper

from one event to the other. Basically, there exist only three extreme ENSO events in recent history - including the 2015-16 one. This number is so small that any new event is worth being studied from several points of view, among which is the Earth rotation view point we adopt.

Shortly after (and even during) this event, researchers (e.g., M. L'Heureux at 2016 EGU, and more recently Paek et al. 2017 in a GRL paper) agreed on the fact that the 2015-16 event was of a nature different from its extreme predecessors. It was basically the first time that one could observe a strong, mixed EP/CP event, and therefore a unique chance to see if the impressive observed rotational signal in the LOD was produced by the same processes as in the pure EP events of 1982-83 and 1997-98.

As we wanted to study the phenomenon from the interaction point of view, we naturally used the torque approach, that was already used in other studies of Earth-Atmosphere interaction in the context of ENSO events, i.e., those of R. Ponte, R. Rosen, J. Dickey, and O. de Viron. Using this approach does not mean that we repeat older studies, but this is the approach that we can apply to better understand the AM exchanges, and better explain the differences between the older events and the latter one.

Is the new story the same as in these previous studies? R. Ponte and R. Rosen showed that coherent mountain torques over the Himalayas, the Andes, and the Rockies created the LOD anomaly during the 1982-83 ENSO, while O. de Viron, S. Marcus, and J. Dickey showed that for the strong 1988-89 La Niña, it was exactly the opposite, consistent with the relation between the Niña and Niño. In de Viron and Dickey (2014), the authors showed that the same conclusion can be drawn using all the ENSO event, and not only the strong events, and that CP events generated a weaker mountain torque. Here, we show that the 2015-16 event, which was, as pointed out by various researchers, of a different nature, resulted in a similar impact on the LOD, but with very different Earth-atmosphere interaction processes, where the mountain torque alone cannot explain the LOD anomaly, and where the friction torque - that often simply damps the anomaly created by the mountain torque - gives a significant positive contribution, driving the LOD anomaly to the same near-millisecond values of the previous ENSO events. Therefore, we show that the observed LOD anomaly was not created by the mountain part of the torque - as one could have thought in virtue of the previous studies (what we now refer to as the 'existing paradigm' - see for example the second sentence in Section 4 of de Viron and Dickey 2014) - but by a mixture of the mountain and friction torques. We think this fact is worth being pointed out, as it relates directly to the changed Earth system dynamics that gave rise to the pronounced rotational signature of this new type of event.

We add a new piece of text to Section 2 of our paper, pointing out that while the angular momentum approach is most suitable for the now-casting or forecasting of LOD, the torque approach can provide dynamical insight into the mechanisms generating the rotational anomalies, and can also serve as an internal consistency check for the models under the extreme conditions accompanying these events. While the strength of frictional coupling (i.e., momentum transfer or torques) between the atmosphere and thermocline layer is a key to the dynamical evolution of ENSO events (e.g., Neelin 1998), this topic is beyond the scope of our paper with its focus on Earth rotation. For the interest of the broader ESD community, however, a new paragraph has been added to the final section of the paper, discussing how these changing atmospheric torques might interact with recent climatic trends.

We also add a new figure - as supplemental material (see the attached file) - showing the time-latitude (Hovmoeller) diagram of the zonal friction drag anomaly in the Eastern Pacific and the evolution of the integrated (positive) friction torque. We completed the explanation by additional text in the last paragraph of Section 3.

The other two minor points were also addressed: the value of the standard LOD (of 86400 s) was referred to as the 'nominal LOD'; we added a reference to L'Heureux et al. (2017) in the text (first sentence of the second paragraph of Section 4).

Please also note the supplement to this comment:

https://www.earth-syst-dynam-discuss.net/esd-2017-52/esd-2017-52-AC2-supplement.pdf

---

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2017-52, 2017.