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Interactive Comment

Interactive comment on "Observation of a tidal effect on the Polar Jet Stream" *by* C. H. Best and R. Madrigali

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General Remarks:

There are two 'spring' tides each sidereal month, namely that coincident with the new moon and that coincident with the full moon. Seasons modulate the difference between these spring tides depending on latitude. The larger the latitude the larger the asymmetry during the summer or winter solstice. At the equator both spring tides are always equal, but for the northern hemisphere the new moon tide is the largest during winter, whereas that coincident with the full moon is the largest during summer. Twice each year both spring tides are approximately equal for all latitudes at spring and autumn equinoxes . This seasonal change causes a 6 monthly phase shift of 14

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days in the maximum tidal force. Superimposed on to this is the 18.6 year cycle of the lunar precession which modulates the latitude dependence of this amplitude. The tractional tidal forcing therefore varies in magnitude with both latitude and time. The Jet Stream is produced by high pressure gradients at the interface of warm tropical air and cold polar air, which is then deflected westwards by the earth's rotation. The flow is quasi-chaotic, especially during winter, yet still shows apparent monthly variations as registered by the arctic oscillation (AO). Our paper proposes that tidal forces acting over large spatial distances are partly responsible for distorting the Jet Stream flow.

Now to address specific points made by reviewer 4

Reviewer Point 1:

"The main argument rests on the comparison of the AO with the calculated 'tractional force'. It is not clear where the authors got the data for the AO time series and how it was derived."

Reviewer point 2:

"Additionally the plots derived from the calculation of the 'tractional force' as described in the supplement are not conclusive. The horizontal component (parallel to earth's surface) of the lunar gravitational force should have a maximum towards the border of the earth disc (as viewed from the moon) not a minimum as shown in Figure 1 of the supplement."

Reply:

The reviewer makes a valid point regarding referencing the data used in the paper for AO. The data used for the analysis are those derived by NOAA 'Teleconnections' see : http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/ao.shtml. I agree that this oversight should be corrected if the paper is to be published. However, the second point that the reviewer makes is incorrect. The horizontal component (parallel to earth's surface) of the lunar tidal force is precisely zero at the border of the

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earth's disc (as viewed from the moon). This is because the tidal force is proportional to the differential of the gravitational force $\frac{1}{R^3}$ (see attached figure below). The 90 degree point is actually the lull point for the tractional force as shown . Figure 1 in the supplement to the paper is therefore essentially correct. Maximum horizontal forces occur at 45 degrees offset to the tidal bulge.

Reviewer Point 3:

"The authors fail to dismiss potential dependencies of the AO on the lunar phase or position other than the gravitational pull. E.g. ocean tidal influence on surface pressure (and therefore the AO)."

Reply:

This is a valid criticism. There is a possibility that ocean tidal movement could indirectly modify surface pressure which could have been discussed. However, any such effect would be difficult to distinguish from atmospheric tides because both effects are essentially in phase. The main purpose of the paper is to demonstrate that such an effect exists at all.

Reviewer Point 4:

"The statistical techniques used are not adequate and not traceable. The visual comparison of two time series as presented in Fig. 1 and Fig. 2 does not provide conclusive evidence. The presented autocorrelation is not explained in any way and the values given in Fig. 3 seem to be too small to support a meaningful correlation."

Reply:

The statistical arguments described in the paper clearly needs improving. I had assumed that Cross-correlation used in Figure 3 was a well known technique for analyzing two time series distributions whose correlation is offset by a fixed interval. This process shows a very small but also very clear 5 day anti-correlation between the AO and tractional tidal force at 45N based on 65 years worth of daily values. This also

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includes summer and winter periods when the phase shifts annually by 14 days, as described above. This small signal emerges above the noise, but perhaps needs to be better explained.

Concluding remarks:

If the editor agreeable, then I would therefore propose to submit a revised draft paper with an improved discussion of statistics and which better addresses the points made by both reviewers.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 22701, 2015.

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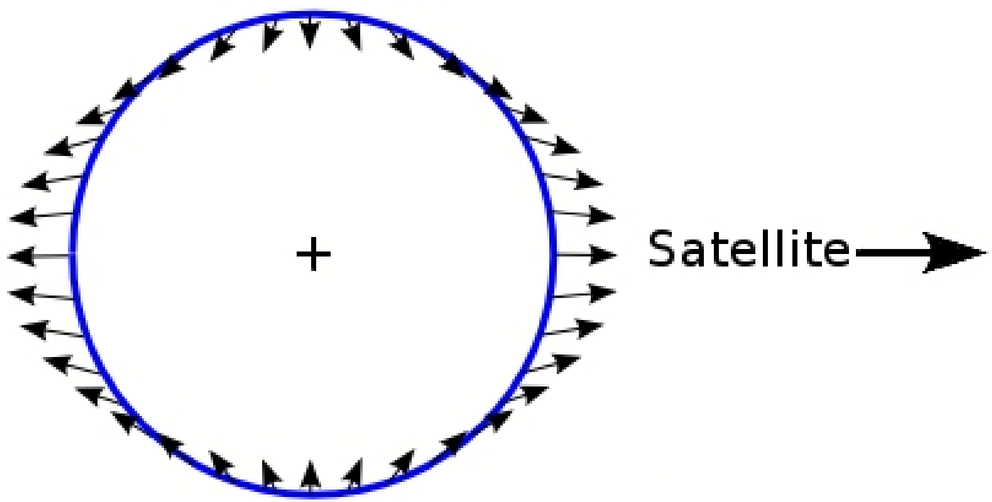

Fig. 1. Tidal vectors at surface of a planet in orbit with a satellite (from Wikipedia)

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