

# ***Interactive comment on* “Strong tidal variations in ice flow observed across the entire Ronne Ice Shelf and adjoining ice streams” by Sebastian H. R. Rosier et al.**

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Review of: Strong tidal variations in ice flow observed across the entire Ronne Ice Shelf and adjoining ice streams, by S. Rosier and others.

## SUMMARY

This paper describes an extensive GPS data set of 3-D ice shelf motion for the Ronne Ice Shelf. It focuses on introducing the data set (43 total GPS sites on floating and grounded ice sheet) and describing the lateral motion with an emphasis on the Msf tidal component. Interpretation is limited to reviewing previous studies relating the low-

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frequency tidal signals to the standard vertical tidal components, but this is appropriate to ESSDD.

Specific comments are divided into “Major”, where the authors should explain what they did in response, and “Minor”, which don’t require documentation in revision. Numbers refer to original page.line. In general the paper is very clear and well written.

– Laurie Padman

## GENERAL COMMENTS

1. I'd prefer that “shelf” always be “ice shelf”; however, in this paper it isn't critical.
2. Say ‘... BY Makinson et al. ...’ rather than ‘... IN Makinson et al. ...’ ?

## MAJOR COMMENTS

MSF is the interaction of principal semidiurnals M2 and S2. This needs to be explained, since the diurnals K1 and O1, while smaller (in general) in the Weddell Sea, are still significant, and their interaction gives MF. Maybe the records are generally too short to deconvolve M<sub>sf</sub> and M<sub>f</sub>, but it seems like M<sub>f</sub> should be there. I also seem to recall papers about diurnals being stronger in lateral motion on grounded ice than semidiurnals, relative to the nearby ocean vertical signal, which suggests that maybe M<sub>f</sub> would be amplified relative to M<sub>sf</sub>, at least on grounded ice?

General: I think you need to be clear that Talutis and Carlson ice streams flow into what you only call “Carlson Inlet”.

5.1-5.2: This seems like a good place to explain, or reiterate, that M<sub>sf</sub> does have the same frequency as the M2/S2-based spring-neap cycle, since it hints at why the nonlinearity that appears as M<sub>sf</sub> lateral motion might arise.

7.11-7.23: (a) This would be clearer if it was organized in frequency: M2, K1, M<sub>sf</sub>, S<sub>sa</sub>. Maybe a short paragraph for each. (b) Then, organize Fig. 5 to the write-up, and cite the specific panel we're meant to look at for each.

7.26: “As the tide rotates”. Which is “the tide” here? Msf, or general energy flux of the principal tides, mainly M2 and S2? But maybe you mean “Although” rather than “As” ? I’m trying to understand how the tidal rotation relates to the lead/lag between the spring-neap modulation and Msf phase, without invoking physics that you haven’t explained.

11.1-11.6: I’d disagree with the idea that interpolated fields “better show the importance of”. Figure 5a is the honest answer. Maybe if you just used a wider color range for Fig. 5 (“jet” rather than new Matlab default), you could easily discuss everything from Fig. 5a.

11.7-11.9: As for the previous comment, the dot plots of Fig. 5 are more honest than the interpolated map, so I’d rather see the dot plot for MSF velocity (as a fraction of mean speed).

11.7-11.16: I didn’t understand this entire paragraph. (a) If the record is long enough to resolve Msf, then the detided signal has Msf removed, so the mean flow \*based on the detided residual\* should be unbiased by non-integer numbers of Msf in the record interval. The problem only arises if you do a standard mean of the non-detided record. (b) Why would the problem be worse in slower-moving parts of the ice sheet, especially if there is a reasonably linear relationship between Msf amplitude and mean speed (Figure 9)? (c) I really don’t find Fig. 8b convincing, as the structure seems to be dominated by regions with poor data constraints.

11.17-12.3: I think we need a bit more information here about \*why\* fortnightly variation \*always\* leads to increased mean speed regardless of mechanism. The three cited papers are all about ice \*streams\*; how does that map to, say, the Ronne ice front? Do you think that the Msf strain rates on the floating ice are increasing the mean flow, and increasing the mean strain?

12.10-12.12: I wouldn’t say that “the Ssa tides \*leads to\* a maximum in S2: they are part of the same component of astronomical forcing, and the description only makes

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sense if you are thinking S2 as being some modulated addition of S2 and K2.

12.19-12.20: My guess is that the statement that “FRIS is ... the best observed ... system” only really applies to the size of the GPS data base. For different aspects of ice shelves, more complete knowledge exists. It is probably good enough to just say that “The extensive data set of GPS records, and the large tidal ranges, ... make the FRIS an excellent place to ...”

12.28-12.29: “has been shown to lead to a higher ...” Not true \*of this paper\*, and maybe not true in general for the ice shelf if the only basis is glaciological models for ice streams?

#### MINOR COMMENTS

1.3: (a) “motion” (of the ice shelf) in what direction? Clearly in the vertical, but less in the horizontal. (b) comma after ‘shelf’

1.10-1.13: Reorganize and/or subdivide the sentence.

1.20: cite for the ‘up to 9 m’ statement. I think this comes from interpreted tilt rather than GPS.

4.15-4.18: This paragraph should be merged with lines 4.3-4.7, to put the observations stuff together before summarizing the hypotheses for nonlinear effects.

4.28: “overwinter” seems like an adjective. So, “continuous overwinter data ...” or “data collection over the winter”

4.33: Don’t need “It is important to emphasise that”

5.7 and 5.11: Why ‘FR-’ sites?

5.12: Less colloquial way to say “these steps were skipped”

6.1: When you say that the Rayleigh criterion (lower case c) “was used”, do you mean that it’s a characteristic of the software, or \*you\* made the decision to use it?

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7.30: No need to hyphenate “time scales”

8.2-8.3: Sentence starting “The various” is just figure caption material.

8.4: capitalization of “data analysis” ?

10.6: Bracketing of citation “(Minchew et al., 2016)”

11.9: formatting of ‘Msf’

12.16-12.17: This interesting issue (aliasing of InSAR-derived velocities) seems like it should have been mentioned in the Introduction.

## FIGURES

F.1: (a) Add ice front to plot. Correct citation for CATS2008a is “an updated version of the inverse tide model described by Padman et al. (2002)”

F.2: (a) Caption should explain ice stream names, including that box-d is Talutis and Carlson ice streams. (b) “smoothed with a low-pass boxcar filter” should probably explain its characteristics (X km) and \*brief\* reason why.

F.3: Part of the ‘TIS’ box is actually also “Carlson Ice Stream”, isn’t it?

F.6: For reasons I can’t explain, I expected grounded ice to be on the \*left\* side of these plots. You could reverse them for me. Or, probably more sensible, add a vertical dashed line on each panel for the GL, then at the top of the plot mark “Ice Stream” and “Ice Shelf”.

F.8: See Major Comments. I don’t think this interpolated plot works well; the dots like Fig. 5 are better, especially for panel (b)

F.9: This might be more information-rich if you used different symbols for ice shelf and ice streams.

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