Review of: "Brief Communication: Arctic sea ice thickness internal variability and its changes under historical and anthropogenic forcing", by Guillian Van Achter et al

General comments

This brief communication analyses the variability of Arctic sea ice thickness in pre-industrial, historical and future climate simulations from the CESM1(CAM5) coupled model. Both temporal analysis of the timeseries of sea ice volume, and spatial analysis of the sea ice thickness are presented, and results from the two analyses are brought together in the discussion.
The main findings are that this model shows two peaks of temporal variability (8 and 16 years) in the pre-industrial simulation, which persist in the historical simulation, and until the middle of the 21st century. The first mode of spatial variability is a dynamic mode related to the AO, and corresponds to the 8 year peak in temporal variability. Both the spatial and temporal variability change significantly from the 2050s when the summer sea ice is lost.

In terms of the originality, scientific quality, significance and presentation quality I asses this communication as good. The application of wavelet analysis to the SIV timeseries is interesting, and it is really good to see the temporal and spatial analysis brought together in the same piece of work.

Overall, I feel the paper could benefit from
- More clarity in the details of the analysis, and some of the explanations.
- Some improvements to figure 1
- A better bringing together of thoughts at the end of the conclusions.

I hope these comments will prove useful.

Specific comments

Lines 46-50: While the model has been well validated for the mean state of ice thickness and extent, and for the declining in ice extent, it is of course not possible to validate the variability in the ice thickness/volume, and so I think the statement that it *can be* assumed that the modelled timeseries is an adequate proxy is perhaps too strong - the assumption is a caveat of the work.

Lines 53-54: Was the analysis done using just one of the historical and future climate ensemble members? I assume so, but it would be good to clarify this. As an aside, it would be interesting to know how robust this analysis is if it is applied to different members of the ensemble.

Lines 59-64: I found this paragraph a little confusing. The removal of the trend and seasonal cycle from monthly data for the SIV timeseries is clear, but I was less sure exactly what was done for the SIT fields before the EOF analysis. Later the analysis of Lindsay and Zhang is mentioned – they used annual mean data, so it would be good to clarify exactly what was done.

Paragraph beginning at line 67: I found this paragraph difficult to follow on first reading. I think it would help the reader to start the second sentence in a way that makes it clearer that the discussion will initially focus on the temporal analysis (the start of the following paragraph is much clearer in this regard).

Figure 1: I have a number of suggestions that would make this figure easier to follow:

- The discussion in the text refers to the time periods in years, whereas the scale in the figure is in months – it would be easier to follow if the scale was also in years.
- Perhaps the lines marking the areas of significant variability could be a colour not used in the scale, so that they stand out more. This is especially needed in 1c, where there is more yellow on the plot itself.
- Maybe the 8 and 16 year periods could be marked by horizontal lines (on the panes representing the wavelet power spectrum).
- I'm not sure why the Fourier spectrum is included with the time-integrated power spectrum, as I don't think it is mentioned in the text.

In addition, the meaning of the hatched area is not explained anywhere.

Lines 110-111: It looks like the peaks discussed here are not significant? In the discussion of Fig 1a, the 42 year peak is not discussed because it is below the 95% red line. However, all the peaks in the time-integrated wavelet spectrum for Fig 1c are below the red line. Can this be clarified – is it that the integrated value is not significant because the peaks are only significant until 2050

Lines 116-7: I am not sure what this last sentence means – could it be clarified please.

Line 128: Could the sentence starting 'The disparities…' be tightened up a bit – I see what it means, but it sounds rather vague as written.

Section 3.2: Mention here that the future period is analysed to 2050.

Section 3.3: I think this analysis is just done for the pre-industrial period? It would be good to make this clear – maybe even in the section title.
The analysis in this section is good, but I found the text confusing in places. Were both the thermodynamic and dynamic aspects investigated for each of the first and second modes for example?

Lines 185-186: The analysis of spatial variability presented in sect 3.2 only covers the period to 2050 – perhaps a statement can be added there about the behaviour past-2050.

Conclusions: the first paragraphs provide a good summary of the work, but the last couple of paragraphs could be stronger. In the final paragraph do you mean the location of these devices? It would be good if this could be more explicit.

Technical corrections

Line 26-27 "They enlightened…"
I did not understand the first part of this sentence (relating to the historical and pre-industrial climates) – is the point that the variability for these periods is the same? It would be good if this could be re-worded to be clearer.

Line 41: It would be good to mention somewhere that this is a CMIP5 model.

Line 70: I would suggest mentioning here (with the Torrence and Compo ref) that the Morland wavelet is used, rather than in the caption for Fig 1.

Line 73: It not mentioned here which 200-year period of the 1700-year control simulation is used, although it is clear from Fig 1, maybe mention that it is the 200 years preceding the historical integration.

Line 81: I don't think the reason for analysing the shorter period is explicitly mentioned in sect 3.1. Perhaps it can be mentioned in sect 3.2.

Line 106: Sentence starting 'Those peaks and bands…' not needed - Fig 1b could instead be referenced in the first sentence of the paragraph.

Line 125: Ref Fig2g in this sentence.

Line 138: Sentence starting 'As the first mode….', rephrase to emphasise where there is and is not agreement in the behaviour of the first and second modes.

Line 140: I don't think this sentence is needed (We looked at…)