Interactive comment on "Comparison of ERA5 and ERA-Interim near surface air temperature and precipitation over Arctic sea ice: Effects on sea ice thermodynamics and evolution" *by* Caixin Wang et al.

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This paper presents an analysis of ERA-Interim and the newly released ERA5 reanalysis over Arctic sea ice. The study mainly involves comparing the near surface air temperature and precipitation fields against data collected by drifting buoys (IMBs and Snow Buoys). The warm bias in ERA-I for low near surface air temperatures was shown to be higher in ERA5 (unfortunately!). The precipitation results were more mixed, as ERA5 seemed to have lower total precipitation but higher snowfall compared to ERA-I (a big increase in the snowfall/total precip ratio). A simple Freezing Degree Day (FDD)

model and a more sophisticated 1D model (HIGHTSI) were used to assess the impact of these differences on simulations of Arctic sea ice mass balance.

In general, the paper was well written and included a clear motivation/set of objectives and data/model descriptions, along with some useful figures and discussion. The study is obviously timely considering the potential utility of ERA5 for Arctic studies in the coming months/years and the lack of current assessment efforts. The study was rather simple in its objectives, however (i.e. it wasn't exactly a complete inter-comparison of ERA5 and ERA-I over Arctic sea ice), and some of the results and surrounding discussion were not as insightful as they could have been. My view is that the paper should be published once some improvements have been made.

General comments

I think it would help to show some more general comparisons between ERA5 and ERAI over the Arctic Ocean/sea ice, e.g. raw and difference maps/time series of air temperature, snowfall, precip, pressure. These could be just annual means but seasonal means might be good to see too. This could be included in the SI but I think it will be valuable to include in the main paper to help motivate the study (are there any big/obvious differences from the off?!). This doesn't need to be too detailed.

I was a bit disappointed in the FDD analysis and am unsure of its value. The main conclusion seems to be that the warm bias introduces a negative thickness bias, which is pretty obvious without the need for an FDD model...I would be tempted to drop this section entirely unless you can make it seem more value-added compared to the 1D modelling study that follows this (and does seem valuable despite my concerns).

To me it's a shame you didn't show a complete regional Arctic sea ice model forced by both reanalyses as this could have been a useful way of showing regional biases in the reanalyses!

While I think the HIGHTSI section is useful and needed, I think it needs to be re-written

and potentially expanded on to improve clarity. e.g.: - I know you cite those model papers but I think you to include at least a brief description of the model here and how those forcings were used. Why no downwelling for example? This is calculated form the cloud cover? I think you can provide some general information then cite the papers for more information. - I got pretty confused by the use of Sp and Sf and think there could be some mistakes here. Why did you start by comparing the Sp runs and not the Sf runs? Sp is a bit of a confusing acronym so maybe you could try something like Tp2mt? - Can you not also show some idealized Arctic mean simulations instead of just the buoy track simulations? This might give us a better sense of what the potential impact of these differences might be when we want to consider the Arctic as a whole. - 'a good representation of precip seems crucial' seems like a pretty loose interpretation of the analysis you presented. I think this discussion needs to tie back better to what exactly your results demonstrated.

I think you need to better justify early on why you only look at these two variables. Maybe mention earlier that you also looked at MSLP in ERAI and ERA5 (reanalyses tend to agree more in this regard as expected) and that you're limited by what the buoys can provide? You later force the HIGHTSI model with other variables (e.g. cloud cover) so I think you should show these and their differences too, despite the lack of buoy obs to validate it against.

Comparing 2 m and 10 m air temps might be illuminating. Any change in how the 2 m air temps are calculated in ERA5 (still not an explicit model level, right?).

Confused why you need to interpolate the ERAI data to the ERA5 grid before interpolating to the buoy position. Guessing this won't be a big issue as ERA5 is of intermediate resolution but still seems odd to me.

How do you deal with the temporal differences between ERAI and ERA5? ERA5 is hourly and ERA-I is 6-hourly?

I'm confused why you don't show the actual ice thickness for the buoys (I think you just

show the estimated ice thickness change from the FDD model?). Also confused as to whether you initialize the FDD model with zero ice thickness or not, as you show ice growth, not ice thickness. Any reason for this? Again, I see little value in this analysis so suggest dropping this and improving the rest of the analysis presented in the paper.

Specific comments

P1 L3-4: 'The decline of Arctic sea ice has been attributed to various interrelated causes, including a general overall warming trend (Steel et al., 2008; Polyakov et al., 2010).' Seems pretty vague so would recommend you either improve this or drop it.

P1 L10: I would replace 'in-situ atmospheric observations' with something like 'direct observations of the atmosphere, sea ice and ocean conditions'?

P1 L15: I suggest you combine this line 'Atmospheric reanalyses etc..' with the one about their use earlier on L12-13.

P1 L22: I think you need to make the point here that the 1950 onwards data isn't yet available yet? Unless you're guessing it will be at the time of publication. . . I also think you need to provide a better discussion of these supposed improvements and how they might increase ERA5's utility for Arctic studies, e.g.: - What do you mean by improved representation of troposphere and global balance? - More consistent? How?

P3 L20: Where were these buoys deployed?

P4 L23: Boisvert not Biosvert

P6 L3-4: And any thoughts on how the cloud physics might have changed in ERA5 to cause this big change in snowfall/precip ratio? I think you should plot this ratio out as a separate figure as it seems like a crucial part of the story.

P6 L4-5: I'm not quite sure how Figure 5 shows it is less anomalous as these are just showing the reanalysis data not compared to anything. Think you need to plot the buoy results too despite the big issues of representation etc.

P6 L10: why not use a daily climatology of density? You cite Warren1999 for the 350 value but this seems overly simplistic considering the results presented in Warren1999.

P8, L4-5: can you briefly describe what this ocean heat flux is? E.g. 2 W/m2?

P9, L30: drop the warm summer bias comment here as you repeat it later.

P10, L1-3: think you should mention the caveat here that the buoy probably isn't giving the 2 m air temperatures. Can we be sure resolving the boundary layer is the actual problem here?

P10, L5-14: I think this needs a bit of rewording for clarity. Really worth stressing that the total precip is lower but the snowfall is higher, right?! I would start with that difference then explain what it means in terms of the comparisons with the buoys. - Think you also need to make the point later regarding which precip was used to force the 1D model and that care needs to be taken regarding how precip is used in the products perhaps. Any particular recommendations here? I.e. do you think we should be using the snowfall product or deriving this from the total precip? There are other ways of doing this also (using higher level temps).

Figure 2: why does the green line seem dashed? Can you move the difference line lower so it's easier to see? - I also think you should show not the difference between ERA5 and ERA-I but two lines representing the differences between the reanalyses and the buoys. Maybe just pick a couple as good examples of the seasonal cycles you mention in the text and make these bigger/clearer, then put the rest in the supplementary information? As it is, it's hard to really get a sense of what these figures show quantitatively.

Figure 4: this is a good figure!

Figure 5: you don't need the second y-axis, just state in the legend that the dashed lines are snow. You should add the units to the label and legend. Why does this not include the buoys change in snow depth? As a second y-axis?! Or converted to

cumulative precip and plotted on the same axis.

Figure 7: I don't think you need to show the FDD values as they don't mean much physically.

Figure 8: why the weird staircase in buoy 2011M? Lower temporal resolution for some reason?