Reviewer comments for “Recent extreme light sea ice years in the Canadian Arctic Archipelago: 2011 and 2012 eclipse 1998 and 2007” by Howell et al.

Recommendation – accept with major modification.

This manuscript examines several anomalously high and low ice cover years in the CAA and places them into a physical process context which draws upon thermodynamic and dynamic explanations. It is interesting work to pursue. I think there is a lot to be learned from these sorts of examinations, especially now that we have crossed into a different sea ice “era”. Process understanding as developed for heavier ice conditions is probably not going to be sufficient, and analyses of more recent anomalous periods are of use. The manuscript requires a fair amount of work before it could be acceptable for publication. There is some analytical work that needs to be redone, and the process descriptions must be reworked and properly referenced. In particular the manuscript makes several physical process conclusions/comments that are hard to follow, not novel, or simply incorrect. These are noted below.

The manuscript also fails to follow up on some very interesting observations, the pursuit of which would provide additional physical insight. Large scale atmospheric flow and trough/ridging patterns were not explored as SAT anomaly driving mechanisms; this is a critical failing. The strong difference between 1998 and the other years was not pursued to the extent it could have been; in particular the MYI pattern difference was very interesting. Why is land-fast ice thickness not decreasing at Resolute Bay? And – what about the action of specific weather events to modify or even dictate the course of a melt season? You mention this mechanism in the first page (August 2012 storm) but never return to it (and while that storm may not have affected Arctic Ocean ice cover, what was its effect on ice advection and the CAA?). The action of a couple of well-times storms was specifically identified in the Atkinson et al 1998 paper as a mechanism which helped make 1998 a very anomalous year. These things must be explored if the manuscript is to serve in its desired capacity to provide physical bases for these anomalies.

Comments major and minor are noted as they appear in order in the document. I will need to see the revisions.

Title – it sounds like a newspaper headline, and it isn't reflective of what you actually are doing. Heavy ice years are given almost as much play as light ice years. The title should be something like “Dynamic and thermodynamic forcing of anomalous ice years in the Can Arc Arch”. Something like that would better reflect what was done in the manuscript.

p1315, Line 7 – use “the” before water features other than lakes.

P1315, Line 26 – to clarify the shift in geographic focus start the sentence as: “Within the CAA, the record lightest sea ice year was 2011 with a mean September…”

P1316, line 5 – Replace Howell et al 2010 with the Atkinson et al 2006 reference here please; the southerly flow/atm circulation for the 1998 anomaly was described there first. The Alt et al 2006 reference may also be applicable; I can't recall at this point. Certainly Alt, along with Agnew, were the ones who described the atmospheric patterns that resulted in SAT anomalies that had nothing to do with what is going on at the surface.

P1315, line 19 – spell out numbers < 10 and just say “years”. In this sentence years is not being used as a variable in a formula.

P1318, lines 6-7 – elaborate on the technological bias or drop the comment because it seems to contradict your next comment concerning the Tivy et al results.

P1318 line 11 – move the comma in front of “therefore”

P1320, line 23 – “To investigated” – no ED here.

P1320, line 23 – presumably annual maximum landfast thicknkess ice values but add that in for clarity. Okay I see later on – not annual values but weekly time series. Do clarify with the lead-off sentence.

P1321, line 15 – say “...using a Kendall tau non-parametric function following...”

P1321, line 15 – State (justify) why in particular you have elected to use this slope estimator method.

P1321, line 15-17 – Did you test for autocorrelation? If so, state the results; if not, do so to properly justify application of pre-whitening.

P1321, line 18 – Define what IceBridge data are; it isn’t as common as IceSAT and readers might not be familiar with it.

P1321, line 21 – “provided *by* the NSIDC”

P1322, line 5 – “from *the* National Center…”

P1322, line 5 – Reanalysis – why would you use a 2.5 degree resolution product that has no hope of capturing SAT in a region as complex as the CAA? Redo SAT and SLP work using the NARR.

Table 2: Add to the caption which row is heavy/which row is light. “Monthly June to September total, multi-year ice (MYI – top row) and first-year ice (FYI – bottom row)…”

p1322, line8-9 - “A summary of standardized ice cover anomalies for the extreme light and heavy ice years is shown in Table 2.” - Go ahead and state what they are at this point, e.g. a sentence like this would be better: “Standardized anomalies are provided in Table 2 for monthly total, FYI and MYI, for heavy and light years.”

p1322, line 12- “These 2011 June anomalies were both weaker...” ? Presumably drop 2011?

p1322, lines 12-20 – this is all really clunky – Get rid of this stuff; Table 2 says all this. You want to just drill down to the analysis/summary comments, such as appear starting line 21.

p1322, line 20 – “Not surprisingly, the...” Don't say things like this unless you state why it is not surprising. State the observation, and then if it is of particular interest, note this and state why. Not all of your readers will be as close to the material.

P1323, line 25-26 – “Although FYI melts more easily, which in turn is more likely facilitate light ice conditions under anomalous atmospheric forcing, ” - clarify this please.

P1324, lines 21-23 – “In addition, the FYI time series illustrates that virtually zero FYI remained following the melt season for all four extreme light ice years.” – too colloquial; restate more like “virtually all FYI melted during the light ice years”

P1327,lines 1,2 – “... 1998 was gradual as oppose to rapid that is likely attributed to the increased presence of thick MYI (Fig. 5a, b).” – it’s “oppose**d** to” and the sentence needs to be broken at “that”, so “...to rapid. This is likely...”.

P1327, line5 – process, not processes.

P1327, lines 4-7 – “Perovich et al. (2007) demonstrated the melt processes is enhanced from an earlier melt onset by increasing the energy available for melt during the melt season that exerts an influence on the minimum area reached over the season.” – I don’t really know what this is saying. I suspect it’s a grammar issue.

P1327, lines 7-9 – “This was the case in 1998 when the earlier melt onset (−6.6 days) resulted in more total ice loss early in the melt season and contributed to the gradual melt of MYI throughout a long melt season (Figs. 5a, b, 9).” – I don’t see this I’m afraid. The rate of total melt from Fig 5 is the same in 1998 as for the other years. MYI decline in that summer is noteworthy because it doesn’t gradually decline. It holds almost steady until well into August, then exhibits a rapid decline. Remove this sentence because you can’t use 1998 as a case in point for gradual MYI decline – it just isn’t there. I don't disagree that total melt starts Fig 5 at a value lower than other years, which I suppose could be early melt and not simply a result of a winter that was not favorable to ice formation, but it is clear that the heavy toll is being taken on FYI.

P1327, lines 14-16 – “However, once melt onset began in 2011 and 2012, the sea ice-albedo feedback served to intensify the strong positive July SAT anomalies and facilitated an even more rapid melt than 2007.” - How would sea ice melt intensify an SAT anomaly? What would the screen-height air temperature be above an ice surface in the CAA in July, and what would it be over the open water? There would be very little difference. Is there a reference for someone measuring this? And – your SAT values/anomalies are derived from NCEP/NCAR RI – there is no way this reanalysis has the spatial resolution or process sensitivity (i.e. Where/when has a given ice-covered bay melted) to ever draw this conclusion for a region as complex as the CAA. This must be far more strongly supported with physical analyses or dropped. I would imagine it was likely an extended period of minimal cloud cover and/or strong southerly advective flow, eg like 1998. That is the scale of physical process RI will pick up.

P1327, Line 16 – “also not anomalous**ly** late ”

p1327, line 16-17 – “Freeze onset dates for 2011 and 2012 were also not anomalous late providing more support for rapid melt driving ice loss in 2011 and 2012 (Fig. 9).” - What does this mean? At least explain how one follows from the other.

P1329, line 9-10 – “The three processes that are associated with heavy ice years are short melt seasons, low mean JJAS SAT anomalies and Arctic Ocean MYI import.” write “...and import of MYI from the Arctic Ocean.”

P1332, lines 5-7 – “We suggest that longer melt seasons within the CAA (Fig. 9; Howell et al., 2009) are resulting in the increased absorption of solar radiation and subsequently delaying fall freeze onset that in turn has reduced the length of time for FYI within the CAA to grow.” - This process is being presented as though it were a new idea. It isn't; provide appropriate citations.

...and check your grammar. Were that sentence to stay as is, it would need to be written as: “We suggest that longer melt seasons within the CAA (Fig. 9; Howell et al., 2009) allow for increased absorption of solar radiation [into the upper part of the water column], warming the water column and so delaying fall freeze onset, which in turn has reduced the length of time for FYI to grow.”

p1333, lines 10-12 – “There is a strong inverse correlation between the length of the navigation and mean MYI area present over shipping season of $r = -0.72$.” - more details here. What/how many years were used? It would be useful to see this plotted.

P1334 – you really can't answer the question, “what is the likelihood”, where likelihood in this context must be taken at its statistical meaning. You have to change the wording on this objective.

Figure 1: The placemap with labels needs to be a fair bit larger. Reverse your color scheme for the ice concentration plot – typical is darker for heavier values; it will also allow the islands to be more readily distinguished.

Figure 2: Place circles on your selected min/max years, or add fine vertical lines, on each of the four monthly plots for clarity. Modify the caption accordingly.

Figure 3: I know it's noted in the text but please also note in the captions which year set you are dealing with (heavy or light). This makes the figures self contained if someone is just skimming the paper.

Figure 8: These plots should correspond to Figs 2 and 3. Remove July and August plots and instead make it June/sept Light and June/Sept Heavy.

Looking at Figure 2 there are two interesting things I see:

1) It looks like FYI in both August and September have been on a slow but persistent downward trend for a long time, whereas MYI held steady and only after 1998 did it really start to drop off.

2) The Sept plot really highlights just how strong a negative anomaly 1998 was, and the the extent of the departure it represented. Trends had been flat until then. The subsequent minima, while low or lower, are working within a context that now favors lower ice years; for 1998 it is clear that wasn't the case. One could even argue for an upward trend 1980-1990 in Sept total anomaly.

Polar plot figures in general – why are you showing SAT anomalies for the entire circum-Arctic? Your focus is the CAA; the maps should stay focused. It makes it very difficult to examine details.

Most of your citations are your own work. Statements are made that need to be backed up by the literature.