Review of 'Recent summer Arctic atmospheric circulation anomalies in a historical perspective' (tc-2014-122) by Belleflamme et al.

We want to thank the reviewer for his meticulous and constructive remarks and suggestions. All proposed language improvements and clarifications will be changed according to the reviewer's propositions.

Specific

Abstract, p.4824, line 13: what do you mean "largely exceed"? - be more specific.

We propose to replace "largely exceed" by "exceed by a factor of two".

p.4825, l.17 "We have put the recent (2007-2012) summertime atmospheric circulation anomalies..." - justify choice of period and why the two more recent (2013, 2014) summers are not included here.

As said above in the text (p.4825, ll.14-17), we want to study whether the 2007-2012 period can be explained by the natural variability of the atmospheric circulation, or if it may be attributed to global warming. To make this more clear, we propose to replace the sentence at p.4825, l.17 by: "We have put the 2007-2012 summertime atmospheric circulation anomaly ...".

p.4827, l.6 "strongly depends on the amount of available station data" (or the number of stations?) - rewrite to clarify.

We propose to write "strongly depends on the number of pressure observations", as said by Compo et al. (2011).

p.4827, l.26: I am not clear how the reference day was chosen.
p.4828, ll.2-4: Rephrase the sentence explaining the reference day, as this doesn't currently make sense.

We propose to replace from p.4827, l.26 ("A given ...") until p.4828, l.3 ("... counting the most similar days.") by: "After having calculated the similarity index (see below) between all pairs of days of the dataset, the day counting the most similar days (i.e. with a similarity index value above the similarity threshold) is selected as the reference day for the first type. All days considered as similar to this reference day are grouped into this type. The same procedure is repeated type by type over the remaining days of the dataset."

p.4828, l.27 - why 20,000 classifications? How was this determined? Why not use e.g. 10,000?

We have used two different approaches (each of them for 10,000 runs) to determine the seeds of the random multiplying factors to ensure that these approaches do not influence our results.
We propose to precise in the text, that there is no significant change in the results when using 5,000 runs, and strictly no change when using 10,000 runs instead of 20,000.

p.4829, l.8: Why were 6 circulation types retained? Why not e.g. 5 or 7?

We retained 6 circulation types because it is the lowest number of types, where the Beaufort Sea High and the Greenland High can be identified as well marked types. The main conclusions of this study are the same when using a higher number of types (e.g. 8 or 10 types). But, as said at p.4829,

l.10, a low number of types allows a more synthetic analysis. We propose to clarify the text accordingly.

p.4829, l.11 "the six obtained circulation types" - how do these different types relate to physical climate forcings and different polar jet stream patterns?

We wanted to focus on circulation variables only, in particular since the reliability of other variables is more questionable over this region (especially for 20CRv2 before 1940). Further, interpreting the circulation types in terms of other variables implies a detailed analysis, including a study on the relationship between the types and the other variables, since this relationship can change over time. In our sense such an analysis goes beyond the scope of this paper.

p.4829, l.20 "Type 6 contains days that are too different from the other types" - how is "too different" defined?

We propose to rephrase: "..., i.e. the days for which the similarity index values with regard to the reference days of all types lie below the similarity thresholds of these types."

p.4831, l.13 "However, the 2013 summer shows opposite extremes" - what about the 2014 summer?

Data for the 2014 summer were not available when this paper was submitted. If needed, we could integrate 2014 for ERA-Interim and NCEP/NCAR.

p.4833, l.10: "the standard deviation of the SLP spread than to its average, which" - does "which" here refer to the average?

Yes. We propose to rephrase to: "... than to its average. As shown on Fig. 3 (top), the average SLP spread over our domain decreases as soon as the beginning of the 20CRv2 era, while the spatial maximum and the standard deviation of the SLP spread remain high until around 1940.

p.4834, l.6: Unclear what "these types" refers to - is it Types 1 & 2 or Types 3, 5 & 6? Also, since, according to p.4833, adding the spread gives more Type 2 only and not more Type 1, I'm not clear why "Adding the spread to the detriment of these types has much more impact on the frequency distribution than subtracting the spread."

Adding the spread gives more Type 2 (and subtracting it gives more Type 1) for the SLP-based classification only (p.4833, ll.2-7). On p.4834, l.6, we are analysing the Z500-based classification.

To clarify p.4834, l.6, we propose to replace it by: "Therefore, subtracting the spread has only a limited impact on the frequency distribution, since it favours Types 1 and 2, which already contain most of the days. On the opposite, adding the spread at the expense of Types 1 and 2 induces much more frequency changes, since more days can be shifted into another type."

p.4834, l.20: "The association of negative NAO phases with high frequencies OF Types 2 and 4, which is even more evident" - how much more evident? Give increase in correlation coefficient?

We propose to add in the text that the average correlation between the NAO index and the circulation type frequencies over the whole 1871-2012 (JJA) period for the 20CRv2 reference run is of -0,24 for Type 2, -0,32 for Type 4, and -0,38 for Types 2+4.

p.4835, l.22 "Type 5 combines the Beaufort SEa High and the Greenland High" - Figure 1 seems to show LOW SLP anomaly over Greenland for Type 5?

This paragraph concerns the Z500-based classification (see p.4835, l.20), where Type 5 shows a high Z500 anomaly (Supplement Fig. S1).

p.4836, ll.1-4 "Overland et al. (2012) nshowed that summers [with Arctic] high pressure...are marked by enhanced SIC loss". It would be worth briefly adding mention of the Arctic Dipole anomaly pattern at this point.

We propose to replace this sentence by:
"Our results seem to confirm those of Wang et al. (2009) and Overland et al. (2012), who showed that the record Arctic sea ice loss observed over the last years can partly be attributed to more frequent positive Arctic Dipole Anomaly (DA) phases. In fact, positive DA phases are characterised by a higher occurrence of a high pressure system over the Canadian Arctic Archipelago and Greenland and a low pressure system over the Kara and Laptev Seas (Wu et al., 2006). Thus, at first glance, the SLP-based Types 2 and 4 can both be associated to a positive DA phase, while the other types, and in particular Types 1 and 3, can be related to a negative DA phase. During positive DA phases, the sea ice export from the Arctic basin through the Fram Strait and the Barents Sea is strongly enhanced, which is particularly effective for massive sea ice loss during summer (Wang et al., 2009)."

and to add the following reference:
Wu B., Wang J., and Walsh J.: Dipole anomaly in the winter Arctic atmosphere and its association with sea ice motion, J Climate, 19, 210-225, doi:10.1175/JCLI3619.1, 2006.

p.4837, l.8: "These PREVIOUS anomalies"?

We propose to write "These anomalies all largely exceed ...".

p.4837, l.17 "which contrasts [2013] with the strong positive anomaly of the preceding summers." - actually the year to year variation in the summer Greenland Blocking Index value was greatest between 2012 and 2013, in the NCEP/NCAR Reanalysis record back to 1948, cf. Hanna et al. 2014b, updated analysis: Hanna, E., Fettweis, X., Mernild, S. H., Cappelen, J., Ribergaard, M. H., Shuman, C. A., Steffen, K., Wood, L. and Mote, T. L. (2014), Atmospheric and oceanic climate forcing of the exceptional Greenland ice sheet surface melt in summer 2012. Int. J. Climatol., 34: 1022–1037. doi: 10.1002/joc.3743.

We propose to add: "The opposite extreme anomalies between 2012 (positive anomaly) and 2013 (negative anomaly) have also been highlighted by Hanna et al. (2014b) on the basis of the Greenland Blocking Index."

Figure 2 caption needs clarification/expansion

We propose to replace it by: "The dotted light lines represent the annual (JJA) SLP-based circulation type frequencies for ERA-Interim (1979-2013) and ERA-40 (1958-1978), for NCEP/NCAR (1948-2013), for the 20CRv2 reference run, and for the 20CRv2 20,000-run ensemble mean (1871-2012). The corresponding solid lines represent the 10-year binomial running mean frequencies. For the 20CRv2 20,000-run ensemble, the 10th and 90th percentile as well as the one standard deviation interval around the mean are also given."