

Interactive comment on “Can we reconstruct Arctic sea ice back to 1900 with a hybrid approach?” by S. Brönnimann et al.

Anonymous Referee #1

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GENERAL COMMENTS

This research addresses an important and unresolved need for better reconstruction of arctic sea ice parameters in the period prior to the 1950, after which observational source data became reliable and extensive enough for accurate hemispheric data sets. This is an important goal because we need a long-term perspective on the very pronounced sea ice decreases observed in the past 3 decades and particularly the most recent years. The existing hemispheric sea-ice data sets such as HadSST are deficient for studies of interannual to multidecadal variability prior to the 1950s. The inadequacies of the HadISST sea-ice dataset are thus clear. The present research is concerned with developing techniques for reconstructing sea ice using advanced statistical tech-

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niques and modelling techniques that make use of historical sea ice time series. If I understand correctly, this sort of approach – at least the statistical component – has been used previously by the authors to reconstruct atmospheric fields and indices for previous centuries in the period prior to gridded datasets. The idea is to explore how this may be applied for sea-ice reconstruction.

SCIENTIFIC/SPECIFIC COMMENTS

As the authors note, there is almost no variability in the HadSST sea ice data prior to the 1950s, because the values are based largely on climatology and interpolation. Indeed these data are so misleading that for missing values would be preferable, at least for studies to place the recent sea-ice losses and long-term context, as well as for studies of ocean-atmosphere-ice co-variability on interannual through multidecadal time scales. This is particularly a problem for seasons other than summer, when there is a relatively large amount of observations for most of the 20th century. As the authors correctly state in Section 1.

Winter sea ice concentration in HadSST shows hardly any variability prior to 1953. (I believe that the Walsh & Chapman gridded data also show hardly any variability prior to mid-century – and believedly are used as input to HadSST and are thus not independent.) For example, reduced sea ice during the early-to-mid 20th warming is not evident in these two datasets, whereas the historical regional data presented in both Johannessen (2004) and Polyakov (2003), and in other papers, have demonstrated a pronounced reduction during the early to mid 20th warming event. The fact that historical sea-ice data sets published in Johannessen et al. (2004) and Polyakov (2003) are being recognized as valuable in such a framework is positive, as these data remain under-utilized. One aspect to note however is the authors' contention that these data (and other historical data) are only for summer. In fact, for the Nordic Seas/Atlantic

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Arctic there are many observations from April to August; see Vinje (2001); Divine & Dick (2006); Johannessen & al. (2004). The Johannessen & al paper (Tellus, 56A, 328-341) describes the “Zakharov” data series, which itself is the result of statistical relationships based on available data observations. These data are also described in the new JGR Oceans paper by Kauker & al (2008) to which the authors refer. (By the way, the interested reader would like to know how the Kauker sea-ice reconstructions compare with those of the present paper.) This should be clarified in this paper.

Using summer ice data as the basis for reconstructions may cause problems, as different seasons will generally have different temporal characteristics and different underlying atmosphere-ocean influences. The winter (April) historical sea-ice data should be consulted and taken into the analysis.

Figs. 4 and 5 present examples of the reconstructed fields for individual years. The spatial detail is clear; however, we have no possibility to thoroughly validate these spatial fields (of course). Nonetheless, one can look directly into the historical data. As the authors acknowledge, there appear to be discrepancies between these reconstructed fields (e.g., for a warm year, 1937) and historical observations.

On the one hand, this reviewer criticizes the HadSST sea-ice data as biased and misleading for using climatology that masks actual variability, such that missing values would be preferred. On the other hand, the present approach may have its own misleading errors (artifacts) in that it produces variability that may not resemble actual variability (to the degree that we can know from the historical observations). This is not to say that their reconstructed variability is over-estimated, but rather that it is not accurately estimated.

The authors are to be commended for addressing this important challenge with new ideas and an advanced quantitative approach. The authors have also chosen a proper journal forum to present and discuss these results, which are acknowledged (e.g., Table 1) to have a number of problems. The authors propose some possible ways to

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reduce the problems; however, these may be intractable to a large degree, even with longer model runs, etc. Therefore, at least until there is a breakthrough, the most reasonable manner to evaluate sea ice extent in the pre-1950s is simply to restrict ourselves to those regional datasets whose accuracy is well constrained. For the reasons that the authors themselves acknowledge, the results from this effort do not merit recommendation for permanent publication.

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