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Interactive comment on "Atmospheric forcing of sea ice anomalies in the Ross Sea Polynya region" *by* Ethan R. Dale et al.

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We thank the reviewer for taking the time to provide constructive comments on our manuscript. We feel the comments provided have allowed us to significantly improve the clarity and structure of our text. Response to specific comments follow, with reviewers comments quoted in bold.

Abstract. This would be more effective if shortened in length. The first paragraph seems out of place in an abstract.

The Abstract has been edited, it now reads:

"The impacts of strong wind events on the Ross Sea Polynya (RSP) and its sea ice concentration and possible consequences for sea ice production are investigated. We utilised bootstrap sea ice concentration (SIC) measurements derived from satellite SSM/I brightness temperatures and compared these with surface winds and temperatures from automatic weather stations (AWS) and weather models (ERA-Interim). Daily data in the austral winter period were used to classify characteristic weather regimes based on the percentiles of wind speed. For each regime a composite of a SIC anomaly was formed for the entire Ross Sea region and we found that persistent weak winds near the edge of the Ross Ice Shelf are generally associated with positive SIC anomalies in the Ross Sea Polynya and vice versa. By analysing sea ice motion vectors derived from the SSM/I brightness temperatures we find during strong wind events significant sea ice motion anomalies throughout the Ross Sea which persist for several days after a strong wind event has ended. Strong, negative correlations are found between SIC and AWS wind speed within the RSP indicating that strong winds cause significant advection of sea ice in the region. We were able to partially recreate these correlations using co-located modelled ERA-Interim wind speeds. However, large AWS and model differences are observed in the vicinity of Ross Island, where ERA-Interim underestimates wind speeds by a factor of 1.7 resulting in a significant misrepresentation of RSP processes in this area based on model data. Thus, the cross correlation functions produced by compositing based on ERA-Interim wind speeds differed significantly from those produced with AWS wind speeds. In general the rapid decrease in SIC during a strong wind event is followed by a more gradual recovery in SIC. The SIC recovery continues over a time period greater than the average persistence of strong wind events as well as the persistence of sea ice motion anomalies. This suggests that the production of new sea ice occurs through thermodynamic rather than dynamic processes."

Fig. 1 Please define the red polygon/region in the caption, as you have described in text (or refer the reader to the text).

Added "The red line outline indicates the region discussed in Section 2." to the caption.

4.25 I have to ask: Even though different investigators have derived ice motion from the passive microwave data set using similar methodology, their quality varies. How have you assessed your derived ice motion estimates?

No validation was made, however we used a standard technique (Emery et al. 1997, Heil et al. 2006, Holland and Kwok 2012). The results show a mean value comparable to other authors (Emery et al. 1997, Heil et al. 2006, Holland and Kwok 2012) and Figures 6 and 7 show physically interpretable signatures this supports the measures used.

Fig. 3 caption: (b) red is the AWS and magenta is ERA-Interim.

This error has been corrected.

5.25 I assume 2-meter winds are used in these analyses. Otherwise, there would be a scale factor. Also of interest is whether the ERA-I winds are directionally biased.

Scale factors have not been used, We are primarily interested in correlations which will remain unaffected. For the intercomparison this will cause a small difference in the observed gradient between the two datasets. AWS heights are consistently set to 2m or 3m (Lazzara et al., 2012) while ERA-I winds are 10m and this difference cannot explain the large variation in the gradients found. The following was added to the discussion:

"ERA-Interim provides 10 m wind speeds while the AWS Wind speeds are measured at 2-3 m (Lazzara et al., 2012, Dee et al. 2011). This would suggest that a scale factor would exist between the two data sets, an effect that was not corrected. While this will not affect the correlation comparisons preformed it may explain the scale factors observed. However this small height difference is not able to explain the large scale factors found indicating that topography must have a significant effect."

Inspection of the wind roses for both AWS and ERA-I winds at Laurie II show no obvious directional bias (Fig 1). Sentence has been added.

"Inspection of ERA-Interim and AWS wind roses revealed no significant directional bias between the two data sets.".

6.10 The Bootstrap algorithm is based on binned TBs over a day, so there is a blur- ring of events (polynya openings) over a 24-hour period. Please clarify the sentence re:varying time lag in 6.5.

The blurring due to the temporal resolution of Bootstrap is a limitation of our analysis. CCF's were produced from daily bootstrap measurements and 24 hour rolling means of 10 min resolution AWS data. This allowed CCF's to be produced at 10 min resolution. The CCF's produced in this manner will be subject to blurring from both the Bootstrap algorithm and the 24 hour means of wind speed used, and are therefore oversampled. The original manuscript justifies the significant correlation at negative delay between AWS wind speeds and SIC as the AWS wind speed autocorrelation has a similar e-folding time to that of the CCF (6.30). The e-folding time for both the CCF and the autocorrelation is limited by this blurring. The sentence "The Bootstrap SIC is derived from 24 hour binned brightness temperatures and we compared these with 24 hour rolling mean of AWS data the resulting correlation functions will be blurred over a 24 hour period." was added to the results section to acknowledge this limitation.

6.15 Isn't this also dependent on the response of the Bootstrap retrievals to changes in observed brightness temperature?

The decay rate here is impacted by temporal resolution of bootstrap data, but the decay rate of the autocorrelation is greater than the 24 hour blurring period so other factors must contribute.

6.18 There is lag between the changes in wind direction observed at Laurie and at the RSP?

We have not focussed on wind direction changes which are beyond the scope of the analysis because of the lack of data within the RSP. Also wind direction is rather persistent and therefore likely has less impact.

6.28 Your arguments re:lag seem reasonable, but I'm still not quite comfortable as to whether the 24-hr sampling of the SIC fields would support your attribution statements. Perhaps I still don't quite clear about your remarks in 6.5.

See previous clarification regarding 6.10.

6.29 You mean the wind speeds autocorrelation has e-folding time of 36 hours. If you included direction, it may be different.

This error has been corrected.

7.10 You should also note that this also depends on the response of the bootstrap algorithm to thin ice growth. The algorithm designates thin ice as open water until the ice reaches a thickness of about 20 cm. So, that may explain some of the asymmetry in the responses.

Kwok et. al. 2007, compares Nasa Team 2 and bootstrap SIC retrievals with AMSR-E derived sea ice thickness. Kwok et al. (2007) idnetified: "From the monthly analyses an ice thickness of $10cm$ corresponds to $83 \pm 3\%$ and $91 \pm 2\%$ ice concentration in the ABA [Bootstrap] and NT2 [Nasa Team 2] estimates." The effect of this is discussed in the original manuscript at 10.32.

8.0 At this point, I recommend that the results section should be broken into subsec- tions. As is, there are five pages of text.

This change has been made.

8.15 A general question: Are they larger differences between the AWS and ERA-I winds when the winds are strong (e.g., katabatics).

Figure 2 indicates a linear relationship between AWS and ERA-I wind speeds with slope of 1.70 as discussed at 5.24 of the original manuscript. Larger absolute differences between AWS and ERA-I are observed at high wind speeds, although the relationship is linear.

9.6 OK, these anomalies are interesting. I guess this is presented as just a remark on the results?

We agree with the reviewer, but have left this as is based on discussion between co-authors.

11.10 I thought Bootstrap accounted for the changing coastline.

The NSIDC product uses a fixed land mask. Comiso et al. (2011) discuss the difficulties producing a dynamic land mask. We do not consider trends over the time period and this will therefore not impact our results.

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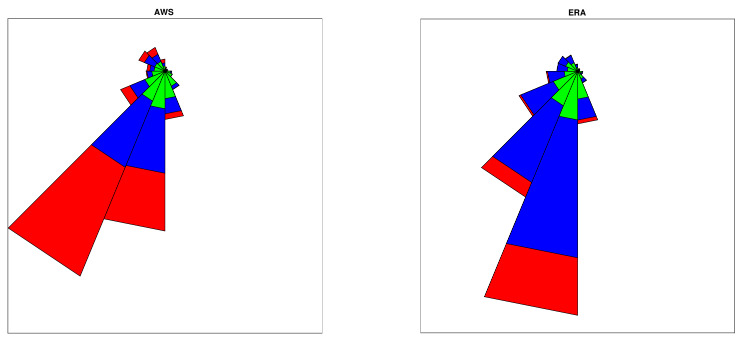

Fig. 1. Wind roses for winds at Laurie II for AWS (left) and ERA-I (right) winds. The green indicates wind speed less than 3.5 m/s, blue between 3.5m/s and 7.5m/s and red greater than 7.5m/s.

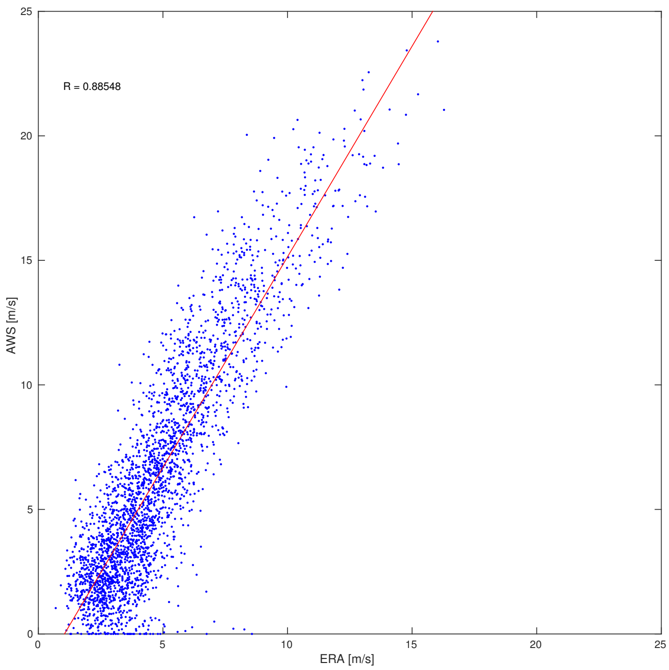

Fig. 2. Scatter plot of winds at Laurie II for AWS and ERA-I wind speeds. The red line indicates the linear fit.