A preliminary assessment of the February 2018 sea-ice forecasts in the Southern Ocean

Coordinating Seasonal Predictions of Sea Ice
in the Southern Ocean for 2017-2019

F. Massonnet, P. Reid, J. Lieser, C. M. Bitz, J. Fyfe, W. Hobbs, K. Kusahara

February 9, 2018

Primary contact:

`francois.massonnet@uclouvain.be`

The Sea Ice Prediction Network South

The Sea Ice Prediction Network for Antarctica (SIPN South) is an international project endorsed by the Year of Polar Prediction (YOPP). Its goal is to make an initial assessment of the ability of current systems to predict Antarctic sea ice globally and regionally, with a focus on the summer season. The project has three strategic objectives:

1. Provide a focal point for seasonal outlooks of Antarctic sea ice (winter and summer), where the results are exchanged, compared, discussed and put in perspective with those from the Arctic thanks to interactions within SIPN,
2. Provide news and information on the state of Antarctic sea ice, highlight recent published research, report ongoing observational campaigns and disseminate upcoming events (conferences, workshops, webinars, et cetera),
3. Coordinate a realistic prediction exercise targeting austral summer 2019, in conjunction with the Year Of Polar Prediction (YOPP)'s Special Observing Period that will take place in January-February 2019.

We like to remind that SIPN South is not intended to be an operational forecasting exercise.

Forecasting sea ice for February 2018

As proposed in the SIPN South implementation plan (detailed here), an initial assessment of forecast capabilities was scheduled for early 2018. A call for contributions (here) was sent in November 2017. **We received a total of 13 submissions and would like to thank all contributors for their participation.** We asked contributors to provide, in order of descending priority, (1) the total Antarctic sea-ice area (denoted "SIA") for each day of February 2018, (2) the sea-ice area per 10° longitude bands (denoted "rSIA") for each day of February 2018 and (3) the sea-ice concentration (denoted "SIC") for each day of February. All 13 contributors were able to submit (1), eight submitted (1) and (2), and five submitted (1), (2) and (3).

Eight groups used fully coupled dynamical models, one group used an ocean-sea ice model forced by atmospheric forcing from past years and four groups used a statistical model trained on past data.

Table 1. Information about contributors to the February 2018 coordinated sea ice forecast experiment.

	Contributor name	*Short name (in figures)*	*Forecasting method*	*Nb. of forecasts*	*Initialization date*	*Diagnostics provided*
1	Naval Research Lab	nrl	Coupled dynamical model	6	Nov. 6th, 2017	SIA + rSIA + SIC
2	Nico Sun	Nico-Sun	Statistical model	1	Nov. 28th, 2017	SIA
3	NASA-GMAO	nasa-gmao	Coupled dynamical model	10	Nov. 27th, 2017	SIA + rSIA + SIC
4	FIO-ESM	FIO-ESM	Coupled dynamical model	1	Dec. 1st, 2017	SIA
5	ECMWF	ecmwf	Coupled dynamical model	50	Nov. 30th, 2017	SIA + rSIA
6	Antarctic Gateway Partnership	Gateway	Statistical model	1	Dec. 10th, 2017	SIA
7	MPAS-CESM	mpas-cesm	Coupled dynamical model	2	Dec. 1st, 2017	SIA + rSIA
8	Lamont Sea Ice Group	Lamont	Statistical model	1	Oct. 31st, 2017	SIA + rSIA + SIC (monthly mean)
9	NASA-GSFC	NASA-GSFC	Statistical model	1	Nov. 30th, 2017	SIA (monthly mean)
10	Modified CanSIPS	Modified-CanSIPS	Coupled Dynamical Model	20	Nov. 30th, 2017	SIA
11	Met Office	MetOffice	Coupled Dynamical Model	42	Dec. 12th, 2017	SIA + rSIA + SIC
12	UCL	ucl	Ocean-sea ice dynamical model	10	July 1st, 2017	SIA + rSIA + SIC
13	EMC	emc	Coupled dynamical model	15	Dec. 15th, 2017	SIA + rSIA + SIC

Circumpolar sea-ice area

Fig. 1 shows the total sea-ice area (SIA) forecasted for each day of February by the 13 contributors. We stress that this diagnostic is not very physical, but it gives a first impression on how the forecasts behave. In this figure, we have also plotted for reference the 2017 February values from an observational reference, the NSDIC-0081 product (Maslanik and Stroeve, 1999). The spread between contributing groups is generally larger than the spread between forecasts from individual contributions. Put differently, the irreducible uncertainty due to unpredictable weather is smaller than the uncertainty associated to the forecasting method: summer sea ice is not entirely unpredictable in the Southern Ocean at 2-month lead time.

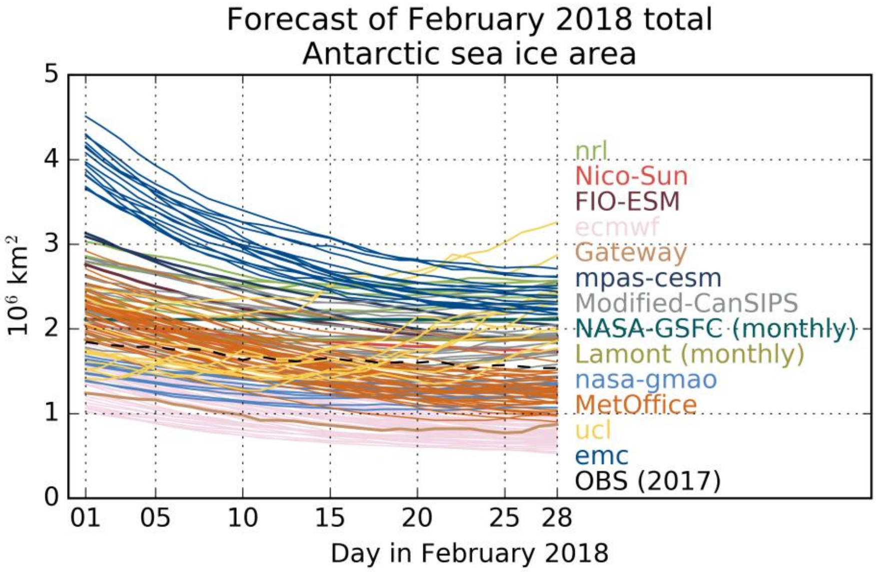

Figure 1. Total (circumpolar) Antarctic sea ice area of the 13 forecasts for each day of February 2018. The black dashed line is an observational reference (Maslanik and Stroeve, 1999) for 2017.

Regional sea-ice area

Figures 2 and 3 show the predicted February mean and minimum regional sea-ice area (rSIA). The data has been anomalised by subtracting the 1979-2014 daily climatology estimated from the NASA Team sea-ice concentration (Peng et al, 2013). It is important to recognise that these anomalies reflect the actual anomalous conditions that could prevail during February, but also include the long-term systematic bias that the model used might have with respect to the reference dataset.

The mean and minimum predictions show very similar features, with relatively low anomalies in East Antarctica, and a tendency towards lower-than-usual SIA in the warming Amundsen-Bellingshausen sea region. The predictions tend towards anomalously high SIA in the Ross Sea, but highly uncertain low anomaly in the Weddell Sea. The large spread in the Ross Sea and Weddell Sea reflects the high variance and complex ocean-atmosphere dynamics in these regions. Current passive microwave observations indicate very low January SIA in these sectors (possibly a reemergence of the last summer record low SIA), and it seems likely to remain below average in February.

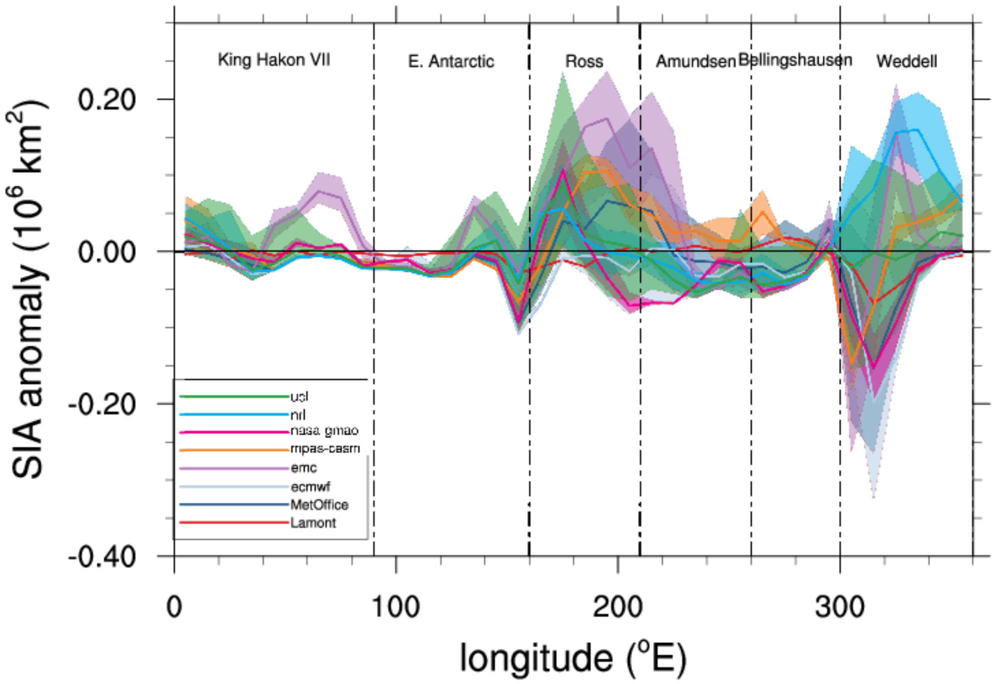

Figure 2. February 2018 mean rSIA anomaly (compared to 1979-2014 NASA Team climatology) by longitude, for each submission. Solid lines show the ensemble mean for each contribution, with transparent shading to indicate ensemble spread.

Figure 4 shows rSIA anomalies by both day and longitude. Regions with negative anomalies tend to have little change over the course of the month, whereas positive anomalies in the Ross-Amundsen region (120-180°W) tend to decrease in intensity over the course of the month (see in particular the UK Met Office, EMC and MPAS-CESM ensemble means). Prediction certainty (indicated by hatching in Figure 4) is consistently high in the East Antarctic region.

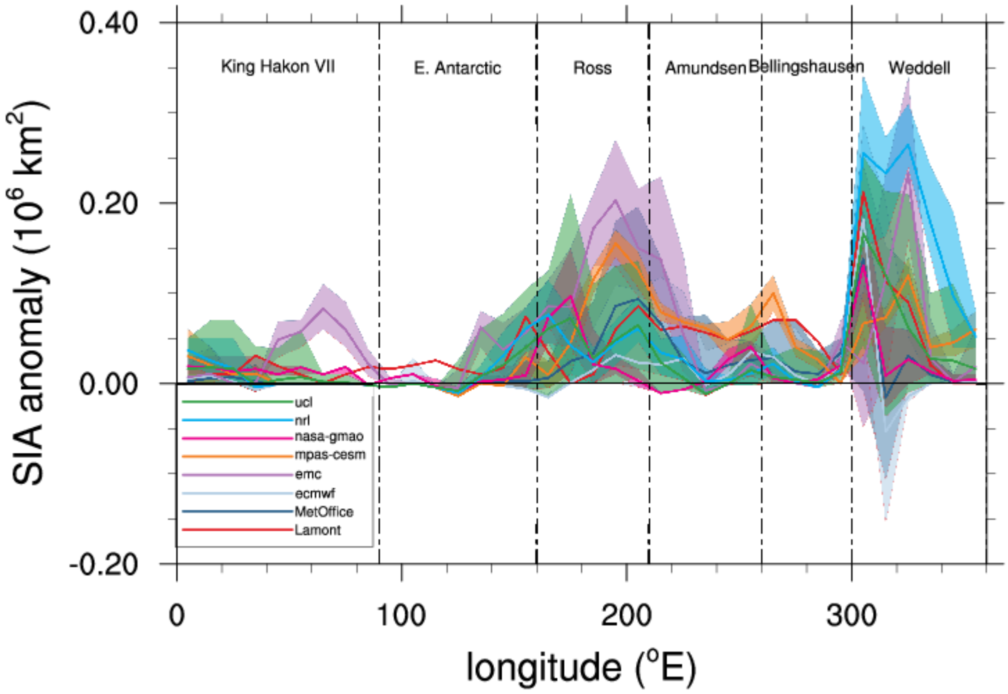

Figure 3. As for Figure 2, but showing the minimum daily rSIA predicted for February 2018.

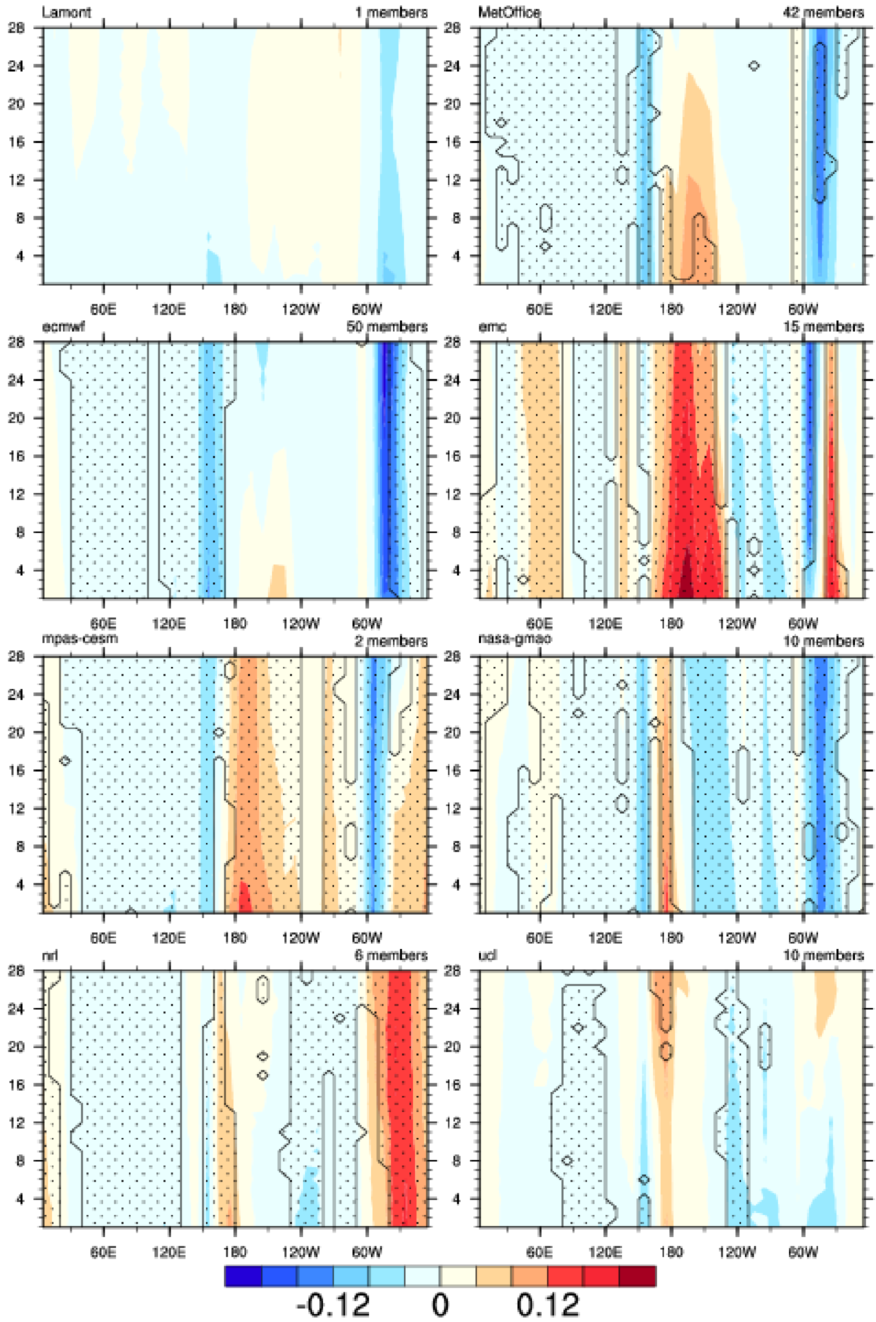

Figure 4. Ensemble-mean predicted daily rSIA anomaly (compared to 1979-2014 NASA Team SIC climatology) for February 2018 (10^6 km^2). For submissions with an ensemble of multiple members, hatching indicates where the sign of the predicted anomaly agrees across all the submission members.

Spatial information

Five groups submitted the spatial information of daily sea-ice concentration for each day of February 2018. Each group used a dynamical model and submitted several forecasts (from 6 to 50), hereafter referred to as "members". Members are usually meant to sample uncertainty associated to the (unpredictable) evolution of the climate system, so that each member of a given model could be seen as a possible realization of that model. If the model is free of errors and it is given correct initial and boundary conditions, then the observed realization would be statistically undistinguishable from the model's members.

Fig. 5 displays the ensemble mean of monthly mean sea-ice concentration for February 2018, together with the sea-ice edge lines (15% sea-ice concentration contours) for each of the members. Sea-ice presence is forecasted in the Weddell Sea

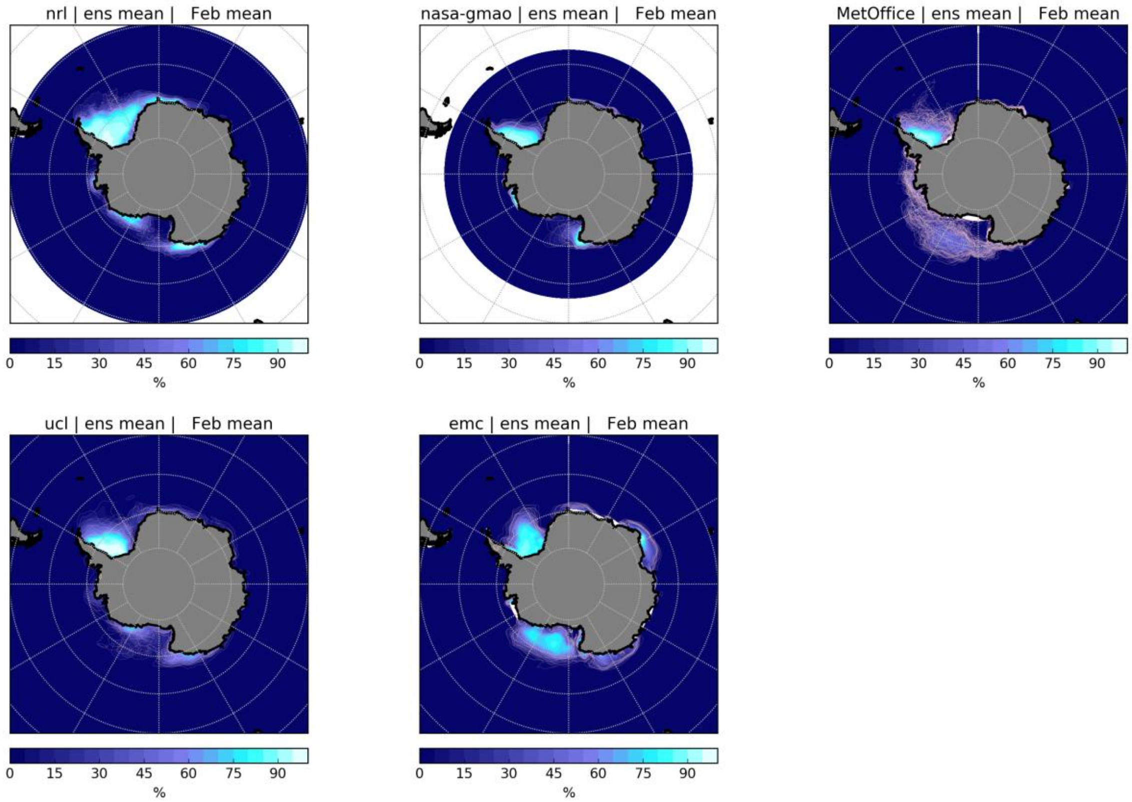

Figure 5. Ensemble mean of February 2018 monthly mean sea ice concentration, as forecasted by the five groups that submitted daily sea ice concentration information. The thin purple lines are the ice edge position for each forecast member, determined as the 15% contour line of the monthly mean sea ice concentration for the member.

along the Antarctic Peninsula in all contributions. This is a region where the ice is climatologically present. Consistently with the analyses conducted in the previous section, significant spread develops in the Ross Sea as reflected by the uncertain sea-ice edge position in the forecasts.

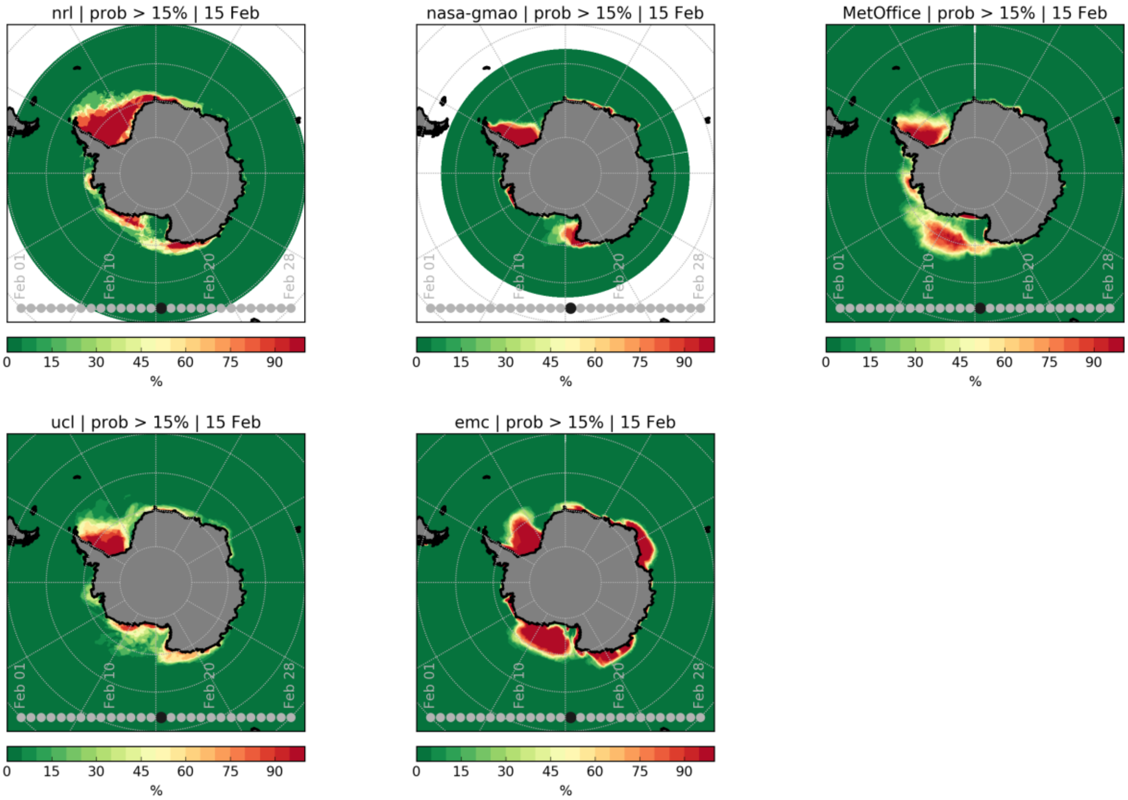

Figure 6. Probability of ice presence for the 15th of February 2018, as forecasted by the five groups that submitted daily sea ice concentration information. The probability of presence corresponds to the fraction of ensemble members that simulate sea ice concentration larger than 15% in a given grid cell, for that day. A dynamic animation of that figure for all 28 days of February is available here.

The maps of ensemble February mean sea-ice concentration (Fig. 5) are useful to appreciate the expected average conditions that could prevail in February, but are difficult to interpret for potential final users of the forecasts. Therefore, we also show the daily probability of sea-ice presence (Fig. 6; a dynamic animation of this figure is available here). Green pixels are those where the ice is extremely unlikely to be present, while red ones are those where the ice is extremely likely to be present. From the forecasts, it can be noted that strategic locations like Prydz Bay (75E, 70S) or the western edge of the Antarctic Peninsula are likely to be accessible during February. Once again, we stress that the forecasting systems have not been assessed against observations yet, so that these forecasts should be interpreted with caution.

Next steps

After February 2018, we will evaluate the forecasts with two observational references. A more detailed analysis of this first exercise will be published in May 2018.

References

Maslanik, J. and J. Stroeve. 1999, updated daily. Near-Real-Time DMSP SSMIS Daily Polar Gridded Sea Ice Concentrations, Version 1. [NSIDC-0081]. Boulder, Colorado USA. NASA National Snow

Peng, G., W. Meier, D. Scott, and M. Savoie. 2013. A long-term and reproducible passive microwave sea ice concentration data record for climate studies and monitoring, *Earth Syst. Sci. Data*. 5. 311-318. http://dx.doi.org/10.5194/essd-5-311-2013 and Ice Data Center Distributed Active Archive Center. doi: http://dx.doi.org/10.5067/U8C09DWVX9LM. [Accessed January 30th, 2018].