The following supplement accompanies the article

Sea ice cycle in western Hudson Bay, Canada, from a polar bear perspective

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Introduction

The supporting material expands on details of the migration of polar bears and provides more detailed analysis in the form of tables and figures that could help the curious reader obtained broader understanding of the polar bear migration and its relationship to sea ice in western Hudson Bay.

Polar bear migration ecology

The median date of migration offshore (± 1 standard deviation) in 2004, 2005, 2006, 2007 and 2008 was on 27th (± 2), 26th (± 4), 28th (± 4), 23rd (± 3) and 28th (± 3) of November, respectively. Polar bears migrated onto the first sea ice forming near shore in the northwest (Fig. S2, Video S1). This often implied a walk north from the location they were collared.

The median date of migration ashore in 2005, 2006, 2007, 2008, and 2009 was on the 26th (± 1), 9th (± 3), 19th (± 7), 20th (± 6) of July and the 14th (± 14) of August, respectively. In most years, before migrating ashore, polar bears used sea ice near the coast in the western and southwestern coastlines of Hudson Bay and it was around this region where they usually returned on land (Fig. S3, Video S1).

In 2005, ice conditions during melting were different than other years. The ice near the shoreline melted quicker than the ice further offshore (Video S1). This year was characterized by warm conditions along the shoreline that could have contributed to a fast melting of sea ice near shore. The warm condition was identified as the "warm mode" of southwestern Hudson Bay region by Galbraith and Larouche (2011) who also pointed out similar conditions in 2006, however the anomaly developed later in that summer. During 2007, 2008, 2009 there was a "cold mode" which may explain the different melting pattern of these other years. In the season 2004-2005, 10 collars were deployed in September 2004 and only 2 collars transmitted regularly in July 2005. The sea ice conditions and the gaps in the polar bear data this year suggest that polar bears may have had to swim ashore for several days before reaching land.

Data from polar bears migrating onshore or offshore outside of the western Hudson Bay polygon were not included in the analysis of migration as it was not relevant to the ice conditions in western Hudson Bay. For example, in summer 2007, polar bears east of our polygon stayed offshore longer using sea ice from outside our polygon along the southeast shoreline of Hudson Bay. Also in autumn 2007, two bears migrated offshore later (on the 5th and 19th of December) onto ice in southeast Hudson Bay.

LITERATURE CITED

Galbraith PS, Larouche P (2011) Reprint of "Sea-surface temperature in Hudson Bay and Hudson Strait in relation to air temperature and ice cover breakup, 1985–2009". J Mar Syst 88:463–475

Table S1 for Fig. 3. Ice phenology from polar bear perspective and ice data products. The polar bear perspective of breakup and freeze-up is the median day of migration onshore and offshore, respectively (in ordinal day). The ice-free period from polar bear perspective is the number of days between the migrations. Ice product breakup (day of ≤ 50%) and freeze-up (day of ≥ 10%) are in ordinal days, and the ice-free period is the number of days between the two dates. Showing individual years when polar bear data is available and time averages ± 1 standard deviations. Star on decadal means, indicates that the mean has been calculated with the data available within the specified period (i.e., AMSR starts on 2002).

	Years with polar bear data					Means			
	2005	2006	2007	2008	2005-2008	1979-1989	1990-1999	2000-2010*	2011-2015
Ice-free (number of days)									
Polar bear	123	142	128	131	131 ±8				
Bootstrap-v2	149	157	151	140	150 ±6	129 ±9	141± 9	146 ±13	153 ±3
AMSR	153	162	156	148	155 ±5			151 ±12	154 ±1
Breakup (ordinal day)									
Polar bear	207	190	199	202	199 ±8				
Bootstrap-v2	177	174	175	187	179 ±6	193 ±5	184 ±13	183± 12	176 ±5
AMSR	174	171	172	184	176 ±6			180± 10	171 ±3
Freeze-up (ordinal day)									
Polar bear	330	332	327	333	331 ±3				
Bootstrap-v2	326	331	332	336	328 ±6	321 ±8	325 ±9	329 ±6	327 ±3
AMSR	327	333	328	332	330 ±6			331 ±6	328 ±3

Table S2 for Fig. 4. Same as Table S1 but using coarser temporal resolution (weekly averages) of sea ice concentration to incorporate CISDA data in the analysis. The ice data breakup and freeze-up dates are estimates from weekly mean sea ice concentration. Breakup and freeze-up are given in week of the year. The ice-free period is the number of weeks between freeze-up and breakup weeks. The polar bear perspective of breakup and freeze-up are the week of the year in which the median date of migration falls. Star on decadal means, indicates that the mean has been calculated with the data available within the specified period (i.e., AMSR starts on 2002).

	Years with polar bear data					Means			
	2005	2006	2007	2008	2005-2008	1979-1989	1990-1999	2000-2010*	2011-2015
Ice-free (number of weeks)									
Polar bear	18	21	18	19	19.0±1.5				
CISDA	20	21	21	19	20.3±0.8	16.5±0.8	18.4±1.8	19.5±1.8	20.4±1.0
Bootstrap-v2	21	22	21	21	21.3±0.4	18.5±1.0	19.9±2.3	20.7±1.9	21.5±0.9
AMSR	21	23	23	21	22.0±1.0			21.4±1.8	20.8±2.3
Breakup (week of the year)									
Polar bear	30	27	29	29	28.8±1.3				
CISDA	27	27	27	29	27.5±0.9	29.5±1.5	28.1±1.4	28.1±1.5	27.5±0.9
Bootstrap-v2	26	26	26	27	26.5±0.4	28.0±0.6	27.1±1.7	26.8±1.5	26.0±0.7
AMSR	26	25	25	27	25.5±0.8			26.3±1.4	26.7±1.0
Freeze-up (week of the year)									
Polar bear	48	48	47	48	47.8±0.5				
CISDA	47	48	48	48	47.8±0.4	46.1±0.8	46.0±0.9	47.5±0.9	47.5±0.8
Bootstrap-v2	48	48	47	48	47.5±0.5	46.5±1.0	47.0±1.3	47.5±0.8	47.5±0.5
AMSR	47	48	48	48	47.8±0.4			47.9±0.9	47.5±0.5

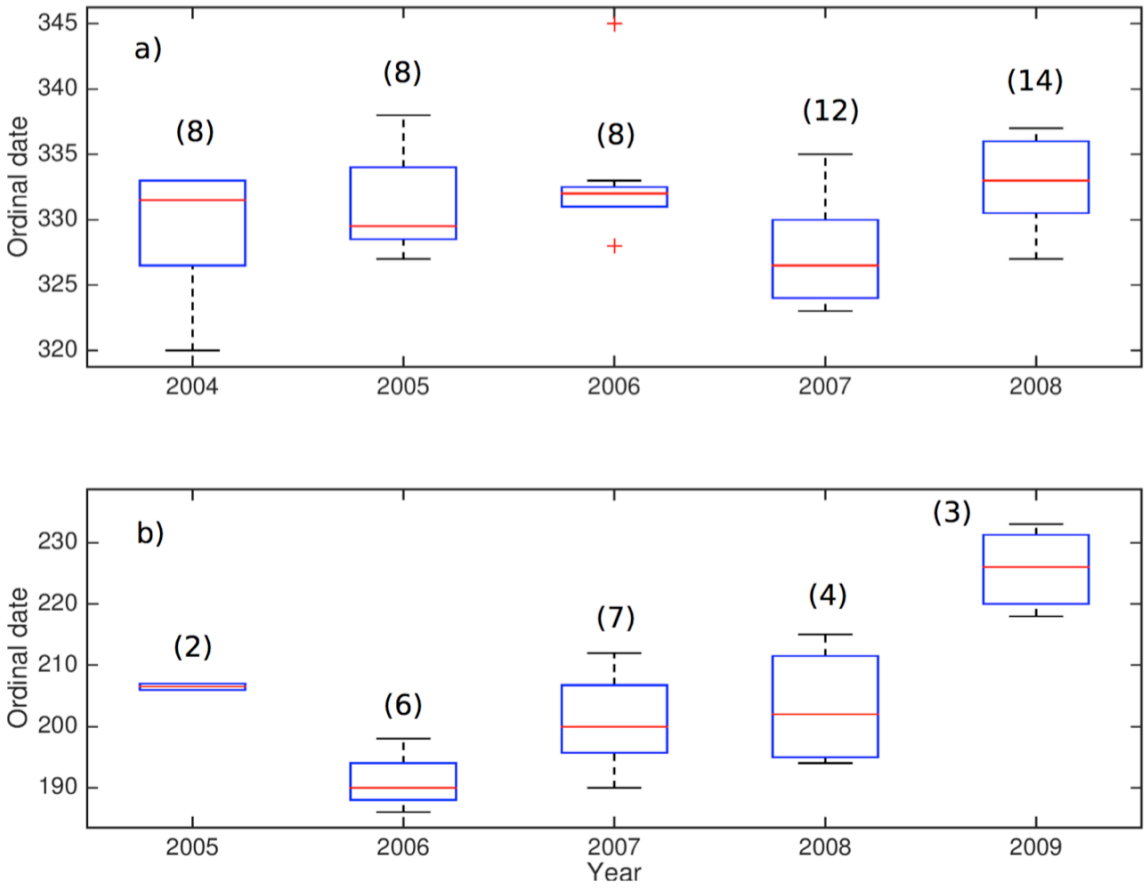

Fig. S1. Polar bear migration (a) offshore and (b) onshore. The upper and lower edges of each box are the 75 and 25 percentiles, respectively. The central line marks the median. The whiskers are the maximum and the minimum data points, excluding outliers. The outliers are the red crosses and the total number of collars per year is beside the corresponding box.

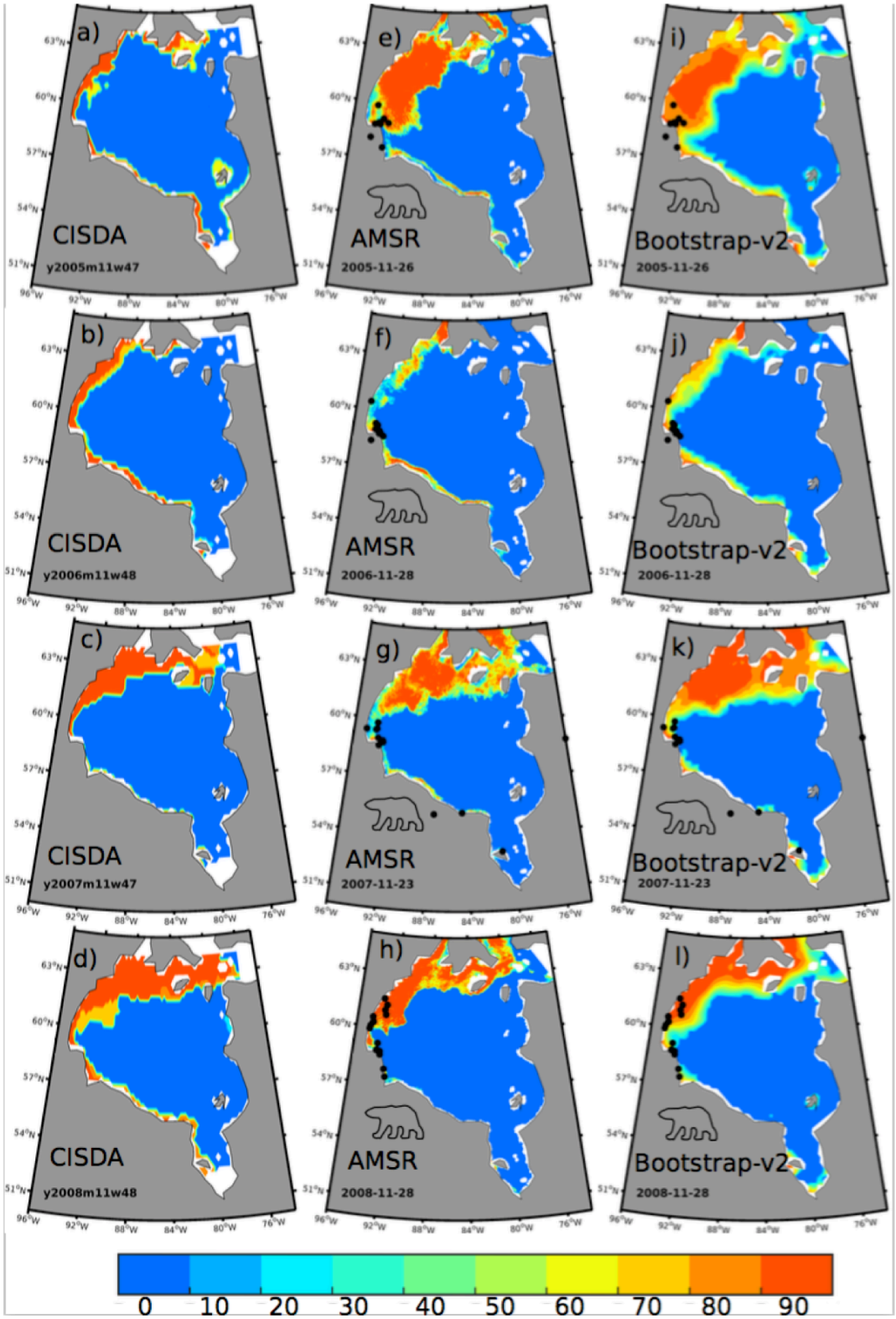

Fig. S2. Snap shots of the sea ice concentration during freeze-up. (a-d) CISDA mean sea ice concentration on the week in which polar bear migrated offshore. The adjacent panels show the sea ice concentration using AMSR (e-h) and Bootstrap-v2 (i-l) on the median date of migration. Map label with a polar bear silhouette include one GPS location per polar bear available that date (filled black dots). Given the specifics of polar bear collar design the transmission can only occur if the polar bear is either on land or on the surface of sea ice. Therefore polar bear locations in open water (dark blue) highlight underestimations of the sea ice data.

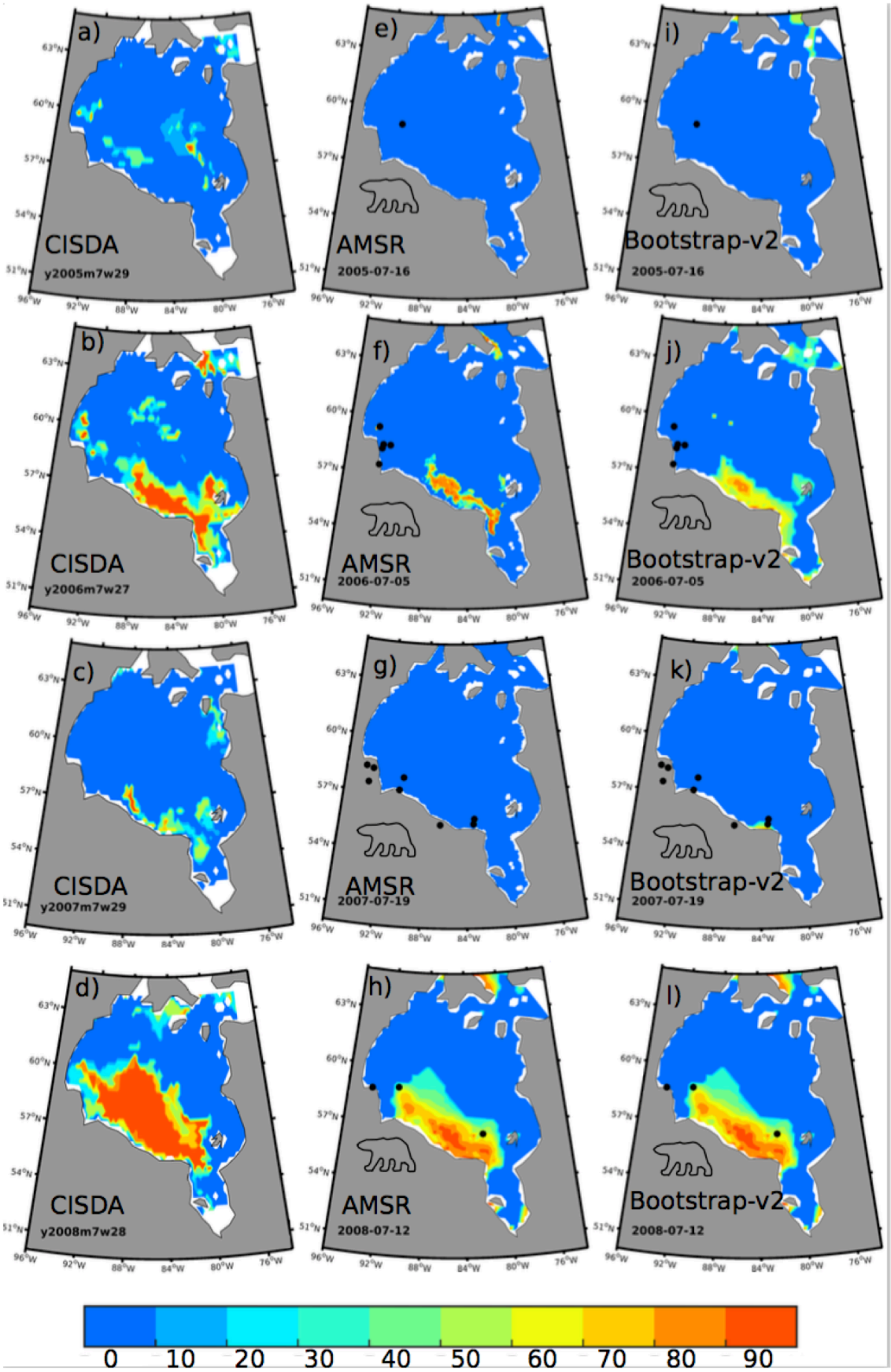

Fig. S3. Same as Fig. S2 but for the polar bear migration onshore.