# 2012 年晩冬期に観測された海氷上の異常積雪深に関する考察

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## On the extraordinary snow on the sea ice off East Antarctica in late winter, 2012

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In late winter-early spring 2012, the second Sea Ice Physics and Ecosystems Experiment (SIPEX II) was conducted off Wilkes Land, East Antarctica, onboard *RV Aurora Australis*. The sea ice conditions were characterized by significantly thick first-year ice and snow, trapping the ship for about 10 days in the near coastal region. The deep snow cover was particularly remarkable, in that its average value of 0.45 m was almost three times that observed on past cruises to the region. To reveal factors responsible, we used in situ observations and the ERA-Interim reanalysis data to examine the relative contribution of the different components of the local-regional snow mass balance equation i.e., snow accumulation on sea ice, precipitation minus evaporation (P-E), and loss by i) snow ice formation and ii) falling into leads due to drifting snow. There is no evidence for abnormally high P-E for the 2012 austral winter. From sea-ice core analysis, it was shown that although snow ice layer was relatively thin in 2012, the difference was not enough to explain the extraordinarily deep snow. Based on these results we deduce that reduced loss of snow into leads was probably responsible for the extraordinary snow depth in 2012. This highlights the importance of snow-sea ice interaction for determining the mean snow depth on the Antarctic sea ice.

**Data & method:** The snow mass balance on sea ice is represented by the following equation (Leonard and Maksym, 2011):

$$\overline{\langle B \rangle} = \overline{\langle P \rangle} - \overline{\langle E \rangle} - \overline{\langle I \rangle} - \overline{\langle L \rangle} \qquad (1)$$

where $\overline{\langle B \rangle}$, $\overline{\langle P \rangle}$, and $\overline{\langle E \rangle}$ are the surface snow accumulation, precipitation, and net sublimation integrated during the winter, respectively. $\overline{\langle I \rangle}$ and $\overline{\langle L \rangle}$ is the loss by conversion into snow ice and falling into open water leads, respectively. Since we examine the snow mass balance on seasonal scale, $\overline{\langle B \rangle}$ corresponds to the mean snow depth observed during the SIPEX II. The net precipitation, $\overline{\langle P \rangle} - \overline{\langle E \rangle}$, was estimated from the following moisture budget equation using the ERA-Interim reanalysis dataset: $P - E = -\partial PW/\partial t - \nabla \cdot \langle q\,\vec{V} \rangle$ for 1990 to 2012, where $PW$ is precipitable water and $\langle q\,\vec{V} \rangle$ is a vertical integration of moisture flux. $\overline{\langle I \rangle}$ was estimated from mean snow ice layer thicknesses within the ice core samples collected in the same region in the same season of 2007 and 2012. $\overline{\langle L \rangle}$ was obtained as a residual of Eq. 1. Since every term in Eq.1 was obtained in 2007 and 2012, here we focus on the comparison between these two years.

**Results**: The estimated mass balance is listed in Table 1. The time series of *P-E* integrated during the winter showed no significant evidence for abnormally high *P-E* in 2012, which is almost the case for other Antarctic regions. These results suggest that lower $\overline{\langle L \rangle}$ is a controlling factor of snow depth on sea ice in this region. Statistical analysis and satellite images suggest that the reduction in $\overline{\langle L \rangle}$ is attributed to rough ice surface associated with active deformation processes and larger floe size due to sea ice expansion.

Table 1. Estimated snow mass balance in winter off East Antarctica.

| Year | < *B* > | < *P* > - < *E* > | < *I* > | < *L* > |
|---|---|---|---|---|
| 2007 | 0.14±0.13 | 0.90 | 0.19±0.21 | 0.57 |
| 2012 | 0.45±0.26 | 0.93 | 0.09±.017 | 0.39 |

(unit: m)

**References**

Leonard, K.C., and T. Maksym, The importance of wind-blown snow redistribution to snow accumulation on Bellingshausen sea ice, Ann. Glaciol., 52(57), 271-278, 2011.