Impact of the future satellite gravity missions on ice-sheet researches

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Antarctic and Greenland ice sheets store 99 % of the pure water on the earth and cause cold sources in the climate system. Mass changes of the ice sheets are characterized with depositional processes (snowfall, for example) and ice-flow processes which transport the masses to the ocean. Therefore, to understand the earth environmental system, these processes and the mass changes must be better known.

In addition to the satellite-borne radio-wave altimeter and airborne (and future available satellite-borne) laser altimeters, satellite gravity missions contribute to these studies. Temporal gravity changes are affected by i) post-glacial rebound, ii) mass changes of the ice sheets, and iii) atmospheric pressure. i) and ii) can be revealed by the GPS measurements on the nunataks around the ice sheets and by air pressure data obtained at automatic weather stations in the interior of the ice sheets, respectively. Moreover, repetitions of the measurements can separate the effects of inter-annual variability in snowfall and long-term trend which affect to the global sea-level rise. Bentley and Wahr (1998) showed that satellite gravity missions can detect the mass changes equivalent to 0.5 mm/a sea-level change.

The total amount of the mass changes of the ice sheets is detectable with low-spatial (~1000 km) resolution sensors. However, high-resolution observations are required to understand the depositional and discharge processes. Snowfall and redistribution of snow processes are little known especially on the Antarctic ice sheet. Besides, gravity missions can reveal the ice flow characteristics. it was pointed out that ice streams, where the flow velocity is much higher (several orders) than the ordinary ice sheets, exist only on the sedimentary rocks. Then, in addition to the climate change, subglacial geology significantly control the ice-sheet change. Then, not only the temporal mass changes but also the static gravity field are important. However, gravity measurements over the ice sheets are very limited.

The impact of satellite and also airborne gravity missions to ice-sheet researches will be described.

[Reference]

Bentley, C.R., and J.M. Wahr, Satellite gravity and the mass balance of the Antarctic ice sheet, Journal of Glaciology, 44 (147), 207-213, 1998.