Seasonal glacier and snow loading in Svalbard recovered from geodetic observations

Halfdan Pascal Kierulf (Norwegian Mapping Authority), Ward van Pelt (Uppsala University), Leonid Petrov (NASA Goddard Space Flight Center), Michael Dähnn (Norwegian Mapping Authority), Ann-Silje Kirkvik (Norwegian Mapping Authority) and Ove Omang (Norwegian Mapping Authority)

Abstract. We processed time-series from seven GNSS stations and one VLBI station in Svalbard. The goal was to capture the seasonal vertical displacements caused by elastic response of variable mass load due to ice and snow accumulation. We found that estimates of the annual signal in different GNSS solutions disagree by more than 3 mm which makes geophysical interpretation of raw GNSS time-series problematic. To overcome this problem, we have used an enhanced Common Mode (CM) filtering technique. The time-series are differentiated by the time-series from remote station BJOS with known mass loading signals removed a priori. Using this technique, we have achieved a substantial reduction of the differences between the GNSS solutions. We have computed mass loading time-series from a regional Climatic Mass Balance (CMB) and snow model that provides the amount of water equivalent at a 1 km resolution with a time step of 7 d. We found that the entire vertical loading signal is present in data of two totally independent techniques at a statistically significant level of 95 per cent. This allowed us to conclude that the remaining errors in vertical signal derived from the CMB model are less than 0.2 mm at that significance level. Refining the land water storage loading model with a CMB model resulted in a reduction of the annual amplitude from 2.1 to 1.1 mm in the CM filtered time-series, while it had only a marginal impact on raw time-series. This provides a strong evidence that CM filtering is essential for revealing local periodic signals when a millimeter level of accuracy is required.