Comparison of GRACE and hydrology mass variations in North America studied by means of principal component analysis

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A four-year time series of GRACE mass changes over North America is analyzed by means of principal component analysis (PCA). PCA decomposes the time series into orthogonal modes of spatial patterns and their principal component time series. PCA can extract non-periodic variations which, ultimately, is an advantage compared to the least-squares fitting of a trend line and periodic components.

Four modes of variability are studied and compared with the modes of water mass variations extracted from three global hydrology models, i.e., GLDAS, CPC and LaD. The first mode comprises mainly mass changes related to the snow accumulation and melting and has a maximum amplitude in the western Cordillera and Québec-Labrador regions. The second mode reveals long-term positive mass changes in central and eastern Canada and negative mass changes in Alaska. Also, the third and fourth GRACE modes are believed to represent water mass variations although no definite relation to hydrology is established. The GLDAS model agrees well with the GRACE observations, but it is found that the CPC model also provides useful information for validating the GRACE-observed mass changes in North America. We conclude that principal component analysis is a useful technique for extracting and validating regional hydrology signals from GRACE gravity field data.