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Antarctic interannual accumulation signals consistently monitored by GRACE satellite gravimetry and ENVISAT radar altimetry

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Interannual variations of the Antarctic ice sheet, notably due to surface mass balance (SMB) fluctuations, are relatively poorly constrained by modeling. Satellite altimetry and satellite gravimetry over the ice sheet provide complementary observations of the related volume and mass effects, respectively. Yet, the (nonlinear) interannual signal contents of these observations have not been extensively studied so far. We compare and jointly interpret ENVISAT radar altimetry (RA) and GRACE satellite gravimetry results, relying on RA products from the Along-Track Repeat Satellite RA approach and on the GRACE 10-day solutions by CNES/GRGS. We adjust the spatial resolution of both datasets based on a rigorous description of the spatial filtering inherent to the GRACE solutions. After correction for glacial isostatic adjustment, the spatial patterns of trends seen by ENVISAT RA and GRACE over the period 10/2002-08/2009 agree well. Even more, the nonlinear interannual variations agree very well with correlation coefficients typically in the order of 0.8. This agreement gives confidence that ENVISAT RA and GRACE consistently reflect geophysical interannual variations. Combining both geodetic datasets aids their interpretation and promises to be valuable for SMB studies on the way to reduce present SMB uncertainties. In a case study we describe the most prominent nonlinear interannual feature as an event of excess snow accumulation in West Antarctica in September/October 2005 with a mass effect of 82 ± 31 Gt.