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A new digital elevation model of the Antarctic derived from combined satellite radar and laser data

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Digital elevation models (DEMs) of Antarctica have been derived, previously, from satellite radar altimetry (SRA) and limited terrestrial data of relatively poor vertical accuracy. Near the ice sheet margins and in other areas of steep relief the SRA data tend to have both poor coverage and accuracy. To remedy this and to extend the coverage south of the latitudinal limit of the SRA missions (81.5° S) we have combined laser altimeter measurements from the Geosciences Laser Altimeter System onboard ICESat with SRA data from the geodetic phase of the ERS-1 satellite mission. The former provide decimetre vertical accuracy but with poor spatial coverage: they have, for example, an across-track spacing of about 20 km at 70° S. The latter have excellent spatial coverage away from steep relief (across-track spacing by contrast is 2.8 km at 70° S) but a poorer vertical accuracy. By combining the radar and laser data using an optimal approach we have maximised the vertical accuracy and spatial resolution of the DEM and minimised the number of grid cells with an interpolated elevation estimate. A slope-dependent bias, however, exists between the laser and radar altimeter height estimates due to the different footprint sizes of the two instruments and the way the SRA data were processed. We have calculated and removed the bias (which was found to be a function of surface slope) from the SRA data and merged them with the laser data by weighting them as a function of their RMS error. We assessed the optimum resolution for producing a DEM based on a trade-off between increased resolution and increased interpolation of grid cells. The optimum resolution was found to be 2 km, which resulted in less than 40% of cells being interpolated (i.e. cells where no measurements exist). At resolutions smaller than this the percentage of interpolated cells rapidly increases. The resolution is also a trade-off between the along and across-

track spacing of the data, which varies with latitude. It reflects the spatial resolution justified by the global data coverage. Thus, close to the latitudinal limit of ICESat (86° S) a higher resolution could be justified. The accuracy of the final DEM was assessed using independent airborne laser altimeter data for a high relief region of West Antarctica. The DEM contains a wealth of information related to ice flow. This is particularly apparent for the two largest ice shelves—the Filchner-Ronne and Ross—where the effect of flow of ice streams and outlet glaciers can be traced as far as the calving fronts. Rifts are clearly visible as are the surface expression of subglacial lakes and other basal features. At this resolution, surface roughness, related to subglacial topography, is also discernable.