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Antarctic ice sheet surface velocity and surface change measurements from RAMP

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From the IGY through the early 1970's, scientific knowledge about Antarctica was gleaned primarily from observations made at points along traverse routes or along sparsely spaced aircraft flight lines. Analysis of these observations provided tantalizing clues about the nature and behavior of the ice sheet and the bedrock beneath. But the data themselves could not provide a continental scale assessment of how different glaciological and geophysical regimes interacted. That situation began to change rapidly in the mid-1970's with the launch of several active and passive sensors on satellites positioned in polar orbit. To complement that suite of sensors, NASA and the Canadian Space Agency began planning in the early 1980's for an imaging campaign using the RADARSAT-1 Synthetic Aperture Radar.

During later parts of the austral winter in 1997 and then again in 2000, Radarsat-1 was used to image Antarctica. Data from the 1997 campaign was assembled into the first high resolution radar image mosaic of the southern continent, which has subsequently been used to map the coastline of the continent in great detail, to study and contrast glaciological regimes about the continent, and to examine glaciological processes such as the evolution of ice shelves by observing ice shelves at various stages of development about the continent. Some data from 1997 and all of the data acquired in 2000 were acquired for interferometric measurement of the surface velocity field. These data are also useful for detecting short term changes in the surface as revealed in coherence maps created when two complex SAR scenes are co-registered.

In this paper, we present an ensemble of several continental data sets including velocities so far computed from the RAMP data set. We compare the RAMP image mosaic with: surface topography patterns using the Digital Elevation Model developed as part of RAMP; BEDMAP compiled basal topography; a RAMP prepared model of surface balance velocities; surface velocities derived from the RAMP interferometric data set, and large scale coherence maps. Through these comparisons, we find good correlations between the basal topography and backscatter strength in the vicinity of the Belgica Highlands. The result is exciting because it suggests that inferences about basal topography can be made using the image mosaic in regions where basal topography data are sparse or completely absent. We also find that there is good correlation between image-mosaic-inferred glaciological structures, the surface balance velocity field and the interferometrically measured velocity field. For example, the modeled velocities patterns capture the extensive network of ice streams draining into the Filchner Ice Shelf. These ice streams are revealed in the RAMP mosaic by the intense crevassing that occurs along their margins and which appears bright in radar imagery and as very dark bands in the coherence maps. Comparisons between the balance velocity model and measured RAMP velocities also reveal where the ice flow is more complex than predicted. West of the Amery ice shelf, measured velocities reveal the presence of numerous small ice streams or outlet glaciers that snake through the region and which are absent in the velocity model.