On the Effects of Ice Divide Motion on Raymond Bumps

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Radio-echo sounding of ice commonly reveals reflecting internal layers that are thought to be isochrones. Beneath ice divides the radar layers frequently exhibit anticlines (arches), which are a consequence of the non linear rheology of ice. This phenomena was first predicted by C. F. Raymond (1983) and is known as Raymond effect. Here we investigate the effects of ice divide motion on the geometry of Raymond bumps.

We show that the rate of ice-divide migration fundamentally affects the shape of the Raymond bumps. Slow migration produce a tilt in the axis of the crests of the arches (e.g. Siple Dome, Antarctica) while fast migrations leave Raymond bumps in a flank position which are advected with the flow while new ones develop in the new stationary position (e.g. Roosevelt Island, Antarctica).

We also explore the formation of double-rooted Raymond bumps (see figure).They appear in the radargrams of Kealey Ice Rise and Fletcher Promontory, both flanking Carlson Inlet in Ellsworth Land, Antarctica. We show that those double-rooted bumps can be produced through a fast migration of the ice divide, followed by a fast return to the old position. This explanation suggests that the flow velocities of currently inactive Carlson Inlet have chanced with time, and that Carlson Inlet may have flown considerably faster in the past.

We show how numerical modeling of transient Raymond bumps can be used to give both quantitative and qualitative information about changes in flow velocities and thicknesses of surrounding ice streams. Radar-echo soundings across ice divides are, thus, an effective way of obtaining information about past changes in ice stream configuration. This echoes similar work on the Siple Coast by Nereson, Raymond and co-workers.