Glacial Flow Modeling of Martian Lobate Debris Aprons (LDAs)

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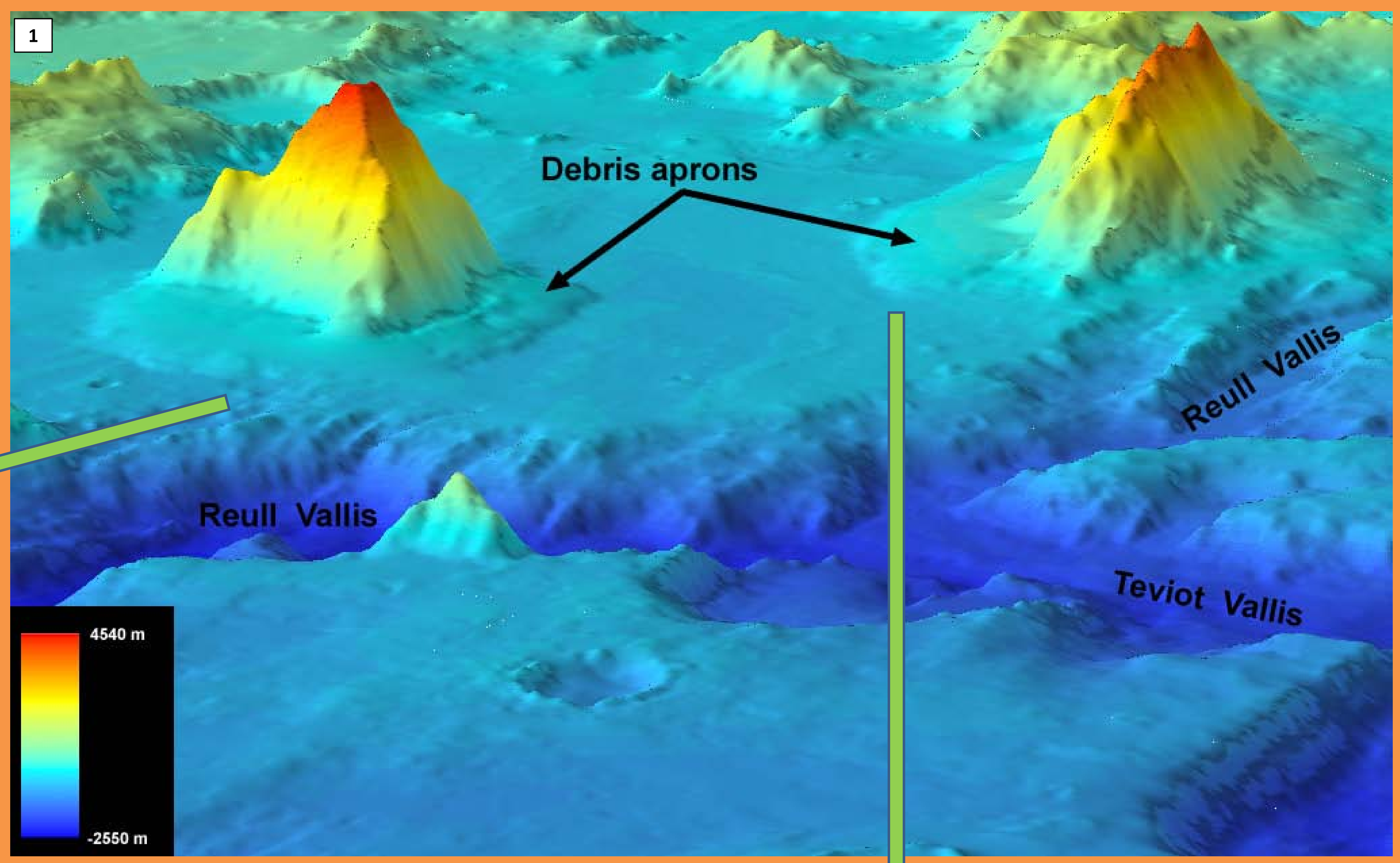
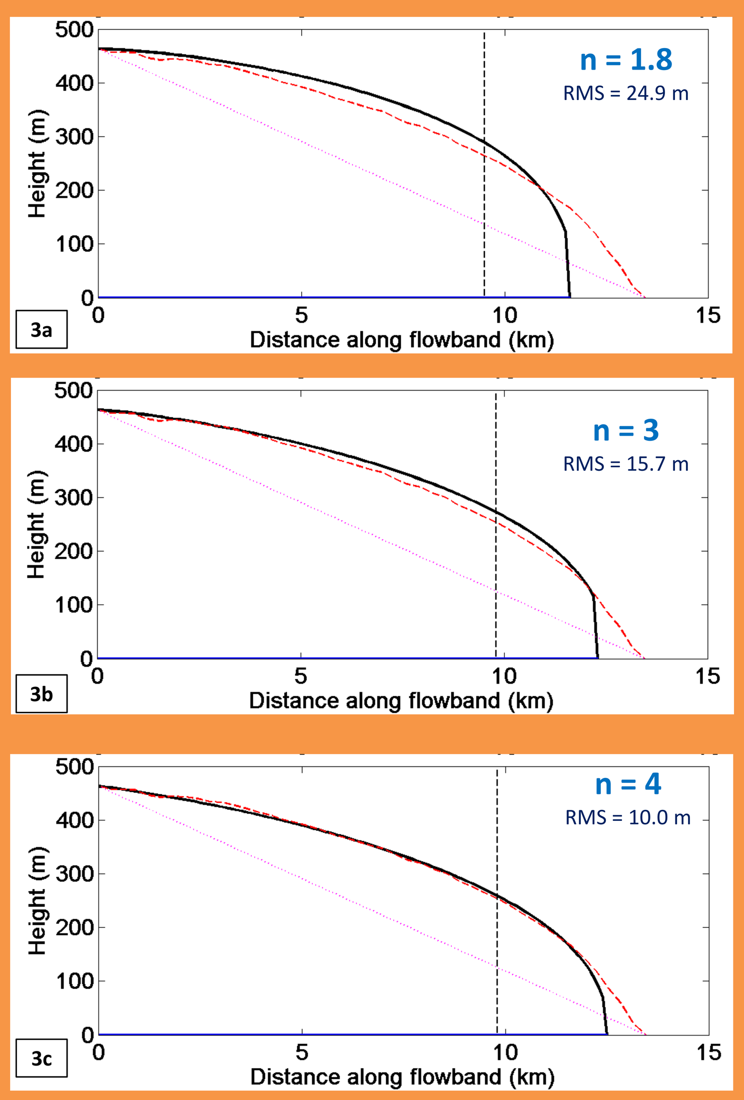
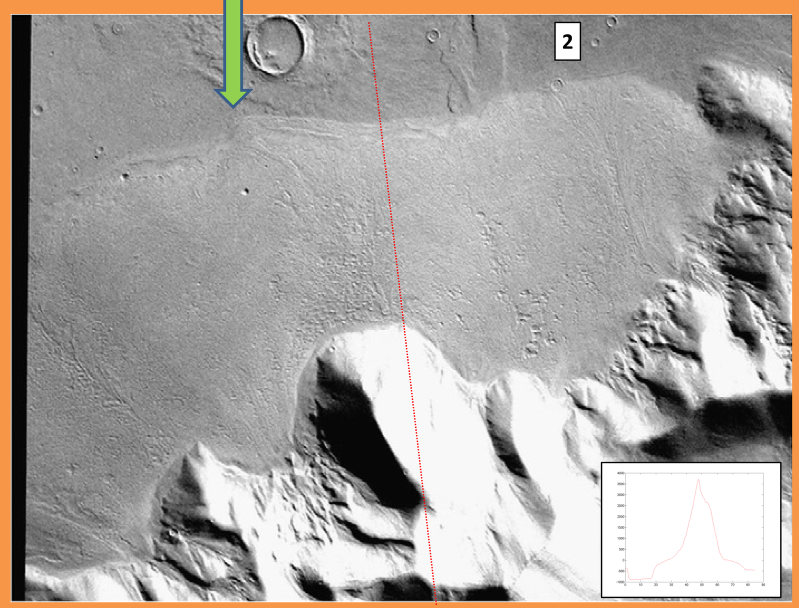
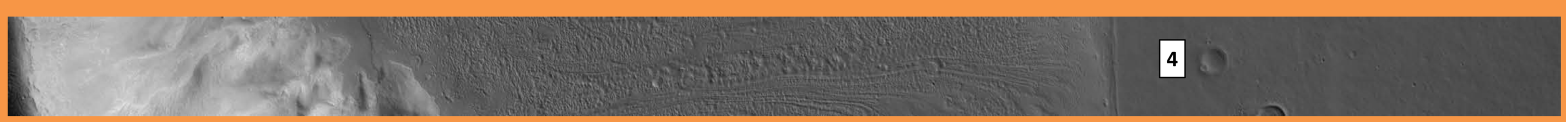
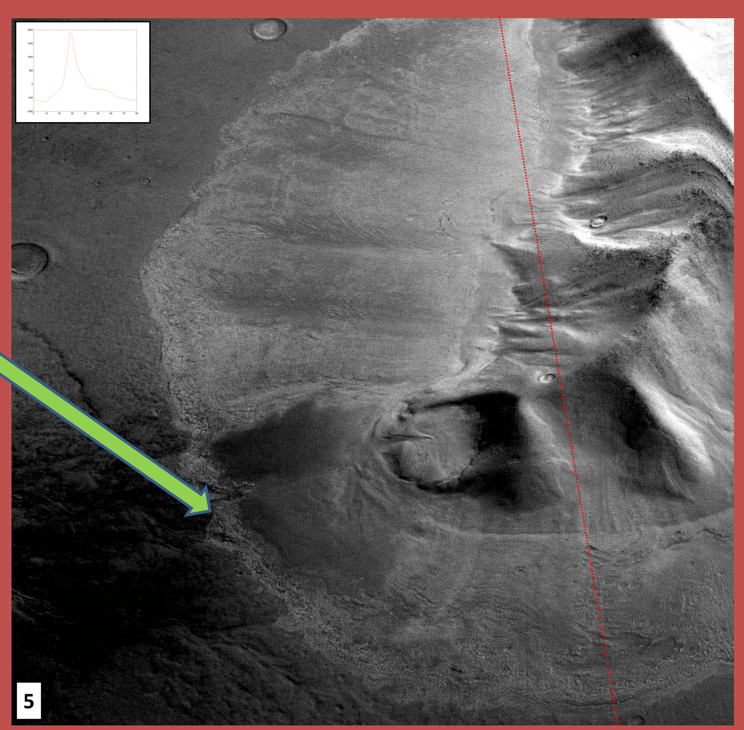


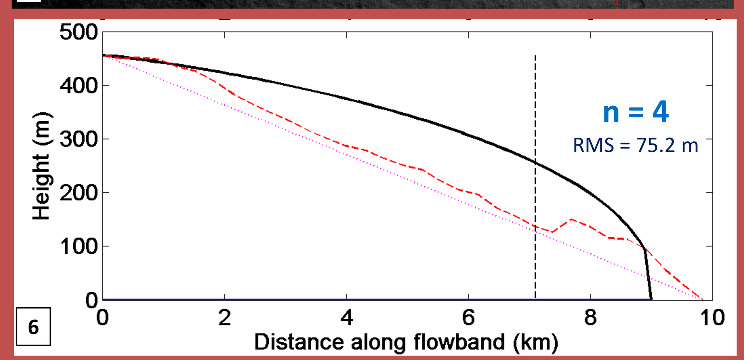




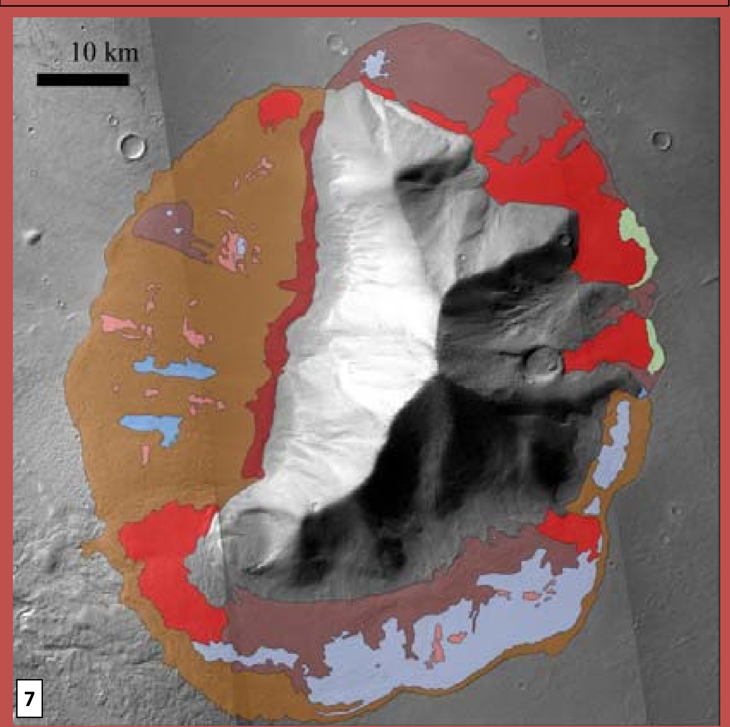
CAPTIONS: **(1)** Shaded-relief perspective of LDAs near Reull Vallis in eastern Hellas. Vertical exaggeration is 5x. From [8]. **(2)** HRSC image of LDA from Fig. 1 (from [9]). Inset shows MOLA profile along dotted red line used in **(3)** Steady-state glacial flow simulations (black lines) of LDA altimetry (red line) conducted for stress exponent of n = 1.8 (3a), n = 3 (3b), and n = 4 (3c). Magenta line is initial surface used for mass balance calculations. Vertical black dashes denotes equilibrium line. **(4)** MOC image of Fig. 2 LDA (boxed "2" and "4" lie next to same crater) showing surface texture change near terminus.







CAPTIONS: **(5)** Perspective HRSC view of LDA from Fig. 1 (ESA/DLR/FU Berlin). Inset shows MOLA profile along dotted red line used in **(6)** flow simulations (black lines) of S slope LDA altimetry. Largest deviation from model fit corresponds to **[7]** middle of heavily-eroded "Lower Knobby" surface texture mapped by *Chuang and Crown* [12] and crater-dated as very young by *Joseph et al.* [3].

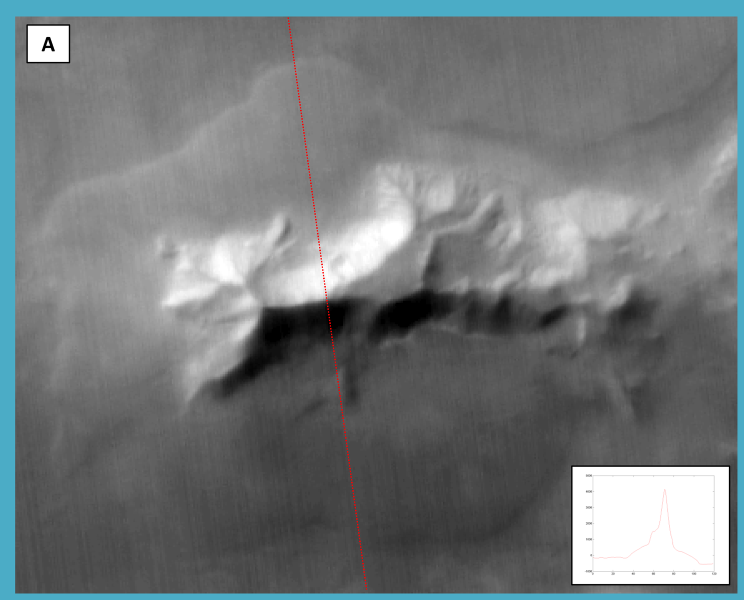


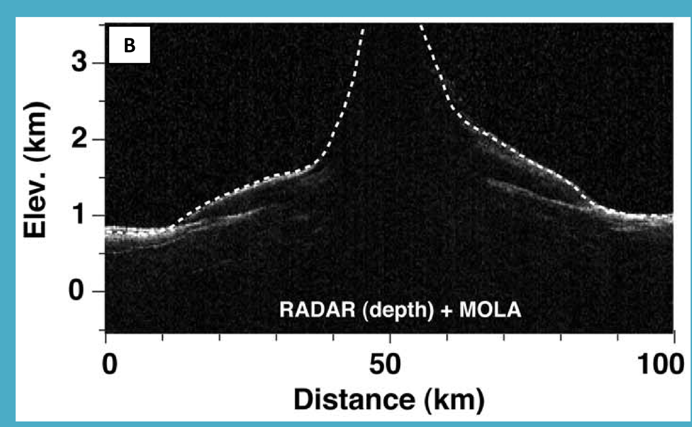
Background (right): Previously, we showed that a steady-state flowband glacial flow model (i) incorporating **slope-dependent sublimation** (ii) of Gemina Lingula(iii) could reproduce Shallow Radar (SHARAD) observations of subsurface stratigraphy (iv), both near the surface (v) and at depth (vi).

Eastern Hellas LDAs (left): Here, we model mid-latitude LDAs near Reull Vallis (1), starting with northern equatorward-facing lobes (2). Our steady-state simulations indicate that **a stress exponent of n=4 provides the best fit to LDA topography** (3), which is consistent with recent laboratory measurements of fine-grained ice + dust [*Goldsby et al.* [1], this session]. The n=4 equilibrium solution spans over 90% of the LDA profile, which may be correlated to a change in surface texture near the terminus (4).

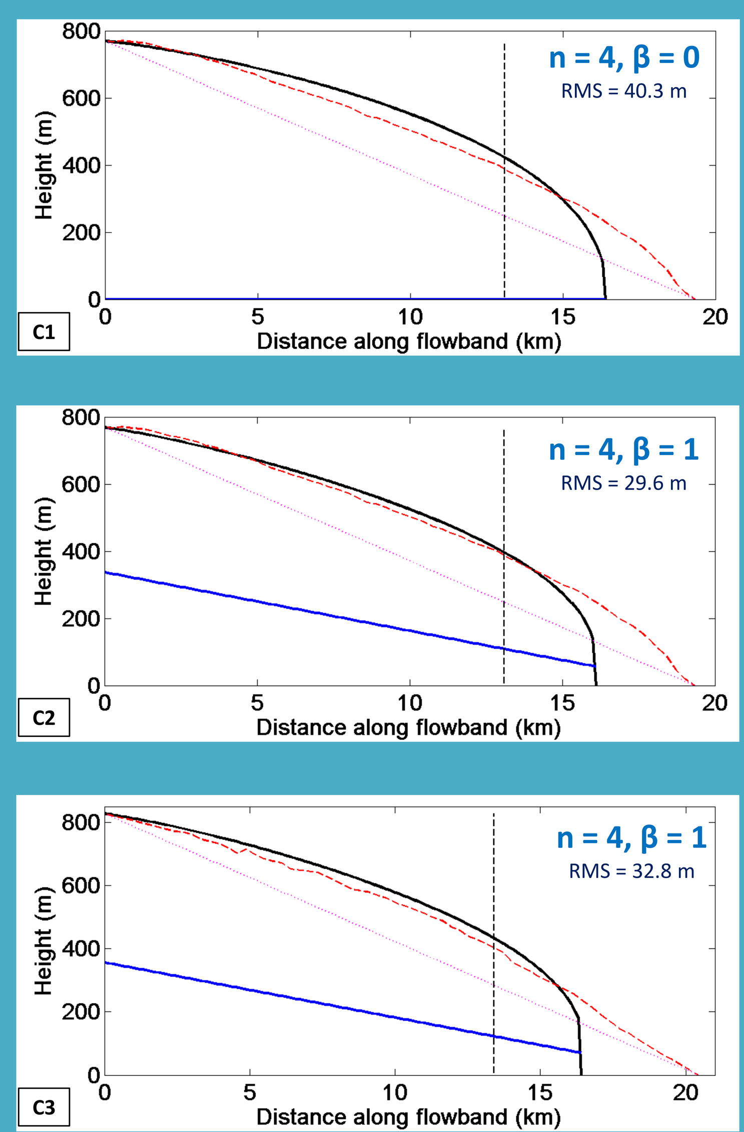
Euripus Mons (below), one of the largest LDAs (A) in Eastern Hellas, exhibits complex radar stratigraphy with typical bed slopes of β=1° (B), which can have a significant effect on surface flow simulations (C1, C2), **though the bed-slope-dependence of our flow modeling is not as dramatic as that of *Parsons and Holt* [2].** The extensiveness of the southern pole-facing lobe (C3) may be due to the presence of a basal deposit on the southern slopes (D). The similarity of this basal layer (E) to the compressed model layer in (vi) suggests that Euripus Mons, like Gemina Lingula, may have undergone an episodic glacial flow history.

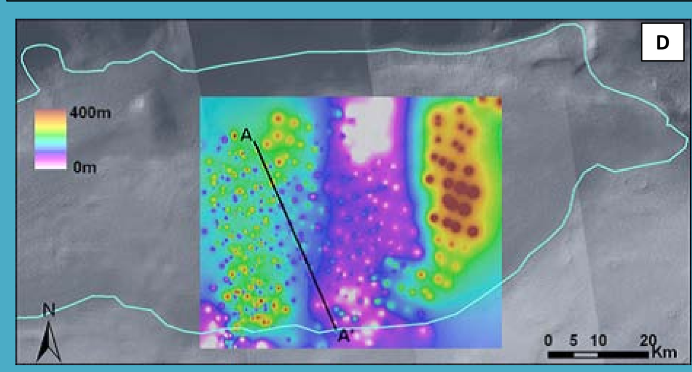
Surface Textures (bottom left) **may be correlated to the quality of the model fit.** The southern slope of LDA in (5) notably diverges from the poor equilibrium solution (6) in area mapped as heavily-eroded terrain that *Joseph et al.* [3] crater-dated as among the LDA's youngest units (7). **Future work: compare model time scales to age of surface textures.**

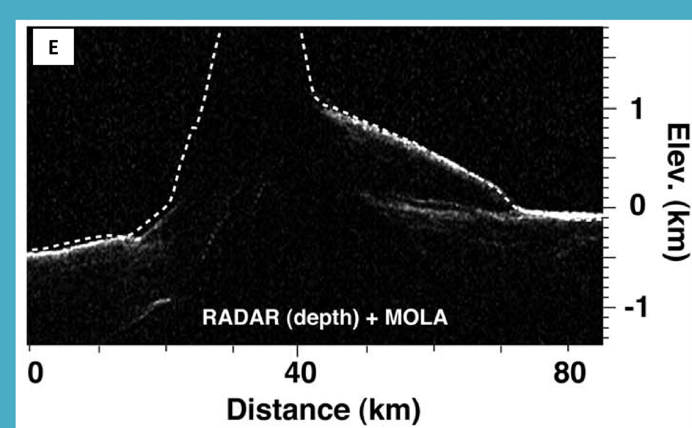


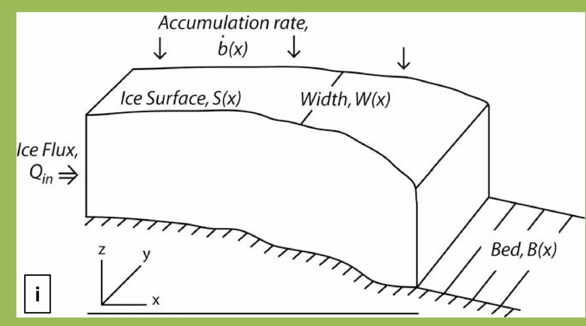


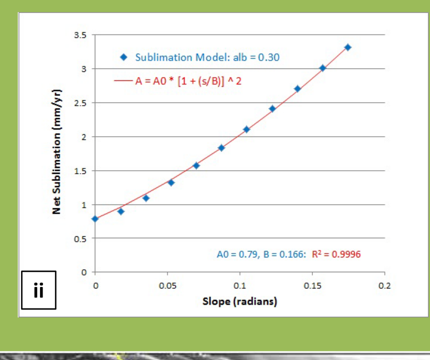
CAPTIONS: **(A)** MOC WA image of Euripus Mons. Inset shows MOLA profile along dotted red line. **(B)** SHARAD depth-corrected radargram of Euripus Mons (N to left), taken from *Holt et al.* [10]. **(C)** Flow simulations (black lines) of LDA altimetry (red lines) for varying bed topography (blue lines): N slope, β=0 (C1); N slope, β=1 (C2); S slope, β=1 (C3). **(D)** SHARAD-interpolated grid of basal deposit thickness on S slope, taken from *Quartini et al.* [11]. **(E)** SHARAD depth-corrected radargram of S slope of Euripus Mons showing thin basal deposit, from *Holt et al.* [10].

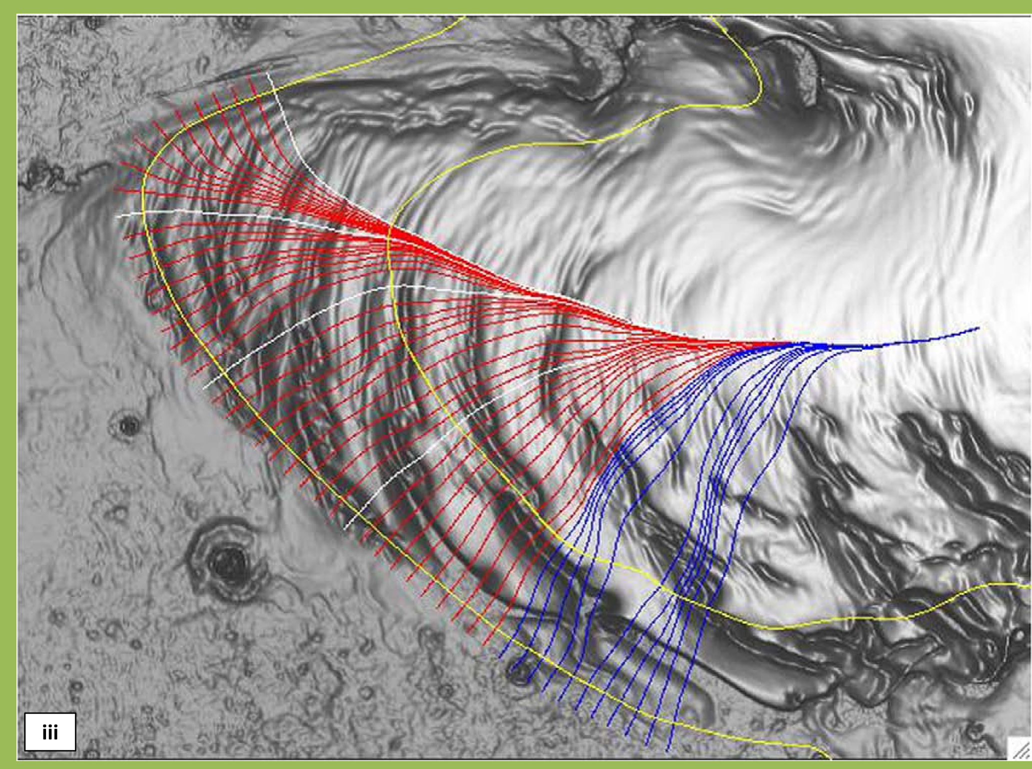




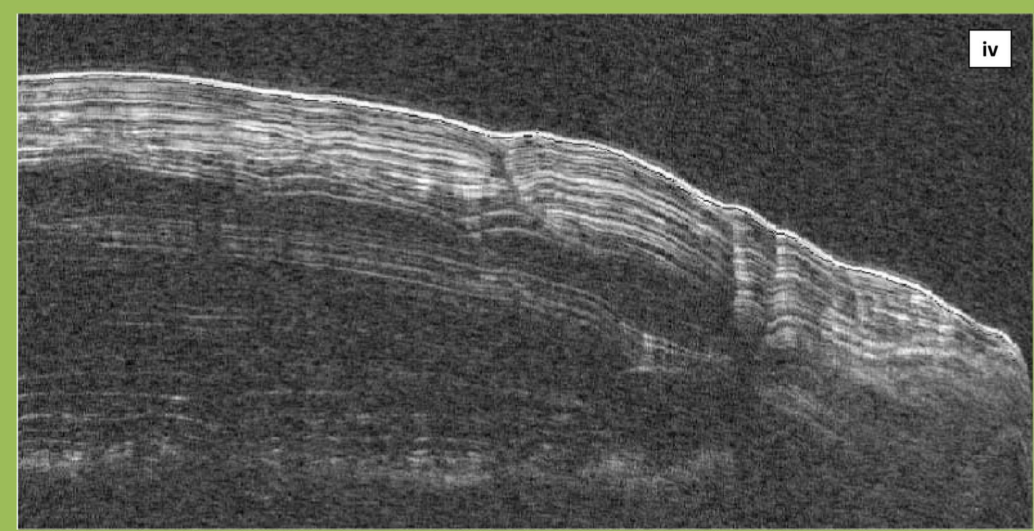


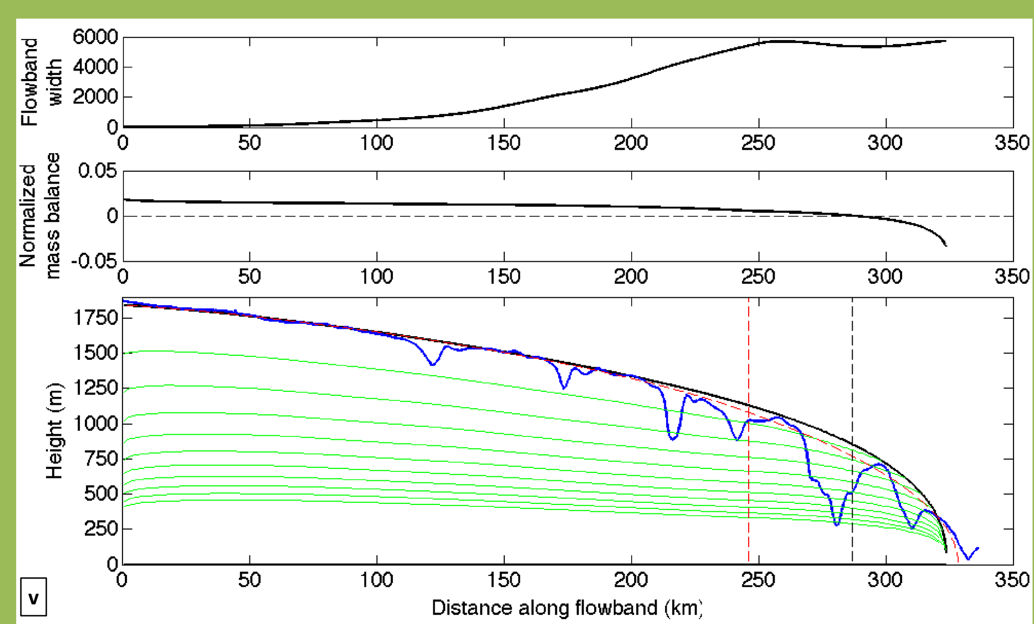


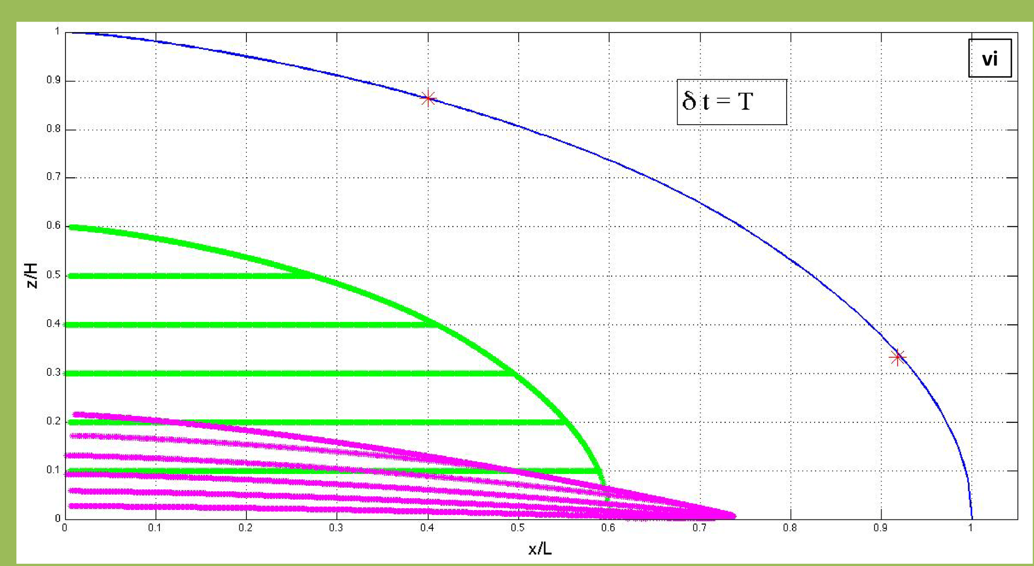




CAPTIONS: **(i)** Geometry of a flowband with width variations. The ice-surface elevation at the divide, flowband width, and bed geometry are required inputs to the model (from [4]). **(ii)** Slope dependence of net sublimation at 85°N, as calculated by [5]. **(iii)** Flow paths along elevation gradients on the interpolated surface derived from inter-trough topography, superimposed on MOLA DEM of Gemina Lingula (from [6]). **(iv)** SHARAD depth-corrected radargram of Gemina Lingula, modified from *Holt et al.* [7]. **(v)** Steady-state flowband model simulation (black line) of Gemina Lingula altimetry (blue line) provides excellent fit to inter-trough topography. Vertical black dashes denotes equilibrium line. Green lines represent subsurface isochrons, which fit SHARAD layers. **(vi)** Deformation of basal deposit in Gemina Lingula (green) due to recent deposition (blue) results in compression (pink) not eradication.







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