EARTH AND SPACE SCIENCE **Autumn 2017**
431 *PRINCIPLES OF GLACIOLOGY* 4 Credits, SLN 14841
505 *THE CRYOSPHERE* 4 Credits, SLN 14862

Homework Week 4 – Glacier Flow

Gwen and Harry are two glaciologists at a research station located 1 km from the head of a glacier. Satellite imagery provided to them shows that the glacier is 350 m wide everywhere. Together with historically collected ice-penetrating radar data, Gwen and Harry have deduced the 3D geometry of the system, and generated a longitudinal transect (Figure 1), as well as a cross section of the glacier immediately adjacent to the research station (Figure 2).

As they are leaving the station, Gwen and Harry were having an argument about which method can better predict glacier flow speeds – kinematic models or physical models. They decide to leave a pole in the center of the glacier over the winter and measure the flow speeds when they return the following year. Harry, who prefers kinematic models, bet Gwen $3000 that his measurements of surface accumulation could produce a better prediction than Gwen's measurements of surface slope. They each went out and took a few measurements, and left for the winter.

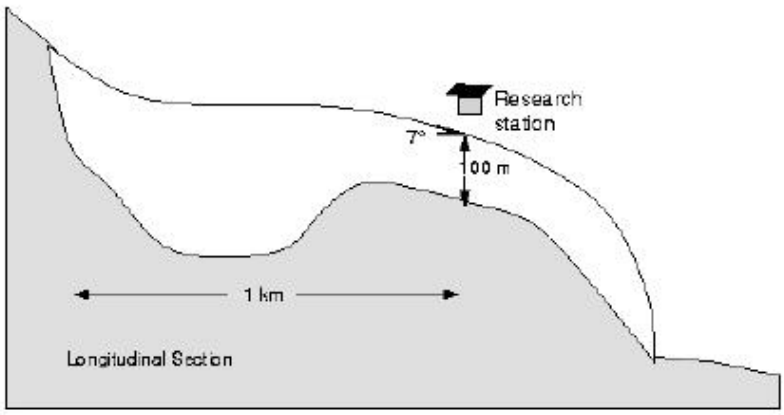


Fig. 1 – Longitudinal cross section of the glacier, generated using ice penetrating radar.

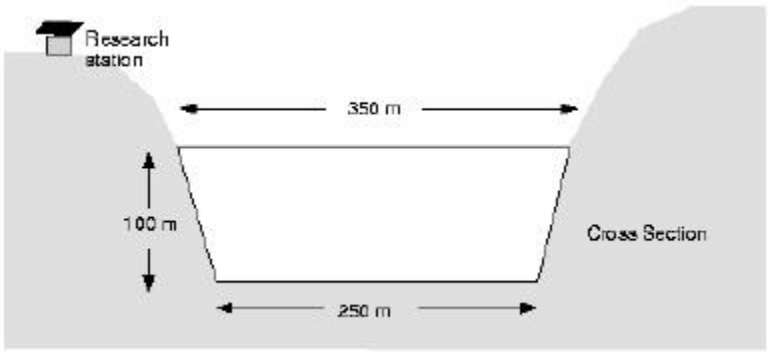
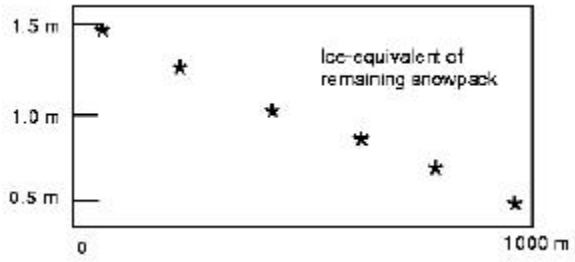


Fig.2 – Cross section perpendicular to flow, adjacent to the research station

Harry's Measurements:

Using a sounding probe, Harry measured the depth to last year's summer snow surface along the center line of the glacier upstream of the station. Together with measurements of snow density, he was able to compute the total accumulation (in meters of ice equivalent) along the glacier.



Gwen's Measurements:
Using a tilt meter, Gwen steps out to the centerline nearest the research station and measures the surface slope. She finds it is 7^{o}.

Problem 1 – How does Harry use the information he collected to estimate ice flow speed (describe both in words, and through any relevant equations)? What will his estimate of surface velocity at the stake be?

Problem 2 – Gwen assumes that, in the Cascades, about half of the motion at the surface is due to sliding at the bed. How does Gwen use her measurements and assumptions about basal sliding to estimate ice flow speed (describe both in words, and through any relevant equations)? What will her estimate of surface velocity at the stake be?

Problem 3 – Why might Gwen and Harry's answers be different? What are the strengths and weaknesses of the 2 methods?