EARTH AND SPACE SCIENCE **Autumn 2017**

431 *PRINCIPLES OF GLACIOLOGY* 4 Credits, SLN 14841

505 *THE CRYOSPHERE* 4 Credits, SLN 14862

Lab Week 8 – Avalanches

Avalanche Forecasting

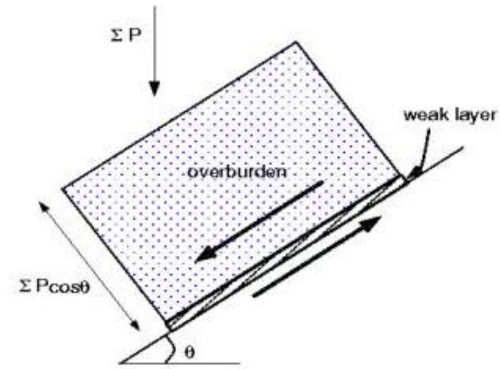
A simple force-balance model predicts snow-slope stability during storms remarkably well, considering the inherent uncertainties.

Model description

Avalanching is predicted when the driving stress exceeds the resisting strength.

Driving stress S_{xy} comes from the gravitational force applied by cumulative precipitation measured at a gauge:

$$S_{xy} = \sum P(t) * g\rho_{ice}\sin(\vartheta)$$



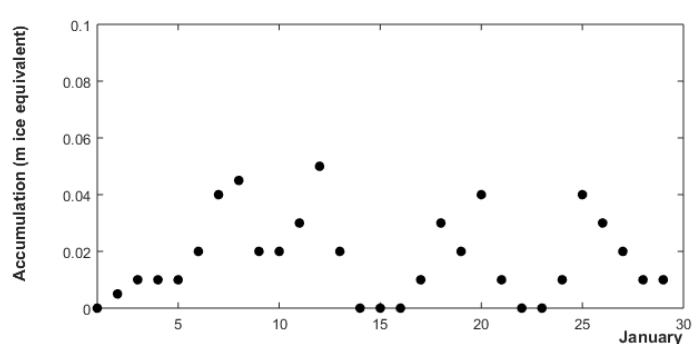
Where P is the daily precipitation rate in meters of ice equivalent, and ϑ is the snow surface slope. Resisting shear stress σ_{xy} of a buried layer is estimated from its density:

$$\sigma_{xy} = A[\rho_0 + Bh]^2$$

where A and B are material constants, ρ_0 is the initial weak layer density, and h is the overburden thickness (in m ice equivalent).

Each day, snow patrol at Vale estimates the average accumulation rate in the typical avalanche initiation zone. Using a shear frame, they have also estimated values for A and B, which depend on the temperature and other physical properties of the system.

Recently, snowpack conditions were right to generate significant hoar frost, resulting in a weak layer at the surface with density of 150 kg/m^3. This low density layer ultimately resulted in an avalanche, which was accurately predicted using the model described above. Use the snow patrol observations of accumulation rate, surface slope, and values of A and B to compute the date of the avalanche at Vale. At what shear stress did this occur?



Surface slope = 20° A = 0.03 [m^5/(kg s^2)] B = 20 [kg / m^4] ρ_0 = 150 kg/m^3