SNOSS Explanation

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1 Introduction

SNOw Slope Stability (SNOSS) model is a numerical avalanche forecasting model that compares the overburden stress due to new snow to the strength of each layer. The ratio of the stress to strength, provides an *index* of snow slope stability and the *probability* of an avalanche will increase as the ratio approaches 1. SNOSS was developed to use in prediction of direct action avalanches in new storm snow. We emphasize that this model is intended as a tool for avalanche forecasters for evaluating snow slope stability during storms. Model values should be used with caution for sites that have not been calibrated. See Conway and Wilbour (1999) for in depth discussion of SNOSS.

2 SNOSS procedure

1. Acquire data from Mesowest server for desired weather station
2. New hourly precipitation is made into a new snow layer with the layer temperature as the air temperature
3. Update the density for all layers using a densification model
4. The stability index and time to failure (see below) are calculated for each layer
5. The snow layer above the old snow surface is tracked through time and plotted
6. A new storm is considered after 12 hours of no new precipitation

3 Model inputs

SNOSS requires hourly precipitation and air temperature to run. New hourly precipitation becomes a new layer that provides an increase in the overburden stress on each layer. Factors that affect the densification rate are the overburden stress, the current layer density, and the layer temperature. A colder layer will not densify as fast as a warmer layer, just as a high density layer will not densify as quickly as a low density layer.

4 Stability index and time to failure

The average stability index $\overline{\Sigma}_z(t)$ at depth z and time t is:

$$\overline{\Sigma}_z(t) = \frac{\text{Shear strength of weak layer}}{\text{Overburden shear stress at weak layer}}$$

The overburden shear stress at the weak layer is a function of the amount of water weight above the weak layer and the angle of the slope. SNOSS is currently hard wired for a 40° slope. The shear strength of the weak layer is a function of the layer density that is updated each time SNOSS is run. When $\overline{\Sigma}_z(t) = 1$, the overburden stress has reached the strength of the weak layer and avalanches are expected to occur. $\overline{\Sigma}_z$ provides an *index* of snow slope stability and the *probability* of an avalanche will increase as $\overline{\Sigma}_z$ approaches 1.

The expected time to failure is:

$$t_f(t) = \frac{\overline{\Sigma}_z(t) - 1}{d\overline{\Sigma}_z/dt} \tag{1}$$

The expected time to failure contains information on how the current conditions are affecting $\overline{\Sigma}_z(t)$. The time to failure is based on when the layer will reach the critical value of $\overline{\Sigma}_z(t) = 1$ (figure 1). However, the critical value of $\overline{\Sigma}_z(t) = 1$ may be different for each site and can only be determined through avalanche observations.

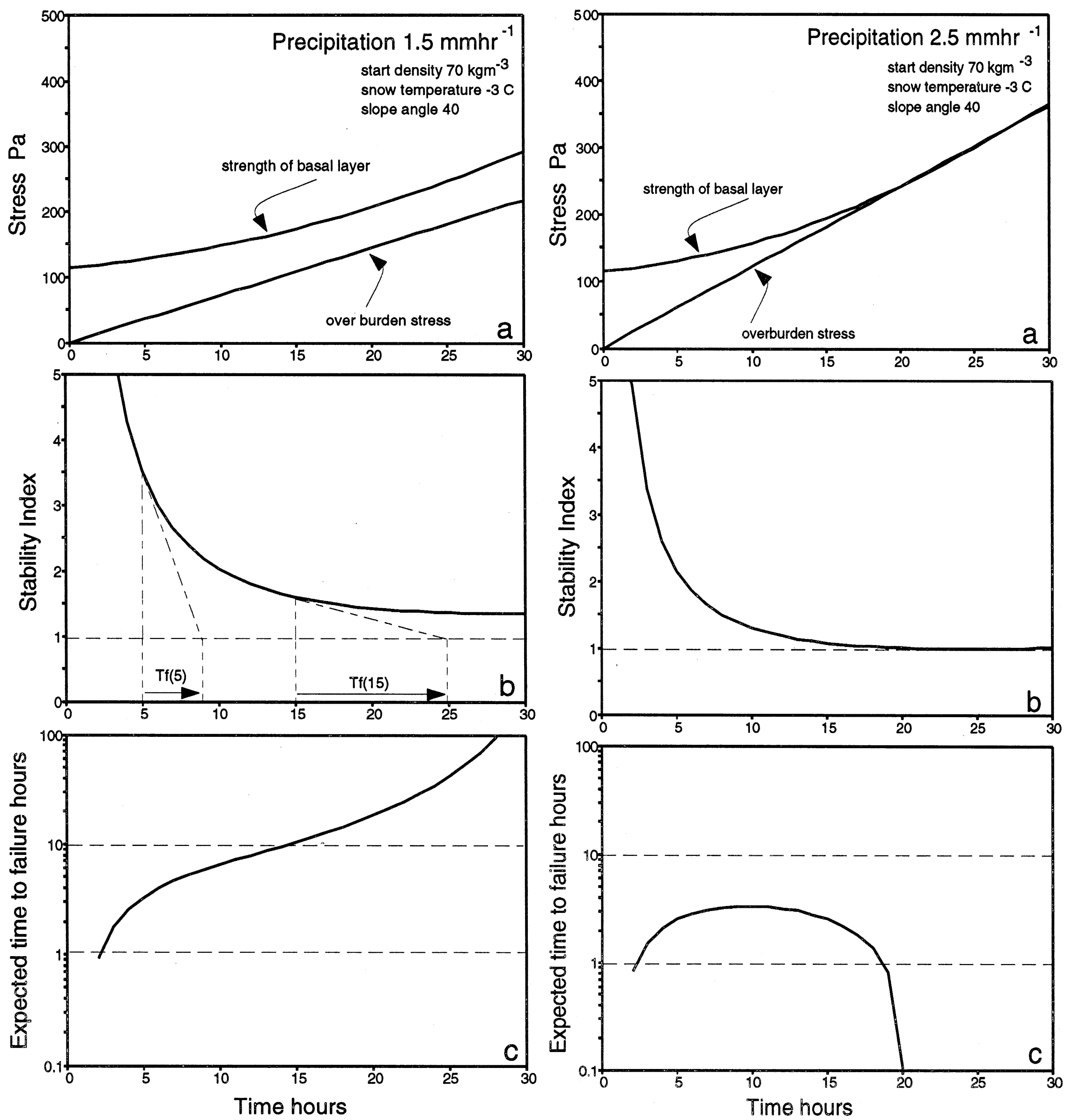

Figure 1: Theoretical SNOSS model for two constant precipitation rates. The evolution of stress, stability index, and expected time to failure are shown. The left plot is a stable snowpack and the right plot is unstable.

5 How to read plots

Figure 2 show the typical figure that is displayed on the webpage. This figure is updated when a new measurement from Mesowest is obtained. For this application of SNOSS, the following table shows values that are used within SNOSS to help interpret the results:

$\overline{\boldsymbol{\Sigma}}_{\mathbf{z}}(\mathbf{t})$	$\overline{\boldsymbol{\Sigma}}_{\mathbf{z}}(\mathbf{t})$ **trend**	$\mathbf{t_f(t)}$
≥ 1	increasing	1000
≥ 1	decreasing	Eqn. 1
≤ 1	decreasing	0

References

Conway, H., and C. Wilbour. 1999. Evolution of snow slope stability during storms. *Cold Reg. Sci. and Tech.*, **30**, 67–77.

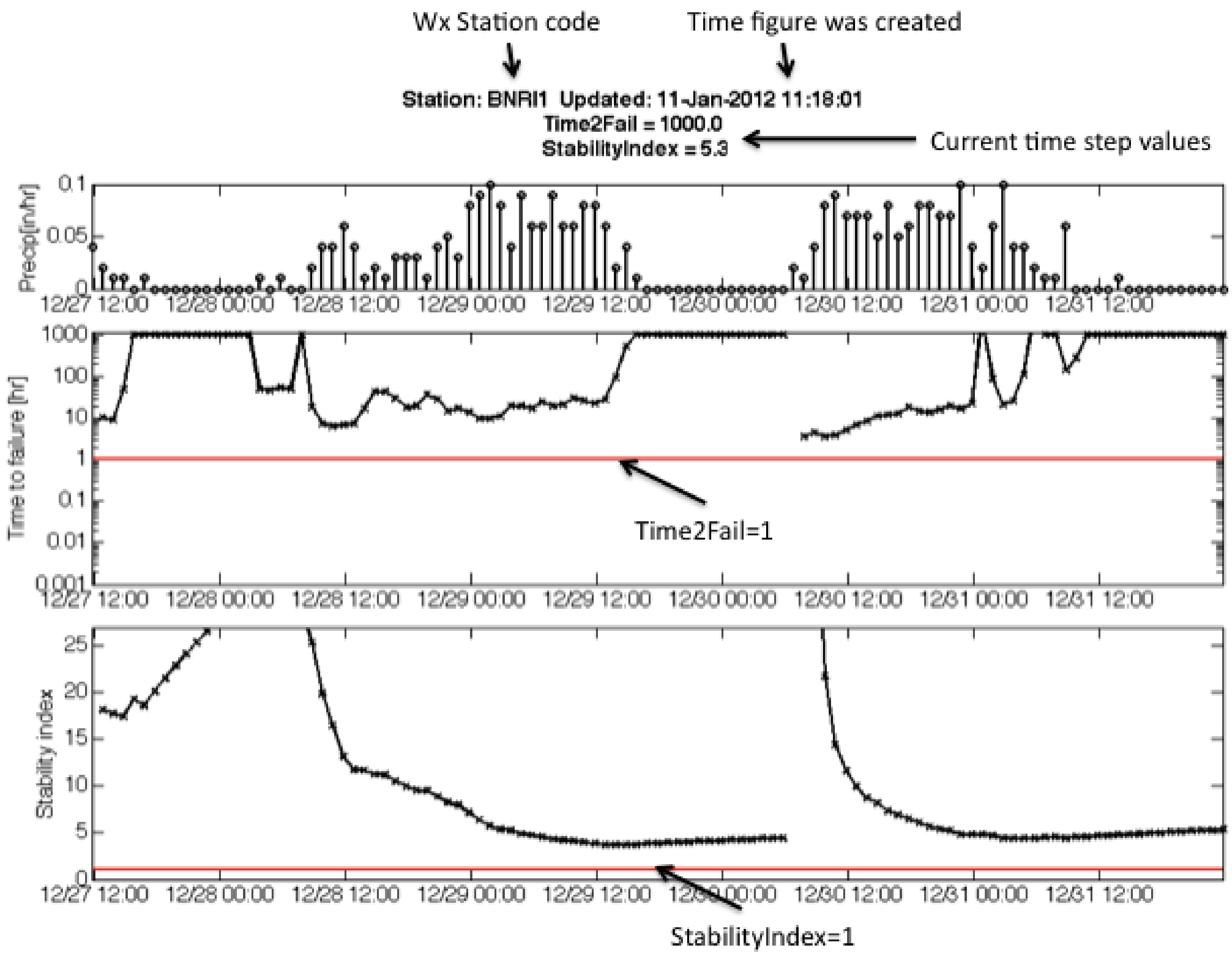

Figure 2: SNOSS results that are uploaded to webpage.