Snow Tracking Game

Objectives:

To undertake snow depth measurements on a periodic basis to better understand snowpack evolution, spatial variability and properties. To track weather conditions including storms and ablation events that induce changes in snow depth.

Notes:

- The snow tracking game will begin on Friday January 15th, 2021 and will continue throughout the semester.
- If your current location of residence is in area with no or intermittent snow, you should identify another site for which you can obtain (near) real-time snow depth and meteorological data.
- When taking snow depth measurements outdoors, please dress appropriately and avoid hazardous areas or especially treacherous conditions.
- During Friday classes, we will discuss recent changes to snowpack conditions in Prince George and other locations where students are currently residing. Please be prepared to discuss your latest snow depth measurements during class.
- The snow tracking game accounts for 10% of your course mark. The data collected during the semester will be incorporated in a project report due on **Thursday, 1 April 2021**. Consult the additional document (to be provided at a later date) that provides the format of the project report as well as questions that you will need to answer following the snow data collection effort.

Background:

Snowcover comprises the net accumulation of snow on the ground resulting from precipitation deposited as snowfall, ice pellets, hoar frost and glaze ice, and water from rainfall, much of which subsequently has frozen, and contaminants. Its structure and dimensions are complex and highly variable both

in space and time. This variability depends on many factors: the variability of the "parent" weather (in particular, atmospheric wind, temperature and moisture of the air during precipitation and immediately after deposition); the nature and frequency of the parent storms; the weather conditions during periods between storms when radiative exchanges may alter the structure, density and optical properties of the snow and wind action may promote scour and redeposition as well as modification of snow density and crystalline structure; the process of metamorphism and ablation which can alter the physical characteristics of the snowcover so that it hardly resembles the freshly-fallen snow; and surface topography, physiography and vegetative cover. Being the end product of both accumulation and ablation, snowcover is the product of complex factors that affect accumulation and loss.

Snowcover properties vary on different spatio-temporal scales. This snow tracking game is designed to give you a better understanding of the temporal variability of snowcover. To that end, you should read the paper by Neumann et al. (2006) and the lecture notes on snowpack formation and ablation as background information.

There are no universally accepted instruments for measuring snow depth, density and water equivalent. Methodologies may even vary widely with the user and site conditions. Several methods used in North America to measure these snow parameters are summarized below.

A number of instruments are used to measure snow depth including snow rulers, graduated rods and aerial snow markers. A ruler or rod is pushed through the snowpack to the ground surface and the depth measured directly. In remote regions, snow markers may be used. The depth of snow at a marker is observed from distant ground points or from aircraft by means of binoculars or telescopes. The technique is usually straightforward and accurate but becomes labour-intensive for frequent sampling. During periods of intense solar radiation, preferential snow melt/evaporation may occur around permanently installed snow rulers.

Snow surveys are generally made at regular intervals throughout winter at designated stations along a permanently marked traverse (snow course) to determine depth, vertically-integrated density, and snow water equivalent. The length of a snow course and the distance between sampling points vary depending on site conditions and uniformity of snowcover. A snow course is generally 120 to 270 m long, with observations taken at 30-m intervals. Site selection should exclude regions affected by snow removal operations or other artificial control of snow conditions.

For more information on snow data measurements and analysis, consult Chapter 6 ("Measurement and Data Analysis") of the "Handbook of Snow" by Gray and Male.

Online Resources:

There are a number of online resources that will assist you to in your data collection effort. For instance, you may consult the following websites for useful information or for supplemental data:

- BC River Forecast Centre
- Environment and Climate Change Canada

References:

- Neumann et al. (2006): Characterizing local scale snow cover using point measurements during the winter season, Atmosphere-Ocean, 44, 257-269.
- Goodison, B.E., Ferguson H.L. and McKay, G.A. (1981), Measurement and Data Analysis. Chapter 6 in Handbook of Snow, Gray, D.M. and Male, D.H. (Eds.), 191-274.

Equipment:

- graduated snow probe or ruler (e.g. metre stick)
- meteorological data
- field notebook (or clipboard with paper) and pencil

Method:

- Select a relatively uniform area where you will conduct your periodic (weekly) snow measurements. This should be the same location each week away from any wind-drifted areas, and roads or other disturbed areas; however, undertaking snow measurements in a forested area is acceptable.

- Make note of the date and time in addition to environmental features (e.g. vegetation type, height and density; site exposure, slope, buildings, etc.) of the location where you conduct the snow measurements. Obtain the coordinates and elevation of the site if possible and take a picture of the site. Finally, obtain a source of reliable meteorological information for your study site.

- The snow measurements involve two components:

    1. Snow depth measurements:

       Conduct a snow depth measurement at approximately 9 a.m. local time each Friday during the winter semester. Record your snow depth measurement to the nearest 0.5 cm. Compute the change in snow depth since the last measurement (starting in the second week of the snow tracking game). Record general meteorological conditions during your measurement of snow depth.

    2. Meteorological conditions:

       Keep track of meteorological conditions during the week and identify any event that may lead to noticeable changes in snow depth. This could be a winter storm, light snow or rainfall, warm temperatures inducing snow melt, etc. Add this information in a comment box besides your weekly snow depth measurement.