**Processes in river basin hydrology and water management**

**Exercise 4 – Cold Region Processes & Change**

Please upload the completed assignment to the Brightspace site of the module.

**Problem**

Snow accumulation and depletion dynamics can be relatively easily represented by temperature index model approaches. In these models snow accumulation and melt are functions of precipitation, mean daily air temperature, a temperature threshold *TT* below which precipitation falls as snow and accumulates in the snow pack (and above which snow melts) as well as a degree-day melt factor *FM*, which is a bulk parameter that serves as a proxy for albedo and other variables influences the energy input to the snow pack.

Use such a model with the data given in the Excel file “Snow” for two catchments in a humid, snow-dominated climate and estimate the *SWE* (i.e. SSnow) and the total liquid water input to the soil **PL,TOT** for each day of the given data series. Use the equations provided in the lecture slide.

**Case 1:**

A catchment with flat terrain at elevation ER = 700 m (which equals the reference elevation at which temperature is measured)

**Case 2:**

A catchment in a mountain region with elevation spanning from 0-2000m. This catchment has the same mean and reference elevation as the above, i.e. ER = 700m, the same observed reference temperatures TR at this elevation and it receives the same precipitation amount P. To estimate the catchment total (i.e. weighted according to the area of each elevation band) SWE and PL,TOT, stratify this catchment into 4 elevation bands (i.e. 0-500m, 500-1000m, 1000-1500m and 1500-2000m) with mean elevations of E1=250m, E2=750m, E3=1250m and E4=1750m, respectively

**Case 3:**

In a different year (Case 3), the mountain catchment experiences higher winter temperatures, which are on average 2oC higher than in Case 2. Use the same model as for Case 2 but with the temperature and precipitation data of Case 3 to estimate snow accumulation and melt.

**Answer the following questions:**

Which of the two catchments with the same mean elevation, the same reference and mean temperatures, and the same total precipitation, accumulates more snow before end of October? Why?

In which of the two catchments does the snow melt occur faster? How many days does the snow cover disappear earlier in one catchment than in the other? Why?

Analysing the temporal dynamics of PL,TOT, in which of the two catchment is more flooding due to snow melt expected? In which of the two catchments does snow melt occur more intensely? Why?

Which of the two catchments is more likely to experience water stress (i.e. drought) during dry, low flow conditions in summer? Why?

On which day of the year are snowpacks completely molten away (“melt-out”) in Case 2 and Case 3, respectively? In which of the two years, i.e. in the cooler (Case 2) or the warmer (Case 3) one, does melt-out occur earlier? Why?