**Lab and Homework 2: Analyzing weather data on ice sheets**

***Provide all answers in a text document or PDF (using e.g. Word, LateX, Jupyter NB), along with your code and/or Excel sheet(s), and send everything to me via a personal message on Slack (preferably) or email before February 26, 1.30 pm. Any files you submit should be named FirstName\_LastName\_HW2 (e.g. Jan\_Lenaerts\_HW2).***



Given in the Dropbox folder are data sets of daily mean weather observations and derived quantities (using a surface energy balance model) collected by two Automatic Weather Stations (AWS) on East Antarctica (see Fig. above), AWS4 (in AWS4\_DAY.txt) and AWS9 (in AWS9\_DAY.txt). A paper describing the data is in the Dropbox folder (Jakobs et al., 2020). The data files each contain 19 columns with the following data:

date: date in format yyyy/mm/dd

year: year in format yyyy

day: day of the year (1-366)

Temp(K): observed air temperature (in K)

T2m(K) : derived temperature at 2 meters above the surface (in K)

T0(K): derived surface temperature (in K)

T0lout(K): observed surface temperature (in K)

ws(m/s): observed wind speed (in m/s)

ws10m(m/s): derived wind speed at 10 meters above the surface (in m/s)

wd(°): observed wind direction (in degrees)

p(hPa): observed atmospheric pressure at the surface (in mb/hPa)

Sin(W/m2): incoming shortwave radiation, defined positive downward (in W/m2)

Sout(W/m2): outgoing shortwave radiation, defined positive upward (in W/m2)

Lin(W/m2): incoming longwave radiation, defined positive downward (in W/m2)

Lout(W/m2): outgoing longwave radiation, defined positive upward (in W/m2)

SH(W/m2): sensible heat flux (in W/m2)

LE(W/m2): latent heat flux (in W/m2)

G(W/m2): ground heat flux (in W/m2)

error(-): error in calculation of SEB (can ignore)

*If any value <-999., it is defined as a missing value or false measurement. Note that the turbulent fluxes and ground heat flux are defined positive when directed towards the surface (i.e. contributing positively to the surface energy balance).*

1. Explore both data sets and all the variables.

* 1. Why do the temperature and wind speed at reference height (2 m and 10 m above the surface, respectively) need to be derived from the actual temperature and wind speed measurements?
  2. Next, with your group, select a full year worth of data that is as complete as possible in both data sets. Use this overlapping year to answer all of the following questions.

1. For AWS4, plot the time series (i.e. one full year) of 2 m temperature, 10 m wind speed, and temperature difference between the surface and two meters above the surface.
   1. Briefly describe and explain the variability and 2 m temperature and 10 m wind speed.
   2. In what season, and for what temperature and/or wind speed conditions is the temperature difference between the surface and 2 m the smallest/largest? For what component of the SEB is this specifically important? Show some plots to guide your answer.
2. Assuming that the surface temperature is not given, calculate surface temperature at AWS4 yourself (HINT: check the lecture slides of the intro to this lab). Plot the result (time series of daily surface temperature over the year). HINT: you can check the validity of your result with the surface temperatures that are given in the data set (T0lout and T0).
3. Plot the radiative and turbulent fluxes at AWS4 and AWS9 in one plot. Briefly discuss and explain the (a) seasonal cycle at both stations, (b) the differences/similarities between two stations (HINT: it can be useful to ‘smooth’ the time series, e.g. a 10-day running mean, to better visualize the seasonal cycle).
4. Calculate the surface energy balance (i.e. the balance of all radiative, turbulent, and ground heat fluxes) at AWS4 and AWS9, and show the result (a time series of SEB for both stations over the overlapping year). Note that the radiative fluxes are all positive numbers, which implies that in this case, SWnet = SWin-SWout and LWnet = LWin-LWout. Is the SEB generally zero, positive or negative at both stations? Explain why the SEB is positive during some days – where is this excess energy going into? (HINT: look at the surface temperature).
5. Calculate the daily mean surface albedo at AWS4 and AWS9, and show the result (a time series of daily mean surface albedo at both stations for the overlapping year). Explain the similarities and differences between the two locations, and relate the result to your answer of the last part of question 5.