Glaciology
EESCGU4220

Practical 2:
Antarctic surface accumulation

Purpose is to familiarize you with;

- analyzing gridded data.
- multi-dimensional arrays
- regional climate model output

1. Download data from:

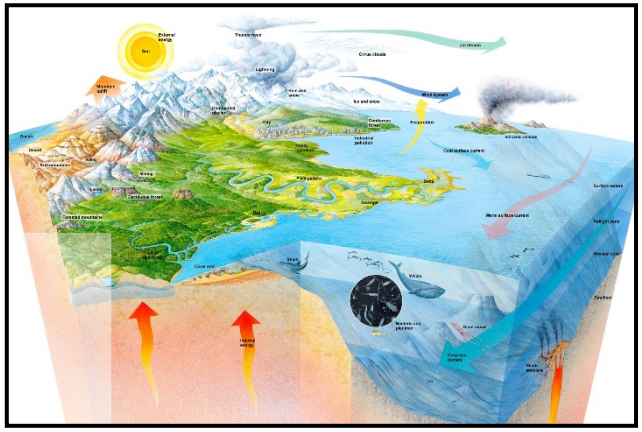
https://storage.googleapis.com/ldeo-glaciology/glaciology4220/practical_2/P2_RACMO.npz

2. Also download the txt file and csv file I send in a slack message earlier today.

3. Open a new notebook.

Climate Models

The real System



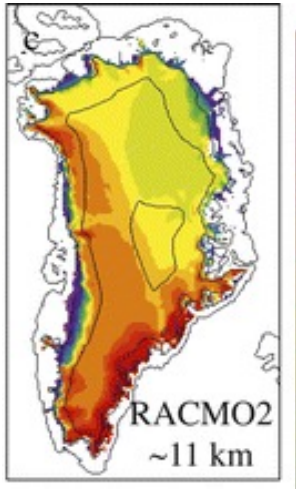
Mathematical model:
e.g. Navier-stokes equations

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{u}) = 0, \quad \text{----- Continuity Equation} \quad (1)$$

$$\frac{\partial \mathbf{u}}{\partial t} + (\mathbf{u} \cdot \nabla)\mathbf{u} = -\frac{1}{\rho}\nabla p + \mathbf{F} + \frac{\mu}{\rho}\nabla^2 \mathbf{u}, \quad \text{----- Equations of Motion} \quad (2)$$

Numerical model

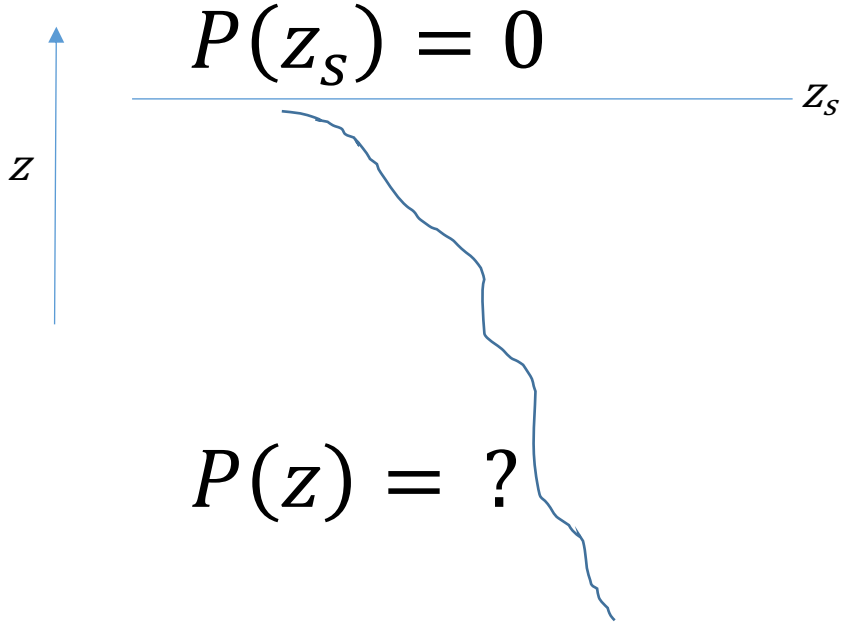
Simulations



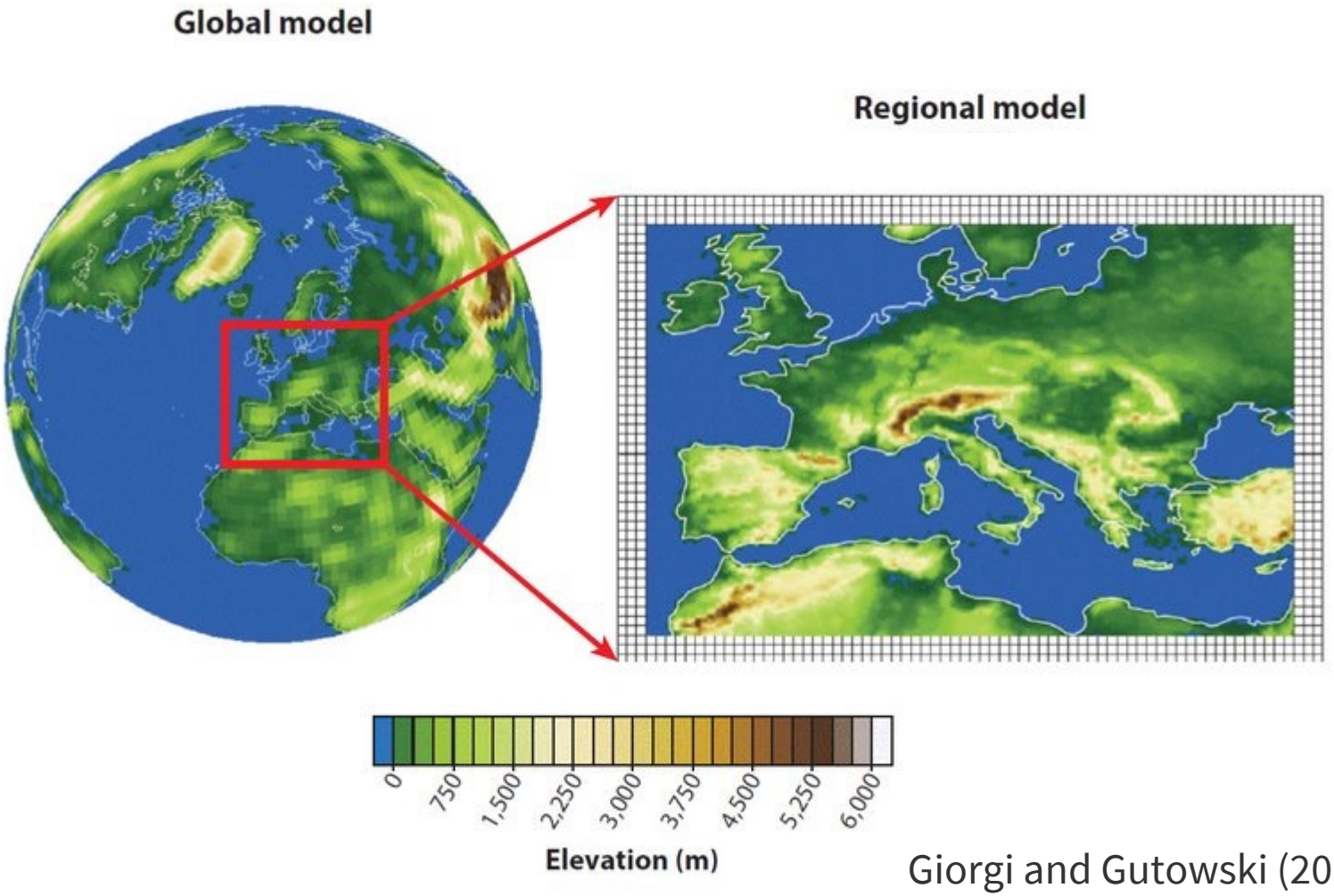
Descritization and numerical integration

- Example: integrating the overburden pressure equation

$$\frac{dP}{dz} = \rho(z)g$$



Regional Climate Models

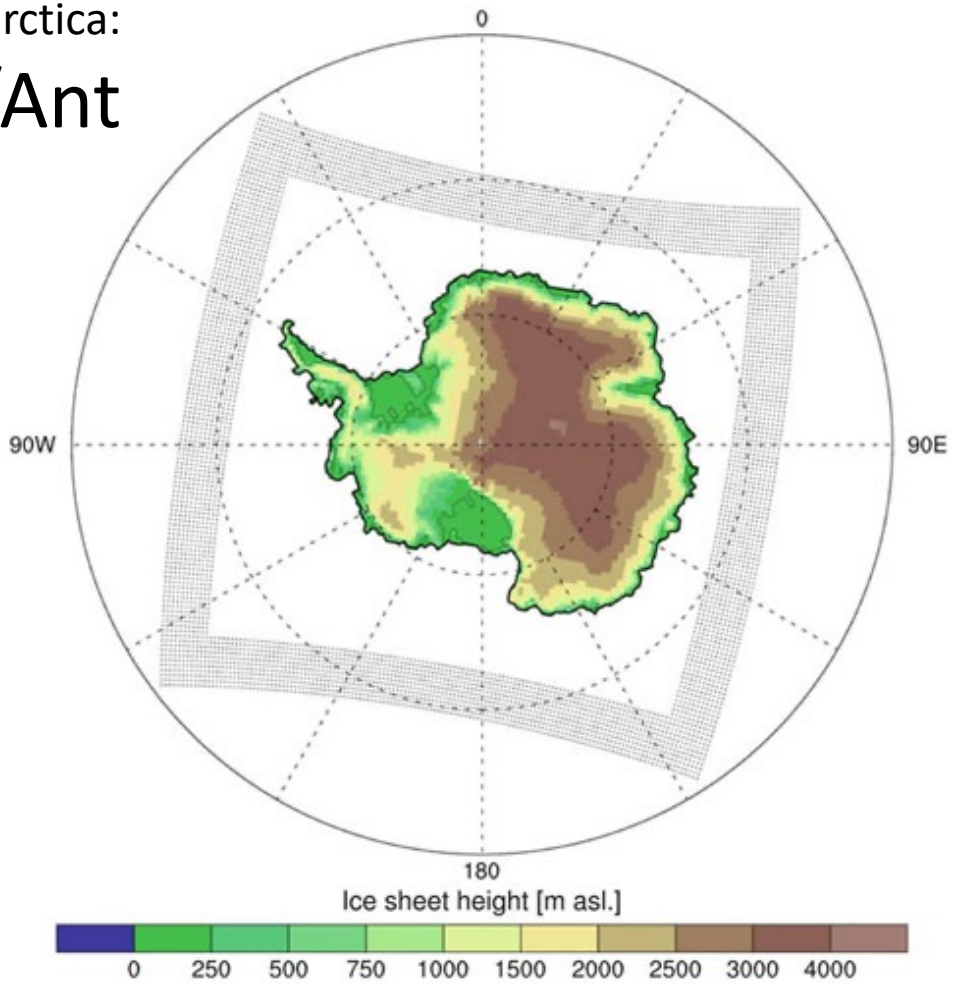


Giorgi and Gutowski (2015)

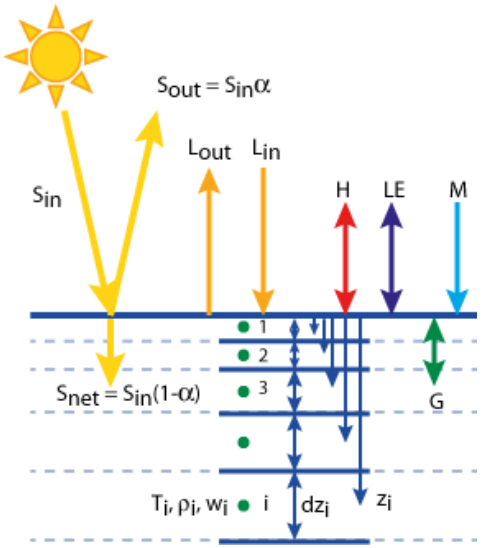
Regional Atmospheric Climate model (RACMO)

Applied to Antarctica:

RACMO/Ant



Includes atmospheric circulation and surface energy balance

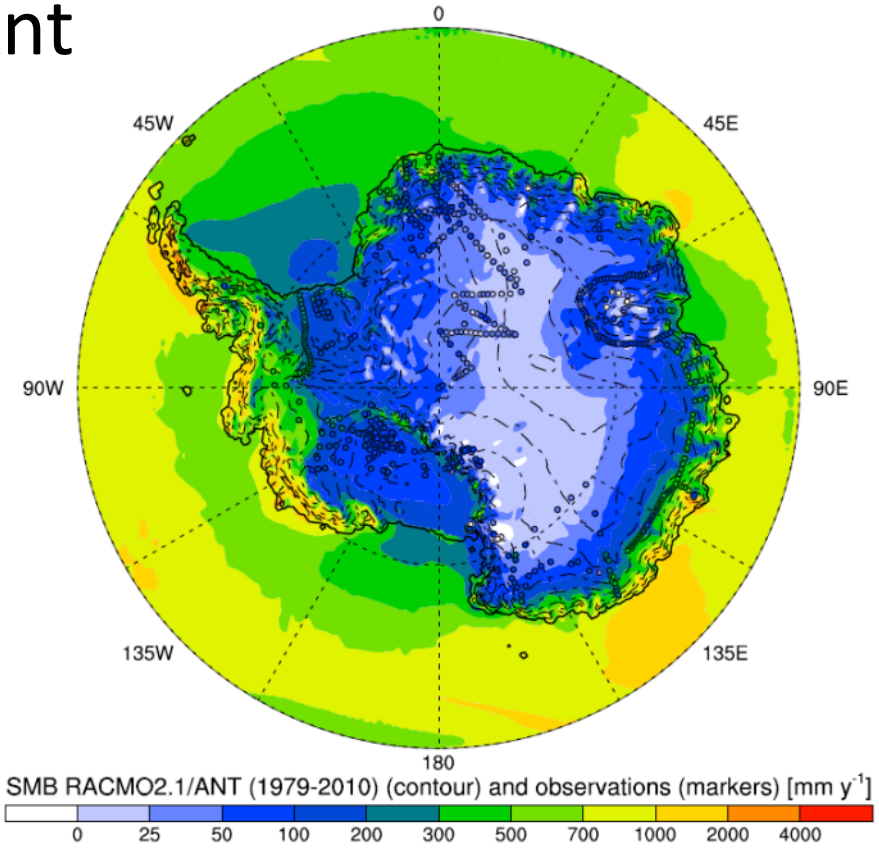


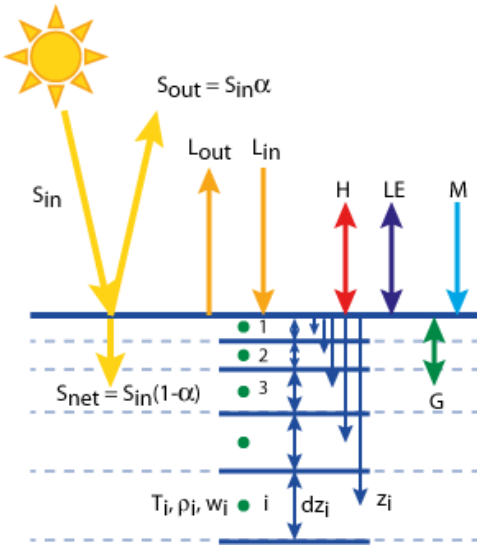
Regional Atmospheric Climate model (RACMO)

Surface mass balance

Applied to Antarctica:

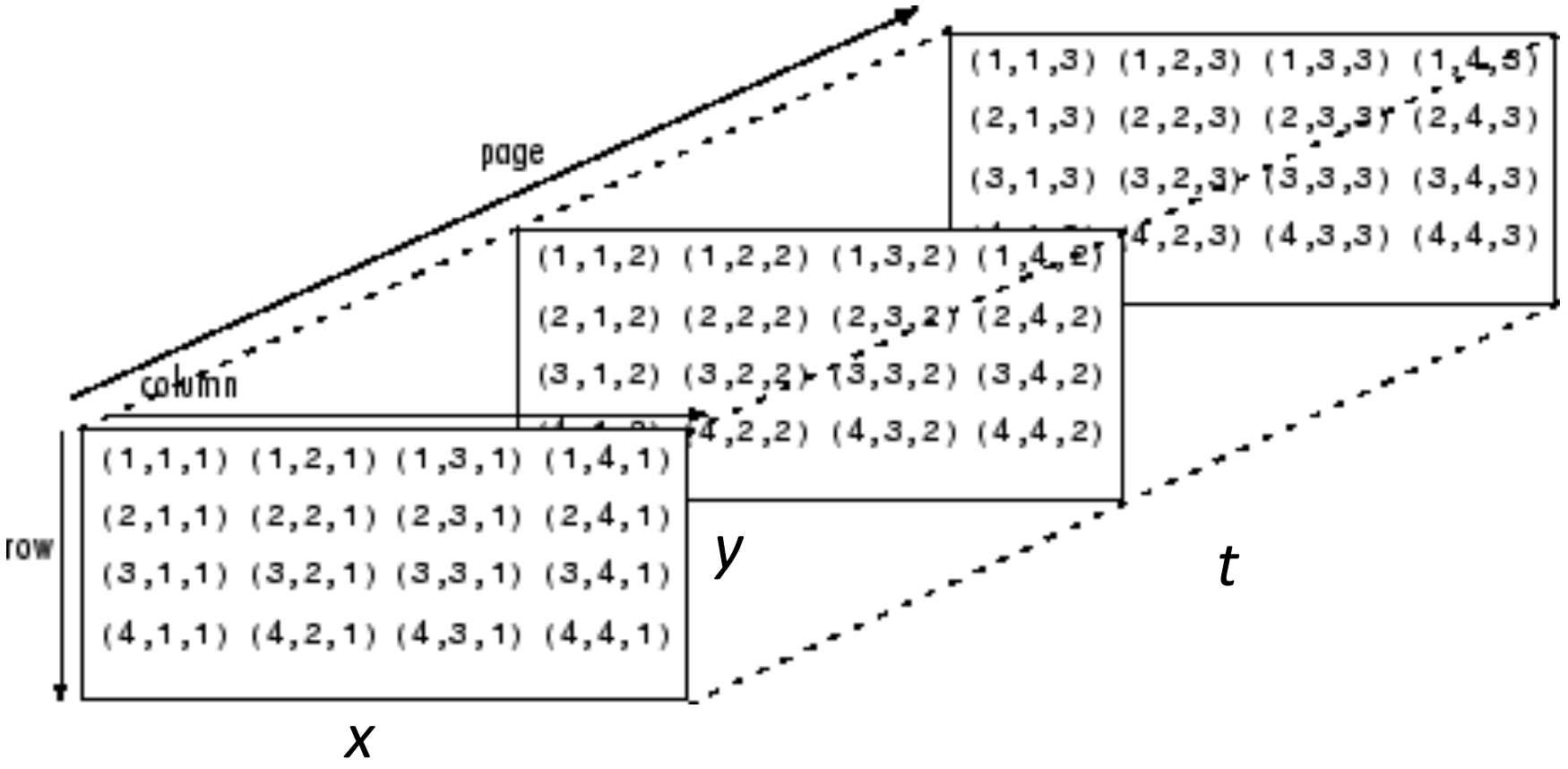
RACMO/Ant





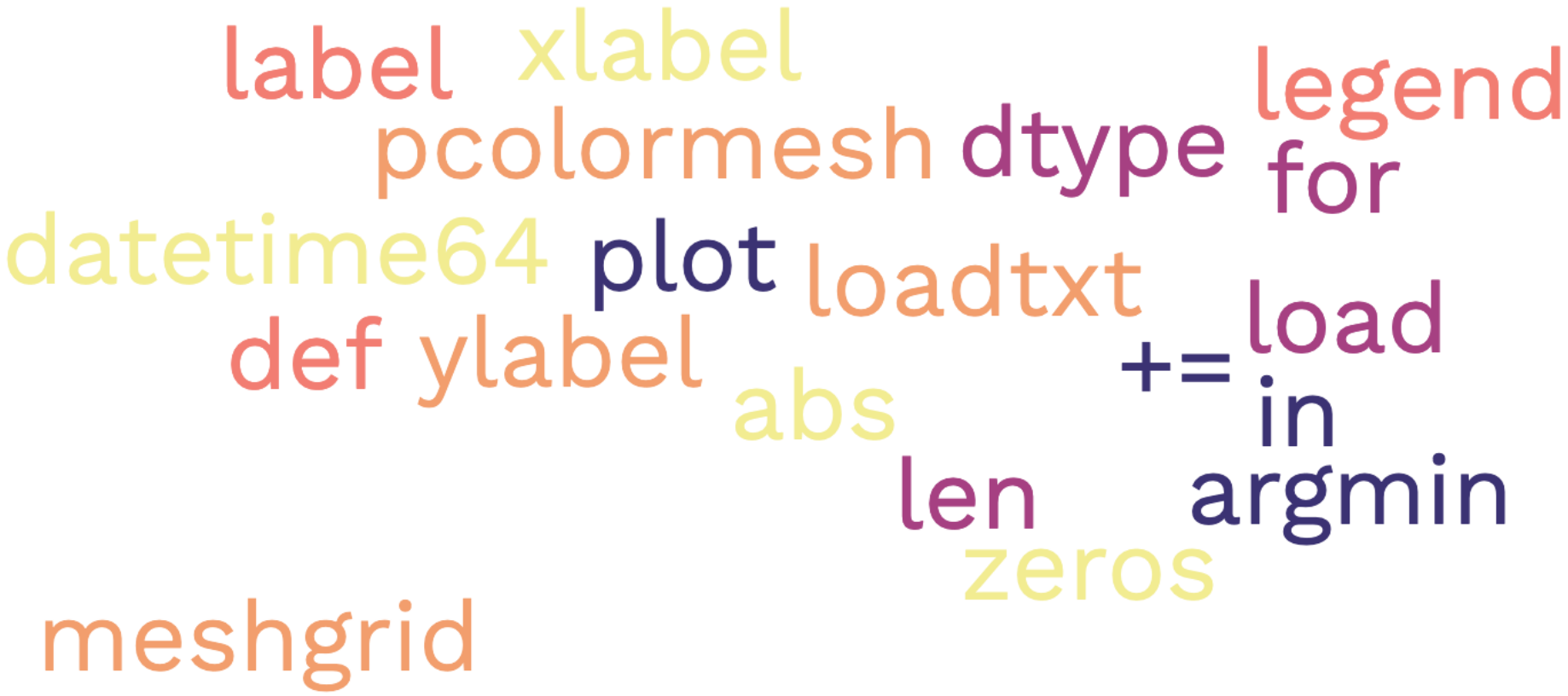
Racmo data

2 spatial dimensions + 1 time dimension



15 minutes

Free exploration of the data



Challenges

(not easy! but try to get to at least number 5.)

1. Extract the 2-m temperature on day 1 of the model output at the site of the West Antarctic Ice Sheet Divide Core (WDC)
   X = -1063200, Y = -431430, Polar stereographic coordinates.
   What date does this correspond to?
2. Plot a time series of 2-m temperature at the WDC.
3. How does 2-m temperature at WDC compare to 2-m temperature at the South Pole Ice Core? (Make a scatter plot).
4. Plot on the same axis (different colors) time series from all the locations contained in the file StationLocations.xls
   - These are the locations of a few Norwegian, New Zealand and US Antarctic bases
   - Obviously you don't want to have to enter all the coordinates by hand!
5. Plot a map of surface mass balance on 18th May 1991 of the model output (what happened on this date?).
6. Plot side-by-side maps of the mean surface temperature and the mean SMB as functions of space.
7. Does mean SMB correlate with mean 2-m temperature?
8. Create a gif animation of air temperature as it varies with time.

Assignment, due Feb 21st :

- Complete up to number 5.
- Write a notebook that will load the data, do all the calculation and produce clearly labelled figures.
- The figures produced should have labelled axes with units, and meaningful titles.
- Add an abstract:
  What is an RCM? What does it do?
  What data have we looked at from what RCM?
  Broadly, what have we done with these data?
- Name you notebook P2_yourname.ipynb and email it to me.