Snow cover heterogeneity and its impact on the Climate and Carbon cycle of Arctic regions (SnowC²)

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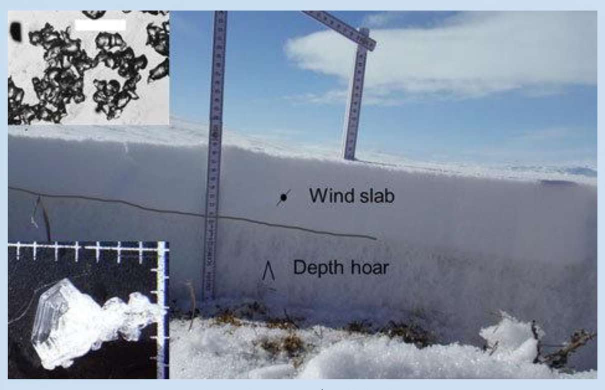
Problematic

- The Arctic has warmed 2 to 3 times faster than the global average (e.g., Cohen et al., 2014) ; nearly four times faster than the globe since 1979 (Rantanen et al., 2022)
- Impacts on ecosystems and human activities such as transportation, resource extraction, water supply, landuse and infrastructure among others.
- Current snow models fail to capture essential aspects of Arctic snowpacks (depth hoar + wind slab + spatial heterogeneity).



Domine et al., (2019)

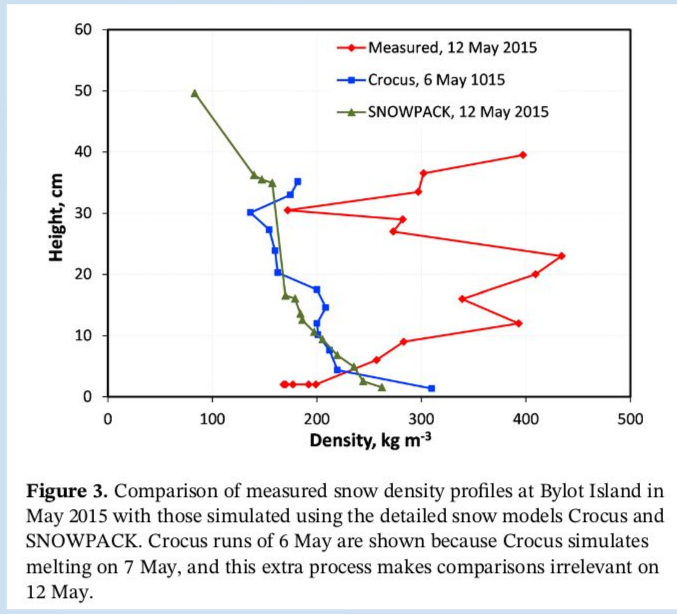


Figure 3. Comparison of measured snow density profiles at Bylot Island in May 2015 with those simulated using the detailed snow models Crocus and SNOWPACK. Crocus runs of 6 May are shown because Crocus simulates melting on 7 May, and this extra process makes comparisons irrelevant on 12 May.

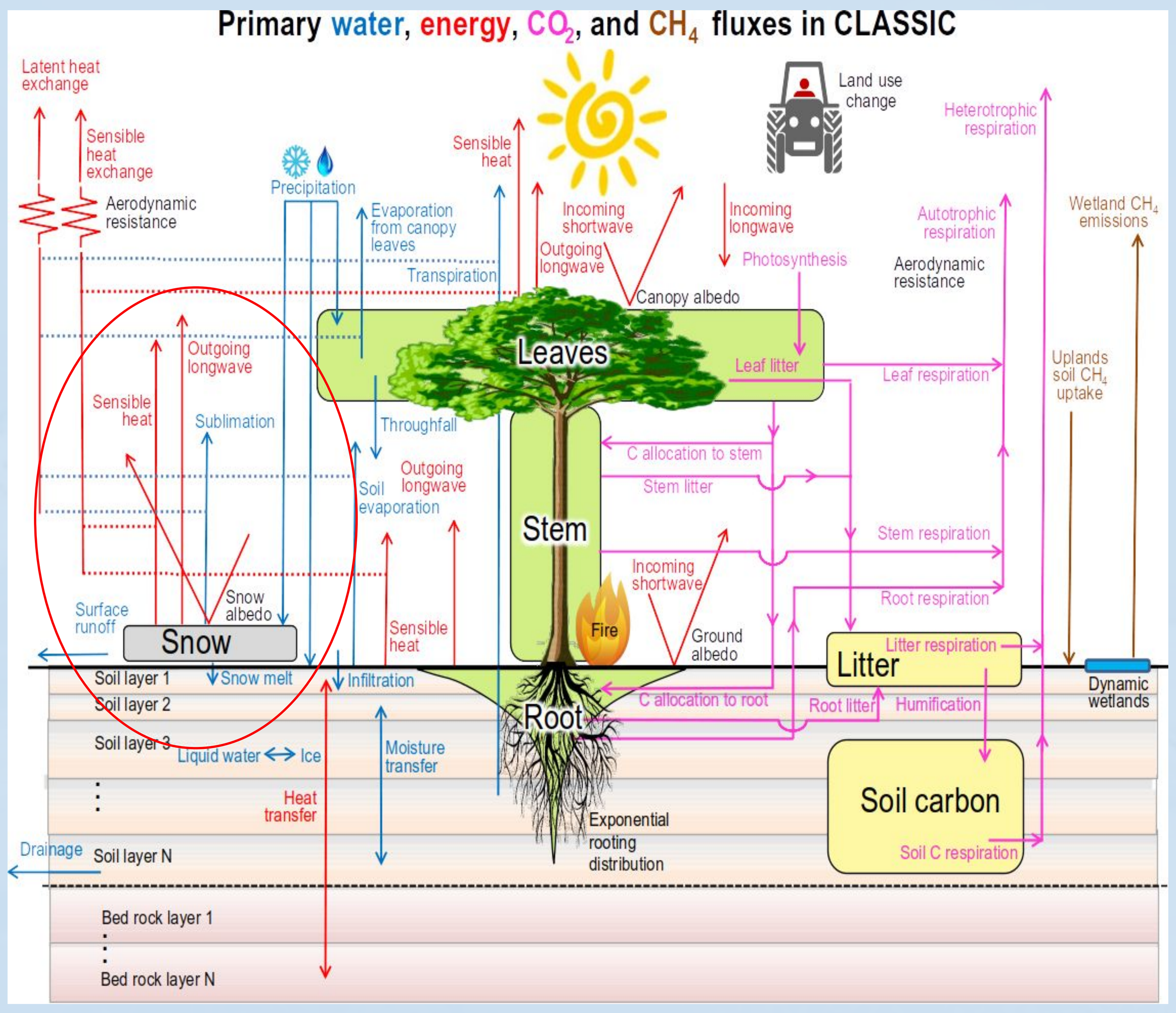
Domine et al., (2018)

Objectives

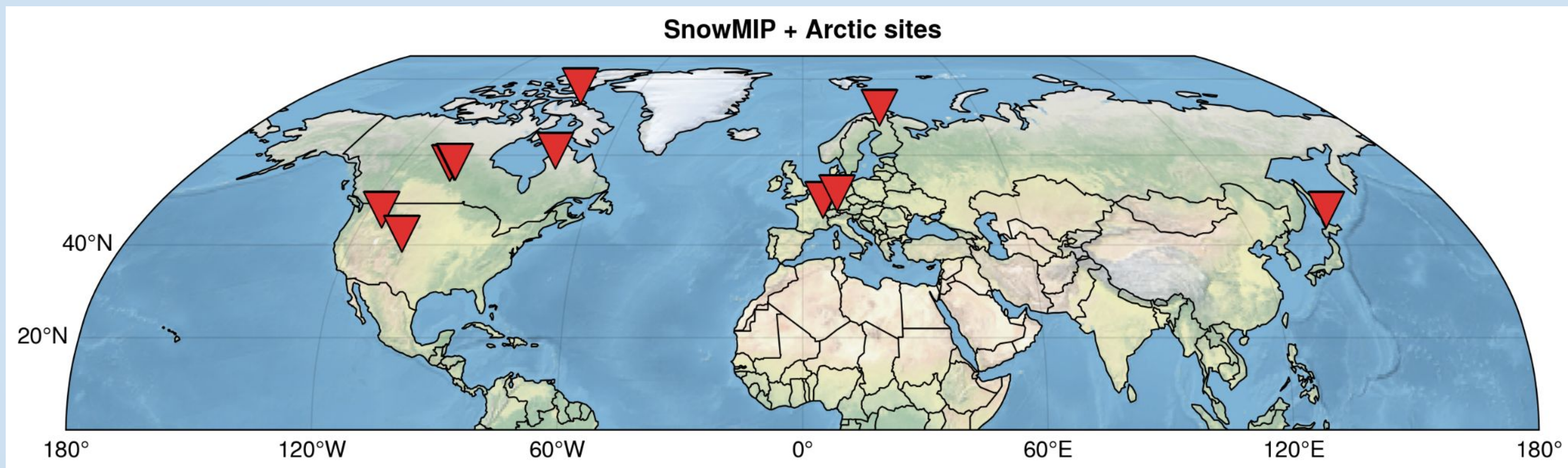
1. Implement a multilayer snowpack in the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC) adapted to the Arctic (in 1D simulations)
2. Include new snow cover fraction parameterizations + multilayer snowpack in spatial Arctic simulations → use of ESA CCI data (snow, land type, etc.) to calibrate and assess these new developments
3. Improved Arctic simulations with new snowpack (snow, energy/carbon fluxes, etc.)

Methods

Schematic illustration of processes simulated by CLASSIC



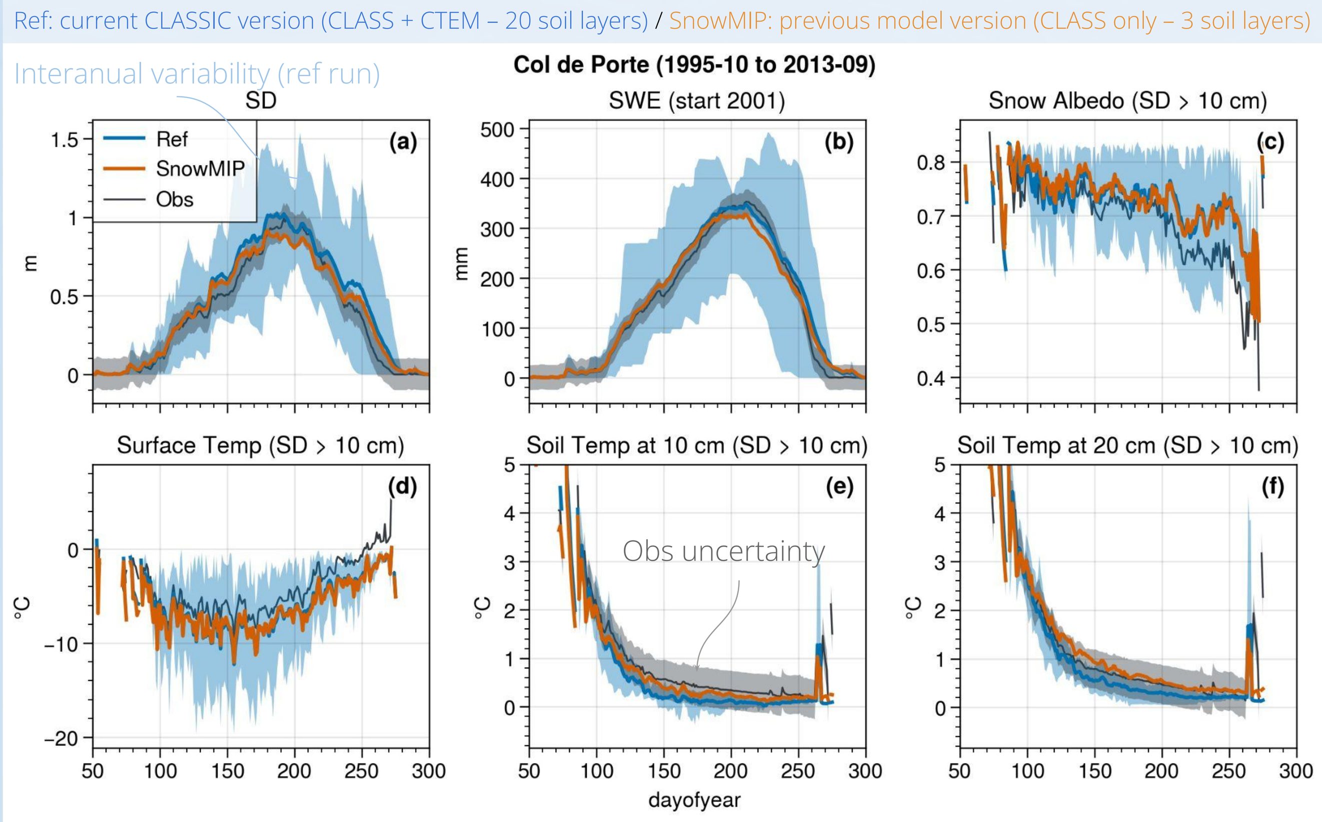
Melton et al. (2020)



1. Use SnowMIP + Arctic sites (Bylot, Umiujaq,...) to assess/develop the multilayer snowpack (e.g., ORCHIDEE, ISBA-ESA, etc.)
2. Arctic adaptation → e.g., Royer et al. (2021): Arctic Crocus (increase the compaction due to the wind + reduce the density of the lower layers)
3. Snow cover fraction param → e.g., Lalande et al. (2023) + ESA CCI data

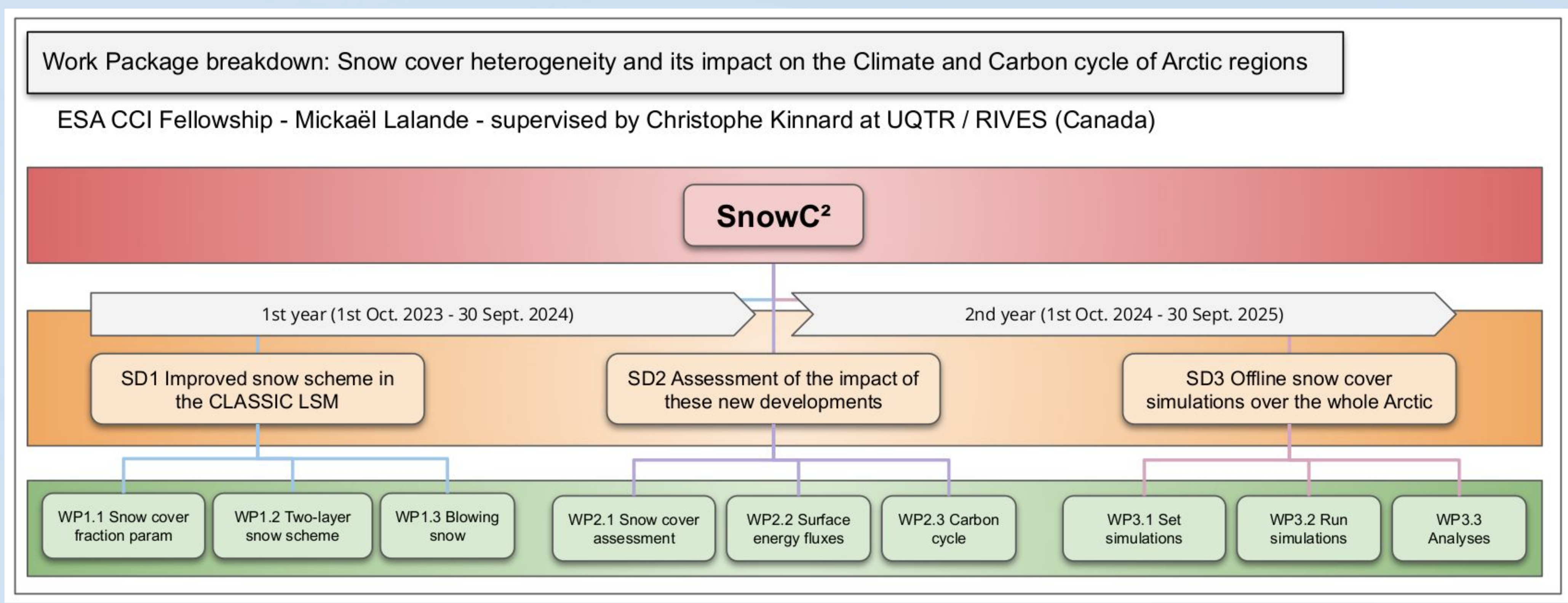
E.g. model skill (alpine site)

Ref: current CLASSIC version (CLASS + CTEM – 20 soil layers) / SnowMIP: previous model version (CLASS only – 3 soil layers)



*CLASS: Canadian Land Surface Scheme (physics) / CTEM: Canadian Terrestrial Ecosystem Model (biogeochemistry)

Project work plan



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