#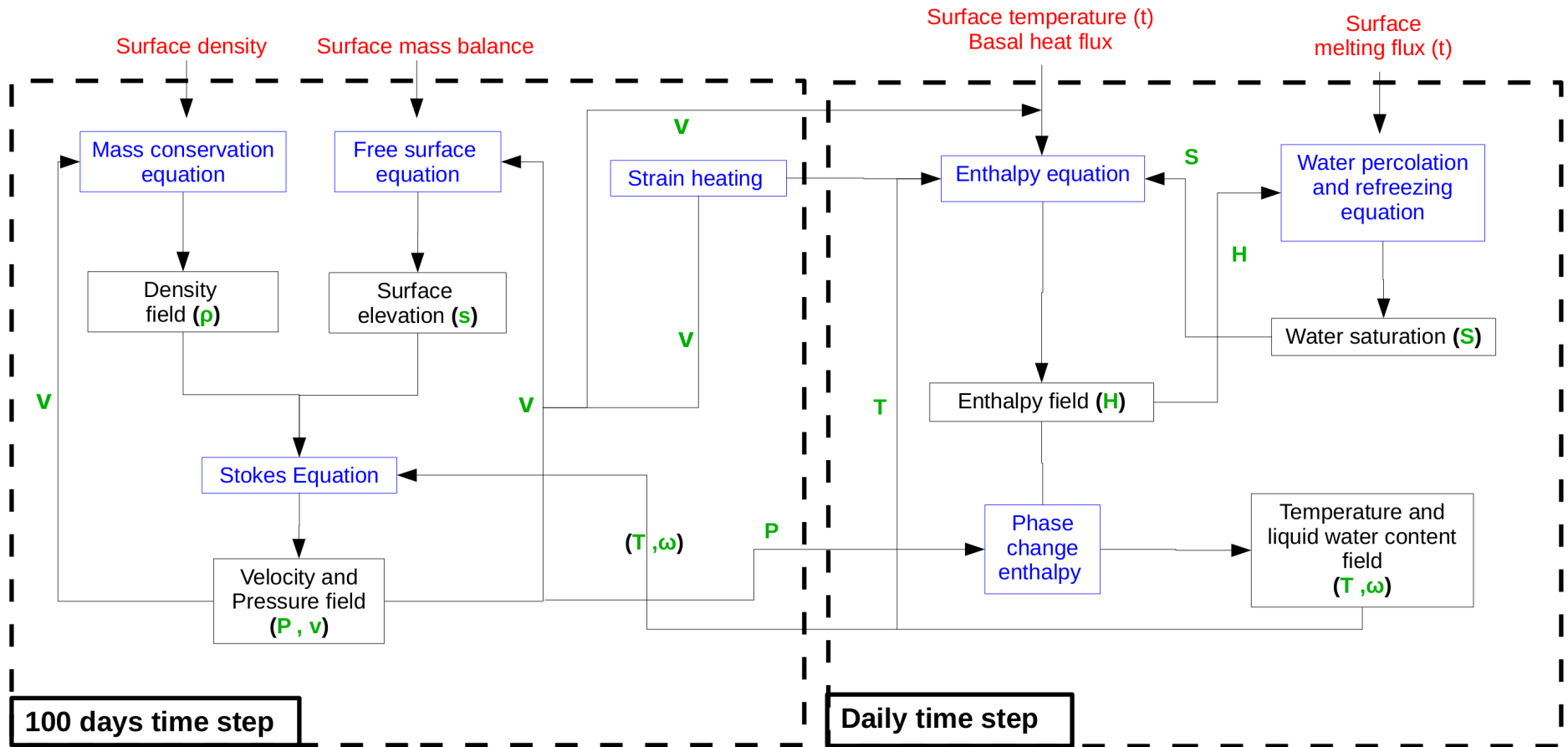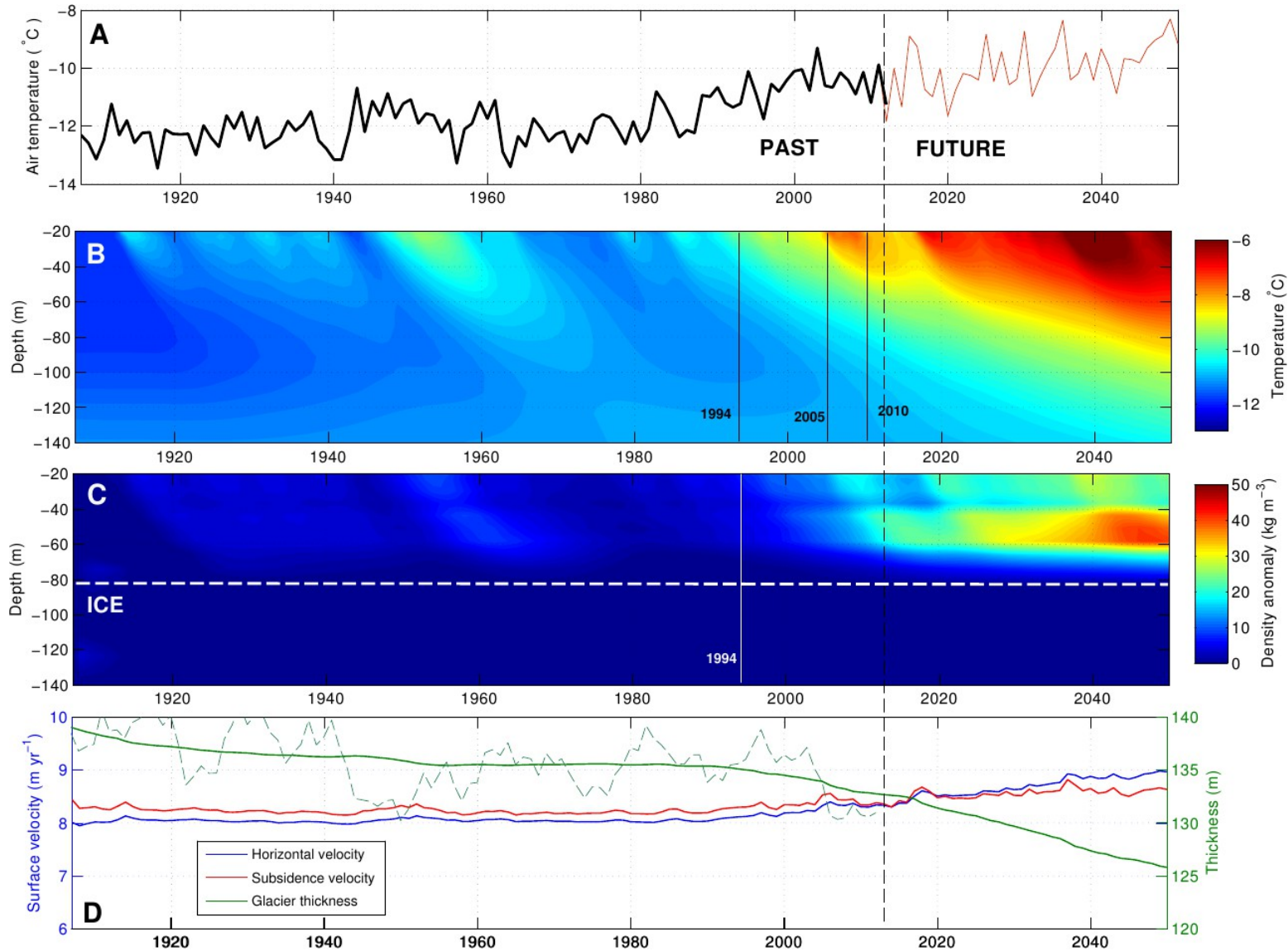 Solving the thermo-mechanical coupled problem in cold accumulation zone: modeling full thermo-mechanical response to climate change

Surface density

Surface mass balance

Surface temperature (t)
Basal heat flux

Surface melting flux (t)

100 days time step

Mass conservation equation

Free surface equation

V

Strain heating

V

Density field (ρ)

Surface elevation (s)

V

V

Stokes Equation

Velocity and Pressure field (P , v)

(T ,ω)

P

Daily time step

Enthalpy equation

S

Water percolation and refreezing equation

H

Enthalpy field (H)

Water saturation (S)

T

Phase change enthalpy

Temperature and liquid water content field (T ,ω)

Variable evolution which are solved in transient simulation :

- Density
- Velocity field
- Free surface elevation

- Enthalpy field
- Water percolation and refreezing

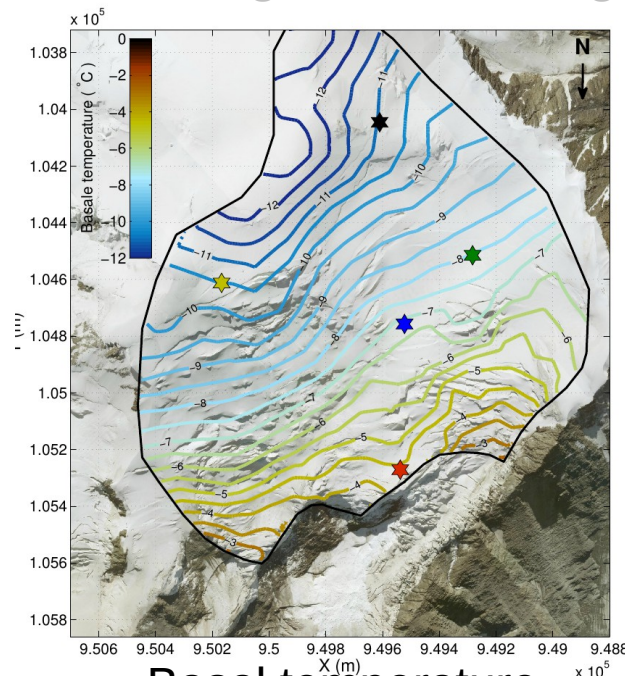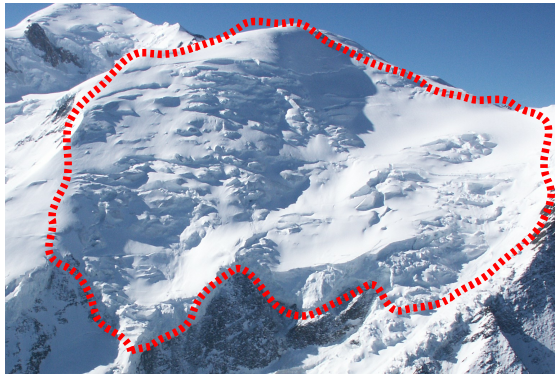# Example 1 : Modeling Col du Dôme thermo-mechanical response to climate change
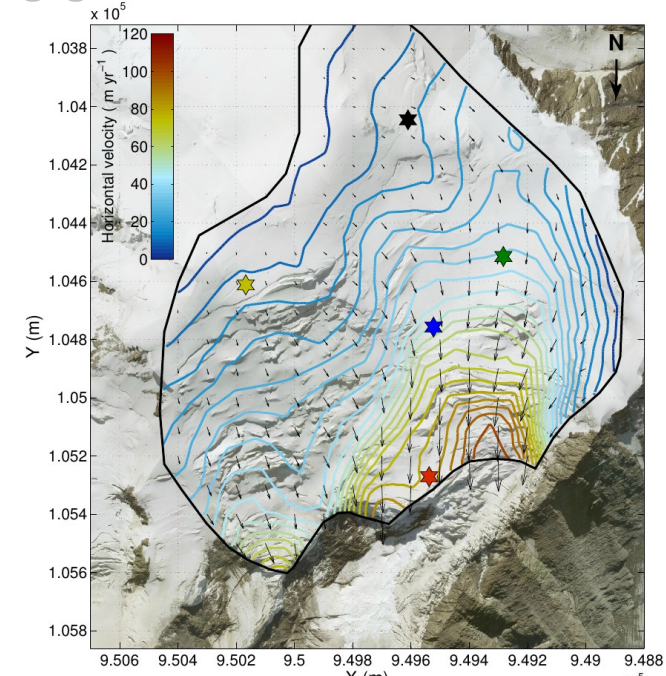

Air temperature

Englacial temperature

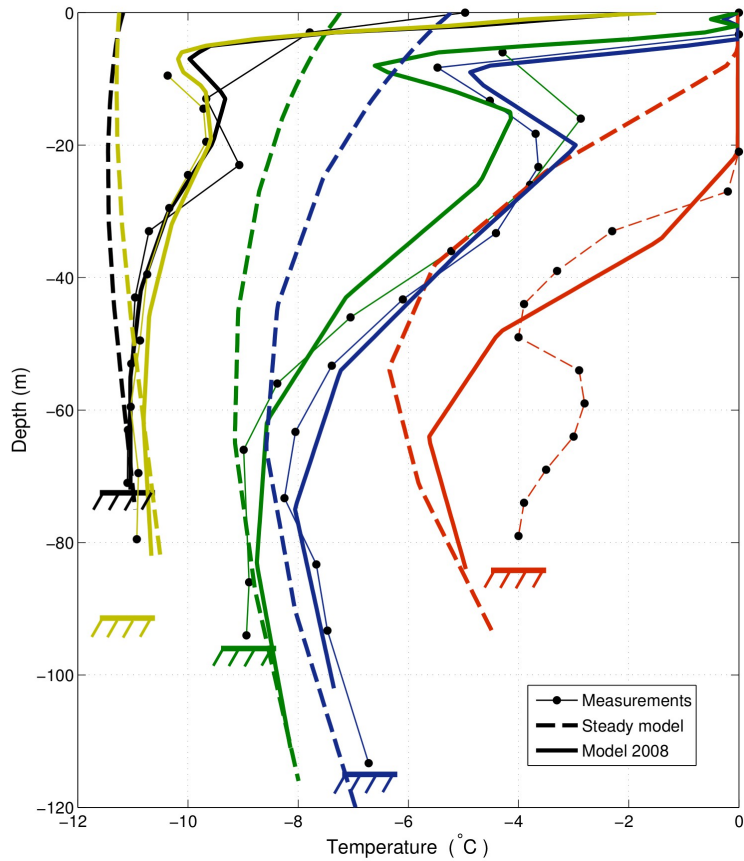Density anomaly

Surface elevation and velocity

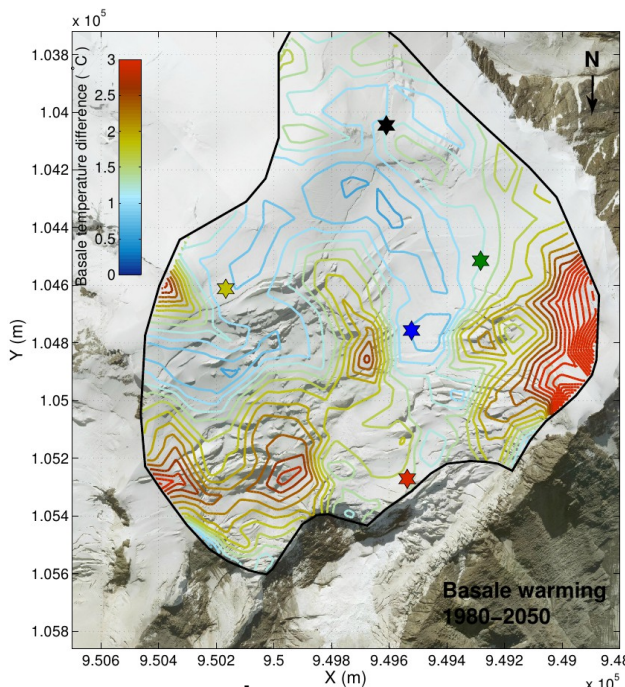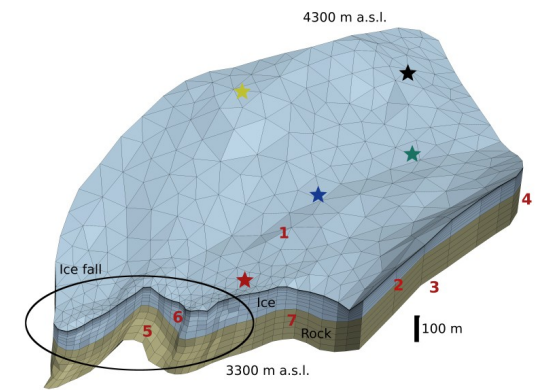# Example 2 : Investigate temperature change on cold hanging glacier

Basal temperature

Velocity field

Comparison with measurement

Basal temperature
warming 1980-2050

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