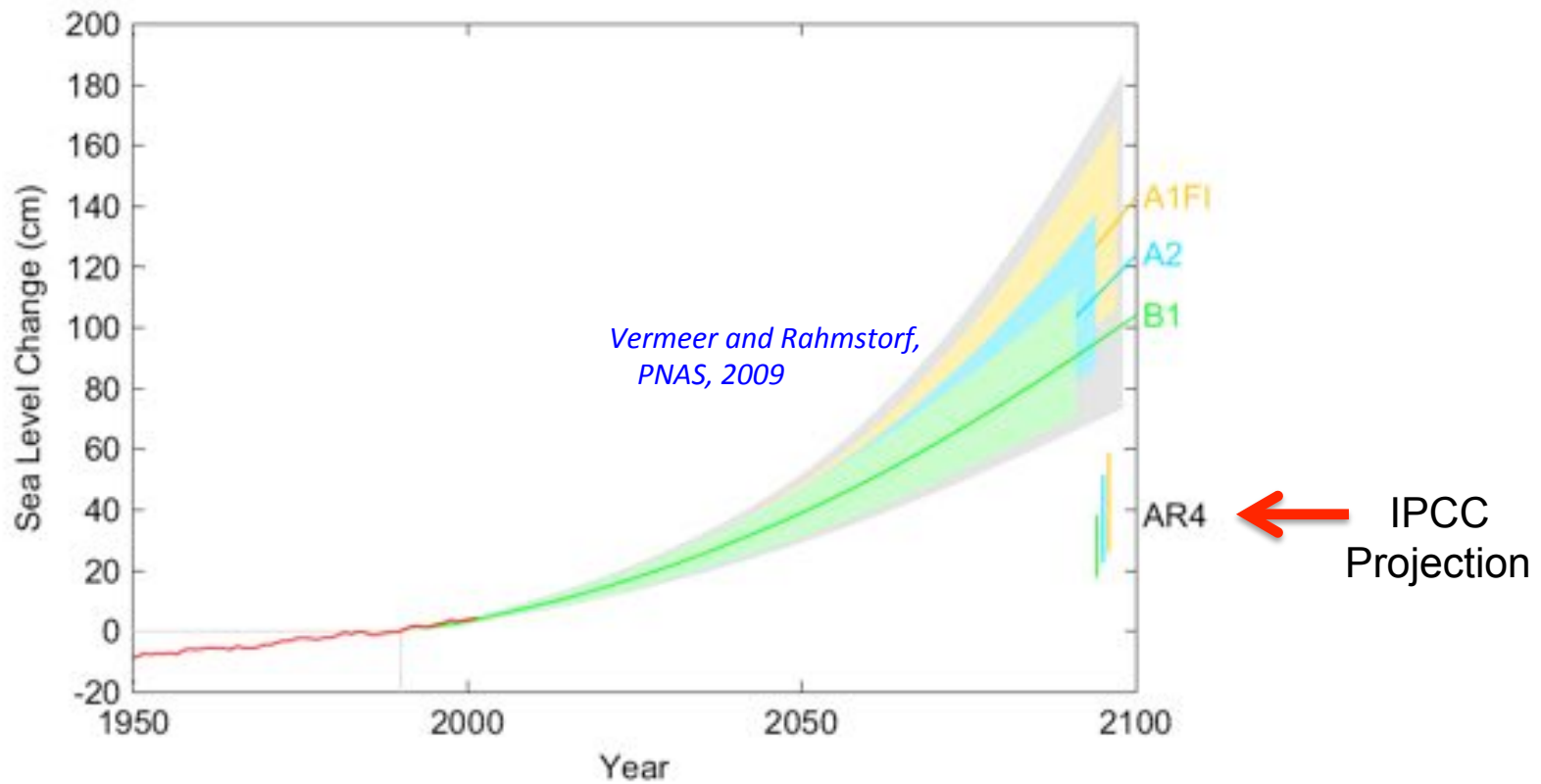


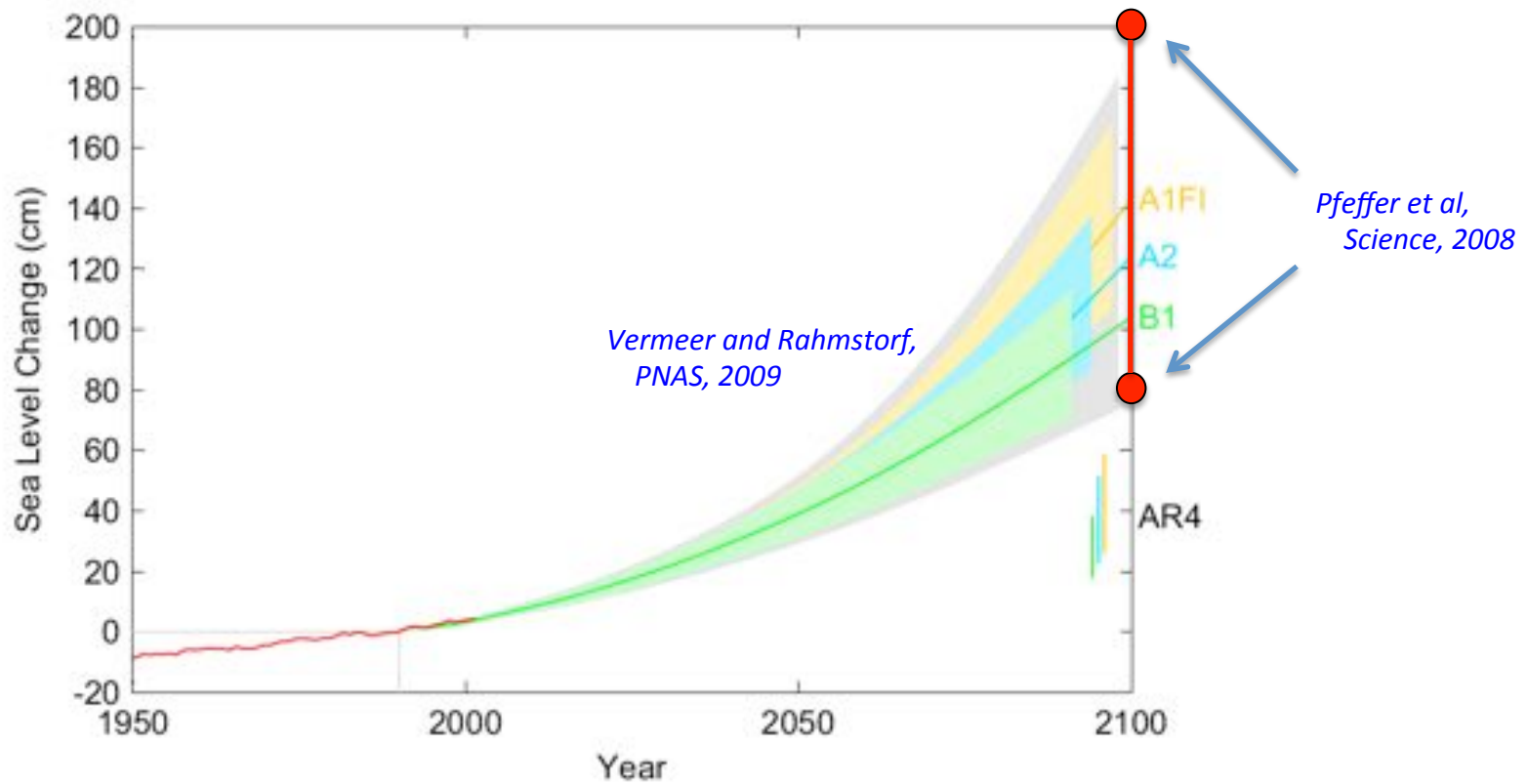
Temperature, Heat Flow, and Borehole Arrays

IDPO Drilling Science Community Planning Workshop

How Much will Sea-Level Rise by 2050, 2100, ... ?



How Much will Sea-Level Rise by 2050, 2100, ... ?



Dynamical Ice Sheet Models, *a few of the Uncertainties*

- **Missing Physics**

- ice streams, etc.

- **Initial Conditions**

- 3D temperature field

- basal temperatures (melting point?)

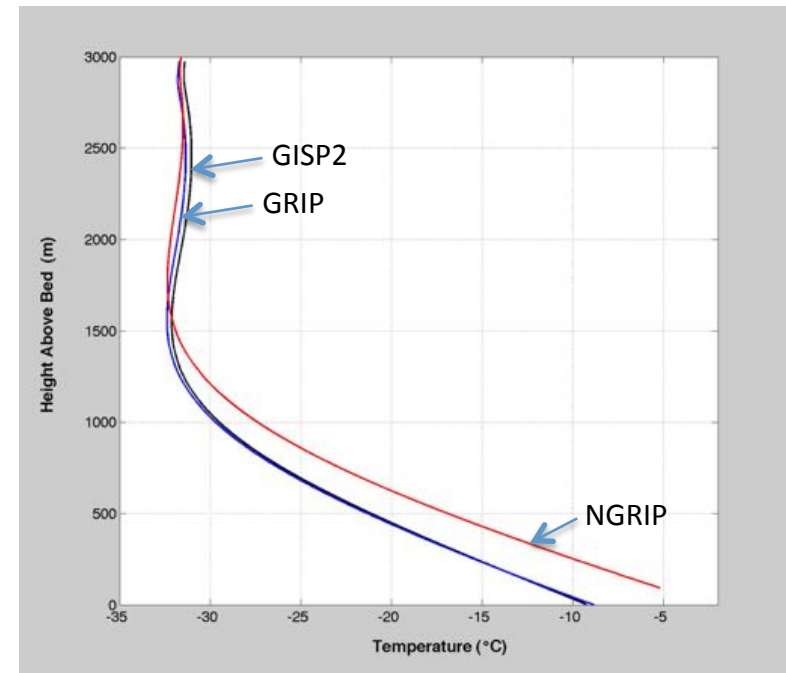
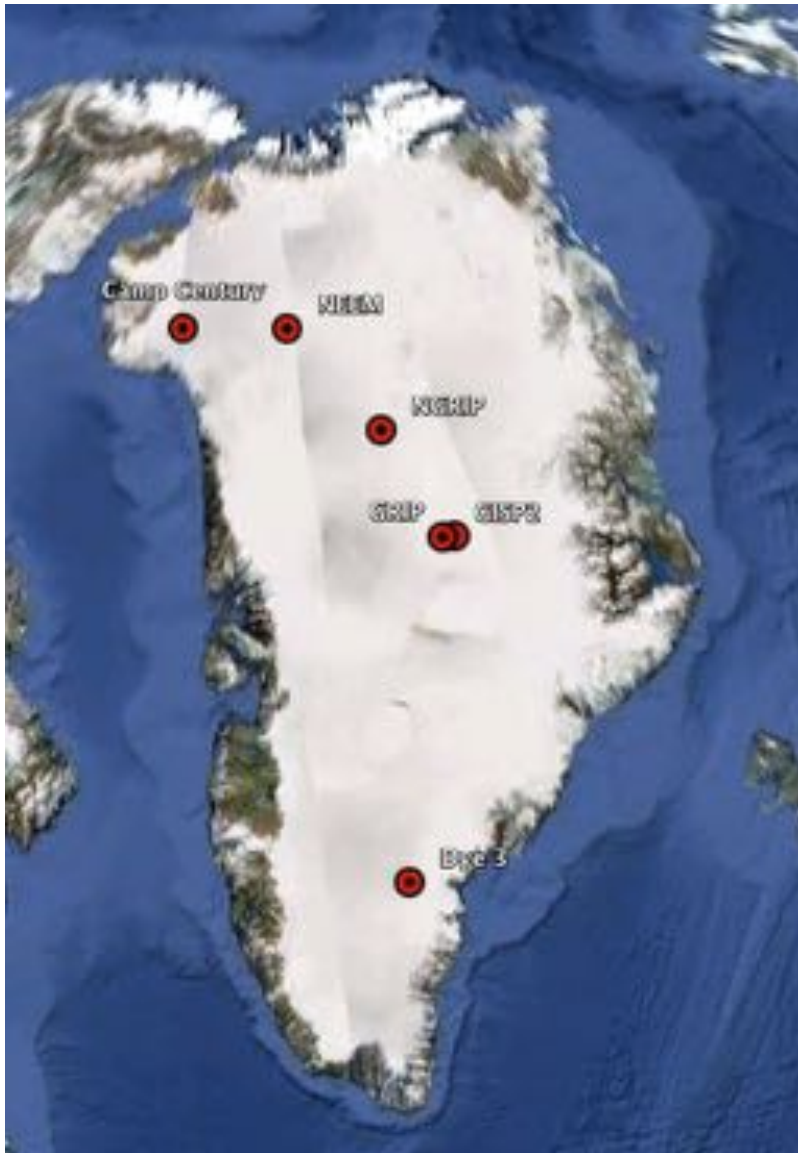
- (NGRIP, WAIS-D)*

- **Boundary Conditions**

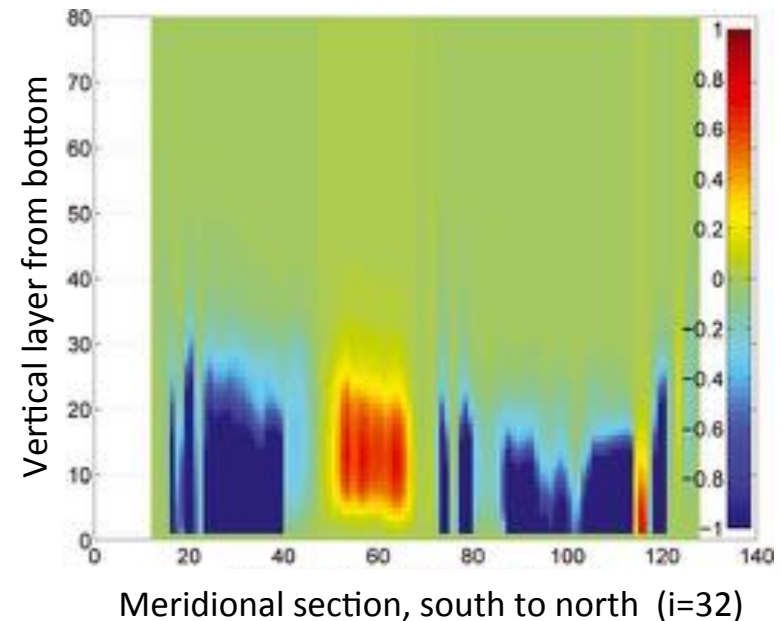
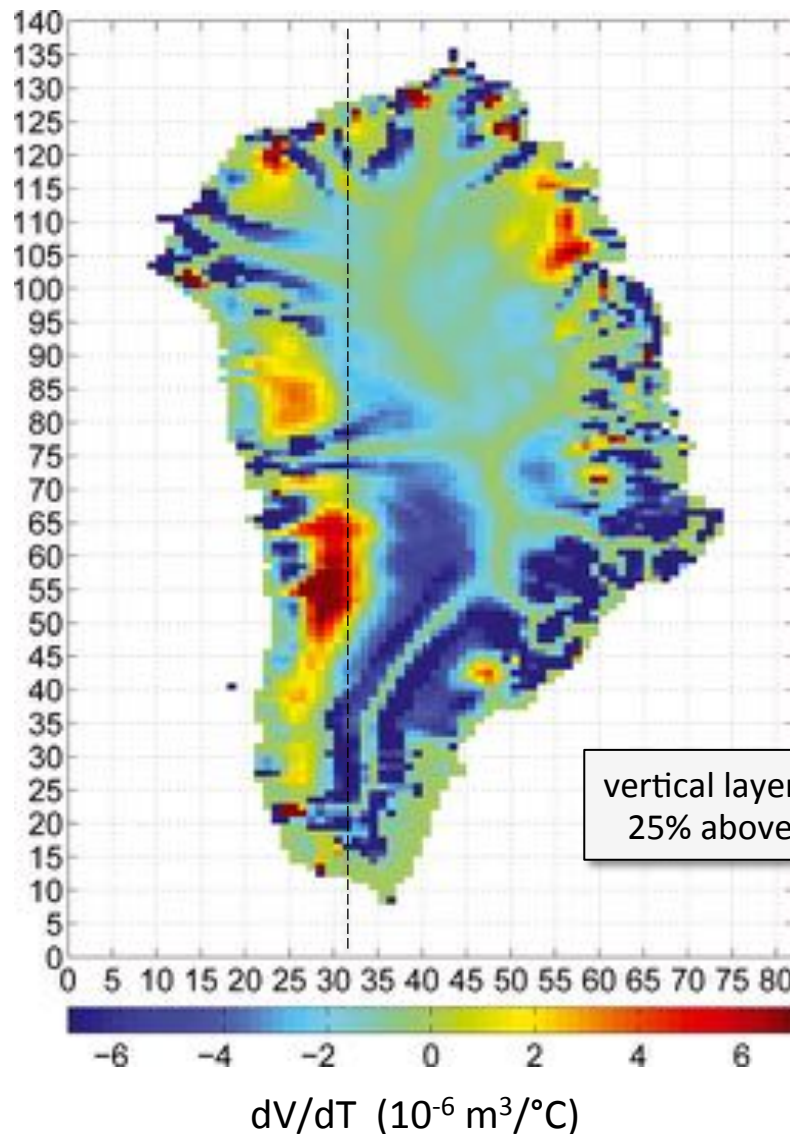
- geothermal heat flow



Initial Conditions: Sites with Temperature Measurements through the Greenland Ice Sheet

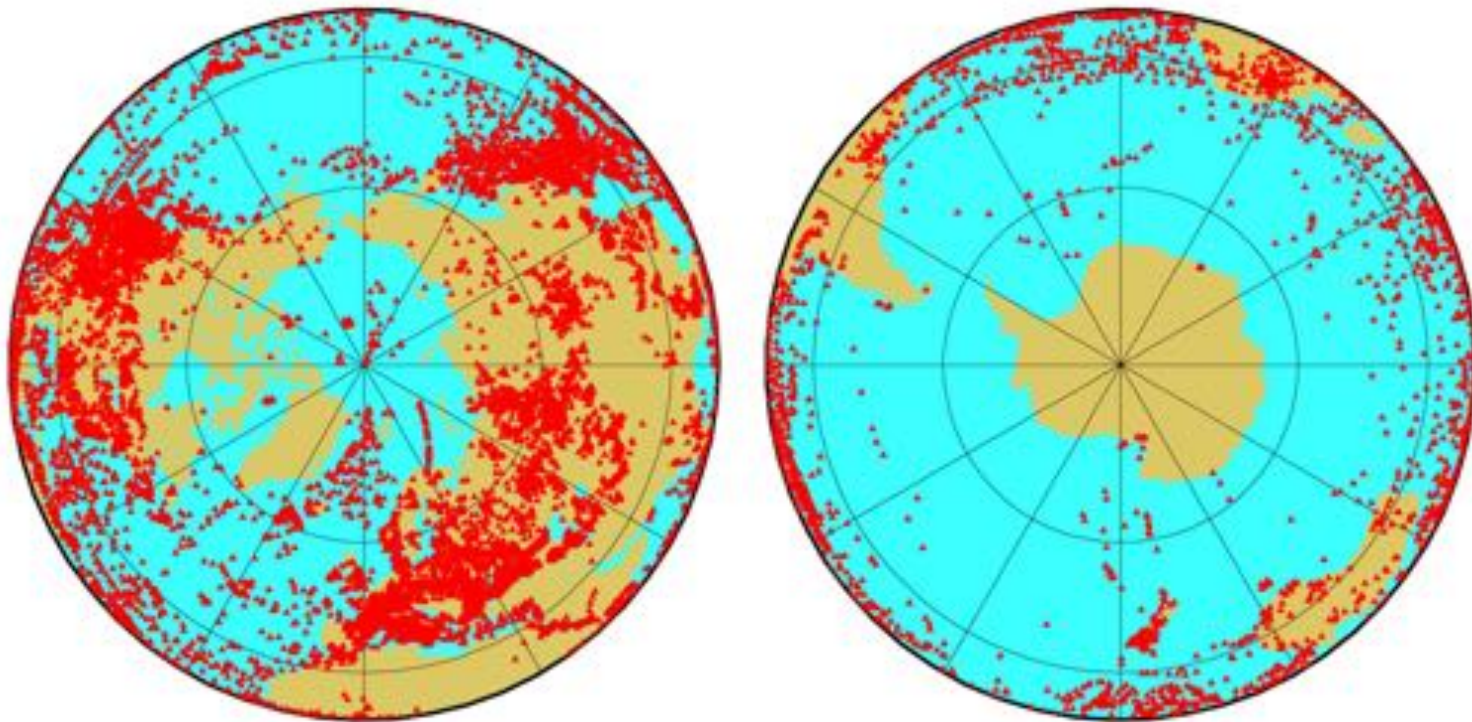


Initial Conditions: Sensitivity of Greenland Ice Sheet Volume to Internal Temperature



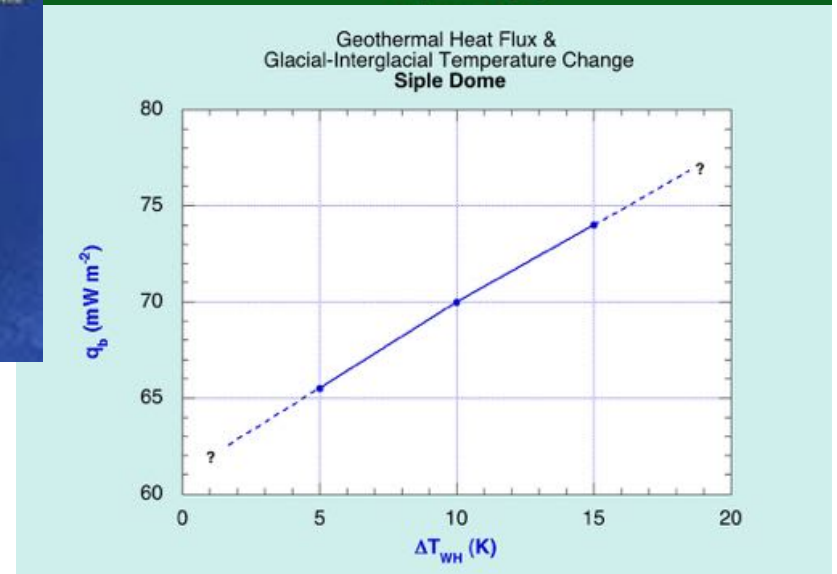
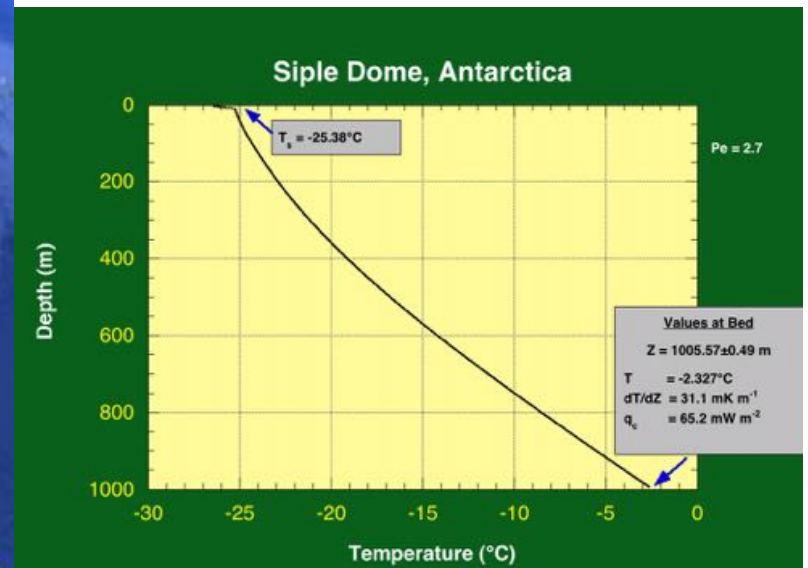
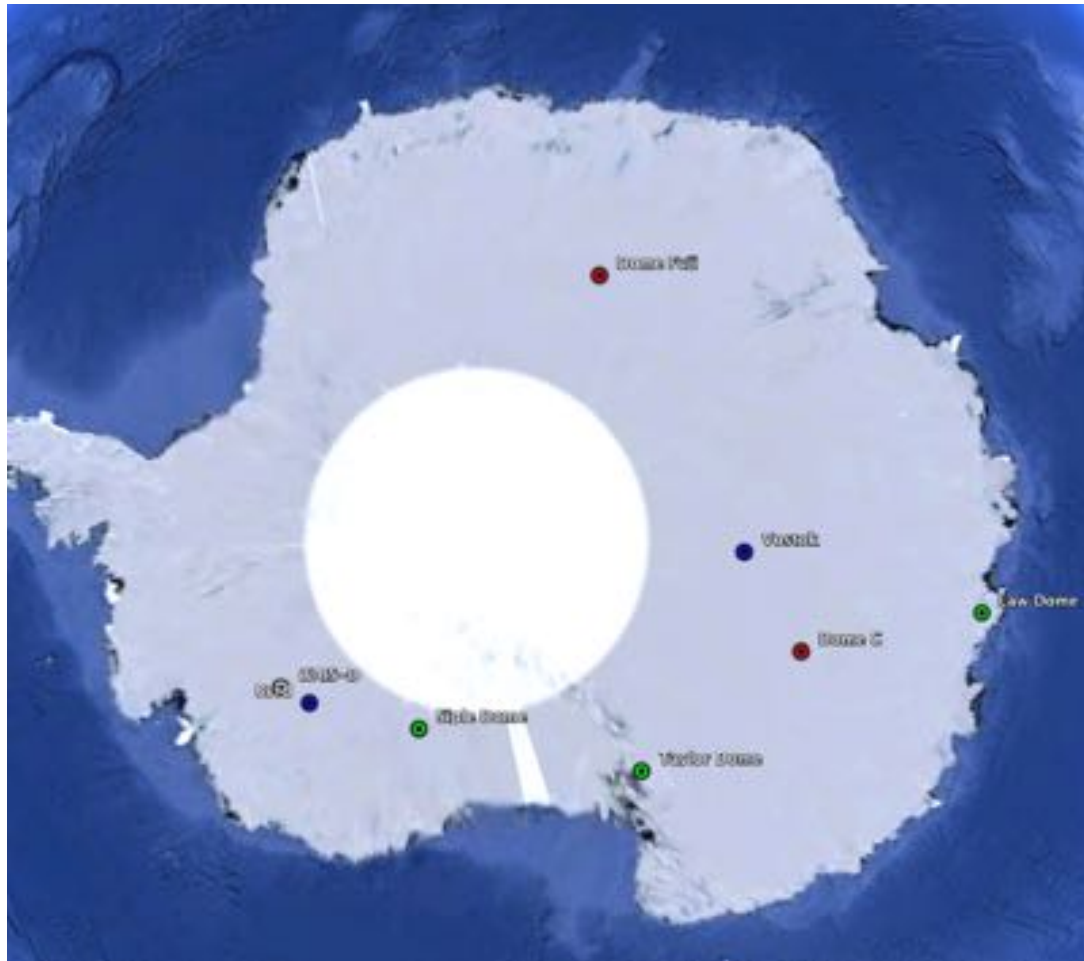
Boundary Conditions: **Geothermal Heat Flow**

- Provides important information about the **structure and dynamics of the earth's crust and upper mantle**.
- Influences the **rate of melting at the base of the ice sheets**, and of **sub-ice hydrology**, which affects **ice dynamics**.

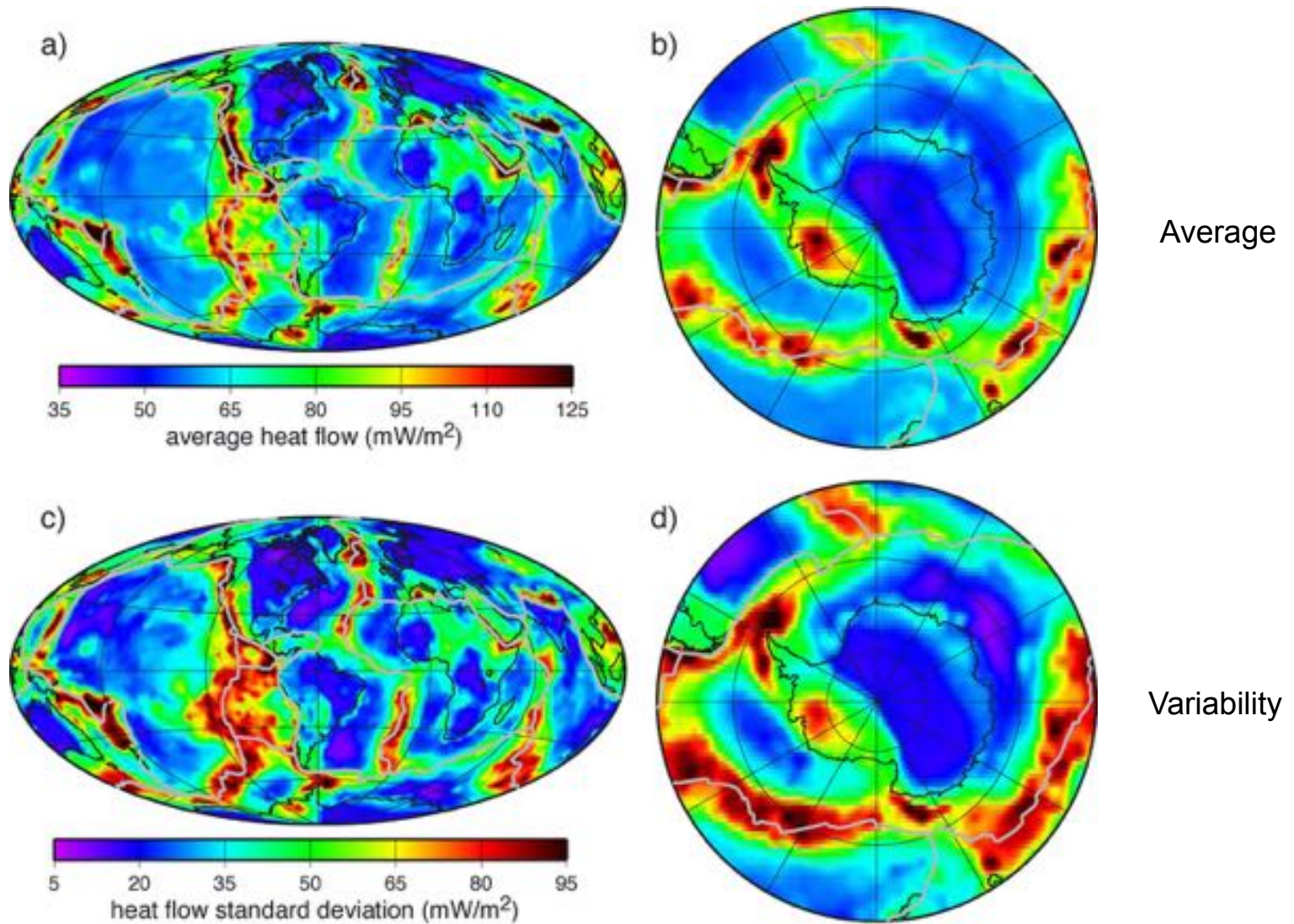


Global Heat Flow Database, IHFC

Sites with Temperature Measurements through the Antarctic Ice Sheet

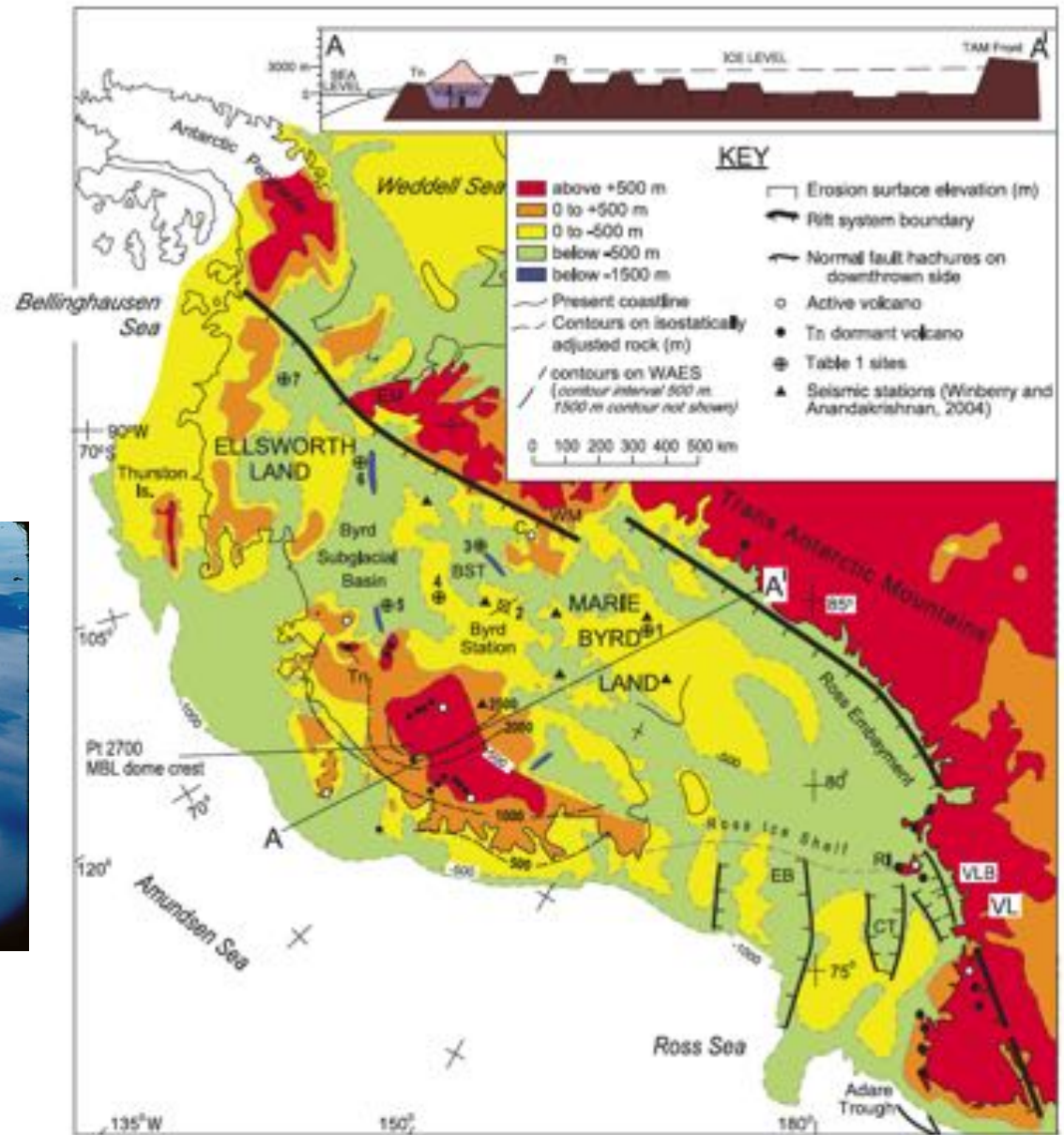
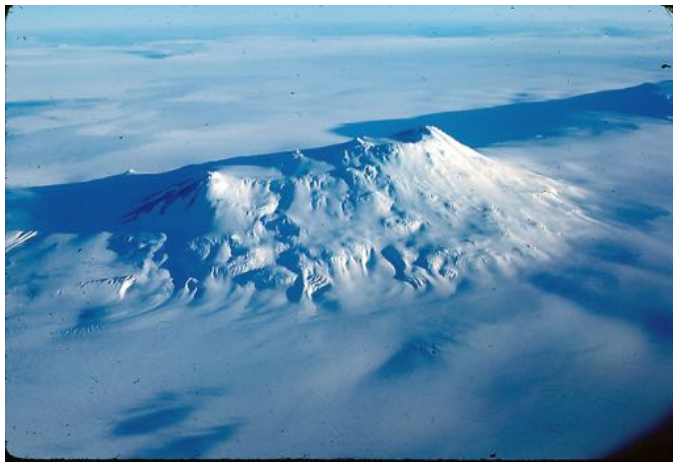


Geothermal Heat Flow inferred from Seismic Velocities





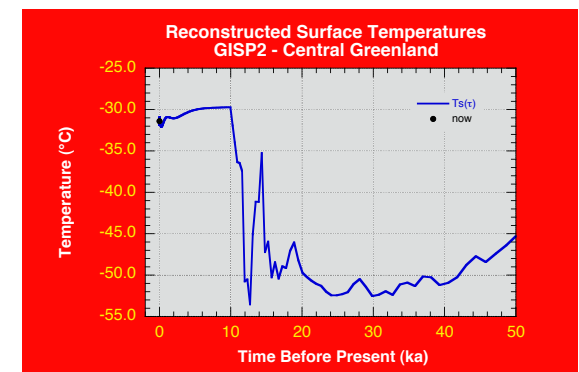
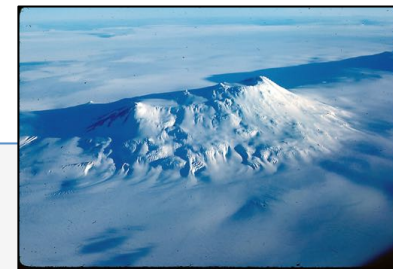
Boundary Conditions: West Antarctic Rift System



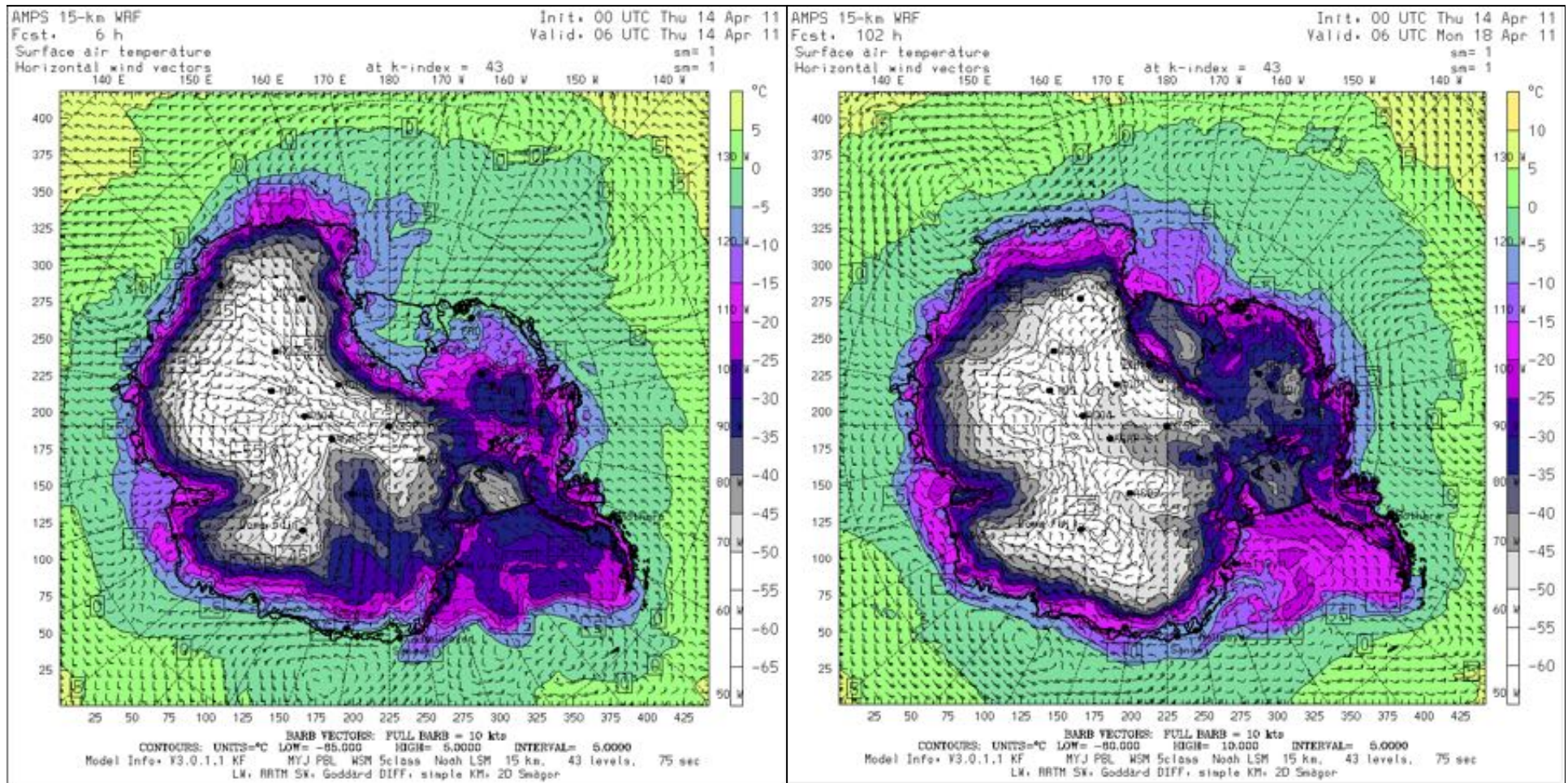
Science Questions for the Next Decade:



- How much will sea-level rise by 2050, 2100, ...?
(need: reduce uncertainties in the model projections)
 - What is the present 3D temperature distribution in the ice sheets?
 - Where are the ice sheets presently frozen to the bed?
 - What is the geothermal heat flux beneath the ice sheets?
- To what extent is the **West Antarctic Rift System** still active?
- What are the dynamics of the **upper mantle**, and distribution of radioactive isotopes in the **earth's crust** beneath the ice sheets?
- What is the **sensitivity of the polar regions to changes in external forcings** in the climate system?
 - magnitude of past surface temperature changes



Climate System: Surface Temperature Distribution



Drill Requirements:

- Produce **minimal thermal disturbance**.
- Capable of **drilling to the bed** of the ice sheets.
- To drill a large array of holes, it must:
 - be capable of a **rapid drilling rate**
 - be **portable**.
- Optimally, the holes would be **small diameter**.

