



National Snow and Ice Data Center
Supporting Cryospheric Research Since 1976

Configuration Uncertainty in Permafrost Modeling

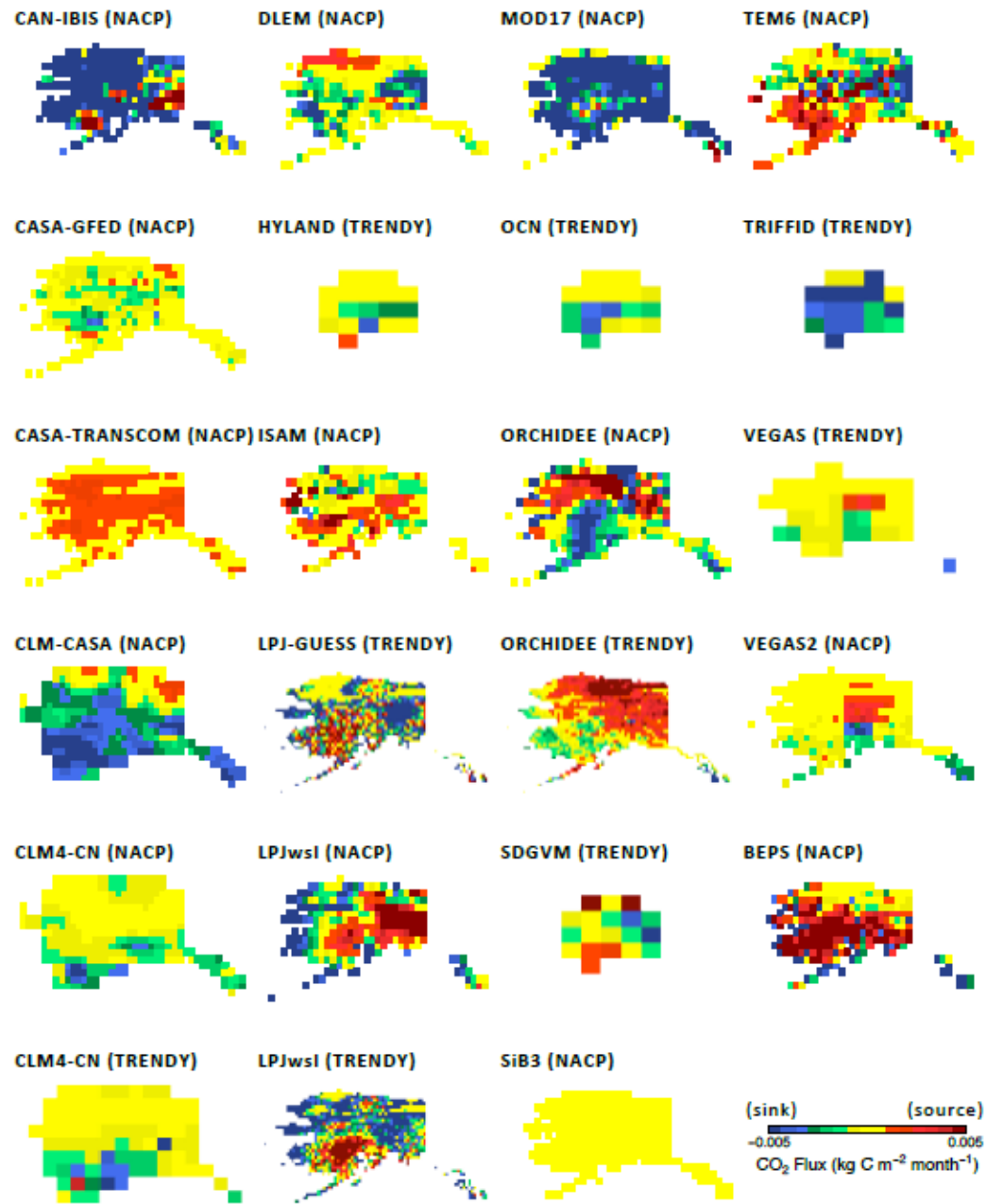
Andrew G Slater



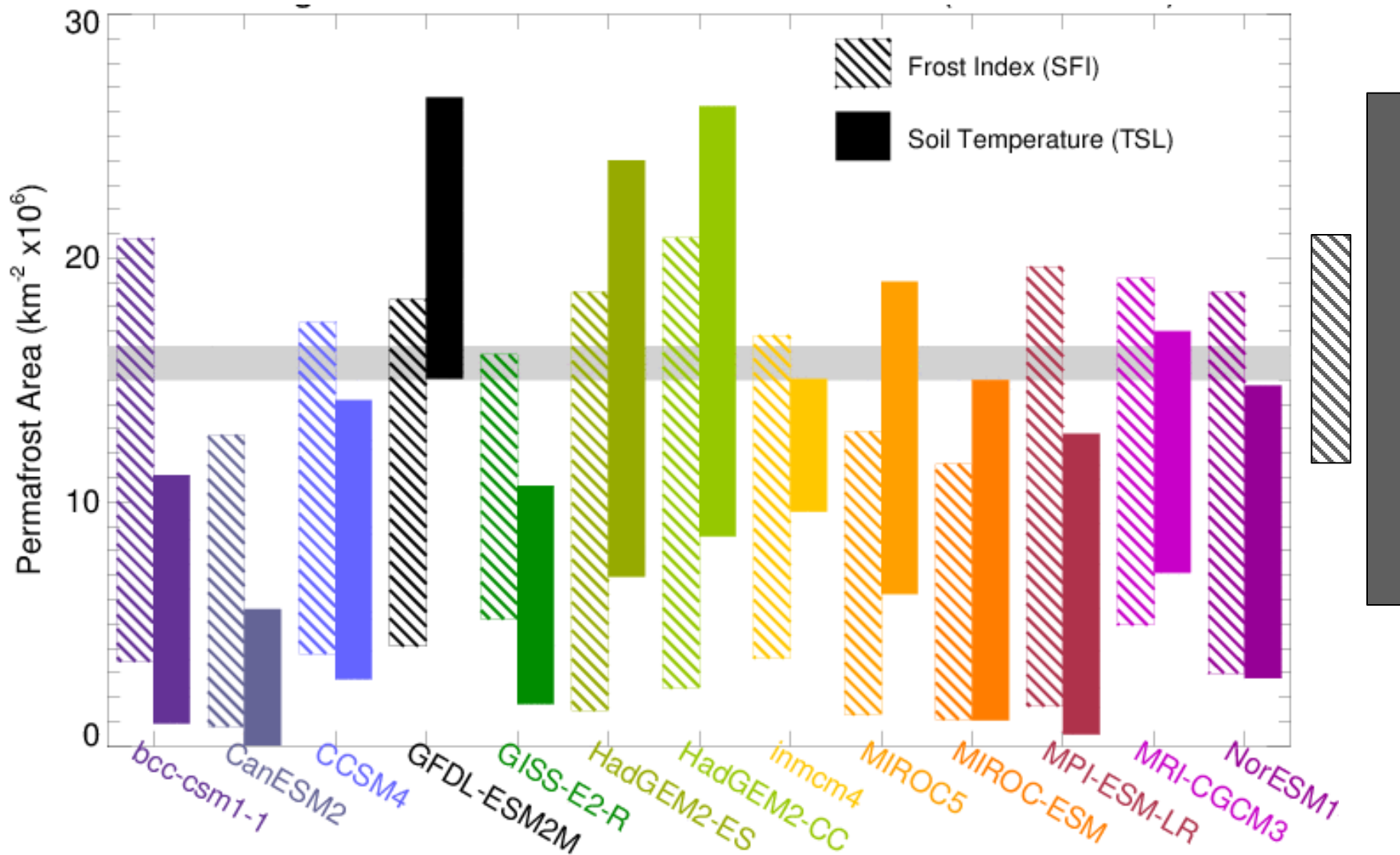
Arctic Modeling

...stressed that all of these models "are perfectly valid representations of what's going on in the Arctic."

“some models have more sophisticated representation of the biophysical processes important in the Arctic than others”

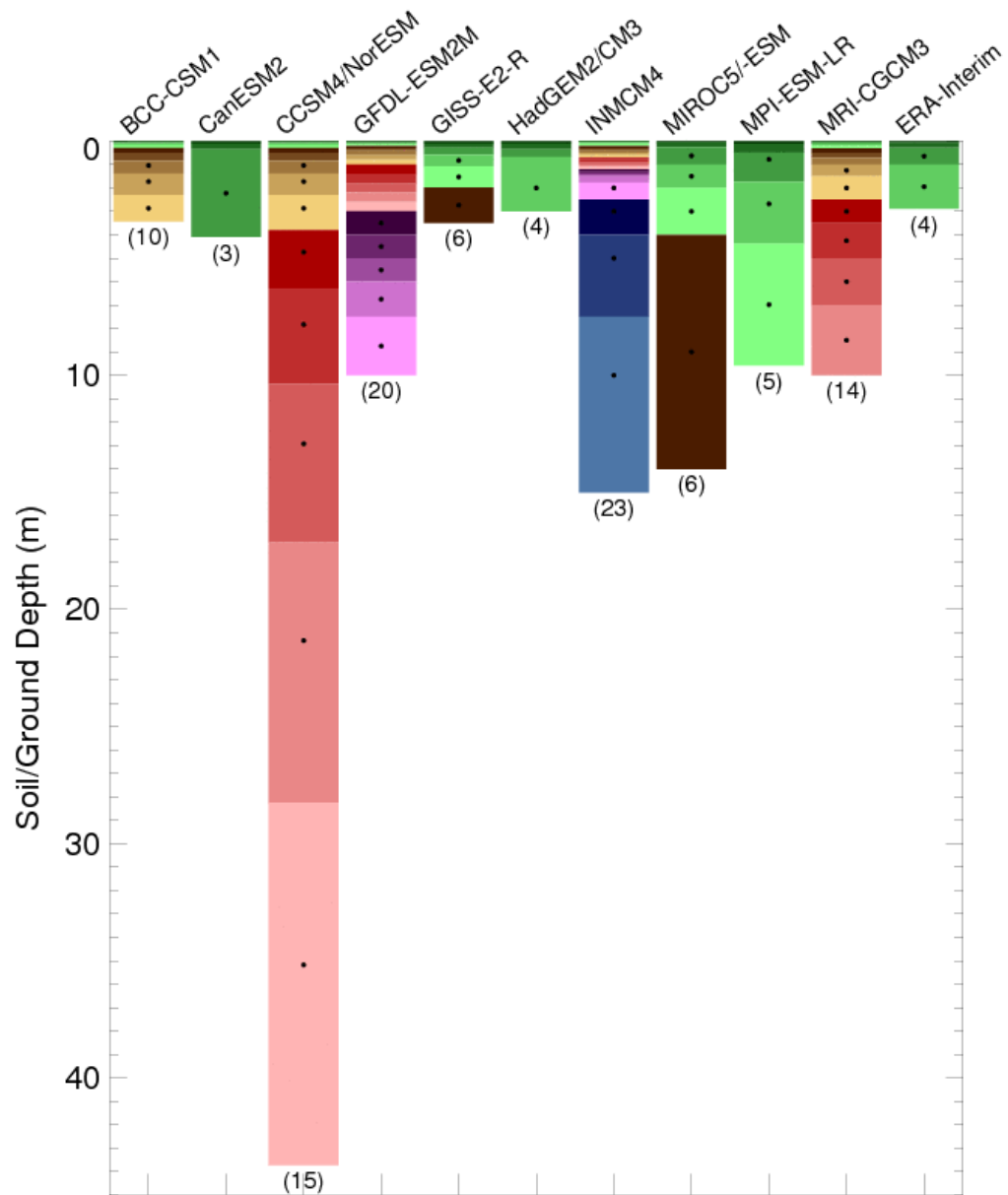


Range of Near-Surface Permafrost Area (1900-2100)



Soil Model Structure

- Number of layers
- Size of layers
- Phase change
- Numeric methods
- Time step



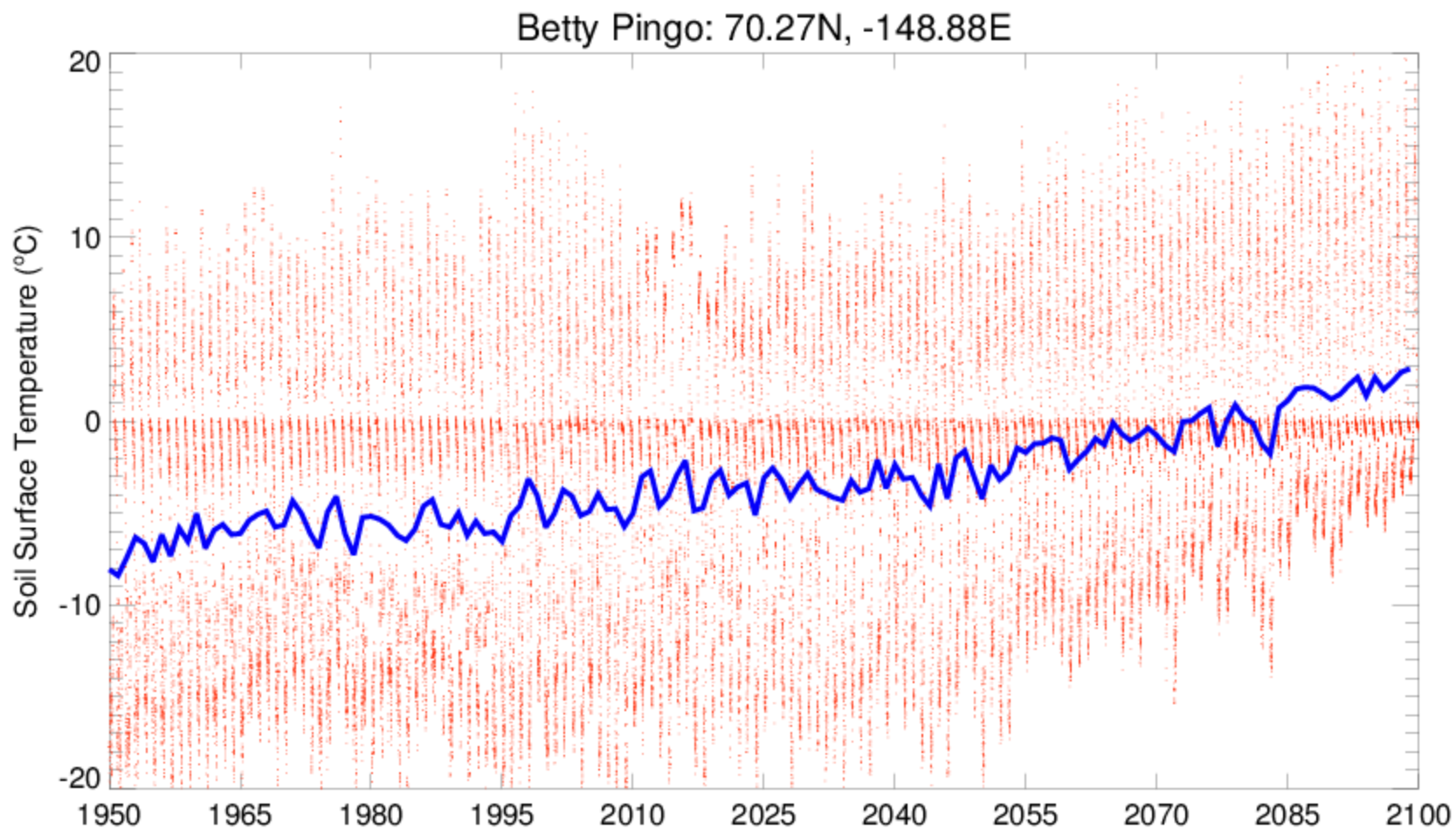
Two Example Sites



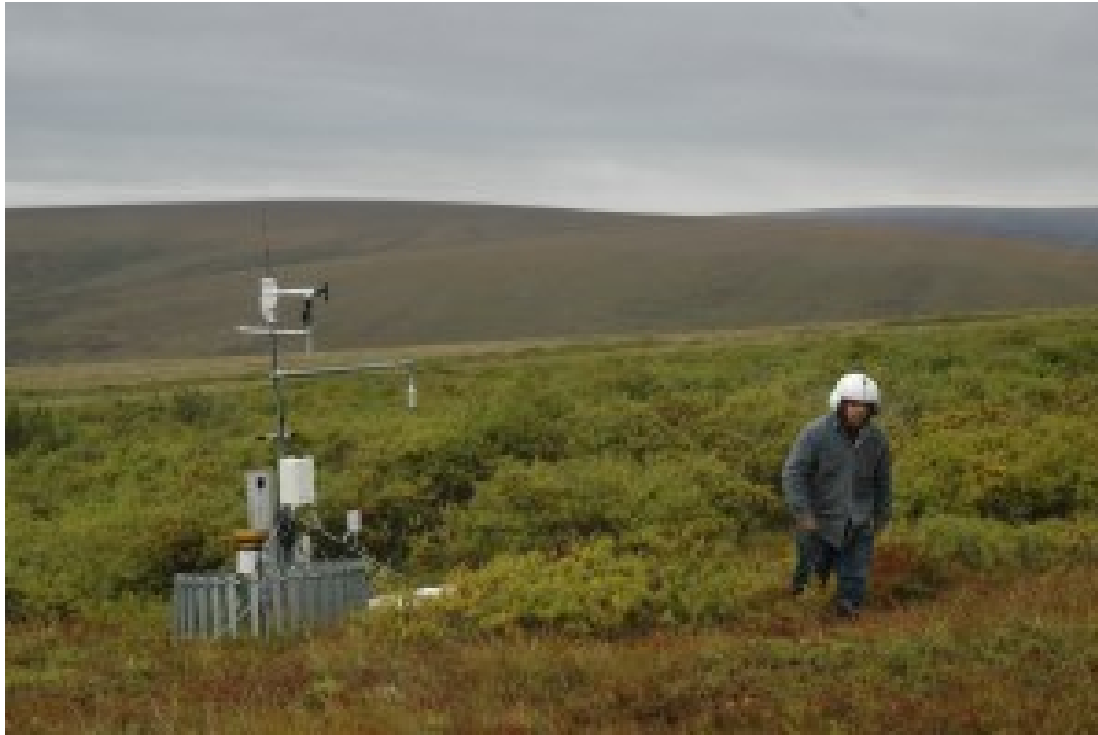
Betty Pingo 70.27N, -148.88E



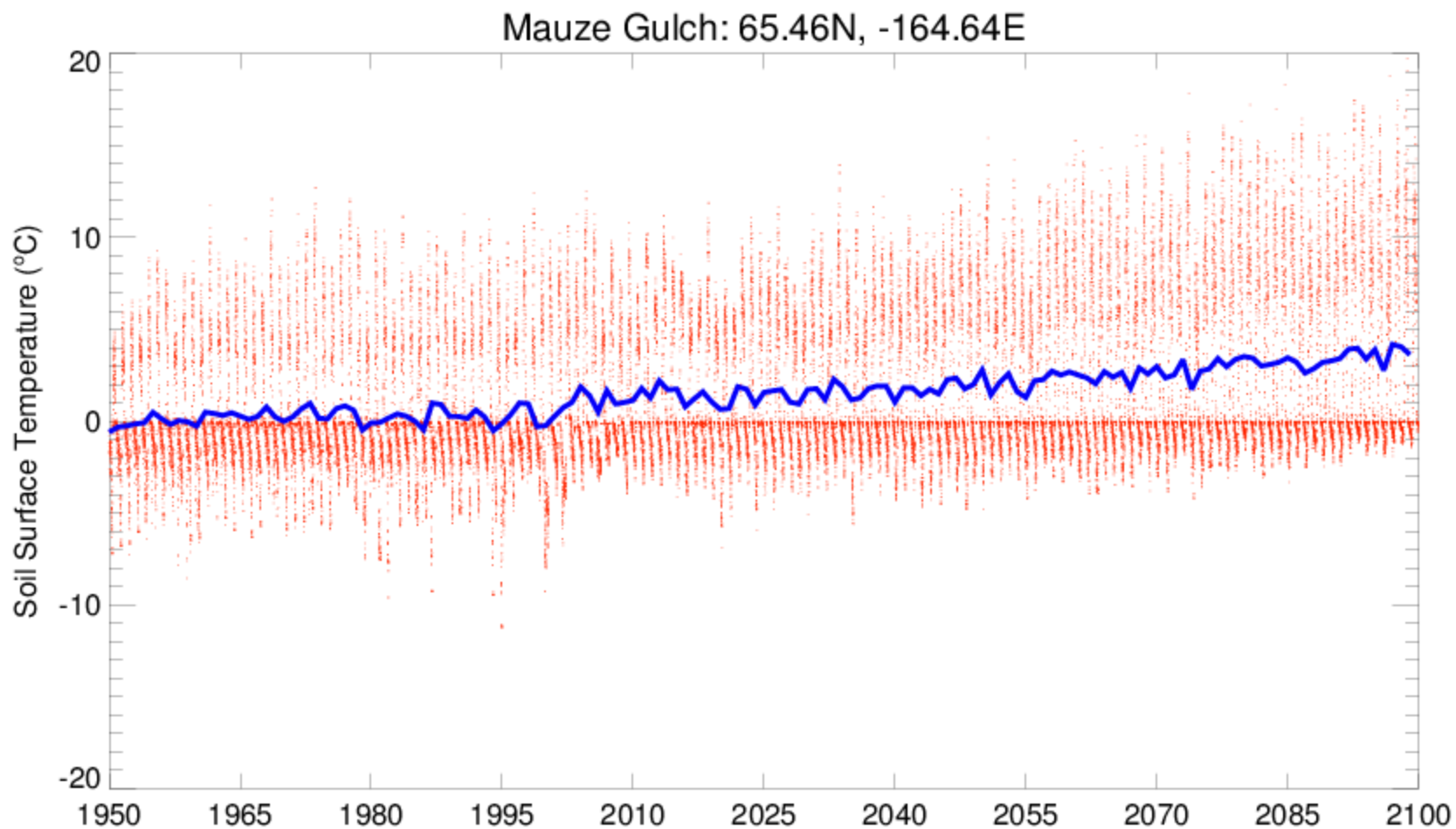
Soil Surface Temperature



Mauze Gulch

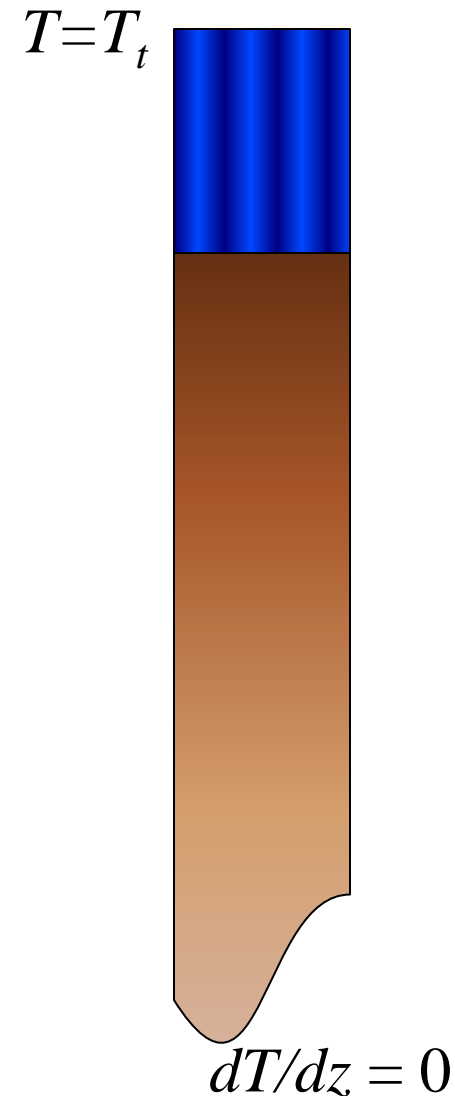
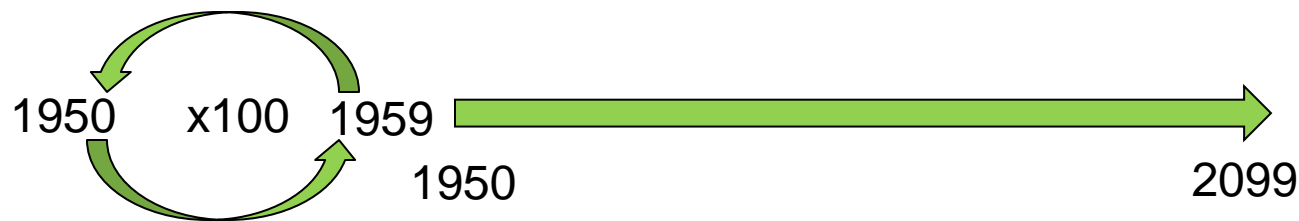


Soil Surface Temperature



Experiment Set-up

- 95% saturation to 4.5m
- Bedrock 4.5m to ?
- 1000yr spin-up (1950-1959)
- UBC = Soil Surf. Temperature
- LBC = Zero Flux

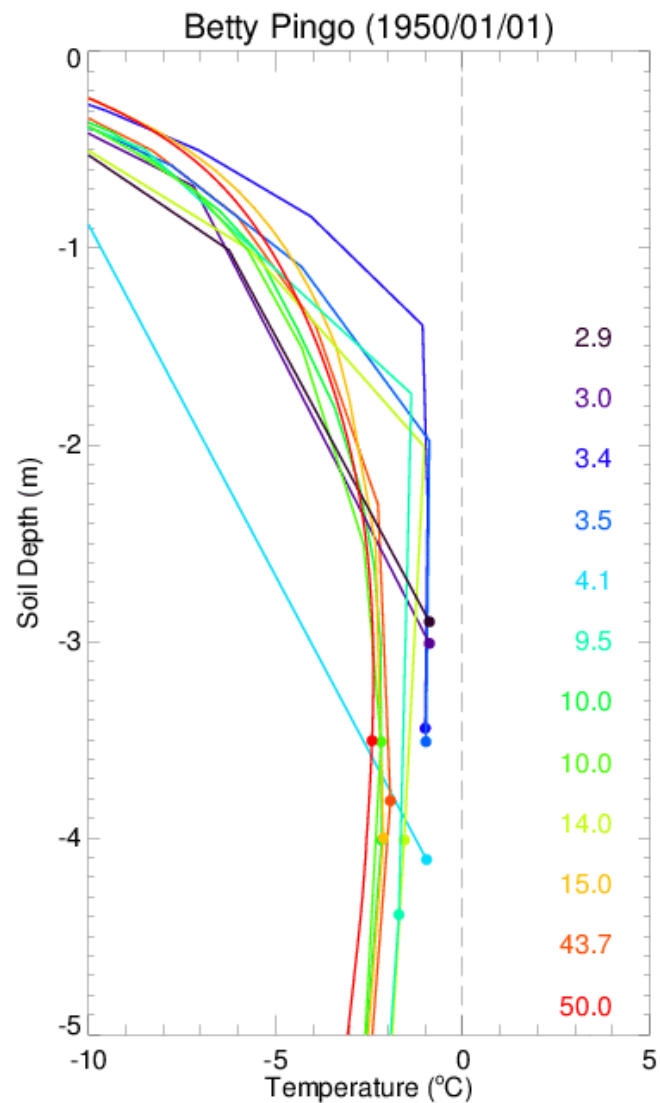
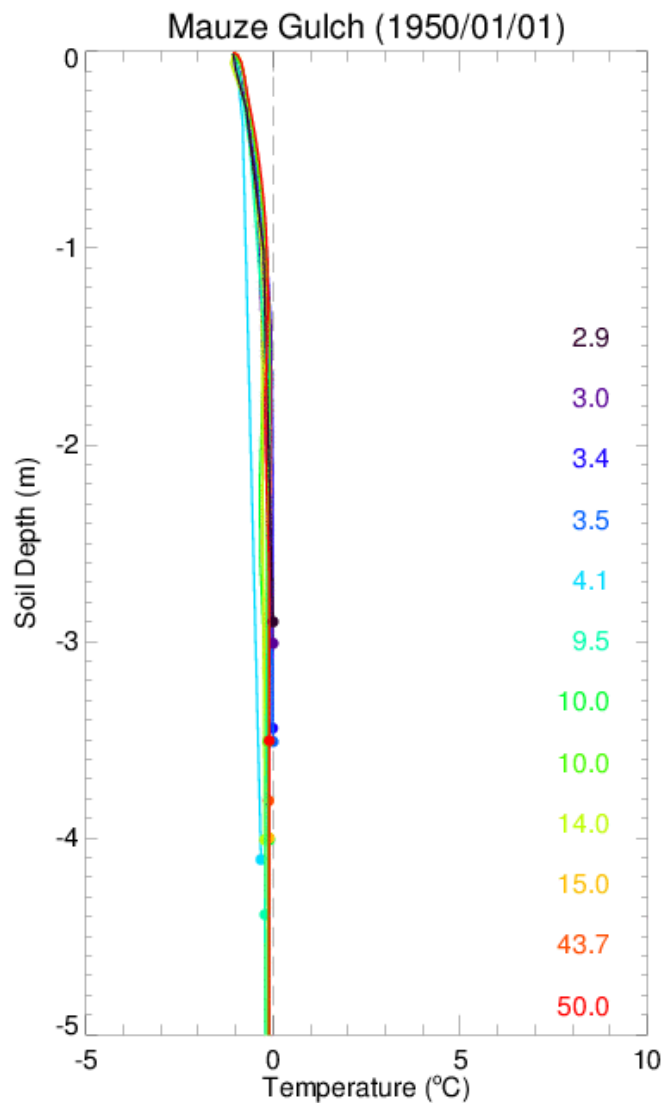


Dealing with Phase Change

- No Phase Change
- Supply & Demand
 - Overshoot 0°C
- Apparent Heat Capacity
 - -1°C to $0^{\circ}\text{C} = L_f$
- Freezing Characteristic Curve

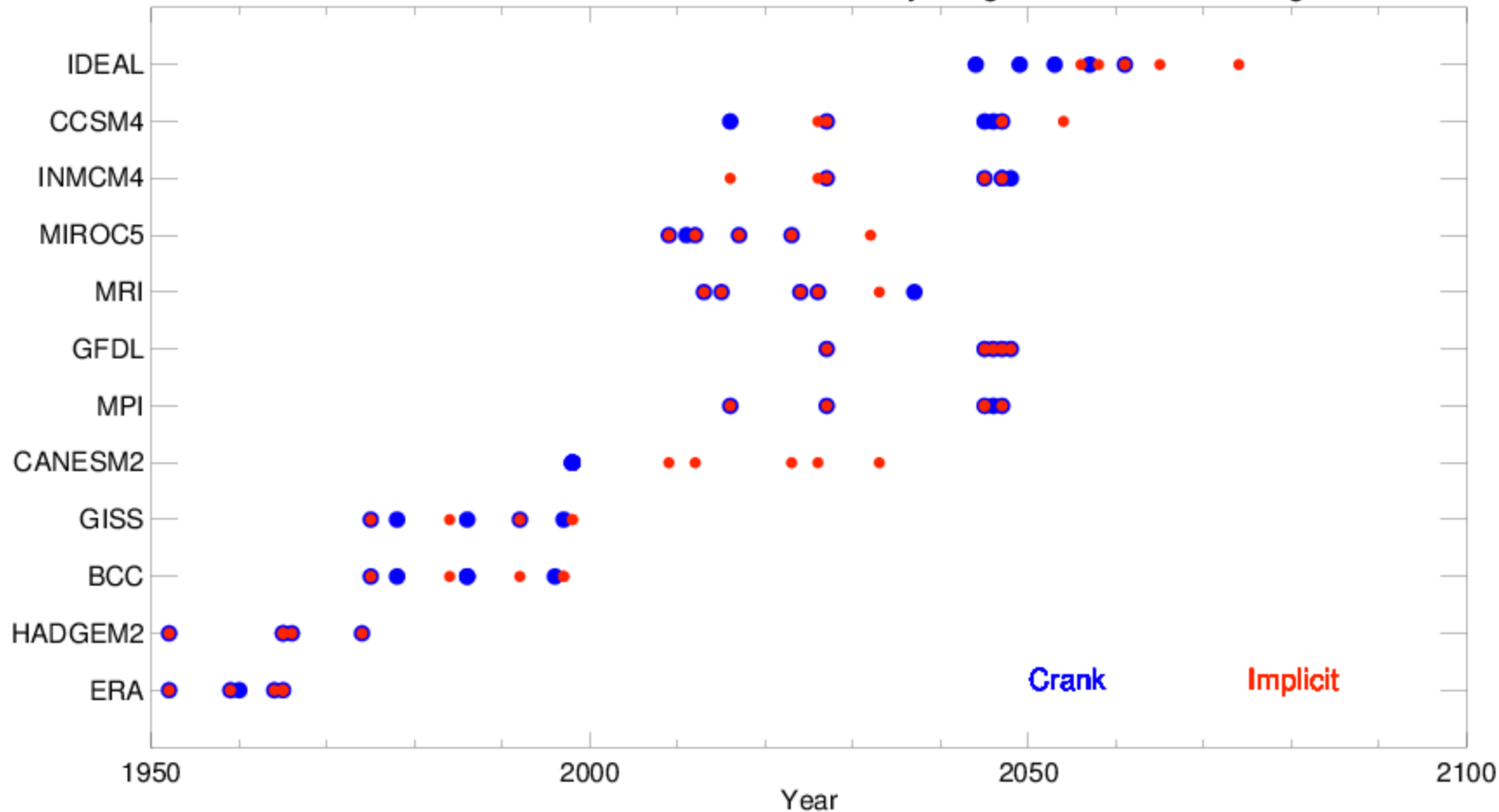


End of Spin-up



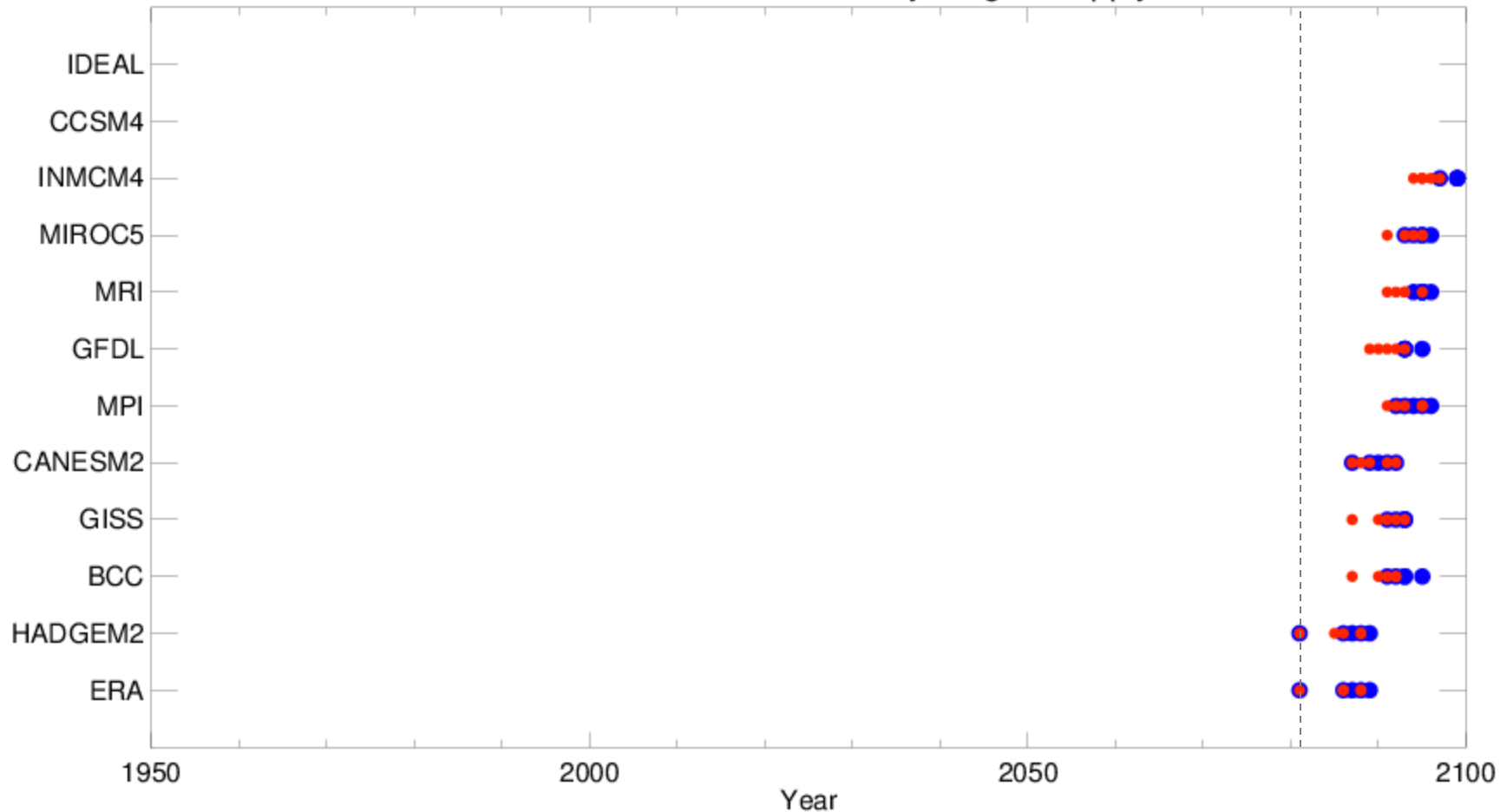
Betty Pingo: No Phase Change

Thaw of Near-Surface Permafrost at Betty Pingo: No Phase Change



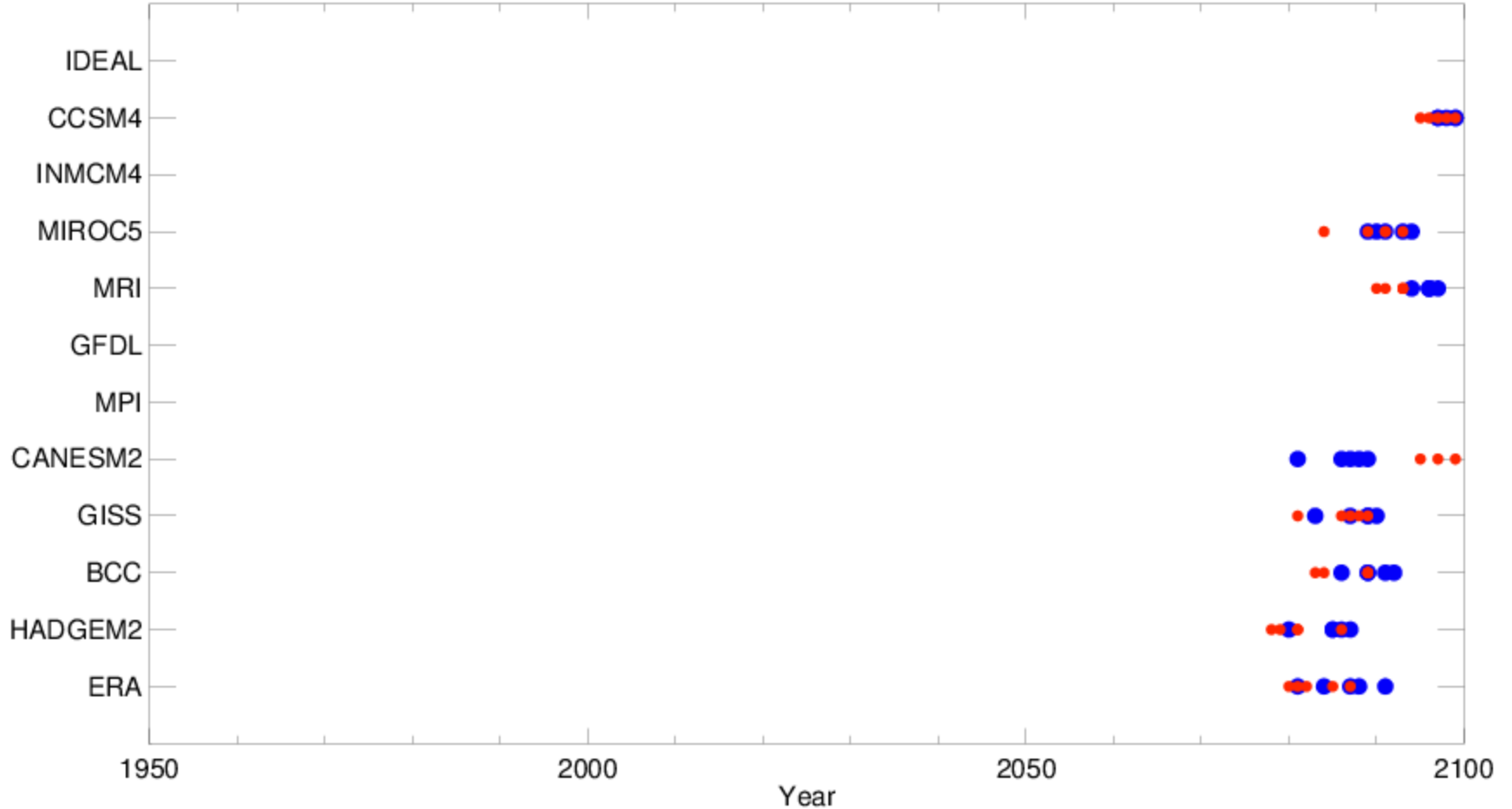
Betty Pingo: Supply & Demand

Thaw of Near-Surface Permafrost at Betty Pingo: Supply & Demand



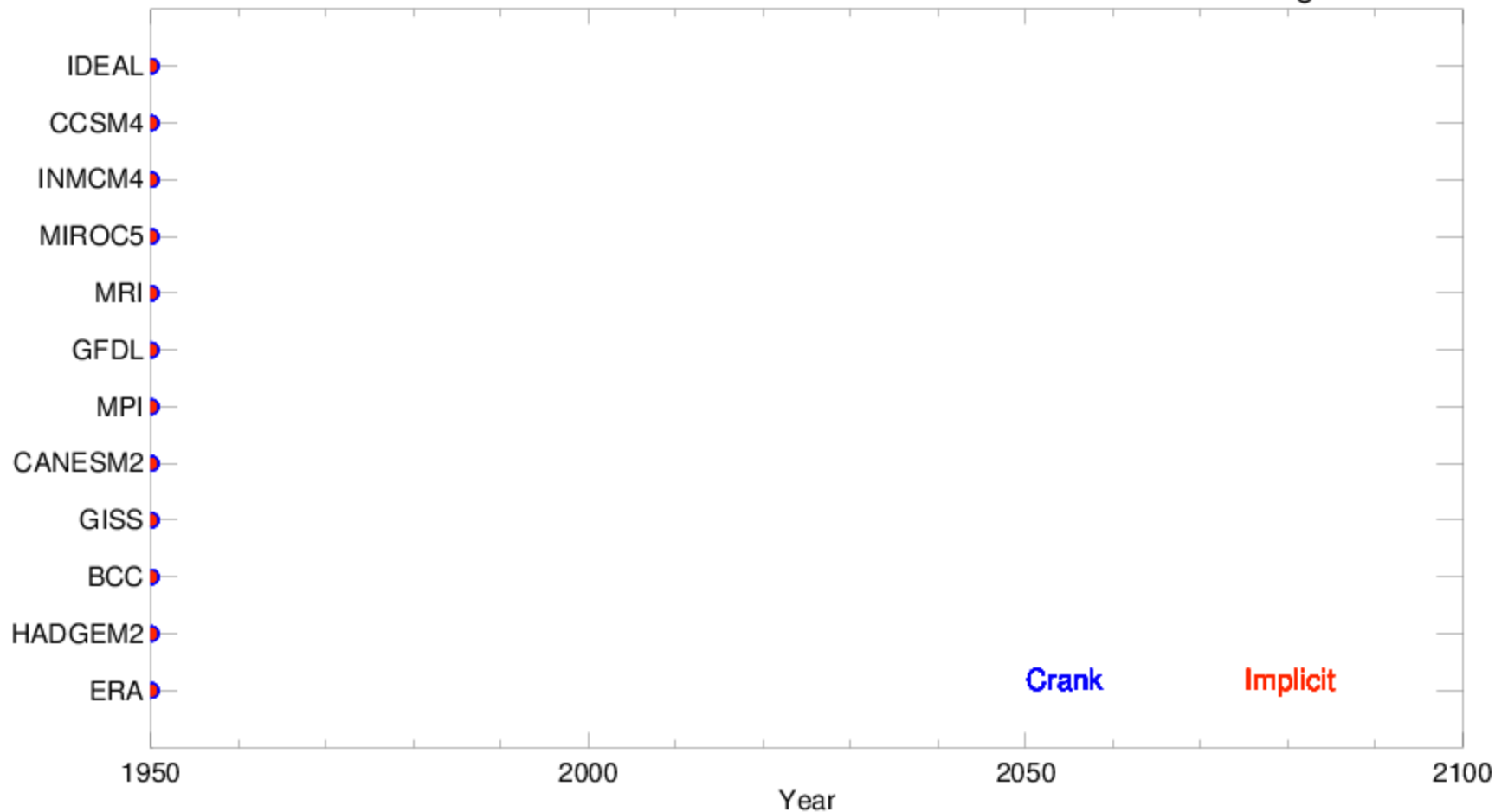
Betty Pingo: Apparent Heat Capacity

Thaw of Near-Surface Permafrost at Betty Pingo: Apparent Heat Capacity



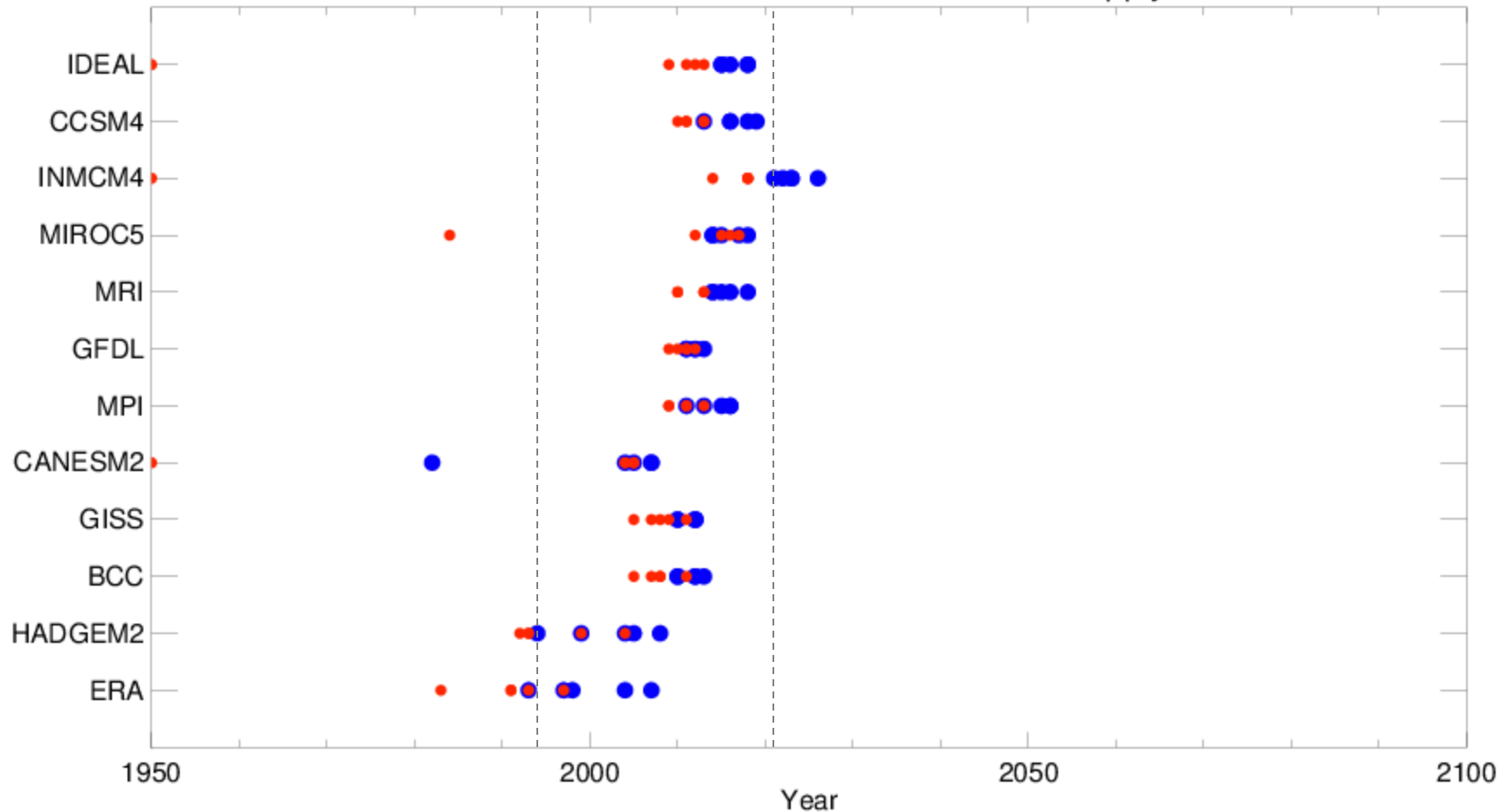
Mauze Gulch: No Phase Change

Thaw of Near-Surface Permafrost at Mauze Gulch: No Phase Change

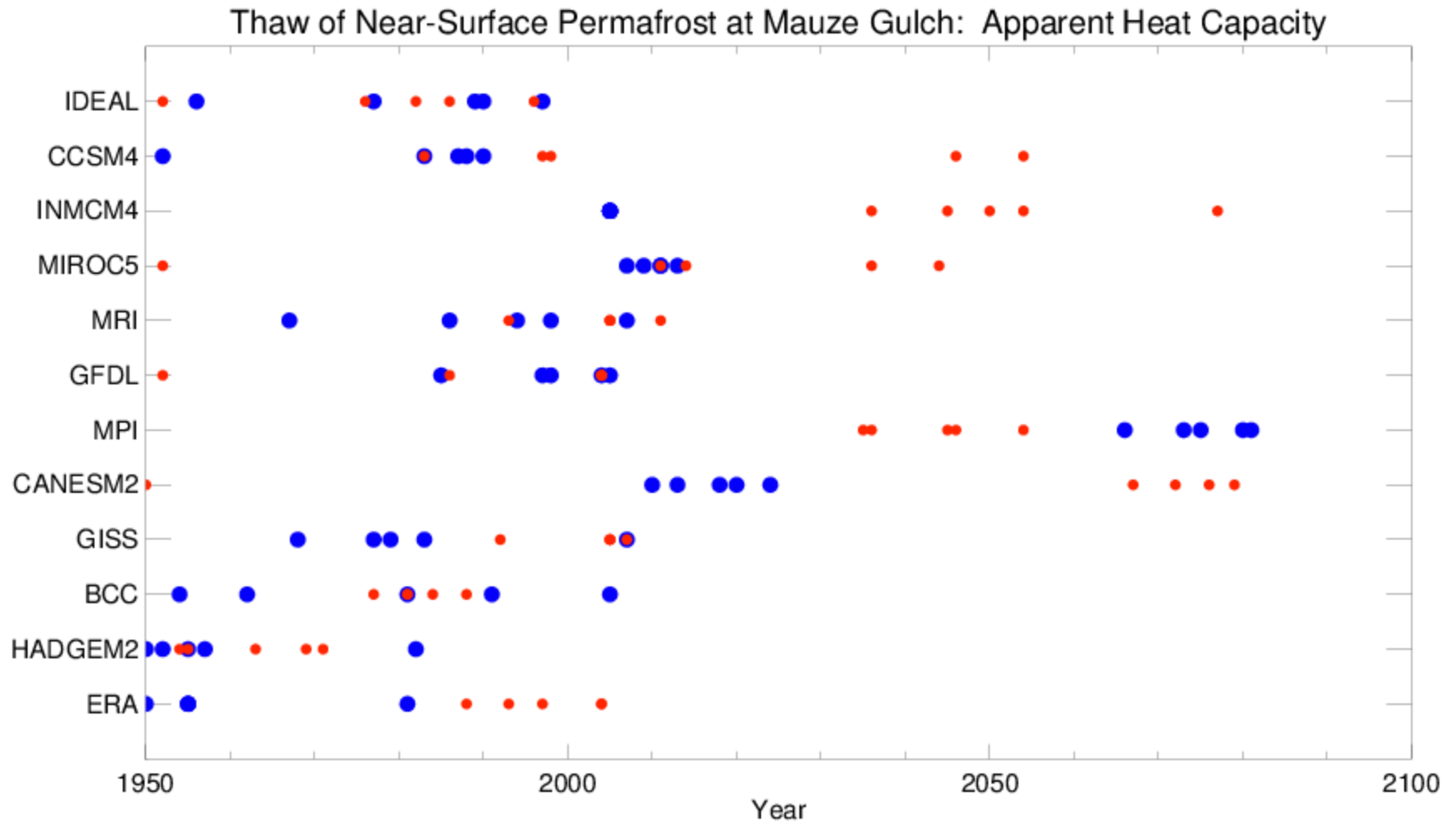


Betty Pingo: Supply & Demand

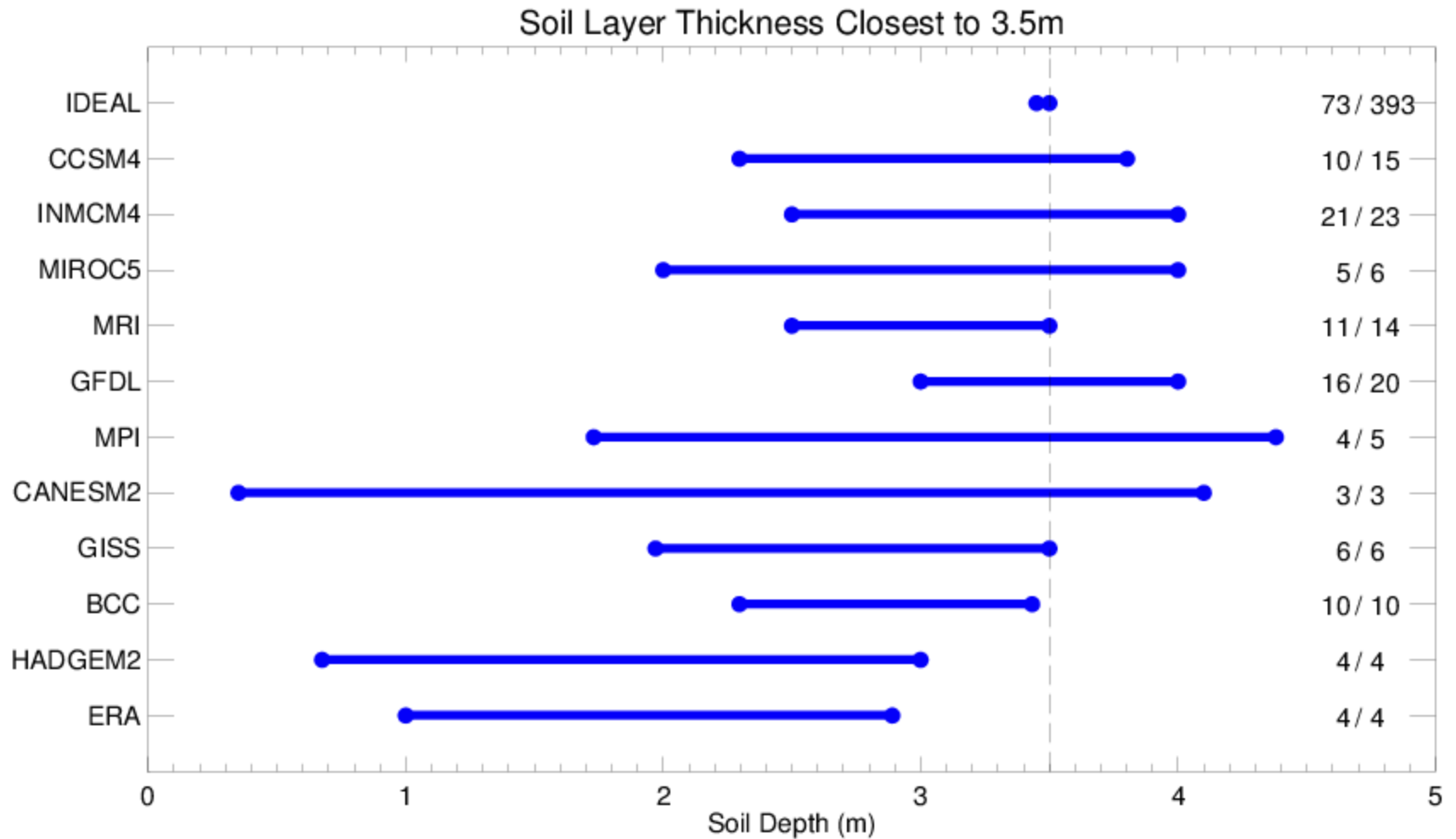
Thaw of Near-Surface Permafrost at Mauze Gulch: Supply & Demand



Betty Pingo: Apparent Heat Capacity

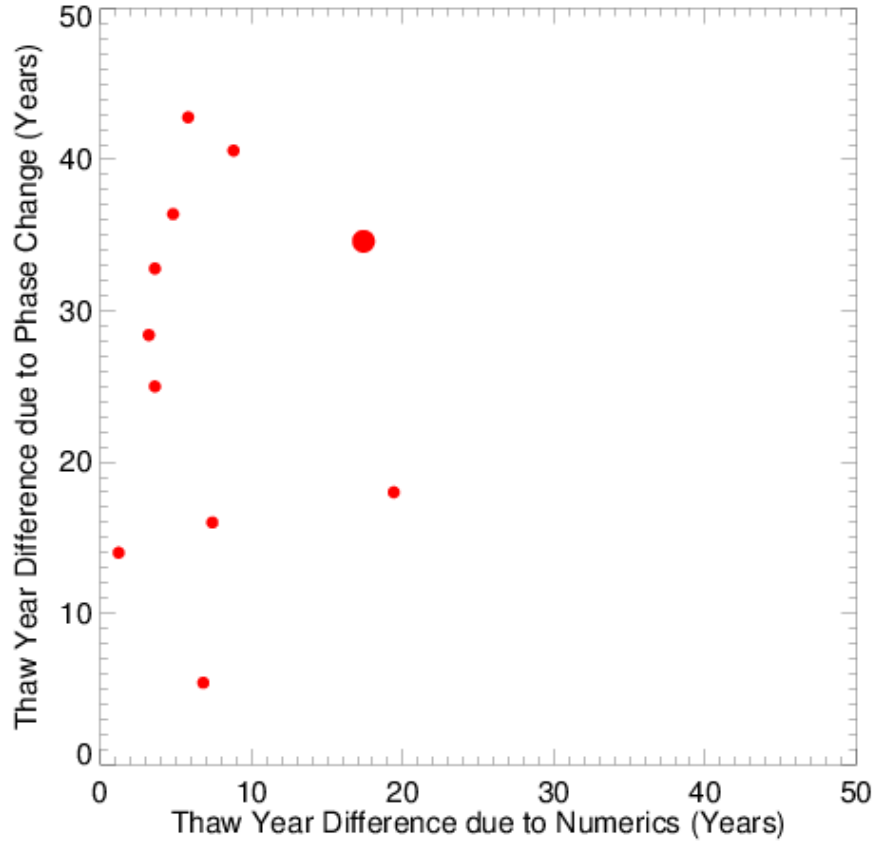


'Near-Surface' Permafrost Layer

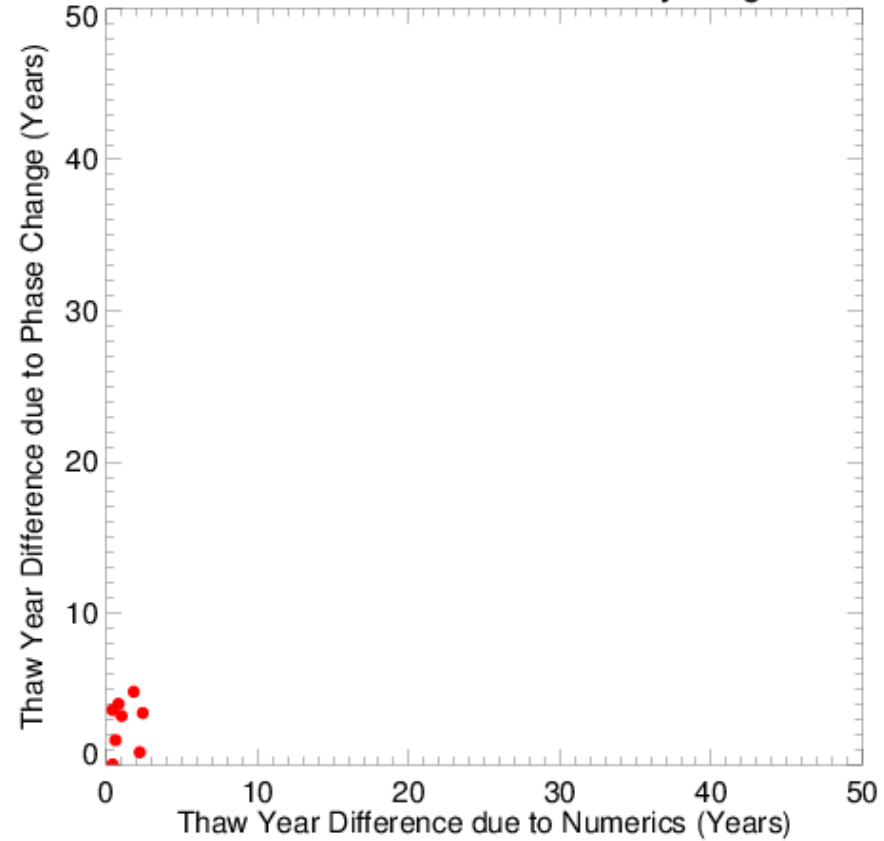


Thaw Year: Numerics vs Phase Parameterization

Difference in Thaw Year Mauze Gulch



Difference in Thaw Year Betty Pingo



Conclusions

- Deeper column acts as greater heat sink
 - Ideally greater than zero annual amplitude
- ~20yr difference in Near Surface Permafrost
- Numerics as important as parameterization
- Greater sensitivity closer to phase temperature
 - Thermal inertia of layer plays a role