

Drought Prediction and Vulnerability of Aquifers

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Research Team



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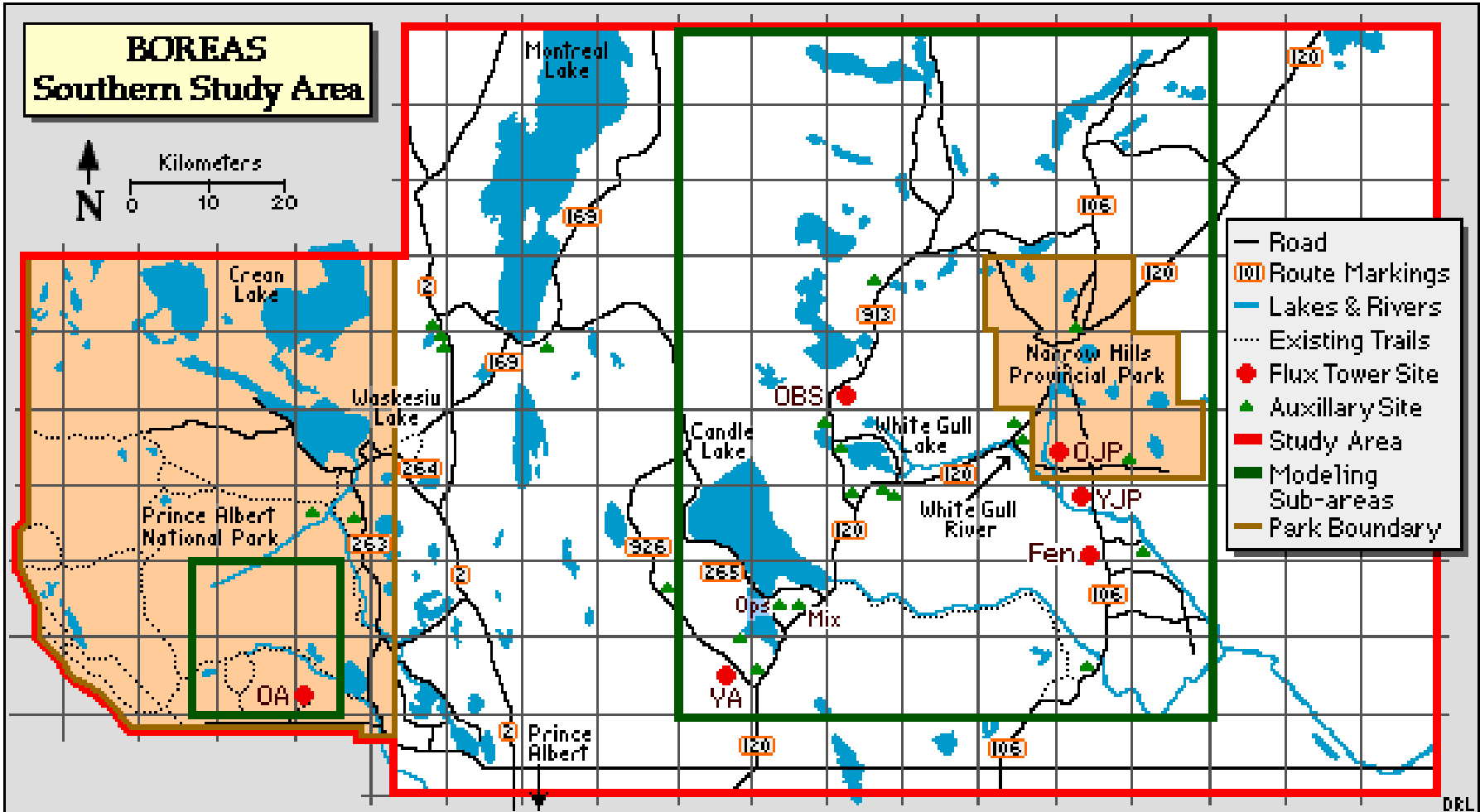
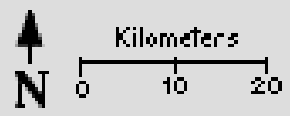
Alireza Hejazi, Ph.D. student (MB)

Ongoing Projects

The background image shows a vast, arid landscape with a cracked, dry earth surface in the foreground. In the middle ground, a small group of people is standing on the flat, cracked ground. The background features rolling, dry hills or mountains under a clear sky.

- **gCLASS development and simulations**
- **North Okanagan SRO grant**
- **Mysteries of northern Canadian climate change**

BOREAS Southern Study Area

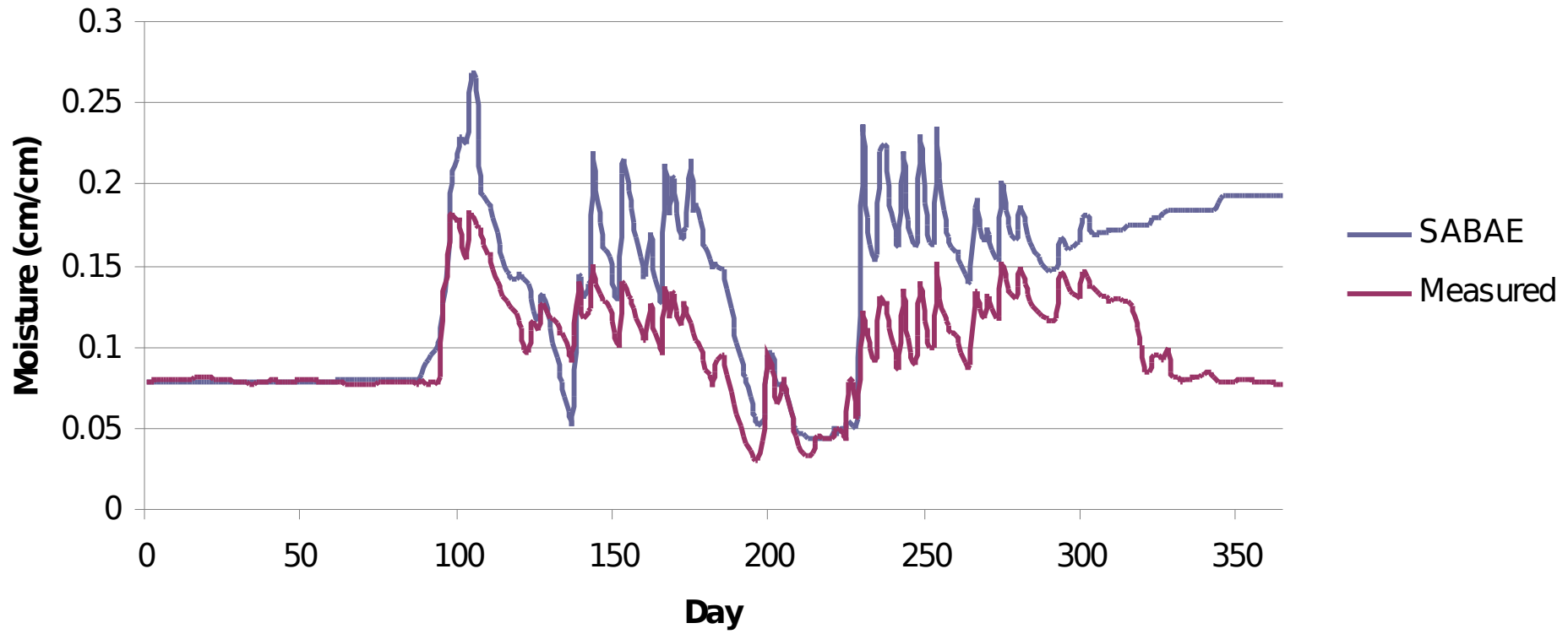


- Road
- 100 Route Markings
- Lakes & Rivers
- Existing Trails
- ◆ Flux Tower Site
- ▲ Auxillary Site
- Study Area
- Modeling Sub-areas
- Park Boundary

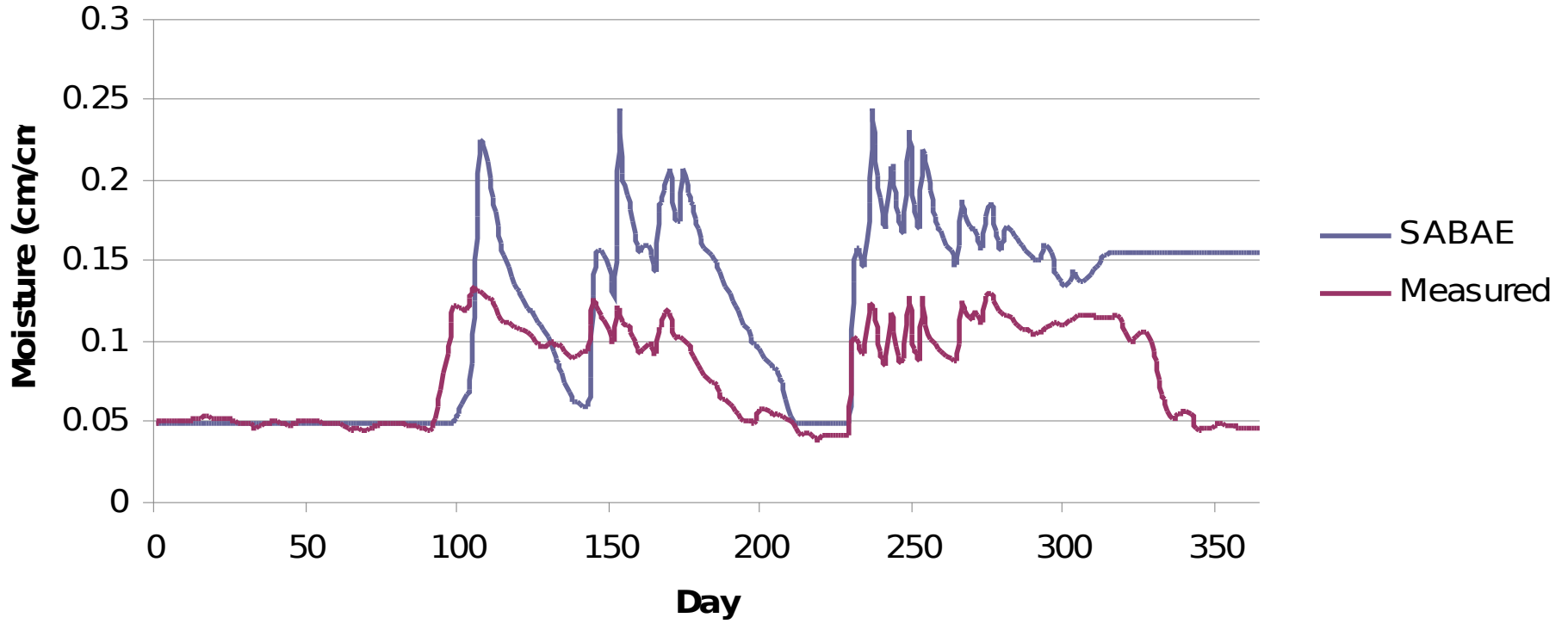
Old Jack Pine Site

1. Latitude/Longitude 53.91634° N, -104.69203° W
2. Elevation 579.27 m
3. Mean Annual Air Temp. 0.4° C
4. Mean Total Annual Precipitation 467.2 mm
5. Soil type is sand and sandy loam
6. Cover Type mature jack pine overstory (established 1914), very sparse green alder understory, predominantly lichen ground cover
7. Date Operations Began 1994, Climate measurements began Mar. 1997 and flux measurements Aug. 1999

Depth = 7.5 cm



Depth=22.5 cm



Summary to Date

The comparison between the results of SABAE (gCLASS) with the observation field data shows that there is a reasonable correspondence between the results of the code and the measured data with respect to the volumetric water content.

Have not obtained completely acceptable results regarding soil temperature.

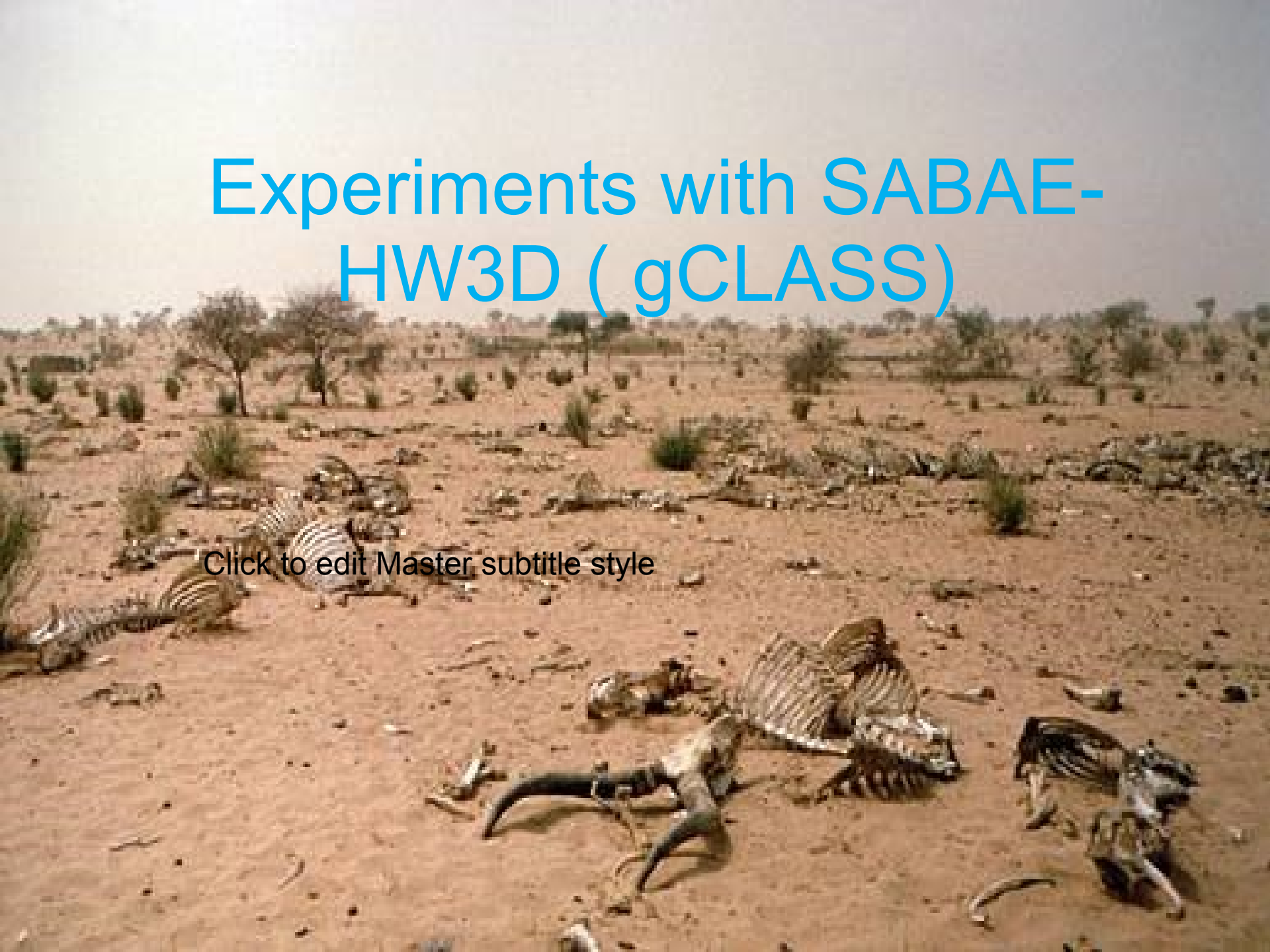
Found the important effects of snow depth in soil temperature and even in soil moisture. Up to now, we have not been able to interpret the exact value of available snow depth in OJP site.

Proposed New Work

- Interpreting the exact value of snow depth from the specific instrument (sensor SR50)
- Extend soil column to at least 3 or 4 meters to reduce the seasonal heat transfer effects
- Imposing water table boundary condition as a lower BC if the value of water table is available at the specific depth.
- Applying the refined mesh (layers) to obtain value of soil moisture and soil temperature at depths similar to the observed depths.
- Running the code for at least 3 years. This helps to reduce the effects of thawing and freezing.

Experiments with SABAE- HW3D (gCLASS)

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Three Objectives

- Reproduce at McGill the results of the benchmark run from gCLASS (SABAE-HW3D) package;
- Run gCLASS in stand-alone mode over the Prairies

A desert landscape with a pyramid in the background and a cracked, dry lake bed in the foreground. The foreground is dominated by a dense pattern of dark, irregular cracks in the dry earth, creating a mosaic-like texture. In the middle ground, a small group of people is standing on a flat, sandy area. In the background, a large pyramid is visible, along with other smaller structures and distant hills under a clear sky.

..continued,

- The project first objective has achieved.
- Also reproduced the two results of benchmark runs provided by Woodbury's group at University of Manitoba.

Proposed New Work

- Prepared the necessary soil and vegetation parameter fields for the standard version of CLASS2.6 over a western Canada simulation domain (including the Prairies) with 100 x 90 grid points.

The domain projection is polar stereographic, with a nominal horizontal resolution of 51 km at 60° north latitude.

Applications of gCLASS over the Prairies could benefit greatly from those parameter fields.

Other Agencies; Impacts

- *Water Sustainability under Climate Change and Increasing Demand: a One-Water Approach at the Watershed Scale (NSERC Strategic opportunities grant)*

“One-Water” Approach

1. Integrated water modeling component led by Dr. Adam Wei, UBC Okanagan
2. Estimation of spatially varied groundwater recharge led by Dr. Al Woodbury, University of Manitoba
3. Surface water and groundwater interactions: geochemistry led by Dr. Craig Nichol, UBC Okanagan
4. Estimation of future water demand led by Dr. John Janmaat, UBC Okanagan

Other Agencies: Impacts

- ***Observations of Northern Latitude Ground-Surface and Surface-Air Temperatures***
(Woodbury, Hanesiak, Akinremi and Buyian)

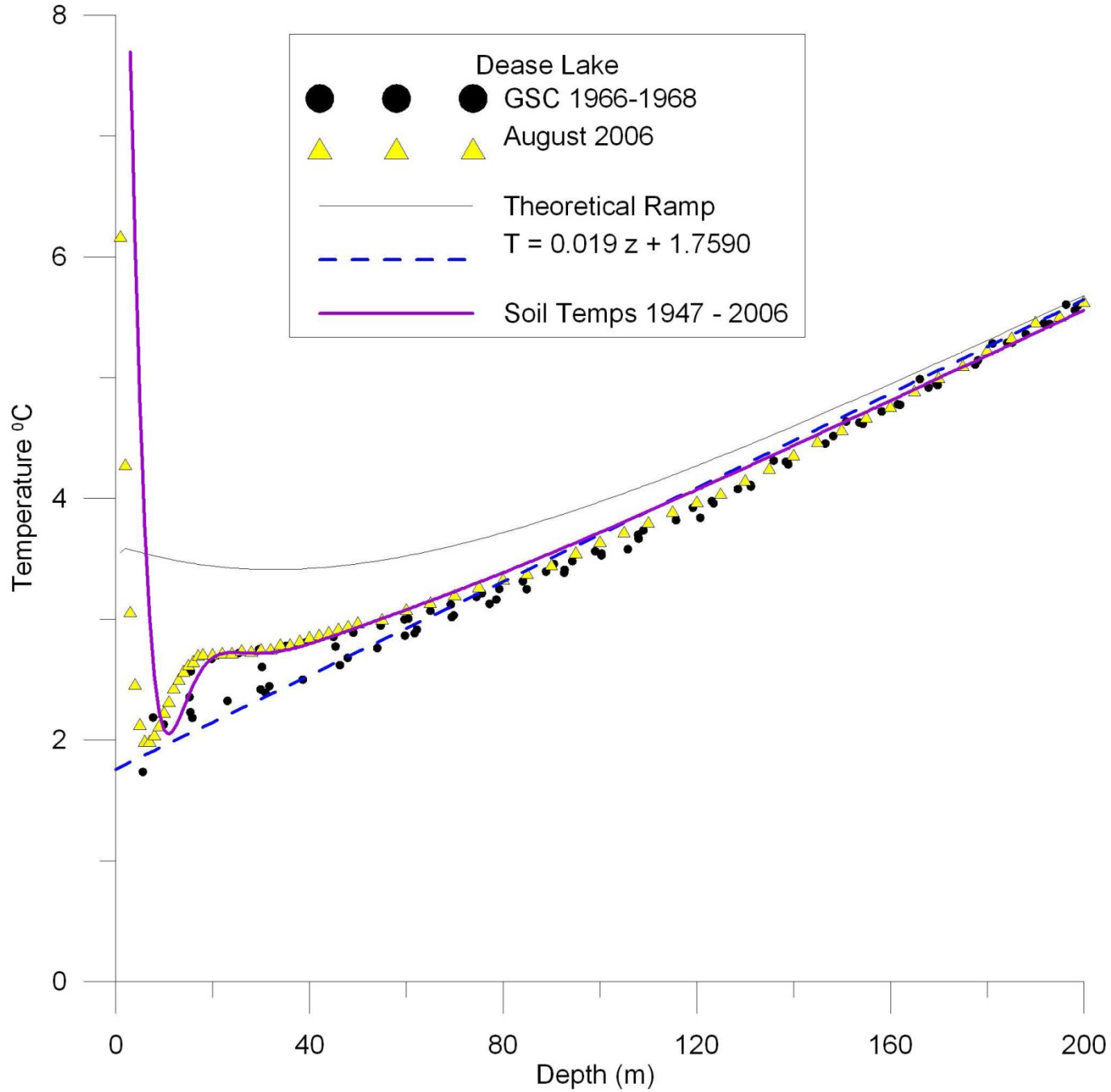




Heat Conduction Modeling

- **VSMB (Baier, also Akinremi) circa 1947 to 2006, daily min, max temperature; precipitation**

Model output used as forcing function in 1D heat conduction modeling



Summary of Work

- Continued work on verification of 1D model
- Planned simulations over the prairies (drought period)
- Further work in the Okanagan, migration of drought from the south
- Northern Canadian climate change

Selected Contributions

Woodbury, A.D., Snelgrove, K.R., Loukili, Y., and S. Yirdaw-Zeleke, Climate change assessment over the Assiniboine Delta Aquifer, Geological Society America, 2005 Salt Lake City Annual Meeting (October 16–19, 2005, Invited)

Loukili, Y., Woodbury, A.D., and K.R. Snelgrove, SABAE-HW – an enhancement of the water balance prediction in the Canadian Land Surface Scheme, 2006 San Francisco, AGU fall meeting (December 11-15, 2006)

Loukili, Y. and A.D. Woodbury, SABAE-HW3D: a Meteor-Hydrological Model Coupling the Land Surface to Groundwater Flow, 88(52), Fall Meet. Suppl., Abstract H33C-1449, 2007.

Loukili, Y., Woodbury, A.D. and K.R. Snelgrove, SABAE-HW – An enhancement of the water balance prediction in the Canadian Land Surface Scheme, *Vados Zone J.*, 7(3), 865–877, 2008.

Woodbury, A.D., H. Ghuyian, J. Hanisak, and O.O. Akinremi, Observations of northern latitude ground surface and surface air temperatures, *Geop. Res. Lett.* (2008), *Accepted pending revision.*