

The topographic Depth-to-Water index
predicts $\delta^{13}\text{C}$ (water stress) in
Picea glauca and *Populus tremuloides*

Gabriel S. Oltean^{1*}

Philip G. Comeau¹

Barry White²

*oltean@ualberta.ca

¹Department of Renewable Resources, University of Alberta

²Forest Management Branch, Alberta Agriculture and Forestry

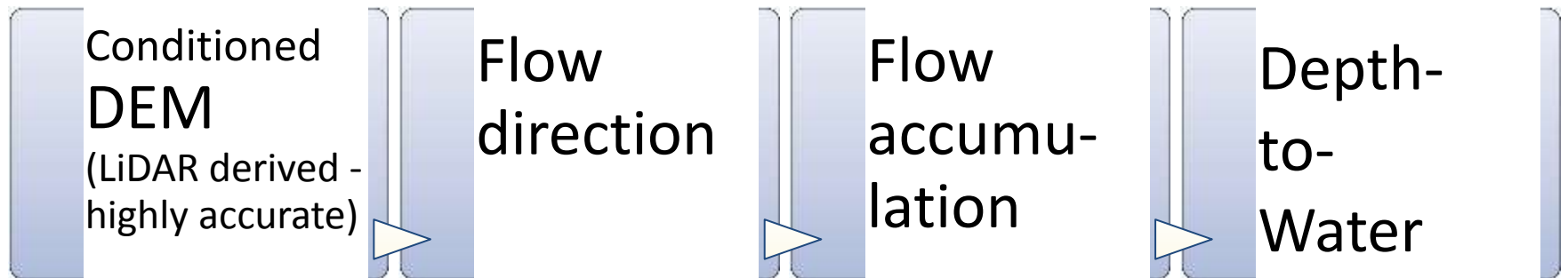
The Depth-to-Water index

$$DTW = \left[\sum \frac{dz_i}{dx_i} a \right] x_c (m)$$

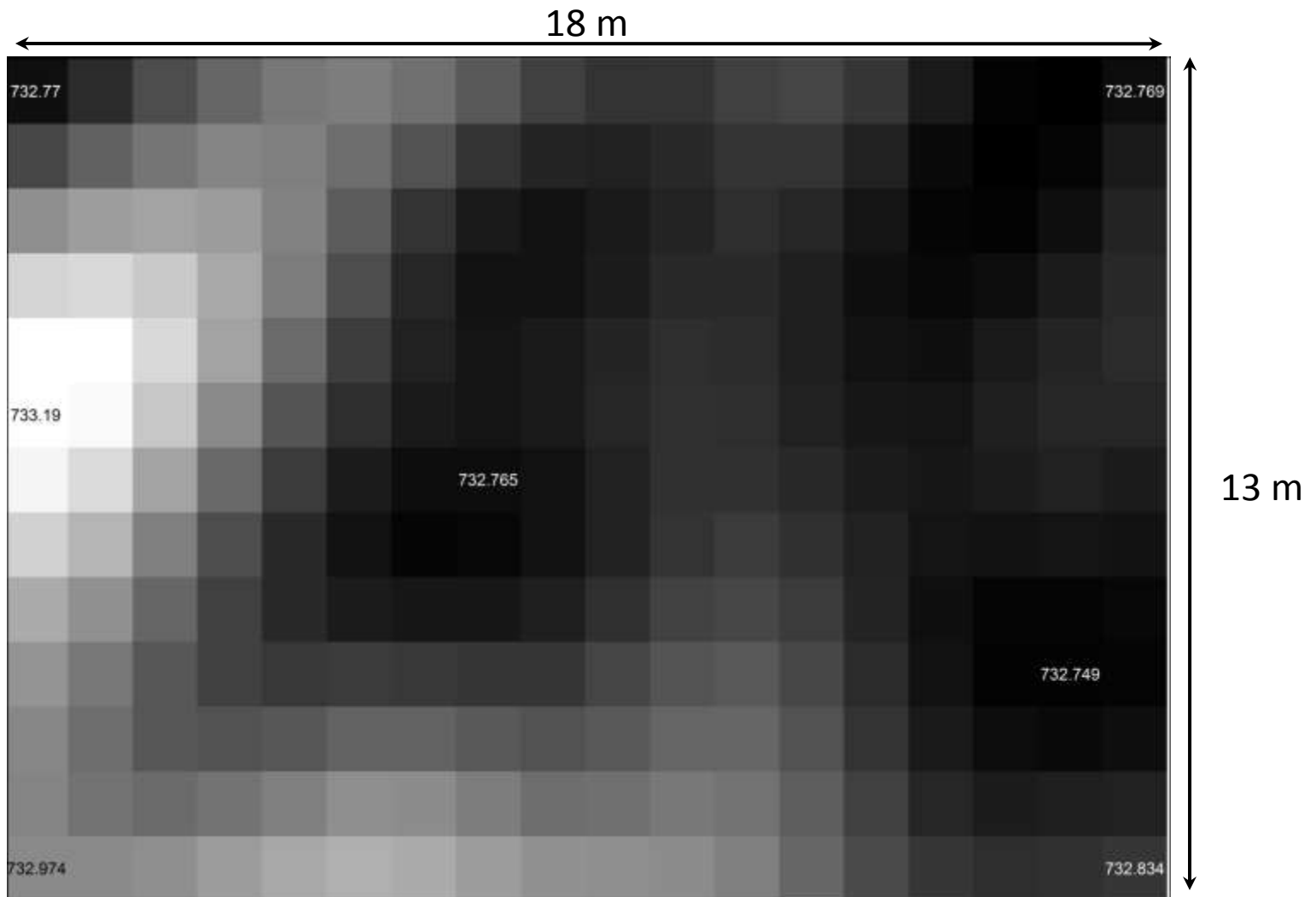
Sum of slopes along the least-cost path from any cell in the landscape to the nearest flow channel (Murphy et al. 2007).

$a = 1$ or $\sqrt{2}$, and $x =$ cell size (1 m)

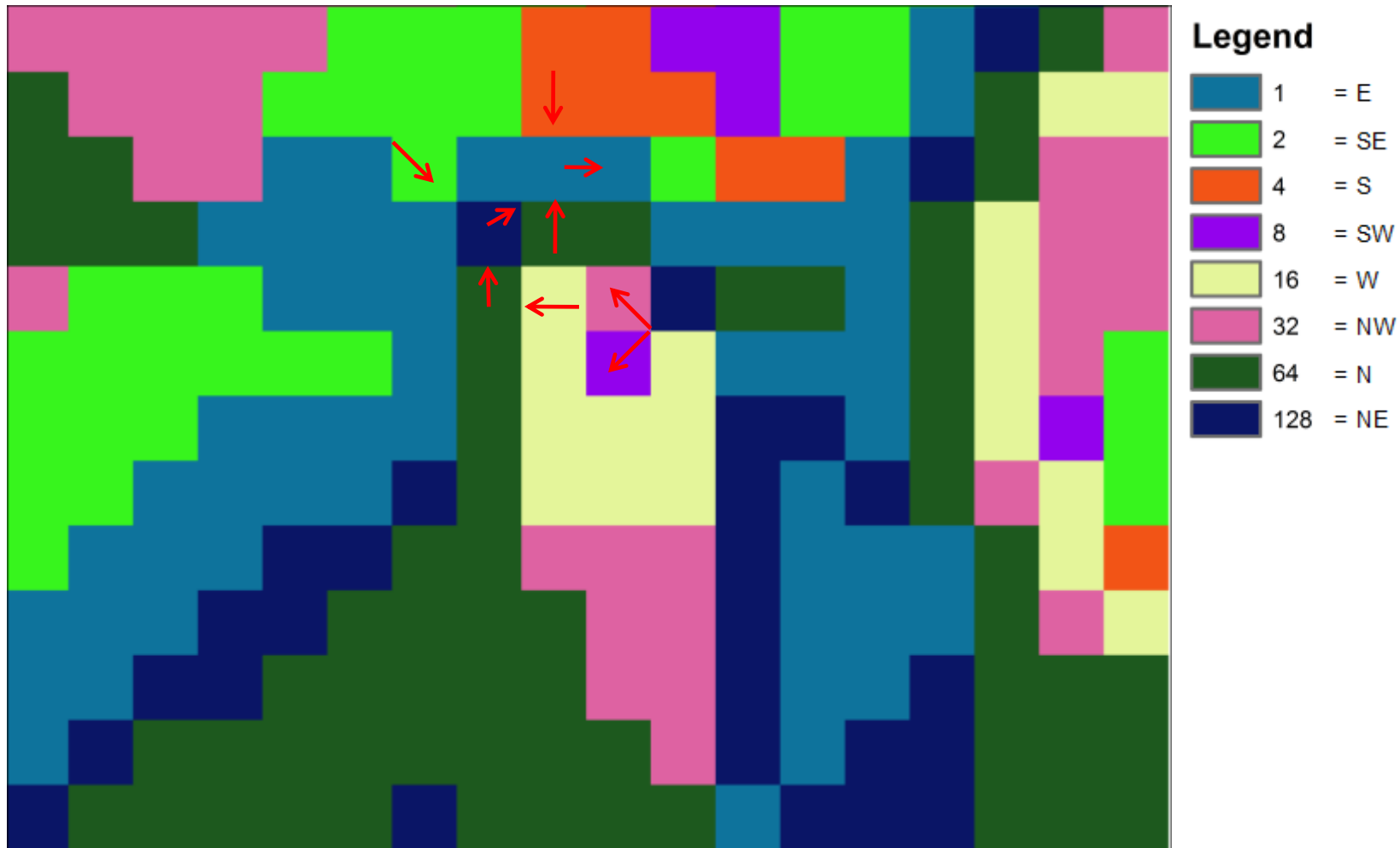
Algorithm:



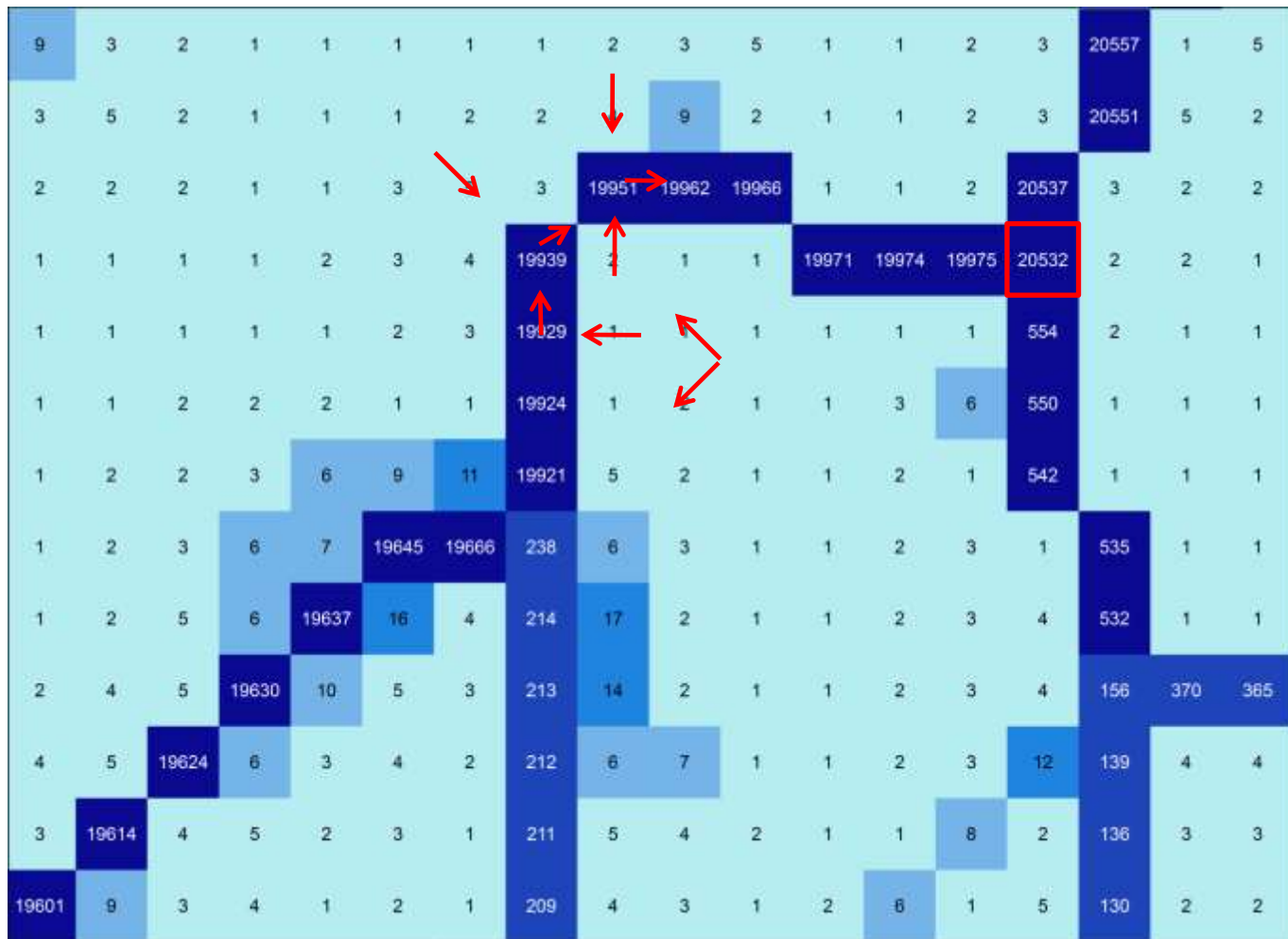
Digital elevation model (DEM)



Flow direction

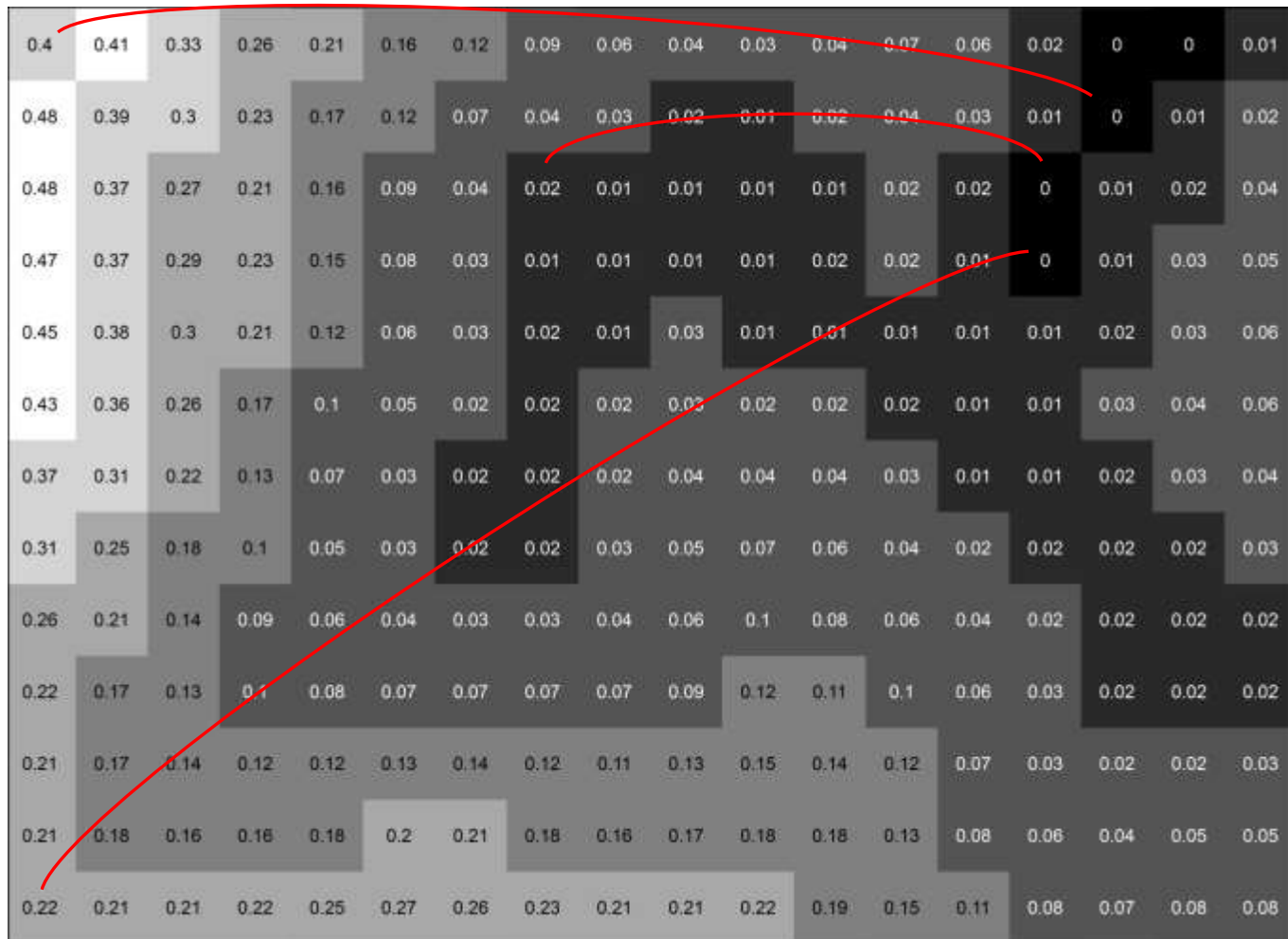


Flow accumulation – D8

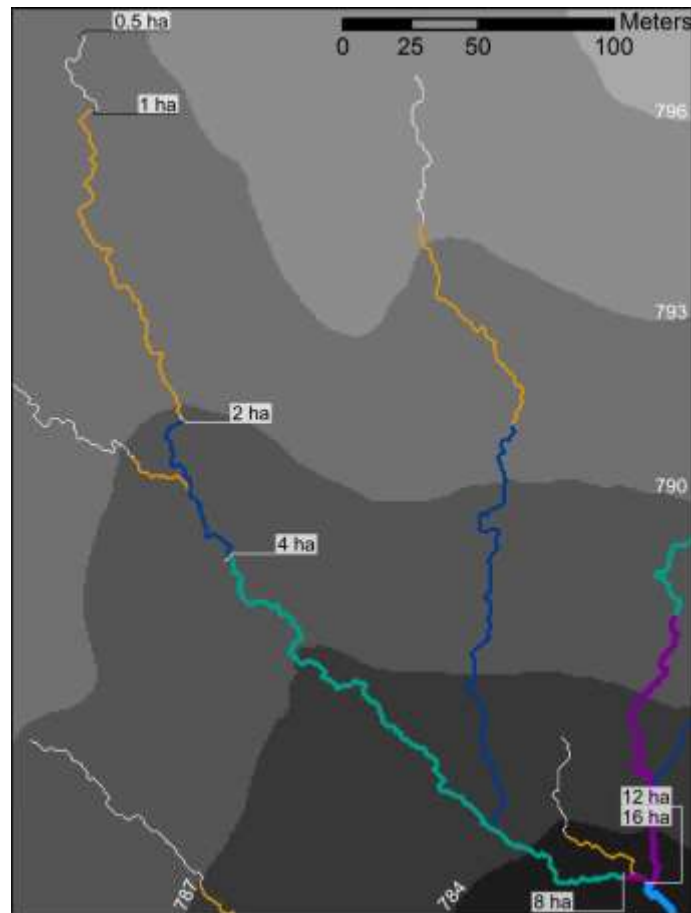


Depth-to-Water (m) at 2 ha

$$DTW = \left[\sum \frac{dz_i}{dx_i} a \right] x_c(m)$$

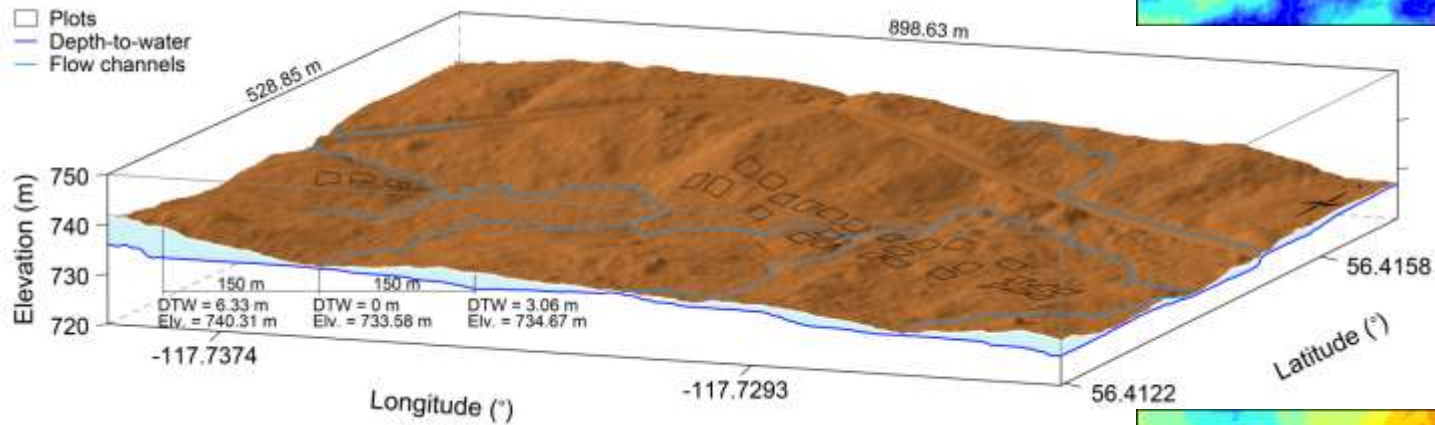
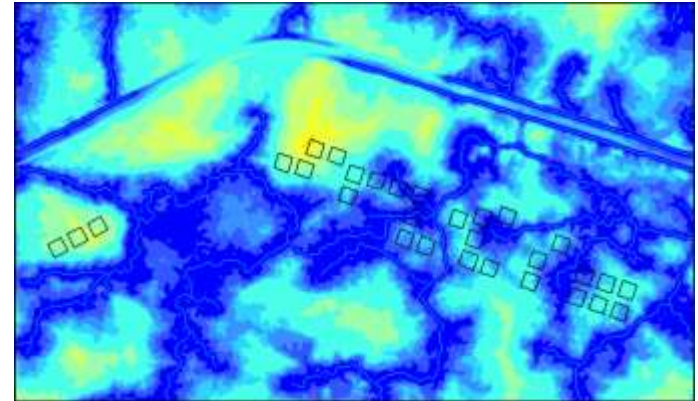


Flow initiation areas

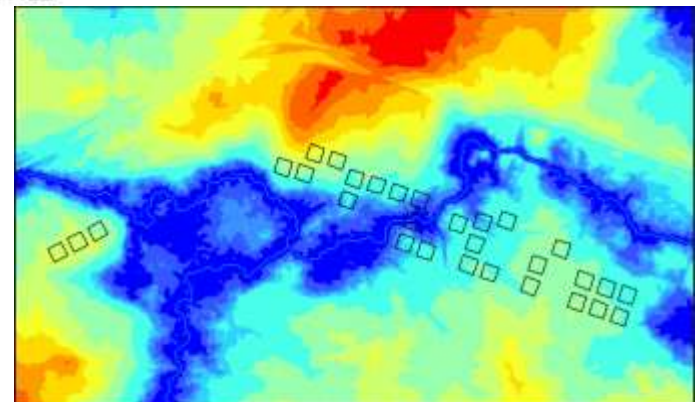


0.5 ha

Example: Peace River, AB



16 ha



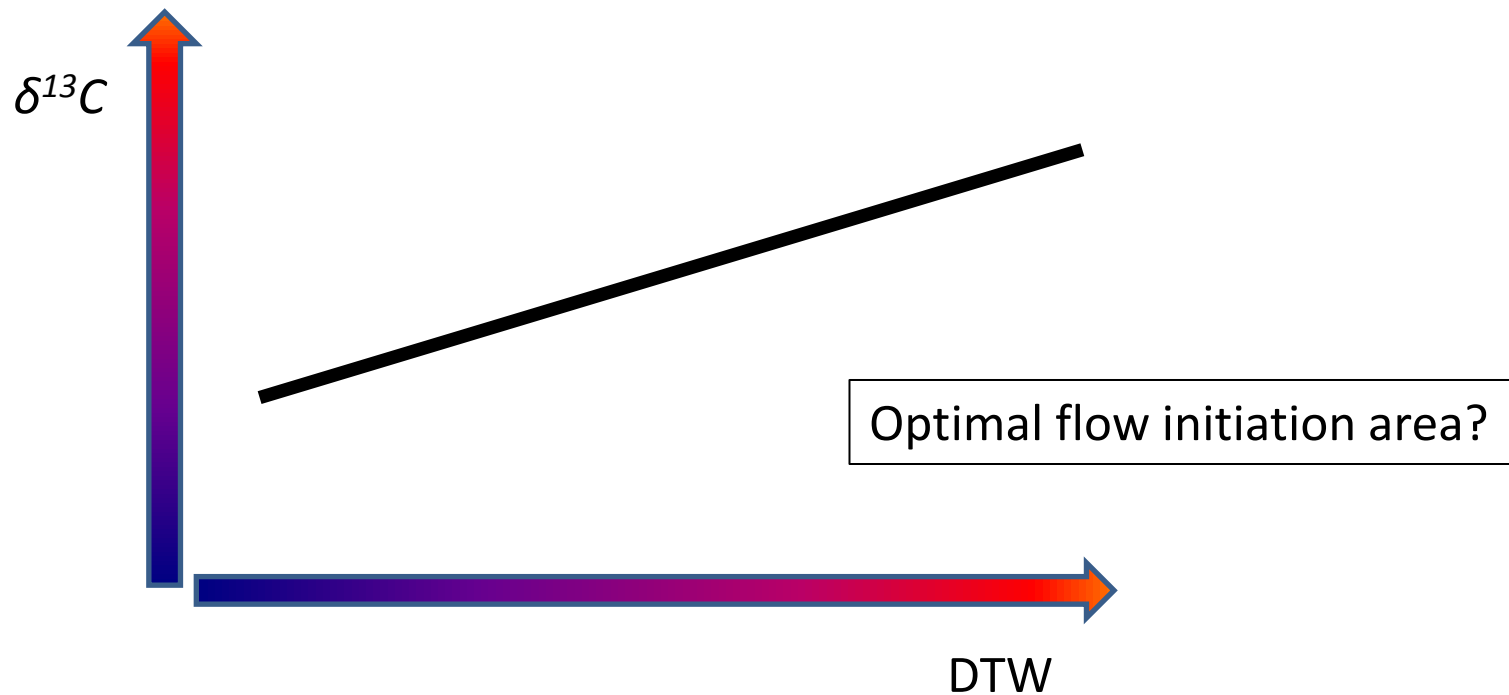
Carbon isotope ratio, $\delta^{13}\text{C}$

Discrimination against ^{13}C :
- by RuBisCO (photosynthesis)
- by stomata (diffusion)

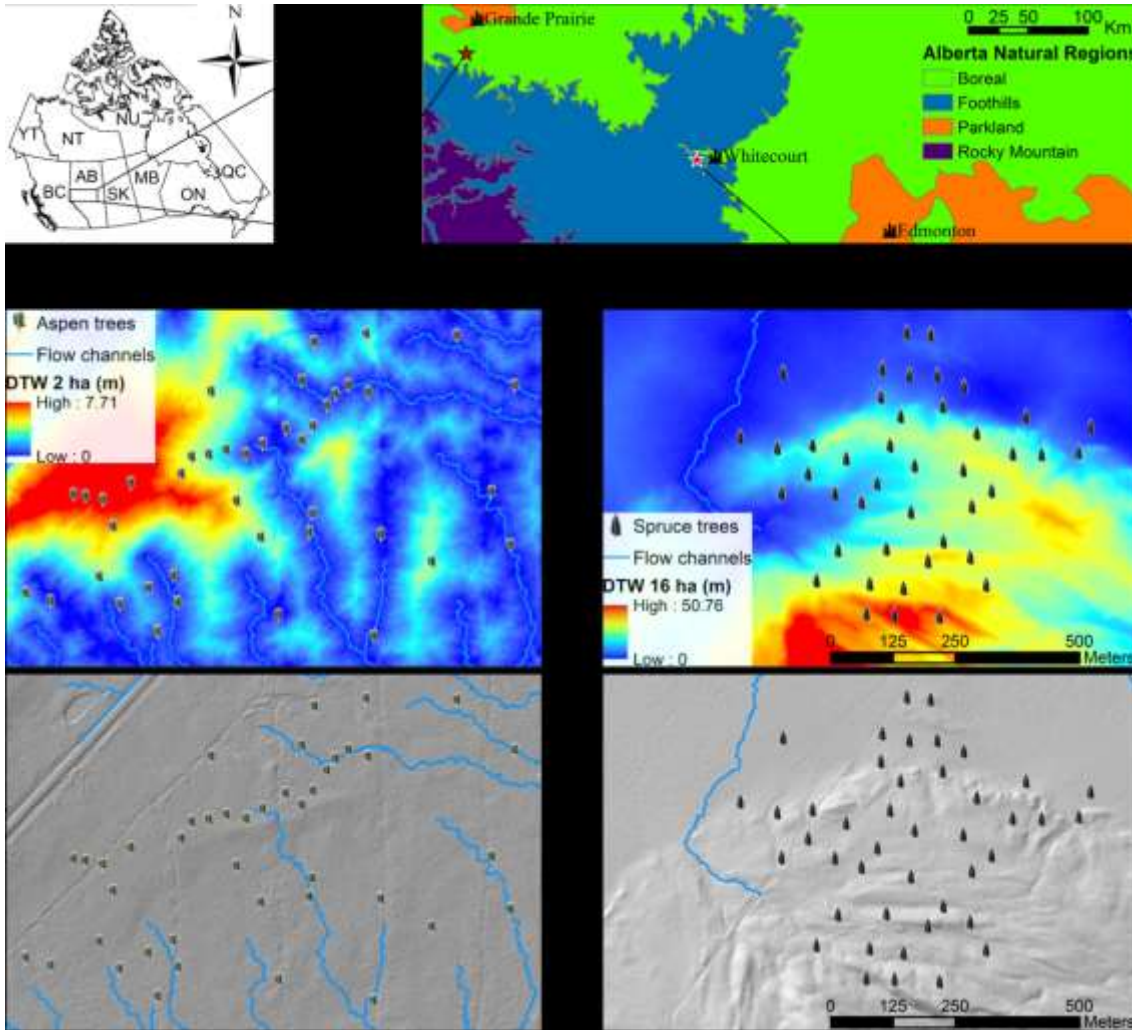
↑ water stress => stomatal closure => ↑ $\delta^{13}\text{C}$

Research question:

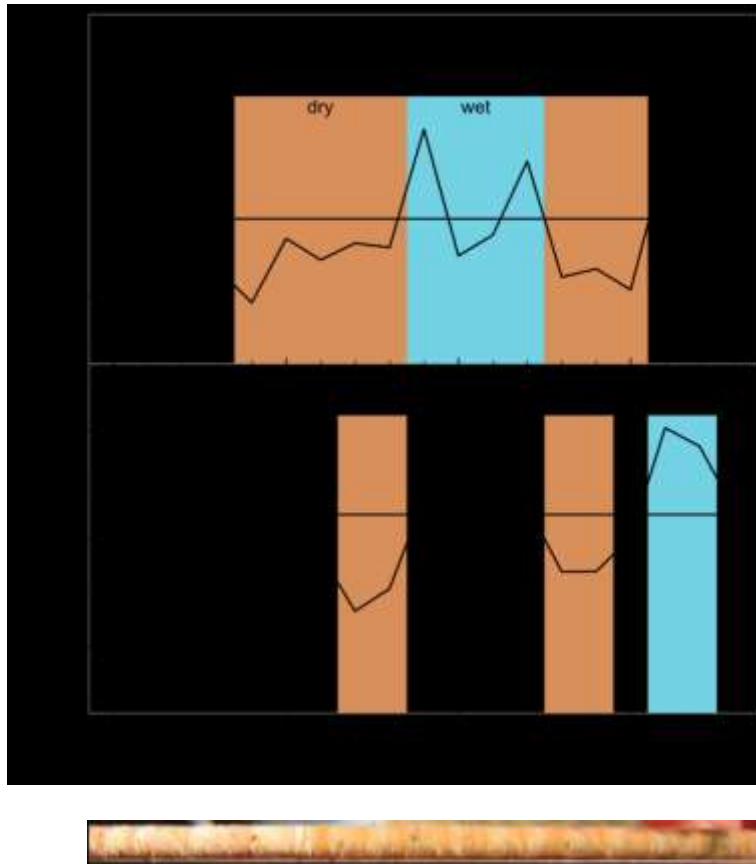
Can DTW predict $\delta^{13}C$ (water stress) in trees?



Methods



Sample processing

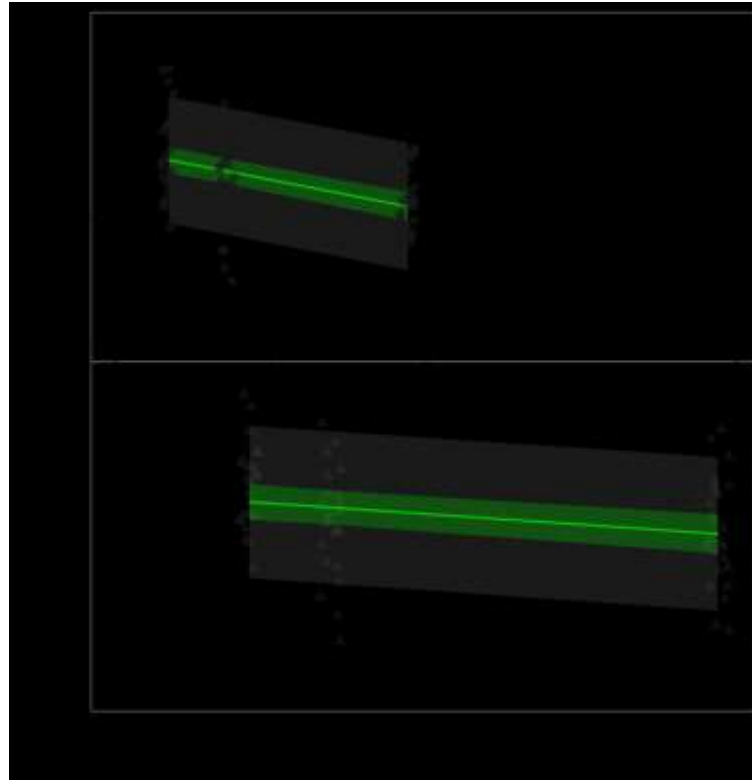


- dried at 70 °C for 48 h
- finely ground with a ball mill
- mass spectrometry system => $\delta^{13}\text{C}$



Results

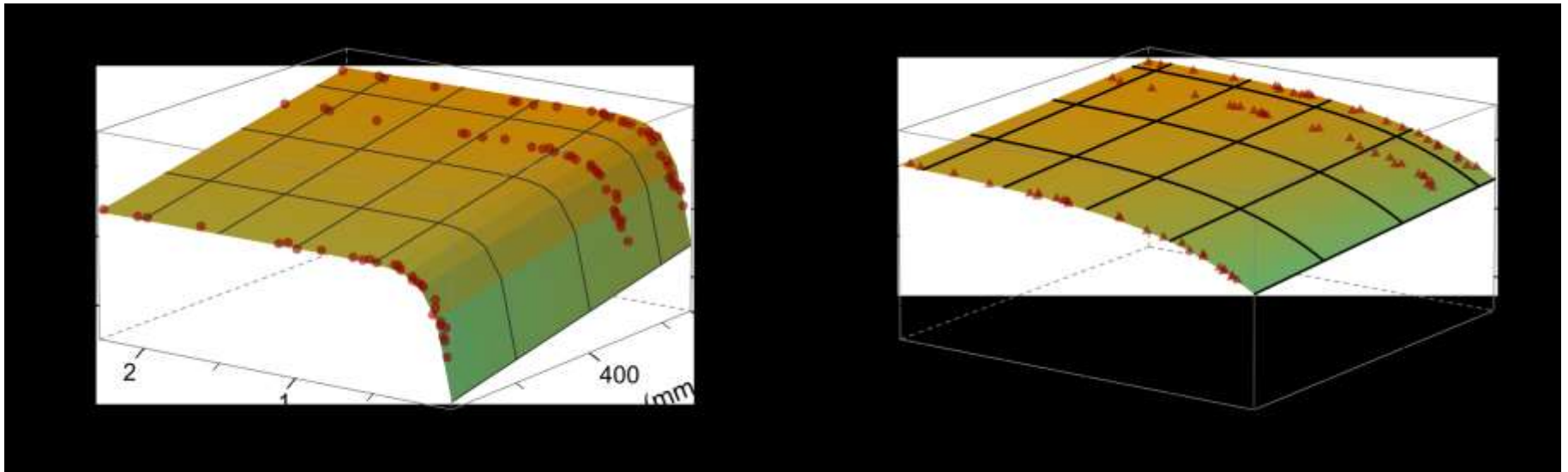
$\delta^{13}\text{C}$ decreases with precipitation



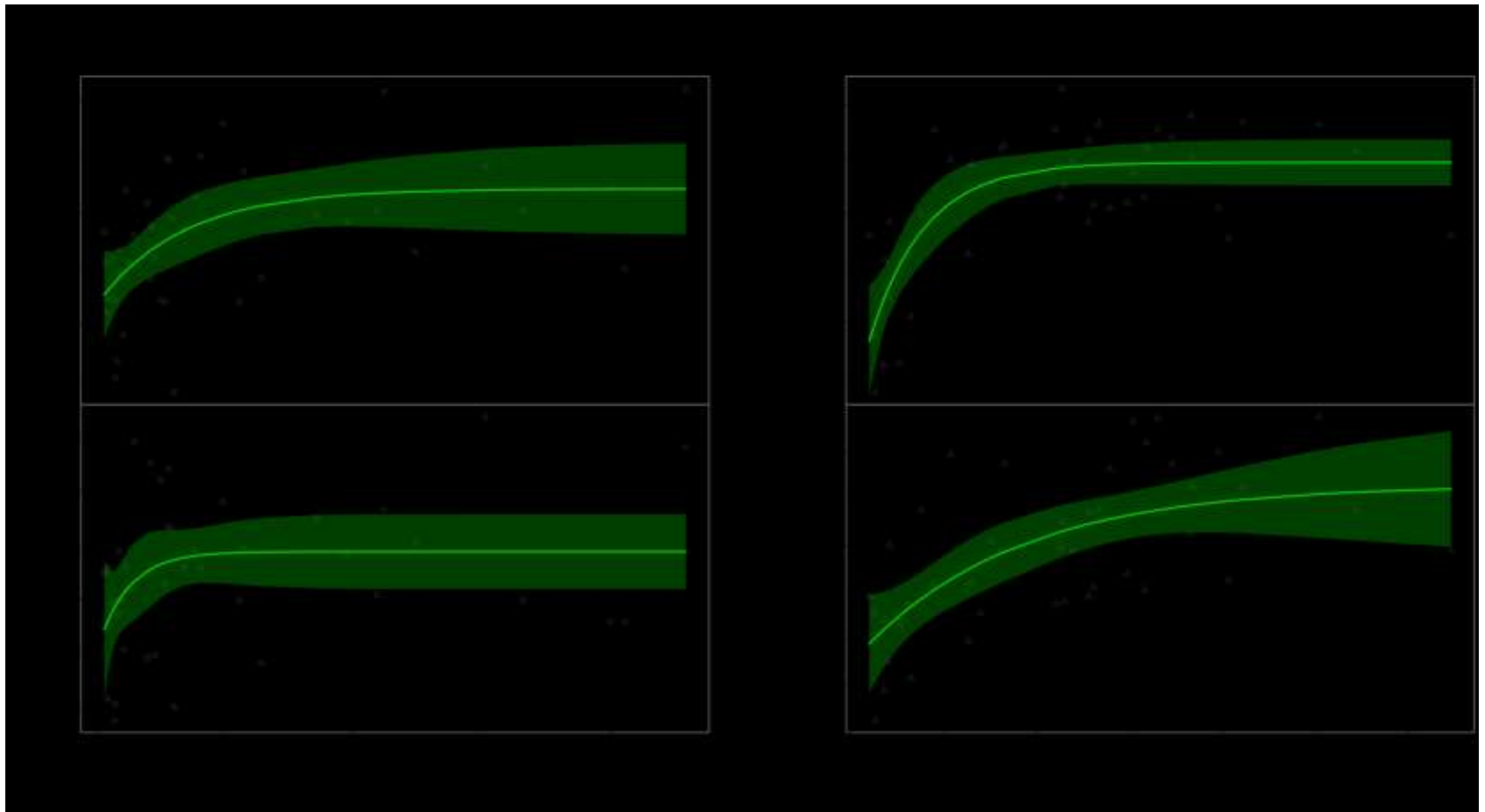
$\delta^{13}\text{C}$ increases with DTW but levels off



$\delta^{13}\text{C}$ increases with DTW and decreases with precip.



Height and DBH increase with DTW



Summary

- DTW can predict water stress at small-scales
- tree size can be obtained from DTW
- optimal flow initiation area depends on terrain topography

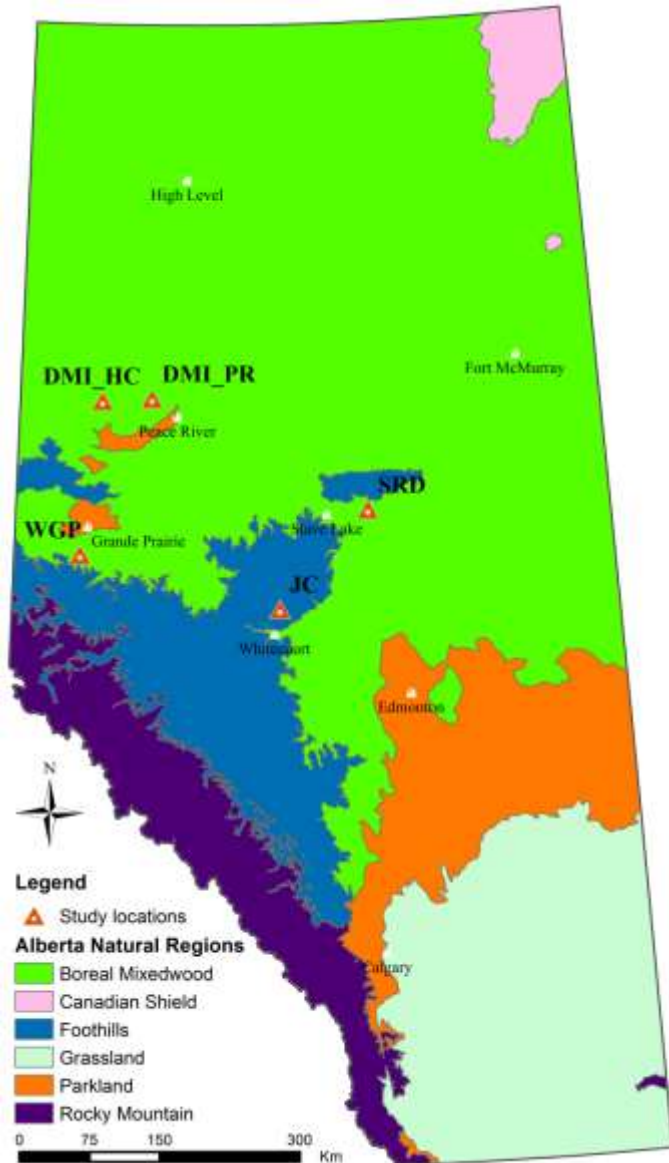
BUT WHY?

Methods

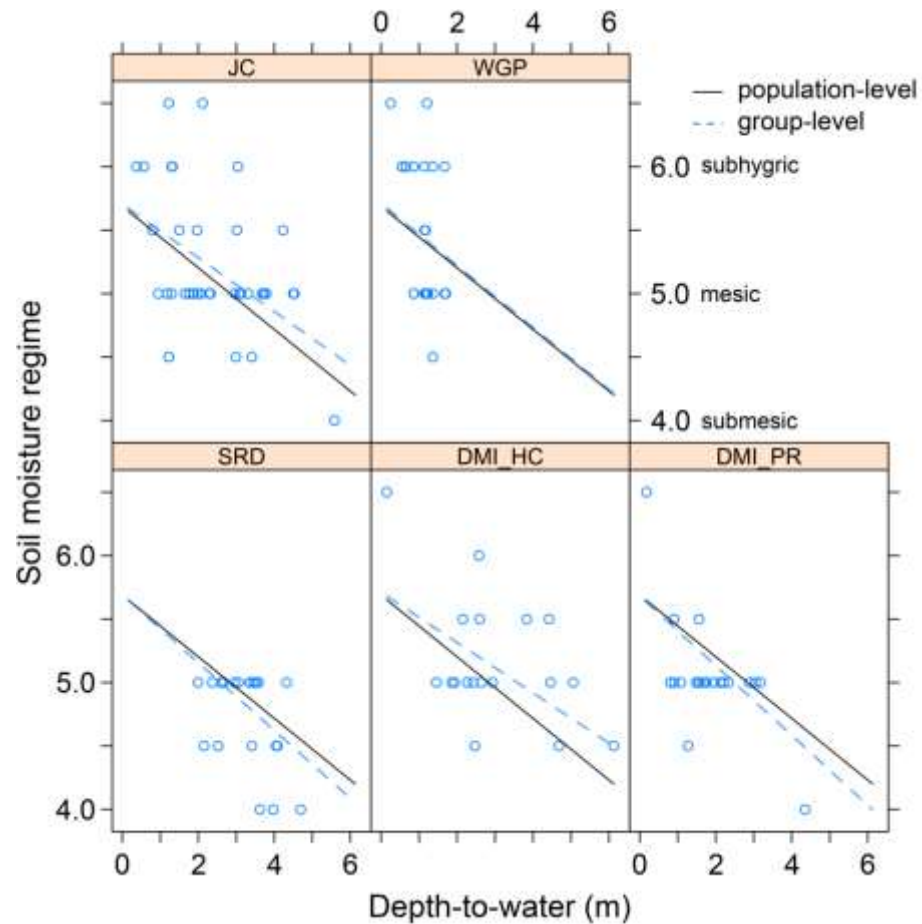
5 Locations

125 plots assessed for:

SMR, SNR, Drainage,
Depth-to-Mottles,
Texture, Ah & Om layers thickness,
Humus (@ JC), Coarse fragment content



Soil moisture regime predicted by DTW at 2 ha



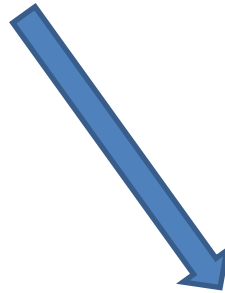
Water-related soil attributes predicted by DTW

Flow initiation area	0.5 ha	1 ha	2 ha	4 ha	8 ha	12 ha	16 ha
Soil moisture	0.09	0.14	0.16	0.12	0.09	0.05	0.05
Drainage	0.15	0.19	0.30	0.18	0.17	0.02	0.02
Depth-to-mottles	0.28	0.17	0.42	0.26	0.21	0.13	0.13
Soil nutrients	0.06	0.06	0.01	0.02	0.02	0.02	0.02
A_h + O_m	0.00	0.00	0.00	0.02	0.01	0.08	0.08

Conclusions

DTW is related to

soil moisture regime
drainage
depth-to-mottles



DTW can predict water stress

Optimal flow initiation area depends on terrain topography

Thank you!

Barbora Smerekova

Vlad Strîmbu

Ivan Bjelanovic



Questions?

Gabriel S. Oltean
oltean@ualberta.ca