EFFECTS OF EXPLICIT LANDSCAPE REPRESENTATION IN A LAND SURFACE SCHEME

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BACKGROUND

- Land Surface Schemes (LSSs) are usually applied as means to provide the lower boundary condition to atmospheric models but now are being used as part of hydrological models.
- LSSs are usually focussed on providing reliable large scale surface states and vertical fluxes to the atmosphere and hydrological inputs to river systems.
- Small scale horizontal processes and landscape heterogeneity are either ignored or aggregated.
- LSS usually assume a uniform snow cover over the entire model grid, which is normally very large (>>10 km x 10 km)

OBJECTIVES

To examine the effects on a LSS prediction of snow cover ablation of the explicit representation of:

1) **Initial Conditions** by comparing distributed and aggregated initial snow water equivalent (SWE), and

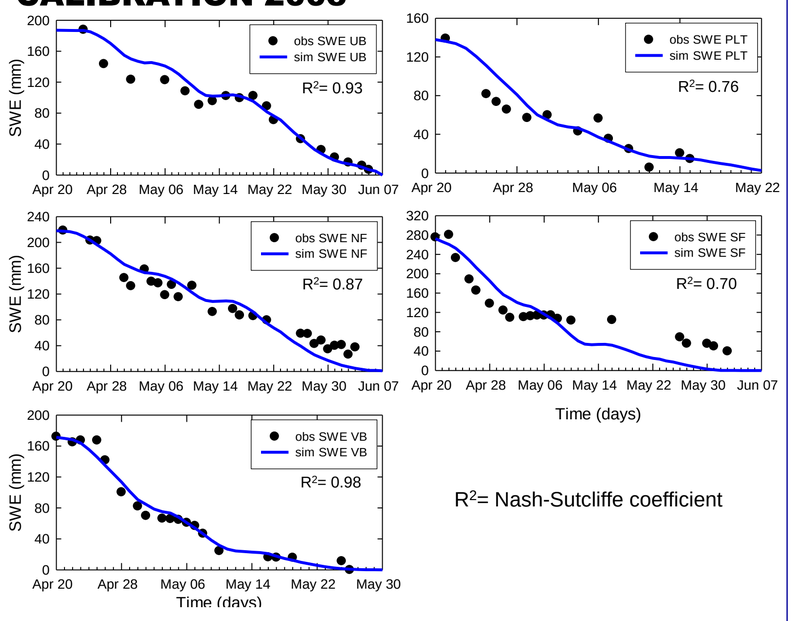
2) **Forcing data**, by contrasting the effect of using incoming short wave radiation corrected by slope and aspect with respect to the use of incoming solar radiation to a flat surface.

METHODOLOGY

Three snow melt periods from 2002 to 2004 were analysed.

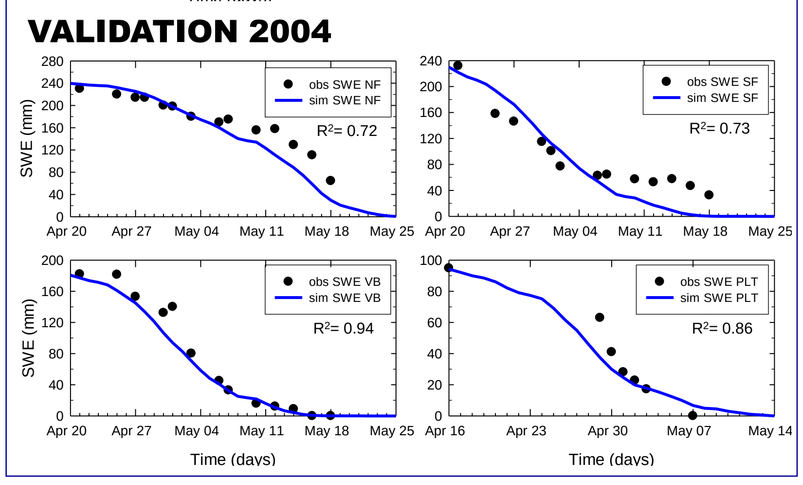
Automatic calibration using the Dynamically Dimensioned Search (DDS) global optimisation algorithm (Tolson and Shoemaker 2007) was performed over 25 parameters (12 for shrubs, 12 for grass, and 1 for snow-cover depletion, SCD) that govern snowmelt in CLASS (Canadian Land Surface Scheme, Verseghy, 1993). In order to reduce the degrees of freedom of the model (i.e. reduce predictive uncertainty), validations were conducted in each landscape using only sensitive and measurable parameters (leaf area index, vegetation height, SCD) while the rest were fixed to their average basin values.

CALIBRATION 2003

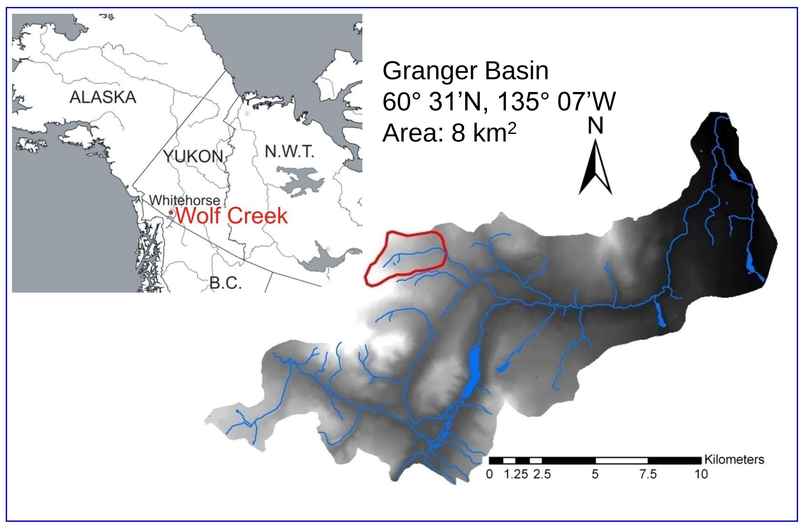


R^2= Nash-Sutcliffe coefficient

VALIDATION 2004



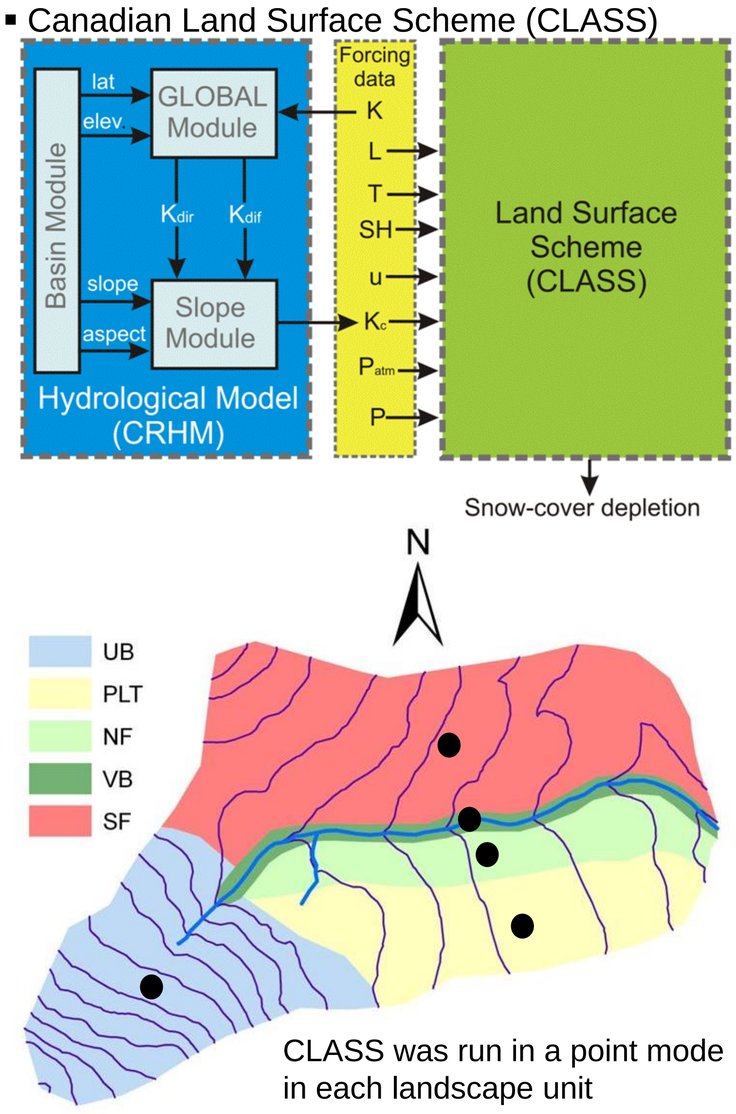
STUDY AREA



MODELLING STRATEGY

Two models were used:

- Cold Region Hydrological Model (CRHM)
- Canadian Land Surface Scheme (CLASS)



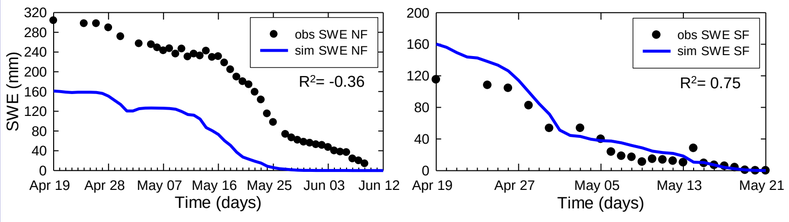
CLASS was run in a point mode in each landscape unit

RESULTS

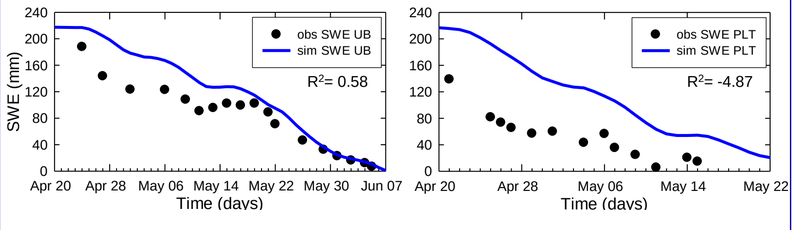
INITIAL CONDITIONS (IC)

Simulations using basin average SWE, rather than landscape unit SWE

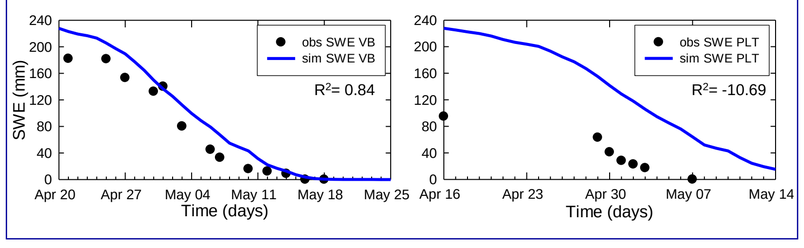
2002



2003



2004



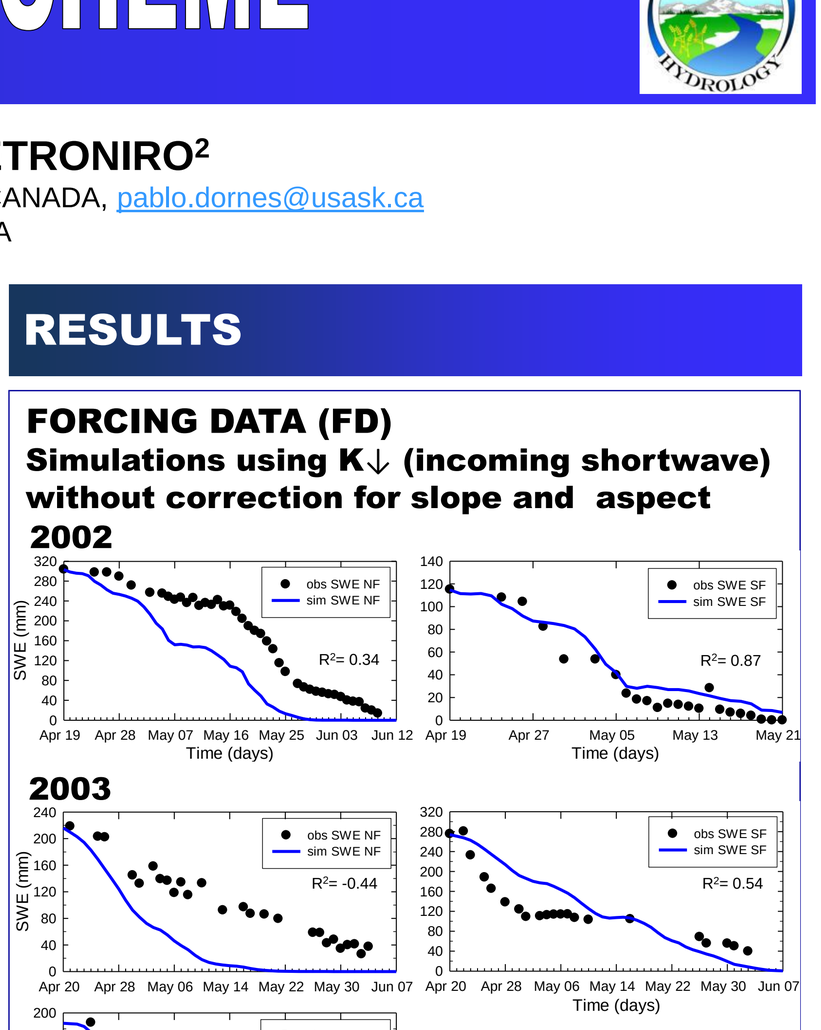
RESULTS

FORCING DATA (FD)

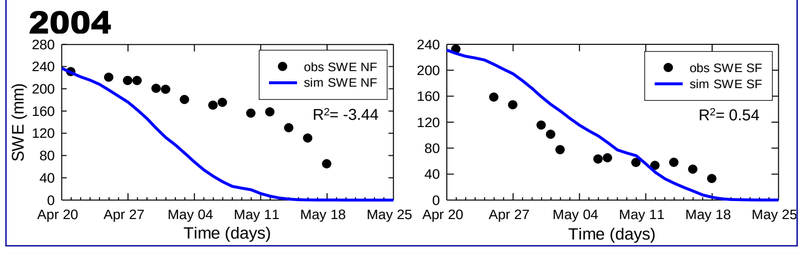
Simulations using K↓ (incoming shortwave) without correction for slope and aspect

2002

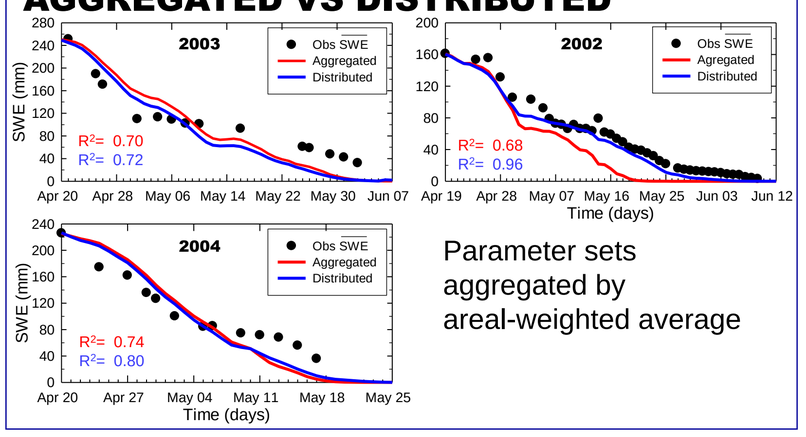
2003



2004



AGGREGATED VS DISTRIBUTED



Parameter sets aggregated by areal-weighted average

DISCUSSION

- Despite the effects due to either IC or FD, combined effects are smaller and some times unimportant.
- Strong redistribution of snow by wind (2003 and 2004), reduces the spatial variability of SCD leading to similar results between the aggregated and distributed models.
- The coincidence of low SWE and high melt energy on the SF slope in 2002 raises the spatial variability of SCD.
- The coincidence of high SWE and high melt energy (2003 and 2004) reduces the spatial variability of SCD.

CONCLUSIONS

- Modelling strategy is based on a combined approach (basin segmentation=inductive, processes description=deductive).
- The conceptualisation of the model grid as a uniform and flat surface was unable to properly describe the observed snow-cover ablation in all the cases.
- The use of a basin-average initial snow-cover proved to have a negative influence in distributed model descriptions.
- Inadequate or unrepresentative forcing data also had unfavourable effects on model predictions.

ACKNOWLEDGMENTS

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