

Drought Impacts on Prairie Snow Hydrology

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Canadian Prairie Drought of 1999-2002

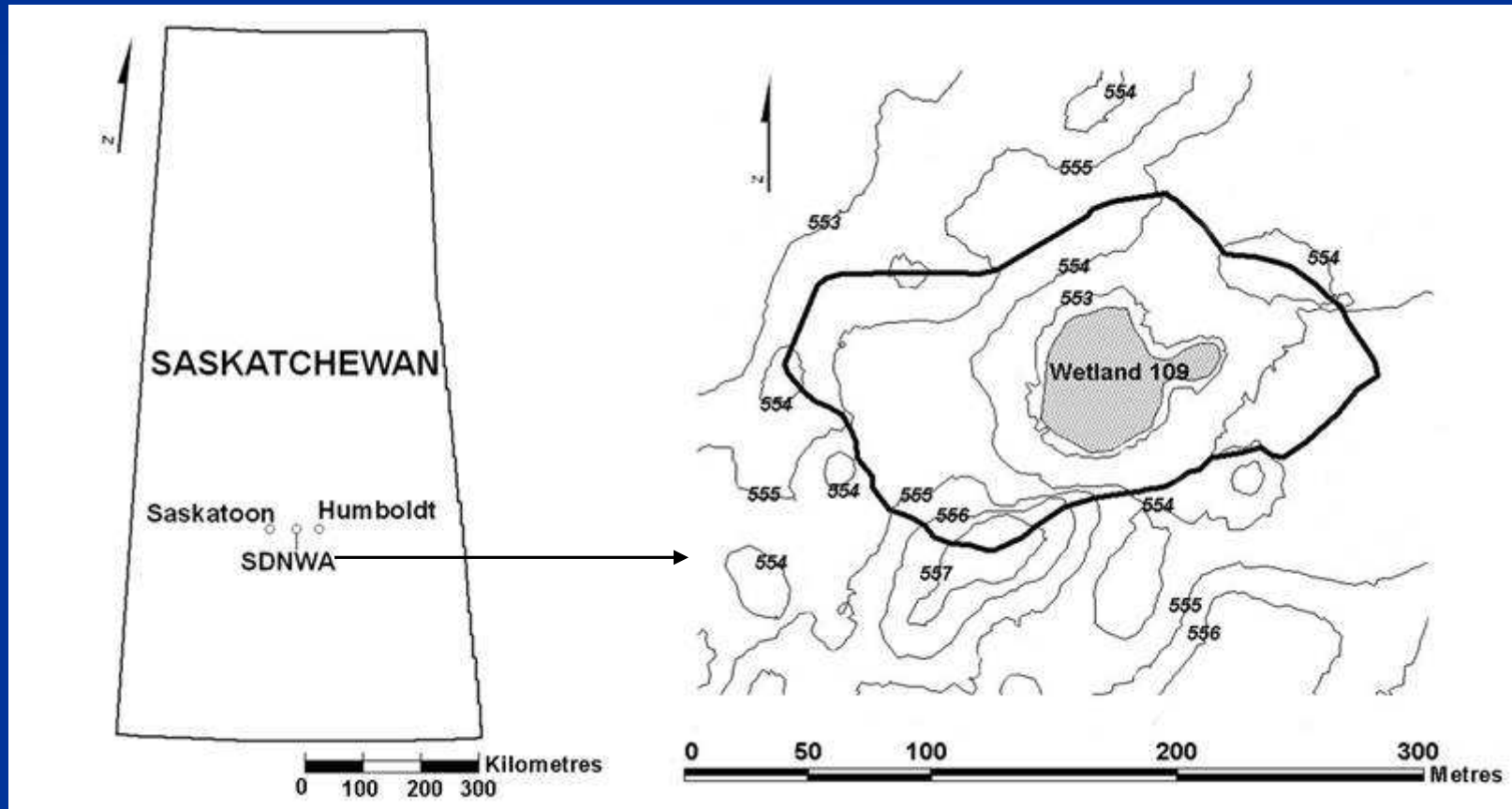
- Drought is a natural hazard and is normal part of climate (Wilhite and Buchanan-Smith, 2005)
- Droughts are frequent on the Canadian Prairies. Over half the years of three decades, 1910-1920, 1930-1939, and 1980-1989 were in drought (Nkemdirim and Weber, 1999)
- The drought of 1999-2004 was the most recent multi-year drought and with 1999-2002 being the most severe on record in parts of the Prairies (Bonsal and Wheaton, 2005; Rannie, 2006)

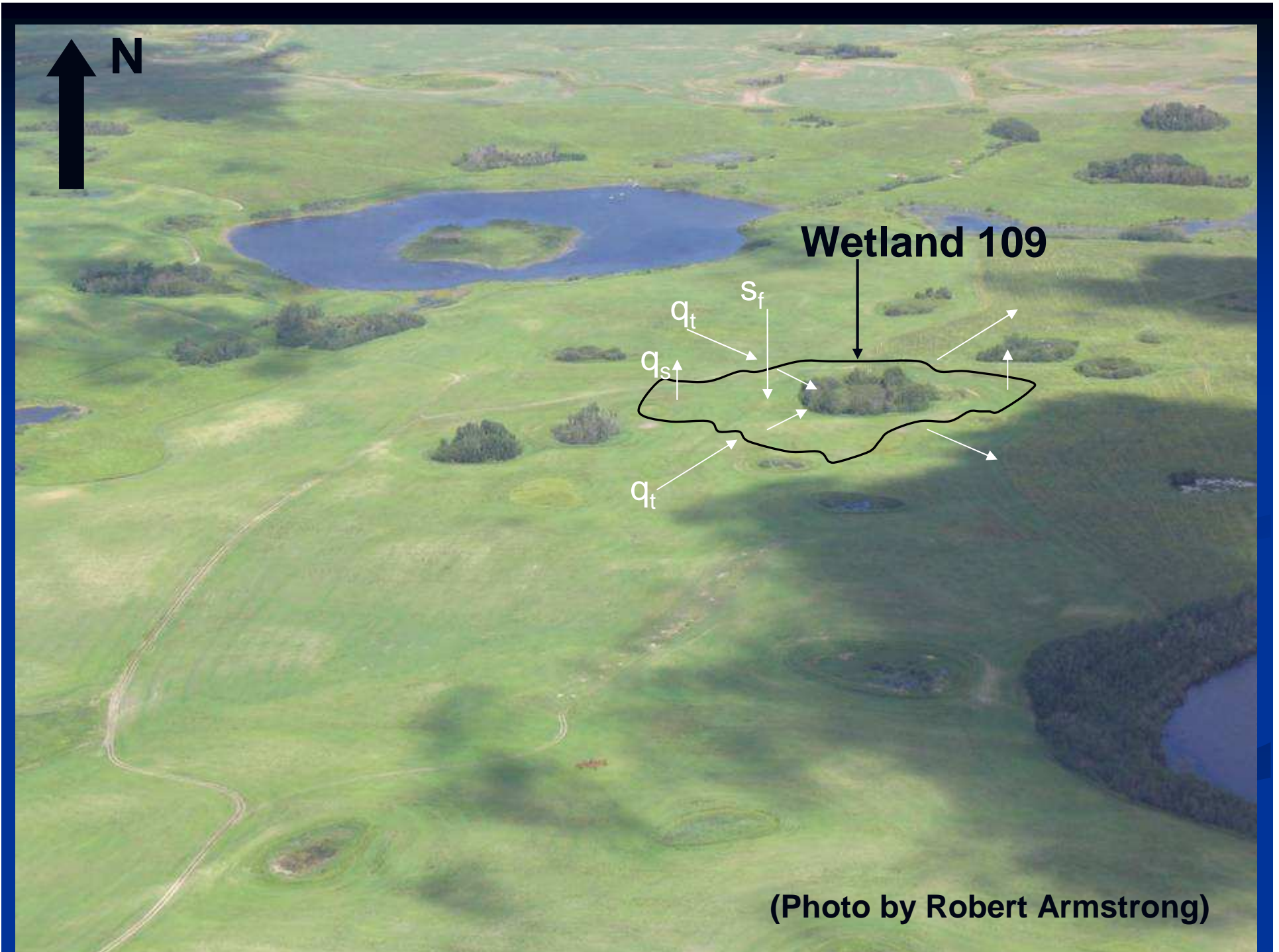
Characteristics and Effects of Drought

- Normally, drought on the Canadian Prairies is featured by below-normal precipitation and above-average air temperature
- Many hydrological processes: blowing snow, blowing snow sublimation, snowmelt, infiltration, snowmelt runoff are sensitive to the meteorological and hydrological conditions during drought (Fang and Pomeroy, 2007)

Study Site

- Wetland 109 at St. Denis National Wildlife Area (SDNWA)
 - Small sized basin (0.02013 km²), ~ 40km east of Saskatoon
 - Rolling landscape, small-sized depressions dominate
 - Internally-drained basin

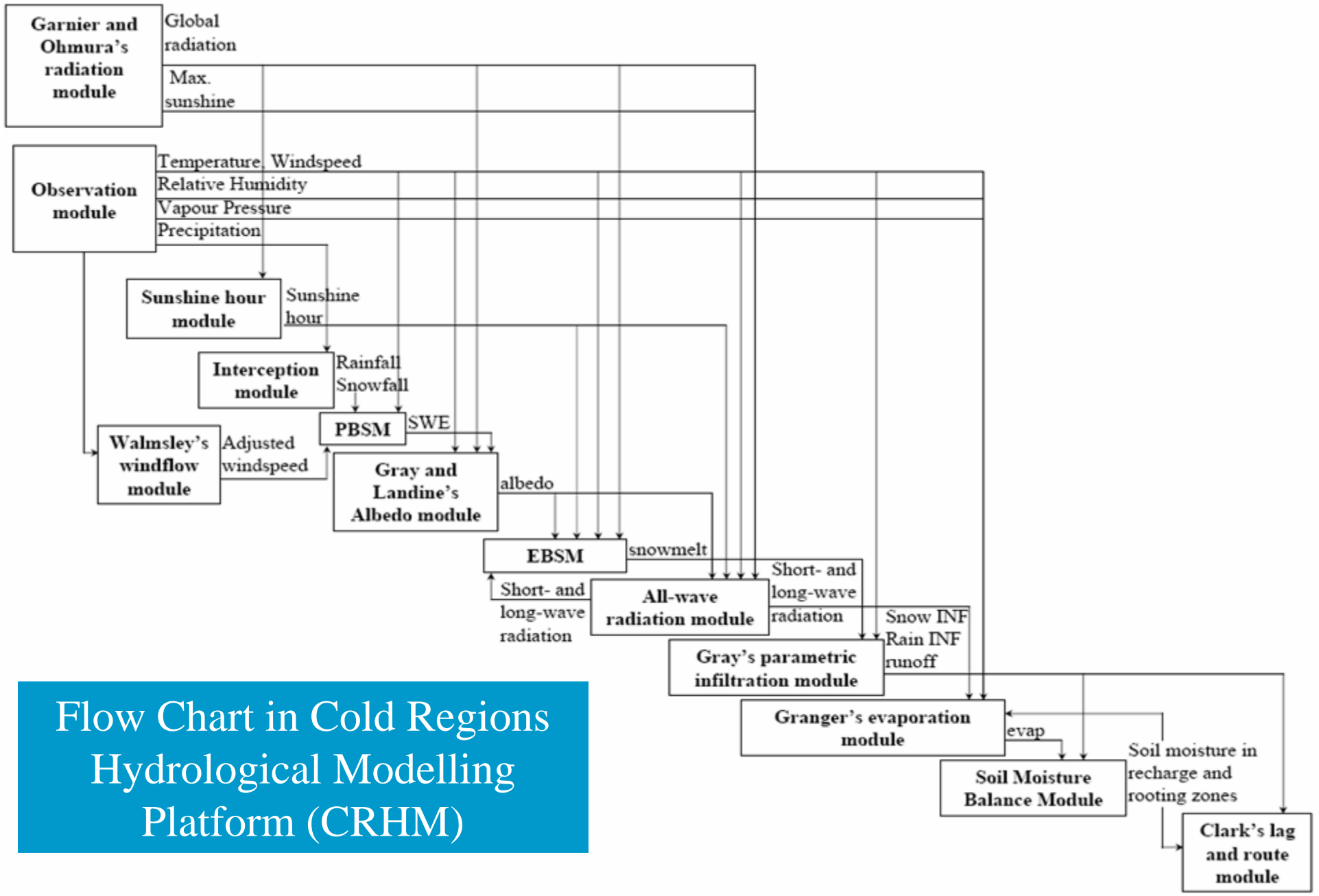




Methods: CRHM drought simulations

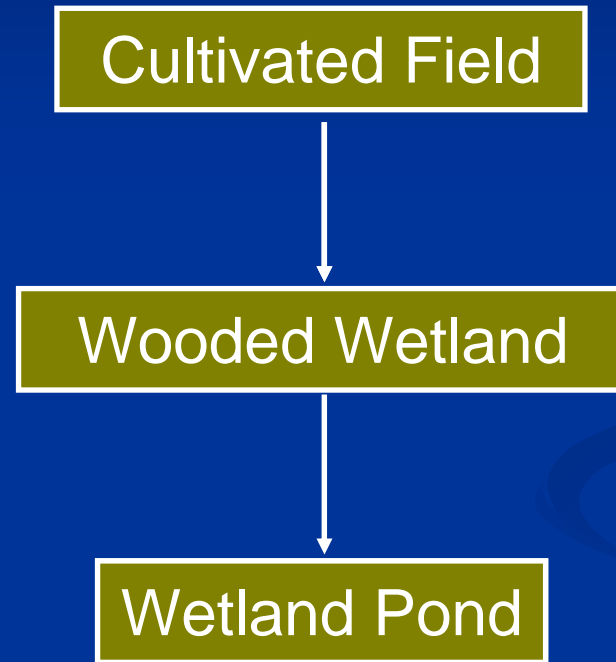
- Physically-based Cold Regions Hydrological Modelling platform was used to estimate SWE, blowing snow sublimation, snow cover duration, winter evaporation, snowmelt, infiltration into unsaturated frozen soils, rainfall infiltration into unfrozen soils, snowmelt runoff for the basin.
- Two HRUs were built to run the CRHM simulations for the basin during hydrological winters of both the severe drought period of 1999-2002 and the non-drought period of 2005-06.

(Note: hydrological winter is Nov 1-May1)



Flow Chart in Cold Regions Hydrological Modelling Platform (CRHM)

Hydrological Response Units (HRUs)

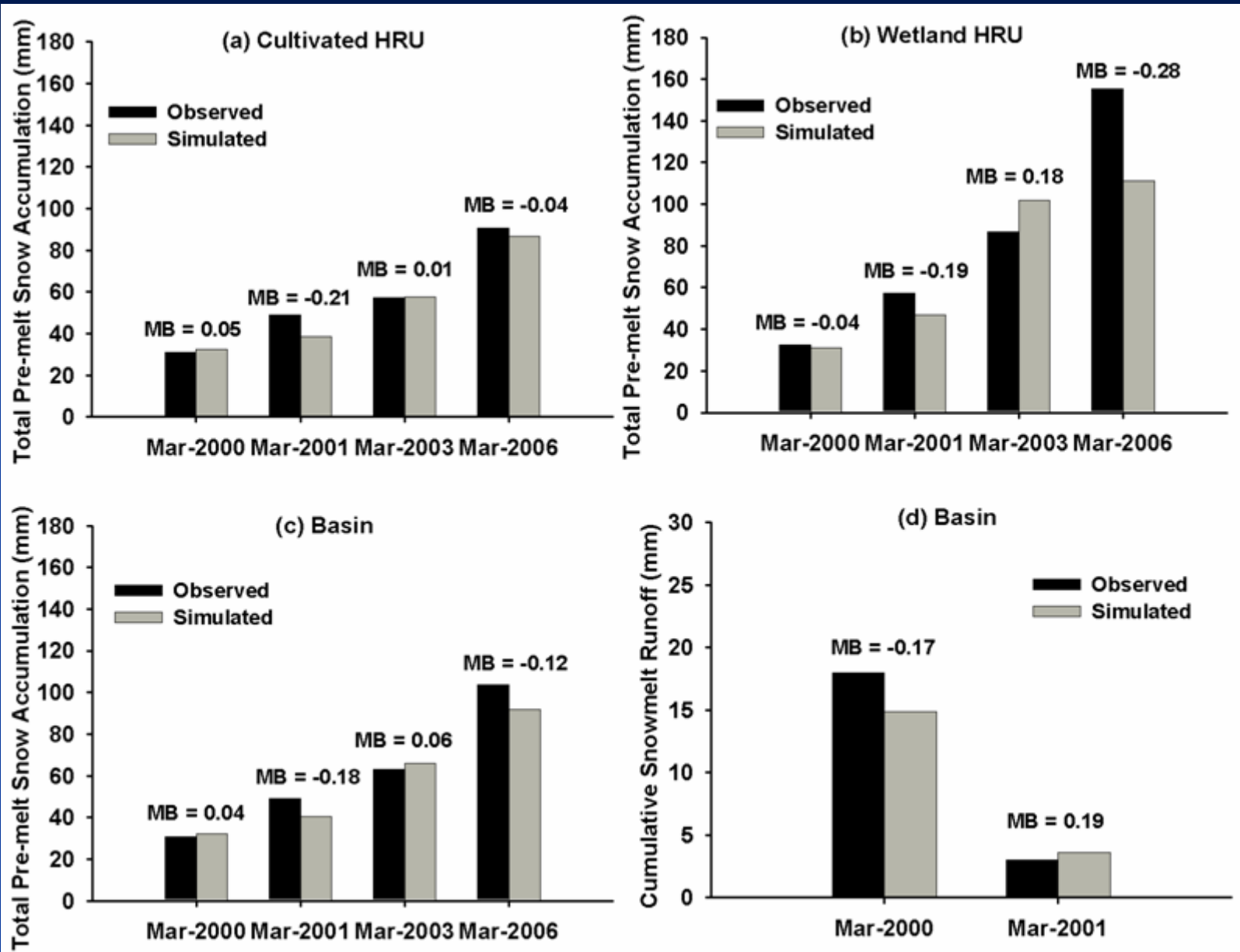


Wetland 109, St. Denis

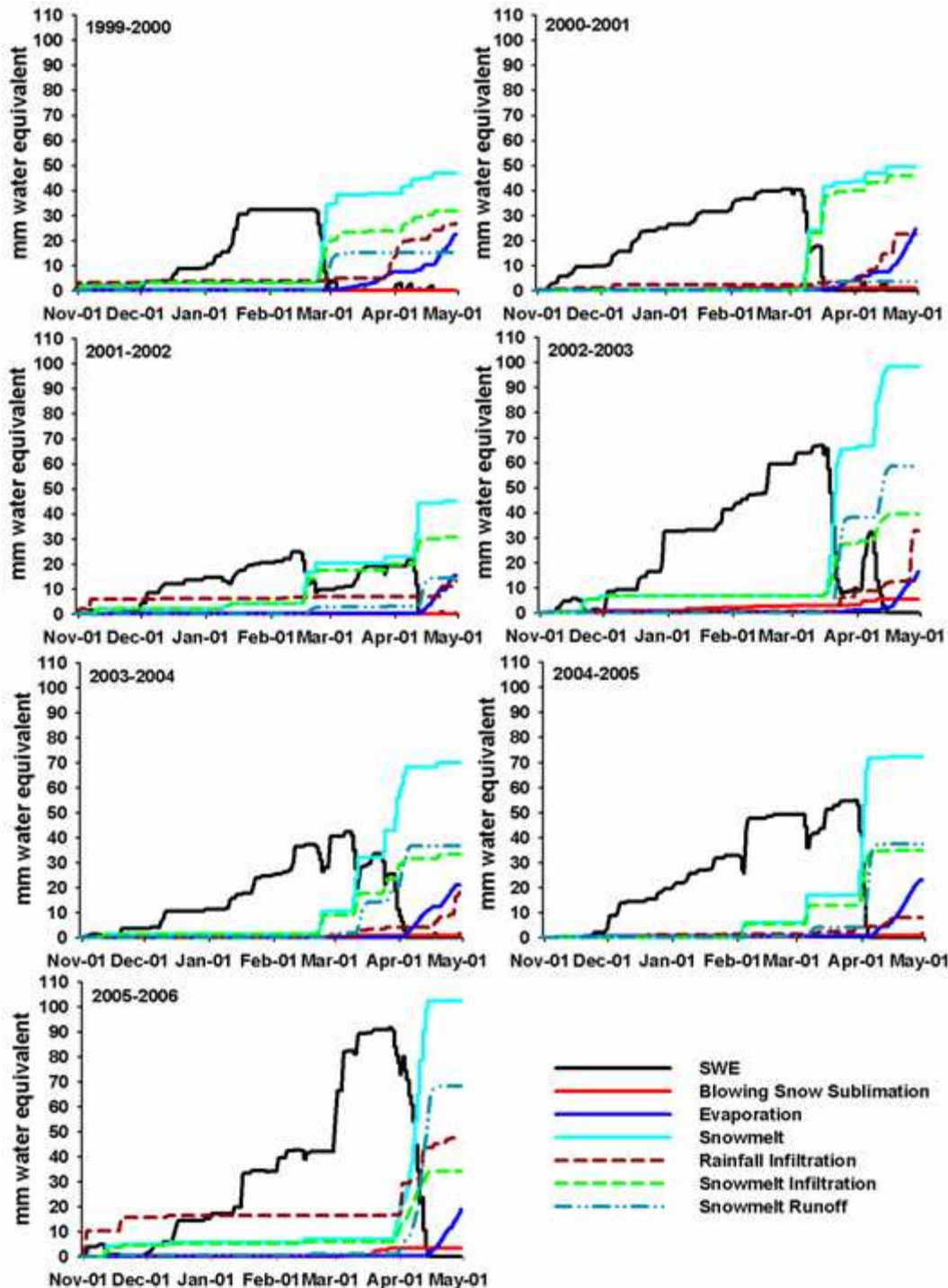
Measured HRU Parameters

HRU Name	Area (km ²)	Fall Soil Moisture (volumetric ratio)	Porosity (ratio)	Vegetation Height (m)
1999-2000				
Cultivated (stubble)	0.01601	0.21	0.48	0.3
Wetland	0.00412	0.23	0.54	5
2000-2001				
Cultivated (stubble)	0.01601	0.19 (0.09)	0.48	0.1
Wetland	0.00412	0.22 (0.00)	0.54	5
2001-2002				
Cultivated (stubble)	0.01601	0.19	0.48	0.15
Wetland	0.00412	0.22	0.54	5
2005-2006				
Cultivated (stubble)	0.01601	0.27	0.48	0.2
Wetland	0.00412	0.32	0.54	5

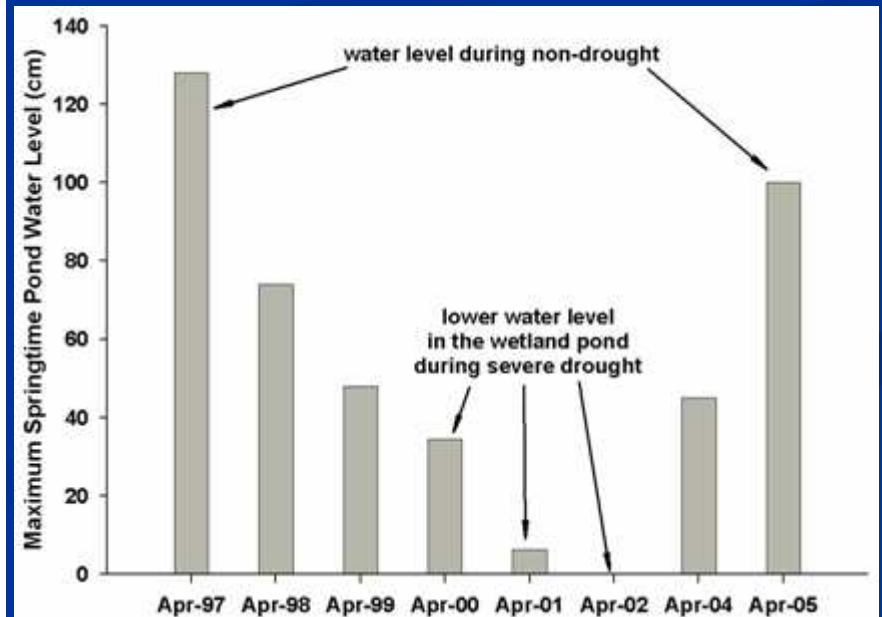
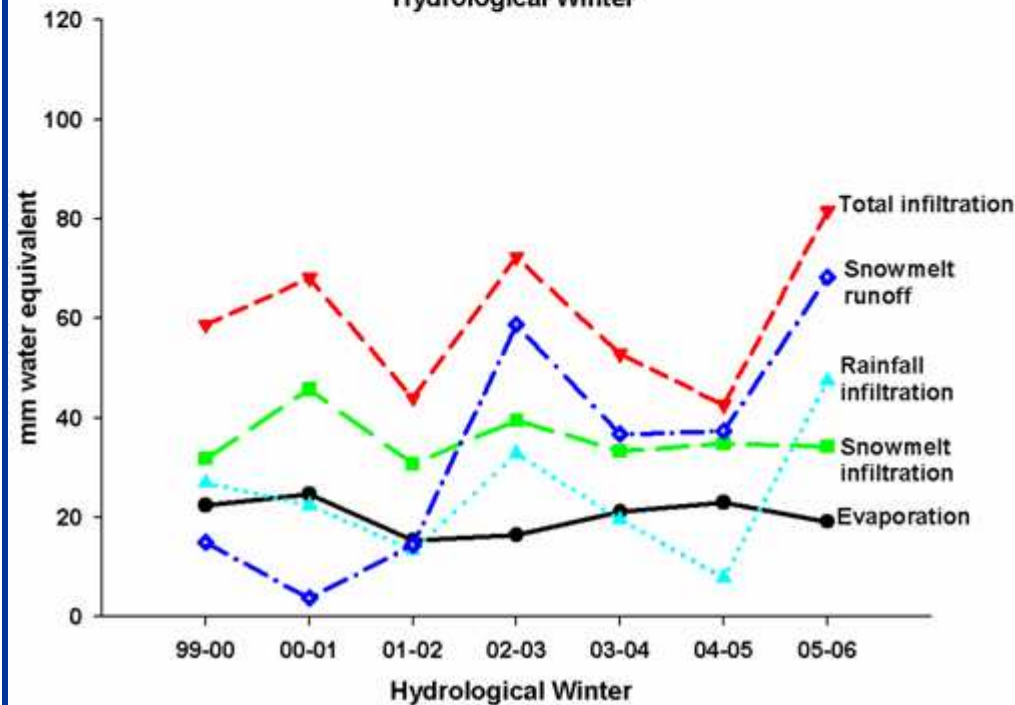
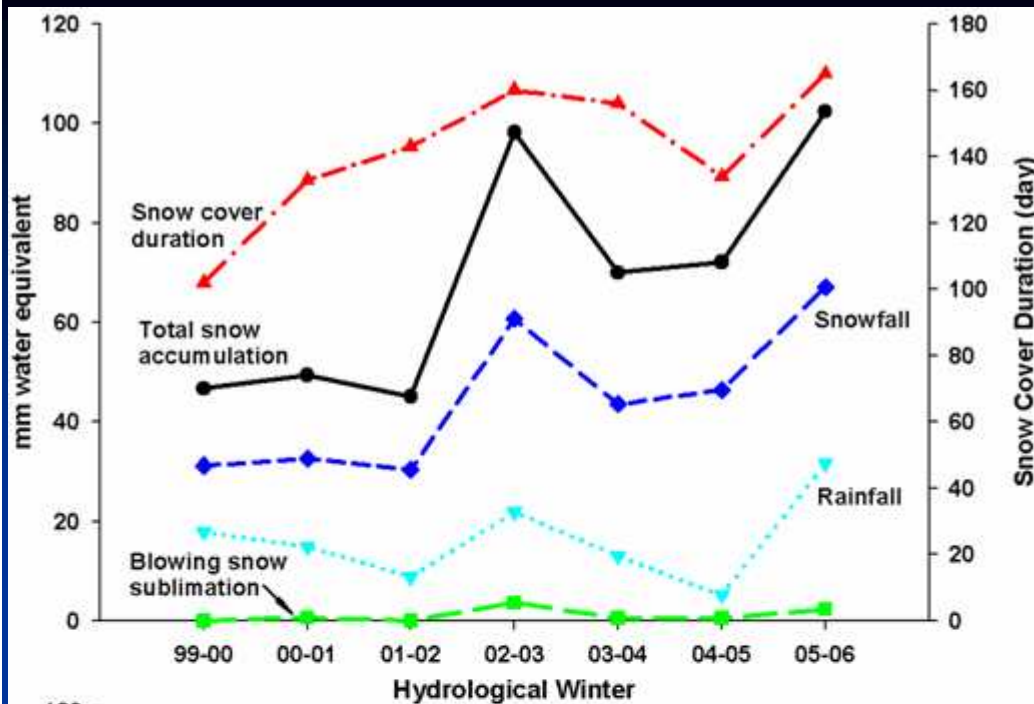
Results: Snowmelt Runoff Test at Wetland 109, St Denis



Results: Simulations of 1999-2005 Drought Impact at St. Denis



Results: Simulations of 1999-2005 Drought Impact at St. Denis



Conclusions

- Combined effects of lower soil moisture, shorter vegetation and colder and drier meteorology in the recent prairie drought caused
 - lower snow accumulation,
 - shorter snow-cover season,
 - reduced blowing snow sublimation, and
 - much lower snowmelt runoff for a small prairie wetland.
- Three years of less than 20 mm of snowmelt runoff resulted in the wetland drying out by April 2002. It has since recovered.

Acknowledgements

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