

Monitoring groundwater and soil moisture with observation wells

Garth van der Kamp

Water Science and Technology, Environment Canada

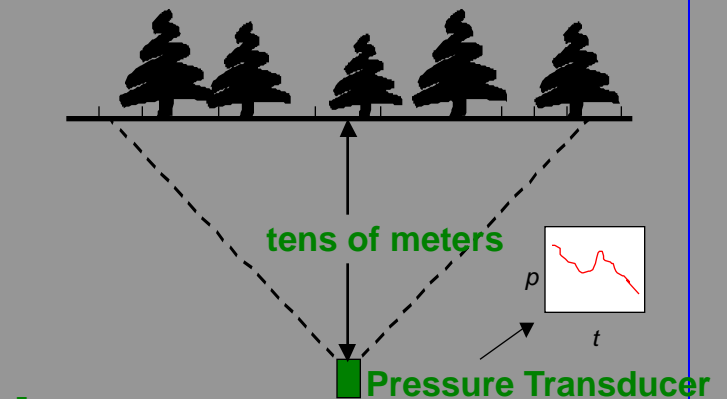
**Bruce Davison
John Fahlman
Kei Lo
Saul Marin
Alan Pietroniro
Craig Smith
Randy Schmidt
Brenda Toth
César Pérez Valdivia**

Overview of the Geological Weighing Lysimeter

► Fundamentals

- Changes of mechanical surface loading are instantaneously transmitted to deep saturated formations resulting in change of pore water pressure;
- Observation wells in confined aquifers can therefore detect pore pressure changes due to hydrological processes such as:
 - ✓ Snow accumulation;
 - ✓ Rainfall;
 - ✓ Evapotranspiration

Conceptual Sketch of Geological Weighing Lysimeter Installation



Duck Lake observation well site - climate station installed in 2008.



Spring of 2001 (looking south)

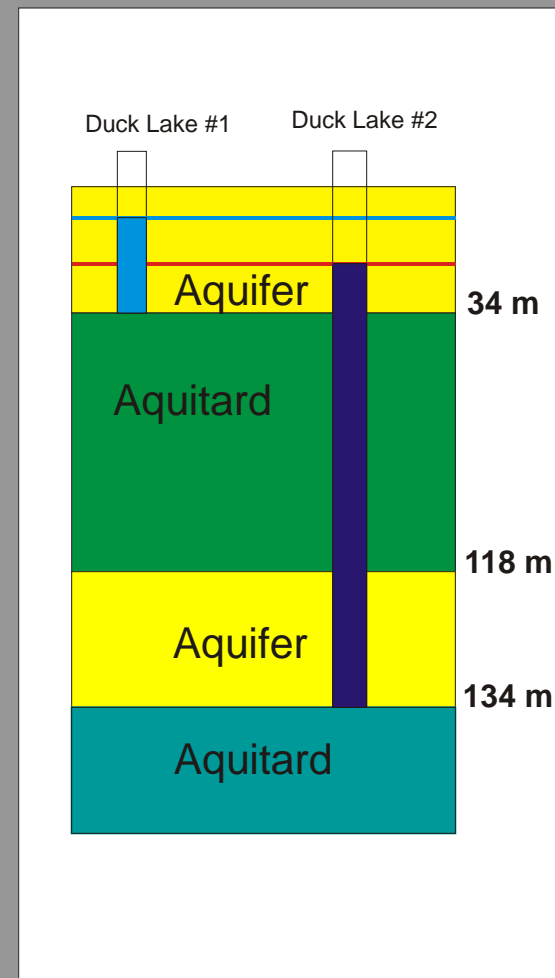
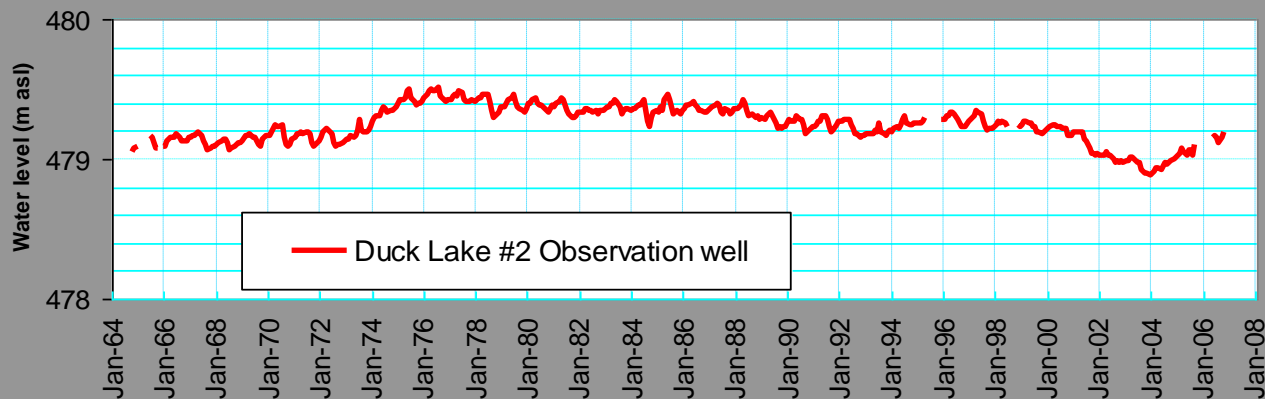
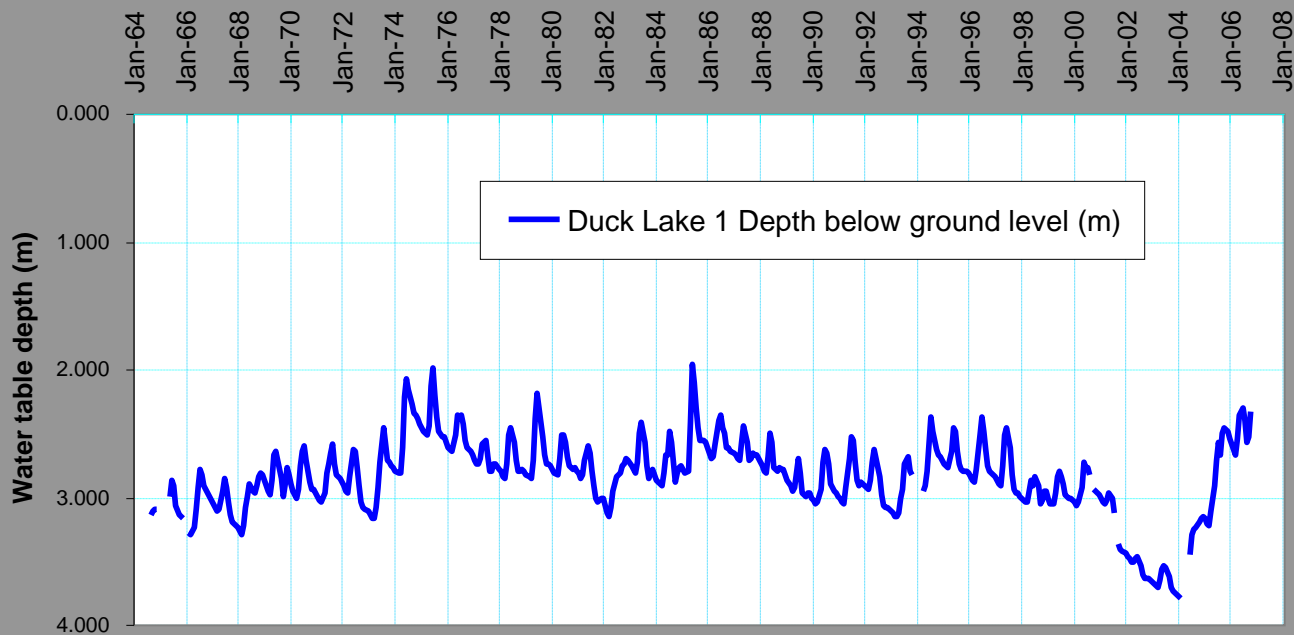
Spring 2001

August 2010



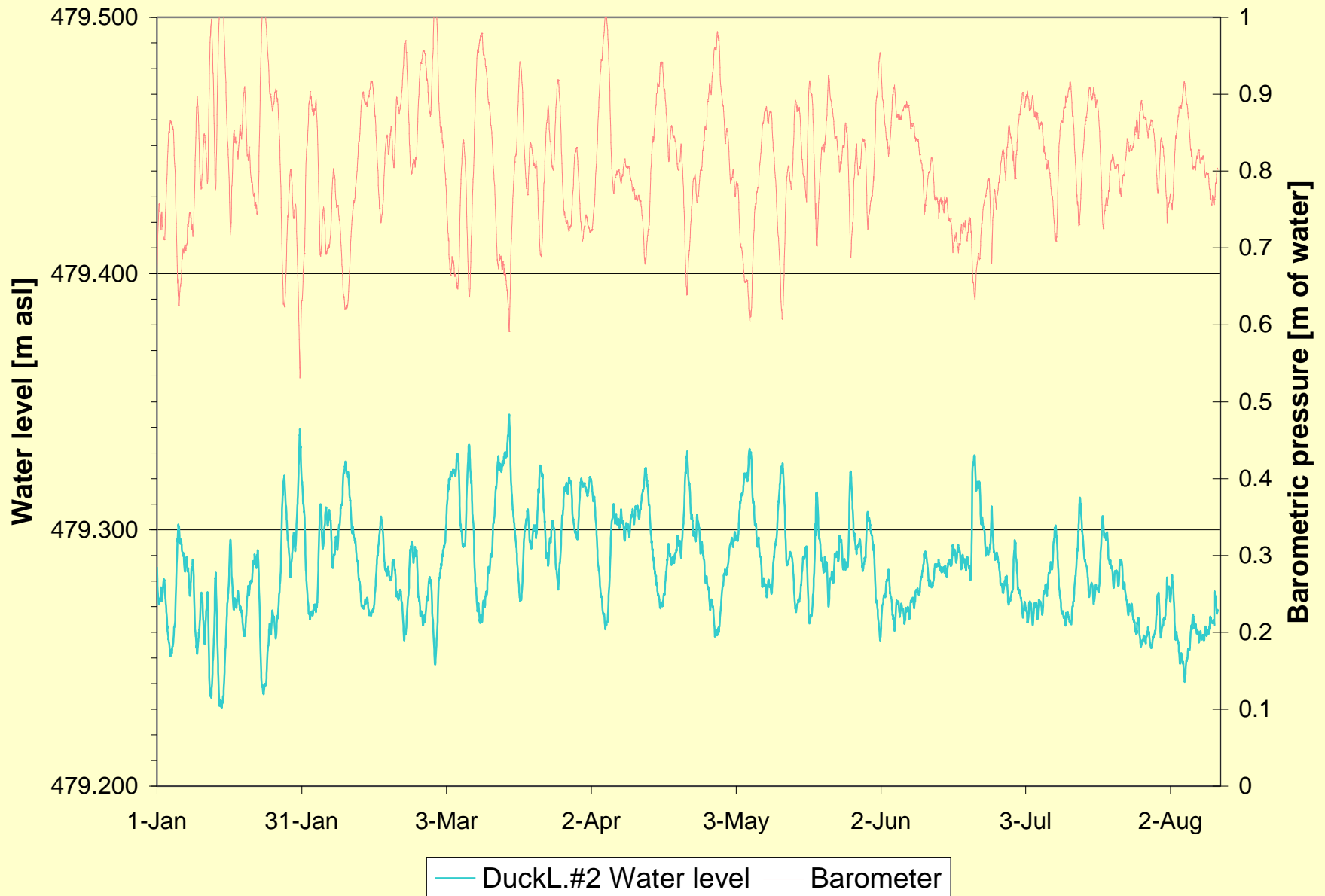
Duck Lake SK Observation wells: water levels, 1964-2006

[Source: SK Watershed Authority, www.swa.ca]



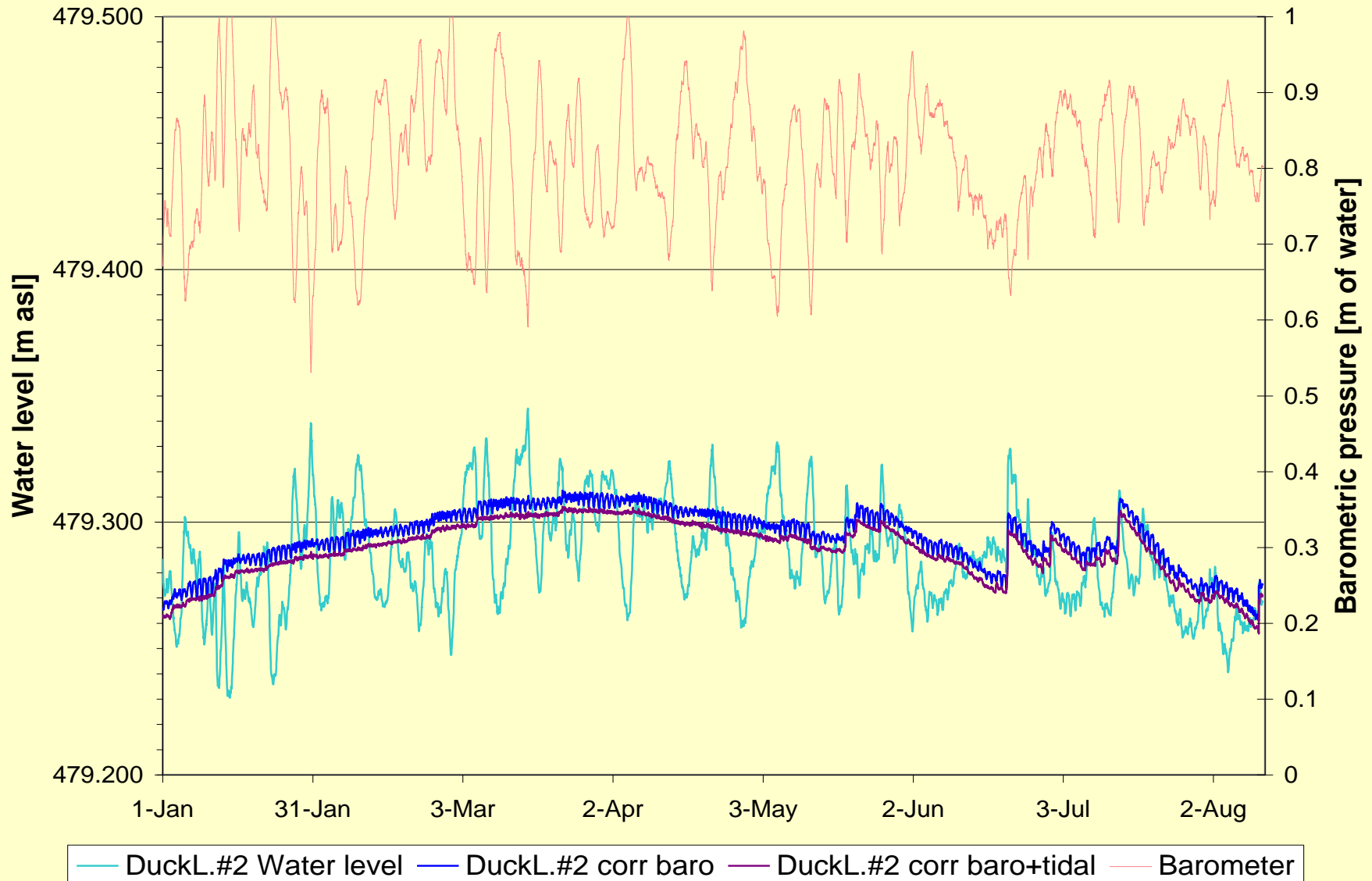
Duck Lake # 2 observation well and barometric pressure

Raw data Jan 1 – August 10, 2009

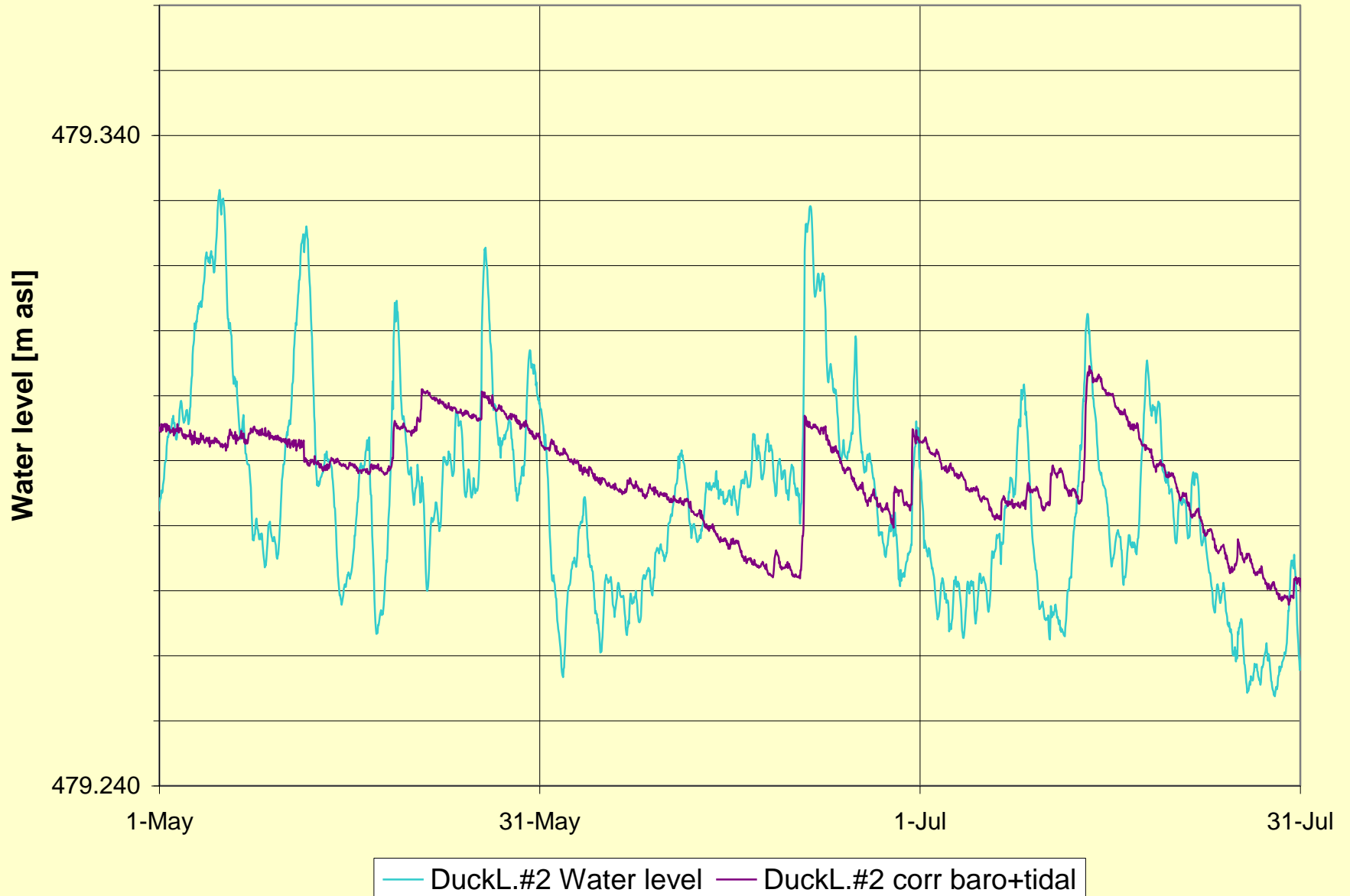


Duck Lake # 2 observation well, and barometric pressure

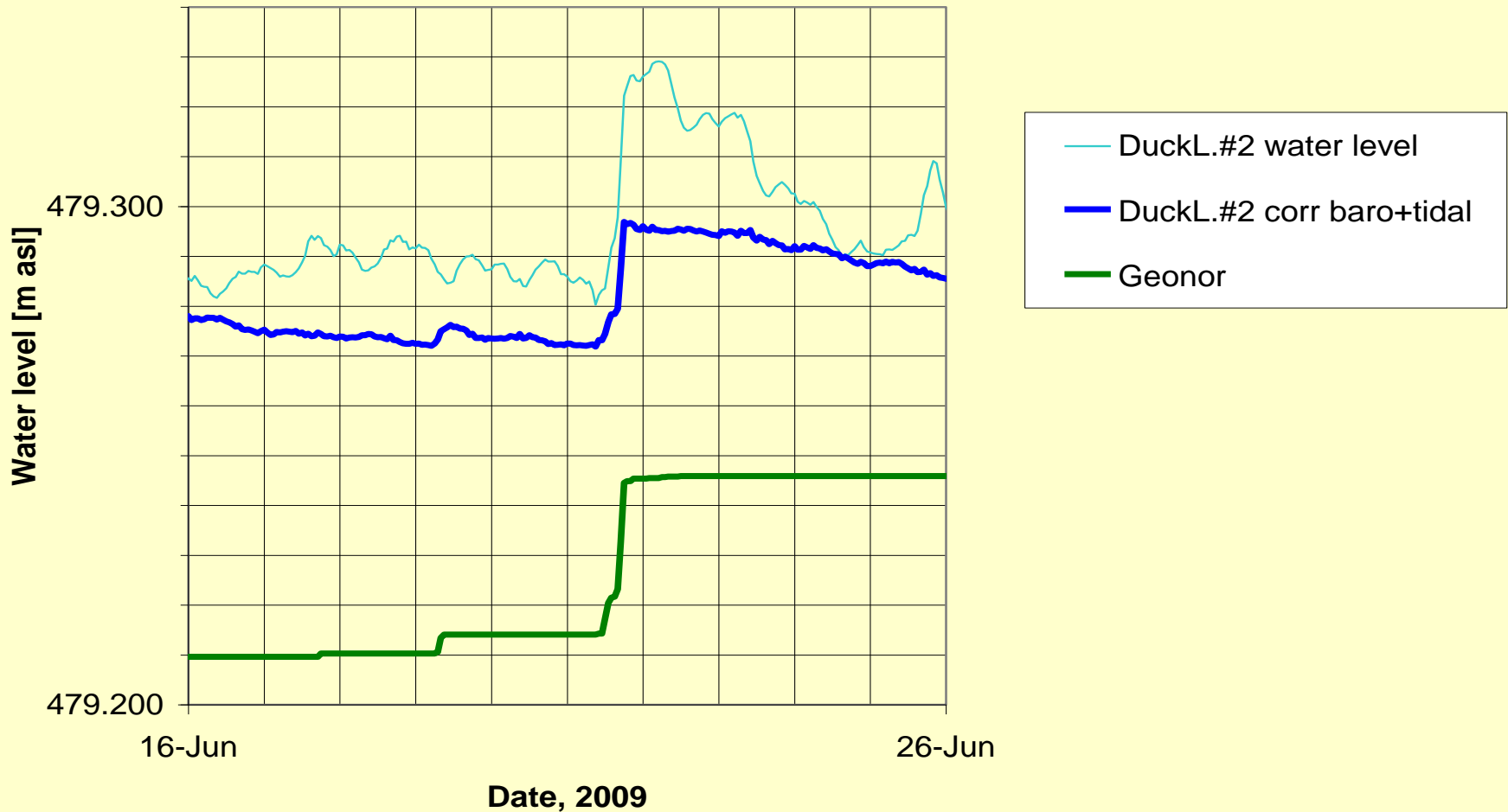
Raw data Jan 1 – August 10, 2009, plus corrections for barometric (multiplied by loading efficiency of 0.798) and earth tides



Duck Lake # 2 observation well: raw data and corrected data: Zoom in: May 1 – July 31, 2009

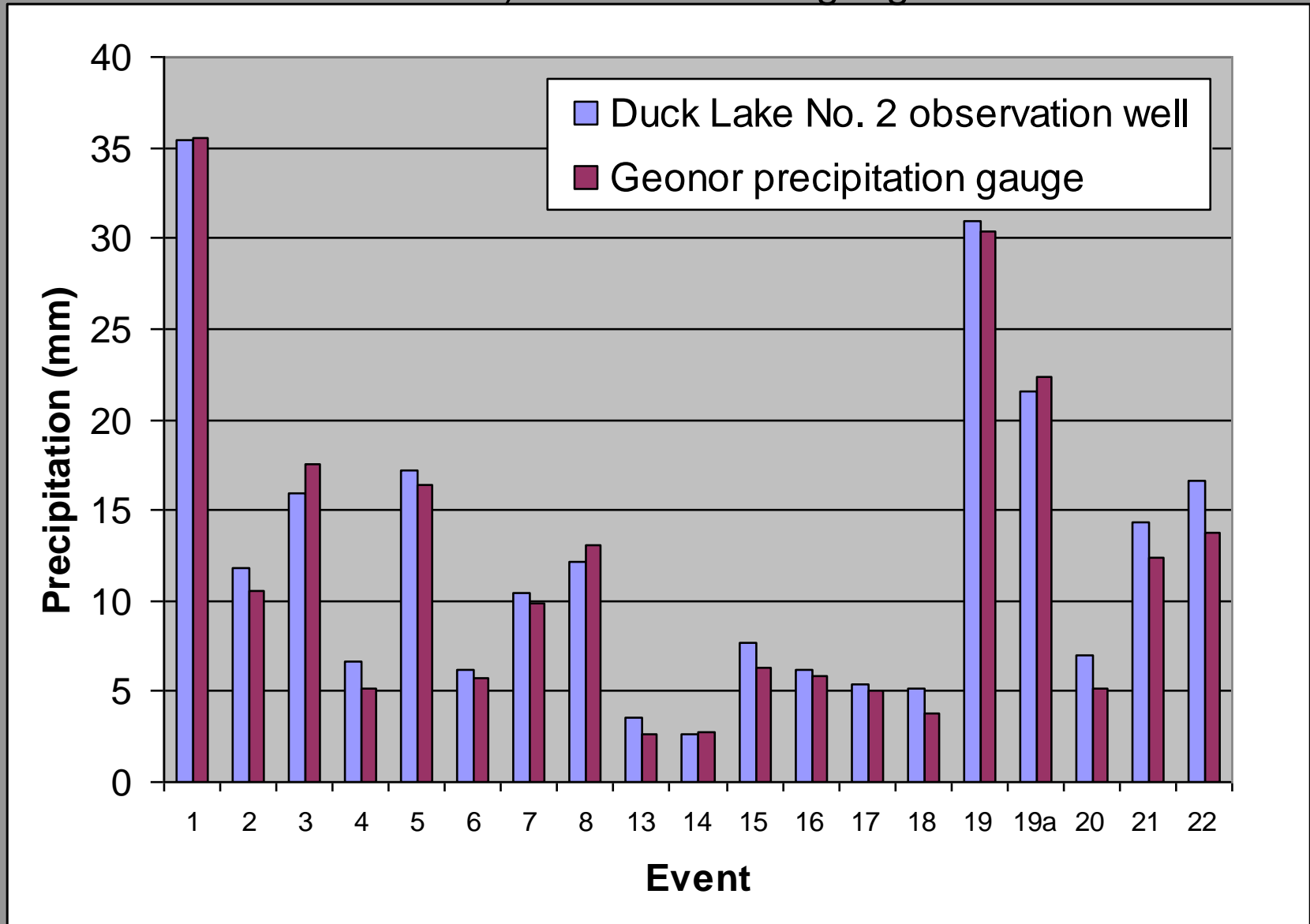


Duck Lake # 2 observation well raw data and corrected data, plus Geonor accumulating rain gauge Zoom in: June 16-June 26, 2009



Comparison of rain event determinations:

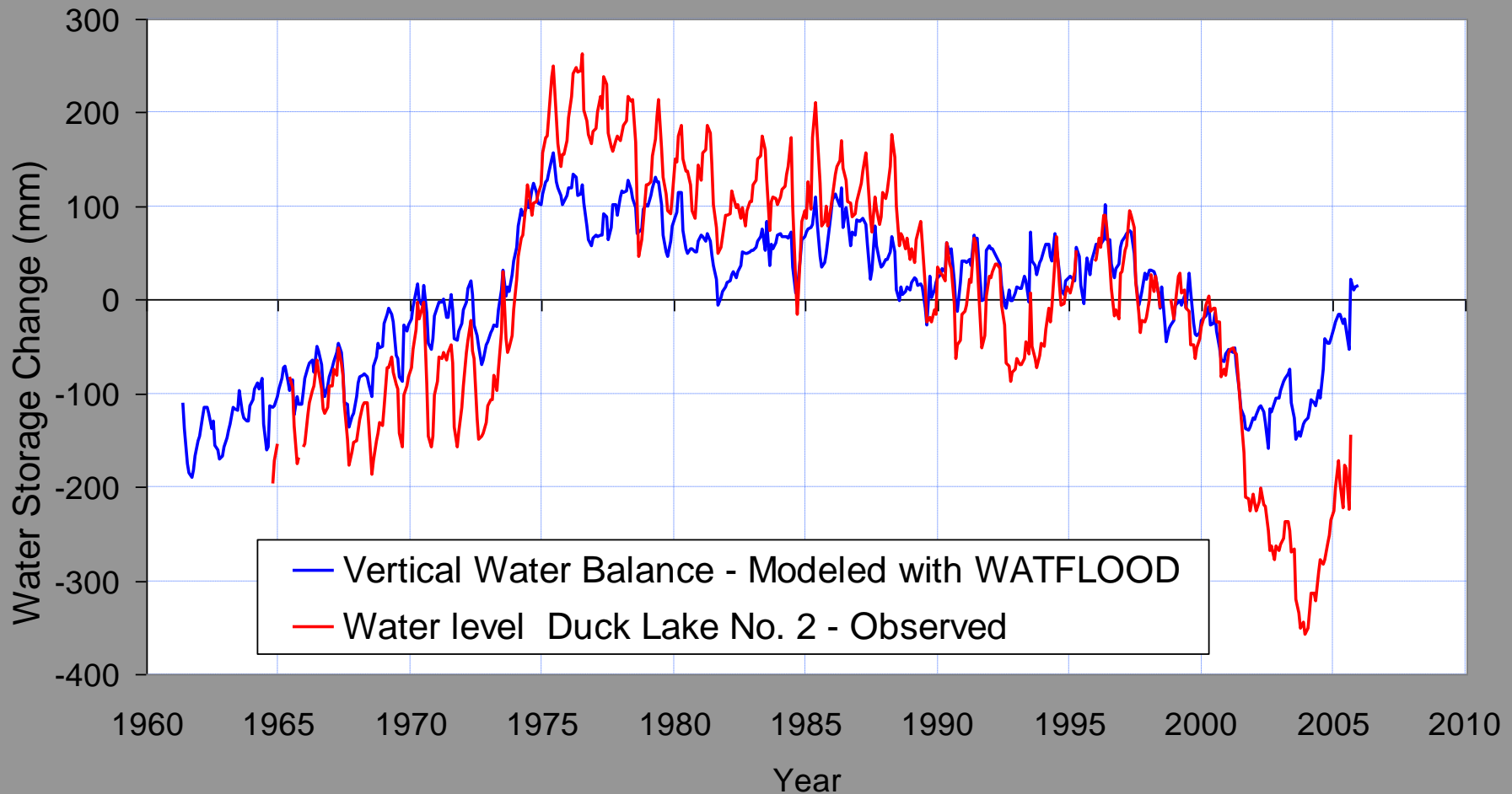
Duck Lake #2 water level records (multiplied by $1/\text{loading efficiency}$, $1/0.798 = 1.26$) versus Geonor gauge records



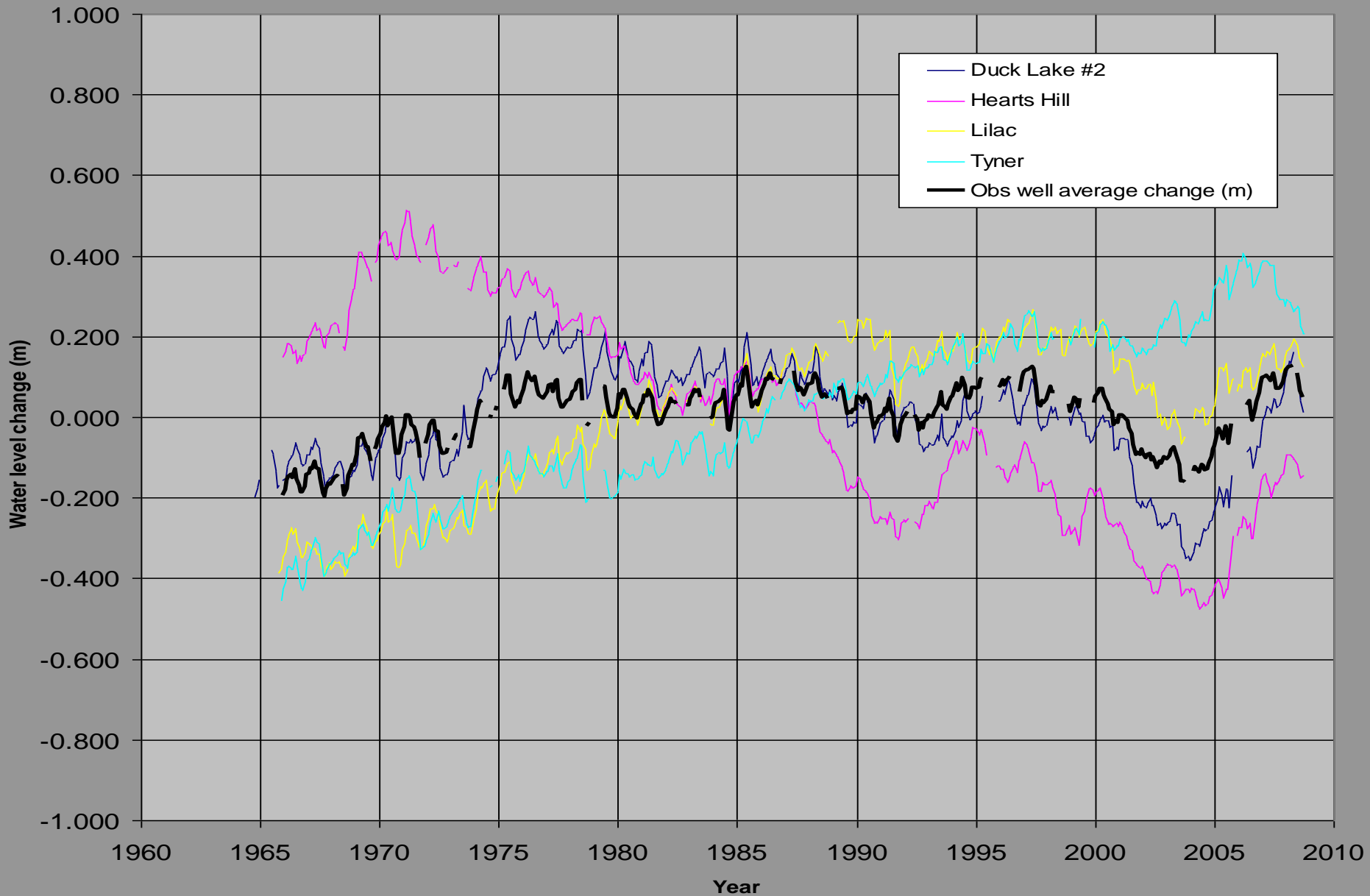
Modeling of the total moisture balance

Comparison of Duck Lake No. 2 (geological weighing lysimeter) water level record with Watflood simulation of the vertical water balance.

[Marin et al., 2010, J of Hydrology]

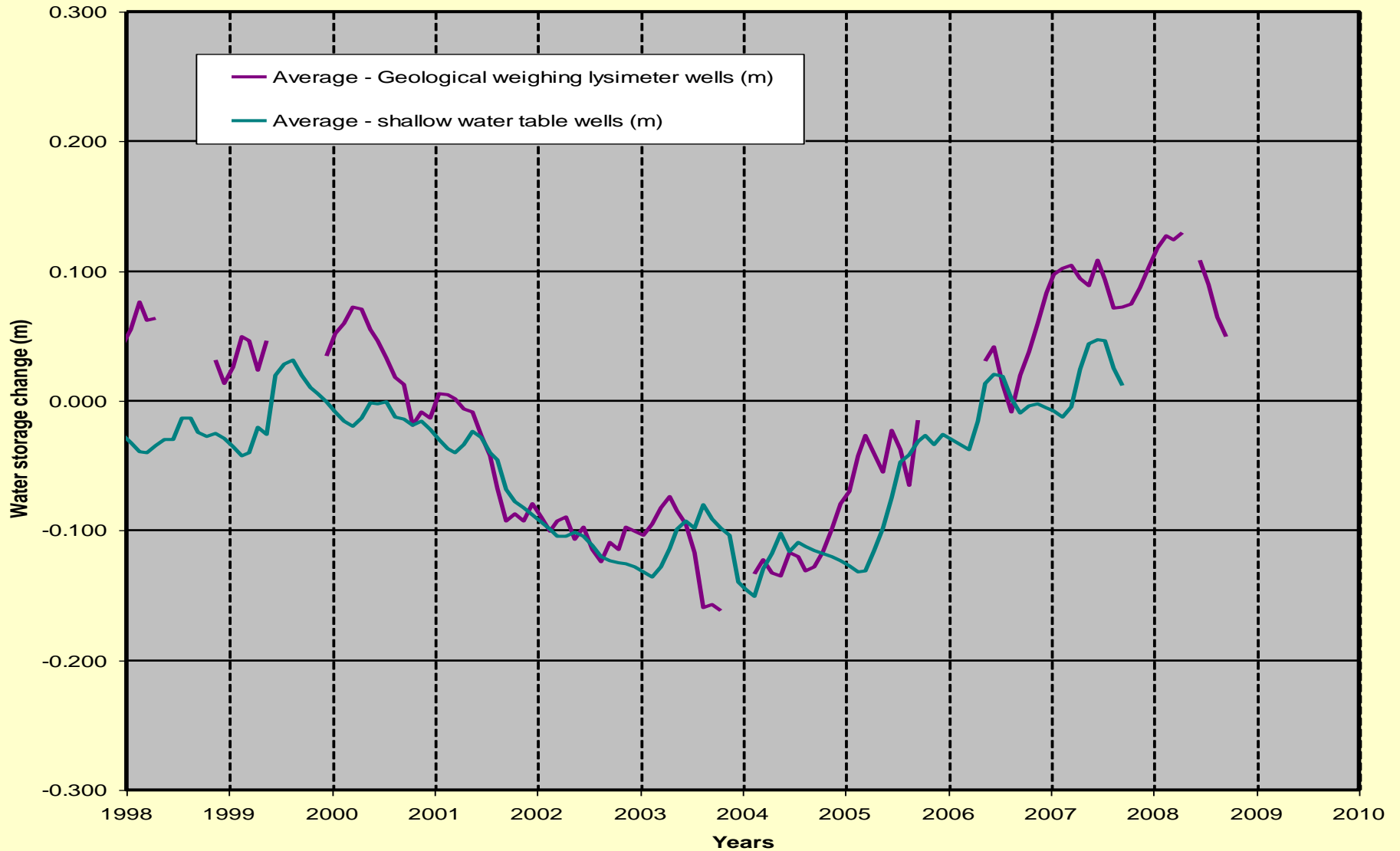


Geological weighing lysimeter wells – southern Saskatchewan, 1965 - 2008



Regional water storage changes in southern Saskatchewan, 1998 - 2008:

- Average of 4 Geological Weighing Lysimeter wells,
- Average of 9 water table wells in sand aquifers (assuming specific yield = 0.30).



Summary

Observation well records can provide a useful record of regional long-term moisture conditions:

- a) Observation wells in water-table aquifers can provide a semi-quantitative indication of moisture below the shallow soil zone
- b) Geological weighing lysimeters (observation wells in deep confined aquifers) can provide a record of total moisture balance averaged over areas of km².

However: The water-level records for deep confined aquifers are commonly disturbed by the effects of pumping. Observation wells that can serve as geological weighing lysimeters are few and far between.

Therefore: The principal use of Geological Weighing Lysimeters may be in validating other moisture observations and models at selected locations, where hydrogeological conditions and surface conditions are suitable.

References

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Thank you.

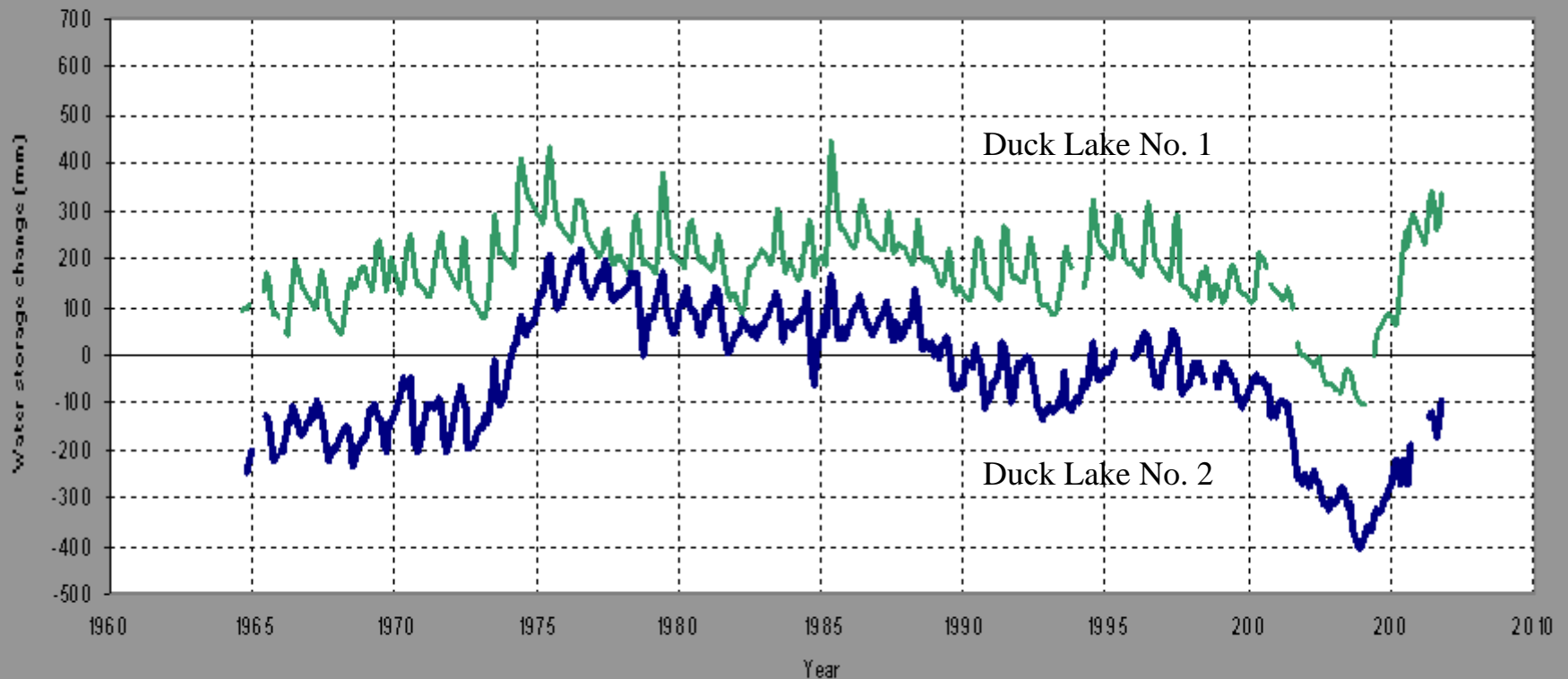
Questions ?

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Saskatchewan Watershed Authority
Drought Research Initiative

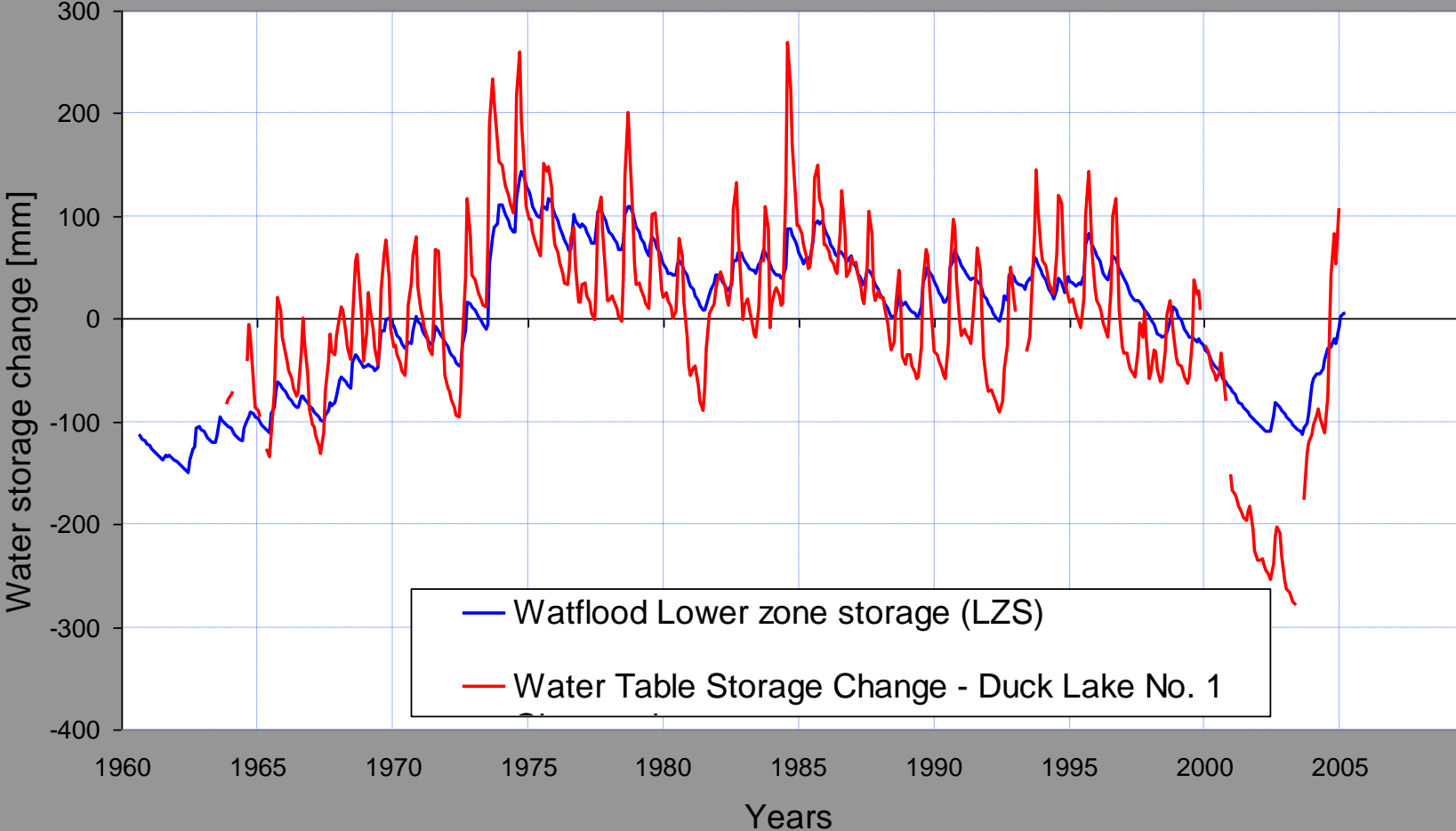
Water storage changes observed for Duck Lake SK observation wells 1965-2007:

Duck Lake No. 1 – Shallow water table well with specific yield = 0.30

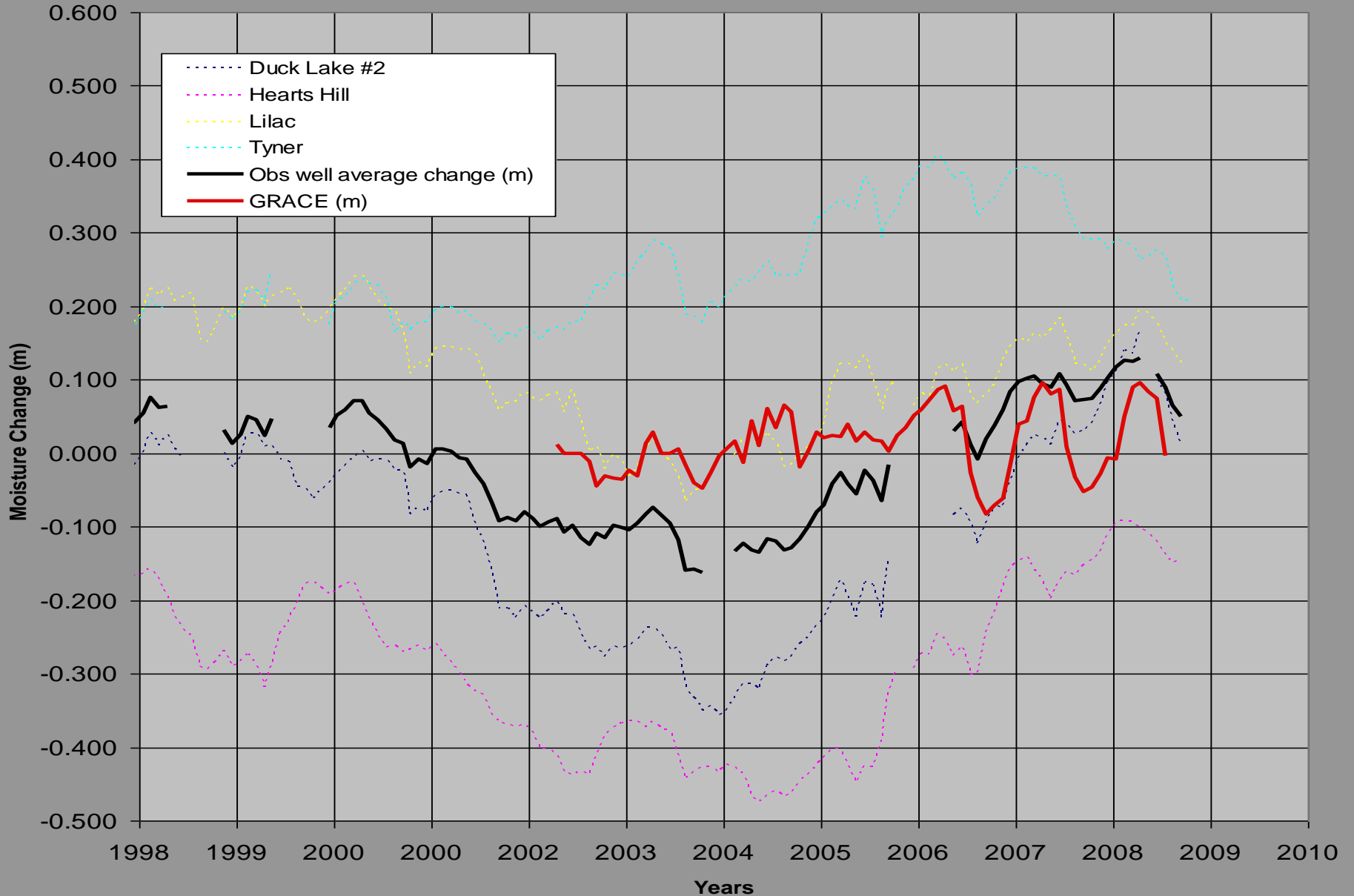
Duck Lake No. 2 – Deep well in confined aquifer (geological weighing lysimeter)



Comparison of Duck Lake No. 1 (water table storage change) with Watflood simulation of the changes of groundwater storage. *See comment on previous slide. More rigorous modeling with MEC-MESH, which includes CLASS is underway.*



GRACE and Average of Saskatchewan Geological Weighing Lysimeter wells



Regional water storage changes in southern Saskatchewan:

- GRACE for southern Saskatchewan *[provided by Yirdaw and Snelgrove]*
- Average of Geological Weighing Lysimeter wells
- Average of water table wells

