Update on Lake Evaporation Studies

NWRI

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Objectives of Evaporation Studies

- Provide a reliable parameterization for open water evaporation for short-term (hourly, daily) calculations.
- Application in Hydrologic and Meteorological models
- Examine:
  - The advection process.
  - Application to remote sensing

Evaporation Models are parameterizations of one or more of the conditions required for evaporation to occur:

For evaporation to occur there must be:

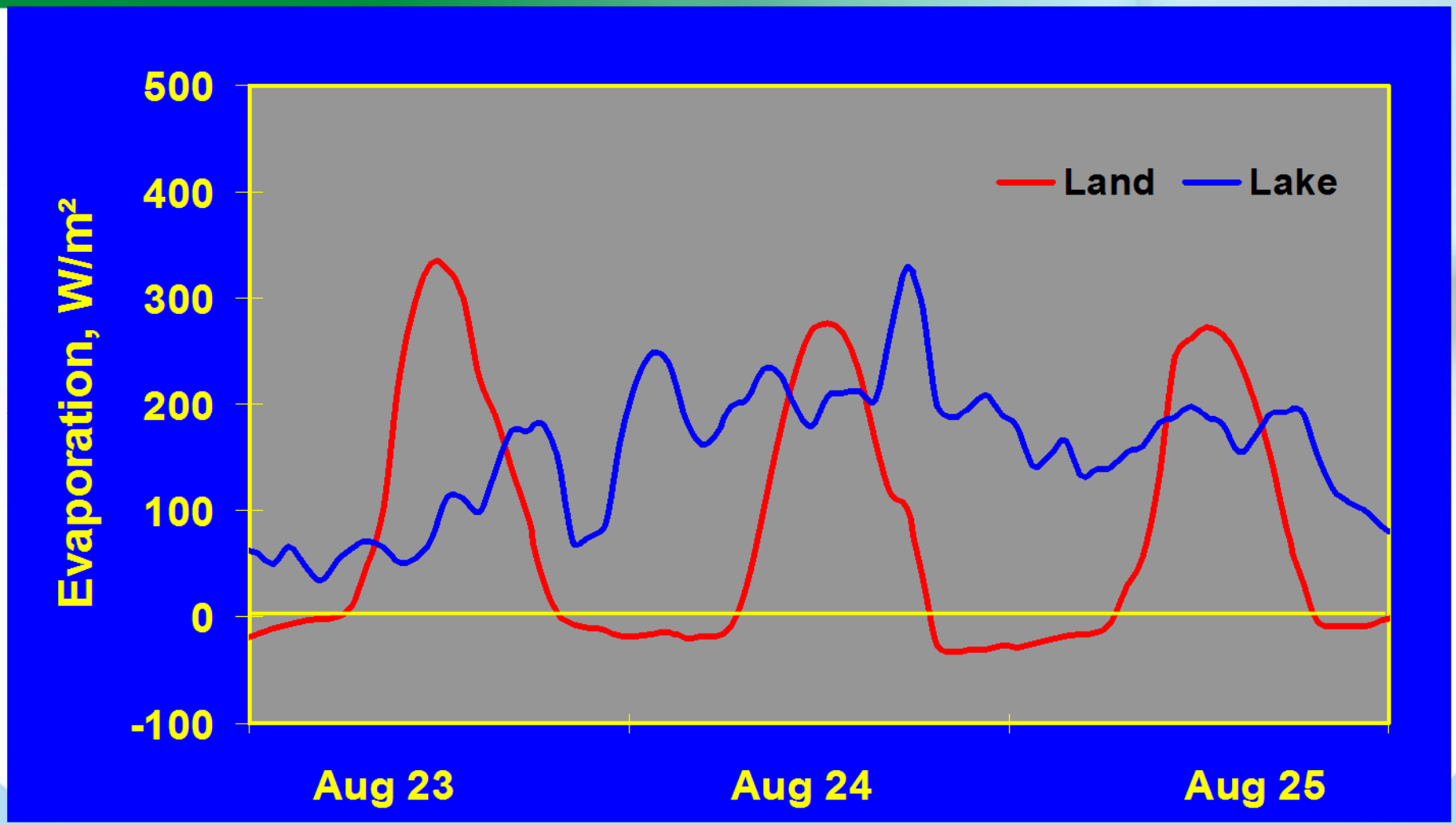
- a supply of water at the surface,

- a supply of energy to satisfy the requirement for the phase change, and

- a transport mechanism to carry the vapour away from the surface (wind, vapour gradient).

Lake Evaporation Observations:

Quill Lake, 1993 - open water and land surface

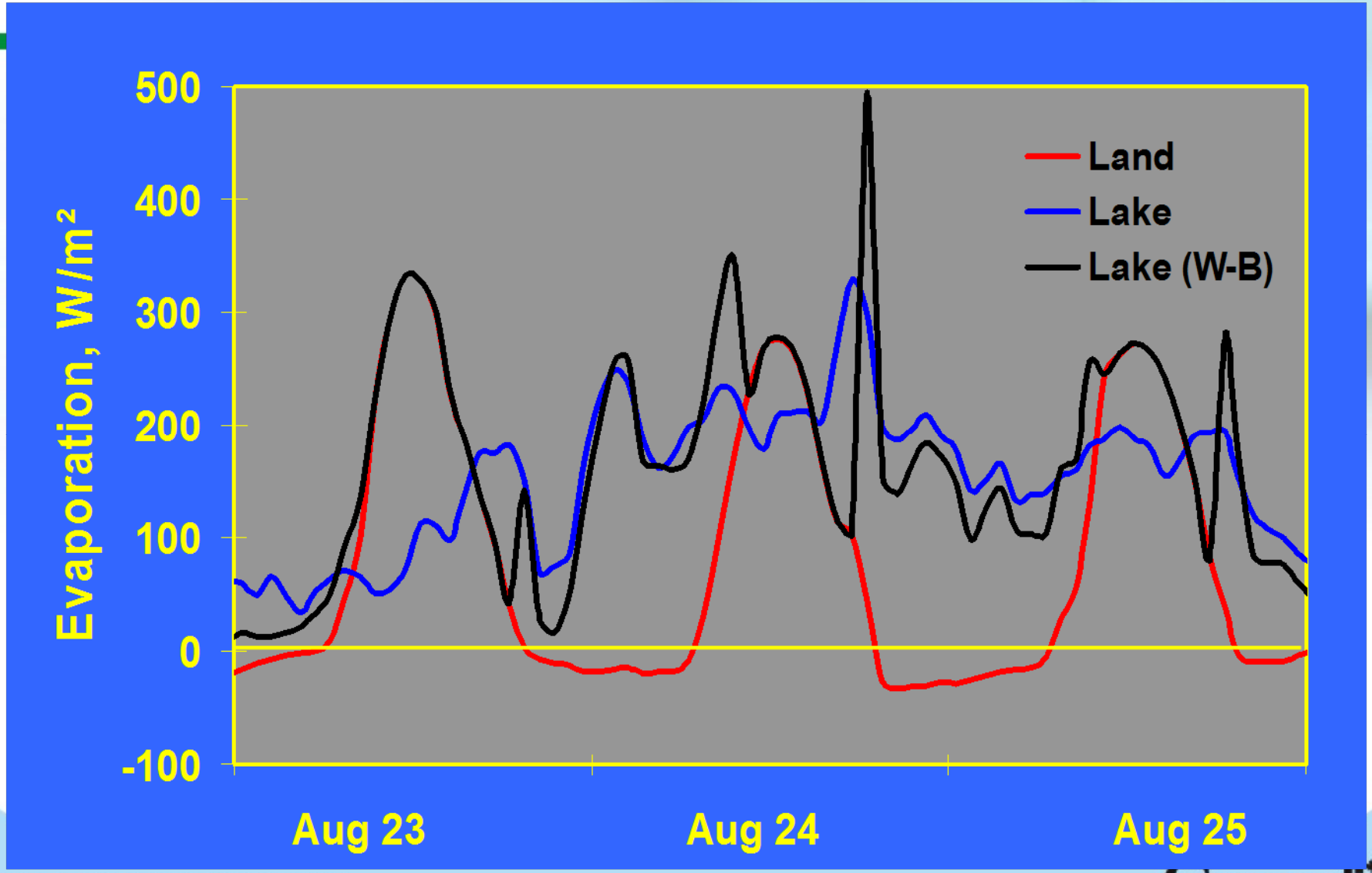


Weisman and Brutsaert (1973) showed that lake evaporation involves advection, and that one needs to have information on both the land and water surfaces.

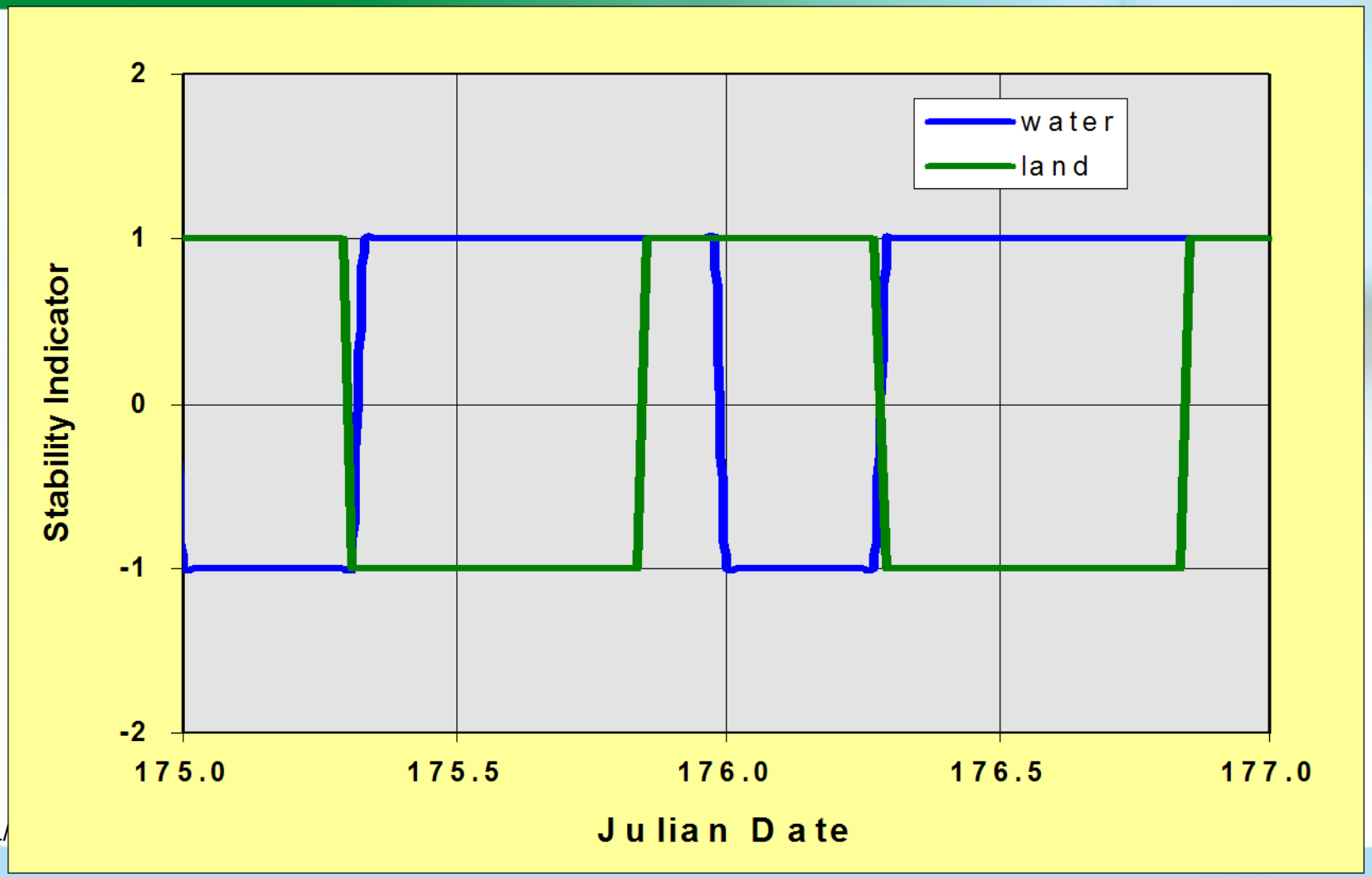
$$E_l = E_a + a\rho u_* \cdot (q_s - q_{as}) \cdot (X_f / Z_o)^{-b}$$

Where the coefficients *a* and *b* are related to dimensionless advection parameters

Quill Lake, 1993



Diurnal Cycle of Stability: Land and Water



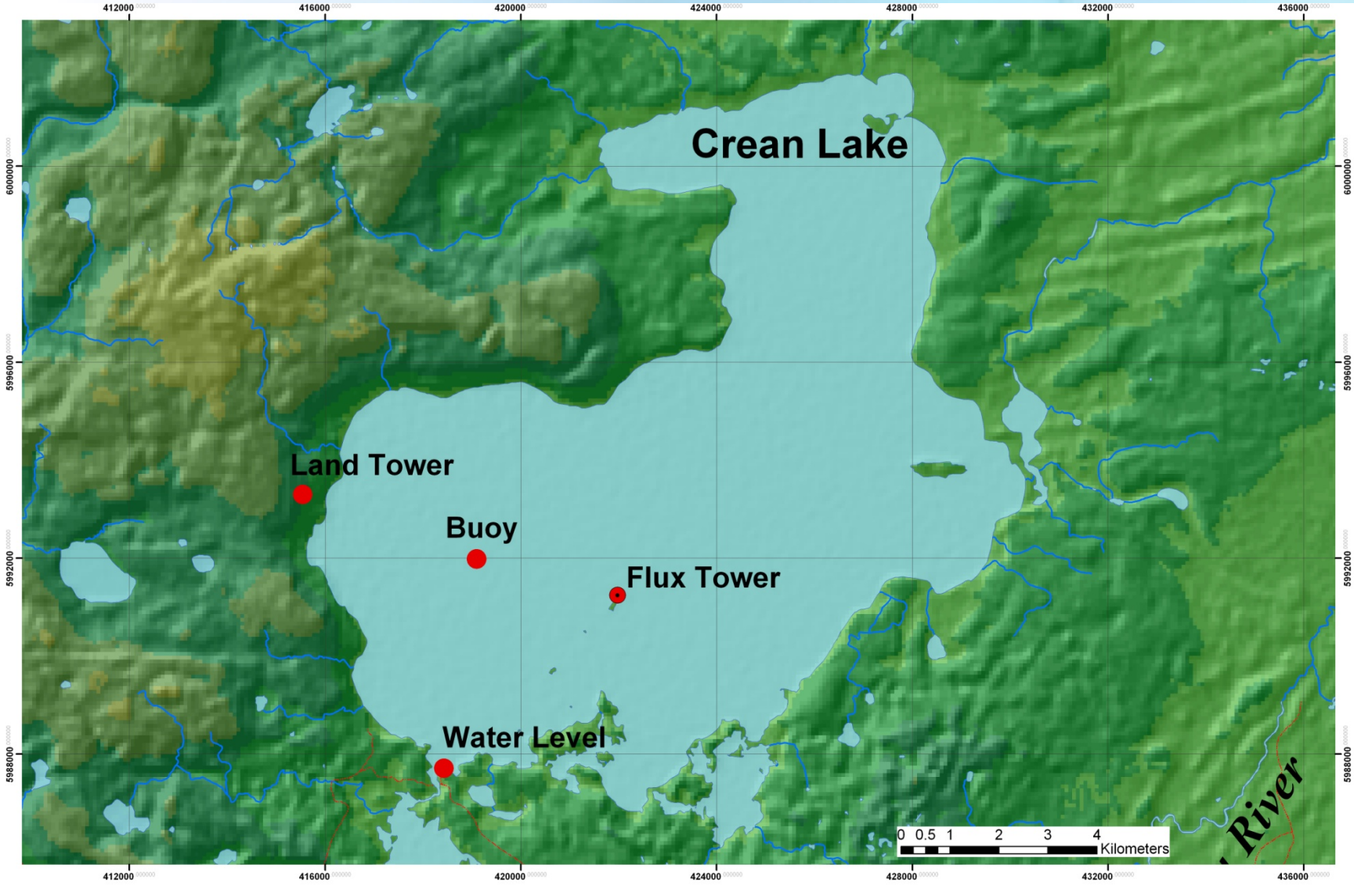
Estimating Lake Evaporation

Will require a knowledge of the water surface temperature, combined with a boundary layer model capable of representing the advection of energy and the proper transfer coefficient for both stable and unstable conditions.

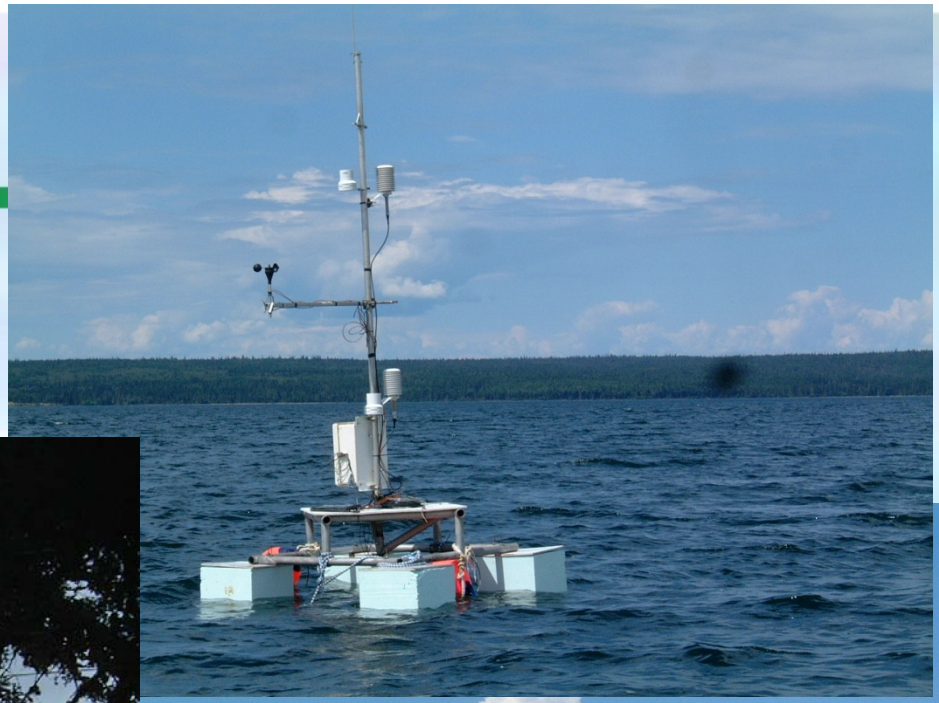
Estimating Lake Evaporation

First step: Examination of the vapour transfer mechanism… the effect of wind speed and fetch.

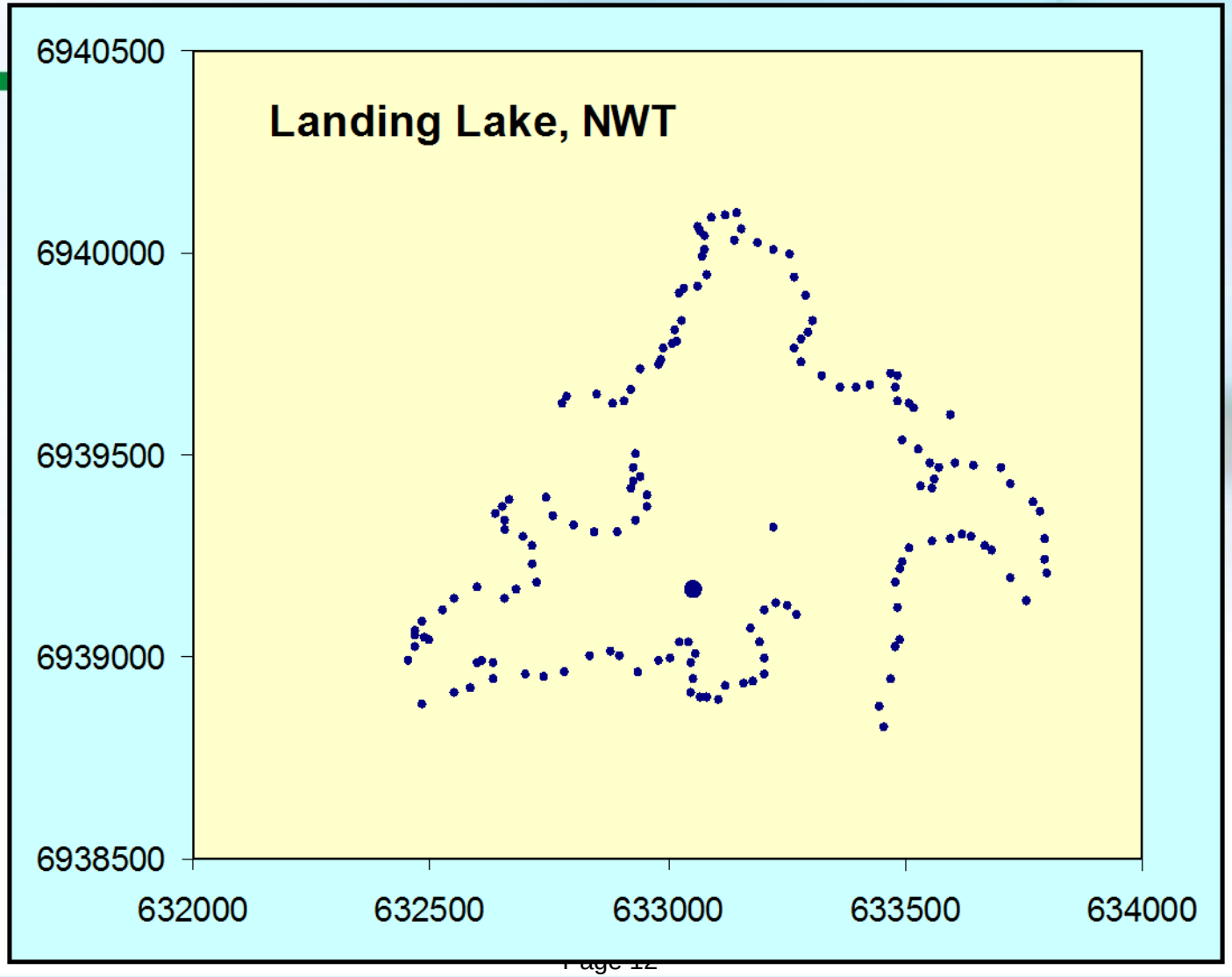
Crean Lake, 2006



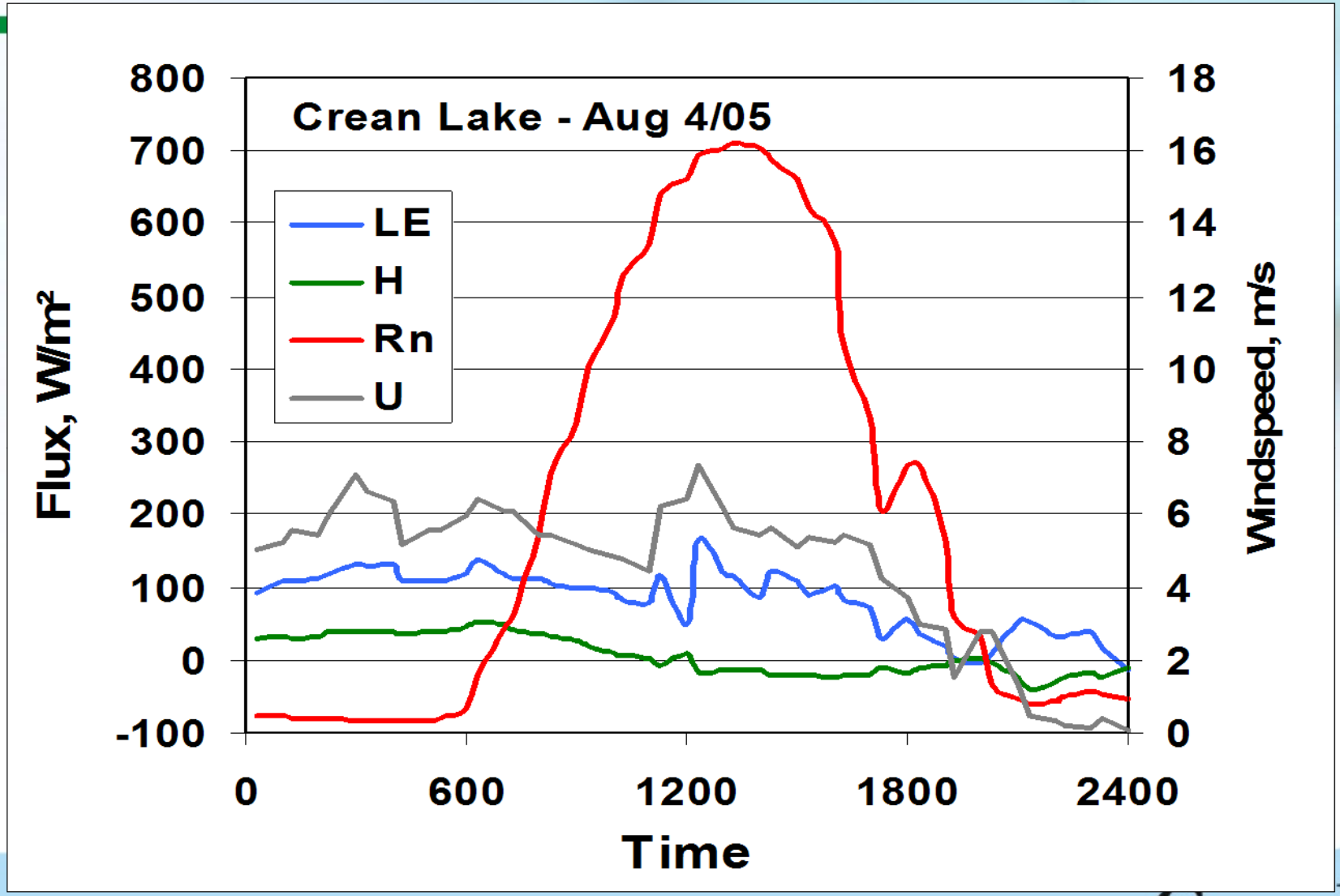
Crean Lake, 2006



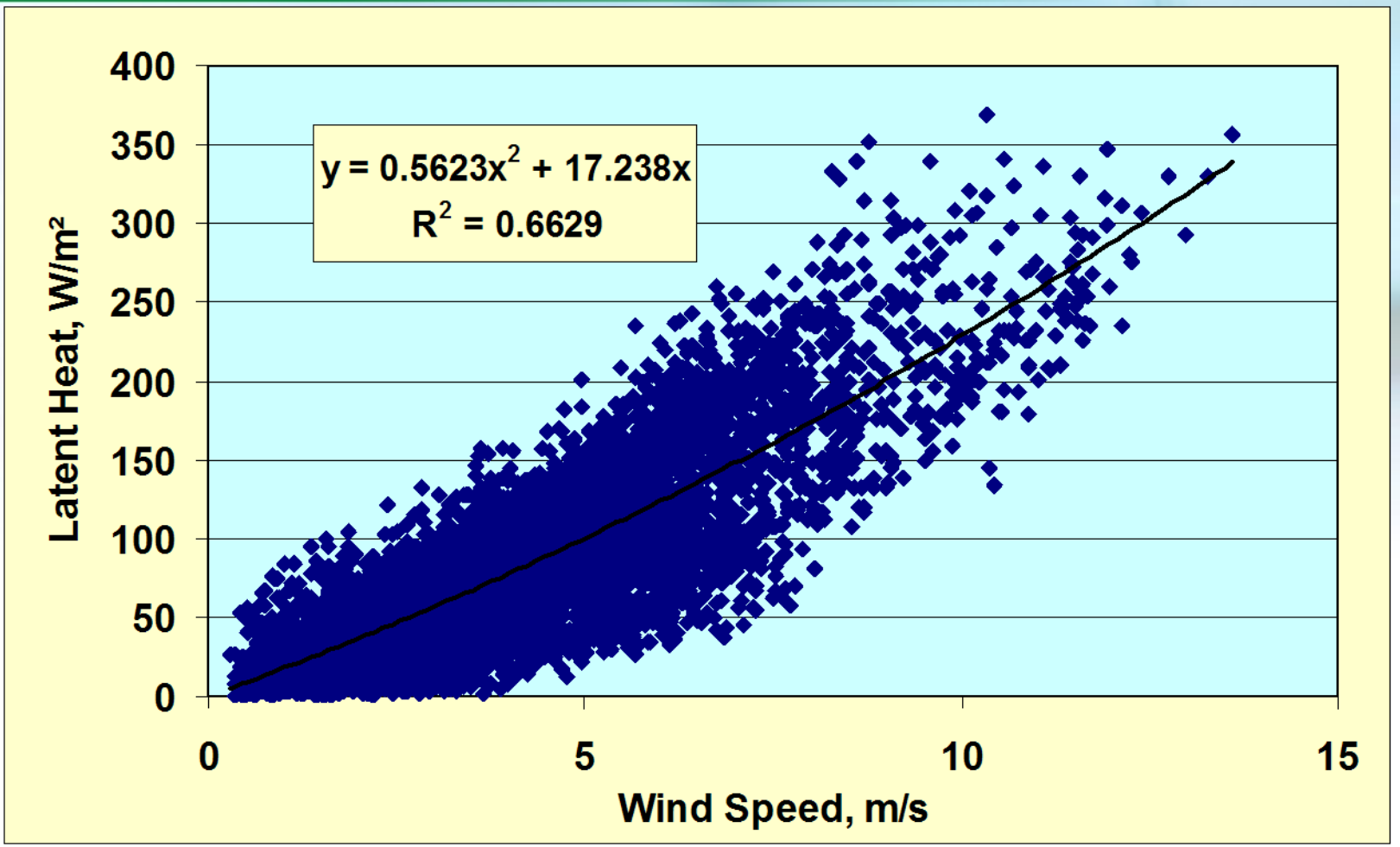
Landing Lake, NWT, 2007



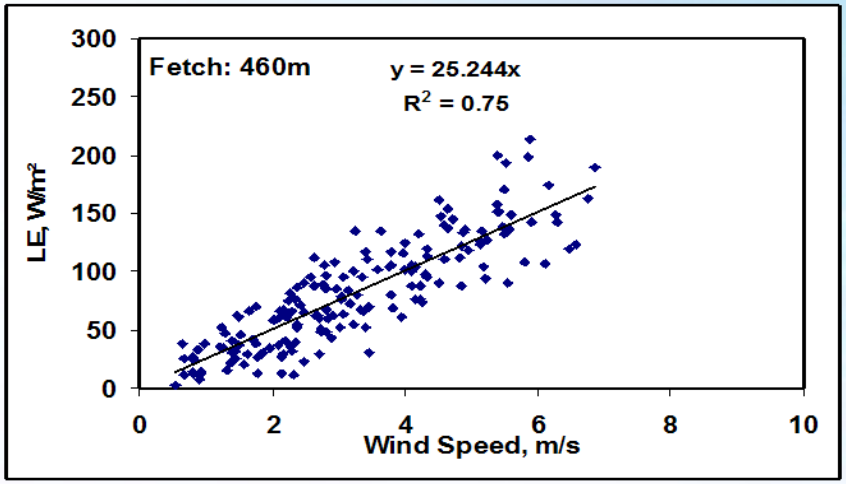
Crean Lake, 2005

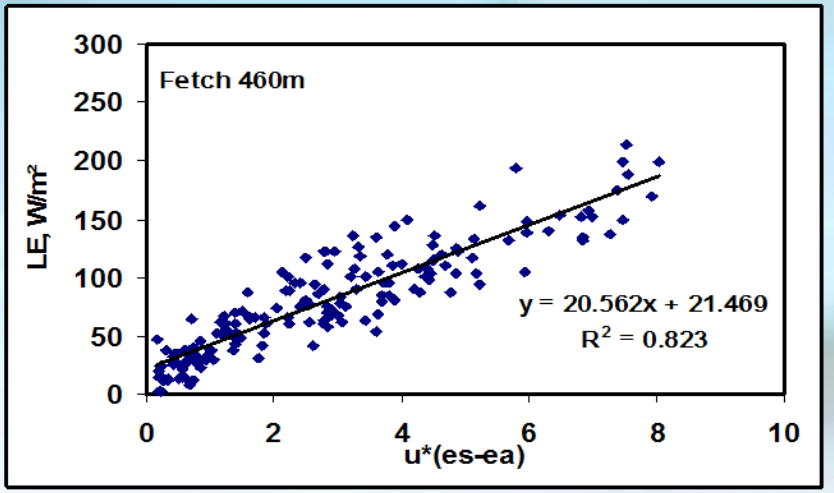


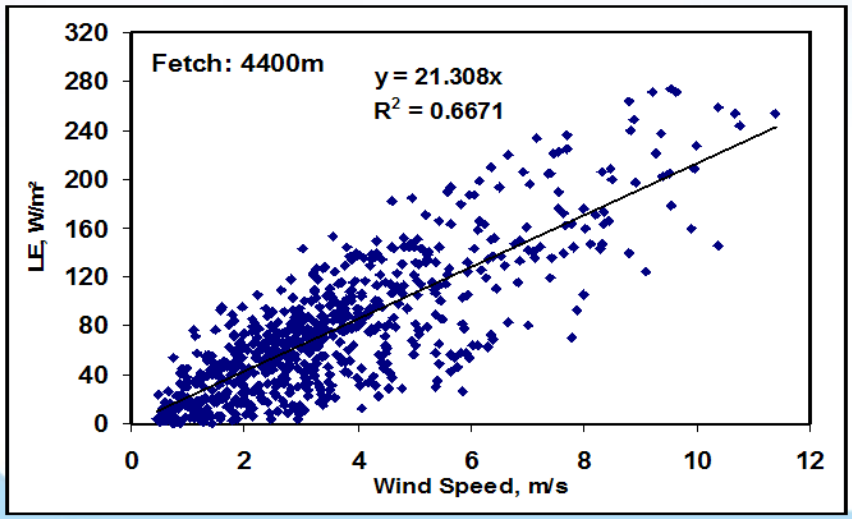
Effect of Wind Speed on Lake Evaporation (Crean '06)

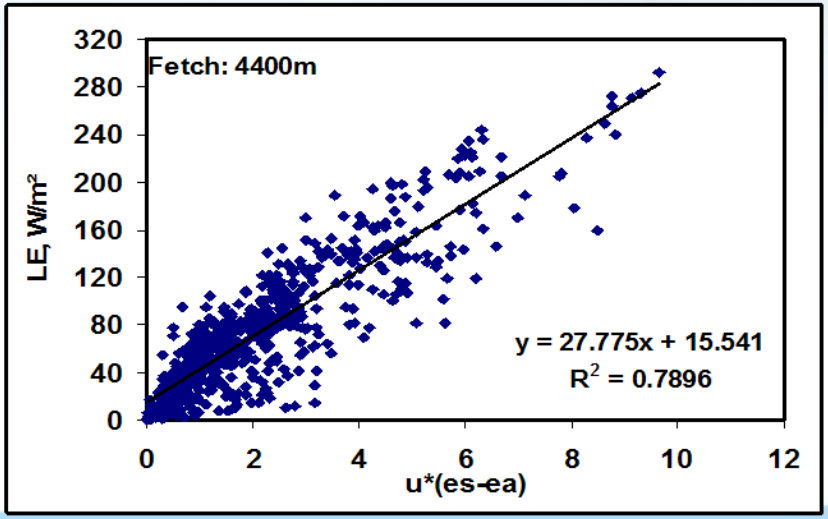


Effect of Fetch on Evaporation

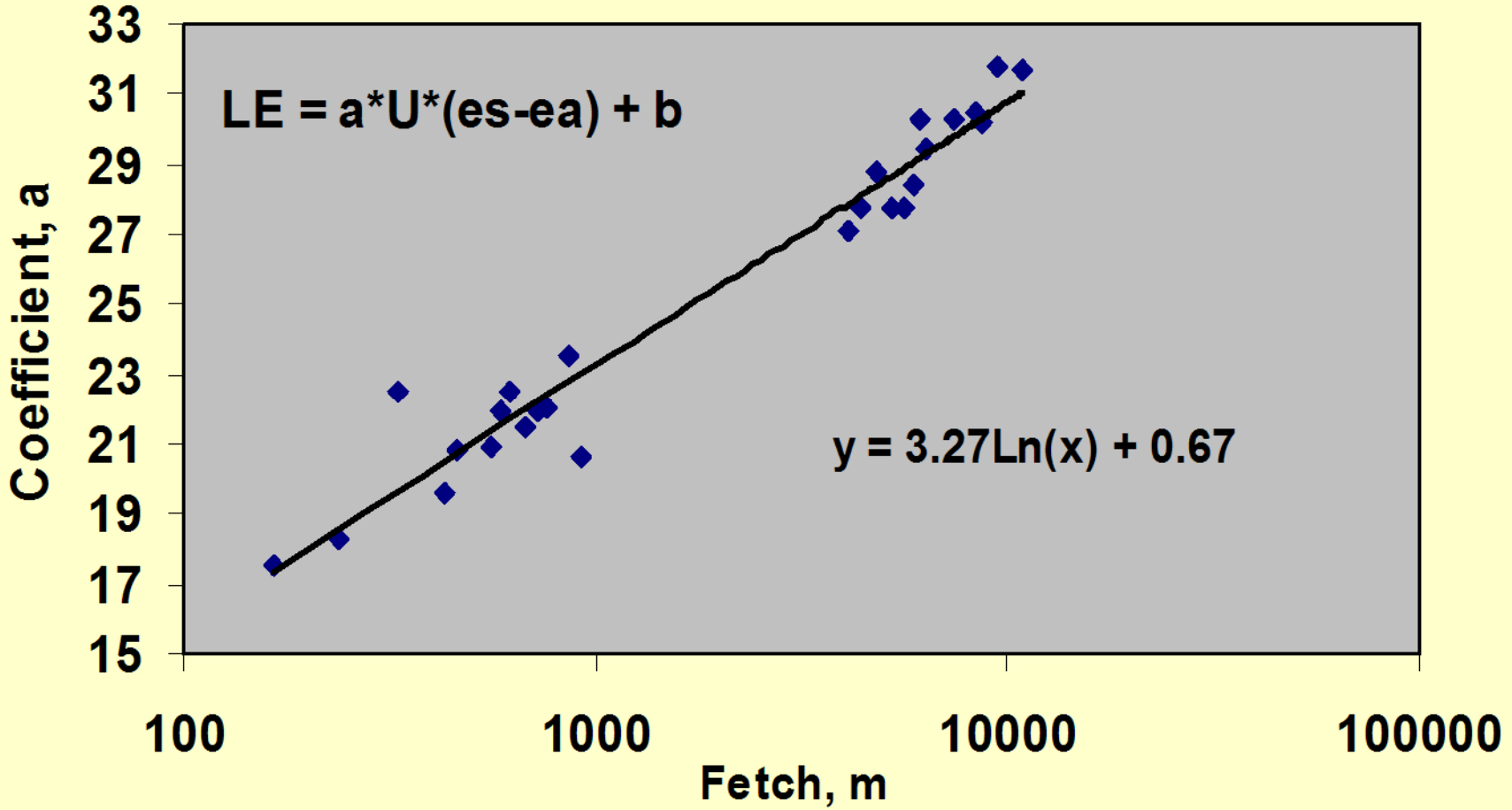








Effect of Fetch



Effect of Fetch on Evaporation

- $LE = a*U*(e_s - e_a) + b$

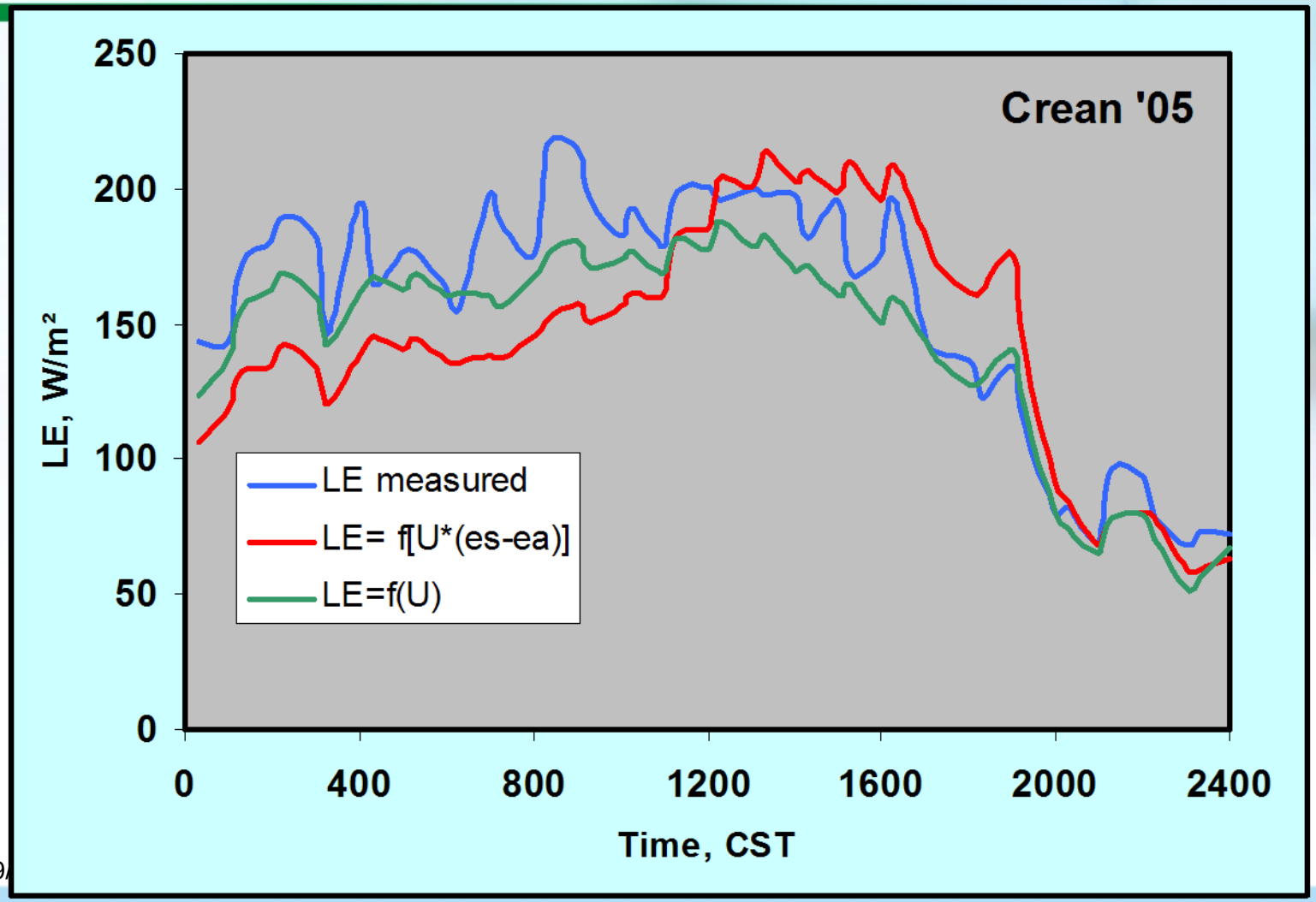
  $a = 3.27 \ln(X) + .67$

  $b = 22.16 - .0015*X$

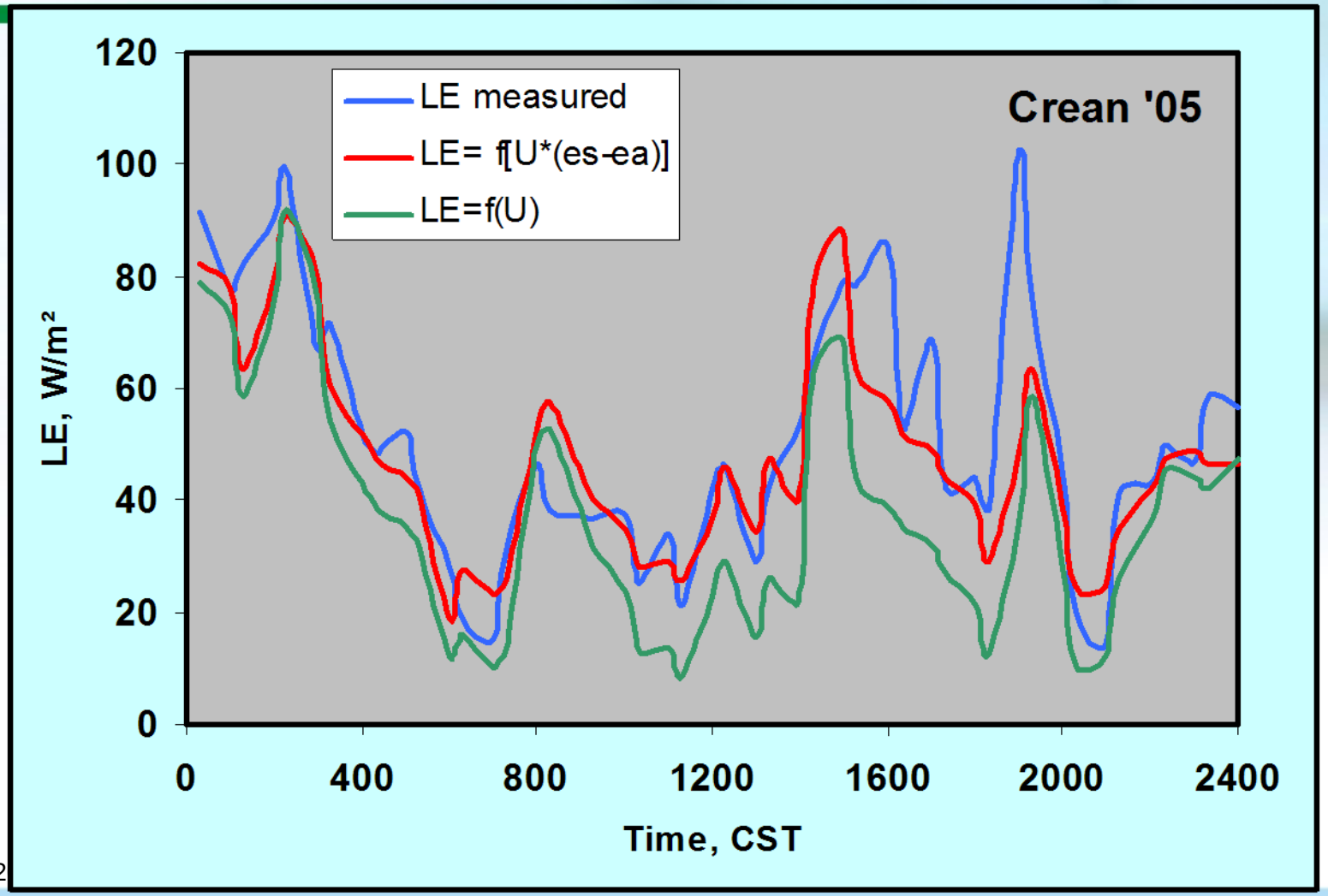
- $LE = c*U$

  $c = 41.82*X^{-.09}$

Modelled Lake Evaporation



Modelled Lake Evaporation



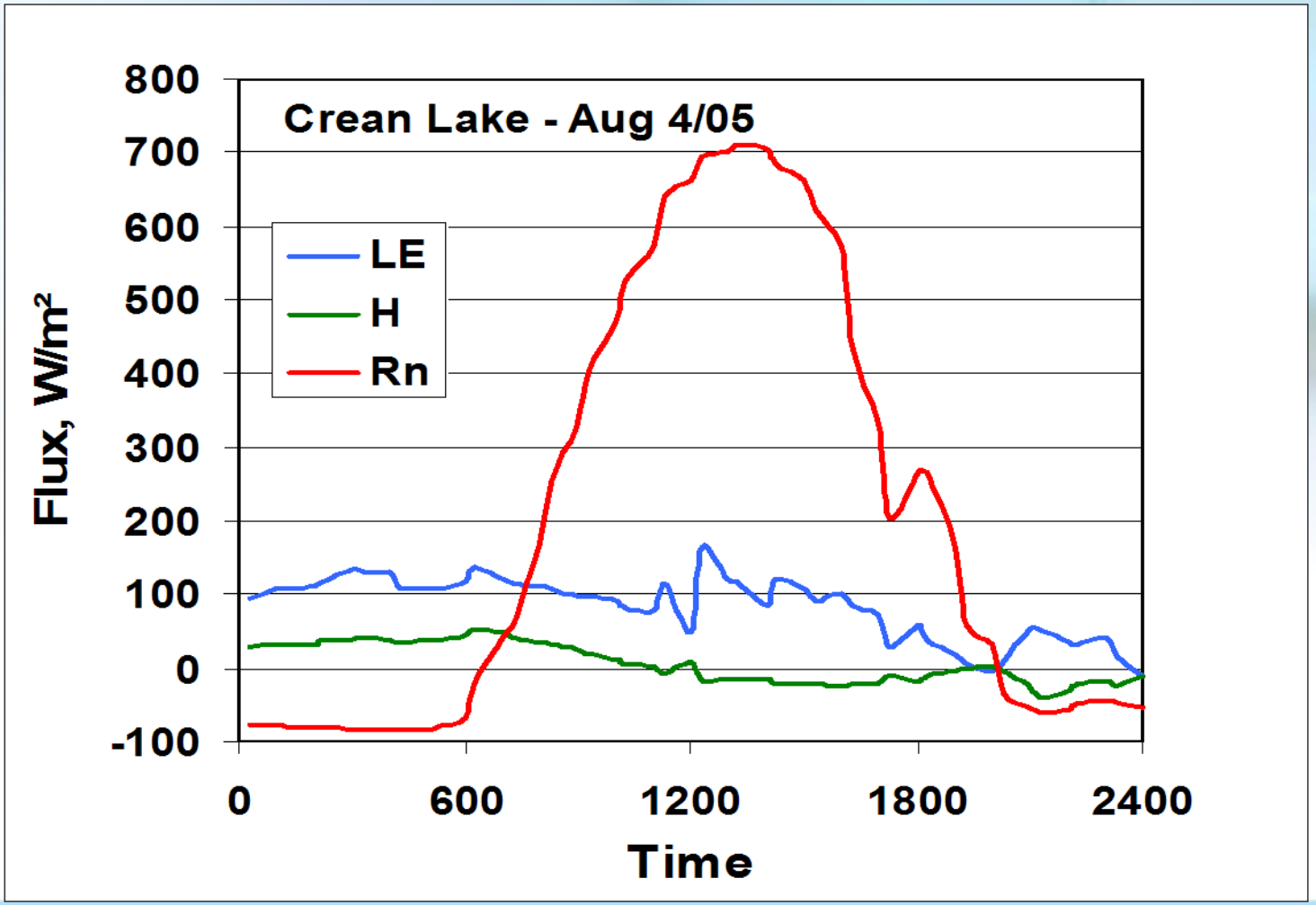
Things to do

- Effect of stability and land-lake contrast.
- Apply to total lake area.
- Redo Weisman-Brutsaert advection analysis with better parameterizations for stable conditions.
- Begin looking at remote sensing.

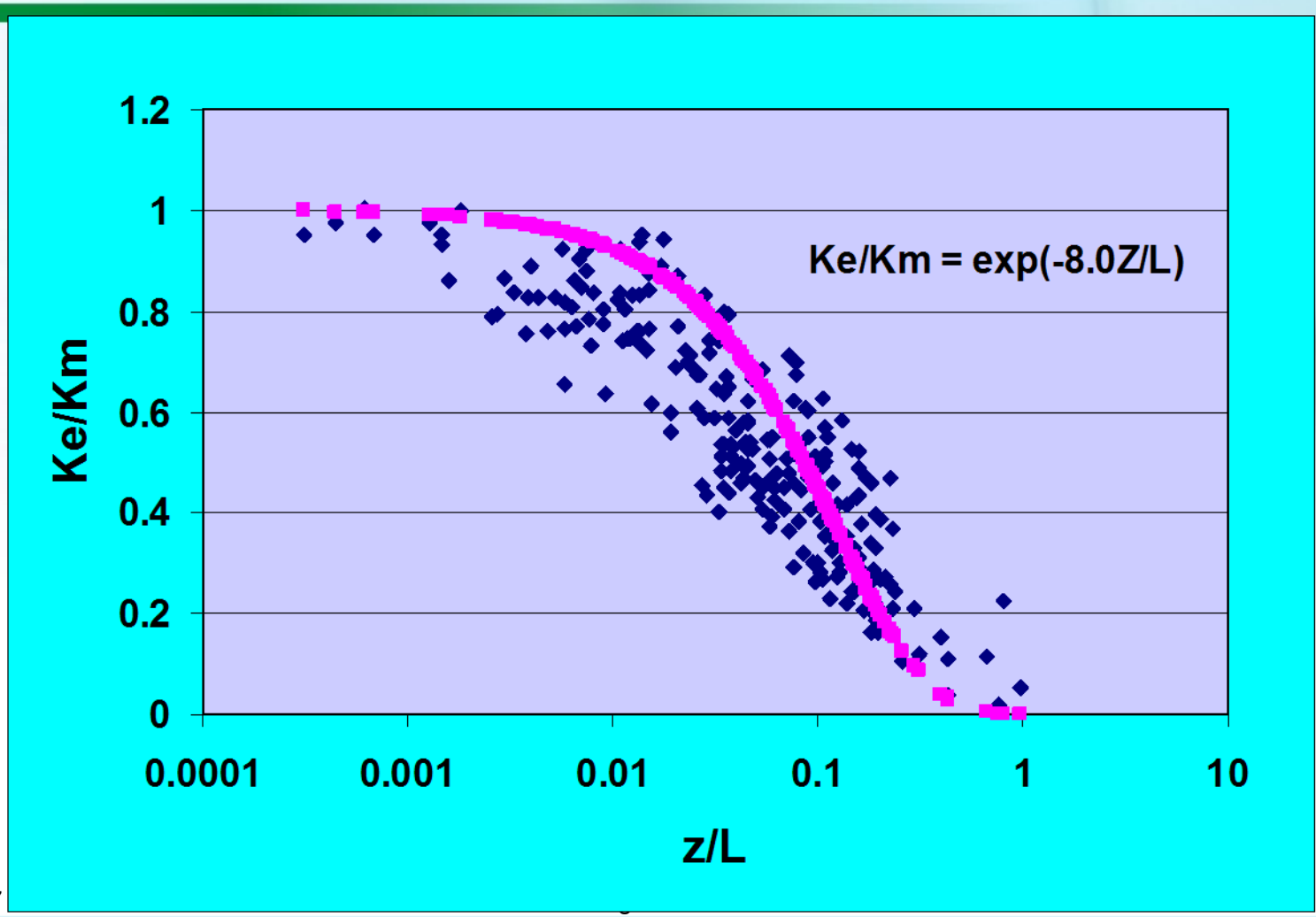
Thank you!

Lake Evaporation Observations:

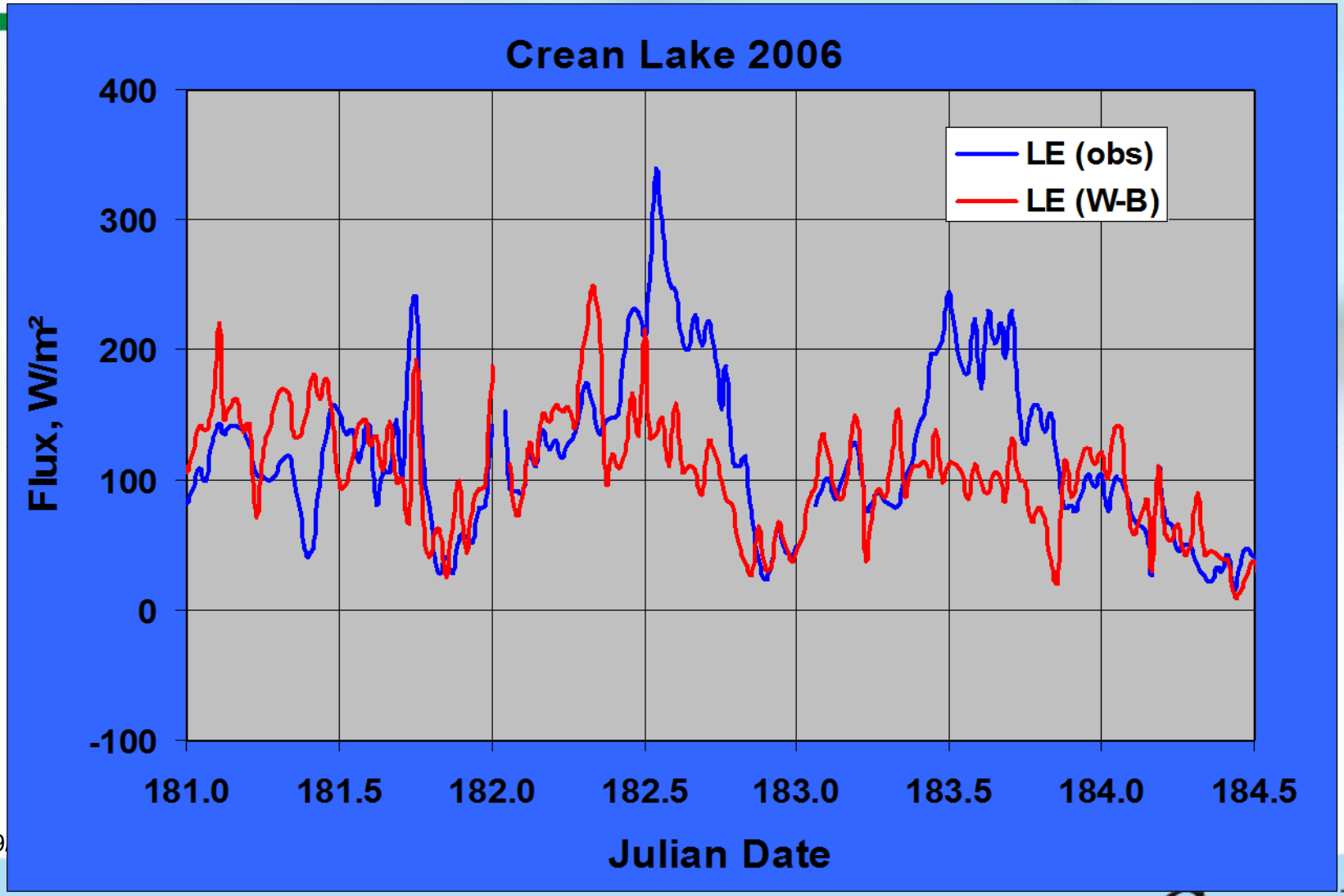
Crean Lake 2005



Ratio of transfer coefficients : stable conditions



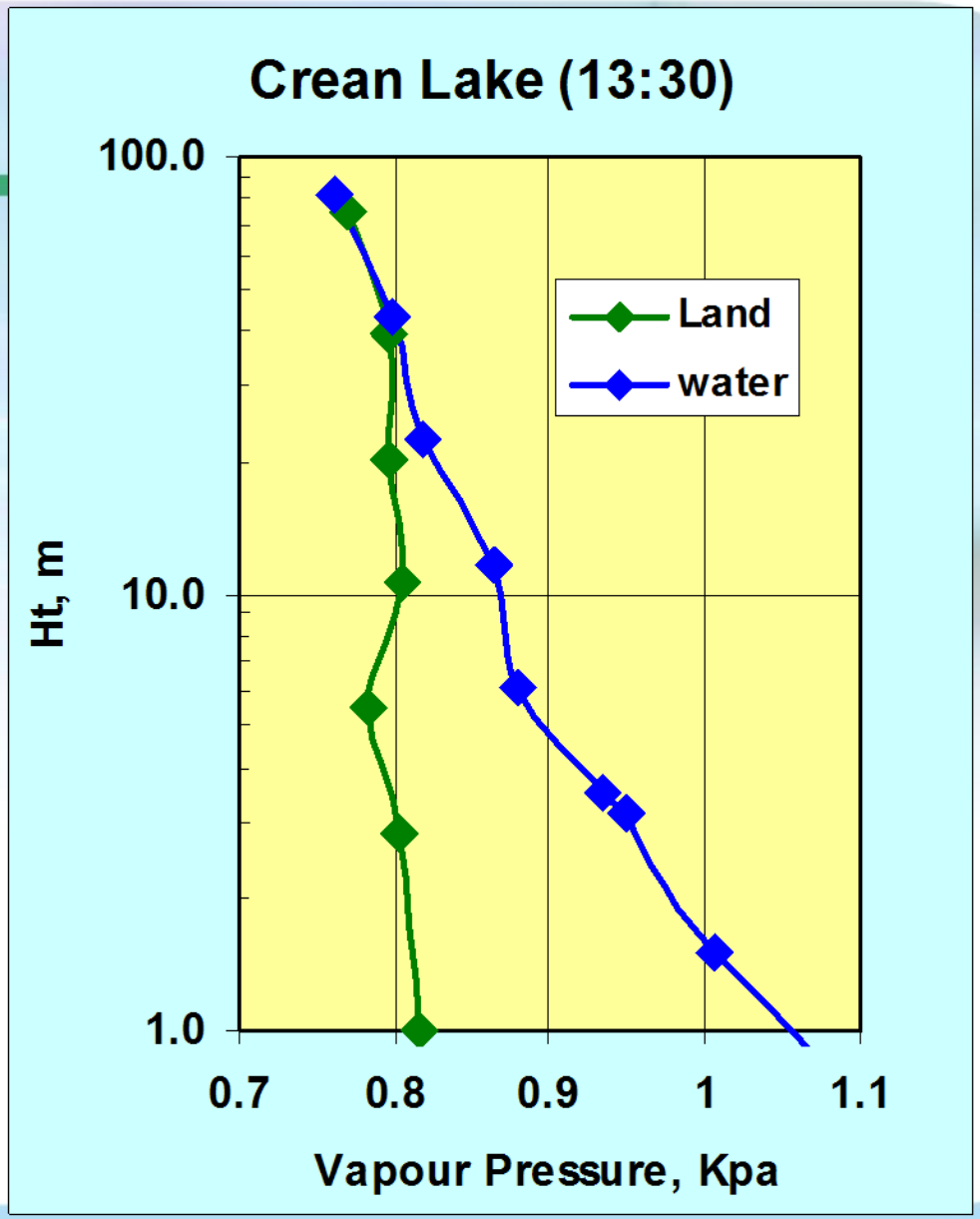
Crean Lake, 2006



Boundary Layer Investigation

- Upwind and Downwind tethersonde profiles were obtained on Sept. 1/06
  - Validation of boundary layer development
  - Estimation of Evaporation from Boundary Layer Integration

Humidity Profiles



11/29/2007