Hydrol. Earth Syst. Sci. Discuss., 7, C1170–C1172, 2010
www.hydrol-earth-syst-sci-discuss.net/7/C1170/2010/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Modelling hourly rates of lake evaporation" *by* R. J. Granger and N. Hedstrom

H. Liu (Referee)

heping.liu@jsums.edu

Received and published: 18 June 2010

This paper provides a very useful approach to estimate lake evaporation.

Lake evaporation process is largely associated with the horizontal advection of air across a discontinuity in multiple properties of the surfaces from lands to water. As a consequence, internal boundary layer (IBL) may develop over water when winds blow from the land (Garratt, 1990). Due to step changes in surface properties (e.g., roughness, temperature, and moisture), subsequent development of the modified profiles of wind, temperature, and humidity, the response of turbulent field, and the growth of IBL is strongly dependent upon the downstream fetch away from the shore. Therefore, the downstream fetch is an important parameter affecting over-lake meteorological variables that, in turn, govern lake evaporation, as indicated in this study.

It is well known that evaporation rates over a water surface depend on vapor pressure difference between water surfaces and the overlying atmosphere (i.e., $e_s - -e_a$) as well as on intensity of turbulent mixing (e.g., Henderson-Sellers, 1986; Liu et al., 2009), as expressed by

$$E = \lambda C_E u_a (e_s - e_a) \quad (1)$$

where e_s and e_a are the vapor pressure (kPa) at the water surface and the reference height, respectively, λ is latent heat of vaporization, and C_E is the bulk transfer coefficients for moisture, and can be formulated by Monin-Obukhov similarity theory (Stull, 1988). When comparing Eq. (1) above and Eqs (1) $--$ (4) in their paper, it is easy to find that the authors related e_a over water to e_a over land by taking into account the influence of the downstream fetch. In addition, it is found that the turbulent exchange coefficient, *CE*, in Eq. (1) is parameterized in their paper in terms of quantifying the horizontal gradient (i.e., land-water contrast) of temperature. In general, their scheme has the theoretical consideration that is well linked to Monin-Obukhov similarity theory.

The above discussions are based on the condition with the air masses that cross from the land to water. However, questions may be raised when lakes are large enough to allow lake breezes to be able to develop particularly when synoptic background winds are weak. Under this circumstance, the over-lake meteorological variables may be uncoupled with those over the land. Local or even mesoscale circulations that develop over the lake-land discontinuity may bring air masses up in the over-lake boundary layer down to the lake surface and have great impacts on turbulence transfer processes. In this case, the land-surface meteorological parameters (temperature and humidity) and particularly the fetch are no longer as important in influencing water-air interactions as when winds blow from the land to water. Therefore, the applicability of the approach proposed in this study may be degraded.

References:

HESSD

7, C1170–C1172, 2010

Garratt, J. R. (1990), The internal boundary layer: a review, *Boundary-Layer Meteorol.*, 50, 171-203.

Henderson-Sellers, B. (1986), Calculating the surface energy balance for lake and reservoir modeling: A review, *Rev. Geophys., 24*, 625-649.

Liu, H. Y. Zhang, S. Liu, H. Jiang, L. Sheng, and Q. L. Williams (2009), Eddy covariance measurements of surface energy budget and evaporation in a cool season over southern open water in Mississippi, *J. Geophys. Res.*, 114, D04110, doi:10.1029/2008JD010891.

Stull, R. B. (1988), *An Introduction to Boundary Layer Meteorology*, Kluwer Acad., Norwell, Mass., 666 pp.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 2727, 2010.