Evaporation from three water bodies of different sizes and climates: measurements and scaling analysis.

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Evaporation from small reservoirs, wetlands, and lakes continues to be a theoretical and practical problem in surface hydrology and micrometeorology because atmospheric flows above such systems can rarely be approximated as stationary and planar-homogeneous with no mean subsidence (hereafter referred to as idealized flow state). Here, the turbulence statistics of temperature (T) and water vapor (q) most pertinent to lake evaporation measurements over three water bodies differing in climate, thermal inertia and degree of advective conditions are explored. The three systems included Lac Leman in Switzerland (high thermal inertia, near homogeneous conditions with no appreciable advection due to long upwind fetch), Eshkol reservoir in Israel (intermediate thermal inertia, frequent strong advective conditions) and Tilopozo wetland in Chile (low thermal inertia, frequent but moderate advection). The data analysis focused on how similarity constants for the flux-variance approach, CT/Cq, and relative transport efficiencies RwT/Rwq, are perturbed from unity with increased advection or the active role of temperature. When advection is small and thermal inertia is large, CT/Cq < 1 (or RwT/Rwq > 1) primarily due to the active role of temperature, which is consistent with a large number of studies conducted over bare soil and vegetated surfaces. However, when advection is significantly large, then CT/Cq > 1 (orRwT/Rwq < 1). When advection is moderate and thermal inertia is low, then CT/Cq ~ 1. This latter equality, while consistent with Monin-Obukhov similarity theory (MOST), is due to the fact that advection tends to increase CT/Cq above unity while the active role of temperature tends to decrease CT/Cq below unity. A simplified scaling analysis derived from the scalar variance budget equation, explained qualitatively how advection could perturb MOST scaling (assumed to represent the idealized flow state).