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Gap-Filling for Latent Heat Fluxes by a Mechanistic Model

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The observation of latent heat fluxes is critical for the correct interpretation of the energy partitioning between atmosphere and biosphere. The eddy-covariance technique provides high resolution (hourly or semi-hourly) measurements of energy, water and carbon exchange. However, complete data sets of surface fluxes are required for the annual estimation of energy, water and carbon exchange between atmosphere and biosphere. Due to the underlying assumptions of the technique, periods of system maintenance and sensor limitations under certain conditions such as rain or low turbulence, data gaps are unavoidable in any long term measurements of eddy-covariance fluxes. Most commonly used gap-filling strategies are based on the exploitation of stochastic information contained in the valid data before and after a gap, and are thus biased by the conditions causing the gap. In this research, a mechanistic model based on the re-arranged Penman-Monteith equation is developed to fill the data gaps in latent heat flux, and it is evaluated using the observations from the flux tower in Morgan-Monroe State Forest (MMSF), Indiana, US. The core of the model consists of two components: one is for the aerodynamic conductance, which accounts for the influence of atmospheric stability on evapotranspiration, and the other is for the canopy conductance, which accounts for the biophysical regulations of evapotranspiration. To evaluate the model, artificial data gaps are introduced over the leaf-on periods of 2000-2003. Acceptable results for the vegetative season are obtained in years 2000, 2001 and 2002 with R-square values about 0.8 (0.64 for year 2003).