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## How well can regional fluxes be derived from smaller-scale estimates

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### Abstract

Regional surface fluxes are essential lower boundary conditions for large-scale numerical weather and climate models and are the elements of global budgets of important trace gases (Stewart *et al.*, 1989). Surface properties affecting the exchange of heat, moisture, momentum and trace gases vary with length scales from 1 m to hundreds of kilometers. A classical difficulty is that fluxes have been measured directly only at points (towers) or along lines (from aircraft). The process of “scaling up” observations limited in space and/or time to represent larger areas has been done by assigning properties to surface types and combining estimated or calculated fluxes using an area-weighted average. Because of nonlinear influences, such as the effect of internal boundary layers, it is not clear that a simple area-weighted average is sufficient to produce the large scale from the small scale, nor is it known how important the uncertainty is to large-scale model outcomes. Simultaneous aircraft and tower data obtained in the relatively simple terrain of the western Alaskan tundra were used to determine the extent to which surface type variation can be related to regional-scale fluxes of heat, moisture, and other properties. Surface type was classified as lake or land with an aircraft-borne infrared thermometer, and flight-level heat and moisture fluxes were related to surface type. The magnitude and variety of sampling errors inherent in eddy correlation flux estimation place limits on how well any flux can be known even in simple geometries. Because of the presence of intrinsic and site-specific uncertainties, regional-scale flux of heat and moisture using aircraft observations in our study area can be reasonably verified to be estimated correctly from linear combinations of small-scale estimates only to within a factor of 1.5. Flights at lower levels or in a more comprehensive or systematic pattern might be able to resolve the contributions from individual surface types better, but an experiment to test any scaling-up hypothesis is

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