Static Pressure-Wind Covariance and Coherent Structures at Two Subalpine Forest Sites

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The coherent motions above a forest canopy are one of the most important mechanisms responsible for exchanging scalars (heat, moisture, and CO2) between the overlying atmosphere and subcanopy airspace. Because the sweep and ejection motions in the coherent structure above a forest occur within several seconds of each other, the overall 30-min covariance between the 3D wind components and turbulent static pressure can be very sensitive to any lags between the wind and pressure measurements. In the measurements, such lags exist because of the horizontal and vertical separation between sensors, changes in wind speed and direction, as well as any electronic delays within the data system. In our study we examine the relationship between turbulent static pressure and along-stream, cross-stream, and vertical wind components, with particular attention to how the pressure and wind are related to the coherent structures that occur above the forest.

In order to examine the covariance between wind and static pressure, we use turbulent static pressure and wind (from 3D sonic anemometers) measured from scaffolding towers at the Niwot Ridge Subalpine Forest site (US-NR1) and Glacier Lakes Ecosystem Experiments Site (GLEES; US-GLE) AmeriFlux sites. These sites are both in subalpine forests in the Rocky Mountains of North America with similar tree heights (on the order of 12-15 m tall). The primary measurements are made above the canopy, at about 1.5 times the forest height. The specific goals of our study are: (1) to confirm that the measured pressure fluctuations and covariance between wind and pressure are consistent at each site, (2) to use the multi-level profile of pressure sensors at US-NR1 to examine how the canopy alters the pressure fluctuations (with particular attention to the changes in coherence and phase), and (3) to use the long-term record at GLEES to evaluate how the covariance of static pressure and vertical wind might affect the Net Ecosystem Exchange (NEE) of CO2.