Eddy Correlation

Turbulent fluxes result from measurable components of large scale air movement. Such air movement can be thought of as horizontal flow of numerous eddies rotating in three dimensions each with its own gas concentrations, humidity, and temperature. At a given location and time (time 1) an eddy will move an air parcel \( C_1 \) downward with speed \( W_1 \), next, at time 2, a second eddy at the same location will move air parcel \( C_2 \) upward with speed \( W_2 \) (see figure 2).

![Figure 2: Eddy covariance relates the speed and direction of an eddy to the concentration of interest. At time 1 an eddy will move an air parcel \( C_1 \) downward with speed \( W_1 \), at time 2 a second eddy at the same location will move air parcel \( C_2 \) upward with speed \( W_2 \).](image)

Measuring the characteristics of these air parcels and their speed and vertical direction constitutes a covariance between the concentration of interest and the wind speed of the eddy. This information can be used to calculate the turbulent vertical flux for a particular concentration, place, and time. Montgomery, (1948) was the first person to formulate the equations necessary for establishing such a convenience, his publication focused on heat fluxes.

The experimental process used to directly measure fluxes is called the eddy covariance or eddy correlations technique. This technique measures the fluctuating component of heat, mass, or momentum past a point. The fluctuating component is the instantaneous deviation from the mean over a given period, e.g. \( u' = U - \bar{U} \), where \( U \) is the wind speed time average (\( O_{30\text{min}} \)). The sampling length should be increased for strongly stable conditions and maybe reduced in stable conditions. However, sampling length in excess of 60min is not recommended due to the influence of mesoscale effects which do not contribute to turbulent fluxes. A sampling frequency of 10Hz is generally considered adequate for typical measurement heights and wind speeds. For these measurements to be representative of the flux at the underlying surface the instruments must be located in the internal boundary layer where the flux is approximately constant with height and statistically stationary. Over the sea surface, these conditions are generally met when fetch length > 1km for a measurement height \( \leq 10m \), Kraus and Businger, (1994).