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Eddy correlation flux measurements: The sediment surface area that contributes to the flux

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ABSTRACT: We investigated the size and shape of the area on the sediment surface, the so-calle footprint, that contributes to the flux in subaqueous eddy correlation measurements. Tracer tracking simulations were performed for a dissolved conservative tracer released from the sediment surface into a current-driven flow not affected by density stratifications and surface waves. Simulations revealed that the footprint length (l) can be calculated as $l = -2.783 - 158.7h$ · $159.2h^2 - 120.8h \log(z_0)$ (all units in m) for eddy correlation measurements heights (h) between 0. and 0.3 m above the sediment surface and for sediment surface roughness parameter (z_0) values between 7.04×10^{-6} and 0.01 m. The upstream distance (x_{max}) to the location that contributes th strongest flux signal can likewise be estimated as $x_{max} = -0.09888 - 11.53h + 10.25h^2 - 6.650h \log(z$ Because vertical turbulent mixing scales with mean current velocity, l and x_{max} are independent current velocity. The footprint width (w) can be calculated as $w = 6.531h$. These expressions were developed for water depths (H) of $H > 27h$. In the depth interval $6.7h > H > 27h$, l can be calculated by multiplying the length, as given above, by the factor $1 + 8.347\exp(-0.2453\ H/h)$, whereas x_{max} is independent of H. For $H > 6.7h$, the tracer transfer rate over the air-water interface controls the size and shape of the footprint. All expressions are valid for isotropic turbulence, but as a first-order estimate, the expressions for l and x_{max} also hold for anisotropic conditions. In contrast, w scales with $\mathrm{sqrt}(E_y/E_z)$, where E_y and E_z are the transverse and the vertical eddy diffusivity, respectively. Finally, we describe how site-specific values of z_0 and leve of anisotropy in a turbulent near-bottom flow can be extracted directly from eddy correlation measurements.

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