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Interactive comment on "On the impact of atmospheric waves on fluxes and turbulence statistics during nighttime conditions: a case study" *by* D. J. Durden et al.

Anonymous Referee #3

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On the Impact of Atmospheric Waves on Fluxes and Turbulence Statistics during Nighttime Conditions: A Case Study Author(s): D. J. Durden et al. MS No.: bg-2012-626 MS Type: Research Article

Recommendation Major revisions are required before this paper can be accepted for publication

Reviewer comments This paper is based upon a fundamental misunderstanding of the nature of eddy covariance measurements of surface-atmosphere exchange. It assumes that surface fluxes of scalars are carried only by 'turbulent' (incoherent) motions. Waves are assumed to carry no scalar flux and so an elaborate methodology

is applied to separate and remove the waves from the turbulence. In fact, both waves and turbulent motions are capable of transferring scalars between the surface and an atmospheric level at which an eddy flux instrument is located. Basically, the scalar doesn't care how it is transported and all the eddy flux device needs to do is to record the average covariance of all components of the vertical velocity and scalar signal.

I think the misunderstanding comes from the assumption that in a wave, the vertical velocity and the scalar concentration must be in quadrature. This is only true of an ideal inviscid wave or in certain circumstances of a wave in a fluid of constant viscosity. When the atmospheric wave is either: non-linear, interacting with turbulence, interacting with canopy drag, in a horizontally inhomogeneous mean field or affected strongly by buoyancy forces, then the quadrature relationship need not hold. In that case, because the wave motions are generally of large amplitude and more coherent than the turbulence, the wave can make a significant contribution to the transport of the scalar and removing it will compromise the measurement of biological exchange. Conversely, if the wave makes only a small or zero contribution to the budget, there is no need to remove it from the eddy covariance signal.

The problem posed by waves is a different one than addressed here. Because the eddy covariance averaging time is generally only a few wave periods, the possibility of only catching a fractional part of a wave period in the averaged covariance is high and, unless the resulting mismatch is captured in the storage term the budget will be in error. However, the errors in the storage term calculation are of a different order to those of flux calculation.

I agree with the authors that the wave signal needs to be separated from the turbulence signal to calculate some aspects of turbulence and wave dynamics but it most emphatically should not be separated when calculating the scalar flux.

Interactive comment on Biogeosciences Discuss., 10, 5149, 2013.