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The uncertainty of CO_2 flux measured by eddy correlation method

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The original definition of turbulent fluxes through air-sea interface is based on the eddy correlation method. In general, the bulk formulas for turbulent fluxes such as momentum, heat and water vapor fluxes are derived from the eddy correlation method. However, for the gas fluxes such as CO_2 flux, the bulk formulas have been obtained from the tracer experiments utilizing ambient gases or deliberately introduced tracers since the eddy correlation method was not reliable for gas fluxes in early days. Recently, with the development of the infrared gas analyzers, the high-speed response of the fluctuation of CO_2 density becomes available and reliable. Flux measurements with closed-path infrared gas analyzer (CP-IRGA) are comparable to the tracer experiments. For turbulent fluxes, it is prefer the open-path gas analyzer (OP-IRGA) due to the inherent advantages in frequency response, power consumption and wind measurement synchronization. However, the CO_2 fluxes measured by OP-IRGA have been found one order larger than those in tracer studies.

With the two long-term measurements by OP-IRGAs in fixed platforms in the shallow coastal area of the South China Sea and Yellow Sea, we evaluated the discrepancy between the observed fluxes by eddy correlation method and the expected fluxes by tracer studies. It is investigated the effects of density correction, water vapor cross-sensitivity and time-average scale on CO_2 fluxes. It is noted that the water vapor cross-sensitivity might be a source of error of CO_2 fluxes, but it cannot be ascribed to the optical contamination. It is emphasized that the time-average scale might be the important reason leading to the large fluxes by the eddy correlation method.