

Field Measurement of Gas Fluxes Using a Non-Gradient Method

A common field experiment equipment for monitoring natural environment and air pollution. Gas fluxes are the key variables characterizing the exchange of masses between the Earth and the atmosphere.

Georgia Tech inventors have formulated a new non-gradient model of gas fluxes without using high frequency data of gas density and wind speed. The innovative non-gradient model of gas fluxes uses a state-of-science mathematical theory known as “fractional calculus” to derive a gas flux using only low frequency (e.g. hourly) time-series measurements of single-level gas density supplemented by routine sub-daily meteorological data. The non-gradient method has a major advantage : reduced instrumental and operational cost compared to that of the EC device without compromising the accuracy of the gas flux product by gradient-based method. Furthermore, the non-gradient technology allows for a new design of gas flux device. Its hardware consists of a gas analyzer available in market for measuring gas density plus a routine meteorological system to measure radiation and temperature with a data logger as an integrated unit. No high frequency (e.g. sub-minute) sampling is needed. Its software component is computer programs for calculating the gas flux using the new non-gradient formula with input data from the data logger at desired time resolution (adjustable by the user).

Summary Bullets

- **Costs:** lower equipment and operation cost without compromising measurement accuracy
- **Efficiency:** efficient modeling gas fluxes at diurnal and seasonal scales
- **Applicability:** natural and pollutant gases over all types of land surfaces.

Solution Advantages

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Potential Commercial Applications

- The device can be used as a stand-alone sensor or a component of comprehensive hydrometeorological stations around the world.
- Ground monitoring of gas pollutants emitted from land surface sources.

Background and More Information

The traditional method for the field measurement of gas fluxes such as carbon dioxide or water vapor over land surfaces is based on the analogy of the Fourier's law applied to atmospheric turbulent flow, i.e. a gas flux is proportional to the corresponding gradient of gas density. The method uses the measured gas density at two or more levels for calculating gas gradient and wind speed for calculating transfer coefficient. This gradient method of gas fluxes tends to have large errors and uncertainties since the gas gradient, as the difference of two close numbers, has larger measurement errors than those of single-level gas density. Modern technology for the measurement of gas fluxes, the eddy covariance (EC) method, requires high frequency (e.g. 10 Hz) measurements of (single-level) gas density and wind speed above the ground. The EC method provides most "direct" measurements of gas fluxes, but at high cost of instrumentation and operation. For example, the EC system is demanding in power supply.

Inventors

- Jingfeng Wang
Associate Professor – Georgia Tech School of Civil & Environmental Engineering
- Yao Tang
Graduate Student – Georgia Tech School of Civil & Environmental Engineering

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