Validation of the Craig-Gordon isotopic model for lake evaporation

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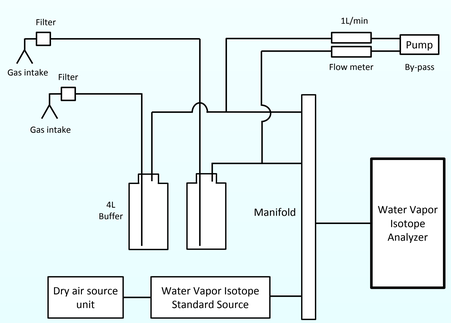
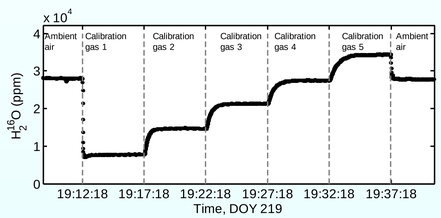
Introduction

- The theory on isotopic composition of evaporation (δ_E) of open water was first proposed by Craig and Gordon in 1965 (C-G model) and has since been widely employed in studies of isotope hydrology and ecology.
- In a typical application, the interfacial surface water layer is assumed to be well-mixed so that the isotopic composition of the evaporating surface is equal to that of the bulk water.
- To date, the C-G model and the associated well-mixed assumption have not been validated against field measurements over natural water bodies.
- In this study, in-situ measurement of δ_E was made on a near-continuous basis using the flux-gradient approach over Lake Taihu, a large shallow lake in East China.

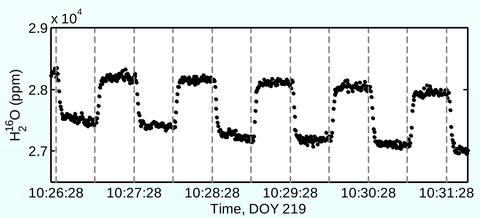
Schematic Design Diagram



Instrument Performance



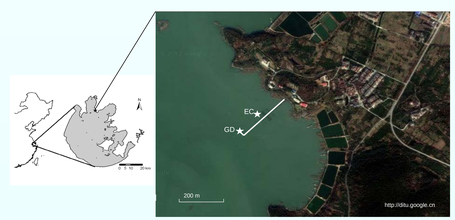
- To eliminate the effect of non-linearity and signal drift, we calibrated the analyzer every 3 h against 5 water vapor standards of identical isotopic compositions that bracketed the ambient humidity.



- When measuring the ambient air, the manifold switched between the two intakes every 30 s. The measurement approached steady state in less than 10 s after each switching.

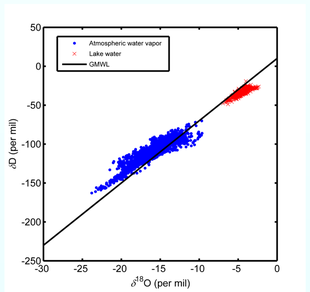
Site and Instruments

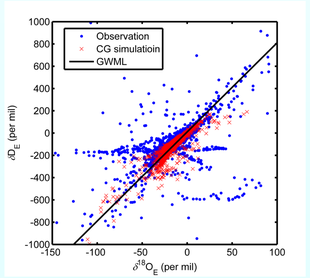
- The experiment site (31°24′N, 120°13′E) was in the north part of Lake Taihu, which is the third largest freshwater lake in China, with a water surface area of 2400 km^2 and a mean water depth of 1.9 m.

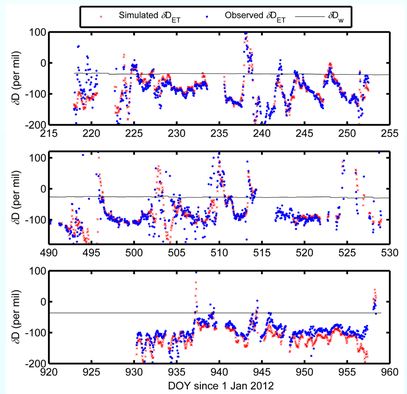


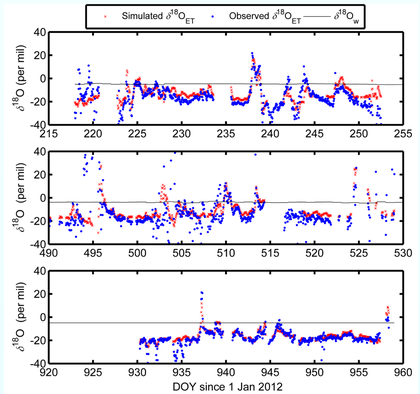
- The flux-gradient method was used to obtain the isotopic compositions of lake evaporation.
- The key instrument was a water vapor analyzer based on the off-axis integrated cavity output spectroscopy.
- The analyzer switched between the two intakes at the 1.1 and 3.5 m height above water.

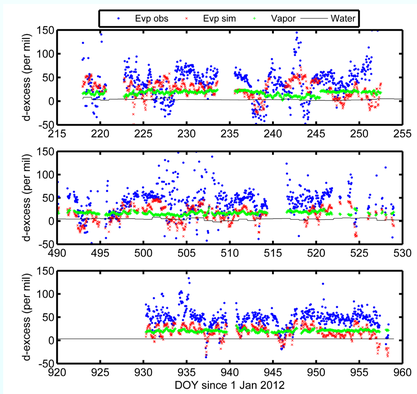
Validation of the Craig-Gordon Model











- The observation has continued to date since Aug 2012.
- The CG model captured the temporal variations in evaporation δ.
- The modeled δD_E and $\delta^{18}O_E$ were much closer to GMWL than the observations.

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