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Daily observations of rainfall, vapour and pan water δ^2H for improved quantification of atmospheric and terrestrial water interactions

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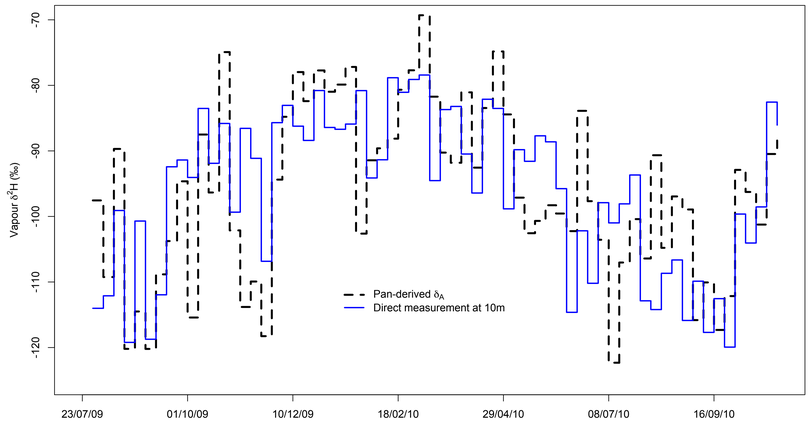
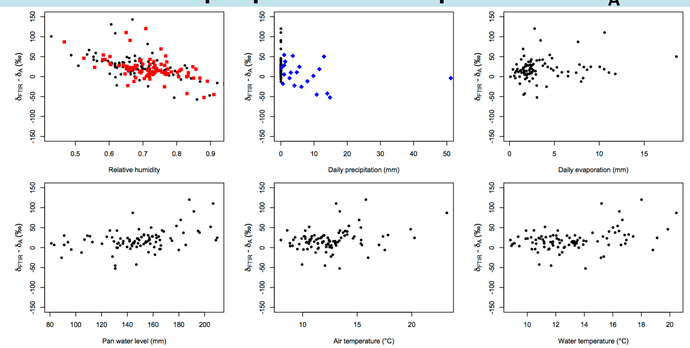
Introduction

- Obtaining ongoing time series data of the isotopic composition of atmospheric moisture (δ_A) can be difficult, especially in remote areas
- δ_A can be estimated by combining the Craig-Gordon evaporation model (Craig & Gordon, 1965) with a mass balance approach (Gonfiantini, 1986)
- This isotopic mass balance method can be applied with the use of evaporation pans (refer to Gibson et al. 1999)
- We had previously found a moderate correlation (R^2=0.49) between direct measurements of water vapour at 10m and the pan-derived δ_A at the Lucas Heights weather station in New South Wales, Australia (Azcurra et al., 2011).
- The pan-derived δ_A model was also found to be sensitive to humidity, which can vary significantly during the week-long sampling periods.
- **Here we investigate if δ_A estimates with the isotopic mass balance approach can be improved with more frequent sampling of the evaporation pan.**



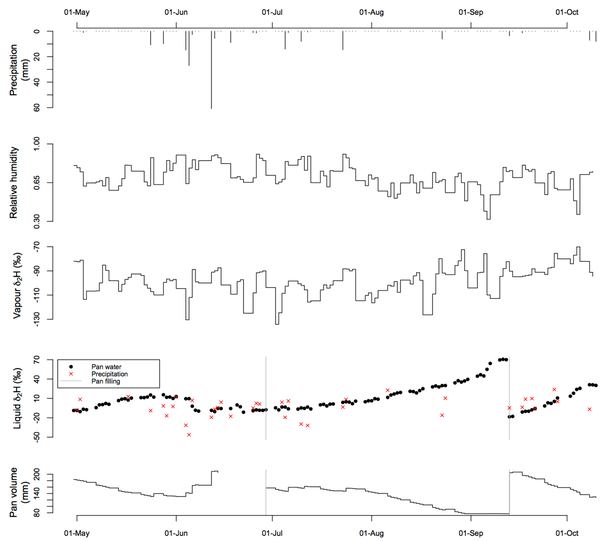
Time series of directly measured δ^2H using Fourier Transform Infrared (FTIR) spectrometry (solid blue line) and of modelled water vapour (broken black line) using weekly sampling intervals.

Effect of input parameters on pan-derived δ_A



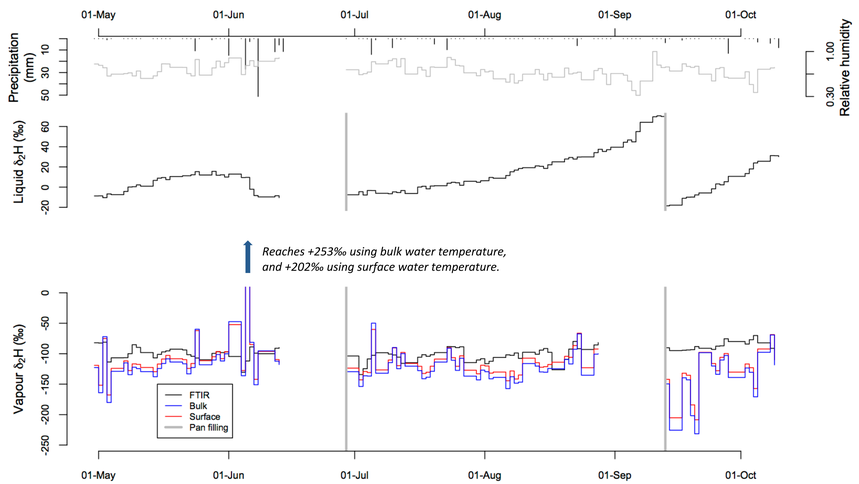
Relative humidity at the surface of the evaporation pan, regardless of whether calculated from bulk (black dots) or surface (red squares) water temperature clearly has an influence on model performance. Pan-derived δ_A is generally more enriched as humidity increases, and more depleted as humidity decreases, when compared to the directly measured δ_{FTIR}. None of the other model input parameters appear to influence model performance in a consistent manner (apparent poor model performance during non-rainfall periods is due to general poor model performance and few time intervals with precipitation).

Data



Data was collected from 30/04/12 – 10/10/12 and comprised of weekday grab samples of the evaporation pan water; daily samples of 24 hour precipitation; precipitation volume, pan water level, air temperature and relative humidity at 15 minute intervals; water vapour isotope measurements by FTIR spectrometry, averaged over 10 minute intervals; and bulk water and surface water temperatures every minute.

Daily pan-derived δ_A



Time series of daily precipitation, mean relative humidity for pan-water sampling intervals, δ_2H of pan water, and δ_2H of measured water vapour from FTIR (black lines) and modelled water vapour using either the bulk pan water temperature (blue lines) or surface pan water temperature (red lines). Gaps in water vapour time series due to errors in pan water level sensor. Use of the surface water temperature improves the model performance compared to δ_A calculated from bulk water temperature. Correlation between δ_A and δ_{FTIR} was poor (R^2<0.2).

Conclusions

- Estimating δ_A using the isotopic mass balance approach at daily sampling intervals was less successful than earlier work at weekly intervals for the same site
- Relative humidity was again found to significantly influence the pan-derived δ_A estimates, with higher humidity values generally causing more enriched δ_A than measured by FTIR, and lower humidity values producing more depleted δ_A
- Pan-derived δ_A estimates did improve when surface water temperature was used instead of bulk water temperature
- The pan-derived δ_A method has some merit, but it has not performed as well in this instance compared to the weekly time series.

References

Azcurra, Hughes, Parkes, Hollins, Gibson, McCabe & Evans (2011), *MODSIM2011*, http://www.mssanz.org.au/modsim2011/I1/azcurra.pdf; Craig & Gordon (1965), *Stable Isotopes in Oceonographic Studies and Paleotemperatures,* pp. 9-130; Gibson, Edwards & Prowse (1999), *J. Hydrol.*, 217, doi: 10.1016/S0022-1694(99)00015-3; Gonfiantini (1986), In *Handbook of Isotope Geochemistry Vol 2*, pp. 113-168.

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