Quantifying Water Balance-Carbon Storage Relationships Using Oxygen Isotope Ratios of Plant Lipids

TOBY MAXWELL[1]*, LUCAS C. R SILVA[1], GABRIEL PEDROSO[1], TIMOTHY A. DOANE[1], FUNGAI N. D. MUKOME[1] AND WILLIAM R. HORWATH[1]

[1]University of California Davis, Davis, CA 95616 (*correspondence: tmaxwel@ucdavis.edu)

The impacts of shifting climate zones on soil carbon (C) storage are poorly understood, although it functions as a major C pool[1]. For example, temperate forests occur across an elevation gradient with various stages of soil development, occupying several distinct climate zones. Soil development and C storage are strongly influenced by temperature, mineralogy, and local precipitation/evapotranspiration (ET) relationships[2], yet quantitative methods have not been established relating C storage to the latter. As a result, there is a need to develop new analytical approaches that improve models and predict impacts of water balance (precipitation inputs minus ET losses) on this labile C pool[1]. To do this, we seek to expand on the well understood relationship between oxygen isotopic ratios of meteoric water and plant water following the isotopic fractionation that occurs during ET[3]. We have shown that this signal is preserved in hexane extracts (i.e. the non-polar compounds) of bulk plant material, which suggests the potential for accumulated organic matter in soils to be used as a proxy for ecosystem water balance.

Recent research has identified that water balance and ET relationships drawn from analysis of δD may not be representative of integrated seasonal water balance[4]. This leads to difficulty in the interpretation of integrated hydrologic relationships from this method. However, the use of $\delta^{18}O$ as a proxy is promising, as plant physiological processes are not observed to affect water $\delta^{18}O$[5]. We look to study lipids, as they are a compound group synthesized using enriched leaf water[6], that are known for their long term residence in soil[7]. Moving forward, we seek to compare $\delta^{18}O$ and δD signals, using n-alkanol and n-alkanone compounds from bulk plant and soil material in to better characterize plant soil atmosphere biophysical relationships.

[1] Anderson *et al* (2010), *Front Eco Environ* **9**, 174-182 [2] Post *et al* (1982), *Nature* **298**, 156-159 [3] Sternberg (2009), *New Phytol* **181**, 553-562. [4] Tipple, B. *et al* (2013), *P Natl Acad Sci USA* **110**, 2659-2664 [5] Barbour (2007), *Funct Plant Biol* **34**, 83-94 [6] Sachse, *et al* (2012) *Annu Rev Earth Pl Sc* **40**, 221-249 [7] Lützow, *et al* (2006), *Eur J Soil Sci* **57**, 426-455