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Interactive comment on "A downward CO_2 flux seems to have nowhere to go" *by* J. Ma et al.

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The authors use a clever title to draw attention to the controversy about carbon sequestration in deserts. Although long debated, the controversy was heightened by Richard Stone in his Science article widely publicized deserts as possible CO2 sinks by asking whether "researchers have found a missing loop in the carbon cycle" (Stone 2008). Studies by Wohlfahrt et al. (2008) in the Mojave Desert of southwestern USA and Xie et al. (2009) in the Gubantanggut Desert of northwestern China made that implication.

It was pointed out by Schlesinger et al. (2009), however, that the numbers don't add up. To sequester that much carbon an unrealistic amount of biomass should have been produced. Likewise, if the carbon was sequestered as pedogenic CaCO3 an unrealistic amount of calcium would be needed from chemical weathering or atmospheric additions.

The study by Ma et al., like the study by Xie et al., was conducted in northwest China at the Fukang Experimentation Station. They acknowledged that carbon did not go into biomass or pedogenic carbonate based on comparisons with data made when the station was established in 1989. Still, their eddy-covariance measurement from 2002 to 2012 showed net CO2 uptake at the study site. They checked the accuracy of their measurements with a closed-chamber method and both methods yielded similar readings.

To account for where the carbon goes they proposed a "passive leaching" mechanism. Atmospheric CO2 is brought down by photosynthesis, respired into the soil profile where a portion is converted into dissolved inorganic carbon (DIC). The DIC then moves into the water table when it is high and carried away when the water table falls. As evidence to support their model, they have 30 years of data showing a water table that fluctuates between about 1 to 3 meters. They also conducted a lab experiment on a soil column simulating a fluctuating water table and used δ13C values to trace carbon from CO2 to DIC.

The paper makes a great contribution, despite the carbon isotope experiment being hard to follow. It is clear that field measurements of DIC in soil and groundwater are now needed to test their hypothesis. The major problem with applying the passive leaching model globally is that many, if not most, desert do not have shallow fluctuating water tables. Vadose zones in these deserts can be 10 to over 100 meters deep. Where would the carbon go in these deserts?

AC: We are very grateful for the referee's positive appraisal of our work. The laboratory soil column leaching experiment, presented here, was just a test of our hypothesis on "passive leaching": surface dissolve inorganic carbon (DIC) can be leached by fluctuations in groundwater. In this study, the saline desert is typical of desert-oasis ecotones. With high groundwater level and strong groundwater fluctuation, the passive leaching of DIC is significant (25 g C m-2 y-1). In desert with low groundwater table, other process such as gaseous CO2 diffusion may dominant. We fully aware that the passive

BGD

11, C4957–C4959, 2014

leaching presented here may occur only within a limited geographic range. To clarify this, field measurements of DIC in soil and groundwater should be ways to advance this line of research. We will add discussion on this point.

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