

Interactive comment on “A downward CO₂ 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.

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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—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 $\delta^{13}\text{C}$ 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?

References

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