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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Combined impacts of current and future dust deposition and regional warming on Colorado River Basin snow dynamics and hydrology" *by* J. S. Deems et al.

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We agree with Dr. Meixner's point that the primary result of our modeling efforts pertains to the effects of dust-on-snow (DOS) on runoff timing, and that the DOS impacts on runoff volume are less well-established. We have nearly a decade of in-situ observations and point-modeling study that clearly links the DOS radiative forcing to earlier and faster snowmelt. Actual observation of water volume losses due to DOS forcing would be quite difficult, if not impossible, and a modeling approach is mandated. By necessity, any modeling approach will depend on what representation and parameterizations of the processes are implemented, and in some sense will rely on the implicit

model sensitivities.

We describe our methods as a “model sensitivity approach”. That the changes in snowmelt and melt-out date in the VIC model correspond well to observations and point modeling is encouraging, and gives confidence that the model snowpack physics are reasonable. Subsequent runoff losses (due primarily to ET) are more difficult to verify.

Dr. Meixner’s second point regarding the “diminishing return aspect of more dust” appears to be a misunderstanding. Under the historic climate forcings, the change in runoff timing (peak and COM) are nearly the same from LD to MD and from MD to ED scenarios – this is important, and one we discuss extensively, noting that this timing sensitivity is maintained under future conditions. The “diminishing return aspect” pertains to the DOS effects on runoff volume. Where the volume difference between LD and MD scenarios was $\sim$5% (again, under historic forcings; this result was from our 2010 PNAS paper), the volume change from MD to ED is only $\sim$1%. We attribute this in the paper to the snow-free season beginning during low ET conditions during early spring; this lower evaporative demand produces different melt-out changes than if the snow-free season begins later in the year.

We have reworded the manuscript in light of Dr. Meixner’s comments to clarify our sensitivity study of DOS effects on runoff volume change, and to emphasize the sustained sensitivity of runoff timing and reduced sensitivity of runoff volume to DOS under future climate conditions.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 6237, 2013.