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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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Reviewer #2 makes four primary points:

1. Dust source regions and their likely response to climate warming should be identified

2. Representativeness of albedo observations should be characterized, as should the spatial variability of DOS loading across the UCRB domain; the spatially uniform application of the dust scenarios could affect the validity of the approach.

3. Potential humidity bias in VIC may affect the empirically-estimated solar radiation; this should be discussed

4. Temporal trends in DOS deposition are not well-established, and thus the DOS hydrologic forcing should not be compared with climate forcings on hydrology.

These are all important points, and we address them in order:

1) We are intentionally non-specific about dust source areas beyond describing the source regions as "Colorado Plateau and Great Basin". The current proportional contribution of specific source locations to dust loading in the UCRB mountains is the subject of ongoing research and to identify specific source locations over others would be premature and beyond the scope of this paper. We rely on the papers cited (Belnap et al., 2009 and Munson et al., 2011) to provide the reader with appropriate background on dust source locations and climate impacts on vegetation cover and dust emission.

2) Our empirical snow albedo decay curves are based on observations at a point location, which we note as well as refer to in our prior work (Painter et al., 2010) where we describe the LD and MD (BDL and ADL in that paper) curve fits to observations.

The point regarding the spatial representativeness is an excellent one, and we agree that it should be discussed. The spatially uniform application of the albedo scenarios is consistent with the sensitivity approach – explicit treatment of spatial variability could also be conducted in a sensitivity experiment, or via an effort to simulate the observed hydrologic time series.

We have revised the manuscript to acknowledge the spatially uniform application of the albedo scenarios and briefly discuss the potential implications, as well as note a recent paper by some of the authors using MODIS products to study spatial variation in dust radiative forcing.

3) We agree that dependence on empirical reconstructions of energy balance components from observations of temperature and precipitation is a handicap of any spatially-distributed, process-based hydrology modeling effort, and we discuss this at length. The Reviewer's suggestion to include the recent humidity/VIC study is a good one –

we have incorporated those results in our discussion.

4) The sentence referred to (p. 6250, lines 16-19) was not intended to refer to a trend in dust deposition, but rather to the relative magnitudes of dust radiative forcing and warming-produced turbulent and longwave forcings on snowmelt (as demonstrated in the cited work by Skiles et al., 2012).

Regarding trends in dust deposition, we deliberately avoid suggestion of a trend in our observed albedo record (8 year duration), because we agree with the reviewer that that record is too short for trend detection. Rather, we take the approach that the strong increase in dust deposition after the 1850s settlement of western lands, the strong current (observed) forcing of snowmelt by dust over a range represented by our 3 dust scenarios, and projected enhanced dust emission from regional sources due to climate warming represent a spectrum of dust impacts on the CO River Basin snowpack. We bracket the potential hydrologic impacts of dust using this spectrum, and posit that the projections of enhanced dust emission due to regional warming will tend to produce a greater frequency of years with dust impact akin to the ED scenario. We have updated the manuscript to more clearly convey this approach.

We have also included discussion of a recent paper (Brahney et al., 2013; published after submission of this manuscript) detailing an increase in dust deposition over the last 17 years. We have clarified the manuscript to reflect this study of the long-term trend of increased dust deposition (not a short-term trend) and to ensure that our discussion of recent dust events is embedded in that context.

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