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Discussions

Interactive comment on "Reply to D. L. Peters' comment on "Streamflow input to Lake Athabasca, Canada" by Rasouli et al. (2013)" *by* K. Rasouli et al.

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Rasouli et al. (2013; R13) presented an analysis of eight hydrometric time series to support an interpretation of declining levels of Lake Athabasca over the period 1960-2010. Based on these recent trends, and previous studies of the paleo-limnology of the region, they conclude that lake levels may drop by 2-3 meters by the end of the century. In his commentary, Peters (2014; P14) provided significant additional information about the hydraulics of the lake and the geomorphology of the basin suggesting that lake level variability is a more complex phenomenon than depicted by R13. P13 has a valid point, and supplies important supplementary data, but this criticism is not

as serious as Peters implies. R13 did not propose or attempt to address these issues but rather examined only the variability of flows entering Lake Athabasca. They investigated lake level fluctuations from the perspective of climate variability whereas P14 takes a different approach focusing on the hydraulic and geomorphic constraints on lake levels, including physical controls on outflow.

The Rasouli et al. (2014; R14) reply to Peters' commentary makes this distinction between their objectives and Peters' main criticism and then supplies further data and analysis to validate their initial conclusions. A more substantive criticism of R13, mentioned but not emphasized by Peters, is the great deal of uncertainty inherent in their extrapolation of recent water level trends in a non-stationary hydro-climatic regime. Linear extrapolation is especially problematic in Canada's western interior, where there are strong inter-annual and decadal modes of variability in instrumental (St. Jacques et al., 2010, 2014) and paleo (Fleming and Sauchyn, 2012; Sauchyn et al., 2011) streamflow time series. Lower frequency variability is evident in the paleo lake level records that R13 used to contextualize their analysis and interpretation of recent water level trends. Wolfe et al. (2008, 2011) inferred lake levels that were 2-4 m lower during 5200-2500 yrs BP and about 2 m higher than present during the Little Ice Age (LIA). R13 used the low middle Holocene lake levels to support their projection of a 2-3 m decline by 2100. As P14 points out, R13 chose not to refer to the higher LIA lake levels and R14 provides only weak justification for this decision: "given the declining streamflow input to Lake Athabasca and hence its level, it seemed irrelevant to bring this matter in our discussion".

On the contrary, natural low-frequency hydroclimatic variability is very relevant. It tends to confound the detection of trends in instrumental time series and the projection of climate changes. Various recent papers (e.g., Deser et al., 2012; Knutti and Sedláček, 2013) conclude that natural variability is the largest source of uncertainty in climate modeling and that it "poses inherent limits to climate predictability". R14 suggests that "a more rigorous approach to better constrain estimates of potential future levels of Lake Athabasca is to employ global climate models (GCMs) or regional climate models (RCMs) driven by future greenhouse gas emissions scenarios". The rigour of this approach would depend very much on the degree to which the chosen GCMs or RCMs are able to simulate the internal variability of the climate system and the natural forcing of inter-annual to decadal variability of the hydrologic regime of the Lake Athabasca basin.

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