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Hydrology and Earth System Sciences Discussions

Interactive comment on "Interannual variations of the terrestrial water storage in the Lower Ob' basin from a multisatellite approach" *by* F. Frappart et al.

Anonymous Referee #1

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Review: hss-2010-226 (hessd-7-6647-2010) Title: Interannual variations of the terrestrial water storage in the Lower Ob' basin from a multisatellite approach

By: F. Frappart, F. Papa, A. Güntner, S. Werth, G. Ramillien, C. Prigent, W. B. Rossow, and M.-P. Bonnet

Minor Edits

Page Action item

6650 The reference to Muskett and Romanovsky should have the date as 2009 (also change this in the references section).

6652 “comsomonly” should likely be changed to commonly.

6658 “Ob”, change to Ob’ for consistency.

6661 “orz”, should likely be deleted.

Comments

The article by Frappart et al. employs a multi-satellite and assimilation model approach to address the water equivalent mass changes of the lower Ob’ River basin in western Siberia. The Ob’ has importance in being one of the three largest Siberian river systems feeding freshwater, sediment and dissolved carbon to the coastal seas of the Arctic Ocean. The Ob’ river system also is a major artery for agriculture, commerce, hydroelectric power and industry. As the authors cite in the references, the Ob’ has attracted quite a number of studies into its hydrologic characteristics. Recent references have also started to explore the implications and impacts of thawing permafrost on the Ob’ hydrologic regime.

I find the paper well written and a valid effort, this time focusing on the lower Ob’. The lower Ob’, from the intersection of the Irtysh River system south to the Ob’ estuary, is distinct from the upper Ob’ by difference in sub-basin hydrologic regime, permafrost characteristics and river management (i.e. dams and reservoirs). The lower Ob’ is underlain by mostly the discontinuous permafrost zone, with the continuous permafrost zone being found closer to its northernmost extent. The upper Ob’ is underlain by non-permafrost, i.e. non-frozen ground. This distinction also goes for the active-layer, i.e. seasonally frozen ground, and the presence of taliks, non-frozen ground beneath river channels, thaw-lakes and even within permafrost bodies (which also contains water). This has an interesting correspondence with the sub-basin hydrologic regimes: the lower Ob’ shows increasing discharge/runoff while the upper Ob’ shows decreasing discharge/runoff. The total Ob’ basin has a very small magnitude trend of discharge/runoff, actually not significantly increasing or decreasing – a steady state. The hydroelectric dams and reservoirs of the upper Ob’ are likely playing into this, unlike

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the Yenisei and Lena River systems. In total the Ob' River system, i.e. watershed, is roughly 70% non-permafrost.

The models employed by the authors suffer from lacking relevance to permafrost, active-layer and talik. The WGHM of Döll et al., 2003, employs a minimization function with a "permafrost factor, fpg" which is an overly simplistic approach, for example. I would say that, "root zone" and "soil moisture" in the model has little if anything at all to do with active-layer and talik. Allow me to give an excerpt from the paper "Active Layer Changes (1968 to 1993) following the Forest-Tundra Fire, Inuvik, N.W.T., Canada" by J. Ross MacKay that appeared in Arctic and Alpine Research, vol. 27, no. 4, p. 323-336, 1995. "In the first 10 to 20 yr following the 1968 Inuvik fire, the active layer deepened at most sites and the ground surface subsided from the thaw of ice-rich permafrost. However, as sites became revegetated, the active layer thinned. Consequently, the top of permafrost aggraded upward at the same rate that the active layer thinned. As the active layer thinned year by year, any ice lenses that remained unthawed at the bottom of the active layer for one or more summers eventually became incorporated into the top of the aggrading permafrost in succeeding winters. In addition, field studies have shown that in summer, pore water from the thawing active layer can migrate downwards, under a temperature gradient, to refreeze in the top of permafrost to increase its ice content (Parmuzina, 1978; Cheng, 1982; Mackay, 1983; Burn, 1988). Therefore, where the active layer progressively thinned, some ice was usually incorporated into the top of aggrading permafrost. The ground surface was then uplifted by the growth of aggradational ice (Mackay, 1972)."

Also one is left to wonder about sub-surface recharge and discharge of the lower and upper Ob'. The models employ parameterized "on-off" switches and no flow paths. Permafrost may be frozen, and it is thawing, and its thermal character in the discontinuous zone can change spatially and temporally in ways that the models do not capture. Taliks are not frozen and they can provide pathways for water transmission (sub-surface discharge and recharge). The models used are in desperate need of realistic and accurate characteristics of permafrost, active-layer and talik, and how they are changing.

To conclude: 1) the models have little to do with the terrain they are being employed to model and 2) the ups and downs of the TOPEX/Poseidon [which reference frame, tide-free, mean-tide or zero-tide was used] need to be considered more carefully than we find in the manuscript. In these ways that I have commented, the estimates and conclusions of this manuscript are not beyond reasonable doubt. However, I commend the authors for their interest and efforts toward addressing the lower Ob' with their methods and models in-hand, however imperfect, and in establishing a “base-line” of sorts for others to more fully address in the future.

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Interactive Comment