This manuscript describes a refinement of an Earth Systems Model that constitutes an early step in incorporating more physically realistic processes for sediment movement in a model framework that by necessity is largely empirical. Delivery of sediment from hillslopes into the channel system is largely empirical. Routing that sediment through the channel system is amenable to more physics-based treatments; however, the large scale of model application necessitates substantial simplifications. I believe the authors have done a good job of incorporating the most essential processes of suspended sediment transport in the channel system, while leaving open the possibility of greater refinement in the future. The manuscript is well-written, clear, and the objectives they pursue in their modeling are novel and of interest to the scientific community.

I don't have any comments that would require major revision of the paper. Therefore, my "major issues" below, are only major in a relative sense – it is just a matter of clarifying some points. The "minor issues" are just some recommended changes in wording.

Major issues:

Most of my major issues pertain to the treatment of reservoirs; if I interpret the paper properly, the wash load effectively gets routed along with the water through the channels, and its only alteration in the channel system is its entrapment in reservoirs. Therefore, the treatment of the reservoirs is exceedingly important. Some of the issues raised below may be clarified in the section where you describe Mosart-water; some of them would be best addressed in the Mosart-sediment sections; and some of them might be better left to the Conclusions, where you describe potential future refinements to the model.

1. You use the effective storage capacity of the reservoir in Eq. (11). Some additional clarification would be useful regarding what this represents. It is common for reservoirs in the western U.S. to have a "normal" pool stage, and above that level a flood storage volume that is infrequently occupied. Is the reservoir capacity the capacity up to the normal pool, or does it include the full capacity including flood storage? Or is it the volume stored at a particular time interval of the simulation?
2. Does reservoir volume change during the simulation? I'm sure you don't have enough information to incorporate detailed stage-volume relationships, but protracted high flow periods or low flow periods and the associated volume changes could yield quite different reservoir residence times that would go into Eq. (11).
3. How is suspended sediment routed through the reservoirs? Assuming a particle of wash load follows a parcel of water, there could be a substantial lag time from the time the particle of wash load enters the reservoir and the time it exits the reservoir. The method of routing of suspended load through the reservoir needs to be described – even if it is highly simplistic.
4. The issue of what constitutes a reservoir is something that will require some thought for future model refinements. The upper Mississippi River, Illinois River, Ohio River, and other large navigable waters in the middle and eastern U.S. have a series of navigation dams that create pools that step the river down in discrete drops at the dams. From your discussion of Illinois River, indicating only a few reservoirs, most likely the navigation pools were not treated as reservoirs. And this is reasonable. However, in representing the hydraulics and sediment routing through these large rivers, these pools are a first-order effect and cover 100's of kms of rivers. The friction slope that is driving the boundary shear stress is commonly dropped by an order of

magnitude relative to the mean stream-bed slope in such pools. Not only does this alter the suspended bed material load, but the mean velocity is lower, and routing of wash load would consequently be altered as well.

The only other issue I had pertains to flood flows. If I understand the paper correctly, the channels are treated as rectangular cross sections. This is a good conceptualization, up until the point when flows go overbank. As a large amount of the annual sediment load is delivered during flood, being able to more realistically capture conditions during flood would be quite important – at least for the big rivers like the Mississippi and Missouri Rivers. If the discharge was twice the bankfull flow, in reality it would engage the floodplain, and temper further increases in the boundary shear stresses experienced by the channel. However, if the flood was carried entirely in a rectangular channel, the depth, velocity, and boundary shear stress would increase dramatically and would certainly overestimate the amount of suspended bed material load. A future refinement that would account for a simple compound channel for the dynamic wave routing could largely alleviate this issue; but of course, it will also take a lot of effort.

Minor issues:

Line 166: replace “kinematic” with “kinetic”

Line 214: replace “pebbles and bounders” with “cobbles and boulders”

Line 235: It should be noted that the Engelund-Hansen relationship is based on their own treatment of C_f, which is not the one used in Eq. (3). The Engelund-Hansen C_f is calculated by taking into account the relative effects of skin friction and form drag that varies with τ^*. Your simplification is warranted given the extra computational expense associated with the shear partitioning process, but it should be explicitly stated.

Line 244: Here you describe how you calculate the variable S_h, but you don’t state what the variable is. (It is the friction slope or slope of the energy grade line).

Line 261: Define the variable D; (I assume that it is not synonymous with D_{50} in Cheng’s formula)

Line 261-262: I recommend using a different variable than υ_t for kinematic viscosity. That is so commonly used to indicate the turbulent eddy viscosity, that it could cause confusion.

Line 320: U.S. Army Corps of Engineers