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Hydrology and
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Discussions

Interactive comment on "The snowmelt runoff forecasting model of coupling WRF and DHSVM" *by* Q. Zhao et al.

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Thank you to the reviewers for their time and thoughtful comments, many of which have been incorporated into the revised manuscript. Below you will find our detailed responses and modifications to the text. (1) (a)Why those models were chosen out of many similar models? Or what are the key features of those models that made them fit better in this study?

I have added the key features of those models into the revised manuscript. WRF: There are highly modular, transportable, and efficient in massively Parallel Computing environment , numerous physics options in the WRF model , advanced data assimilation system developed in tandem with the model it self . The simulations and real-time forecasting show that WFR model has good property for forecasting many kind of weather. The WRF model fully coupled “online” chemistry; therefore WRF model system has broad application not only in weather forecasts, but also in air quality forecasts.

DHSVM:

There is a perfect snow accumulation and melt algorithm in DHSVM model. DHSVM models the processes associated with snowpack morphology as described by Storck and Lettenmaier (1999; 2000) and Storck (2000) using a two-layer ground snowpack representation of snow accumulation and melt. This snowpack model utilizes separate energy and mass balance components to represent the various physical processes affecting the snowpack. It also accounts for energy exchanges taking place between the atmosphere, overstory canopy, and main snowpack. The energy balance components of the model address snowmelt, refreezing, and changes in snowpack heat content, while the mass-balance equations address the snow accumulation and ablation processes, transformations in the snow water equivalent, and snowpack water yield (Wigmosta, 2002).

(b)Are there any key parameters need to be calibrated or tuned for the studied watershed? HydrologyïijŇvegetation and soil parameter schemes have been successfully developed for simulations in North America. Totally 33 parameters were calculated and adjusted in terms of basin climatic and natural conditions. To apply DHSVM model system to snowmelt runoff modelingïijŇthe parameter scheme must be improved and renewed. In factïijŇthe total 33 parameters were all recalculated and reset by using up-to-date hydrometeorology theory and methodologyïijŇand with focus on certain critical parameters such as soil porosityïijŇfield capacityïijŇwilting point and vertical saturated hydraulic conductivity for each layer for soil typeïijŇlateral saturated hydraulic conductivity for each soil type. Because at spring melt season, there is few evergreen needleleaf in the study area, while others have not yet grown and were cover by snow, so LAI and height of vegetation except evergreen needleleaf was adjusted as bare land. There were two important soil parameters (Maximum Infiltration rate and Mannings n) should be adjusted in snowmelt runoff modeling. Maximum Infilatration rate: Seasonal ground frost is widespread in the catchment at spring melt season. The spatial distribution of frozen soil and snow cover at the start of the spring melt season plays an important role in the generation of spring runoff. Many fileld studies of snowmelt infiltration into frozen soils are reported in the literature (Kane and Stein, 1983 Granger Burn, 1991; D. M. Gray, Brenda Toth and L. Zhao, 2001; Cherkauer, K. A., and D. P. Lettenmaier, 2003; Guo-Yue Niu and Zong-Liang, 2006; Yang Xia Zhang and ShuFen Sun, 2007; Baisheng Ye, 2009). The hydrological effects of frozen soil is suppressing infiltration and encouraging surface runoff. In this paper, we empirically hypothesize that the seasonal frozen soil distributes under snow cover region and maximum infiltration rate of frozen soil is 0.0. Mannings n: The delay of the snowmelt runoff as compared to the time of energy input at snow surface is found to be due to water holding capacity of snowpack and the horizontal travel time of meltwater along the ground. So that the peak time of daily runoff was put off. In this paper the soil parameter, Mannings n (Coefficient of Roughness), was adjusted to conforms the simulated daily flood-peak time to observation data. There is no a hydrological and meteorological station in this study area, our group observed the snowmelt process for 3 years (2006,2007, 2008), we have observed the daily flood-peak time at spring melt season in 2006 and 2007, unfortunately there was not enough time series runoff data. We can adjusted a few parameter (Coefficient of Roughness, Stream network parameters, etc) based on the observation in 2006 and 2007. With the new model parameter schemes, the forecasted snowmelt runoff agree with the record database and modeling efficiency was better than that with original parameter schemes (Fig. 2).

(c) What are the key processes that control the final flood forecasting results, which algorithms /parameterizations made it a success in this study. It might be worth of some efforts to make more in depth analysis of the results to answer above questions

The soil parameters are the key parameterizations to snowmelt runoff modeling. I have added a chapter about DHSVM calibration analysis.

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(2)

There is no a hydrological and meteorological station in this study area, our group had observed the snowmelt for 3 years (2006,2007, 2008), unfortunately there was not enough time series daily runoff data in 2006 and 2007. So we can only adjust some parameters based on a few observation data in 2006 and 2007.

(3) Some more references are required when describes the models and data. We have added some latest reference into the revised manuscript.

The data included terrain elevation, land-use/vegetation, land-water mask, soil type, vegetation fraction and deep soil temperature from USA AVHRR satellite inversion data. The soil class was based on USDA texture, the terrain elevation was Global 30 s DEM data, and the vegetation category was USGS standard (U.S. Department of the Interior, and U.S. Geological Survey, 2000, 2006).

The cumulus parameterization was New Kain-Fritsch scheme. The microphysics scheme was WRF Single- Moment 3-class scheme (WSM3). A rapid and accurate radiative transfer model (RRTM) longwave scheme and Dudhia scheme were adopted for long-wave radiation and short-wave radiation. The planetary boundary layer scheme was Yonsei University (YSU) scheme. The 5-layer thermal diffusion surface physics scheme was chosen (Kain, J. S., and J. M. Fritsch, 1990, 1993; Hong, S. Y., and H. L. Pan, 1996; Mlawer, E. J., etc, 1997; Hong, S. Y., H. M. H. Juang, and Q. Zhao, 1998; Chen, S. H., and J. Dudhia, 2000).

(4)The English of this manuscript needs a good editing. Thanks for your suggestion, we have check the manuscript again, and corrected some mistake.

References: Baisheng Ye, Daqing Yang, Zhongliang Zhang, and Douglas L. Kane: Variation of hydrological regime with permafrost coverage over Lena Basin in Siberia, Journal of Geophysical Research, VOL. 114, D07102, doi:10.1029/2008JD010537, 2009.

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Burn, C.R.: Snowmelt infiltration into frozen soil at sites in the discontinuous permafrost zone near Mayo, YUkon Territory. In: Prowse, T.P., Ommanney, C.S.L. (eds), Northern Hydrology: Selective Perspectives, NHRI Symposium No. 6, National Hydrology Research Institute, Environment Canada, Saskatoon, Saskatchewan, pp. 445–459, 1991.

Chen, S. H., and J. Dudhia: Annual report: WRF physics, Air Force Weather Agency, 38pp, 2000.

Cherkauer, K. A., and D. P. Lettenmaier: Simulation of spatial variability in snow and frozen soil, J. Geophys. Res., 108(D22), 8858, doi: 10.1029/2003JD003575, 2003.

D. M. Gray, Brenda Toth and L. Zhao, et al: Estimating areal snowmelt infiltration into frozen soils, Hydrological Process, 15(16), 3095 – 3111, 2001.

Guo-Yue Niu and Zong-Liang Yang: Effects of Frozen Soil on Snowmelt Runoff and Soil Water Storage at a Continental Scale, Journal of Hydrometeorology, 7(10), 937-952, 2006.

Hong, S. Y., and H. L. Pan: Nonlocal boundary layer vertical diffusion in a medium-range forecast model. Mon. Wea. Rev., 124, 2322-2339, 1996.

Hong, S. Y., H. M. H. Juang, and Q. Zhao: Implementation of prognostic cloud scheme for a regional spectral model, Mon. Wea. Rev., 126, 2621-2639, 1998.

Jens Bartholmes and Ezio Todini: Coupling meteorological and hydrological models for flood Forecasting, Hydrology and Earth System Sciences, 9(4), 333-346, 2005.

K. E. Saxton, W. J. Rawls, J. S. Romberger, and R. I. Papendick: Estimating Generalized Soil-water Characteristics from Texture, Soil SCI. SOC. AM. J., VOL. 50, 1031-1036, 1986. Kain, J. S., and J. M. Fritsch: A one-dimensional entraining/ detraining plumes model and its application in convective parameterization. J. Atmos. Sci., 47, 2784-2802, 1990.

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Interactive Discussion

Discussion Paper

Kain, J. S., and J. M. Fritsch: Convective parameterization for mesoscale models: The Kain-Fritcsh scheme. The representation of cumulus convection in numerical models, K.A. Emanuel and D.J. Raymond, Eds., Amer. Meteor. Soc., 246 pp, 1993.

Kiamehr, R., and Sjoberg, L. E.: Effect of the SRTM global DEM on the determination of a high resolution geoid model; a case study in Iran, Journal of Geodesy, 79(9), 532, 2005.

Mlawer, E. J., S. J. Taubman, P. D. Brown, M. J. Iacono, and S. A. Clough: Radiative trans-fer for inhomogeneous atmosphere: RRTM, a validated correlated-k model for the long-wave, J. Geophys. Res., 102(14), 16663-16682, 1997.

P. A. M. Berry, J. D. Garlick, R. G. Smith: Near-global validation of the SRTM DEM using satellite radar altimetry, Remote Sensing of Environment, 106, 17-27, 2007.

U.S. Department of the Interior, and U.S. Geological Survey: Sawgrass Density, Biomass, and Leaf Area Index: A Flume Study in Support of Research on Wind Sheltering Effects in the Florida Everglades, Open-File Report 00-172, 2000.

U.S. Department of the Interior, and U.S. Geological Survey:: Vegetation Classification for South Florida Natural Areas: Saint Petersburg, Fl, United States Geological Survey, Open-File Report 2006-1240, 1-142, 2006.

W. J. Rawls, A. Nemes, Y. A. Pachepsky, and K. E. Saxton: Using the NRCS National Soils Information System (NASIS) to Provide Soil Hydraulic Properties for Engineering Applications, American Society of Agricultural and Biological Engineers, 50(5), 1715-1718, 2007.

USGS: Shuttle Radar Topography Mission (SRTM)âĂŤ“Finished” Products: U.S. Geological Survey. URL: http://edc.usgs.gov/products/elevation/srtmbil.html, last date accessed: 30 June 2005.

Xia Zhang, ShuFen Sun and Yongkang Xue: Development and Testing of a Frozen Soil Parameterization for Cold Region Studies, Journal of Hydrometeorology, 8(4), 690-701,

2007.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 3335, 2009.