Texas A & M University and U.S. Bureau of Reclamation

Model Description Form for Regional Hydroclimate Model (RegHCM)

Name of Model:

Regional Hydroclimate Model (RegHCM)

Model Type:

Physically-based, distributed, regional scale, fully-coupled atmospheric-hydrologic model

Model Objective(s) :

To simulate coupled atmospheric-land hydrologic processes in time and space continuously at climatic scales (10s – 100s of years) for the quantitative assessment of water balances under changing climatic conditions and land surface conditions over continental, country and watershed domains in terms of precipitation, air temperature, snowmelt, evapotranspiration, soil water storage, and streamflow

Agency and Office:

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Model Structure or Mathematical Basis:

RegHCM is made up of the atmospheric component of the nonhydrostatic 5th Generation Mesoscale Model of Penn State-NCAR (MM5) that is coupled in a two-way-interaction to a physically-based regional-scale land hydrology model. The regional hydrology model component is based upon upscaled hydrologic conservation equations that are scalable with the spatial grid scales.

Model Parameters:

Soil depth, grid area median saturated hydraulic conductivity, grid areal standard deviation of log saturated hydraulic conductivity, grid area mean porosity, grid area mean residual water content, grid area mean bubbling pressure, grid area mean pore size distribution index, land surface Manning roughness, river channel width and Manning roughness

Spatial Scale Employed in the Model:

Spatial grid scales: 3km – 20km

Temporal Scale Employed in the Model:

Time steps: 1minute – 1 day – 1 month

Input Data Requirements:

Input data for the above-listed model parameters. Also, input data for atmospheric state variables at all atmospheric layers of the model

Computer Requirements:

Cluster of Desktop PCs with Intel Core 2 Duo Processors

Model Output:

Hourly, daily or monthly grid-average precipitation and air temperature, streamflow from the watersheds in the modeled region, and the following grid-area-average hydrologic output: snowmelt, snow cover, interception, infiltration, evapotranspiration, surface soil water content, soil water storage, direct runoff

Parameter Estimation / Model Calibration:

Most RegHCM parameters are estimated directly from the land and satellite databases; stream channel widths and Manning roughness are estimated from calibration

Model Testing and Verification:

In a typical application, RegHCM is tested and verified by the comparison of its climatic and hydrologic simulation outputs (typically precipitation, air temperature, streamflow, snowmelt rates, snow cover, evaporation) against observations over a 10-year historical period

Model Sensitivity:

Discussed in the paper

M.L. Kavvas, Z.Q. Chen, L. Tan, S.-T. Soong, A. Terakawa, J. Yoshitani, K. Fukami, “A Regional-Scale Land Surface Parameterization Based on Areally-Averaged Hydrologic Conservation Equations”, Hydrological Sciences Journal, 43(4), 611-631, 1998

Model Reliability:

The quality of the output produced by RegHCM depends fundamentally on the quality of the atmospheric initial/boundary conditions and on the quality of the land input data

Model Application / Case Studies:

The RegHCM development and application has been evolving since early 1990s. The first version of RegHCM, called IRSHAM (Integrated Regional-Scale Hydrologic-Atmospheric Model) was applied during 1990-1995 to the assessment of water balances over Japan under climate change, and over California and Korean Peninsula for climate change studies during late 1990s. The new version of RegHCM, as described here, was applied over the Middle East, over the Mekong River Basin, over Malaysian Peninsula and over several watersheds in California for long-term water balance studies

Documentation:

M.L.Kavvas, Z.-Q.Chen, L.Tan, S.-T.Soong, A.Terakawa, J.Yoshitani, M.Fujikane and A.Watanabe, "A Coupled Mesoscale Hydrologic-Atmospheric Model for the Study of Climate Over Eastern Asia and Japan", Proceedings of The Second International Study Conference on GEWEX in Asia and GAME, Pattaya, Thailand, pp. 191-194, March, 1995

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M.L. Kavvas, Z.-Q. Chen, L. Tan, S.-T. Soong, J. Yoshitani, K. Masukura, M. Kaneki, K. Fukami, “A Coupled Regional Hydrologic-Atmospheric Model for the Study of Hydroclimate over California”, Invited keynote paper, Proceedings of the 4th International Conference on Hydro-Science and Engineering, Seoul, Korea, Vol. IV, Ed. By Yoon, Y.N., Jun, B.H., Seoh, B.H., Choi, G.W., Sept. 26-29, 2000

J.Yoshitani, M.L.Kavvas and Z.Q. Chen, “Coupled regional-scale hydrological-atmospheric model for the study of climate impact on Japan”, In *Soil-Vegetation-Atmosphere Transfer Schemes and Large-Scale Hydrological Models,* Proceedings of International Symposium on S3: Soil-Vegetation-Atmosphere Transfer Schemes and Large-Scale Hydrological Models, during Sixth Scientific Assembly of the International Association of Hydrological Sciences (IAHS), 191-198, 2001

Z.Q.Chen, M.L.Kavvas, J.Yoshitani, K.Masukura, M.L.Anderson, “Assessing Climate Change Impacts on Regional Water Resources”, Proceedings of ASCE Conference on Water Resources Planning and Management, Ed.by D.F.Kibler, Roanoke, VA, May 19-22, 2002, 11pp., 2002

J. Yoshitani, M.L.Kavvas, and Z.Q.Chen, “Regional-scale Hydroclimate Model”, Chapter 7 in Mathematical Models of Large Watershed Hydrology, ed. by V.P.Singh and D.K.Frevert, Water Resources Publications LLC, 237-282, 2002

Other Comments: