Hydrologic Engineering Center

Training Course on

ADVANCED APPLICATIONS OF HEC-HMS

11 – 15 March, 2019
Davis, California

Course Objectives

The course covers a variety of areas that go beyond the Basic HEC-HMS course which focuses on event-based flood hydrology. This course contains a major module on continuous simulation, including the details of modeling water content in the soil, evaporation and transpiration, and details of the components included in HEC-HMS for representing these processes. This course contains additional modules on model calibration and validation. A major module is included for snow processes and snowmelt modeling, with particular attention paid to proper calibration techniques when using snow data. Modules revolving around optimization and new uncertainty analysis tools within HEC-HMS is also provided. The week wraps up with newer forecasting features.

HEC Instructors

Mike Bartles
Tom Brauer
Greg Karlovits
Matt Fleming
Bill Scharffenberg

Advanced HMS Training Course

Monday

8:00 – 9:00	Introductions and Opening Activities
9:00 – 10:00	**1.1 Lecture 1: Continuous Simulation Methodologies** (Scharffenberg) Explanation of differences between event and continuous simulation. Description of the soil moisture accounting and deficit constant methods that can be used for continuous simulation.
10:00 – 10:15	Break
10:15 – 11:00	**1.2 Lecture 2: Evapotranspiration** (Brauer) Explanation of the physical process of plant water use and approaches to simulating evapotranspiration. Discussion of the importance of evapotranspiration in the water balance over long time periods, the methods available in HEC-HMS for modeling ET.
11:00 – 12:00	**1.3 Lecture 3: Soil Data and Parameter Estimation** (Bartles) Introduction to soil databases and the information they contain. Explanation of procedures that can be used to estimate parameters from the soil data base to populate continuous simulation models.
12:00 – 13:00	Lunch
13:00 – 14:00	**1.4 Workshop 1: Estimating Loss Model Parameters** (Bartles, Brauer) Use a soil data base to estimate parameters for the soil moisture accounting and deficit constant continuous models.
14:00 – 14:15	Review (Bartles)
14:15 – 14:30	Break
14:30 – 15:30	**1.5 Lecture 4: Model Calibration and Validation** (Brauer) Explanation of model calibration versus model validation. Discussion of techniques and statistical metrics used to evaluate model performance.
15:30 – 16:45	**1.6 Workshop 2: Calibrating and Validating a Single Event Model** (Brauer, Bartles) Practice calibrating single event models and explore different calibration techniques. Validate a model to independent events using parameters from model calibration.
16:45 – 17:00	Review (Brauer)

Tuesday

8:00 – 10:30	**2.1 Workshop 3: Calibrating a Continuous Simulation Model** (Brauer, Bartles) Practice calibrating continuous simulation models. Explore the effect of different methods for representing evapotranspiration.
10:30 – 10:45	Review (Brauer)
10:45 – 11:00	Break
11:00 – 12:00	**2.2 Lecture 5: Case Study of a Continuous Simulation Model for the Russian River Watershed** (Brauer) Discussion of the application of HEC-HMS to the Russian River Forecast Informed Reservoir Operation (FIRO) study and how the HEC-HMS model was developed and calibrated.
12:00 – 13:00	Lunch
13:00 – 13:45	**2.3 Lecture 6: Snow Hydrology** (Bartles) Brief history of snowmelt/accumulation modeling. Explanation of the physical processes at work during snow fall and pack accumulation. Discussion of the role of ripening and pack melt.
13:45 – 14:30	**2.4 Lecture 7: Temperature Index Modeling** (Bartles) Introduction to the temperature index approach to snowmelt/accumulation modeling with guidance on parameter estimation including a comparison to other modeling techniques.
14:30 – 14:45	Break
14:45 – 15:30	**2.5 Lecture 8: Data Needs for Snow Modeling** (Karlovits) Introduction to the types of atmospheric data required for snow modeling. Discussion of methodologies used to collect information about the snow pack. Sources of data and appropriate processing procedures.
15:30 – 16:45	**2.6 Workshop 4: Point Snowmelt Calibration** (Fleming, Karlovits) Review atmospheric data and prepare a temperature index snow melt model. Become familiar with the temperature index snowmelt model. Calibrate to SNOTEL sites.
16:45 – 17:00	Review (Fleming)

Wednesday

8:00 – 9:15	**3.1 Workshop 5: Gridded Snowmelt Calibration** (Bartles, Fleming) Continuation of previous workshop. Use results of point calibration to inform parameterization of gridded model. Calibrate to SNODAS data.
9:15 – 9:30	Review (Bartles)
9:30 – 9:45	Break
9:45 – 10:30	**3.2 Lecture 9: Case Study of a Gridded Snowmelt Model for the Columbia River Watershed** (Fleming) Discussion of the application of HEC-HMS to the Columbia River study and how the HEC-HMS model was developed and calibrated for a multi-million dollar study which evaluated alternative reservoir operation scenarios within the Columbia River watershed.
10:30 – 11:15	**3.3 Lecture 10: New Optimization and Uncertainty Analysis Capabilities** (Scharffenberg) Introduction to the Markov Chain Monte Carlo Optimization and Uncertainty Analysis capabilities.
11:15 – 12:00	**3.4 Workshop 6: Deterministic Model Optimization** (Karlovits, Scharffenberg) Use optimize tools to create optimal model parameters. Both minimization and maximization objective functions will be used and the modeler will identify one final parameter set.
12:00 – 13:00	Lunch
13:00 – 13:15	Review (Karlovits)
13:15 – 14:45	**3.5 Workshop 7: Markov Chain Monte Carlo Optimization** (Karlovits, Scharffenberg) Use new MCMC features to optimize the model. Explore model output from the optimization trial and compare optimal parameter sets to the deterministic parameter set from the previous workshop.
14:45 – 15:00	Review (Karlovits)
15:00 – 15:15	Break
15:15 – 16:15	**3.6 Lecture 11: Uncertainty Analysis** (Scharffenberg) Discussion of the new Uncertainty Analysis capabilities in HEC-HMS. The classical Monte Carlo sampling options will be discussed along with the parameter set sampling option.

Thursday

8:00 – 9:30	**4.1 Workshop 8: Application of the HEC-HMS Uncertainty Analysis Compute Option** (Karlovits, Scharffenberg) Use the Uncertainty Analysis to better understand sensitivity of model parameters. First use analytical distributions. Possibly think about using MCMC results.
9:30 – 9:45	Review (Karlovits)
9:45 – 10:00	Break
10:00 – 11:00	**4.2 Workshop 9: Uncertainty Analysis using MCMC Optimization Results** (Fleming, Bartles) Use previously-computed MCMC optimization results within an uncertainty analysis.
11:00 – 12:00	**4.3 Lecture 12 Application of HEC-HMS within HEC-WAT** (Fleming) Discuss the use of HEC-HMS within HEC-WAT. Describe the required inputs and usage of the Flood Risk Analysis compute option. Demo of HEC-WAT.
12:00 – 13:00	Lunch
13:00 – 13:15	Review (Fleming)
13:15 – 14:15	**4.4 Lecture 13: Case Study of MCMC Capabilities** (Karlovits) Discussion of the application of HEC-HMS to the Trinity River study and how the HEC-HMS model was used to quantify hydrologic uncertainty for a multi-million dollar dam and levee safety application.
14:15 – 14:30	Break
14:30 – 15:15	**4.5 Lecture 14: Frequency Storms in HEC-HMS** (Bartles) Discuss hypothetical and frequency storm Meteorologic Models in HEC-HMS. Investigate storm area, temporal patterns and other critical components.
15:15 – 16:00	**4.6 Workshop 10: Frequency Storm** (Fleming, Karlovits) Use the Depth-Area Analysis to develop flow-frequency curves at multiple locations. Also, develop custom depth-area reduction curves and compare against those from NOAA Atlas 2.
16:00 – 16:15	Review (Fleming)

Friday

8:00 – 9:00	**5.1 Lecture 15: Flood Forecasting** (Bartles) Introduction to forecasting features within HEC-HMS and their application for standalone use and use within the Corps Water Management System (CWMS).
9:00 – 9:15	Break
9:15 – 10:45	**5.2 Workshop 11: Application of HEC-HMS for Flood Forecasting** (Bartles, Fleming) Application of the forecast alternative simulation, zonal editors, and slider bar adjustment tool for application of HEC-HMS to flood forecasting.
10:45 – 11:00	Review (Bartles)
11:00 – 11:30	Conclusion and Closing Activities (Fleming)