Distributed Hydrologic Model (DHM) for AWIPS OB8.3

Software Design Document

Version 1.1

Revision History

Date	Version	Description	Author
09/20/2007	1.0	Preliminary version	A. Vo & L. Cajina
09/21/2007	1.1	Update from PAL review	J. Gofus

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1. Overview

This document provides design information for enhancements to the Distributed Hydrologic Model software in OB8.3. The requirements for these enhancements can be classified into the following categories and are documented in the OSIP CONOPS and Requirement Specification Document.

a) Add the ability to specify SAC-State Mods using a percent of maximum mod value and modify the existing SAC-State Mods GUI to display the current sac state conditions as average values.
b) Allow users the option to select MPE based precipitation or SNOW-17 rain plus melt precipitation grids as the input precipitation data source
Update DHM's algorithm for computing hourly QPF to account for observed data.

2. System Architecture

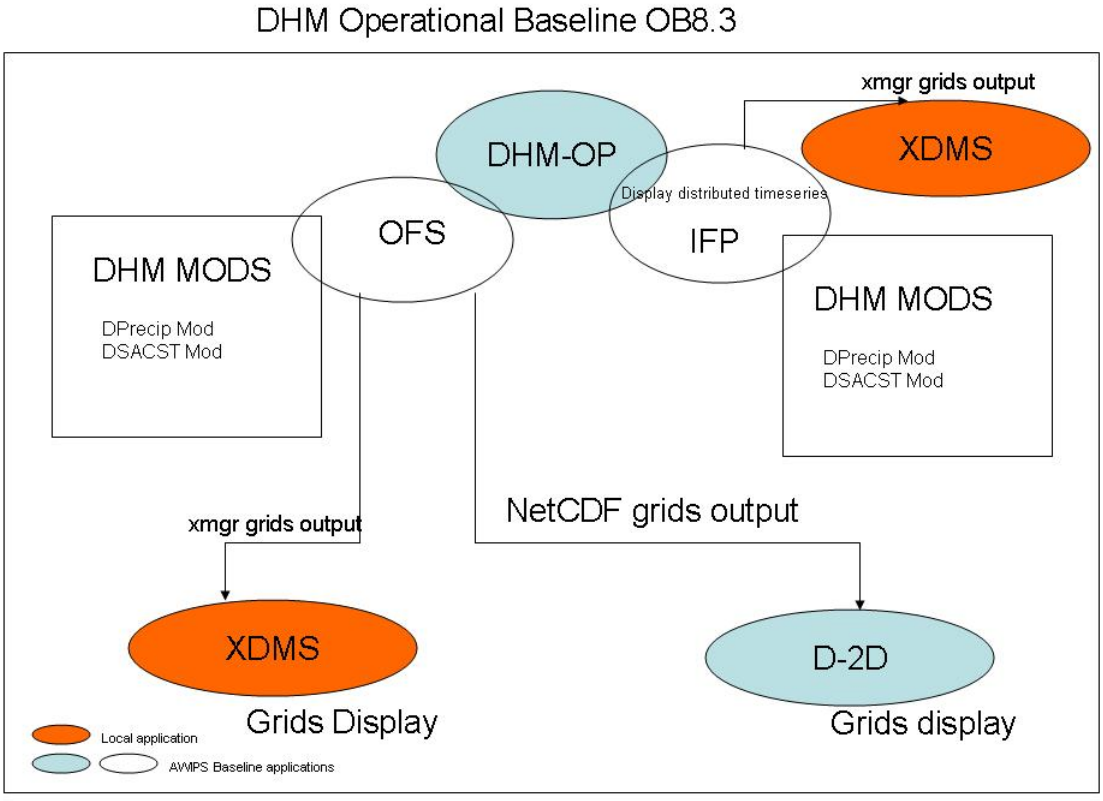


Figure 1. DHM Operation Baseline OB8.3

3. High-Level Design Features

A comparison of DHM design features in OB8.3 compared to OB8.2 is provided in the table below.

Design Feature	**AWIPS OB8.3**	**AWIPS OB8.2**
Programming Languages	Same as OB8.2	Java 1.5, C, C^{++}, Fortran
Mode of Use	Same as OB8.2	**Batch Mode**: as an operation within OFS/FCST **GUI Mode**: as an operation, with IFP
Graphical Displays	Same as OB8.2	**Timeseries**: Tulsa Plot and/or PLOT-TS operations through IFP (XMOTIF) **Grids**: XDMS and D2D viewer **Mod Utility**: Precipitation mod display through IFP (JAVA), Sac State mod display through IFP (JAVA) **Calibration Utility**: stand-alone application to transfer calibrated grid values to operations (JAVA)
Libraries	Same as OB8.2	4 shareware jar files • commons-io1.3.1.jar • toolsUI-2.2.12.jar • jgrapht-0.6.0.jar • commons-collections-3.1.jar 5 OHD developed jar files • dhm.jar • dhm-tests.jar • ofs.jar

		• distrouting.jar • rdhmutilities.jar • dhmguis.jar 2 OHD developed shared libraries • librdhmutilites.so • libdistrouting.so
Scripts	Same as OB8.2	**Batch Mode:** ofs – used to set CLASSPATH and LD_LIBRARY_PATH environment variables prior to executing DHM abort_nwsrfs – used to cleanup any log files created by abnormal termination of FCST **GUI Mode:** start_ifp_nwsrfs – used to set CLASSPATH and LD_LIBRARY path environment variables prior to executing DHM abort_nwsrfs – used to cleanup any log files created by abnormal termination of IFP (same script used in batch mode) ifp_cleanup – used to cleanup any temporary DHM grids copied for executing DHM within IFP

Memory (Physical disk space and RAM)	Same as OB8.2	RAM – default AWIPS environment Disk Space – Grid data in /awips/hydroapps and /data/dhm
Application Default Tokens (APPS_DEFAULTS)	All tokens from OB8.2 and **new**dhm_rain_plus_melt_data_dir – directory with rain+melt XMRG grid data	dhm_data_dir – directory with input/output XMRG data dhm_d2d_data_dir – directory used to write output viewable in D2D dhm_d2d_notify_bin – directory with dhmNotify exe; used to ping D2D notification server ifp_griddb_dir – directory with user's local set of precipitation XMRGs (used when running DHM-OP through IFP) ifp_dhm_data_dir – directory with user's local set of dhm input/output data (used when running DHM-OP through IFP)

4. Sac-State Mods in OB8.3

The enhancements related to DHM Sac-State mods is stated as requirement 46.1in the requirements document.

4.1 Description

Implementing the requirement has a GUI and computations component. Details of the GUI component are further explained in the document "Distributed Hydrologic Modeling User Interface Document", version 1.2. The computations component is explained here.

4.1.1 DHM SAC States Multiplier Mod Description

A DHM Sac-State Multiplier Mod is one or more scalar multipliers used to edit the Sacramento model state variables for each grid cell within a basin. A Sac-State multiplier mod decreases or increases the model computed sac state in each cell by multiplying the mod value and original state value. The result is an edited state value in millimeters. Sac-State Mods are specified using {state name, mod value} pairs. Each mod can specify 1 - 6 pairs.

4.1.2 DHM SAC States Percent of Maximum Mod Description

A DHM Sac-State Percent of Maximum mod is one or more percentages used to edit the Sacramento model state variables for each grid cell within a basin. A Sac-State percent of maximum mod edits the current Sacramento model state variables for each grid cell in a basin to a percent of its maximum value. The result is an edited state value in millimeters. Sac-State percent of maximum mods are specified using {state name, mod value} pairs. Each mod can specify 1 - 6 pairs.

4.2 Design Details

In OB8.2, DHM only allowed multiplier mods and the mod GUI did not display current mod value(s) (if any are already defined). With requirement 46.1, the new Sac-State mod GUI will provide the user the option to select what type of Mod to apply (multiplier or percentage) and the GUI's initial settings will display any current mods.

The following list describes design changes needed to implement this enhancement:

- Update setProperty method to receive basin name and current mods string
- Update SAC state panel to change the GUI layout
- Update the mod format to distinguish which type of mod will be applied to the current SAC state
  Old mod string format: .DSACST 0701200212z UZTWC 2.0 UZFWC 2.0

  New mod string format: .DSACST 0701200212z UZTWCM 2.0 UZFWCP 2.0
  Multiplier mod definition:UZTWCM 2.0: applies a multiplier of 2 mod to the Upper Zone Tension Water Contents on July 1, 2002 12z

Percent full mod definition:UZFWCP 20.0 : applies a 20 percent of maximum mod to the Upper Zone Free Water Contents on July 1, 2002 12z

- Update SAC calculations to handle multiplier and percent mods

The list of code affected is:
C routines:

- Update C (JNI calls) to pass the basin ID and mods string to the java GUI class
- Update C IFP source code to pass the current operation name
- Update C call backs to handle user selection of operation name

Java Classes and methods:

- Update SAC States Mods Gui Classes to handle new GUI
- Update SacStateMod class to parse new mod strings
- Update SacState class to compute an updated state based on a multiplier mod

See Appendix A for changes to Sac States Mod GUI.

5. DHM to use SNOW-17 Precipitation Data – RDHM Rain Plus Melt Grids

This enhancement can be found in item 84.2 of the requirements document.

5.1 Description

In areas where snowmelt processes are important, a snow model is used to determine the net precipitation for ingesting into the soil moisture model (SAC-SMA). DHM does not model snowmelt processes. RDHM (OHD's research version of distributed modeling) can model snowmelt processes (using SNOW-17) and produce precipitation grids (rain + melt) for ingesting into the soil moisture model (SAC-SMA)

In OB8.2, only MPE based precipitation grids are used in the gridded SAC-SMA model calculations. In OB8.3, DHM will give users the option to select rain plus melt or MPE based precipitation grids.

5.2 Design Details

The bulleted list below describes the changes needed to enhance DHM to accept more than one type of precipitation input grid.

- Update the DHM-OP definition to allow users to request rain plus melt or MPE based precipitation grids (MPE based grids are used by default)

- Update DHM-OP execution to pass a flag indicating the type of precipitation data to use in the SAC-SMA model calculations

- Update C to java initialization (JNI calls) to pass the flag to Java

- Update Java modeler to load the appropriate precipitation service based on the flag passed from the DHM-OP definition.

More details about these changes are in Appendix B.

6. Update QPF with Observed Data

Enhancing DHM's QPF algorithm to account for observed Precipitation is stated as requirement 83.3.1 in the requirements document.

6.1 Description

The DHM operation uses 6 hour QPF accumulation grids for forecast precipitation. The 6 hour accumulation is uniformly distributed to create hourly values. The QPF accumulations cover 6 hour synoptic times (i.e. 0z – 6z, 6z-12z, 12z-18z). Prior to OB8.2, DHM did not account for observed data when the forecast period started at a non 6 hour synoptic time*. This enhancement will allow DHM to account for observed precipitation when calculating an hourly QPF value.

*In most cases the forecast period is configured to start on the current day at 12z. If this is the case, or the forecast period starts at another 6 hr synoptic time (0z, 6z, or 18z), these enhancements to the QPF algorithm will not be used.

6.2 Design Details

Design Changes: Update algorithm used to calculate hourly precipitation during the forecast period. See Appendix A for details on the effects of these changes.

Code Affected:

- Class: PrecipService.java
- Method: add a new method to accumulate any observed precip since the start of the qpf period
- Class: QpfProvider.java
- Method: oneHourAccumulationInMm() , update the existing code to subtract off any accumulated observed precip prior to uniformly distributing QPF

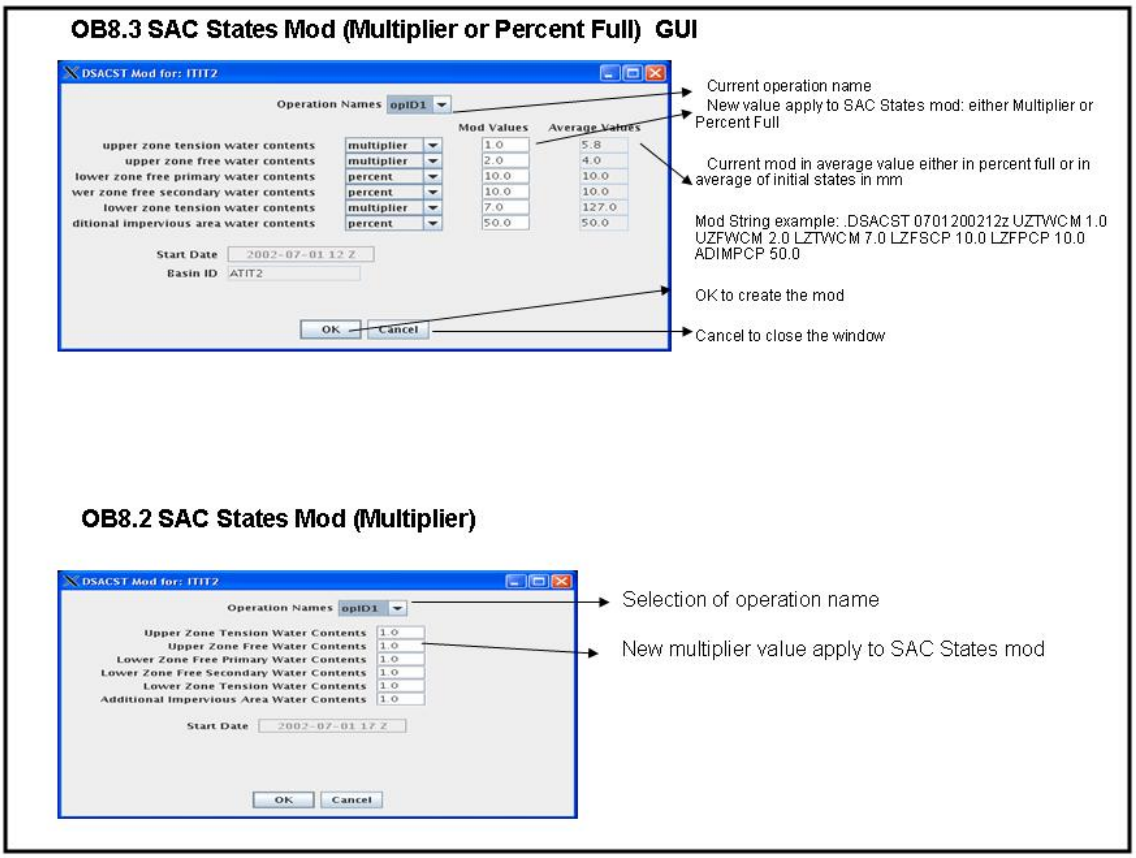
7. Package Naming Convention

The standard OHD package naming convention, beginning with "ohd.hseb.dhm", will be adopted. Sub-package name convention will follow the guidelines established by Sun. See http://java.sun.com/docs/codeconv/html/CodeConventions.doc8.html.

8. Error, Warning, Information Strategy

The strategy for displaying Error/Warning messages is to follow the existing Error/Warning Message guidelines for the NWSRFS. The error message will be displayed in the background window as OB8.2.

Appendix A: Changes to Sac States Mod GUI



9. Appendix B: Ingest Rain + Melt Grids

Use RDHM Rain + Melt Grids for Precipitation Input to SAC-SMA

- Design Changes: DHM-OP definition
  - Update DHM-OP definition to allow users to request Rain + Melt Grids instead of normal precipitation grids as input

```
DHM-OP     DHMB3
INFLOW: DHMB2   SQIN  1   DHMBAS2
INFLOW: DHMB2   SQIN  1   DHMBAS2
INFLOW: DHMB2   SQIN  1   DHMBAS2
OUTLET: DHMB3   SQIN  1   DHMBAS1
```

```
DHM-OP     DHMB3
INFLOW: DHMB2   SQIN  1   DHMBAS2
INFLOW: DHMB2   SQIN  1   DHMBAS2
INFLOW: DHMB2   SQIN  1   DHMBAS2
USE_RAIN_PLUS_MELT:
OUTLET: DHMB3   SQIN  1   DHMBAS1
```

new keyword

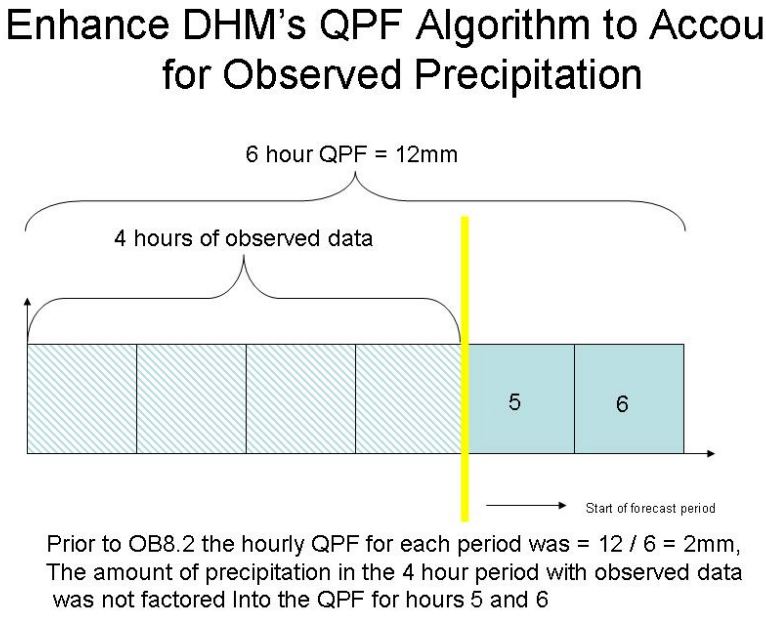
Use RDHM Rain + Melt Grids for Precipitation Input to SAC-SMA

- Design Changes: Reading RDHM grids
  - Define a new token to tell where RDHM rain + melt grids are located
  - Format of RDHM grids is known (xmrg-like), already read this format for other data
  - Grid name format is documented
    - xmrgMMDDYYYYHHz *

* Note no need to differentiate between forecast period and observed period as is done today for precipitation data
Observed = xmrgMMDDYYYYHHz , Forecast = xmrg6_YYYYMMDDHHzfXX

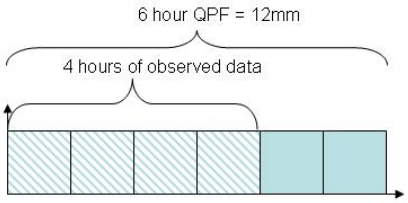
** When the new keyword is specified, rain plus melt precipitation grids are used, if not specified MPE based precipitation grids are used

10. Appendix C: Effects of Enhancing QPF Algorithm



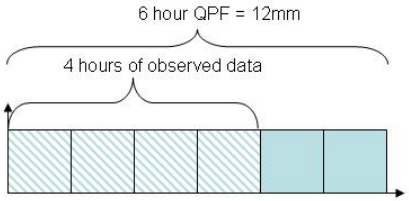
Enhance DHM's QPF Algorithm Examples

OB8.3 QPF Same As OB8.2



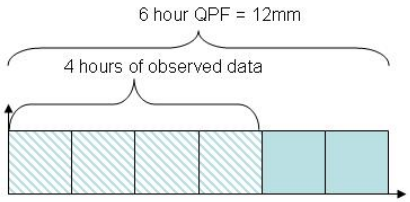
If 4 hours of observed data = **8 mm**
QPF for last 2 hours = **2 mm/hr**

OB8.3 QPF Increases



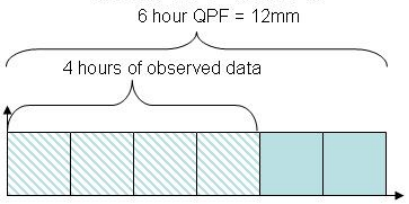
If 4 hours of observed data = **4 mm**
QPF for last 2 hours = **4 mm/hr**

OB8.3 QPF Decreases



If 4 hours of observed data = **10 mm**
QPF for last 2 hours = **1 mm/hr**

OB8.3 QPF set to 0



If 4 hours of observed data = **12 mm or more**
QPF for last 2 hours = **0 mm/hr**