NATIONAL WEATHER SERVICE
OFFICE of HYDROLOGIC DEVELOPMENT

Distributed Hydrologic Model for AWIPS OB8.3 Test Plan Document

Version 1.0

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1. Introduction

The Distributed Hydrologic Model (DHM) for AWIPS OB8.3 is being implemented to satisfy requirements as stated in the Operational Requirements Document- Operational Implementation of a Distributed Hydrologic Model Build 1 OB8.3 Version 5.6 for the complete Distributed Hydrologic Model - OSIP 04-007. Described herein is a plan for independently testing the new DHM against the requirements stated in Appendix B

1.1 Identification

OSIP Project ID :	**Project Name or Title**		
04-007	**Distributed Hydrologic Model (DHM)**		
DCS	**3474**		
Project Lead	**Ai Vo**	**Project Area Lead**	**Joe Gofus**
System	*AWIPS OB8.3*	**Target Build or Release**	*OB8.3*

1.2 Scope

The purpose of the Test Plan is to provide a plan of action, the scope, approach, resources, and schedule of intended activities that the Office of Hydrologic Development's Hydrologic Software Engineering Branch (OHD-HSEB) for testing the requirements that meet the specific criteria for the Operational Implementation of a Distributed Hydrologic Model project.

1.2.1 References

(*1) Requirements Specifications: S:\OHD-1\HOSIP\Distributed Hydrologic Modeling\HOSIP Documents\DHM OSIP Concept of Operations V 5-6.doc*
(2) Detailed Feature Specifications using HTML Tables: PrecipitationSpecifcations and ModSpecifications(Appendix A)

1.2.2 Test objectives

This test plan document addresses all expected testing for DHM in AWIPS Build 8.3. DHM development for OB8.3 consists of three major components, each developed by OHD:

1. DHM functionality in SAC State Percent full Mod (Requirement 46.2)

2. DHM to provide the option to use Rainfall plus melt Precipitation Grid to ingest into Soil Moisture model calculation (SAC-SMA) or to use just SAC-SMA Precipitation Grid (Requirement 84.2)

3. DHM to account for observed Precipitation in the model calculation (Requirement 83.8.1)

1.2.3 Features to be tested

- ? Percent Full Sac State Modifications GUI (IFP Program only)
- ? Percent Full Sac State Modifications (IFP and OFS programs)
- ? User selection to use Rainfall Plus Melt Precip Grid (SNOW-17 Data) or to use MPE grid data into SAC-SMA model calculation (OFS Program only)
- ? DHM to account for observed Precipitation in the model calculation (IFP and OFS

programs)

1.2.4 Test Acceptance Criteria

Successful testing of DHM in OB8.3 requires all tests listed in the test procedures to pass. In the case of automated tests, a summary of all the tests in the form below will be displayed. It's expected for all tests to pass. If **any** individual command fails, the entire **test** case is **considered** to fail.

X Passed 0 Failed

For the manual tests, the expected results shown in the test procedures (e.g. expected text output or expected graphical displays) should appear as shown in the test procedures. If the actual result does not match the **expected result**, it will be treated as a **failed test** case.

If a test fails, a deficiency report (DR) will be created and the severity score will be assigned. Repeat the test procedures after the DR has been fixed.

In the event failures occur, the following information must be provided to the developer:

1) Document the problem
2) Summarize test steps so developer can recreate the problem.
3) Capture output results
4) Create DR

OB8.2 test procedures will be run to ensure the DHM OB8.2 still works the same way and new test procedures for OB8.3 will be added to test the additional OB8.3 features.

1.2.5 Test Constraints and Limitations

The testing must be performed on an AWIPS OB8.3 machine. Complete end-to-end testing of DHM (i.e. viewing grids through D2D) will require the D2D program localized to FWR (West Gulf River Forecast Center) or to use XDMS a local application that is maintained by ABRFC.

2. Methodology

2.1 Test Strategy

Using the requirements document referenced in test procedures, OHD will use a suite of automated and manual tests to verify the requirements are satisfied. The nature of the requirement (i.e. whether or not it involves a GUI) will dictate whether an automated or manual test is used.

Automated tests, comparing results of scenarios first run through the science prototype, will be used for testing DHM in batch mode through OFS Manual step-by-step tests will be used for the IFP program.

As part of a separate review, OHD-HSEB developers not part of DHM development team will review the code to verify compliance with OHD/HSEB standards. Following the review, the code will be

updated as needed.

The DHM will be tested in the following ways:

? OB83 PIT Testing at NWS HQ
? Raytheon Software Testing Team

2.2 Test Input Conditions and Data Requirements

DHM test inputs consist of actual and generated data sets for WGRFC area.

2.3 Test Output/Test Results

Test Procedures document will be used to track test results.

? Requirement number
? Qualification Method, identifying the specific test used to verify that the software satisfied the requirement.
? Result/Comments

Note overall pass/fail conclusion; if any steps in the procedure failed or otherwise behaved differently that expected, this must be noted.

2.4 Test Tools and Environmental Requirements

Test Systems – OHD will use NHDR development and test machines for internal testing, and will use an AWIPS OB8.3 provided test machine (NHDA) after checking into AWIPS.

2.5 Deliverables

The deliverables associated with the DHM testing effort include:

? The DHM Test Plan (delivered with AWIPS Build)
? The DHM Test Procedures (delivered with AWIPS Build)
? The DHM Operation User Manual
? The AWIPS Release Notes (delivered with AWIPS Build)

Appendix A

1.2 DHM Sac-State Mods

A DHM Sac-State (DSACST) mod is one or more mod values used to edit the sacramento model state variables for each grid cell in a basin.
The mod is applied for a single time step within the observed data period. DSACST mods contain the following information in a mod file

mod file description	
value in mod file	**meaning**
.DSACST	keyword denoting a DHM sac-state modification
1201200612z	date and time (when the sac-state modification is applied)
UZTWCM 2.0, UZFWCM 2.0, LZTWCM 2.0, LZFPCM 2.0, LZFSCM 2.0, and/or ADIMPCM 2.0	sac-state keyword and multiplier pair (one or more values are specified on the same line)
or	
UZTWCP 50, UZFWCP 50, LZTWCP 50, LZFPCP 50, LZFSCP 50, and/or ADIMPCP 50	sac-state keyword and percentage pair (one or more values are specified on the same line)

1.1 Multiplier Mods

A DSACST multiplier mod decreases or increases the model computed sac state in each cell by multiplying the mod value and the original cell value.
In cases where applying the mod causes the new value to be greater than the corresponding maximum parameter value, the sac state
is set to the maximum parameter value. For example for the following mod:

sac state mod contents	`.DSACST 1201200612z UZTWCM 2.0 UZFWCM 2.0 LZTWCM 2.0 LZFSCM 2.0 LZFPCM 2.0 ADIMPCM 2.0`

the following should be true

check modified sac state values on	**12/01/2006 12z**		
sac state identifier	**original value**	**maximum parameter value**	**new sac state value()**
additional impervious area water contents	5	10	10
lower zone tension water contents	10.0	100	20.0
lower zone free primary water contents	50.0	70	70.0

DSACST multiplier mods are specified using {state name, mod value} pairs. Each DSACST mod can specify 1 - 6 pairs.
For example if the following mod is defined,

sac state mod contents	`.DSACST 1201200612z UZTWCM 2.0 UZFWCM 2.0 LZTWCM 2.0 LZFSCM 2.0 LZFPCM 2.0`

then the following must be true:

test if sac state mod is defined		
date and time	**sac state identifier**	**is sac state mod defined**
12/01/2006 12z	upper zone tension water contents	yes
12/01/2006 12z	upper zone free water contents	yes
12/01/2006 12z	lower zone tension water contents	yes
12/01/2006 12z	lower zone free primary water contents	yes
12/01/2006 12z	lower zone free secondary water contents	yes
12/01/2006 12z	additional impervious area water contents	no

and if another mod is defined:

sac state mod contents	`.DSACST 1201200612z UZTWCM 2.0 UZFWCM 2.0`

then the following must be true:

test if sac state mod is defined		
date and time	**sac state identifier**	**is sac state mod defined**
12/01/2006 12z	upper zone tension water contents	yes
12/01/2006 12z	upper zone free water contents	yes
12/01/2006 12z	lower zone tension water contents	no
12/01/2006 12z	lower zone free primary water contents	no
12/01/2006 12z	lower zone free secondary water contents	no
12/01/2006 12z	additional impervious area water contents	no

1.1 Percentage Mods

A DSACST percentage mod decreases or increases the model computed sac state in each cell by setting the state to a percentage of the maximum value
The following table shows which parameters are used to determine maximum values

mod file description	
sac state id	**parameter with maximum value**
uztwc	uztwm
uzfwc	uzfwm
lztwc	lztwm
lzfsc	lzfpm
lzfpc	lzfpm
adimpc	uztwm + lztwm

For example for the following mod

sac state mod contents	`.DSACST 1201200612z UZTWCP 20.0 UZFWCP 20.0 LZTWCP 20.0 LZFSCP 20.0 LZFPCP 20.0`

the following should be true

check modified sac state values on	**12/01/2006 12z**		
sac state identifier	**original value**	**maximum parameter value**	**new sac state value()**
upper zone tension water contents	5	10	2
lower zone tension water contents	10.0	100	20.0
lower zone free primary water contents	50.0	70	14.0

DSACST percentage mods are specified using {state name, mod value} pairs. Each DSACST mod can specify 1 - 6 pairs.
For example if the following mod is defined,

sac state mod contents	`.DSACST 1201200612z UZTWCP 20.0 UZFWCP 20.0 LZTWCP 20.0 LZFSCP 20.0 LZFPCP 20.0 ADIMPCP 20.0`

then the following must be true:

test if sac state mod is defined		
date and time	**sac state identifier**	**is sac state mod defined**
12/01/2006 12z	upper zone tension water contents	yes
12/01/2006 12z	upper zone free water contents	yes
12/01/2006 12z	lower zone tension water contents	yes
12/01/2006 12z	lower zone free primary water contents	yes
12/01/2006 12z	lower zone free secondary water contents	yes

12/01/2006 12z	additional impervious area water contents	yes

1.1 Multiple Sac State Multiplier Mods

Sac state multiplier mods for the same date are allowed.
When a multiplier mod is specified for the same state and date, the state value is repeatedly multiplied.
For example, if the following mods are defined, the following should be true.

sac state mod contents	`.DSACST 1201200612z UZTWCM 2.0 LZFSCM 2.0 ADIMPCM 2.0` `.DSACST 1201200612z UZTWCM 2.0`

check modified sac state values on	**12/01/2006 12z**		
sac state identifier	**original value**	**maximum parameter value**	**new sac state value()**
upper zone tension water contents	10.0	100	40.0
lower zone free secondary water contents	50.0	70	70.0
lower zone free primary water contents	20.0	70	20.0

1.1 Multiple Sac State Percentage Mods

Multiple sac state percentage mods for the same date is not allowed
When a percentage mod is specified for the same state and date the last one takes precedence.
For example, if the following mods are defined, the following should be true.

sac state mod contents	`.DSACST 1201200612z UZTWCP 10.0 LZFSCP 20.0 ADIMPCP 20.0` `.DSACST 1201200612z UZTWCP 20.0`

check modified sac state values on	**12/01/2006 12z**		
sac state identifier	**original value**	**maximum parameter value**	**new sac state value()**
upper zone tension water contents	10.0	100	20.0
lower zone free secondary water contents	50.0	70	14.0
lower zone free primary water contents	20.0	70	20.0

1.1 Both Sac State Mod Types

When using a percentage mod and multiplier mod for the same date and time the last one takes precedence.
For example, if the following mods are defined, the following should be true.

sac state mod contents	`.DSACST 1201200612z UZTWCP 20.0 LZFSCP 20.0` `.DSACST 1201200612z UZTWCM 3.0`

check modified sac state values on	**12/01/2006 12z**		
sac state identifier	**original value**	**maximum parameter value**	**new sac state value()**
upper zone tension water contents	10.0	100	30.0
lower zone free secondary water contents	50.0	70	14.0

and

sac state mod contents	`.DSACST 1201200612z UZTWCM 2.0` `.DSACST 1201200612z UZTWCP 30.0 LZFSCP 40.0`

check modified sac state values on	**12/01/2006 12z**		
sac state identifier	**original value**	**maximum parameter value**	**new sac state value()**
upper zone tension water contents	10.0	100	30.0
lower zone free secondary water contents	50.0	70	28.0

1.1 Both Sac State Mod Types On the Same Date

Specifying multiplier and percentage mods for the same mod is allowed (must be for different states).
For example, if the following mods are defined, the following should be true.

sac state mod contents	`.DSACST 1201200612z UZTWCM 2.0 LZFSCP 20.0`

check modified sac state values on	**12/01/2006 12z**		
sac state identifier	**original**	**maximum parameter**	**new sac state**

	value	**value**	**value()**
upper zone tension water contents	10.0	100	20.0
lower zone free secondary water contents	50.0	70	14.0

1.2 DHM Precipitation

Precipitation values are a mixture of hourly observed values and six hour QPF values with a maximum time after which precip is 0.

The precip over an hour is a function of 2 parameters, qpfStartHour and qpfEndHour:

- ? if the hour requested is before the qpfStartHour, precip is observed
- ? if the hour requested is on or after the qpfStartHour and before the qpfEndHour, the precip is the uniformly distributed qpf (minus any observed data durig the qpf period)
- ? if the hour is on or after the qpfEndHour, the precip is 0

Here are some examples:

ohd.hseb.dhm.specs.Precip						
coordinate	**observation end hour**	**qpf end hour**	**constant 6 hour qpf value**	**constant observed value**	**hour starting at**	**one hour accumulation at hour()**
(1,1)	1/10/2003 4z	1/10/2003 12z	12	3.5	1/10/2003 10z	2
(1,1)	1/10/2003 9z				1/10/2003 11z	0.25
(1,1)	1/10/2003 9z		9		1/10/2003 11z	0.0
(1,1)	1/10/2003 4z				1/10/2003 12z	0
(1,1)	1/10/2003 4z				1/10/2003 13z	0
(1,1)	1/10/2003				1/10/2003 2z	3.5

	4z					
(1,1)	1/10/2003 4z				1/10/2003 3z	3.5

The following sections explain observed and qpf precip.

1.2 Hourly Observed Precip

Hourly observed precip grids are stored in xmrgMMDDCCYYHHz format.

ohd.hseb.dhm.specs.Precip	
hour starting at	**possible observed grid files()**
01/30/2003 12z	xmrg0130200313z
12/31/2003 23z	xmrg0101200400z

1.2 6 Hour Qpf

Future Precipation values are read from xmrg files. The file named xmrg6[mmddyyyyhh]fxxx contains the accumulated precip forecasted on mm/dd/yyyy hh, where hh is either 00,06,12, or 18z, for the six-hour period ending xxx hours after mmddyyyhh. Examples are shown below.

ohd.hseb.dhm.specs.Precip		
filename	**time qpf issued()**	**end of six hour period covered()**
xmrg6_2003013012f006	01/30/2003 12Z	01/30/2003 18Z
xmrg6_2003013000f018	01/30/2003 00Z	01/30/2003 18Z
xmrg6_2003013012f012	01/30/2003 12Z	01/31/2003 00Z

The accumulated future precipitation for a given hour is computed by:

- determining the closest 6 hour synoptic time (i.e. 00,06, 12, or 18z) for a given forecast hour,
- reading the most recent forecast xmrg for the 6 hour synoptic time and subtracting off any precip already observed during the 6 hour period,

- uniformly distributing any parts of the 6 hour value into hourly values, and
- setting future precip to if the given forecast hour is beyond a user defined limit

Determining the closest six hour synoptic time after the forecast hour

Here are some examples that show whether an hour is contained in a particular six hour period:

ohd.hseb.dhm.specs.Precip		
six hour period ending on	**hour starting at**	**is hour contained in six hour period()**
01/20/2002 12z	01/20/2002 10Z	yes
	01/20/2002 6z	yes
	01/20/2002 12z	no

Given some files on disk, determine which ones contain precip forecasts for the one hour period of interest. Of the files that contain precip forecasts for the hour of interest, use the file that is most recent.

ohd.hseb.dhm.specs.Precip			
files on disk	**hour starting at**	**files containing forecasts for this one hour period()**	**most rece data for t**
xmrg6_2003013012f006, xmrg6_2003013006f012, xmrg6_2003013000f018, xmrg6_2003012918f024, xmrg6_2003012912f024	01/30/2003 17z	xmrg6_2003013012f006, xmrg6_2003013006f012, xmrg6_2003013000f018, xmrg6_2003012918f024	xmrg6_2

Uniformly distributing the 6 hour value into hourly values

ohd.hseb.dhm.specs.Precip			
six hour qpf	**number of hours**	**amount of**	**accumulation for**

accumulation in millimeters	in qpf period with observed data	observed data	each hour in millimeters()
6	0	0	1
3	0	0	0.50
6	2	3	0.75
3	2	4	0.0

1.2 Using Rain Plus Melt for DHM Precipitation

In some cases a snow model is needed to get a more accurate description of precipitation inputs for the SAC-SMA model
For these cases snowpack melting and ablation can increase or reduce the amount of precip entering the soil

1.1 Rain Plus Melt Grids

The naming of rain plus melt grids closely matches the convention for MPE based precip grids (extra .gz extension). These grids are also hourly accumulations
defined on an HRAP Grid

ohd.hseb.dhm.specs.Precip	
hour starting at	**rain plus melt grid file name()**
01/30/2003 12z	xmrg0130200313z.gz
12/31/2003 23z	xmrg0101200400z.gz

given a directory where the files are located, starting hour, and HRAP coordinate the hourly accumulation in mm is known

ohd.hseb.dhm.specs.Precip				
extent	**directory**	**hour starting at**	**coordinate**	**rain plus melt one hour precip accumulation in mm()**
(627,355), (633,358)	../testData/	07/04/2002 00z	(631,356)	15.6