# *Running ENS_POST_CP*

The Ensemble Post-Processor Calibration Program is used to calibrate the parameters necessary for a run of ENS_POST.

It is calibrated once for each ESP output time series file type to which ENS_POST will be applied and makes use of historical simulations produced by ESP and observed datacard stream flow data. This manual describes how to execute ENS_POST_CP.

## *1. Configuration*

ENS_POST_CP uses apps-default tokens to determine locations of directories required to operate.

### *1.1 Environment Variables*

The following apps-defaults tokens must be available for ENS_POST_CP to properly execute:

| Name | Example Implementation Directory | Purpose |
|---|---|---|
| *ens_input* | $(ens_dir)/input/$(ofs_level) | directory containing all input directories for the ens script |
| *ens_output* | $(ens_dir)/output | directory of output files generated by ens script |
| *espts_dir* | $(ens_files)/espts | directory of ESP output time series |

## *2. Batch Mode*

ENS_POST_CP is intended to run from a batch command file via the ens script.

### *2.1 Running Batch Operations*

The following can be used to run ENS_POST_CP from a batch file:

```
ens -p ens_post_cp -I <batch_filename> -o <output _filename>
```

where batch_filename is the name of the input file to use with ENS_POST_CP (described below)
output filename is the file to contain the diagnostic output from the ENS_POST_CP run

The input file must be located in the directory $(ens_input)/error_model and the output file is placed in $(ens_output)/$(LOGNAME).

### *2.2 Instructions*

This section is intended to provide step-by-step instructions for a first time user to construct an ENS_POST_CP batch file. All commands and actions, denoted in **bold**, will be described in sections 2.5 and 2.6.

*Step 1: Set the Directory Containing ESP Output Time Series Files*
Typically, this directory is that corresponding to the apps-default token espts_dir. However, if the user desires, they may manually set this directory by calling the command **ESPTS_DIR**.

*Step 2: Set the Seasons For Which Calibration is to be Performed*
Sometimes, due to limited data, it is necessary to group the data into seasons for calibration purposes. Setting the seasons is performed via the commands **NUMSEASONS** and **SEASON#**.

*Step 3: Set the Time Step Used*
Typically, the error models are calibrated to a 24-hour time step, which is the usual time step of observed stream flow data. However, if the simulated and observed data are both available at a smaller time step or if a larger time step is desired, the command **TIMESTEP** can be used.

*Step 4: Set Mathematical Parameters*
Numerous mathematical parameters are made available that can be controlled by the user from within the batch file. However, it is strongly recommended they not be changed. The commands used to set these parameters are **OBS_OMEGA**, **SIM_OMEGA**, **INT_MIN**, **INT_MAX**, **INT_NUM**, **INT_NUM_LO**, **INT_NUM_HI**, **CUTOFF** and **CALIB_DAY**.

*Step 5: Set the Error Model to Calibrate*
The error models available, described in Appendix A of ENS_POST User Manual, are ER1, ER2D and ER2S. Because of a quirk of the programming, within ENS_POST_CP, the abbreviation ER1 corresponds to"ErrorModel0", ER2D corresponds to"ErrorModel1New" and ER2S corresponds to"ErrorModel1NewStoch". The error model is specified via the command **ERRORMODEL**.

*Step 6: Run the Calibration Program*
After setting the run parameters, to execute the calibration, decide first on the datacard format observed time series file and the historical simulation (HS) ESP output time series files you wish to use for the calibration. These should have data for the same segment. To execute the calibration, use the action **CALIBRATE**.

## *2.3 Batch File Format*

The format of the batch file is the same as that of the ESPADP batch file, as described in section 3.3.3 of the ESPADP User Manual.

## *2.4 Definitions*

This section provides definitions used throughout this section and the remaining sections. Additional definitions to those in this section will be provided as needed. The definitions are as follows:

Command: A batch input that sets a parameter for an ENS_POST action. The name of the command is identical to the <token> in the line of the batch input file.

Action: A batch input that instructs ENS_POST to produce output of some kind. There is only one available action currently within ENS_POST and that is **RUN_ENS_POST**.

## *2.5 Batch Commands*

This section provides an alphabetical listing of all of the available batch commands. Commands, denoted in **bold**, set parameter values for an ENS_POST_CP batch action (see Section 2.6). They do NOT result in output. The <value> within the line of the batch input file that contains the command is usually restricted, depending on that command. Acceptable values will be listed for each command. The following are ENS_POST_CP commands:

**CALIB_DAY = <value>**
*Description*: Sets the lead time in days at which calibration should be performed, allowing the user to find the parameters resulting in the best performance at any lead time. DO NOT SET THIS VALUE UNLESS YOU ARE CERTAIN YOU NEED TO!
*Acceptable Values*: An integer between 1 and the maximum lead time in days of the ESP stream flow forecasts to be post-processed.
*Default Value*: 5

**CUTOFF = <value>**
*Description*: Sets the probability associated with the stream flow cutoff value separating high flows from low flows. DO NOT SET THIS VALUE UNLESS YOU ARE CERTAIN YOU NEED TO!
*Acceptable Values*: Either a probability between 0 and 1 (not-inclusive) or -999.0 to signify that no separation of high flows and low flows is used.
*Default Value*: 0.25

**ERRORMODEL = <value>**
*Description*: Sets the error model applied within ENS_POST. The available error models are described in Appendix A of ENS_POST User Manual
*Acceptable Values*:"ErrorModel0" (ER1),"ErrorModel1New" (ER2D),"ErrorModel1NewStoch" (ER2S).
*Default Value*: none

*NOTE: Calibrating ErrorModel1New (ER2D) will also result in calibrated parameters for both of the other error models. If you need all three models, then just calibrate ER2D.*

**ESPTS_DIR = <directory>**
*Description*: Sets the directory ENS_POST_CP searches for the ESP output time series file specified in the **RUN_ENS_POST** action.
*Acceptable Values*: A complete directory name.
*Default Value*: The directory pointed to by apps-defaults token espts_dir.

**INT_MIN = <value>**
*Description*: Sets the lower bound on the region used to compute the numerical integration that is used within the back-transformation. DO NOT SET THIS VALUE UNLESS YOU ARE CERTAIN YOU NEED TO!
*Acceptable Values*: Any real number smaller than the value of **INT_MAX**.
*Default Value*: -4.5

**INT_MAX = <value>**
*Description*: Sets the upper bound on the region used to compute the numerical integration that is used within the back-transformation. DO NOT SET THIS VALUE UNLESS YOU ARE CERTAIN YOU NEED TO!
*Acceptable Values*: Any real number larger than the value of **INT_MIN**.

*Default Value*: 4.5

**INT_NUM = <value>**

*Description*: Sets the number of intervals used between the smallest and largest observed values in normal space in the computation of the numerical integration within the back-transformation. DO NOT SET THIS VALUE UNLESS YOU ARE CERTAIN YOU NEED TO!

*Acceptable Values*: Any positive integer.

*Default Value*: 100

**INT_NUM_HI = <value>**

*Description*: Sets the number of intervals used between the largest observed values in normal space and the value of **INT_MAX** in the computation of the numerical integration within the back-transformation. DO NOT SET THIS VALUE UNLESS YOU ARE CERTAIN YOU NEED TO!

*Acceptable Values*: Any positive integer.

*Default Value*: 11

**INT_NUM_LO = <value>**

*Description*: Sets the number of intervals used between the value of **INT_MIN** and the smallest observed values in normal space in the computation of the numerical integration within the back-transformation. DO NOT SET THIS VALUE UNLESS YOU ARE CERTAIN YOU NEED TO!

*Acceptable Values*: Any positive integer.

*Default Value*: 7

**NUMSEASONS = <value>**

*Description*: Sets the number of seasons used for calibration.

*Acceptable Values*: An integer value from 1 to 12 or"monthly" to specify 12 monthly seasons.

*alue*: "monthly"

**OBS_OMEGA = <value>**

*Description*: Sets the omega parameter controlling the upper tail of the empirical observed cumulative distribution function beyond the largest observed value. DO NOT SET THIS VALUE UNLESS YOU ARE CERTAIN YOU NEED TO!

*Acceptable Values*: Any positive real number.

*Default Value*: 2.5

**SEASON# = <value>**

*Description*: Sets the months within the season given by the #, where # is an integer from 1 to the number of seasons. For example, SEASON3 is used to define the third season.

*Acceptable Values*: A comma separated list of integers corresponding to months (1 = Jan, 12 = Dec). An example would be"3,4,5" which would be March, April and May.

*Default Value*: If NUMSEASONS was set to"monthly", then the default for SEASON# is the month corresponding to #. Otherwise, the default is no months in the season and the calibration will fail.

**SIM_OMEGA = <value>**

*Description*: Sets the omega parameter controlling the upper tail of the empirical simulated cumulative distribution function beyond the largest simulated value. DO NOT SET THIS VALUE UNLESS YOU ARE CERTAIN YOU NEED TO!

*Acceptable Values*: Any positive real number.

*Default Value*: 2.5

**TIMESTEP = <value>**
*Description*: Sets the time step at which the calibration of the error model is to be performed.
*Acceptable Values*: Any integer that is evenly divisible by the time steps of both the observed datacard format file and the historical simulation ESP output time series file used in the calibration (see 2.6, below).
*Default Value*: 24

## *2.6 Batch Actions*

Actions, denoted in **bold**, instruct ENS_POST_CP to produce some output using the current batch mode command settings. For actions, the value on the batch input line defining the action is a list of options for that action. The list of options is comma separated and must NEVER include spaces. The parameters are given below for each action. The following is the ENS_POST_CP action:

**CALIBRATION = <obs_filename>,<sim_filename>**
*Description*: Calibrate the specified error model using the observed and simulated files passed in.
*Options*:

1. obs_filename: Must be the name of a datacard format file within the **ESPTS_DIR** directory. This should contain observed stream flow data used in the calibration.
2. sim_filename: Must be the name of a historical simulation (HS) ESP output time series file within the **ESPTS_DIR** directory. This should contain the simulated stream flow data used in the calibration.

*NOTE: A historical simulation file can be generated via ESP. Appendix A provides instructions for how to do so.*

## *2.7 Example*

Figure 1.1 provides an example of an ENS_POST_CP batch file.

```
# 1. Set the value of the ESPTS_DIR command setting.
ESPTS_DIR = /awips/hydroapps/rfc/nwsrfs/ens/files/oper/espts

# 2. Set the calibration seasons.
NUMSEASONS = 2
SEASON1 = 12,1,2,3,4,5
SEASON2 = 6,7,8,9,10,11

# 3. Set the time step used.
TIMESTEP = 24

# 4. Override the default cutoff setting.
# This is just an example... it is not recommended you do this!
CUTOFF = 0.30

# 5. Set the Error Model to use.
ERRORMODEL = ER2D

# 6. Run the calibration.
CALIBRATE = EMYSW.EMYSW.QME.24.OBS,EMYSW.EMYSW.QINE.06.HS
```

Figure 1.1. Example ENS_POST_CP batch input file.

## *2.8 Output*

The output generated by a run of ENS_POST_CP are the parameter and CDF files described in Appendix B and Appendix C of the ENS_POST User Manual.

# *Appendix A. Notes on Generating the HS File*

When generating the historical simulation (HS) file, it is important to remember that the window must allow for 12 conditional simulation months. To do so, the Operational Forecast System program FCST input deck used to generate the .HS file should have the following properties:

1. The WINDOWS start date equal to the STARTESP date.
2. The WINDOWS end date should be the one of the days of the month *preceding* the month of the WINDOWS start date.

The following is an example of an input deck to generate the historical simulation file for the segment SDLYW2 on September 15, 2000:

```
@SETOPTIONS
  STARTESP  0914/2000/
  WINDOWS(1) 0915/2000/ 0830/2001/
  HISTWYRS 1950 1993
  ONESEG DLYW2
  HISTSIM(1)
  REGULATE(1)
  PERMWRIT(1)
@COMPUTE ESP
```