MEFP Plugin Framework
User's Manual

Version: OHD-CORE-CHPS-4.4.a
Release Date: 16 May 2016

National Weather Service
Office of Hydrologic Development

Table of Contents

1 Overview 4

1.1 Notation 4

1.2 Terminology 4

1.3 Directories of Note 4

1.4 Pre-installation Steps 5

2 Adding/Removing Forecast Sources 6

2.1 MEFPPE 7

2.1.1 Action: Create/Modify forecastSourcesDefinition.xml 7

2.2 MEFPEnsembleGeneratorModelAdapter 12

2.2.1 Action: Create/Modify forecastSourcesDefinition.xml 12

2.2.2 Action: Create the Module Dataset File 13

2.2.3 Action: Modify the MEFPEnsembleGeneratorModelAdapter Module Configuration File 14

3 Designing a Plugin Forecast Source 18

3.1 Identify Candidate Forecast Source 18

3.2 Configure Source(s) of Operational Forecasts 18

3.2.1 Create Operational Mechanism to Acquire Forecasts 18

3.2.2 Configure for Operational Import in CHPS 18

3.3 Configure Source(s) of Archived Forecasts or Reforecasts 22

3.3.1 Acquire Reforecasts 22

3.3.2 Reformat Files If Necessary 22

3.3.3 Configure Workflow to Import, Interpolate, and Export Time Series 23

3.4 Identify Where Reforecasts Will Be Located Within AWIPS 26

3.4.1 Put the Reforecast Files in Place 26

3.5 Assign Source Id 26

3.6 Create forecastSourcesDefinition.xml Entry 27

3.6.1 Define Process By Which Reforecasts Can Be Prepared 27

3.6.2 Encode the Process as Instructions in forecastSourcesDefinition.xml 27

3.6.3 Manually Test Process 29

3.7 Test Parameter Estimation 29

3.7.1 Prepare the Reforecasts 29

3.7.2 Estimate Parameters 32

3.8 Install New Source in MEFPEnsembleGeneratorModelAdapter 32

3.9 Test Ensemble Generation 32

3.10 Prepare Delivery for Other RFCs 33

4 XML Instructions for forecastSourcesDefinition.xml 35

4.1 Element: source [1…] 37

4.2 Element: reforecastPreparationSteps [1] 38

4.2.1 Element: reforeastAcquisitionInstructions [0…] 39
4.2.2 Element: combineReforecastInstructions [0…] 43
4.2.3 Element: moveReforecastFilesInstructions [0…] 45
4.2.4 Element: multimodelConstructionInstructions [0…] 46
4.2.5 Element: systemCallInstructions [0…] 48
5 Tips and Troubleshooting 49

1 Overview

The MEFP plugin framework allows for forecast sources to be added to the MEFPPE and MEFP ensemble generation software without requiring a new version of the HEFS software. This manual provides the following:

- **General instructions for how to add or remove forecast sources from the MEFPPE and the MEFPEnsembleGeneratorModelAdapter.**
- **Guidelines for how to design a new plugin forecast source.**
- **Instructions for XML configuration related to forecast source definitions.**

1.1 *Notation*

Within this document, the following notation is used:

- All graphical interface components are **Capitalized and in Bold**.
- All XML snippets are in this font or this font.
- All command line entries are in this font.
- All important terms defined in the Section 1.2, Terminology, are *italicized*.

1.2 *Terminology*

- *parameter estimation standalone (PE SA)*: The standalone in which the MEFPPE is configured to execute. See the *MEFPPE Configuration Guide*.
- *installation standalone (install SA)*: The standalone in which changes will be made to the MEFP ensemble generation workflow. It is recommended that changes be made to a standalone for testing purposes prior to synchronizing those changes to the operational system.

1.3 *Directories of Note*

The following directories will be referred to in the instructions provided below:

- <*PE SA region_dir*>: The *PE SA* region home directory, typically "##rfc_sa".
- <*PE SA configuration_dir*>: The *PE SA* Config directory, typically <*PE SA region_dir*>/Config.
- <*MEFPPE run area*>: The MEFPPE run area directory; see the *MEFPPE Configuration Guide*. Typically <*PE SA region_dir*>/Models/hefs/mefppeRunArea.
- <*install SA region dir*>: The *install SA* region home directory, typically "##rfc_sa".
- <*install SA configuration_dir*>: The *install SA* Config directory, typically <*install SA region_dir*>/Config.

1.4 *Pre-installation Steps*

1. Identify the *PE SA*. Changes described herein to add, create, or remove a new forecast source can be made directly in the *PE SA*. The changes are easy to back-out, meaning there is little risk and no need to create a backup.

2. Create an *install SA*. Changes made to operational MEFP module configuration files should be made in an SA for testing purposes. They can then be synchronized with the operational configuration once testing is complete.

2 Adding/Removing Forecast Sources

In this section, we describe the process by which forecast sources can be added or removed from the MEFPPE (for parameter estimation) and MEFPEnsembleGeneratorModelAdapter (for ensemble generation).

The process of adding or removing forecast sources requires modifying an XML file and, in the case of the MEFPEnsembleGeneratorModelAdapter, updating a module data set file. The instructions provided below are generally applicable for all forecast sources, including those sources built-in to the HEFS software: RFC (QPF/QTF), GEFS, and CFSv2.

The climatology (or "Historical") forecast source is always available whether or not it is included in the XML files modified as per the instructions below.

2.1 *MEFPPE*

To add or remove forecast sources from MEFPPE, the following file must be edited:

<*MEFPPE run area*>/.systemFiles/forecastSourcesDefinition.xml

The format of that file is described below via examples and Section 4 provides further details.

If the forecastSourcesDefinition.xml file is not created as per the instructions below, the default forecast sources will be available within the MEFPPE for parameter estimation: RFC, GEFS, CFSv2, and Climatology (Historical).

2.1.1 Action: Create/Modify forecastSourcesDefinition.xml

The forecastSourcesDefinition.xml file specifies an ordered list of the forecast sources to be included in the MEFPPE software. If the file is not found, then the default sources are available, which is equivalent to the following content within the forecastSourcesDefinition.xml:

EXAMPLE: Default Forecast Sources

The following forecastSourcesDefinition.xml defines the default forecast sources used in MEFPPE:

```
<forecastSources>
  <source class="ohd.hseb.hefs.mefp.sources.rfcfcst.RFCForecastSource" id="RFC"></source>
  <source class="ohd.hseb.hefs.mefp.sources.gefs.GEFSForecastSource" id="GEFS"></source>
  <source class="ohd.hseb.hefs.mefp.sources.cfsv2.CFSv2ForecastSource" id="CFSv2"></source>
  <source class="ohd.hseb.hefs.mefp.sources.historical.HistoricalForecastSource" id="Historical"></source>
</forecastSources>
```

Within the source XML element in the example above, the class attribute defines the Java class associated with the forecast source, while the id attribute defines a source-specific identifier.

If the forecastSourcesDefinition.xml file is provided and is to include the default sources shown above, then use the source XMLelement exactly as provided above; do not modify any part of it or MEFPPE will function correctly.

To add a plugin forecast source, modify the forecastSourcesDefinition.xml file to include a source XML element for the forecast source and content instructing MEFPPE on how to prepare reforecasts for that forecast source.

EXAMPLE:WPC QPF

The following shows the default source element configuration of the WPC plugin forecast source:

```
<forecastSources>
  <source class="ohd.hseb.hefs.mefp.sources.rfcfcst.RFCForecastSource" id="RFC"></source>
  <source class="ohd.hseb.hefs.mefp.sources.plugin.PluginForecastSource" id="WPC">

    <!-- WPC plugin requires reforecast acquisition instructions.  The other sources specified herein are default
         source with their reforecast acquisition instructions hardcoded in the source code. -->
    <reforecastPreparationSteps defaultNumberOfForecastDays="3" defaultInitialYear="2000" defaultLastYear="2013">

      <!-- ACQUIRE 12Z REFORECASTS -->
      <!-- The reforecastOutputBaseDirectory should be a local directory and must match the output directory for the
           export module in the workflow specified below. -->
      <!-- The "yes" combineReforecasts value tells the processor to combine reforecasts across all T0s into a single large
           file for each location, removing the T0-specific files. -->
      <reforecastAcquisitionInstructions stepId="AcquireReforecasts"
        stepDescription="Acquire 12Z reforecasts 2000 - 2013"
        reforecastOutputBaseDirectory="@writableOutputDirectoryOnLocalDisk@"
        combineReforecasts="yes">
        <sftpInstructions maxReconnects="10" maxWaitForPuttingFileInPlace="600000">
          <serverURL>lx4-nhdr</serverURL>
          <userName>me</userName>
          <password></password>
          <serverDirectory>/fs/hefs/testdata/wpc_qpf_processed/</serverDirectory>
          <fileNamePattern>*/*12.grb2</fileNamePattern>
          <!-- Must match the import directory used by the workflow below. -->
          <localDirectory>IMPORT DIRECTORY FOR SA</localDirectory>
        </sftpInstructions>
        <workflowInstructions maxWaitToExecute="30000" maxWaitForExecutionToComplete="30000">
          <workflowID>ImportMEFP-WPCGrids</workflowID>
        </workflowInstructions>
      </reforecastAcquisitionInstructions>

      <!-- COMBINE REFORECAST FILES ACQUIRED WITH THOSE ALREADY IN PLACE IN THE RUN AREA -->
      <!-- No outputDir element specified below indicates that combined file is placed in plugin data directory in the
           MEFPPE run area..-->
      <combineReforecastsInstructions stepId="PutReforecastFilesInPlace"
        stepDescription="Combine new reforecasts with current reforecasts"
        removeFilesAfterCombining="no">

        <!-- Specifies that files found in the default data directory for this plugin within the MEFPPE run area will be
             combined with those in the directory below, allowing for incremental changes to the reforecast file. -->
        <directory>OUTPUTDIR</directory>

        <!-- Must match the reforeastOutputBaseDirectory specified in the acquisition instructions above. -->
        <directory>@writableOutputDirectoryOnLocalDisk@</directory>
      </combineReforecastsInstructions>

    </reforecastPreparationSteps>

  </source>
```

```
        <source class="ohd.hseb.hefs.mefp.sources.gefs.GEFSForecastSource" id="GEFS"></source>
        <source class="ohd.hseb.hefs.mefp.sources.cfsv2.CFSv2ForecastSource" id="CFSv2"></source>
        <source class="ohd.hseb.hefs.mefp.sources.historical.HistoricalForecastSource" id="Historical"></source>
</forecastSources>
```

In the example above, the XML element reforecastPreparationSteps provides instructions for preparing the reforecasts for the forecast source. Notice that it is placed after the RFC forecast source and before the GEFS source; within the MEFPPE, that ordering dictates the tab-order in the MEFPPE, described below, as well as the order of files within the parameter .tgz file when parameters are estimated. The importance of order when generating ensembles is described in Section 2.2.1.1. The schema for the source and reforecastPreparationSteps XML elements are described in Section 4.

Instructions providing the content of the reforecastPreparationSteps XML element will either be included with any plugin source delivery or will be designed by the user if an RFC-specific forecast source is to be created; see Section 0.

2.1.1.1 Removing a Forecast Source

To remove an existing forecast source (plugin or default), the forecastSourcesDefinition.xml file must be modified removing (or commenting-out) the appropriate source XML element. For example, the following will remove the RFC forecast source from the MEFPPE, but include the other default sources:

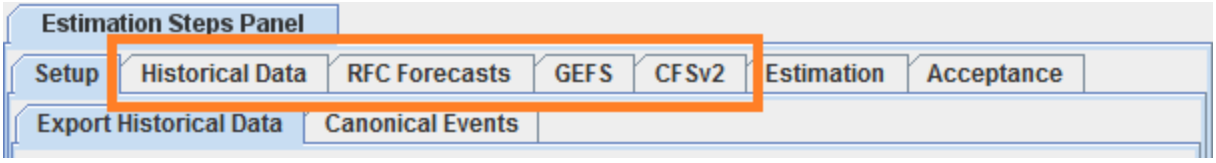
EXAMPLE: Removed RFC Forecast Source

The following forecastSourcesDefinition.xml removes the RFC forecast source:

```
<forecastSources>
  <!--<source class="ohd.hseb.hefs.mefp.sources.rfcfcst.RFCForecastSource" id="RFC"></source>-->
  <source class="ohd.hseb.hefs.mefp.sources.gefs.GEFSForecastSource" id="GEFS"></source>
  <source class="ohd.hseb.hefs.mefp.sources.cfsv2.CFSv2ForecastSource" id="CFSv2"></source>
  <source class="ohd.hseb.hefs.mefp.sources.historical.HistoricalForecastSource" id="Historical"></source>
</forecastSources>
```

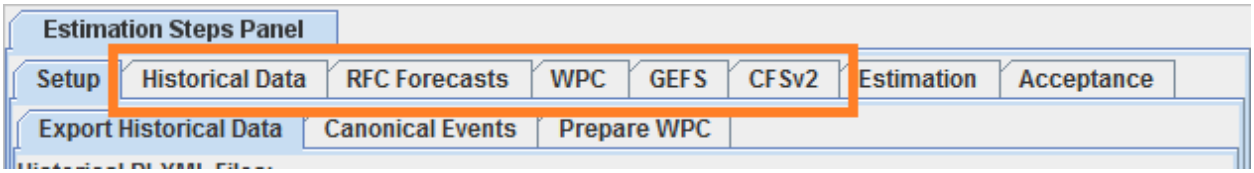
2.1.1.2 Impact on MEFPPE Interface

The id attribute provided in the source XML element specifies the identifier displayed in the tabs of the **Estimation Steps Panel** of the MEFPPE; see the *MEFP User's Manual*. For example, the following are the default tabs**:**

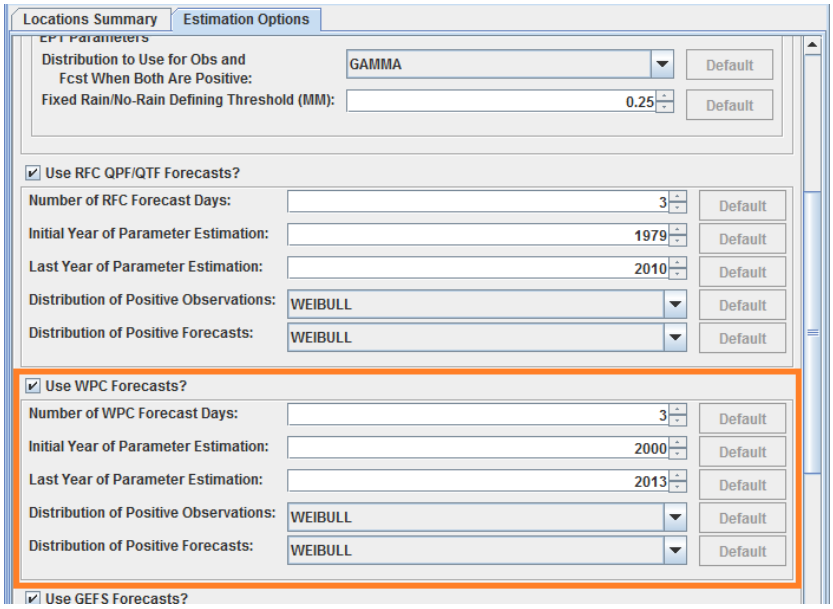


- The climatology and RFC forecast sources are the only exceptions to the tab-name rule, having specialized names for their tabs that do not match the id attribute.
- The climatology (Historical Data) forecast source tab is always displayed first.

The following are the tabs after the WPC plugin forecast source is added, as per the example above:



Additionally, the available sources impacts the source-specific estimation options provided in the **Estimation Options Subpanel** of the **Estimation Panel**. For example, if the WPC forecast source plugin is included, the following options will be available:



2.1.1.3 Impact on Estimated Parameters

The MEFPPE is capable of reading any MEFPPE generated parameter .tgz file, regardless of the forecast sources defined therein. Furthermore, the **Parameter Diagnostics Panel** will always display parameters for the forecast sources that were available when that parameter file was

generated. What is displayed in diagnostics is not dependent on the forecast sources defined in the forecastSourceDefinition.xml file. However, whenever parameters are estimated for all or one forecast source, the resulting parameter file will only include parameters for those sources included in the forecastSourcesDefinition.xml file in the order specified therein.

For example, with the default forecast sources, the following files are included in a parameter .tgz file in order (tar –ztvf is used to extract the following listing):

```
sh-4.1$ tar -ztvf CREC1HOF.precipitation.mefp.
-rw-r--r-- hankherr/0    25282 1969-12-31 19:0 mainParameters.xml
-rw-r--r-- hankherr/0     6168 1969-12-31 19:0 RFCSourceModelParameters.meta.xml
-rw-r--r-- hankherr/0   520917 1969-12-31 19:0 RFCSourceModelParameters.values.xml
-rw-r--r-- hankherr/0   760040 1969-12-31 19:0 RFCSourceModelParameters.precip.events.bin
-rw-r--r-- hankherr/0    12884 1969-12-31 19:0 GEFSSourceModelParameters.meta.xml
-rw-r--r-- hankherr/0  1013231 1969-12-31 19:0 GEFSSourceModelParameters.values.xml
-rw-r--r-- hankherr/0  4351544 1969-12-31 19:0 GEFSSourceModelParameters.precip.events.bin
-rw-r--r-- hankherr/0    19176 1969-12-31 19:0 CFSv2SourceModelParameters.meta.xml
-rw-r--r-- hankherr/0  1466860 1969-12-31 19:0 CFSv2SourceModelParameters.values.xml
-rw-r--r-- hankherr/0  1354888 1969-12-31 19:0 CFSv2SourceModelParameters.precip.events.bin
-rw-r--r-- hankherr/0    20600 1969-12-31 19:0 HistoricalSourceModelParameters.meta.xml
-rw-r--r-- hankherr/0   631772 1969-12-31 19:0 HistoricalSourceModelParameters.values.xml
-rw-r--r-- hankherr/0 12613800 1969-12-31 19:0 HistoricalSourceModelParameters.precip.events.bin
-rw-r--r-- hankherr/0   293368 1969-12-31 19:0 historicalTimeSeries.bin
-rw-r--r-- hankherr/0  5758051 1969-12-31 19:0 historicalTimeSeries.xml
-rw-r--r-- hankherr/0   395625 1969-12-31 19:0 questionableParameterLog.xml
sh-4.1$ ^C
```

However, if the RFC forecast source is removed and parameters are re-estimated for this point, the following is the content of the parameter file:

```
sh-4.1$ tar -ztvf CREC1HOF.precipitation.mefp.
-rw-r--r-- Hank.Herr/0   25257 1969-12-31 19:0 mainParameters.xml
-rw-r--r-- Hank.Herr/0   12900 1969-12-31 19:0 GEFSSourceModelParameters.meta.xml
-rw-r--r-- Hank.Herr/0 1008635 1969-12-31 19:0 GEFSSourceModelParameters.values.xml
-rw-r--r-- Hank.Herr/0 4351544 1969-12-31 19:0 GEFSSourceModelParameters.precip.events.bin
-rw-r--r-- Hank.Herr/0   19193 1969-12-31 19:0 CFSv2SourceModelParameters.meta.xml
-rw-r--r-- Hank.Herr/0 1464254 1969-12-31 19:0 CFSv2SourceModelParameters.values.xml
-rw-r--r-- Hank.Herr/0 1354888 1969-12-31 19:0 CFSv2SourceModelParameters.precip.events.bin
-rw-r--r-- Hank.Herr/0   20621 1969-12-31 19:0 HistoricalSourceModelParameters.meta.xml
-rw-r--r-- Hank.Herr/0  630394 1969-12-31 19:0 HistoricalSourceModelParameters.values.xml
-rw-r--r-- Hank.Herr/0 10051000 1969-12-31 19:0 HistoricalSourceModelParameters.precip.events.bin
-rw-r--r-- Hank.Herr/0   233768 1969-12-31 19:0 historicalTimeSeries.bin
-rw-r--r-- Hank.Herr/0  4669856 1969-12-31 19:0 historicalTimeSeries.xml
-rw-r--r-- Hank.Herr/0   414426 1969-12-31 19:0 questionableParameterLog.xml
sh-4.1$
```

The same is also true if parameters are estimated for only one source: the parameter files associated with forecast sources no longer included in the forecastSourcesDefinition.xml file are removed from the parameter file and the remaining files are reordered appropriately.

2.2 *MEFPEnsembleGeneratorModelAdapter*

To add or remove forecast sources used by the MEFPEnsembleGeneratorModelAdapter, the same forecastSourcesDefinition.xml file as modified for the MEFPPE must be provided. Specifically, the file is exported as a module data set as part of an exportDataSetActivity within the module configuration file for the MEFPEnsembleGeneratorModelAdapter.

If the module data set file is not created and exported as per the instructions below, the default forecast sources will be available to the MEFPEnsembleGeneratorModelAdapter, regardless of the sources for which parameters are available in the parameter file.

2.2.1 Action: Create/Modify forecastSourcesDefinition.xml

As stated above, the content of the forecastSourcesDefinition.xml file should match that of the same file defined for the MEFPPE, except that the reforecastPreparationSteps XML element should be removed from within the new source XML element. For example, this file would make the WPC plugin forecast source available to the MEFPEnsembleGeneratorModelAdapter:

EXAMPLE: WPC QPF

The following forecastSourcesDefinition.xml includes all default forecast sources and the WPC plugin forecast source (see the *WPC Plugin Configuration Guide*):

```
<forecastSources>
  <source class="ohd.hseb.hefs.mefp.sources.rfcfcst.RFCForecastSource" id="RFC"/>
  <source class="ohd.hseb.hefs.mefp.sources.plugin.PluginForecastSource" id="WPC"/>
  <source class="ohd.hseb.hefs.mefp.sources.gefs.GEFSForecastSource" id="GEFS"/>
  <source class="ohd.hseb.hefs.mefp.sources.cfsv2.CFSv2ForecastSource" id="CFSv2"/>
  <source class="ohd.hseb.hefs.mefp.sources.historical.HistoricalForecastSource" id="Historical"/>
</forecastSources>
```

Removing the reforecastPreparationSteps XML element is recommended, but may not be required depending on how the element is defined. For example, for WPC it is required because the reforecastPreparationSteps element uses a FEWS global property that cannot be processed during adapter execution, leading to an error.

2.2.1.1 Importance of Forecast Source Order

The order of the forecast sources specified in the foreastSourcesDefinition.xml file is important for the generation of ensembles. Specifically, the order dictates the priority assigned to each forecast source by the MEFP when constructing the final output ensemble. In general, the sources should be ordered from shortest lead-time to longest lead-time.

EXAMPLE: Default Source Order

In the default order shown previously, the ensemble generated based on the RFC forecast source is used first, filling in lead times out to typically 1-5 days. Then the ensemble generated based on the GEFS forecast source is used for lead times for which the RFC forecast source was not available, typically out to 15 days. Next, the ensemble generated based on the CFSv2 forecast source is used starting from the end of the GEFS forecast source typically out to 270 days. Lastly, the climatology forecast source is applied for however long it is configured.

For all sources, the number of lead times is specified by the run-file property <source>NumberOfForecastDays (see Section 4.4 of the *MEFP User's Manual*) and, if it is set to 0 or not provided, then the source will not be included in the output ensemble.

2.2.2 Action: Create the Module Dataset File

A FEWS module dataset file is a .zip file located within the directory <*install SA configuration dir*>/Config/ModuleDataSetFiles. The name of the file without the .zip extension must match a module instance id defined in the ModuleInstanceDescriptors.xml configuration file. So that a new module instance need not be defined for this file, it is recommended that the module data set .zip file to be created be named after the module configuration file it which it is exported.

To create the module dataset .zip file, execute the following commands from the directory containing the forecastSourcesDefinition.xml file created in the previous step:

```
zip <module instance id>.zip forecastSourcesDefinition.xml
mv <module instance id>.zip <install SA configuration dir>/Config/ModuleDataSetFiles/.
```

where <module instance id> matches an id defined in the ModuleInstanceDescriptors.xml file.

EXAMPLE: Using MEFPPE forecastSourcesDefinition.xml File

If the module configuration file to be modified is KEYINF_MEFP_FMAP_Forecast.xml, and if the forecastSourcesDefinition.xml defined within the MEFPPE run area is to be used, then do the following:

```
cd <MEFPPE run area>/.systemFiles
zip KEYINF_MEFP_FMAP.zip forecastSourcesDefinition.xml
mv KEYINF_MEFP_FMAP.zip <install SA configuration dir>/Config/ModuleDataSetFiles/.
```

Since the .zip file name uses an already existing module configuration file for its name, no changes must be made to the ModuleInstanceDesciptors.xml file.

The example above creates the .zip file in the *PE-SA* but moves it to he *install SA*.

2.2.3 Action: Modify the MEFPEnsembleGeneratorModelAdapter Module Configuration File

Once the module dataset file is created, it must be exported so that the MEFPEnsembleGeneratorModelAdapter can find it.

2.2.3.1 Set exportDataSetDir

Set the exportDataSetDir XML element to match the workDir.

EXAMPLE

The correct setting to use for the exportDataSetDir XML element within the general element of an MEFPEnsembleGeneratorModelAdapter module configuration file so that the adapter can see the forecastSourcesDefinition.xml file to be exported:

```
...
  <general>
     <description>MEFP Ensemble Generator</description>
     <piVersion>1.8</piVersion>
     <rootDir>%TEMP_DIR%</rootDir>
     <workDir>%ROOT_DIR%/work</workDir>
     <exportDir>%ROOT_DIR%/input</exportDir>
     <exportDataSetDir>%ROOT_DIR%/work</exportDataSetDir>
     <exportIdMap>IdExportMEFPMAP</exportIdMap>
     <importDir>%ROOT_DIR%/output</importDir>
     <dumpFileDir>$GA_DUMPFILEDIR$</dumpFileDir>
     <dumpDir>%ROOT_DIR%</dumpDir>
     <diagnosticFile>%ROOT_DIR%/output/diag.xml</diagnosticFile>
  </general>
...
```

The module dataset file must be exported to the work directory in order for the MEFPEnsembleGeneratorModelAdapter to find it.

2.2.3.2 *Add* makeDir *to the* startUpActivities

Ensure that the work directory is created. If necessary, add a makeDir XML element to the startUpActivities XML element that will create the work directory. If no startUpActivities XML element exists, add it to the module configuration file.

EXAMPLE

A makeDir activity added to the startUpActivities XML element instructing the FEWS General Adapter to make the work directory which will contain the data set exported next:

```
...
<startUpActivities>
   <makeDir>
      <dir>%ROOT_DIR%/work</dir>
   </makeDir>
</startUpActivities>
...
```

2.2.3.3 *Add* exportDataSetActivity

Add an exportDataSetActivity XML element exporting the data set, providing the name of the .zip file created in Section 2.2.2 without the .zip extension as the moduleInstanceId.

EXAMPLE

An exportDataSetActivity XML element added to the MEFPEnsembleGeneratorModelAdapter module configuration file so that the module data set KEYINF_MEFP_FMAP_Forecast.zip is exported to the work directory:

```
...
<exportDataSetActivity>
    <moduleInstanceId>KEYINF_MEFP_FMAP_Forecast</moduleInstanceId>
</exportDataSetActivity>
...
```

2.2.3.4 *Specify Run-File Properties*

Specify the run-file properties as appropriate for the new forecast source.

EXAMPLE

Modifications made to the properties element of the MEFPEnsembleGeneratorModelAdapter module configuration file so that the WPC plugin forecast source is used; see highlighted text. The wpcNumberOfForecastDays is set to 3 days, so that MEFP uses 3 days of the WPC QPF forecast when generating ensembles. The wpcUseEPT is set to true, ensuring the EPT model is used for precipitation intermittency modeling.

```
...
<properties>
   <string key="hindcasting" value="$MEFP_HINDCASTING$"/>
   <string key="parameterDir" value="$MEFP_ROOT_DIR$/mefpParameters"/>
   <int key="wpcNumberOfForecastDays" value="3"/>
   <int key="rfcNumberOfForecastDays" value="0"/>
   <int key="gefsNumberOfForecastDays" value="15"/>
   <int key="cfsv2NumberOfForecastDays" value="0"/>
   <int key="climatologyNumberOfForecastDays" value="0"/>
   <string key="wpcUseEPT" value="true"/>
   <string key="rfcUseEPT" value="true"/>
   <int key="initialEnsembleYear" value="1952"/>
   <int key="lastEnsembleYear" value="2013"/>
</properties>
...
```

By default, EPT will be used, so the wpcUseEPT property will default to true. It is only included in the example above for illustrative purposes.

2.2.3.5 *Modify* exportTimeSeriesActivity

Lastly, operational forecast time series must be exported, as part of the exportTimeSeriesActivity, in order for the MEFPEnsembleGeneratorModelAdapter to generate ensembles that incorporate that source. The length of the time series must meet or exceed the configured number of forecast days. Furthermore, the qualifierId of the exported time series must match the id attribute of the source XML element defining the source in the forecastSourcesDefinition.xml file. Id-mapping may be used to assign an appropriate qualifierId.

EXAMPLE

The following is an example of a timeSeriesSet added to the exportTimeSeriesActivity XML element in the configuration file for the MEFPEnsembleGeneratorModelAdapter. The example is for NERFC:

```
...
<timeSeriesSet>
  <moduleInstanceId>FMAP_PreProcessing_HPC</moduleInstanceId>
  <valueType>scalar</valueType>
  <parameterId>FMAP</parameterId>
  <locationSetId>Catchments_HEFS_Hudson</locationSetId>
  <timeSeriesType>external forecasting</timeSeriesType>
  <timeStep unit="hour" multiplier="6"/>
  <relativeViewPeriod unit="day" start="0" startOverrulable="true" end="2" endOverrulable="false"/>
  <readWriteMode>read only</readWriteMode>
</timeSeriesSet>
...
```

In order to associate a qualifierId of WPC with this time series, lines similar to the following were added to the id-mapping file referred to by the exportIdMap XML sub-element of the general element, as shown in the example in Section 2.2.3.1 :

```
...
<map internalLocation="HOPR1SNE" externalParameter="FMAP" internalParameter="FMAP"
      externalLocation="HOPR1SNE" externalQualifier="WPC"/>
...
```

One line is needed per locationId for which WPC QPF forecasts will be exported.

3 Designing a Plugin Forecast Source

In this section, a step-by-step process by which a new plugin forecast source can be designed by a user is presented.

3.1 *Identify Candidate Forecast Source*

In order for a candidate forecast source to be used, the following must be true:

- The forecasts must be available for use in operational MEFP execution, and must be capable of being imported by CHPS.
- Archived forecasts or reforecasts must be available for use in parameter estimation, and must be capable of being imported by CHPS.

The forecast source need not be a gridded forecast source, but must be able to yield time series that correspond to catchments for which MEFP can execute. Multi-model forecast sources are possible, but remember that MEFP currently only makes use of the ensemble mean in estimating parameters and generating ensembles.

3.2 *Configure Source(s) of Operational Forecasts*

In order to use a plugin forecast source, forecasts from that source(s) must be available operationally for use in MEFP. Furthermore, those forecasts must be in a form that can be imported by CHPS. As such, the first step in designing a new forecast source is to identify how to acquire and import operational forecasts.

A situation that may require identifying multiple sources includes a multi-model ensemble forecast source where the multimodel ensemble will be constructed via CHPS for ensemble generation and MEFPPE for parameter estimation.

3.2.1 Create Operational Mechanism to Acquire Forecasts

Standard mechanisms to acquire operational forecasts should be employed. This includes pulling the forecasts from the SBN and/or acquiring the forecasts via FTP/SFTP.

3.2.2 Configure for Operational Import in CHPS

Configure one or more workflows that can import the operational forecasts and, if the forecasts are gridded, spatially interpolate them for catchments. Be sure to confirm that the imported data matches the forecasts provided in the imported file. Talk to your CHPS configuration focal point if you have any questions.

Files that may require creation or modification in order to import the operational forecasts include the following:

- Grids.xml: For gridded forecasts, the grid must be defined within this file.
- Locations.xml: For gridded forecasts, a new grid may need to be defined, and that grid is defined in Grids.xml by a locationId which must be defined in Locations.xml. For non-gridded forecasts, changing this file may not be necessary.
- Module to import the forecast: For gridded forecasts, the import module should use the locationId defined above. For non-gridded forecasts, it may make use of an existing location set and id-mapping.
- Module (transformation) to spatially interpolate the grids (if gridded): MEFP/MEFPPE operates on catchments, so any forecast must be interpolated to match those catchments.
- Operational import workflow: Workflow that calls the import and interpolation module operationally.
- ModuleInstanceDescriptors.xml: Add descriptors for any newly created modules.
- WorkflowDescriptors.xml: Add descriptors for any newly created workflows.

EXAMPLE: NERFC WPC QPF

The following example shows how NERFC imports QPF provided by WPC (formerly HPC). The configuration from which this example was pulled is old. NERFC acquires the WPC QPF forecasts via FTP. The forecasts are provided in GRIB format. The following locationId is defined in Locations.xml:

```
…
    <location id="HPC" name="HPC">
            <shortName>HPC</shortName>
            <x>-123.059 </x>
            <y>38.413</y>
    </location>
…
```

The following regular XML element is defined in Grids.xml:

```
…
  <regular locationId="HPC">
    <rows>689</rows>
    <columns>1073</columns>
    <lambertConformalConic>
      <originLatitude>25.0</originLatitude>
      <originLongitude>265.0</originLongitude>
      <firstStandardParallelLatitude>25.0</firstStandardParallelLatitude>
      <secondStandardParallelLatitude>25.0</secondStandardParallelLatitude>
    </lambertConformalConic>
    <gridCorners>
```

```
            <geoDatum>WGS 1984</geoDatum>
            <upperLeft>
               <x>-130.13937712795388</x>
               <y>49.958437615088435</y>
               <z>0.0</z>
            </upperLeft>
            <lowerRight>
               <x>-69.19419381895221</x>
               <y>20.30332235930985</y>
               <z>0.0</z>
            </lowerRight>
         </gridCorners>
      </regular>
...
```

The following import module, ImportQPF_HPC.xml, is defined for importing the gridded forecasts:

```
...
<?xml version="1.0" encoding="UTF-8"?>
<timeSeriesImportRun xmlns="http://www.wldelft.nl/fews" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.wldelft.nl/fews http://chps1/schemas/timeSeriesImportRun.xsd">
      <import>
            <general>
                  <importType>grib2</importType>
                  <folder>$IMPORT_FOLDER_GRIB2$/hpc</folder>
                  <fileNamePatternFilter>*.grb</fileNamePatternFilter>
                  <idMapId>IdImportHPC</idMapId>
                  <unitConversionsId>ImportEnglishUnits</unitConversionsId>
                  <importTimeZone>
                        <timeZoneOffset>+00:00</timeZoneOffset>
                  </importTimeZone>
                  <gridStartPoint>SW</gridStartPoint>
            </general>
            <timeSeriesSet>
                  <moduleInstanceId>ImportQPF_HPC</moduleInstanceId>
                  <valueType>grid</valueType>
                  <parameterId>FMAP</parameterId>
                  <locationId>HPC</locationId>
                  <timeSeriesType>external forecasting</timeSeriesType>
                  <timeStep unit="hour" multiplier="6"/>
                  <readWriteMode>add originals</readWriteMode>
                  <synchLevel></synchLevel>
                  <expiryTime unit="day" multiplier="5"/>
            </timeSeriesSet>
      </import>
</timeSeriesImportRun>...
```

The following module, FMAP_PreProcessing_HPC.xml, spatially interpolates the imported grids for catchments defined in location set with locationSetId “Catchments_FFG”:

```
<?xml version="1.0" encoding="UTF-8"?>
<transformationModule xmlns="http://www.wldelft.nl/fews" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.wldelft.nl/fews http://chps1/schemas/transformationModule.xsd" version="1.0">
    <variable>
        <variableId>fmap_grid</variableId>
        <timeSeriesSet>
            <moduleInstanceId>ImportQPF_HPC</moduleInstanceId>
            <valueType>grid</valueType>
            <parameterId>FMAP</parameterId>
            <locationId>HPC</locationId>
            <timeSeriesType>external forecasting</timeSeriesType>
            <timeStep unit="hour" multiplier="6"/>
            <relativeViewPeriod unit="hour" start="0" startOverrulable="true" end="240"
              endOverrulable="true"/>
            <readWriteMode>add originals</readWriteMode>
        </timeSeriesSet>
    </variable>
    <variable>
        <variableId>fmap_scalar</variableId>
        <timeSeriesSet>
            <moduleInstanceId>FMAP_PreProcessing_HPC</moduleInstanceId>
            <valueType>scalar</valueType>
            <parameterId>FMAP</parameterId>
            <locationSetId>Catchments_FFG</locationSetId>
            <timeSeriesType>external forecasting</timeSeriesType>
            <timeStep unit="hour" multiplier="6"/>
            <relativeViewPeriod unit="hour" start="0" startOverrulable="true" end="240"
              endOverrulable="true"/>
            <readWriteMode>add originals</readWriteMode>

            <expiryTime unit="day" multiplier="5"/>
        </timeSeriesSet>
    </variable>
    <transformation id="SampleFMAP">
        <interpolationSpatial>
            <average>
                <inputVariable>
                    <variableId>fmap_grid</variableId>
                </inputVariable>
                <outputVariable>
                    <variableId>fmap_scalar</variableId>
                </outputVariable>
            </average>
        </interpolationSpatial>
    </transformation>
</transformationModule>
```

The import module is included within the standard ImportGrids.xml workflow configuration file. The spatial interpolation module is included within the standard Preprocess.xml workflow configuration file. The ModuleInstanceDescriptors.xml file was updated to include the two modules above. No change was required for the WorkflowDescriptors.xml file.

3.3 *Configure Source(s) of Archived Forecasts or Reforecasts*

In order for parameters to be estimated by the MEFPPE, archived forecasts or reforecasts must be available covering a period time that overlaps with the historical data available for the catchments for which parameters will be estimated.

- Throughout the remainder of this document, "reforecasts" should be understood as "archived forecasts or reforecasts".
- MEFPPE can handle multiple sources of reforecasts, if that is necessary. For instance, a multi-model source forecast source may require reforecast files from different servers may be needed.

3.3.1 Acquire Reforecasts

Once the source is identified, acquire the reforecast files.

3.3.2 Reformat Files If Necessary

MEFPPE requires that the files reside on an SFTP server (described later) and satisfy these requirements:

- For each past T0, the reforecast for a single source, or a single model within a multi-model source, is completely contained in one file. This includes all data types to be used in MEFPPE for parameter estimation.
- There is only one T0 included per file.
- The name of the file must include the corresponding past T0 specified in the format "YYYYMMDDhh" (in GMT) as the last component of the filename before the file extension. Components within the name can be separated by either '_' or '.'. For example, if the past T0 is Feb 18, 2004 at 0Z and the file extension is ".grb2", then the filename may be "reforecast_2004021800.grb2" or "gefs.2004021800.grb2".

MEFPPE will process each file via a CHPS workflow executed using a system time set to the past T0 as parsed from the file name. If the last filename component before the file extension cannot be parsed using the format mentioned above, the file will be skipped.

Given these requirements, some amount of reformatting of the reforecasts may be necessary. Specifically, if they are provided in a single (likely compressed) package, it must be unpackaged. Furthermore, if the files are provided including multiple T0s per file, or multiple files per T0, then they must be reformatted appropriately to satisfy the rules above.

EXAMPLE 1: WPC QPF
The WPC QPF archived forecast files were provided so that both the 0Z and 12Z forecast for each past date were included in a single GRIB2 file. The application wgrib2 was used to unpackage it so that the 0Z and 12Z archived forecasts were in separate GRIB2 files. Files were created with names "p06i_YYYYMMDDhh.grb2", each containing 6-h total precipitation.

EXAMPLE 2: GEFS (Precipitation)
The GEFS (next generation; 2015) reforecasts were provided so that for each past T0, a separate GRIB format file was provided per lead time (i.e., 96 files per T0). Those files were combined using the application cat so that a single file included all 96 lead-times. Files were created with the names "gefs.YYYYMMDDhh.grb2", each containing total precipitation, minimum temperature, and maximum temperature at a 6-hour time step.

3.3.3 Configure Workflow to Import, Interpolate, and Export Time Series

For parameter estimation, the reforecast grids must be imported and spatially interpolated in the exact same manner as is done for operational forecasting. Hence, the import workflow created for the reforecasts should start with the operational import workflow and modules created in Section 3.2.2. Make changes as needed to the configuration for importing reforecasts, either creating new modules or changing the existing ones. For example, the reforecasts may be available at a different resolution than the operational forecasts.

In addition to importing and spatially interpolating the reforecasts, the resulting forecast time series or ensembles must be exported to the file system in XML (.xml) files or FastInfoset (.fi; recommended) XML files. The following rules must be obeyed when exporting the files:

- The name of the file exported must make it so that the file for one past T0 does not override another past T0. For that reason, the time series T0 (pi-timeseries XML element forecastDate) should be incorporated in the file name.
- All files for one location must be exported to one directory.
- Files for different locations must be exported to different location-specific directories, and the name of the directories must match the locationId displayed in the MEFPPE interface for that location. The locationId is determined from historical data made available to MEFPPE.
- All location-specific directories must be located within one (base) directory.

During reforecast preparation, the MEFPPE will combine all T0-specific reforecast files into a single file for each location, after which the T0-specific files will be removed. Since there may be thousands of such files, it is highly recommended that the export module used export the reforecast time series to files on a local disk on the machine used to run the PE SA.

EXAMPLE:WPC QPF

See the default delivered WPC QPF import workflow for a complete example, where nearest-neighbor (to the catchment centroid) spatial interpolation is used. The export module called by that workflow makes use of the TimeSeriesExporterModelAdapter delivered with HEFS (see the *MEFP User's Manual* Section 4.4.2.). This is because it allows for files with many different names to be exported via a single module. For example:

```
<generalAdapterRun xmlns="http://www.wldelft.nl/fews" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.wldelft.nl/fews http://fews.wldelft.nl/schemas/version1.0/generalAdapterRun.xsd">
   <!-- This module can run at any time relative to the reforecast data's
        external forecast time.  The forecast time assumed in output time
        series is computed based on provided data, as discussed below
        (see t0ComputationAdjustmentFactorFromFirstDataValue
        run info property). -->
   <general>
      <description>WPC Reforecast Interpolated Time Series Exporter</description>
   <piVersion>1.8</piVersion>
      <rootDir>%TEMP_DIR%</rootDir>
      <workDir>%ROOT_DIR%/work</workDir>
      <exportDir>%ROOT_DIR%/input</exportDir>
      <exportDataSetDir>%ROOT_DIR%</exportDataSetDir>
      <importDir>%ROOT_DIR%/output</importDir>
      <dumpFileDir>$GA_DUMPFILEDIR$</dumpFileDir>
      <dumpDir>%ROOT_DIR%</dumpDir>
      <diagnosticFile>%ROOT_DIR%/output/diag.xml</diagnosticFile>
   </general>
   <activities>
      <startUpActivities>
         <purgeActivity>
            <filter>%ROOT_DIR%/run_info.xml</filter>
         </purgeActivity>
      </startUpActivities>

      <exportActivities>
         <exportTimeSeriesActivity>
            <exportFile>inputs.xml</exportFile>
            <timeSeriesSets>
               <timeSeriesSet>
                  <moduleInstanceId>MEFP_WPCQPF_Interpolate_Location_FMAP</moduleInstanceId>
                  <valueType>scalar</valueType>
                  <parameterId>FMAP</parameterId>
                  <locationSetId>Catchments_WPC</locationSetId>
                  <timeSeriesType>temporary</timeSeriesType>
                  <timeStep unit="hour" multiplier="6"/>
                  <readWriteMode>read complete forecast</readWriteMode>
                  <ensembleId>main</ensembleId>
               </timeSeriesSet>
            </timeSeriesSets>
         </exportTimeSeriesActivity>

         <exportRunFileActivity>
            <exportFile>%ROOT_DIR%/run_info.xml</exportFile>
```

```
            <properties>
              <!-- Valid arguments to put within '@' symbols are locationId, parameterId,
                   ensembleId, handbook5Id, and the forecastDateT0 argument function which
                   takes two parameters: date format and time zone.  This uses standard
                   Graphics Generator arguments syntax, so refer to its documentation for
                   more information. -->
              <string key="fileNamePattern"
              value="@locationId@/@locationId@.@parameterId@.@forecastDateT0(yyyyMMddHH;GMT)@.fi"/>

              <!-- The base directory for output files.  Subdirectories  based on the file names
                   are created as needed. -->
              <string key="exportDir" value="@writableOutputDirectoryOnLocalDisk@"/>

              <!-- The external forecast time FEWS associates with the grid does not match
                   the file name.  Hence, I use this mechanism to compute the forecast time
                   relative to the data start time.-->
              <int key="t0ComputationAdjustmentFactorFromFirstDataValue" value="-6"/>
            </properties>
          </exportRunFileActivity>
        </exportActivities>

        <executeActivities>
          <executeActivity>
            <command>
              <className>ohd.hseb.hefs.exporter.adapter.TimeSeriesExporterModelAdapter</className>
              <binDir>$HEFSBINDIR$</binDir>
            </command>
            <arguments>
              <argument>%ROOT_DIR%/run_info.xml</argument>
            </arguments>
            <timeOut>300000</timeOut>
          </executeActivity>
        </executeActivities>
      </activities>
    </generalAdapterRun>
```

- All files are located under subdirectories within the directory, @writableOutputDirectoryOnLocalDisk@. The value of that argument is specified during the installation of the WPC plugin forecast source. The argument is then replaced via the installation script so that, after running the script, this argument will not be seen in the file.
- All subdirectories use the argument @locationId@ as their names, making use of the locationId of the time series being exported.
- The names of the files exported to each subdirectory does not matter, though the exported time series for different T0s must not overwrite each other, which using the argument function @forecastDateT0(yyyyMMddHH;GMT)@ ensures.

3.4 *Identify Where Reforecasts Will Be Located Within AWIPS*

The MEFPPE acquires the reforecasts using SFTP. The following information must be identified:

- SFTP server URL (or ip-address)
- Log-in user name
- Log-in password
- Directory, accessible by the SFTP user, under which reforecast files will be placed

If the plugin forecast source will only be used for your RFC, then the reforecasts can be placed on any machine at your RFC visible to the machine used for parameter estimation. Furthermore, the log-in user name and password need not be supplied if ssh keys are setup for the user who will run the MEFPPE. See Section 4.2.1.1.

If the plugin forecast source will be shared with other RFCs, then an appropriate SFTP server that is visible to CHPS machines must be identified. Since the user name and password will be provided in an ASCII XML file (see Section 4.2.1.1), it is recommended that user be one with extremely limited access to the SFTP server.

The directory selected must be one for which a simple file-name pattern, such as that used in an ls command, matches all of the T0-specific reforecast files that must be processed. See Section 4.2.1.1.

EXAMPLE: WPC QPF
The WPC QPF archived forecast files are available at 165.92.28.41. The user name is "hefsdownload" with password (not provided here). The server directory is /home/hefsdownload/data/processedASCIIGrids/pluginData/wpc_qpf_processed.

3.4.1 Put the Reforecast Files in Place

With the server, log-in information, and directory identified, the T0-specific reforecast files must be put in place.

3.5 *Assign Source Id*

The selected source id should be a short abbreviation (or acronym) that must be unique to the plugin source. For example, RFC, GEFS, CFSv2, WPC, and Historical (climatology) are unique ids already used. In a future release, GEFS2015 will be introduced for the next generation of GEFS.

3.6 *Create forecastSourcesDefinition.xml Entry*

See Section 4 for how to configure the XML instructions specifying the steps for preparing the reforecasts for parameter estimation.

3.6.1 Define Process By Which Reforecasts Can Be Prepared

Based on the information gathered in previous steps, define a process by which reforecasts can be prepared. This process should be one that acquires reforecast files from the SFTP server identified in Section 3.4, executes the parameter estimation import/export workflows identified in Section 3.3.3, moves files around as needed, and possible even makes system calls. Regardless of what steps are included in the process, the steps must be compatible with instruction XML elements to be defined in the forecastSourcesDefinition.xml. Available capabilities and the corresponding XML element are as follows:

Capability	XML Element	Section
Acquire reforecasts from an SFTP server one-at-a-time, process each file via a CHPS workflow to export location and T0 specific PI-timeseries files, and combine those T0-specific files into a single PI-timeseries file including all T0s per location.	reforecastAcquisitionInstructions	Section 4.2.1
Combine location-specific PI-timeseries files across various directories into one overall one PI-timeseries file per location for which file(s) were found. One time series or ensemble will be included per T0. This is useful for updating the location-specific PI-timeseries file stored in the MEFPPE run area with new reforecasts.	combineReforecastInstructions	Section 4.2.2
Move location-specific PI-timeseries files from one directory to another.	moveReforecastFilesInstructions	Section 4.2.3
Combine location-specific PI-timeseries files across various directories into multi-model ensembles, yielding one PI-timeseries file per location containing multi-model ensembles.	multimodelConstructionInstructions	Section 4.2.4
Execute a system call of some kind, including running an external (to CHPS) program, shell script, or basic command, such as “mv” or “cp”.	systemCallInstructions	Section 4.2.5

Refer to the section specified for each XML element for a complete description of that capability.

3.6.2 Encode the Process as Instructions in forecastSourcesDefinition.xml

See Section 4 for instructions on configuring reforecast preparation steps within forecastSourcesDefinition.xml.

EXAMPLE: WPC QPF

The following is the default configuration of the WPC plugin forecast source within forecastSourcesDefinition.xml. It performs a reforecast acquisition step that includes acquiring reforecasts via SFTP and processing them via a workflow called ImportMEFP-WPCGrids which exports location-specific interpolated time series to a local disk. It then combines the newly

acquire reforecasts with reforecasts already available MEFPPE run area, effectively moving the reforecasts into place and allowing for incremental updates to the available reforecasts.

```
<source class="ohd.hseb.hefs.mefp.sources.plugin.PluginForecastSource" id="WPC">

   <!-- WPC plugin requires reforecast acquisition instructions.  The other sources specified herein are default
        source with their reforecast acquisition instructions hardcoded in the source code. -->
   <reforecastPreparationSteps defaultNumberOfForecastDays="3" defaultInitialYear="2000" defaultLastYear="2013">

      <!-- ACQUIRE 12Z REFORECASTS -->
      <!-- The reforecastOutputBaseDirectory should be a local directory and must match the output directory for the export
           module in the workflow specified below. -->
      <!-- The "yes" combineReforecasts value tells the processor to combine reforecasts across all T0s into a single large
           file for each location, removing the T0-specific files. -->
      <reforecastAcquisitionInstructions stepId="AcquireReforecasts" stepDescription="Acquire 12Z reforecasts 2000 - 2013"
           reforecastOutputBaseDirectory="@writableOutputDirectoryOnLocalDisk@" combineReforecasts="yes">
         <sftpInstructions maxReconnects="10" maxWaitForPuttingFileInPlace="600000">
            <serverURL>165.92.28.41</serverURL>
            <userName>hefsdownload</userName>
            <password>2012</password>
            <serverDirectory>/home/hefsdownload/data/processedASCIIGrids/pluginData/wpc_qpf_processed/</serverDirectory>
            <fileNamePattern>*/*12.grb2</fileNamePattern>
            <!-- Must match the import directory used by the workflow below. -->
            <localDirectory>$IMPORT_FOLDER_WPC_REFORECASTS$</localDirectory>
         </sftpInstructions>
         <workflowInstructions maxWaitToExecute="30000" maxWaitForExecutionToComplete="30000">
            <workflowID>ImportMEFP-WPCGrids</workflowID>
         </workflowInstructions>
      </reforecastAcquisitionInstructions>

      <!-- COMBINE REFORECAST FILES ACQUIRED WITH THOSE ALREADY IN PLACE IN THE RUN AREA -->
      <!-- No outputDir element specified below indicates that combined file is placed in plugin data directory in the
           MEFPPE run area..-->
      <combineReforecastsInstructions stepId="PutReforecastFilesInPlace"
         stepDescription="Combine new reforecasts with current reforecasts" removeFilesAfterCombining="no">

         <!-- Specifies that files found in the default data directory for this plugin within the MEFPPE run area will be
              combined with those in the directory below, allowing for incremental changes to the reforecast file. -->
         <directory>OUTPUTDIR</directory>

         <!-- Must match the reforeastOutputBaseDirectory specified in the acquisition instructions above. -->
         <directory>@writableOutputDirectoryOnLocalDisk@</directory>
      </combineReforecastsInstructions>

   </reforecastPreparationSteps>
</source>
```

3.6.3 Manually Test Process

Manually perform the steps defined in the process. Focus on the SFTP and workflow execution steps. The other steps, particularly those involving constructing a multi-model ensemble, cannot be easily tested manually.

3.7 *Test Parameter Estimation*

Two steps must be tested to confirm the new plugin forecast sources works:

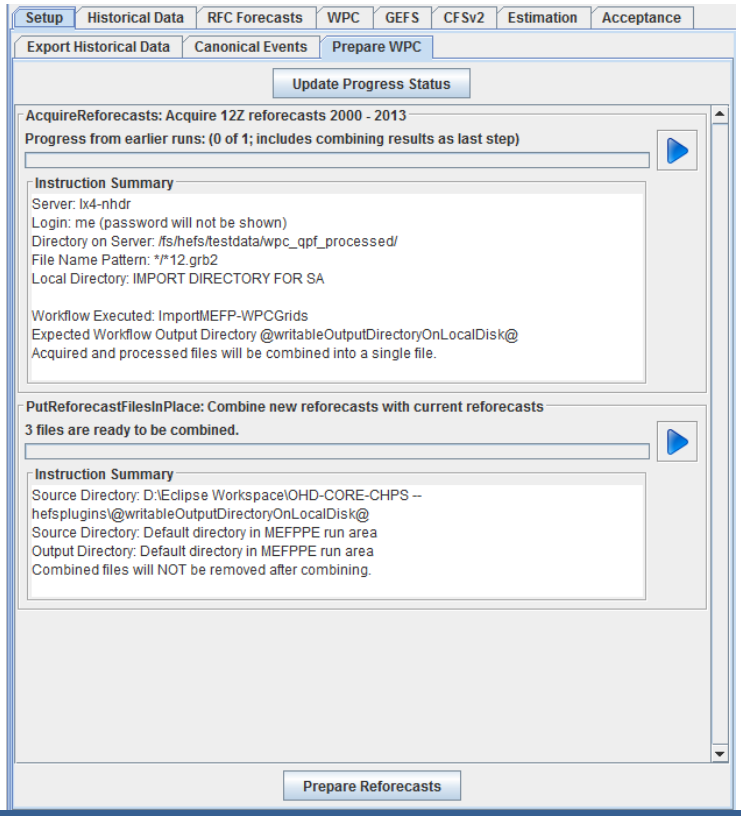
1. Prepare the reforecasts.
2. Estimate parameters.

3.7.1 Prepare the Reforecasts

To prepare the reforecasts, star the *PE SA* and the MEFPPE. Set the port number within the **Export Historical Data Subpanel** of the **Setup Subpanel** and click on the **Prepare Reforecasts Button** of the **Prepare <Source> Subpanel** within the **Setup Subpanel** of the MEFPPE.

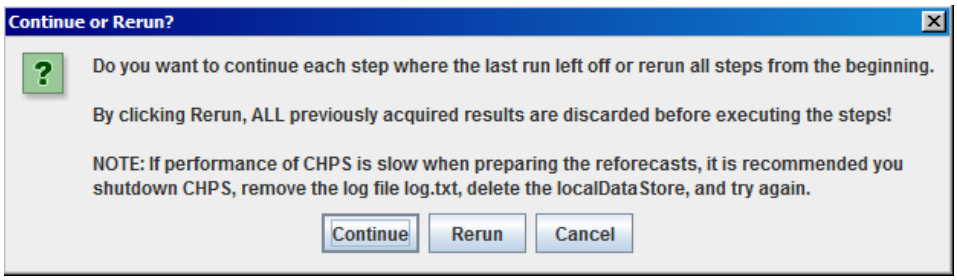
EXAMPLE: WPC QPF

An example of the **Prepare WPC Subpanel** is as follows:



The **Prepare Reforecasts Button** is at the bottom. It will perform the steps shown above the button: "AcquireReforecasts" and "PutReforecastFilesInPlace". See Section 4.

Upon clicking the button, a confirmation dialog will open:

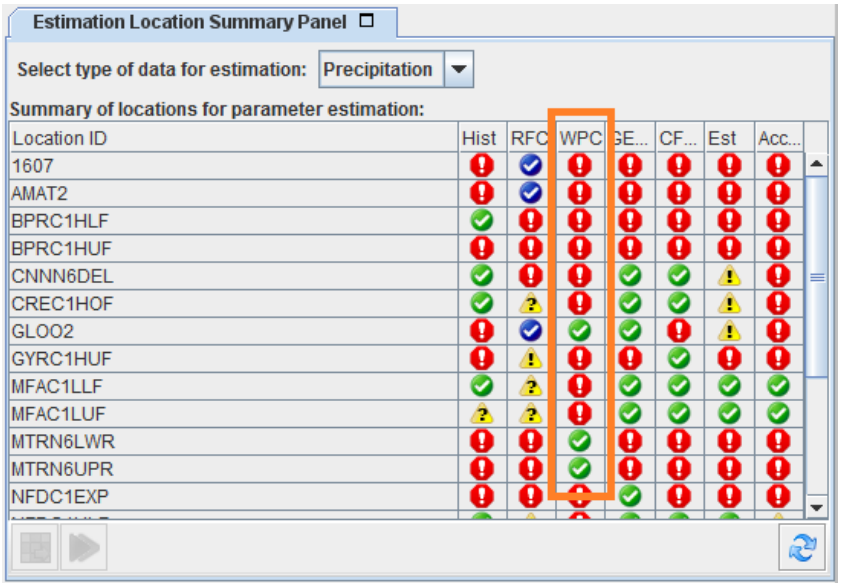


The first time reforecast preparation is performed, either the **Continue** or **Rerun** button can be clicked. After that, the **Continue** button can be clicked to start reforecast preparation where the last run left off (useful if the MEFPPE or CHPS crashes while preparing reforecasts). If the **Rerun Button** is clicked and reforecasts have already been prepared (see the **Location Summary Panel** screen shot below), then an additional confirmation dialog will open indicating how many reforecast files will be removed from the MEFPPE run area. Click **Rerun** again to confirm the rerun request and remove <u>all</u> already prepared reforecast files for the plugin source.

After clicking **Continue** or **Rerun**, a progress bar will display progress while the **Run/Cancel Button** to the right of the bar will allow for stopping the current reforeacast preparation process, without losing existing progress. For example:

See Section 3.5 of the *MEFP User's Manual* for more information.

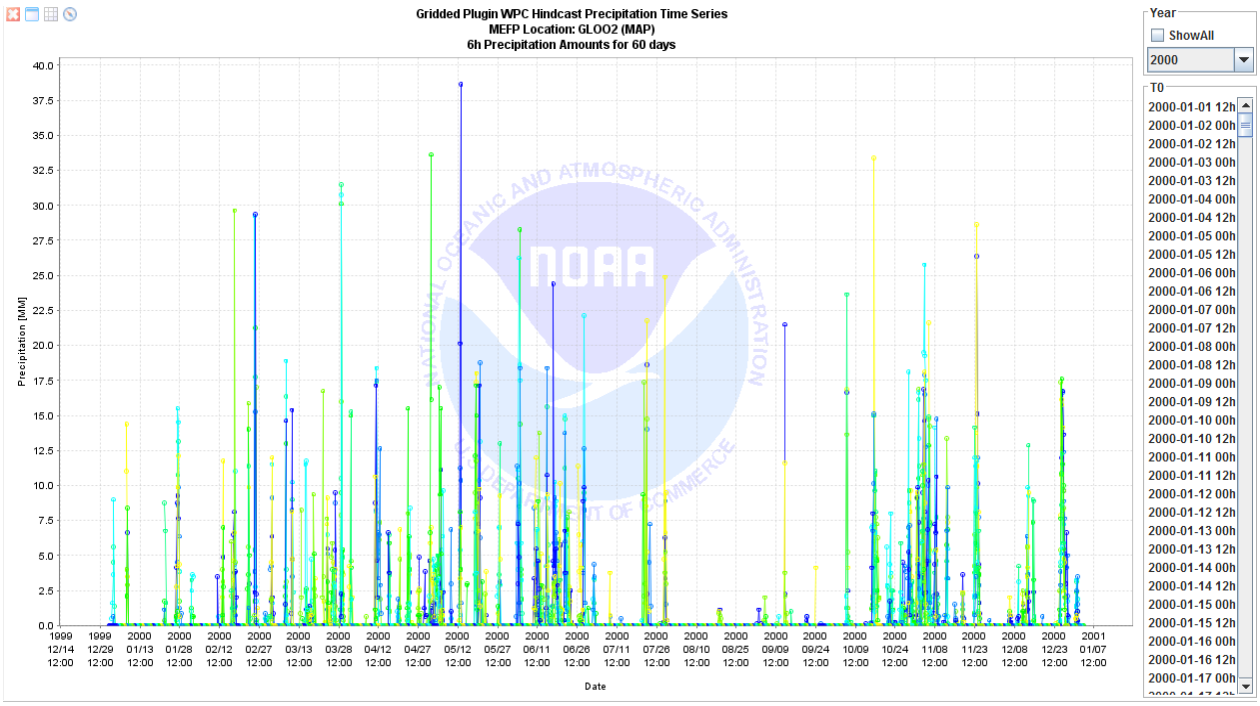
After preparation is complete, the **Location Summary Panel** of the MEFPPE should display a icon for all locations for which the reforecasts have been prepared. For example:



You are encouraged to use the **Diagnostics Panel** of the MEFPPE to view the reforecast time series for various locations in order to confirm that they appear reasonable.

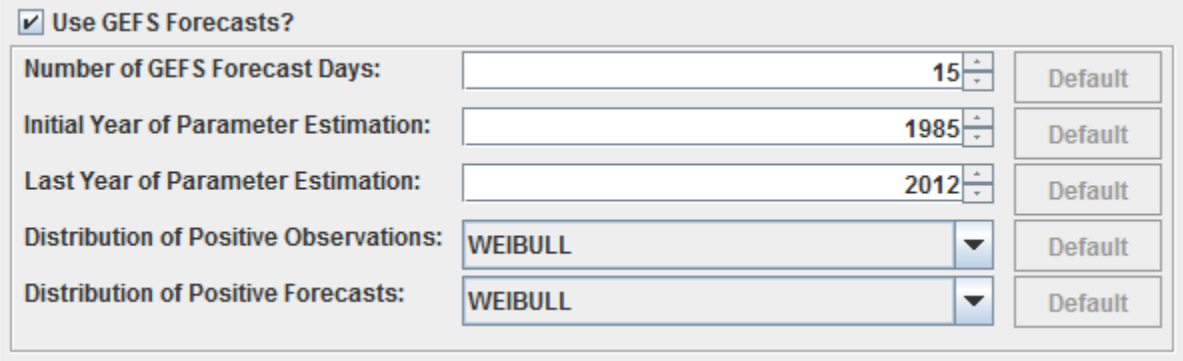
EXAMPLE: WPC QPF

The following time series diagnostics correspond to the WPC plugin forecast source and location GLOO2 at ABRFC:



3.7.2 Estimate Parameters

Parameter estimation is performed as usual. With the addition of the new plugin forecast source, a new set of estimation opions will be available within the **Estimation Options Subpanel** specific for that source that includes the following options:



The default value for the number of days, initial year, and last year options are defined via the reforecastPreparationSteps XML element of the forecastSourcesDefinition.xml file; see Section 4 for more information. Set the options appropriately before estimating parameters.

When estimating parameters for a new forecast source, if all of the general estimation options are left unchanged, then it is recommended that you estimate parameters only for the source being added. After clicking the **Perform Step Button**, in the **Continue? Dialog** that opens, select the new forecast source from the **Select Source for Parameter Estimation Choice Box** and click **Continue**.

3.8 *Install New Source in MEFPEnsembleGeneratorModelAdapter*

Make the source available to the MEFPEnsembleGeneratorModelAdapter, as per the instructions provided in Section 2.2.

3.9 *Test Ensemble Generation*

Using the newly estimated parameters generated during testing in Section 3.7, confirm that the MEFPEnsembleGeneratorModelAdapter is configured correctly by executing the appropriate HEFS or MEFP workflow. Execute the module in debug mode through the standard means:

- In the module configuration file, set the printDebugInfo run-file property to have value 1.
- Use the F12-option within the **Manual Forecast Dialog** to run the module in debug mode.

Locate the run directory created by executing in debug mode and open the file …/output/diag.xml. Look for lines that include the source id. Specifically, there should be a diagnostics line element that includes the text,

"Generating forecast ensemble … for the source <source id> Forecasts which has…"

Additional log-lines should indicate that parameters for the source were found and that forecast ensembles were generated for specific canonical events.

EXAMPLE: WPC QPF

For the WPC QPF plugin forecast source, the following lines confirm source parameters were found and read in from the parameter file

---

<line level="4" description="The current tar entry file WPCSourceModelParameters.meta.xml matches that expected for source WPC Forecasts; reading source parameters..."/>
<line level="4" description="Done reading tarred parameter files for source WPC Forecasts."/>

The following lines indicate that forecast ensembles were generated for the specific T0 and for specific canonical events:

<line level="3" description="Generating forecast ensemble for T0 2013-05-20 12:00:00 GMT for the source WPC Forecasts which has a number of forecast days set to 3..."/>
...
<line level="4" description="Generating and applying forecast ensemble for source WPC Forecasts and event CanonicalEvent(number = <xml number:20>, start = <xml startPeriod:12>, end = <xml endPeriod:12>, numens = <xml numberOfLaggedEnsembleMembers:5>) which has value 0.0 and correlation parameter -0.04905(-99 is always used for resampled climatology)."/>
<line level="4" description="Generating and applying forecast ensemble for source WPC Forecasts and event CanonicalEvent(number = <xml number:4>, start = <xml startPeriod:4>, end = <xml endPeriod:4>, numens = <xml numberOfLaggedEnsembleMembers:5>) which has value 33.391605377197266 and correlation parameter -0.00214(-99 is always used for resampled climatology)."/>
...

3.10 *Prepare Delivery for Other RFCs*

If the forecast source is to be delivered to other RFCs, then an appropriate release package must be developed.

For the MEFPPE, the following should be included:

- The complete reforecast import workflow and all associated module configuration files.
- Instructions for how to make changes to the global properties or region configuration files, such as Grids.xml, Locations.xml, ModuleInstanceDescriptors.xml, and WorkflowDescriptors.xml.
- Content to add to the <*MEFPPE run area*>/.systemFiles/forecastSourcesDefinition.xml file. Refer to Section 2.1 of this document as needed.

For the MEFPEnsembleGeneratorModelAdapter, the following should be included:

- Instructions or guidelines for how to acquire the operational forecast.
- Example operational forecast workflow and associated module configuration files.
- Instructions for how to make changes to the global properties or region configuration files, such as Grids.xml, Locations.xml, ModuleInstanceDescriptors.xml, and WorkflowDescriptors.xml.
- Instructions for how to include the forecast source in the MEFPEnsembleGeneratorModelAdatper module configuration files, referring to Section 2.2 of this document as needed.

The release package and instructions should be provided to other RFCs via email or through other appropriate means.

4 XML Instructions for forecastSourcesDefinition.xml

The reforecast preparation steps are specified within the XML element reforecastPreparationSteps in the forecastSourcesDefinition.xml file. The top level element of that file is forecastSources. One source XML element entry must be included as a sub-element for each forecast source to be made available to the MEFPPE and MEFPEnsembleGeneratorModelAdapter.

The reforecastPreparationSteps element, which is not necessary for the forecastSourcesDefinition.xml provided to the MEFPEnsembleGeneratorModelAdapter, is included within the source element:

```
<source class="ohd.hseb.hefs.mefp.sources.plugin.PluginForecastSource" id="WPC">
   <reforecastPreparationSteps ...>
…
   </reforecastPreparationSteps>
</source>
```

The reforecastPreparationSteps XML element is necessary for the MEFPPE for plugin forecast sources. However, it is not necessary for source elements corresponding to the default forecast sources: RFC, GEFS, CFSv2, and Historical (climatology).

In this section, instructions for specifying attributes and elements within the source and reforecastPreparationSteps XML elements are provided.

EXAMPLE: WPC-QPF

The following is a forecastSourcesDefinition.xml file that includes all default sources as well as the WPC plugin forecast source:

```
<forecastSources>
   <source class="ohd.hseb.hefs.mefp.sources.rfcfcst.RFCForecastSource" id="RFC" />
   <source class="ohd.hseb.hefs.mefp.sources.plugin.PluginForecastSource" id="WPC">

      <!-- WPC plugin requires reforecast acquisition instructions.  The other sources specified herein are default
           source with their reforecast acquisition instructions hardcoded in the source code. -->
      <reforecastPreparationSteps defaultNumberOfForecastDays="3" defaultInitialYear="2000" defaultLastYear="2013">

         <!-- ACQUIRE 12Z REFORECASTS -->
         <!-- The reforecastOutputBaseDirectory should be a local directory and must match the output directory for the export
              module in the workflow specified below. -->
         <!-- The "yes" combineReforecasts value tells the processor to combine reforecasts across all T0s into a single large
              file for each location, removing the T0-specific files. -->
         <reforecastAcquisitionInstructions stepId="AcquireReforecasts" stepDescription="Acquire 12Z reforecasts 2000 - 2013"
            reforecastOutputBaseDirectory="@writableOutputDirectoryOnLocalDisk@" combineReforecasts="yes">
            <sftpInstructions maxReconnects="10" maxWaitForPuttingFileInPlace="600000">
               <serverURL>165.92.28.41</serverURL>
               <userName>hefsdownload</userName>
               <password>2012</password>
```

```
            <serverDirectory>/home/hefsdownload/data/processedASCIIGrids/pluginData/wpc_qpf_processed/</serverDirectory>
               <fileNamePattern>*/*12.grb2</fileNamePattern>
               <!-- Must match the import directory used by the workflow below. -->
               <localDirectory>$IMPORT_FOLDER_WPC_REFORECASTS$</localDirectory>
            </sftpInstructions>
            <workflowInstructions maxWaitToExecute="30000" maxWaitForExecutionToComplete="30000">
               <workflowID>ImportMEFP-WPCGrids</workflowID>
            </workflowInstructions>
         </reforecastAcquisitionInstructions>

         <!-- COMBINE REFORECAST FILES ACQUIRED WITH THOSE ALREADY IN PLACE IN THE RUN AREA -->
         <!-- No outputDir element specified below indicates that combined file is placed in plugin data directory in the
             MEFPPE run area..-->
         <combineReforecastsInstructions stepId="PutReforecastFilesInPlace"
            stepDescription="Combine new reforecasts with current reforecasts" removeFilesAfterCombining="no">

            <!-- Specifies that files found in the default data directory for this plugin within the MEFPPE run area will be
                combined with those in the directory below, allowing for incremental changes to the reforecast file. -->
            <directory>OUTPUTDIR</directory>

            <!-- Must match the reforeastOutputBaseDirectory specified in the acquisition instructions above. -->
            <directory>@writableOutputDirectoryOnLocalDisk@</directory>
         </combineReforecastsInstructions>

      </reforecastPreparationSteps>
   </source>
   <source class="ohd.hseb.hefs.mefp.sources.gefs.GEFSForecastSource" id="GEFS" />
   <source class="ohd.hseb.hefs.mefp.sources.cfsv2.CFSv2ForecastSource" id="CFSv2" />
   <source class="ohd.hseb.hefs.mefp.sources.historical.HistoricalForecastSource" id="Historical" />
</forecastSources>
```

4.1 *Element: source [1…]*

A source XML element must be specified for each forecast source within the forecastSources XML element. It provides both a Java class that defines the forecast source and an id that identifies the forecast source within both the MEFPPE and the MEFPEnsembleGeneratorModelAdapter configuration file. The order of the source elements is important (see Sections 2.1.1 and 2.2.1.1).

For a plugin forecast source, the class attribute must always be ohd.hseb.hefs.mefp.sources.plugin.PluginForecastSource:

<source class="ohd.hseb.hefs.mefp.sources.plugin.PluginForecastSource" id=…

Attributes

Name	Data Type	Required?	Description
defaultNumberOfForecastDays	int (>0)	No	Specifies default value of estimation option for the number of forecast days. If not specified, the value is 0, meaning it is not used.
defaultInitialYear	int	No	Specifies the default value of estimation option for the initial year of data used in parameter estimation. If not specified, 1979 is used.
defaultLastYear	int	No	Specifies the default value of estimation option for the last year of data used in parameter estimation. If not specified, 2010 is used.

Sub-Elements

Name	Data Type	Required?	Description
reforecastPreparationSteps (1 instance)	N/A	No/Yes*	See Section 4.2.

* Only required for plugin forecast sources.

4.2 *Element: reforecastPreparationSteps [1]*

Defines the steps to perform in order to prepare reforecasts for use by MEFPPE. Any one of several types of steps can be performed, but the end goal must always be the following:

Location-specific PI-timeseries FastInfoset (.fi) files placed under the directory <*MEFPPE run area*>/pluginData/<source id attribute> and named as follows:

<locationId>.<"precipitation" or "temperature">.reforecasts.fi

EXAMPLE: WPC QPF
The following are files that may be seen at ABRFC for the locations GLOO2, CBNK1, and so on: <*MEFPPE run area*>/plugData/WPC GLOO2.precipitation.reforecasts.fi CBNK1.precipitation.reforecasts.fi …

Attributes

Name	Data Type	Required?	Description
class	String (word)	Yes	Specifies the Java class corresponding to the forecast source, which must be a subclass of ohd.hseb.hefs.mefp.sources.MEFPForecastSource. For plugin forecast sources, always set this attribute to ohd.hseb.hefs.mefp.sources.plugin.PluginForecastSource.
id	String	Yes	Short abbreviation or acronym to be used to identify the source within the MEFPPE and MEFPEnsembleGeneratorModelAdapter configuration files.

Sub-Elements

Name	Data Type	Required?	Description
combineReforecastsInstructions	N/A	No	See Section 4.2.2
moveReforecastFilesInstructions	N/A	No	See Section 4.2.3
multimodelConstructionInstructions	N/A	No	See Section 4.2.4
reforecastAcquisitionInstructions	N/A	No*	See Section 4.2.1 (this sub-element is described in the first subsection below since it is the most important sub-element)
systemCallInstructions	N/A	No	See Section 4.2.5

* Though the reforecastAcquisitionInstructions is not required by the software, in practice it is required unless a system call is used to acquire reforecast files.

Any number of instances of any of these sub-elements can be included in any order.

4.2.1 Element: reforeastAcquisitionInstructions [0…]

Specifies instructions for how to acquire reforecast files via SFTP and the workflow to execute that imports, spatially interpolates (if necessary), and export location-specific and T0-specific PI-timeseries files. Lastly, unless instructed not to do so, it will combine the T0-specific files into one location-specific PI-timeseries file containing all reforecast time series for that location. The name of that file will match that mentioned in Section 4.2 as required by MEFPPE.

The process followed by the MEFPPE to acquire and process reforecast files is as follows:

1. Connect to the SFTP server following instructions in sftpInstructions element.
2. Gather a list of files based on the serverDirectory and fileNamePattern elements in the sftpInstructions.
3. Acquire the first file and put it in the /tmp directory.
4. Move that file to the CHPS import directory as specified by the localDirectory element within the sftpInstructions and that must match that expected by the workflow to execute.
5. Simultaneously: (1) execute the workflow specified by the workflowInstructions element; (2) acquire the next reforecast file and put it in the /tmp directory.
6. When the workflow finishes, go to Step 4.
7. Stop the process when no more SFTP files can be acquired.

In addition to stopping when no more SFTP reforecast files are available for processing, the process will also stop (error out) if either the SFTP connection breaks and cannot be reconnected or the CHPS workflow takes too long to complete when processing a reforecast file. See the attributes listed in Sections 4.2.1.1 and 4.2.1.2.

Attributes

Name	Data Type	Req'd?	Description
stepId	String	Yes	Provides an id for the step. The id is displayed in the MEFPPE interface.
stepDescription	String	Yes	A description of the step. The description is displayed in the MEFPPE interface.
reforecastOutputBaseDirectory	String	No*	If not specified, it is assumed that the directory is the default <*MEFPPE run area*>/pluginData subdirectory specified in Section 4.2. The output directory where location-specific and T0-specific reforecast PI-timeseries files will be exported. This must match the directory to which the export module of the workflow to execute will export location-specific and T0-specific files. The export module must also create one subdirectory per location with the subdirectory name specifying the locationId. The MEFPPE will combine the T0-specific files into location-specific PI-timeseries files containing all reforecasts for that location (unless the combineReforecast attribute is set to "No"). Those location-specific files will be placed in this output directory and the location-specific directories will be removed.

Name	Data Type	Req'd?	Description
combineReforecasts	"Yes"/"No"	No	If not specified, the default value is "Yes". If "No" is used, then the T0-specific reforecast PI-timeseries files created by the SFTP-workflow process will not be combined into a single files corresponding to each location. Hence, the files will not be usable by MEFPPE. Therefore, it is recommended that a later reforecastAcquisitionInstructions XML element specify the same reforecastOutputBaseDirectory so that it will include those files in its combine process. For example, if a forecast source has both 0Z and 12Z reforecasts, it may be useful to process each of them independently via two SFTP-workflow processes, with the first using combineReforecasts of "No" and the second "Yes". Thus, the thousands of reforecast files are only combined one time after the second set of reforecast files is processed.

* Though not required, it is recommended that the directory be on a local disk relative to the machine on which MEFPPE is executing. The reason being that a significant amount of disk I/O will be performed, including reading and removing potentially thousands of files.

Sub-Elements

Name	Data Type	Required?	Description
sftpInstructions (1 instance)	N/A	Yes	See Section 4.2.1.1
workflowInstructions (1 instance)	N/A	Yes	See Section 4.2.1.2

4.2.1.1 Element: SFTPInstructions [1]

Provides instructions for SFTPing to acquire reforecast files.

Attributes

Name	Data Type	Req'd?	Description
maxReconnects	integer (>0)	No	If not specified, the value is 10. Specifies the number of attempts that will be made to reconnect to the SFTP server if it becomes disconnected while processing reforecasts. The reforecast preparation process will stop if this limit is exceeded.
maxWaitForPuttingFileInPlace	integer (>0)	No	If not specified, the value is 1,000 seconds. Specifies the number of milliseconds the MEFPPE will wait for the workflow to finish processing so that the next reforecast file can be moved from the /tmp directory to the import (local) directory. The reforecast preparation process will stop if this limit is exceeded.

Sub-Elements

Name	Data Type	Req'd?	Description
serverURL	String	Yes	The URL to which to connect.

Name	Data Type	Req'd?	Description
userName	String	Yes	The log-in user name to use. If connecting as the user executing MEFPPE, specify "me" as the userName. This is only appropriate if the reforecast files to acquire are located on a machine at your RFC.
password	String	Yes	The log-in password to use. If left empty, no password will be provided. This will only work if SSH keys are defined allowing for connecting to the server without specifying a password.
serverDirectory	String	Yes	The directory on the server under which reforecasts will be found.
fileNamePattern	String	Yes	The pattern matching the files to acquire. If the user were to log-in to the server, go to the serverDirectory, and perform an "ls" command with this pattern as its argument, it will list the files to acquire. Note that ls commands may sometimes fail because of the argument list being too long; i.e., too many files match the pattern. For the purposes of this listing, however, that is not a possibility, so do not worry about the argument list becoming too long.
localDirectory	String	Yes	The directory on your local machine where files will be placed after being acquired. They are moved into place after first being downloaded to the /tmp directory. This directory must match that expected by the import module within the workflow to be executed.

4.2.1.2 Element: WorkflowInstructions [1]

Provides instructions for executing the CHPS workflow to import, spatially interpolate, and export the reforecast files. The workflow must meet these requirements:

The import module of the workflow should import files from a directory that matches the localDirectory specified for the SFTPInstructions.

If present, the spatial-interpolation module of the workflow should match that employed operationally.

The export module must satisfy the following:

- It must output files to subdirectories under the reforecastOutputBaseDirectory specified as an attribute of reforecastAcquisitionInstructions.
- One subdirectory must be created per location with a name matching the appropriate locationId.
- Within each subdirectory, reforecast time series and ensembles are provided in .xml or .fi files such that each files contains time series for only one T0 (forecastDate time series header element).

Attributes

Name	Data Type	Req'd?	Description
maxWaitToExecute	Int (>0)	No	If not specified, the value is 30 seconds. Specifies how long MEFPPE will wait to execute the specified workflow after it completes; i.e., the amount of time it will wait for the next files to be acquired and put in the import directory. The preparation process will stop if this limit is exceeded.
maxWaitForExecutionToComplete	int (>0)	No	If not specified, the value is 30 seconds. Specifies how long MEFPPE will wait for the workflow to complete. The preparation process will stop if this limit is exceeded.

Sub-Elements

Name	Data Type	Req'd?	Description
workflowID	String	Yes	The workflowId of the CHPS workflow to execute.

EXAMPLE: WPC-QPF

```
<!-- The "yes" combineReforecasts value tells the processor to combine reforecasts across all T0s into a single large
     file for each location, removing the T0-specific files. -->
<reforecastAcquisitionInstructions stepId="AcquireReforecasts" stepDescription="Acquire 12Z reforecasts 2000 - 2013"
   reforecastOutputBaseDirectory="@writableOutputDirectoryOnLocalDisk@" combineReforecasts="yes">
   <sftpInstructions maxReconnects="10" maxWaitForPuttingFileInPlace="600000">
      <serverURL>165.92.28.41</serverURL>
      <userName>hefsdownload</userName>
      <password>2012</password>
  <serverDirectory>/home/hefsdownload/data/processedASCIIGrids/pluginData/wpc_qpf_processed/</serverDirectory>
      <fileNamePattern>*/*12.grb2</fileNamePattern>
      <!-- Must match the import directory used by the workflow below. -->
      <localDirectory>$IMPORT_FOLDER_WPC_REFORECASTS$</localDirectory>
   </sftpInstructions>
   <workflowInstructions maxWaitToExecute="30000" maxWaitForExecutionToComplete="30000">
      <workflowID>ImportMEFP-WPCGrids</workflowID>
   </workflowInstructions>
</reforecastAcquisitionInstructions>
```

4.2.2 Element: combineReforecastInstructions [0…]

Combines location-specific reforecast PI-timeseries files from multiple input directories, producing a file in an output directory. The following rules apply:

- All files combined must have a name that matches the format specified in Section 4.2. Files with any other names are ignored.
- When combining time series, those with the same locationId, parameterId, ensembleId, ensembleMemberIndex, and forecastDate XML elements are considered repeats. In that case, only the last such time series found among the specified input directories is included in the output file.
- The output directory (outputDir attribute) can be an input directory (directory sub-element), in which case the combination process results in adding new or changed reforecasts to an existing list of reforecasts. This is useful when the available reforecasts may change over time.

Attributes

Name	Data Type	Req'd?	Description
stepId	String	Yes	Provides an id for the step. The id is displayed in the MEFPPE interface.
stepDescription	String	Yes	A description of the step. The description is displayed in the MEFPPE interface.
outputDir	String	No	If not specified, it is assumed that the directory is the default <*MEFPPE run area*>/pluginData subdirectory specified in Section 4.2. After combining the reforecasts for a location, a single file named according to the format described in Section 4.2 will be created under the directory specified.
removeFilesAfterCombining	"Yes"/"No"	No	If not specified, "Yes" is the value. If "Yes", the files read in will be removed after the output file is successfully created.

Sub-Elements

Name	Data Type	Required?	Description
directory (1 or more instances)	String	Yes (at least one)	See the description; this specifies an input directory for the combination process. All files matching the name format specified in Section 4.2 will be processed. The order of these elements defines the order used for handling repeats. Reforeast time series found in files within directories provider later in the list are given higher priority when combining the files. See the bulleted-list of rules defined above. A value "OUTPUTDIR" to specify that the output directory is an input directory.

EXAMPLE: WPC-QPF

The following uses the default outputDir attribute value so that files are placed in the <MEFPPE run area>/pluginData subdirectory specified in Section 4.2.

```
<!-- COMBINE REFORECAST FILES ACQUIRED WITH THOSE ALREADY IN PLACE IN THE RUN AREA -->
<!-- No outputDir element specified below indicates that combined file is placed in plugin data directory in the
    MEFPPE run area..-->
<combineReforecastsInstructions stepId="PutReforecastFilesInPlace"
  stepDescription="Combine new reforecasts with current reforecasts" removeFilesAfterCombining="no">

  <!-- Specifies that files found in the default data directory for this plugin within the MEFPPE run area will be
      combined with those in the directory below, allowing for incremental changes to the reforecast file. -->
  <directory>OUTPUTDIR</directory>

  <!-- Must match the reforeastOutputBaseDirectory specified in the acquisition instructions above. -->
  <directory>@writableOutputDirectoryOnLocalDisk@</directory>
</combineReforecastsInstructions>
```

4.2.3 Element: moveReforecastFilesInstructions [0…]

Moves or copies files from one directory to another directory. Only files matching the name format specified in Section 4.2 are moved.

Attributes

Name	Data Type	Req'd?	Description
stepId	String	Yes	Provides an id for the step. The id is displayed in the MEFPPE interface.
stepDescription	String	Yes	A description of the step. The description is displayed in the MEFPPE interface.
type	"copy"/"move"	No	If not specified, a move is performed. Specifies if the step should copy or move the files from the fromDir to the toDir directory.

Sub-Elements

Name	Data Type	Required?	Description
fromDir (1 instance)	String	Yes	Specifies the directory from which files matching the name format specified in Section 4.2 will be moved or copied.
toDir (1 instance)	String	No	If not specified, it is assumed that the directory is the default <*MEFPPE run area*>/pluginData subdirectory specified in Section 4.2. Specifies the directory to where files are moved or copied.

EXAMPLE

```
<moveReforecastFilesInstructions stepId="BackupReforecastFiles" stepDescription="Move reforecast files to backup dir."
type="move">
    <fromDir>/awips/chps_local/hank/wpcReforecasts/ABRFC</fromDir>
    <toDir>/awips/chps_local/hank/wpcReforecasts/ABRFC.backup</toDir>
</moveReforecastFilesInstructions>
```

4.2.4 Element: multimodelConstructionInstructions [0…]

Combines location-specific reforecast PI-timeseries files from multiple input directories, constructing multi-model ensembles, and generating a single location-specific reforecast PI-timeseries file in an output directory. The following rules apply:

- All files combined must have a name that matches the format specified in Section 4.2. Files with any other names are ignored.
- The contents of identically named (location and data type specific) files are combined into multi-model ensembles as follows:
    - For the first directory provided, all location-specific files are processed. For each location-specific file, the time series are read in and those for the same T0 (forecastDate) are assumed to comprise an ensemble (see the Note below). The ensembles are then stored by T0 in a *master list* of ensembles and the process moves on to the next directory.
    - For each directory thereafter, all location-specific files are processed. For each location-specific file, the time series are read in. In the *master list* of ensembles for that location, if a T0 does not have a corresponding T0 in the file being processed, then it is removed. Otherwise, the time series with that T0 in the file being processed are added to the existing ensemble in the *master list* for that T0 as another member.
- The maximum lead-time of members in a multimodel ensemble can either be left unchanged or can be reduced to the smallest lead time of any one member. This is controlled via the attribute trimTimeSeriesToCommonLength.
- The resulting reforecast multi-model ensembles are output to location-specific files in the specified output directory named according to the format specified in Section 4.2.

When adding a time series to a multimodel ensemble, the following elements of the time series header must be identical: locationId, parameterId, forecastDate, startTime, qualifierId, ensembleId, timeStep. While attempting to add a new member to an existing ensemble, if any check fails, the current processing location-specific file will be skipped and the process will continue with the next file.

Attributes

Name	Data Type	Req'd?	Description
stepId	String	Yes	Provides an id for the step. The id is displayed in the MEFPPE interface.
stepDescription	String	Yes	A description of the step. The description is displayed in the MEFPPE interface.
outputDir	String	No	If not specified, it is assumed that the directory is the default <*MEFPPE run area*>/pluginData subdirectory specified in Section 4.2. All multi-model ensemble location-specific reforecast time series are output to files in this directory named according to the format specified in Section 4.2.

Name	Data Type	Req'd?	Description
removeFilesAfterCombining	"Yes"/"No"	No	If not specified, "Yes" is the value. If "Yes", the files read in will be removed after the output file is successfully created.
trimTimeSerisToCommonLength	"Yes"/"No"	No	If not specified, the value is "Yes". If Yes, then in constructing the multi-model ensemble, all members will be trimmed so that their maximum lead time is that of the shortest provided ensemble member. If No, the members will not be modified, so that they may possess different maximum lead times, implying different forecast periods.

Sub-Elements

Name	Data Type	Required?	Description
directory (1 or more instances)	String	Yes (at least one)	See the description; this specifies an input directory for the combination process. All files matching the name format specified in Section 4.2 will be processed. The order of these elements defines the order used for handling repeats. Reforeast time series found in files within directories provider later in the list are given higher priority when combining the files. See the bulleted-list of rules defined above.

EXAMPLE

```
<multimodelConstructionInstructions stepId="ConstructMultimodelEnsemble"
stepDescription="Combine reforecasts into multi-model ensembles for common T0s"
removeFilesAfterCombining="yes"
trimTimeSeriesToCommonLength="no">
   <directory>/awips/chps_local/hank/firstModel</directory>
   <directory>/awips/chps_local/hank/secondModel</directory>
   <directory>/awips/chps_local/hank/thirdModel</directory>
</multimodelConstructionInstructions>
```

4.2.5 Element: systemCallInstructions [0…]

Makes a system call, including a command specified by attribute systemCommand and arguments specified by argument XML elements.

Each time a system call is made, the environment is setup to match the current user environment. Any changes made by a previous system call will be discarded (i.e., one system call has no memory of changes made to the environment by previous system calls).

Attributes

Name	Data Type	Req'd?	Description
stepId	String	Yes	Provides an id for the step. The id is displayed in the MEFPPE interface.
stepDescription	String	Yes	A description of the step. The description is displayed in the MEFPPE interface.
systemCommand	String	Yes	The system command to execute, which may need to include the complete path if the command cannot be found in the user's environment.

Sub-Elements

Name	Data Type	Required?	Description
argument (1 or more instances)	String	No	An argument passed to the system call exactly as if it were added to the command line. The list provided by the argument elements are passed to the system command in order.

EXAMPLE

Performs an ls * command:

```
<!-- This is solely a pointless test of the system call feature.-->
<systemCallInstructions stepId="TestSystemCall" stepDescription="Calls ls *" systemCommand="ls">
   <argument>*</argument>
</systemCallInstructions>
```

5 Tips and Troubleshooting

This section will be added to as items are identified.