MEFP Configuration Guide

Forecast Components

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1 Overview

Generating MEFP ensemble operational forecasts requires the execution of two types of component workflows: (1) data ingest workflows to prepare gridded forecast inputs to MEFP (described in the document *MEFP Configuration Guide: Data Ingest Components*); and (2) a forecast workflow that generates forecast ensembles. For more information, see the *HEFS Software Getting Started Manual*.

Presented here are instructions for the following:

- Configuring number (2) above: a forecast workflow that generates forecast ensembles, specifically forecast ensembles of 6-hour FMAP and FMAT.
- Configuring the ensemble FMAP and FMAT output to be used as input to an ensemble streamflow forecast workflow.
- Preparing MEFP to be executed as part of a hindcast run.

In addition to installing software, adding MEFP forecasting components to CHPS requires adding and updating FEWS configuration files, and using the FEWS GUI to verify the installation is successful.

In cases where a configuration file is new and generic (valid for all RFCs), the file is included in the release-package and added to the configuration. For cases where a configuration change contains text that is specific to an RFC (new or existing file) a description of the text and/or a sample file is provided.

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.
- All command line entries are in this font.
- All important terms defined in the Section 1.2, Terminology, are *italicized*.

1.2 *Terminology*

- *installation standalone*: The standalone in which the MEFP forecast components will be installed, setup in Section 1.4.
- *installation forecast group* –or– *fgroup*: The forecast group determined in Section 1 of the *MEFP Configuration Guide: Data Ingest Components*. It will be denoted <*fgroup*> below when used in the name of a directory or file, except when referred to within a snippet of XML, in which case it will be referred to as *fgroup*; this is to avoid confusion with other uses of '<' and '>' in the XML syntax.
- *installation segment*: The id of the first segment for which MEFP is to execute, determined in Section 1 of the *MEFP Configuration Guide: Data Ingest Components*.

- *installation catchments*: The locationIds of all of the catchments within *the installation forecast group* for which MEFP must generate ensembles of FMAP and FMAT, determined in Section 1 of the *MEFP Configuration Guide: Data Ingest Components*.

1.3 *Directories of Note*

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

- <*region_dir*>: The *installation standalone* (see Section 1.4) region home directory, typically "##rfc_sa".
- <*configuration_dir*>: The standalone Config directory, typically <*region_dir*>/Config.
- <*tar_root_dir*>: The directory where the release package was untarred.
- <*mefp_root_dir*>: The directory selected to hold CFSv2 location time series files and MEFP parameter files; see the *MEFP Configuration Guide: Data Ingest Components*.

1.4 *Pre-installation Steps*

1. Install the HEFS release as described in the *HEFS Install Notes*.

2. Install the MEFP data ingest components as described in the *MEFP Configuration Guide: Data Ingest Components*. Data ingest is a necessary precursor to executing the MEFP operationally. Furthermore, the instructions therein define the *installation forecast group*, *installation segment*, and *installation catchments* (stations) for which the MEFP must execute and, therefore, parameters must be estimated. Specifically, the location sets defined via those instructions will be used herein. It also creates some directories needed for the installation below and creates the <*mefp_root_dir*> in which parameter files generated by the MEFPPE are stored.

- Data ingest is always required to provide input to the MEFP, but not all catchments for which the data ingest components are running must have the MEFP forecast components installed. In fact, it is recommended that the data ingest components be running for a catchment at least 20 days before MEFP is used to generate forecast ensembles for that catchment in order to build up an archive of CFSv2 location-specific time series files.

- If any step below states that something should have already been done or installed when installing the data ingest components, refer to *MEFP Configuration Guide: Data Ingest Components* accordingly.

3. Install the MEFPPE as described in the *MEFPPE Configuration Guide* and use the software to estimate parameters for the catchments for which MEFP must execute (see previous step). This must be done before confirming the installation in Section 2.3.

4. Create an *installation standalone* for initial installation of the MEFP forecast components. The standalone must include configuration files added as part of the installation of the data

ingest components (it may be the same standalone used therein). Configuration changes made here will later be ported to an OC for synchronization to the central server, but only after installation is successful on a standalone.

The *installation standalone* created here should not be the same as the *parameter estimation standalone* used for installation and configuration of the MEFPPE.

Installation instructions below will be based upon the segment, stations, and group identified during the installation of the data ingest components. Instructions for extrapolating to other segments, stations, and groups will be provided.

1.5 *Release Package*

As part of installing the HEFS release, the release package was acquired and untarred in a directory referred to in the *HEFS Install Notes* as *<tar_root_dir>*. Within this document, only the contents of the subdirectory mefp are used. The mefp subdirectory contents are as follows, with a description of each subdirectory:

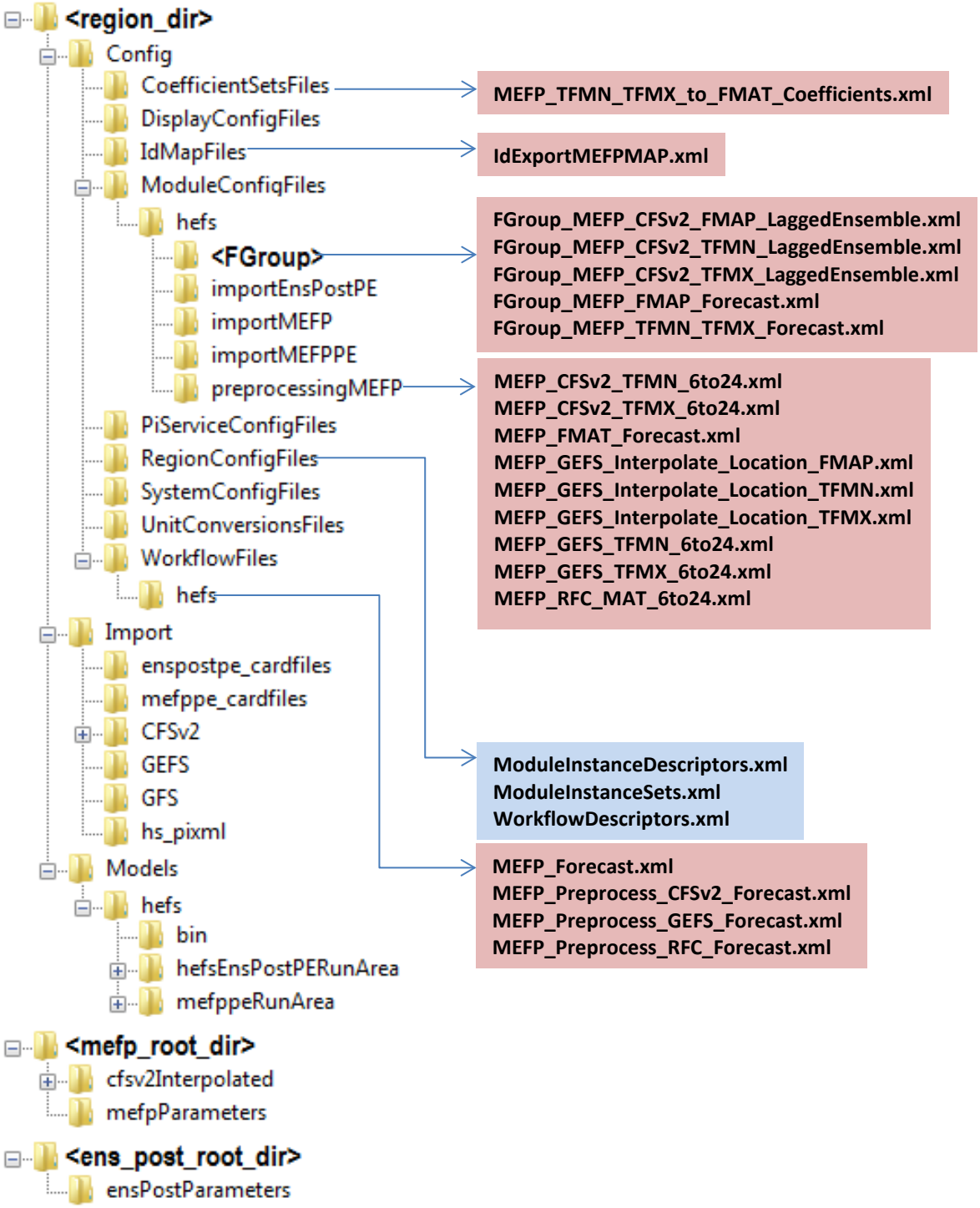
<tar_root_dir>/mefp/…
Config – Configuration files to be installed directly into the *installation standalone*.
samples – Sample files referred to in the instructions below as needed.

1.6 *Affected Configuration Files*

The diagram in Figure 1 summarizes all configuration files created or modified by the installation steps provided in this document. The directory structure shown includes all directories affected by any HEFS component. Files with a light red background are general across all RFCs, while those with a light blue background are specific to each RFC and require editing. Note the following:

- The directory "**<FGroup>**" was renamed during installation of the data ingest components to match the first forecast group for which MEFP will execute.
- The directory corresponding to **<mefp_root_dir>** was created during installation of the data ingest components and is pointed to by a global property.
- The directory corresponding to **<ens_post_root_dir>** is used by the EnsPost and EnsPostPE application and will not be used herein.
- The directories shown under **<region_dir>**/Import were created during installation of the data ingest components.

Figure 1: Configuration files created or modified during installation.



2 Installing MEFP Forecast Components

This section provides instructions for the following:

- Making needed additions and changes to configuration files in the *installation standalone*
- Verifying the installation of the MEFP forecast components in the standalone
- Synchronizing those changes with the central server

By the end of this section, all modules and workflows necessary for the MEFP to execute and generate ensembles will be put in place and verified.

In all sections that follow, changes that must be made to allow for additional segments and forecast groups to be added will be marked by the following: **TO ADD NEW SEGMENT** or **FORECAST GROUP**. The list of those tasks will be summarized in Section 3.

2.1 *Copy New Files and Directories (Required)*

Execute the following command to copy *all* new files and directories that are necessary for running the MEFP forecast components into the *installation standalone* directory structure

```
cd <tar_root_dir>/mefp
cp –r Config <region_dir>/.
```

No existing files are overwritten or removed by these commands. Most of the files and directories just copied will not be modified further. However, the files under <*configuration_dir*>/ModuleConfigFiles/hefs/FGroup will need to be moved and modified; see Section 2.2.1.

2.2 *Configuration File Changes (All Steps Required)*

Described in the following sections are changes that must be made to the configuration files to setup the MEFP Forecast.

2.2.1 Move and Modify Files Added in Step 2.1

Action: Move the contents of the FGroup directory to the directory <*fgroup*> which was created during the installation of the data ingest components. Change the file names to use the *installation forecast group* name instead of "FGroup". The *installation forecast group* is denoted below as <*fgroup*>:

```
cd <configuration_dir>/ModuleConfigFiles/hefs
mv FGroup/* <fgroup>/.  #The directory <fgroup> was created during install of data ingest components
rm –r FGroup
cd <fgroup>
mv FGroup_MEFP_CFSv2_FMAP_LaggedEnsemble.xml \
    <fgroup>_MEFP_CFSv2_FMAP_LaggedEnsemble.xml
mv FGroup_MEFP_CFSv2_TFMN_LaggedEnsemble.xml \
    <fgroup>_MEFP_CFSv2_TFMN_LaggedEnsemble.xml
mv FGroup_MEFP_CFSv2_TFMX_LaggedEnsemble.xml \
    <fgroup>_MEFP_CFSv2_TFMX_LaggedEnsemble.xml
mv FGroup_MEFP_FMAP_Forecast.xml \
    <fgroup>_MEFP_FMAP_Forecast.xml
mv FGroup_MEFP_TFMN_TFMX_Forecast.xml \
    <fgroup>_MEFP_TFMN_TFMX_Forecast.xml
```

Action: Modify all of the files under the directory <*region_dir*>/Config/ModuleConfigFiles/hefs/<*fgroup*> as follows:

Within each file, replace ALL instances of the text "FGroup" with the installation forecast group name, <*fgroup*>.

This modification will affect moduleInstanceIds and locationSetIds referred within these files:

<*configuration_dir*>/ModuleConfigFiles/hefs/<*fgroup*>/…
<*fgroup*>_MEFP_CFSv2_FMAP_LaggedEnsemble.xml
<*fgroup*>_MEFP_CFSv2_TFMN_LaggedEnsemble.xml
<*fgroup*>_MEFP_CFSv2_TFMX_LaggedEnsemble.xml
<*fgroup*>_MEFP_FMAP_Forecast.xml
<*fgroup*>_MEFP_TFMN_TFMX_Forecast.xml

Description: Certain model adapters must be executed by forecast group due to memory limitations. The "FGroup" files provided with the installation serve as a template and must be renamed appropriately upon installation. Text within those files must also be modified.

The module configuration file changes above assume that the appropriate locationSet was defined in the file <*configuration_dir*>/RegionConfigFiles/LocationSets.xml for the forecast group as part of the installation of the data ingest components.

TO ADD A NEW FORECAST GROUP

The actions to perform to add a new forecast group are similar to those above, except that the new files are created as copies of existing module configuration files for <*fgroup*>:

Action: Copy contents of the <*fgroup*> directory to create new files for the <*newgroup*>. The directory <*newgroup*> should have been created when adding the new forecast group for the data ingest components.

```
cd <configuration_dir>/ModuleConfigFiles/hefs/<fgroup>
cp <fgroup>_*LaggedEnsemble.xml ../<newgroup>/.
cp <fgroup>*_Forecast.xml ../<newgroup>/.
cd ../<newgroup>
mv <fgroup>_MEFP_CFSv2_FMAP_LaggedEnsemble.xml \
    <newgroup>_MEFP_CFSv2_FMAP_LaggedEnsemble.xml
mv <fgroup>_MEFP_CFSv2_TFMN_LaggedEnsemble.xml \
    <newgroup>_MEFP_CFSv2_TFMN_LaggedEnsemble.xml
mv <fgroup>_MEFP_CFSv2_TFMX_LaggedEnsemble.xml \
    <newgroup>_MEFP_CFSv2_TFMX_LaggedEnsemble.xml
mv <fgroup>_MEFP_FMAP_Forecast.xml \
    <newgroup>_MEFP_FMAP_Forecast.xml
mv <fgroup>_MEFP_TFMN_TFMX_Forecast.xml \
    <newgroup>_MEFP_TFMN_TFMX_Forecast.xml
```

Action: Do the same replacement as in the second **Action** above, but do the replacement in the just created files, replacing <*fgroup*> with <*newgroup*>.

2.2.2 Modify File Added in Step 2.1: MEFP_Preprocess_CFSv2_Forecast.xml

Action: Modify the workflow file for preprocessing CFSv2 time series:

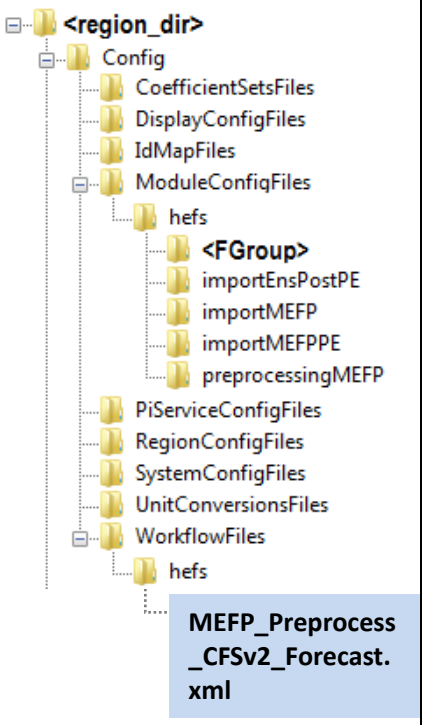
<*configuration_dir*>/WorkflowFiles/hefs/MEFP_Preprocess_CFSv2_Forecast.xml

Replace "FGroup" with the name of the installation forecast group, <*fgroup*>. See the example below for how the file should appear after making changes (the affected lines are in **bold**), replacing *fgroup* with the name of the *installation forecast group*.

Each affected line in the example is a single line of text, but may be forced to wrap because it cannot fit in the table below on one line.

Description: This workflow is executed to generate CFSv2 lagged ensembles for use in MEFP and aggregate those lagged ensembles as needed for MEFP execution. It includes three forecast-group specific module executions in addition to other transformations.

TO ADD A NEW FORECAST GROUP
This workflow is intended to generate lagged ensembles for all forecast groups for which MEFP will execute. After creating the new *LaggedEnsemble modules in Step 2.2.1, add activity XML elements to call those modules in this workflow. Copy and paste the existing three module activities for <*fgroup*> and modify appropriately for the new group.

Standard Location: <*configuration_dir*>**/WorkflowFiles/hefs/**	**Contents:** ***MEFP_Preprocess_CFSv2_Forecast.xml***
	<?xml version="1.0" encoding="UTF-8"?> <workflow 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/workflow.xsd" version="1.1"> <!-- IMPORTANT NOTE: Look for portions marked with the following: ***** FORECAST GROUP SPECIFIC ****** Those sections must be modified if forecast groups are changed or added for generating lagged ensmebles or executing MEFP. --> <!-- ========== --> <!-- CFSv2 --> <!-- ========== --> <!-- NOTE: The below does NOT compute the ensemble mean for CFSv2; that is handled by the MEFPEnsembleGeneratorModelAdapter since the number of members to include is depends upon the canonical event, which only MEFP knows about. --> <!-- ****** FORECAST GROUP SPECIFIC ****** --> <!-- Generate the CFSv2 6h lagged ensembles. This is done by group due to memory limitations of the adapter, so add one group of three modules per forecast group. --> <activity> <runIndependent>true</runIndependent> **<moduleInstanceId>*fgroup*_MEFP_CFSv2_FMAP_LaggedEnsemble</moduleInstanceId>** </activity> <activity> <runIndependent>true</runIndependent> **<moduleInstanceId>*fgroup*_MEFP_CFSv2_TFMN_LaggedEnsemble</moduleInstanceId>** </activity> <activity> <runIndependent>true</runIndependent> **<moduleInstanceId>*fgroup*_MEFP_CFSv2_TFMX_LaggedEnsemble</moduleInstanceId>** </activity> <!-- Aggregate the 6h CFSv2 temp data to 24h min and max. For each day, the min is over 18, 0, 6, and 12Z times. This means the first four values in the time series used for day 1 (after 12Z), second 4 for day 2, and so on. Note this is NOT done by group!--> <activity> <runIndependent>true</runIndependent> <moduleInstanceId>MEFP_CFSv2_TFMN_6to24</moduleInstanceId> </activity>

Standard Location: <*configuration_dir*>**/WorkflowFiles/hefs/**	**Contents:** ***MEFP_Preprocess_CFSv2_Forecast.xml***
	<activity> <runIndependent>true</runIndependent> <moduleInstanceId>MEFP_CFSv2_TFMX_6to24</moduleInstanceId> </activity> </workflow>

2.2.3 Modify File Added in Step 2.1: MEFP_Forecast.xml

Action: Modify the workflow file for executing MEFP to generate forecast ensembles:

<*configuration_dir*>/WorkflowFiles/hefs/MEFP_Forecast.xml

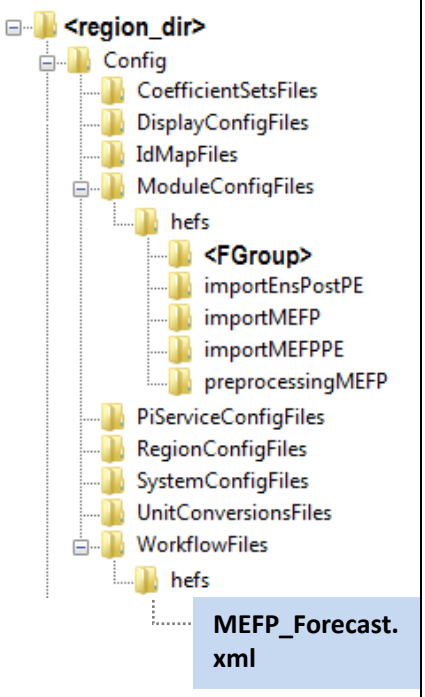
Replace "FGroup" with the name of the installation forecast group, <*fgroup*>. See the example below for how the file should appear after making changes (the affected lines are in **bold**), replacing *fgroup* with the name of the *installation forecast group*.

- Each affected line in the example is a single line of text, but may be forced to wrap because it cannot fit in the table below on one line.
- The activities related to preprocessing RFC QTF (not QPF) forecasts are commented out by default, because they are not used as part of the MEFP ensemble generation by default. See Section 2.2.5 and 2.2.6. If either forecast source is to be used, uncomment the appropriate activity XML element highlighted in the example below.

Description: This workflow is executed to generate MEFP forecast ensembles. It includes two forecast-group specific module executions in addition to other transformations.

TO ADD A NEW FORECAST GROUP
This workflow is intended to generate MEFP forecast ensembles for all forecast groups. After creating the new MEFP*Forecast modules in Step 2.2.1, add activity XML elements to call those modules in this workflow. Copy and paste the existing two module activities for <*fgroup*> and modify appropriately for the new group.

Standard Location:
<configuration_dir>/**WorkflowFiles/hefs/**



Contents:
MEFP_Forecast.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<workflow 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/workflow.xsd" version="1.1">

  <!-- IMPORTANT NOTE: Look for portions marked with the following:

       ***** FORECAST GROUP SPECIFIC ******

       Those sections must be modified if forecast groups are changed or added for
       generating lagged ensmebles or executing MEFP. -->

  <!-- ============================================== -->
  <!--              Preprocess Data                   -->
  <!-- ============================================== -->
  <!-- Uncomment this activity if RFC forecast source is to be used for
       temperature forecasting.-->
  <!--<activity>
      <runIndependent>true</runIndependent>
      <workflowId>MEFP_Preprocess_RFC_Forecast</workflowId>
  </activity>-->

  <activity>
    <runIndependent>true</runIndependent>
    <workflowId>MEFP_Preprocess_GEFS_Forecast</workflowId>
  </activity>
  <activity>
    <runIndependent>true</runIndependent>
    <workflowId>MEFP_Preprocess_CFSv2_Forecast</workflowId>
  </activity>


  <!-- ============================================== -->
  <!--           Generate MEFP Forecast               -->
  <!-- ============================================== -->

  <!-- ****** FORECAST GROUP SPECIFIC ****** -->
  <!-- Execute the MEFP to generate FMAP and TFMN, TFMX forecasts -->
  <!-- Add one activity per group and data type. -->
  <activity>
    <runIndependent>true</runIndependent>
    <moduleInstanceId>fgroup_MEFP_FMAP_Forecast</moduleInstanceId>
  </activity>
  <activity>
    <runIndependent>true</runIndependent>

<moduleInstanceId>fgroup_MEFP_TFMN_TFMX_Forecast</moduleInstanceId
>
  </activity>

  <!-- Converts all TFMN/TFMX data to FMAT forecast data
  for all groups at once. -->
  <activity>
```

Standard Location: <*configuration_dir*>**/WorkflowFiles/hefs/**	**Contents:** ***MEFP_Forecast.xml***
	<runIndependent>true</runIndependent> <moduleInstanceId>MEFP_FMAT_Forecast</moduleInstanceId> <ensemble> <ensembleId>MEFP</ensembleId> <runInLoop>true</runInLoop> </ensemble> </activity> </workflow>

2.2.4 Modify File Added in Step 2.1: MEFP_RFC_MAT_6to24.xml

Action: One of two actions must be done in this step pertaining to the file:

<*configuration_dir*>/ModuleConfigFiles/hefs/preprocessingMEFP/MEFP_RFC_MAT_6to24.xml

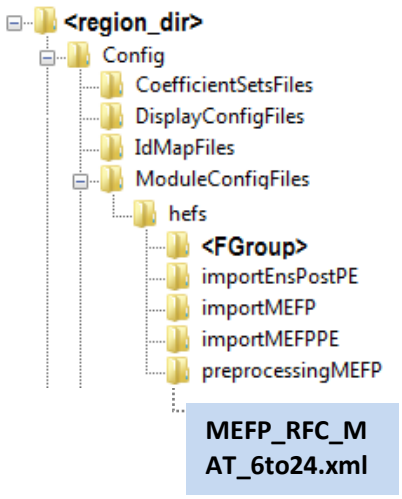
Option 1: If the RFC QTF source is being used as a forecast source for generating temperature ensembles, then modify the transformation in the file so that it uses the correct the 6-hour RFC QTF forecasts. See the example below which focuses on only the part of the module that must be changed. Change the highlighted timeSeriesSet XML element appropriately so that it specifies all RFC QTF 6-hour time series to be used as input to MEFP (focus on the moduleInstanceId, in particular, and make sure it is valid for your RFC). The transformation converts the 6-hour time series to 24-hour minimum and maximum temperature time series (parameterIds of TFMN and TFMX, respectively), which is the required input format for MEFP.

Option 2: If the RFC QTF source is not being used as a forecast source for generating temperature ensembles, then no modification is required (i.e., skip this step). By default, the RFC QTF forecast source is already *turned off* (see Section 6.1.2), so that it is not used.

- Each affected line in the example is a single line of text, but may be forced to wrap because it cannot fit in the table below on one line.
- Be sure to set the endOverrulable flag in the relativeViewPeriod XML element to be "false" so that the period covered by the time series is always the same regardless of the forecast workflow's forecast length.

Description: MEFP requires all input temperature forecasts to be 24-hour minimum/maximum temperature. This module converts 6-hour mean temperature forecasts appropriately. The 6-hour mean time series is assumed to specify values at 0, 6, 12, and 18Z. This file is deleted if the RFC forecast source for temperature is *completely removed*; see Section 6.1.2.

TO ADD A NEW FORECAST GROUP
Add to the timeSeriesSet XML element appropriately for any new forecast groups, as needed, but only if the RFC QTF forecast source is used.

Standard Location: <*configuration_dir*>**/ModuleConfigFiles/ hefs/preprocessingMEFP/**	**Contents:** ***MEFP_RFC_MAT_6to24.xml***
	<?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"> … <!-- Input variable: FMAT, or MAT in the future --> <variable> <variableId>rfc_fmat_6</variableId> **<timeSeriesSet>** **<moduleInstanceId>FGroup_MergeMAT_Forecast</moduleInstanceId>** **<valueType>scalar</valueType>** **<parameterId>MAT</parameterId>** **<locationSetId>Catchments_HEFS_FGroup</locationSetId>** **<timeSeriesType>simulated forecasting</timeSeriesType>** **<timeStep unit="hour" multiplier="6"/>** **<relativeViewPeriod unit="day" start="0" startOverrulable="true" end="6" endOverrulable="false"/>** **<readWriteMode>read only</readWriteMode>** **</timeSeriesSet>** </variable> … </transformationModule>

2.2.5 Modify File Renamed in Step 2.2.1: <*fgroup*>_MEFP_FMAP_Forecast.xml

Action: Modify the module that executes the MEFPEnsembleGeneratorModelAdapter to generate precipitation forecast ensembles:

<*configuration_dir*>/ModuleConfigFiles/hefs/<*fgroup*>/<*fgroup*>_MEFP_FMAP_Forecast.xml

See the example below, which shows the entire module configuration file. Do the following:

- Replace all instances of *fgroup* with the *installation forecast group* name, which should match the <*fgroup*> in the name of the file.
- If the RFC QPF forecast source is to be used (i.e., the RFC number of forecast days will be larger than 0), uncomment the first highlighted timeSeriesSet XML element. Modify it appropriately so that it specifies all RFC QPF 6-hour time series to be used as input to MEFP for the forecast group.
- Change the highlighted exportRunFileActivity element appropriately so that the properties specify the number of forecast days of each resource to be used as input to MEFP.

By default, only the GEFS and CFSv2 forecast sources are used. For general instructions on *turning off* or *completely removing* forecast sources, see Section 6.1.2.

- Each affected line in the example is a single line of text, but may be forced to wrap because it cannot fit in the table below on one line.

- For all exported timeSeriesSet XML elements, make sure that the endOverrulable flag in the relativeViewPeriod XML element to be "false" so that the time series exported to the MEFPEnsembleGeneratorModelAdapter is the same length regardless of the forecast length for the workflow.

- Do not remove or modify the "hindcasting" run file property. Using it as is makes it easy to let MEFP know that it is to run in hindcast mode. See Section 5.

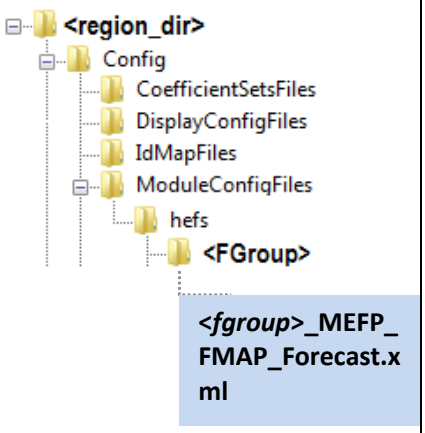
- When including the climatology forecast source, MEFP should only be used to generate resampled climatology (set climatologyNumberOfForecastDays to a desired value and leave the property useResampledClimatology as its default value "true"). If raw climatology is to be used, however, it is recommended that CHPS transformations be employed. In that case, make sure that the climatologyNumberOfForecastDays property is set to "0" in the exportRunFileActivities section (as is done below). Then see Section 4 for instructions on constructing a streamflow forecast workflow that is forced with raw climatology appended to the end of MEFP output.

Description: MEFP requires all RFC forecast source input precipitation forecasts to be 6-hour time series with either no qualifierId or a qualifierId of "RFC".

For details on the effects of run-file properties, including the ability to specify catchment-specific source number of forecast days, specifying the first and last year of generated ensemble members, and the order of precedence applied to the forecast sources when combining them into an MEFP generated forecast ensemble, see Section 4 of the *MEFP User's Manual*.

TO ADD A NEW FORECAST GROUP

Perform the same modification described here, but for the new forecast group. The name of the file to modify will be <*newgroup*>_MEFP_FMAP_Forecast.xml.

Standard Location: <*configuration_dir*>**/ModuleConfigurationFiles/hefs/<*fgroup*>/**	**Contents:** ***<fgroup>_MEFP_FMAP_Forecast.xml***
	<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"> <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%</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> <activities> <startUpActivities> </startUpActivities> <exportActivities> <exportTimeSeriesActivity> <exportFile>inputs.xml</exportFile> <timeSeriesSets> <!-- RFC QPF FMAP (future MAP, in this case) time series; uncomment if used. --> <!-- <timeSeriesSet> <moduleInstanceId>FMAP_PreProcessing_QPF</moduleInstanceId> <valueType>scalar</valueType> <parameterId>MAPX</parameterId> <locationSetId>Catchments_HEFS_*fgroup*</locationSetId> <timeSeriesType>simulated forecasting</timeSeriesType> <timeStep unit="hour" multiplier="6"/> <relativeViewPeriod unit="day" start="0" startOverrulable="true" end="5" endOverrulable="false"/> <readWriteMode>read only</readWriteMode>

Standard Location: <*configuration_dir*>**/ModuleConfigurationFiles/hefs/<*fgroup*>/**	**Contents:** **<*fgroup*>*_MEFP_FMAP_Forecast.xml***

```
                </timeSeriesSet>
-->
                <!-- GEFS FMAP Ensemble Mean -->
                <timeSeriesSet>

<moduleInstanceId>MEFP_GEFS_Interpolate_Location_FMAP</moduleInstanceId
>
                    <valueType>scalar</valueType>
                    <parameterId>FMAP</parameterId>
                    <qualifierId>GEFS</qualifierId>
                    <locationSetId>Catchments_HEFS_fgroup</locationSetId>
                    <timeSeriesType>external forecasting</timeSeriesType>
                    <timeStep unit="hour" multiplier="6"/>
                    <relativeViewPeriod unit="day" start="0" startOverrulable="true"
end="16" endOverrulable="false"/>
                    <readWriteMode>read only</readWriteMode>
                </timeSeriesSet>

                <!-- CFSv2 entire lagged ensemble -->
                <timeSeriesSet>

<moduleInstanceId>fgroup_MEFP_CFSv2_FMAP_LaggedEnsemble</moduleInst
anceId>
                    <valueType>scalar</valueType>
                    <parameterId>FMAP</parameterId>
                    <qualifierId>CFSv2</qualifierId>
                    <locationSetId>Catchments_HEFS_fgroup</locationSetId>
                    <timeSeriesType>external forecasting</timeSeriesType>
                    <timeStep unit="hour" multiplier="6"/>
                    <relativeViewPeriod unit="day" start="0" startOverrulable="true"
end="270" endOverrulable="false"/>
                    <readWriteMode>read only</readWriteMode>
                    <ensembleId>CFSv2</ensembleId>
                </timeSeriesSet>

            </timeSeriesSets>
        </exportTimeSeriesActivity>

        <exportRunFileActivity>
            <exportFile>%ROOT_DIR%/run_info.xml</exportFile>
            <properties>
                <int key="printDebugInfo" value="0"/>
                <string key=”hindcasting” value=”$MEFP_HINDCASTING$”/>
                <string key="parameterDir"
value="$MEFP_ROOT_DIR$/mefpParameters"/>
                <int key="rfcNumberOfForecastDays" value="0"/>
                <int key="gefsNumberOfForecastDays" value="15"/>
                <int key="cfsv2NumberOfForecastDays" value="270"/>
                <int key="climatologyNumberOfForecastDays" value="0"/>
                <string key="rfcUseEPT" value="true"/>
                <!-- do not change the following property -->
                <string key="useResampledClimatology" value="true"/>
                <int key="initialEnsembleYear" value="1961"/>
```

Standard Location: <*configuration_dir*>**/ModuleConfigurationFiles/hefs/<*fgroup*>/**	**Contents:** **<*fgroup*>*_MEFP_FMAP_Forecast.xml***

```
                <int key="lastEnsembleYear" value="1997"/>
                <string key="samplingTechnique" value="STRATIFIED_RANDOM"/>
            </properties>
        </exportRunFileActivity>
    </exportActivities>

    <executeActivities>
        <executeActivity>
            <command>

<className>ohd.hseb.hefs.mefp.adapter.MEFPEnsembleGeneratorModelAdapter
</className>
                <binDir>$HEFSBINDIR$</binDir>
            </command>
            <arguments>
                <argument>%ROOT_DIR%/run_info.xml</argument>
            </arguments>
            <timeOut>300000</timeOut>
        </executeActivity>
    </executeActivities>

    <importActivities>
        <importTimeSeriesActivity>
            <importFile>outputs.xml</importFile>
            <timeSeriesSets>
                <timeSeriesSet>

<moduleInstanceId>fgroup_MEFP_FMAP_Forecast</moduleInstanceId>
                    <valueType>scalar</valueType>
                    <parameterId>FMAP</parameterId>
                    <locationSetId>Catchments_HEFS_fgroup</locationSetId>
                    <timeSeriesType>external forecasting</timeSeriesType>
                    <timeStep unit="hour" multiplier="6"/>
                    <readWriteMode>add originals</readWriteMode>
                    <ensembleId>MEFP</ensembleId>
                </timeSeriesSet>
            </timeSeriesSets>
        </importTimeSeriesActivity>
    </importActivities>

  </activities>
</generalAdapterRun>
```

2.2.6 Modify File Renamed in Step 2.2.1: <*fgroup*>_MEFP_TFMN_TFMX_Forecast.xml

Action: Modify the module that executes the MEFPEnsembleGeneratorModelAdapter to generate temperature forecast ensembles:

<*configuration_dir*>/ModuleConfigFiles/hefs/<*fgroup*>/<*fgroup*>_MEFP_TFMN_TFMX_Forecast.xml

See the example below, which shows the entire module configuration file. Do the following:

- Replace all instances of *fgroup* with the *installation forecast group* name, which should match the <*fgroup*> in the name of the file.
- If the RFC QTF forecast source is to be used (i.e., the RFC number of forecast days will be larger than 0), uncomment the first pair of highlighted timeSeriesSet XML elements. Replace the two instances of *fgroup* with the *installation forecast group* name. Be sure to complete the step in Section 2.2.4 appropriately given the forecast source is being used.
- Change the highlighted exportRunFileActivity element appropriately so that the properties specify the number of forecast days of each resource to be used as input to MEFP.

By default, only the GEFS and CFSv2 forecast sources are used. For general instructions on *turning off* or *completely removing* forecast sources, see Section 6.1.2.

- Each affected line in the example is a single line of text, but may be forced to wrap because it cannot fit in the table below on one line.

- For all exported timeSeriesSet XML elements, make sure that the endOverrulable flag in the relativeViewPeriod XML element to be "false" so that the time series exported to the MEFPEnsembleGeneratorModelAdapter is the same length regardless of the forecast length for the workflow.

- Do not remove or modify the "hindcasting" run file property. Using it as is makes it easy to let MEFP know that it is to run in hindcast mode. See Section 5.

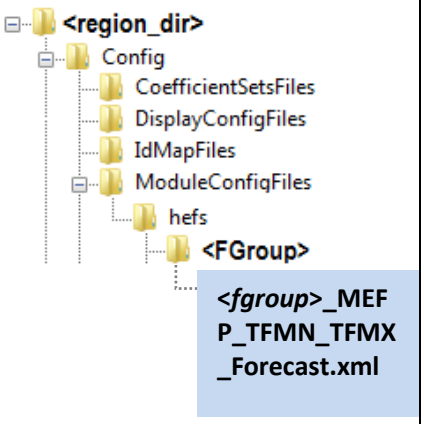
- When including the climatology forecast source, MEFP should only be used to generate resampled climatology (set climatologyNumberOfForecastDays to a desired value and leave the property useResampledClimatology as its default value "true"). If raw climatology is to be used, however, it is recommended that CHPS transformations be employed. In that case, make sure that the climatologyNumberOfForecastDays property is set to "0" in the exportRunFileActivities section (as is done below). Then see Section 4 for instructions on constructing a streamflow forecast workflow that is forced with raw climatology appended to the end of MEFP output.

Description: For details on the effects of run-file properties, including the ability to specify catchment-specific source number of forecast days, specifying the first and last year of generated

ensemble members, and the order of precedence applied to the forecast sources when combining them into an MEFP generated forecast ensemble, see Section 4 of the *MEFP User's Manual*.

TO ADD A NEW FORECAST GROUP

Perform the same modification described here, but for the new forecast group. The name of the file to modify will be <*newgroup*>_MEFP_TFMN_TFMX_Forecast.xml.

Standard Location: <*configuration_dir*>/**ModuleConfigurationFiles/hefs/<*fgroup*>/**	**Contents:** ***<fgroup>_MEFP_TFMN_TFMX_Forecast.xml***
	<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"> <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%</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> <activities> <startUpActivities> </startUpActivities> <exportActivities> <exportTimeSeriesActivity> <exportFile>inputs.xml</exportFile> <timeSeriesSets> <!-- RFC FMAT (future MAT, in this case) time series; uncomment if used. --> <!-- <timeSeriesSet> <moduleInstanceId>MEFP_RFC_MAT_6to24</moduleInstanceId> <valueType>scalar</valueType> <parameterId>TFMN</parameterId> <locationSetId>Catchments_HEFS_*fgroup*</locationSetId> <timeSeriesType>simulated forecasting</timeSeriesType> <timeStep id="12Z"/> <relativeViewPeriod unit="day" start="0" startOverrulable="true" end="5" endOverrulable="false"/> <readWriteMode>read only</readWriteMode> </timeSeriesSet> <timeSeriesSet> <moduleInstanceId>MEFP_RFC_MAT_6to24</moduleInstanceId> <valueType>scalar</valueType>

Standard Location: <*configuration_dir*>/**ModuleConfigurationFiles/hefs/**<***fgroup***>**/**	**Contents:** <***fgroup***>***_MEFP_TFMN_TFMX_Forecast.xml***

```
                <parameterId>TFMX</parameterId>
                <locationSetId>Catchments_HEFS_fgroup</locationSetId>
                <timeSeriesType>simulated forecasting</timeSeriesType>
                <timeStep id="12Z"/>
                <relativeViewPeriod unit="day" start="0" startOverrulable="true"
end="5" endOverrulable="false"/>
                <readWriteMode>read only</readWriteMode>
              </timeSeriesSet>
-->

            <!-- CFSv2 TFMN/TFMX Lagged Ensemble -->
            <timeSeriesSet>

<moduleInstanceId>MEFP_CFSv2_TFMN_6to24</moduleInstanceId>
              <valueType>scalar</valueType>
              <parameterId>TFMN</parameterId>
              <qualifierId>CFSv2</qualifierId>
              <locationSetId>Catchments_HEFS_fgroup</locationSetId>
              <timeSeriesType>external forecasting</timeSeriesType>
              <timeStep id="12Z"/>
              <relativeViewPeriod unit="day" start="0" startOverrulable="true"
end="270" endOverrulable="true"/>
              <readWriteMode>read only</readWriteMode>
              <ensembleId>CFSv2</ensembleId>
            </timeSeriesSet>
            <timeSeriesSet>

<moduleInstanceId>MEFP_CFSv2_TFMX_6to24</moduleInstanceId>
              <valueType>scalar</valueType>
              <parameterId>TFMX</parameterId>
              <qualifierId>CFSv2</qualifierId>
              <locationSetId>Catchments_HEFS_fgroup</locationSetId>
              <timeSeriesType>external forecasting</timeSeriesType>
              <timeStep id="12Z"/>
              <relativeViewPeriod unit="day" start="0" startOverrulable="true"
end="270" endOverrulable="true"/>
              <readWriteMode>read only</readWriteMode>
              <ensembleId>CFSv2</ensembleId>
            </timeSeriesSet>

          </timeSeriesSets>
        </exportTimeSeriesActivity>

        <exportRunFileActivity>
          <exportFile>%ROOT_DIR%/run_info.xml</exportFile>
          <properties>
            <int key="printDebugInfo" value="0"/>
            <string key="hindcasting" value="$MEFP_HINDCASTING$"/>
            <string key="parameterDir"
value="$MEFP_ROOT_DIR$/mefpParameters"/>
            <int key="rfcNumberOfForecastDays" value="0"/>
            <int key="gefsNumberOfForecastDays" value="15"/>
            <int key="cfsv2NumberOfForecastDays" value="270"/>
```

Standard Location: <*configuration_dir*>**/ModuleConfigurationFiles/hefs/<*fgroup*>/**	**Contents:** ***<fgroup>_MEFP_TFMN_TFMX_Forecast.xml***

```
                <int key="climatologyNumberOfForecastDays" value="0"/>
                <string key="useEPT.RFC" value="true"/>
                <!-- do not chang the following property -->
                <string key="useResampledClimatology" value="true"/>
                <int key="initialEnsembleYear" value="1961"/>
                <int key="lastEnsembleYear" value="1997"/>
              </properties>
            </exportRunFileActivity>
          </exportActivities>

          <executeActivities>
            <executeActivity>
              <command>

<className>ohd.hseb.hefs.mefp.adapter.MEFPEnsembleGeneratorModelAdapter
</className>
                <binDir>$HEFSBINDIR$</binDir>
              </command>
              <arguments>
                <argument>%ROOT_DIR%/run_info.xml</argument>
              </arguments>
              <timeOut>300000</timeOut>
            </executeActivity>
          </executeActivities>

          <importActivities>
            <importTimeSeriesActivity>
              <importFile>outputs.xml</importFile>
              <timeSeriesSets>
                <timeSeriesSet>

<moduleInstanceId>fgroup_MEFP_TFMN_TFMX_Forecast</moduleInstanceId>
                  <valueType>scalar</valueType>
                  <parameterId>TFMN</parameterId>
                  <locationSetId>Catchments_HEFS_fgroup</locationSetId>
                  <timeSeriesType>external forecasting</timeSeriesType>
                  <timeStep times="12:00"/>
                  <readWriteMode>add originals</readWriteMode>
                  <ensembleId>MEFP</ensembleId>
                </timeSeriesSet>
                <timeSeriesSet>

<moduleInstanceId>fgroup_MEFP_TFMN_TFMX_Forecast</moduleInstanceId>
                  <valueType>scalar</valueType>
                  <parameterId>TFMX</parameterId>
                  <locationSetId>Catchments_HEFS_fgroup</locationSetId>
                  <timeSeriesType>external forecasting</timeSeriesType>
                  <timeStep times="12:00"/>
                  <readWriteMode>add originals</readWriteMode>
                  <ensembleId>MEFP</ensembleId>
                </timeSeriesSet>
              </timeSeriesSets>
            </importTimeSeriesActivity>
```

Standard Location: <*configuration_dir*>**/ModuleConfigurationFiles/hefs/<*fgroup*>/**	**Contents:** ***<fgroup>_MEFP_TFMN_TFMX_Forecast.xml***
	</importActivities> </activities> </generalAdapterRun>

2.2.7 Modify Existing File: ModuleInstanceDescriptors.xml

Action: Define new module instance descriptors in the file:

<*configuration_dir*>/RegionConfigFiles/ModuleInstanceDescriptors.xml

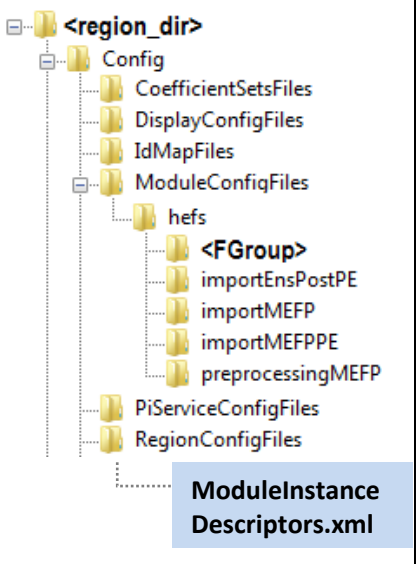
See the example below for text to use, replacing *fgroup* with the name of the *installation forecast group*. A sample (using FGroup instead of *fgroup*) is provided in the following file:

<*tar_root_dir*>/mefp/samples/Config/RegionConfigFiles/ModuleInstanceDescriptors.xml

Description: The added modules are used to interpolate GEFS forecast grids to locations and aggregate the time series appropriately; generate CFSv2 lagged ensembles and aggregate the time series appropriately; execute the MEFP to generate precipitation and minimum/maximum temperature forecast ensembles; and apply a diurnal pattern to disaggregate the 24-hour minimum/maximum temperature ensembles to 6h mean FMAT time series.

TO ADD A NEW FORECAST GROUP

Add descriptors necessary for any new modules created following steps in Section 2.2.1. Copy the existing descriptors specific for <*fgroup*> and modify the moduleInstanceDescriptor XML element appropriately for the new forecast group.

Standard Location: <*configuration_dir*>**/RegionConfigFiles/**	**Contents:** ***ModuleInstanceDescriptors.xml***
	<?xml version="1.0" encoding="UTF-8"?> <moduleInstanceDescriptors 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/moduleInstanceDescriptors.xsd" version="1.0"> … **<!-- BEGIN MEFP Forecast Components ========== -->** **<!-- MEFP Operational Forecast Modules: Prepare input time series and execute MEFP operationally. -->** **<!-- GEFS related modules: Grid to locations to needed time steps. -->** **<moduleInstanceDescriptor id="MEFP_GEFS_Interpolate_Location_FMAP">** **<moduleId>TransformationModule</moduleId>** **</moduleInstanceDescriptor>** **<moduleInstanceDescriptor id="MEFP_GEFS_Interpolate_Location_TFMN">** **<moduleId>TransformationModule</moduleId>** **</moduleInstanceDescriptor>** **<moduleInstanceDescriptor id="MEFP_GEFS_Interpolate_Location_TFMX">** **<moduleId>TransformationModule</moduleId>** **</moduleInstanceDescriptor>** **<moduleInstanceDescriptor id="MEFP_GEFS_TFMN_6to24">**

Standard Location: <*configuration_dir*>**/RegionConfigFiles/**	**Contents:** ***ModuleInstanceDescriptors.xml***

```
      <moduleId>TransformationModule</moduleId>
   </moduleInstanceDescriptor>
   <moduleInstanceDescriptor id="MEFP_GEFS_TFMX_6to24">
      <moduleId>TransformationModule</moduleId>
   </moduleInstanceDescriptor>

   <moduleInstanceDescriptor
      id="fgroup_MEFP_CFSv2_FMAP_LaggedEnsemble">
      <moduleId>GeneralAdapter</moduleId>
   </moduleInstanceDescriptor>
   <moduleInstanceDescriptor
      id="fgroup_MEFP_CFSv2_TFMN_LaggedEnsemble">
      <moduleId>GeneralAdapter</moduleId>
   </moduleInstanceDescriptor>
   <moduleInstanceDescriptor
      id="fgroup_MEFP_CFSv2_TFMX_LaggedEnsemble">
      <moduleId>GeneralAdapter</moduleId>
   </moduleInstanceDescriptor>
   <moduleInstanceDescriptor id="MEFP_CFSv2_TFMN_6to24">
      <moduleId>TransformationModule</moduleId>
   </moduleInstanceDescriptor>
   <moduleInstanceDescriptor id="MEFP_CFSv2_TFMX_6to24">
      <moduleId>TransformationModule</moduleId>
   </moduleInstanceDescriptor>

   <!-- RFC related modules: Temperature to appropriate time step. -->
   <moduleInstanceDescriptor id="MEFP_RFC_MAT_6to24">
      <moduleId>TransformationModule</moduleId>
   </moduleInstanceDescriptor>

   <!-- Modules to run the MEFP operationally. -->
   <moduleInstanceDescriptor id="fgroup_MEFP_FMAP_Forecast">
      <moduleId>GeneralAdapter</moduleId>
   </moduleInstanceDescriptor>
   <moduleInstanceDescriptor id="fgroup_MEFP_TFMN_TFMX_Forecast">
      <moduleId>GeneralAdapter</moduleId>
   </moduleInstanceDescriptor>

   <!-- Module to postprocess the TFMN/TFMX into a 6h FMAT. -->
   <moduleInstanceDescriptor id="MEFP_FMAT_Forecast">
      <moduleId>TransformationModule</moduleId>
   </moduleInstanceDescriptor>

   <!-- END MEFP Forecast Components ========================== -->
...
</moduleInstanceDescriptors>
```

2.2.8 Modify Existing File: WorkflowDescriptors.xml

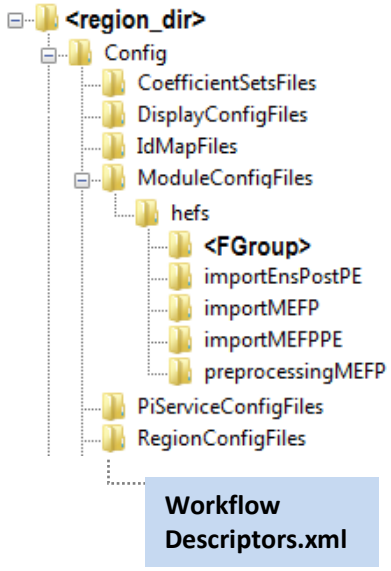
Action: Define new workflow descriptors in the file:

<configuration_dir>/RegionConfigFiles/WorkflowDescriptors.xml

See the example below for text to use. A sample is provided in the following file:

<tar_root_dir>/mefp/samples/Config/RegionConfigFiles/WorkflowDescriptors.xml

Description: The added workflows are used to prepare RFC, GEFS, and CFSv2 time series for usage in MEFP and to execute MEFP to generate forecast ensembles.

Standard Location: *<configuration_dir>*/**RegionConfigFiles/**	**Contents:** ***WorkflowDescriptors.xml***
	<?xml version="1.0" encoding="UTF-8"?> <workflowDescriptors 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/workflowDescriptors.xsd" version="1.0"> … **<!-- BEGIN MEFP Forecast Components ========== -->** **<!-- MEFP-specific workflows -->** **<workflowDescriptor id="MEFP_Forecast" forecast="true" visible="true"** **name="MEFP_Forecast" allowApprove="false">** **<description>Generate MEFP ensembles</description>** **<runExpiryTime unit="hour" multiplier="24"/>** **</workflowDescriptor>** **<!-- These workflows are executed as part of MEFP_Forecast and do not need their own runExpiryTimes. -->** **<workflowDescriptor id="MEFP_Preprocess_RFC_Forecast"** **forecast="true" visible="false"** **name="MEFP_Preprocess_RFC_Forecast" allowApprove="false">** **<description>Preprocess RFC data for use in MEFP</description>** **</workflowDescriptor>** **<workflowDescriptor id="MEFP_Preprocess_GEFS_Forecast"** **forecast="true" visible="false"** **name="MEFP_Preprocess_GEFS_Forecast" allowApprove="false">** **<description>Preprocess GEFS data for use in MEFP</description>** **</workflowDescriptor>** **<workflowDescriptor id="MEFP_Preprocess_CFSv2_Forecast"** **forecast="true" visible="false"** **name="MEFP_Preprocess_CFSv2_Forecast" allowApprove="false">** **<description>Preprocess CFSv2 data for use in MEFP</description>** **</workflowDescriptor>** **<!-- END MEFP Forecast Components ========== -->** … </workflowDescriptors>

2.2.9 Modify Existing File: ModuleInstanceSets.xml

Action: Define new module instance sets to contain the forecast group specific *LaggedEnsemble and MEFP*Forecast modules:

<*configuration_dir*>/RegionConfigFiles/ModuleInstanceSets.xml

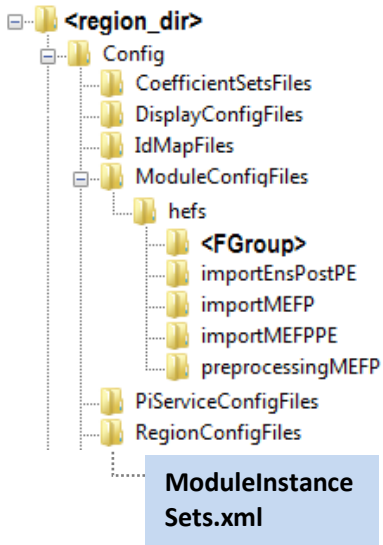
See the example below for text to use, replacing *fgroup* with the name of the *installation forecast group*. A sample (using FGroup instead of *fgroup*) is provided in the following file:

<*tar_root_dir*>/mefp/samples/Config/RegionConfigFiles/ModuleInstanceSets.xml

Each moduleInstanceId XML element is a single line of text, but may be forced to wrap because it cannot fit in the table below on one line.

Description: The added workflows are used to define module instance sets referred to in other module configuration files required for MEFP.

TO ADD A NEW FORECAST GROUP
Add entries in the module instance sets for any new modules created following steps in Section 2.2.1. Copy the existing entries in each set specific for <*fgroup*> and modify the moduleInstanceId XML element appropriately for the new forecast group.

Standard Location: <*configuration_dir*>**/RegionConfigFiles/**	**Contents:** ***ModuleInstanceSets.xml***
	<?xml version="1.0" encoding="UTF-8"?> <moduleInstanceSets 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/moduleInstanceSets.xsd" version="1.1"> … **<!-- BEGIN MEFP Forecast Components ========== -->** **<!-- Need for MEFP -->** **<moduleInstanceSet id="ALL_MEFP_Forecasts"** **name="ALL MEFP Forecasts">** **<!-- Add group specific entries for FMAP. For FMAT,** **only one entry needed, already included below.-->** **<moduleInstanceId>*fgroup*_MEFP_FMAP_Forecast</moduleInstanceId>** **<moduleInstanceId>MEFP_FMAT_Forecast</moduleInstanceId>** **</moduleInstanceSet>** **<moduleInstanceSet id="ALL_MEFP_CFSv2_TFMN_LaggedEnsembles"** **name="ALL CFSv2 TFMN LaggedEnsemble Modules">** **<!-- Add group specific entries. Used by module** **MEFP_CFSv2_TFMN_6to24.-->**

Standard Location: <*configuration_dir*>**/RegionConfigFiles/**	**Contents:** ***ModuleInstanceSets.xml***
	<moduleInstanceId>*fgroup*_MEFP_CFSv2_TFMN_LaggedEnsemble</moduleInstanceId> **</moduleInstanceSet>** **<moduleInstanceSet id="ALL_MEFP_CFSv2_TFMX_LaggedEnsembles"** **name="ALL CFSv2 TFMX LaggedEnsemble Modules">** **<!-- Add group specific entries. Used by module** **MEFP_CFSv2_TFMX_6to24.-->** **<moduleInstanceId>*fgroup*_MEFP_CFSv2_TFMX_LaggedEnsemble</moduleInstanceId>** **</moduleInstanceSet>** **<moduleInstanceSet id="ALL_MEFP_TFMN_TFMX_Forecasts"** **name="ALL MEFP Forecasts">** **<!-- Add group specific entries. Used by module** **MEFP_FMAT_Forecast.-->** **<moduleInstanceId>*fgroup*_MEFP_TFMN_TFMX_Forecast</moduleInstanceId>** **</moduleInstanceSet>** **<!-- END MEFP Forecast Components ========== -->** … </moduleInstanceSets>

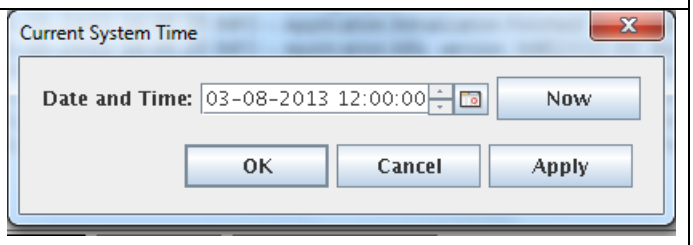
2.3 *Confirm Configuration*

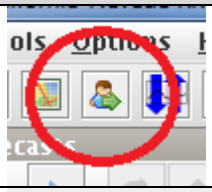
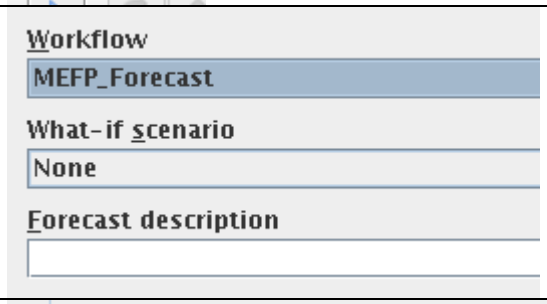
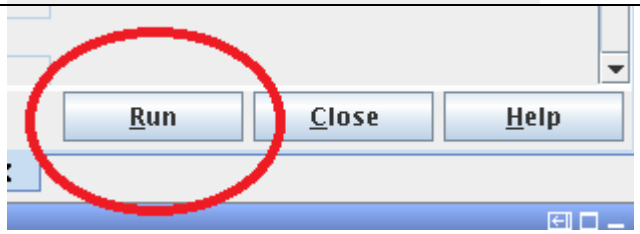
Described below are steps to perform to test that the installation was successful. This requires that the data ingest components have been installed, and for at least one forecast time (T0, system time) the following gridded forecasts must be present (imported using the data ingest components):

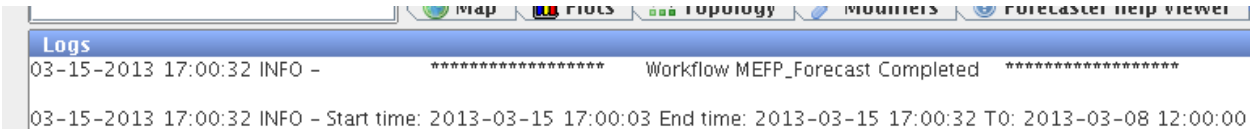
- GEFS: Same day as T0, but at 00Z; gridded forecasts must have be in the localDataStore of the *installation standalone*.
- CFSv2: Day prior to T0 at 12Z; CFSv2 location-specific time series files must have been exported to files under the directory <*mefp_root_dir*>/cfsv2Interpolated for the *installation catchments*.

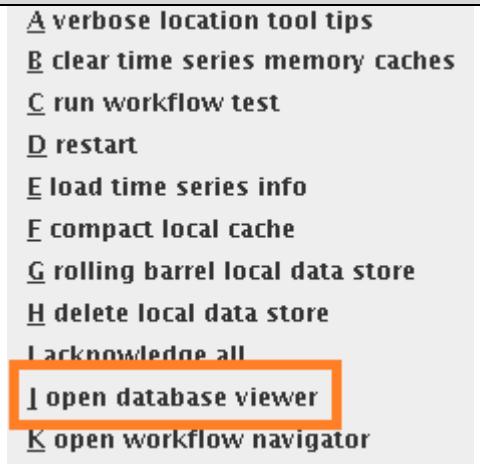
That forecast time will be used for testing in the steps presented below (Step 2). Furthermore, parameters must have been estimated for the *installation catchments* with appropriately named parameter files under <*mefp_root_dir*>/mefpParameters.

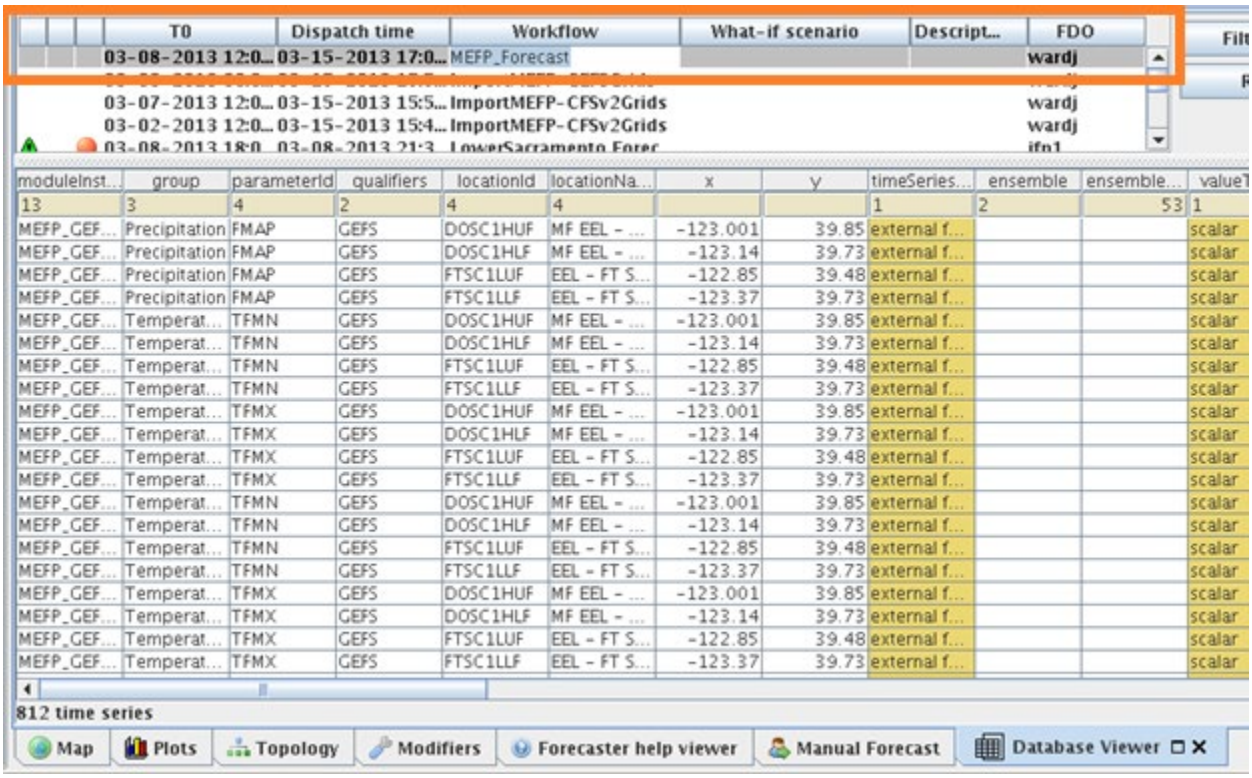
This confirmation will not include the RFC forecast source, since most RFCs will not use it. For the RFC forecast source to be used, it may be necessary to perform Steps 2.2.4, 2.2.5, and/or 2.2.6 to turn on the source (uncomment the timeSeriesSet XML) and specify an appropriate RFC time series to use as input for operational forecasting. Additionally, run-information properties must be modified to turn on the RFC forecast source; see the *MEFP User's Manual* for instructions on how to configure the MEFPEnsembleGeneratorModelAdapter.

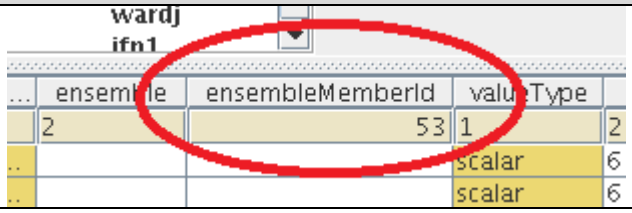
#	Action	Expected Results
1	Start FEWS using the installation standalone: ***cd*** <*region_dir*> ***cd ..*** ***./ohdPlugins/fews_ohdPlugins.sh.rboff ##rfc_sa &*** The *.rboff script is used for testing purposes.	FEWS will be started. The splash screen displayed will vary by RFC. The default splash screen is:  After a short time, the CHPS interface will open.
2	Only perform this step if the current system time is not correct for testing. Click on the **Current system time Label** at the bottom of the CHPS interface so that the **Current System Time Dialog** opens. Set the system time appropriately and click **OK**.	

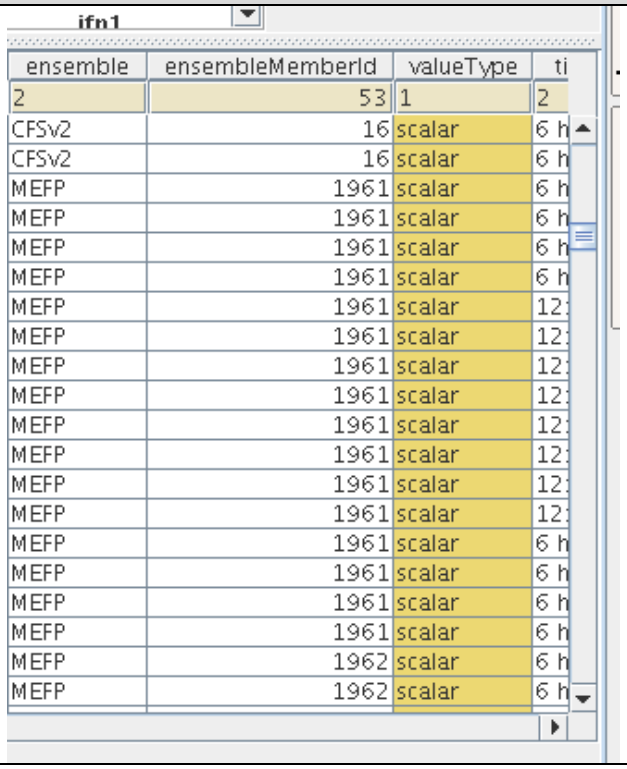
#	Action	Expected Results
3	Click on the **Manual Forecast Button**.	
4	The **Manual Forecast Panel** will open, allowing you to select a workflow to run. From the **Workflow List**, select the "MEFP_Forecast" workflow.	
5	In the **Manual Forecast Panel**, click **Run**. **NOTE:** The workflow MEFP_Forecast is designed to output the same length time series regardless of the forecast length specified in the panel. Thus, it is okay to leave the forecast length as its default when clicking **Run**.	
6	When MEFP Forecast is done, you should see "Workflow MEFP_Forecast Completed" in the logs panel:	

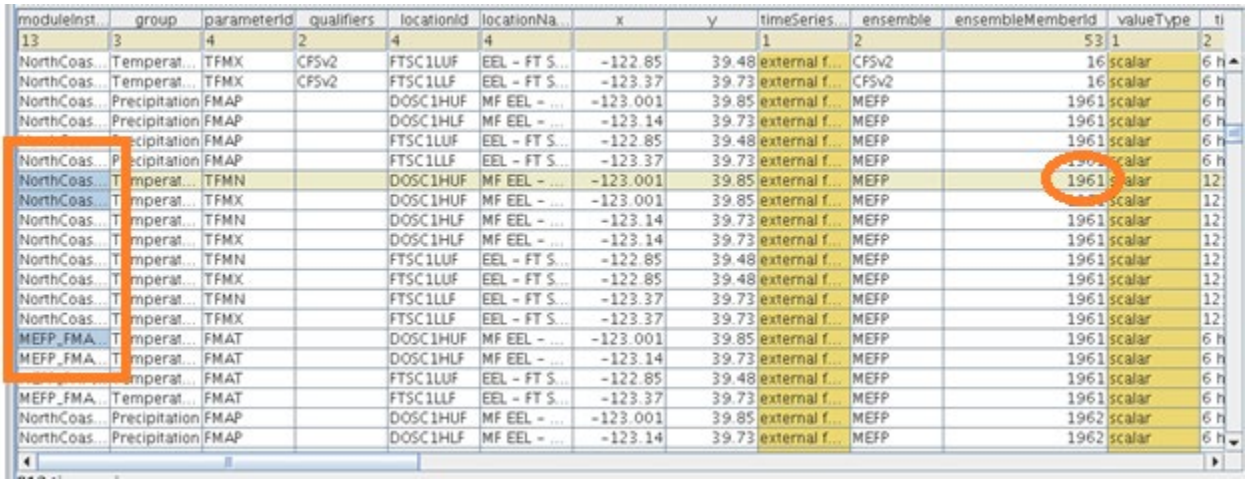


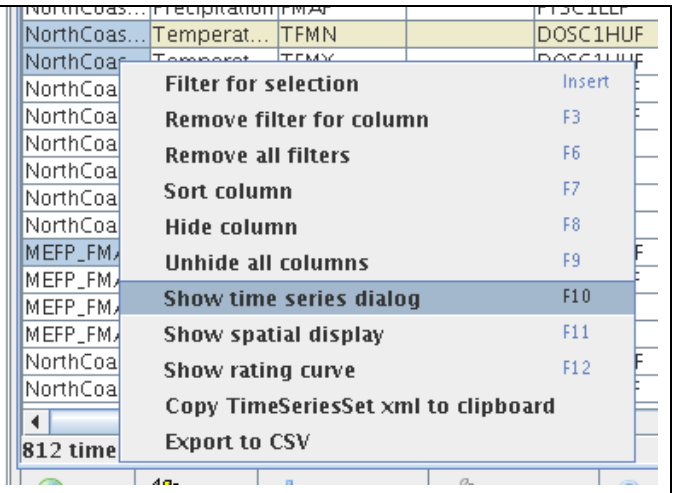
#	Action	Expected Results
7	To verify that ensembles were generated, click in the **Logs Panel**, hit the <F12> key, and hit the <J> key to open the **Database Viewer**.	
8	MEFP_Forecast should be the most recently executed workflow at the top of the table. Select the row that corresponds to it.	

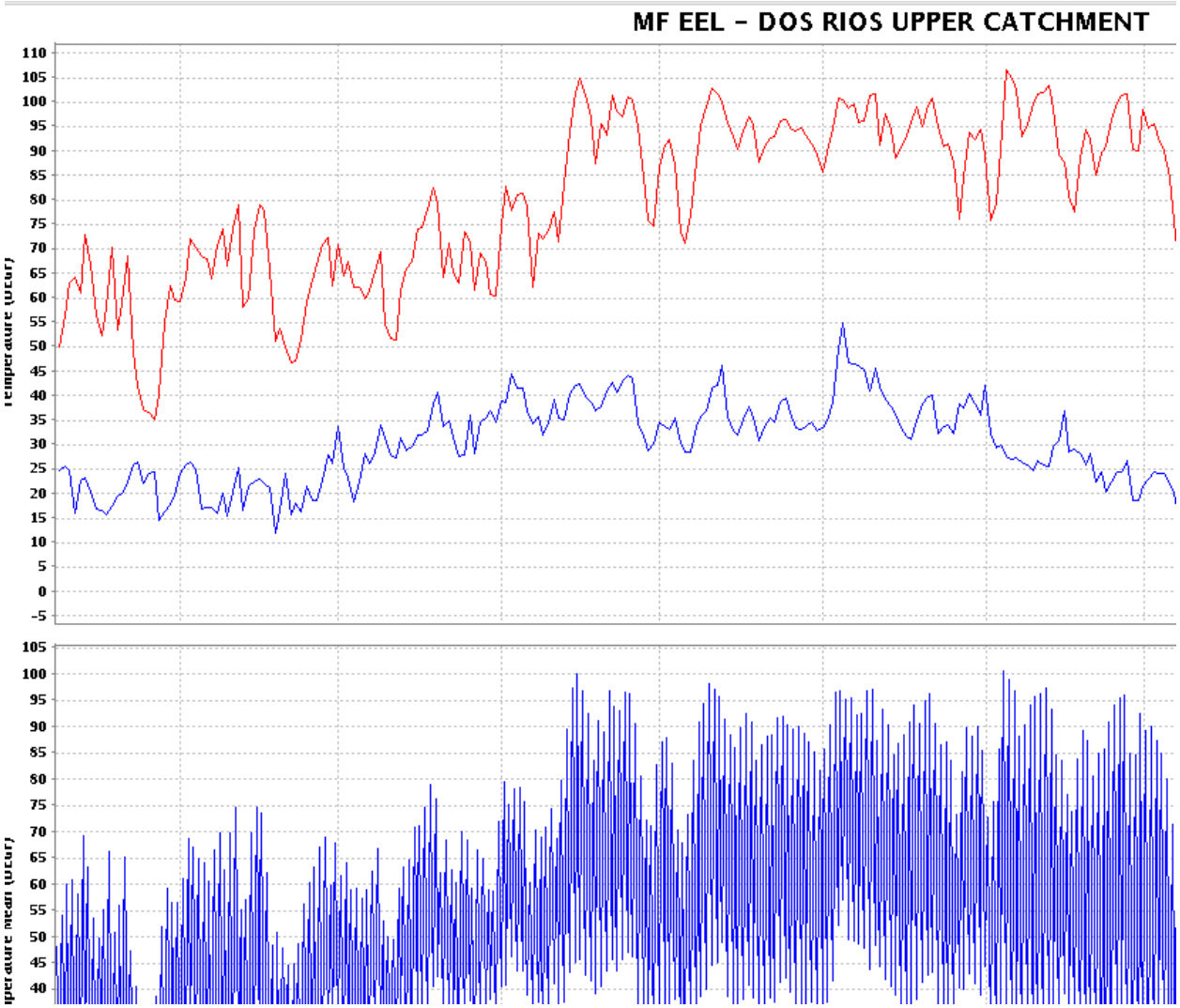


#	Action	Expected Results
9	Click on the "ensembleMemberId" column to sort the data by ensemble member index. You may have to expand the column to see the full name.	

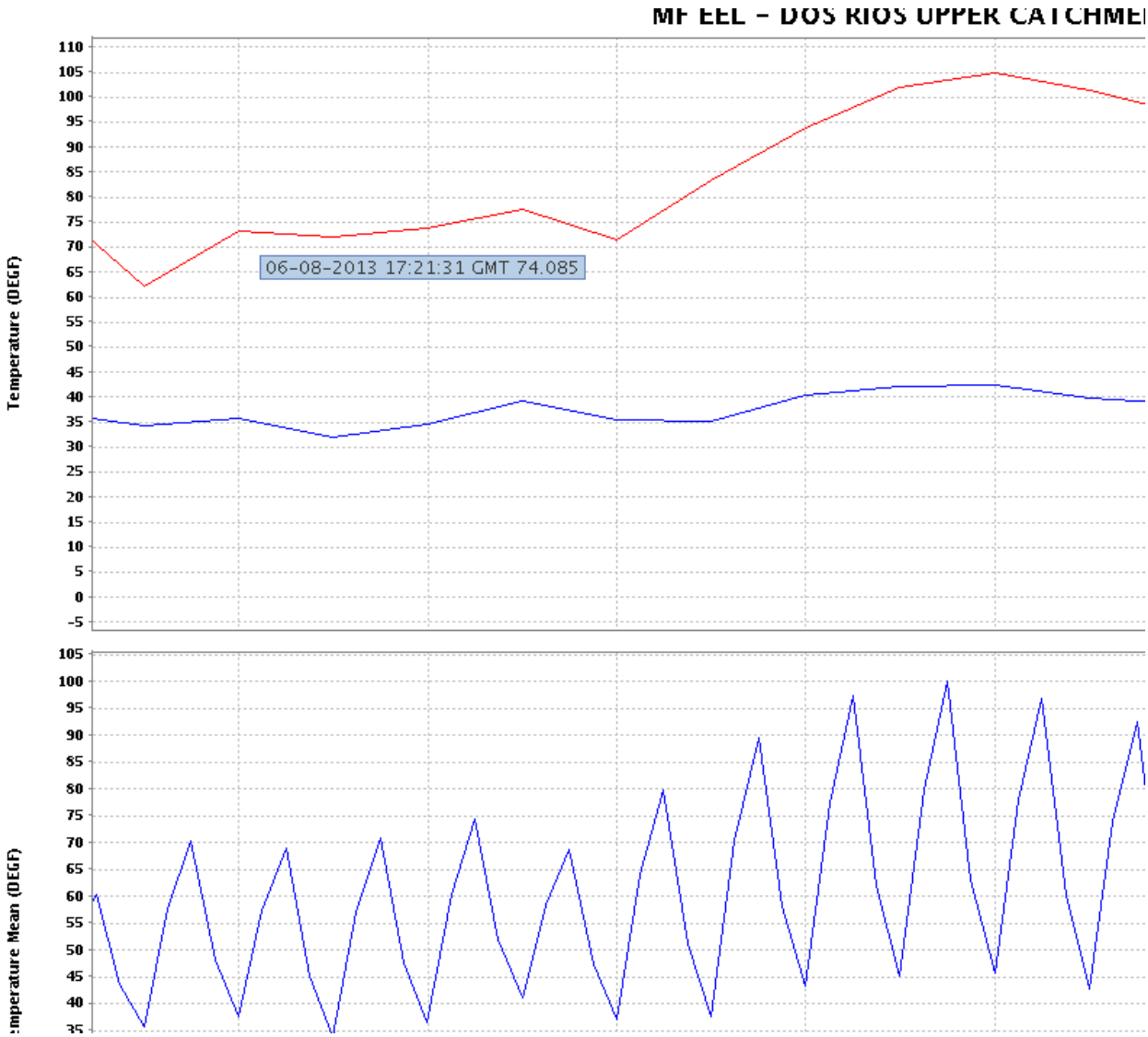
#	Action	Expected Results
10	Select a year for which to view results and scroll to the portion of the table where the ensembleMemberId (ensemble member index) column value is that year. The year 1961 is used in the example here.	
11	Pick a locationId for which to view results. This will vary between RFCs. In the example here, locationId DOSC1HUF was chosen. <Shift> + left click to select the TFMN, TFMX, and FMAT for that location, and for the selected ensemble member index.	



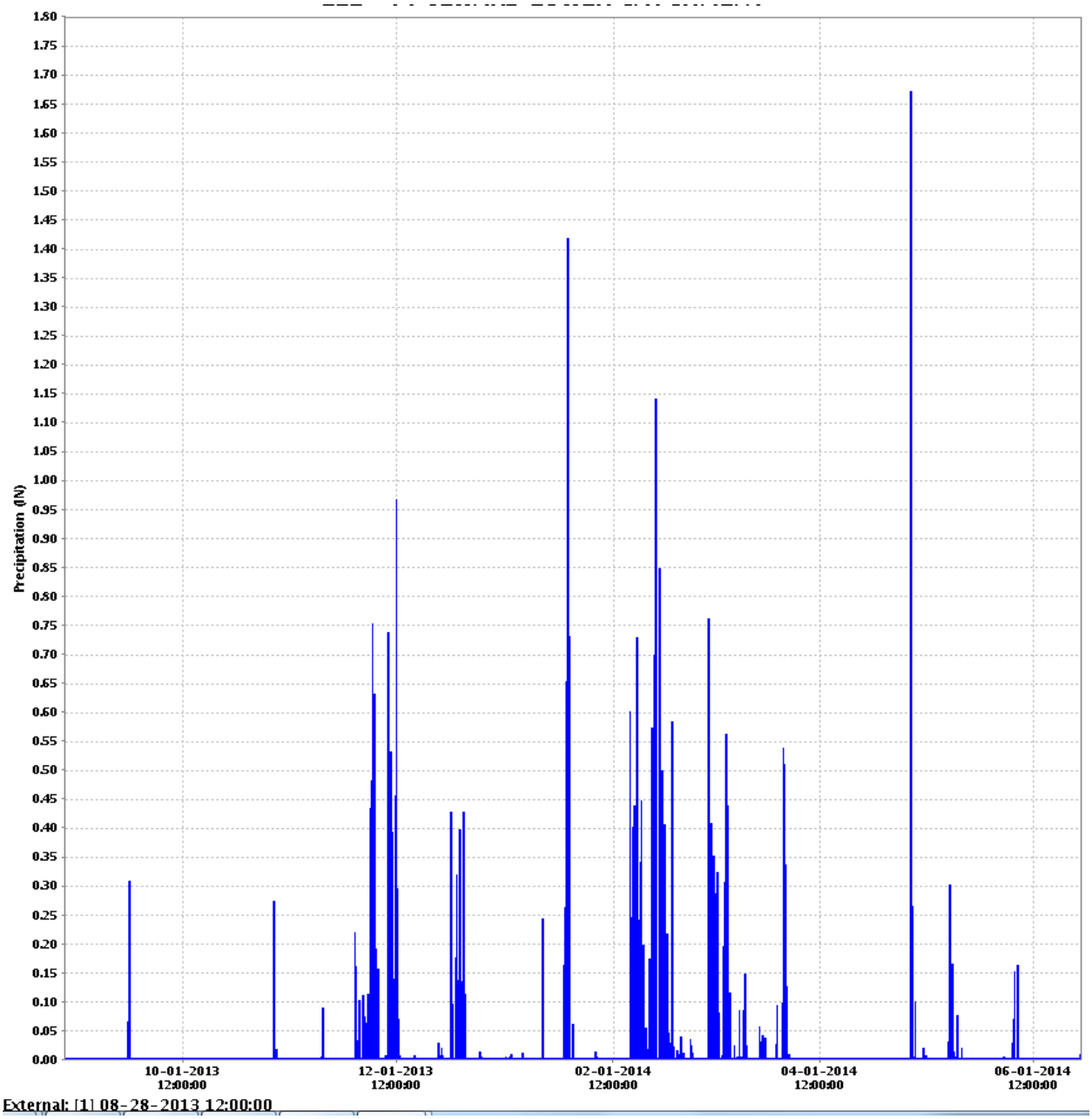
12	Right click and select “Show time series dialog” from the popup menu. The time series will be displayed. In two subplots, with the TFMX/TFMN time series displayed in the top subplot and the FMAT time series displayed in the bottom.	



13	For a zoomed-in view, select a region of the **Database Viewer** by clicking and dragging a small rectangle from upper left to lower right. The generated FMAT should lie between the max and min temps.	



14	Repeat Steps 11 – 13, but view the FMAP time series for the same year. Select the appropriate row (parameterId FMAP) in the **Database Viewer** as in Step 11, show the time series as in Step 12 (example below), and zoom in for a closer look as in Step 13.	


Precipitation (IN)
1.80
1.75
1.70
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
10-01-2013 12:00:00
12-01-2013 12:00:00
02-01-2014 12:00:00
04-01-2014 12:00:00
06-01-2014 12:00:00
External: [1] 08-28-2013 12:00:00

2.4 *Synchronize Changes to the Central Server (Required)*

Once the installation steps above are complete, including confirmation, port all of the configuration changes to the central server. Three files are modified while all others are new; see Figure 1 in Section 1.6 for a list (files in blue boxes are modified and those in red boxes are new). Use the FEWS configuration manager (cm) tool for installing the files in the central server (place the changes in the FEWS OC, validate, and synchronize/upload the changes).

The MEFP forecast components depend upon the global property MEFP_ROOT_DIR which should have already been setup correctly in the FSS global property files as part of the installation of the data ingest components.

TO ADD A NEW SEGMENTS OR FORECAST GROUPS
Repeat this synchronization step for any newly created or modified files.

2.5 *Setup Expiry Times*

Expiry times for all data generated as part of the data ingest process can be set within module configuration files, when scheduling a workflow, as part of the workflow descriptor, via n MC default, or via global properties; this list is in order of preference (e.g., a setting in a module configuration file is used by CHPS over a workflow descriptor setting). Within the default delivered configuration files, the following default expiry time is used:

- All non-temporary data generated as part of the MEFP forecast workflow has a default expiry time of 24 hours, which is set within the workflow descriptors; see Step 2.2.8.

This default is chosen to allow for the output from the MEFP forecast workflow to be used within one day of generation, which should be sufficient if HEFS is executed once per day. However, it may need to be increased if HEFS is run less often.

If you want to define a different expiry time than that which is default, it is recommended you define the expiry with the workflow descriptor. Do the following:

Action: Determine what expiry time is desired for each output time series to be stored in the database (i.e., not temporary) within the workflow:

<*configuration_dir*>/WorkflowFiles/hefs/…
MEFP_Forecast.xml

This workflow runs other workflows to preprocess data for RFC, GEFS, and CFSv2 forecast sources, before executing the MEFP ensemble generator model adapter followed by a module that applies a diurnal pattern to transform 24-hour minimum and maximum temperatures output by MEFP into 6-hourly FMAT temperature time series.

The default expiry times are explained above and defined within the module configuration files.

When determining the expiry time to use, you should consider how often HEFS will be executed, and then ensure that the output from the MEFP forecast workflow is stored in the database long enough for it to be used.

Action: Define the default expiry times with the workflow descriptors. Open the file

<*configuration_dir*>/RegionConfigFiles/WorkflowDescriptors.xml

and modify the runExpiryTime XML element to the workflowDescriptor element appropriately for the workflows added in Step 2.2.8. For example, for a default of three days, do the following:

```
...
  <workflowDescriptor id="MEFP_Forecast" forecast="true" visible="true"
    name="MEFP_Forecast" allowApprove="false">
```

```
    <description>Generate MEFP ensembles</description>
    <runExpiryTime unit="day" multiplier="3"/>
</workflowDescriptor>
...
```

As always with CHPS, be sure that the change is synchronized to the central server.

3 Adding Segments and Forecast Groups

Before adding a new segment or forecast group to the MEFP forecast components, do the following:

1. Add the new segment or forecast group to the MEFP data ingest components. See Section 3 of the *MEFP Configuration Guide: Data Ingest Components*.
2. Estimate parameters for all of the catchments required for the new segment or forecast group. See Section 3 of the *MEFPPE Configuration Guide* for basic instructions on how to estimate parameters.

3.1 *Adding a New Segment*

No additional steps are required beyond those for the data ingest component and estimating the parameters.

3.2 *Adding a New Forecast Group*

To add a new forecast group:

- Identify the segments for which the MEFP will be executed within that group
- Identify the locationIds for any catchments used in those segments for which MEFP must generate FMAP and FMAT forecast ensembles.

The actions described in the following sections must be repeated in order (see the **TO ADD NEW…** descriptions in each section):

- Section 2.2.1 – Create copies of an existing forecast group's module configuration directory and files.
- Section 2.2.2, 2.2.3 – Modify the workflows to execute the new forecast group's modules.
- Section 2.2.4 – If the RFC forecast source for temperature is being used, modify the existing timeSeriesSet XML element to add RFC QTF time series for the new catchments if the RFC forecast source is used.
- Section 2.2.5, 2.2.6 – Modify contents of module configuration files for the new group.
- Section 2.2.7 – Add the created modules to the ModuleInstanceDescriptors.xml file.
- Section 2.2.9 – Add the created modules to the sets defined in ModuleInstanceSets.xml.
- Section 2.3 – Confirm the installation for the new forecast group.
- Section 2.4 – Synchronize changes to the central server.

4 Incorporating MEFP in Streamflow Forecasts

For a specific forecast group, the details of the steps required to incorporate the MEFP in ensemble streamflow forecasts at an RFC are RFC-specific. In general, the steps to perform are as follows:

1. Add the MEFP output to merge transformations for MAP and MAT.
2. Create an HEFS forecast pre-processing workflow that calls SetTimes* modules and the merge transformations needed for ensemble forecasting.
3. Create an HEFS ensemble forecast workflow that calls the pre-processing workflow, streamflow forecast workflows for each segment, and HEFS Ensemble Post-Processor workflows, if used.

Use the existing ESP workflows as base line when developing or modifying the necessary files. By doing so, the streamflow forecast workflow will already incorporate sampled MAP/MAT time series as part of standard ESP forecasting. This is the recommended approach if raw climatology is to be used to extend the output of the MEFP in order to generate streamflow forecast ensembles with a length greater than what is output by MEFP. Each of these steps is described in more detail in a section below.

The resulting HEFS ensemble forecasting workflow depends upon the MEFP workflow having run successfully. The MEFP workflow is configured in the file

<*configuration_dir*>/Config/WorkflowFiles/hefs/MEFP_Forecast.xml

and has the name "MEFP_Forecast" in the **Manual Forecast Display Panel** of CHPS.

In the sections that follow, general instructions for completing the steps are provided for a general forecast group. Examples are provided for the KEYINF forecast group at ABRFC. You should *not* copy-and-paste information from the examples; they are only to be used for guidance. Since the XML files involved and the modules and workflows within those files vary between RFCs, instructions at the level of detail as those in Section 2 cannot be provided.

4.1 *Add MEFP to Merge Transformations (Required)*

Action: Add the output from the MEFP to merge transformation module configuration files for the forecast group.

Description: All RFCs use a merge transformation in order to prepare precipitation and temperature inputs for streamflow forecasting. The transformation is typically applied by forecast group and includes multiple sources of precipitation or temperature as input variables yielding a single output time series. At the end of this section is an example of a merge transformation for ABRFC for precipitation data. Typically, such module configuration files are located in the directory:

<*configuration_dir*>/Config/ModuleConfigFiles/preprocessing

The name of the file will usually be prefixed with the name of the forecast group; for example, for the KEYINF forecast group at ABRFC, the module configuration files to modify are KEYINF_MergeMAP.xml and KEYINF_MergeMAT.xml.

In order to incorporate the precipitation output from MEFP as input to streamflow forecasts, the following variable XML element must be added to the precipitation (MAP or MAPX) merge transformation as for the appropriate forecast group (replace *fgroup* with the name of the forecast group and modify the variableId as desired):

```
<variable>
  <variableId>MAP_MEFP</variableId>
  <timeSeriesSet>
    <moduleInstanceId>fgroup_MEFP_FMAP_Forecast</moduleInstanceId>
    <valueType>scalar</valueType>
    <parameterId>FMAP</parameterId>
    <locationSetId>Catchments_HEFS_fgroup</locationSetId>
    <timeSeriesType>external forecasting</timeSeriesType>
    <timeStep unit="hour" multiplier="6"/>
    <relativeViewPeriod unit="hour" start="0" startOverrulable="true" end="0" endOverrulable="true" />
    <readWriteMode>read only</readWriteMode>
    <ensembleId>MEFP</ensembleId>
  </timeSeriesSet>
</variable>
```

It is critical to leave the startOverrulable and endOverrulable attributes of the relativeViewPeriod XML element as "true" so that CHPS can assign the start and end times based on the forecast period for the streamflow forecast workflow.

In order to incorporate the temperature output from MEFP as input to streamflow forecasts, the following variable XML element must be added to the temperature (MAT) merge transformation as an input variable for the appropriate forecast group (replace *fgroup* with the name of the forecast group and modify the variableId as desired):

```
<variable>
   <variableId>MAT_MEFP</variableId>
   <timeSeriesSet>
      <moduleInstanceId>MEFP_FMAT_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAT</parameterId>
      <locationSetId>Catchments_HEFS_fgroup</locationSetId>
      <timeSeriesType>external forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6"/>
      <relativeViewPeriod unit="hour" start="-240" startOverrulable="true" end="0" endOverrulable="true" />
      <readWriteMode>read only</readWriteMode>
      <ensembleId>MEFP</ensembleId>
   </timeSeriesSet>
</variable>
```

Again, it is critical that the startOverrulable and endOverrulable attributes of the relativeViewPeriod XML element as true in so that CHPS can assign the start and end times based on the forecast period for the streamflow forecast workflow. The MEFP_FMAT_Forecast module used above converts 24-hour minimum and maximum temperature (TFMN and TFMX) time series output by MEFP to 6-hour instantaneous temperature (FMAT) time series; see the configuration file:

<*configuration_dir*> /ModuleConfigFiles/hefs/preprocessingMEFP/MEFP_FMAT_Forecast.xml

Even though the MEFP_FMAT_Forecast module generates output for the location set "Catchments_HEFS", in the temperature merge module, only the forecast group specific location set should be used.

The variable XML elements defined above must then be included in the merge transformation section as an input before the ESP MAP/MAT input variable is included, so that MEFP output takes precedence over ESP (raw climatology). See the examples below.

The first configuration example is the precipitation (MAP) merge operation is for ABRFC: KEYINF_MergeMAP_Forecast.xml. The sections using MEFP output are highlighted. Do not copy any of the below XML for installation purposes, as it is specific to ABRFC.

In the example below, the output from the sample transformation (with variableId MAP_ESP_Forecast) that generates raw climatology is still used within the Merge, but is prioritized lower than the MEFP output. This will allow the sampled raw climatology to be used to extend the MEFP forecast beyond its configured time period if needed.

```
<?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>MAPX_observed_1</variableId>
   <timeSeriesSet>
      <moduleInstanceId>MAPX_PreProcessing_QPE</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MAPX</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>external historical</timeSeriesType>
      <timeStep unit="hour" multiplier="1" />
      <relativeViewPeriod unit="hour" start="-240"
         startOverrulable="true" end="0" />
      <readWriteMode>add originals</readWriteMode>
      <ensembleId>main</ensembleId>
   </timeSeriesSet>
</variable>
<variable>
   <variableId>MAPX_observed</variableId>
   <timeSeriesSet>
      <moduleInstanceId>MAPX_PreProcessing_QPE</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MAPX</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>external historical</timeSeriesType>
      <timeStep unit="hour" multiplier="6" />
      <relativeViewPeriod unit="hour" start="-240"
         startOverrulable="true" end="0" />
      <readWriteMode>add originals</readWriteMode>
      <ensembleId>main</ensembleId>
   </timeSeriesSet>
</variable>
<variable>
   <variableId>MAP_Historic</variableId>
   <timeSeriesSet>
      <moduleInstanceId>ImportDataCard</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MAP</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>external historical</timeSeriesType>
      <timeStep unit="hour" multiplier="6" />
      <relativeViewPeriod unit="day" start="-36500" end="0" />
      <readWriteMode>read only</readWriteMode>
   </timeSeriesSet>
</variable>
<variable>
   <variableId>MAP_Historic_Hourly</variableId>
   <timeSeriesSet>
      <moduleInstanceId>KEYINF_PreProcess_Historic</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MAP</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>external historical</timeSeriesType>
      <timeStep unit="hour" multiplier="6" />
      <relativeViewPeriod unit="day" start="-36500" end="0" />
      <readWriteMode>read only</readWriteMode>
   </timeSeriesSet>
```

```
</variable>
<variable>
   <variableId>MAP_ESP_forecast</variableId>
   <timeSeriesSet>
      <moduleInstanceId>KEYINF_SampleESP_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MAP</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6" />
      <relativeViewPeriod unit="day" start="0" end="0"
         endOverrulable="true" />
      <readWriteMode>read only</readWriteMode>
   </timeSeriesSet>
</variable>
<variable>
   <variableId>MAP_forecast</variableId>
   <timeSeriesSet>
      <moduleInstanceId>KEYINF_SampleQPF_PreProcessing_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAP</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6" />
      <relativeViewPeriod unit="hour" start="-240"
         startOverrulable="true" end="0" endOverrulable="true" />
      <readWriteMode>add originals</readWriteMode>
   </timeSeriesSet>
</variable>
<variable>
   <variableId>MAP_forecast_ALL</variableId>
   <timeSeriesSet>
      <moduleInstanceId>ABRFC_ALLQPF_PreProcessing_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAP</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6" />
      <relativeViewPeriod unit="hour" start="-240"
         startOverrulable="true" end="0" endOverrulable="true" />
      <readWriteMode>add originals</readWriteMode>
   </timeSeriesSet>
</variable>
<variable>
   <variableId>MAP_forecast_CONTIN</variableId>
   <timeSeriesSet>
      <moduleInstanceId>ABRFC_Contin_PreProcessing_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAP</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6" />
      <relativeViewPeriod unit="hour" start="-240"
         startOverrulable="true" end="0" endOverrulable="true" />
      <readWriteMode>add originals</readWriteMode>
   </timeSeriesSet>
```

```
</variable>
<!-- Begin HEFS -->
<variable>
   <variableId>MAP_MEFP</variableId>
   <timeSeriesSet>
      <moduleInstanceId>KEYINF_MEFP_FMAP_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAP</parameterId>
      <locationSetId>Catchments_HEFS_KEYINF</locationSetId>
      <timeSeriesType>external forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6"/>
      <relativeViewPeriod unit="hour" start="0" startOverrulable="true" end="0" endOverrulable="true" />
      <readWriteMode>read only</readWriteMode>
      <ensembleId>MEFP</ensembleId>
   </timeSeriesSet>
</variable>
<!-- End HEFS -->
<variable>
   <variableId>MAPX_merged_tmp</variableId>
   <timeSeriesSet>
      <moduleInstanceId>KEYINF_MergeMAP_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MAPX</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>temporary</timeSeriesType>
      <timeStep unit="hour" multiplier="6" />
      <relativeViewPeriod unit="hour" start="-240"
         startOverrulable="true" end="0" endOverrulable="true" />
      <readWriteMode>read only</readWriteMode>
   </timeSeriesSet>
</variable>
<variable>
   <variableId>MAPX_merged</variableId>
   <timeSeriesSet>
      <moduleInstanceId>KEYINF_MergeMAP_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MAPX</parameterId>
      <locationSetId>Catchments_KEYINF</locationSetId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6" />
      <relativeViewPeriod unit="hour" start="-240"
         startOverrulable="true" end="0" endOverrulable="true" />
      <readWriteMode>add originals</readWriteMode>
      <synchLevel>1</synchLevel>
   </timeSeriesSet>
</variable>
<transformation id="ChangeT-1-to-6-MAP">
   <aggregation>
      <accumulative>
         <inputVariable>
            <variableId>MAPX_observed_1</variableId>
         </inputVariable>
         <outputVariable>
            <variableId>MAPX_observed</variableId>
         </outputVariable>
      </accumulative>
```

```
      </aggregation>
    </transformation>
    <transformation id="MergeMAP">
      <merge>
        <simple>
          <inputVariable>
            <variableId>MAPX_observed</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAP_MEFP</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAP_forecast</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAP_ESP_forecast</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAP_forecast_ALL</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAP_forecast_CONTIN</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAP_Historic</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAP_Historic_Hourly</variableId>
          </inputVariable>
          <outputVariable>
            <variableId>MAPX_merged_tmp</variableId>
          </outputVariable>
        </simple>
      </merge>
    </transformation>
    <transformation id="InterpolateMAP">
      <interpolationSerial>
        <default>
          <inputVariable>
            <variableId>MAPX_merged_tmp</variableId>
          </inputVariable>
          <defaultValue>0.00</defaultValue>
          <outputVariable>
            <variableId>MAPX_merged</variableId>
          </outputVariable>
        </default>
      </interpolationSerial>
    </transformation>
  </transformationModule>
```

This second configuration example is the temperature (MAT) merge operation is for NERFC: Hudson_MergeMAT_Forecast.xml. The sections using MEFP output are highlighted. Furthermore, parts of the file dealing with other inputs have been removed and replaced with

"..." to save space. Do not copy any of the below XML for installation purposes, as it is specific to NERFC.

NERFC is used as an example of how to handle merging when there are both upper and lower catchments. The variable is defined only once, but is used in the merge transformation for both the MergeMATLO and MergeMATUP transformations. The variable need not be defined specifically for lower and upper catchments, since the output of the two transformations, variables MAT_LO_merged and MAT_UP_merged, already restricts the catchments to lower and upper.

```
<?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">
    ...
    <!-- Begin HEFS -->
    <variable>
        <variableId>MAT_MEFP</variableId>
        <timeSeriesSet>
         <moduleInstanceId>MEFP_FMAT_Forecast</moduleInstanceId>
         <valueType>scalar</valueType>
         <parameterId>FMAT</parameterId>
         <locationSetId>Catchments_HEFS_Hudson</locationSetId>
         <timeSeriesType>external forecasting</timeSeriesType>
         <timeStep unit="hour" multiplier="6"/>
         <relativeViewPeriod unit="hour" start="-240" startOverrulable="true" end="0" endOverrulable="true" />
         <readWriteMode>read only</readWriteMode>
         <ensembleId>MEFP</ensembleId>
        </timeSeriesSet>
    </variable>
    <!-- End HEFS -->

    <variable>
        <variableId>MAT_UP_merged_tmp</variableId>
        <timeSeriesSet>
            <moduleInstanceId>Hudson_MergeMAT_Forecast</moduleInstanceId>
            <valueType>scalar</valueType>
            <parameterId>MAT</parameterId>
            <locationSetId>Catchments_Hudson_Upper</locationSetId>
            <timeSeriesType>temporary</timeSeriesType>
            <timeStep unit="hour" multiplier="6"/>
            <relativeViewPeriod unit="hour" start="-240" startOverrulable="true" end="0" endOverrulable="true"/>
            <readWriteMode>read only</readWriteMode>
        </timeSeriesSet>
    </variable>
    <variable>
        <variableId>MAT_LO_merged</variableId>
        <timeSeriesSet>
            <moduleInstanceId>Hudson_MergeMAT_Forecast</moduleInstanceId>
            <valueType>scalar</valueType>
            <parameterId>MAT</parameterId>
            <locationSetId>Catchments_Hudson_Lower</locationSetId>
            <timeSeriesType>simulated forecasting</timeSeriesType>
```

```
            <timeStep unit="hour" multiplier="6"/>
            <relativeViewPeriod unit="hour" start="-240" startOverrulable="true" end="0" endOverrulable="true"/>
            <readWriteMode>read only</readWriteMode>
        </timeSeriesSet>
    </variable>
    <variable>
        <variableId>MAT_UP_merged</variableId>
        <timeSeriesSet>
            <moduleInstanceId>Hudson_MergeMAT_Forecast</moduleInstanceId>
            <valueType>scalar</valueType>
            <parameterId>MAT</parameterId>
            <locationSetId>Catchments_Hudson_Upper</locationSetId>
            <timeSeriesType>simulated forecasting</timeSeriesType>
            <timeStep unit="hour" multiplier="6"/>
            <relativeViewPeriod unit="hour" start="-240" startOverrulable="true" end="0" endOverrulable="true"/>
            <readWriteMode>read only</readWriteMode>
        </timeSeriesSet>
    </variable>
    <transformation id="MergeMATLO">
        <merge>
            <simple>
                <inputVariable>
                    <variableId>MAT_GFE_LO_observed</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_MEFP</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_RTMA_observed</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_LO_observed</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_SREF_LO_forecast</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_NAEFS_LO_forecast</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>NYWater_Lower</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_GFE_Contingency_LO_forecast</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_LO_sampleESP</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_GFE_LO_forecast</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_MOS_forecast</variableId>
                </inputVariable>
                <inputVariable>
                    <variableId>MAT_LO_sampleESP_Mean</variableId>
```

```
            </inputVariable>
            <inputVariable>
                <variableId>MAT_LO_forecast</variableId>
            </inputVariable>
            <inputVariable>
                <variableId>Datacard_LO</variableId>
            </inputVariable>
            <outputVariable>
                <variableId>MAT_LO_merged_tmp</variableId>
            </outputVariable>
        </simple>
    </merge>
</transformation>
<transformation id="InterpolateMATLO">
    <interpolationSerial>
        <linear>
            <inputVariable>
                <variableId>MAT_LO_merged_tmp</variableId>
            </inputVariable>
            <outputVariable>
                <variableId>MAT_LO_merged</variableId>
            </outputVariable>
        </linear>
    </interpolationSerial>
</transformation>
<transformation id="MergeMATUP">
    <merge>
        <simple>
            <inputVariable>
                <variableId>MAT_GFE_UP_observed</variableId>
            </inputVariable>
            <inputVariable>
                <variableId>MAT_MEFP</variableId>
            </inputVariable>
            <inputVariable>
                <variableId>MAT_RTMA_observed</variableId>
            </inputVariable>
            <inputVariable>
                <variableId>MAT_UP_observed</variableId>
            </inputVariable>
            <inputVariable>
                <variableId>MAT_SREF_UP_forecast</variableId>
            </inputVariable>
            <inputVariable>
                <variableId>MAT_NAEFS_UP_forecast</variableId>
            </inputVariable>
            <inputVariable>
                <variableId>NYWater_Upper</variableId>
            </inputVariable>
            <inputVariable>
                <variableId>MAT_UP_sampleESP</variableId>
            </inputVariable>
            <inputVariable>
                <variableId>MAT_GFE_Contingency_UP_forecast</variableId>
            </inputVariable>
            <inputVariable>
```

```
            <variableId>MAT_GFE_UP_forecast</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAT_MOS_forecast</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAT_UP_sampleESP_Mean</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>MAT_UP_forecast</variableId>
          </inputVariable>
          <inputVariable>
            <variableId>Datacard_UP</variableId>
          </inputVariable>
          <outputVariable>
            <variableId>MAT_UP_merged_tmp</variableId>
          </outputVariable>
        </simple>
    </merge>
</transformation>
<transformation id="InterpolateMATUP">
    <interpolationSerial>
        <linear>
          <inputVariable>
            <variableId>MAT_UP_merged_tmp</variableId>
          </inputVariable>
          <outputVariable>
            <variableId>MAT_UP_merged</variableId>
          </outputVariable>
        </linear>
    </interpolationSerial>
</transformation>
  </transformationModule>
```

4.2 *Create a Pre-Processing Workflow for Ensemble Forecasting (Required)*

Action: Create a pre-processing workflow for the forecast group that will set the times for the ensemble forecast run and prepare inputs for the streamflow forecast workflows.

Action: Add the needed descriptor to the workflow descriptors file:

<*configuration_dir*>/RegionConfigFiles/WorkflowDescriptors.xml.

Description: The pre-processing workflow must call appropriate SetTimes* modules and execute all of the merge modules necessary for an ensemble forecast for the forecast group. It may include the following:

- Merge transformation for precipitation (*MergeMAP_Forecast or *MergeMAPX_Forecast), edited in Section 4.1
- Merge transformation for temperature (*MergeMAT_Forecast), edited in Section 4.1
- Merge transformation for potential evaporation data (*MergeMAPE_Forecast)
- Sample transformations used to sample raw-climatology MAP and MAT data for standard ESP forecasts
- Others as needed

- Use your standard ESP pre-processing workflow for that forecast group for guidance.

- In the example below, the default ESP set times module is called, which has module id SetTimes_ESP_Forecast. If HEFS products are to be created with a forecast length that differs from your RFC's standard ESP forecast lengths, you should create a copy of the SetTimes_ESP_Forecast module called SetTimes_HEFS_Forecast and change the minForecastLength XML element appropriately. The workflow created here should call that new module instead of SetTimes_ESP_Forecast. The length of an HEFS ensemble streamflow forecast cannot exceed the length of the output from MEFP; see Section 4.2.1.

The following example is for the KEYINF forecast group in ABRFC:

```
<?xml version="1.0" encoding="UTF-8"?>
<workflow 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/workflow.xsd" version="1.1">
  <activity>
    <runIndependent>true</runIndependent>
    <moduleInstanceId>SetTimes_LastObserved</moduleInstanceId>
  </activity>
  <activity>
    <runIndependent>true</runIndependent>
    <moduleInstanceId>SetTimes_ESP_Forecast</moduleInstanceId>
  </activity>
```

```
  <activity>
    <runIndependent>true</runIndependent>
    <moduleInstanceId>KEYINF_MergeMAT_Forecast</moduleInstanceId>
    <ensemble>
      <ensembleId>MEFP</ensembleId>
      <runInLoop>true</runInLoop>
    </ensemble>
  </activity>
  <activity>
    <runIndependent>true</runIndependent>
    <moduleInstanceId>KEYINF_MergeMAP_Forecast</moduleInstanceId>
    <ensemble>
      <ensembleId>MEFP</ensembleId>
      <runInLoop>true</runInLoop>
    </ensemble>
  </activity>
  <activity>
    <runIndependent>true</runIndependent>
    <moduleInstanceId>KEYINF_MergeMAPE_Forecast</moduleInstanceId>
    <ensemble>
      <ensembleId>MEFP</ensembleId>
      <runInLoop>true</runInLoop>
    </ensemble>
  </activity>
</workflow>
```

4.2.1 Note on Ensemble Workflow Forecast Length

When defining the forecast length for running the pre-processing workflow created above, which is used to control the length of the streamflow forecasts generated in the workflow to be described in Section 4.3, it must not be longer than the members of the MEFP_Forecast workflow generated ensembles which are used as input, unless extended using raw climatology as described in Section 4.1.

The period covered by the members of MEFP_Forecast workflow generated ensembles is not impacted in any way by the forecast length used when running the MEFP_Forecast workflow.

The time period covered by the each member of an MEFPEnsembleGeneratorModelAdapter generated forecast ensemble is equal to the largest number of forecast days for any source, specified by the run file properties <source>NumberOfForecastDays in the module configuration file (see the *MEFP User's Manual* section on the adapter):

```
<int key="rfcNumberOfForecastDays" value="0"/>
<int key="gefsNumberOfForecastDays" value="15"/>
<int key="cfsv2NumberOfForecastDays" value="270"/>
<int key="climatologyNumberOfForecastDays" value="330"/>
```

In this example, each member of the MEFP forecast ensemble will be 330 days in length. This applies to generated ensembles of 6-hour FMAP time series and 24-hour TFMN and TFMX time series.

The ensembles of 24-hour TFMN and TFMX time series are then converted to an ensemble of 6-hour FMAT time series for use in streamflow forecasting in the MEFP_FMAT_Forecast module. The length of the forecast ensemble yielded by that module is controlled via the relativeViewPeriod XML elements defined in its configuration file (default is 365 days):

<*configuration_dir*>/ModuleConfigFiles/hefs/preprocessingMEFP/MEFP_FMAT_Forecast.xml

The generated FMAT ensemble will cover a time period equal to the shorter of the length of the MEFP generated forecast ensemble and the relativeViewPeriod in this module. See Section 6.2.2 for instructions on how to extend the forecast period of the MEFP_Forecast workflow generated ensembles.

4.3 *Create an Ensemble Forecasting Workflow (Required)*

Action: The ensemble forecasting workflow must call the following workflows and modules:

- The pre-processing workflow created for the forecast group in Section 4.2.
- Standard operational forecast workflows for the segments within the forecast group run in a loop with ensembleId "MEFP".
- (Optional) Any HEFS Ensemble Post-Processor modules configured for the segments of the forecast group. See the *HEFS EnsPost Configuration Guide* and the example below.

Action: Add the needed descriptor to the workflow descriptors specified in the file

<*configuration_dir*>/RegionConfigFiles/WorkflowDescriptors.xml.

The workflow descriptor should be setup with forecast, visible, allowApprove and autoApprove all set to "true":

```
<workflowDescriptor id="…" name="…" forecast="true" visible="true" allowApprove="true"
autoApprove="true">
```

Be sure to set an appropriate runExpiryTime for the workflow's output.

Use your standard ESP ensemble forecast workflow for guidance.

The following example is for the KEYINF forecast group in ABRFC:

```
<?xml version="1.0" encoding="UTF-8"?>
<workflow 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/workflow.xsd" version="1.1">
    <!-- Prepare the inputs to the streamflow models to use MEFP. -->
    <activity>
        <runIndependent>false</runIndependent>
        <workflowId>HEFS_PreProcessing_Forecast</workflowId>
    </activity>

    <!-- Run the operational forecast flow modules for each segment in a loop with ensembleId "MEFP". -->
    <activity>
        <runIndependent>false</runIndependent>
        <workflowId>CBNK1_Flow_Forecast</workflowId>
        <ensemble>
            <ensembleId>MEFP</ensembleId>
            <runInLoop>true</runInLoop>
        </ensemble>
    </activity>
    <activity>
        <runIndependent>false</runIndependent>
```

```
        <workflowId>BLKO2_Flow_Forecast</workflowId>
        <ensemble>
            <ensembleId>MEFP</ensembleId>
            <runInLoop>true</runInLoop>
        </ensemble>
    </activity>

    <!—Post-process streamflow ensembles using EnsPost. -->
    <activity>
        <runIndependent>false</runIndependent>
        <moduleInstanceId>CBNK1_ENSPOST_Forecast</moduleInstanceId>
    </activity>
    <activity>
        <runIndependent>false</runIndependent>
        <moduleInstanceId>BLKO2_ENSPOST_Forecast</moduleInstanceId>
    </activity>
</workflow>
```

4.4 *Confirm Configuration*

Confirming the configuration can be done in the *installation standalone*, or whatever standalone was used to test the MEFP configuration. The general process uses standard CHPS tools and is as follows:

1. Ensure that the correct system time (T0) is used, based on the data available in the standalone (See Section 2.3 for MEFP requirements and make sure that the initial conditions, including states and latest observed flows, are available for hydrologic models)

2. Execute the MEFP_Forecast workflow using the CHPS **Manual Forecast Dialog** and confirm that ensembles were generated. See Section 2.3 for guidance.

3. Execute the HEFS ensemble forecasting workflow created in Section 4.2.1.

4. Confirm that ensembles of streamflow were generated for the segments in question using the CHPS **Database Viewer** or via Graphics Generator products visible in the **GraphGen Thumbnails Panel** when the appropriate segments are made active in the **Forecasts Panel** of the CHPS interface.

4.5 *Synchronize Changes to the Central Server (Required)*

Once the installation steps above are complete, including confirmation, port all of the configuration changes to the central server. This should include merge transformation files modified in Section 4.1 and workflow additions made in Sections 4.2 and 4.2.1.

4.6 *Schedule the Workflow (Optional)*

If desired, the created forecast group ensemble streamflow workflows can be scheduled to run through the normal mechanism of scheduling a workflow. However, there are two important factors to consider when scheduling:

- A single end-to-end workflow should be constructed that executes the MEFP_Forecast workflow immediately before executing the ensemble streamflow workflows constructed for all forecast groups.
- The run must be timed so that it executes AFTER all of the scheduled MEFP data ingest workflows that provide required data for the MEFP to execute. It should also be run after operational forecasts have been generated, particularly if HEFS EnsPost is included. For the MEFP, the time of the last required data ingest workflow is the one that ingests the 12Z CFSv2 forecast for the previous day, which executes at 17Z of the current day (a 29-hour lag). As such, the scheduled workflow for a 12Z forecast on the current day should run no earlier than about 17:30Z.

5 Hindcasting with MEFP

The MEFPEnsembleGeneratorModelAdapter is capable of executing in hindcast mode to generate hindcasts, but, to do so, two changes must be made to the MEFP module configuration files and the workflow that executes them prior to generating the hindcasts:

1. The MEFP adapter must be told to run in hindcasting mode.

2. The forecast source pre-processing workflows must be turned off.

Once those changes are made, the model can be run as part of a hindcast workflow as any other workflow using the batch forecast option within the CHPS **Manual Forecast Dialog**.

Perform the actions below to prepare the MEFPEnsembleGeneratorModelAdapter for hindcast execution. Once the steps are complete, normal hindcasting can commence.

See the list of hindcasting date/time restrictions at the end of this section!

Action: Define the run-file property hindcasting and set its value to "true" in all MEFP adapter configuration files. See Sections 2.2.5 and 2.2.6: if you did not modify the hindcasting run file property, this can be done by defining the global property MEFP_HINDCASTING and setting its value to be true:

```
MEFP_HINDCASTING=true
```

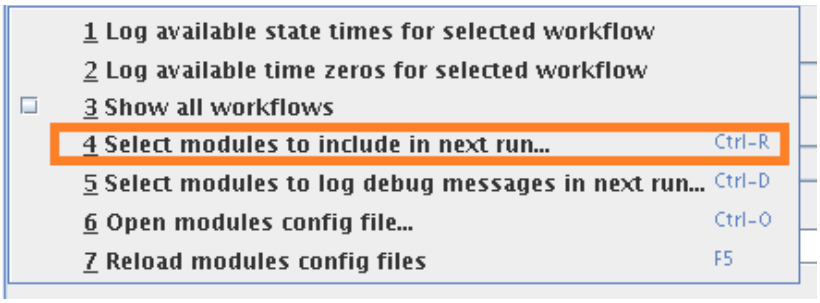
Alternatively, you can set the hindcasting run file property to be "true" in the module configuration file directly:

```
<string key="hindcasting" value="true"/>
```

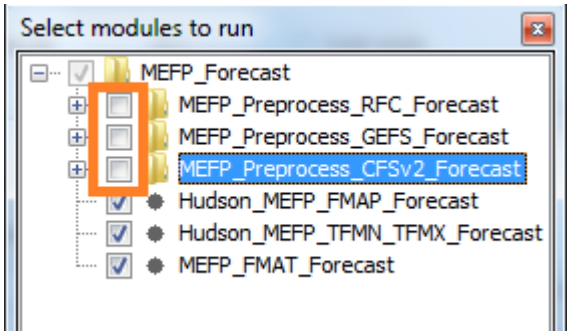
This must be done for every module configuration file that executes the MEFPEnsembleGeneratorModelAdapter and is part of the hindcasting workflow. For example:

```
<exportRunFileActivity>
  <exportFile>%ROOT_DIR%/run_info.xml</exportFile>
  <properties>
    <int key="printDebugInfo" value="0"/>
    <string key="hindcasting" value="true"/>
    <string key="parameterDir" value="$MEFP_ROOT_DIR$/mefpParameters"/>
    ...
  </properties>
</exportRunFileActivity>
```

Action: Using the CHPS **Manual Forecast Dialog**, prior to executing the batch forecast, turn off all pre-processing workflows in the MEFP_Forecast workflow. Select the hindcasting workflow to be executed from the **Workflow List** and press <F12>. From the pop-up menu that opens, click on "Select modules to include in next run…":



Find the workflow "MEFP_Forecast" that must be part of the hindcasting workflow and uncheck the three "MEFP_Preprocess*Forecast" workflows; for example (in this example, the hindcasting workflow is the MEFP_Forecast workflow):



Click **OK** to close the **Select module to run Dialog**.

- Turning off the pre-processing workflows can also be accomplished by commenting out the activities that execute them in the MEFP_Forecast workflow configuration file. The approach above, however, is simpler in that it requires no configuration file changes.

- This is done to avoid errors that will occur when preprocessing the data in hindcast mode. Specifically, no operational RFC/GEFS/CFSv2 data is available to preprocess. Instead, MEFP uses the historical archived/reforecast data that was employed during parameter estimation.

Action: Perform the remaining steps necessary in order to execute the hindcast workflow and generated hindcasts.

MEFP HINDCASTING RESTRICTIONS

The MEFP can only generate hindcasts for historical dates for which archived forecasts (for RFC forecast source) or reforecasts (for GEFS, and CFSv2) were available during parameter estimation for all forecast sources to be used by MEFP (i.e., those sources included in parameter estimation and for which the operational number of forecast days is larger than 0; see the section on the MEFPEnsembleGeneratorModelAdapter in the *MEFP User's Manual*). When executed in hindcast mode, MEFP extracts the reforecasts to be used as input to the MEFP algorithm from the parameter file.

The reforecasts available during parameter estimation include all such data made available to the MEFPPE, even if restrictions in the estimation options indicated those reforecasts were not directly used to estimate parameters. For example, GEFS includes reforecasts starting in 1979. If the estimation options for MEFPPE provided a start year of 1980, the 1979 reforecasts were still available during parameter estimation and, therefore, 1979 dates can be used in hindcasting.

If an archive forecast or reforecast was not available for a date for which a hindcast is to be generated, then a message similar to the following will be generated:

> [2013-03-11 19:20:25,476] ERROR - ExecuteActivity.processDiagnosticFile - GA.Execution.Model.Error: In adapter model: Error executing model: Canonical event values for the CFSv2 forecast source and forecast time 1995-01-14 12:00:00 GMT were not found for location WALN6DEL (MAP); cannot generate hindcast.

Archive forecasts and reforecasts are available for the following range of dates for each source:

Source	Start Date	End Date	Notes
RFC	Varies by RFC	Varies by RFC	
GEFS	1/1/1985	7/30/2012	
CFSv2	1/1/1982	12/27/2012	CFSv2 reforecasts consist of complete, 16-member lagged ensembles. They are generated every 5-days beginning at the start date.

When including the CFSv2 forecast source, if hindcasts are being generated for every day in some historical period, errors should be expected four out of five of those days, because reforecasts are available every fifth day, and this may cause errors in the rest of the hindcast workflow. Thus, it is important to choose the batch forecast dates carefully when using CFSv2 as a forecast source (or ignore results for dates for which errors occur).

6 Tips and Trouble Shooting

This section provides basic tips and troubleshooting related to the configuration of the MEFP forecast components.

6.1 *Tips*

6.1.1 Specifying the Diurnal Pattern to Convert TFMN and TMFX to FMAT

The MEFP outputs forecast ensembles of 24-hour minimum temperature (TFMN) and maximum temperature (TFMX). However, most models that use temperature, such as SNOW-17, requires 6-hour mean temperature values (FMAT) at the standard GMT synoptic times: 0, 6, 12, 18Z. The module that converts TFMN and TFMX to FMAT is the following:

<*configuration_dir*>/ModuleConfigFiles/hefs/preprocessingMEFP/MEFP_FMAT_Forecast.xml

It performs diurnal computations based on coefficients defined in this file:

<*configuration_dir*>/CoefficientSetsFiles/ MEFP_TFMN_TFMX_to_FMAT_Coefficients.xml

By default, the file defines these coefficients:

```
...
  <coefficientSet id="FMAT 18Z">
    <user>
      <simple>
        <coefficient id="COEFF_18Z_TFMN_AFTER"  value="0.0"/>
        <coefficient id="COEFF_18Z_TFMN_BEFORE" value="0.4"/>
        <coefficient id="COEFF_18Z_TFMX_AFTER"  value="0.6"/>
        <coefficient id="COEFF_18Z_TFMX_BEFORE" value="0.0"/>
      </simple>
    </user>
  </coefficientSet>
  <coefficientSet id="FMAT 0Z">
    <user>
      <simple>
        <coefficient id="COEFF_0Z_TFMN_AFTER"  value="0.05"/>
        <coefficient id="COEFF_0Z_TFMN_BEFORE" value="0.025"/>
        <coefficient id="COEFF_0Z_TFMX_AFTER"  value="0.925"/>
        <coefficient id="COEFF_0Z_TFMX_BEFORE" value="0.0"/>
      </simple>
    </user>
  </coefficientSet>
  <coefficientSet id="FMAT 6Z">
    <user>
      <simple>
        <coefficient id="COEFF_6Z_TFMN_AFTER"  value="0.67"/>
        <coefficient id="COEFF_6Z_TFMN_BEFORE" value="0.0"/>
        <coefficient id="COEFF_6Z_TFMX_AFTER"  value="0.33"/>
        <coefficient id="COEFF_6Z_TFMX_BEFORE" value="0.0"/>
```

```
        </simple>
      </user>
    </coefficientSet>
    <coefficientSet id="FMAT 12Z">
      <user>
        <simple>
          <coefficient id="COEFF_12Z_TFMN_AFTER"  value="0.0"/>
          <coefficient id="COEFF_12Z_TFMN_BEFORE" value="0.0"/>
          <coefficient id="COEFF_12Z_TFMX_AFTER"  value="0.0"/>
          <coefficient id="COEFF_12Z_TFMX_BEFORE" value="0.0"/>
          <coefficient id="COEFF_12Z_TFMN_ON"     value="0.95"/>
          <coefficient id="COEFF_12Z_TFMX_ON"     value="0.05"/>
        </simple>
      </user>
    </coefficientSet>
...
```

The coefficients defined for "FMAT 18Z", "FMAT 0Z", and "FMAT 6Z" all define scalars (multipliers) to apply to the TFMN and TFMX values for the 12Z times both *before* ("_BEFORE" suffixed coefficients) and *after* ("_AFTER") the given time of day. For example, for a given day, the default coefficients define the 6-hour FMAT values to be as follows:

$$FMAT_{18Z} = 0.0 * TFMN_{AFT} + 0.4 * TFMN_{BEF} + 0.6 * TFMX_{AFT} + 0.0 * TFMX_{BEF}$$
$$FMAT_{0Z} = 0.05 * TFMN_{AFT} + 0.025 * TFMN_{BEF} + 0.925 * TFMX_{AFT} + 0.0 * TFMX_{BEF}$$
$$FMAT_{6Z} = 0.67 * TFMN_{AFT} + 0.0 * TFMN_{BEF} + 0.33 * TFMX_{AFT} + 0.0 * TFMX_{BEF}$$

The coefficients defined for "FMAT 12Z" define scalars to apply to the TFMN and TFMX values for the same time as the desired 12Z time, as well as the 12Z values for both the day before and the day after. For example, for a given day, the default coefficients to define the 6-hour FMAT value for 12Z is as follows:

$$FMAT_{12Z} = 0.0 * TFMN_{AFT} + 0.0 * TFMN_{BEF} + 0.0 * TFMX_{AFT} + 0.0 * TFMX_{BEF} + 0.95 * TFMN_{ON} + 0.5 * TFMX_{ON}$$

Modify the diurnal pattern as needed to suit the needs of your RFC.

This diurnal pattern may need to be kept in synch with the diurnal pattern to convert from 6-hour historical temperature time series (MAT) to 24-hour forecast minimum and maximum temperature (TFMN and TFMX), which is used by MEFPPE when importing datacard data (see the appendix in the *MEFPPE Configuration Guide*).

6.1.2 Turning off, Turning On, and Completely Removing Forecast Sources

The configuration files delivered with the release of MEFP, by default, assume that all forecast sources, RFC QPF/QTF, GEFS, and CFSv2, could potentially be used by MEFP to generate forecast ensembles. However, by default, only the GEFS and CFSv2 forecast sources are *turned on*, meaning that they have a number of forecast days set within the MEFPEnsembleGeneratorModelAdapter module run-file properties that is larger than 0. The RFC is *turned off*, by default.

TURNING OFF A FORECAST SOURCE

To *turn off* a forecast source in the MEFP for a particular data type, make it so that the forecast source is *not* used by the MEFP and the preprocessing workflows are not executed. Do the following:

Action: Set the <source>NumberOfForecastDays run file property in the appropriate MEFPEnsembleGeneratorModelAdapter module configuration file(s) to be "0". The file(s) to modify vary by forecast group and data type:

***precipitation*:**
<*configuration_dir*>/ModuleConfigFiles/hefs/<*fgroup*>/<*fgroup*>_MEFP_FMAP_Forecast.xml

***temperature*:**
<*configuration_dir*>/ModuleConfigFiles/hefs/<*fgroup*>/<*fgroup*>_MEFP_TFMN_TFMX_Forecast.xml

Action: Comment out the portion of the same adapter module configuration file(s) within the exportTimeSeriesActivity XML element that exports the time series for the forecast source. Comments in the configuration file mark the appropriate sections for each source.

Action: Do not include the modules associated with that data type within the MEFP_Forecast workflow execution. The modules to not include for each source and data type are as follows:

RFC QPF/QTF:
precipitation:
-none-
temperature:
MEFP_RFC_MAT_6to24.xml

GEFS:
precipitation:
MEFP_GEFS_Interpolate_Location_FMAP.xml
temperature:
MEFP_GEFS_Interpolate_Location_TFMN.xml
MEFP_GEFS_Interpolate_Location_TFMX.xml
MEFP_GEFS_TFMN_6to24.xml
MEFP_GEFS_TFMX_6to24.xml

CFSv2:

precipitation:

<*fgroup*>_MEFP_CFSv2_FMAP_LaggedEnsemble.xml (one per forecast group)

temperature:

MEFP_CFSv2_TFMN_6to24.xml
MEFP_CFSv2_TFMX_6to24.xml
<*fgroup*>_MEFP_CFSv2_TFMN_LaggedEnsemble.xml (one per forecast group)
<*fgroup*>_MEFP_CFSv2_TFMX_LaggedEnsemble.xml (one per forecast group)

To exclude a module, modify the pre-processing workflow configuration file for the source,

<*configuration_dir*>/WorkflowFiles/hefs/MEFP_Preprocess_<source>_Forecast.xml

and comment out the activity XML element that calls the module.

Alternatively, if executed within an SA standalone, the **Manual Forecast Dialog** can be used to exclude a module by selecting the workflow, pressing <F12>, clicking "Select modules to include in next run…" from the popup menu that opens, and unchecking the appropriate modules.

It is recommended that this alternative only be used while experimenting in order to determine which sources to use or when debugging a problem. Once a decision is made pertaining to the sources to use, make the change directly to the workflow files as described above.

TURNING ON A FORECAST SOURCE

To *turn on* a forecast source, reverse the process described above. The general steps are as follows (see the instructions for *turning off* a forecast source for more details):

- Set the <source>NumberOfForecastDays run file property in the appropriate MEFPEnsembleGeneratorModelAdapter module configuration file(s) to be the desired number.
- Uncomment the portion of the same adapter module configuration file(s) within the exportTimeSeriesActivity XML element that exports the time series for the forecast source.
- Include the modules for the forecast source in the MEFP_Forecast workflow by uncommenting them. See the *turning off* instructions above for the modules to include.

COMPLETELY REMOVING A FORECAST SOURCE

To *completely remove* a forecast source so that no modules or workflows exist related to that source, do the following:

It is not easy to reverse the changes below. Once completely removed, the only way to recover the changes is by re-installing and re-configuring the appropriate files following instructions provided in this configuration guide. As such, only *completely remove* a forecast source if you are absolutely certain it will never be used at your RFC.

Action: Remove all module configuration files associated with the forecast source and data type(s) that is to be completely removed. The module configuration files to be removed for each source and data type are the same as those listed above.

Action: For each module configuration file removed, remove the corresponding module instance descriptor defined in <*configuration_dir*>/RegionConfigFiles/ModuleInstanceDescriptors.xml.

Action: If the forecast source is to be removed for both data types, then remove the preprocessing workflow configuration file defined for the forecast source. Otherwise, modify the preprocessing workflow removing the activity XML elements for the modules removed above. The workflow configuration file to be either removed or modified for each source is as follows:

RFC: MEFP_Preprocess_RFC_Forecast.xml
GEFS: MEFP_Preprocess_GEFS_Forecast.xml
CFSv2: MEFP_Preprocess_CFSv2_Forecast.xml

These workflow configuration files are all located in <*configuration_dir*>/WorkflowFiles/hefs.

Action: If a workflow configuration file is removed, remove the corresponding workflow descriptor defined in <*configuration_dir*>/RegionConfigFiles/WorkflowDescriptors.xml.

Action: If a workflow configuration file is removed, modify the workflow configuration file

<*configuration_dir*>/WorkflowFiles/hefs/MEFP_Forecast.xml

Remove the activity XML element that calls to the removed preprocessing workflow.

Action: Modify the module configuration files that execute the MEFPEnsembleGeneratorModelAdapter to remove the source. The files to modify are listed above for *turning off* a forecast source. This requires removing all timeSeriesSet XML elements defined within the exportTimeSeriesActivity XML element for the forecast source and removing any run file properties that are prefixed with the name of the forecast source (in lower case letters). The following is an example of a GEFS run file property:

```
<int key="gefsNumberOfForecastDays" value="0"/>
```

Action: If the forecast source to be completely removed is GEFS, or CFSv2, then remove the associated scheduled workflow for importing the gridded forecasts. For each source, the workflow is as follows:

GEFS: ImportMEFP-GEFSGrids.xml
CFSv2: ImportMEFP-CFSv2Grids.xml

6.1.3 Appending Raw Climatology to MEFP Output using CHPS

MEFP appends climatology-based output to its generated forecast ensemble whenever the number of forecast days for the climatology forecast source is set to a non-zero value that exceeds the largest number of forecast days set for any other source. This value is set within the run file properties section of the module configuration file. For example:

```
<exportRunFileActivity>
  <exportFile>%ROOT_DIR%/run_info.xml</exportFile>
  <properties>
    …
    <int key="gefsNumberOfForecastDays" value="15"/>
    <int key="cfsv2NumberOfForecastDays" value="270"/>
    <int key="climatologyNumberOfForecastDays" value="330"/>
    …
```

The MEFP climatology-based output is "resampled" climatology, applying the MEFP algorithm to generate smoothed climatology and appending those values to the ensemble members.

If "raw" climatology, which directly uses historical data to yield an ensemble equivalent to ESP, is preferred, then CHPS transformations must be used. Specifically, a sample transformation should be performed to create a raw-climatology ensemble and a merge transformation should be performed to append it to the end of the MEFP output. For resampled climatology, MEFP should continue to be used (set the property climatologyNumberOfForecastDays accordingly).

Provided below are instructions to add a module to sample raw climatology and merge it with the output from MEFP, and incorporate that module within existing MEFP/HEFS workflows. The four steps to perform are as follows:

1. **Action: Create a sample and merge module, *_MEFP_SampleAndMerge_Forecast.xml. Add an appropriate module instance descriptor.**

Create a module to sample historical (datacard) MAP and MAT time series and merge them with the 6-hourly output of the MEFP. The modules that generate the 6-hourly MEFP output are the modules <*fgroup*>_MEFP_FMAP_Forecast and <*fgroup*>_MEFP_FMAT_Forecast, where <*fgroup*> is the applicable forecast group. An example of a *_MEFP_SampleAndMerge_Forecast.xml module configuration file is provided below for the Hudson forecast group in NERFC; embedded comments explain the different sections of the configuration file:

The example below can be used as a template if all instances of "Hudson", highlighted in green, are changed to the appropriate forecast group name for your RFC. Other RFC-specific changes may be needed, as well.

```
<?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">
   <!-- Precipitation Inputs: historical 6-hour MAP and FMAP ensemble output from MEFP. -->
   <variable>
      <variableId>MAP_Historic</variableId>
      <timeSeriesSet>
         <moduleInstanceId>ImportDataCard</moduleInstanceId>
         <valueType>scalar</valueType>
         <parameterId>MAP</parameterId>
         <locationSetId>Catchments_HEFS_Hudson</locationSetId>
         <timeSeriesType>external historical</timeSeriesType>
         <timeStep unit="hour" multiplier="6"/>
         <readWriteMode>read complete forecast</readWriteMode>
      </timeSeriesSet>
   </variable>
   <variable>
      <variableId>MAP_MEFP</variableId>
      <timeSeriesSet>
         <moduleInstanceId>Hudson_MEFP_FMAP_Forecast</moduleInstanceId>
         <valueType>scalar</valueType>
         <parameterId>FMAP</parameterId>
         <locationSetId>Catchments_HEFS_Hudson</locationSetId>
         <timeSeriesType>external forecasting</timeSeriesType>
         <timeStep unit="hour" multiplier="6"/>
         <readWriteMode>read complete forecast</readWriteMode>
         <ensembleId>MEFP</ensembleId>
      </timeSeriesSet>
   </variable>

   <!-- Precipitation Outputs: Sampled raw-climatology ensemble and merged MEFP output and raw climatology. -->
   <variable>
      <variableId>MAP_sampled</variableId>
      <timeSeriesSet>
         <moduleInstanceId>Hudson_MEFP_SampleAndMerge_Forecast</moduleInstanceId>
         <valueType>scalar</valueType>
         <parameterId>FMAP</parameterId>
         <qualifierId>sample</qualifierId>
         <locationSetId>Catchments_HEFS_Hudson</locationSetId>
         <timeSeriesType>temporary</timeSeriesType>
         <timeStep unit="hour" multiplier="6"/>
         <relativeViewPeriod unit="day" start="0" end="0" endOverrulable="true"/>
         <readWriteMode>add originals</readWriteMode>
         <ensembleId>MEFP</ensembleId>
      </timeSeriesSet>
   </variable>
   <variable>
      <variableId>MAP_merged</variableId>
      <timeSeriesSet>
```

```
      <moduleInstanceId>Hudson_MEFP_SampleAndMerge_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAP</parameterId>
      <qualifierId>historicalmerge</qualifierId>
      <locationSetId>Catchments_HEFS_Hudson</locationSetId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6"/>
      <relativeViewPeriod unit="day" start="0" end="0" endOverrulable="true"/>
      <readWriteMode>add originals</readWriteMode>
      <ensembleId>MEFP</ensembleId>
   </timeSeriesSet>
</variable>

<!-- Temperature Inputs: historical 6-hour MAT and FMAT ensemble output from MEFP with diurnal pattern applied. -->
<variable>
   <variableId>MAT_Historic</variableId>
   <timeSeriesSet>
      <moduleInstanceId>ImportDataCard</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MAT</parameterId>
      <locationSetId>Catchments_HEFS_Hudson</locationSetId>
      <timeSeriesType>external historical</timeSeriesType>
      <timeStep unit="hour" multiplier="6"/>
      <readWriteMode>read complete forecast</readWriteMode>
   </timeSeriesSet>
</variable>
<variable>
   <variableId>MAT_MEFP</variableId>
   <timeSeriesSet>
      <moduleInstanceId>Hudson_MEFP_FMAT_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAT</parameterId>
      <locationSetId>Catchments_HEFS_Hudson</locationSetId>
      <timeSeriesType>external forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6"/>
      <readWriteMode>read complete forecast</readWriteMode>
      <ensembleId>MEFP</ensembleId>
   </timeSeriesSet>
</variable>

<!-- Temperature Outputs: Sampled raw-climatology ensemble and merged MEFP output and raw climatology. -->
<variable>
   <variableId>MAT_sampled</variableId>
   <timeSeriesSet>
      <moduleInstanceId>Hudson_MEFP_SampleAndMerge_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAT</parameterId>
      <qualifierId>sample</qualifierId>
      <locationSetId>Catchments_HEFS_Hudson</locationSetId>
      <timeSeriesType>temporary</timeSeriesType>
      <timeStep unit="hour" multiplier="6"/>
      <relativeViewPeriod unit="day" start="0" end="0" endOverrulable="true"/>
      <readWriteMode>add originals</readWriteMode>
      <ensembleId>MEFP</ensembleId>
   </timeSeriesSet>
</variable>
```

```
<variable>
   <variableId>MAT_merged</variableId>
   <timeSeriesSet>
      <moduleInstanceId>Hudson_MEFP_SampleAndMerge_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAT</parameterId>
      <qualifierId>historicalmerge</qualifierId>
      <locationSetId>Catchments_HEFS_Hudson</locationSetId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6"/>
      <relativeViewPeriod unit="day" start="0" end="0" endOverrulable="true"/>
      <readWriteMode>add originals</readWriteMode>
      <ensembleId>MEFP</ensembleId>
   </timeSeriesSet>
</variable>
```

<!-- Sample the MAP data to yield a raw-climatology ensemble. The startWaterYear parameter can be used to toggle between traditional water year (10/01) and calendar year (01/01); this setting should match the one used for MEFP (i.e. memberIndexingYear property)**. Other parameters specify the members (years) to create, which must match the output from MEFP. -->**

```
<transformation id="SampleESP_MAP">
   <sample>
      <historical>
         <inputVariable>
            <variableId>MAP_Historic</variableId>
         </inputVariable>
         <startYear>1950</startYear>
         <firstEnsembleMemberIndex>1950</firstEnsembleMemberIndex>
         <ensembleMemberCount>48</ensembleMemberCount>
         <startWaterYear>--10-01</startWaterYear>
         <outputVariable>
            <variableId>MAP_sampled</variableId>
         </outputVariable>
      </historical>
   </sample>
</transformation>

<-- Merge the output from MEFP with the sampled raw climatology just created. -->
<transformation id="MergeMEFP_MAP">
   <merge>
      <simple>
         <inputVariable>
            <variableId>MAP_MEFP</variableId>
         </inputVariable>
         <inputVariable>
            <variableId>MAP_sampled</variableId>
         </inputVariable>
         <outputVariable>
            <variableId>MAP_merged</variableId>
         </outputVariable>
      </simple>
   </merge>
</transformation>

<!-- Sample the MAT data to yield a raw-climatology ensemble. The startWaterYear parameter
can be used to toggle between traditional water year (10/01) and calendar year (01/01); this
```

```
   setting should match the one used for MEFP.  Other parameters specify the members (years)
   to create, which must match the output from MEFP. -->
   <transformation id="SampleESP_MAT">
      <sample>
         <historical>
            <inputVariable>
               <variableId>MAT_Historic</variableId>
            </inputVariable>
            <startYear>1950</startYear>
            <firstEnsembleMemberIndex>1950</firstEnsembleMemberIndex>
            <ensembleMemberCount>48</ensembleMemberCount>
            <startWaterYear>--10-01</startWaterYear>
            <outputVariable>
               <variableId>MAT_sampled</variableId>
            </outputVariable>
         </historical>
      </sample>
   </transformation>

   <-- Merge the output from MEFP with the sampled raw climatology just created. -->
   <transformation id="MergeMEFP_MAT">
      <merge>
         <simple>
            <inputVariable>
               <variableId>MAT_MEFP</variableId>
            </inputVariable>
            <inputVariable>
               <variableId>MAT_sampled</variableId>
            </inputVariable>
            <outputVariable>
               <variableId>MAT_merged</variableId>
            </outputVariable>
         </simple>
      </merge>
   </transformation>
</transformationModule>
```

Once created, add an appropriate descriptor to the ModuleInstanceDescriptor.xml file. Continuing with the same example:

```
   <moduleInstanceDescriptor id="Hudson_MEFP_SampleAndMerge_Forecast">
         <moduleId>TransformationModule</moduleId>
   </moduleInstanceDescriptor>
```

IMPORTANT: The example above uses datacard data as input to the sample transformation. It is important that the historical time series from which the transformation is sampling raw climatology data matches the historical time series used by MEFPPE to estimate MEFP parameters (except for changes made in MEFPPE for quality control purposes). If not, then the raw-climatology data may not properly align with the MEFP output. This may cause a problem, in particular, when generating temperature (FMAT) ensembles since the time-of-day of the maximum (and minimum) temperature values assumed by the diurnal pattern transformation contained with the module MEFP_FMAT_Forecast may not match that in the historical time series. The historical data used by MEFPPE in parameter estimation must always be on standard synoptic (GMT) forecast times: 0, 6, 12, 18Z. Specifically, if datacard data is used as input, MEFPPE associated transformation modules do the following (see the *MEFPPE Configuration Guide*):

a. Import the datacard data into the appropriate local time zone. For example, the import datacard module for MEFPPE (ImportMEFPPEDatacardsInLocaltime) may use a time zone of GMT-5 for EST data.
b. Shift the local time data so that each value is assigned to the closest GMT synoptic forecast time. For an example of such a shift transformation, see how the variable "gmt_fmat" is used within the module configuration file MEFP_MAT_to_TAMN_TAMX.xml (ModuleConfigFiles/hefs/importMEFPPE).

Altogether, this means that, if datacard data is used for sampling raw climatology, then it must be imported in an appropriate time zone to match a and b above. For example, for EST, the appropriate shift to use is -6 (-5 hours for the

2. Action: Modify *_PreProcessing_HEFS_Forecast.xml to call the module *_MEFP_SampleAndMerge_Forecast.

The call to the module *_MEFP_SampleAndMerge_Forecast, created above, should be made after the SetTimes* modules are called, but before the *MergeMAT_Forecast and *MergeMAP_Forecast modules are called. Continuing with the example above:

```
<?xml version="1.0" encoding="UTF-8"?>
<workflow 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/workflow.x
sd" version="1.1">
    <activity>
        <runIndependent>true</runIndependent>
        <moduleInstanceId>SetTimes_LastObserved</moduleInstanceId>
    </activity>
    <activity>
        <runIndependent>true</runIndependent>
        <moduleInstanceId>SetTimes_Forecast_HEFS</moduleInstanceId>
    </activity>
```

```
    <!-- Call the sample and merge module here as preparation for using MEFP output as input to standard
    streamflow forecast workflows. -->
    <activity>
        <runIndependent>true</runIndependent>
        <moduleInstanceId>Hudson_MEFP_SampleAndMerge_Forecast</moduleInstanceId>
    </activity>

    <activity>
        <runIndependent>true</runIndependent>
        <moduleInstanceId>Hudson_MergeMAT_Forecast</moduleInstanceId>
        <ensemble>
            <ensembleId>MEFP</ensembleId>
            <runInLoop>true</runInLoop>
        </ensemble>
    </activity>
    <activity>
        <runIndependent>true</runIndependent>
        <moduleInstanceId>Hudson_MergeMAP_Forecast</moduleInstanceId>
        <ensemble>
            <ensembleId>MEFP</ensembleId>
            <runInLoop>true</runInLoop>
        </ensemble>
    </activity>
</workflow>
```

When using raw climatology, the overall length of the output from MEFP, after merging with raw climatology, is controlled within a SetTimes_* module. In the example above, the SetTimes_Forecast_HEFS module is used. If 330 days of output is required (e.g., 270 days of GEFS and CFSv2 with days 271-330 filled in using raw climatology), then the module must specify a minimum length (minForecastLength XML element) of 330 days.

3. Action: Update the *_MergeMAP_Forecast.xml and *_MergeMAT_Forecast.xml files to use the output from the *_MEFP_SampleAndMerge_Forecast module.

In each file, the variable that linked to the output from MEFP should be changed to the time series output from the *_MEFP_SampleAndMerge_Forecast module. For example, in the file Hudson_MergeMAP_Forecast.xml at NERFC, this timeSeriesSet XML element should be used for the variable "MAP_MEFP":

```
  <variable>
    <variableId>MAP_MEFP</variableId>
    <timeSeriesSet>
      <moduleInstanceId>Hudson_MEFP_SampleAndMerge_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAP</parameterId>
      <qualifierId>historicalmerge</qualifierId>
      <locationSetId>Catchments_HEFS_Hudson</locationSetId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
```

```
      <timeStep unit="hour" multiplier="6"/>
      <relativeViewPeriod unit="hour" start="0" end="0" endOverrulable="true" />
      <readWriteMode>read only</readWriteMode>
    </timeSeriesSet>
  </variable>
```

In the file Hudson_MergeMAT_Forecast.xml at NERFC, this timeSeriesSet XML element should be used for the variable "MAT_MEFP":

```
  <variable>
    <variableId>MAT_MEFP</variableId>
    <timeSeriesSet>
      <moduleInstanceId>Hudson_MEFP_SampleAndMerge_Forecast</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>FMAT</parameterId>
      <qualifierId>historicalmerge</qualifierId>
      <locationSetId>Catchments_HEFS_Hudson</locationSetId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
      <timeStep unit="hour" multiplier="6"/>
      <relativeViewPeriod unit="hour" start="0" end="0" endOverrulable="true" />
      <readWriteMode>read only</readWriteMode>
    </timeSeriesSet>
  </variable>
```

4. **Action: Remove the run-file property** useResampledClimatology **from the appropriate module configuration files that execute the MEFPEnsembleGeneratorModelAdapter, and set the property** climatologyNumberOfForecastDays **to be 0.**

MEFP will always uses resampled climatology, so the property is no longer used. Since raw climatology is being used, MEFP should not extend its output using resampled climatology, so the climatology forecast source should not be used.

6.2 *Troubleshooting*

Provided here are recommendations for how to resolve problems encountered in using the MEFP in operational forecasting. \

6.2.1 Executing Modules in Debug Mode

The MEFP configuration files include many calls to standard FEWS transformations, as well as calls to two HEFS provided model adapters: the CFSv2LaggedEnsembleModelAdapter and the MEFPEnsembleGeneratorModelAdapter. All modules can be run in debug mode using the standard mechanism: select the workflow in the **Manual Forecast Dialog**, press <F12>, and select the modules to run in debug mode. However, to get additional debug information out of the CFSv2LaggedEnsembleModelAdapter and MEFPEnsembleGeneratorModelAdapter, the run-file property printDebugInfo must be set to a positive number; for example:

```
<int key="printDebugInfo" value="1"/>
```

When executed with a positive printDebugInfo, the two adapters will output all debug information lines to the diagnostics file for ingest by CHPS at a debug level.

6.2.2 FMAP/FMAT Ensembles Not Long Enough for Streamflow Forecasting

If errors occur when running the just-created ensemble forecasting workflow due to missing MAP or MAT data in the SNOW17 or SAC-SMA models, then it may be caused by the forecast length for the workflow being longer than the time period covered by the output of the MEFP_Forecast workflow.

The MEFPEnsembleGeneratorModelAdapter executes the MEFP model to generate ensembles of 6-hour FMAT and 24-hour TFMN and TFMX time series. The 24-hour ensembles of TFMN and TFMX time series are then converted to ensembles 6-hour FMAT time series in the MEFP_FMAT_Forecast module. The ensembles of 6-hour FMAP and 6-hour FMAT time series are then used as input to the streamflow forecasting process (in most cases). Section 4.2.1 describes how the time period covered by the ensmebles of 6-hour FMAP and FMAT time series are controlled through module configuration files.

If the time period covered by the ensembles of FMAP or FMAT time series output by the MEFP_Forecast workflow is not long enough for your desired streamflow forecasts, then do the following:

1. Make sure the ensembles output by the MEFPEnsembleGeneratorModelAdapter are long enough by setting the <source>NumberOfForecastDays properties accordingly. Typically, this means increase the climatologyNumberOfForecastDays to the desired length.
2. For temperature, set the end times of all relativeViewPeriod XML elements in the MEFP_FMAT_Forecast module configuration file to be at least the desired length. Do not modify the TFMN and TFMX time series that are input to the module, since they use a readWriteMode of "read complete forecast".

It is okay for the end times for the relativeViewPeriod XML elements in the MEFP_FMAT_Forecast module to exceed the length of the forecast ensembles output by MEFP; the FMAT time series will be cutoff to the appropriate length given the output from MEFP. This is why a default length of 365 days is used, since it should cover most cases.

6.2.3 No Acceptable First Time Series Found for CFSv2LaggedEnsembleModelAdapter

The section applies if you see a message output from a module that executes the CFSv2LaggedEnsembleModelAdapter similar to the following:

> Error executing model: Error building ensemble component list for ASEN6HUD: No acceptable first time series file was found in the archive directory with a time within 24 hours of 2013-03-26 12:00:00 GMT for location ASEN6HUD and parameter FMAP.

In such a case, the CFSv2 location specific time series files may have failed to export during data ingest. See the tips and troubleshooting in *MEFP Configuration Guide: Data Ingest Components*.