## Introduction

Most menu items in CAVE reference a bundle, which is defined in an .XML file. CAVE extends the concept of an AWIPS-1 bundle, which was essentially just a component of a procedure. Bundles in AWIPS-2 describe the specifications of a CAVE display. At a minimum, bundles specify the type of plot (contour map, station model plot, time series, sounding) and provide a connection to the data through queries to the metadata database.

To illustrate a bundle, we'll look at a model family in the volume menu. Recall the baseFamilies.xml file that's located under CAVE ► Menus ►Volume ►baseFamilies.xml in the Localization Perspective or in the localization/menus subdirectory of the volumebrowser plugin. Figure 1 is the bottom portion of that file. Note that these menu items are bundleItems and each reference a file in a bundles/volume directory. Like the menu files, these bundles can be in CAVE's etc directory or in the localization store, and all of them are available in the Localization Perspective. We will examine the NAM40 Model Family (a sample is in Figure 2), which references the DefaultFamily.xml bundle. Note that several different model families use this same bundle, and various key-value pairs can be passed into the bundle as well.

```xml
<contribute xsi:type="bundleItem" file="bundles/volume/DefaultFamily.xml"
    menuText="NAM80" id="nam80" useReferenceTime="true">
    <substitute key="modelName" value="ETA"/>
    <substitute key="TP" value="TP6hr"/>
    <substitute key="frameCount" value="15"/>
</contribute>
<contribute xsi:type="bundleItem" file="bundles/volume/DefaultFamily.xml"
    menuText="RUC13" id="ruc13" useReferenceTime="true">
    <substitute key="modelName" value="RUC130"/>
    <substitute key="TP" value="TP3hr"/>
    <substitute key="frameCount" value="13"/>
</contribute>
<contribute xsi:type="bundleItem" file="bundles/volume/DefaultFamily.xml"
    menuText="RUC" id="ruc" useReferenceTime="true">
    <substitute key="modelName" value="RUC236"/>
    <substitute key="TP" value="TP3hr"/>
    <substitute key="frameCount" value="9"/>
</contribute>
<contribute xsi:type="bundleItem" file="bundles/volume/UKMET.xml"
    menuText="UKMET" id="ukmet" useReferenceTime="true">
    <substitute key="TP" value="TP6hr"/>
    <substitute key="frameCount" value="15"/>
</contribute>
</menuTemplate>
```

Figure 1. Bottom portion of baseFamilies.xml, one of the menu files for the Volume menu.

## Example: DefaultFamily.xml bundle for a model family

Bundles are available in the Localization Perspective under CAVE ► Bundles. DefaultFamily.xml is located in a volume folder under Bundles. The NAM40 model family structure (Figure 3) is defined by the DefaultFamily bundle. The NAM40 Model Family has two contour plots (500 mb height and 500 mb vorticity) visible by default with six more that can be toggled off and on. Remember that the product legend is a visible representation of the vertical structure of the display (which products overlay or underlay other products). There's a one-to-one correspondence between the product legend and the contents (and order) of the "resources" in the display bundle.



Figure 2. Sample display of NAM40 model family.



Figure 3. Structure of NAM40 Model Family as shown by its product legend.

The DefaultFamily.xml (Figure 4) starts by specifying that the display is a map ("d2DMapRenderableDisplay") using the CONUS scale with default density, magnification, and zoom settings. The map center is approximately at 79.1 deg longitude and 33.9 deg latitude. The first product to be displayed (called a resource), is a visible contour, with solid lines with a width of 1 pixel. The rest of the bundle describes the various layers in the display (each is a "resource").

```
<bundle xmlns:ns2="group">
    <displayList>
        <displays xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:type="d2DMapRenderableDisplay" scale="CONUS" density="1.0"
                magnification="1.0" zoomLevel="1.0" mapCenter="-79.09835514095181 33.915979250804455 0.0">
            <descriptor xsi:type="mapDescriptor">

                <resource>
                    <loadProperties xsi:type="gridLoadProperties" displayType="CONTOUR" loadWithoutData="false">
                        <capabilities>
                            <capability xsi:type="outlineCapability" lineStyle="SOLID" outlineOn="true" outlineWidth="1"/>
                        </capabilities>
                        <resourceType>PLAN_VIEW</resourceType>
                    </loadProperties>
                    <properties isSystemResource="false" isBlinking="false" isMapLayer="false" isHoverOn="false" isVisible="true">
                        <pdProps maxDisplayWidth="100000000" minDisplayWidth="0"/>
                    </properties>
```
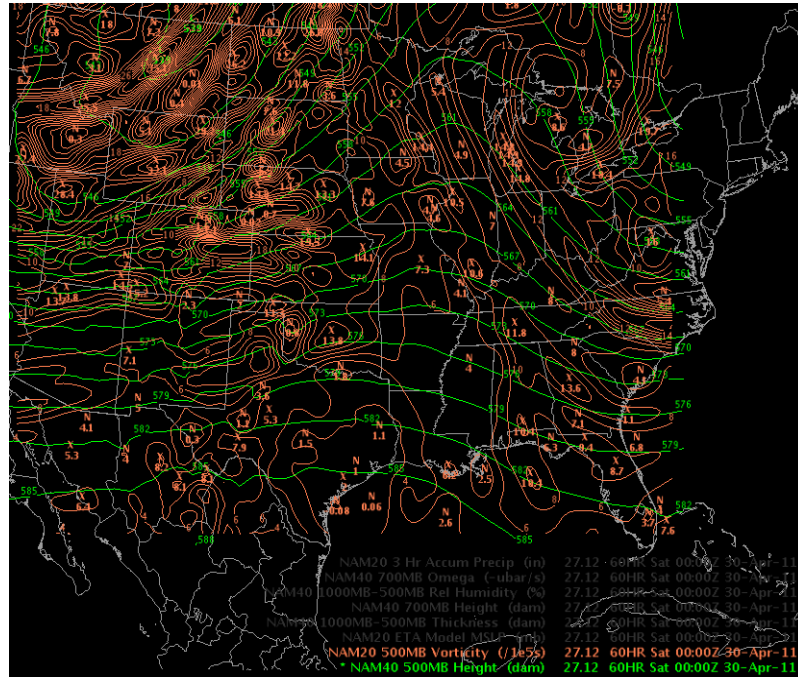
Figure 4. Topmost section of DefaultFamily.xml.

The first resource defined in the bundle (Figure 5) is a visible ("isVisible" tag) contour plot ("displayType" tag) with solid lines ("lineStyle" tag). The weather data that the resource loads is defined by a resourceData tag. This particular resource is a gridResourceData. AWIPS-2 defines various kinds of resourceData for different types of data and combinations of data. A few examples of resourceData include radarResourceData, bestResResourceData, radarMosaicResourceData (all for radar data), plotResourceData for station plots, satResourceData for satellite, and wwaResourceData for warning polygons. A special resourceData called firstAvailableResourceData was created to allow bundles to make a choice of a resource to display from among several predefined alternatives based upon which resource currently has weather data associated with it. The CAVE/EDEX Configuration exercise on constructing model families provides several examples of using firstAvailableResrouceData.

```xml
<resource>
    <loadProperties xsi:type="gridLoadProperties" displayType="CONTOUR" loadWithoutData="false">
        <capabilities>
            <capability xsi:type="outlineCapability" lineStyle="SOLID" outlineOn="true" outlineWidth="1"/>
        </capabilities>
        <resourceType>PLAN_VIEW</resourceType>
    </loadProperties>
    <properties isSystemResource="false" isBlinking="false" isMapLayer="false" isHoverOn="false" isVisible="true">
        <pdProps maxDisplayWidth="100000000" minDisplayWidth="0"/>
    </properties>
    <resourceData xsi:type="gridResourceData" retrieveData="true" isUpdatingOnMetadataOnly="false" isRequeryNecessa
        <metadataMap>
            <mapping key="modelInfo.parameterAbbreviation">
                <constraint constraintValue="GH" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.modelName">
                <constraint constraintValue="${modelName}" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.leveltwovalue">
                <constraint constraintValue="-999999" constraintType="EQUALS" />
            </mapping>
            <mapping key="pluginName">
                <constraint constraintValue="grib" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.masterLevel.name">
                <constraint constraintValue="MB" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.levelonevalue">
                <constraint constraintValue="500.0" constraintType="EQUALS"/>
            </mapping>
        </metadataMap>
        <alertParser xsi:type="dataCubeAlertMessageParser"/>
    </resourceData>
</resource>
```

Figure 5. First resource in DefaultFamily.xml bundle for 500 mb height contours.

The weather data is connected to this contour plot by using a metadataMap which creates a database query for this plot. CAVE uses the metadata map to build a database SQL query to discover if data are available to make the map (and to populate the "green times" in the menus). In this case, the data to be plotted is 500 mb height that was ingested using the grib plugin (mapping keys of parameterAbbreviation, level.masterLevel.name, level.levelonevalue, and pluginName). The menu entry passes in a value (in this case, "mesoEta212" for the NAM40) for ${modelName}, which is how this same bundle can be used for multiple models. This modelName value is defined in the index.xml menu file for the volume menu. The

constraintType does not have to be "EQUALS".  "LIKE" matches strings with wildcards, for example.

The bundle builds the display from the bottom-up, so the first resource defined the 500 mb height contour.  The second resource (Figure 6) provides the details for the 500 mb vorticity plot.  Its specifications are exactly the same as for the 500 mb height plot except the parameterAbbreviation is "AV" for absolute vorticity.

```xml
<resource>
    <loadProperties xsi:type="gridLoadProperties" displayType="CONTOUR" loadWithoutData="false">
        <capabilities>
            <capability xsi:type="outlineCapability" lineStyle="SOLID" outlineOn="true" outlineWidth="1"/>
        </capabilities>
        <resourceType>PLAN_VIEW</resourceType>
    </loadProperties>
    <properties isSystemResource="false" isBlinking="false" isMapLayer="false" isHoverOn="false" isVisible="true">
        <pdProps maxDisplayWidth="100000000" minDisplayWidth="0"/>
    </properties>
    <resourceData xsi:type="gridResourceData" retrieveData="true" isUpdatingOnMetadataOnly="false" isRequeryNecessar
        <metadataMap>
            <mapping key="modelInfo.parameterAbbreviation">
                <constraint constraintValue="AV" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.modelName">
                <constraint constraintValue="${modelName}" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.leveltwovalue">
                <constraint constraintValue="-999999" constraintType="EQUALS"/>
            </mapping>
            <mapping key="pluginName">
                <constraint constraintValue="grib" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.masterLevel.name">
                <constraint constraintValue="MB" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.levelonevalue">
                <constraint constraintValue="500.0" constraintType="EQUALS"/>
            </mapping>
        </metadataMap>
        <alertParser xsi:type="dataCubeAlertMessageParser"/>
    </resourceData>
</resource>
```

Figure 6.  Second resource in DefaultFamily.xml bundle for the 500 mb vorticity plot.

The third resource (Figure 7) specifies the sea-level pressure contours.  This plot is not visible by default, the parameterAbbreviation is "msl-P", and the level is defined as "SFC" rather than "MB".

```xml
<resource>
    <loadProperties xsi:type="gridLoadProperties" displayType="CONTOUR" loadWithoutData="false">
        <capabilities>
            <capability xsi:type="outlineCapability" lineStyle="SOLID" outlineOn="true" outlineWidth="1"/>
        </capabilities>
        <resourceType>PLAN_VIEW</resourceType>
    </loadProperties>
    <properties isSystemResource="false" isBlinking="false" isMapLayer="false" isHoverOn="false" isVisible="false">
        <pdProps maxDisplayWidth="100000000" minDisplayWidth="0"/>
    </properties>
    <resourceData xsi:type="gridResourceData" retrieveData="true" isUpdatingOnMetadataOnly="false" isRequeryNecessar
        <metadataMap>
            <mapping key="modelInfo.parameterAbbreviation">
                <constraint constraintValue="msl-P" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.modelName">
                <constraint constraintValue="${modelName}" constraintType="EQUALS"/>
            </mapping>
            <mapping key="pluginName">
                <constraint constraintValue="grib" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.masterLevel.name">
                <constraint constraintValue="SFC" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.levelonevalue">
                <constraint constraintValue="0.0" constraintType="EQUALS"/>
            </mapping>
        </metadataMap>
        <alertParser xsi:type="dataCubeAlertMessageParser"/>
    </resourceData>
</resource>
```

Figure 7. Third resource in DefaultFamily.xml for surface pressure plot.

The next plot in the model family (Figure 8) is a layer product, 1000-500 mb thickness.  The plot specifications say the plot is not visible by default, that the parameterAbbreviation is "dZ" for thickness, that the levelName is "MB" and there are two levels defined (levelonevalue = 1000 and leveltwovalue = 500).

```xml
<resource>
    <loadProperties xsi:type="gridLoadProperties" displayType="CONTOUR" loadWithoutData="false">
        <capabilities>
            <capability xsi:type="outlineCapability" lineStyle="SOLID" outlineOn="true" outlineWidth="1"/>
        </capabilities>
        <resourceType>PLAN_VIEW</resourceType>
    </loadProperties>
    <properties isSystemResource="false" isBlinking="false" isMapLayer="false" isHoverOn="false" isVisible="false">
        <pdProps maxDisplayWidth="100000000" minDisplayWidth="0"/>
    </properties>
    <resourceData xsi:type="gridResourceData" retrieveData="true" isUpdatingOnMetadataOnly="false" isRequeryNecessar
        <metadataMap>
            <mapping key="modelInfo.parameterAbbreviation">
                <constraint constraintValue="dZ" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.modelName">
                <constraint constraintValue="${modelName}" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.leveltwovalue">
                <constraint constraintValue="500.0" constraintType="EQUALS"/>
            </mapping>
            <mapping key="pluginName">
                <constraint constraintValue="grib" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.masterLevel.name">
                <constraint constraintValue="MB" constraintType="EQUALS"/>
            </mapping>
            <mapping key="modelInfo.level.levelonevalue">
                <constraint constraintValue="1000.0" constraintType="EQUALS"/>
            </mapping>
        </metadataMap>
        <alertParser xsi:type="dataCubeAlertMessageParser"/>
    </resourceData>
</resource>
```

Figure 8.  Fourth resource in DefaultFamily.xml bundle for 1000-500 mb thickness contours.

The baseline bundle files delivered with AWIPS-2 mimic AWIPS-1 displays because of the black-box conversion from AWIPS-1 to AWIPS-2.  However, there is nothing in the AWIPS-2 design that precludes various combinations of plots and resourceDatas from being defined as new bundles and attached to new menus as AWIPS-2 continues to be developed.