DRAFT

Project Report
ATC-355

CIWS Product Description
Revision 1.0

G. Rappa
S. Troxel

July 22, 2009

Lincoln Laboratory

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Lexington, Massachusetts

Prepared for the Federal Aviation Administration
Washington, DC 20591

DRAFT

ABSTRACT

Lincoln Laboratory has developed an information model for the distribution of data products from the National CIWS prototype, currently operating at Lincoln Laboratory in Lexington, Massachusetts. This document is intended to serve as a reference for the description of CIWS data product files.

DRAFT

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LIST OF ILLUSTRATIONS

LIST OF TABLES

1. INTRODUCTION

This document contains a description of CIWS data products that are packaged and distributed for external users. CIWS data products are categorized as gridded and non-gridded. Gridded CIWS products are typically expressed as rectangular arrays whose elements contain a data value coinciding with uniformly-spaced observations or computed results on a 2-D surface. Gridded data arrays map to earth's surface through a map projection, for example, Lambert Conformal or Lambert Azimuthal Equal-Area. Non-gridded data usually express observations or computed results associated with singular geo-spatial locations.

CIWS prototype data products were used to develop, refine, and evaluate a reference information model for gridded and non-gridded data. Data packaging methods were evaluated and selected on the basis of public-domain open-source availability and metadata support. Network Common Data Format (NetCDF), provided by Unidata, was selected as the information model for gridded CIWS products. Geography Markup Language (GML), defined by the Open Geospatial Consortium (OGC) was selected for non-gridded products.

2. NATIONAL CIWS GRIDDED PRODUCT FILES

National CIWS gridded products consist of one or more rectangular arrays of data values or flags, uniformly-spaced in some map projection such as Lambert Azimuthal Equal Area (LAEA). The files are formatted using Unidata NetCDF4 which relies on NetCDF API software and HDF5 file access software.

Product descriptions are summarized in the following sections. Appendix A includes more detailed product file summaries in "network Common Data Form Language" (CDL), generated by the *ncdump* utility.

Whenever possible, variables and attributes defined in CIWS product files abide by Climate and Forecast (CF) metadata conventions. The recommendations defined for the CF convention are available via Web site: **http://cf-pcmdi.llnl.gov/**.

2.1 GRID MAPPING PROJECTIONS

The National CIWS gridded product files are mapped using the Lambert Azimuthal Equal Area projection. This projection was selected for its convenience while forming the mosaic of individual radar observations. According to CF convention, an additional pair of grids is packed with each NetCDF file to declare the latitude and longitude of every grid element. However, in order to reduce the file sizes, the latitude/longitude grids are omitted from CIWS product files. Clients may instead compute grid bin locations using element indices and well-defined projection mapping routines available at a number of public-domain Web sites. Useful map projection attributes are included in the CIWS NetCDF. The grid mapping variable and its corresponding attributes, as they appear in most CIWS gridded product files, is as follows:

```
int grid_mapping0 ;
            grid_mapping0:grid_mapping_name = “lambert_azimuthal_equal_area” ;
            grid_mapping0:long_name = “Lambert Azimuthal Equal Area Projection” ;
            grid_mapping0:latitude_of_projection_origin = 38. ;
            grid_mapping0:longitude_of_projection_origin = -98. ;
            grid_mapping0:false_easting = 0. ;
            grid_mapping0:false_northing = 0. ;
            grid_mapping0:earth_radius = 6370997. ;
```

The grid mapping variable may also contain attribute information describing the Earth radius associated with the map projection. The Earth radius information is typically required for software that maps projected grid elements (x, y offset) to locations (latitude, longitude). A sample software bin-to-location mapping is provided below, using the General Cartographic Transformation Package (GCTP). The GCTP software is available at URL: http://gcmd.nasa.gov/records/USGS-GCTP.html

The GCTP library, named “geolib.a”, contains functions that perform forward and inverse mapping projection conversions. Instructions for building the library accompany the software package.

The following sample program, written in C++, illustrates how the location of each bin in a nominal National CIWS grid may be computed:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <iostream>

extern “C”
{
#include “cproj.h”
}

using namespace std;

int main( int argc, char** argv )
{
  static double pi = 4.0 * atan( 1.0 );

  int numRows = 3520;
  int numCols = 5120;
  double eastSpacing_m = 1000.;
  double northSpacing_m = 1000.;
  double centerLat_deg = 38.0;
  double centerLon_deg = -98.0;
  double falseEasting_m = 0.0;
  double falseNorthing_m = 0.0;
  double earthRadiusSpereical_m = 6370997.;  /* see sphdz.c */

  double centerLat_rad = ( pi / 180. ) * centerLat_deg;
  double centerLon_rad = ( pi / 180. ) * centerLon_deg;

  lamazinvint( earthRadiusSpereical_m, centerLon_rad, centerLat_rad,
               falseEasting_m, falseNorthing_m );

  for( int row = -numRows/2 ; row < numRows/2 ; row++ )
  {
    double y_m = (double)row * northSpacing_m;

    for( int col = -numCols/2 ; col < numCols/2 ; col++ )
    {
      double x_m = (double)col * eastSpacing_m;
      double gc_lat_rad, gc_lon_rad;

      if( lamazinv( x_m, y_m, &gc_lon_rad, &gc_lat_rad ) != OK )
      {
        fprintf( stderr, “Error converting x_m=%f, y_m=%f\n”, x_m, y_m );
        exit( EXIT_FAILURE );
      }
      else
      {
        double gc_lat_deg = ( 180. / pi ) * gc_lat_rad;
        double gc_lon_deg = ( 180. / pi ) * gc_lon_rad;

        printf( “ %5d %5d : %7.1f %7.1f : %8.4f %8.4f\n”,
          row, col, x_m*.001, y_m*.001, gc_lat_deg, gc_lon_deg );
      }
```

```
    } // for(col)

  }  // for(row)

  exit( EXIT_SUCCESS );
}
```

The highlighted text in the above code refers to GCTP functions. In the above example, the arguments passed to the *lamazinvint* function would be extracted from a NetCDF file as the attributes of the grid mapping variable. For the Lambert Azimuthal Equal Area map projection, the National CIWS and GCTP both define earth radius as spherical (identical major and minor axis lengths) and equal to 6370997.0 meters.

Applications written in Java may use similar map projection manipulation software available from the PROJ.4 Cartographic Projections Library at URL: **http://trac.osgeo.org/proj/**.

2.2 QUANTIZED DATA VALUES

Some of the National CIWS products are expressed in "quantized" format, for the benefit of clients with reduced-bandwidth communication circuits to the Internet. A quantized product file contains a primary data variable whose elements are filtered to a pre-defined set of thresholds. The resultant NetCDF file therefore contains a data array with less variation among its elements, thereby improving its compression, and resulting in smaller product files.

An example of VIL quantization is illustrated in Table 1. The information in this table should not be hard-coded into client software for decoding purposes. Instead, the threshold values and associated intensity levels may be extracted from the VIL variable attributes (see Appendix A for NetCDF listings in CDL).

TABLE 1

VIL Quantization Table

Encoded VIL Codes	Decoded VIL Values (kg/m^2)	Corresponding Precip Intensity (NWS Levels)
0	0.0	0
13	0.0317	0a
58	0.1416	1a
63	0.1538	1b
113	0.2759	1c
317	0.7739	2
1448	3.5353	3
2900	7.0803	4
4977	12.1512	5
13574	33.1407	6

Notes: Level "0a" is depicted as Level 0 in Standard Mode and as Level 1a in Winter Mode. Levels 1a, 1b, and 1c are all depicted as Level 1 in Standard Mode.

An example of Echo Top quantization is illustrated in Table 2. The information in this table should not be hard-coded into client software for decoding purposes. Instead, the threshold values and associated intensity levels may be extracted from the ECHO_TOP variable attributes (see Appendix A for NetCDF listings in CDL).

TABLE 2

Echo Top Quantization Table

Encoded Echo Top Codes	Decoded Echo Top Values (kfeet)
0	0.0
5	5
10	10
15	15
20	20
25	25
30	30
35	35
40	40
45	45
50	50+

2.3 DATA DIMENSIONS

Data variables in gridded NetCDF product files are declared as four-dimensional (4-D) arrays to allow for future expansion of product coverage and for commonality among all gridded product files. The 4-D arrays are packed according to NetCDF convention with the least-varying dimension first and most-varying dimensions last. For example, a VIL array is defined as follows:

```
short VIL( t0, z0, y0, x0 );
```

t0 is the time coordinate which will be constant for single-grid files and an array of times for forecast grid files. Thus, most current product files (non-forecast) are fundamentally 2-D arrays. **z0** is an altitude coordinate and remains constant (zero) for most National CIWS products (since altitude is not varied among CIWS products). **y0** is the grid row index and **x0** is the grid column index.

2.4 GRIDDED FILE TIME EXPRESSIONS

The National CIWS gridded files contain a number of expressions for time, most of which are assigned standard names that follow Climate and Forecast (CF) convention. However, two non-CF metadata variables qualify data collection times: **start_time** and **stop_time**. The start and stop time describe the collection time interval from which the data sample was gathered. Table 3 defines all of the time variables appearing in the gridded CIWS product files and identifies those that match CF convention. Figure 1 illustrates how these times relate to each other with respect to data collection, processing, and forecast.

TABLE 3

Gridded Product Time Expressions

Variable Name	CF Standard Name	Definition
time	time	Product validity time
start_time	--	The time data collection began
stop_time	--	The time data collection ended
forecast_reference_time	forecast_reference_time	The time of the analysis from which the forecast was made
forecast_period	forecast_period	The time interval between the forecast reference time and the validity time
Time entries highlighted (yellow) only appear in forecast product files.		

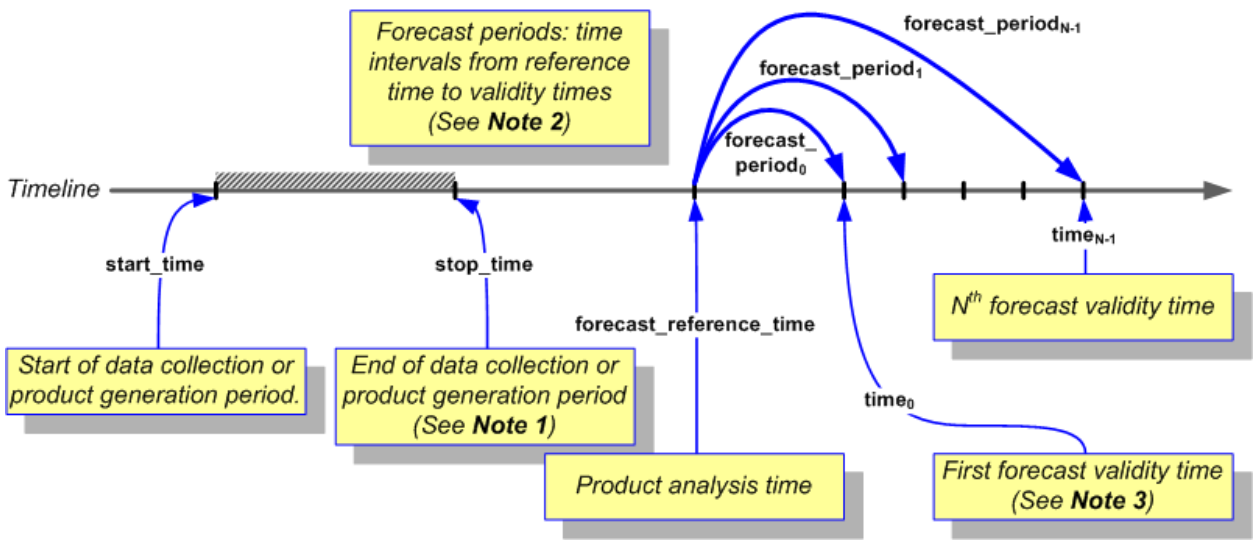

Figure 1. Gridded file time expression diagram

Notes:

[1] The **stop_time** may drift beyond the **forecast_reference_time** in systems that continue collecting data while processing existing data sets.

[2] The forecast periods may be computed using:

$$\textbf{forecast\_period}_i = \textbf{time}_i - \textbf{forecast\_reference\_time}$$

However, the **forecast_period** values are included in the NetCDF files as a convenience for file clients.

[3] For current (non-forecast) data sets, $\textbf{time}_0$ is identical to the **forecast_reference_time** and the **forecast_period** is zero.

3. NATIONAL CIWS GRIDDED PRODUCT DESCRIPTIONS

The gridded CIWS data products that have been encoded with NetCDF format are:

- Current CONUS Precip (VIL) Dataset
- Current CONUS Quantized Precip (VIL) Dataset
- Forecast CONUS Precip (VIL) Dataset
- Forecast CONUS Quantized Precip (VIL) Dataset
- Current CONUS Echo Top Dataset
- Current CONUS Quantized Echo Top Dataset
- Forecast CONUS Echo Top Dataset
- Forecast CONUS Quantized Echo Top Dataset
- Current CONUS Satellite Dataset

The following subsections contain descriptions of National CIWS non-gridded product files. Examples of non-gridded product file summaries (CDL listings) appear in Appendix A.

3.1 CURRENT CONUS PRECIP (VIL) DATASET

The Current Precip (VIL) dataset is a NetCDF-4 file containing three CONUS-extent variables:

- VIL(1,1,3520,5120) Current VIL indicates the amount of atmospheric liquid as observed with radar and computed over an extent of a volume scan. VIL values are expressed with 16-bit digital codes whose scaled values span the full range of VIL: **0.0 to 80.0 kg/m^2**. VIL variable attributes (*scale_factor* and *add_offset*) are included for the conversion of encoded VIL into floating point values according to NetCDF and CF convention.

- VIL_FLAGS(1,1,3520,5120) VIL status flags indicate data quality with CF-compliant bit-mapped status flags:
    - The **no coverage** status condition indicates that no radar coverage was available for the corresponding VIL data array element.
    - The **impaired** status condition indicates that the corresponding VIL data array element suffers some form of degradation, such as beam blockage.

- PRECIP_PHASE(1,1,3520,5120) Precipitation phase flags only assume three possible values to indicate the potential for precipitation phase or state:

    - The **liquid** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of liquid precipitation.

- The **mixed** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of a mixture of liquid and frozen precipitation.
- The **frozen** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of frozen liquid, for example, snow.

The VIL product filename convention is as follows:

edu.mit.ll.wx.ciws.VIL.Netcdf4.1km.*YYYYMMDD***T***hhmmss***Z.nc**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

3.2 CURRENT CONUS QUANTIZED PRECIP (VIL) DATASET

The Current Quantized Precip (VIL) dataset is a NetCDF-4 file containing three CONUS-extent variables. Quantized VIL values are filtered to a pre-defined set of thresholds for improved compressibility and smaller files.

- VIL(1,1,3520,5120) Current quantized VIL indicates the amount of atmospheric liquid as observed with radar and computed over an extent of a volume scan. Quantized VIL values are expressed with 16-bit digital codes whose scaled values span the full range of VIL: **0.0 to 80.0 kg/m^2**. VIL variable attributes (*scale_factor* and *add_offset*) are included for the conversion of encoded VIL into floating point values according to NetCDF and CF convention.

- VIL_FLAGS(1,1,3520,5120) VIL status flags indicate data quality with CF-compliant bit-mapped status flags:

  - The **no coverage** status condition indicates that no radar coverage was available for the corresponding VIL data array element.
  - The **impaired** status condition indicates that the corresponding VIL data array element suffers some form of degradation, such as beam blockage.

- PRECIP_PHASE(1,1,3520,5120) Precipitation phase flags only assume three possible values to indicate the potential for precipitation phase or state:
  - The **liquid** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of liquid precipitation.
  - The **mixed** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of a mixture of liquid and frozen precipitation.
  - The **frozen** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of frozen liquid, for example, snow.

The filename convention is as follows:

edu.mit.ll.wx.ciws.QuantizedVIL.Netcdf4.1km.*YYYYMMDD***T***hhmmss***Z.nc**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

3.3 FORECAST CONUS PRECIP (VIL) DATASET

The Forecast VIL dataset is a NetCDF-4 file containing two CONUS-extent variables:

- VIL(24,1,3520,5120) Forecast VIL represents a forecast of the amount of atmospheric liquid. Forecast VIL values are expressed with 16-bit digital codes whose scaled values span the full range of VIL: **0.0 to 80.0 kg/m^2**. VIL variable attributes (*scale_factor* and *add_offset*) are included for the conversion of encoded VIL into floating point values according to NetCDF and CF convention. All 24 VIL forecasts are included in each NetCDF file by varying the time coordinate of the 4-D VIL variable from 5 minutes to 2 hours at 5-minute intervals.

- PRECIP_PHASE(24,1,3520,5120) Forecast precipitation phase flags only assume three possible values to indicate the forecast potential for precipitation phase or state. A precipitation phase grid is defined for each forecast so the PHASE_FLAGS array uses a time coordinate with 24 values.
    - The **liquid** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of liquid precipitation.
    - The **mixed** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of a mixture of liquid and frozen precipitation.
    - The **frozen** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of frozen liquid, for example, snow.

- VIL_FLAGS(1,1,3520,5120) VIL status flags indicate data quality with CF-compliant bit-mapped status flags:

    - The **no coverage** status condition indicates that no radar coverage was available for the corresponding VIL data array element.
    - The **impaired** status condition indicates that the corresponding VIL data array element suffers some form of degradation, such as beam blockage.

    This VIL_FLAGS array in the forecast file is identical to the VIL_FLAGS array in the current VIL file (See Section 3.1) and is duplicated here for user convenience. The same flag array may be applied to all forecast time horizons.

The filename convention is as follows:

edu.mit.ll.wx.ciws.VILForecast.Netcdf4.1km.*YYYYMMDD***T***hhmmss***Z.nc**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

3.4 FORECAST CONUS QUANTIZED PRECIP (VIL) DATASET

The Forecast Quantized VIL dataset is a NetCDF-4 file containing two CONUS-extent variables. Quantized VIL values are filtered to a pre-defined set of thresholds for improved compressibility and smaller files.

- VIL(24,1,3520,5120) Forecast quantized VIL represents a forecast of the amount of atmospheric liquid. Forecast Quantized VIL values are expressed with 16-bit digital codes whose scaled values span the full range of VIL: **0.0 to 80.0 kg/m^2**. VIL variable attributes (*scale_factor* and *add_offset*) are included for the conversion of encoded VIL into floating point values according to NetCDF and CF convention. All 24 VIL forecasts are included in each NetCDF file by varying the time coordinate of the 4-D VIL variable from 5 minutes to 2 hours at 5-minute intervals.

- PRECIP_PHASE(24,1,3520,5120) Forecast precipitation phase flags only assume three possible values to indicate the forecast potential for precipitation phase or state. A precipitation phase grid is defined for each forecast so the PHASE_FLAGS array uses a time coordinate with 24 values.
    - The **liquid** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of liquid precipitation.
    - The **mixed** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of a mixture of liquid and frozen precipitation.
    - The **frozen** phase flag indicates that precipitation in the corresponding VIL data array is likely to consist of frozen liquid, for example, snow.

- VIL_FLAGS(1,1,3520,5120) VIL status flags indicate data quality with CF-compliant bit-mapped status flags:

    - The **no coverage** status condition indicates that no radar coverage was available for the corresponding VIL data array element.
    - The **impaired** status condition indicates that the corresponding VIL data array element suffers some form of degradation, such as beam blockage.

    This VIL_FLAGS array in the forecast file is identical to the VIL_FLAGS array in the current Quantized VIL file (See Section 3.2) and is duplicated here for user convenience. The same flag array may be applied to all forecast time horizons.

The filename convention is as follows:

edu.mit.ll.wx.ciws.QuantizedVILForecast.Netcdf4.1km.*YYYYMMDD***T***hhmmss***Z.nc**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

3.5 CURRENT CONUS ECHO TOP DATASET

The Current Echo Top dataset is a NetCDF-4 file containing two CONUS-extent data variables:

- ECHO_TOP(1,1,3520,5120) Current Echo Top indicates the maximum altitude of observed radar returns computed over an extent of a volume scan. Echo Top values are expressed with 8-bit digital codes whose scaled values span the full range of Echo Tops: **0 to 70,000 feet** (1000-foot increments). Echo Top variable attributes (*scale_factor* and *add_offset*) are included for the conversion of encoded Echo Tops into floating point values according to NetCDF and CF convention.

- ECHO_TOP_FLAGS(1,1,3520,5120) Echo Top status flags indicate data quality with CF-compliant bit-mapped status flags:
  - The **no coverage** status condition indicates that no radar coverage was available for the corresponding Echo Top data array element.
  - The **impaired** status condition indicates that the corresponding Echo Top data array element suffers some form of degradation, such as beam blockage.
  - The **topped** status condition indicates that significant radar returns were observed among the uppermost elevation scans and that a storm may extend above the reported echo top values.

The Echo Top product filename convention is as follows:

edu.mit.ll.wx.ciws.EchoTop.Netcdf4.1km.*YYYYMMDD***T***hhmmss***Z.nc**
where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

3.6 CURRENT CONUS QUANTIZED ECHO TOP DATASET

The Current Quantized Echo Top dataset is a NetCDF-4 file containing two CONUS-extent variables. Quantized values are filtered to a pre-defined set of thresholds for improved compressibility and smaller files.

- ECHO_TOP(1,1,3520,5120) Current Echo Top indicates the maximum altitude of observed radar returns computed over an extent of a volume scan. Echo Top values are expressed with 8-bit digital codes whose scaled values span the full range of Echo Tops: **0 to 70,000 feet** (1000-foot increments). Echo Top variable attributes (*scale_factor* and *add_offset*) are included for the conversion of encoded Echo Tops into floating point values according to NetCDF and CF convention.

- ECHO_TOP_FLAGS(1,1,3520,5120) Echo Top status flags indicate data quality with CF-compliant bit-mapped status flags:
  - The **no coverage** status condition indicates that no radar coverage was available for the corresponding Echo Top data array element.

- The **impaired** status condition indicates that the corresponding Echo Top data array element suffers some form of degradation, such as beam blockage.
- The **topped** status condition indicates that significant radar returns were observed among the uppermost elevation scans and that a storm may extend above the reported echo top values.

The Echo Top product filename convention is as follows:

edu.mit.ll.wx.ciws.QuantizedEchoTop.Netcdf4.1km.*YYYYMMDD***T***hhmmss***Z.nc**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

3.7 FORECAST CONUS ECHO TOP DATASET

The Forecast Echo Top dataset is a NetCDF-4 file containing one CONUS-extent data variable:

- ECHO_TOP(24,1,3520,5120) Forecast Echo Top indicates the maximum altitude of forecast precipitation. Echo Top values are expressed with 8-bit digital codes whose scaled values span the full range of Echo Tops: **0 to 70,000 feet** (1000-foot increments). Echo Top variable attributes (*scale_factor* and *add_offset*) are included for the conversion of encoded Echo Tops into floating point values according to NetCDF and CF convention.

The Forecast Echo Top product filename convention is as follows:

edu.mit.ll.wx.ciws.EchoTopsForecast.Netcdf4.1km.*YYYYMMDD***T***hhmmss***Z.nc**

3.8 FORECAST CONUS QUANTIZED ECHO TOP DATASET

The Forecast Quantized Echo Top dataset is a NetCDF-4 file containing one CONUS-extent data variable:

- ECHO_TOP(24,1,3520,5120) Forecast Echo Top indicates the maximum altitude of forecast precipitation. Echo Top values are expressed with 8-bit digital codes whose scaled values span the full range of Echo Tops: **0 to 70,000 feet** (1000-foot increments). Echo Top variable attributes (*scale_factor* and *add_offset*) are included for the conversion of encoded Echo Tops into floating point values according to NetCDF and CF convention.

The filename convention is as follows:

edu.mit.ll.wx.ciws.QuantizedEchoTopsForecast.Netcdf4.1km.*YYYYMMDD***T***hhmmss***Z.nc**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

3.9 CURRENT CONUS SATELLITE DATASET

The Current Satellite dataset is a NetCDF-4 file containing one CONUS-extent variable. Since this product consists of remapped satellite observations, data values are expressed using 8-bit codes whose scaled values represent an intensity level derived from both GOES satellites (East and West). The current satellite intensity values range from 0 to 33 and have no units. Although a unit-less data quantity does not comply with normal CF conventions, this non-standard satellite data expression will be used until an alternate expression is identified.

- RemappedSatellite(1,1,3520,5120) Current satellite observations from East and West GOES satellite stations. Satellite image values are expressed with 8-bit digital codes from 0 to 33.

The filename convention is as follows:

edu.mit.ll.wx.ciws.Satellite.Netcdf4.1km.*YYYYMMDD***T***hhmmss***Z.nc**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

4. NATIONAL CIWS NON-GRIDDED PRODUCT FILES

The non-gridded CIWS data products contain data values that are organized as points, curves, contours, or text messages. The geospatially sparse and irregular spacing of these data lend themselves to encoding using the human-readable, text-based Extensible Mark-up Language (XML) format, rather than a gridded format such as NetCDF. To reduce file sizes, the XML files are compressed using gzip and the XML text content is formatted without spaces or indentation (not pretty-printed). Many browsers (e.g., Firefox, Internet Explorer) will automatically pretty-print the XML file contents when the file is loaded in the browser, making the XML easier to view.

XML schema files (.xsd files) utilize an XML grammar to specify what elements may be used in XML documents, the order of the elements, the number of occurrences of each element, and the content and data type of each element and attribute. Thus, the schemas serve as a type of format description for the XML data files. Every XML data file should not only be well-formed (syntactically correct XML), but must also be valid in that it obeys the element ordering, frequency, and types defined in the associated schema.

The application schemas that support CIWS non-gridded product data models draw upon multiple layers of XML data content models. These include the basic XML data types as well as data types developed in accordance with Open Geospatial Consortium (OGC) and ISO standards including Geography Markup Language (GML), Observations & Measurements (OM), and weather and aviation weather-specific data types collaboratively developed by various US and European agencies including Weather Exchange Schema (WXXS) and a general weather data type schema (WX).

The complete set of supporting XML schema can be downloaded by running subversion to anonymously check out the schema directory tree from the wxforge subversion repository. The following is an example series of commands for downloading the schema into a local directory named "*wxforge*"

```
chdir ~
mkdir wxforge
chdir wxforge
svn checkout http://wxforge.wx.ll.mit.edu/svn/ogc-
bindings/trunk/schemas schemas
```

If a username is requested, enter "*anonymous*", followed with a password of your e-mail address, e.g., "*joe-client@company.com*". The subversion checkout will populate a directory named "schemas".

Namespace prefixes are used within XML element tags to avoided naming conflicts when utilizing data types from multiple packages. The CIWS XML data are encoded utilizing data types from the namespaces described in Table 4.

TABLE 4

XML Schema Namespace Description

Namespace Prefix	Namespace	Schema Directory	Description
Default (no prefix)	http://www.w3.org/2001/XMLSchema	N/A	XML standard schema
gml	http://www.opengis.net/gml/3.2	net/opengis/gml/3.2.1	OGC GML schema
om	http://www.opengis.net/om/1.0/gml32	net/opengis/om/1.0.0_gml32	OGC Observations & Measurements (O&M) schema
wx	http://www.eurocontrol.in/wx/1.1	int/eurocontrol/wx/1.1.0	General weather schema
avwx	http://www.eurocontrol.int/wxxs/1.1	int/eurocontrol/wxxs/1.1.0	Aviation weather schema implementation of Eurocontrol's WXXM
nawx	http://www.faa.gov/nawx/1.1	gov/faa/nawx/1.1.0	North American (e.g., FAA) aviation weather schema

The CIWS non-gridded product data models make strong use of the feature model of GML and the OGC schema for Observations and Measurements, which defines an observation as follows:

> *"An Observation is an action with a result which has a value describing some phenomenon. […] An observation feature binds a result to a feature of interest, upon which the observation was made. The observed property is a property of the feature of interest. An observation uses a procedure to determine the value of the result, which may involve a sensor or observer, analytical procedure, simulation, or other numerical process."*[1]

Additionally, the CIWS data models take advantage of a developmental extension of O&M that adds a Forecast type as a semantically parallel companion of the Observation type (see wxForecast.xsd in the wx namespace).

The non-gridded CIWS data products that have been encoded with XML format are:

- Current Growth & Decay Trends Dataset
- Current Storm Echo Top Tags Dataset

---

[1] Cox, S., ed. (2006), "Observations and Measurements", OpenGIS Consortium document 05-087r4, Version 0.14.7, [Web URL: http://portal.opengeospatial.org/files/?artifact_id=17038 (March, 2009)]

- Current & Forecast Storm Leading Edge Positions Dataset
- Current Storm Motion Vectors Dataset
- Forecast Standard-Mode Precip (VIL) Contours Dataset
- Forecast Winter-Mode Precip (VIL) Contours Dataset
- Forecast Echo Tops Contours Dataset
- Echo Tops Forecast Accuracy Scores Dataset
- Standard-Mode Precip (VIL) Forecast Accuracy Scores Dataset
- Winter-Mode Precip (VIL) Forecast Accuracy Scores Dataset
- Current Lightning Flash Dataset

The following subsections contain descriptions of National CIWS non-gridded product files. Examples of non-gridded product XML files appear in Appendix B.

4.1 CURRENT GROWTH AND DECAY TRENDS DATASET

The Current Growth & Decay Trends dataset is a GML file containing contours that indicate regions where storm growth or decay has been detected. A single outline contour delineates a growth or decay region (but there may be many separate growth or decay regions). Prior to XML conversion, the contour values are expressed as integer-scaled "interest" probability values ranging from 0 to 254 with values > 128 considered to be growth, and values < 128 considered to be decay. A value of 125 was the threshold that was applied to produce the decay contour, and a value of 130 was the growth contour level. During XML encoding, these interest values are converted to a signed probability ranging from -1.0 to 1.0 using the relation:

GD Probability = (InterestValue – 128) / (254 - 128)

Thus, growth contours are represented in the XML with positive contour values (+0.016), and decay contours are represented with negative contour values (-0.024). The growth contour features are ordered first in the XML feature collection, followed by the decay contours.

The filename convention is as follows:

edu.mit.ll.wx.ciws.GrowthDecay_YYYYMMDD**T**hhmmss**Z.xml.gz**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

XML Application Schema

The table below lists some of the important application-level schema used to encode this product.

Namespace	Schema Location	Schema File
wx	int/eurocontrol/wx/1.1.0	wxBase.xsd
wx	int/eurocontrol/wx/1.1.0	wxObservation.xsd
wx	int/eurocontrol/wx/1.1.0	wxContour.xsd

4.2 CURRENT STORM ECHO TOP TAGS DATASET

The Current Storm Echo Top Tags dataset is a GML file containing storm echo top tags. Each tag is a latitude/longitude coordinate point with an accompanying text value indicating the storm echo top altitude in meters.

The filename convention is as follows:

edu.mit.ll.wx.ciws.StormInfo_EchoTopTags_YYYYMMDD**T**hhmmss**Z.xml.gz**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

XML Application Schema

The table below lists some of the important application-level schema used to encode this product.

Namespace	Schema Location	Schema File
wx	int/eurocontrol/wx/1.1.0	wxBase.xsd
wx	int/eurocontrol/wx/1.1.0	wxObservation.xsd
nawx	gov/faa/nawx/1.1.0	wxEchoTopPoint.xsd

4.3 CURRENT & FORECAST STORM LEADING EDGE POSITIONS DATASET

The Current & Forecast Storm Leading Edge Positions dataset is a GML file containing current and forecast leading edge contours of NWS Level 3 (41 dBZ) precipitation intensity.

The top-level feature collection in the XML contains two feature members: the *Observation* and the *Forecast*. The *result* section of the *Observation* contains a feature collection of the current *LeadingEdge* contours. The *result* section of the *Forecast* contains a feature collection of the 10- and 20-minute forecast *LeadingEdge* extrapolation contours. Each forecast *LeadingEdge* contour contains a

featureOfInterest link to the associated current *LeadingEdge* contour in the *Observation* block (see the XML example that follows).

The filename convention is as follows:

edu.mit.ll.wx.ciws.StormInfo_LeadingEdges_YYYYMMDD**T**hhmmss**Z.xml.gz**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

XML Application Schema

The table below lists some of the important application-level schema used to encode this product.

Namespace	Schema Location	Schema File
wx	int/eurocontrol/wx/1.1.0	wxBase.xsd
wx	int/eurocontrol/wx/1.1.0	wxObservation.xsd
wx	int/eurocontrol/wx/1.1.0	wxForecast.xsd
wx	int/eurocontrol/wx/1.1.0	wxContour.xsd
nawx	gov/faa/nawx/1.1.0	wxLeadingEdge.xsd
gml	net/opengis/gml/3.2.1	geometryPrimitives.xsd

4.4 CURRENT STORM MOTION VECTORS DATASET

The Current Storm Motion Vectors dataset is a GML file containing storm motion vectors that indicate the speed and direction of motion for individual storm cells of NWS Level 3 or greater. Each motion vector is encoded in a *MotionVector* feature element within the *result* feature collection block of the *Observation* node, and consists of an observation time, position (latitude, longitude), speed in knots, and direction in degrees.

The filename convention is as follows:

edu.mit.ll.wx.ciws.StormInfo_MotionVecs_YYYYMMDD**T**hhmmss**Z.xml.gz**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

XML Application Schema

The table below lists some of the important application-level schema used to encode this product.

Namespace	Schema Location	Schema File
wx	int/eurocontrol/wx/1.1.0	wxBase.xsd
wx	int/eurocontrol/wx/1.1.0	wxObservation.xsd
wx	int/eurocontrol/wx/1.1.0	wxMotionVector.xsd

4.5 FORECAST CONTOURS DATASETS

The Forecast Contours datasets are GML files containing forecast contours of Level 3+ (Standard-Mode Precip), Level 1c+ (Winter-Mode Precip), or 30+ Kft (Echo Tops).

In the XML, these are encoded in a *Forecast* feature member whose *result* block contains a feature collection of zero or more *Contour* features. Each *Contour* includes: forecast valid time, contour value (units of kg/m^2 for VIL and meters for echo tops), and a *Curve* with a list of latitude and longitude coordinates delineating the contour outline.

The filename conventions are as follows:

edu.mit.ll.wx.ciws.Standard_VilForecastContours_YYYYMMDD**T**hhmmss**Z.xml.gz**
edu.mit.ll.wx.ciws.Winter_VilForecastContours_YYYYMMDD**T**hhmmss**Z.xml.gz**
edu.mit.ll.wx.ciws.EchoTopsForecastContours_YYYYMMDD**T**hhmmss**Z.xml.gz**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

XML Application Schema

The table below lists some of the important application-level schema used to encode this product.

Namespace	Schema Location	Schema File
wx	int/eurocontrol/wx/1.1.0	wxBase.xsd
wx	int/eurocontrol/wx/1.1.0	wxForecast.xsd
wx	int/eurocontrol/wx/1.1.0	wxContour.xsd
gml	net/opengis/gml/3.2.1	geometryPrimitives.xsd

A sample XML encoding of the CIWS Standard-Mode VIL Forecast Contours product is provided in Appendix B. The encoding is similar for the Winter-Mode VIL and Echo Tops Forecast Contour products.

4.6 FORECAST ACCURACY SCORES DATASETS

The Forecast Accuracy Scores datasets are GML files containing accuracy scores for the Echo Tops, Standard-Mode Precip (VIL), and Winter-Mode Precip (VIL) forecast products. The Forecast Accuracy is a measure of how well the 30-, 60- or 120-minute forecasts performed in the past. It is not a measure of the current forecast accuracy.

The XML *result* section of the *Observation* contains a feature collection of forecast accuracy *ScoredRegion* nodes. A *ScoredRegion* contains information about the region that was scored, the contour level that was scored, and a *regionScores* block containing a repeating series of *periodScore* properties corresponding to each of the three forecast periods. For example:

```
<nawx:ScoredRegion>

  <!-- Info about the region that was scored -->
  <nawx:region>

    <wx:AreaOfInterest gml:id="id6">
      <gml:description>ABQ</gml:description>
      <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:Airports"/>
      <gml:name>ABQ</gml:name>
    </wx:AreaOfInterest>

  </nawx:region>

  <!-- Contour level that was scored (30 kft in this example)-->
  <nawx:scoredContourLevel>Height30</nawx:scoredContourLevel>

  <!-- Scores for each forecast interval -->
  <nawx:regionScores>
    <nawx:PeriodScore>
      <nawx:period uom="minutes">30</nawx:period>
      <nawx:score uom="percent">70</nawx:score>
    </nawx:PeriodScore>

    <nawx:PeriodScore>
      <nawx:period uom="minutes">60</nawx:period>
      <nawx:score uom="percent">55</nawx:score>
    </nawx:PeriodScore>

    <nawx:PeriodScore>
      <nawx:period uom="minutes">120</nawx:period>
      <nawx:score uom="percent">60</nawx:score>
    </nawx:PeriodScore>

  </nawx:regionScores>

</nawx:ScoredRegion>
```

The filename conventions are as follows:

edu.mit.ll.wx.ciws.FcstAccuracy_EchoTops_YYYYMMDD**T**hhmmss**Z.xml.gz**
edu.mit.ll.wx.ciws.FcstAccuracy_StandardPrecip_YYYYMMDD**T**hhmmss**Z.xml.gz**

edu.mit.ll.wx.ciws.FcstAccuracy_WinterPrecip_YYYYMMDD**T**hhmmss**Z.xml.gz**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

XML Application Schema

The table below lists some of the important application-level schema used to encode this product.

Namespace	Schema Location	Schema File
wx	int/eurocontrol/wx/1.1.0	wxBase.xsd
wx	int/eurocontrol/wx/1.1.0	wxObservation.xsd
nawx	gov/faa/nawx/1.1.0	wxForecastAccuracy.xsd

A sample XML encoding of the CIWS Echo Tops Forecast Accuracy Scores product is provided in Appendix B. The encoding is similar for the two seasonal variants of the Precip Forecast Accuracy Scores products.

4.7 CURRENT LIGHTNING FLASH DATASET

The Current Lightning Flash dataset is a GML file containing cloud-to-ground lightning flash detections from the National Lightning Detection Network (NLDN) aggregated over the preceding six-minutes. A new XML file is produced when the product is updated once per minute.

The XML *result* section of the *Observation* contains a feature collection of *LightningFlash* features. Each *LightningFlash* element contains the observation time, strength (in kiloAmperes), number of strokes, and the latitude/longitude point location. For example:

```
<nawx:LightningFlash gml:id="id5">
  <wx:observationTime>
    <gml:TimeInstant gml:id="id6">
      <gml:timePosition>20080709T035425Z</gml:timePosition>
    </gml:TimeInstant>
  </wx:observationTime>
  <nawx:strength uom="kA">-30.00</nawx:strength>
  <nawx:numStrokes>3</nawx:numStrokes>
  <nawx:geometry>
    <gml:Point gml:id="id7">
    <gml:pos srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
      38.6116 -81.6016</gml:pos>
    </gml:Point>
  </nawx:geometry>
</nawx:LightningFlash>
```

The filename convention is as follows:

edu.mit.ll.wx.ciws.Lightning_YYYYMMDD**T**hhmmss**Z.xml.gz**

where *YYYYMMDD*T*hhmmss*Z represents a basic ISO-8601 expression of the data reference time (GMT) using year (YYYY), month (MM), day (DD), hour (hh), minute (mm) and second (ss).

XML Application Schema

The table below lists some of the important application-level schema used to encode this product.

Namespace	Schema Location	Schema File
wx	int/eurocontrol/wx/1.1.0	wxBase.xsd
wx	int/eurocontrol/wx/1.1.0	wxObservation.xsd
nawx	gov/faa/nawx/1.1.0	wxLightning.xsd

GLOSSARY

API	Application Programming Interface
CDL	Network Common Data Form Language
CF	Climate and Forecast
CIWS	Corridor Integrated Weather System
CONUS	Continental United States
FAA	Federal Aviation Administration
GML	Geography Markup Language
GMT	Greenwich Mean Time
HDF5	Hierarchical Data Format – Version 5
LAEA	Lambert Azimuthal Equal Area
MIT	Massachusetts Institute of Technology
MIT LL	MIT Lincoln Laboratory
NetCDF	Network Common Data Format
NLDN	National Lightning Detection Network
NWS	National Weather Service
OGC	Open Geospatial Consortium
OM	Observations and Measurements
Unidata	University Data Interactive Computing and Communications Systems
URL	Uniform Resource Locator
VIL	Vertically Integrated Liquid Water
WCS	Web Coverage Service
WFS	Web Feature Service
WXXS	Weather Exchange Schema
XML	Extensible Markup Language

WEB REFERENCES

The following Web site addresses provide useful information and/or software related to National CIWS product files.

Unitdata NetCDF Software
`http://www.unidata.ucar.edu/software/netcdf/`

HDF5 Software
`http://www.hdfgroup.org/HDF5/index.html`

Climate and Forecast Meta Data Conventions
`http://f-pcmdi.llnl.gov`

General Cartographic Transformation Package (GCTP)
`http://gcmd.nasa.gov/records/USGS-GCTP.html`

PROJ.4 Cartographic Projections Library
`http://trac.osgeo.org/proj/`

APPENDIX A
GRIDDED PRODUCT DATASET FILE SUMMARIES

The following summaries were produced with the *ncdump* utility, which comes with the NetCDF software library. It reads a NetCDF file and writes the CDL text equivalent. In the examples to follow, the lengthy y0 and x0 coordinate variable listings were abbreviated for the sake of brevity; a "…" indicates where data were removed.

A1 CURRENT CONUS PRECIP (VIL) DATASET CDL

```
netcdf edu.mit.ll.wx.ciws.VIL.Netcdf4.1km.20090327T143500Z {
dimensions:
        time = 1 ;
        z0 = 1 ;
        y0 = 3520 ;
        x0 = 5120 ;
        xml_metadata_len = 43781 ;
      variables:
        double time(time) ;
          time:standard_name = "time" ;
          time:long_name = "Product validity time" ;
          time:units = "seconds since 1970-01-01T00:00:00Z" ;
          time:calendar = "gregorian" ;
          time:string = "2009-03-27T14:35:00Z" ;
        double z0(z0) ;
          z0:standard_name = "altitude" ;
          z0:long_name = "Product altitude" ;
          z0:units = "meters" ;
          z0:axis = "Z" ;
          z0:positive = "up" ;
        double y0(y0) ;
          y0:standard_name = "projection_y_coordinate" ;
          y0:long_name = "Distance from projection reference point latitude" ;
          y0:units = "meters" ;
        double x0(x0) ;
          x0:standard_name = "projection_x_coordinate" ;
          x0:long_name = "Distance from projection reference point longitude" ;
          x0:units = "meters" ;
        double start_time ;
          start_time:long_name = "Data observation start time" ;
          start_time:units = "seconds since 1970-01-01T00:00:00Z" ;
          start_time:calendar = "gregorian" ;
          start_time:string = "2009-03-27T14:25:00Z" ;
          start_time:comment = "Data observation start time is the time data collection began" ;
        double stop_time ;
          stop_time:long_name = "Data observation stop time" ;
          stop_time:units = "seconds since 1970-01-01T00:00:00Z" ;
          stop_time:calendar = "gregorian" ;
          stop_time:string = "2009-03-27T14:35:00Z" ;
          stop_time:comment = "Data observation stop time is the time data collection ended" ;
        int grid_mapping0 ;
          grid_mapping0:grid_mapping_name = "lambert_azimuthal_equal_area" ;
```

```
          grid_mapping0:long_name = "Lambert Azimuthal Equal Area Projection" ;
          grid_mapping0:latitude_of_projection_origin = 38. ;
          grid_mapping0:longitude_of_projection_origin = -98. ;
          grid_mapping0:false_easting = 0. ;
          grid_mapping0:false_northing = 0. ;
          grid_mapping0:earth_radius = 6370997. ;
        char xml_metadata(xml_metadata_len) ;
          xml_metadata:long_name = "Product meta data" ;
          xml_metadata:comment = "Itemizes constituent mosaic tiles and radar sources" ;
        short VIL(time, z0, y0, x0) ;
          VIL:standard_name = "atmosphere_cloud_liquid_water_content" ;
          VIL:long_name = "Vertically integrated liquid water (VIL)" ;
          VIL:class_name = "VIL" ;
          VIL:product_name = "VIL" ;
          VIL:ancillary_variables = "VIL_FLAGS PRECIP_PHASE" ;
          VIL:units = "kg m-2" ;
          VIL:grid_mapping = "grid_mapping0" ;
          VIL:scale_factor = 0.00244148075807978 ;
          VIL:add_offset = 0. ;
          VIL:_FillValue = -1s ;
          VIL:valid_range = 0s, 32767s ;
        byte VIL_FLAGS(time, z0, y0, x0) ;
          VIL_FLAGS:standard_name = "atmosphere_cloud_liquid_water_content status_flag" ;
          VIL_FLAGS:long_name = "VIL data quality flags" ;
          VIL_FLAGS:class_name = "VIL_FLAGS" ;
          VIL_FLAGS:product_name = "VIL_FLAGS" ;
          VIL_FLAGS:grid_mapping = "grid_mapping0" ;
          VIL_FLAGS:_FillValue = 0b ;
          VIL_FLAGS:valid_range = 1b, 3b ;
          VIL_FLAGS:flag_masks = 3b, 3b ;
          VIL_FLAGS:flag_values = 1b, 2b ;
          VIL_FLAGS:flag_meanings = "no_coverage impaired" ;
        byte PRECIP_PHASE(time, z0, y0, x0) ;
          PRECIP_PHASE:standard_name = "atmosphere_cloud_liquid_water_content status_flag" ;
          PRECIP_PHASE:long_name = "Precipitation phase flags" ;
          PRECIP_PHASE:class_name = "PHASE_FCST" ;
          PRECIP_PHASE:product_name = "PHASE000" ;
          PRECIP_PHASE:grid_mapping = "grid_mapping0" ;
          PRECIP_PHASE:_FillValue = 0b ;
          PRECIP_PHASE:valid_range = 1b, 3b ;
          PRECIP_PHASE:flag_values = 1b, 2b, 3b ;
          PRECIP_PHASE:flag_meanings = "liquid mixed frozen" ;

      // global attributes:
          :Conventions = "CF-1.3" ;
          :history = "File created 2009-03-27T14:35:10Z on machine compute-7-4.local by
ProductAdapterVIL 1.0.0" ;
          :institution = "Data produced by the MIT Lincoln Lab Weather Sensing Group" ;
          :references = "http://www.wx.ll.mit.edu" ;
          :source = "National CIWS Data Stream: MosTileAsm:Mosaic:CiwsRelay" ;
          :title = "National CIWS VIL Mosaic Product - 1 km @ 2.5 minutes" ;
          :comment = "Mosaic of VIL derived from NEXRAD, TDWR and Canadian radar systems." ;
          :FileType = "NetCDF" ;
```

```
        :FileFormat = "Netcdf4" ;
    data:

    time = 1238164500 ;
    z0 = 0 ;
    y0 = -1759500, -1758500, -1757500, -1756500, -1755500, -1754500, -1753500,
        -1752500, -1751500, -1750500, -1749500, -1748500, -1747500, -1746500,
    ...
        1745500, 1746500, 1747500, 1748500, 1749500, 1750500, 1751500, 1752500,
        1753500, 1754500, 1755500, 1756500, 1757500, 1758500, 1759500 ;

     x0 = -2559500, -2558500, -2557500, -2556500, -2555500, -2554500, -2553500,
        -2552500, -2551500, -2550500, -2549500, -2548500, -2547500, -2546500,
    ...
        2550500, 2551500, 2552500, 2553500, 2554500, 2555500, 2556500, 2557500,
        2558500, 2559500 ;
}
```

A2 CURRENT CONUS QUANTIZED PRECIP (VIL) DATASET CDL

```
netcdf edu.mit.ll.wx.ciws.QuantizedVIL.Netcdf4.1km.20090327T143500Z {
dimensions:
  time = 1 ;
  z0 = 1 ;
  y0 = 3520 ;
  x0 = 5120 ;
  xml_metadata_len = 43781 ;
variables:
  double time(time) ;
    time:standard_name = "time" ;
    time:long_name = "Product validity time" ;
    time:units = "seconds since 1970-01-01T00:00:00Z" ;
    time:calendar = "gregorian" ;
    time:string = "2009-03-27T14:35:00Z" ;
  double z0(z0) ;
    z0:standard_name = "altitude" ;
    z0:long_name = "Product altitude" ;
    z0:units = "meters" ;
    z0:axis = "Z" ;
    z0:positive = "up" ;
  double y0(y0) ;
    y0:standard_name = "projection_y_coordinate" ;
    y0:long_name = "Distance from projection reference point latitude" ;
    y0:units = "meters" ;
  double x0(x0) ;
    x0:standard_name = "projection_x_coordinate" ;
    x0:long_name = "Distance from projection reference point longitude" ;
    x0:units = "meters" ;
  double start_time ;
    start_time:long_name = "Data observation start time" ;
    start_time:units = "seconds since 1970-01-01T00:00:00Z" ;
    start_time:calendar = "gregorian" ;
    start_time:string = "2009-03-27T14:25:00Z" ;
    start_time:comment = "Data observation start time is the time data collection began" ;
  double stop_time ;
    stop_time:long_name = "Data observation stop time" ;
    stop_time:units = "seconds since 1970-01-01T00:00:00Z" ;
    stop_time:calendar = "gregorian" ;
    stop_time:string = "2009-03-27T14:35:00Z" ;
    stop_time:comment = "Data observation stop time is the time data collection ended" ;
  int grid_mapping0 ;
    grid_mapping0:grid_mapping_name = "lambert_azimuthal_equal_area" ;
    grid_mapping0:long_name = "Lambert Azimuthal Equal Area Projection" ;
    grid_mapping0:latitude_of_projection_origin = 38. ;
    grid_mapping0:longitude_of_projection_origin = -98. ;
    grid_mapping0:false_easting = 0. ;
    grid_mapping0:false_northing = 0. ;
    grid_mapping0:earth_radius = 6370997. ;
  char xml_metadata(xml_metadata_len) ;
    xml_metadata:long_name = "Product meta data" ;
    xml_metadata:comment = "Itemizes constituent mosaic tiles and radar sources" ;
  short VIL(time, z0, y0, x0) ;
    VIL:standard_name = "atmosphere_cloud_liquid_water_content" ;
    VIL:long_name = "Vertically integrated liquid water (VIL)" ;
    VIL:class_name = "VIL" ;
    VIL:product_name = "VIL" ;
    VIL:ancillary_variables = "VIL_FLAGS PRECIP_PHASE" ;
```

```
    VIL:units = "kg m-2" ;
    VIL:grid_mapping = "grid_mapping0" ;
    VIL:scale_factor = 0.00244148075807978 ;
    VIL:add_offset = 0. ;
    VIL:_FillValue = -1s ;
    VIL:valid_range = 0s, 32767s ;
    VIL:flag_values = 0s, 13s, 58s, 63s, 113s, 317s, 1448s, 2900s, 4977s, 13574s ;
    VIL:flag_meanings = "0 0a 1a 1b 1c 2 3 4 5 6" ;
  byte VIL_FLAGS(time, z0, y0, x0) ;
    VIL_FLAGS:standard_name = "atmosphere_cloud_liquid_water_content status_flag" ;
    VIL_FLAGS:long_name = "VIL data quality flags" ;
    VIL_FLAGS:class_name = "VIL_FLAGS" ;
    VIL_FLAGS:product_name = "VIL_FLAGS" ;
    VIL_FLAGS:grid_mapping = "grid_mapping0" ;
    VIL_FLAGS:_FillValue = 0b ;
    VIL_FLAGS:valid_range = 1b, 3b ;
    VIL_FLAGS:flag_masks = 3b, 3b ;
    VIL_FLAGS:flag_values = 1b, 2b ;
    VIL_FLAGS:flag_meanings = "no_coverage impaired" ;
  byte PRECIP_PHASE(time, z0, y0, x0) ;
    PRECIP_PHASE:standard_name = "atmosphere_cloud_liquid_water_content status_flag" ;
    PRECIP_PHASE:long_name = "Precipitation phase flags" ;
    PRECIP_PHASE:class_name = "PHASE_FCST" ;
    PRECIP_PHASE:product_name = "PHASE000" ;
    PRECIP_PHASE:grid_mapping = "grid_mapping0" ;
    PRECIP_PHASE:_FillValue = 0b ;
    PRECIP_PHASE:valid_range = 1b, 3b ;
    PRECIP_PHASE:flag_values = 1b, 2b, 3b ;
    PRECIP_PHASE:flag_meanings = "liquid snow mixed" ;

// global attributes:
    :Conventions = "CF-1.3" ;
    :history = "File created 2009-03-27T14:35:13Z on machine compute-7-4.local by
ProductAdapterQuantizedVIL 1.0.0" ;
    :institution = "Data produced by the MIT Lincoln Lab Weather Sensing Group" ;
    :references = "http://www.wx.ll.mit.edu" ;
    :source = "National CIWS Data Stream: MosTileAsm:Mosaic:CiwsRelay" ;
    :title = "National CIWS Quantized VIL Mosaic Product - 1 km @ 2.5 minutes" ;
    :comment = "Mosaic of VIL derived from NEXRAD, TDWR and Canadian radar systems." ;
    :FileType = "NetCDF" ;
    :FileFormat = "Netcdf4" ;
data:

 time = 1238164500 ;

 z0 = 0 ;

 y0 = -1759500, -1758500, -1757500, -1756500, -1755500, -1754500, -1753500,
    -1752500, -1751500, -1750500, -1749500, -1748500, -1747500, -1746500,
...
    1745500, 1746500, 1747500, 1748500, 1749500, 1750500, 1751500, 1752500,
    1753500, 1754500, 1755500, 1756500, 1757500, 1758500, 1759500 ;

 x0 = -2559500, -2558500, -2557500, -2556500, -2555500, -2554500, -2553500,
    -2552500, -2551500, -2550500, -2549500, -2548500, -2547500, -2546500,
...
    2550500, 2551500, 2552500, 2553500, 2554500, 2555500, 2556500, 2557500,
    2558500, 2559500 ;
}
```

A3 FORECAST CONUS PRECIP (VIL) DATASET CDL

```
netcdf edu.mit.ll.wx.ciws.VILForecast.Netcdf4.1km.20090327T143000Z {
dimensions:
  times = 24 ;
  time = 1 ;
  z0 = 1 ;
  y0 = 3520 ;
  x0 = 5120 ;
  xml_metadata_len = 43760 ;
variables:
  double times(times) ;
    times:standard_name = "time" ;
    times:long_name = "Product validity times" ;
    times:units = "seconds since 1970-01-01T00:00:00Z" ;
    times:calendar = "gregorian" ;
    times:string = "2009-03-27T14:35:00Z/2009-03-27T16:30:00Z" ;
  double time(time) ;
    time:long_name = "Product flags validity times" ;
    time:units = "seconds since 1970-01-01T00:00:00Z" ;
    time:calendar = "gregorian" ;
    time:string = "2009-03-27T14:30:00Z" ;
  double z0(z0) ;
    z0:standard_name = "altitude" ;
    z0:long_name = "Product altitude" ;
    z0:units = "meters" ;
    z0:axis = "Z" ;
    z0:positive = "up" ;
  double y0(y0) ;
    y0:standard_name = "projection_y_coordinate" ;
    y0:long_name = "Distance from projection reference point latitude" ;
    y0:units = "meters" ;
  double x0(x0) ;
    x0:standard_name = "projection_x_coordinate" ;
    x0:long_name = "Distance from projection reference point longitude" ;
    x0:units = "meters" ;
  double start_time ;
    start_time:long_name = "Data observation start time" ;
    start_time:units = "seconds since 1970-01-01T00:00:00Z" ;
    start_time:calendar = "gregorian" ;
    start_time:string = "2009-03-27T14:20:00Z" ;
    start_time:comment = "Data observation start time is the time data collection began" ;
  double stop_time ;
    stop_time:long_name = "Data observation stop time" ;
    stop_time:units = "seconds since 1970-01-01T00:00:00Z" ;
    stop_time:calendar = "gregorian" ;
    stop_time:string = "2009-03-27T14:30:00Z" ;
    stop_time:comment = "Data observation stop time is the time data collection ended" ;
  double forecast_reference_time ;
    forecast_reference_time:standard_name = "forecast_reference_time" ;
    forecast_reference_time:long_name = "Forecast reference time" ;
    forecast_reference_time:units = "seconds since 1970-01-01T00:00:00Z" ;
    forecast_reference_time:calendar = "gregorian" ;
    forecast_reference_time:string = "2009-03-27T14:30:00Z" ;
    forecast_reference_time:comment = "Forecast reference time is the time of the analysis from
which the forecast was made" ;
  int forecast_period(times) ;
    forecast_period:standard_name = "forecast_period" ;
```

```
    forecast_period:long_name = "Time interval between the forecast reference time and the
validity time" ;
    forecast_period:units = "seconds" ;
  int grid_mapping0 ;
    grid_mapping0:grid_mapping_name = "lambert_azimuthal_equal_area" ;
    grid_mapping0:long_name = "Lambert Azimuthal Equal Area Projection" ;
    grid_mapping0:latitude_of_projection_origin = 38. ;
    grid_mapping0:longitude_of_projection_origin = -98. ;
    grid_mapping0:false_easting = 0. ;
    grid_mapping0:false_northing = 0. ;
    grid_mapping0:earth_radius = 6370997. ;
  char xml_metadata(xml_metadata_len) ;
    xml_metadata:long_name = "Product meta data" ;
    xml_metadata:comment = "Itemizes constituent mosaic tiles and radar sources" ;
  short VIL(times, z0, y0, x0) ;
    VIL:standard_name = "atmosphere_cloud_liquid_water_content" ;
    VIL:long_name = "Vertically integrated liquid water (VIL)" ;
    VIL:class_name = "FCST" ;
    VIL:product_name = "FCST" ;
    VIL:ancillary_variables = "PRECIP_PHASE" ;
    VIL:units = "kg m-2" ;
    VIL:grid_mapping = "grid_mapping0" ;
    VIL:scale_factor = 0.00244148075807978 ;
    VIL:add_offset = 0. ;
    VIL:_FillValue = -1s ;
    VIL:valid_range = 0s, 32767s ;
  byte PRECIP_PHASE(times, z0, y0, x0) ;
    PRECIP_PHASE:standard_name = "atmosphere_cloud_liquid_water_content status_flag" ;
    PRECIP_PHASE:long_name = "Precipitation phase flags" ;
    PRECIP_PHASE:class_name = "PHASE_FCST" ;
    PRECIP_PHASE:product_name = "PHASE_FCST" ;
    PRECIP_PHASE:grid_mapping = "grid_mapping0" ;
    PRECIP_PHASE:_FillValue = 0b ;
    PRECIP_PHASE:valid_range = 1b, 3b ;
    PRECIP_PHASE:flag_values = 1b, 2b, 3b ;
    PRECIP_PHASE:flag_meanings = "liquid mixed frozen" ;
  byte VIL_FLAGS(time, z0, y0, x0) ;
    VIL_FLAGS:standard_name = "atmosphere_cloud_liquid_water_content status_flag" ;
    VIL_FLAGS:long_name = "VIL data quality flags" ;
    VIL_FLAGS:class_name = "VIL_FLAGS" ;
    VIL_FLAGS:product_name = "VIL_FLAGS" ;
    VIL_FLAGS:grid_mapping = "grid_mapping0" ;
    VIL_FLAGS:_FillValue = 0b ;
    VIL_FLAGS:valid_range = 1b, 3b ;
    VIL_FLAGS:flag_masks = 3b, 3b ;
    VIL_FLAGS:flag_values = 1b, 2b ;
    VIL_FLAGS:flag_meanings = "no_coverage impaired" ;

// global attributes:
    :Conventions = "CF-1.3" ;
    :history = "File created 2009-03-27T14:32:41Z on machine compute-7-5.local by
ProductAdapterVILForecast 1.0.0" ;
    :institution = "Data produced by the MIT Lincoln Lab Weather Sensing Group" ;
    :references = "http://www.wx.ll.mit.edu" ;
    :source = "National CIWS Data Stream:
StormForecast:CombineFinalForecast:ForecastImages:CiwsRelay" ;
    :title = "National CIWS VIL Mosaic Product - 1 km @ 2.5 minutes" ;
    :comment = "Mosaic of VIL derived from NEXRAD, TDWR and Canadian radar systems." ;
    :FileType = "NetCDF" ;
    :FileFormat = "Netcdf4" ;
data:
```

```
 times = 1238164500, 1238164800, 1238165100, 1238165400, 1238165700,
    1238166000, 1238166300, 1238166600, 1238166900, 1238167200, 1238167500,
    1238167800, 1238168100, 1238168400, 1238168700, 1238169000, 1238169300,
    1238169600, 1238169900, 1238170200, 1238170500, 1238170800, 1238171100,
    1238171400 ;

 time = 1238164200 ;

 z0 = 0 ;

 y0 = -1759500, -1758500, -1757500, -1756500, -1755500, -1754500, -1753500,
    -1752500, -1751500, -1750500, -1749500, -1748500, -1747500, -1746500,
...
    1745500, 1746500, 1747500, 1748500, 1749500, 1750500, 1751500, 1752500,
    1753500, 1754500, 1755500, 1756500, 1757500, 1758500, 1759500 ;

 x0 = -2559500, -2558500, -2557500, -2556500, -2555500, -2554500, -2553500,
    -2552500, -2551500, -2550500, -2549500, -2548500, -2547500, -2546500,
...
    2550500, 2551500, 2552500, 2553500, 2554500, 2555500, 2556500, 2557500,
    2558500, 2559500 ;
}
```

A4 FORECAST CONUS QUANTIZED PREIP (VIL) DATASET CDL

```
netcdf edu.mit.ll.wx.ciws.QuantizedVILForecast.Netcdf4.1km.20090327T143000Z {
dimensions:
  times = 24 ;
  time = 1 ;
  z0 = 1 ;
  y0 = 3520 ;
  x0 = 5120 ;
  xml_metadata_len = 43760 ;
variables:
  double times(times) ;
    times:standard_name = "time" ;
    times:long_name = "Product validity times" ;
    times:units = "seconds since 1970-01-01T00:00:00Z" ;
    times:calendar = "gregorian" ;
    times:string = "2009-03-27T14:35:00Z/2009-03-27T16:30:00Z" ;
double time(time) ;
    time:long_name = "Product flags validity times" ;
    time:units = "seconds since 1970-01-01T00:00:00Z" ;
    time:calendar = "gregorian" ;
    time:string = "2009-03-27T14:30:00Z" ;
  double z0(z0) ;
    z0:standard_name = "altitude" ;
    z0:long_name = "Product altitude" ;
    z0:units = "meters" ;
    z0:axis = "Z" ;
    z0:positive = "up" ;
  double y0(y0) ;
    y0:standard_name = "projection_y_coordinate" ;
    y0:long_name = "Distance from projection reference point latitude" ;
    y0:units = "meters" ;
  double x0(x0) ;
    x0:standard_name = "projection_x_coordinate" ;
    x0:long_name = "Distance from projection reference point longitude" ;
    x0:units = "meters" ;
  double start_time ;
    start_time:long_name = "Data observation start time" ;
    start_time:units = "seconds since 1970-01-01T00:00:00Z" ;
    start_time:calendar = "gregorian" ;
    start_time:string = "2009-03-27T14:20:00Z" ;
    start_time:comment = "Data observation start time is the time data collection began" ;
  double stop_time ;
    stop_time:long_name = "Data observation stop time" ;
    stop_time:units = "seconds since 1970-01-01T00:00:00Z" ;
    stop_time:calendar = "gregorian" ;
    stop_time:string = "2009-03-27T14:30:00Z" ;
    stop_time:comment = "Data observation stop time is the time data collection ended" ;
  double forecast_reference_time ;
    forecast_reference_time:standard_name = "forecast_reference_time" ;
    forecast_reference_time:long_name = "Forecast reference time" ;
    forecast_reference_time:units = "seconds since 1970-01-01T00:00:00Z" ;
    forecast_reference_time:calendar = "gregorian" ;
    forecast_reference_time:string = "2009-03-27T14:30:00Z" ;
    forecast_reference_time:comment = "Forecast reference time is the time of the analysis from
which the forecast was made" ;
  int forecast_period(times) ;
    forecast_period:standard_name = "forecast_period" ;
```

```
    forecast_period:long_name = "Time interval between the forecast reference time and the
validity time" ;
    forecast_period:units = "seconds" ;
  int grid_mapping0 ;
    grid_mapping0:grid_mapping_name = "lambert_azimuthal_equal_area" ;
    grid_mapping0:long_name = "Lambert Azimuthal Equal Area Projection" ;
    grid_mapping0:latitude_of_projection_origin = 38. ;
    grid_mapping0:longitude_of_projection_origin = -98. ;
    grid_mapping0:false_easting = 0. ;
    grid_mapping0:false_northing = 0. ;
    grid_mapping0:earth_radius = 6370997. ;
  char xml_metadata(xml_metadata_len) ;
    xml_metadata:long_name = "Product meta data" ;
    xml_metadata:comment = "Itemizes constituent mosaic tiles and radar sources" ;
  short VIL(times, z0, y0, x0) ;
    VIL:standard_name = "atmosphere_cloud_liquid_water_content" ;
    VIL:long_name = "Vertically integrated liquid water (VIL)" ;
    VIL:class_name = "FCST" ;
    VIL:product_name = "FCST" ;
    VIL:ancillary_variables = "PRECIP_PHASE" ;
    VIL:units = "kg m-2" ;
    VIL:grid_mapping = "grid_mapping0" ;
    VIL:scale_factor = 0.00244148075807978 ;
    VIL:add_offset = 0. ;
    VIL:_FillValue = -1s ;
    VIL:valid_range = 0s, 32767s ;
    VIL:flag_values = 0s, 13s, 58s, 63s, 113s, 317s, 1448s, 2900s, 4977s, 13574s ;
    VIL:flag_meanings = "0 0a 1a 1b 1c 2 3 4 5 6" ;
  byte PRECIP_PHASE(times, z0, y0, x0) ;
    PRECIP_PHASE:standard_name = "atmosphere_cloud_liquid_water_content status_flag" ;
    PRECIP_PHASE:long_name = "Precipitation phase flags" ;
    PRECIP_PHASE:class_name = "PHASE_FCST" ;
    PRECIP_PHASE:product_name = "PHASE_FCST" ;
    PRECIP_PHASE:grid_mapping = "grid_mapping0" ;
    PRECIP_PHASE:_FillValue = 0b ;
    PRECIP_PHASE:valid_range = 1b, 3b ;
    PRECIP_PHASE:flag_values = 1b, 2b, 3b ;
    PRECIP_PHASE:flag_meanings = "liquid snow mixed" ;
  byte VIL_FLAGS(time, z0, y0, x0) ;
    VIL_FLAGS:standard_name = "atmosphere_cloud_liquid_water_content status_flag" ;
    VIL_FLAGS:long_name = "VIL data quality flags" ;
    VIL_FLAGS:class_name = "VIL_FLAGS" ;
    VIL_FLAGS:product_name = "VIL_FLAGS" ;
    VIL_FLAGS:grid_mapping = "grid_mapping0" ;
    VIL_FLAGS:_FillValue = 0b ;
    VIL_FLAGS:valid_range = 1b, 3b ;
    VIL_FLAGS:flag_masks = 3b, 3b ;
    VIL_FLAGS:flag_values = 1b, 2b ;
    VIL_FLAGS:flag_meanings = "no_coverage impaired" ;

// global attributes:
    :Conventions = "CF-1.3" ;
    :history = "File created 2009-03-27T14:33:11Z on machine compute-7-5.local by
ProductAdapterQuantizedVILForecast 1.0.0" ;
    :institution = "Data produced by the MIT Lincoln Lab Weather Sensing Group" ;
    :references = "http://www.wx.ll.mit.edu" ;
    :source = "National CIWS Data Stream:
StormForecast:CombineFinalForecast:ForecastImages:CiwsRelay" ;
    :title = "National CIWS Quantized VIL Mosaic Product - 1 km @ 2.5 minutes" ;
    :comment = "Mosaic of VIL derived from NEXRAD, TDWR and Canadian radar systems." ;
    :FileType = "NetCDF" ;
```

```
    :FileFormat = "Netcdf4" ;
data:

 times = 1238164500, 1238164800, 1238165100, 1238165400, 1238165700,
    1238166000, 1238166300, 1238166600, 1238166900, 1238167200, 1238167500,
    1238167800, 1238168100, 1238168400, 1238168700, 1238169000, 1238169300,
    1238169600, 1238169900, 1238170200, 1238170500, 1238170800, 1238171100,
    1238171400 ;

 time = 1238164200 ;

 z0 = 0 ;

 y0 = -1759500, -1758500, -1757500, -1756500, -1755500, -1754500, -1753500,
    -1752500, -1751500, -1750500, -1749500, -1748500, -1747500, -1746500,
...
    1745500, 1746500, 1747500, 1748500, 1749500, 1750500, 1751500, 1752500,
    1753500, 1754500, 1755500, 1756500, 1757500, 1758500, 1759500 ;

 x0 = -2559500, -2558500, -2557500, -2556500, -2555500, -2554500, -2553500,
    -2552500, -2551500, -2550500, -2549500, -2548500, -2547500, -2546500,
...
    2550500, 2551500, 2552500, 2553500, 2554500, 2555500, 2556500, 2557500,
    2558500, 2559500 ;
}
```

A5 CURRENT CONUS ECHO TOP DATASET CDL

```
netcdf edu.mit.ll.wx.ciws.EchoTop.Netcdf4.1km.20090323T151500Z {
dimensions:
        time = 1 ;
        z0 = 1 ;
        y0 = 3520 ;
        x0 = 5120 ;
        xml_metadata_len = 42380 ;
variables:
        double time(time) ;
                time:standard_name = "time" ;
                time:long_name = "Product validity time" ;
                time:units = "seconds since 1970-01-01T00:00:00Z" ;
                time:calendar = "gregorian" ;
                time:string = "2009-03-23T15:15:00Z" ;
        double z0(z0) ;
                z0:standard_name = "altitude" ;
                z0:long_name = "Product altitude" ;
                z0:units = "meters" ;
                z0:positive = "up" ;
        double y0(y0) ;
                y0:standard_name = "projection_y_coordinate" ;
                y0:long_name = "Distance from projection reference point latitude" ;
                y0:units = "meters" ;
        double x0(x0) ;
                x0:standard_name = "projection_x_coordinate" ;
                x0:long_name = "Distance from projection reference point longitude" ;
                x0:units = "meters" ;
        double start_time ;
                start_time:long_name = "Data observation start time" ;
                start_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                start_time:calendar = "gregorian" ;
                start_time:string = "2009-03-23T15:05:00Z" ;
                start_time:comment = "Data observation start time is the time data collection
began" ;
        double stop_time ;
                stop_time:long_name = "Data observation stop time" ;
                stop_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                stop_time:calendar = "gregorian" ;
                stop_time:string = "2009-03-23T15:15:00Z" ;
                stop_time:comment = "Data observation stop time is the time data collection
ended" ;
        int grid_mapping0 ;
                grid_mapping0:grid_mapping_name = "lambert_azimuthal_equal_area" ;
                grid_mapping0:long_name = "Lambert Azimuthal Equal Area Projection" ;
                grid_mapping0:latitude_of_projection_origin = 38. ;
                grid_mapping0:longitude_of_projection_origin = -98. ;
                grid_mapping0:false_easting = 0. ;
                grid_mapping0:false_northing = 0. ;
                grid_mapping0:earth_radius = 6370997. ;
        char xml_metadata(xml_metadata_len) ;
                xml_metadata:long_name = "Product meta data" ;
                xml_metadata:comment = "Itemizes constituent mosaic tiles and radar sources" ;
        byte ECHO_TOP(time, z0, y0, x0) ;
                ECHO_TOP:standard_name = "convective_cloud_top_altitude" ;
                ECHO_TOP:long_name = "Echo Top (Echo Top)" ;
                ECHO_TOP:class_name = "ECHO_TOP" ;
                ECHO_TOP:product_name = "ECHO_TOP" ;
```

```
                ECHO_TOP:ancillary_variables = "ECHO_TOP_FLAGS" ;
                ECHO_TOP:units = "international_feet" ;
                ECHO_TOP:grid_mapping = "grid_mapping0" ;
                ECHO_TOP:scale_factor = 1000. ;
                ECHO_TOP:add_offset = 0. ;
                ECHO_TOP:_FillValue = -1b ;
                ECHO_TOP:valid_range = 0b, 70b ;
        byte ECHO_TOP_FLAGS(time, z0, y0, x0) ;
                ECHO_TOP_FLAGS:standard_name = "convective_cloud_top_altitude status_flag" ;
                ECHO_TOP_FLAGS:long_name = "Echo Top data quality flags" ;
                ECHO_TOP_FLAGS:class_name = "ECHO_TOP_FLAGS" ;
                ECHO_TOP_FLAGS:product_name = "ECHO_TOP_FLAGS" ;
                ECHO_TOP_FLAGS:grid_mapping = "grid_mapping0" ;
                ECHO_TOP_FLAGS:_FillValue = 0b ;
                ECHO_TOP_FLAGS:valid_range = 1b, 7b ;
                ECHO_TOP_FLAGS:flag_masks = 3b, 3b, 4b ;
                ECHO_TOP_FLAGS:flag_values = 1b, 2b, 4b ;
                ECHO_TOP_FLAGS:flag_meanings = "no_coverage impaired topped" ;

// global attributes:
                :Conventions = "CF-1.3" ;
                :history = "File created 2009-03-23T15:15:14Z on machine compute-7-4.local by
ProductAdapterEchoTop $Revision: 1.2.2.2 $" ;
                :institution = "Data produced by the MIT Lincoln Lab Weather Sensing Group" ;
                :references = "http://www.wx.ll.mit.edu" ;
                :source = "National CIWS Data Stream: MosTileAsm:Mosaic:CiwsRelay" ;
                :title = "National CIWS Echo Top Mosaic Product - 1 km @ 2.5 minutes" ;
                :comment = "Mosaic of Echo Top derived from NEXRAD, TDWR and Canadian radar
systems." ;
                :FileType = "NetCDF" ;
                :FileFormat = "Netcdf4" ;
data:

 time = 1237821300 ;

 z0 = 0 ;

 y0 = -1759500, -1758500, -1757500, -1756500, -1755500, -1754500, -1753500,
    -1752500, -1751500, -1750500, -1749500, -1748500, -1747500, -1746500,
...
    1745500, 1746500, 1747500, 1748500, 1749500, 1750500, 1751500, 1752500,
    1753500, 1754500, 1755500, 1756500, 1757500, 1758500, 1759500 ;

 x0 = -2559500, -2558500, -2557500, -2556500, -2555500, -2554500, -2553500,
    -2552500, -2551500, -2550500, -2549500, -2548500, -2547500, -2546500,
...
    2550500, 2551500, 2552500, 2553500, 2554500, 2555500, 2556500, 2557500,
    2558500, 2559500 ;
}
```

A6 CURRENT CONUS QUANTIZED ECHO TOP DATASET CDL

```
netcdf edu.mit.ll.wx.ciws.QuantizedEchoTop.Netcdf4.1km.20090323T151500Z {
dimensions:
        time = 1 ;
        z0 = 1 ;
        y0 = 3520 ;
        x0 = 5120 ;
        xml_metadata_len = 42380 ;
variables:
        double time(time) ;
                time:standard_name = "time" ;
                time:long_name = "Product validity time" ;
                time:units = "seconds since 1970-01-01T00:00:00Z" ;
                time:calendar = "gregorian" ;
                time:string = "2009-03-23T15:15:00Z" ;
        double z0(z0) ;
                z0:standard_name = "altitude" ;
                z0:long_name = "Product altitude" ;
                z0:units = "meters" ;
                z0:positive = "up" ;
        double y0(y0) ;
                y0:standard_name = "projection_y_coordinate" ;
                y0:long_name = "Distance from projection reference point latitude" ;
                y0:units = "meters" ;
        double x0(x0) ;
                x0:standard_name = "projection_x_coordinate" ;
                x0:long_name = "Distance from projection reference point longitude" ;
                x0:units = "meters" ;
        double start_time ;
                start_time:long_name = "Data observation start time" ;
                start_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                start_time:calendar = "gregorian" ;
                start_time:string = "2009-03-23T15:05:00Z" ;
                start_time:comment = "Data observation start time is the time data collection
began" ;
        double stop_time ;
                stop_time:long_name = "Data observation stop time" ;
                stop_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                stop_time:calendar = "gregorian" ;
                stop_time:string = "2009-03-23T15:15:00Z" ;
                stop_time:comment = "Data observation stop time is the time data collection
ended" ;
        int grid_mapping0 ;
                grid_mapping0:grid_mapping_name = "lambert_azimuthal_equal_area" ;
                grid_mapping0:long_name = "Lambert Azimuthal Equal Area Projection" ;
                grid_mapping0:latitude_of_projection_origin = 38. ;
                grid_mapping0:longitude_of_projection_origin = -98. ;
                grid_mapping0:false_easting = 0. ;
                grid_mapping0:false_northing = 0. ;
                grid_mapping0:earth_radius = 6370997. ;
        char xml_metadata(xml_metadata_len) ;
                xml_metadata:long_name = "Product meta data" ;
                xml_metadata:comment = "Itemizes constituent mosaic tiles and radar sources" ;
        byte ECHO_TOP(time, z0, y0, x0) ;
                ECHO_TOP:standard_name = "convective_cloud_top_altitude" ;
                ECHO_TOP:long_name = "Echo Top (Echo Top)" ;
                ECHO_TOP:class_name = "ECHO_TOP" ;
                ECHO_TOP:product_name = "ECHO_TOP" ;
```

```
                ECHO_TOP:ancillary_variables = "ECHO_TOP_FLAGS" ;
                ECHO_TOP:units = "international_feet" ;
                ECHO_TOP:grid_mapping = "grid_mapping0" ;
                ECHO_TOP:scale_factor = 1000. ;
                ECHO_TOP:add_offset = 0. ;
                ECHO_TOP:_FillValue = -1b ;
                ECHO_TOP:valid_range = 0b, 70b ;
                ECHO_TOP:flag_values = 0b, 5b, 10b, 15b, 20b, 25b, 30b, 35b, 40b, 45b, 50b ;
                ECHO_TOP:flag_meanings = "0 5 10 15 20 25 30 35 40 45 50+" ;
        byte ECHO_TOP_FLAGS(time, z0, y0, x0) ;
                ECHO_TOP_FLAGS:standard_name = "convective_cloud_top_altitude status_flag" ;
                ECHO_TOP_FLAGS:long_name = "Echo Top data quality flags" ;
                ECHO_TOP_FLAGS:class_name = "ECHO_TOP_FLAGS" ;
                ECHO_TOP_FLAGS:product_name = "ECHO_TOP_FLAGS" ;
                ECHO_TOP_FLAGS:grid_mapping = "grid_mapping0" ;
                ECHO_TOP_FLAGS:_FillValue = 0b ;
                ECHO_TOP_FLAGS:valid_range = 1b, 7b ;
                ECHO_TOP_FLAGS:flag_masks = 3b, 3b, 4b ;
                ECHO_TOP_FLAGS:flag_values = 1b, 2b, 4b ;
                ECHO_TOP_FLAGS:flag_meanings = "no_coverage impaired topped" ;

// global attributes:
                :Conventions = "CF-1.3" ;
                :history = "File created 2009-03-23T15:15:16Z on machine compute-7-4.local by
ProductAdapterQuantizedEchoTop $Revision: 1.3.2.3 $" ;
                :institution = "Data produced by the MIT Lincoln Lab Weather Sensing Group" ;
                :references = "http://www.wx.ll.mit.edu" ;
                :source = "National CIWS Data Stream: MosTileAsm:Mosaic:CiwsRelay" ;
                :title = "National CIWS Echo Top Mosaic Product - 1 km @ 2.5 minutes" ;
                :comment = "Mosaic of Echo Top derived from NEXRAD, TDWR and Canadian radar
systems." ;
                :FileType = "NetCDF" ;
                :FileFormat = "Netcdf4" ;
data:

 time = 1237821300 ;

 z0 = 0 ;

 y0 = -1759500, -1758500, -1757500, -1756500, -1755500, -1754500, -1753500,
    -1752500, -1751500, -1750500, -1749500, -1748500, -1747500, -1746500,
...
    1745500, 1746500, 1747500, 1748500, 1749500, 1750500, 1751500, 1752500,
    1753500, 1754500, 1755500, 1756500, 1757500, 1758500, 1759500 ;

 x0 = -2559500, -2558500, -2557500, -2556500, -2555500, -2554500, -2553500,
    -2552500, -2551500, -2550500, -2549500, -2548500, -2547500, -2546500,
...
    2550500, 2551500, 2552500, 2553500, 2554500, 2555500, 2556500, 2557500,
    2558500, 2559500 ;
}
```

A7 FORECAST CONUS ECHO TOP DATASET CDL

```
netcdf edu.mit.ll.wx.ciws.EchoTopsForecast.Netcdf4.1km.20090323T151000Z {
dimensions:
        times = 24 ;
        z0 = 1 ;
        y0 = 3520 ;
        x0 = 5120 ;
        xml_metadata_len = 42811 ;
variables:
        double times(times) ;
                times:standard_name = "time" ;
                times:long_name = "Product validity times" ;
                times:units = "seconds since 1970-01-01T00:00:00Z" ;
                times:calendar = "gregorian" ;
                times:string = "2009-03-23T15:15:00Z/2009-03-23T17:10:00Z" ;
        double z0(z0) ;
                z0:standard_name = "altitude" ;
                z0:long_name = "Product altitude" ;
                z0:units = "meters" ;
                z0:positive = "up" ;
        double y0(y0) ;
                y0:standard_name = "projection_y_coordinate" ;
                y0:long_name = "Distance from projection reference point latitude" ;
                y0:units = "meters" ;
        double x0(x0) ;
                x0:standard_name = "projection_x_coordinate" ;
                x0:long_name = "Distance from projection reference point longitude" ;
                x0:units = "meters" ;
        double start_time ;
                start_time:long_name = "Data observation start time" ;
                start_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                start_time:calendar = "gregorian" ;
                start_time:string = "2009-03-23T15:00:00Z" ;
                start_time:comment = "Data observation start time is the time data collection
began" ;
        double stop_time ;
                stop_time:long_name = "Data observation stop time" ;
                stop_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                stop_time:calendar = "gregorian" ;
                stop_time:string = "2009-03-23T15:10:00Z" ;
                stop_time:comment = "Data observation stop time is the time data collection
ended" ;
        double forecast_reference_time ;
                forecast_reference_time:standard_name = "forecast_reference_time" ;
                forecast_reference_time:long_name = "Forecast reference time" ;
                forecast_reference_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                forecast_reference_time:calendar = "gregorian" ;
                forecast_reference_time:string = "2009-03-23T15:10:00Z" ;
                forecast_reference_time:comment = "Forecast reference time is the time of the
analysis from which the forecast was made" ;
        int forecast_period(times) ;
                forecast_period:standard_name = "forecast_period" ;
                forecast_period:long_name = "Time interval between the forecast reference time
and the validity time" ;
                forecast_period:units = "seconds" ;
        int grid_mapping0 ;
                grid_mapping0:grid_mapping_name = "lambert_azimuthal_equal_area" ;
                grid_mapping0:long_name = "Lambert Azimuthal Equal Area Projection" ;
```

```
                grid_mapping0:latitude_of_projection_origin = 38. ;
                grid_mapping0:longitude_of_projection_origin = -98. ;
                grid_mapping0:false_easting = 0. ;
                grid_mapping0:false_northing = 0. ;
                grid_mapping0:earth_radius = 6370997. ;
        char xml_metadata(xml_metadata_len) ;
                xml_metadata:long_name = "Product meta data" ;
                xml_metadata:comment = "Itemizes constituent mosaic tiles and radar sources" ;
        byte ECHO_TOP(times, z0, y0, x0) ;
                ECHO_TOP:standard_name = "convective_cloud_top_altitude" ;
                ECHO_TOP:long_name = "Echo Top (Echo Top)" ;
                ECHO_TOP:class_name = "ECHO_TOP" ;
                ECHO_TOP:product_name = "ECHO_TOP" ;
                ECHO_TOP:units = "international_feet" ;
                ECHO_TOP:grid_mapping = "grid_mapping0" ;
                ECHO_TOP:scale_factor = 1000. ;
                ECHO_TOP:add_offset = 0. ;
                ECHO_TOP:_FillValue = -1b ;
                ECHO_TOP:valid_range = 0b, 70b ;

// global attributes:
                :Conventions = "CF-1.3" ;
                :history = "File created 2009-03-23T15:13:09Z on machine compute-7-6.local by
ProductAdapterEchoTopsForecast $Revision: 1.2.2.2 $" ;
                :institution = "Data produced by the MIT Lincoln Lab Weather Sensing Group" ;
                :references = "http://www.wx.ll.mit.edu" ;
                :source = "National CIWS Data Stream: EchoTopsForecastProc:Images:CiwsRelay" ;
                :title = "National CIWS Echo Tops Mosaic Product - 1 km @ 2.5 minutes" ;
                :comment = "Mosaic of Echo Tops derived from NEXRAD, TDWR and Canadian radar
systems." ;
                :FileType = "NetCDF" ;
                :FileFormat = "Netcdf4" ;
data:

 times = 1237821300, 1237821600, 1237821900, 1237822200, 1237822500,
    1237822800, 1237823100, 1237823400, 1237823700, 1237824000, 1237824300,
    1237824600, 1237824900, 1237825200, 1237825500, 1237825800, 1237826100,
    1237826400, 1237826700, 1237827000, 1237827300, 1237827600, 1237827900,
    1237828200 ;

 z0 = 0 ;

 y0 = -1759500, -1758500, -1757500, -1756500, -1755500, -1754500, -1753500,
    -1752500, -1751500, -1750500, -1749500, -1748500, -1747500, -1746500,
...
    1745500, 1746500, 1747500, 1748500, 1749500, 1750500, 1751500, 1752500,
    1753500, 1754500, 1755500, 1756500, 1757500, 1758500, 1759500 ;

 x0 = -2559500, -2558500, -2557500, -2556500, -2555500, -2554500, -2553500,
    -2552500, -2551500, -2550500, -2549500, -2548500, -2547500, -2546500,
...
    2550500, 2551500, 2552500, 2553500, 2554500, 2555500, 2556500, 2557500,
    2558500, 2559500 ;
}
```

A8 FORECAST CONUS QUANTIZED ECHO TOP DATASET CDL

```
netcdf edu.mit.ll.wx.ciws.QuantizedEchoTopsForecast.Netcdf4.1km.20090323T151000Z {
dimensions:
        times = 24 ;
        z0 = 1 ;
        y0 = 3520 ;
        x0 = 5120 ;
        xml_metadata_len = 42811 ;
variables:
        double times(times) ;
                times:standard_name = "time" ;
                times:long_name = "Product validity times" ;
                times:units = "seconds since 1970-01-01T00:00:00Z" ;
                times:calendar = "gregorian" ;
                times:string = "2009-03-23T15:15:00Z/2009-03-23T17:10:00Z" ;
        double z0(z0) ;
                z0:standard_name = "altitude" ;
                z0:long_name = "Product altitude" ;
                z0:units = "meters" ;
                z0:positive = "up" ;
        double y0(y0) ;
                y0:standard_name = "projection_y_coordinate" ;
                y0:long_name = "Distance from projection reference point latitude" ;
                y0:units = "meters" ;
        double x0(x0) ;
                x0:standard_name = "projection_x_coordinate" ;
                x0:long_name = "Distance from projection reference point longitude" ;
                x0:units = "meters" ;
        double start_time ;
                start_time:long_name = "Data observation start time" ;
                start_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                start_time:calendar = "gregorian" ;
                start_time:string = "2009-03-23T15:00:00Z" ;
                start_time:comment = "Data observation start time is the time data collection
began" ;
        double stop_time ;
                stop_time:long_name = "Data observation stop time" ;
                stop_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                stop_time:calendar = "gregorian" ;
                stop_time:string = "2009-03-23T15:10:00Z" ;
                stop_time:comment = "Data observation stop time is the time data collection
ended" ;
        double forecast_reference_time ;
                forecast_reference_time:standard_name = "forecast_reference_time" ;
                forecast_reference_time:long_name = "Forecast reference time" ;
                forecast_reference_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                forecast_reference_time:calendar = "gregorian" ;
                forecast_reference_time:string = "2009-03-23T15:10:00Z" ;
                forecast_reference_time:comment = "Forecast reference time is the time of the
analysis from which the forecast was made" ;
        int forecast_period(times) ;
                forecast_period:standard_name = "forecast_period" ;
                forecast_period:long_name = "Time interval between the forecast reference time
and the validity time" ;
                forecast_period:units = "seconds" ;
        int grid_mapping0 ;
                grid_mapping0:grid_mapping_name = "lambert_azimuthal_equal_area" ;
                grid_mapping0:long_name = "Lambert Azimuthal Equal Area Projection" ;
```

```
                grid_mapping0:latitude_of_projection_origin = 38. ;
                grid_mapping0:longitude_of_projection_origin = -98. ;
                grid_mapping0:false_easting = 0. ;
                grid_mapping0:false_northing = 0. ;
                grid_mapping0:earth_radius = 6370997. ;
        char xml_metadata(xml_metadata_len) ;
                xml_metadata:long_name = "Product meta data" ;
                xml_metadata:comment = "Itemizes constituent mosaic tiles and radar sources" ;
        byte ECHO_TOP(times, z0, y0, x0) ;
                ECHO_TOP:standard_name = "convective_cloud_top_altitude" ;
                ECHO_TOP:long_name = "Echo Top (Echo Top)" ;
                ECHO_TOP:class_name = "ECHO_TOP" ;
                ECHO_TOP:product_name = "ECHO_TOP" ;
                ECHO_TOP:units = "international_feet" ;
                ECHO_TOP:grid_mapping = "grid_mapping0" ;
                ECHO_TOP:scale_factor = 1000. ;
                ECHO_TOP:add_offset = 0. ;
                ECHO_TOP:_FillValue = -1b ;
                ECHO_TOP:valid_range = 0b, 70b ;
                ECHO_TOP:flag_values = 0b, 5b, 10b, 15b, 20b, 25b, 30b, 35b, 40b, 45b, 50b ;
                ECHO_TOP:flag_meanings = "0 5 10 15 20 25 30 35 40 45 50+" ;

// global attributes:
                :Conventions = "CF-1.3" ;
                :history = "File created 2009-03-23T15:13:19Z on machine compute-7-6.local by
ProductAdapterQuantizedEchoTopsForecast $Revision: 1.2.2.2 $" ;
                :institution = "Data produced by the MIT Lincoln Lab Weather Sensing Group" ;
                :references = "http://www.wx.ll.mit.edu" ;
                :source = "National CIWS Data Stream: EchoTopsForecastProc:Images:CiwsRelay" ;
                :title = "National CIWS Quantized Echo Tops Mosaic Product - 1 km @ 2.5 minutes"
;
                :comment = "Mosaic of Echo Tops derived from NEXRAD, TDWR and Canadian radar
systems." ;
                :FileType = "NetCDF" ;
                :FileFormat = "Netcdf4" ;
data:

 times = 1237821300, 1237821600, 1237821900, 1237822200, 1237822500,
    1237822800, 1237823100, 1237823400, 1237823700, 1237824000, 1237824300,
    1237824600, 1237824900, 1237825200, 1237825500, 1237825800, 1237826100,
    1237826400, 1237826700, 1237827000, 1237827300, 1237827600, 1237827900,
    1237828200 ;

 z0 = 0 ;

 y0 = -1759500, -1758500, -1757500, -1756500, -1755500, -1754500, -1753500,
    -1752500, -1751500, -1750500, -1749500, -1748500, -1747500, -1746500,
...
    1745500, 1746500, 1747500, 1748500, 1749500, 1750500, 1751500, 1752500,
    1753500, 1754500, 1755500, 1756500, 1757500, 1758500, 1759500 ;

 x0 = -2559500, -2558500, -2557500, -2556500, -2555500, -2554500, -2553500,
    -2552500, -2551500, -2550500, -2549500, -2548500, -2547500, -2546500,
...
    2550500, 2551500, 2552500, 2553500, 2554500, 2555500, 2556500, 2557500,
    2558500, 2559500 ;
}
```

A9 CURRENT CONUS SATELLITE DATASET CDL

```
netcdf edu.mit.ll.wx.ciws.Satellite.Netcdf4.1km.20090323T150836Z {
dimensions:
        time = 1 ;
        z0 = 1 ;
        y0 = 3520 ;
        x0 = 5120 ;
variables:
        double time(time) ;
                time:standard_name = "time" ;
                time:long_name = "Product validity time" ;
                time:units = "seconds since 1970-01-01T00:00:00Z" ;
                time:calendar = "gregorian" ;
                time:string = "2009-03-23T15:08:36Z" ;
        double z0(z0) ;
                z0:standard_name = "altitude" ;
                z0:long_name = "Product altitude" ;
                z0:units = "meters" ;
                z0:axis = "Z" ;
                z0:positive = "up" ;
        double y0(y0) ;
                y0:standard_name = "projection_y_coordinate" ;
                y0:long_name = "Distance from projection reference point latitude" ;
                y0:units = "meters" ;
        double x0(x0) ;
                x0:standard_name = "projection_x_coordinate" ;
                x0:long_name = "Distance from projection reference point longitude" ;
                x0:units = "meters" ;
        double start_time ;
                start_time:long_name = "Data observation start time" ;
                start_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                start_time:calendar = "gregorian" ;
                start_time:string = "2009-03-23T15:01:29Z" ;
                start_time:comment = "Data observation start time is the time data collection
began" ;
        double stop_time ;
                stop_time:long_name = "Data observation stop time" ;
                stop_time:units = "seconds since 1970-01-01T00:00:00Z" ;
                stop_time:calendar = "gregorian" ;
                stop_time:string = "2009-03-23T15:08:36Z" ;
                stop_time:comment = "Data observation stop time is the time data collection
ended" ;
        int grid_mapping0 ;
                grid_mapping0:grid_mapping_name = "lambert_azimuthal_equal_area" ;
                grid_mapping0:long_name = "Lambert Azimuthal Equal Area Projection" ;
                grid_mapping0:latitude_of_projection_origin = 38. ;
                grid_mapping0:longitude_of_projection_origin = -98. ;
                grid_mapping0:false_easting = 0. ;
                grid_mapping0:false_northing = 0. ;
                grid_mapping0:earth_radius = 6370997. ;
        byte RemappedSatellite(time, z0, y0, x0) ;
                RemappedSatellite:long_name = "Remapped satellite derived from visible, infrared
or both" ;
                RemappedSatellite:class_name = "RemappedSatellite" ;
                RemappedSatellite:product_name = "RemappedSatellite" ;
                RemappedSatellite:grid_mapping = "grid_mapping0" ;
                RemappedSatellite:_FillValue = -1b ;
                RemappedSatellite:valid_range = 0b, 33b ;
```

```
// global attributes:
                :Conventions = "CF-1.3" ;
                :history = "File created 2009-03-23T15:14:45Z on machine compute-7-4.local by
ProductAdapterSatellite $Revision: 1.2.2.1 $" ;
                :institution = "Data produced by the MIT Lincoln Lab Weather Sensing Group" ;
                :references = "http://www.wx.ll.mit.edu" ;
                :source = "National CIWS Data Stream:
SatelliteRemapper:SatelliteImages:CiwsRelay" ;
                :title = "National CIWS Satellite Mosaic Product - 1 km @ 15 minutes" ;
                :comment = "Mosaic of satellite derived from East and West GOES." ;
                :FileType = "NetCDF" ;
                :FileFormat = "Netcdf4" ;
data:

 time = 1237820916 ;

 z0 = 0 ;

 y0 = -1759500, -1758500, -1757500, -1756500, -1755500, -1754500, -1753500,
    -1752500, -1751500, -1750500, -1749500, -1748500, -1747500, -1746500,
...
    1745500, 1746500, 1747500, 1748500, 1749500, 1750500, 1751500, 1752500,
    1753500, 1754500, 1755500, 1756500, 1757500, 1758500, 1759500 ;

 x0 = -2559500, -2558500, -2557500, -2556500, -2555500, -2554500, -2553500,
    -2552500, -2551500, -2550500, -2549500, -2548500, -2547500, -2546500,
...
    2550500, 2551500, 2552500, 2553500, 2554500, 2555500, 2556500, 2557500,
    2558500, 2559500 ;
}
```

APPENDIX B
NON-GRIDDED PRODUCT DATASET FILES

The following are annotated GML examples for the non-gridded CIWS data products.

B1 CURRENT GROWTH & DECAY TRENDS DATASET GML

```
<?xml version="1.0" encoding="UTF-8"?>
<wx:WxFeatureCollection xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://www.eurocontrol.int/wx/1.1 ../wx.xsd"
 xmlns:wx="http://www.eurocontrol.int/wx/1.1"
 xmlns:xlin="http://www.w3.org/1999/xlink"
 xmlns:om="http://www.opengis.net/om/1.0/gml32"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 xmlns:nawx="http://www.faa.gov/nawx/1.1"
 gml:id="id0">

  <wx:featureMember>
    <!--
    Observation containing collection of storm growth and decay contours
    -->
    <wx:Observation gml:id="id1">
      <!--
      Sampling time in this example is a time period spanning the radar scan(s)
      used to observe the storms
      -->
      <om:samplingTime>
        <gml:TimePeriod gml:id="id2">
          <gml:beginPosition>20080709T035000Z</gml:beginPosition>
          <gml:endPosition>20080709T040000Z</gml:endPosition>
        </gml:TimePeriod>
      </om:samplingTime>

      <!--
      Unique identifier for Growth and Decay algorithm used to identify contour
      regions of storm growth and decay.
      -->
      <om:procedure xlin:href="urn:fdc:faa.gov:System:CIWS:Algorithm:GrowthDecay"/>

      <!-- Observed property is link to storm cell class in weather ontology -->
      <om:observedProperty xlin:href="http://sweet.jpl.nasa.gov/2.0/atmoFront.owl#Cell"/>

      <!--
        Feature of interest in this case is the CIWS national processing grid region
      -->
      <om:featureOfInterest>
        <wx:AreaOfInterest gml:id="id3">
          <gml:description>CIWS national radar coverage area</gml:description>
          <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:System:CIWS:National"/>
          <gml:name>CIWS-National</gml:name>
          <wx:extentOf>
            <gml:Envelope>
              <gml:lowerCorner>19.3098 -122.358</gml:lowerCorner>
              <gml:upperCorner>48.9457 -61.7424</gml:upperCorner>
            </gml:Envelope>
```

```
    </wx:extentOf>
  </wx:AreaOfInterest>
</om:featureOfInterest>

<!--
Observation result is a feature collection of Contour objects.
Growth regions will have positive probability contour values.
Decay regions will have negative probability contour values.
-->
<om:result>
  <!-- Feature collection of Contours -->
  <wx:WxFeatureCollection gml:id="id4">
    <!-- Growth contours (positive contourValues) -->
    <wx:featureMember>
      <wx:Contour gml:id="id5">
        <wx:observationTime>
          <gml:TimeInstant gml:id="id6">
            <gml:timePosition>20080709T040000Z</gml:timePosition>
          </gml:TimeInstant>
        </wx:observationTime>
        <wx:contourValue uom="1">0.016</wx:contourValue>
        <wx:geometry>
          <gml:Curve srsName="urn:ogc:def:crs:EPSG:4326" gml:id="id7">
            <gml:segments>
              <gml:LineStringSegment>
                <gml:posList srsDimension="2" count="69">
                  22.7981 -98.3621 ... 22.7981 -98.3621
                </gml:posList>
              </gml:LineStringSegment>
            </gml:segments>
          </gml:Curve>
        </wx:geometry>
      </wx:Contour>
    </wx:featureMember>
    <wx:featureMember>
      <wx:Contour gml:id="id8">
        <wx:observationTime>
          <gml:TimeInstant gml:id="id9">
            <gml:timePosition>20080709T040000Z</gml:timePosition>
          </gml:TimeInstant>
        </wx:observationTime>
        <wx:contourValue uom="1">0.016</wx:contourValue>
        <wx:geometry>
          <gml:Curve srsName="urn:ogc:def:crs:EPSG:4326" gml:id="id10">
            <gml:segments>
              <gml:LineStringSegment>
                <gml:posList srsDimension="2" count="35">
                  23.1515 -97.2881 ... 23.1515 -97.2881
                </gml:posList>
              </gml:LineStringSegment>
            </gml:segments>
          </gml:Curve>
        </wx:geometry>
      </wx:Contour>
    </wx:featureMember>

    <!-- Decay contours (negative contourValues) -->
    <wx:featureMember>
      <wx:Contour gml:id="id884">
        <wx:observationTime>
          <gml:TimeInstant gml:id="id885">
```

```
              <gml:timePosition>20080709T040000Z</gml:timePosition>
            </gml:TimeInstant>
          </wx:observationTime>
          <wx:contourValue uom="1">-0.024</wx:contourValue>
          <wx:geometry>
            <gml:Curve srsName="urn:ogc:def:crs:EPSG:4326" gml:id="id886">
              <gml:segments>
                <gml:LineStringSegment>
                  <gml:posList srsDimension="2" count="30">
                    25.2176 -80.9128 ... 25.2176 -80.9128
                  </gml:posList>
                </gml:LineStringSegment>
              </gml:segments>
            </gml:Curve>
          </wx:geometry>
        </wx:Contour>
      </wx:featureMember>
      <wx:featureMember>
        <wx:Contour gml:id="id887">
          <wx:observationTime>
            <gml:TimeInstant gml:id="id888">
              <gml:timePosition>20080709T040000Z</gml:timePosition>
            </gml:TimeInstant>
          </wx:observationTime>
          <wx:contourValue uom="1">-0.024</wx:contourValue>
          <wx:geometry>
            <gml:Curve srsName="urn:ogc:def:crs:EPSG:4326" gml:id="id889">
              <gml:segments>
                <gml:LineStringSegment>
                  <gml:posList srsDimension="2" count="53">
                    25.0624 -80.1727 ... 25.0624 -80.1727</gml:posList>
                </gml:LineStringSegment>
              </gml:segments>
            </gml:Curve>
          </wx:geometry>
        </wx:Contour>
      </wx:featureMember>
    </wx:WxFeatureCollection>
  </om:result>
 </wx:Observation>
</wx:featureMember>
</wx:WxFeatureCollection>
```

B2 CURRENT STORM ECHO TOP TAGS DATASET GML

```
<?xml version="1.0" encoding="UTF-8"?>
<wx:WxFeatureCollection
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:wx="http://www.eurocontrol.int/wx/1.1"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:om="http://www.opengis.net/om/1.0/gml32"
  xmlns:xlin="http://www.w3.org/1999/xlink"
  xmlns:nawx="http://www.faa.gov/nawx/1.1"
  xsi:schemaLocation="http://www.eurocontrol.int/wx/1.1 ../wx.xsd"
  gml:id="id0">

  <wx:featureMember>
    <!--
    Observation contains a collection of EchoTopPoint objects
    -->
    <wx:Observation gml:id="id1">
      <!--
      Sampling time in this example is a time period spanning the radar
      scan(s) used to observe the storms
      -->
      <om:samplingTime>
        <gml:TimePeriod gml:id="id2">
          <gml:beginPosition>20080709T035000Z</gml:beginPosition>
          <gml:endPosition>20080709T040000Z</gml:endPosition>
        </gml:TimePeriod>
      </om:samplingTime>
      <!--
      Unique identifier for algorithm used to identify storm echo tops
      -->
      <om:procedure xlin:href="urn:fdc:faa.gov:System:CIWS:Algorithm:StormInfoGen"/>

      <!-- Observed property is link to storm echo top class in weather ontology -->
      <om:observedProperty xlin:href="http://www.ll.mit.edu/2009/storm.owl#StormEchoTop"/>

      <!--
        Feature of interest in this case is the CIWS national processing grid region
      -->
      <om:featureOfInterest>
        <wx:AreaOfInterest gml:id="id3">
          <gml:description>CIWS national radar coverage area</gml:description>
          <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:System:CIWS:National"/>
          <gml:name>CIWS-National</gml:name>
          <wx:extentOf>
            <gml:Envelope>
              <gml:lowerCorner>19.3098 -122.358</gml:lowerCorner>
              <gml:upperCorner>48.9457 -61.7424</gml:upperCorner>
            </gml:Envelope>
          </wx:extentOf>
        </wx:AreaOfInterest>
      </om:featureOfInterest>

      <!--
      Observation result is a feature collection of one or more
      EchoTopPoint objects.
      -->
      <om:result>
        <wx:WxFeatureCollection gml:id="id4">
```

```
          <wx:featureMember>
            <nawx:EchoTopPoint gml:id="id5">
              <wx:observationTime>
                <gml:TimeInstant gml:id="id6">
                  <gml:timePosition>20080709T040000Z</gml:timePosition>
                </gml:TimeInstant>
              </wx:observationTime>
              <nawx:echoTop uom="m">17678.4</nawx:echoTop>
              <nawx:geometry>
                <gml:Point gml:id="id7">
                  <gml:pos srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
                    35.8601 -96.2508
                  </gml:pos>
                </gml:Point>
              </nawx:geometry>
            </nawx:EchoTopPoint>
          </wx:featureMember>
          <wx:featureMember>
            <nawx:EchoTopPoint gml:id="id8">
              <wx:observationTime>
                <gml:TimeInstant gml:id="id9">
                  <gml:timePosition>20080709T040000Z</gml:timePosition>
                </gml:TimeInstant>
              </wx:observationTime>
              <nawx:echoTop uom="m">15240.0</nawx:echoTop>
              <nawx:geometry>
                <gml:Point gml:id="id10">
                  <gml:pos srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
                    34.9074 -79.9736
                  </gml:pos>
                </gml:Point>
              </nawx:geometry>
            </nawx:EchoTopPoint>
          </wx:featureMember>
        </wx:WxFeatureCollection>
      </om:result>
    </wx:Observation>
  </wx:featureMember>
</wx:WxFeatureCollection>
```

B3 CURRENT & FORECAST STORM LEADING EDGE POSITIONS DATASET GML

```
<?xml version="1.0" encoding="UTF-8"?>
<wx:WxFeatureCollection
  gml:id="id0"
  xmlns:wx="http://www.eurocontrol.int/wx/1.1"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:om="http://www.opengis.net/om/1.0/gml32"
  xmlns:xlin="http://www.w3.org/1999/xlink"
  xmlns:nawx="http://www.faa.gov/nawx/1.1">
  <!--
  There are two featureMembers in this top-level feature collection: the
  Observation and the Forecast.  The Observation contains data for the current
  leading edge storm contours, while the Forecast contains data for the
  extraploated (forecast) leading edge contours.
  -->
  <wx:featureMember>
    <!--
    Observation
    -->
    <wx:Observation gml:id="id1">
      <!--
      Sampling time in this example is a time period spanning the radar scan(s)
      used to observe the storms
      -->
      <om:samplingTime>
        <gml:TimePeriod gml:id="id2">
          <gml:beginPosition>20080709T035000Z</gml:beginPosition>
          <gml:endPosition>20080709T040000Z</gml:endPosition>
        </gml:TimePeriod>
      </om:samplingTime>

      <!--
      Unique identifier for storm motion algorithm (notional example)
      -->
      <om:procedure xlin:href="urn:fdc:faa.gov:System:CIWS:Algorithm:StormInfoGen"/>

      <!-- Observed property is link to StormLeadingEdge class in weather ontology -->
      <om:observedProperty xlin:href="http://www.ll.mit.edu/2009/storm.owl#StormLeadingEdge"/>

      <!--
        Feature of interest in this case is the CIWS national processing grid region
      -->
      <om:featureOfInterest>
        <wx:AreaOfInterest gml:id="id3">
          <gml:description>CIWS national radar coverage area</gml:description>
          <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:System:CIWS:National"/>
          <gml:name>CIWS-National</gml:name>
          <wx:extentOf>
            <gml:Envelope>
              <gml:lowerCorner>19.3098 -122.358</gml:lowerCorner>
              <gml:upperCorner>48.9457 -61.7424</gml:upperCorner>
            </gml:Envelope>
          </wx:extentOf>
        </wx:AreaOfInterest>
      </om:featureOfInterest>

      <!--
      Observation result is a feature collection of LeadingEdge contour
```

```
    objects. Each LeadingEdge has observationTime, contourValue, and geometry
    properties.
    -->
    <om:result>
      <wx:WxFeatureCollection gml:id="id4">
        <wx:featureMember>
          <nawx:LeadingEdge gml:id="id8">
            <wx:observationTime>
              <gml:TimeInstant gml:id="id9">
                <gml:timePosition>20080709T040000Z</gml:timePosition>
              </gml:TimeInstant>
            </wx:observationTime>
            <wx:contourValue uom="dBZ">41.0</wx:contourValue>
            <wx:geometry>
              <gml:Curve srsName="urn:ogc:def:crs:EPSG:4326" gml:id="id10">
                <gml:segments>
                  <gml:LineStringSegment>
                    <gml:posList srsDimension="2" count="25">
                      21.6194 -81.2048 ... 21.4 -81.2073
                    </gml:posList>
                  </gml:LineStringSegment>
                </gml:segments>
              </gml:Curve>
            </wx:geometry>
          </nawx:LeadingEdge>
        </wx:featureMember>
        <wx:featureMember>
          <nawx:LeadingEdge gml:id="id17">
            <wx:observationTime>
              <gml:TimeInstant gml:id="id18">
                <gml:timePosition>20080709T040000Z</gml:timePosition>
              </gml:TimeInstant>
            </wx:observationTime>
            <wx:contourValue uom="dBZ">41.0</wx:contourValue>
            <wx:geometry>
              <gml:Curve srsName="urn:ogc:def:crs:EPSG:4326" gml:id="id19">
                <gml:segments>
                  <gml:LineStringSegment>
                    <gml:posList srsDimension="2" count="12">
                      23.0977 -97.0796 ... 23.0902 -97.1876
                    </gml:posList>
                  </gml:LineStringSegment>
                </gml:segments>
              </gml:Curve>
            </wx:geometry>
          </nawx:LeadingEdge>
        </wx:featureMember>
      </wx:WxFeatureCollection>
    </om:result>
  </wx:Observation>
</wx:featureMember>

<!-- Forecast -->
<wx:featureMember>
  <wx:Forecast gml:id="id5">
    <wx:forecastTime>
      <!--
      This is the time period spanning the range of forecast times
      contained in the Forecast result.
      -->
      <gml:TimePeriod gml:id="id6">
```

```
    <gml:beginPosition>20080709T041000Z</gml:beginPosition>
    <gml:endPosition>20080709T042000Z</gml:endPosition>
  </gml:TimePeriod>
</wx:forecastTime>

<!-- The analysis time for the forecast (aka, "forecast reference time") -->
<wx:forecastAnalysisTime>20080709T040000Z</wx:forecastAnalysisTime>

<!-- Issue time of the forecast -->
<wx:issueTime>20080709T040000Z</wx:issueTime>

<!-- Next (expected) issue time for forecast of same time -->
<wx:nextIssueTime>20080709T040230Z</wx:nextIssueTime>

<!--
Unique identifier for storm motion algorithm (notional example)
-->
<wx:procedure xlin:href="urn:fdc:faa.gov:System:CIWS:Algorithm:StormInfoGen"/>

<!-- Observed property is link to StormLeadingEdge class in weather ontology -->
<wx:forecastProperty xlin:href="http://www.ll.mit.edu/2009/storm.owl#StormLeadingEdge"/>

<!-- Link to Observation's featureOfInterest -->
<wx:featureOfInterest xlin:href="#id3"/>

<!--
Forecast result is a feature collection of forecast LeadingEdge contour
objects.
-->
<wx:result>
  <wx:WxFeatureCollection gml:id="id7">
    <wx:featureMember>
      <nawx:LeadingEdge gml:id="id11">
        <!-- The target forecast time (10-minute forecast in this case) -->
        <wx:forecastTime>
          <gml:TimeInstant gml:id="id12">
            <gml:timePosition>20080709T041000Z</gml:timePosition>
          </gml:TimeInstant>
        </wx:forecastTime>
        <wx:contourValue uom="dBZ">41.0</wx:contourValue>
        <wx:geometry>
          <gml:Curve srsName="urn:ogc:def:crs:EPSG:4326" gml:id="id13">
            <gml:segments>
              <gml:LineStringSegment>
                <gml:posList srsDimension="2" count="25">
                  21.6137 -81.2589 ... 21.3942 -81.2614
                </gml:posList>
              </gml:LineStringSegment>
            </gml:segments>
          </gml:Curve>
        </wx:geometry>
      </nawx:LeadingEdge>
    </wx:featureMember>
    <wx:featureMember>
      <nawx:LeadingEdge gml:id="id14">
        <wx:forecastTime>
          <gml:TimeInstant gml:id="id15">
            <gml:timePosition>20080709T042000Z</gml:timePosition>
          </gml:TimeInstant>
        </wx:forecastTime>
        <wx:contourValue uom="dBZ">41.0</wx:contourValue>
```

```
            <wx:geometry>
              <gml:Curve srsName="urn:ogc:def:crs:EPSG:4326" gml:id="id16">
                <gml:segments>
                  <gml:LineStringSegment>
                    <gml:posList srsDimension="2" count="25">
                      21.6079 -81.313 ... 21.3884 -81.3154</gml:posList>
                  </gml:LineStringSegment>
                </gml:segments>
              </gml:Curve>
            </wx:geometry>
          </nawx:LeadingEdge>
        </wx:featureMember>
      </wx:WxFeatureCollection>
    </wx:result>
  </wx:Forecast>
 </wx:featureMember>
</wx:WxFeatureCollection>
```

B4 CURRENT STORM MOTION VECTORS DATASET GML

```
<?xml version="1.0" encoding="UTF-8"?>
<wx:WxFeatureCollection
  gml:id="id0"
  xmlns:wx="http://www.eurocontrol.int/wx/1.1"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:om="http://www.opengis.net/om/1.0/gml32"
  xmlns:xlin="http://www.w3.org/1999/xlink">

  <wx:featureMember>
    <!--
    Observation
    -->
    <wx:Observation gml:id="id1">
      <!--
      Sampling time in this example is a time period spanning the radar scan(s)
      used to observe the storms
      -->
      <om:samplingTime>
        <gml:TimePeriod gml:id="id2">
          <gml:beginPosition>20080709T035000Z</gml:beginPosition>
          <gml:endPosition>20080709T040000Z</gml:endPosition>
        </gml:TimePeriod>
      </om:samplingTime>

      <!--
      Unique identifier for storm motion algorithm (notional example)
      -->
      <om:procedure xlin:href="urn:fdc:faa.gov:System:CIWS:Algorithm:StormInfoGen"/>

      <!-- Observed property is link to StormMotion class in weather ontology -->
      <om:observedProperty xlin:href="http://www.ll.mit.edu/2009/storm.owl#StormMotion"/>

      <!--
        Feature of interest in this case is the CIWS national processing grid region
      -->
      <om:featureOfInterest>
        <wx:AreaOfInterest gml:id="id3">
          <gml:description>CIWS national radar coverage area</gml:description>
          <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:System:CIWS:National"/>
          <gml:name>CIWS-National</gml:name>
          <wx:extentOf>
            <gml:Envelope>
              <gml:lowerCorner>19.3098 -122.358</gml:lowerCorner>
              <gml:upperCorner>48.9457 -61.7424</gml:upperCorner>
            </gml:Envelope>
          </wx:extentOf>
        </wx:AreaOfInterest>
      </om:featureOfInterest>

      <!--
      Observation result is a feature collection of MotionVector
      objects. Each MotionVector has observationTime, location, speed, and
      direction properties.
      -->
      <om:result>
        <wx:WxFeatureCollection gml:id="id4">
          <wx:featureMember>
```

```
            <wx:MotionVector gml:id="id5">
              <wx:observationTime>
                <gml:TimeInstant gml:id="id6">
                  <gml:timePosition>20080709T040000Z</gml:timePosition>
                </gml:TimeInstant>
              </wx:observationTime>
              <gml:pos srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
                40.3277 -83.7614
              </gml:pos>
              <wx:speed uom="kt">14.74</wx:speed>
              <wx:direction uom="deg">61.12</wx:direction>
            </wx:MotionVector>
          </wx:featureMember>
          <wx:featureMember>
            <wx:MotionVector gml:id="id7">
              <wx:observationTime>
                <gml:TimeInstant gml:id="id8">
                  <gml:timePosition>20080709T040000Z</gml:timePosition>
                </gml:TimeInstant>
              </wx:observationTime>
              <gml:pos srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
                35.0664 -79.9819
              </gml:pos>
              <wx:speed uom="kt">3.29</wx:speed>
              <wx:direction uom="deg">93.13</wx:direction>
            </wx:MotionVector>
          </wx:featureMember>
        </wx:WxFeatureCollection>
      </om:result>
    </wx:Observation>
  </wx:featureMember>
</wx:WxFeatureCollection>
```

B5 FORECAST STANDARD-MODE PRECIP (VIL) CONTOURS DATASET GML

```
<?xml version="1.0" encoding="UTF-8"?>

<wx:WxFeatureCollection gml:id="id0"
  xmlns:wx="http://www.eurocontrol.int/wx/1.1"
  xmlns:om="http://www.opengis.net/om/1.0/gml32"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">

  <wx:featureMember>

    <wx:Forecast gml:id="id1">
      <!--
        Forecast target time. For a time series forecast (+30 min, +60 min, +120 min) the
        forecast time is a period spanning the series (same strategy as O+M sampling time).
      -->
      <wx:forecastTime>
        <gml:TimePeriod gml:id="id2">
          <gml:beginPosition>2008-07-09T04:30:00Z</gml:beginPosition>
          <gml:endPosition>2008-07-09T06:00:00Z</gml:endPosition>
        </gml:TimePeriod>
      </wx:forecastTime>

      <!--
         Analysis time for the forecast. Also commonly referred to as forecast
         reference time
      -->
      <wx:forecastAnalysisTime>2008-07-09T04:00:00Z</wx:forecastAnalysisTime>
      <!--
        Issue time and next expected issue time for forecast. In cases where the
        forecast is machine-generated, the issueTime is typically the same as the
        analysis time
      -->
      <wx:issueTime>2008-07-09T04:00:00Z</wx:issueTime>
      <wx:nextIssueTime>2008-07-09T04:05:00Z</wx:nextIssueTime>

      <wx:procedure xlin:href="urn:fdc:faa.gov:System:CIWS:Algorithm:VilForecastContours"/>
      <wx:forecastProperty xlin:href="http://sweet.jpl.nasa.gov/2.0/atmoFront.owl#Cell"/>

      <!--
        Feature of interest in this case is the CIWS national processing grid region
      -->
      <wx:featureOfInterest>
        <wx:AreaOfInterest gml:id="id3">
          <gml:description>CIWS national radar coverage area</gml:description>
          <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:System:CIWS:National"/>
          <gml:name>CIWS-National</gml:name>
          <wx:extentOf>
            <gml:Envelope>
              <gml:lowerCorner>19.3098 -122.358</gml:lowerCorner>
              <gml:upperCorner>48.9457 -61.7424</gml:upperCorner>
            </gml:Envelope>
          </wx:extentOf>
        </wx:AreaOfInterest>
      </wx:featureOfInterest>

      <!-- The storm cell parameter being measured -->
```

```
<wx:parameter xlin:href="http://faa.gov/ontology/weather.owl#VIL"/>

<!-- Forecast result is a feature collection of wx:Contour features -->
<wx:result>
  <!--
  For CIWS, the expected sequence of forecast contour features within the
  following feature collection is as follows:
    30-min fcast Contours
    60-min fcast Contours
    120-min fcast Contours

  For Standard (non-winter) mode products, the fcst contours correspond to
  NWS Level 3

  For Winter mode products, the fcst contours correspond to
  NWS Level 1c
  -->
  <wx:WxFeatureCollection gml:id="id4">

    <!-- 30-minute forecasts -->
    <wx:featureMember>
      <wx:Contour gml:id="id5">
        <!-- Valid time of forecast -->
        <wx:forecastTime>
          <gml:TimeInstant gml:id="id6">
            <gml:timePosition>2008-07-09T04:30:00Z</gml:timePosition>
          </gml:TimeInstant>
        </wx:forecastTime>
        <wx:contourValue uom="kg_m-2">19.44</wx:contourValue>
        <wx:geometry>
          <gml:Curve gml:id="id7">
            <gml:segments>
              <gml:LineStringSegment>
                <gml:posList srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
                  21.3645 -81.3251 ...  21.3645 -81.3251
                </gml:posList>
              </gml:LineStringSegment>
            </gml:segments>
          </gml:Curve>
        </wx:geometry>
      </wx:Contour>
    </wx:featureMember>

    <!-- 60-minute forecasts -->
    <wx:featureMember>
      <wx:Contour gml:id="id875">
        <wx:forecastTime>
          <gml:TimeInstant gml:id="id876">
            <gml:timePosition>2008-07-09T05:00:00Z</gml:timePosition>
          </gml:TimeInstant>
        </wx:forecastTime>
        <wx:contourValue uom="kg_m-2">19.44</wx:contourValue>
        <wx:geometry>
          <gml:Curve gml:id="id877">
            <gml:segments>
              <gml:LineStringSegment>
                <gml:posList srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
                  21.3684 -81.5287 ... 21.3684 -81.5287
                </gml:posList>
              </gml:LineStringSegment>
            </gml:segments>
```

```
            </gml:Curve>
          </wx:geometry>
        </wx:Contour>
      </wx:featureMember>

      <!-- 120-minute forecasts -->
      <wx:featureMember>
        <wx:Contour gml:id="id1676">
          <wx:forecastTime>
            <gml:TimeInstant gml:id="id1677">
              <gml:timePosition>2008-07-09T06:00:00Z</gml:timePosition>
            </gml:TimeInstant>
          </wx:forecastTime>
          <wx:contourValue uom="kg_m-2">19.44</wx:contourValue>
          <wx:geometry>
            <gml:Curve gml:id="id1678">
              <gml:segments>
                <gml:LineStringSegment>
                  <gml:posList srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
                    21.3354 -81.8537 ... 21.3354 -81.8537
                  </gml:posList>
                </gml:LineStringSegment>
              </gml:segments>
            </gml:Curve>
          </wx:geometry>
        </wx:Contour>
      </wx:featureMember>
    </wx:WxFeatureCollection>
  </wx:result>
 </wx:Forecast>
</wx:featureMember>
</wx:WxFeatureCollection>
```

B6 ECHO TOPS FORECAST ACCURACY SCORES DATASET GML

```
<?xml version="1.0" encoding="UTF-8"?>
<wx:WxFeatureCollection xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://www.eurocontrol.int/wx/1.1 ../wx.xsd"
 xmlns:wx="http://www.eurocontrol.int/wx/1.1"
 xmlns:xlink="http://www.w3.org/1999/xlink"
 xmlns:om="http://www.opengis.net/om/1.0/gml32"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 xmlns:nawx="http://www.faa.gov/nawx/1.1"
 gml:id="id0">

  <!--
    Observation containing collection of forecast accuracy ScoredRegions
  -->
  <wx:featureMember>

    <wx:Observation gml:id="id1">

      <!--
      Sampling time in this example is a time period spanning the radar volume scan used to
      observe (and analyze) storms for motion.
      -->
      <om:samplingTime>
        <gml:TimePeriod gml:id="id2">
          <gml:beginPosition>20080709T040000Z</gml:beginPosition>
          <gml:endPosition>20080709T040000Z</gml:endPosition>
        </gml:TimePeriod>
      </om:samplingTime>

      <!--
      Unique identifier for ForecastAccuracy algorithm used to compute the scores
      -->
      <om:procedure

xlink:href="urn:fdc:faa.gov:System:CIWS:Algorithm:EchoTops:ForecastVerification:Standard_FcstAccu
racy"/>

      <!-- Observed property is link to storm cell class in weather ontology -->
      <om:observedProperty xlink:href="http://www.ll.mit.edu/2009/storm.owl#StormEchoTop"/>

      <!--
        Feature of interest in this case is the CIWS national processing grid region
      -->
      <om:featureOfInterest>
        <wx:AreaOfInterest gml:id="id3">
          <gml:description>CIWS national radar coverage area</gml:description>
          <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:System:CIWS:National"/>
          <gml:name>CIWS-National</gml:name>
          <wx:extentOf>
            <gml:Envelope>
              <gml:lowerCorner>19.3098 -122.358</gml:lowerCorner>
              <gml:upperCorner>48.9457 -61.7424</gml:upperCorner>
            </gml:Envelope>
          </wx:extentOf>
        </wx:AreaOfInterest>
      </om:featureOfInterest>

      <!--
```

```
Observation result is a feature collection of ScoredRegion objects.
-->
<om:result>
  <!-- Feature collection of ScoredRegions -->
  <wx:WxFeatureCollection gml:id="id4">

    <wx:featureMember>
      <nawx:ScoredRegion gml:id="id5">
        <!-- Info about the region that was scored -->
        <nawx:region>
          <wx:AreaOfInterest gml:id="id6">
            <gml:description>ABQ</gml:description>
            <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:Airports"/>
            <gml:name>ABQ</gml:name>
          </wx:AreaOfInterest>
        </nawx:region>
        <!-- Contour level that was scored (30 kft in this example)-->
        <nawx:scoredContourLevel>Height30</nawx:scoredContourLevel>
        <!-- Scores for each forecast interval -->
        <nawx:regionScores>
          <nawx:PeriodScore>
            <nawx:period uom="minutes">30</nawx:period>
            <nawx:score uom="percent">70</nawx:score>
          </nawx:PeriodScore>
          <nawx:PeriodScore>
            <nawx:period uom="minutes">60</nawx:period>
            <nawx:score uom="percent">55</nawx:score>
          </nawx:PeriodScore>
          <nawx:PeriodScore>
            <nawx:period uom="minutes">120</nawx:period>
            <nawx:score uom="percent">60</nawx:score>
          </nawx:PeriodScore>
        </nawx:regionScores>
      </nawx:ScoredRegion>
    </wx:featureMember>

    <wx:featureMember>
      <nawx:ScoredRegion gml:id="id10">
        <!-- Info about the region that was scored -->
        <nawx:region>
          <wx:AreaOfInterest gml:id="id11">
            <gml:description>ATL</gml:description>
            <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:Airports:"/>
            <gml:name>ATL</gml:name>
          </wx:AreaOfInterest>
        </nawx:region>
        <!-- Contour level that was scored -->
        <nawx:scoredContourLevel>Height30</nawx:scoredContourLevel>
        <!-- Scores for each forecast interval -->
        <nawx:regionScores>
          <nawx:PeriodScore>
            <nawx:period uom="minutes">30</nawx:period>
            <nawx:score uom="percent">90</nawx:score>
          </nawx:PeriodScore>
          <nawx:PeriodScore>
            <nawx:period uom="minutes">60</nawx:period>
            <nawx:score uom="percent">85</nawx:score>
          </nawx:PeriodScore>
          <nawx:PeriodScore>
            <nawx:period uom="minutes">120</nawx:period>
            <nawx:score uom="percent">80</nawx:score>
```

```
                </nawx:PeriodScore>
              </nawx:regionScores>
            </nawx:ScoredRegion>
          </wx:featureMember>

        </wx:WxFeatureCollection>
      </om:result>
    </wx:Observation>
  </wx:featureMember>
</wx:WxFeatureCollection>
```

B7 CURRENT LIGHTNING FLASH DATASET GML

```
<?xml version="1.0" encoding="UTF-8"?>
<wx:WxFeatureCollection
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:wx="http://www.eurocontrol.int/wx/1.1"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:om="http://www.opengis.net/om/1.0/gml32"
  xmlns:xlin="http://www.w3.org/1999/xlink"
  xmlns:nawx="http://www.faa.gov/nawx/1.1"
  xsi:schemaLocation="http://www.eurocontrol.int/wx/1.1 ../wx.xsd"
  gml:id="id0">

  <wx:featureMember>
    <!--
    Observation contains a collection of LightningFlashes
    -->
    <wx:Observation gml:id="id1">
      <!--
      Sampling time in this example is the time period over which lightning
      flashes were aggregated
      -->
      <om:samplingTime>
        <gml:TimePeriod gml:id="id2">
          <gml:beginPosition>20080709T035425Z</gml:beginPosition>
          <gml:endPosition>20080709T035954Z</gml:endPosition>
        </gml:TimePeriod>
      </om:samplingTime>
      <!--
      Unique identifier for process used to collect lightning information
      -->
      <om:procedure xlin:href="urn:fdc:faa.gov:System:CIWS:Algorithm:LghtAggregator:National"/>

      <!-- Observed property is link to lightning flash class in weather ontology -->
      <om:observedProperty xlin:href="http://www.ll.mit.edu/2009/storm.owl#LightningFlash"/>

      <!--
        Feature of interest in this case is the CIWS national processing grid region
      -->
      <om:featureOfInterest>
        <wx:AreaOfInterest gml:id="id3">
          <gml:description>CIWS national radar coverage area</gml:description>
          <gml:identifier codeSpace="urn:fdc:faa.gov:AreaOfInterest:System:CIWS:National"/>
          <gml:name>CIWS-National</gml:name>
          <wx:extentOf>
            <gml:Envelope>
              <gml:lowerCorner>19.3098 -122.358</gml:lowerCorner>
              <gml:upperCorner>48.9457 -61.7424</gml:upperCorner>
            </gml:Envelope>
          </wx:extentOf>
        </wx:AreaOfInterest>
      </om:featureOfInterest>

      <!--
      Observation result is a feature collection of one or more
      LightningFlash objects.
      -->
      <om:result>
        <wx:WxFeatureCollection gml:id="id4">
```

```
          <wx:featureMember>
            <nawx:LightningFlash gml:id="id5">
              <wx:observationTime>
                <gml:TimeInstant gml:id="id6">
                  <gml:timePosition>20080709T035425Z</gml:timePosition>
                </gml:TimeInstant>
              </wx:observationTime>
              <nawx:strength uom="kA">-30.00</nawx:strength>
              <nawx:numStrokes>3</nawx:numStrokes>
              <nawx:geometry>
                <gml:Point gml:id="id7">
                  <gml:pos srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
                    38.6116 -81.6016
                  </gml:pos>
                </gml:Point>
              </nawx:geometry>
            </nawx:LightningFlash>
          </wx:featureMember>

          <wx:featureMember>
            <nawx:LightningFlash gml:id="id8">
              <wx:observationTime>
                <gml:TimeInstant gml:id="id9">
                  <gml:timePosition>20080709T035425Z</gml:timePosition>
                </gml:TimeInstant>
              </wx:observationTime>
              <nawx:strength uom="kA">-8.00</nawx:strength>
              <nawx:numStrokes>1</nawx:numStrokes>
              <nawx:geometry>
                <gml:Point gml:id="id10">
                  <gml:pos srsName="urn:ogc:def:crs:EPSG:4326" srsDimension="2">
                    35.5534 -96.7741
                  </gml:pos>
                </gml:Point>
              </nawx:geometry>
            </nawx:LightningFlash>
          </wx:featureMember>
        </wx:WxFeatureCollection>
      </om:result>
    </wx:Observation>
  </wx:featureMember>
</wx:WxFeatureCollection>
```