RealTime diagnostics System (version 1.0.0)

RTS, a meteorological computation and plotting package

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This manual describes how to use the Realtime Diagnostics System (version 1.0.0), a meteorological diagnostics and display application.

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1 Overview

The RealTime diagnostics and display System (RTS) was originally developed at the University at Albany / State University of New York (SUNY), starting in 2004. The intention of the RTS is to generate high resolution, high quality plots of advanced diagnostic variables in real-time. Moreover, the RTS is designed to archive the generated images over a long period of time and provide an easy-to-use web based interface for access to - and animation of - long periods of image data.

As noted in the licencing and copying agreement (see Appendix A [Copying Conditions], page 9) we encourage all users of this software to become developers and to contribute to the evolution of the RTS. Please share any developments or enhancements that you add to the system so that others may benefit from your efforts.

1.1 RTS Components

The RTS is a collection of programs and scripts that compute advanced diagnostics, plot the resulting fields, handle the image data and allow users to quickly access long time-series loops through a web interface. The languages used in the development of the RTS include FORTRAN90, Korn Shell, HTML, PHP, Perl and Python. Although a high level of familiarity with each of these languages is not required for the basic installation and running of the RTS, modifications to the components of the RTS may require some level of proficiency in them.

'`generateTropPlots.sh`'
: This Korn Shell script forms the basis of the automated features of the RTS. It resides in the `realtimeSystem/automation` folder and directs the generation and image manipulation processes. Modifications to this script may be necessary if the system configurations have changed since the package was installed or if a customized level of service is required. This script may be executed as a `cron` job with short repeat intervals (5 minutes is used at the University at Albany) to check for the completion of dataset decoding by the LDM.

'`mapping.f90`'
: This FORTRAN90 source code is the workhorse of the RTS and handles all data I/O and processing, and image generation. It resides in the `realtimeSystem/mapping_f90` folder and can be compiled to produce the `mapping` executable. Modifications to this file are required if any of the diagnostics are to be changed or updated.

'`mapping`'
: This executable is generated when the RTS package is built and is installed into the `realtimeSystem/mapping_f90` folder. It is executed by the `generateTropPlots.sh` script and must be regenerated each time that the `mapping.f90` source code is modified.

'`settings.cfg`'
: This plain-text settings file is not included with the RTS distribution; instead, it is generated each time that the `generateTropPlots.sh` script detects a newly-decoded data file. File path and type information is written automatically to this file.

'config' This folder contains plotting-specific configurations for the mapping executable. It resides in the realtimeSystem/mapping_f90 folder and contains a number of easily-identifiable configuration files. These files may be changed withough recompiling the mapping executable.

'realtimeupdate.py'
This Python program generates and updates the web-based user interface. It is contained in the HTDOCS folder, where HTDOCS is defined at the configuration-time of the package. No modifications should be required to this file unless extensive changes are made to the structure or functionality of the RTS.

'dtmaps.cgi-tmpl'
This Perl Common Gateway Interface (CGI) script template is used to create dtmaps.cgi, the Perl script that handles the extraction of images requested by a user on the web-based interface. It resides in the HTDOCS/cgi-bin folder, where HTDOCS is defined at the configuation-time of the package. There should be no need for modifications to the template, but inline documentation describes the functionality of the CGI script.

'animSelect.php-tmpl'
This HTML document template is used to create animSelect.php, the web-based user interface for the RTS. It resides in the HTDOCS/DTmaps folder, where HTDOCS is defined at the configuation-time of the package. There should be no need to modify this template unless extensive changes are made to the RTS.

'animSelect.cfg'
This plain-text configuration file allows for a great level of flexibility in the interface by providing a stand-alone set of configurations that are used in the generation of the dtmaps.cgi and animSelect.php interface files from the templates described above. The realtimeupdate.py program processes this configuration file whenever it is executed, generating new interface files from the templates. This file must be modified every time that new fields, domains, levels or time increments are added to the RTS.

1.2 RTS Dependencies

The RTS depends on a number of libraries for computation and plotting processes. In addition, some non-standard applications are required for the complete processing of the resulting data.

The MetCal/SPA package is a basic requirement for the RTS. This package is available from and should be installed and configured for any system on which the RTS is to be built. The MetCal/SPA libraries provide the bulk of the RTS functionality.

The NCAR Graphics package is also required for the RTS. This package is available from and should be installed and configured before the RTS system is built. Although the MetCal/SPA package is designed to be compiled with or without NCAR Graphics installed, an NCAR Graphics enabled version of the MetCal/SPA is required for RTS functionality. This package should therefore be configured and installed before MetCal/SPA.

The NCAR Spherepack package is required for the highly-accurate global spherical calculations employed by the RTS. Although not a strict requirement, since the RTS will also run without spherical computations, both computational time and accuracy are enhanced if the NCAR Spherepack package (available at) is configured and installed before MetCal/SPA or the RTS is built. Notes on the installation of Spherepack are available at .

The poster utility is required for the generation and printing of 11x17 size Special Services plots. As of RTS version 1.0.0, polar stereographic dynamic tropopause maps are generated and printed using this utility. The poster program is available at .

2 Running the RealTime System

This chapter describes how to configure, install and run the RTS in both interactive and batch mode. Please note that the packages on which the SPA depends (see Section 1.2 [Dependencies], page 2) should be installed and configured before this installation of the RTS is begun.

2.1 Installation of the RTS

Once all of the packages on which the RTS depends have been configured and installed (see Section 1.2 [Dependencies], page 2), the RTS package itself can be configured. The RTS uses GNU autotools to ensure platform-independence and to ease the setup and installation process. An example of the commands issued to configure, build an install the RTS is:

```
./configure --prefix=/path/to/install \
  HTDOCS=/path/to/web/document/directory
make all >&make.out
make install >&install.out
```

The `configure` script included with the RTS distribution usually does a good job of determining the setup of your machine. Be sure to watch for warnings as the configuration progresses, since not all problems are fatal, but they may impact the performance of the RTS. Additional settings can be made by the user at configure time. For a full list of the configurable settings, type:

```
./configure --help
```

Potentially useful configurable options include:

'`--prefix=/path/to/install`'
: This option allows the user to set the path into which the computational section of the RTS is installed (i.e. the `realtimeSystem` directory and its subdirectories). The default for this option is `/usr/local`.

'`HTDOCS=/path/to/web/document/directory`'
: This option allows the user to set the path into which the web-based portion of the RTS is installed (i.e. the `cgi-bin` and `DTmaps` folders). The location pointed to by this path should be visible by your web server, or should be linkable to a directory visible by the web server (any linking will need to be done manually). The default for this option is `/usr/local/etc`.

'`SSDIR=/path/to/special/services/directory`'
: This option allows the user to set the path in which the Special Services output of the RTS is stored. These are usually images that are of particular interest for a limited amount of time or designed for a special purpose. The default for this option is `HTDOCS`.

'`WORKFILE=/name/of/LDM/decoder/output`'
: This option allows the user to set the absolute path and name of the output file generated by the LDM decoders as they convert grib data to GEMPAK format. This value will almost certainly vary depending on your local system. All that the decoder output (to the file named here) has to contain once it has

finished processing the GEMPAK file is the word `Finished` (capitalization is important) and long listing (`ls -l`) of the decoded file. The default for this option is `/unidata/products/workdir/gfs255/gfs255.out`.

'`SERVER=serverName`'
: If the data decoding and image storage services are not being run on the local machine (this should be considered unusual) then a remote server name can be entered using this option. The default value for this option is the local machine name.

2.2 Running the RTS interactively

The interactive running mode of the RTS is the simplest way to run the system; however, it is also less powerful than the automated mode described in the next section. The first step in running interactively is to create the settings file `settings.cfg` in the compuation and image generation directory `/path/to/install/realtimeSystem/mapping_f90`, where `/path/to/install` is described in the installation section above. Initially, this directory contains only the `mapping.f90` source, the `mapping` executable and the `config` subdirectory. The `settings.cfg` file can be created manually:

```
'type' 'gem'
'input file information' 'list',1
                         '/data/file/path/and/name'
'output file information' 0
'grid file information' ''
```

In this example, the `/data/file/path/and/name` should be replaced by the absolute path to the data file to be processed. Once this file has been produced, simply run the `mapping` executable to generate the RTS images for the given analysis. The images will be created in the local directory and will remain there once the `mapping` program terminates.

2.3 Running the RTS in automated mode

The automated mode of the RTS is the standard format in which to run the system. The `generateTropPlots.sh` Korn Shell script (residing in the `/path/to/install/realtimeSystem/automation` folder, where `/path/to/install` is described in the installation section above) controls the execution of the `mapping` program in this mode and also separates the output images into formats that can be used directly by the web interface. Although every attempt has been made to keep the RTS as user-configurable as possible, it is possible (and perhaps even likely) that the `generateTropPlots.sh` script will need to be modified before the system will run flawlessly in automated mode on a given system.

As a first step, the user should try running `./generateTropPlots.sh` from the command line in the `/path/to/install/realtimeSystem/automation` directory (since this directory itself is likely not in the path). If the system produces output beginning with `generateTropPlots log`, then the automated system has initialized the `mapping` executable correctly. If no such output appears, then the third line of the `generateTropPlots.sh` script should be changed to read:

```
debug=1
```

This will run the script in debugging mode and allow the user to make any required modifications.

Once the `generateTropPlots.sh` launch script is running, it will appear to hang as the `mapping` executable goes through the compuation and plotting process. Note that this execution can take up to 2 hours on a Linux box for high resolution images. This explains why the debugging mode can come in handy while the system is being established. After the plots are generated, `generateTropPlots.sh` takes over to convert the resulting images to a web-ready format and to transfer them to appropriate archive subdirectories. This image processing can take another 1.5 to 2 hours on a Linux machine for high resolution grids. The images are transferred to the `/path/to/web/document/directory/DTmaps/realtime` subdirectires that are named according to the image produced. Images accumulate in these archive directories ad infinitum (or at least until the disk space runs out).

The RTS can be run in a fully-automated format by combinging the automatic mode RTS functionality with Unix/Linux `cron`. Adding a job to the user `crontable` will use `generateTropPlots.sh` to create and event handler that detects the completion of LDM data decoding if the RTS is properly configured.

```
0,10,20,30,40,50 * * * * /path/to/install/realtimeSystem/automation/generateTropPlots.sh \
  >/tmp/log-out 2>/tmp/log-err || cat /tmp/log-err
```

This line added to the `crontable` (with the `/path/to/install` changed as noted in the installation section) will result in an RTS event handler that checks every 10 minutes for decoding completion. Once a new data file is decoded, `generateTropPlots.sh` writes a new `settings.cfg` configuration file for the `mapping` executable and begins to process the data. This is the standard running mode for the RTS.

3 Modifying the RealTime System

The two primary components of the RTS are the compuational/plotting segement (found in the `/path/to/install/realtimeSystem` folder, see Section 2.1 [Installation], page 4) and the web interface segement (found in the `/path/to/web/document/directory` folder, see Section 2.1 [Installation], page 4). Modifications to either or both of these may be desirable or required.

3.1 Modifying the Caluclation and Plotting RTS Components

The computational and plotting components of the RTS are located in the `/path/to/install/realtimeSystem` folder (see Section 2.1 [Installation], page 4).

The first modifications made to the RTS will likely be necessary ones made to the automated launch script `generateTropPlots.sh`. Despite proper configuration, it is possible (and even likely) that the user will have to modify this launch script to get the RTS running in automated mode (see Section 2.3 [Automated Running], page 5). The `generateTropPlots.sh` script has a debugging flag near the top of the file to assist in the modification process. It is most likely path names and utility references that will need to be changed in the initial modifications. Once the RTS is running in automated mode, very few changes should need to be made to the `generateTropPlots.sh` file. Even if new plots are added, no changes to the launch script are required.

Once the RTS is running in both interactive and automated modes (see Chapter 2 [Running the RTS], page 4), additional plots can be added (or existing plots taken away) and other compuatational or plotting changes can be made by modifying the `mapping.f90` source code. Familiarity with both FORTRAN90 and the MetCal/SPA package will greatly assist in modifications to this component of the RTS. To recompile the `mapping` executable, the MetCal command sequence should be run in the `mapping_f90` subdirectory.

```
comp90.d
make mapping
```

This will build a system-dependent makefile and create the `mapping` executable. Note that other MetCal utilities can be used to provide further flexibility in terms of modifications to the computational subprograms called by `mapping`.

Modifications to these two files (`generateTropPlots.sh` and `mapping.f90`) should permit for the customization of the compuataional and plotting component of the RTS.

3.2 Modifying the Web Interace RTS Components

The web interface component of the RTS is located in the `/path/to/web/document/directory` folder (see Section 2.1 [Installation], page 4).

Few initial modifications should be required to the web interface, providing that the `HTDOCS` option was properly set at configuration time. Common post-installation modifications are accomplished using the `animSelect.cfg` configuration file. The configuration file is divided into sections using `#text#` identifiers, where `text` is one of PATH, FIELD, LEVEL, REGION, INCREMENT, QUALITY, or SIZE. The options provided to users of the web interface are all set in this configuration file. For example, to add a new region (call it 'Asia' for example), an entry in the `#REGION#` section would have to be added:

```
region_asia => 'Asia'
```

The naming of all values in animSelect.cfg is important since the CGI script (dyntrop.cgi) relies on them to find the correct archive subdirectory. In this case, a new domain called asia would have to have been added to the mapping.f90 source (see Section 3.1 [Calculation and Plotting], page 7). The string value on the right hand side of the region identifier in this example is completely arbitrary; however, the _asia extension on the region string on the left hand side must match with the changes to the mapping.f90 code. Similarly, a new 2D field can be added (call it 'MG Field of Doom') by inserting a new entry below the #FIELD# header:

```
field_FoD => 'MG Field of Doom'
levelling_FoD => '2D'
extensions_FoD => '.jpg'
titles_FoD => 'DTmaps/titles/FoDTitle.html'
headers_FoD => 'DTmaps/headers/FoDHead.html'
captions_FoD => 'DTmaps/captions/FoDCap.html'
```

This is a little more complicated than the previous example, but follows similar lines. On the first line, the field is given an output name ('MG Field of Doom'). This name is completely arbitray; however, the _FoD extension on the field string means that the name of the files generated by mapping are FoD. If this is confusing, try running the mapping executable interactively and watching as the image files are generated. The names of the image files match with one of the sets of field specifications under the #FIELD# header of the animSelect.cfg file. The second line indicates that the field is only two dimensional. In fact, the only important value here is 3D - all other values (for example, 2D, tropopause or Bob) are handled identically as 2D fields. The titles, header and captions strings identify the HTML snippets that are concatenated into the animation web page as it is generated. If these files do not exist, default strings appear. In the case of the example, these files should be generated manually in the folder referred to in animSelect.cfg.

Modifications for the other headings are similar (and generally simpler). Once a modification to the configuration file (animSelect.cfg) is complete, the web interface must be rebuilt with the new information. This is accomplished by running the realtimeupdate.py program (located in the /path/to/web/document/directory directory). This program can be run in the Python shell for full functionality, or can be executed as:

```
python realtimeupdate.py
```

The template files (dyntrop.cgi-tmpl and animSelect.php-tmpl) are processed to create the web interface. Although the current version of the interface can be backed up using the Python shell, all changes to dyntrop.cgi and animSelect.php are ephemeral and are replaced once realtimeupdate.py is run. It is thus very important to remember that any changes to the web interface should be made in the template files rather than in the interface files themselves. Following any change to the templates, simply run realtimeupdate.py to generate a new web interface.

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