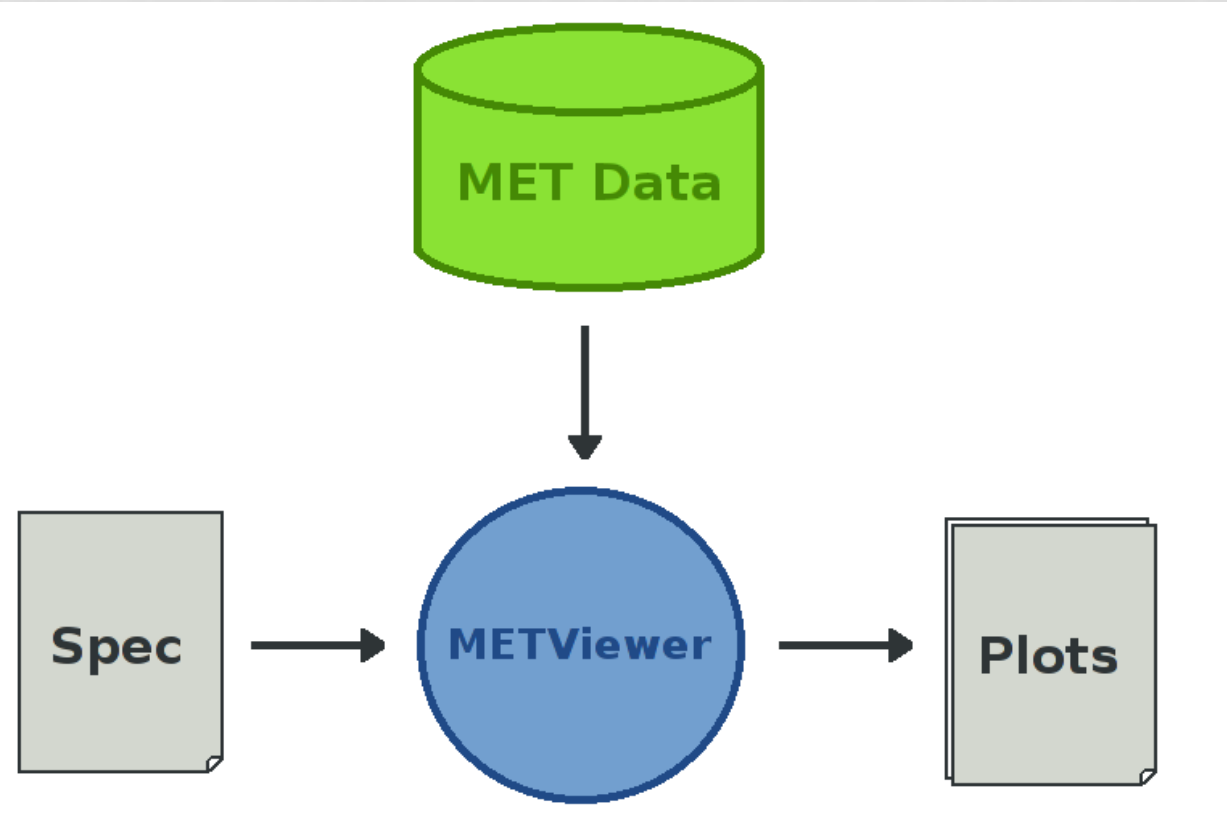
METViewer

What Is MET Viewer?

METViewer is a data visualization (plotting) system



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Design Principles of METViewer

- **Relational database:** for searching, sorting and grouping MET output data - MySQL
- **Plotting system:** for consistent and robust graphics – R
- **Web application:** for accessibility, portability and ease of use – java & apache tomcat
- **Batch processing:** for generating many plots with only a few simple commands - java
- **Distributable**

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What METViewer Does

- Reads MET verification statistics output from a **database**
- Creates plots using the **R** statistical package
- Includes a **web application** that can be accessed from a web browser to create a single plot
  - Specification for each plot is built using a series of controls and then **serialized into XML**
  - For each plot, **METViewer generates:** 1) an SQL query, 2) an R script to create the plot, 3) a flat file containing the data that will be plotted and 4) the plot itself

Available to anyone online:

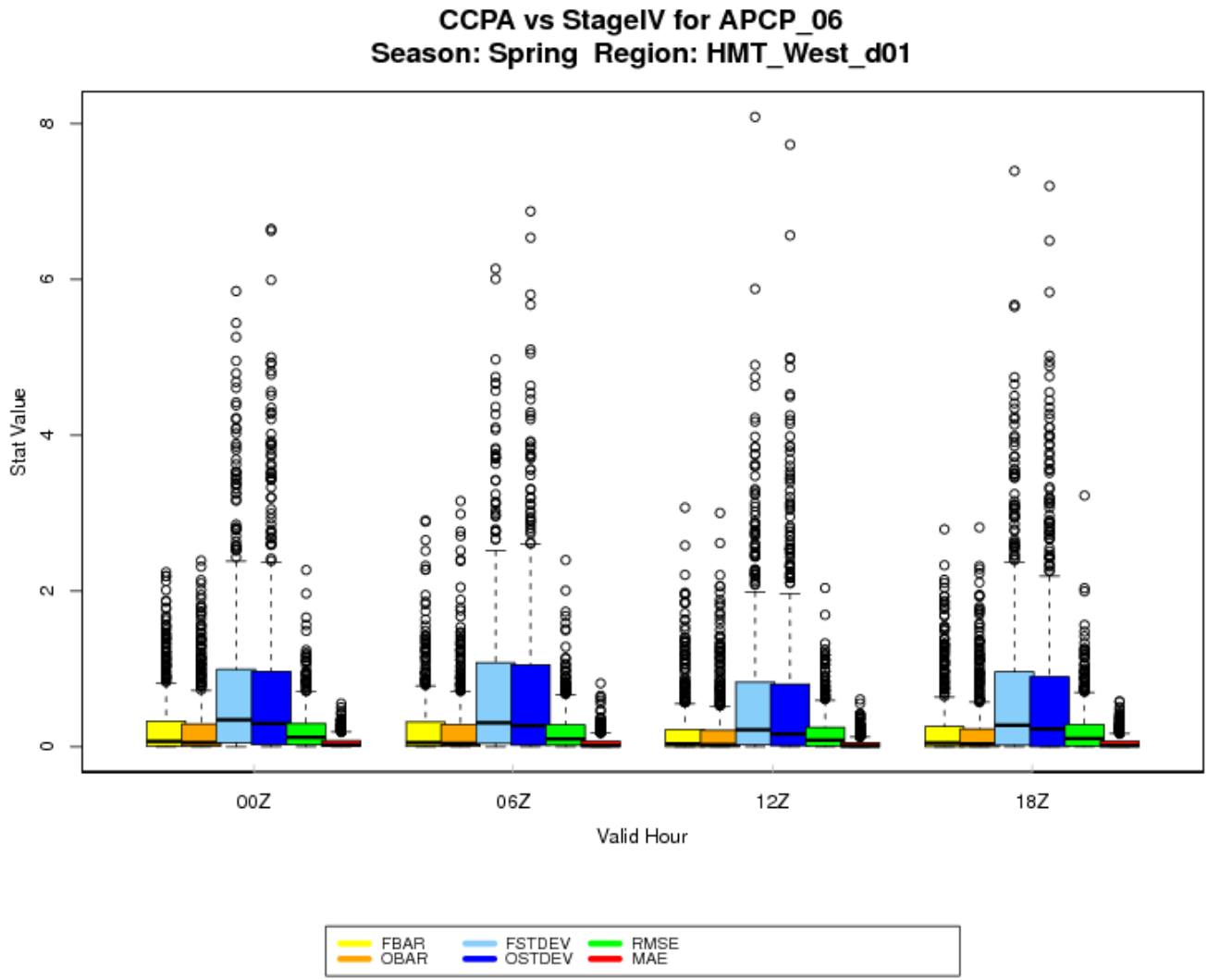
http://www.dtcenter.org/met/metviewer/metviewer.jsp?db=hmt_2010 ***DTC***

- Note: the link is a public test version and hence is limited to a single database

OR http://lark.fsl.noaa.gov:8080/metviewer/metviewer.jsp ***GSD***

(Restricted to fsl.noaa.gov users)

Sample Result



Aggregated by diurnal cycle valid times; Comparison of one gridded dataset with another gridded dataset (StageIV and 'improved' StageIV)

Building METViewer

MET Viewer System

The process of populating the MET Viewer (CON'T)

- http://lark.fsl.noaa.gov:8080/metviewer/doc/

METViewer Documentation

This contains documentation for the METViewer plotting system:

- Installing MET Viewer ← Initial Steps
- Database Loading Module - mv_load ← Repeated
- Batch Plotting Module - mv_batch
- Common XML Structures

MET Viewer System

- MET Viewer relies on the following tools
  - **Java JDK**
  - **ant** – used to build java code (not unlike make)
  - **apache tomcat** – to host metviewer on as website as server
  - **mySQL** – relational database
  - **R** – plotting software
  - **metviewer** – suite of tools (scripts) to populate a database and extract data according to requests, etc
- VM (virtual machine) called '***lark***' created, has all the software tools needed
- No need to log onto to run MET Viewer
- May only need to log onto lark to import data for MET Viewer (most steps can be done remotely)

Importing Data To METViewer

MET Viewer Importing Data

How do you import data into the MET Viewer?

1. Create verification statistics (.stat files) using MET
   - WRF output lends itself to use with MET
2. Organize verif stat data files in a tree-like dir structure which emulates a database structure, where
   - Top level directories reference domains, ensemble membs
   -
   -
   - E.g.

dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F000_01h__000000L_20110511_160000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F001_01h__010000L_20110511_170000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F002_01h__020000L_20110511_180000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F003_01h__030000L_20110511_190000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F004_01h__040000L_20110511_200000V.stat

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   - Top level directories reference domains, ensemble membs
   - Mid level directories reference dates
   -
   - E.g.

dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F000_01h__000000L_20110511_160000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F001_01h__010000L_20110511_170000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F002_01h__020000L_20110511_180000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F003_01h__030000L_20110511_190000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F004_01h__040000L_20110511_200000V.stat

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   - Top level directories reference domains, ensemble membs
   - Mid level directories reference dates
   - Low level dir reference output type
   - E.g.

dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F000_01h__000000L_20110511_160000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F001_01h__010000L_20110511_170000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F002_01h__020000L_20110511_180000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F003_01h__030000L_20110511_190000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F004_01h__040000L_20110511_200000V.stat

MET Viewer Importing Data

How do you import data into the MET Viewer?

1. Create verification statistics (.stat files) using MET
   - WRF output lends itself to use with MET
2. Organize verif stat data files in a tree-like dir structure which emulates a database structure, where
   - Top level directories reference domains, ensemble membs
   - Mid level directories reference dates
   - Low level dir reference output type & contain hourly content
   - E.g.

dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F000_01h__000000L_20110511_160000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F001_01h__010000L_20110511_170000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F002_01h__020000L_20110511_180000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F003_01h__030000L_20110511_190000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F004_01h__040000L_20110511_200000V.stat

MET Viewer Importing Data

How do you import data into the MET Viewer?

3. Create an XML script with instructions that closely match the dirs containing the data files

- E.g.

```
<connection>
        <host>lark</host>
        <database>mv_hmt_ed_2011</database>
<folder_tmpl>/exchange/tmp/HMT/West/2011/dwr_domains/{model}/{fcst_valid}/{output_type}/</folder_tmpl>
    <date_list name="folder_dates_01h">
        <start>2011051116V_01h</start>
        <format>yyyyMMddHH'V_01h'</format>
    </date_list>
<field name="model">
            <val>ewp2_d01</val>
            <val>ewp3_d01</val>
```

MET Viewer Importing Data

Directory structure for data (again)

dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F000_01h__000000L_20110511_160000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F001_01h__010000L_20110511_170000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F002_01h__020000L_20110511_180000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F003_01h__030000L_20110511_190000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F004_01h__040000L_20110511_200000V.stat

Directory & content

Xml

```
<connection>
        <host>lark</host>
        <database>mv_hmt_ed_2011</database>
<folder_tmpl>/exchange/tmp/HMT/West/2011/dwr_domains/{model}/{fcst_valid}/{output_type}/</
folder_tmpl>
    <date_list name="folder_dates_01h">
        <start>2011051116V_01h</start>
        <format>yyyyMMddHH'V_01h'</format>
    </date_list>
<field name="model">
            <val>ewp1_d01</val>
            <val>ewp2_d01</val>
            <val>ewp3_d01</val>
```

MET Viewer Importing Data

Directory structure for data (again)

dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F000_01h__000000L_20110511_160000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F001_01h__010000L_20110511_170000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F002_01h__020000L_20110511_180000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F003_01h__030000L_20110511_190000V.stat
dwr_domains/ewp2_d01/2011051116V_01h/grid_stat/grid_stat_d01_F004_01h__040000L_20110511_200000V.stat

Directory & content

Xml

```
<connection>
        <host>lark</host>
        <database>mv_hmt_ed_2011</database>
<folder_tmpl>/exchange/tmp/HMT/West/2011/dwr_domains/{model}/{fcst_valid}/{output_type}/
</folder_tmpl>
    <date_list name="folder_dates_01h">
        <start>2011051116V_01h</start>
        <format>yyyyMMddHH'V_01h'</format>
    </date_list>
<field name="model">
            <val>ewp2_d01</val>
            <val>ewp3_d01</val>
```

MET Viewer Importing Data

How do you import data into the MET Viewer? (CON'T)

4. Create mySQL database entry
   - e.g. 'create database **mv_hmt_ed_2011'**
5. Load metviewer database tables,
   - i.e. 'mv_hmt_ed_2011 < sql/**mv_mysql.sql'**
6. Load the data file content into mySQL, using script which reads the XML file
   - bin/**mv_load.sh** load_hmt_2011.xml

MET Viewer Importing Data

How do you import data into the MET Viewer? (CON'T)

7. Change the list of databases accessible through the METViewer web application
   - web app properties file must be modified and
   - web application must be rebuilt and re-deployed

MET Viewer Importing Data

Result of Steps

- E.g.

```
<connection>
        <host>lark</host>
        <database>mv_hmt_2011</database>
<folder_tmpl>/exchange/tmp/HMT/West/2011/dwr_domains/{model}/{fcst_valid}/{output_type}/</folder_tmpl>
    <date_list name="folder_dates_01h">
        <start>2011051116V_01h</start>
        <format>yyyyMMddHH'V_01h'</format>
    </date_list>
<field name="model">
            <val>ewp2_d01</val>
            <val>ewp3_d01</val>
```

MET Viewer Importing Data

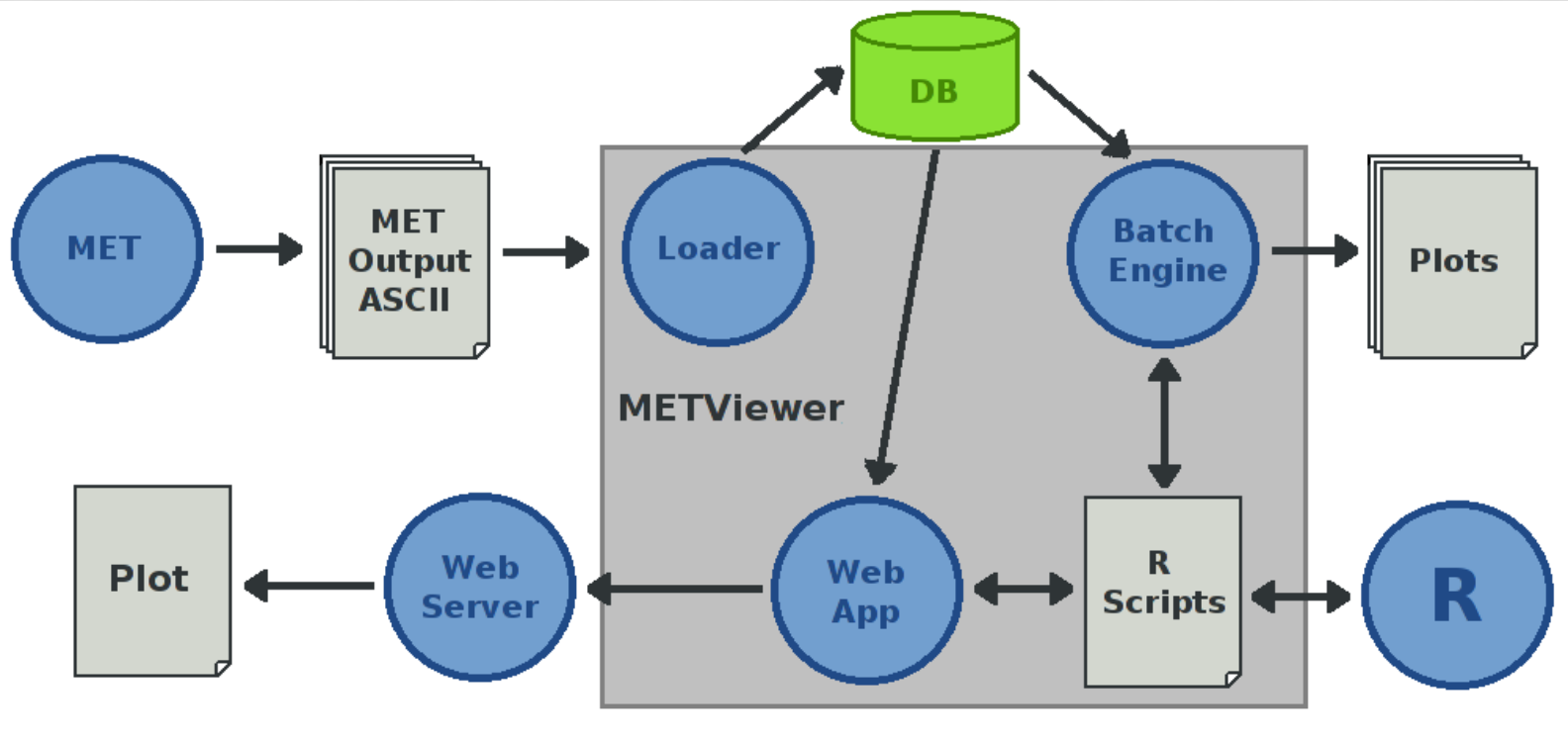
Importing data to MET Viewer (recap)

Create a METViewer database:

- **Create a database** to store MET data, which has the prefix 'mv_', e.g. mv_met_data:
  $ cd [install]/metviewer
  $ mysql -u[db_username] -p[db_password] -e'create database [db_name];'
  $ mysql -u[db_username] -p[db_password] [db_name] < sql/mv_mysql.sql
- **Create an XML load specification document** which contains information about *your* MET data
- **Run the MET Viewer load tool** using the XML load specification as input [load_xml] and monitor progress:
  $ cd [install]/metviewer
  $ bin/mv_load.sh [load_xml] [optional redirection of output]

METViewer Design

MET Viewer consists of components which implement solutions



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MET Viewer
Results of Steps

lark $ mysql –u[username] –p[password]

- mysql> **show databases**; (DB that contain Tables)
- +----------+
- | Database |
- +----------+
- | mv_hmt_2011 |
- | **mv_hmt_ed_2011** |
- | mv_met_data |
- | mysql |
- +----------+
- 5 rows in set (0.10 sec)

MET Viewer
Results of Steps

mysql> **show tables**; (List of Tables)

- +----------+
- | **data_file** |
- | data_file_lu |
- | instance_info |
- | line_data_cnt |
- | line_data_ctc |
- | line_data_cts |
- | line_data_fho |
- | line_data_isc |
- | line_data_mctc |
- | line_data_mctc_cnt |
- | line_data_mcts |
- | line_data_mpr |
- | **stat_header** |
- …

MET Viewer
Results of Steps

mysql> **describe data_file**; (Table Information)

```
+---------------------+-----------------------+--------+-------+------------+------+
| Field               | Type                  | Null   | Key   | Default    | Extra |
+---------------------+-----------------------+--------+-------+------------+------+
| data_file_id        | int(10) unsigned      | NO     | PRI   | NULL       |       |
| data_file_lu_id     | int(10) unsigned      | NO     | MUL   | NULL       |       |
| filename            | varchar(256)          | YES    | MUL   | NULL       |       |
| path                | varchar(512)          | YES    |       | NULL       |       |
| load_date           | datetime              | YES    |       | NULL       |       |
| mod_date            | datetime              | YES    |       | NULL       |       |
+---------------------+-----------------------+--------+--------+-----------+------+
6 rows in set (0.00 sec)
```

MET Viewer
Results of Steps

mysql> **select** * from **data_file**; (Table Contents)

data_ file_id	data_ file_lu_id	filename	load_date	mod_date
0	1	grid_stat_d02_F006_06h_060000L_20101209_000000V.stat	2011-08-02 20:57:06	2010-12-18 05:14:39
1	1	grid_stat_d02_F012_06h_120000L_20101209_000000V.stat	2011-08-02 20:57:07	2010-12-18 05:14:43
2	1	grid_stat_d02_F036_06h_360000L_20101209_000000V.stat	2011-08-02 20:57:07	2010-12-18 05:14:46
3	1	grid_stat_d02_F006_06h_060000L_20101215_120000V.stat	2011-08-02 20:57:07	2010-12-18 06:25:18
4	1	grid_stat_d02_F012_06h_120000L_20101215_120000V.stat	2011-08-02 20:57:09	2010-12-18 06:25:21
5	1	grid_stat_d02_F018_06h_180000L_20101215_120000V.stat	2011-08-02 20:57:09	2010-12-18 06:25:25
6	1	grid_stat_d02_F024_06h_240000L_20101215_120000V.stat	2011-08-02 20:57:09	2010-12-18 06:25:28
7	1	grid_stat_d02_F030_06h_300000L_20101215_120000V.stat	2011-08-02 20:57:09	2010-12-18 06:25:31
8	1	grid_stat_d02_F036_06h_360000L_20101215_120000V.stat	2011-08-02 20:57:09	2010-12-18 06:25:34
9	1	grid_stat_d02_F042_06h_420000L_20101215_120000V.stat	2011-08-02 20:57:09	2010-12-18 06:25:37
10	1	grid_stat_d02_F048_06h_480000L_20101215_120000V.stat	2011-08-02 20:57:09	2010-12-18 06:25:40

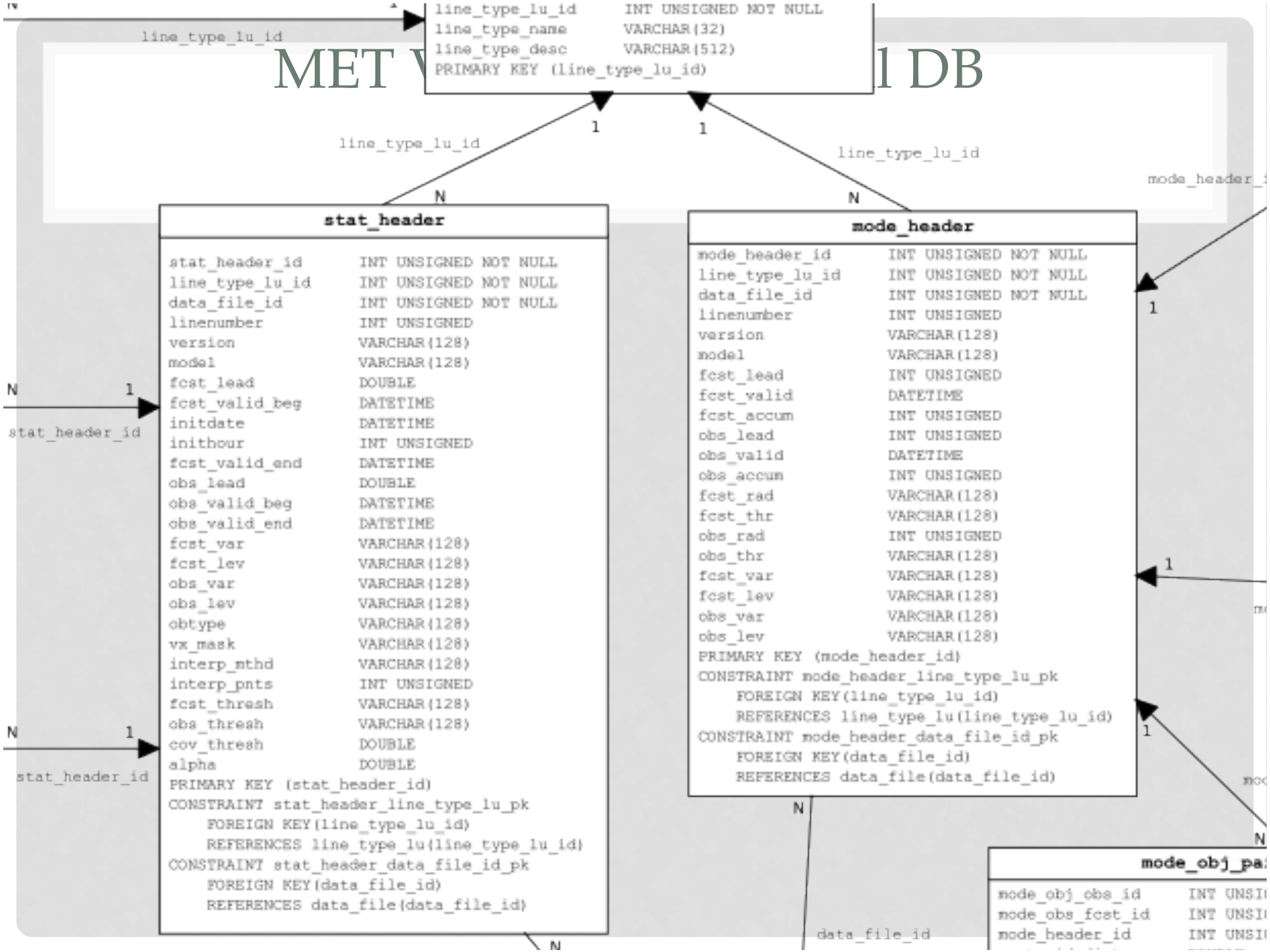
MET Viewer
Results of Steps

mysql> **select** stat_header_id, model, interp_mthd, fcst_thresh from **stat_header**;

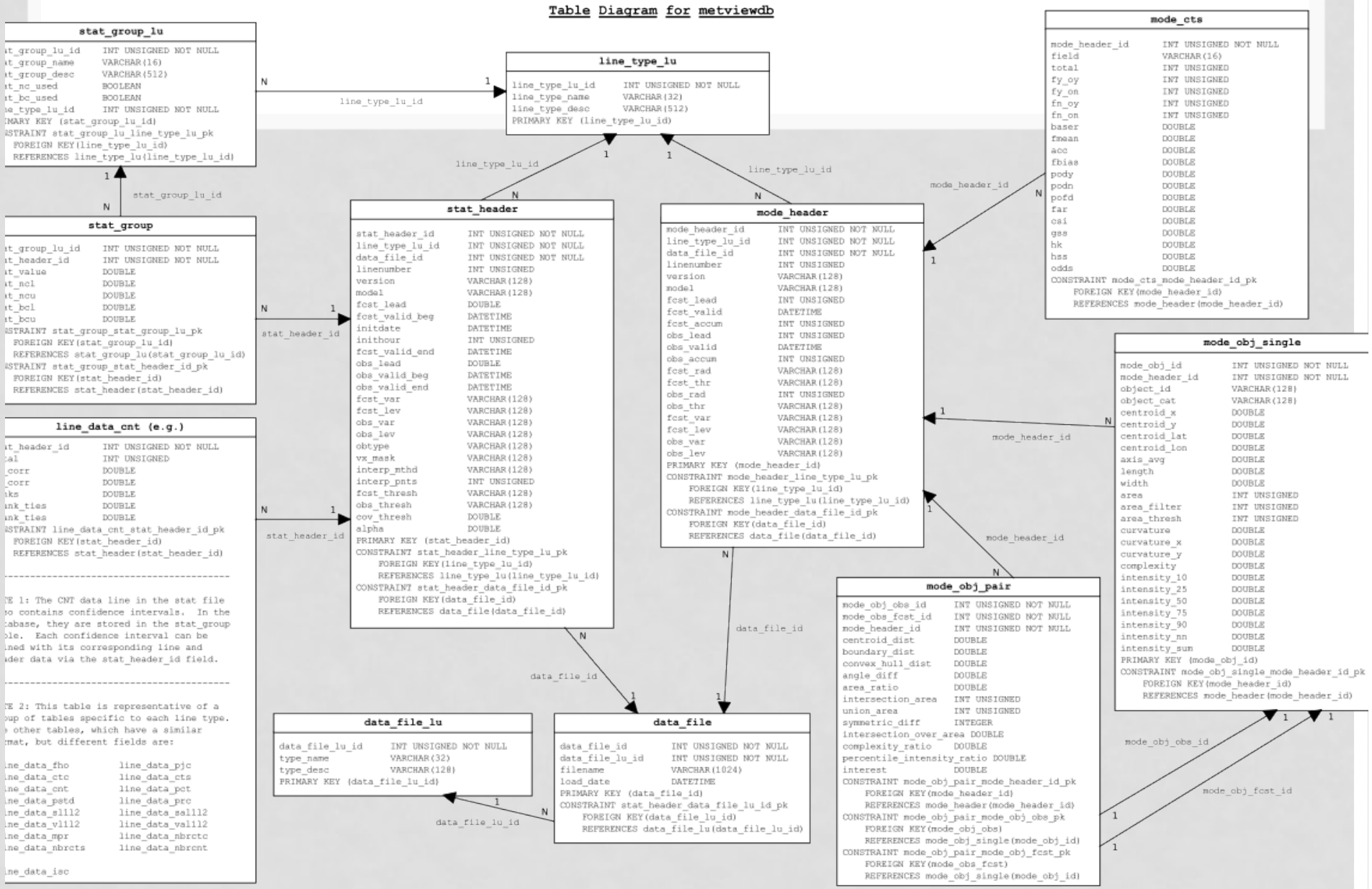
(Table Contents, second e.g.)

```
+--------------+------------+------------------+-----------------------------------------+
|stat_         |model       | interp_mthd      | fcst_thresh
|header_id     |            |                  |
+--------------+------------+------------------+-----------------------------------------+
|            0 | gfs-d02    | UW_MEAN          | >=2.540                                 |
|            1 | gfs-d02    | UW_MEAN          | >=6.350                                 |
|            2 | gfs-d02    | UW_MEAN          | >=12.700                                |
|            3 | gfs-d02    | UW_MEAN          | >=25.400                                |
|            4 | gfs-d02    | UW_MEAN          | >=50.800                                |
|            5 | gfs-d02    | UW_MEAN          | >=2.540,>=6.35,>=12.7,>=25.4,>=50.8
|            6 | gfs-d02    | UW_MEAN          | NA                                      |
|            7 | gfs-d02    | NBRHD            | >=2.540                                 |
|            8 | gfs-d02    | NBRHD            | >=6.350                                 |
|            9 | gfs-d02    | NBRHD            | >=12.700                                |
```

MET V l DB


line_type_lu_id INT UNSIGNED NOT NULL
line_type_name VARCHAR(32)
line_type_desc VARCHAR(512)
PRIMARY KEY (line_type_lu_id)
line_type_lu_id
line_type_lu_id
line_type_lu_id
stat_header
stat_header_id INT UNSIGNED NOT NULL
line_type_lu_id INT UNSIGNED NOT NULL
data_file_id INT UNSIGNED NOT NULL
linenumber INT UNSIGNED
version VARCHAR(128)
model VARCHAR(128)
fcst_lead DOUBLE
fcst_valid_beg DATETIME
initdate DATETIME
inithour INT UNSIGNED
fcst_valid_end DATETIME
obs_lead DOUBLE
obs_valid_beg DATETIME
obs_valid_end DATETIME
fcst_var VARCHAR(128)
fcst_lev VARCHAR(128)
obs_var VARCHAR(128)
obs_lev VARCHAR(128)
obtype VARCHAR(128)
vx_mask VARCHAR(128)
interp_mthd VARCHAR(128)
interp_pnts INT UNSIGNED
fcst_thresh VARCHAR(128)
obs_thresh VARCHAR(128)
cov_thresh DOUBLE
alpha DOUBLE
PRIMARY KEY (stat_header_id)
CONSTRAINT stat_header_line_type_lu_pk
FOREIGN KEY(line_type_lu_id)
REFERENCES line_type_lu(line_type_lu_id)
CONSTRAINT stat_header_data_file_id_pk
FOREIGN KEY(data_file_id)
REFERENCES data_file(data_file_id)
mode_header
mode_header_id INT UNSIGNED NOT NULL
line_type_lu_id INT UNSIGNED NOT NULL
data_file_id INT UNSIGNED NOT NULL
linenumber INT UNSIGNED
version VARCHAR(128)
model VARCHAR(128)
fcst_lead INT UNSIGNED
fcst_valid DATETIME
fcst_accum INT UNSIGNED
obs_lead INT UNSIGNED
obs_valid DATETIME
obs_accum INT UNSIGNED
fcst_rad VARCHAR(128)
fcst_thr VARCHAR(128)
obs_rad INT UNSIGNED
obs_thr VARCHAR(128)
fcst_var VARCHAR(128)
fcst_lev VARCHAR(128)
obs_var VARCHAR(128)
obs_lev VARCHAR(128)
PRIMARY KEY (mode_header_id)
CONSTRAINT mode_header_line_type_lu_pk
FOREIGN KEY(line_type_lu_id)
REFERENCES line_type_lu(line_type_lu_id)
CONSTRAINT mode_header_data_file_id_pk
FOREIGN KEY(data_file_id)
REFERENCES data_file(data_file_id)
stat_header_id
stat_header_id
mode_header_
data_file_id
mode_obj_pa
mode_obj_obs_id
mode_obs_fcst_id
mode_header_id

MET Viewer – Relational DB



MET Viewer – Calculations

- Calculations using SQL queries is, only, when the **calc_stats** option is enabled **or** in the case of some derived MODE statistics: ACOV, MAXINT and those prefixed with RATIO_ and AREARAT_

- CTC stat calculations, e.g.

```
CREATE FUNCTION calcGSS (total INT, fy_oy INT, fy_on INT, fn_oy INT, fn_on INT) RETURNS
CHAR(16) DETERMINISTIC
BEGIN
   DECLARE c REAL;
   IF total = 0 THEN RETURN 'NA'; END IF;
   SET c = ( (fy_oy + fy_on) / total ) * (fy_oy + fn_oy);
   RETURN FORMAT( (fy_oy - c) / (fy_oy + fy_on + fn_oy - c), 4);
END
```

- Most **calculations are performed in R** during the aggregation or plotting process.

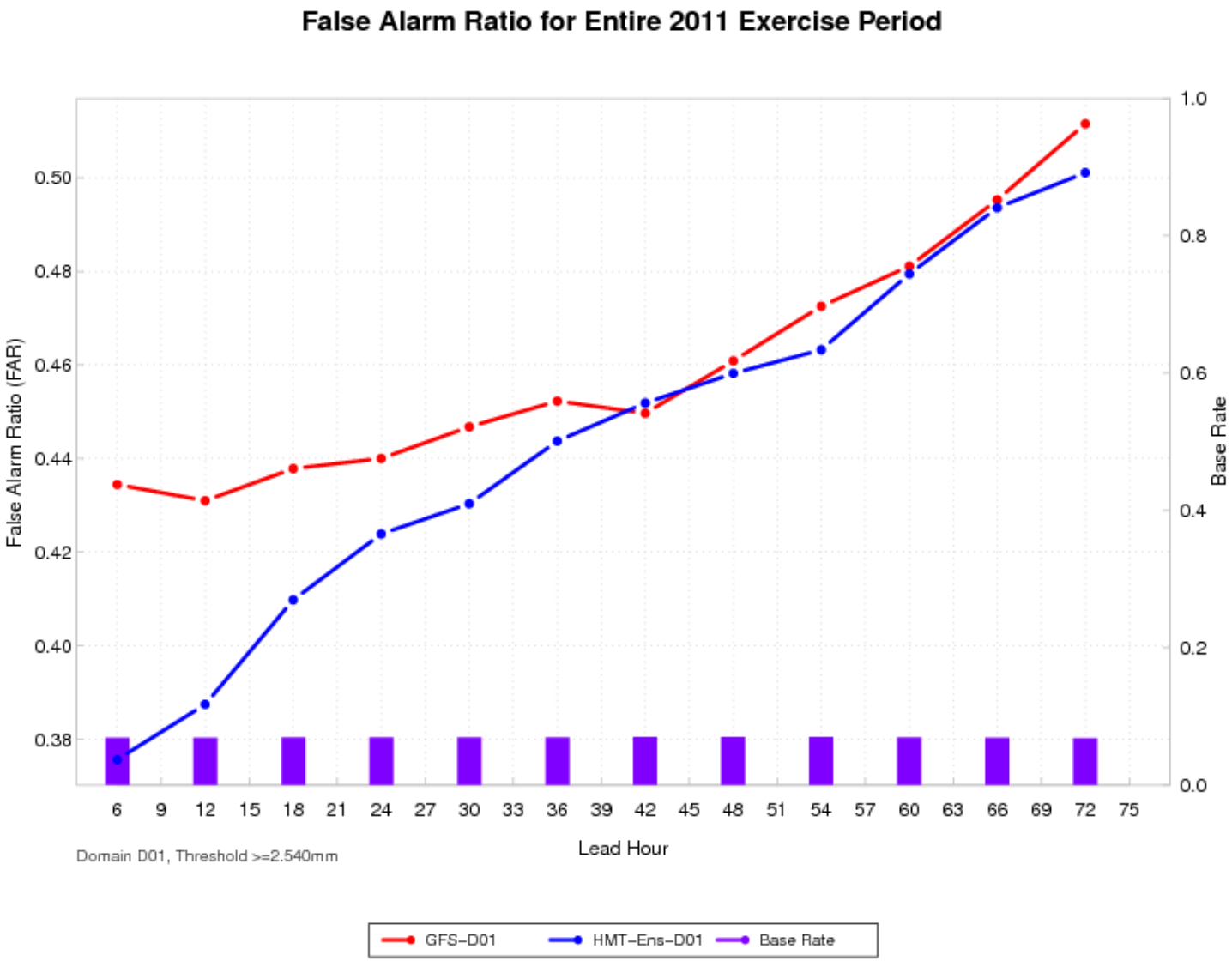
MET Viewer – Calculations

http://www.r-project.org/

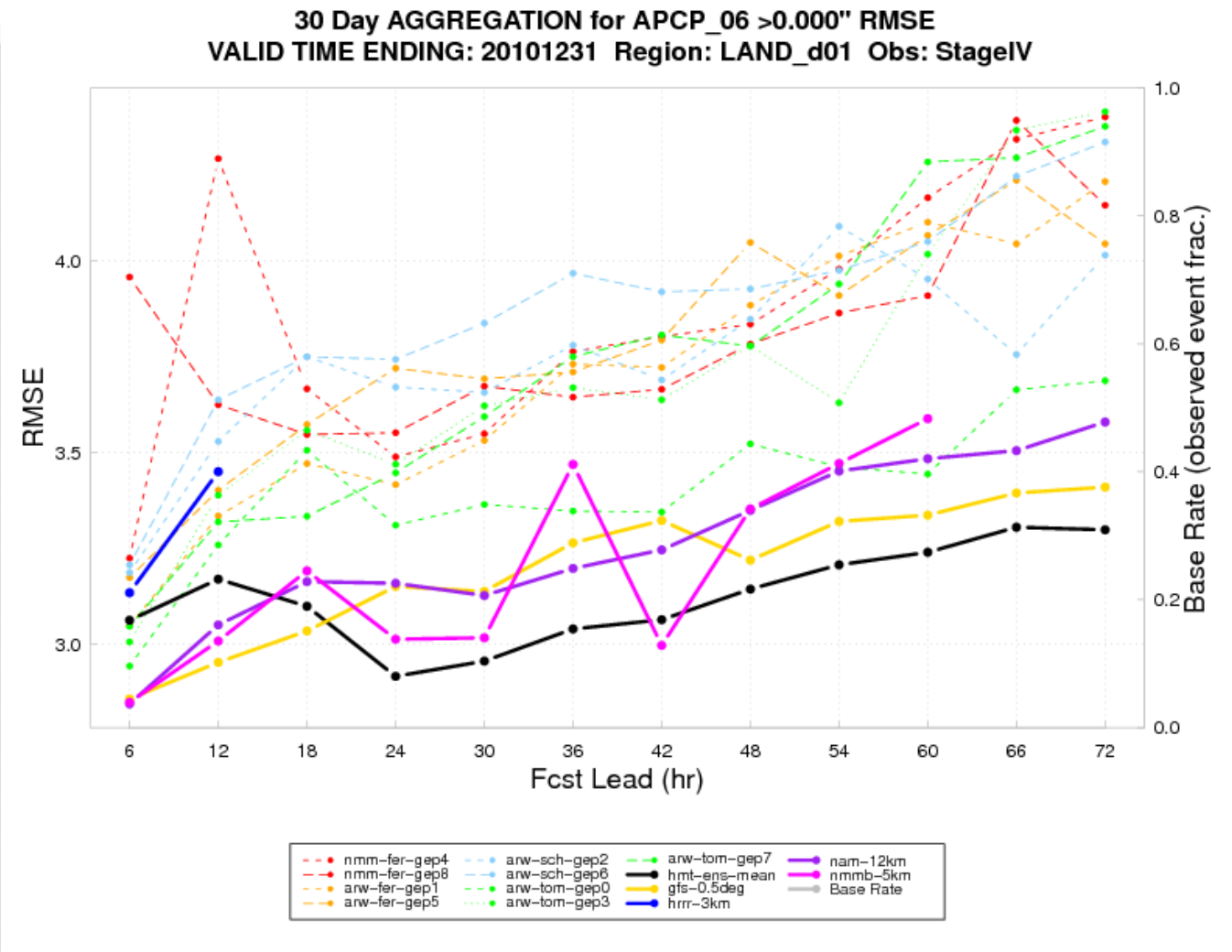
R is an integrated suite of software facilities for data manipulation, calculation and graphical display. It includes

- an effective data handling and storage facility,
- a suite of operators for calculations on arrays, in particular matrices,
- a large, coherent, integrated collection of intermediate tools for data analysis,
- graphical facilities for data analysis and display either on-screen or on hardcopy, and
- a well-developed, simple and effective programming language which includes conditionals, loops, user-defined recursive functions and input and output facilities

Result


False Alarm Ratio for Entire 2011 Exercise Period
False Alarm Ratio (FAR)
0.50
0.48
0.46
0.44
0.42
0.40
0.38
Base Rate
1.0
0.8
0.6
0.4
0.2
0.0
6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75
Lead Hour
Domain D01, Threshold >=2.540mm
GFS-D01
HMT-Ens-D01
Base Rate

Result



30-day aggregations, with multiple models and ensemble members, plotted over lead times

MET Viewer Importing Data

Process of importing data to METViewer (RECAP)

With verification task, e.g. '***HMT_2012***':

1. In SQL, create database '***mv_hmt_2012***' (mv= metviewer)
2. In SQL, grant all permissions on '***mv_hmt_2012***'
3. Load db tables

   mysql –u [user] **mv_hmt_2012 < mv_mysql.sql**
4. Load MET output data into db

   bin/mv_load.sh load_hmt_2012.xml >& log/load_[date].log
5. **Edit** java servlet file to include '***mv_hmt_2012***'

   /usr/local/metviewer/webapp/metviewer/WEB-INF/classes/**mvservlet.properties**
6. Rebuild web application – cd /usr/local/metviewer, run **ant**
7. Change **permissions** for global execute and write access, as R will be run by the end-user (need to write and execute scripts)
8. Re-deploy application to webserver

MET Viewer Conversion Script

LAPS ets scores converted to MET (a DTC for a project compared the output of the NCEP verification system to that of MET, via conversion script…)

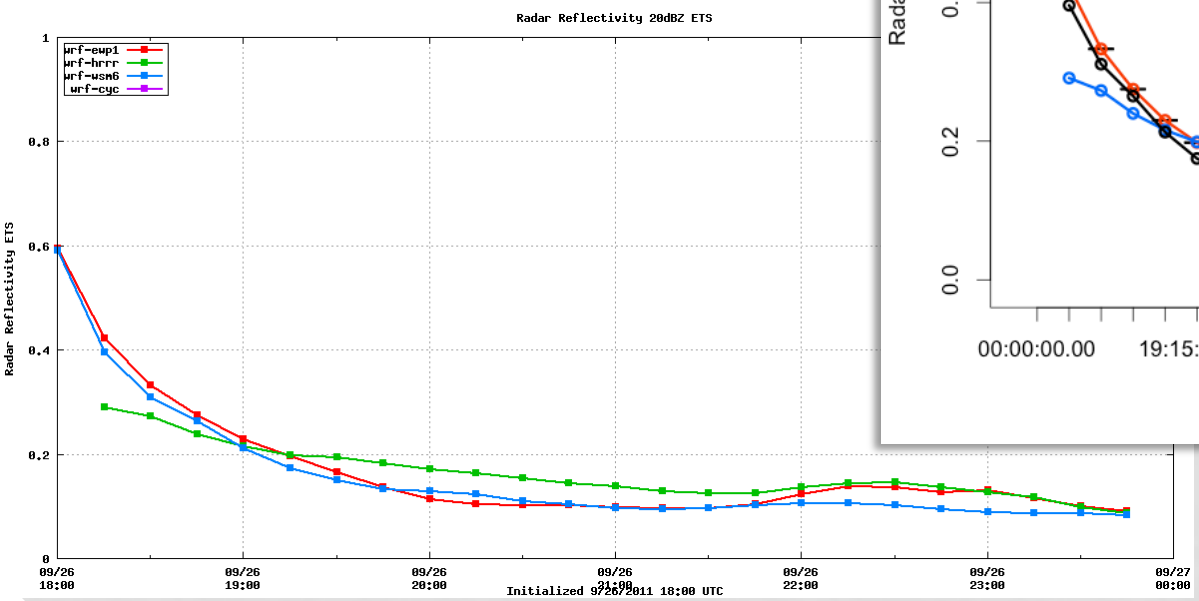
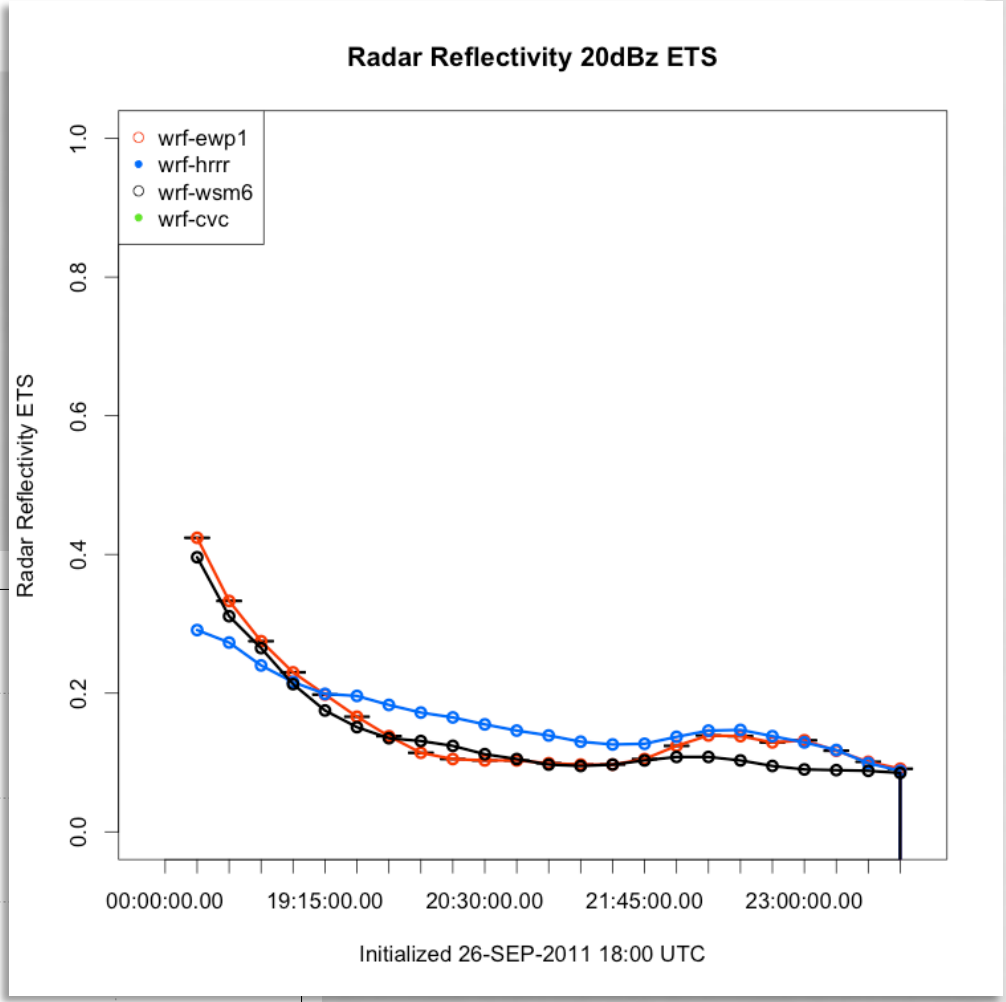
- $ cat 112761200.ets

Date	wrf-ewp1	wrf-hrrr	wrf-wsm6	wrf-cyc
3-OCT-2011 12:00:00.00	0.481	0.071	0.459	0.469
3-OCT-2011 12:15:00.00	0.245	0.083	0.239	0.147
3-OCT-2011 12:30:00.00	0.150	0.060	0.124	0.105
3-OCT-2011 12:45:00.00	0.079	0.049	0.070	0.088
3-OCT-2011 13:00:00.00	0.058	0.042	0.069	0.093
3-OCT-2011 13:15:00.00	0.052	0.048	0.072	0.094

LAPS .ets

MET .stat

- VERSION MODEL FCST_LEAD FCST_VALID_BEG FCST_VALID_END OBS_LEAD OBS_VALID_BEG OBS_VALID_END FCST_VAR FCST_LEV OBS_VAR OBS_LEV OBTYPE VX_MASK INTERP_MTHD INTERP_PNTS FCST_THRESH OBS_THRESH COV_THRESH ALPHA LINE_TYPE
- V3.0.1 ewp1_d01 040000 20110518_040000 20110518_040000 000000 20110518_040000 20110518_040000 REFC L0 REFC SFC ANALYS FULL UW_MEAN 1 >20.000 >20.000 NA NA CTC 105309 145 56 3081 102027
- V3.0.1 ewp1_d01 040000 20110518_040000 20110518_040000 000000 20110518_040000 20110518_040000 REFC L0 REFC SFC ANALYS FULL UW_MEAN 1 >20.000 >20.000 NA 0.05000 CTS 105309 0.03063 0.02961 0.03169 NA NA 0.00191 0.00166 0

GNU Plot vs. R Plot

LAPS ets scores