

# ***WRFDA***

## ***Analysis/Forecast Verification***

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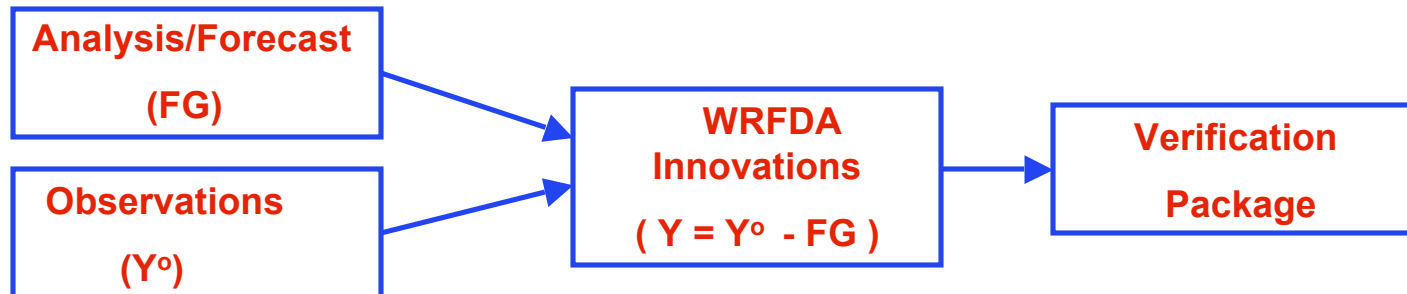
## ***Talk overview***

- **WRFDA verification strategy**
- **What are its advantages?**
- **How to run and generate the desired graphics?**
- **Future updates**

# ***How to Verify Analysis/Forecast?***

- **Two ways:**
  - **Against Observations**
  - **Against any analysis available in grid space (Control Analysis)**
- **Verification scores:**
  - **Root Mean Square Error (RMSE)**
  - **Mean bias (BIAS)**
  - **Absolute Mean bias (ABIAS)**

# Observation based Verification



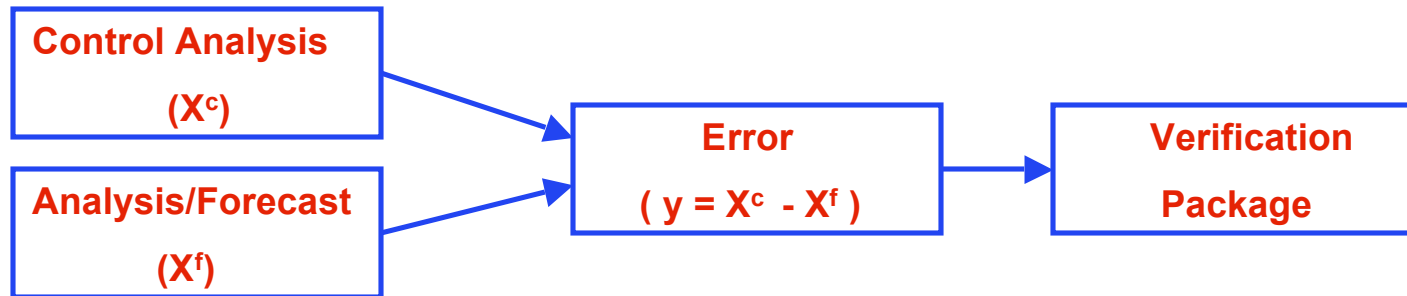
Verification code is under

`var/da/da_verif_obs`

compile `all_wrfvar` creates the desired executable

`da_verif_obs.exe`

# ***Analysis based Verification***



Code resides under “**var/da/da\_verif\_anal**” directory

“**compile all\_wrfvar**” creates the desired executable

(**da\_verif\_anal.exe**)

## ***Some advantages***

- Consistent with WRFDA QC
- Consistent with WRF model topography
- It makes use of built-in WRFDA observation operators
- In principle, verification is possible against any
  - Observation type individually or collectively
  - Verification analysis may be from any independent source or produced by any experiment
- It has its own built-in graphics (NCL) package

# ***How to run verification against observation?***

It works in **two steps**

- **Step 1:** Execute “var/script/da\_run\_suite\_verif\_obs.ksh”  
It will create all the desired input files (gts\_omb\_oma”) for verification
- **Step 2:** Execute “var/script/da\_verif\_obs\_plot.ksh”  
It will generate the desired graphics
- These scripts are executed (in the same order) via a suitable wrapper script, which needs to be written depending on the requirements

# ***Wrapper for da\_run\_suite\_verif\_obs***

**Important variables needs to be declared for this wrapper script:**

- |                                 |                                                                                                                                       |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <b>INITIAL_DATE</b>             | <b>: Verification starting date (yyyymmddhh)</b>                                                                                      |
| <b>FINAL_DATE</b>               | <b>: Verification ending date (yyyymmddhh)</b>                                                                                        |
| <b>CYCLE_PERIOD</b>             | <b>: Date advance increment in hour</b>                                                                                               |
| <b>EXP_DIR</b>                  | <b>: Experiment directory name (full path)</b>                                                                                        |
| <b>FILTERED_OBS_DIR</b>         | <b>: Directory where the observations “filtered_obs”<br/>against which verification will be done</b>                                  |
| <b>VERIFICATION_FILE_STRING</b> | <b>: It is either "wrfout" or "wrf_3dvar_input", depending<br/>on which files are saved while running WRF-forecasts<br/>in FC_DIR</b> |
| <b>VERIFY_HOUR</b>              | <b>: 0 for analysis &amp; 12, 24, etc. corresponding to the<br/>desired forecast hour verification</b>                                |

# Wrapper for `da_verif_obs_plot`

## Important variables:

**WRFVAR\_DIR** : Main WRFDA directory (full path)  
**REG\_DIR** : Directory holding sub-directories for each experiment generated in Step 1  
*For example: "gts\_omb\_oma" file corresponding to experiment "verify\_12" (directory for 12 hr forecast verification) for "2005081700" should be in \$REG\_DIR/verify\_12/2005081700/wrfvar*  
**RUN\_DIR** : Full path of the directory where plots will be generated  
**NUM\_EXPT** : Total number of experiments (Currently maximum 10)  
**EXP\_NAMES** : Experiment directory names as they exist in REG\_DIR (blank separated)  
**EXP\_LEGENDS** : Legend strings for each experiments respectively (comma separated)  
**START\_DATE** : Starting date ("YYYYMMDDHH") for verification  
**END\_DATE** : Ending date ("YYYYMMDDHH") for verification  
**INTERVAL** : Time interval (in hours) for incrementing date/time.  
**NUM\_OBS\_TYPE** : Number of observation types for verification  
**OBS\_TYPES** : Verification observation types like, "synop", "buoy", "sound" etc.  
**PLOT\_WKS** : Name of workstation for plots like "X11", "pdf" etc.  
**DESIRED\_LEVELS** : Pressure levels (in hPa) for plotting diagnostics  
**DESIRED\_SCORES** : Diagnostics like "RMSE", "BIAS" or "ABIAS"  
**EXP\_LINES\_COLORS** : Color sequence for various experiments.  
**VERIFY\_DATE\_RANGE**: String to specify title for X-axis

## ***Verif\_obs\_plot output***

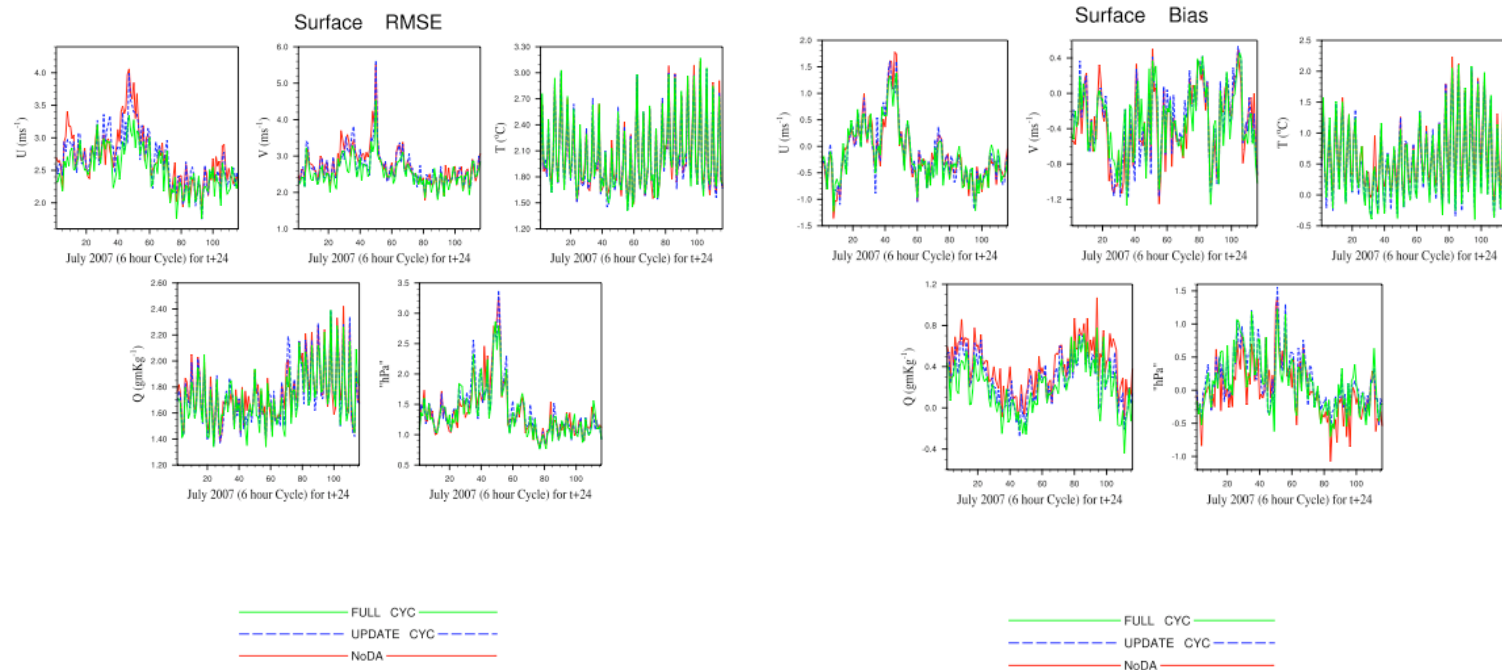
In RUN\_DIR, following graphics will be generated for each of the desired scores (RMSE, BIAS, ABIAS)

- Time series for surface and all the desired upper air levels
- Vertical profiles
- Time Average for surface and all the upper air levels (Histograms)

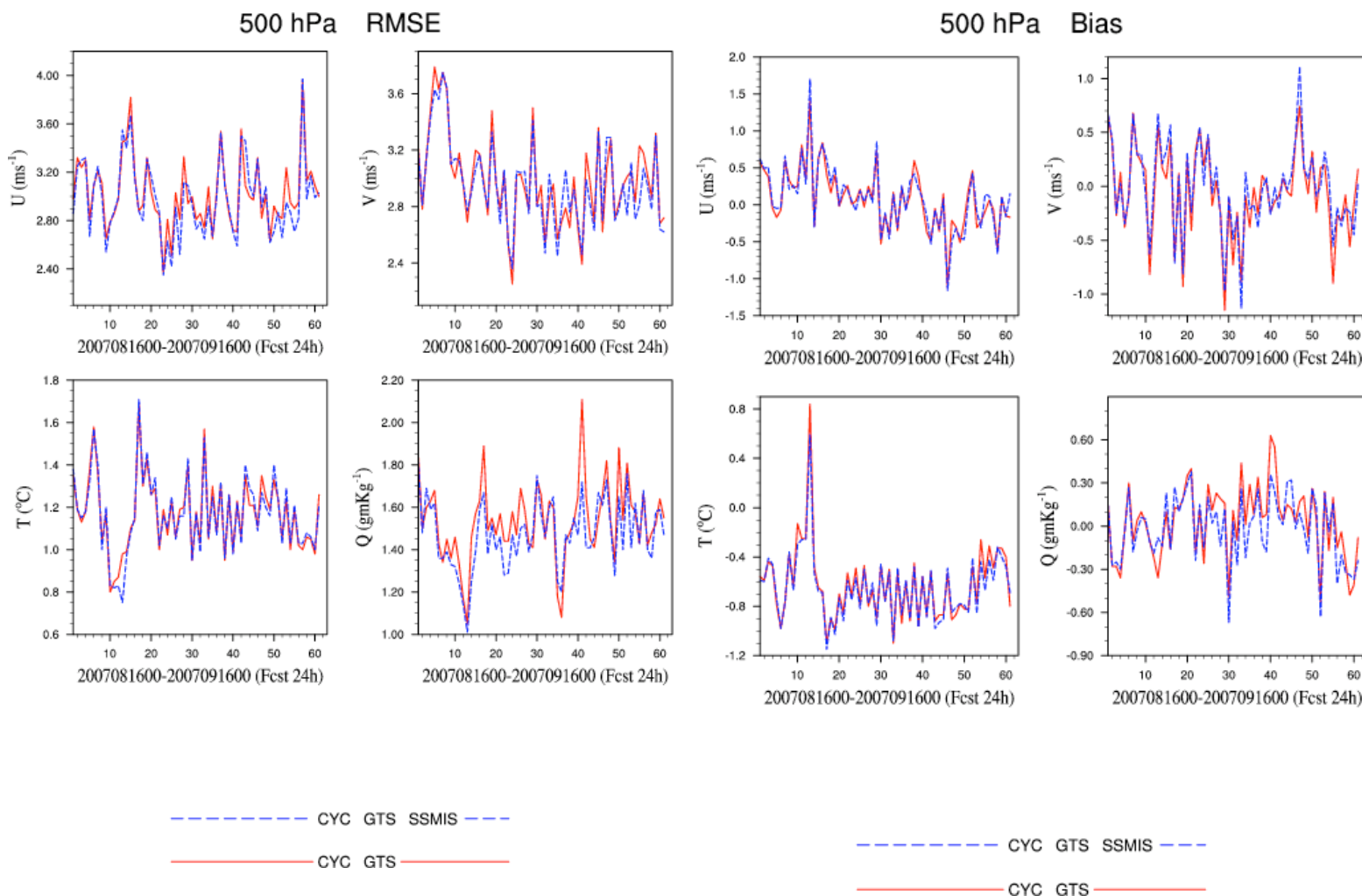
```

-rw-r--r--  1 rizvi  ncar      597691 Oct 13 12:49 Time_Series_SFC_RMSE.pdf
-rw-r--r--  1 rizvi  ncar      291856 Oct 13 12:49 Time_Series_SFC_BIAS.pdf
-rw-r--r--  1 rizvi  ncar      319570 Oct 13 12:49 Time_Series_SFC_ABIAS.pdf
-rw-r--r--  1 rizvi  ncar    1571714 Oct 13 12:49 Time_Series_UPA_RMSE.pdf
-rw-r--r--  1 rizvi  ncar      753440 Oct 13 12:49 Time_Series_UPA_BIAS.pdf
-rw-r--r--  1 rizvi  ncar      769452 Oct 13 12:49 Time_Series_UPA_ABIAS.pdf
-rw-r--r--  1 rizvi  ncar      463151 Oct 13 12:49 Profile_RMSE.pdf
-rw-r--r--  1 rizvi  ncar      467553 Oct 13 12:49 Profile_BIAS.pdf
-rw-r--r--  1 rizvi  ncar    12769280 Oct 13 14:54 Profile_ABIAS.pdf
-rw-r--r--  1 rizvi  ncar      129469 Oct 13 12:49 Time_Average_SFC_RMSE.pdf
-rw-r--r--  1 rizvi  ncar      136679 Oct 13 12:49 Time_Average_SFC_BIAS.pdf
-rw-r--r--  1 rizvi  ncar      142219 Oct 13 12:49 Time_Average_SFC_ABIAS.pdf
-rw-r--r--  1 rizvi  ncar      352928 Oct 13 12:49 Time_Average_UPA_RMSE.pdf
-rw-r--r--  1 rizvi  ncar      402740 Oct 13 12:49 Time_Average_UPA_BIAS.pdf
-rw-r--r--  1 rizvi  ncar      365264 Oct 13 12:49 Time_Average_UPA_ABIAS.pdf
    
```

# Verif\_obs\_plot -- Surface Time Series

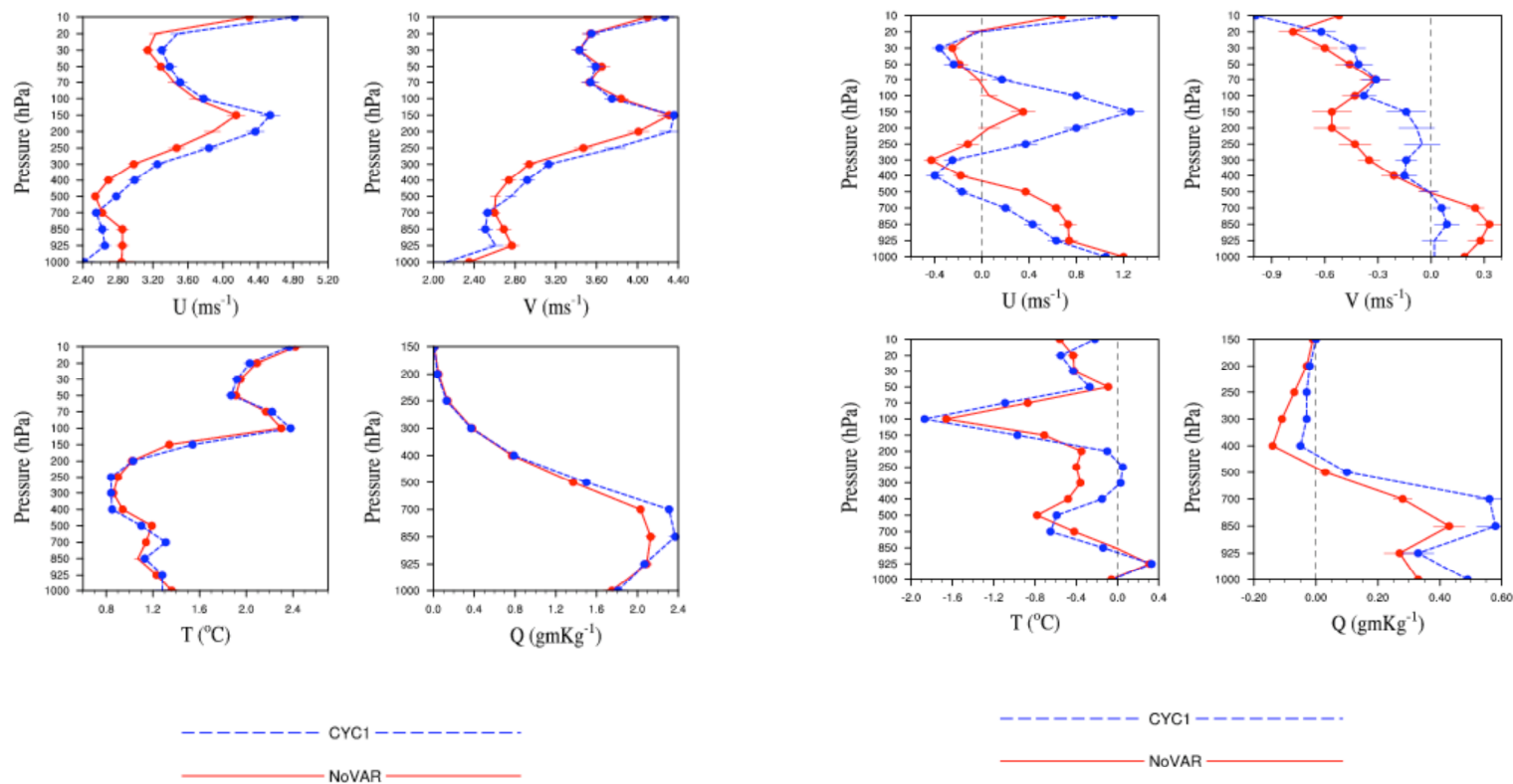


# Verif\_obs\_plot -- Upper air Time Series

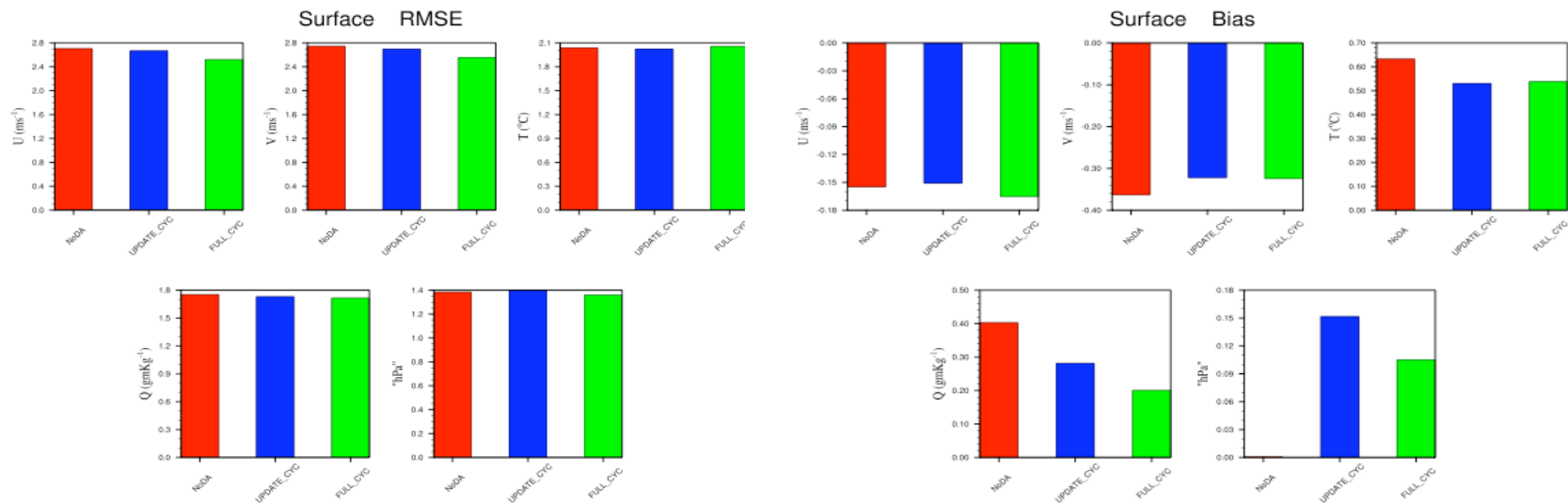


# Verif\_obs\_plot -- Profile

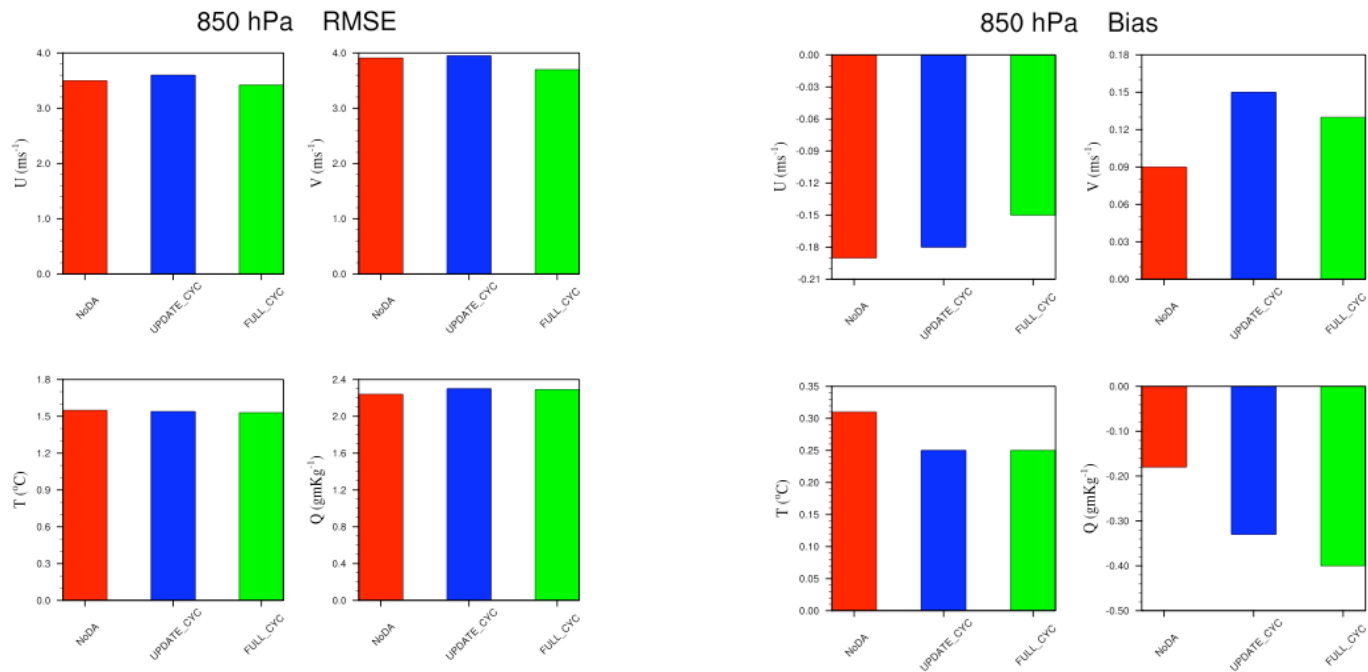
RMSE Profiles for t8\_15km: 15th August-15th September 2007 (t+12) Bias Profiles for t8\_15km: 15th August-15th September 2007 (t+12)



# Verif\_obs\_plot -- Surface Time Average



# Verif\_obs\_plot -- Upper air Time Average



## ***How to run verification against Analysis?***

- Each experiment forecasts needs to be arranged in separate directories with date-wise sub-directories
- Desired graphics will be generated in “RUN\_DIR” by executing “var/script/da\_verif\_anal\_plot.ksh” via a suitable wrapper script

# ***Wrapper for da\_verif\_anal\_plot***

## **Important variables:**

|                                 |                                                                                                                                              |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WRFVAR_DIR</b>               | : Main WRFDA directory (full path)                                                                                                           |
| <b>REG_DIR</b>                  | : Directory holding forecast sub-directories for each experiment                                                                             |
| <b>RUN_DIR</b>                  | : Directory where plots will be generated                                                                                                    |
| <b>NUM_EXPT</b>                 | : Total number of experiments (Currently maximum 10)                                                                                         |
| <b>EXP_DIR</b>                  | : Experiment directory names as they exist in REG_DIR (blank separated)                                                                      |
| <b>EXP_NAMES</b>                | : Experiment names as they exist in REG_DIR (blank separated)                                                                                |
| <b>EXP_LEGENDS</b>              | : Legend string for each experiments (comma separated)                                                                                       |
| <b>DESIRED_LEVELS</b>           | : Legend string for each experiments (comma separated)                                                                                       |
| <b>DESIRED_SCORES</b>           | : Diagnostics like "RMSE", "BIAS" or "ABIAS"                                                                                                 |
| <b>START_DATE</b>               | : Starting date ("YYYYMMDDHH") for verification                                                                                              |
| <b>END_DATE</b>                 | : Ending date ("YYYYMMDDHH") for verification                                                                                                |
| <b>INTERVAL</b>                 | : Time interval (in hours) for incrementing date/time                                                                                        |
| <b>VERIFY_HOUR</b>              | : Verification hour                                                                                                                          |
| <b>CONTROL_EXP_DIR</b>          | : Directory name for verifying analysis                                                                                                      |
| <b>VERIFY_ITS_OWN_ANALYSIS</b>  | : Set "true" or "false" if each experiment is going to be verified against its own analysis or against a fixed analysis in "CONTROL_EXP_DIR" |
| <b>VERIFICATION_FILE_STRING</b> | : It should be "wrfout" or "wrfinput" depending on what is available                                                                         |
| <b>VERIFY_DATE_RANGE</b>        | : String to specify X-axis title                                                                                                             |
| <b>PLOT_WKS</b>                 | : Name of workstation for plots like "X11", "pdf" etc.                                                                                       |

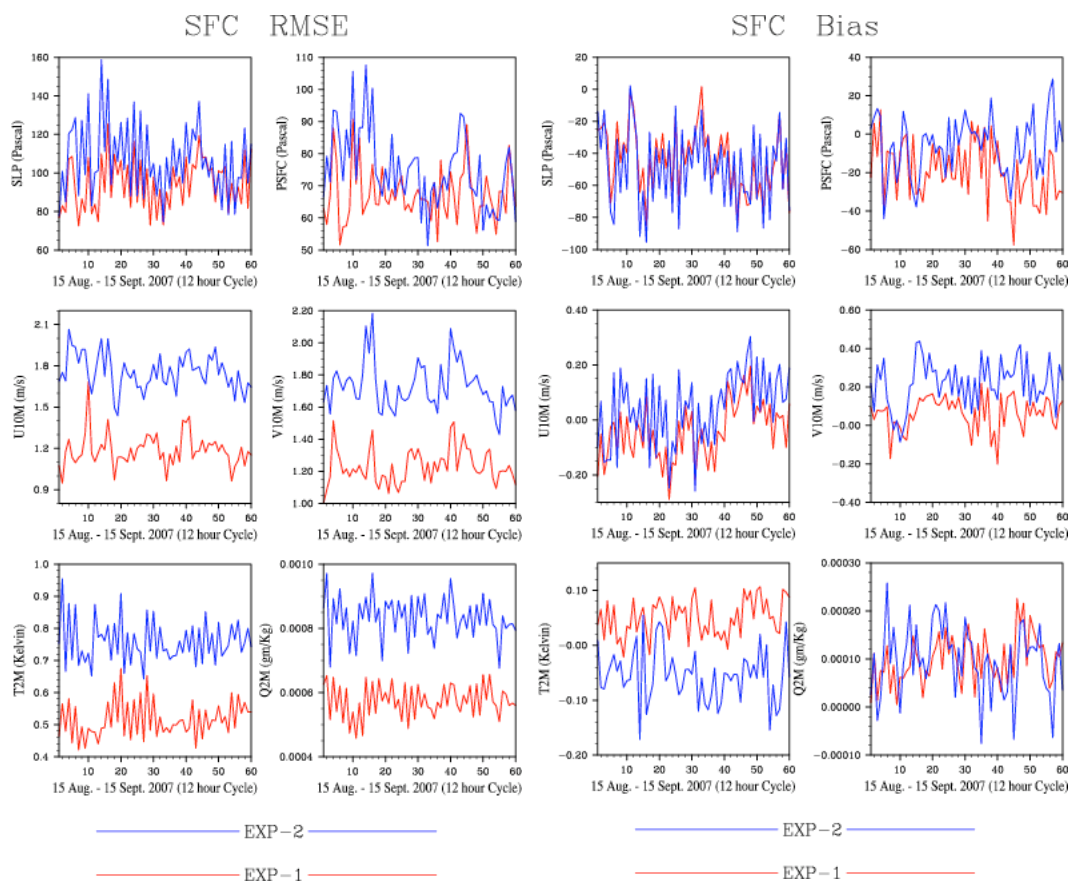
## Verif\_anal\_plot output

In RUN\_DIR, following graphics will be generated for each of the the desired scores (RMSE, BIAS or ABIAS)

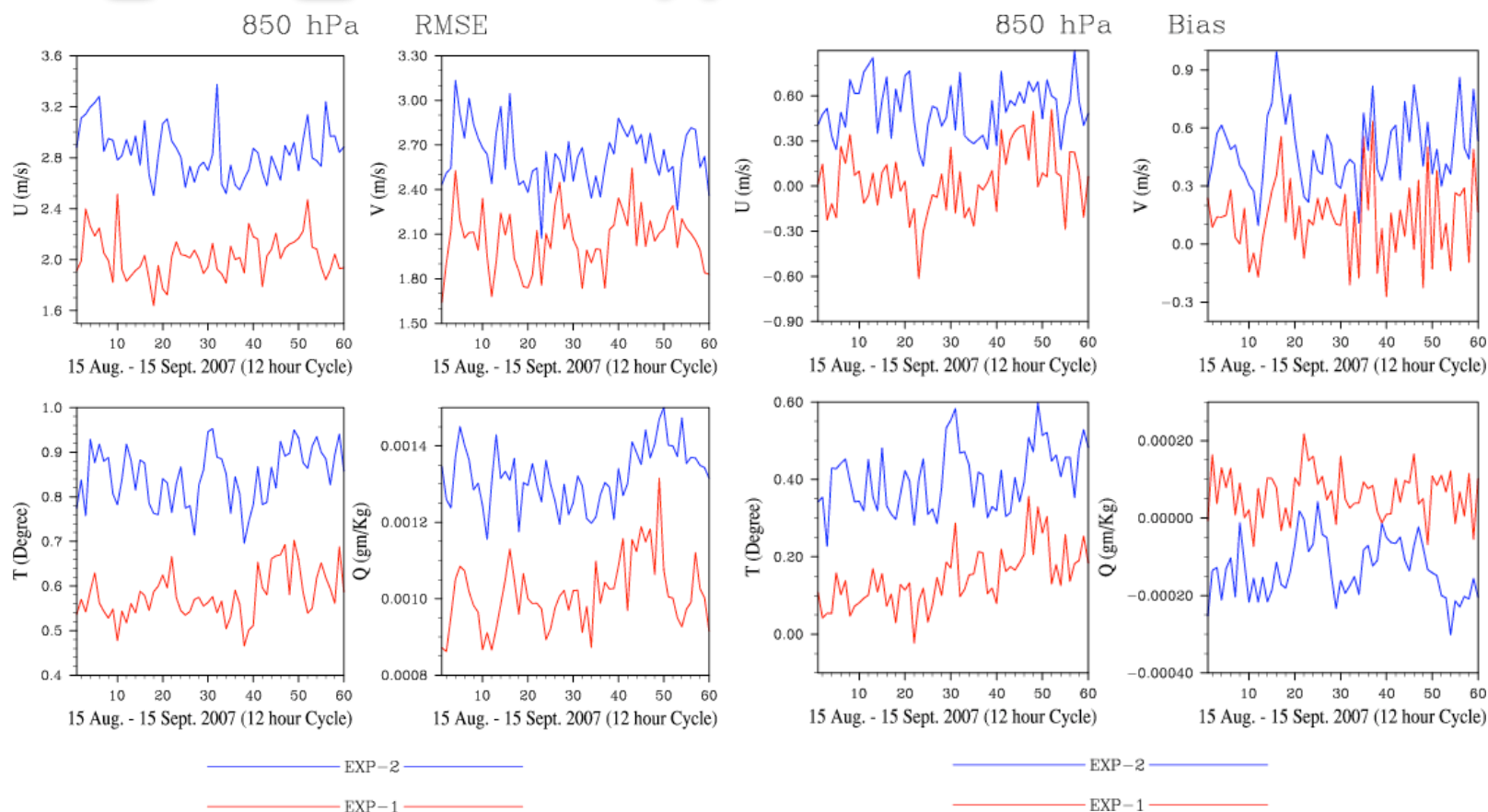
- Time series for surface fields (U10, V10, T2, Q2 & Psfc)
- Time series for upper air fields (U, V, T & Q) for the desired levels
- Upper air profiles for U, V, T & Q
- Time average for surface and upper air fields for the desired levels (Histogram)

|            |   |       |      |                                                        |
|------------|---|-------|------|--------------------------------------------------------|
| -rw-r--r-- | 1 | rizvi | ncar | 235624 Dec 31 15:14 Time_Series_UPA_RMSE-850-hr24.pdf  |
| -rw-r--r-- | 1 | rizvi | ncar | 237504 Dec 31 15:14 Time_Series_UPA_BIAS-850-hr24.pdf  |
| -rw-r--r-- | 1 | rizvi | ncar | 183367 Dec 31 15:14 Time_Series_UPA_RMSE-200-hr24.pdf  |
| -rw-r--r-- | 1 | rizvi | ncar | 173293 Dec 31 15:14 Time_Series_UPA_BIAS-200-hr24.pdf  |
| -rw-r--r-- | 1 | rizvi | ncar | 322432 Dec 31 15:14 Time_Series_SFC_RMSE-hr24.pdf      |
| -rw-r--r-- | 1 | rizvi | ncar | 325796 Dec 31 15:14 Time_Series_SFC_BIAS-hr24.pdf      |
| -rw-r--r-- | 1 | rizvi | ncar | 100323 Dec 31 15:14 Time_Average_UPA_RMSE-850-hr24.pdf |
| -rw-r--r-- | 1 | rizvi | ncar | 112711 Dec 31 15:14 Time_Average_UPA_BIAS-850-hr24.pdf |
| -rw-r--r-- | 1 | rizvi | ncar | 71525 Dec 31 15:14 Time_Average_UPA_RMSE-200-hr24.pdf  |
| -rw-r--r-- | 1 | rizvi | ncar | 81035 Dec 31 15:14 Time_Average_UPA_BIAS-200-hr24.pdf  |
| -rw-r--r-- | 1 | rizvi | ncar | 163671 Dec 31 15:14 Time_Average_SFC_RMSE-hr24.pdf     |
| -rw-r--r-- | 1 | rizvi | ncar | 182593 Dec 31 15:14 Time_Average_SFC_BIAS-hr24.pdf     |
| -rw-r--r-- | 1 | rizvi | ncar | 237409 Dec 31 15:14 Profile_RMSE-hr24.pdf              |
| -rw-r--r-- | 1 | rizvi | ncar | 238775 Dec 31 15:14 Profile_BIAS-hr24.pdf              |

# Verif\_anal\_plot -- Surface Time Series

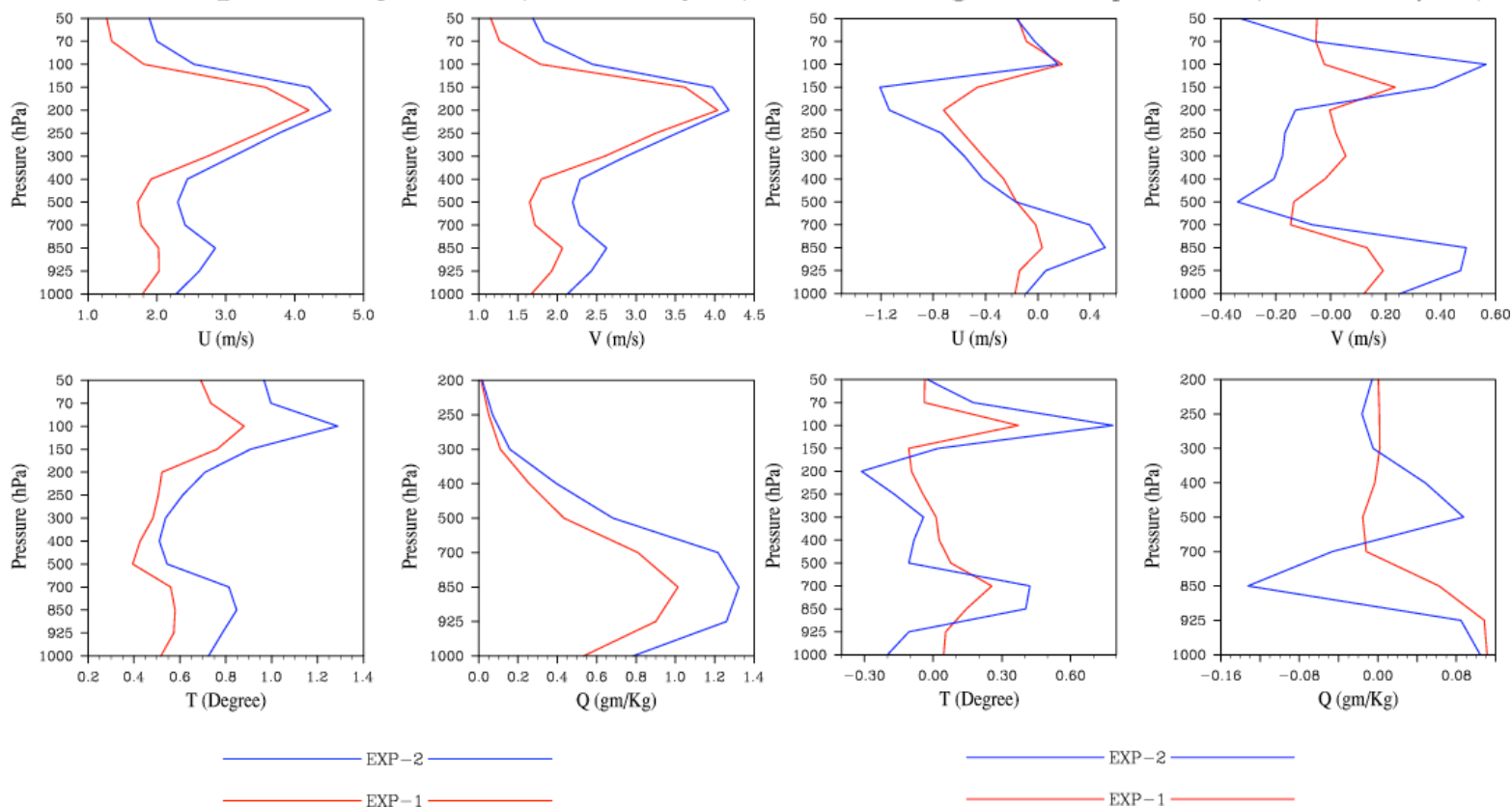


# Verif\_anal\_plot -- Upper air Time Series

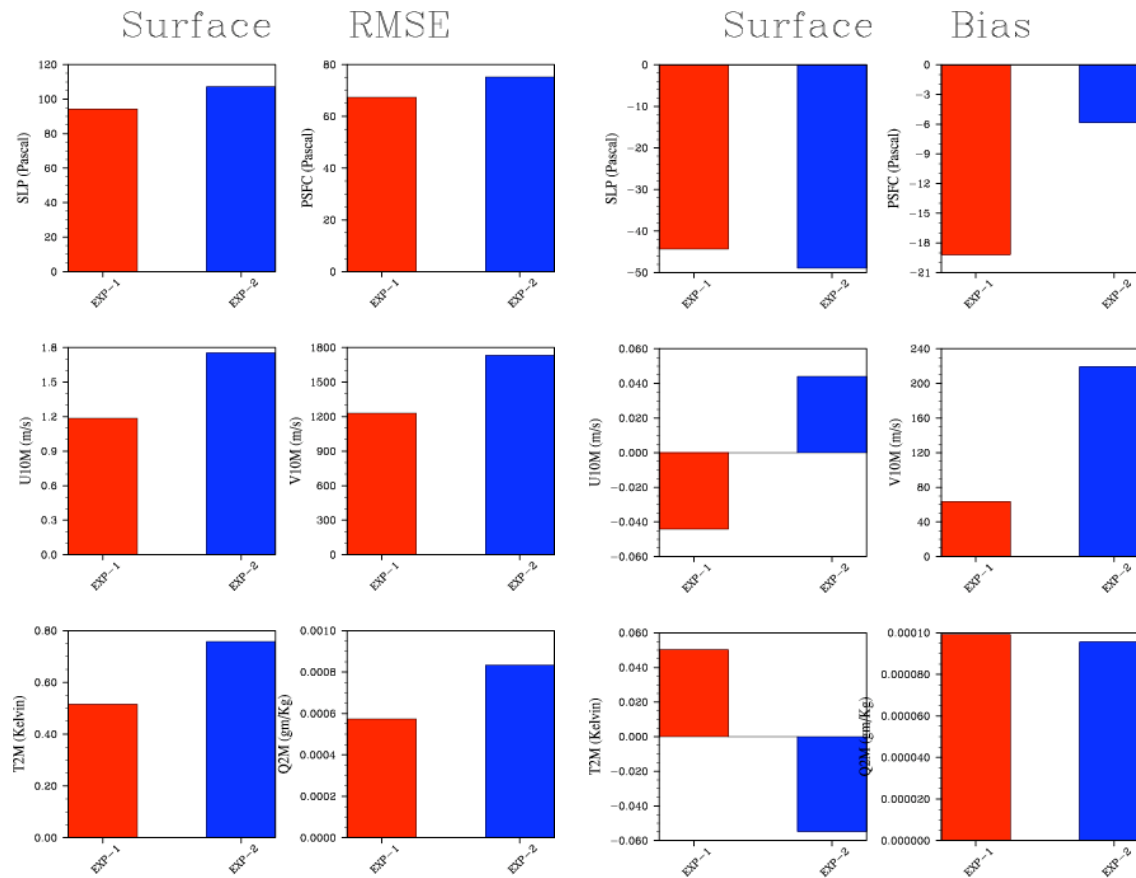


# Verif\_anal\_plot -- Profile

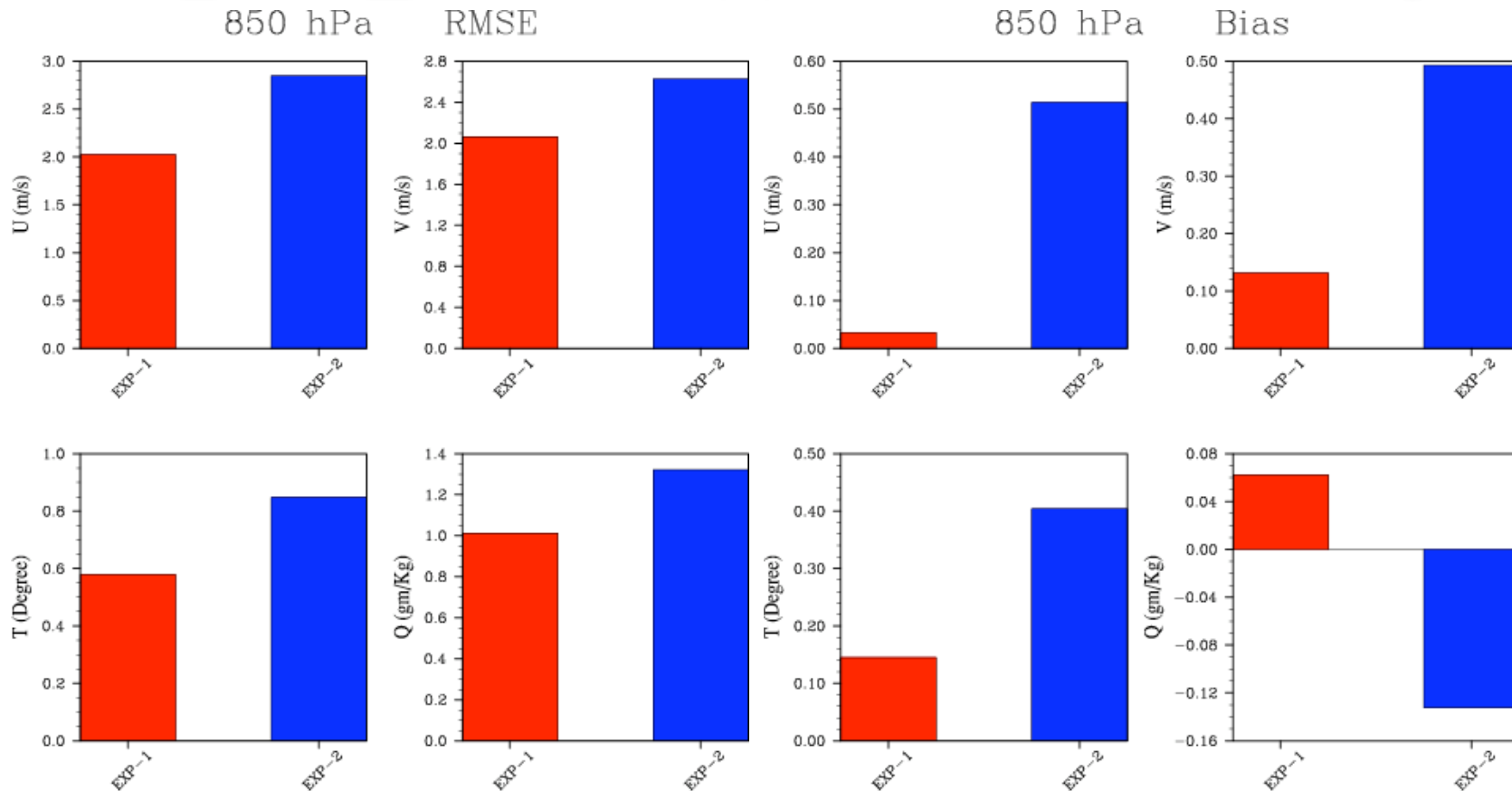
RMSE 15 Aug. – 15 Sept. 2007 (12 hour Cycle) Bias 15 Aug. – 15 Sept. 2007 (12 hour Cycle)



# Verif\_anal\_plot -- Surface Time Average



# Verif\_anal\_plot -- Upper air Time Average



## ***Future update about grid point verification***

- Procedure name has been changed from “DA\_VERIF\_ANAL” to “DA\_VERIF\_GRID”
- Verification about V\vector wind (WV) and Geopotential (Z) have been added
- New procedure works in two steps a) computation of basic scores and b) display of results .  
To achieve this following two environment variables have been introduced

**RUN\_VERIF\_GRID\_STATS** (default set as TRUE)

**RUN\_VERIF\_GRID\_PLOTS** (default set as TRUE)

- Four more pressure levels in vertical at 5, 3, 2, & 1 hPa have been added
- Following new environment variable is introduced to control display of the desired top level

**TOP\_HPA\_LEVEL\_FOR\_VERT\_PROFILES** (default set as 50 hPa)

- Display of results for the desired 2D or 3D variables may be controlled through

**NUM2D** (default set as 6) , **NUM3D** (default set as 6),

**VAR2D** (default set as “SLP PSFC U10M V10M T2M Q2M”) and

**VAR3D** (default set as “U V T QVAVOR Z WV”)