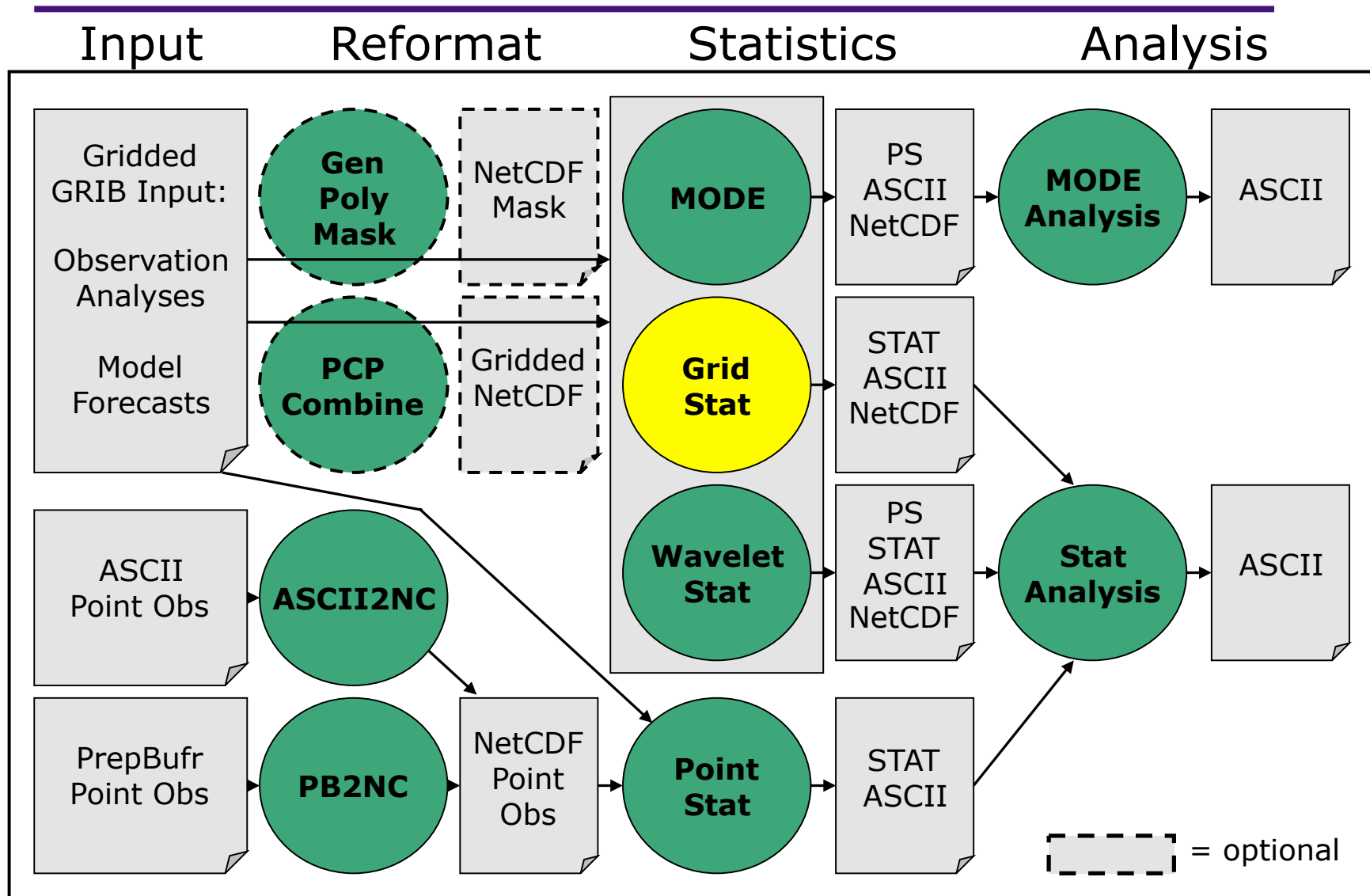
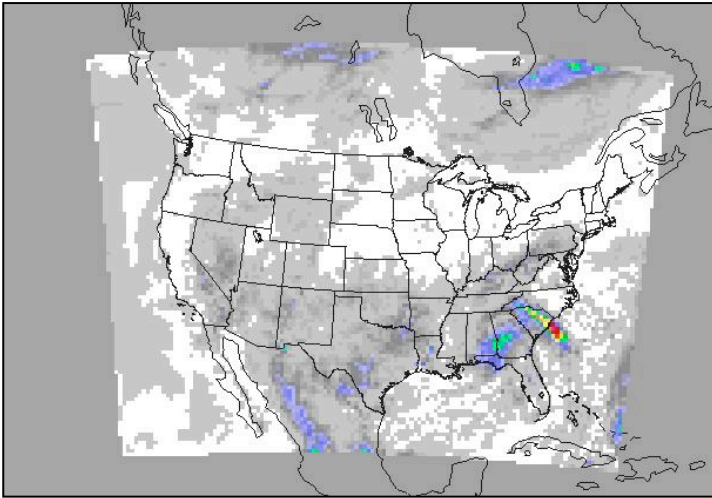


# Grid-Stat Tool



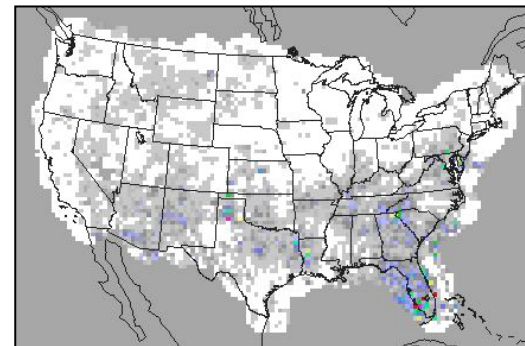
# Grid-Stat: Overview

---



- Compare **gridded forecasts** to **gridded observations** on the **same grid**.
- Accumulate matched pairs over a defined area at a **single point in time**.
- Verify one or more **variables/levels**.
- Analysis tool provided to aggregate through time.

- Verification methods:
  - **Continuous** statistics for raw fields.
  - **Categorical** counts and statistics for thresholded fields.
  - Parametric and non-parametric **confidence intervals** for statistics.
  - Compute **partial sums** for raw fields.
  - Methods for **probabilistic** forecasts.
  - Continuous statistics and categorical counts/statistics using **neighborhood** verification method.



# Grid-Stat: Input/Output

---

- Input Files
  - Gridded forecast and observation files
    - GRIB output of WRF Post-Processor (or other)
    - NetCDF output of PCP-Combine
  - ASCII configuration file
- Output Files
  - ASCII statistics file with all output lines (end with “.stat”)
  - Optional ASCII files sorted by line type with a header row (ends with “\_TYPE.txt”)
  - Optional NetCDF matched pairs file

# Grid-Stat: Usage

---

Usage: grid\_stat

**fcst\_file**

**obs\_file**

**config\_file**

**[-outdir path]**

**[-v level]**

fcst_file	Forecast file in GRIB or NetCDF
obs_file	Observation file in GRIB or NetCDF
config_file	ASCII configuration file
-outdir	Output directory to be used
-v	Level of logging

# Grid-Stat: Configuration

---

- 27 configurable parameters – only set a few:
  - Precipitation accumulated over 24 hours.
    - **fcst\_field[] = [“APCP/A24”];**
  - Any rain and moderate rain.
    - **fcst\_thresh[] = [“gt0.00 gt20.00”]; (mm)**
  - Look at all the points and only the eastern United States.
    - **mask\_grid[] = [“FULL”];**
    - **mask\_poly[] = [“EAST.poly”];**
  - Compute neighborhood statistics with two sizes.
    - **nbr\_width[] = [3, 5];**
  - Generate all possible statistic types, except probabilistic.
    - **output\_flag[] = [ 2, 2, 2, 2, 2, 2, 0, 0, 0, 0, 2, 2, 2, 1 ];**

# Grid-Stat: Run

---

- METv2.0/bin/grid\_stat \  
sample\_fcst.grb sample\_obs.nc \  
GridStatConfig\_APCP24 -outdir out -v 2

```
Forecast File: sample_fcst.grb
Observation File: sample_obs.nc
Configuration File: GridStatConfig_APCP24
-----
```

```
Processing APCP/A24 versus APCP/A24, for interpolation method UW_MEAN(1), over region FULL, using 6412 pairs.
Computing Categorical Statistics.
Computing Continuous Statistics.
Processing APCP/A24 versus APCP/A24, for interpolation method UW_MEAN(1), over region EAST, using 2586 pairs.
Computing Categorical Statistics.
Computing Continuous Statistics.
Processing APCP/A24 versus APCP/A24, for interpolation method NBRHD(9), raw thresholds of >0.000 and >0.000,
over region EAST, using 5829 pairs.
```

```
... MORE NEIGHBORHOOD COMPUTATIONS ...
```

```
-----
Output file: out/grid_stat_240000L_20050808_000000V.stat
Output file: out/grid_stat_240000L_20050808_000000V_fho.txt
Output file: out/grid_stat_240000L_20050808_000000V_ctc.txt
Output file: out/grid_stat_240000L_20050808_000000V_cts.txt
Output file: out/grid_stat_240000L_20050808_000000V_cnt.txt
Output file: out/grid_stat_240000L_20050808_000000V_sl112.txt
Output file: out/grid_stat_240000L_20050808_000000V_nbrctc.txt
Output file: out/grid_stat_240000L_20050808_000000V_nbrcts.txt
Output file: out/grid_stat_240000L_20050808_000000V_nbrcnt.txt
Output file: out/grid_stat_240000L_20050808_000000V_pairs.nc
```

# Grid-Stat: ASCII Output Types

---

- Statistics line types: 12 possible
  - Same as Point-Stat
    - FHO, CTC, CTS, CNT, and SL1L2
    - PCT, PSTD, PJC, and PRC
  - Omitted for Grid-Stat
    - SAL1L2, VL1L2, or VAL1L2
  - Neighborhood – define neighborhood, apply threshold
    - Neighborhood continuous statistics (NBRCNT)
    - Neighborhood contingency table counts (NBRCTC)
    - Neighborhood contingency table statistics (NBRCTS)
- 21 header columns common to all line types
- Remaining columns specific to each line type

# Grid-Stat: Sample Output

---

1. **STAT** file output for sample run:
  - 2 lines each for **CNT** and **SL1L2**
    - = 2 verification regions (FULL and EAST)
  - 4 lines each for **FHO**, **CTC**, and **CTS**
    - = 2 regions \* 2 thresholds
  - 8 lines each for **NBRCNT**, **NBRCTC**, **NBRCTS**
    - = 2 regions \* 2 thresholds \* 2 neighborhood sizes
2. Additional **TXT** files for each line type
3. **NetCDF** file containing matched pairs

# Grid-Stat: CTC Output Line

---

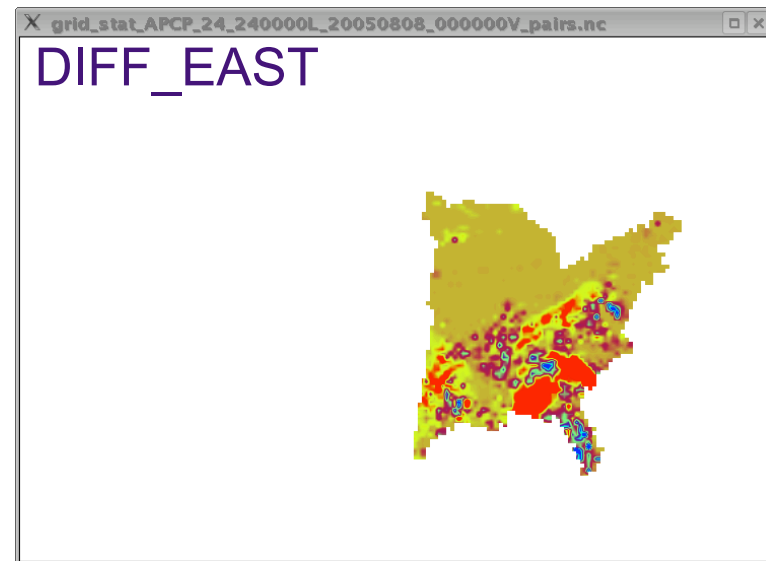
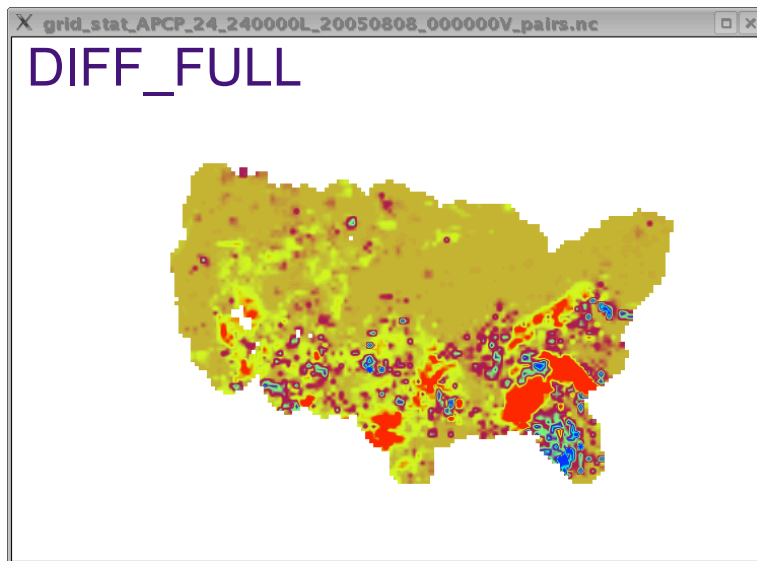
<b>VERSION</b>	V2.0
<b>MODEL</b>	WRF
<b>FCST_LEAD</b>	240000
<b>FCST_VALID_BEG</b>	20050808_000000
<b>FCST_VALID_END</b>	20050808_000000
<b>OBS_LEAD</b>	000000
<b>OBS_VALID_BEG</b>	20050808_000000
<b>OBS_VALID_END</b>	20050808_000000
<b>FCST_VAR</b>	APCP_24
<b>FCST_LEV</b>	A24
<b>OBS_VAR</b>	APCP_24
<b>OBS_LEV</b>	A24
<b>OBTYPE</b>	MC_PCP

<b>VX_MASK</b>	EAST
<b>INTERP_MTHD</b>	UW_MEAN
<b>INTERP_PNTS</b>	1
<b>FCST_THRESH</b>	>=20.000
<b>OBS_THRESH</b>	>=20.000
<b>COV_THRESH</b>	NA
<b>ALPHA</b>	NA
<b>LINE_TYPE</b>	CTC
<b>TOTAL</b>	2586
<b>FY_OY</b>	5
<b>FY_ON</b>	104
<b>FN_OY</b>	70
<b>FN_ON</b>	2407

# Grid-Stat: NetCDF Matched Pairs

---

- Forecast, observation, and difference fields for each combination of...
  - Variable, level, masking region, and interpolation method (smoothing)
- Sample output contains 6 fields:
  - FCST, OBS, and DIFF for FULL and EAST



# Verifying Probabilities

---

- Probabilistic verification methods added for:
  - Grid-Stat, Point-Stat, and Stat-Analysis
- Define Nx2 contingency table using:
  - Multiple forecast probability thresholds
  - One observation threshold

Forecast	Observation		Total
	$o = 1$ (e.g., "Yes")	$o = 0$ (e.g., "No")	
$p_1 = \text{midpoint of } (0 \text{ and threshold1})$	$n_{11}$	$n_{10}$	$n_{1.} = n_{11} + n_{10}$
$p_2 = \text{midpoint of (threshold1 and threshold2)}$	$n_{21}$	$n_{20}$	$n_{2.} = n_{21} + n_{20}$
⋮	⋮	⋮	⋮
$p_j = \text{midpoint of (threshold } i \text{ and 1)}$	$n_{j1}$	$n_{j0}$	$n_{j.} = n_{j1} + n_{j0}$
<b>Total</b>	$n_{.1} = \sum n_{i1}$	$n_{.0} = \sum n_{i0}$	$T = \sum n_{i.}$

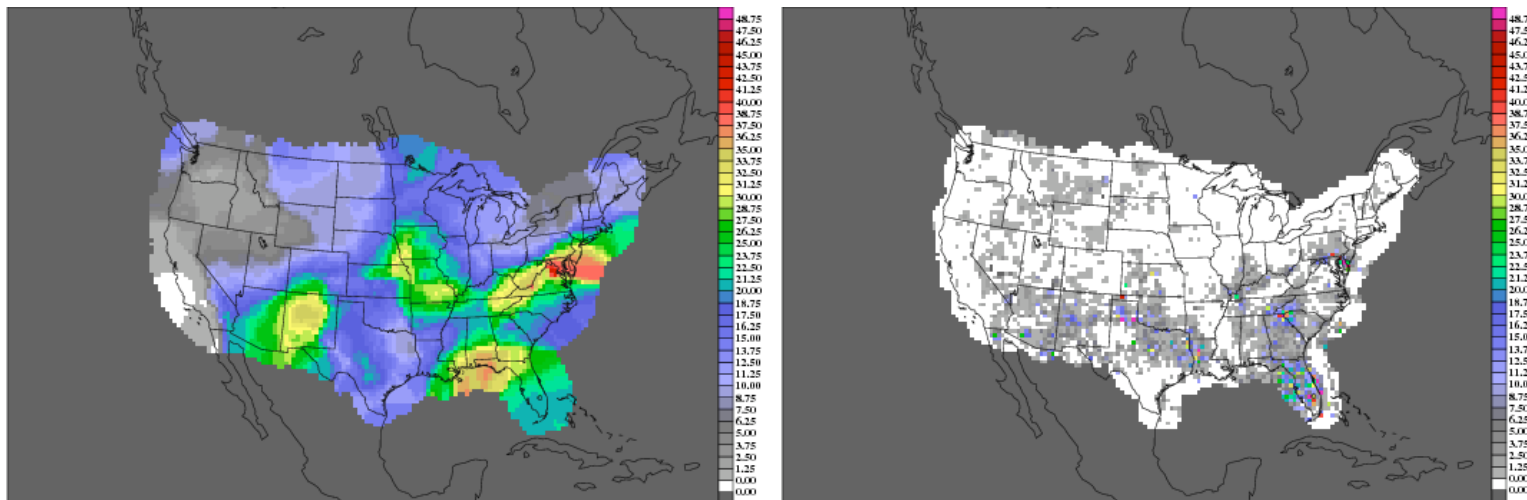
Example:

- FCST: Probability of precip [0.00, 0.25, 0.50, 0.75, 1.00]
- OBS: Accumulated precip > 0.00

# Verifying Probabilities: Example

---

- Verify probability of precip with total precip:

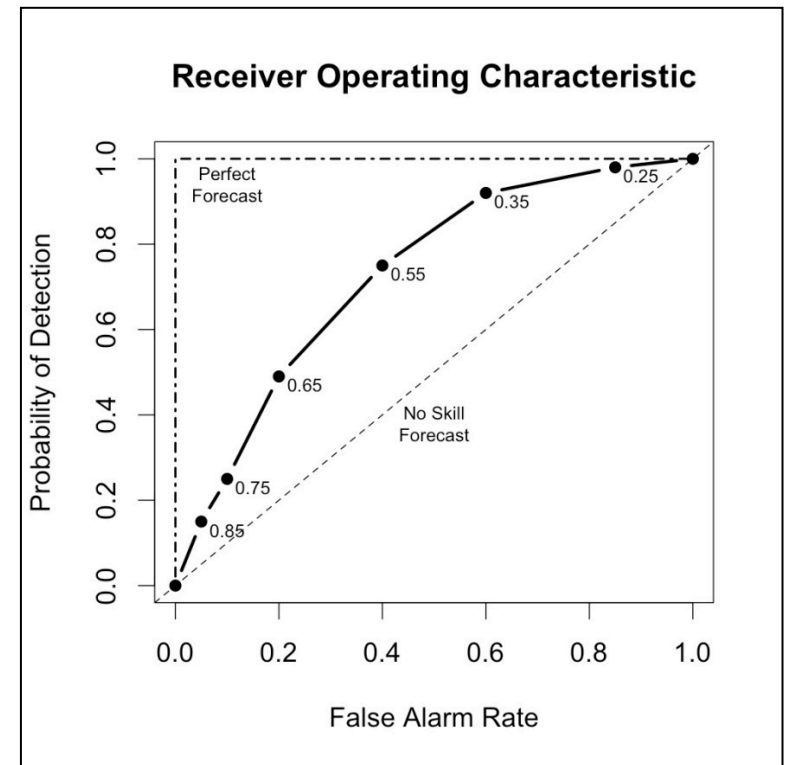


- Configuration file settings:

- `fcst_field[] = ["POP/Z0/PROB"];`
- `obs_field[] = ["APCP/A12"];`
- `fcst_thresh[] = ["ge0.00 ge0.25 ge0.50 ge0.75 ge1.00"];`
- `obs_thresh[] = ["gt0.00"];`

# Verifying Probabilities: Output

- Statistical Output (Line Type):
  - Nx2 Table Counts (PCT)
  - Joint/Conditional factorization table with calibration, refinement, likelihood, and base rate by threshold (PJC)
  - Receiver Operating Characteristic (ROC) plot points by threshold (PRC)
  - Reliability, resolution, uncertainty, area under ROC Curve, and Brier Score (PSTD)



# Comparing Different Fields

---

- Grid-Stat and Point-Stat may be used to compare two different variables.
  - User must interpret results.
  - Example: Convective Precip vs. Total Precip
  - Configuration file settings:
    - Selecting variable/levels:
      - `fcst_field[] = ["ACPCP/A24"];`
      - `obs_field[] = ["APCP/A24"];`
    - Selecting thresholds:
      - `fcst_thresh[] = ["gt0.0 ge20.0"];`
      - `obs_thresh[] = [];` (leave blank to use fcst setting)

# Verifying Winds

---

- Verify u, v, and speed, but not wind direction.
- Incremental support for wind direction:
  - Enhancements for **Point-Stat** and **Grid-Stat**:
    - Add wind speed thresholds to determine which u/v pairs are included in the vector partial sums (**VL1L2**).
  - Enhancements for **Stat-Analysis**:
    - Support new job to aggregate one or more vector partial sum lines and compute statistics for the wind direction errors.
      - Mean forecast and observation wind directions, mean error (F-O), and mean absolute error

# Wind Direction: Example

## Point-Stat: VL1L2 Lines

VX MASK	THRESH	LINE_TYPE	TOTAL	UFBAR	VFBAR	UOBAR	VOBAR	UVFOBAR	UVFFBAR	UVOOBAR
DTC_165	>=1.000	VL1L2	653	1.91117	0.07900	1.40658	-0.06126	13.01039	18.12575	20.31649
DTC_165	>=3.000	VL1L2	279	3.13561	-0.35096	2.87061	-0.30072	26.50472	30.03257	38.25362
DTC_165	>=5.000	VL1L2	96	5.21268	-2.74580	5.47813	-2.01667	49.90791	51.10427	70.78802
DTC_166	>=1.000	VL1L2	2431	-1.62742	0.25391	-1.23402	-0.04393	18.48309	29.70179	21.89615
DTC_166	>=3.000	VL1L2	1610	-1.84581	0.16061	-1.47491	-0.11217	24.45214	36.67400	29.36032
DTC_166	>=5.000	VL1L2	520	-0.93518	-0.45435	-0.25923	-0.49558	37.21821	52.51917	47.26483

## Stat-Analysis: aggregate\_stat jobs

```
JOB_LIST:      -job aggregate_stat -fcst_thresh >=1.000 -line_type VL1L2 -out_line_type WDIR
COL_NAME:     TOTAL  FBAR      OBAR      ME      MAE
ROW_MEAN_WDIR: 2      183.25038  0.22749  -3.02289  7.88372
AGGR_WDIR:    3084   103.87238  85.96574 -17.90663  NA
```

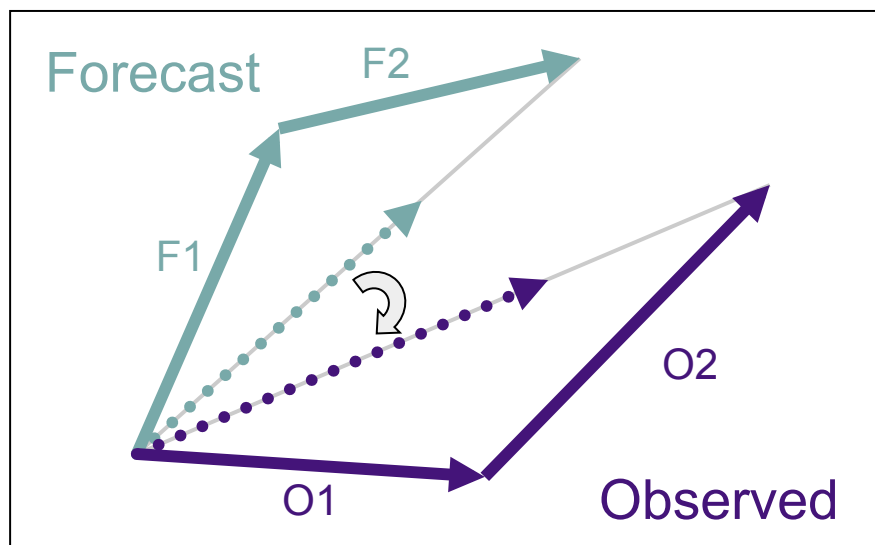
```
JOB_LIST:      -job aggregate_stat -fcst_thresh >=3.000 -line_type VL1L2 -out_line_type WDIR
COL_NAME:     TOTAL  FBAR      OBAR      ME      MAE
ROW_MEAN_WDIR: 2      5.67967   0.81565  -4.86402  4.86402
AGGR_WDIR:    1889    94.38140  80.45939 -13.92200  NA
```

```
JOB_LIST:      -job aggregate_stat -fcst_thresh >=5.000 -line_type VL1L2 -out_line_type WDIR
COL_NAME:     TOTAL  FBAR      OBAR      ME      MAE
ROW_MEAN_WDIR: 2      0.93288   338.91179 -22.02109 22.02109
AGGR_WDIR:    616     358.38152 319.08761 -39.29391  NA
```

# Wind Direction: Output

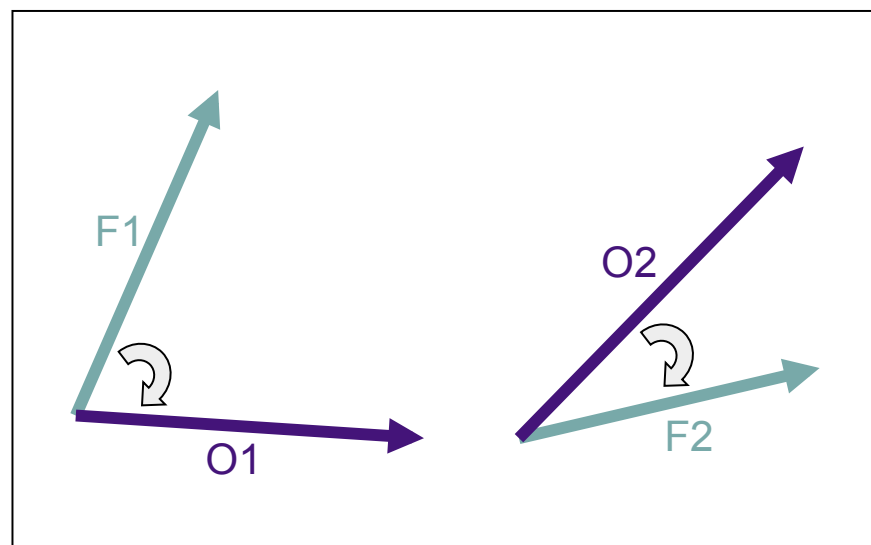
- AGGR\_WDIR

1. Aggregate VL1L2 partial sums lines
2. Derive wind directions and errors



- ROW\_MEAN\_WDIR

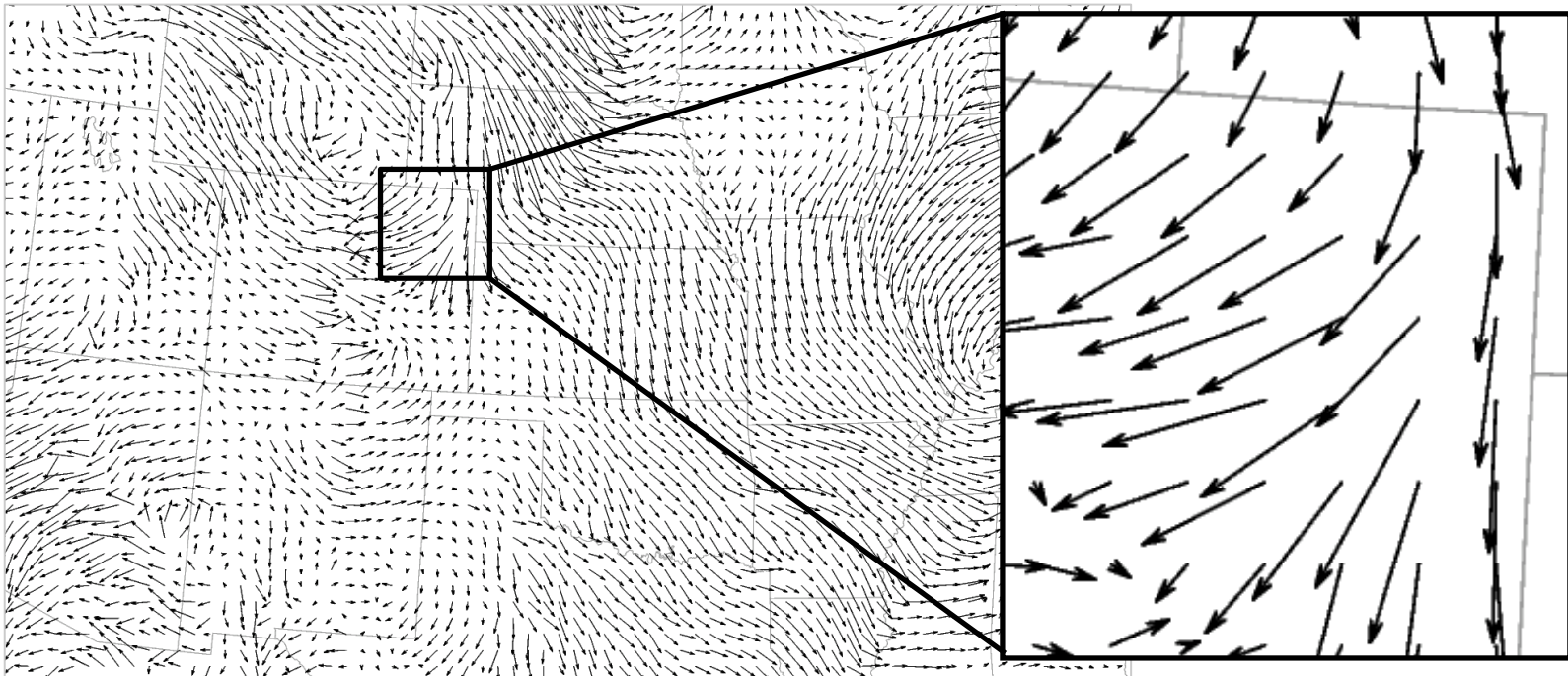
1. Derive wind directions and errors for each VL1L2 line
2. Compute mean of errors



# Wind Direction: Suggestions

---

- When aggregating, wind directions can cancel out.
  - Verify over regions with unimodal wind direction.
  - Verify u and v components separately.



# MET Config File GUI

---

- Now a web GUI exists to assist in creation of some of these files:

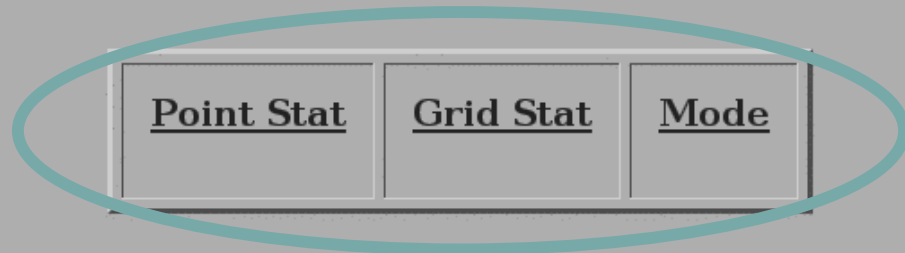
<http://verif.rap.ucar.edu/cgi/metgui/base.cgi>

- All fields are described.
- Fill in blank fields.
- Submit to get ASCII config file, then save from browser to your machine.

```
////////////////////////////////////  
//  
// Point Stat Config File  
//  
//   Generated by MET Config File Web Utility  
//  
//   June 23, 2009   12:33 pm   MDT  
//  
////////////////////////////////////  
  
model = "WRF";  
beg_ds = -5400;  
end_ds = -5400;  
  
fcst_field [] = [ "TMP/P750-900", "UGRD/Z10", "VGRD/Z10" ];  
obs_field [] = [];  
  
fcst_thresh [] = [ "lt273 ge273", "ge5", "ge5" ];  
obs_thresh [] = [];  
  
fcst_wind_thresh [] = [ "NA" ];  
obs_wind_thresh [] = [];  
  
message_type [] = [ "ADPUPA", "ADPSFC" ];  
mask_grid [] = [ "DTC165", "DTC166" ];  
mask_poly [] = [ "MET_BASE/data/poly/LMV.poly" ];  
mask_sid = "";  
  
ci_alpha [] = [ 0.10, 0.05 ];  
boot_interval = 1;  
boot_rep_prop = 1.00;  
n_boot_rep = 1000;  
boot_rnd = "mt19937";
```

**Welcome to the MET config file generator!**

**Please choose which MET tool you're using:**



Point Stat   Grid Stat   Mode

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<b>Obs Wind Threshold</b>	<input type="text"/>	eliminate winds below a certain speed. This threshold filters the winds based on speed, even when u and v winds are input. Format is the same as for fcst_thresholds.																					
<b>Message Type</b>	<table border="0"> <tr> <td><input checked="" type="checkbox"/> ADPUPA</td> <td><input type="checkbox"/> AIRCAR</td> <td><input type="checkbox"/> AIRCFT</td> </tr> <tr> <td><input checked="" type="checkbox"/> ADPSFC</td> <td><input type="checkbox"/> ERS1DA</td> <td><input type="checkbox"/> GOESND</td> </tr> <tr> <td><input type="checkbox"/> GPSIPW</td> <td><input type="checkbox"/> MSONET</td> <td><input type="checkbox"/> PROFLR</td> </tr> <tr> <td><input type="checkbox"/> QKSWND</td> <td><input type="checkbox"/> RASSDA</td> <td><input type="checkbox"/> SATEMP</td> </tr> <tr> <td><input type="checkbox"/> SATWND</td> <td><input type="checkbox"/> SFCBOG</td> <td><input type="checkbox"/> SFCSHP</td> </tr> <tr> <td><input type="checkbox"/> SPSSMI</td> <td><input type="checkbox"/> SYNDAT</td> <td><input type="checkbox"/> VADWND</td> </tr> <tr> <td><input type="checkbox"/> ANYAIR</td> <td><input type="checkbox"/> ANYSFC</td> <td><input type="checkbox"/> ONLYSF</td> </tr> </table>	<input checked="" type="checkbox"/> ADPUPA	<input type="checkbox"/> AIRCAR	<input type="checkbox"/> AIRCFT	<input checked="" type="checkbox"/> ADPSFC	<input type="checkbox"/> ERS1DA	<input type="checkbox"/> GOESND	<input type="checkbox"/> GPSIPW	<input type="checkbox"/> MSONET	<input type="checkbox"/> PROFLR	<input type="checkbox"/> QKSWND	<input type="checkbox"/> RASSDA	<input type="checkbox"/> SATEMP	<input type="checkbox"/> SATWND	<input type="checkbox"/> SFCBOG	<input type="checkbox"/> SFCSHP	<input type="checkbox"/> SPSSMI	<input type="checkbox"/> SYNDAT	<input type="checkbox"/> VADWND	<input type="checkbox"/> ANYAIR	<input type="checkbox"/> ANYSFC	<input type="checkbox"/> ONLYSF	Specifies a list of the message types to use for verification. At least one message_type must be provided.
<input checked="" type="checkbox"/> ADPUPA	<input type="checkbox"/> AIRCAR	<input type="checkbox"/> AIRCFT																					
<input checked="" type="checkbox"/> ADPSFC	<input type="checkbox"/> ERS1DA	<input type="checkbox"/> GOESND																					
<input type="checkbox"/> GPSIPW	<input type="checkbox"/> MSONET	<input type="checkbox"/> PROFLR																					
<input type="checkbox"/> QKSWND	<input type="checkbox"/> RASSDA	<input type="checkbox"/> SATEMP																					
<input type="checkbox"/> SATWND	<input type="checkbox"/> SFCBOG	<input type="checkbox"/> SFCSHP																					
<input type="checkbox"/> SPSSMI	<input type="checkbox"/> SYNDAT	<input type="checkbox"/> VADWND																					
<input type="checkbox"/> ANYAIR	<input type="checkbox"/> ANYSFC	<input type="checkbox"/> ONLYSF																					
<b>Mask Station IDs</b>	<input type="text"/>	A filename that contains a space-separated list of station ID's at which verification should be performed.																					
		A comma-separated list of pre-defined NCEP grids over which to perform the Point-Stat verification. The																					

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Done

Fill in fields

Read description of options

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# Resamples	<input type="text" value="1000"/>	Defines the number of subsamples that should be taken when computing bootstrap confidence intervals. This variable should be set large enough so that when confidence intervals are computed multiple times for the same set of data, the intervals do not change much. Setting this variable to zero disables the computation of bootstrap confidence intervals that may be necessary to run in realtime or near-realtime over large domains.
Random Number Generator	<input type="text" value="mt19937"/>	Defines the random number generator to be used in the computation of bootstrap confidence intervals. Subsamples are chosen at random from the full set of matched pairs. The randomness is determined by the random number generator specified.
Bootstrap Seed	<input type="text"/>	May be set to a specific value to make the computation of bootstrap confidence intervals fully repeatable. When left empty, the random number generator seed is chosen automatically which will lead to slightly different bootstrap confidence intervals being computed each time the data is run. Specifying a value here ensures that the bootstrap confidence intervals will be computed the same over multiple runs of the same data.

← Submit form

Smoothing Parameters

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Done

```
////////////////////////////////////  
//  
// Point Stat Config File  
//  
//   Generated by MET Config File Web Utility  
//  
//   June 23, 2009   12:33 pm   MDT  
//  
////////////////////////////////////  
  
model = "WRF";  
  
beg_ds = -5400;  
  
end_ds = -5400;  
  
fcst_field [] = [ "TMP/P750-900", "UGRD/Z10", "VGRD/Z10" ];  
  
obs_field [] = [];  
  
fcst_thresh [] = [ "lt273 ge273", "ge5", "ge5" ];  
  
obs_thresh [] = [];  
  
fcst_wind_thresh [] = [ "NA" ];  
  
obs_wind_thresh [] = [];  
  
message_type [] = [ "ADPUPA", "ADPSFC" ];  
  
mask_grid [] = [ "DTC165", "DTC166" ];  
  
mask_poly [] = [ "MET_BASE/data/poly/LMV.poly" ];  
  
mask_sid = "";  
  
ci_alpha [] = [ 0.10, 0.05 ];  
  
boot_interval = 1;  
  
boot_rep_prop = 1.00;  
  
n_boot_rep = 1000;
```

Resulting file  
Save to your  
computer.