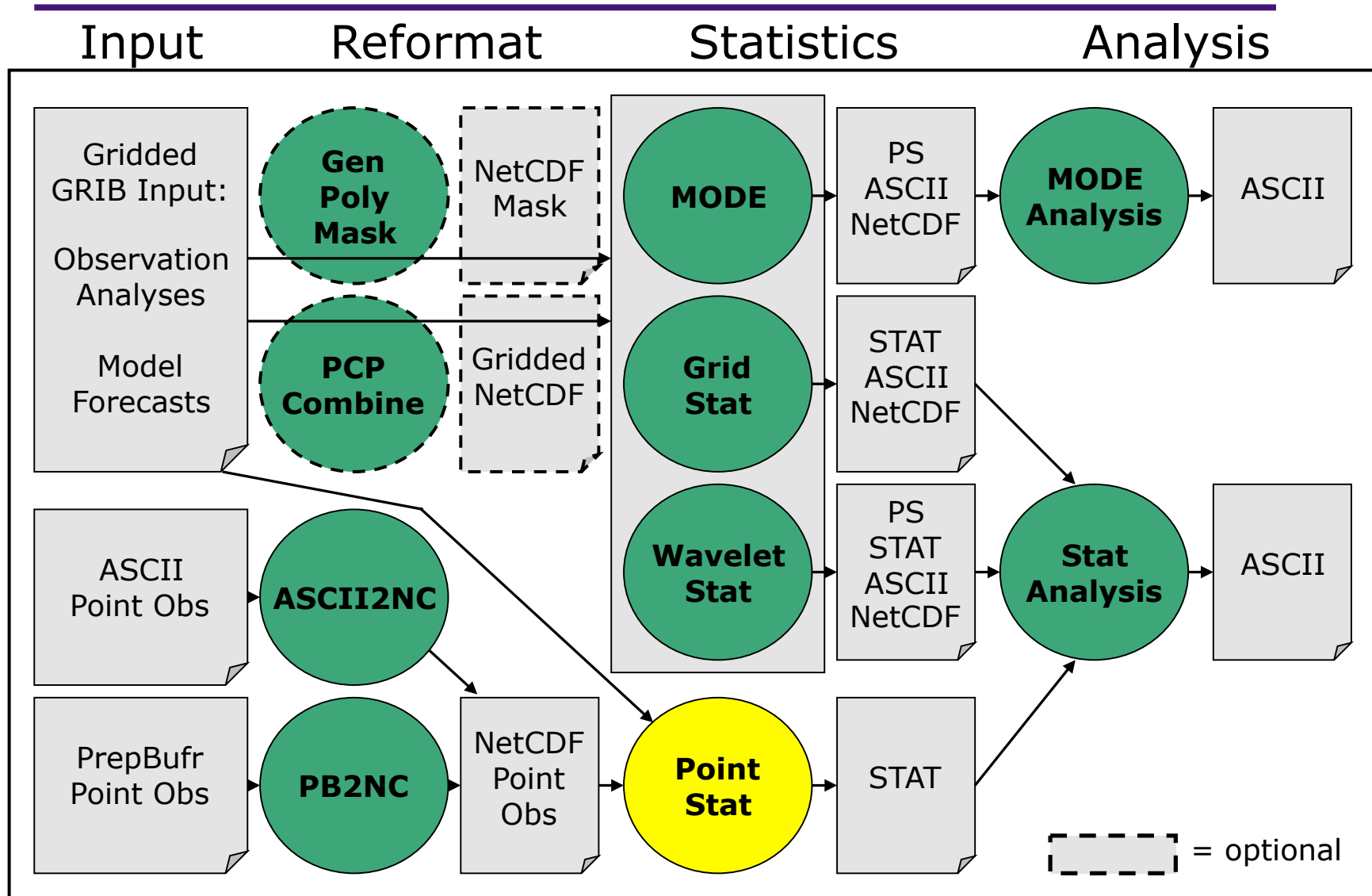
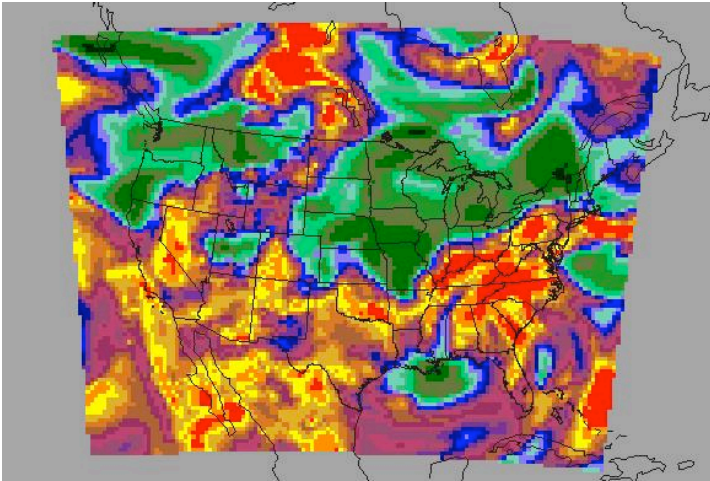


Point-Stat Tool



Point-Stat: Overview



- Compare **gridded forecasts** to **point observations**.
- 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 and/or the raw matched pair values.
 - Methods for **probabilistic** forecasts.



Point-Stat: Input/Output

- Input Files
 - Gridded forecast file
 - GRIB output of WRF Post-Processor (or other)
 - NetCDF output of PCP-Combine
 - Point observation file
 - NetCDF output of PB2NC
 - NetCDF output of ASCII2NC
 - 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”)

Point-Stat: Usage

Usage: point_stat

fcst_file

obs_file

config_file

[-climo climo_file]

[-ncfile netcdf_file]

[-valid_beg time]

[-valid_end time]

[-outdir path]

[-v level]

fcst_file	Forecast file in GRIB or NetCDF
obs_file	Point observation file in NetCDF (PB2NC or ASCII2NC)
config_file	ASCII configuration file
-climo	Climatological file for computing anomaly partial sums
-ncfile	Additional point observation files in NetCDF
-valid_beg	Beginning of valid time window for matching
-valid_end	End of valid time window for matching
-outdir	Output directory to be used
-v	Level of logging

Point-Stat: Configuration

- 28 configurable parameters – only set a few:
 - Temperature at the surface (2-meter).
 - `fcst_field[] = ["TMP/Z2"];`
 - Temperature below freezing.
 - `fcst_thresh[] = ["le273"];`
 - Match to observations at the surface.
 - `message_type[] = ["ADPSFC"];`
 - Look at all the points in my domain.
 - `mask_grid[] = ["FULL"];`
 - Match observation to the nearest forecast value.
 - `interp_wdth[] = [1];`
 - Generate all possible statistic types, except probabilistic.
 - `output_flag[] = [2, 2, 2, 2, 2, 2, 2, 2, 0, 0, 0, 0, 2];`

Point-Stat: Run

- METv2.0/bin/point_stat \
sample_fcst.grb sample_pb.nc \
PointStatConfig_TMPZ2 -outdir out -v 2

```
Forecast File: sample_fcst.grb
Climatology File: none
Configuration File: PointStatConfig_TMPZ2
Observation File: sample_pb.nc
-----
Reading records for TMP/Z2.
For TMP/Z2 found 1 forecast levels and 0 climatology levels.
-----
Searching 179772 observations from 44076 PrepBufr messages.
-----
Processing TMP/Z2 versus TMP/Z2, for observation type ADPSFC, over region FULL, for interpolation method
UW_MEAN(1), using 11370 pairs.
Computing Categorical Statistics.
Computing Continuous Statistics.
Computing Scalar Partial Sums.
-----
Output file: out/point_stat_360000L_20070331_120000V.stat
Output file: out/point_stat_360000L_20070331_120000V_fho.txt
Output file: out/point_stat_360000L_20070331_120000V_ctc.txt
Output file: out/point_stat_360000L_20070331_120000V_cts.txt
Output file: out/point_stat_360000L_20070331_120000V_cnt.txt
Output file: out/point_stat_360000L_20070331_120000V_sl112.txt
Output file: out/point_stat_360000L_20070331_120000V_sal112.txt
Output file: out/point_stat_360000L_20070331_120000V_vl112.txt
Output file: out/point_stat_360000L_20070331_120000V_val112.txt
Output file: out/point_stat_360000L_20070331_120000V_mpr.txt
```

Point-Stat: ASCII Output Types

- Statistics line types: 13 possible
 - Categorical - apply threshold
 - Contingency table counts and stats (FHO, CTC, CTS)
 - Continuous - raw fields
 - Continuous statistics (CNT)
 - Partial Sums (SL1L2, SAL1L2, VL1L2, VAL1L2)
 - Probabilistic
 - Contingency table counts and stats (PCT, PSTD)
 - Continuous statistics and ROC curve (PJC, PRC)
 - Matched pairs
 - Raw matched pairs – a lot of data! (MPR)
- 21 header columns common to all line types
- Remaining columns specific to each line type

Point-Stat: Sample Output

1. **STAT** file output for sample run:
 - 1 line each for **FHO**, **CTC**, **CTS**, **CNT**, **SL1L2**
 - 11,370 lines for **MPR**!
2. Additional **TXT** files for each line type

```
Output file: out/point_stat_360000L_20070331_120000v.stat
Output file: out/point_stat_360000L_20070331_120000v_fho.txt
Output file: out/point_stat_360000L_20070331_120000v_ctc.txt
Output file: out/point_stat_360000L_20070331_120000v_cts.txt
Output file: out/point_stat_360000L_20070331_120000v_cnt.txt
Output file: out/point_stat_360000L_20070331_120000v_sl1l2.txt
Output file: out/point_stat_360000L_20070331_120000v_sal1l2.txt
Output file: out/point_stat_360000L_20070331_120000v_vl1l2.txt
Output file: out/point_stat_360000L_20070331_120000v_val1l2.txt
Output file: out/point_stat_360000L_20070331_120000v_mpr.txt
```


Point-Stat: CTC Output Line

VERSION	V2.0
MODEL	WRF
FCST_LEAD	360000
FCST_VALID_BEG	20070331_120000
FCST_VALID_END	20070331_120000
OBS_LEAD	000000
OBS_VALID_BEG	20070331_103000
OBS_VALID_END	20070331_133000
FCST_VAR	TMP
FCST_LEV	Z2
OBS_VAR	TMP
OBS_LEV	Z2
OBTYPE	ADPSFC

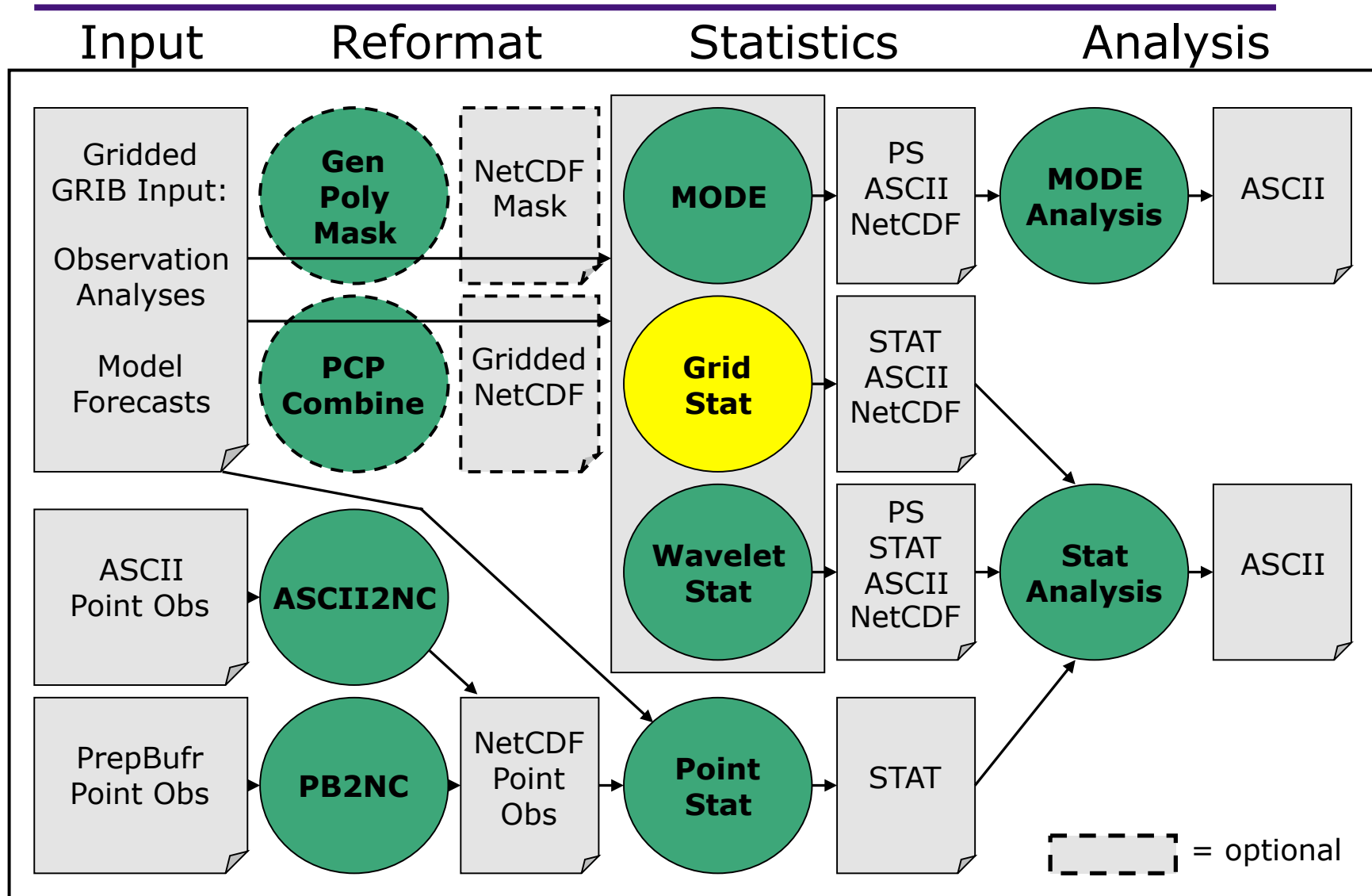
VX_MASK	FULL
INTERP_MTHD	UW_MEAN
INTERP_PNTS	1
FCST_THRESH	<273.000
OBS_THRESH	<273.000
COV_THRESH	NA
ALPHA	NA
LINE_TYPE	CTC
TOTAL	11370
FY_OY	1635
FY_ON	380
FN_OY	438
FN_ON	8917

Point-Stat: Matched Pairs

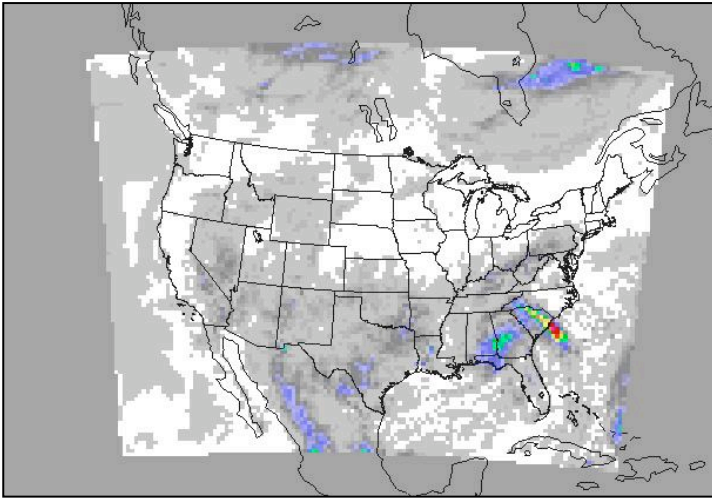
- Matched Pair (MPR) line type contains 1 line for each matched pair.
- Data overload!

TOTAL	INDEX	OBS_LAT	OBS_LON	OBS_LVL	OBS_ELV	FCST	OBS	CLIMO
11370	1	43.93000	-60.01000	1010.79999	4.01053	271.87788	271.54999	NA
11370	2	46.43000	-71.93000	1016.09998	102.04903	268.50255	269.45001	NA
11370	3	44.23000	-78.36000	1004.50000	191.44466	272.94013	272.35001	NA
11370	4	51.67000	-124.40000	916.50000	872.82202	263.69020	264.95001	NA
11370	5	58.61000	-117.16000	973.90002	337.50449	272.37757	270.95001	NA
11370	6	52.18000	-122.04000	906.50000	938.08594	271.37738	264.35001	NA
11370	7	50.68000	-127.36000	1020.20001	22.03931	275.44020	275.04999	NA
11370	8	50.45000	-100.59000	949.09998	562.38477	272.18978	271.75000	NA
11370	9	57.13000	-61.47000	899.70001	834.87476	258.06464	254.64999	NA
11370	10	47.56000	-59.16000	1000.90002	40.06803	272.06486	269.54999	NA
11370	11	47.41000	-72.79000	1006.90002	169.37592	266.37724	265.95001	NA
11370	12	45.76000	-62.68000	1014.00000	1.99518	268.94018	268.64999	NA
11370	13	49.24000	-65.33000	1014.90002	28.96468	264.25276	267.25000	NA
11370	14	43.29000	-79.79000	1017.79999	77.03765	273.56474	275.85001	NA
11370	15	48.78000	-123.04000	1015.70001	23.93772	278.12724	280.25000	NA

Grid-Stat Tool

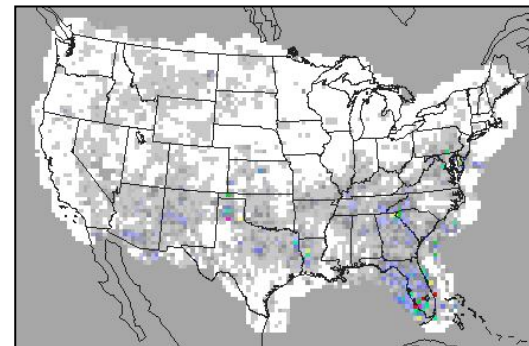


Grid-Stat: Overview



- 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

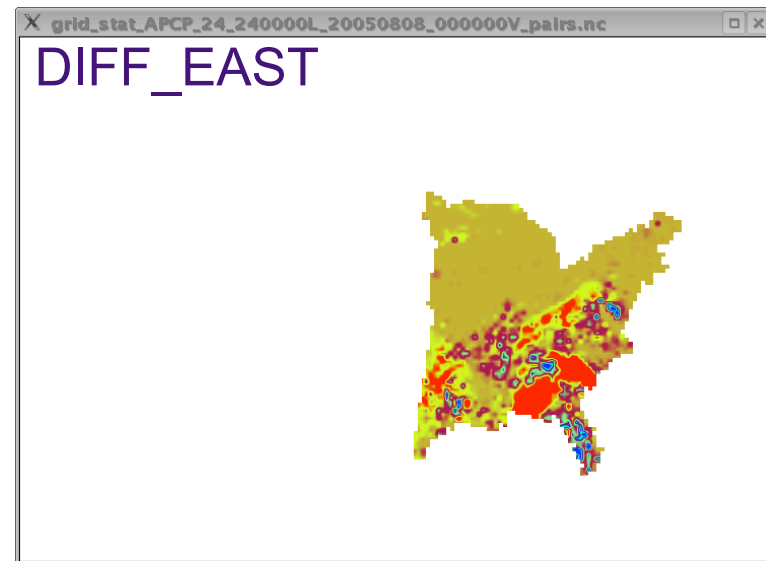
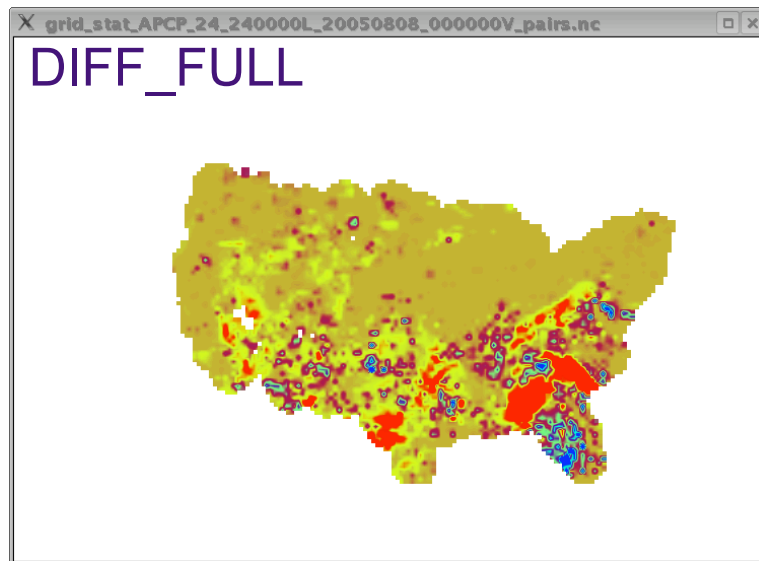
Grid-Stat: CTC Output Line

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

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

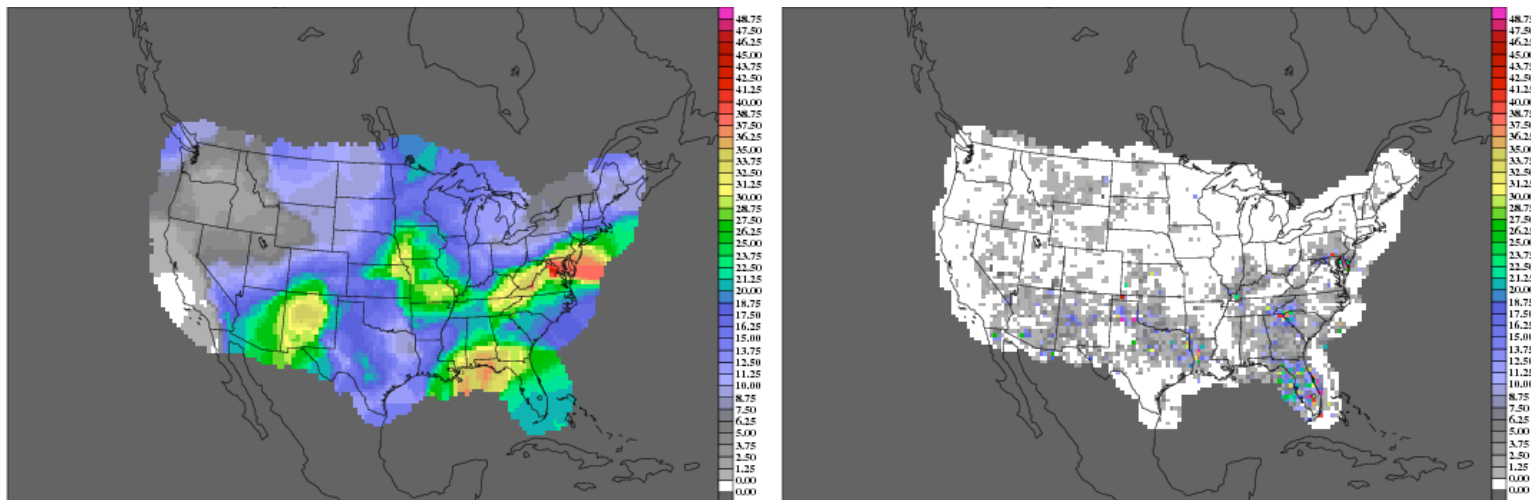
Forecast	Observation		Total
	$o = 1$ (e.g., "Yes")	$o = 0$ (e.g., "No")	
$p_1 = \text{midpoint of } (0 \text{ and threshold1})$	n_{11}	n_{10}	$n_{1.} = n_{11} + n_{10}$
$p_2 = \text{midpoint of } (\text{threshold1 and threshold2})$	n_{21}	n_{20}	$n_{2.} = n_{21} + n_{20}$
\vdots	\vdots	\vdots	\vdots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

Example:

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

Verifying Probabilities: Example

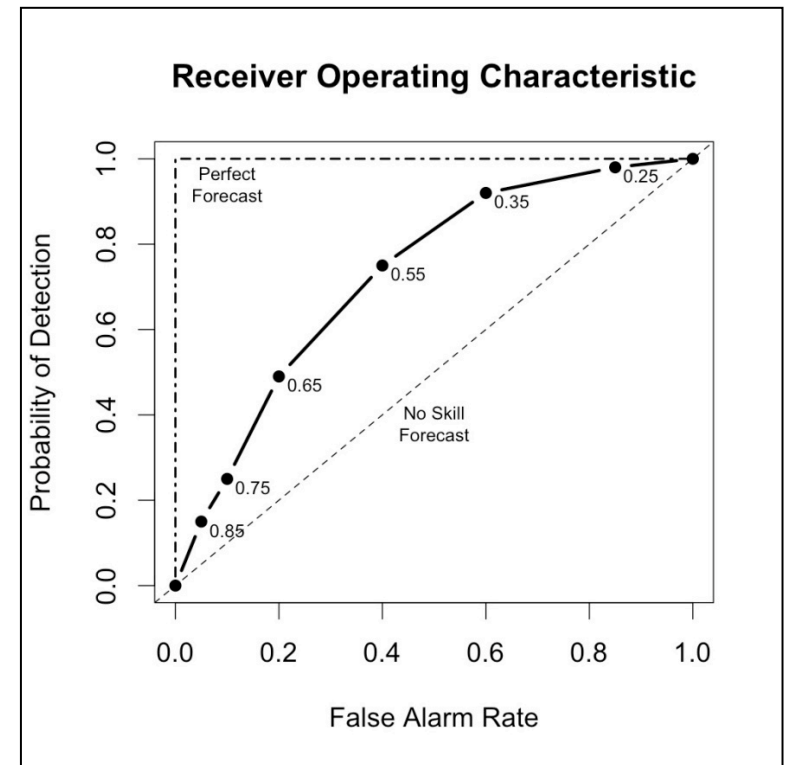
- Verify probability of precip with total precip:



- 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: Total Precip vs. Convective Precip
 - Configuration file settings:
 - Selecting variable/levels:
 - `fcst_field[] = ["APCP/A24"];`
 - `obs_field[] = ["ACPCP/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
```

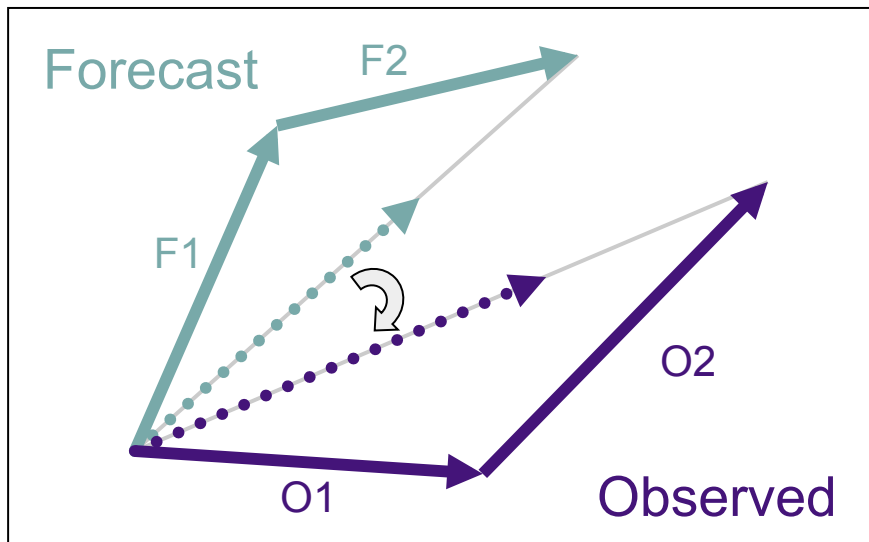
```
JOB_LIST:      -job aggregate_stat -fcst_thresh >=3.000 -line_type VL1L2 -out_line_type WDIR
COL_NAME: TOTAL FBAR      OBAR      ME      MAE
ROW_MEAN_WDIR: 2      5.67967 0.81565  -4.86402  4.86402
AGGR_WDIR: 1889  94.38140 80.45939 -13.92200 NA
```

```
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

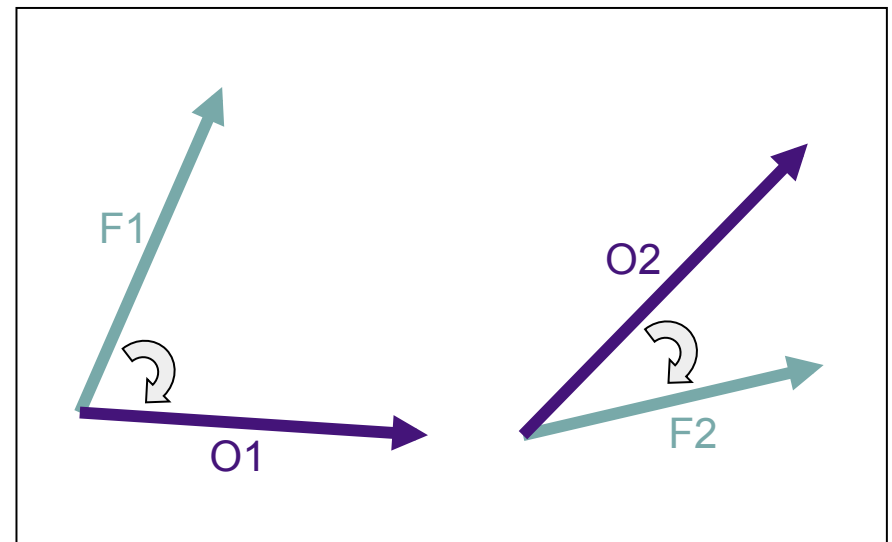
- AGGR_WDIR

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



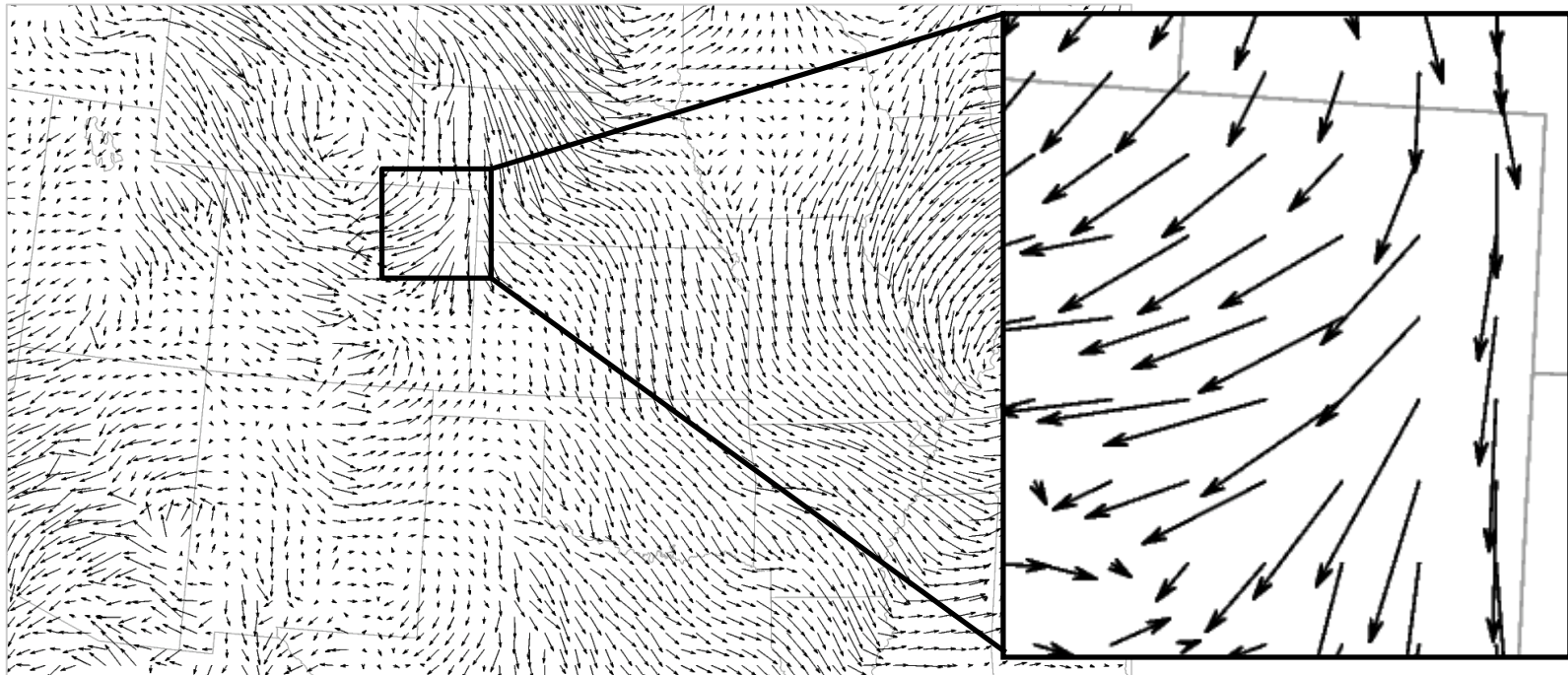
- ROW_MEAN_WDIR

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";
```

File Edit View History Bookmarks Tools Help



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Welcome to the MET config file generator!

Please choose which MET tool you're using:

Point Stat

Grid Stat

Mode

Done

File Edit View History Bookmarks Tools Help			
Most Visited			
Obs Wind Threshold	<div></div> <p>Fill in fields</p>		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.
Message Type	<div> <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 </div>		Specifies a list of the message types to use for verification. At least one message_type must be provided.
Mask Station IDs	<div></div> <p>Read description of options</p>		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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# 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.

Smoothing Parameters

Done

Submit form


```

////////////////////////////////////
//
// 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_seed = "123456789"

```

Resulting file

Save to your
computer.