Downloading and Compiling MET

Julie Prestopnik

Release History

- MET was first released in 2007
- **METv6.1**: Released December 04, 2017
  - **Major Enhancements**:
    - Added specification of point obs using the variable name (vs. GRIB code)
    - Added "convert(x)" config file option for conversion functions (convert(x)= C_to_F(x);)
    - Added "censor_thresh" and "censor_val" config file options for filtering thresholds and replacement values
    - Added new Economic Cost-Loss Value (ECLV) STAT line type derived from CTC or PCT lines
    - Added new Gradient (GRAD) STAT line type for statistics derived from gradients, including the S1 score
    - Added new Relative Position (RELP) STAT line type
    - Option to compute 1-D Fourier Decomposition when generating CNT, SL1L2, SAL1L2, VL1L2, and VAL1L2 output lines
    - Added initial support for binned climatologies by adding "climo_stdev" and "climo_cdf_bins" config file options
  - **Other Enhancements**:
    - Support for Gaussian grids and Polar Stereographic CF-Compliant NetCDF files
    - Shape option added to config files to define a square or circle area
    - Added support for reading BUFR files directly, rather than just PREPBUFR

MET Users

- **METv6.1**: Released December 04, 2017
  - Pre-installed on tutorial machines
- 3500+ registered MET users from 132 countries
  - 48/27/14/11%: University/Gov't/Nonprofit/Private
  - 30/16/6/3%: USA/China/India/Brazil
- On-line and hands-on tutorials

Downloading MET

- Download MET release and compile locally.
  - Register and download:
    - **www.dtcenter.org/met/users**

- Language:
  - Primarily in C++ with calls to a Fortran library

- Supported Platforms and Compilers:
  1. Linux with GNU compilers
  2. Linux with Portland Group (PGI) compilers
  3. Linux with Intel compilers

www.dtcenter.org/met/users

DTC Developmental Testbed Center

MET USERS PAGE

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MODEL EVALUATION TOOLS

Welcome

Welcome to the users page for the Model Evaluation Tools (MET) verification package. MET was developed by the National Center for Atmospheric Research (NCAR) Developmental Testbed Center (DTC) through the generous support of the U.S. Air Force Weather Agency (AFWA) and the National Oceanic and Atmospheric Administration (NOAA).

Description

MET is designed to be a highly-configurable, state-of-the-art suite of verification tools. It was developed using output from the Weather Research and Forecasting (WRF) modeling system but may be applied to the output of other modeling systems as well.

MET provides a variety of verification techniques, including:

- Standard verification scores comparing gridded model data to point-based observations
- Standard verification scores comparing gridded model data to gridded observations
- Spatial verification methods comparing gridded model data to gridded observations using neighborhood, object-based, and intensity-scale decomposition approaches
- Ensemble and probabilistic verification methods comparing gridded model data to point-based or gridded observations
- Aggregating the output of these verification methods through time and space

EVENTS

AMS 2018 NWP using Docker Containers
01.06.2018 to 01.06.2018
Location: AMS Annual Meeting in Austin, TX

2018 Hurricane WRF Tutorial
01.23.2018 to 01.25.2018
Location: College Park, MD

ANNOUNCEMENTS

MET Version 6.1 Release
12.04.2017

Release v3.9a of the HWRF system
10.16.2017

MET NEWS

MET Online Tutorial
New for METv6.1 on 2017.12.04

METv6.0 Running within a Docker container
New for Mac and Windows 10 users who wish to skip building and installing METv6.0

MET SPONSORS

National Center for Atmospheric Research (NCAR)

NCAR

Dependencies

- REQUIRED:

  - C++/Fortran Compilers (GNU, PGI, Intel)
  - GNU Make Utility
  - Unidata's NetCDF4 library (both NetCDF-C and NetCDF-CXX)
  - HDF5 library (required to support NetCDF4)
  - NCEP's BUFRLIB Library v10.2.3
  - GNU Scientific Library (GSL)
  - Z Library (zlib)

- OPTIONAL:
  - GRIB2 C-Library with JASPER and PNG libraries
  - HDF4 and HDF-EOS2 libraries for MODIS-Regrid tool
  - Cairo and FreeType libraries for MODE-Graphics tool

- RECOMMENDED:
  - Unified Post-Processor
  - COPYGB (included with Unified Post-Processor)
  - wgrib and wgrib2
  - R statistics and graphics package

Directory Structure

File or Directory	Contents
README	Installation instructions and release notes
configure (plus supporting files and subdir)	Used by the autoconf build process; Configures the MET package for installation on a system
bin/	Built MET executables
data/	Contains map data, colortables, sample input data, GRIB and GRIB2 table files, and default configuration files
doc/	MET User's Guide
out/	Output generated by the test scripts
scripts/	Test scripts to be run after building MET
src/	MET Source Code

Building MET

- Steps for building MET:
  1. Build required/optional libraries.
     - Same family of compilers for MET
  2. Download and unpack latest MET patches.
  3. autoconf determines available compilers, but can be explicitly set by the user
  4. Set environment variables in .cshrc or equivalent file
     - Paths for HDF5, NetCDF, BUFRLIB, and GSL libraries
     - The compilation of various tools can be turned on/off
  5. Configure the installation for your system and run configure
     - The compilation of various tools can be turned on/off
  6. Run make install and make test and check for runtime errors.
     - Test scripts run each of the MET tools at least once.
     - Uses sample data distributed with the tarball.

Existing MET Builds

- ## MET User's Page
  - Download -> Existing MET Builds

- ## Cheyenne
  - module use /glade/p/ral/jnt/MET/MET_releases/cheyenne/modulefiles
  - module load met/6.1

- ## Theia
  - module use /contrib/modulefiles
 - module load met/6.1

MET Flowchart

MET Overview v6.1
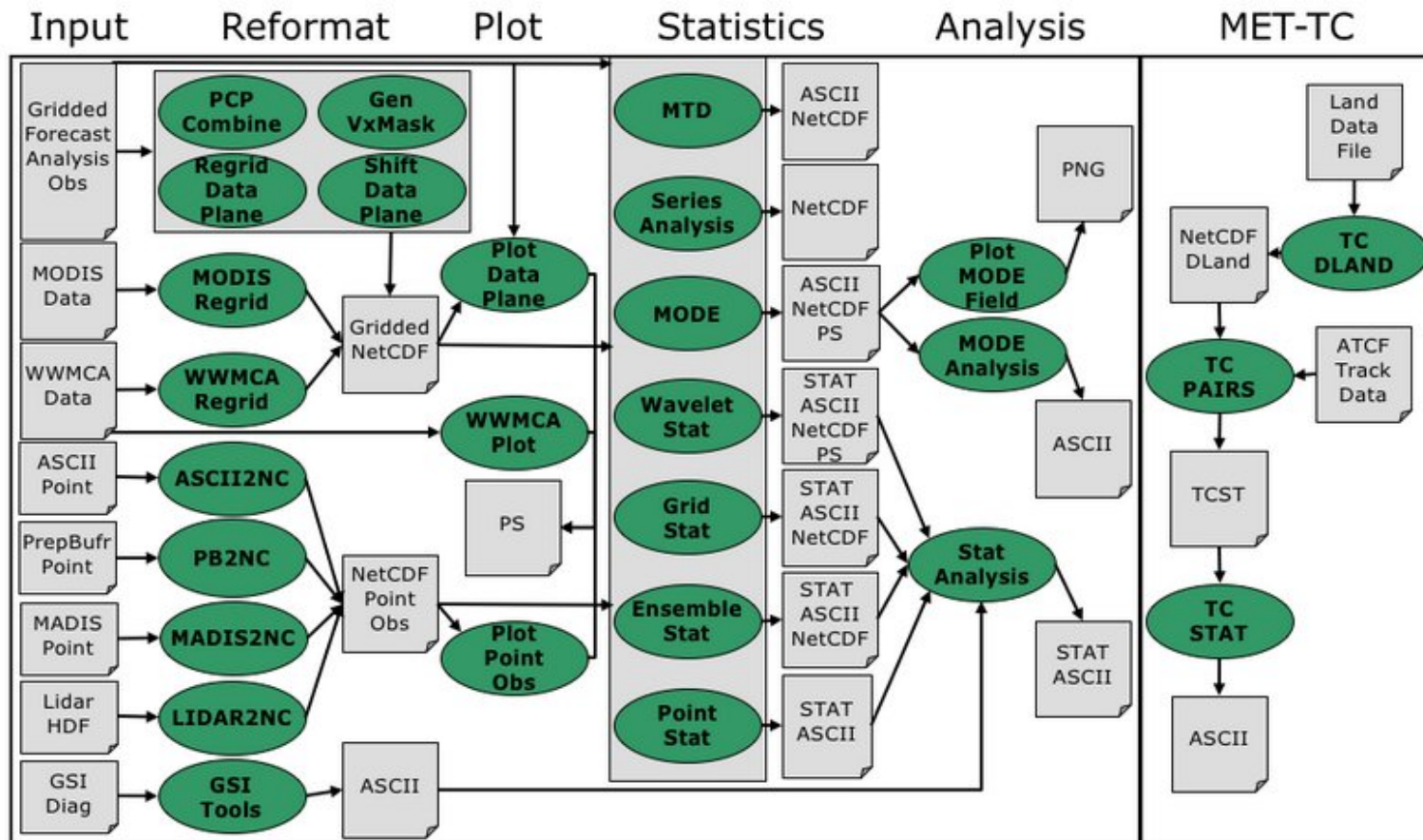
Configuration Files

- MET tools controlled using command line options and ASCII configuration files

    - Well commented and documented in MET User's Guide

    - Easy to modify

    - Distributed with the tarball

- Configuration files control things such as:

    - Fields/levels to be verified

    - Thresholds to be applied

    - Interpolation methods to be used

    - Verification methods to be applied

    - Regions over which to accumulate statistics

    - README file in data/config area describes various settings

Graphics

- Limited graphics incorporated into MET
- Options for plotting MET statistical output
  - R, NCL, IDL, GNUPlot, and many others
- Sample plotting scripts on MET website
- Future METViewer database/display system
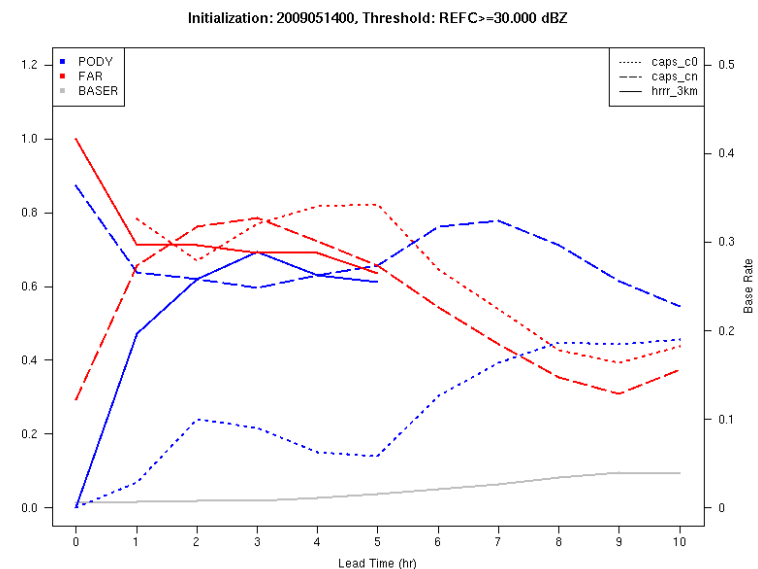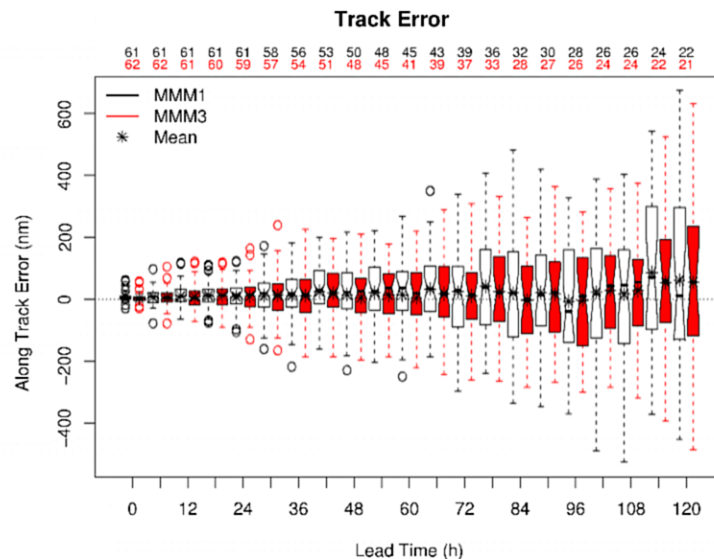
R Statistics and Graphics

- The R Project for Statistical Computing (www.r-project.org)
  - Powerful statistical analysis and plotting tools
  - Large and growing user community
  - Freely available and well supported for Linux/Windows/Mac
- Sample R plotting and analysis scripts posted on the MET website
- Use R to plot data in the practical sessions

Getting Started with MET

A Typical Use Case

Julie Prestopnik

Use Case: Point Verification

MET Overview v6.1
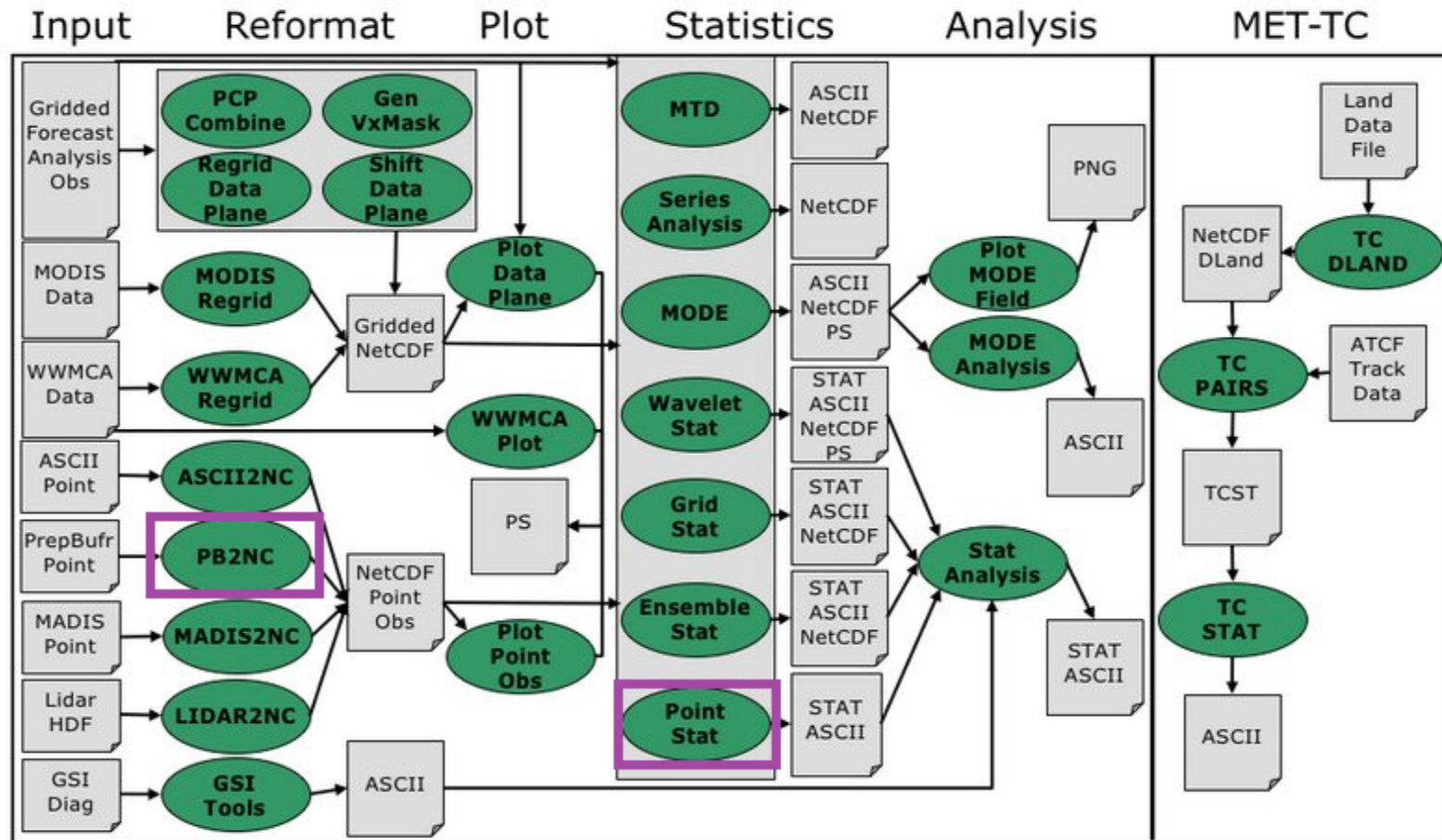
Use Case: 2-m Temperature

- Verify 2-m temperature versus PREPBUFR point observations.

- Initialized 2008080712 with 3-hourly output to 48h

- Run WRFOUT through UPP to create GRIB

- Unidata's IDV for display
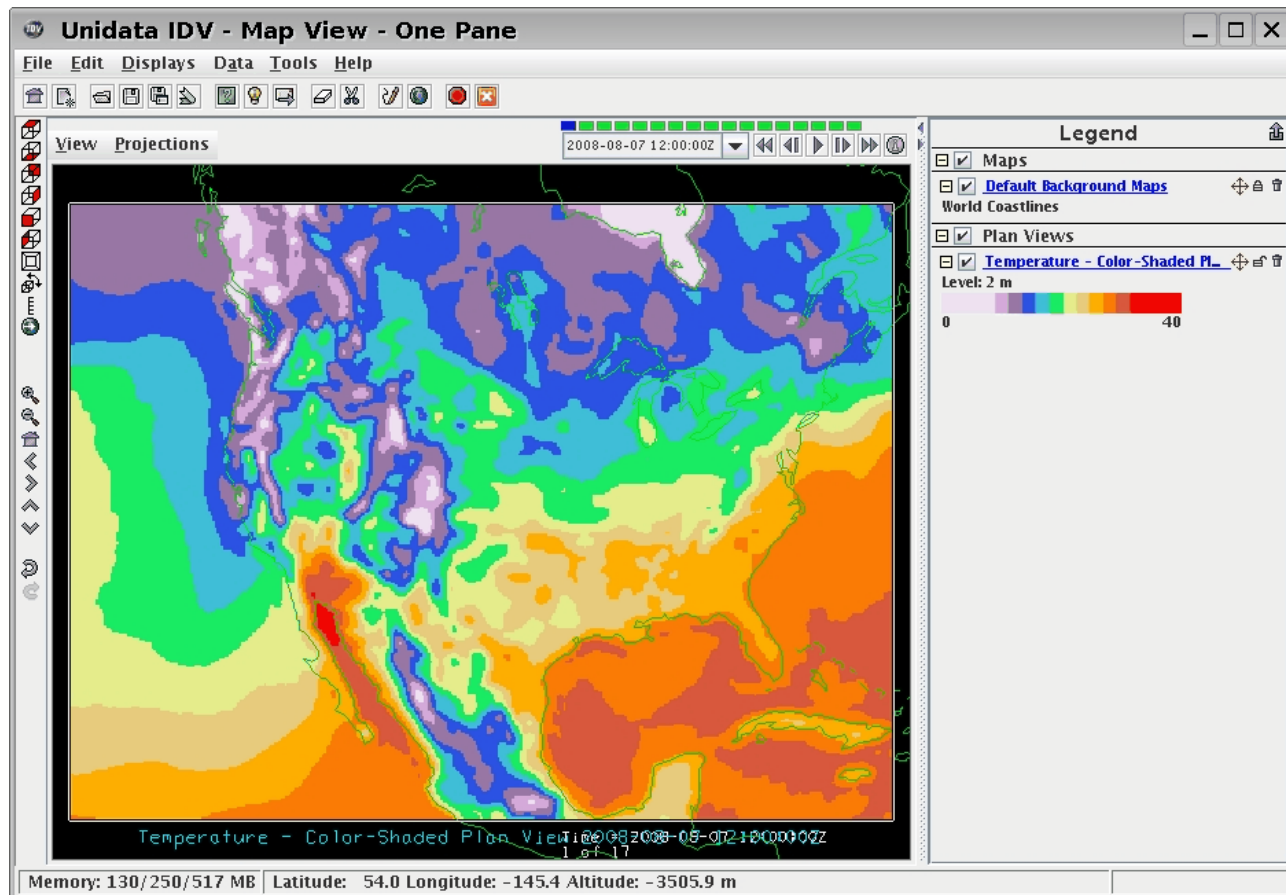
Use Case: Find Observations

- MET downloads page
  - Select "Observation Datasets"
  - NCAR CISL Site:
    - DS337.0
    - Global PREPBUFR point observations

> - NCAR CISL Site:
>   - **DS337.0**: NCEP ADP Global Upper Air and Surface Observations (PREPBUFR and NetCDF PB2NC Output) - archive starting May 1997:
>   http://rda.ucar.edu/datasets/ds337.0

Use Case: Get Observations

- Register and log in
- NCAR CISL Site:
  - DS337.0
  - Select 20080807 through 20080809
  - Pull daily PREPBUFR files
  - Can view by "Faceted Browse" or "Complete File List" (shown here)

Use Case: Process Observations

- GDAS PREPBUFR
  - 4/day in 6-hr chunks
  - nr = not restricted

```
exposure:jpresto% ls 2008*
20080807.nr:
prepbufr.gdas.20080807.t00z.nr    prepbufr.gdas.20080807.t12z.nr
prepbufr.gdas.20080807.t06z.nr    prepbufr.gdas.20080807.t18z.nr

20080808.nr:
prepbufr.gdas.20080808.t00z.nr    prepbufr.gdas.20080808.t12z.nr
prepbufr.gdas.20080808.t06z.nr    prepbufr.gdas.20080808.t18z.nr

20080809.nr:
prepbufr.gdas.20080809.t00z.nr    prepbufr.gdas.20080809.t12z.nr
prepbufr.gdas.20080809.t06z.nr    prepbufr.gdas.20080809.t18z.nr
```

```
exposure:jpresto% /usr/local/met-6.1/bin/pb2nc obs/20080807.nr/prepbufr.gdas.20080807.t00z.nr
obs/20080807.nr/prepbufr.gdas.20080807.t00z.nc PB2NCConfig -v 2
DEBUG 1: Default Config File: /usr/local/met-6.1/share/met/config/PB2NCConfig_default
DEBUG 1: User Config File: PB2NCConfig
DEBUG 1: Creating NetCDF File:        obs/20080807.nr/prepbufr.gdas.20080807.t00z.nc
DEBUG 1:
DEBUG 1: Pre-processing Bufr File for metadata (BUFR variable names) from obs/20080807.nr/prep
bufr.gdas.20080807.t00z.nr
DEBUG 1:
DEBUG 1: Processing Bufr File:  obs/20080807.nr/prepbufr.gdas.20080807.t00z.nr
DEBUG 1: Blocking Bufr file to: /tmp/tmp_pb2nc_blk_3604_0
DEBUG 2: PrepBufr Time Center:        20080807_000000
DEBUG 2: Searching Time Window:       20080806_180000 to 20080807_060000
DEBUG 2: Processing 336773 PrepBufr messages...
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
DEBUG 2: Total PrepBufr Messages processed     = 336773
DEBUG 2: Rejected based on message type        = 0
DEBUG 2: Rejected based on station id          = 0
DEBUG 2: Rejected based on valid time          = 0
DEBUG 2: Rejected based on masking grid        = 0
DEBUG 2: Rejected based on masking polygon     = 282327
DEBUG 2: Rejected based on elevation           = 0
DEBUG 2: Rejected based on pb report type      = 0
DEBUG 2: Rejected based on input report type   = 0
DEBUG 2: Rejected based on instrument type     = 0
DEBUG 2: Rejected based on zero observations   = 2366
DEBUG 2: Total PrepBufr Messages retained      = 52080
DEBUG 2: Total observations retained or derived = 213961
```
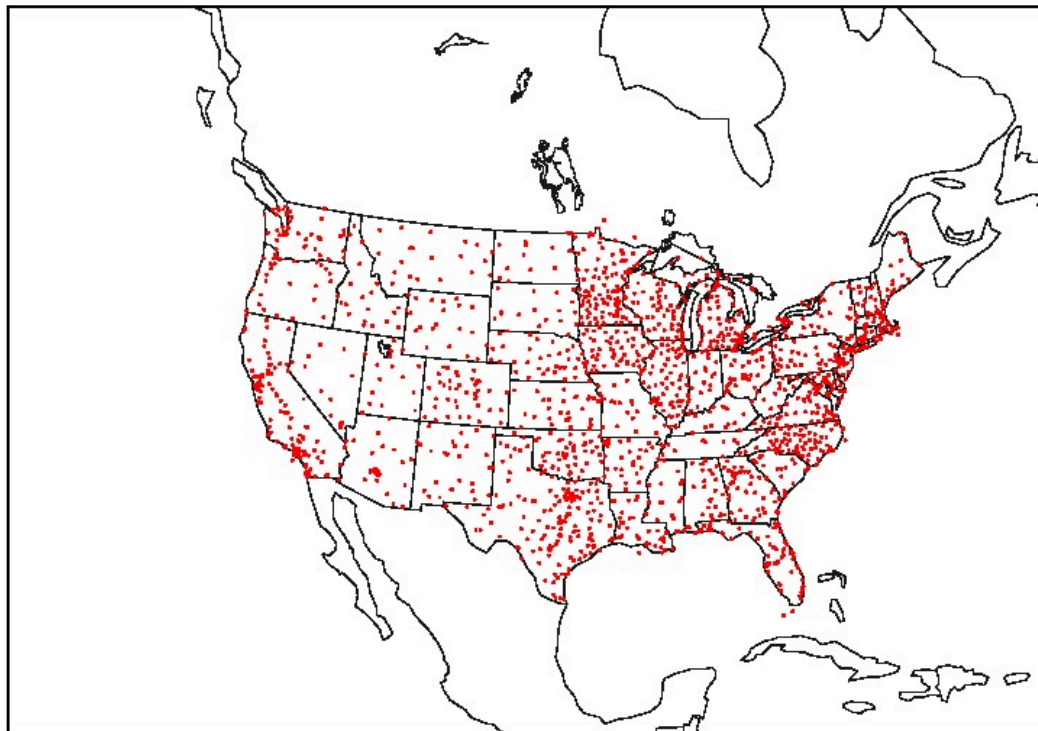
- Run each through **pb2nc**
  - All observation types
  - Full 6-hr time window
  - Quality marker of 9
  - Only over CONUS

Use Case: Plot 2-m TMP Obs

- 2-m TMP obs in ADPSFC message type
- Run **plot_point_obs** utility to display obs

prepbufr.gdas.20080807.t00z.nc

Use Case: Verify 2-m TMP Fcst

- Run **point_stat** to compare gridded forecast to point observations.

  - Once/fcst time

  - Obs +/- 5 min

  - Bilinear interp

  - Score over FULL model domain

  - Continuous statistics line (incl RMSE)

```
CALLING: /usr/local/met-6.1/bin/point_stat fcst/2008080712/
WRFPRS_TMP_2m.tm00 obs/20080807.nr/prepbufr.gdas.20080807.
t12z.nc PointStatConfig  -outdir out -v 2
Default Config File: /usr/local/met-6.1/share/met/config/
PointStatConfig_default
User Config File: /d1/jpresto/DTC/doc/MET_Tutorial_201801/
use_case/PointStatConfig
GSL_RNG_TYPE=mt19937
GSL_RNG_SEED=22173274
Forecast File: fcst/2008080712/WRFPRS_TMP_2m.tm00
Observation File: obs/20080807.nr/prepbufr.gdas.20080807.
t12z.nc

-----------------------------------------------------------

Reading data for TMP/Z2.
Processing masking regions.
For TMP/Z2 found 1 forecast levels, 0 climatology mean
levels, and 0 climatology standard deviation levels.

-----------------------------------------------------------

Searching 205379 observations from 50339 messages.

-----------------------------------------------------------

Processing TMP/Z2 versus TMP/Z2, for observation type
ADPSFC, over region FULL, for interpolation method
BILIN(4), using 782 pairs.
Computing Continuous Statistics.
```

Use Case: Continuous Statistics

- One STAT output file for each lead time
- Continuous line type (CNT) including CI's

```
exposure:jpresto% ls -1 *.stat
point_stat_000000L_20080807_120000V.stat
point_stat_030000L_20080807_150000V.stat
point_stat_060000L_20080807_180000V.stat
point_stat_090000L_20080807_210000V.stat
point_stat_120000L_20080808_000000V.stat
point_stat_150000L_20080808_030000V.stat
point_stat_180000L_20080808_060000V.stat
point_stat_210000L_20080808_090000V.stat
point_stat_240000L_20080808_120000V.stat
point_stat_270000L_20080808_150000V.stat
point_stat_300000L_20080808_180000V.stat
point_stat_330000L_20080808_210000V.stat
point_stat_360000L_20080809_000000V.stat
point_stat_390000L_20080809_030000V.stat
point_stat_420000L_20080809_060000V.stat
point_stat_450000L_20080809_090000V.stat
point_stat_480000L_20080809_120000V.stat
```

Column	48hr fcst	Column	48hr fcst
TOTAL	771	MAE	1.84045
FBAR	290.54368	MSE	5.5114
FSTDEV	4.49174	BCMSE	5.34955
OBAR	290.94598	RMSE	2.34764
OSTDEV	3.89426	E10	-3.39623
PR_CORR	0.85709	E25	-1.93107
ME	-0.40230	E50	-0.39260
ESTDEV	2.31441	E75	1.05912
MBIAS	0.99862	E90	2.56695

Use Case: Time Series of RMSE

RMSE for 2m TMP vs ADPSFC over CONUS
2008080712 Initialization

48hr RMSE = 2.35
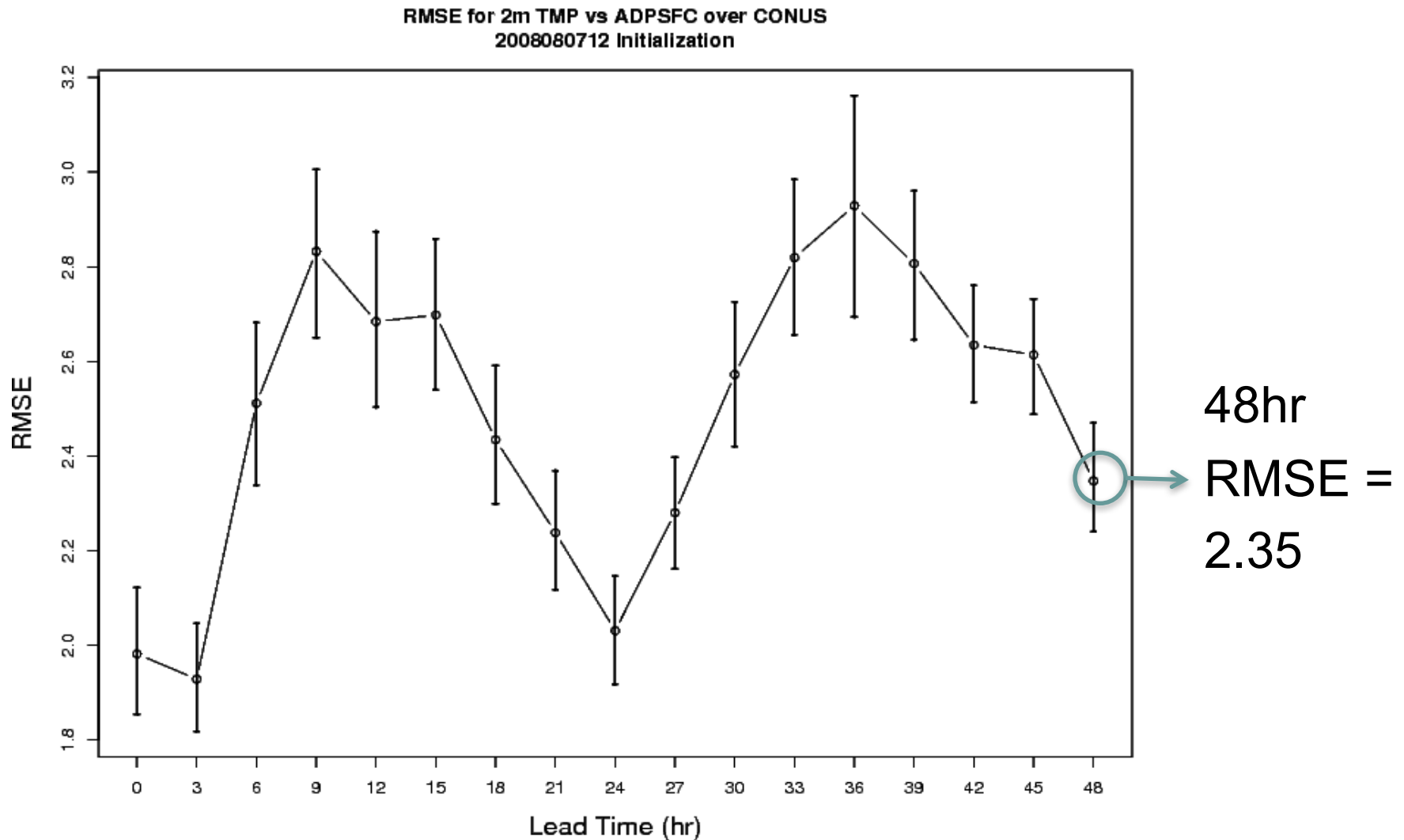
Use Case: Conclusions

- Diurnal cycle for surface temperature
  - RMSE best in the morning (perfect RMSE = 0)
  - RMSE worst in the evening
- Performance degrades as lead time increases
- Too little data to make strong conclusions
  - This is a single initialization
  - Verify/aggregate over a month, season, or year