File Formats and Pre-Processing

- File Formats
- Pre-processing Tools
- Useful Links

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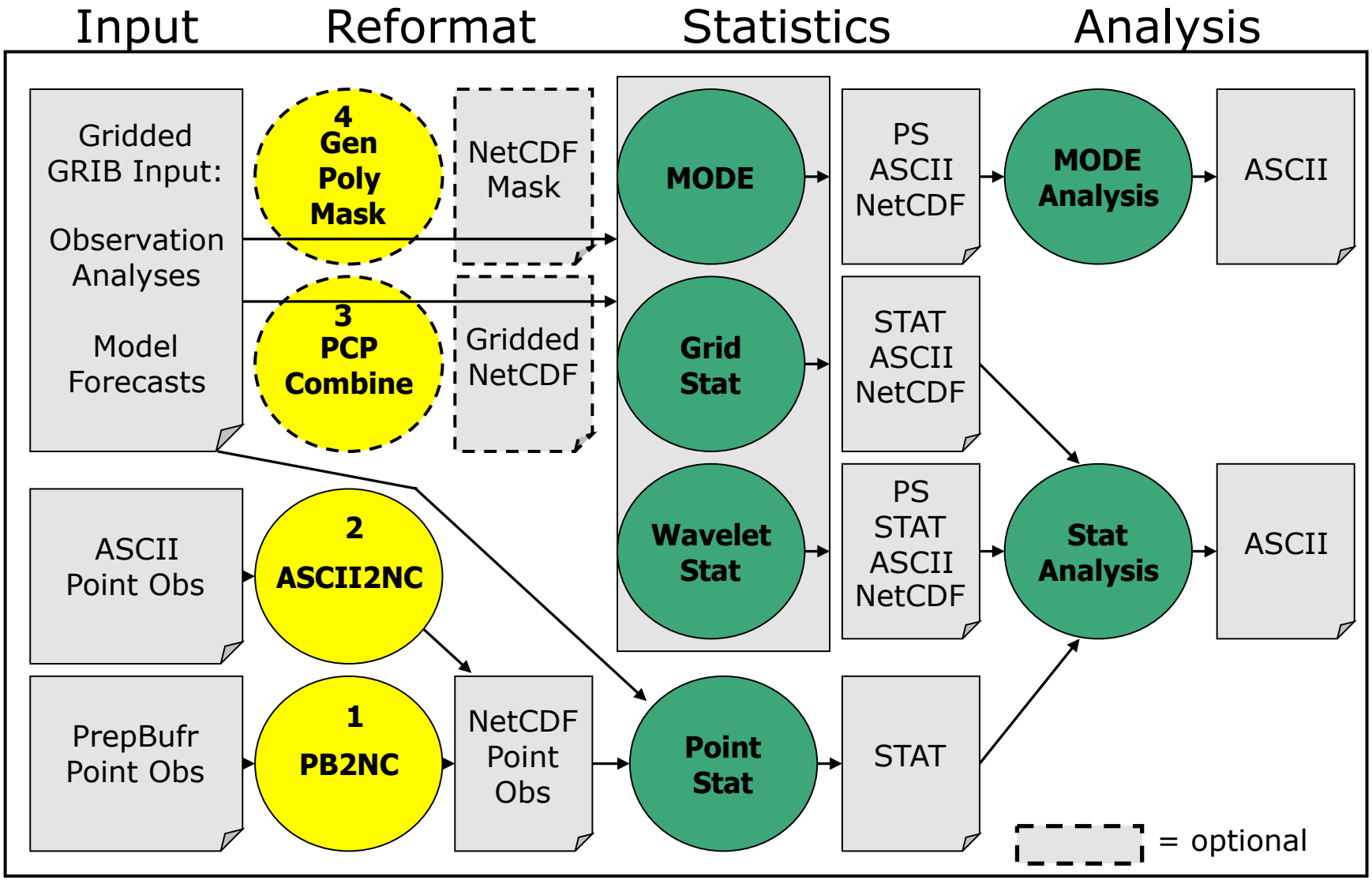
Supported File Formats

- **Forecasts**
  - **GRIB** – GRIdded Binary file format (*version 1)
  - **NetCDF** – MET specific network Common Data Format
- **Observations**
  - **PREPBUFR** – binary dataset prepared by NCEP from varied data sources.
  - **ASCII** – MET specific format (10-cols x n-rows)
  - **GRIB** – i.e. NEXRAD Level II or IV
  - **NetCDF** – MET specific NetCDF format

Pre-Processing / Reformatting



Data Reformating Tools

- **PB2NC and ASCII2NC**
  - Arrange observational data into the NetCDF point format expected by Point-Stat.
- **PCP_Combine (optional)**
  - Sum precipitation values across two or more time periods.
  - Subtract precipitation values to create values for finer subperiods.
  - Produces gridded NetCDF file that can be used as input grid for any Statistics tool.
- **Gen_Poly_Mask (optional)**
  - Used when more complex masking is needed.
  - Produces a NetCDF file of pre-defined mask.
  - May be used for masking in any Statistics tools.

1. PB2NC Tool

- **Stands for "PREPBUFR to NetCDF"**
- **Functionality:**
  - Filters and reformats PREPBUFR point observations into intermediate NetCDF format.
  - Configuration file specifies:
    - Observation types, locations, elevations, quality marks, times, and variables to retain or derive for use in Point-Stat.
- **Data formats:**
  - Reads PREPBUFR using NCEP's BUFRLIB.
  - Writes point NetCDF as input to Point-Stat.

Note: v2.0 no longer requires CWORDSH to pre-process PREPBUFR files.

PREPBUFR

- **BUFR** is the World Meteorological Organization (WMO) standard binary code for the representation and exchange of observational data.
  - http://www.nco.ncep.noaa.gov/sib/decoders/BUFRLIB/
  - http://www.ecmwf.int/products/data/software/
- The **PREPBUFR** format is produced by NCEP for analyses and data assimilation. The system that produces this format:
  - Assembles observations dumped from a number of sources
  - Encodes
    - information about the observational error for each data type
    - background (first guess) interpolated to each data location
  - Performs both rudimentary multi-platform quality control and more complex platform-specific quality control
- **MET currently only supports PREPBUFR.** Let us know if you need to read in other BUFR format.

What is in PREPBUFR file?

METv2.0/data/sample_obs/prepbufr/ndas.t00z.prepbufr.tm12.20070401.nr

```
==> append : to filename to view the  data source
BUFR
230ADPUPA   UPPER-AIR (RAOB, PIBAL, RECCO, DROPS) REPORTS
231AIRCAR   MDCRS ACARS AIRCRAFT REPORTS
232AIRCFT   AIREP/PIREP, AMDAR(ASDAR/ACARS), E-ADAS(AMDAR
BUFR) ACF233SATWND   SATELLITE-DERIVED WIND REPORTS
234PROFLR   WIND PROFILER REPORTS
235VADWND   VAD (NEXRAD) WIND REPORTS
236SATEMP   TOVS SATELLITE DATA (SOUNDINGS, RETRIEVALS,
RADIANCES) 237ADPSFC   SURFACE LAND (SYNOPTIC, METAR)
REPORTS                238SFCSHP   SURFACE MARINE (SHIP, BUOY, C-
MAN PLATFORM) REPORTS    239SFCBOG   MEAN SEA-LEVEL
PRESSURE BOGUS REPORTS                240SPSSMI   SSM/I
RETRIEVAL PRODUCTS (REPROCESSED WIND SPEED, TPW)
241SYNDAT   SYNTHETIC TROPICAL CYCLONE BOGUS REPORTS
242ERS1DA   ERS SCATTEROMETER DATA (REPROCESSED WIND
SPEED)       243GOESND   GOES SATELLITE DATA (SOUNDINGS,
RETRIEVALS, RADIANCES) 244QKSWND   QUIKSCAT SCATTEROMETER
DATA (REPROCESSED WIND SPEED)   245MSONET   MESONET
SURFACE REPORTS (COOPERATIVE NETWORKS)        246GPSIPW
GLOBAL POSITIONING SATELLITE-INTEGRATED PRECIP. WATER
247RASSDA   RADIO ACOUSTIC SOUNDING SYSTEM (RASS) TEMP
PROFILE RPTSM063000BYTCNT...
```

Result of running unix "less" or "more" command:

>less \ ndas.t00z.prepbufr.tm12.20070401.nr

PREPBUFR - Known Issues

- CWORDSH blocking
  - In v1.0 and v1.1 it was needed to structure to data properly for reading by the MET fortran code.
  - Need eliminated in v2.0.
- Compilation of PREPBUFR on 64-bit OS
  - If you will be using PREPBUFR files, you should compile everything using 32-bit flags.
  - Investigation of this problem in ongoing.

PB2NC: Usage

Usage: pb2nc

prepbufr_file

netcdf_file

config_file

[-pbfile prepbufr_file]

[-valid_beg time]

[-valid_end time]

[-nmsg n]

[-dump path]

[-v level]

prepbufr_file	**Input obs file in PrepBufr format**
netcdf_file	**Output name for NetCDF file**
config_file	**PB2NC configuration file**
-pbfile	**Additional input PrepBufr files**
-valid_beg	**Beginning of valid time window** [YYYYMMDD_[HH[MMSS]]
-valid_end	**End of valid time window** [YYYYMMDD_[HH[MMSS]]
-nmsg	**Number of PrepBufr messages to process**
-dump	**Dump entire contents of PrepBufr file to file in path**
-v	**Level of logging**

PB2NC: Run

- **METv2.0/bin/pb2nc** \
  ndas.t00z.prepbufr.tm12.20070401.nr \
  out/sample_pb.nc PB2NCConfig_tutorial -v 2

```
Reading Config File:    PB2NCConfig_default
Creating NetCDF File:   out/sample_pb.nc
Processing PrepBufr File:       ndas.t00z.prepbufr.tm09.20070401.nr
Blocking PrepBufr file to:      /tmp/pb2nc_1705_0_blk.pb
PrepBufr Time Center:   20070331_150000
Searching Time Window:  20070331_133000 to 20070331_163000
Processing 70884 PrepBufr messages...
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80%
85% 90% 95% 100%
Total PrepBufr Messages processed       = 70884
Rejected based on message type          = 0
Rejected based on station id            = 0
Rejected based on valid time            = 0
Rejected based on masking grid          = 0
Rejected based on masking polygon       = 0
Rejected based on elevation             = 0
Rejected based on pb report type        = 0
Rejected based on input report type     = 0
Rejected based on instrument type       = 0
Rejected based on zero observations     = 24153
Total PrepBufr Messages retained        = 46731
Total observations retained or derived  = 142709
```

This example takes a few minutes to run

Output NetCDF file is designated as out/ sample_pb.nc

We will see the NetCDF format in a few slides

2. ASCII2NC Tool

- **Stands for "ASCII to NetCDF"**
- **Functionality:**
  - Reformat ASCII point observations into intermediate NetCDF format.
  - One input ASCII format supported (10 columns).
  - No configuration file.
- **Data formats:**
  - Reads MET specific ASCII format with point obs.
  - Writes point NetCDF as input to Point-Stat.
  - ***Future: support additional standard ASCII formats.***

ASCII2NC: Usage

Usage: ascii2nc

ascii_file

netcdf_file

[-format ascii_format]

[-v level]

ascii_file	**Input obs file in ASCII format**
netcdf_file	**Output name for NetCDF file**
-format	**Override using MET specific point format** (*Future Option*)
-v	**Level of logging**

MET specific ASCII Format

Msg	STID	ValidTime	Lat	Lon	Elev	GC	Lvl	Hgt	Ob
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	7	837.0	1618	1618
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	11	837.0	1618	273.05
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	17	837.0	1618	271.85
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	52	837.0	1618	92
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	53	837.0	1618	0.00417
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	7	826.0	1724	1724
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	11	826.0	1724	274.55 …..

Msg	**Message type**
STID	**WMO Station ID**
ValidTime	**Valid time for observation**
Lat	**Latitude** [North]
Lon	**Longitude** [East]
Elev	**Elevation** [m] *(Note: currently not used by MET code so can be filled with -9999.)*
GC	**GRIB code for variable** ***(i.e. AccPrecip = 61; MSLP = 2; Temp = 11, etc…)*** http://www.cpc.ncep.noaa.gov/products/wesley/opn_gribtable.html
Lvl	**Pressure** [mb] or **Accumulation Interval** [hr]
Hgt	**Height above Mean Sea Level** [m – MSL] *(Note: currently not used by MET code so can be filled with -9999.)*
Ob	**Observed value**

MET specific ASCII Format

Msg	STID	ValidTime	Lat	Lon	Elev	GC	Lvl	Hgt	Ob	Grib Code Identifies Variables
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**7**	837.0	1618	1618	***HGT**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**11**	837.0	1618	273.05	***TMP**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**17**	837.0	1618	271.85	***DPT**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**52**	837.0	1618	92	***RH**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**53**	837.0	1618	0.00417	***MixRat**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**7**	826.0	1724	1724	***HGT**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**11**	826.0	1724	274.55 …..	***TMP**

Msg	**Message type**
STID	**WMO Station ID**
ValidTime	**Valid time for observation**
Lat	**Latitude** [North]
Lon	**Longitude** [East]
Elev	**Elevation** [m] *(Note: currently not used by MET code so can be filled with -9999.)*
GC	**GRIB code for variable** ***(i.e. AccPrecip = 61; MSLP = 2; Temp = 11, etc…)*** http://www.cpc.ncep.noaa.gov/products/wesley/opn_gribtable.html
Lvl	**Pressure** [mb] or **Accumulation Interval** [hr]
Hgt	**Height above Mean Sea Level** [m – MSL] *(Note: currently not used by MET code so can be filled with -9999.)*
Ob	**Observed value**

MET specific ASCII Format

Msg	STID	ValidTime	Lat	Lon	Elev	GC	Lvl	Hgt	Ob	Ob assigns value to variable
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**7**	837.0	1618	**1618**	***HGT**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**11**	837.0	1618	**273.05**	***TMP**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**17**	837.0	1618	**271.85**	***DPT**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**52**	837.0	1618	**92**	***RH**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**53**	837.0	1618	**0.00417**	***MixRat**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**7**	826.0	1724	**1724**	***HGT**
ADPUPA	72365	20070331_120000	35.03	-106.62	1618.0	**11**	826.0	1724	**274.55**	***TMP**

* *Use a value of "-9999" to indicate missing data*

Msg	**Message type**
STID	**WMO Station ID**
ValidTime	**Valid time for observation**
Lat	**Latitude** [North]
Lon	**Longitude** [East]
Elev	**Elevation** [m] *(Note: currently not used by MET code so can be filled with -9999.)*
GC	**GRIB code for variable** ***(i.e. AccPrecip = 61; MSLP = 2; Temp = 11, etc…)*** http://www.cpc.ncep.noaa.gov/products/wesley/opn_gribtable.html
Lvl	**Pressure** [mb] or **Accumulation Interval** [hr]
Hgt	**Height above Mean Sea Level** [m – MSL] *(Note: currently not used by MET code so can be filled with -9999.)*
Ob	**Observed value**

ASCII2NC: Run

- **METv2.0/bin/ascii2nc** sample_obs.txt \
  sample_ascii.nc -v 2

This example has 2140 obs and takes seconds to run

Output NetCDF file

Result of ncdump –h

Result of ncdump –v obs_arr

```
netcdf sample_ascii {
dimensions:
        mxstr = 15 ;
        hdr_arr_len = 3 ;
        obs_arr_len = 5 ;
        nhdr = 5 ;
        nobs = UNLIMITED ; // (2140 currently)
variables:
        char hdr_typ(nhdr, mxstr) ;
                hdr_typ:long_name = "message type" ;
        char hdr_sid(nhdr, mxstr) ;
                hdr_sid:long_name = "station identification" ;
        char hdr_vld(nhdr, mxstr) ;
                hdr_vld:long_name = "valid time" ;
                hdr_vld:units = "YYYYMMDD_HHMMSS UTC" ;
        float hdr_arr(nhdr, hdr_arr_len) ;
                hdr_arr:long_name = "array of observation station header values" ;
                hdr_arr:_fill_value = -9999.f ;
                hdr_arr:columns = "lat lon elv" ;
                … ;
        float obs_arr(nobs, obs_arr_len) ;
                obs_arr:long_name = "array of observation values" ;
                obs_arr:_fill_value = -9999.f ;
                obs_arr:columns = "hdr_id gc lvl hgt ob" ;
                obs_arr:hdr_id_long_name = "index of matching header data" ;
                … ;
```

```
obs_arr =
 0, 7, 837, 1618, 1618,
 1, 11, 837, 1618, 273.05,
 2, 17, 837, 1618, 271.85,
 3, 52, 837, 1618, 92,
 4, 53, 837, 1618, 0.00417,
 5, 7, 826, 1724, 1724,
 6, 11, 826, 1724, 274.55,
 7, 17, 826, 1724, 272.15,
 8, 52, 826, 1724, 84,
 9, 53, 826, 1724, 0.00432,
 10, 7, 815.3, 1829, 1829,
 11, 11, 815.3, 1829, 276.45,
 12, 17, 815.3, 1829, 265.75,
 13, 52, 815.3, 1829, 45,
 14, 53, 815.3, 1829, 0.0027,
 15, 7, 815, 1832, 1832,
 16, 11, 815, 1832, 276.55,
 17, 17, 815, 1832, 265.55,
 18, 52, 815, 1832, 44,
 19, 53, 815, 1832, 0.00266,
 20, 7, 784.7, 2134, 2134,
 21, 11, 784.7, 2134, 274.05,
 22, 17, 784.7, 2134, 264.15,
 23, 52, 784.7, 2134, 47,
…
```

3. PCP-Combine Tool

- **Stands for "Precip-Combine"**
- **Functionality:**
  - Mathematically combines precipitation fields across multiple files.
    - Add precipitation over 2 files with or without different accumulation intervals
      - *2 NMM output files with 3-hr to get 6-hr accumulation.*
    - Sum precipitation over 2 or more files when accumulation interval is the same
      - *12 WSR-88D Level II data to go from 5 min accumulation to 1-hr accumulation.*
    - Subtract precipitation in 2 files
      - *2 ARW output files to go from 12 hr accumulations to 6 hour accumulation*
  - Specify field name on the command line.
  - No configuration file.
- **Data formats:**
  - Reads GRIB format.
  - Writes gridded NetCDF as input to stats tools.

PCP-Combine: Usage

Usage: pcp_combine

[-sum sum_args]

or [-add add_args]

or [-subtract sub_args]

[-gc code]

[-v level]

-sum	**Accumulates data over multiple files with same accum interval.** ***Sum_args***: (init_time, in_accum, valid_time, out_accum, out_file, -pcpdir path, -pcprx reg_exp)
-add	**Accumulates data over 2 files with or without different accum. intervals.** ***Add_args:*** (in_file1, Accum1, in_file2, Accum2, out_file).
-subtract	**Subtracts data over two files.** ***Sub_args:*** (in_file1, Accum1, in_file2, Accum2, out_file).
-gc	**GRIB code for variable** *(i.e. ACPC = 61; NCPCP* =62*; ACPCP* =63*, etc…).*
-v	**Level of logging**

PCP-Combine: Run

Two example command lines

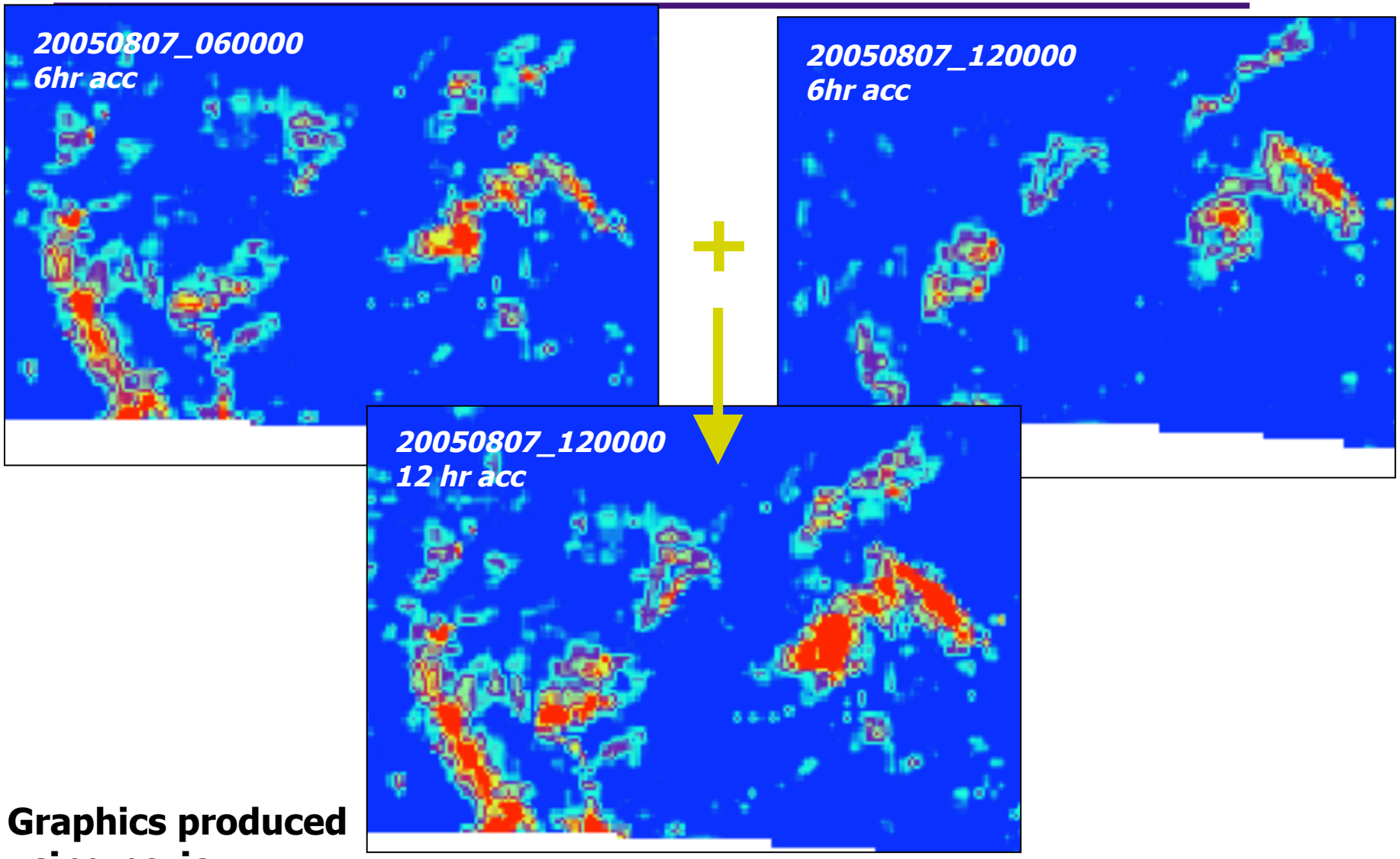
1) **Adding 2 (6-hourly) accumulation forecast files into 1 (12-hourly) accumulation forecast.**

```
METv2.0/bin/pcp_combine \
-add 20050807_060000.grb 6 \
20050807_120000.grb 6 \
sample_fcst.nc
```

2) **Summing 12 (1-hourly) accumulation observation files into 1 (12-hourly) accumulated observation file.**

```
METv2.0/bin/pcp_combine \
-sum 00000000_000000 1 \
20050807_120000 12 \
sample_obs.nc -pcpdir data/ST2ml
```

PCP-Combine: Example #1



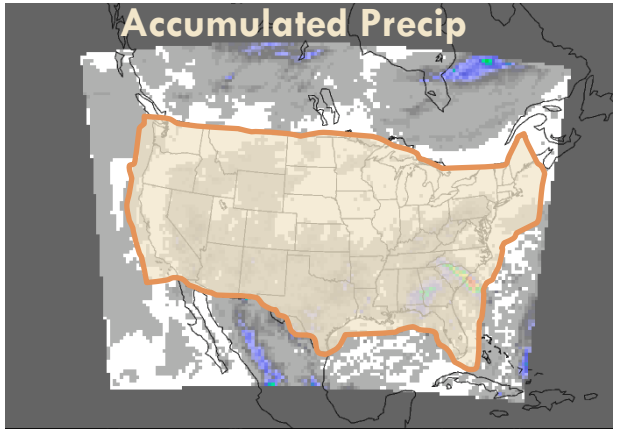
Graphics produced using ncview

4. Gen Poly Mask Tool

- **Stands for "Generate Polyline Mask"**

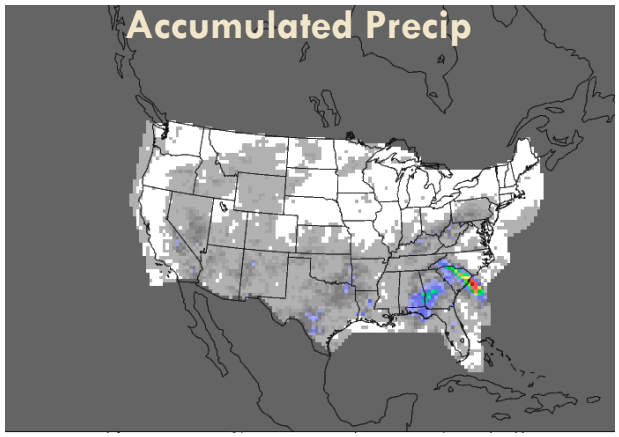
- **Functionality:**
  - Uses a lat/lon polyline to generate a 0/1 mask field to be applied to your data.
  - Applies this mask once – prior to running Point-Stat or Grid-Stat
  - No configuration file.

- **Data formats:**
  - Reads ASCII formatted polyline file.
  - Reads GRIB file.
  - Reads NetCDF files from PCP-Combine.
  - Writes gridded NetCDF file of 0/1 mask.



CONUS

31.1931 -120.4211
31.2291 -120.4976
31.2650 -120.5741
31.3009 -120.6123
31.3369 -120.6506
31.3728 -120.6888
31.4087 -120.6888
31.4447 -120.7270
992 more points…



GRIB vs GRIB2

- **GRIB (or GRIB1): WRF postprocessor (WPP) produces GRIB1 format using copyGB tool**
  - Performs horizontal interpolation and destaggering (in the case of WRF-NMM) onto a defined grid.
  - Useful for both cores in creating an output grid not fixed by the model integration domain.
    - http://www.dtcenter.org/wrf-nmm/users/downloads/
- **GRIB2: NCEP and other WMO organizations have historical data in GRIB1 but now use GRIB 2 as the standard for gridded binary data.**
- **At least two GRIB2toGRIB1 converters available**
  - **NCEP cnvgrib**
    - http://www.nco.ncep.noaa.gov/pmb/codes/GRIB2/
  - **UCAR/CISL Grib Converter**
    - http://dss.ucar.edu/libraries/grib/c.html

Data Inventory Tools

- **wgrib** – dumps GRIB1 headers and data.
  - http://www.cpc.ncep.noaa.gov/products/wesley/wgrib.html
- **wgrib2** – dumps GRIB2 headers and data.
  - http://www.cpc.ncep.noaa.gov/products/wesley/wgrib2/
- **ncdump -** dumps NetCDF headers and data.
  ncview – plots gridded NetCDF data.
  - http://www.unidata.ucar.edu/software/netcdf/
- **GrADS** – command line interface to produce plots.
  - http://www.iges.org/grads/downloads.html
- **NCL** – command line interface to convert data formats, do data analysis and produce plots.
  - http://www.ncl.ucar.edu/
- **IDV** – gui-driven visualization of many gridded and point datasets.
  - http://www.unidata.ucar.edu/software/idv/