

Verification at NCEP/EMC

Geoff DiMego, Guang-Ping Lou, Binbin
Zhou, Perry Shafran, Marina Tsidulko

geoff.dimego@noaa.gov

(301) 763-8000 ext 7221

Operational Extra-Tropical Cyclone Tracks Verification System

Tracking, sorting and matching model analysis and its
corresponding forecast cyclone tracks for verification

Guang Ping Lou NOAA/NWS/NCEP/EMC/MMB
Tim Marchok NOAA/OAR/GFDL

Routine Model Storm Tracks

Operationally, the Marchok “genesis” tracker is invoked on the following forecast models: GFS, NAM, CMC, UKMO, ECMWF, NOGAPS, and ensemble forecasts GEFS, SREF, CMC and ECMWF.

All cyclones of sufficient strength and longevity are tracked.

Cyclone tracks are plotted and graphics are pushed to a web server.

Tracks are archived in ATCF format.

<http://www.emc.ncep.noaa.gov/mmb/gplou/mchurr/nwprod/>

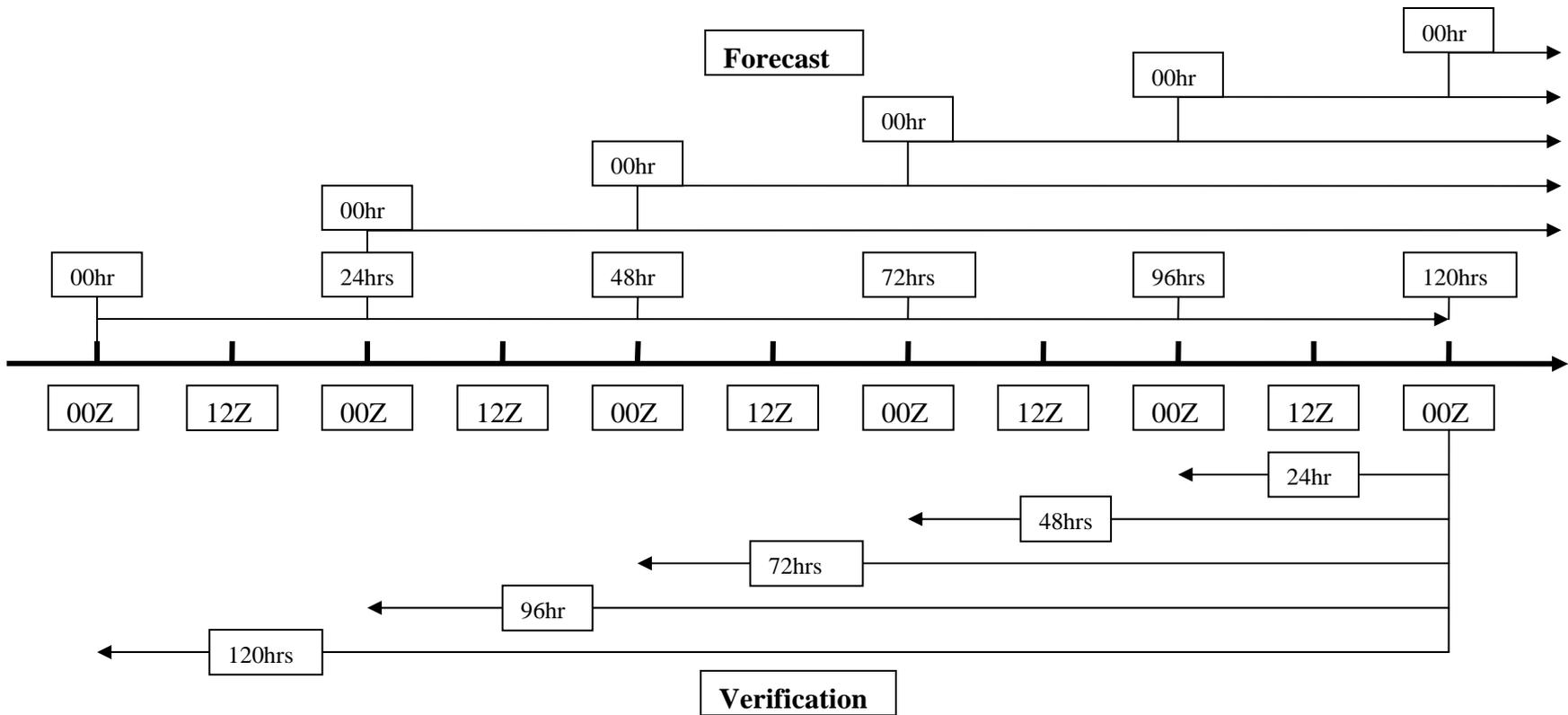
The verification challenge

- A “truth” is needed. In the tropical case, HPC puts out storm vitals file containing the best observed tracks as the “truth”. However, there is no vitals file for extra-tropical storms and it is too labor intensive to do operationally at HPC, OPC + TPC.

Solution:

- Utilize existing 00 hr (i.e. analysis) forecast model position) as “truth”, stringing them together to form the “observed” storm tracks.

Schematic Diagram:



Extra-Cyclone Tracks Verification:

- 1.Extra-Tropical cyclone verification will use analysis as the truth since observed cyclone tracks are not available.
- 2Therefore the tcvitals are already contained in the output of the forecast tracker after it completes the tracker processing. The first three records in the output file are the analysis position and intensity of the cyclone.
- 3Position, center pressure, and/or direction, and wind strength for each quadrant are possible variables for verification every 12(24) hours. Mean errors of these variables can be calculated in the interval of 12(24) hours on a monthly bases and/or continuously (moving average).

Sorting

- 1. Model analysis ATCF data are picked out from the forecast tracks.**
- 2. Search nearby cyclone center in the next synoptic time. The criteria for recognizing as the same cyclone are: 3.5 by 4.5 lat and lon in middle to low latitudes; 4.5 by 5.5 lat and lon in high latitudes. Set aside preliminary storm tracks.**
- 3. Search for cyclones that are weakened and then re-appeared within 12 hours in the vicinity areas.**
- 4. Perform another iteration that strings fragmented analysis storm tracks to form a unique track that will span the storm's life cycle from cyclogenesis to dissipation.**

Matching

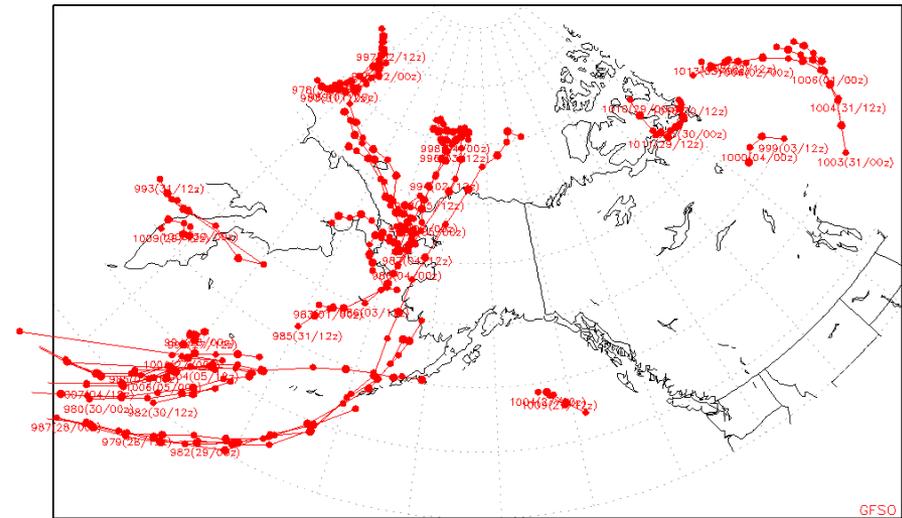
- 1) Separate each forecast track into an independent file.**
- 2) Search for analysis cyclone track that matches the forecast track.**
- 3) Combine the forecast and analysis tracks into one file. Operationally, previous 10 day's cyclones are lined up for verification.**

3. Examples

From 12Z March 26 to 12Z April 5, there are a total of 24 traceable extra-tropical cyclones that are automatically searched out within the operational tracking domains. Of these 24 cyclones, 86 forecasts were made.

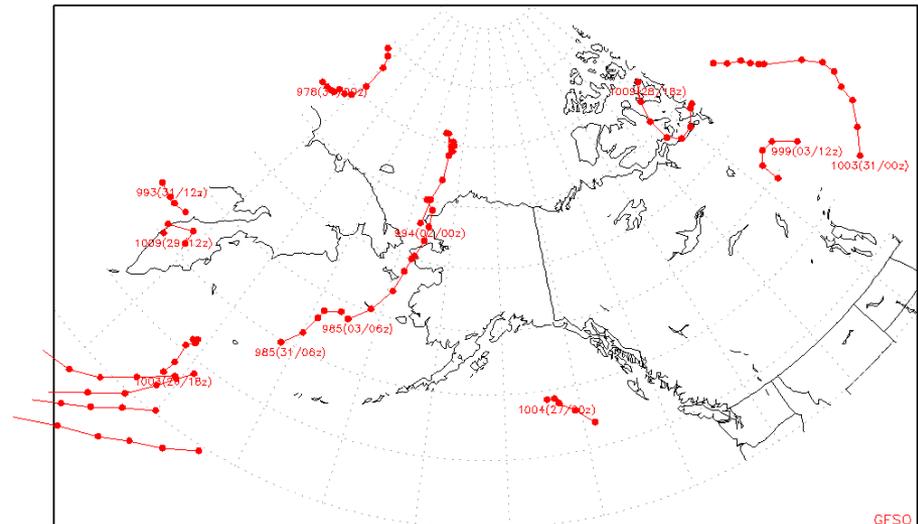
Top panel: GFS forecast tracks
Bottom panel: analysis tracks in Alaska and vicinity

Model Forecast Storm Tracks
For forecast with initial time = 2008040512



Date (dd/hhz) is first time storm was able to be tracked in model

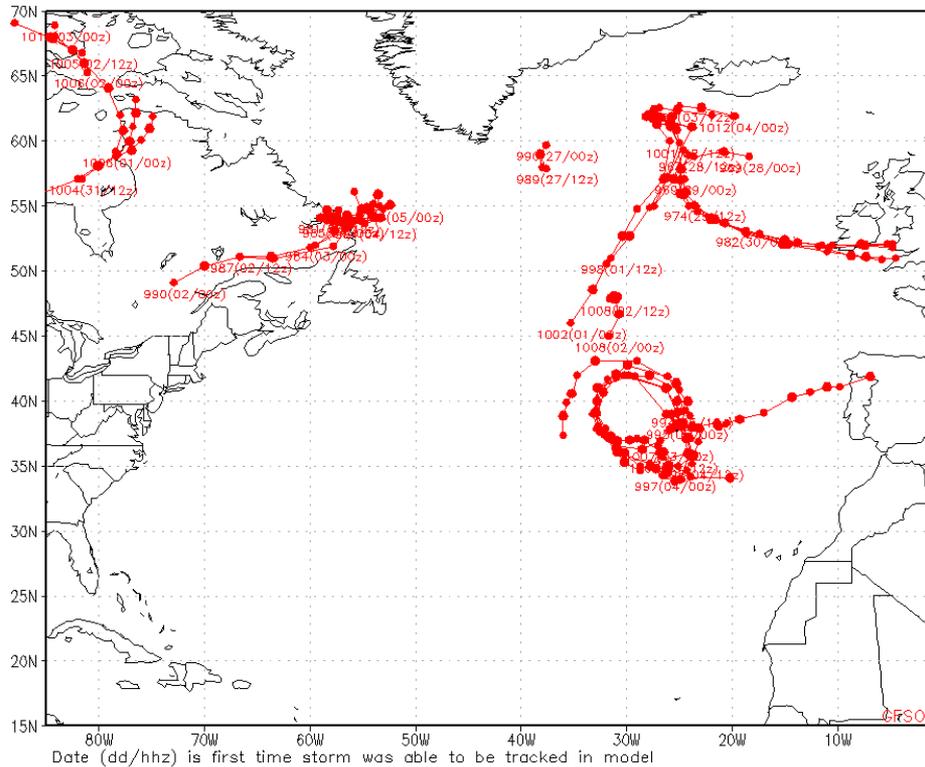
Model Forecast Storm Tracks
For forecast with initial time = 2008040512



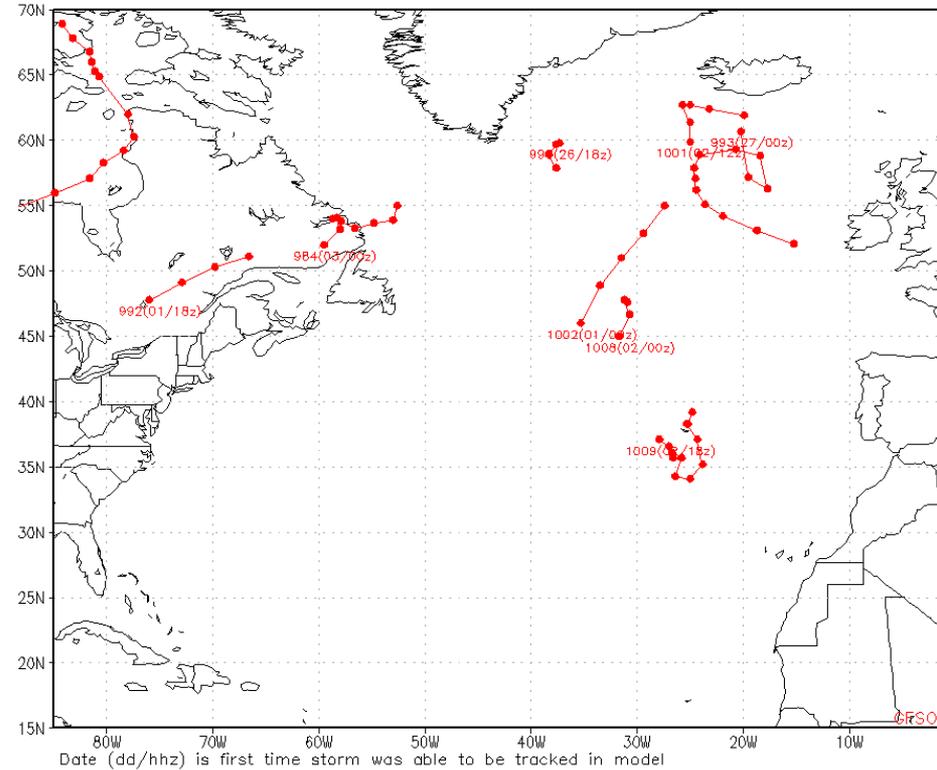
Date (dd/hhz) is first time storm was able to be tracked in model

GFS forecast (left) and analysis (right) tracks in 10 day span in North Atlantic region (12Z March 26 – 12Z April 5, 2008)

Model Forecast Storm Tracks
For forecast with initial time = 2008040512



Model Forecast Storm Tracks
For forecast with initial time = 2008040512



Verification

Following Marchok's conventional tropical storm verification procedure, cyclone tracks are arranged in two "decks":

- a) Adeck, contains past 10 day's forecast tracks.**
- b) Bdeck, holds analysis tracks that match the forecast's.**

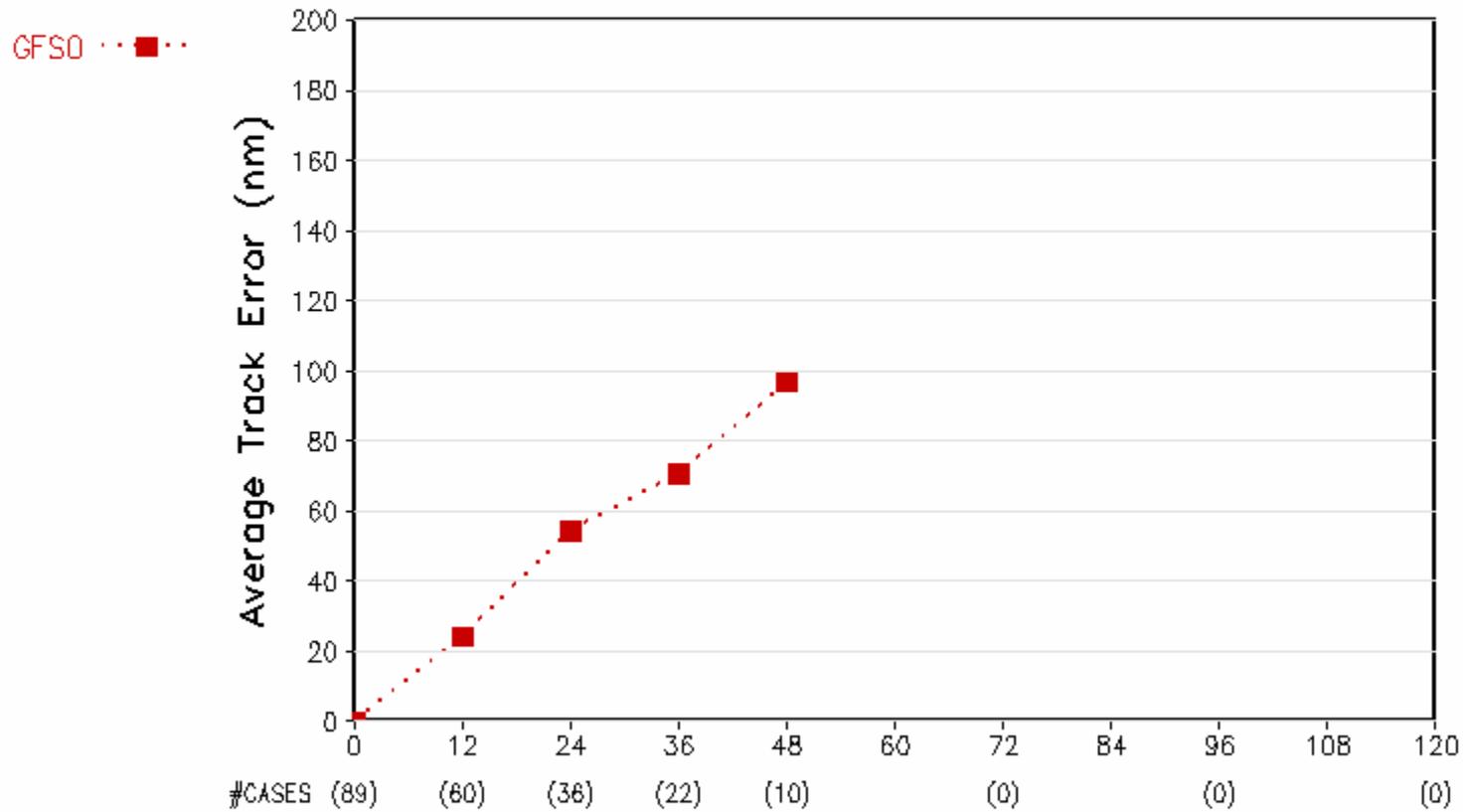
Verification is done for both track distance errors and intensity errors amongst other stats.

A VSDB record is produced.

In the examples shown previous slides, track errors are calculated as displayed next.

Average forecast distance errors for tracks in 10 day span

Track Forecast Error Comparison for Midlatitude Storms
GFS Versus GFS Analysis Tracks (12Z April 05 2008)



Verification output table

Average track errors (NM) for homogeneous sample

fcst hrs	00	12	24	36	48	72	96	120
GFS	0.0	24.2	54.5	70.6	96.8	0.0	0.0	0.0
#Cases	89	60	36	22	10	0	0	0

Error standard deviation

fcst hrs	00	12	24	36	48	72	96	120
GFS	0.0	24.7	59.6	53.2	76.6	0.0	0.0	0.0

Average Xbias (NM)

fcst hrs	00	12	24	36	48	72	96	120
GFS	0.0	-1.0	-10.7	-6.8	28.4	0.0	0.0	0.0

Average Ybias (NM)

fcst hrs	00	12	24	36	48	72	96	120
GFS	0.0	-4.8	-10.3	-26.7	-64.8	0.0	0.0	0.0

Discussion

- **In the first stage, the operational track verification will be performed on those tracks that are initiated on the analysis cyclones for past 10 days every 12 hours. Will move to every 6 hours next for those models producing more frequent output.**
- **Forecast and analysis tracks are not well matched even in the same model.**
- **Tracks from forecast models will only be verified against their own analysis tracks for now.**
- **A "unified" sfc analysis produced every 6 hours amongst OPC, HPC and TPC should soon be put into gridded form, providing realistic "observed" cyclone tracks (after applying the tracker). This may be the "best" hope for middle latitude cyclones, but not a global analysis.**

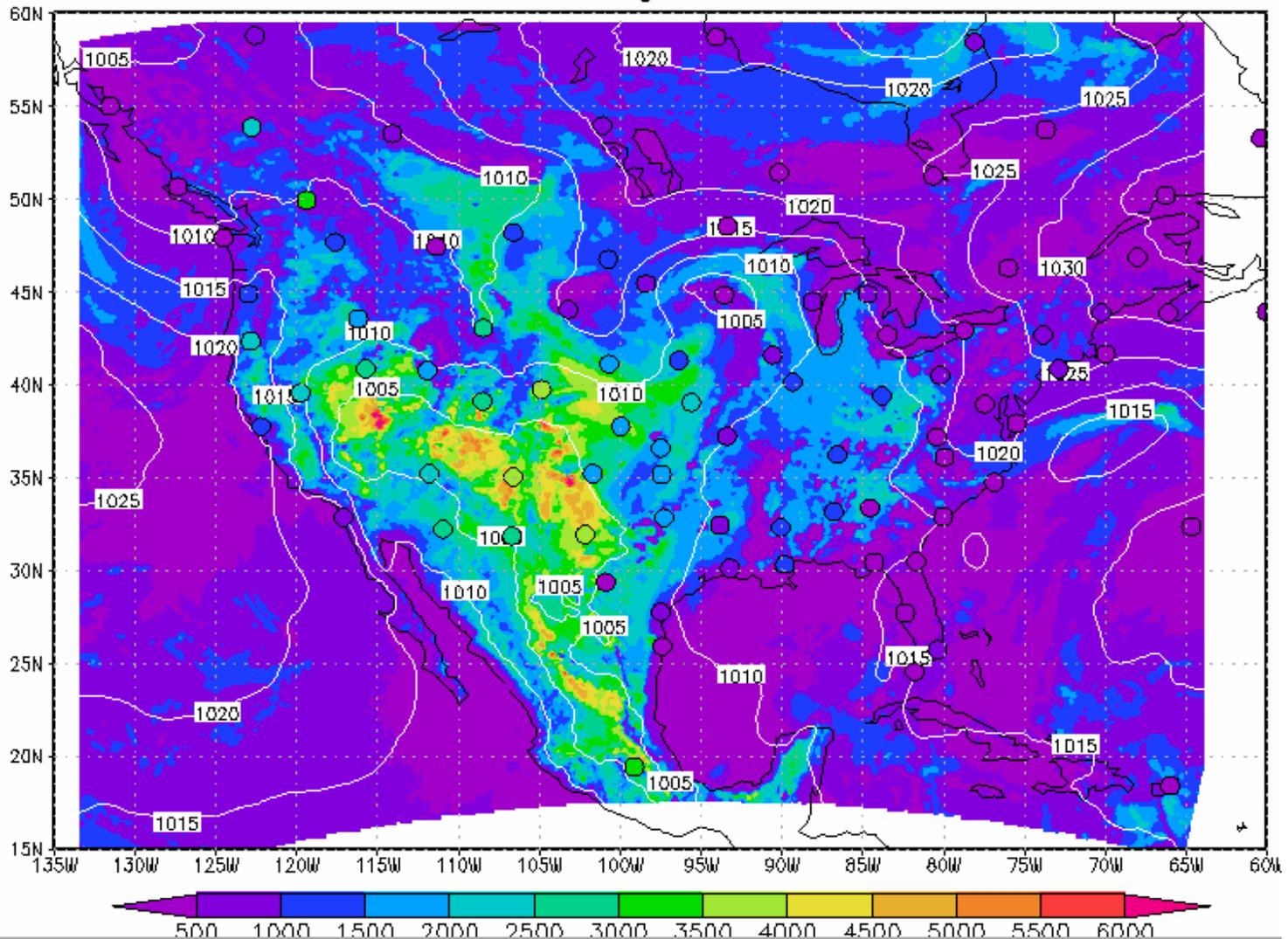


PBL Height Verification vs RAOB

[Click here to see stations' current time series](#)

[Click here to see stations' summer 2005 time series](#)

12hr fcst NAM PBL height Valid 00Z07APR2008



Air Quality Forecast (AQF)
 Public Page
 AQF Verification Page
[Documents](#)

Change Type:

PBL

Year: 2008
 Month: Apr
 Day: 07

Select Hour:

00

Select Model:

NAM (wrf/nmm)

Select Region:

awip 218

Get map

[NCEP Home](#)
[NOAA Home](#)
[EPA Home](#)

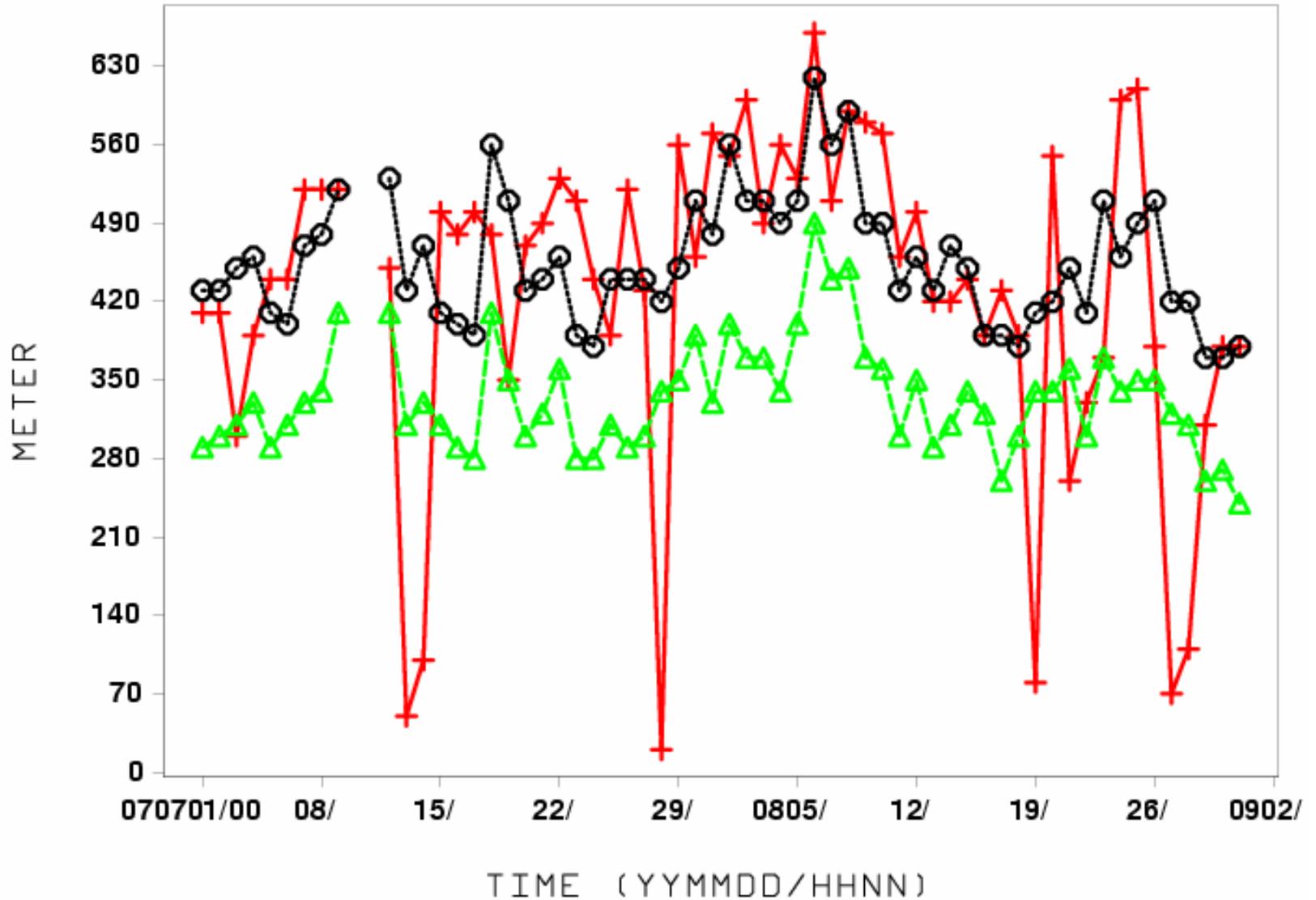
[Send Comments](#)

Current Time Series at San Diego, CA

PBL DEPTH Station: 72293 SAN DIEGO

CA US 132m; fhour=12

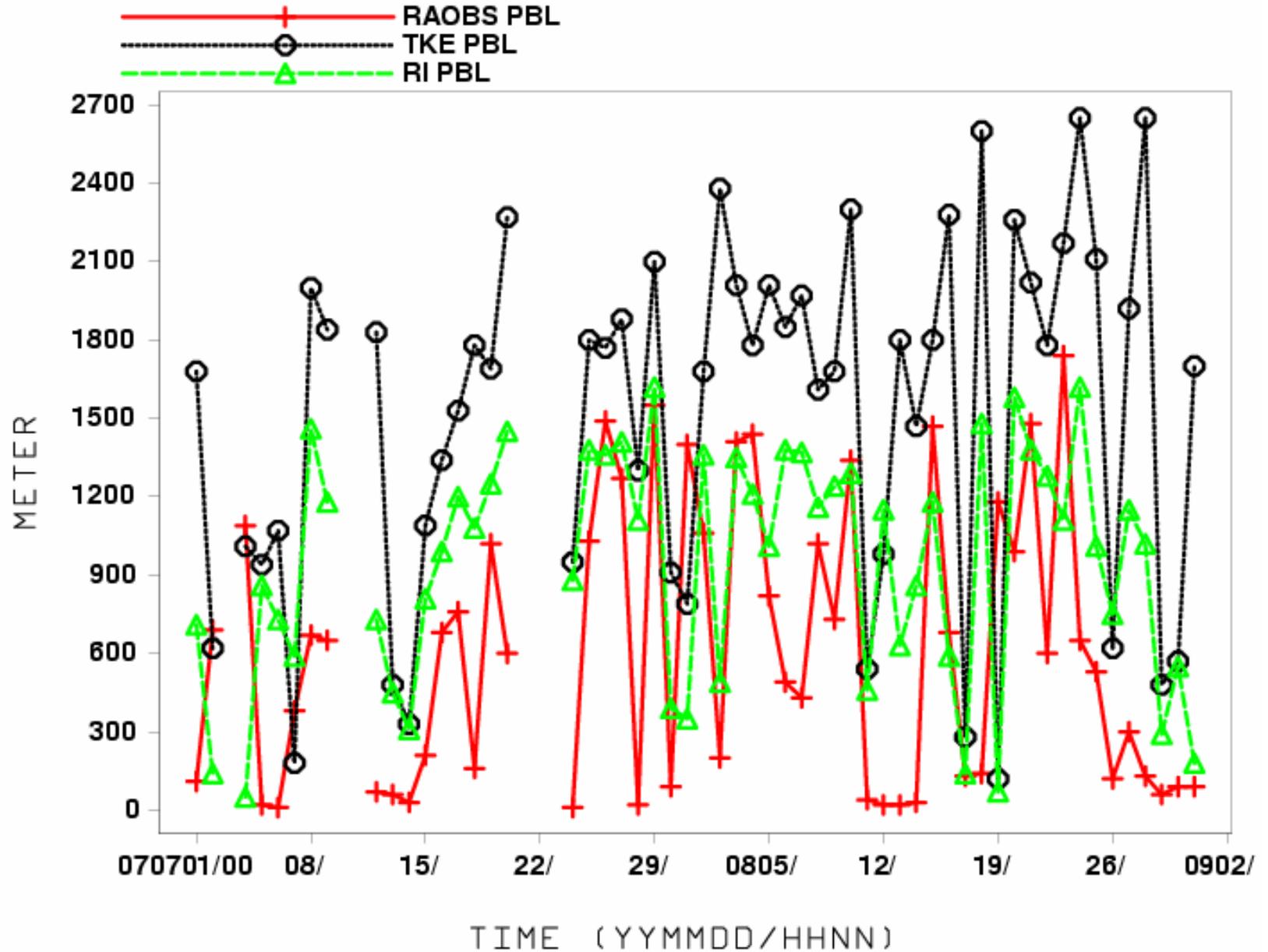
- RAOBS PBL
- TKE PBL
- RI PBL



Current Time Series at Little Rock, AR

PBL DEPTH Station: 72340 LITTLE ROCK

AR US 172m; fhour=12

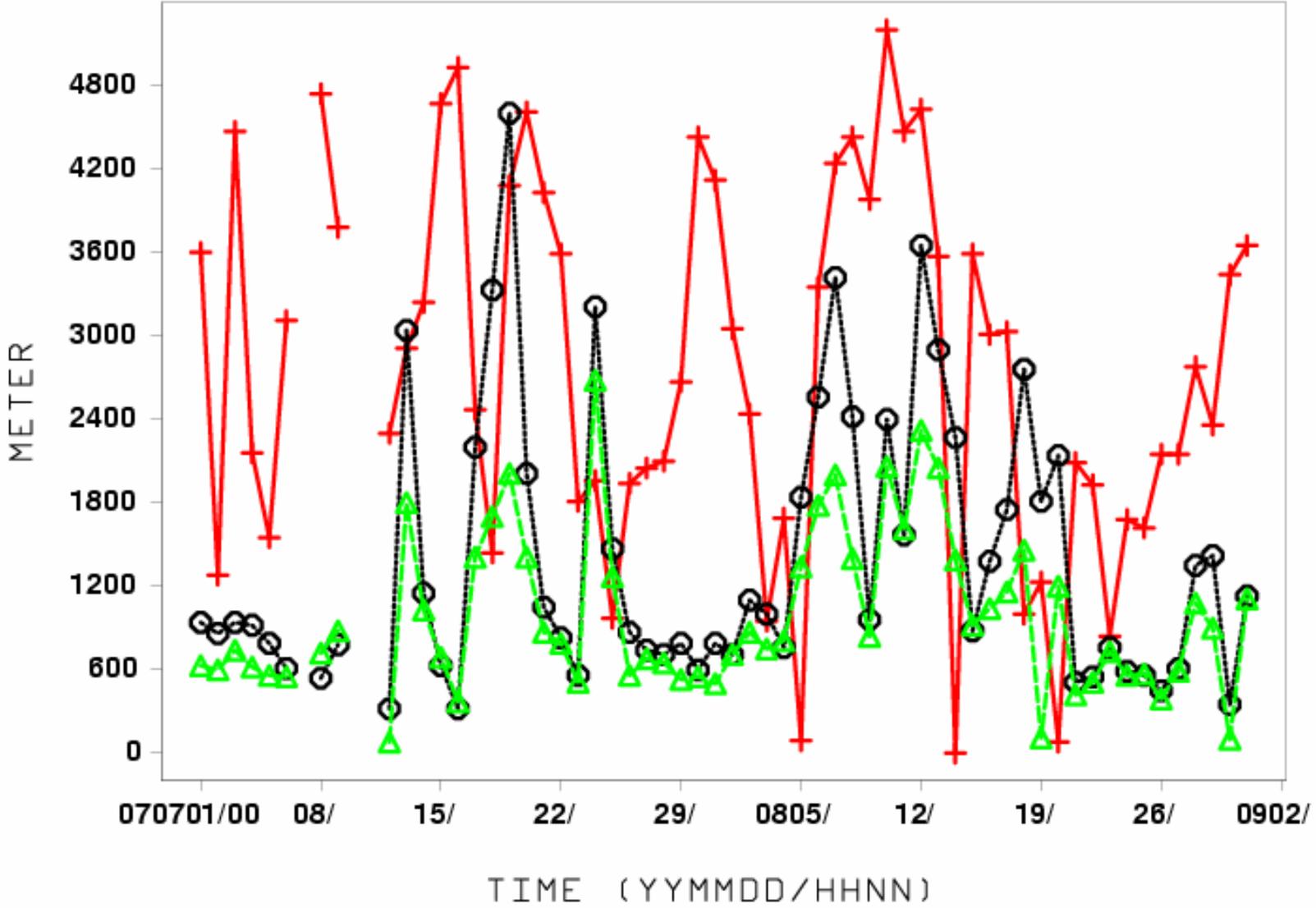


Current Time Series at Salt Lake City, UT

PBL DEPTH Station: 72572 SALT LAKE CITY

UT US 1289m; fhour=12

- RAOBS PBL (Red solid line with '+' markers)
- TKE PBL (Black dashed line with 'o' markers)
- RI PBL (Green dashed line with '^' markers)



NCEP Verification of Operational Models

MYSQL-based Ensemble Verification System

Begin Period: Begin Day: Event Equalizer:

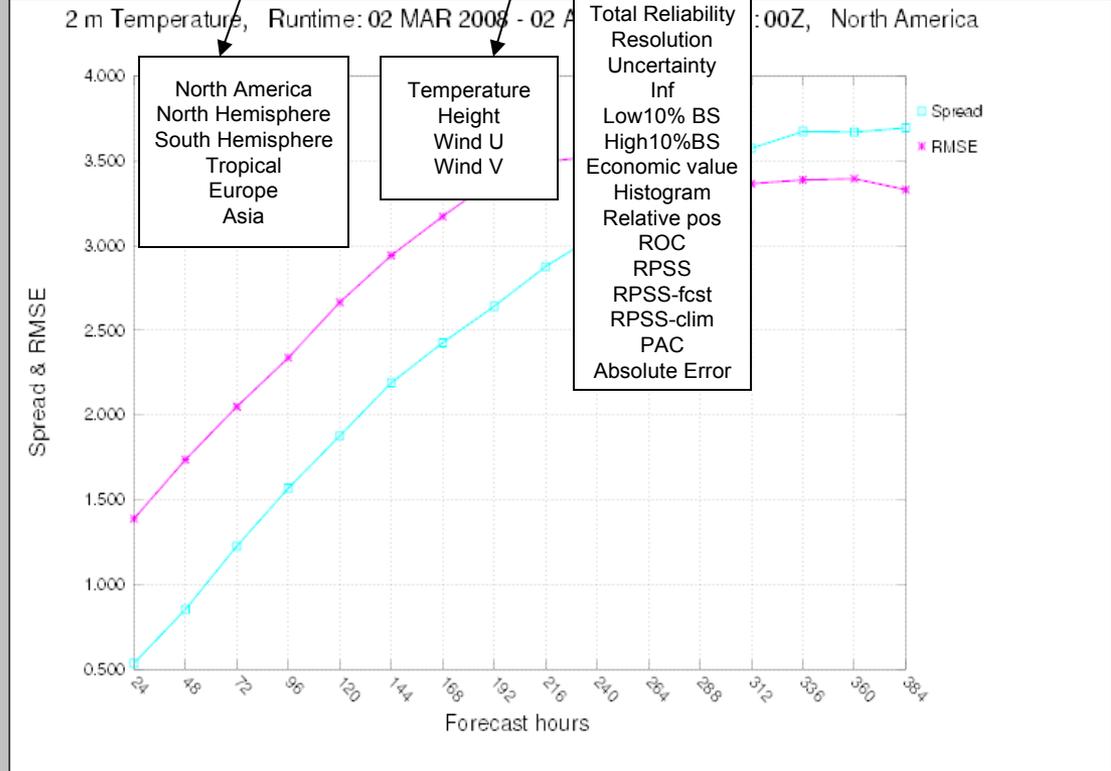
End Period: End Day: On Off

Ensemble system: GENS Verification Domain: Parameter: Level:

Plot differences Model Runtime (cycle): Statistic: Observation Type:

Forecast Hour:

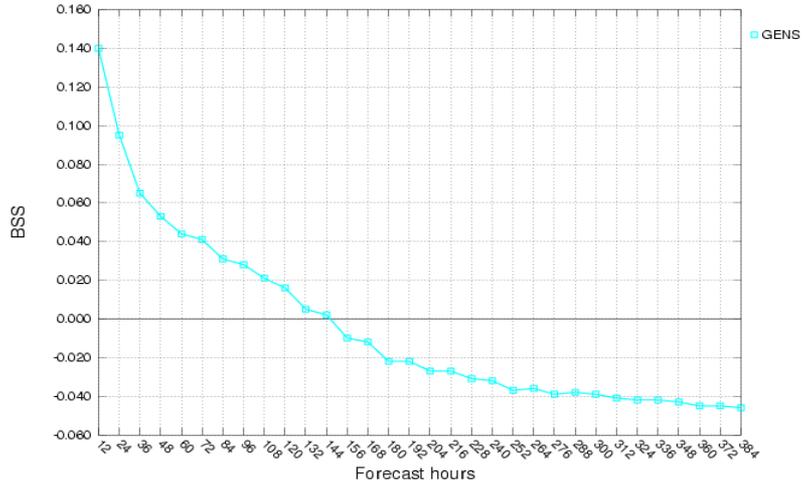
Data Tables: [GENS](#) [PDF graphic](#) [Email comments](#)



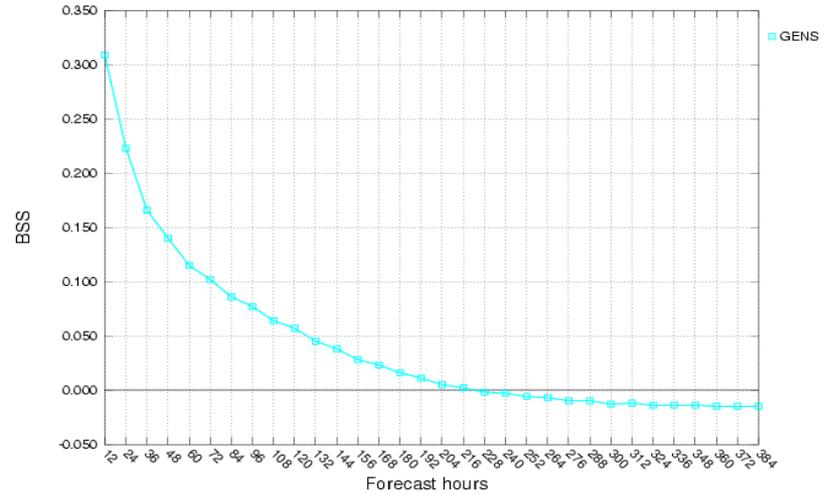
MYSQL-based Ensemble FVS

- Web GUI adapted from GSD RTVS
- MYSQL tables were specially
 - Designed for ensemble verification
 - Normalized
- Only GENS verification data at this time
- EMC/NCEP's GENS verification data
 - Converted into VSDB-like format
 - Routinely stored into MYSQL DB
- User send request web online
- Web sends request to MYSQL server
- MYSQL server selects required data
- MYSQL server computes stats
- MYSQL server creates plots
- MYSQL server sends back the result to the user

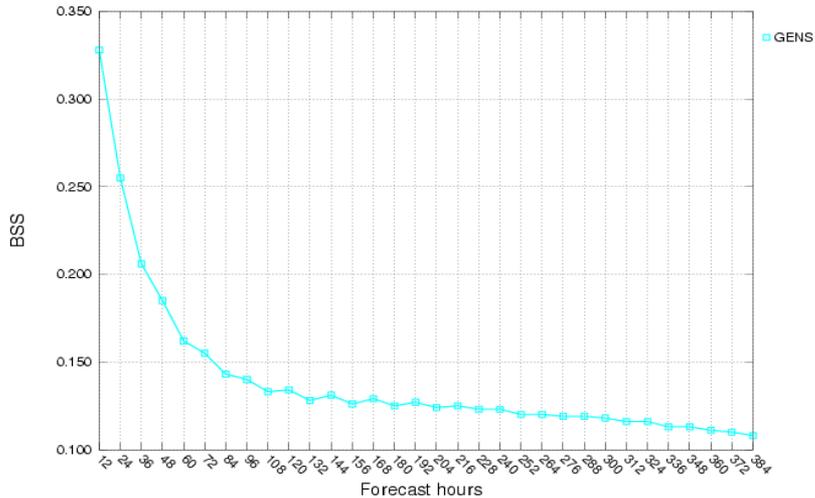
2 m Temperature, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America



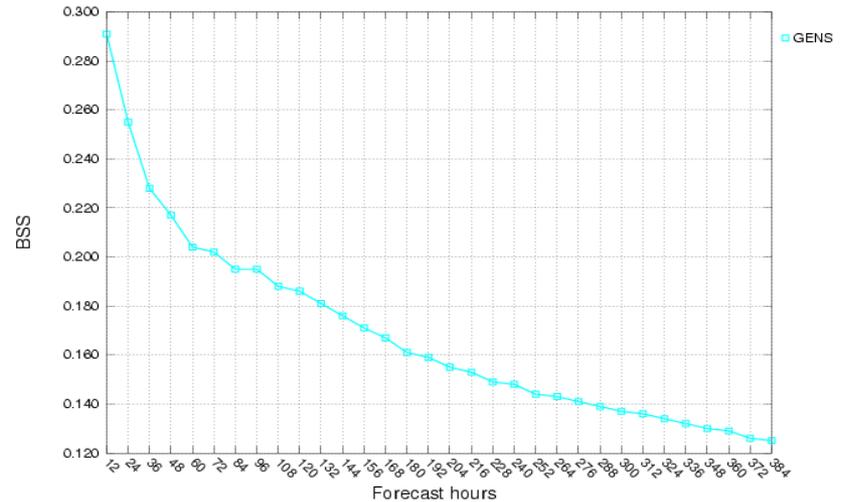
2 m Temperature, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, South Hemisphere



2 m Temperature, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, Tropical



2 m Temperature, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, Asia

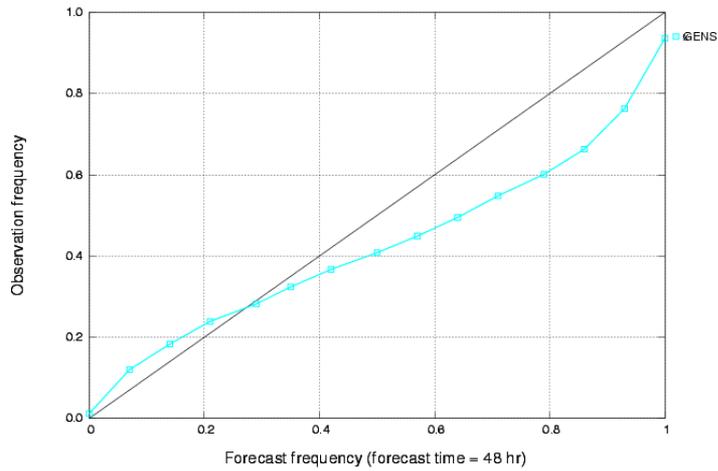


Y2007 Brier Skill Score of T2m (Climatology data as ref) over NA, SH, TR and AS for all fcst hours

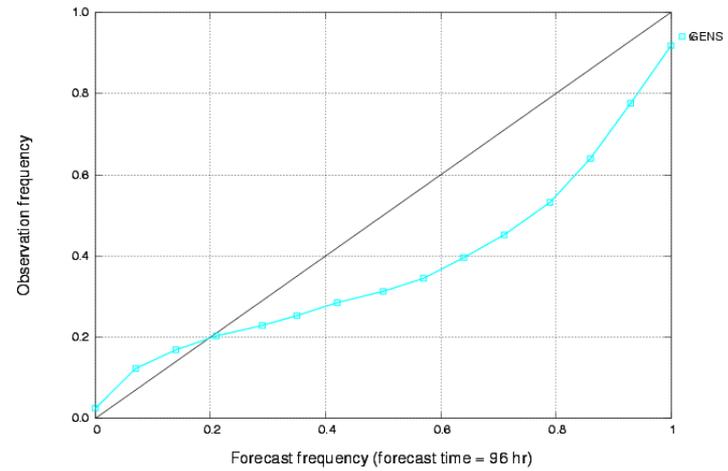
NA has skill before 144hr (6 days); SH has skill before 216hr (9 days)

TR and AS have skills for all fcst hours (16 days)

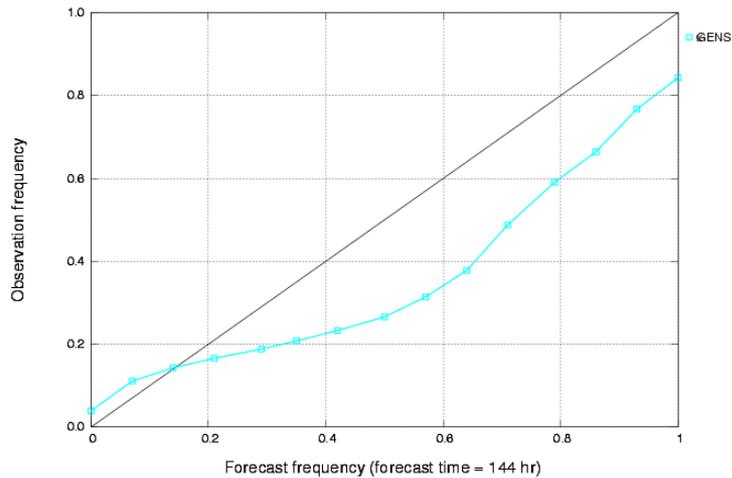
500 hPa Height, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America



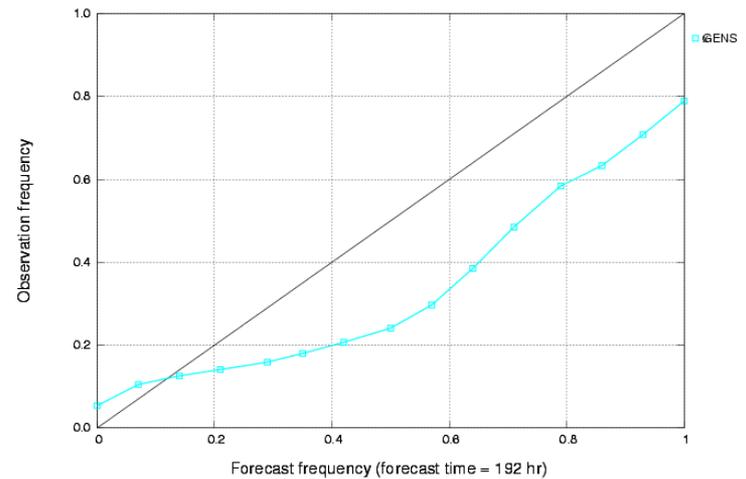
500 hPa Height, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America



500 hPa Height, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America



500 hPa Height, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America

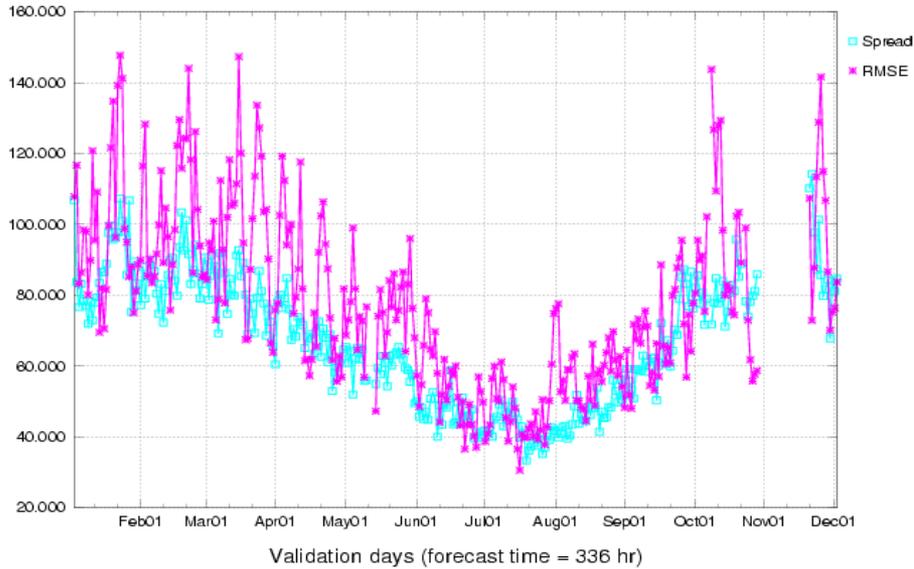


Y2007 Reliability of 500mb Height over NA for different fcst times: 2, 4, 6, and 8 days

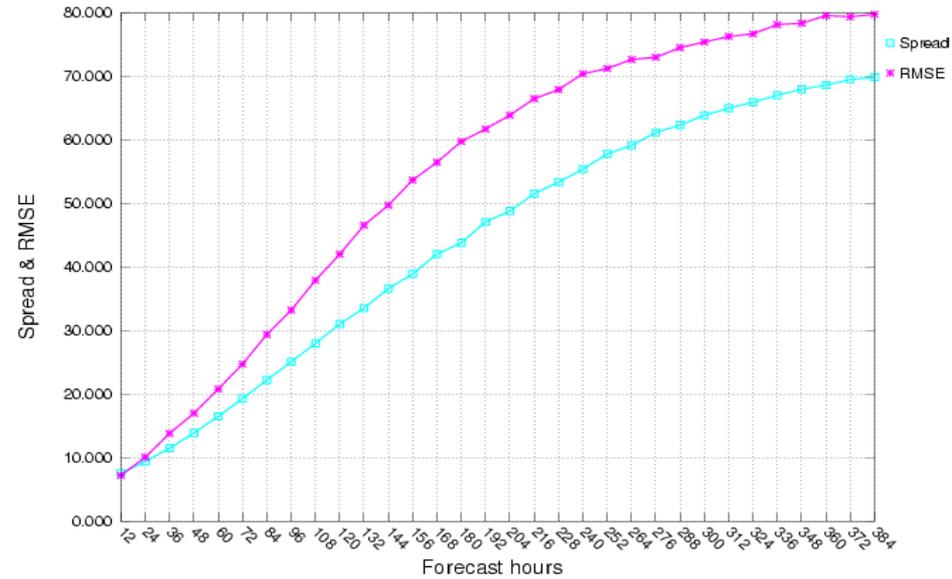
→ Decrease with forecast range

→ Positive bias

500 hPa Height, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America



500 hPa Height, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America

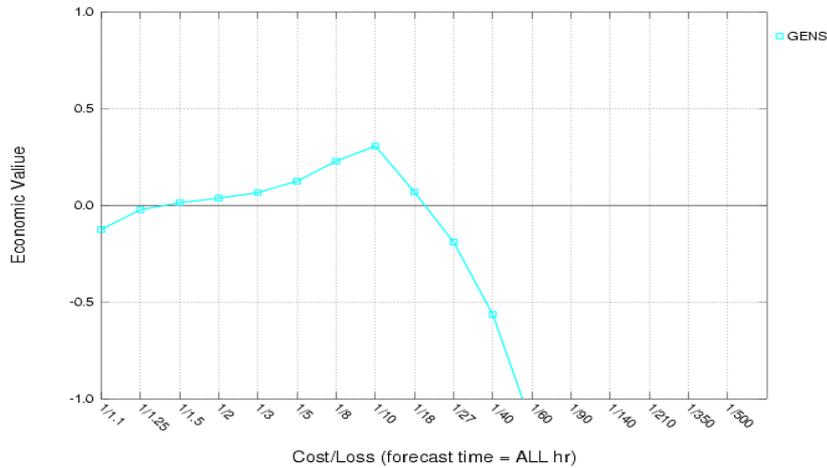


NA: Y2007 500mb height's Spread and RMSE on different days/months (left) and fcst times (right)

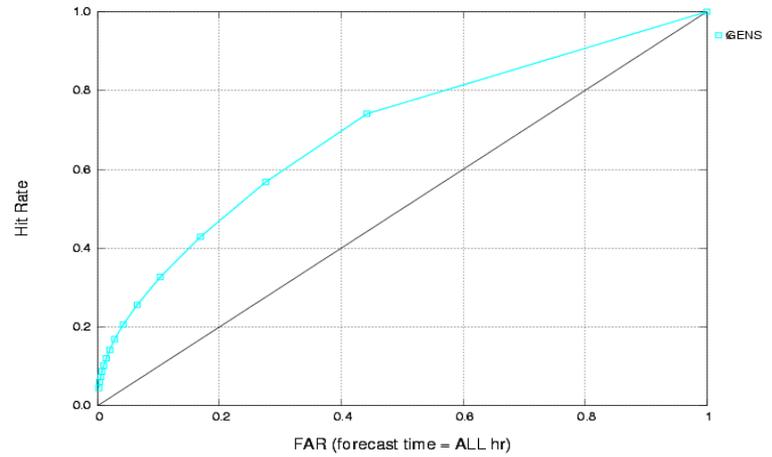
→ Spread generally follow RMSE for all times → Good performance indicator for an ensemble system

→ After 6days (144hr), Spread and RMSE increase with fcst time in parallel → Also a good indicator

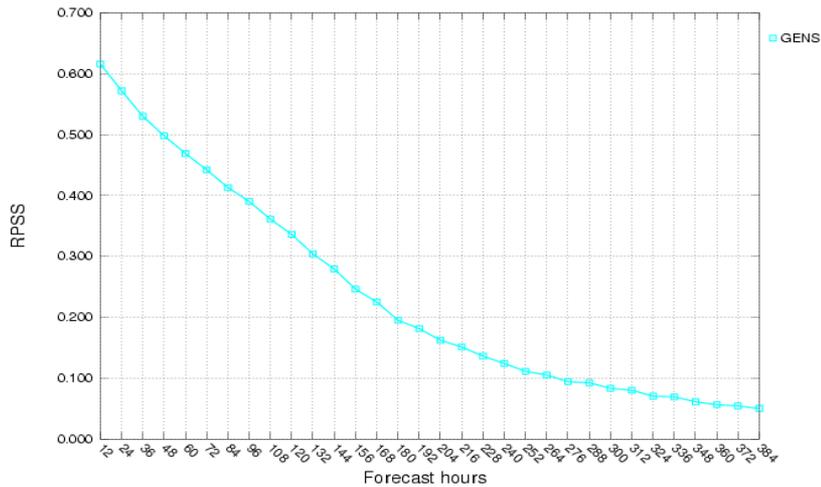
2 m Temperature, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America



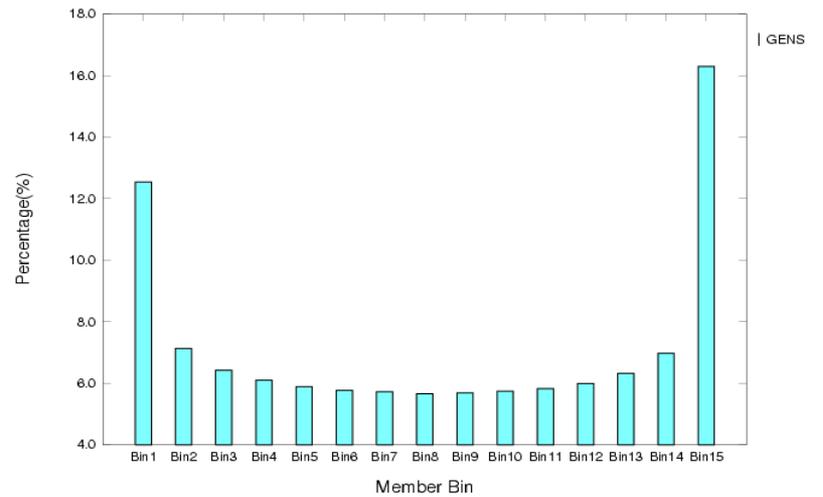
2 m Temperature, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America



2 m Temperature, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America



2 m Temperature, Runtime: 03 JAN 2007 - 03 DEC 2007, Cycle: ALL, North America



NA: Y2007 2mT economic value (upper-left: for C/L > 1/18, has value), ROC (upper-right: has skill), Ranked Prob Skill Score (lower-left: has skill for all fcst times) and Talagrand distribution (lower-right: outlier rate 12 % + 16 %)

■ Future Work:

- o Unify SREF's verification system (gridtobsE and grid-to-grid)
 - Generate same data format as GENS's
- o Add unified SREF verification data to MYSQL-based Ensemble FVS
- o Add NAEFS (North America Ensemble Forecast System) data to MYSQL
- o Add other ensemble forecasts (e.g. bias correction)