Next Global Ensemble Forecast System

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Ensemble Team

http://wwwt.emc.ncep.noaa.gov/gmb/yzhu/html/imp/201109_imp.html

Contents

- Next GEFS configuration
- GFS version 9.01
- Initialization
- Stochastic perturbation (STTP)
- Retrospective experiments
- Future plan

Proposal Changes

- Model and initialization
  - Using GFS V9.01 instead of GFS V8.00
  - Improved Ensemble Transform with Rescaling (ETR) initialization
  - Improved Stochastic Total Tendency Perturbation (STTP)
- Configurations
  - T254 (55km) horizontal resolution for 0-192 hours (from T190 – 70km)
  - T190 (70km horizontal resolution for 192-384 hours (same as current opr)
  - L42 vertical levels for 0-384 hours (from L28)
- Part of products will be delayed by approximately 20 minutes
  - Due to limit CCS resources
  - 40 nodes for 70 minutes (start +4:35 end: +5:45)
- Unchanged:
  - 20+1 members per cycle, 4 cycles per day
  - pgrb file output at 1*1 degree every 6 hours
  - GEFS and NAEFS post process output data format
- Why do we make this configurations?
  - Considering the limited resources
  - Resolution makes difference (example of T126 .vs T190)
- What do we expect from this implementation?
  - Preliminary results (NH 500hPa and SH 500hPa height and tracks)

GSI/GFS Changes (Fall 2010 – V9.0)

- **Assimilation Changes**
  - Assimilate tropical storm pseudo sea-level pressure obs
  - GPSRO changes - improved QC, re-tuned obs errors.
  - Give more weight to profile data in upper troposphere / lower stratosphere
  - Change evaporation efficiency parameter in SASCNV forward model to be consistent with current global_fcst model
  - Extend satinfo to include N19 hirs/4, amsua, mhs (no N19 assimilation)
  - Extend ozinfo and update code to recognize and read in N19 sbuv/2, GOME, and OMI ozone (no assimilation)
  - Ability to process RARS (currently only EARS) 1b data
  - Extensions to allow global_gsi to run from T878L91 spectral coefficient files
  - Code optimization
- **Model Changes:**
  - Restructure the Global Model code
  - Code unification between GFS & GEFS
  - Consolidate Global Post codes used in GFS & GDAS
  - Upgrade to ESMF 3.1.02rp
  - Modify low cloud definition
  - Output additional parameters for TIGGE & ICAO
  - Introduce more accurate algorithm for several diagnostic variables
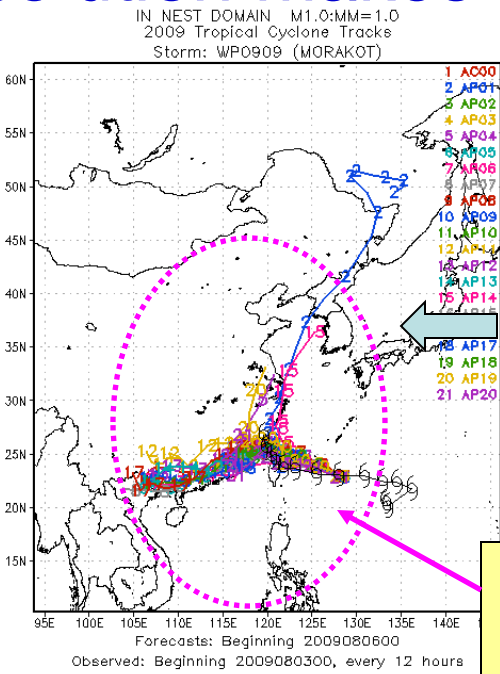
GSI/GFS Bug Fix (GFSv9.01)

- Analysis Changes
  - Improved OMI QC
  - Removal of redundant SBUV/2 total ozone
  - Retune SBUV/2 ozone ob errors
  - Relax AMSU-A Channel 5 QC
  - New version of CRTM 2.0.2
  - Inclusion of Field of View Size/Shape/Power for Radiative transfer
  - Remove down weighting of collocated radiances
  - Limit moisture >= 1.e-10 in each outer iteration and at end of analysis
  - Inclusion of uniform (higher resolution) thinning for satellite radiances
  - Improve location of Buoys in vertical (move from 20 to 10m)
  - Improved GSI code with optimization and additional options
  - Recomputed background errors
  - Inclusion of SBUV from NOAA-19
  - Ambiguous vector quality control for ASCAT (type 290) data
- Model Changes
  - New Thermal Roughness Length – Reduce low level warm bias over land
  - Set minimum moisture Value in Stratosphere to 1.0E-7 – Reduce strato. cooling
 - Reduce background diffusion in the Stratosphere – Reduce strato. neg wind bias

FCST +4:35 --- +5:15

FCST +4:35 --- +5:35

Current

Future

NCEP_POST +4:37 --- +5:17

NCEP_POST (PGB) +4:37 --- +5:37

20m late finish

FNMOC_ENS_DEBIAS +7:20 --- +7:30

NAEFS products start

+5:00 +6:00 +7:00 +7:35 +8:00 +9:00

ENS_DEBIAS +4:40 --- +5:24

ENS_DEBIAS +5:00 --- +5:44

CMC_ENS_PREP **CMC_ENS_POST** +7:20 --- +7:22

CMC_ENS_DEBIAS +7:22 --- +7:26

PROB_PRODUCTS +5:24 --- +6:45

PROB_PRODUCTS +5:44 --- +6:40

20m late start

5m early finish

NAEFS_PROB_PROD (1) +7:33 -- +8:08

NAEFS products (2) +8:08 --- +9:08

GEFS/NAEFS 6-hr window flow chart

Resolution makes difference for Typhoon Morakot

Ini: 2009080600

T126 ensemble

T190 ensemble

Most models do not make right forecasts
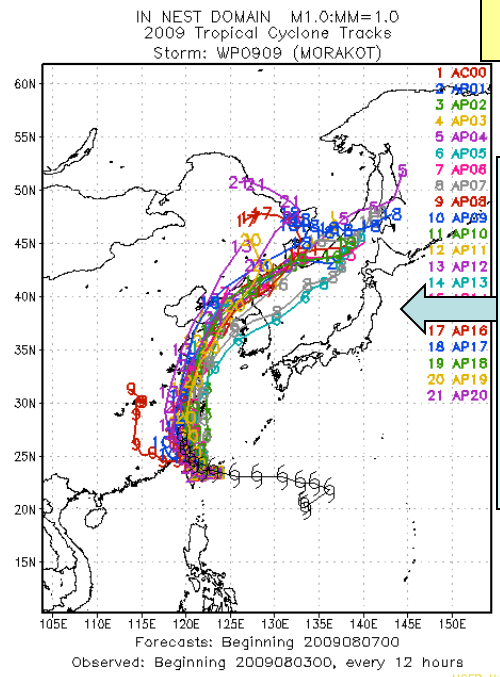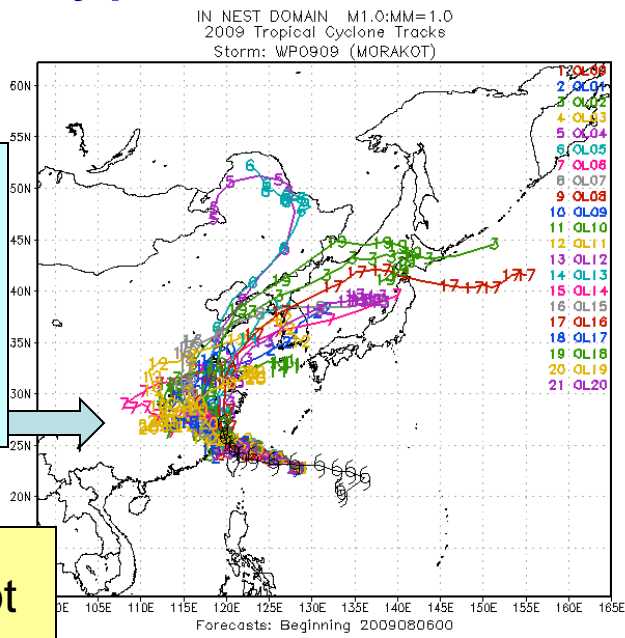
Ini: 2009080700

T126 ensemble

T190 ensemble

Anomaly Correlation

Winter 2 months

GFS V8.0 .vs V9.0

Northern Hemisphere 500hPa Height
Ensemble Mean Anomaly Correlation
Average For 20091202 – 20100201

NH 500hPa height

Skillful line

11.00d

10.25d

Southern Hemisphere 500hPa Height
Ensemble Mean Anomaly Correlation
Average For 20091202 – 20100201

SH 500hPa height

Northern Hemisphere 850hPa Temp.
Ensemble Mean Anomaly Correlation
Average For 20091202 – 20100201

NH 850hPa temperature

Southern Hemisphere 850hPa Temp.
Ensemble Mean Anomaly Correlation
Average For 20091202 – 20100201

SH 850hPa temperature

T190L28
T254L42

Anomaly Correlation

Forecast days

RMS Error & Spread

Summer 2 months

GFS V8.0 .vs V9.0

Northern Hemisphere 500hPa Height
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20100802 − 20100930

NH 500hPa height

Southern Hemisphere 500hPa Height
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20100802 − 20100930

SH 500hPa height

Northern Hemisphere 850hPa Temp.
Ensemble Mean RMSE and Ensemble SPREAD
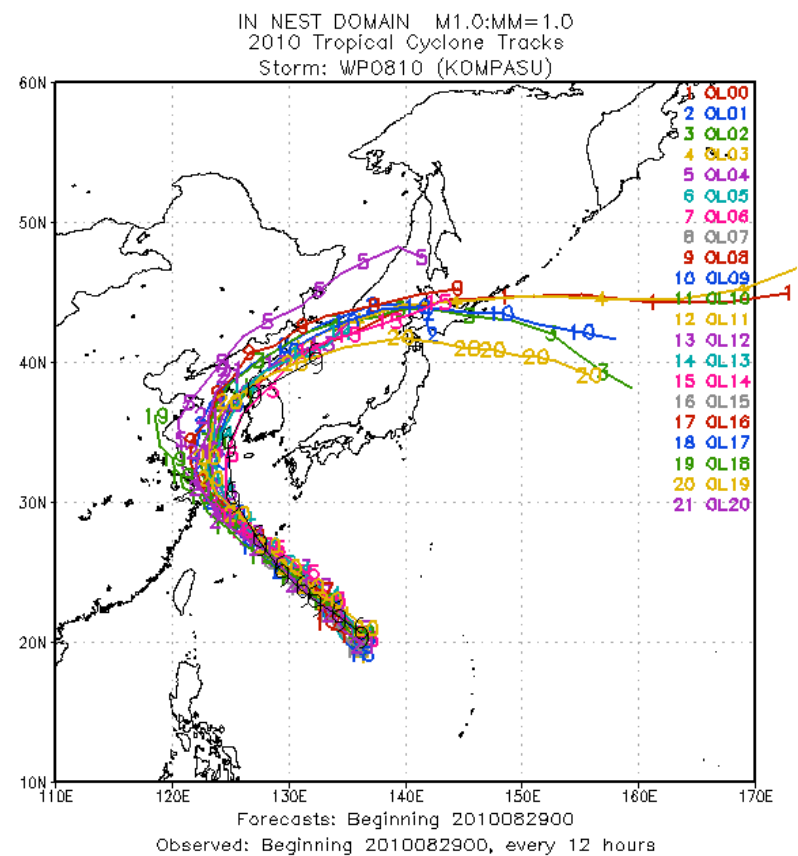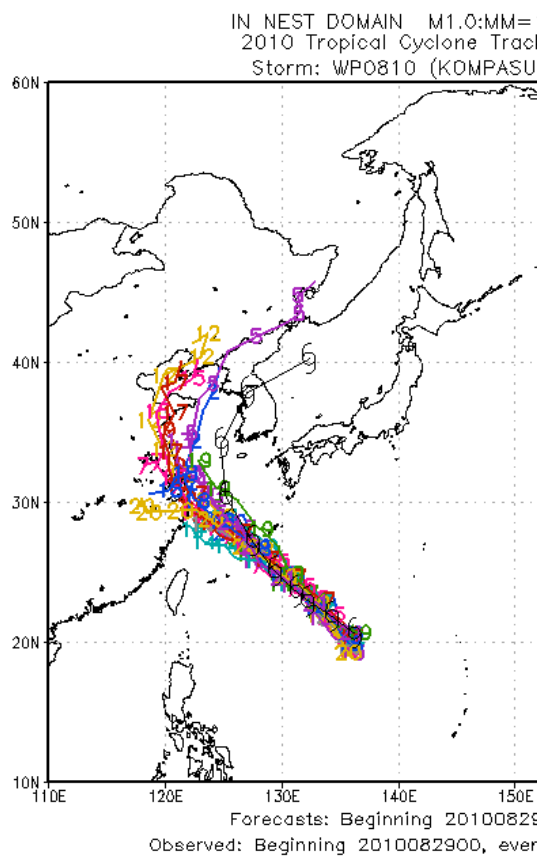Average For 20100802 − 20100930

NH 850hPa temperature

Southern Hemisphere 850hPa Temp.
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20100802 − 20100930

SH 850hPa temperature

Track forecast error for 2010 season (AL+EP+WP)

Period: 08/02 – 09/25/2010

Contributed by Dr. Jiayi Peng (EMC/NCEP)
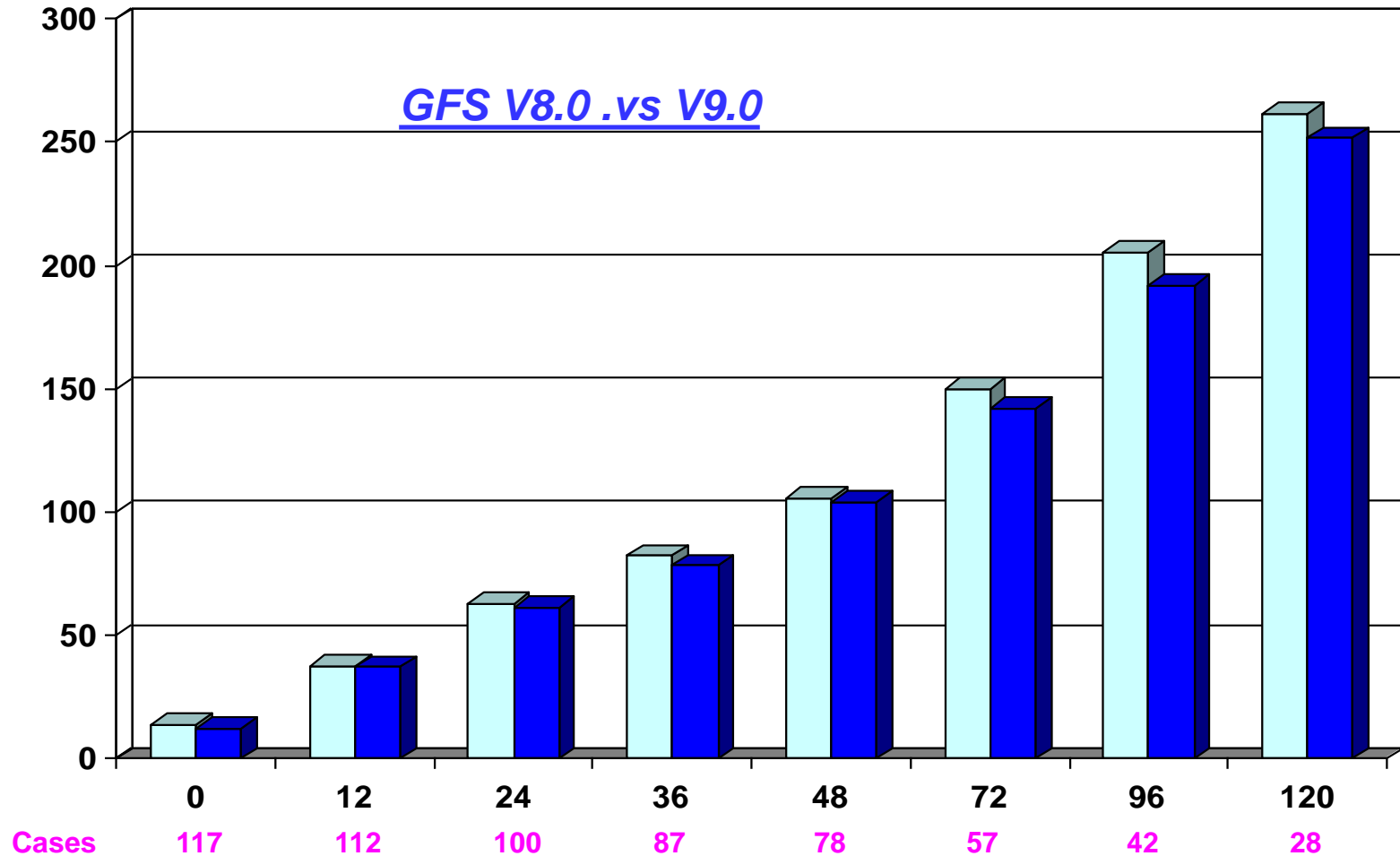
Ensemble track forecast for hurricane Kompasu

Left: Current GEFS operation

T190L28 (GFS V8.0)

Right: Future GEFS

T254L42 (0-192 hours)

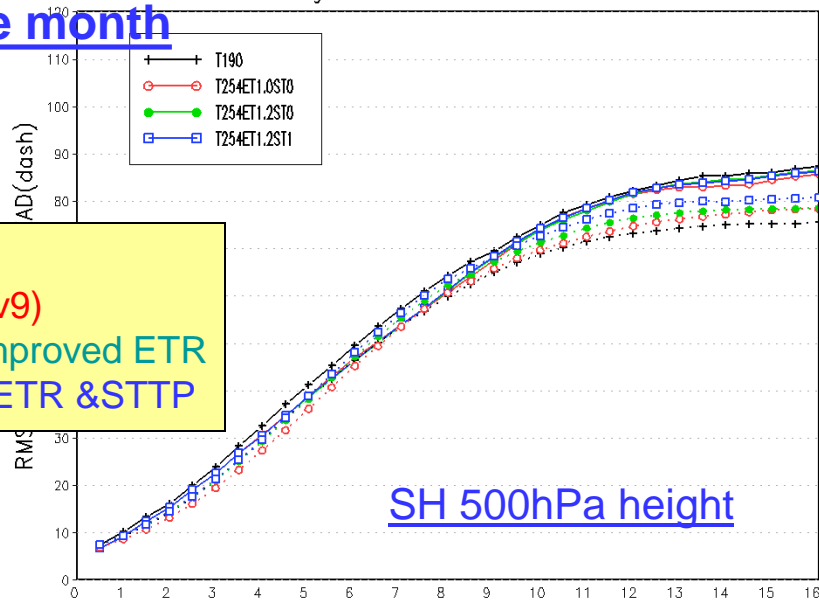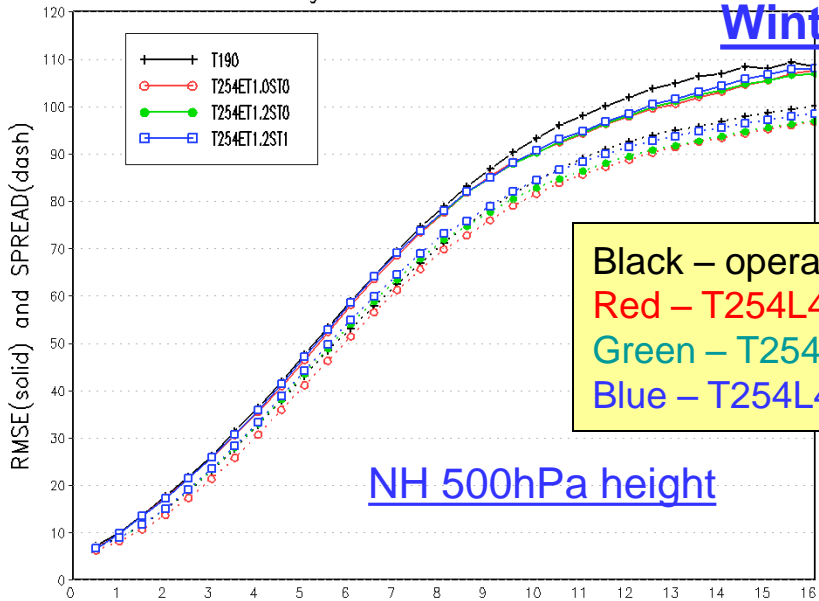T190L42 (192-384 hours)

GFS V9.0
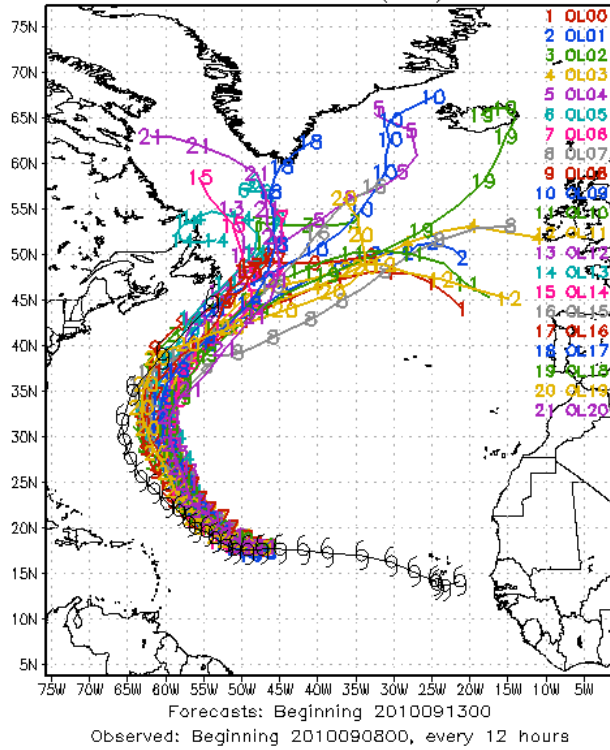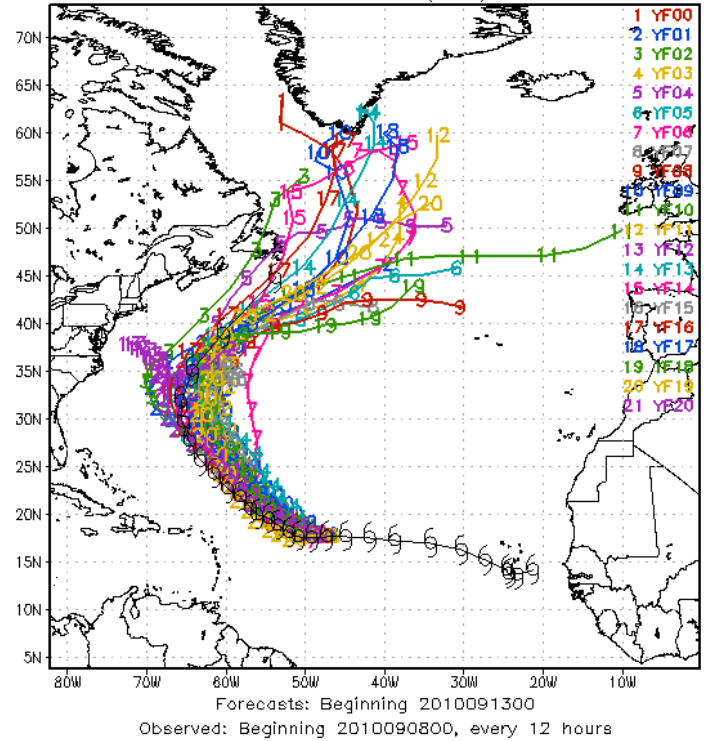
Ensemble track forecast for hurricane IGOR

Proposal Changes

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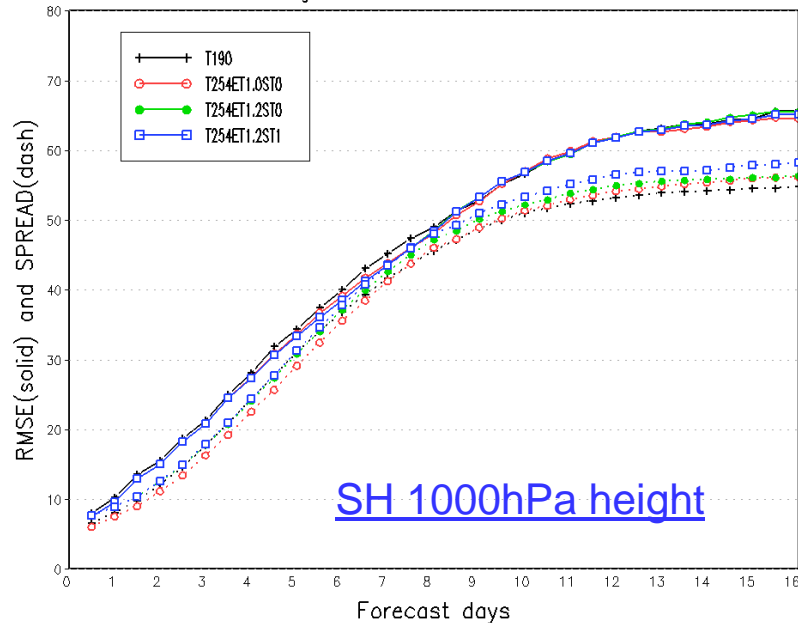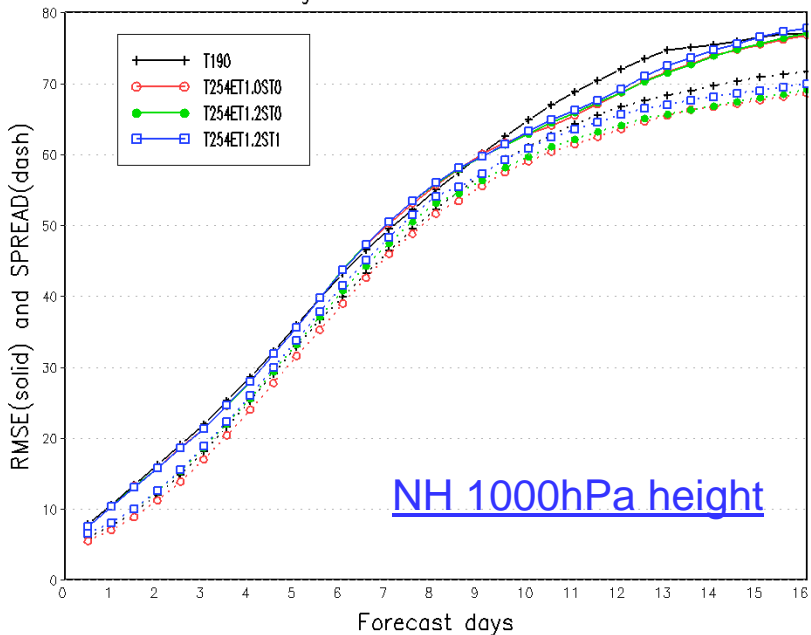 - Preliminary results (NH 500hPa and SH 500hPa height and tracks)

RMS & Spread
Winter one month

Northern Hemisphere 500hPa Height
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20091202 – 20091229

NH 500hPa height

Southern Hemisphere 500hPa Height
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20091202 – 20091229

SH 500hPa height

Black – operation
Red – T254L42 (GFSv9)
Green – T254L42 + improved ETR
Blue – T254L42+imp ETR &STTP

GFS V8.0 .vs V9.0

Northern Hemisphere 1000hPa Height
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20091202 – 20091229

NH 1000hPa height

Southern Hemisphere 1000hPa Height
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20091202 – 20091229

SH 1000hPa height

Legend (all plots):
- T190
- T254ET1.0ST0
- T254ET1.2ST0
- T254ET1.2ST1

Axis labels: RMSE(solid) and SPREAD(dash); Forecast days

Bred Vector
(Introduced 1990's)
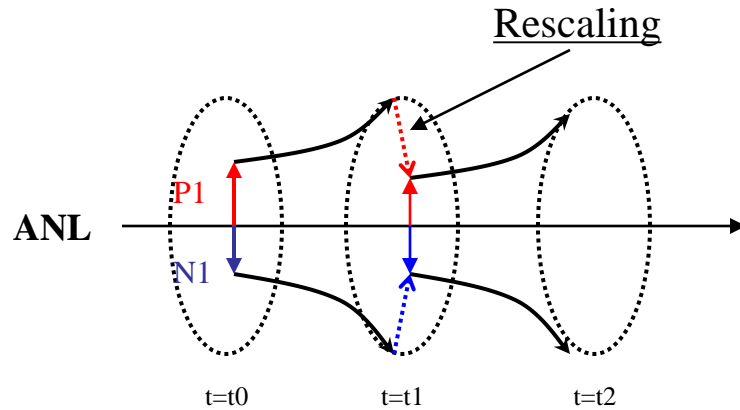
P#, N# are the pairs of positive and negative

P1 and P2 are independent vectors

Simple scaling down (no direction change)
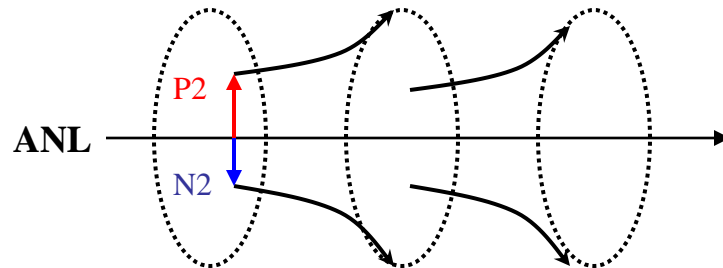
Ensemble Transform with Rescaling
(Current Operation)
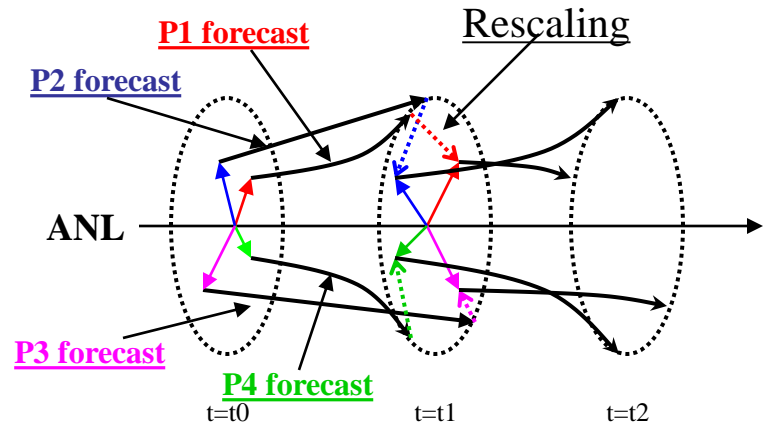
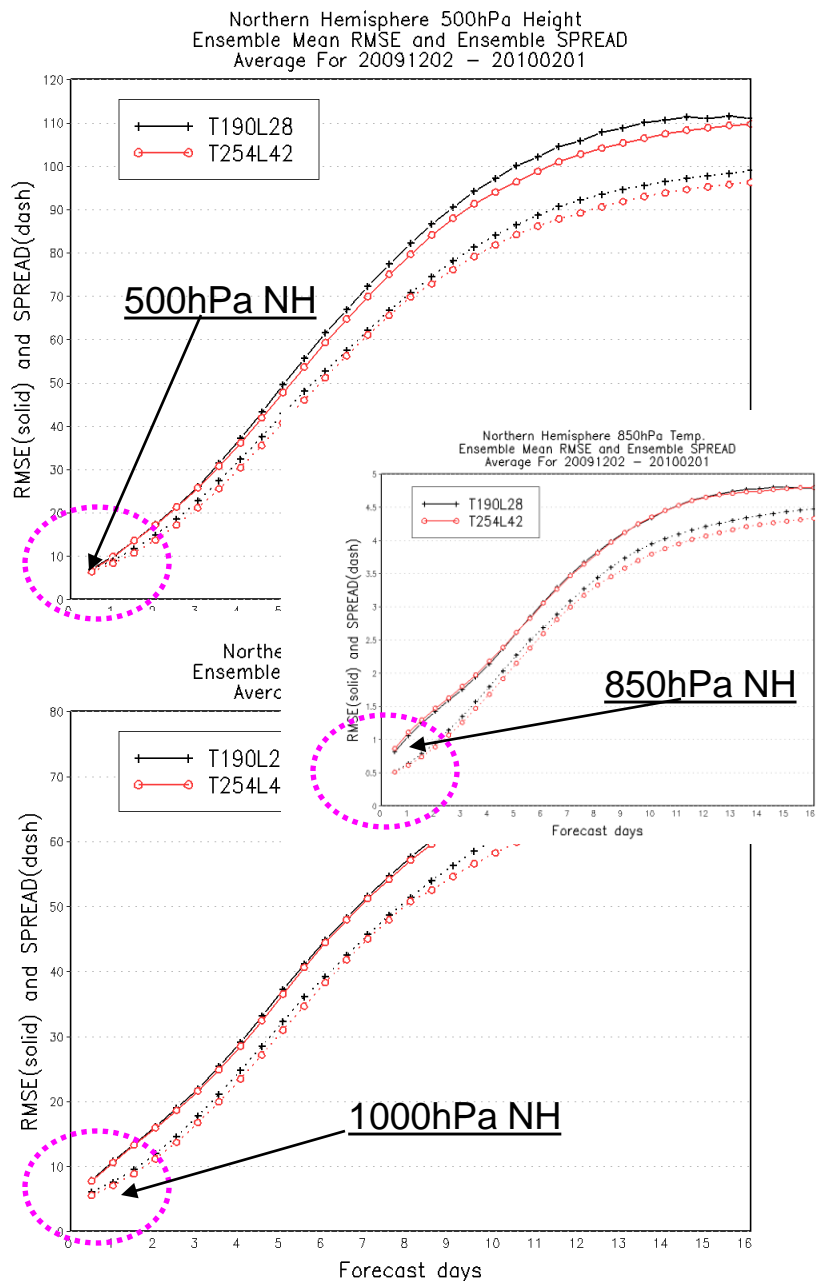P1, P2, P3, P4 are orthogonal vectors

No pairs any more

To centralize all perturbed vectors (sum of all vectors are equal to zero)

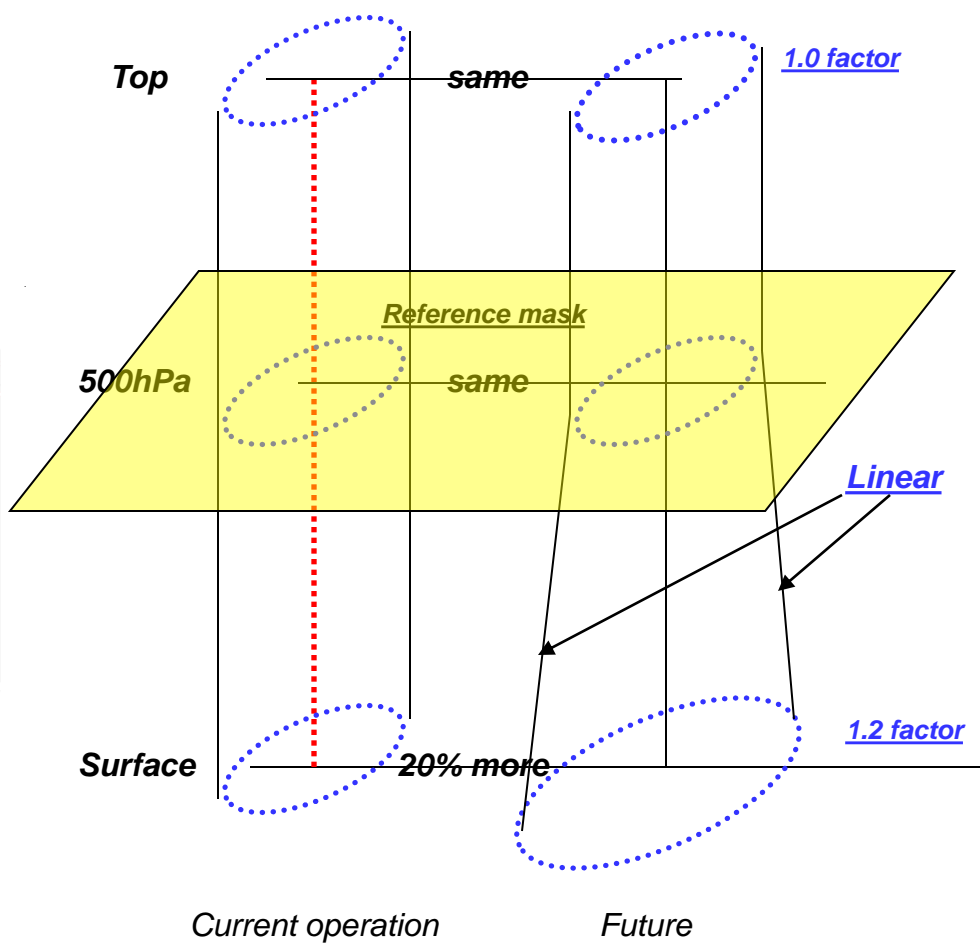Scaling down by applying mask (2D mark is generated based on mid-of-troposphere near 500hPa as a reference)

The direction of vectors will be tuned by ETR.

How do we tune ETR initial perturbations ?

Schematic of tuning initial perturbations

Anomaly Correlation

Summer 2 months

GFS V8.0 .vs V9.01

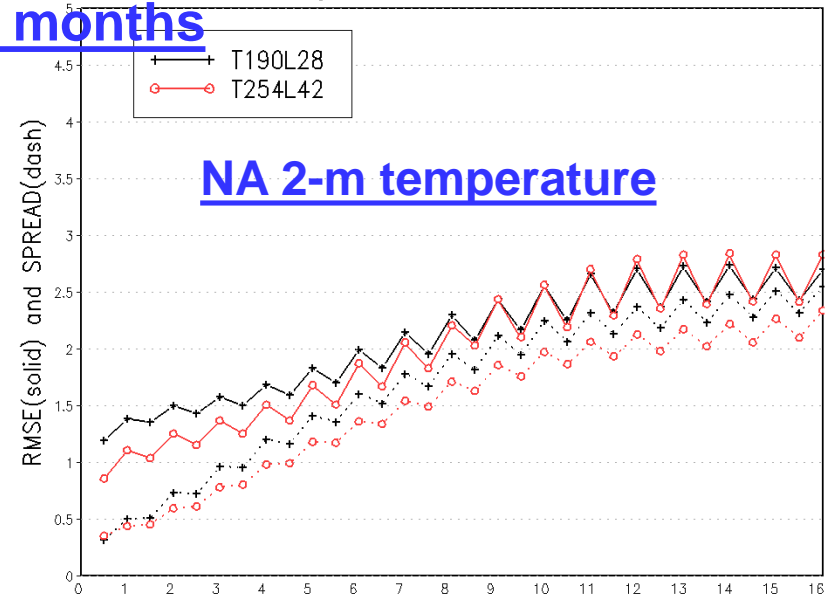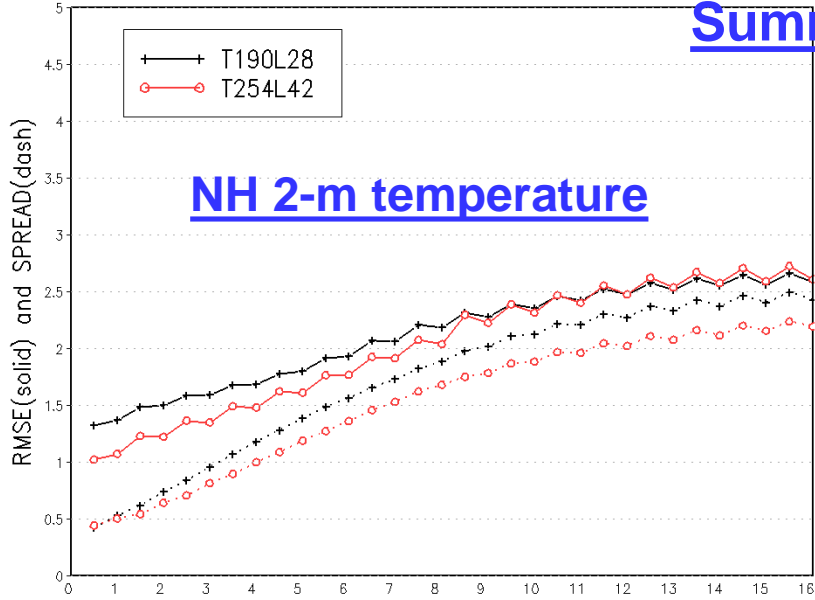**Anomaly Correlation**

Summer 2 months

Northern Hemisphere 2 Meter Temp.
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20100802 – 20100930

NH 2-m temperature
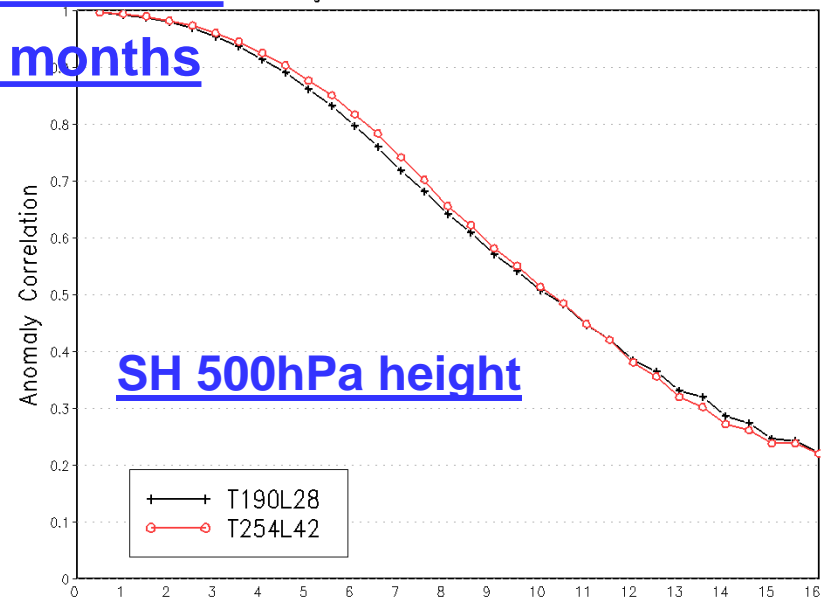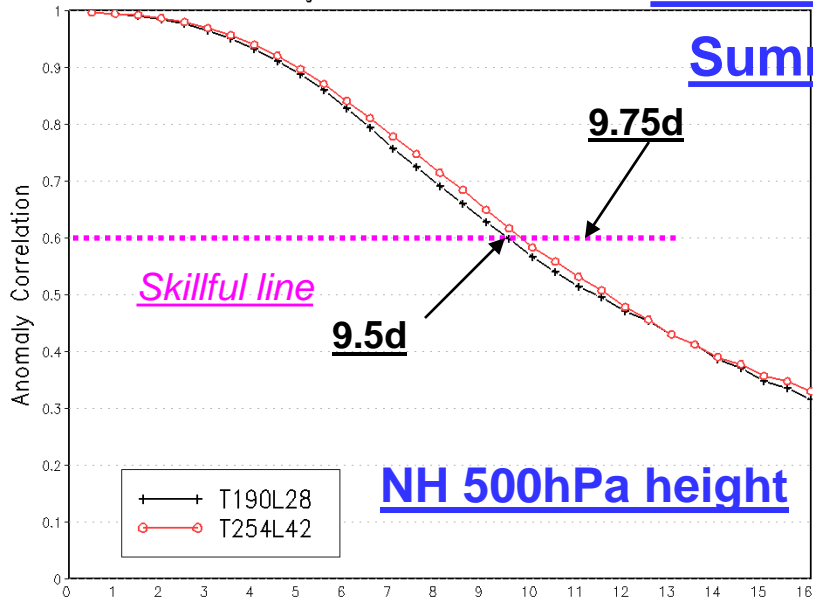
North American 2 Meter Temp.
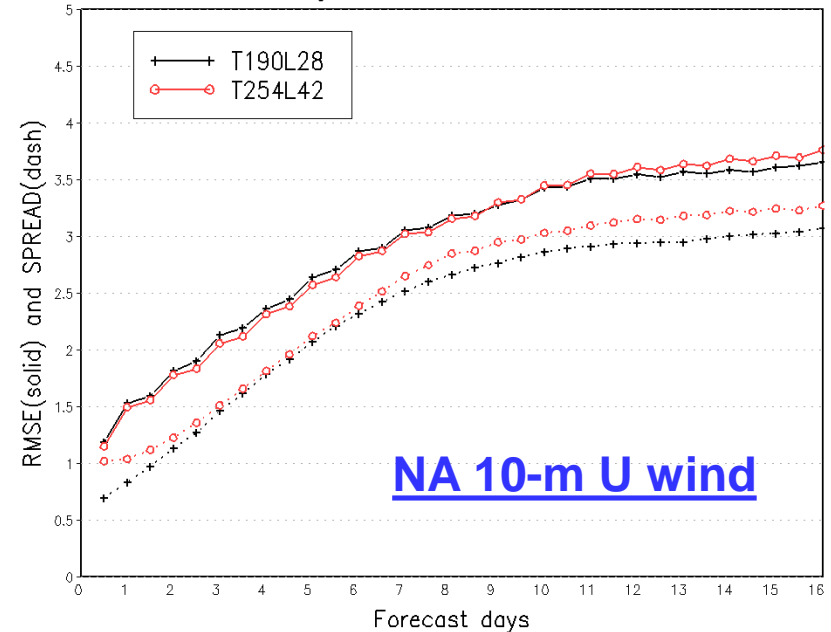Ensemble Mean RMSE and Ensemble SPREAD
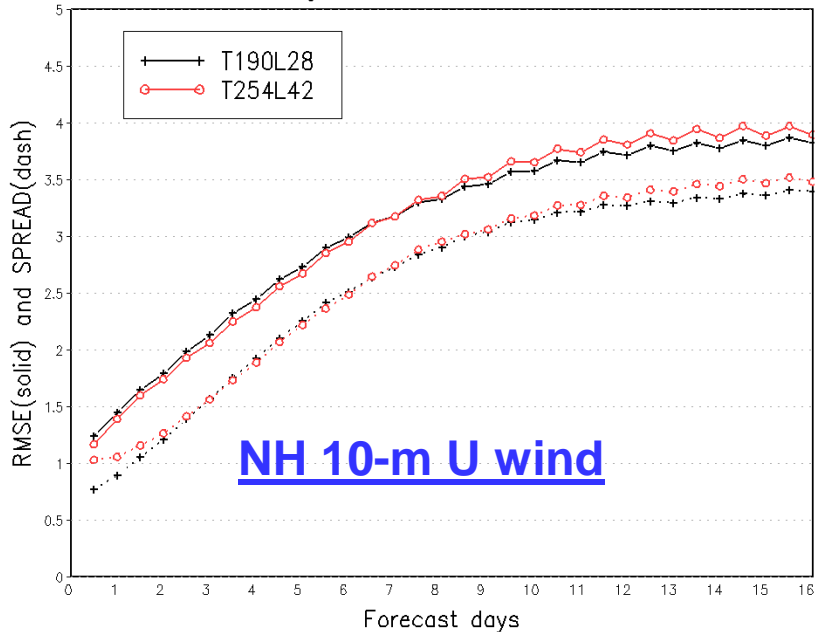Average For 20100802 – 20100930

NA 2-m temperature

GFS V8.0 .vs V9.01

Northern Hemisphere 10 Meter Wind(U)
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20100802 – 20100930

NH 10-m U wind

North American 10 Meter Wind(U)
Ensemble Mean RMSE and Ensemble SPREAD
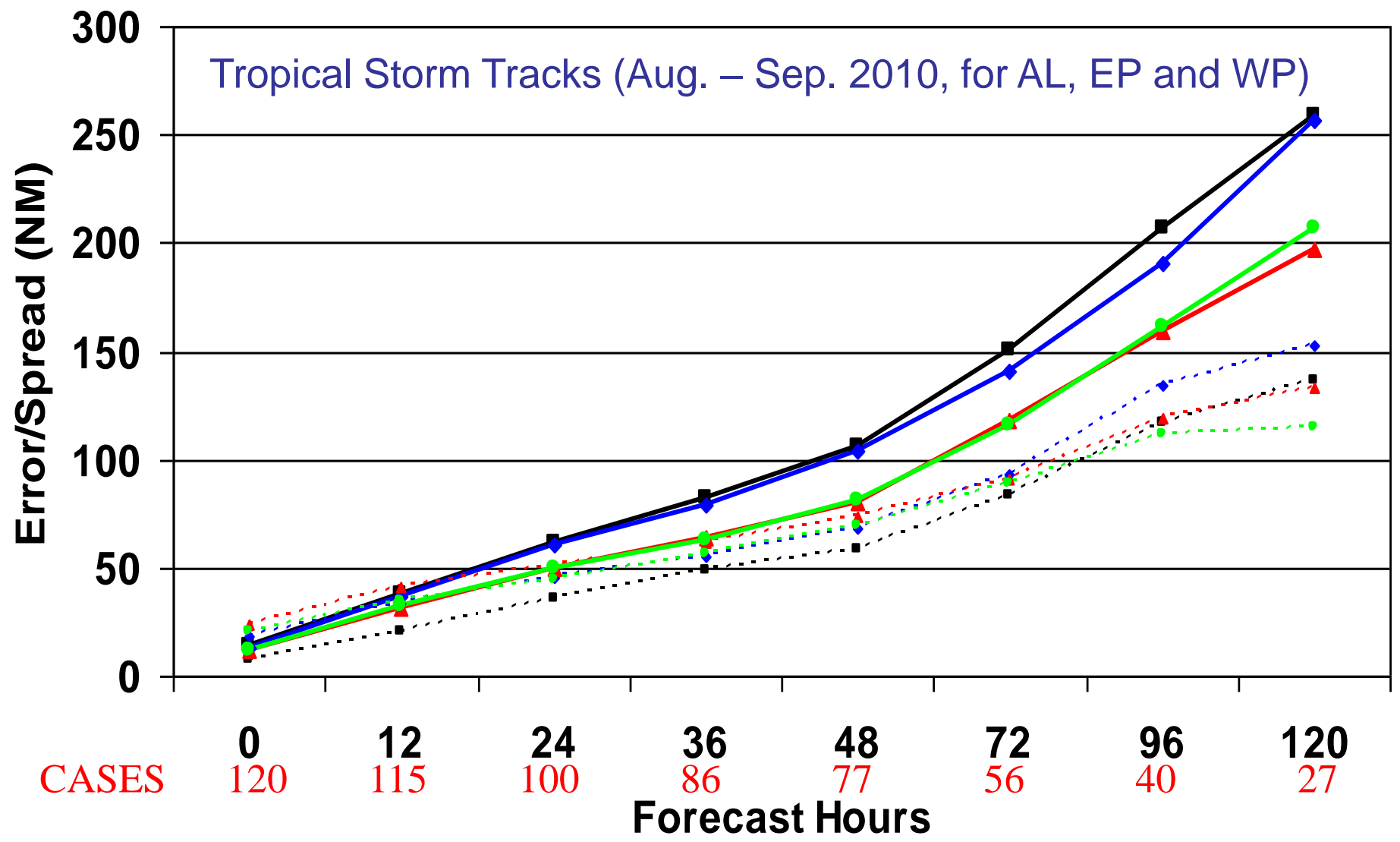Average For 20100802 – 20100930

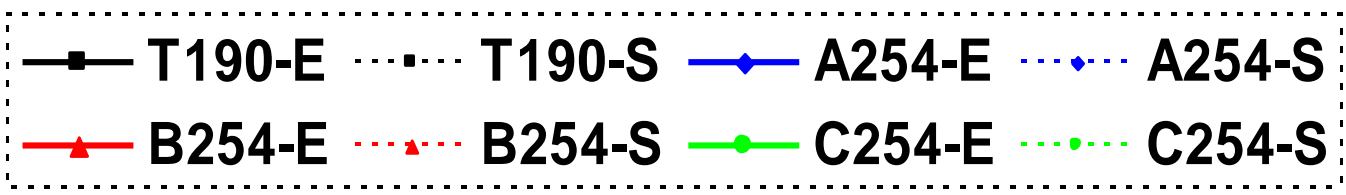**NA 10-m U wind**

Tracks Verification

T190 – GFSv8.0 – current operation
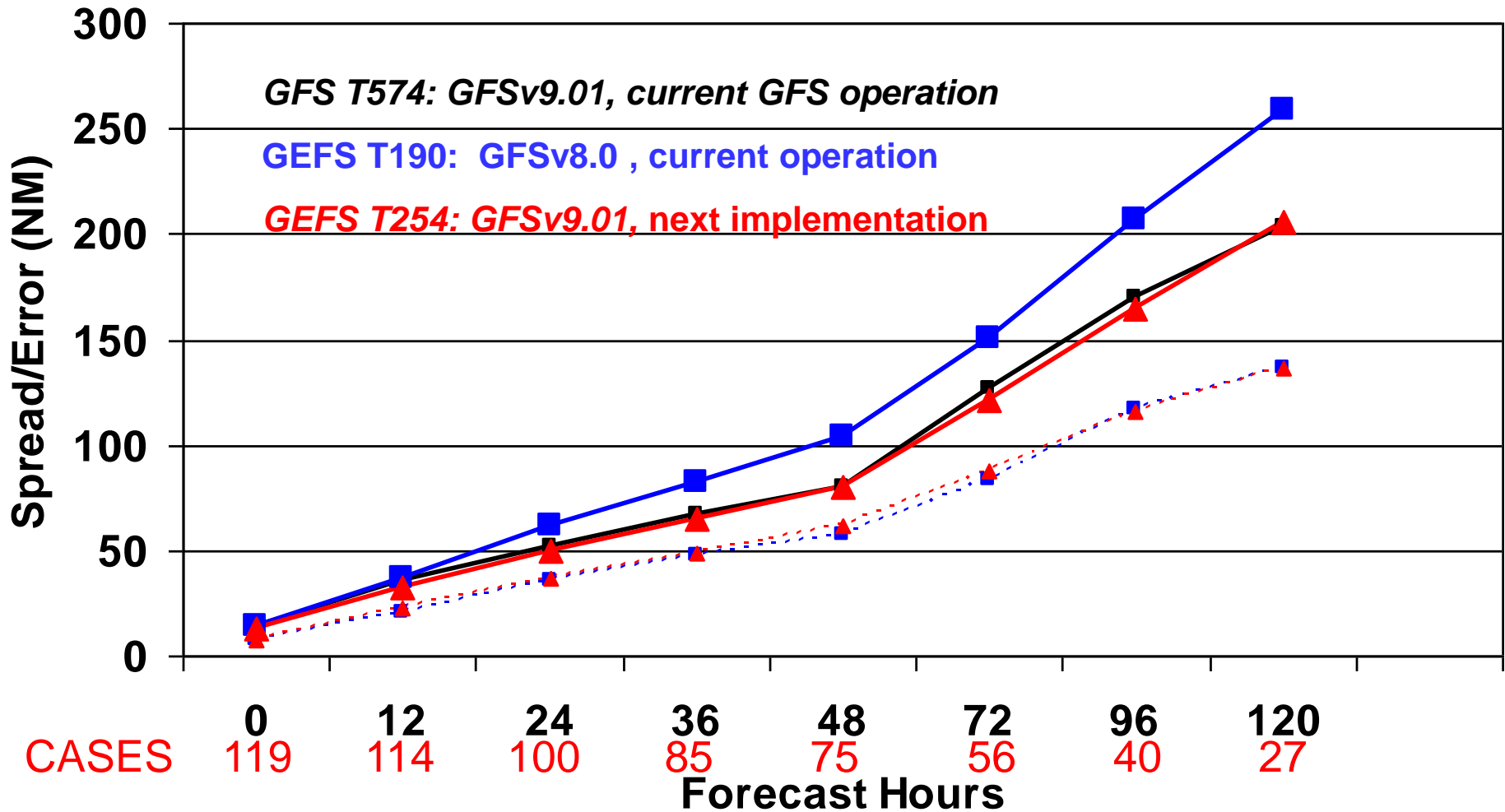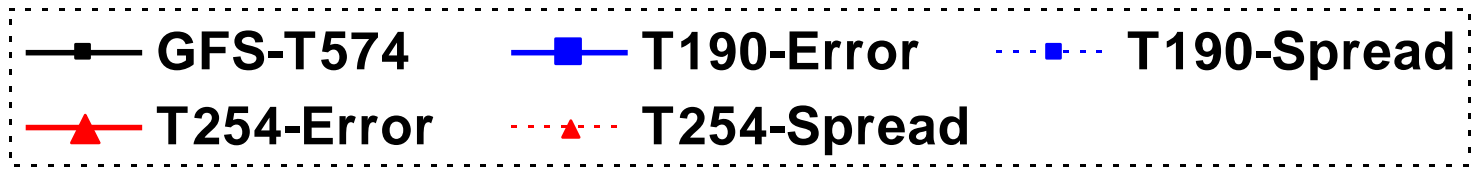
A254 – GFSv9.0 – T254L42 without relocation

B254 – GFSv9.01 – T254L42 without relocation, but tuned initial perturbations

C254 – GFSv9.01 – T254L42 without relocation

D254 – GFSv9.01 with relocation, tuned initial perturbation (come in soon)
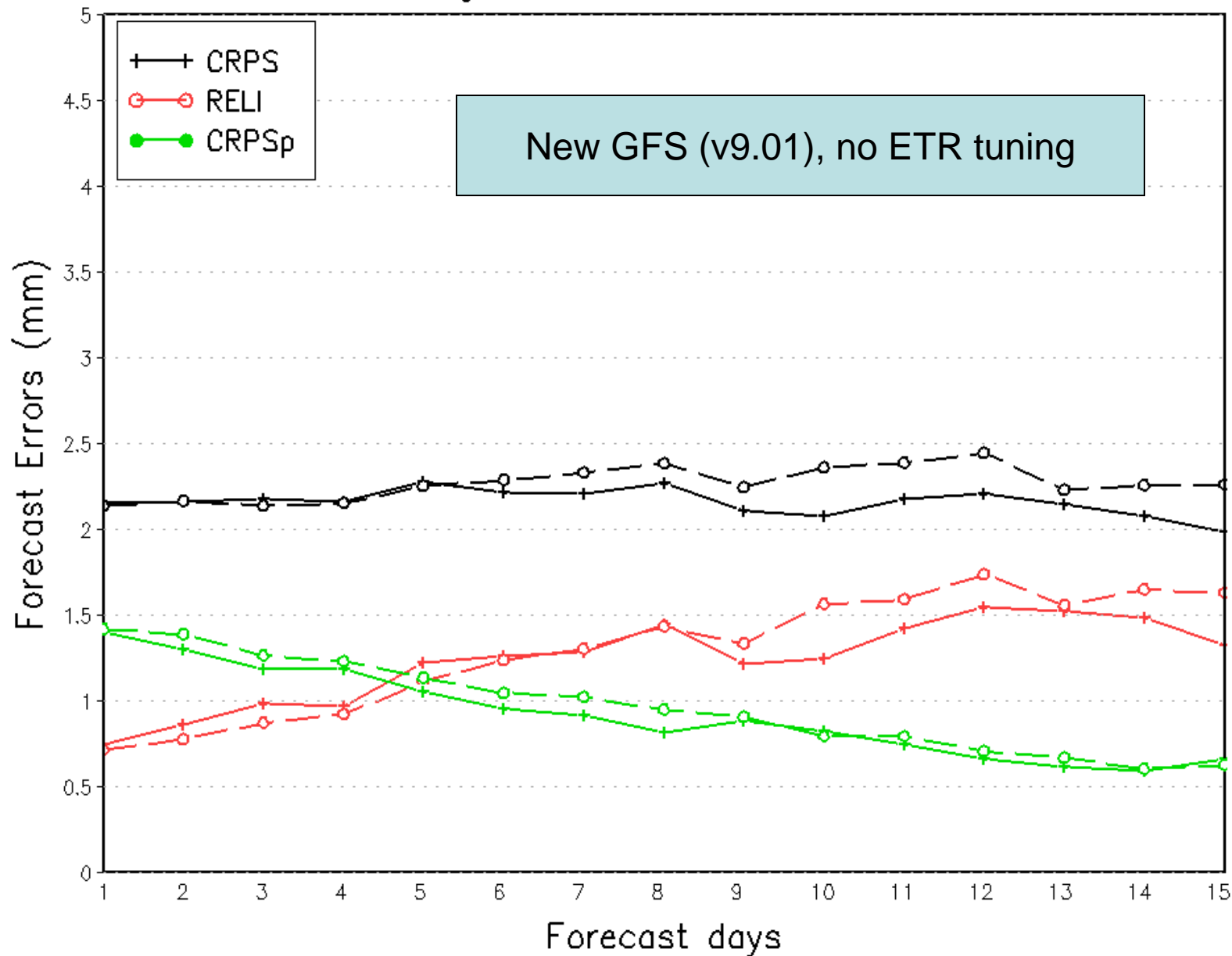
Tropical Storm Tracks (Aug. – Sep. 2010, for AL, EP and WP)

Legend: T190-E, T190-S, A254-E, A254-S, B254-E, B254-S, C254-E, C254-S

Forecast Hours	0	12	24	36	48	72	96	120
CASES	120	115	100	86	77	56	40	27

Error/Spread (NM)

GEFS-T254 next implementation in 2011

Ensemble Precipitation Verification
CRPS, RELI, CRPSpot(RESO & UNCE)
Average For 20100827 – 20100930

New GFS (v9.01), no ETR tuning

Ensemble Precipitation Verification
ETS and TSS for threshold >= 10.0mm/24hours
Average For 20100827 – 20100930

AVERAGE BOXES: TOTAL=1040.28 OBS=69.40 BIAS(NCEP_D1)=1.03

Solid—Oa_1.0d,Dash—lk_1.0d

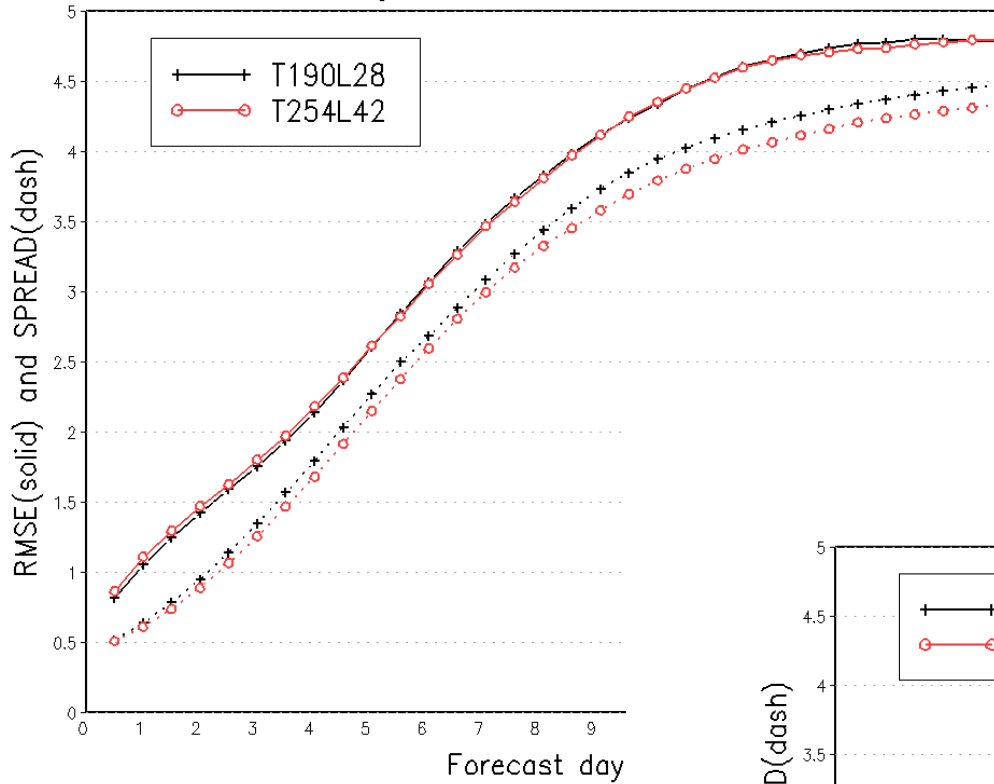New GFS (v9.01), no ETR tuning
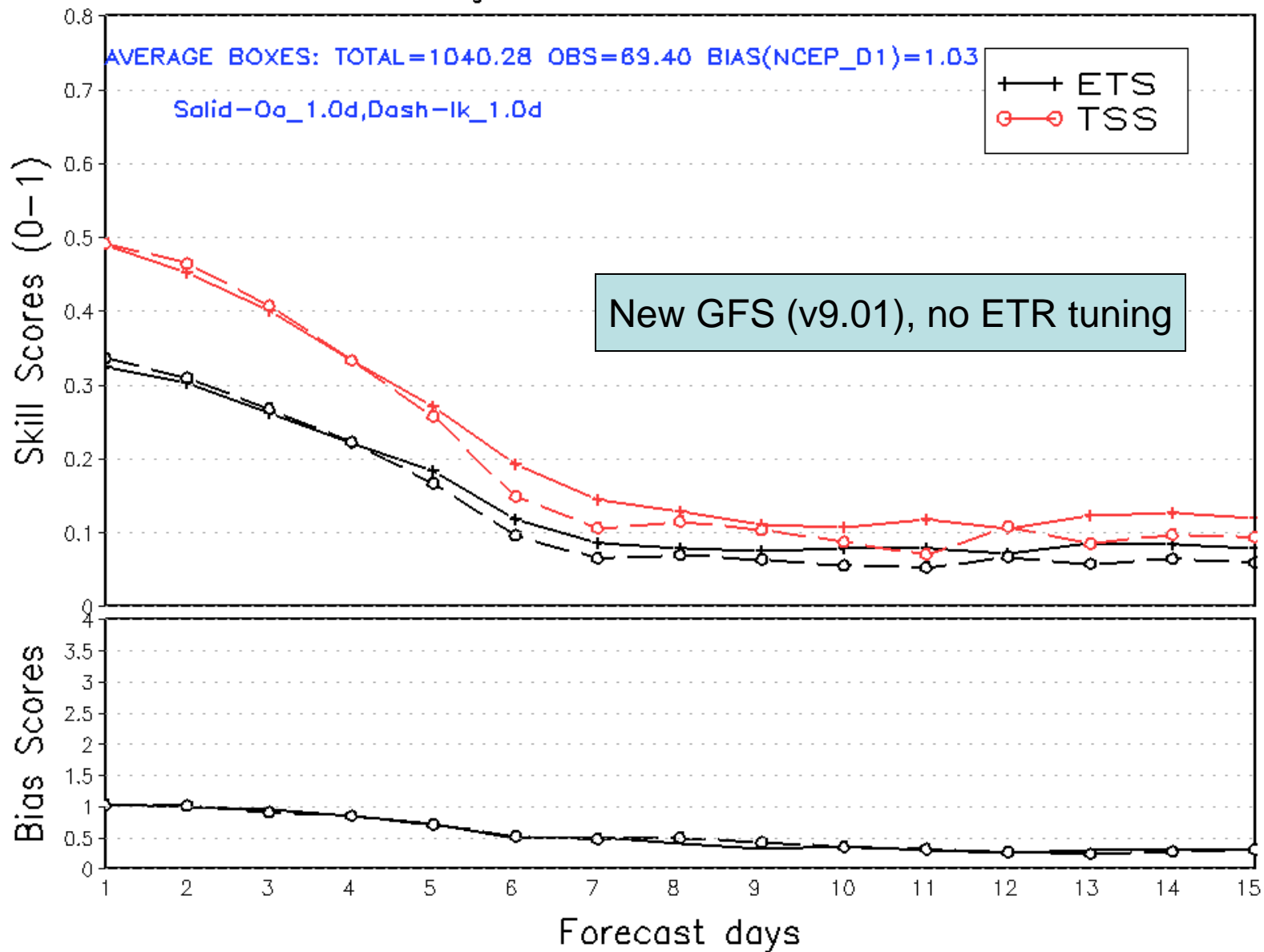
Flow Chart for Hybrid Variation and Ensemble Data Assimilation System (HVEDAS) - concept
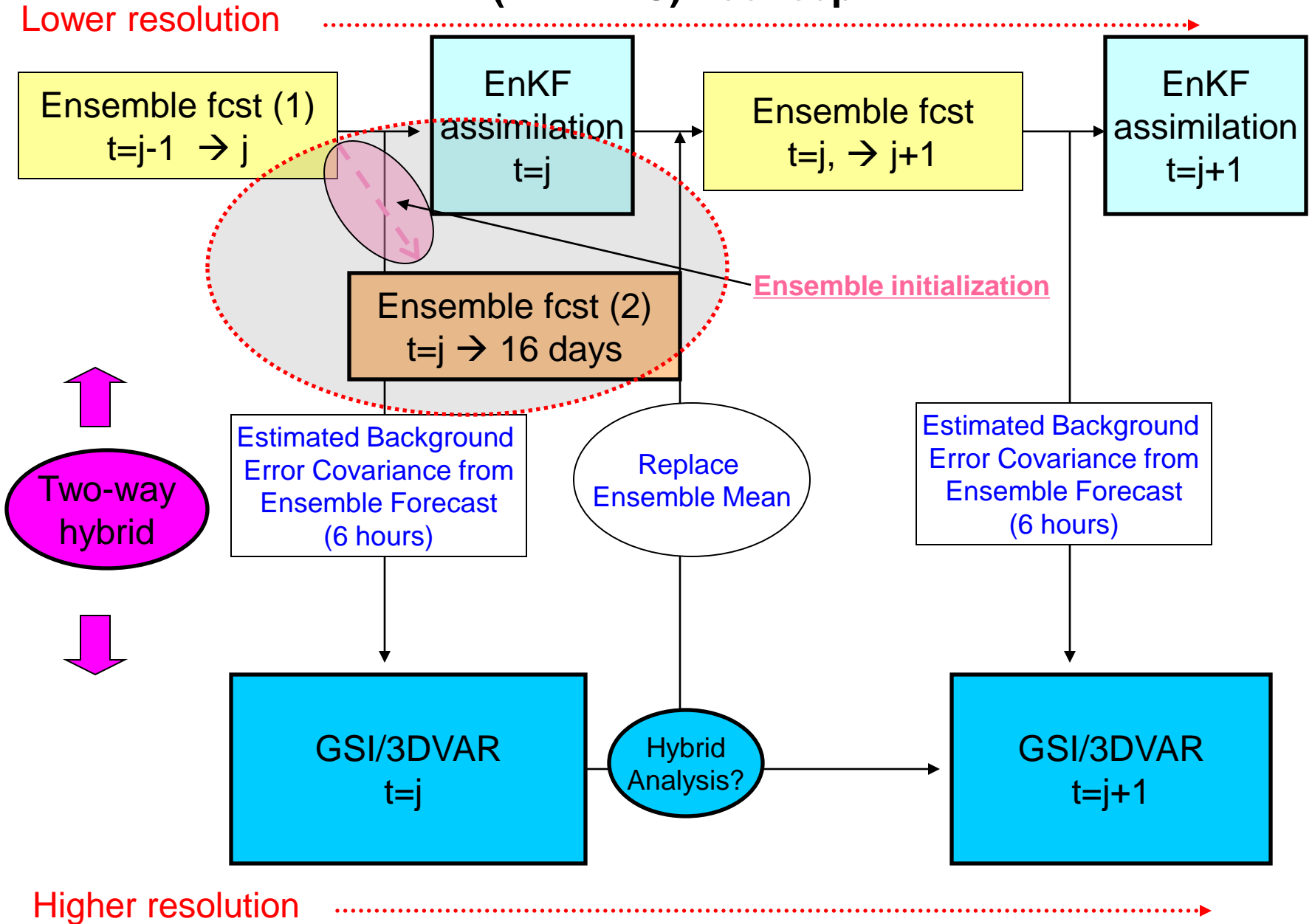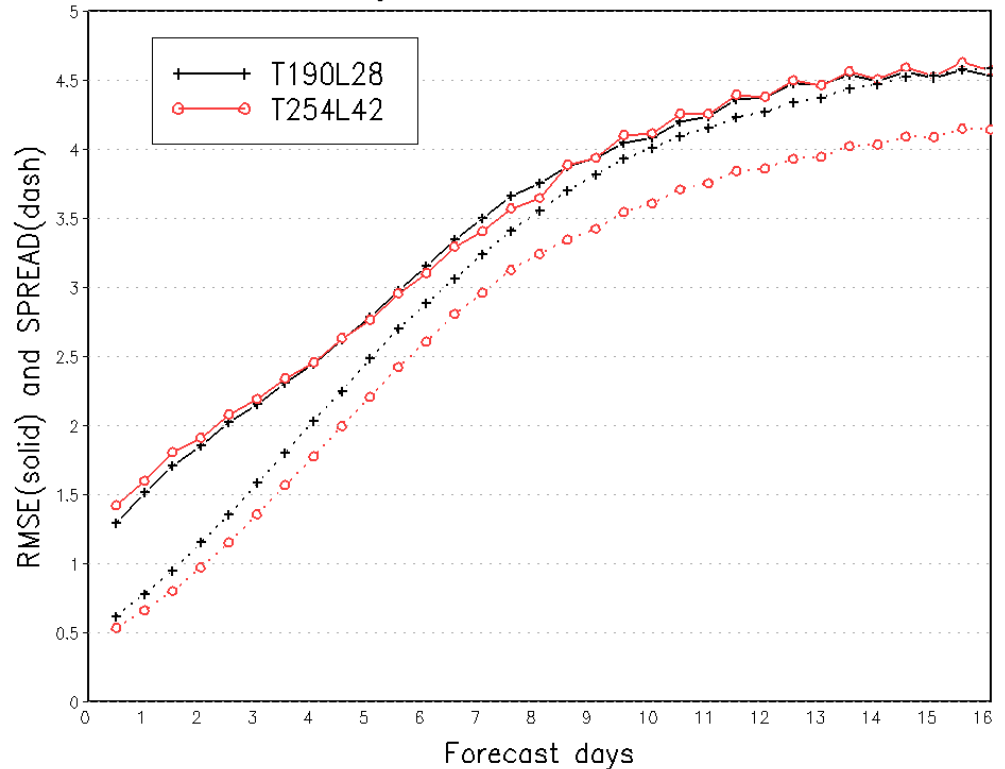
Background!!!

Northern Hemisphere 850hPa Temp.
Ensemble Mean RMSE and Ensemble SPREAD
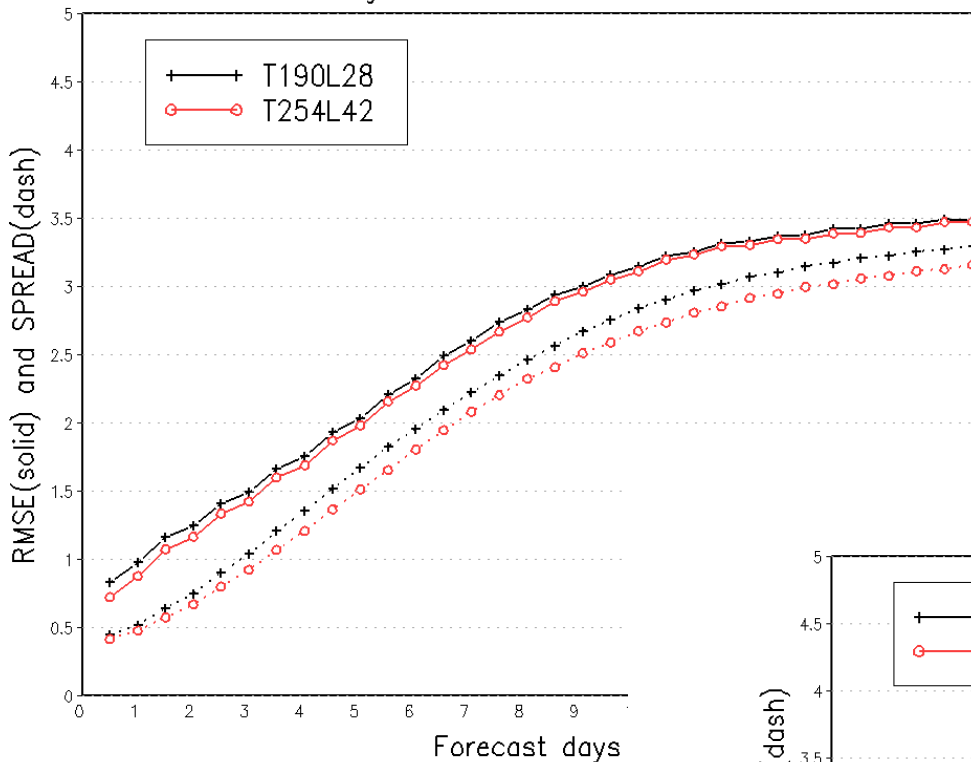Average For 20091202 – 20100201

2009-2010 winter 2 months

T190L28 – similar to current GEFS set up. But GFS analysis and forecast are matched (V8.0)

Northern Hemisphere 2 Meter Temp.
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20091202 – 20100201

T254L42 – GFS analysis and forecast are matched (V9.0)

Northern Hemisphere 850hPa Temp.
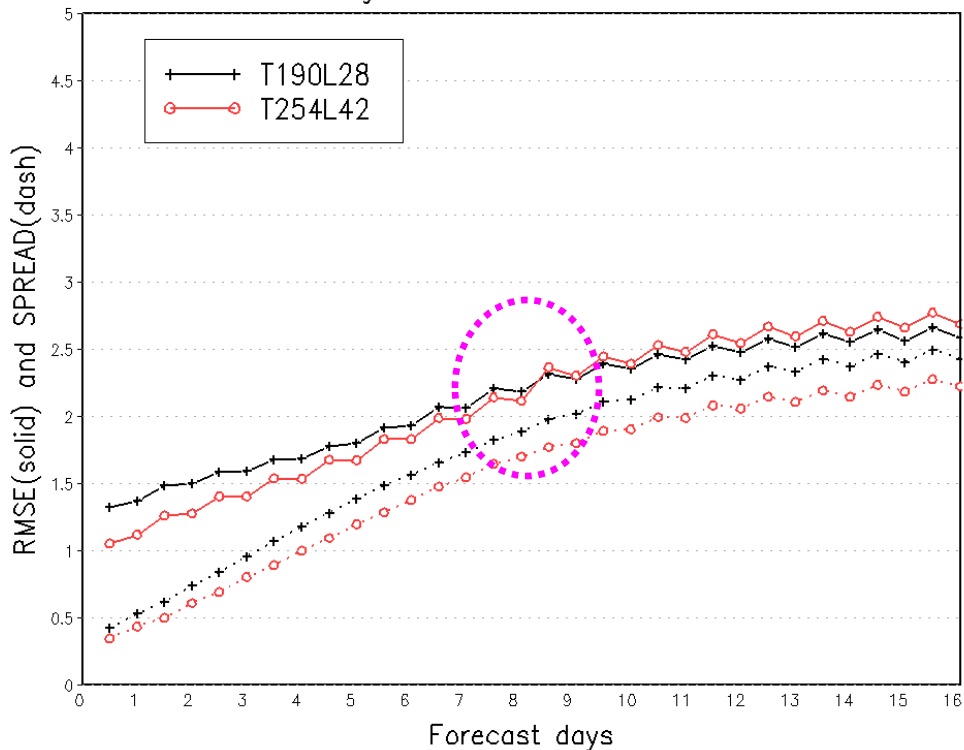Ensemble Mean RMSE and Ensemble SPREAD
Average For 20100802 – 20100930

Northern Hemisphere 2 Meter Temp.
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20100802 – 20100930
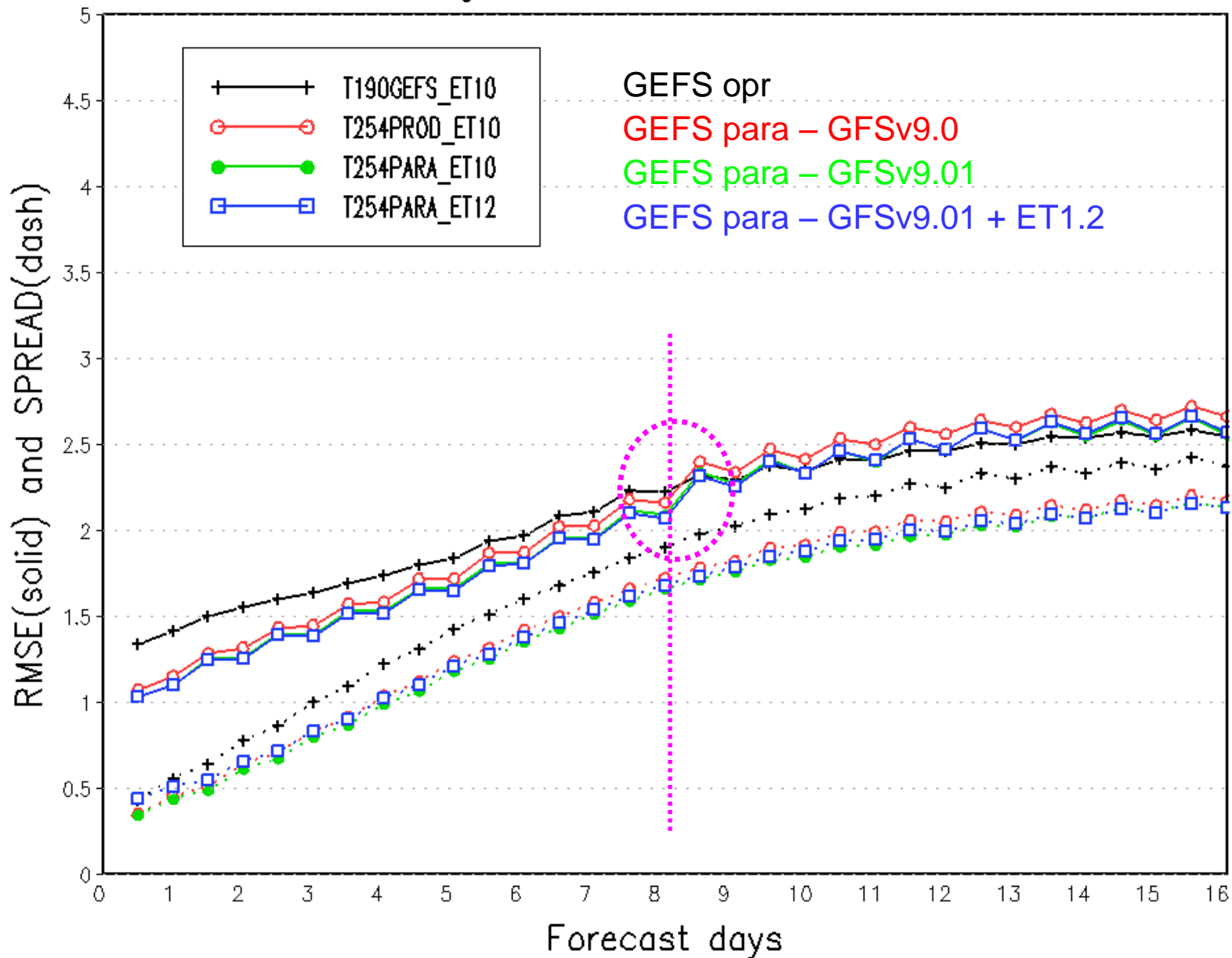
2010 Summer 2 months

T190L28 – Current GEFS set up. But GFS analysis (V9.0) and forecast (V8.0) are not matched.

T254L42 – GFS analysis and forecast are matched (V9.0)

Northern Hemisphere 2 Meter Temp.
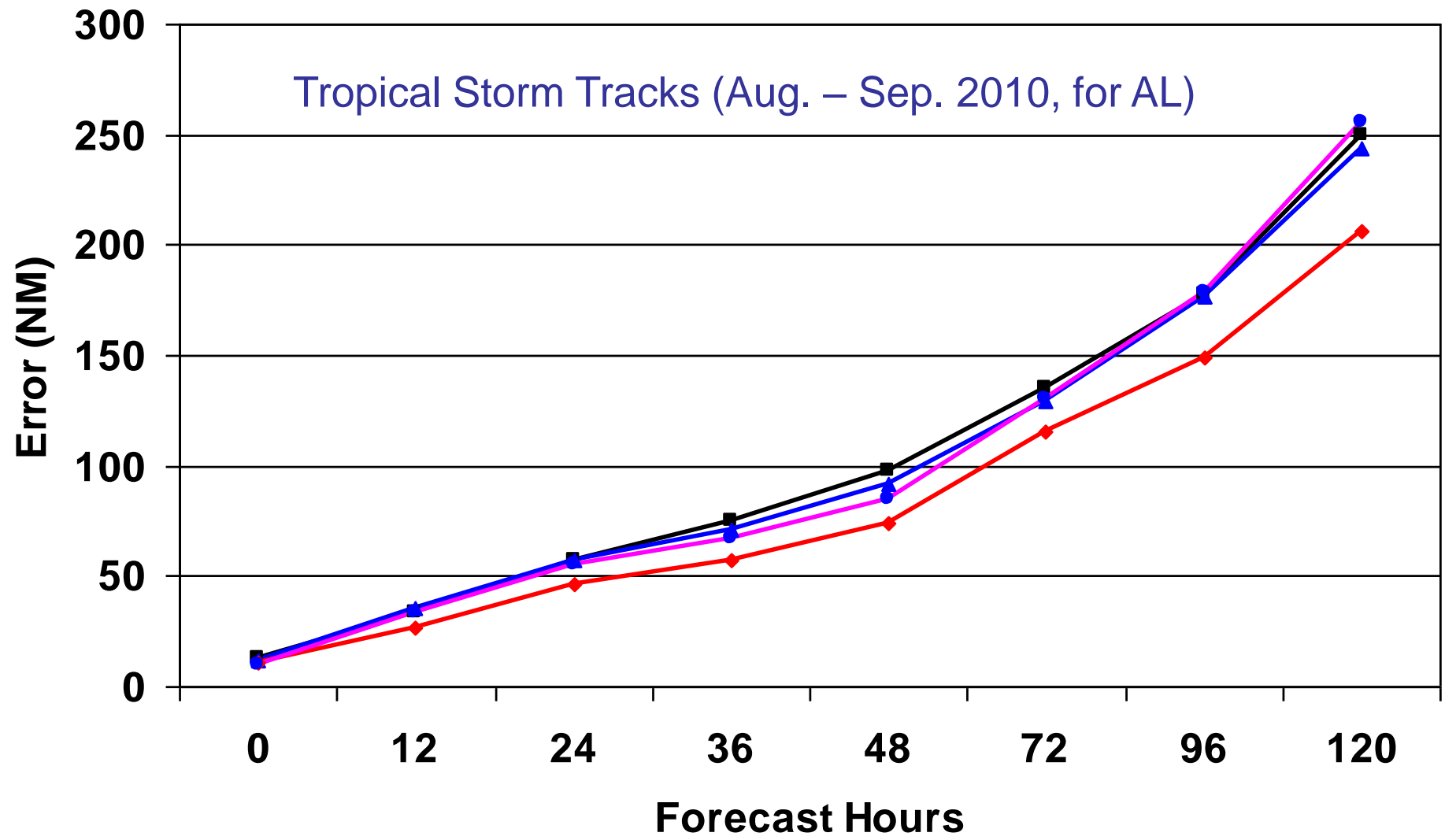Ensemble Mean RMSE and Ensemble SPREAD
Average For 20100802 − 20100905

Legend:
- T190GEFS_ET10 — GEFS opr
- T254PROD_ET10 — GEFS para – GFSv9.0
- T254PARA_ET10 — GEFS para – GFSv9.01
- T254PARA_ET12 — GEFS para – GFSv9.01 + ET1.2

RMSE(solid) and SPREAD(dash)

Forecast days

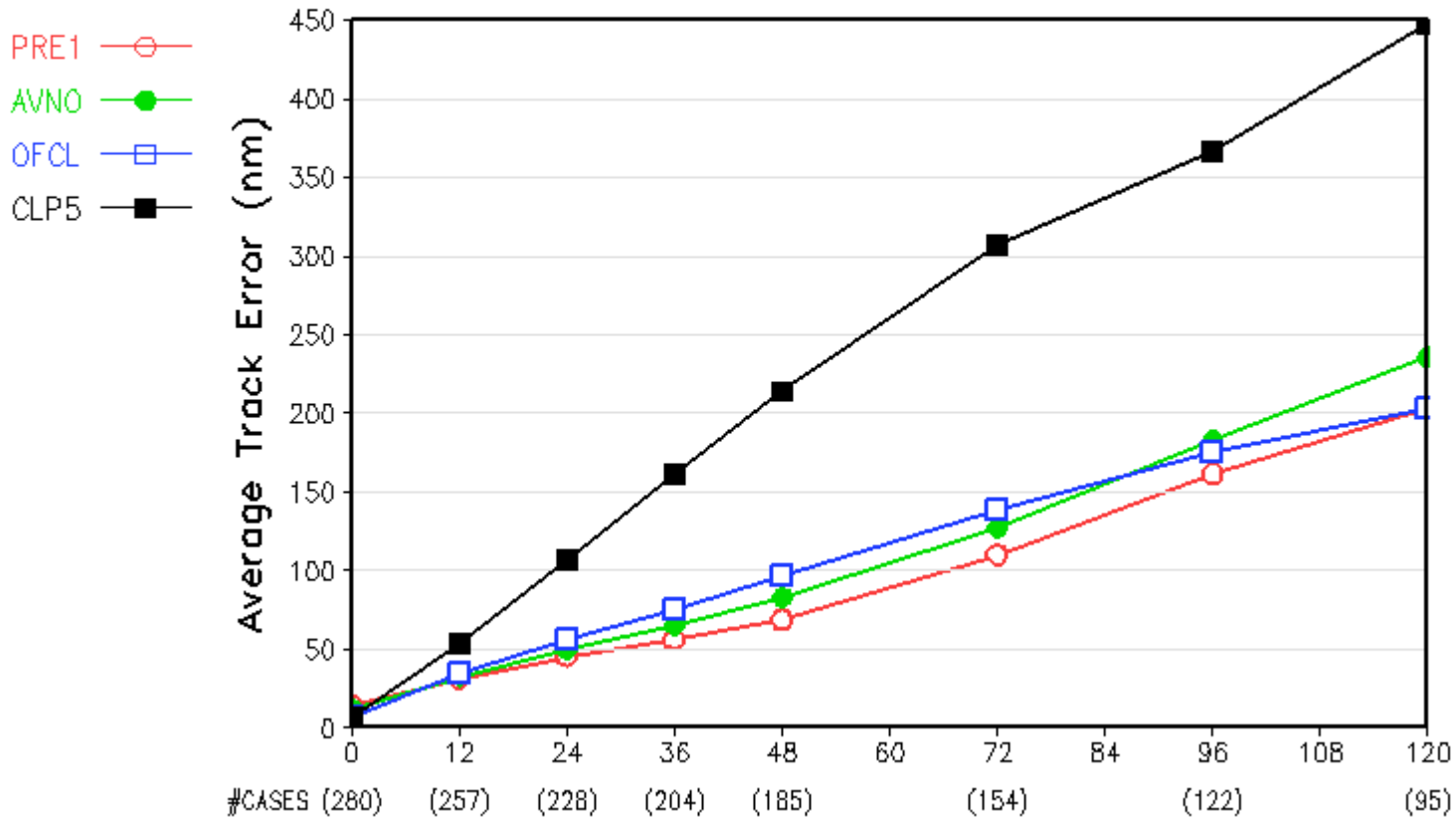Tropical Storm Tracks (Aug. – Sep. 2010, for AL)

Atlantic Track Errors

Hurricane Track Errors — Atlantic 2010
20100601__20100923__4cyc

Green – Production GFSv9.0
Red – GSI/GFS v9.01

From John Ward

T2m (L28 − L42) for 2008100100