

# ***Community Tools: “gen\_be”***

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## ***Talk overview***

- What is “gen\_be”?
- How it works?
- Some technical details
- Important “namelist” options
- scripts and graphics
- “gen\_be” diagnostics for “CON200” and “T8” domain

## What is “gen\_be”?

- It computes different components of background error (BE) statistics for WRF-ARW model
- It may produce BE both for WRFDA and GSI
- It is designed to work either for NMC or Ensemble (ENS) method
- It is available with WRFDA package

<http://www.mmm.ucar.edu/wrf/users/wrfda/download>

Note: Currently not available with V3.2. It should be included with next WRFDA release.

- It resides in “gen\_be” sub-directory under its main directory

## How “gen\_be” works?

- After configuring “wrfda”, all the desired executables may be built using “./compile all\_wrfvar” command
- It works in three stages (stage0, stage1 and stage2)
- These three stages needs to be executed in the same order
- Each stage has its own corresponding parallel script which is executed via a suitable “wrapper” script

## **“gen\_be” ----- Stage0:**

- It executes “gen\_be\_stage0\_gsi.f90” code
- Main function:
  - Process WRF-ARW forecasts and output the desired info about the domain configuration
  - Convert horizontal wind components (U,V) to stream function and velocity potential ( $\Psi, \chi$ )
  - Forms desired perturbations depending on whether “NMC” or “ENS” method to be used

## **“gen\_be” ----- Stage1:**

- It executes “gen\_be\_stage1\_gsi.f90” code
- Its main function is to remove the temporal mean for “NMC” method

## **“gen\_be” ----- Stage2:**

- It executes “gen\_be\_stage2\_gsi.f90” code
- Its main function is to compute the following:
  - Regression coefficients for velocity potential ( $\chi$ ), temperature (t) and surface pressure (ps)
  - Unbalanced parts of  $\chi$ , t and ps
  - Variance of all the control variables
  - Horizontal and vertical length-scales of the control variables
  - Variance of relative humidity (rh) in 5% bins of mean rh

## Some technical details about “gen\_be”

- Horizontal length-scale ( $L$ ) are computed following Wan Shu et al. (*MWR*, 2002)

$$L = \left\{ -\frac{8 * \text{Variance}(X)}{\text{Variance}\{\nabla^2(X)\}} \right\}^{1/4}$$

- For each sigma level ( $l$ ), vertical length-scale ( $VL$ ) is computed using vertical error covariance ( $vcor$ ) for each sigma level level with adjacent level just below this level as follows:

$$VL(l) = \left\{ \frac{1}{\text{abs}[2 - vcor(l) - vcor(l + 1)]} \right\}^{1/2}$$

- Regression coefficients for  $\chi$  are latitude dependent. However for  $t$  and  $ps$ , it does not vary with latitude
- Vertical length-scales do not vary with latitude.
- Horizontal length-scales and variance varies with latitude



## Important “namelist” options

Variable Name	Type	Default Option	Description
BE_METHOD	Character	NMC	Method of computing BE statistics NMC or ENS, the ensemble based
POISSON_METHOD	Integer	1	Method for Poisson solver 1 – Spectral 2 – Relaxation
FFT_METHOD	Integer	2	Fast Fourier Transform 1 - Cosine    2 - Sine
FSTAT	Logical	False	Includes the contribution of coriolis parameter effect for temperature and psi regression coefficients
LAT_BINS_IN_DEG	Real	1.0	Width of Latitude bins in degrees
LESS_Q_FROM_TOP	Integer	0	Number of top model sigma levels to eliminate moisture BE statistics
Debug options	Integer	0	Flag for debugging the code

## ***Scripts and graphics***

- A top level script “gen\_be\_gsi.ksh” executes various stages of “gen\_be”. This is executed via a suitable “wrapper”
- “stage0” has its own separate script “gen\_be\_stage0\_gsi.ksh”. It is called by the top level script, if it is desired to run this stage
- Thus to run “gen\_be”, only a wrapper script needs to be developed which includes information about domain configuration, location of forecast output files, initial and final dates, desired namelist options etc.
- Successful execution produces the desired background error statistics file as “wrf-arw-gsi\_be” in “RUN\_DIR” directory
- To display the contents of “wrf-arw-gsi\_be”, the NCL script “plot\_gsi\_be.ncl” may be run via a suitable “wrapper” script

# A sample “wrapper” to run “gen\_be”

```
#!/bin/ksh -aeu
#-----
# Script gen_be_wrapper.ksh
## Author : Syed RH Rizvi, MMM/ESSL/NCAR, Date:04/15/2009
# Purpose: Calculates WRF-ARW background error statistics for GSI
#-----
export WRFVAR_DIR=/mmm/users/rizvi/code/trunk_mbe
export SCRIPTS_DIR=/mmm/users/rizvi/code/WRFDA_scripts/var/scripts
export GRAPHICS_DIR=/mmm/users/rizvi/code/WRFDA_scripts/var/graphics/ncl
export NUM_WE=44           # 1 point less than stagger points in WE
export NUM_SN=44           # 1 point less than stagger points in SN
export NUM_LEVELS=27       # 1 point less than stagger point in vertical
export LESS_Q_FROM_TOP=0   # Exclude levels from top for moisture statistics
export LAT_BINS_IN_DEG=5.0 # Lat bins (in deg) for BE stats
export DEBUG=0
export REGION=con200
export DAT_DIR=/ptmp/rizvi/data
export REG_DIR=$DAT_DIR/$REGION
export EXPT=run_gsi_be_lat_bin_size_${LAT_BINS_IN_DEG}_Inps
export RUN_DIR=$REG_DIR/$EXPT
export FC_DIR=$REG_DIR/novar/fc
export RUN_GEN_BE_GSI_STAGE0=true
export RUN_GEN_BE_GSI_STAGE1=true
export RUN_GEN_BE_GSI_STAGE2=true
export START_DATE=2007070200 # the first perturbation valid date
export END_DATE=2007073112  # the last perturbation valid date
export INTERVAL=12
${SCRIPTS_DIR}/gen_be/gen_be_gsi.ksh
```

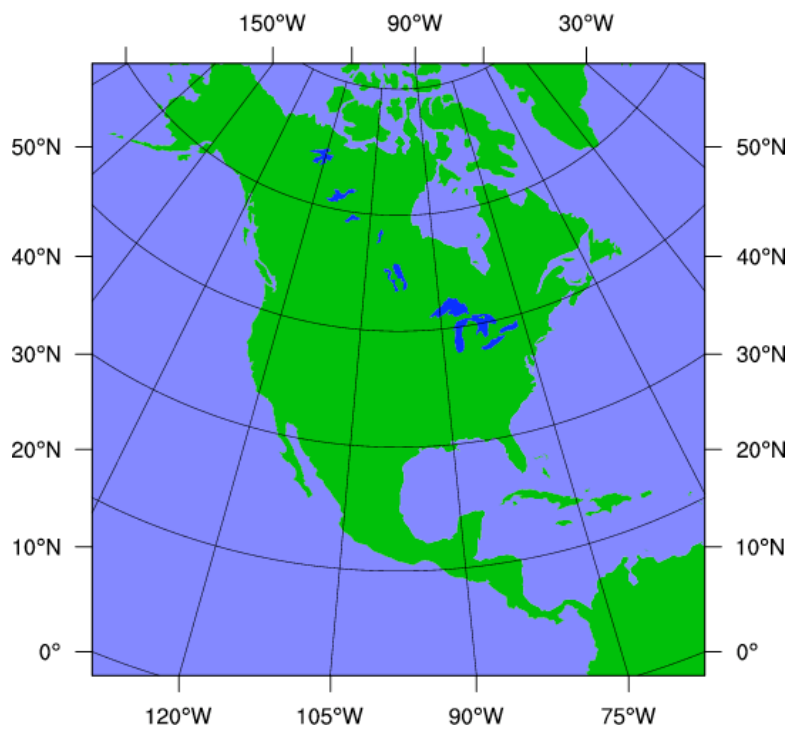


## A sample “wrapper” to display BE

```
#!/bin/ksh -aeu
#-----
# Script : wrapper_gen_be_gsi_plot.ksh
# Author: Syed RH Rizvi, UCAR/NCAR/ESSL/MMM/DAG Date: 08/12/2009
# Purpose: Wrapper for the display of background error statistics for GSI
#-----
export SCRIPTS_DIR=/mmm/users/rizvi/code/WRFDA_scripts/var/scripts
export GRAPHICS_DIR=/mmm/users/rizvi/code/WRFDA_scripts/var/graphics/ncl
export GRAPHIC_WORKS=pdf
export NUM_WE=44           # 1 point less than stagger points in WE
export NUM_SN=44          # 1 point less than stagger points in SN
export NUM_LEVELS=27      # 1 point less than stagger point in vertical
export REGION=con200
export PLOT_CORRELATION=true
export DAT_DIR=/ptmp/rizvi/data
export REG_DIR=$DAT_DIR/$REGION
export EXPT=run_gsi_be
export RUN_DIR=$REG_DIR/$EXPT
ncl ${GRAPHICS_DIR}/gen_be/plot_gsi_be.ncl
#-----
if $PLOT_CORRELATION ; then
# Plot Correlation:
ncl ${GRAPHICS_DIR}/gen_be/gsi_correlation.ncl
fi
```

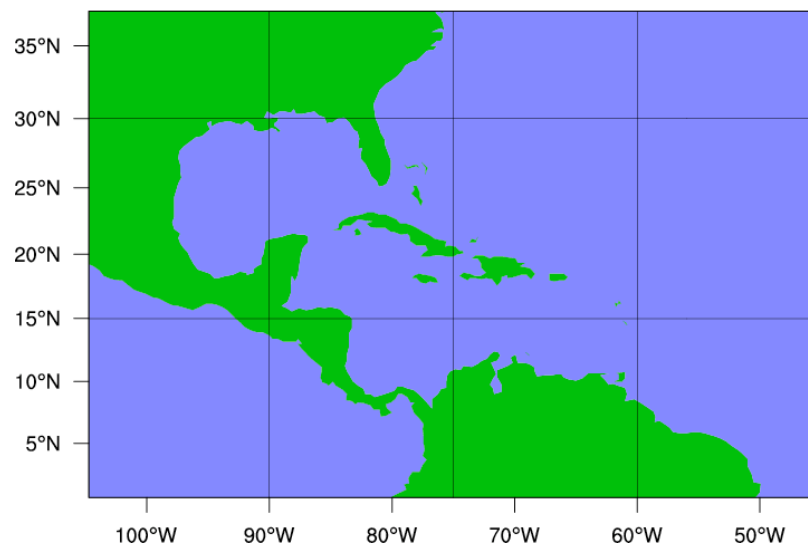
# BE diagnostics

CONUS 200 Km Domain



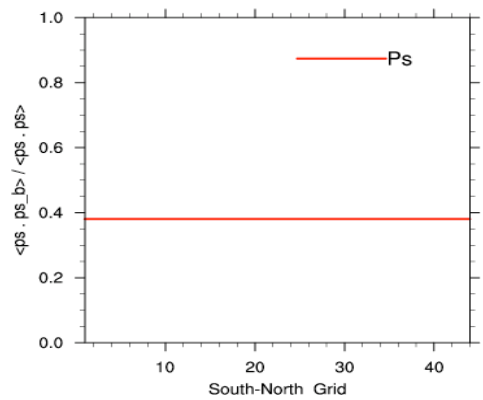
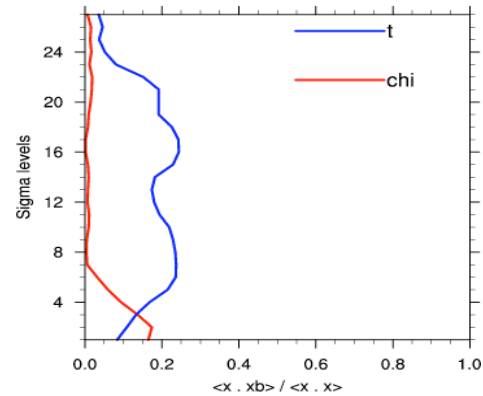
Grid: 45 x 45 x 28

AFWA T8 45Km Domain

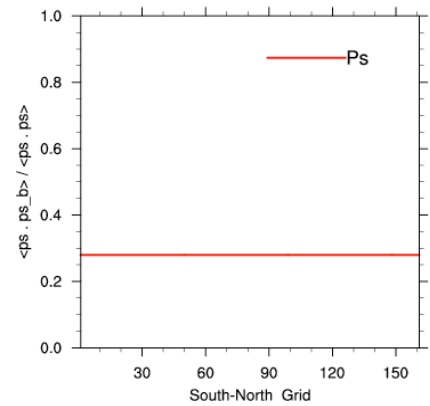
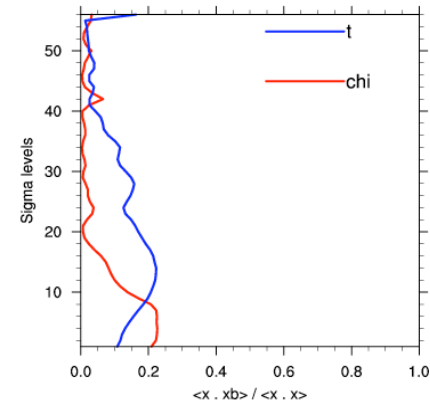


Grid: 140 x 94 x 57

# WRF-ARW BE diagnostics -- balanced fields

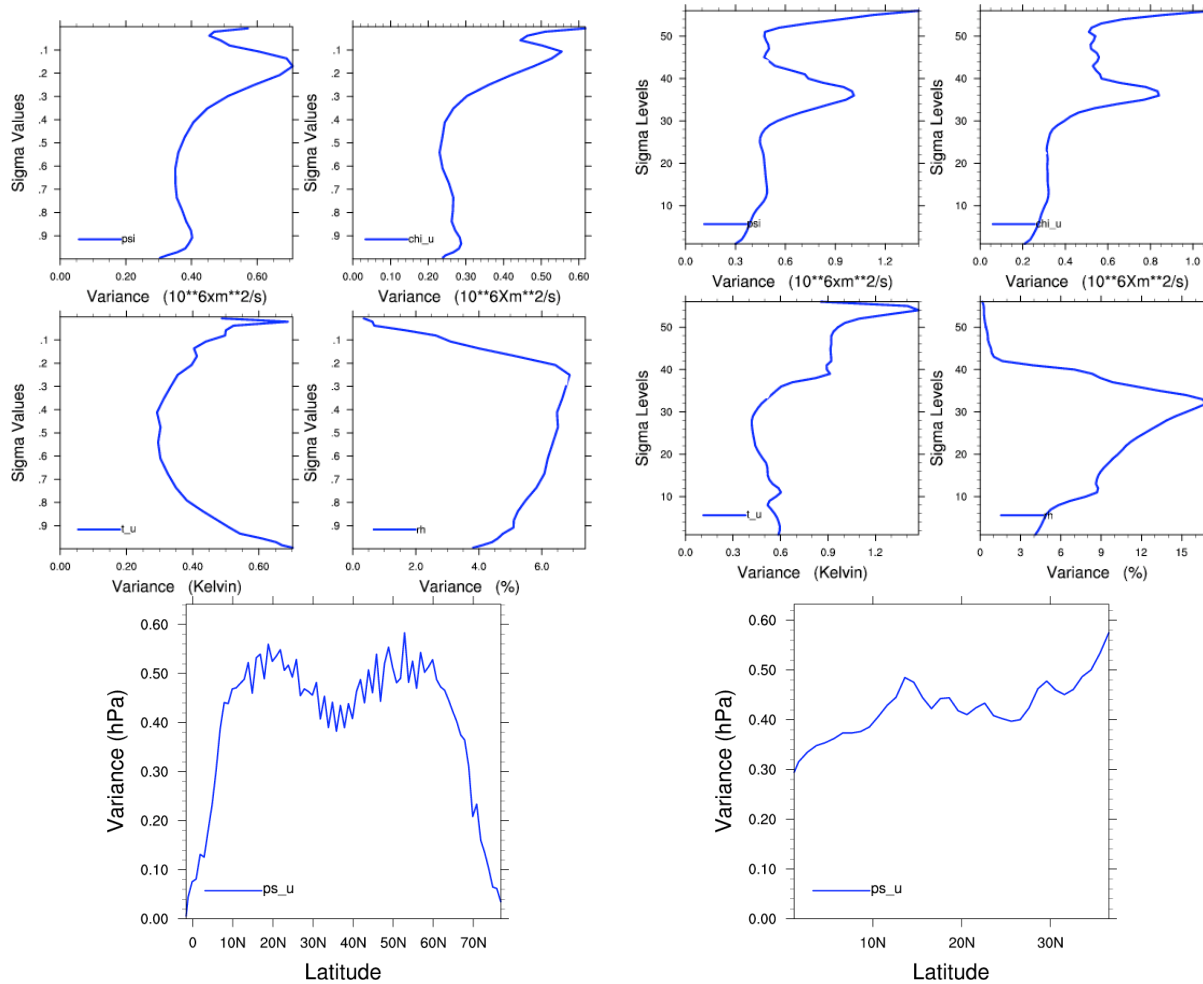


CONUS, 200 Km Domain



T8, 45 Km Domain

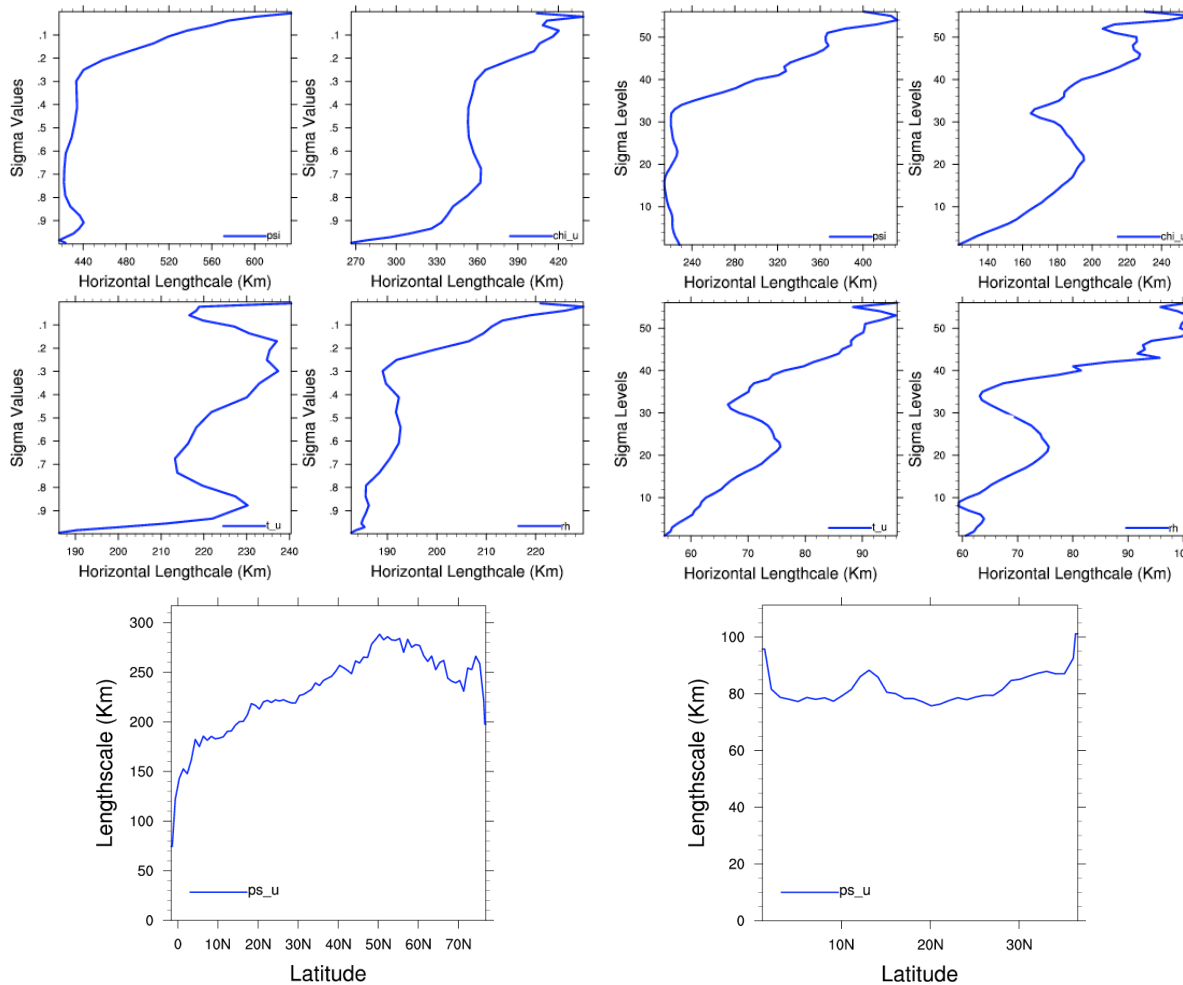
# WRF-ARW BE diagnostics -- Variance



CONUS, 200 Km Domain

T8, 45 Km Domain

# BE diagnostics -- Horizontal Length-scales

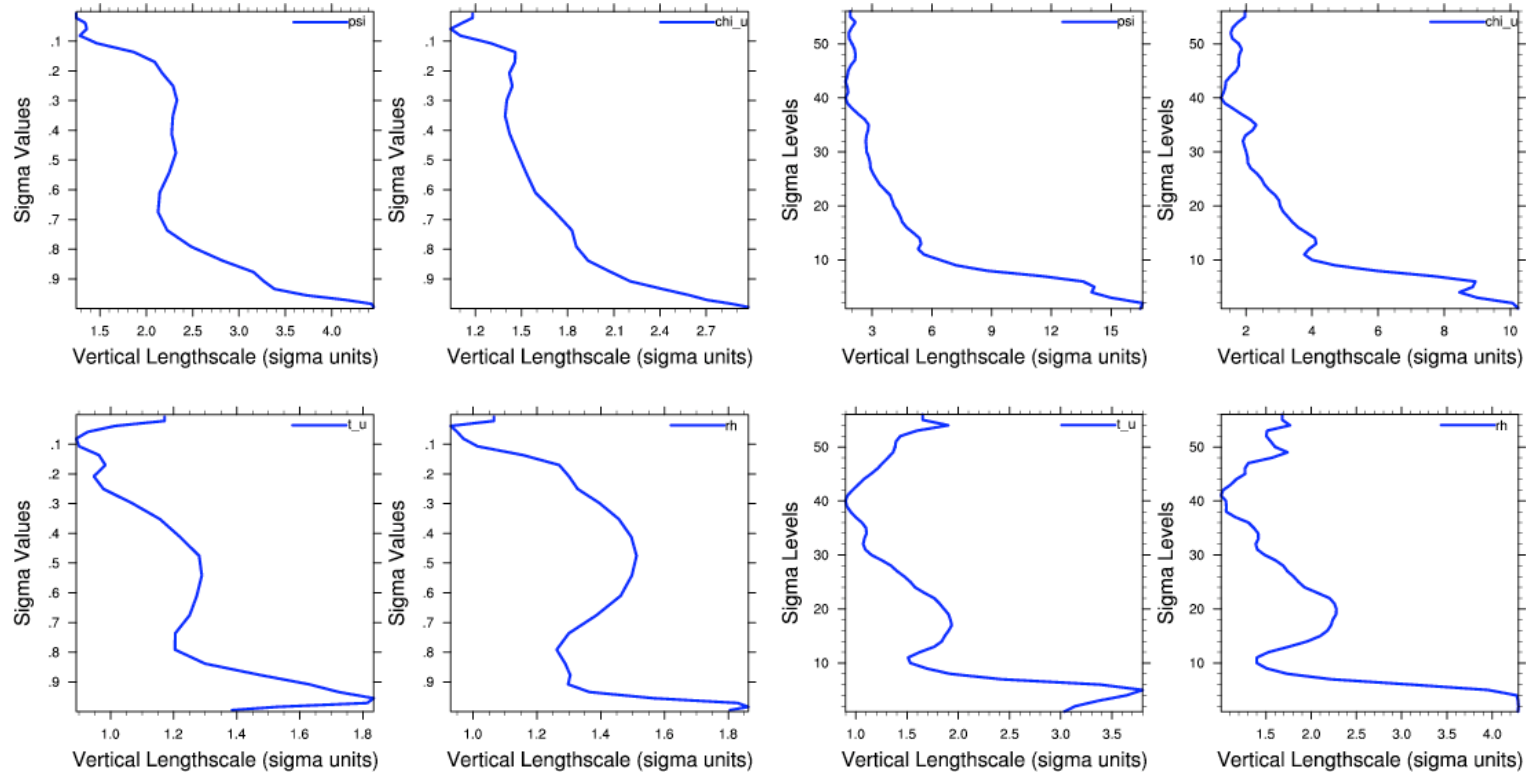


CONUS, 200 Km Domain

T8, 45 Km Domain



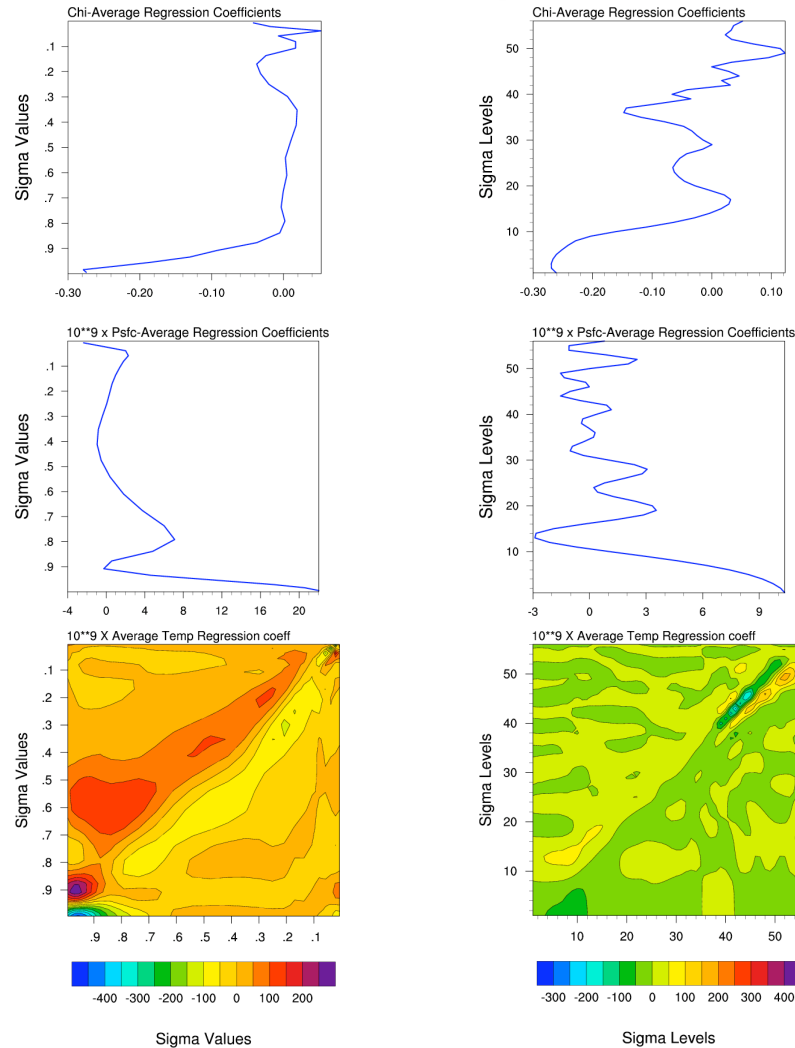
# BE diagnostics -- Vertical Length-scales



CONUS, 200 Km Domain

T8, 45 Km Domain

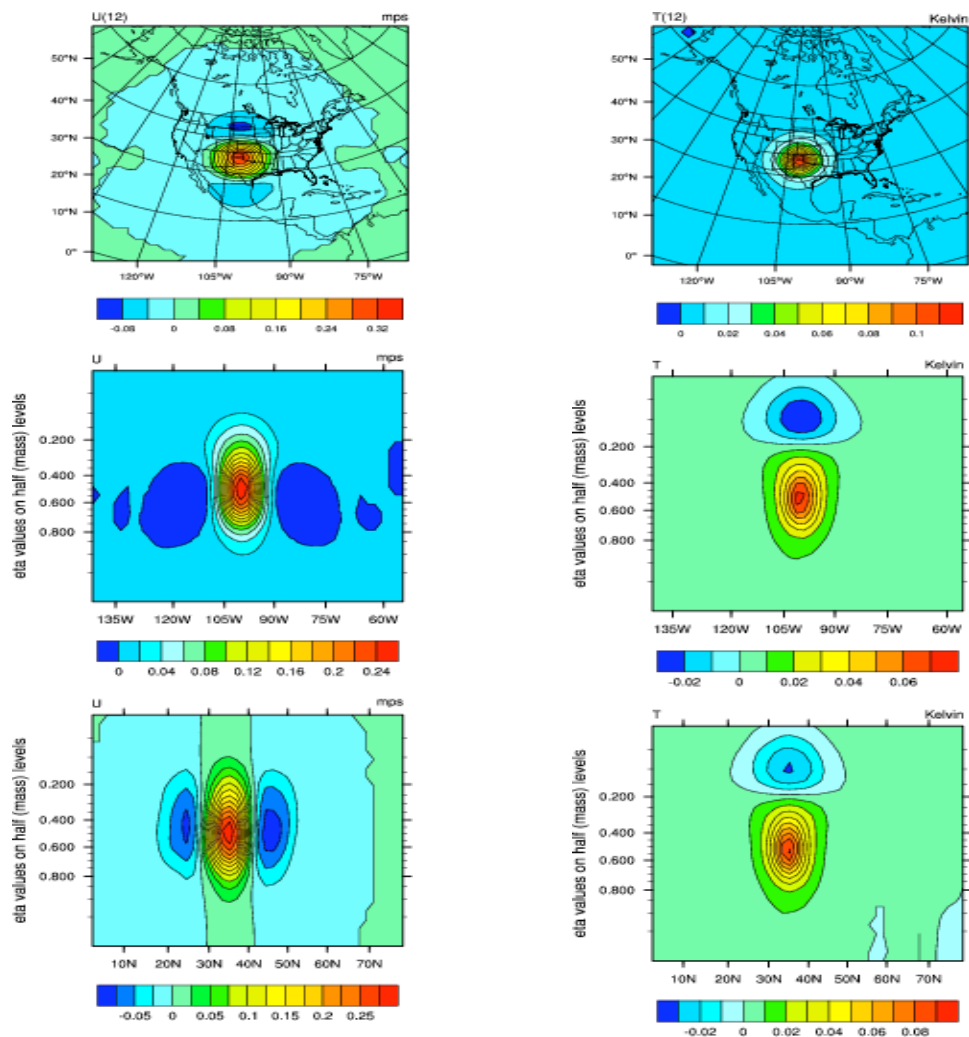
# BE diagnostics -- Regression coeff



CONUS, 200 Km Domain

T8, 45 Km Domain

# Single Obs test for CONUS 200 Km domain



U - Observation

T - Observation

