

# Data Assimilation Research Testbed Tutorial



## Section 16: Diagnostic Output

Version 2.0: September, 2006

## DART Diagnostic Output Categories:

### 1. State space:

Values of models state vector.

Output using netCDF format.

### 2. Observation space:

Values of the observations.

DART specific obs\_sequence format for now.

### 3. Regression confidence factor:

Values for state vector / observation pairs.

Output as flat ascii (soon to be netCDF).

### 4. Program diagnostic output:

Identification for source code version and namelist values.

Error, warning, message output from modules.

## State Space Diagnostic Files:

Available in netCDF (common data format)

(<http://my.unidata.ucar.edu/content/software/netcdf/index.html>).

1. Prior state (Prior\_Diag.nc): state before assimilation.
2. Posterior state (Posterior\_Diag.nc): state after assimilation.
3. Truth (True\_State.nc): truth for OSSEs.

Contents of prior and posterior controlled by filter\_nml:

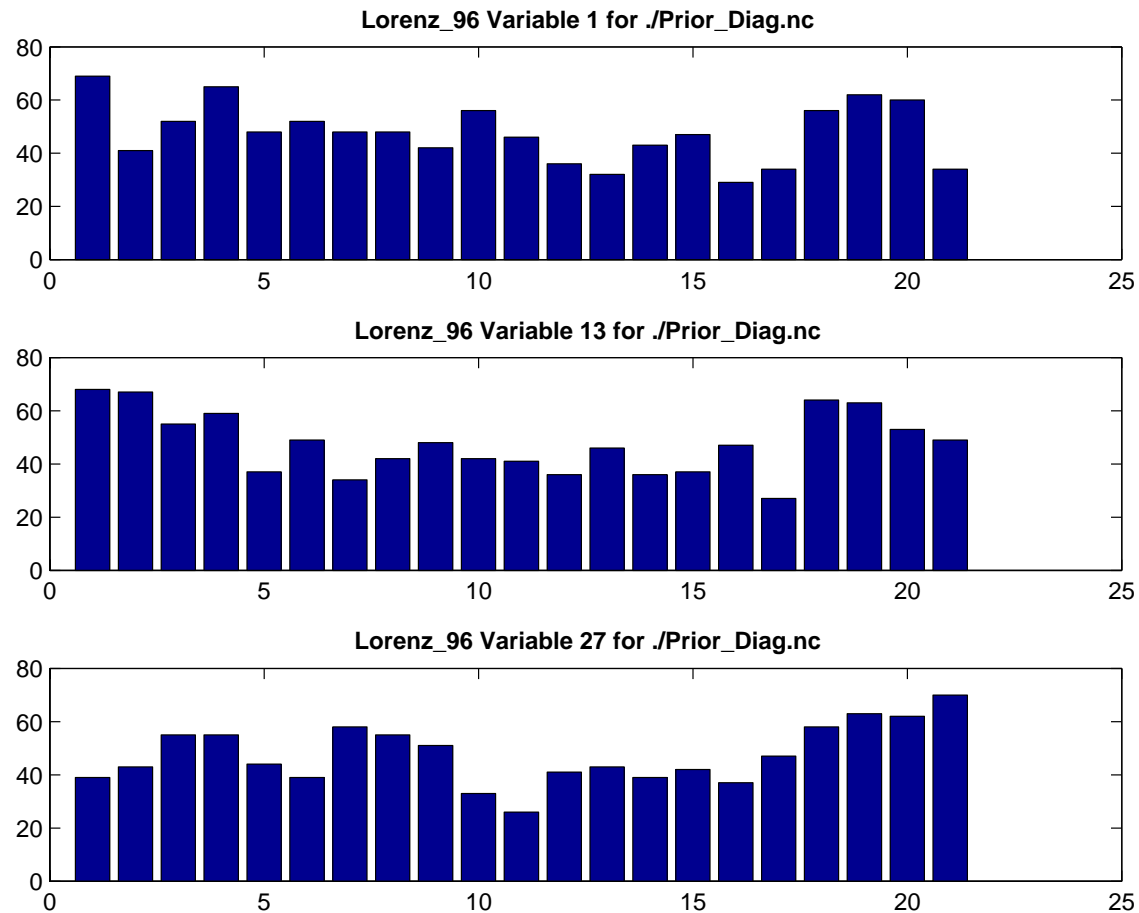
1. *output\_state\_ens\_mean* = *.true.*, (include ensemble mean);
2. *output\_state\_ens\_spread* = *.true.*, (include ensemble spread);
3. *num\_output\_state\_members* = 20,  
(include this many of the individual ensemble members);
4. *output\_interval* = 2, (only output every nth assimilation time);

Output interval for True\_State.nc in perfect\_model\_obs\_nml.

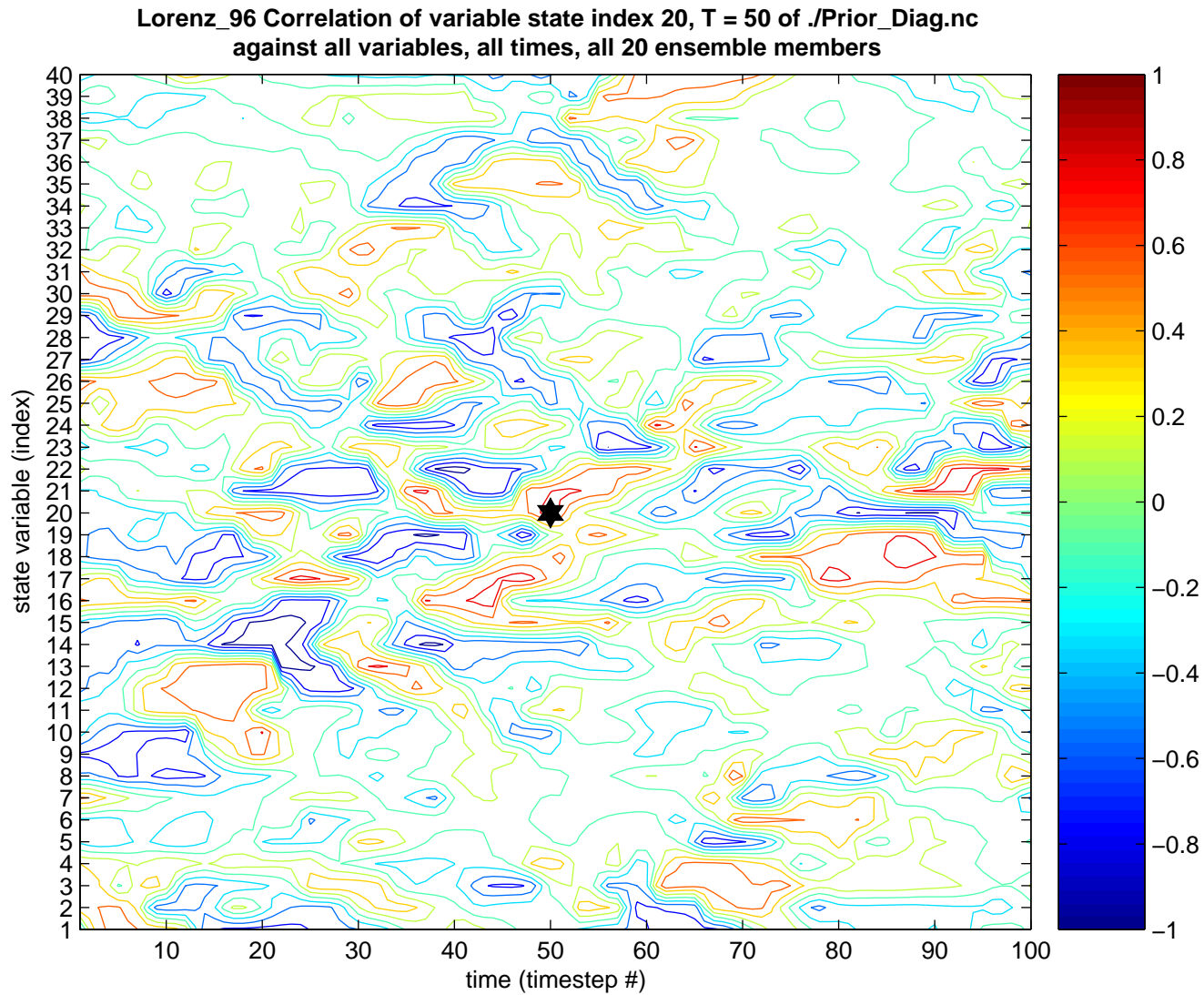
# Viewing the State Space netCDF files:

## 1. Standard DART matlab diagnostics:

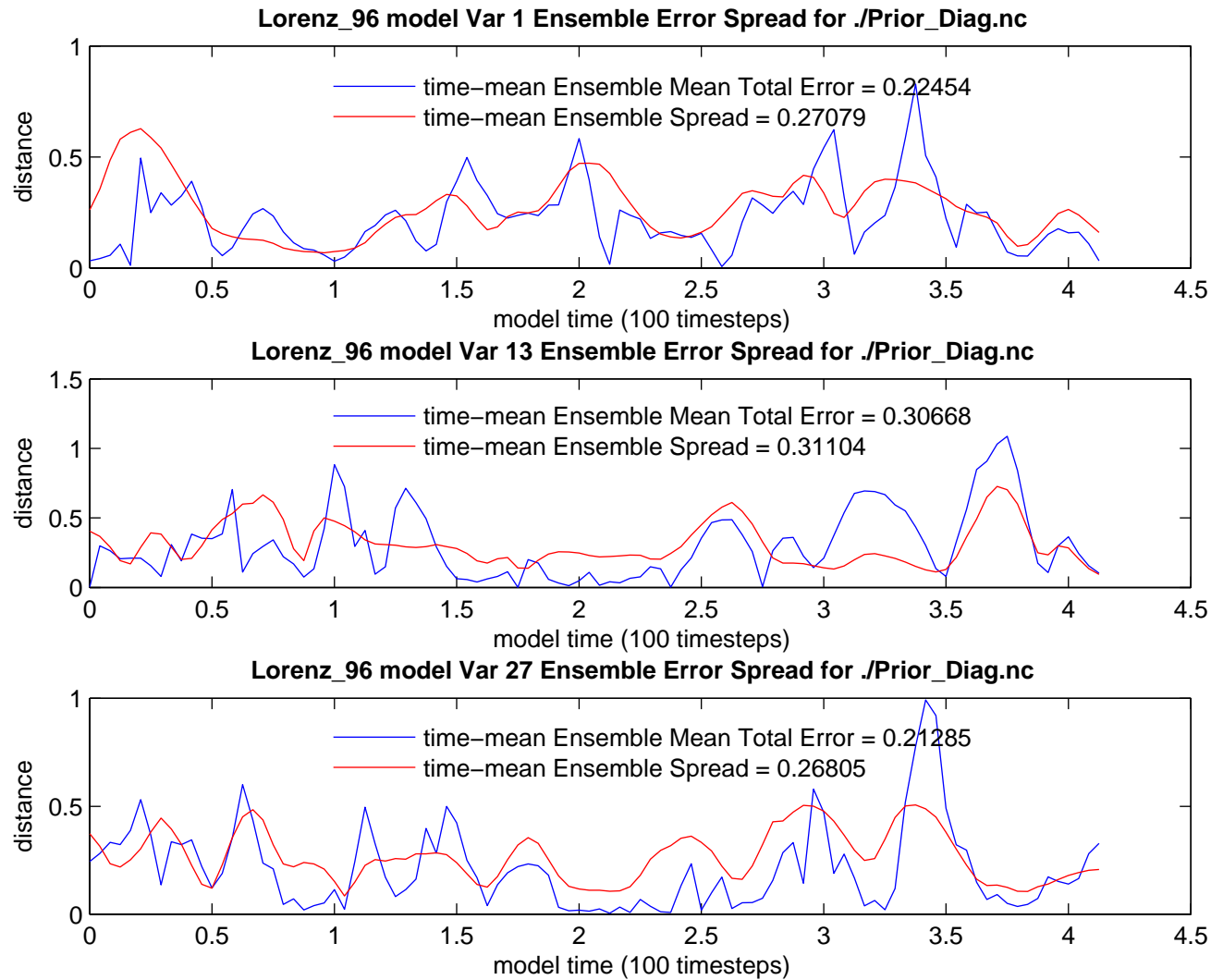
a. [plot\\_bins](#): rank histograms,



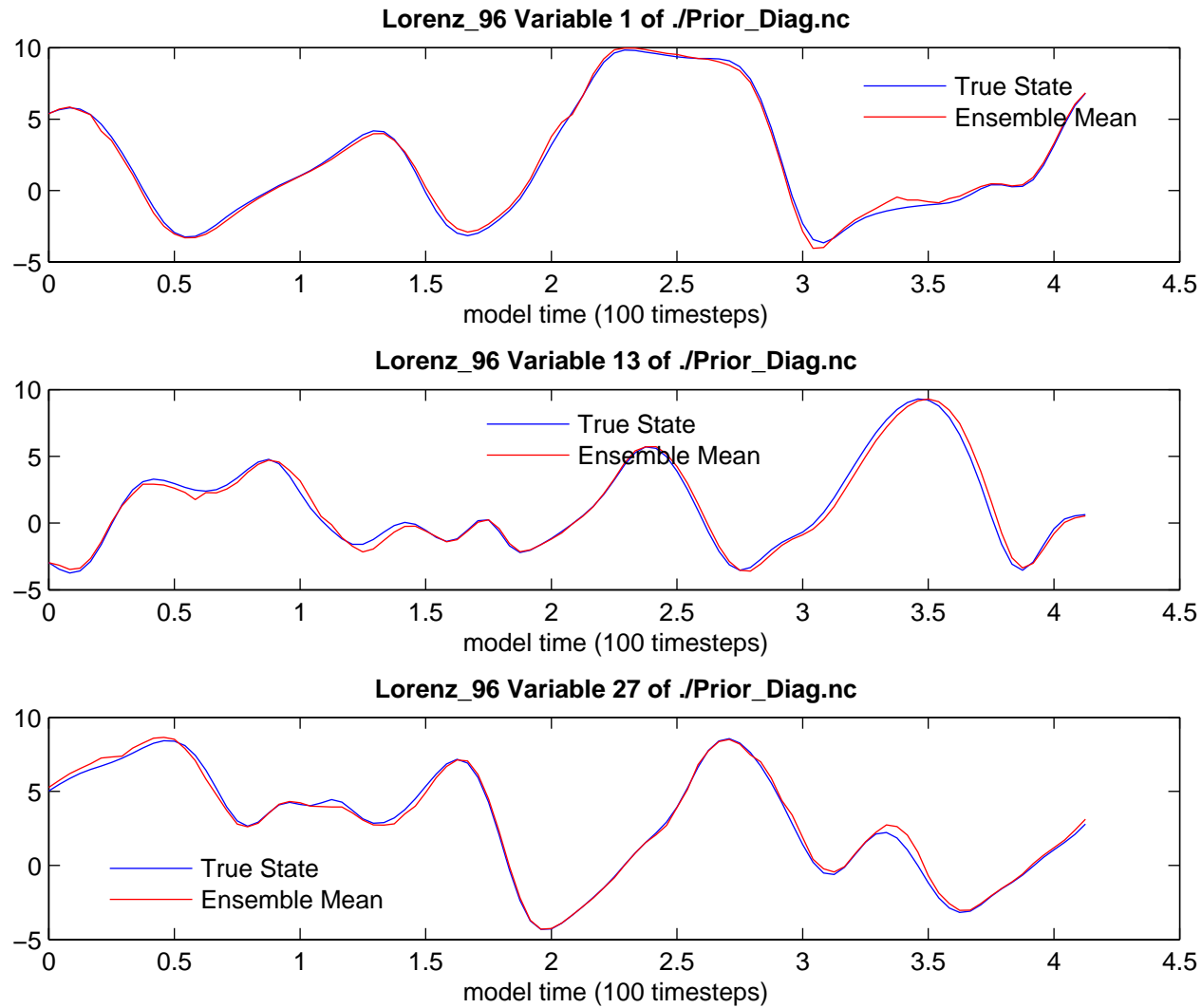
b. `plot_correl`: correlation  $x(t)$  with all other state vars at all times,



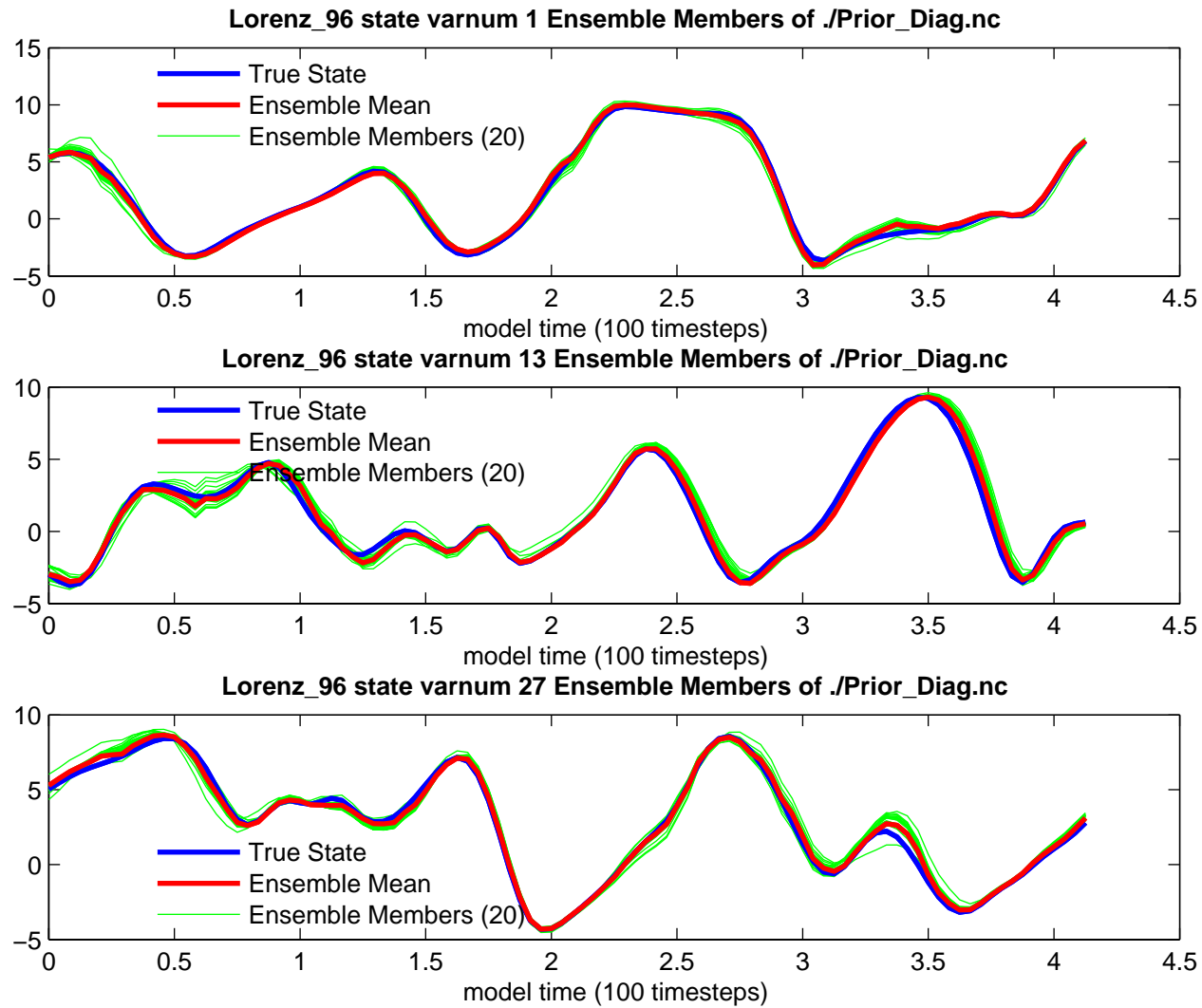
c. `plot_ens_err_spread`: rms error and spread,



d. `plot_ens_mean_time_series`: time series of ens. mean,

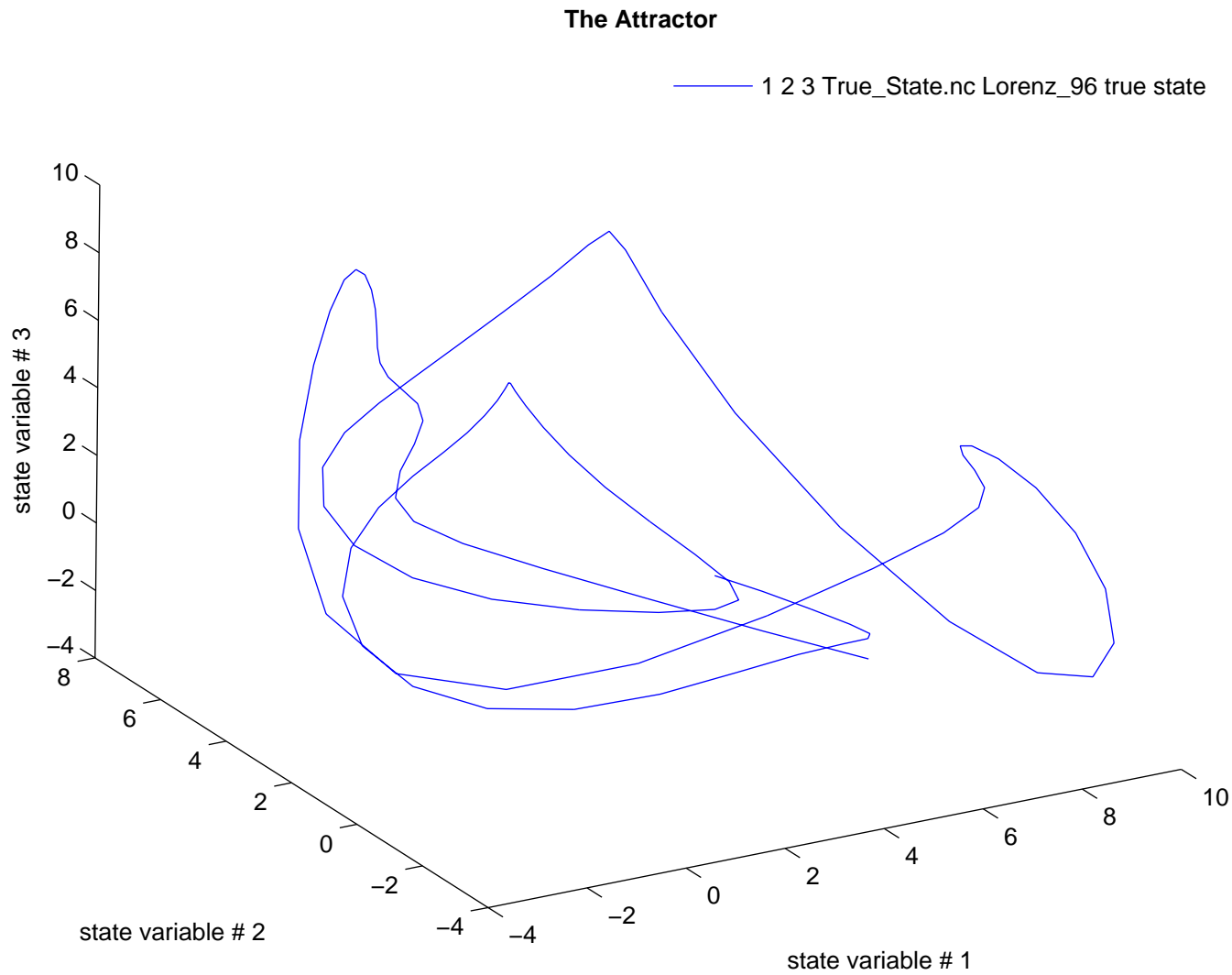


e. `plot_ens_time_series`: time series all available ensembles,

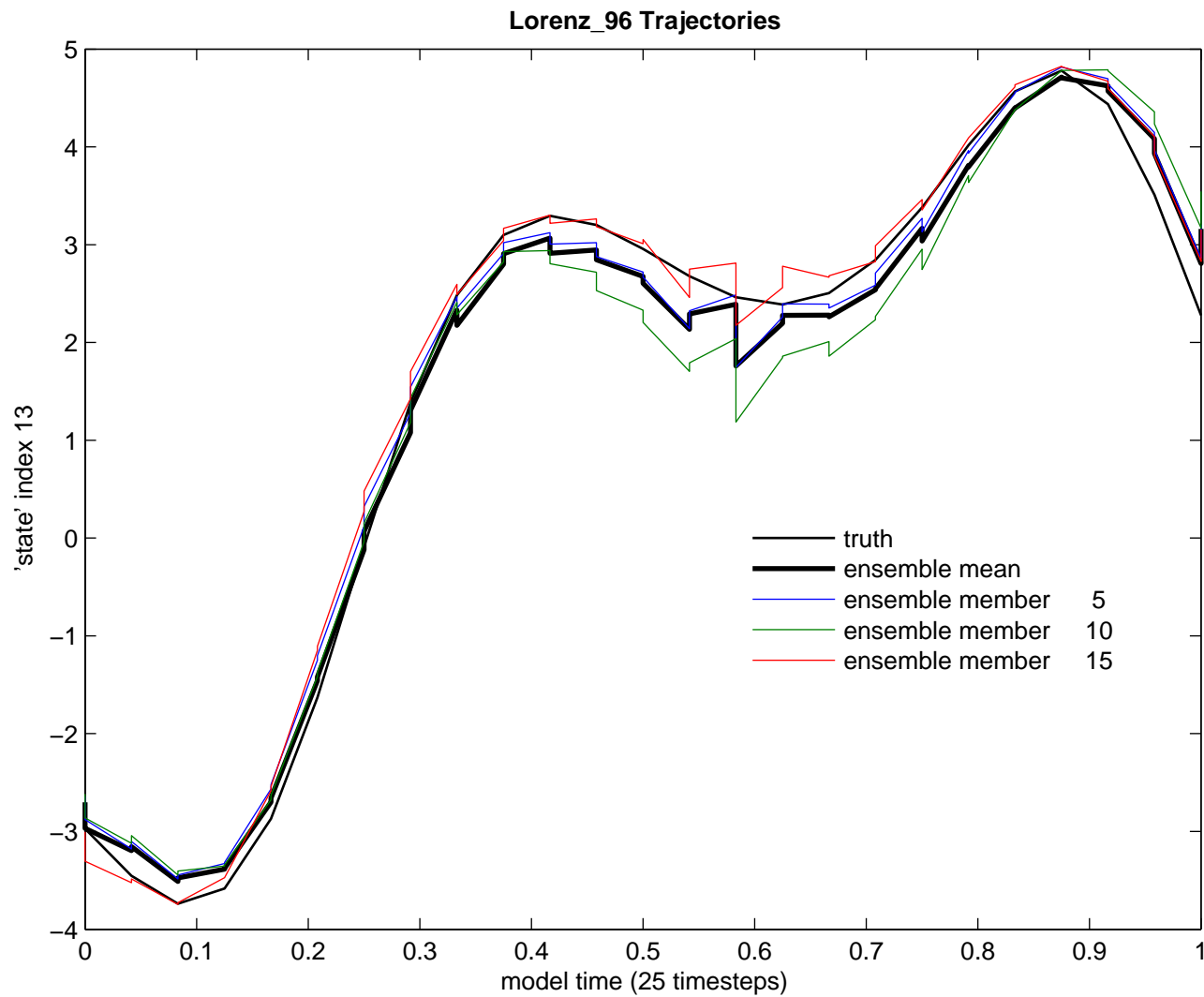




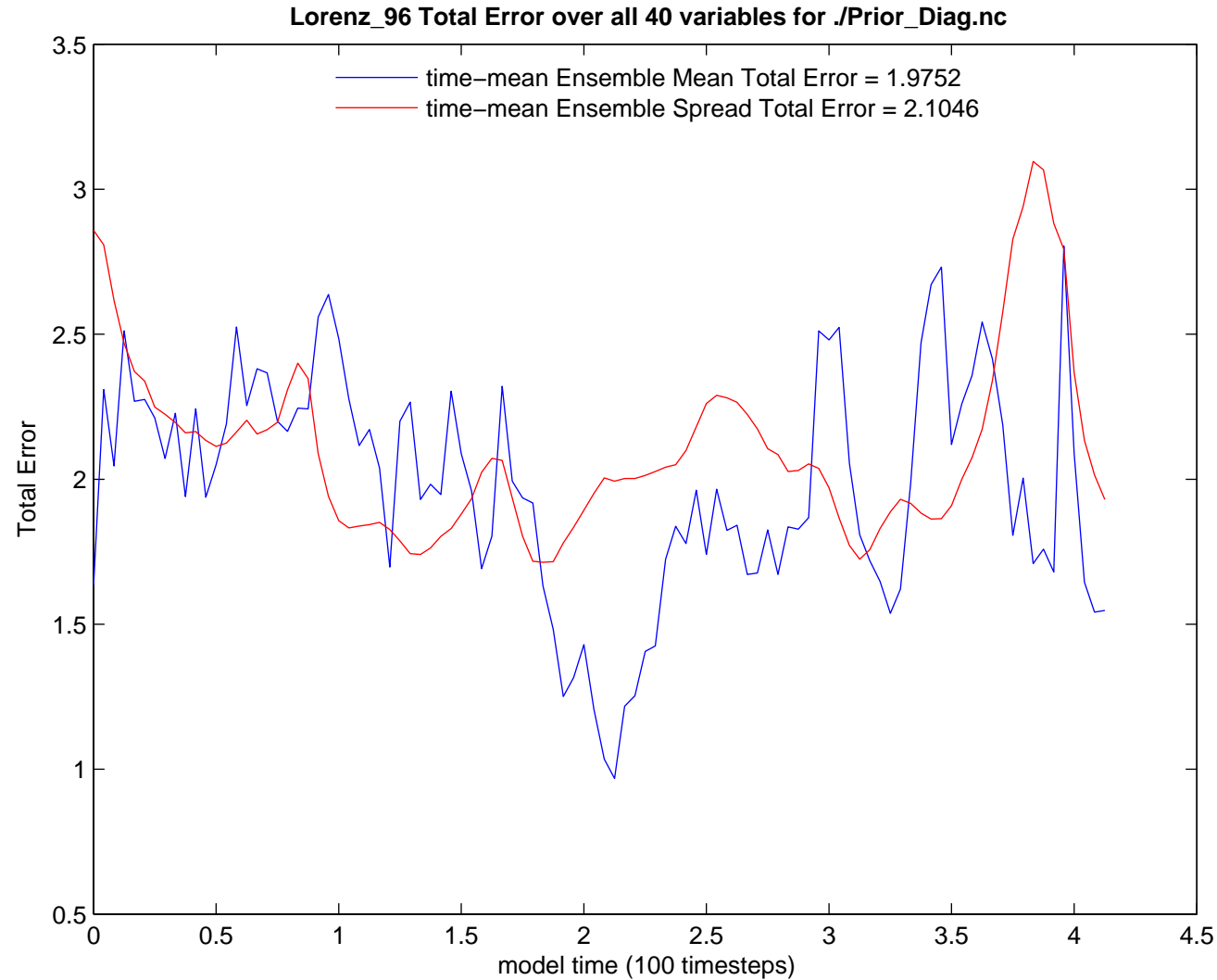
f. `plot_phase_space`: 3D phase space time evolution,



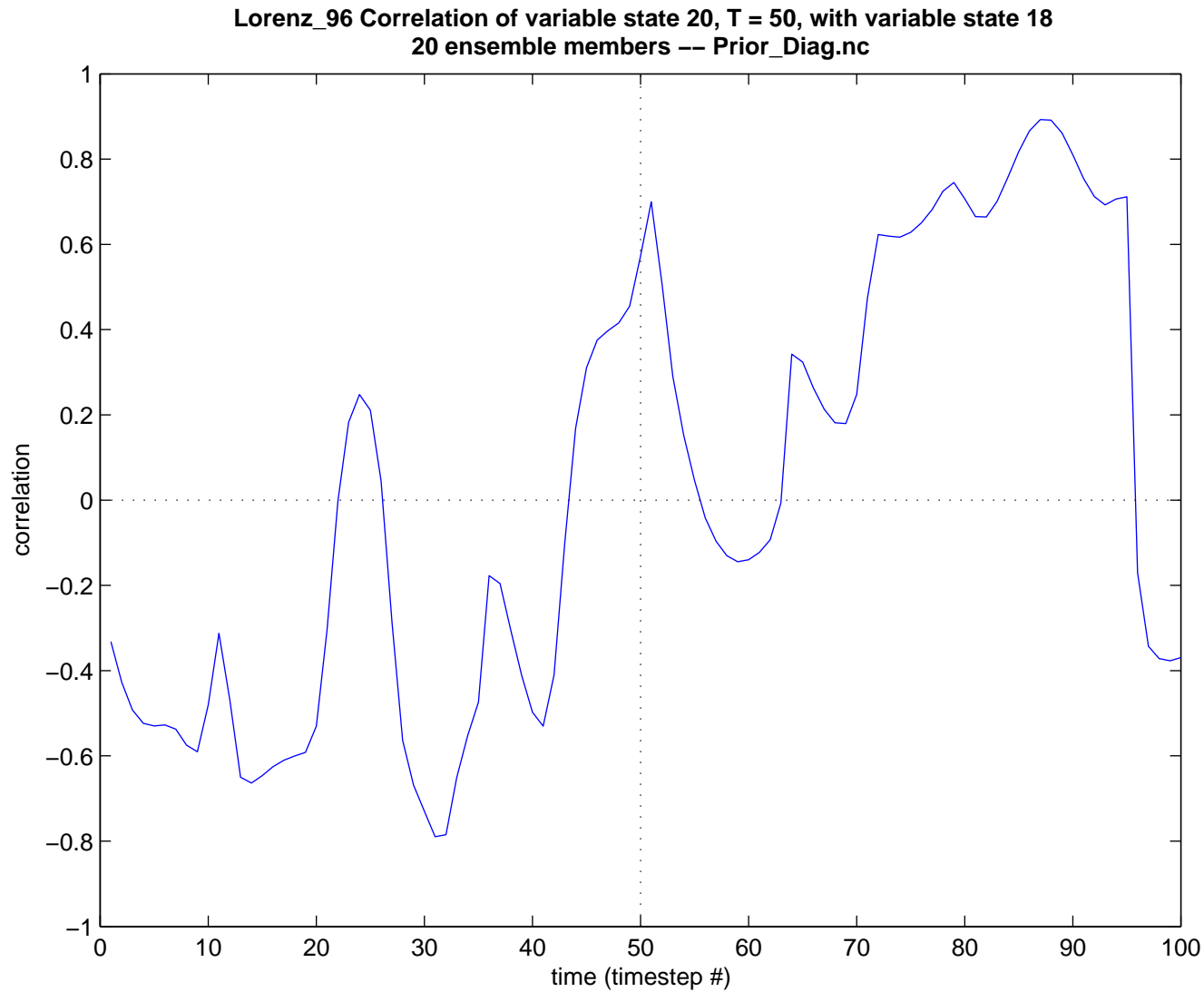
g. `plot_sawtooth`: truth, prior and posterior time series,



h. `plot_total_err`: total error for different fields,



i. `plot_var_var_correl`:  $x(t)$  correlation to single variable, all times.

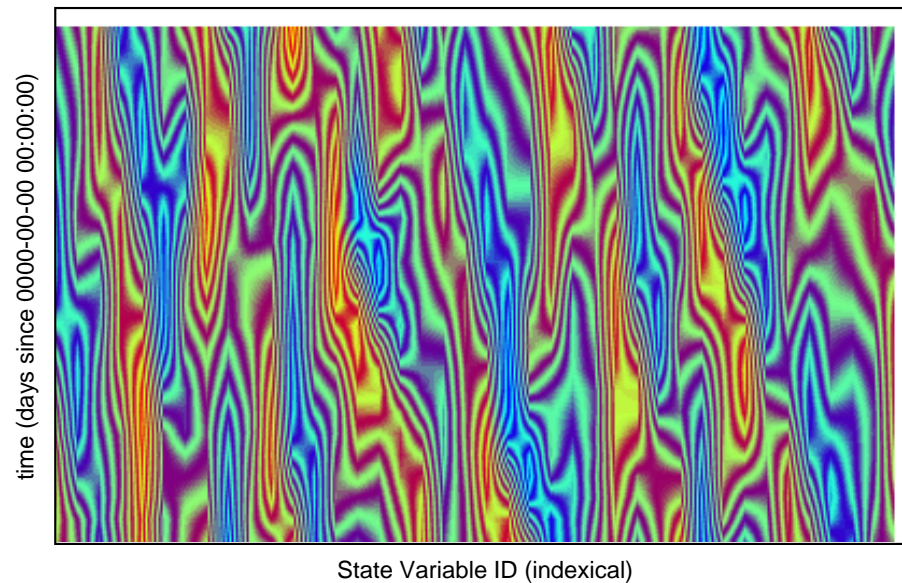


## Viewing the State Space netCDF files:

2. ncview: a quick, dirty, but surprisingly useful netCDF viewer.  
([http://meteora.ucsd.edu:80/~pierce/ncview\\_home\\_page.html](http://meteora.ucsd.edu:80/~pierce/ncview_home_page.html))

Displays spatial slices, time series,...

model state or fcopy



prior ensemble state

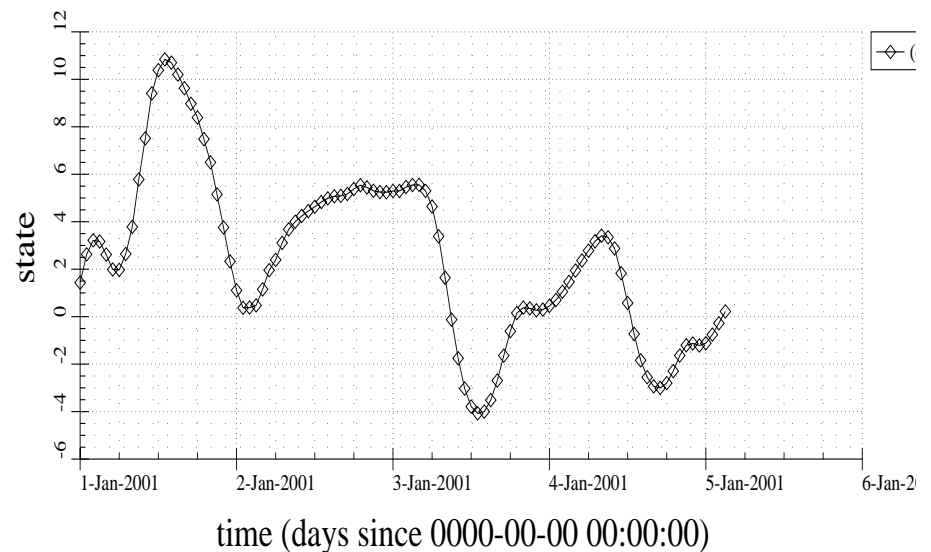
Range of model state or fcopy: -6.18328 to 11.6954 (null)

Range of State Variable ID: 1 to 40 indexical

Range of time: 0 to 1 days since 0000-00-00 00:00:00

Current ensemble member or copy: 1 nondimensional

Frame 1 in File Prior\_Diag.nc



model state or fcopy from prior ensemble state

## Viewing the State Space netCDF files:

3. Many other graphical/analysis programs can read netCDF.  
(Note that we use udunits metadata convention).
4. NCO tools allow operations on netCDF files:  
(<http://nco.sf.net>)  
Selecting hyperslices of fields,  
Differencing netCDF files,  
Averaging, etc.

## Observation Space netCDF files:

Observation sequence file output by filter has prior, posterior, observed value, (and truth for OSSEs).

Contents of *obs\_sequence.final* controlled by filter\_nml:

1. `obs_sequence_in_name = "obs_seq.out"`,  
Name of input observation sequence file.
2. `obs_sequence_out_name = "obs_seq.final"`,  
Name of output final observation sequence.
3. `output_obs_ens_mean = .true.`,  
Output the ensemble mean observation estimate.
4. `output_obs_ens_spread = .true.`,  
Output the ensemble spread.
5. `num_output_obs_members = 0`,  
Output this many individual ensemble estimates.

(See section 18 for viewing *obs\_sequence* files).

## Regression confidence factor output:

Controlled by `reg_factor_nml`:

1. `save_reg_diagnostics = .true.`, should file be output?
2. `save_reg_diagnostics = .false.`, name of output file.

File size could be (model size) x (number obs.) x (number assim times).  
Very big, even for small models (only first 4 obs output default).

Normally, modify code in `reg_factor_mod.f90` to control:

Output is at end of `select_regression = 1` code block.

Format is ascii:

time in days, time in seconds, obs index, state index,  $\alpha$ .

Plot with matlab *plot\_reg\_factor*.



## Program Diagnostic Output:

File *dart\_log.out*

Written to by all DART executables.

Contains registration information:

- Program start time,
- CVS version of code for each module used,
- Namelist values for each module,
- Names of output files,
- Diagnostic output for modules (through *error\_handler*),
- Warnings and fatal errors from DART code.

Watch out: This file is NOT cleared by DART. Can get longggggggg...