

ARW Practice Cases

ARW Practice Cases cindyhg Mon, 07/15/2019 - 14:37

Exercises

ARW Practice Cases

Case 1: Single observation test with GLOBAL BE

Case 1: Single observation test with GLOBAL BE cindyhg Mon, 07/15/2019 - 14:38

ARW SINGLE OBSERVATION TEST W/ GLOBAL BE

Introduction

This exercise consists of running the GSI analysis with a single pseudo observation at a specified location, to illustrate how that observation influences the analysis.

Further information on setting up a single observation test is available in section 4.2 of the GSI User's Guide.

The ARW background field is provided in netcdf format, and the global BE is employed as the background error covariance.

Setting up the Run Script

Setting up the Run Script cindyhg Mon, 07/15/2019 - 14:40

ARW SINGLE OBSERVATION TEST W/ GLOBAL BE

Setting up the Run Script

For this exercise, make a copy of the prepared basic run script from the section [Prepare run script for basic cases](#):

```
cp run_gsi_regional.ksh run_gsi_regional.ksh_psot .
```

Make the following additional modifications to the script `run_gsi_regional.ksh_psot` :

- Set the name/path for the analysis run directory
- Set up the one observation test option to true
- **if_oneob=Yes**
- Select the background field format
- **bk_core=ARW**
- Select the global background error covariance
- **bkcv_option=GLOBAL**

An example of this run script is available from the link [run_gsi_regional.ksh](#)

Check the GSI namelist

Users can check the namelist to see how to set up a single observation test. The related namelist options include :

- **oneobtest=.true.**
- Set the location of the pseudo observation: **&SINGLEOB_TEST**
maginnov=1.0,magoberr=0.8,oneob_type='t',
oblat=38.,oblon=279.,obpres=500.,obdattim=\${ANAL_TIME},

```
obhourset=0.,
/
```

An example namelist is available [here](#).

Running the Script

Running the Script cindyhg Mon, 07/15/2019 - 14:40

ARW SINGLE OBSERVATION TEST W/ GLOBAL BE

Running the Script

In this example, GSI is run as a 4-core MPI job. If you named your run script `run_gsi_regional.ksh_psot` and run on PBS system (Cheyenne), type:

```
qsub run_gsi_regional.ksh_psot
```

to launch the job. The progress of the job can be monitored by examining the tail of the standard out file in the run directory as set in the variable `WORK_ROOT` :

```
tail stdout
```

When completed, the contents of this run directory are provided in the following [list](#).

Case 2: Single observation test with NAM BE

Case 2: Single observation test with NAM BE cindyhg Mon, 07/15/2019 - 14:42

ARW SINGLE OBSERVATION TEST W/ NAM BE

Introduction

This exercise consists of running the GSI analysis with a single pseudo observation at a specified location, to illustrate how that observation influences the analysis.

Further information on setting up a single observation test is available in section 4.2 of the GSI User's Guide.

The ARW background field is provided in netcdf format, and the NAM (North American Mesoscale Model) BE is employed as the background error covariance.

Setting up the Run Script

Setting up the Run Script cindyhg Mon, 07/15/2019 - 14:43

ARW SINGLE OBSERVATION TEST W/ NAM BE

Setting up the Run Script

For this exercise, make a copy of the prepared basic run script:

```
cp run_gsi_regional.ksh_basic run_gsi_regional.ksh_psot .
```

Make the following additional modifications to the script `run_gsi_regional.ksh_psot` :

- Set the name/path for the analysis run directory
- Set up the one observation test option to true
- `if_oneob=Yes`
- Select the background field format
- `bk_core=ARW`

- Select the NAM background error covariance
- **bkcv_option=NAM**

An example of this run script is available from the link [run_gsi_regional.ksh](#)

Check the GSI namelist

Users can check the namelist to see how to set up a single observation test. The related namelist options include :

- **oneobtest=.true.**
- Set the location of the pseudo observation: **&SINGLEOB_TEST**
maginnov=1.0,magoberr=0.8,oneob_type='t',
oblat=38.,oblon=279.,obpres=500.,obdattim=\${ANAL_TIME},
obhourset=0.,
/

An example namelist is available [here](#).

Running the Script

Running the Script cindyhg Mon, 07/15/2019 - 14:44

ARW SINGLE OBSERVATION TEST W/ NAM BE

Running the Script

In this example, GSI is run as a 4-core MPI job. If you named your run script **run_gsi_regional.ksh** and run on PBS system (Cheyenne), type:

```
qsub run_gsi_regional.ksh
```

to launch the job.

The progress of the job can be monitored by examining the tail of the standard out file in the run directory as specified in the variable **WORK_ROOT** :

```
tail stdout
```

When completed, the contents of this run directory are provided in the following [list](#).

Results

Results cindyhg Mon, 07/15/2019 - 14:45

ARW SINGLE OBSERVATION TEST W/ NAM BE

Results

The standard output file **stdout** contains the run diagnostics, such as convergence information and observation distribution from the GSI run. Details of the standard output file are available in section 4.1 of the GSI User's Guide.

Information about the use of observations by the analysis, and the corresponding statistics are available from the **fit** files (named **fort.2***). The fit files located in the run directory should agree with the following fit files for [temperature](#) (fit_t1); [wind](#) (fit_w1); [moisture](#) (fit_q1); [surface pressure](#) (fit_p1).

Visualizing the Analysis

The model analysis may be visualized through use of the ncl script **GSI_singleobs_arw.ncl** provided with the community GSI under **./util/Analysis_Uilities/plots_ncl**. It plots the XY (left column) and XZ (right column) cross sections of the analysis increment fields through the grid point that has the maximum temperature increment.

To visualize your output, copy the ncl script to run directory and change lines:

- change **cdf_analysis = addfile("wrf_inout.cdf","r") to point to analysis results.**
- change **cdf_bk = addfile("\${DATA_ROOT}/wrfout_d01_2018-08-12_12:00:00.cdf","r") to point to background.**

A sample script can be found at [GSI_singleobs_arw.ncl](#)

Once you have customized the script, run the script with the command:

```
ncl GSI_singleobs_arw.ncl
```

The script will generate a file: **GSI_singleObse_T_arw.pdf**. Use **display GSI_singleObse_T_arw.pdf** to show the image. Compare this image with the reference solution [\[PDF\]](#) for this configuration.

Case 3: 3DVAR with conventional data (PrepBUFR)

Case 3: 3DVAR with conventional data (PrepBUFR) cindyhg Tue, 07/16/2019 - 10:47

3DVAR GSI USING ARW BACKGROUND (PREPBUFR)

Introduction

This exercise consists of running the GSI analysis with an ARW netcdf formatted background field, conventional data from prepbuf.

Further information on setting up the run is available in chapter 3 of the GSI User's Guide.

The ARW background field is provided in netcdf format, and the regional NAM BE is employed as the background error covariance.

Setting up the Run Script

Setting up the Run Script cindyhg Tue, 07/16/2019 - 10:48

3DVAR GSI USING ARW BACKGROUND (PREPBUFR)

Setting up the Run Script

For this exercise, make a copy of the previously prepared run script:

```
cp run_gsi_regional.ksh_basic run_gsi_regional.ksh .
```

Make the following additional modifications to the script **run_gsi_regional.ksh** :

- Set the name/path for the analysis run directory to
- **WORK_ROOT=\${run_directory}**
- Select the background field format **bk_core=ARW**
- Select the NAM regional background error covariance **bkcv_option=NAM**
- Comment out the links to the radiance data, gpsro and radar data:
- **# ln -s \${srcobsfile[\$ii]} \${gsiobsfile[\$ii]}**

An example of this run script is available from the link [run_gsi_regional.ksh](#)

Running the Script

Running the Script cindyhg Tue, 07/16/2019 - 10:49

3DVAR GSI USING ARW BACKGROUND (PREPBUFR)

Running the Script

For this example, GSI is run as a 4-core MPI job. If you run on PBS system (Cheyenne), type:

```
qsub run_gsi_regional.ksh
```

to launch the job.

The progress of the job can be monitored by examining the tail of the standard out file in the run directory as specified in the variable **WORK_ROOT** :

```
tail stdout
```

The contents of this run directory are provided in the following [list](#).

Results

Results cindyhg Tue, 07/16/2019 - 10:49

3DVAR GSI USING ARW BACKGROUND (PREPBUFR)

Results

The standard output file [stdout](#) contains the run diagnostics, such as convergence information, and observation distribution from the GSI run. Details of the standard output file are available in section 4.1 of the GSI User's Guide.

Information about the use of observations by the analysis, and the corresponding innovations are available from the **fit** files (named **fort.2***). The fit files located in the run directory should agree with the following fit files for [temperature](#) (fit_t1); [wind](#)(fit_w1); [moisture](#) (fit_q1); [surface pressure](#) (fit_p1); and [radiance](#) (fit_rad1); and [GPS](#) (fort.212); and [radar radial velocity](#)(fort.209).

Convergence information is available in the file: [fort.220](#)

Visualizing the Analysis

The model analysis may be visualized through modifying the ncl script **Analysis_increment.ncl** provided with the community GSI under **./util/Analysis_Uilities/plots_ncl**. This script plots the analysis increments from conventional observations at at level 1 and 20.

To visualize your output, copy the ncl script to run directory and make the following changes:

- Set: **cdf_analysis = addfile("wrf_inout.cdf","r")** to point to analysis results
- Set: **cdf_bk = addfile("\${PATH}/wrf_inout.cdf","r")** to point to background file.
- Set: **kmax=1** for plot at level 2 or 20 for plot at level 21

The sample scripts for these plots can be found at [GSI Analysis_increment.ncl](#)

Once you have customized the script for your output directory, run the script with the command:

```
nc1 GSI_Analysis_increment.nc1
```

Once done a pdf file **GSI_Analysis_increment_20.pdf** will be generated for 21 level analysis increment in the run directory. Compare these images with the reference solution [[PDF](#)]. Here is reference for the 2nd level [[PDF](#)].

Case 4: 3DVAR with conventional data (PrepBUFR) plus other data

Case 4: 3DVAR with conventional data (PrepBUFR) plus other data cindyhg Tue, 07/16/2019 - 10:50

3DVAR GSI USING ARW BACKGROUND (PREPBUFR AND OTHER OBS)

Introduction

This exercise consists of running the GSI analysis with an ARW netcdf formatted background field, conventional data from prepbufr, satellite radiances, gpsro and radar data.

Further information on setting up the run is available in chapter 3 of the GSI User's Guide.

The ARW background field is provided in netcdf format, and the regional NAM BE is employed as the background error covariance.

Setting up the Run Script

Setting up the Run Script cindyhg Tue, 07/16/2019 - 10:51

3DVAR GSI USING ARW BACKGROUND (PREPBUFR AND OTHER OBS)

Setting up the Run Script

For this exercise, make a copy of the previously prepared run script:

```
cp run_gsi_regional.ksh_basic run_gsi_regional.ksh .
```

Make the following additional modifications to the script **run_gsi_regional.ksh** :

- Set the name/path for the analysis run directory to
- **WORK_ROOT=\${run_directory}**
- Select the background field format **bk_core=ARW**
- Select the NAM regional background error covariance **bkcv_option=NAM**
- Open the links to the radiance data, gpsro and radar data by un-commenting the following line:
- **ln -s \${srcobsfile[\$ii]} \${gsiobsfile[\$ii]}**

An example of this run script is available from the link [run_gsi_regional.ksh](#)

Running the Script

Running the Script cindyhg Tue, 07/16/2019 - 10:51

3DVAR GSI USING ARW BACKGROUND (PREPBUFR AND OHTER OBS)

Running the Script

For this example, GSI is run as a 4-core MPI job. If you run on PBS system (Cheyenne), type:

```
qsub run_gsi_regional.ksh
```

to launch the job.

The progress of the job can be monitored by examining the tail of the standard out file in the run directory as specified in the variable **WORK_ROOT** :

tail stdout

The contents of this run directory are provided in the following [list](#).

Results

Results cindyhg Tue, 07/16/2019 - 10:52

3DVAR GSI USING ARW BACKGROUND (PREPBUFR AND OTHER OBS)

Results

The standard output file **stdout** contains the run diagnostics, such as convergence information, and observation distribution from the GSI run. Details of the standard output file are available in section 4.1 of the GSI User's Guide.

Information about the use of observations by the analysis, and the corresponding innovations are available from the **fit** files (named **fort.2***). The fit files located in the run directory should agree with the following fit files for [temperature](#) (fit_t1); [wind](#)(fit_w1); [moisture](#) (fit_q1); [surface pressure](#) (fit_p1); and [radiance](#) (fit_rad1); and [GPS](#) (fort.212); and [radar radial velocity](#)(fort.209).

Convergence information is available in the file: [fort.220](#)

Visualizing the Analysis

The model analysis may be visualized through modifying the ncl script **Analysis_increment.ncl** provided with the community GSI under **./util/Analysis_Uilities/plots_ncl**. This script plots the data impact from additional satellite radiance, gpsro and radar data (analysis with conventional, satellite radiance, gpsro and radar data minus analysis with conventional data only) at level 31.

To visualize your output, copy the ncl script to run directory and make the following changes:

- Set: **cdf_analysis = addfile("wrf_inout.cdf","r") to point to analysis results**
- Set: **cdf_bk = addfile("\${Path to case 3 result}/wrf_inout.cdf","r") point to case 3 analysis file.**
- Set: **kmax=20** for plot at level 21

The sample scripts for these plots can be found at [GSI Analysis_increment.ncl](#)

Once you have customized the script for your output directory, run the script with the command:
ncl Analysis_increment.ncl

Once done a pdf file **GSI_Analysis_increment_20.pdf** will be generated in the run directory. Compare these images with the reference solution [\[PDF\]](#).

Case 5: 3D Hybrid EnVar

Case 5: 3D Hybrid EnVar cindyhg Tue, 07/16/2019 - 10:53

GSI 3D HYBRID FOR ARW USING GLOBAL ENSEMBLE FORECAST

Introduction

This exercise runs the GSI 3 Dimensional Ensemble-Variational (EnVar) hybrid analysis with the ARW background, conventional data at 12z August 12, 2018.

Please note the ARW background field is provided in netcdf format, and the NAM BE is employed as the background error covariance in this experiment. The global ensemble forecasts are linked to run this GSI hybrid test.

Setting up the Run Script for GSI hybrid analysis

Setting up the Run Script for GSI hybrid analysis cindyhg Tue, 07/16/2019 - 10:53

GSI 3D HYBRID FOR ARW USING GLOBAL ENSEMBLE FORECAST

Setting up the Run Script for GSI hybrid analysis

Copy the sample run script `run_gsi_regional.ksh` from the practical case 3 ([ARW 3DVAR with PrepBUFR](#)) to a working directory and make the following modifications to run GSI hybrid analysis:

- Set the name/path for the analysis run directory to
- `WORK_ROOT=${run_directory}`
- Set the location of the ensemble files in the variable `ENS_ROOT=...`
- Set to run GSI hybrid analysis: `if_hybrid=Yes`
- Set not to run GSI 4D hybrid analysis: `if_4DEnVar=No`

Please note that the sample script provides links to the GFS ensemble data for this tutorial case only. If you are running your own GSI hybrid case with a different date, please make any necessary modifications to specify the variable `ENS_ROOT` and `ENSEMBLE_FILE_mem` in the run script.

Running the Script

Running the Script cindyhg Tue, 07/16/2019 - 10:54

SETUP GSI 3D HYBRID FOR ARW USING GLOBAL ENSEMBLE FORECAST

Running the Script

If you run on PBS system (Cheyenne), type:

```
qsub run_gsi_regional.ksh
```

to launch the job.

The progress of the job can be monitored by examining the tail of the standard out file in the run directory as specified in the variable `WORK_ROOT` :

```
tail stdout
```

When completed, the contents of this run directory are provided in the following [list](#).

Results

Results cindyhg Tue, 07/16/2019 - 10:55

SETUP GSI 3D HYBRID FOR ARW USING GLOBAL ENSEMBLE FORECAST

Results

The standard output file `stdout` contains the run diagnostics, such as convergence information, and observation distribution from the GSI run. Details of the standard output file are available in section 4.1 of the GSI User's Guide.

Information about the use of observations by the analysis, and the corresponding innovations are available from the **fit** files (named **fort.2***). The fit files located in the run directory should agree with the following fit files for [temperature](#) (fit_t1); [wind](#)(fit_w1); [moisture](#) (fit_q1); [surface pressure](#) (fit_p1); and [radiance](#) (fit_rad1); and [GPS](#) (fort.212); and [radar radial velocity](#)(fort.209).

Convergence information is available in the file: [fort.220](#)

Visualizing the Analysis

Use the same method as the practical case 3 (ARW 3DVAR) to make plots of the analysis increments. This time, plots will be made for the 2nd level (kmax=1) and level 21 (kmax=20). Once done pdf files **GSI_Analysis_increment_1.pdf** and **GSI_Analysis_increment_20.pdf** will be generated in the run directory. Compare these images with the reference solution [[level 2](#)] and [[level 21](#)].

Case 6: Cycling Case

Case 6: Cycling Case cindyhg Tue, 07/16/2019 - 10:56

GSI CYCLING RUN ARW BACKGROUND

Introduction

This exercise illustrate the basic structure and flow of a cycling data assimilation system, as shown in this [chart \(time doesn't match with the new case\)](#). It consists of running the GSI analysis with an ARW netcdf background field, and then the GSI analysis provides the initial fields for running a WRF-ARW forecast. The forecast output can be used as the GSI background for next GSI analysis.

The regional NAM BE is employed as the background error covariance and only conventional observations are assimilated in this example.

There are 4 steps in this GSI-ARW cycling data assimilation exercise:

- Step 1: GSI Data Analysis for 12Z of August 12, 2018. This step is similar to the online exercise [ARW 3DVAR with conventional data \(PrepBUFR\)](#)
- Step 2: WRF-ARW model forecast at 12Z of August 12, 2018, using the GSI analysis from step 1.
- Step 3: GSI Data Analysis for 18Z of August 12, 2018, using the 6-hour forecast output from step 2.
- Step 4: WRF-ARW model forecast at 18Z of August 12, 2018, using the GSI analysis from step 3.

GSI analysis at 12Z

GSI analysis at 12Z cindyhg Tue, 07/16/2019 - 10:57

GSI CYCLING RUN ARW BACKGROUND

GSI analysis at 12Z

For this step of GSI analysis at 12Z of August 12, 2018, we will use the GSI analysis output **wrf_inout** from the online exercise 03 [ARW 3DVAR with conventional data \(PrepBUFR\)](#).

If you haven't practiced case 03, simply follow the steps in the above link to perform the GSI data assimilation and get the analysis.

Set up WRF-ARW run at 12Z

Set up WRF-ARW run at 12Z cindyhg Tue, 07/16/2019 - 10:58

GSI CYCLING RUN ARW BACKGROUND

Set up WRF-ARW run at 12Z

For this step of WRF-ARW run at 12Z of August 12, 2018, we will use the GSI analysis output `wrf_inout` from the online exercise 05 as the initial fields to launch 6-hour WRF forecast.

First, make sure you have a compiled code of the latest WRF-ARW code (V4.0). You can download the boundary condition for WRF from [link](#).

Please follow the WRF tutorial and documents for the details of the WRF system application.

Here we provide the namelist file for reference of WRF run:

[namelist.input](#)

Running the ARW and checking the forecast results

The ARW can be run by creating a run script [run_wrf.ksh](#) and submitting it in the run directory:

```
bsub < run_wrf.ksh
```

It will take a few minutes to finish. Once done, users should see the forecast files in each forecast hour from 12z to 20z like

```
wrfout_d01_2018-08-12_HH_00:00:00 .
```

The contents of this run directory are provided in the following [list](#).

The ARW standard output file [rsl.out.0000](#) is provided for reference.

GSI analysis at 18Z

GSI analysis at 18Z cindyhg Tue, 07/16/2019 - 10:58

GSI CYCLING RUN ARW BACKGROUND

GSI analysis at 18Z

For this step of GSI analysis at 18Z of August 12, 2018, we will use the 6-hour forecast output from the WRF run at 12Z as the background and conventional observations at 18Z. The steps to set up the GSI analysis is very similar to case 03, except for the background field and observations. The example run script can be found [here](#).

Running the GSI run Script and checking the results

After GSI runs, a run directory will be created according to the path set in the variable `WORK_ROOT`. The contents of this run directory are provided in the following [list](#).

The standard output file `stdout` and the `fit` files for this GSI run: [temperature](#) (fit_t1); [wind](#) (fit_w1); [moisture](#) (fit_q1).

Convergence information (section 4.6 of the GSI User's Guide) is available in the file: [fort.220](#)

WRF-ARW run at 18Z

As a continued data assimilation run, the 18Z GSI analysis from the above step is then used as the initial field, together with the WRF background conditions at 18Z, to launch the WRF forecast at 18Z. The steps are very similar to the WRF run at 12Z and therefore not repeated here.

Case 7: 4D Hybrid EnVar Case

Case 7: 4D Hybrid EnVar Case cindyhg Tue, 07/16/2019 - 10:59

GSi 4D HYBRID FOR ARW USING GLOBAL ENSEMBLE FORECAST

Introduction

This exercise runs the GSI 4 Dimensional Ensemble-Variational (EnVar) hybrid analysis with the ARW background and conventional data at 18z August 12, 2018.

Please note the ARW background field is provided at three time levels in netcdf format from case 6, and the NAM BE is employed as the background error covariance in this experiment. The global ensemble files at three time levels are linked to run this GSI 4DEnVar hybrid test.

Please check the [Download Practice Data](#) section if need to obtain the background, observation, and ensemble forecast files.

Setting up the Run Script for GSI 4D hybrid analysis

Setting up the Run Script for GSI 4D hybrid analysis cindyhg Tue, 07/16/2019 - 10:59

GSi 4D HYBRID FOR ARW USING GLOBAL ENSEMBLE FORECAST

Setting up the Run Script for GSI 4D hybrid analysis

Copy the sample run script `run_gsi_regional.ksh` from the practical case 3 ([ARW 3DVAR with PrepBUFR](#)) to a working directory and make the following modifications to run GSI 4D hybrid analysis:

- set the analysis time to
`ANAL_TIME=2017051318`
- Set the name/path for the analysis run directory to
- `WORK_ROOT=${run_directory}`
- Set the location of the ensemble files in the variable `ENS_ROOT=...`
- set the `BK_ROOT` to where you store the background files, WRF forecast at 3 time levels
- set the path to the background file at the analysis time
`BK_FILE=${BK_ROOT}/wrfout_d01_2018-08-12_18:00:00`
- set to run 4D hybrid analysis
`if_hybrid=Yes`
`if_4DEnVar=Yes`

As can be seen in the sample run script, for `${if_4DEnVar} = Yes`, there are two additional background files at 1 hour before and after the analysis time, as specified in the variable `BK_FILE_M1` and `BK_FILE_P1`; there are also two additional sets of ensemble files before and after the analysis time, as specified in the variable `ENSEMBLE_FILE_mem_m1` and `ENSEMBLE_FILE_mem_p1`. Please make sure those variables setup right.

An example of this run script is available from the link [run_gsi_regional.ksh](#)

Running the Script

Running the Script cindyhg Tue, 07/16/2019 - 11:00

GSi 4D HYBRID FOR ARW USING GLOBAL ENSEMBLE FORECAST

Running the Script

If you run on PBS system (Cheyenne), type:

```
qsub run_gsi_regional.ksh
```

to launch the job.

The progress of the job can be monitored by examining the tail of the standard out file in the run directory as specified in the variable **WORK_ROOT** :

```
tail stdout
```

When completed, the contents of this run directory are provided in the following [list](#).

Results

Results cindyhg Tue, 07/16/2019 - 11:00

GSI 4D HYBRID FOR ARW USING GLOBAL ENSEMBLE FORECAST

Results

The standard output file [stdout](#) contains the run diagnostics, such as convergence information, and observation distribution from the GSI run. Details of the standard output file are available in section 4.1 of the GSI User's Guide.

Information about the use of observations by the analysis, and the corresponding innovations are available from the **fit** files (named **fort.2***). The fit files located in the run directory should agree with the following fit files for [temperature](#) (fit_t1); [wind](#)(fit_w1); [moisture](#) (fit_q1); [surface pressure](#) (fit_p1); and [radiance](#) (fit_rad1); and [GPS](#) (fort.212); and [radar radial velocity](#)(fort.209).

Convergence information is available in the file: [fort.220](#)

Visualizing the Analysis

Use the same method as the practical case 3 (ARW 3DVAR) to make plots of the analysis increments. This time, plots will be made for the 2nd level (kmax=1) and level 21 (kmax=20). Once done pdf files **GSI_Analysis_increment_1.pdf** and **GSI_Analysis_increment_20.pdf** will be generated in the run directory. Compare these images with the reference solution [[level 2](#)] and [[level 21](#)].