**A sample weakly coupled ensemble DA system based on DAFCC1**

**User’s Guide**

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## Get the sample ensemble DA system and DAFCC1 code

## Download source code and unzip

Users can download the DAFCC1 source code from the zenodo address mentioned in the manuscript (<https://doi.org/10.5281/zenodo.3739729>). After downloading, users can get the compressed package “DAFCC-v1.0.zip” and run command “unzip DAFCC-v1.0.zip”. The unzipped directory is the working directory of the DAFCC1, including a README file and the directory *C-Coupler*.

Users can download the sample ensemble DA system code from the Github address mentioned in the manuscript (<https://github.com/ChaoSun14/Sample_DA_system_with_DAFCC1.git>). After downloading, users can get the compressed package “*Sample\_DA\_system\_with\_DAFCC1.zip*” and run command “*unzip Sample\_DA\_system\_with\_DAFCC1.zip*”. The unzipped directory includes the directory of the C-Coupler platform (*C-Coupler\_platform\_with\_DAFCC*), the directory of the modifications to adapt WRF (*Modified\_WRF*), FIO-AOW (*Modified\_FIO-AOW*), GSI/EnKF (*Modified\_GSI\_EnKF*) by DAFCC1, the directory of WPS and WRF namelists to generate initial and lateral boundary conditions (*Namelists*) and a README file. Each sub-directory also has a README file that briefly describes the contents of the current directory.

## Directory structure

The working directory of the C-Coupler platform (*C-Coupler\_platform\_with\_DAFCC*) consists of four directories: the *model\_platform,* *inputdata, FIO-AOW* and *WRF*. The *model\_platform* contains three main directories: *models*, *scripts*, and *config,* to store the configuration information, source code and scripts for operating the simulations. The *inputdata* contains several sub directories to respectively store the input data for component models. The *FIO-AOW* and *WRF* are the directories for users to configure, compile and run the integrated models.

User should put the sub-directory *C-Coupler* of DAFCC1 in the directory *model\_platform/models/libs/*.

## Setup of WRF-GSI/EnKF

## Prepare GSI/EnKF DLLs

The original GSI/EnKF resources, including source code, build system, utilities, practice data, and documentation, are available from the website <https://dtcenter.org/com-GSI/users/downloads/index.php>. The modifications to adapt GSI/EnKF by DAFCC1 are available from the directory *Modified\_GSI\_EnKF*.

After the integration of GSI/EnKF by DAFCC1, the original build system with slight modifications is used to generate the DLLs. The DLLs compiled successfully are place in the directory *WRF/CCPL\_dir/libs*.

## Prepare WRF

The original WRF resources are available from the website <https://www2.mmm.ucar.edu/wrf/users/downloads.html>. The modifications to adapt WRF by DAFCC are available from the directory *Modified\_WRF*. After the integration of WRF by DAFCC1, the codes are place in the directory *model\_platform/models/atm/*.

Initial and lateral boundary conditions for the ensemble run of WRF are taken from the NCEP Global Ensemble Forecast System (GEFS) (<https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/global-ensemble-forecast-system-gefs>). The WPS and WRF namelists to generate initial and lateral boundary conditions are available from the directory *Namelists.* The generated ensemble initial and boundary conditions of WRF should be separately stored in the directory *inputdata/atm/WRF4.0/demo/realtime/2016060100/ensemble/*\*.

## Configure the DA experiment

The configuration information of all DA algorithm instances used in the DA experiment is contained in an XML configuration file *WRF/CCPL\_dir/config/all/ensemble\_procedures/wrf\_root\_DA\_config.xml*. Users can configure flexibly according to their needs. Users also needs to prepare the *working\_directory* and *config\_scripts* set in the XML configuration file in the right place.

## Configure, compile and run WRF

## Configure WRF

Before configure WRF, users should run command “*source source\_env.sh*” under the working directory *WRF*. *source\_env.sh* encapsulates two scripts “*model\_platform/scripts/register\_platform.sh*” and “*inputdata/register\_inputdata.sh*” to register some setting environment variables of the C-Coupler platform.

Users can modify the file *WRF/config/common/case.conf* to make model related settings, such as simulation time, number of ensemble, parallelism, etc, as shown in Fig. 1.

system

{

compset=wrf\_ens

mach=generic\_linux // machine name

libs=c\_coupler

}

common

{

case\_desc=the ensemble run of wrf

leap\_year=false

orbYear=1990

original\_case\_name=wrf

original\_config\_time=180124-121037

rest\_freq\_count=21600

rest\_freq\_unit=seconds

run\_restart\_date=0000-00-00

run\_restart\_second=00000

run\_start\_date=2016-06-01 // start date

run\_start\_second=00000 // start second

run\_stop\_date=2016-06-02 // end date

run\_stop\_second=00000 // end second

run\_type=initial

ensemble\_number=10 // number of ensemble

}

wrf : atm : WRF4.0

{

cpl\_interface\_time\_step=3600

grid=128x60

num\_thread=1

num\_total\_proc=8 // parallel setting

stop\_latency\_seconds=0

}

Figure 1. *WRF/config/common/case.conf.*

To configure WRF, users should run command “*./configure*” under the working directory.

## Compile WRF

To compile WRF, users need to first prepare the common compile environment by modifying the file *WRF/config/common/machine/{machine name}/common\_compiler.{machine name}.cfg*, where the *machine name* is defined in the file *WRF/config/common/case.conf.* Then, users should run the command “*./compile*” under the working directory. The log files of the compilation are stored under the sub directory *run* of the working directory.

Users can run the command “*./clean para*” to remove the files produced by the compilation, where *para* means the parameter for *clean*. The parameter can be the name of a component model or a library, or *all*. For command“*./clean all*”, all files produced by compilation will be removed.

## Run WRF

Before run WRF, users should run command “*source source\_da\_env.sh*” under the working directory to register some setting environment variables used in GSI/EnKF and then run command “*./prepare\_da.sh*” to prepare files for GSI/EnKF.

To run WRF, users should run the command “*./runcase*” under the working directory. Note that, “*./runcase*” is common to any kind of simulations on any kind of hardware platforms.

## Evaluation of WRF-GSI/EnKF

The results and log files of WRF run are stored under the directory *WRF/run/ensemble\_\*/atm/wrf/data*, while each ensemble member has a separate running directory. The results ofGSI/EnKF are stored under the directoryset in the XML configuration while their running logs are included in the running logs of the WRF, which includes the statistics of the running time and standard outputs of each module.

## Setup of the sample ensemble DA system

## Prepare GSI/EnKF DLLs

The same as Section 2.1, but the DLLs compiled successfully are place in the directory *FIO-AOW/CCPL\_dir/libs*.

## Prepare FIO-AOW

Please contact Zhao Biao ([bzhao@fio.org.cn](mailto:bzhao@fio.org.cn)) and Wang Guansuo ([wanggs@fio.org.cn](mailto:wanggs@fio.org.cn)) for the original FIO-AOW resources. The modifications to adapt FIO-AOW by DAFCC1 are available from the directory *Modified\_FIO-AOW*.

After the integration of FIO-AOW by DAFCC1, the codes of FIO-AOW are place in the directory *model\_platform/models/*, while the codes of different component model are placed in different component directories.

Initial and lateral boundary conditions for the ensemble run of WRF are taken from the NCEP Global Ensemble Forecast System (GEFS) (<https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/global-ensemble-forecast-system-gefs>). The WPS and WRF namelists to generate initial and lateral boundary conditions are available from the directory *Namelists.* The generated ensemble initial and boundary conditions of WRF should be separately stored in the directory *inputdata/atm/WRF3.6/demo/realtime/2016060100/ensemble/*\*. Initial and lateral boundary conditions for POM and MASNUM are from Zhao Biao ([bzhao@fio.org.cn](mailto:bzhao@fio.org.cn)), which have been stored in the directory *inputdata/* *POM\_FIO2/demo/realtime/2016060100/start/* and *inputdata/* *wave/MASNUM2/demo/realtime/2016060100/start/* separately.

## Configure the sample ensemble DA system

The configuration information of all DA algorithm instances used in the DA experiment is contained in an XML configuration file *FIO-AOW/CCPL\_dir/config/all/ensemble\_procedures/wrf\_ensemble\_set\_DA\_config.xml*. Users can configure flexibly according to their needs. Users also needs to prepare the *working\_directory* and *config\_scripts* set in the XML configuration file in the right place.

## Configure, compile and run FIO-AOW

## Configure FIO-AOW

Before configure FIO-AOW, users should run command “*source source\_env.sh*” under the working directory *FIO-AOW*. *source\_env.sh* encapsulates two scripts “*model\_platform/scripts/register\_platform.sh*” and “*inputdata/register\_inputdata.sh*” to register some setting environment variables of the C-Coupler platform.

Users can modify the file *FIO-AOW/config/common/case.conf* to make model related settings, such as simulation time, number of ensemble, parallelism of different component models, etc. To configure *FIO-AOW*, users should run command “*./configure*” under the working directory.

## Compile FIO-AOW

To compile FIO-AOW, users need to first prepare the common compile environment by modifying the file *FIO-AOW/config/common/machine/{machine name}/common\_compiler.{machine name}.cfg*, where the *machine name* is defined in the file *WRF/config/common/case.conf.* Users can also modify compile environment for each component model. For example, for atmospheric component WRF, the file is *FIO-AOW/config/atm/wrf/compiler.cfg*. Then, users should run the command “*./compile*” under the working directory. The log files of the compilation are stored under the sub directory *run* of the working directory.

Users can run the command “*./clean para*” to remove the files produced by the compilation, where *para* means the parameter for *clean*. The parameter can be the name of a component model or a library, or *all*. For command“*./clean all*”, all files produced by compilation will be removed.

## Run FIO-AOW

Before run FIO-AOW, users should firstly run command “*source source\_da\_env.sh*” under the working directory to register some setting environment variables used in GSI/EnKF and then run command “*./prepare\_da.sh*” to prepare files for GSI/EnKF.

To run FIO-AOW, users should run the command “*./runcase*” under the working directory.

## Evaluation of the sample ensemble DA system

As only the atmospheric component WRF is assimilated using GSI/EnKF, the results and log files of WRF run are stored under the directory *FIO-AOW/run/ensemble\_\*/atm/wrf/data*, while the results of POM and MASNUM run are stored under the directory *FIO-AOW/run/ensemble\_\*/ocn/pom/data*, and *FIO-AOW/run/ensemble\_\*/wave/masnum/data* separately. Each ensemble member of each component model has a separate running directory.

The results ofGSI/EnKF are stored under the directoryset in the XML configuration while their running logs are included in the running logs of the WRF, which includes the statistics of the running time and standard outputs of each module.