

SANGOMA: Stochastic Assimilation for the Next Generation Ocean Model Applications

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Deliverable 6.13: Code release 2 documentation

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Executive summary

This deliverable is the second code release of the Sangoma project. Compared to the previous release new tools have been added and the tools have been adapted to the common data model (deliverable 1.3). This ensures that the tools can be easily used together and integrated in other assimilation systems. In this release the documentation has also been expanded. Examples have been added on how these tools should be used. The software report of deliverable D2.4 includes the documentation of the tools while this deliverable is the released software bundle with installation instructions.

Intended audience: developers installing the software

Chapter 1

Technical highlights

1.1 List of functions

The software is organized in the following sub-directories:

Fortran : Tools coded in Fortran

diagnostics functions to compute statistics to assess the performance of an assimilation system

sangoma_ComputeEnsStats.F90 : Compute ensemble rank histograms

sangoma_ComputeHistogram.F90 : Compute ensemble statistics

sangoma_ComputeMutInf.F90 : Compute mutual information

sangoma_ComputeRE.F90 : Compute relative entropy

sangoma_ComputeSensitivity.F90 : Compute ensemble sensitivity

sangoma_ComputeSensitivity_op.F90 : Compute ensemble sensitivity with observation operator given as a subroutine

sangoma_arm.F90 : Calculate array modes and associated quantities

sangoma_computeBRIER.F90 : Compute the Brier skill score and its decomposition, and the entropy

sangoma_computeCRPS.F90 : Compute the CRPS and its decomposition

sangoma_computeRCRV.F90 : Compute the CRPS and its decomposition (Source File: sangoma_computeCRPS.F90) Compute the bias and the dispersion of the RCRV

perturbations : methods to generate ensemble perturbations

sangoma_EOFcovar.F90 : Initialize covariance matrix from EOF decomposition

sangoma_MVNormalize.F90 : Perform multivariate normalization

mod_sangoma_pseudornd.F90 : Generate correlated random field

utilities :

sangoma_computepod.F90 : Compute dominant POD modes from an ensemble of snapshots.

sangoma_costgrad.F90 : Compute the values of Objective function and Gradient using reduced state dimensions.

Matlab : Tools coded for Matlab and Octave

diagnostics: functions to compute statistics to assess the performance of an assimilation system

mutual_information.m : Compute mutual information in a particle filter

relative_entropy.m : Compute relative entropy in a particle filter

sensitivity.m : Compute sensitivity of posterior mean to observations in a particle filter

perturbations : various methods to generate ensemble perturbations

WCE : Weakly constrained ensemble perturbations. Create ensemble perturbations that have to satisfy an a priori linear constraint

transformations :

Anam : Empirical Gaussian Anamorphosis. Determine the empirical transformation function such that a transformed variable follows a Gaussian distribution

utilities :

HFRadarExtract : Observation operator for HF radar surface currents

1.2 Requirements

- GNU make and a Fortran compiler (such as gfortran, ifort,...). Under Linux, make and gfortran can be installed by the package manager. For example under Debian/Ubuntu, gfortran and make are installed by:

```
sudo apt-get install make gfortran libfftw3-dev
```

For Red Hat/Fedora/Centos, these packages can be installed by:

```
yum install make gcc-gfortran fftw-devel
```

For Windows and Mac OS, pre-compiled binaries of gfortran are available at <http://gcc.gnu.org/wiki/GFortran>.

- LAPACK and BLAS. Reference versions of those libraries are available at <http://www.netlib.org/lapack/> and <http://www.netlib.org/blas/>. An optimized version of BLAS should be preferred.
- FFTW for computing the Fast Fourier Transform available at <http://www.fftw.org> for the tool `sangoma_pseudornd2D`.
- GNU octave or MATLAB. GNU octave is an open-source clone of MATLAB available at <http://www.gnu.org/software/octave/>.

1.3 Installation instructions

Download the file <http://sourceforge.net/projects/sangoma/files/sangoma-1.0.tar.gz> from the Sourceforge site and decompress it. The decompressed files will be in a folder named sangoma-1.0

```
wget http://sourceforge.net/projects/sangoma/files/sangoma-1.0.tar.gz
tar -xvzf sangoma-1.0.tar.gz
```

1.3.1 Fortran tools

The Fortran tools can be compiled by issuing make in sub-directory Fortran/ of the sangoma-1.0 directory:

```
$ make
gfortran -O3 -fdefault-real-8 -I/usr/include -c sangoma_base.F90 -o sangoma_base.o
...
ar: creating libsangoma_tools.a
ranlib libsangoma_tools.a
```

This creates a library file called libsangoma_tools.a and the module files mod_sangoma_pseudornd.mod and sangoma_base.mod (possibly in uppercase depending on the compiler). The sangoma tools can be used from a Fortran or C program. A Fortran program must be compiled by using the option -I (indicating the path to the module files) and the option -L (the path of the library) and the name of the library -lsangoma_tools. For example:

```
gfortran -I/path myprogram.f90 -L/path -lsangoma_tools
```

For a C program, only the options -L/path and -lsangoma_tools must be specified.

If a different Fortran compiler is used instead of gfortran, then the variables FC and FFLAGS in the Makefile need to be adapted.

1.3.2 MATLAB/GNU octave tools

The MATLAB/GNU octave tools in the sub-directories of the directory Matlab/ can be used by including the corresponding directory in your MATLAB/GNU octave search path by using the script sangoma_addpath for including all tools. Individual tools can be added by using:

```
addpath('/path/to/subfolder');
```

The tools WCE, Anam and HFRadarExtract include test scripts named wce_demo, anam_test and test_hfradar_extractf respectively that verifies the correct functioning of the packages. Examples

Examples for the tools are provided in the sub-directory examples/ that is include in each category-directory. In case of the Fortran codes, there is a Makefile in the directory that compiles all examples.

1.4 Documentation

Documentation of the tools is available at <http://www.data-assimilation.net/Documents/sangomaDL2.4.pdf>.

Deviation from of the Description of Work

This deliverable conforms to the description of work.