

SANGOMA: Stochastic Assimilation for the Next Generation Ocean Model Applications

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Important note: The detailed description of each tool is found within deliverables D2.3 (Software V0 report) and D3.2 (Living document) and therefore is not repeated here. The present report simply concentrates on how to get the tools and how to install them. It is also included in the download package <http://sourceforge.net/projects/sangoma/files/latest/download> on the Sangoma sourceforge <http://sourceforge.net/projects/sangoma/>

SANGOMA data assimilation tools

This software package from the [SANGOMA project](#) provides several utilities that are used in connection with data assimilation problems. The software is organized in the following sub-directories:

- **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
 - `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
 - `sangoma_EOFcovar.F90`: Initialize covariance matrix from EOF decomposition
 - `sangoma_MVNormalize.F90`: Perform multivariate normalization
 - **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**:
 - **EnKF**: Traditional Ensemble Kalman filter as introduced by Evensen and Burgers
 - **HFRadarExtract**: Observation operator for HF radar surface currents
 - **POD**: Inverse modeling method based on model reduction using proper orthogonal decomposition

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
```

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

```
yum install make gcc-gfortran
```

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.

- **GNU octave** or **MATLAB**. GNU octave is an open-source clone of MATLAB available at <http://www.gnu.org/software/octave/>.
- Some tools use also the data assimilation framework **OpenDA** available at <http://www.openda.org/>. OpenDA is based on **Java** (version 1.6 or higher) available at <http://www.java.com>. Only the Java version from ORACLE is tested.

Installation instructions

Download the file <http://sourceforge.net/projects/sangoma/files/sangoma-0.1.tar.gz> from the Sourceforge site and decompress it. The decompressed files will be in a folder named sangoma-0.1

```
wget http://sourceforge.net/projects/sangoma/files/sangoma-0.1.tar.gz
tar -xvzf sangoma-0.1.tar.gz
```

Fortran tools

The Fortran tools `sangoma_EOFcovar.F90`, `sangoma_MVNormalize.F90`, `sangoma_ComputeHistogram.F90` and `sangoma_ComputeEnsStats.F90` can be compiled by issuing `make` in the `sangoma-0.1` directory:

```
make
gfortran -O3 -fdefault-real-8 -c
diagnostics/sangoma_ComputeEnsStats.F90 -o
diagnostics/sangoma_ComputeEnsStats.o
gfortran -O3 -fdefault-real-8 -c
diagnostics/sangoma_ComputeHistogram.F90 -o
diagnostics/sangoma_ComputeHistogram.o
gfortran -O3 -fdefault-real-8 -c
perturbations/sangoma_EOFcovar.F90 -o
perturbations/sangoma_EOFcovar.o
gfortran -O3 -fdefault-real-8 -c
perturbations/sangoma_MVNormalize.F90 -o
perturbations/sangoma_MVNormalize.o
ar -r libsangoma_tools.a diagnostics/sangoma_ComputeEnsStats.o
diagnostics/sangoma_ComputeHistogram.o
perturbations/sangoma_EOFcovar.o
perturbations/sangoma_MVNormalize.o
ar: creating libsangoma_tools.a
ranlib libsangoma_tools.a
```

This creates a library called `libsangoma_tools.a` that can be used with the linker option `-lsangoma_tools` in your programs.

If a different Fortran compiler is used instead of `gfortran`, then the variables `FC`

and FFLAGS in the Makefile need to be adapted.

MATLAB/GNU octave tools

The MATLAB/GNU octave tools `WCE`, `Anam`, `HFRadarExtract`, `mutual_information`, `relative_entropy`, and `sensitivity` can be used by including the corresponding directory in your MATLAB/GNU octave search path

```
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.

Java tools

Installing instructions of OpenDA can be found at <http://www.openda.org/>.

Documentation

Documentation of the tools is available at <http://www.data-assimilation.net/Documents/sangomaDL2.3.pdf>.

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