

# OpenDA-NEMO framework for Ocean analysis and prediction

SANGOMA meeting

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# Outline

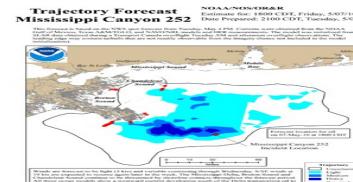
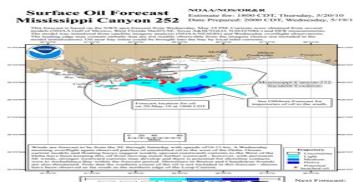


- Data assimilation and calibration in one sheet
- OpenDA architecture
- Coupling NEMO into OpenDA
- Example of Data assimilation
- Summary

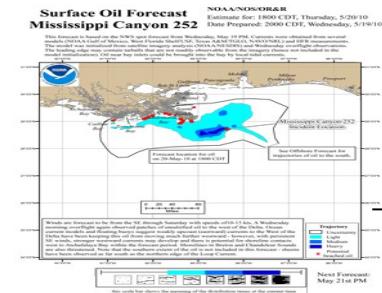
# Data assimilation and Model calibration in one sheet



- A generic toolbox for data-assimilation
  - (real time) data assimilation



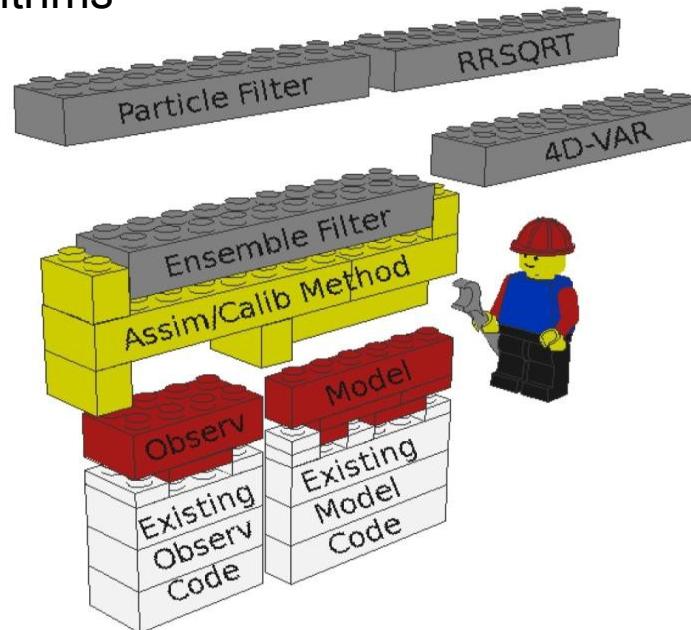
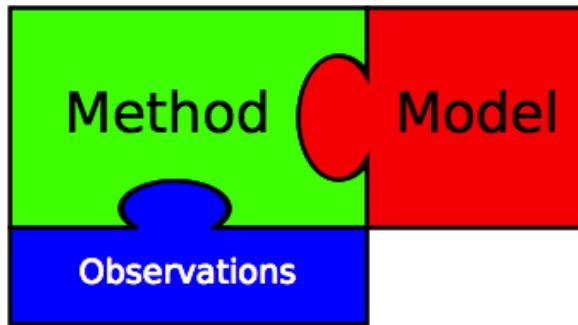
- model calibration
- impact of observations



# OpenDA: framework for Data Assimilation



- Content:
  - Set of interfaces that define interactions between components
  - Library of data-assimilation algorithms
  - DA philosophy
  - Building blocks only need to be implemented once



# OpenDA Website



- [www.opendata.org](http://www.opendata.org)
- Downloads
  - Users
  - Developers
- Documentation
- Wrappers for models
- OpenDA association



OpenDA: an open-source data-assimilation toolbox - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.opendata.org/joomla/index.php

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OpenDA: an open-source data-assi... +

**OpenDA**

A+ A- search...

**MAIN MENU**

- About OpenDA
  - Questions and answers
  - OpenDA applications
  - The OpenDA association
- Downloads
- Documentation
- Forum
- Support
- Getting involved
- Partners & Services

**LOGIN FORM**

Logging in is only necessary if you want to participate in the discussions on the forum. For all other uses of this site or Done

**Integrating models and observations**

OpenDA is an open interface standard for (and free implementation of) a set of tools to quickly implement data-assimilation and calibration for arbitrary numerical models. OpenDA wants to stimulate the use of data-assimilation and calibration by lowering the implementation costs and enhancing the exchange of software among researchers and end-users.

A model that conforms to the OpenDA standard can use all the tools that are available in OpenDA. This allows experimentation with data-assimilation/calibration methods without the need for extensive programming. Reversely, developers of data-assimilation/calibration software that make their implementations compatible with the OpenDA interface will make their new methods usable for all OpenDA users (either for free or on a commercial basis).

OpenDA has been designed for high performance. Hence, even large-scale models can use it. Also, OpenDA allows users to optimize the interaction between their model and the data-assimilation/calibration methods. Hence, data-assimilation with OpenDA can be as efficient as with custom-made

**Announcements**

[Full release now available](#)  
The full sources for OpenDA version 1.0 are now available on this OpenDA website. Click [here](#) to download the source, binaries for windows and linux, examples and more.

[OpenDA 1.0 released](#)  
OpenDA version 1.0 has been officially released at May 10, 2010 during the JonsMod workshop at Deltares in the Netherlands. Information relating to the release can be found [here](#)

S3Fox

# Models in OpenDA



- Formal form of a model

$$\frac{dx}{dt} = M(x(t), u(t), p, w(t))$$

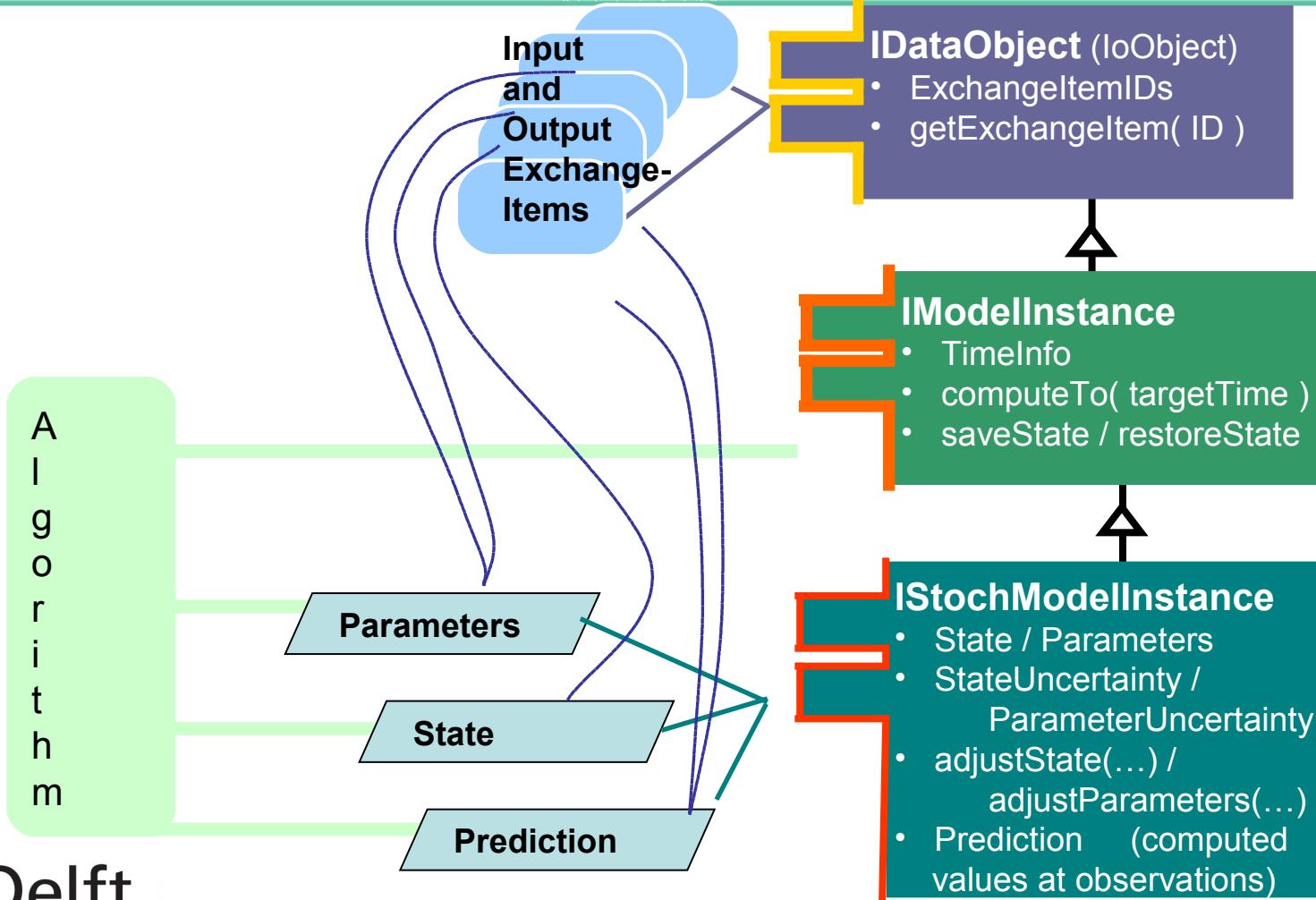
- State of model instance  $x(t), u(t), p, w(t)$
- Object oriented concepts:

- Data encapsulation; state cannot be directly changed only through the methods like:

GetState, Axpystate, Compute...

- Multiple instances of model
- Algorithm has no knowledge on model internals

# Black box coupling in OpenDA



# Coupling NEMO into OpenDA



- Namelist File:
  - NemoNamelistFileWrapper
  - Edit namelist file after each analysis step.
- Restart.nc
  - NemoRestartFileWrapper
  - Modifying data at analysis step
- nemo\_exchangeitem
  - Input and Output exchange items interface

# NEMO-OpenDA



```
<?xml version="1.0" encoding="UTF-8"?>
<openDaApplication xmlns="http://www.opendata.org">
    <stochObserver
        className="org.opendata.observers.NoosTimeSeriesStochObserver">
        <workingDirectory>./stochObserver</workingDirectory>
        <configFile>noosObservations378.xml</configFile>
    </stochObserver>
    <stochModelFactory
        className="org.opendata.blackbox.wrapper.BBStochModelFactory">
        <workingDirectory>./stochModel</workingDirectory>
        <configFile>nemoStochModel378.xml</configFile>
    </stochModelFactory>
    <algorithm className="org.opendata.algorithms.kalmanFilter.EnKF">
        <workingDirectory>algorithm</workingDirectory>
        <configString>enkf.xml</configString>
    </algorithm>
    <resultWriter className="org.opendata.resultwriters.NetcdfResultWriter">
        <workingDirectory>.</workingDirectory>
        <configFile>enkf_.nc</configFile>
    </resultWriter>
    </resultWriters>
</openDaApplication>
```

# NEMO-OpenDA



```
<?xml version="1.0" encoding="UTF-8"?>
<blackBoxStochModel xmlns="http://www.opendata.org".....>
    <modelConfig>
        <file>./nemoModel.xml</file>
    </modelConfig>
    <vectorSpecification>
        <state>
            <vector id="ub" />
            <vector id="vb" />
            <vector id="tb" />
            <vector id="sb" />
            <vector id="sshb" />
            <vector id="un" />
            <vector id="vn" />
            <vector id="tn" />
            <vector id="sn" />
            <vector id="sshn" />
        </state>
        <predictor>
            <subVector id ="pointssh0101.none"
sourceVectorId="sshn"><selection index1="0101" /> </subVector>
        </predictor>
    </vectorSpecification>
```

# NEMO-OpenDA

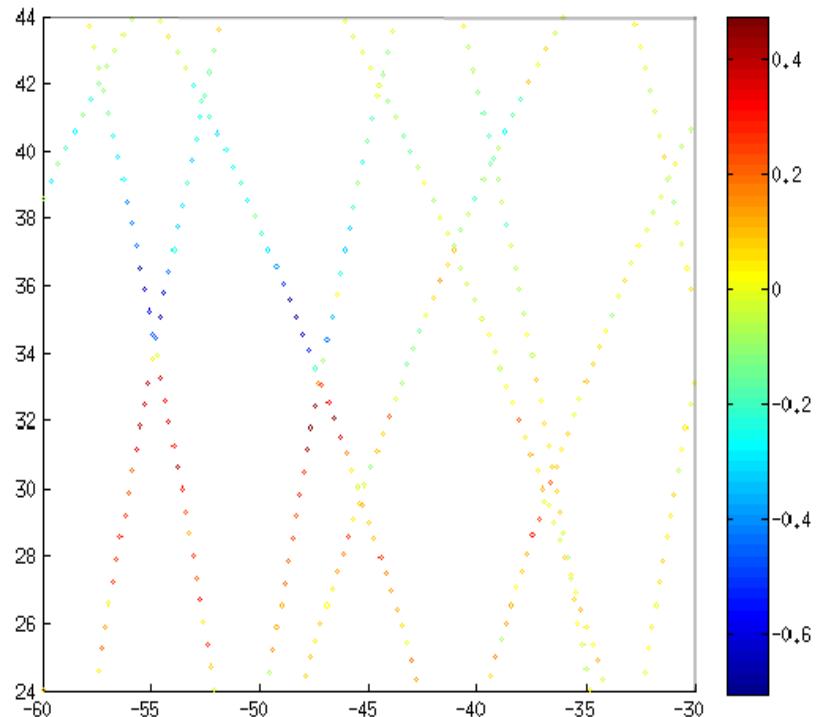


```
<?xml version="1.0" encoding="UTF-8"?>
<noosObserver xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">

    <timeSeries id="pointssh0101" status="use" standardDeviation="0.06">
        pointssh0101.noos
    </timeSeries>
    <timeSeries id="pointssh0199" status="use" standardDeviation="0.06">
        pointssh0199.noos
    </timeSeries>
</noosObserver>

=====
# Timeseries
=====
# Location      : pointssh0101
# Position       : (-2.045543,57.361939)
# Source         : observed
# Timezone       : GMT
=====
200801010000    -0.8300
200801010010    -0.8800
200801010020    -0.9100
```

# Experiment Setup



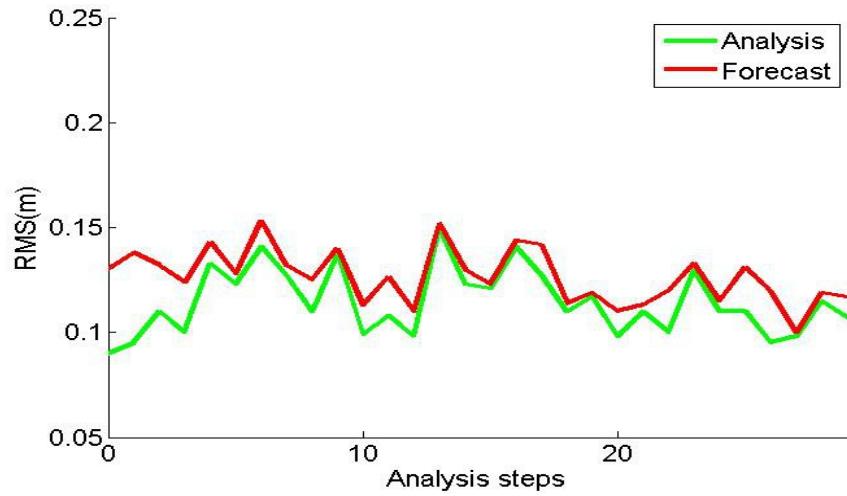
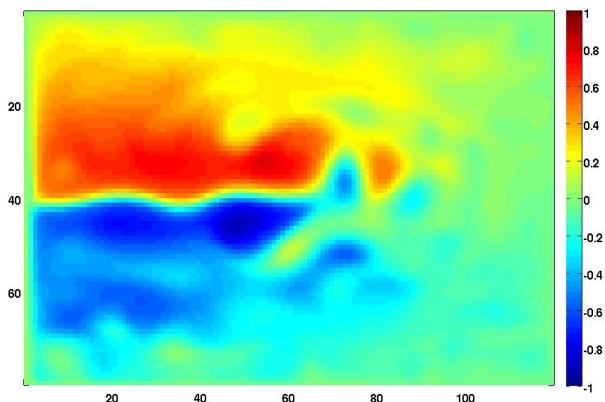
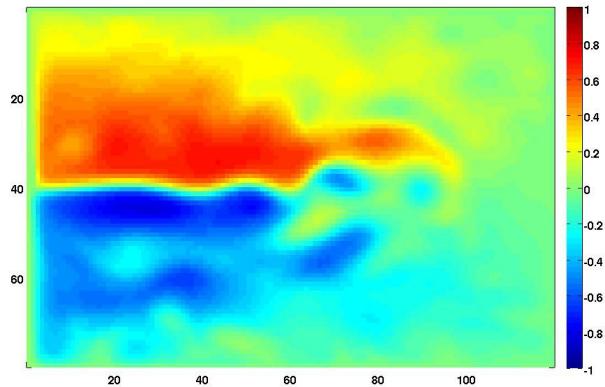
## Medium Case Benchmark

- Free run 40 years.
- State vector includes:  
(ub,vb,sb,tb,sshb,un,vn,sn,tn,sshn)
- Assimilation period: (2 months)

## Ensemble Kalman filter

- 40 Ensemble members
- SSH observations. ENVISAT, Jason-1
- Analysis: 2 days
- No Localization

# Experiment Results



RMS for the SSH

# Summary



- NEMO-OpenDA framework is established
- Way Forward:
  - Local Analysis in OpenDA
  - Parallel Analysis
  - Sequential, batch processing
  - representative observer

Thanks