

OpenDA-NEMO framework for Ocean analysis and prediction

SANGOMA meeting

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Outline

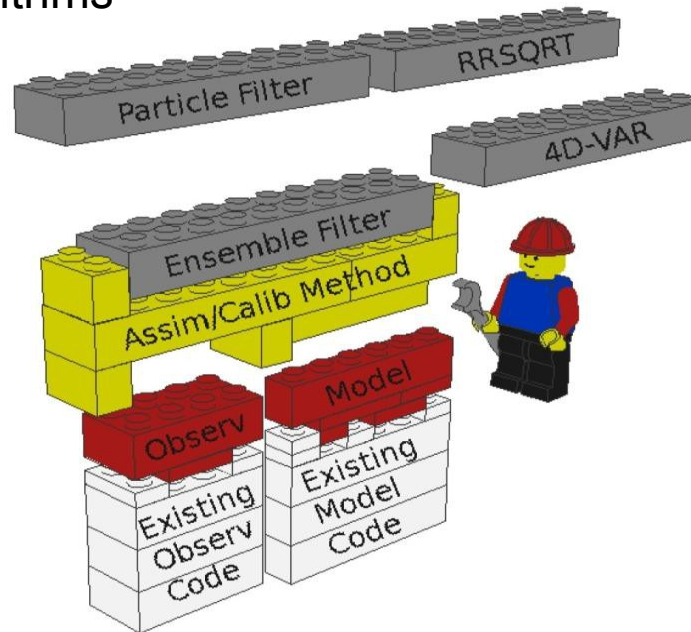
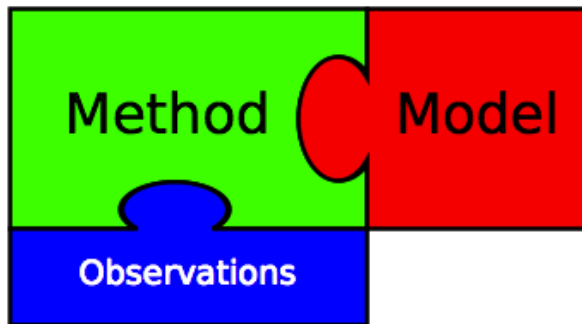


- Data assimilation and calibration in one sheet
- OpenDA architecture
- Coupling NEMO into OpenDA
- Example of Data assimilation
- Summary

OpenDA: framework for Data Assimilation



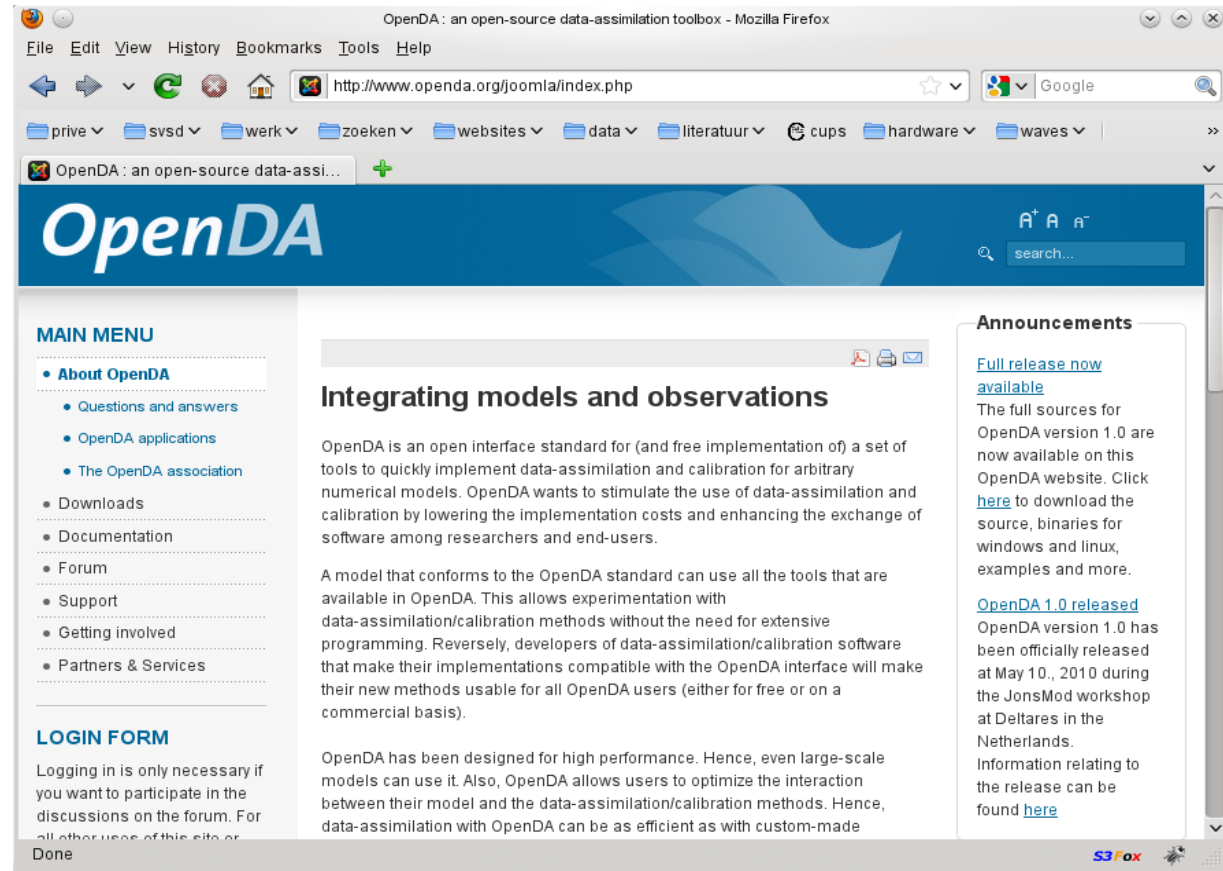
- Content:
 - Set of interfaces that define interactions between components
 - Library of data-assimilation algorithms
 - DA philosophy
 - Building blocks only need to be implemented once



OpenDA Website



- www.openda.org
- Downloads
 - Users
 - Developers
- Documentation
- Wrappers for models
- OpenDA association



- Formal form of a model

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

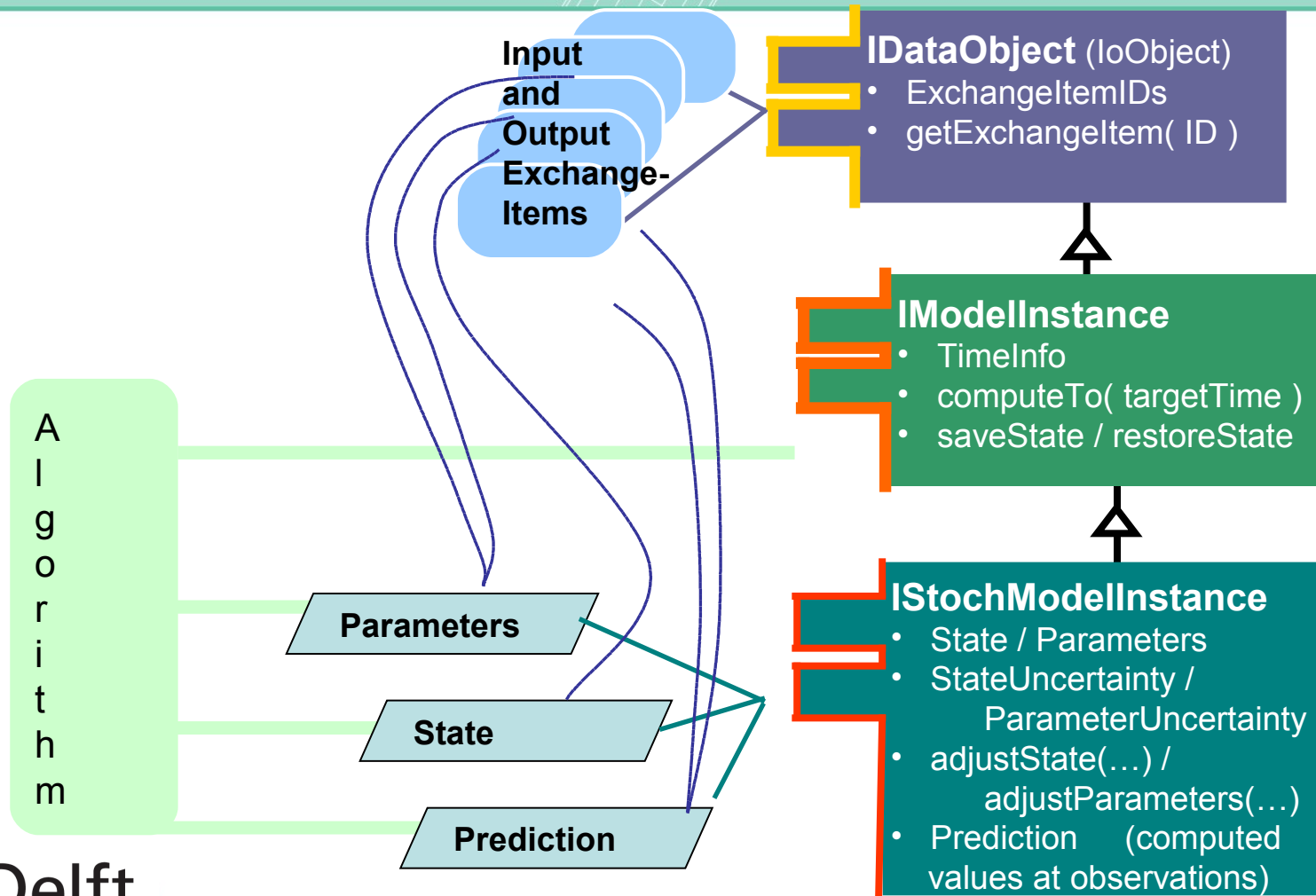
- State of model instance $x(t), u(t), p, w(t)$
- Object oriented concepts:

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

GetState, AxdyState, 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.openda.org">
  <stochObserver
className="org.openda.observers.NoosTimeSeriesStochObserver">
    <workingDirectory>./stochObserver</workingDirectory>
    <configFile>noosObservations378.xml</configFile>
  </stochObserver>
  <stochModelFactory
className="org.openda.blackbox.wrapper.BBStochModelFactory">
    <workingDirectory>./stochModel</workingDirectory>
    <configFile>nemoStochModel378.xml</configFile>
  </stochModelFactory>
  <algorithm className="org.openda.algorithms.kalmanFilter.EnKF">
    <workingDirectory>algorithm</workingDirectory>
    <configString>enkf.xml</configString>
  </algorithm>
  <resultWriter className="org.openda.resultwriters.NetcdfResultWriter">
    <workingDirectory>.</workingDirectory>
    <configFile>enkf_.nc</configFile>
  </resultWriter>
</resultWriters>
</openDaApplication>
```

NEMO-OpenDA



```
<?xml version="1.0" encoding="UTF-8"?>
<blackBoxStochModel xmlns="http://www.openda.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

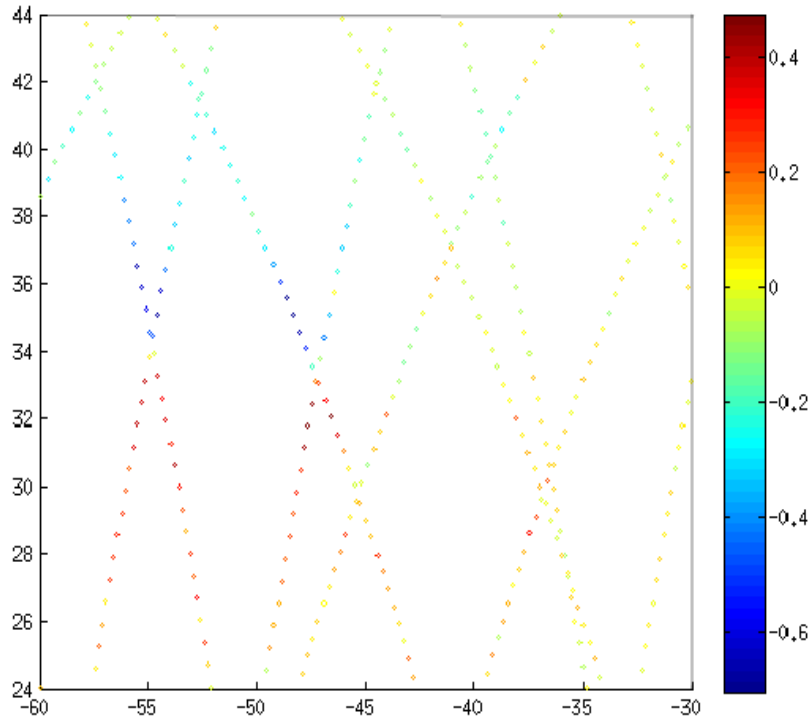


```
<?xml version="1.0" encoding="UTF-8"?>
<noosObserver xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">

    <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



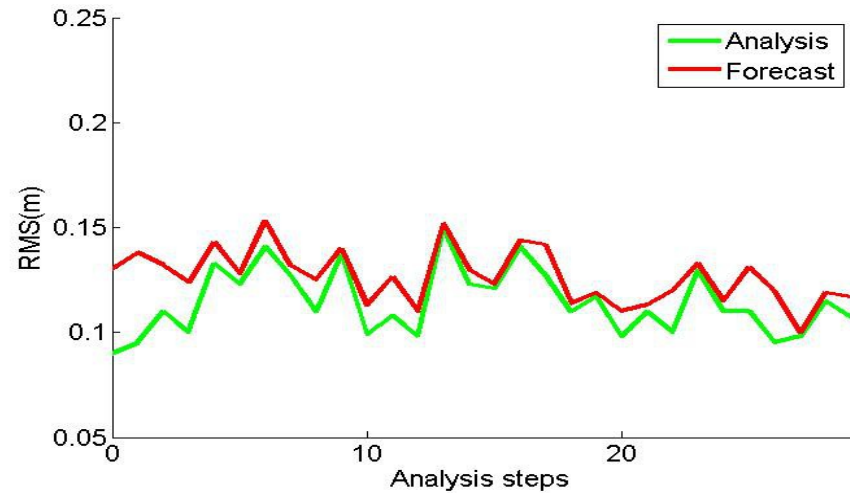
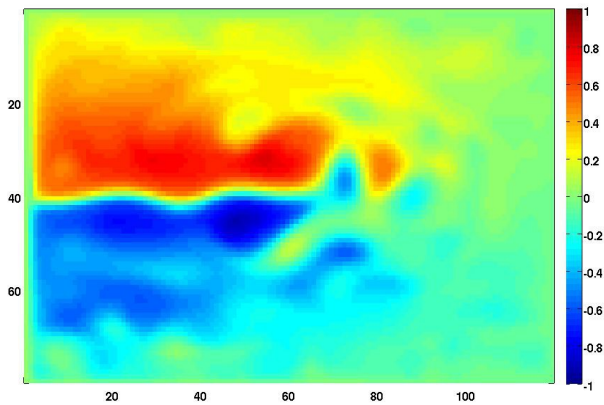
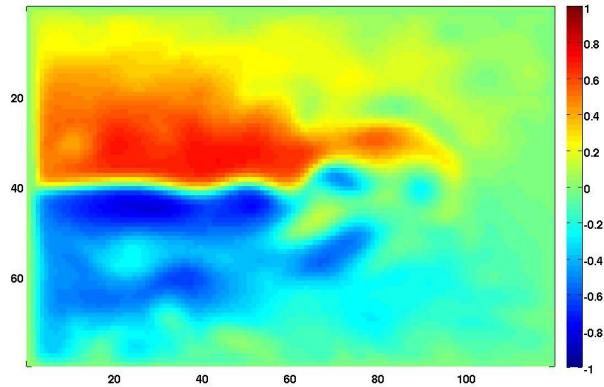
Medium Case Benchmark

- 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