OpenDA–OpenMI framework for Hydrological data assimilation

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Overview

- Goal
- Black box coupling in OpenDA
- OpenMI
- OpenDA-OpenMI framework
- Problems
- Medium size example
- Next Steps
Goal

- OpenDA: framework for Data Assimilation
- MIKE-SHE: Integrated catchment modelling
- Data assimilation with MIKE-SHE
Black box coupling in OpenDA

Input and Output Exchange-Items

IDataObject (IoObject)
- ExchangeItemIDs
- getExchangeItem( ID )

IModelInstance
- TimeInfo
- computeTo( targetTime )
- saveState / restoreState

IStochModelInstance
- State / Parameters
- StateUncertainty / ParameterUncertainty
- adjustState(...) / adjustParameters(...) 
- Prediction (computed values at observations)

Parameters

State

Prediction
Black box coupling in OpenDA

Selected Input EI’s
Selected Output EI’s

Parameters
State
Prediction

Input EI’s
Output EI’s

Model executable(s)
OpenMI

- MIKE-SHE has an OpenMI interface
OpenDA–OpenMI framework

Parameters

State

Prediction

Selected
Input
EI’s

Selected
Output
EI’s

Input EI’s

Output EI’s

Linkable Component
OpenDA–OpenMI framework

- Programming language: OpenDA (Java) OpenMI (C#)
- IKVM automatic translation of OpenDA to C# libraries
- Generic Layer
- MIKE-SHE specific Layer
- Debugging?
OpenDA–OpenMI framework
OpenDA–OpenMI framework

- One week behind a single desk in Delft
- Email/Skype
- Repository
Problems (found and fixed)

- SetExchangeItem (MIKE-SHE) not correctly implemented
  - Work around in OpenMI wrapper code
- Performance when all OpenMI exchangeItems are available
  - Configure MIKE-SHE to only export relevant/used ones
- Localization support in OpenDA Black Box is not optimal
  - Added optional interfaces for easy connection
- Observation matching in OpenDA Black Box only on exchangeItem ID
  - Added optional interfaces for full control
Medium size example

**Karup Catchment**
- Uncertainty based on GLUE (generalised likelihood uncertainty estimation)
- Perturbed
- Rainfall & Potential ET.
- Parameters (UZ, SZ, OL)

**Ensemble Kalman filter**
- 30 Ensemble members
- Daily hydraulic head observations \( m = 35 \)
- Synthetic
- State updating \( n = 522 \)
- Localization
At Point A

Challenge the future
At Point B

![Hydraulic head graph over years from 1970 to 1979](image)

- Blue line: Without Assimilation
- Red line: Truth
- Green line: Assimilated

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Challenge the future

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Next steps

• Doing all kinds of experiments
  – EnKF
  – EnSR
  – Localization
  – Various fields in model state

• DHI C# observation code

• ...