Integrated modelling with XBeach

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Mitigation measures during storms

(a) Petten

(b) Petten

Confidence interval creation

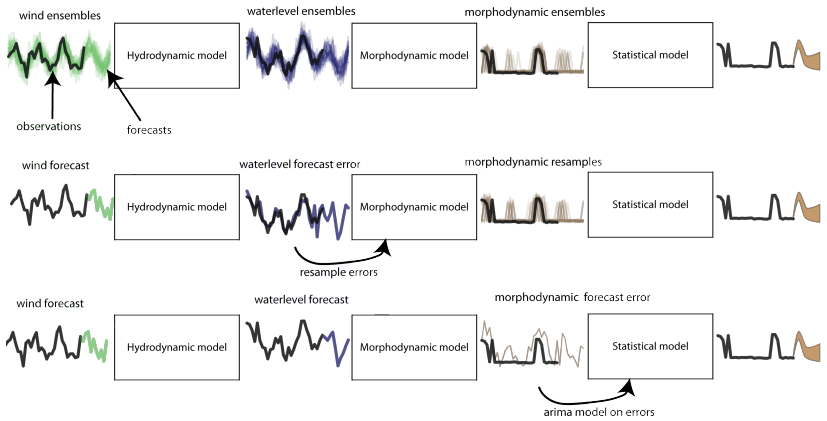

Figure: Confidence interval calculations

Groundwater nourishment interaction

(a) Basement in Ter Heijde

Geplaatst op: 05-02-2010 om 09:35 uur

Kustversterking oorzaak wateroverlast Ter Heijde

De werkzaamheden voor de kustversterking bij Ter Heijde waren de oorzaak van de tijdelijke stijging van het grondwater. Hierdoor werden in de dagen voor Kerstmis de bewoners van de Evertsenstraat, de Kortnaerstraat en de Karel Doormanweg in Ter Heijde verrast door opkomend grondwater in hun kelders en kruipruimtes. Dit blijkt uit het onderzoek dat Projectbureau Delflandse Kust heeft laten uitvoeren door een onafhankelijk ingenieursbureau.

(b) Westland news

Goal

Make XBeach exchange data while running with other models.

Challenges in integrated coupling

- Setup
- Calibration
- Domain mapping (terminology,etc.)
- Numerical issues
- **Software architecture**

1 model

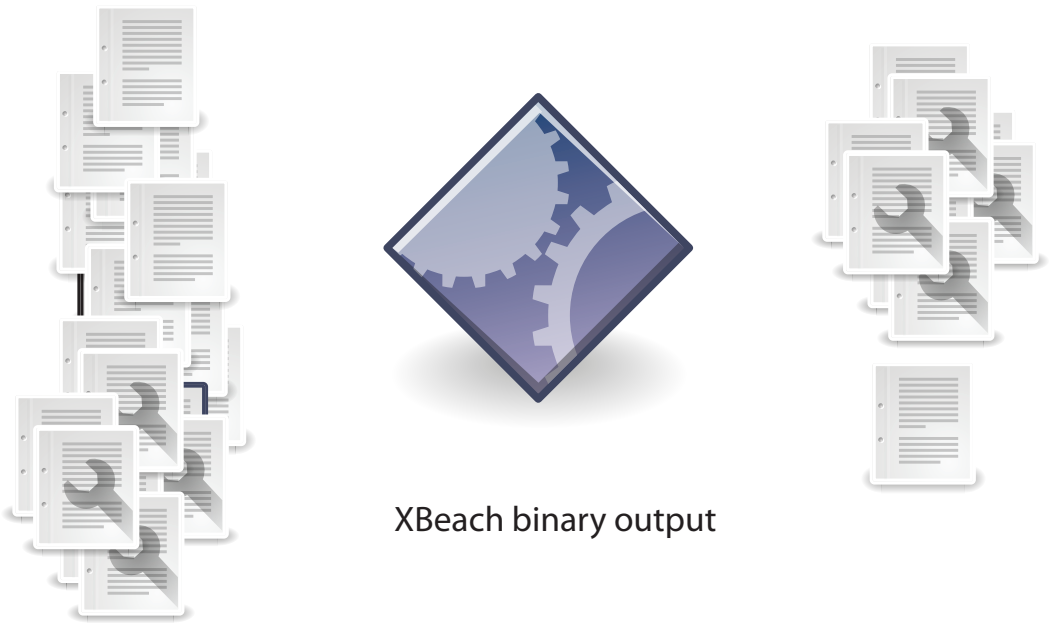

Figure: Single model with input and output files

1 model, standardised output

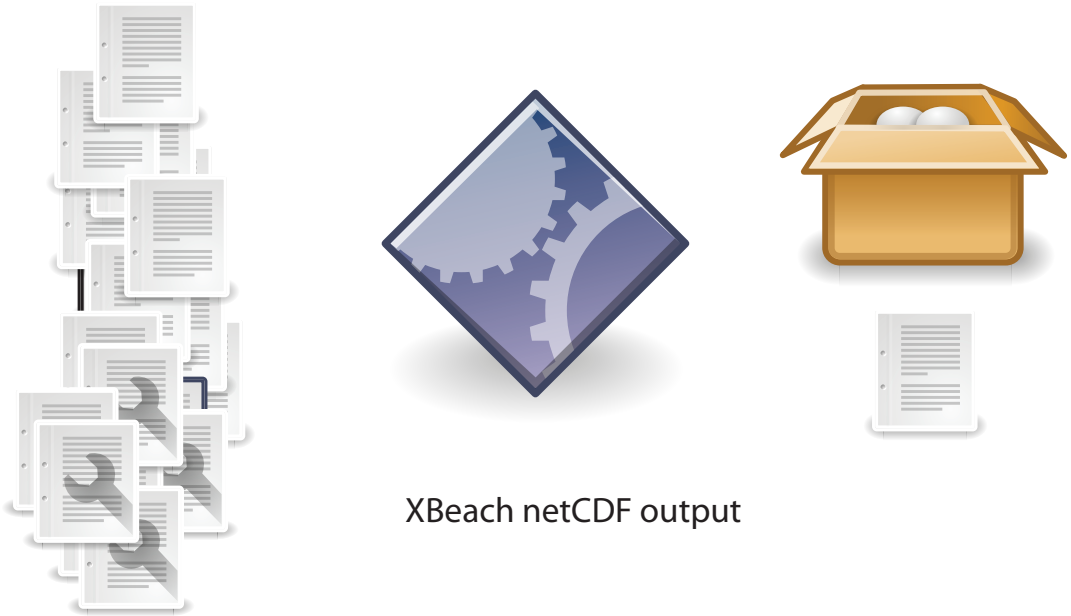

Figure: Output standardisation

Offline coupling

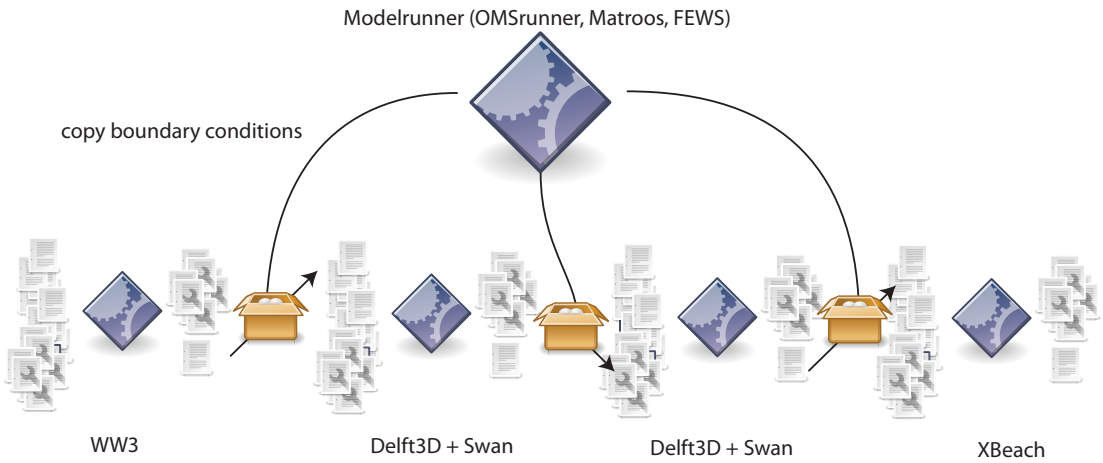

Figure: Lots of models, coupled offline

Online coupling

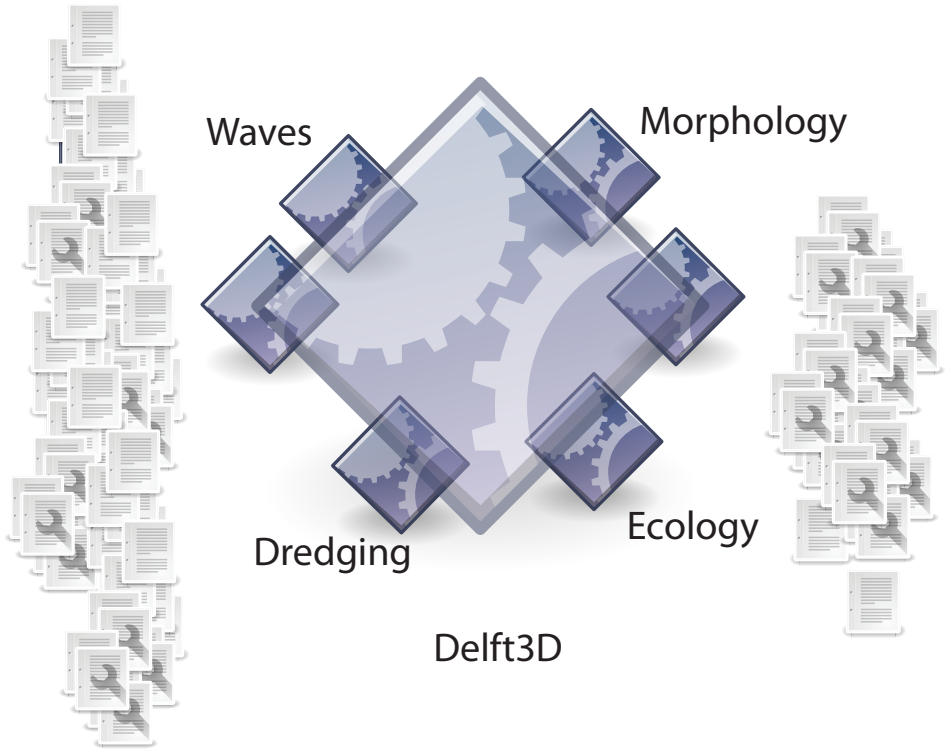

Figure: Monolithic architecture of old Delft3D

Online coupling

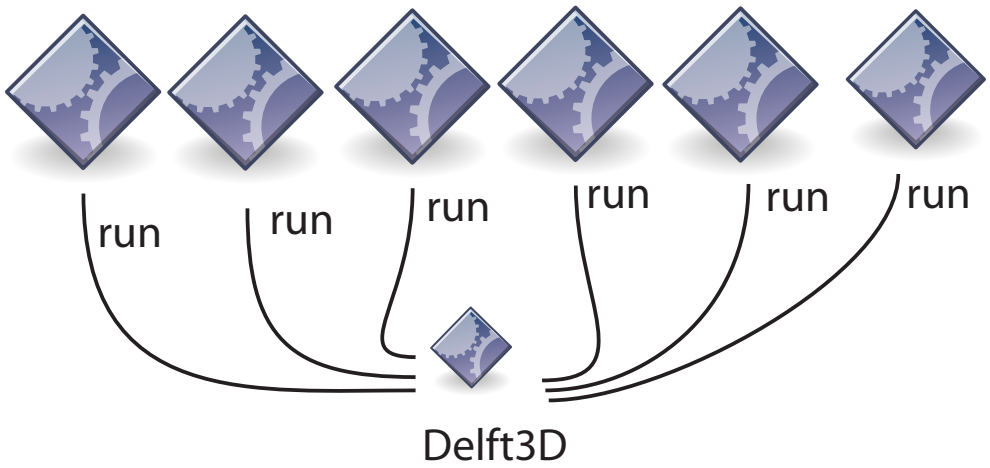

Figure: Current architecture of Delft3D

Modelling Frameworks

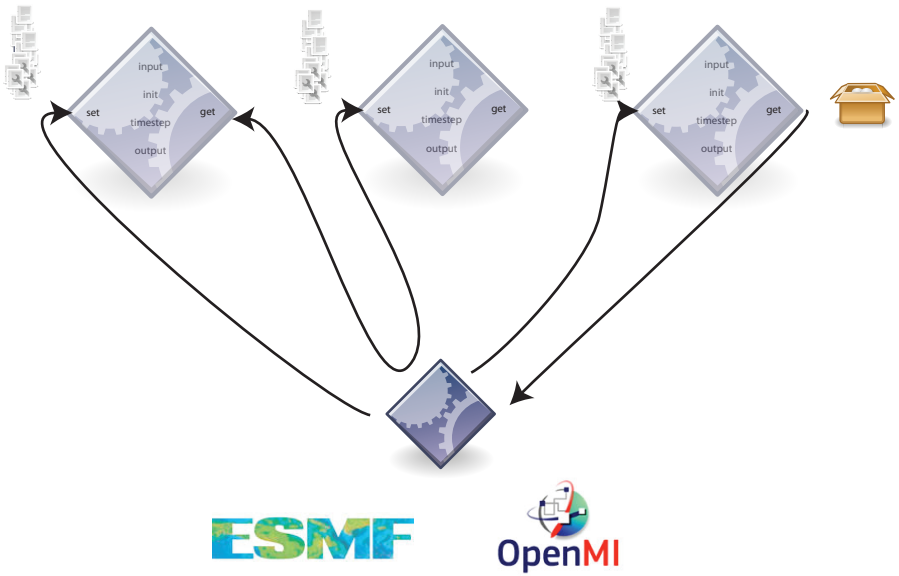

Figure: libxbeach as a OpenMI and ESMF component

Modelling Frameworks

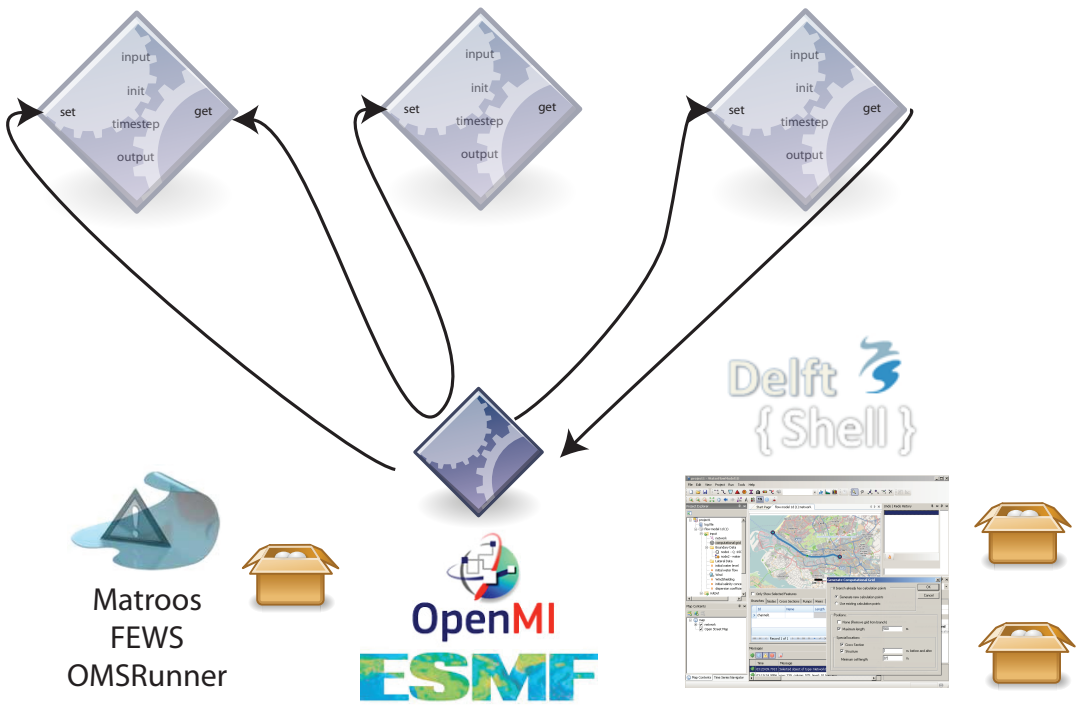

Figure: Integrating models in Deltares environment

Modelling Frameworks

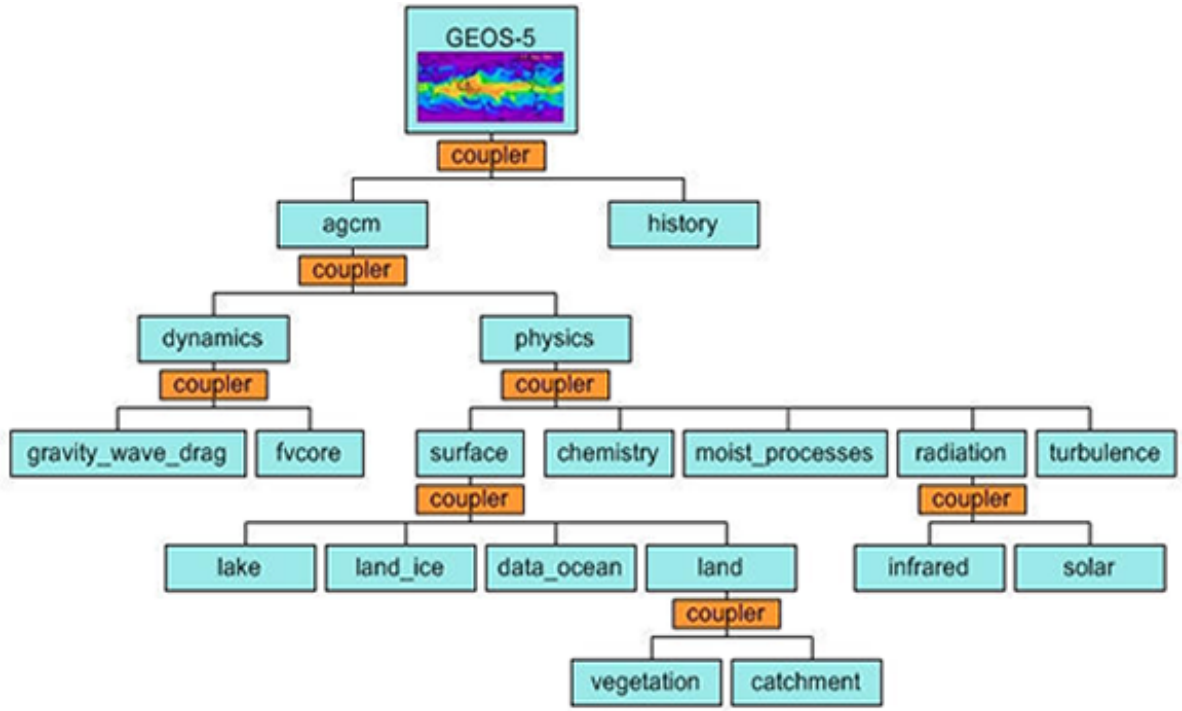

Figure: Integrating models in NASA environment

What have we learned?

Old	New
Mediocre, large scope	Narrow scope, supreme
Closed	Open (api + source)
Share data through files	Share data in memory
Own file format	Standard files
Program	Library

XBeach

Lines of Code = 17,685
Person-Years (Person-Months) = 4.08 (49.00)
Total Estimated Cost to Develop = EUR 551,603
(excluding tests)

Non intrusiveness

Non intrusiveness

How to connect XBeach to other models without any code creeping into XBeach?

5 step plan

1. Make a library
2. Allow for introspection
3. Solve language barriers
4. Stick to your domain
5. Write tests

Make a library

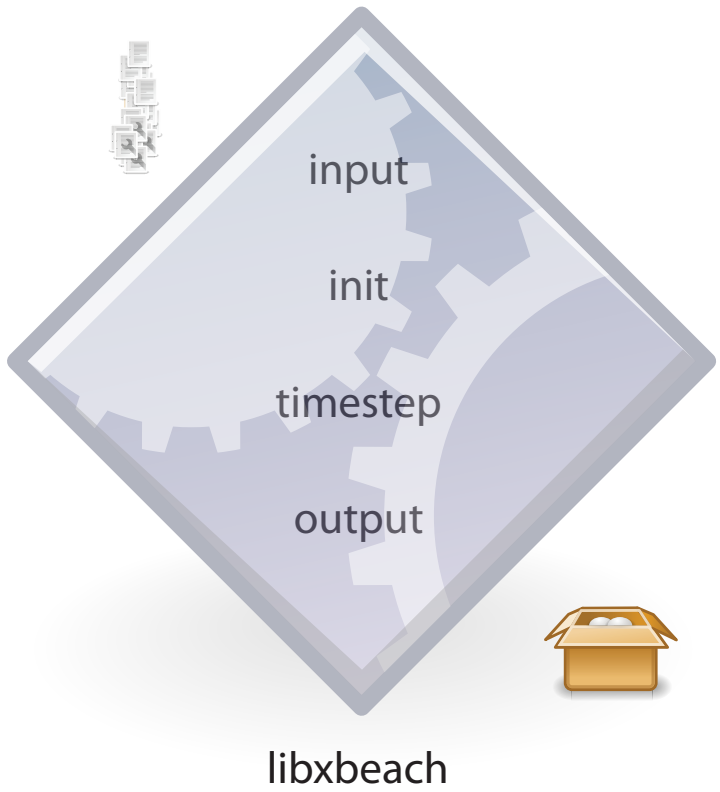

Figure: Internals of XBeach

Introspection

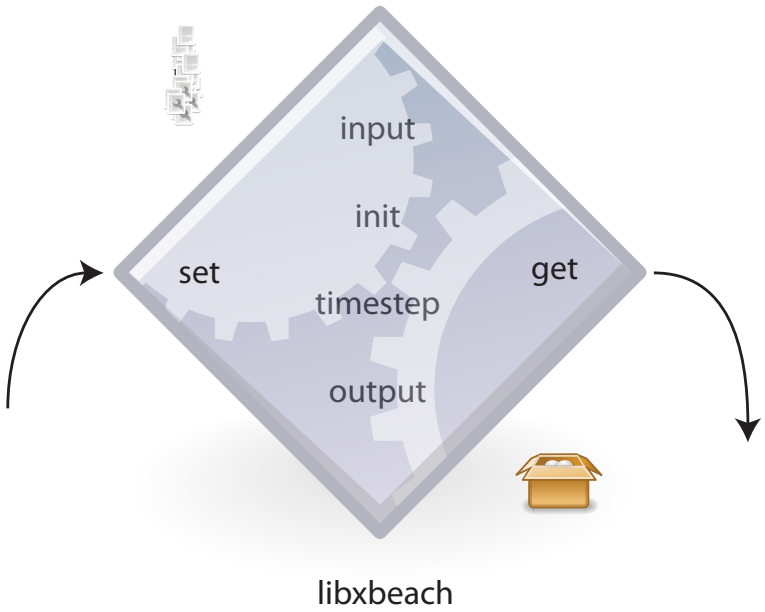

Figure: Internals of libxbeach

Language barriers

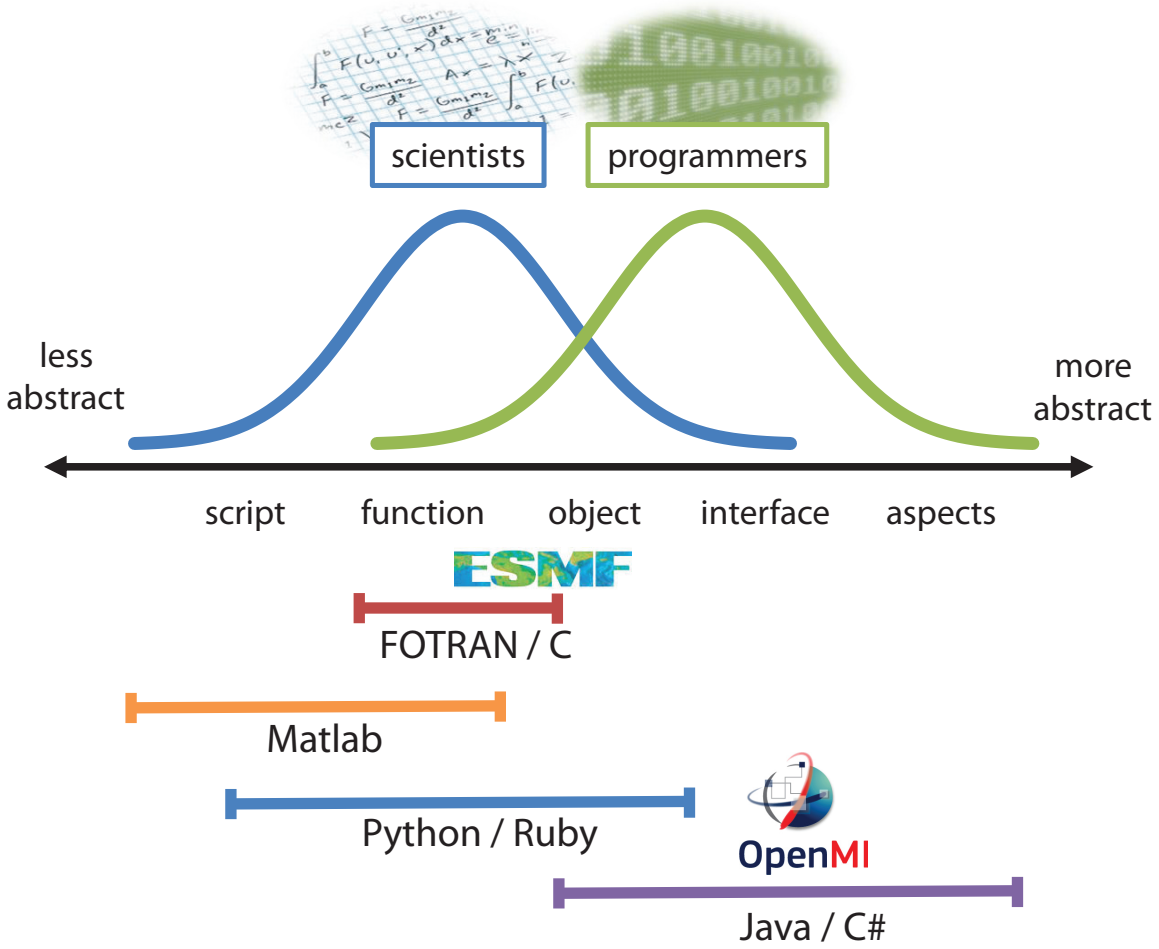

Figure: Abstraction scale with different programming languages and

ESMF vs OpenMI

ESMF	Description	OpenMI 2.0
ESMF_AppDriver	Main program/controller	OpenMI gui + command line runner
ESMF_GridComp	Component with input and output (run, initialize, finalize)	IBaseLinkableComponent
ESMF_CplComp	Maps input to a output state (used for conversion of units, grids, spatial transformation).	SDK / OpenMI Tools
ESMF_State	Connectable input and output items	IBaseExchangeItem / IBaseInput / IBaseOutput
ESMF_Array	Values (arrays, datatype) + attributes (units, spatial information)	IValueDefinition, IBaseExchangeItem, IElementSet
ESMF_Grid	Geospatial representation of connected items	IElementSet
ESMF_Field	Grid with an array, staggering, location	IElementSet, SDK
ESMF_Time	Time management	Itime
ESMF_Calendar	Time management	ITime
ESMF_TimeInterval	Time management	ITime

Figure: OpenMI and ESMF

Implementation effort (lines of code)

Framework	ESMF	OpenMI
library	111	111
language F90,c	29	29
language c,c#	0	65
framework	93	117
coupler	44	0
test	194	189

AGU poster

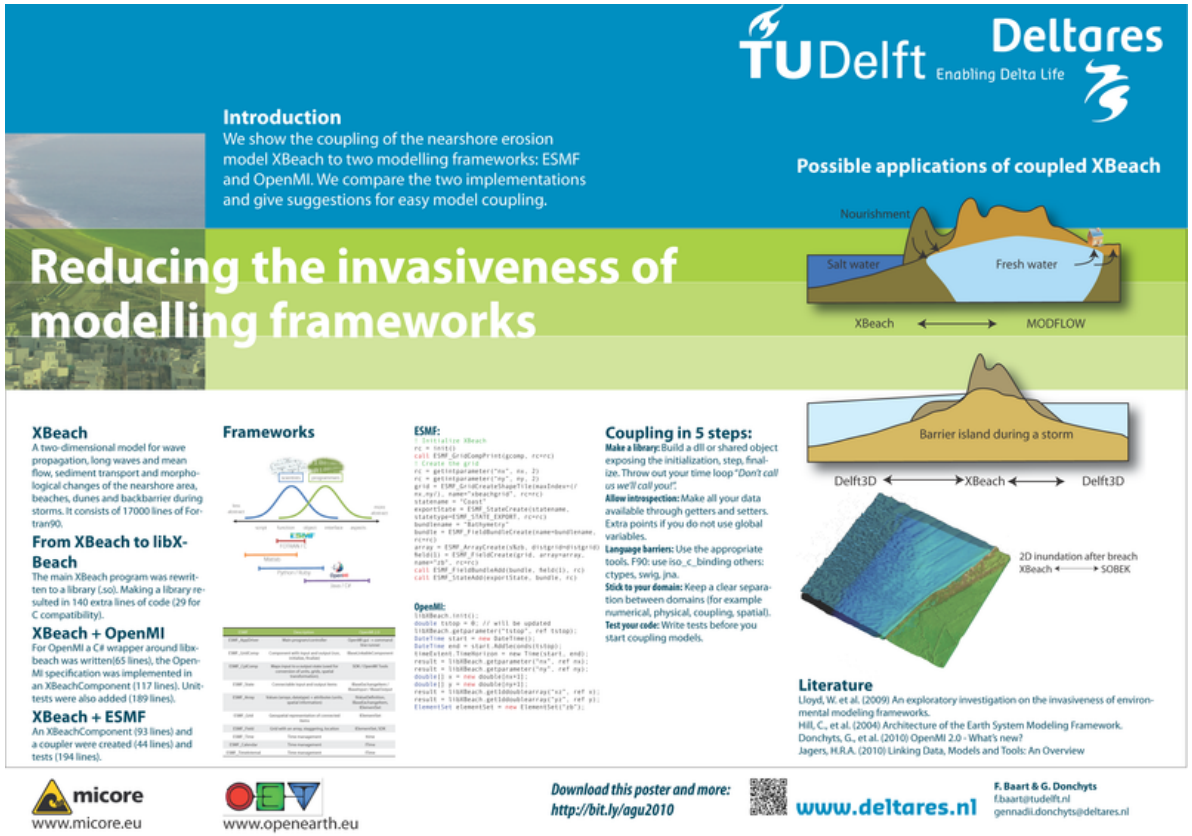

Figure: Poster presented at AGU conference. See http://bit.ly/AGU2010

Application of coupled XBeach

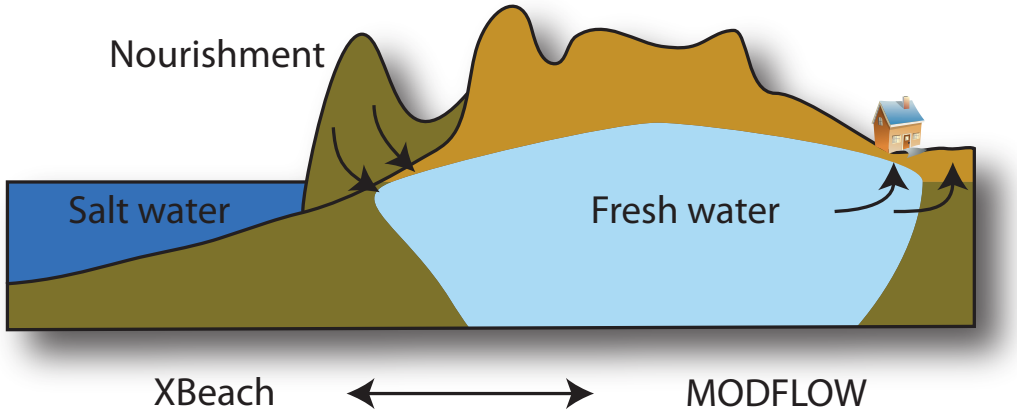

Figure: Application

Application of coupled XBeach

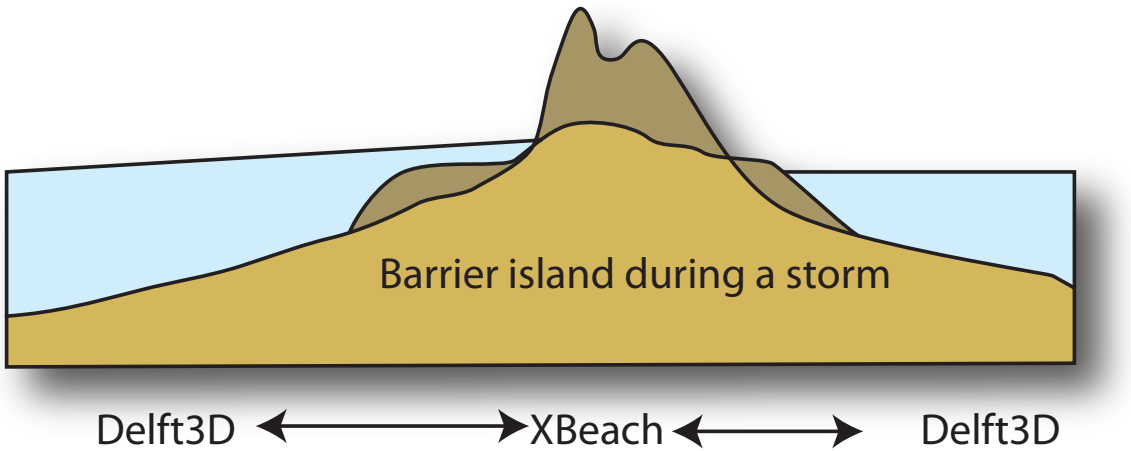

Figure: OpenMI and ESMF

Other applications

- SWASH integration
- Stranded ship modelling
- Swimmer simulator

Other applications

- Integration into Delta Shell
- Export to FEWS-pi
- R coupling for data assimilation/sensitivity analysis
- Matlab coupling for simple experiments

Call for applications

Please use this in Msc projects.

ESMF as a basis

ESMF as a base for fortran model coupling

OpenMI on top of ESMF