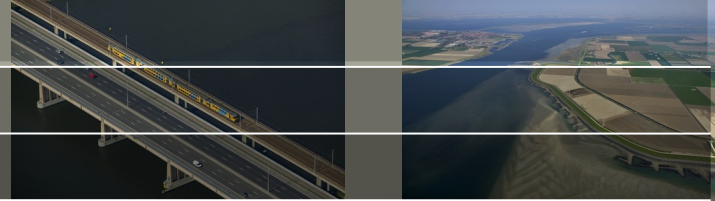




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Delft3D numerical model calibration with OpenDA

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Julius Sumihar, Firmijn Zijl, Albrecht Weerts,
Ghada El Serafy, Herman Gerritsen, ...
Deltares
&
Nils van Velzen, Alja Vrieling, Jeroen Gerrits, ...
Vortech**



Installation of OpenDA

- Installation of OpenDA binaries
- Automated calibration concepts
- A simple calibration example

Calibration for Delft3D-Flow

- Black-box model wrappers
- Installation of Delft3D wrapper
- Calibration example with Delft3D-Flow for a simplified estuary
- Next steps...

Installation of Windows binaries

1. Locate zip-file on sourceforge (use link on <http://www.openda.org>)
2. Download openda v2.0 windows binaries
3. Unpack zip-file (use a path without spaces)
4. Make a shortcut for run_openda_gui.bat
5. Test by starting the batch script

Known issues:

- A 32bit java environment is included to avoid issues with incompatible java versions.
- Sometimes existing directories in the PATH environment variable cause trouble.

Download OpenDA

Activities Firefox Wed Apr 4, 18:49

open_data_assimilation - Browse /openda_version_2.0/win32 at SourceForge.net - Mozilla Firefox

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sourceforge.net/projects/openda/files/openda_version_2.0/win32/

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Looking for the latest version? [Download OpenDA_2.0_r3242_bin.zip \(129.5 MB\)](#)

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Name	Modified	Size	
↑ Parent folder			
OpenDA_2.0_r3256_src.zip	2012-03-13	302.7 MB	 <input type="checkbox"/>
OpenDA_2.0_r3245_bin.zip	2012-02-19	100.8 MB	 <input type="checkbox"/>

Totals: 2 Items 3.5 MB

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http://sourceforge.net/projects/openda/files/...n_2.0/win32/OpenDA_2.0_r3245_bin.zip/download

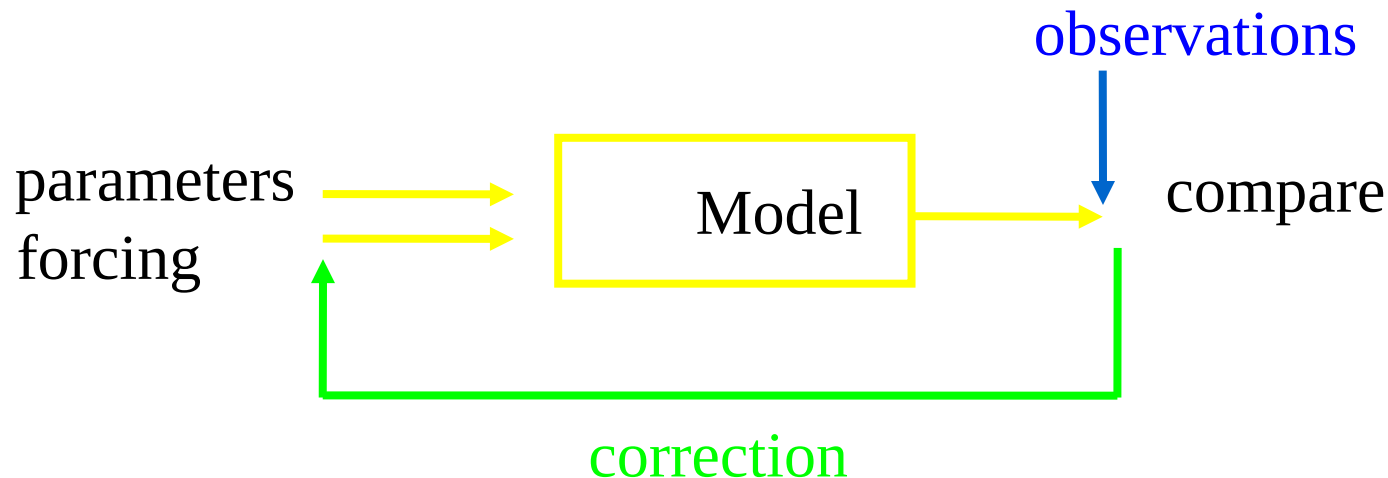
Gratis persoonlijkheidstest

De meest nauwkeurige persoonlijkheidstest die nu gratis verkrijgbaar is op het internet.

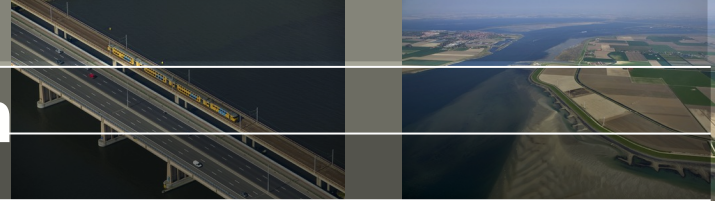
Ontdek jouw ware aard Start de test

Automated calibration concepts

- Many models contain uncertain parameters, often related to friction, boundary conditions or sub-soil material properties
- Model output can be validated against observations.



Optimization of a costfunction



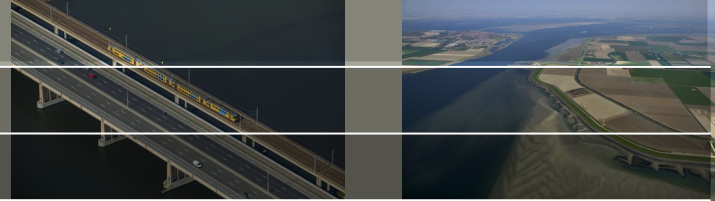
- Calibration is defined as an optimization problem
- Elaborate background in statistics: log-likelihood function
- Measure distance or misfit of model to observations
- Depends on uncertainty of observations

$$J_p = \sum_t \frac{(y_o(t) - y_m(t))^2}{\sigma_o^2}$$

- May be ill posed!
- Additional background term

$$J_p = \frac{(p - p_0)^2}{\sigma_p^2}$$

DUD algorithm

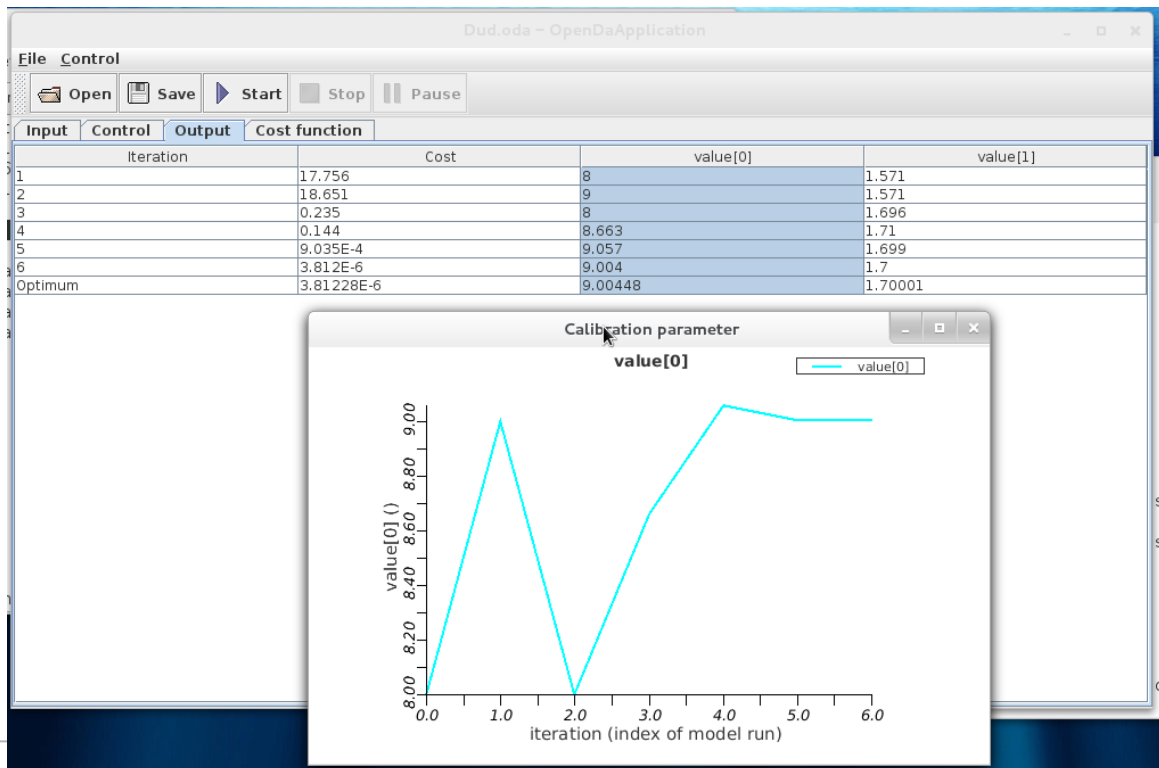


DUD (efficient for nearly linear models)

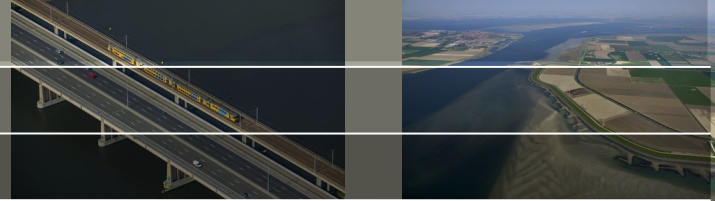
- **Start with running:**
 - **first guess**
 - **& modified run for each parameter**
- **Linearize the model around these values**
- **Solve linear problem**
- **If this is an improvement update linearization with new point**
- **Else do a line-search (only until there is improvement)**

A simple calibration example

- Run DUD calibration for linear oscillator
 - Start OpenDA gui
 - Open examples/simple_oscillator/Dud.oda
 - Start computations

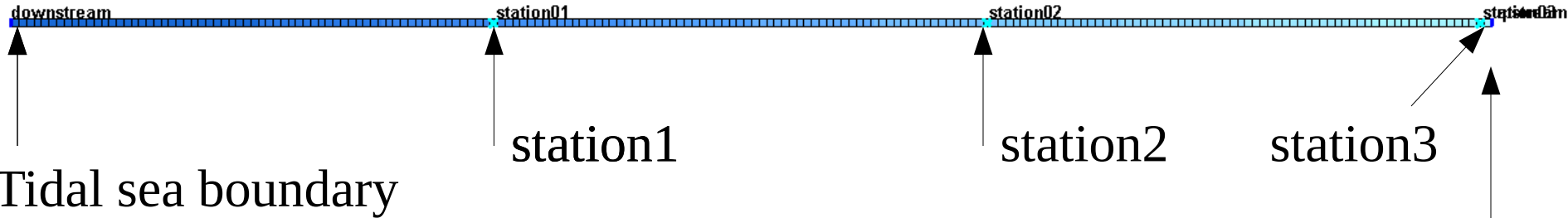
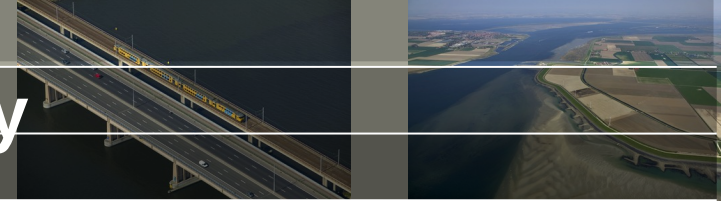


Black-box model wrappers



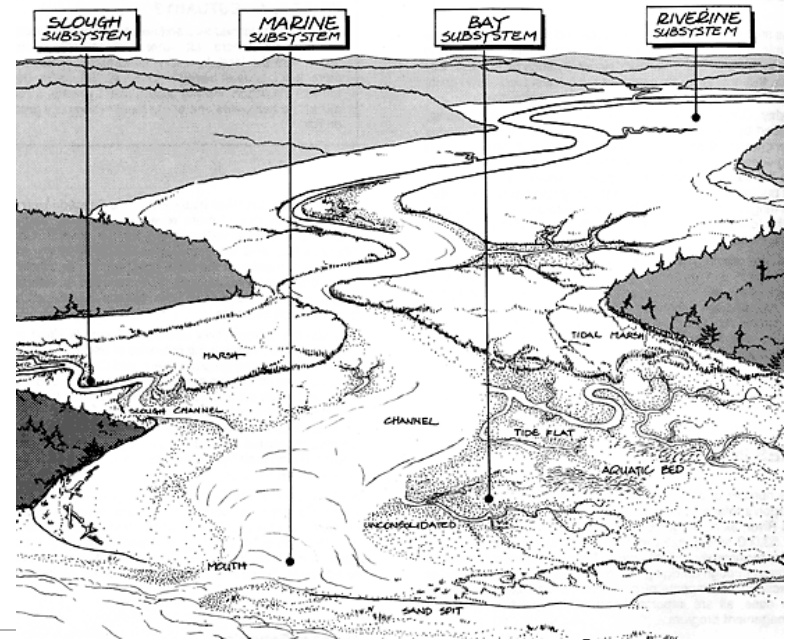
TODO

Simplified model of an estuary

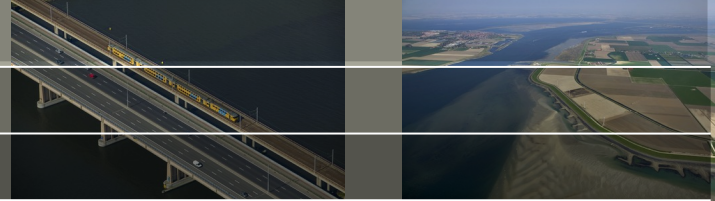


River discharge boundary

- One dimensional model
- Tidal boundary
M2 (12h25min) and S2 (12h)
- Constant slope depth
- Constant river inflow
- 3 Observation locations
- Observations are not real but generated with 'truth' model.

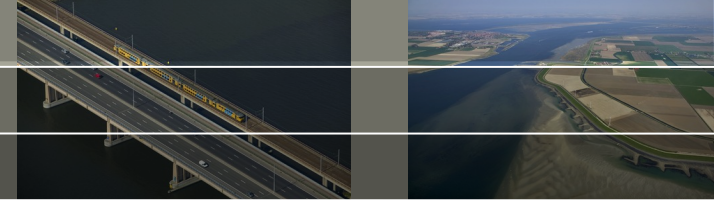


Exercise



- Download `openda_d3d_plugin.zip` from <http://www.openda.org/course> and unpack to `openda/bin`
- Download `estuary.zip` from <http://www.openda.org/course> and unpack
- Run the simulation with OpenDA, using the main OpenDA file `simulate.oda`
- Prepare some time-series plots with quickplot
 - Start matlab in directory `src/tools_lgpl/matlab/quickplot/progrsrc` and run `d3d_qp`
 - the observations are available as `tekal` file, for including them in the plots (use `add to plot` and change the color)
 - Output can be found in `estuary/work/work0`
- What are the most likely causes of differences between observations and model?

Estuary example Delft3D



Activities Firefox Wed Apr 4, 1

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- [estuary.zip](#) ←
- [estuary_calibration_exercise.pdf](#)
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Quickplot

The image shows a MATLAB R2011b environment with the Delft3D-QUICKPLOT dialog box open. The dialog box is titled "Delft3D-QUICKPLOT" and has a menu bar with "File", "Macro", "Window", and "Help". It contains several sections for configuring the plot:

- File:** A dropdown menu showing the current file path: ".../src/delft3d/delft3d/probleem/trih-OldCd...".
- Domain:** A dropdown menu set to "water level".
- Subfield:** A dropdown menu.
- Time:** A checkbox for "All" is checked, with a value of "25" in a text box. Below it is a "Show Times" checkbox and a list box.
- Station:** A dropdown menu set to "Key Colony Beach". Below it are three rows for "M", "N", and "K", each with a checkbox for "All" and an empty text box.
- Export:** A "Load Data" button, a "Define V..." button, an "Add to P..." button, and a "Quick View" button.
- Plot Style:** A "Data" dropdown set to "As in file", a "Colour" dropdown set to a blue color, a "Line" dropdown set to "-", a "Width" text box set to "0.5", and a "Marker" dropdown set to "none".
- Clipping Values:** A text box set to "-999".
- Export File Type:** A dropdown menu set to "csv file (time series)".
- Export Data...:** A button.

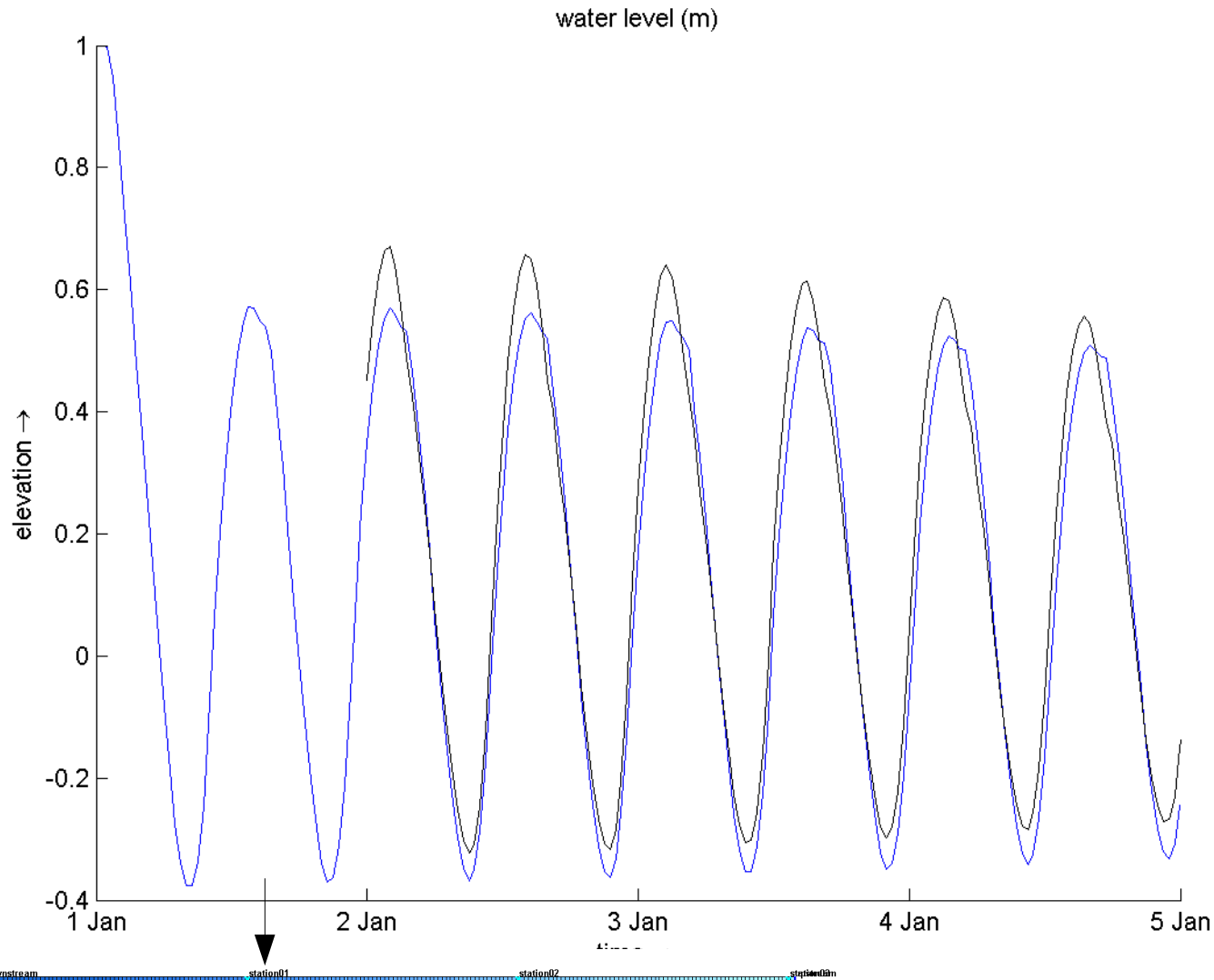
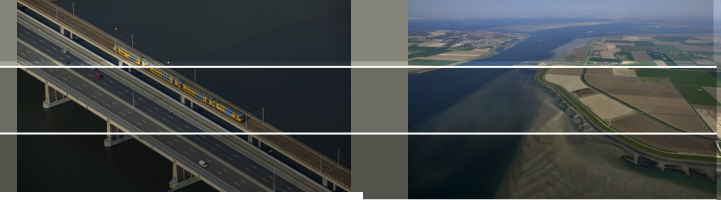
In the background, the MATLAB Command Window shows the following code:

```
>> d3d_  
Undefined function or variable 'd3d_'.  
  
>> d3d_qp  
fx >>
```

The file explorer on the left shows the "progsrc" folder containing various files, including "d3d_qp.m".

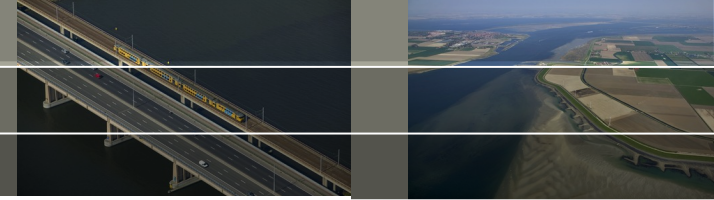
A blue banner at the bottom of the image contains the text: "src/tools_lgpl/matlab/quickplot/progsrc and run d3d_qp".

Initial performance

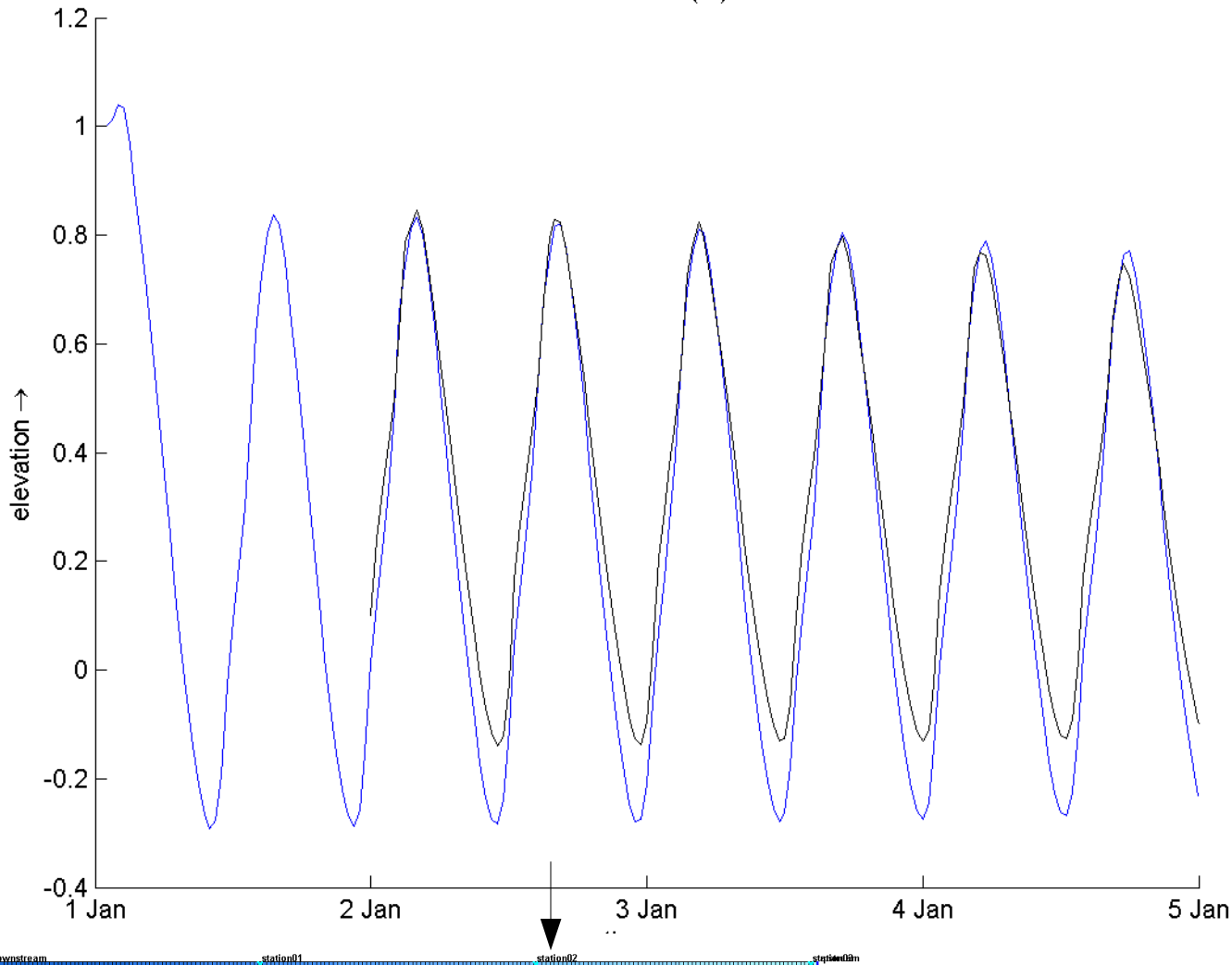


RMSE=9cm

Initial performance

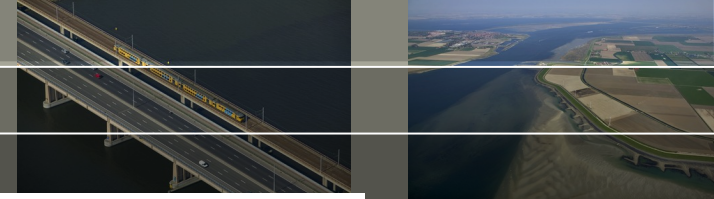


water level (m)

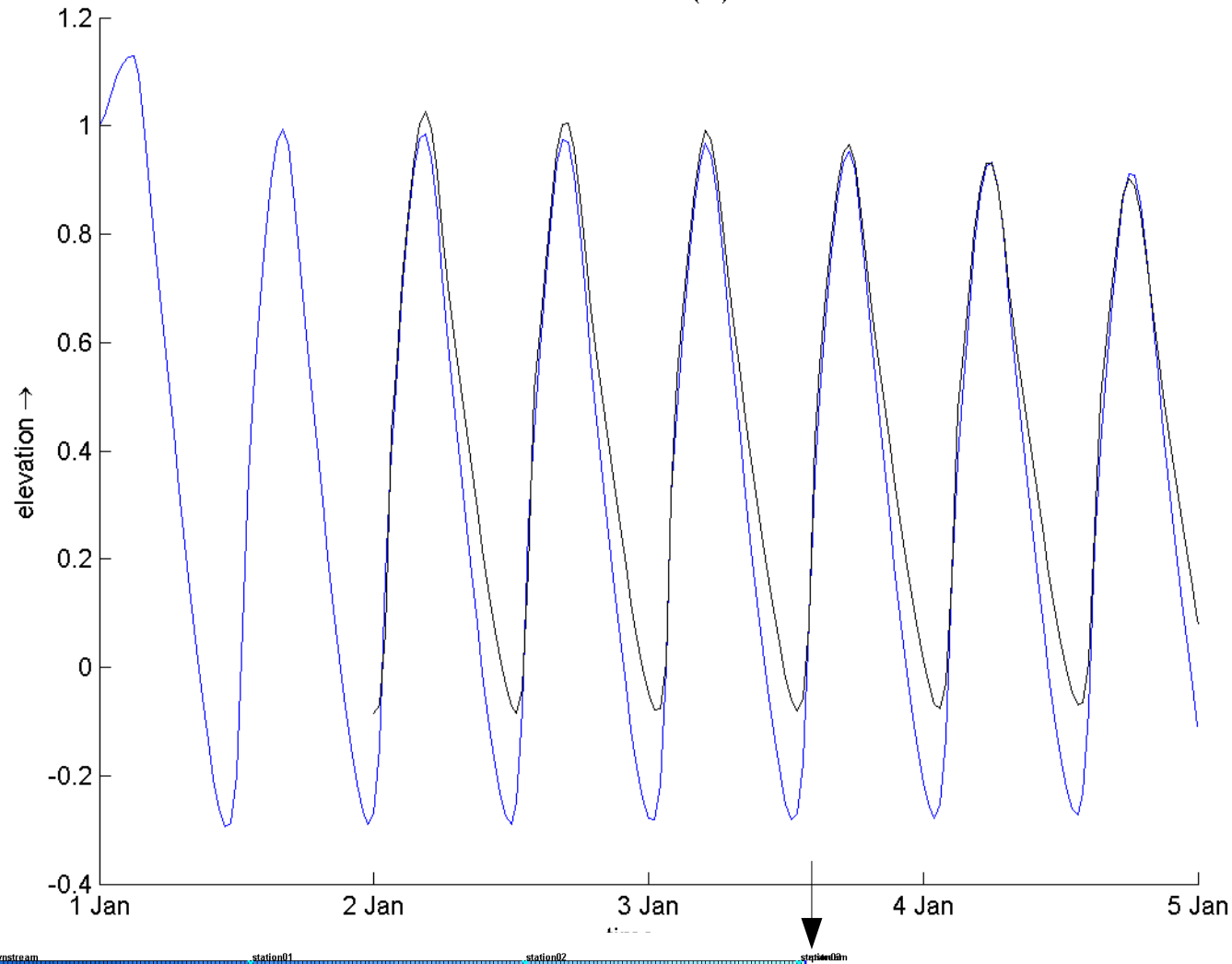


RMSE=12cm

Initial performance

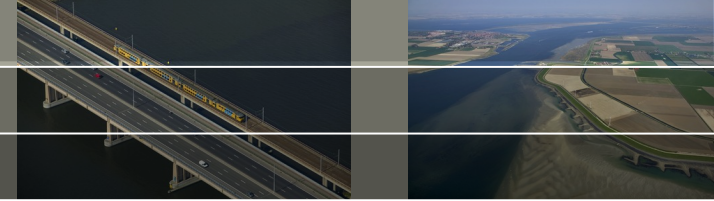


water level (m)



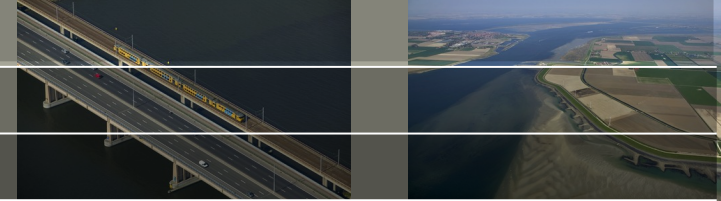
RMSE=7cm

Exercise

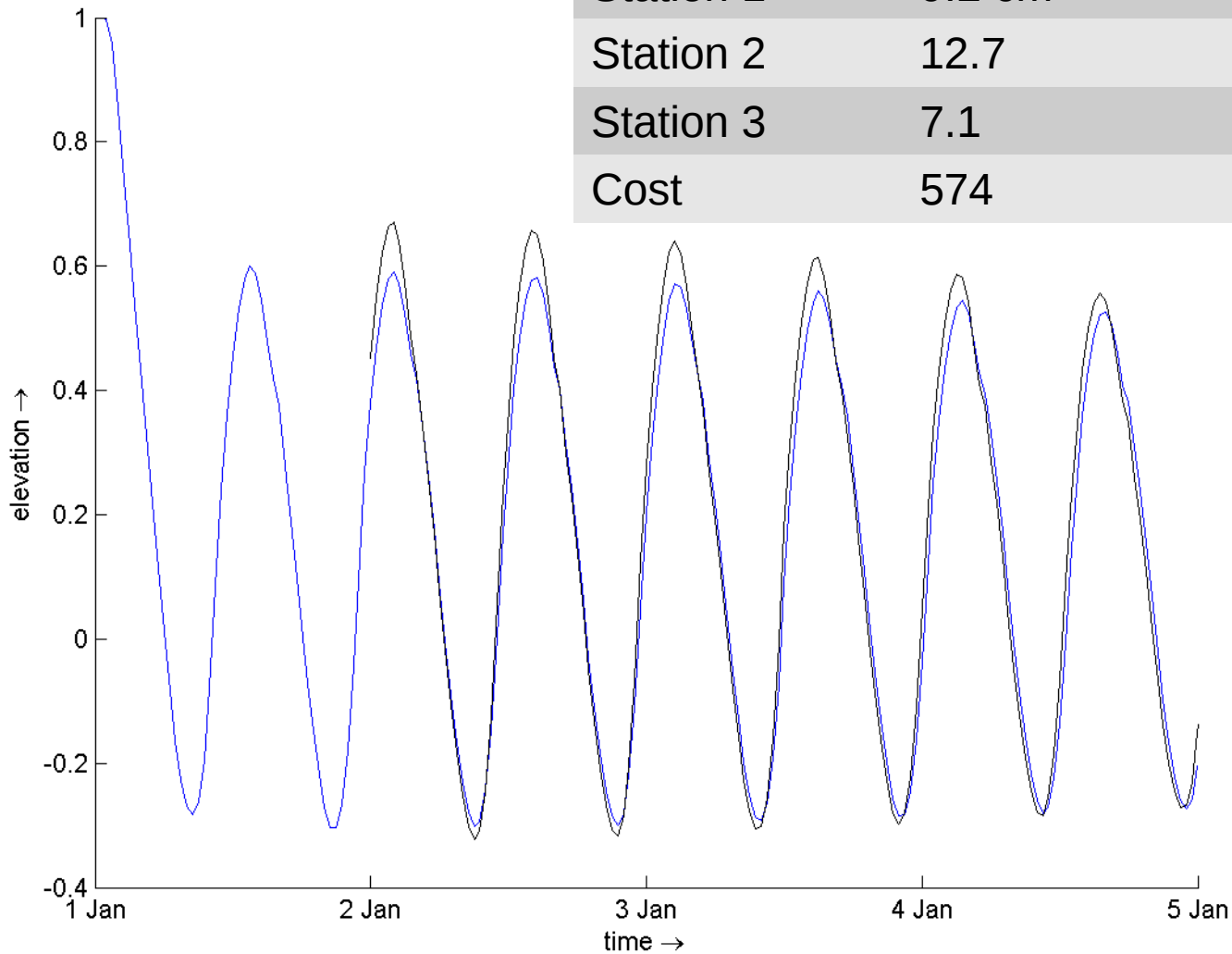


- Run the calibration for a globally constant change to the bathymetry (experiment DEP)
 - Start OpenDA with estuary/calibration.oda
 - Look at the output in the control tab and output tab
 - The output of each of the runs can be found in work/work<number>
 - Plot the time-series with quickplot.
- Is this what you expected?

Calibration Depth

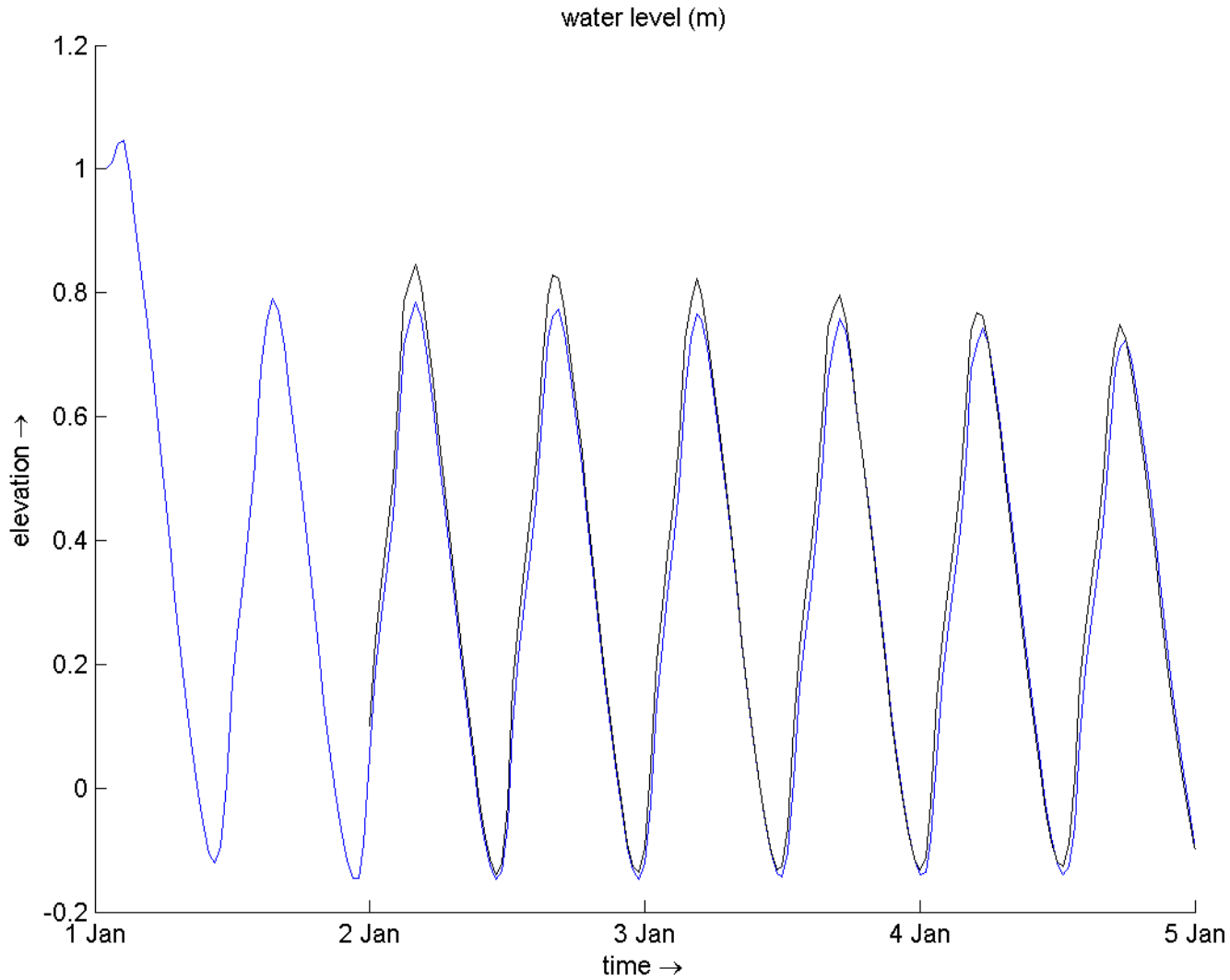
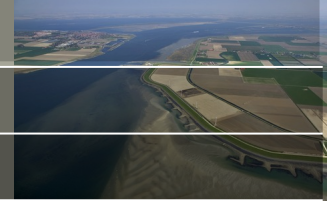


Station 1

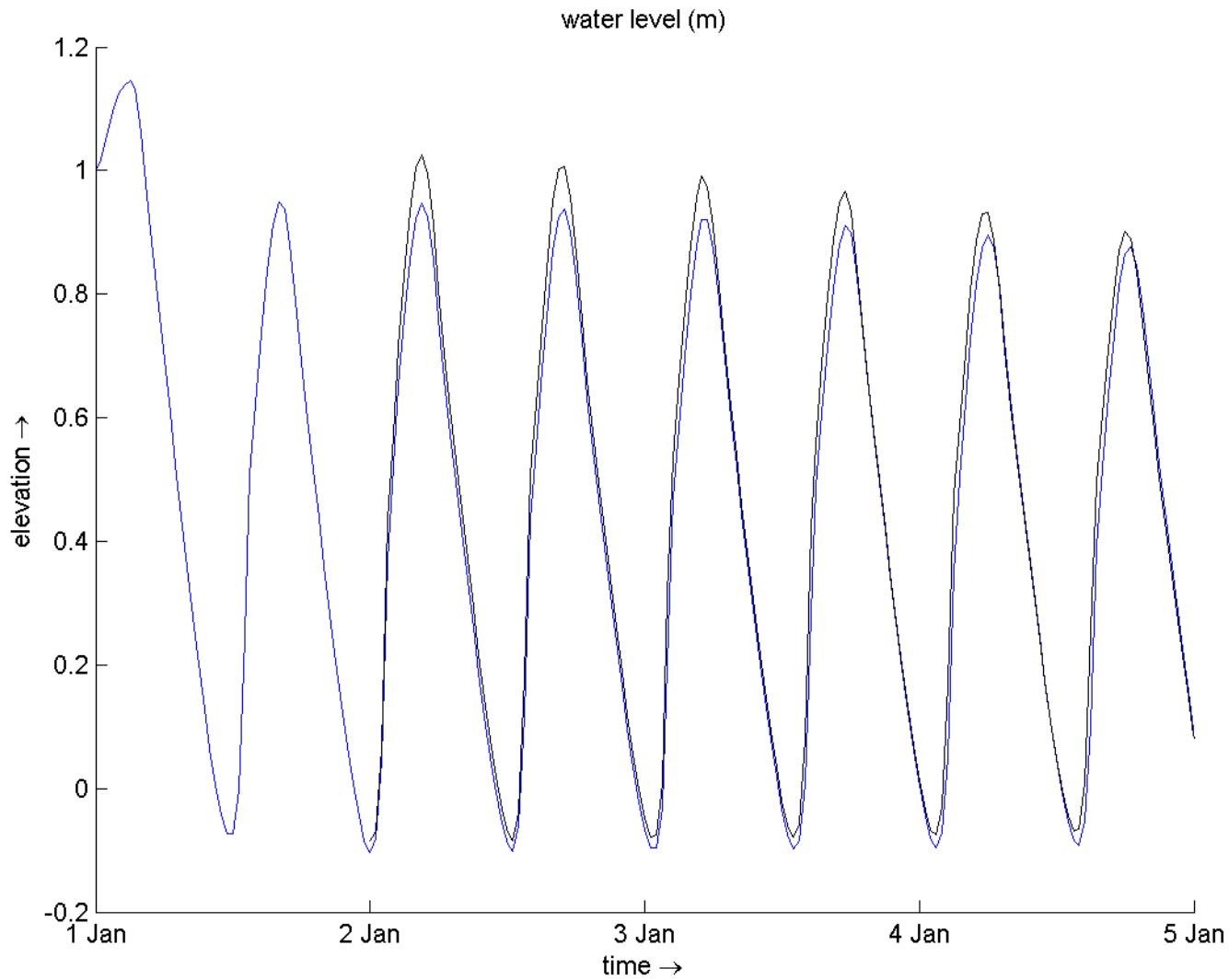
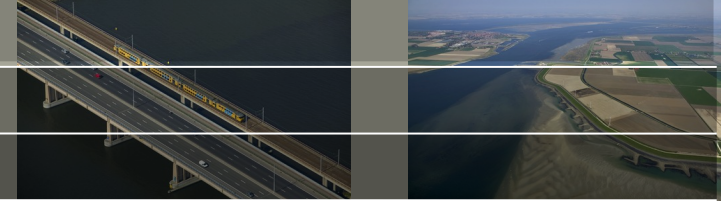


Name	First guess	DEP calib.
Station 1	9.2 cm	4.5
Station 2	12.7	5.0
Station 3	7.1	4.9
Cost	574	134

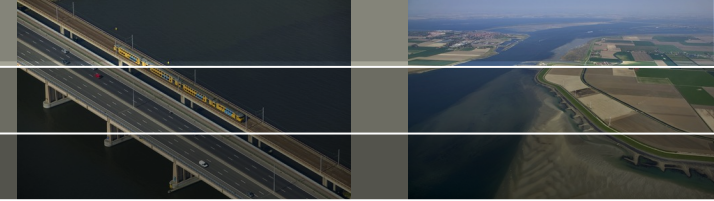
DEP output Station 2



DEP output Station 3



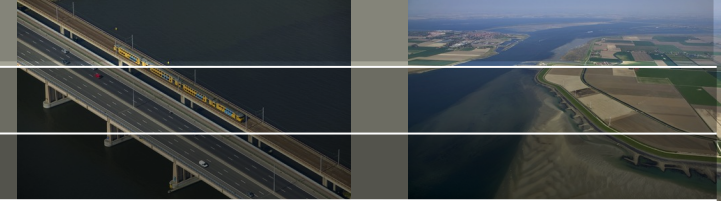
Exercise



Since the amplitude shows a similar deviation from observations in the whole domain we add calibration of M2 tides at boundary.

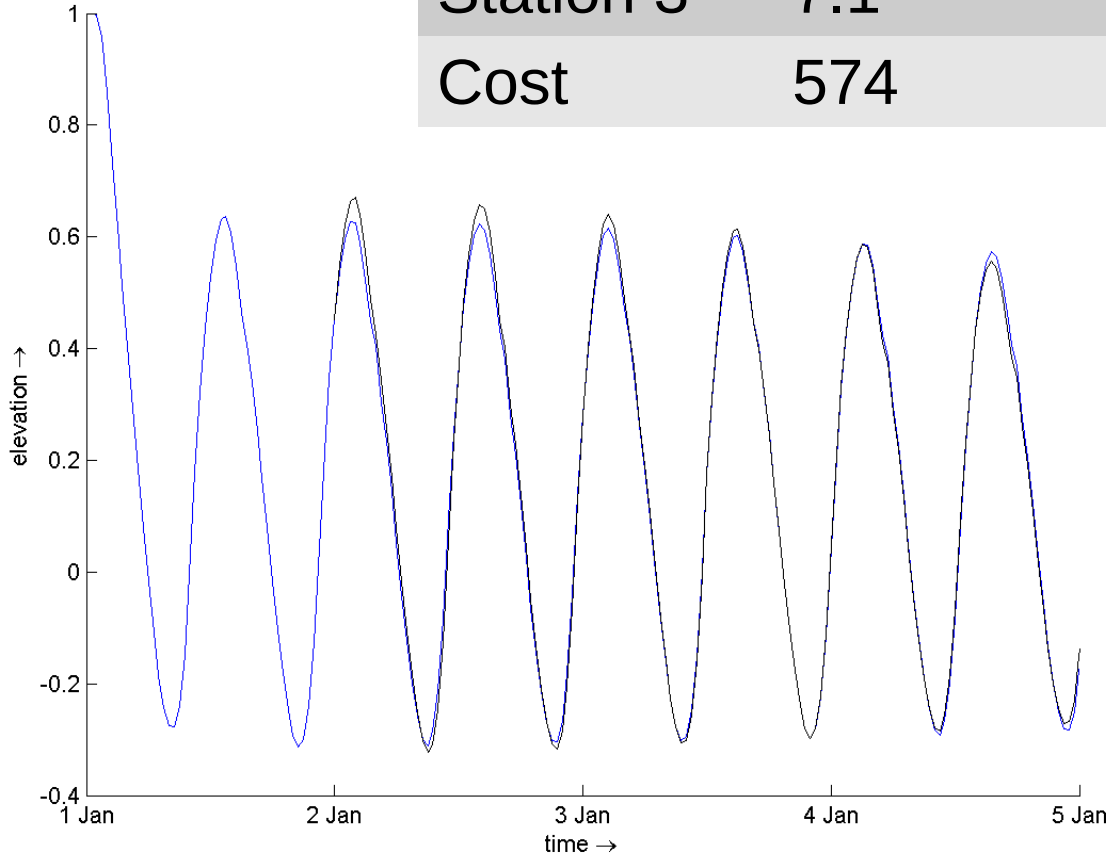
- Add the calibration (experiment DEP+M2)
 - Uncomment M2 section in stochModel/D3DStochModel.xml
 - Run calibration
 - Look at the output and plot the time-series.
 - Is this what you expected?

Calibration Depth+M2

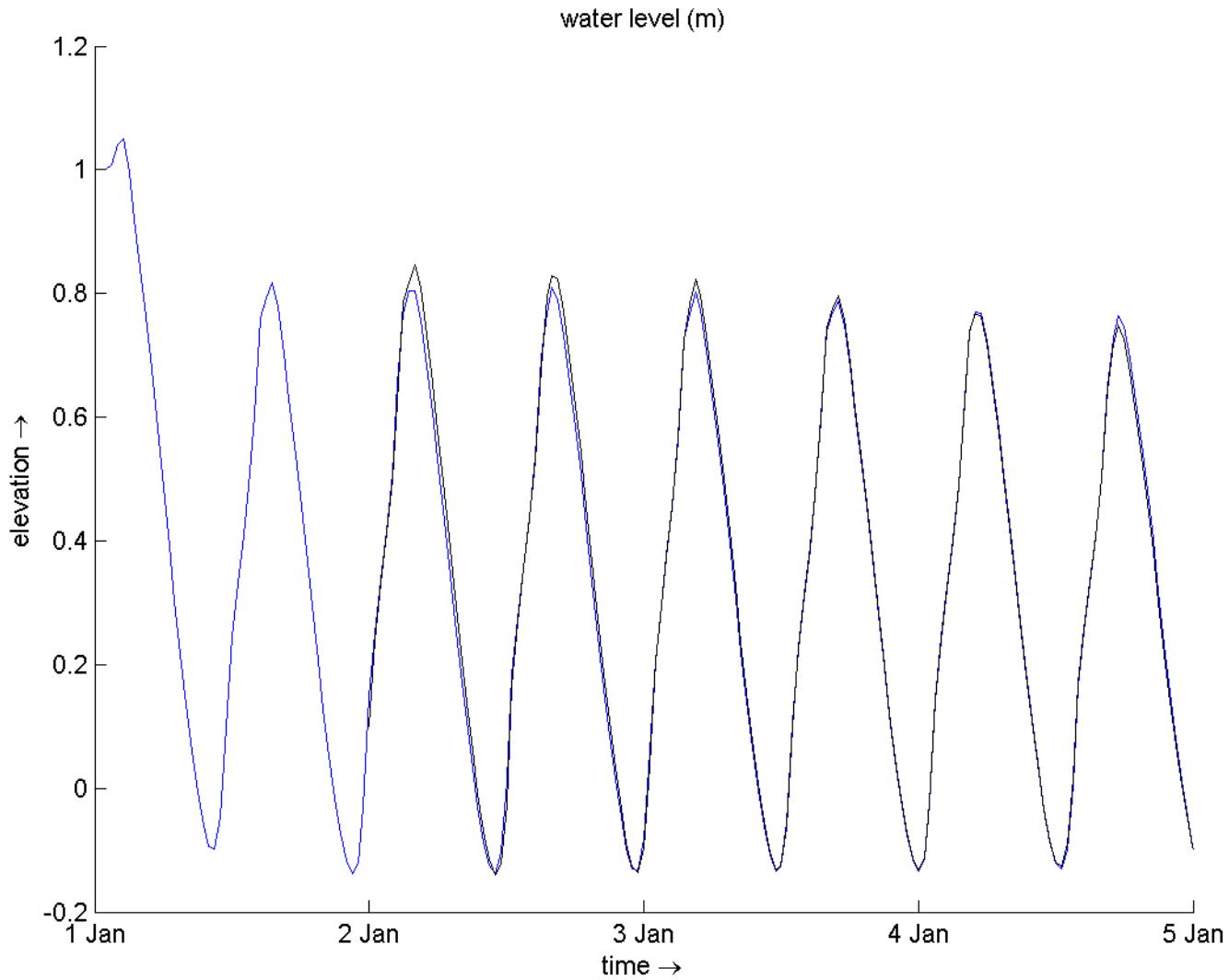
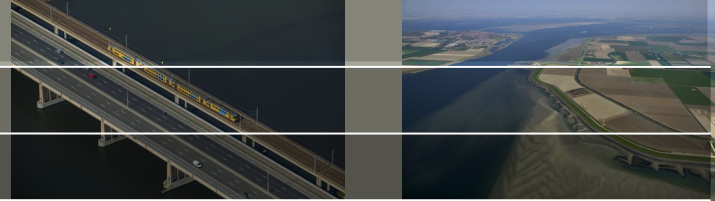


Station 1

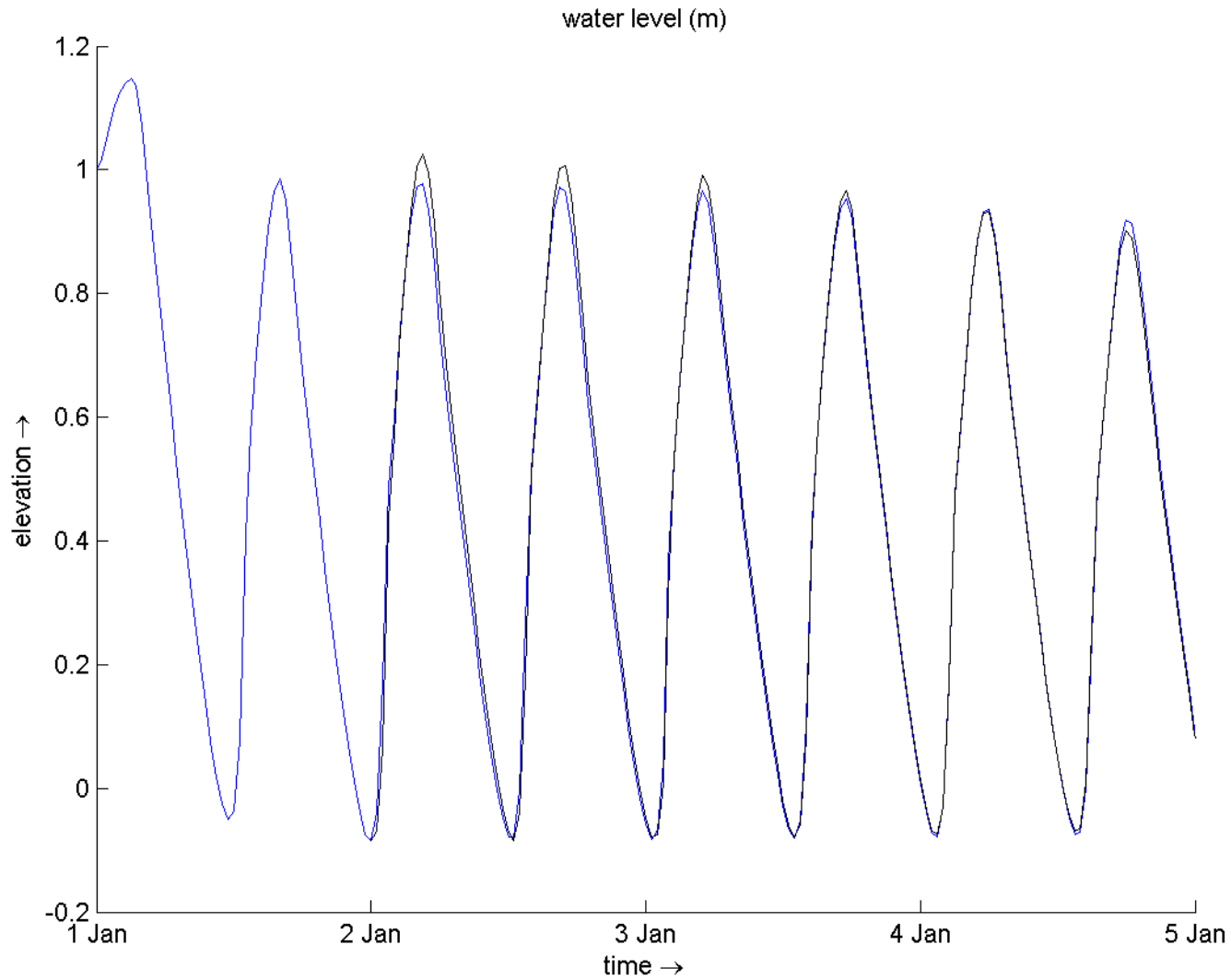
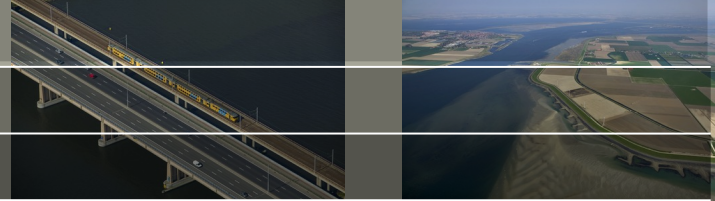
Name	First guess	DEP	DEP+M2
Station 1	9.2 cm	4.5	1.1
Station 2	12.7	5.0	1.4
Station 3	7.1	4.9	1.1
Cost	574	134	8.4



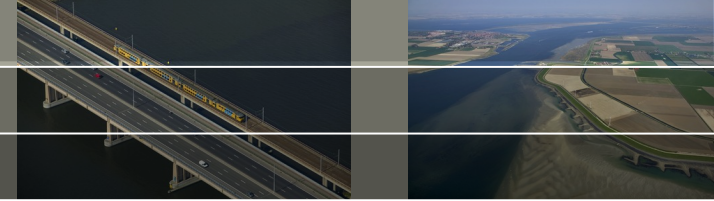
DEP+M2 output Station 2



DEP+M2 output Station 3



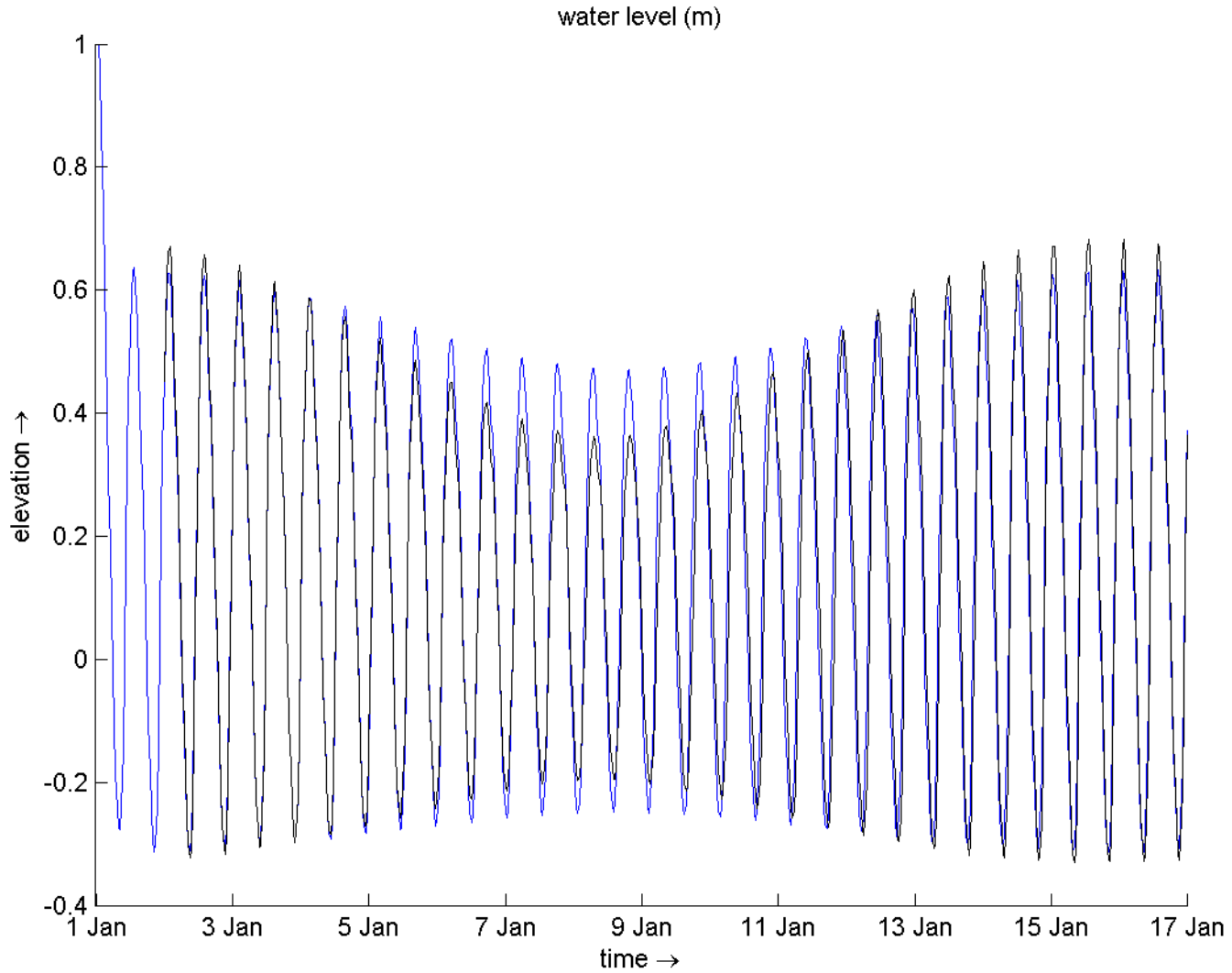
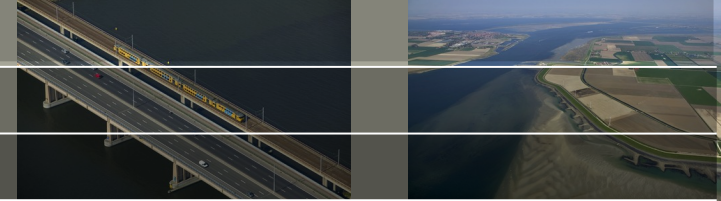
Exercise



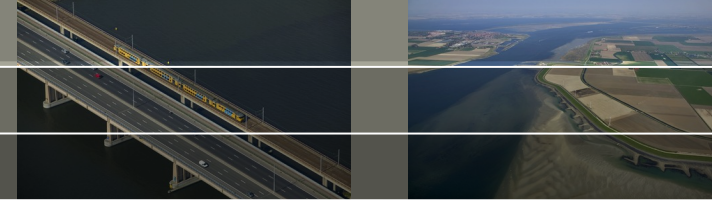
The output looks nice. The cost-function is much lower, but there is still a problem...

- Make a longer run with the final run of experiment DEP+M2
 - Modify `work/work<last_number>/estuary.mdf` and change the `Tstop = 2.3040000e+004` which is 17-1-1991 0:00h; alternatively use the gui.
 - Run `deltares_hydro.exe` for this case
 - Make time-series plots
 - What is wrong?

Long run for DEP+M2 result



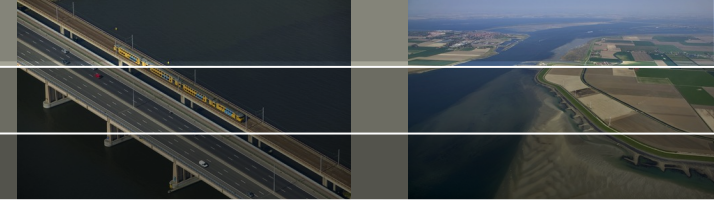
Exercise



The error in S2 was attributed to M2. Let's make fix this with a longer simulation and adding S2 to the calibration

- Add S2 to calibration and lengthen simulation experiment DEP+M2
 - Modify input_d3d/estuary.mdf and change the Tstop = 2.3040000e+004 which is 17-1-1991 0:00h; see also estuary_long.mdf
 - Lengthen the observations in stochobserver/noosObservations.xml to 17-1-1009 0:00h; see noosObservations_long.xml
 - Uncomment S2 section in stochModel/D3DStochModel.xml
 - Run calibration with OpenDA
- What would go wrong if we would use only 3 days of observations for calibration of S2 and M2?

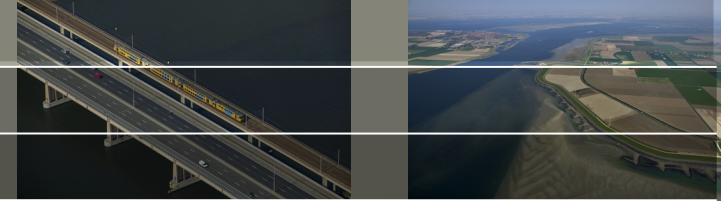
Calibration DEP+M2+S2



Name	First guess	DEP+M2+S2
Station 1		0.9cm
Station 2		0.7
Station 3		0.2
Cost	5281	1.5

Parameter	Final value (change)	True values
M2.Amplitude	0.1 cm	0.0 cm
M2.Phase	0.4 degr	0.0 degr
S2.Amplitude	10.1 cm	10.0 cm
S2.Phase	0.3 degr	0.0 degr
Depth	-92cm	-100cm

And much more



- Calibration of roughness
- Calibrate blocks of the grid for depth or roughness
- Proportional instead of additive modification of parameters
- Make subselections of observations
- Restarts
- Parallel computing
- Output formats and selection
- Try other algorithms
- Calibration of other models, such as sobek, swan or waqua
-

Calibration of a storm surge model

