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Enabling Delta Life

D-Flow Flexible Mesh: a showcase of hydrodynamic applications on flexible unstructured grids

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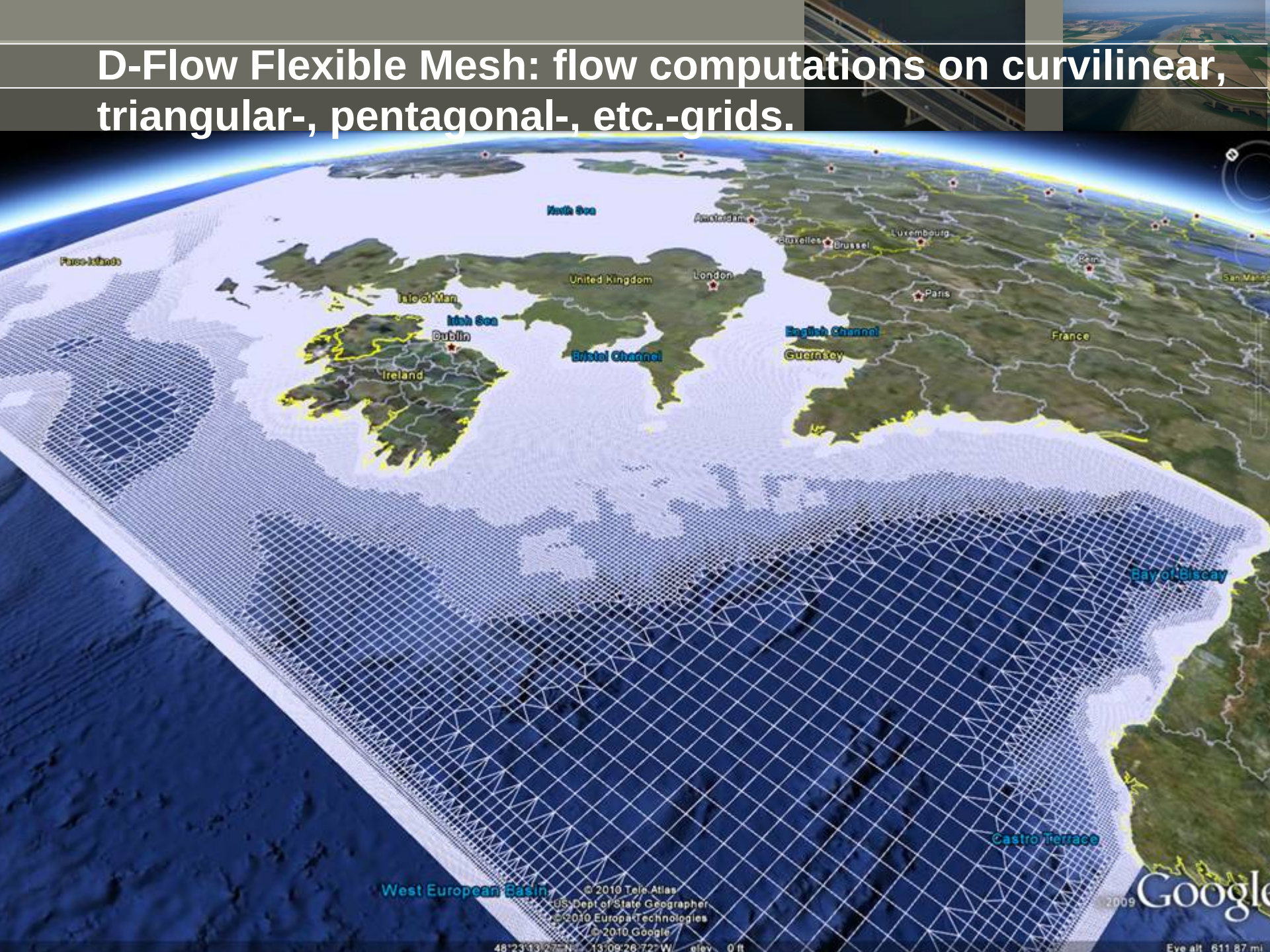
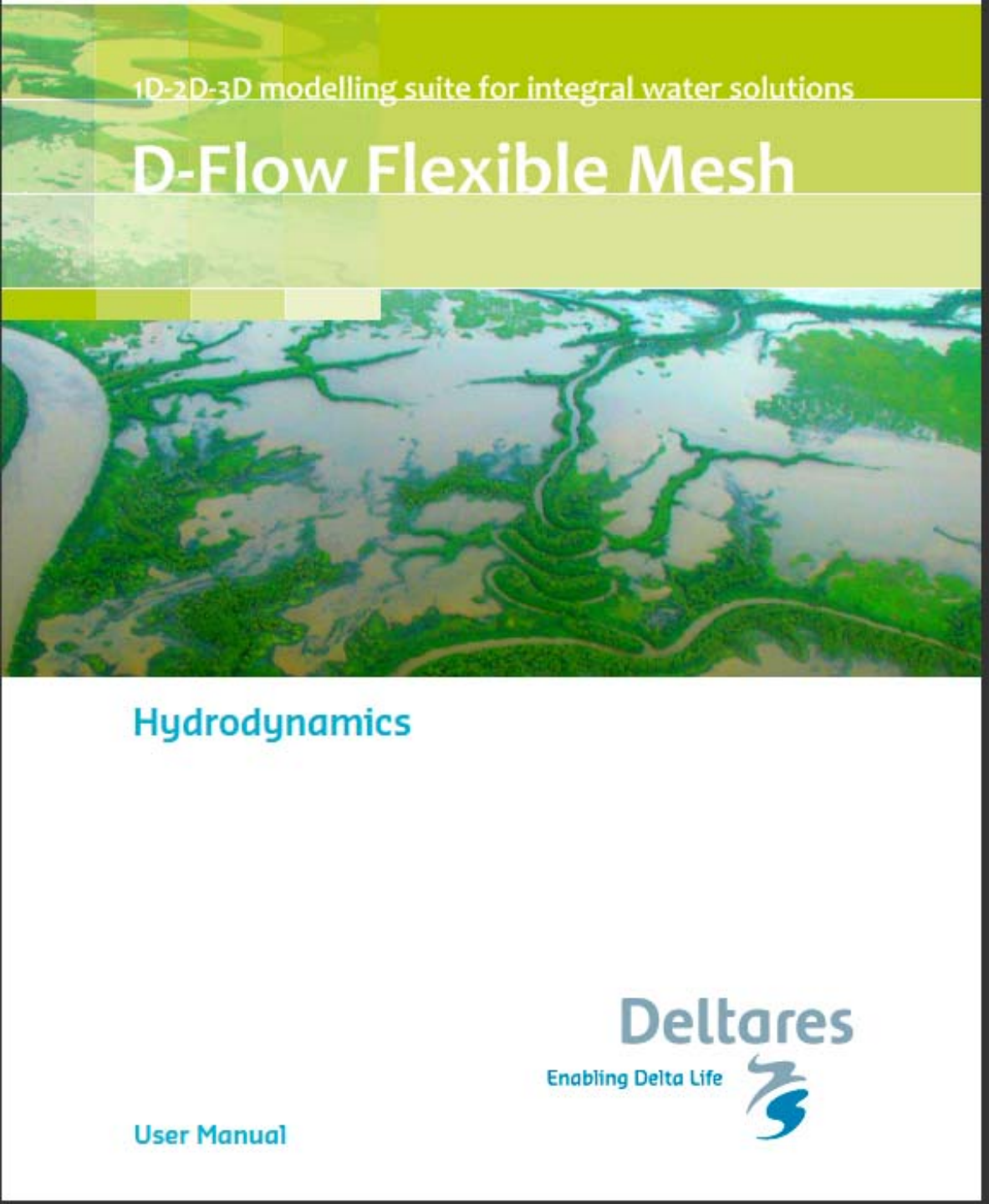
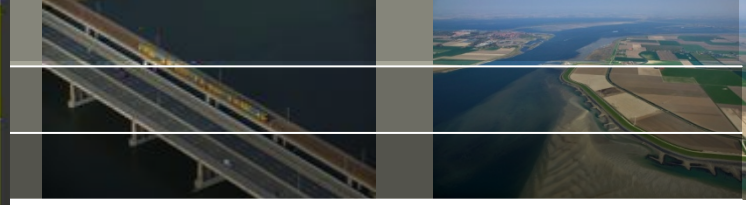
JONSMOD 2012
May 22, 2012

D-Flow Flexible Mesh: flow computations on curvilinear, triangular-, pentagonal-, etc.-grids.







D-Flow Flexible Mesh (FM)

New hydrodynamical engine.

Combines techniques from Delft3D-FLOW and SOBEK

2009-2011: 1D+2D(+3D)

2012-2013: 3D+morphology, parallellization, misc. couplings.

Flexible Meshes:

- Curvilinear grids
- Extended with triangles
- Integral coupling with 1D

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D-Flow Flexible Mesh applications

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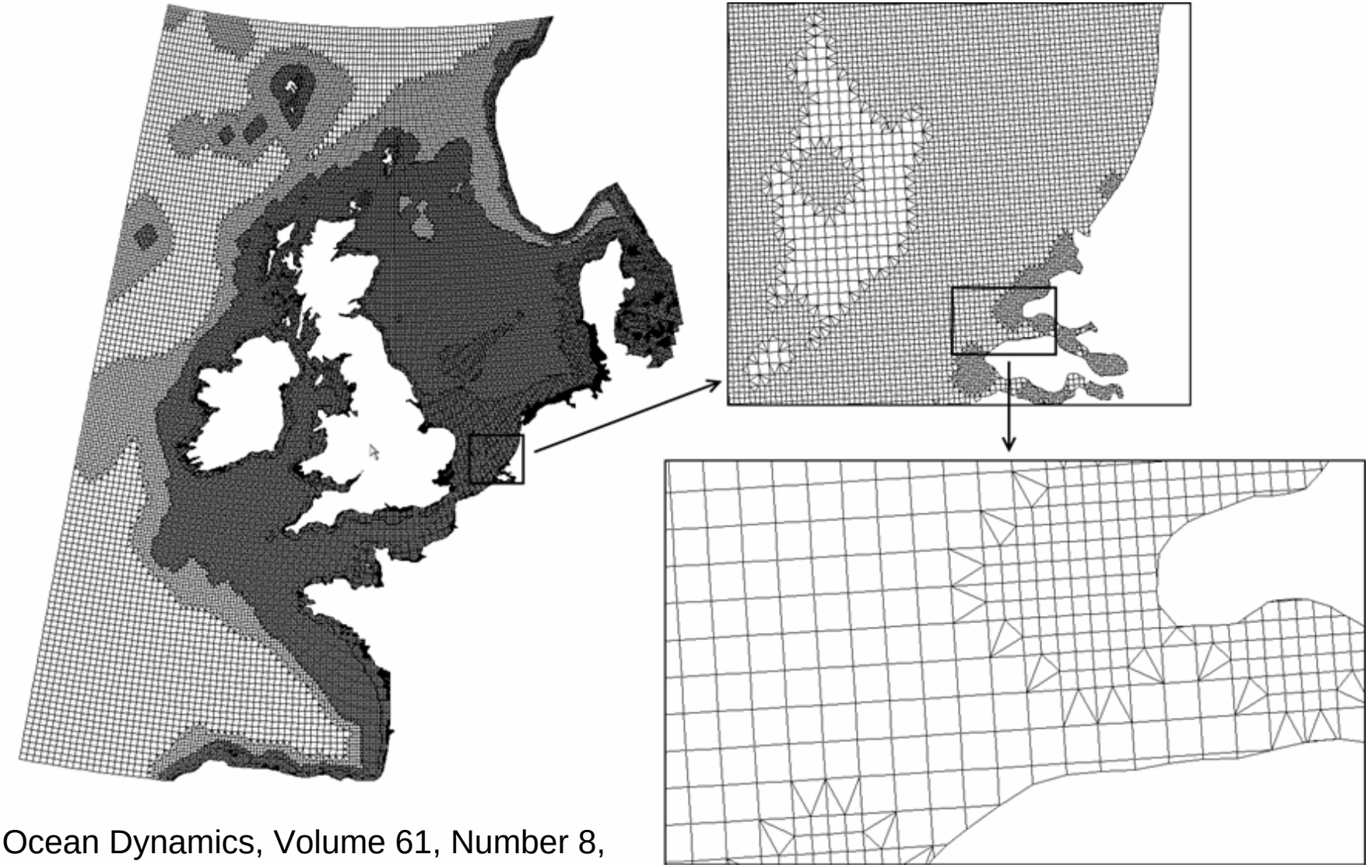
CSM model Courant grid (coarse in deeper parts)
(JONSMOD 2010)



Ocean Dynamics, Volume 61, Number 8, pp. 1175-1188, 2011. DOI: 10.1007/s10236-011-0423-6

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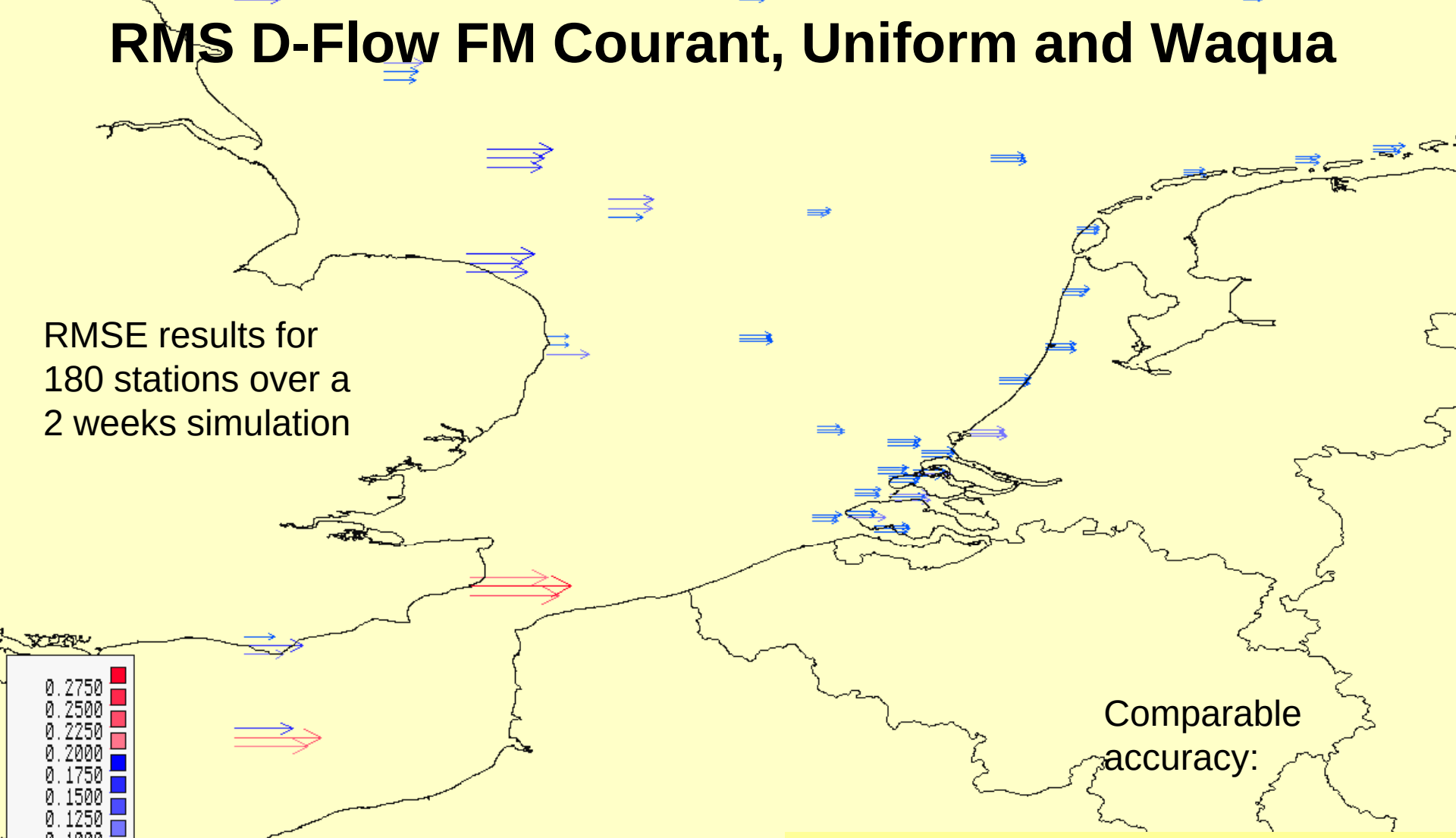
RMS D-Flow FM Courant, Uniform and Waqua



RMSE results for
180 stations over a
2 weeks simulation

Comparable accuracy:

D-Flow FM Courant	: 5.95 cm
D-Flow FM uniform	: 5.84 cm
(Calibrated WAQUA	: 5.72 cm)

Comparable accuracy, at what cost?
Comparison of computation times

Computation time one week of simulation DCMv5 (~9,3 km)

in seconds

WAQUA	31s	(Dutch Rijkswaterstaat)
TRIWAQ	34s	
Delft3D-FLOW	60s	(Delft3D curvilinear)
D-Flow FM (**single** thread)	84s	
D-Flow FM (**eight** thread OpenMP)	35s	
D-Flow FM (**eight** thread, Saad ILUd BiCG-STAB)	24s	(D-Flow FM, same grid)

D-Flow FM competes in computation time with established packages (in spite of possibly expected data structure overhead).

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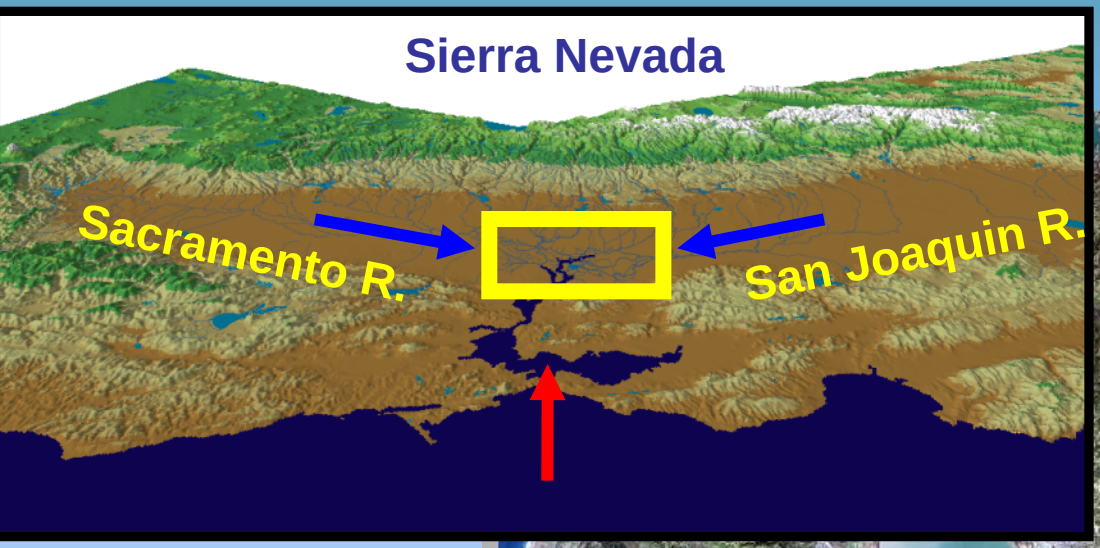
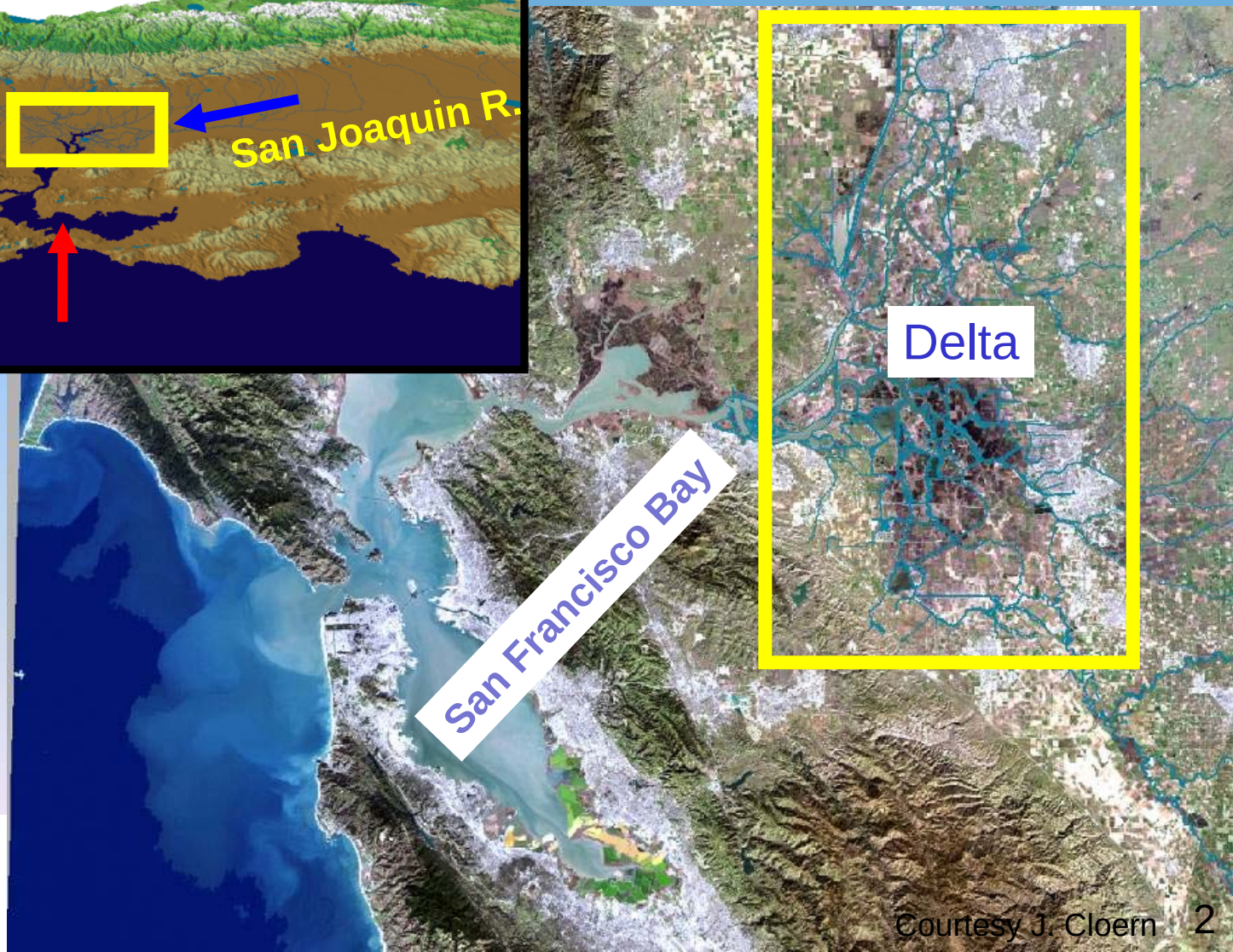
CASCaDE II:

"[..] extend modeling capabilities to assess Delta ecosystem response to changes in climate and physical configuration"





Pacific Ocean

Courtesy:
Mick van der Wegen
(UNESCO-IHE)

UNESCO-IHE
Institute for Water Education

Courtesy J. Cloern

Bays + Sacramento-delta behind San Francisco

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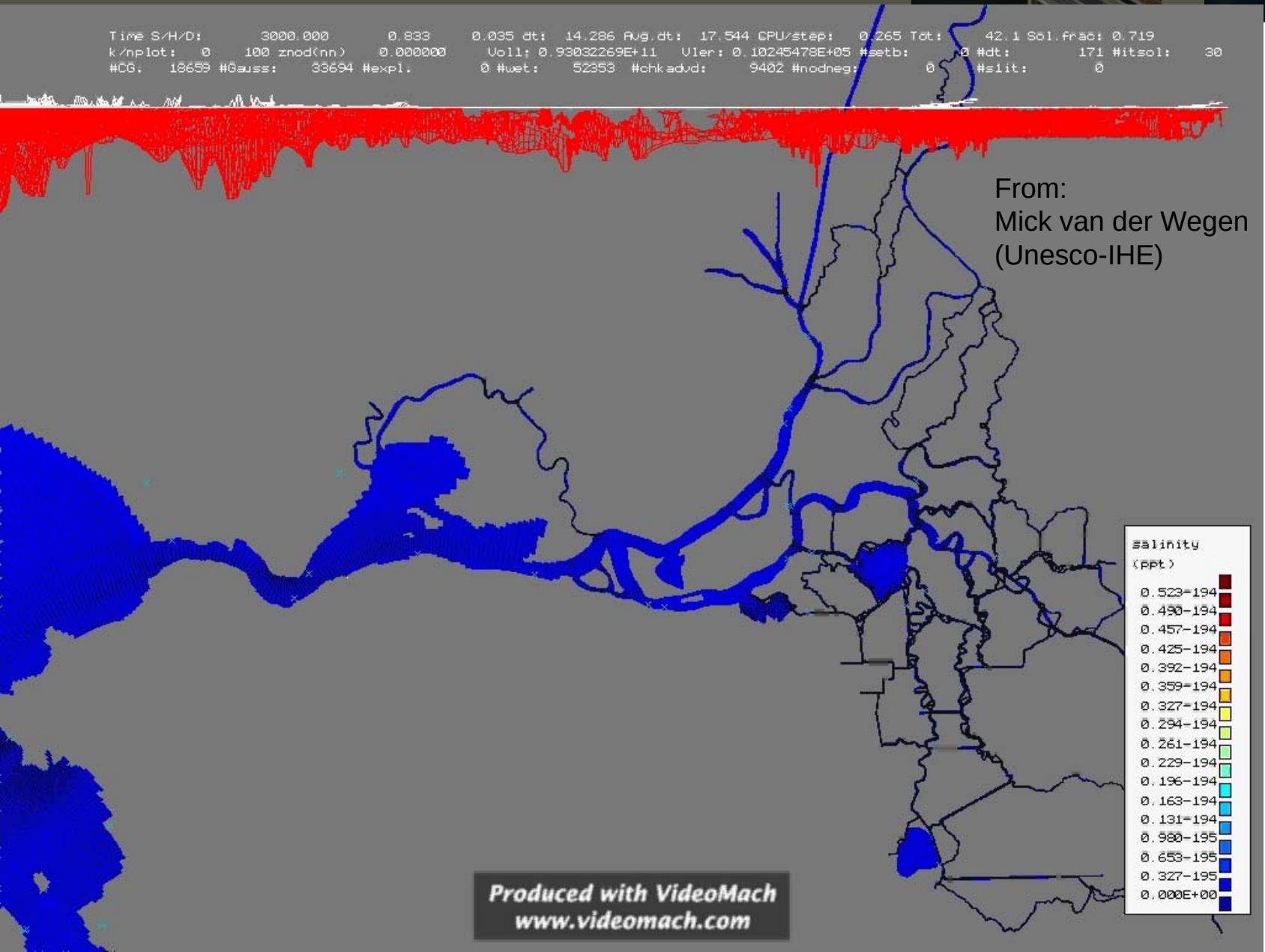
Deltas: numerous curvilinear rivers, triangles for coupling and for lakes

Intrusion of salt water and contaminants.



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A finer-scale model: the Kam Tin Drainage channel

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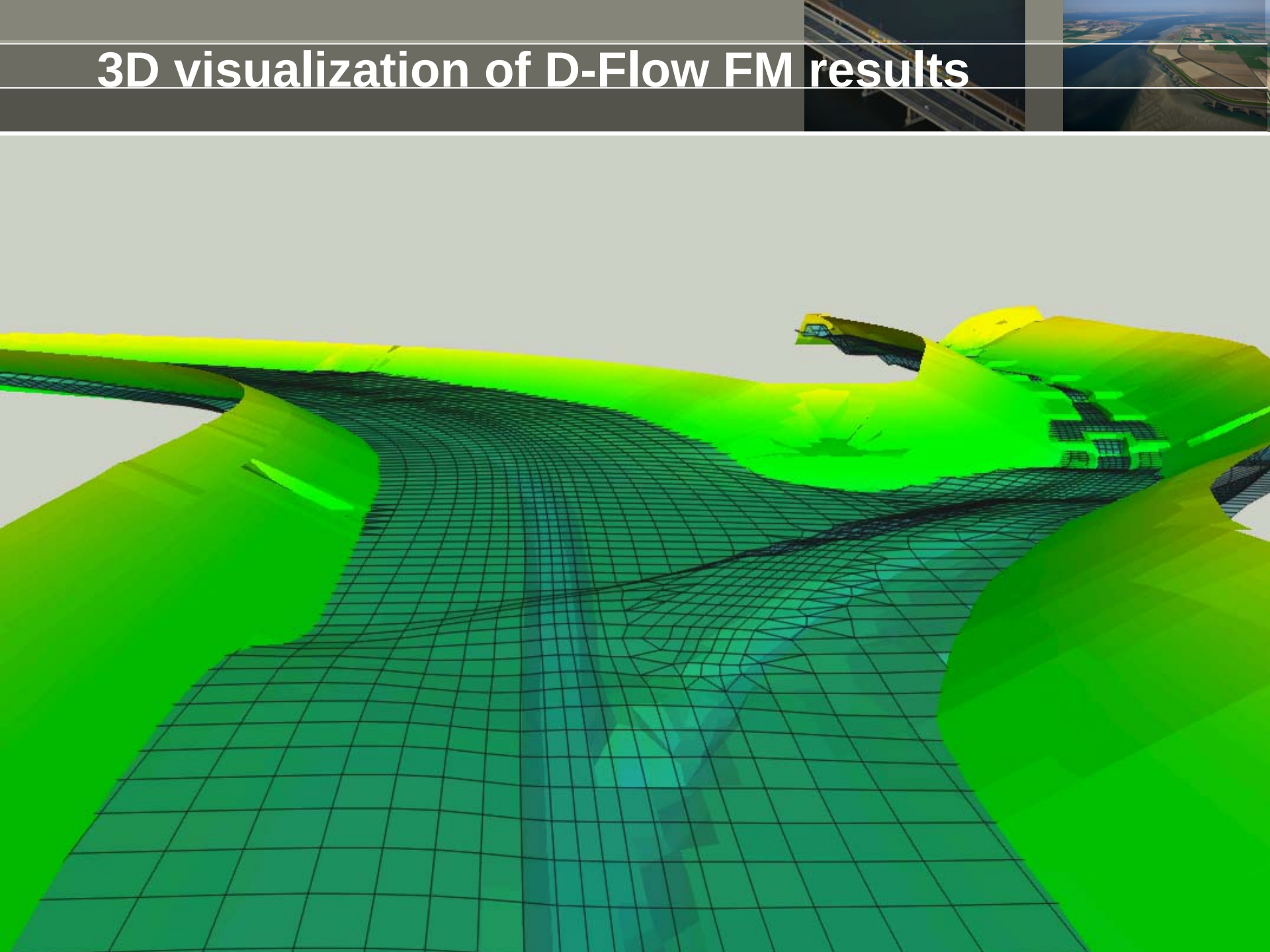
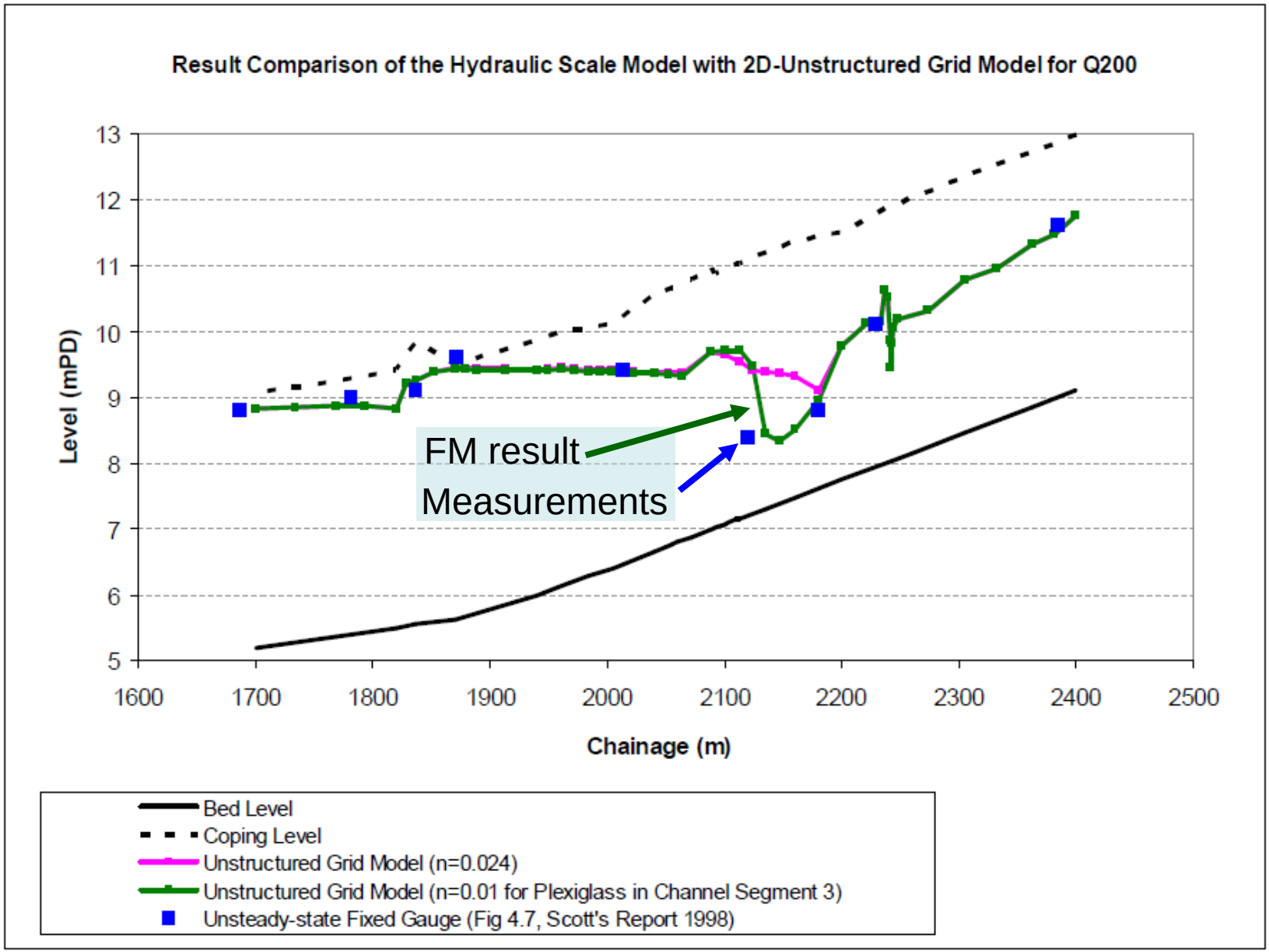
File Edit View Tools Add Help
hong kong
Exit Photo
peak flows ~ 6 m/s
©2009 Google
Eye alt 10 m

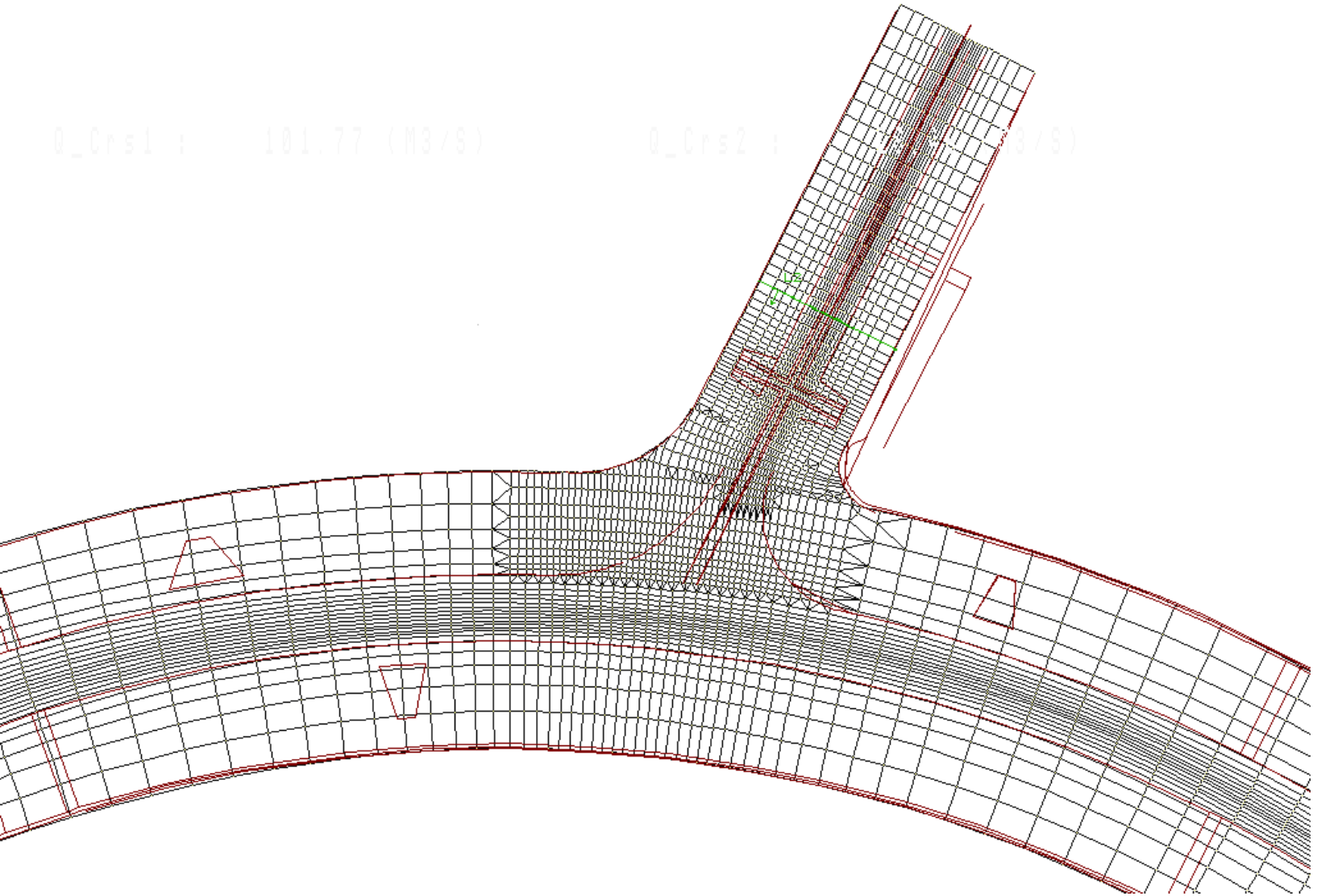
3D visualization of D-Flow FM results



Good agreement with measurements from laboratory/scale model



Drainage channel Hong Kong: locally fine resolution



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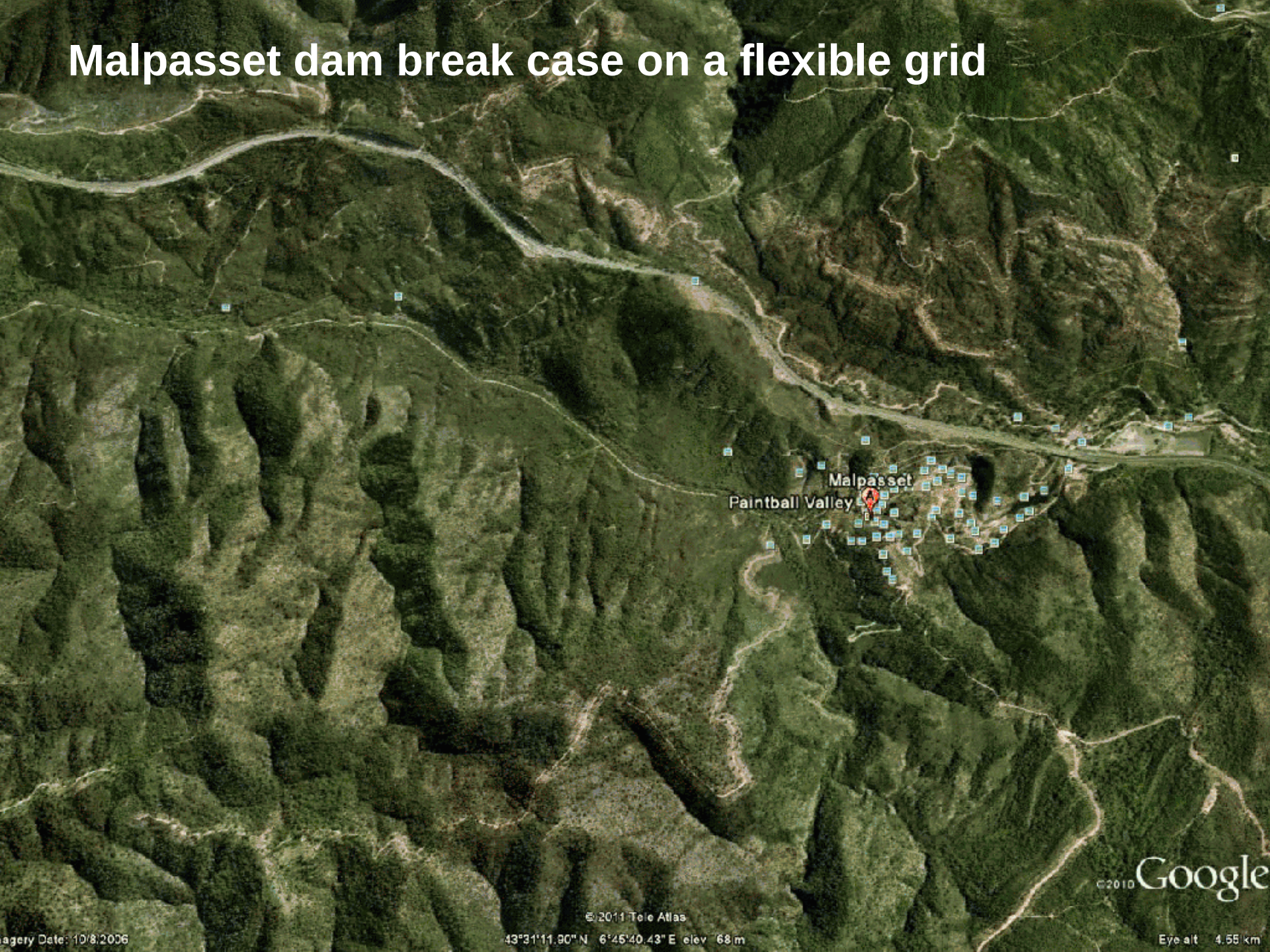
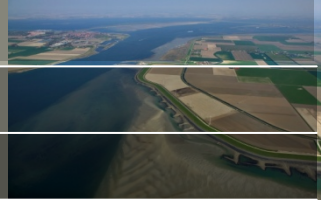
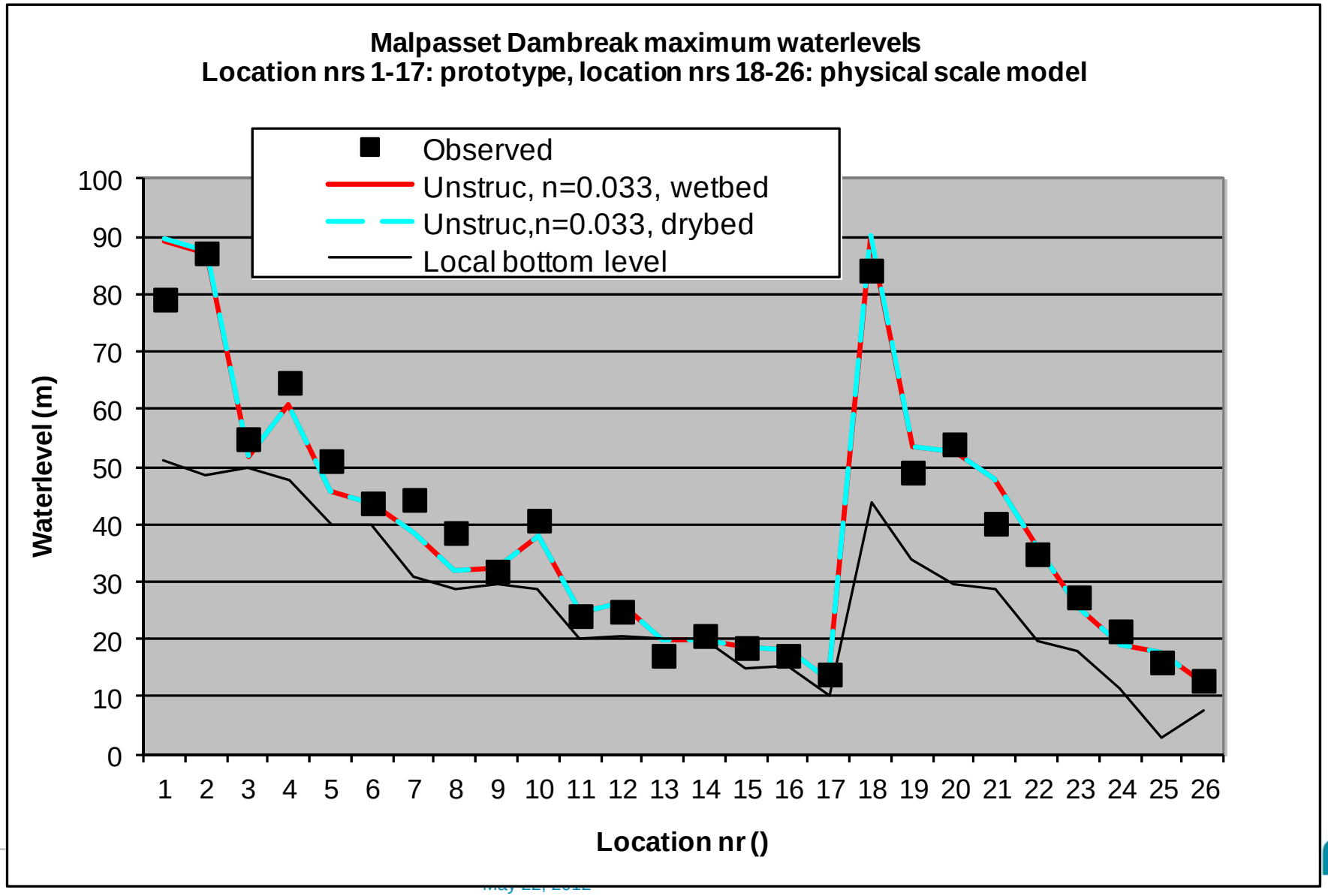
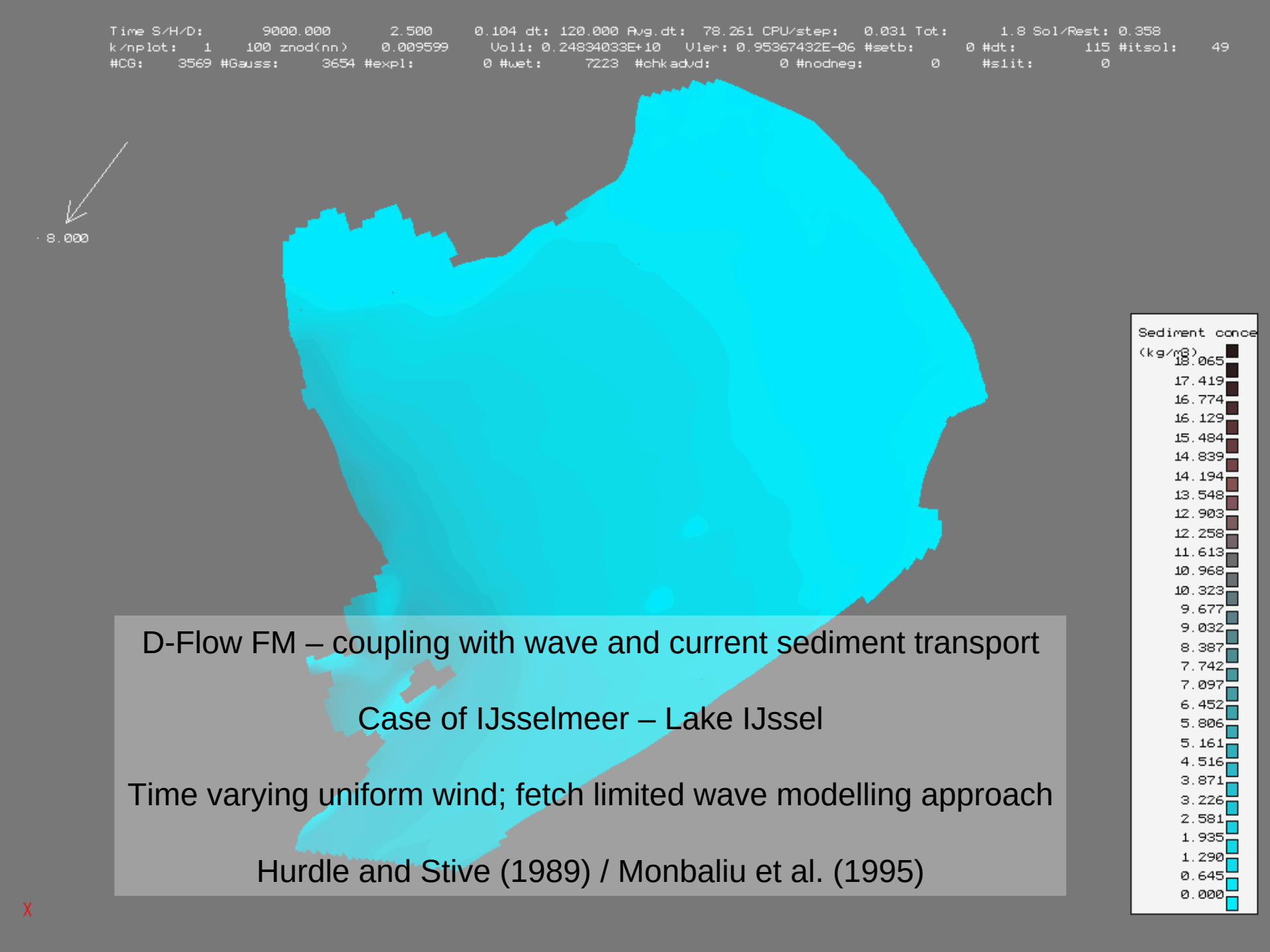
Malpasset dam break case on a flexible grid



Malpasset Dambreak



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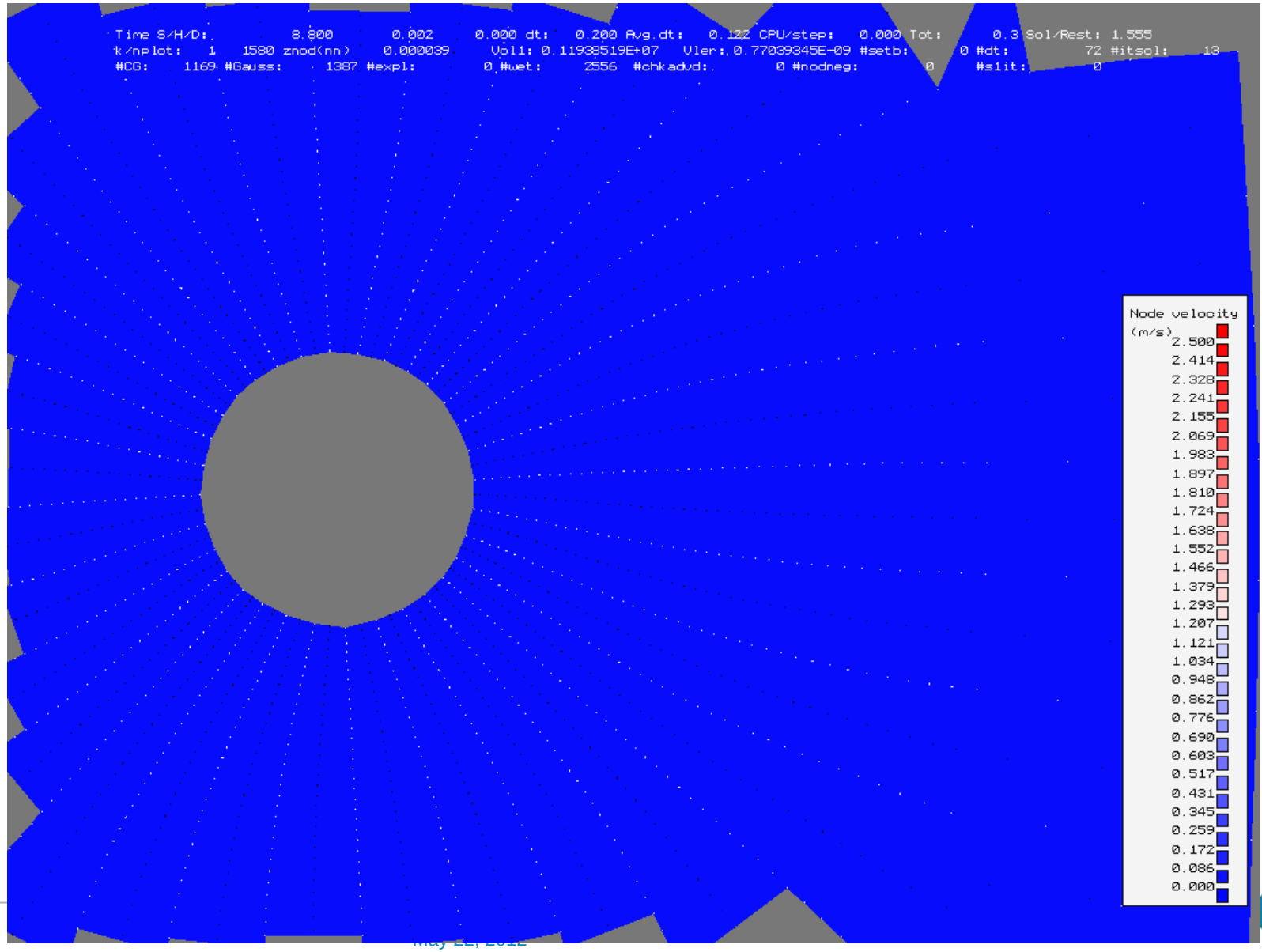
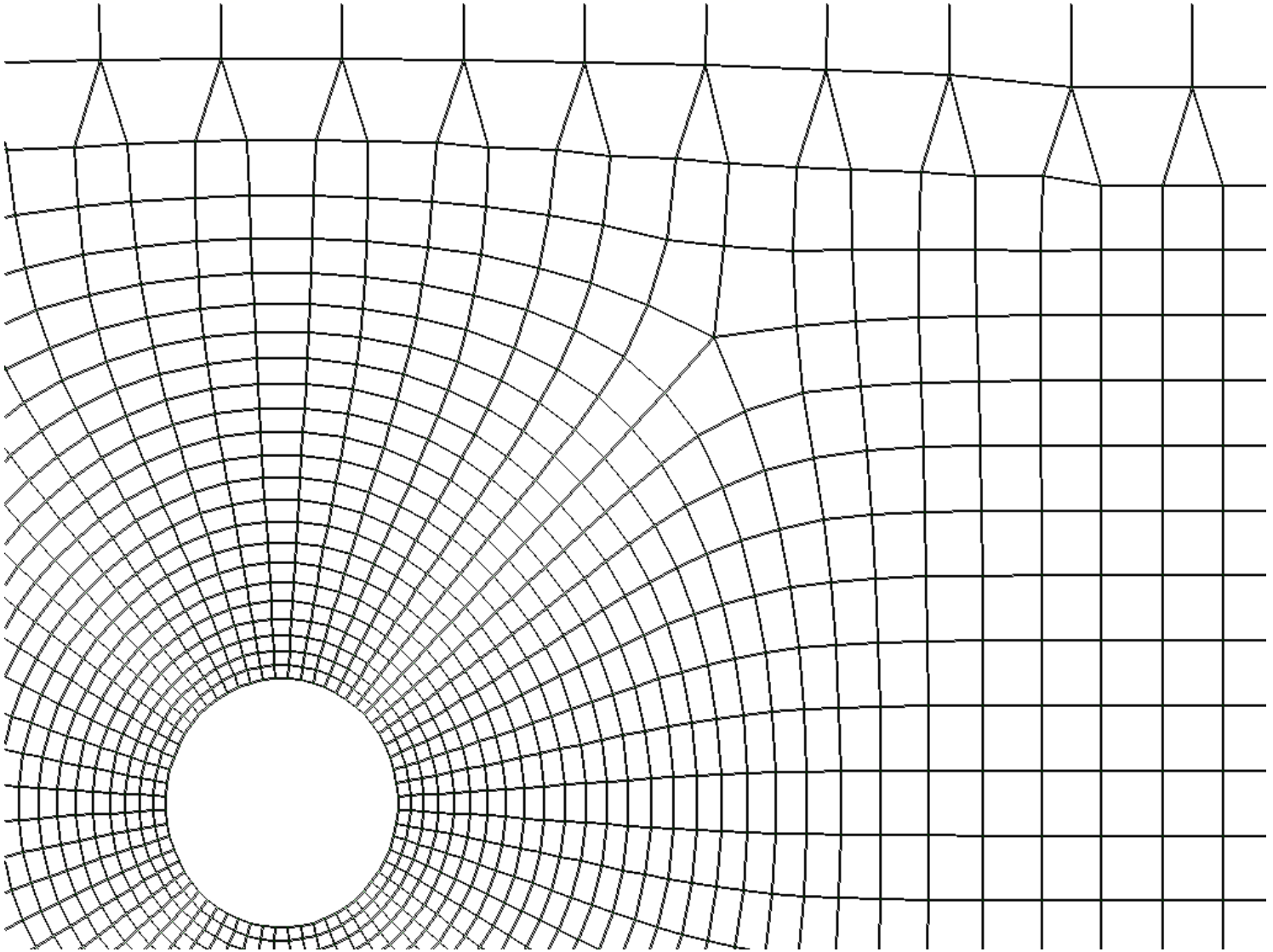
5.161
4.516
3.871
3.226
2.581
1.935
1.290
0.645
0.000
D-Flow FM – coupling with wave and current sediment transport
Case of IJsselmeer – Lake IJssel
Time varying uniform wind; fetch limited wave modelling approach
Hurdle and Stive (1989) / Monbaliu et al. (1995)

Viscous flow around a cilinder (vortex shedding)



Flexible grid: horizontal in main channel, circular to support pillar's boundary layer.



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Mahakam-delta: 1D-2D(-3D) modelling