Observation and model systems for local scale domains such as harbours and narrow channels

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OPNet Meeting 2/2008 Geilo

Background - Observations

- Analysis of the physical state
- Boundary Conditions and Initial Values
- Data-assimilation in models
- Validation
- Still to sparse to resolve all relevant length scale
- Remote sensing - Surface signal

Background - Models

- Many good ocean models and modellers
- Resolution still an underlying problem
- A grid size of approx. 1 mm necessary to resolve all relevant length scales
- Results still very sensitive to subgrid scale closures
- With typical grid sizes: Still many important processes on a subgrid scale
- Underlying problem: The basic assumptions may not be valid
- Surface elevation predictable
- Mean flow predictable
- Model currents often more smooth than corresponding measurements
- Instantaneous local flow very difficult to model

Background - Model systems for the coast

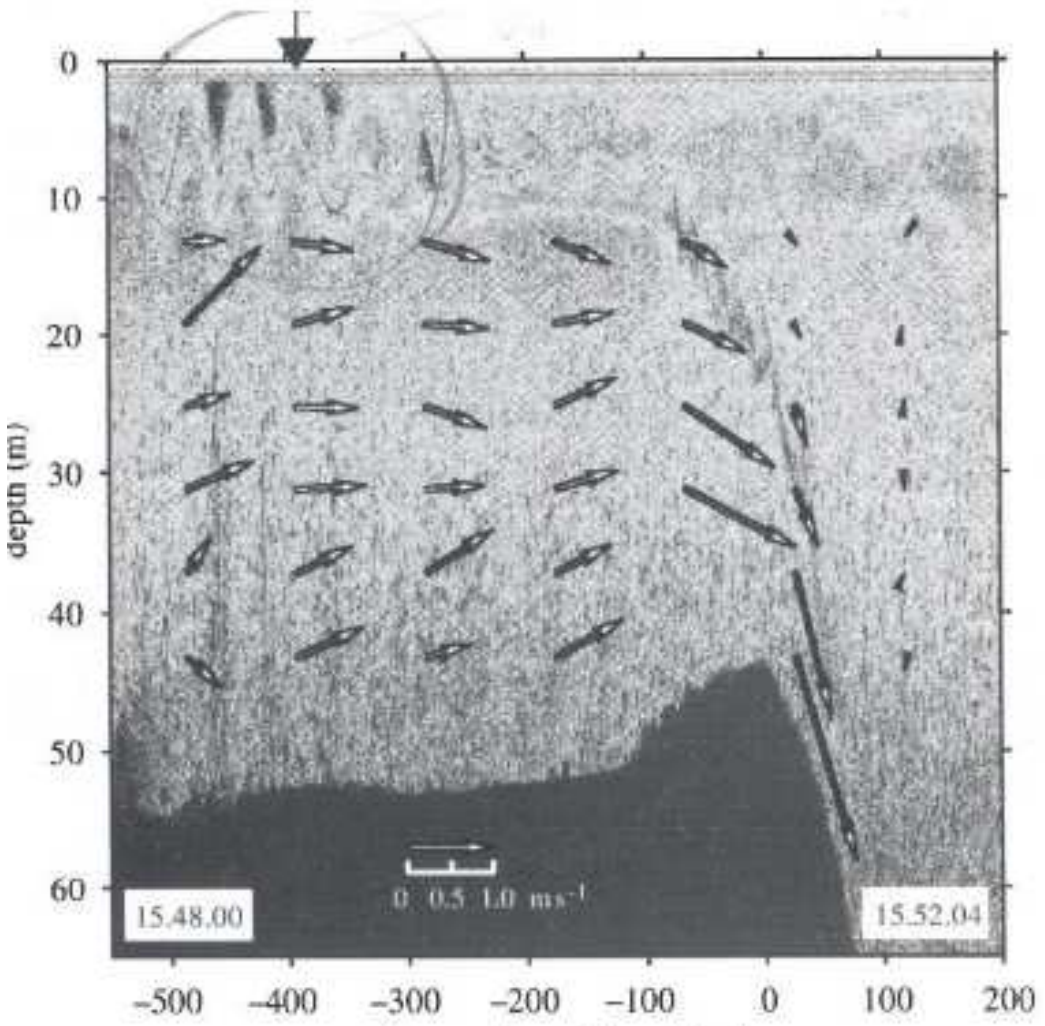
- This was planned for approximately 15 years ago?
- Why is such a system not established?
- Relevant people are 'spread out' on many institutions, governmental bodies, companies?
- Underlying scientific difficulties: Are we 'good enough' to develop systems with predictive skills?
- Resolution of models and density of observations
- Funding: Who are going to pay for this?

Local scale flow

- Often a strong transfer of energy from large scale tidal flow to smaller scales
- Topography - headlands, sills, curvature
- Stratification - Internal waves
- Non-linearities
- With sufficient resolution: Non-hydrostatic pressure counteract non-linear steepening

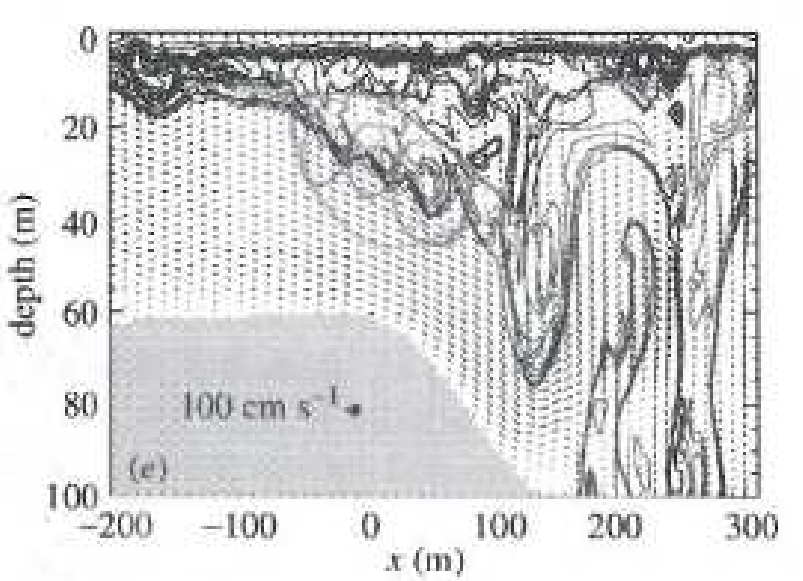
The Knight Inlet - British Columbia

Observations from Cummins, Vagle, Armi and Farmer (2003)
Transfer of tidal energy to horizontal eddies, overturning vortices, and internal waves, and subsequently to irreversible mixing



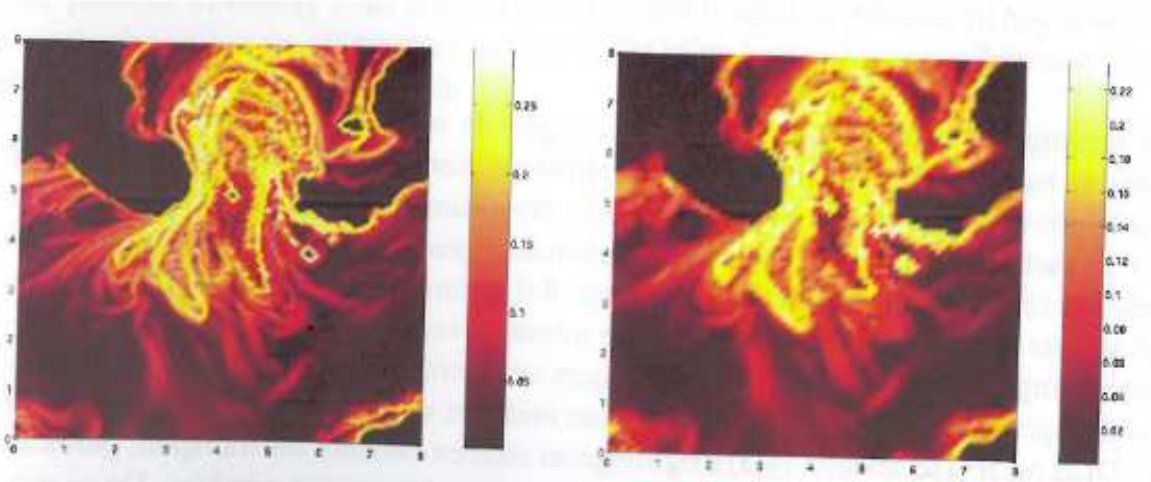
The Knight Inlet - British Columbia

Model results from Cummins, Vagle, Armi and Farmer (2003)



Mixing in tidal systems - Orre 2004

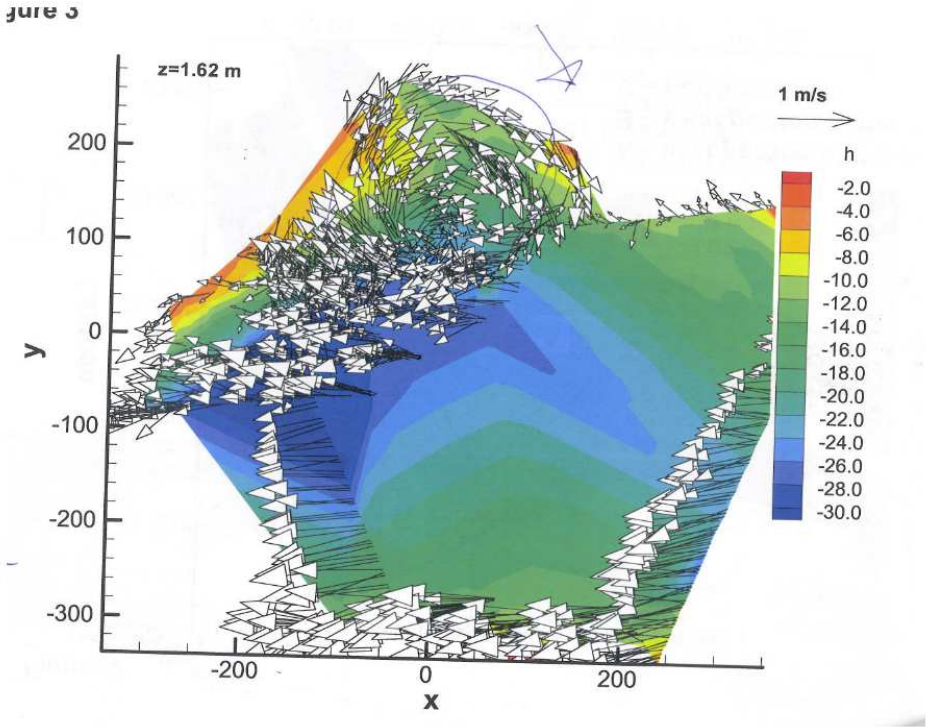
Model results from Orre 2004 ($r(t) = r(0)e^{\lambda t}$)



Figur 5.3: Sammenligning av DLE-verider etter drift av partiklene over 18.6 timer. Plottet til venstre er generert fra tidevannsmodellen med 50 meter romlig oppløsning, plottet til høyre med 100 meter romlig oppløsning.

Strong eddies in Lousianna - Li and Weeks 2008

Measurements from Li and Weeks 2008



Vatlestraumen

From Press Release after Torunn Stranden Davidsens's PhD 2008

Foto Magne Turøy
KOSTET STATEN DYRT: Staten må betale mesteparten av regningen etter "Rocknes"-forliset.

Farlig spiral påvist i Vatlestraumen

Vatlestraumen

Measurements by Aanderaa Instruments

Flow in Curved Channels

From the PhD Thesis by Torunn Stranden Davidsen

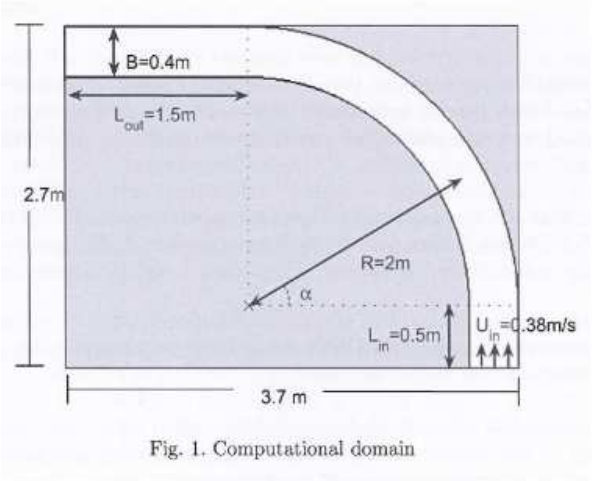
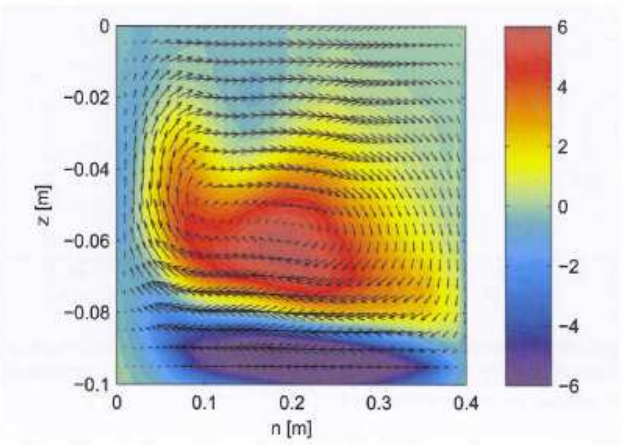


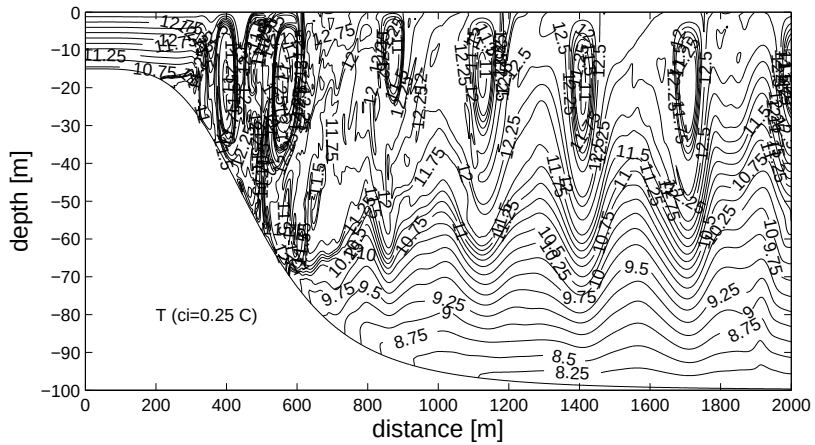
Fig. 1. Computational domain

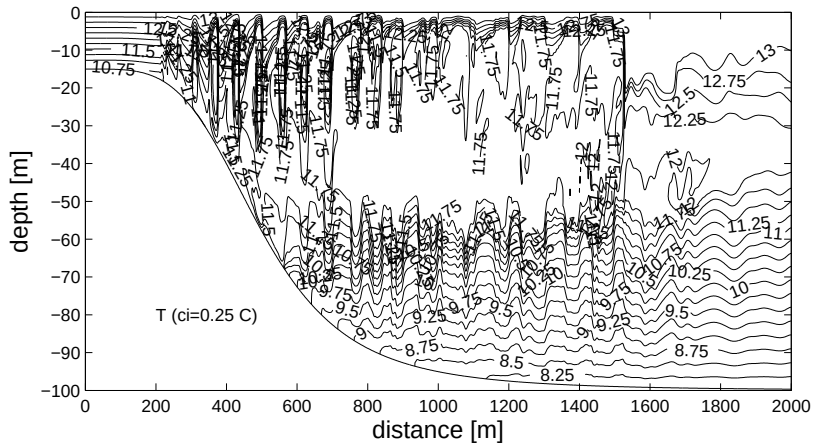


Saltstraumen

Picture from Wikipedia

Temperatures at maximum inflow in Loch Etive





Non-hydrostatic results on top and hydrostatic results below

Discussion

- Need for local area model+observation systems
- Harbours, narrow dangerous sounds, dispersal studies, sewage, fish farming
- There are potential customers
- Large scale forcing known
- Need to resolve the effects of the local topography to capture the variability of the currents
- Scientific and Administrative leadership?
- Robust and efficient high resolution non-hydrostatic models for special small domains