

Development of eddies in an idealized shelf slope area due to an along slope barotropic jet

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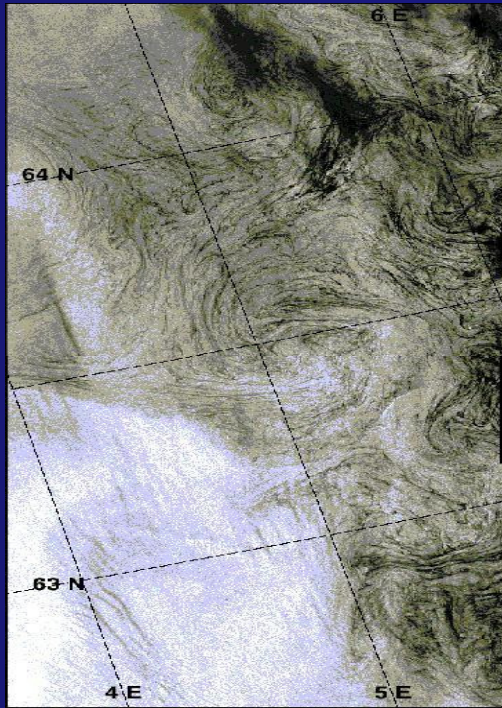
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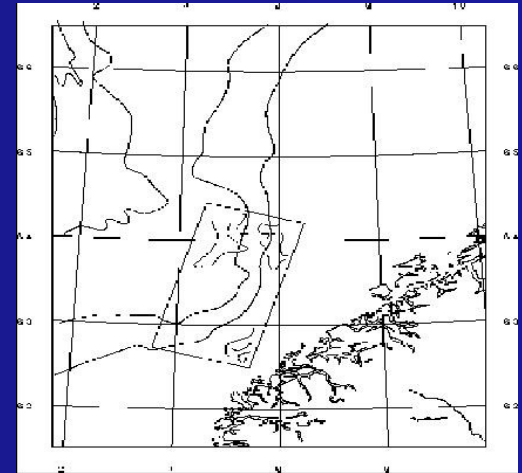
Motivation



ENVISAT ASAR
Widswatch
images

SAR Eddy
mapping

NERSC



Overview

- ◆ Model/model setup
- ◆ Model result
 - ◆ Horizontal surface velocities
 - ◆ 2D Fourier figures
 - ◆ Vertical section figures
- ◆ Stability analysis
- ◆ Conclusion

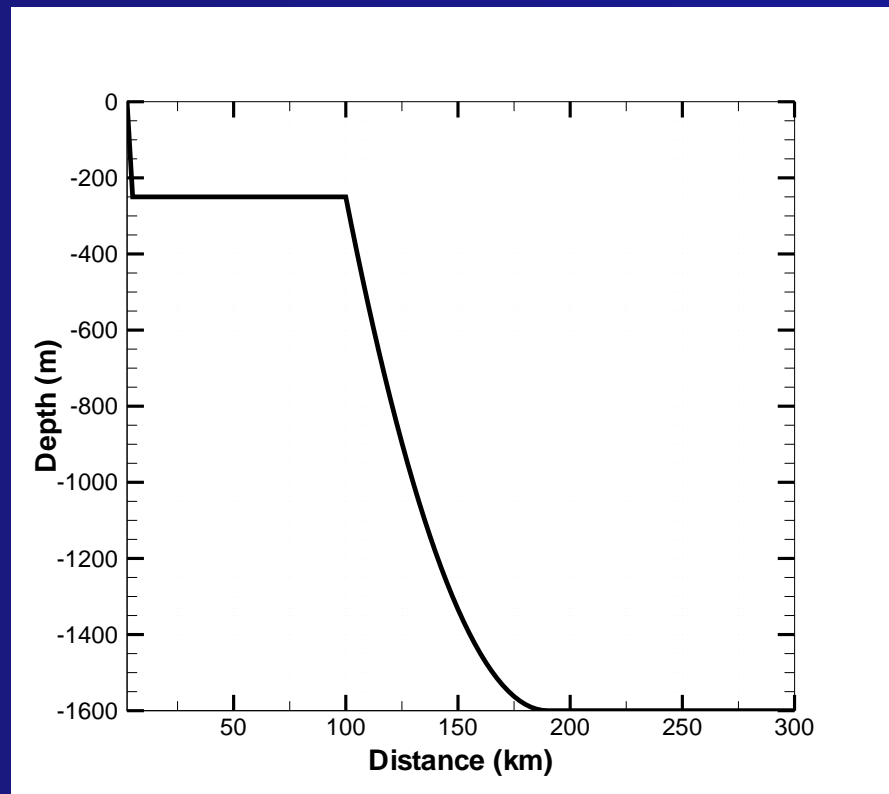


Model

- ◆ Bergen Ocean Model (BOM)
 - ◆ σ -coordinate model
 - ◆ Mode splitting
 - ◆ Assumptions
 - ◆ Hydrostatic approximation
 - ◆ Boussinesq approximation



Model



Vertical view of the shelf topography.

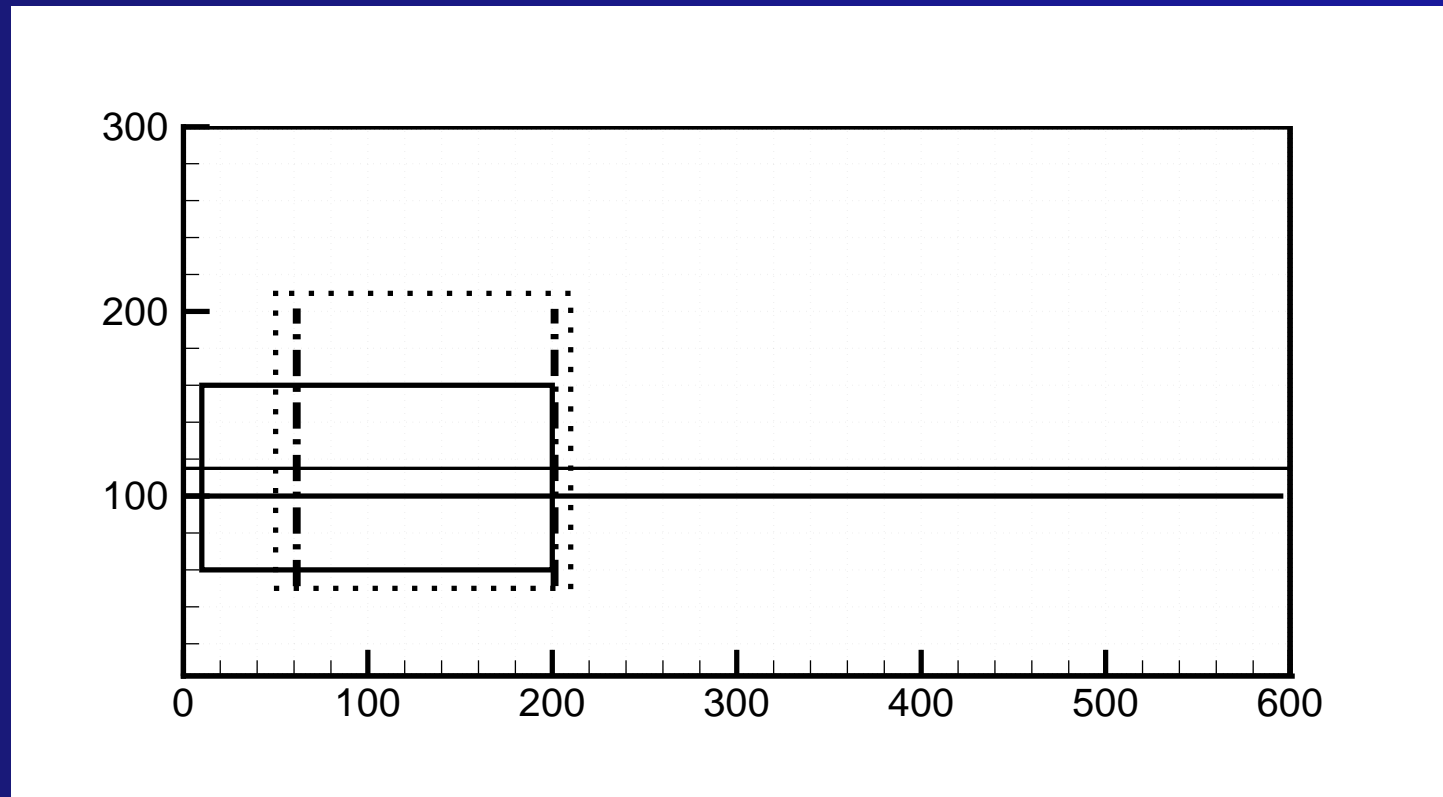


Model

- ◆ 2.5 km grid resolution in horizontal
- ◆ 61 σ -layers in vertical
- ◆ FRS zones (15 grid cells wide)
- ◆ Gaussian jet along the shelf (0.4 m/s)
- ◆ Viscosity $0.2 \text{ m}^2/\text{s}$
- ◆ No bottom friction



Model



Overview over the model area (km)

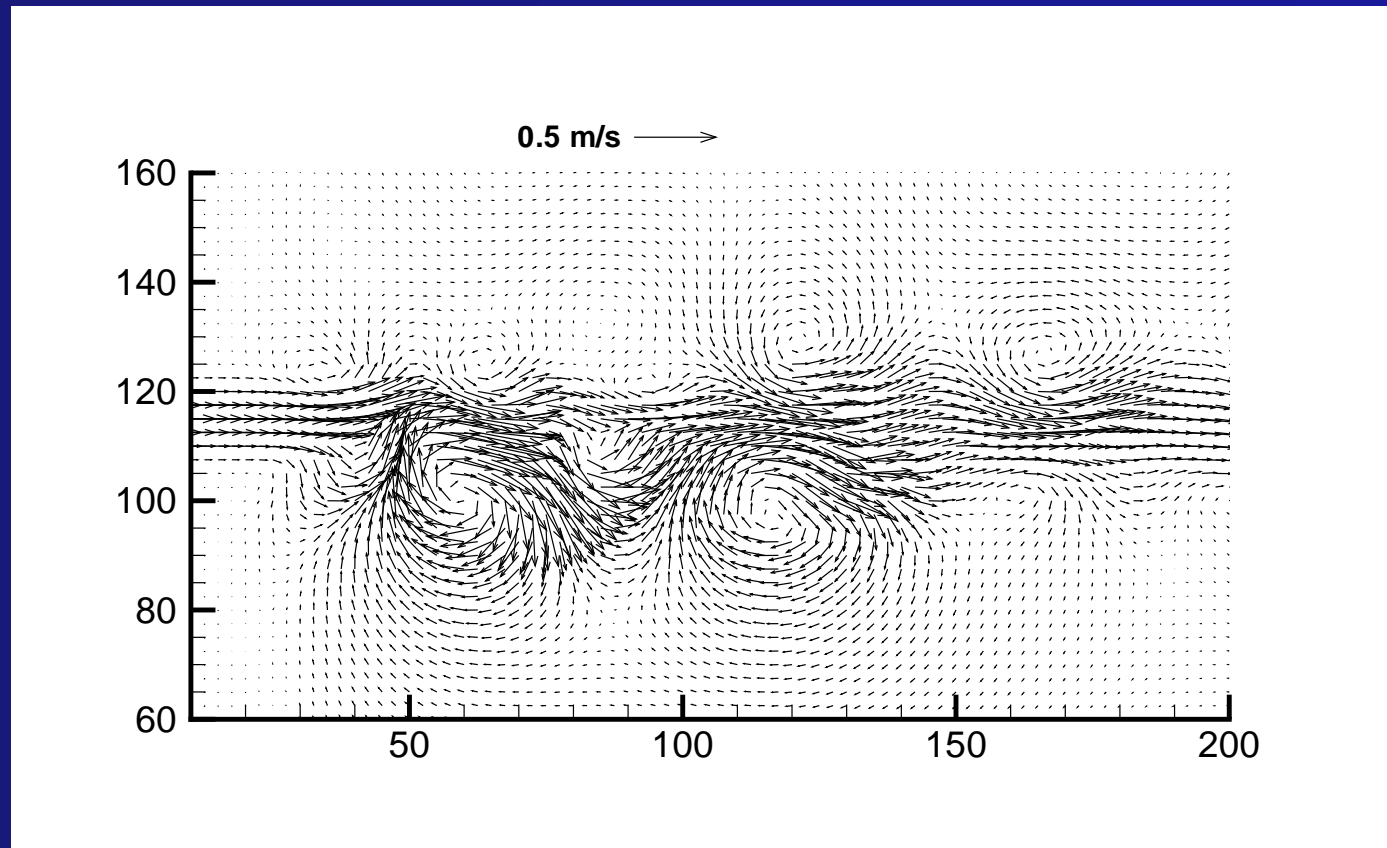


Simulations

- ◆ Barotropic simulation
- ◆ 2-layer simulation
 - ◆ Interface at approximately 550 m depth
 - ◆ Density surface layer $\rho_{surf} = 1027.5$
 - ◆ Density bottom layer $\rho_{bott} = 1028.05$
 - ◆ Jet in both layers



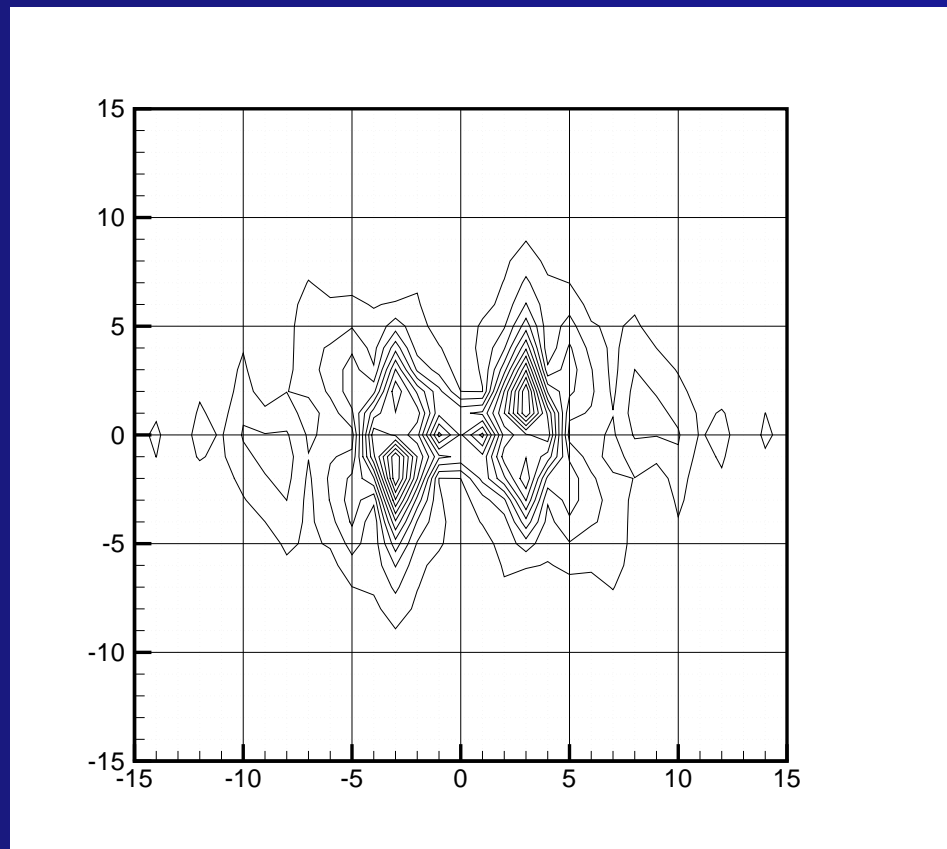
Barotropic simulation



Horizontal surface velocities after 240 hours.



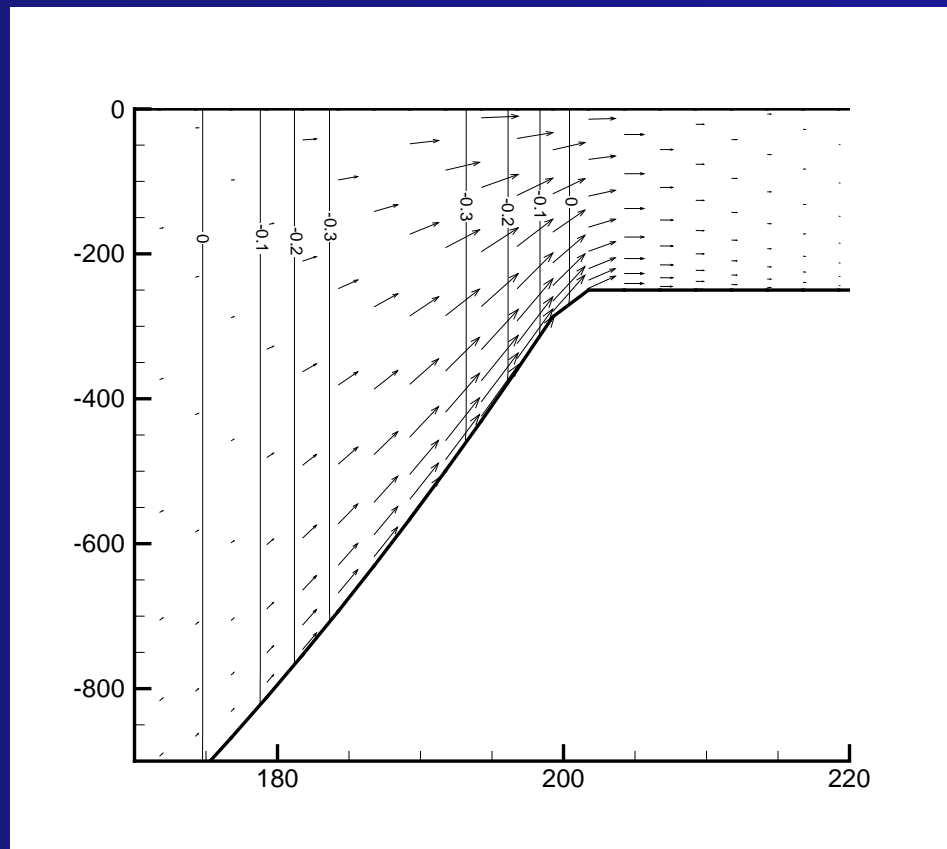
Barotropic simulation



2D Fourier components after 240 hours.



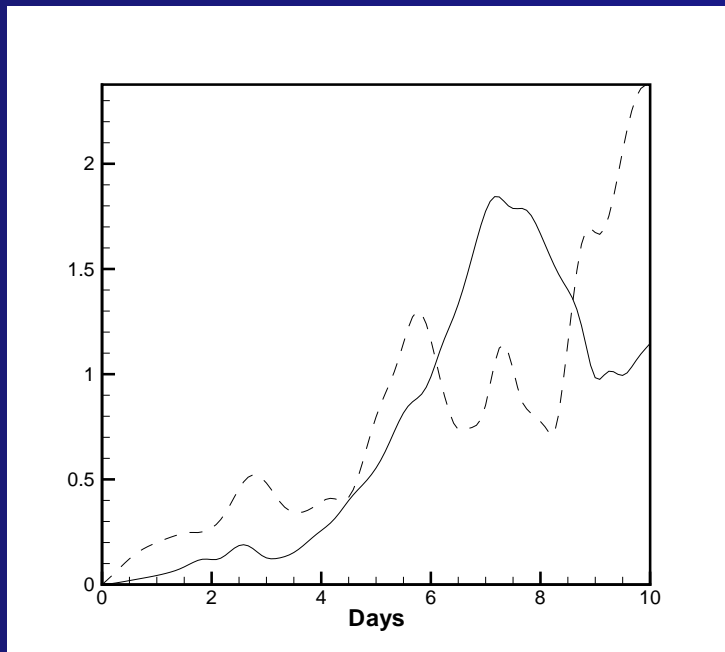
Barotropic simulation



Vertical profile after 240 hours.



Barotropic simulation



Solid line: ≈ 40 km
Growth rate 0.53 day^{-1}

Dashed line: ≈ 80 km

Sum of Fourier components.

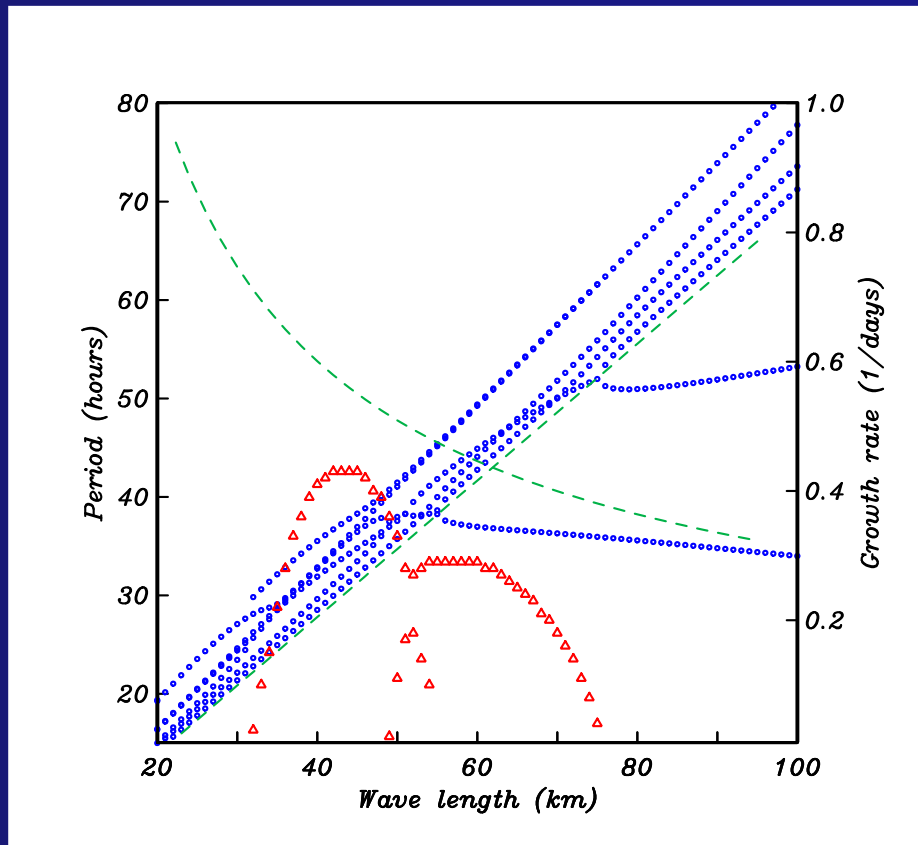


Summary barotropic simulation

- ◆ Generation of eddies
 - ◆ Cyclonic (weak) at deeper part
 - ◆ Anti cyclonic (strong) at shallow part
 - ◆ 40-80 km along shelf
 - ◆ 40-∞ km cross shelf
- ◆ Spatial fluctuations of the jet



Stability analysis



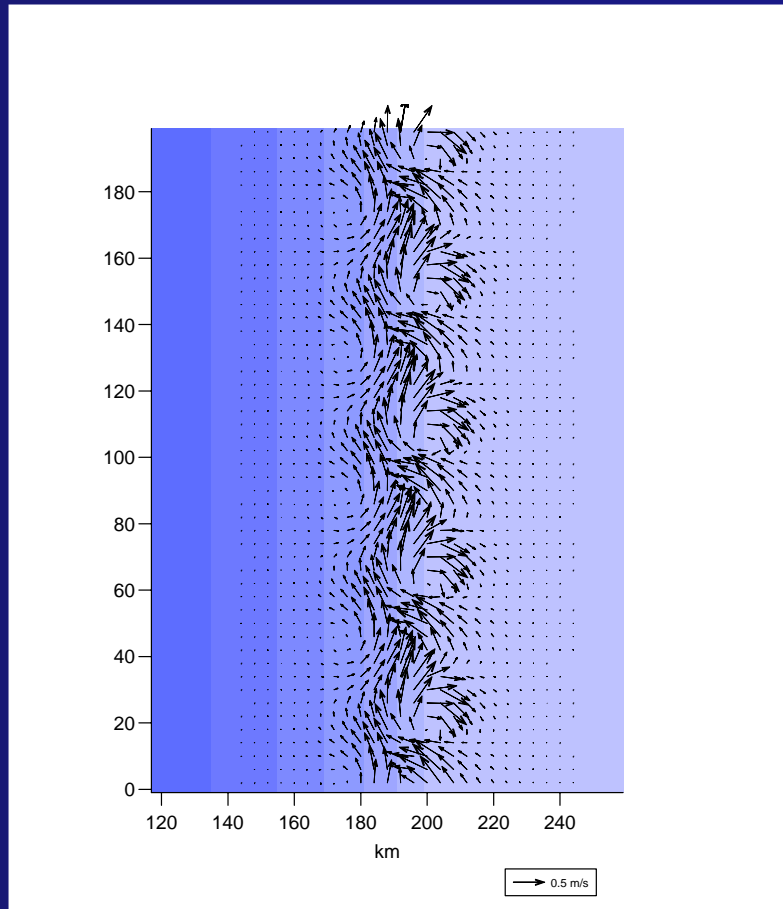
Unstable modes:
35 - 75 km

Max growth rate:
 0.43 day^{-1}

Wavelength $\approx 40 \text{ km}$



Stability analysis

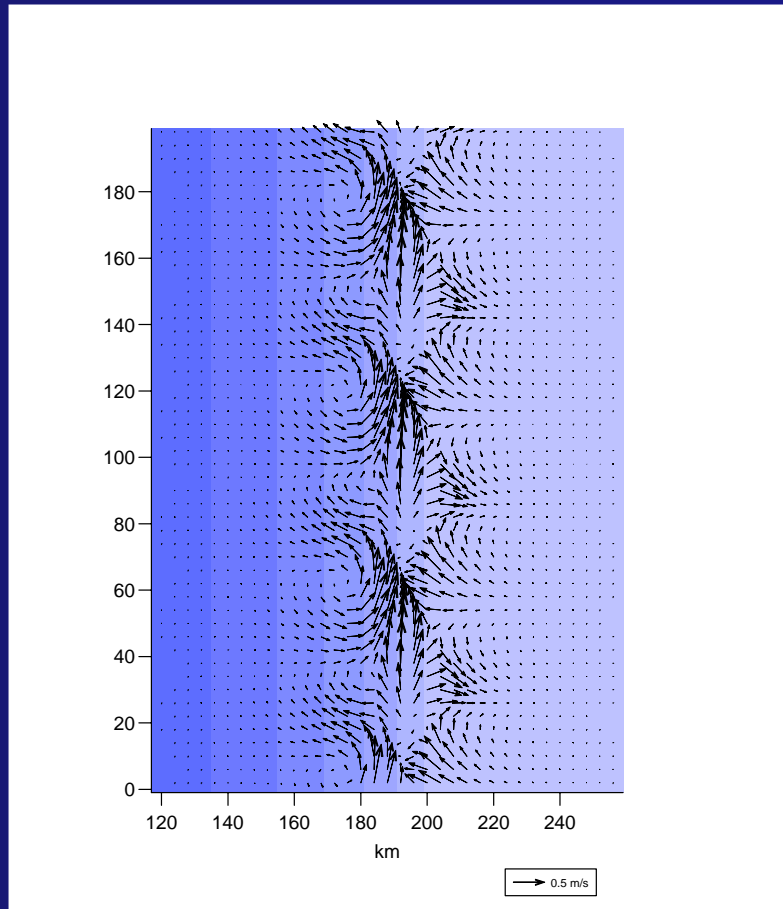


Unstable mode
with wave length
 $\lambda = 43$ km.

Horizontal current field.



Stability analysis

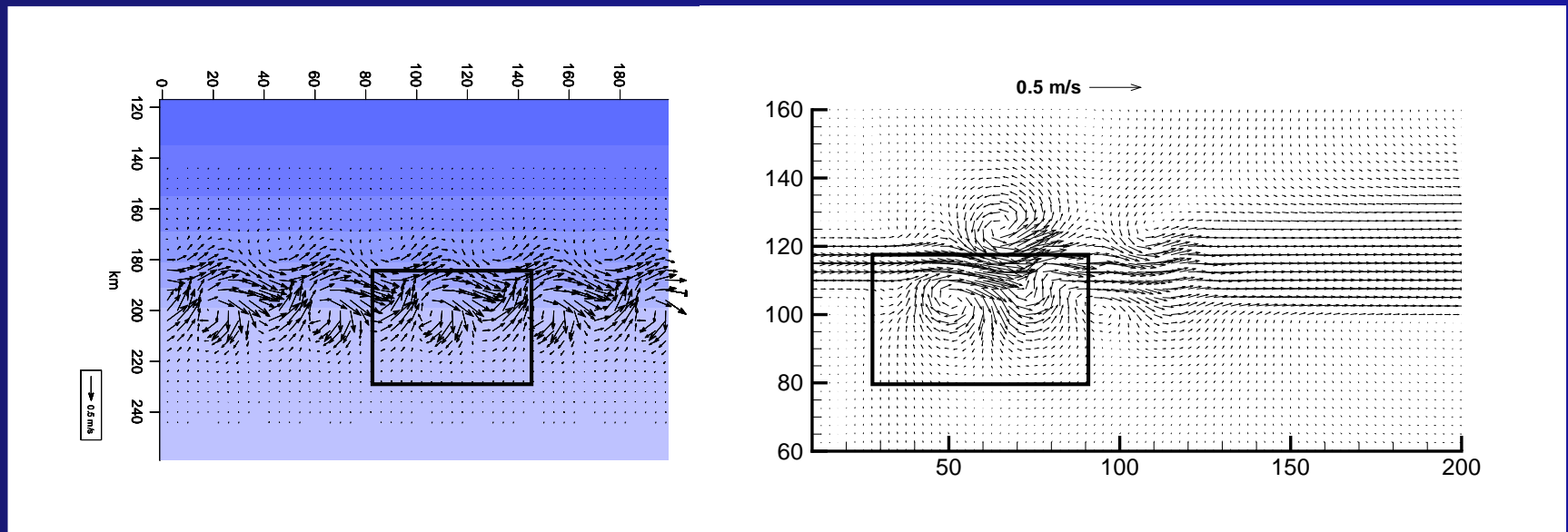


Unstable mode
with wave length
 $\lambda = 58$ km.

Horizontal current field.



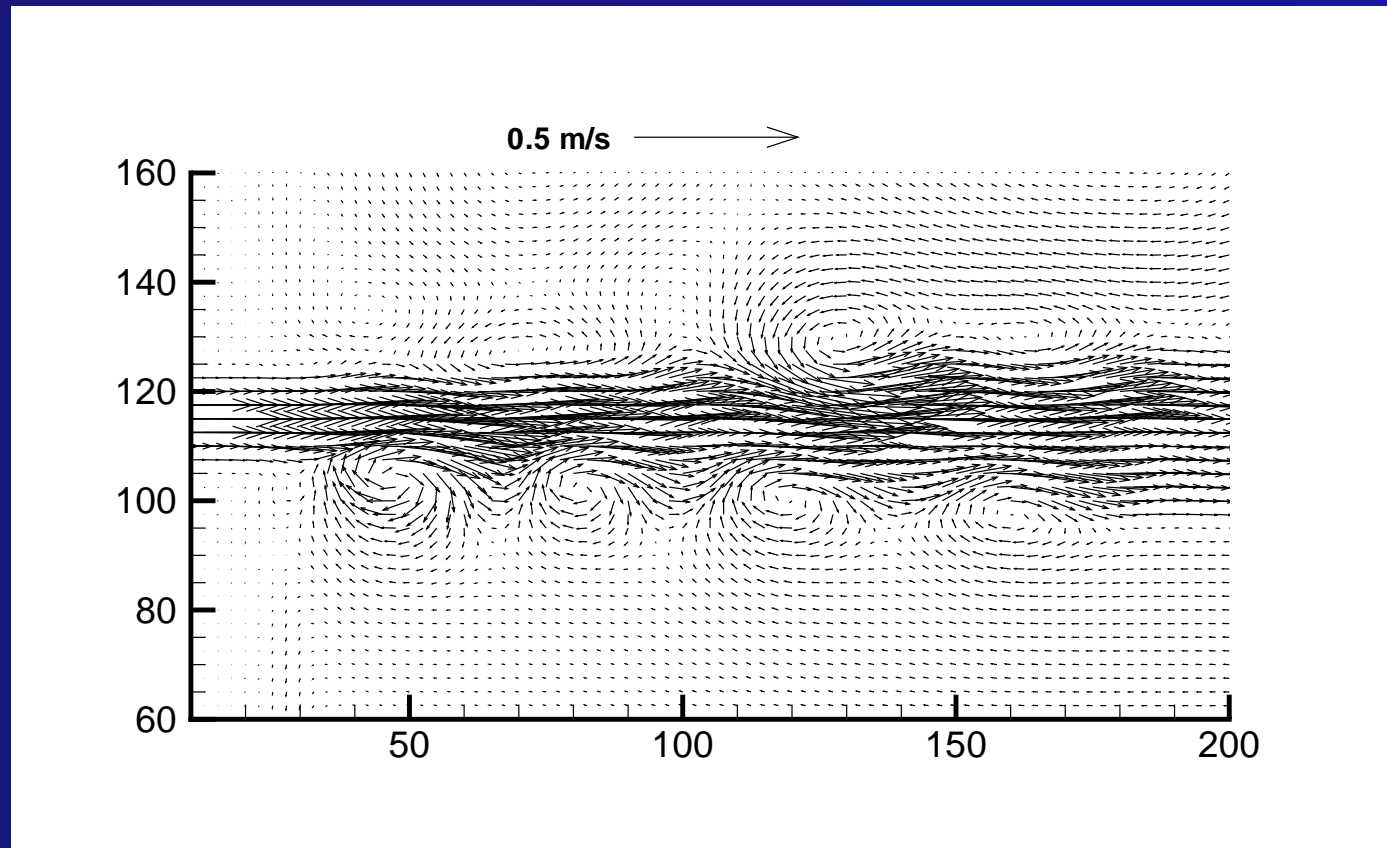
Visual comparison



Unstable mode with wave length $\lambda = 43$ km is recognized in the model result after 120 hours.



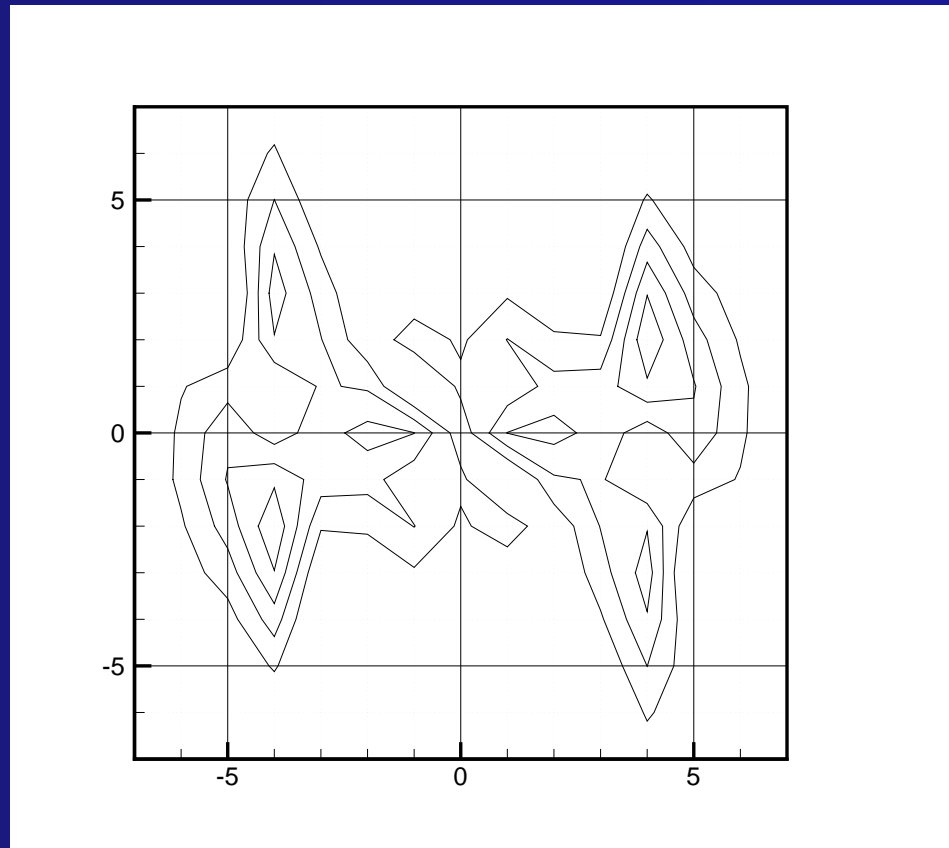
Two layer simulation



Horizontal surface velocities after 240 hours.



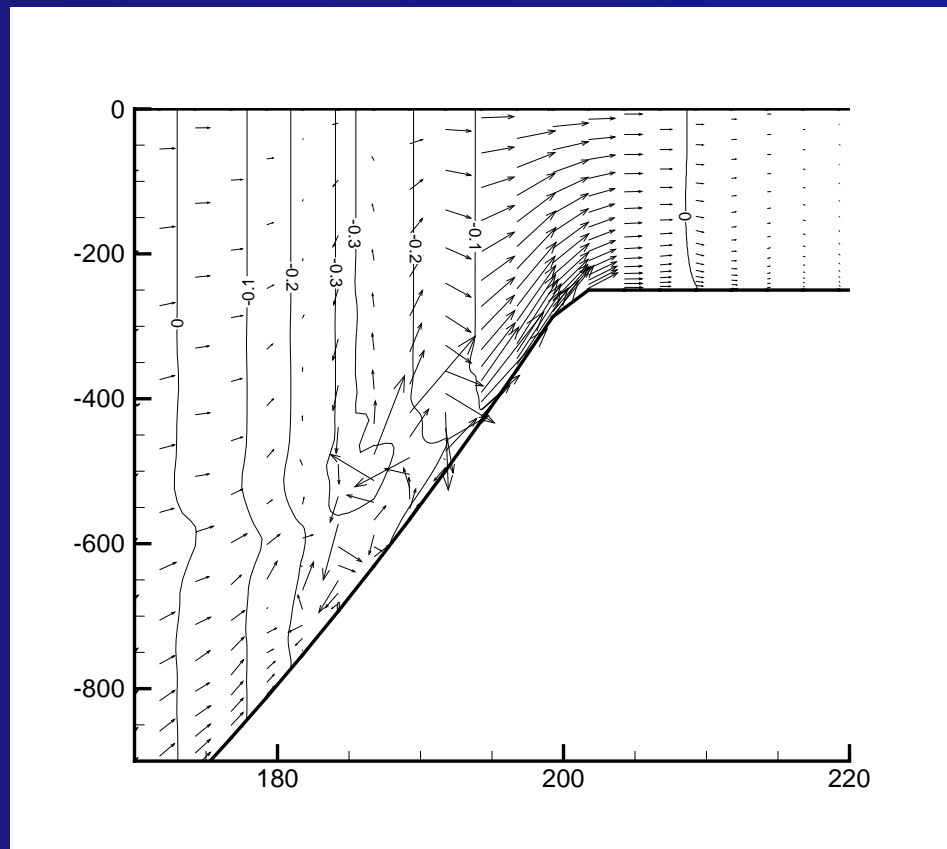
Two layer simulation



2D Fourier components after 240 hours.



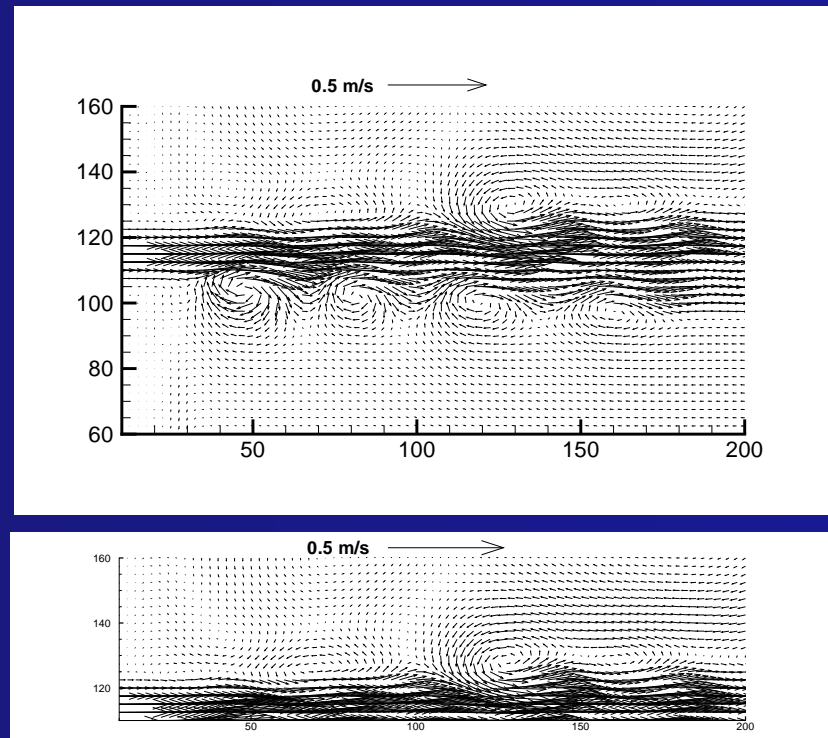
Two layer simulation



Vertical profile after 240 hours.



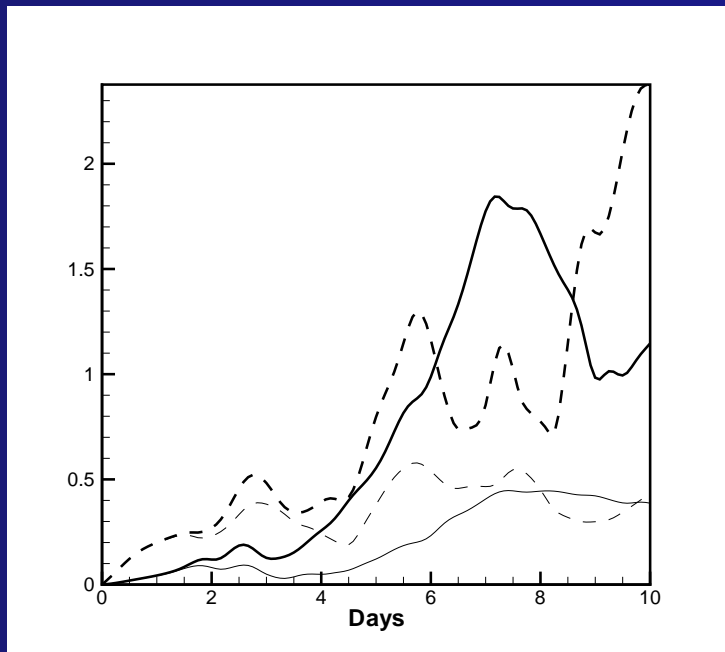
Two layer simulation



Velocity arrows from the surface (upper) and the interface (lower) show barotropic behavior.



Barotropic vs two layer



Bold line: barotropic
Narrow line: 2 layer

Solid line: ≈ 40 km
Dashed line: ≈ 80 km

Sum of Fourier components.



Summary two layer simulation

- ◆ Generation of weak eddies
 - ◆ Cyclonic (weak) at deeper part
 - ◆ Anti cyclonic (stronger) at shallow part
 - ◆ 40 km along shelf
 - ◆ 50-80 km cross shelf
- ◆ High activity in the interface
 - ◆ Relatively directional stable
- ◆ Barotropic behavior of the eddies



Conclusions

- ◆ Eddies developed due to an along shelf jet
 - ◆ Barotropic simulation
 - ◆ Length scale and growth rate in accordance with Gjeviks stability analysis



Conclusions

- ◆ Two layer
 - ◆ Weaker eddies than in the barotropic simulation
 - ◆ High activity in the core of the jet
 - ◆ Eddies have barotropic behavior

