

# ***TOPAZ***

***handling upgrades... with time***

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<http://topaz.nersc.no>



# **The Mohn-Sverdrup Center for global ocean studies and operational oceanography**

- Henrik Mohn (pronounce as in "moon")
  - Founder of the Norwegian Met Institute in 1866
  - Postulated the transpolar current in 1884
- Harald Sverdrup
  - The Maud expedition with Amundsen
  - Director of Scripps, the war years...
- Funded by a private endowment (4 M\$ on 5 years) from Trond Mohn, Bergen.
- Will employ 20 people within the following years

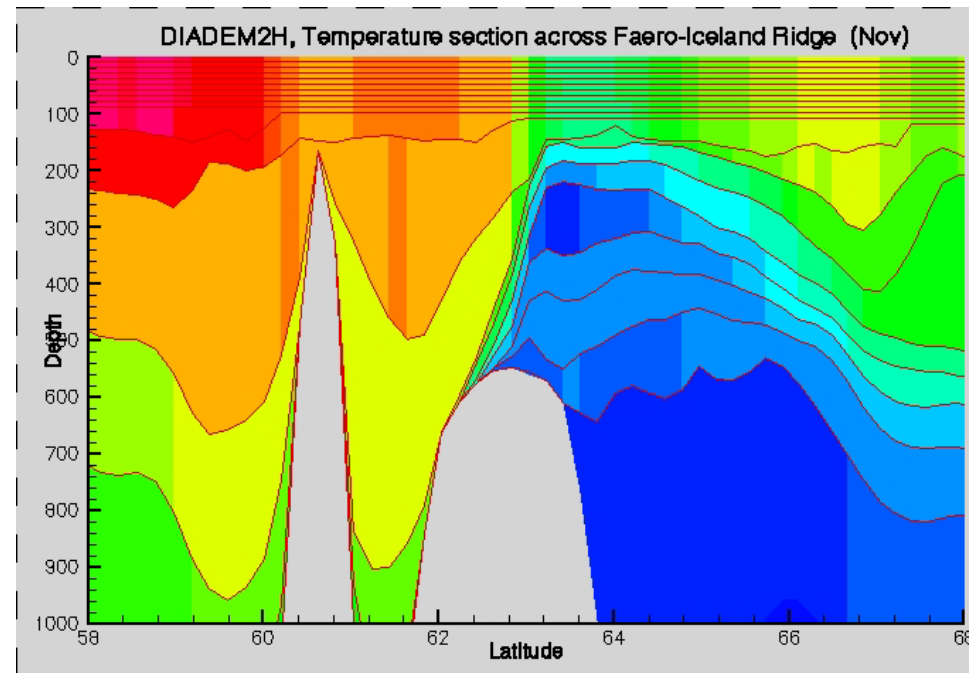


# Workplan

- Indian Ocean: Duplicate the TOPAZ system
  - 2 PhD
  - Follow the work initiated by Vibeke Haugen - Jensen
- High resolution system for the Nordic Seas
  - 1 Post-doc + 1 PhD
- Ecosystem modelling
  - Validation of HYCOM – C:N-REcoM
  - 1 Post-doc + 1 PhD

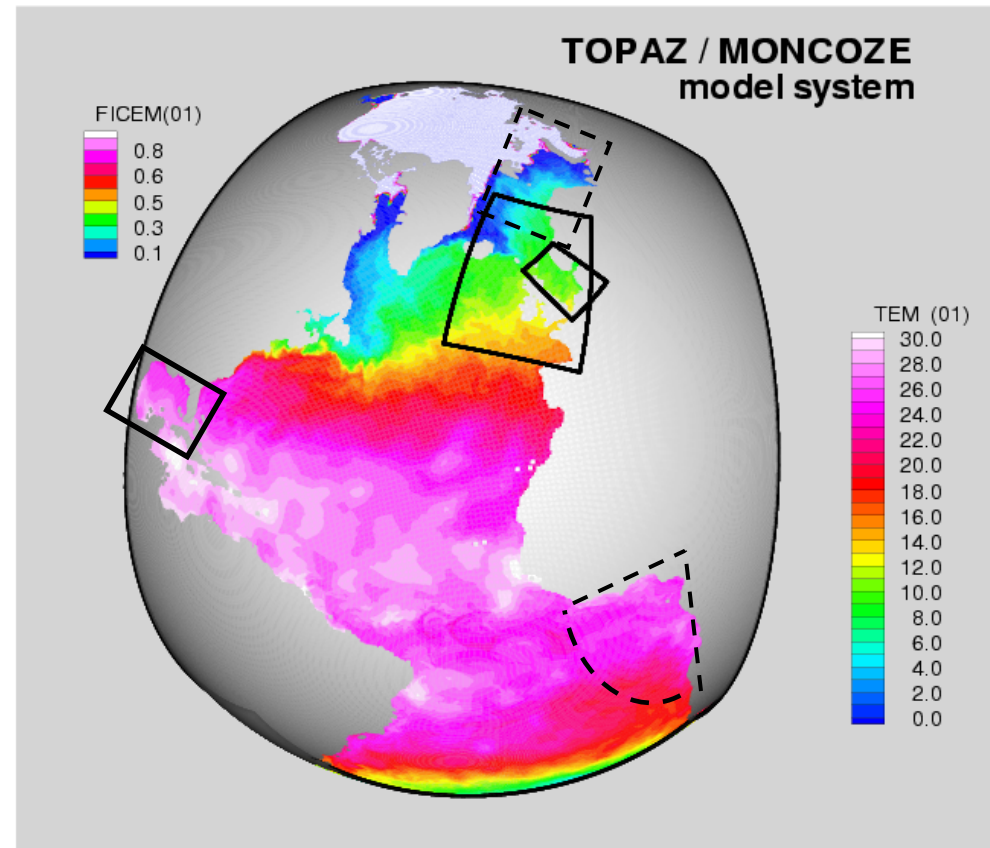
# The ingredients in TOPAZ

- 3D numerical ocean model
  - HYCOM (U. Miami, USA)
  - Sea Ice model (Hunke 1999)
  - Biogeochem. model (AWI, D)
- Observations
  - Altimetry, SST (CLS, F)
  - Sea Ice (NSIDC, USA)
  - In-situ (CORIOLIS, F)
- Data assimilation
  - Ensemble Kalman Filter [Evensen 1994, 2003, 2004]



# The TOPAZ model system

- TOPAZ: Atlantic and Arctic
  - 18-35 km resolution
  - 22 z/isopycnal layers
  - EnKF assimilation
- Nested models
  - Arbitrary resolution
  - Arbitrary orientation
  - Specific assimilation



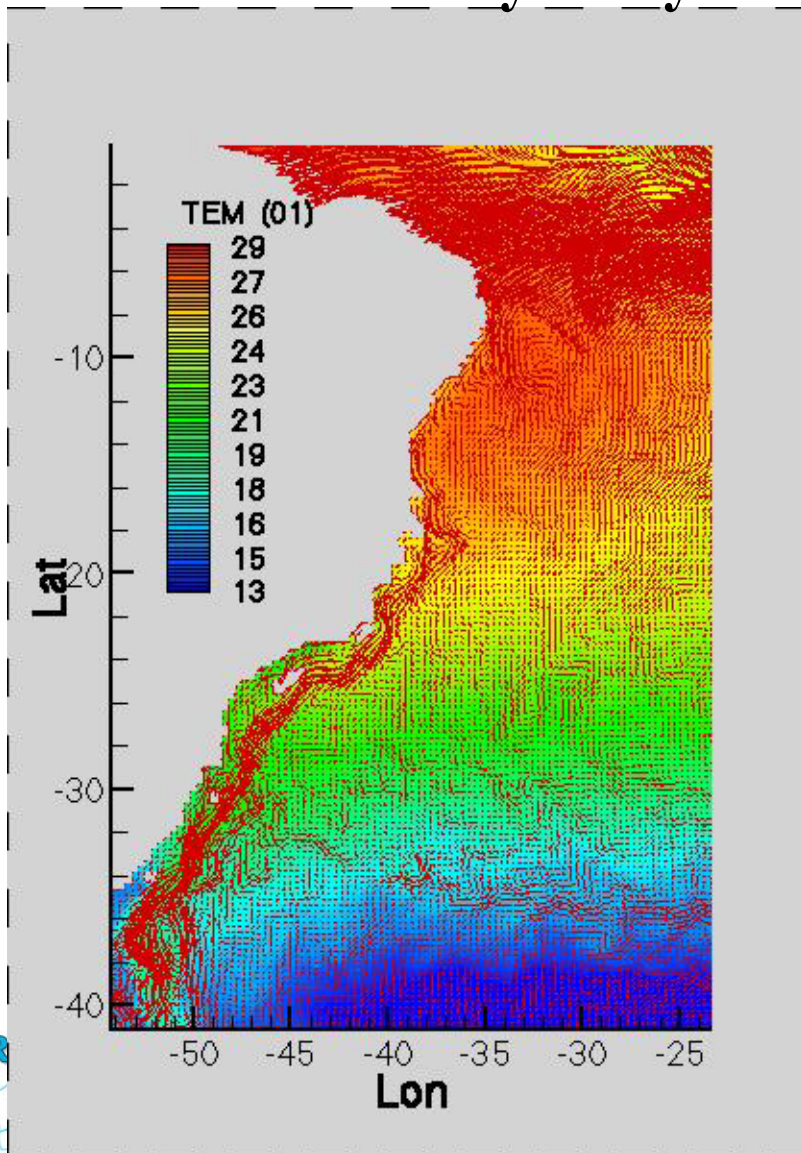
# What happened since the last meeting?

- HYCOM: Upgrading v1.3 to v2.1 (ongoing)
  - "Standard" HYCOM interface (forcing, relaxations ...)
  - Levitus Climatology -> GDEM 3
  - ETOPO5 -> GEBCO
  - Included Hudson Bay but not the Mediterranean
  - T-S relaxations at open boundary
  - Tried a 1Sv. "port" in Bering Strait, but ...



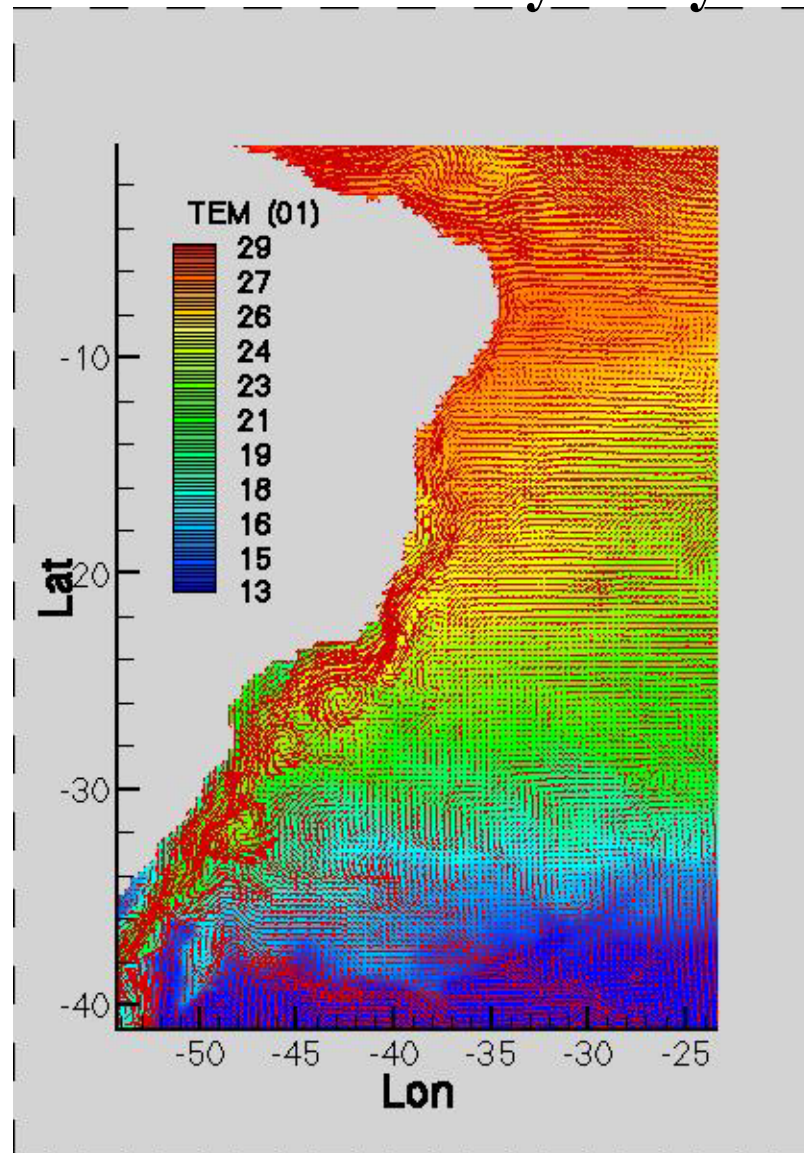
# HYCOM v1.3

## ETOPO5 bathymetry



# HYCOM v2.1

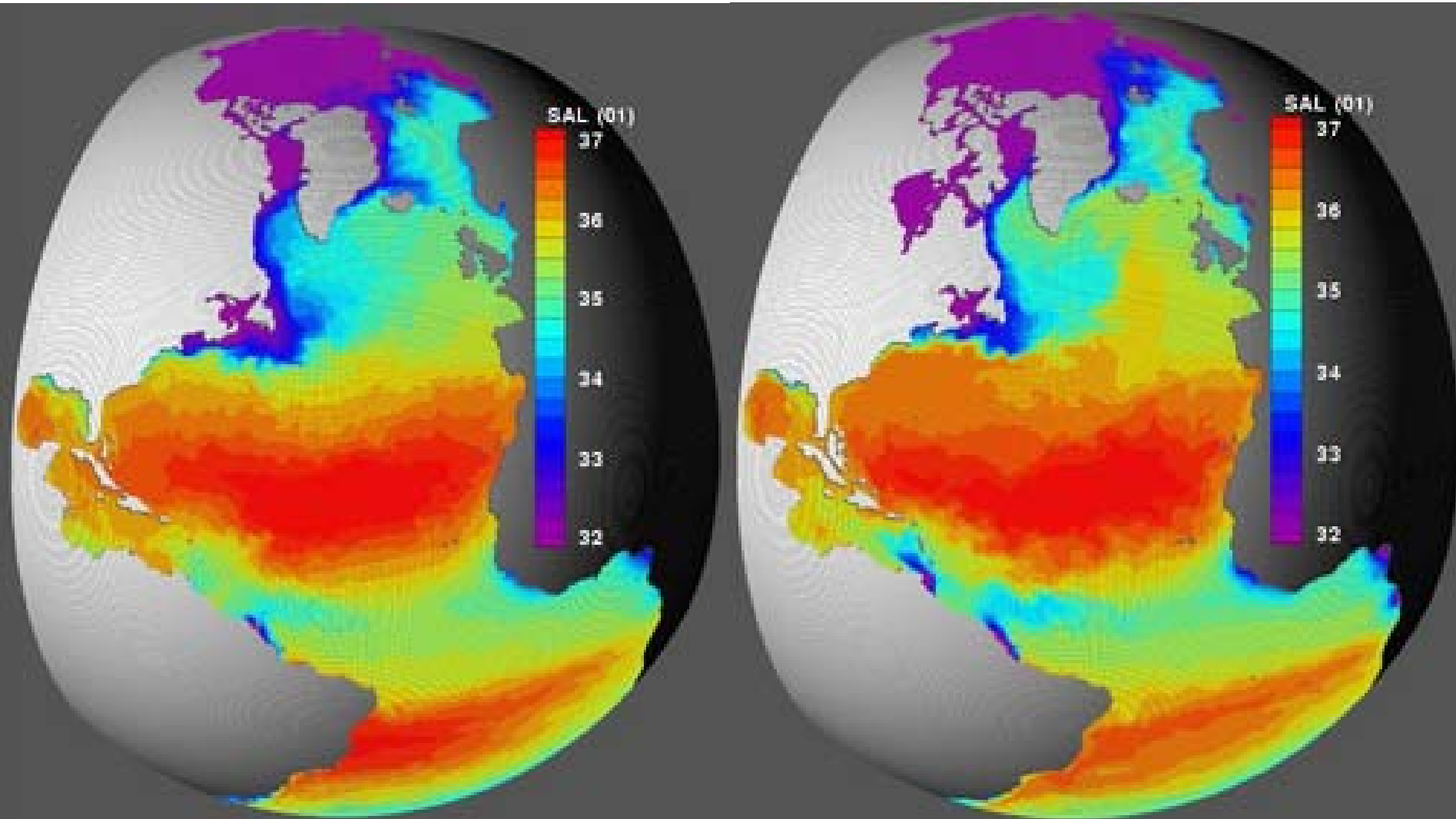
## GEBCO bathymetry

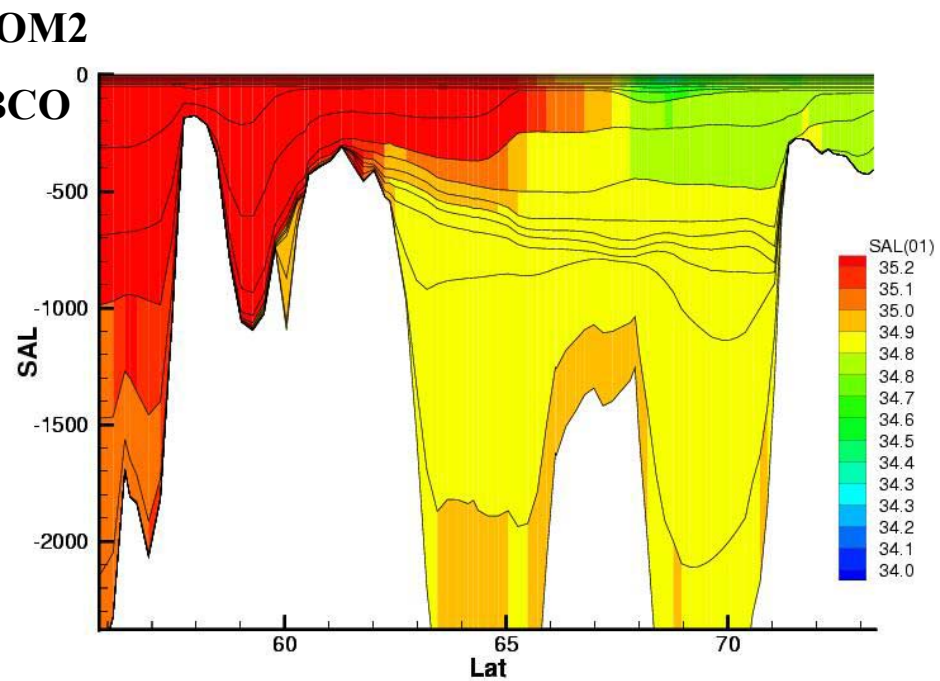
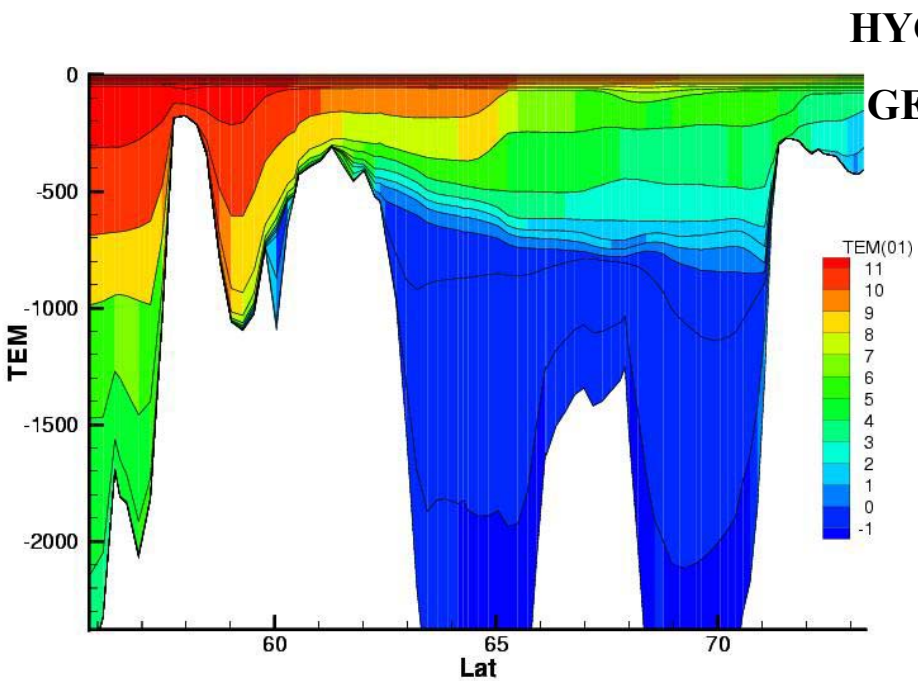
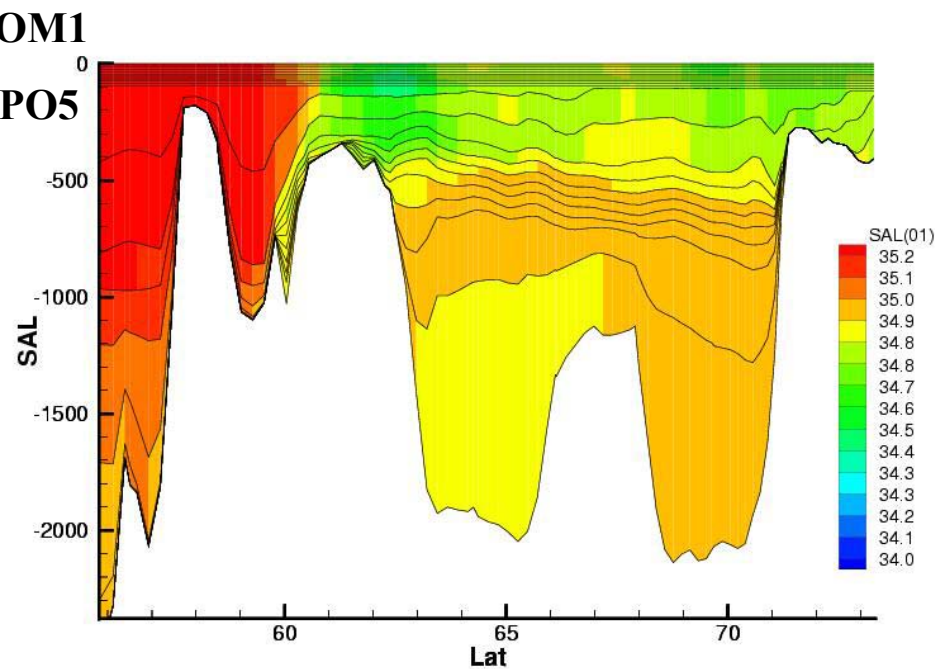
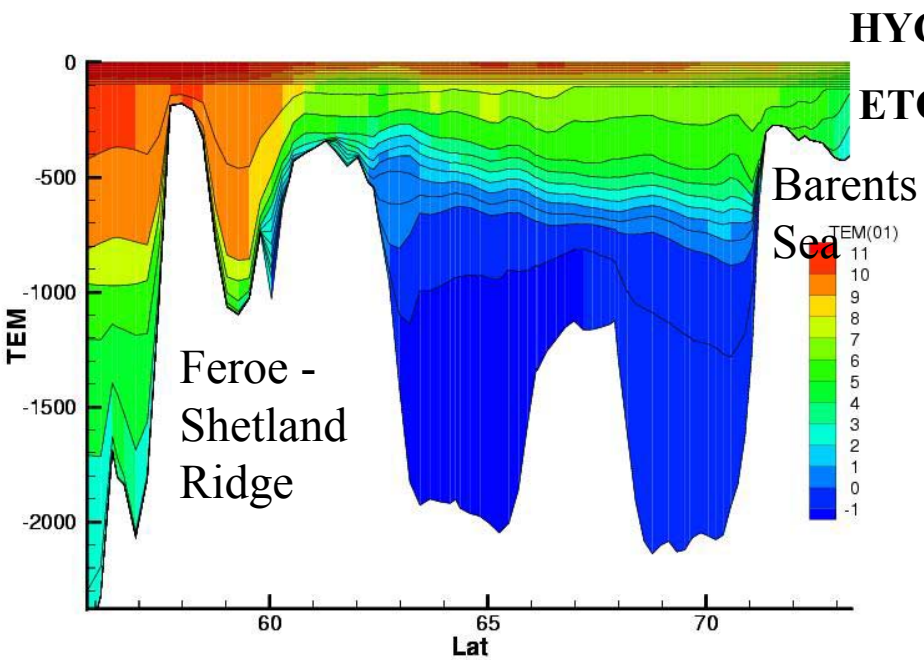


# Oct. 5 surface salinity snapshot

Old TOPAZ

New TOPAZ (free run)





# Temporary Assessment

- 2D Bottom pressures make better NAC inflow into the Nordic Seas
- Comparison with AVHRR SSTs is much better with v2.1, possibly thanks to 3m top layers instead of 10m

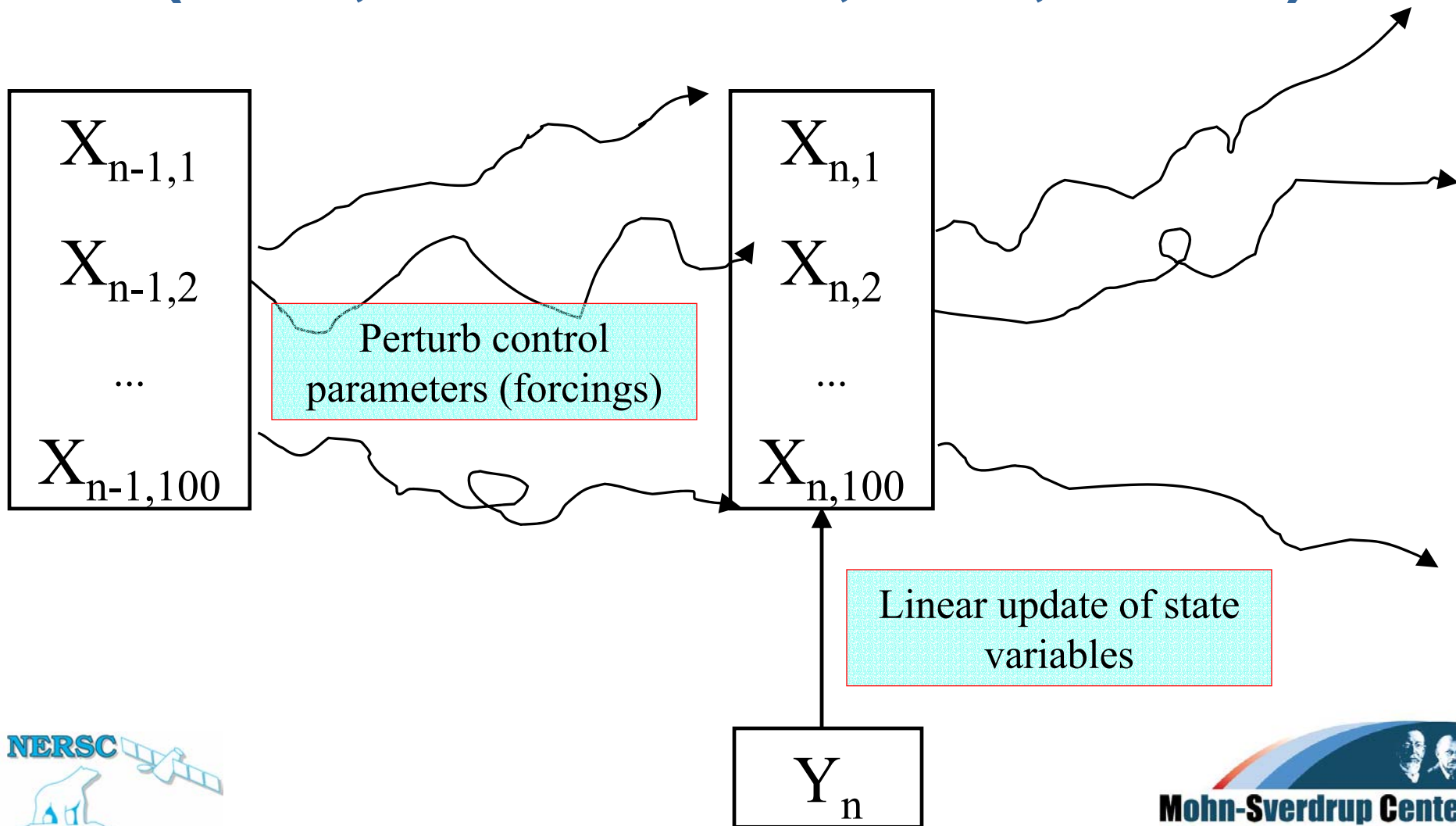
# What is data assimilation?

***Goal: make models respect observations***

- **Optimal control theory**
  - Optimize **control parameters** (forcing, initial)
  - To fit measurements
- **Spatial statistics theory**
  - Estimation of **state variables**
  - Measurements have a domain of influence
  - Physical variables are linked in complex ways
- Complementary views on the problem.



# The Ensemble Kalman Filter (EnKF, Evensen 1994, 2003, 2004...)



# EnKF latest development

- EnKF Square root analysis schemes.
  - Reduce numerical noise
- Improved sampling for EnKF initialization.
  - Better results for similar CPU cost.
- G. Evensen 2004 *Square root analysis schemes and improved sampling for the EnKF*, Ocean Dynamics, *in press* (Dec. 2004?)

# Current activities

- Assimilation: Choose a mean SSH
  - CLS (Rio)
  - Home made (HYCOM)

Rather similar, except in Nordic Seas (30cm diff.)
- Do something at Gibraltar Strait (relaxation)
- Gulf of Mexico forecast comparison
  - Still awaiting FBI authorization to nest into NRL HYCOM 1/12<sup>th</sup>
- Assisting the Nansen-Zhu centre (Beijing)



# High-resolution forecasting

1 Post-Doc

1 PhD



# Gulf of Mexico nowcast Oct. 20

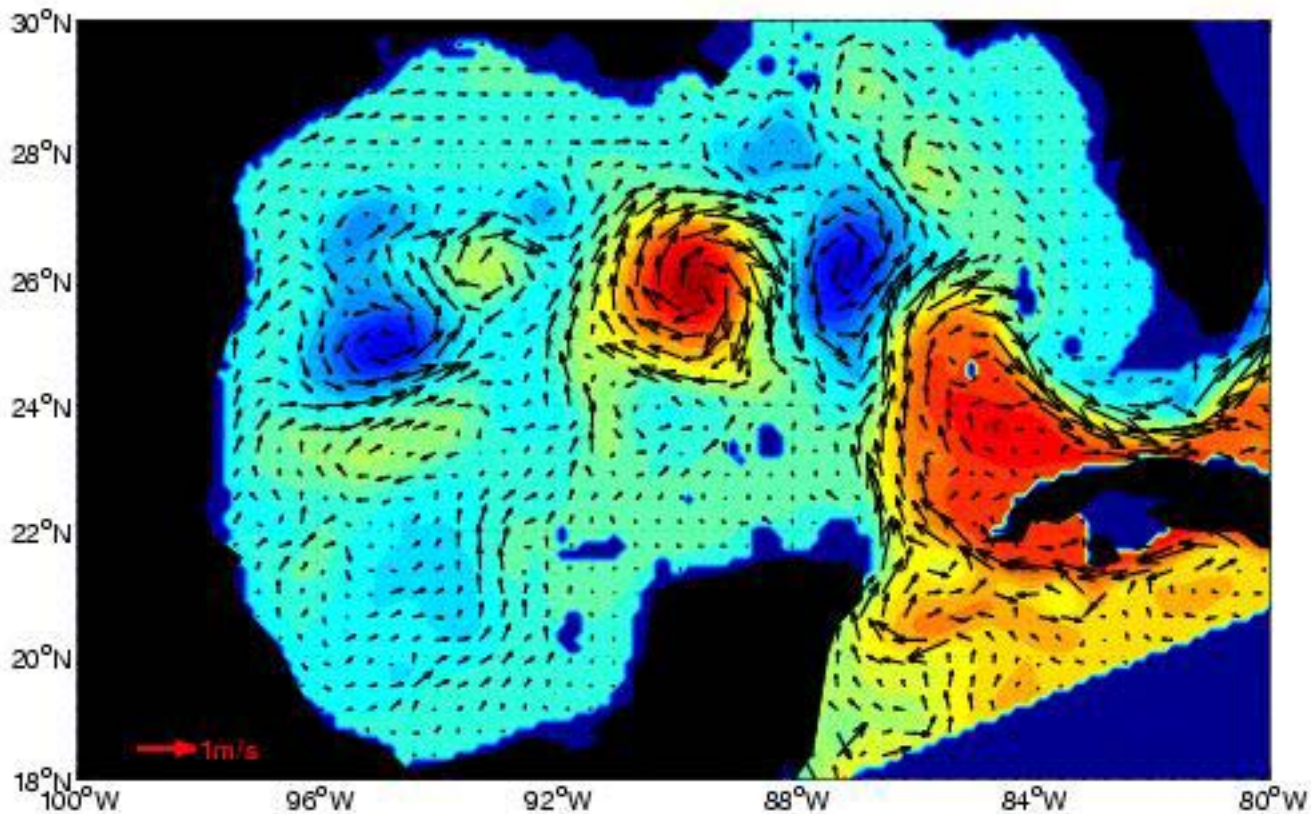
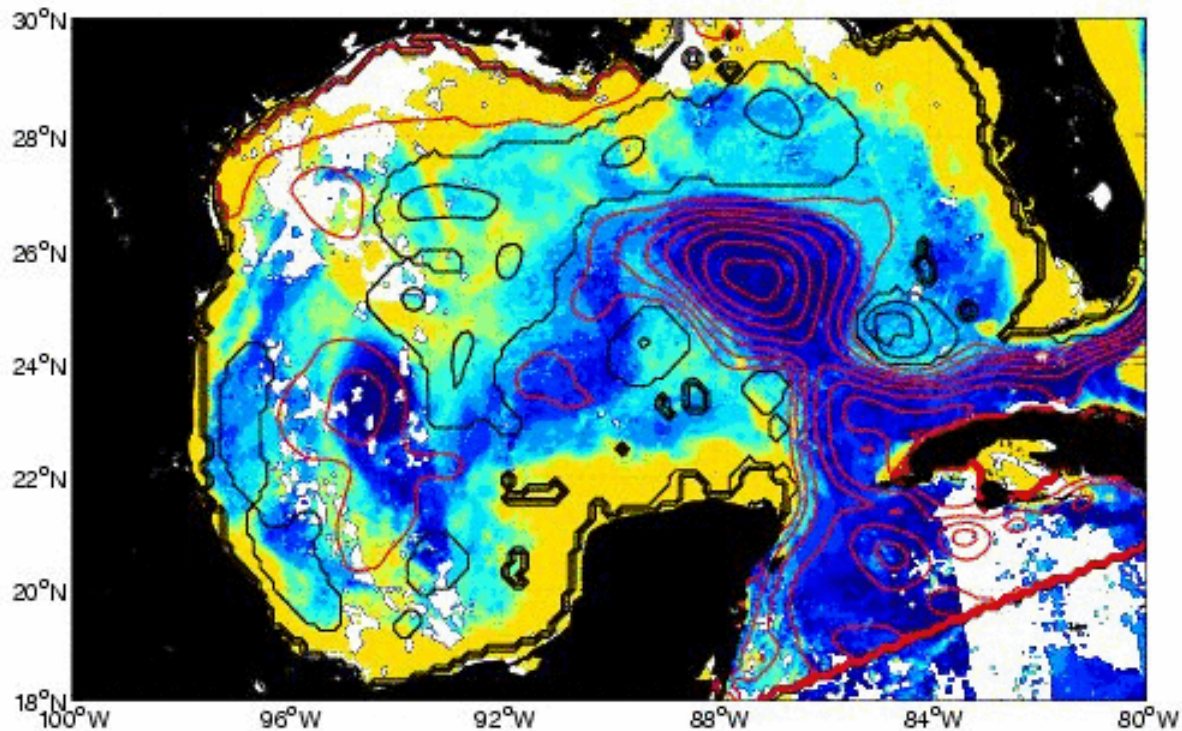


Illustration: François Counillon

# Validation

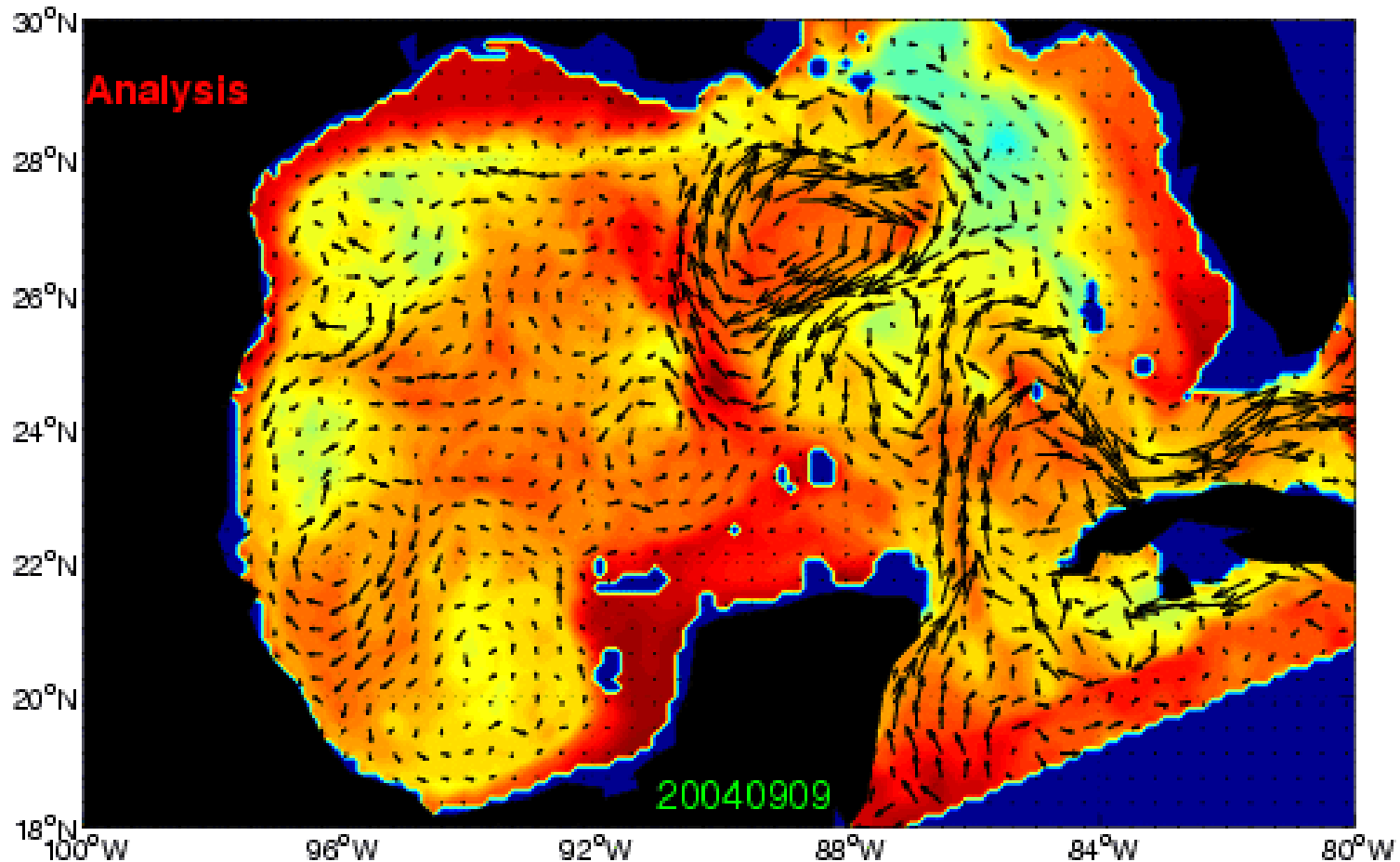
overlay with ocean color data from MODIS  
(not assimilated)



From June to Sept. 2004: eddy shedding

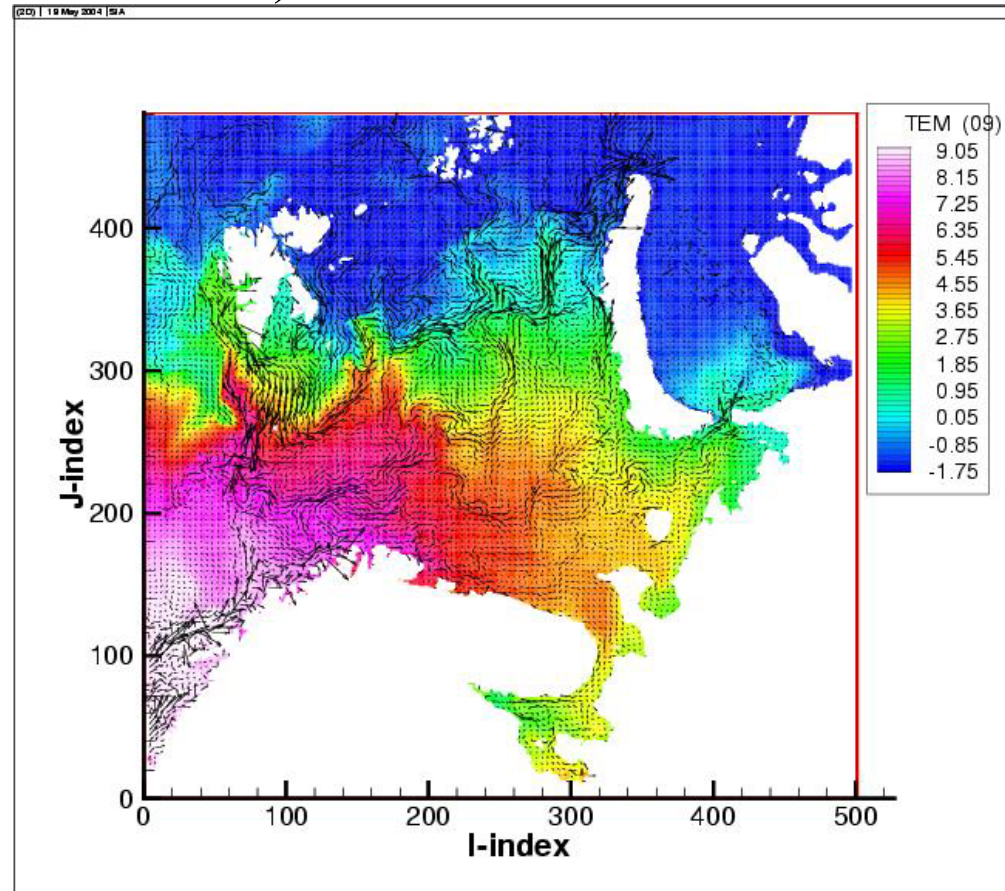
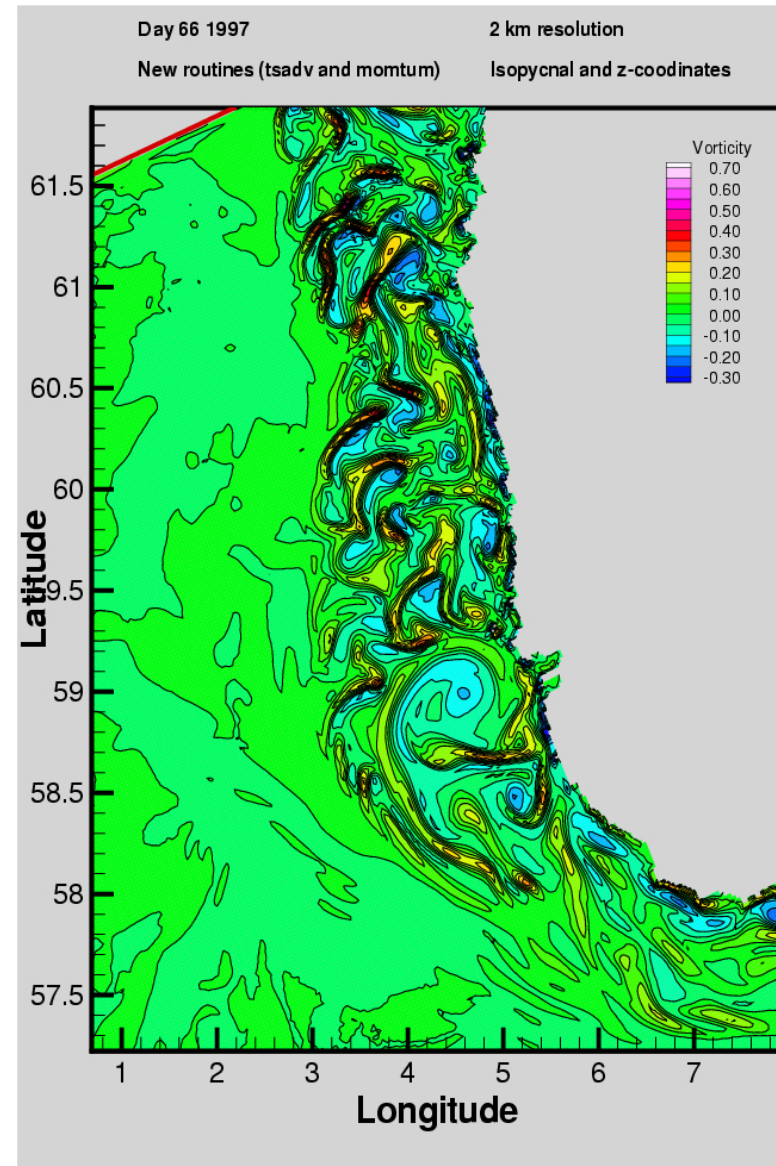
# Surface currents and temperature during Ivan

## High-integrity wind fields from OWI



# Future perspectives

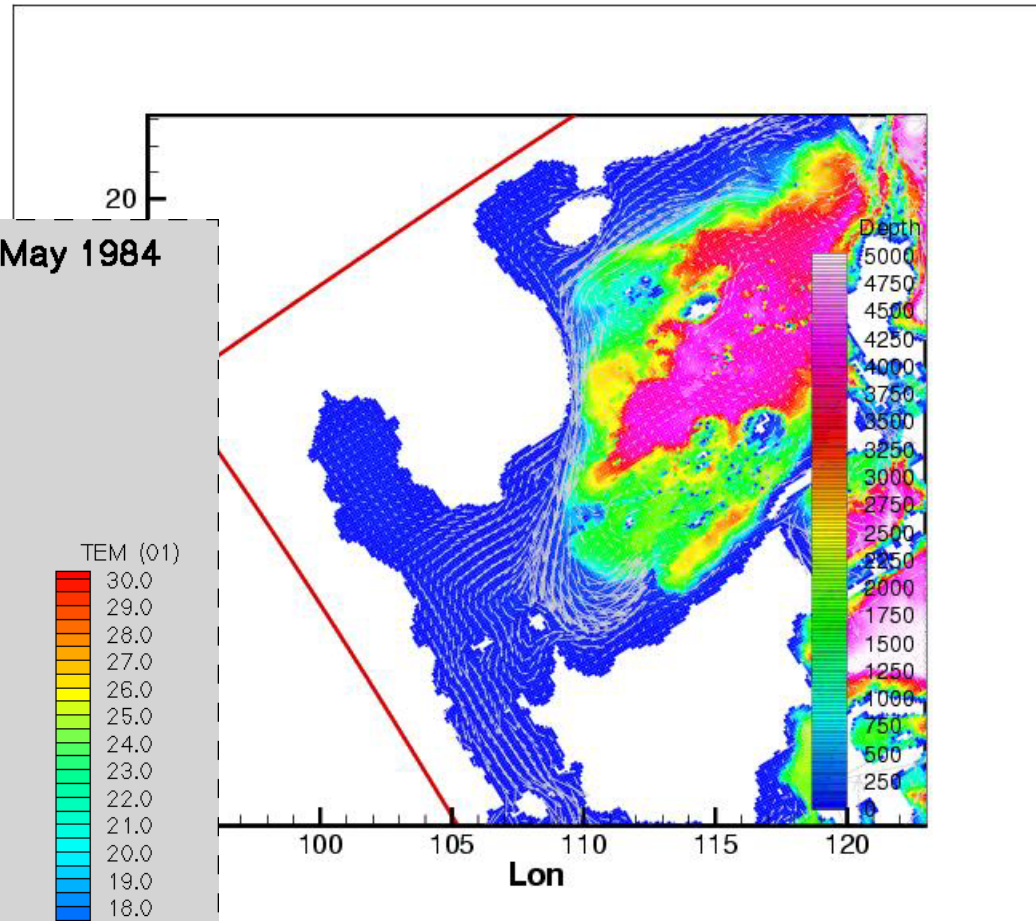
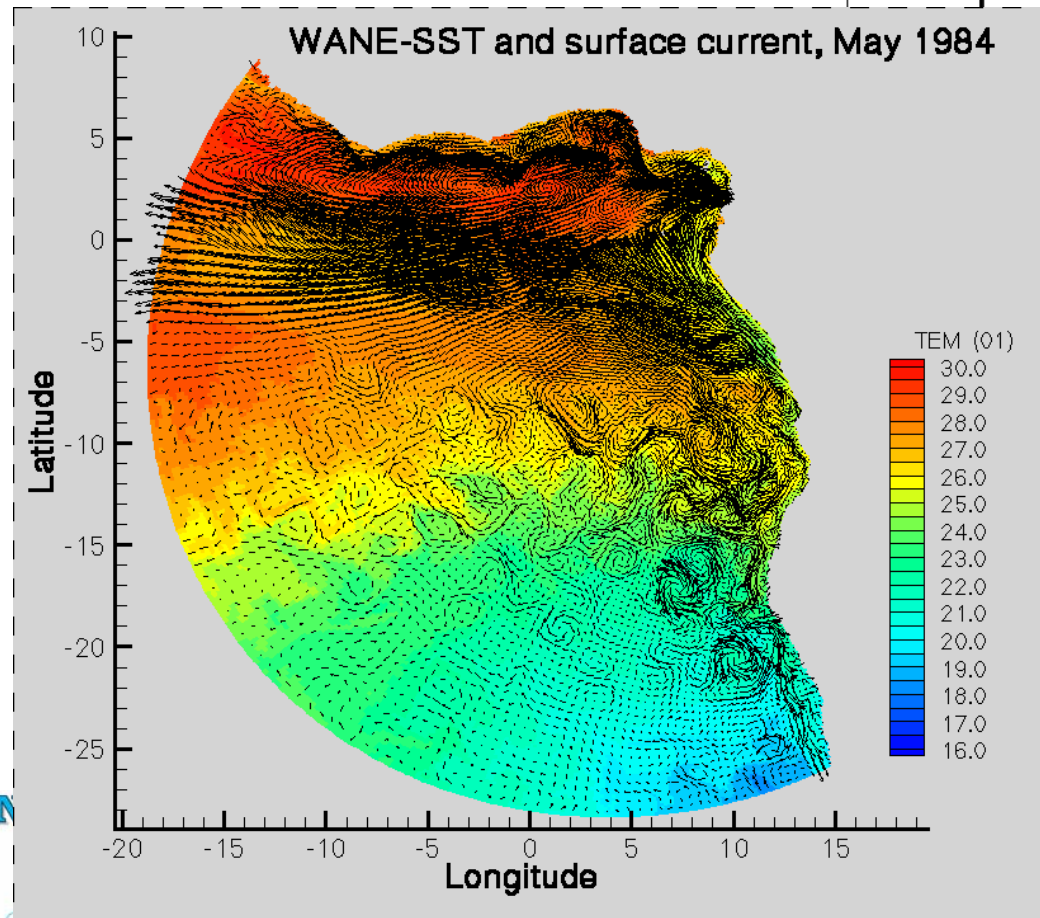
- Nordic Seas (1 Post-Doc + 1 PhD)



Illustrations by H. Sagen  
and N. Winther

# And more ...

Illustr. G. Evensen



Illustr. C. Hansen

# Ecosystem forecasting

1 Post Doc

1 PhD student



# Ecosystem modelling

3D ecosystem model:  
FDM coupled with  
HYCOM

CPU x10 !!!

Illustration

L.J. Natvik

