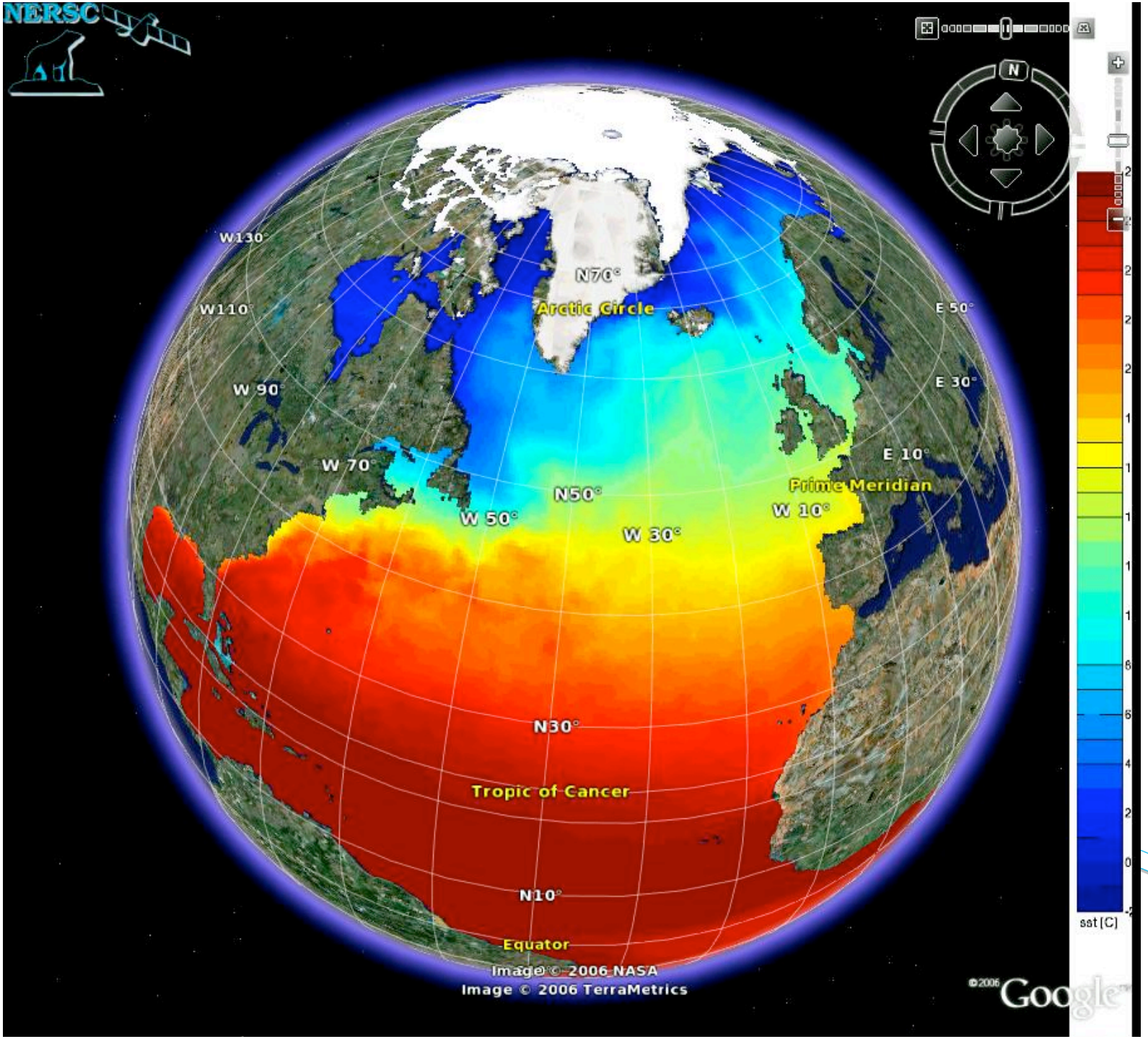
DRAGON in support of harmonizing European and Chinese marine monitoring for Environment and Security System

DRAGONESS

BILATERAL EU-P.R. OF CHINA PROJECT 2007-2010

NERSC contribution to WP 4


NERSC
W130°
W110°
W 90°
W 70°
N70°
Arctic Circle
E 50°
E 30°
E 10°
Prime Meridian
W 10°
N50°
W 50°
W 30°
N30°
Tropic of Cancer
N10°
Equator
sst [C]
Image © 2006 NASA
Image © 2006 TerraMetrics
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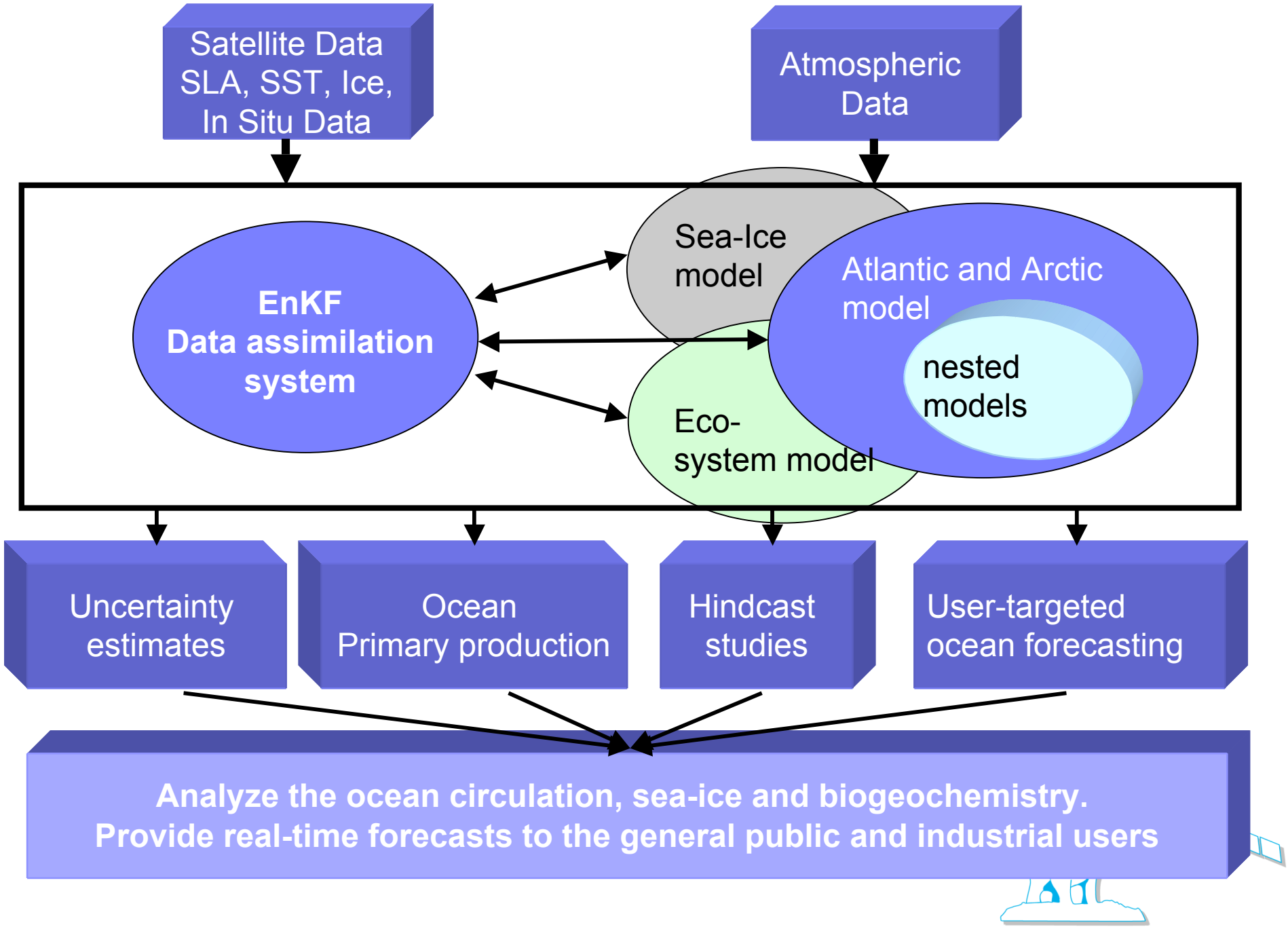
NERSC inventory

- HYCOM ocean model
- EnKF assimilation experiment
- Atlantic-Arctic model
- Indian Ocean/Southern Ocean model
- Nested models


Satellite Data
SLA, SST, Ice,
In Situ Data
Atmospheric
Data
EnKF
Data assimilation
system
Sea-Ice
model
Atlantic and Arctic
model
nested
models
Eco-
system model
Uncertainty
estimates
Ocean
Primary production
Hindcast
studies
User-targeted
ocean forecasting
Analyze the ocean circulation, sea-ice and biogeochemistry.
Provide real-time forecasts to the general public and industrial users

The TOPAZ model system

- 3D ocean model
  - HYCOM (U. Miami, USA)
  - Coupled sea-ice model
  - Biogeochemical models
- Observations
  - Altimetry, SST (CLS, F)
  - Sea Ice (NSIDC, USA)
  - In-situ (CORIOLIS, F)
- ECMWF forcings
- Data assimilation
  - Ensemble Kalman Filter

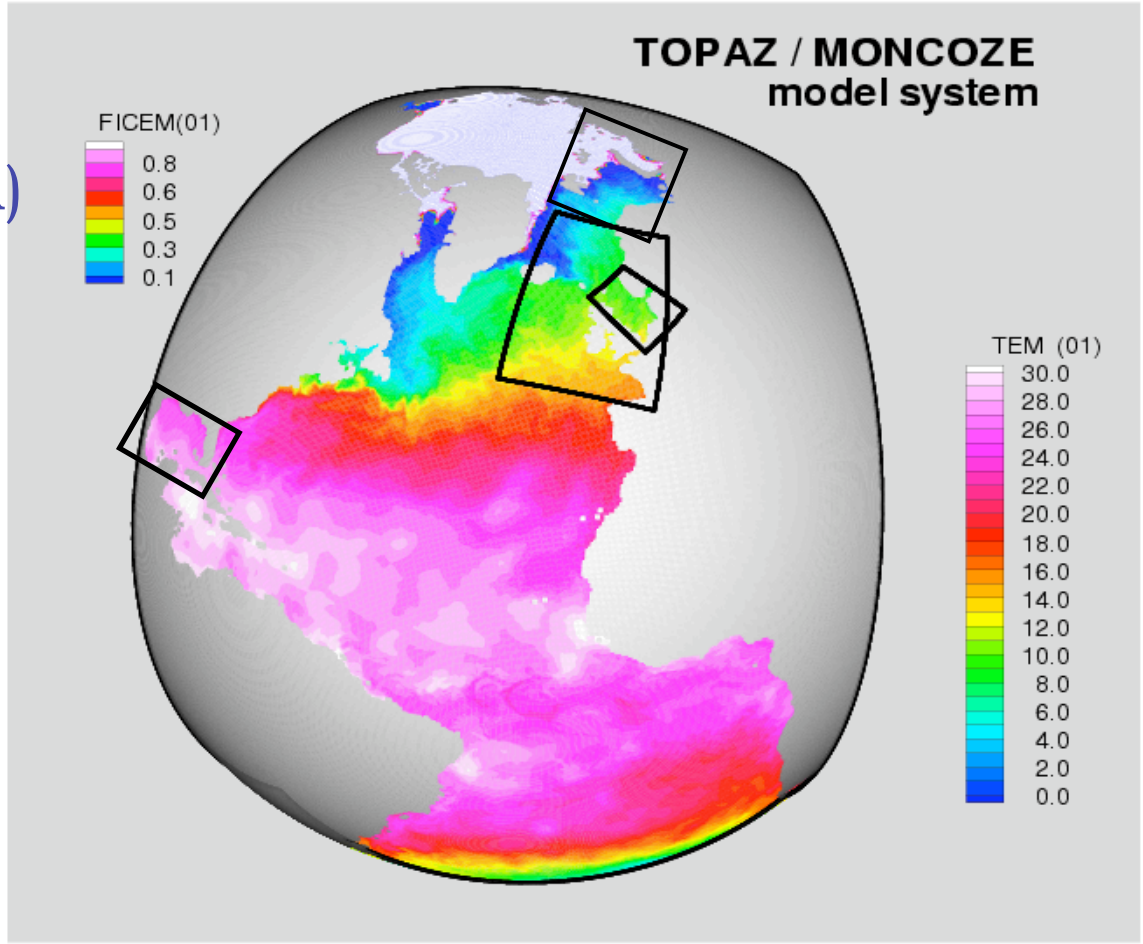
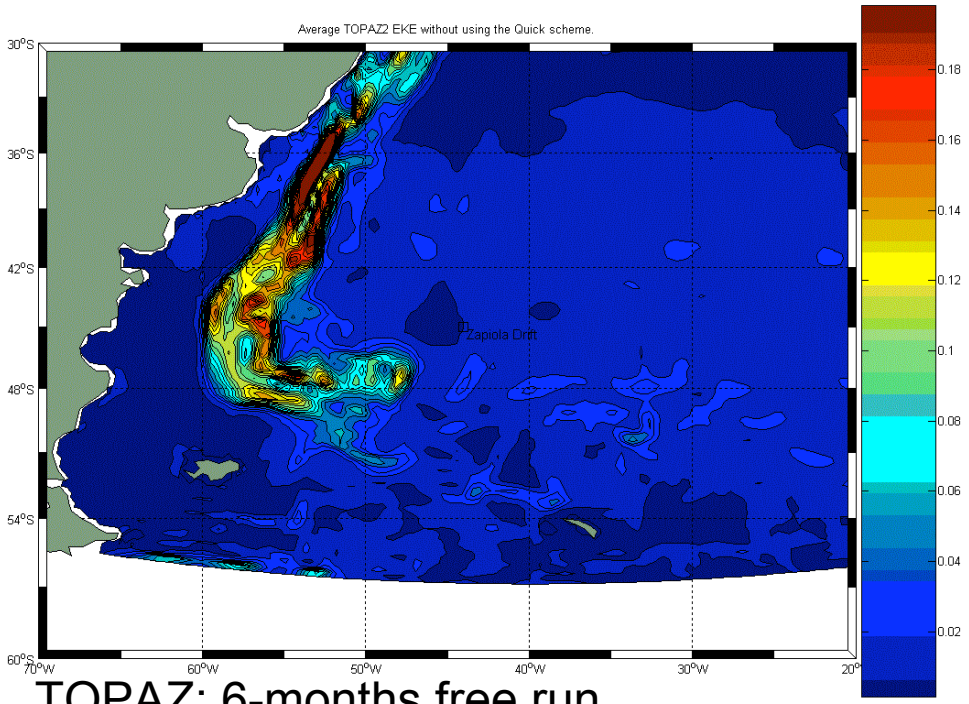


Illustration
Zapiola Eddy

- Topographically-steered C-shaped Eddy Kinetic Energy

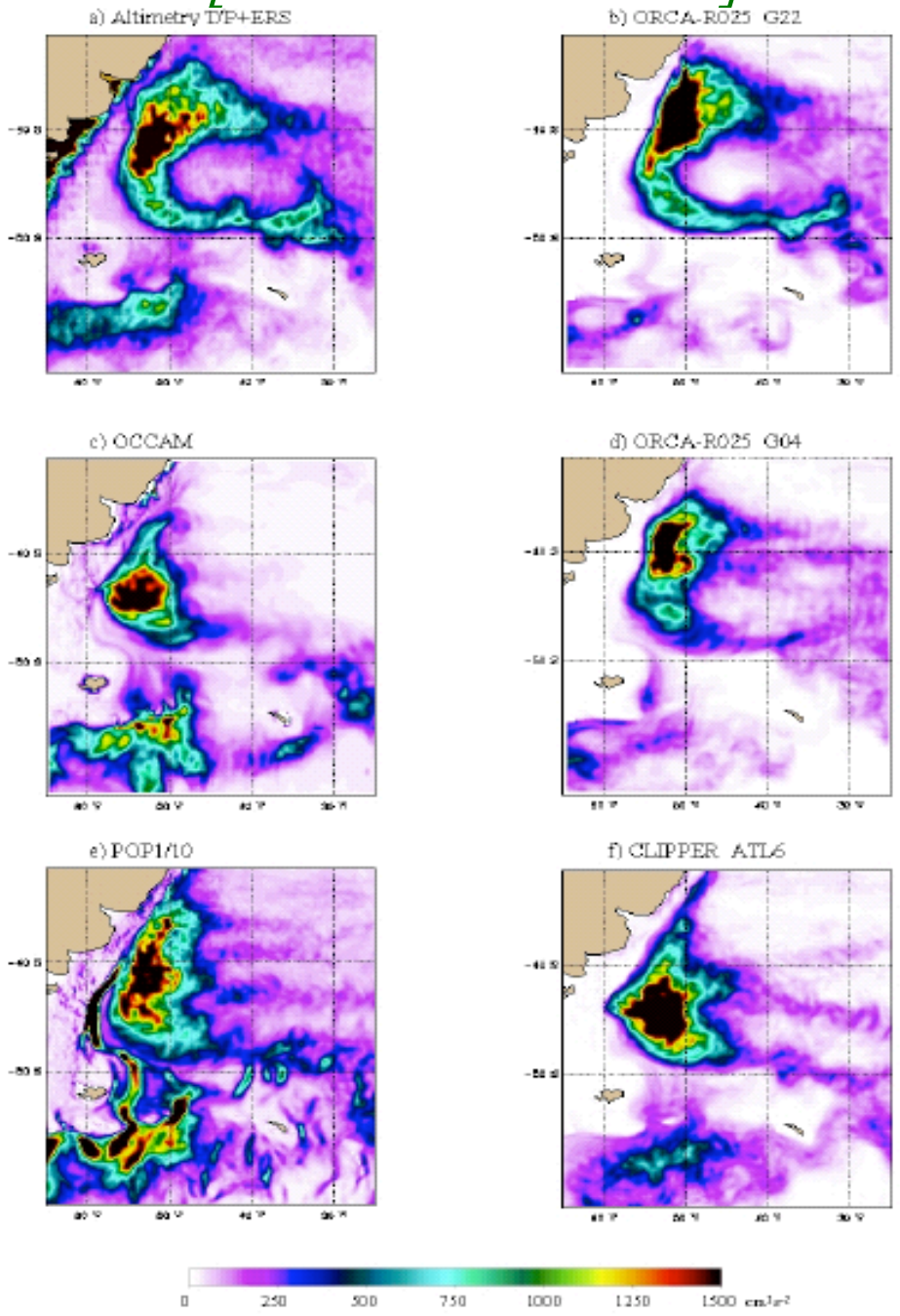


TOPAZ: 6-months free run

(no assimilation)

[G. Nondal]

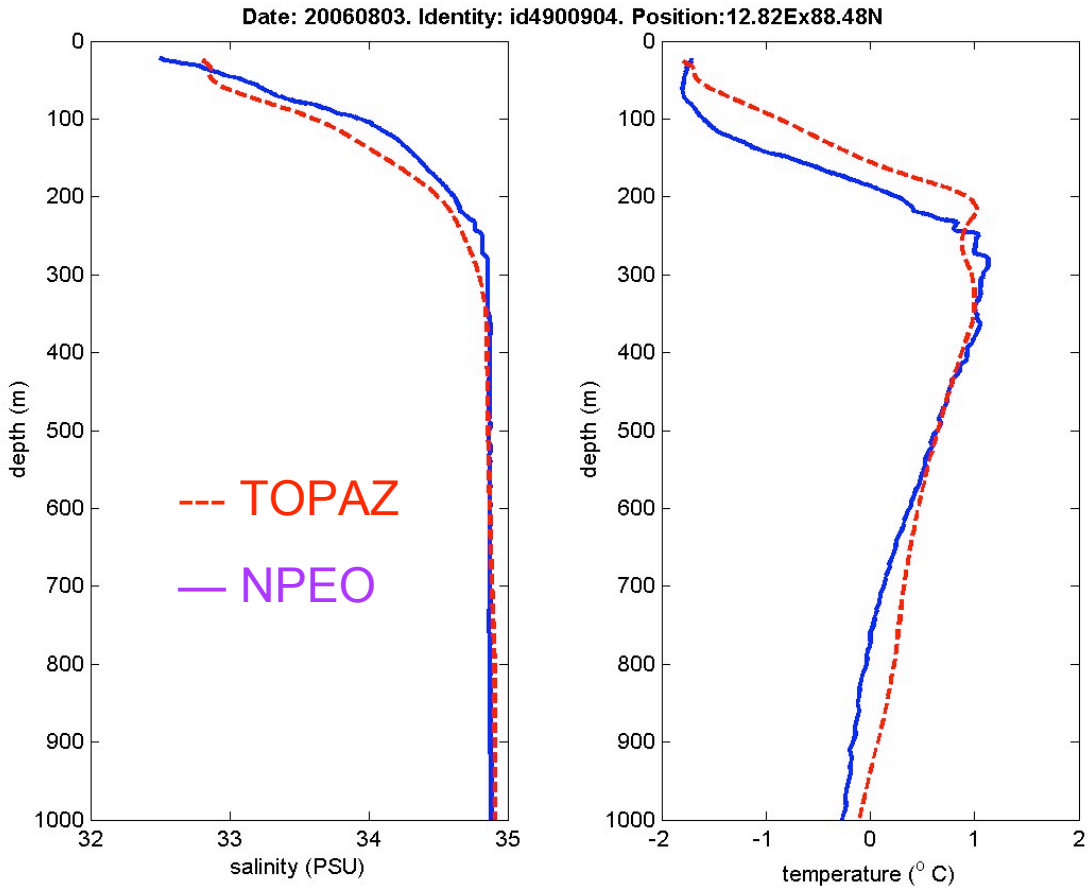
[Barnier et al. 2006]



Validation in the Arctic

[F. Høydalsvik]

- NPEO 2006 profiles (also in Coriolis data)

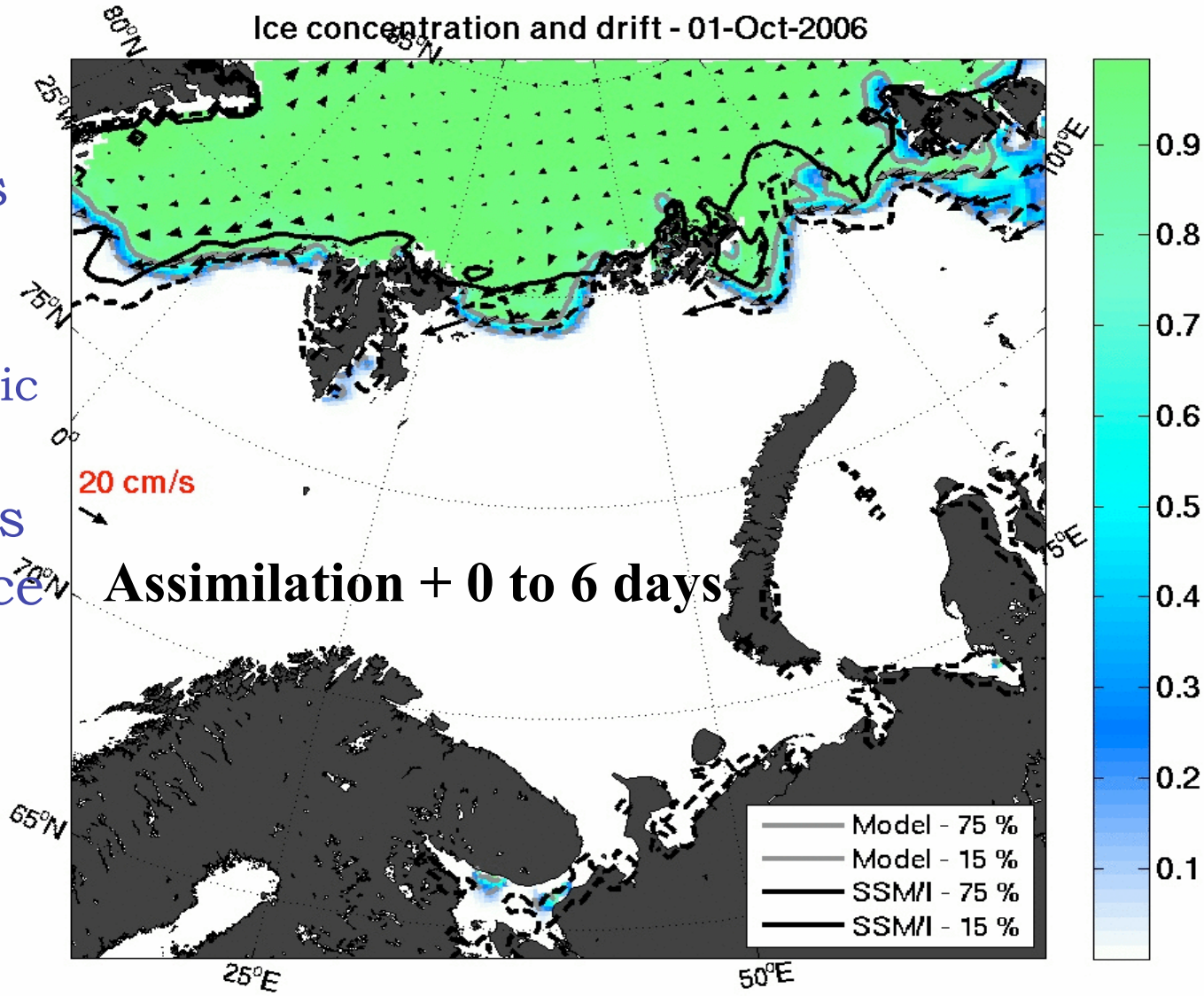


*: North Pole Environment Observatory

Ice coverage

[K.A. Lisæter]

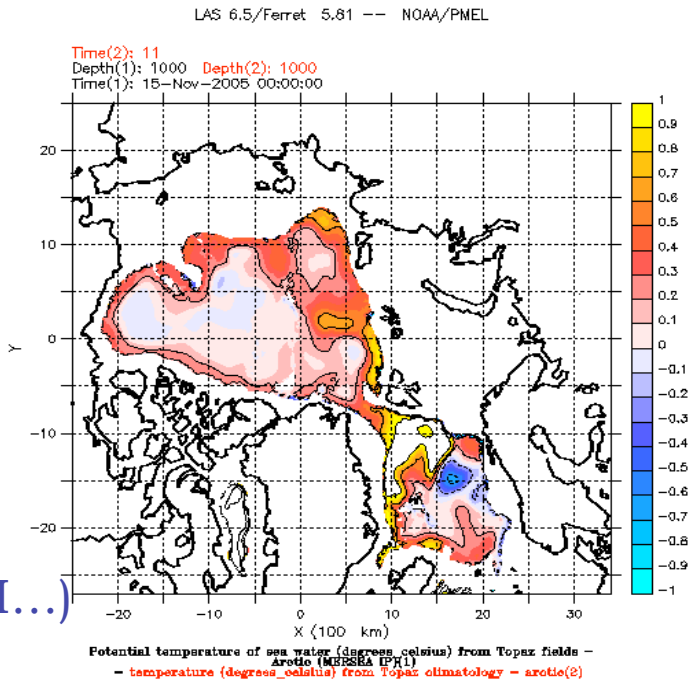
- Ice cover depends
  - On surface water properties
  - On thermodynamic fluxes
- Ice concentrations is assimilated once a week in TOPAZ
- No assimilation “shocks”
- Forecast skills?



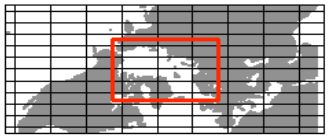
The Arctic TEP

http://arctic.mersea.eu.org

- Arctic Thematic Portal (TEP) in MERSEA IP is operational since October 2005
  - Visualization of forecast and analyses
    - Live Access Server
  - Download
    - THREDDS (data server)
    - OpENDAP (protocol)
  - Comparisons against
    - Climatology
    - … Other models (FOAM, Mercator, HYCOM…)



[K.A. Lisæter, B. Solli]



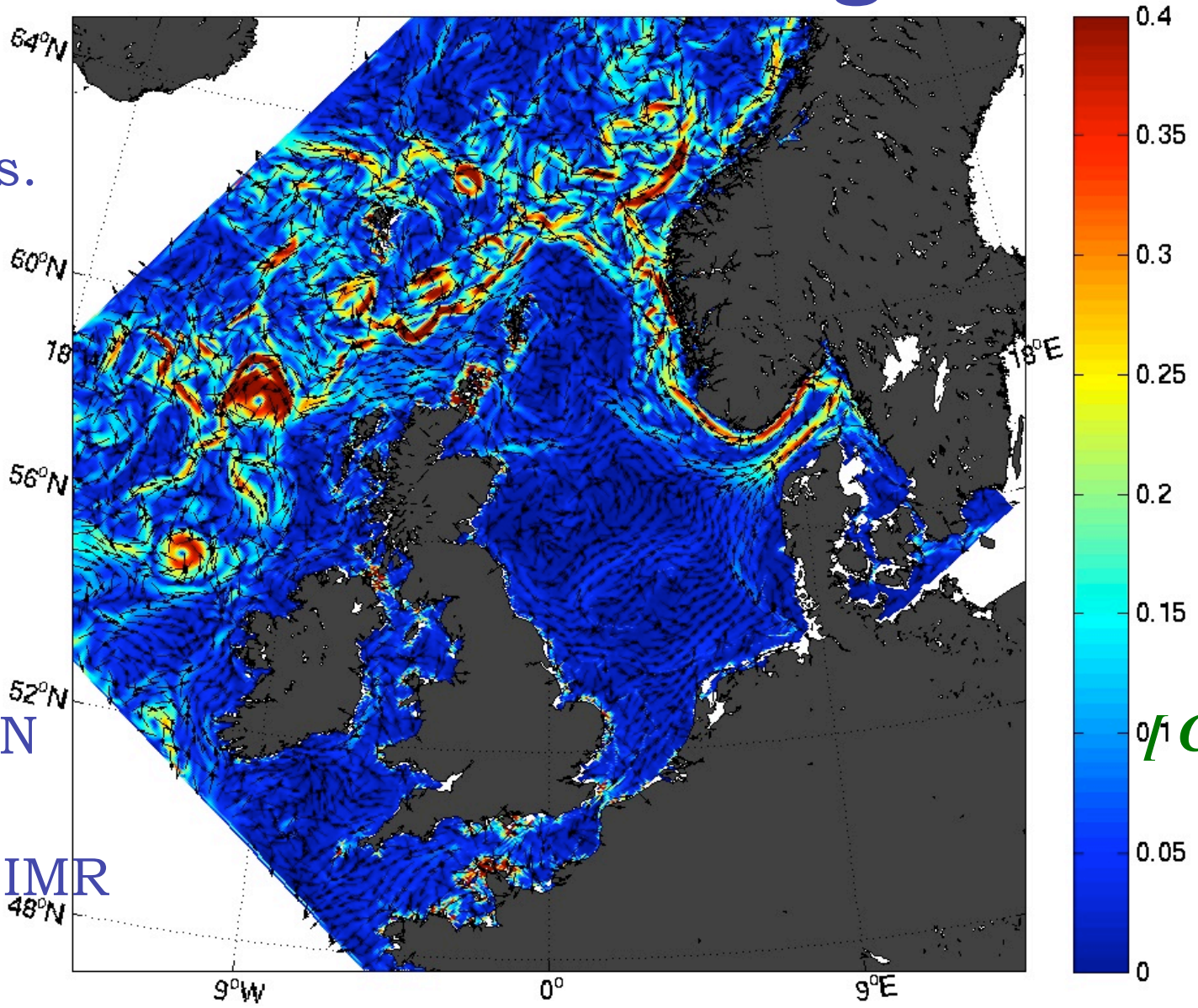
System Applications

- Nested systems in
  - North Sea (N. Winther/C. Hansen)
  - Gulf of Mexico (F. Counillon)
  - Barents Sea (I. Keghouche)
  - Agulhas Current (B. Backeberg)

- Ecosystem models

North Sea / Norwegian Sea

HYCOM
4 km res.

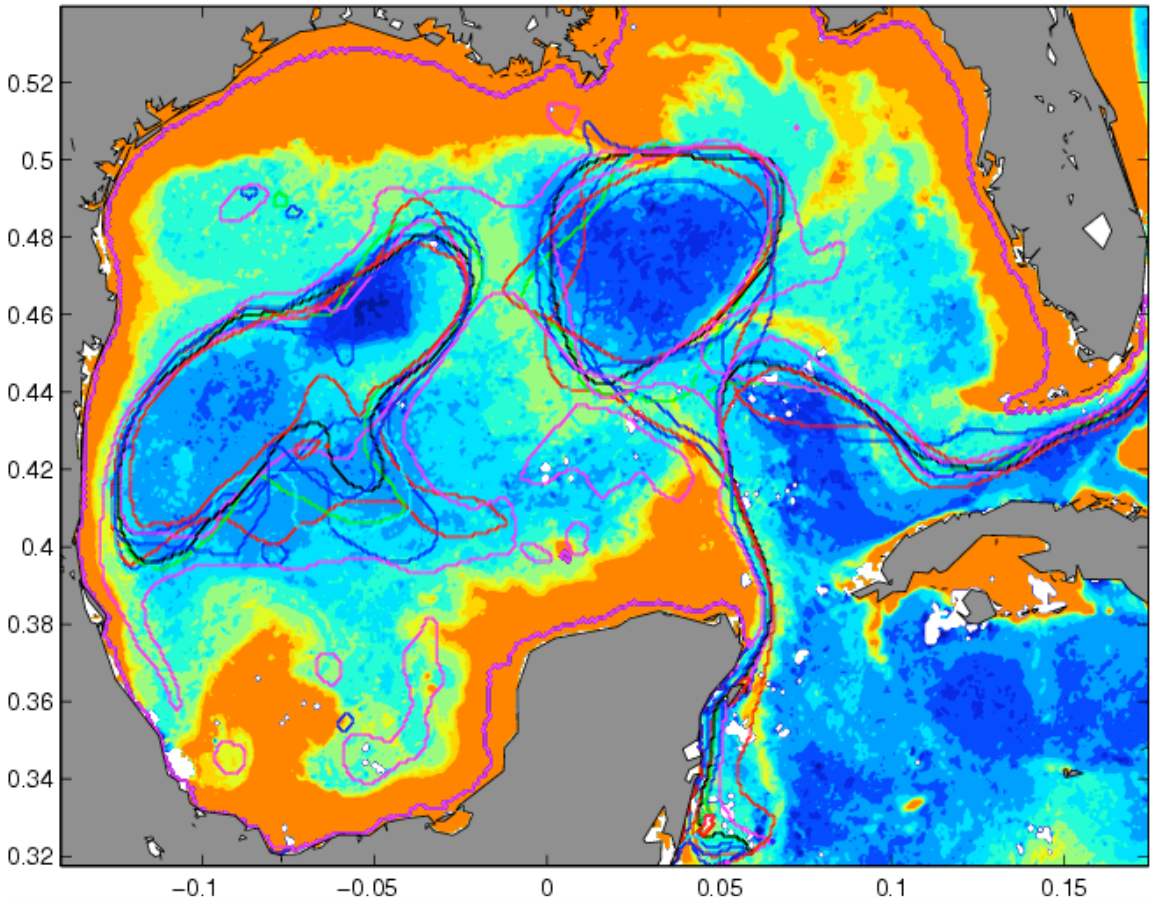


CONMAN
Collab.
Met.no/IMR

[C. Hansen]

Gulf of Mexico
ensemble forecasting

[F. Counillon]



HYCOM settings:

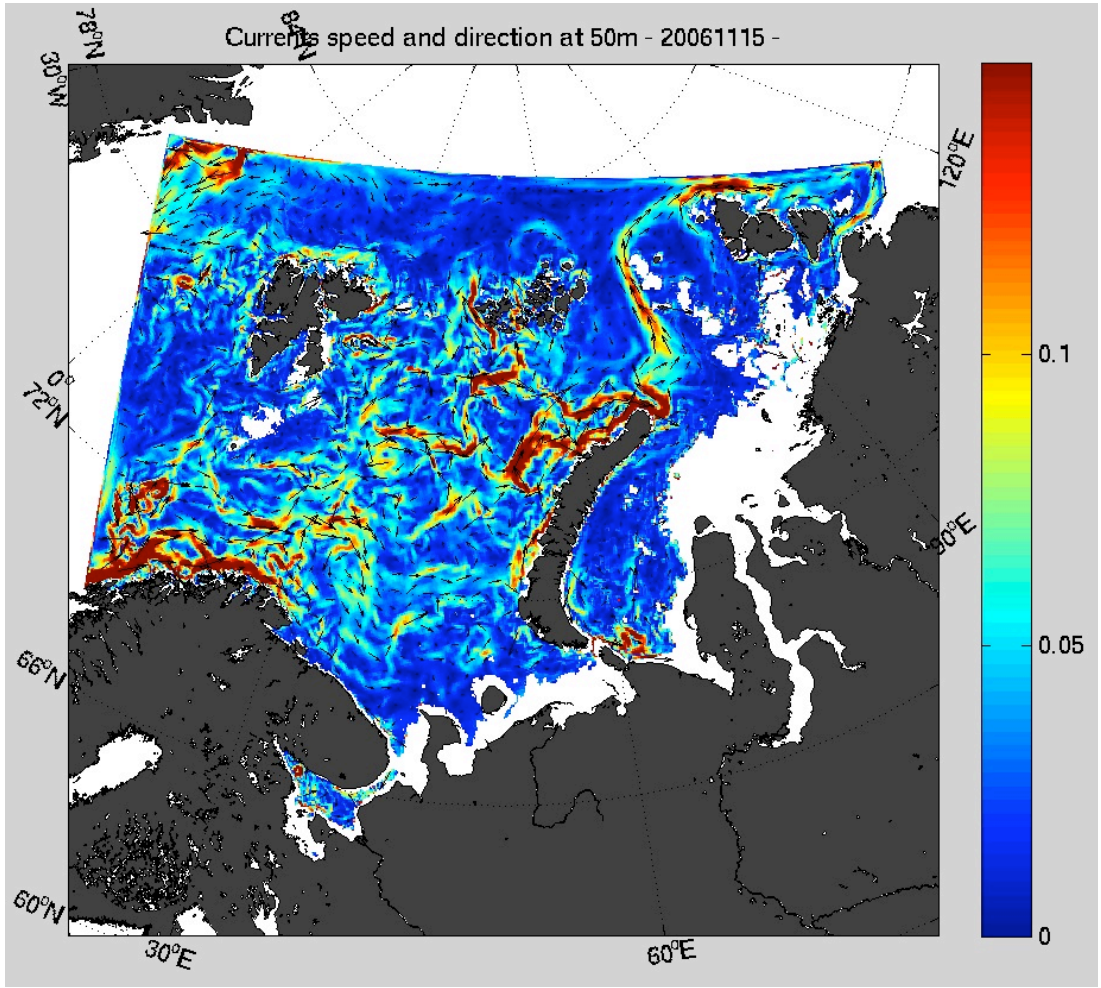
- 5 km horizontal resolution (1/20th)
- Assimilation of SSH
- Randomness from
  - Initial fields (assimilation)
  - Forcing fields

Overlay of model 7d forecast fronts (“spaghetti plot”) and posterior Ocean Color observed from MODIS

NERSC

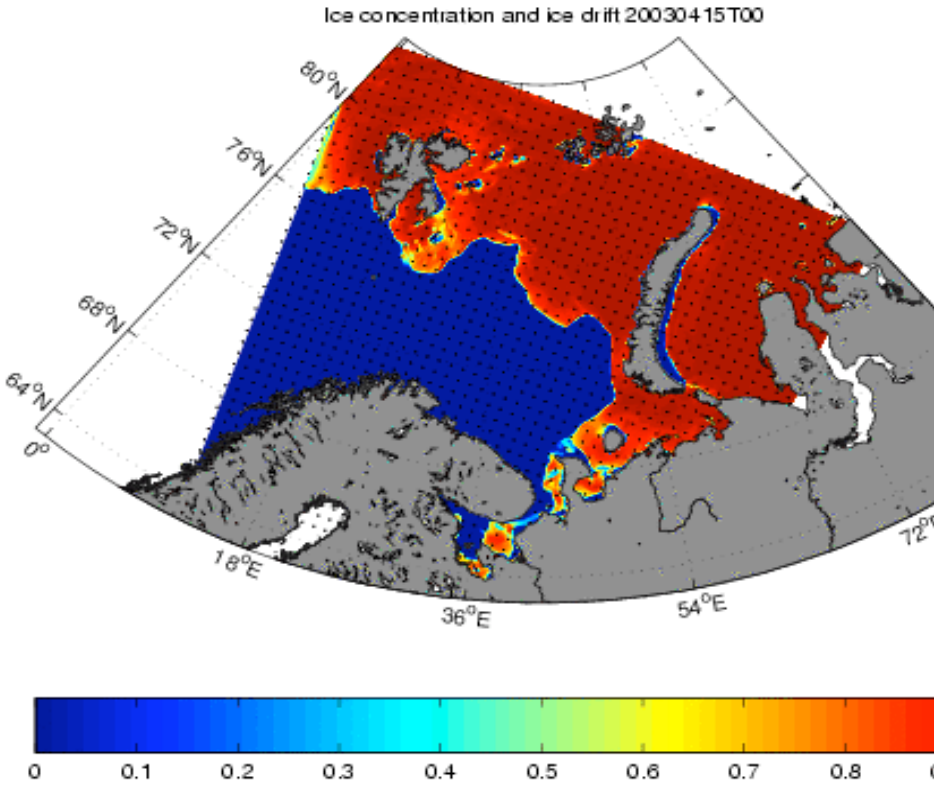
Barents Sea 5km HYCOM

In real-time since September 2006 ***[I. Keghouche]***



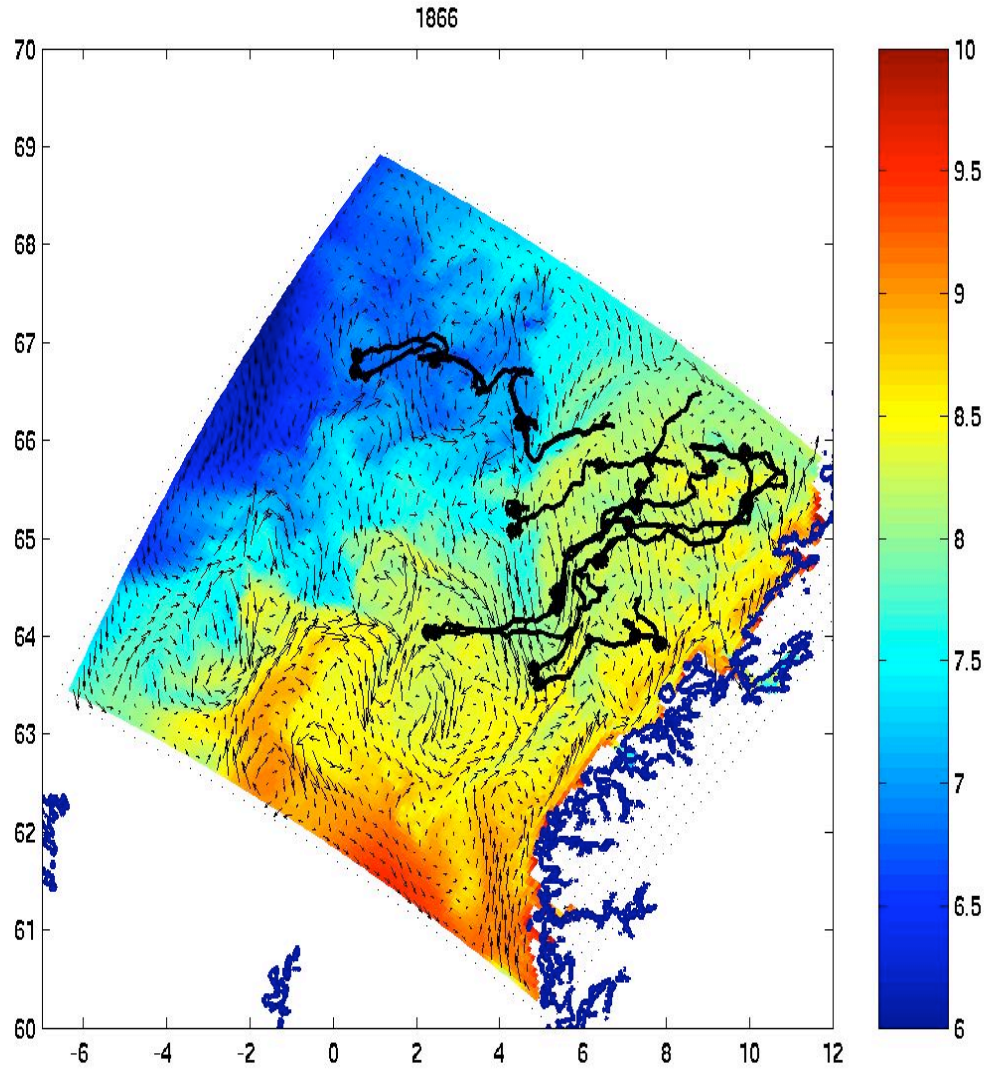
Objectives:

Ice-ocean Monitoring,
Iceberg forecasting



Ecosystem models

- HYCOM coupled with
  - NPZD models (Fasham)
  - NORWECOM (IMR)
  - Individual Based Model (IBM) *C. Finnmarchicus* (IMR)
- Focus on the Norwegian Sea
  - Influence of fronts and eddies on the marine ecosystem
  - Cross-shelf transport of zooplankton



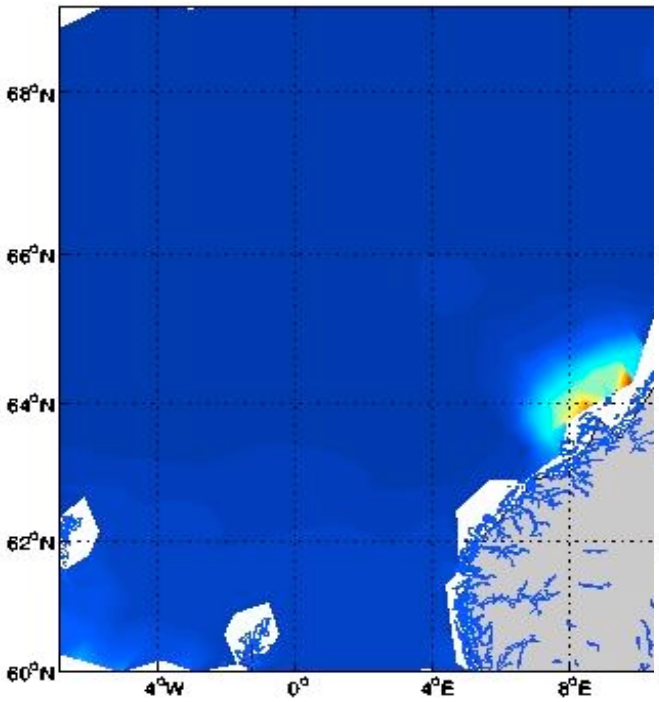
Drift trajectories of *C. Finnmarchicus*

[A. Samuelsen]

Effect of model horizontal resolution

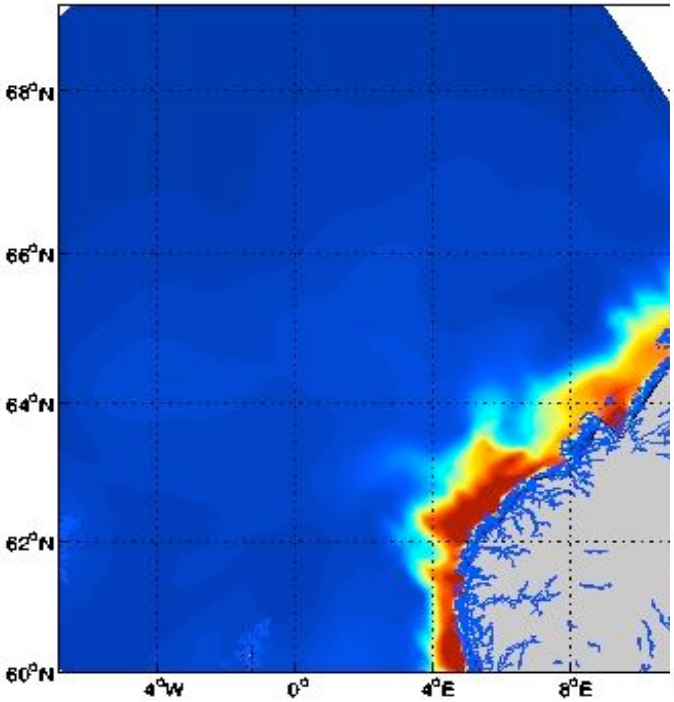
[C. Hansen]

40 km



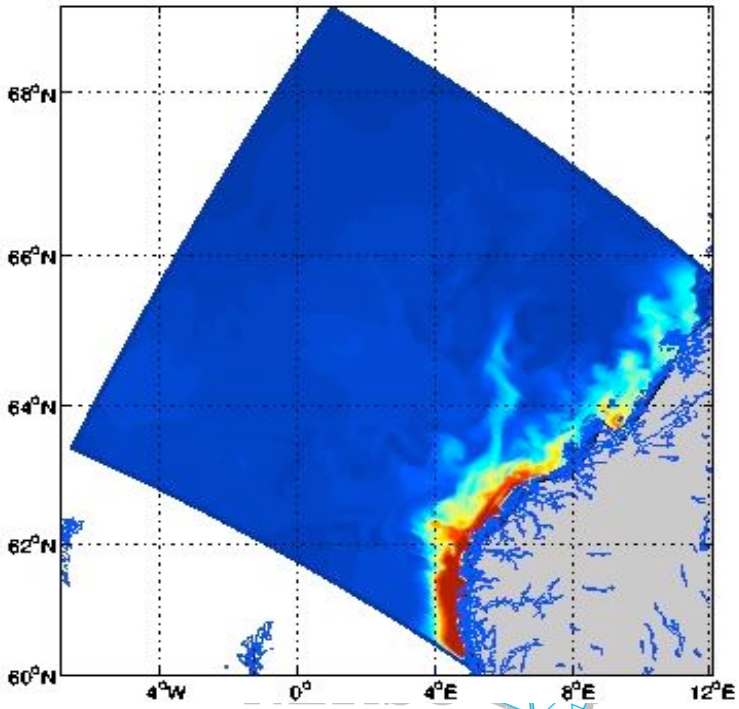
Scale 0-8 mg N /l

15 km



Scale 0-25 mg N /l

5 km



Scale 0-25 mg N /l

HYCOM – NORWECOM Diatoms, April 1997

Next upgrades …

Model developments

- Higher (x2) resolution 11 km TOPAZ3: April 2007
- Ecosystem models

Assimilation

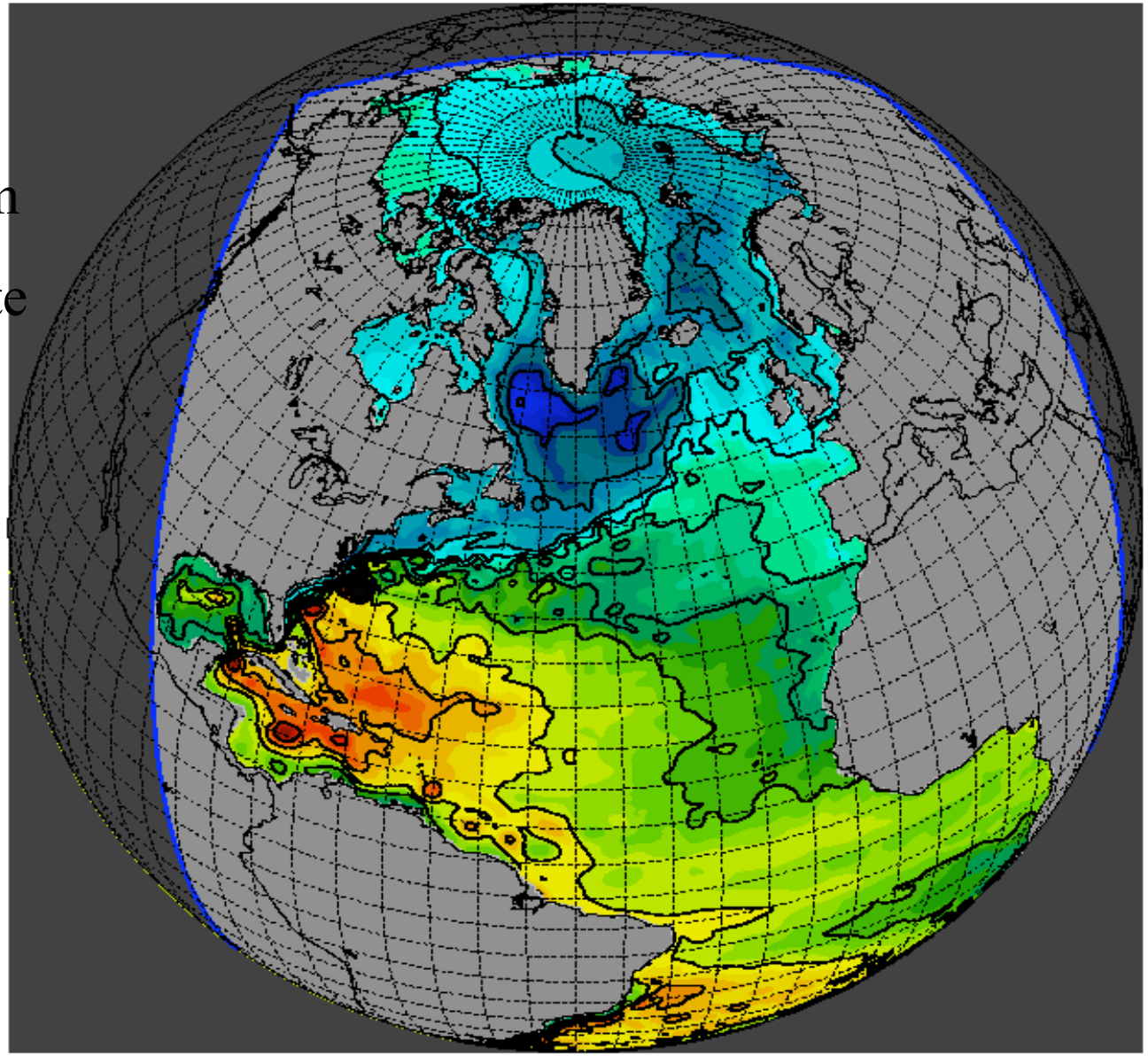
- More observations
  - sea-ice drift (CERSAT, Ifremer)
  - sea-ice thickness (ESA, CryoSat2, 2009)
  - In-situ data (Coriolis, Ifremer)
- Parameter estimation (Evensen 2006)
- Improved analysis schemes (Sakov & Oke, 2006)

TOPAZ v2

Sea Surface Heights – 6th Apr 2006

Resolution
18km to 36 km

27 million state variables



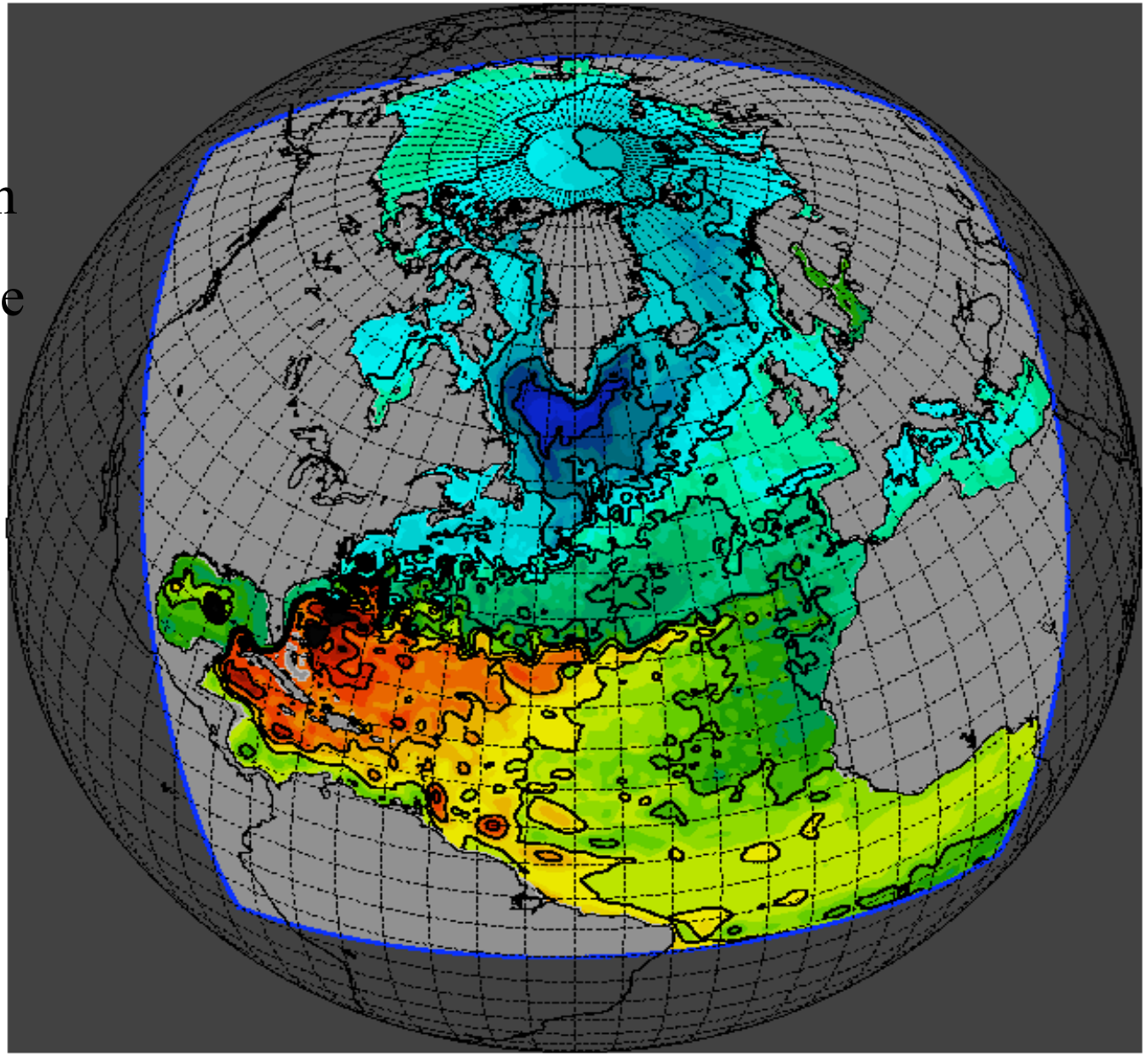
TOPAZ v3

Sea Surface Heights – Spinning up

Resolution
11km to 16 km

81 million state variables

More realistic Gulf Stream



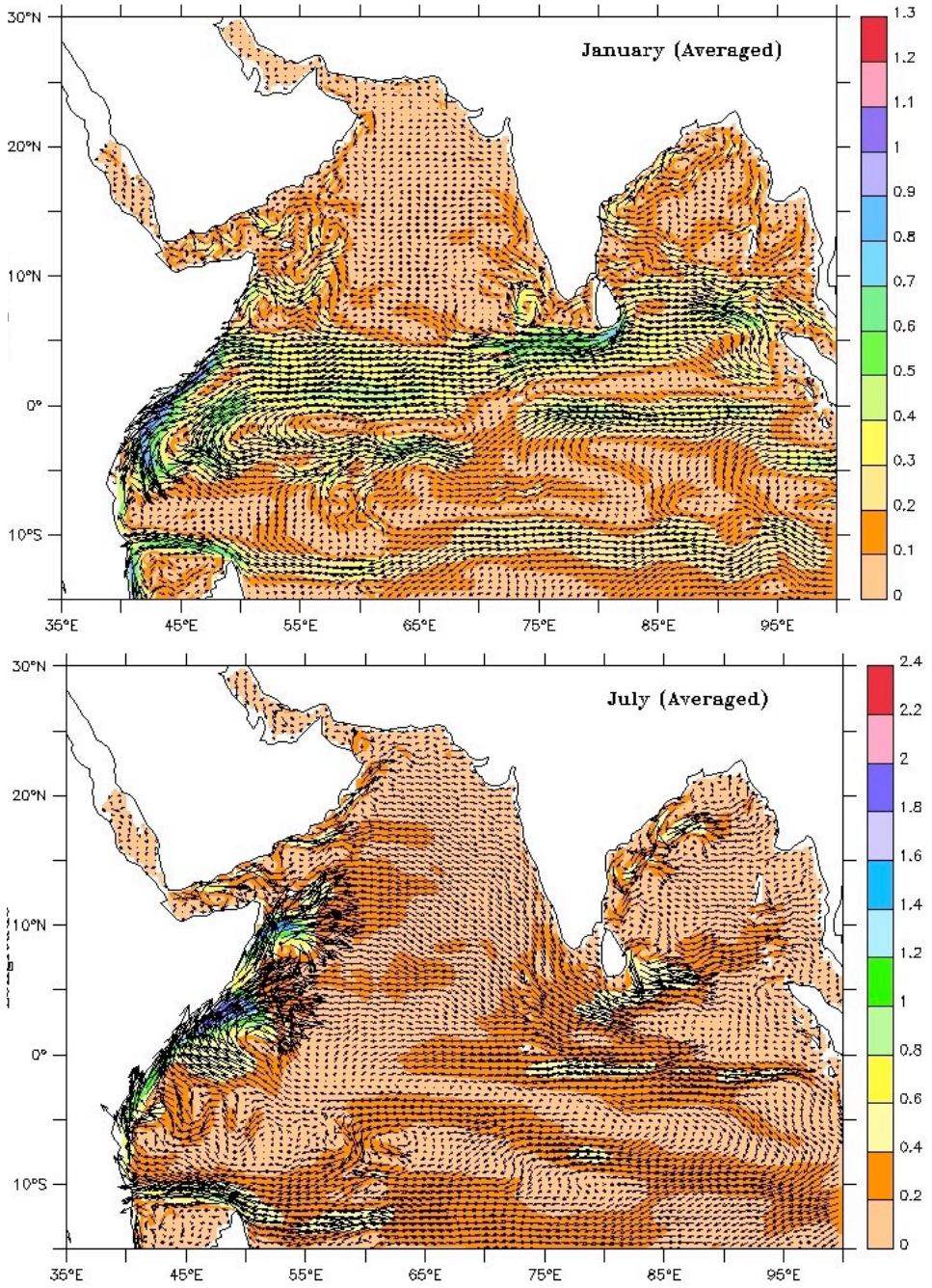
Improved circulation Nordic Seas

Geographical extensions

- Indian & Southern Oceans
- Pacific Ocean
- Agulhas

Indian Ocean

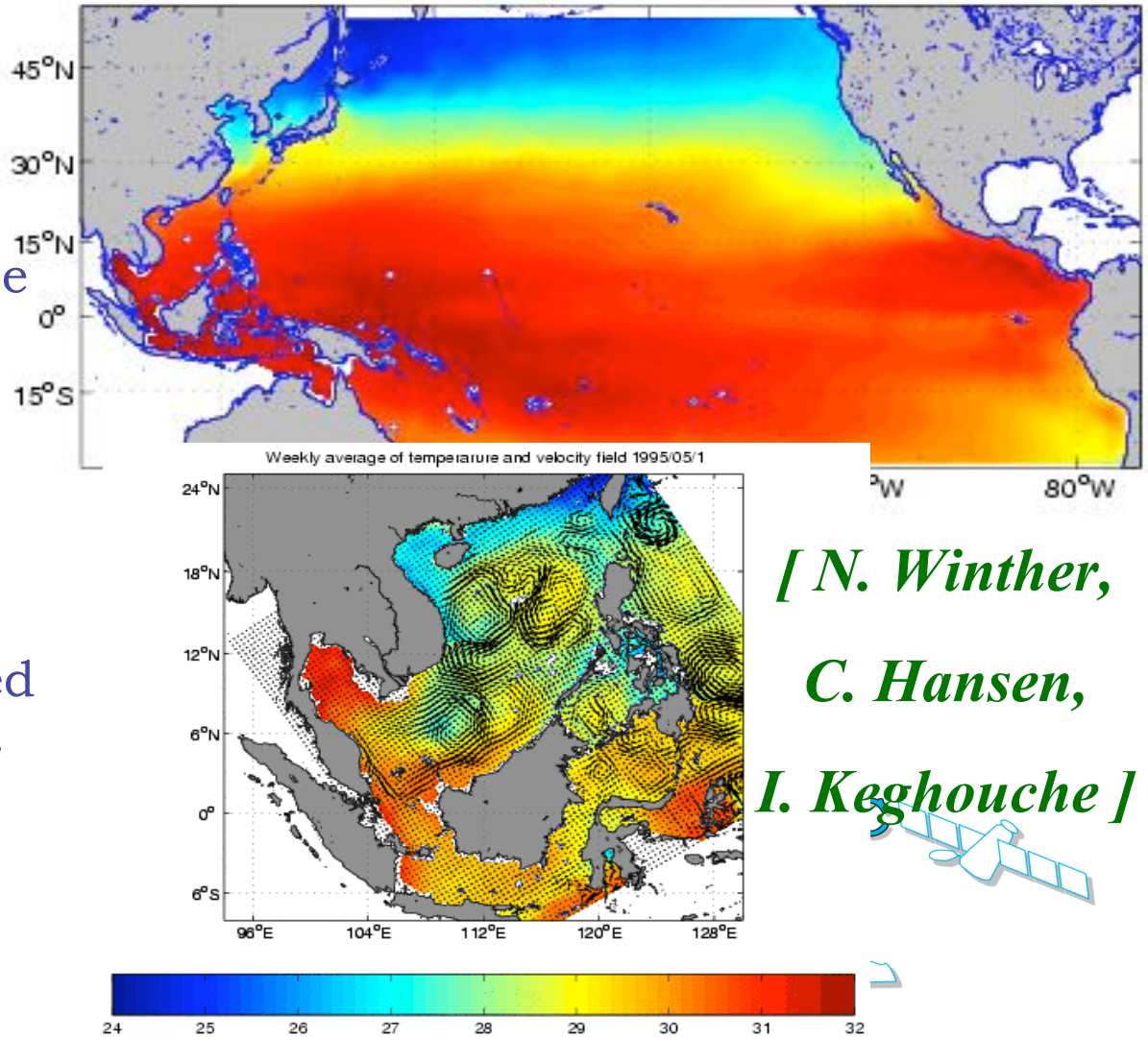
- A clone of TOPAZ is being validated
  - India and Antarctic setup
    - Nesting to Agulhas Region
  - Monsoon circulation is qualitatively correct
    - Top: January
    - Bottom: July
- Next:
  - Data assimilation
    - Sea Level Anomalies
    - Sea Surface Temperatures
    - Argo profiles
  - Operational runs



[S. George, R. Mankettikara]

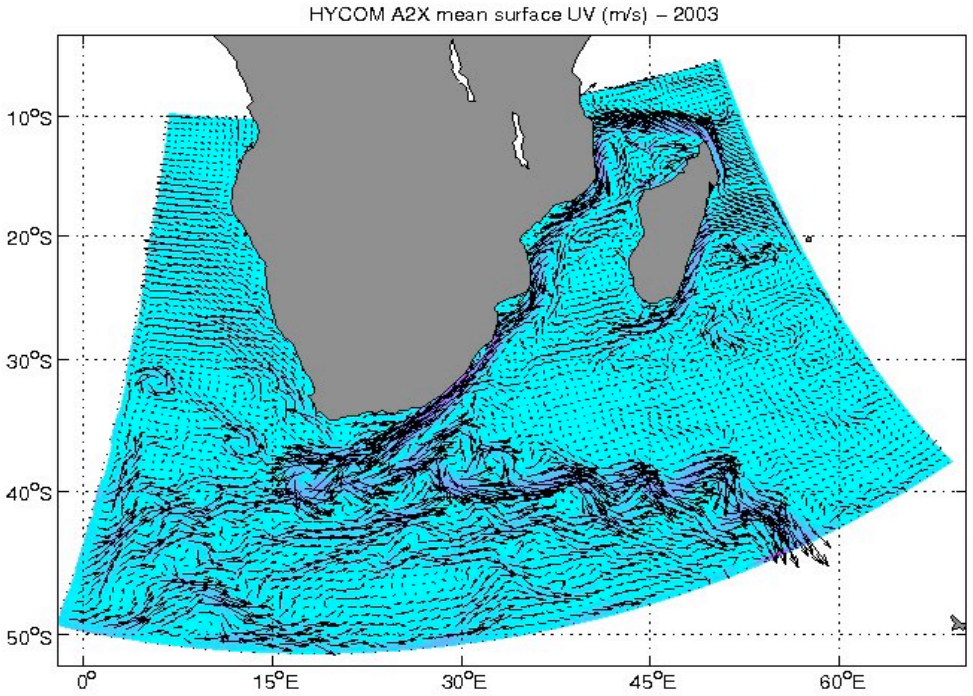
Pacific Ocean

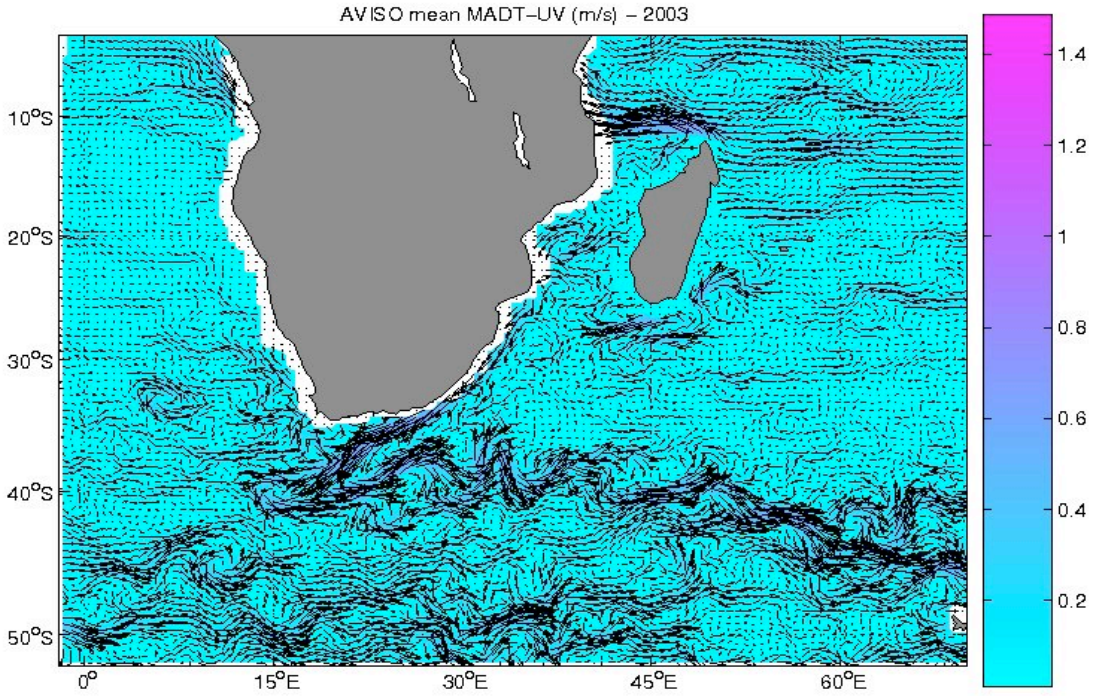
- Pacific 0.5deg resolution
  - Transferred to IAP and NMEFC in Beijing for use with EnKF.
  - 3 papers submitted
- Nested model in the South China Sea (1/10th degree)
  - Models initially developed for Ocean Numerics Ltd.
  - Run 20-years hindcast
  - Compares well to tidal and mesoscale currents (ADCP).



[N. Winther, C. Hansen, I. Keghouche]

Model validation – circulation





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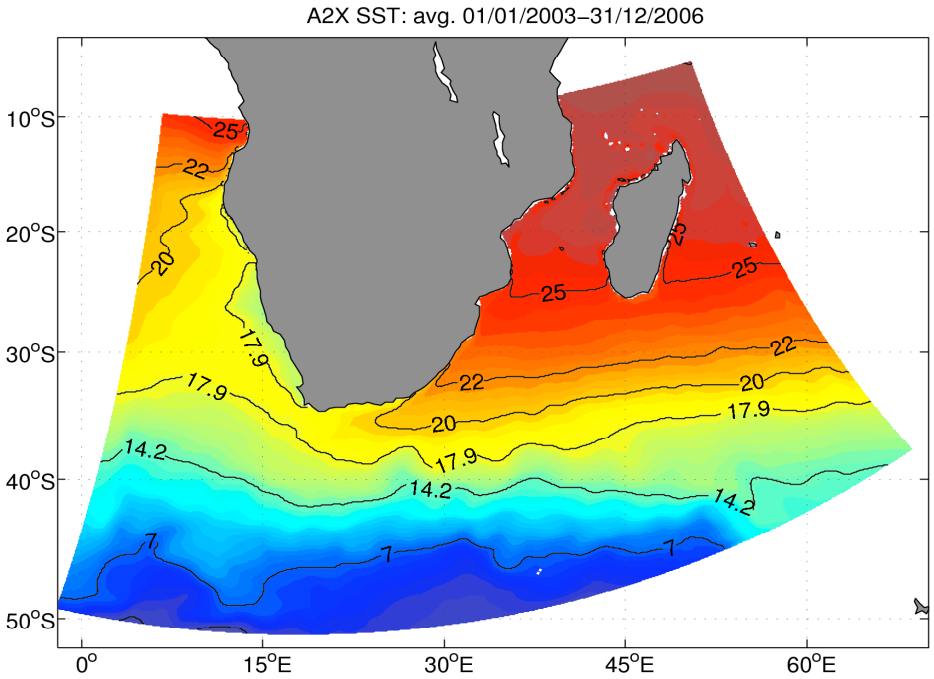
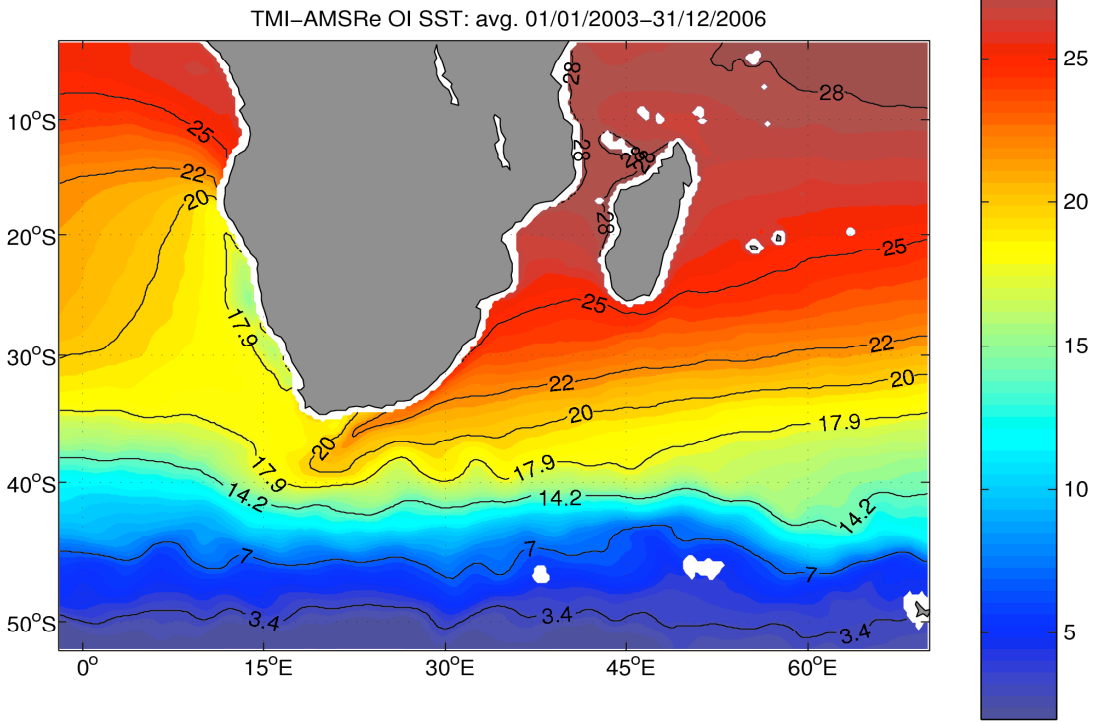
Model validation – SST





HYCOM A2X SST

- Reduced southwestward penetration of SST worse than anticipated!!

TMI-AMSRe OI SST

- Microwave SST unaffected by clouds
- Global high resolution (~25 km) coverage only available from June 2002
- Much better representation of mesoscale features

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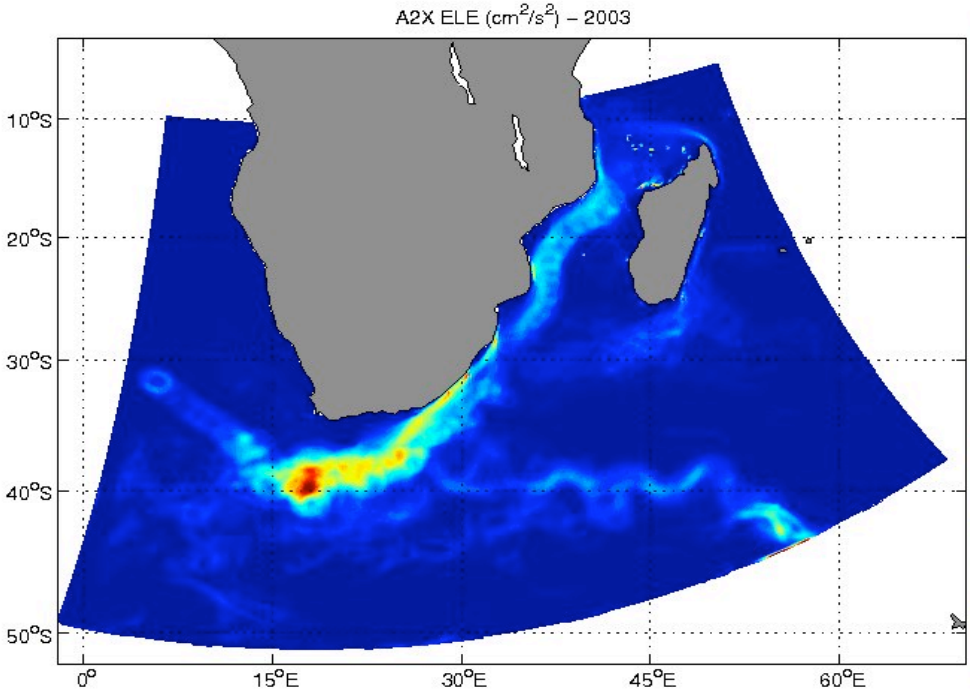
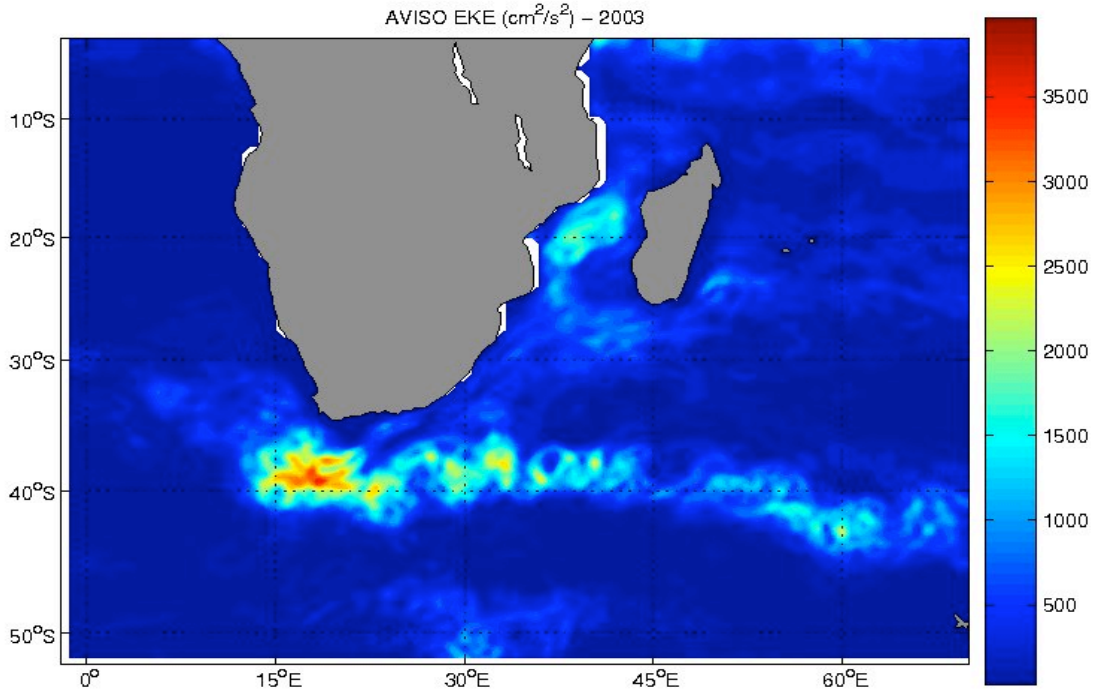
Model validation – mesoscale variability



EKE integrated to bottom



EKE derived from SLA observations from altimetry

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Conclusions, objectives

- The combination EnKF+HYCOM has some skills
  - The EnKF is a generic assimilation method
  - TOPAZ shows skills in many regions of the world oceans
  - Upgrade to TOPAZ3 in April 2007
  - Systematic validation in collaboration with MERSEA
  - Collaboration with NOPP-HYCOM
- Ecosystem
  - On research mode
  - Large scale system operational in 2008.
- Ice modeling
  - Next: Improved modeling of the Marginal Ice Zone
- Sub-modules in development mode
  - Iceberg
  - Floats / Larvæ drift

Participation in EU FP7

- The Marine Core Service (MCS) under GMES will be implemented for full operation in 2008 - MyOcean.
- MCS will consist of a 7 components; one global and five regional monitoring and forecasting centers
  - Mediterranean (in lead INGV)
  - Black Sea (MRI, Ukraine)
  - Iberian, Bay of Biscay
  - Northeast European Shelves (in lead UK Met)
  - Baltic (in lead DMI)
  - Arctic (in lead NERSC)
  - Global (in lead MERCATOR)
- TOPAZ will be assimilation and forecasting system for the Arctic MCS.
- The MERSEA IP and its extension to MCS are the European contribution to GODAE

DRAGON in support of harmonizing European and Chinese marine monitoring for Environment and Security System

DRAGONESS

BILATERAL EU-P.R. OF CHINA PROJECT 2007-2010

NERSC contribution to WP 6

Workshop, Summer School, Symposium

- We will need to combine these DRAGONESS evebts with other complementary activities
- Final DRAGON meeting in Beijing in March/April 2008
- Themes to be considered and prioritized for Workshop/Summer school
- Ocean remote sensing training course in 2010 (DRAGON 2)
- PORSEC take place in December 2008, Gangzhou
- Symposium to be held in China in 2nd-3rd quarter of 2010

Action Items

- Update Gantt diagram (Johnny) including start of WP 5 at T0 (Update WP 5 plan)
- NZU effort in WP 3 moved to WP 4
- Institute Logo (miss MOST, SIO/SOA, BNU, NMEFC, NSOAS, GKSS, ORS Cons.)
- Updated standard template for deliverables to be circulated (Johnny)
- Avoid redundancy between WPs - Leader/Co-leader responsibility)
- Make Chinese/European capacity more visible (EuroGOOS, NearGOOS), etc. (all)
- Use flowchart for WP 1 for all tasks (WP leader/Co-leader)
- How can we optimize the match between DRAGON and DRAGONESS (all)
- Themes for workshop and summer schools (all)

-Invite WP 4/WP 5 representatives to MERSEA final meeting in April 2008

-- Check where and (if) when the final GODAE meeting take place.

-- Special session of PORSEC (Werner Alpers to check)

- Summary paper of the kick-off meeting for EOS (action Werner and Chuanmin, Hu)