The TOPAZ3 forecasting system

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Introduction

- Main objective of data assimilation
 - Estimate the most likely state(s) of the ocean
- Sub-objectives (cf. Crosnier & Le Provost)
 - Accuracy (versus observations)
 - Consistency (physical sense)
 - Performance (forecast skills)
- These are strongly dependent on the data assimilation method
 - Spatial interpolation

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Multivariate correlations



System description

Doubling the horizontal resolution EnKF assimilation of sea ice drift





The TOPAZ model system

- TOPAZ: Atlantic and Arctic
 - HYCOM v2.1.03 (<u>http://www.hycom.org</u>)
 - EVP ice model coupled
 - 18-35 km resolution -> 11 16 km
 - 22 hybrid layers
- EnKF, (<u>http://enkf.nersc.no</u>)
 - 100 members
 - Sea Level Anomalies (CLS)
 - Sea Surface Temperatures
 - Sea Ice Concentrations (SSM/I)
 - Sea ice drift (CERSAT)
- Runs weekly
- ECMWF forcing
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 - Class 1-4 products on the OPeNDAP (http://topaz.nersc.no)









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Circulation in Nordic Seas on 15th Aug 2007





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Example of ice concentrations 15/03/07



Example of ice concentrations 15/03/07





Example of ensemble error estimates Sea ice thickness





Ensemble average

13th March 2007

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Ensemble standard dev.

13th March 2007

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Ice drift assimilation Why the EnKF?

Ice Drift 20070204-20070207 -- Red: Obsວິດອີໄມອ:Ensemble Member 1



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Correlation ice drift (y) – ice thickness

Divergence from the coast

- When new ice is freezing, thinner ice replaces the thick ice
- positive correlation of ycomponent with ice thickness
- Convergence to the coast
 - The ice is packing
 - Negative correlation of ycomponent with ice thickness





Impact of assimilation





On ice concentrations

On ice thickness



Validation in the Arctic

Accuracy ? Consistency ? Performance ?







Sparse profiles under ice



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Ice drift validation



In-situ

- Ice drifting buoys (Statoil/CMR)
- Manned expeditions
- Remote sensing
 - ASAR (NERSC) WP2
 - QuickSCAT (Ifremer)
- Modelling
 - TOPAZ2

A good agreement
 J. Wåhlin, S. Sandven,
 NERSC J
 Mohn-Sverdrup Cer

Buoys on ice

- International Arctic Buoy Program (US, Can)
- Less on the European side
 - Ex: Statoil/CMR in March 2006.

[J. Wåhlin, S. Sandven,

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Period: 15-18.03	ASAR Wideswath	Ifremer data	TOPAZ model	Drifting buoys
Displacement (km)	63.0	56.9	52.2	64.4
Direction (°)	190	192	186	196

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Do volume fluxes change with data assimilation?







Transports with/without assimilation Year 2006 F. Høydalsvik

	TOPAZ2 / EnKF	TOPAZ2 Ctrl	Obs. estimates
Northwards volume into Nordic Seas	11.1 Sv	9.5 Sv	8 - 9 Sv
Atlantic water only (35psu+)	3.5 Sv + 3.6 Sv	0.4 Sv + 0.15 Sv	3.7 Sv + 3.5 Sv
Southwards volume out of Nordic Seas	10 Sv	9.1 Sv	7.3 Sv
Volume: Nordic into Arctic (Fram Strait + Barents Sea)	2.9 Sv + 3.3 Sv	4.6 Sv + 3.9 Sv	9.5 Sv ? + 5.5 Sv ?

The assimilation improves the Northwards transport of Atlantic water, but not the total volume fluxes: it does not improve the deep circulation (only surface observations are assimilated).

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Forecast skills Example of ice concentrations, 8th November 2006



Conclusions

- The TOPAZ3 upgrade does large improvements
 - But maybe limited by HYCOM V2.1.03?
- The EnKF shows some skills in
 - Accuracy
 - Consistency
 - Performance





Plans

- Upgrade to HYCOM V2.1.34
- Assimilation of Argo data
- Inclusion of ecosystem model
- Exploitation of TOPAZ at met.no
- 30-years reanalysis (in 2009)





Open positions deadline 15 Sept. 2007

- Post-doc (Oceanographer): Eddy-resolving modelling of the Nordic Seas. Immediate Start. 2 years.
- Post-Doc (Oceanographer/mathematician): non-Gaussian data assimilation in a coupled HYCOM-Ecosystem model. Start Summer 2008. 2 years.
- PhD fellow (Mathematician): assimilation of sea-ice drift and parameters estimation. Start Jan- 2008. 3 years
- PhD fellow (Mathematician): Methodological developments of the EnKF for oil reservoir simulations. 3 years
- ... Director NERSC.

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