Assessment of Metocean Forecast Data and Consensus Forecasting

*Ben Brushett[1] , Brian King[1] and Charles Lemckert[2]

[1]RPS APASA, [2]Griffith University

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Overview of Presentation

- Background
- Two drifter studies – Tasman Sea (2010) and Indian Ocean (2012)
- Four ocean models tested – based on three different ocean forecast models (BLUElink, FOAM, HYCOM, and NCOM)
- Consensus forecasting applied, combining all four ocean models

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Background

- The studies were undertaken as there are now several different ocean current forecast systems available in the Australian region

- It was deemed that an assessment of these models should take place to determine which may be the most reliable for maritime SAR and pollutant response (i.e. oil spills)

- Perhaps a combination of all four models (using consensus forecasting) may be a better approach?

- Used a particle trajectory model to predict the drift of drifters in the Tasman Sea and in the Indian Ocean

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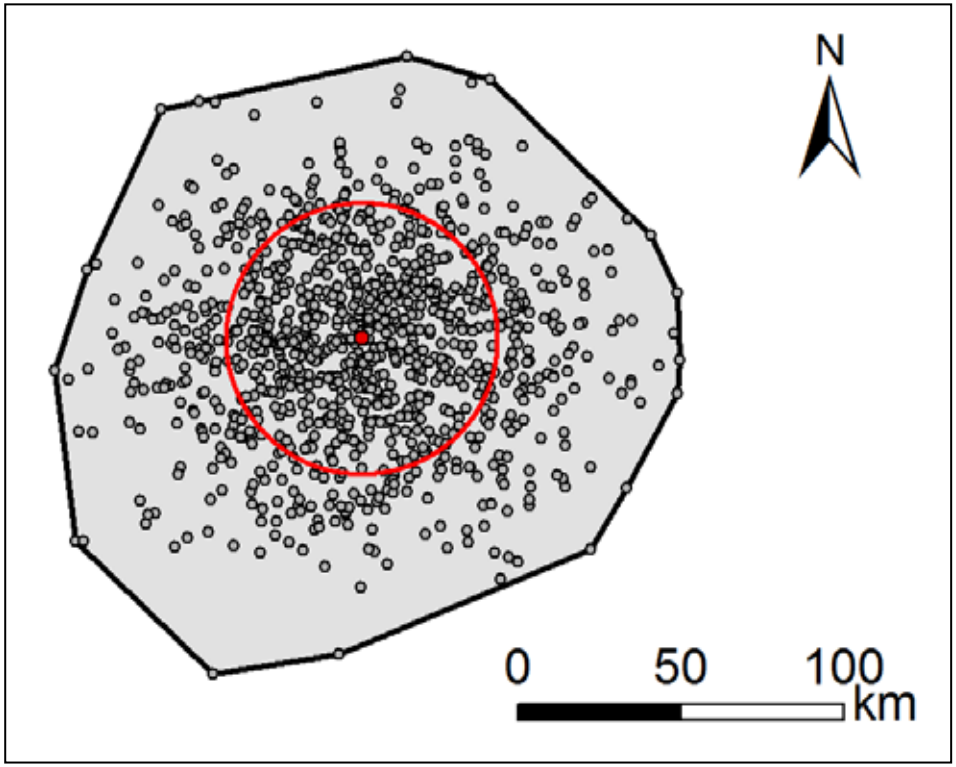
SARMAP and the COASTMAP EDS

- Drift modelling software – SARMAP
  - Lagrangian particle trajectory model
  - Uses large number of particles to simulate the potential trajectories and dispersion of drifting objects
  - Ocean current forecasts and wind forecasts from the COASTMAP EDS are used to provide environmental forcing to the model
  - Rather than focussing on any single ocean forecast – use as many forecast models as are available

SARMAP particle trajectory model

- The figure shows a sample output:
  - 1,000 particles
  - Convex hull surrounding all particles
  - Centroid of particles



Model Settings

Parameter	Tasman Sea Study	Indian Ocean Study
Model Simulation Time:	120 Hours	120 Hours
Initial Position Error:	0.5 Nm	0.5 Nm
Search Object	SVP and SVP-L	SVP
Leeway Speed	0.1% and 1%	0.1%
Divergence Angle	0°	0°
Wind Forcing:	GFS	GFS
Current Forcing:	BLUElink, FOAM, HYCOM, NCOM	BLUElink, FOAM, HYCOM, NCOM
Model Time Step (dt):	10 Minutes	10 Minutes
Model Output Frequency:	60 Minutes	60 Minutes
Number of Model Particles:	1,000	1,000

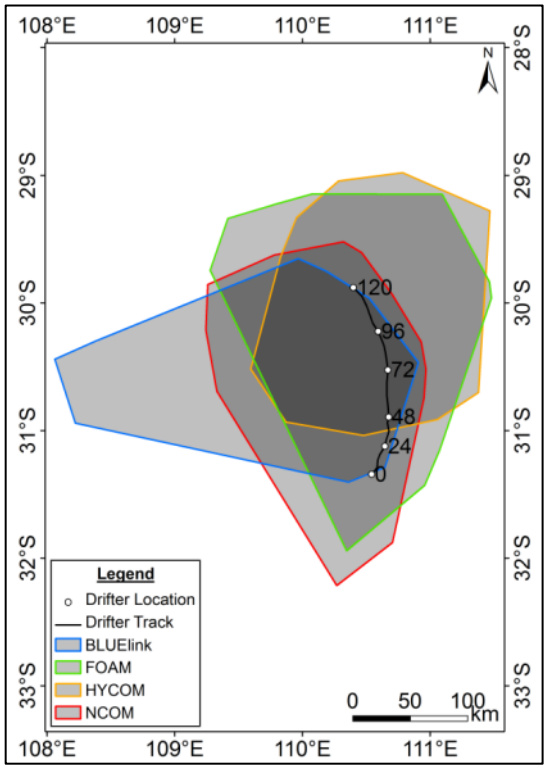
Metocean Datasets

Model Name	Horizontal Resolution	Vertical Coordinate	Temporal Resolution	Grid Limits [Higher Resolution]
BLUElink	1/10° (11.1 km)	47 *z* levels	24 hr	Global [16°N - 75°S, 90°E - 180°E]
FOAM	1/6° (18.5 km)	50 *z* levels	24 hr	Global [0°N - 60°S, 100°E - 77°W]
HYCOM	1/12° (9.3 km)	32 Isopycnal/*σ*/*z*	24 hr	Global
NCOM	1/8° (13.9 km)	40 *σ*/*z* level	6 hr	Global
GFS	1/2° (55.6 km)	64 *σ* levels	6hr	Global

What is Consensus Forecasting?

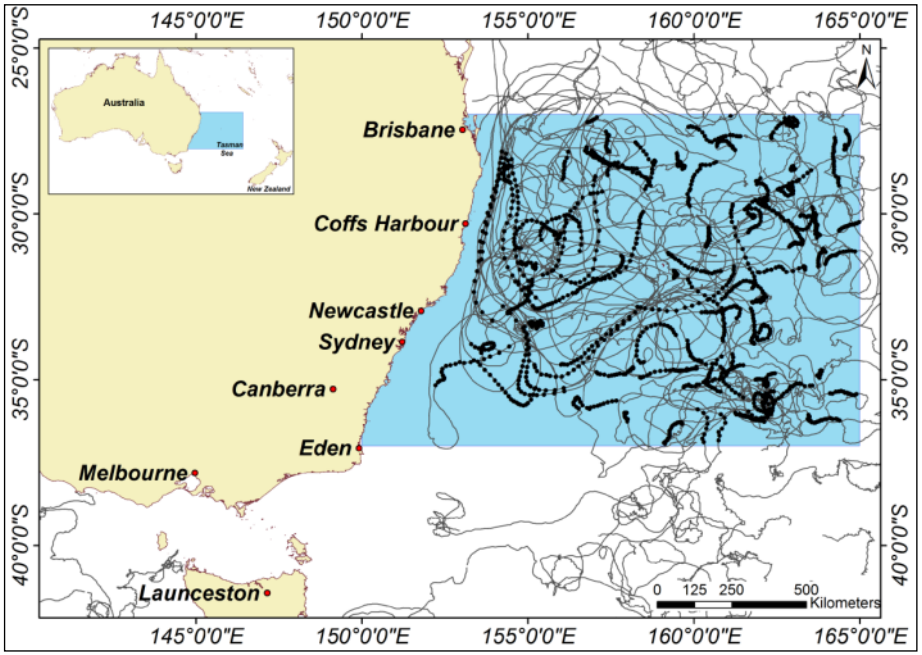
- Consensus forecasting is the addition or combination of several individual forecasts to a single multi-model forecast

- *Using 'consensus' as the basis for a decision emanates from the notion that the cumulative knowledge of all concerned individuals is greater than that of a single individual.*
  Fritsch, et al. (2000)

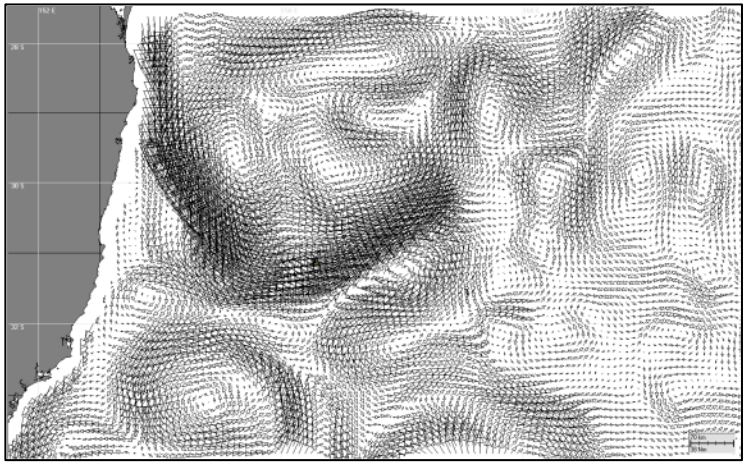


Tasman Sea Drifter Study

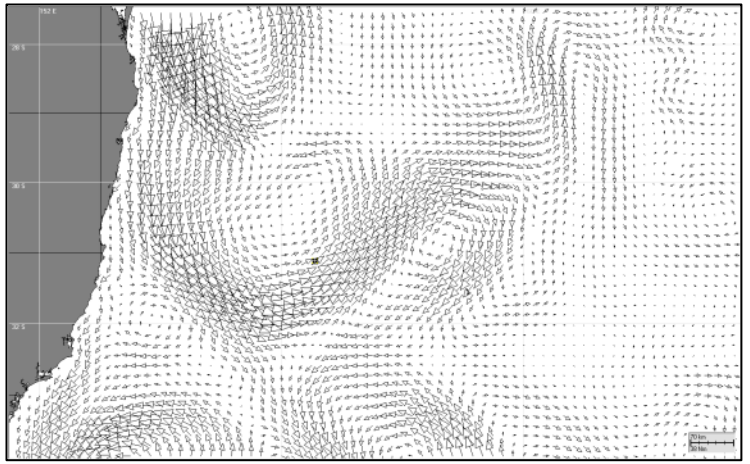
- January to December 2010
- 63 x 5-day SVP/SVP-L drifter tracks
- Four different ocean models
- Error analysis including:
  - Mean Absolute Error (MAE) in km
  - Hit rate analysis



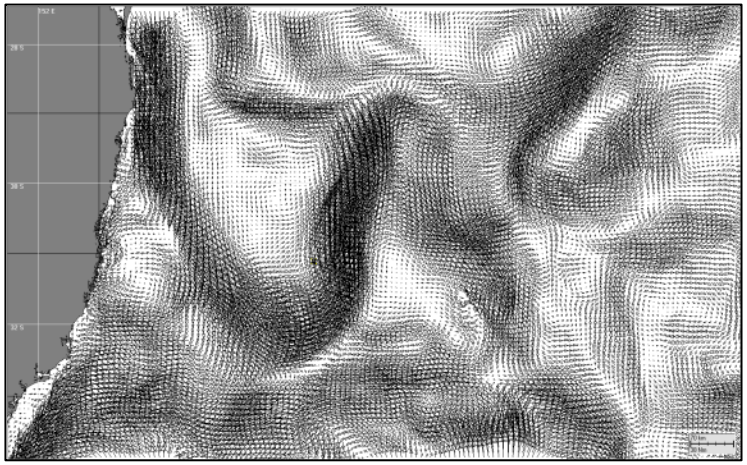
Tasman Sea Currents



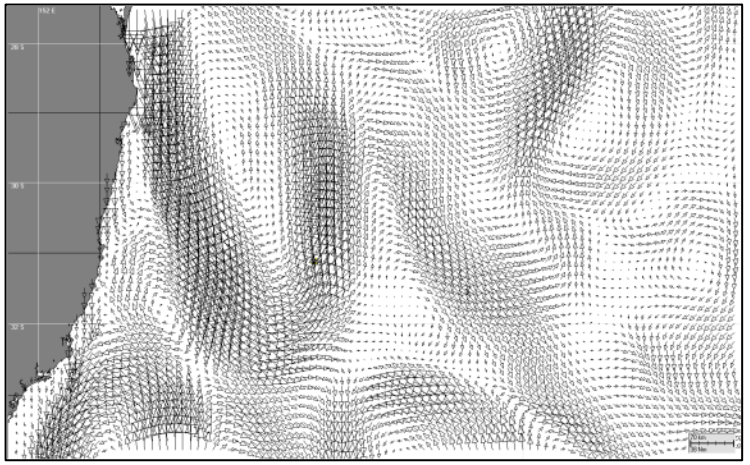
BLUElink



FOAM



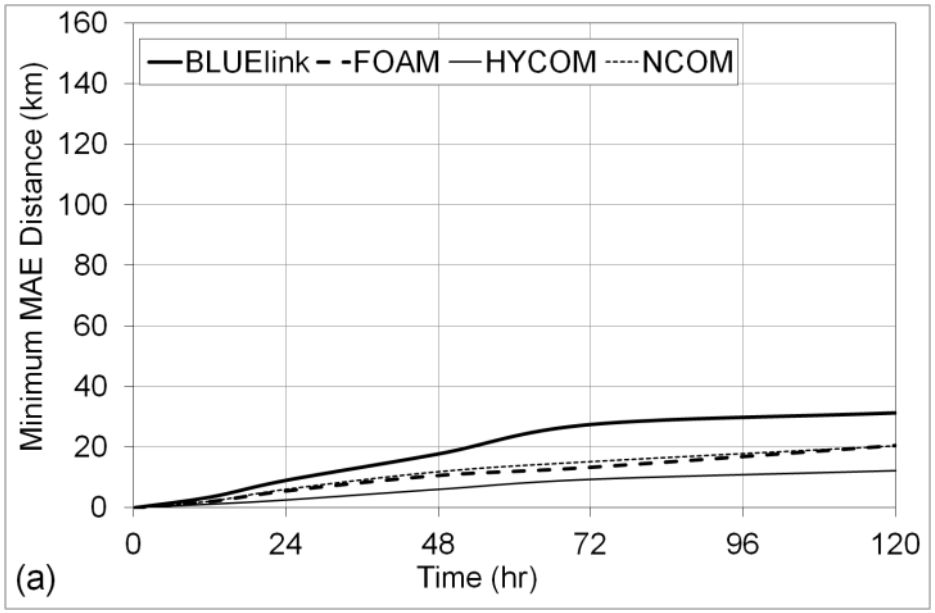
HYCOM

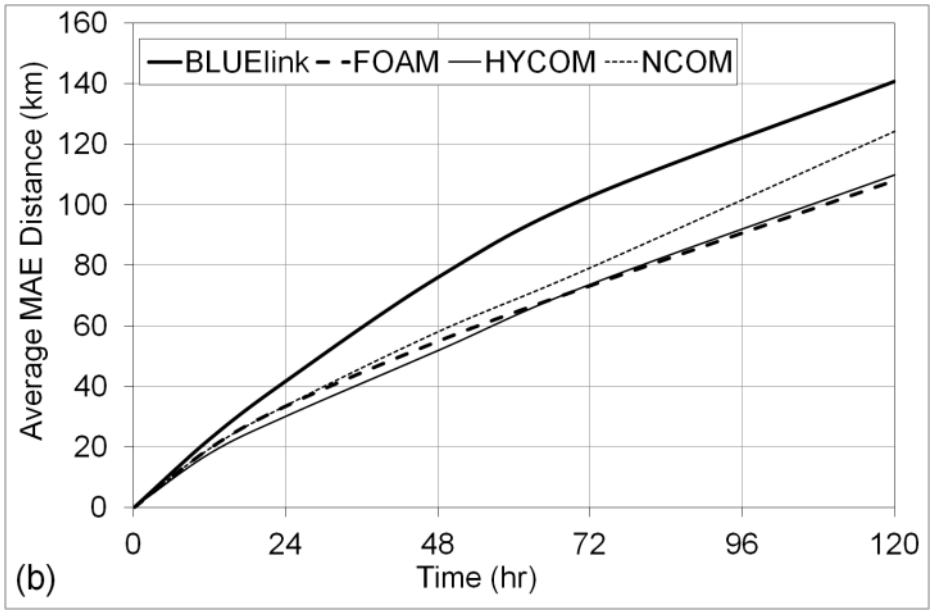


NCOM

Tasman Sea Drifter Study

§ Mean Absolute Error (MAE) – Minimum and Average





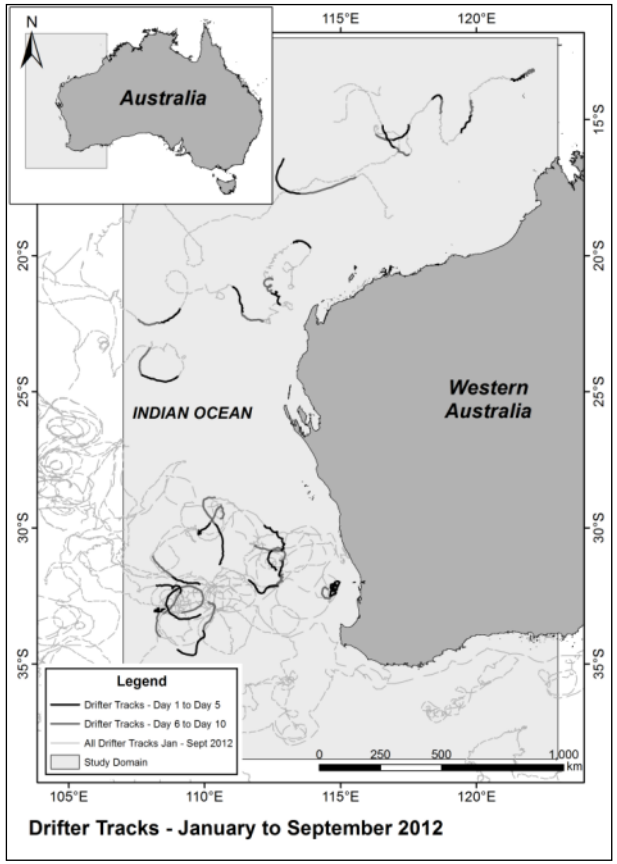
Tasman Sea Drifter Study

- Hit rate at 24 hours and 120 hours

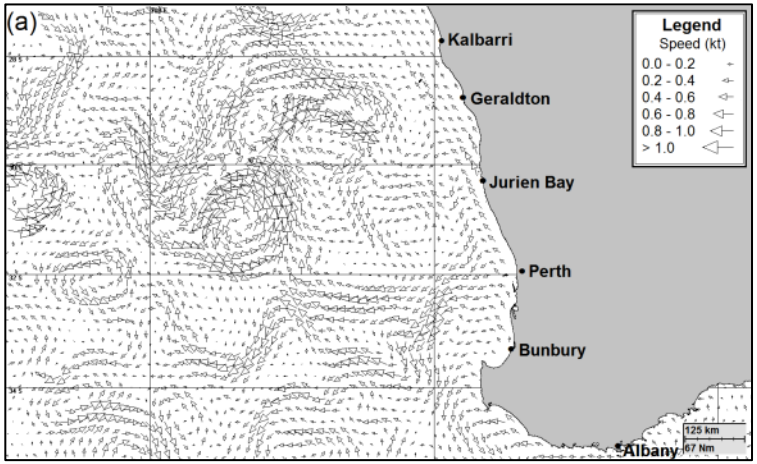
	24 hours Hit Rate	120 hours Hit Rate
BLUElink	73.0%	68.3%
FOAM	74.6%	63.5%
HYCOM	88.9%	82.5%
NCOM	79.4%	77.8%
2+ Consensus	84.1%	84.1%
3+ Consensus	76.2%	69.8%
4 Consensus	61.9%	42.9%

Indian Ocean Drifter Study

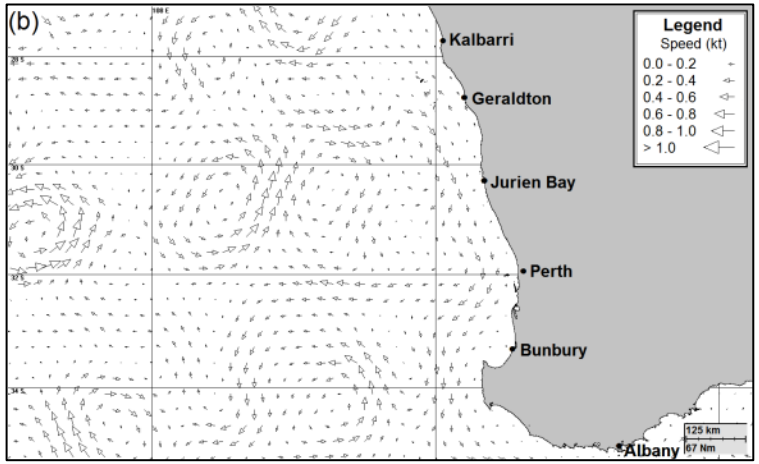
- January to September 2012
- 45 x 5-day SVP drifter tracks
- Four different ocean models
- Error analysis including:
  - Mean Absolute Error (MAE) in km
  - Hit rate analysis
  - Search area size comparison
  - Drift length comparison



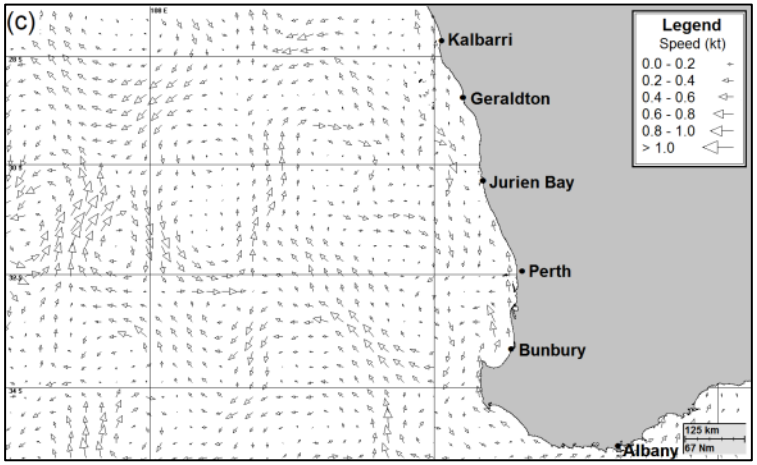
Indian Ocean Currents



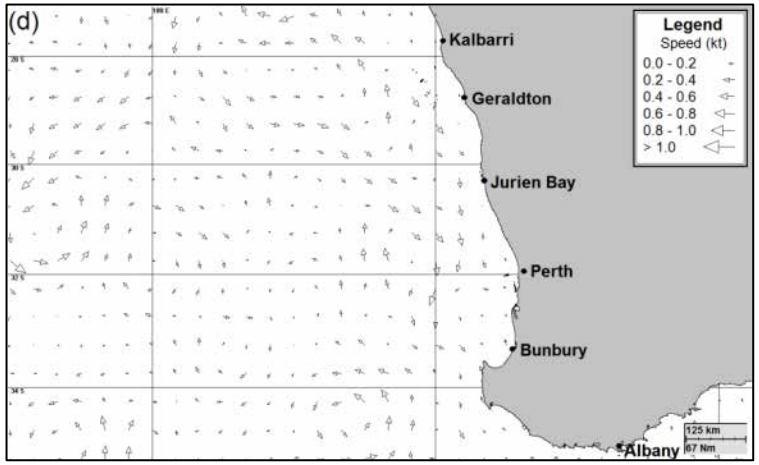
BLUElink



FOAM



HYCOM



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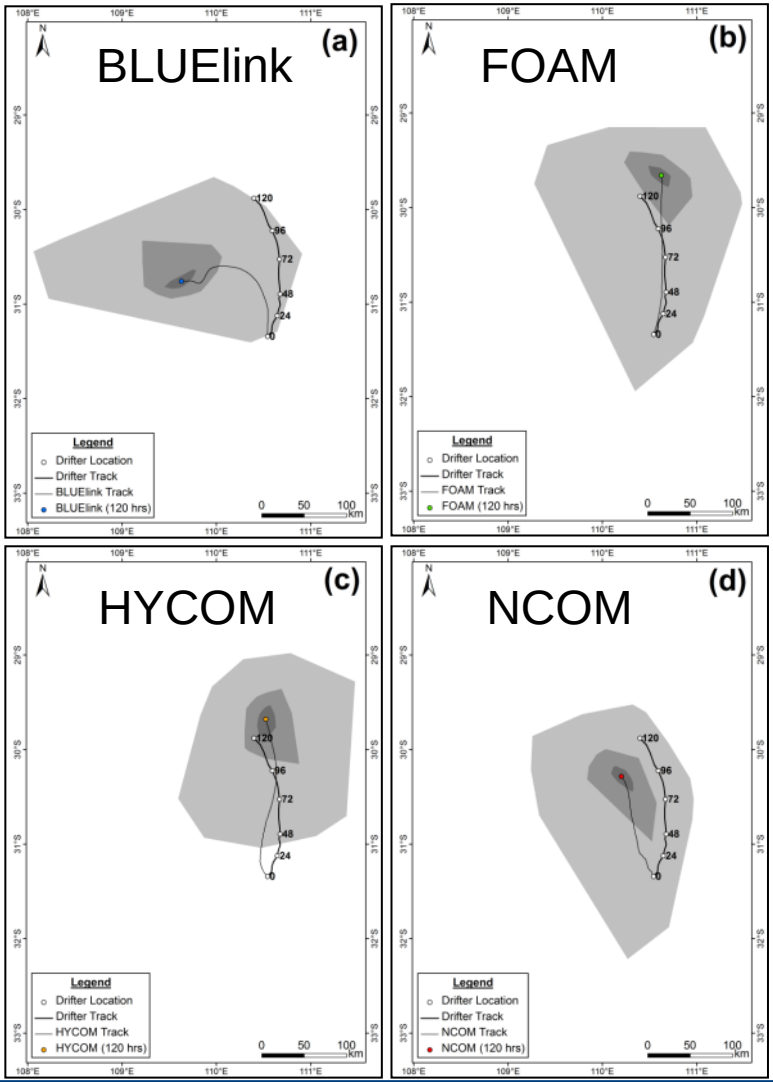
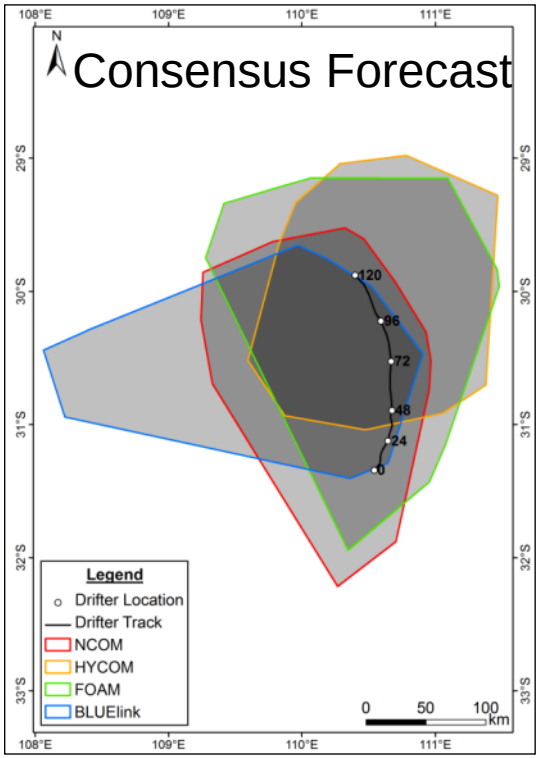
Indian Ocean Drifter Study





Indian Ocean Drifter Study

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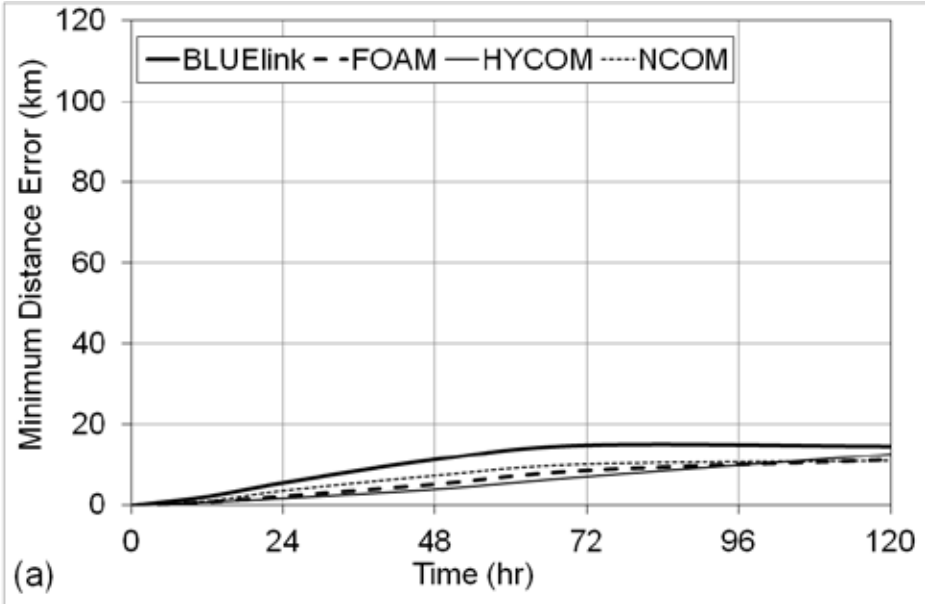
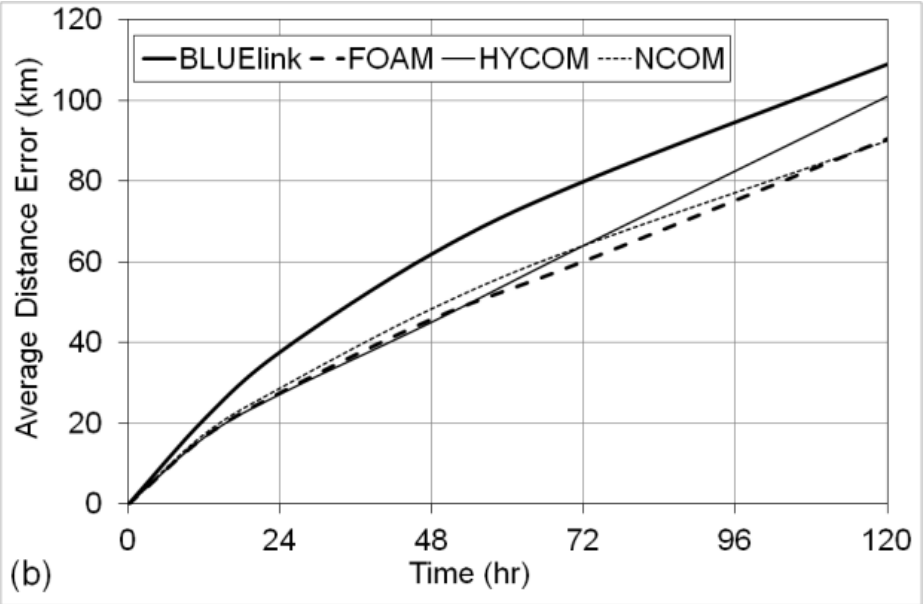




Indian Ocean Drifter Study

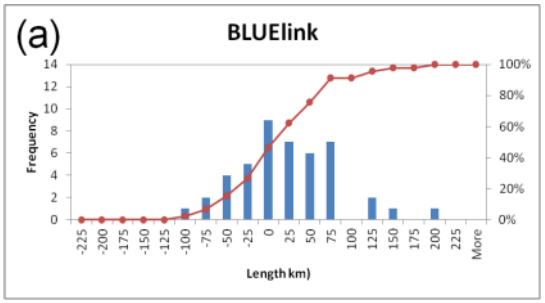
§ Hit rate and Search Area Size at 24 hours and 120 hours

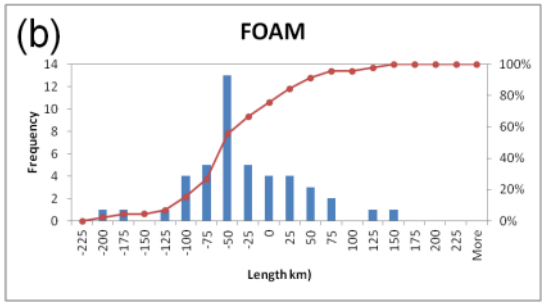
	24 hours		120 hours	
	Hit Rate	Search Area (km^2)	Hit Rate	Search Area (km^2)
BLUElink	84.4%	5,568	64.4%	36,966
FOAM	88.9%	5,396	80.0%	32,491
HYCOM	93.3%	4,936	71.1%	35,945
NCOM	84.4%	5,439	80.0%	31,541
2+ Consensus	95.6%	5,880	88.9%	38,083
3+ Consensus	86.7%	4,188	73.3%	23,803
4 Consensus	68.9%	2,400	37.8%	10,174

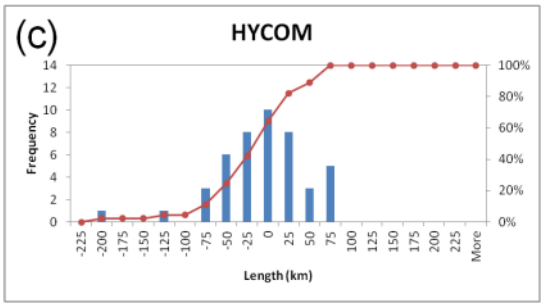
Indian Ocean Drifter Study

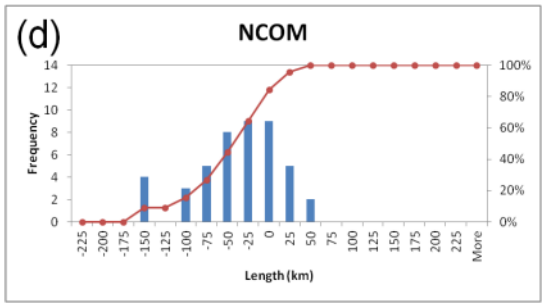
§ Drift Length

120 hours	Length (km) [%]
	Average
SVP Drifter	134.7
BLUElink	144.3 [+7.2%]
FOAM	91.4 [-32.1%]
HYCOM	116.0 [-13.8%]
NCOM	84.2 [-37.5%]









Conclusions

- Good result from all four models and the results indicate that all four models performed adequately
- Several models are required for consensus forecasting to work
- Further work may be required in terms of developing other metrics for model evaluation
- Continuous evaluation is essential as models evolve
- Drift comparisons of the forecast currents with drifters is very important in terms of operational oceanography and the application of the use of ocean currents for forecasting the drift of persons, craft, objects, or oil at sea.

Future works

- Undertake further drift studies with SLDMB drifters where possible.
- Undertake comparisons with
  - The BLUElink ensemble averaged surface velocity layer, compared with the present use of BLUElink
  - New BLUElink coming out later this year
  - The latest versions of HYCOM-NCEP and HYCOM-NAVY, and the latest version of UK FOAM.
  - Further investigate and refine the Consensus Forecast methodology

Thank You

- Thank you for your attention throughout this presentation