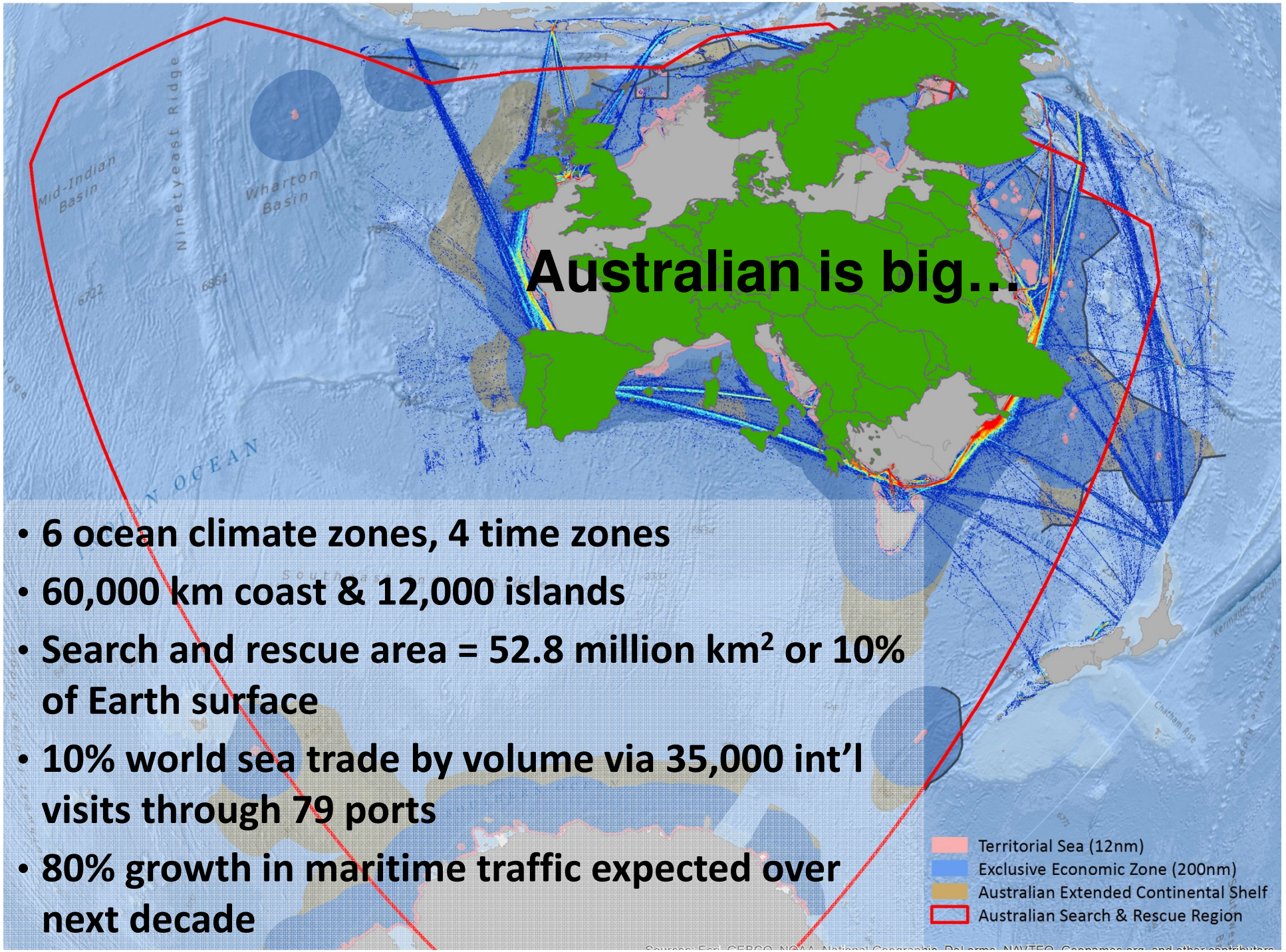
Australian Government
Australian Maritime Safety Authority

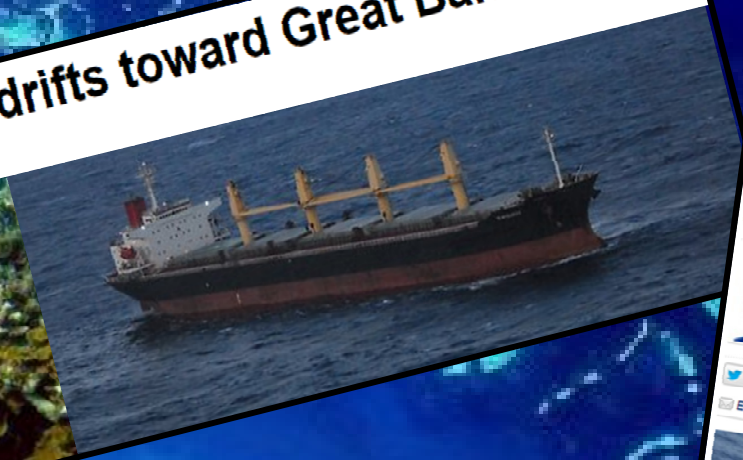
Simulating large vessel drift

Jillian Carson-Jackson,
Manager, Maritime Communications and Vessel Tracking,
Australian Maritime Safety Authority


Australian is big…
• 6 ocean climate zones, 4 time zones
• 60,000 km coast & 12,000 islands
• Search and rescue area = 52.8 million km² or 10% of Earth surface
• 10% world sea trade by volume via 35,000 int'l visits through 79 ports
• 80% growth in maritime traffic expected over next decade
Territorial Sea (12nm)
Exclusive Economic Zone (200nm)
Australian Extended Continental Shelf
Australian Search & Rescue Region
Mid-Indian Basin
Ninetyeast Ridge
Wharton Basin
Chatham Rise

Troubled freighter drifts toward Great Barrier Reef

May 19, 2012



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Cargo ship towed away from Great Barrier Reef after engine breaks down

January 13, 2015

Natalie Bochenski
Reporter
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police craft Lyle M Hoey sits alongside the cargo ship Thor Commander after its main engine broke down.
: AMSA

Image credit: Andrea Innes

SHIP DRIFTING NEAR REEF POINTS TO FUTURE, GROUPS SAY

Tue 13 January 2015

Daily Mercury

NEWS & MEDIA

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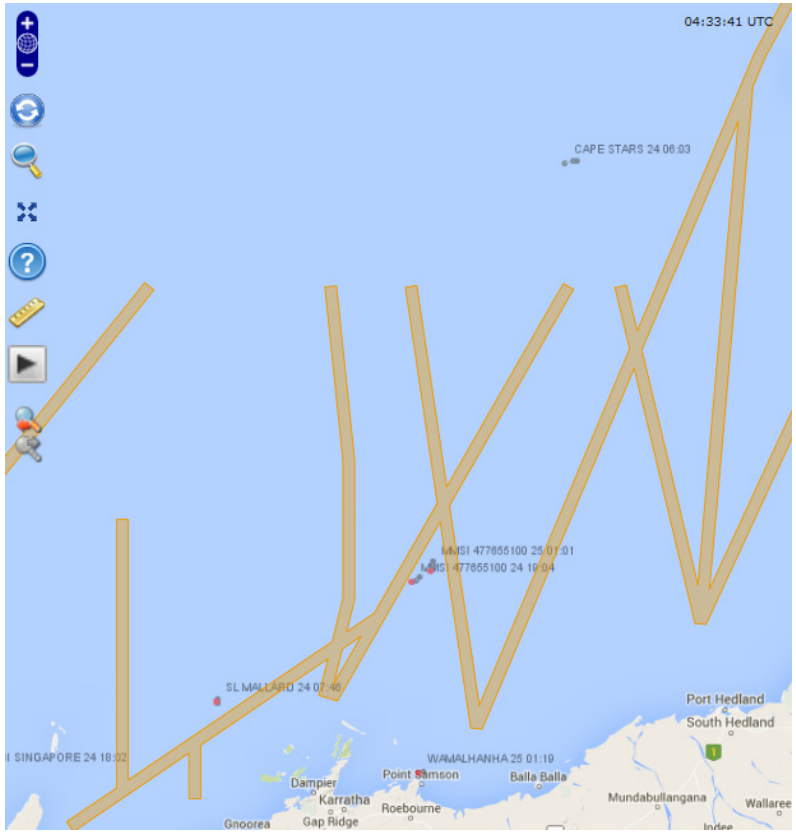
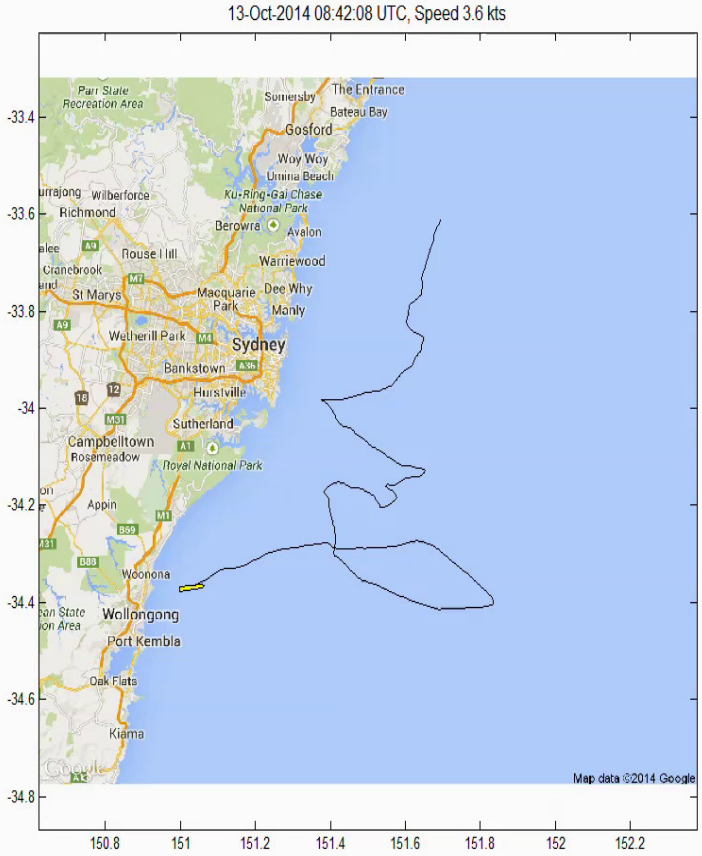
Simulating large vessel drift

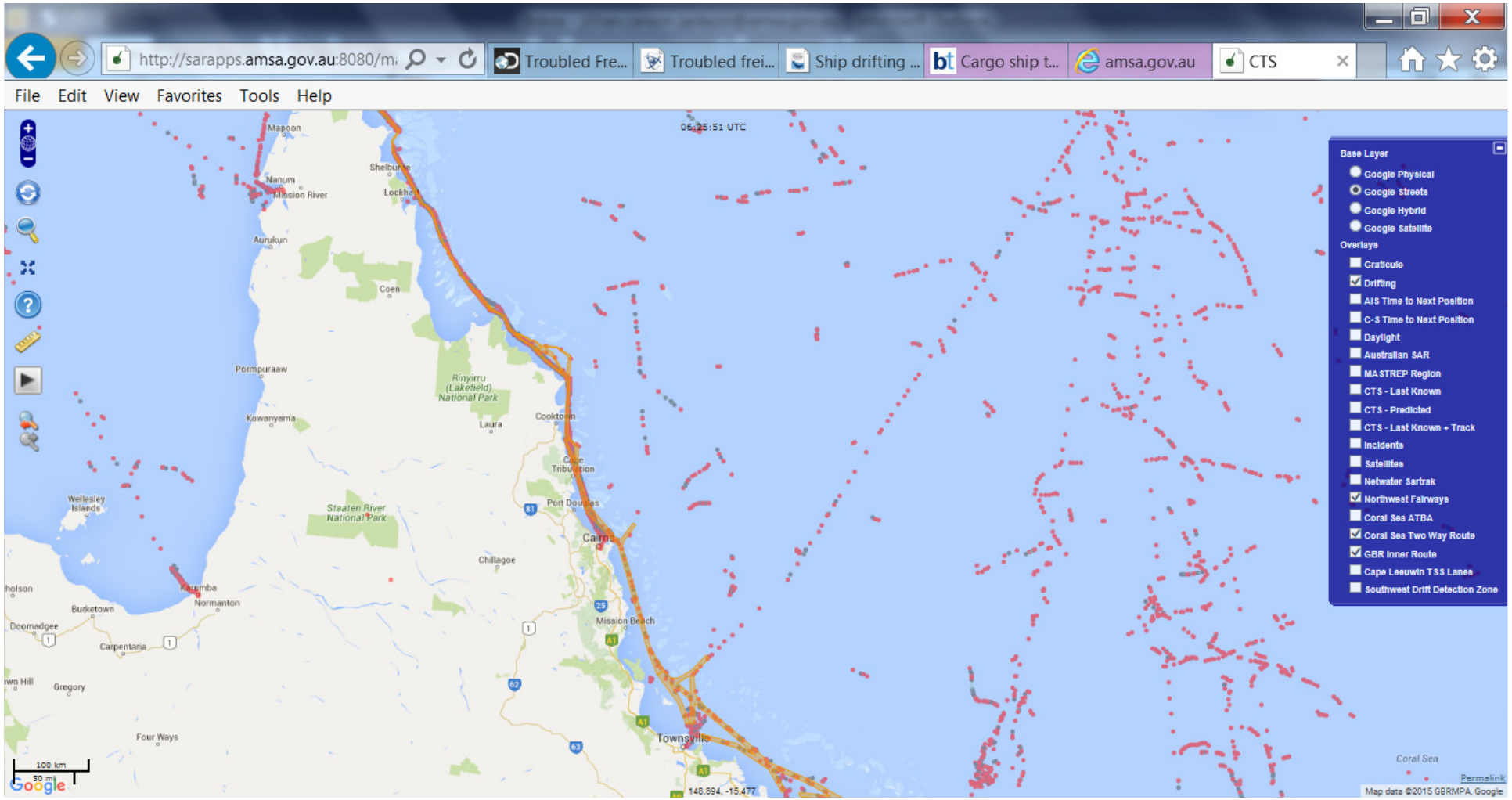


Is a vessel drifting?

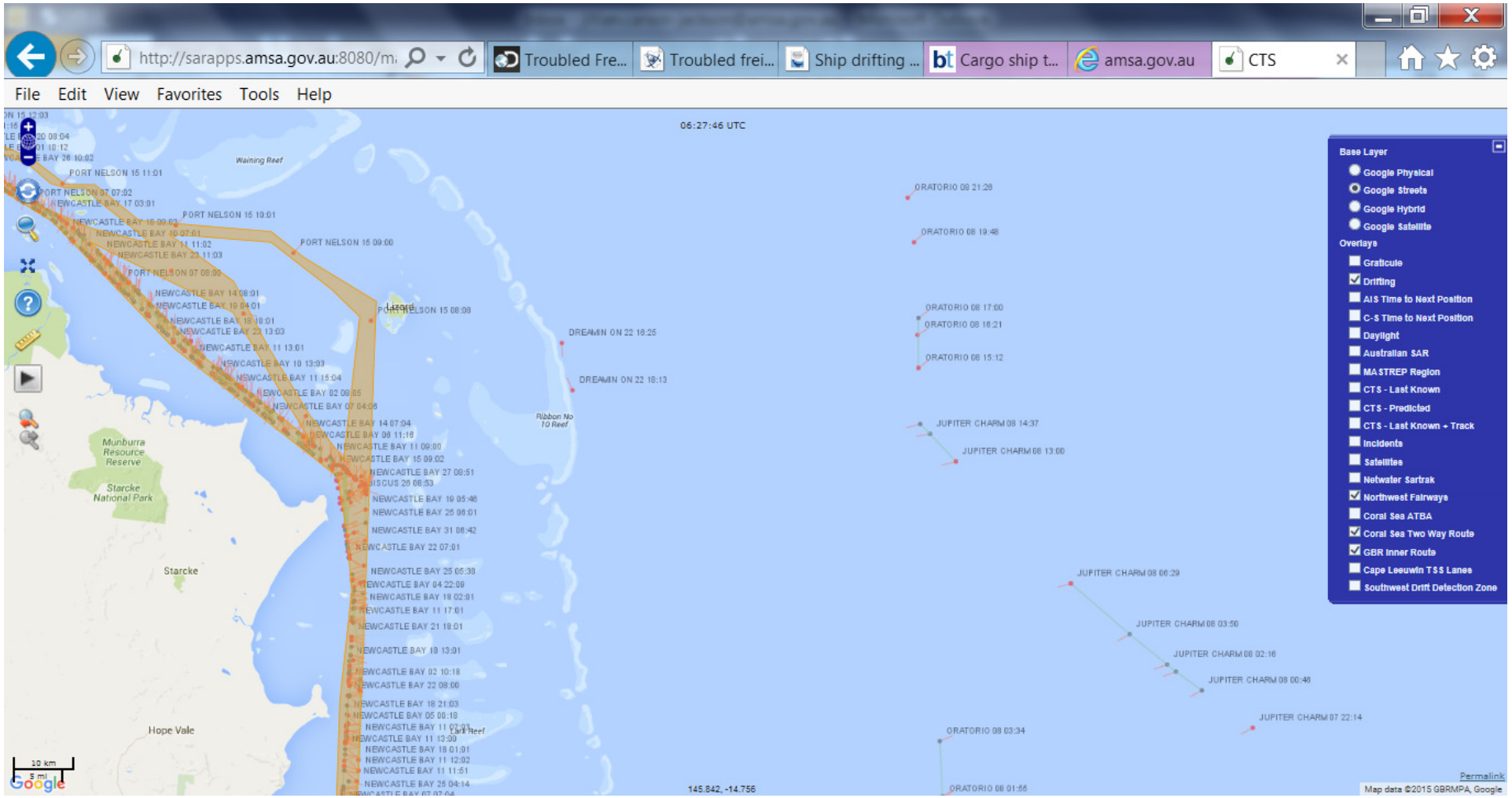


If so, where might it go?

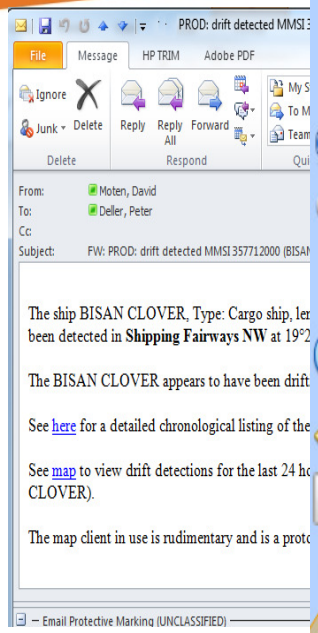
Drift Candidates - Detecting possible drift vessel



Drift Candidates - Detecting possible drift vessel

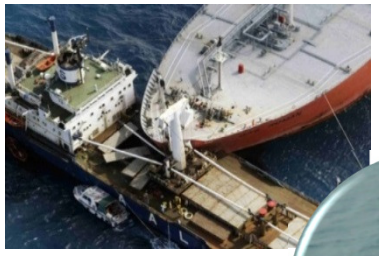


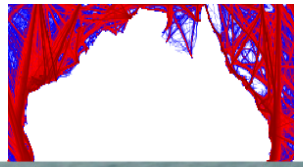
Abnormal behaviour - Drift Alerts

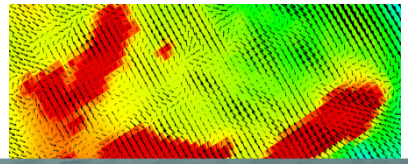


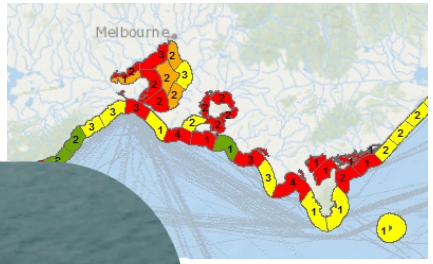
Heading	Difference	Speed (knots)	Regions
171.0	45	1.9	
165.0	46	1.7	
167.0	81	0.3	
178.0	119	0.6	
179.0	103	1.0	
139.0	100	0.7	
120.0	70	0.3	
122.0	45	0.3	
5.0	315	3.0	
128.0	99	0.7	
146.0	47	0.4	
141.0	63	0.3	
273.0	45	2.0	Shipping Fairways NW
284.0	53	1.6	Shipping Fairways NW
294.0	62	1.2	Shipping Fairways NW
303.0	73	0.9	Shipping Fairways NW
310.0	86	0.6	Shipping Fairways NW
317.0	106	0.4	Shipping Fairways NW

Conceptual framework - multi-layered risk estimation





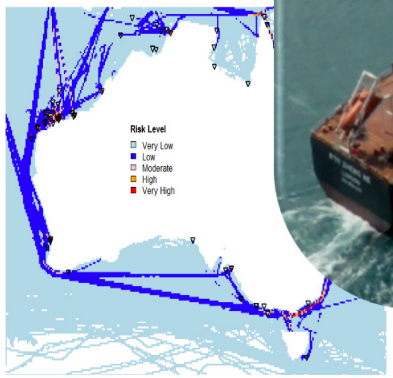




Layer 1 (2011):
Ship specific risk
(proxy for safety qualit

3):
(economic,
al, ecological)

Total Risk Ex
Protect: proper



- oil on water
- oil on coast

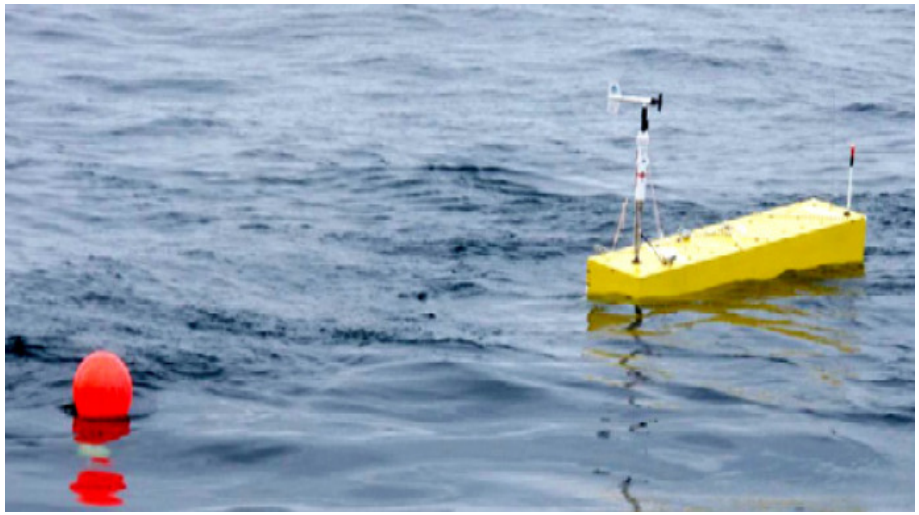
4/15): Effects of
options (RCO):
- al aids
- vigation
- fic services
- clearance
- y response
- s and audits
- preparedness
- general surveillance
- Pilotage
- Other

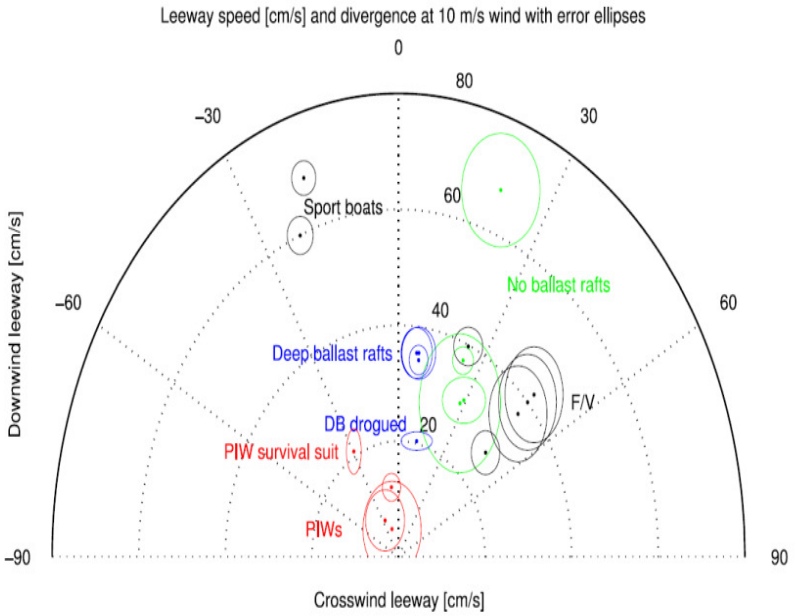
(Acceptable) residual risk

Numerical Model to Simulate Drift Trajectories of Large Vessels

Simon Mortensen, HoD Marine DHI Australia

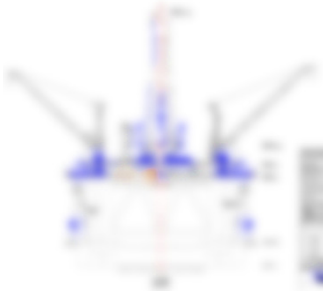
Limitations of Existing Approach

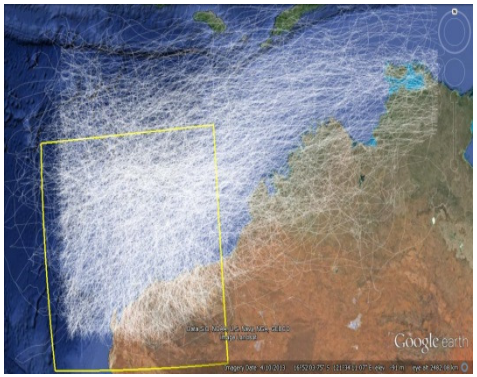




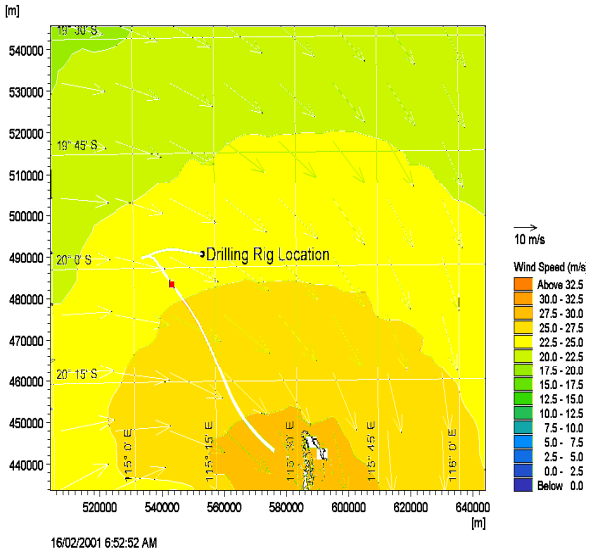
- Wind induced drift calculated stochastically based on a discrete number of controlled field drift experiments
- Derived model parameters designed for persons / small crafts
- No direct evaluation of vessel leeway drift
- Wave induced drift forces are either not included or simplified (wind related)
- Full 3D hull representation is not included in response assessment

Treatment of Incident Forces Separately

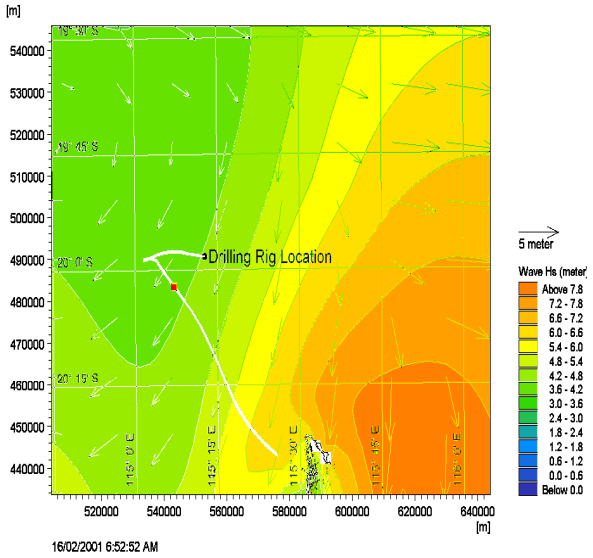




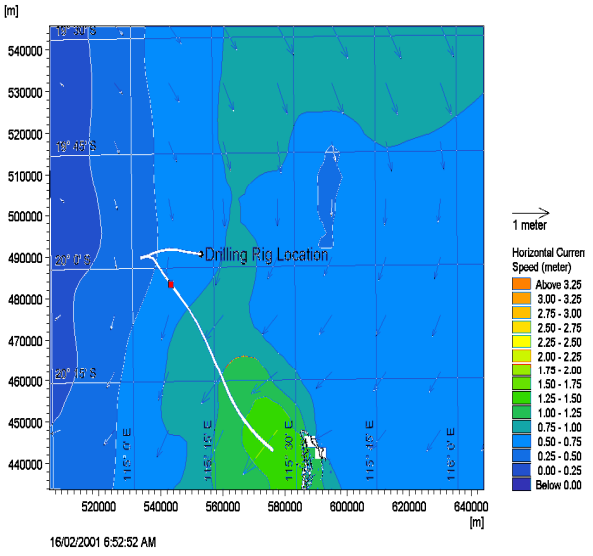
Wind Field



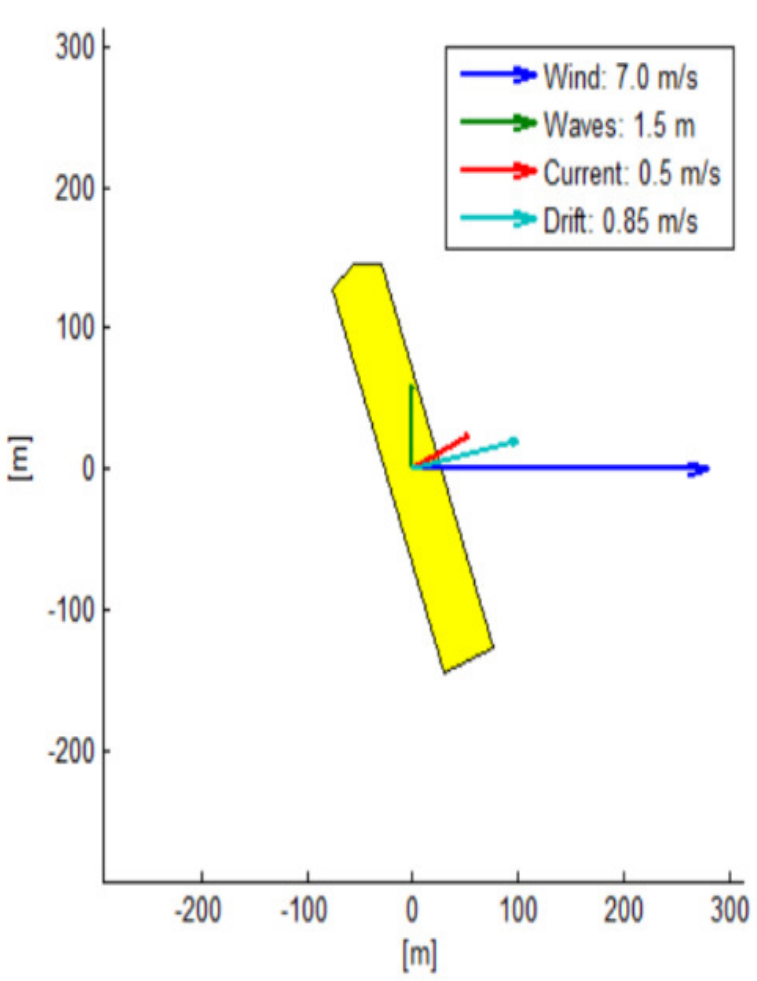
Wave Field

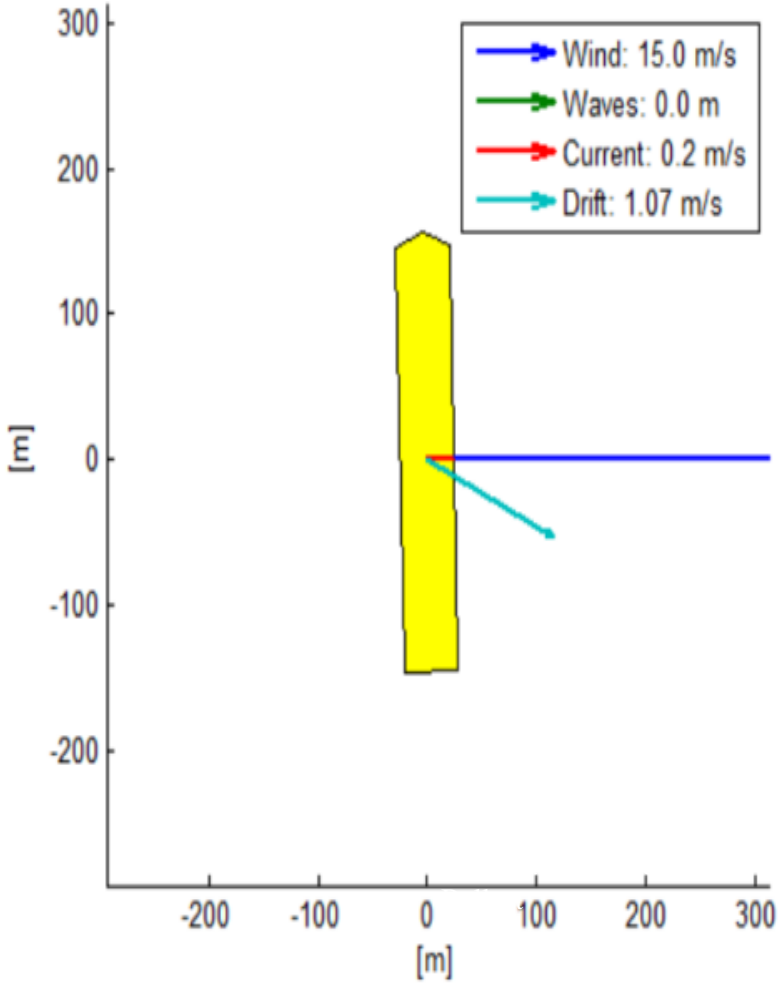


Current Field



Treatment of Incident Forces Separately

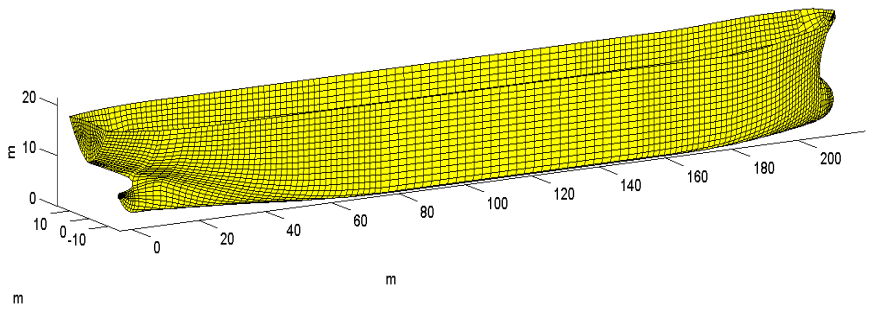


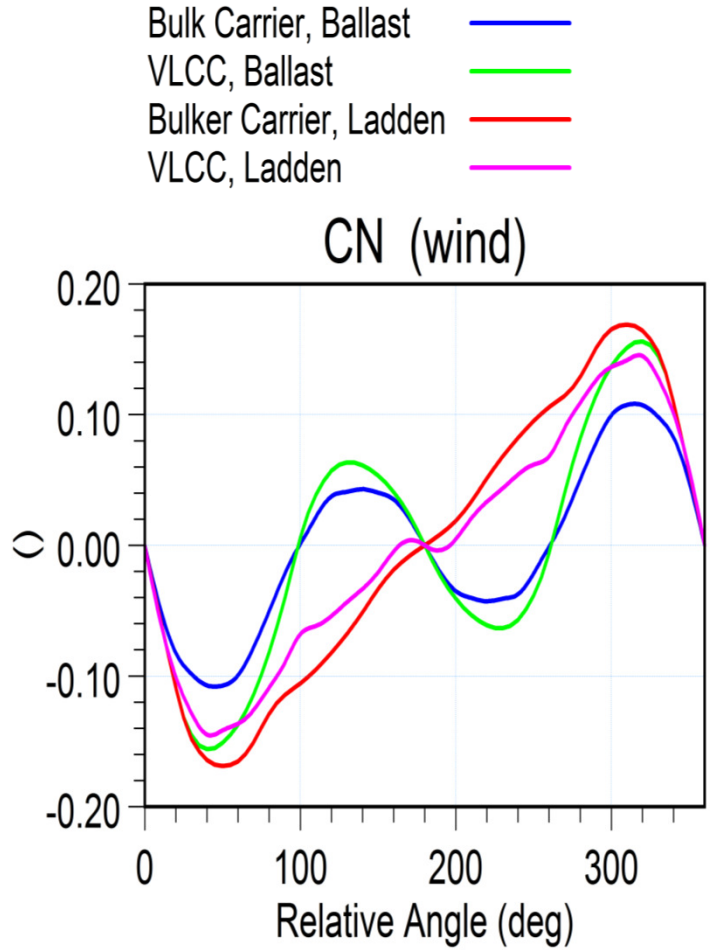


Physical Response of Real Vessels

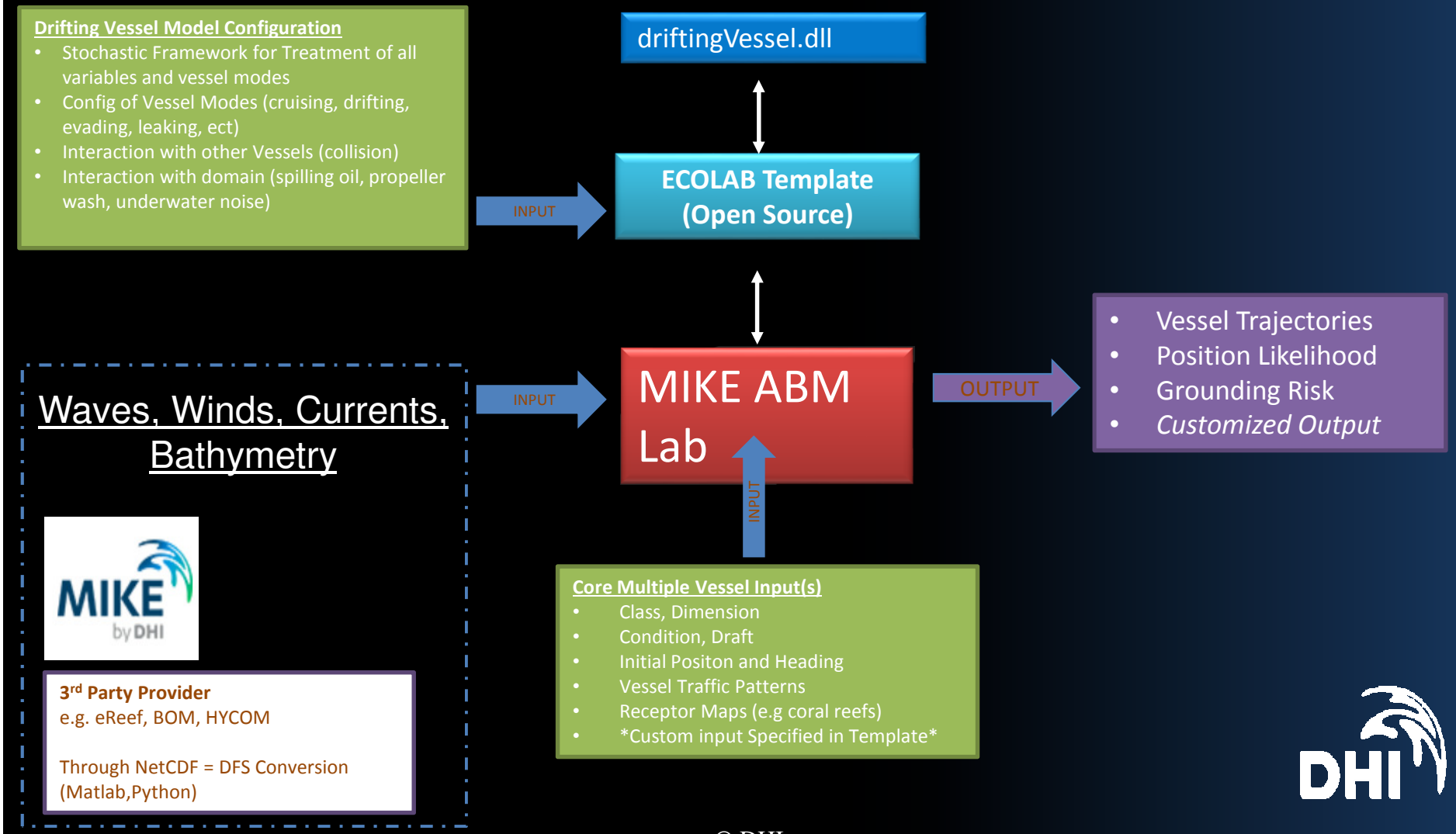
Response depends on:

- Vessel Class
- Vessel Dimension
- Vessel Draft
- Loading Condition
- Water Depth
- Incident Wave Spectrum
- Relative Vessel Orientation
- Vessel Speed



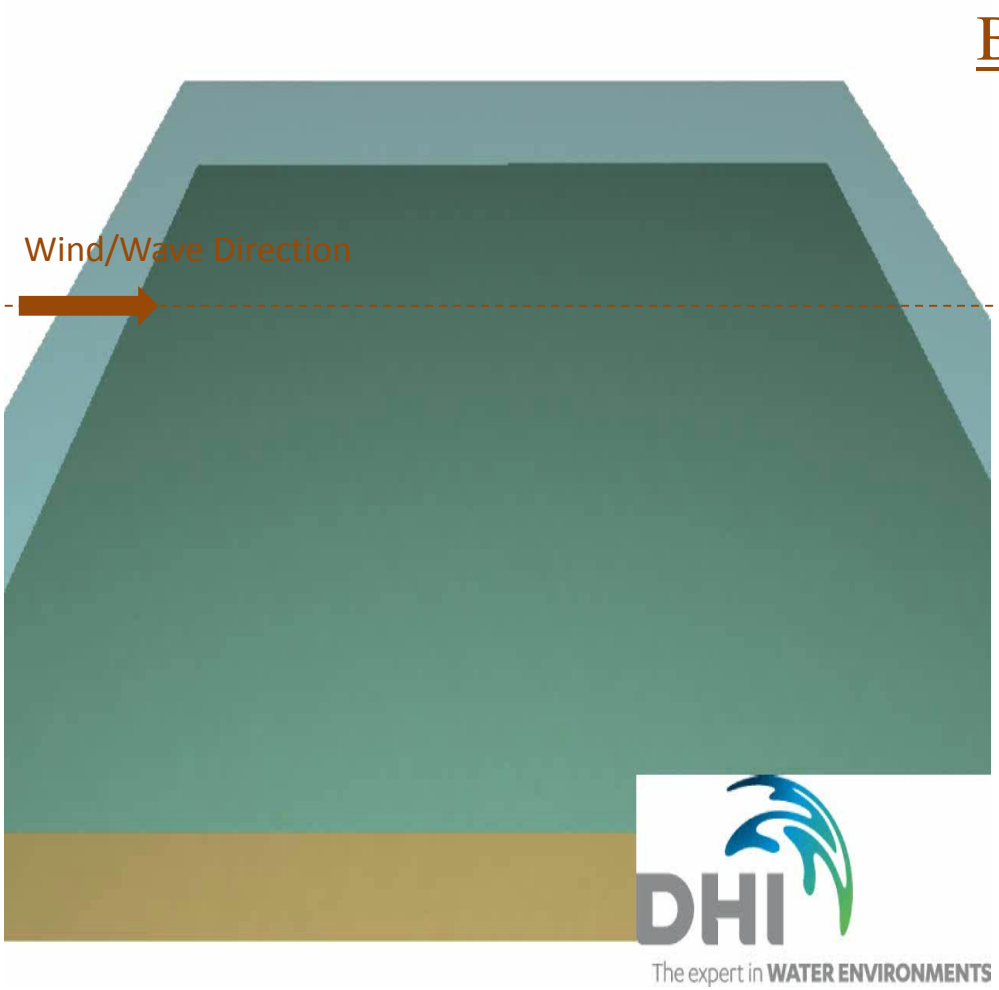


MIKE by DHI Integration



Introducing The Hockey Puck Test

Initial Vessel Heading:
0° North



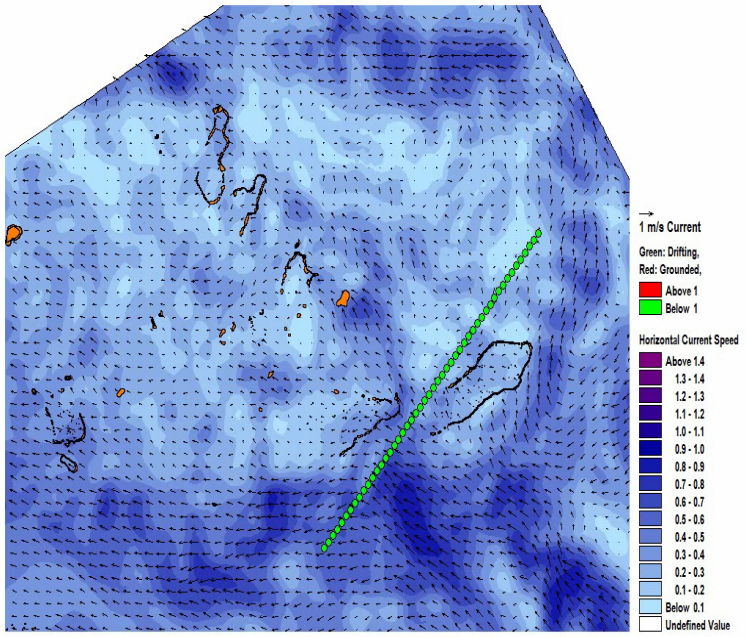
Bulk Carrier, Ballast

- No Wind, Hs: 2m, Tp: 6s, West
- No Wind, Hs: 2m, Tp: 10s, West
- No Wind, Hs: 5m, Tp: 10s, West
- 10 m/s West, no Waves
- 20 m/s West, no Waves

VLCC

- 10 m/s West, no Waves, ballast

Strategic Grounding Risk – 3 year dataset

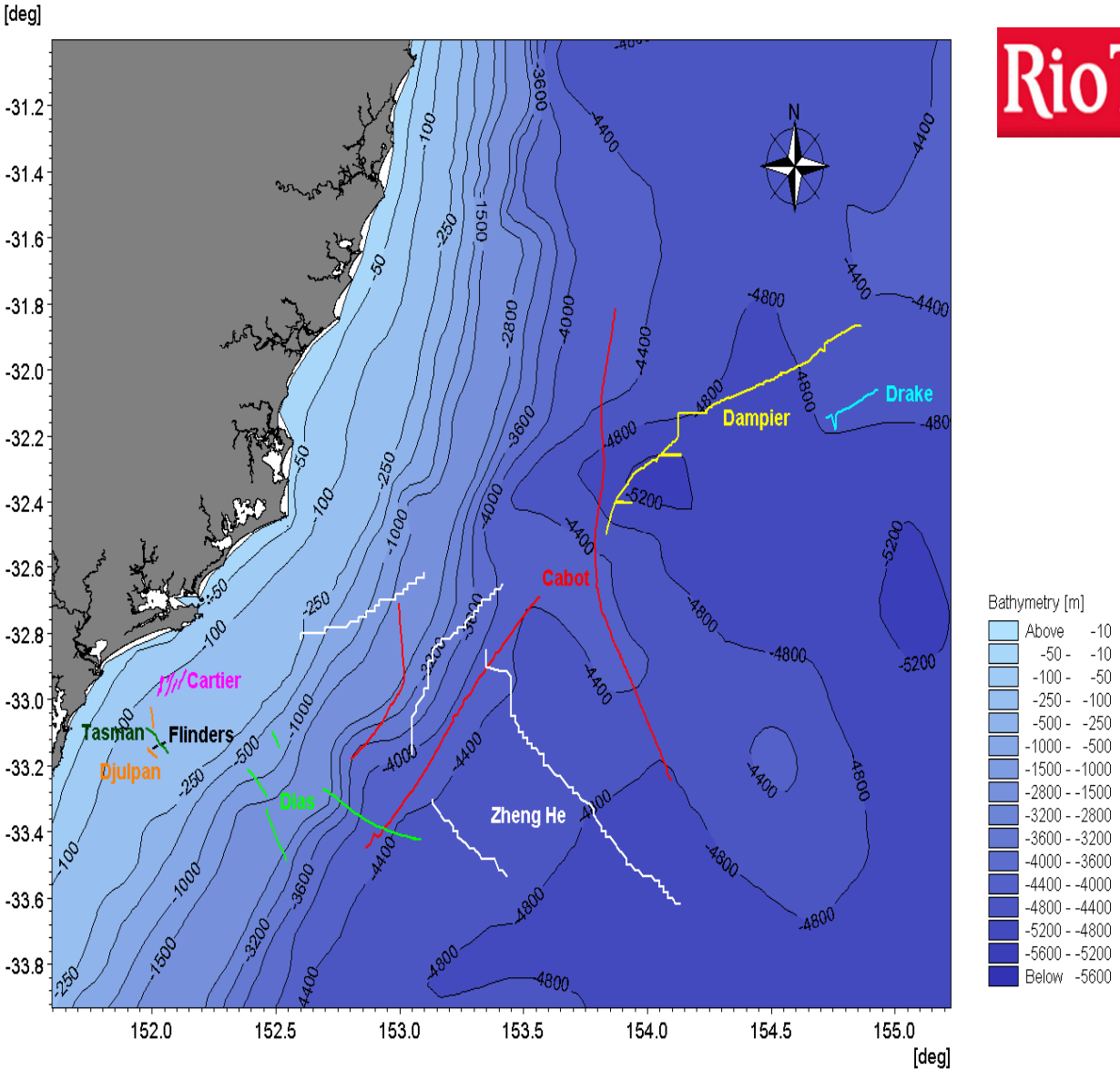


OZSEA

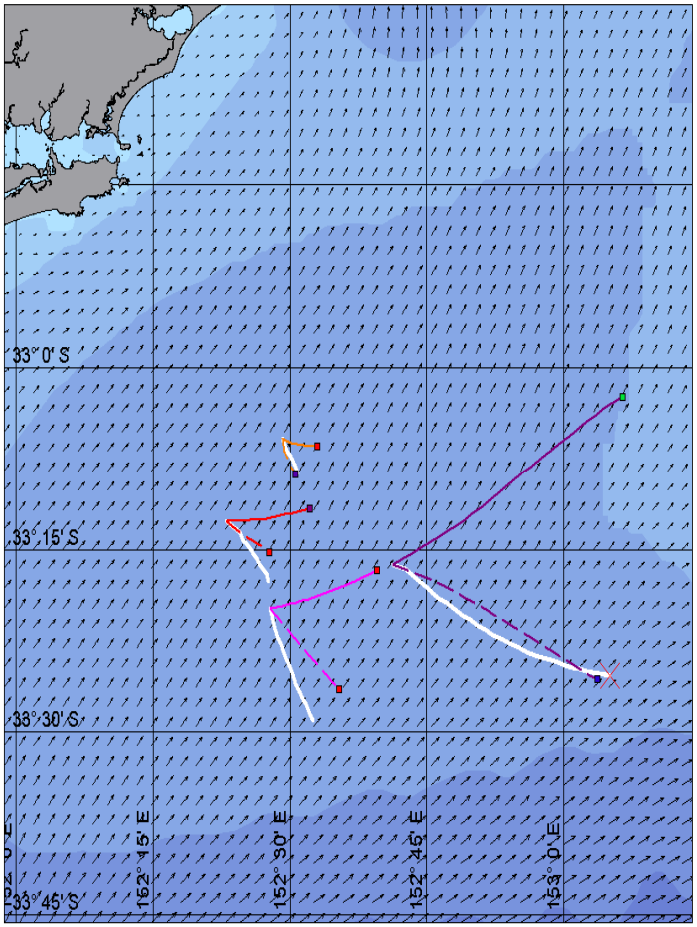
By DHI

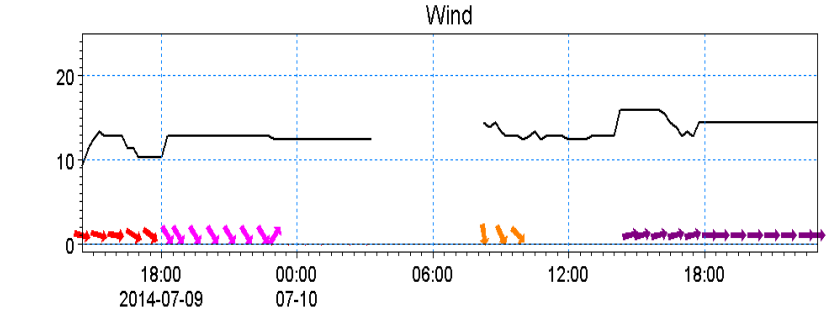
eReefs

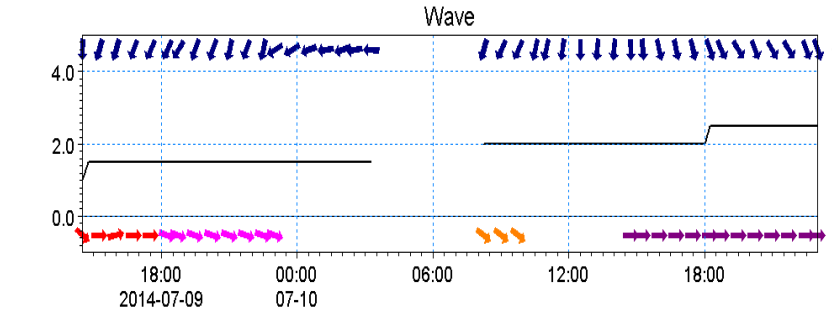
Validating vessel drift

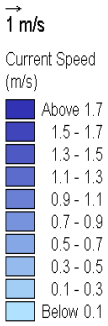


Vessel: RTM Dias







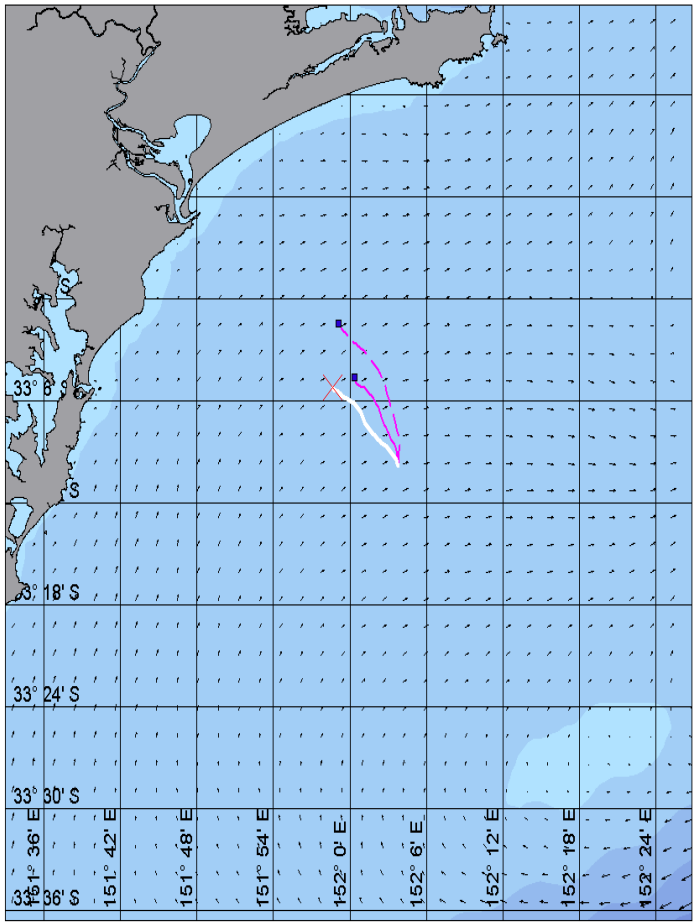


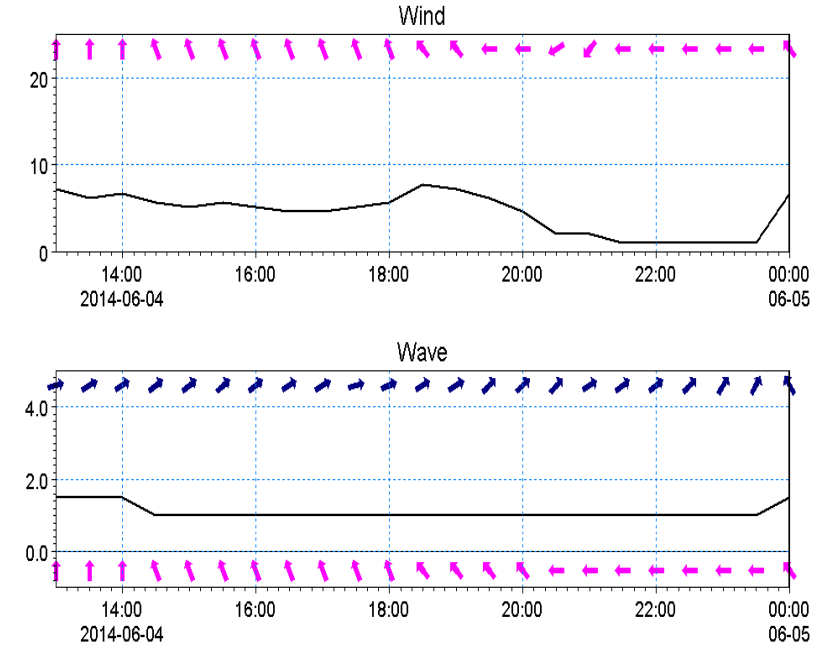
Solid line: Netwater.
Dash line: HYCOM

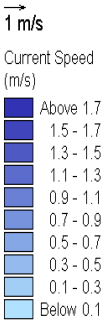
11/07/2014 4:45:00 PM

Rio Tinto

Vessel: RTM Tasman





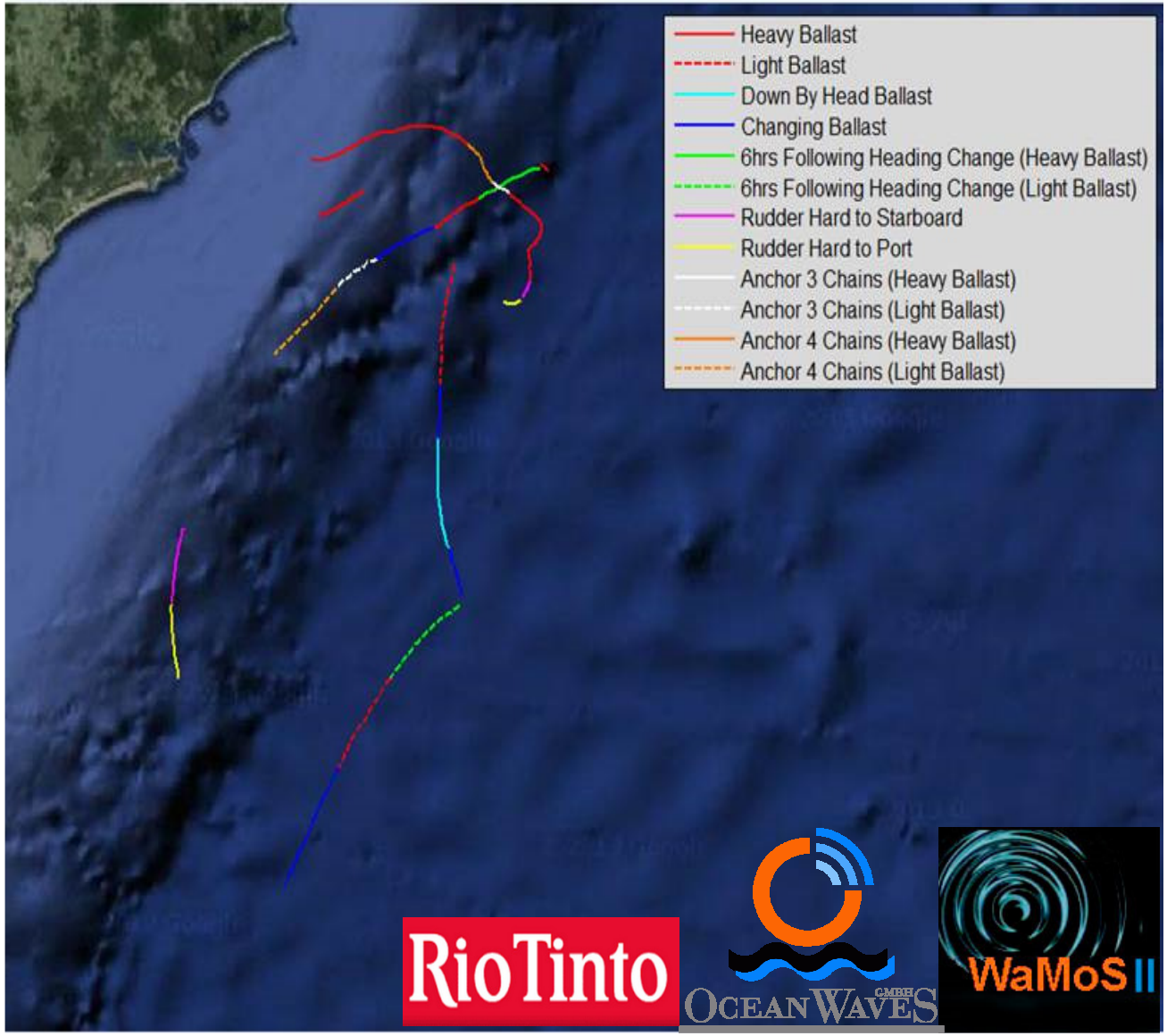


Solid line: Netwater.
Dash line: HYCOM

5/06/2014 00:00:00

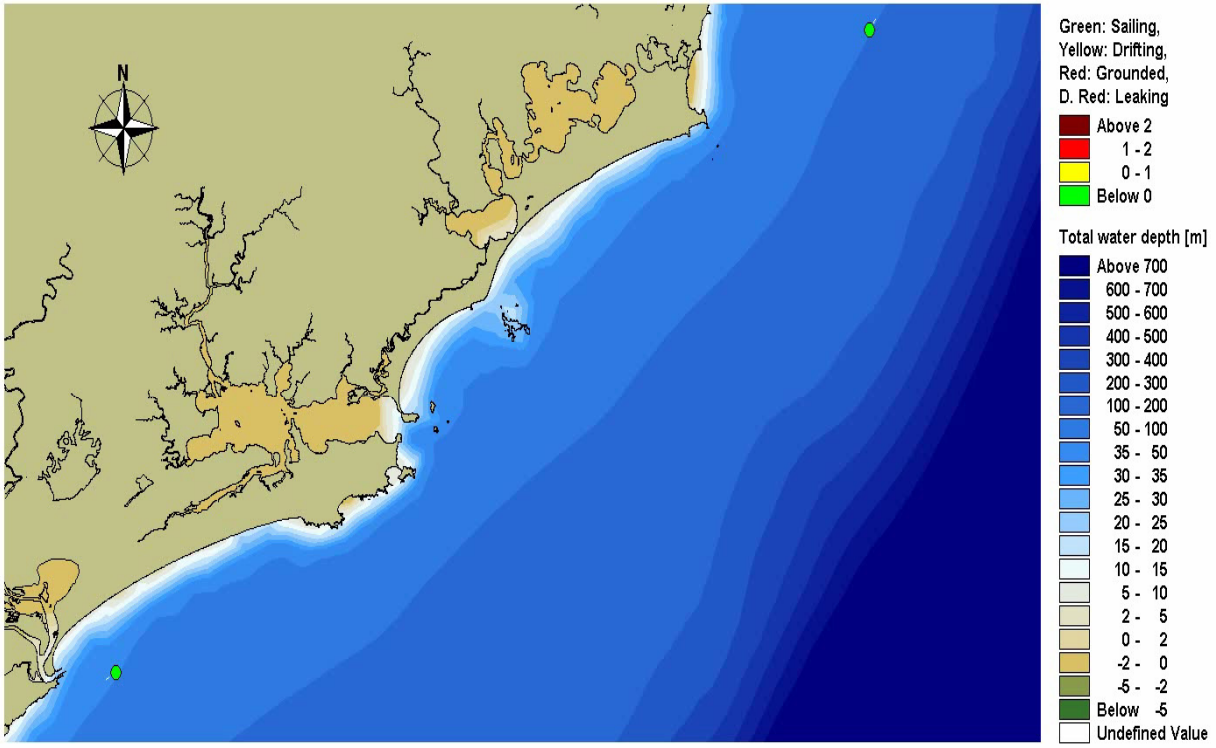
Rio Tinto

Controlled drift - Zhen He



- WAMOS (wave spectra)
- Datum buoys (current)
- Ships officers (vessel plots / mitigation measures
- Met data – wave / weather stations

Simulating Vessel Drift



20/07/2014 22:15:00 Time Step 1 of 96.

So – what next?

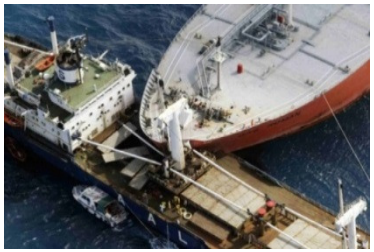
Operational

- 24/7 response to vessel drift candidates (e-mail /sms)
- Web interface with vessel parameters, state of load, position – request drift simulation
- DHI to provide estimate drift ‘trumpet’ - drift algorithm using environmental inputs (later – integrate in systems)

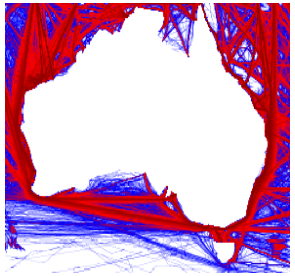
Strategic

- Link drift models to anticipated vessel density based on growth expectations
- Determine expected possible drift candidates, location and drift patterns to assist with determining risk control options

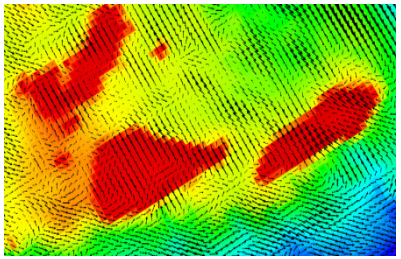
Conceptual framework - multi-layered risk estimation



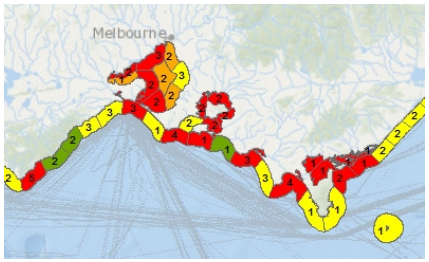
Layer 1 (2011):
Ship specific risk (proxy for safety quality)



Layer 2 (2013/14/15):
Eg. Nm travelled, days in area, other metric (proxy for vessel traffic densities and/or exposure)

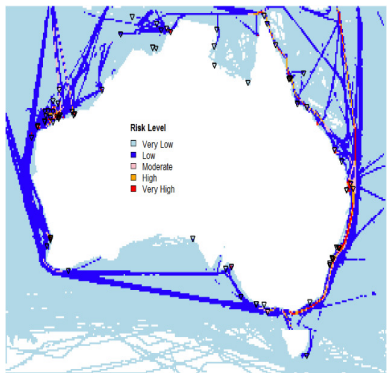


Layer 3 (2014/15): DHI Physical environmental layer (wind, waves, currents, bathymetry)



Layer 4 (2013):
Sensitivities (economic, cultural/social, ecological)

Total Risk Exposure:
Protect: property, life and marine environment



Expressed as:
- probabilities
- expected numbers
- monetary value at risk (proxy to consequences)
- oil on water
- oil on coast

Risk Management (feedback loop)

Layer 5 (2014/15): Effects of risk control options (RCO):
- navigational aids
- aids to navigation
- vessel traffic services
- under keel clearance
- emergency response
- inspections and audits
- pollution preparedness
- general surveillance
- Pilotage
- Other

(Acceptable) residual risk

For a short article on the research to date, visit the AMSA website and check out the AMSA Aboard article!

www.amsa.gov.au

New research into vessel drift modelling

In a partnership with not-for-profit research organisation DHI and vessel operator Rio Tinto Marine, we are conducting research to better understand how large vessels drift in Australian waters when they lose power.

Existing drift models appear to account well for effects of ocean currents and wind on the movement of smaller vessels and rafts, or oil slicks. However, it is now believed these models underestimate the effect of local waves and swell on the total drift force affecting, in particular, large vessels.

We are responsible for regulating ship safety in Australian waters, including arranging emergency towage for vessels that lose propulsion and may run aground, causing casualties or marine pollution incidents.

Such a tool would improve our response by providing a more accurate forecast of trajectories and grounding risk. It can also assist emergency towage vessels predict the intercept location to render assistance.

According to AMSA project lead, Paul Irving, the new model will take into account a number of factors specific to how large vessels are built, operate and behave when drifting.

"Creating a drift model that can more accurately forecast trajectories for ships is an exciting prospect and has attracted interest from industry in Australia and abroad. The modelling will look at the very specific interactions between local sea conditions and the specific characteristics of the vessel, including size, loading condition and ballast state.

"Our partners are crucial – this is a truly international, cooperative venture. We couldn't do this without DHI's modelling expertise; the cooperation of Rio Tinto Marine for providing their large bulk carriers to supply data recorded throughout actual drift scenarios; and the German maritime radar company OceanWaveS with their expertise in real time, local measurement by radar of the local ocean swell conditions and direction," Paul said.

To gain the base data, the vessel uses its X band radar in very specific short range mode to collect data about the size and direction of waves and swell immediately around it, while simultaneously collecting data about other conditions such as wind and currents, and recording its track across the sea, in response to all these forces. These are later calibrated against local wave buoys and weather stations.

Rio Tinto Marine is allowing the project to collect data from their 205,000 dwt vessels waiting to load coal off Newcastle. In accordance with port requirements, the ships drift offshore in a rather large and widespread queue. Although it started out just as way of learning more about how ships behave so they could be modelled better, the work is now gaining in ambition. Once baseline data about behaviour is collected over several days, the master can then look to change shipboard conditions, by shifting the rudder position, by adding or removing ballast, or maybe even by walking out an anchor. All of these factors influence how the vessel drifts and may in the future provide insight about how a stricken vessel could assist itself, lower its risk of grou and lessen any possible impact upon the environment, while waiting for help to arrive. In August, the RTM *Zheng He* collected data for nine days to with validation of the DHI models.

Thank you…

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jac@amsa.gov.au

Australian Maritime Safety Authority
www.amsa.gov.au