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Operational Drift Forecast Modelling in Support of the AMSA Search for Malaysia Airlines MH370

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Forum for Operational Oceanography

Fremantle – July 2015

CSIRO

Australian Government
Bureau of Meteorology

Overview of Presentation

- Introduction of the incident and drift planning working group
- SARMAP and the COASTMAP EDS
- Ocean currents in the search area – based on three different ocean forecast models (BLUElink, HYCOM NCEP and HYCOM Navy)
- Best practice consensus forecasting using all three ocean models
- Comparisons using SLDMB drifters to assess each of the ocean model's performance throughout the incident

Background

- Malaysian Airlines flight MH370 went missing on the 8th of March 2014 whilst en route from Kuala Lumpur, Malaysia to Beijing, China

- The Australian Maritime Safety Authority (AMSA) became involved in the drift planning once the search area was focussed on waters within the Australian SRR

- Due to the difficulties in the scenario, AMSA established a drift planning working group to ensure international best practice was carried out in this complex incident

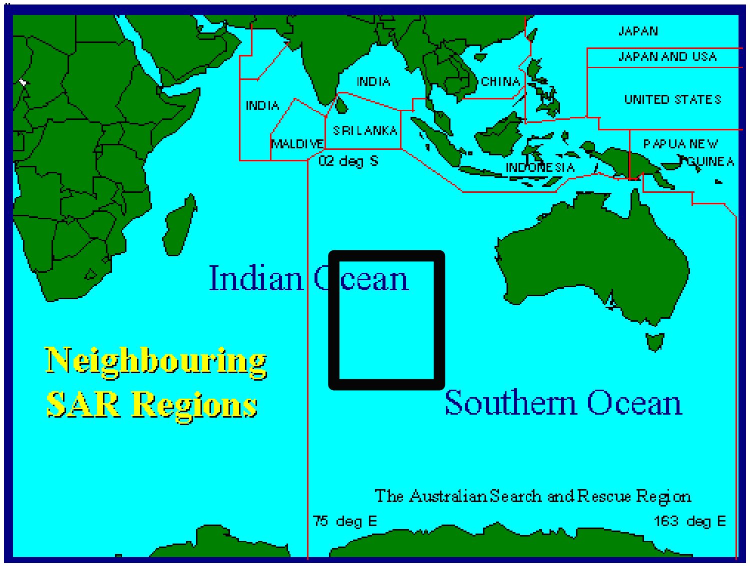
The Drift Planning Working Group

- Members of the drift planning working group included specialists from several organisations including:

  - AMSA – RCC
  - RPS APASA
  - CSIRO
  - BoM
  - US Coast Guard
  - GEMS

Bureau of Meteorology (BoM) Support

- The Bureau of Meteorology has responsibility for providing meteorological services to AMSA during SAR operations.
- For MH370, search planning and scheduling was based on advice from BOM on approaching cloud, wind and swell systems.
- Search ships would need to shift by over 200km to avoid weather systems, delaying operations by two days or more.
- Aircraft required good visibility and high cloud base



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 SAR 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

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Metocean datasets used throughout the event:

- Australian Bureau of Meteorology (BoM):
  - BLUElink OceanMAPS forecast ocean currents
  - ACCESS-R winds
- US NOAA/NCEP
  - HYCOM-NCEP forecast ocean currents
  - GFS winds
- US Navy
  - HYCOM-Navy forecast ocean currents
- CSIRO
  - Gridded Sea Level Anomaly (GSLA) geostrophic currents

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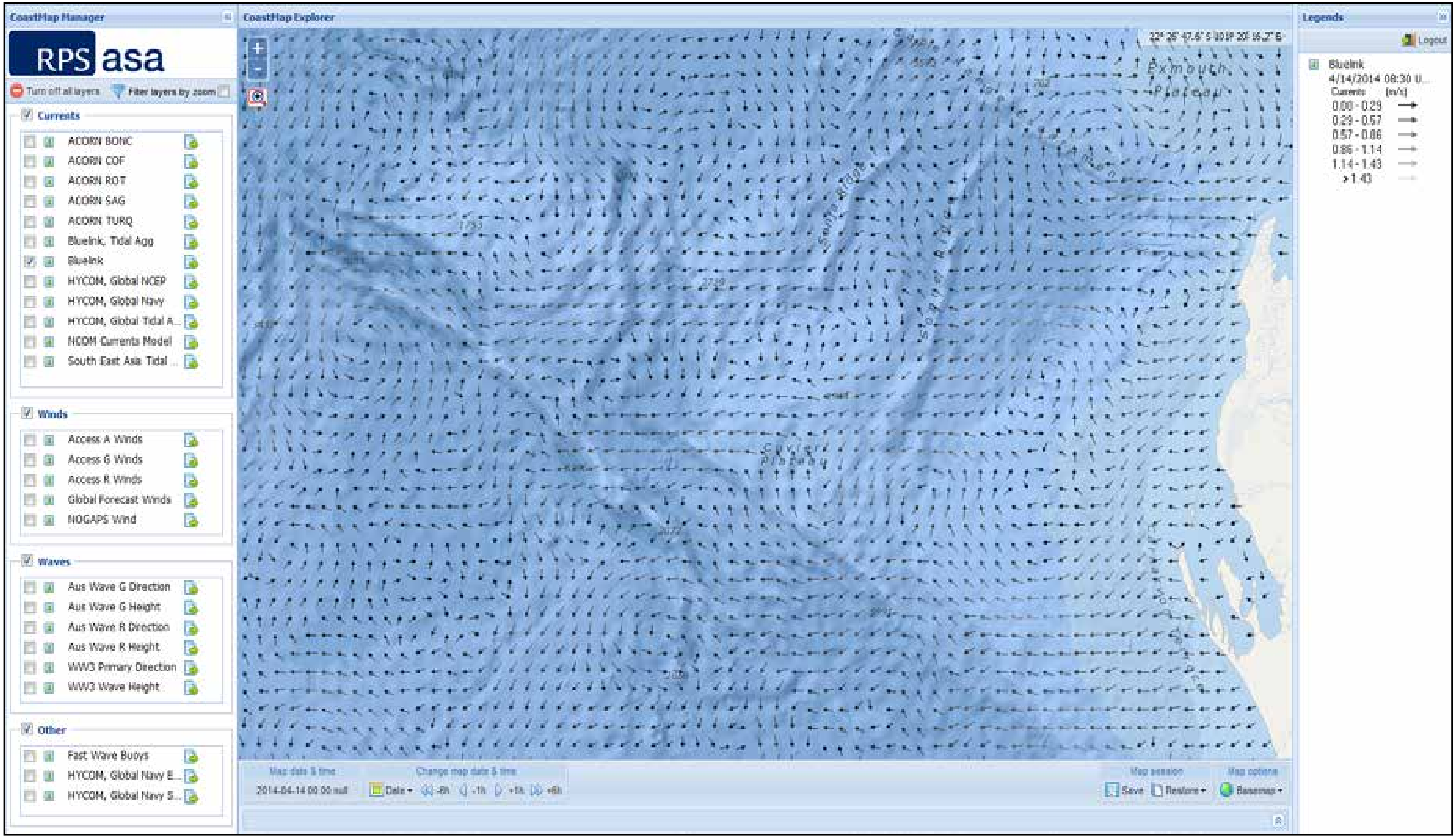
BLUElink



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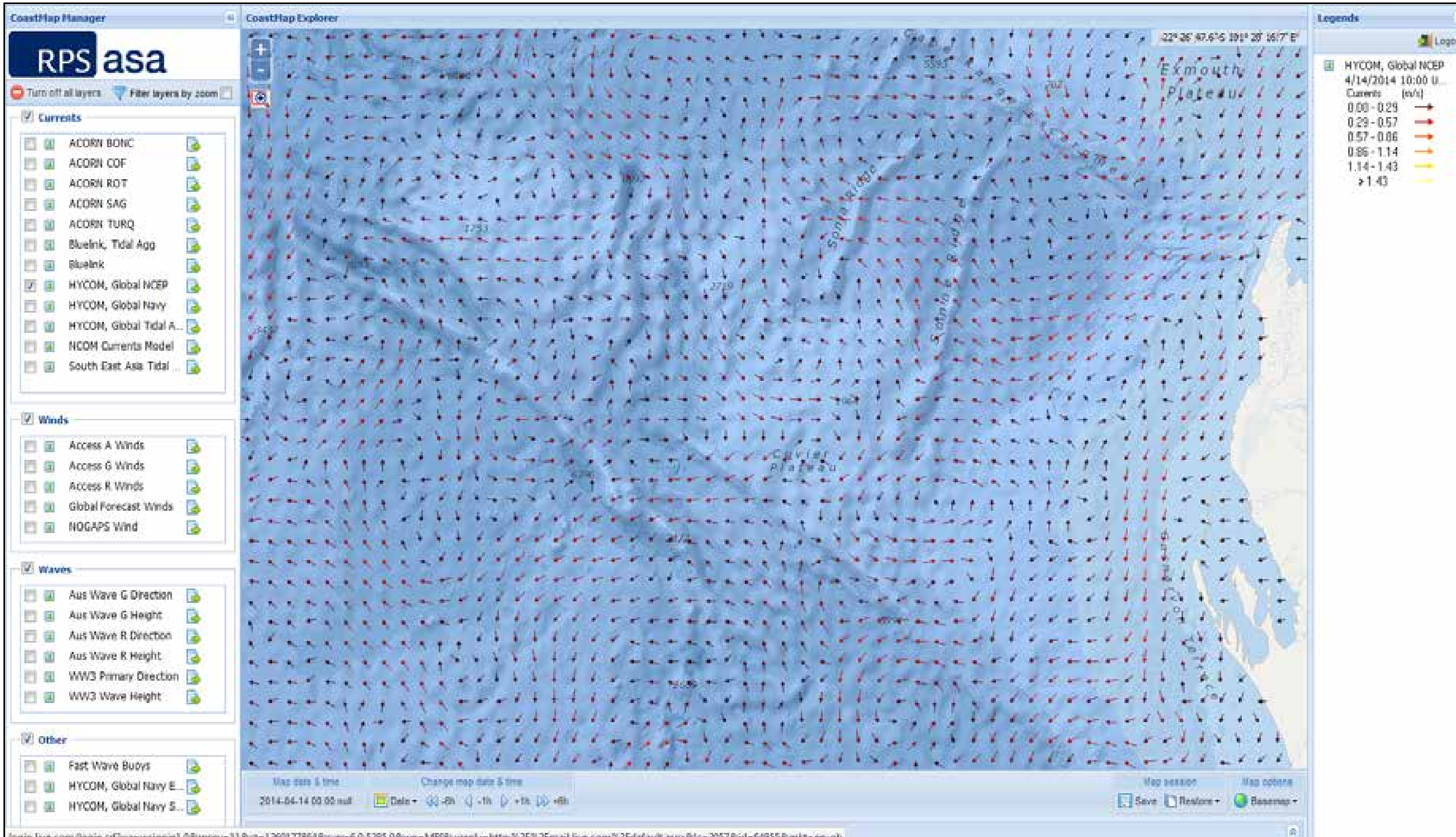
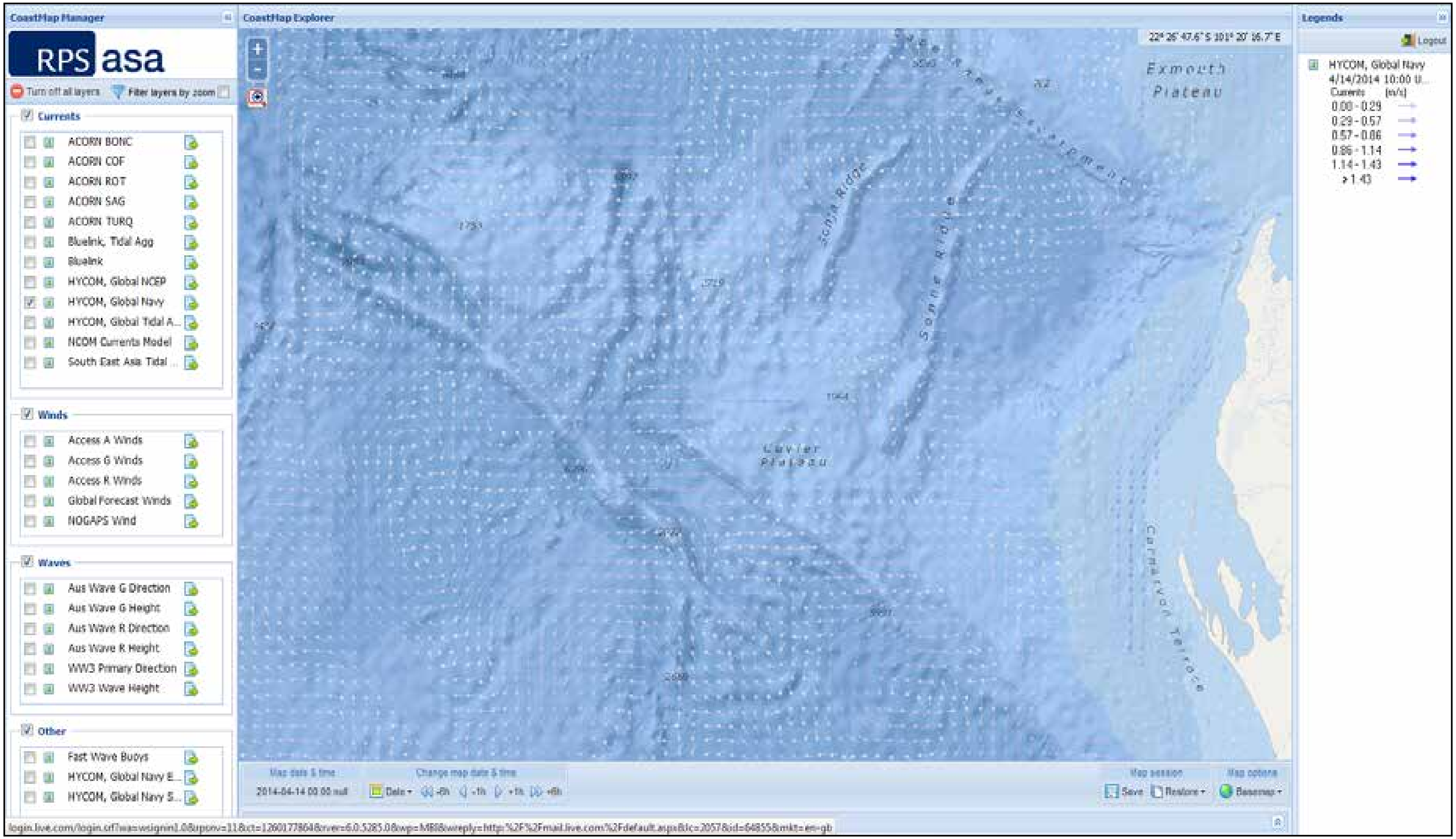
HYCOM (NCEP)



HYCOM (Navy)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HYCOM, Global Navy
HYCOM, Global Tidal A...
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Basemap

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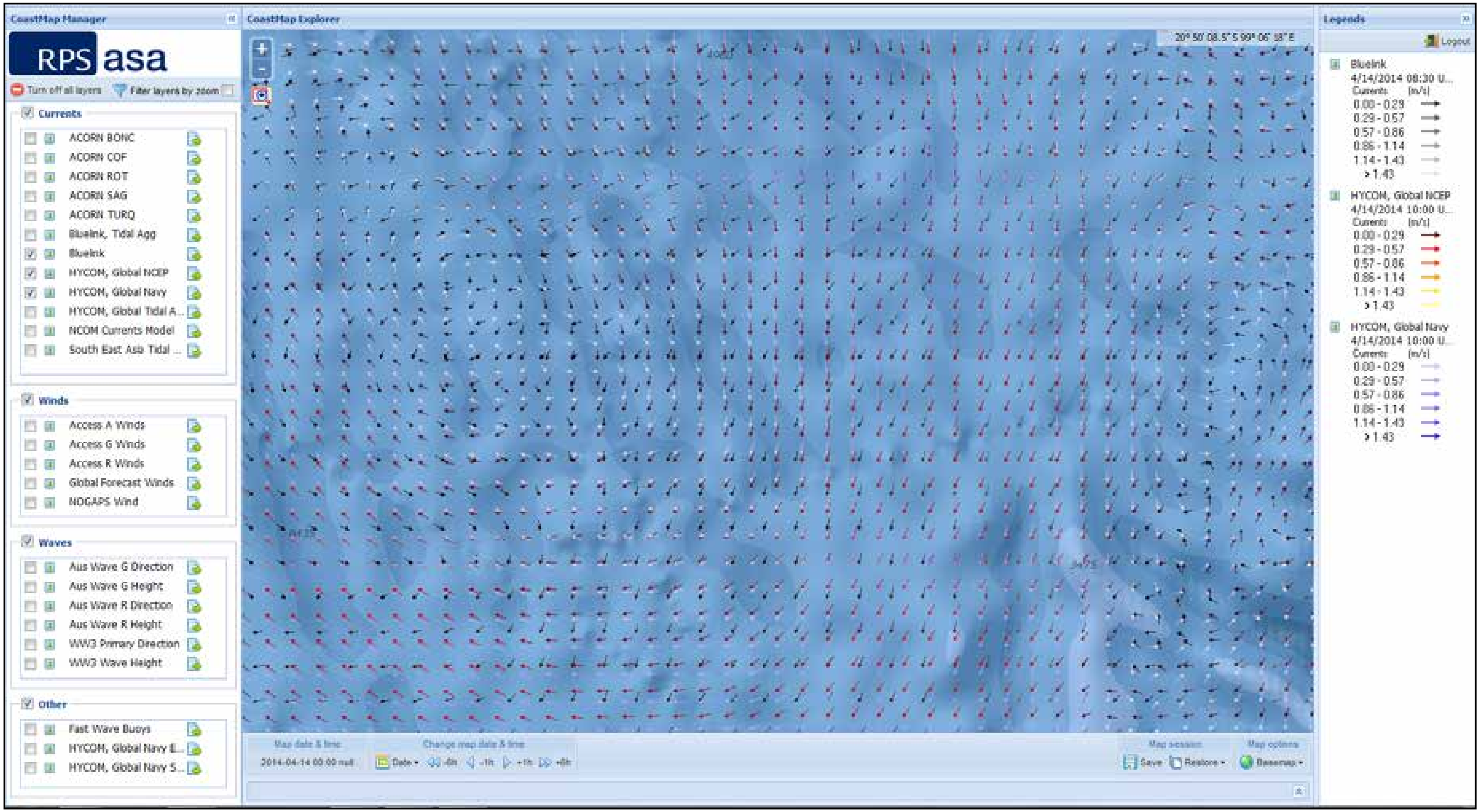
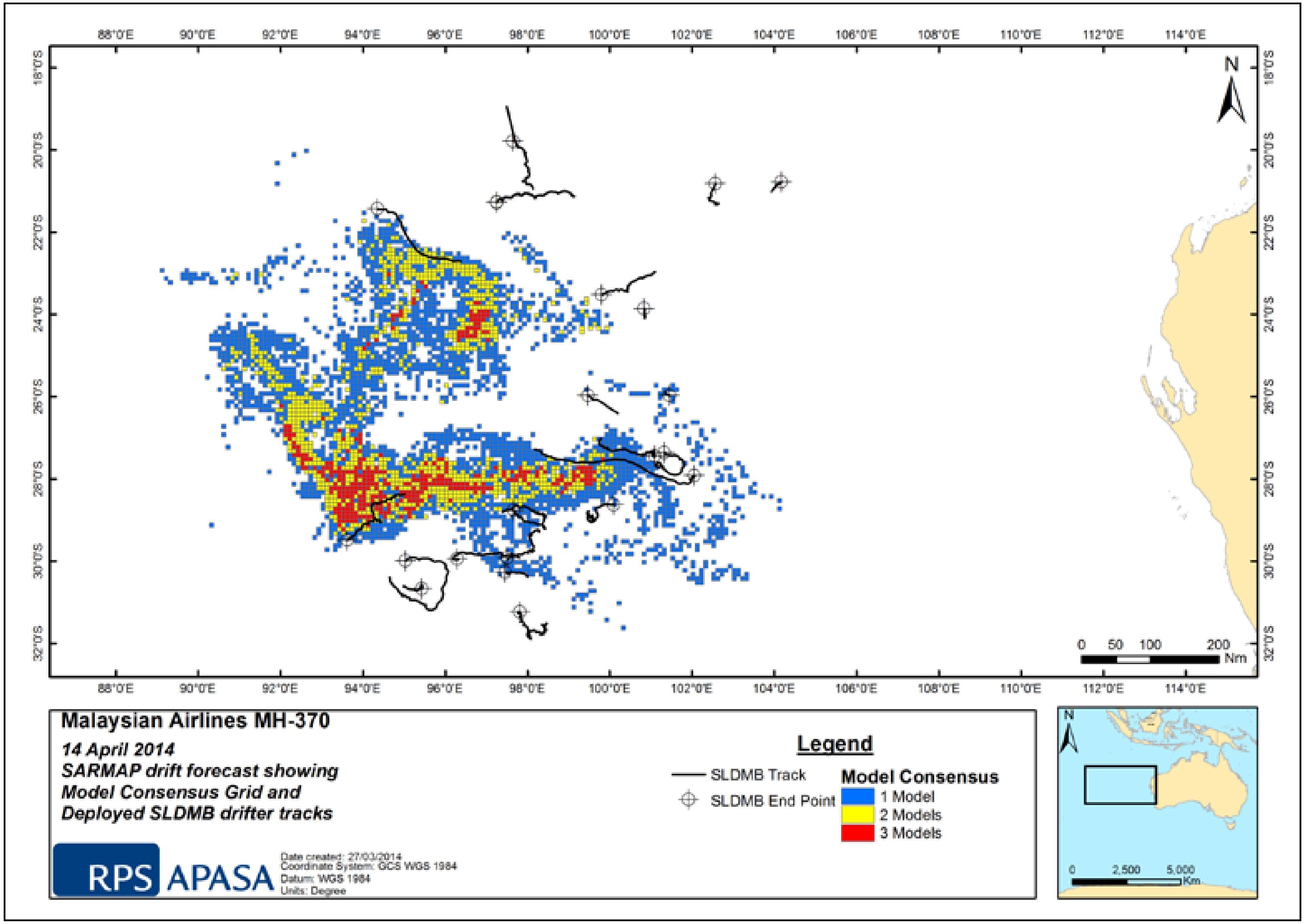
Three Models Combined



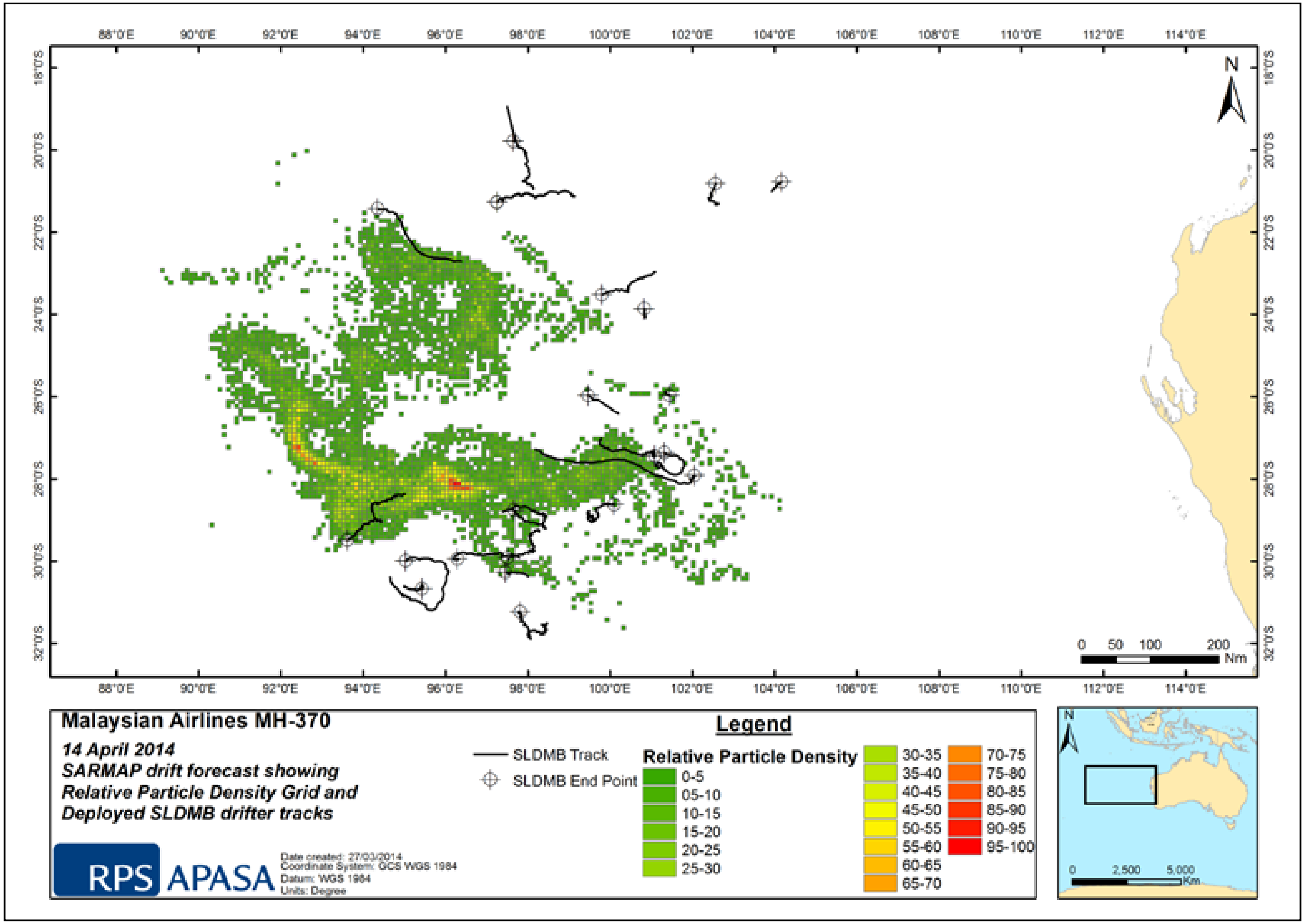
Consensus Forecasting

- Consensus forecasting was carried out to:
  - Account for more variability than any single ocean model could represent
  - Provide higher likelihood zones where multiple forecasts overlapped

Consensus Drift Area



RPS APASA Combined Particle Density Drift Area



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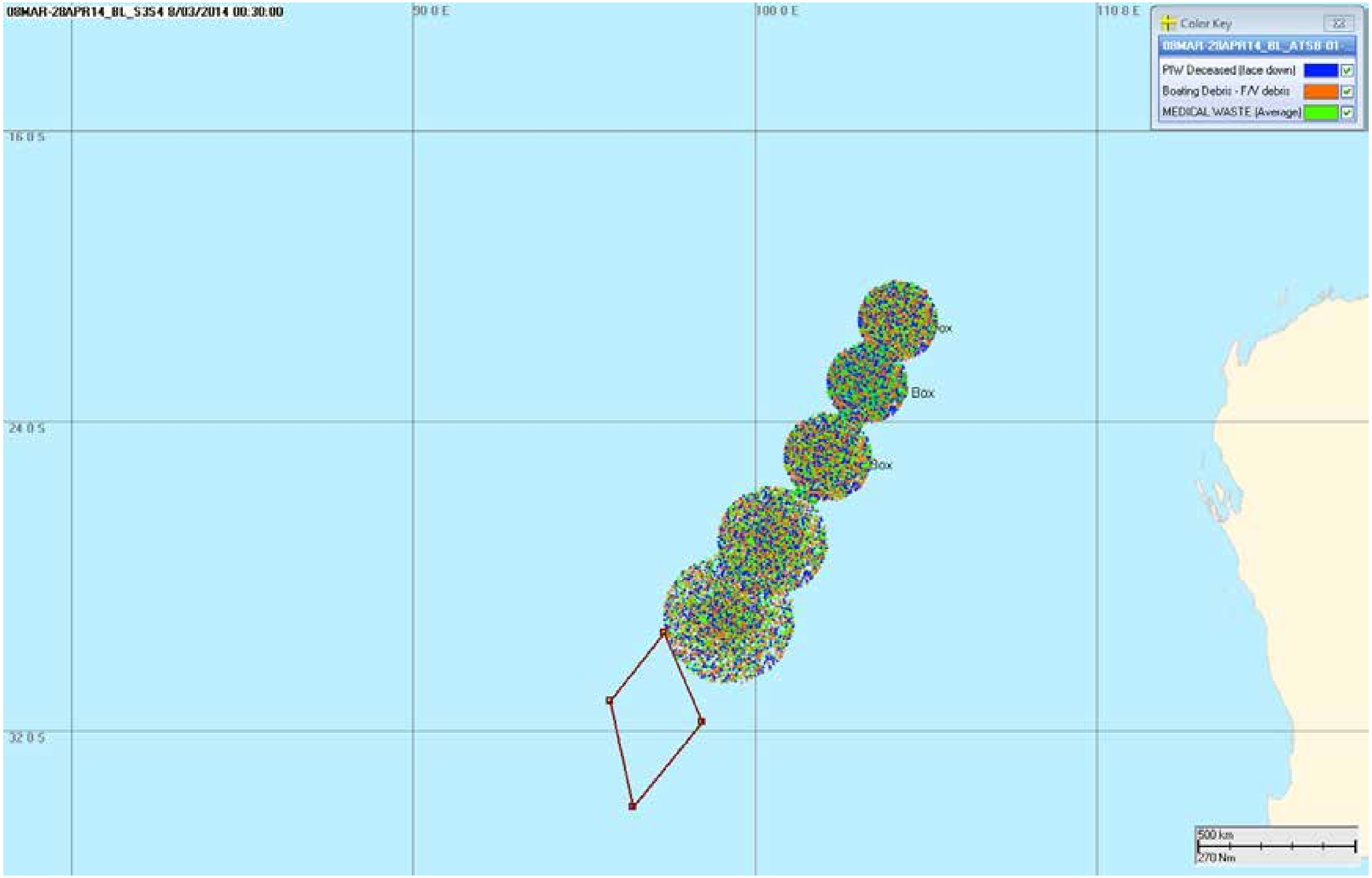
Animation of Drift Area – 52 Days

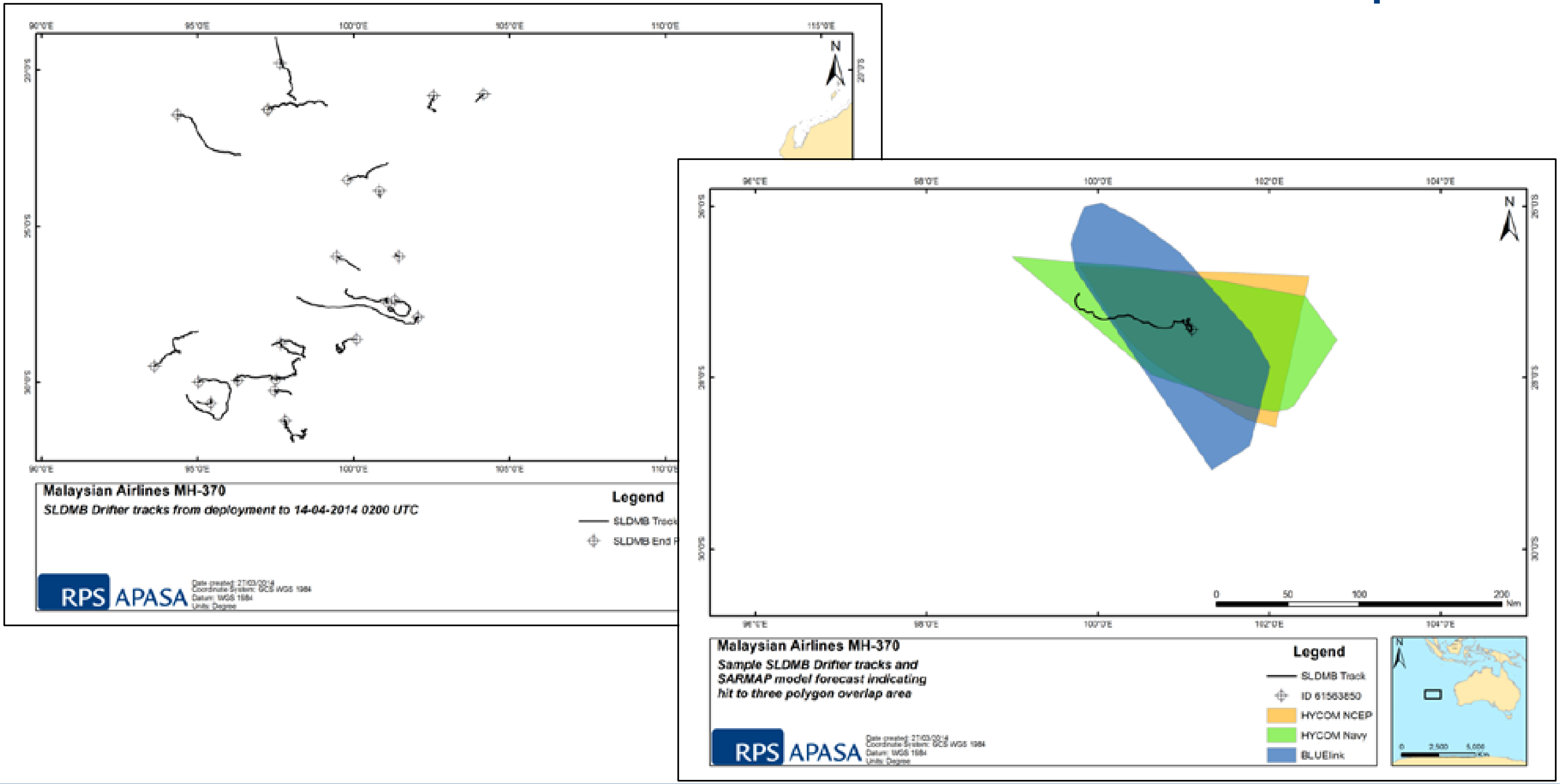


SLDMB model verification

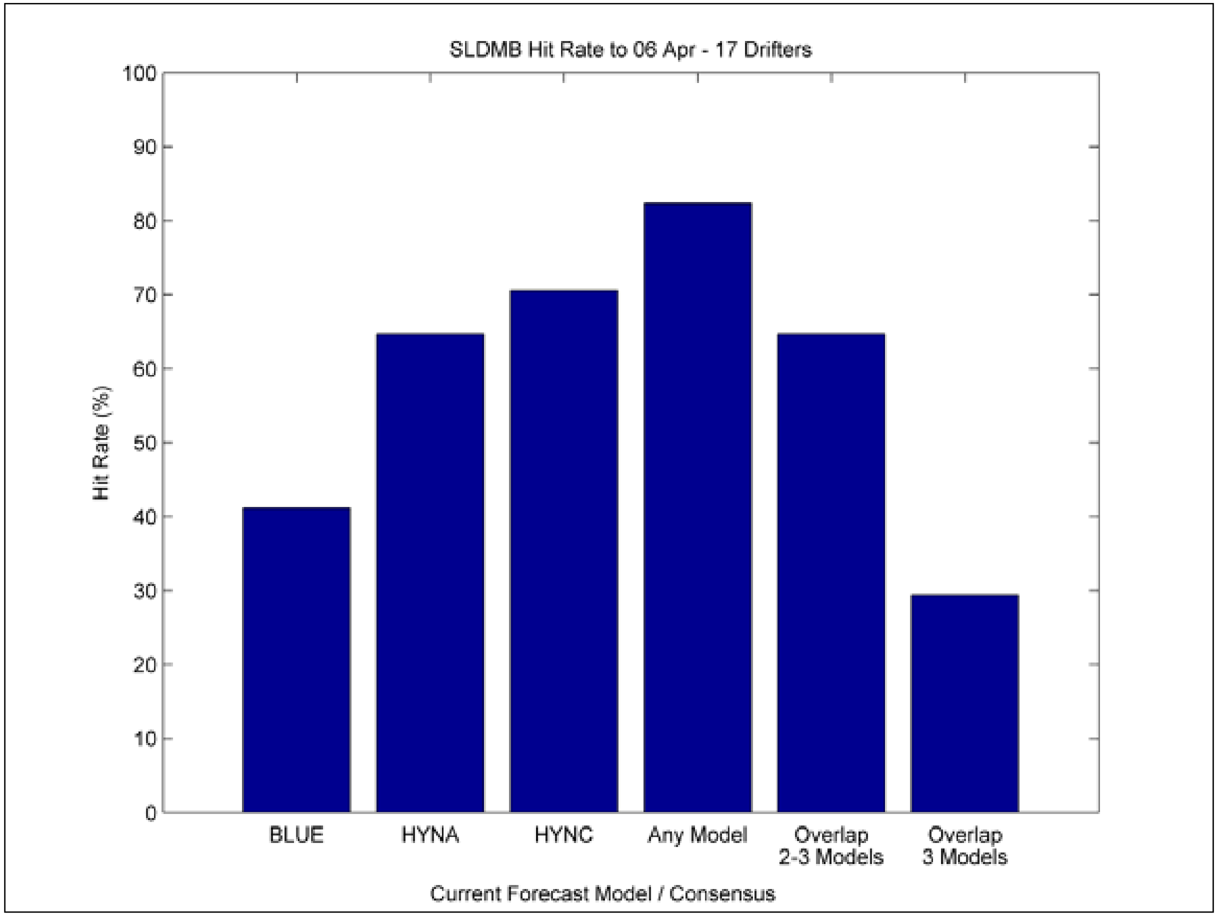
- Used to ground truth the known complex oceanic currents
- SLDMBs – to assist in determination of best data set
- Deploy in advance of proposed move of search area
- 33 x SLDMB's successfully deployed to validate drift modelling
- Comparisons run against all three oceanic current data sets to provide information as to the highest performing data set

Image courtesy of AMSA

SLDMB model verification – 30 March to 14 April



SLDMB model verification – 30 March to 6 April



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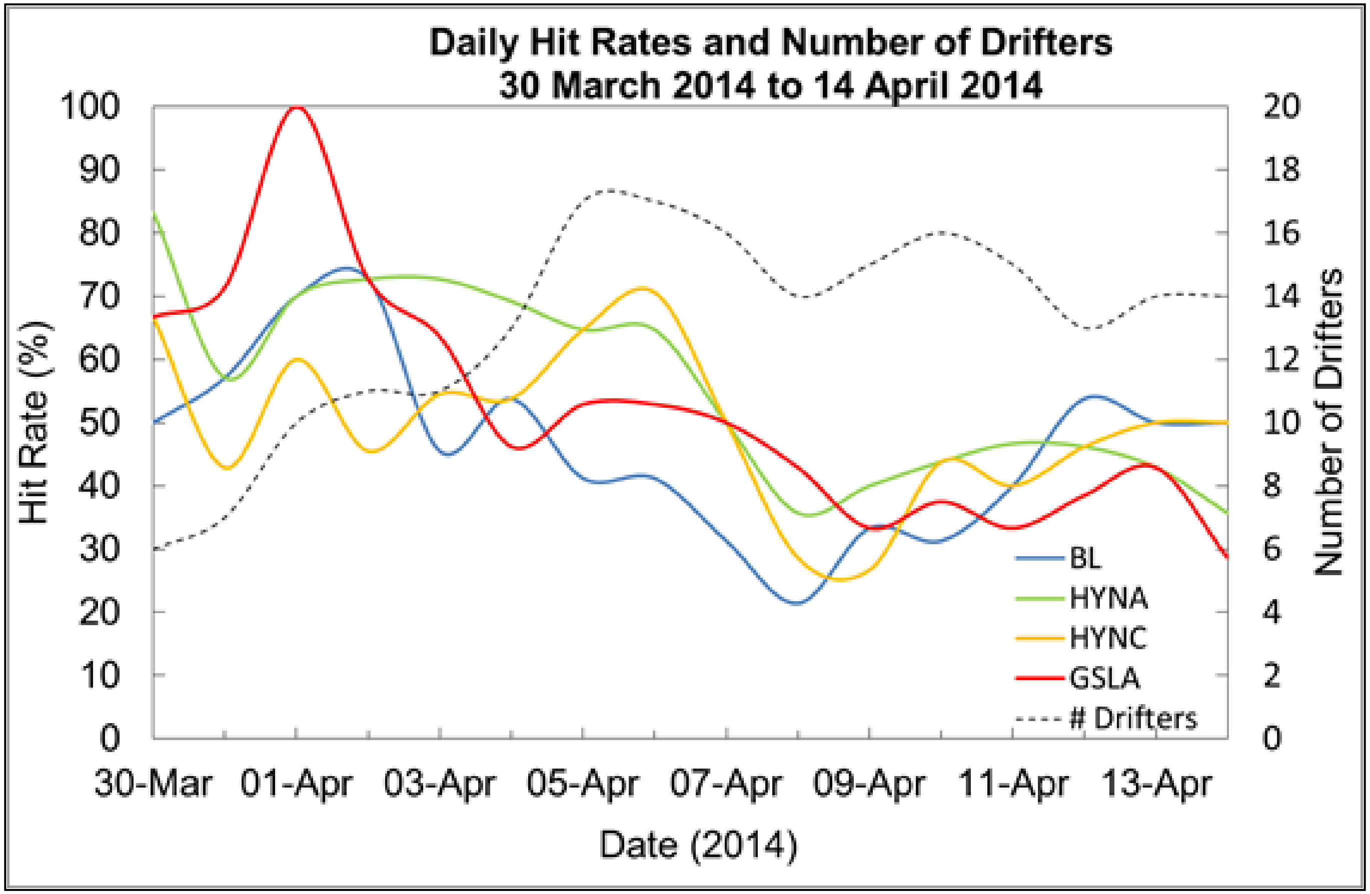
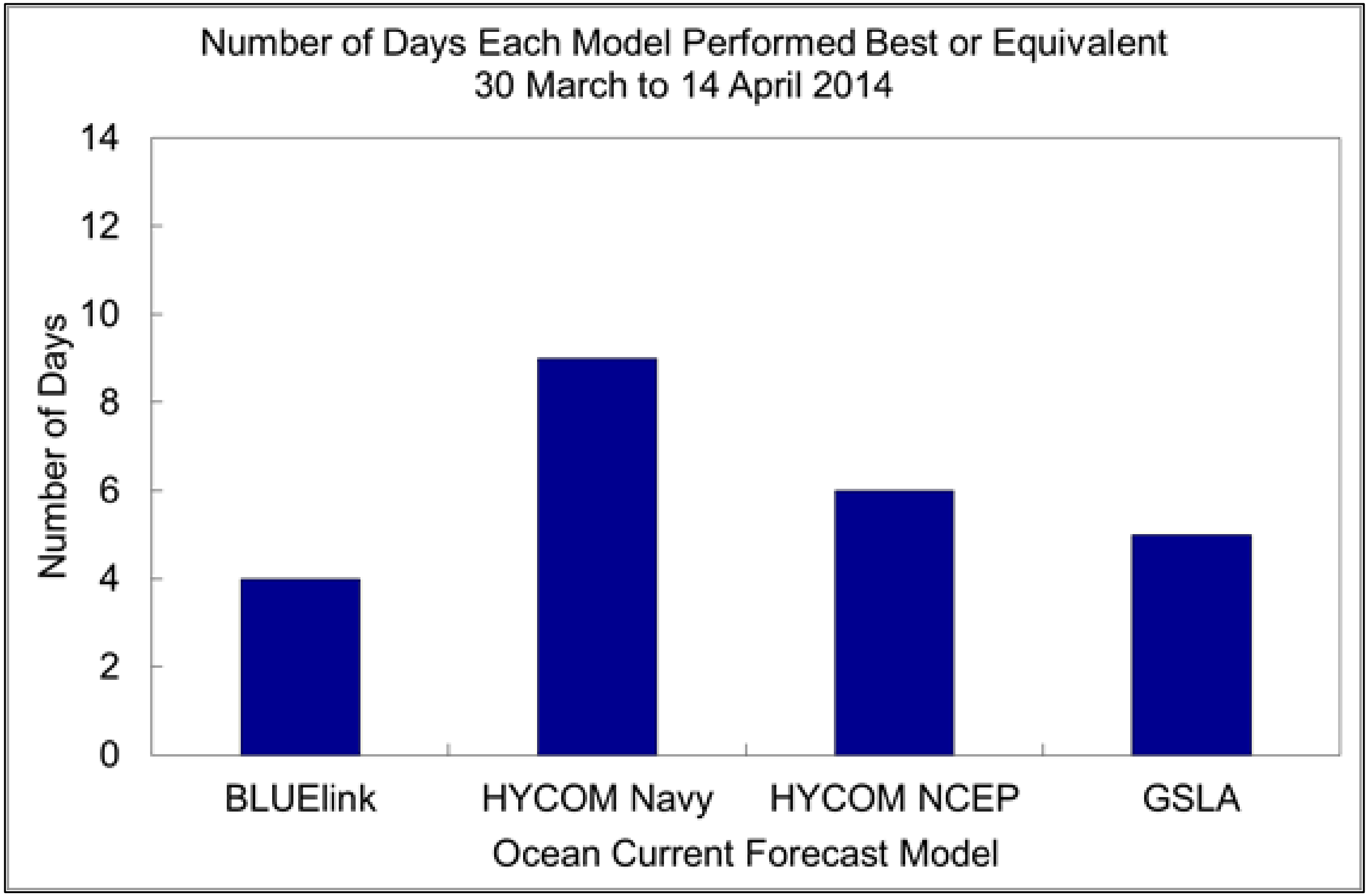
SLDMB model verification – 30 March to 14 April



SLDMB model verification – 30 March to 14 April



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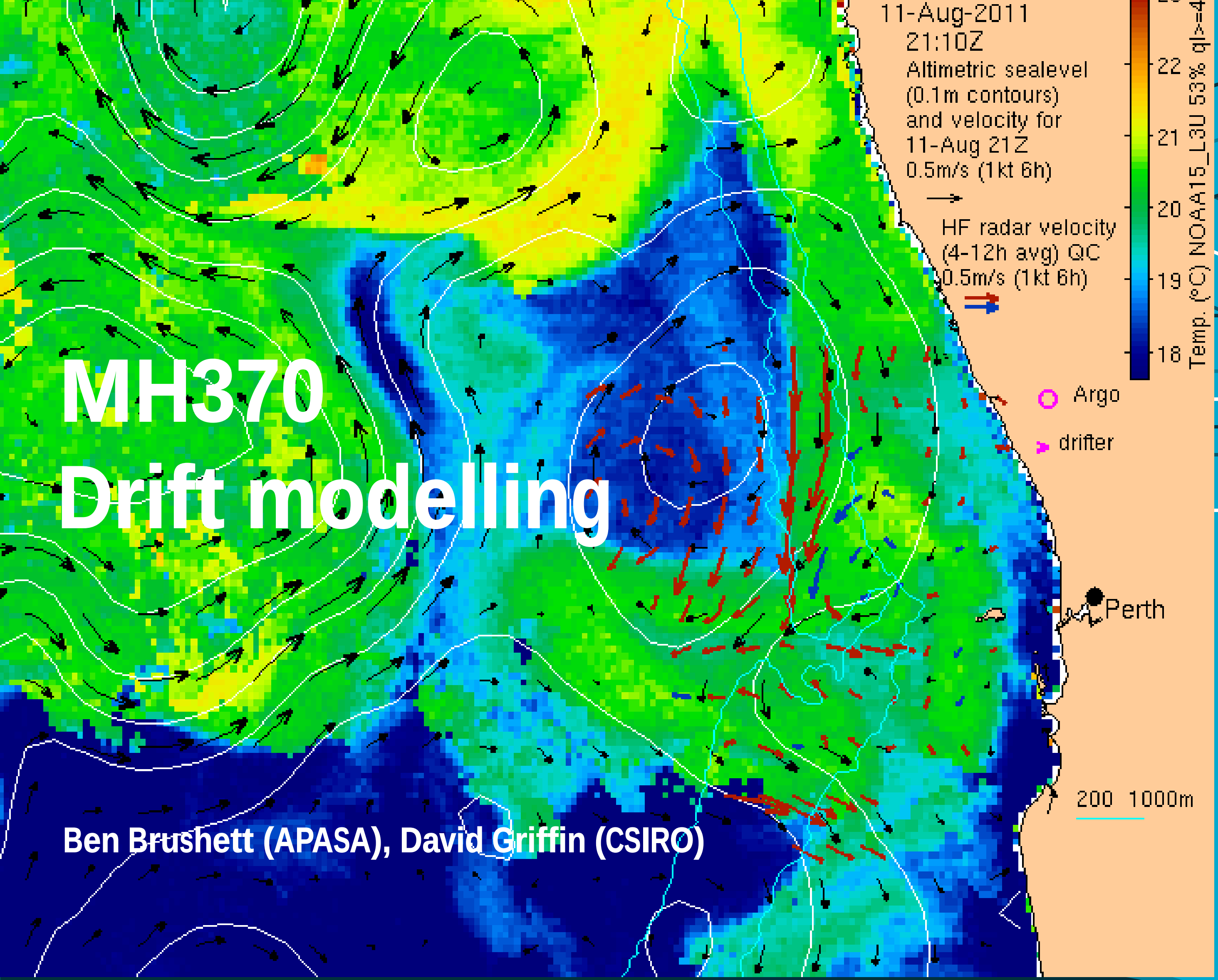
Summary

- Complex environment, very complex scenario
- Best practice combined and consensus forecasting was applied to consider more variability than any one single model could represent
- Consensus forecasting was used to present numerous different outcomes and determine where these coincided
- Model performance was evaluated throughout the incident, using SLDMB drifters
- Comparisons using SLDMB drifters allow for a model skill assessment to be built up over time
- Skill assessment may allow for potential weighting of the consensus forecast to improve results



MH370
Drift modelling

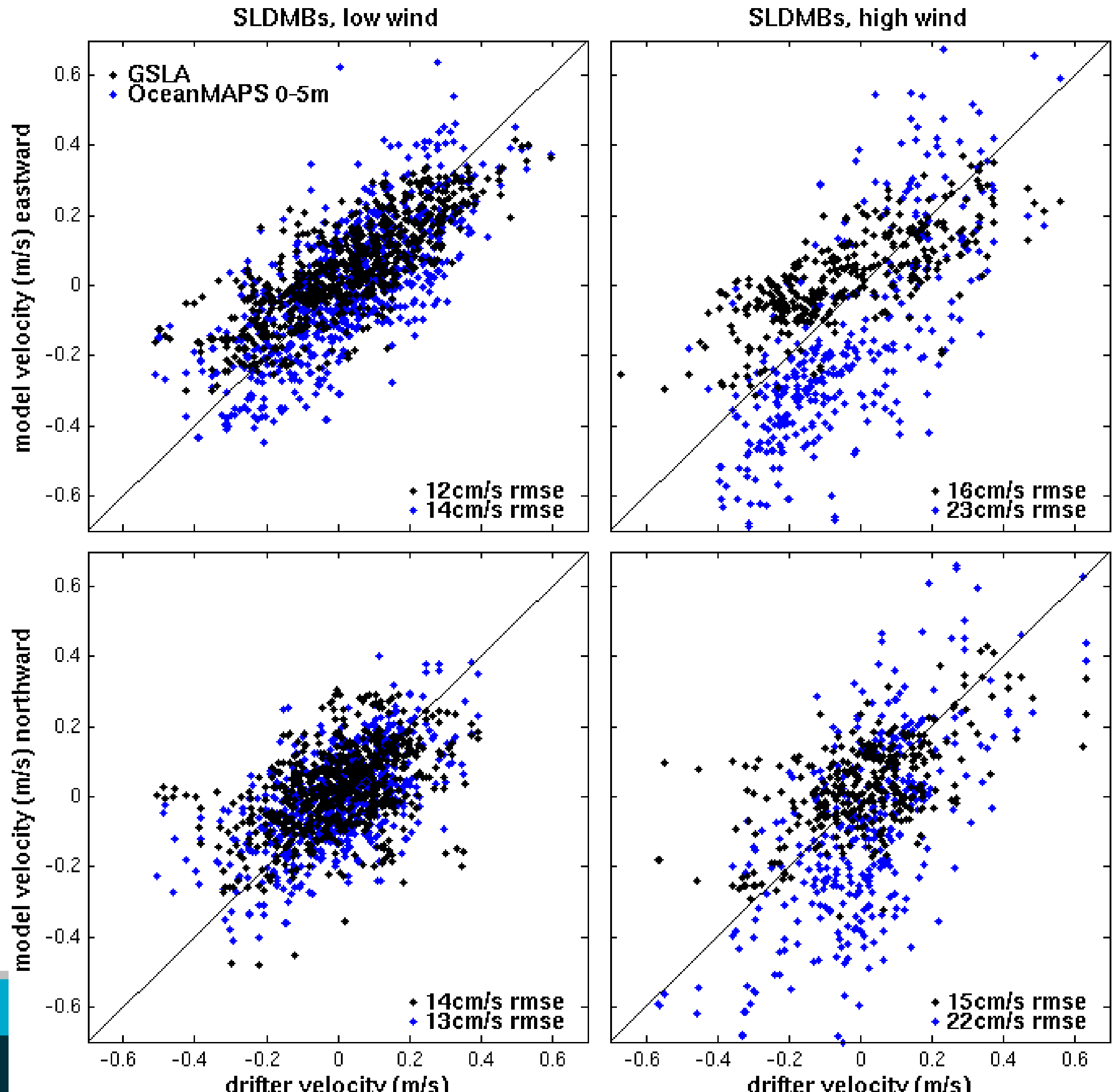
Ben Brushett (APASA), David Griffin (CSIRO)

CSIRO

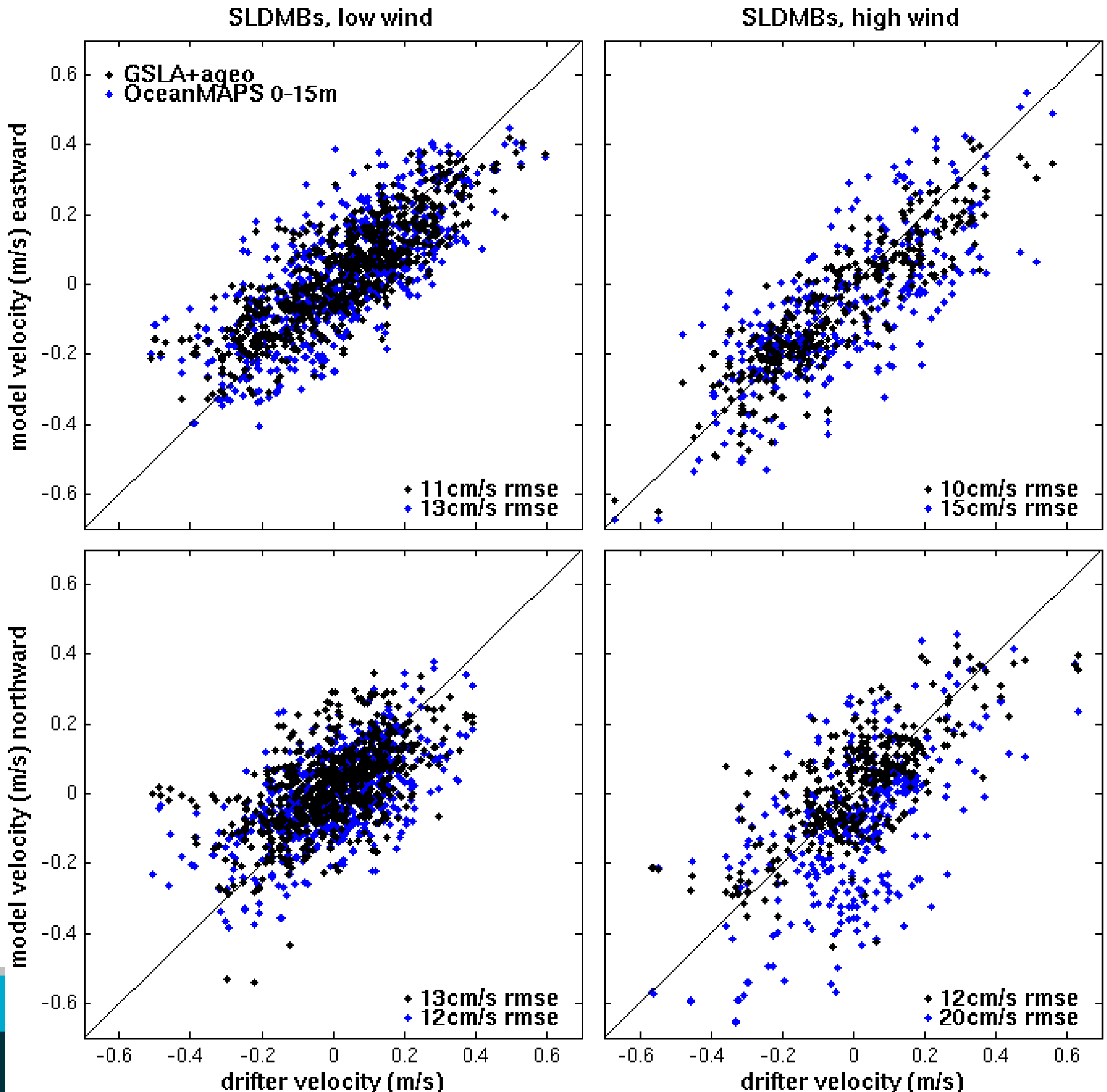
Surface velocity: 0, 0.5m or 12m?

- Global drifters are drogued at 7-17m
- But for oil spill and SAR, need 0m velocity
- AMSA's buoys are drogued at 0.5m – many deployed
- A chance to check OceanMAPS surface layer (0-5m)

SLDMBs cf GSLA & OceanMAPS layer 1



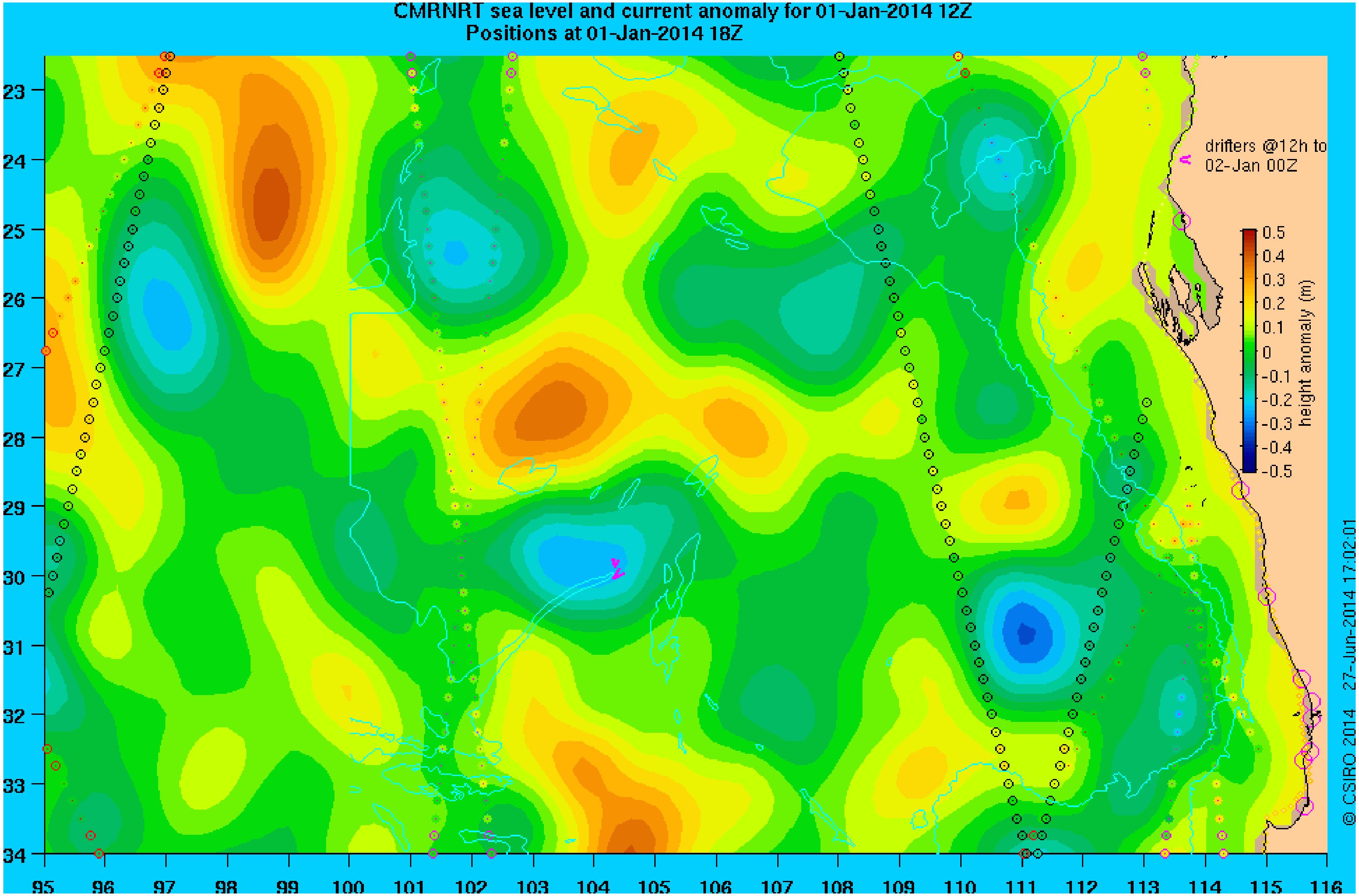
SLDMBs cf GSLA+ & OceanMAPS layer 1-3



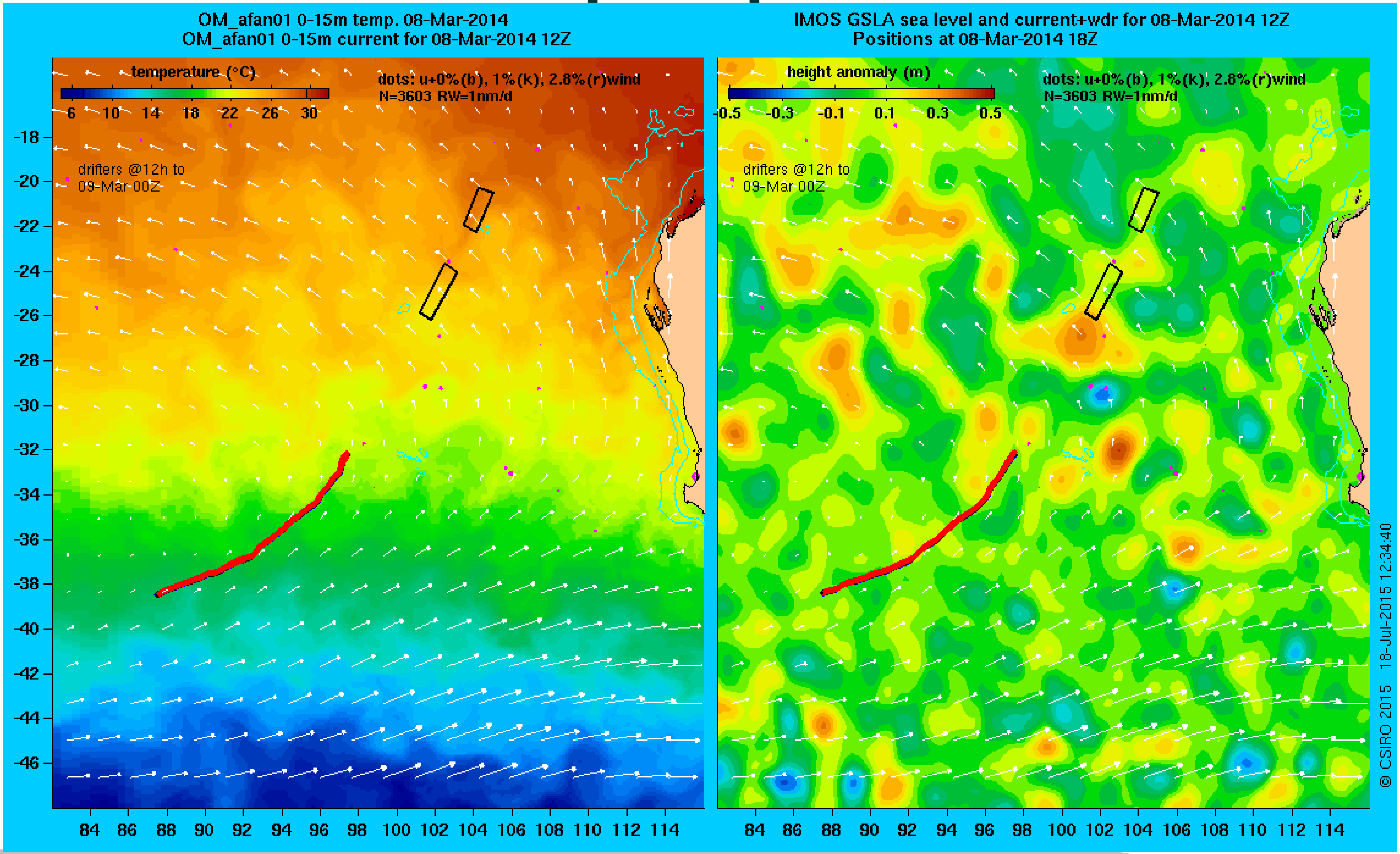
Conclusion

- OceanMAPS surface layer is much too wind-sensitive (momentum not mixed, just T&S, during convection).
- GSLA geostrophic velocities have less rms error (no baroclinic instability).

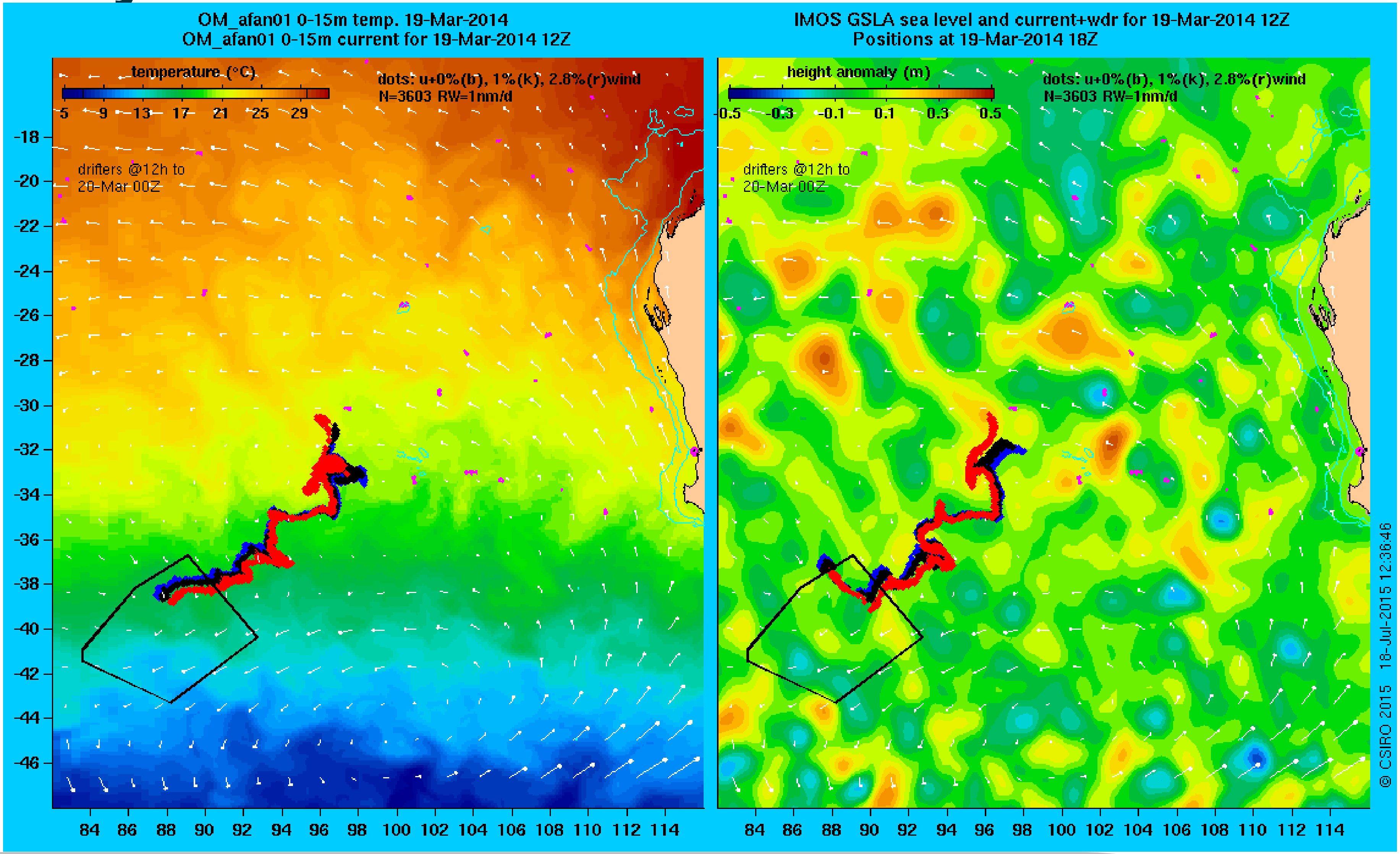
Some drifters are easier to track than others



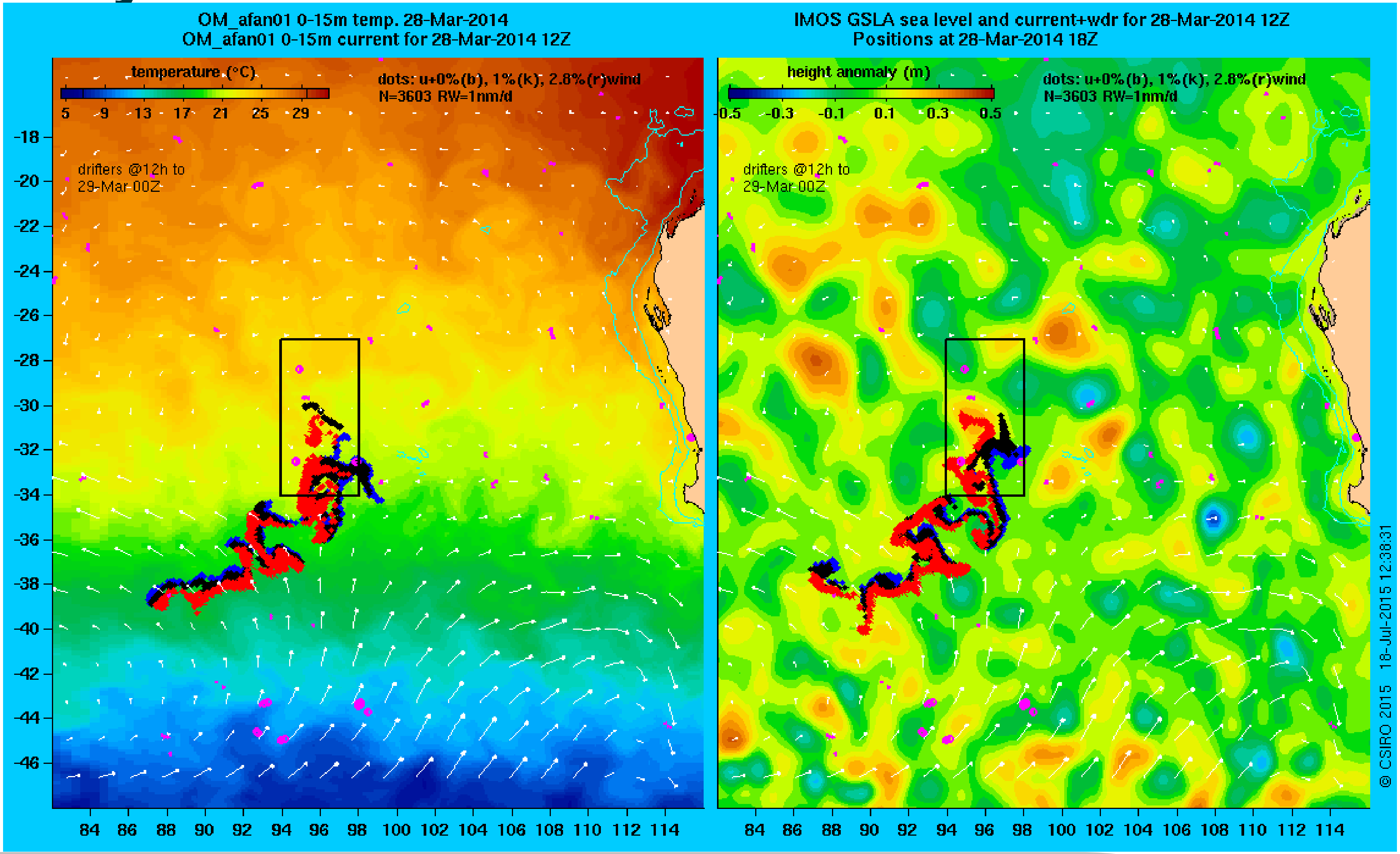
Oct 2014 revised splashpoint



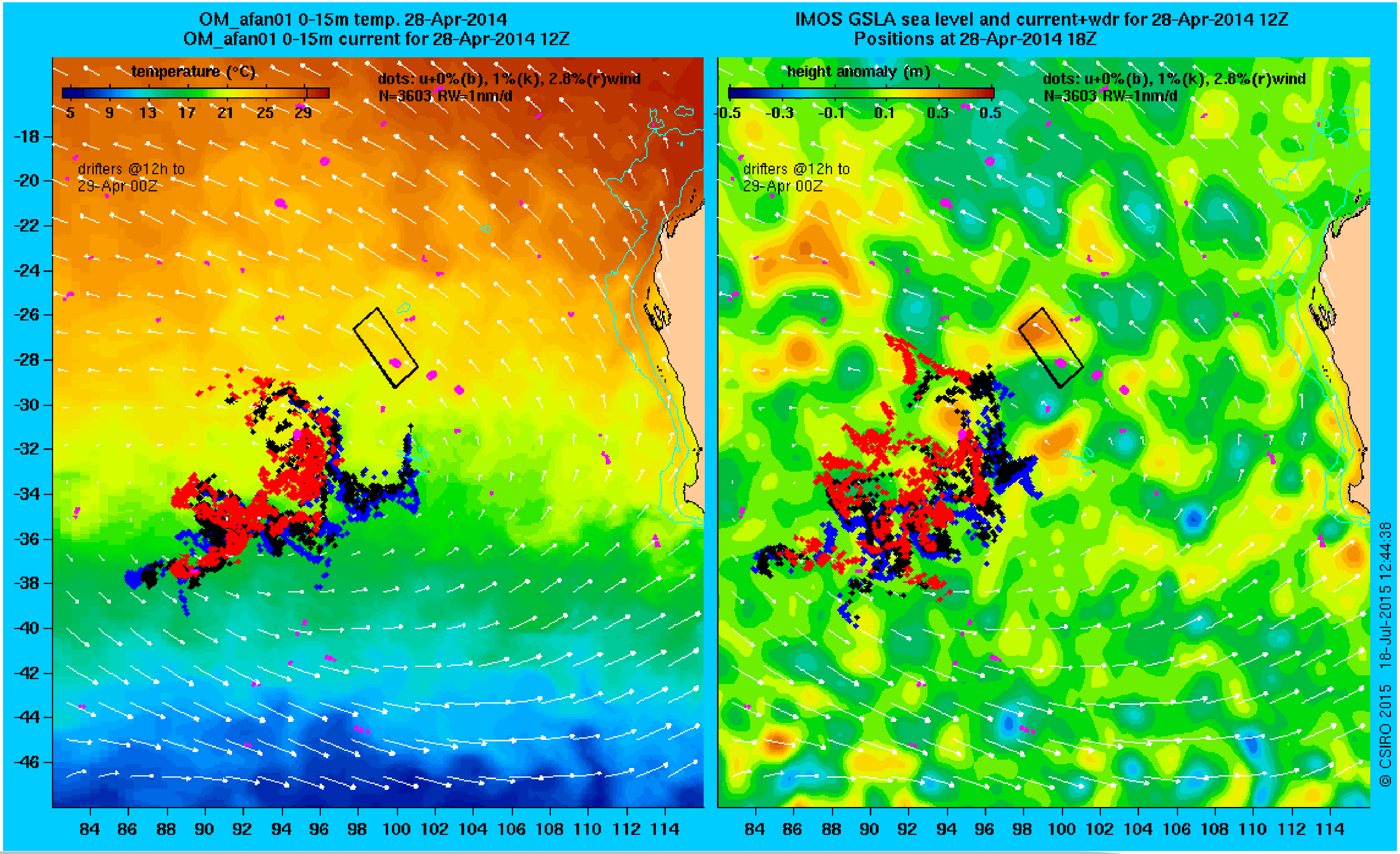
Day 2 of search



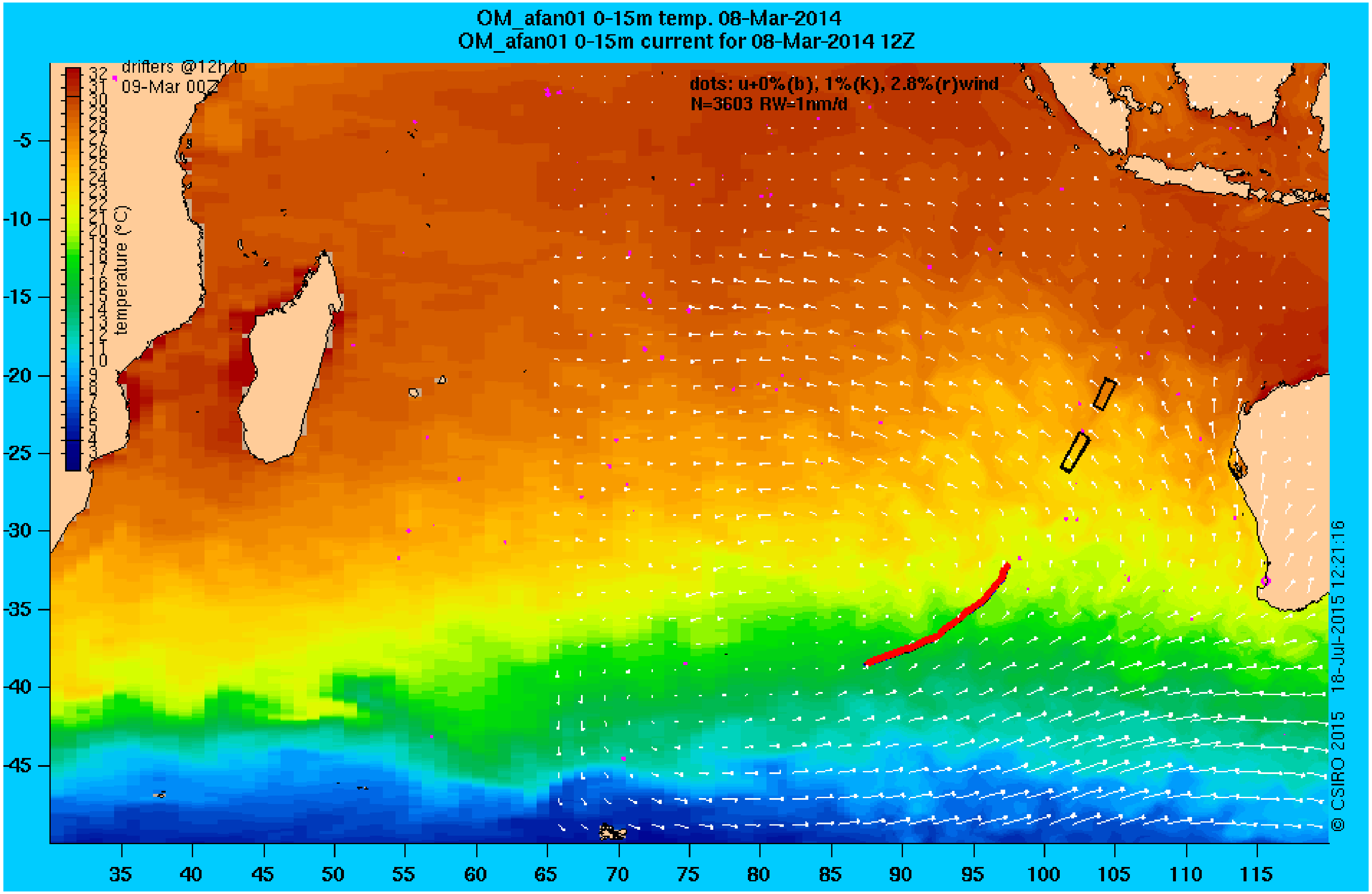
Day 10 of search



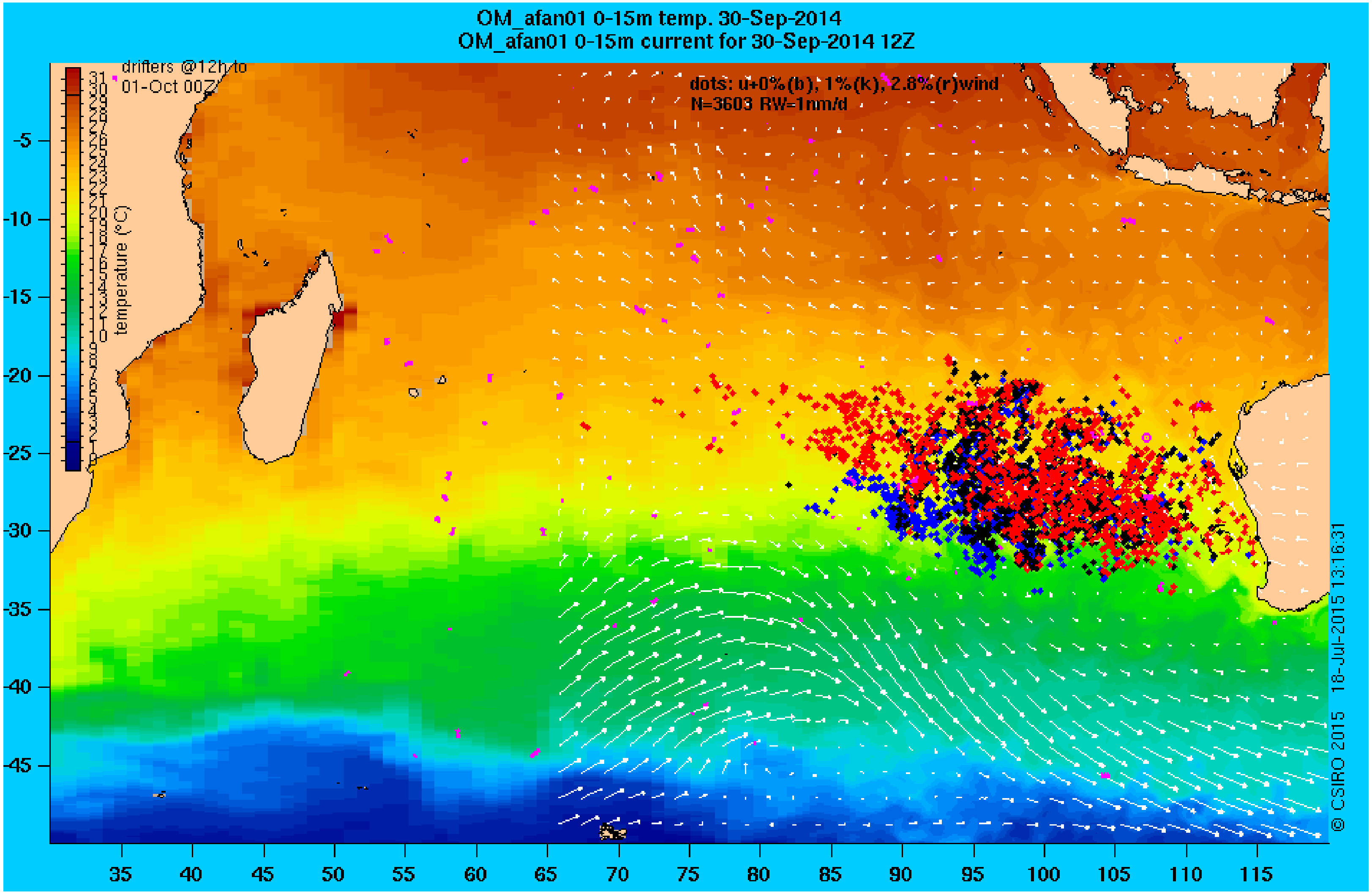
End of search



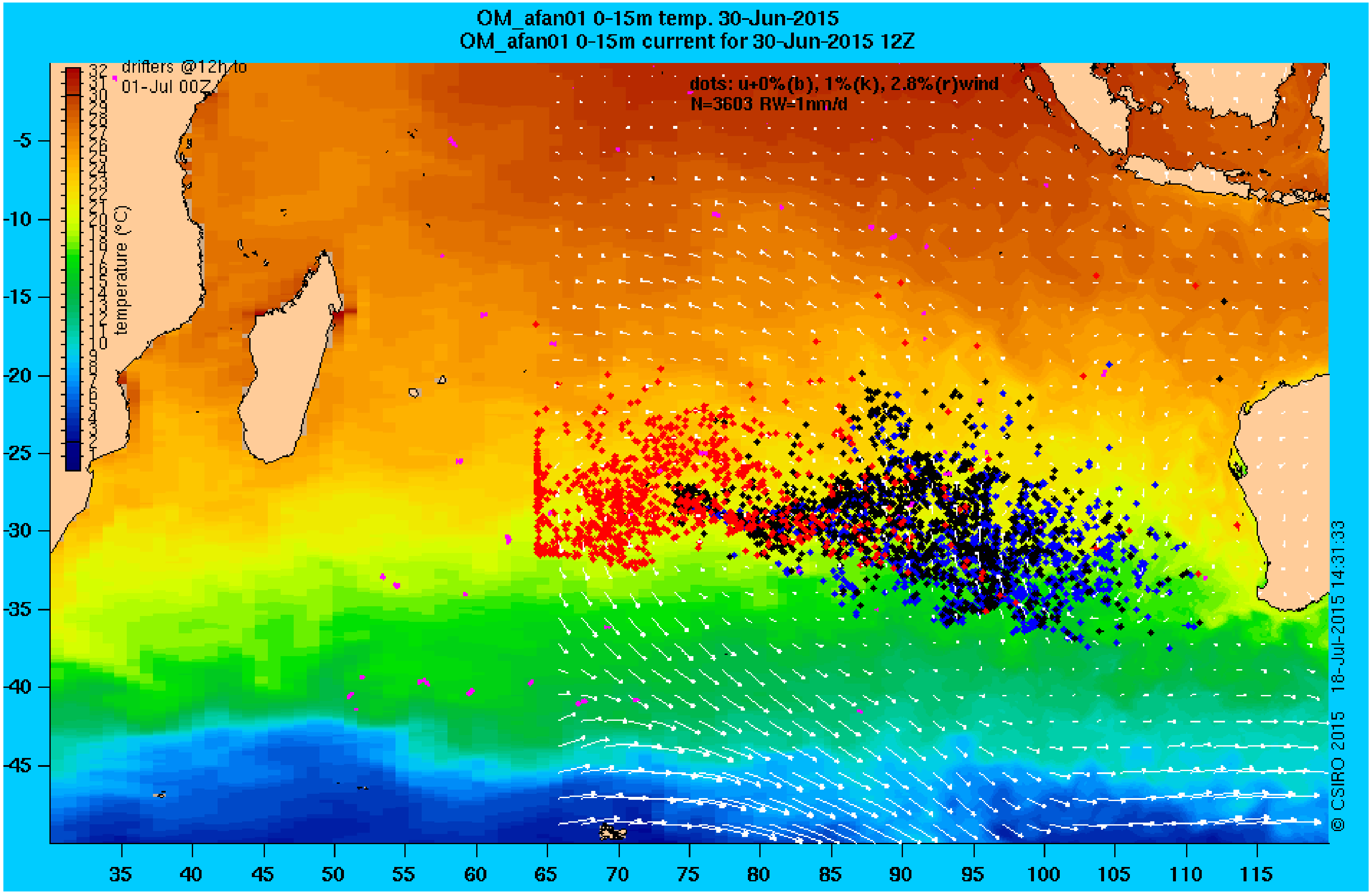
The bigger picture – 8 March



30 Sep 2014 – closest to WA



30 June 2015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drifters @12h to
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© CSIRO 2015 18-Jul-2015 14:31:33
-5
-10
-15
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35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115

Thank you

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