EFFECT OF WIND FORCING ON BIAS IN WAVE MODEL FORECASTS

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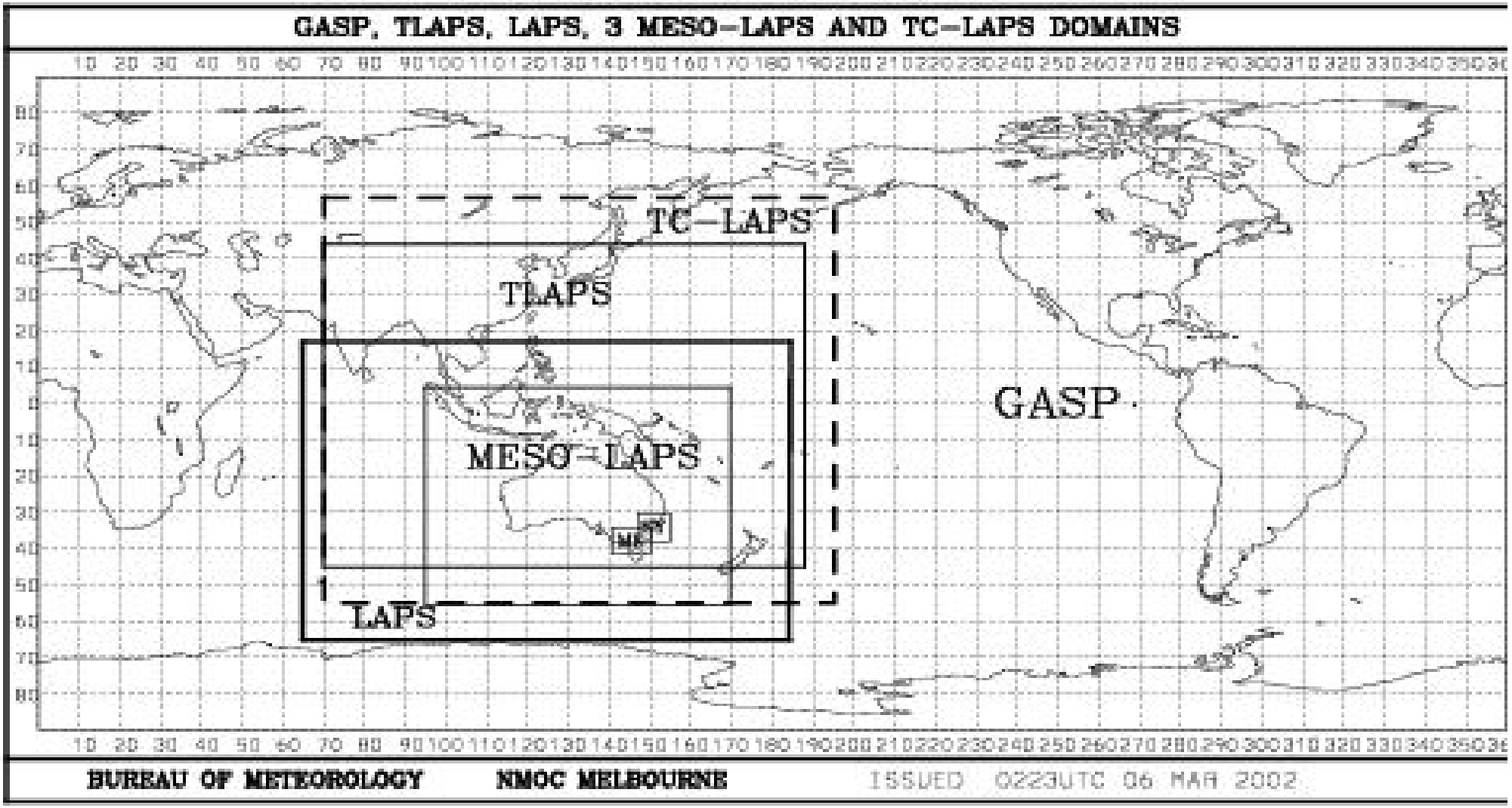
Overview

- Brief description of current operational systems
- Verification of Marine Winds
  - Previous (2002) results
  - Effect of model upgrade
- Wave Model Performance
  - Using statistically corrected winds
  - Impact of improvements in forecast winds
- Summary

Operational NWP Systems

- LAPS (Limited Area Prediction System)
  - Various domains of differing resolution
  - Concentrate on LAPS_375 (0.375^{o} horizontal resolution)
- GASP (Global Assimilation and Prediction System)
  - Spectral model, currently T239 (approx. 0.75^{o} horizontal resolution at equator)

Model Domains

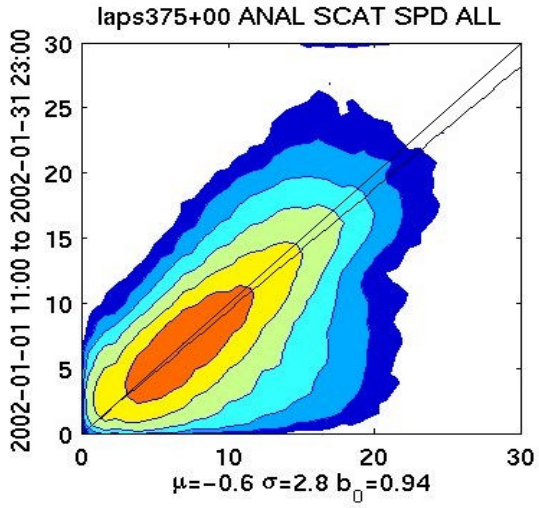


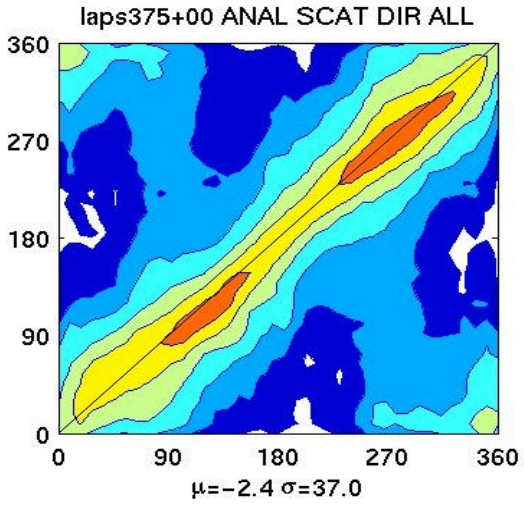
Operational Wave Models

- WAM – run over 3 domains
- Global
  - Forced by 3-hourly time-averaged winds from GASP
- Regional
  - LAPS domain
  - Forced by instantaneous hourly winds from LAPS
- Meso-Scale
  - MESO_LAPS domain
- Global and Regional Models use deep water physics only and include assimilation of altimeter wave data

Verification of Marine Winds

- Limited by availability of representative *in situ* observational data
- Availability of remotely sensed data
  - Scatterometer winds
    - Spatial average over scale of 25 km
    - Available over entire domain
    - Some QC issues (but known)
    - (was) Independent data


laps375+00 ANAL SCAT SPD ALL
2002-01-01 11:00 to 2002-01-31 23:00
μ=-0.6 σ=2.8 b0=0.94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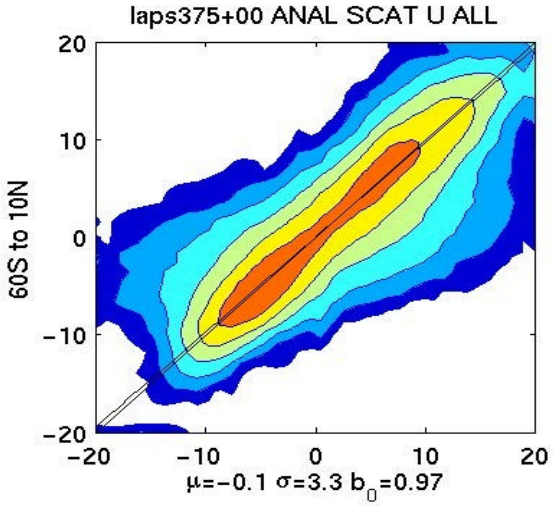
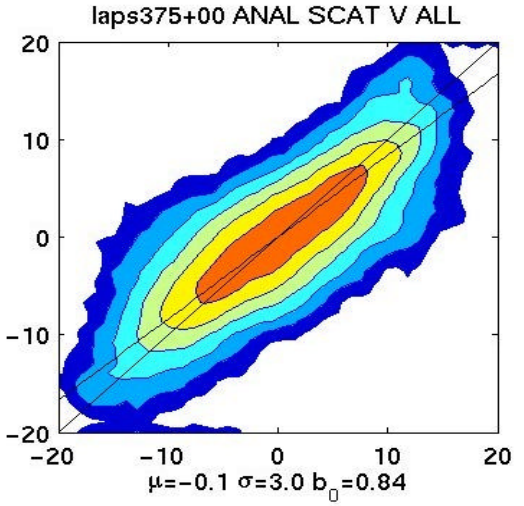
μ=-2.4 σ=37.0


laps375+00 ANAL SCAT U ALL
60S to 10N
μ=-0.1 σ=3.3 b0=0.97

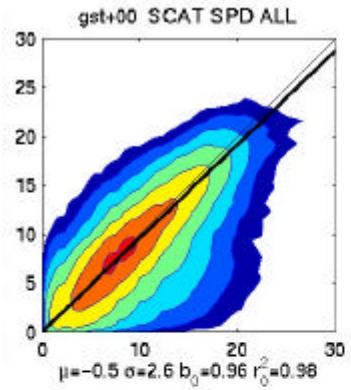

laps375+00 ANAL SCAT V ALL
μ=-0.1 σ=3.0 b0=0.84

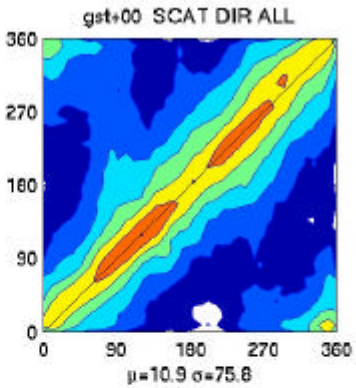
NWP Model Upgrades

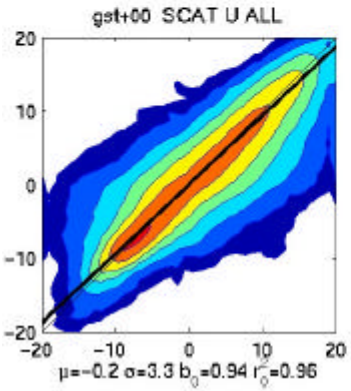
- Current GASP has 29 vertical levels (lowest level ~ 70m)
  - Winds at 10 m interpolated using boundary layer model
- Trial in progress with increase in levels to 33
  - Extra levels in Boundary Layer
  - Lowest level ~ 10 m
  - Allows assimilation of scatterometer data

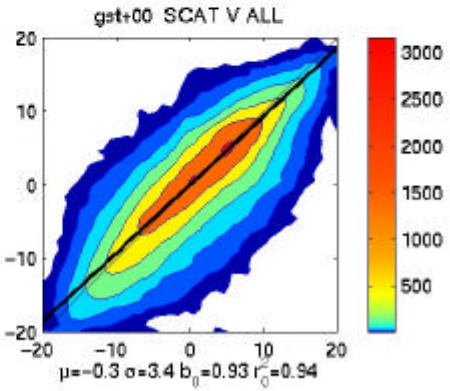
Winds from Operational (L29) Model

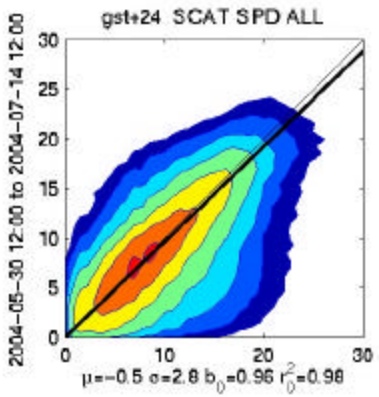
Analysis **24 hr forecast**

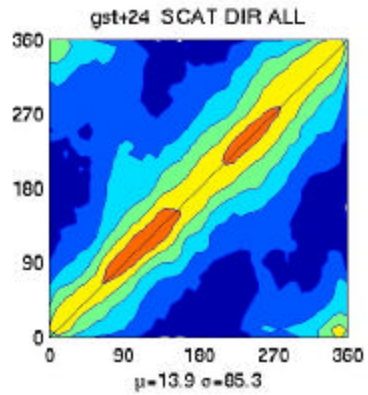


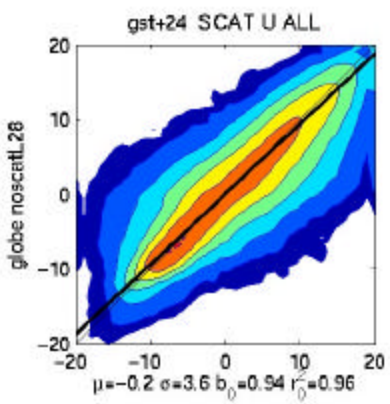


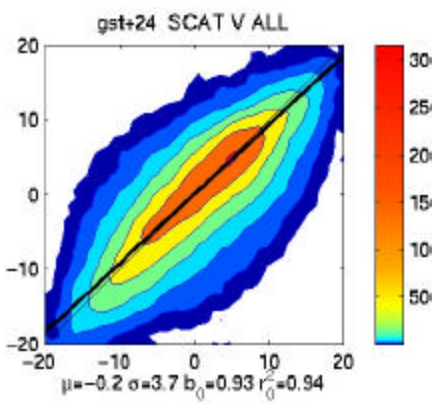












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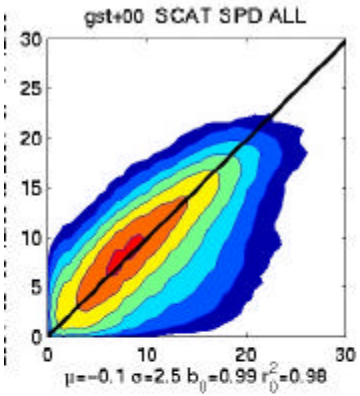
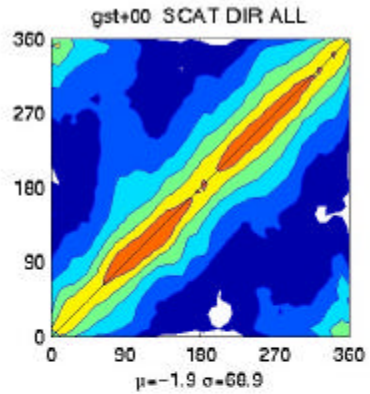
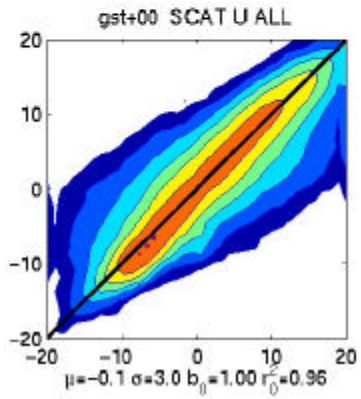
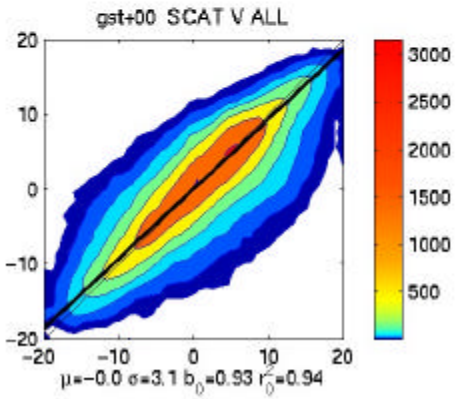
Winds from Test (L33) Model (with scatt assimilation)

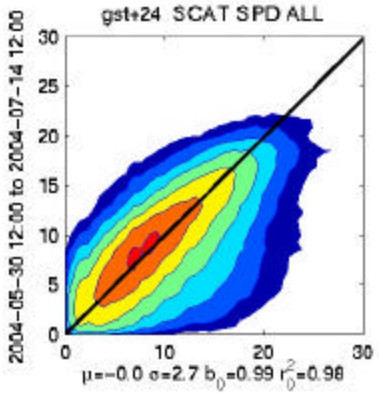
Analysis **24 hr forecast**

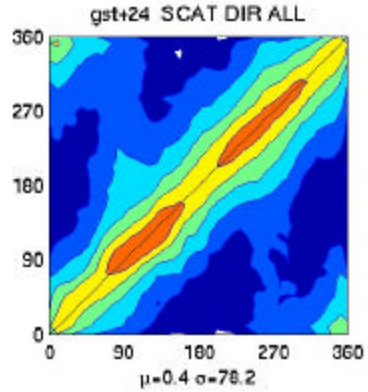


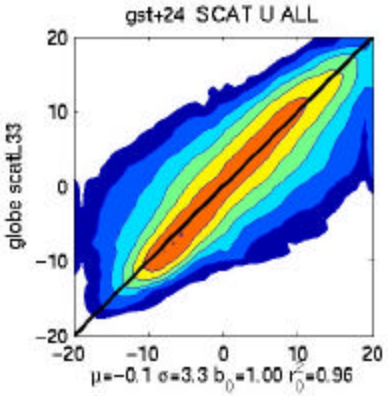


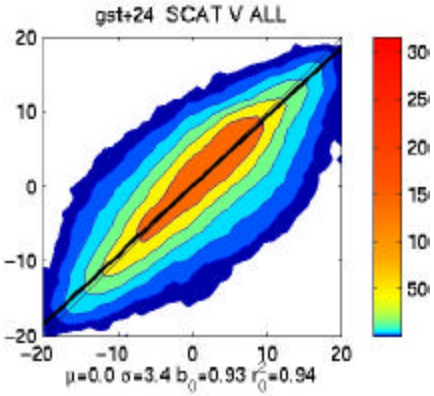












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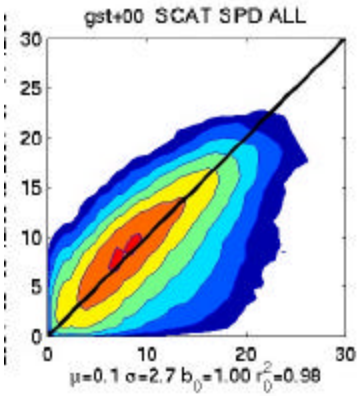
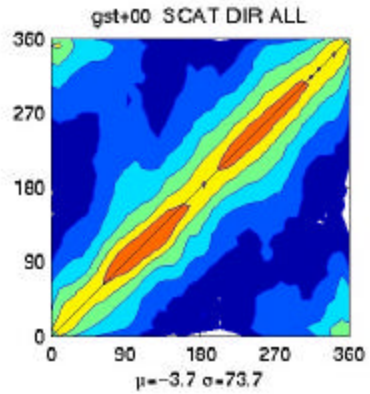
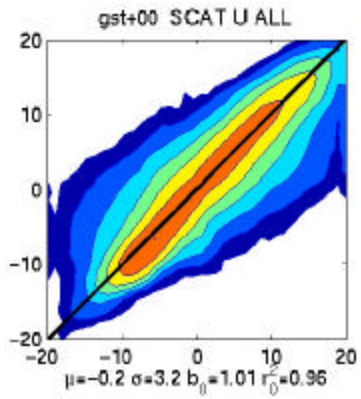
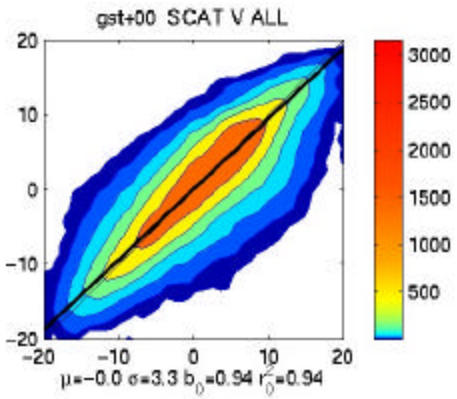
Winds from Test (L33) Model (without scatt assimilation)

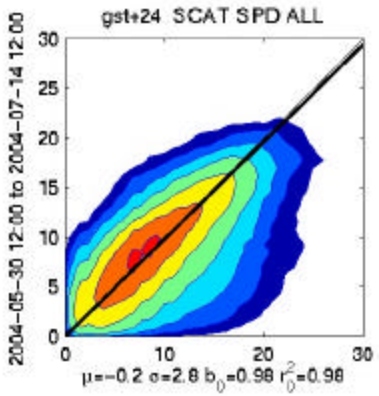
Analysis **24 hr forecast**

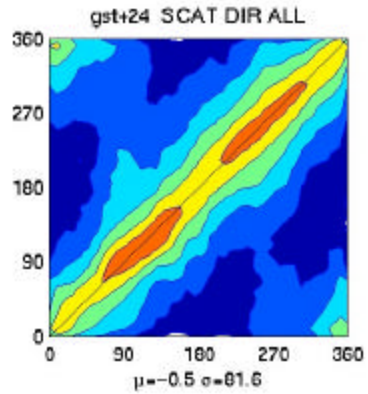


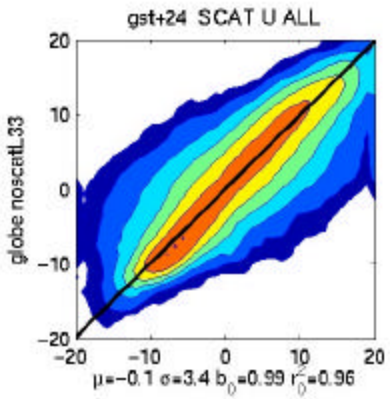


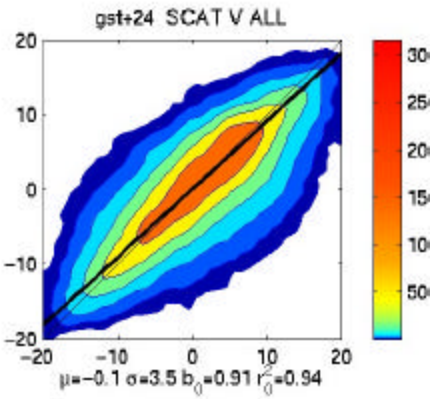












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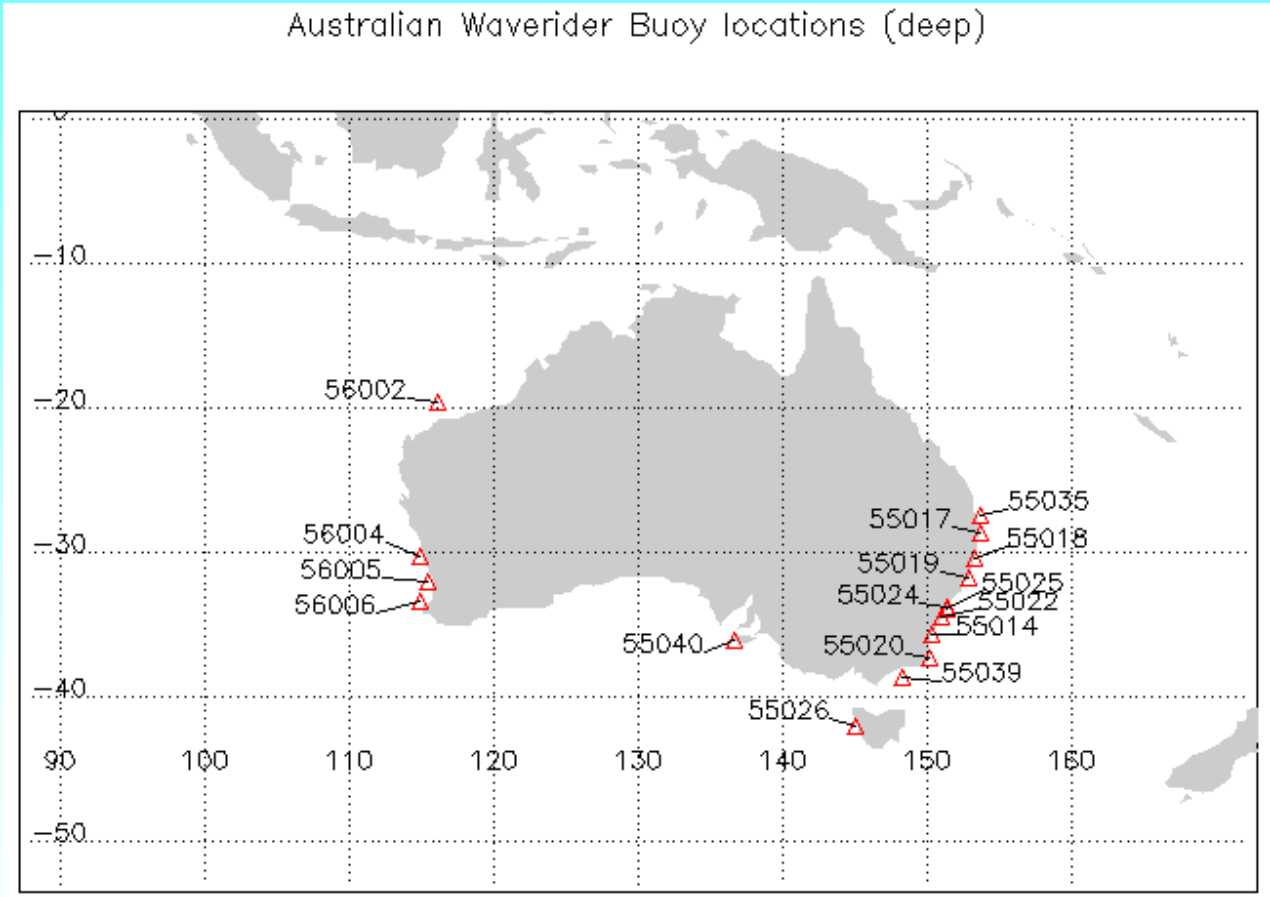
Wave Verification Sites



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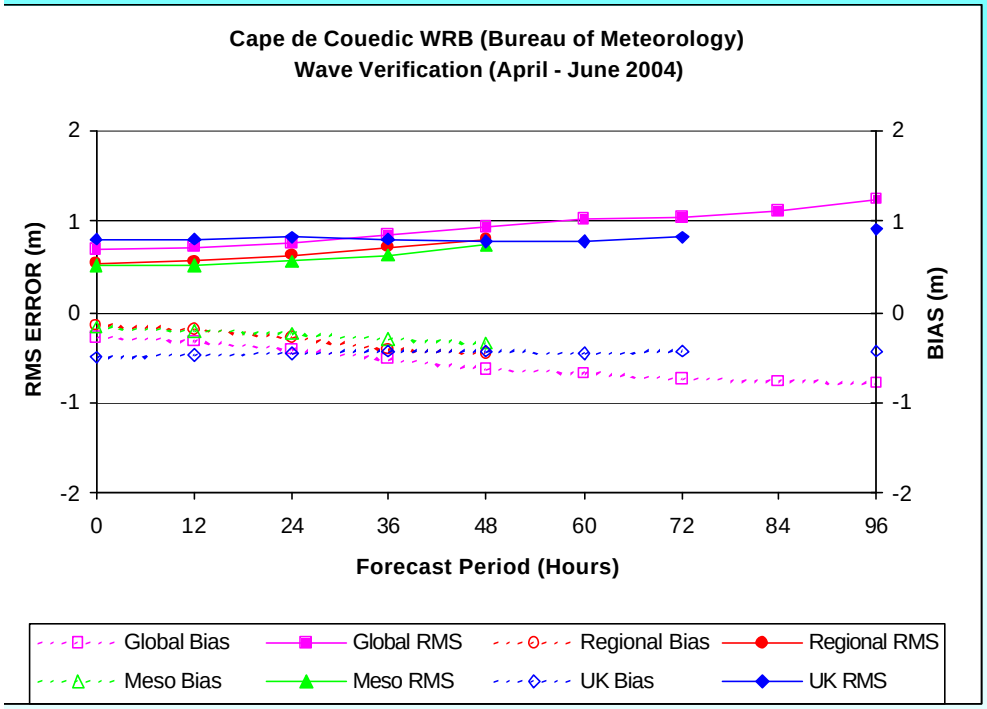
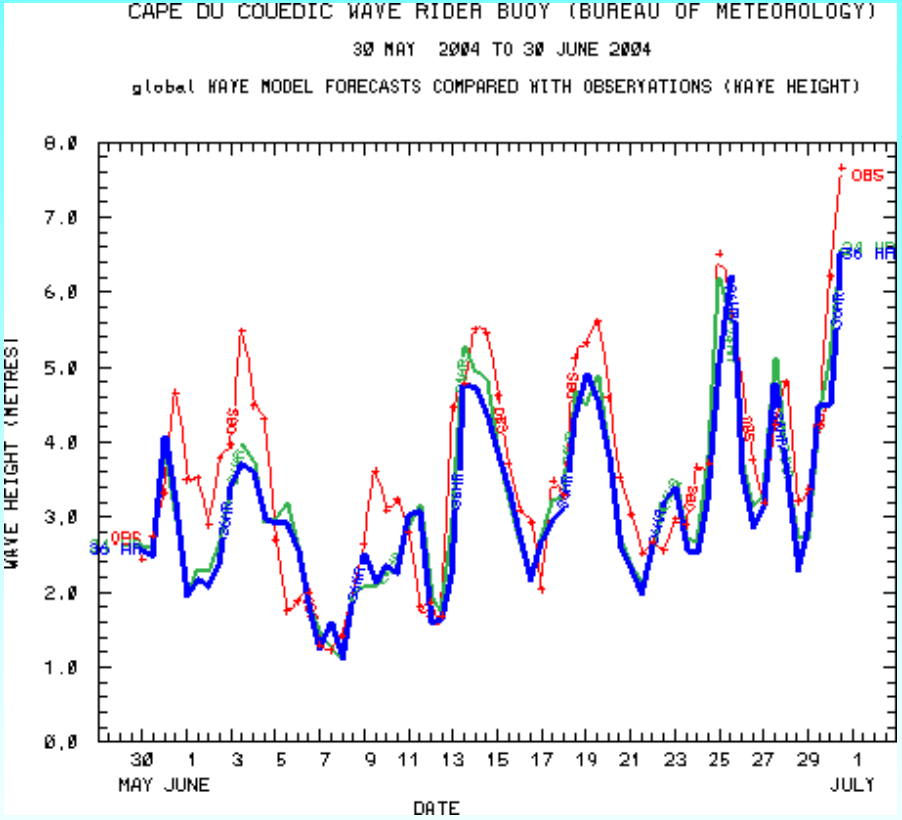
Routine Verification



RMS and Bias



Time-series of observations and forecasts

Using Statistically Corrected Winds

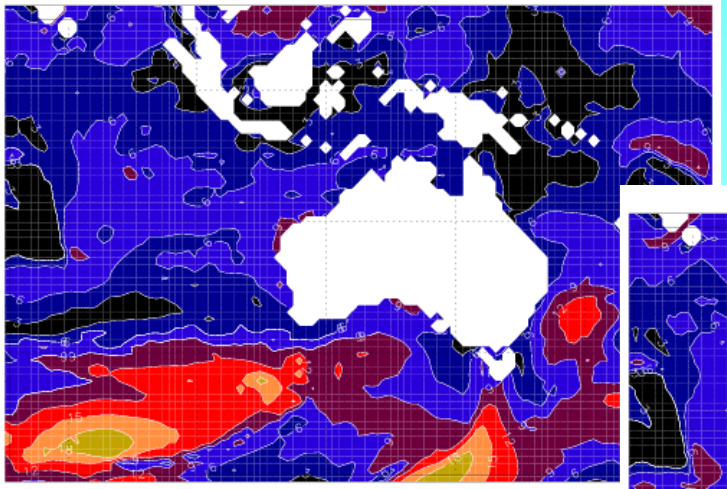
- For fully developed sea: $$SWH = \frac{0.22 U_{10}^2}{g}$$

- So worth investigating effect of wind bias
- From before:

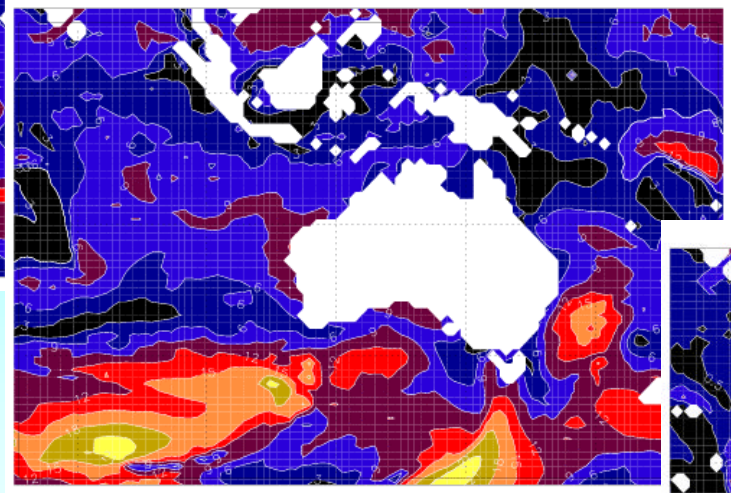
$$u_{\text{adj}} = 1.11 u_{\text{opnl}}$$
$$v_{\text{adj}} = 1.25 v_{\text{opnl}}$$

- Wave model run with this adjusted wind forcing

Wind Forcing

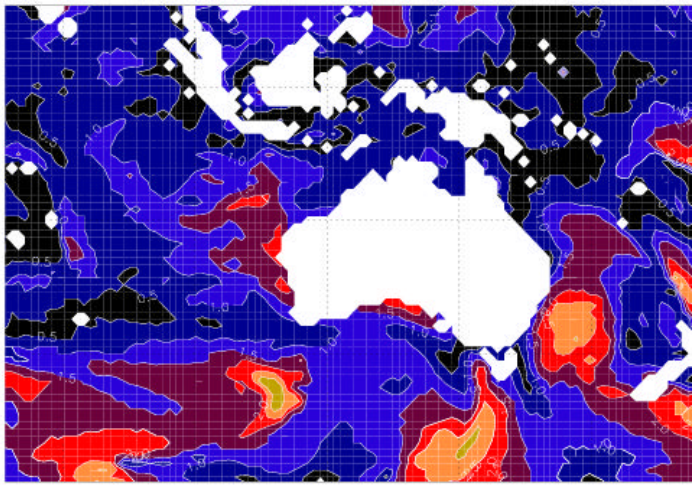


Operational 10-m winds

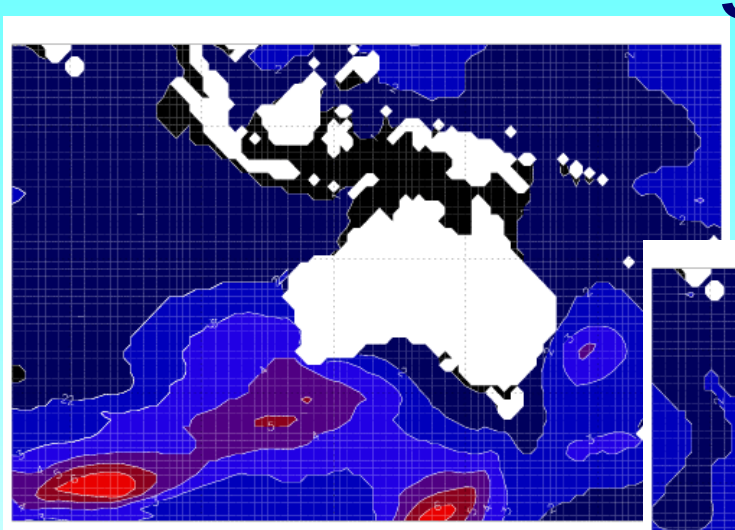


Adjusted 10-m winds

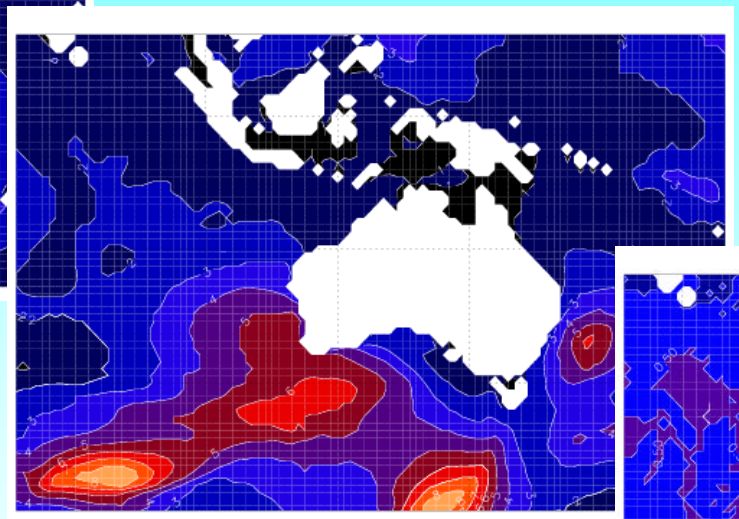
Difference



Modelled Significant Wave Height

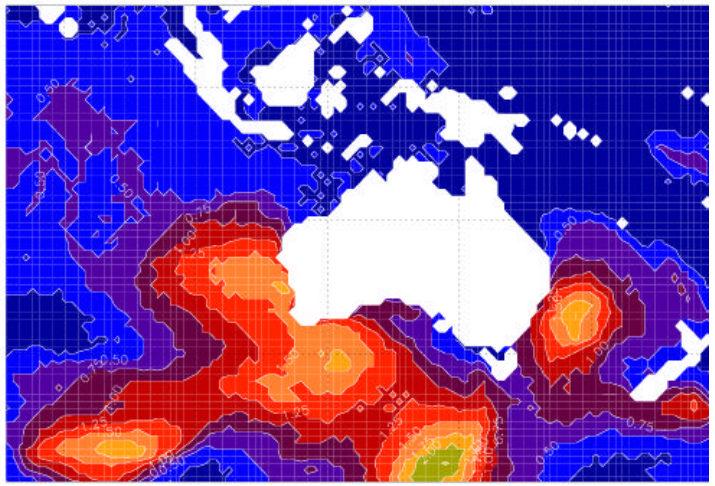


Operational 24 hr wave forecast

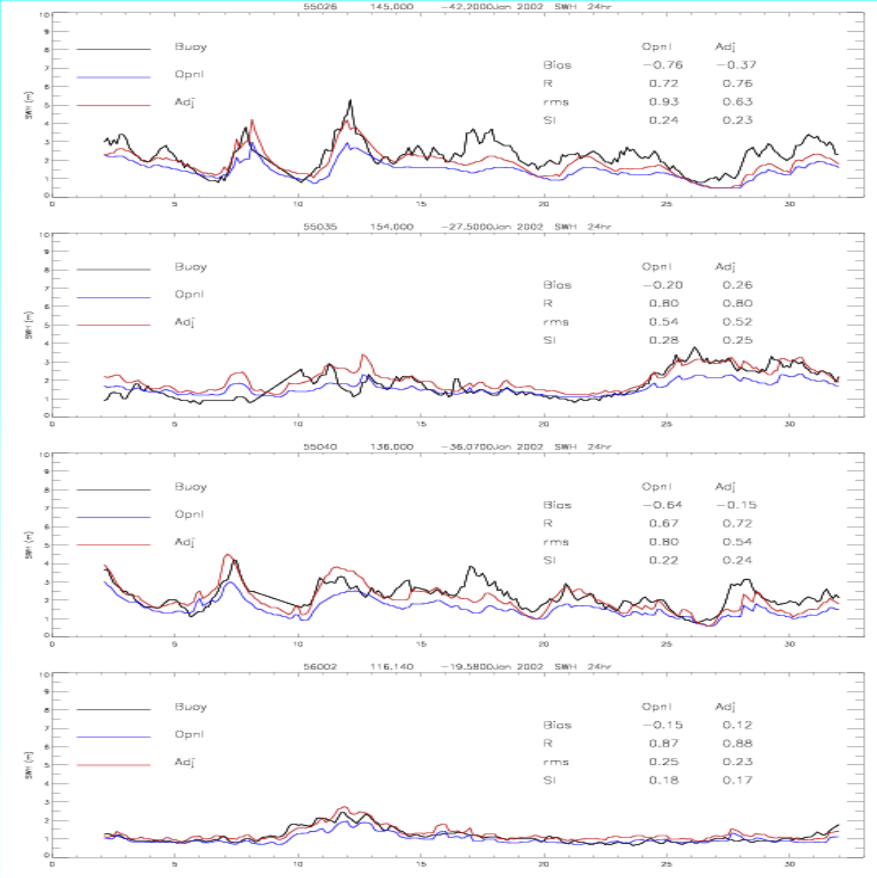


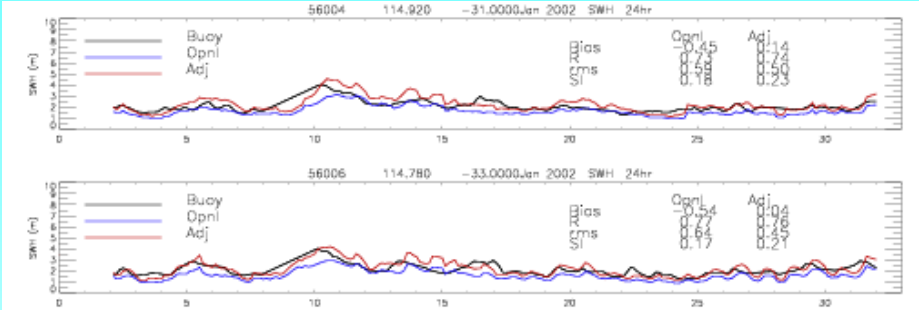
Adjusted SWH forecast

Difference

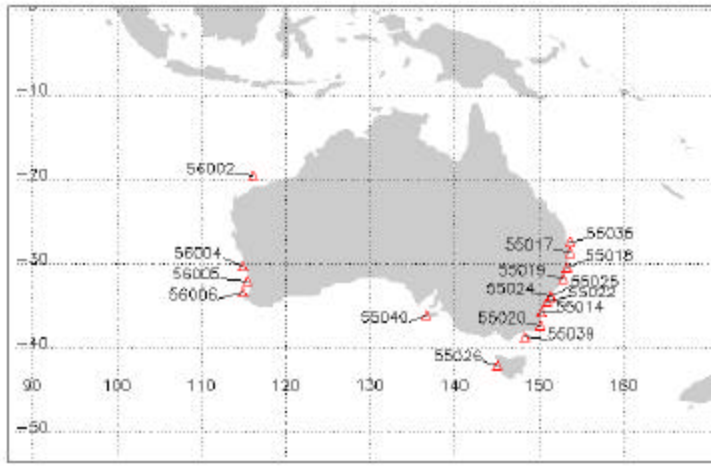


Verification against *in situ* data





Australian Waverider Buoy locations (deep)



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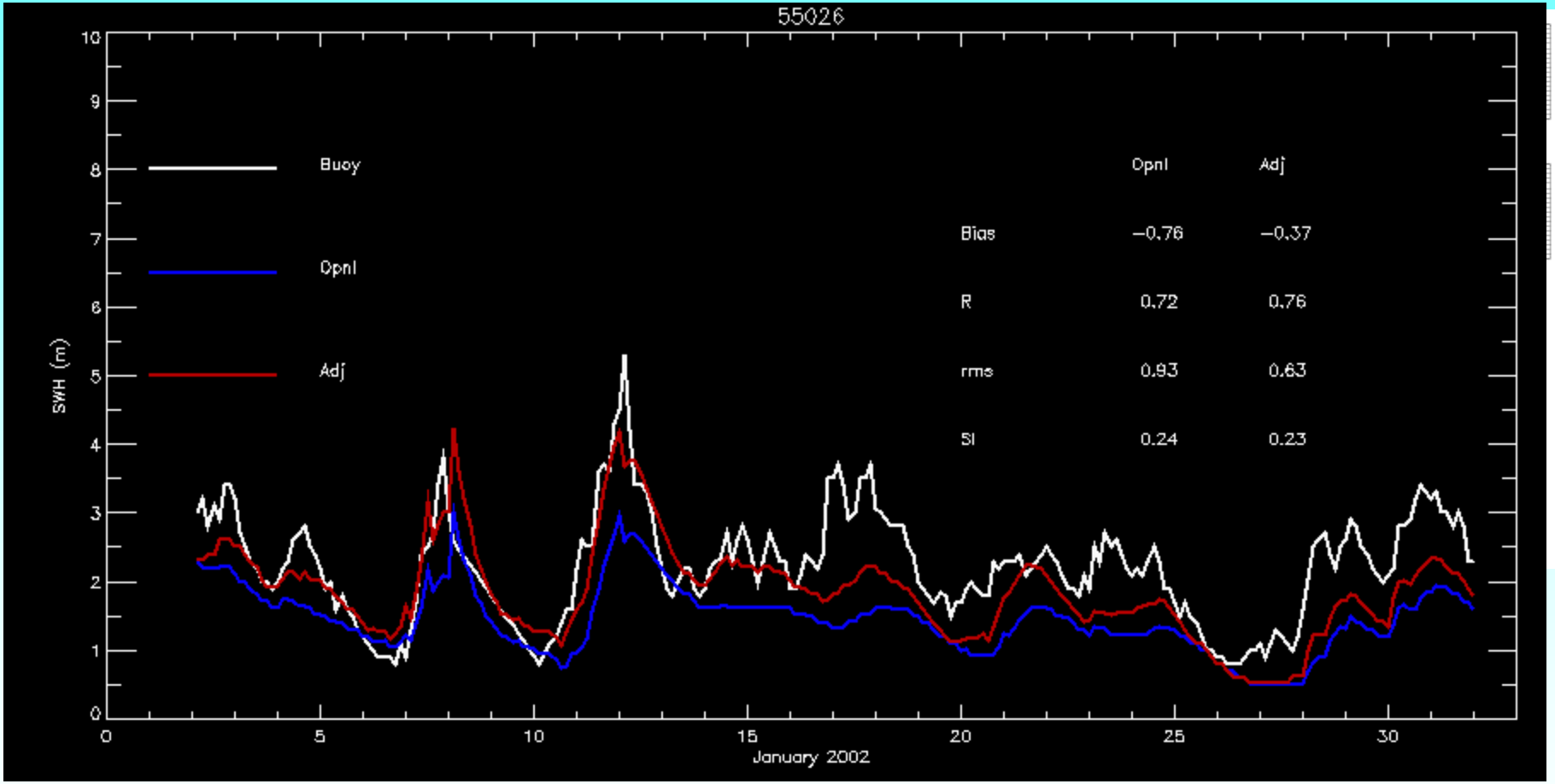
Verification at Cape Sorell (55026)



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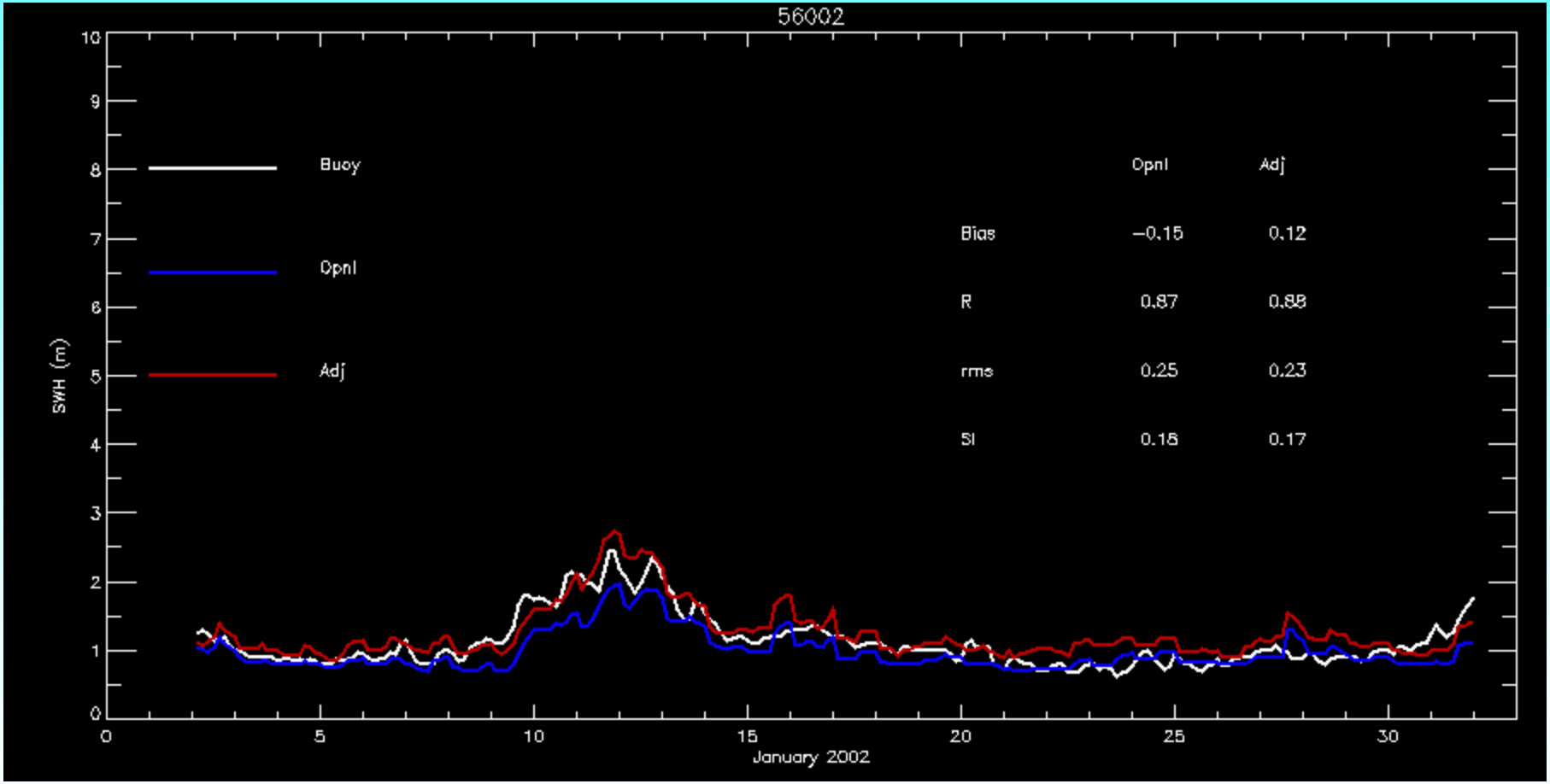
Verification at North Rankin (56002)



Impacts

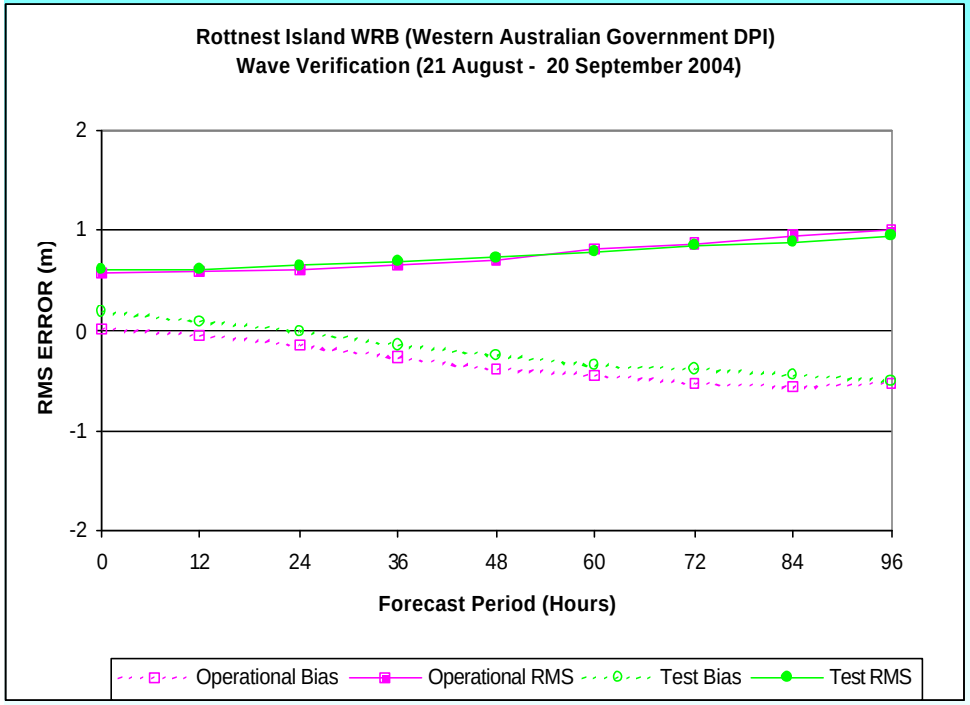
- Mean operational wind speed = 6.6 m s^{-1}
- Mean adjusted wind speed = 7.7 m s^{-1} (+17%)

- Mean increase in SWH = 0.42 m (+21%)
- Adjusted wind speed accounts for much of the observed bias in the wave model

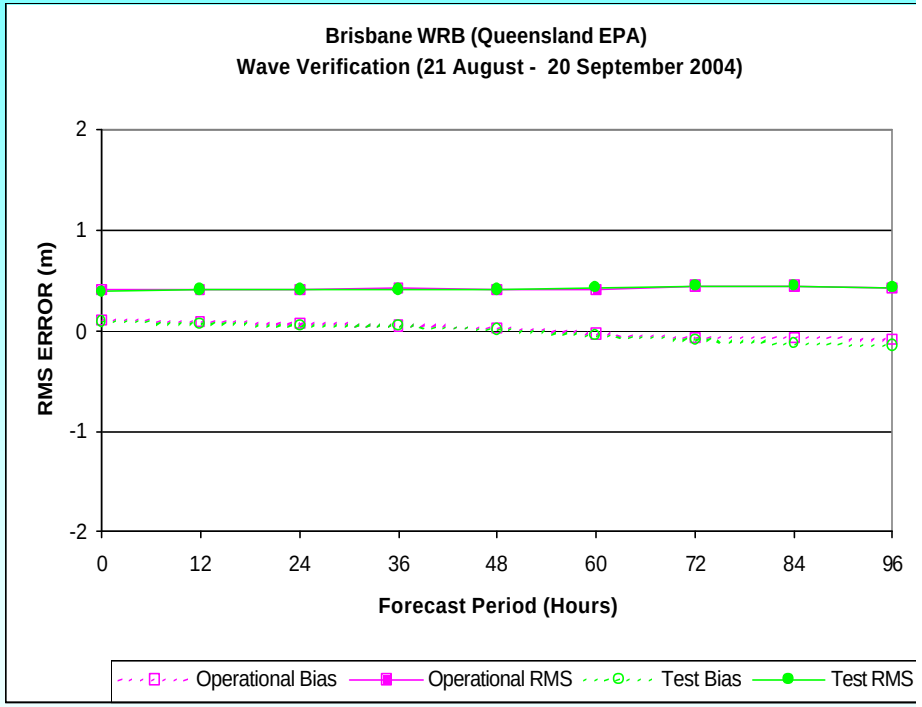
Effects of Improvements in Model Forecast Winds

- Test GASP has improved wind forecasts
  - Less bias
- Used to force wave model run in parallel with operational system (same configuration)
- Same starting fields but will evolve differently
- Compare results at *in situ* locations

Verification



Rottnest Island (56005)



Brisbane (55035)

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Impacts

- Differences at the two sites (geographical effect?)
- Brisbane not exposed to swell sfrom southern Ocean
- At Rottnest Island (and other sites) reduced bias
  - BUT
    - Positive bias for short term forecasts
    - Still negative bias for longer term
  - Does model predict intensity of weather systems
  - Do source terms in WAM need to be tuned

Conclusion

- Negative bias in wind forecast contributes to negative bias in wave forecast
- Correcting wind bias accounts for most of bias in wave forecast
- No bias in upgraded wind forecast but still bias in wave forecasts
- Does wave model need re-tuning?