Recent and Future Changes Affecting Met Office Models' Tropical Cyclone Predictions

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Tropical Cyclone Operations and Research Forum

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Outline

- Recent upgrades to Met Office models
  - Model upgrade in 2014
  - New initialization technique in 2015
  - Impact of the above on tropical cyclone intensity and track predictions
- Future plans for Met Office models
- Challenge for the future: Rapid Intensification
- Tropical cyclone products

Recent Upgrades to Met Office Models

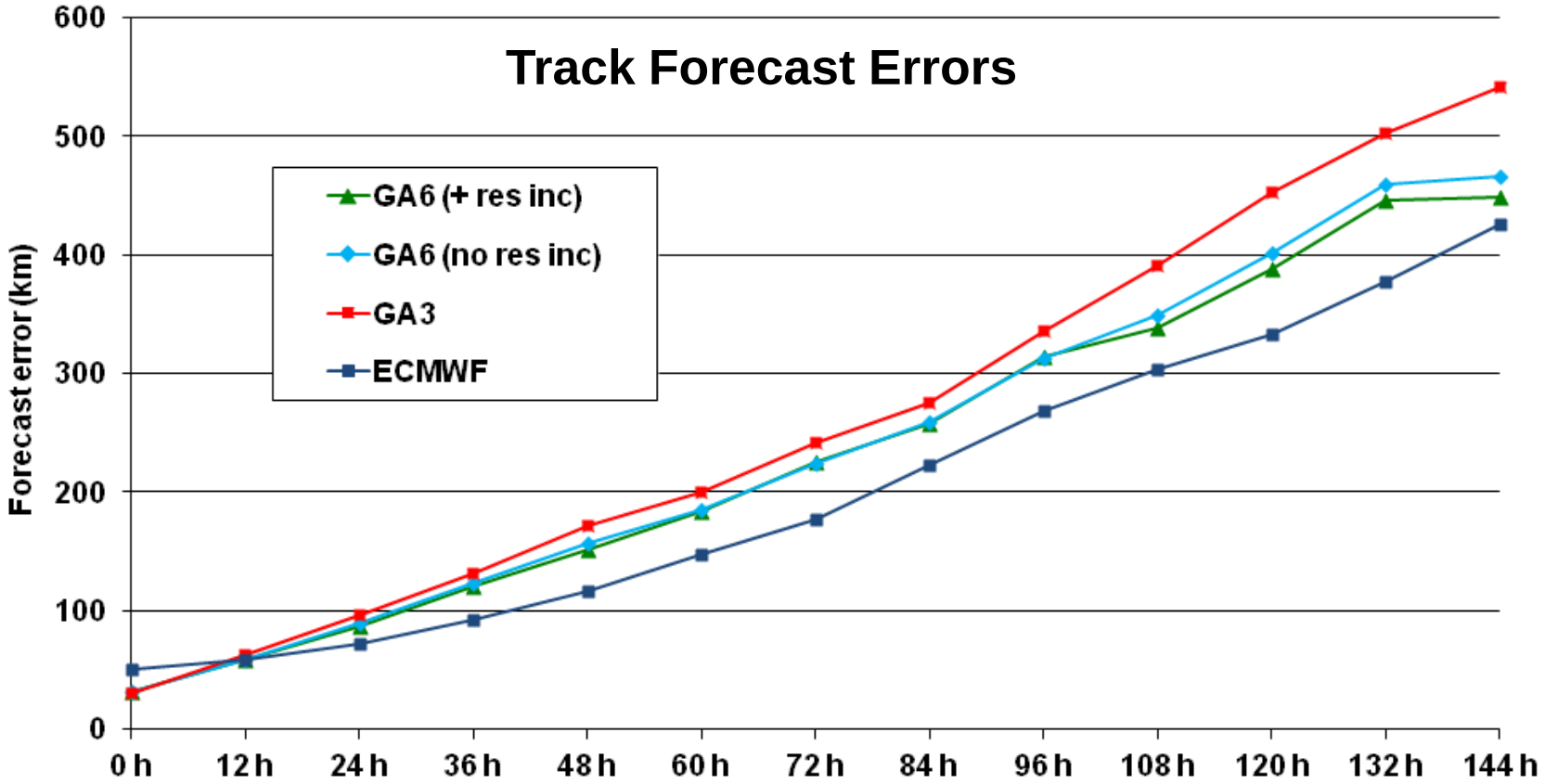
Model Upgrade in 2014

- Major upgrade July 2014 to Global models – known as GA6
  - ENDGame dynamical core
  - Numerous physics changes
  - Deterministic model horizontal resolution - ~17 km
  - Data assimilation resolution - ~40 km
  - Improved satellite data usage (IASI/ATOVS/scatt/GPSRO)
  - 24-member ensemble horizontal resolution ~33km (MOGREPS-G)
  - Improvements to storms (tropical and mid-latitude), MJO, jet-level winds, gravity waves
- Published paper to come soon
  - http://www.metoffice.gov.uk/research/news/2014/endgame-a-new-dynamical-core

Impact of model upgrade (GA6)

Trial periods from 2012

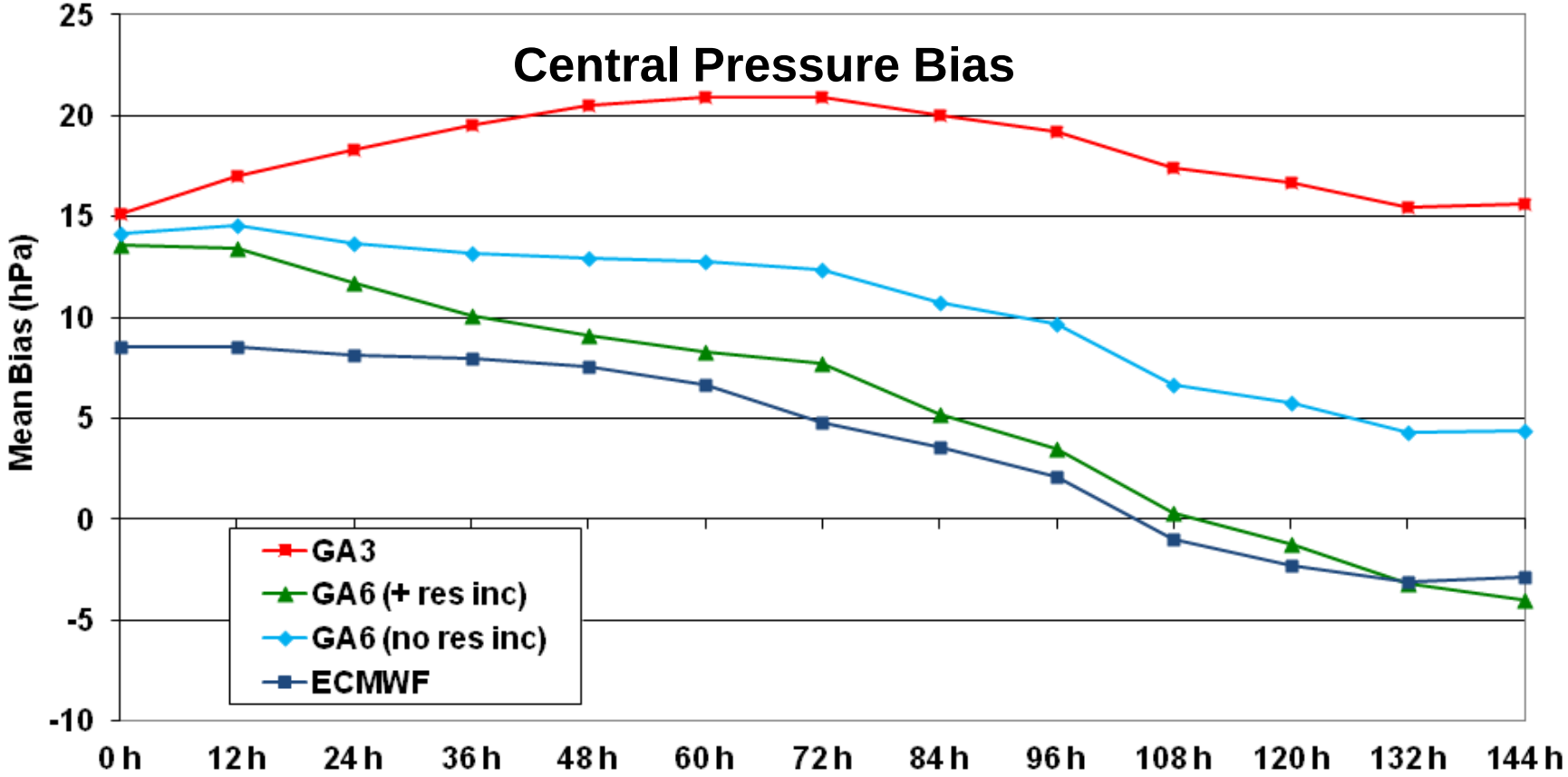
- GA6 + res inc TC track forecast errors 8.6% lower than GA3
- Most impact from dynamics/physics/DA



Impact of model upgrade (GA6)

Trial periods from 2012

- GA6 reduces weak bias, particularly at longer lead times
- Resolution change an important component



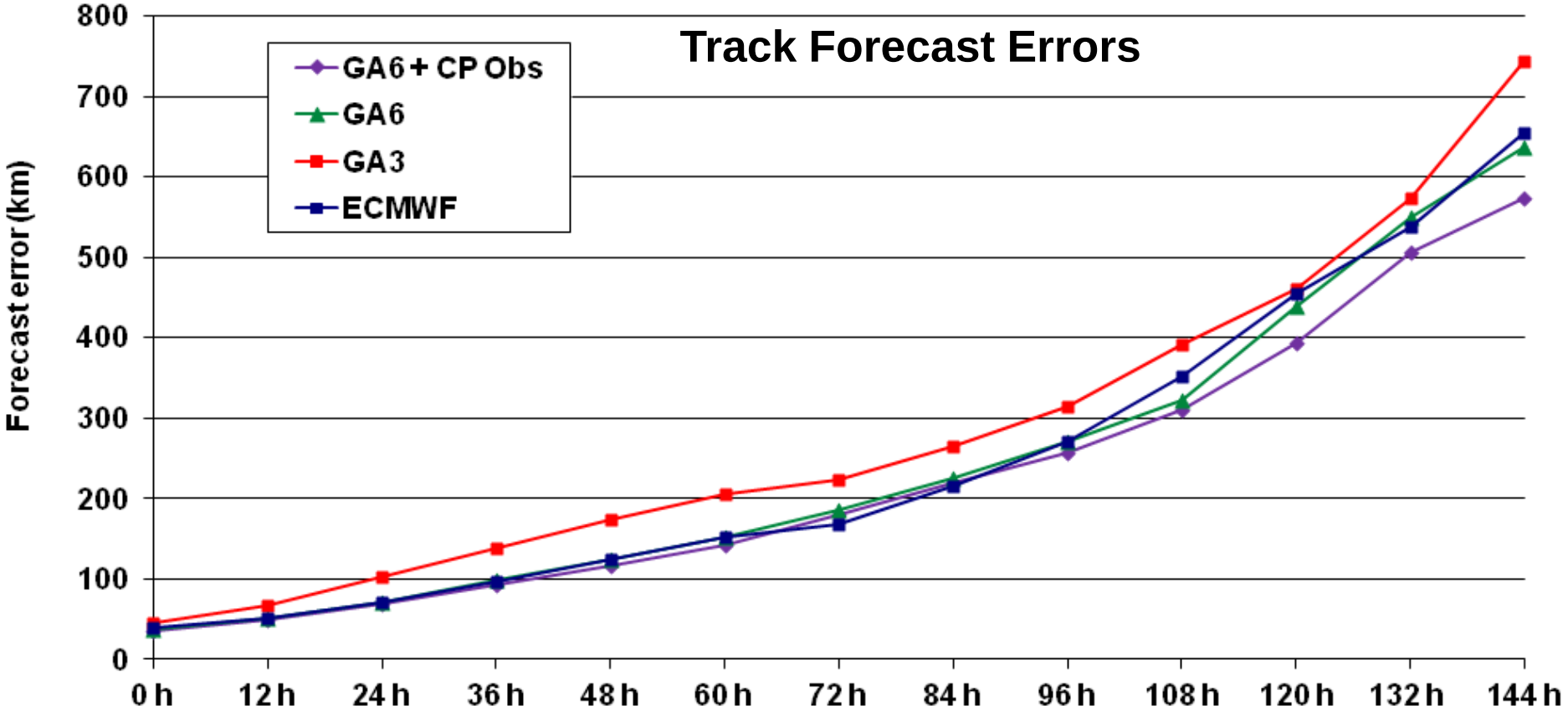
Initialization of tropical cyclones

- Old scheme introduced 1994
  - based on ‘bogus’ observations of lower tropospheric winds
  - Initially resulted in 30% reduction in TC track error
  - Impact reduced with time and eventually removed in 2012
- New scheme introduced February 2015
  - Assimilation of central pressure estimates from TC warning centres
  - 3 or 6-hourly estimates interpolated/extrapolated to produce hourly ‘observations’
  - Positive impact for both track and intensity predictions

Impact of new initialization

Trial period from 2013

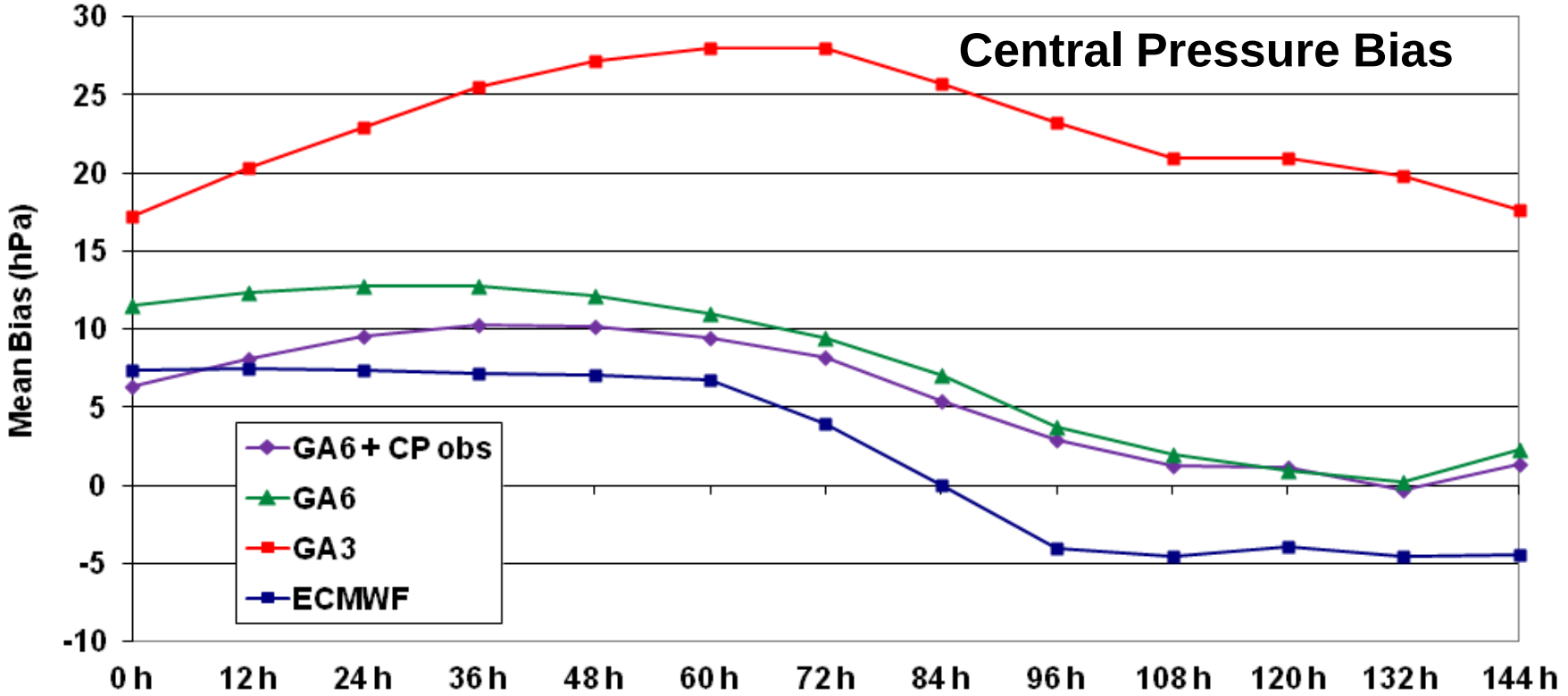
- GA6 + CP obs TC track forecast errors 6.2% lower than GA6 and 30.9% lower than GA3



Impact of new initialization

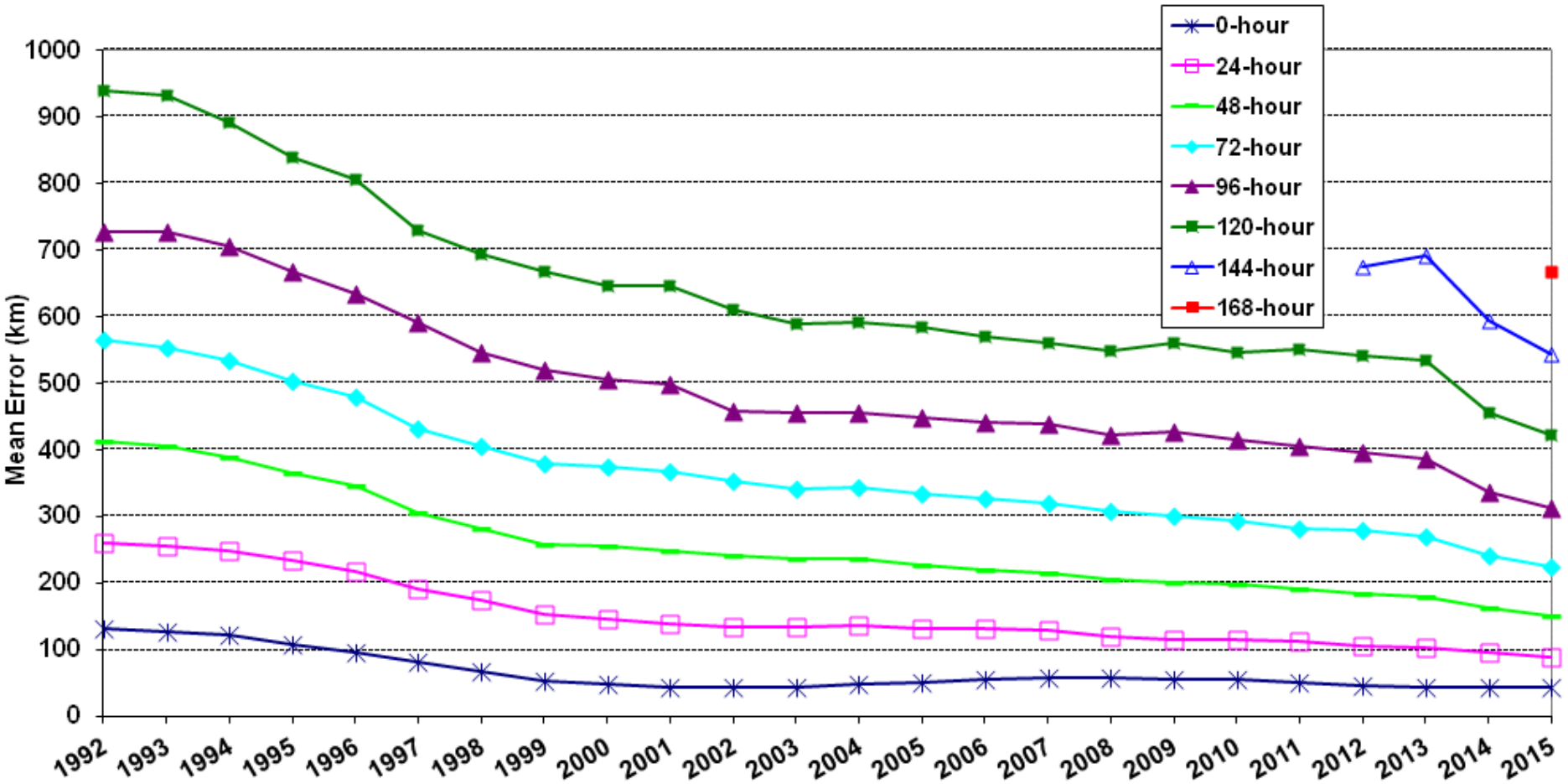
Trial period from 2013

- GA6 + CP obs reduced bias at short lead times
- Forecast mean absolute error reduced by 1.6 mb (against GA6) and 9.3 mb (against GA3)



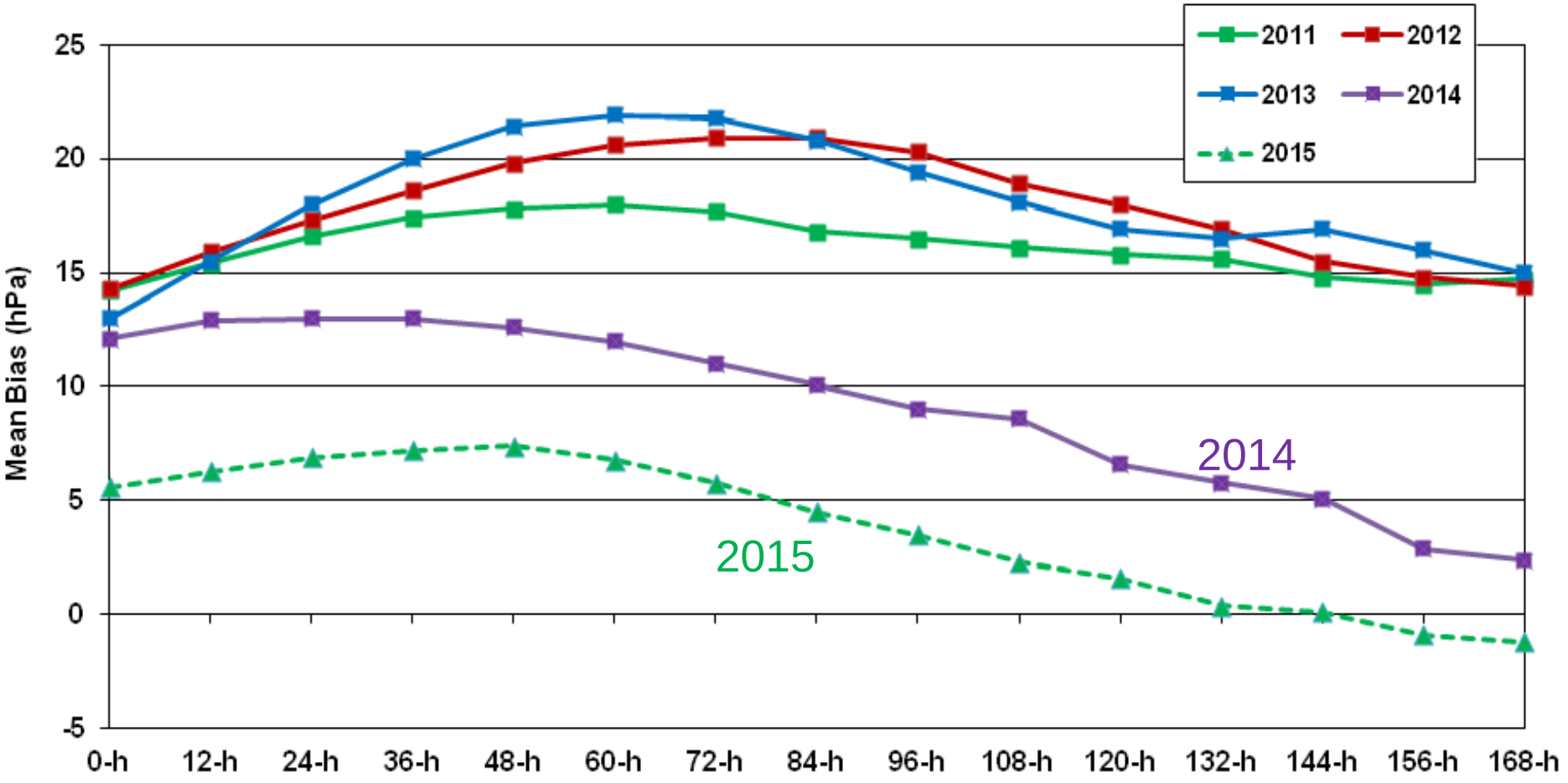
Met Office Global Model Northern Hemisphere TC Track Errors

- 5-year running mean shows significant reduction in 2014-15



Met Office Global Model Northern Hemisphere TC Central Pressure Bias

- Large reductions in bias seen in 2014 and 2015

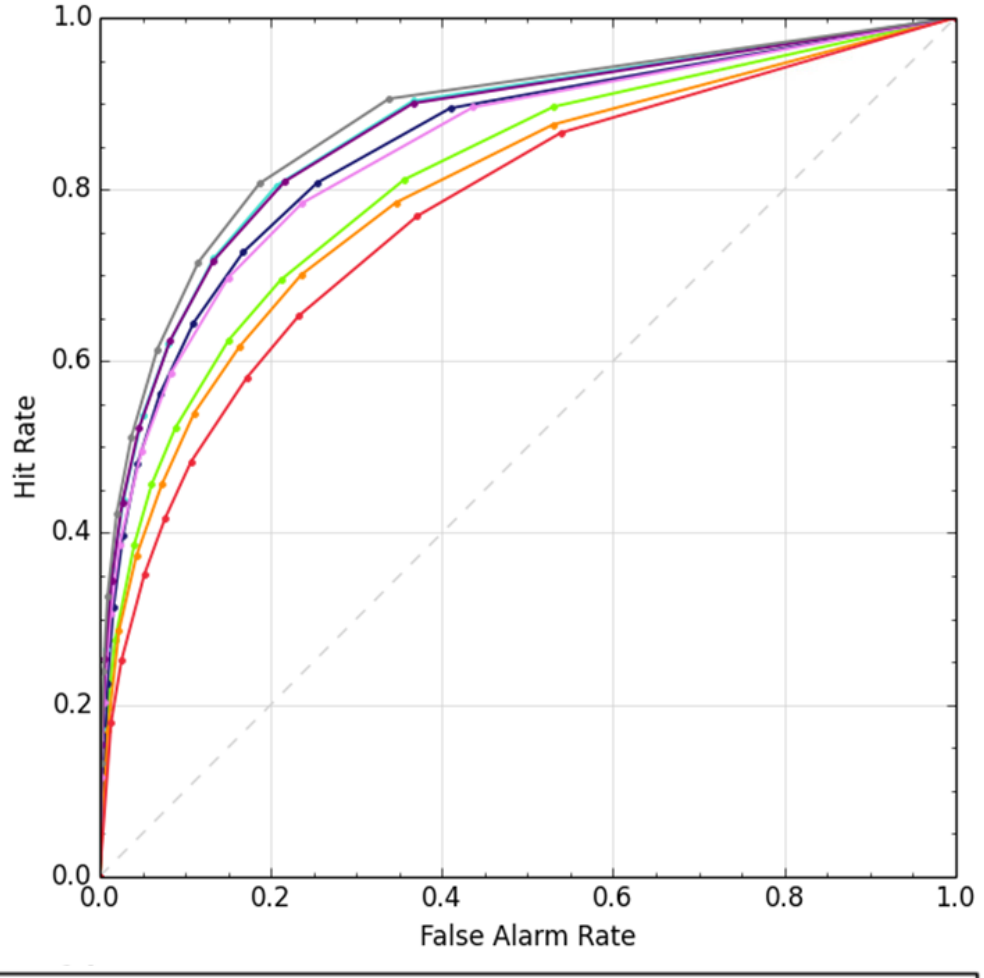


Ensemble Prediction Schemes Relative Operating Characteristics

July 2014-July 2015

- MOGREPS-G score higher than MOGREPS-15 and GEFS, but lower than ECMWF

- Multi-model ensemble (MOGREPS-G, GEFS and ECMWF) gives best score



Future plans for Met Office models

Future plans for Met Office models

- 15 March 2016: VarBC (variational bias correction), new satellite data
  - Variable, but near neutral for TC track and intensity
  - Globally, positive impact on general verification scores

- August 2016: Further changes to satellite data usage
  - Assessment on TC predictions to be undertaken
  - Deterministic forecast data extension to seven days

Future plans for Met Office models

- Early 2017: GA7 – next major science upgrade
  - Changes focused on clouds and radiation
  - Horizontal resolution: Deterministic 10 km or 12 km, Ensembles 20 km
  - Full assessment being carried out in next few months

- Late 2017/early 2018: GA8 – science upgrade
  - Full details to be finalised
  - Convection changes focussed on tropical performance

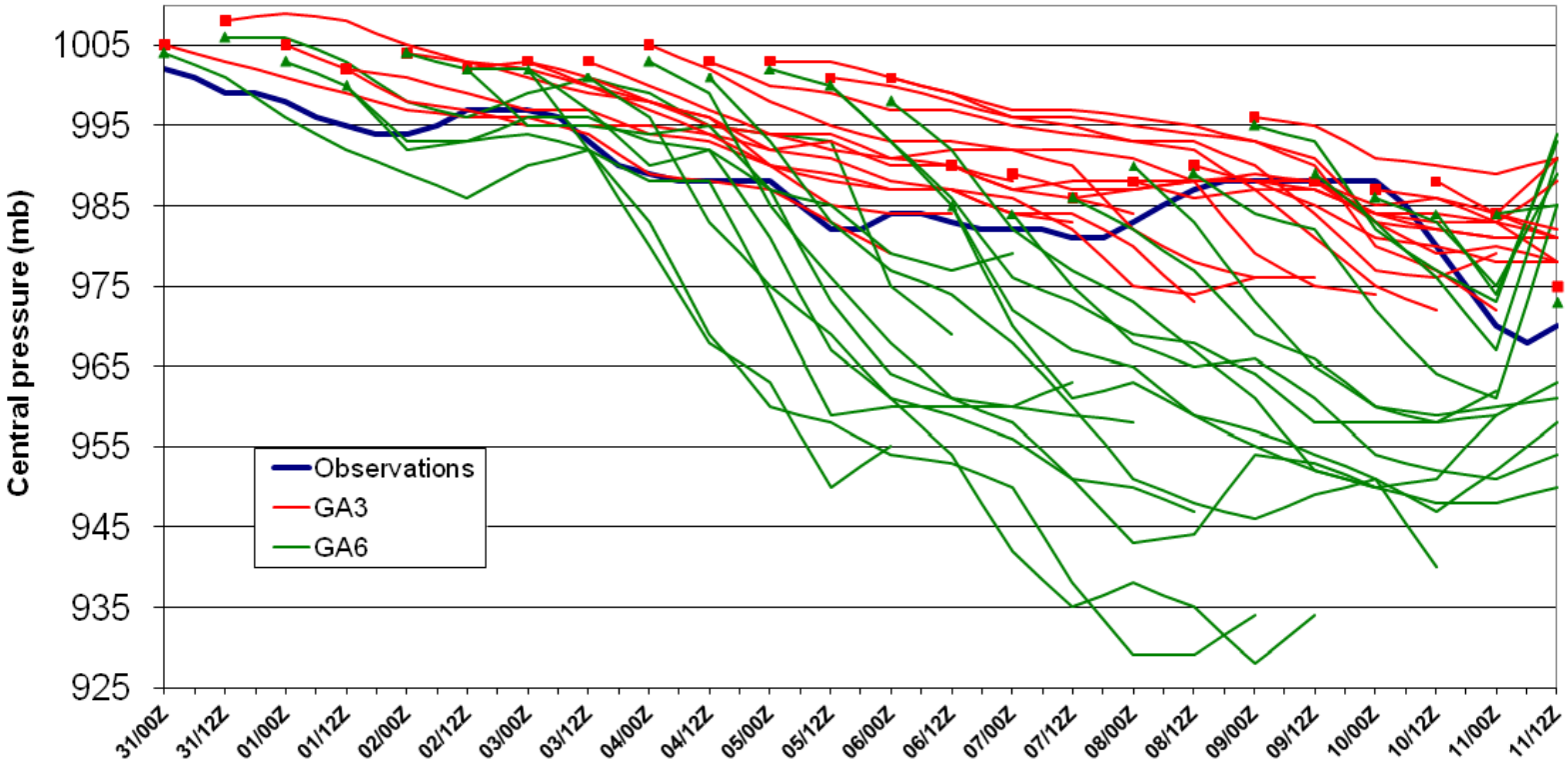
Future plans for Met Office models

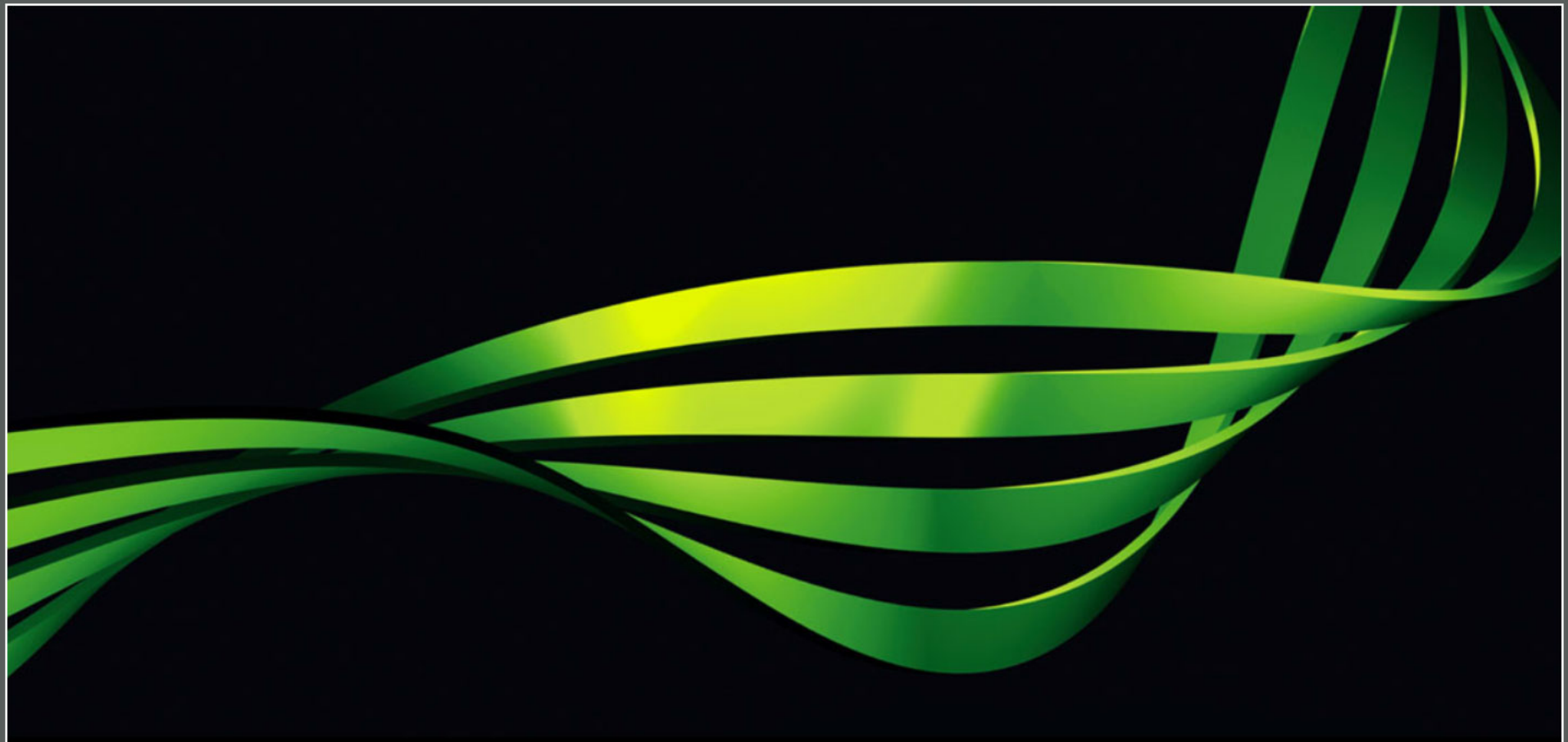
- 2018 onwards – resolution changes:
  - Seasonal to ~25 km (currently 60 km) early 2018
  - Deterministic L120-L200 (currently L70) 2018/2019 time frame

- Coupled NWP model
  - Implementation 2019 at earliest
  - Initial trials show representation of cold wakes

Future plans for Met Office models

- Hurricane Leslie (2012) slow-moving, intensity constrained by upwelling
  - More energetic GA6 model resulted in over-deepening

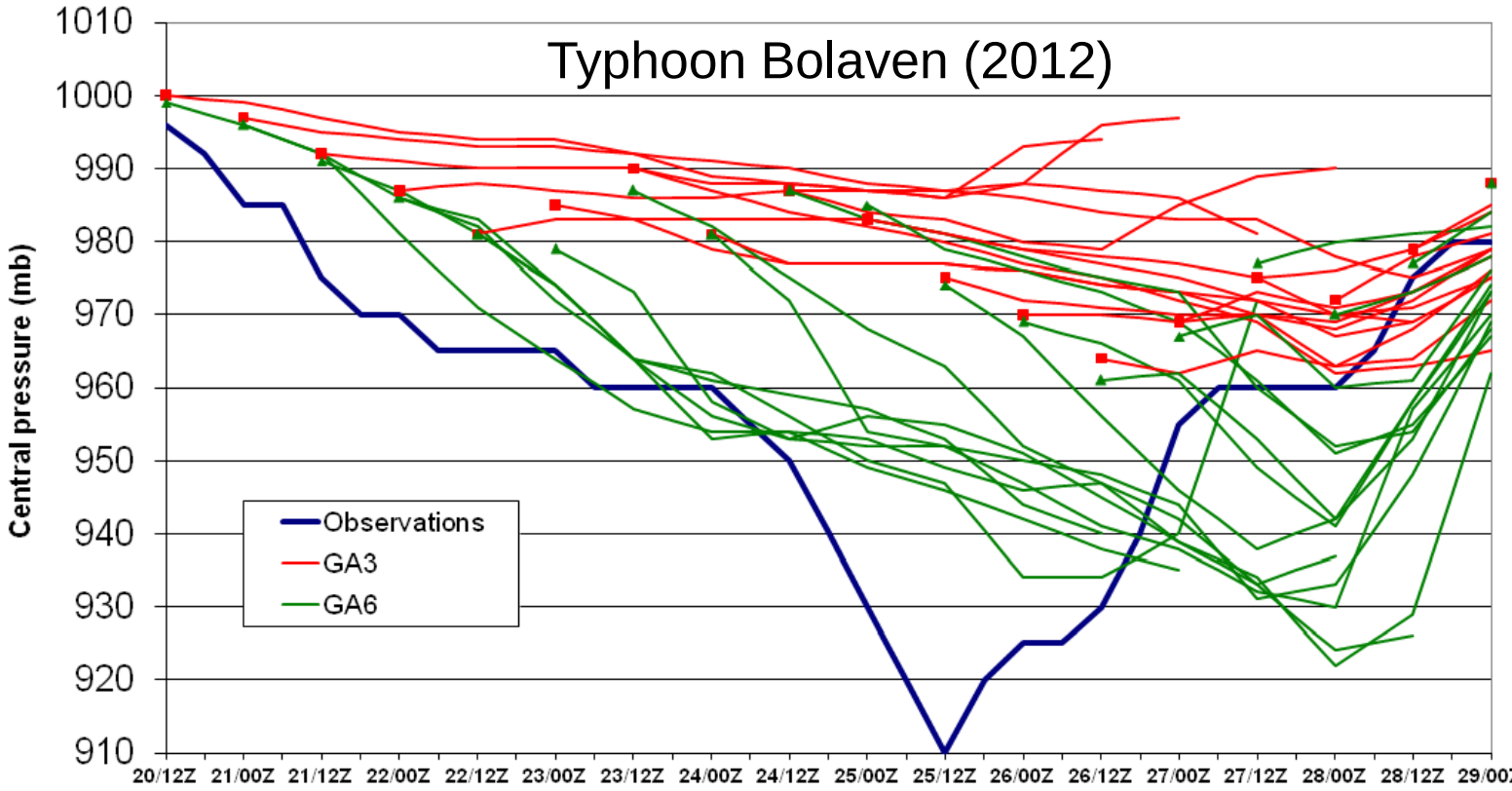




Challenge for the future: Rapid Intensification

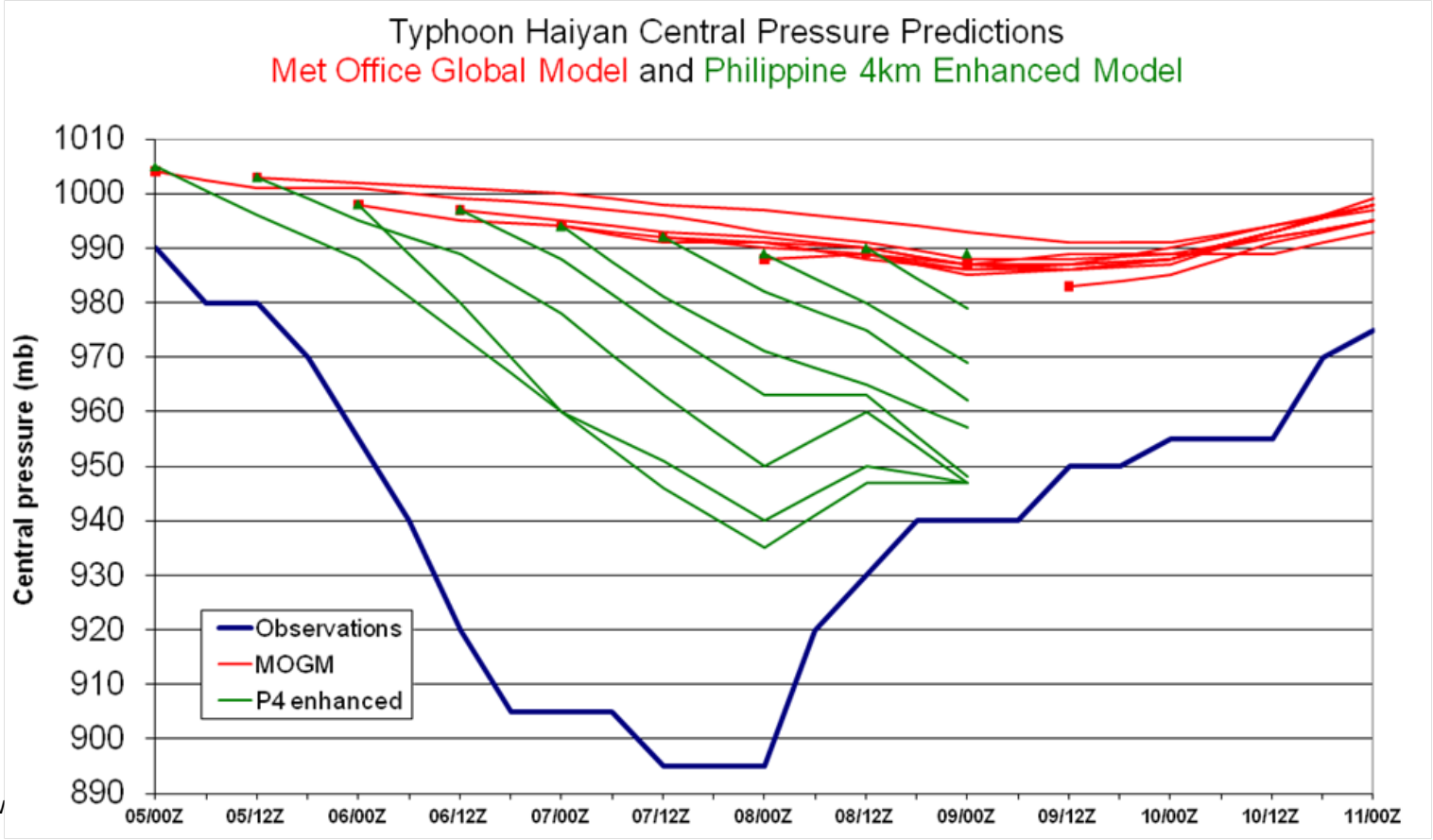
Challenge for the future: Rapid Intensification

- Met Office model upgrade has improved intensity predictions
- But bias to strengthen TCs for too long amplified



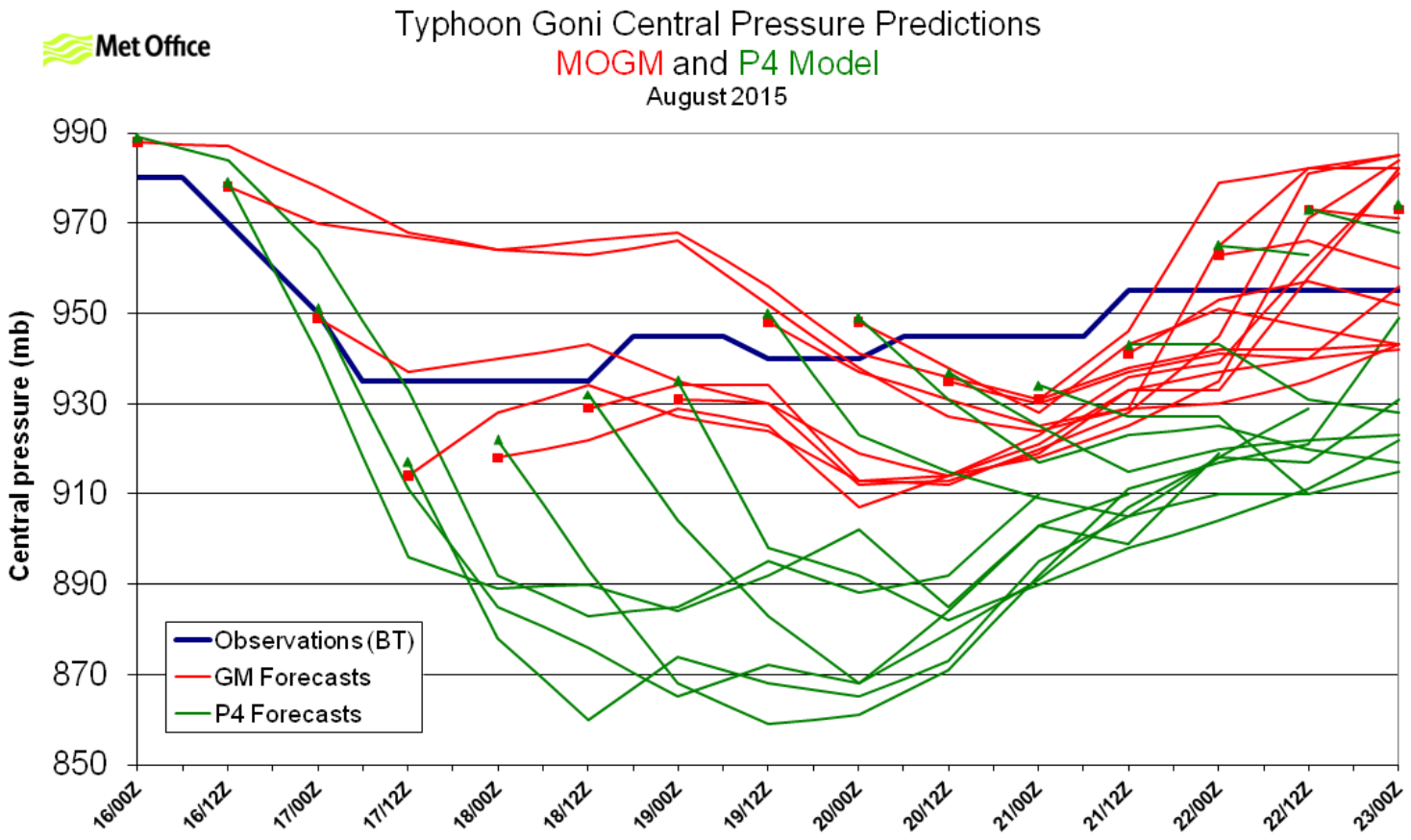
Challenge for the future: Rapid Intensification

- 4 km resolution Philippines model shows resolution can help
- Colleague Chris Short to present more at AMS 32HURR



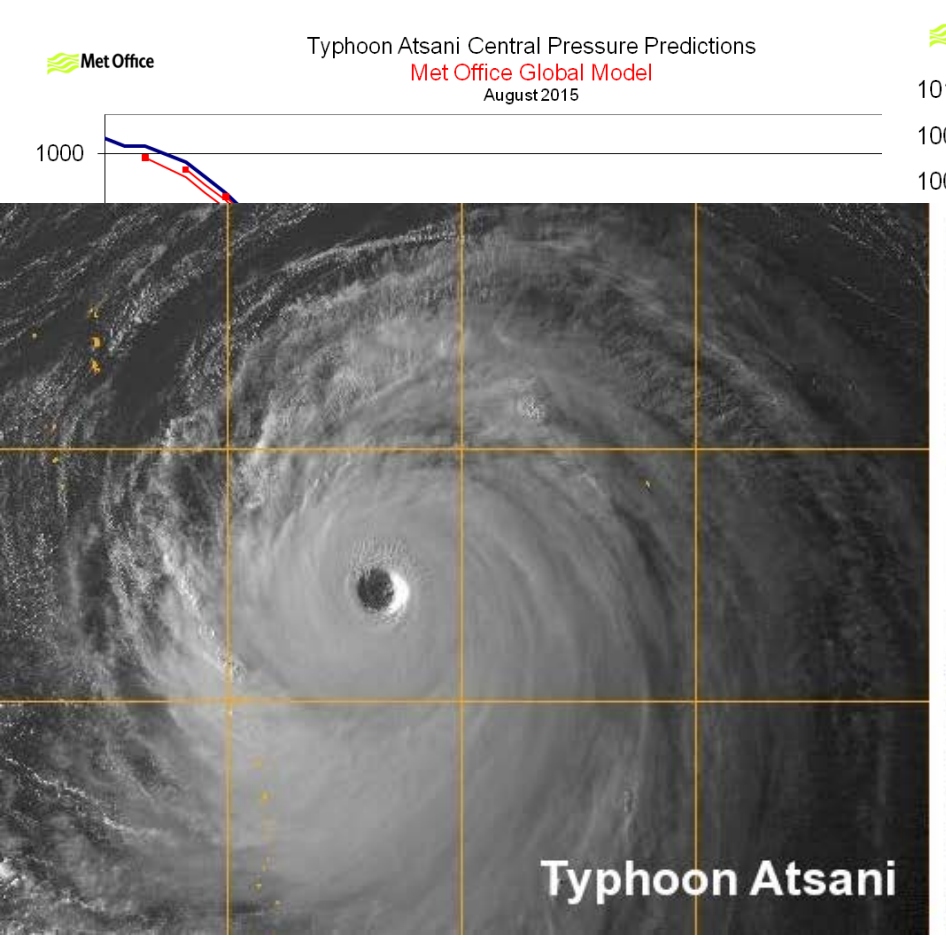
Challenge for the future: Rapid Intensification

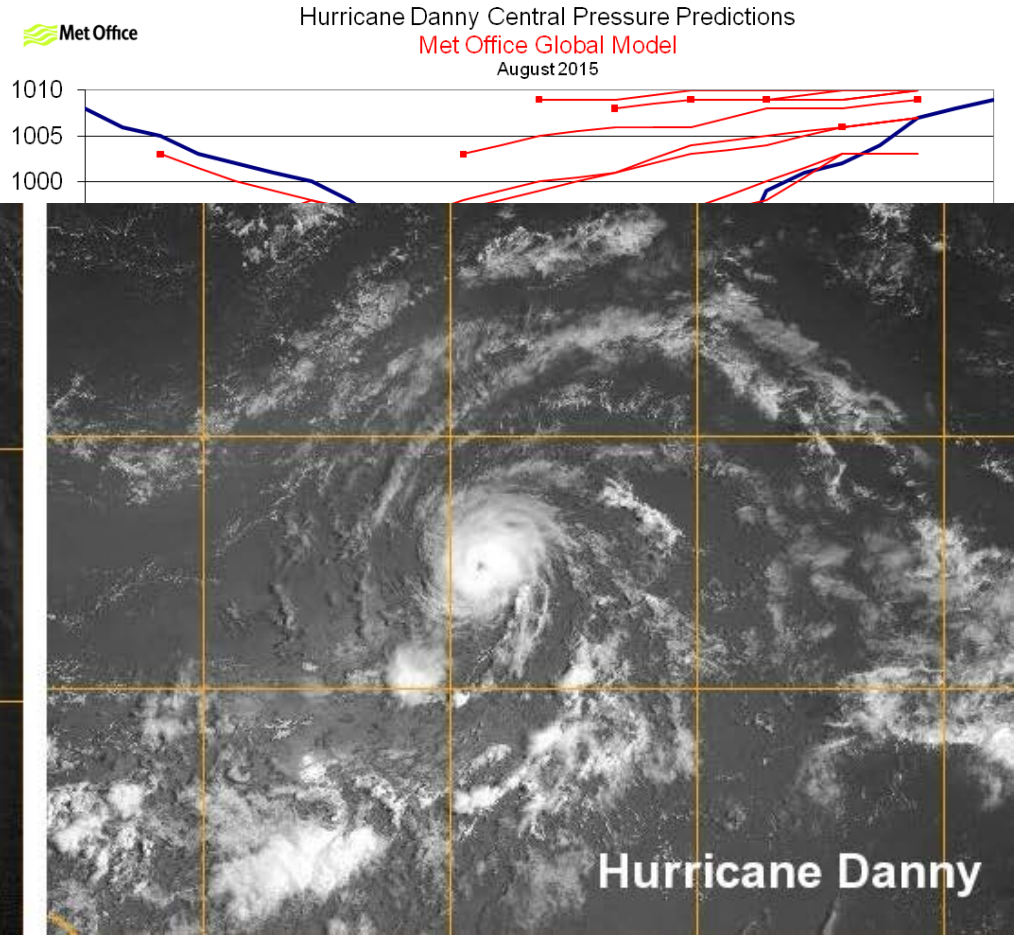
- Resolution alone not enough
- Can result in significant over-deepening



Challenge for the future: Rapid Intensification

- Atsani and Danny both intensified 35 mb in 24 hours





Challenge for the future: Rapid Intensification

- Ability to capture RI dependent on inner core gradients and TC size
  - Can we expect models to capture 24 mb/nmile gradients as in Patricia?
- Increased resolution: capture more strong TCs
- Coupling: potential to reduce over-deepening
- No silver bullet. Model physics, data assimilation, data coverage will also play an important role.


THE END

Met Office Products

Met Office Products

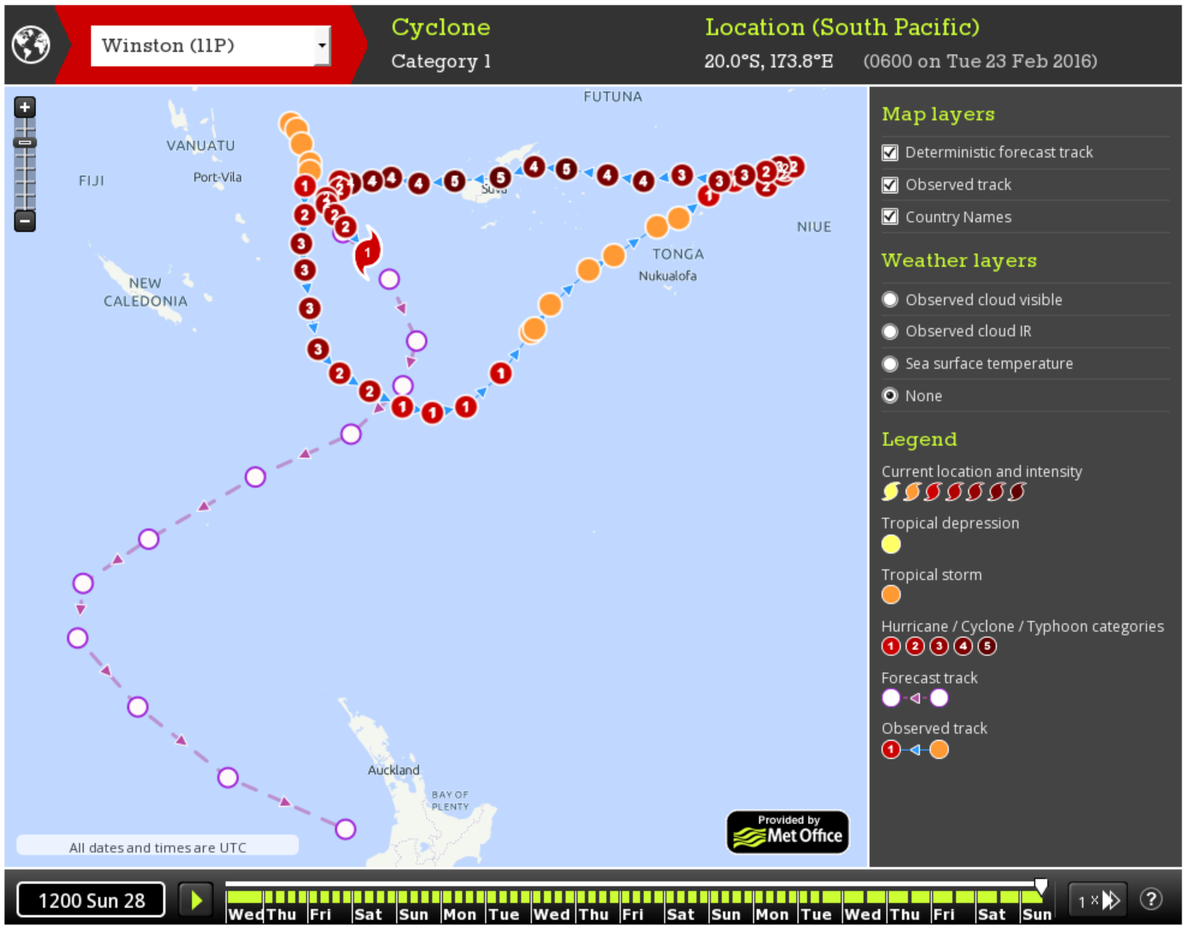
- Deterministic
  - Raw model data from ftp server
  - Plain text track and intensity forecast data via web or GTS
  - ‘adeck’ format bulletin via GTS (FXXT04 EGRR)
- Ensemble
  - Various graphical products available to warning centres
  - Raw tracks sent to NHC for use in internal systems
- Seasonal
  - Public Atlantic forecast in May
  - Monthly updates sent to NHC

Met Office Products

MET OFFICE TROPICAL CYCLONE GUIDANCE FOR NORTH-EAST PACIFIC AND ATLANTIC

GLOBAL MODEL DATA TIME 0000UTC 30.08.2015

HURRICANE IGNACIO   ANALYSED POSITION : 16.8N 147.4W



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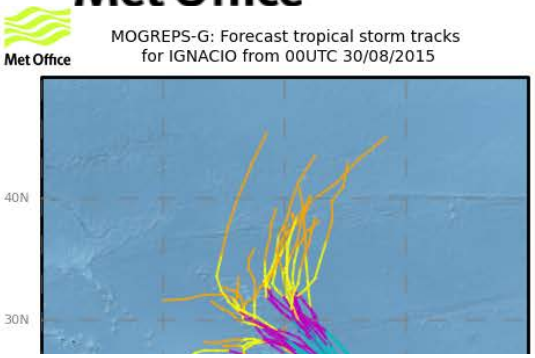
L (MB)	MAXIMUM WIND SPEED (KNOTS)
	81
	70
	68
	72
	74
	71
	71
	69
	66
	68
	61
	59
	58

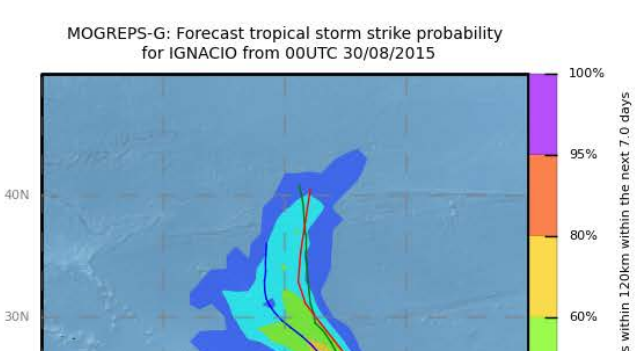
: 13.1N 127.1W

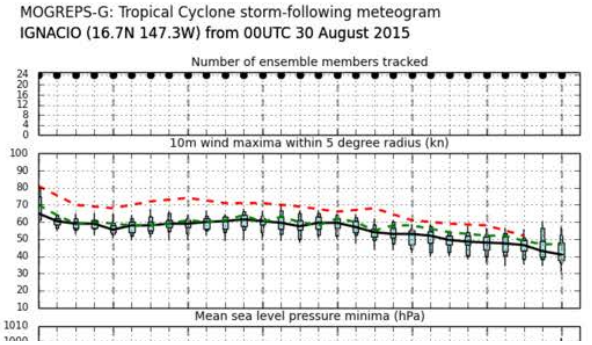
L (MB)	MAXIMUM WIND SPEED (KNOTS)
	57
	60
	60
	56
	59
	62
	57
	56
	57
	56
	55
	55
	52

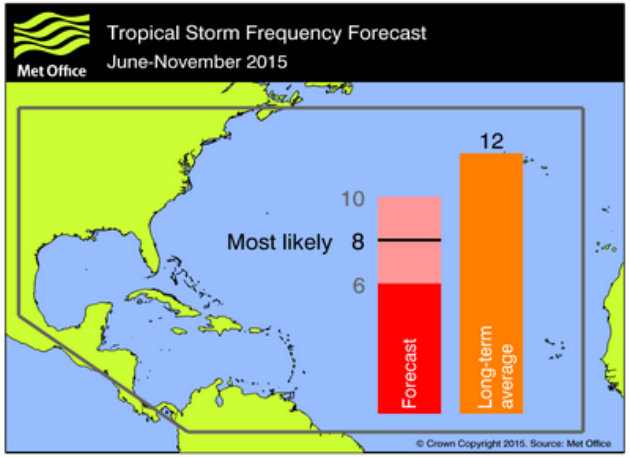
0000UTC 04.09.2015 120 16.7N 144.1W 978
1200UTC 04.09.2015 132 17.3N 144.6W 977
0000UTC 05.09.2015 144 18.3N 145.1W 977

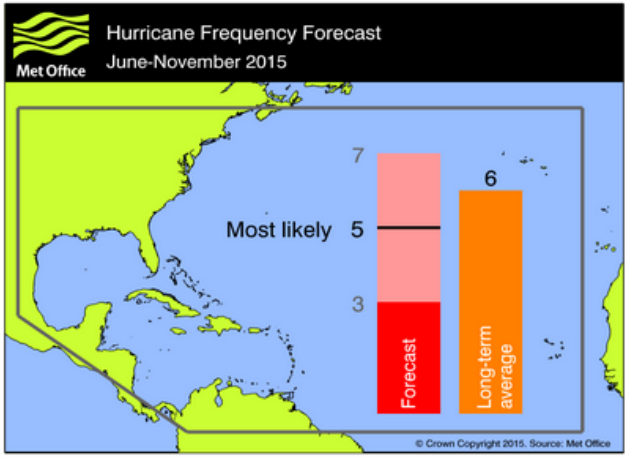
Met Office Products

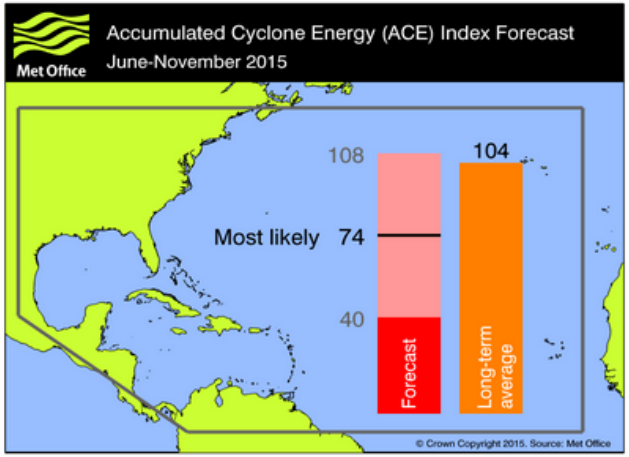


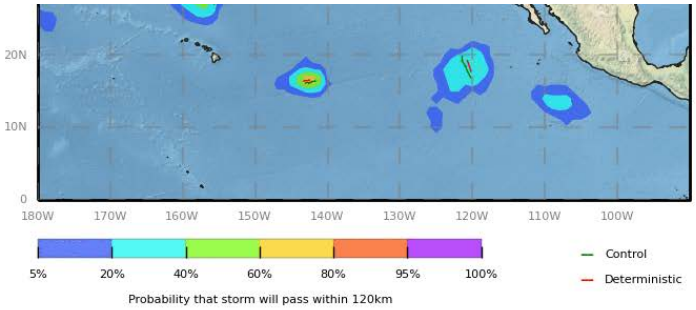


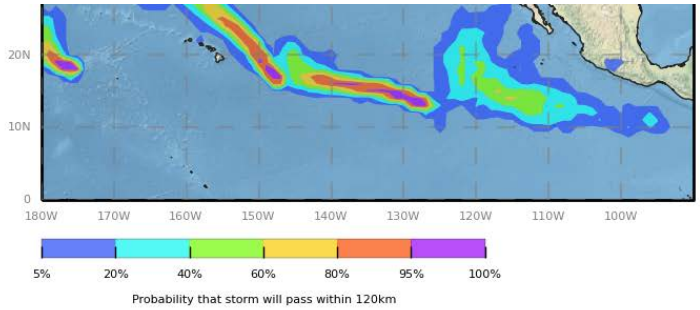










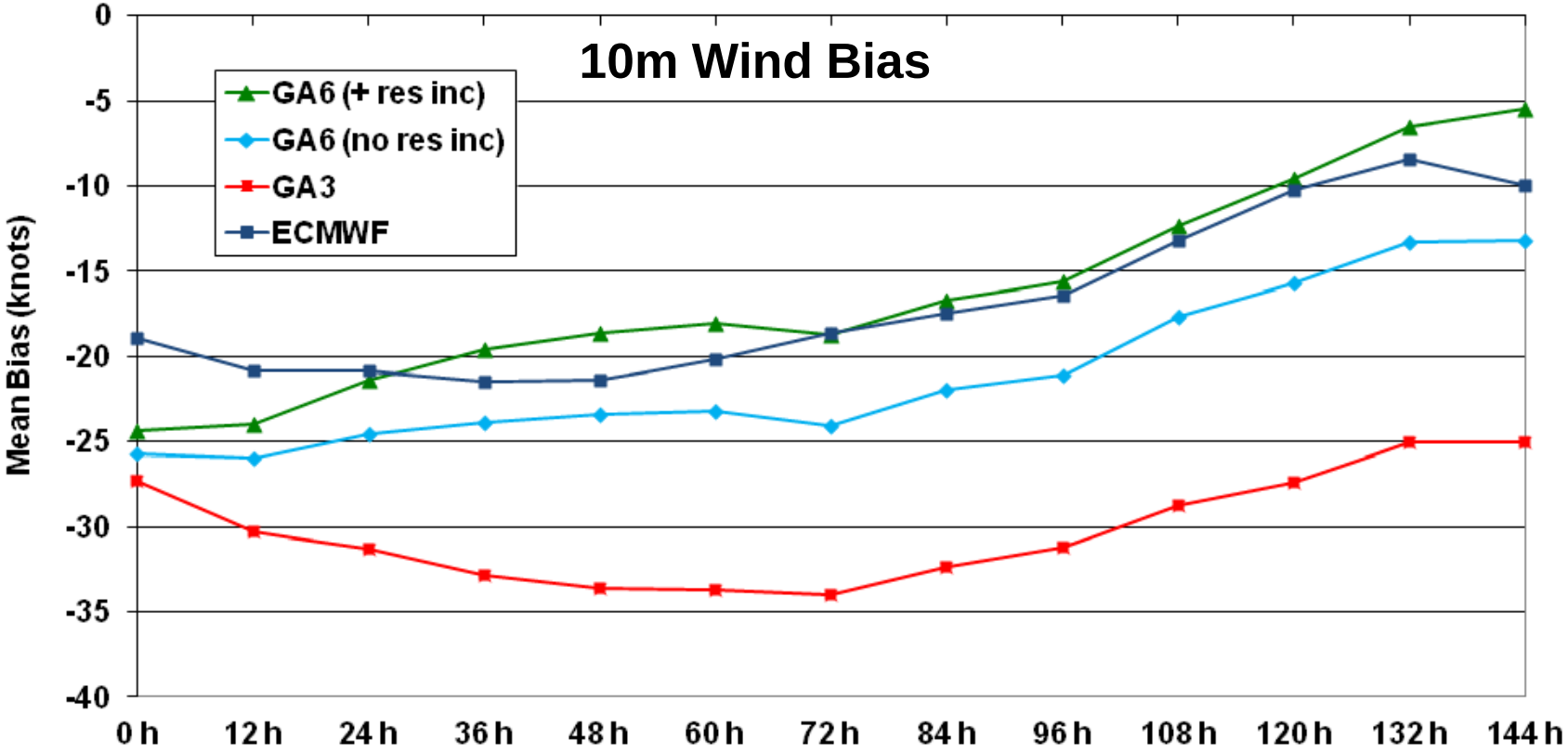


Additional slides

Impact of model upgrade (GA6)

Trial periods from 2012

- GA6 reduces weak bias, very similar to ECMWF
- N.B. Comparing 10m model wind with 1-min average wind



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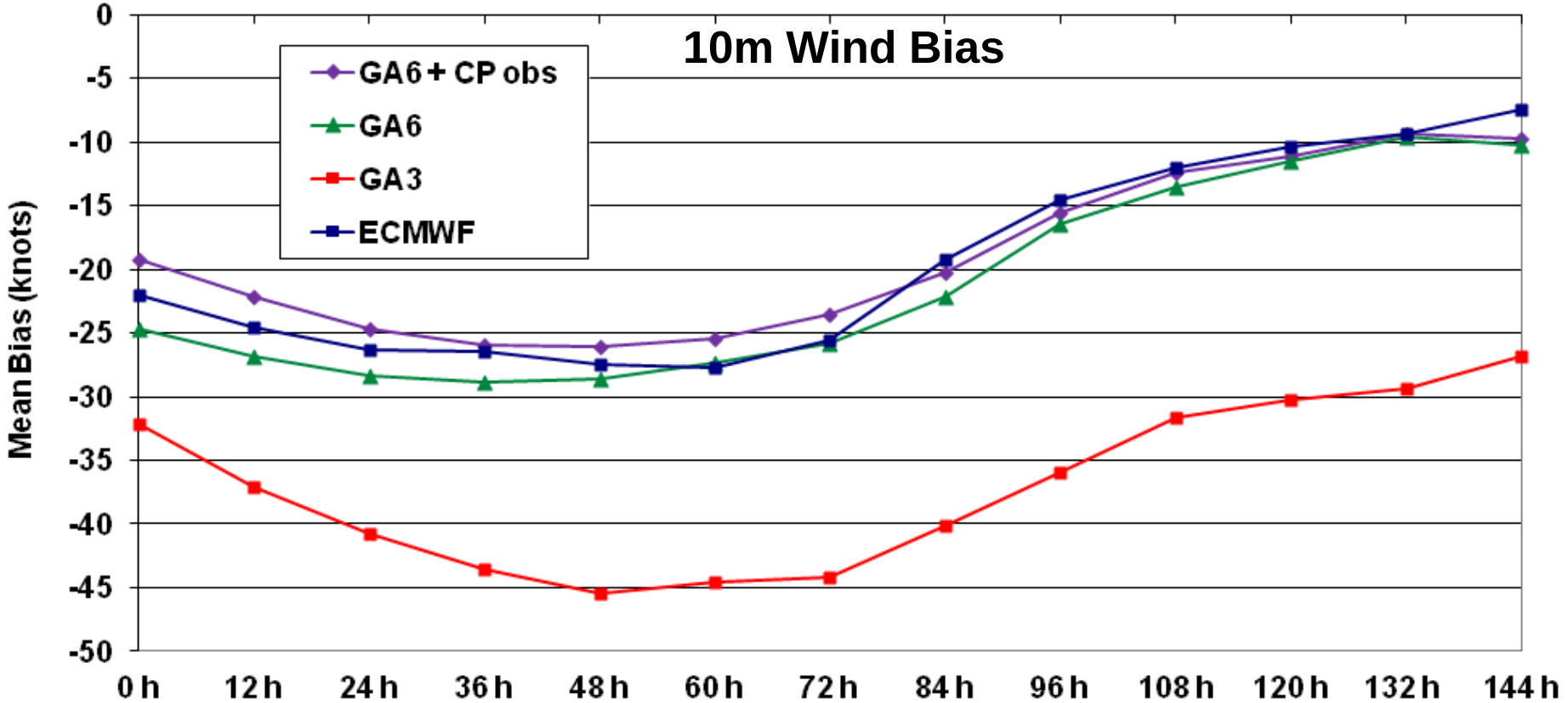

Met Office Global Model Northern Hemisphere TC 10m Wind Bias

- Large reductions in bias seen in 2014 and 2015