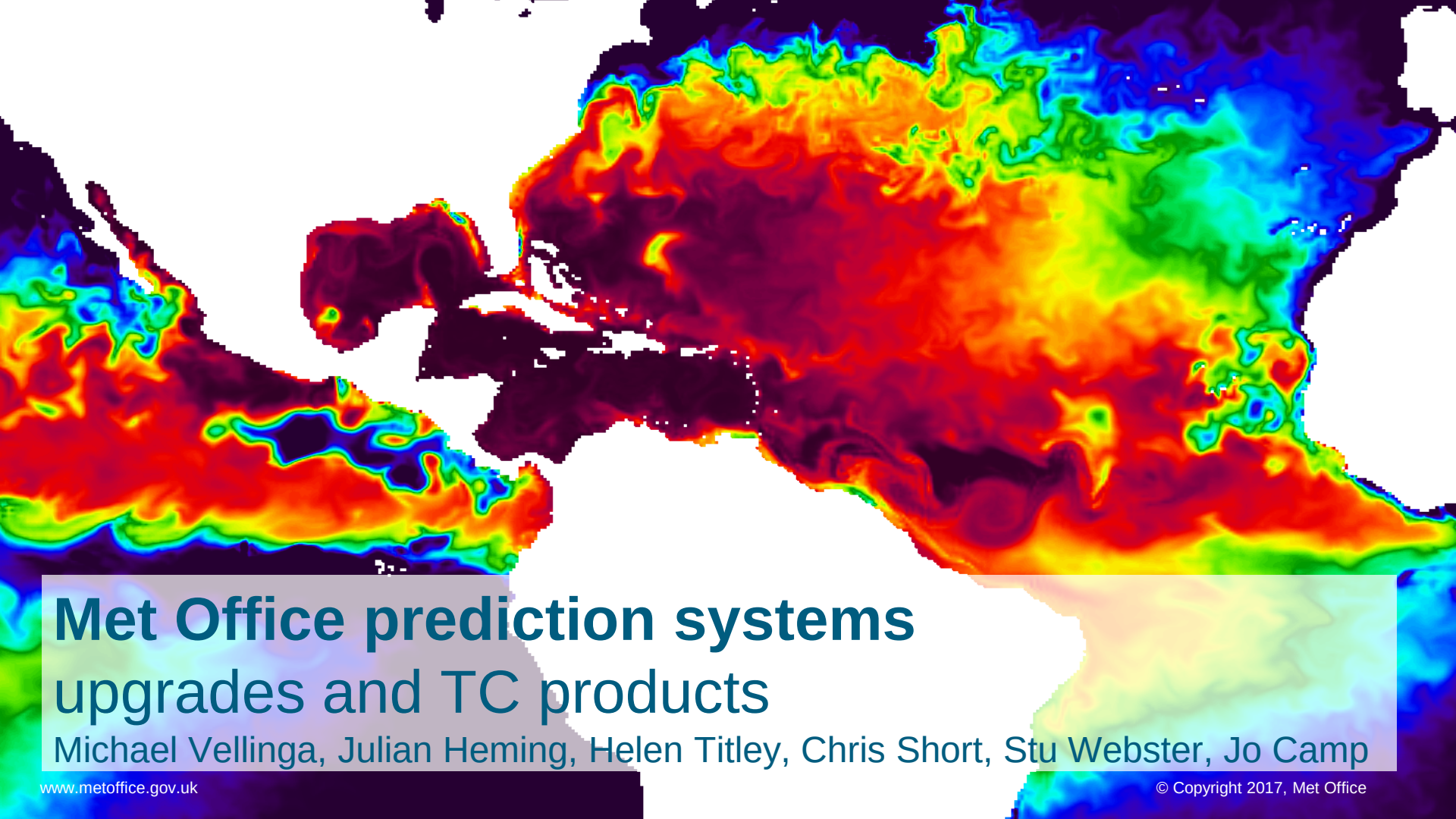


Met Office prediction systems

upgrades and TC products

Michael Vellinga, Julian Heming, Helen Titley, Chris Short, Stu Webster, Jo Camp

Met Office operational forecasting systems

	Forecast period	Atmosphere resolution	Ocean resolution	Ensemble size	Initial. Frequency
Global UM	7 days	10 km	x	x	4x / day
MOGREPS-G	7 days	20 km	x	18 (36)	4x / day
Glosea5	7 months	60 km	0.25° x 0.25°	2 (fc)	1x / day

Recent model improvements (2017 – 2018)

- Numerous changes to DA
- Global UM: increase model resolution lon x lat : 24 x 17 km → 14 x 10 km
- MOGREPS-G: increase model resolution: 46 x 33 km → 28 x 20 km
- MOGREP-G: increase ensemble size : 12 members per cycle → 18 members per cycle.

Increased Horizontal Resolution 2017

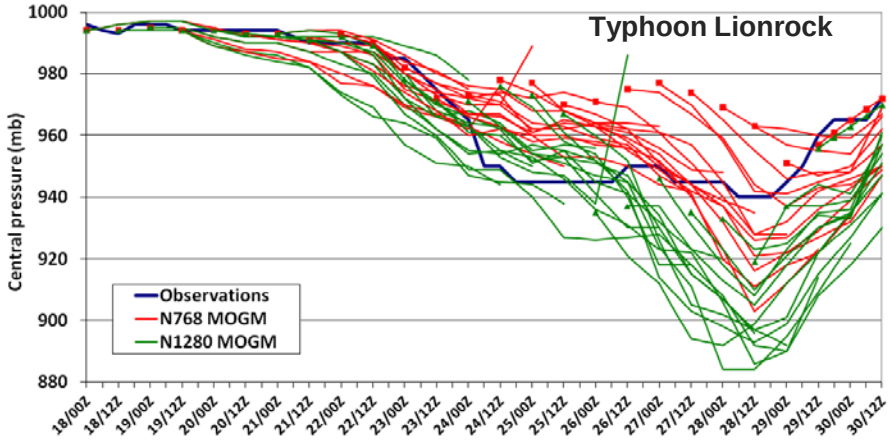
Global UM horizontal increased in July 2017 (approximately 10km grid spacing)

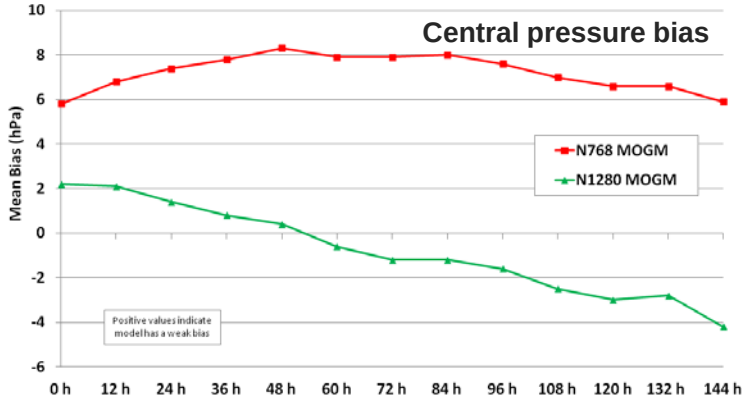
Offline trials for periods in 2016

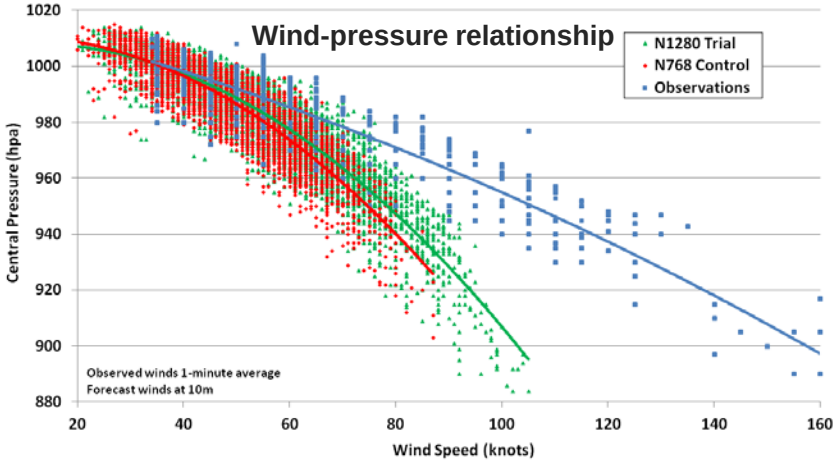
3% reduction in track forecast error

TCs more intense – reduction in weak bias (central pressure)

Over deepening in slow-moving Typhoon Lionrock







contact: **julian.heming@metoffice.gov.uk**

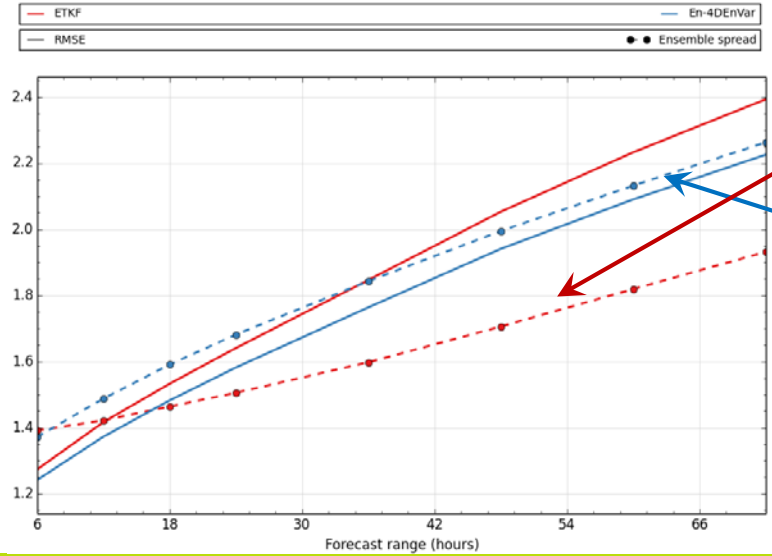
Planned changes to operational systems

- 2018/19: MOGREPS-G: improved generation of ICs for increased ensemble spread
- 2019: more realistic profile of drag over the ocean to improve wind-pressure relationship
- 2020: Global model: UM to be coupled to dynamical ocean with initialisation through weakly-coupled DA

Global ensemble prediction system MOGREPS-G

Changes to Met Office Global Ensemble (MOGREPS-G) in 2018/19

- Minor change scheduled to go live July 2018
  - Improvements to stochastic physics to improve the ensemble spread
- Major change scheduled to go live late 2018 / early 2019
  - Moving the ensemble perturbation system from ETKF to En-4DEnVar



RMSE (solid) and spread (dashed) of wind at 850 hPa for the tropics, measured against ECMWF analyses

ETKF has good spread at initial time, but grows too slowly

En-4DEnVar (Ensemble of data assimilations) has much faster spread growth, and this matches errors better.

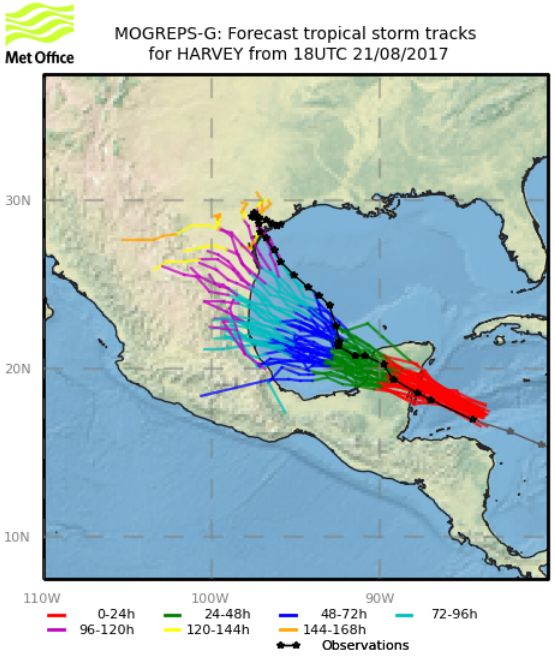
Mainly due to additive inflation for model errors

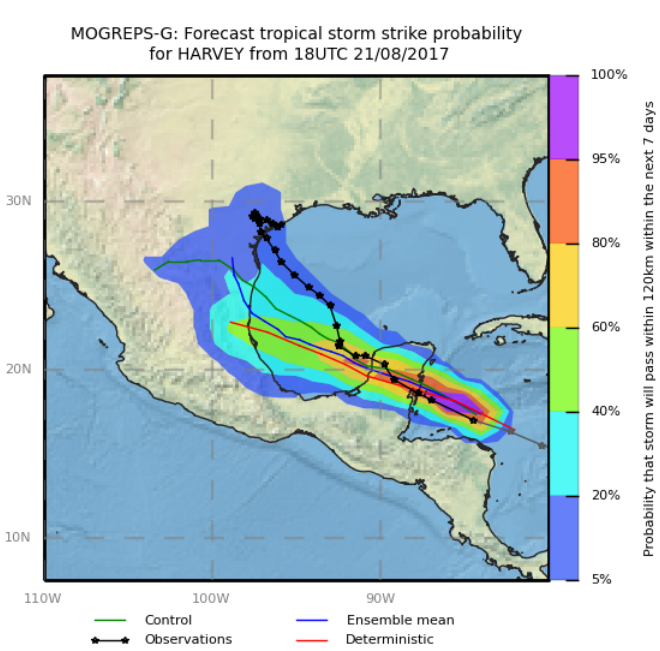
Using partial re-centring around deterministic analysis gives additional increase in skill and reduces jumpiness

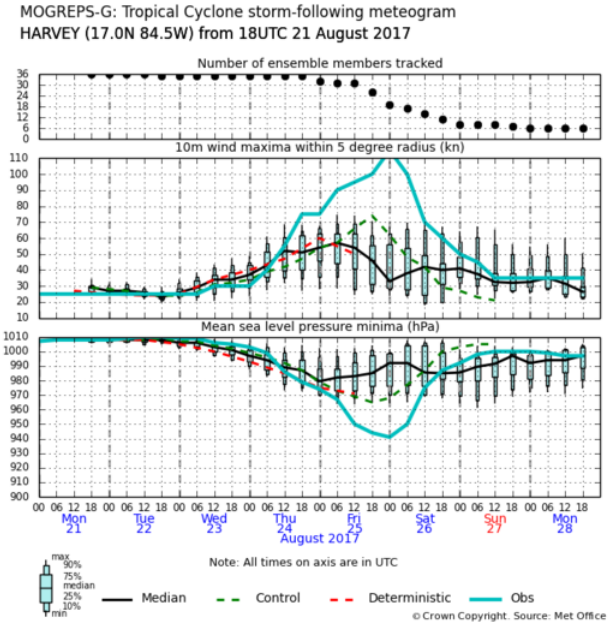
Affect on Tropical Cyclone track and intensity currently being evaluated using trial data

Details in Bowler et al (2017); Q. J. R. Meteorol. Soc., DOI:10.1002/qj.2964.

Met Office Products: strike probability MOGREPS-G Harvey





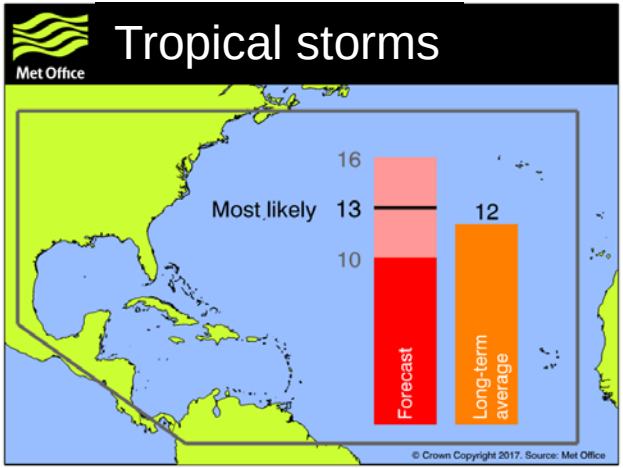


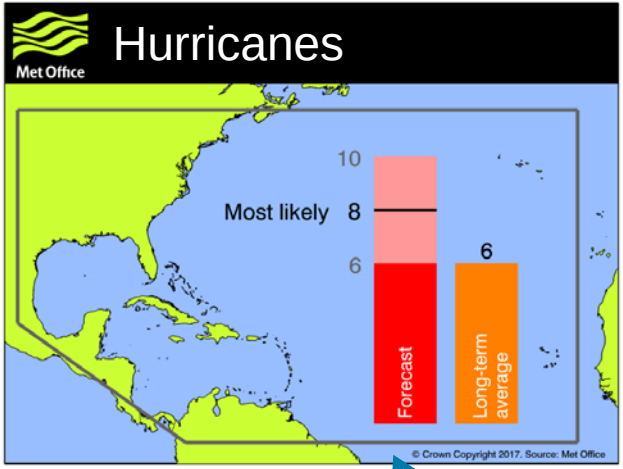
- Track: Good spread in ensemble including many north of the deterministic. Obs to the north edge of spread.
- Intensity: Deterministic and ensemble capture start of intensification on 23rd/24th but not the rapid intensification on 25th.

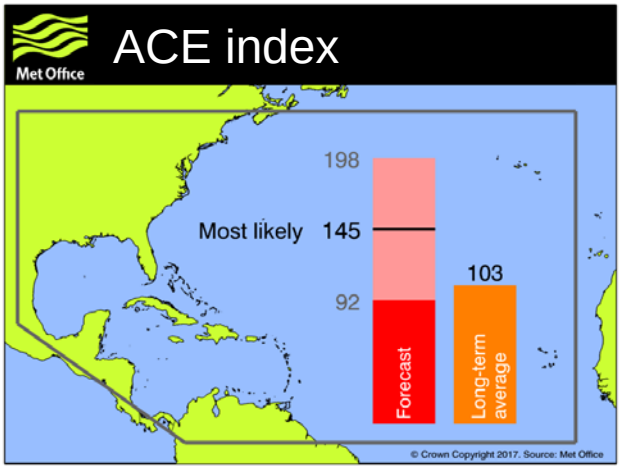
T+105 ahead of landfall in Texas

Seasonal forecasting system Glosea5

Met Office seasonal forecast
June–November 2017







	Trop. storms	Hurricanes	ACE index
Forecast mean:	13	8	145
70% range:	10–16	6–10	92–198
Observed:	16*	10	225

Observed numbers of **tropical storms** and **hurricanes** were within the forecast range.

ACE index was under-predicted

* Tropical storm Arlene formed outside the period covered by this forecast

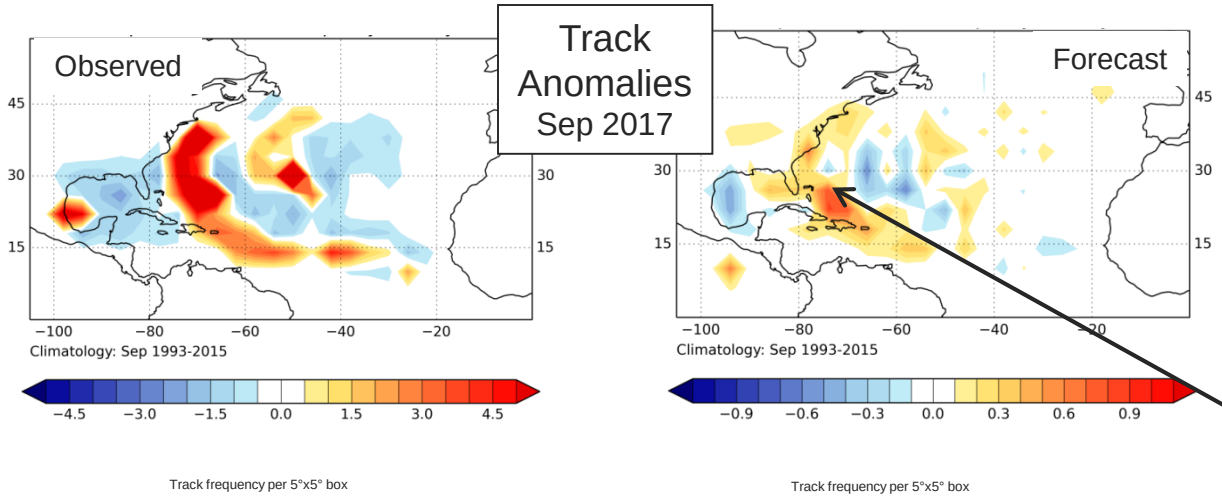
Seasonal outlook N Atlantic storm season, updated monthly from March

contact: **joanne.camp@metoffice.gov.uk**

2017 Atlantic season

NCEP (Sep 2017)

GloSea5 (Sep 2017)



NE Caribbean landfalls

- Three hurricanes (Irma, Maria, Jose) tracked closer to or over the NE Caribbean during Sep 2017.

- These hurricanes were steered around the westward periphery of the subtropical high.

- Risk of increased activity around NE Caribbean was well predicted by GloSea5 from forecasts initialised 15 May.

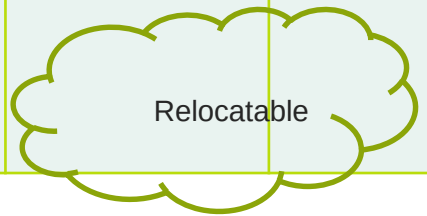
Forecast start:15 May

Camp et al 2018, ASL

Forecasting systems under development

run near-real time since July 2017

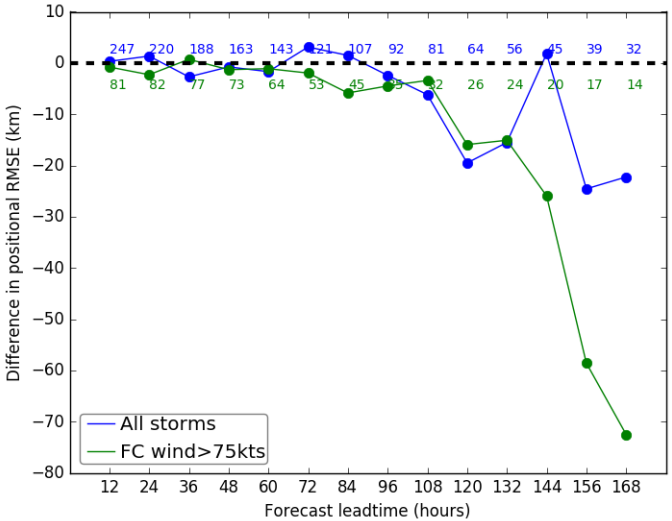
	Forecast period	Atmosphere resolution	Ocean resolution	Ensemble size	Initial. Frequency
Coupled deterministic	15 days	10 km	0.25° x 0.25°	x	1x / day
Convective permitting regional (SE Asia) ensemble LBC from MOGREPS-G	5 days	4.4 km	x	18	4x / day



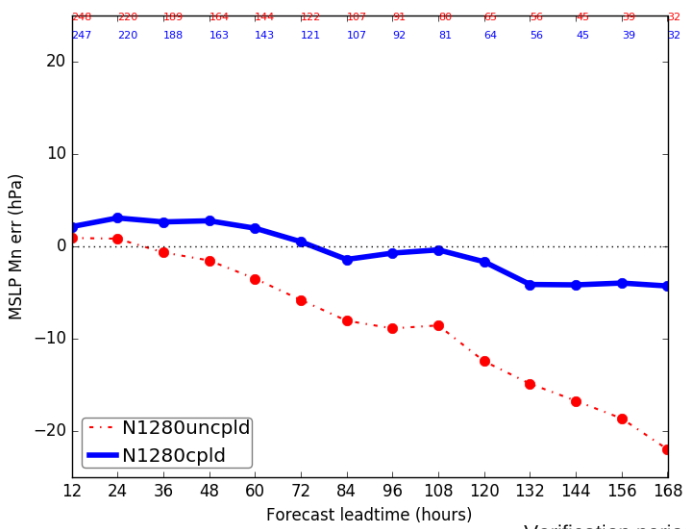
Air-sea coupling in global model

benefits TC forecasts:

Improved track error (mainly XT)



Improved (reduced) over-deepening bias



Verification period July 2017- Jan 2018

contact: **michael.vellinga@metoffice.gov.uk**

Met Office

and finally
please provide us with feedback!

- Performance of Met Office models in 2017 season? (MOGREPS, deterministic)
- Do you prefer processing ‘raw’ track data or receiving bespoke products (eg storm activity, strike probability, multi-model products)?
- anything else…
- email: michael.vellinga@metoffice.gov.uk
- **See you at 33rd AMS Conference on Hurricanes and Tropical Meteorology!**

Met Office

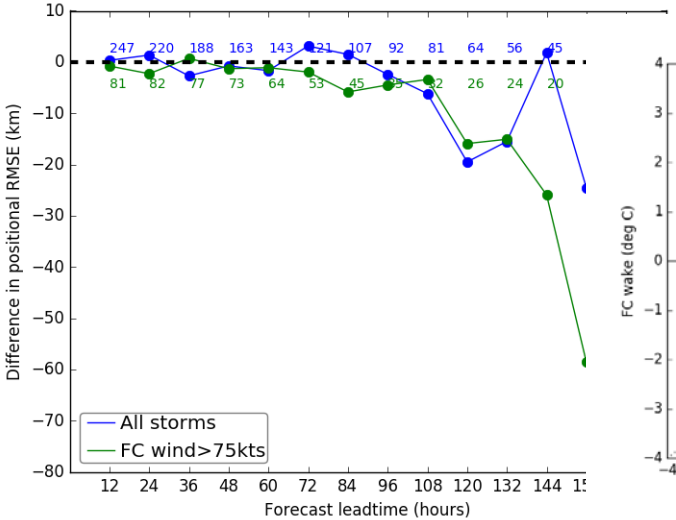
Thank you!

Extra slides

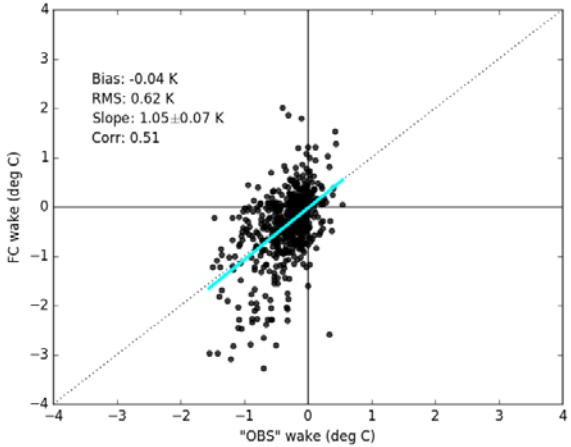
Air-sea coupling in global model

benefits TC forecasts:

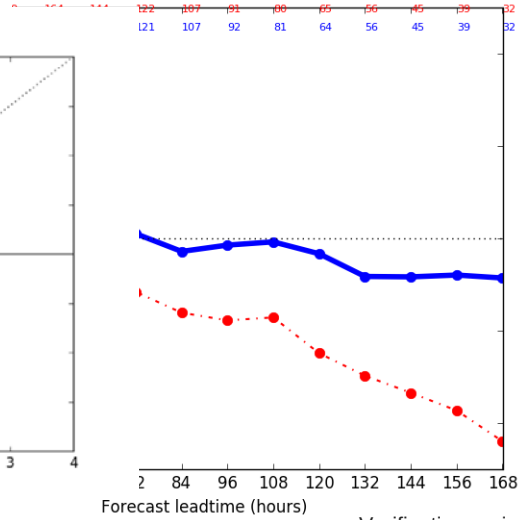
Improved track error (mainly XT)



Wake forecast



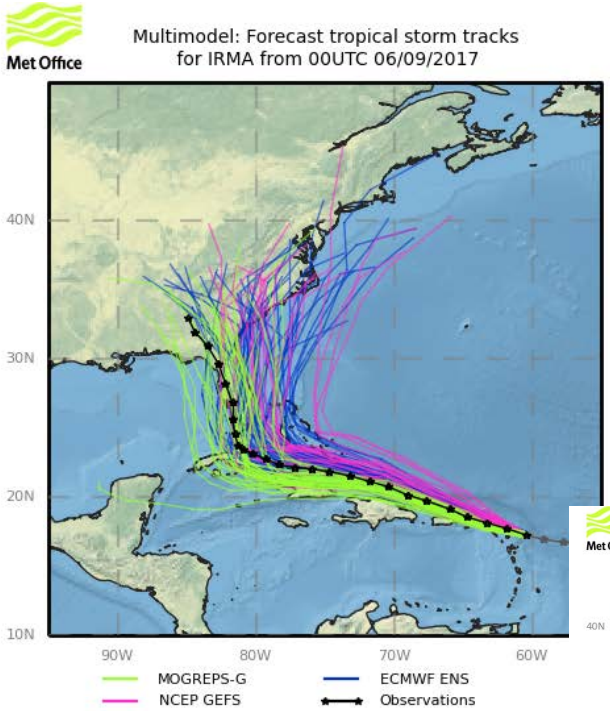
Improved (reduced) over-deepening bias

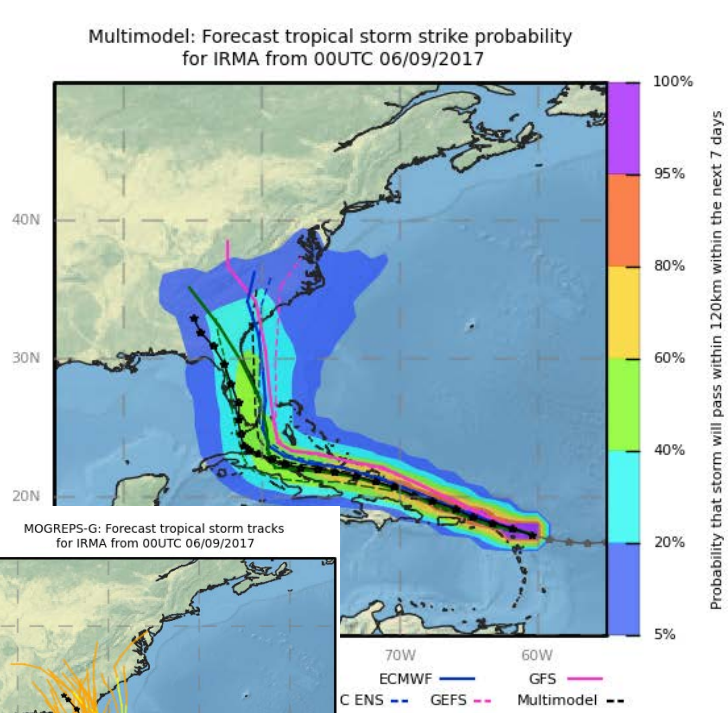


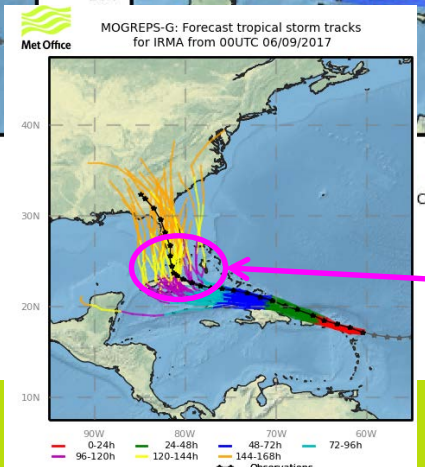
Verification period July 2017- Jan 2018

contact: **michael.vellinga@metoffice.gov.uk**

Products: multi-model ensemble forecasts Irma







00UTC 06/09/2017
3/4.5 days ahead of landfall in Cuba/Florida

- Location of northward turn and subsequent Florida landfall location well indicated by MOGREPS-G
- MOGREPS-G ensemble mean is west of deterministic models and other ensembles over Florida and close to observed track up west coast
- But majority of tracks too far south over Cuba and too slow (predicting Florida landfall on 11th not 10th) giving large along-track errors

contact: **helen.titley@metoffice.gov.uk**

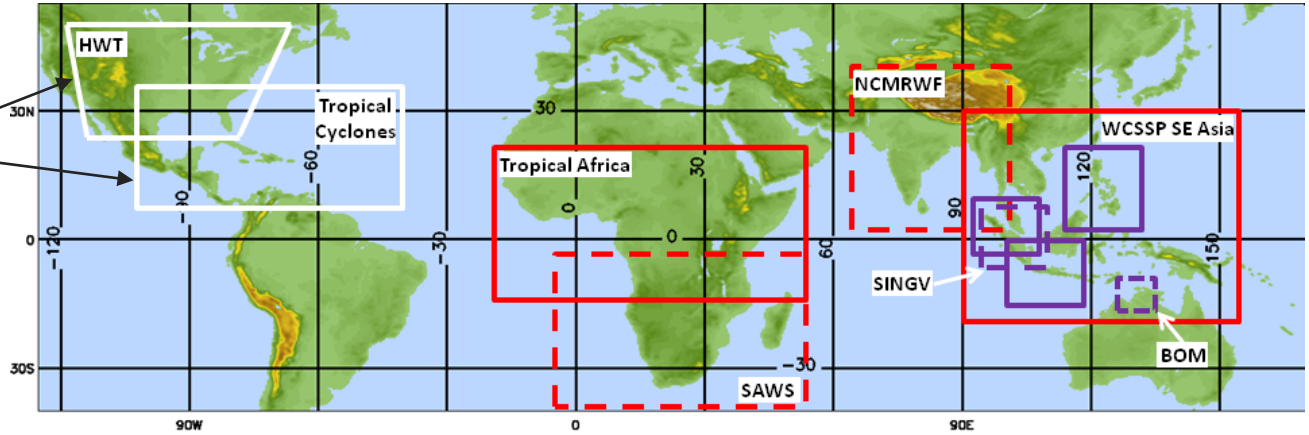
Extra slides:

convection permitting regional models (probabilistic and deterministic)

Testing RA1-T

Looking at domains across the tropics

Temporary domains



4km Met Office running in real time

1.5km Met Office running in real time

4km UM Partner

1.5km UM Partner

contact: **stuart.webster@metoffice.gov.uk**

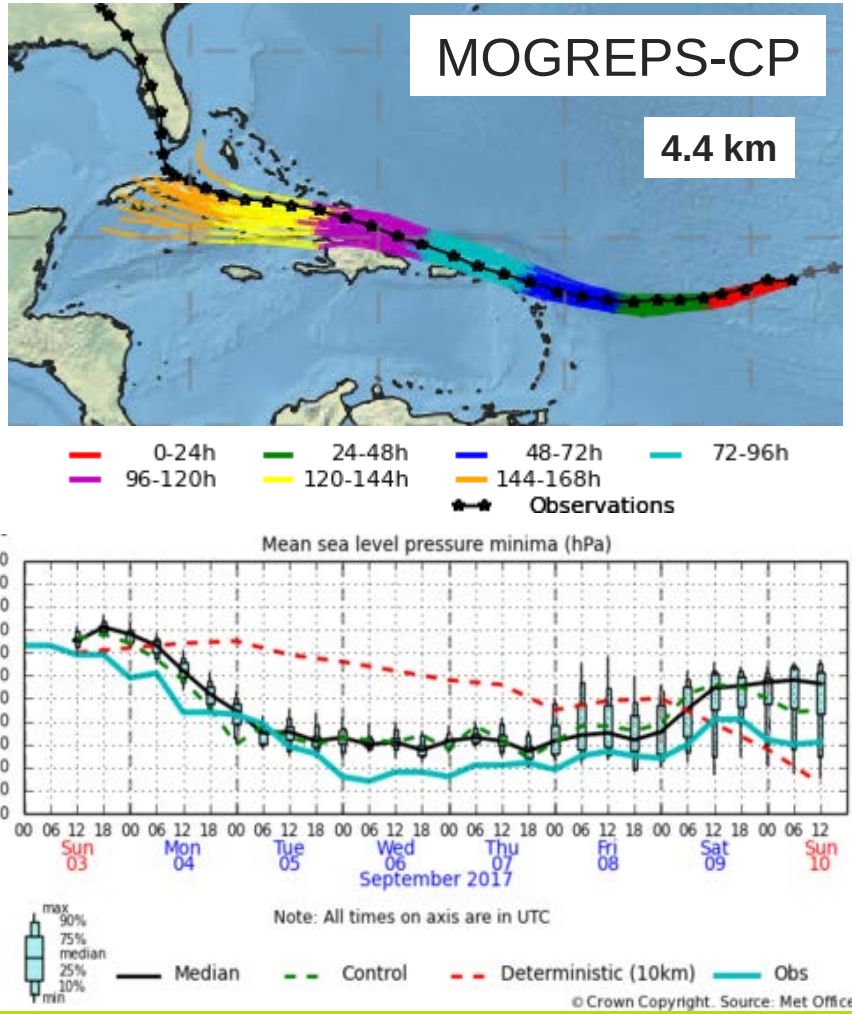
Hurricane Irma

Highlights from forecast reruns

- 7 day forecasts run every 12 hours from 30/8/17 12UTC to 11/9/17 12UTC.
- Track statistics for forecasts initialised 12UTC on 3rd September 2017.
- Compare to MOGREPS-G (next slide)

Comparison shows that CP-ensemble:-

- has much improved central pressures, including intensification rates.
- has a smaller spread of the tracks.
  - N.B. not always, e.g. Jose.
- faster moving storm



Hurricane Irma

Highlights from forecast reruns

- 7 day forecasts run every 12 hours from 30/8/17 12UTC to 11/9/17 12UTC.
- Track statistics for forecasts initialised 12UTC on 3rd September 2017.
- Compare to MOGREPS-CP (previous slide)

Comparison shows that CP-ensemble:-

- has much improved central pressures, including intensification rates.
- has a smaller spread of the tracks.
  - N.B. not always, e.g. Jose.
- faster moving storm, which is an improvement