ECMWF activities for improved hurricane forecasts

Royal Met. Soc. January 2019

Linus Magnusson

linus.magnusson@ecmwf.int

Thanks to: Fernando Prates, Kristian Mogensen, Mohamed Dahoui, Simon Lang, …
The operational ECMWF forecasting system

**High resolution deterministic forecast (HRES):**
- twice per day 9 km, 137 levels, to 10 days ahead

**Ensemble forecast (ENS):**
- twice per day 51 members, 18 km, 91 levels, to 15 days ahead
- Monday/Thursday 00 UTC extended to 46 days ahead with 36 km
  - Reforecast dataset with 11 members for past 20 years

**Seasonal forecast:** once a month
- 51-members, ~35 km 91 levels, to 7 months ahead (35 years of hindcasts with 25 members)
- sub-set of 15 members is run for 13 months every quarter

All forecasts coupled to 0.25 degree NEMO ocean model
Hurricane Irma – observed path

- Leeward Islands 6 Sept (NL, FR, ..)
- Virgin Islands (US, UK)
- Florida (10 Sept)
- 30 August
Extended-range forecasts of tropical cyclone activity valid 28 Aug – 3 September
Forecast for TC Irma from 31 August 00UTC

Symbols indicate position and intensity 6 Sept 00UTC

HRES (red)
ENS CF (blue)
ENS PF (grey)
BestTrack (black)
HRES – red
ENS control – green
ENS members – grey/blue
Effect of ocean coupling

Uncoupled (no ocean feedback)

(COncstant SST)

Coupled

(Cooling of the SST due to heat flux)
Effect of ocean coupling for TC Irma

SST in 6 Sept 00UTC+96h

Central pressure

Maximum wind

Sfc. heat flux

9 km Uncoupled (red)
9 km Coupled (blue)

5 km Uncoupled (pink)
5 km Coupled (cyan)

cf Mogensen et al. (2017)
Effect of ocean coupling (August and September 2017)

![Graph showing mean error central pressure over steps for 9-km Coupled and 9-km Uncoupled models.](image-url)
Impact from dropsondes on Harvey intensification

Harvey

First guess departures (mainly Global Hawk)

24 Aug 00UTC

24 Aug 12UTC
Trend in tropical cyclone position error

VT: January - December  All basins

homogeneous samples
bars: 95% C.I.

Error (km)

OPER
ERA5

+168h
+120h
+72h
+0h

year
Difficult cases

Florence (2018)
(Symbols at day 9)

Jebi (2018)
(Symbols at day 6)
How to define a forecast bust?

**Options**
- Large uncertainties in the forecast (ensemble or between models)
- Very large errors revealed after the case
- Relatively small uncertainties but where a small change in path lead to large changes in the potential
- Dependency on propagation speed, cross-track error, …

*Ensemble mean error (y-axis) and ensemble spread (x-axis) for 5-day forecasts from ECMWF, for all cases in 2015-2017 cases in the Atlantic and eastern Pacific.*
Pressure and wind bias 2017

Differences:
- Resolution (9 km vs. 18 km)
- Ocean coupling
Impact of removing satellite data

(a) All obs 20170831 00UTC

(b) No Sat 20170831 00UTC
5- km experimental ensemble for TC Irma

Wind/pressure relation

Blue/cyan – 18 km ensemble
Red/pink – 5 km ensemble
Black - BestTrack