

# ECMWF activities for improved hurricane forecasts

Royal Met. Soc. January 2019

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Thanks to: Fernando Prates, Kristian Mogensen, Mohamed Dahoui, Simon Lang, ...

# The operational ECMWF forecasting system

## High resolution deterministic forecast (HRES) :

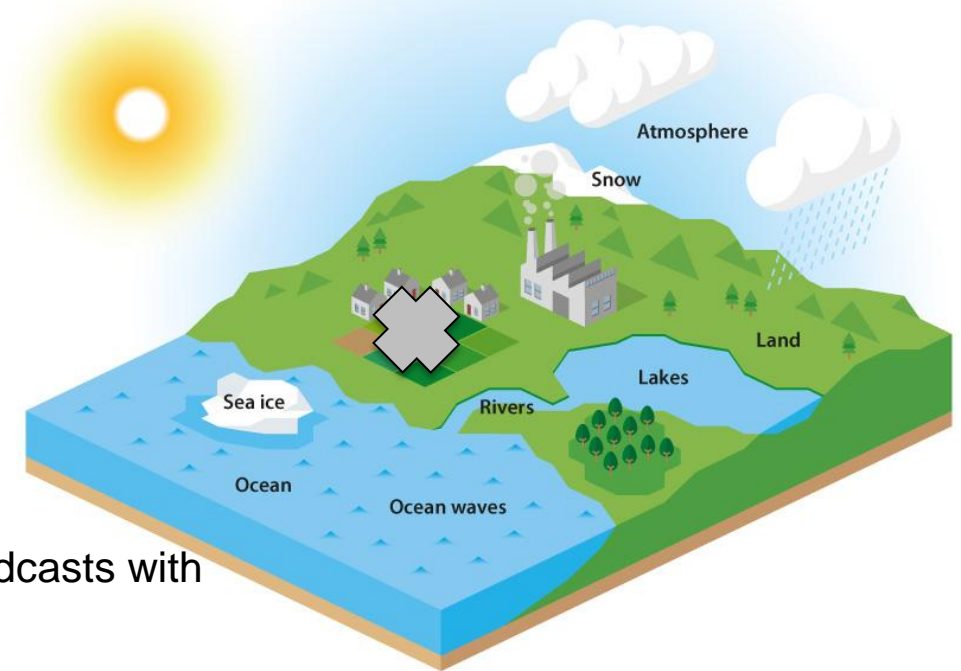
- twice per day 9 km, 137 levels, to 10 days ahead

## 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

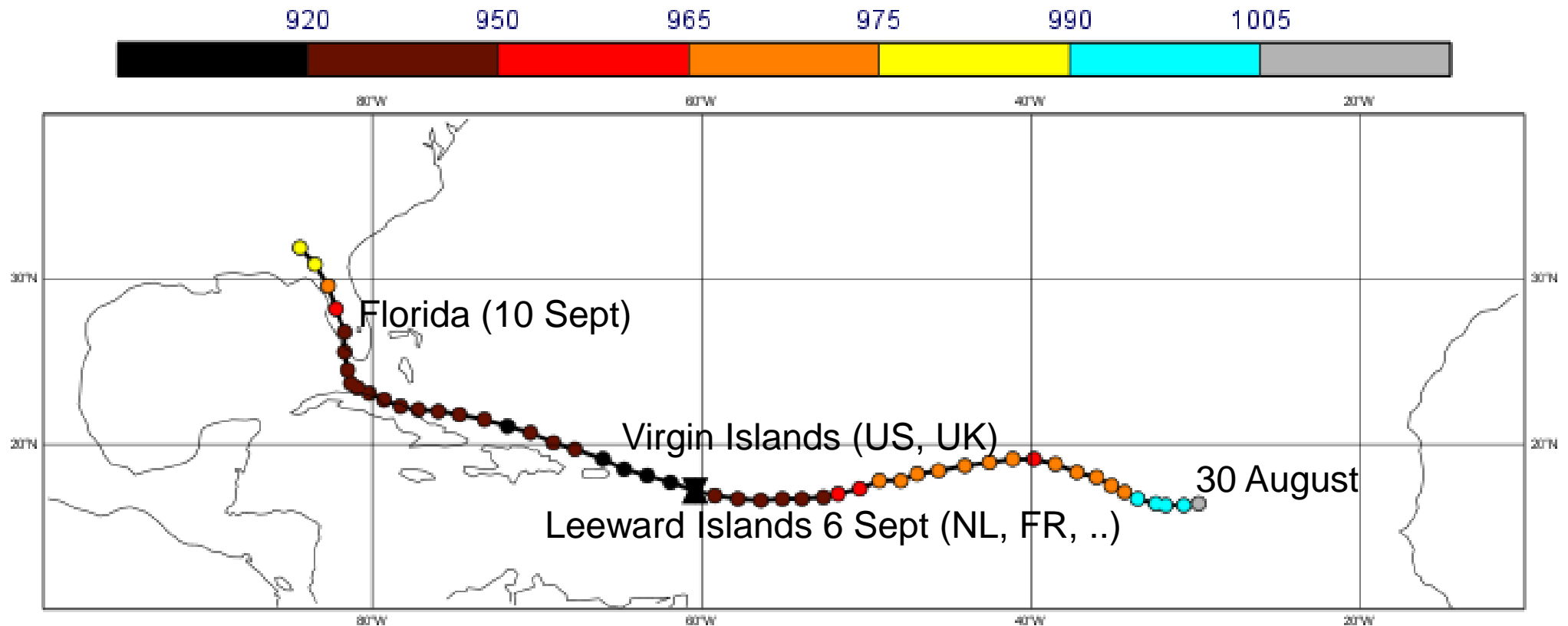
## Seasonal forecast: once a month

- 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



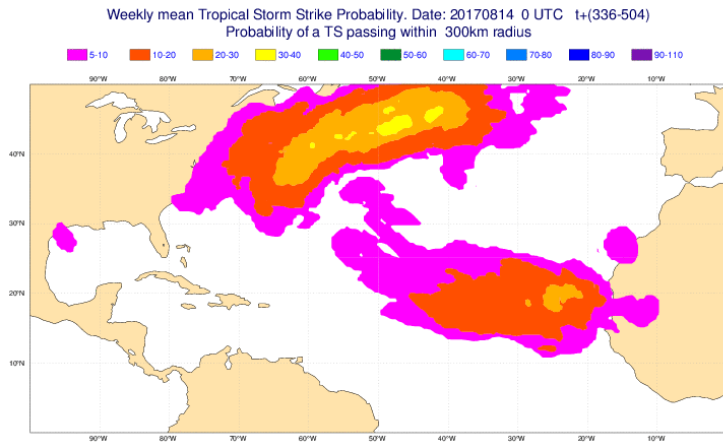
All forecasts coupled to 0.25 degree NEMO ocean model

# Hurricane Irma – observed path

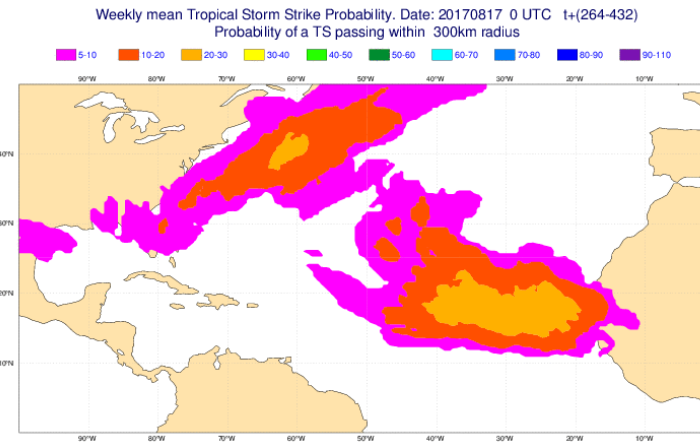


# Extended-range forecasts of tropical cyclone activity valid 28 Aug – 3 September

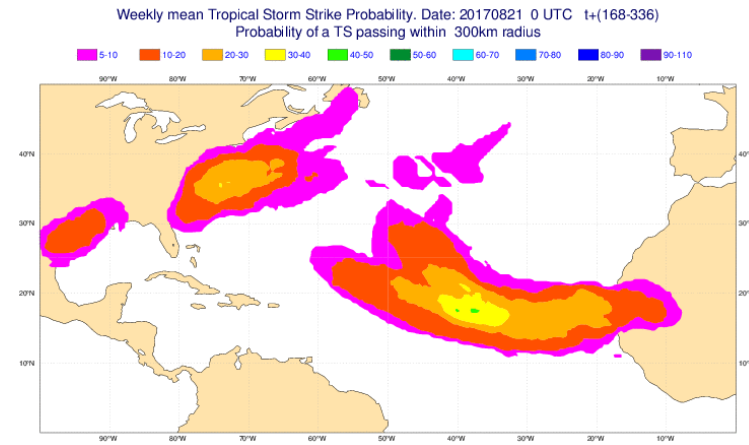
14 August



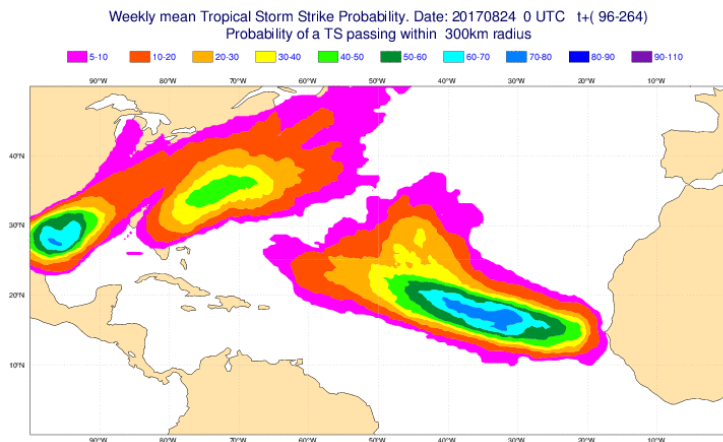
17 August



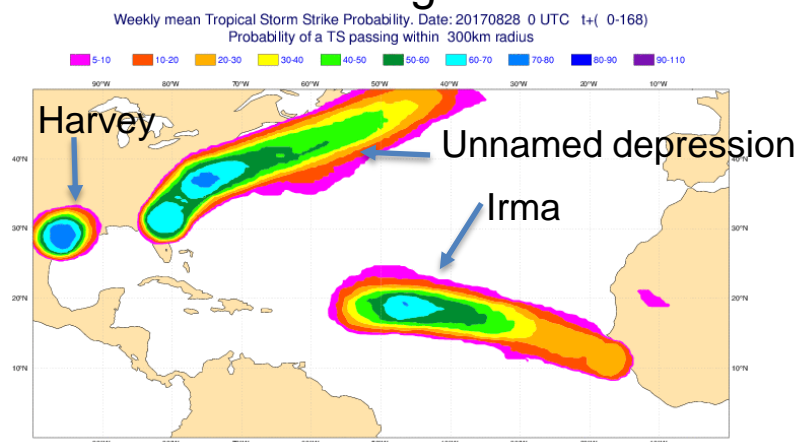
21 August



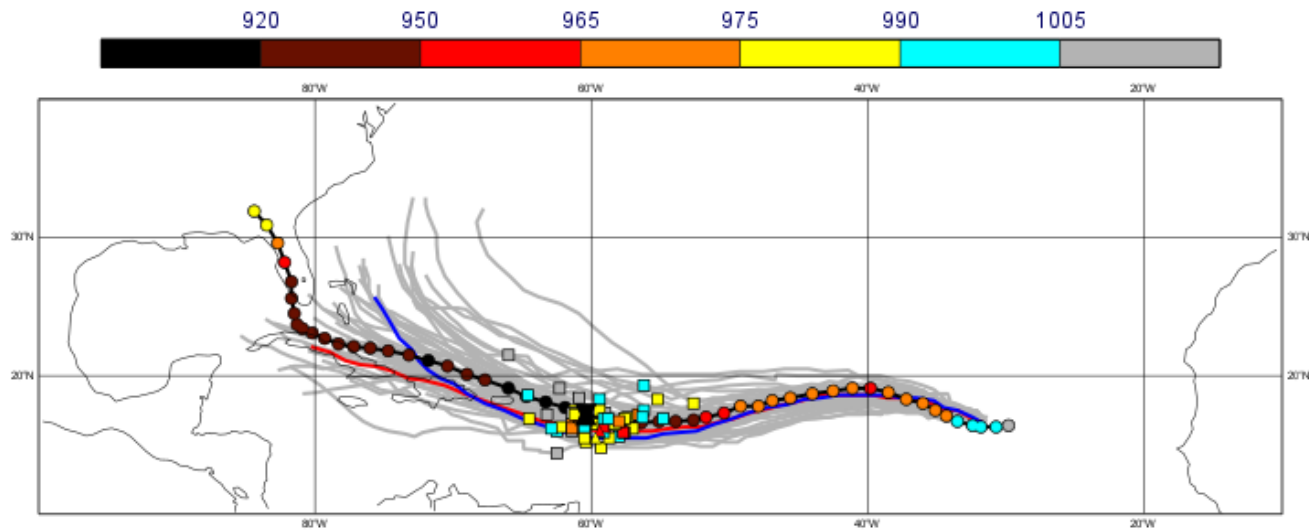
24 August



28 August

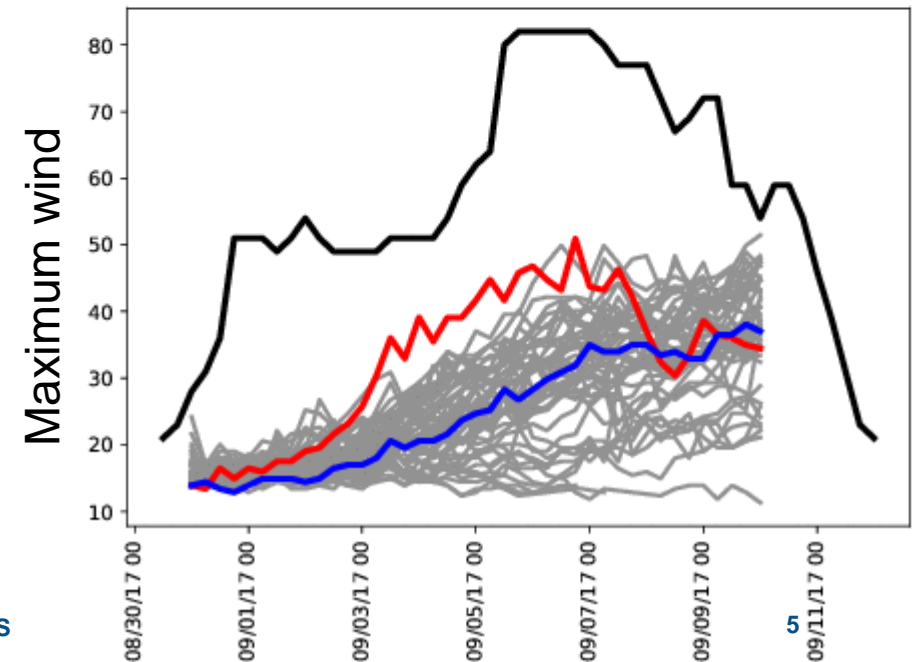
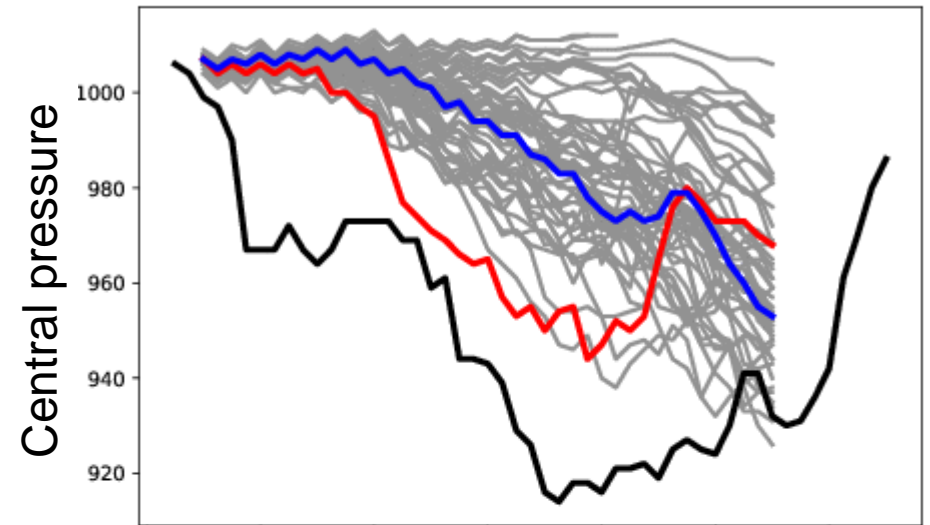


# Forecast for TC Irma from 31 August 00UTC

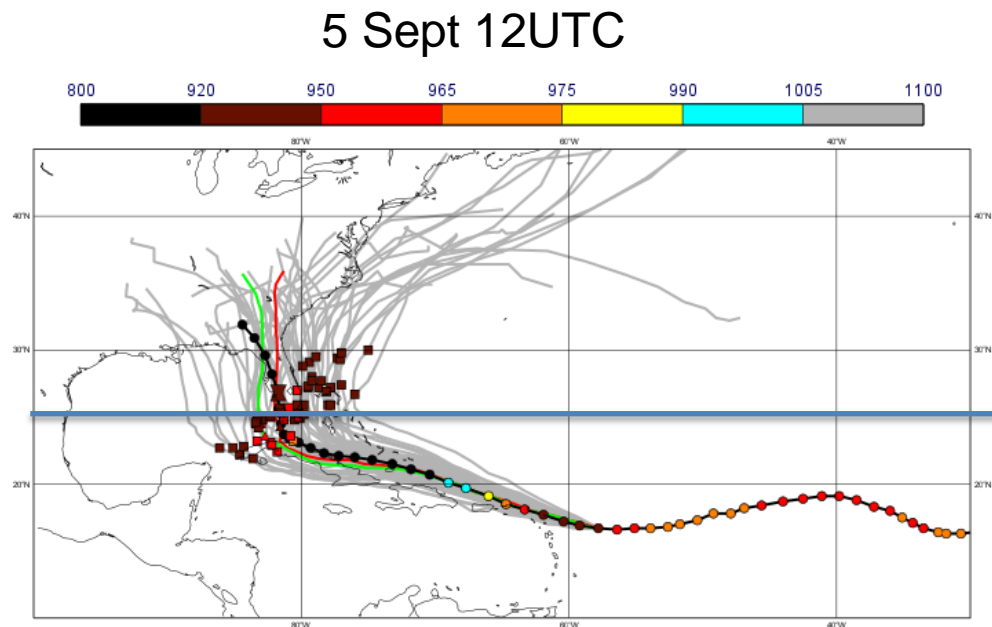


Symbols indicate position and intensity 6 Sept 00UTC

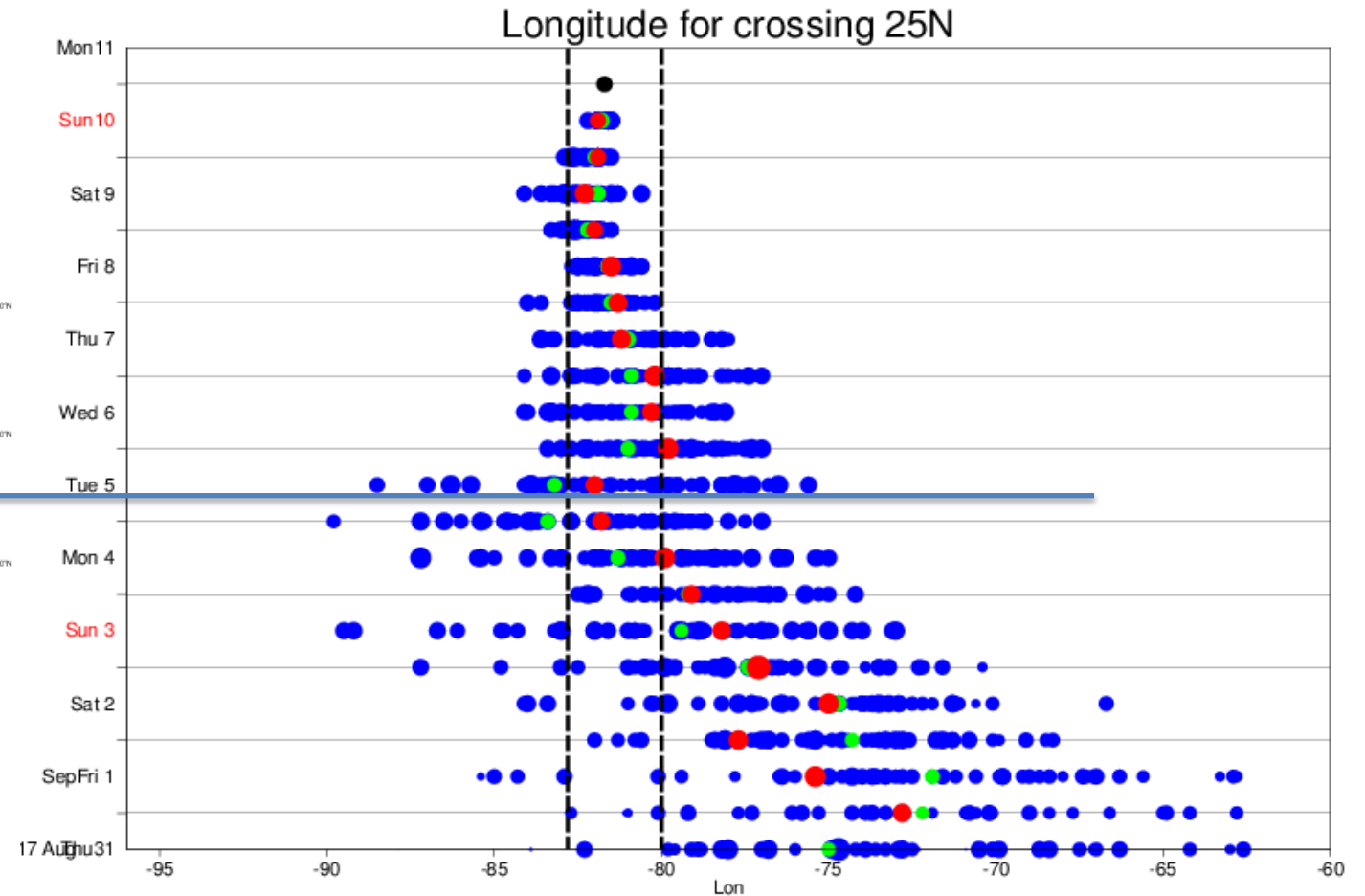
HRES (**red**)  
ENS CF (**blue**)  
ENS PF (**grey**)  
BestTrack (**black**)



# Predictions for Florida landfall 11 Sept 00UTC

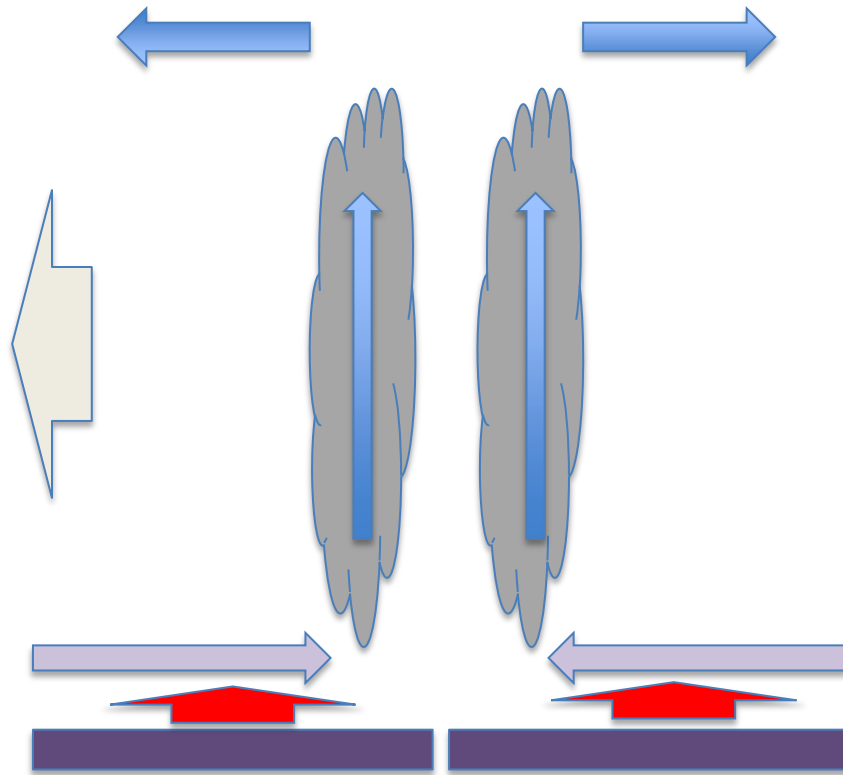


HRES – red  
ENS control – green  
ENS members – grey/blue



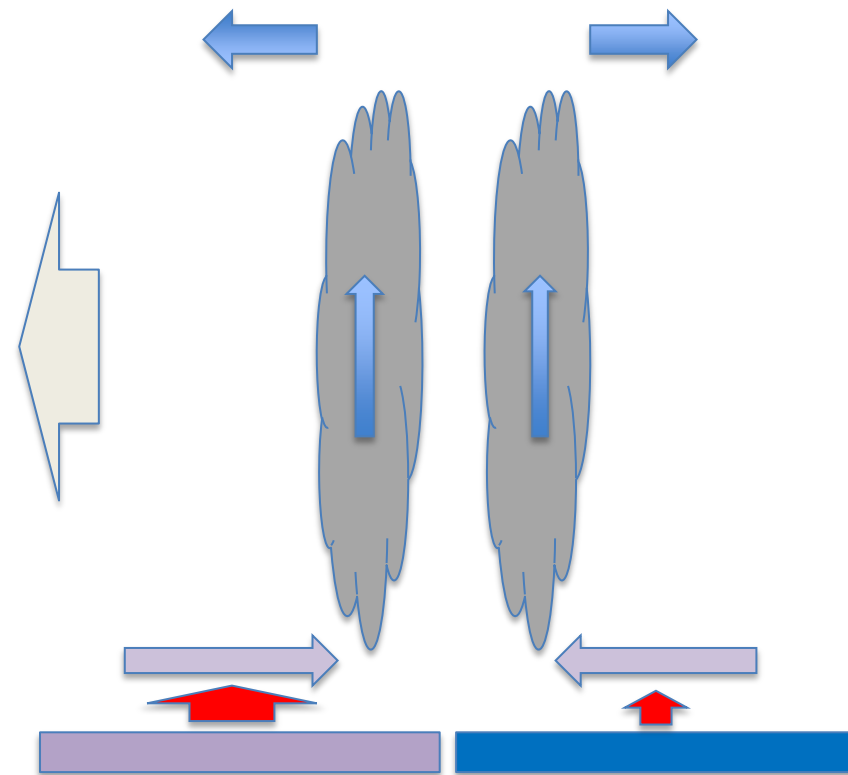
# Effect of ocean coupling

Uncoupled (no ocean feedback)



(constant SST)

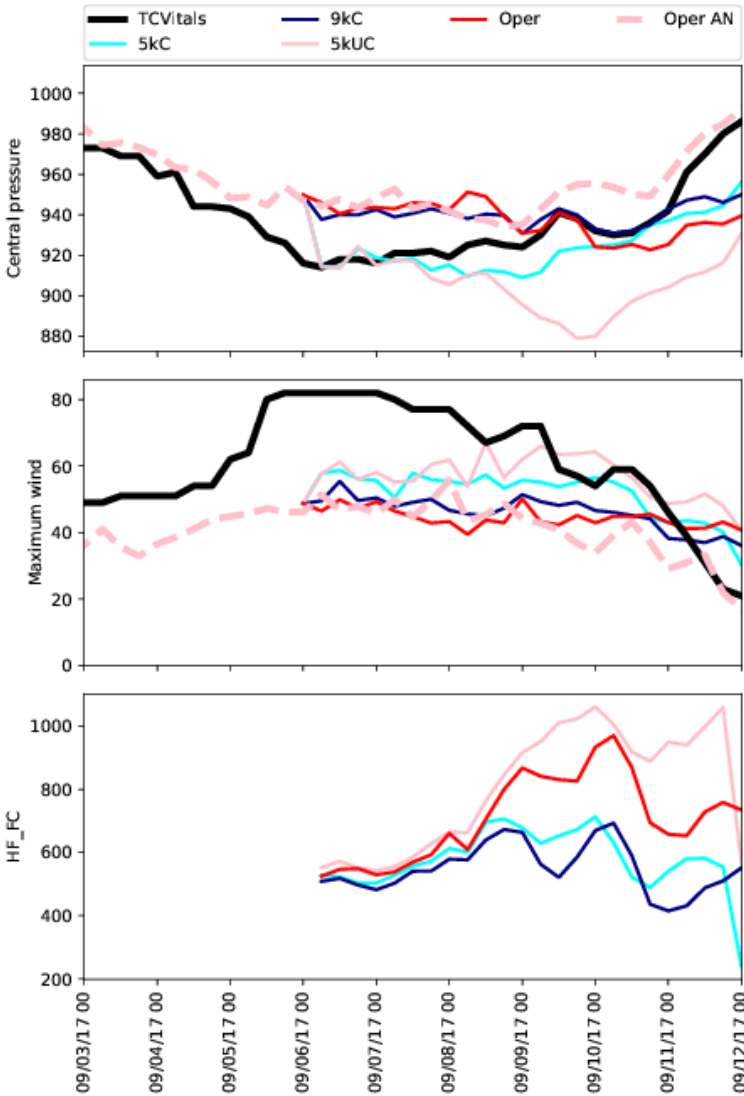
Coupled



(Cooling of the SST due to heat flux)

# Effect of ocean coupling for TC Irma

Central pressure  
Maximum wind  
Sfc. heat flux



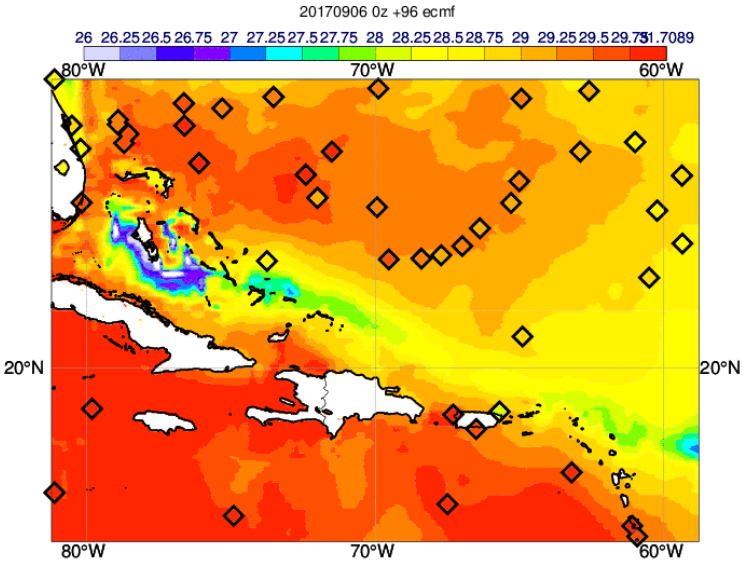
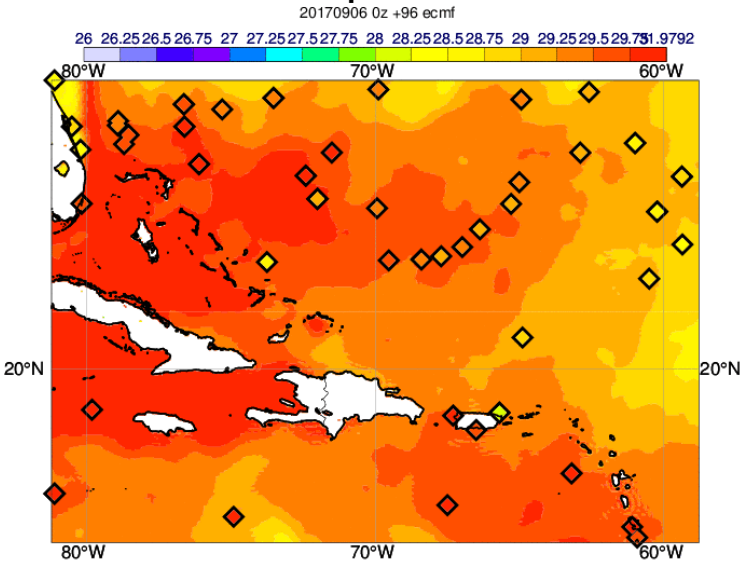
9 km Uncoupled (red)  
9 km Coupled (blue)

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

5 km uncoupled

5 km coupled

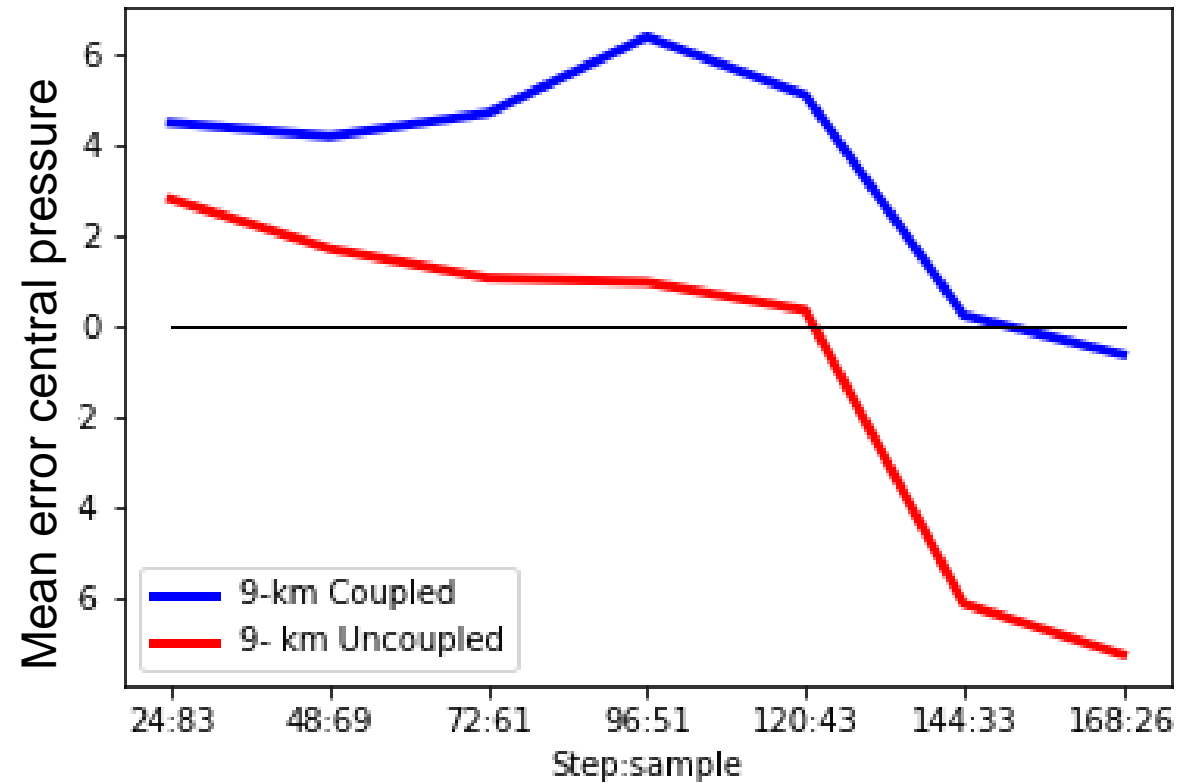
SST in 6 Sept 00UTC+96h



cf Mogensen et al. (2017)

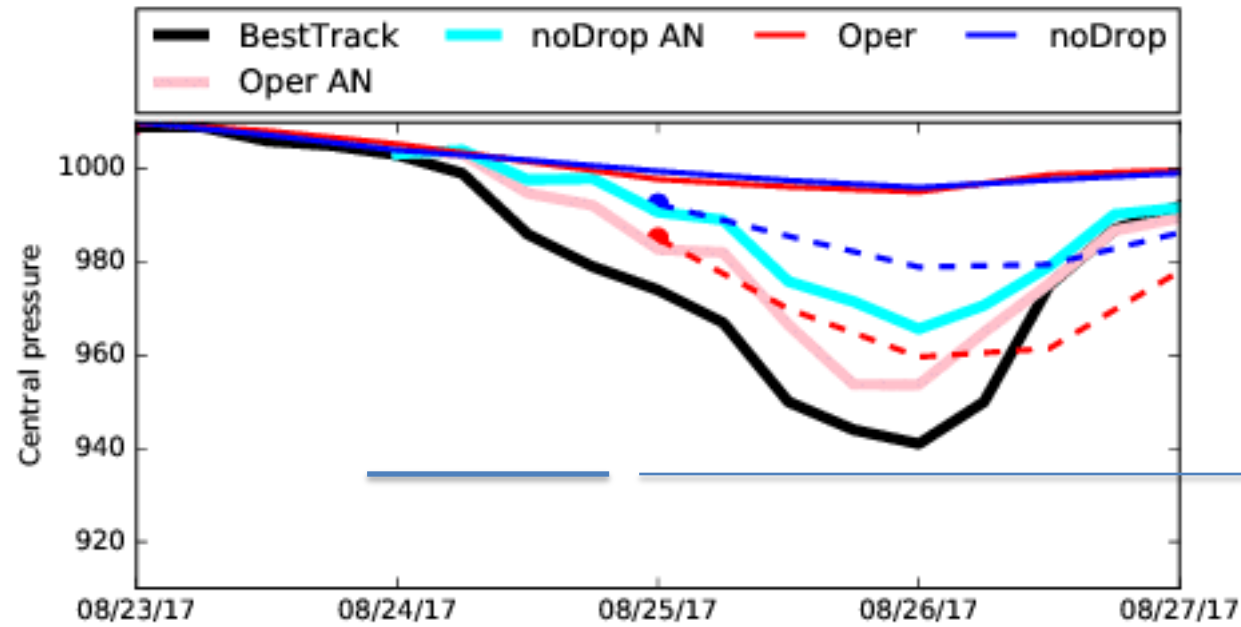


## Effect of ocean coupling (August and September 2017)



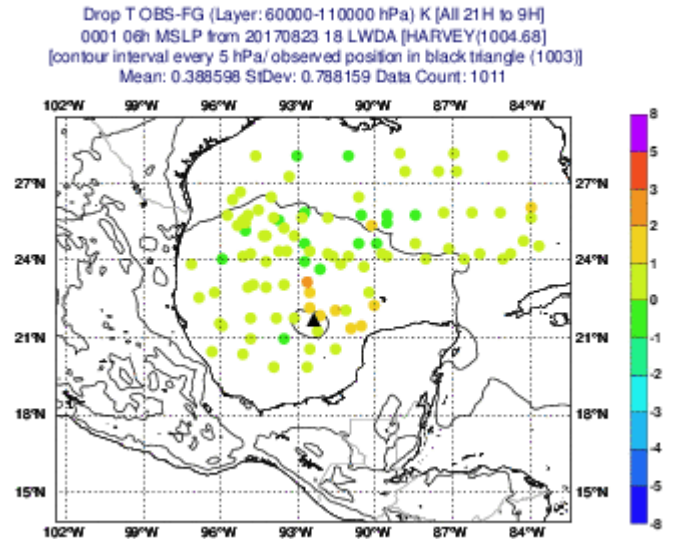
# Impact from dropsondes on Harvey intensification

## Harvey

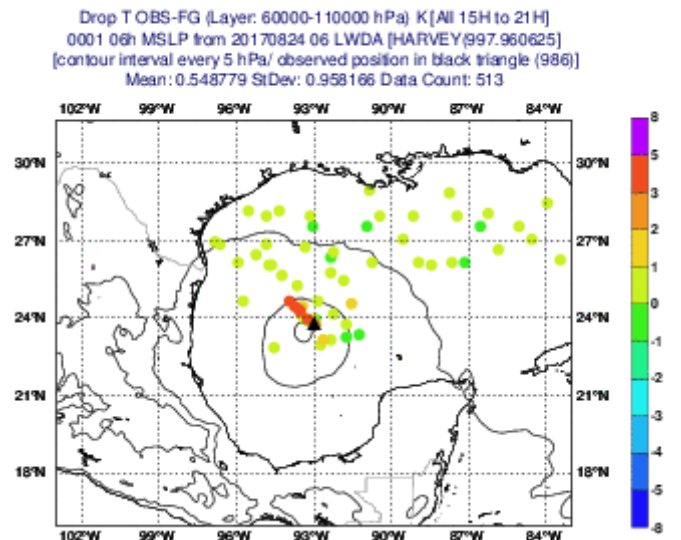


First guess departures (mainly Global Hawk)

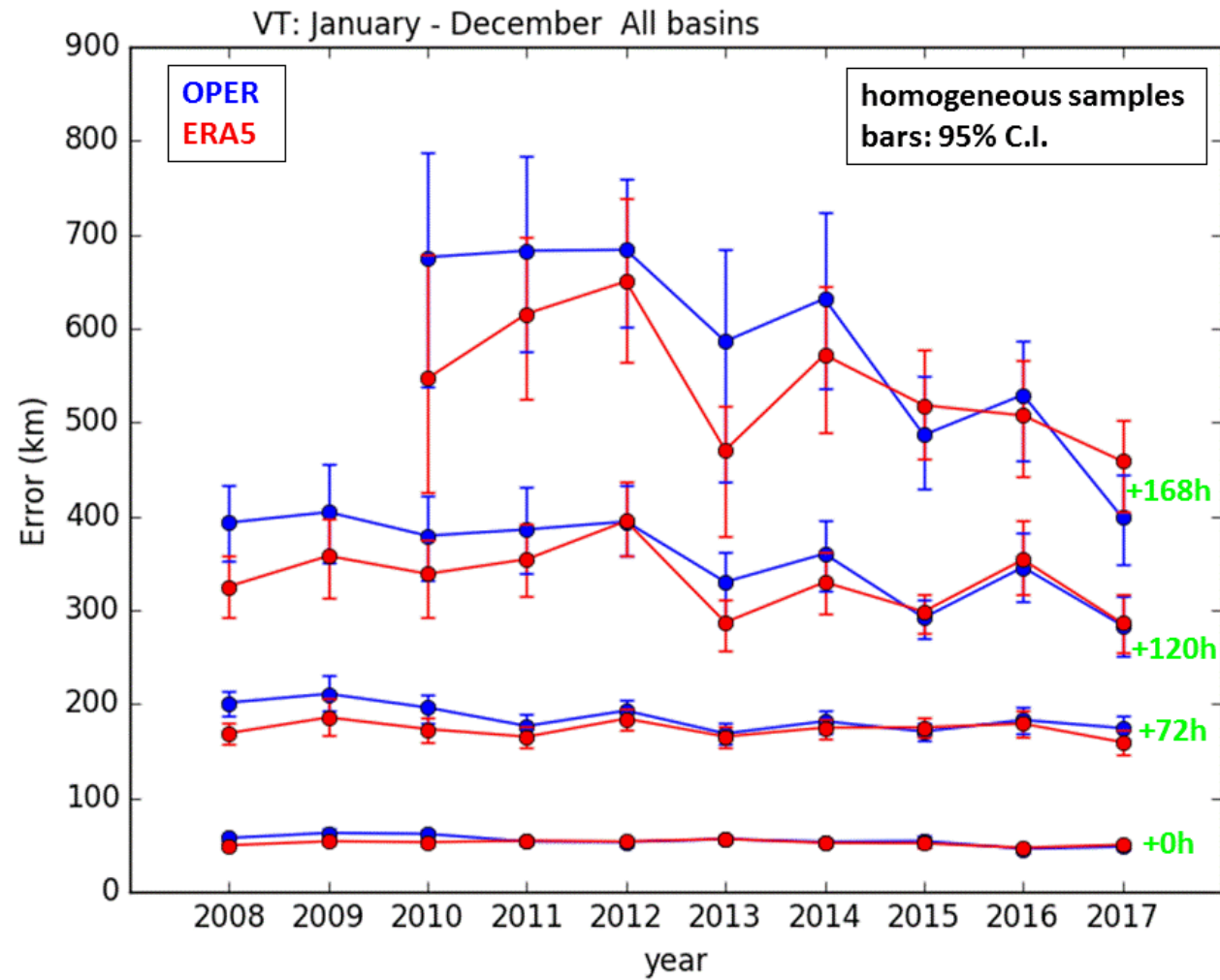
24 Aug 00UTC



24 Aug 12UTC

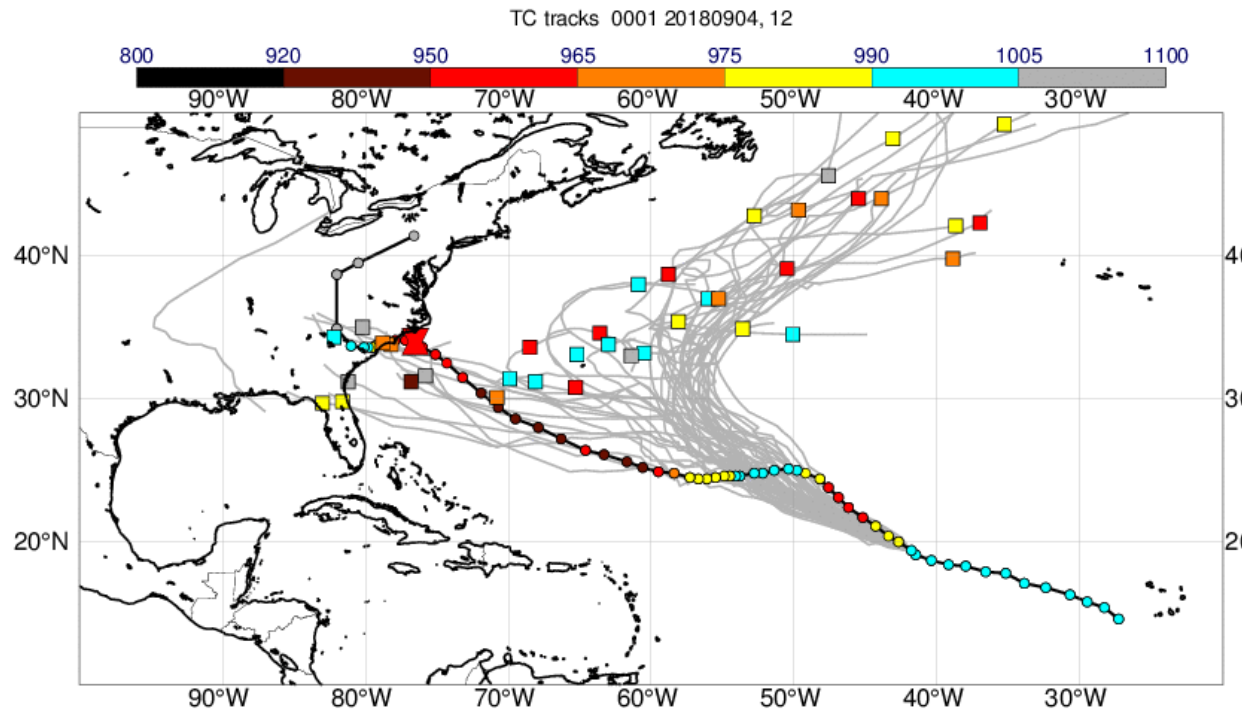


# Trend in tropical cyclone position error



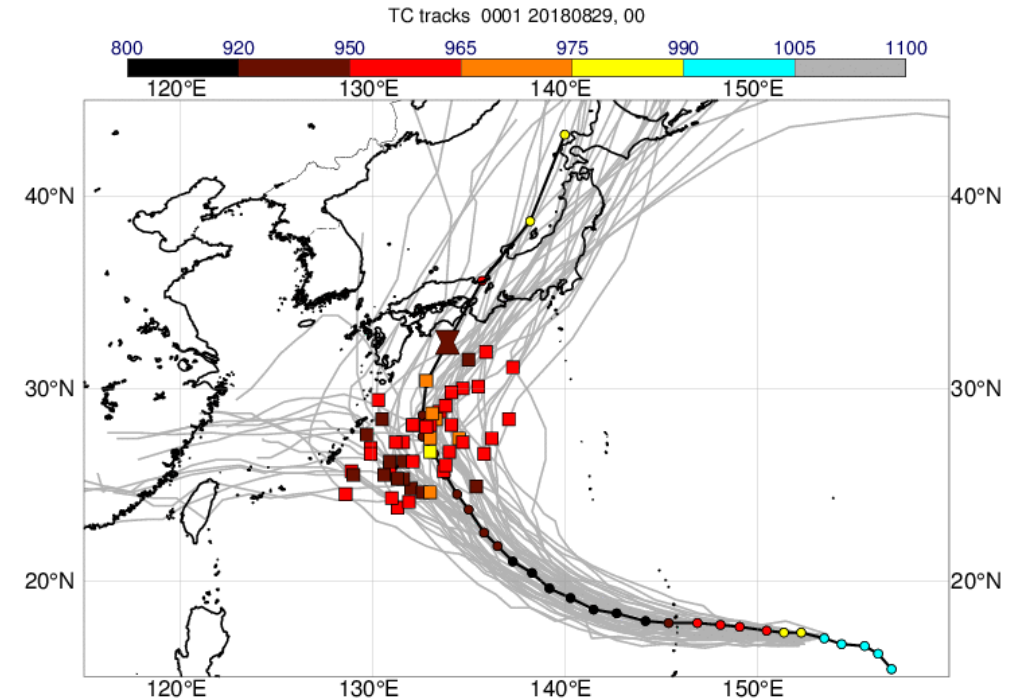
# Difficult cases

## Florence (2018)



(Symbols at day 9)

## Jebi (2018)



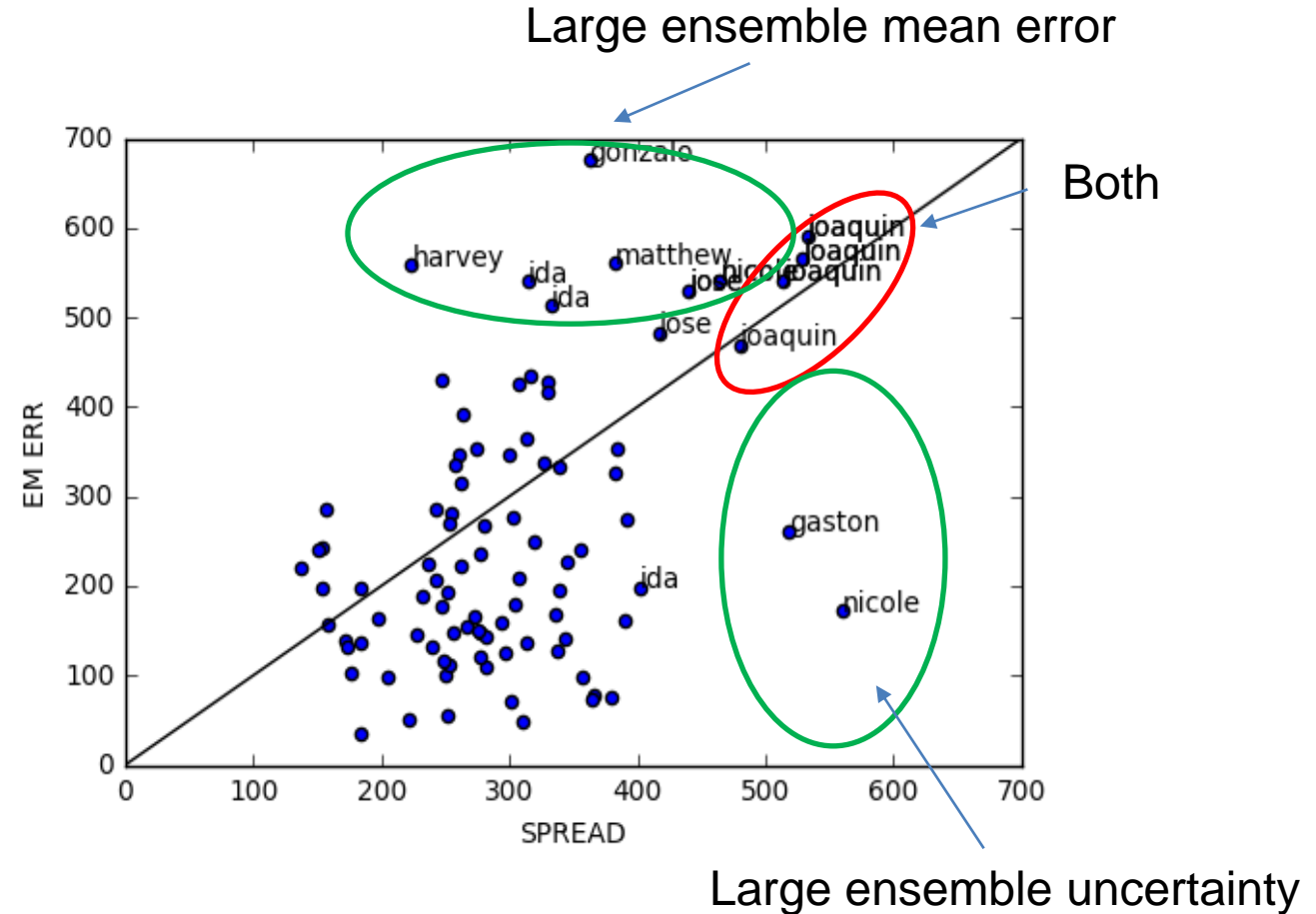
(Symbols at day 6)



## 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, ...

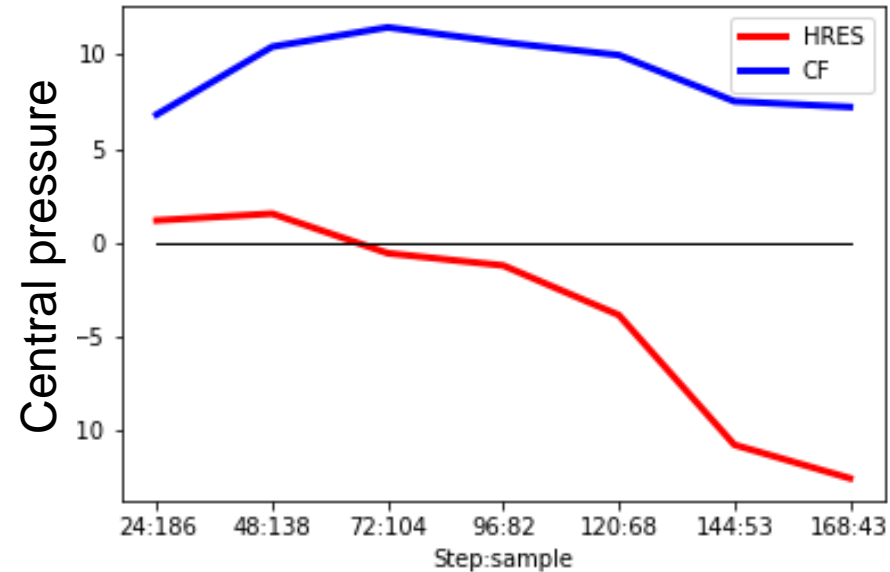


*Ensemble mean error (y-axis) and ensemble spread (x-axis) for 5-day forecasts from ECMWF, for all cases in 2015-2017 cases in the Atlantic and eastern Pacific.*



# Pressure and wind bias 2017

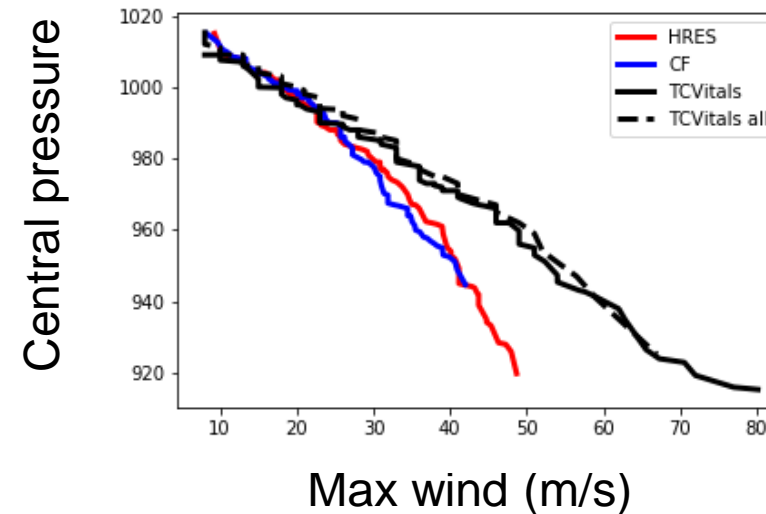
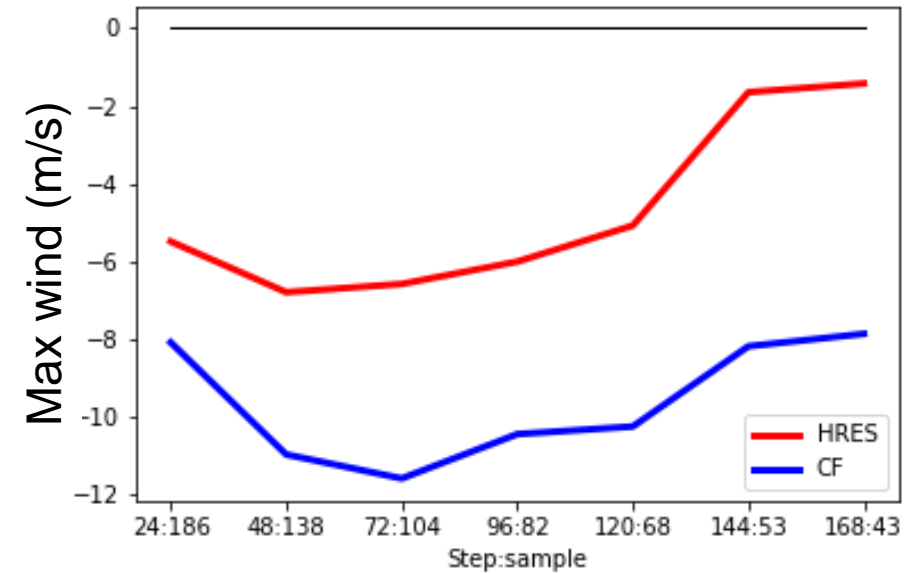
Mean “Central pressure” error



Differences:

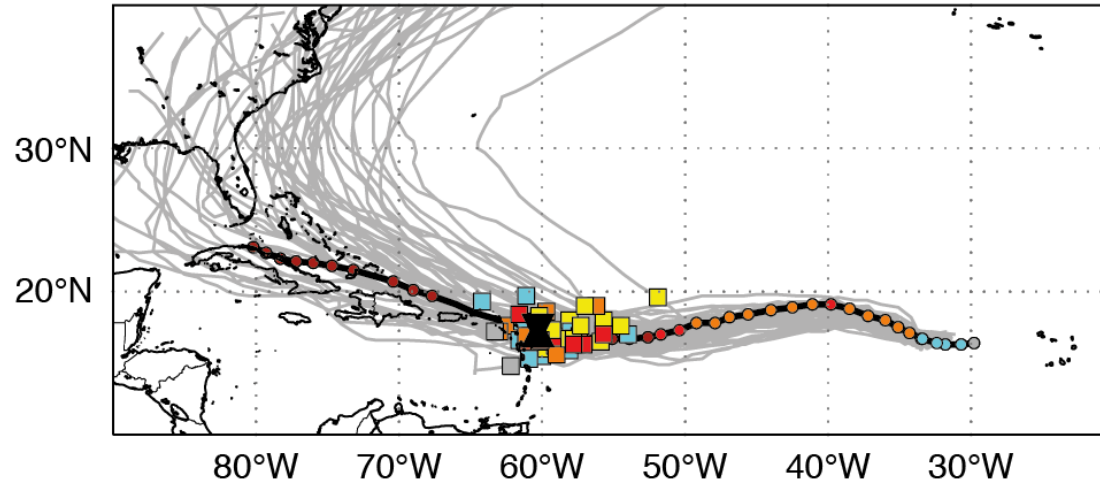
- Resolution (9 km vs. 18 km)
- Ocean coupling

Mean “Max wind” error (m/s)

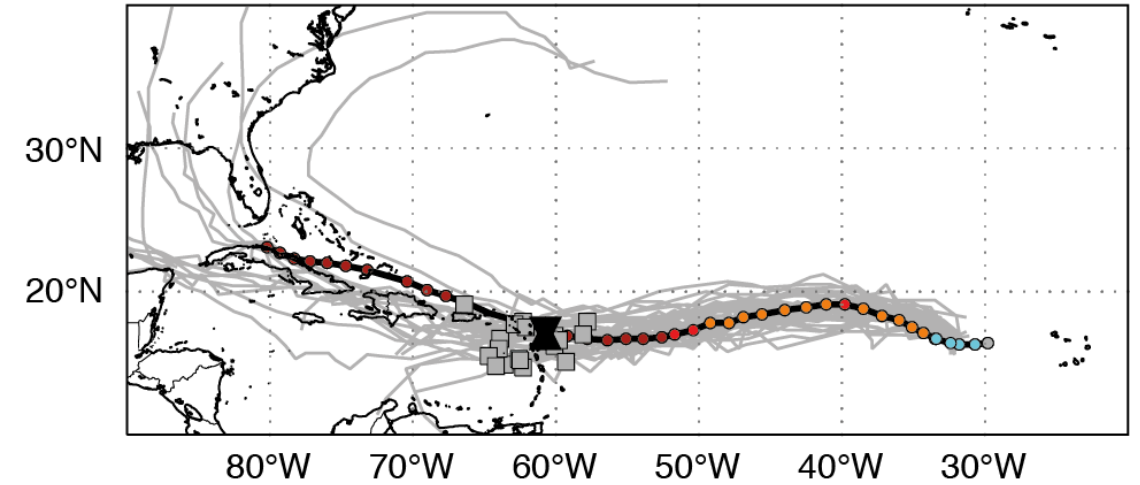


# Impact of removing satellite data

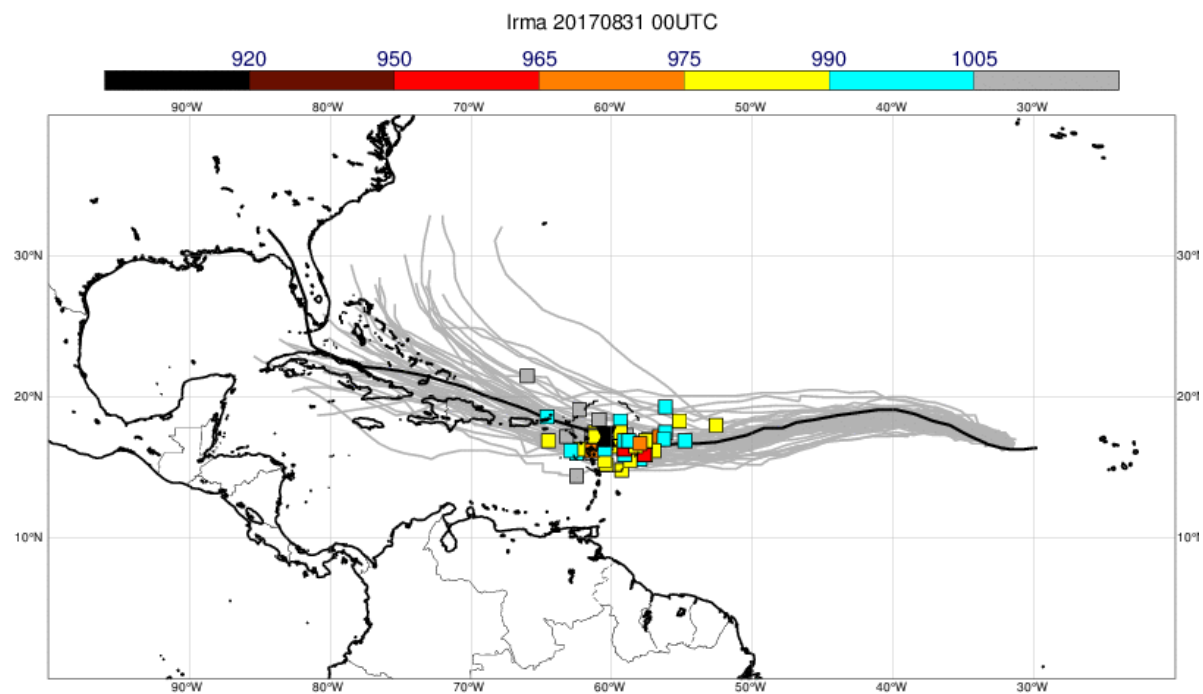
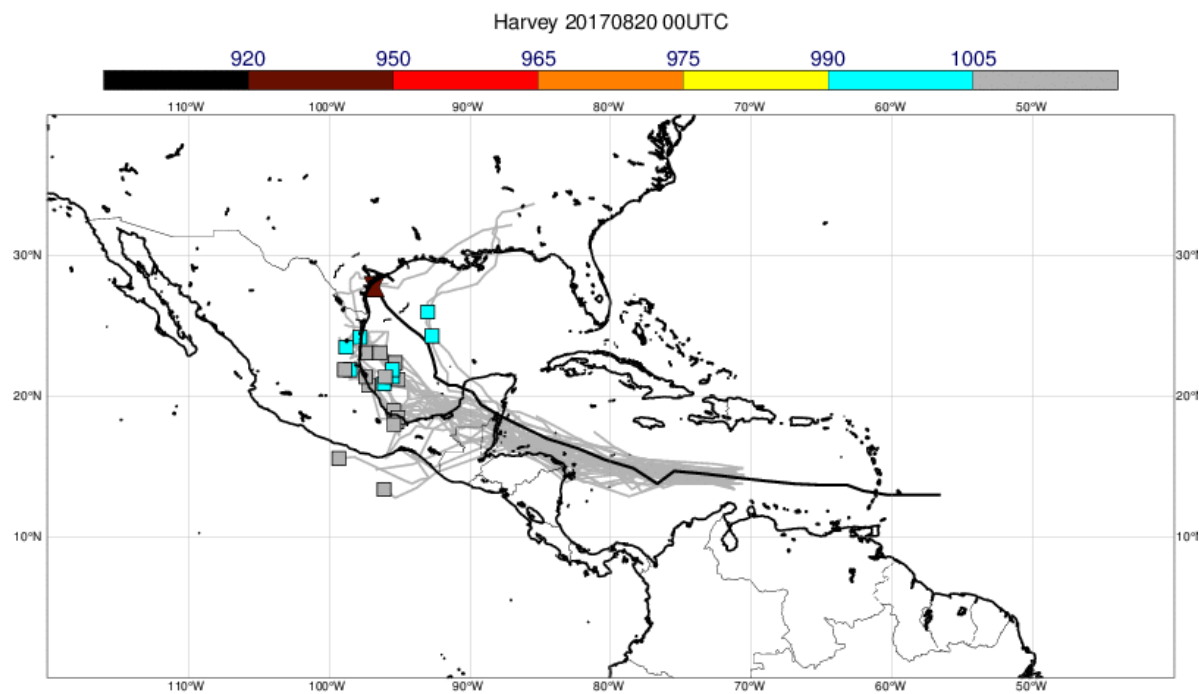
**a** All obs 20170831 00UTC



**b** No Sat 20170831 00UTC

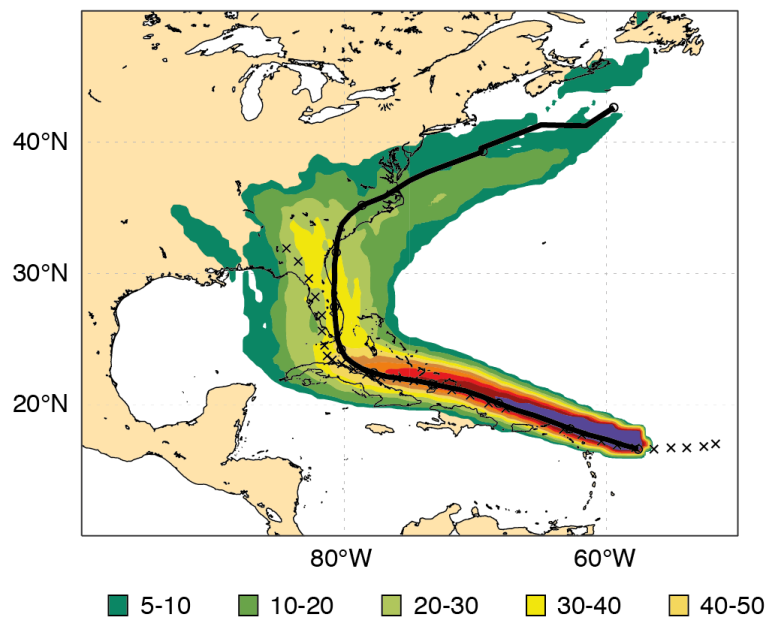




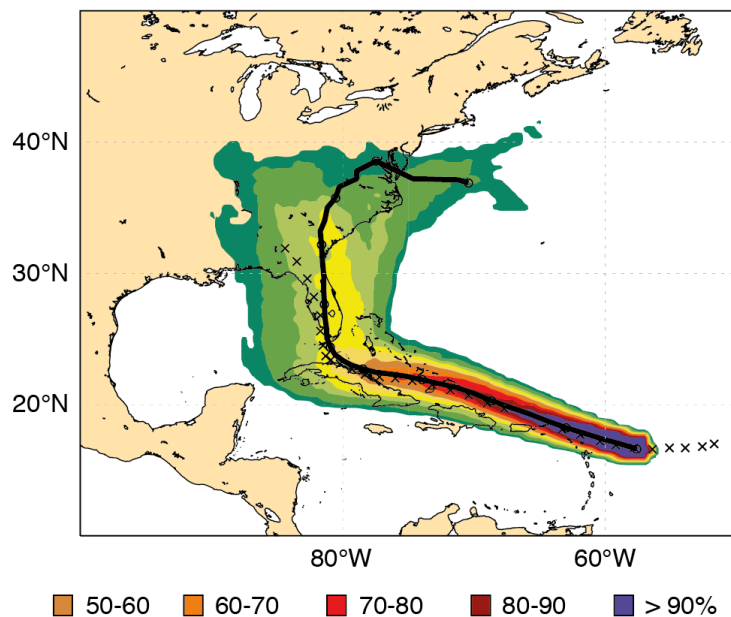


# 5- km experimental ensemble for TC Irma

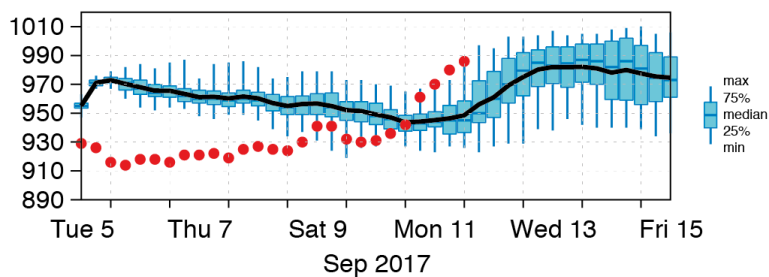
**a** Operational 18 km ensemble -track



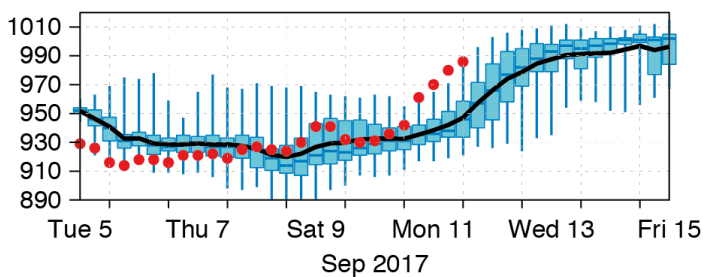
**b** Experimental 5 km ensemble -track



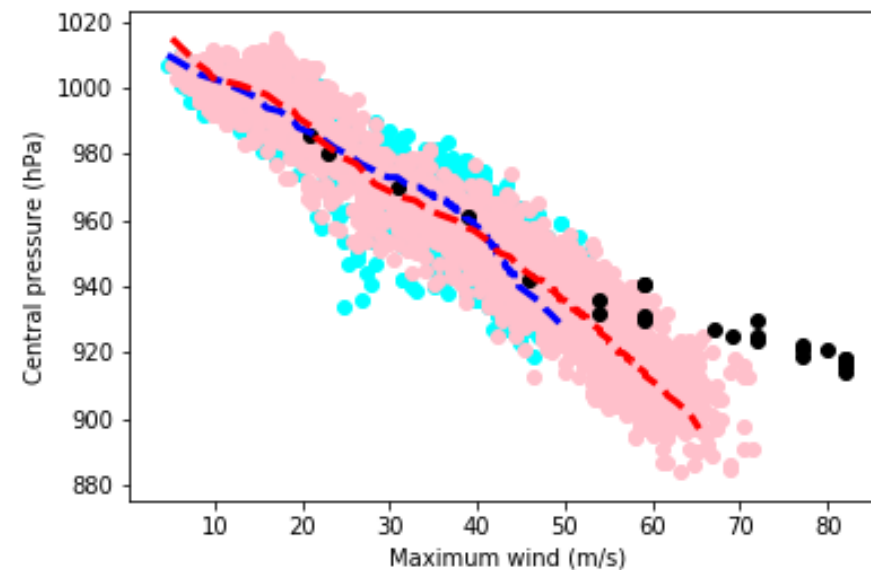
**c** Operational 18 km ensemble – central pressure



**d** Experimental 5 km ensemble –central pressure



Wind/pressure relation



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