The impact of Aeolus wind observations on the predictability of extreme weather

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Acknowledgement
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Study overview

The assimilation of Aeolus HLOS wind profile information has shown to improve forecasts of temperature, humidity and winds, particularly in the upper troposphere and lower stratosphere, with the largest signal seen in the tropics. The impact persists in the mid range. Good impact at high latitude too (see presentation from Mike Rennie).

Is this also true for extreme weather events?

Project objective: To investigate whether the assimilation of Aeolus wind data improve the predictability of strong storms in the extra-tropics and tropics

A **focus** is put on:

- *tropical cyclones*
- *extratropical storms*, with a particular emphasis on Europe *preliminary analysis => no conclusive results yet*
- European *forecast busts* *preliminary analysis => no conclusive results yet*

The project started in July 2021 and is ending in February 2023.

Impact experiments

Long Observing System Experiments (OSEs) from *July 2019 to December 2021* (covering 3 TC seasons), using reprocessed and operational data.

Dataset: ***Second reprocessing campaign*** dataset by the Aeolus DISC (Data, Innovation, and Science Cluster) which provides a new, high quality dataset from July 2019 to October 2020. This reprocessed dataset, combined with the current operational data, provide a long timeseries of high-quality Aeolus measurements.

Observing System Experiments (done in strong collaboration with the ESA DISC team members at ECMWF)

- *Control (CTRL):* *L*ike the operational configuration with all operational observations used apart from Aeolus. "*No Aeolus*"
- *Aeolus:* *Like t*he *Control* experiment **plus** Aeolus data.

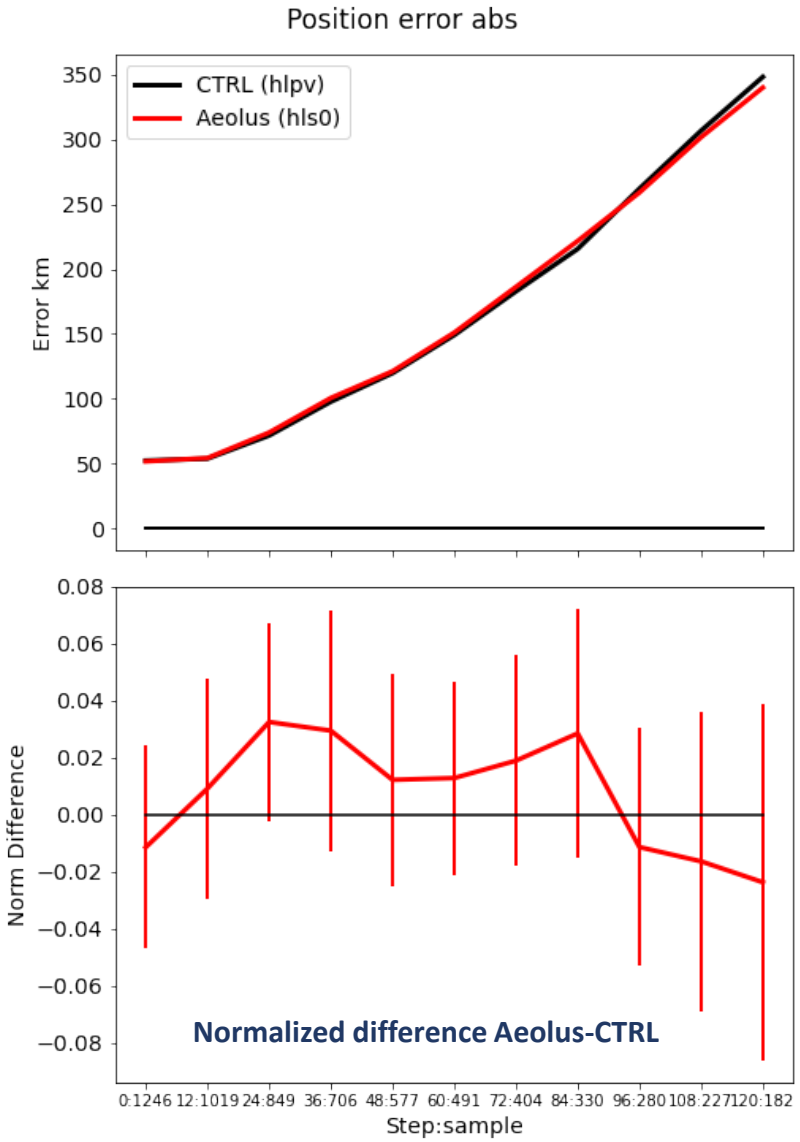
NWP System: The pre-existing ECMWF Aeolus assimilation system (within IFS)

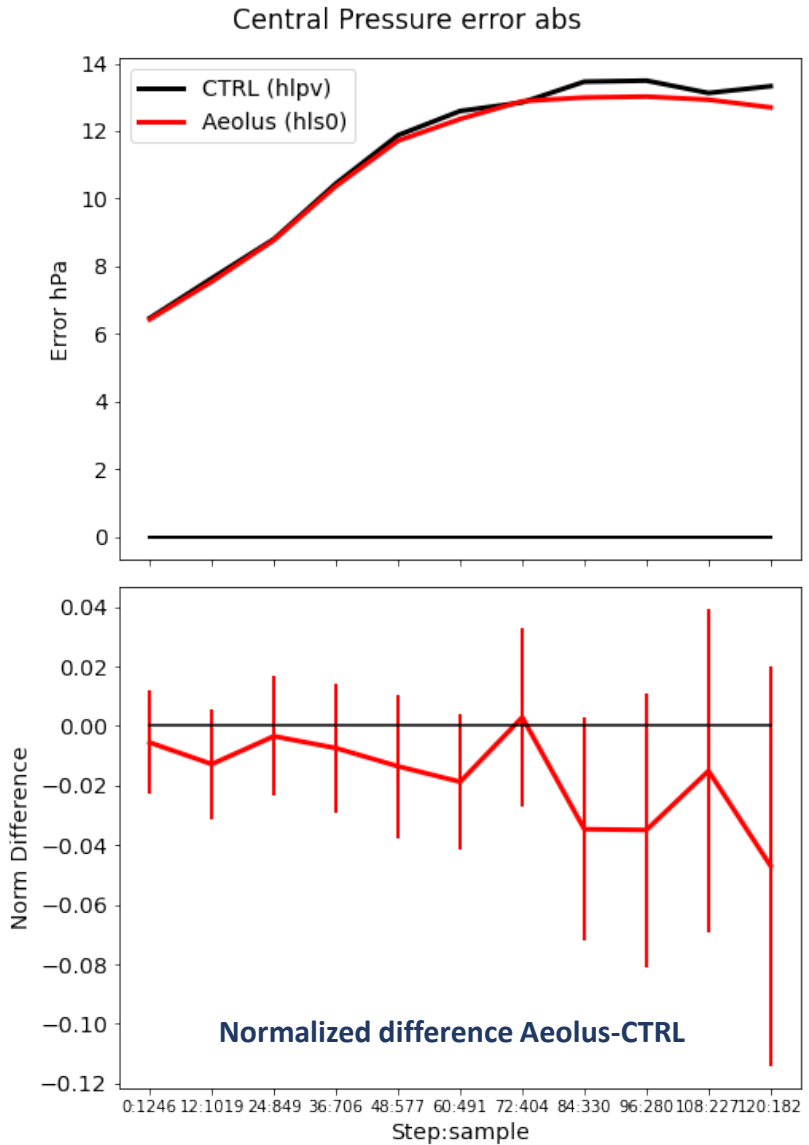
OSE set-up

- IFS model version CY47R2 (Operational in December 2020)
- Resolution: **Tco639 ~18 km** (producing global forecast out to day-10)

Impact on TC forecast error

Impact of Aeolus observations on the analyses and forecasts of tropical cyclones trajectories and intensities.
Preliminary results on the **position** and **intensity** error for the *CTRL* and *Aeolus* experiments

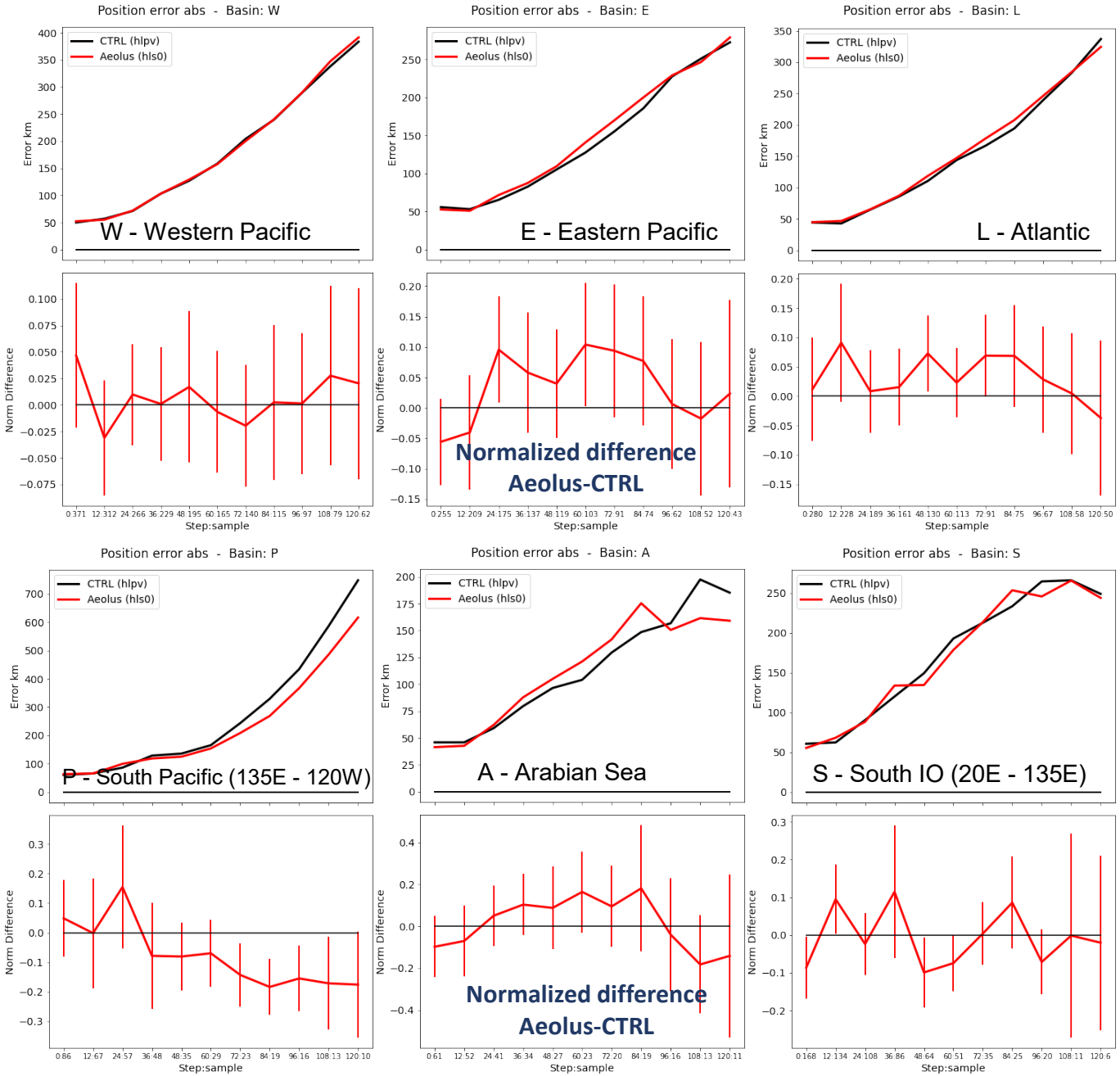




Global statistics

- ***Data from 1 July 2019 to 31 August 2020***
- Aeolus impact on position error is slightly negative/neutral
- Impact on intensity error is positive/neutral
- Results not consistent over time so far, sampling errors are important

Impact on TC forecast error



Regional statistics by TC basin

Position Error (Absolute value)

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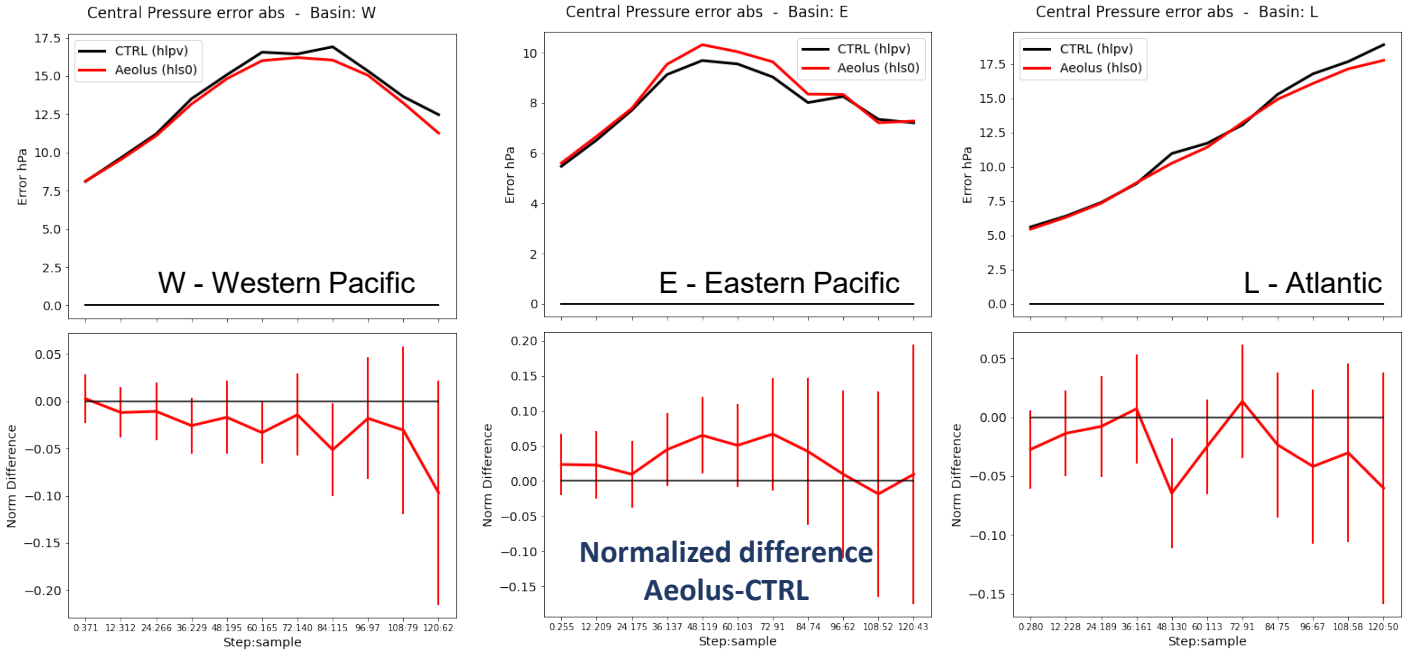
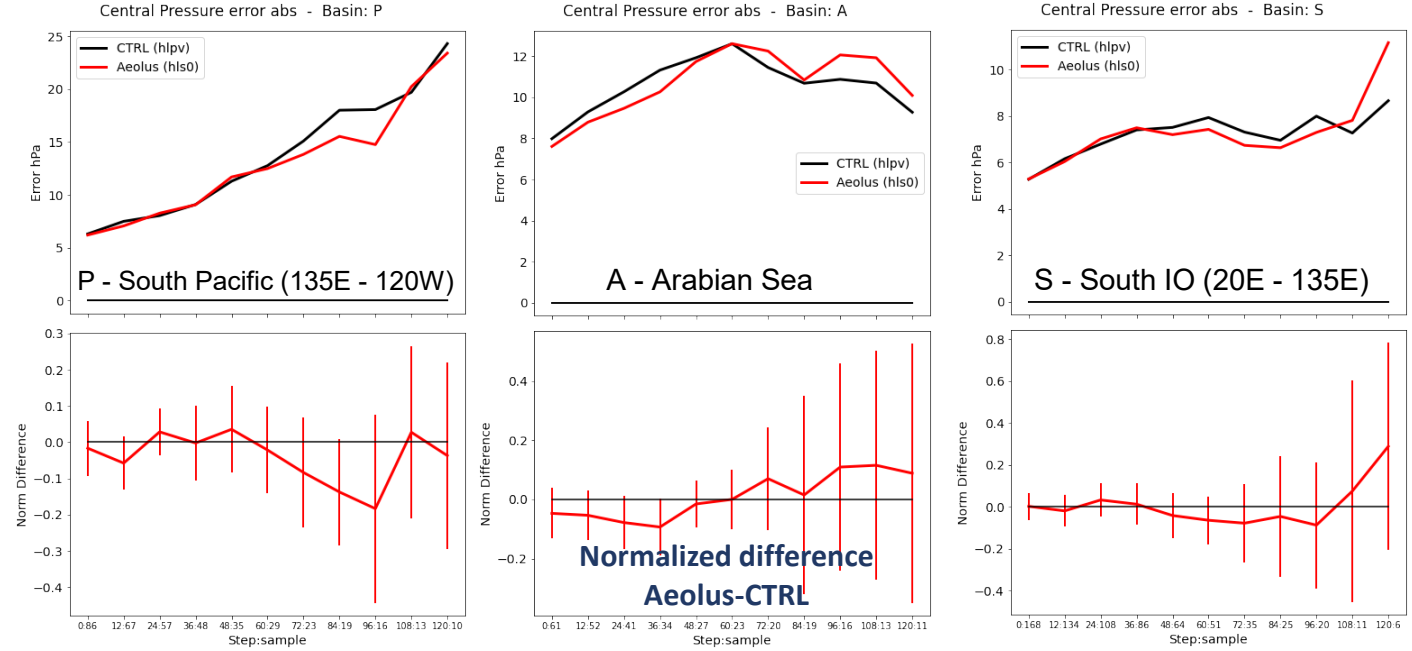
Impact on TC forecast error





Regional statistics by TC basin

Intensity Error (Absolute value)

Tropical Cyclones – case studies

A selection of case studies has been identified for deeper analysis:

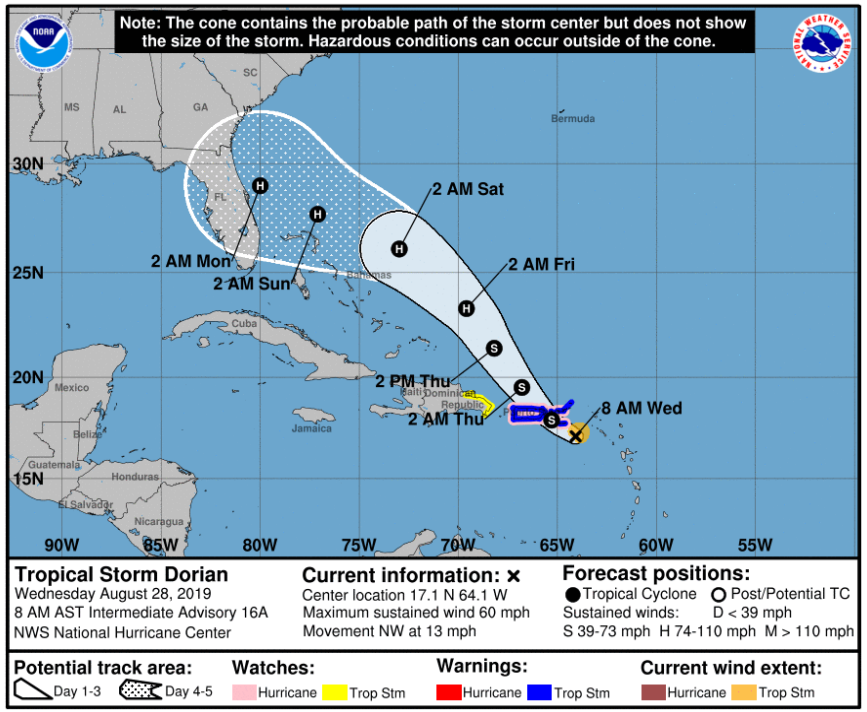
Storm	Basin	Cat	Start	End
Dorian	N Atlantic	5	24/08/19	10/09/19
Lorenzo	N Atlantic	5	23/09/19	04/10/19
Hagibis	NW Pacific	5	04/10/19	22/10/19
Ampham	N Indian	5	16/05/20	21/05/20
Isaias	N Atlantic	1	30/07/20	05/08/20
Laura	N Atlantic	4	20/08/20	29/08/20
Teddy	N Atlantic	4	13/09/20	23/09/20
Nangka	NW Pacific	TS	11/10/20	14/10/20
Iota	N Atlantic	4	13/11/20	18/11/20
Eloise	S Indian	2	14/01/21	25/01/21
Tauktae	N Indian	4	15/05/21	18/05/21
Kate	N Atlantic	TS	29/08/21	01/09/21
Larry	N Atlantic	3	01/09/21	11/09/21

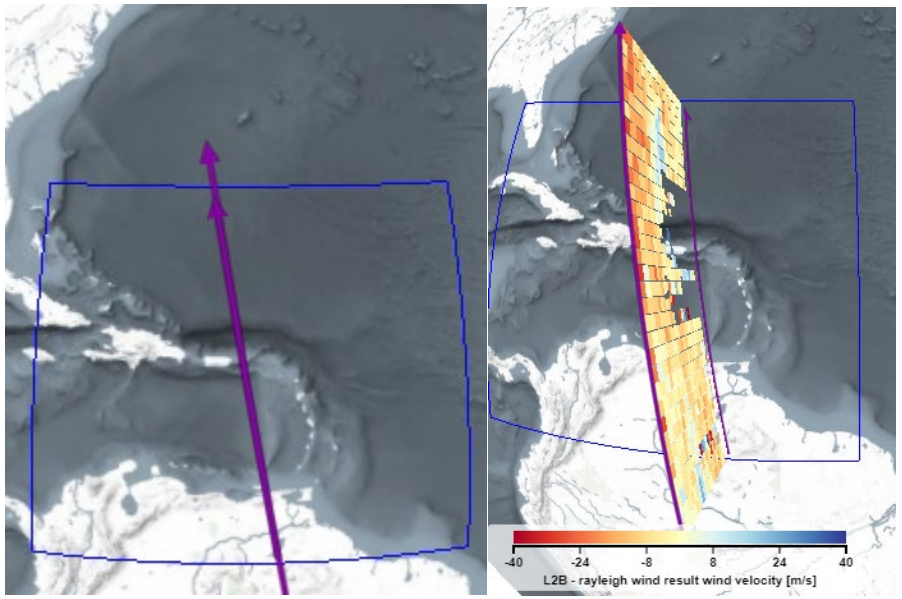
The list is not exhaustive: more case could be selected while comparing the OSEs results.

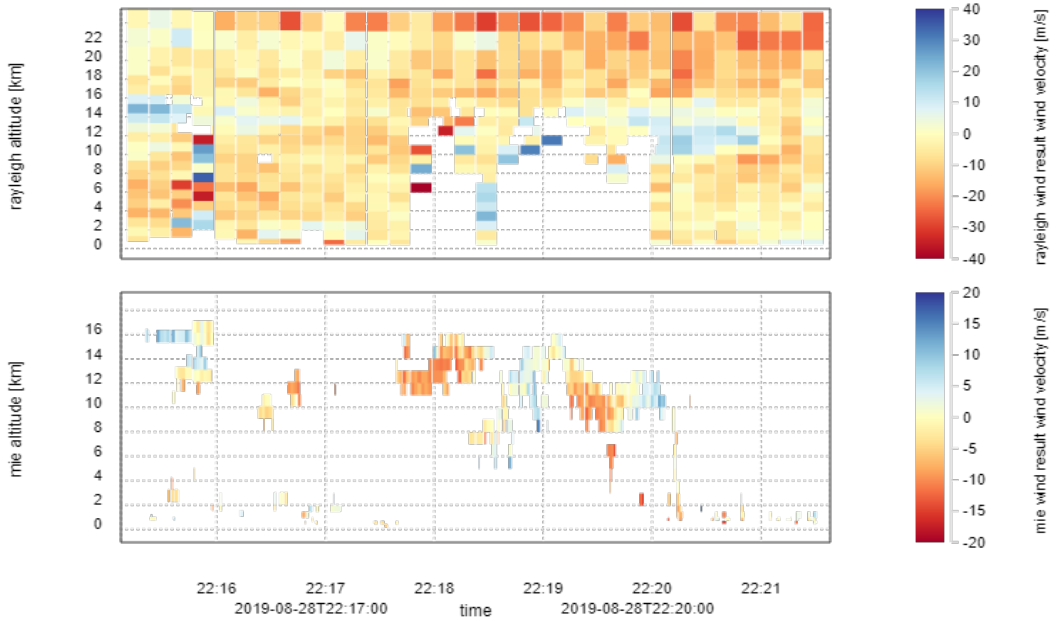
Tropical Cyclone – Aeolus coverage

TC Dorian, North Atlantic Ocean

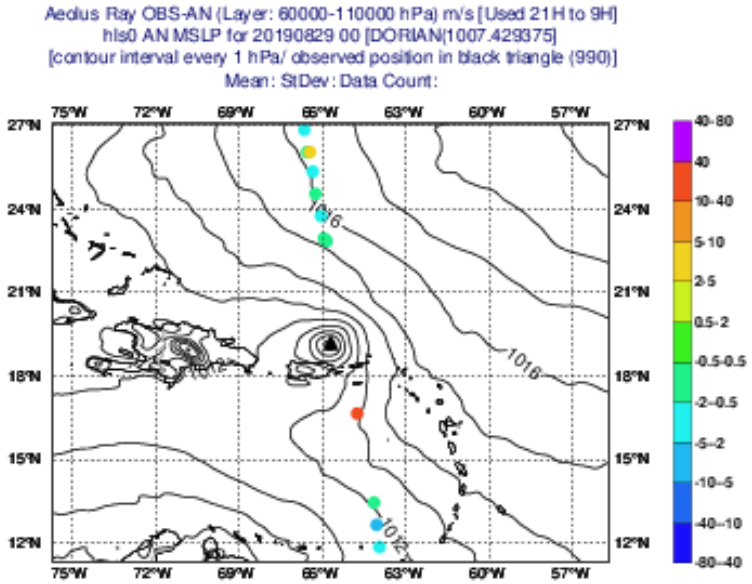
28 August 2019

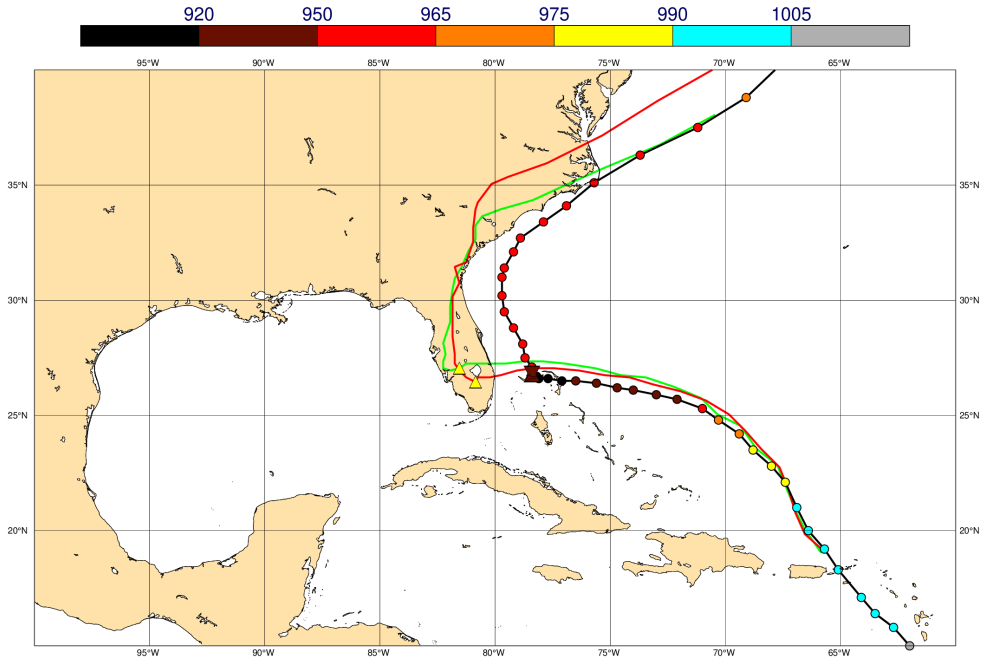






TC Dorian





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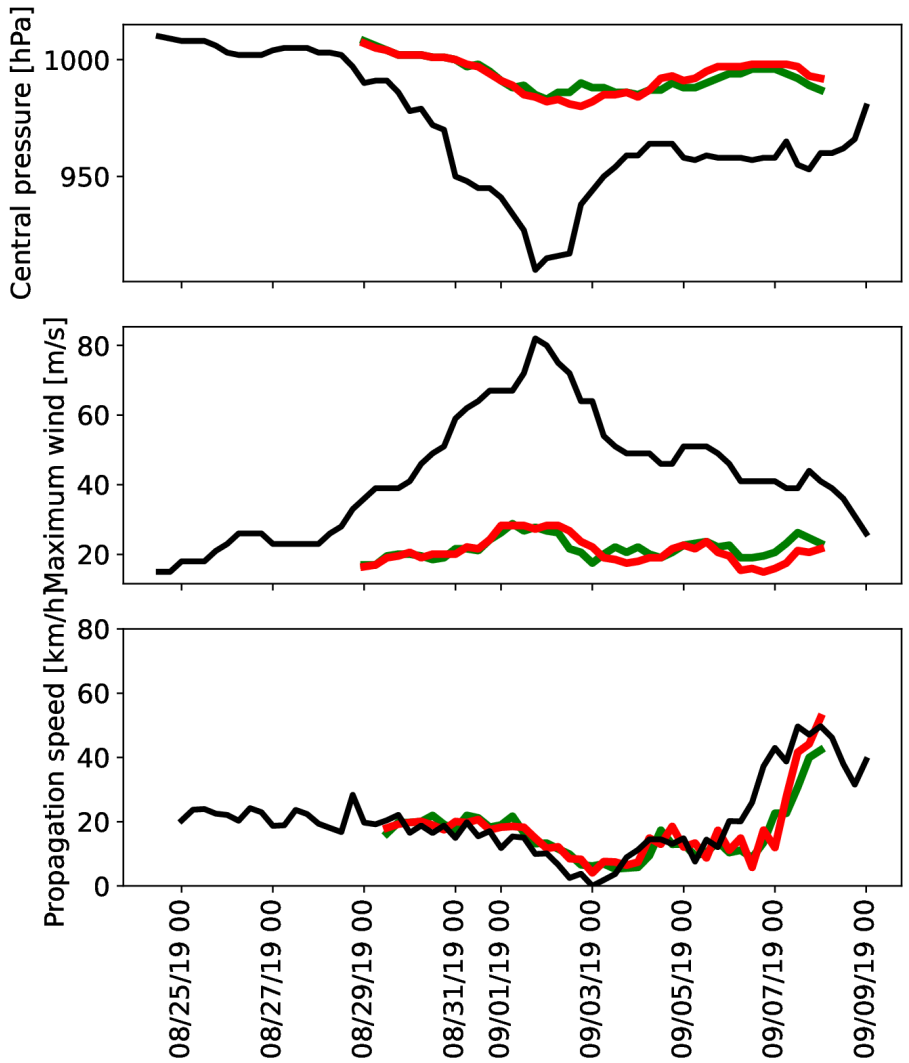
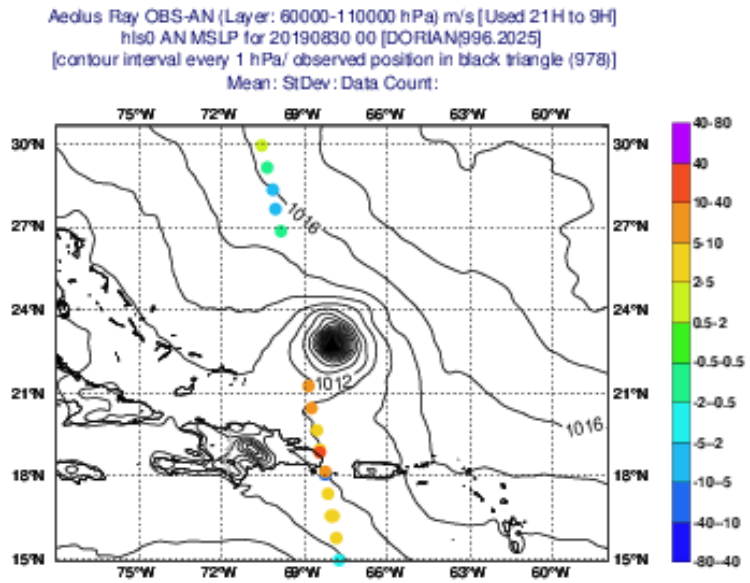
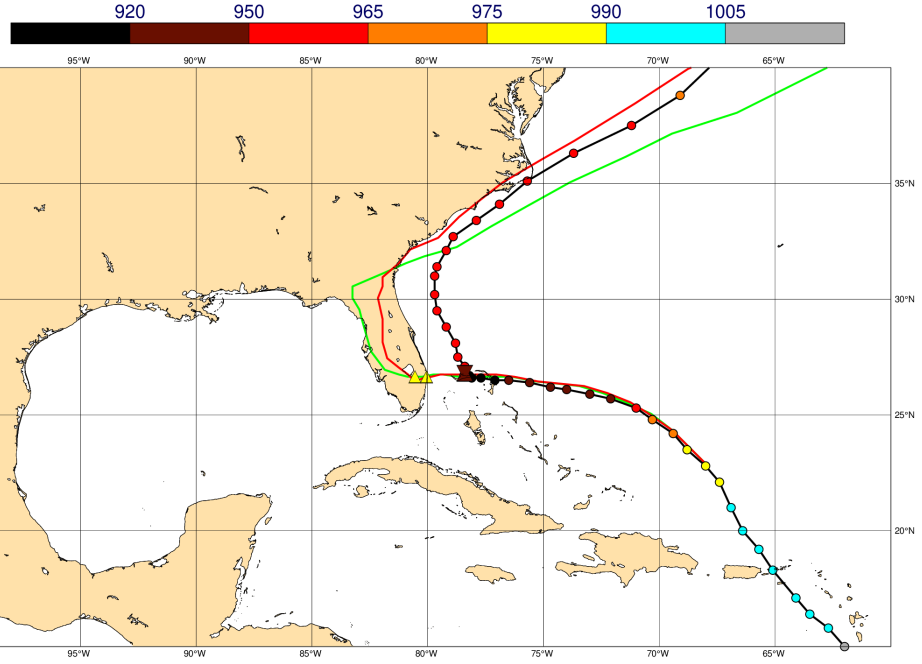


CTRL (hlpv) Aeolus (hls0) BestTrack

TC Dorian





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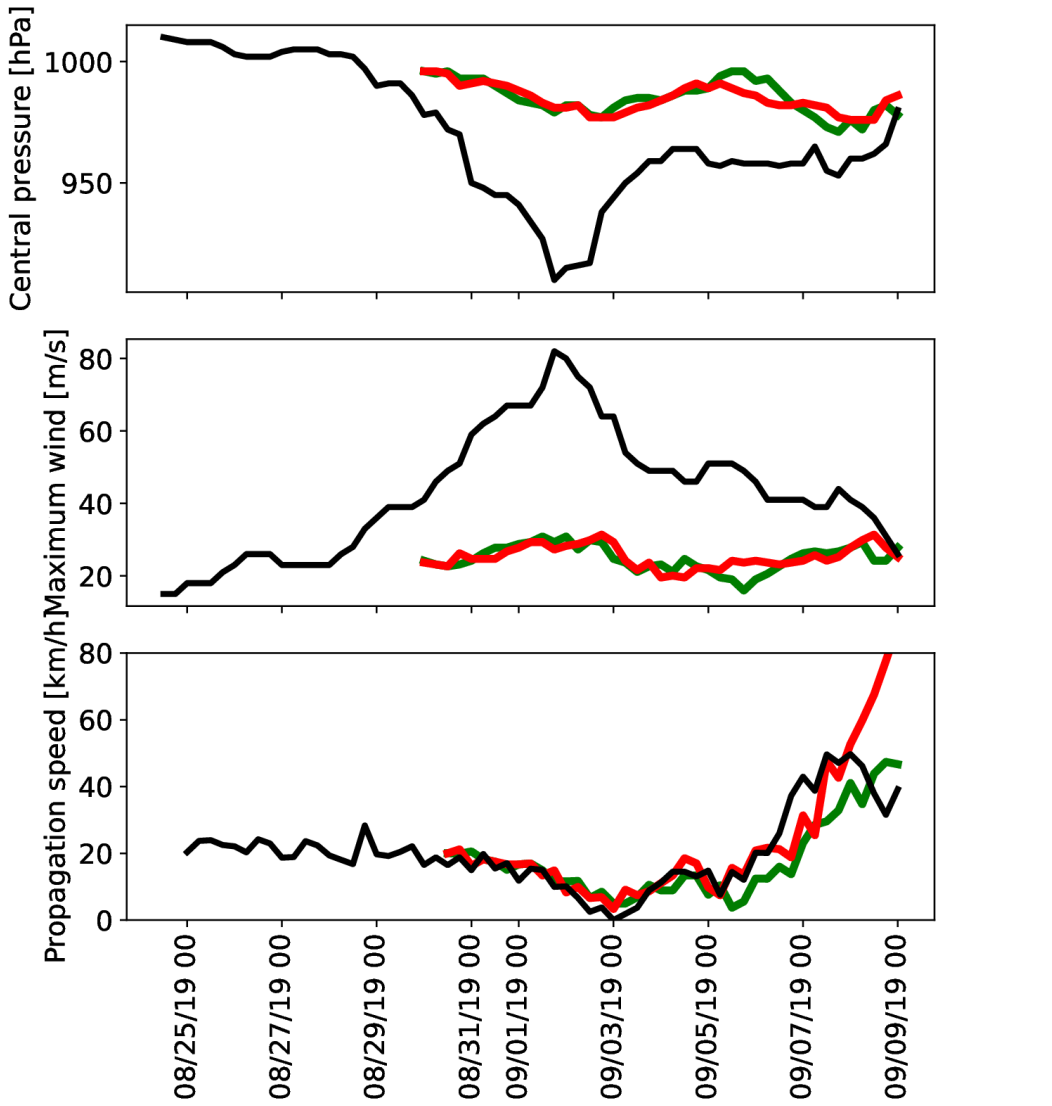

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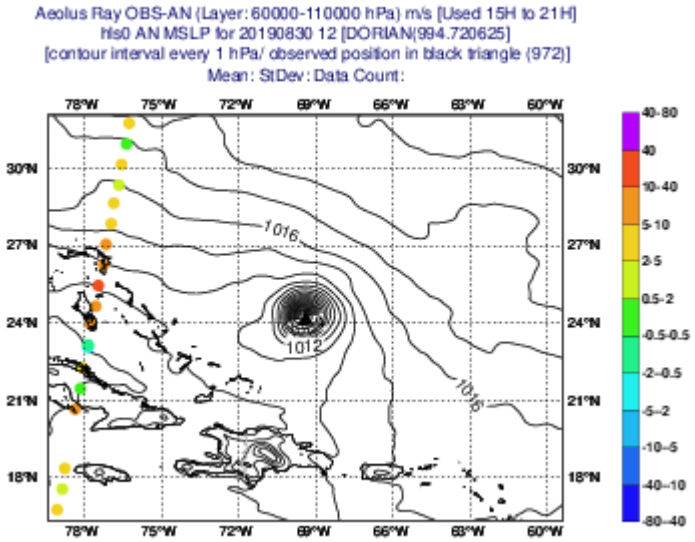

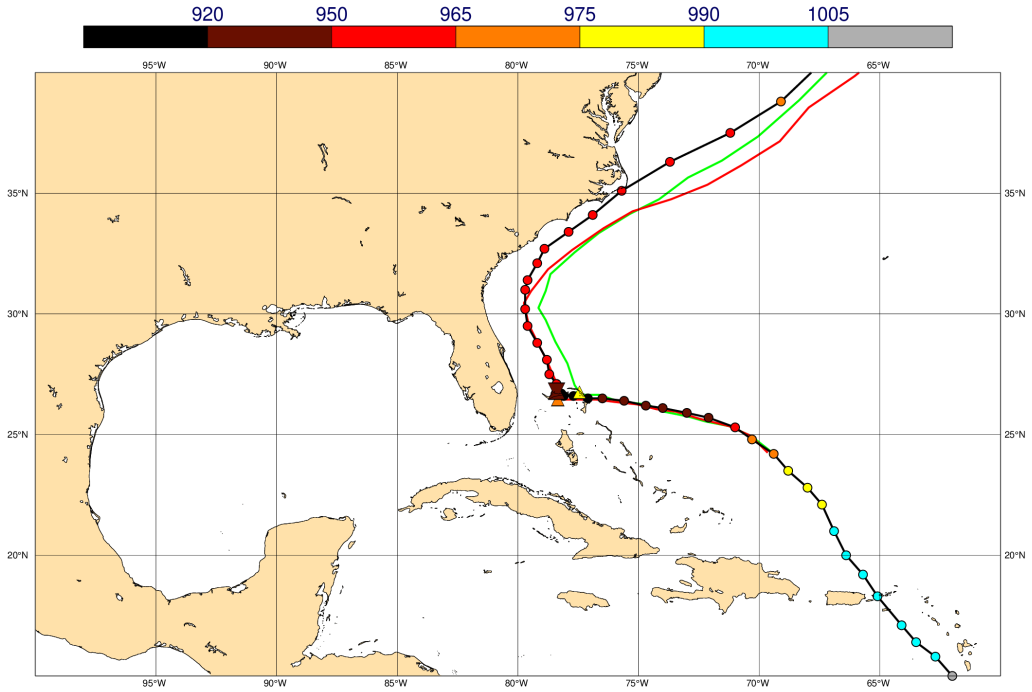

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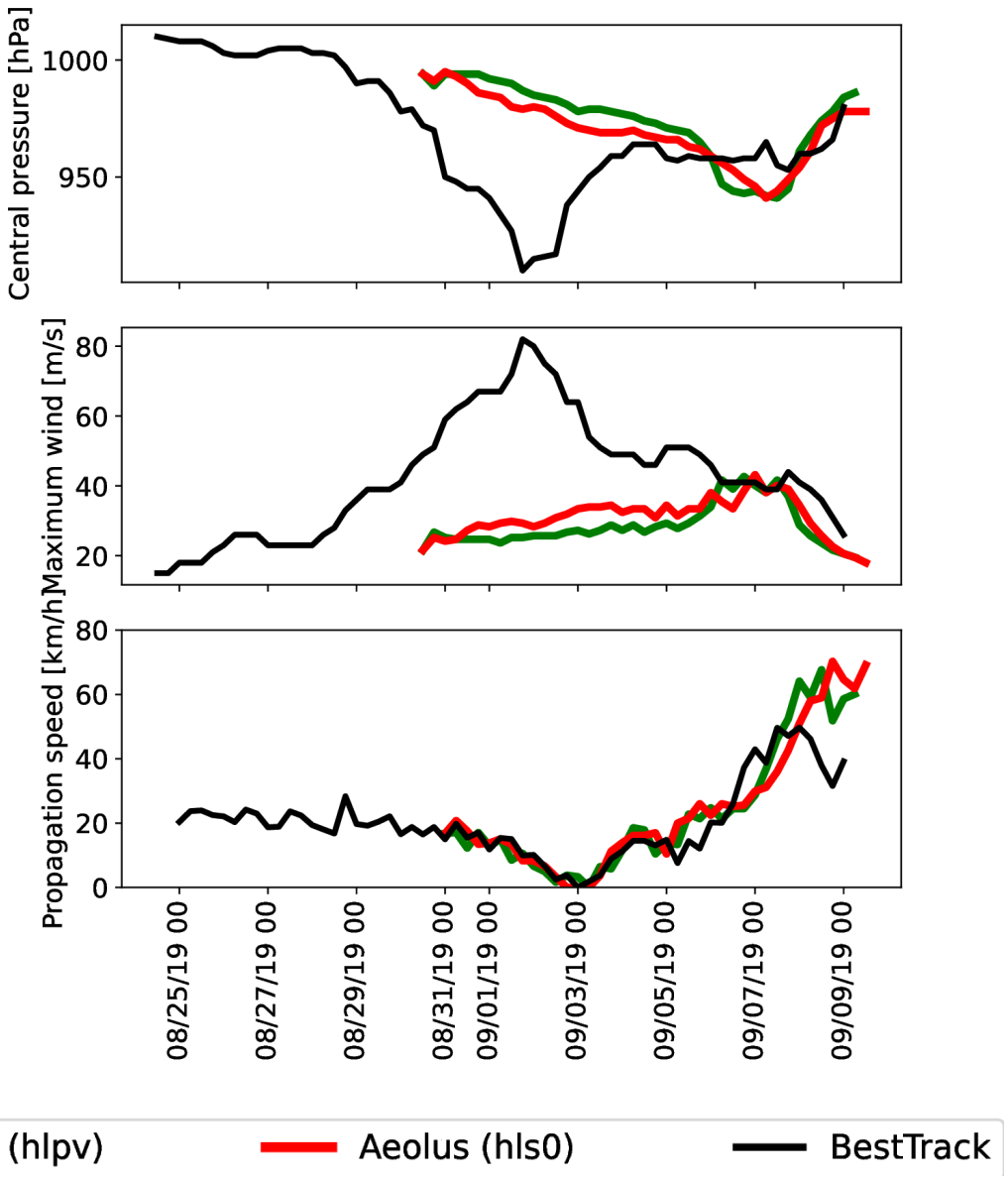

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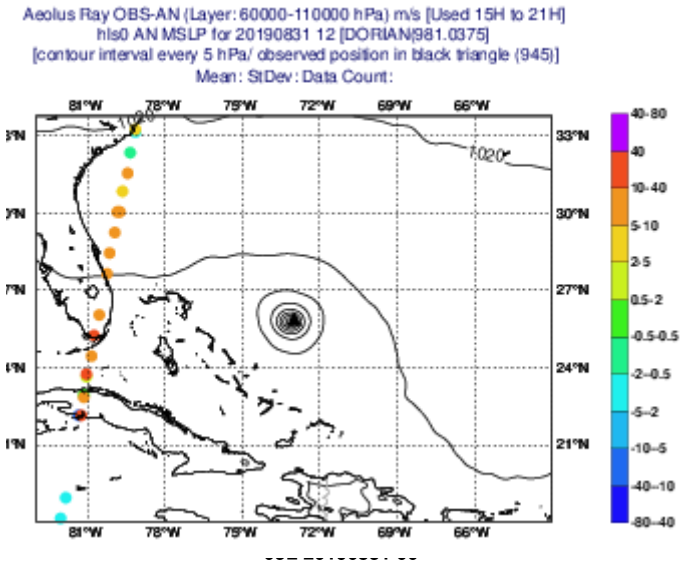

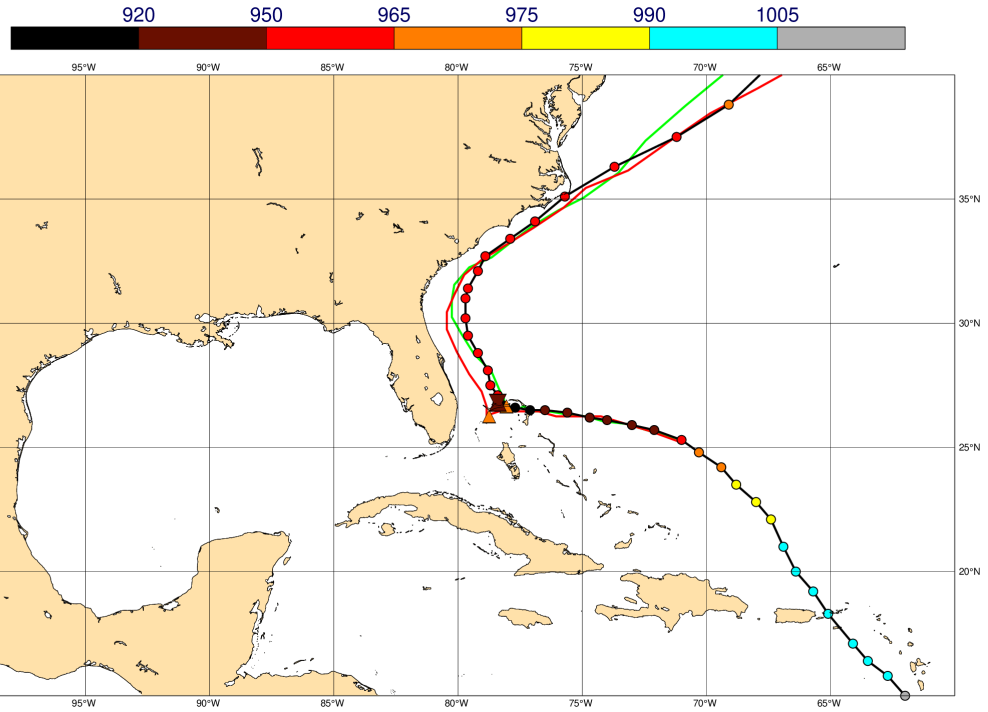

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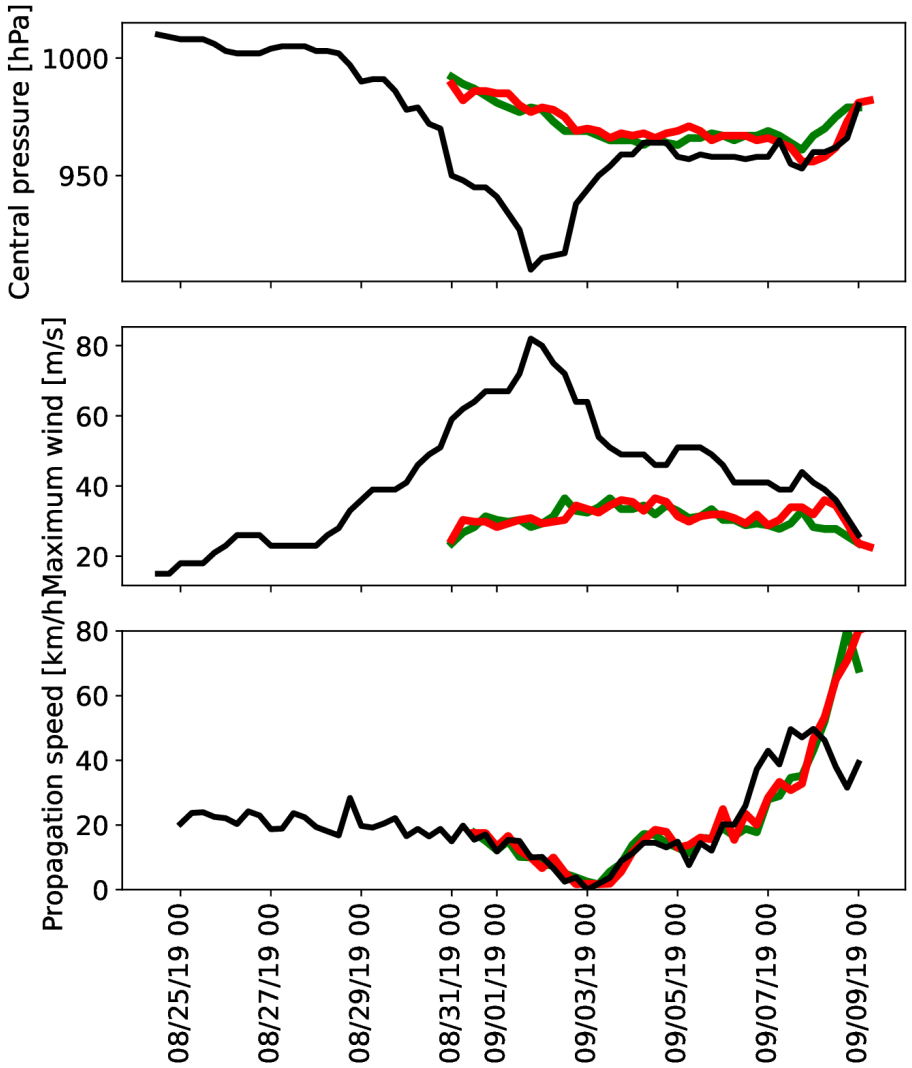

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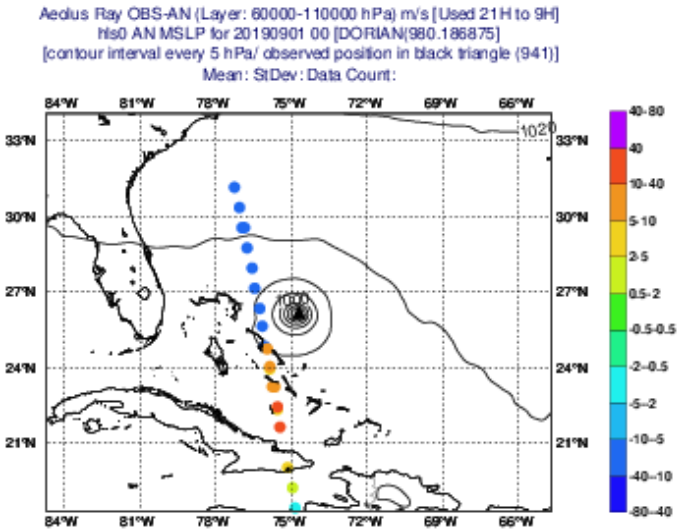

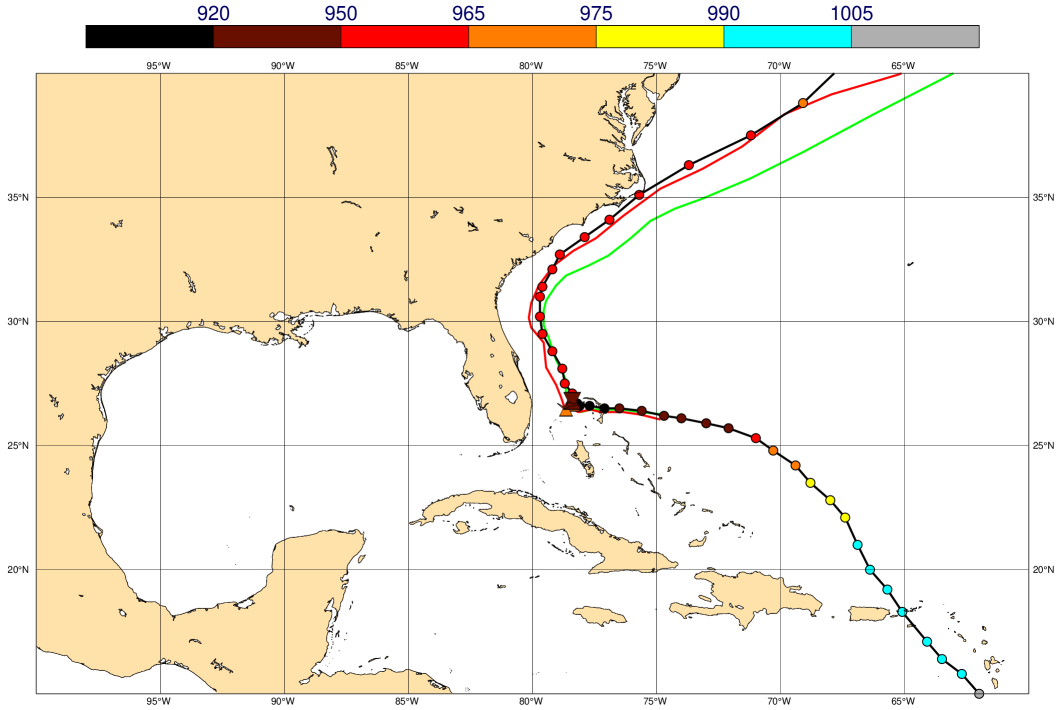

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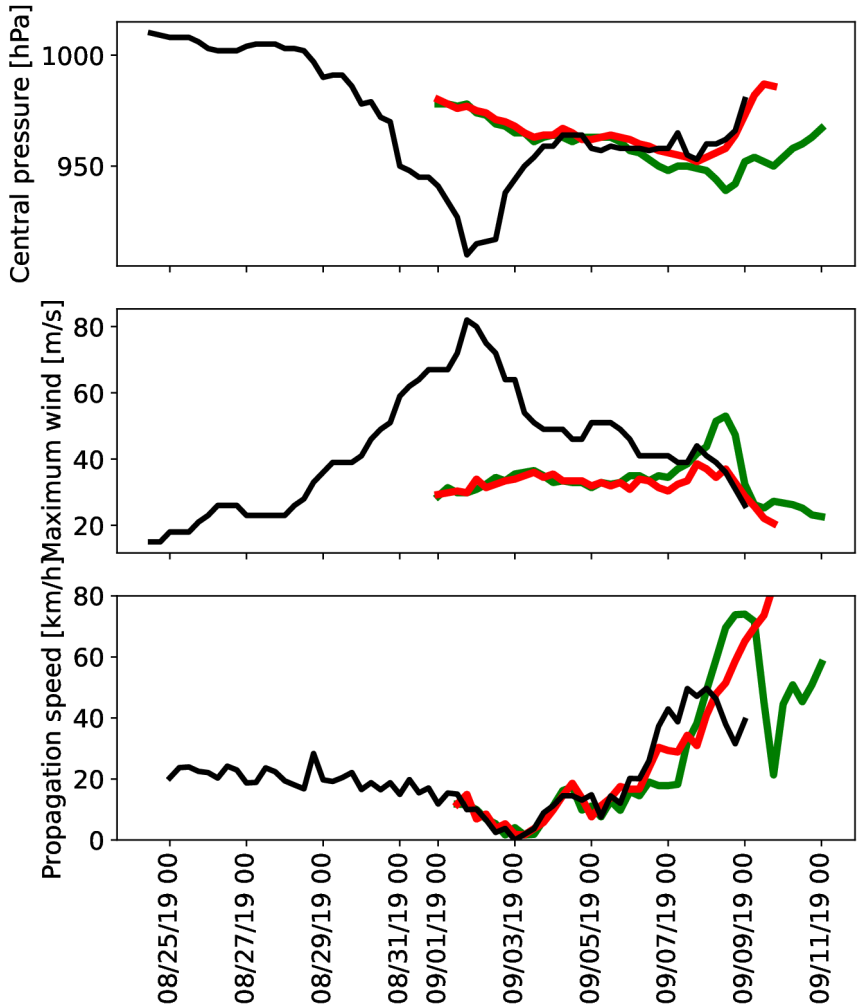
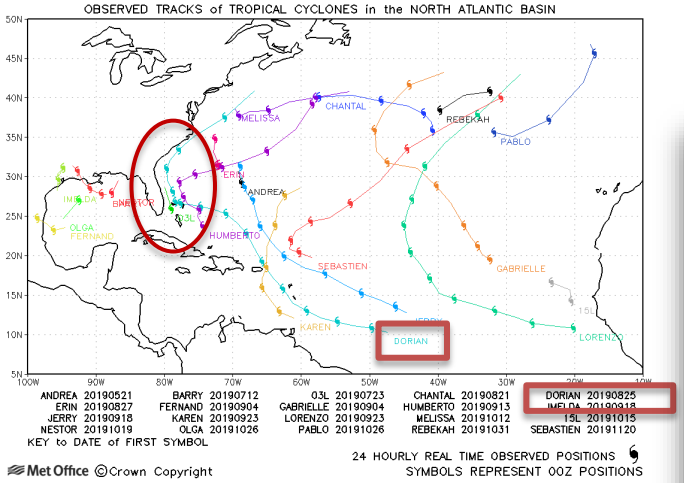


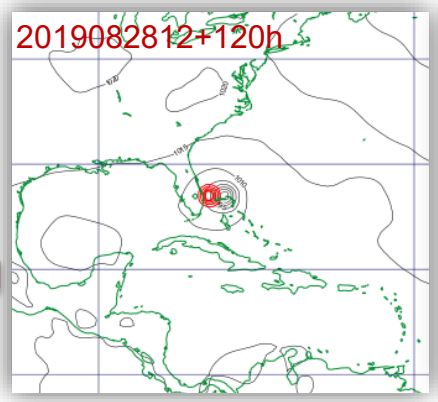
CTRL (hlpv) Aeolus (hls0) BestTrack

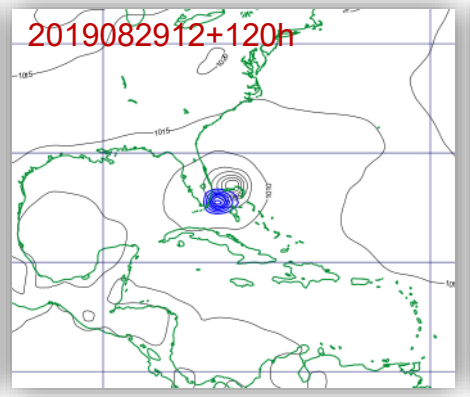
Tropical Cyclones

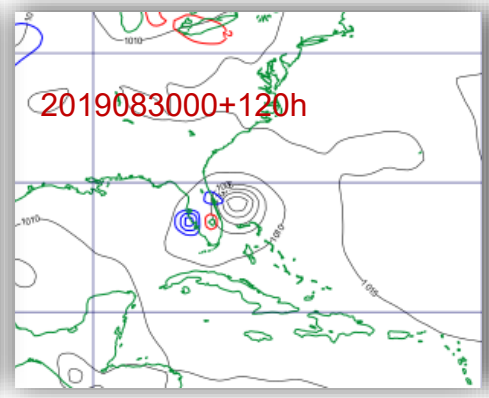
Comparison of OSEs fields (MSLP, z500/z200,…) and identify main differences. Try to associate them to specific TC.

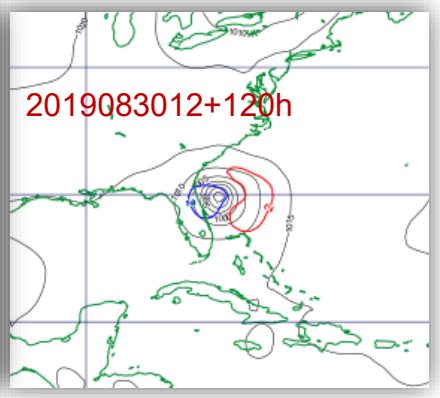


Example: MSL Pressure 5-day forecast without/with Aeolus data assimilated (T+120h)

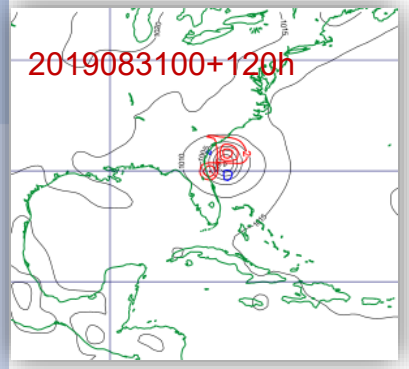


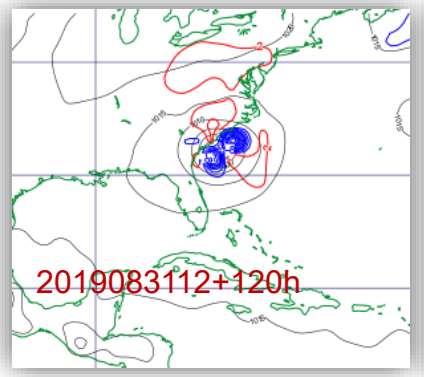


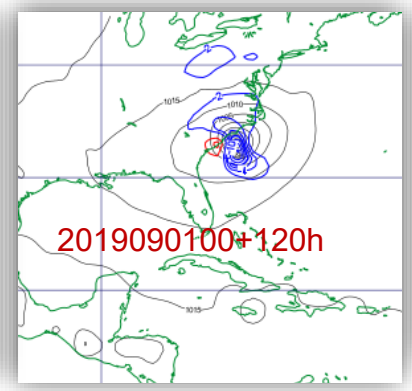


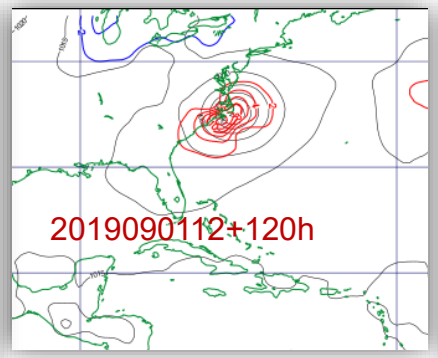


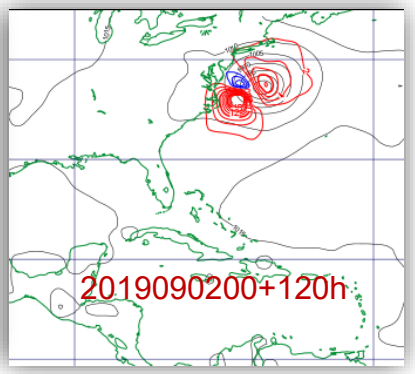
Blue contours where Aeolus experiment is better.
Red contours where it is worse.
Isolines 2 hPa

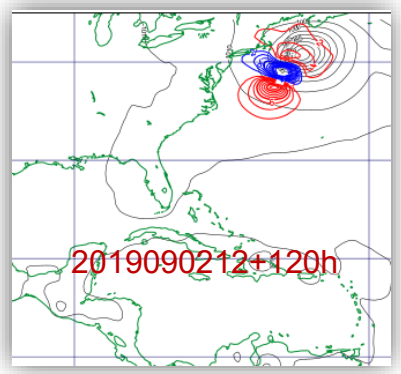












Summary

- This ongoing ESA project is assessing the impact of assimilating Aeolus observations on severe weather events (European extra-tropical storms, tropical cyclones and European forecast busts).
- Long Observing System Experiments are running to assess the impact over a long period (we aim at 30 month period).
- Many case studies have been identified for tropical cyclones and extra-tropical storms and a more will come up when comparing the OSEs.
- Preliminary assessment of the impact on TC intensity and position error showed slightly negative/neutral impact on the position error, positive/neutral impact on the intensity error. No clear regional signal seen. Results depend on the sampling.
- With improved winds, a better steering flow is expected. This is not translated yet into better TC forecast.
- Forecast busts for each experiment are identified (as the OSEs progress) and analysed. The area where the error originates are identified. We will be looking in details at a few cases.
- Many case studies have been identified for extra-tropical storms and we started comparing the OSEs fields.
- Still work in progress! More clear results in the next months.

We look forward to seeing you on our booth in the centre of the exhibition area, attached to the central ESA booth...

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