

Intercomparison of operational wave forecasting systems against
in-situ observations: data from BoM, DMI, DWD, ECCC,
ECMWF, JMA, KMA, LOPS, METEOAM, METFR, METNO,
NCEP, NIWA, PRTOS, SHNSM, UKMO.

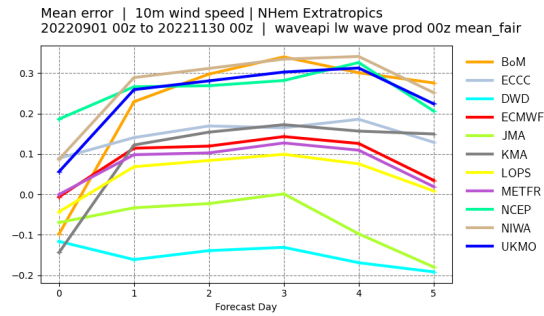
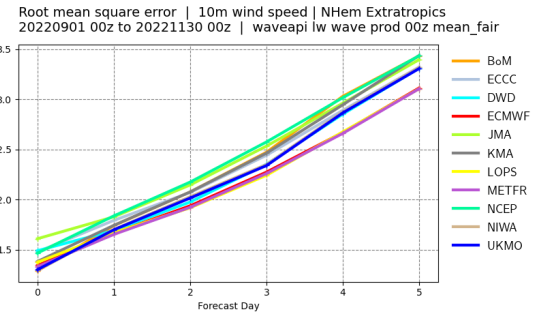
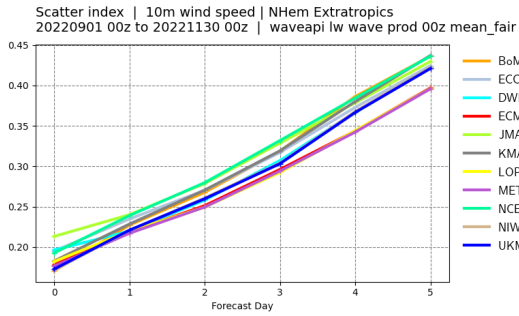
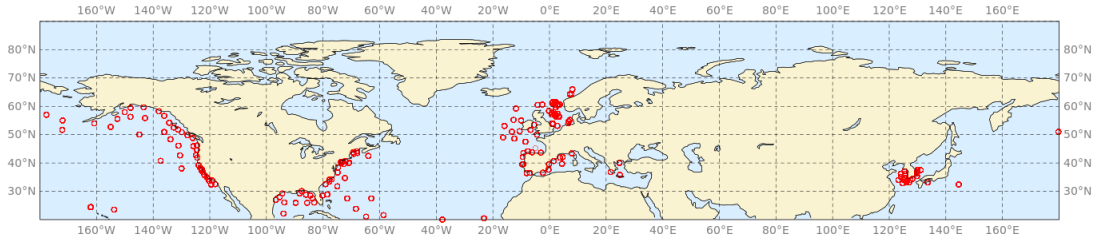
00 UTC runs only

WMO Lead Centre for Wave Forecast Verification LC-WFV,
European Centre for Medium-Range Weather Forecasts ECMWF

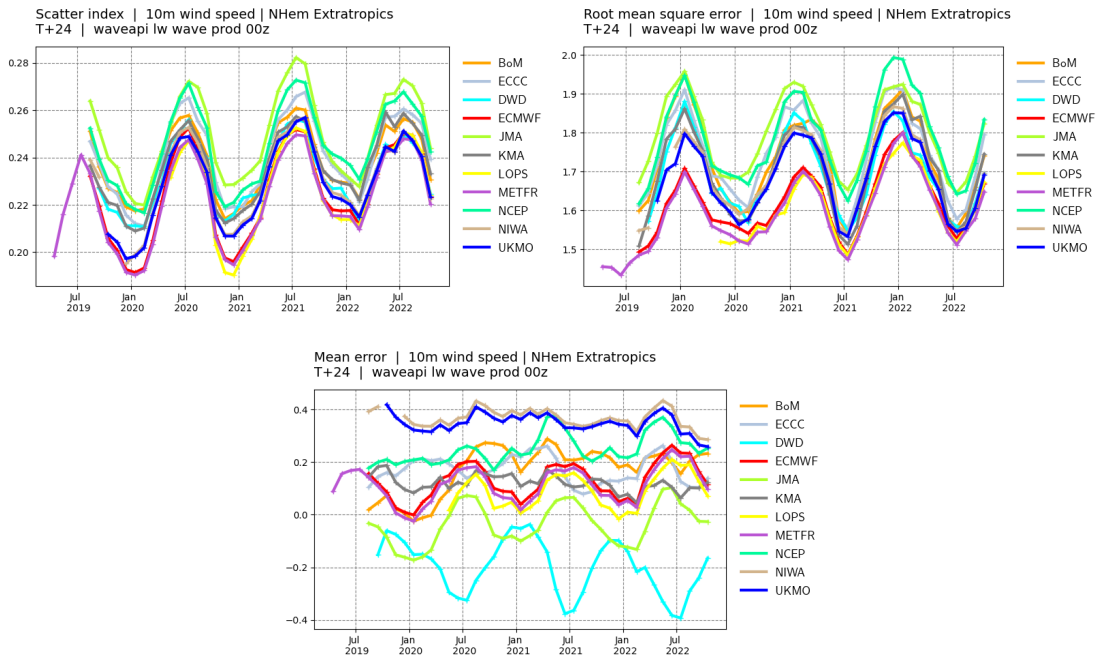
March 29, 2023

PART III: 10 meter wind speed (10ff)

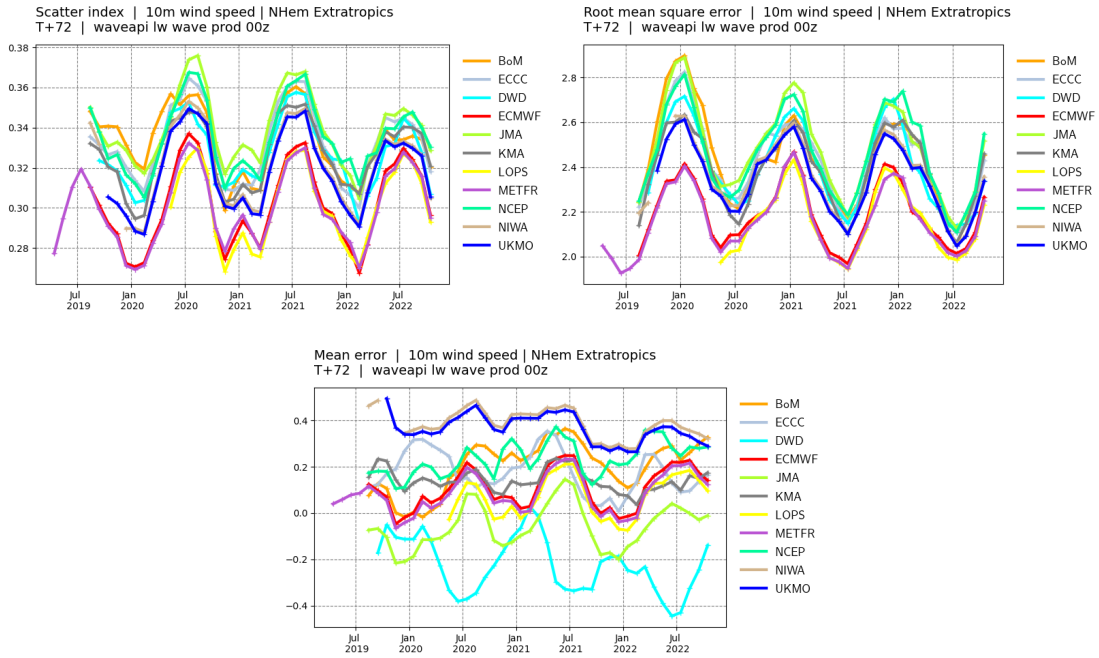
Buoys observations - from 20220901 to 20221130 - (10ff)



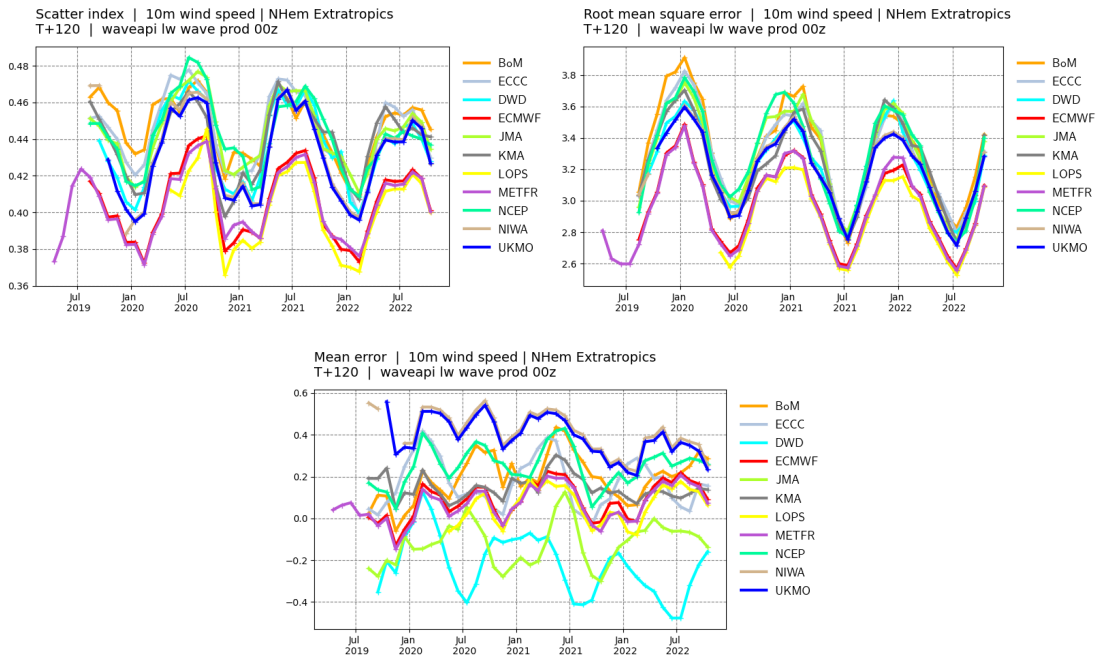
Northern Hemisphere. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



Northern Hemisphere. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

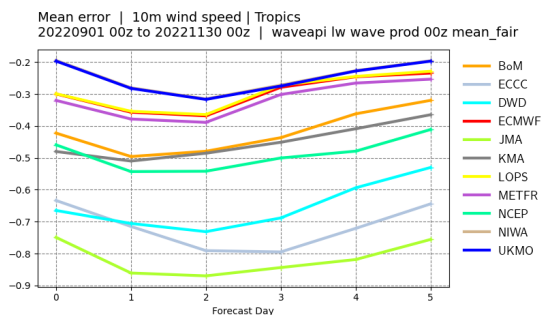
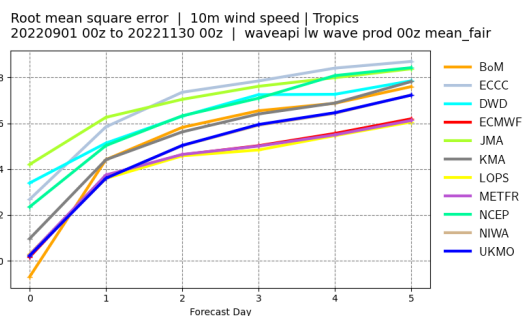
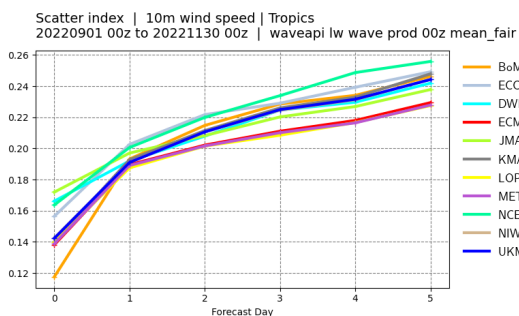
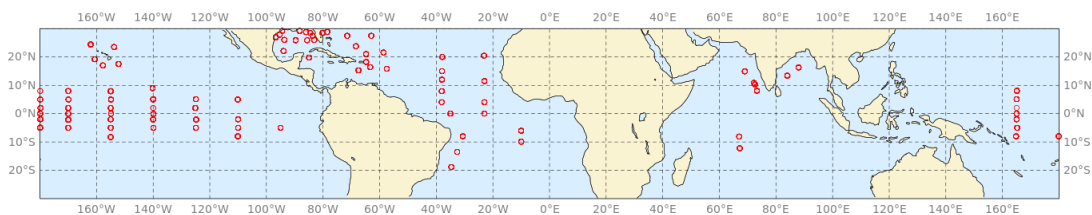


Northern Hemisphere. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

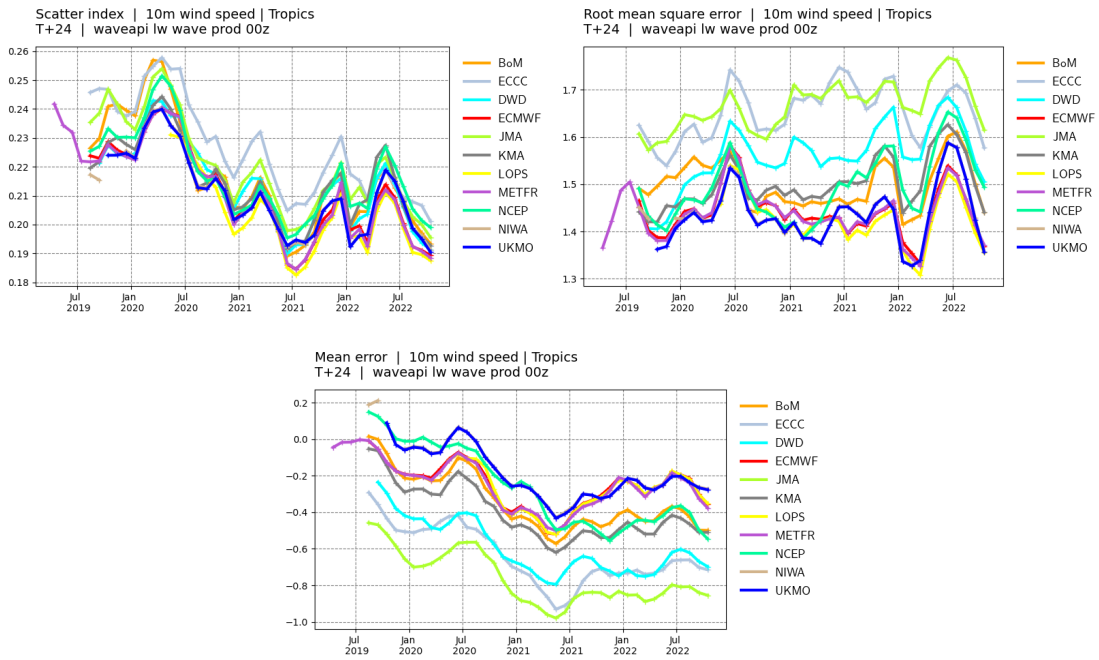


Northern Hemisphere. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

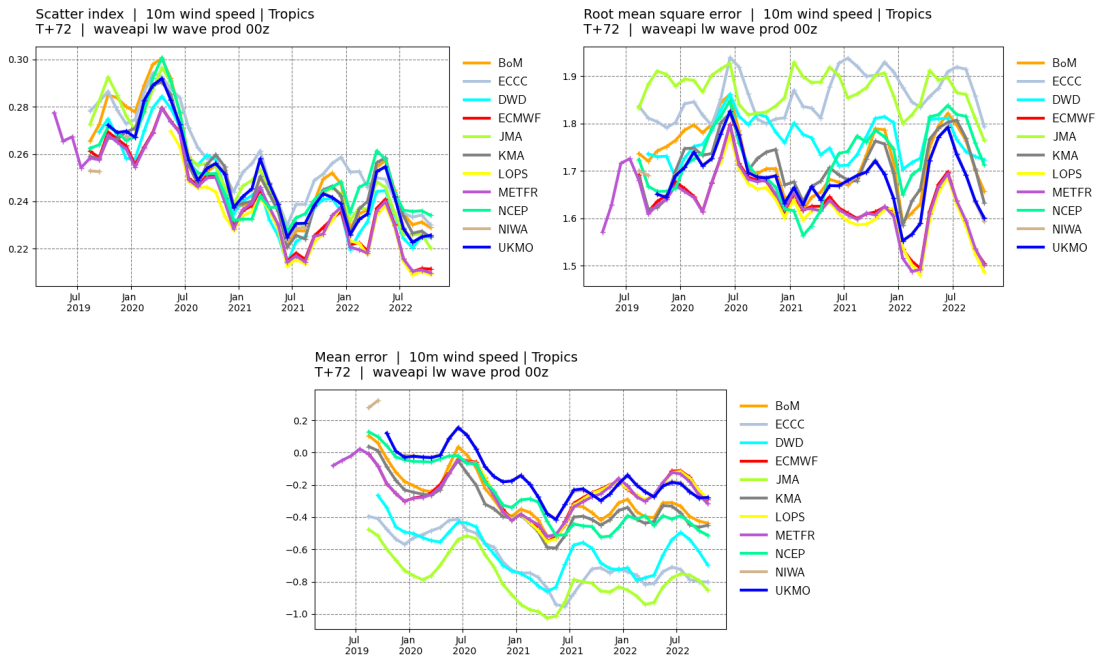
Buoys observations - from 20220901 to 20221130 - (10ff)



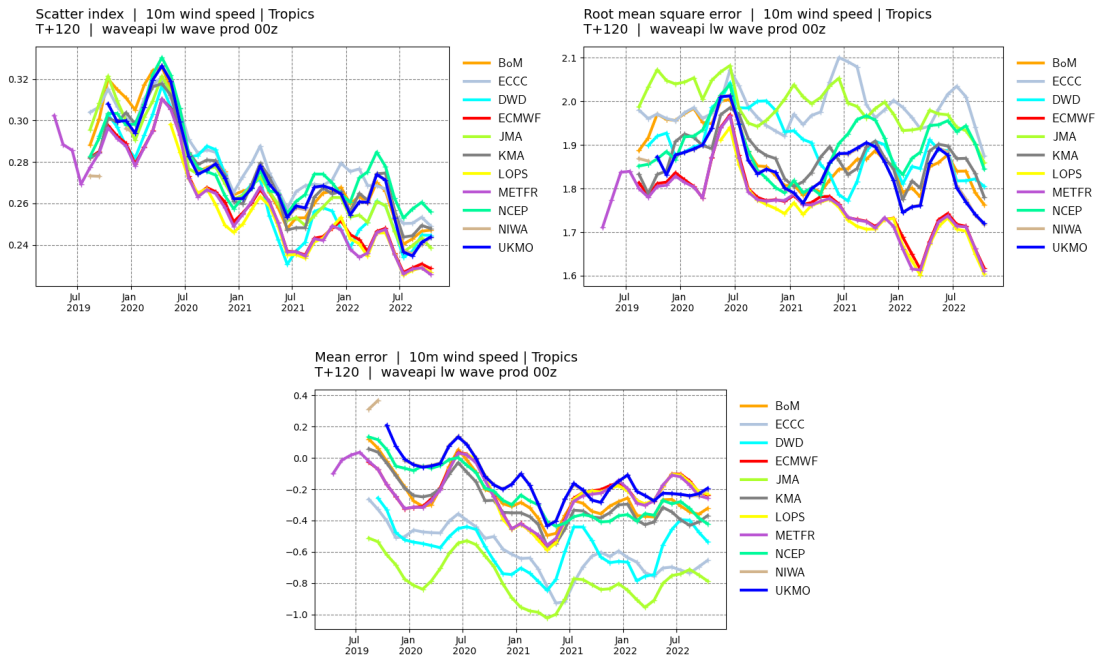
Tropics. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



Tropics. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

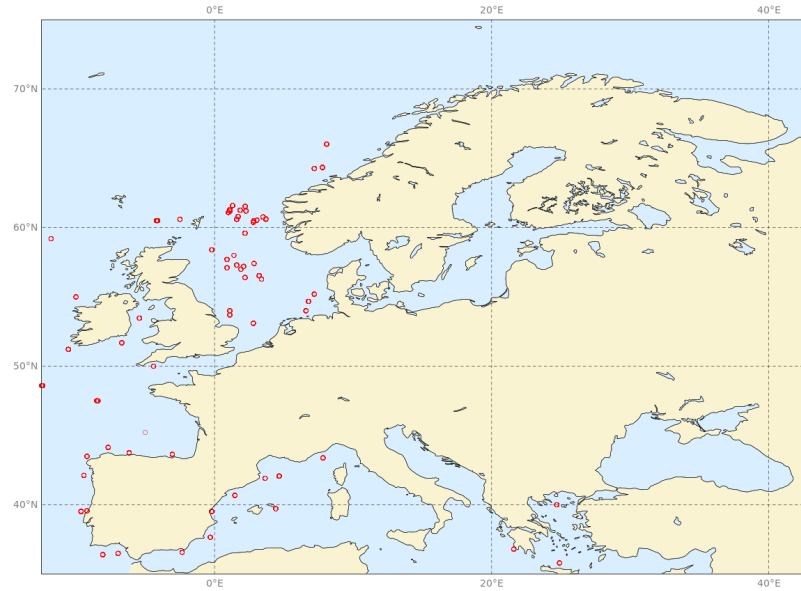


Tropics. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

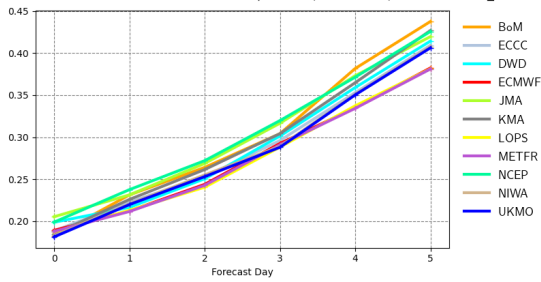


Tropics. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

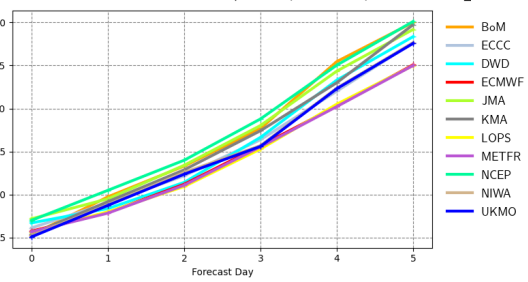
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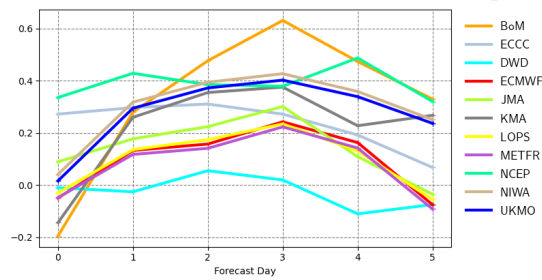
Scatter index | 10m wind speed | Europe
20220901 00z to 20221130 00z | waveapi lw wave prod 00z mean_fair



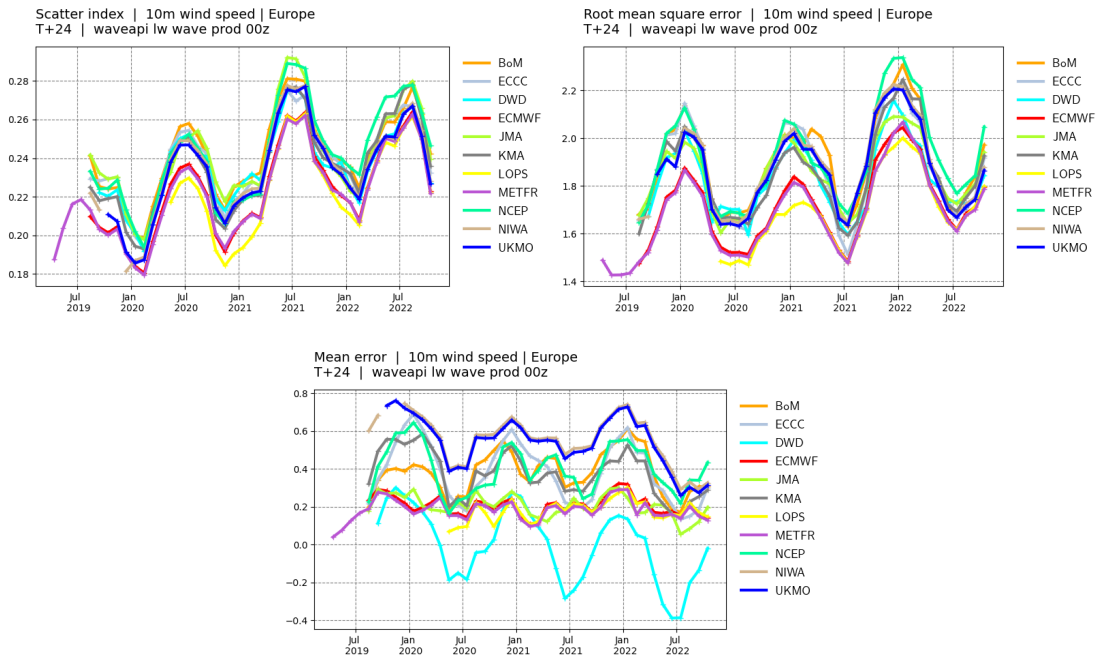
Root mean square error | 10m wind speed | Europe
20220901 00z to 20221130 00z | waveapi lw wave prod 00z mean_fair



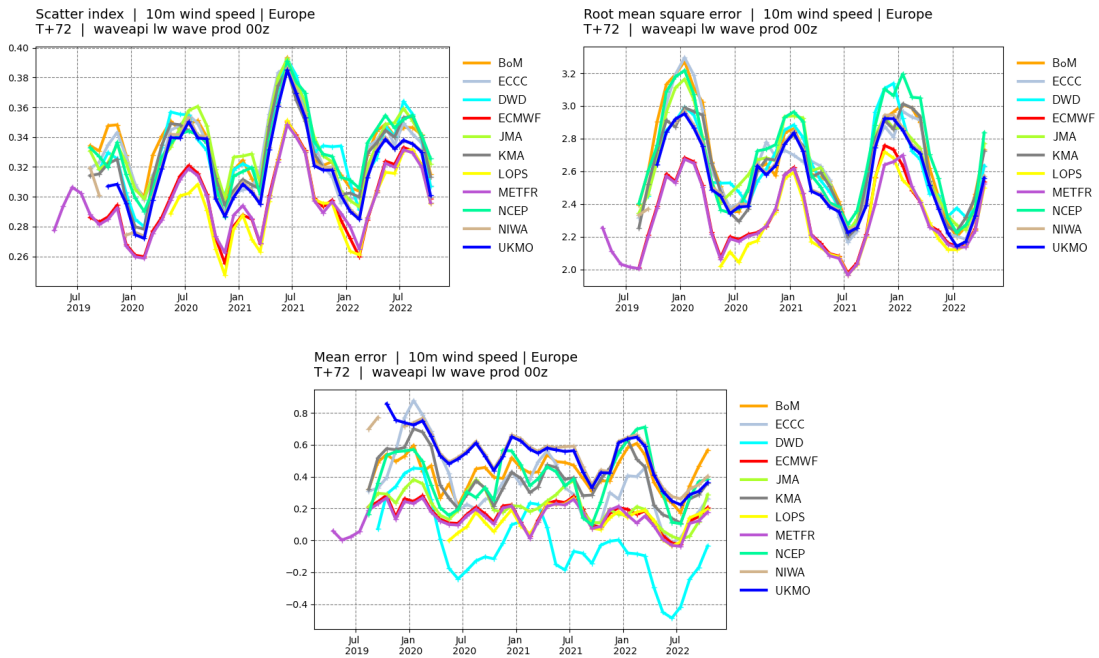
Mean error | 10m wind speed | Europe
20220901 00z to 20221130 00z | waveapi lw wave prod 00z mean_fair



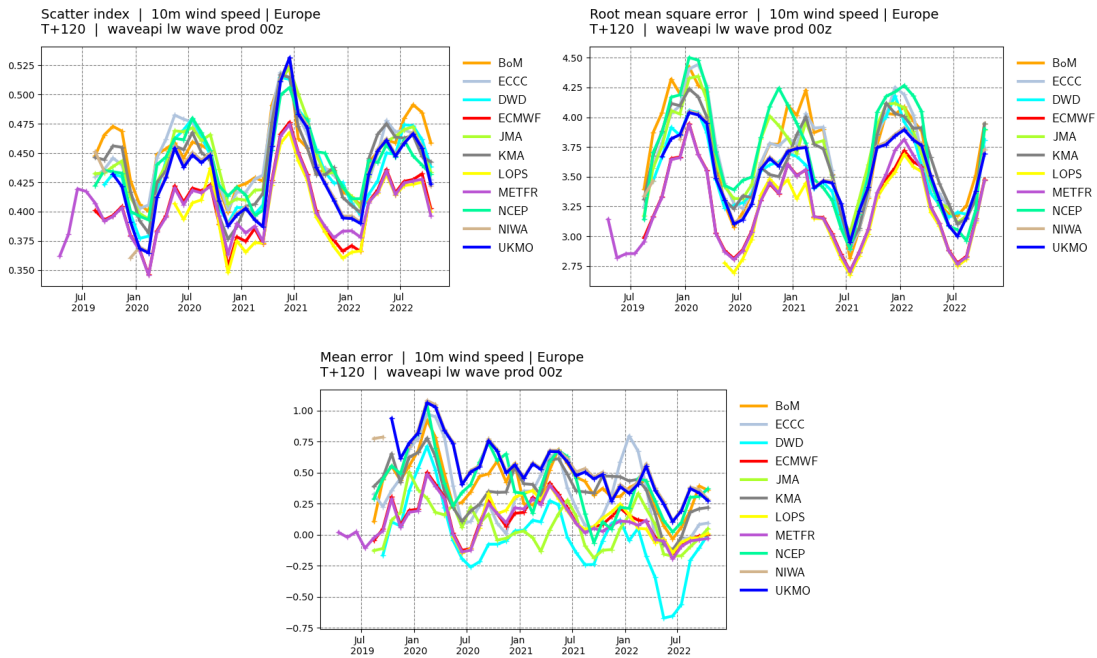
Europe. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



Europe. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

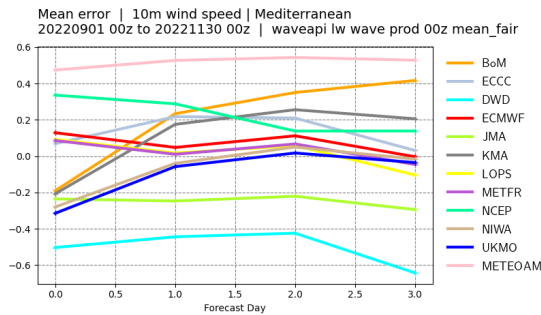
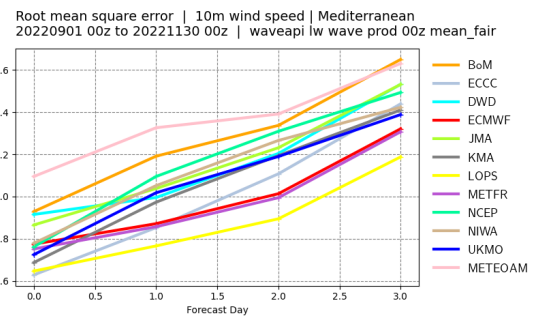
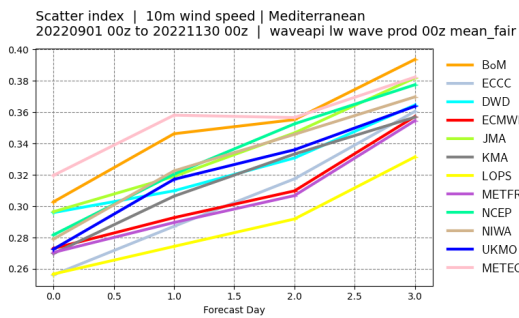
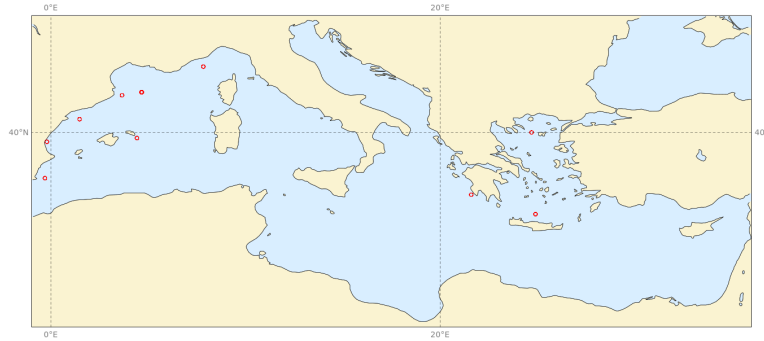


Europe. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

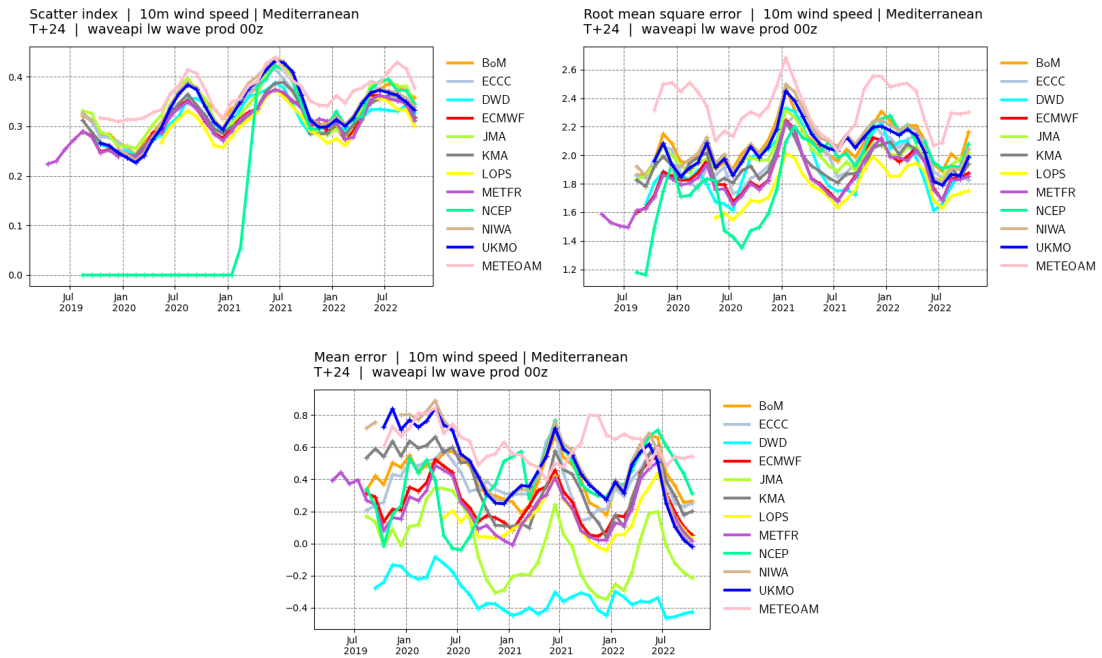


Europe. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

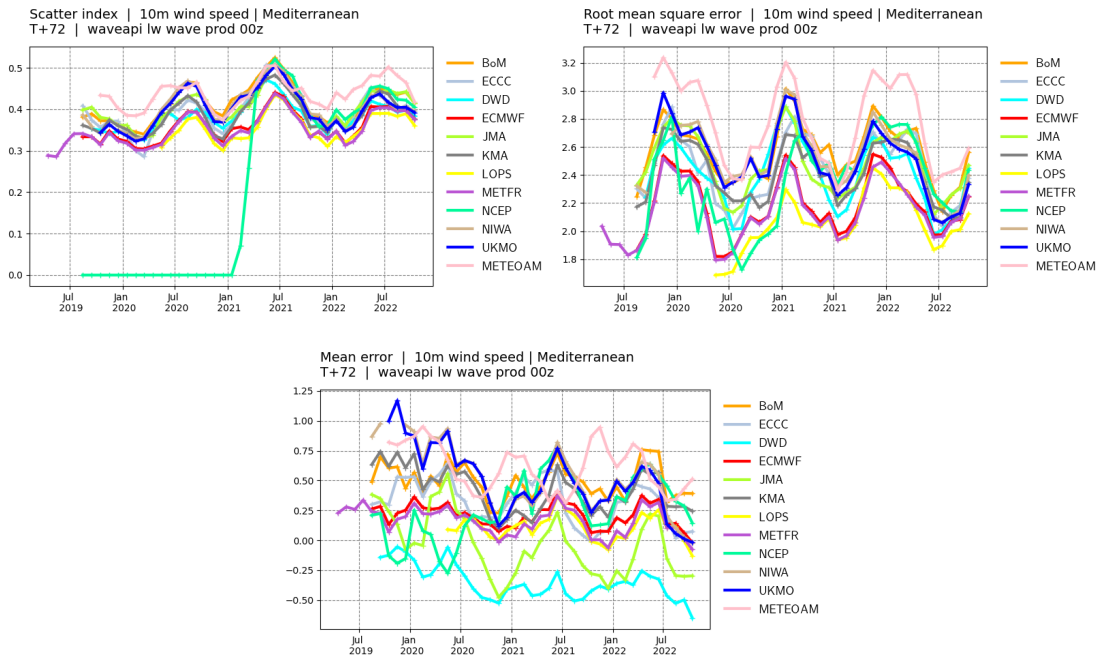
Buoys observations - from 20220901 to 20221130 - (10ff)



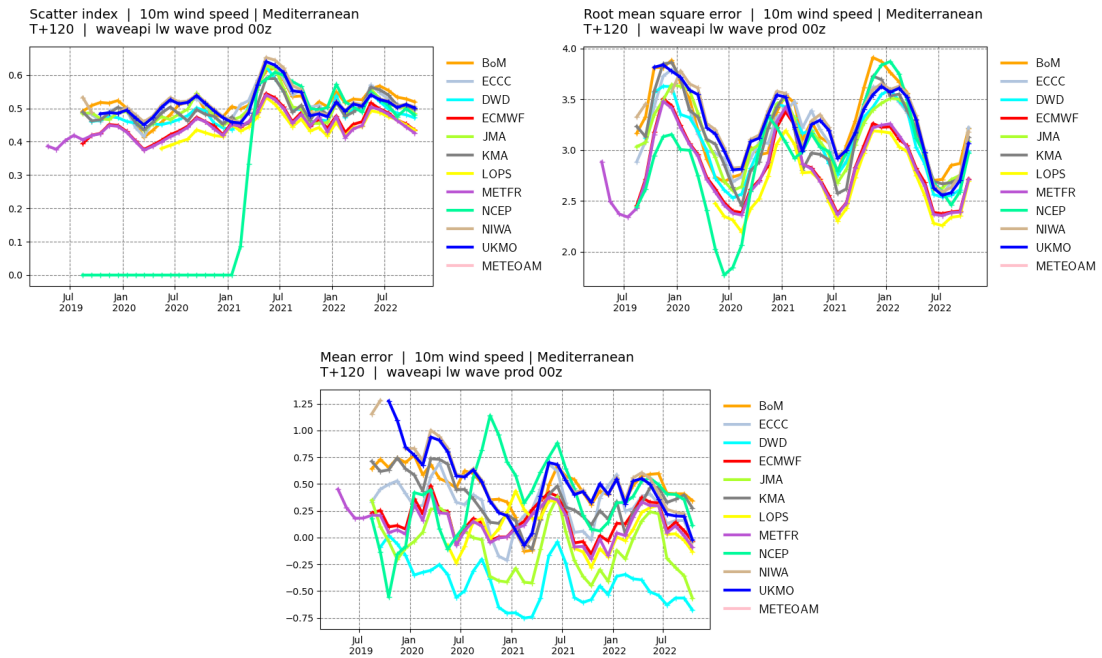
Mediterranean Sea. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



Mediterranean Sea. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

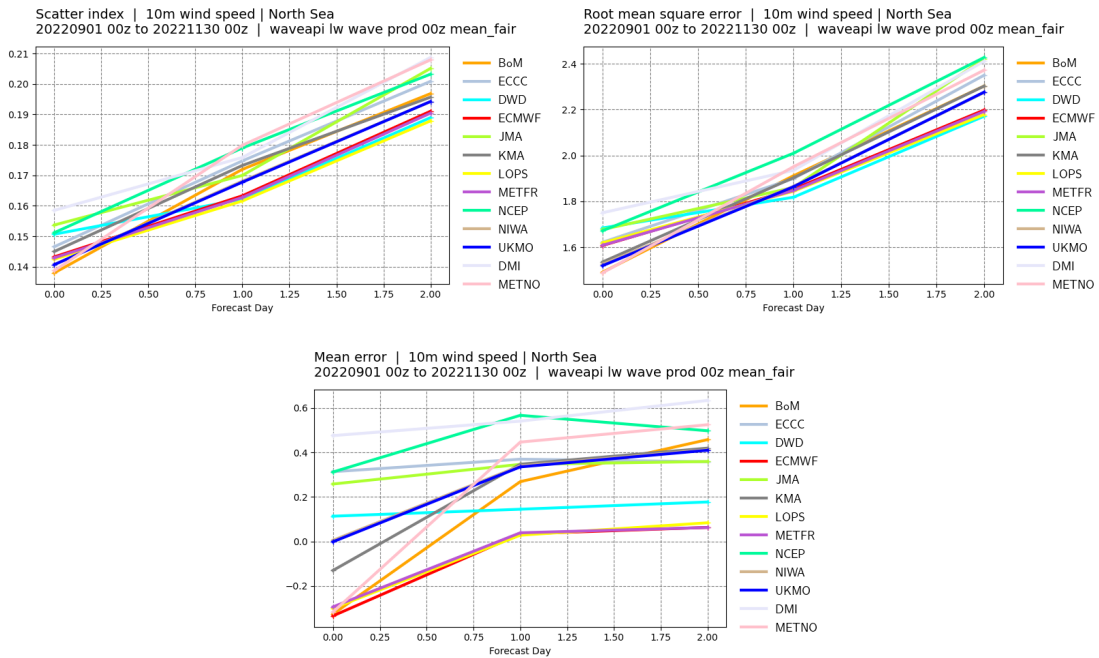
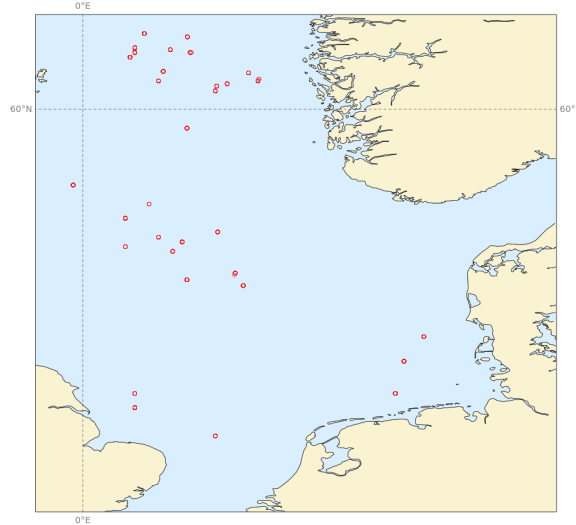


Mediterranean Sea. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

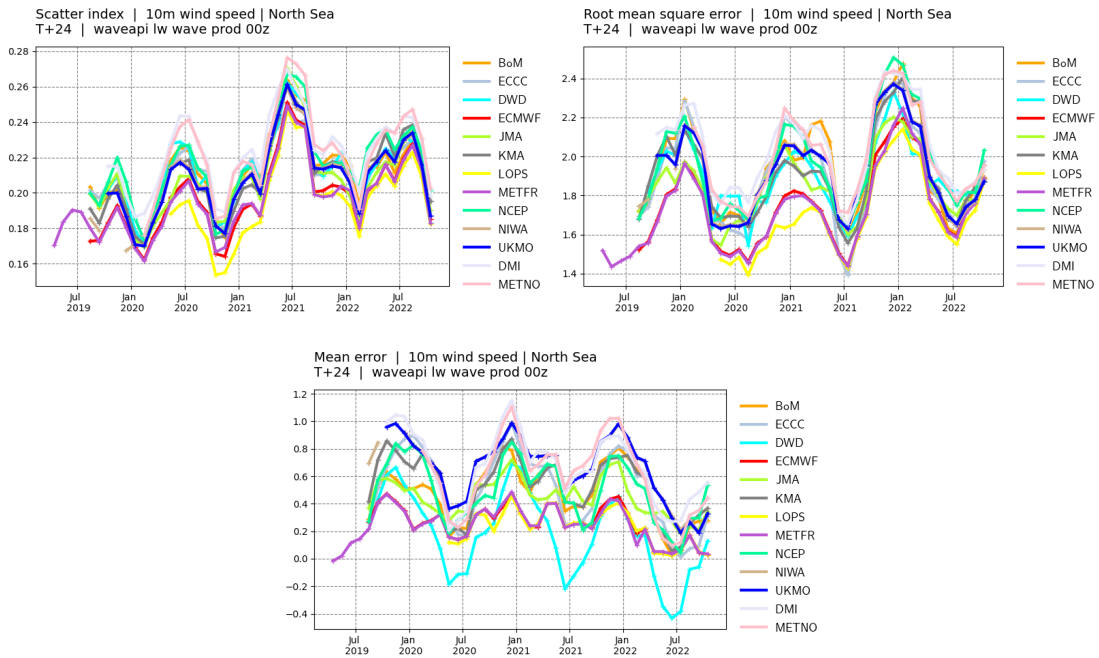


Mediterranean Sea. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

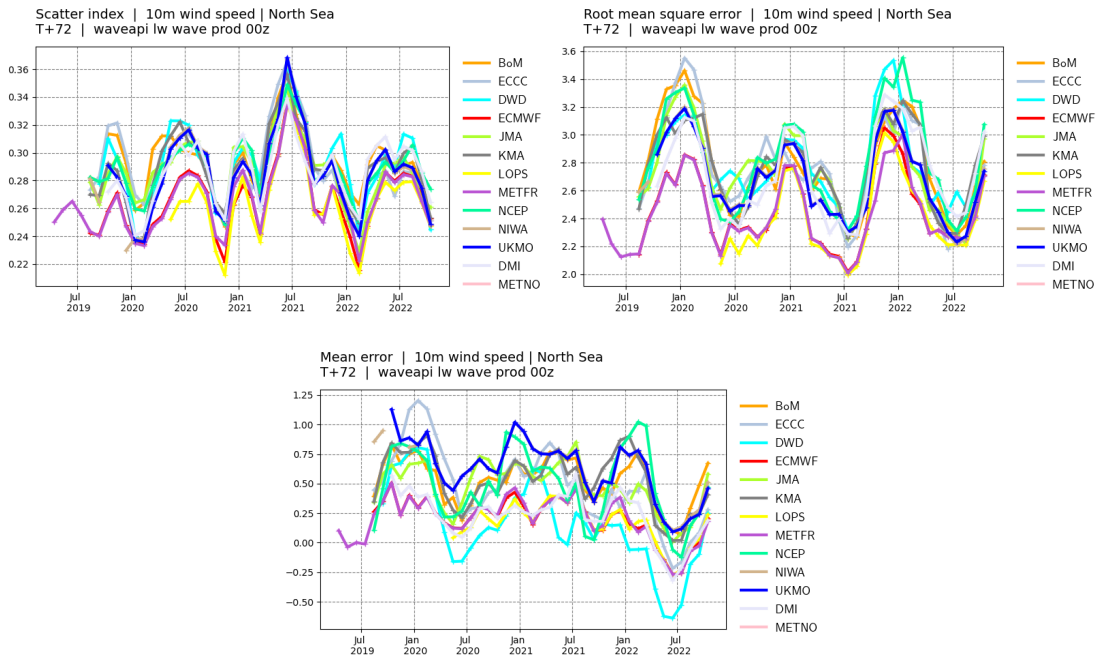
Buoys observations - from 20220901 to 20221130 - (10ff)



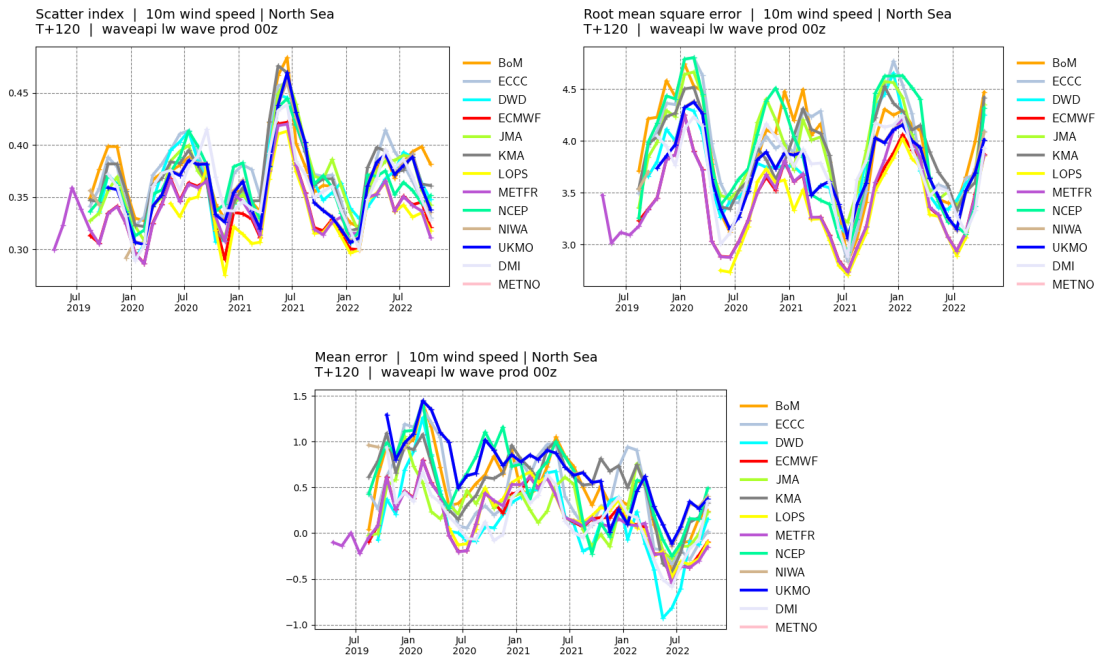
North Sea. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



North Sea. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

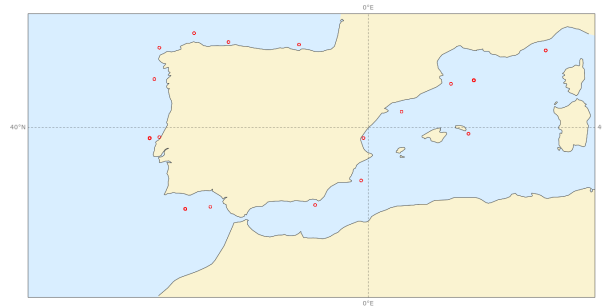


North Sea. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

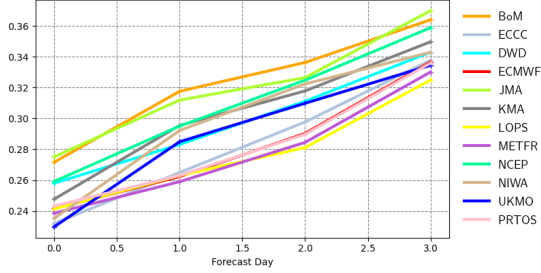


North Sea. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

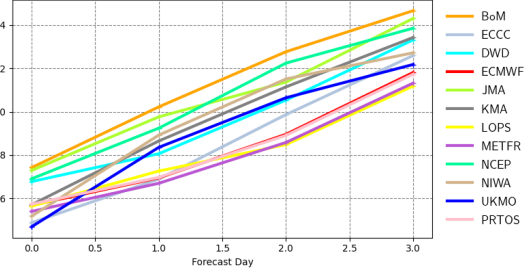
Buoys observations - from 20220901 to 20221130 - (10ff)



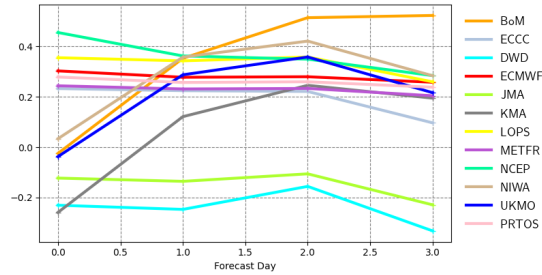
Scatter index | 10m wind speed | SW Europe
20220901 00z to 20221130 00z | waveapi lw wave prod 00z mean_fair



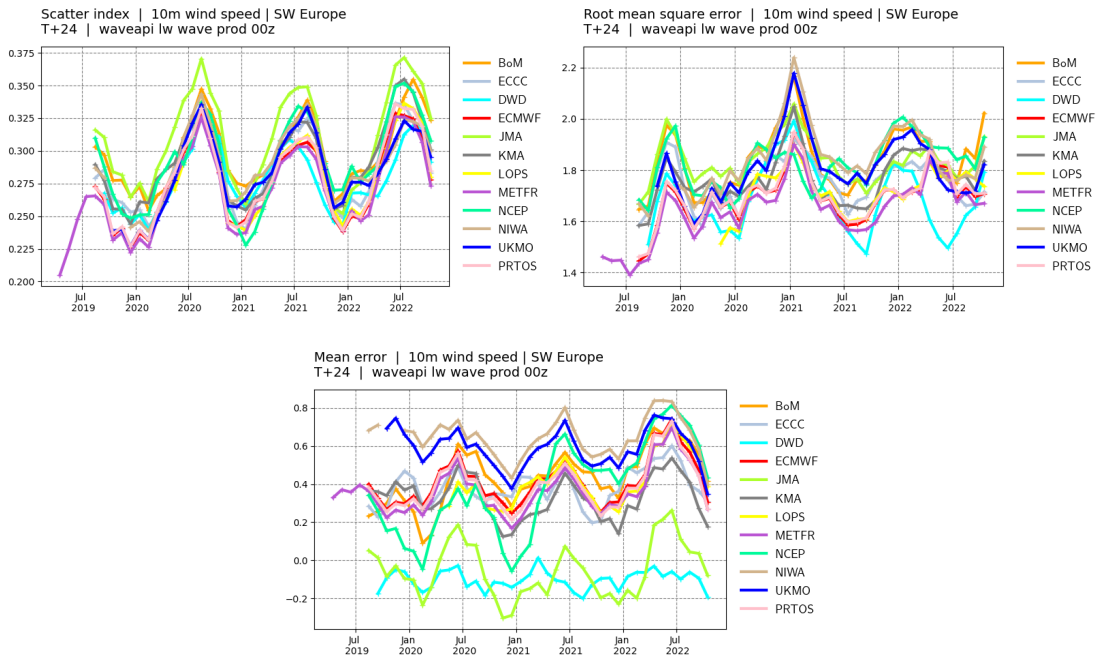
Root mean square error | 10m wind speed | SW Europe
20220901 00z to 20221130 00z | waveapi lw wave prod 00z mean_fair



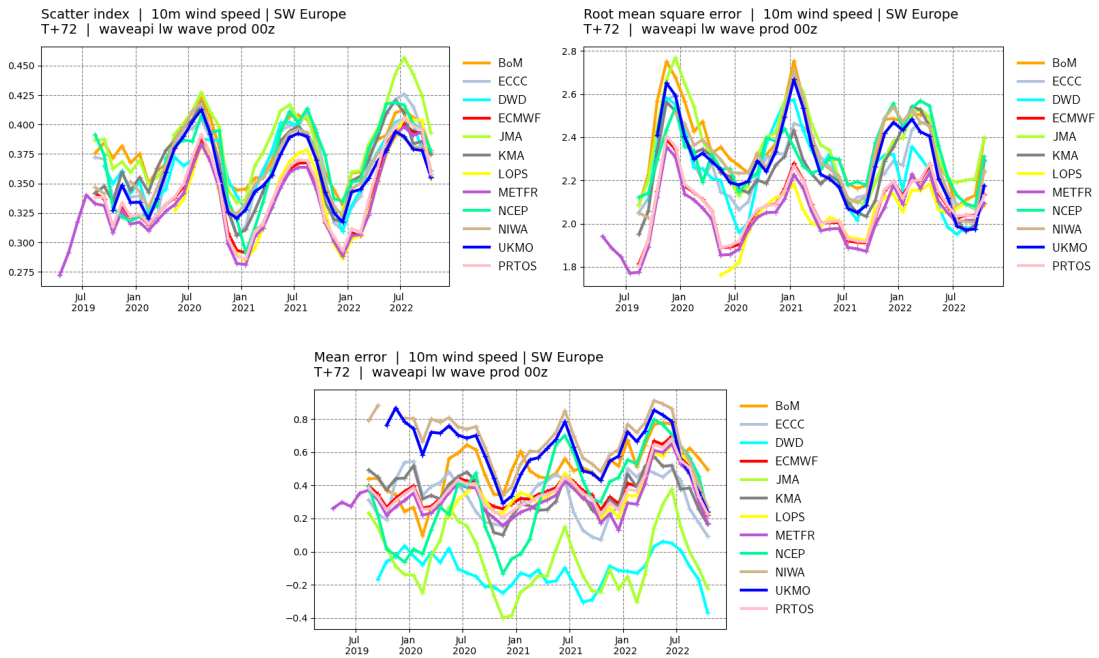
Mean error | 10m wind speed | SW Europe
20220901 00z to 20221130 00z | waveapi lw wave prod 00z mean_fair



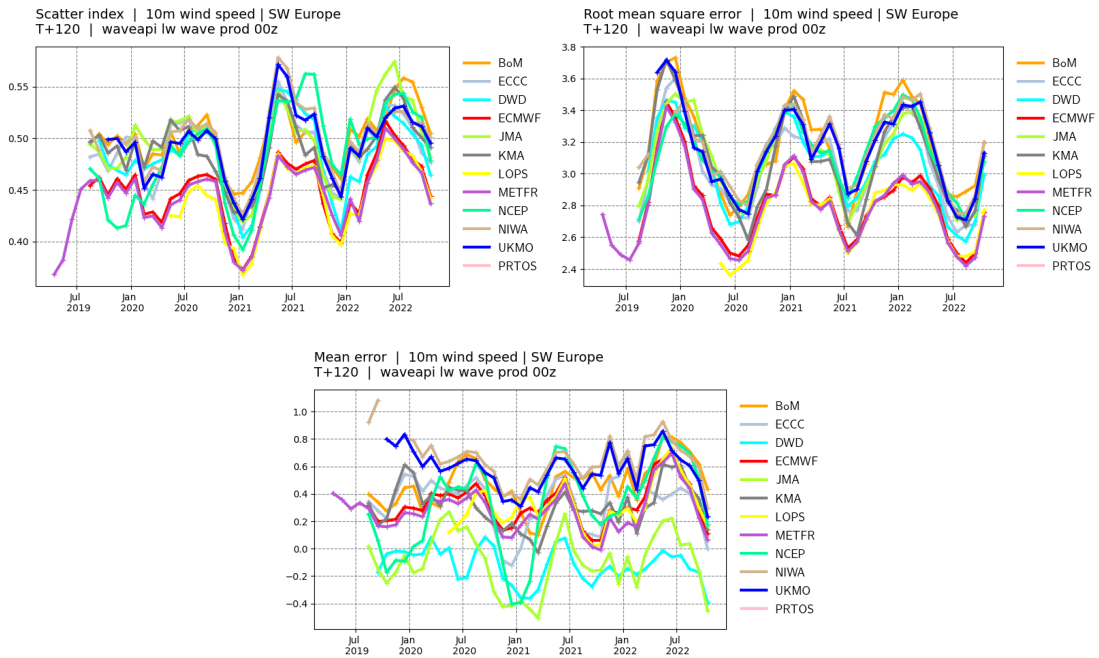
South West Europe. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



South West Europe. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

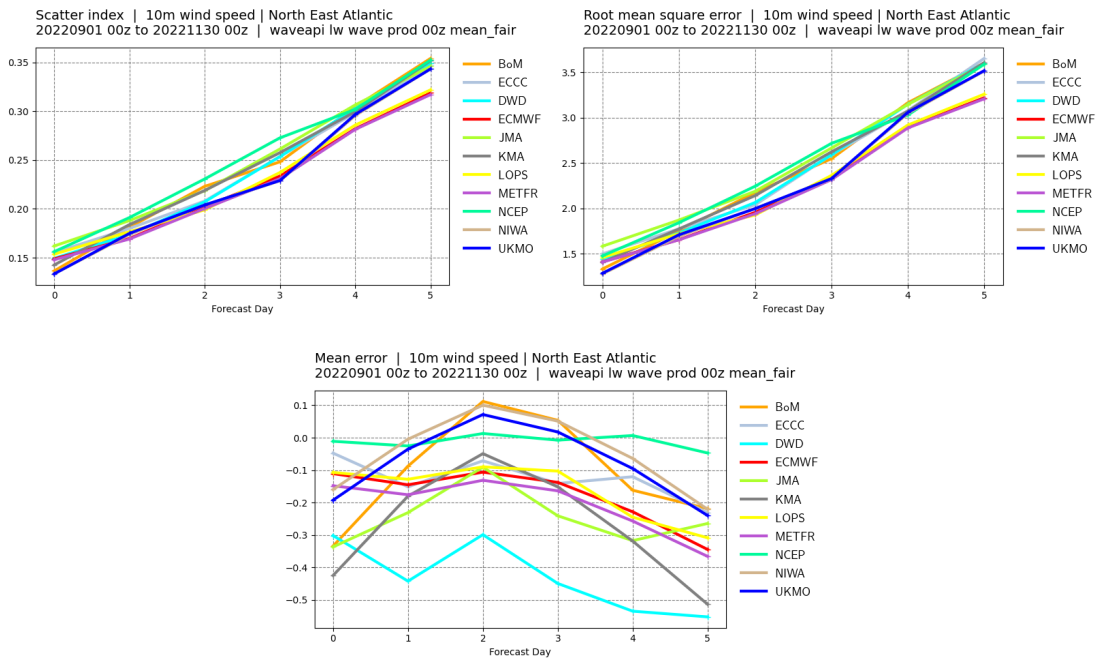
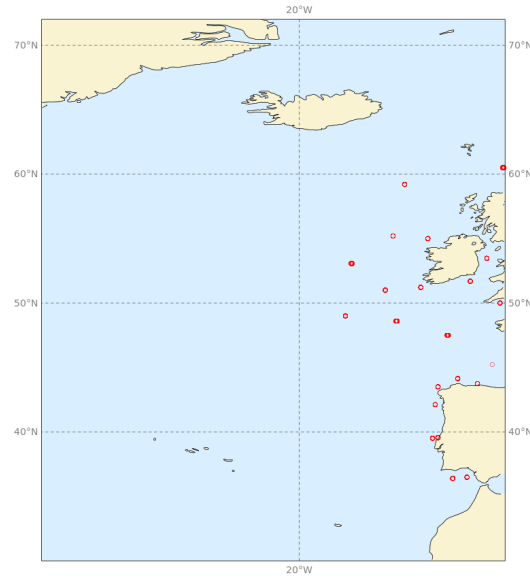


South West Europe. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

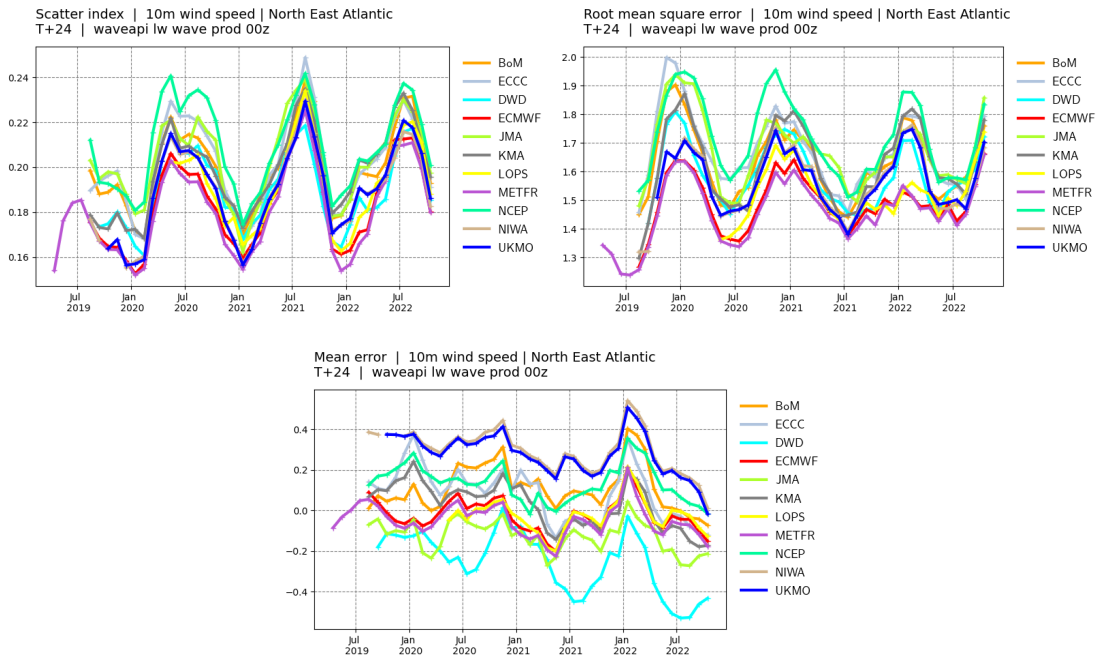


South West Europe. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

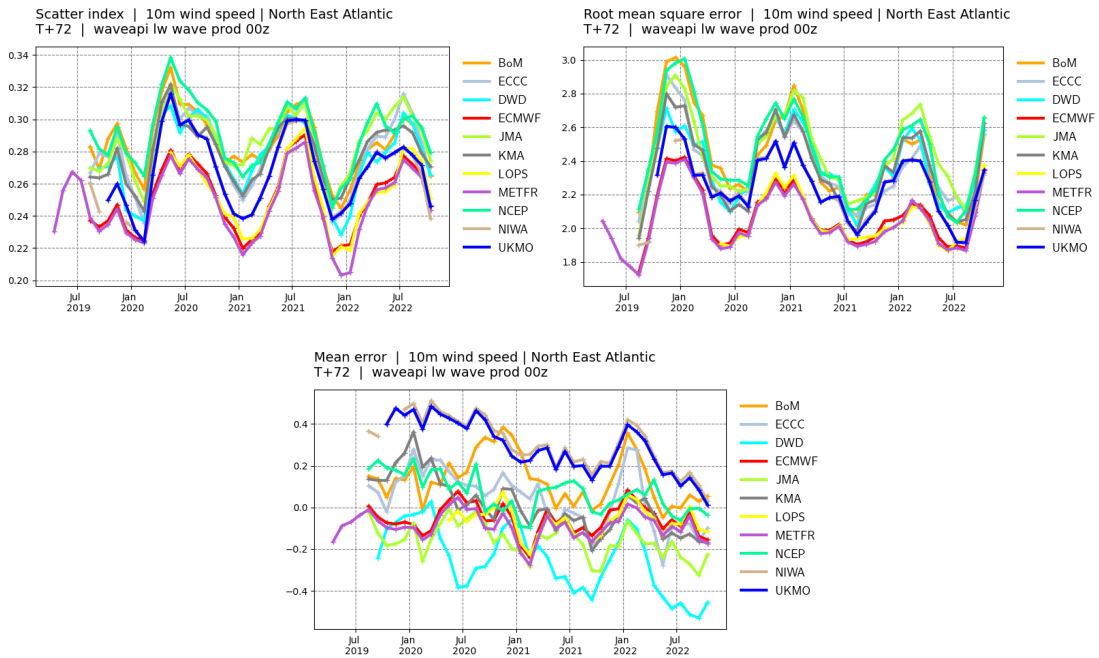
Buoys observations - from 20220901 to 20221130 - (10ff)



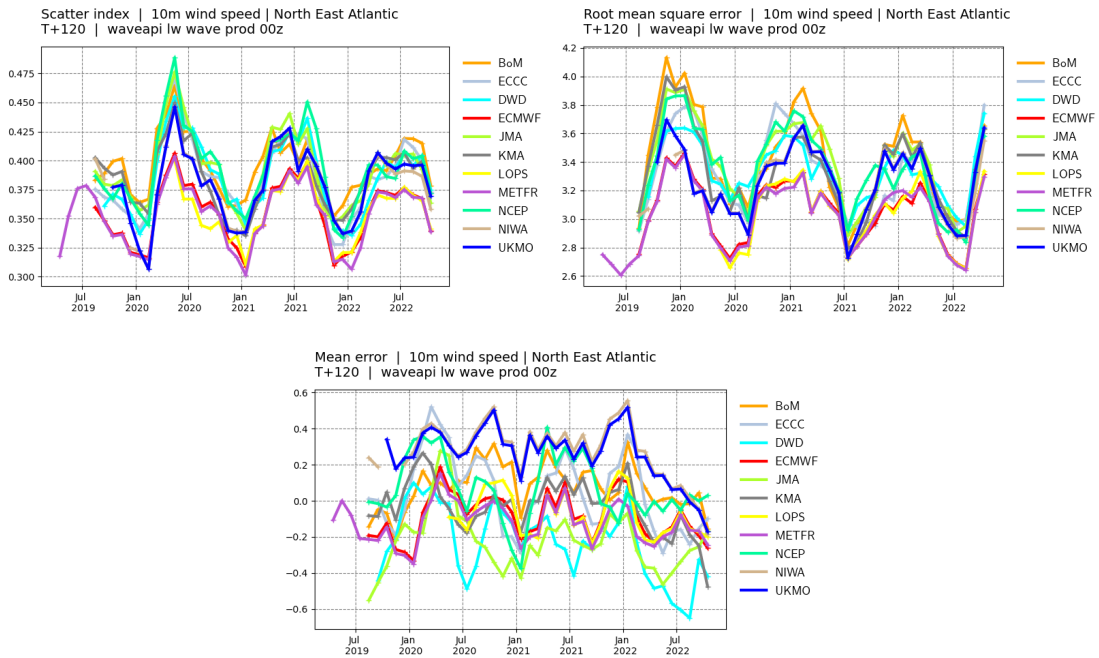
North East Atlantic. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



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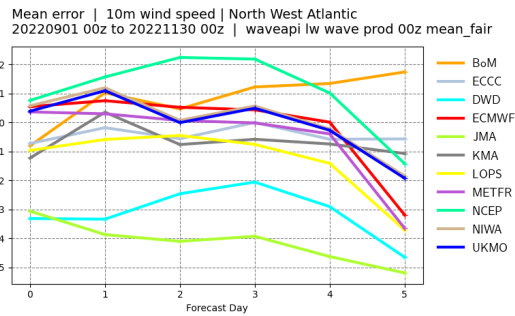
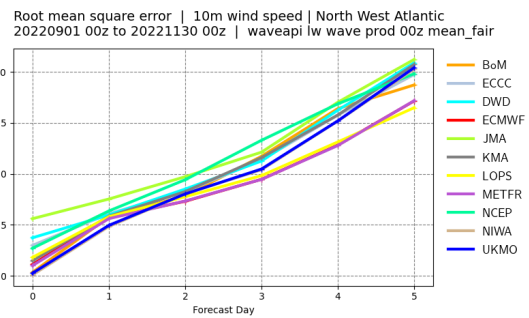
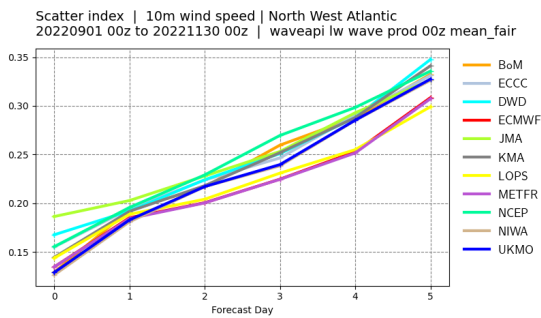
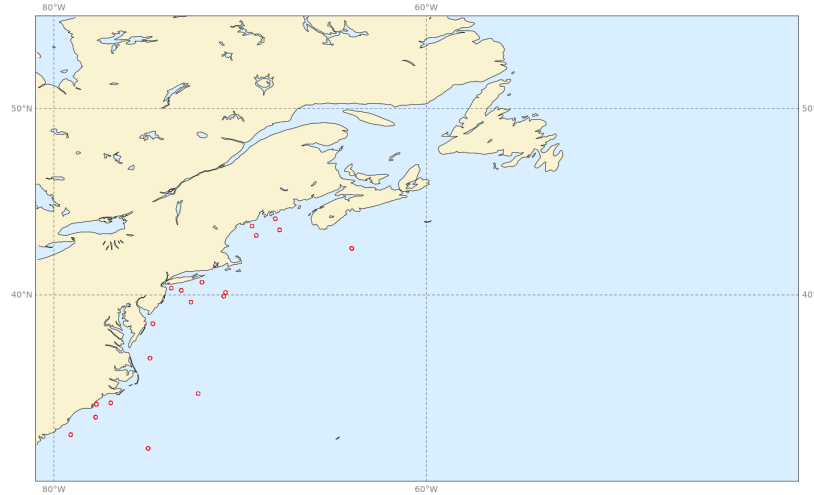


North East Atlantic. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

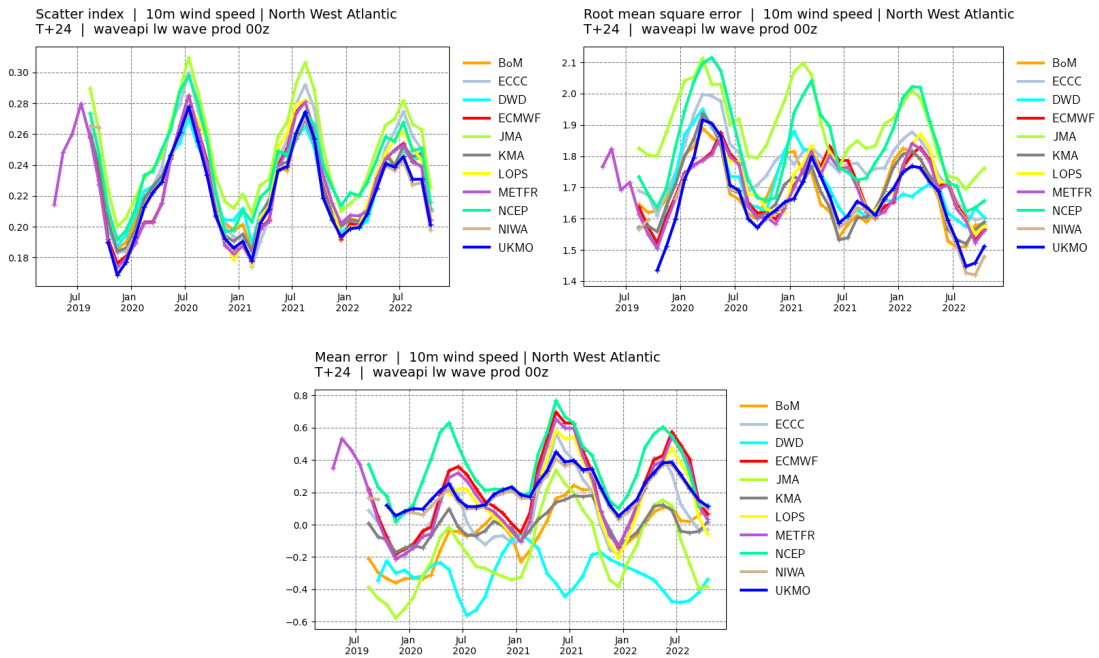


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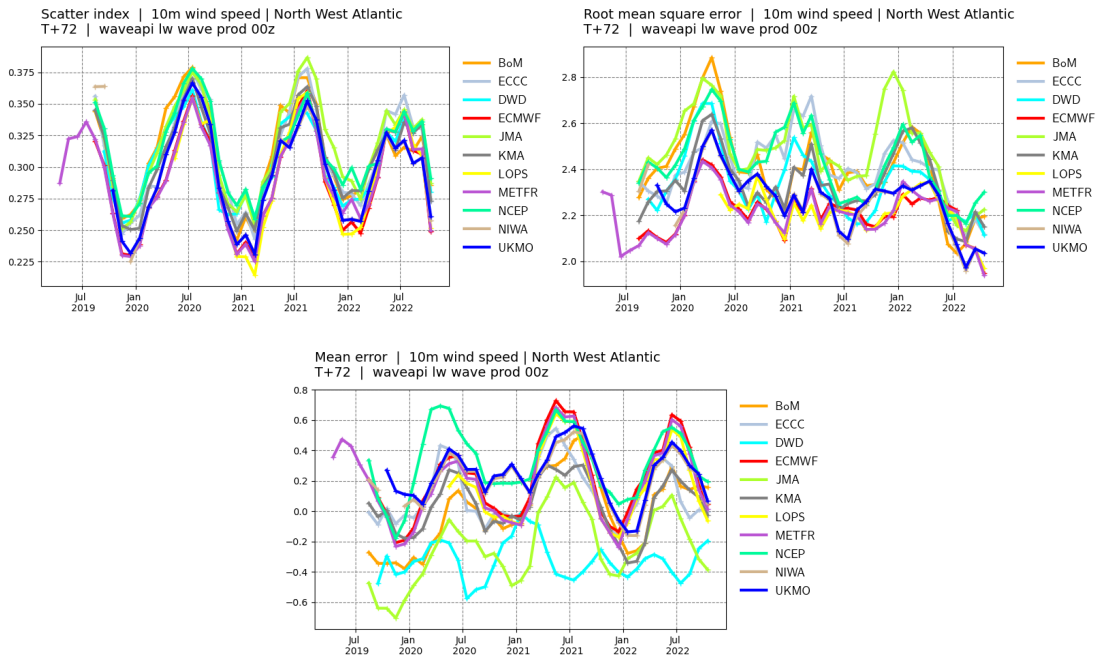
Buoys observations - from 20220901 to 20221130 - (10ff)



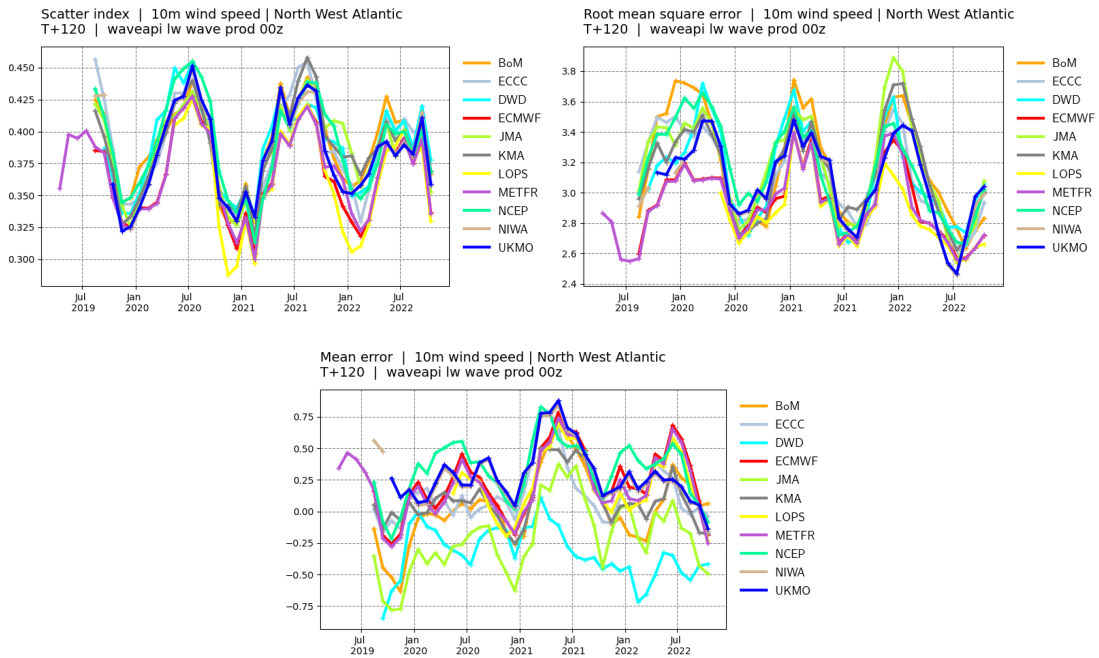
North West Atlantic. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



North West Atlantic. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

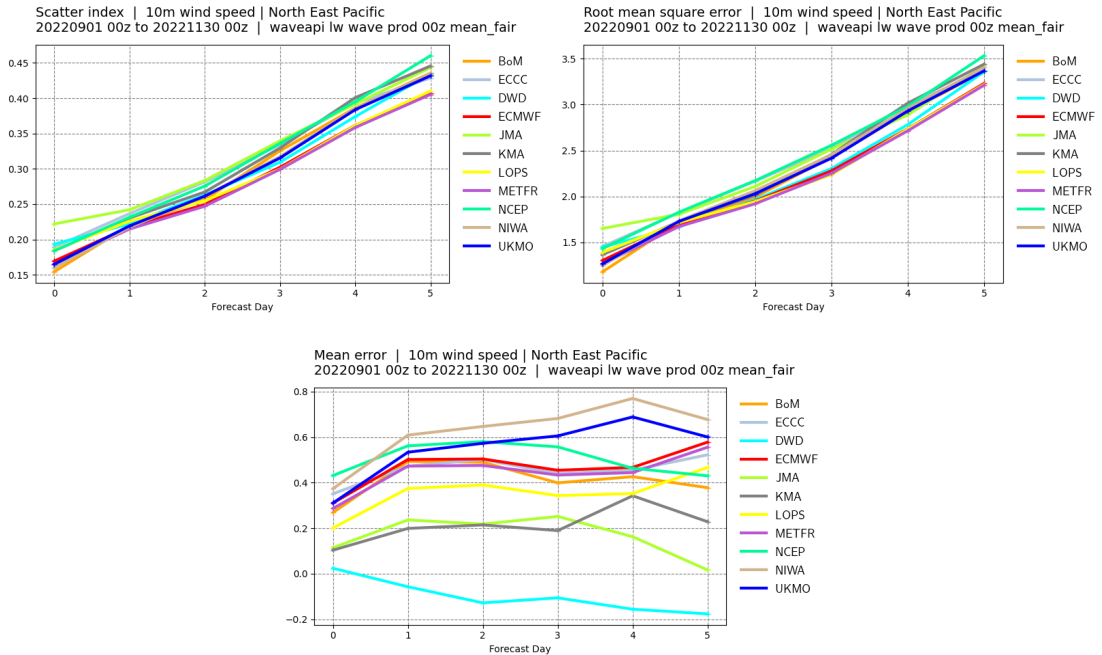
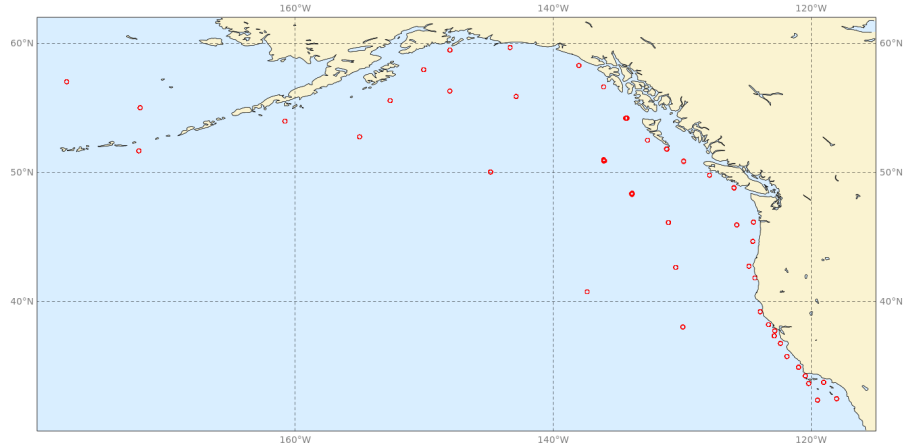


North West Atlantic. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

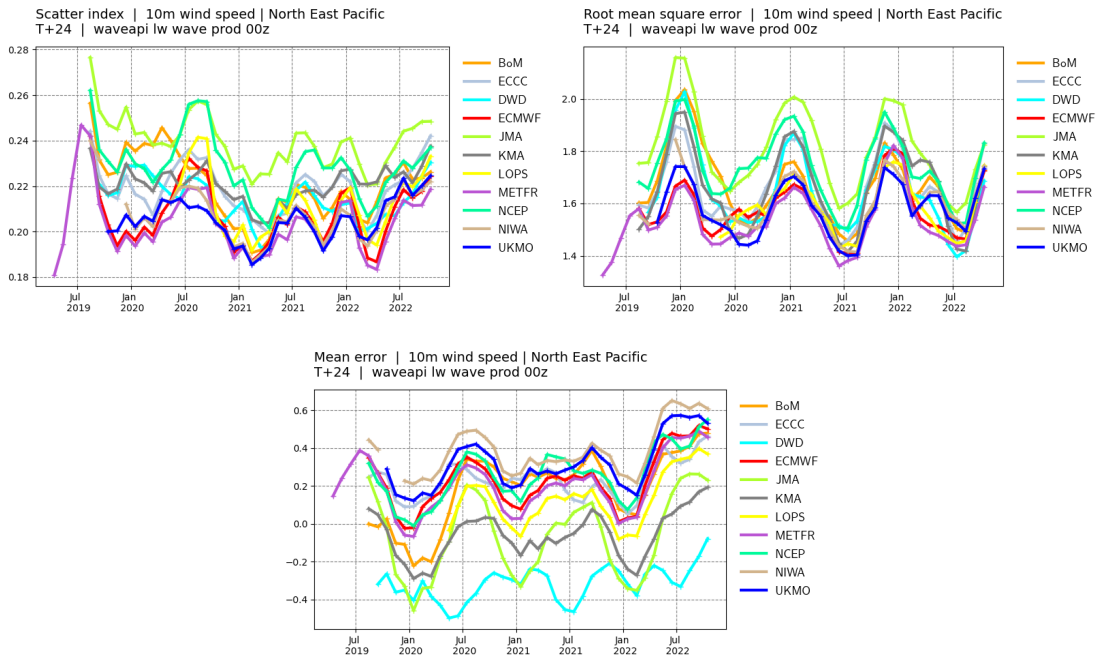


North West Atlantic. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

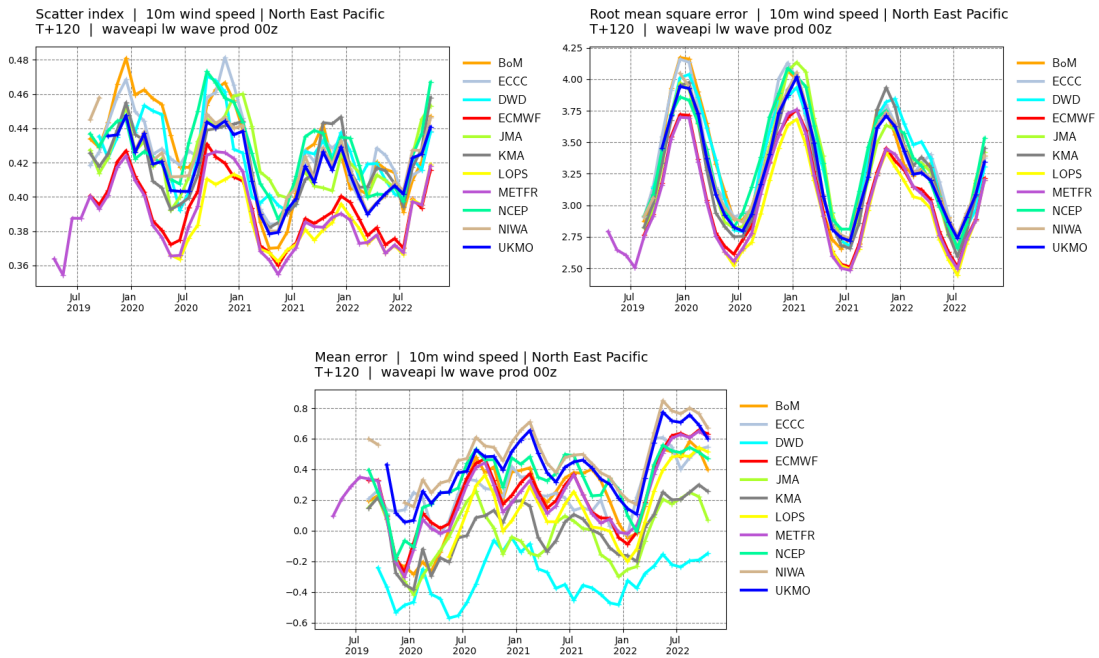
Buoys observations - from 20220901 to 20221130 - (10ff)



North East Pacific. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

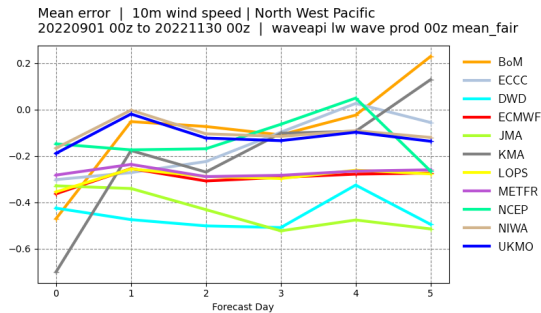
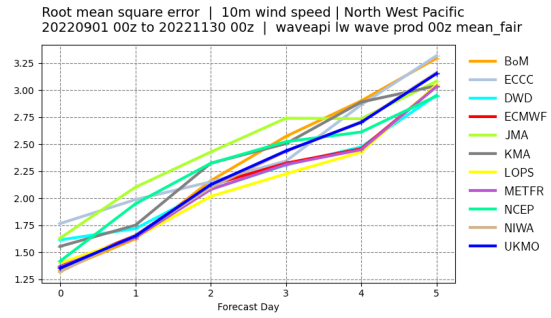
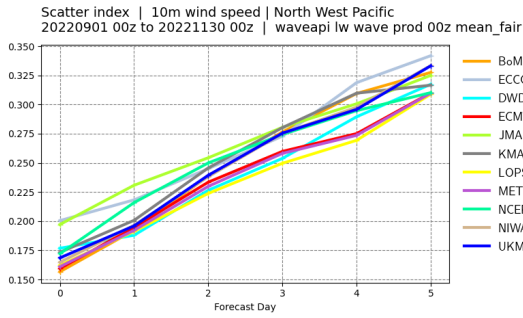
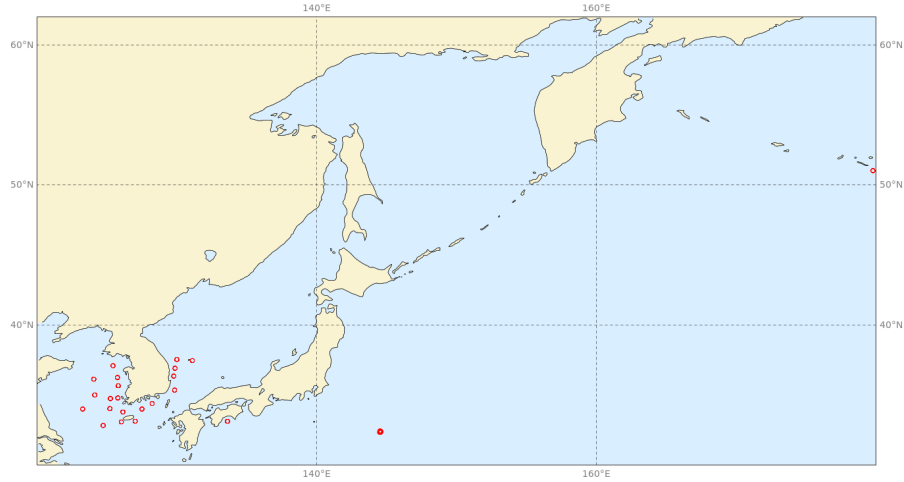


North East Pacific. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

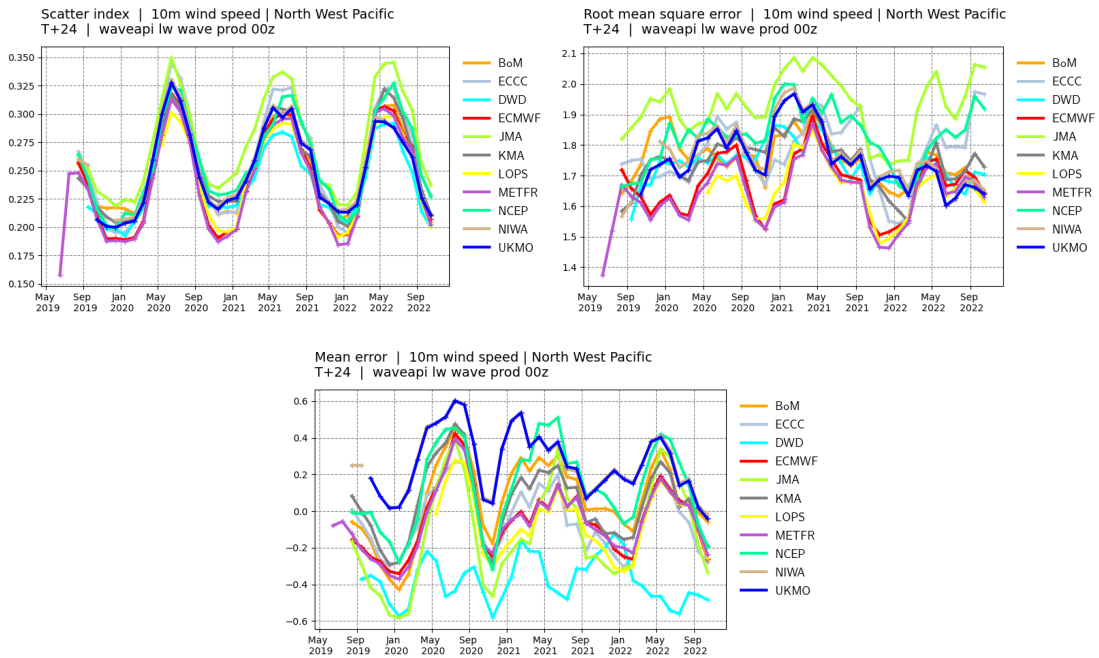


North East Pacific. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

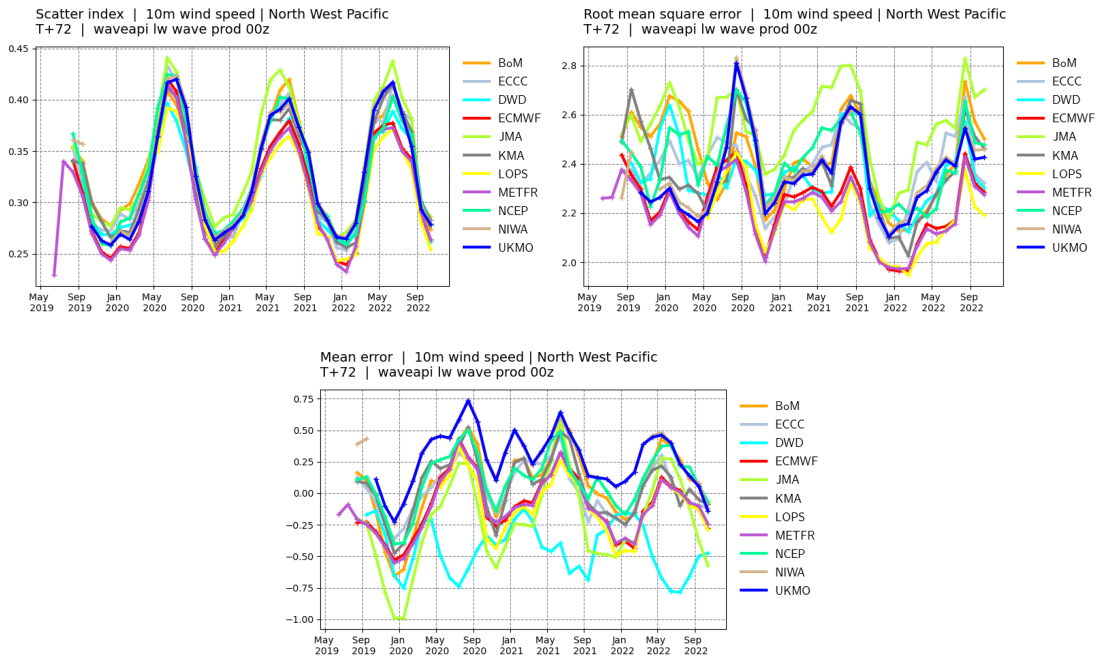
Buoys observations - from 20220901 to 20221130 - (10ff)



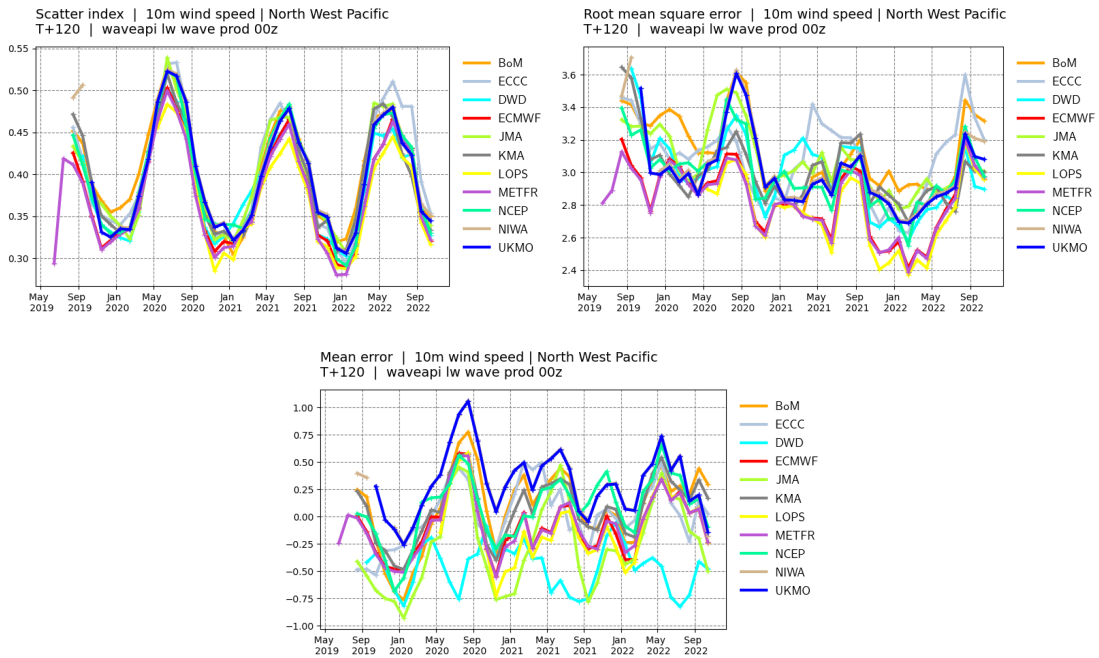
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North West Pacific. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

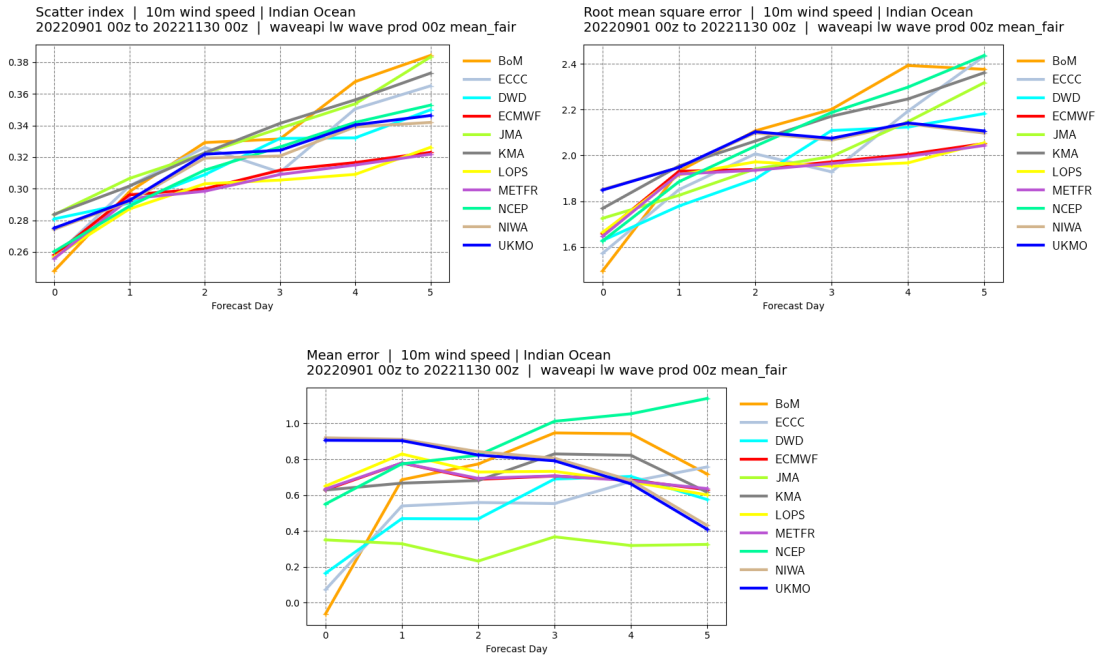
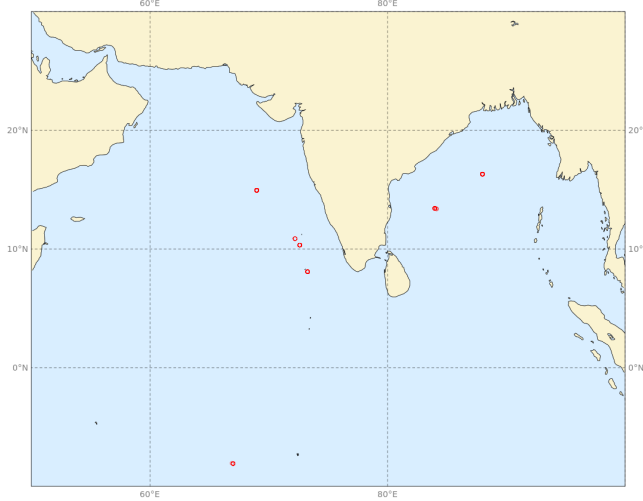


North West Pacific. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

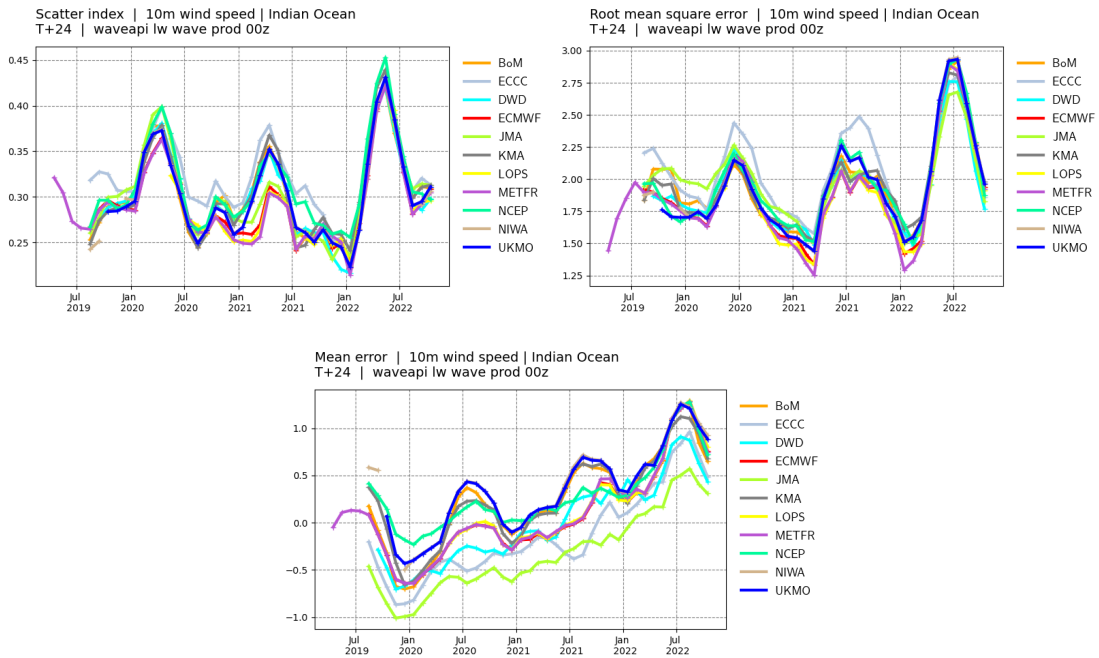


North West Pacific. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

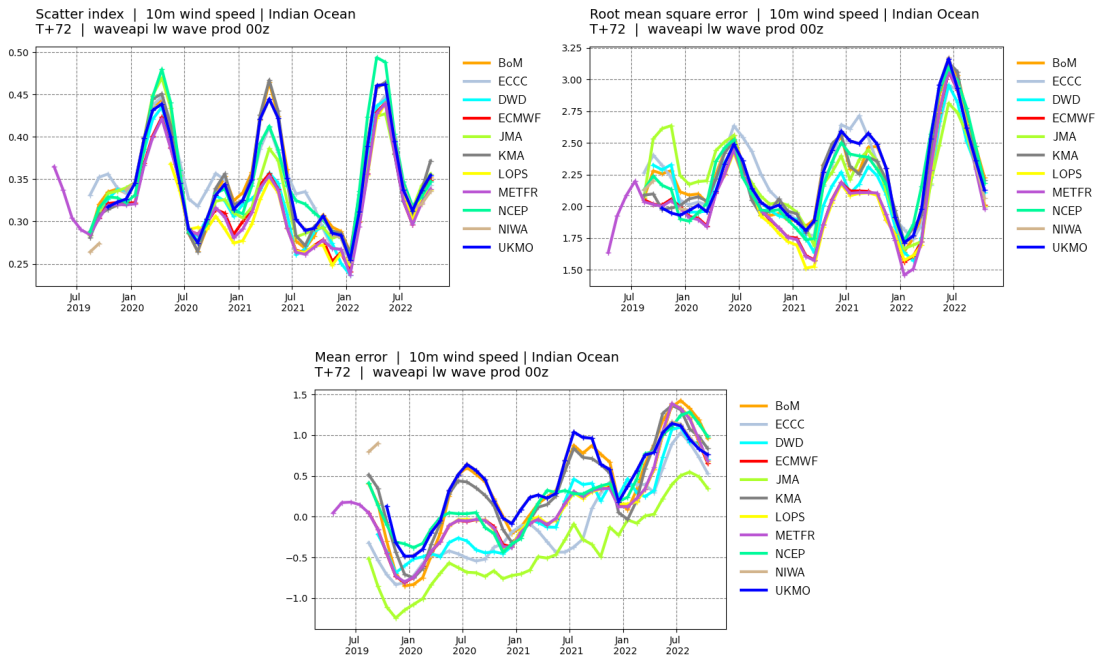
Buoys observations - from 20220901 to 20221130 - (10ff)



Indian Ocean. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

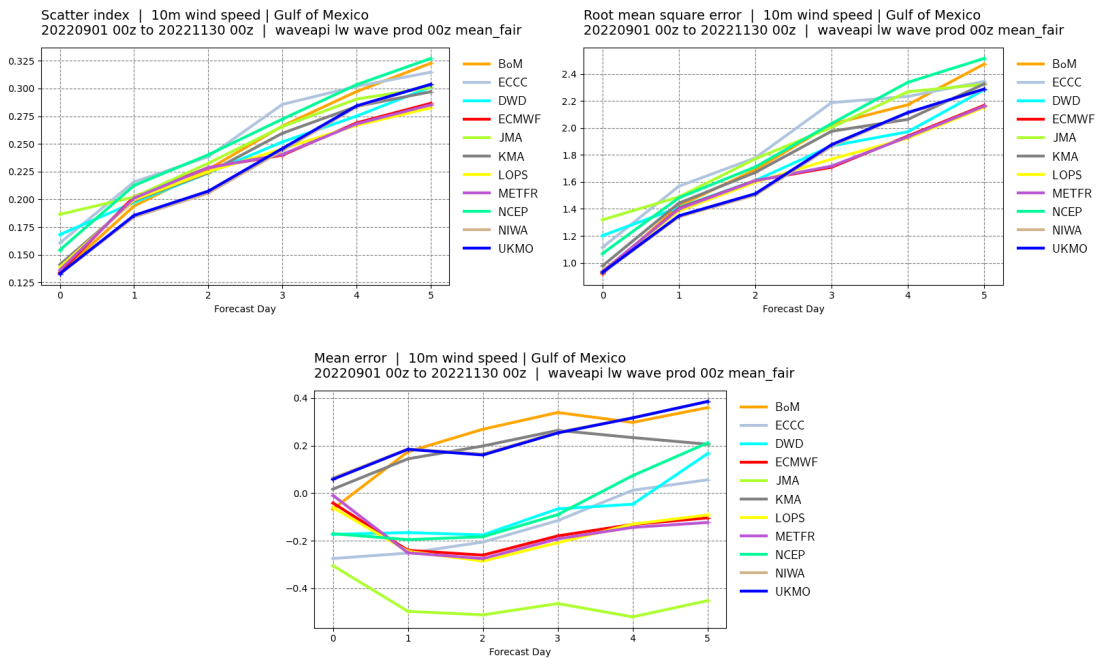
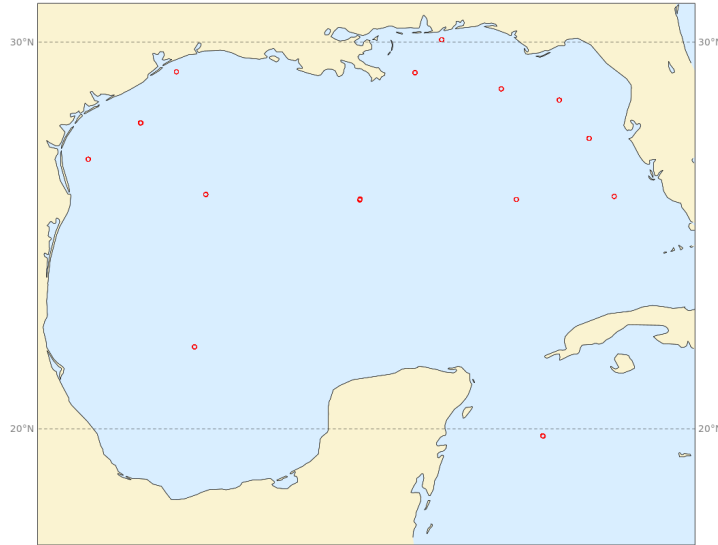


Indian Ocean. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

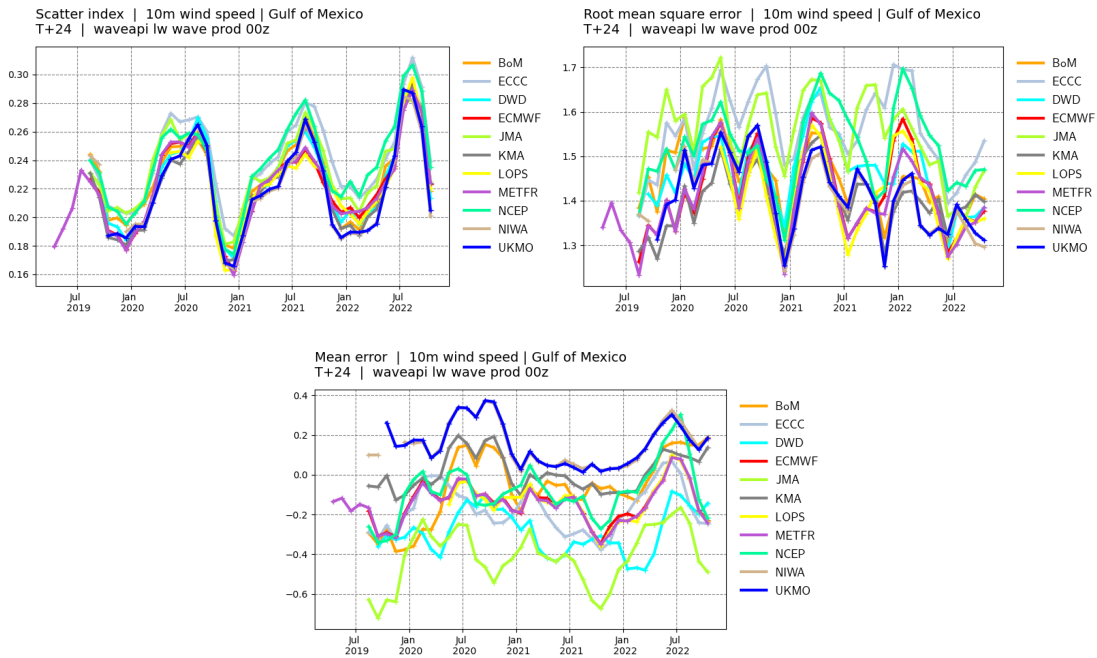


Indian Ocean. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

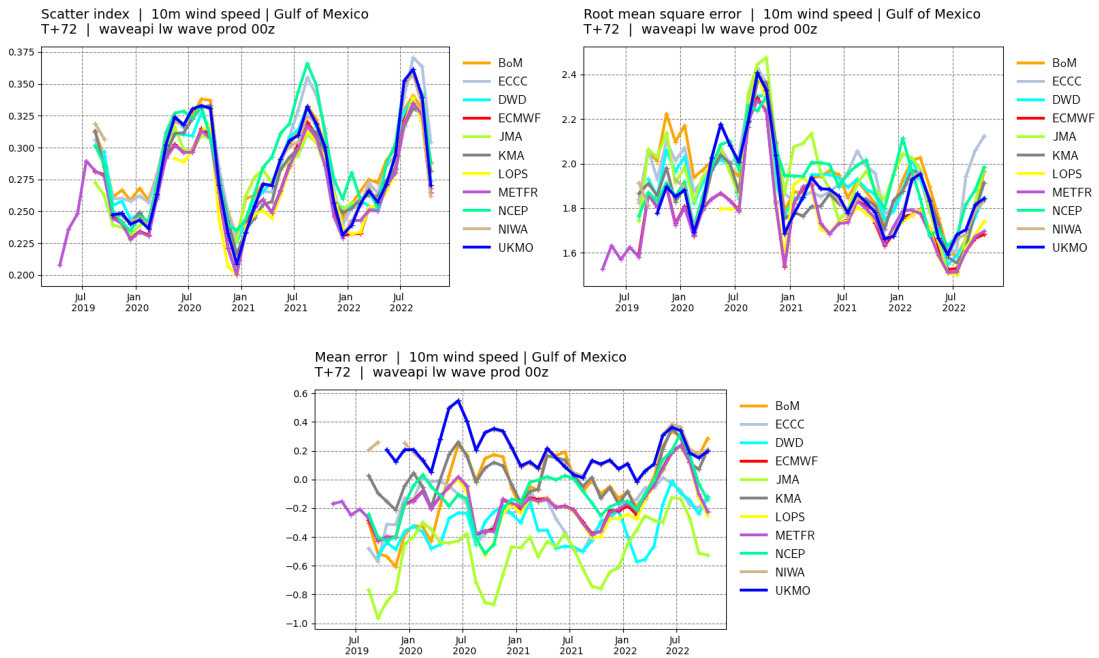
Buoys observations - from 20220901 to 20221130 - (10ff)



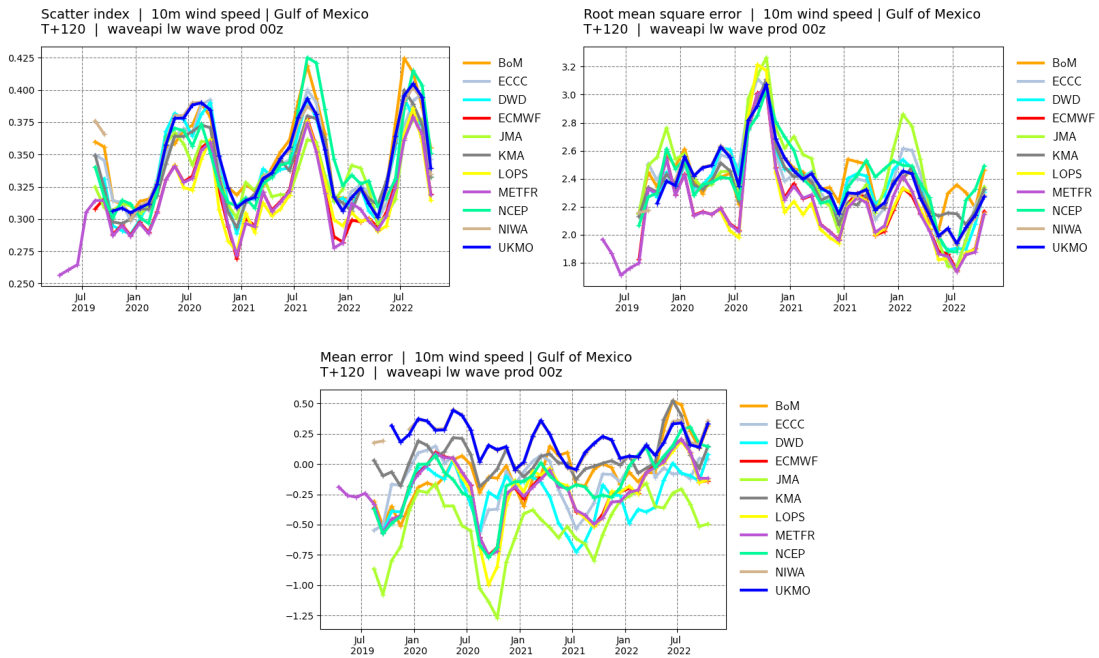
Gulf of Mexico. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



Gulf of Mexico. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

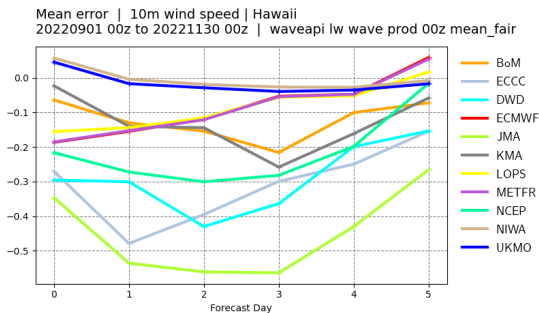
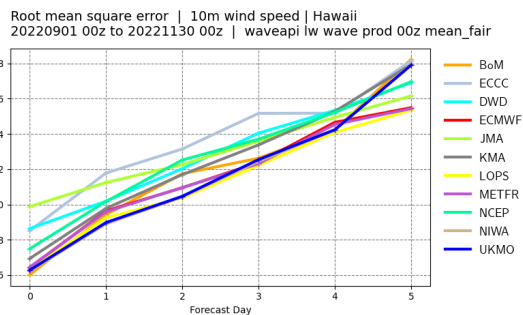
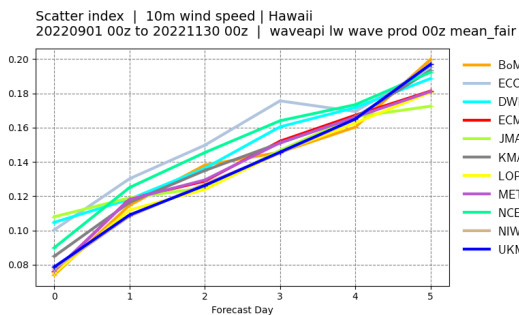
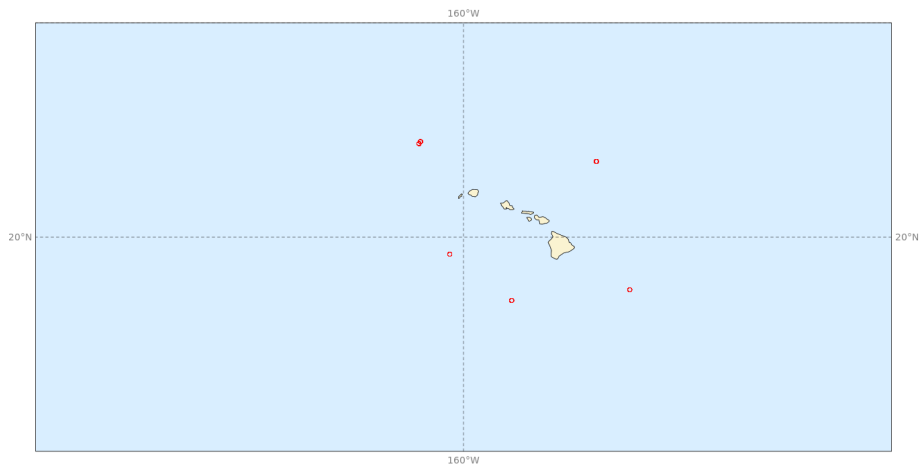


Gulf of Mexico. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

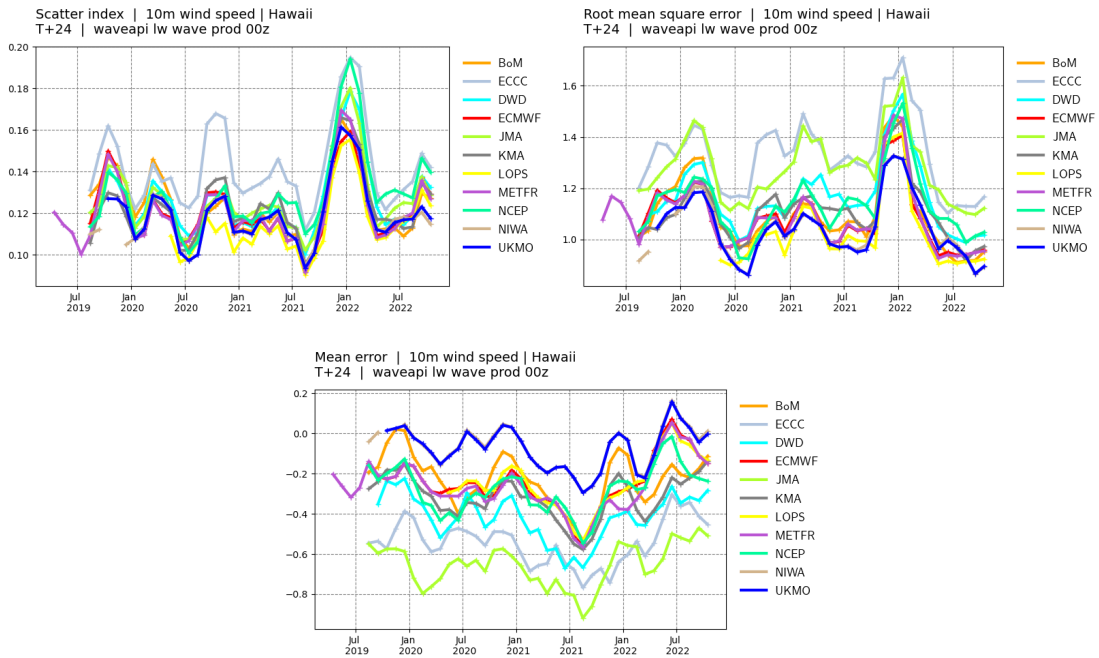


Gulf of Mexico. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

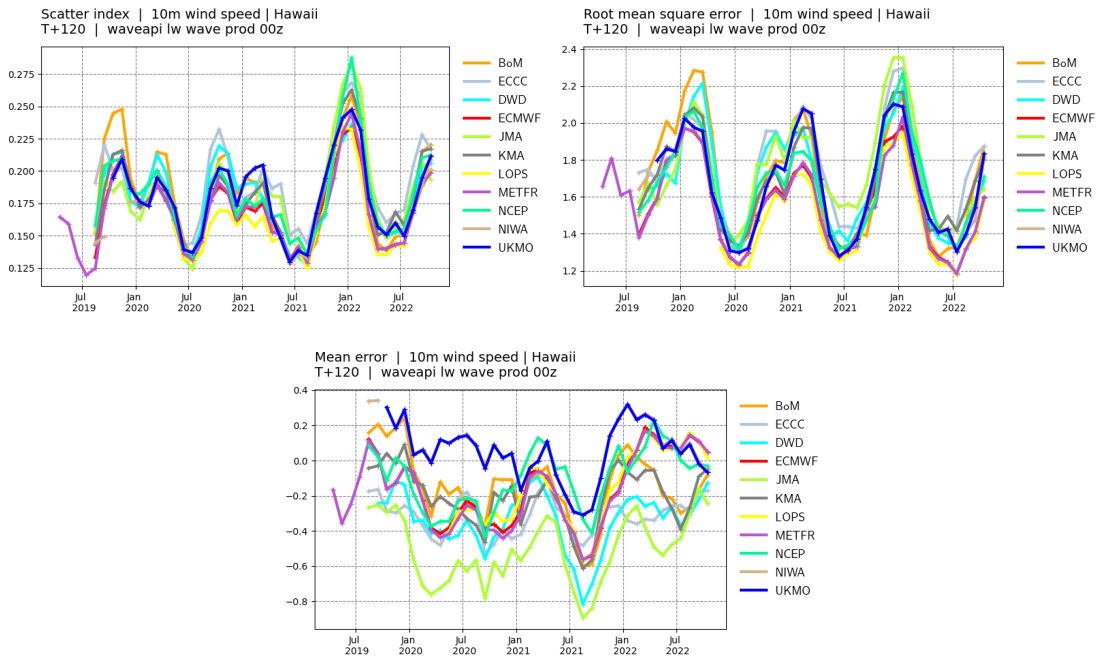
Buoys observations - from 20220901 to 20221130 - (10ff)



Hawaii. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

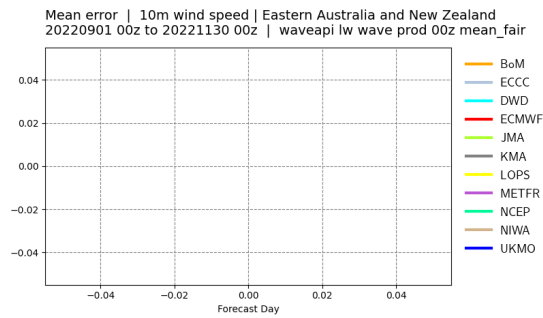
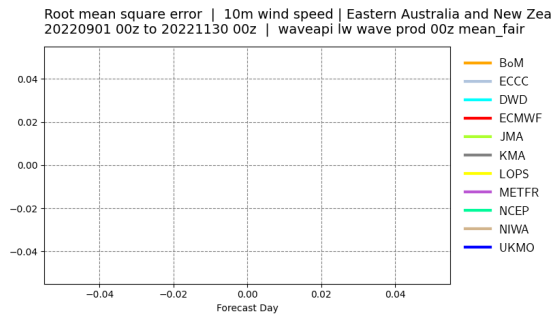
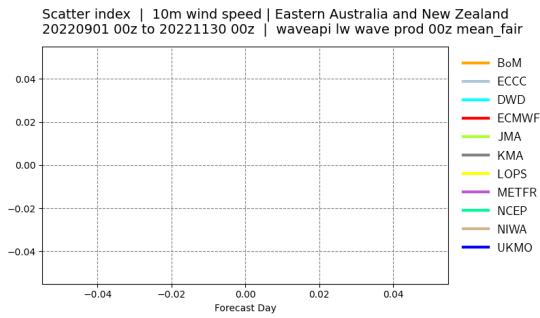
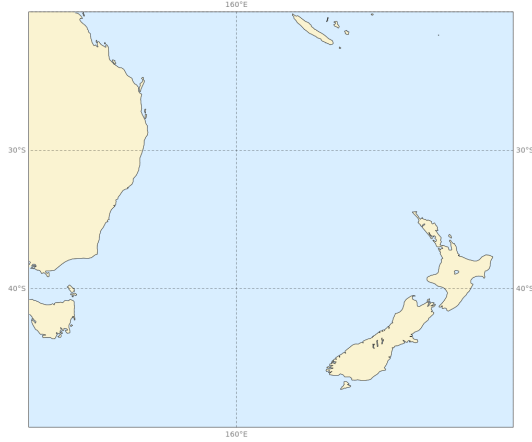


Hawaii. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

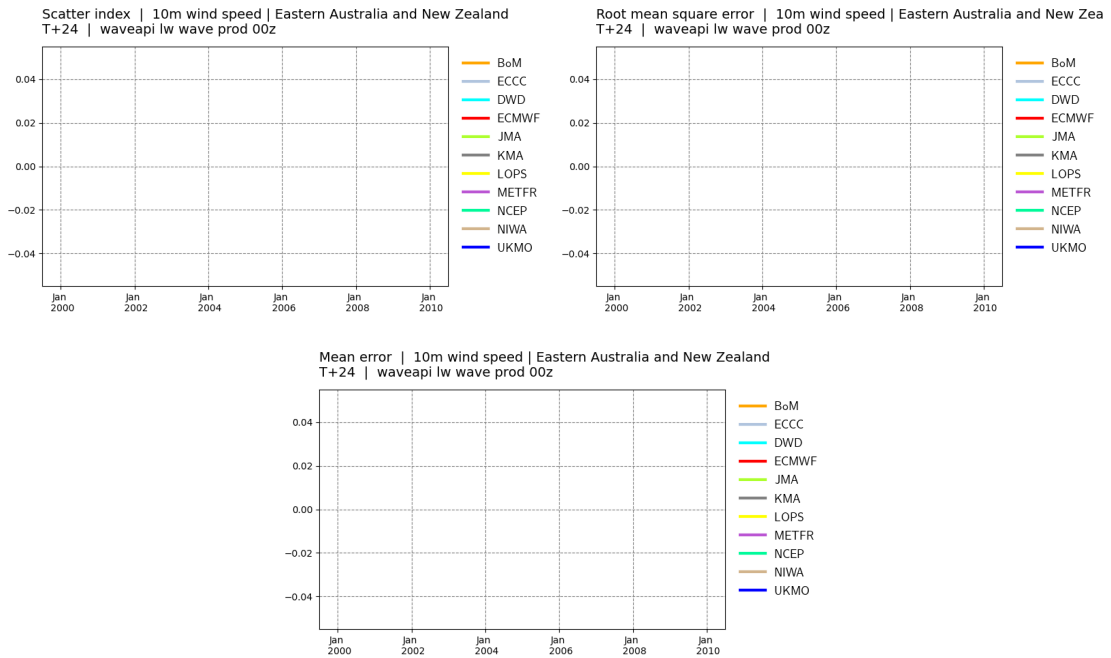


Hawaii. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

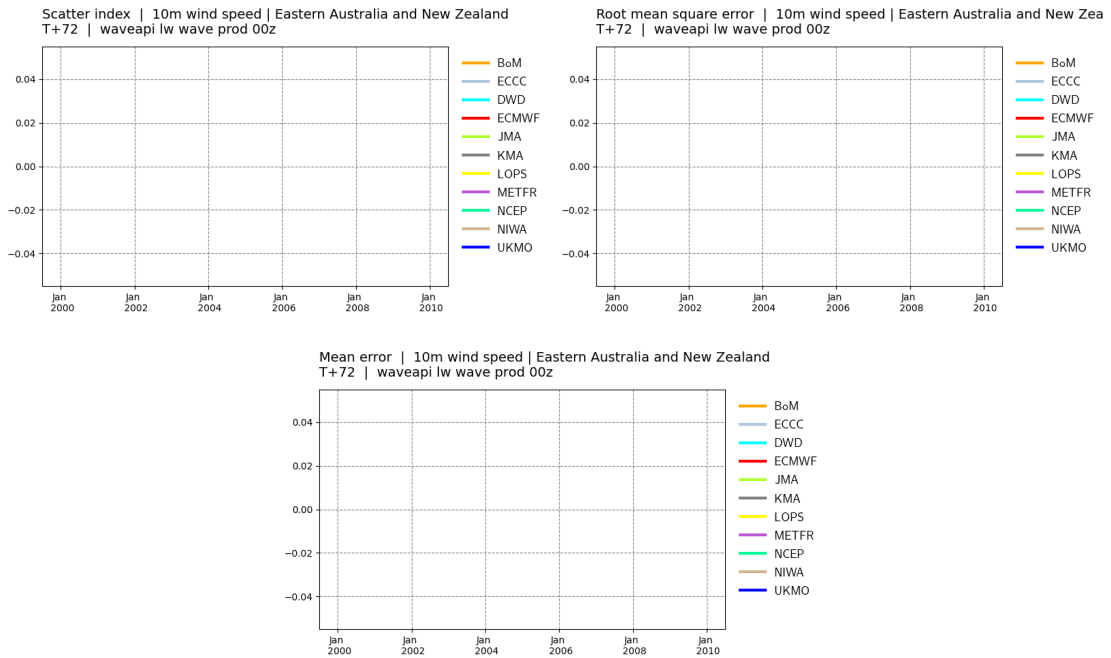
Buoys observations - from 20220901 to 20221130 - (10ff)



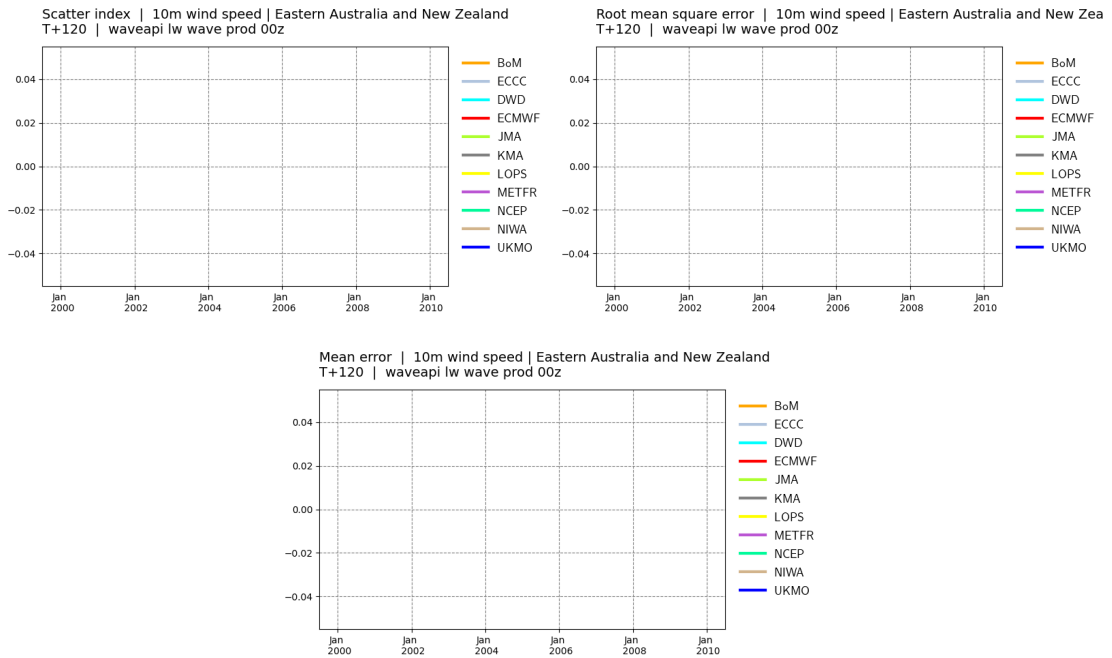
East Australia - New Zealand. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



East Australia - New Zealand. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

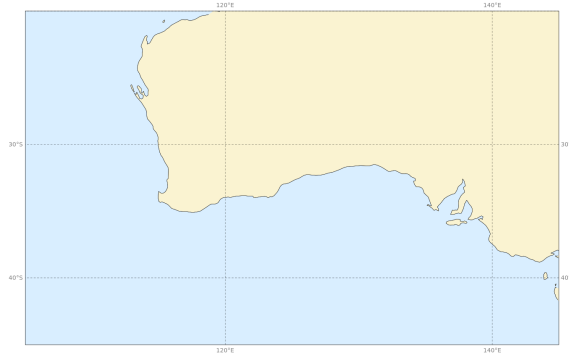


East Australia - New Zealand. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

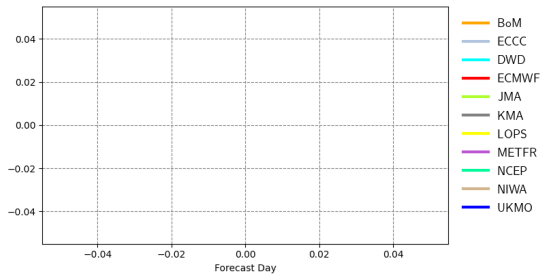


East Australia - New Zealand. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

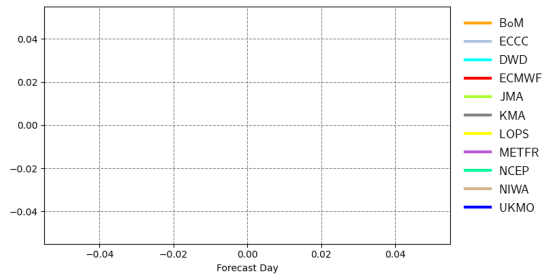
Buoys observations - from 20220901 to 20221130 - (10ff)



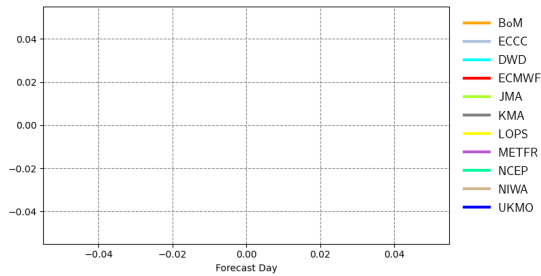
Scatter index | 10m wind speed | South Southwestern Australia
20220901 00z to 20221130 00z | waveapi lw wave prod 00z mean_fair



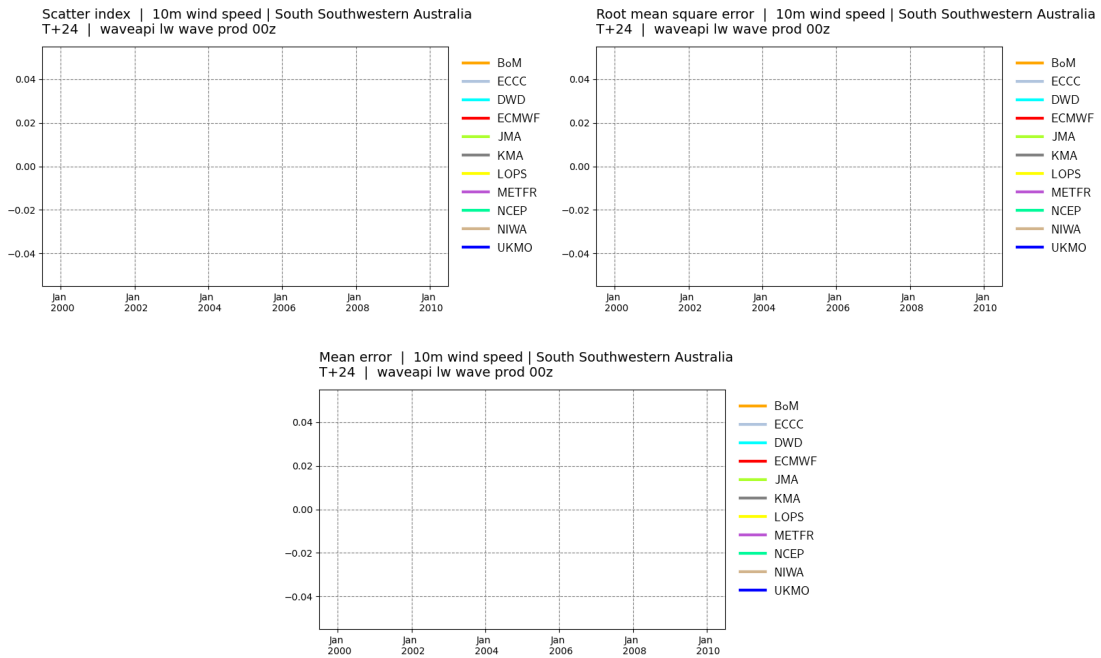
Root mean square error | 10m wind speed | South Southwestern Australia
20220901 00z to 20221130 00z | waveapi lw wave prod 00z mean_fair



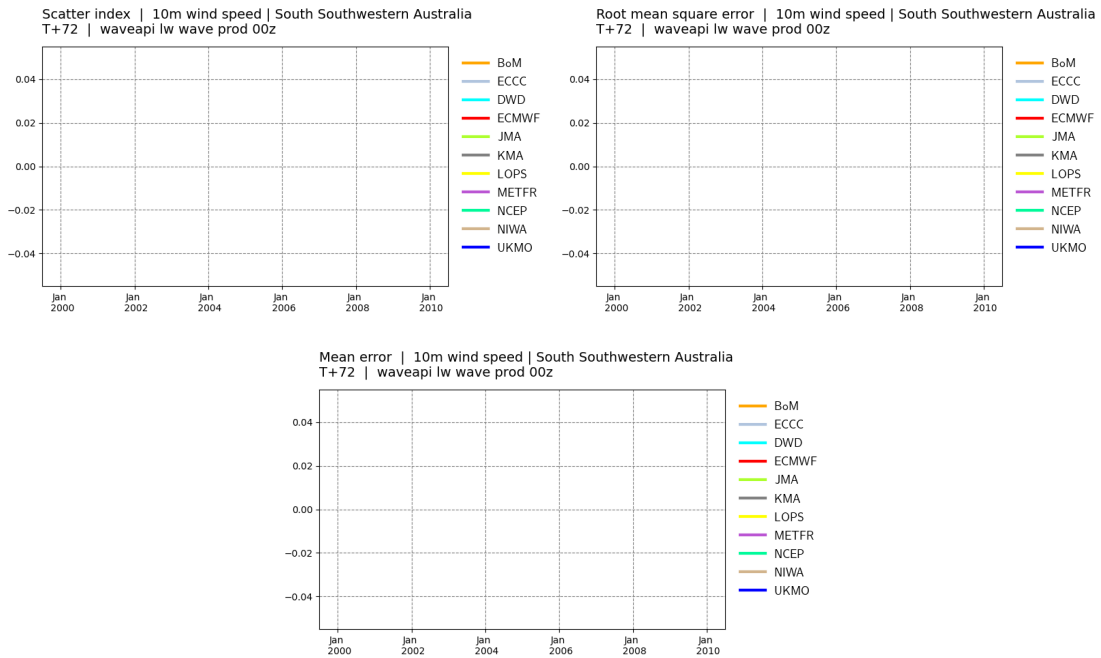
Mean error | 10m wind speed | South Southwestern Australia
20220901 00z to 20221130 00z | waveapi lw wave prod 00z mean_fair



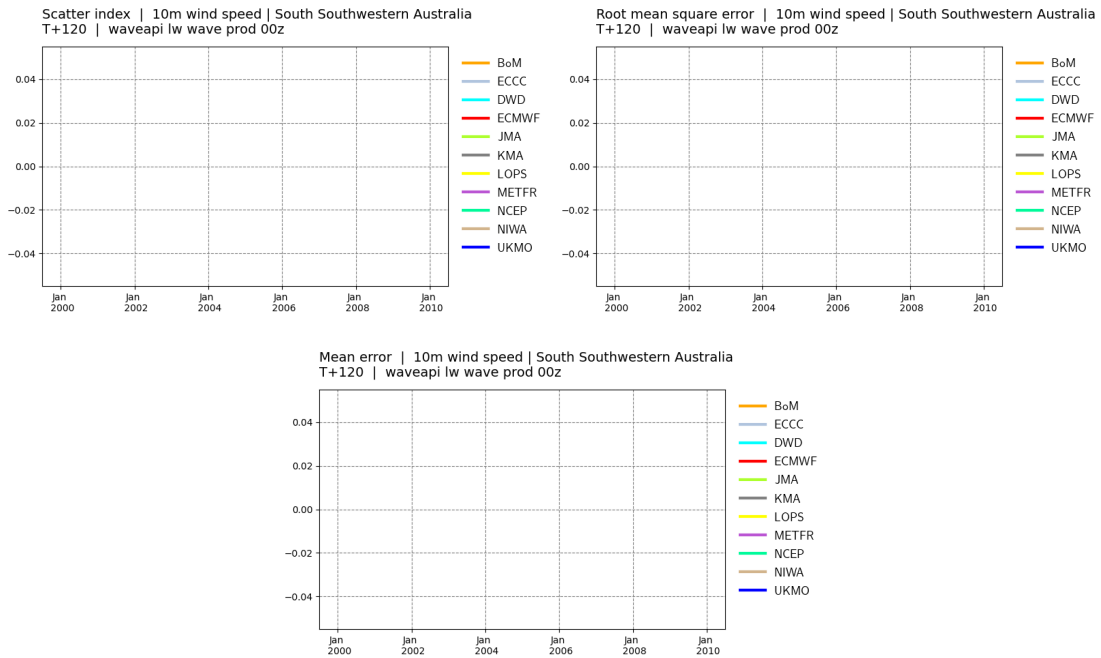
South South West Australia. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



South South West Australia. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



South South West Australia. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



South South West Australia. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).