

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.

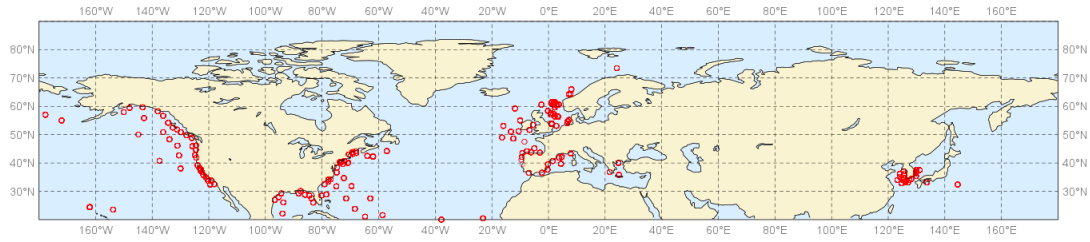
00 UTC runs only

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

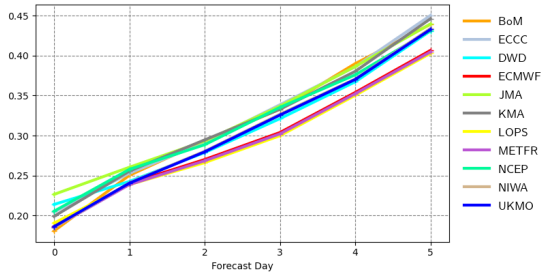
June 22, 2022

PART III: 10 meter wind speed (10ff)

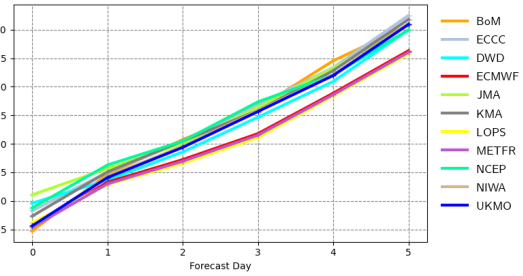
Buoys observations - from 20220301 to 20220530 - (10ff)



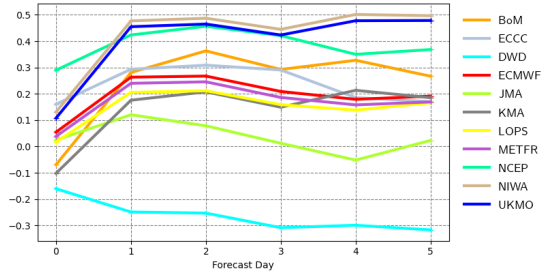
Scatter index | 10m wind speed | NHem Extratropics
20220301 00z to 20220530 00z | waveapi lw wave prod 00z mean_fair



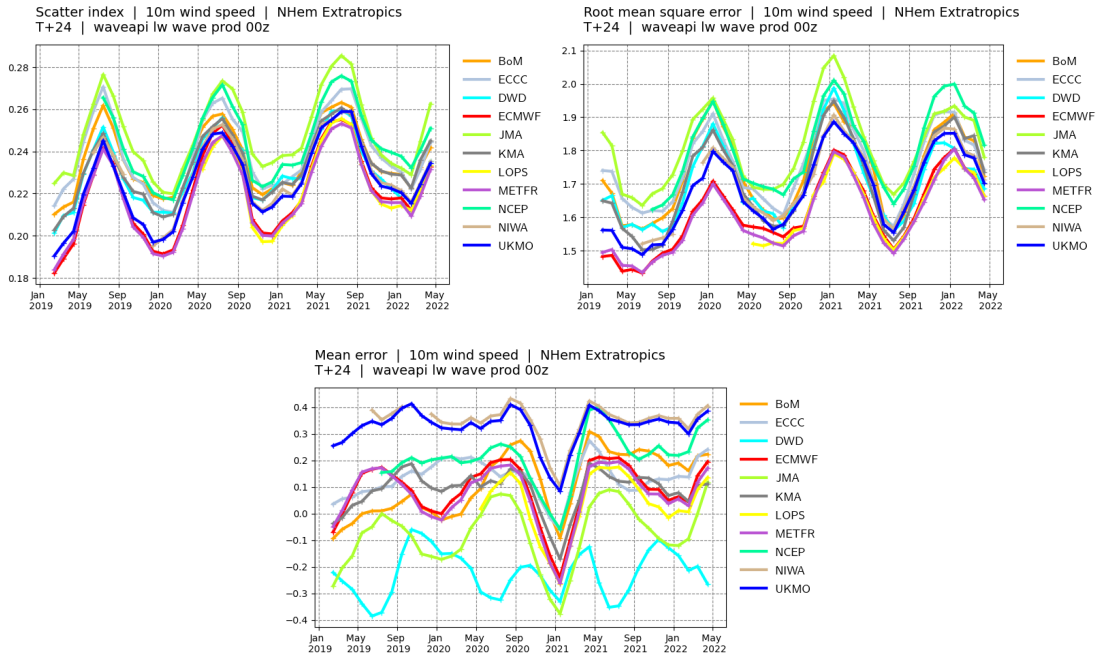
Root mean square error | 10m wind speed | NHem Extratropics
20220301 00z to 20220530 00z | waveapi lw wave prod 00z mean_fair



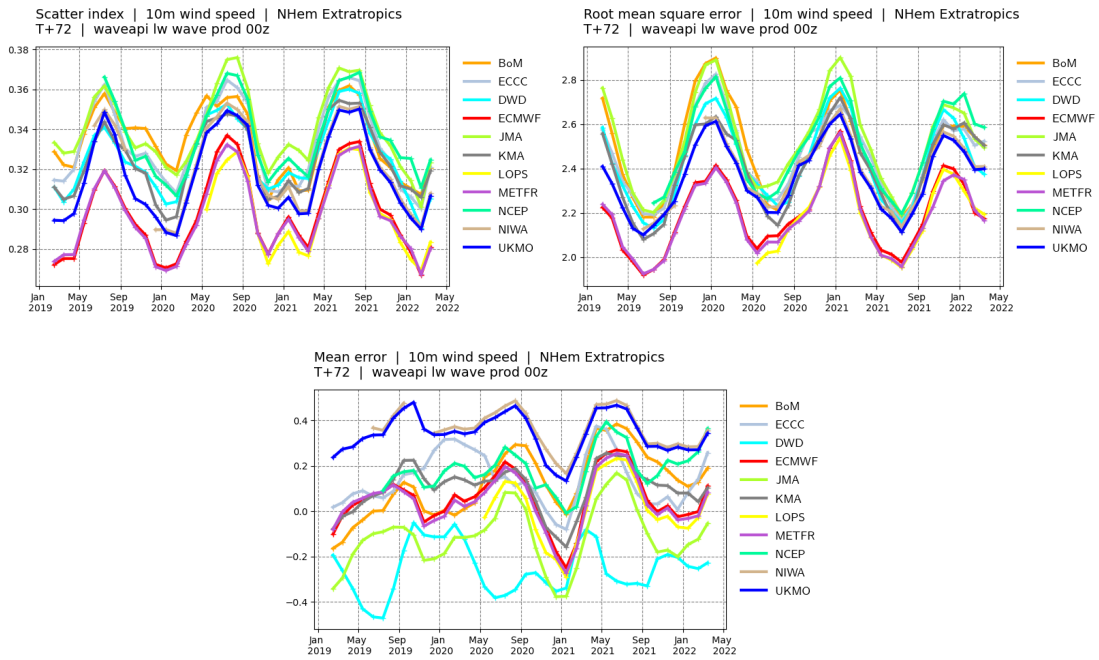
Mean error | 10m wind speed | NHem Extratropics
20220301 00z to 20220530 00z | waveapi lw wave prod 00z mean_fair



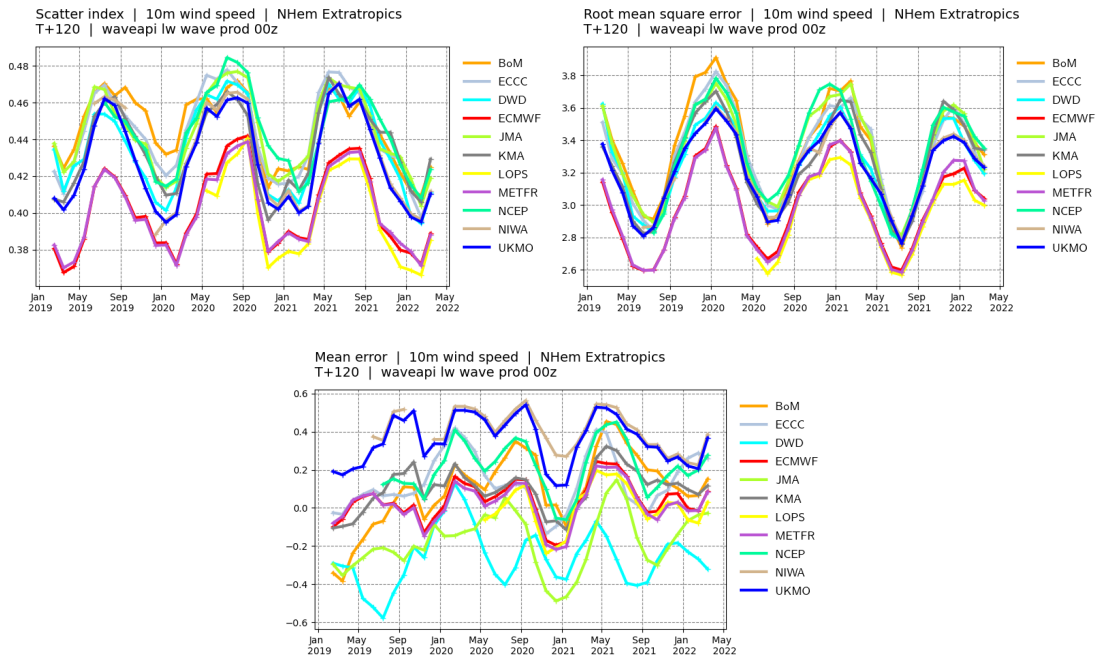
Northern Hemisphere. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



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).

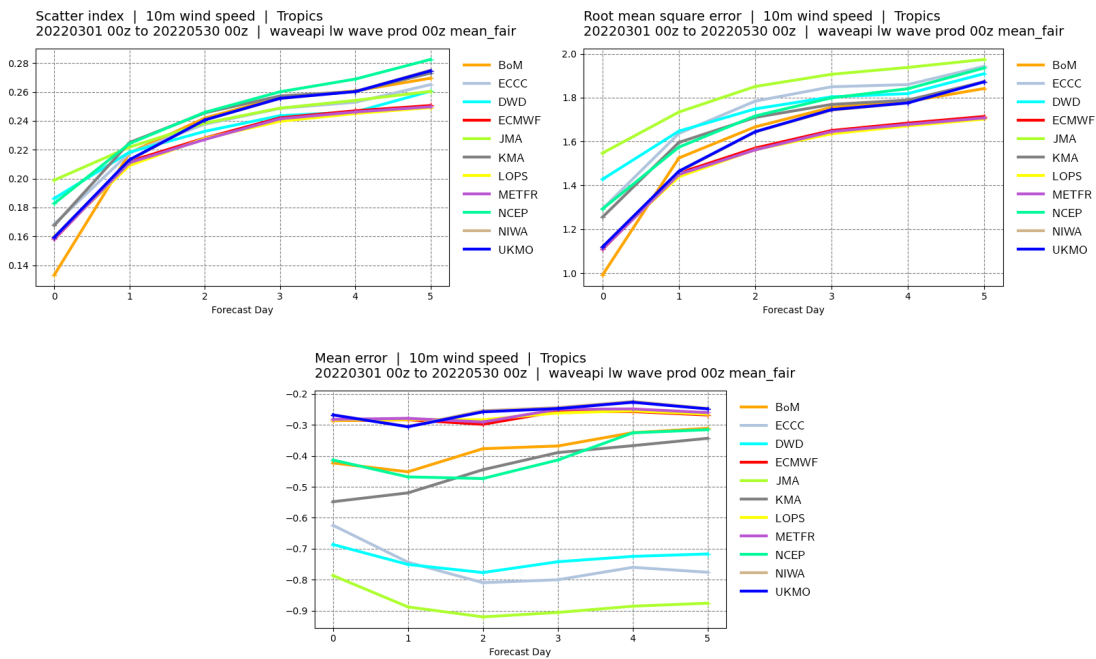
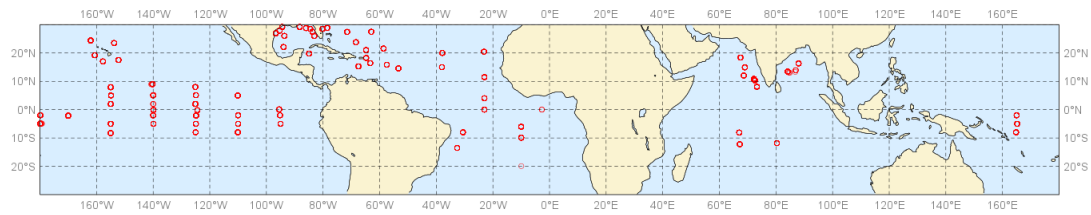


Northern Hemisphere. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

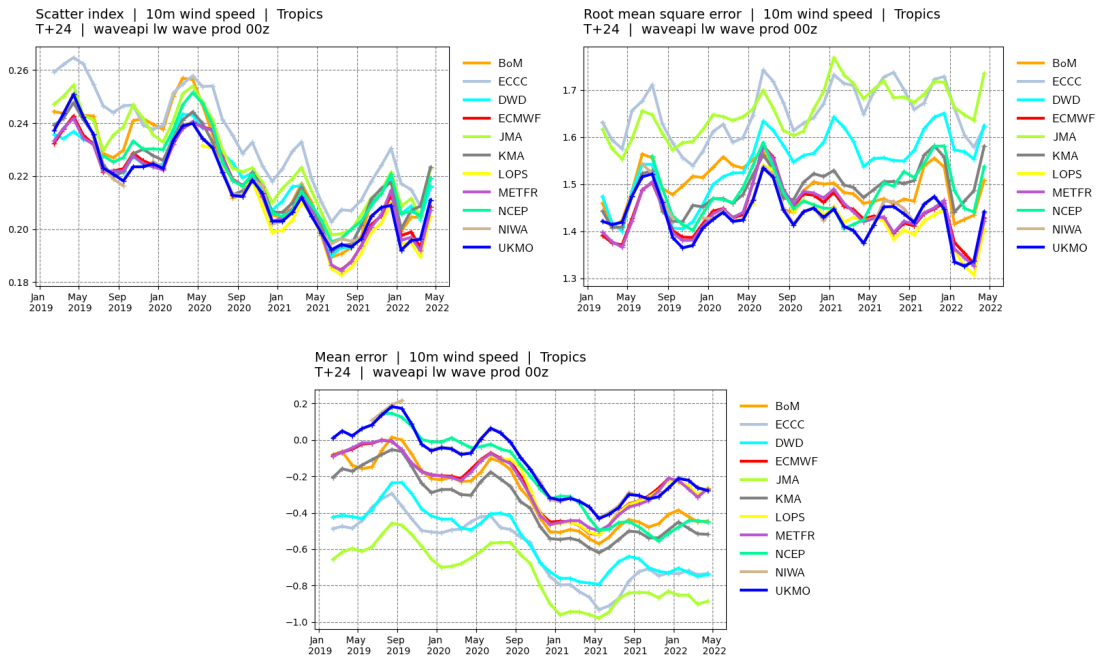


Northern Hemisphere. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

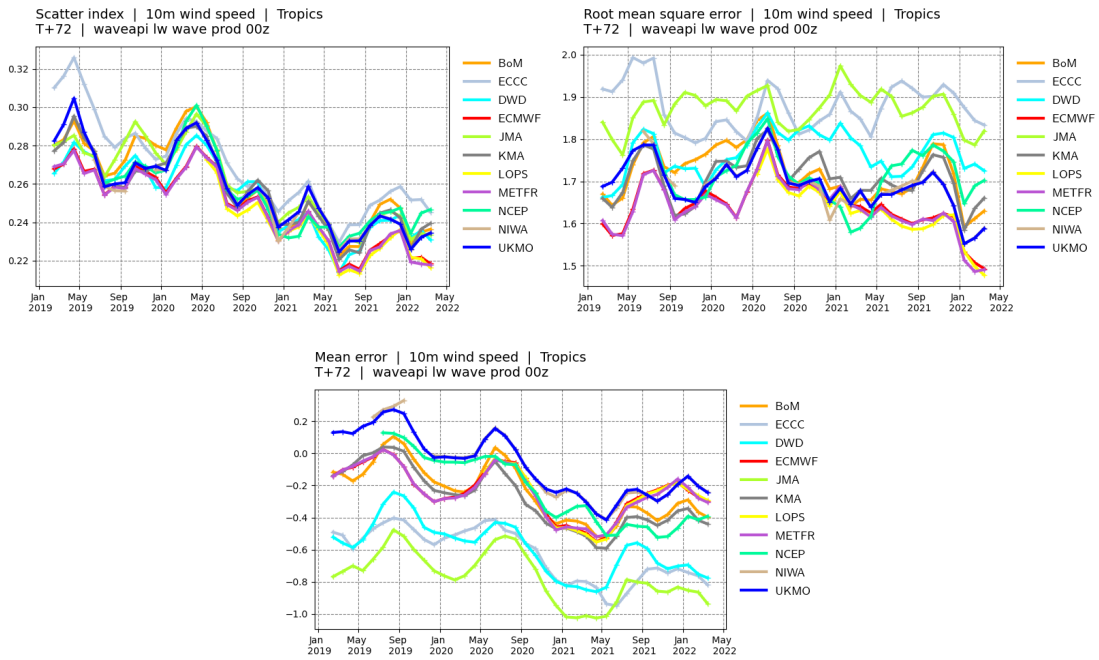
Buoys observations - from 20220301 to 20220530 - (10ff)



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).

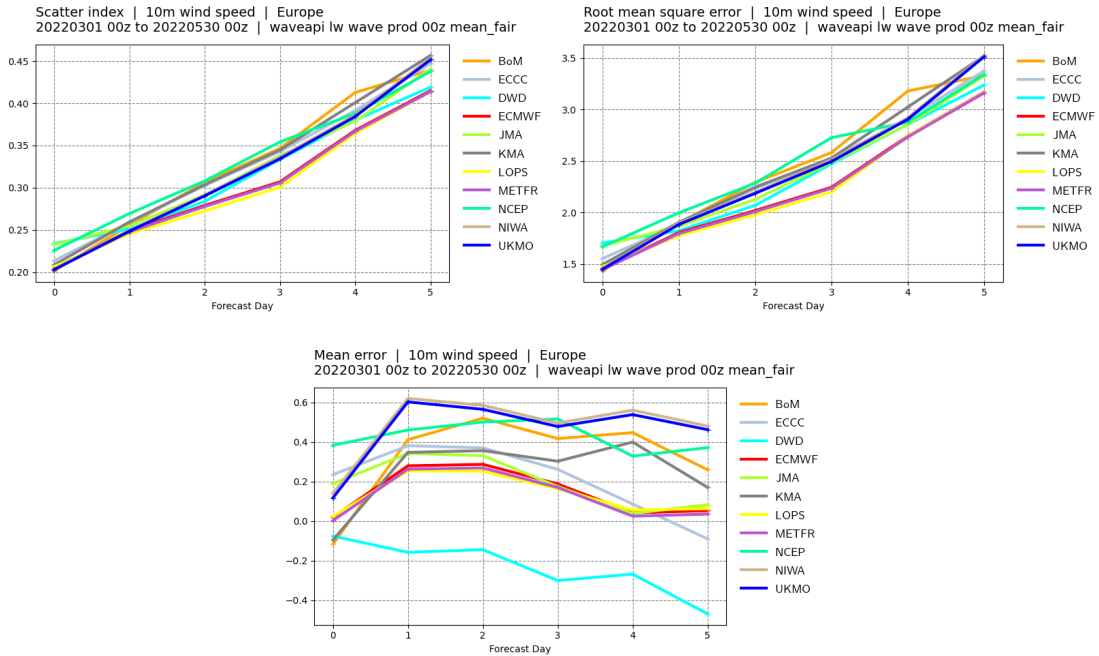
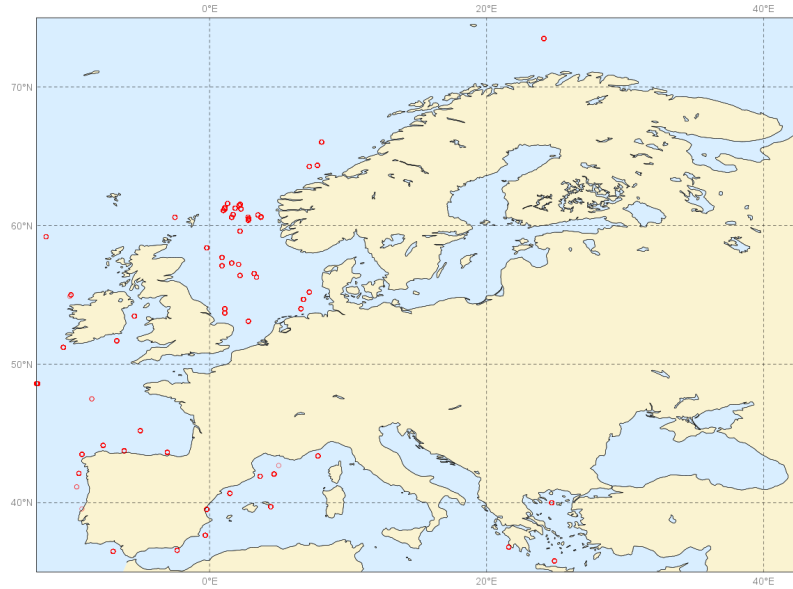


Tropics. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

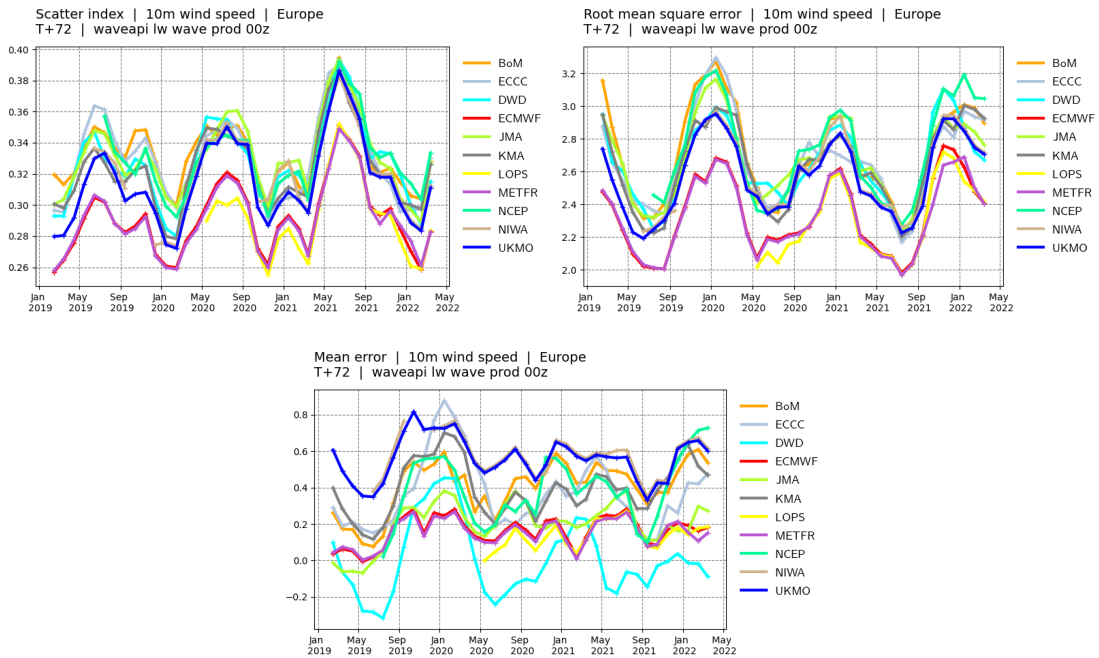


Tropics. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

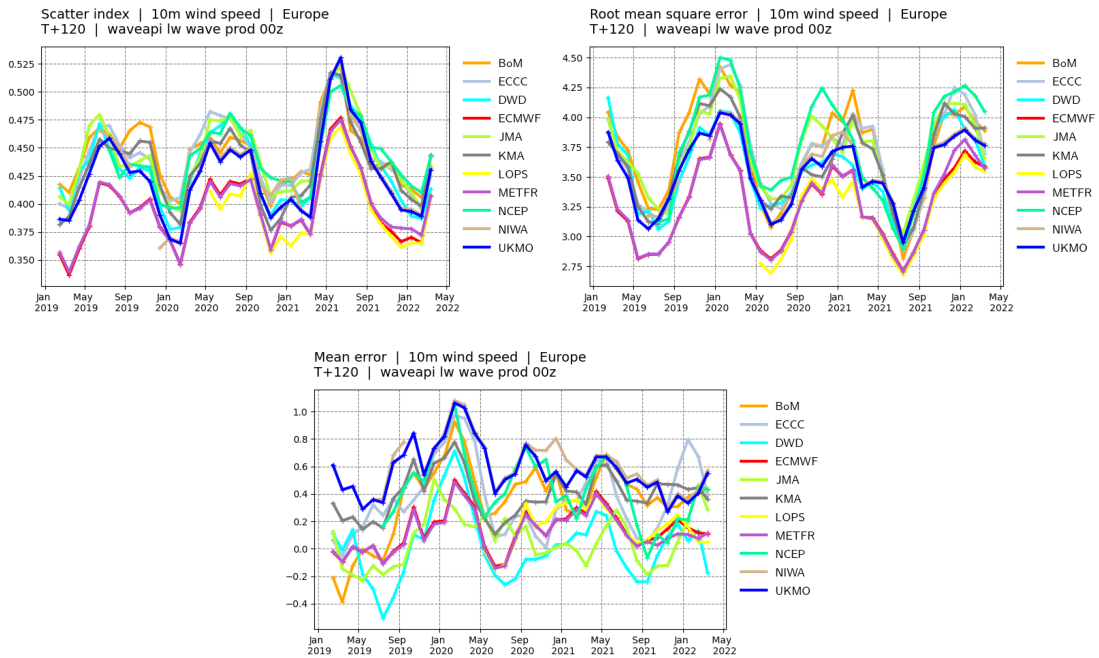
Buoys observations - from 20220301 to 20220530 - (10ff)



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).

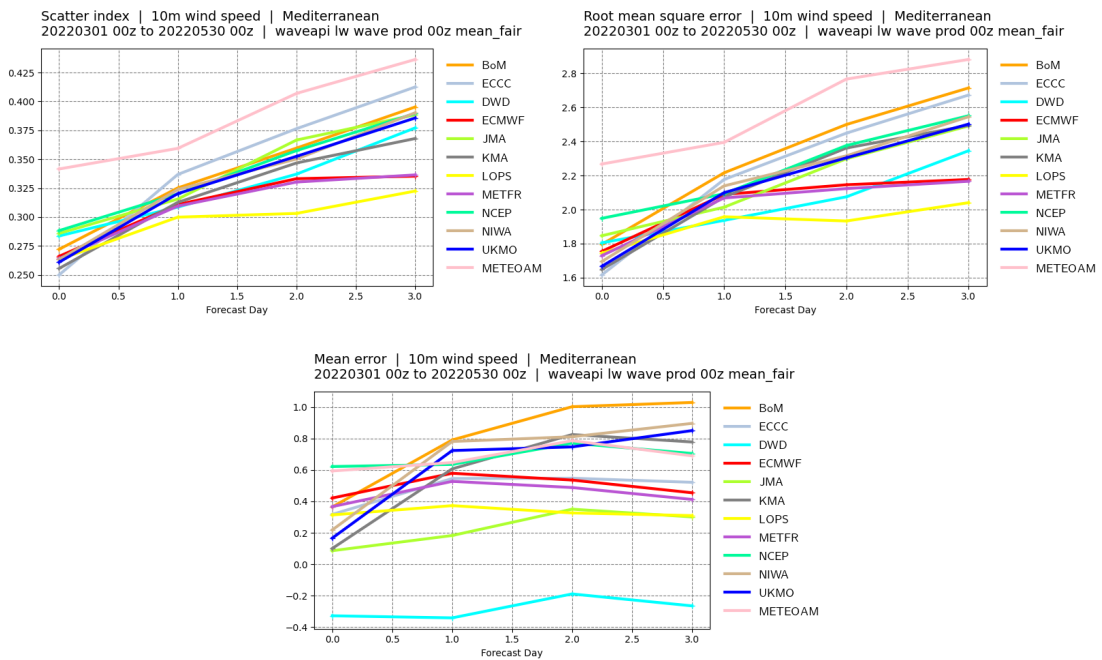
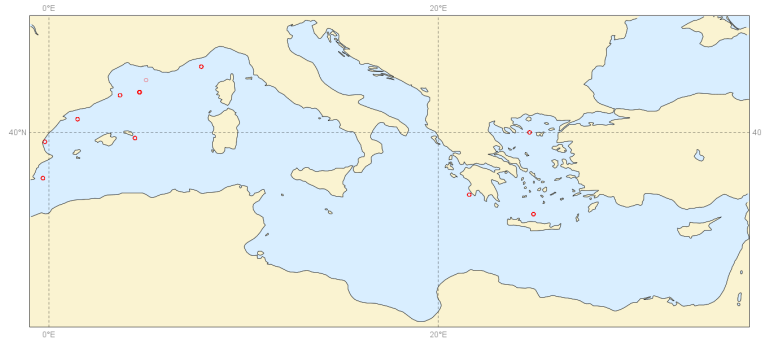


Europe. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

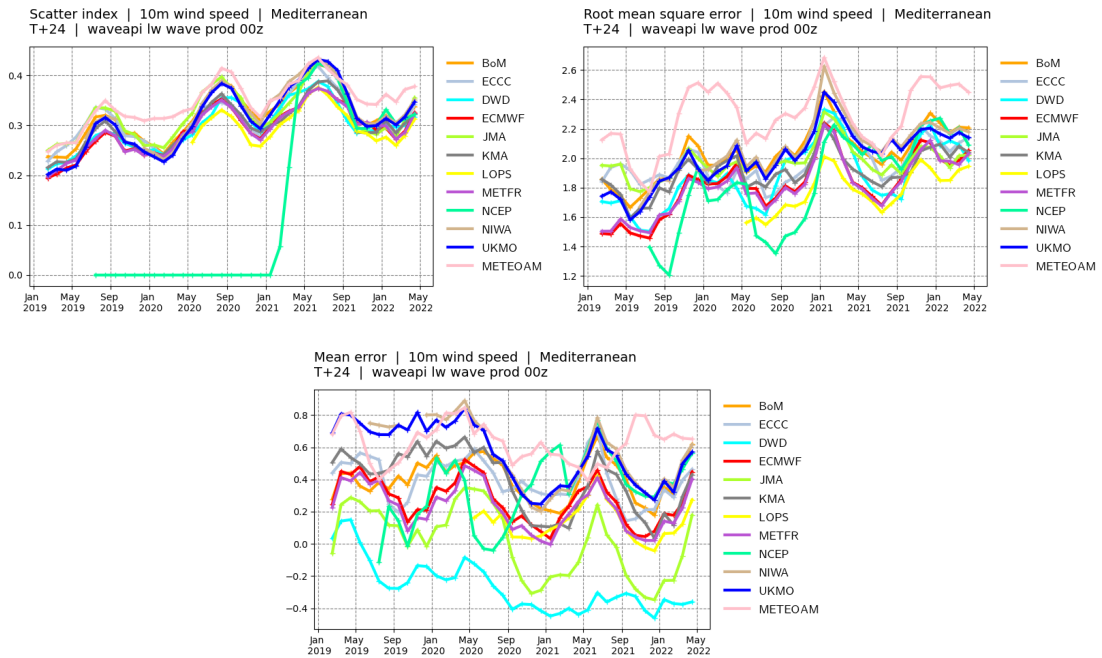


Europe. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

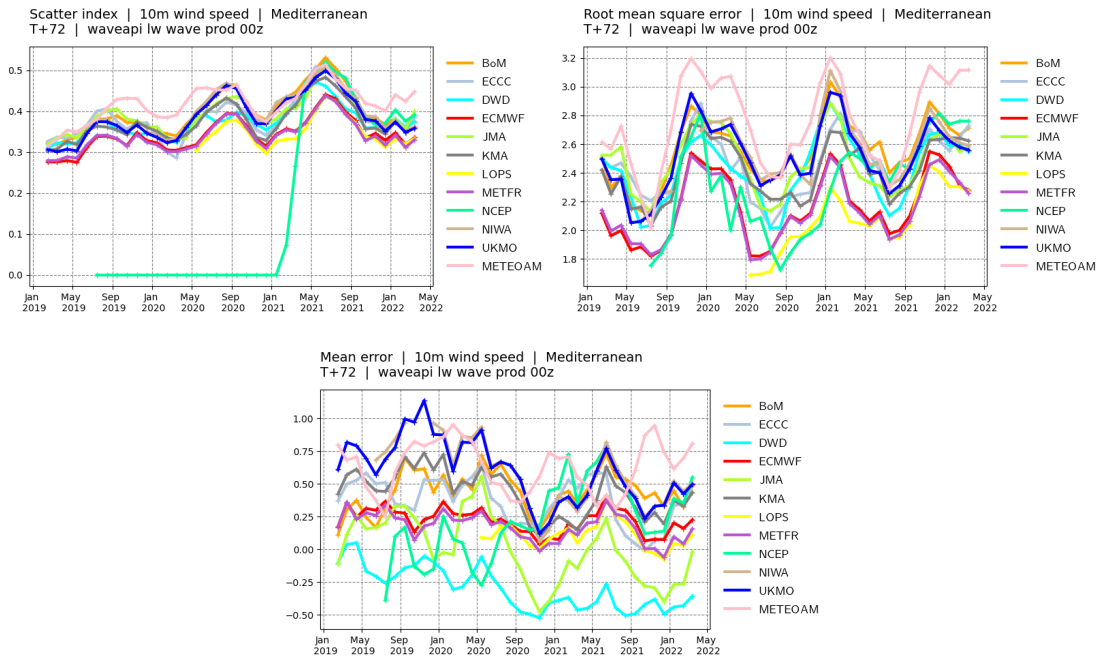
Buoys observations - from 20220301 to 20220530 - (10ff)



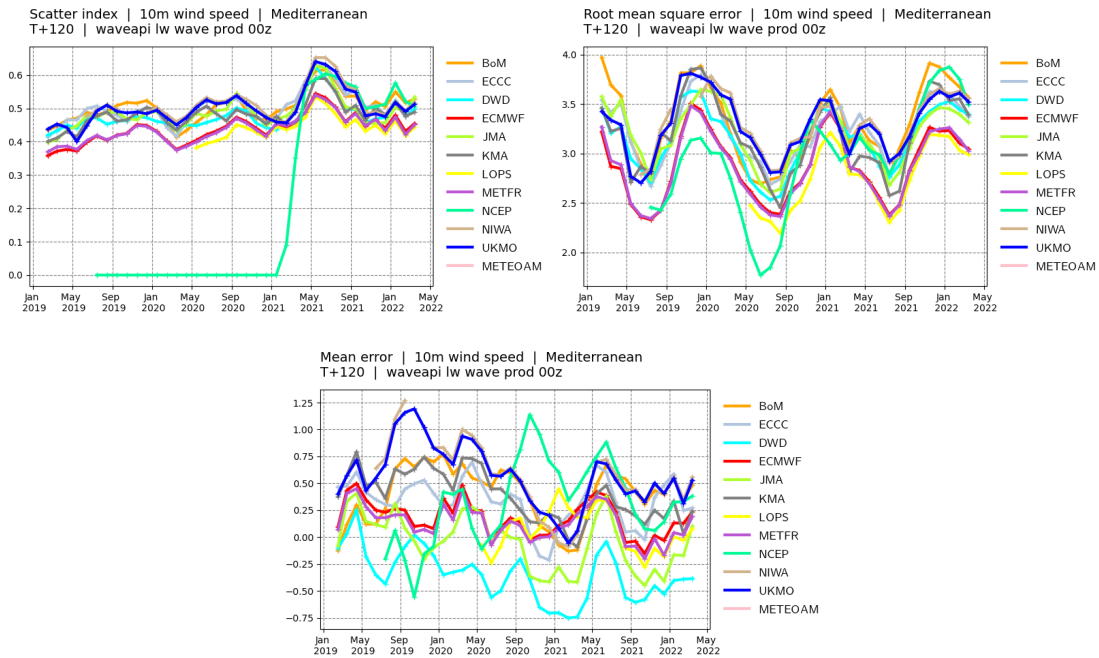
Mediterranean Sea. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



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).

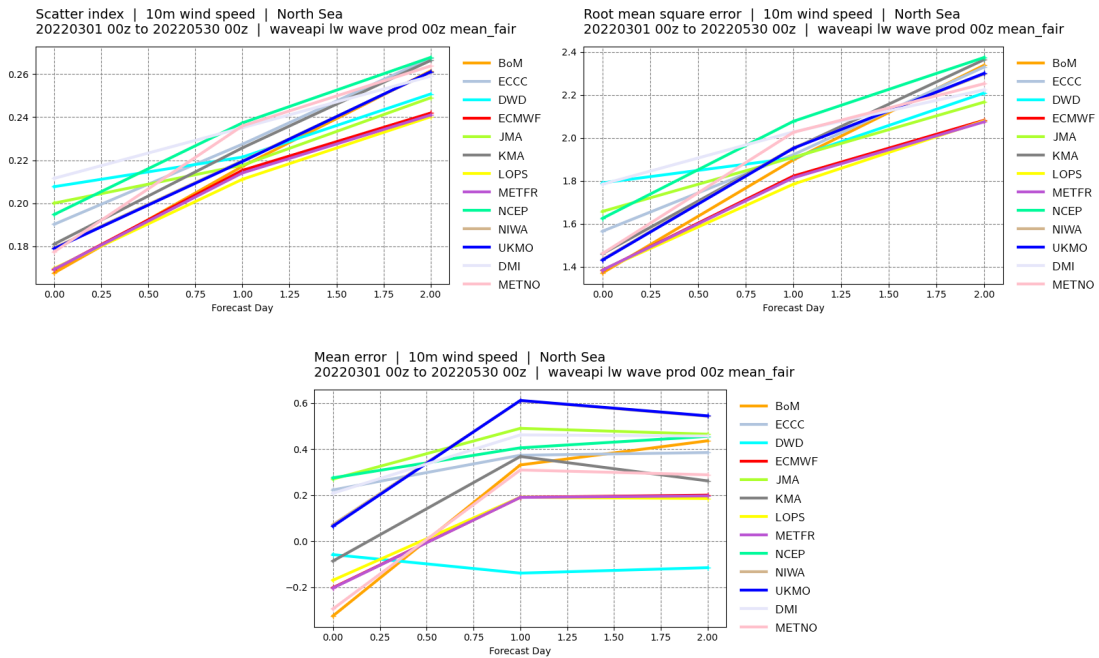
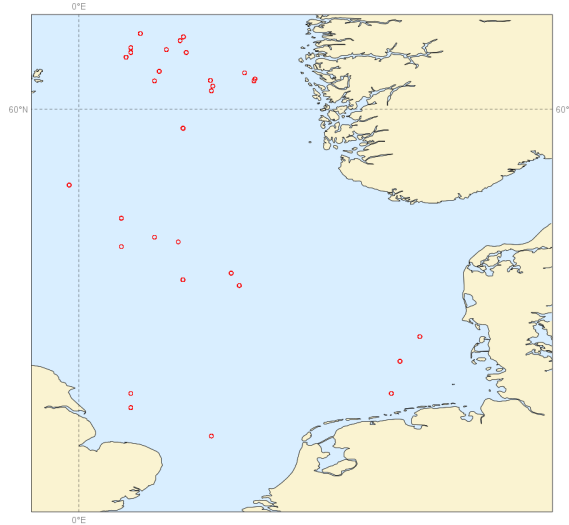


Mediterranean Sea. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

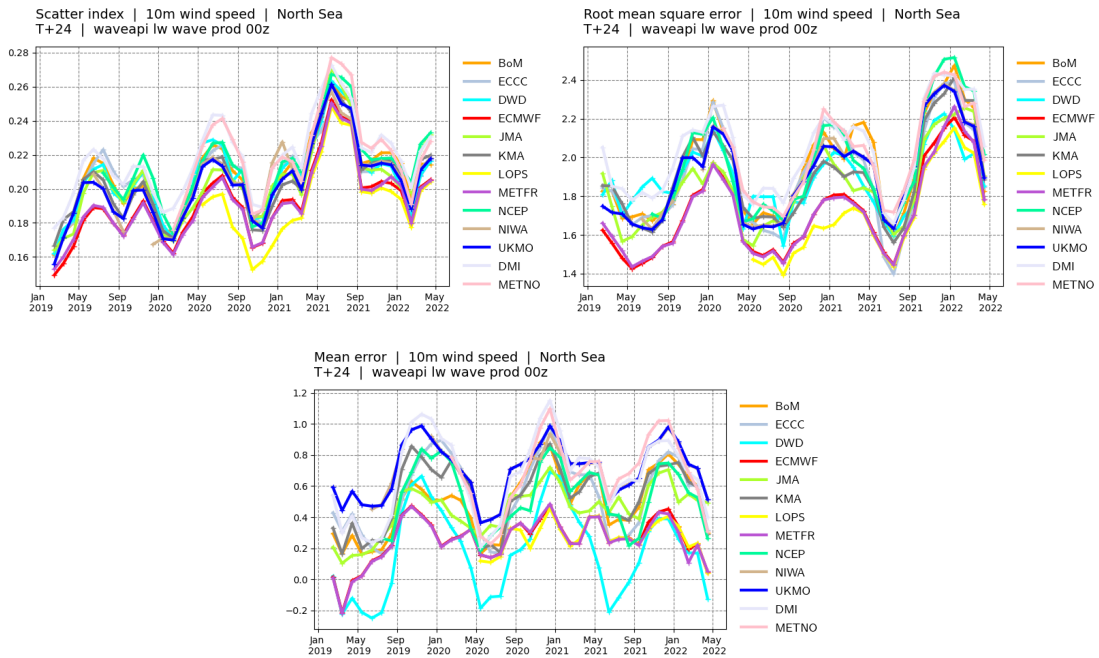


Mediterranean Sea. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

Buoys observations - from 20220301 to 20220530 - (10ff)

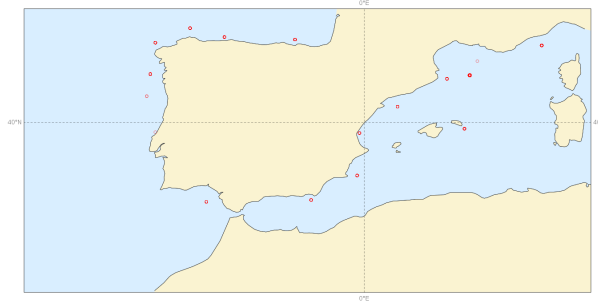


North Sea. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

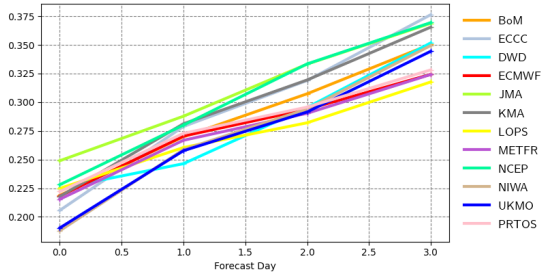


North Sea. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

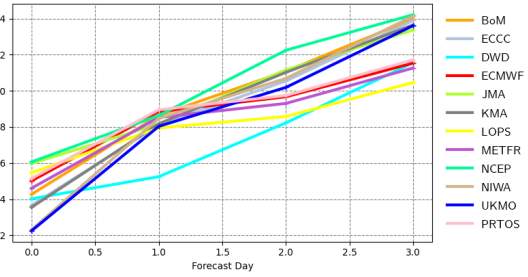
Buoys observations - from 20220301 to 20220530 - (10ff)



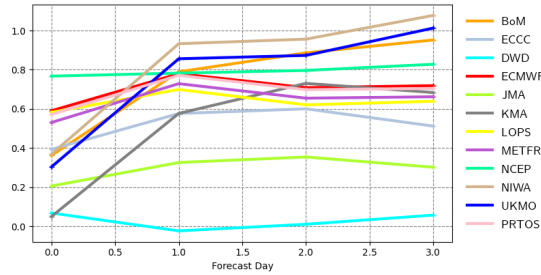
Scatter index | 10m wind speed | SW Europe
20220301 00z to 20220530 00z | waveapi lw wave prod 00z mean_fair



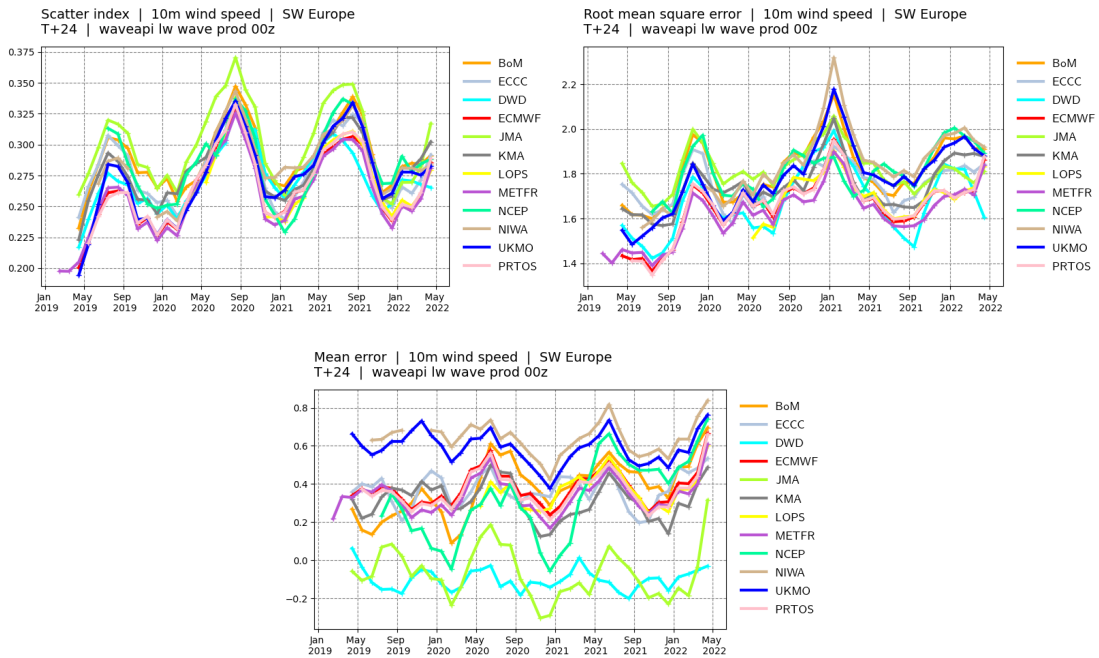
Root mean square error | 10m wind speed | SW Europe
20220301 00z to 20220530 00z | waveapi lw wave prod 00z mean_fair



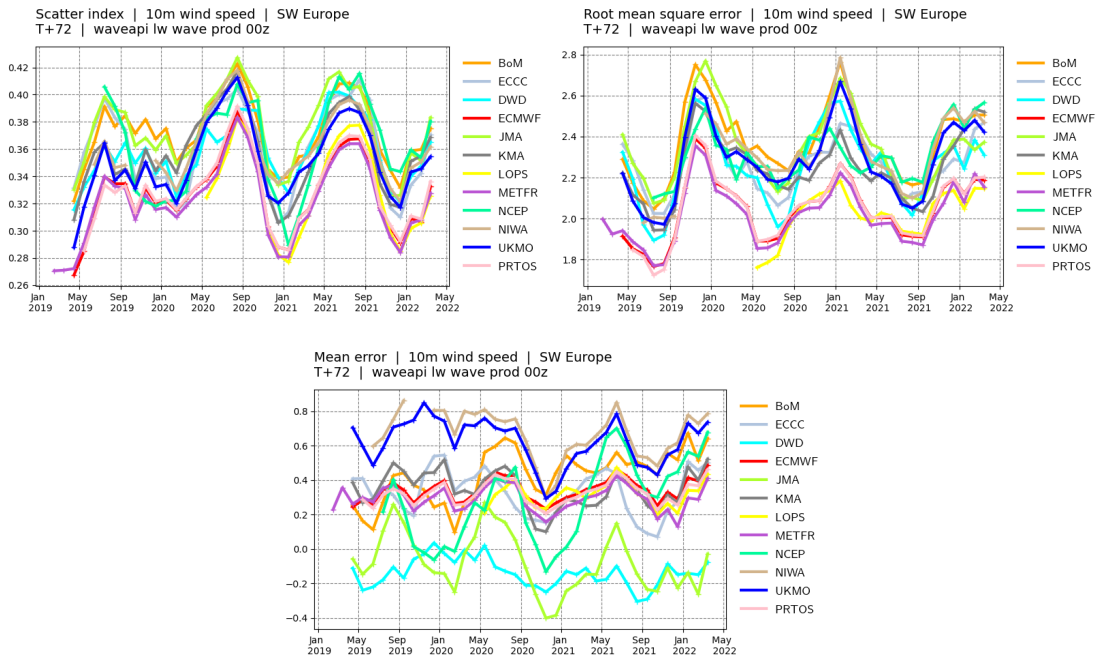
Mean error | 10m wind speed | SW Europe
20220301 00z to 20220530 00z | waveapi lw wave prod 00z mean_fair



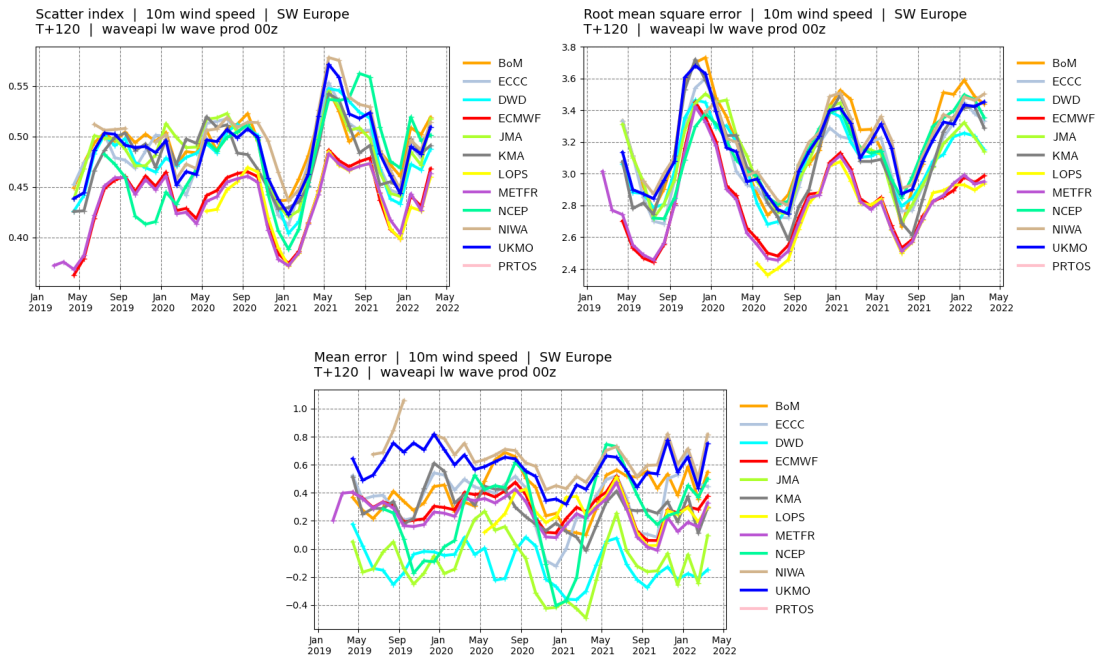
South West Europe. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



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).

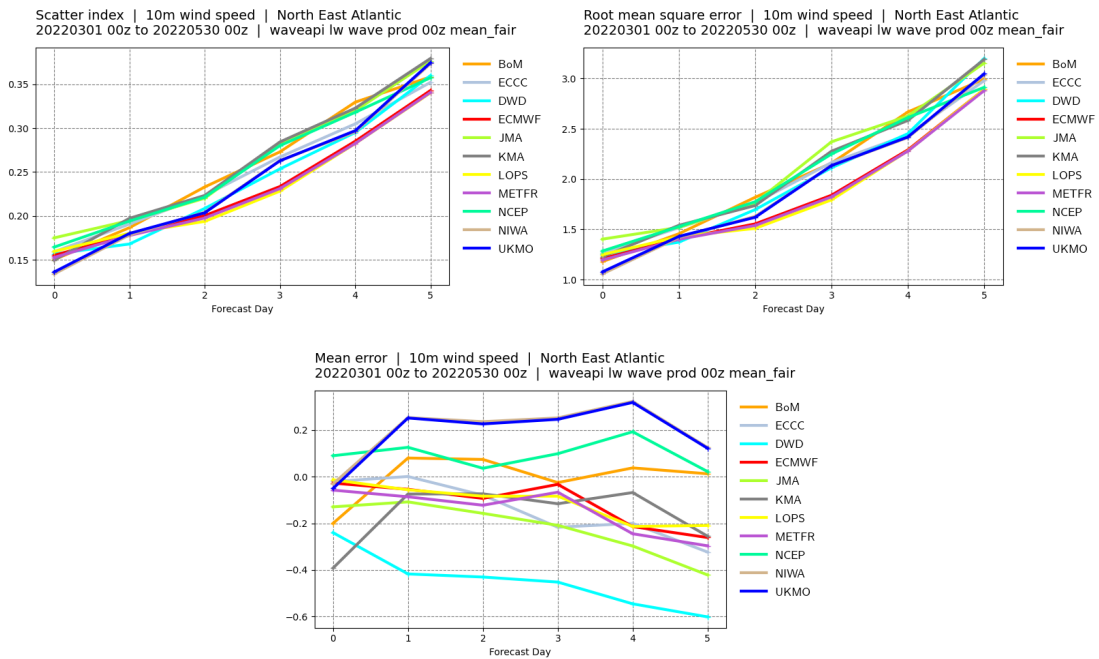
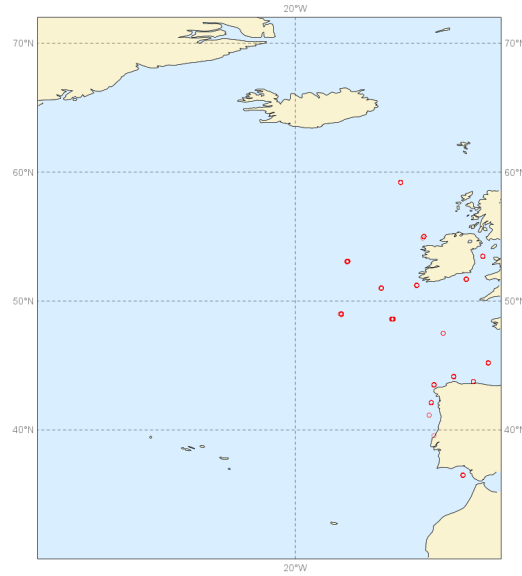


South West Europe. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

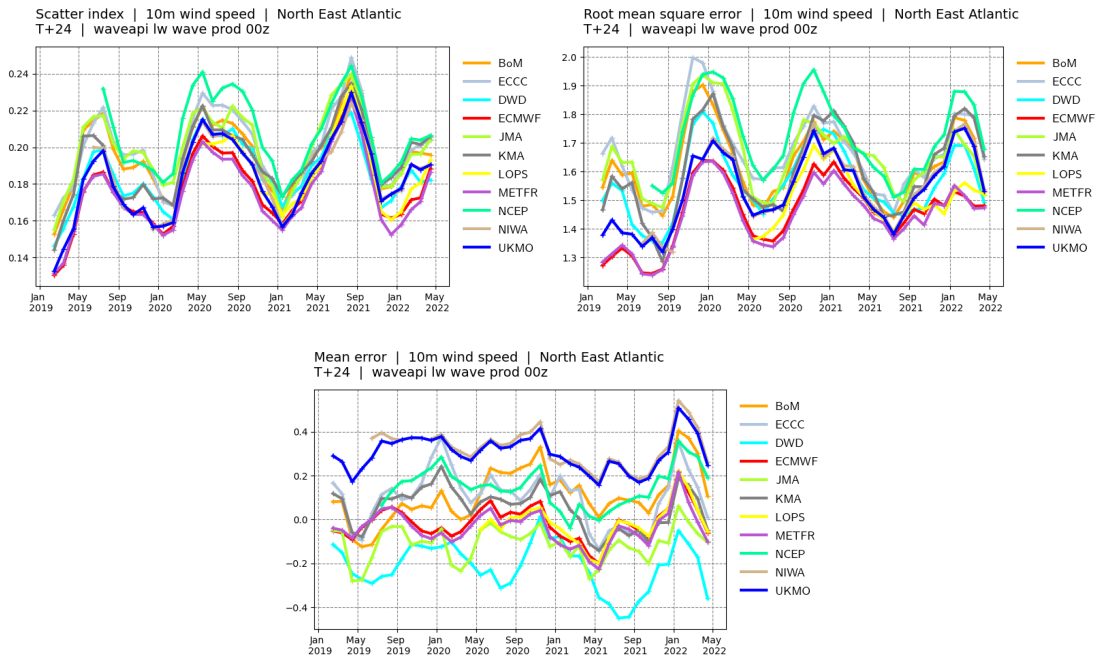


South West Europe. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

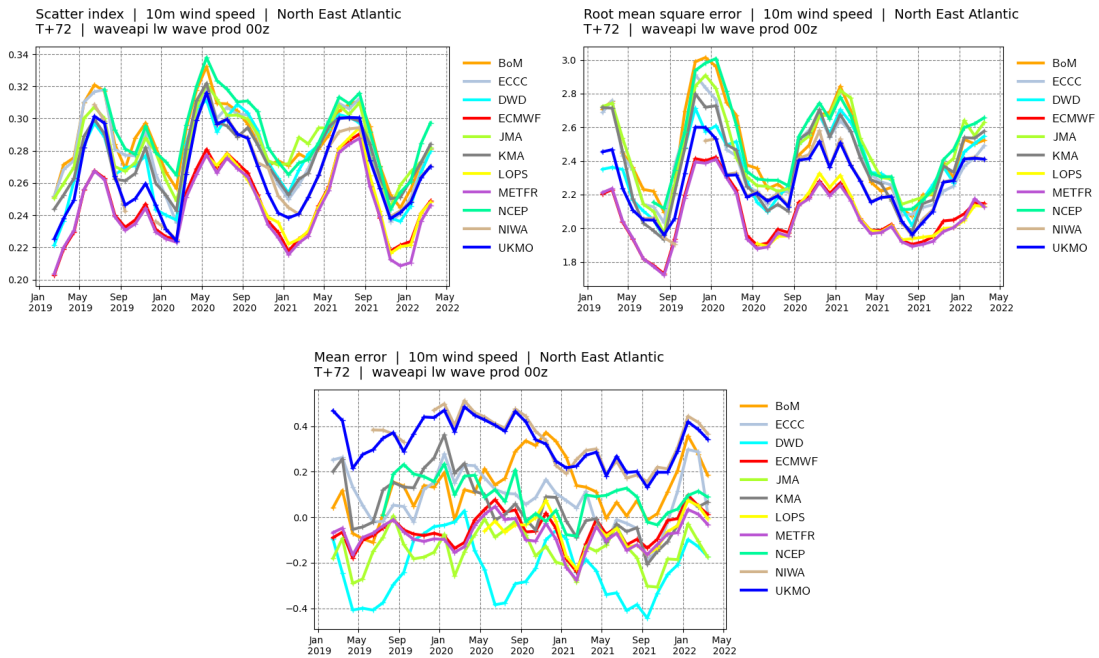
Buoys observations - from 20220301 to 20220530 - (10ff)



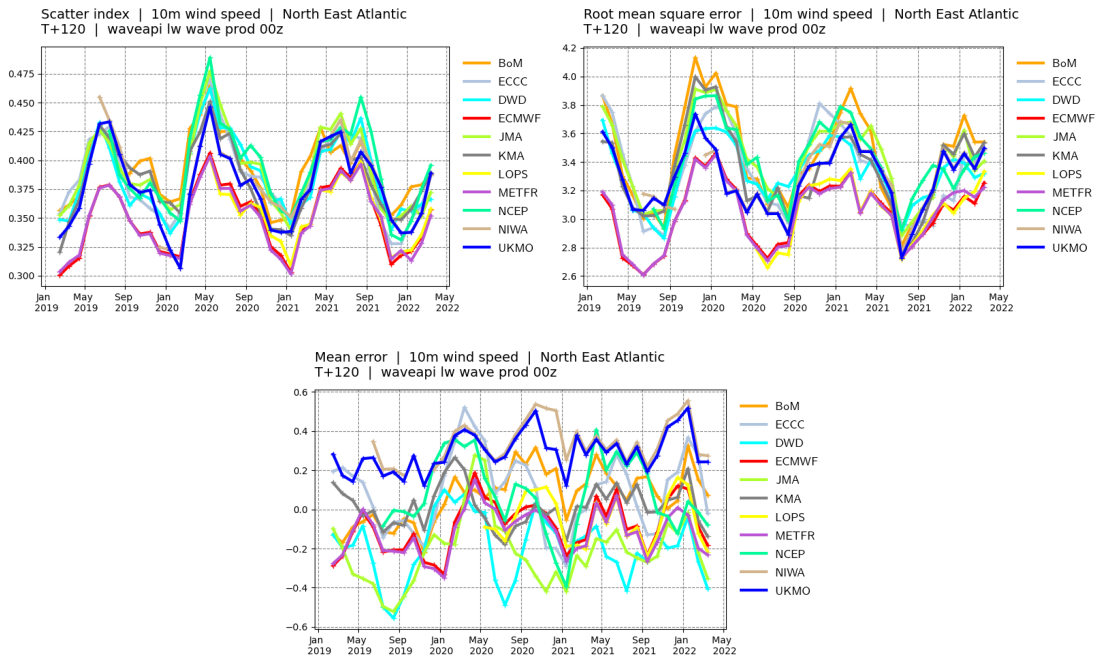
North East Atlantic. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



North East 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).

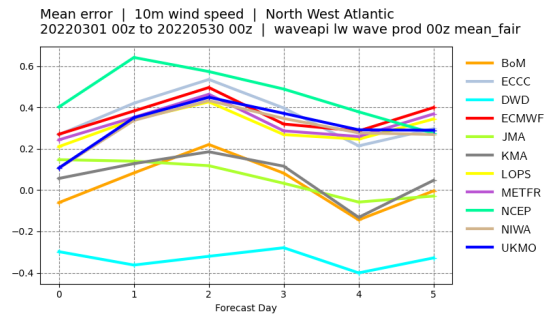
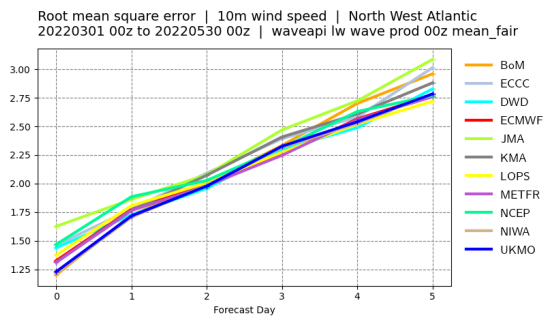
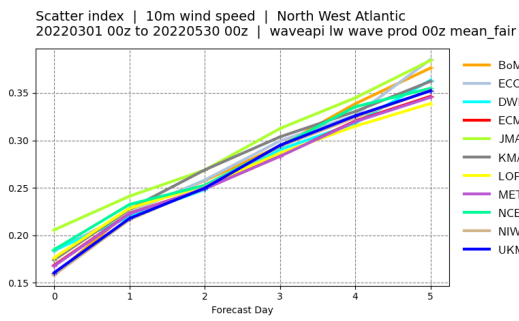
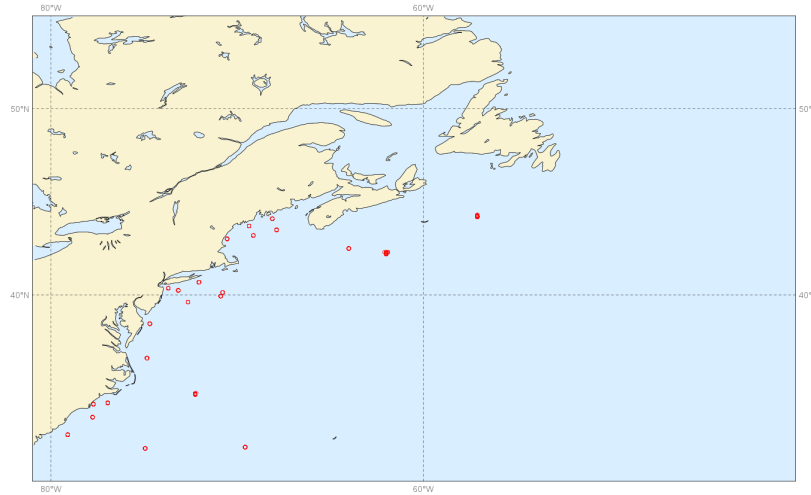


North East Atlantic. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

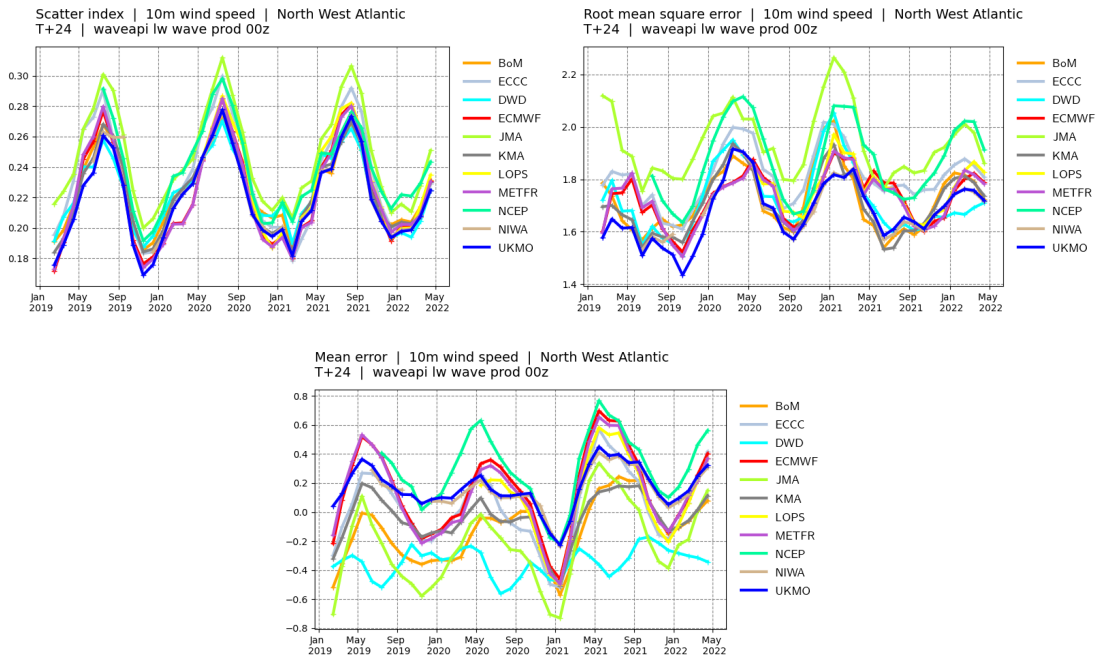


North East Atlantic. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

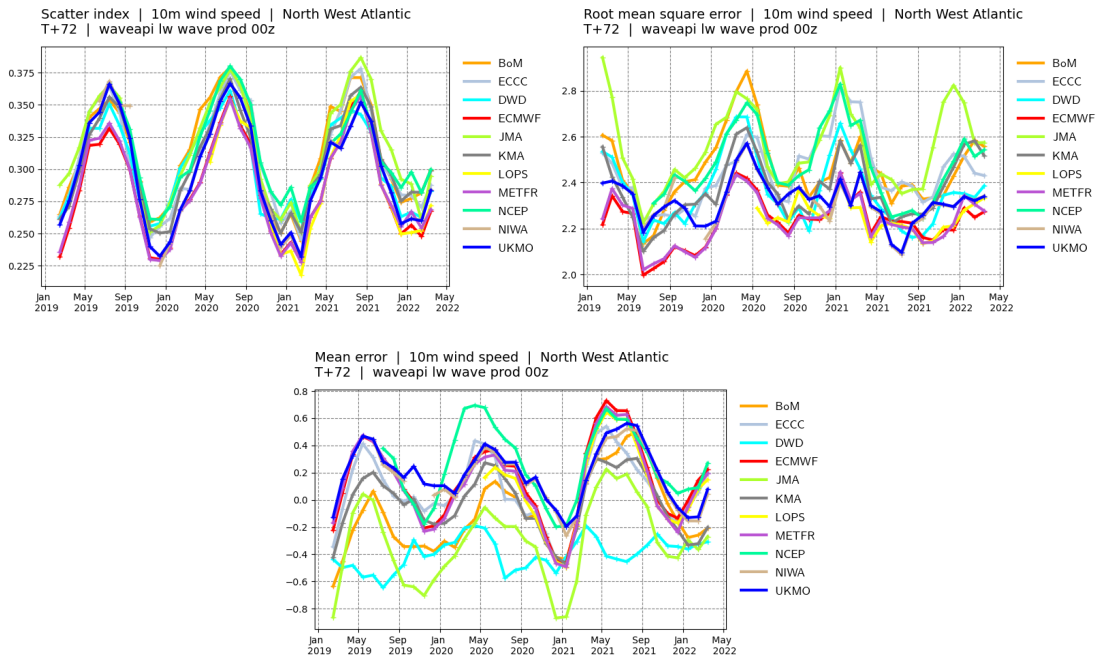
Buoys observations - from 20220301 to 20220530 - (10ff)



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).

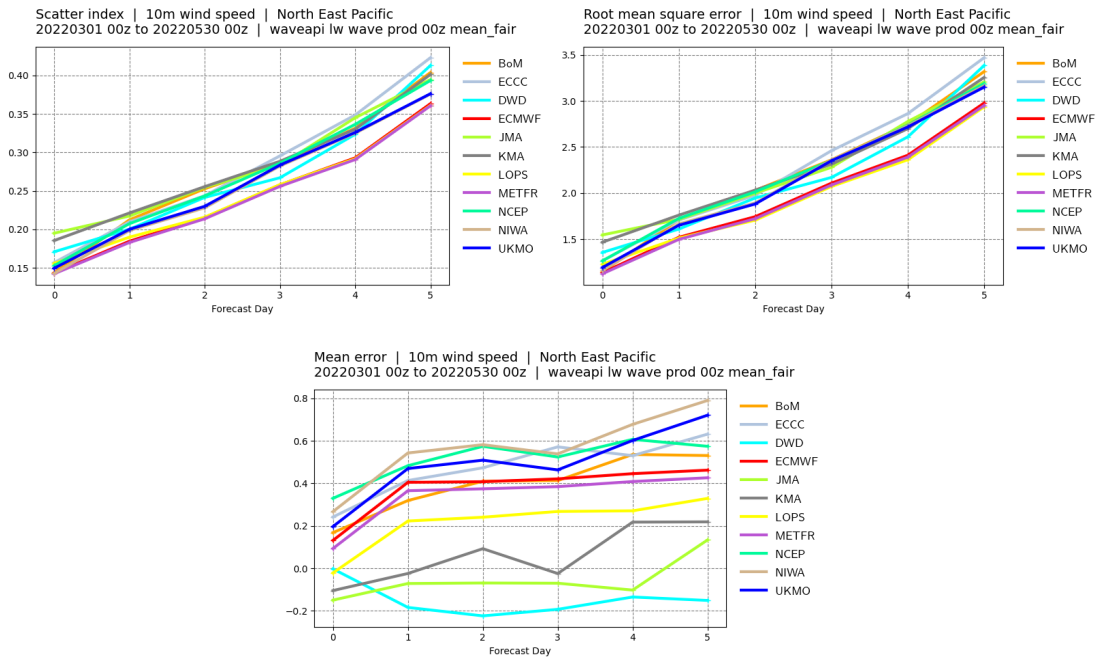
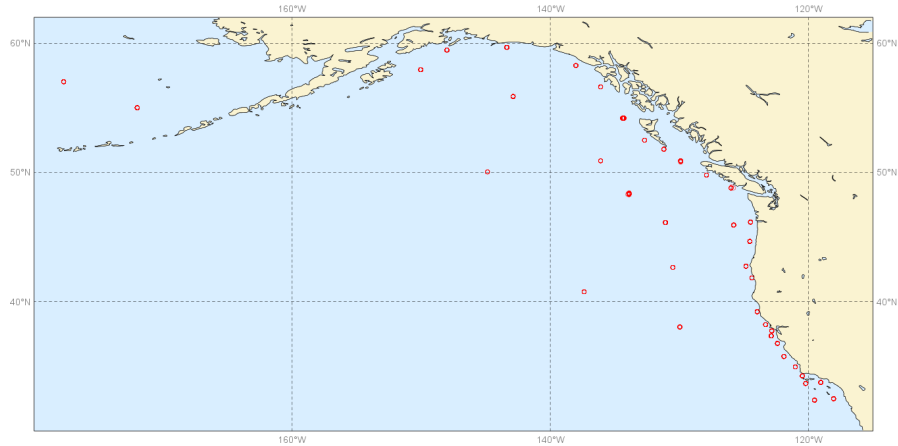


North West Atlantic. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

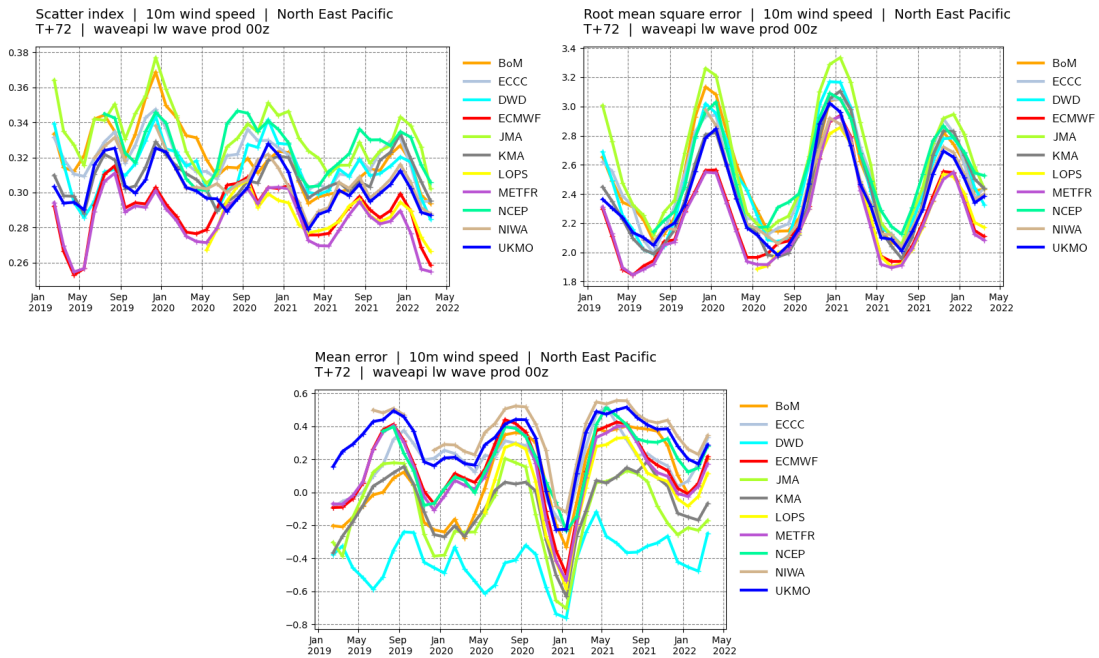


North West Atlantic. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

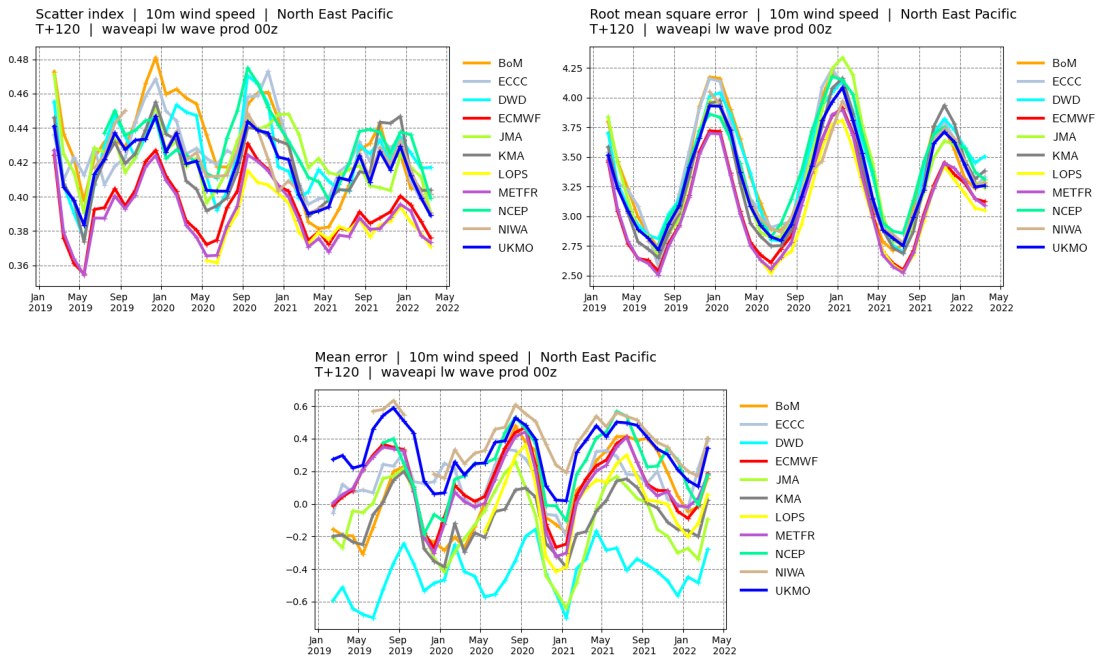
Buoys observations - from 20220301 to 20220530 - (10ff)



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).

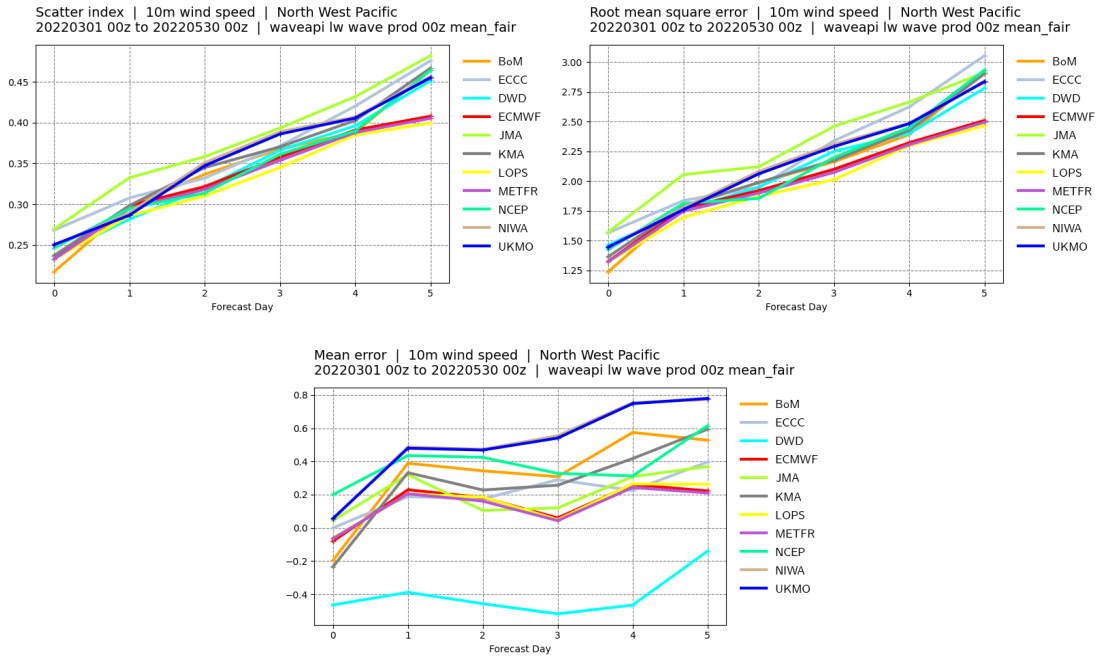
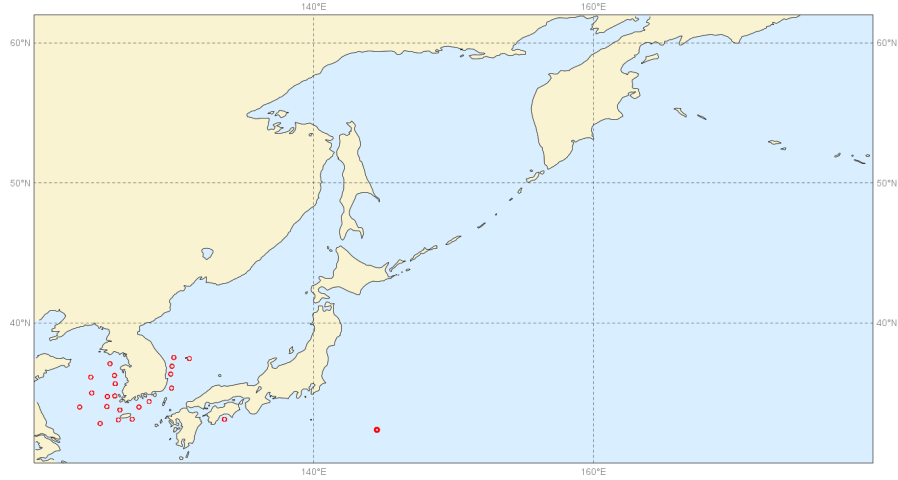


North East Pacific. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

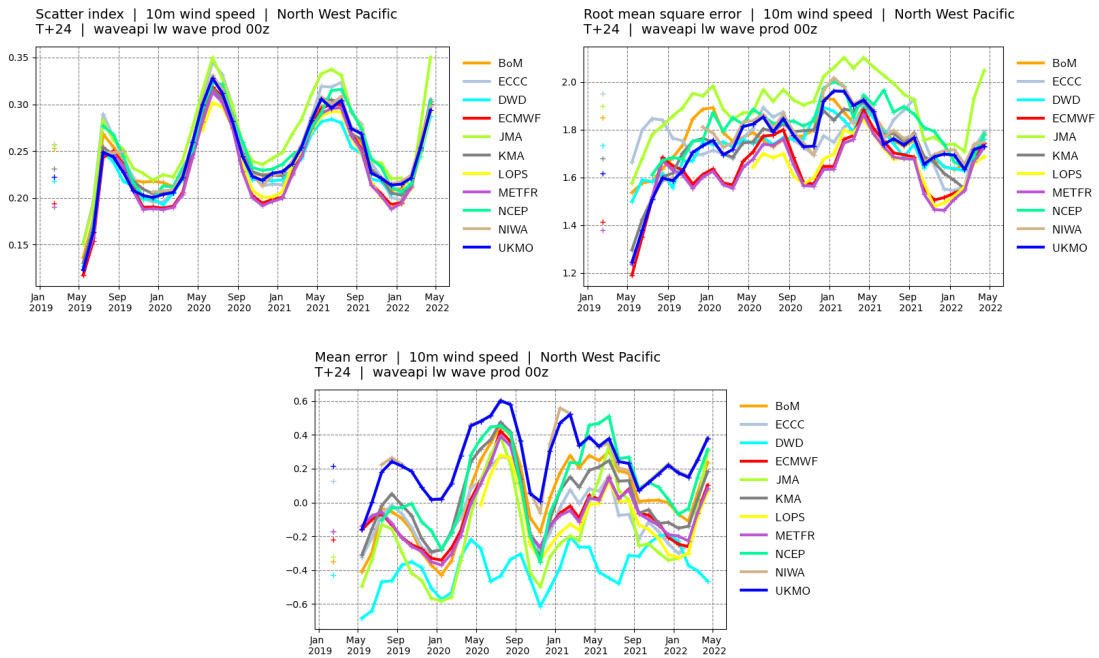


North East Pacific. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

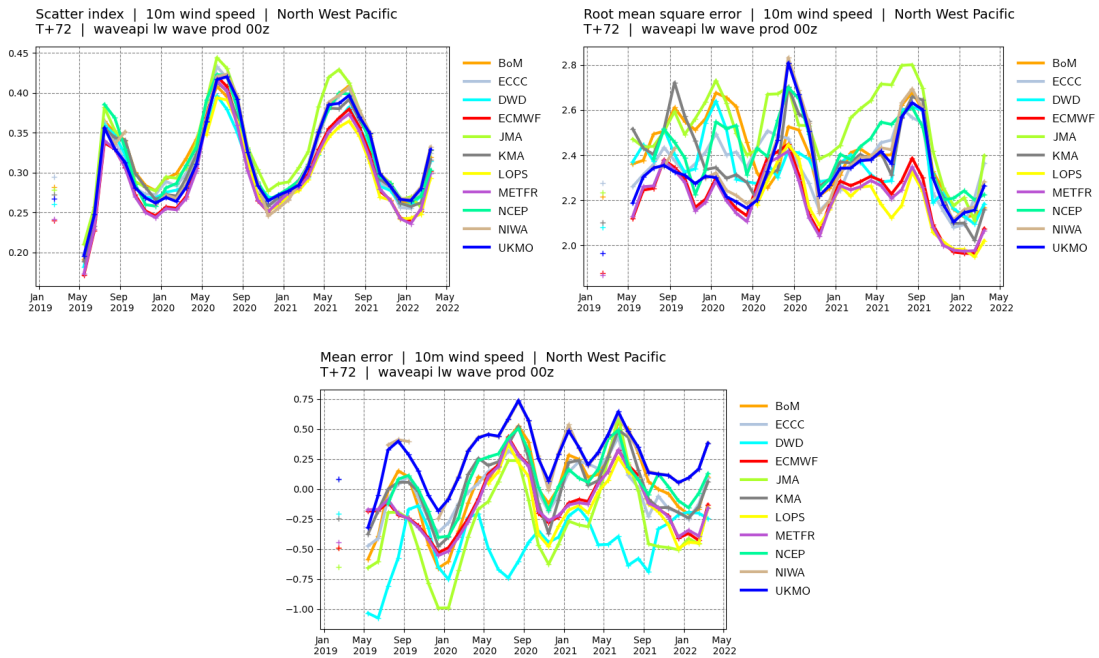
Buoys observations - from 20220301 to 20220530 - (10ff)



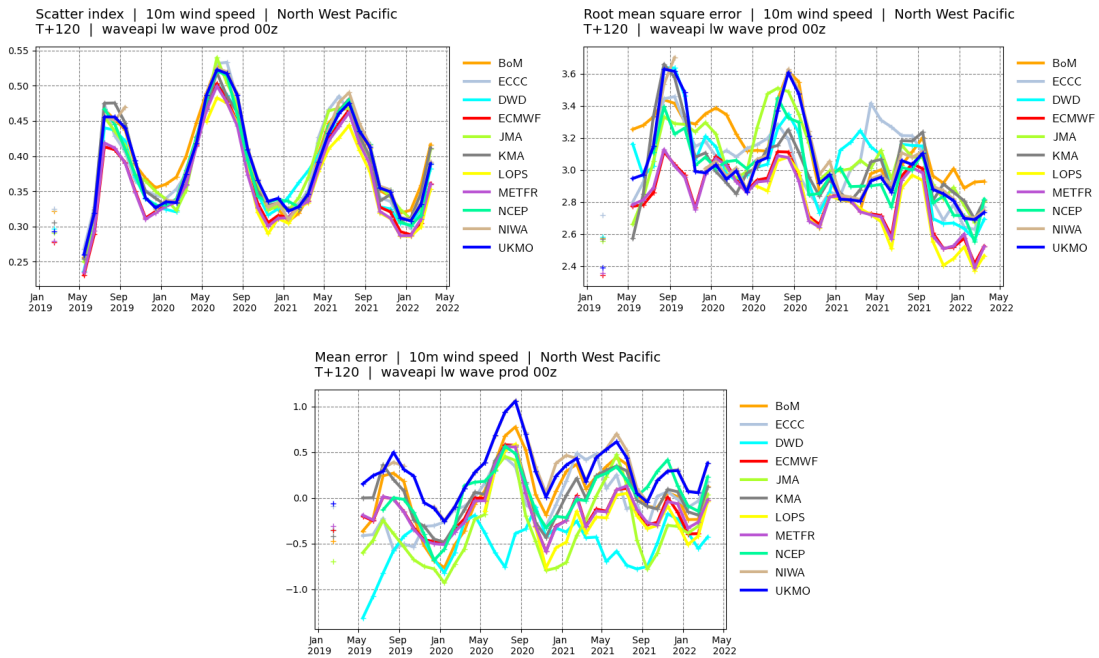
North West Pacific. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



North 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).

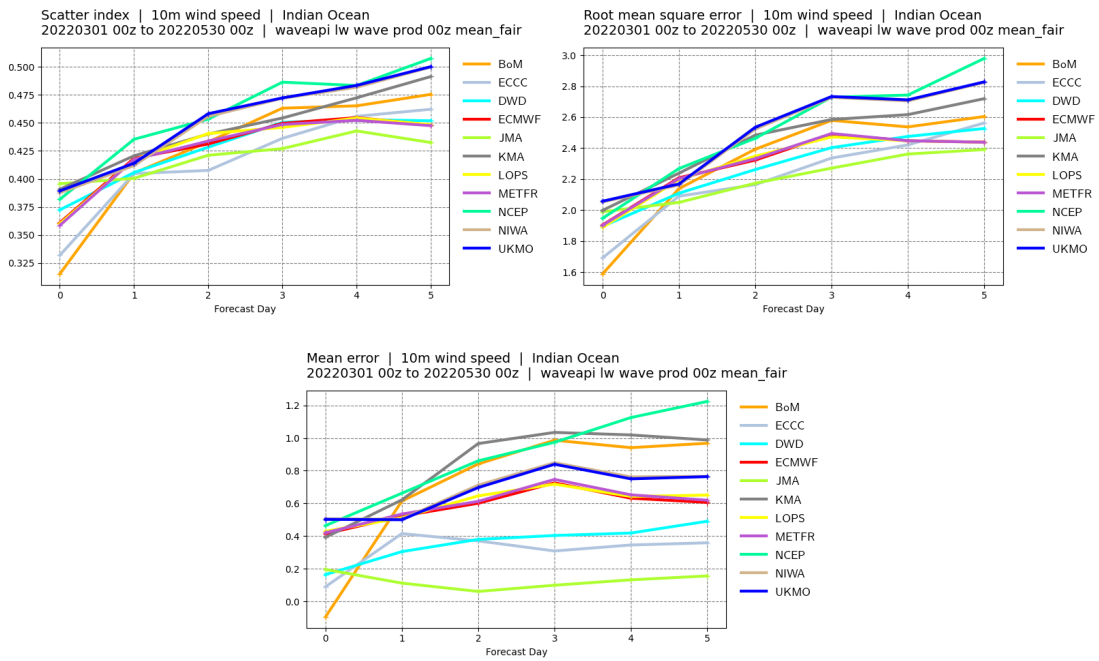
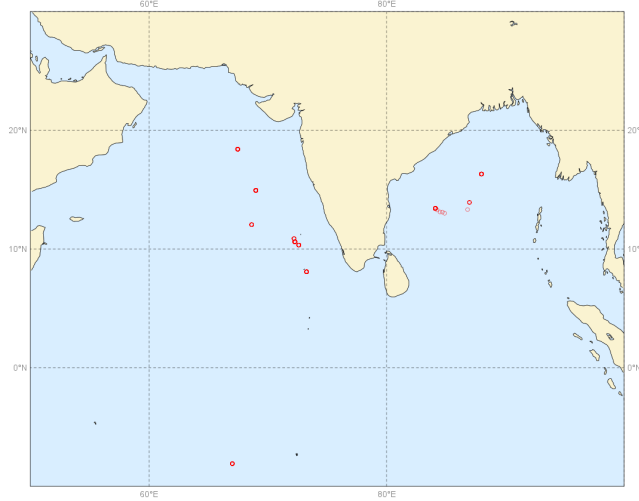


North West Pacific. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

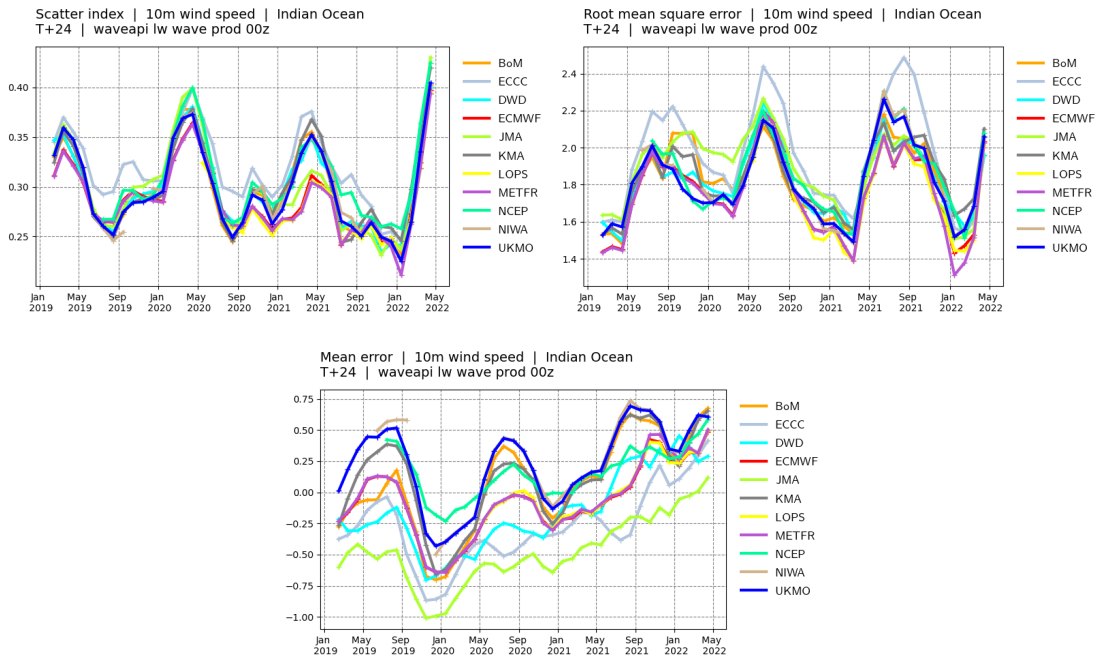


North West Pacific. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

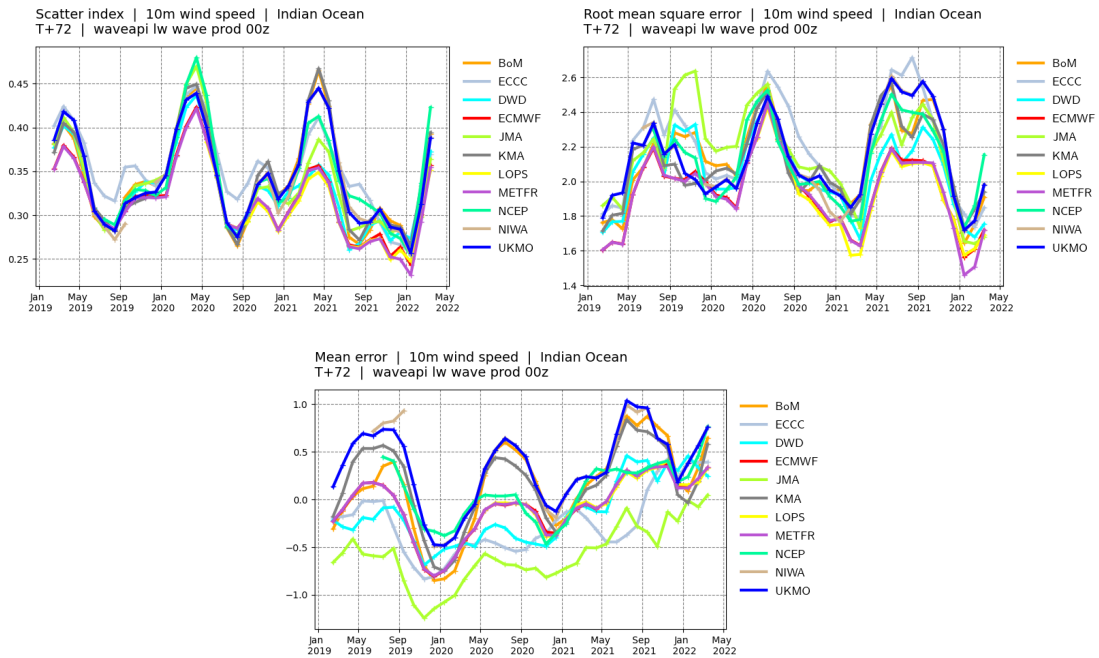
Buoys observations - from 20220301 to 20220530 - (10ff)



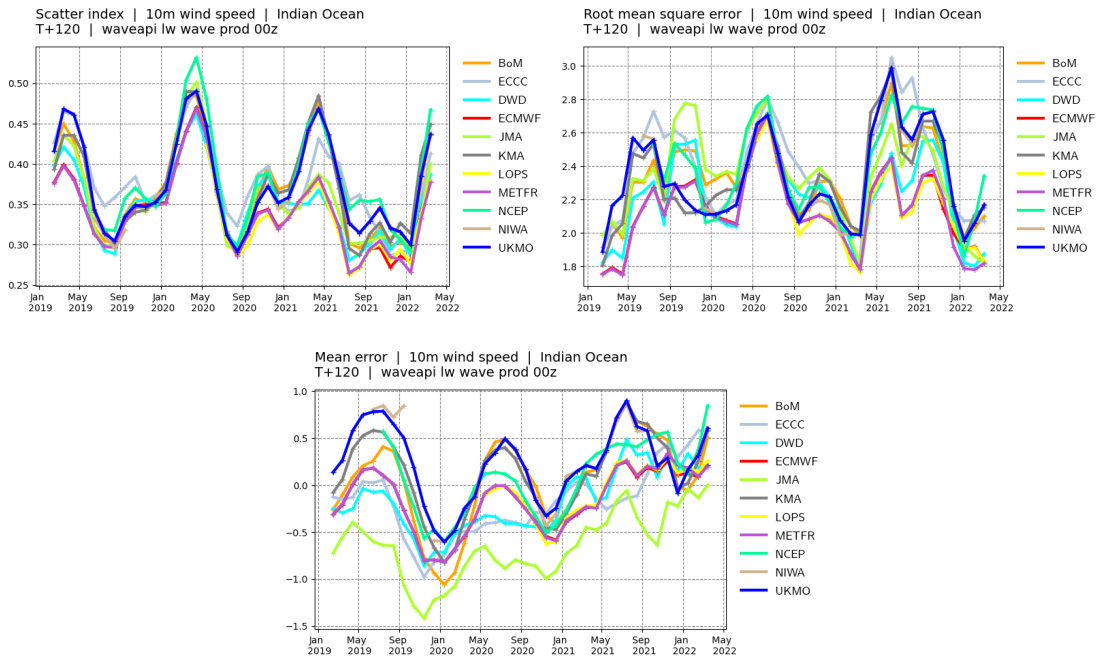
Indian Ocean. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



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).

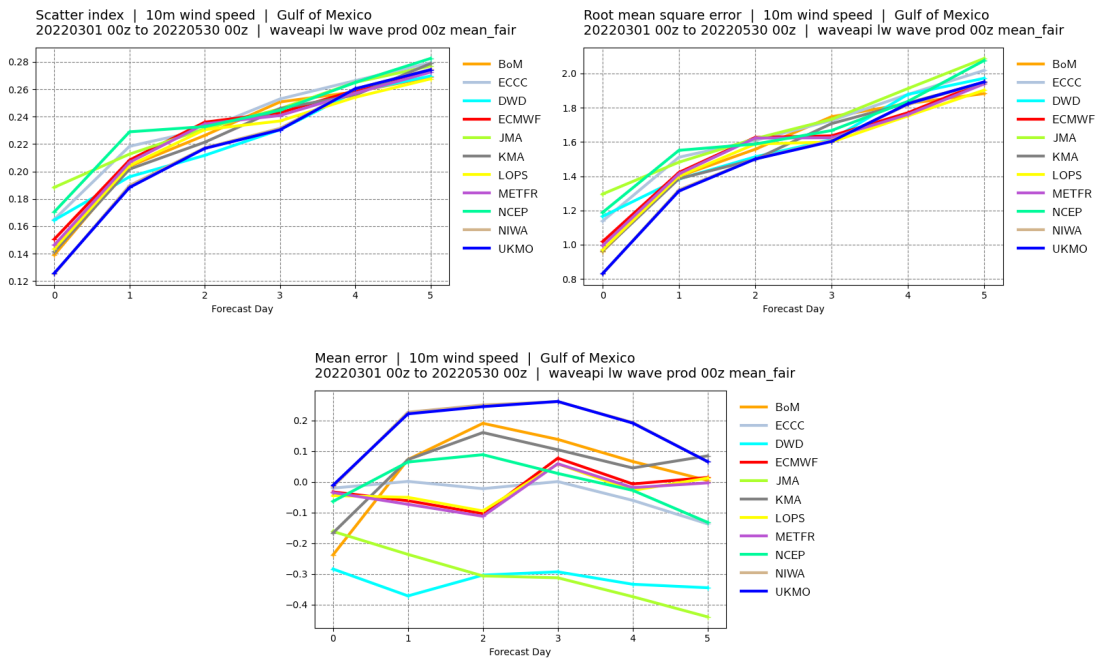
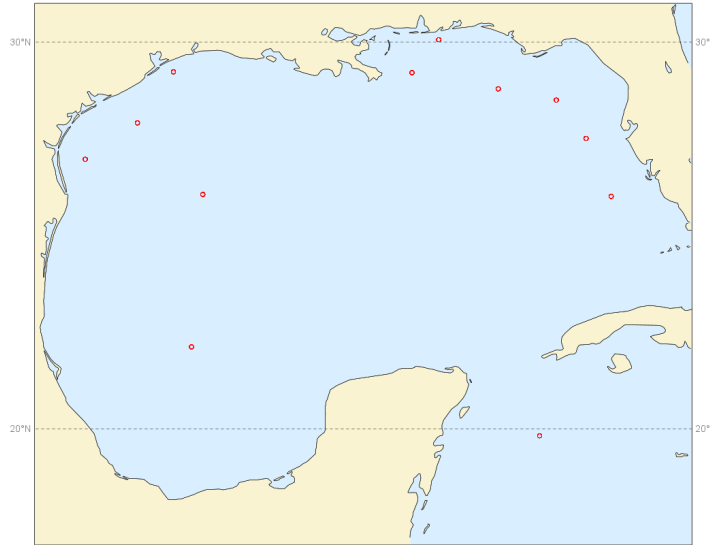


Indian Ocean. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

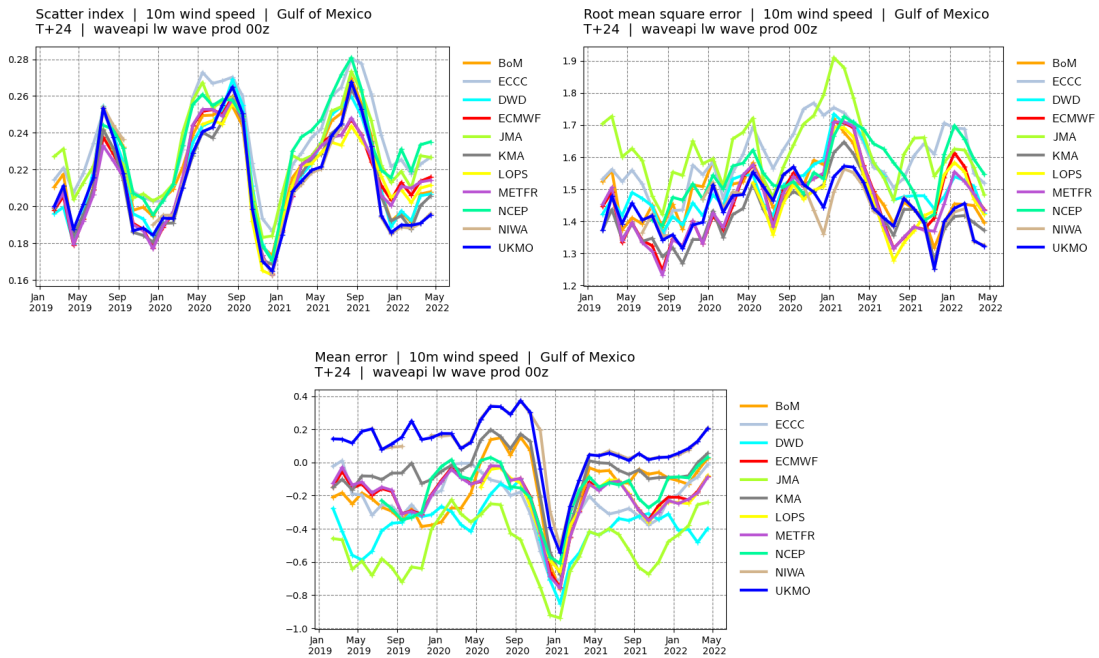


Indian Ocean. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

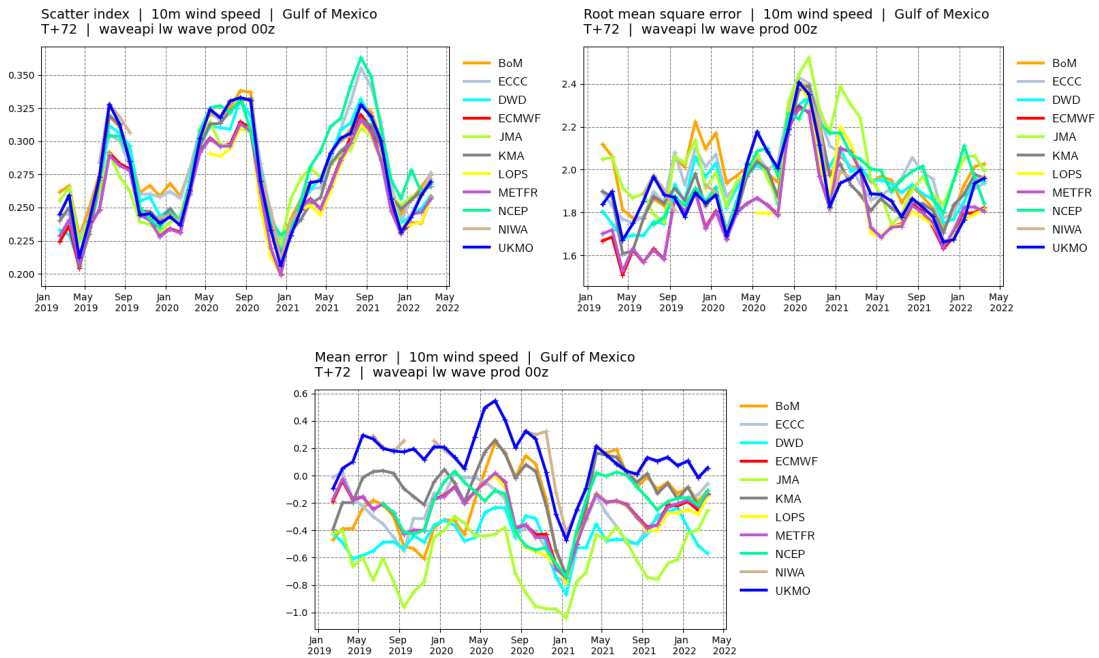
Buoys observations - from 20220301 to 20220530 - (10ff)



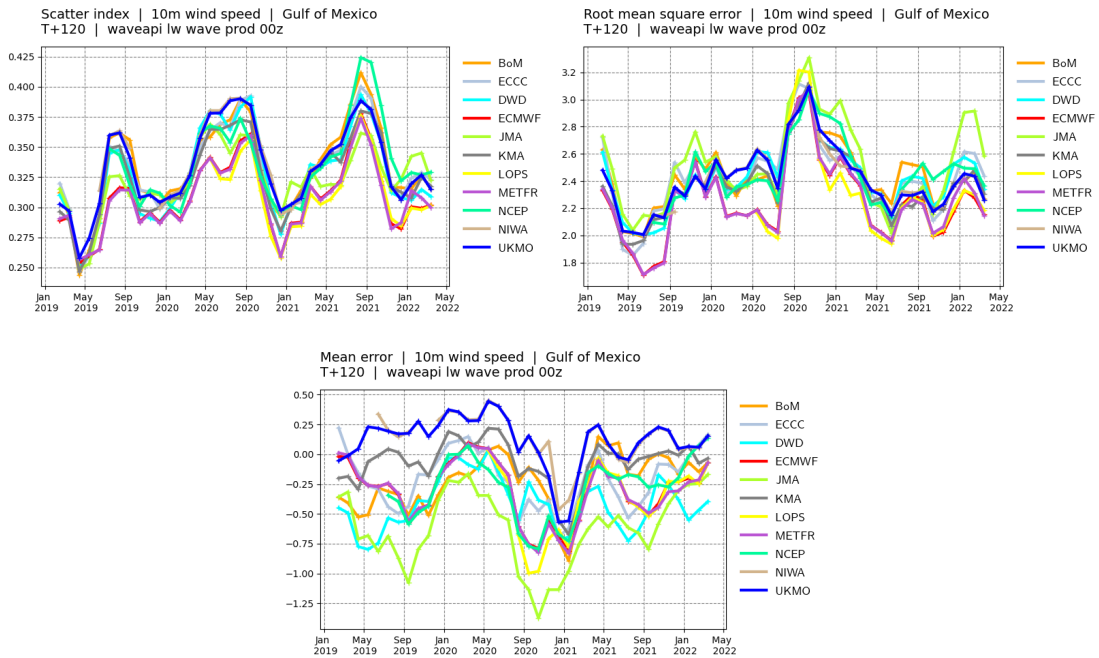
Gulf of Mexico. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



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).

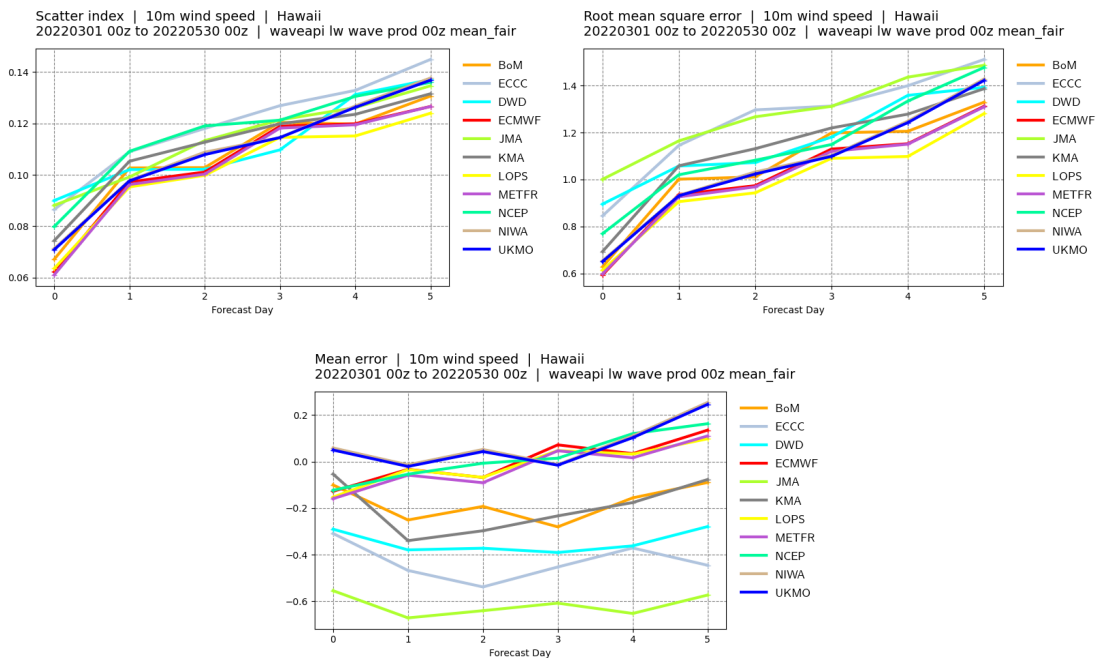
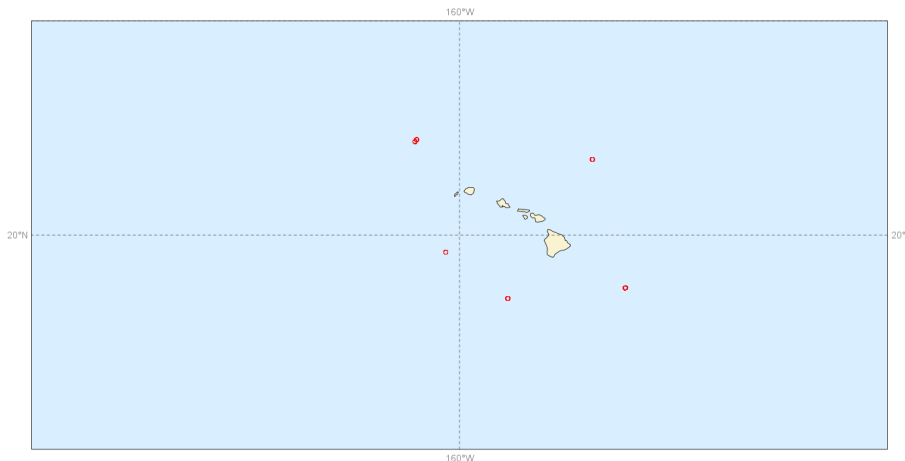


Gulf of Mexico. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

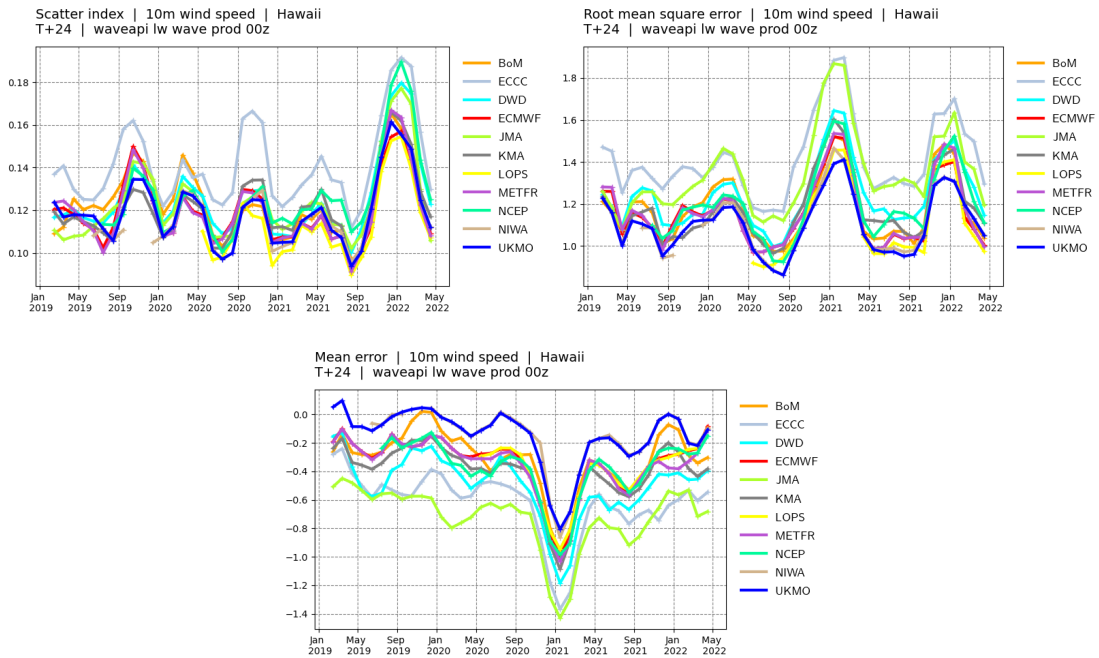


Gulf of Mexico. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

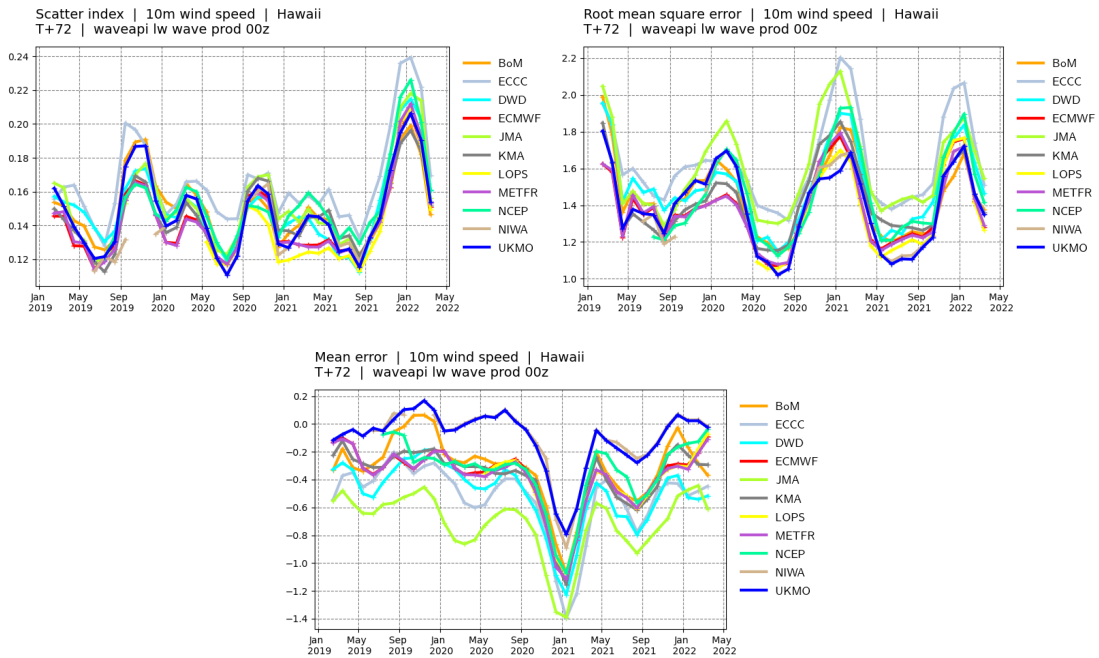
Buoys observations - from 20220301 to 20220530 - (10ff)



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).

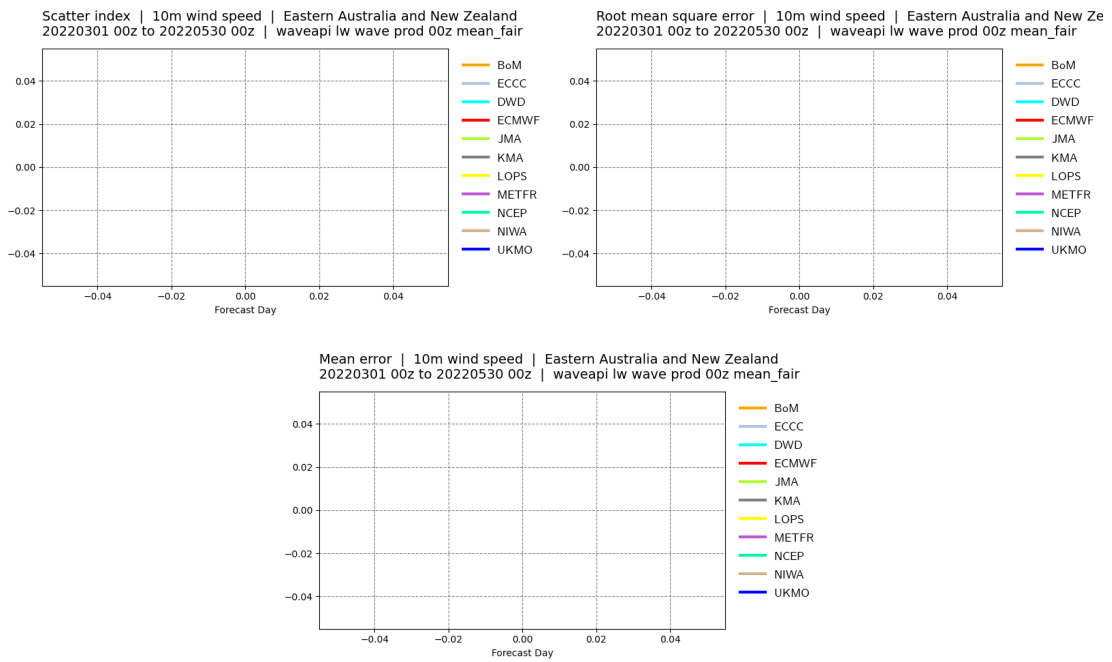
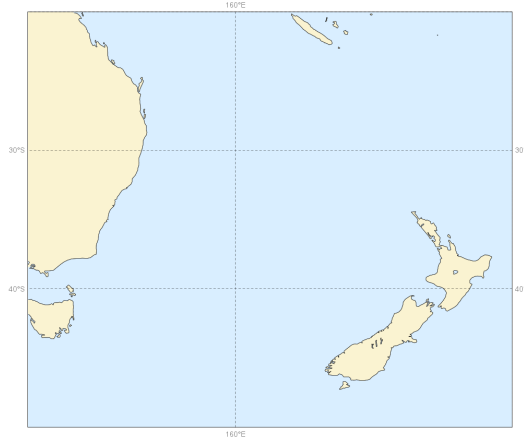


Hawaii. Scores time-series at **day 1**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

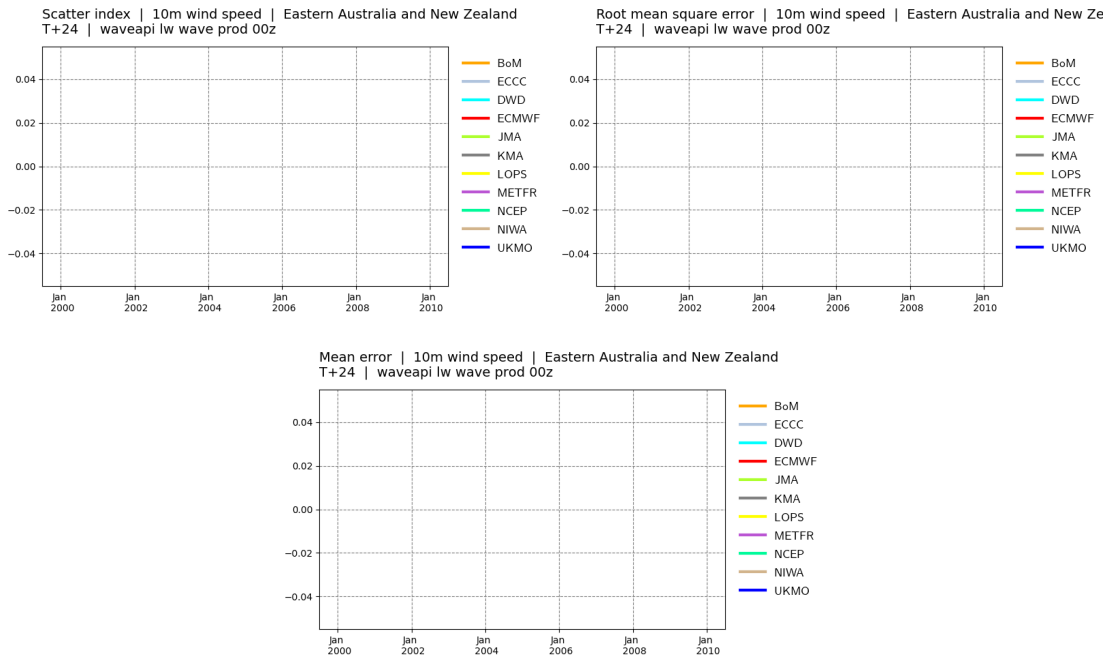


Hawaii. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

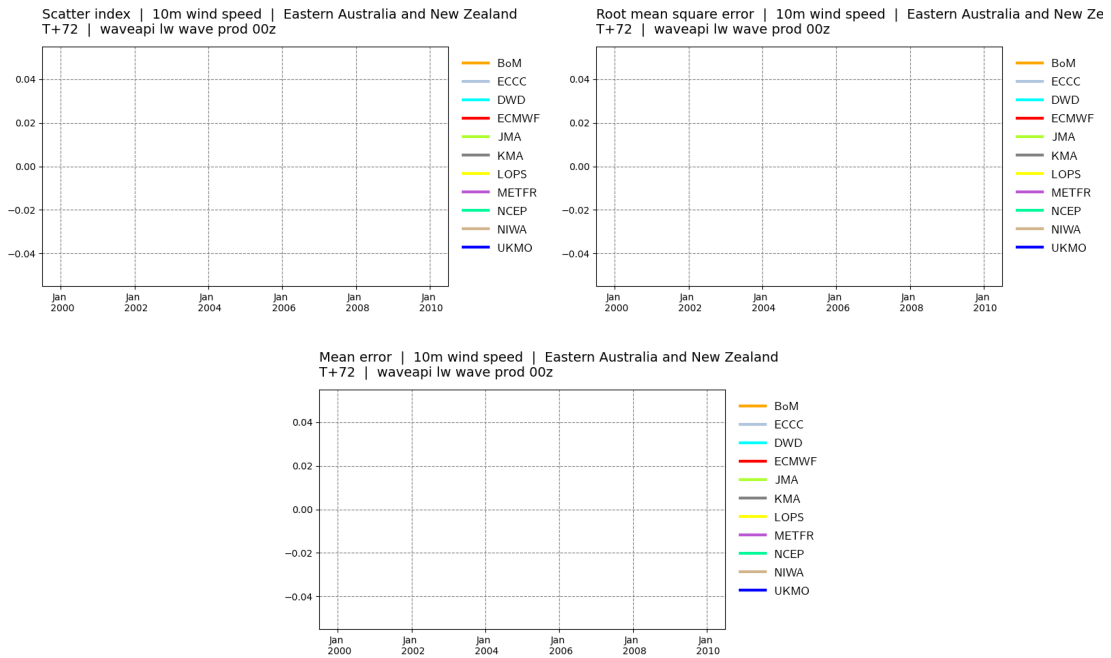
Buoys observations - from 20220301 to 20220530 - (10ff)



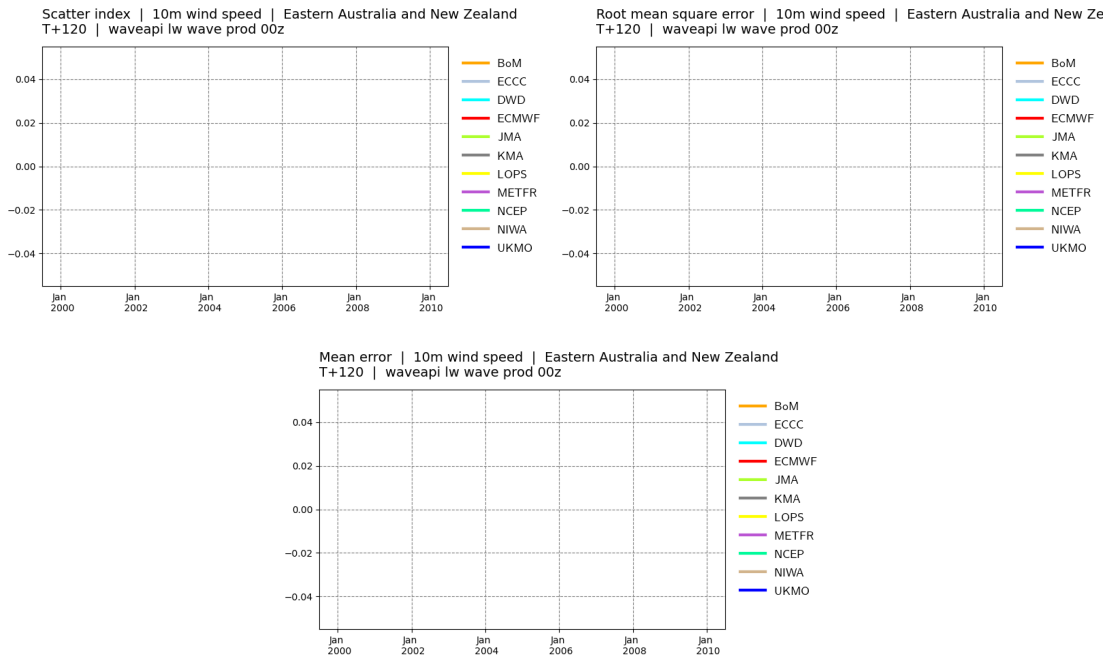
East Australia - New Zealand. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



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).

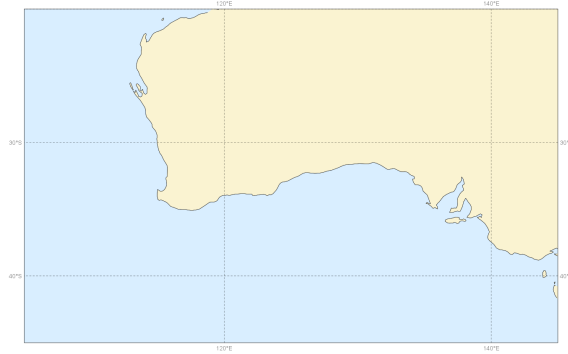


East Australia - New Zealand. Scores time-series at **day 3**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

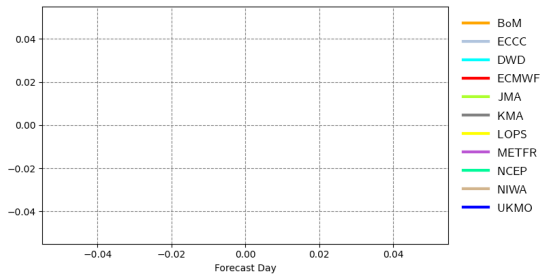


East Australia - New Zealand. Scores time-series at **day 5**. Top left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Top right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).

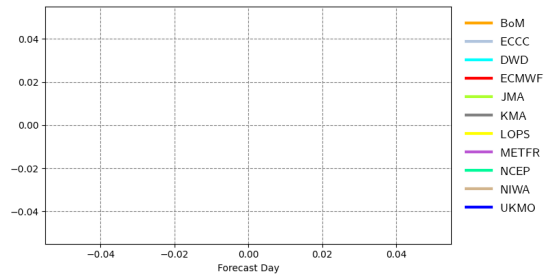
Buoys observations - from 20220301 to 20220530 - (10f)



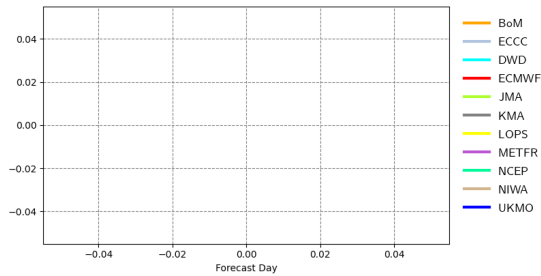
Scatter index | 10m wind speed | South Southwestern Australia
20220301 00z to 20220530 00z | waveapi lw wave prod 00z mean_fair



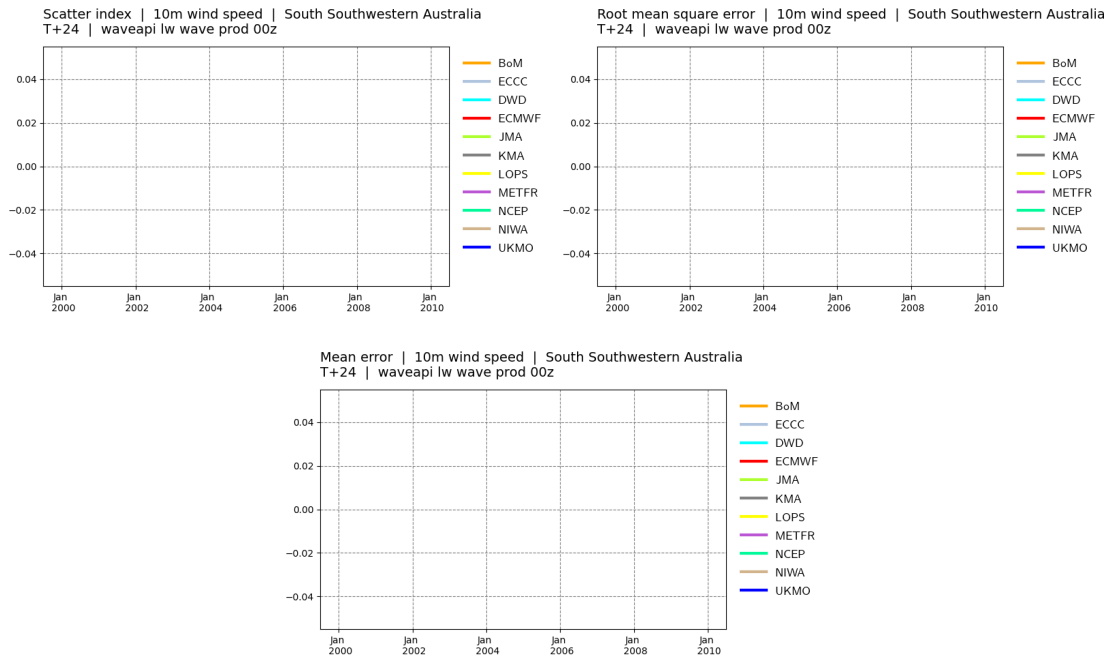
Root mean square error | 10m wind speed | South Southwestern Australia
20220301 00z to 20220530 00z | waveapi lw wave prod 00z mean_fair



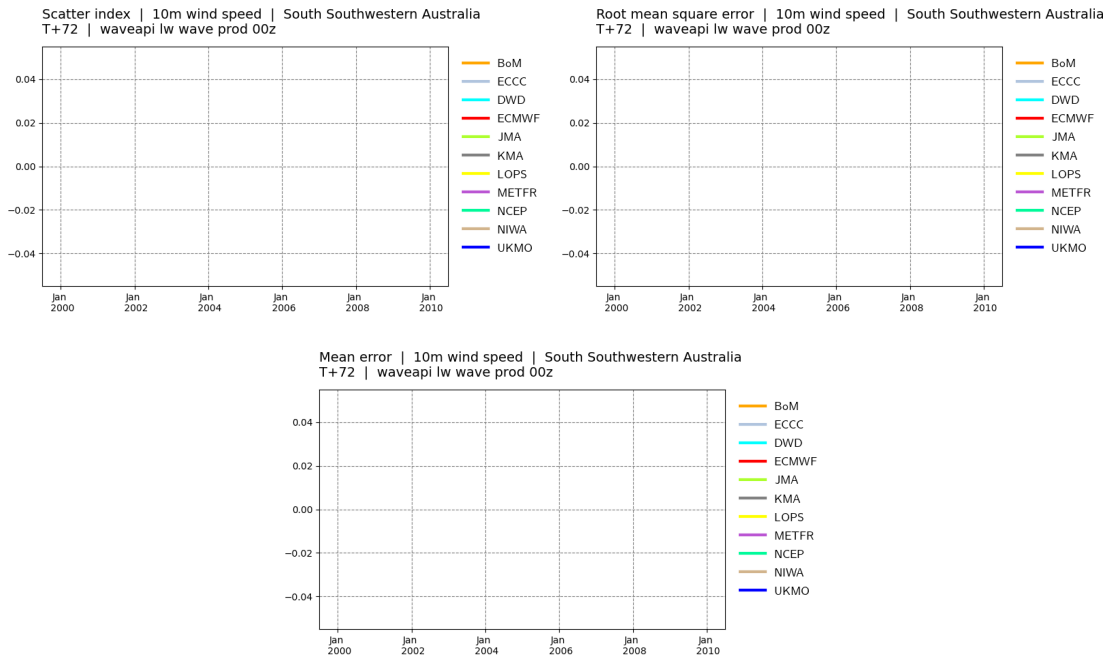
Mean error | 10m wind speed | South Southwestern Australia
20220301 00z to 20220530 00z | waveapi lw wave prod 00z mean_fair



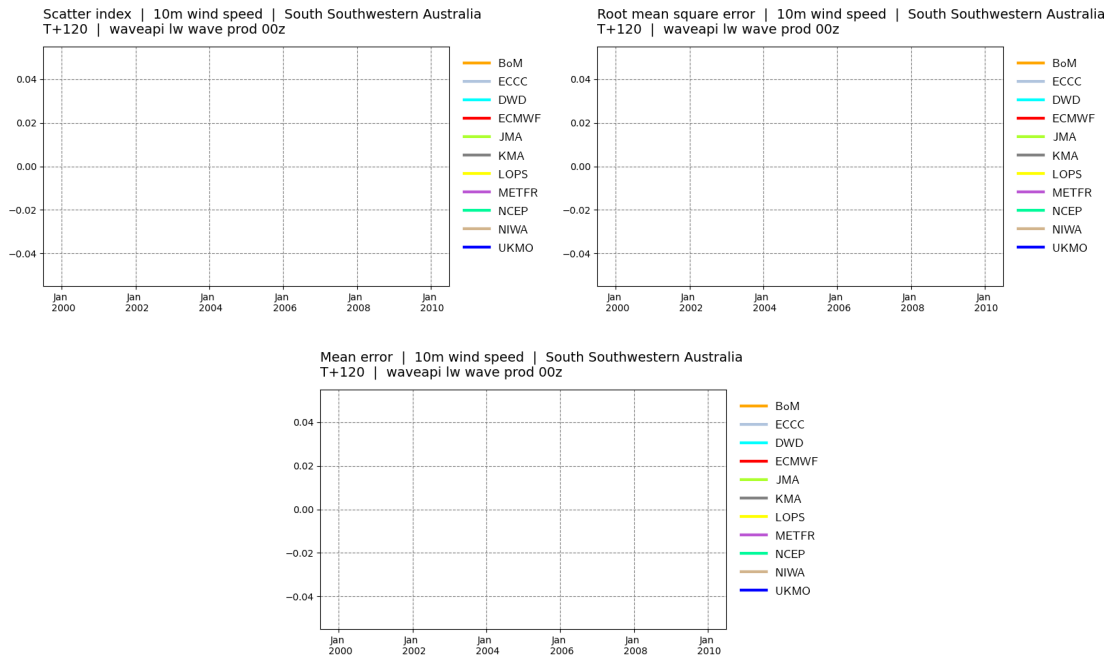
South South West Australia. Top panel: observation distribution. Middle left panel: Forecast scatter index (standard deviation of the difference normalised by the mean of the observations). Middle right panel: Forecast root mean square error (RMSE). Bottom panel: forecast mean error (bias).



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).