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On the improvement of high resolution AROME winds for operational wave forecast under cyclonic conditions : validation with altimeters wave data

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MOTIVATION:

Wind forcing at the ocean surface plays a key role for catching accurate initial conditions of wind waves and swell propagation in cyclonic conditions. To this end the upgraded high resolution atmospheric model AROME-OM of MF dedicated for regional domains (west-indies and La Reunion) will be upgraded in September 2017.

In this version the AROME-OM model is forced by 1-D ocean mixed layer (referred to as 1-D OML) with initial conditions of SST from the Mercator-Ocean model.

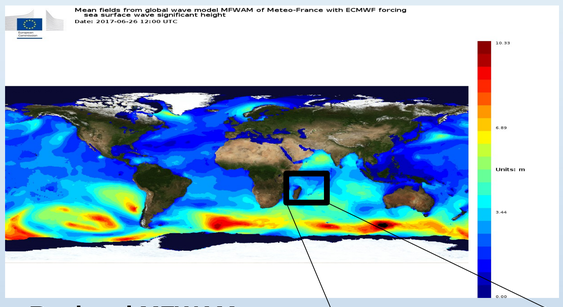
The goal of this study is to investigate the impact of two wind forcing provided by the atmospheric model AROME-OM system on the wave forecast during cyclones and hurricane events.

Runs of the regional wave model MFWAM for La Reunion has been performed. The validation on significant wave height is implemented With altimeters wave data

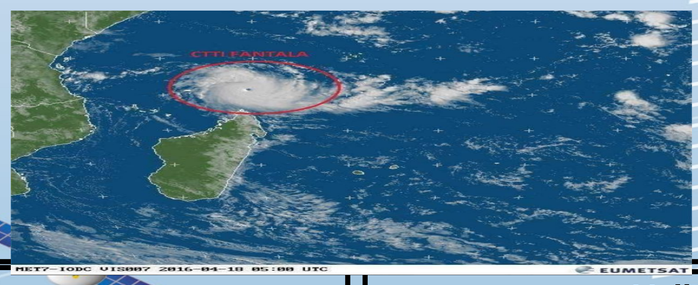
The forcing of 1-D ocean mixed layer model :

1-D ocean mixed layer model coupled to AROME-OM system has been developed by Giordani et al . (2003). The system of equations is based on the conservation of heat, salt and momentum and the turbulent vertical mixing parametrization is based on the second-order turbulent moments expressed as a function of the TKE.

The Operational wave forecasting system of Meteo-France Global-CMEMS-MFC

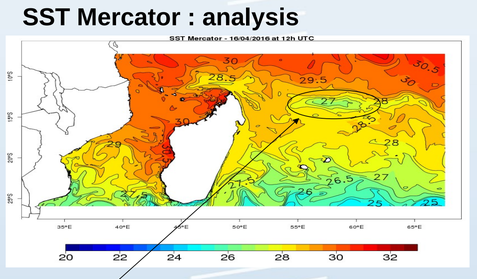


Regional MFWAM La Réunion (10km) Wind forcing from AROME 2.5 km (Non-Hydrostatic atmospheric model

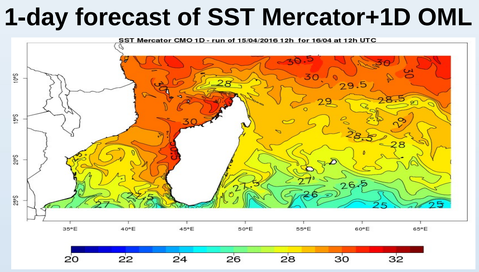


16 April 2016 at 12:00 UTC

SST Mercator : analysis

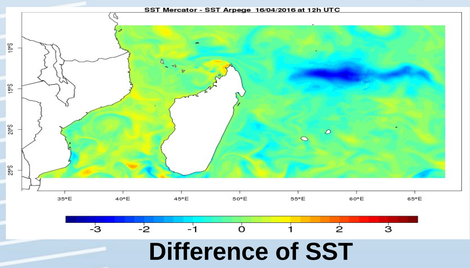


1-day forecast of SST Mercator+1D OML

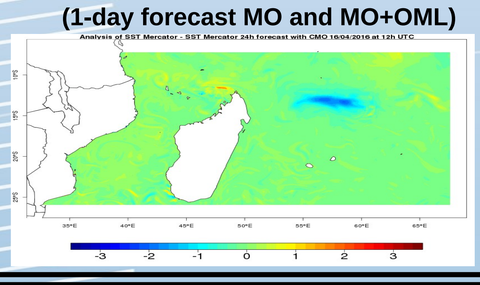


Cooling from the ocean dynamics

Difference of SST (MO-ARPEGE)

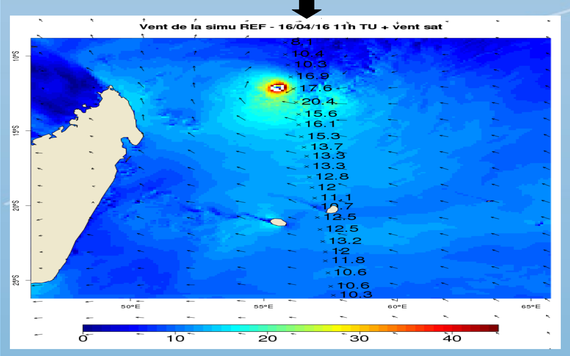


Difference of SST (1-day forecast MO and MO+OML)

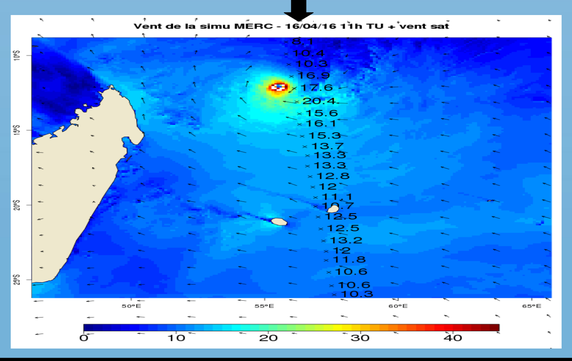


Impact on cyclone Fantala April 2016

Winds from AROME with SST-ARPEGE

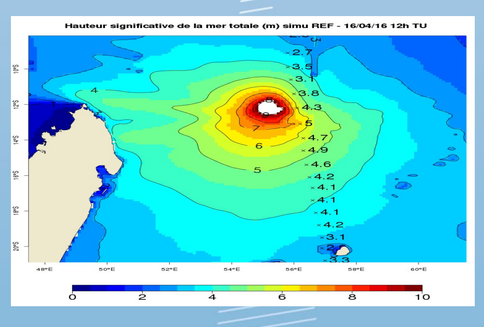


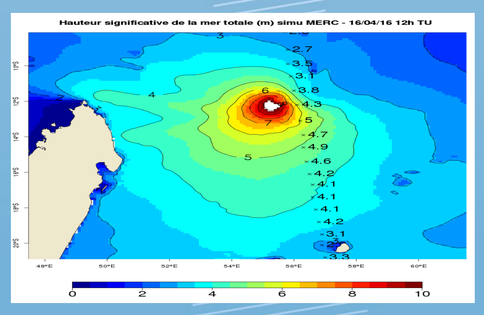
Winds from AROME with SST-Mercator



Significant Wave height

16 April 2016 at 12:00 UTC

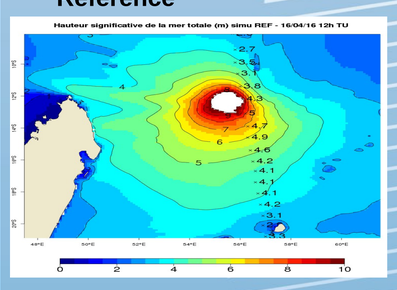




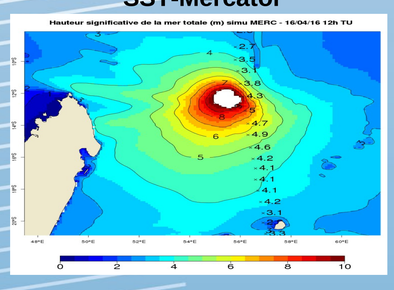
Validation of 36-hours forecast starting from 15 April 2016 at 12:00 UTC

Snapshots of SWH after 1-day forecast

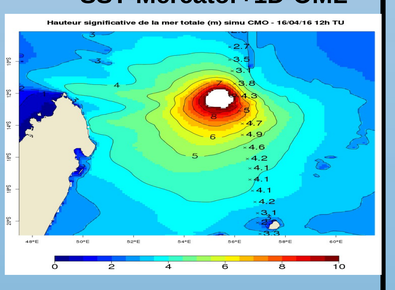
Reference



SST-Mercator



SST-Mercator+1D-OML



Number=1230	Reference	SST-MO	1D-OM-MO
Biais (m)	0,22	0,18	0,17
RMSE	18,4 %	16,9 %	16,4%
Scatter index	16,7 %	15,6 %	15,3 %
Pente	1,2	1,2	1,2
Interception	-0,4	-0,3	-0,3

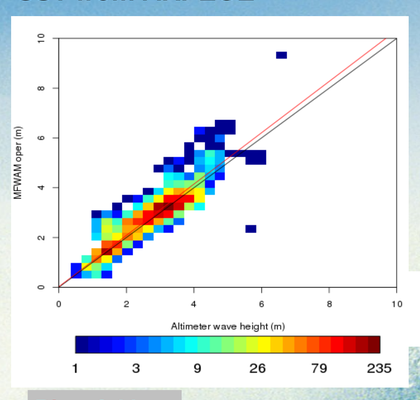
Statistics from the comparison with altimeters during the 36-hour forecast

Reference : SST from ARPEGE
SST-MO : SST from Mercator-Ocean Ocean system
1D-OML-MO : 1-D ocean mixed layer with Initialisation from SST-MO

Validation of the results during the cyclone Fantala with Jason-3 and Saral wave data April 2016

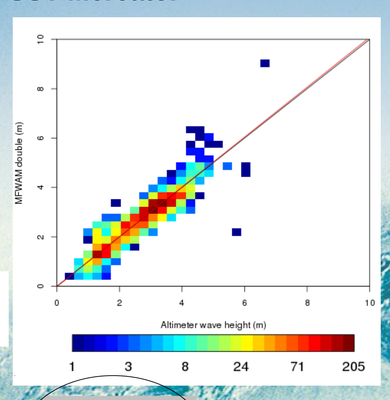
Scatter plots of SWH

SST from ARPEGE



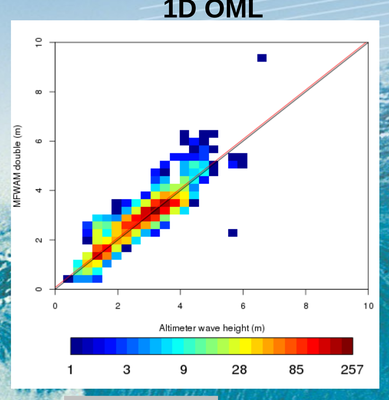
Bias=0.11
SI=14.3%
Slope=1.00
Intercept=0.0

SST Mercator



Bias=0.01
SI=12.3%
Slope=1.00
Intercept=0.0

SST-Mercator an 1D OML



Bias=0.08
SI=13.7%
Slope=1.00
Intercept=0.1

During the analysis the best performance is obtained when forcing with SST from Mercator-Ocean model.

CONCLUSIONS

- The AROME-OM model with 1-D ocean mixed layer reduce the overestimation of winds during the cyclone Fantala in the Indian ocean.
- The use of 1-D ocean mixed layer model shows a significant improvement during the 36-hours waves forecast (good reduction of the bias of SWH).
- The waves analysis during the cyclone Fantala indicates better performance of the model MFWAM when AROME model is forced by SST from Mercator-Ocean system : thanks to altimeters wave data.
- The 1D ocean mixed layer needs to be adjusted in order to catch better the change in the SST during the first hours of the forcing.