OPERATIONAL FORECASTING OF WIND-GENERATED WAVES BY TROPICAL CYCLONES AND ALTIMETRY

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with support of CNES

Ifremer

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Toujours un temps d'avance

- Content

  - Motivation

    MF responsibilities
    - International: GMDSS and RSMC
    - National: Warning System

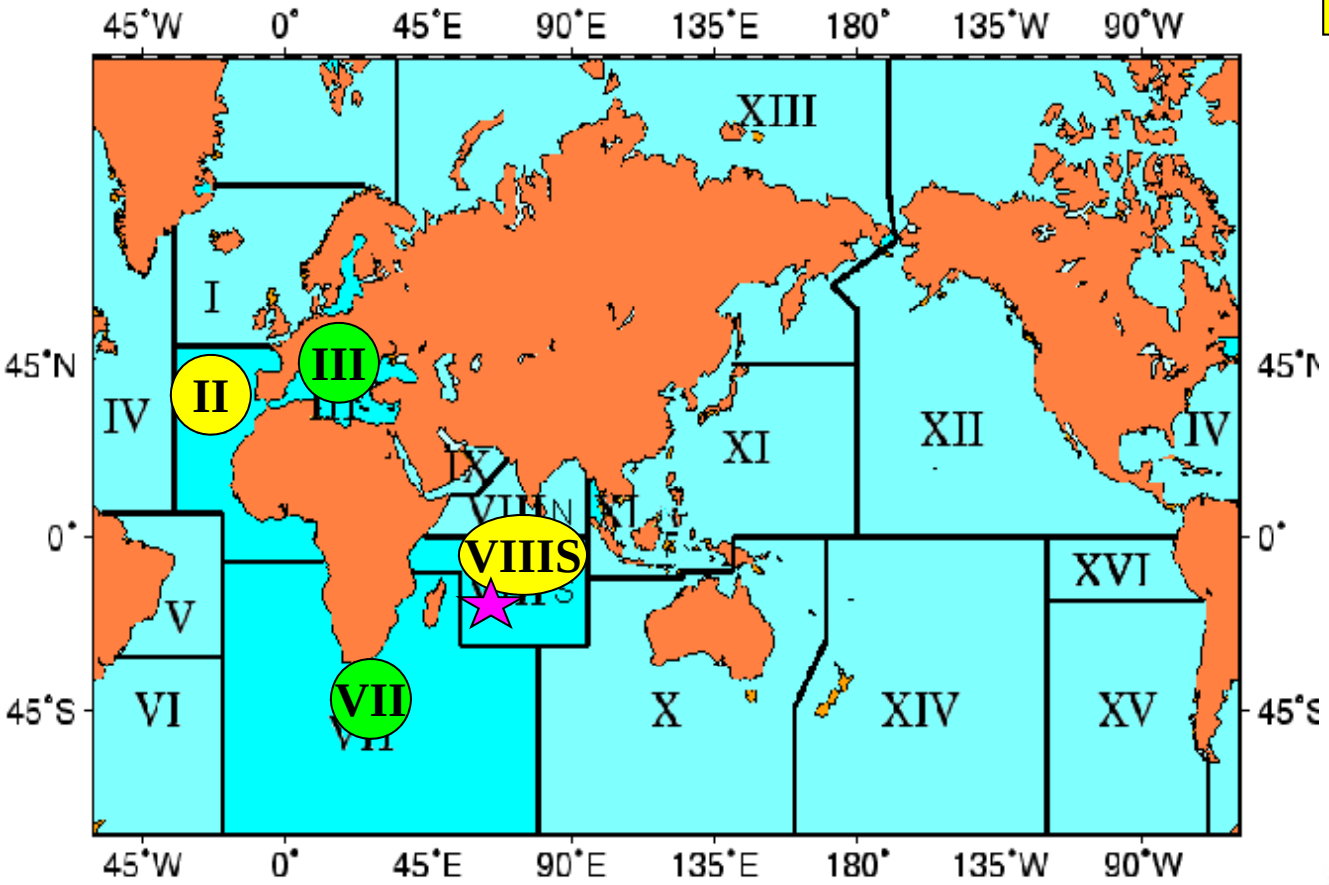
  - New wave forecasting system
    - New wave model
    - New data assimilation (ASAR L2 + Altimeters)

  - Contribution of Altimeter data for operational wave forecasting
    - Data for Wave Modelling improvement
    - Data for Wave Forecasting Systems Verification
    - Data for model monitoring: forecasters

  - Summary/perspectives

International duties:France within the GMDSS

Global Marine Distress and Safety System
RMSC La REUNION



✓Issuing Service for Metarea II and Metarea VIII(S)

✓Preparation Service for Metarea III (W), Metarea VII

MF LA REUNION: Regional Specialized Met Center (RMSC):

Tropical Cyclone Monitoring

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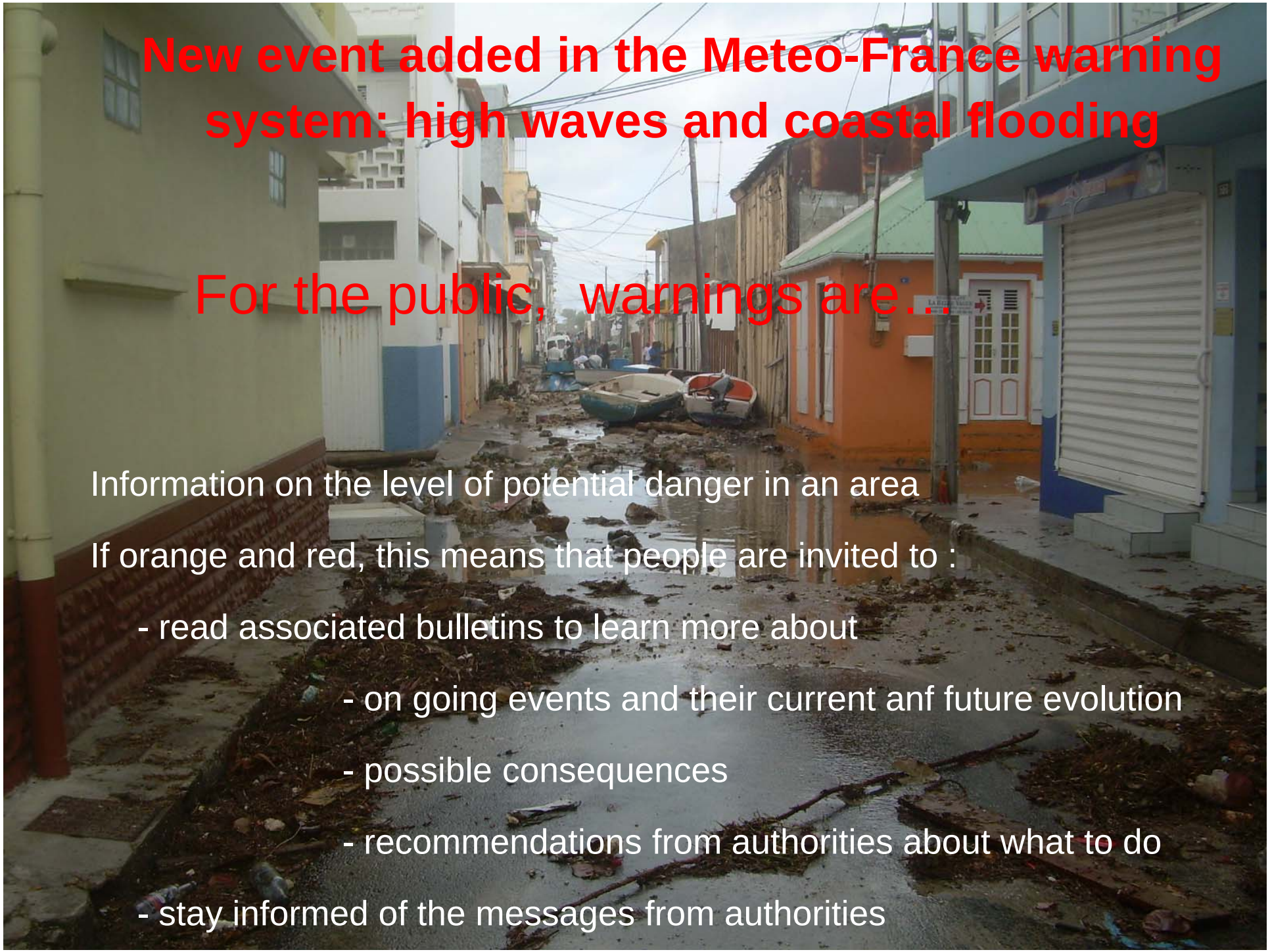


New event added in the Meteo-France warning system: high waves and coastal flooding

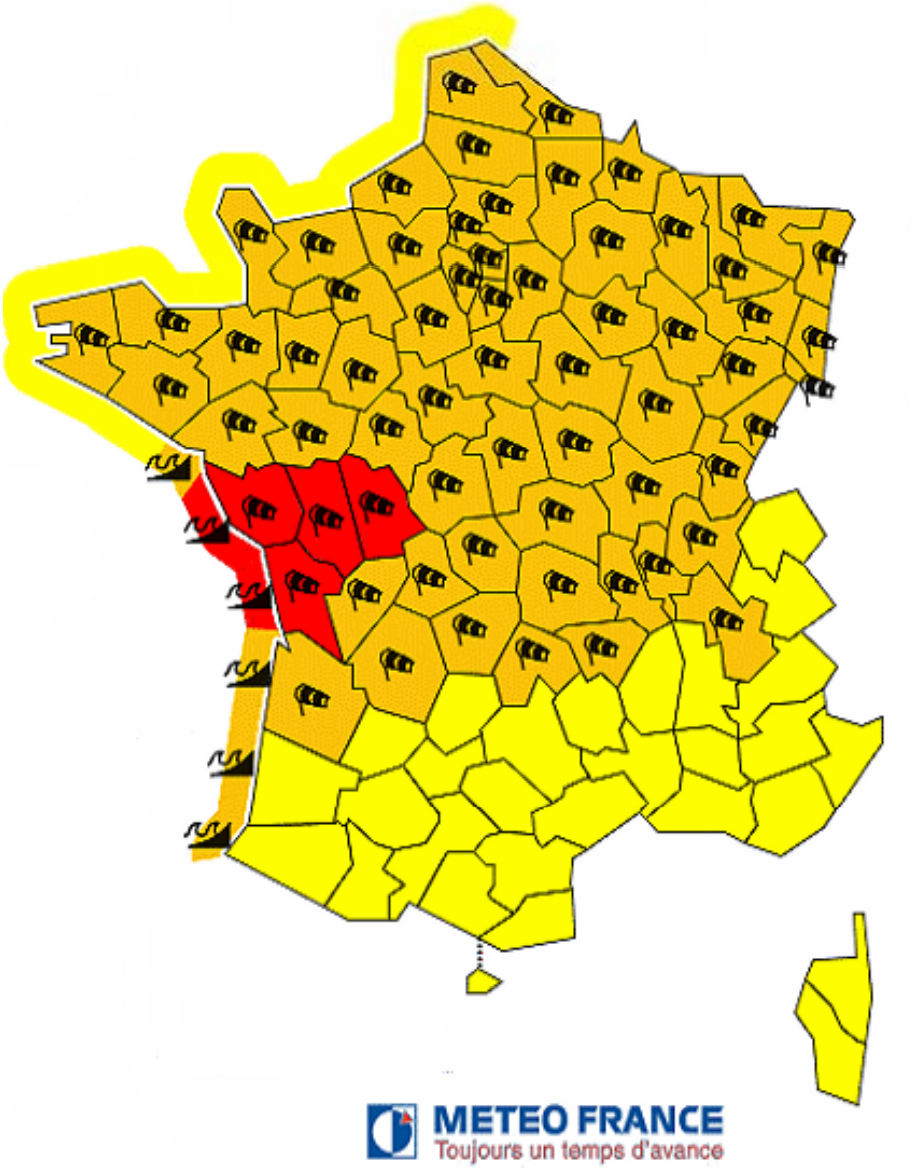
For the public, warnings are…

Information on the level of potential danger in an area

If orange and red, this means that people are invited to :

- read associated bulletins to learn more about
  - on going events and their current anf future evolution
  - possible consequences
  - recommendations from authorities about what to do
- stay informed of the messages from authorities

Example of Warning Map



•High waves and coastal flooding warning system operational since october 3 rd this year.

•Decision to speed up the setting taken after Xynthia storm which was associacted with dramatic coastal flooding

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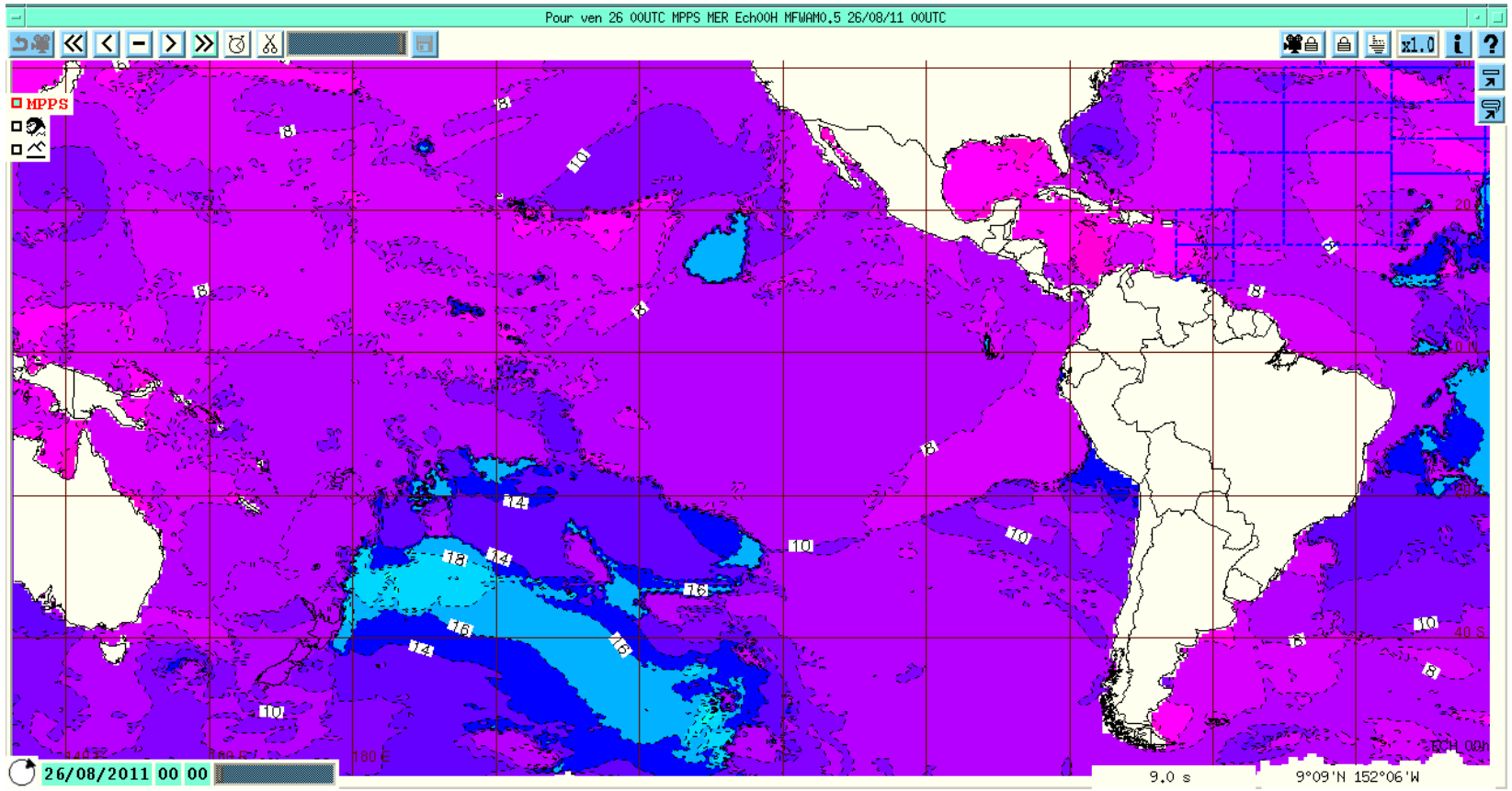
Example of event that activated the warning system in French Polynesia:



5 m and **18s** (wave length 500 m) swell

Expected wave set up, locally more than 1.5 m

No buoy data, only data from space

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New wave forecasting system of Meteo-France: MFWAM, thanks to joint efforts with :

- ECMWF (source code-validation with buoy data)
- SHOM (Physics)
- IFREMER (Validation with Altimeter data)
- CNES (Data assimilation-Validation)

-MFWAM based on ECWAM source code modified for new wave physics- mainly the dissipation term (Ardhuin et al . 2010)

-Introduction of ASAR LP2 and Altimeter data (Aouf et al. 2010)

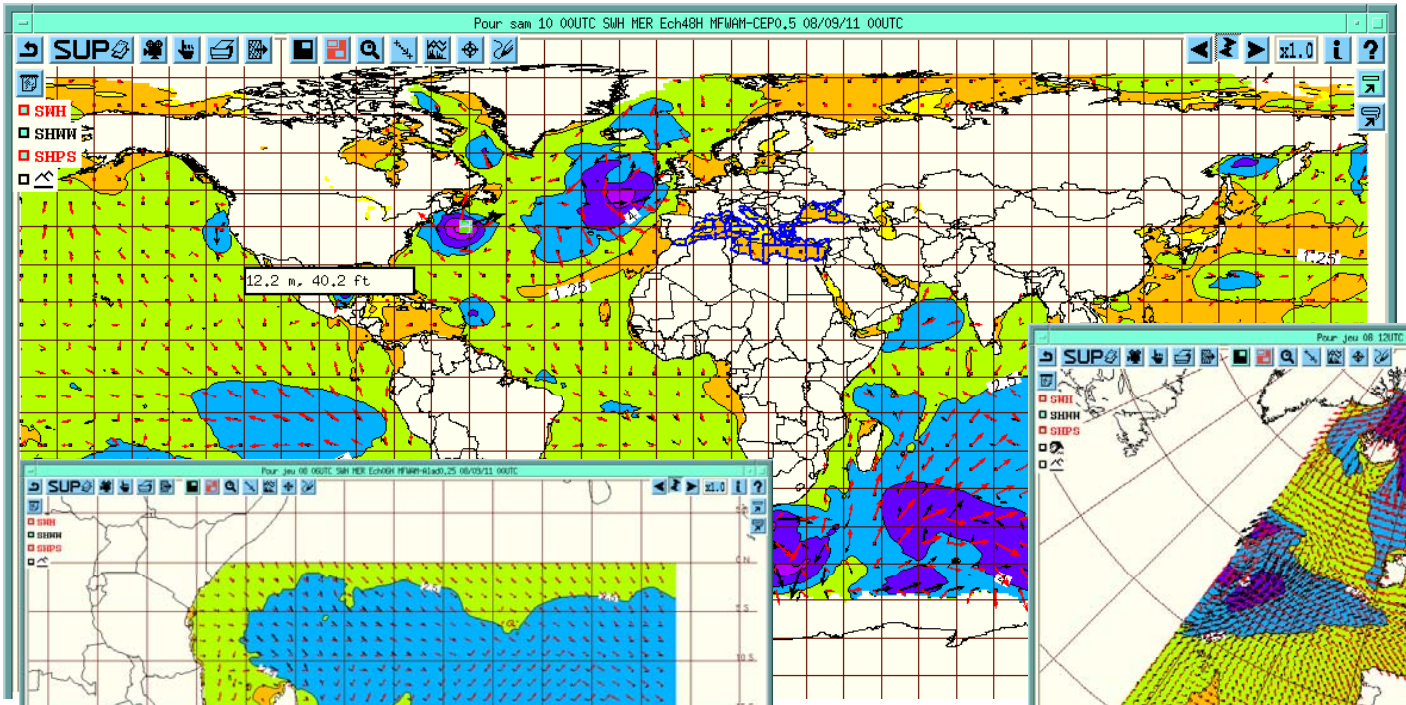
-Implementation of Multi-grid nesting: from Global to Regional models

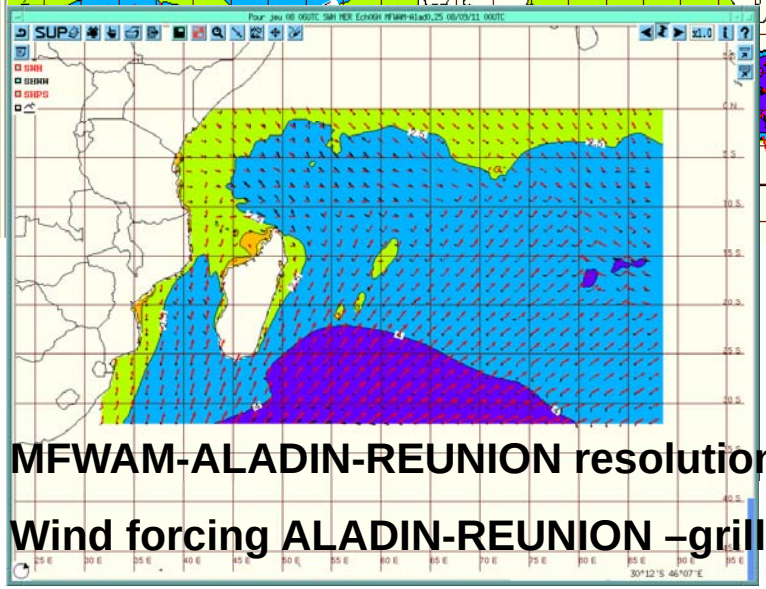
-Introduction of a partitioning scheme for swell components

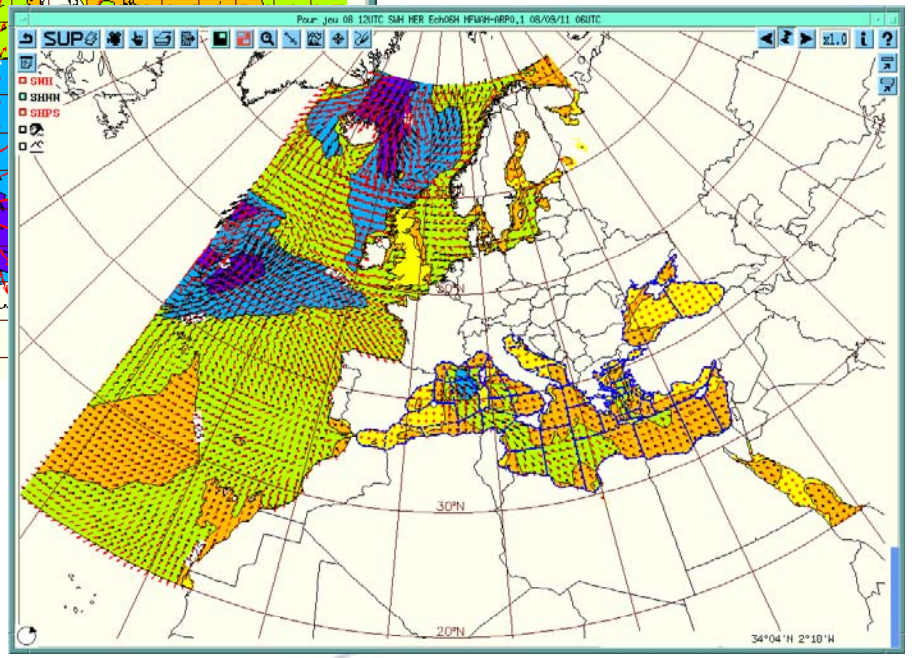
New wave forecasting system of Meteo-France:

2 global wave models MFWAM driven by different wind forcings: ECMWF and ARPEGE/IFS - resolution 55km

1 regional wave model MFWAM resolution 10km driven by ARPEGE. Soon with ECMWF aswell







MFWAM-ALADIN-REUNION resolution 0.25°

Wind forcing ALADIN-REUNION –grille 0.1 km

With hurricane bogusing – Next year other domains

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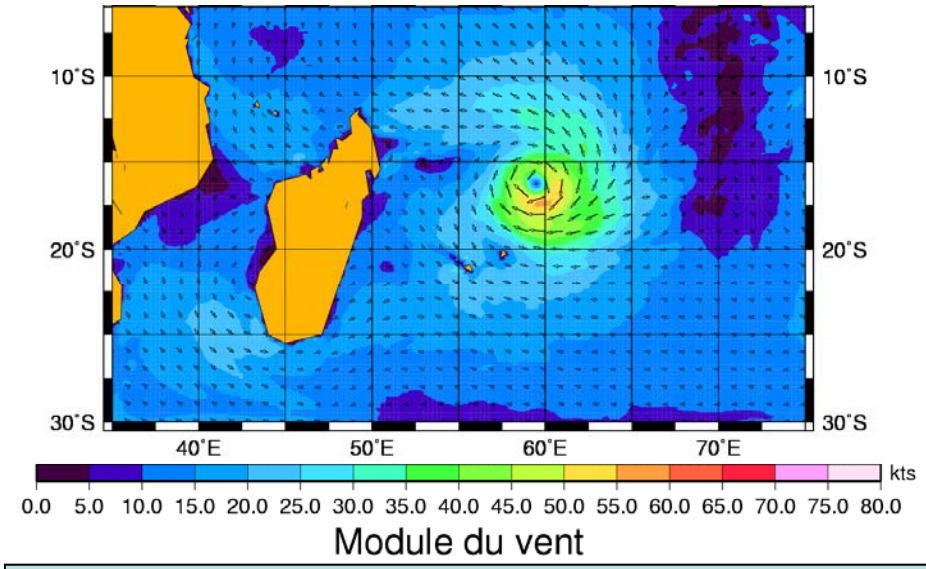
ALADIN-Réunion Model

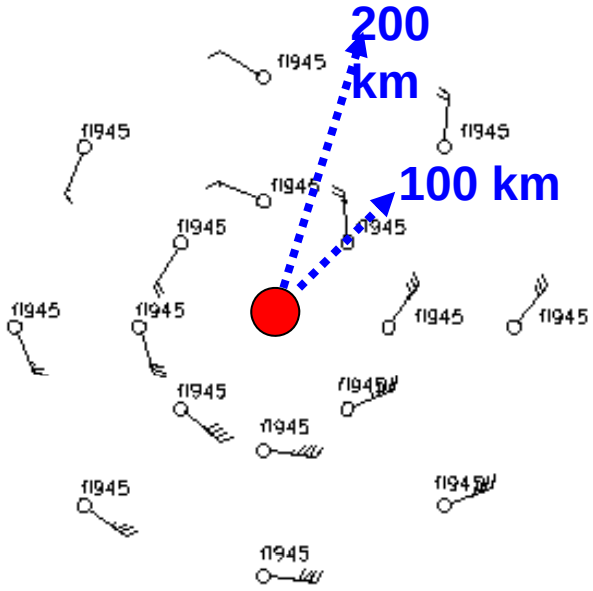


- **Operational since nov. 2006**
- **10km** horizontal résolution
- **3D Var** assimilation scheme c
  a 6h window (4/day)
- 60 vertical levels
- **2-day leadtime** forecast (at 0
  and 12h UTC). 3-day very soc
  BC from Arpege model.

Observation dataset

- **SYNOP/SHIP/BUOY, Radiosondes, Profilers, Aircra**
- **Cloud winds (METEOSAT 7, 9)**
- **Scatterometer winds (QuikScat, ERS-2 and METOP-**
- **ATOVS HIRS, AMSU-A, AMSU-B (NOAA 15,16,17,18**
  AQUA ; METOP-A), AIRS (AQUA)
- **SSMI in clear-sky conditions (DMSP F13, F14)**
- **Satellite GPS**

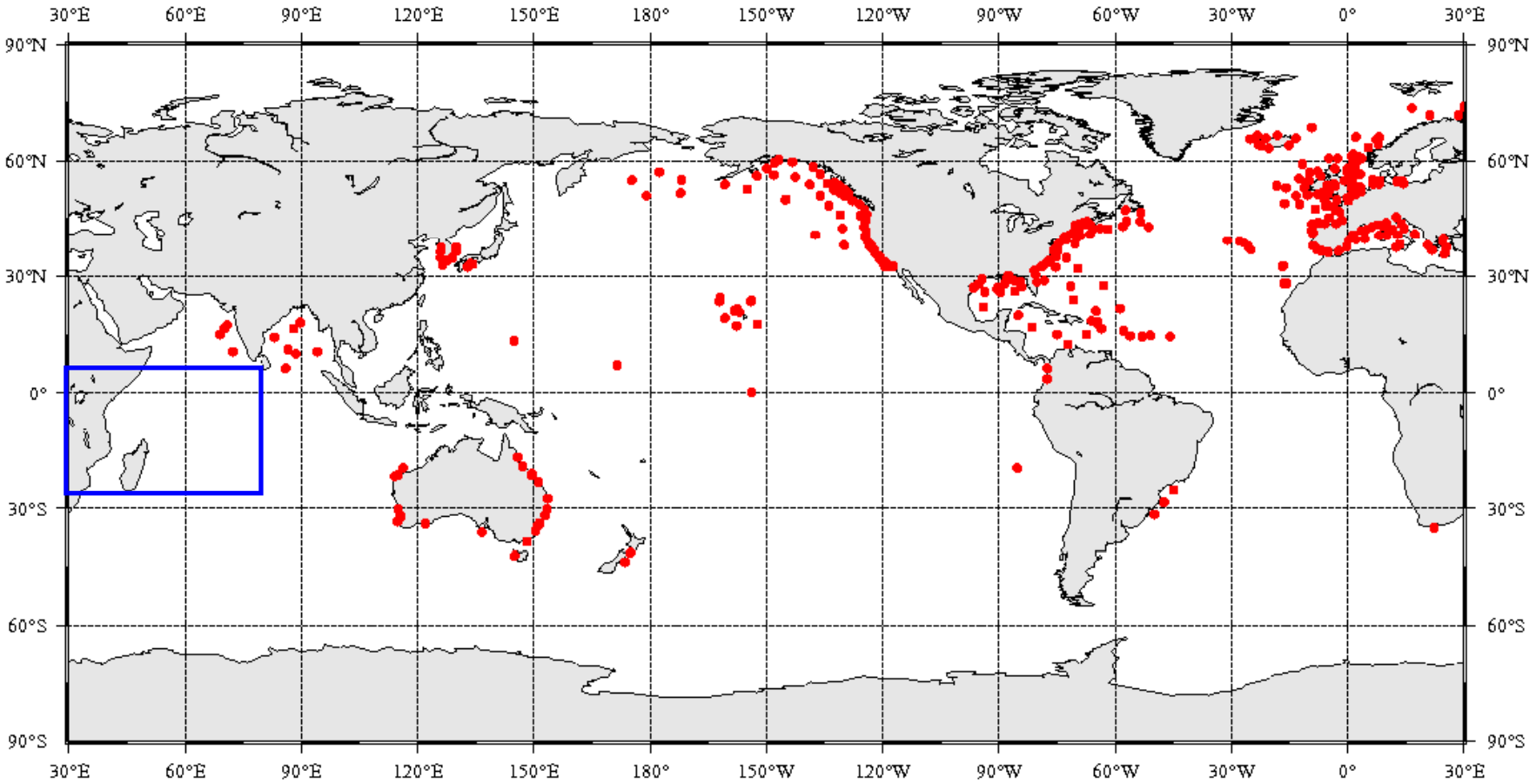
But Lack of observation in the Hurricane



pseudo-

Systematic Verification of the Wave Forecasting System:

1. ECMWF/WFVS (Wave Forecasting Verification System) based on Marine Automatic Weather Stations (MAWS)



2. ESA/GlobWave Pilot System to extend the WFVS to **altimeter data** Following WMO/JCOMM recommandation

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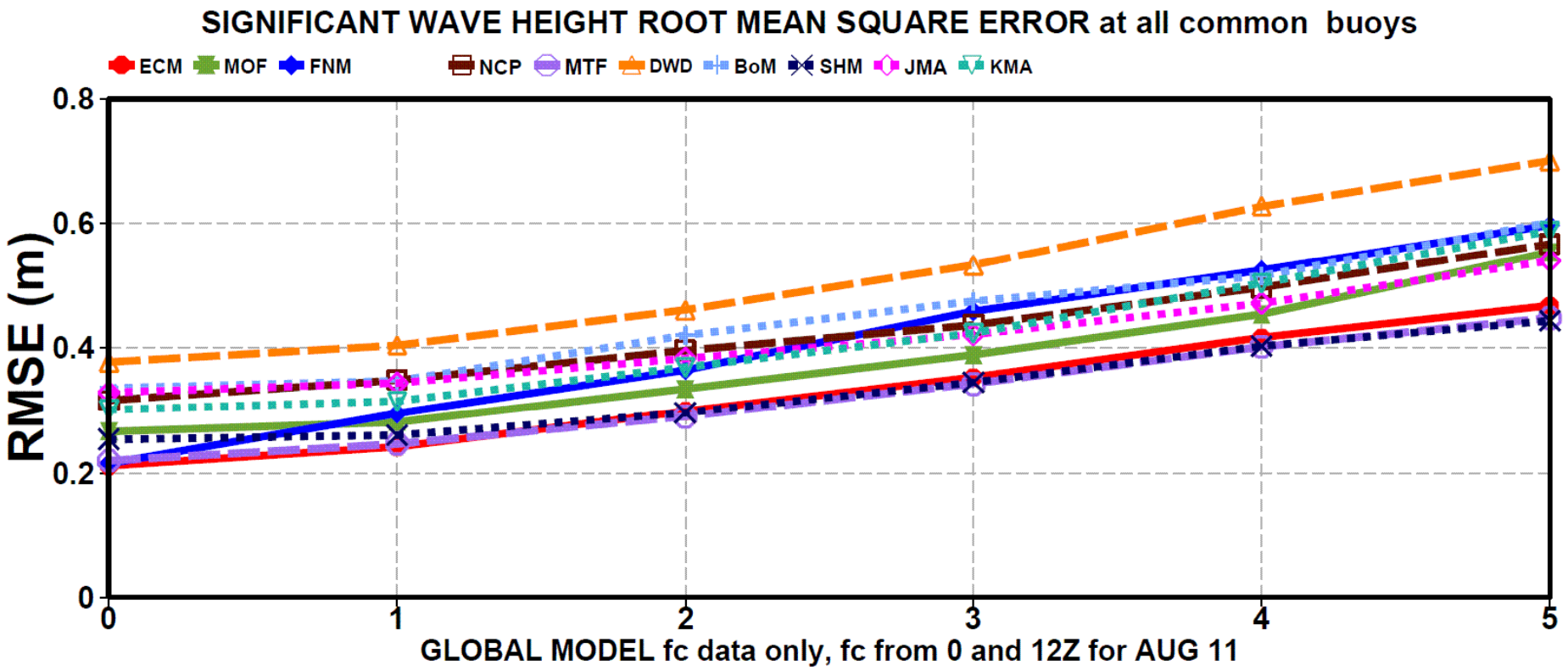

MF-----

ECMWF___

SHOM - --

NCEP_ _ _

In situ Data for validation of wave forecasting systems

Soon including Altimeter data:

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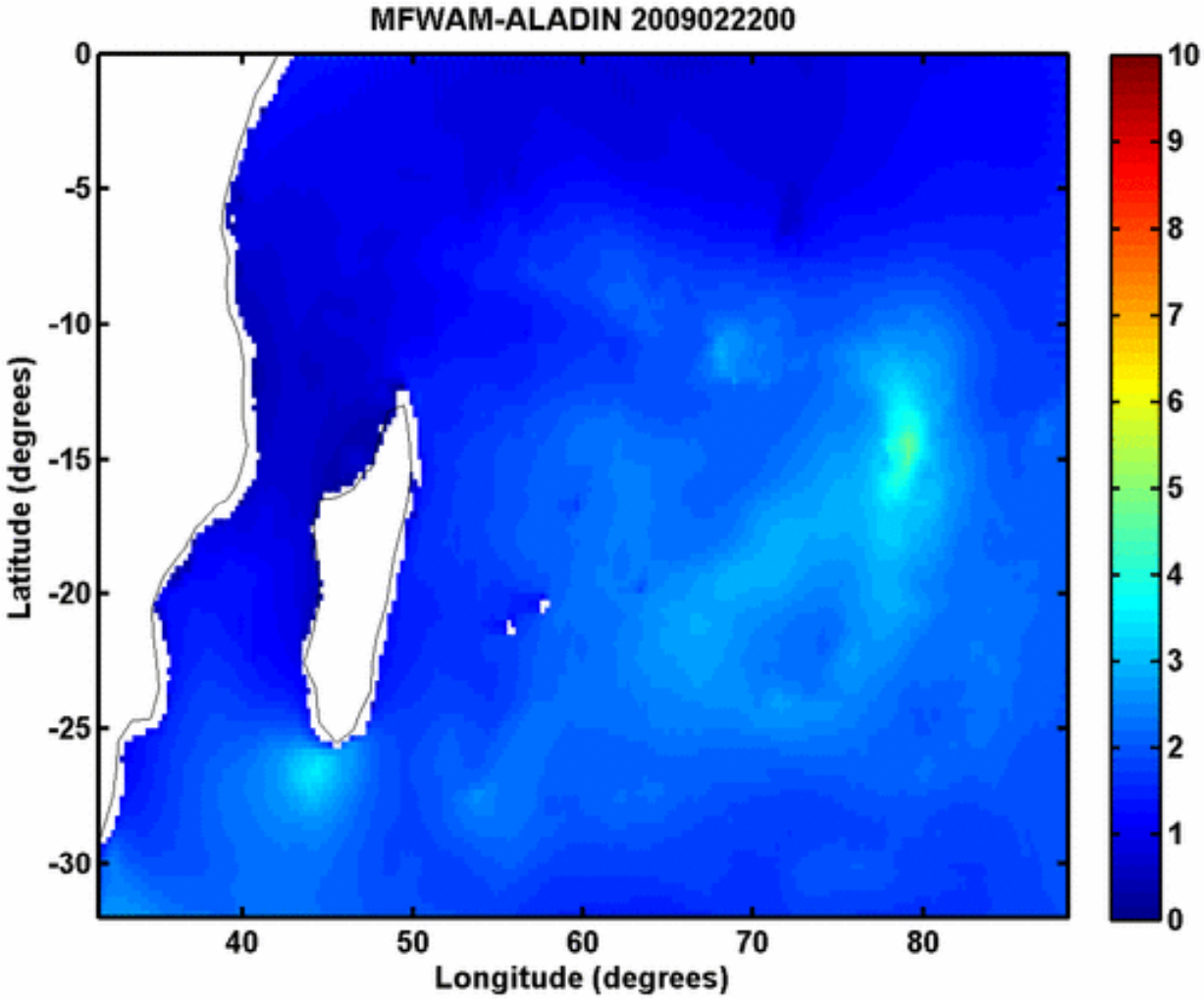
Modelling Waves from TC requires appropriate wind forcing and Wave model:

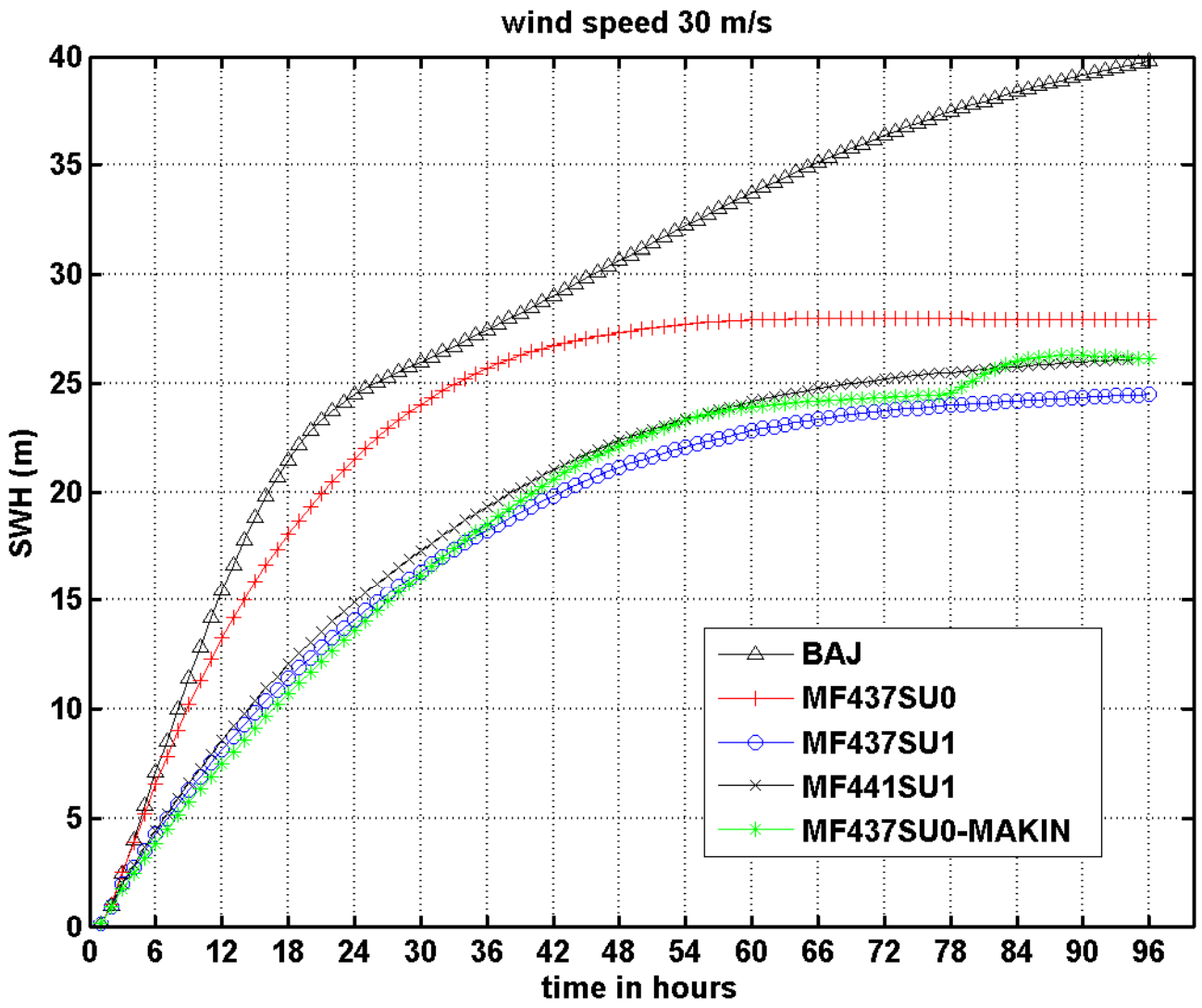
- realistic winds at typical scale of 10-25 km

- realistic wave growth at high winds



MFWAM-ALADIN

Growth curves for wind speed of 30 m/s (about hurricane threshold)

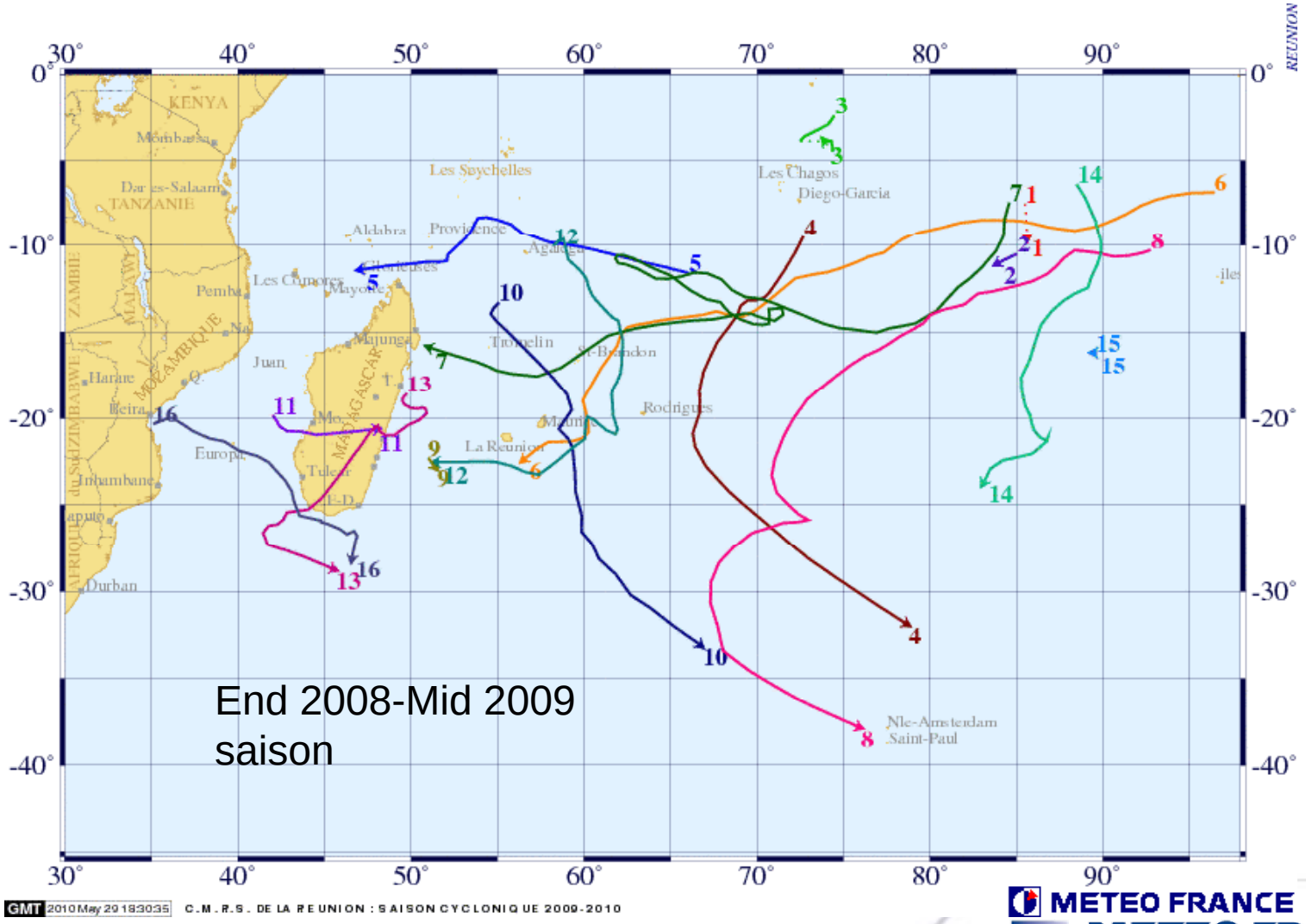


What means realistic growth curves at high wind speed?

Large differences depending on parameterization of source terms!!!

Hopefully, wave growth mainly due to winds below 25 m/s associated with larger fetch and less differences in growth curves.

Validation over 2 seasons (2008-2009)



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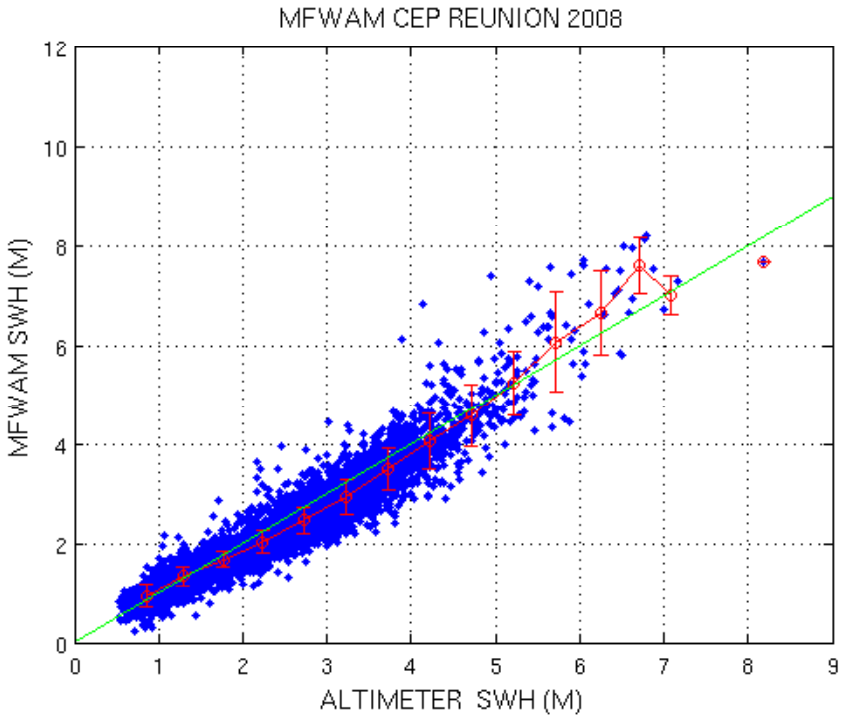
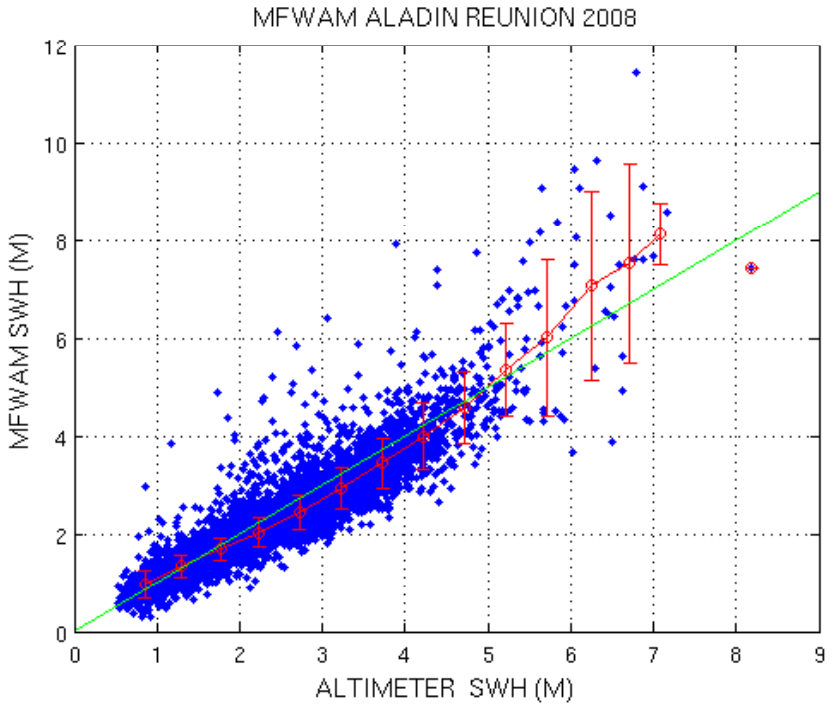
Altimeter data → Model improvment



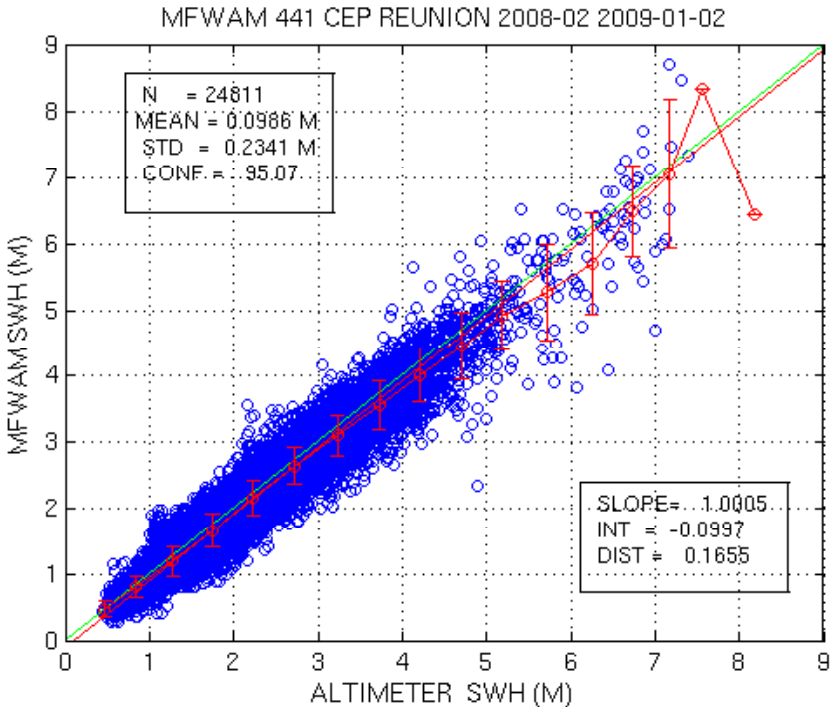


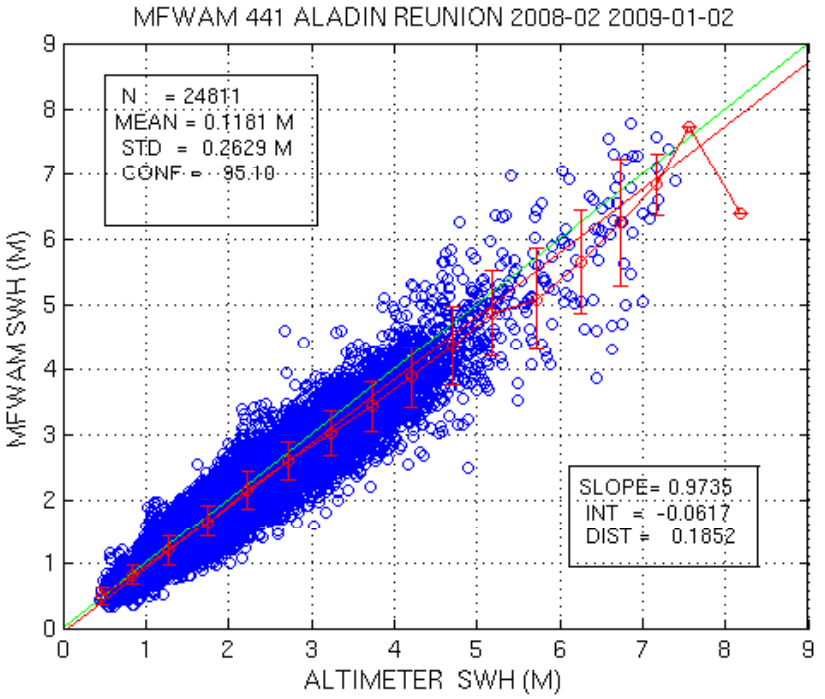
ALTIMETER DATA BASE: IFREMER

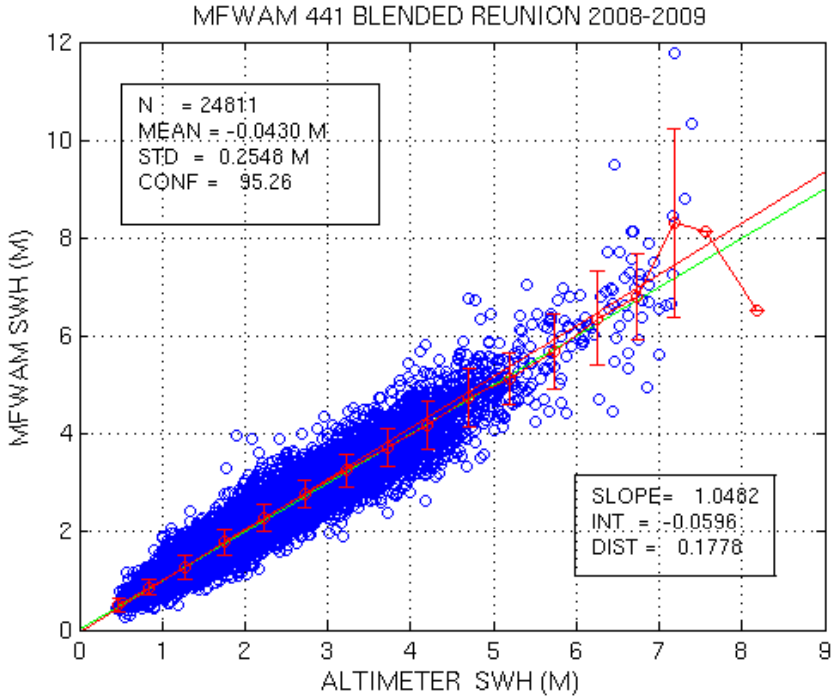
ERS-2 ENVISAT JASON1-2 GFO

Intercalibrated data averaged along track over 1° in latitude

First Version of MFWAM (437, see Ardhuin et al. 2010,JPO): overestimation of high waves with all wind forcings







Implementation of MFWAM-441 (see Ardhuin et al. 2010, JPO)

- Drag Limitation (Zo max)
- Shelter term added in the input source term
- Dissipation rate modified
- Tested with 3 sources of wind:
  - **. Aladin**
  - **. ECMWF**
  - **. Blended (Scatt + ECMWF guess)**

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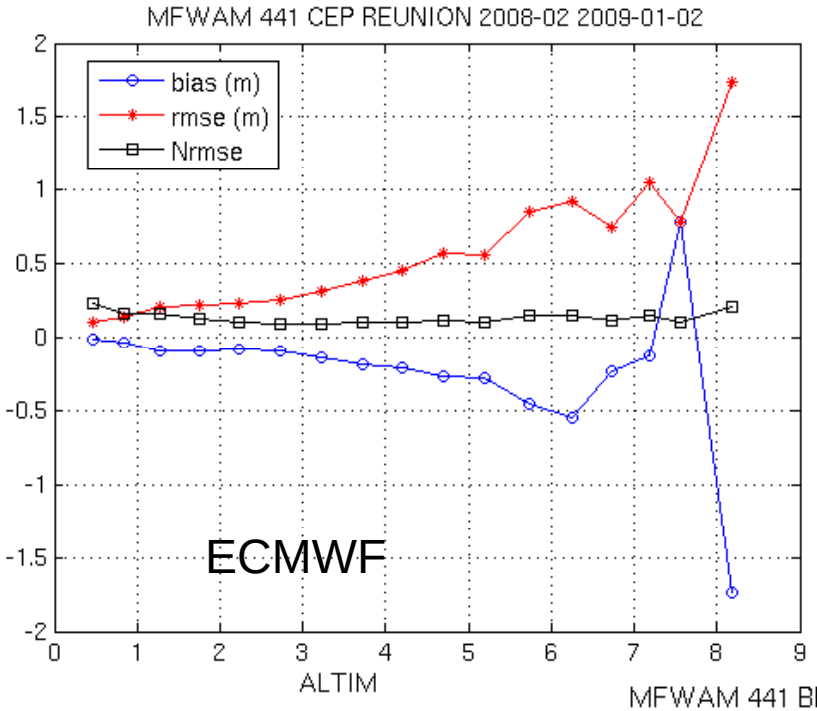

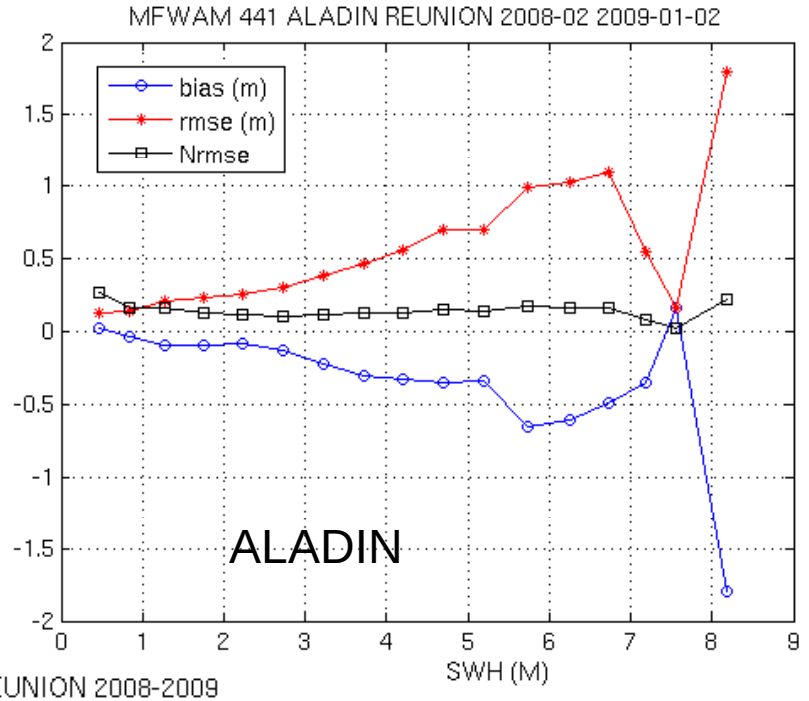

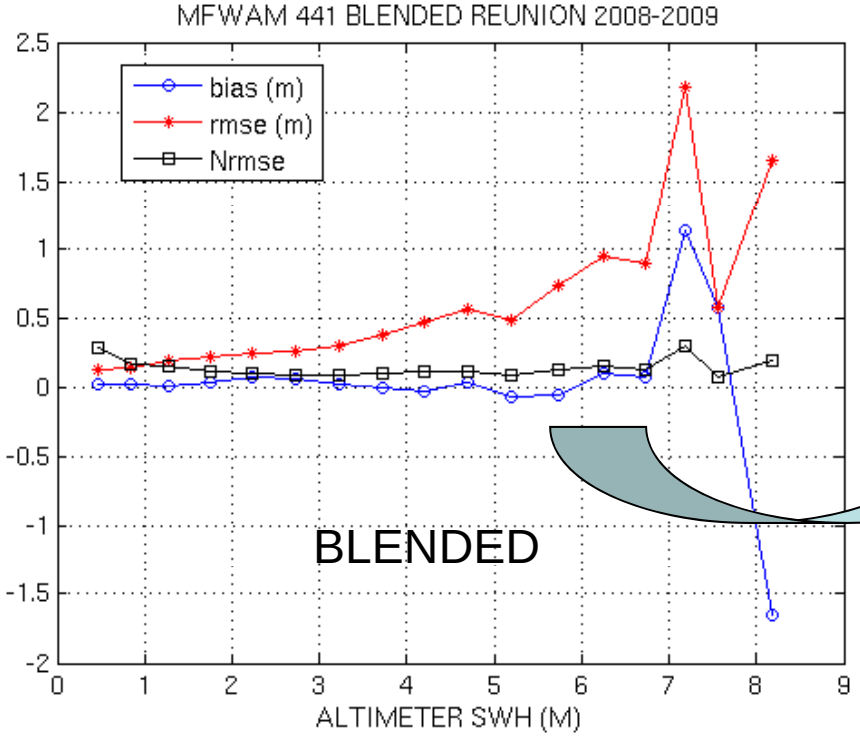

Biais reduction
(blue curve)

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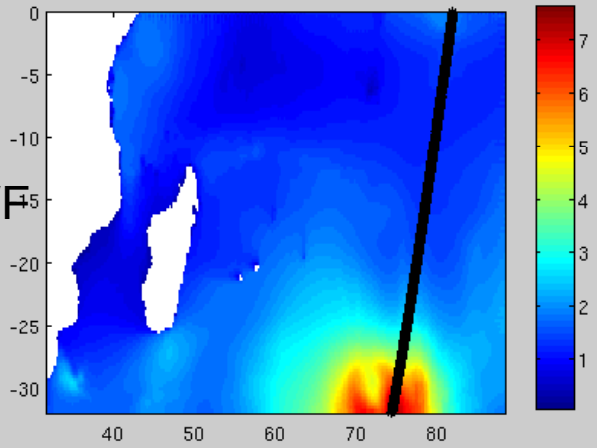
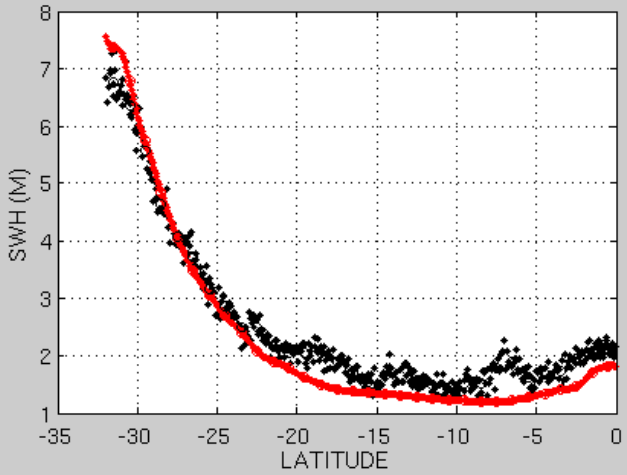
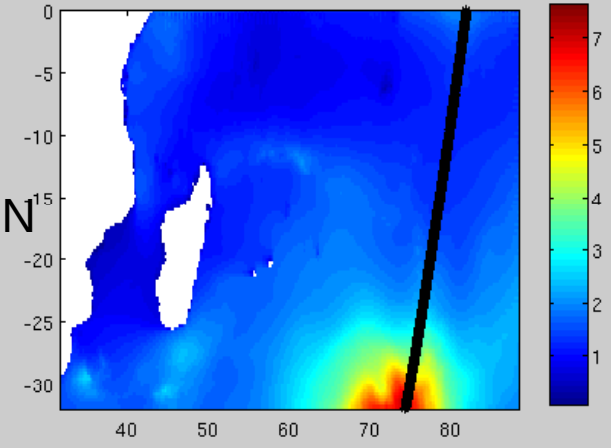
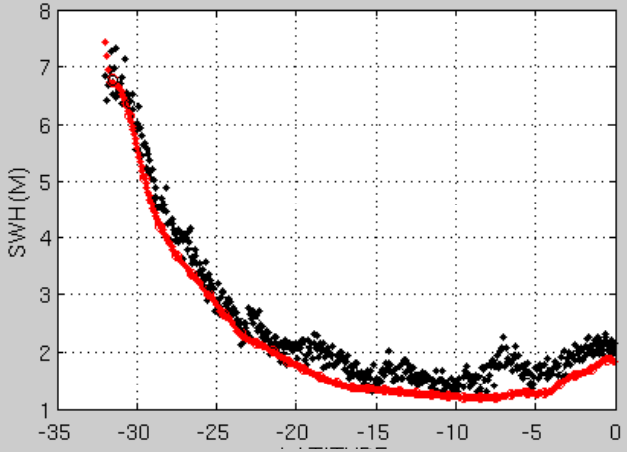
ECMWF



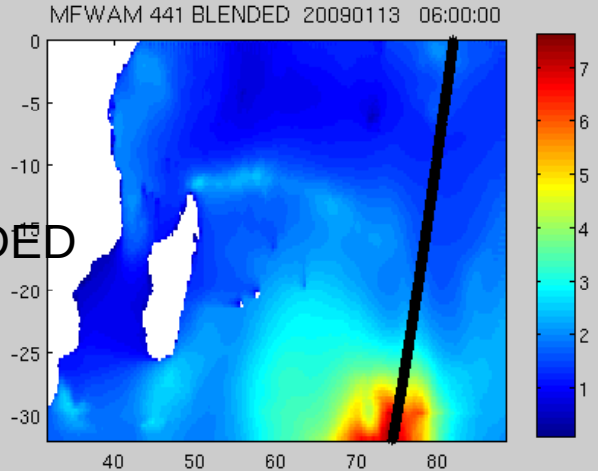


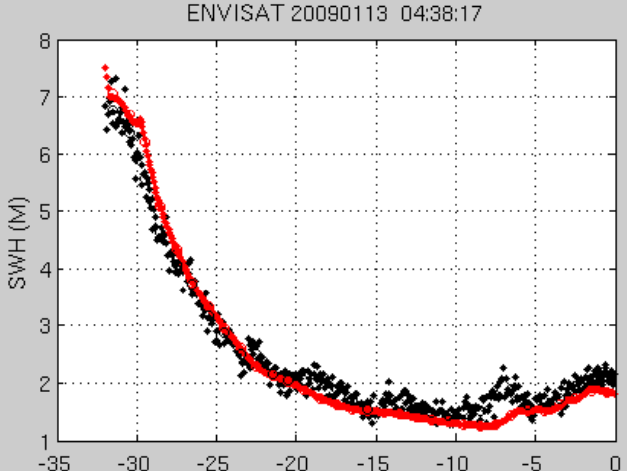
ALADIN





BLENDED





Case with small differences

however

Blended better

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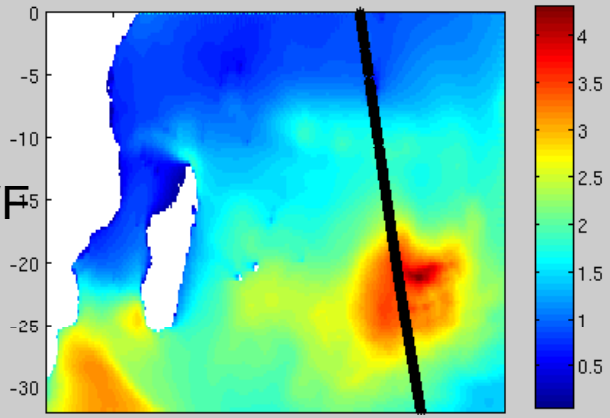
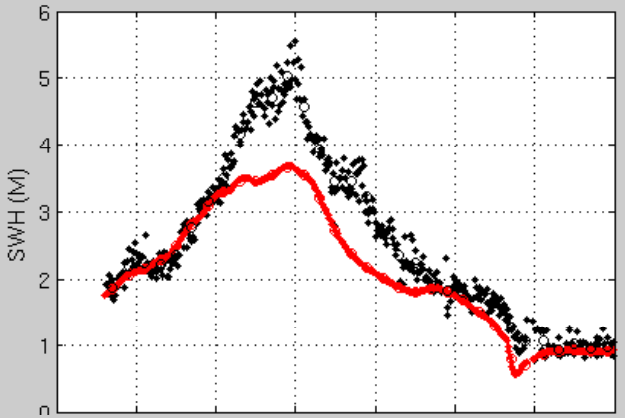
emps d'avance

ECMWF





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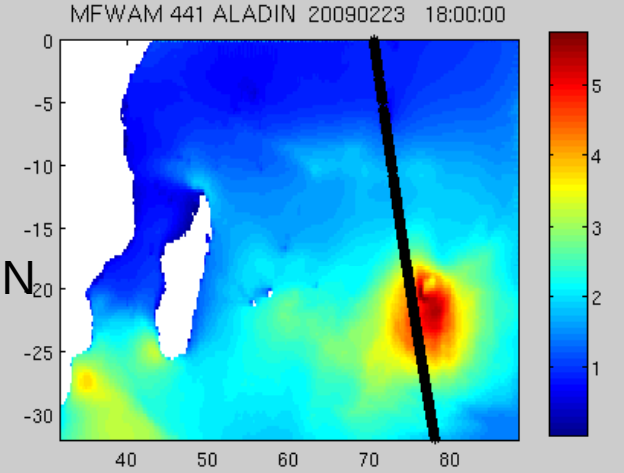

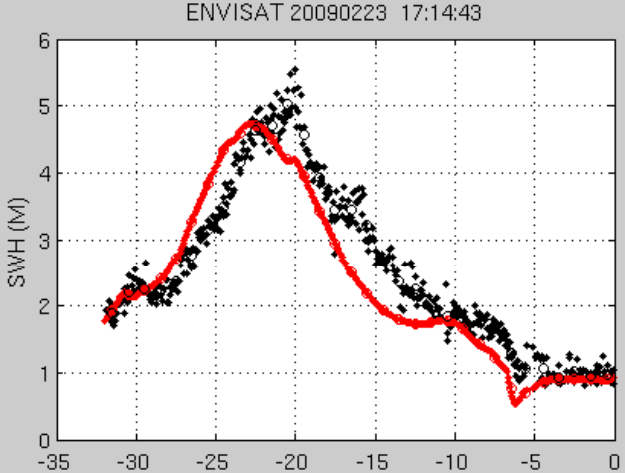

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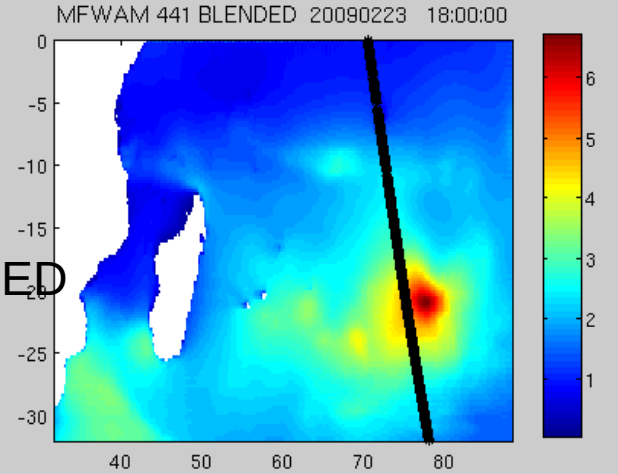

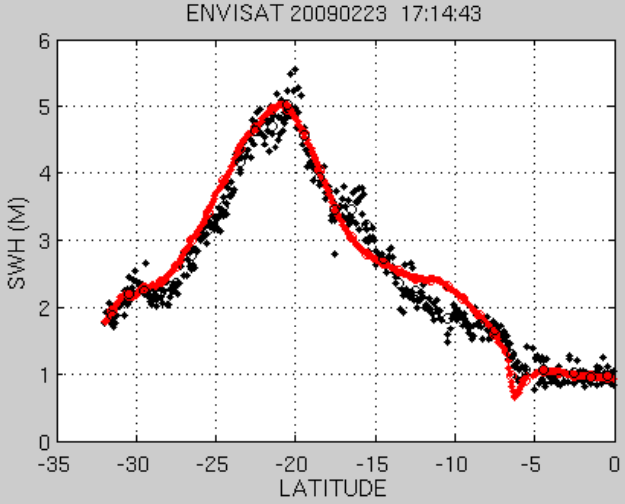

Large biais

Small biais but shifted position ---> increases rmse

No bias right position

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emps d'avance

SUMMARY/PERSPECTIVES

- Importance of satellite data for validation, calibration of model parameterizations – also for model monitoring
- Interpretation of statistics in term of rmse difficult because of the uncertainty on the TC position-> analyse all cases
- Need to extent the comparisons to other periods (2010 and 2011) and other areas (Northern Atlantic) in order to study more cases with larger wave heights
- Regional models for Carribean area, French Polynesia, New Caledonia will be implemented in 2012. For most of those areas no in situ data are available.
- Include data from future missions: SARAL/ALTIKA…
- Analyse winds from altimetry (Quilfen Wind Algorithm)