Forecasting Tropical Cyclones

Philippe Caroff, Sébastien Langlade, Thierry Dupont, Nicole Girardot

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- Introduction

- Seasonal forecast

- Monthly forecast

- Medium- to short-range forecasts

For each time-range we will see :   the products,
                                     some elements of assessment or feedback,
                                     what is done with the products

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La Réunion is one of the 6 RSMC for tropical cyclone monitoring and warning.

Its responsibility area is the south-west Indian Ocean.

http://www.meteo.fr/temps/domtom/La_Reunion/webcmrs9.0/#

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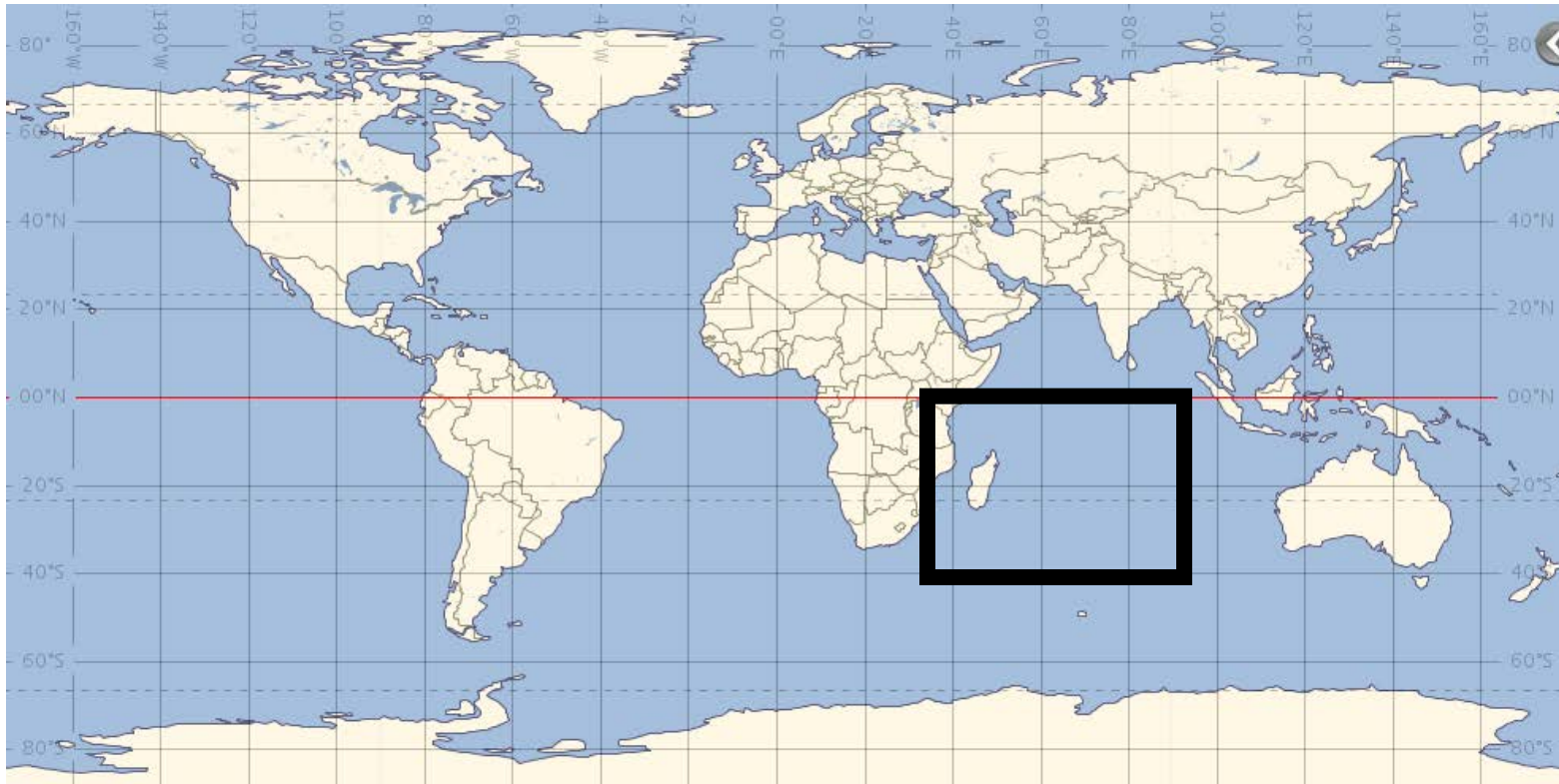
TRAINING

Organisation of international training courses and workshops

RESEARCH

Research Centre for tropical Cyclones (collaboration with La Réunion University) → LACy (Laboratoire de l'Atmosphère et des Cyclones) : https://lacy.univ-reunion.fr

DEMONSTRATION

SWFDP (Severe Weather Forecasting Demonstration Project) http://www.meteo.fr/extranets/page/index/affiche/id/76216

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- The cyclone season goes from 1st of July to 30 June but more than 90% of the activity takes place between November and April
- The average number of named cyclones (i.e. tropical storms) is 9.
- But the number of tropical cyclones varies from year to year (from 3 to 14)

South-West Indian Ocean - Number of named systems per season
from 1999-2000 to 2013-2014
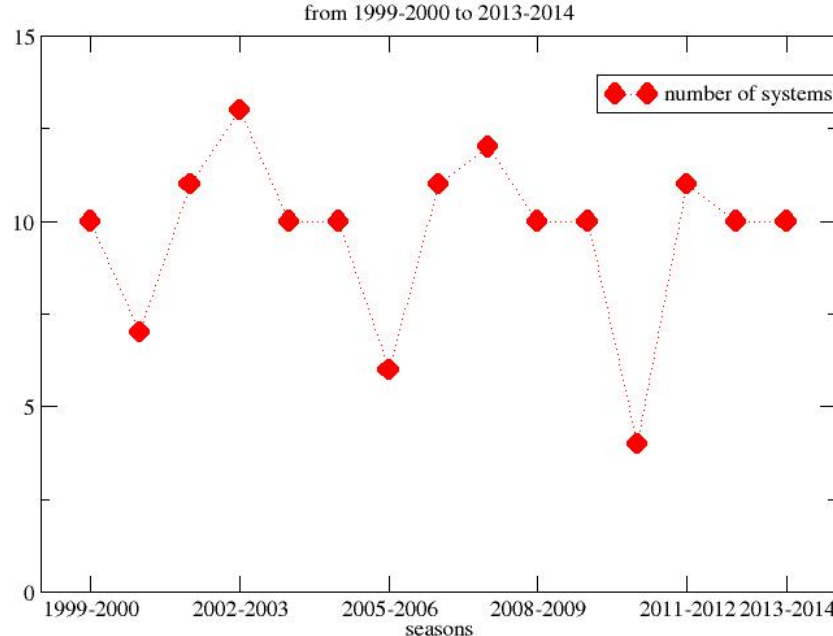
Can the seasonal forecast systems give indication of this signal ?

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Seasonal Forecast Products

Forecasts of tropical cyclone activity anomaly are produced with
ECMWF Seasonal Forecast System, and also with EUROSIP models
(union of UKMO+ECMWF+NCEP+MF seasonal forecast systems)
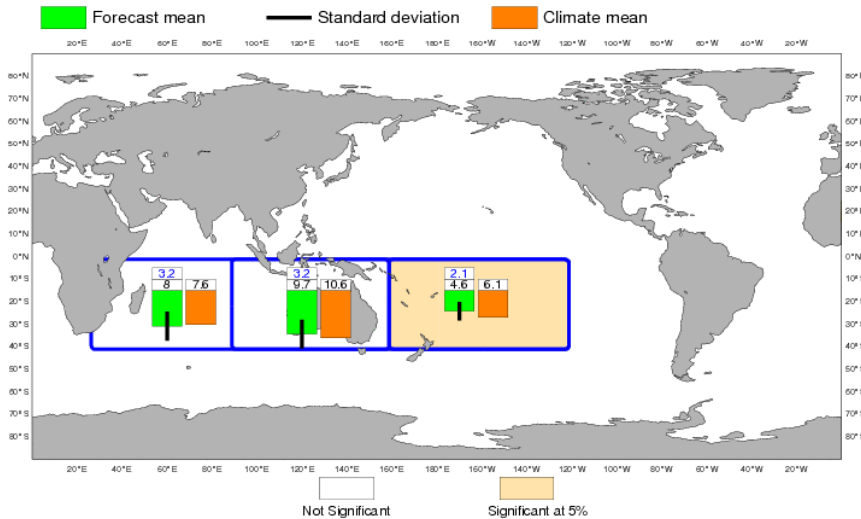
Other products can be informative, for example SST plots.

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Seasonal Forecast Assessment

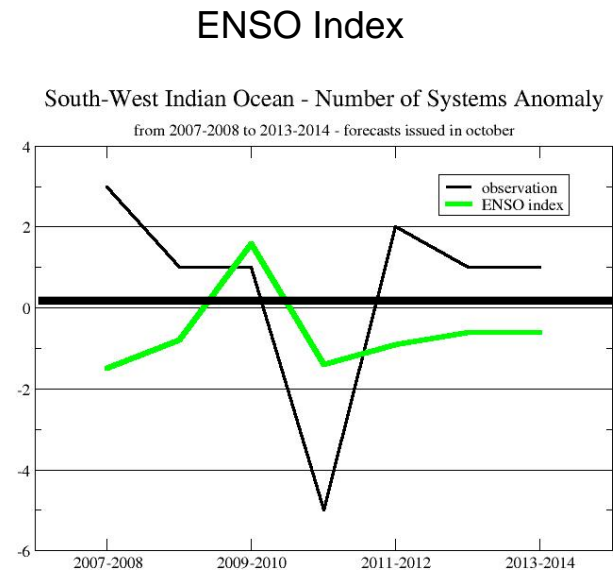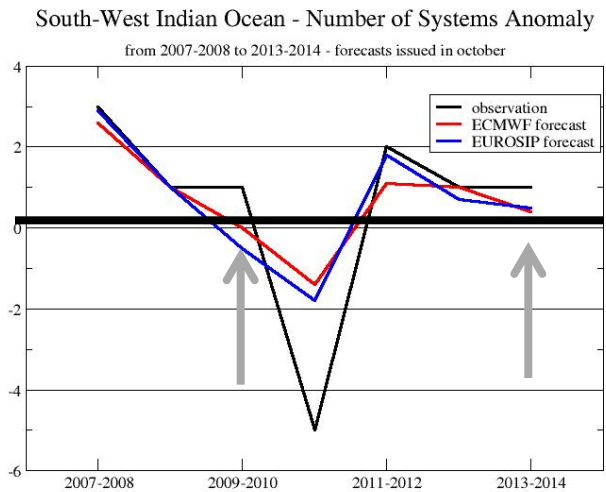Simple comparison of products and indices (large scale patterns)

Data used :

- ECMWF Seasonal Forecast issued on October from Sept 2007 to Sept 2013
- EUROSIP Seasonal Forecast ……………..…….. "…………………………
- ENSO index for NDJ from http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml
- AAO index for NDJ from http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/aao/monthly.aao.index.b79.current.ascii.table
- PNA index for NDJ fromhttp://www.cpc.ncep.noaa.gov/products/precip/CWlink/pna/norm.pna.monthly.b5001.current.ascii.table
- MJO intensity for the full season from http://cawcr.gov.au/staff/mwheeler/maproom/RMM/RMM1RMM2.74toRealtime.txt
- SST anomaly for NDJFMA from MOFC initial state
- Best track data from RSMC La Réunion

The sample size is small : from 2007-2008 to 2013-2014 (7 seasons) !

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Comparison of the anomaly of number of named systems and indices
(all the graphics are not shown)

ECMWF and EUROSIP Seasonal Forecasts
(grey arrows = non-significative forecast)

ENSO Index

South-West Indian Ocean - Number of Systems Anomaly
from 2007-2008 to 2013-2014 - forecasts issued in october

South-West Indian Ocean - Number of Systems Anomaly
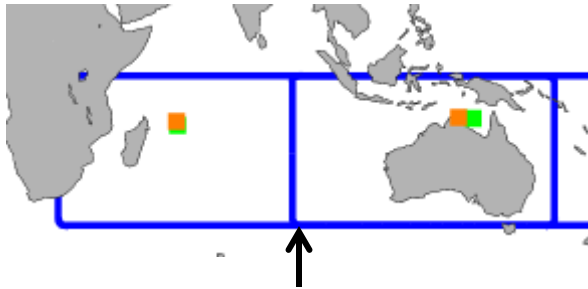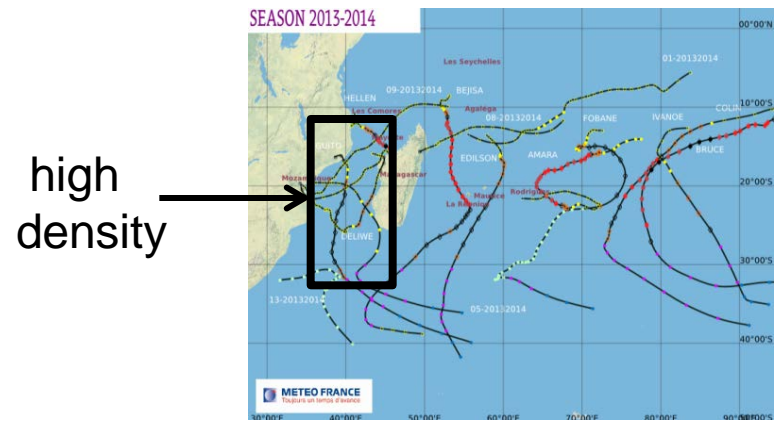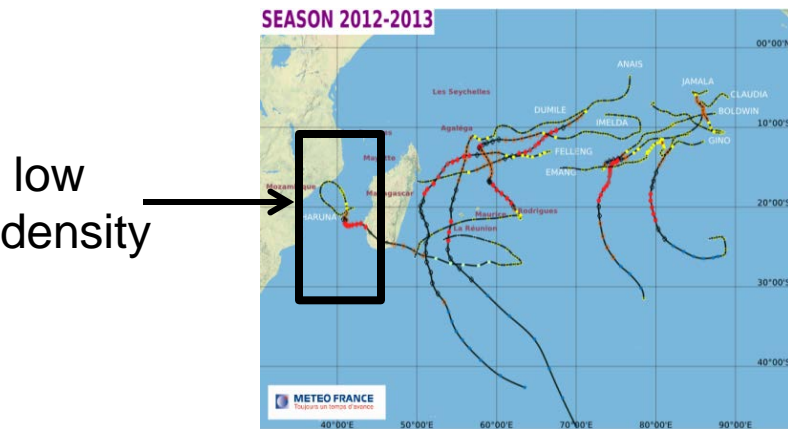from 2007-2008 to 2013-2014 - forecasts issued in october

→ Seasonal forecasts show a clear relation with observations,

→ all other indices are not relevant (here example of ENSO), except the average MJO intensity, but it is not predictable at seasonal time scale.
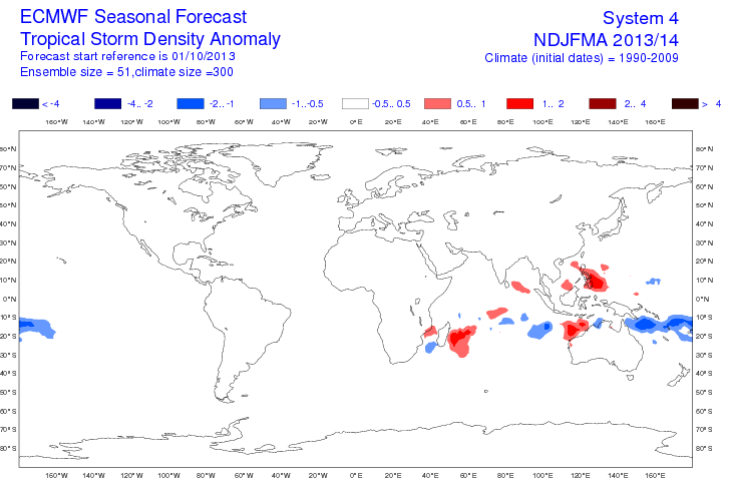
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Example of 2 different seasons :

SEASON 2012-2013

low
density →

SEASON 2013-2014

high
density →

↑

The former product for location of anomalies was too synthetic.

The new one (density anomaly) seems more informative (no assessment at this time)

→

ECMWF Seasonal Forecast
Tropical Storm Density Anomaly
Forecast start reference is 01/10/2013
Ensemble size = 51,climate size =300

System 4
NDJFMA 2013/14
Climate (initial dates) = 1990-2009

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The seasonal forecasts are valuable for the RSMC forecasters : it helps them understand and anticipate the evolution of the ocean-atmosphere system.

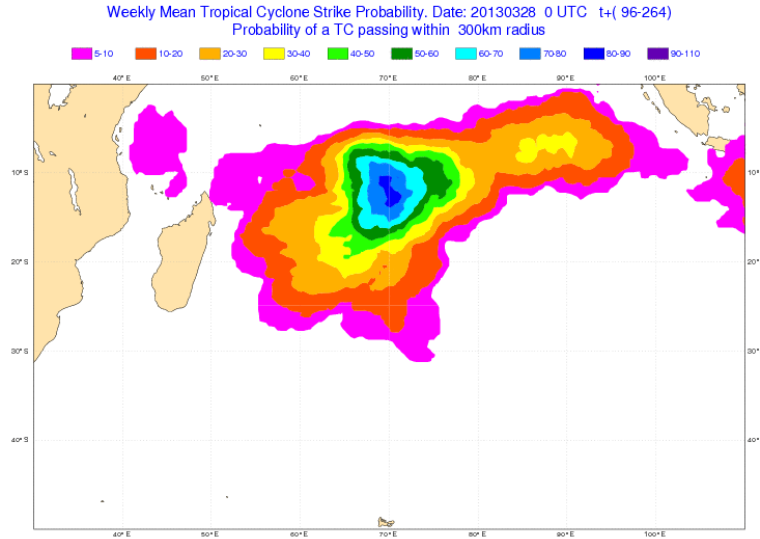But, what else? And shall we communicate this information ?

→ Seasonal forecast is rather anecdotal as it is only a basin-scale information. It tells nothing about the possible impacts (and that's what matters for the populations)

→The point is that it could be even dangerous or counterproducive in terms of prevention to say to the public : « there will be less systems/activity than usual »… People could misunderstand this information and relax their awareness, becoming less vigilant.
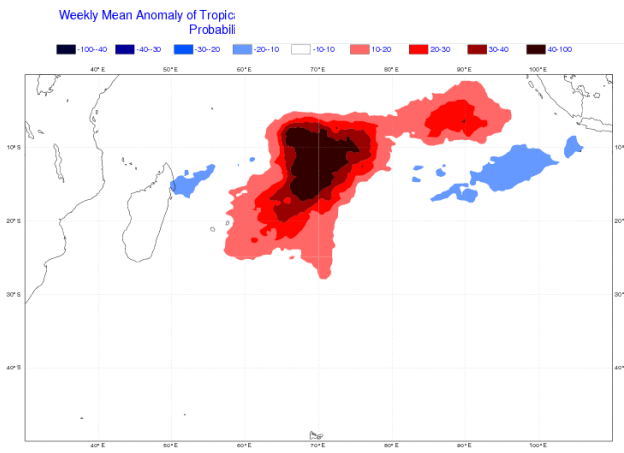
→ It is anyway impossible to say : « there will be no cyclone over your area »

→ The main message before the cyclone season will always be : « be prepared ! » (whatever the anticipated level of activity of the season)

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Several products based on ECMWF monthly forecasts exist :

Weekly Mean Tropical Cyclone Strike Probability. Date: 20130328 0 UTC t+(96-264)
Probability of a TC passing within 300km radius

Strike-Probabilities of Tropical Cyclone / Storm / Hurricane

(TC / TS / HR)

Weekly Mean Anomaly of Tropical Probabili...

Strike-Probability Anomaly of Tropical Cyclone / Storm / Hurricane

ECMWF MONTHLY FORECASTS
FORECAST BASED 24/04/2014 00UTC
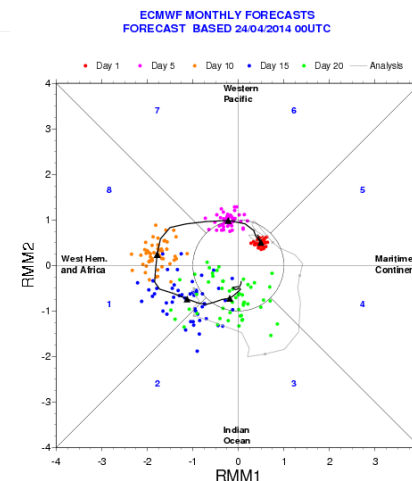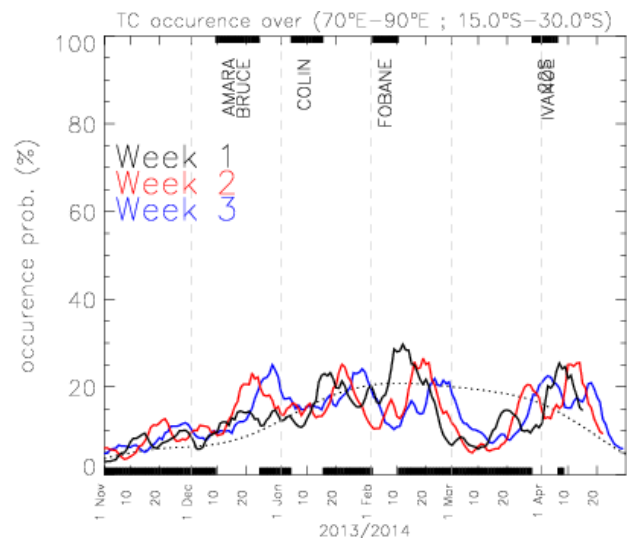
MJO Forecasts (RMM diagram)

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Probability of TC genesis and TC occurrence

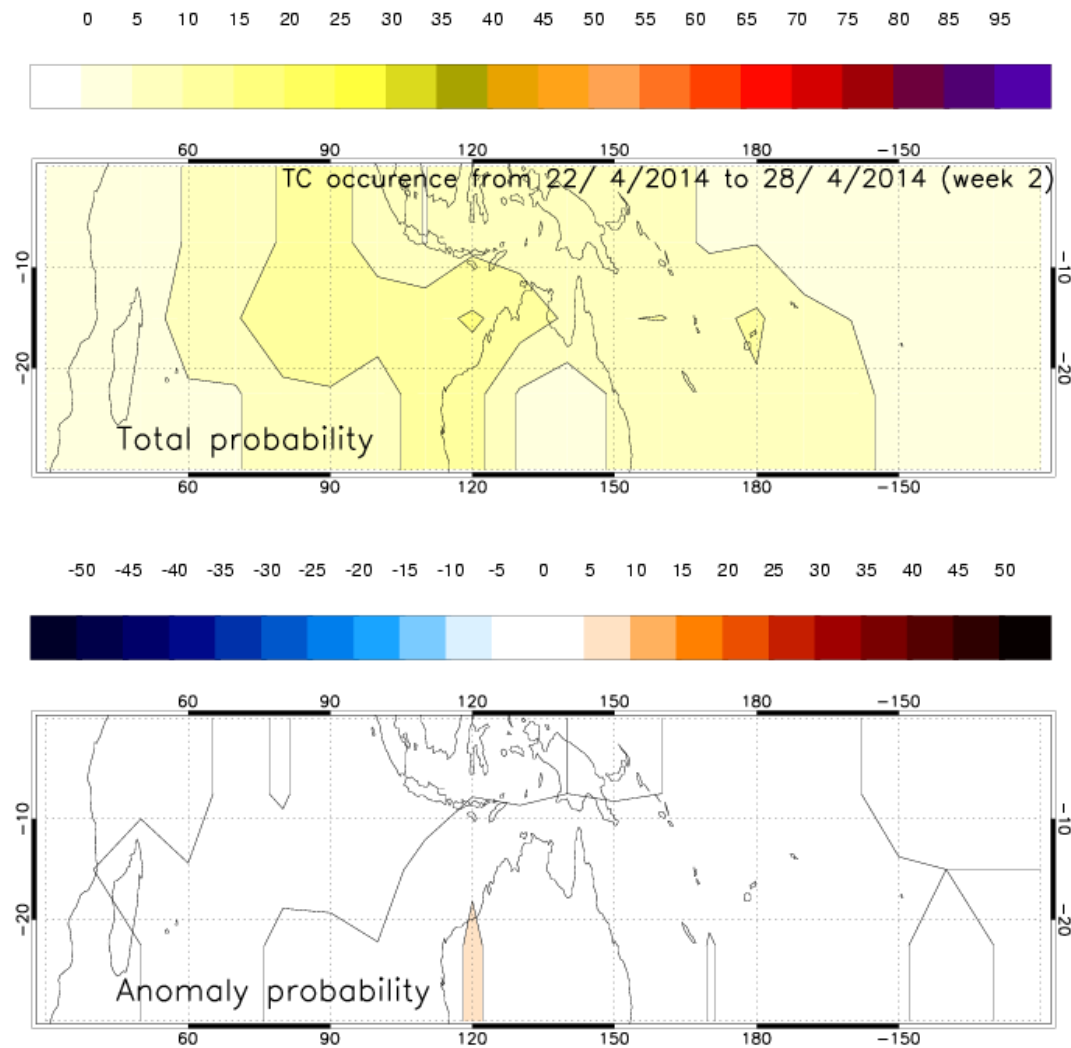Statistical method based on a logistic regression with different indices :

MJO, Nino3.4 SST, Trans-Nino Index, Indian Ocean Dipole.

Developed by Anne Leroy (M-F Nouvelle-Calédonie) and Matthew Wheeler (BOM)

http://www.meteo.nc/cyclone/coin-des-experts

temporal representation for area
70E – 90E / 15S – 30S

Spatial representation for week 2

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Assessment of MJO is quite well documented,

for example : « Evolution of ECMWF sub-seasonal forecast skill scores over the past 10 years », F. Vitart, ECMWF Technical Memorandum 694.

→ **skill up to week 3**

→ **Propagation slightly too slow**

→ **Intensity slightly underestimated**

Assessment of Statistical vs Dynamical product :

« A comparison of Dynamical and Statistical Predictions of Weekly Tropical Cyclone Activity in the Southern Hemisphere », F. Vitart, A. Leroy, M. C. Wheeler, Monthly Weather Review 138, sept. 2010.

→ **skill up to week 3 for both statistical and dynamical forecasts**,

→ **dynamical forecasts overestimate the number of TCs**,

→ **combination of statistical and dynamical improves the skill**.

Subjective assessment of ECMWF products TC, TS and HR probabilities from week 1 to week 3, during last two seasons.

Questions are :

- How can we use monthly products?
- Comparison of 2012-2013 and 2013-2014 seasons (important changes in November 2013)

Conclusions are :

→ HR (hurricane) risk are extremely rare, only week 1 and when the system is present in the initial state of the model,

→ no positive anomaly of TC → no risk of cyclone

→ best compromise to minimize False Alarm and Non Detection seems to be : prob(TC) >= 60% or prob(TS) >= 5%

→ it is difficult to compare two seasons because the samples are not the same, the locations are different. There is a possible improvement for week 2 and 3 regarding the number of non-detection.

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Every day, a technical bulletin is issued by the RSMC,

(http://www.meteo.fr/temps/domtom/La_Reunion/webcmrs9.0/#)

- Description of present systems

- description of parameters related to genesis potential and diagnosis of daily risk of cyclogenesis for the next 5 days.

→Although this daily bulletin focusses on short to medium range forecasts of cyclogenesis, the cyclone forecaster looks at and evaluates the pertinence of monthly forecast and may include extended outlook and additional information at monthly time range in the bulletin

Example from 21/02/2014 :

« **long range tendency of cyclone activity** : … The ECMWF monthly forecast suggests, with a good confidence level, that this situation [activity lower than normal] should last until the end of the month, and even extend during the first decade of march. »

TC strike-probability anomaly – week 2

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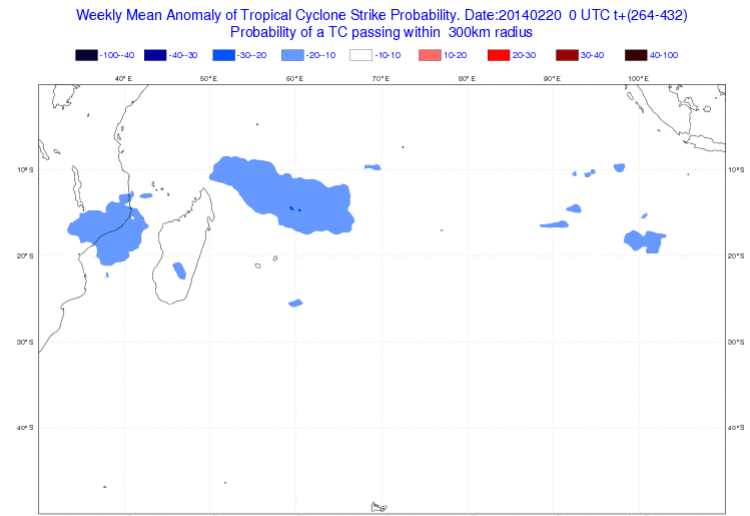
## For cyclogenesis detection :

Tropical Cyclone Strike Probability Start date:Wednesday 28 May 2014 at 00 UTC
valid for 48hours from Thursday 29 May 2014 at 00 UTC to Saturday 31 May 2014 at 00 UTC
Probability of a Tropical Cyclone passing within 300km radius
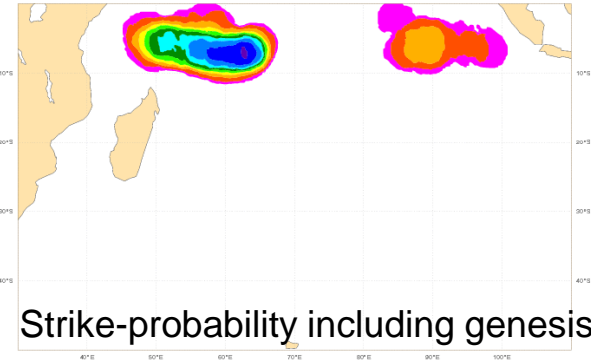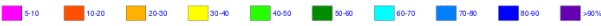
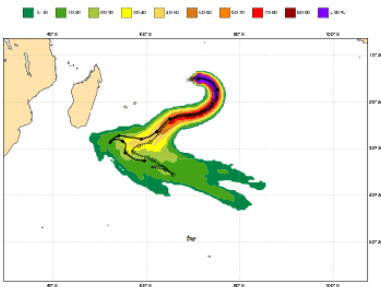Strike-probability including genesis

Pmer - Isoligne 998 hPa
modele du 04/02/2012 12h echeance 168h valide le 11/02/2012 12h
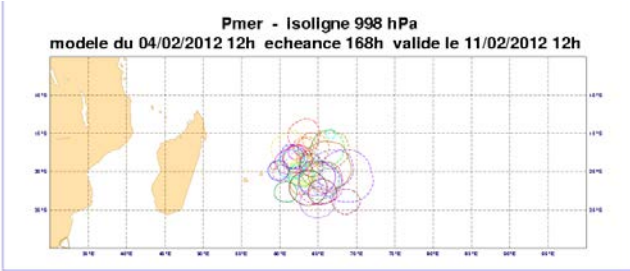
MSLP spaghettis
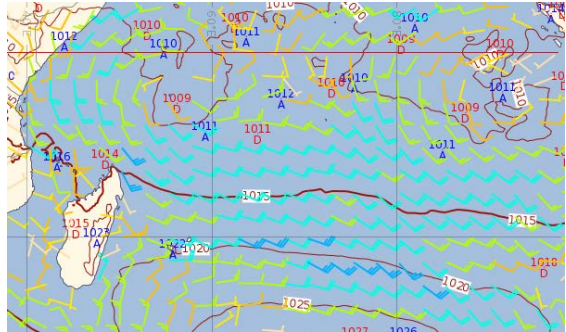
fields from deterministic models

For intensity and track forecasts :
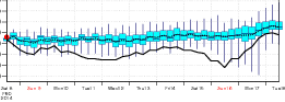
+ all the fields from deterministic models :
MSLP, wind, vorticity, temperature, humidity…

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Feedbacks from RSMC Forecasters

- ✓ Clear/impressive improvement of cyclogenesis detection since 5-6 years : nearly no non-detection and very few false-alarms
- ✓ Permanent improvement of track forecasts, even at medium-range
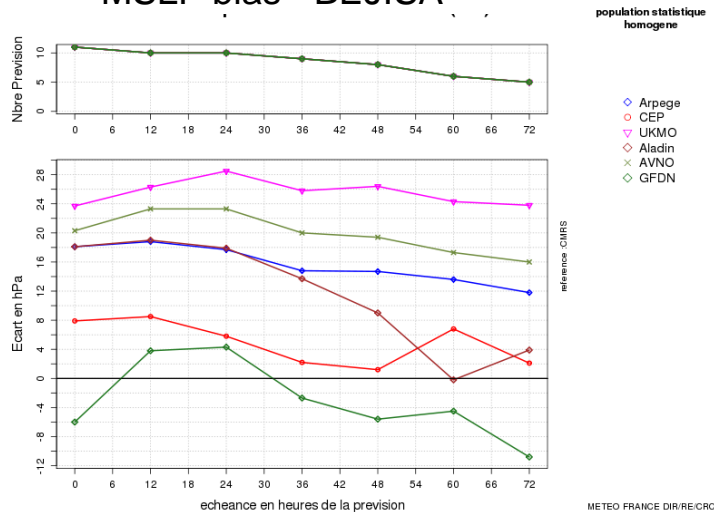- ✓ « bluffing » behavior of HRES model (example of Bejisa)

HRES forecast 9 days in advance
(red point = observed position)
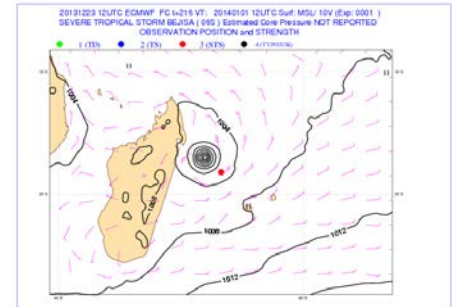
Direct Position Error - BEJISA
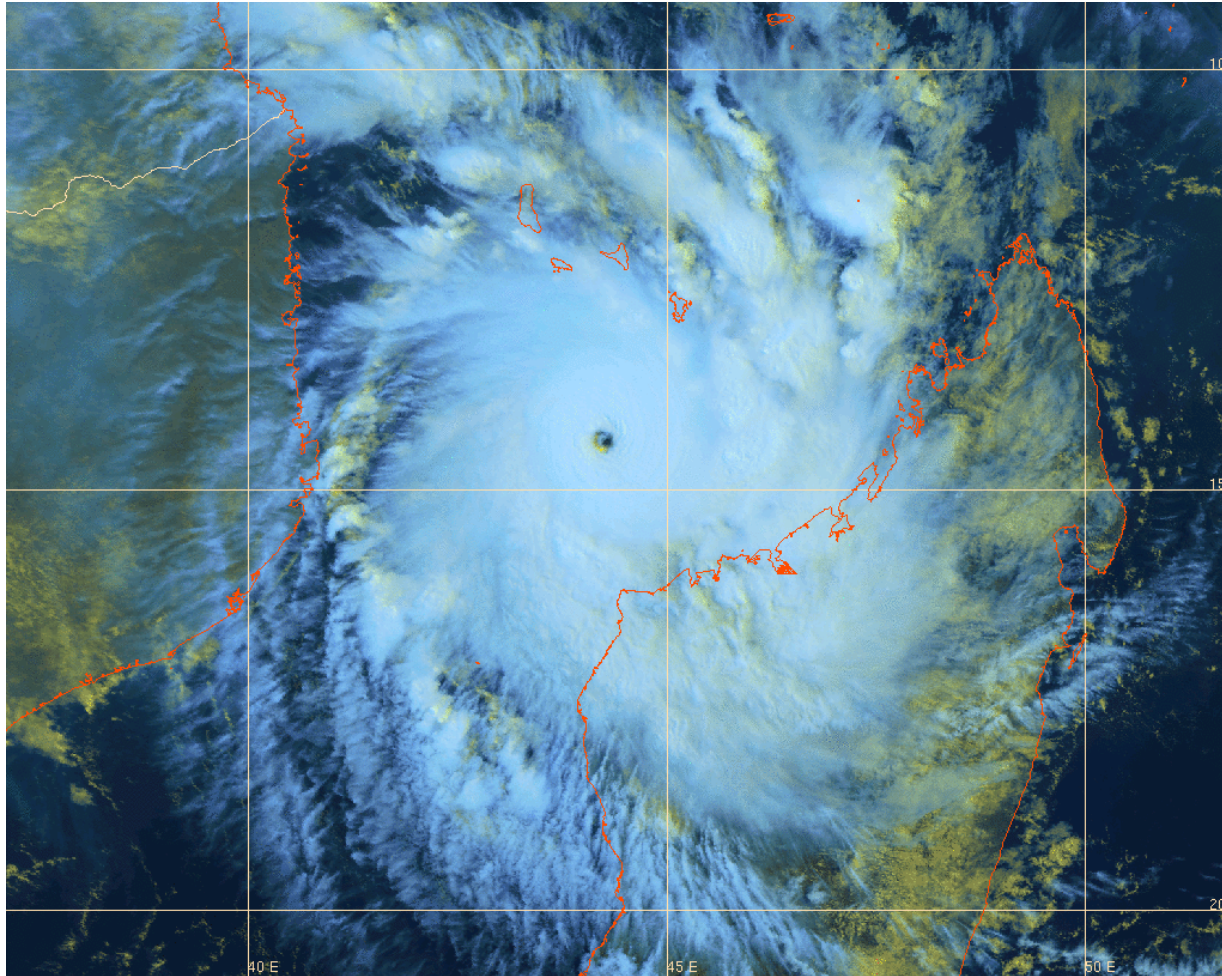


MSLP bias - BEJISA

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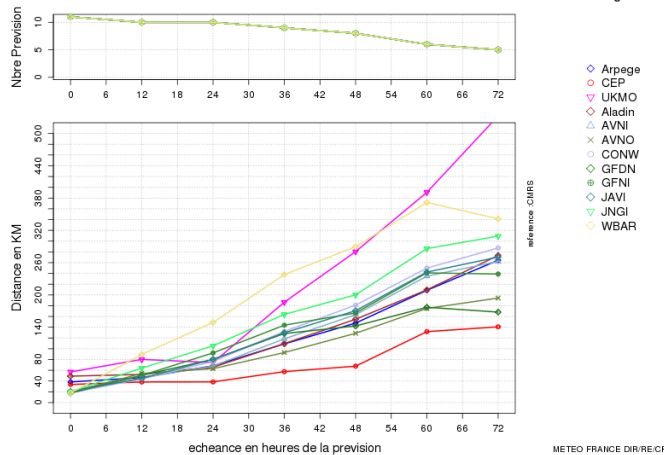
but not perfect :   **Intensity forecasts still challenging**

TC Hellen (from 29/03/2014 to 01/04/2014) was a spectacular case of major bust

(unprecedented « explosive » intensification up to level 7.0 (Dvorak), 915 hPa)

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TC Hellen problems : late/barely detection of genesis,

large underestimation of intensity

Tropical Storm Strike Probability Start date:Thursday 27 March 2014 at 12 UTC
valid for 48hours from Friday 28 March 2014 at 12 UTC to Sunday 30 March 2014 at 12 UTC
Probability of a Tropical Storm passing within 300km radius

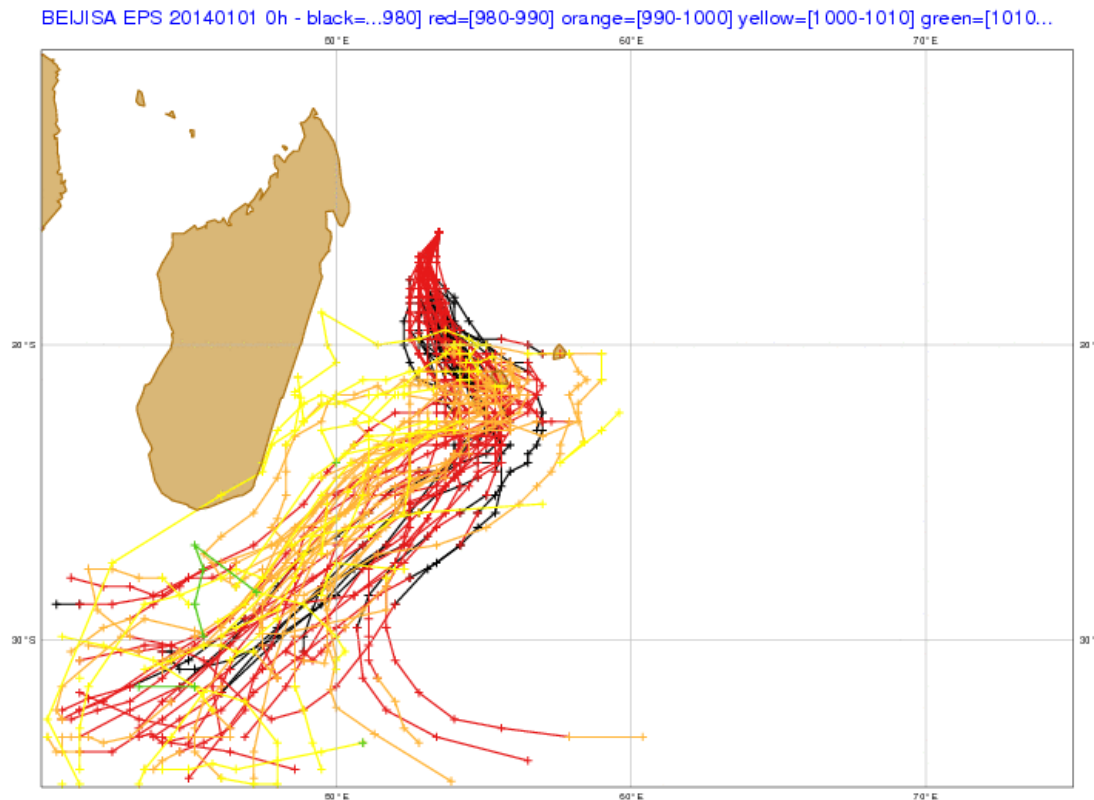INTENSITE pour HELLEN (14S) PREVISIONS CEP
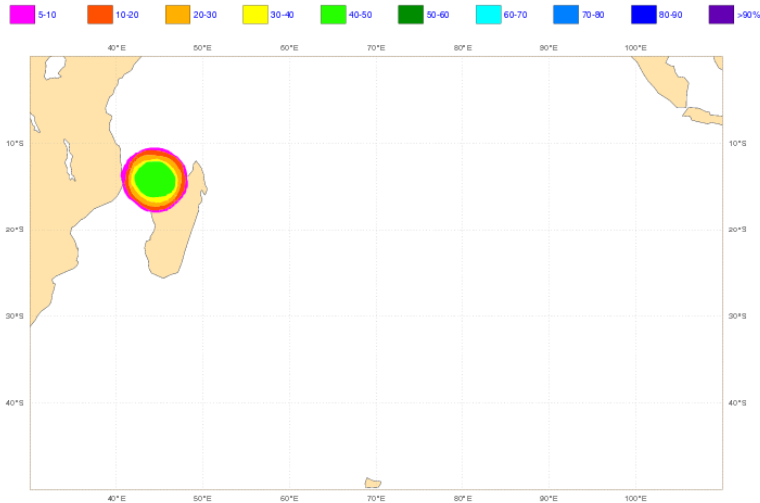
only 40% of EPS members
2 days in advance
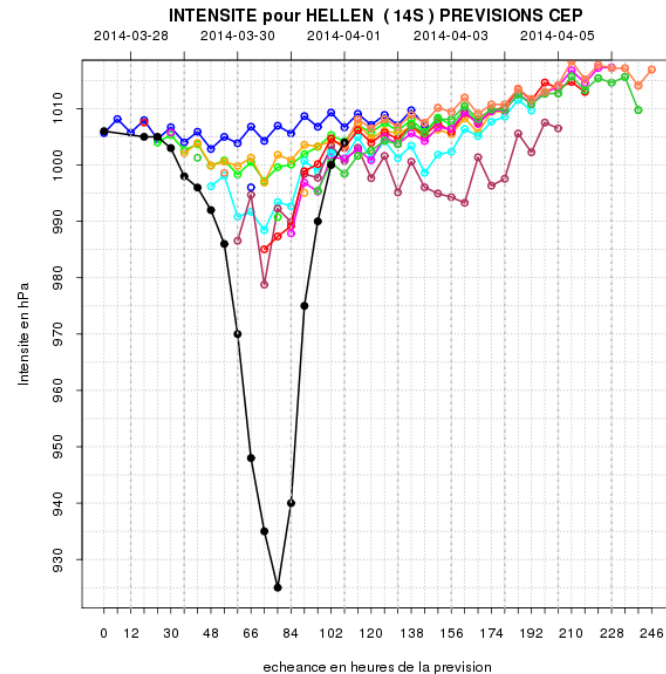
forecasts with successive
HRES largely underestimated
max intensity

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Suggestion for a new product :

Plumes map with colours according to the intensity

Example of Bejisa (EPS from 01/01/2014)

BEIJISA EPS 20140101 0h - black=...980] red=[980-990] orange=[990-1000] yellow=[1 000-1010] green=[1010...

…< 980 hPa

980 – 990 hPa

990 – 1000 hPa

1000 – 1010 hPa

1010 hPa < …

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- Indication of genesis risk in the daily bulletin

- Alerts and warning messages for security, public, aeronautical and marine users/stakeholders

- Estimation of other risks : storm surge, cyclonic swell… (coupled models)

- Product with area of uncertainty (caculated with ECMWF EPS) : http://www.meteo.fr/temps/domtom/La_Reunion/webcmrs9.0/#

« Verification of ensemble-based uncertainty circles around tropical cyclone track forecasts», T. Dupont, M. Plu, P. Caroff, G. Faure, 2011, Wea. Forecasting, 26, 664-676.

Exemple : TC GIOVANNA 11 Feb. 2012 at 1200Z forecast

METEO FRANCE
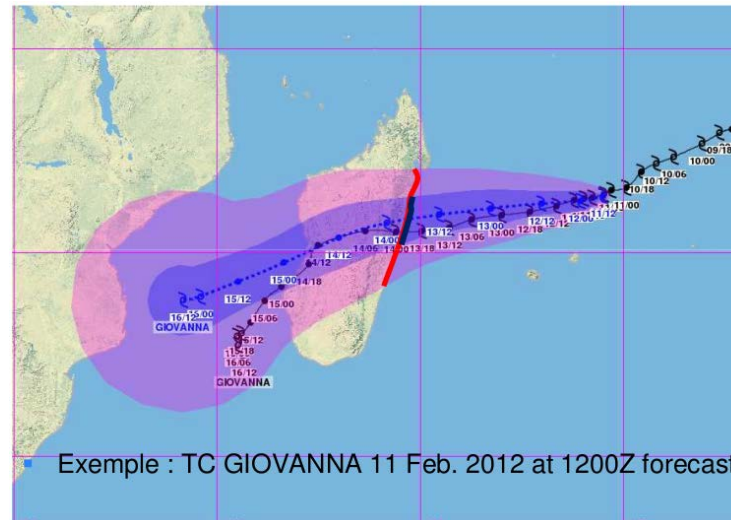
Conclusion / Summary

→Useful products for all time-ranges

→Permanent improvements, but remaining challenges and still job to do !

→Communication about severe events is a sensitive matter

Thank you for your attention !

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