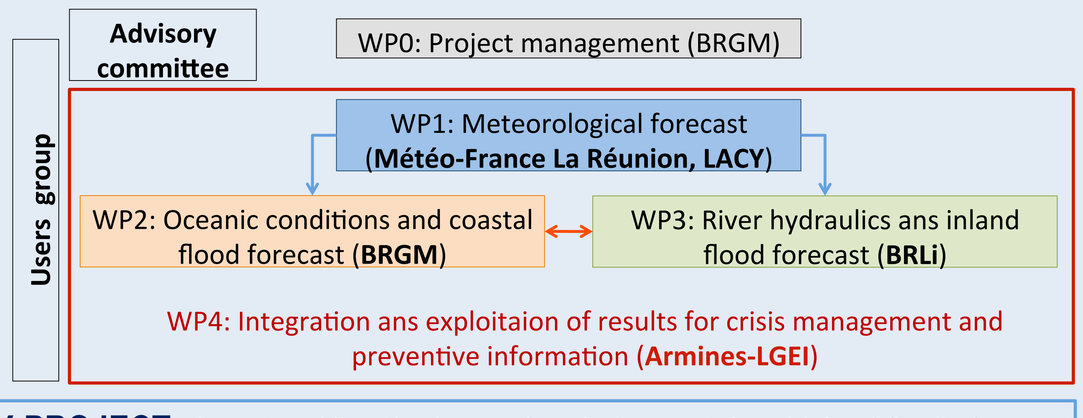
An integrated tool for forecasting tropical cyclone and induced floods

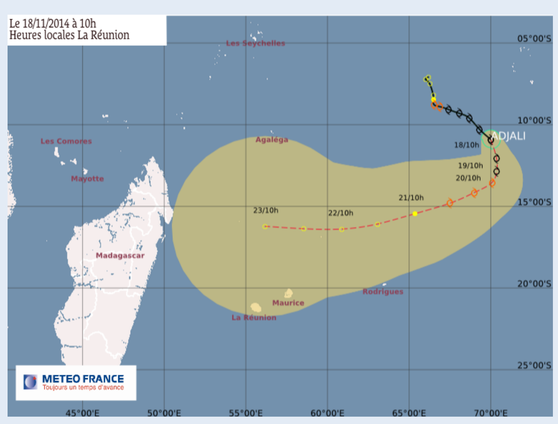
F. Bonnardot, H. Quetelard : METEO-FRANCE, DIROI, Saint-Denis de La Réunion, France
O. Bousquet , D. Barbary, S. Bielli , C. Barthe, J. Meister : LACy, UMR 8106, St Denis de La Réunion, France
S. Lecacheux, R. Pedreros, F. Paris, E. Chateauminois, A. Nicolae-Lerma, J. Rohmer : BRGM, France
R. Recouvreur, M. C. Germain : BRLi, France
S. Sauvagnagues, P. A. Ayral, F. Tena-Chollet : ARMINES, Mines d'Ales, France

CONTEXT

Most French Overseas Territories are located within tropical regions and thus exposed to cyclone-induced hazards such as marine and river inundations. They share specific issues as most of them are quite small steep volcanic islands with a complex orography. Therefore, the potential coastal and hydrological impact is tightly related to the **track** and the **intensity** of the tropical cyclone (TC) transiting nearby. Although TC track and intensity forecast have been steadily improving over the last decades, a lot of uncertainty remains. Risk managers need both a reliable forecast of the TC evolution and induced impacts and an estimation of the forecast uncertainty.

Since Météo-France in La Réunion Island has been formally designated as Regional Specialized Meteorological Centre **(RSMC)** for the provision of forecasts and warnings of hurricanes in the south-west Indian Ocean (SWIO), a technique was developped to measure and display the uncertainty around RSMC's official track forecast. This method, using the position distribution provided by ECMWF EPS ensemble scenarios, was proved to be more accurate then methods based on climatological distribution of position error (Dupont & Al 2011). Thus, this method is a first step towards probabilistic forecast but can not reach SPICY's project objectives which consist in quantifying local impacts (wind, waves, coastal flooding) with 48-72h hours leadtime forecast **in a probabilistic manner**.





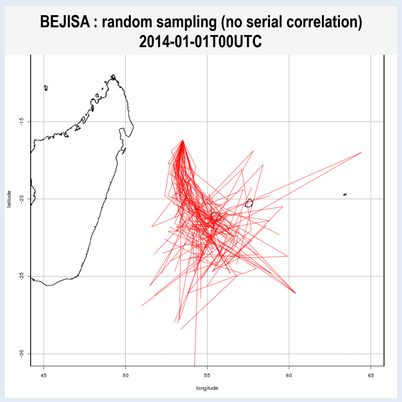
Preliminary results on the method to generate ensemble track and intensity scenarios with associated probabilities are presented bellow.

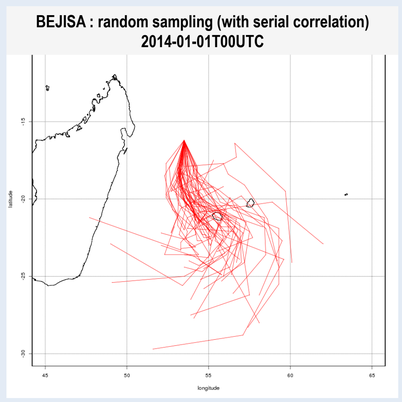
SPICY PROJECT aims at tackling the issue of cyclonic coastal and inland floods forecast in the French Overseas Territories through the development of technological building blocks and the realization of a demonstrator for **Réunion Island**. To reach this objective, the project addresses some limitations of the current forecasting system and contribute to international ongoing efforts on cyclonic and induced impacts prediction, focusing on :

- **assessment of meteorological uncertainties (ensemble tracks generation techniques),**
- high resolution meteorological modelling taking into account orography and real-time data assimilation,
- the extension of forecast information to coastal and inland floods through the development of dedicated modules, notably in urban areas,
- the study of marine/river interaction and its consequences on the flood extent,
- the management of computation times and the investigation of optimization techniques,
- the development of users interfaces to improve the accuracy and relevance of the information provided to emergency managers.

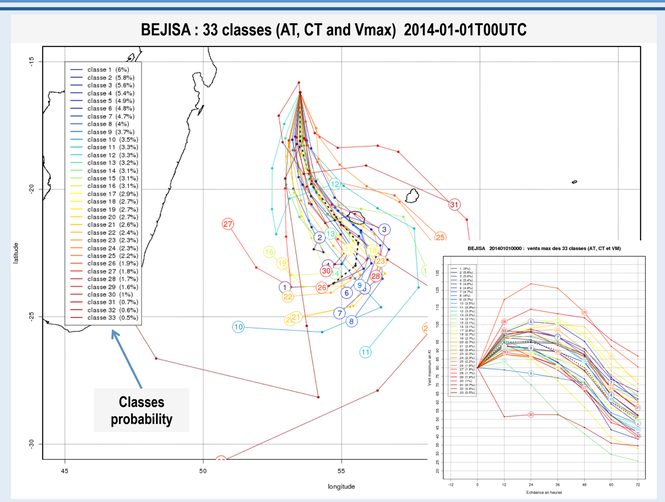
TC BEJISA

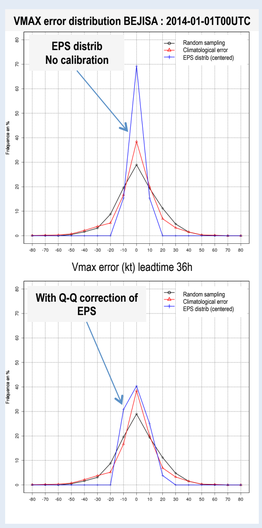
STEP 1 : Generation of 1000 scenarios by randomly sampling RSMC operational forecast track (AT, CT) and intensity error distribution, taking into account the temporal serial correlations (Monte-Carlo method implemented in NHC, DeMaria & Al, 2009). Each scenario has a probability of 0.01

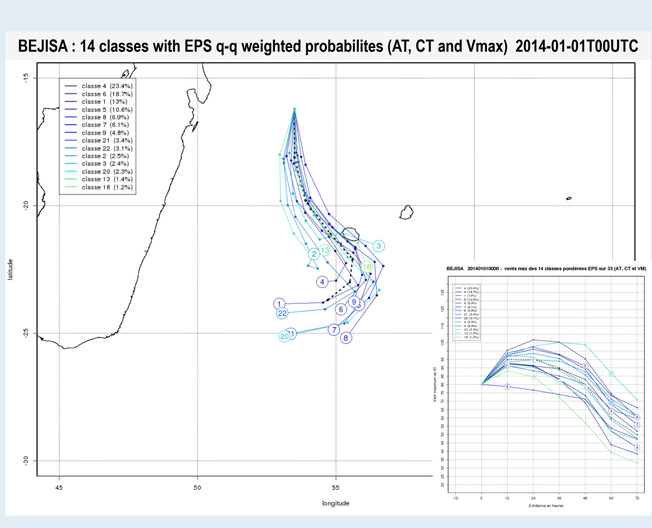




STEP 2 : CHA classification in order to reduce the number of scenarios (1000 -> ~30). Probability of each cluster is deduced from the number of tracks included in the class (prob=nbTrack/ 1000). Tests are being conducted in order to estimate the minimum number of classes necessary to describe with a reasonable precision the panel of possible scenarios and the resulting impacts and probabilities.







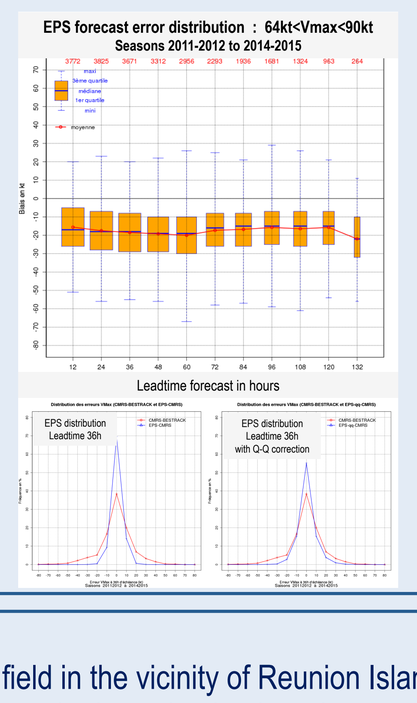
STEP 3 : Classes probability weighting using ECMWF EPS ensemble

Each EPS member is re-classified within the CHA classification. Different methods are being investigated in order to decide the best way to use the intensity distribution among the 51 EPS members. Is this information relevant to measure the intensity forecast uncertainty? Three options are identified :

1.The information is not relevant : we concider only the position distribution issued from EPS and keep a random distribution for intensity based on the climatological forecast error.

2.The information is relevant : we consider the intensity distribution provided by the EPS as well as the position distribution (both being centered on the official forecast).

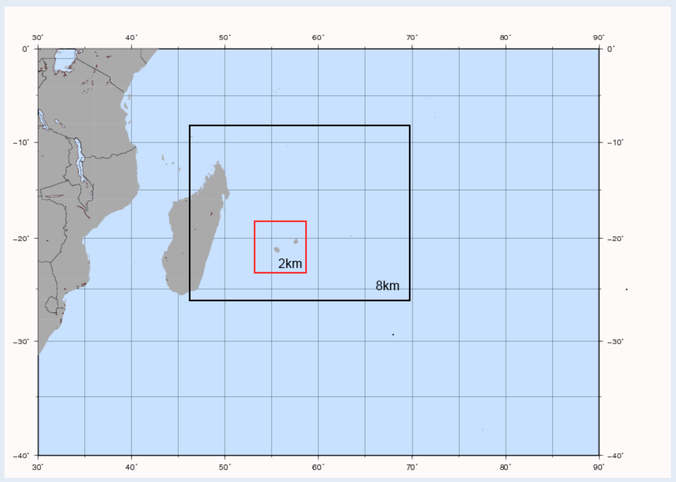
3.The information is relevant but needs calibration: we consider the intensity distribution corrected by a "quantile-quantile" function.

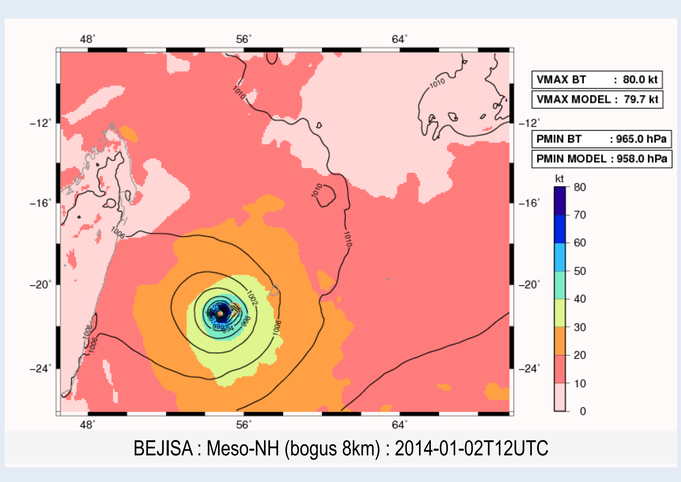


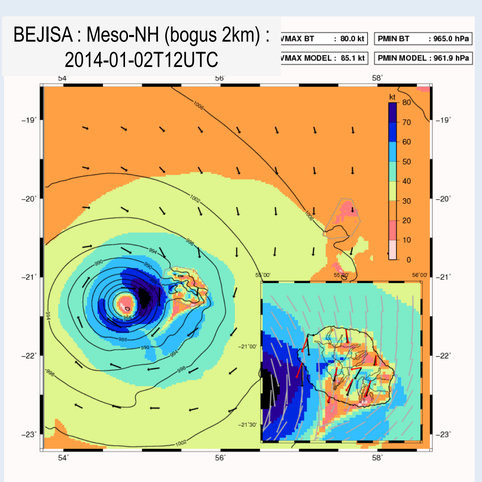
NEED TO EVALUATE DIFFERENT METHODS (Brier scores, ROC…)

STEP 4 : Wind and pressure fied generation for each scenario

The easiest way is to use Holland parametric model. This option presents two main limitations. The information provided away from the TC is poor and local wind field in the vicinity of Reunion Island is not relevant due to the topography of the Island. Therefore , the use of Meso-NH model in a light configuration (two imbricated grids at 8 and 2 km resolution) is under investigation in order to tackle these limitations. The vortex (Holland parametrization) is bogused into the large scale wind field provided by ECMWF's IFS model. A short simulation (less than one hour) is run so that the vortex can balance with the large scale conditions and the local wind field can fit with the Island deformation effects.







The configuration is being tested among 4 historical TCs that have impacted Reunion Island : BEJISA (2014), FELLENG (2014), GAMEDE (2007) and DINA (2002). First results show that

- 15mn simulation is enough to stabilise the cyclone intensity and structure.
- 1h simulation is needed to catch the local wind structure induced by the interaction of the cyclone and the topography of the Island

32st Conference on Hurricanes and Tropical Meteorology – Puerto Rico – 2016

contact: hubert.quetelard@meteo.fr francois.bonnardot@meteo.fr

This work is supported by the French National Research Agency (ANR – 14 – CE03 – 0013). More details on the project are available at http://spicy.brgm.fr