PISSARO workshop – 1<sup>st</sup> June 2022



### Forecasting extreme events in the southwest Indian Ocean on a monthly scale

# Evaluation of the tropical cyclone tracks in the S2S prediction for the SWIO

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### The PISSARO project

#### <u>Objective</u>

Evaluation of the S2S database weeks 2 to 4 (tropical cyclone and extreme precipitation forecast) for users in the SWIO region

Why evaluation? To provide information on the uncertainty associated with the S2S forecast to users of the product developed in the framework of PISSARO

#### <u>A methodological challenge for TC</u> <u>tracks S2S forecast evaluation</u>

How to match a forecast cyclone to an observed cyclone? Which criteria of time and distance? Which criteria for path length or duration of the cyclonic episode?

How to evaluate an ensemble forecast of tropical cyclone tracks? How to evaluate a set of 51 scenarios against a single observation to extract scores?

A methodological challenge that we continue to struggle with!!!

#### Example of S2S forecast of 1 run for a timerange of 2 weeks (i.e. D+14 to D+20)



Figure. Set of potential trajectories (forecast 2 weeks in advance) for the week of 18 January 2021 during which cyclone ELOISE was observed. In orange, systems that have reached the tropical cyclone stage in the forecast. Data : ECMWF Source: DIROI/EC team.



Figure. ELOISE trajectory according the the best-track of the RSMC of La Réunion. Source: Météo-France

### S2S TC tracks

#### Data



Work based on the **large database of the S2S prediction project** i.e. 7 years of intra-seasonal forecasts and 25 years of replay of past forecasts with improved model versions.

#### Focus on the ECMWF and ARPEGE dataset

(atmospheric parameters + TC tracks)

Accessed to the TC tracks database provided by the S2S prediction project

Application of the ECMWF tracker (Vitart et al., 2001; Van der Grijn et al., 2005) on the real-time and hindcast data

## Integration into a QGIS database of the S2S cyclonic trajectories for the ECMWF and ARPEGE model to facilitate their processing and comparison with observations.

0° 10°S 20°S 40°S 30°E 45°E 60°E 75°E 90°E 105°E 105°E

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Example of forecast of 1 run for a timerange of 2 weeks (i.e. D+14 to D+20)

### Use of a pre-existing classification

Our approach: Classifying the observed and predicted trajectories to facilitate the comparison



- Classification defined
  empirically by EC/DIROI (G. Jumaux and F. Bonnardot)
- Identification of groups of trajectories by clustering methods



### Use of a pre-existing classification

Figures. Clustering of the observed between 1986 and 2020 tropical cyclone with the classification defined empirically by the DIROI/EC team (only the most frequent clusters are shown). Courtesy of F. Bonnardot.





Potential impacts on Madagascar and on the coastal countries of the Mozambique Channel



### Pre-processing of the data (I)

#### <u>Credit</u>

All the following results are from the internship of **Simon Charpigny** (engineering student at ENSTA) from September 2021 to February 2022, supervised by H. Vérèmes, S. Malardel and F. Bonnardot. **Only the ECMWF dataset has been used.** 

	Best-track	Real-time
cluster	1985-2021	2015-2021
111	0.12	0.07
212	0.09	0.04
222	0.19	0.13
323	0.13	0.03
333	0.25	0.05
999	0.15	0.64

Table of the frequency distribution of trajectories in the best-tracks and in the real-time for the main clusters



Decrease of the max wind threshold for forecasts from 34 kts to 25 kts

Figure. Evolution of the BT-RT difference (solid line) and the score (dotted line) as a function of the threshold wind for classification

### Pre-processing of the data (II)

14

12



Moyenne d'occurences sur la saison 2015-2020, real-time, vent seuil : 25 kts, Monday

#### clusters 10 333 323 Occurrences 313 8 223 222 213 212 112 111 0.69 0.43 0.45 0.7 2 0.67 0.63 0.96 n 2 5 2 3 Janvier-Avril

#### Filtering on min. track length required

#### More work on filtering needed

Too many tracks in the forecast

#### Over/underestimation of specific clusters

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#### Moyenne d'occurrences sur la saison 2015-2020, real-time, vent seuil : 25 kts, Monday

### Clustering of the real-time tracks



Figure. Application of the classification to the S2S TC tracks for W0 real-time forecasts (vertical bars) compared to the observations (top coloured dots) during the 2015-2016 season with a the preliminary pre-processing of the data. Pre-processing of the data is still a work in progress.

### Summary and outlooks

Summary

- Clustering of all the tracks available in the S2S database for the ECMWF model
- Comparison of the classes obtained from 1 to 4 weeks forecasts over the past 6 years with the "observed" TCs
- Highlight of model biases on max. wind (too weak) and trajectories (too many short ones).
  - → Calibration done (25 knots for TS stage and filtering of too short trajectories)

Outlooks

- Refining the pre-processing of the data
- Calculation of skill scores
- Exploration of automatic clustering methods (internship in progress by Mike Payet supervised by Quoc-Phi Duong)
- Development of products

### Outlooks On product development

Figure. Proba strike product, 2-week forecast of the probability of a storm or tropical cyclone passing within a 300 km radius for the week of 18-25 January. Source: ECMWF.

ELOISE January 2021 Tropical cyclone Figure proposed in the framework of PISSARO



Figure. Set of potential trajectories (forecast 2 weeks in advance) for the week of 18 January 2021 during which cyclone ELOISE was observed. In orange, systems that have reached the tropical cyclone stage in the forecast. Data : ECMWF Source: DIROI/EC team.





### Outlooks

### Product development based on this work

Use the trajectory classification work to offer forecasters all the information contained in S2S while extracting more precise information than the probability strike product information, such as the type of trajectory most likely to be observed.





Figure in the middle. The distribution of the different predicted trajectories for this prediction. The histogram shows a higher probability of occurrence of trajectory 222 type track which corresponds to the class of the observed track of the tropical cyclone Berguitta.

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*PISSARO: Prévisions Intra-Saisonnières et Saisonnières avec AROme* is co-funded by The European Union and Région Réunion



