Projet de Recherche INTERREG-V océan Indien 2014-2020
A1/OT1/OS-01a - Action II-2 TN

ReNovRisk-Cyclones et Précipitations

L14 : Compilation des actes et supports des présentations effectuées dans des conférences internationales

Olivier BOUSQUET

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Livrable 14

Compilation des actes et supports des présentations effectuées dans des conférences internationales

Le projet a fait l'objet de présentations dans 3 conférences internationales

- **International Conference on Southern Hemisphere Meteorology and Oceanography 2018, Australie, Février 2018 (oral)**
- **33eme Conférence sur les cyclones tropicaux, USA, Avril 2018 (oral)**
- **American Geophysical Union, Annual Meeting 2019, USA, 2019 (affiche)**

Les abstracts et présentations sont inclus ci-après.

9C.7A The SWIO-TC Experiment: A Field Experiment to Improve Understanding and Prediction of Tropical Cyclone Intensification in the SW Indian Ocean

Wednesday, 18 April 2018: 12:00 PM More
Champions ABC (Sawgrass Marriott)

Olivier Bousquet, LACY (UMR 8105), Saint-Denis, Reunion; and J. P. Duvel R. F. Rogers, P. Caroff, F. Roux, and P. Tulet

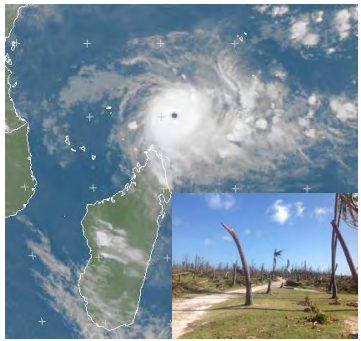
Audio File
Recorded Presentation

Tropical cyclones (TCs) are associated with heavy rainfall and strong winds that may cause huge human, material and environmental losses in many tropical and subtropical regions. This is particularly true in the southwest Indian Ocean (SWIO) basin, a poorly studied region that experiences a cyclonic activity roughly as intense as in the North-Atlantic basin. Over the last decades, a large number of storms have indeed caused devastations in the Mascarenes (Mauritius, La Réunion), Madagascar, Mozambique and other neighboring countries. In March 2017, TC Enawo and Dineo, caused for instance hundreds of fatalities and more than one million refugees in Madagascar and Mozambique, respectively.
The ability to collect high quality observations within and around tropical cyclones is essential to improve their representation in new high-resolution numerical weather prediction models currently being developed by most major weather services. This is all the more important in the SWIO basin where observations are extremely limited with, in particular, no routine aircraft observation and very sparse ground-based observation networks. In order to address this problem, the international research program ReNov'Risk-Cyclones was recently funded by EU to reinforce permanent observation capabilities in this cyclonic basin and to organize a 4-month field campaign dedicated to the study of tropical cyclones developing in this area.
This presentation will discuss the current status and main scientific objectives on the field phase of this research program, which aims, in particular, to assess the meteorological and oceanic impacts of TC on inhabited territories of the SWIO basin. This field campaign, referred to as the SWIO-TC Experiment, will be conducted in Jan-Apr 2019. It will provide unprecedented observations of tropical cyclones and other high impact weather events developing in this cyclonic basin by coordinating dedicated atmospheric (e.g., regional radiosounding network, aeroclippers, dedicated ground-based/spaceborne remote sensing observations), and oceanic measurements (e.g., buoys, gliders, spaceborne measurements) in the Mozambique Channel and Mascarene Archipelago.

- Indicates paper has been withdrawn from meeting
- Indicates an Award Winner

SWIO-TC EXPERIMENT

A field campaign to improve understanding and prediction of tropical cyclones in the SW Indian Ocean basin



Olivier Bousquet

Laboratoire de l'Atmosphère et des Cyclones (LACy)

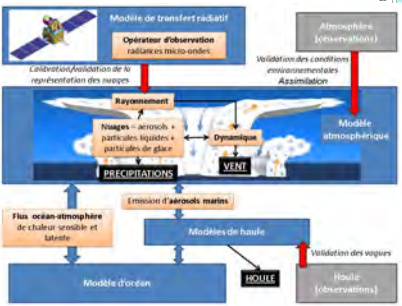
R. Rogers (NOAA/HRD) - J.-P. Duvel (CNRS/LMD)

F. Roux (Toulouse University) - P. Tulet (LACy)

E Lees, J. Durand, D. Vignelles, E. Cordier (LACy)

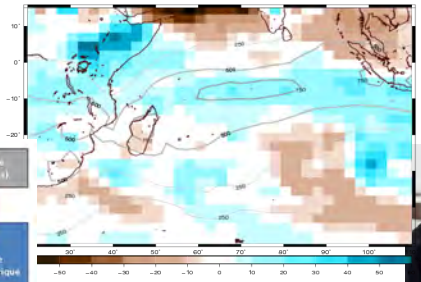
ReNovRisk – Cyclones (2017-2020)

Impacts of TC at current and future horizons



NWP

Next generation of NWP systems



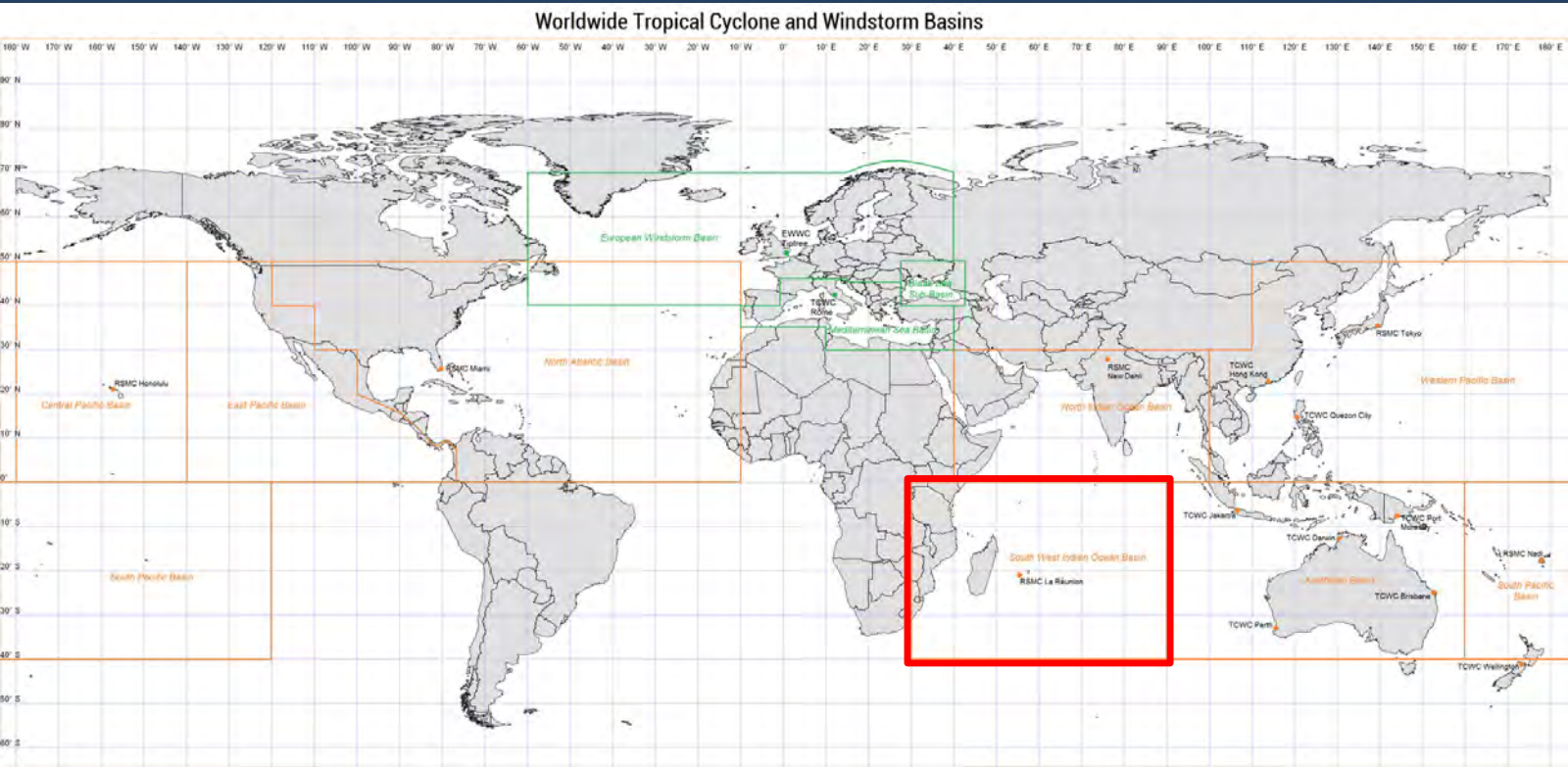
CLIMATE

Impact of CC on TC activity

OUTREACH AND TRAINING

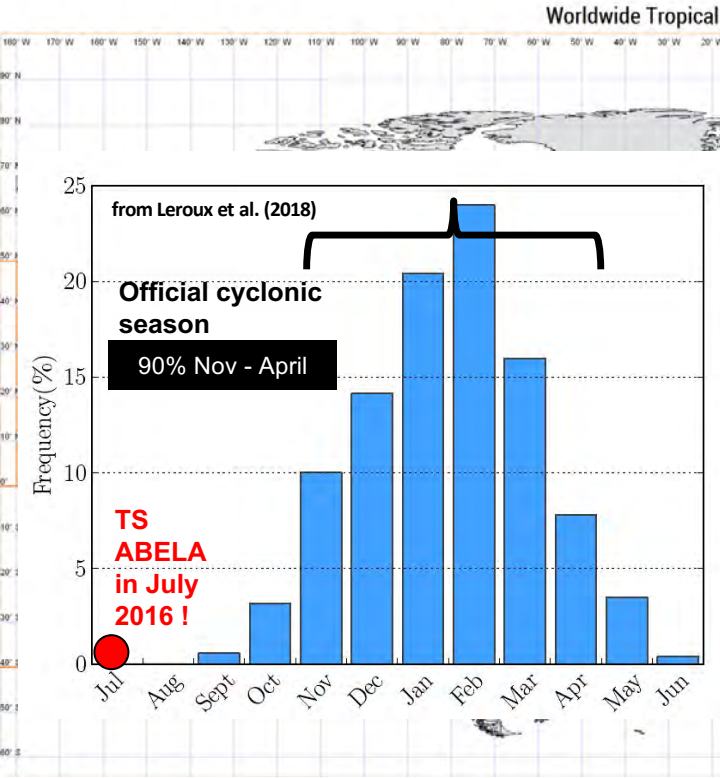
OBSERVATION

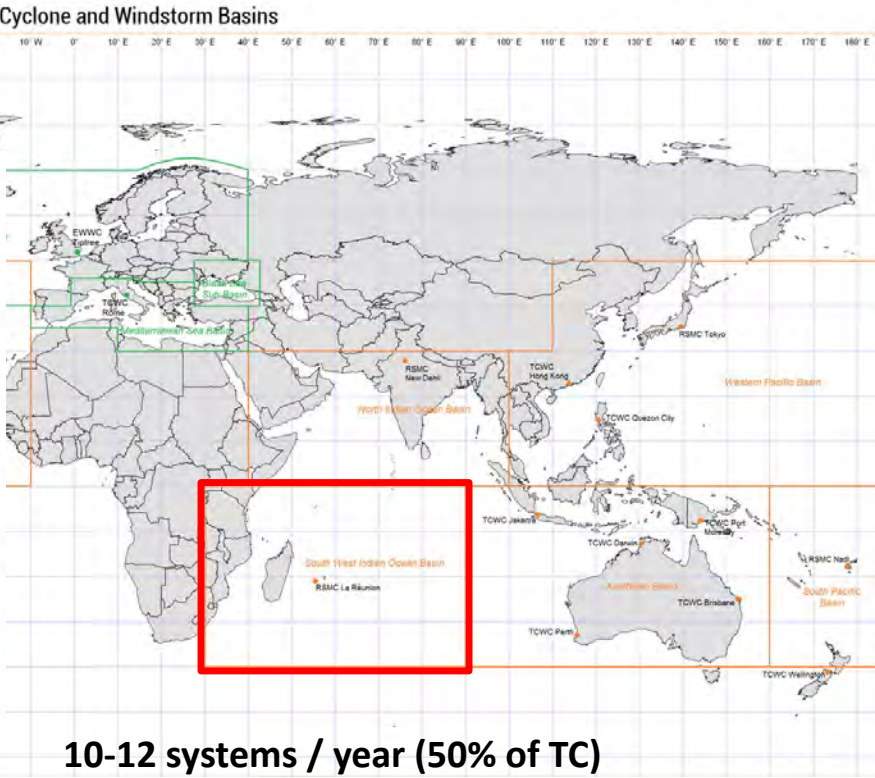
SWIO BASIN


Worldwide Tropical Cyclone and Windstorm Basins
European Windstorm Basin
EWWC
Exeter
TCWC
Rome
Mediterranean Sea Basin
North Atlantic Basin
RSMC Miami
RSMC Honolulu
Central Pacific Basin
East Pacific Basin
South Pacific Basin
RSMC
New Delhi
North Indian Ocean Basin
RSMC Tokyo
TCWC
Hong Kong
Western Pacific Basin
TCWC Quezon City
TCWC Jakarta
TCWC Port Moresby
TCWC Darwin
South West Indian Ocean Basin
RSMC La Réunion
Australian Basin
TCWC Brisbane
TCWC Perth
RSMC Nadi
South Pacific Basin
TCWC Wellington

SWIO BASIN

CLIMATOLOGY OF THE SWIO CYCLONIC BASIN





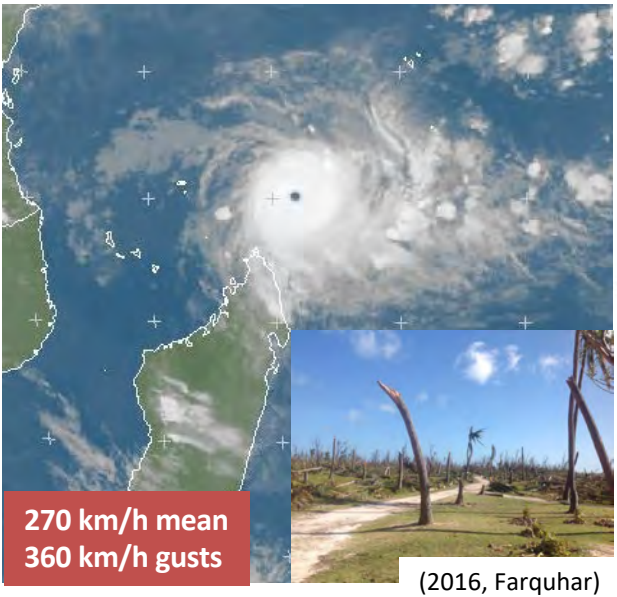
10-12 systems / year (50% of TC)

SWIO BASIN

A large (unusual) number of major storms occurred in the last 4 years (7 VITC)

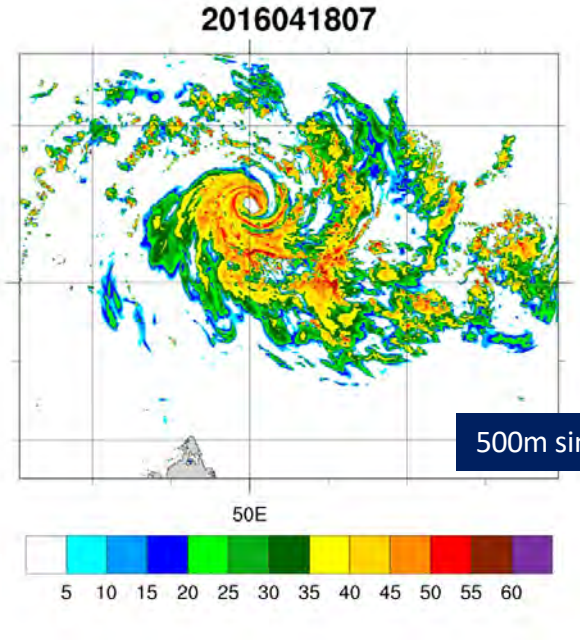
Fantala (04/2016)

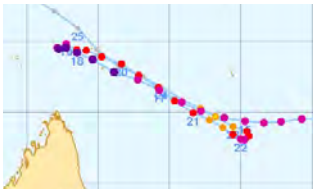
Most Intense TC ever observed in the SWIO

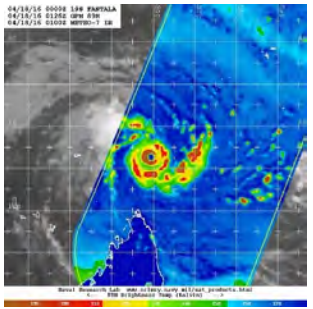


270 km/h mean
360 km/h gusts

(2016, Farquhar)







500m simulation of ERC

SWIO BASIN

Last 2 seasons

2017 : DINEO (Mozambique) & ENAWO (Madagascar)
400 fatalities – 1 million refugees
2018 : AVA / DUMAZILE / ELIAKIM (Madagascar) – ? fatalities – ? refugees

AVA (2018)

ENAWO (2017)

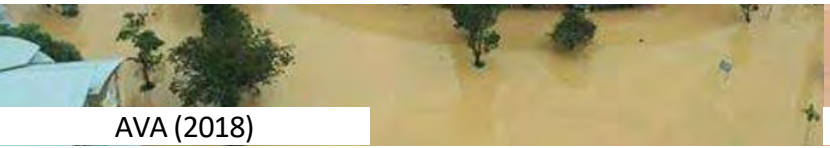
SWIO BASIN

Last 2 seasons

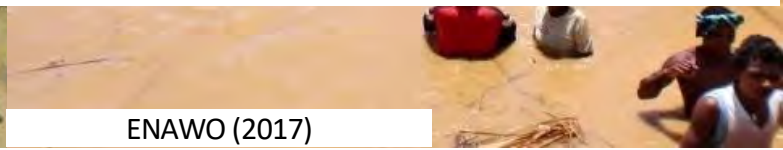
2017 : DINEO (Mozambique) & ENAWO (Madagascar)
400 fatalities – 1 million refugees
2018 : AVA / DUMAZILE / ELIAKIM (Madagascar) – ? fatalities – ? refugees

We need to improve watch and warning products

Every hour saved can save many lifes



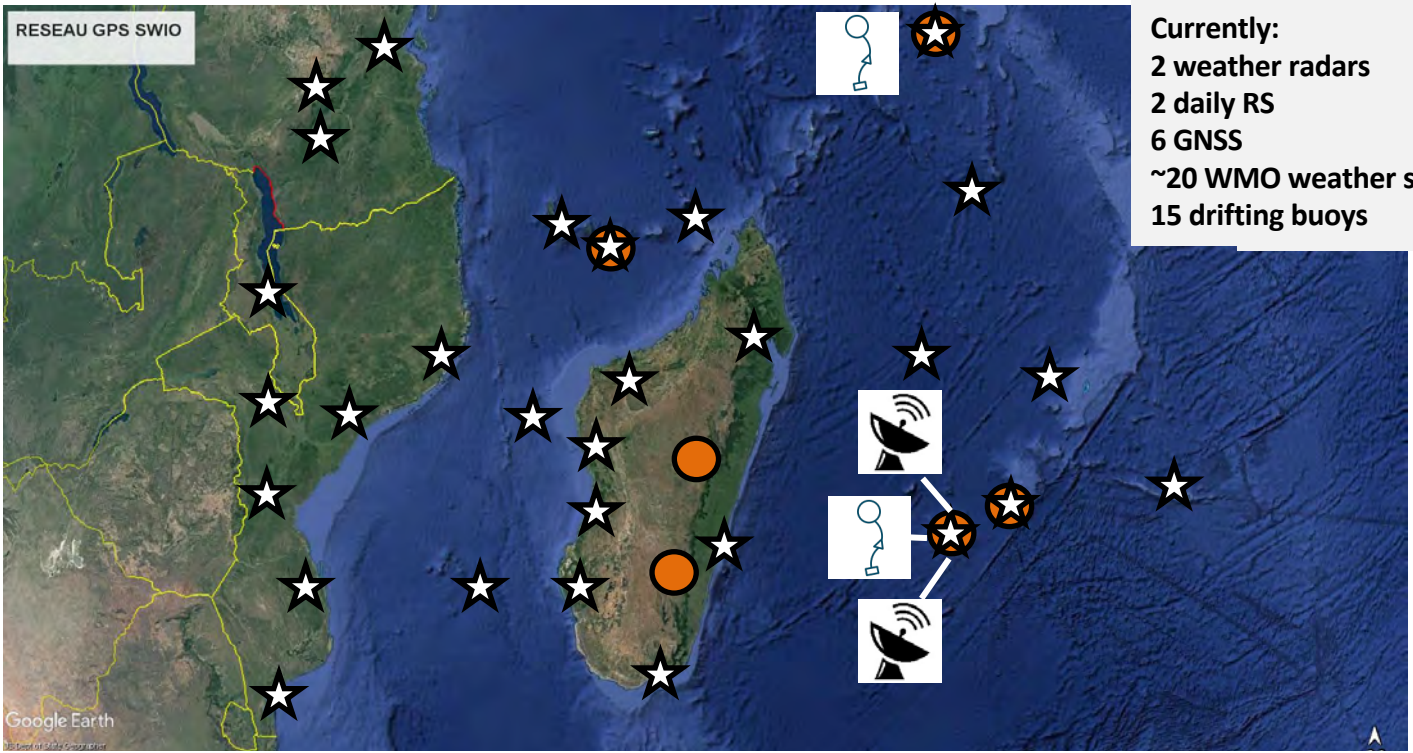
AVA (2018)



ENAWO (2017)

SWIO-TC EXPERIMENT

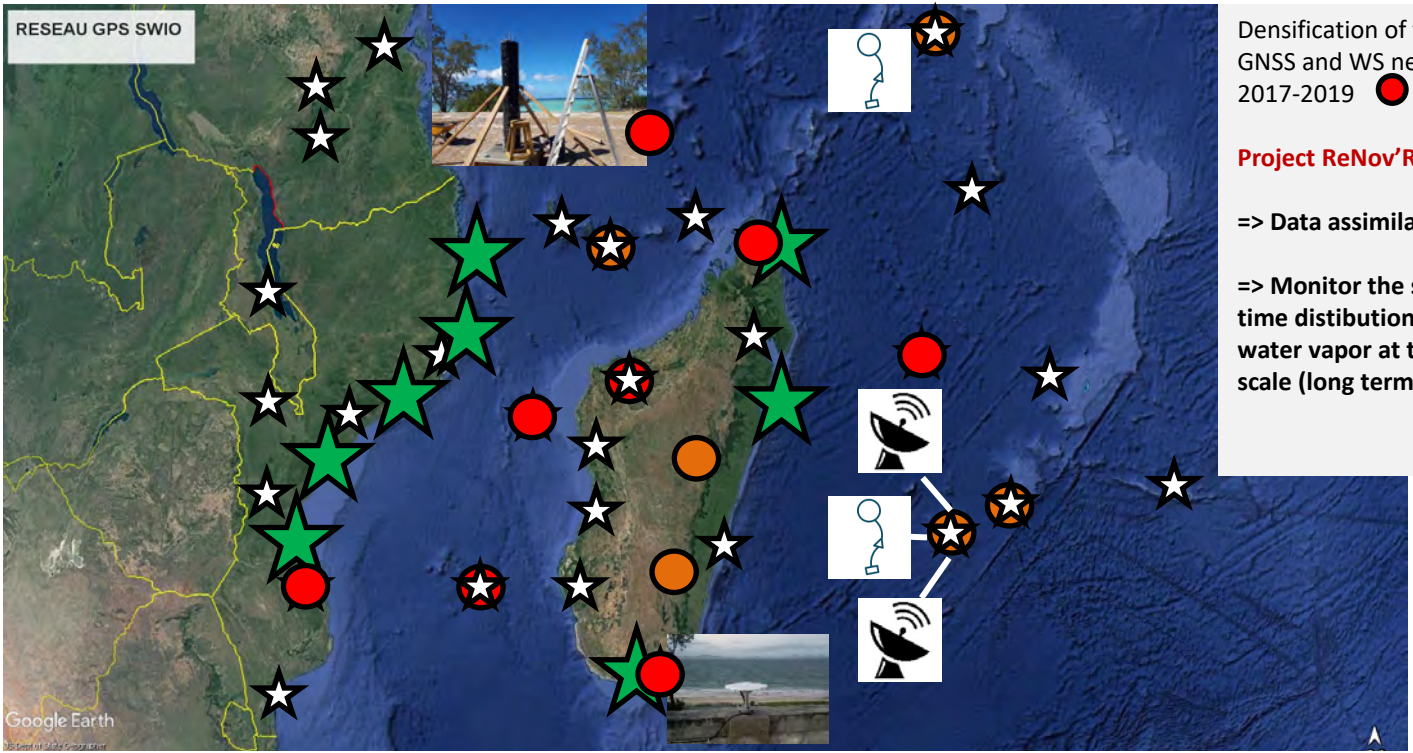
Permanent ground-based observations in the SWIO basin



Currently:
2 weather radars
2 daily RS
6 GNSS
~20 WMO weather stations
15 drifting buoys

SWIO-TC EXPERIMENT

New permanent observations (GNSS)



Densification of the GNSS and WS network 2017-2019

Project ReNov'Risk (EU)

=> Data assimilation

=> Monitor the space-time distibution of water vapor at the basin scale (long term trends)

SWIO-TC EXPERIMENT

FIELD CAMPAIGN - 15 January to 15 April 2019 – Project ReNov'Risk (EU)

Objective: collect, for the first time ever in the SWIO basin, an extensive observation dataset during (at least) one full cyclonic season

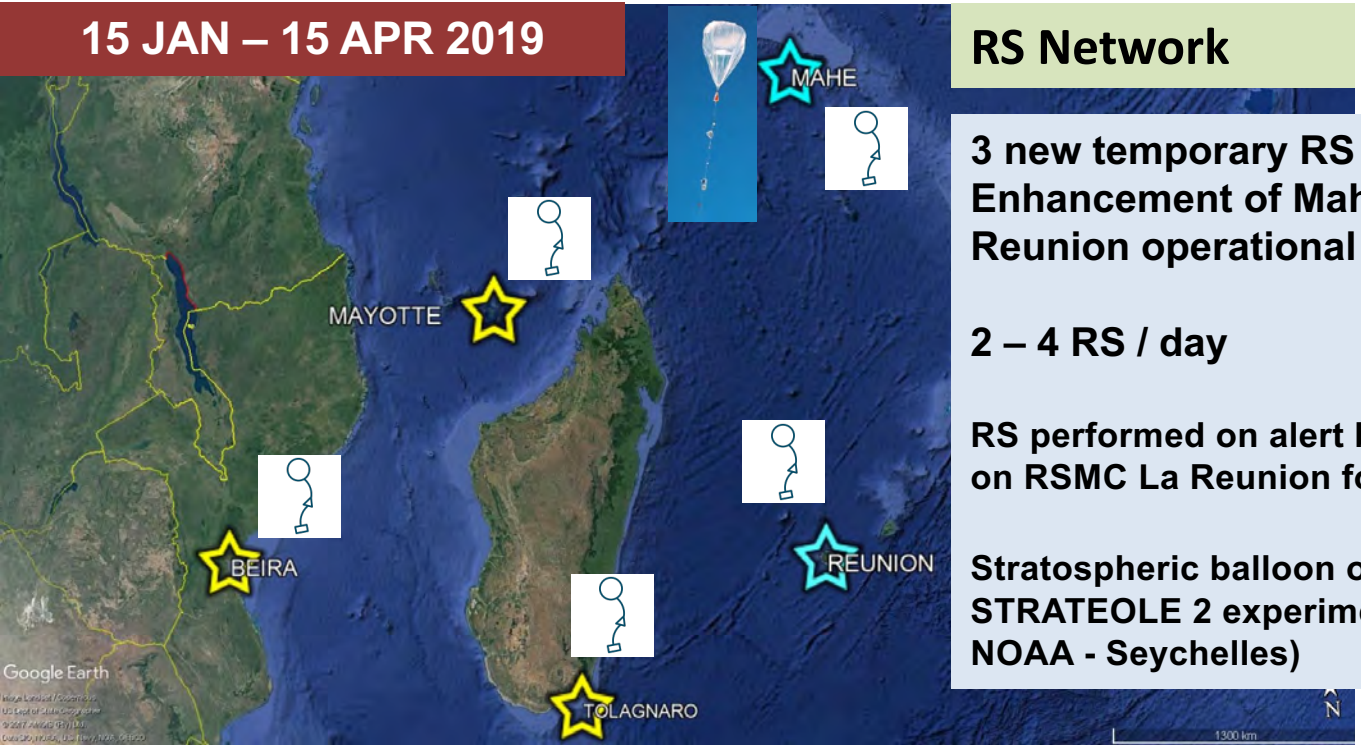
Funding: EU (ReNov'Risk-CP Research program – INTERREG-V TF)

- ❑ Investigate atmospheric and oceanic environment of TC (cyclogenesis – intensific.)
- ❑ Measure air-sea fluxes and aerosol concentrations (numerical parameterizations)
- ❑ Collect high resolution microphysical measurements (model validation)
- ❑ Study physical processes (rapid intensification - air/sea interactions)

SWIO-TC EXPERIMENT

Balloon measurements

15 JAN – 15 APR 2019



RS Network

3 new temporary RS stations + Enhancement of Mahe and Reunion operational RS

2 – 4 RS / day

RS performed on alert based on RSMC La Reunion forecasts

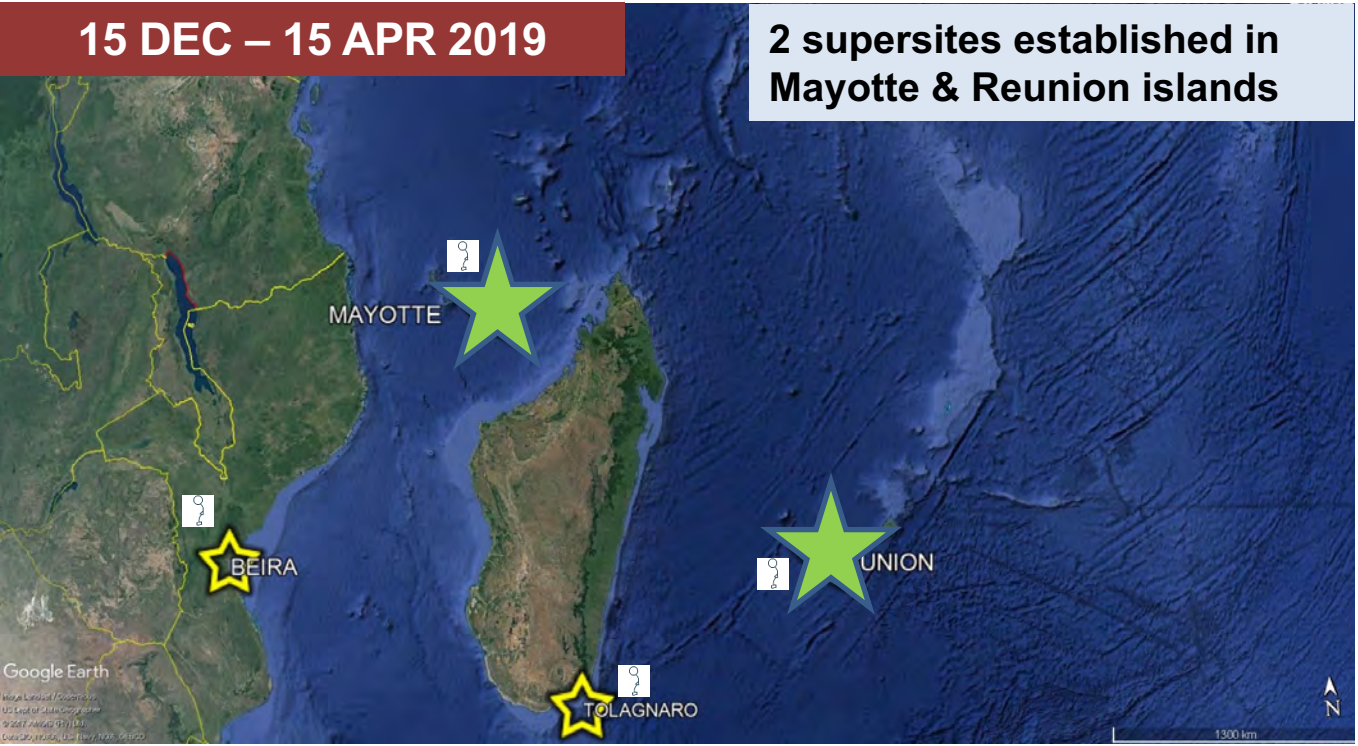
Stratospheric balloon observations STRATEOLE 2 experiment (CNES & NOAA - Seychelles)

SWIO-TC EXPERIMENT

Observation supersites

15 DEC – 15 APR 2019

2 supersites established in Mayotte & Reunion islands



SWIO-TC EXPERIMENT

Reunion Island supersite

Dual-pol weather radars (3 GHz) / Cloud radars (35 and 95 GHz) / 2DVD / 2xMWR / Isotopes analyzers / aerosol lidars / …

Maïdo Research Station (built by LACy in 2013 - **45 instruments of all kind)**

In-situ analysers, passive and active remote sensing (5 lidars, radiometers…), lightning, CPC…

Operated 24/24 during the field campaign

SWIO-TC EXPERIMENT

Reunion Island supersite

Air-sea interactions

UAS

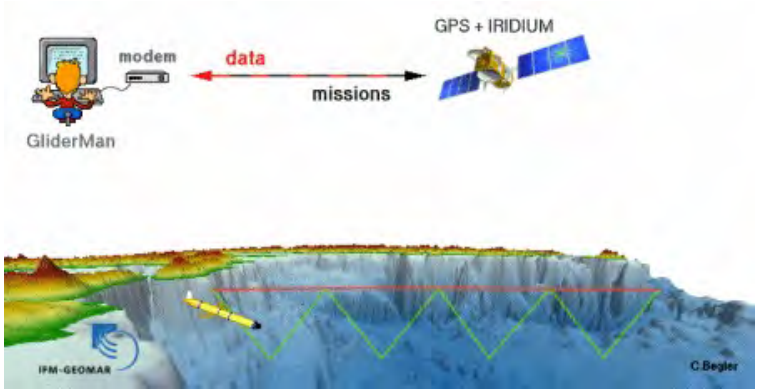
BOREAL – 1000 km range –10H autonomy – 5 kg payload

Air-sea fluxes and aerosol concentrations within and nearby TC

SWIO-TC EXPERIMENT

Reunion Island supersite

Ocean GLIDERS



3 devices launched from Reunion Island

Range of 750 km
2 month autonomy

⇒ OML properties under TCs
Temp, Salinity, Currents…

SWIO-TC EXPERIMENT

New spaceborne observations

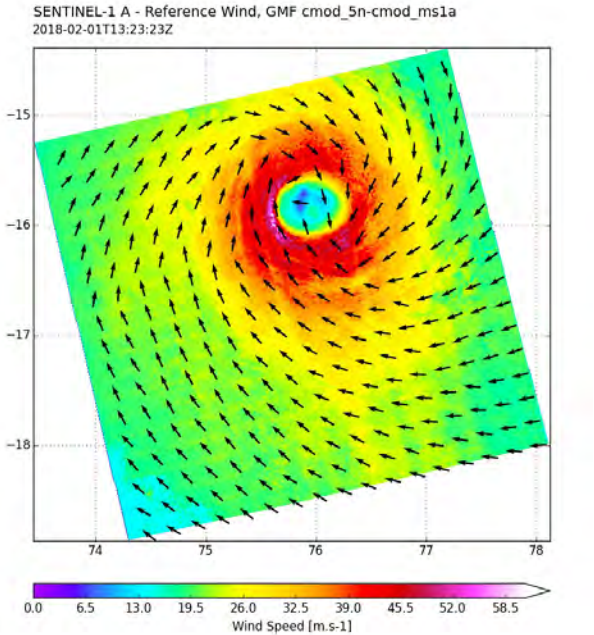
SAR space missions – SENTINEL (EU) – RadarSat2 (CAN)

Research agreement with the European Space Agency to make « on demand » acquisition from Synthetic Aperture Radars (SAR) onboard SENTINEL A satellites (COPERNICUS, 48-h notice)

⇒ **high resolution (500m) surface wind and sea swell data under TC**

⇒ **data assimilation / RSMC analyses**

TC CEBILE – 01/02/2018

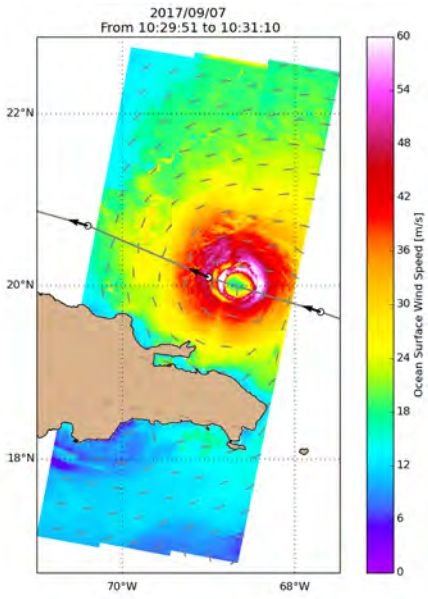


Collaboration with ESA/COPERNICUS – IFREMER – CLS – RSMC

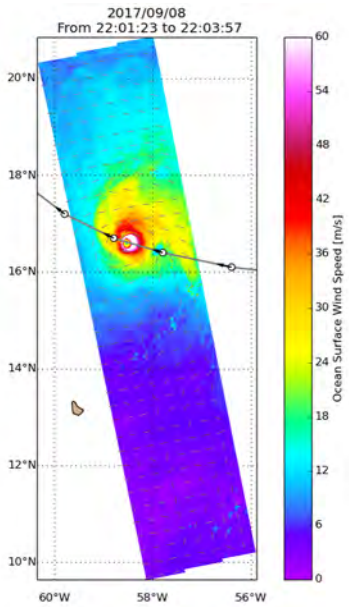
SWIO-TC EXPERIMENT

New spaceborne observations

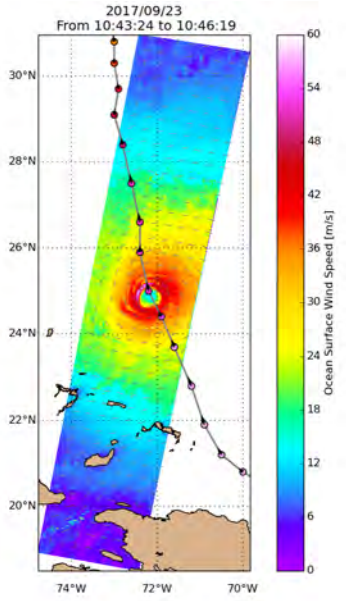
Test campaign NA basin - 2017



IRMA



JOSE



MARIA

SWIO-TC EXPERIMENT

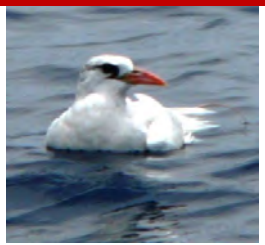
Voluntary observers

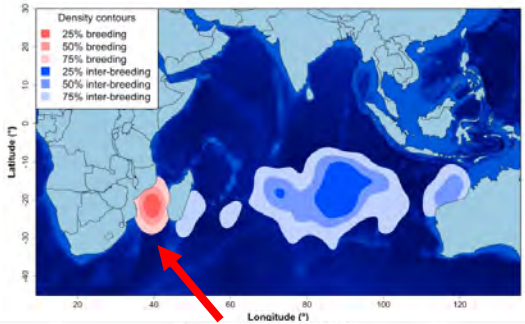
Use sea birds to measure SST and currents

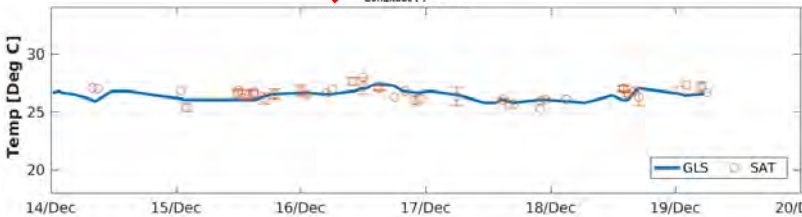
GLS

GPS TEMP

Collaboration with biodiversity lab of Reunion University







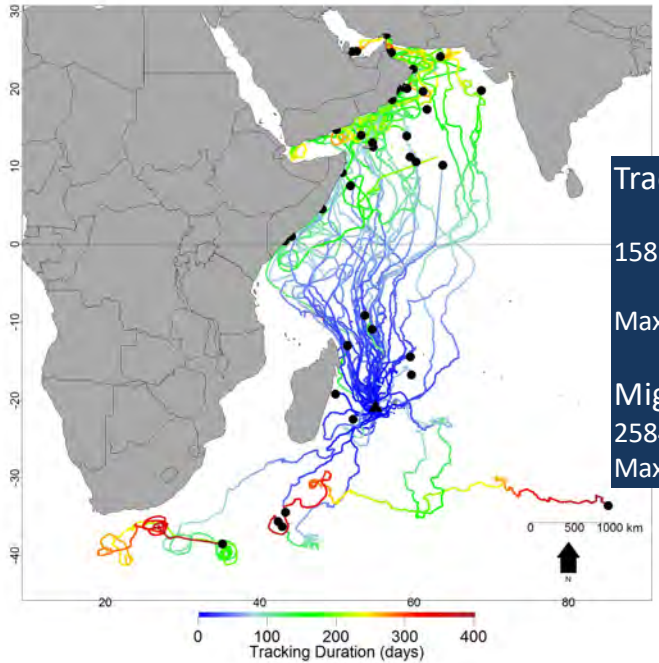
SST - Bird / Sat comparison over 1 week
South Mozambique Channel - Biais ~ 0.5°

data in cloudy conditions / significant human resources

SWIO-TC EXPERIMENT

Voluntary observers

Use sea turtles to measure temperatures in the OML



Tracking duration

158 days ± 112

Maximum : 401 days

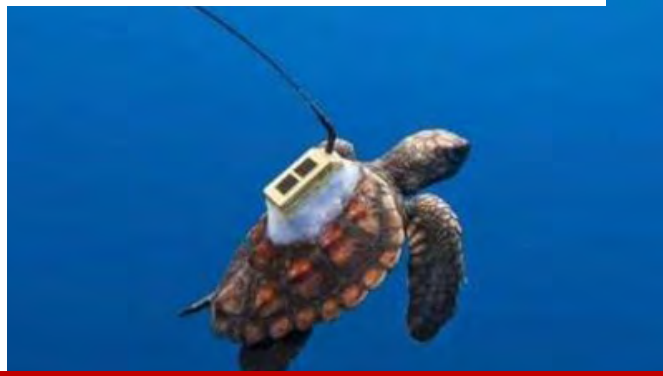
Migration distance

2584 km ± 1350

Maximum : 4591 km

Experiment will start in late 2018
Goal is to equip ~25 turtles/year

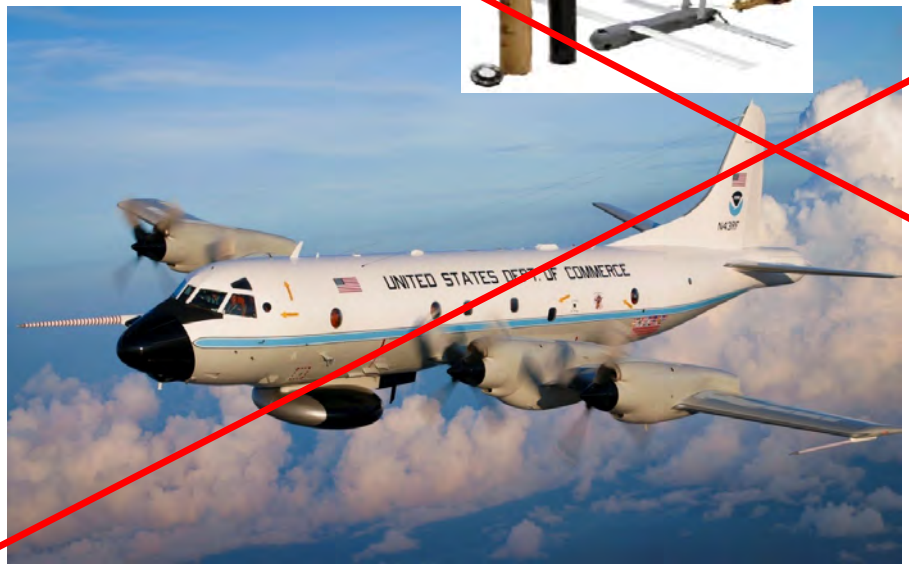
⇒ **Verify / improve ocean / coupled model simulations / data assimilation**



Collaboration with Reunion Island turtle conservation institute

SWIO-TC EXPERIMENT

Aircraft (pending – 150/200 hours - ~ 10 missions)



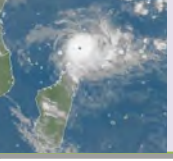
15 Feb – 15 Mar 2019

P-3 - NOAA/HRD

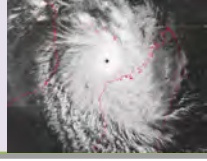
Based at St-Denis (Réunion)

Tail and LF radar
Dropsondes
in-situ microphysics (C&W)
Flux measurements
Electrical field

MAYBE IN 2021



SWIO-TC EXPERIMENT



Collaborations are welcome

Thank You

olivier.bousquet@meteo.fr

Theme 2: Atmospheric Processes

2.1 Observations – Atmospheric, marine and remote

The SWIO-TC Experiment: A field campaign to improve understanding and prediction of tropical cyclones and their impacts in the SW Indian Ocean

Bousquet, Olivier[1]

Presenting author's e-mail: olivier.bousquet@meteo.fr

[1]LACy, UMR 8105 (Meteo-France, CNRS, Reunion University)

Session 2.1 – February 8, 2018, 1100-1115

Tropical cyclones (TCs) are associated with heavy rainfall and strong winds that may cause huge human, material and environmental losses in many tropical and subtropical regions. This is particularly true in the southwest Indian Ocean (SWIO) basin, a poorly studied region that experiences a cyclonic activity roughly as intense as in the North-Atlantic basin. Over the last decades, a large number of storms have indeed caused devastations in Mauritius, La Réunion, Madagascar, Mozambique and other neighboring countries. In March 2017, TC Enawo and Dineo, caused for instance hundreds of fatalities and more than one million refugees in Madagascar and Mozambique, respectively.

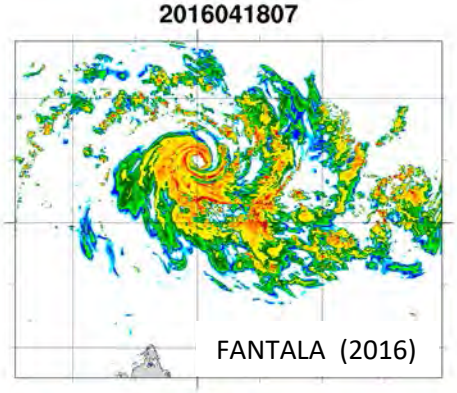
The ability to collect high quality observations in and around tropical cyclones is essential to improve their representation in new high-resolution Numerical Weather Prediction (NWP) models currently being developed by most major Weather Services. This is all the more important in the SWIO basin where observation networks are extremely limited with, in particular, no routine aircraft observations and very sparse ground-based observations. One of the objectives of the EU-funded project ReNovRisk-Cyclones (2017-2020) is to overcome these shortcomings through strengthening permanent and temporary observation capabilities in this particularly active cyclonic basin.

This presentation will focus on the field phase of this collaborative, international, research program, which aims to assess the meteorological and oceanic impacts of TC on inhabited territories of the SWIO basin. This field experiment, referred to as the SWIO-TC Experiment, will be conducted in Jan-Apr 2019. It will provide unprecedented observations of tropical cyclones and other high impact weather events of the SWIO basin by coordinating dedicated atmospheric and oceanic measurements in the Mozambique Channel and Mascarene Archipelago. The current status, main scientific objectives and potential applications of this project will be discussed.

SWIO-TC EXPERIMENT

A field campaign to improve understanding and prediction of tropical cyclones in the SW Indian Ocean basin

ICSHMO – Sydney – 8 Feb 2018



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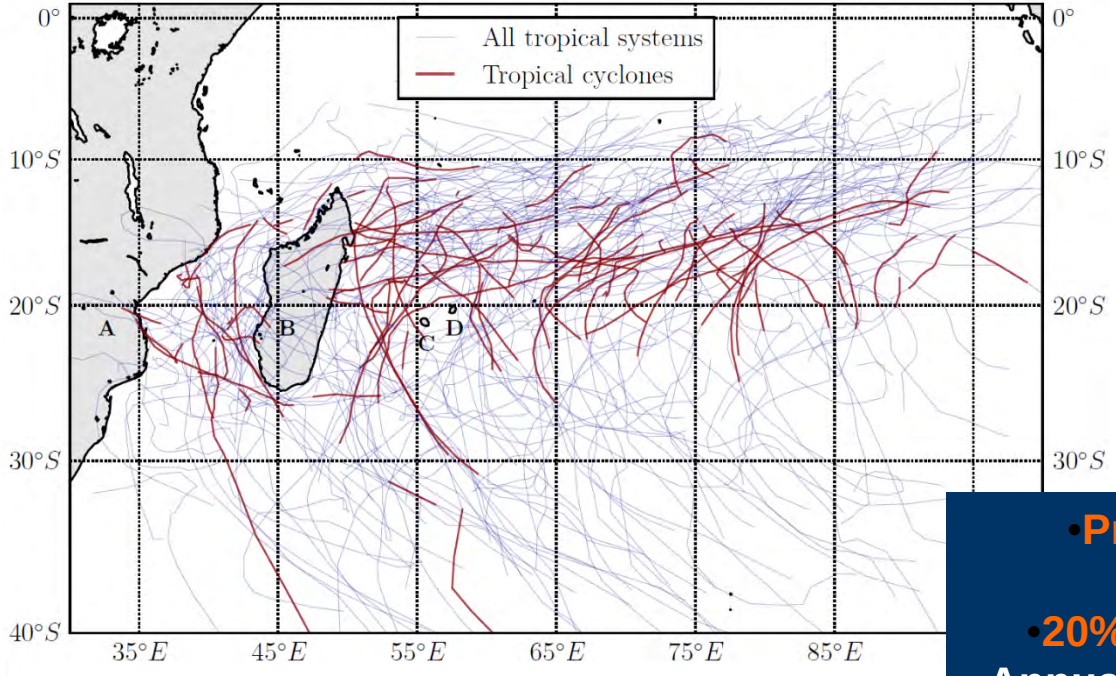
SWIO-TC EXPERIMENT

CLIMATOLOGY OF THE SWIO CYCLONIC BASIN



1999-2016

183 systems

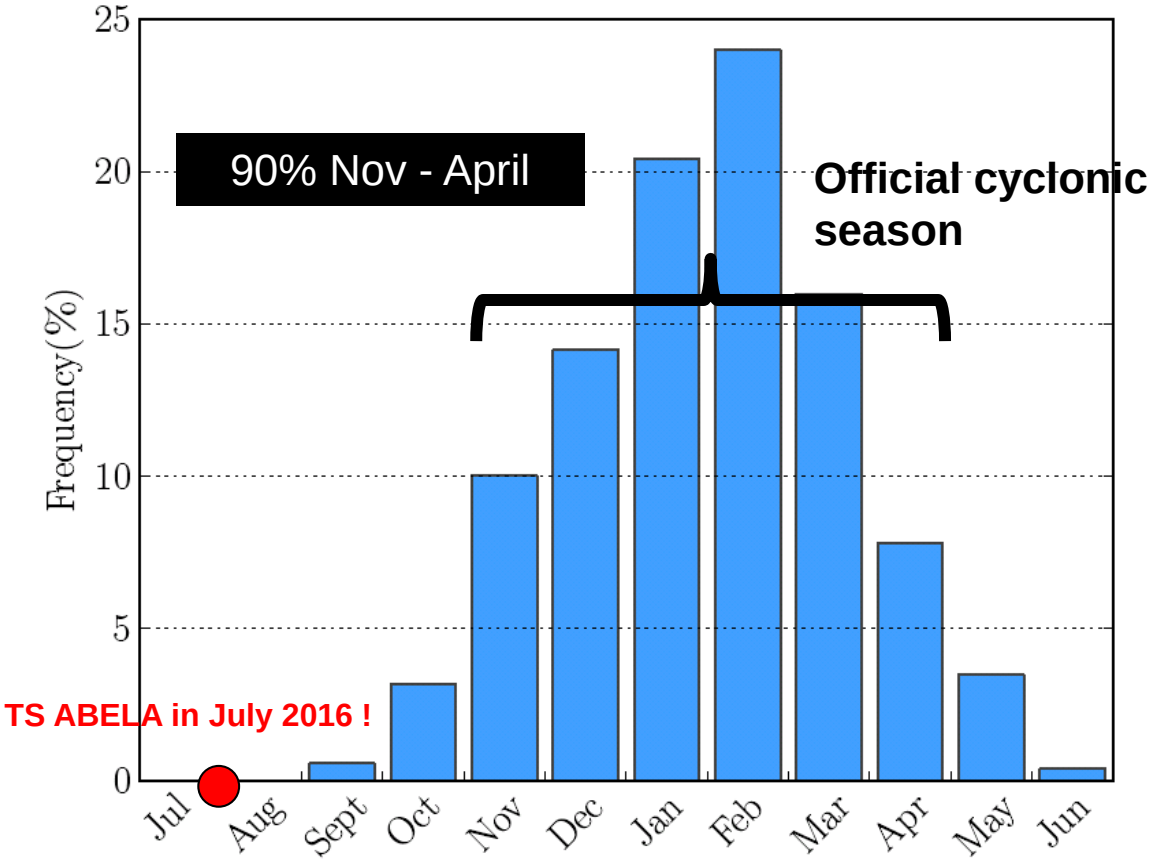
36 tropical perturbations
65 tropical storms
80 tropical cyclones

- **Preferred development area: 10-20°**
- **Zonal trajectory**
- **20% of activity in Mozambique Channel**
- **Annual mean = 10-12 systems (5-6 cyclones)**

The SWIO cyclonic basin is one of the most active in the world (activity ~ equivalent to that of the NATL basin)

SWIO-TC EXPERIMENT

CLIMATOLOGY OF THE SWIO CYCLONIC BASIN



Monthly distribution

Leroux et al. (2018, JAMC)

17 seasons (1999-2016)
183 cases

Cyclonic season – 15/11 – 15/04

~ 10% of early or late systems

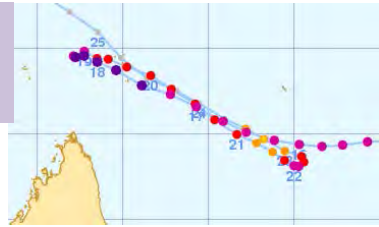
SWIO-TC EXPERIMENT

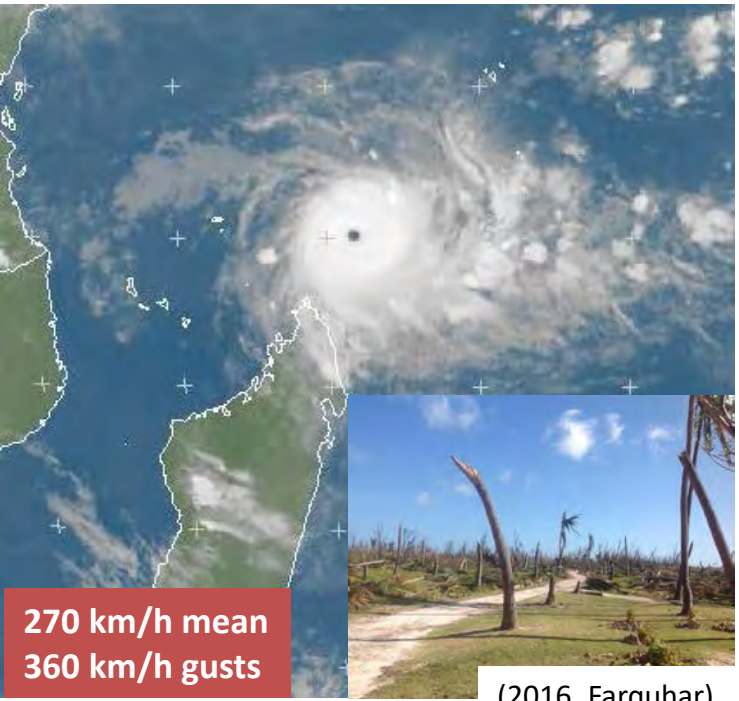
CLIMATOLOGY

A large (unusual) number of extremely intense TC occurred in the last 4 years (7 VITC)

Fantala (04/2016)

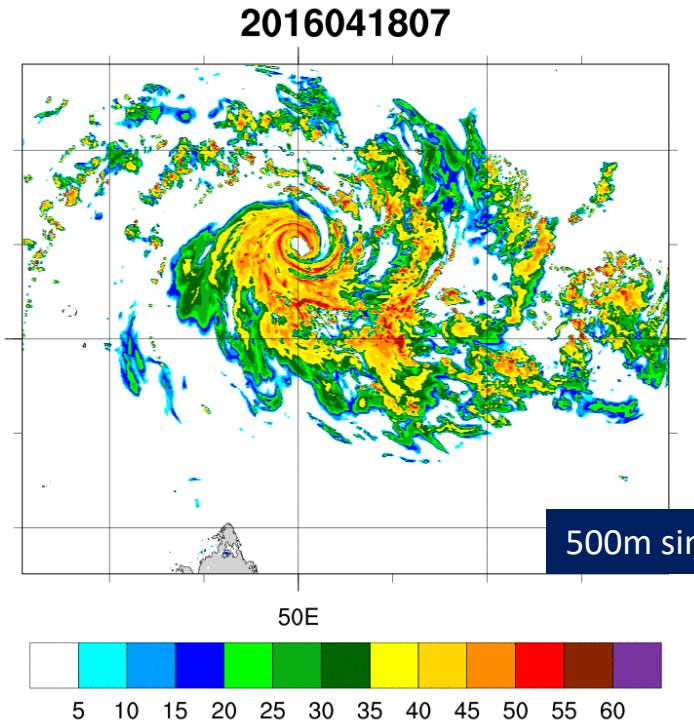
Most Intense TC ever observed in the SWIO

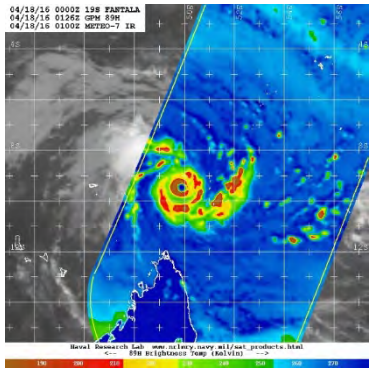




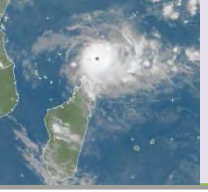
270 km/h mean
360 km/h gusts

(2016, Farquhar)

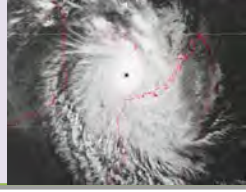




500m simulation of ERC



SWIO-TC EXPERIMENT



CLIMATOLOGY

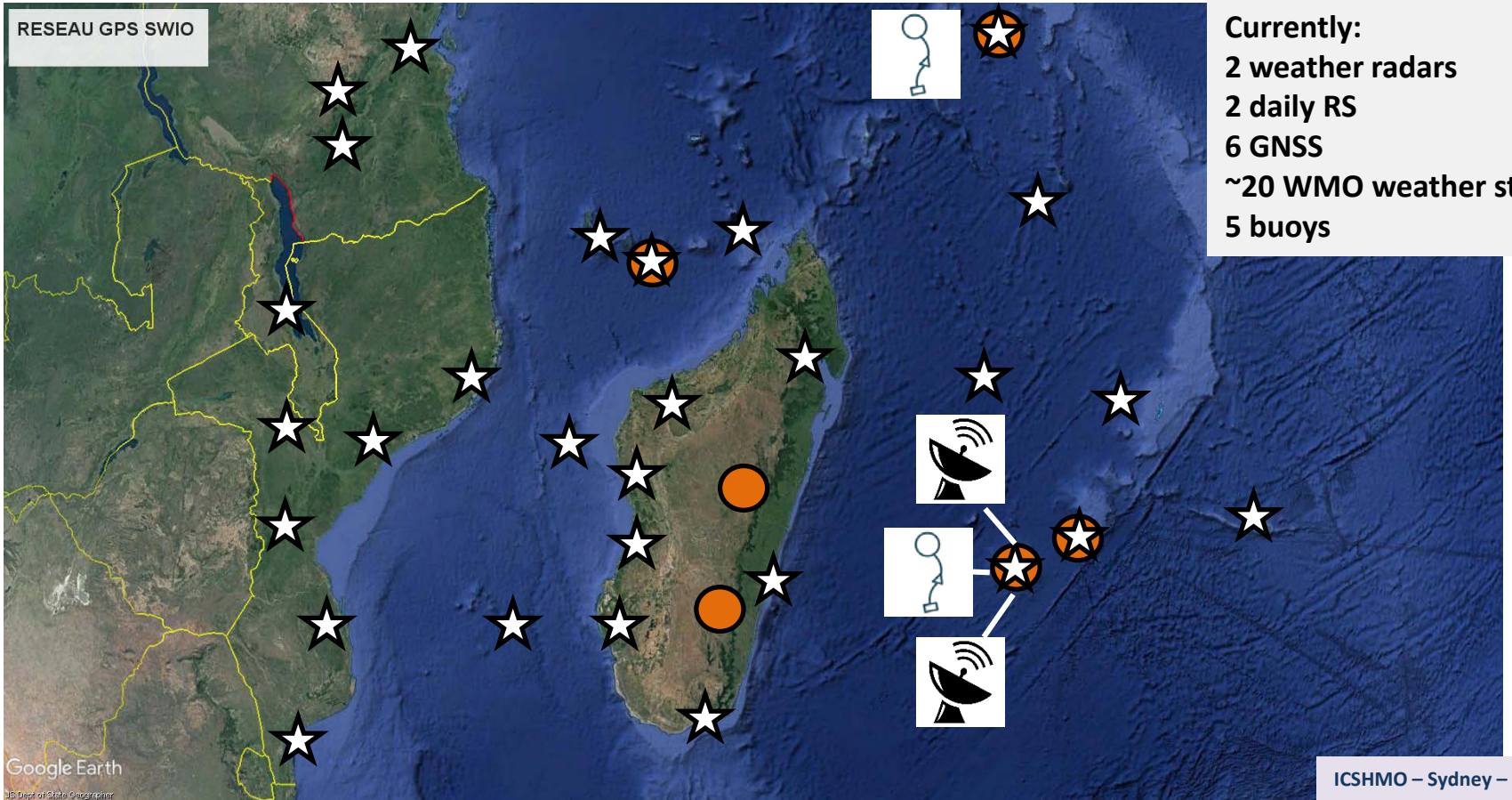
2017 : DINEO (Mozambique) & ENAWO (Madagascar)
400 fatalities – 1 million refugees
2018 : AVA (Madagascar) – 200 fatalities – 200 000 refugees

AVA (2018, Madagascar)

ENAWO (2017, Madagascar)

SWIO-TC EXPERIMENT

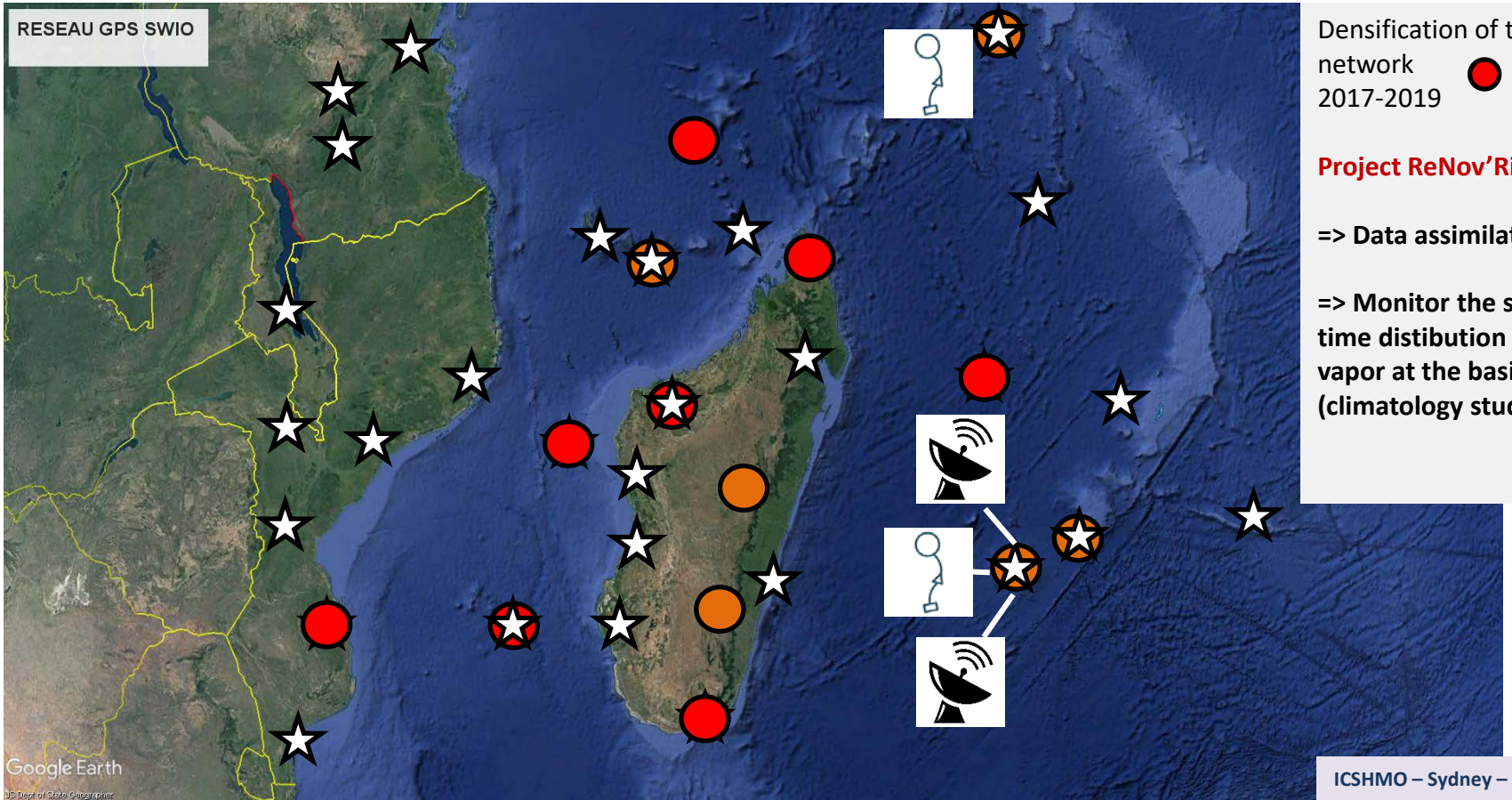
Permanent ground-based observations in the SWIO basin



Currently:
2 weather radars
2 daily RS
6 GNSS
~20 WMO weather stations
5 buoys

SWIO-TC EXPERIMENT

New permanent observations (GNSS)



Densification of the GNSS network 2017-2019

Project ReNov'Risk (EU)

=> Data assimilation

=> Monitor the space-time distibution of water vapor at the basin scale (climatology studies)

SWIO-TC EXPERIMENT

FIELD CAMPAIGN - 1st January to 15 April 2019 – Project ReNov'Risk (EU)

Objective: collect, for the first time ever in the SWIO basin, an extensive observation dataset during (at least) one full cyclonic season

Funding: EU (ReNov'Risk-CP Research program – INTERREG-V TF)

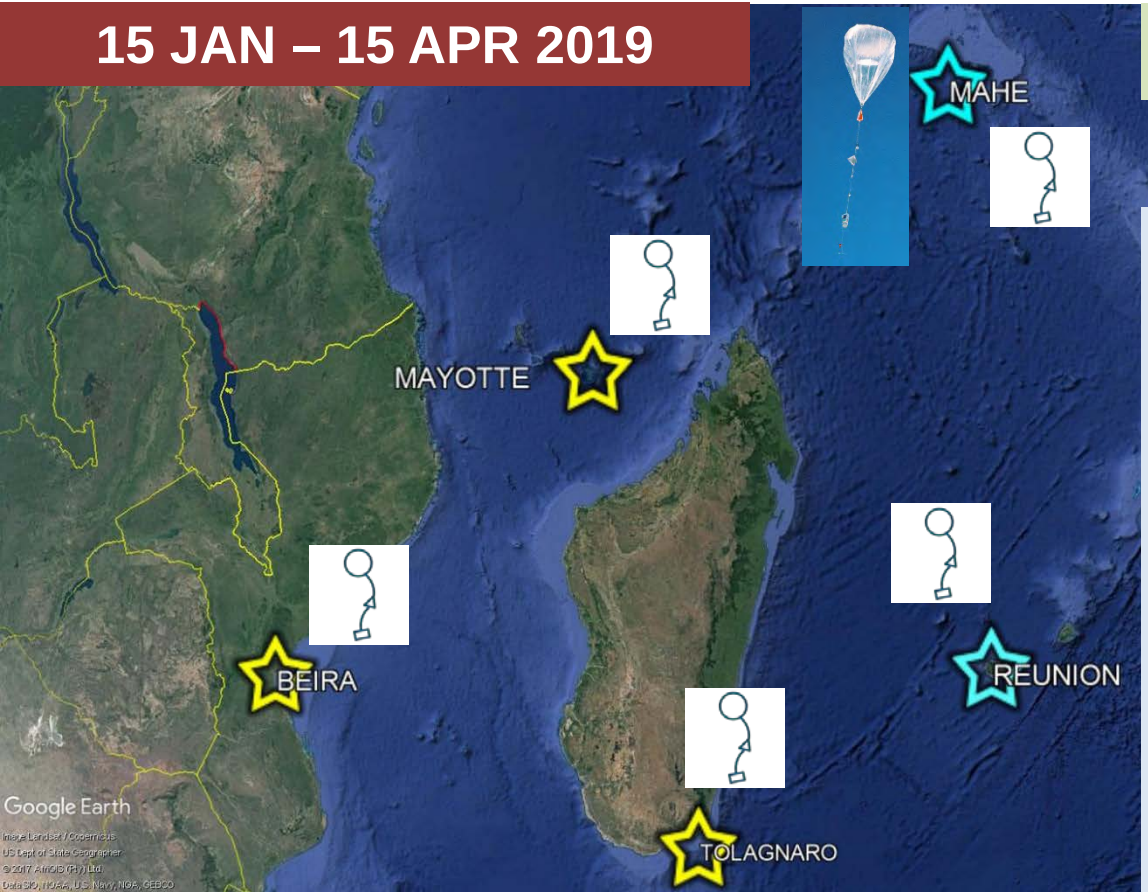
- ❑ Investigate atmospheric and oceanic environment of TC (cyclogenesis – intensific.)
- ❑ Measure air-sea fluxes and aerosol concentrations (numerical parameterizations)
- ❑ Collect high resolution microphysical measurements (model validation)
- ❑ Study physical processes (rapid intensification - air/sea interactions)

...

SWIO-TC EXPERIMENT

Balloon measurements

15 JAN – 15 APR 2019



RS Network

3 new temporary RS stations + Enhancement of Mahe and Reunion operational RS

2 – 8 RS / day

RS performed on alert based on RSMC La Reunion forecasts

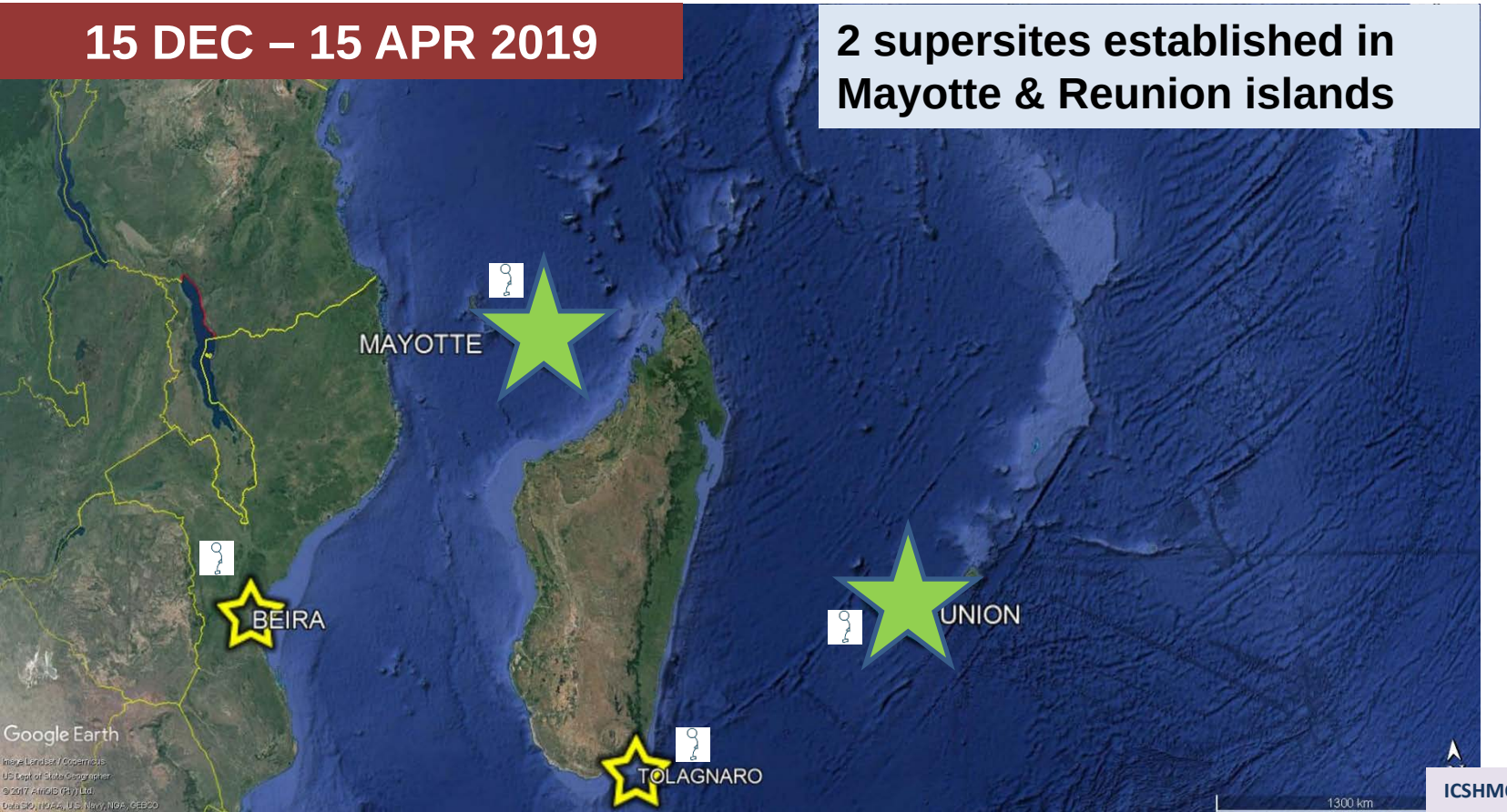
Stratospheric balloon observations STRATEOLE 2 experiment (CNES & NOAA - Seychelles)

SWIO-TC EXPERIMENT

Observation supersites

15 DEC – 15 APR 2019

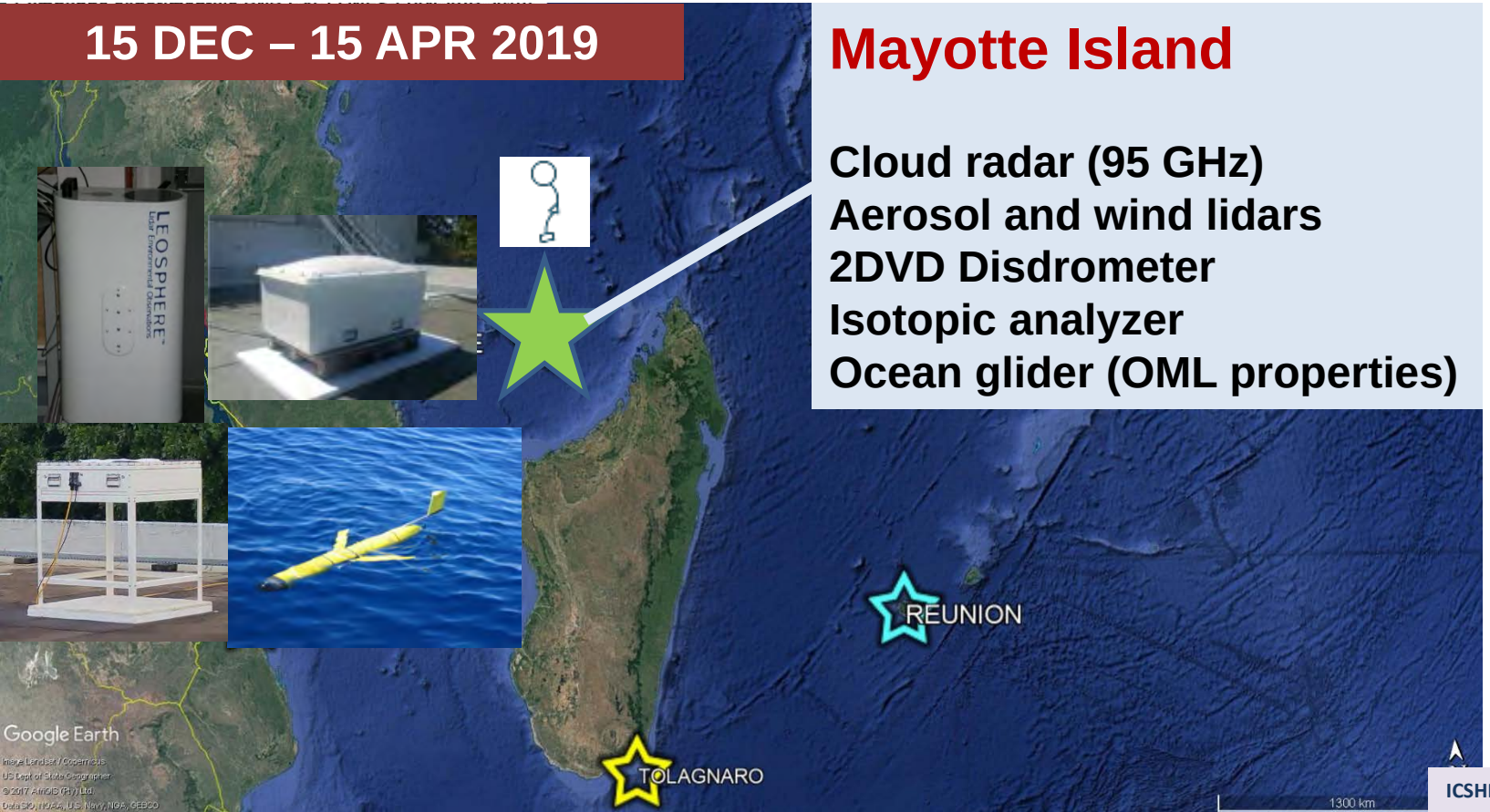
2 supersites established in Mayotte & Reunion islands



SWIO-TC EXPERIMENT

Mayotte supersite

15 DEC – 15 APR 2019



Mayotte Island

Cloud radar (95 GHz)
Aerosol and wind lidars
2DVD Disdrometer
Isotopic analyzer
Ocean glider (OML properties)

SWIO-TC EXPERIMENT

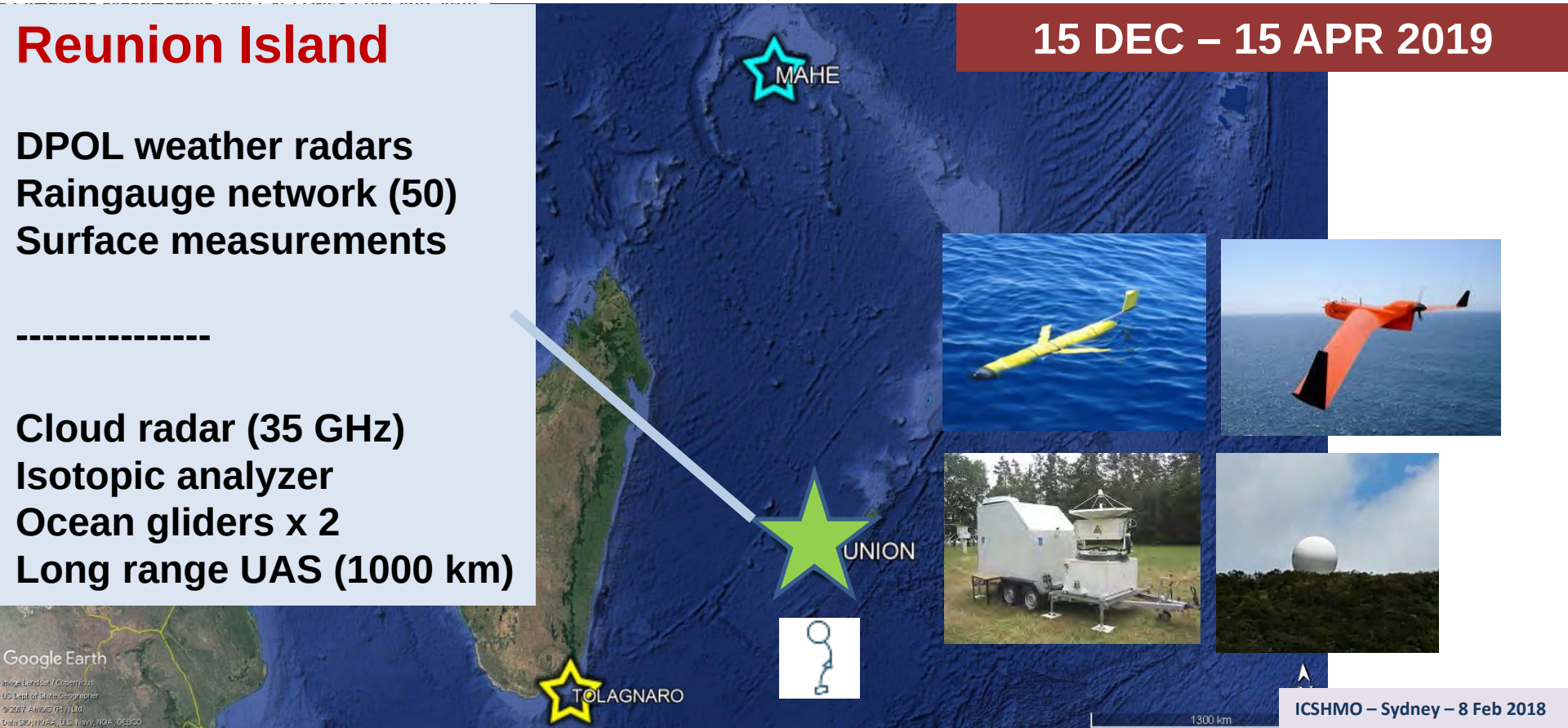
Reunion Island supersite

Reunion Island

DPOL weather radars
Raingauge network (50)
Surface measurements

Cloud radar (35 GHz)
Isotopic analyzer
Ocean gliders x 2
Long range UAS (1000 km)

15 DEC – 15 APR 2019



SWIO-TC EXPERIMENT

Reunion Island supersite (Maido atmospheric station)

15 DEC – 15 APR 2019

Maïdo Research Station (built by LACy in 2013 - **45 instruments of all kind)**
In-situ analysers, passive and active remote sensing (5 lidars, radiometers…), lightning, CPC …

Operated 24/24 during the field campaign

SWIO-TC EXPERIMENT

Aircraft (pending – 150 hours requested - ~ 10 missions)

15 Feb – 15 Mar 2019

P-3 - NOAA/HRD

Based at St-Denis (Réunion)

Tail and LF radar
Dropsondes
in-situ microphysics (C&W)
Flux measurements
Electrical field
…

Coyotte UAS

Low level measurements within TC eye

SWIO-TC EXPERIMENT

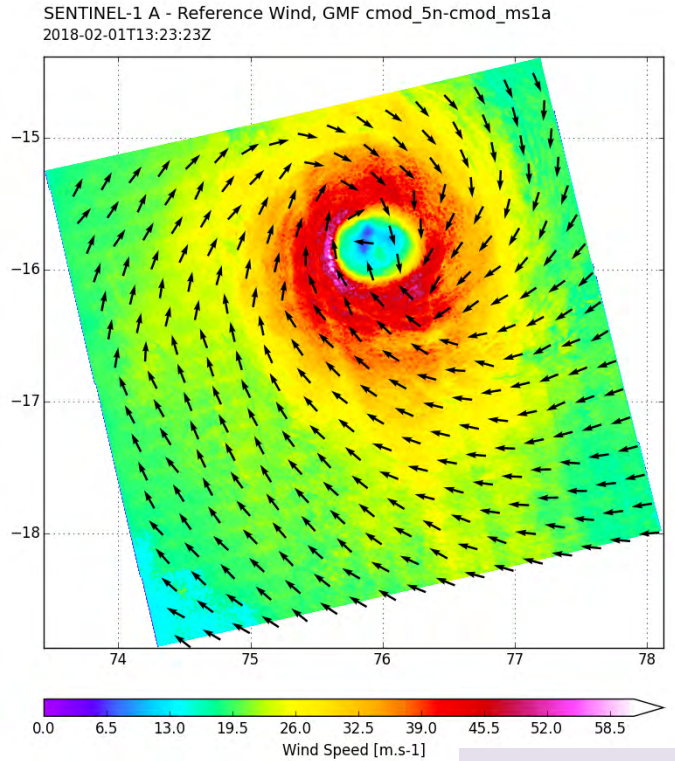
New spaceborne observations

SAR space missions – SENTINEL (EU)

Research agreement with the European Space Agency to make « on demand » acquisition from Synthetic Aperture Radars (SAR) onboard SENTINEL A European satellites (COPERNICUS, 48-h notice)

⇒ **high resolution surface wind and sea swell data under TC**

TC CEBILE – 01/02/2018



Collaboration with ESA/COPERNICUS – IFREMER - CLS

SWIO-TC EXPERIMENT

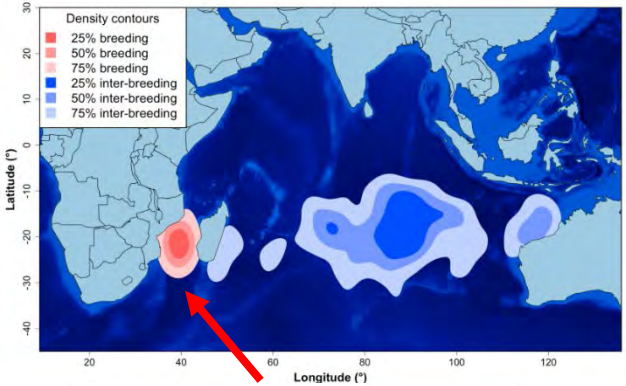
Fun (exploratory) observations

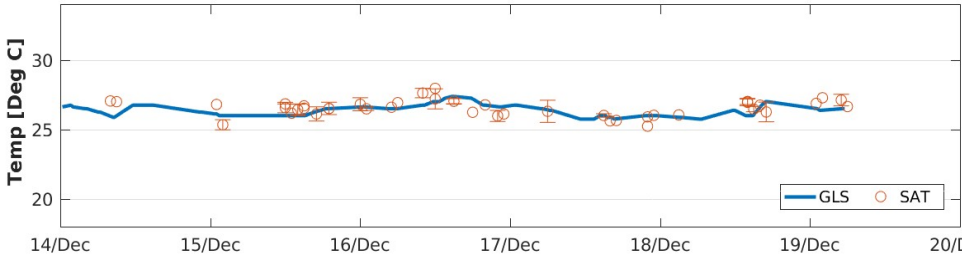
Use sea birds to measure SST and currents near TCs or areas of heavy convection

GLS

GPS TEMP

Collaboration with biodiversity lab of Reunion University



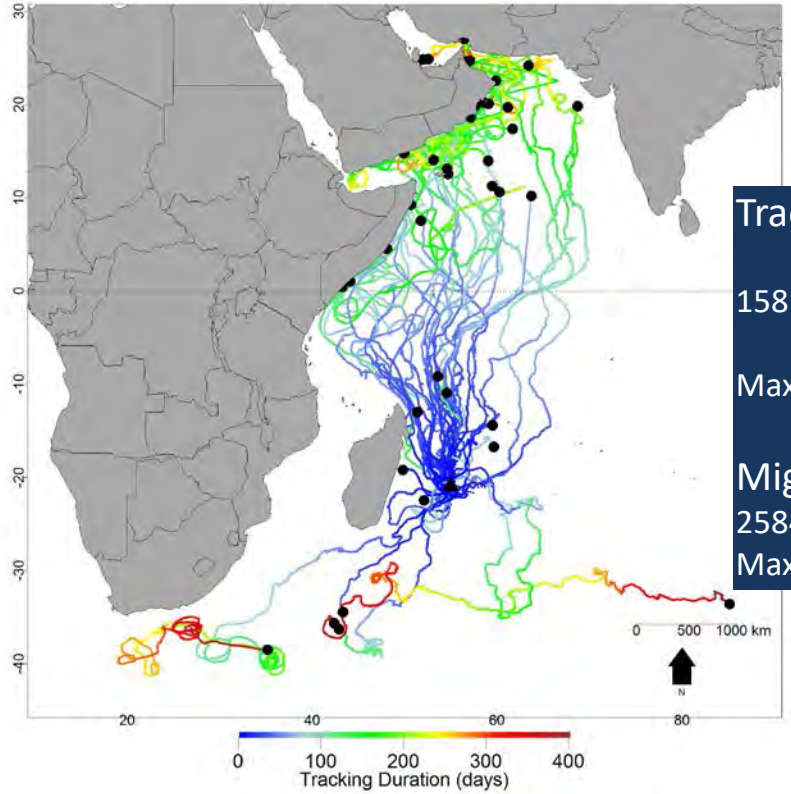


SST - Bird / Sat comparison over 1 week
South Mozambique Channel - Biais ~ 0.5°

SWIO-TC EXPERIMENT

Fun (exploratory) observations

Use sea turtles to measure temperatures in the OML



Tracking duration

158 days ± 112

Maximum : 401 days

Migration distance

2584 km ± 1350

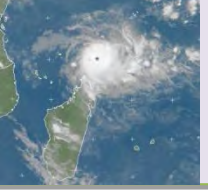
Maximum : 4591 km

Experiment will start in late 2018

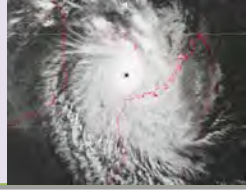
Goal is to equip ~25 turtles/year

⇒ **Verify / improve ocean / coupled model simulations**

Collaboration with Reunion Island turtle conservation institute



SWIO-TC EXPERIMENT



Collaborations welcome

The SWIO-TC experiment represents an unprecedented effort for studying tropical cyclones of the SW Indian Ocean basin

Collaborations are very welcome

For more information contact **olivier.bousquet@meteo.fr**

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LACy
UMR 8105

A53L-3078 - Observation and forecast verification of cloud fraction over Reunion Island (21°S, 55.5°E) using a 95 GHz cloud radar

Friday, 13 December 2019

23:40 - 04:00

Moscone South - Poster Hall

Swirl Topics

Extreme Events & Hazards - SWIRL

Abstract

In order to validate and improve the representation of low and high level tropical clouds in NWP systems, a 95 GHz Doppler cloud radar (BASTA) was deployed in Reunion Island (SW Indian Ocean, 21°S; 55.5E) in November 2016.
The benefit of cloud radars over satellite observations lies in their ability to characterize cloud properties at very high resolution. With this respect BASTA allows for several operation modes characterized by vertical resolutions of 12.5m (fog and low clouds), 25m (midlevel clouds), and 100m (cirrus and high clouds).
Cloud radar observations are first compared against lidar and satellite measurements to evaluate the radar capability to sample clouds up to the tropopause level (20 km). Then a 2-year analysis of the vertical distribution of clouds over Saint-Denis (Réunion Island) is performed from 12s resolution radar observations. Radar data show an abnormal vertical distribution of the cloud fraction during winter 2017 with much higher cloud occurence than usual. A close examination of operational radiosoundings indicate that this unusual situation was due to the presence of a positive moisture anomaly resulting from warmer than usual sea surface temperatures in the Mascarene Archipelago. Cloud fraction observations are then compared against high resolution (2.5 km) AROME-Indian Ocean NWP forecasts over the same period. Results indicate that the model tends to underestimate (resp. overestimate) cloud cover at low (resp. high) levels. Differences appear related to both an improper representation of orography at low levels and looser vertical resolution of the model at higher levels.

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