

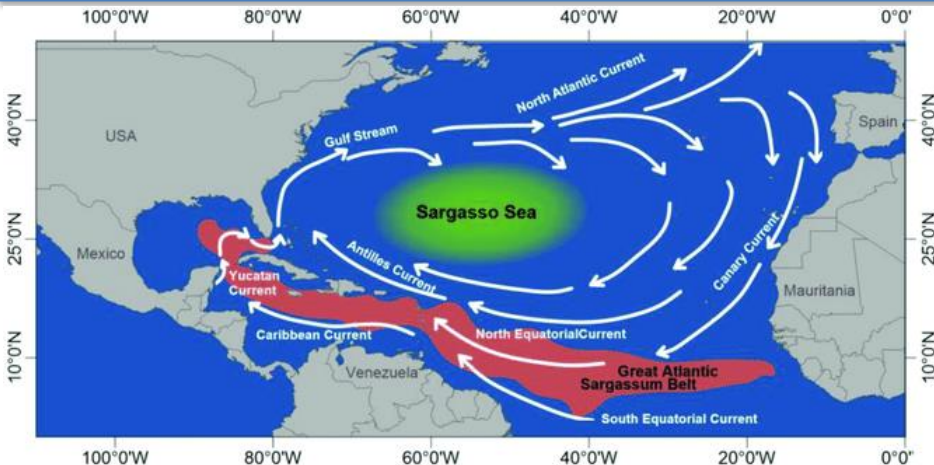


**MERCATOR
OCEAN**
INTERNATIONAL

A regional higher resolution model of Caribbean Arc

Application to the Sargassum algae drift & beaching
forecasting

Sylvain Cailleau, Laurent Bessières



Sargassum drift
an increasing natural phenomenon
Changes in the last decade: « The great Atl. Sargassum belt », local blooms, huge beachings, ...
Possible human origine : global climate warming, Amazon nutrient, ...

A French issue



✓ Research projects

FORESEA: saisonnal FC

CESAR: Sargassum detection



✓ Private services: CLS SAMtool



✓ « Sargassum plan » launch by the Ministry of the Environment



Environmental, economical & health impacts
especially in the Caribbean area & along the south american coasts

An international issue

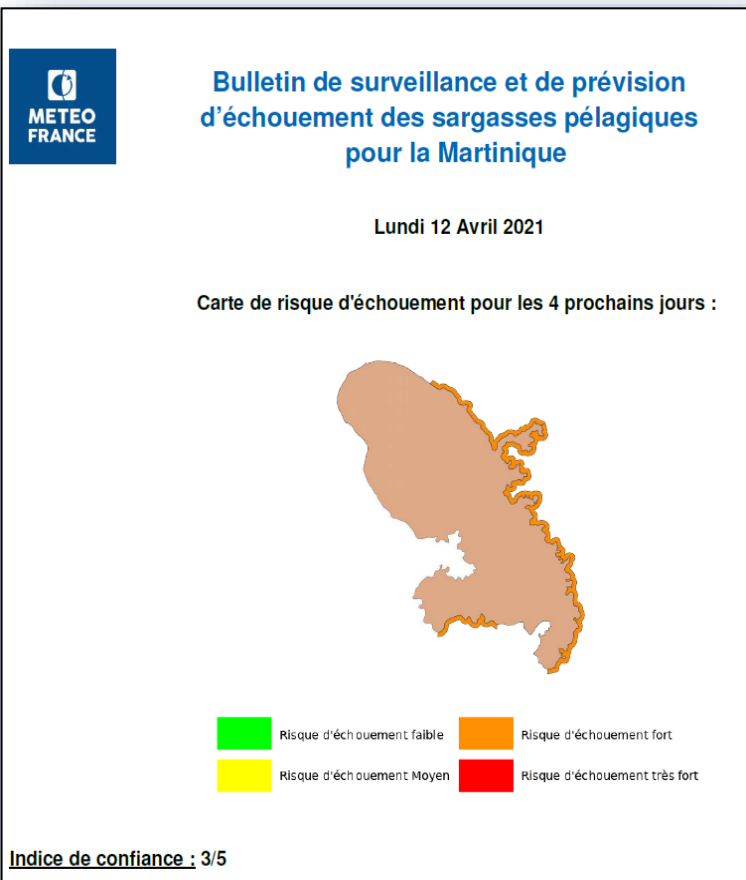


One of the priorities of **GEO Blue Planet**

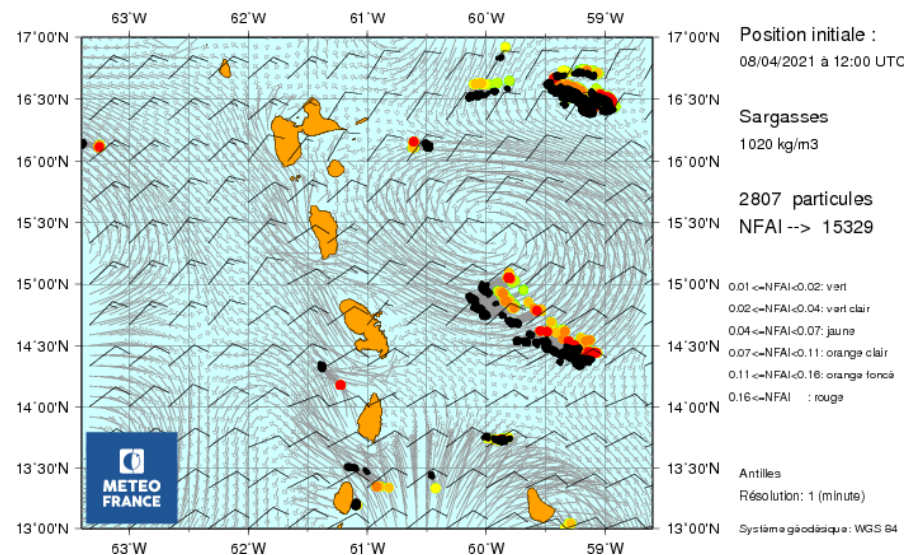
MétéoFrance (French MetOffice) provides FC bulletins of Sargassum beaching based on:

→ Sat. detection

→ Drift model MOTHY forced by the subsurface current from the 1/12° global modele (GLO12) of MOi

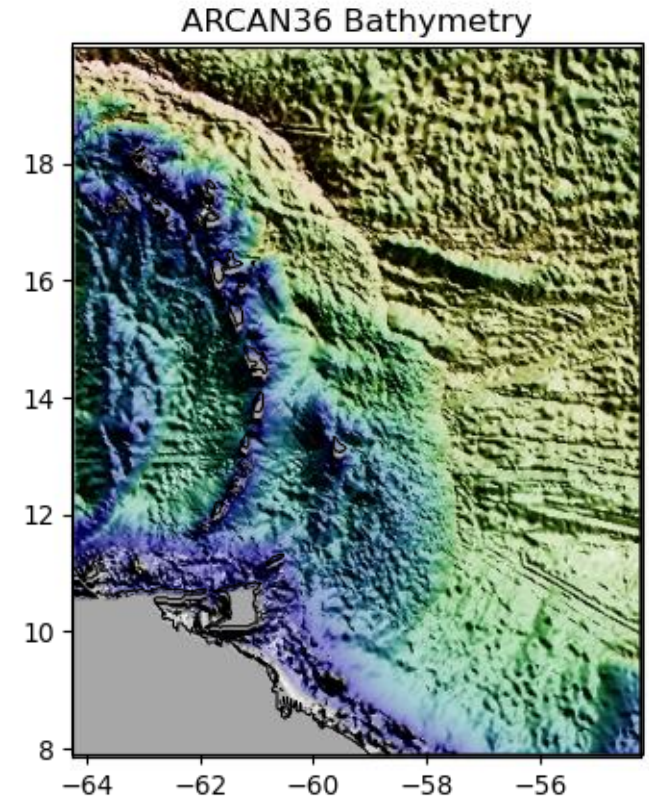


MOTHY/CEP MERCATOR_PSY4 : Prévision pour le 09/04/2021 à 00 UTC



Model Configuration

- ❑ **Code:** NEMO 3.6
- ❑ **Resolution:** $1/36^\circ$ (~ 3 Km) - 50 z-levels
- ❑ **Domain:** Caribbean Arc:
 $64.25^\circ\text{W}, 7.89^\circ\text{N} / 54.17^\circ\text{W}, 20.08^\circ\text{N}$ (364 x 454 pts)
- ❑ **Simu. period:** 2019
- ❑ **OBCs :** GLO $1/12^\circ$ (*T, S, U, V, SSH* daily)
- ❑ **Atm. forcing:** ECMWF (inverse barometer included)
- ❑ **Tidal forcing:** FES 2014 – 11 harmonics (*Lyard et al. 2021*)
- ❑ **Spectral Nudging:** towards large scale & low frequency GLO12 (*T, S, U, V*)



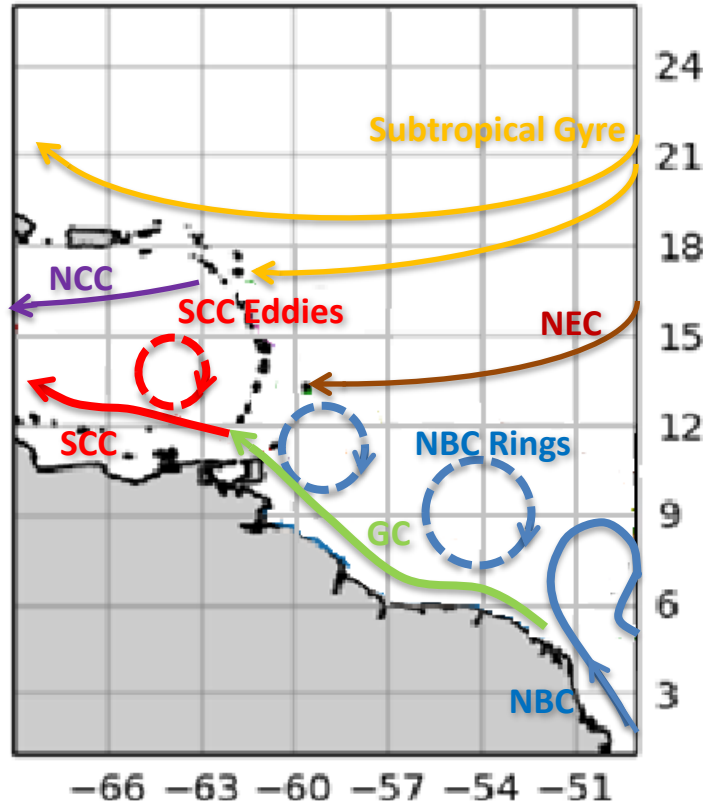
OCEAN DYNAMICS IN THE CARIBBEAN ARC

Guyane Current (GC)

South Caribbean Current (SCC)

SCC rings due to the SCC instability
(possible impact of the NBC rings' filaments crossing the Caribbean Arc)

North Caribbean Current (NCC)



Subtropical Gyre

North Equatorial Current (NEC)

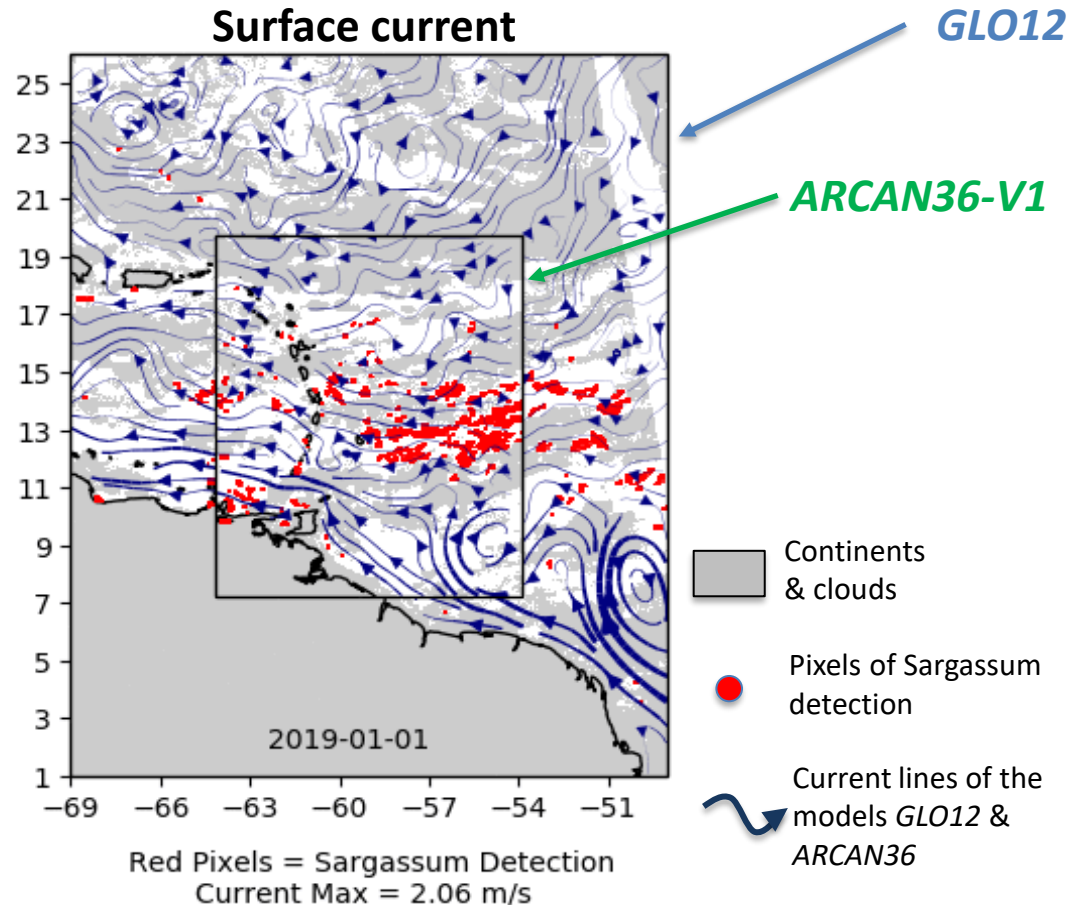
Retroflexion (6-8°N) due to the meeting of the North Brazilian Current (NBC) & the North Equatorial Counter Current

NBC Rings (from the retroflexion)

VALIDATION ARCAN36 – Simulated ocean dynamics

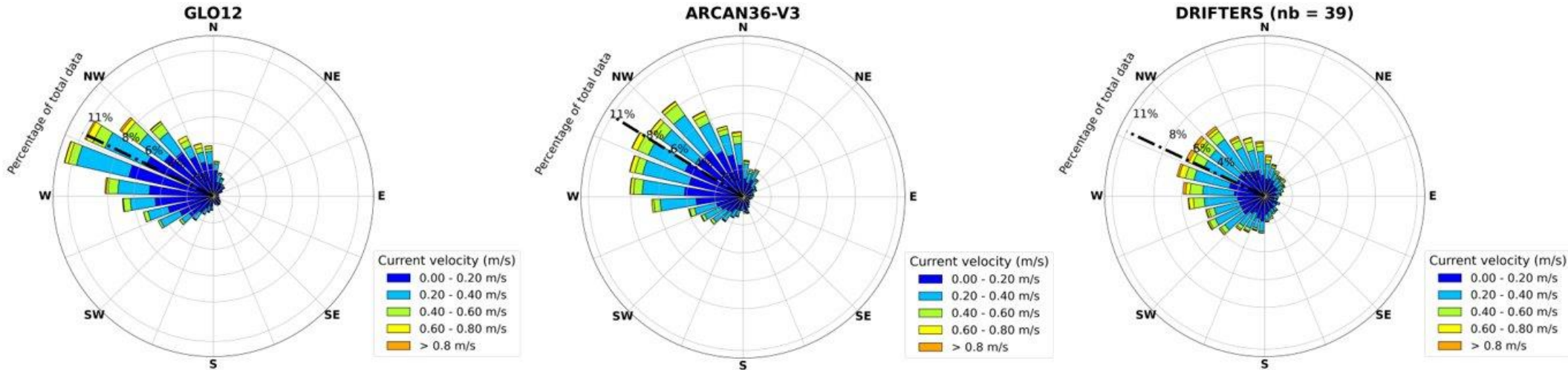
CLASS I

- ❑ Realistic solution
- ❑ Meso-scale characteristics propagation
- ❑ The Sargassum follow the current lines
- ❑ Sargassum aggregation at the periphery of the NBC rings



**Obs. data: Sargassum detection (MODIS, AFAI method : Wang & Hu, 2016): SAREDA-DA Project (Berline et al., 2020)*

Surface current roses from real & virtual drifters collocated on the ARCAN36 domain & for 2019



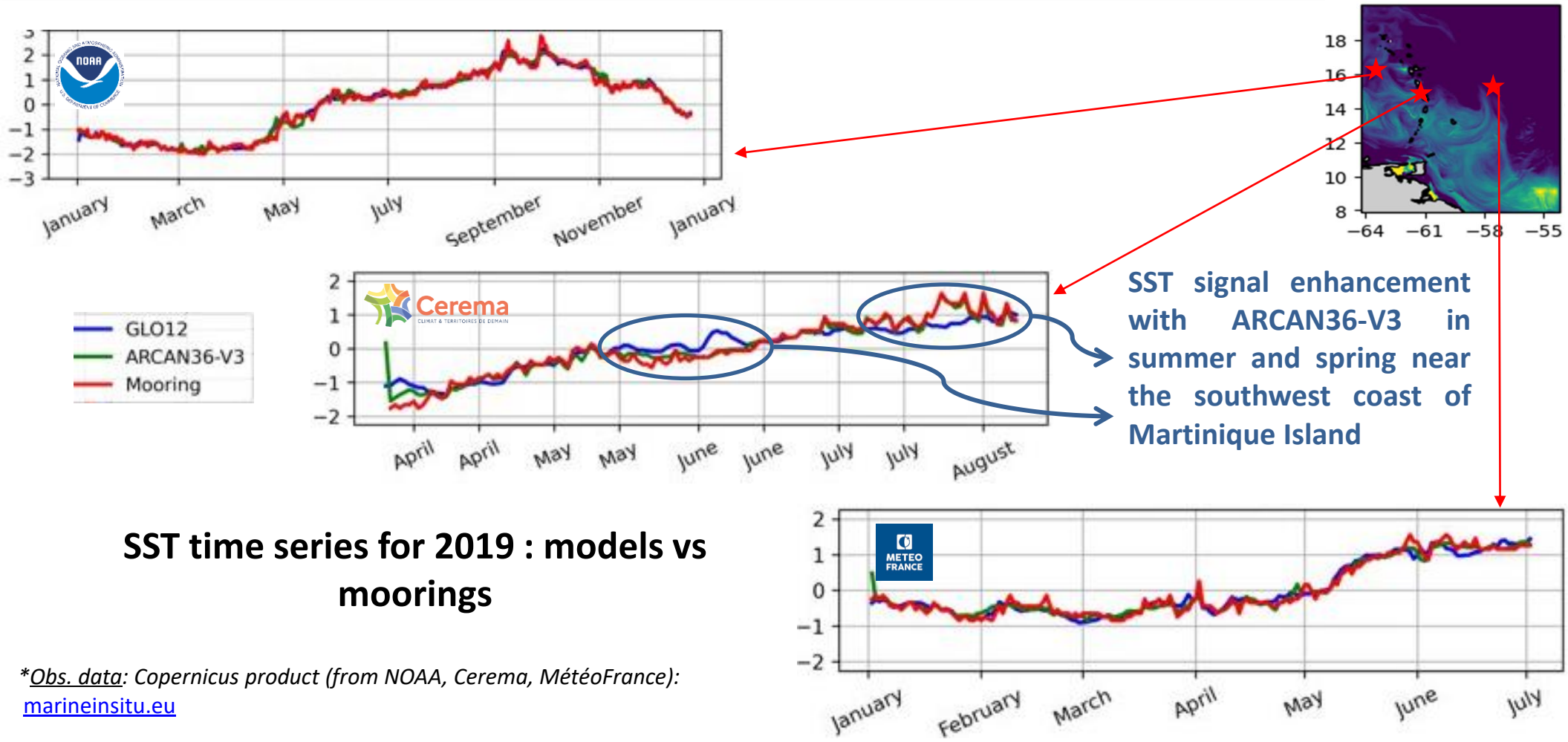
❑ Significant over-estimation of the W-N-W GLO12 drifter trajectory trend

❑ Drifters' trajectories actually improved for ARCAN36

**Obs. data: Copernicus product (from IFREMER, CLS, AZTI):*
[INSITU GLO UV L2 REP OBSERVATIONS 013_044](#)

VALIDATION ARCAN36 – ARCAN36 benefits vs GLO12

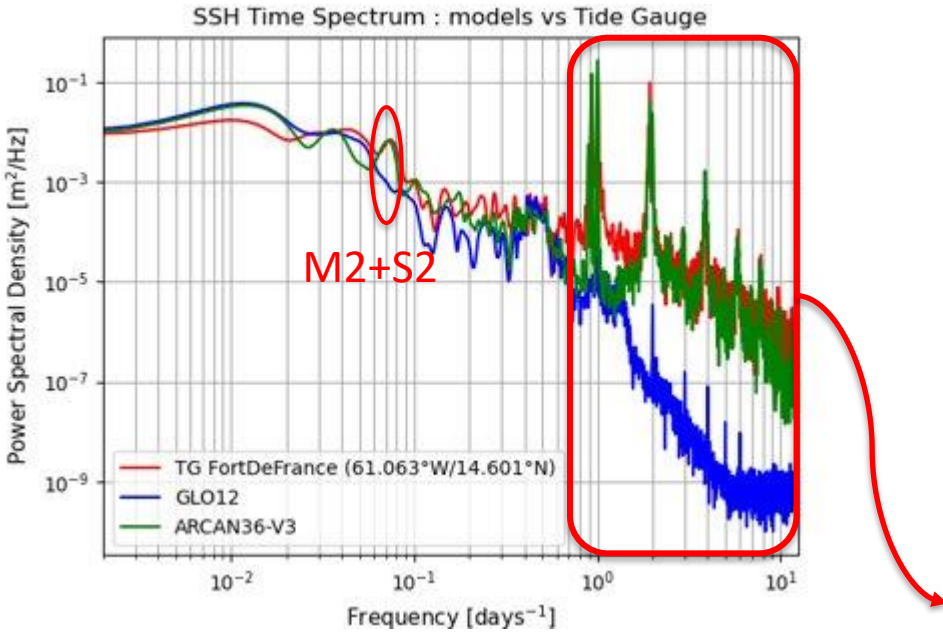
CLASS II



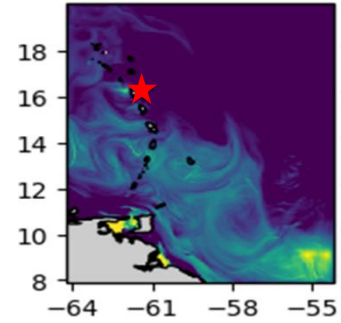
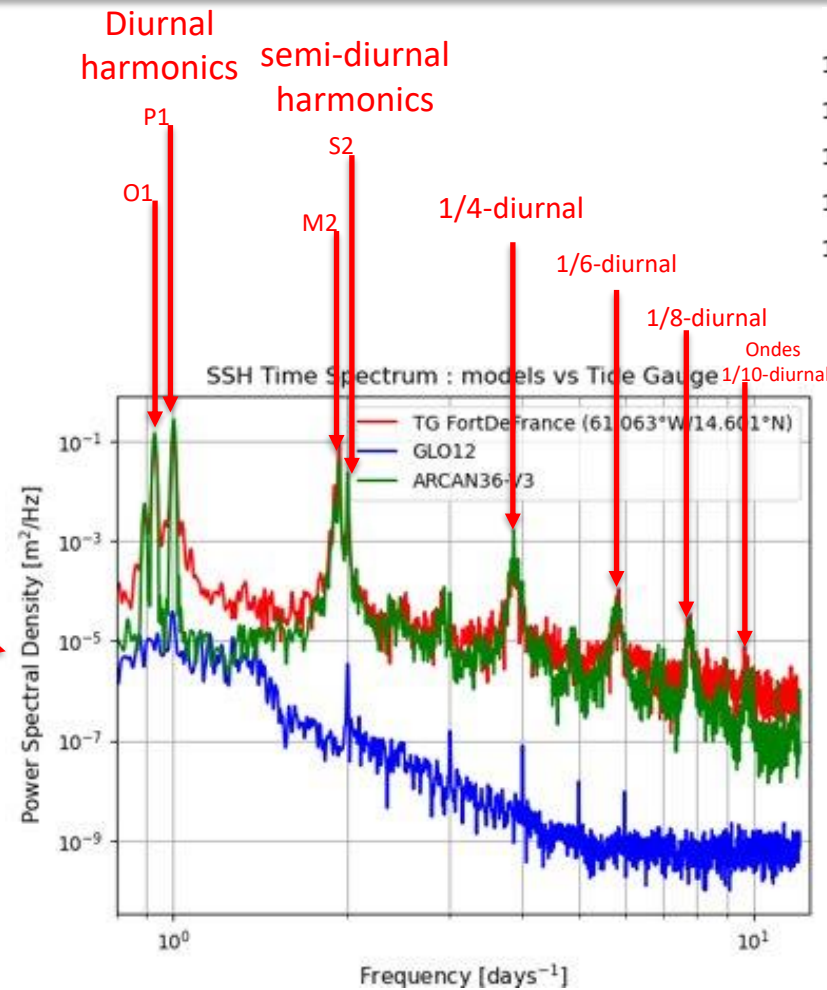
*Obs. data: Copernicus product (from NOAA, Cerema, MétéoFrance):
marineinsitu.eu

VALIDATION ARCAN36 – Tidal forcings benefits

CLASS II



- ❑ ARCAN36 & tide gauge spectra are quite well fitted
- ❑ ARCAN36 is clearly powerfull vs GLO12



Tide gauge
Fort de France
(Martinique)

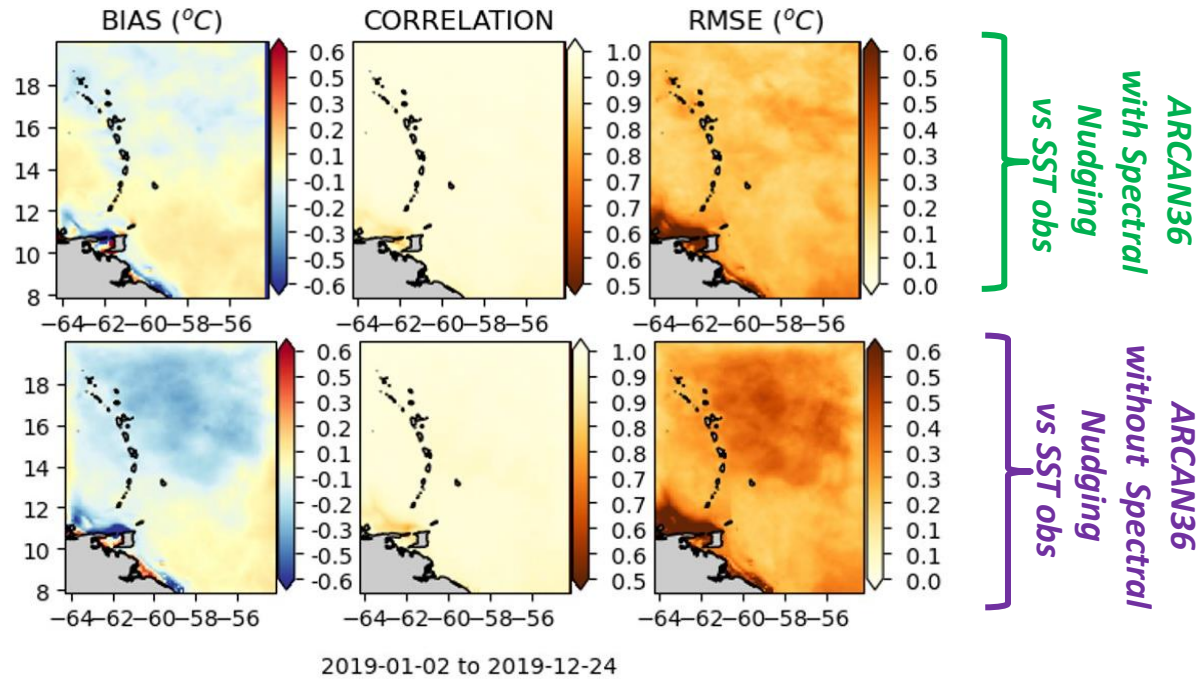
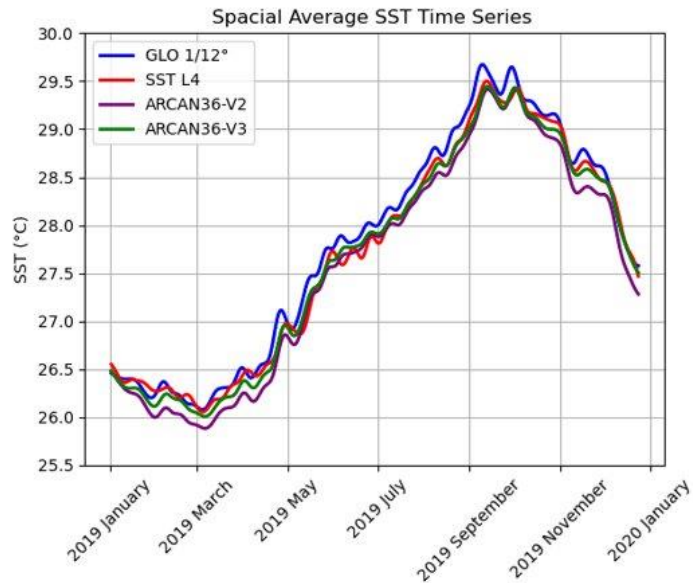


*Obs. data: Copernicus product (from SHOM):
marineinsitu.eu

VALIDATION ARCAN36 – Spectral Nudging benefits

CLASS IV

SST time series & SST stats on the ARCAN36 domain & for 2019



- Time series of ARCAN36 with SN & obs. are better fitted

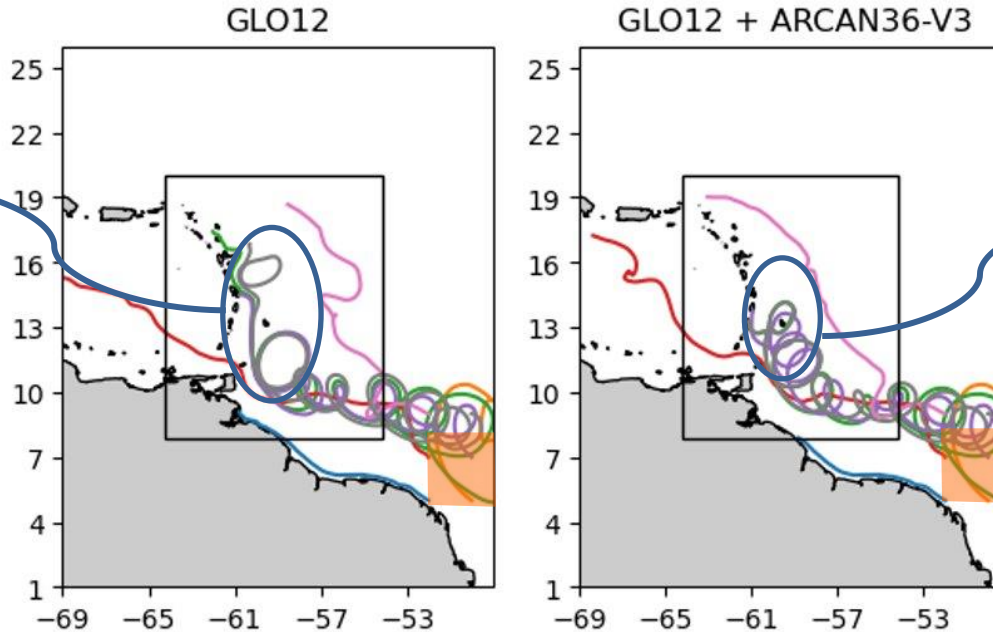
- SN clearly improves bias & RMSE
- SN improves OBCs' behaviour

*Obs. data: Copernicus product (from UK Met Office):
[SST_GLO_SST_L4_NRT_OBSERVATIONS_010_001](#)

Evolution of an NBC ring: ARCAN36 vs GLO12

Comparison of Lagrangian trajectories

The NBC ring seems to dissipate itself between the Caribbean Arc & Barbados Island



The NBC ring diameter decreases in by arriving close to the Caribbean Arc but conserves its shape & tends to go on northward by engulfing the Barbados Island

The ARCAN36 scenario corresponds to the observations
(Fratantoni et al, 2006)

2019/01/02 - 2019/04/10

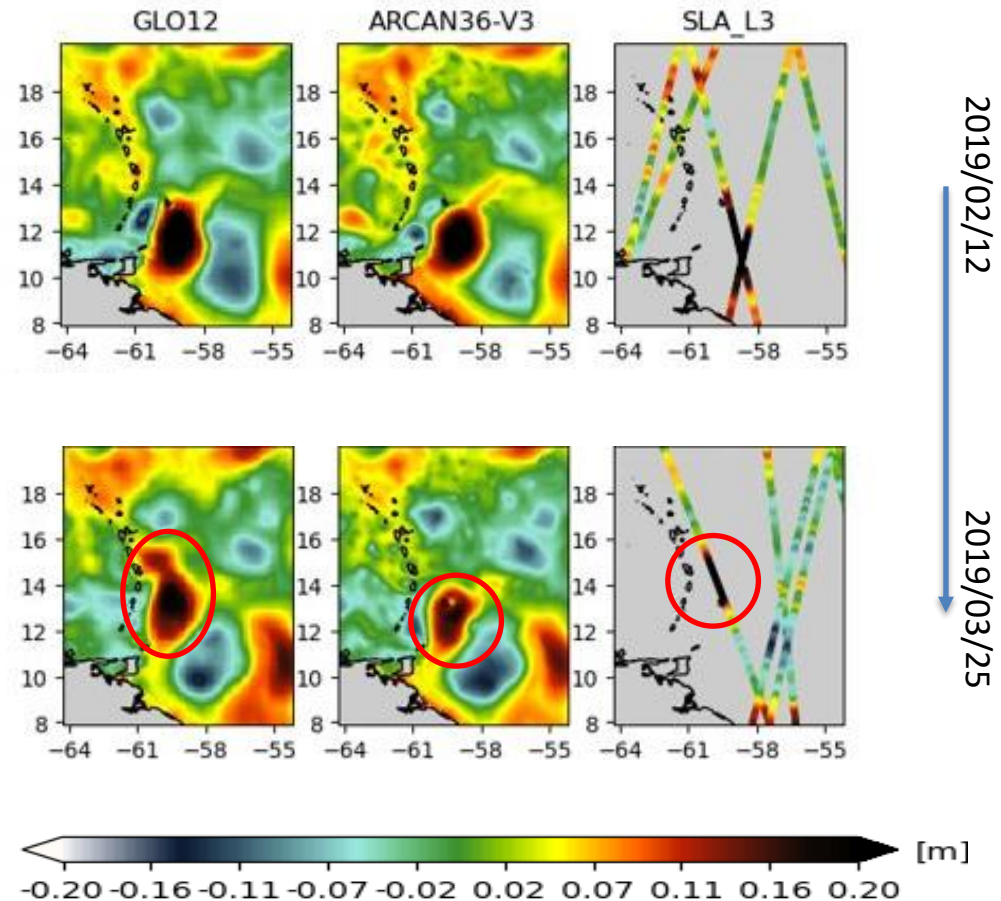
Trajectories of 16 virtual Lagrangian drifters initially seeded in a NBC ring on the retroreflection area (orange square: 52°W-49°W / 5°N-8°N)

Evolution of an NBC ring: ARCAN36 vs GLO12

Comparison of SLA

- ❑ The NBC ring is well represented by both models
- ❑ SLA signature of the eddy arriving on the Caribbean arc:
 - ✓ Obs.: the eddy keeps its structure & is deflected northward after passing the Barbados
 - ✓ ARCAN36: the eddy keeps its structure by engulfing Barbados → a delay / obs.
 - ✓ GLO12: the eddy tends to be deformed

Difficulty to conclude



❑ **ARCAN36/GLO12 Sensitivity tests of MétéoFrance on Sargassum drift FC**

❑ **Student-internship of Master II:**

✓ Ewen Jamet:

Sargassum aggregation process

➔ Partnership with *MIO (Med. Inst. of Oceano.)*

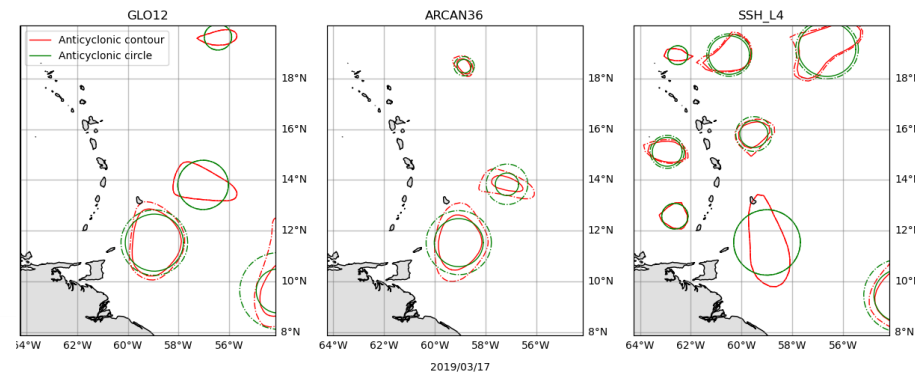
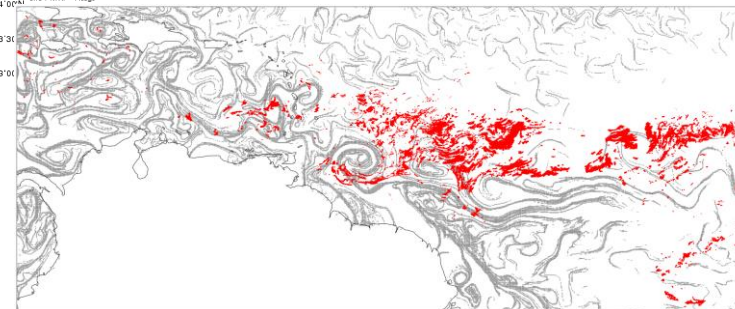
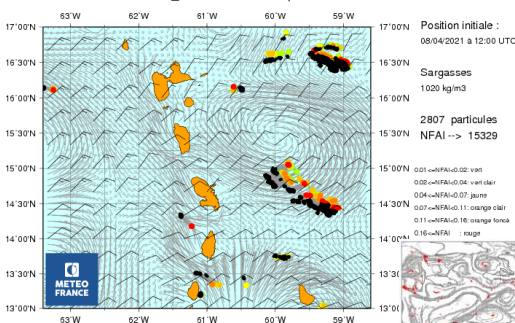
✓ Flavie Dubost & Leonel Chiendje:

Eddy tracking study

➔ Partnership with *Cotonou & Toulouse Univ., LEGOS (Lab. d'Etudes en Géophys. & Océano. Spatiales) & IRD (Inst. de Rech. & Dev.)*

➔ Partnership with *ECCC (Env. & Chgt. Clim. Canada)*

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THANK YOU !

