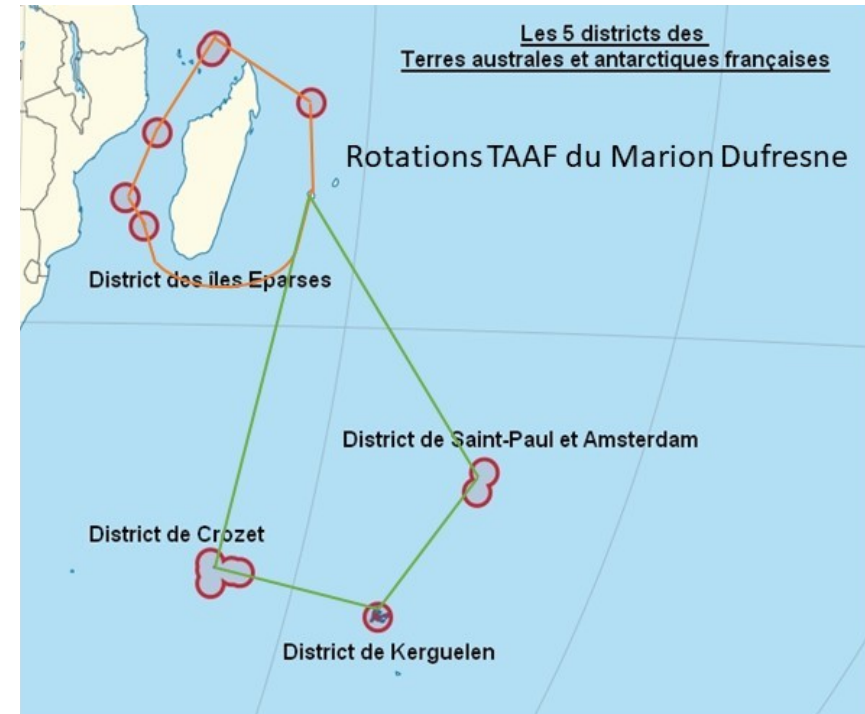




Marion Dufresne Atmospheric Program – Indian Ocean



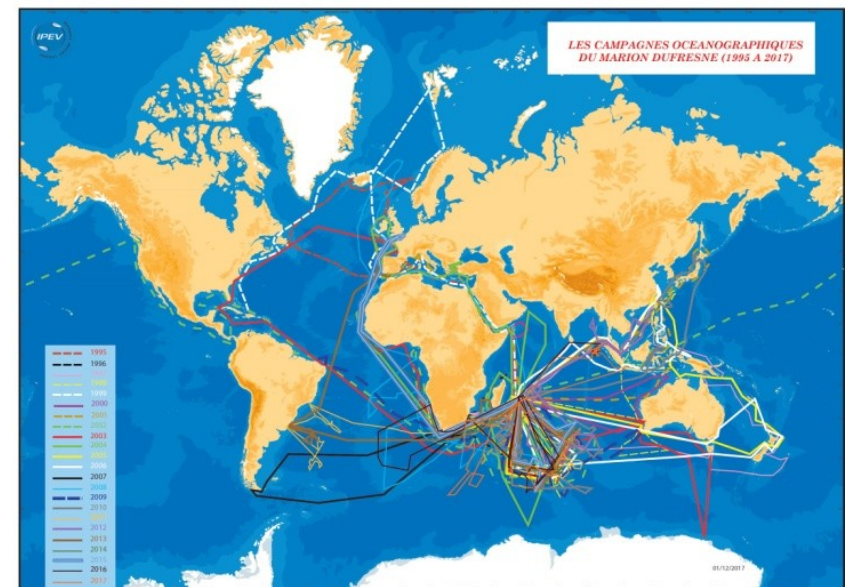
MAP-IO : towards a marine observatory for the study of ocean-atmosphere interactions and satellites calibrations



Atmospheric and biological measurements

- Using the repeatability of the TAAF routes: evolution and trends
- IFREMER scientific campaigns: additional measurements to the international scientific programs and diversification of study areas.
- Large French partnership: LACy, MIO, LaMP, LAERO, LATMOS, LOA, LSCE, LOG, LOCEAN, ENSTA-Bretagne

19 permanent instruments



Biological composition

Partners : MIO, LOG, LOCEAN

Intégration future IR OHIS

Climat / trends : phytoplankton measurement, fishery resource evolution

- Mapping of phytoplankton functional groups
- Seasonal / intra-seasonal study and trends
- Key parameters for scientific campaigns
- Cal/Val anomalies PHYSAT
- Data banking on ODATIS data center

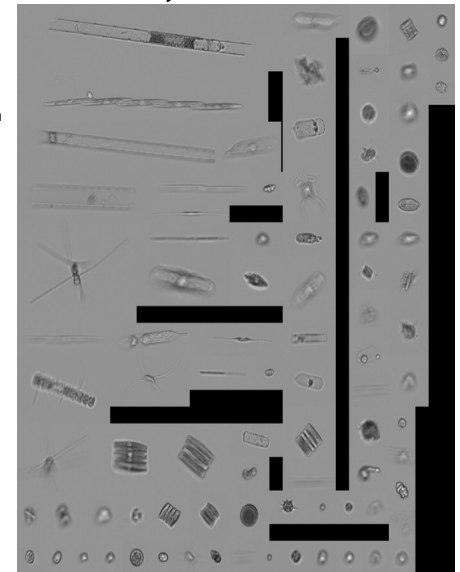
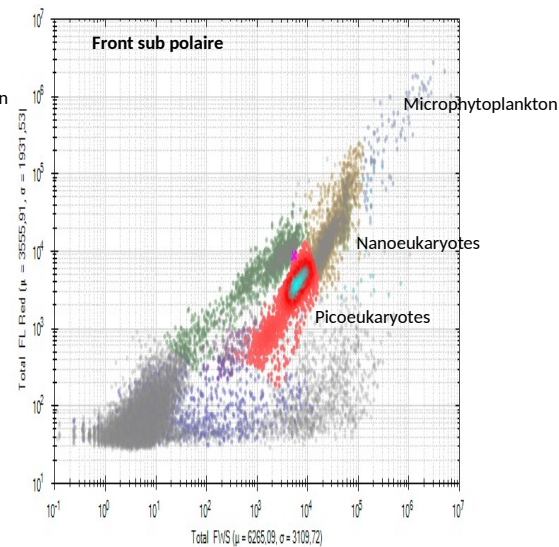
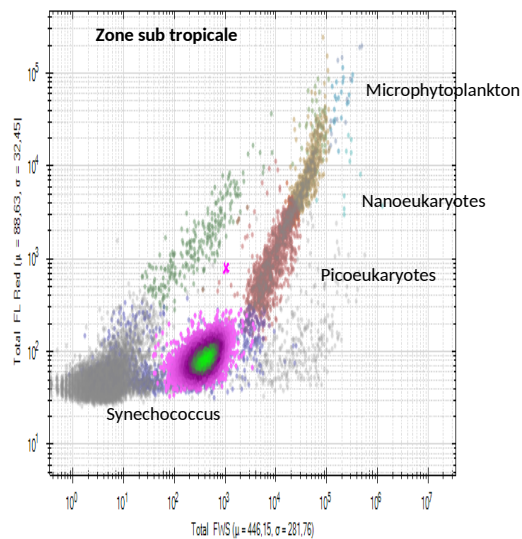
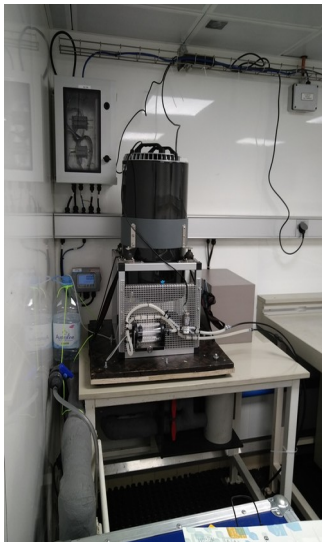
Groupes fonctionnels résolus

Prochlorococcus
Synechococcus
 Picoeukaryotes
 Nanoeukaryotes
 Microphytoplankton
 Cryptophytes like
 Coccolitophoridae like

Phytoplankton (flow cytometer)



Types and community structures, dynamics and trends, satellites



SWINGS campaign : Valorization within the framework of the project **OSTST KERTREND-SAT** (LOCEAN/MIO)= LAGRANGIAN ALTIMETRY FOR CLIMATE TRENDS AND ECOLOGICAL INTERACTIONS IN THE SOUTH INDIAN OCEAN (*Lloyd Izard, Francesco D'ovidio, Cédric Cotté, Gérald Grégori, Andrea Doglioli, Melilotus Thyssen, Karine Leblanc*).

2 thesis, Stage ENS. Data treatment (ECOREV RAPP project).

CO₂, emission and cycle

Partners : LOCEAN, LSCE

Future integration SNO OISO / IR ICOS

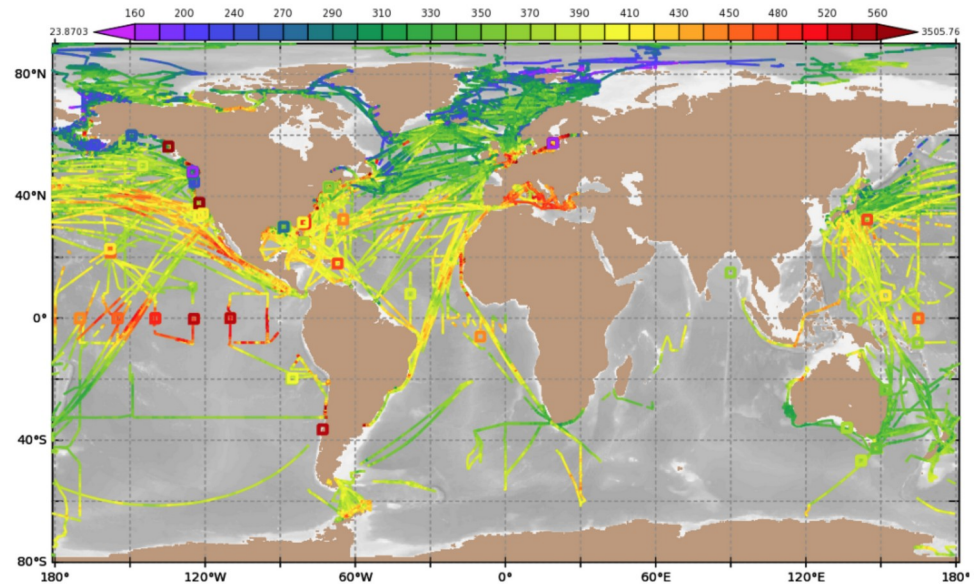
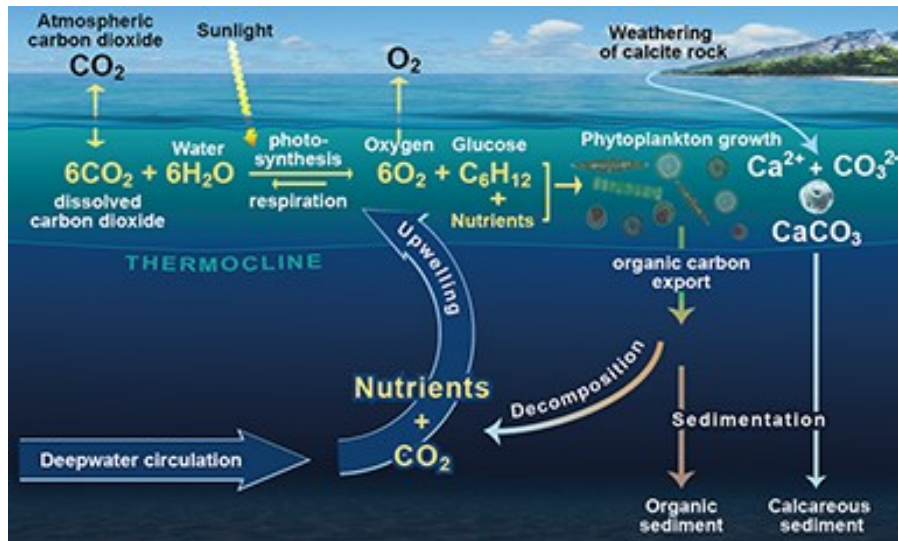
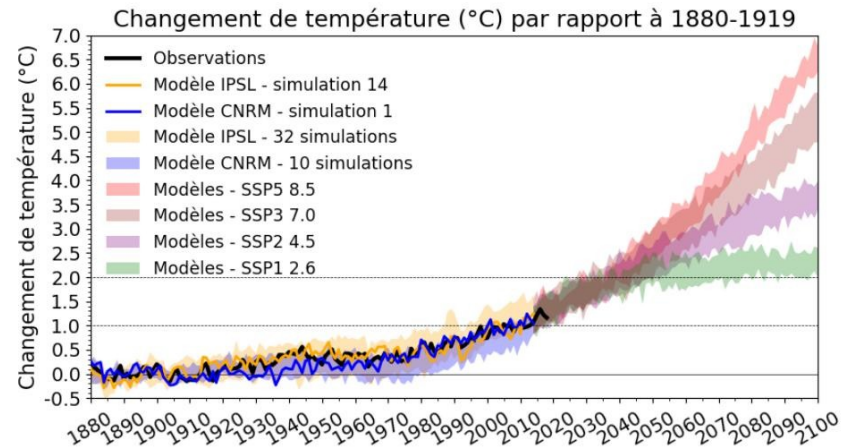
Climat / trends : Study of the CO₂ cycle for the Indian and Southern Oceans. 40% of CO₂ exchanges within the circumpolar circulation

Improvement of climate models: calibrations, parameterizations.

CO₂ measurement (dissolved, atmosphere)



Solubility and biological pump. Climate-trends, CO₂ flux



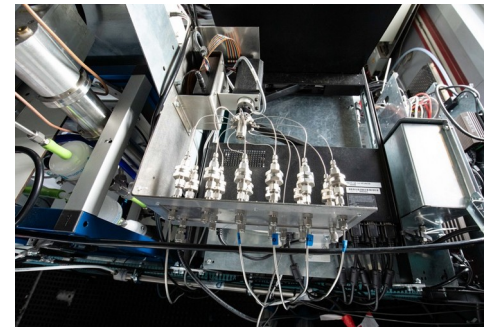
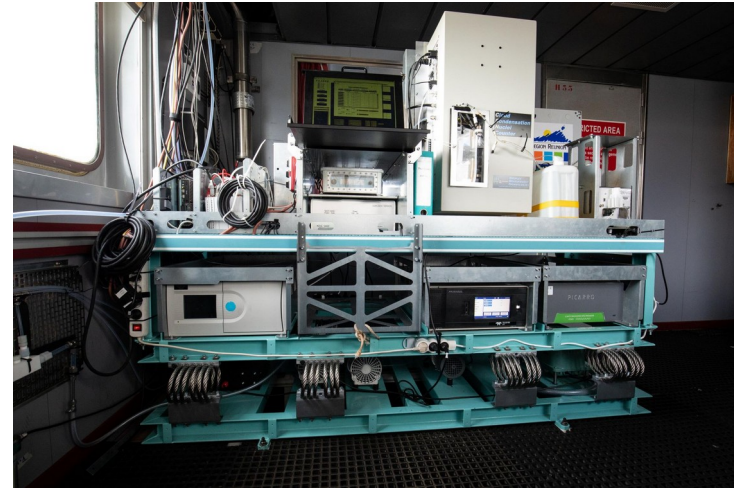
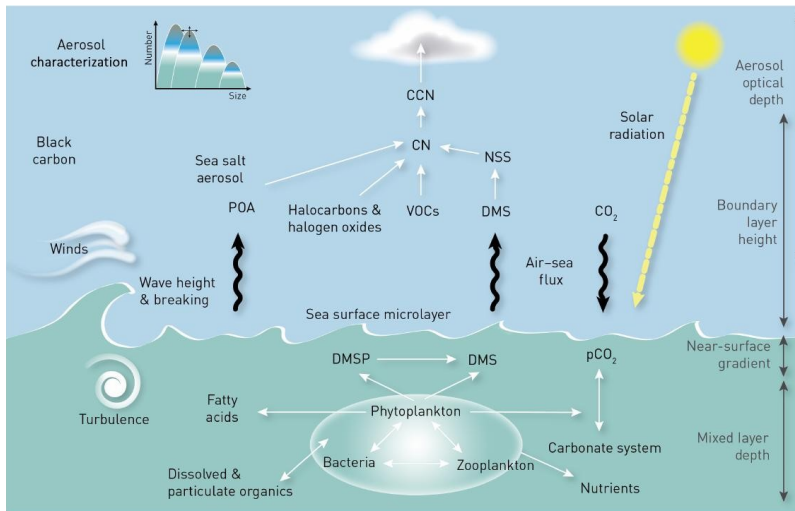
Future integration SNO OISO, IR ICOS

International synthesis of oceanic fCO₂ measurements 2010-2019 (SOCAT database)

ocean-atmosphere exchanges : measurement & objectives

Partners : LaMP, LACy, LAERO, MIO , LSCE

Future integration SNO CLAP / IR ACTRIS
SNO ICOS-FR / IR ICOS



Aerosols – sea salts

Size distribution 5 nm à 40 µm

Total number

CCN properties

Gas : CO₂, CH₄, CO, H₂O, NO_x, O₃

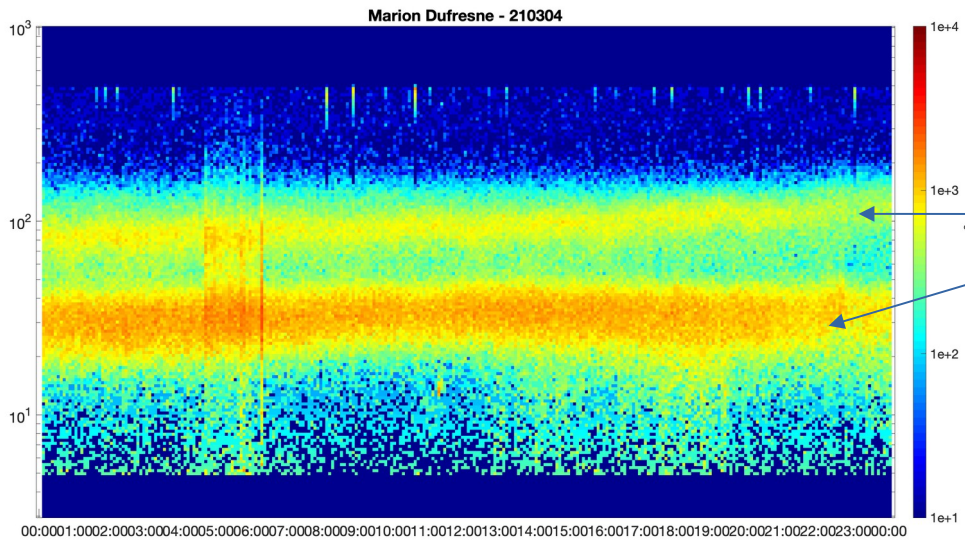
- ✓ Parameterization of sea salt and sea spray emissions in strong winds.
- ✓ Size distribution and CCN properties of marine aerosols.
- ✓ Study of trace gases in relation to biological activity and ocean surface state.
- ✓ Aerosol-cloud life cycle: cyclones, extra-tropical depression.

Programs : ERC Sea2Clouds, ANR SWINGS, proposal ANR SOPHYAC

Valorisation : Ph-D (LACy, LOA) and two Ph-D proposals (LaMP et LAERO)

Ocean-atmosphere exchanges : aerosols

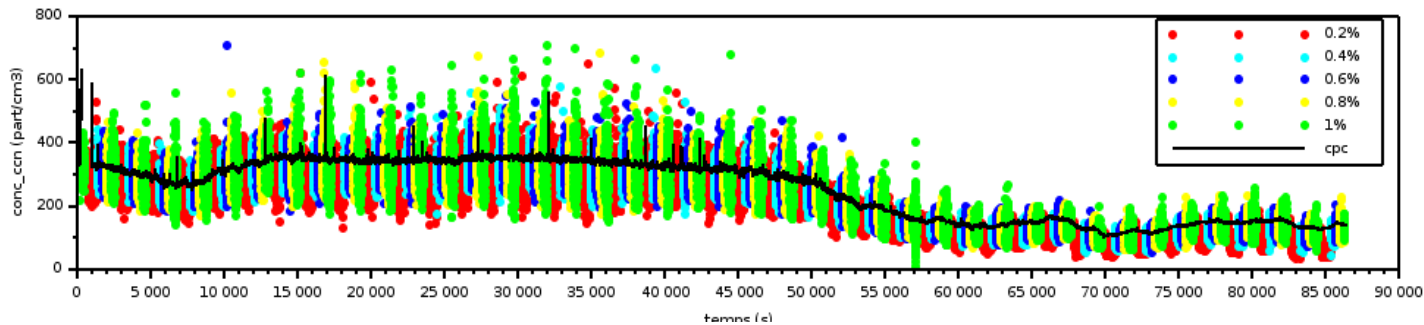
SMPS



Two modes: 30 nm and 100 nm (similar to those measured in sea water spray generation experiments).

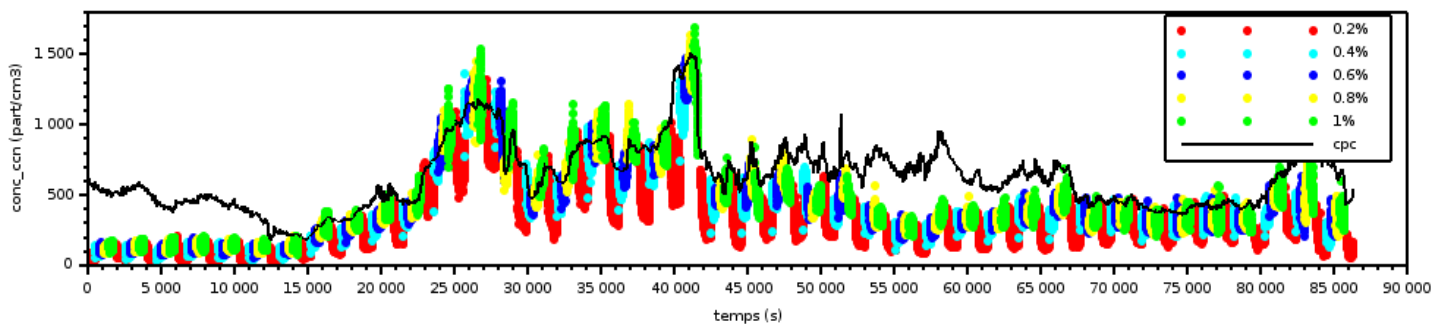
CPC + CCN-100

Concentration ccn et cpc écriété 20210207



Storm: February 7, 2021 (between Marion and Crozet ; all aerosols are activated)

Concentration ccn et cpc écriété 20210306



Low wind : March 6, 2021 (highly variable activation)

Ocean-atmosphere exchanges : greenhouse gases

Partners : LSCE, LaMP

Future integration : SNO ICOS-FR / IR ICOS

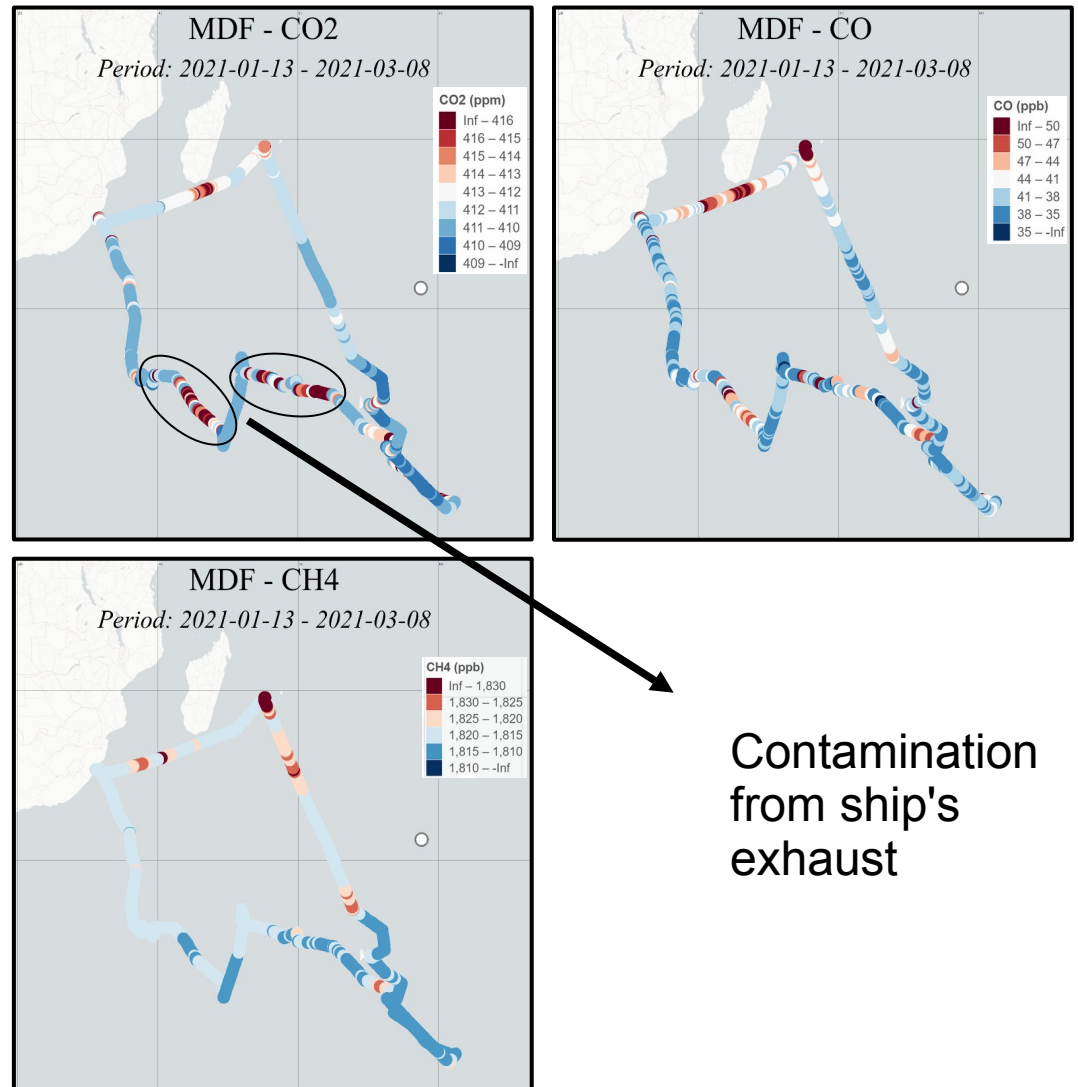
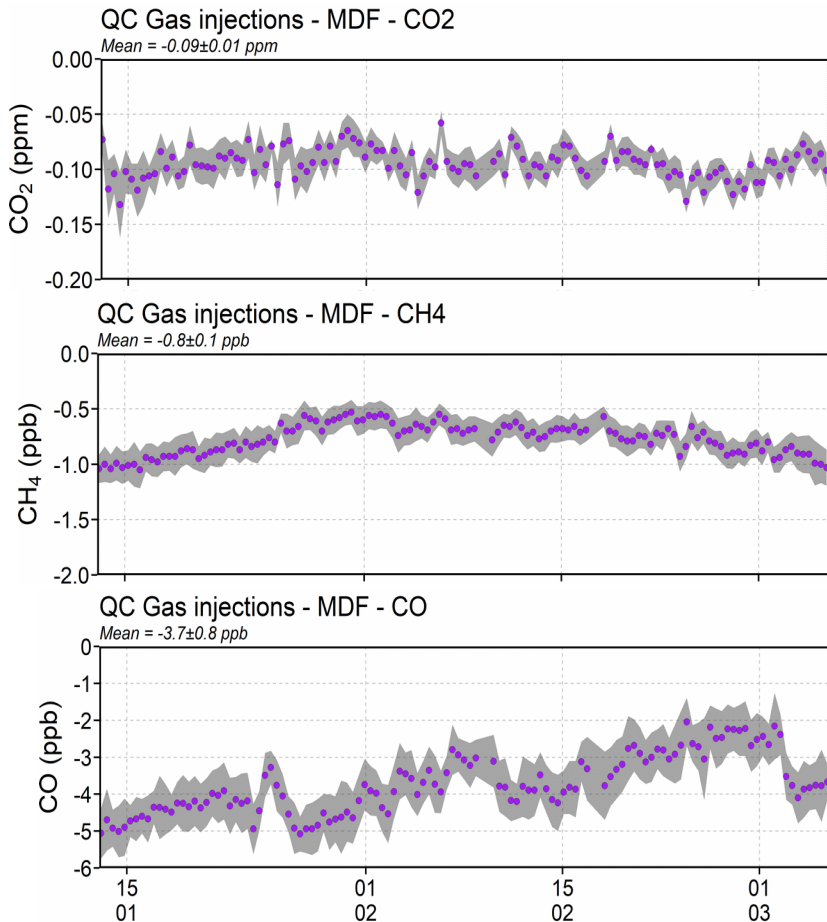


Small deviations noted (soon to be calibrated):

-0.09 ppm for CO₂ (WMO goal = ±0.1 ppm)

-0.8 ppb for CH₄ (WMO goal = ±2 ppb)

-4 ppb for CO (WMO goal = ±2 ppb)

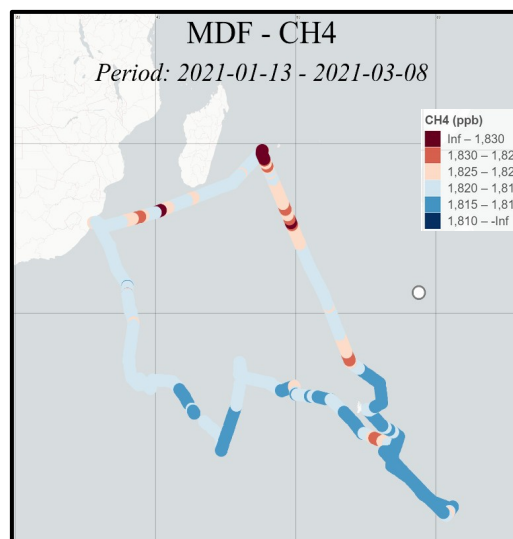
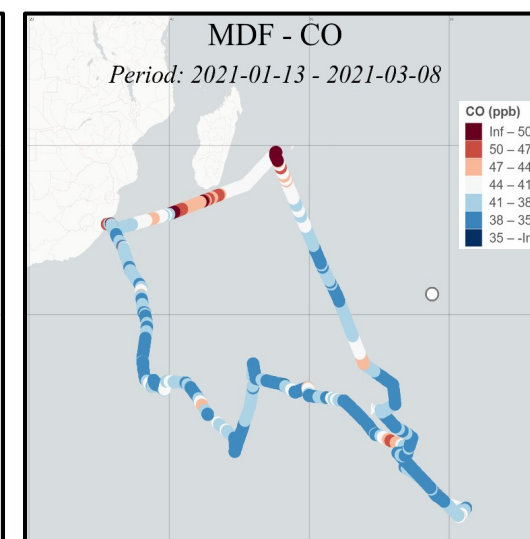
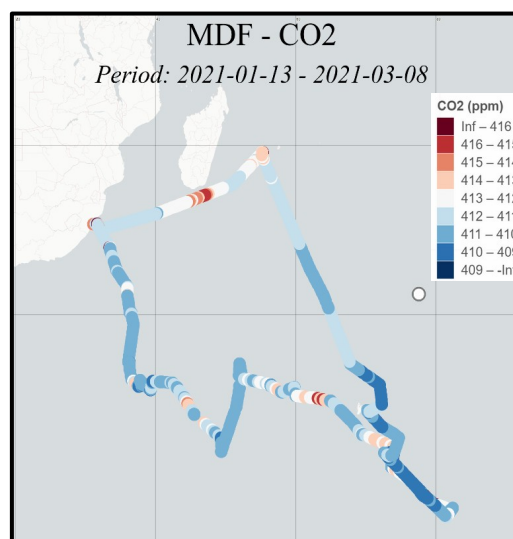
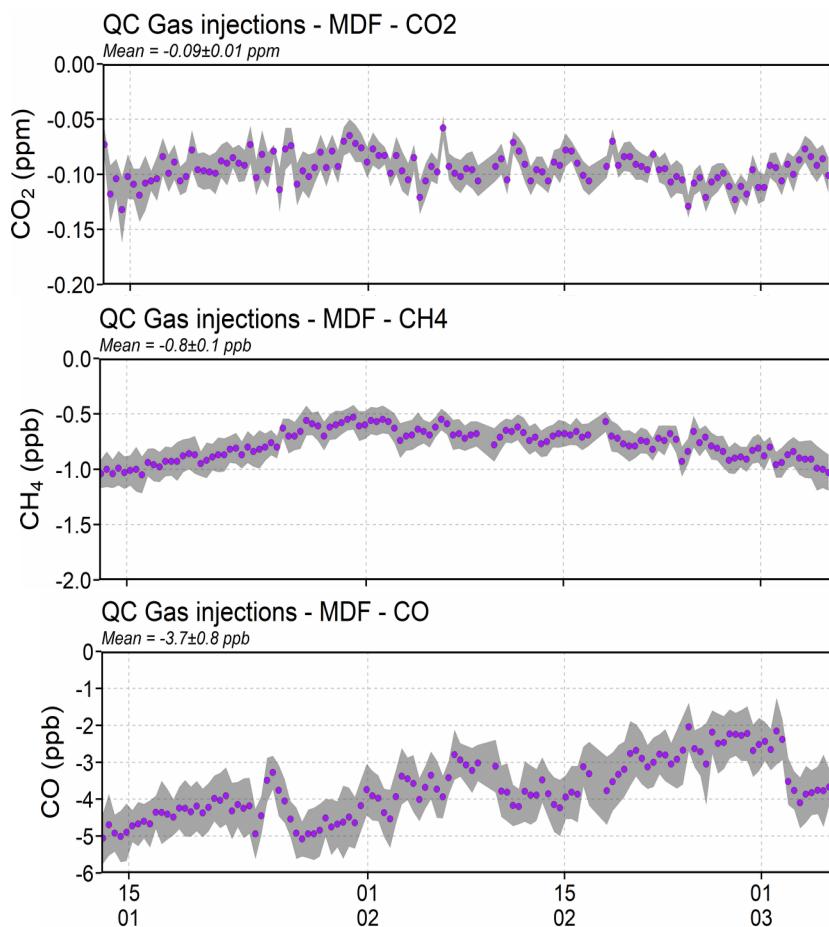


Ocean-atmosphere exchanges : greenhouse gases



Processing:

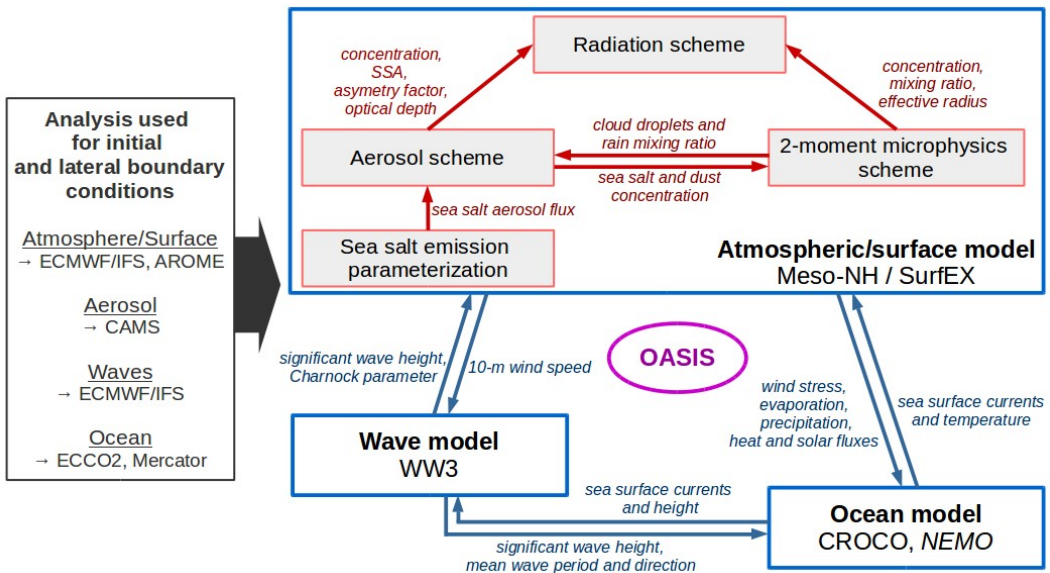
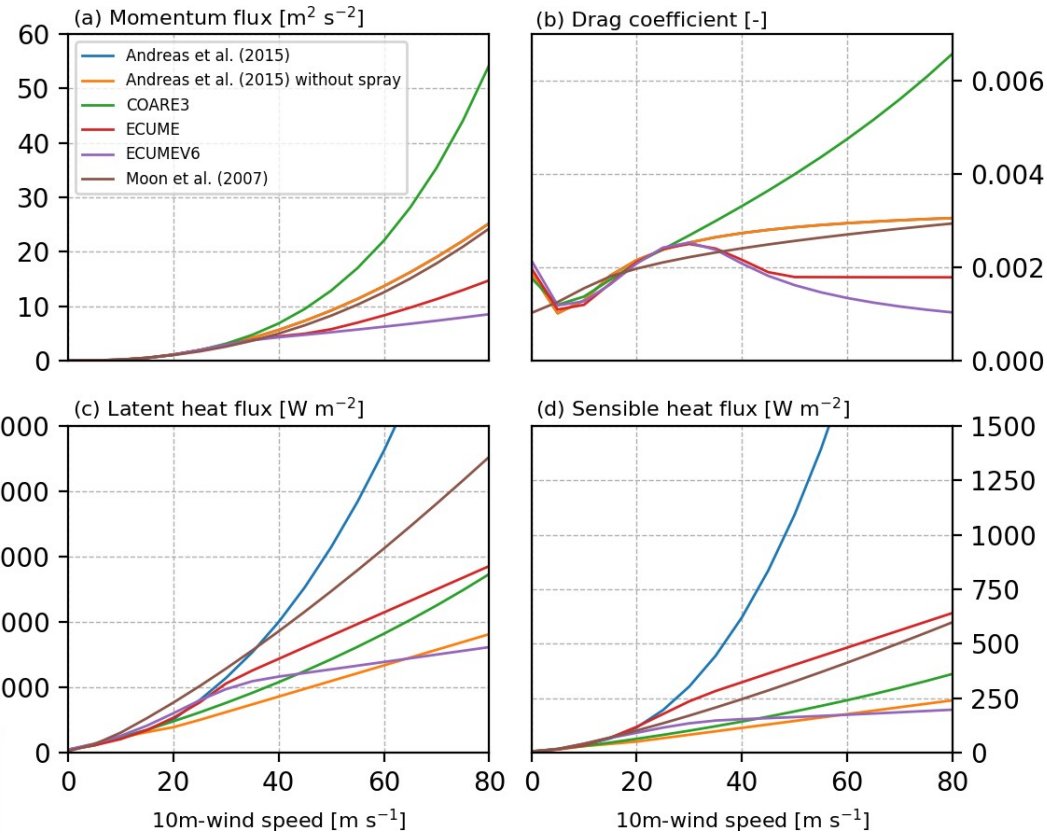
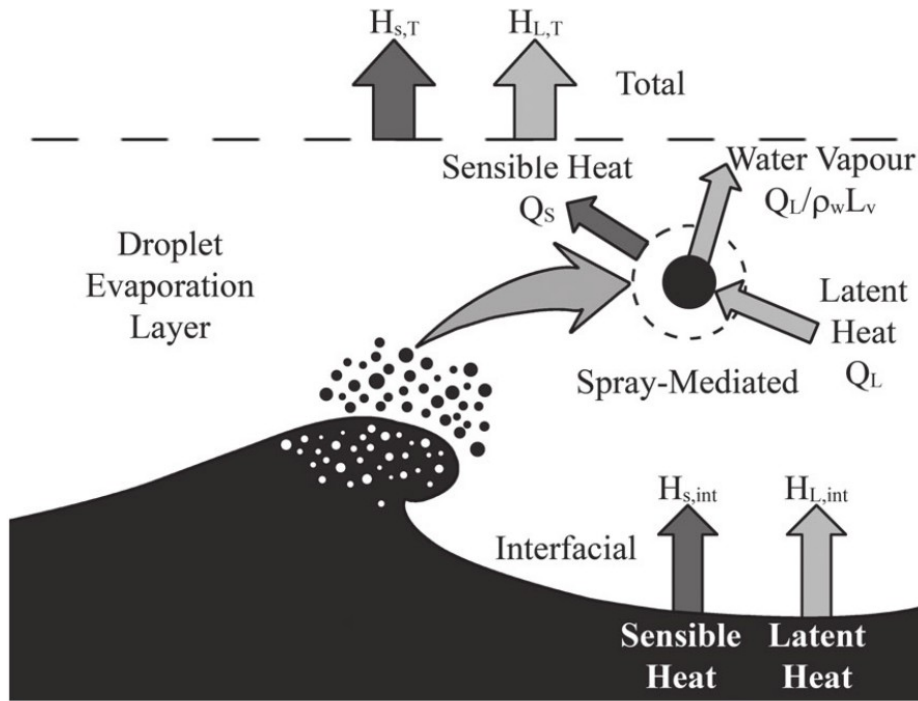
- ✓ SNO ICOS-FR database
- ✓ Spike detection algorithm
- ✓ Manual QA/QC by instrument PI



After statistical filtering:
elimination of
contamination peaks

Turbulent flows by strong winds and swell

LACy, LAERO, MIO



Ferry-box
(wave, currents, salinity, temperature, viscosity)



Station meteo
(wind, humidity, temperature, vent, pressure)

Coupled simulation : atmosphere-ocean-wave

Aerosol load & optical properties

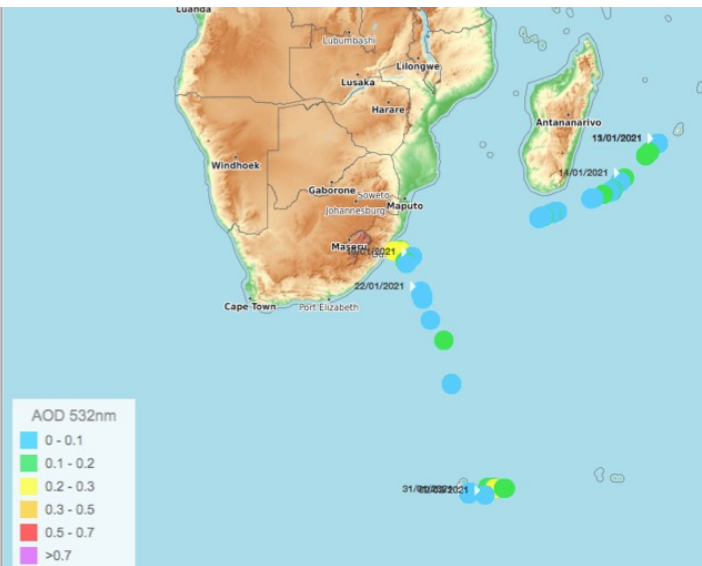
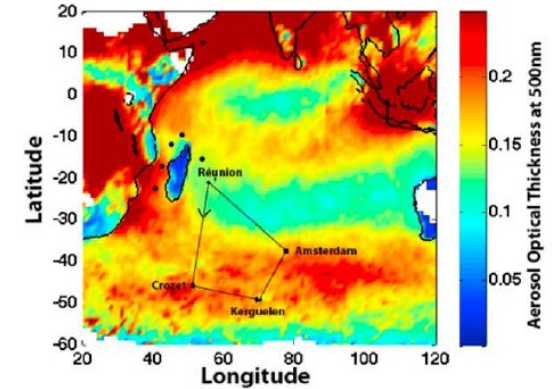
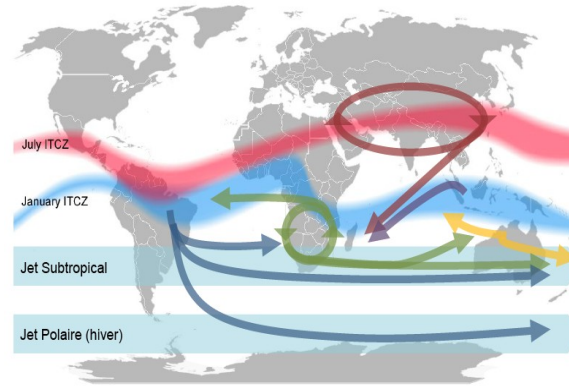
Parteners : LACy, LOA

Future integration SNO AERONET / IR ACTRIS-FR / ESA

Aerosols (optical depth)



Pollution, aerosols on free troposphere



✓ **Plumes (fire, desert dusts) :**
distribution and composition of the atmosphere over the Indian Ocean

✓ **Study of the sky radiance and spectral AOD :**
cal/val new generation of Europe satellites
(ESA/IDEAS and ESA/QA4EO)

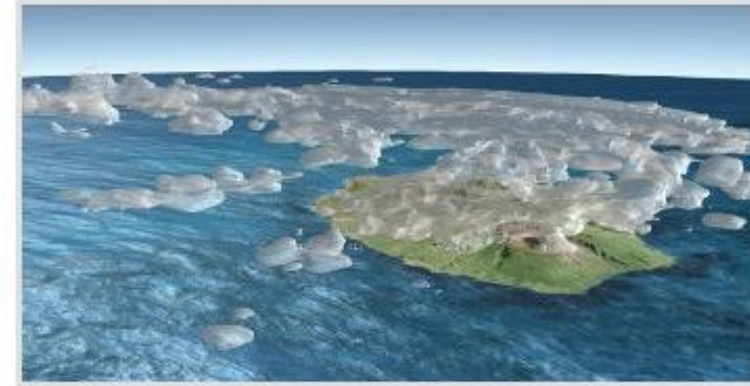
✓ **Prototypes :**

- ➔ development of CE318T photometers on ship fleet
- ➔ dedicated acquisition chain treatments under development for ACTRIS-FR

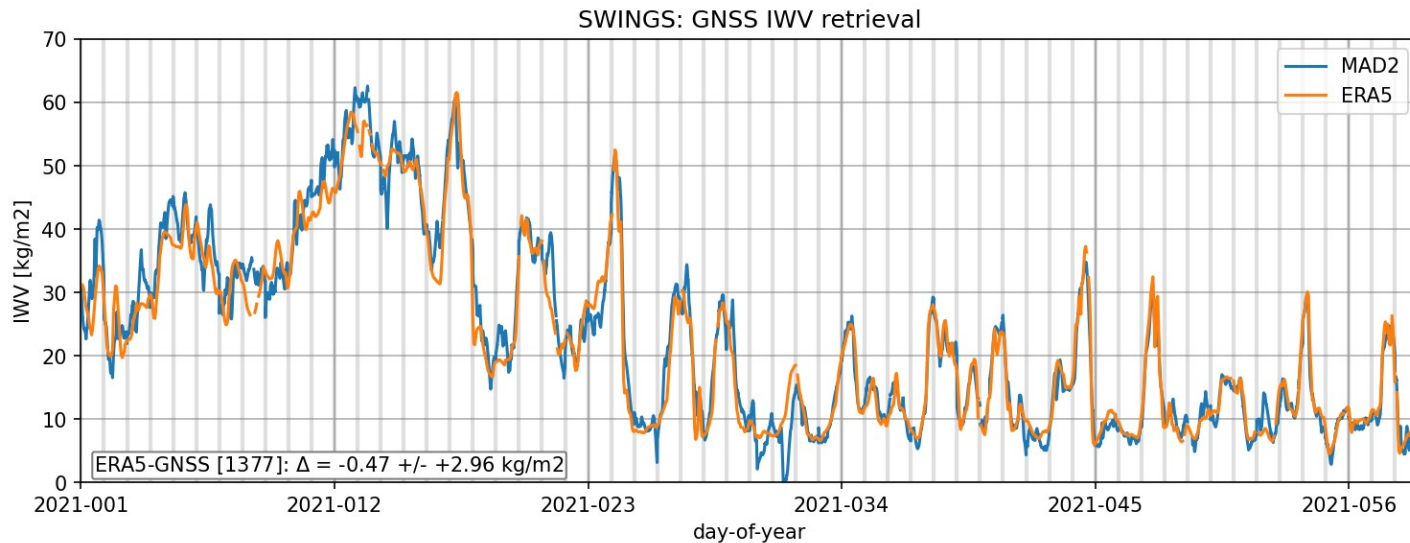
Atmospheric water

Partners : LACy, ENSTA-Bretagne

Future integration : RGP, SNO RENAG



Nebulosity , water vapour  Assimilation, weather forecasting - cyclones



- ✓ Data assimilation ZTD (AROME et ECMWF) via RGP network (IGN)
- ✓ Cal/val satellite: altimetry, radiometry and IWV
- ✓ Process studies (meteorology / cyclogenesis, radiation budget)

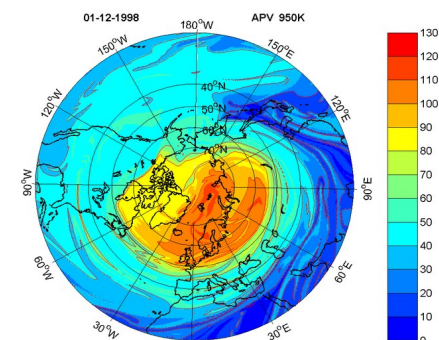
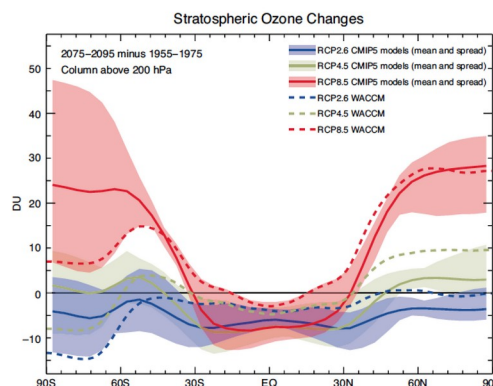
Stratosphère O3, NO2 et UV

Partenaires : LACy, LATMOS

Intégration SNO NDACC

Mini SAOZ

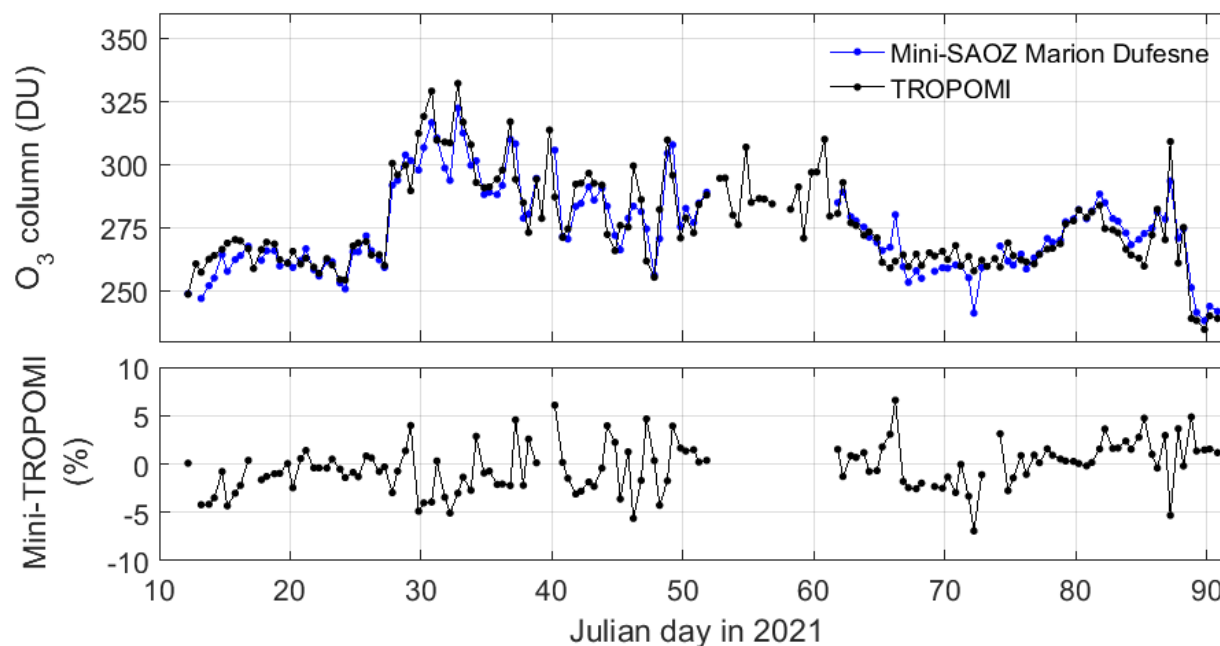
Radiomètres UV



Ozone, UV et NO2 (integrated)



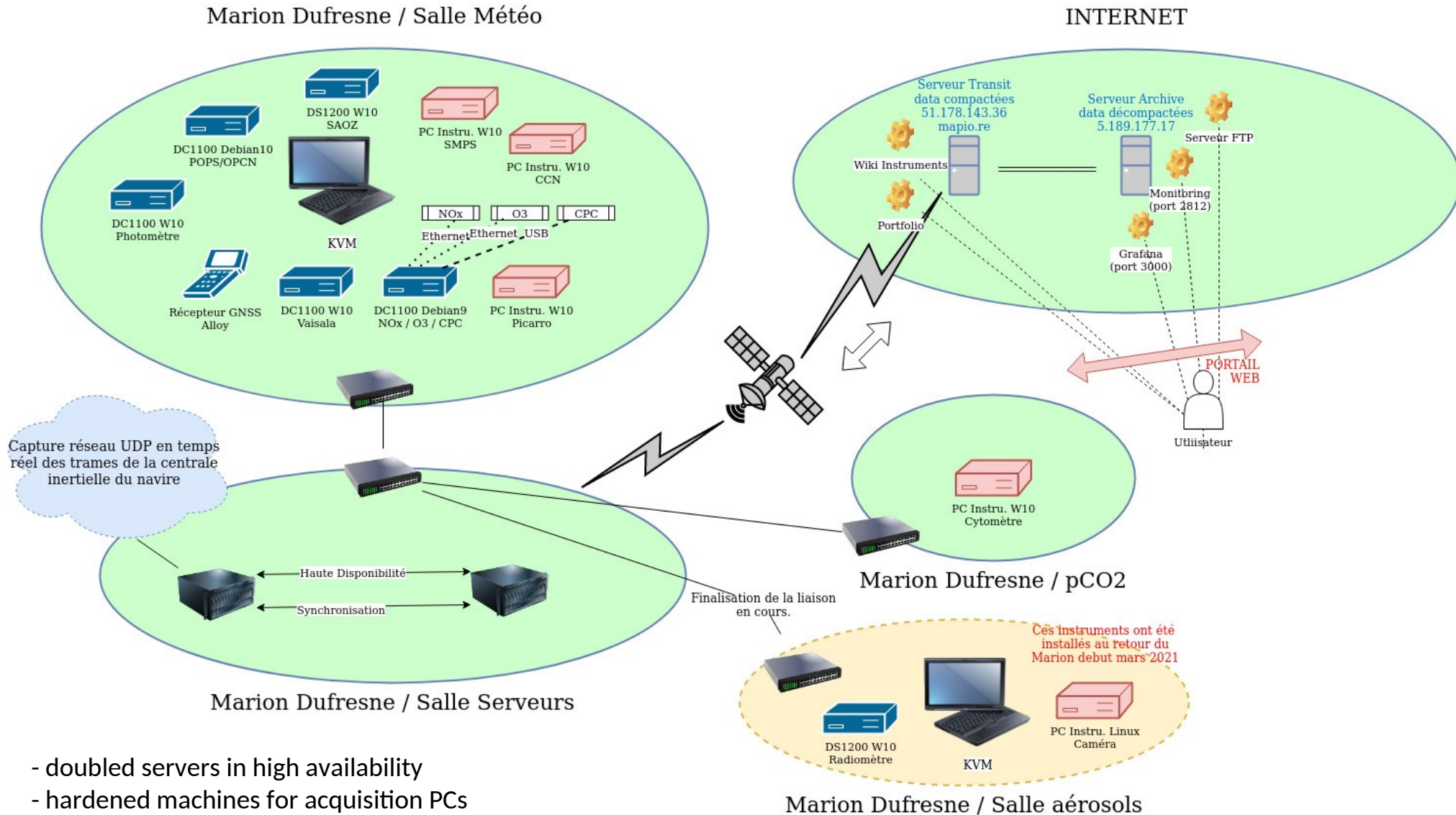
Stratospheric ozone and climat



- ✓ Evolution of the intertropical barrier via O3 columns: link between OPAR and Kerguelen
- ✓ Instrumental synergy: H2O comparison miniSAOZ vs GNSS, UV calibration via miniSAOZ

➔ First papers on 2021

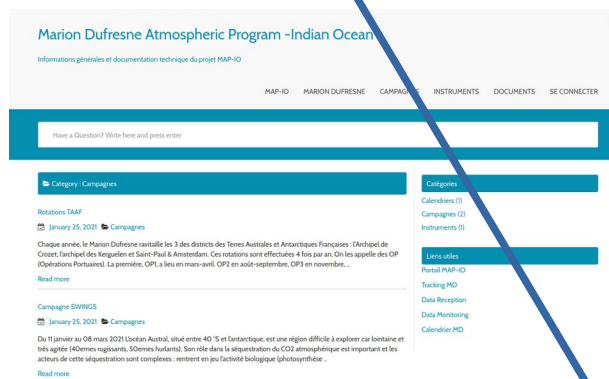
Acquisition – data transfer



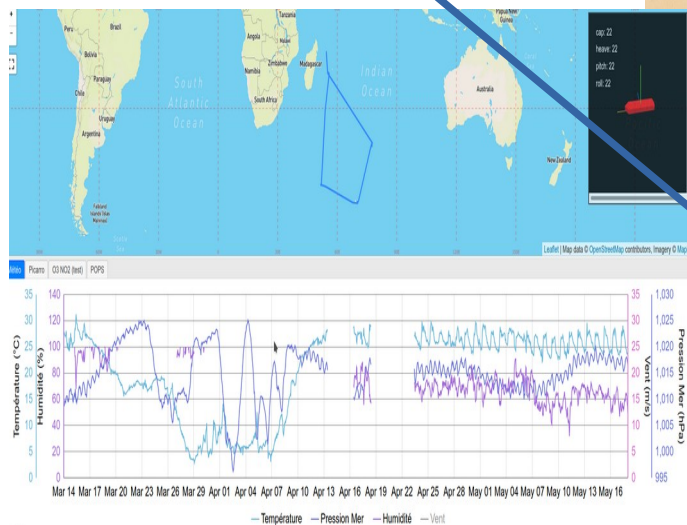
- doubled servers in high availability
- hardened machines for acquisition PCs
- remote access via 2 gateways and 4 SSH ports
- permanent monitoring
- visualization of data presence/absence status
- visual control script of the operation
- the large data remain on board on the two servers and are retrieved at each stopover

web site MAP-IO : www.mapio.re

WIKI & Documentation
(program, instruments,
procedures)



Graphical visualization of
data in relation to the with
the position of the vessel



MAP-IO

VUE LONGITUDINALE BABORD
(longitudinal view (portside))

MARION DUFRESNE

MARION DUFRESNE ATMOSPHERIC PROGRAM INDIAN OCEAN
[\[OBJECTIF\]](#) [\[DERNIERE MISSION\]](#) [\[RUBRIQUES\]](#)

Notre objectif

L'objectif de MAP-IO est d'étudier la composition de l'atmosphère et les processus océan-atmosphère ayant un impact sur le climat régional et la prévision numérique du temps.
Ce programme scientifique s'appuie sur la bancarisation de données océaniques et atmosphériques en équipant le navire Marion Dufresne de 19 systèmes de mesure de l'atmosphère pérennes et autonomes.

Dernière mission

Le Marion Dufresne a quitté La Réunion le 12 mars 2021 pour faire route vers les archipels Crozet et Kerguelen puis les îles Saint-Paul et Amsterdam, administrés par la collectivité des Terres australes et antarctiques françaises (TAAF). Il est rentré au port de la Pointe des Galets le 12 avril 2021. En raison du contexte sanitaire, nous n'avons pas d'information certaine sur les prochaines rotations. Vous pouvez cependant [consulter le calendrier prévisionnel des missions](#) [ici](#)

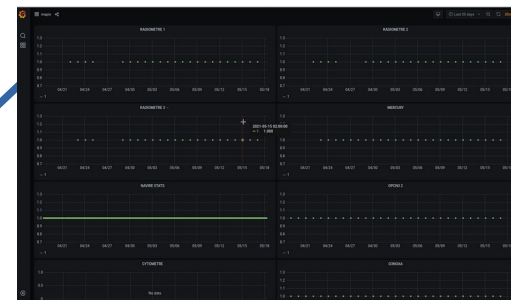
Rubriques

- WIKI
- Monitoring
- Etat des données
- Graphes et géolocalisation
- Contacts & Participants
- Portfolio

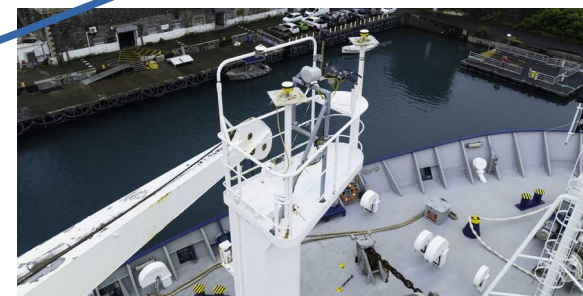
Data monitoring

System	Status	Load
vent120181_contabosever.net	OK	[0.42] [0.19] [0.19]
Program	Status	Output
RADIOMETRE_1	OK	2021-05-17 00:00:00
RADIOMETRE_2	OK	2021-05-17 00:00:00
RADIOMETRE_3	OK	2021-05-17 00:00:00
MERCURY	OK	2021-05-17 00:00:00
TRIMBLE	OK	2021-05-17 23:00:00
BLUAT	Status failed	status: 1
NOX	OK	2021-05-18 03:00:01
O3	OK	2021-05-18 03:00:01
O3_GONGAT	OK	4 result(s) were expected and got 4
PICABRO	OK	2021-05-17 00:00:11
GCN3D0	OK	2021-05-17 23:00:01
QPCN3_1	OK	2021-05-17 00:00:00
QPCN3_2	OK	2021-05-17 00:00:00
PCPS_0	Status failed	2021-04-21 00:00:00
PCPS_1	Status failed	2021-04-21 00:00:00
CLYOMETRE	Status failed	2021-04-13 22:11:00
SAC3	OK	2021-05-18 00:00:00
SMPS	Status failed	2021-04-21 00:00:00
PHOTOMETRE	Status failed	2021-04-18 00:00:00
CONOMA	OK	2021-05-17 00:00:00
CPC	OK	2021-05-18 01:00:01
CENTRAL_POSITION	OK	2021-05-17 23:59:58
CENTRAL_CAPUT	OK	2021-05-17 23:59:58
CENTRAL_INSTANT_POS	OK	2021-05-18 08:31:59
NAVIRE_STATS	OK	2021-05-18 00:00:00
DISK_ETP_Server	OK	64KG free space available
DISK_Transil_Server	OK	14KG free space available
LATMOS_SETUP_CONNECTION	OK	Next retry in: 03:06:14

Data (grafana)



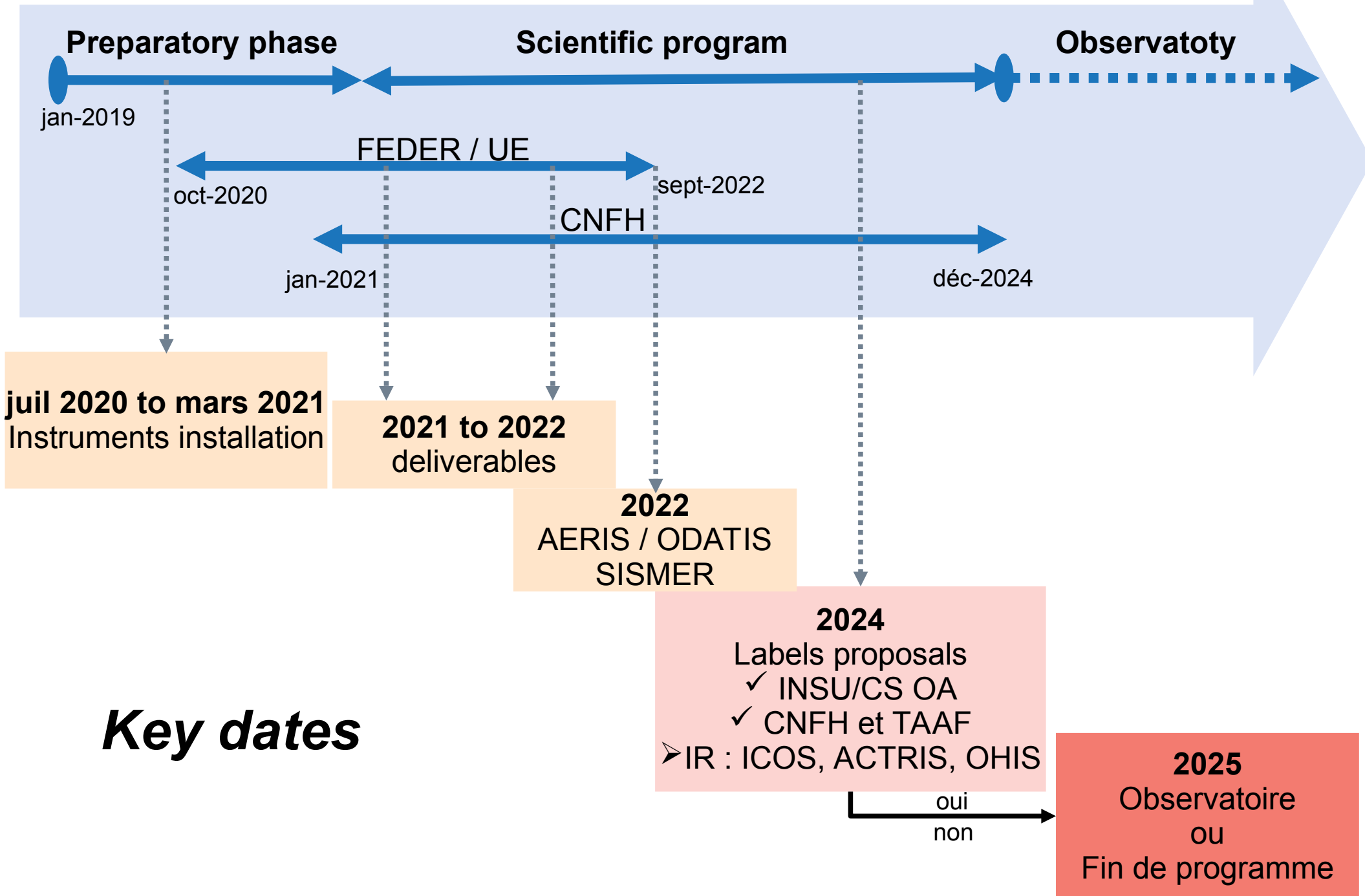
Portfolio



Contacts

In progress : FLEXPART trajectography

Evolution du programme



Insertion stratégique MAP-IO

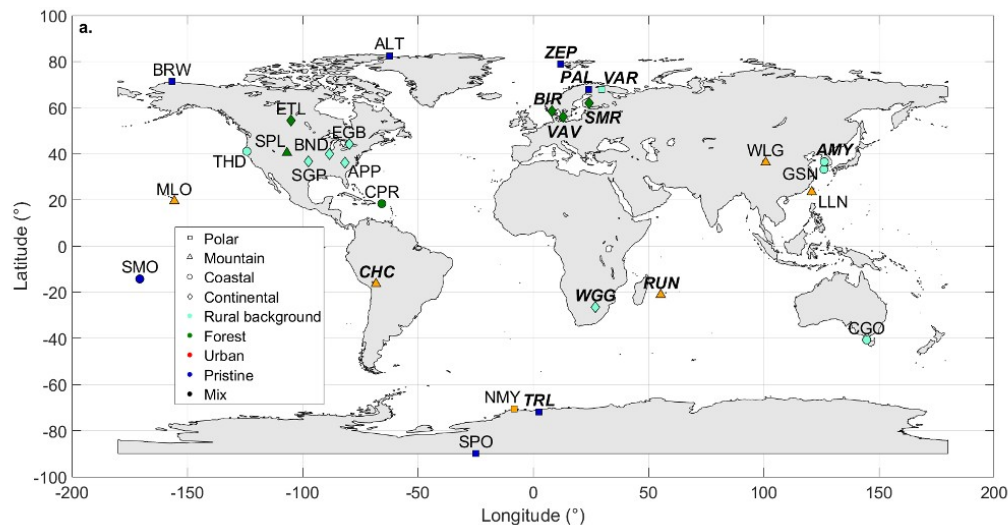
Blue growth and climate:

- ➔ Regional strategy for resilience to climate change (Reunion Region)
- ➔ Blue book of Overseas Territories (French state), METISS ocean program
- ➔ FP9 mission 3 "health of the oceans" and "European leadership in an integrated metrology system" (EU)

Large scientific consortium

- 10 scientific laboratories
- 19 scientists, ~ 40 participants
- 5 SNO et 3 IR

2024-2025 : IR implementation ?





MAP-IO



Contact : P. Tulet (pierre.tulet@aero.obs-mip.fr)