RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

JC2
JOURNÉES CNES JEUNES CHERCHEURS

11, 12 ET 13 OCTOBRE 2023
CITÉ DE L'ESPACE

Doctorant ou Postdoctorant

NOM et Prénom: CARLI Elisa

Titre / Sujet: 2D ocean mesoscale in the Southern Ocean with SWOT

NOM et Prénom du responsable CNES: Annick Sylvestre-Baron

Laboratoire d'accueil: LEGOS

NOM et Prénom du Directeur de thèse: Rosemary Morrow

Partenaire éventuel / co-financeur: CLS

Sujet / Objectifs

The **Southern Ocean** is the valve regulating the Earth's climate, storing about **75%** of the global oceanic uptake of **excess heat** and about **35%** of the global uptake of **excess carbon** from the atmosphere (Bourgeois et al. (2022)).

Scars observations make it hard to fully assess the impact of mesoscale and submesoscale dynamics (<200 km) on the ocean heat transport, representing a potential **gap in our understanding** of the evolution of global oceanic and atmospheric heat content (Fox-Kemper et al. (2011))

New satellite **SWOT allows for global observation** of these structures

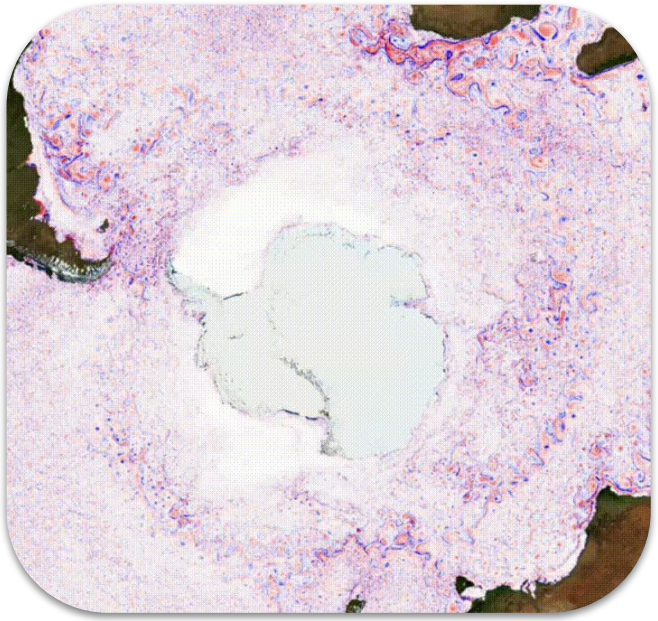
Assessing the **influence of mesoscale and submesoscale dynamics in the Southern Ocean,** studying vertical velocity and heat transport to the ocean interior (model)

Studying the possibility to **reconstruct these vertical fluxes from surface data** (model)

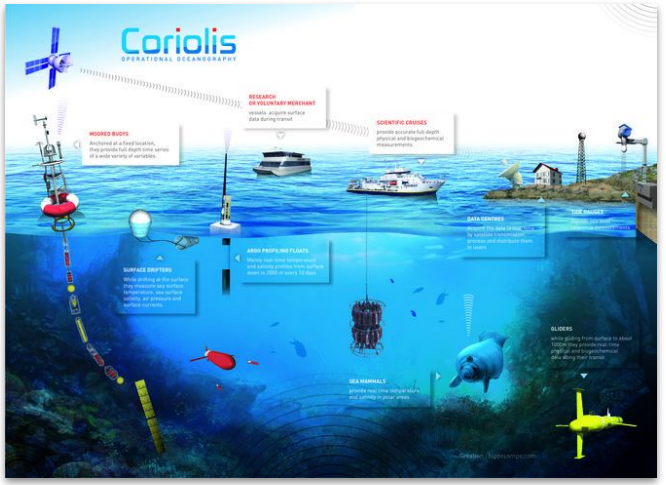
Analysing **SWOT real data** to reproduce all my results with real satellite data

Matériel

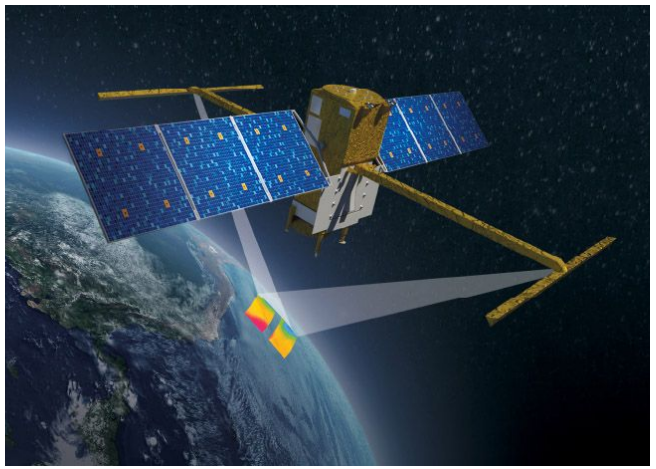
Global Ocean Circulation Models



In Situ measurements



Satellite measurements



and a lot of Python

Méthode

Eddy diagnostics

Eddy Kinetic Energy

$$EKE = \frac{1}{2}(u'^2 + v'^2)$$

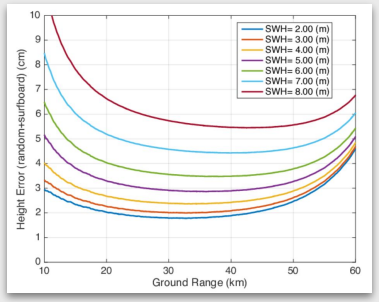
Strain Rate

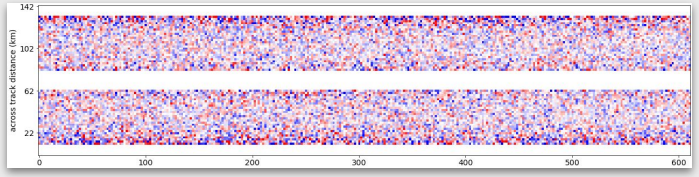
$$S_g = \sqrt{\left(\frac{\partial u_g}{\partial x} - \frac{\partial v_g}{\partial y}\right)^2 + \left(\frac{\partial v_g}{\partial x} + \frac{\partial u_g}{\partial y}\right)^2}$$

Energy cascades

$$\Pi_{cg}(x) = -\rho_0[(\overline{u^2} - \overline{u}^2)\overline{u}_x + (\overline{uv} - \bar{u}\bar{v})(\overline{u}_y + \overline{v}_x) + (\overline{v^2} - \overline{v}^2)\overline{v}_y]$$

Noise mitigation algorithms





Convolutional Neural Networks (CNN): succession of convolutional layers, in particular the class of **autoencoders** is used (**U-Net**)

Surface Quasi Geostrophic Theory

Goal:
Reconstruct the vorticity and the **vertical velocity field in the ocean interior** from the surface SSH

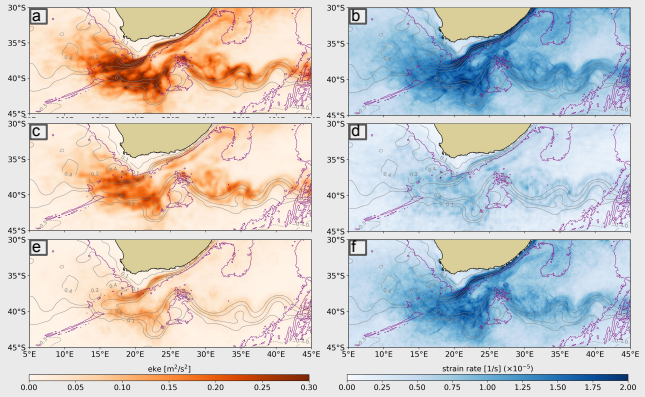
Hypothesis:
- Uniform **potential vorticity PV** in the domain

- Dynamics governed by **boundary conditions**

Premiers résultats ou résultats espérés

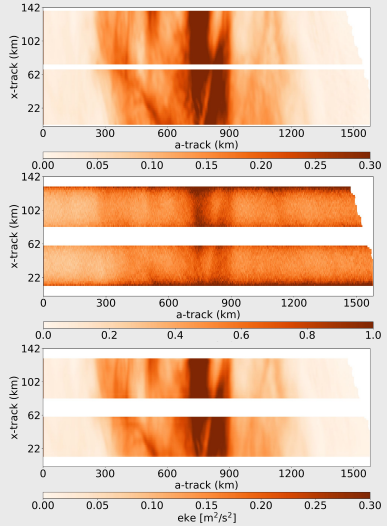
Eddy diagnostics

Mesoscale and submesoscale have a **great influence in the Southern Ocean,** and we are **missing much of the information** with current satellite altimetry data



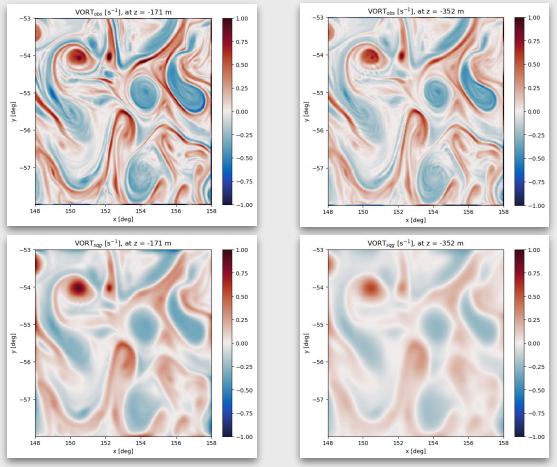
Noise mitigation algorithms

SWOT data will bring much of this missing information, with a **spatial resolution reaching 15 km** in our region



Surface Quasi Geostrophic Theory

SQG is working in the ocean interior, **reconstructing vertical velocity and vorticity structures down to 30-40 km**



Apply the methodology to **SWOT and validate** with in situ data