On the **multiscale** character of sea ice dynamics: an **energy** perspective.

Romain Caneill[1], Pierre Rampal[1], Mickaël Bourgoin[2], David Marsan[3], and Jérôme Weiss[4]

[1] Univ. Grenoble Alpes, CNRS, IRD, Grenoble INP, IGE, Grenoble, France
[2] Univ. Lyon, Ens de Lyon, Univ Claude Bernard, CNRS, Laboratoire de Physique, Lyon, France
[3] ISTerre, Université Savoie Mont-Blanc, CNRS, IRD, IFSTTAR, Le Bourget-du-Lac, France
[4] ISTerre, CNRS, Université Grenoble Alpes, Grenoble, France

Context

Winter Arctic sea ice is a brittle solid plate that covers the ocean and insulates it from atmospheric heat and momentum fluxes. Still, large heat fluxes can occur when sea ice fractures and forms leads. Moreover, due to a large drag coefficient, sea ice imposes stress at the surface of the underlying ocean, and damps small scale oceanic structures.

The sea ice dynamics looks chaotic, displacement is highly intermittent and the deformation is localised in space along the fractures.

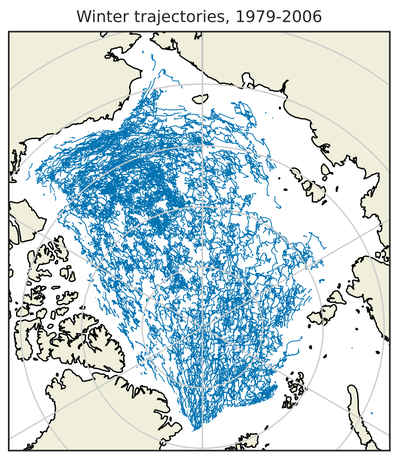
Objectives

1. Characterise the dynamics of sea ice
2. Propose a model for sea-ice mechanical energy pathways
3. How much momentum energy is transfered from the sea ice to the ocean, and at what spatial scale?

Data – methods

IABP

- Buoys in winter, years 1979 – 2006
- Compute fluctuating velocities



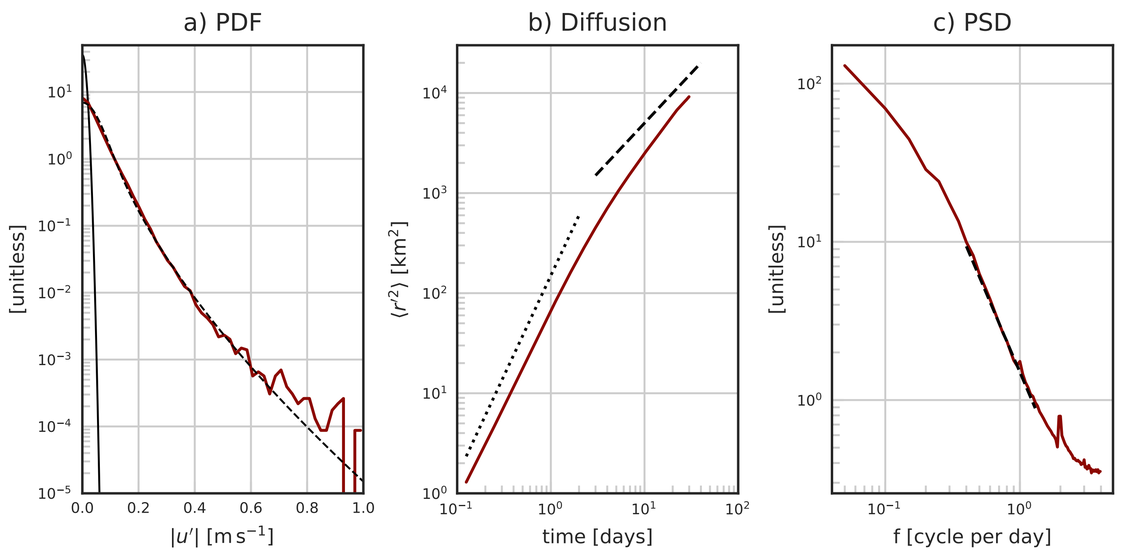
Structure function

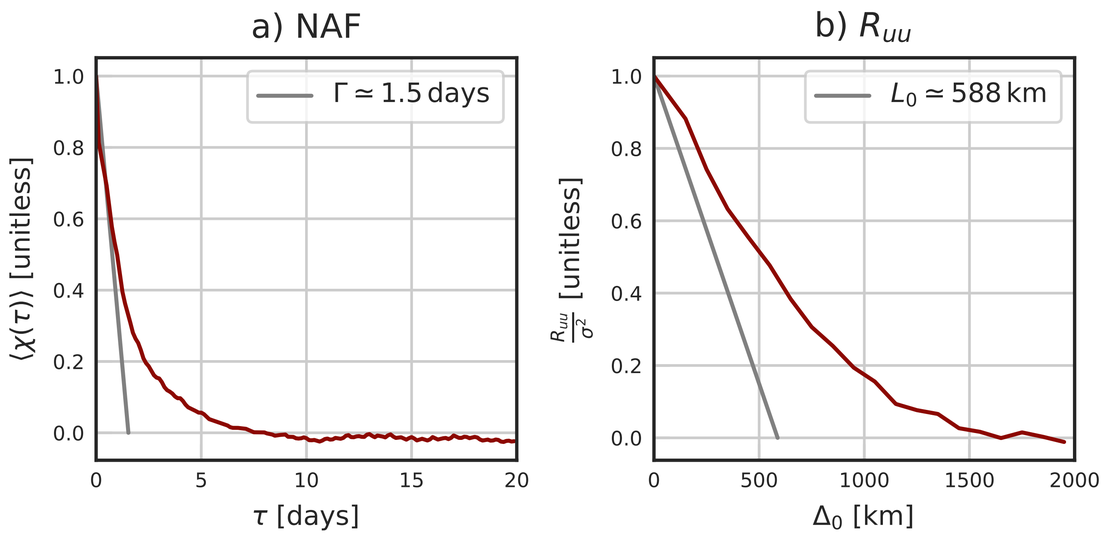
$$S_2 = \langle \delta\mathbf{u} \cdot \delta\mathbf{u} \rangle \quad (1)$$

$$S_{au} = \langle \delta\mathbf{a} \cdot \delta\mathbf{u} \rangle \quad (2)$$

$S_{au} = 0 \implies$ no kinetic energy cascade

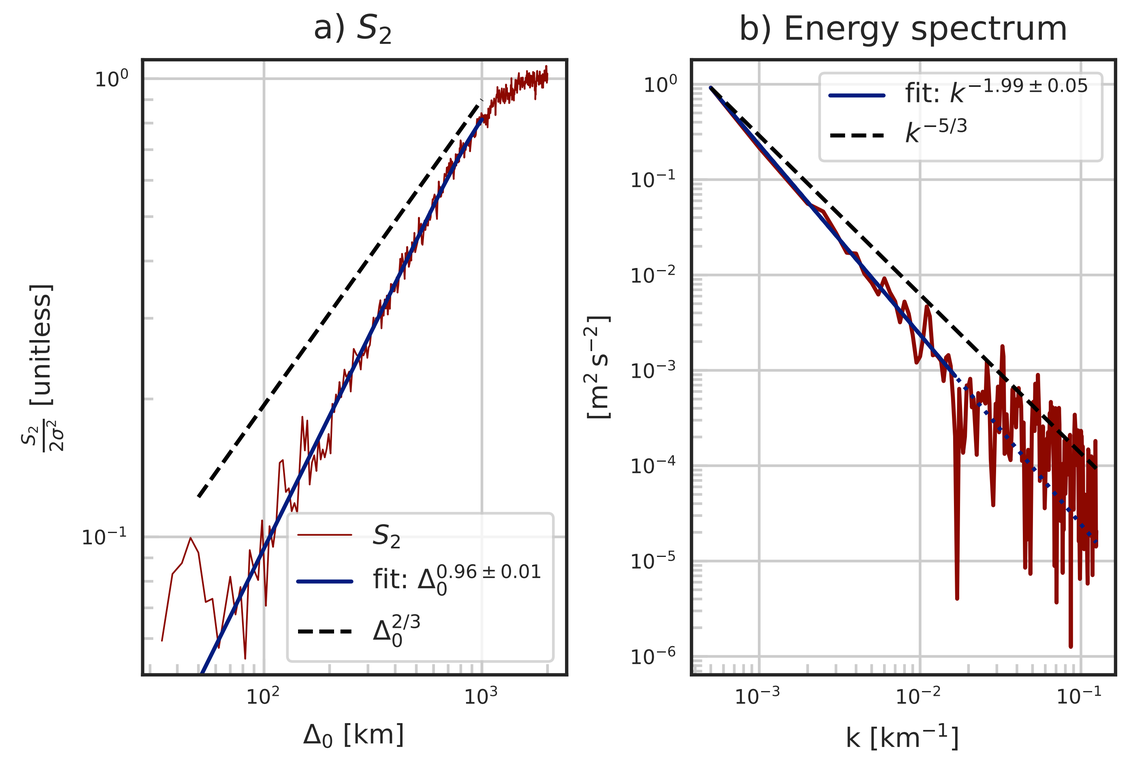
General description

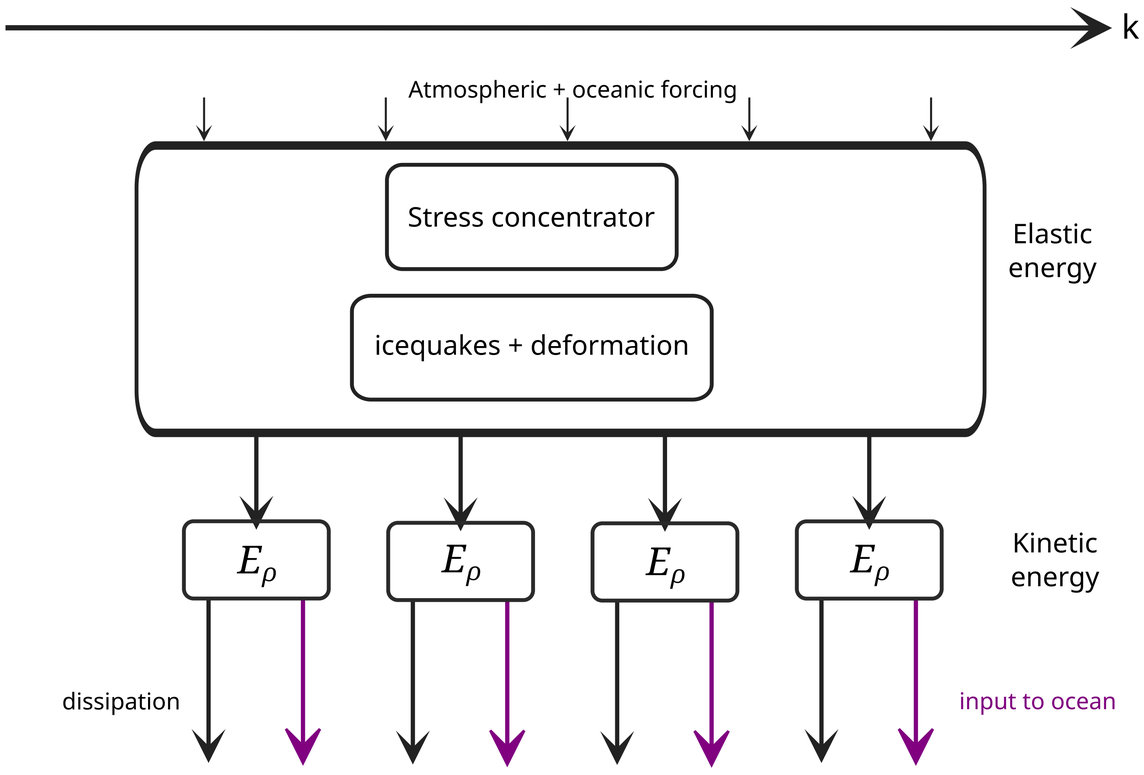


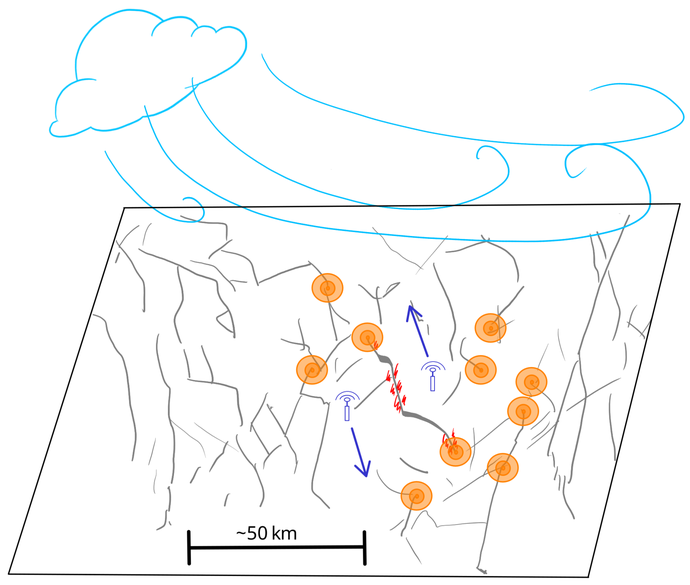


$$\Lambda = \Gamma\sigma_u \simeq 18\,\text{km} \simeq \frac{L_0}{30} \quad (3)$$

Multiscale energy transfer







- Multiscale fractures
- Coulombic friction (red waves)
- Stress concentrator (orange colors)
- Forcing and displacement at different scales

Conclusions

- Sea ice acts as a filter for mechanical energy between atmosphere and ocean
- Elastic energy in transfered accross scale: stress concentration
- Multiscale fractures in the sea ice imply multiscale disspation
- Paper in preparation, stay tuned!