DLR

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living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE OF OUR PLANET FROM SPACE

EUMETSAT ECMWF EUSPA

Surface TRansport, kinetic Energy, Air-sea fluxes & Mixing (STREAM)

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24/05/2022

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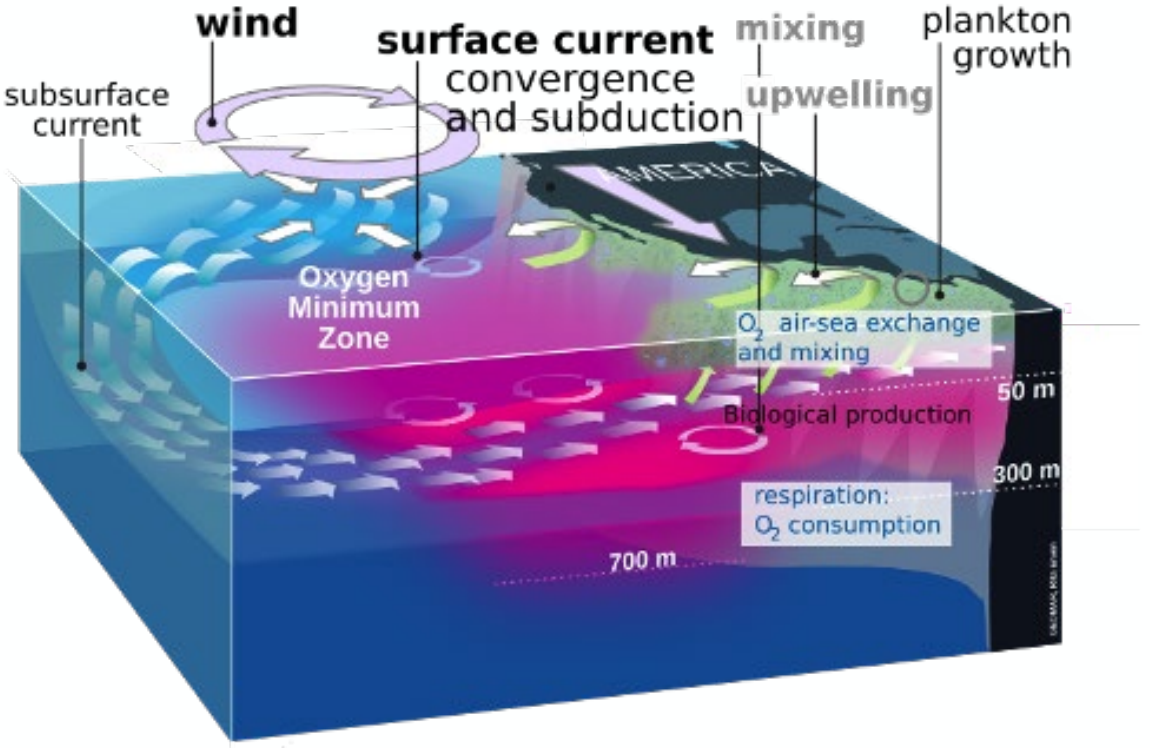
1. Context: measuring ocean dynamics at the air-sea interface

How is Earth losing its cool?

90% of the answer is in the ocean

Currents and **vertical fluxes** bring ocean in contact with the atmosphere

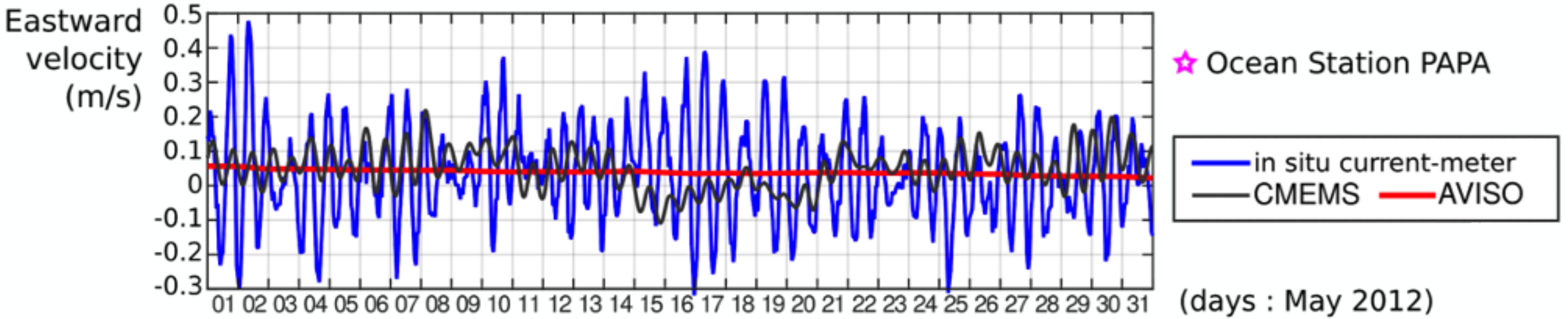
not just a temper issue: gas exchanges, ocean momentum, kinetic energy …



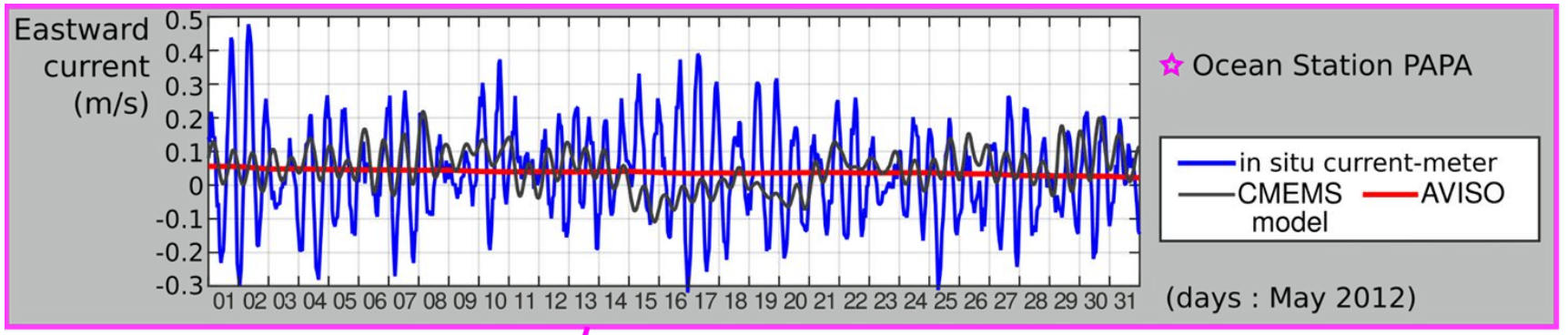
1. Context: if you think we know ocean surface currents…

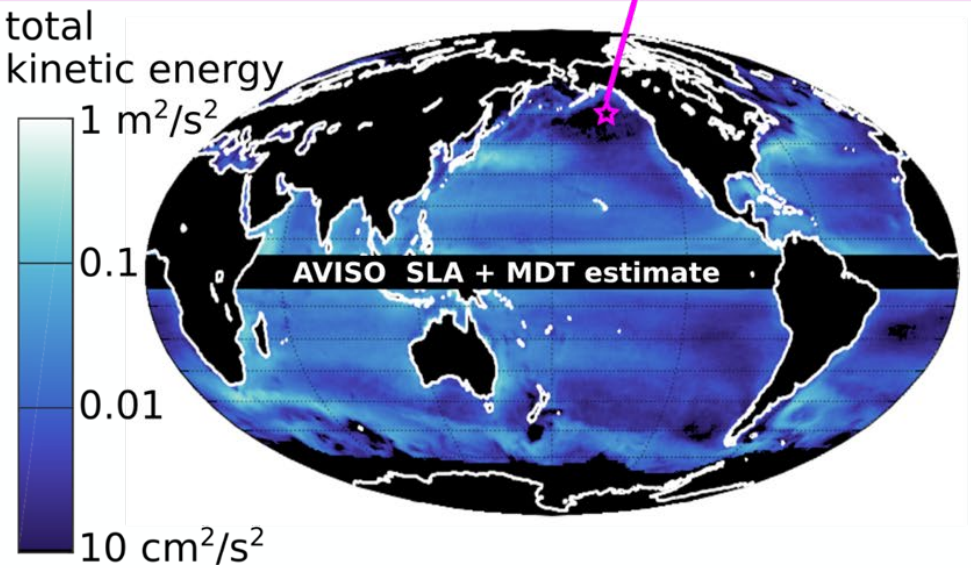
…let's pick one of the few places with in situ data

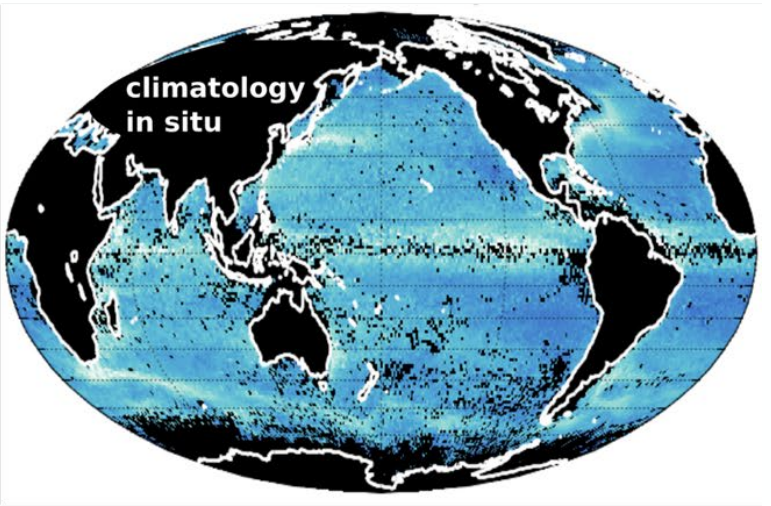
(thanks to M. Cronin et al., NOAA/PMEL)



1. Context: State of the art in ocean current obs & modelling

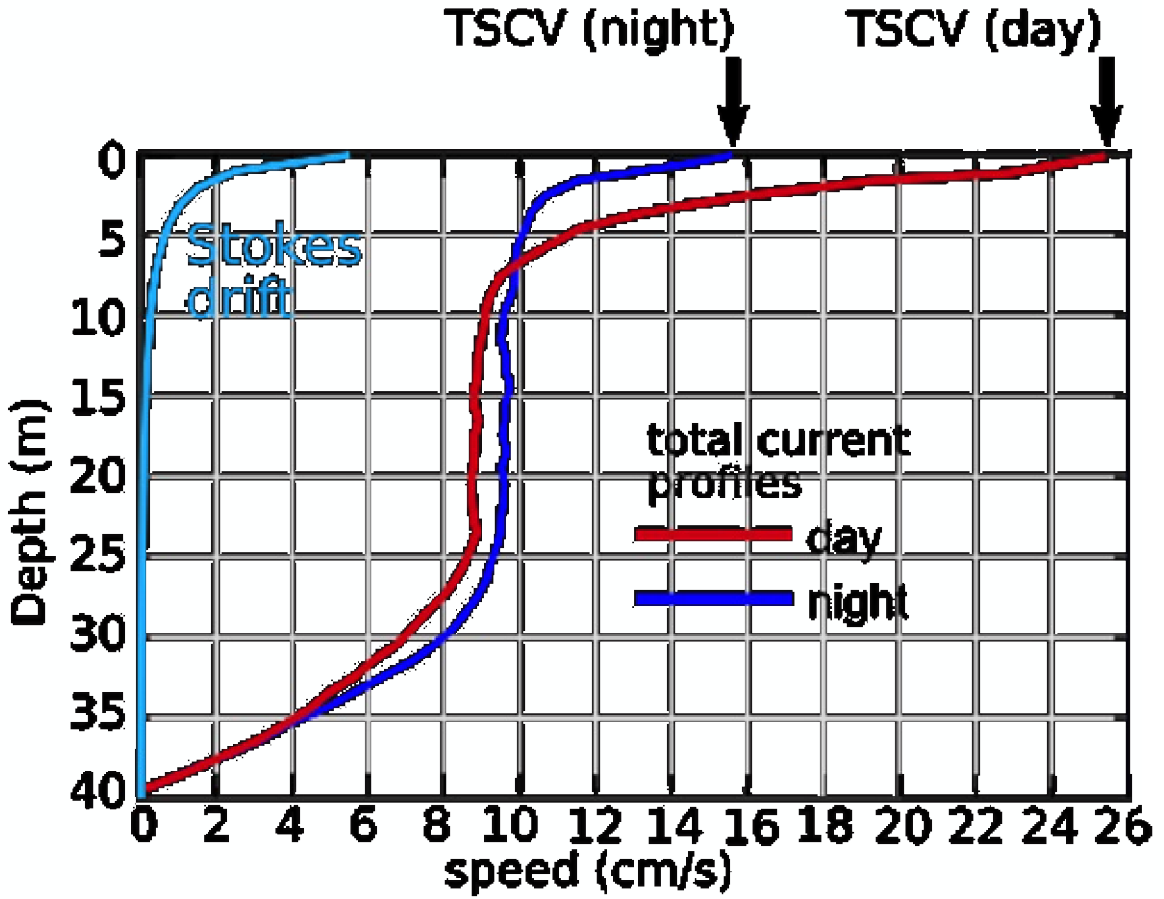


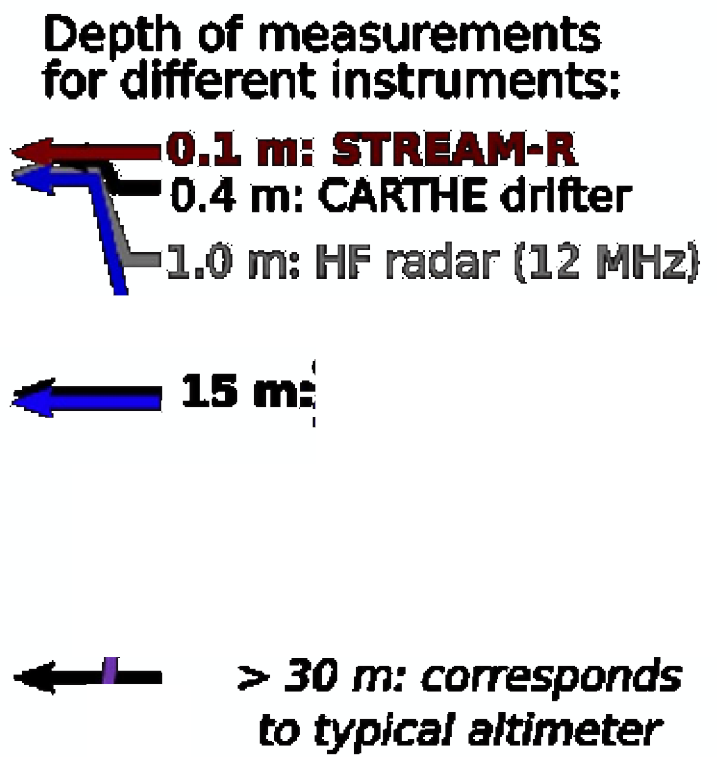




most ocean places: > 90% of kinetic energy is missing in altimetry-derived « surface current estimates »

2. Open questions: current & mixing



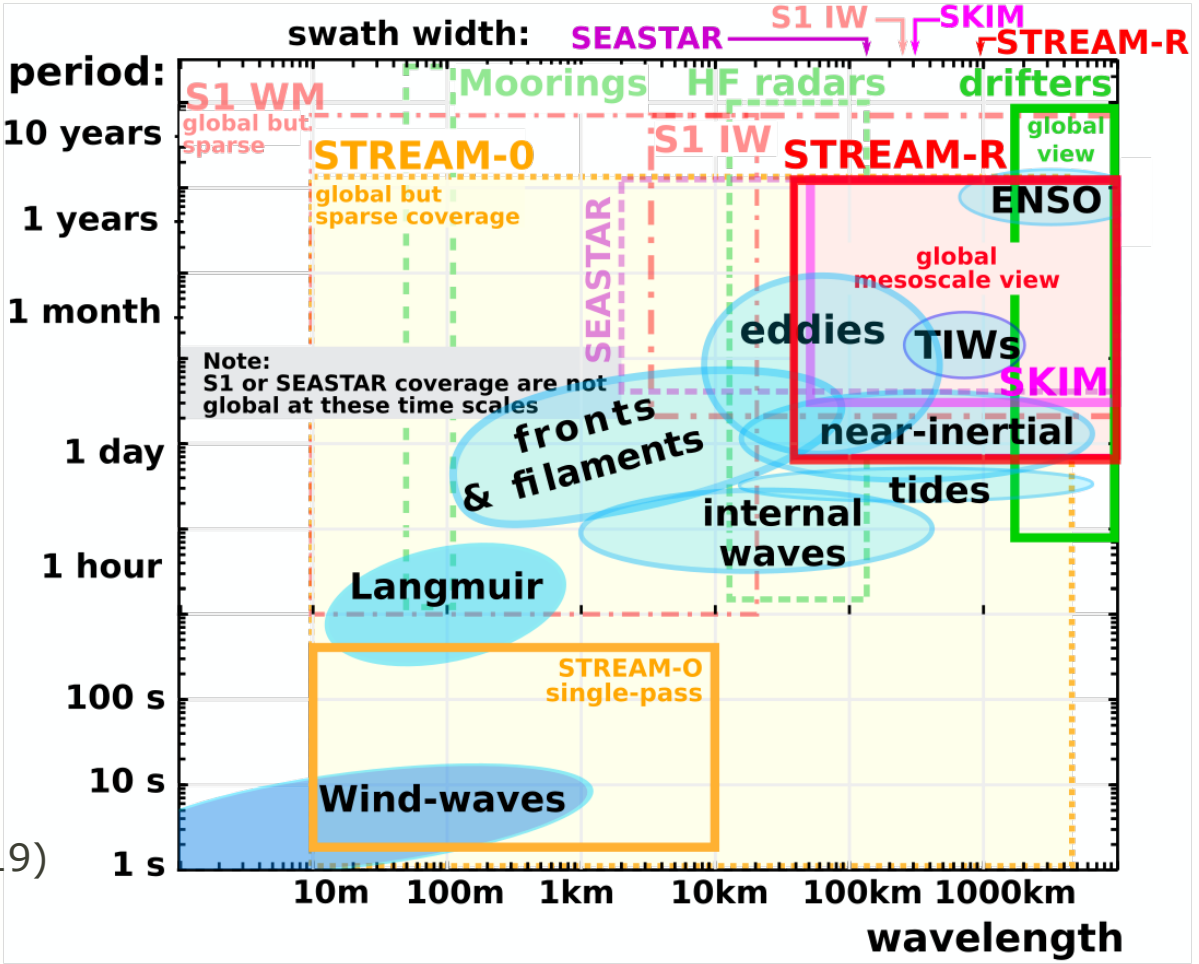


2. Open questions: current & mixing … what scales?

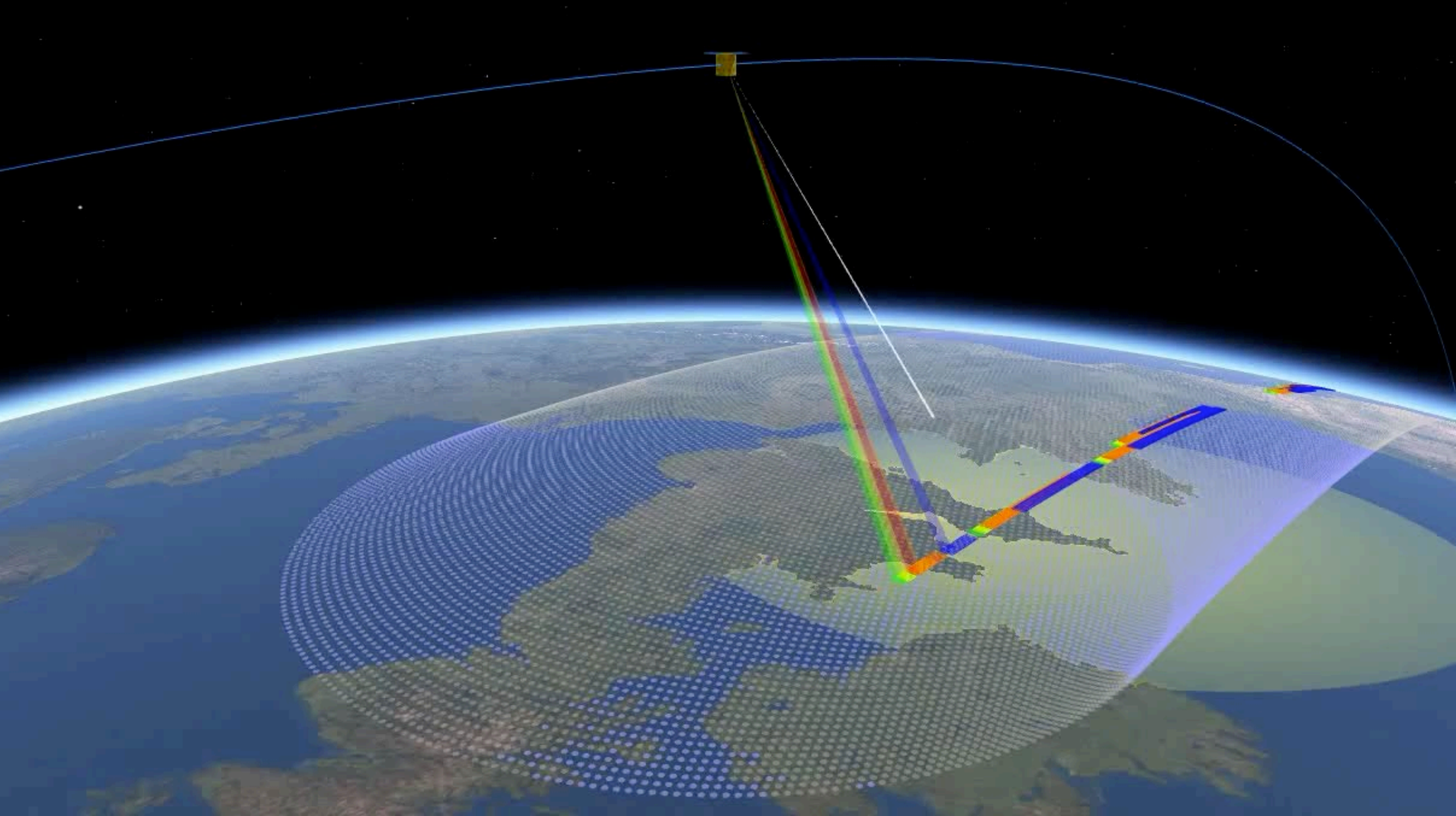
Important processes occur at all scales
- Surface current mapping:

SEASTAR (EE11 candidate mission)
is going for 1 km resolution,
but not global

Altimeters map dominant currents, L>200-400 km, T>15 d
(not at Equator)

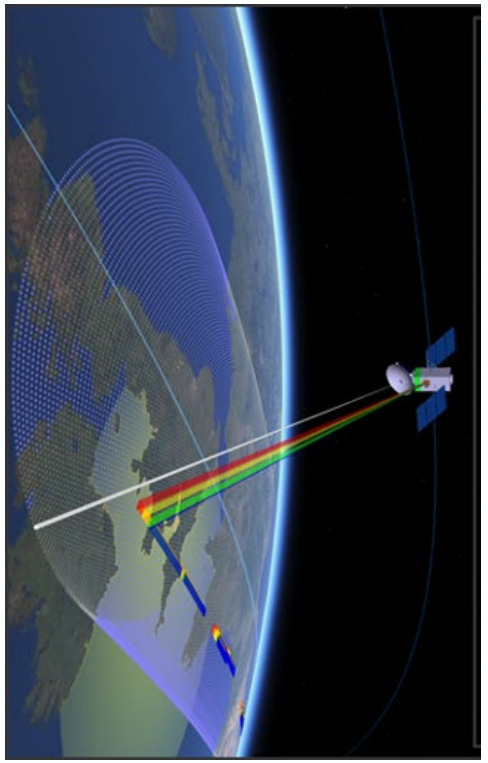


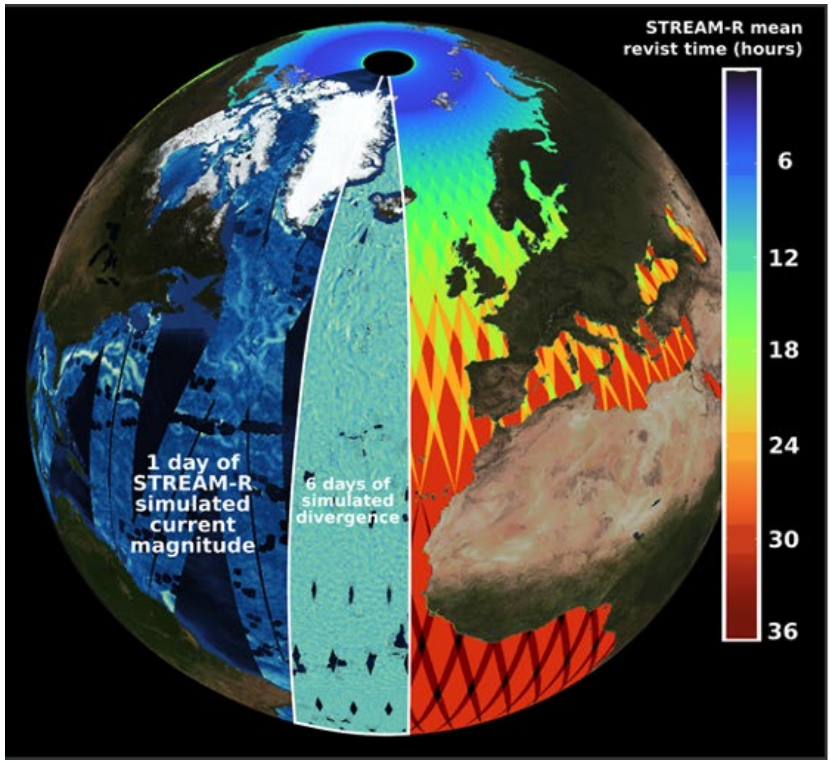
(adapted from Ardhuin et al. BAMS 2019)



3. Measurement concept: 2 instruments

- Ka-band pencil beam Doppler radar (**STREAM-R**) for surface wind & current vectors: 1000 km wide swath
  1-day global revisit at 25 km resolution (see Ubelmann et al. JGR 2021 for implications)



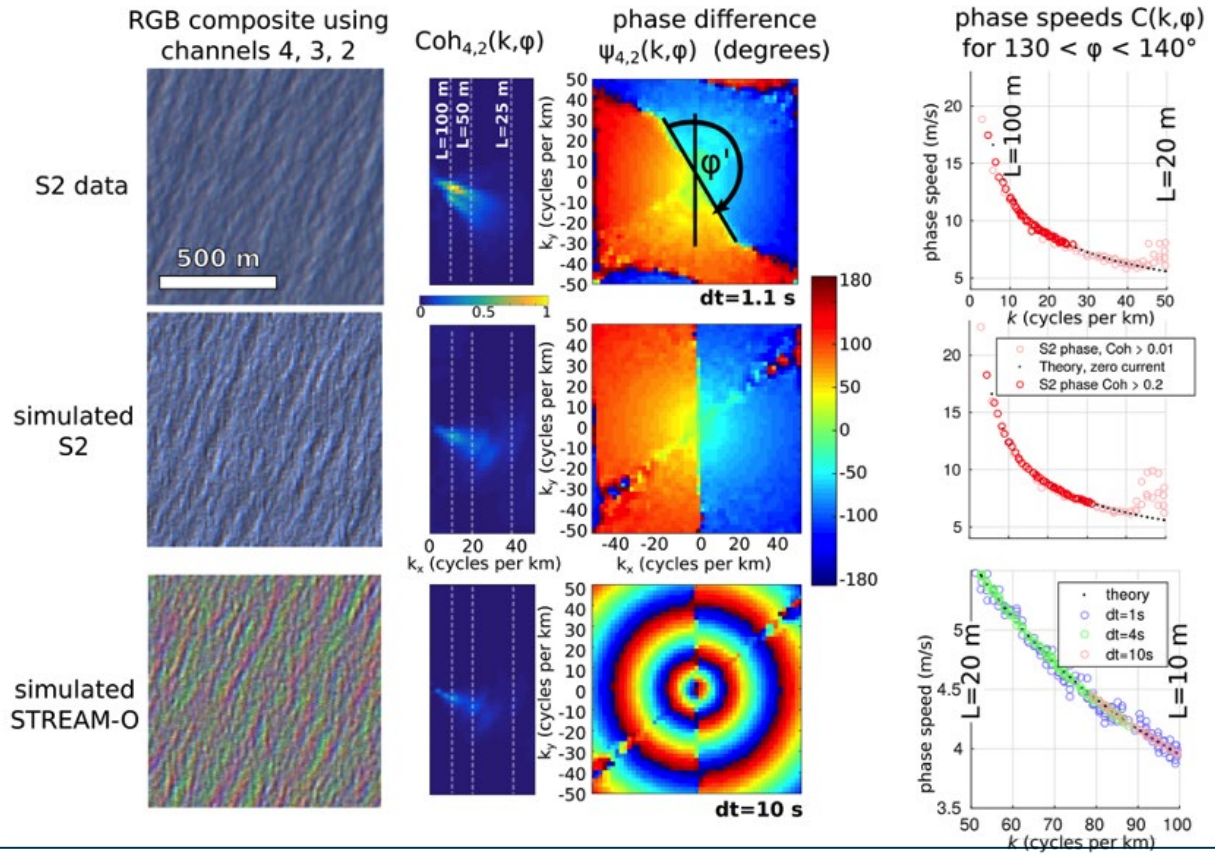


STREAM-R, a « more ambitious » SKIM is close to the baseline also envisaged for NASA proposal « OdySea »

3. Measurement concept: 2 instruments

- Optical push-frame 5-beams (**STREAM-O**) giving 5 m resolution and 1 to 10 s time lags: 10 km wide swath

Phase shifts for different wavelengths should give currents at different depths, linked to mixing

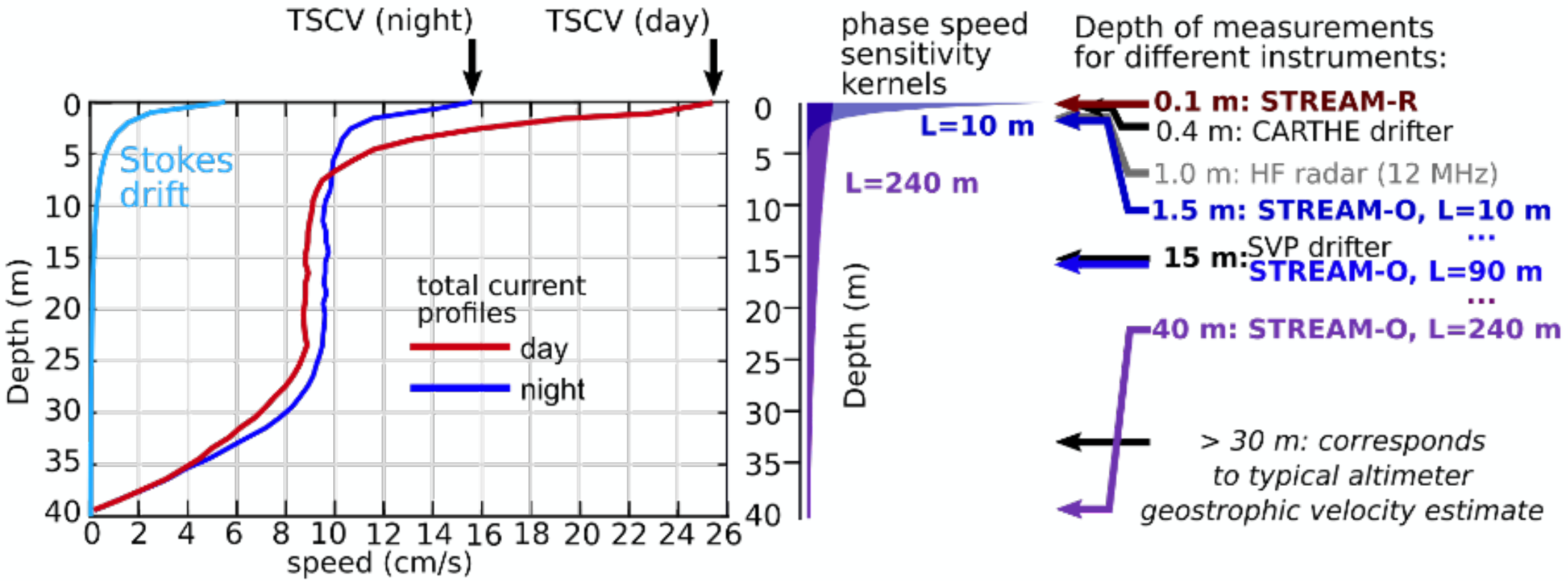


Simulated inter-beam coherence (STREAM proposal for EE11)

3. Measurement concept: 2 instruments

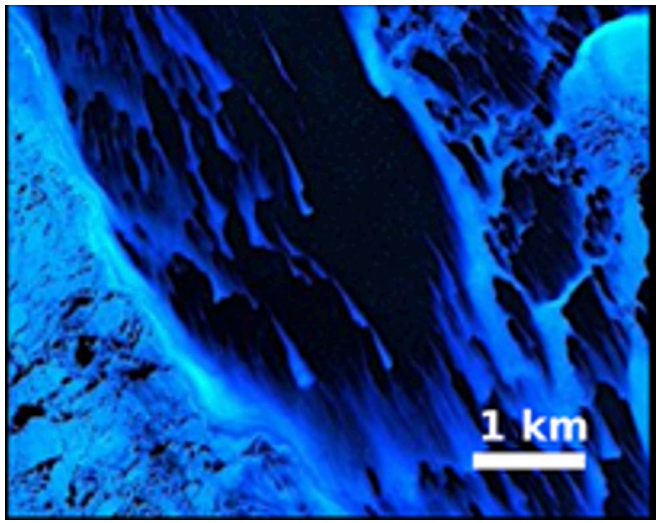
Vertical shear of current of 5 cm/s can be resolved for a 8 km x 8 km area using only 3 beams

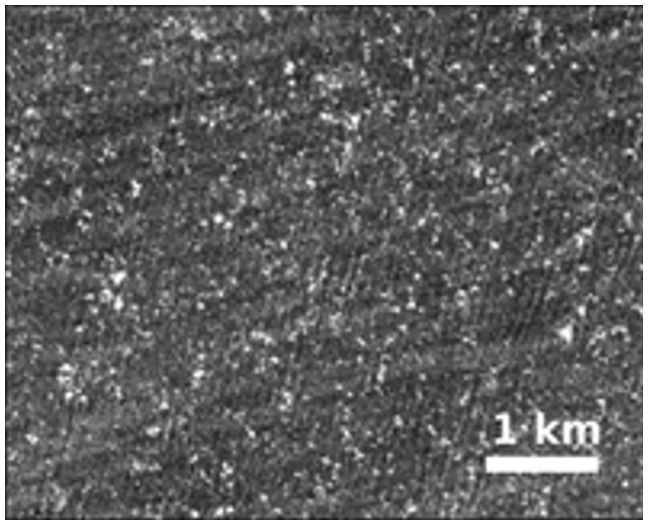
(Ardhuin et al. 2021)

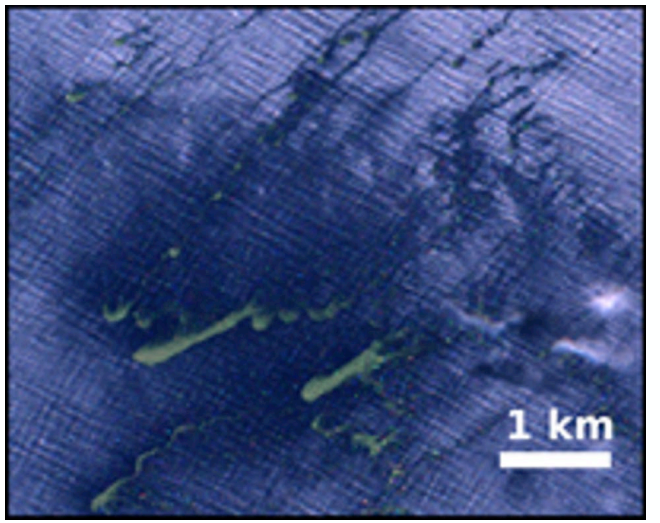


3. STREAM-O … the places you'll see

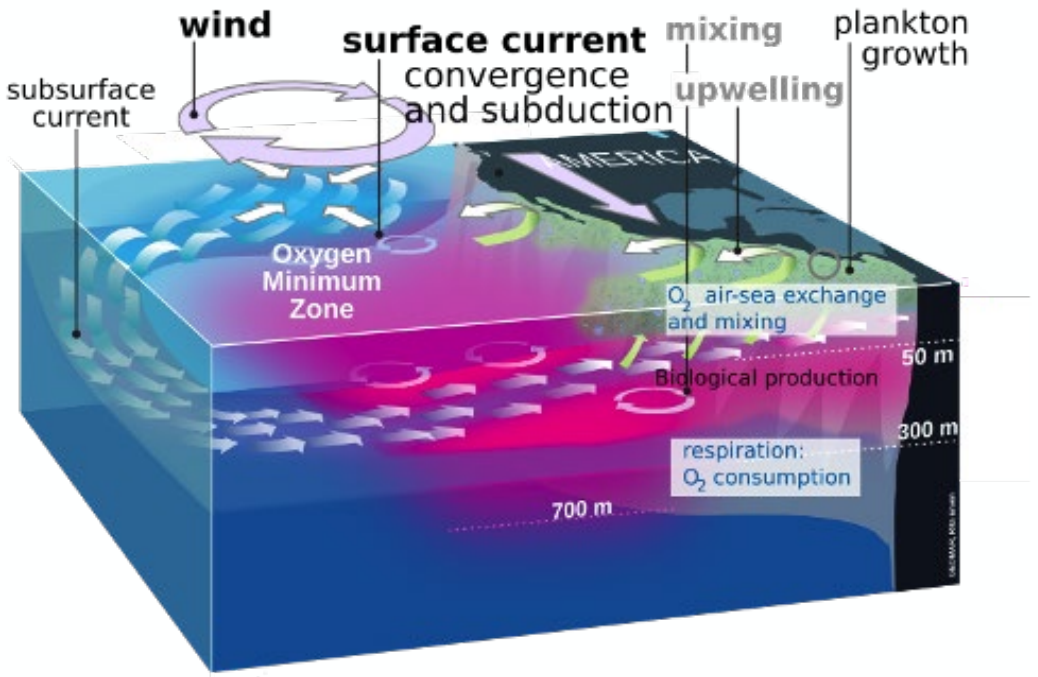
- A sparse sampling of the oceans at high resolution reveals patterns related to wind, waves & currents (ice floes, Langmuir turbulence, sargassum, slicks …)

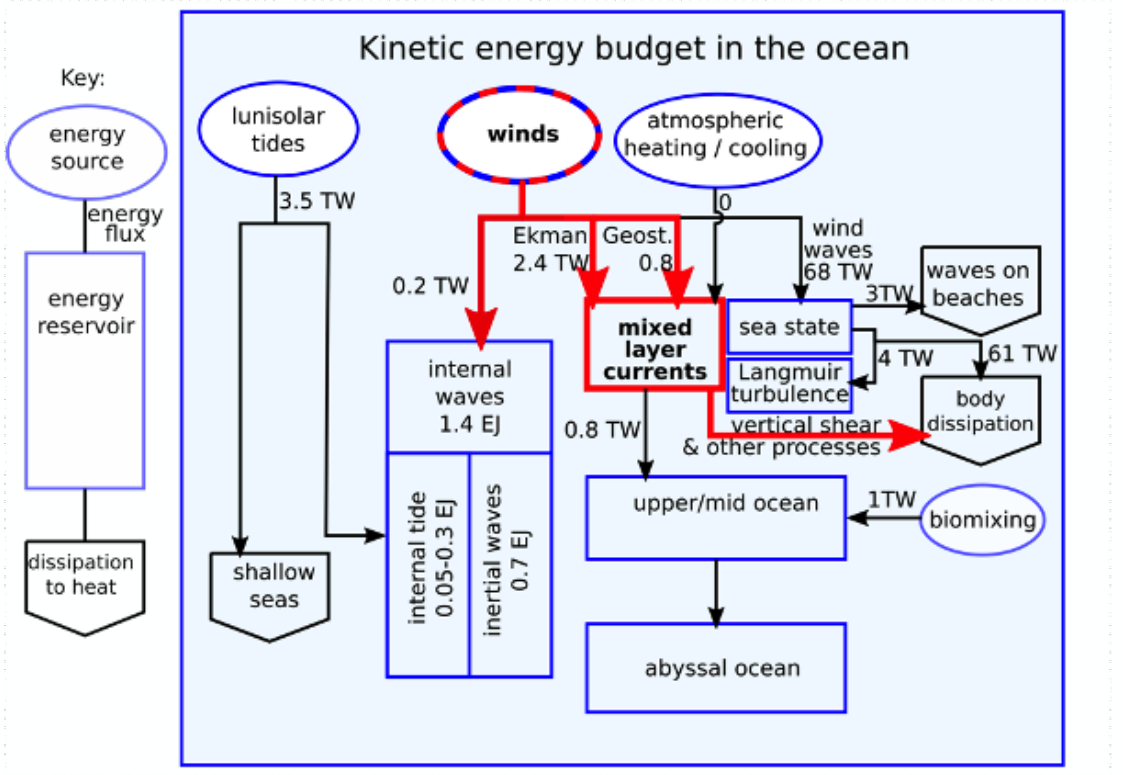






4. Science and products





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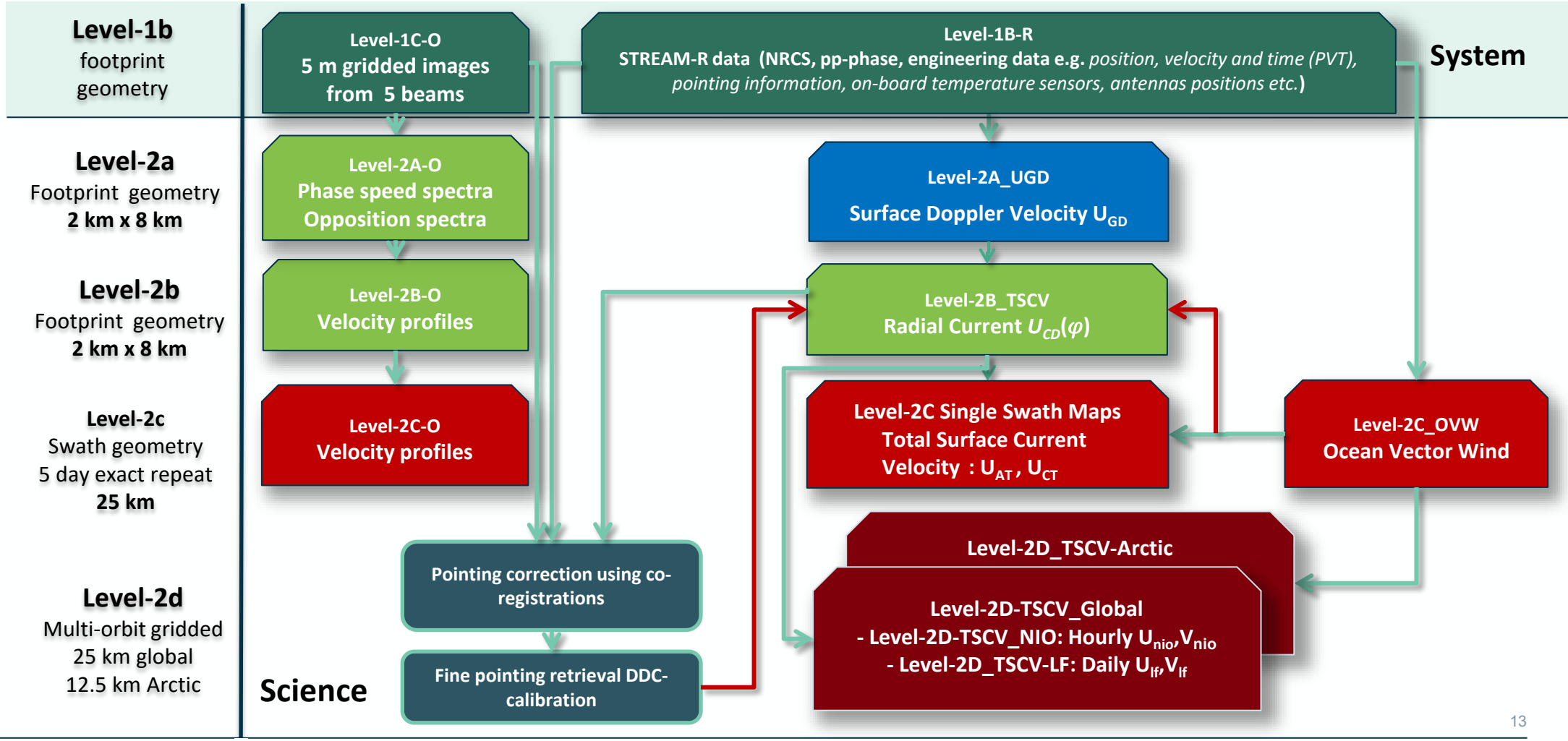
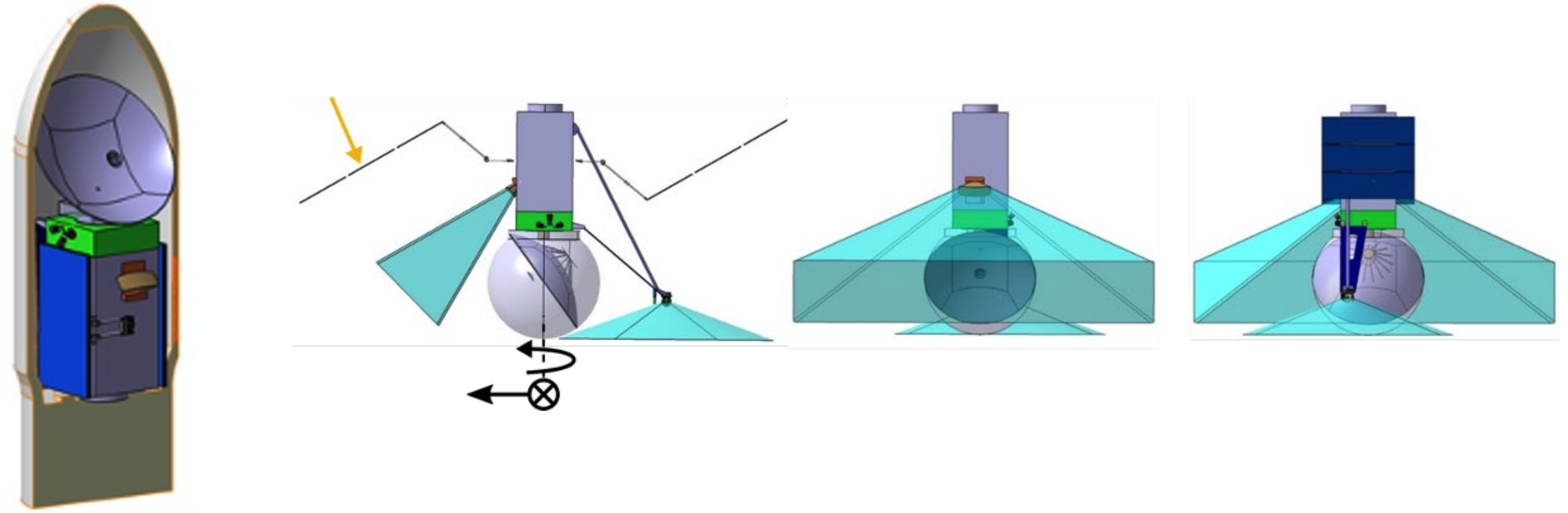


5. Engineering challenges

- big rotating antenna
- O(1 microradian) pointing knowledge

STREAM-O data can be used to diagnose / refine STREAM-R pointing issues.



What's next for ocean current remote sensing?

SKIM (12° incidence Doppler scat, waves & currents) was proposed to EE9
STREAM (45° incidence Doppler scat, winds and currents + Optical) was proposed to EE11: "too expensive"
OdySea (55° incidence Doppler scat, winds and currents) is being prepared for 2022 NASA explorer

Also some ocean coverage at higher resolution will be given by Harmony (EE10) and maybe SEASTAR (EE11)…
while Sentinel 1s are still providing sparse 1-component Doppler (with remaining issues due to thermal control)
and Sentinel 2s have O(30 cm) mispointing uncertainties that give O(30 cm/s) current uncertainties

Was STREAM proposal too bold for the EE11 call?
Should we split away the optical part (cost + other opportunities)?

We will be looking at different options

7. Acknowledgements
We are grateful to the following people who have contributed data, figures, text and feedback on the STREAM proposal. The fact that their name is listed here is not a statement of their endorsement - nor an endorsement of their employer - for the views and results presented in this document:
Matias Alday, Jean-François Blanc, Romain Bourdalé-Badie, Sophia Brumer, Eric Caubet, Bertrand Chapron, Jean-Marc Delouis, Gérald Dibarboure, Shane Elipot, Lucile Gaultier, Chelle Genteman, Sarah Gille, Sébastien Goulet, Marc Herbelleau, Ben Holt, Johnny Johannessen,Bruno Lafrance, Thomas Lavergne, Pierre-Yves Le Traon, Alain Mallet, Amala Mahadevan, Louis Marié, Dimitris Menemenlis, Aime Meygret, Frédéric Nouguier, Laurent Phalippou, Nadia Pinardi, Ana Rubio, Annick Sylvestre-Baron, Celine Tison, Clement Ubelmann, Bia Villas Boas, David Woolf, Carl Wunsch, Xialong Yu, Maria Yurovskaya, Yury Yurovsky.