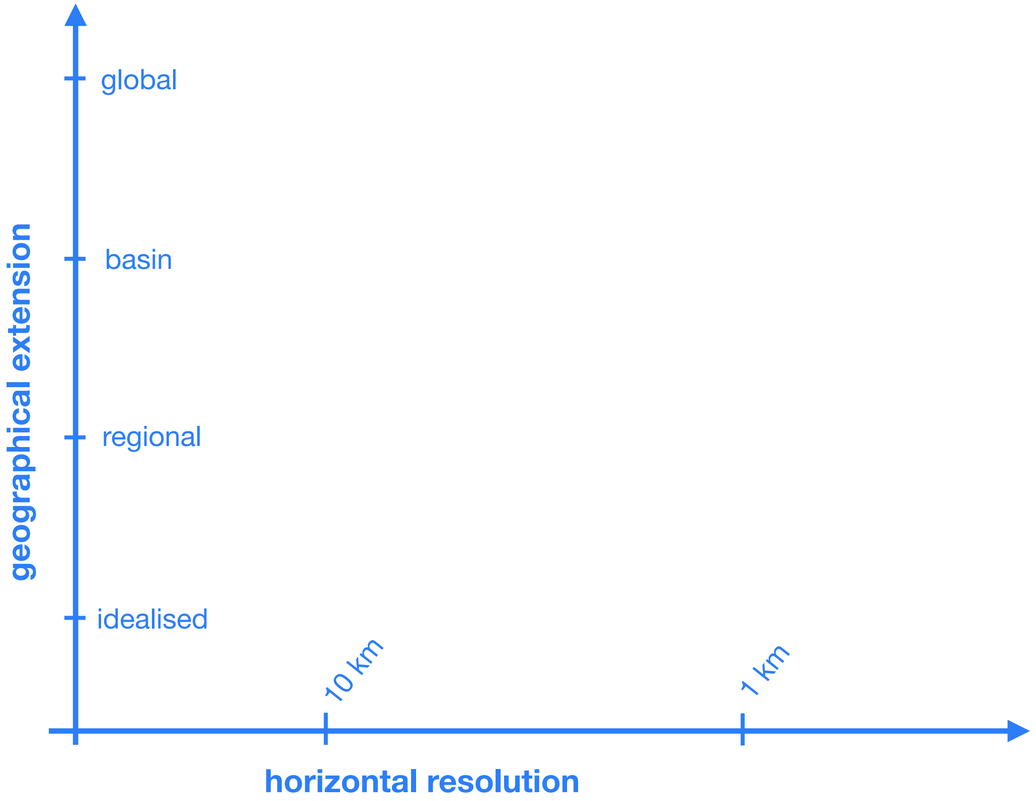
Updates from the high-resolution modelling working group meetings

co-chairs : B. Arbic, J. Le Sommer, L. Renault & P. Klein

Ocean circulation models and the SWOT mission

The landscape of SWOT ocean models



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- prefiguring the future SWOT observations
- tremendous progress over this period (resolution, resolved processes, domains)

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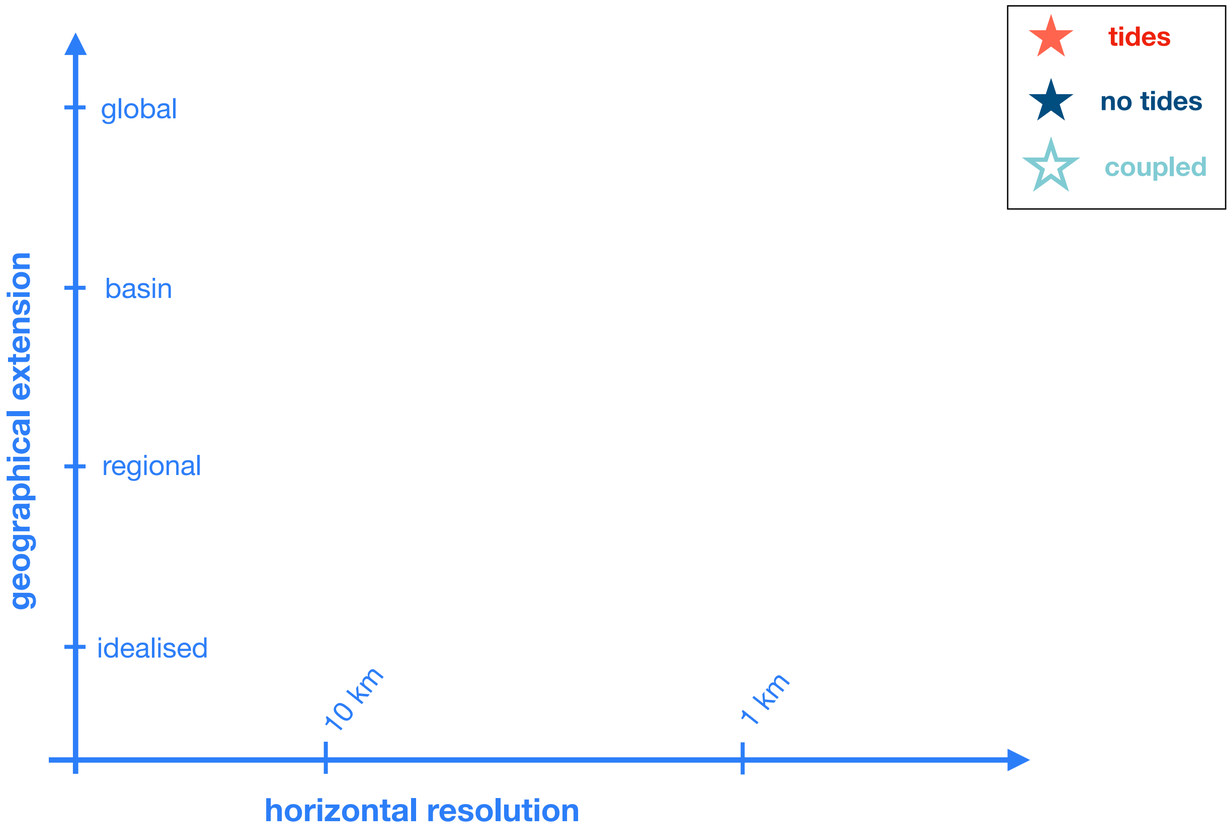

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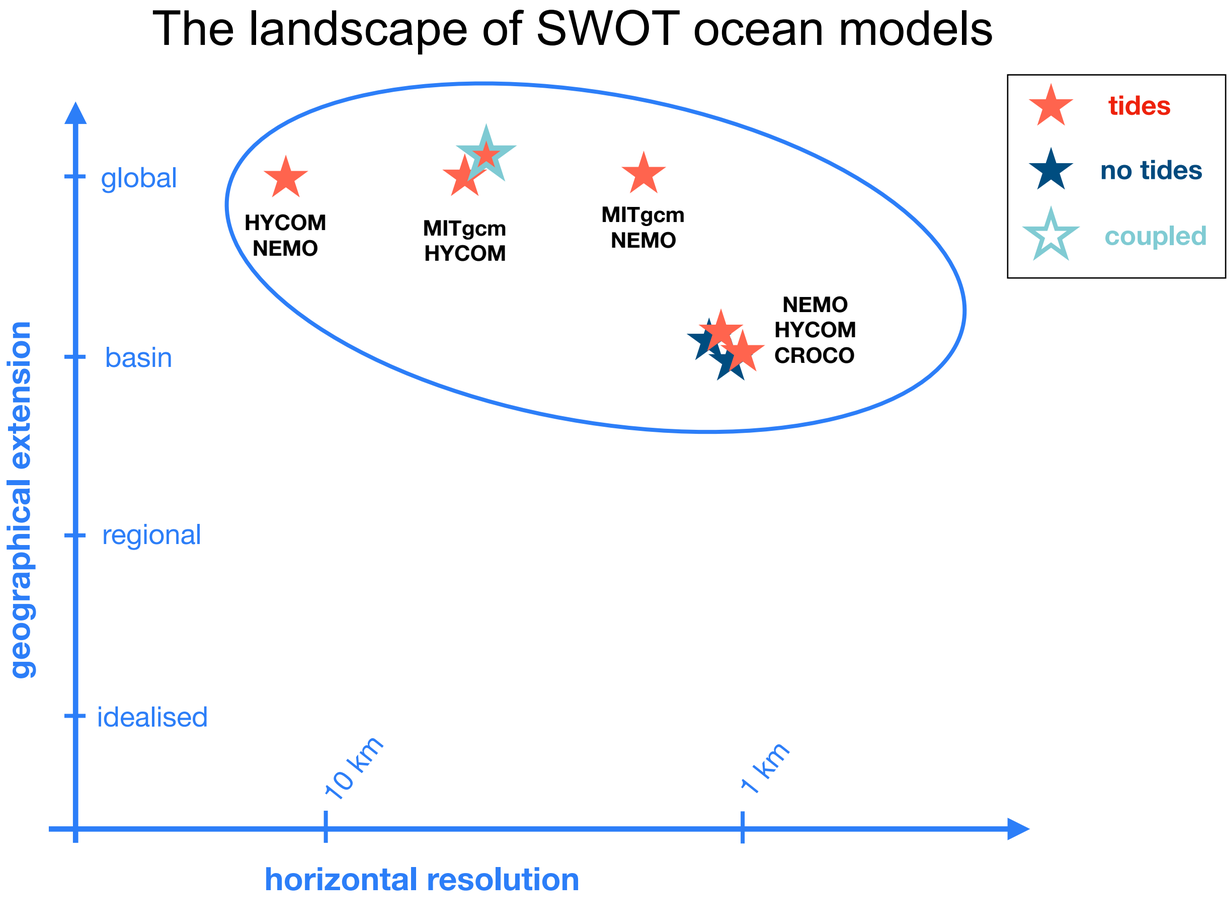

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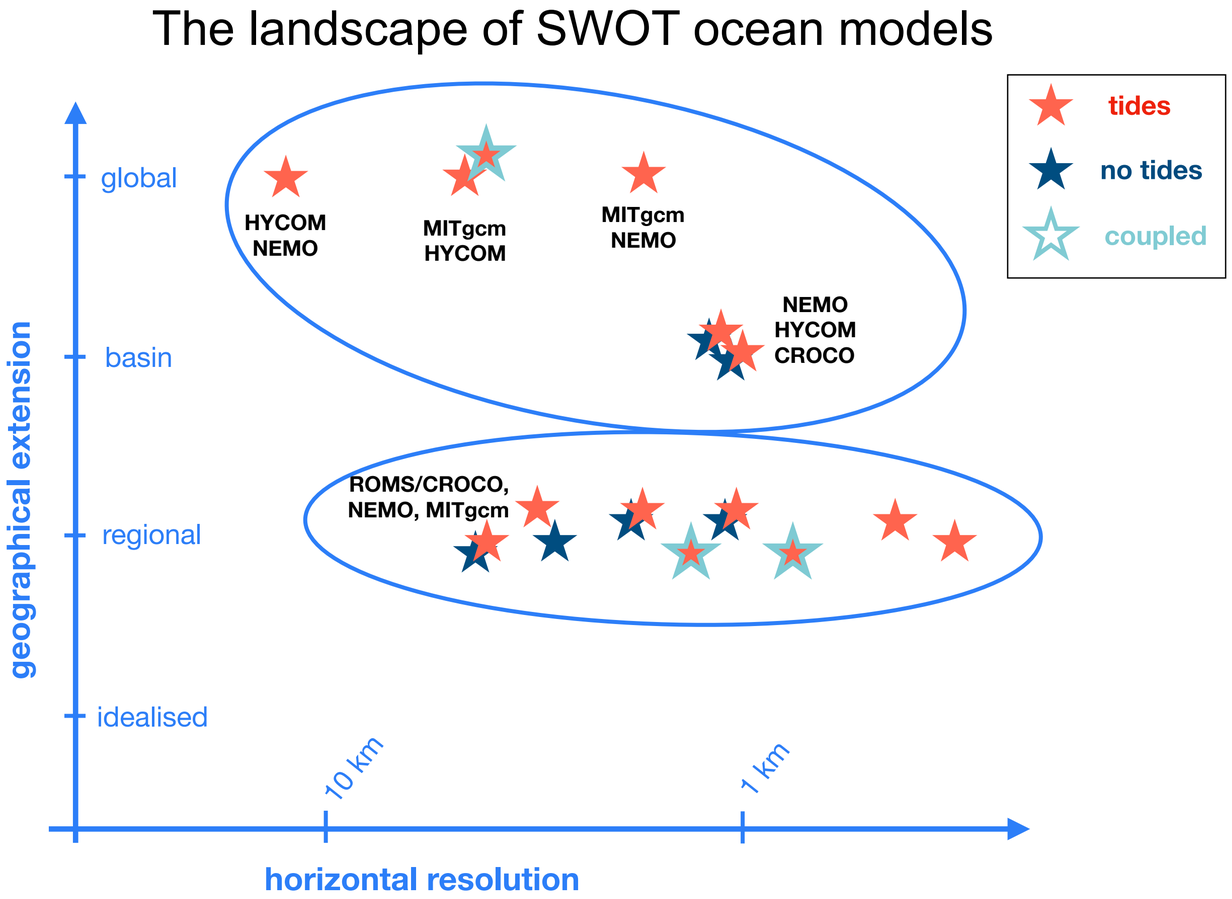

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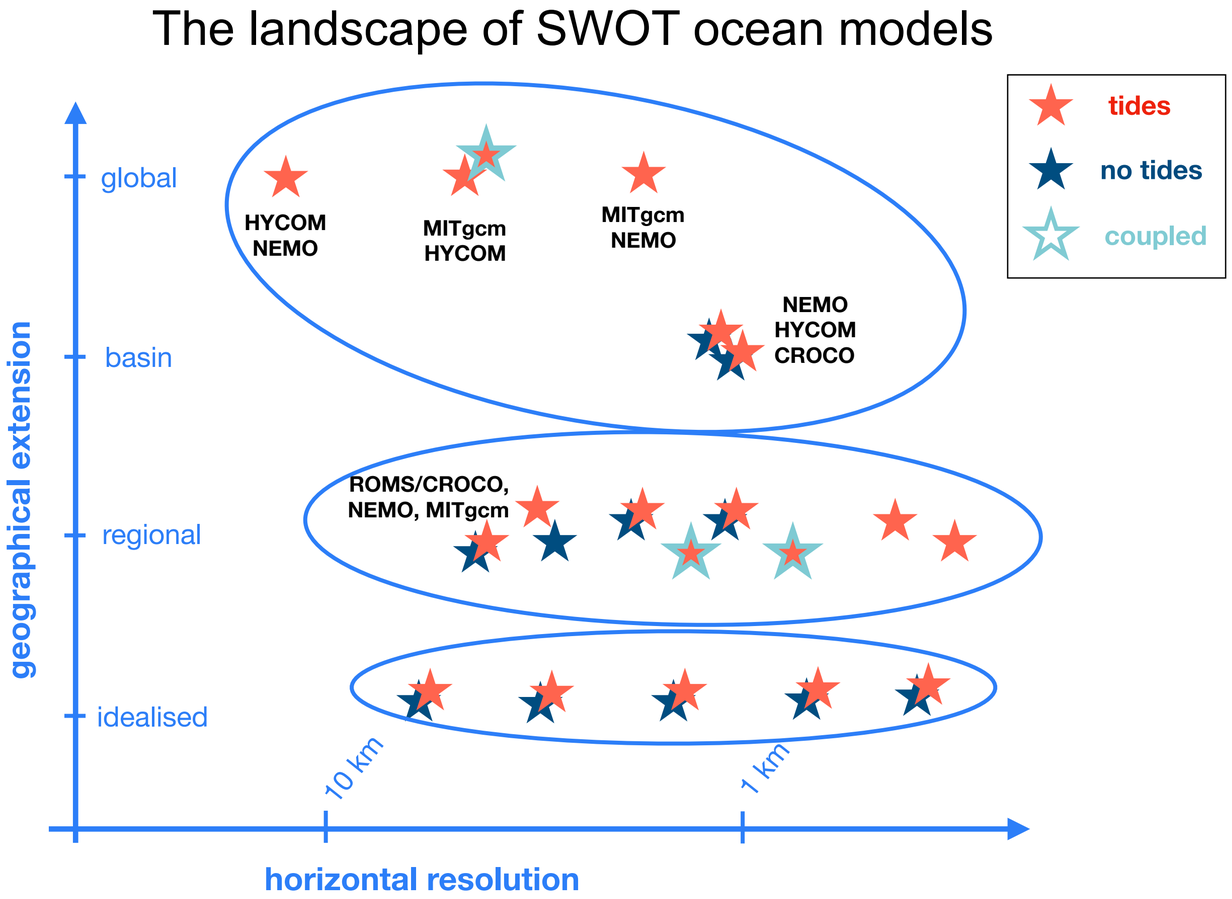

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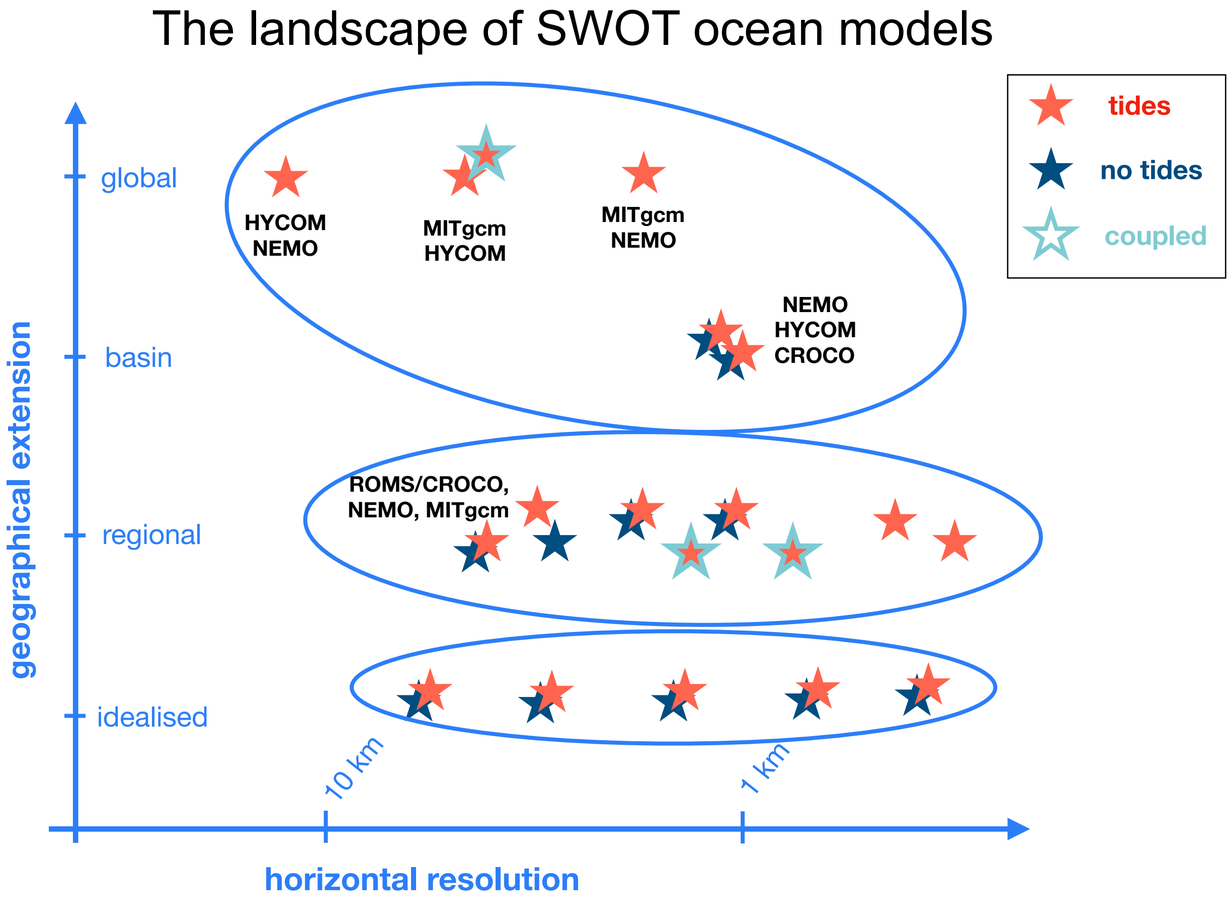

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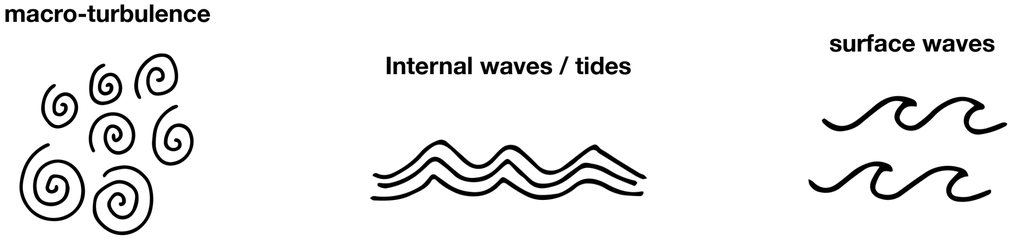
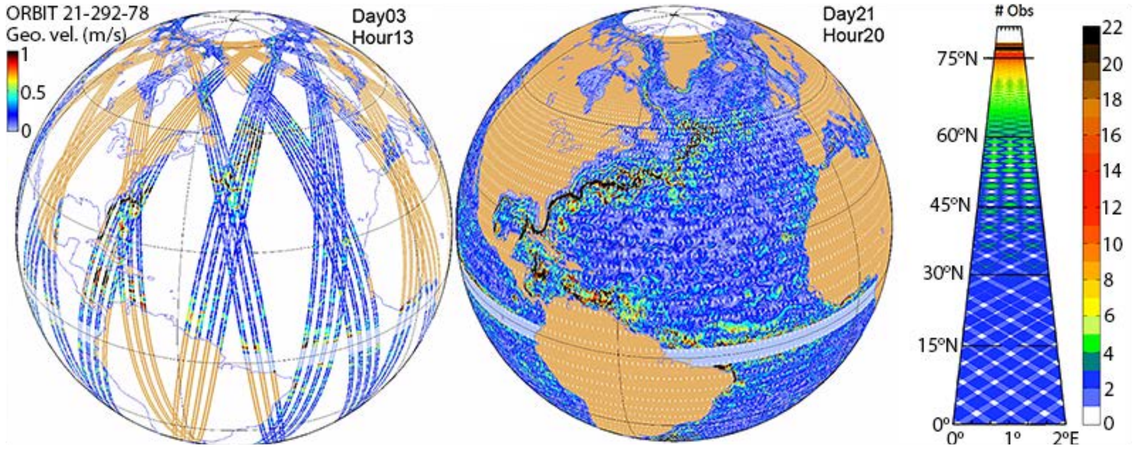
Disentangling different geophysical signals





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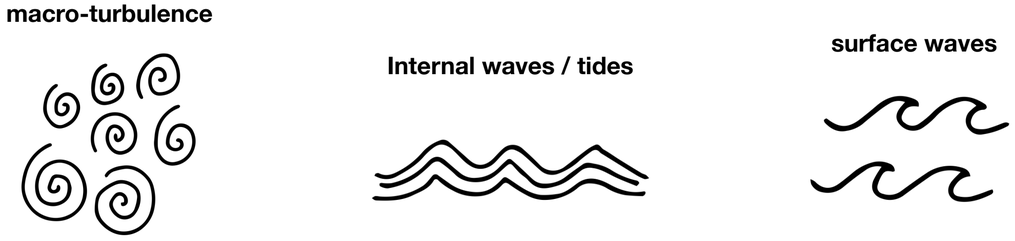

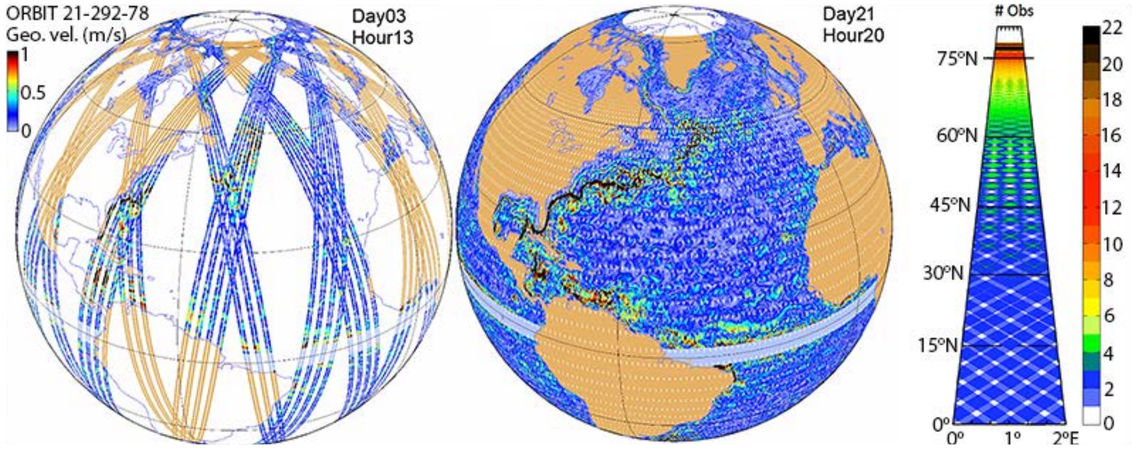

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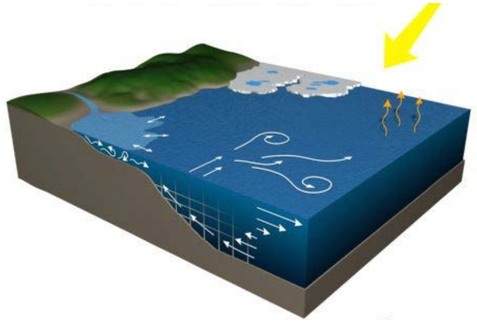
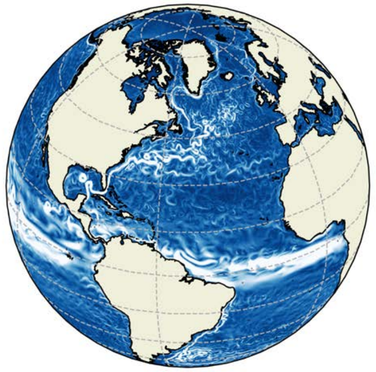
- prefiguring the future SWOT observations
- tremendous progress over this period (resolution, resolved processes, domains)
- **The collected data (SWOT, AdAC, FSP) will help improve models in return**

Models will now help planning field campaigns and interpreting the SWOT data

The SWOT high-resolution modelling work-group





The group

- about 50 participants to the working group meetings
- combines both people who run model experiments and users of model data
- 9 core projects with a strong modelling component (3 US, 5 Fr, 1Jp)
- most group members also attend other SWOT ST WGs (Inversion, tides, Regional)

Activities

- a bottom-up process for defining the priorities and organisation (early 2021)
- a presentation/discussion of each the 9 core projects on April 28th
- then science focused meetings on one of the three priority topics (June 30th, Aug. 25th)
- for each meeting : 2 x 20 min talks (with external inviteed) + discussion

Meetings are recorded and open to all (mailing list + SWOT ST forum on AVISO website)

Key priorities topics to be addressed

Focus on three topics where ocean models will be key to the mission success

- (i) modelling internal waves/tides and their interactions with balanced flows

- (ii) (sub-)mesoscale air-sea interactions and their impact on (upper) ocean dynamics

- (iii) preparing the analysis of SWOT ocean and SWOT-AdAC data

An open forum :

- to quickly disseminate recent works using ocean models in prep. for SWOT

- for model developers to exchange on the key priorities, opportunities & new ideas

- for model “users” to learn more about the status, skills and limitations of models

Internal waves/tides and their interaction with balanced flows (1/2)

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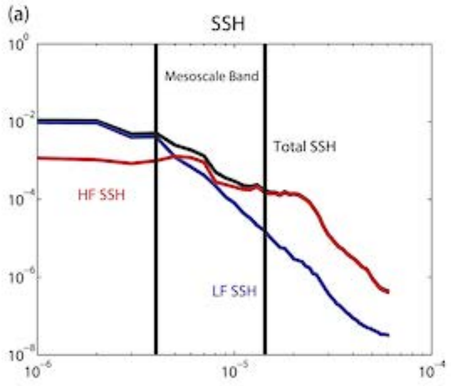

Richman et al. (2012)

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- in some regions and wavenumber bands, waves can dominate over non-wave signals

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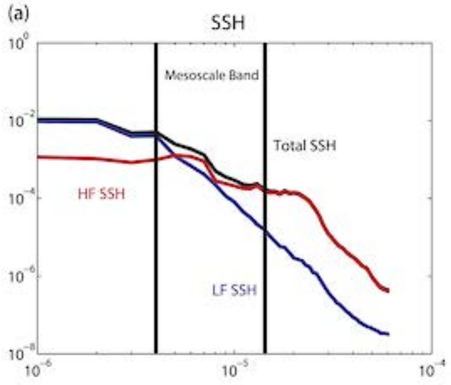

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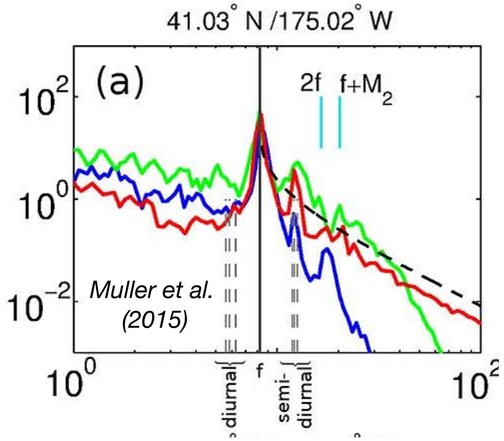

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- they are able to simulate Garrett-Munk spectra due to non-linear wave interactions

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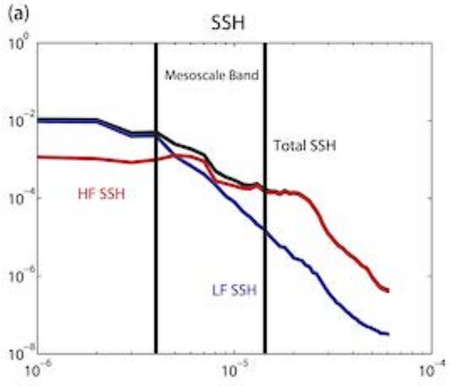

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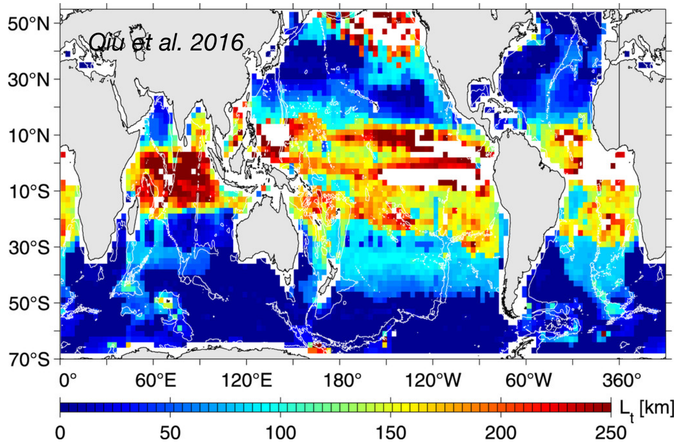

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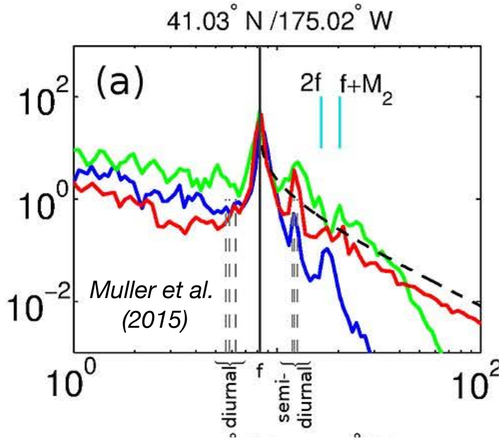
- strong geographical and seasonal variations



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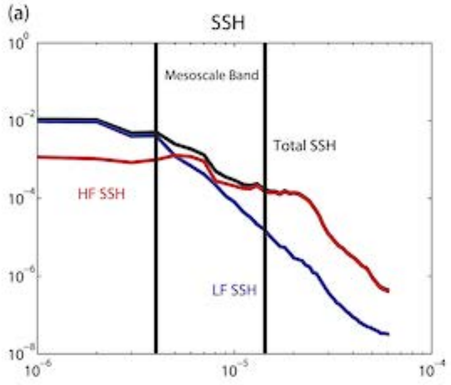

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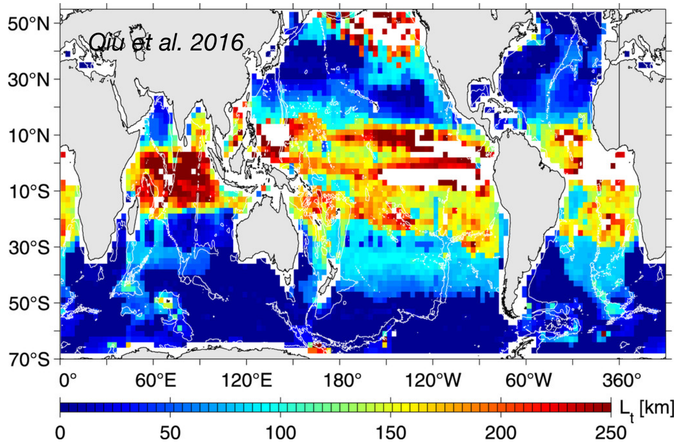

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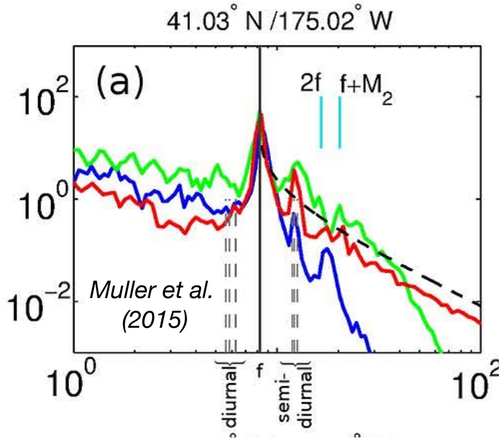

- some models are designed to resolve tidal dynamics and internal wave
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- how models capture wave dynamics and interactions is very sensitive to the model formulation
- need to systematically confront models among themselves and with observations
- over the past years, a renewed interest on how balanced and unbalanced motions interact (KE)

Key questions to prepare the exploitation of SWOT ocean data

Internal waves/tides and their interaction with balanced flows (2/2)

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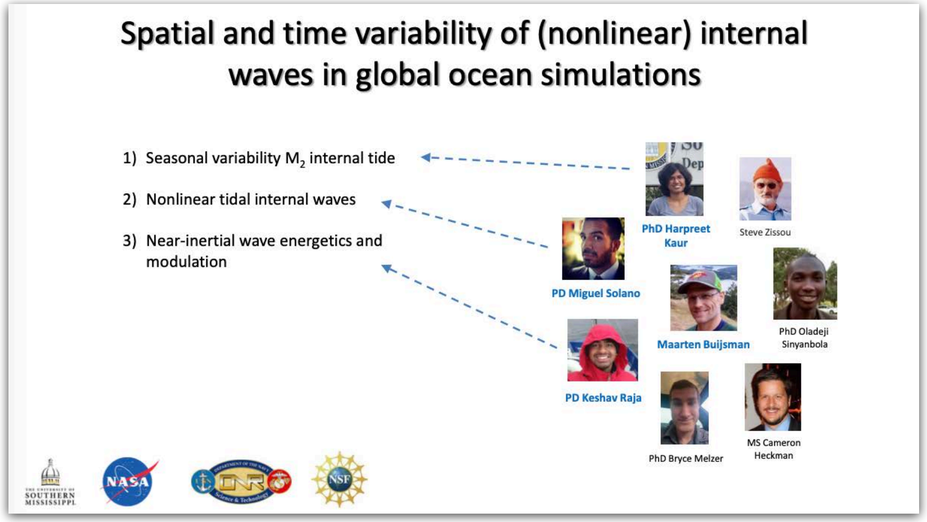
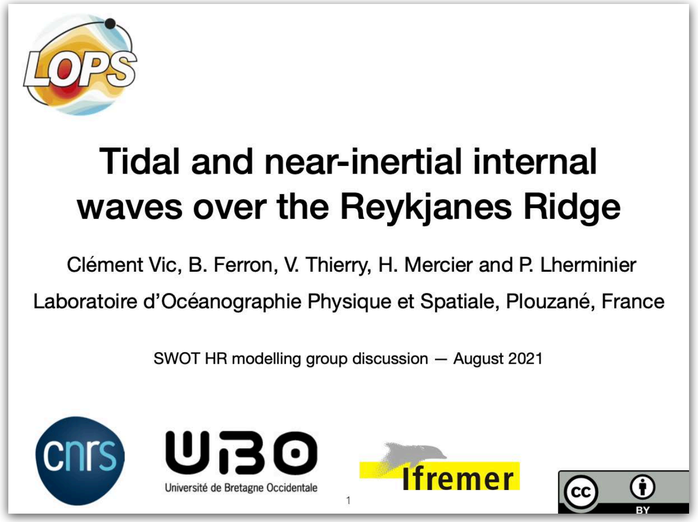
Session on the **variability of internal tides, IW and NIW** (on Aug. 25)





From a model perspective (with HyCOM)

- seasonality of M2 tides (stationarity, etc…)
- nonlinear tidal internal beams (higher harmonics)
- modulation of internat waves (trapping in anticyclone)

From a observation perspective (Reykjanes)

- variability of M2/S2 tides (cross ridge, spring/neap)
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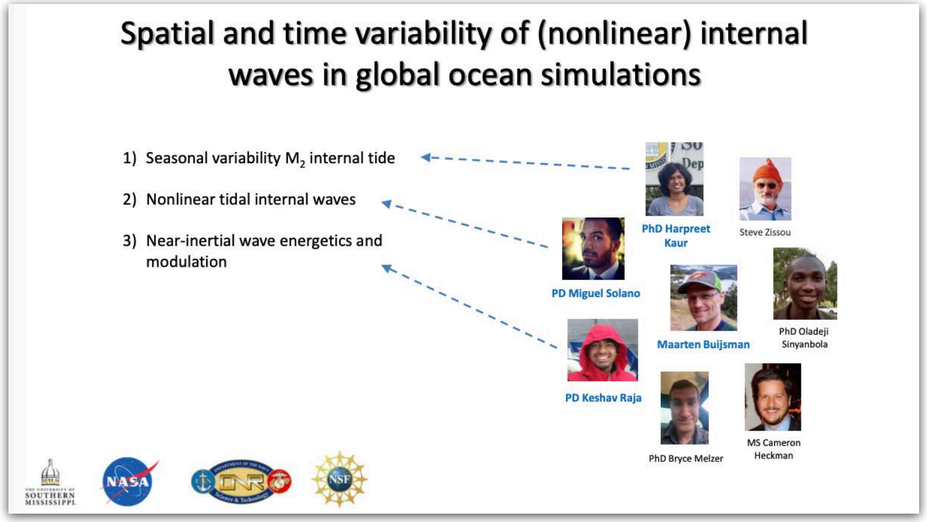

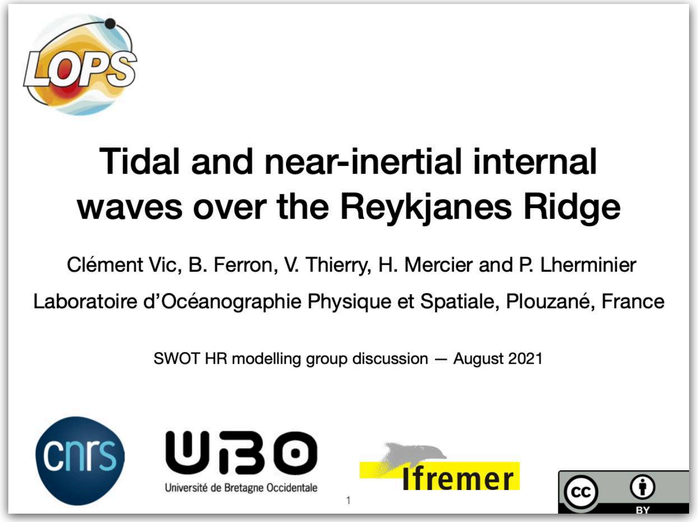

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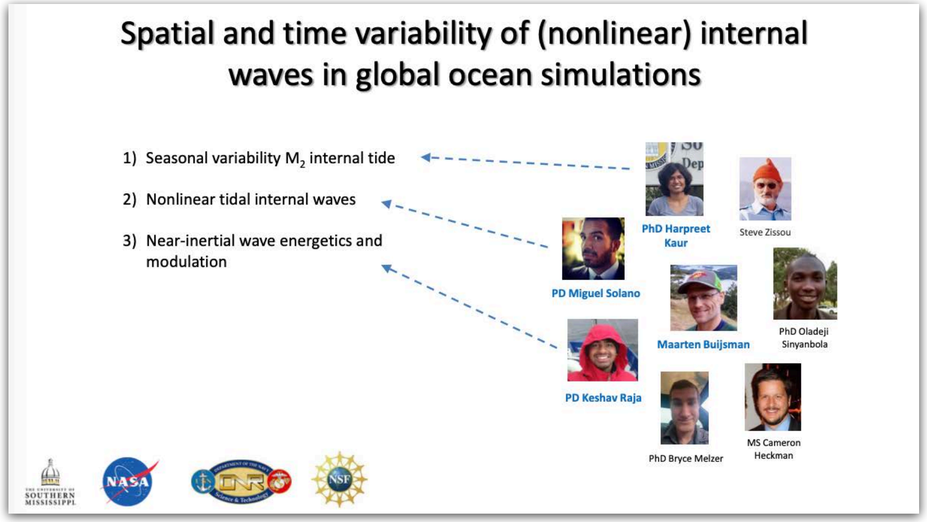

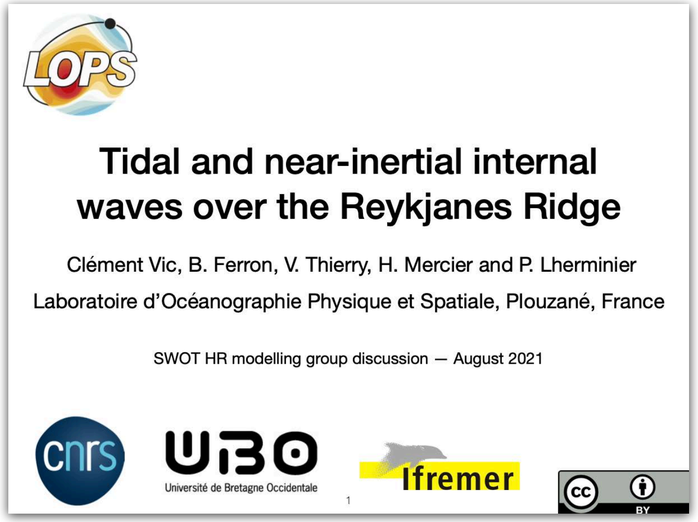

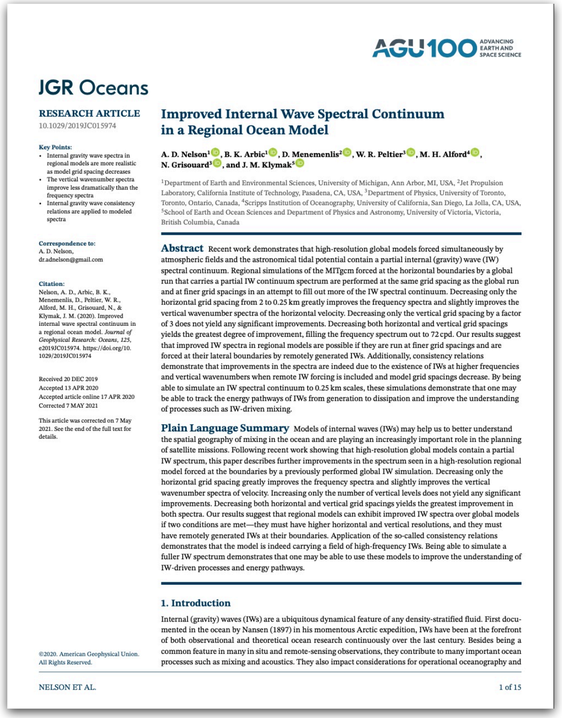

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Also, more **practical aspects** :

conditions for regional model to capture well IW and the GM spectrum (forcing, resolution, etc…)

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(Sub-)mesoscale air-sea interactions and their impact (1/2)

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Important feedback mechanisms due to mesoscale variability have been identified.

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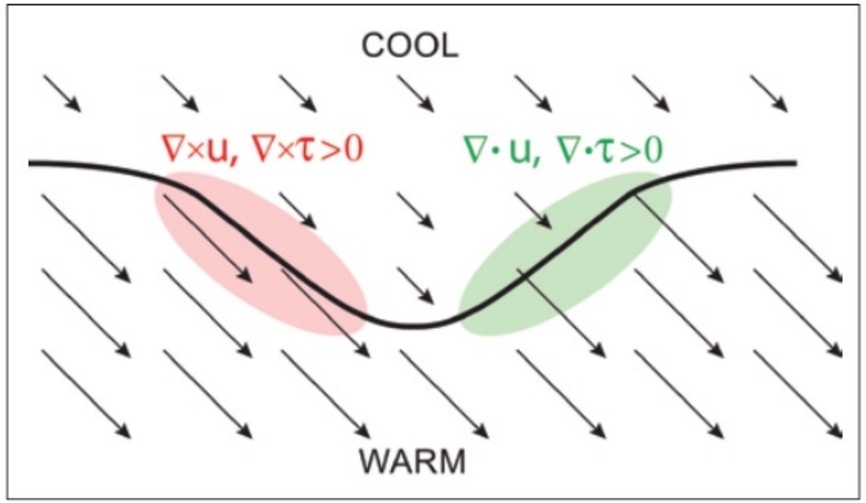

Chelton and Xie 2010

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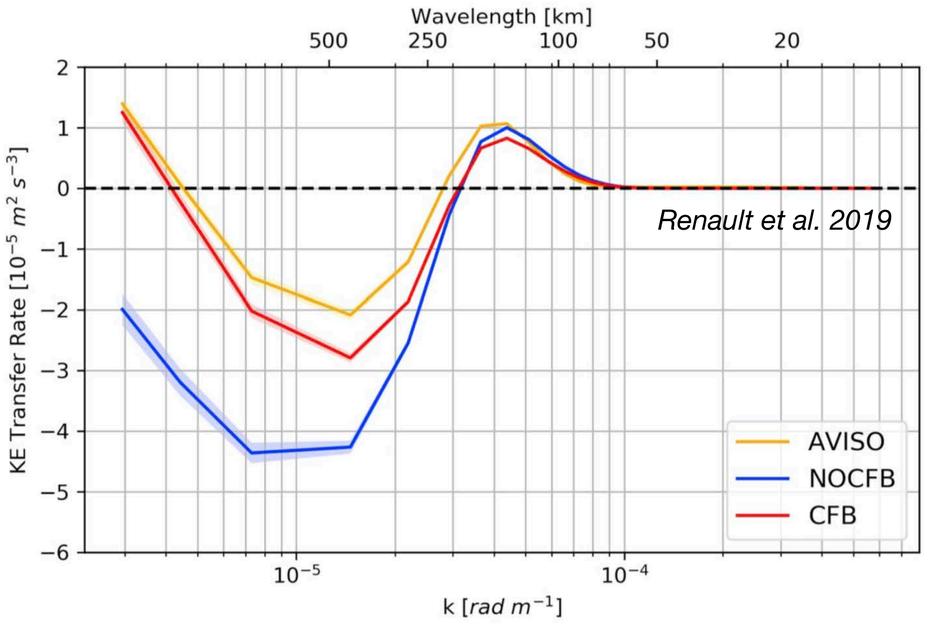

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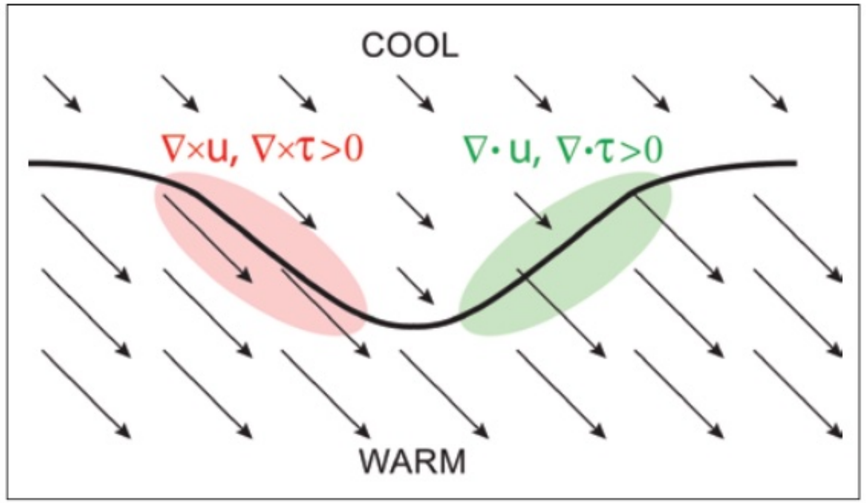

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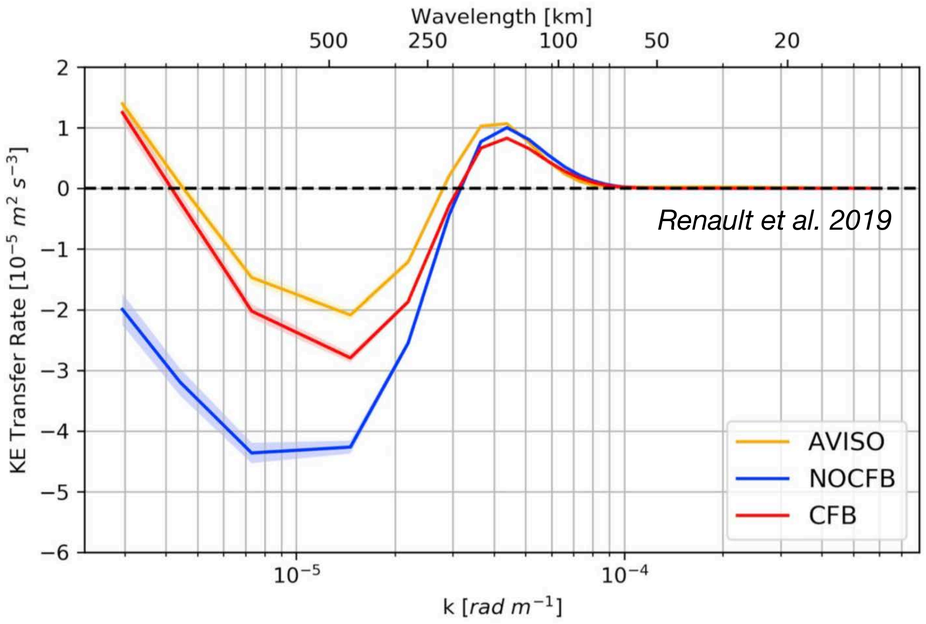

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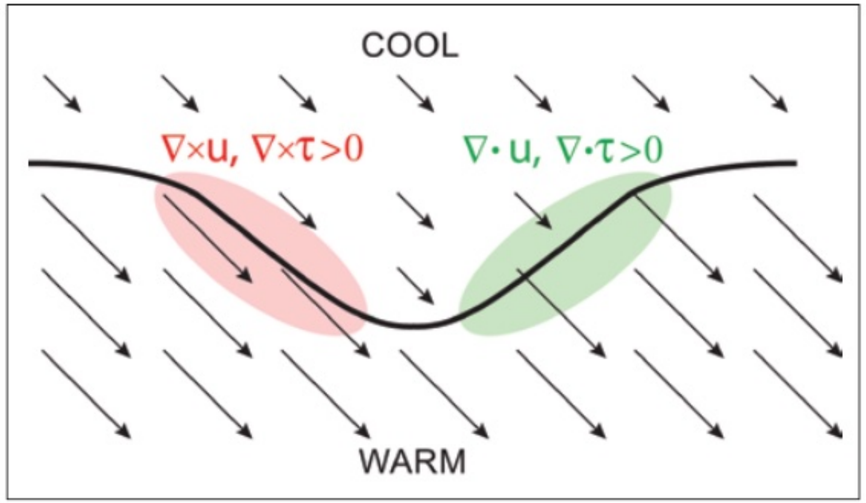

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Current frontier :

impact on climate time scale, interactions at submesoscale, vertical exchanges, role of surface waves

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Session on the scientific and institutional **context of air-sea interactions** studies on June 30th

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Sebastiaan Swart, Meghan Cronin and the SCOR WG 162

SWOT will provide :

- more obs at focus site in connection with OASIS deployments
- opportunities for in-depth process studies at cross-over site
- opportunities for synergistic capacity building
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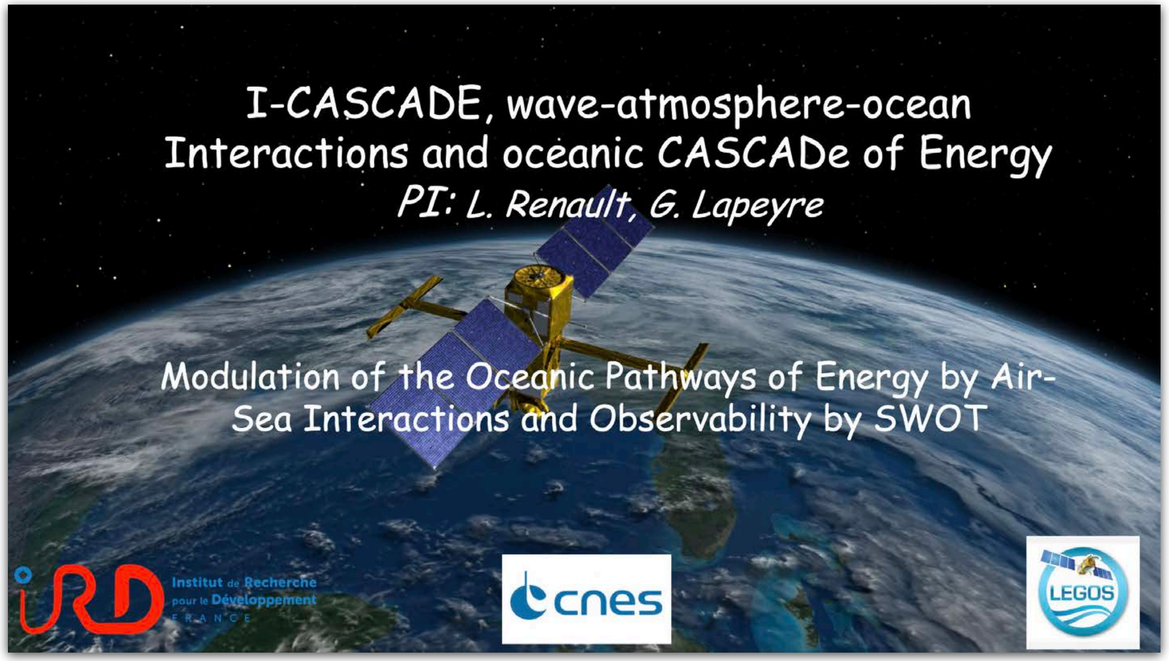

Lionel Renault : recent results on CFB and TFB and their large scale impacts

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Science status

- CFB largely impacts Energy cascade (key to explain future SWOT data)
- TFB induces a sink of EAPE from mesoscale eddies to the atmosphere
- Surface Waves : the SWOT simulator appears to be sensitive to Hsig

Preparing the exploitation of SWOT ocean and AdAC data (1/2)

Overarching objective, foster exchanges in order to optimise

(i) the use of models for preparing field campaigns and SWOT algorithms

(ii) the benefit that modellers will get from the mission and AdAC initiative

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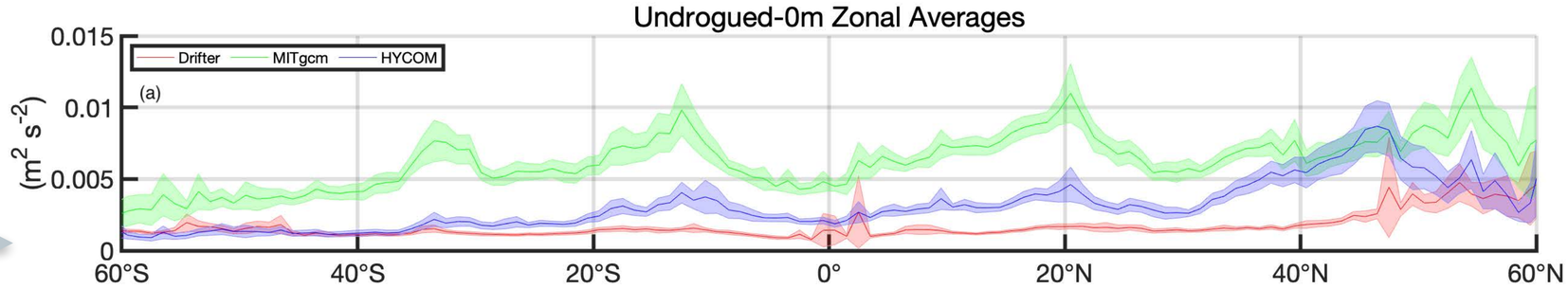
A key activity : foster systematic model intercomparison

comparison of HyCOM25, LLC4320
with drifters KE in the semi-diurnal band
showing that LLC4320 over-estimates tides



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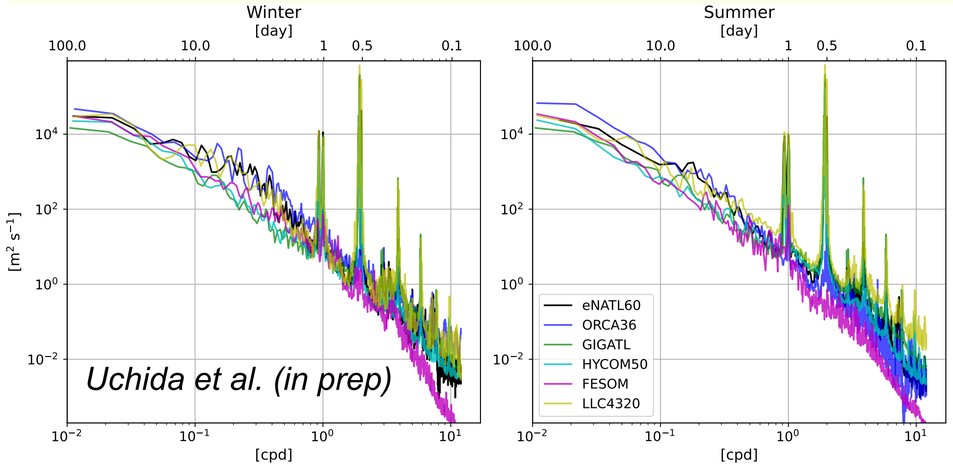

A key activity : foster systematic model intercomparison

Cloud-based hi-res model intercomparison project focusing in SWOT Covers, led by T. Uchida

PANGEO

https://github.com/roxyboy/SWOT-AdAC-ocean-model-intercomparison

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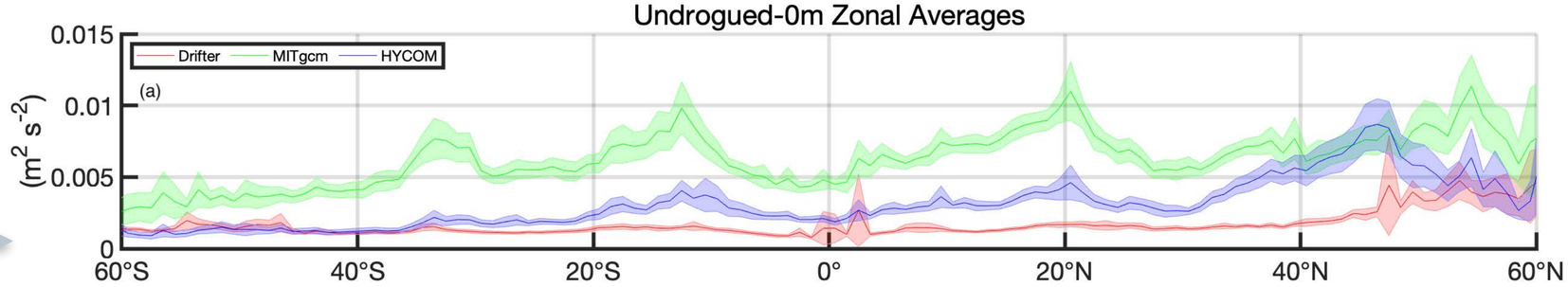

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A joint session on with the regional validation group in early Nov. 2021

Specific objective :

- provide a status of on-going regional modelling efforts
- discuss their articulation with basin-to-global scale modelling efforts.
- discuss how cloud-platforms could help preparing the campaigns and the exploitation of SWOT data.
- engage the broader modelling community for maximising the relevance of the in-situ data for models

Take-home message

The SWOT high-resolution modelling group

- an active, open, **science** driven group, interested in ocean processes
- organised in order to **help the mission** as much as possible
- focusing on three main areas of discussion :
    - (i) modelling internal waves/tides and their interactions with balanced flows
    - (ii) (sub-)mesoscale air-sea interactions and their impact on (upper) ocean dynamics
    - (iii) preparing the analysis of SWOT ocean and SWOT-AdAC data
- in collaboration with all the other SWOT ocean working groups

Take-home message

The SWOT high-resolution modelling group

- an active, open, **science** driven group, interested in ocean processes
- organised in order to **help the mission** as much as possible
- focusing on three main areas of discussion :
    - (i) modelling internal waves/tides and their interactions with balanced flows
    - (ii) (sub-)mesoscale air-sea interactions and their impact on (upper) ocean dynamics
    - (iii) preparing the analysis of SWOT ocean and SWOT-AdAC data
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The fast sampling phase will be key to make progress on the above questions