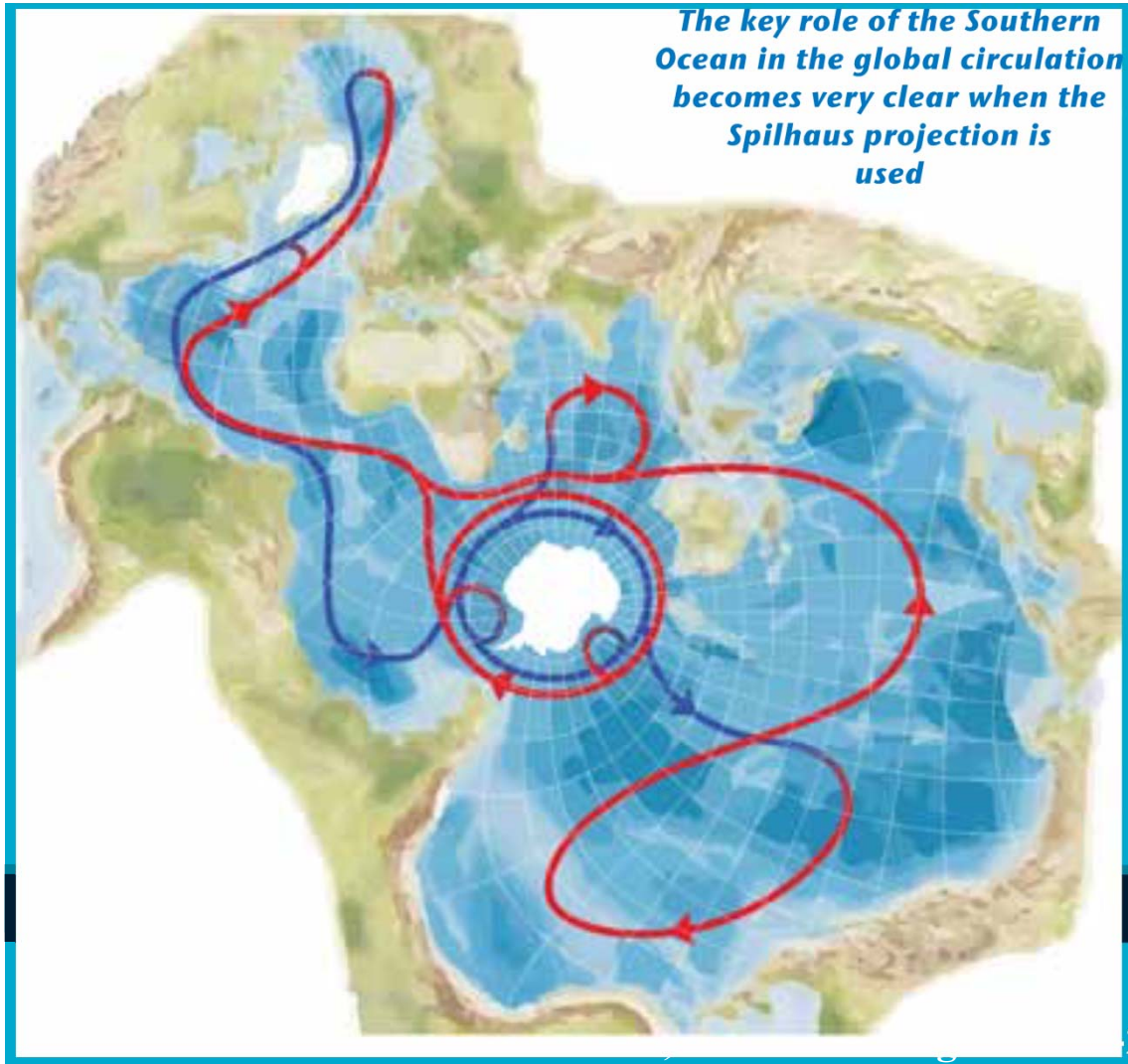
# SWOT-ACC,
# Satellite and ship-based investigation of meso-submesoscale interactions in the Antarctic Circumpolar Current.

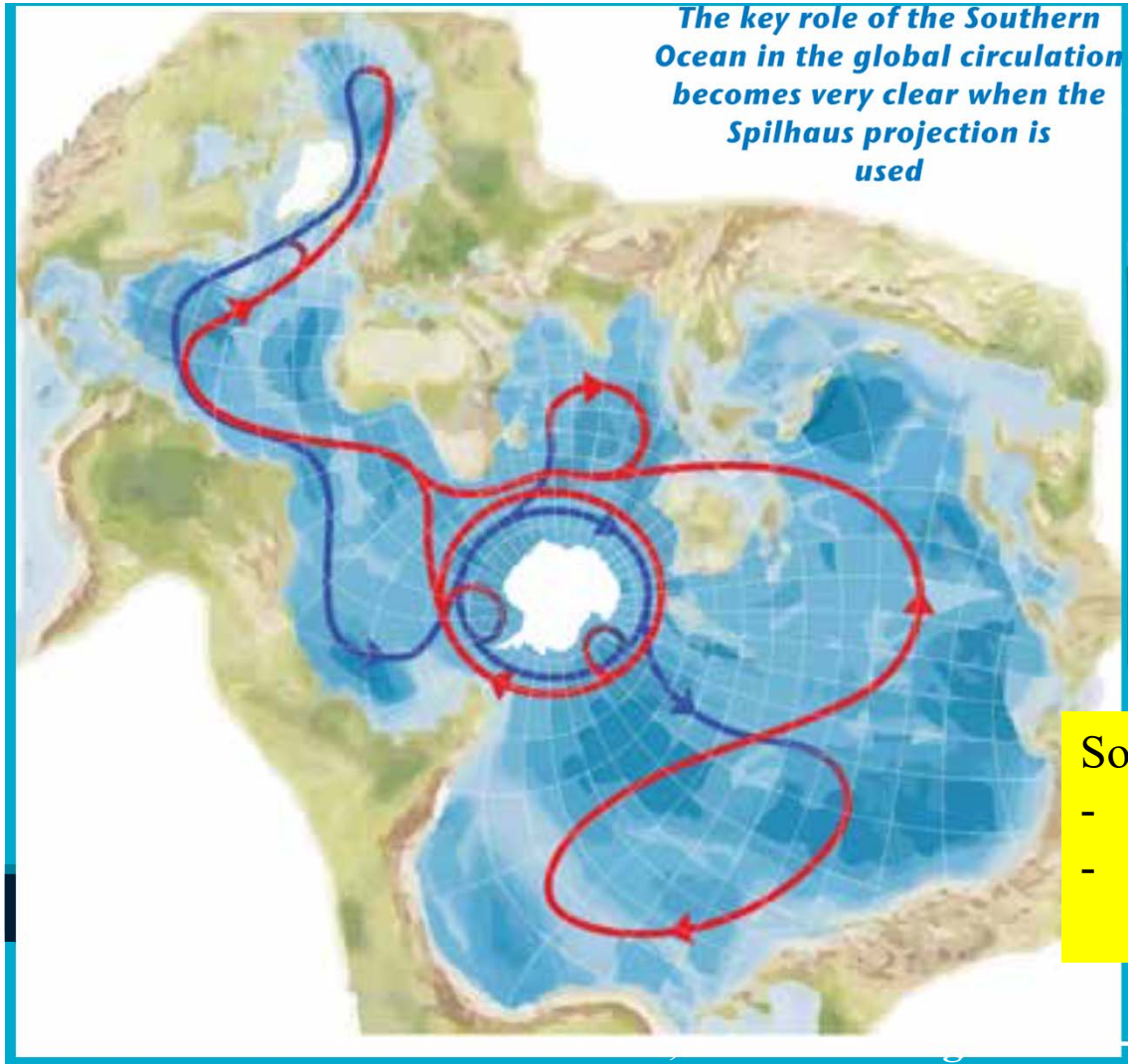

**B. Legresy[1,2], H. Phillips[3], M. Nikurashin[3], K. Polzin[4], N. Bindoff[3], C. Auger[1] S. Rintoul[1], R, Watts[5], R. Morrow[6]**

CLIMATE SCIENCE CENTRE

1. CSIRO Climate Science Centre, Hobart Australia
2. AAPP Australian Antarctic Program Partnership, IMAS, Hobart Australia
3. IMAS University of Tasmania, Hobart Australia
4. WHOI, USA
5. URI, USA
6. LEGOS, FRANCE




Meredith, Ocean challenge 2019

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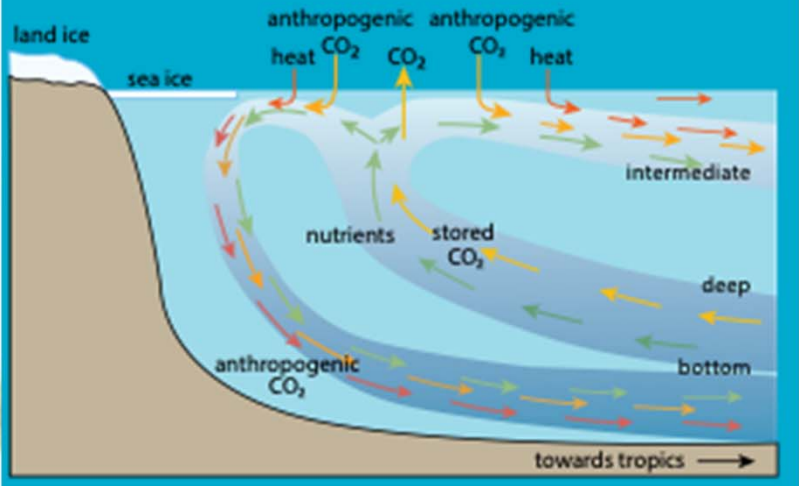
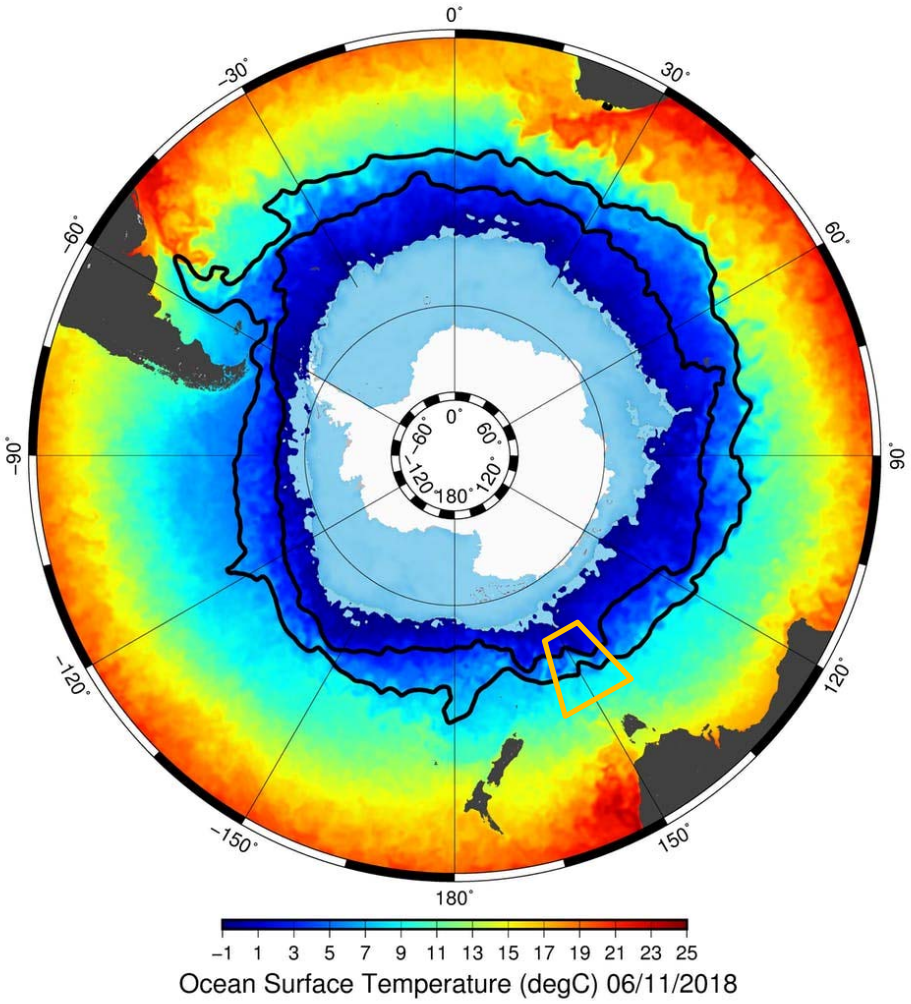



Southern Ocean =
- ¾ of global anthropogenic heat uptake
- 43% of anthropogenic CO2 uptake (with large variability)

-2019




Antarctic Circumpolar Current Meandering South of Tasmania

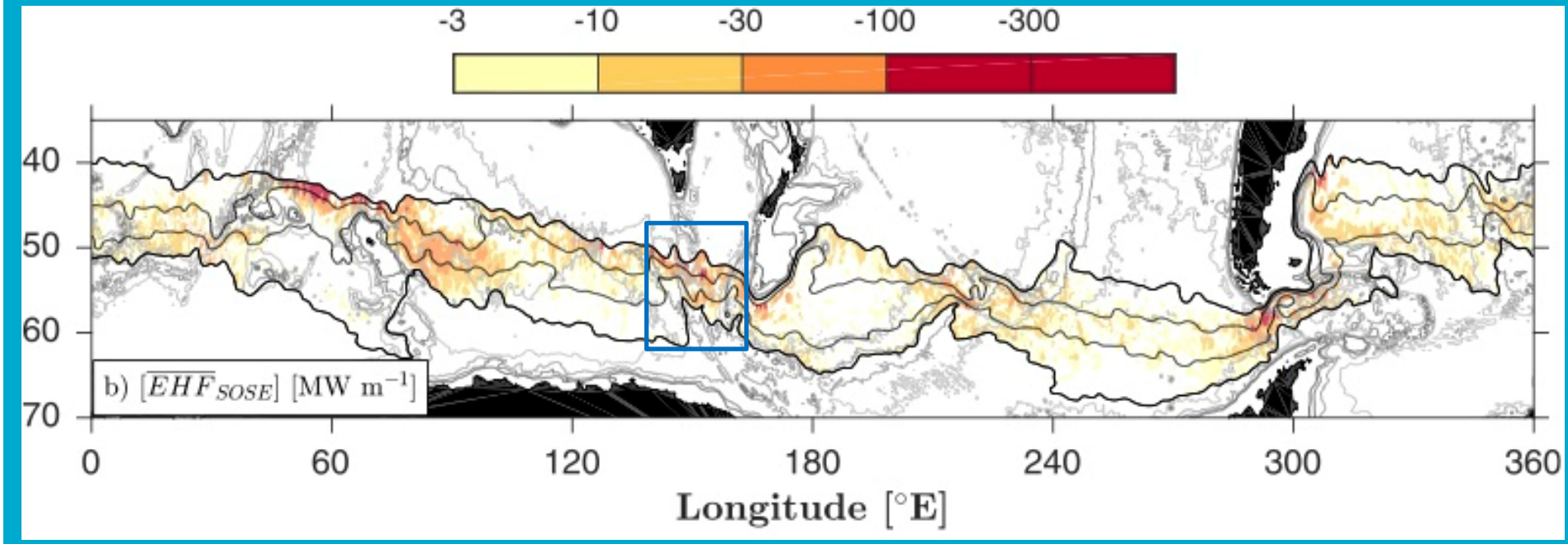
Interest of the area.

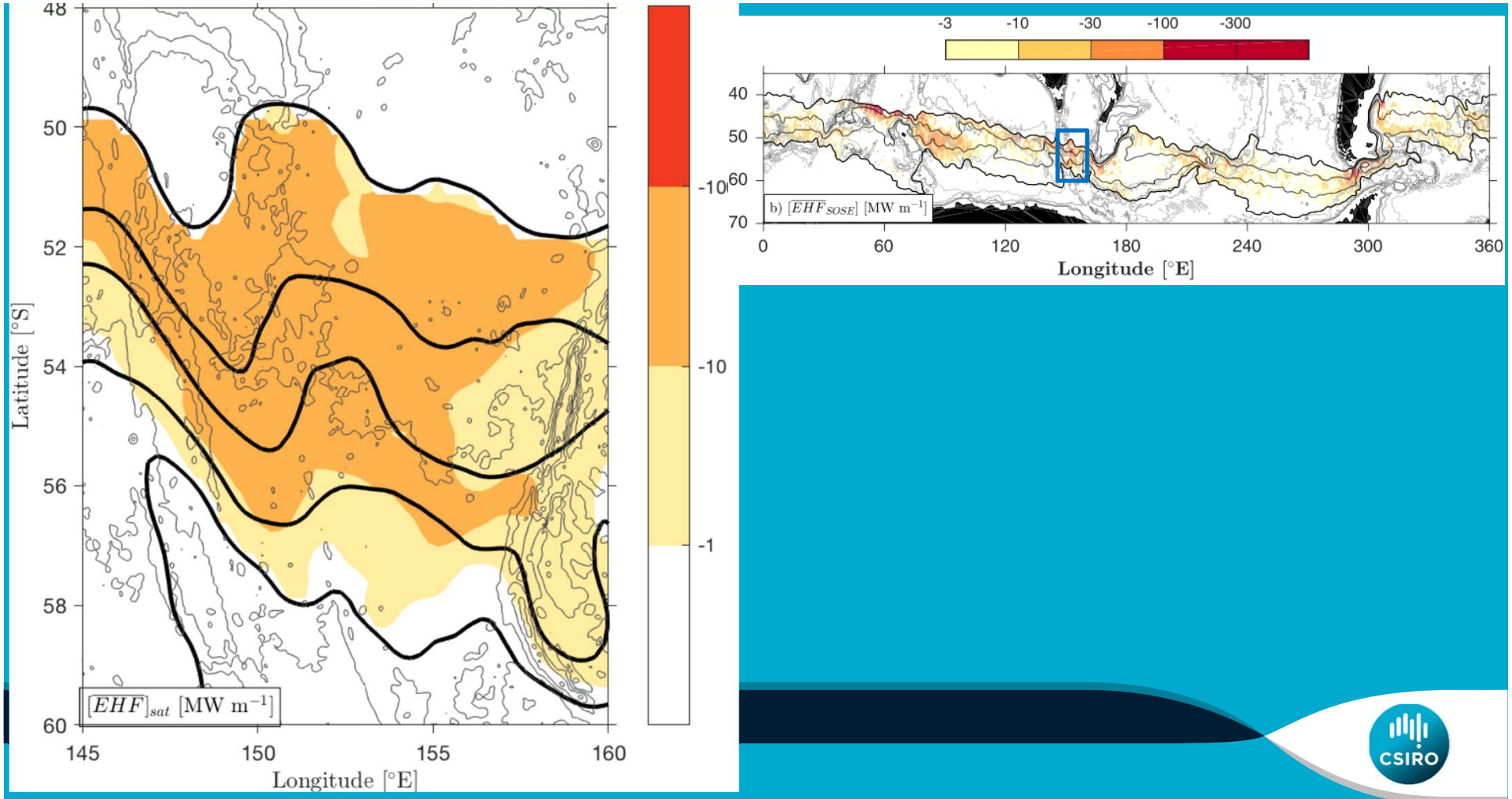
- Identified Eddy Heat Flux Hotspot
- Interesting Meandering target with sub-mesoscale activity
- Conveniently logistically close to Tas
- One of the SWOT FSP crossing (Fast Sampling Phase)
- Relative good SNR

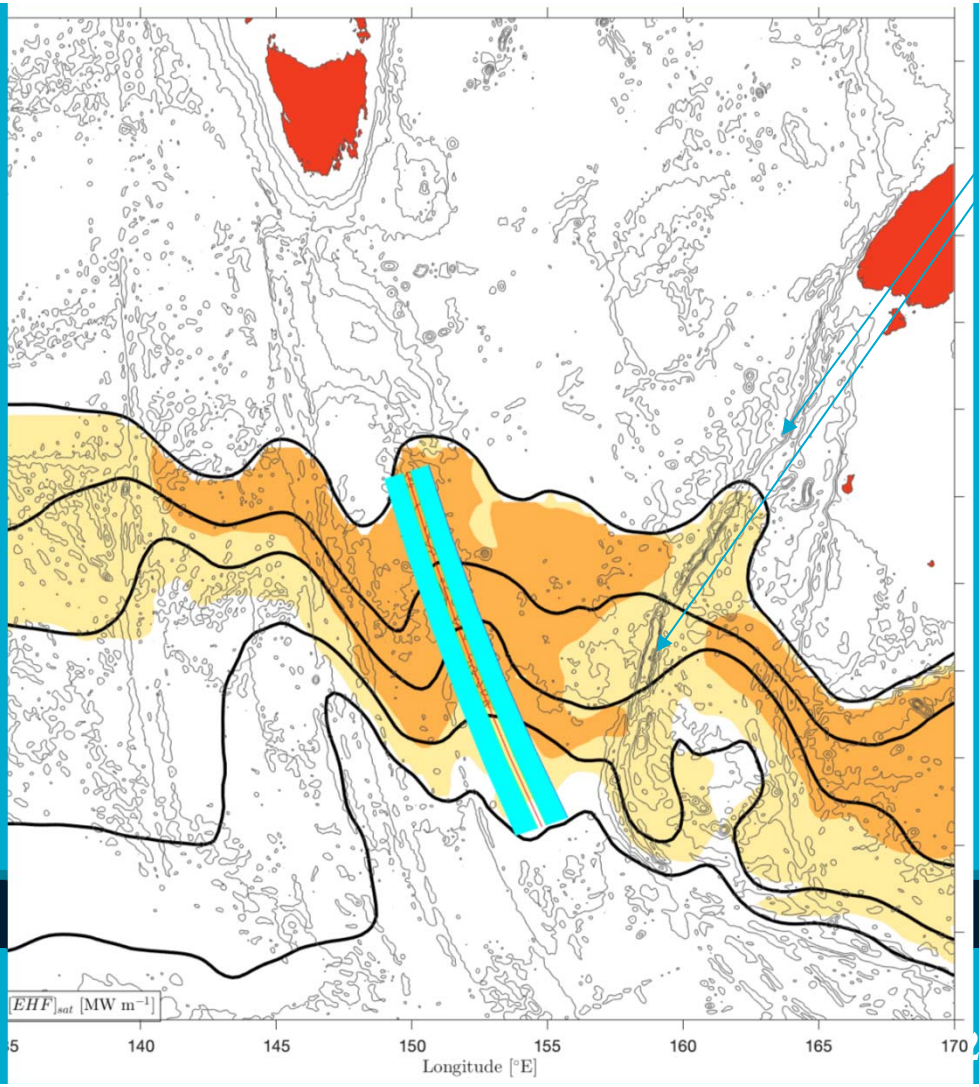
Phillips et al., 2018

- Identified Eddy Heat Flux Hotspot

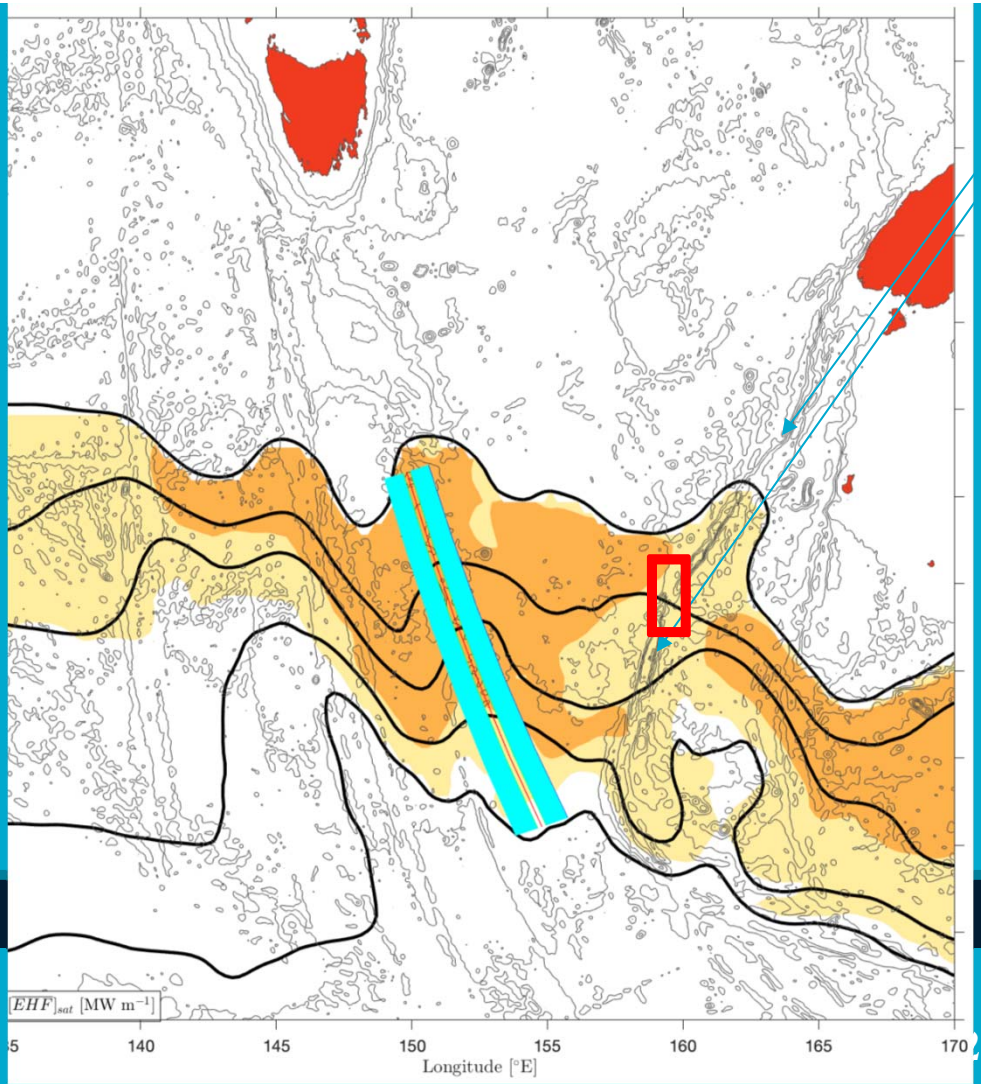
Foppert et al., 2017




48
50
52
54
56
58
60
Latitude [°S]
145
150
155
160
Longitude [°E]
$\overline{EHF}_{sat}$ [MW m$^{-1}$]
-10
-1
-3
-10
-30
-100
-300
40
50
60
70
0
60
120
180
240
300
360
Longitude [°E]
b) $\overline{EHF}_{SOSE}$ [MW m$^{-1}$]
CSIRO

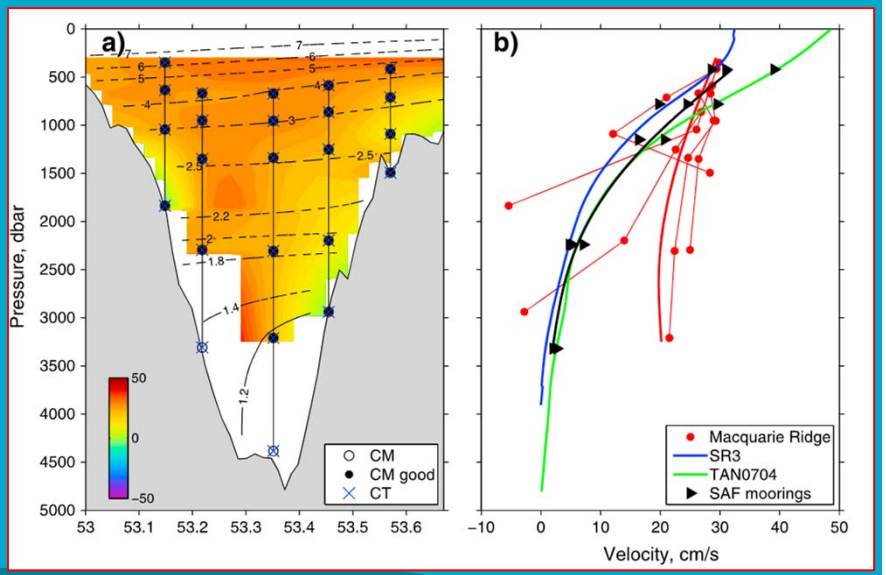



- 1d repeat pass right across the hotspot
- Upstream of the macquarie ridge

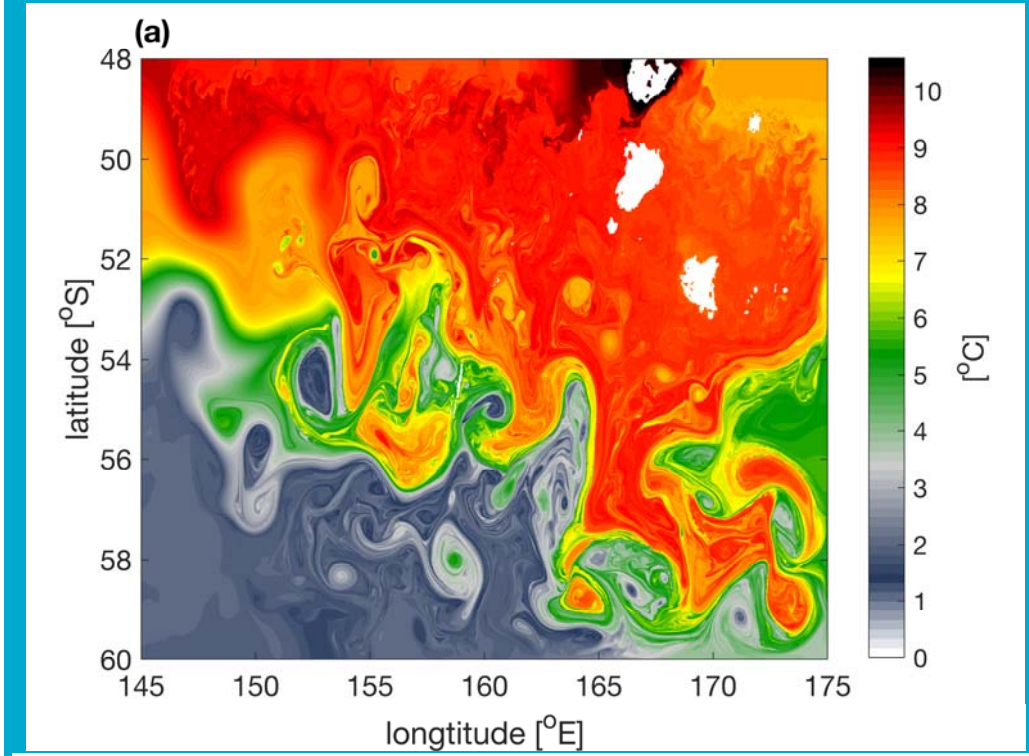



- 1d repeat pass right across the hotspot
- Upstream of the macquarie ridge

The ACC funnels in tiny gates across the ridge (Rintoul et al., 2014)



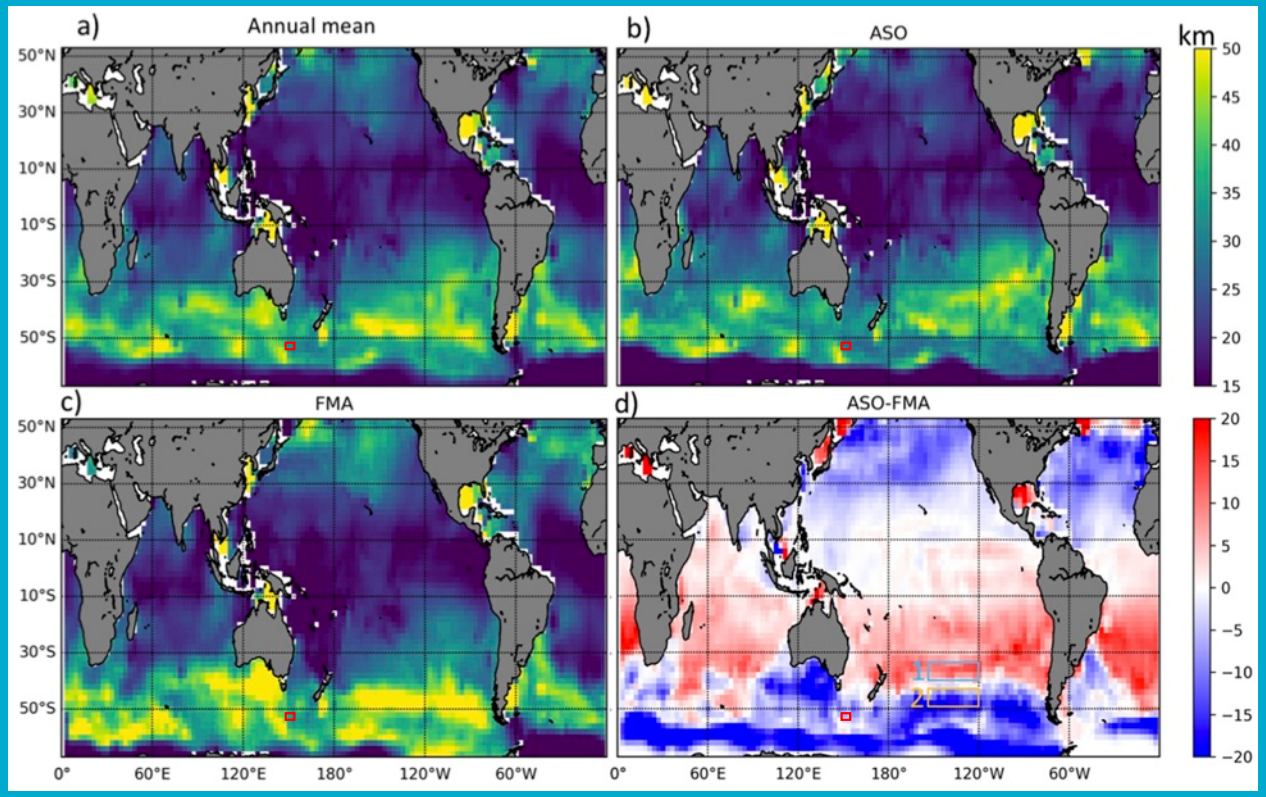

Induces large instabilities




MITgcm 800m resolution.

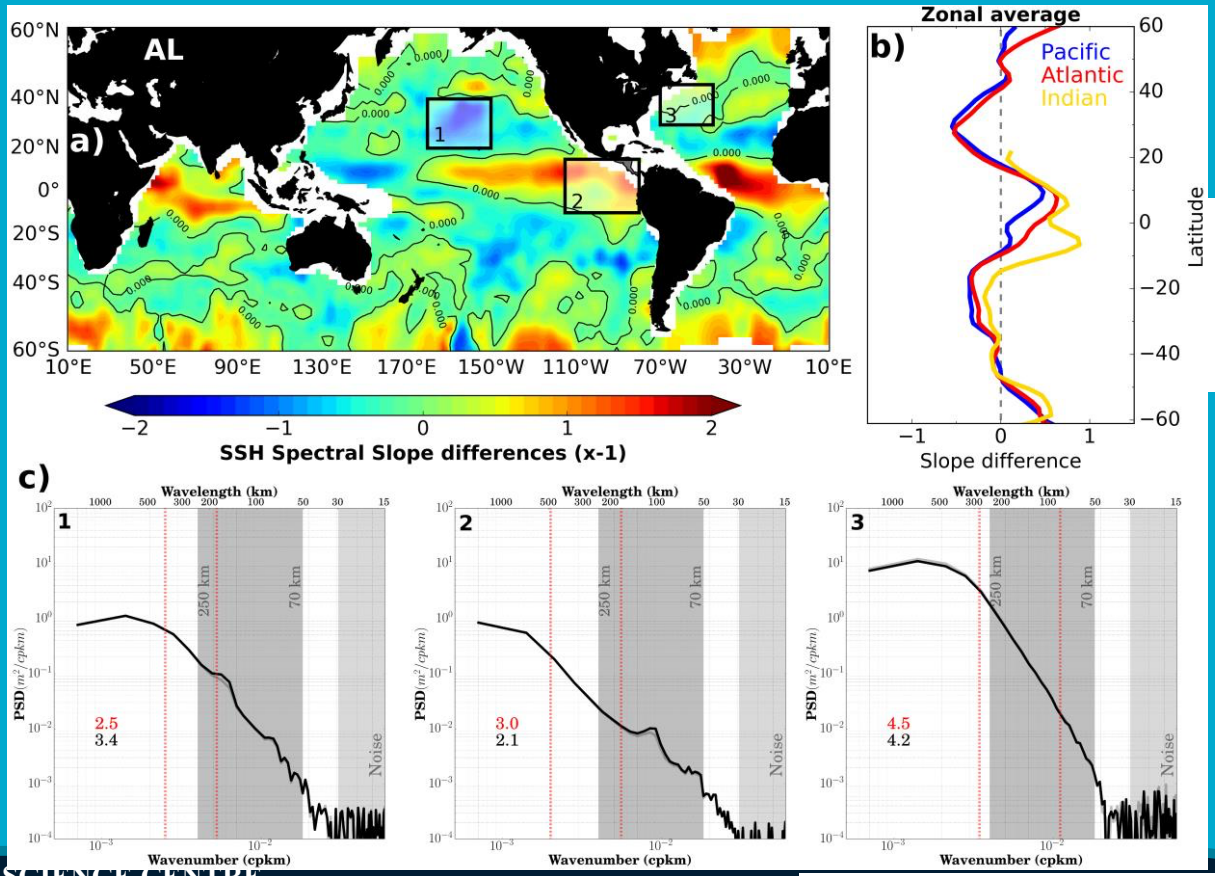
Temperature @ 200m (Zhang and Nikurashin in rev.)

Signal to Noise Ratio For SWOT observability




Wang et al., 2019

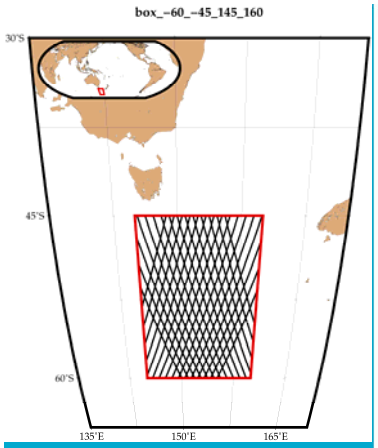
SSH Spectrum



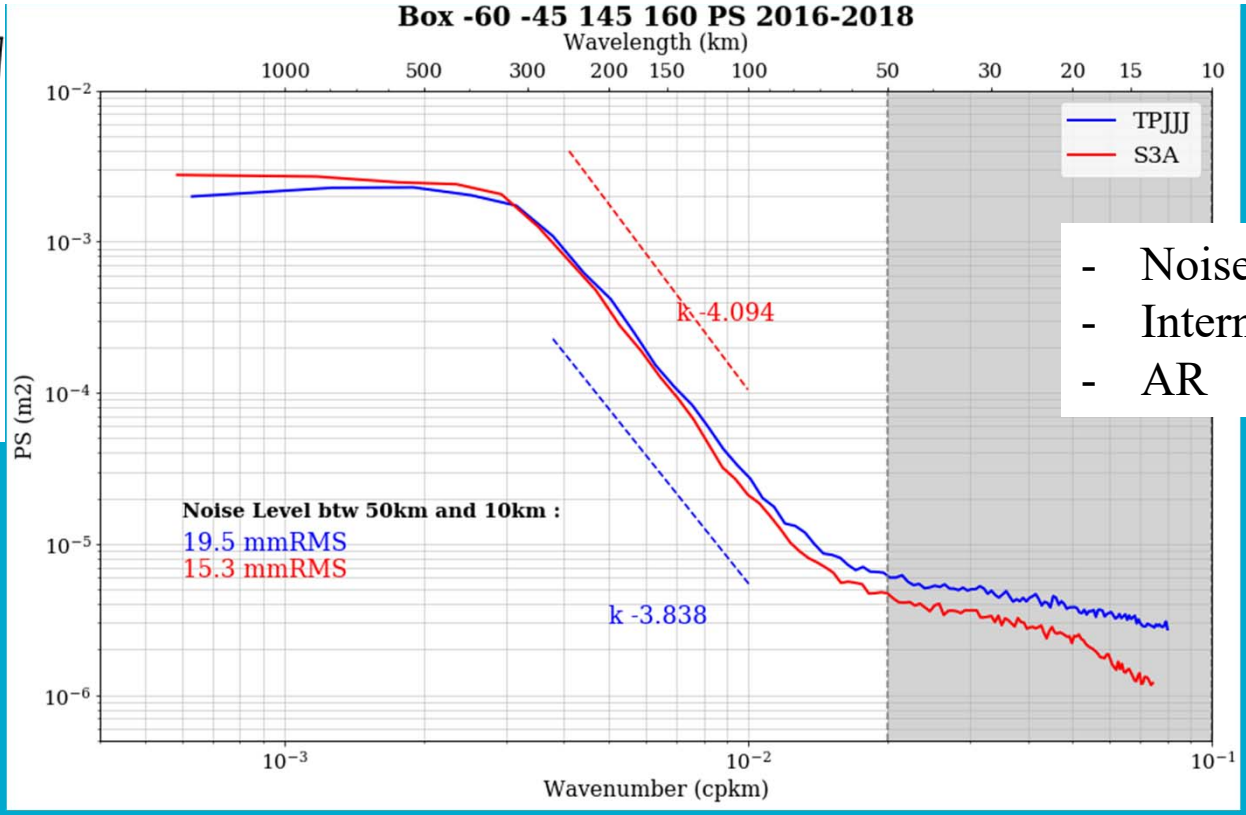

- Noise floor
- Internal tides/waves
- AR

Vergara et al., 2019

See also discussion by Richman et al., 2012, Xu and Fu, 2012, Dufau et al., 2014 …




SSH
Spectrum
3 overlapping
years (JAS/S3A)

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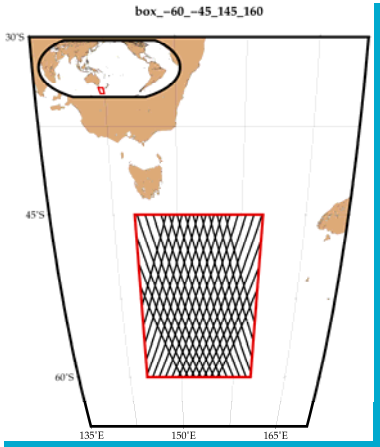


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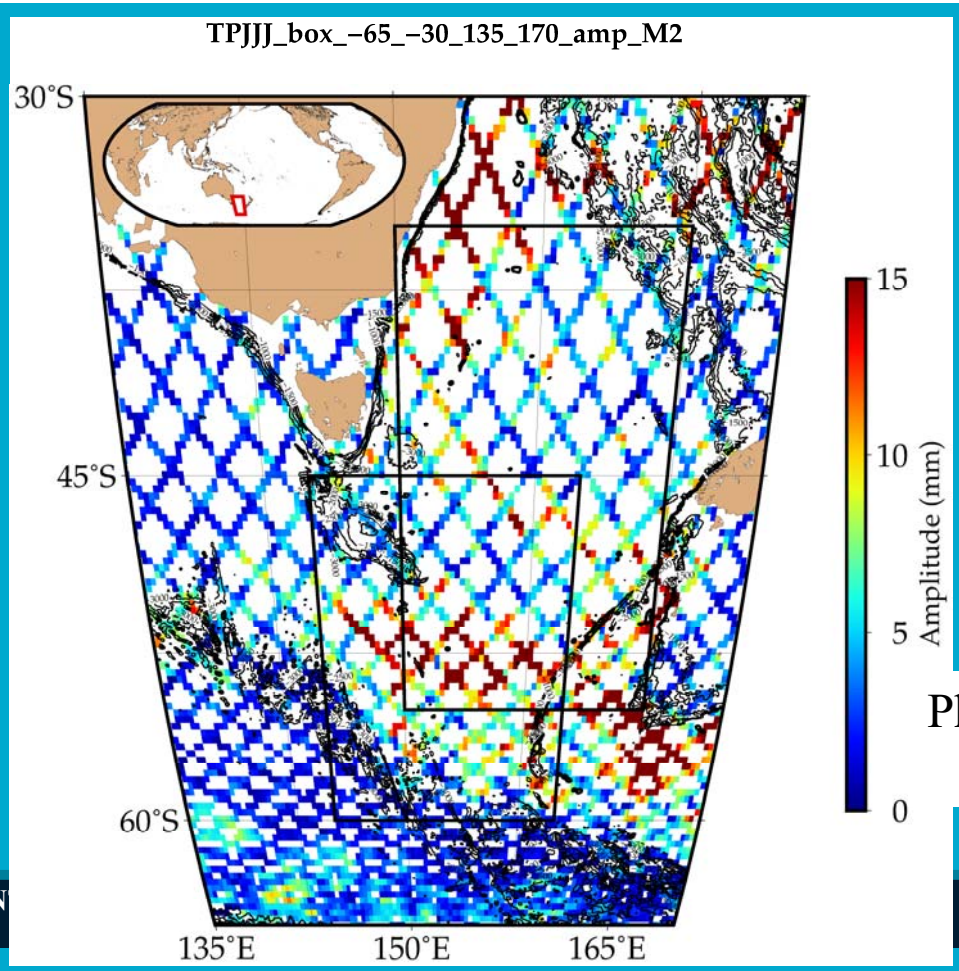
Spectrum

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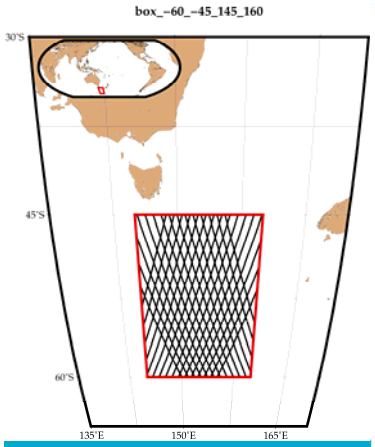
Phase locked Internal tide fit
(e.g. Zaron, 2017)

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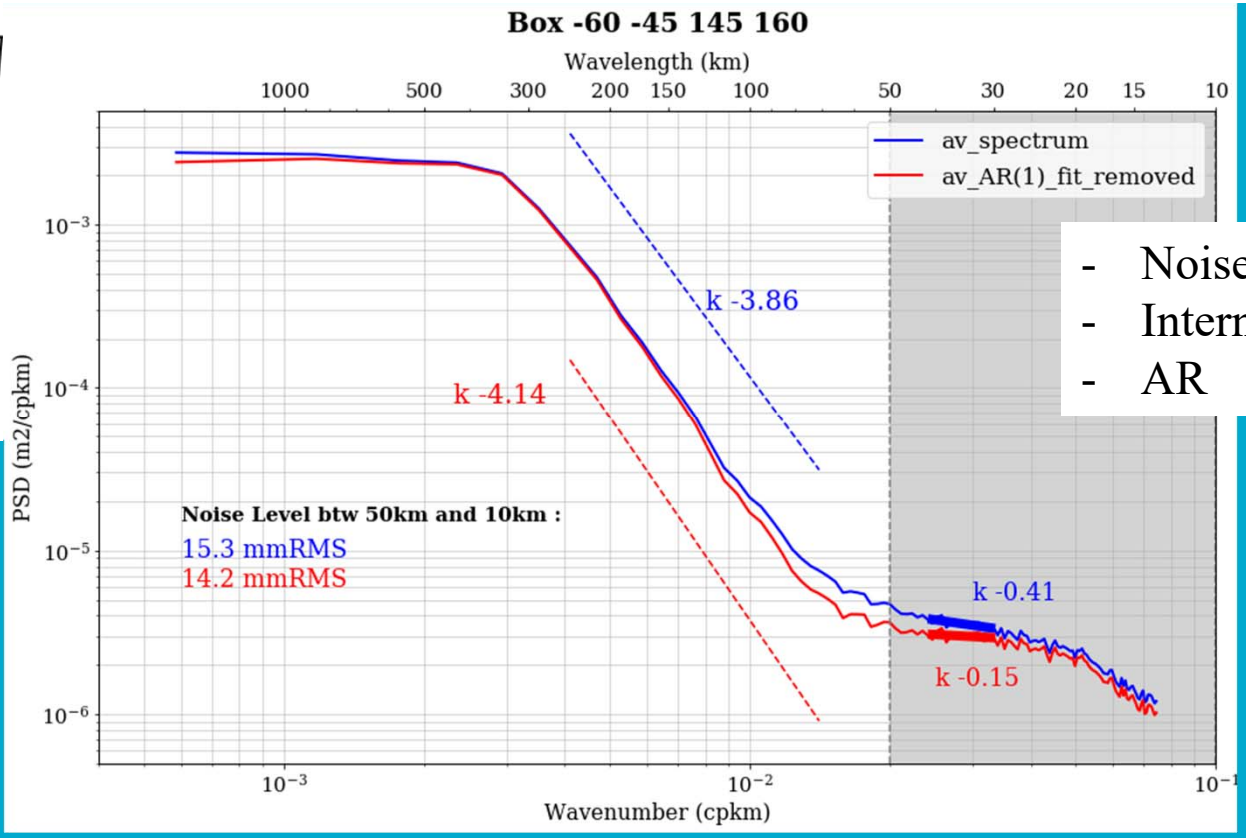


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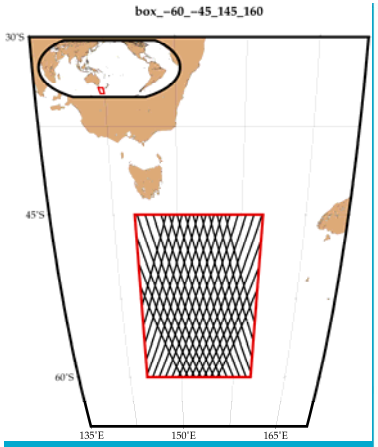


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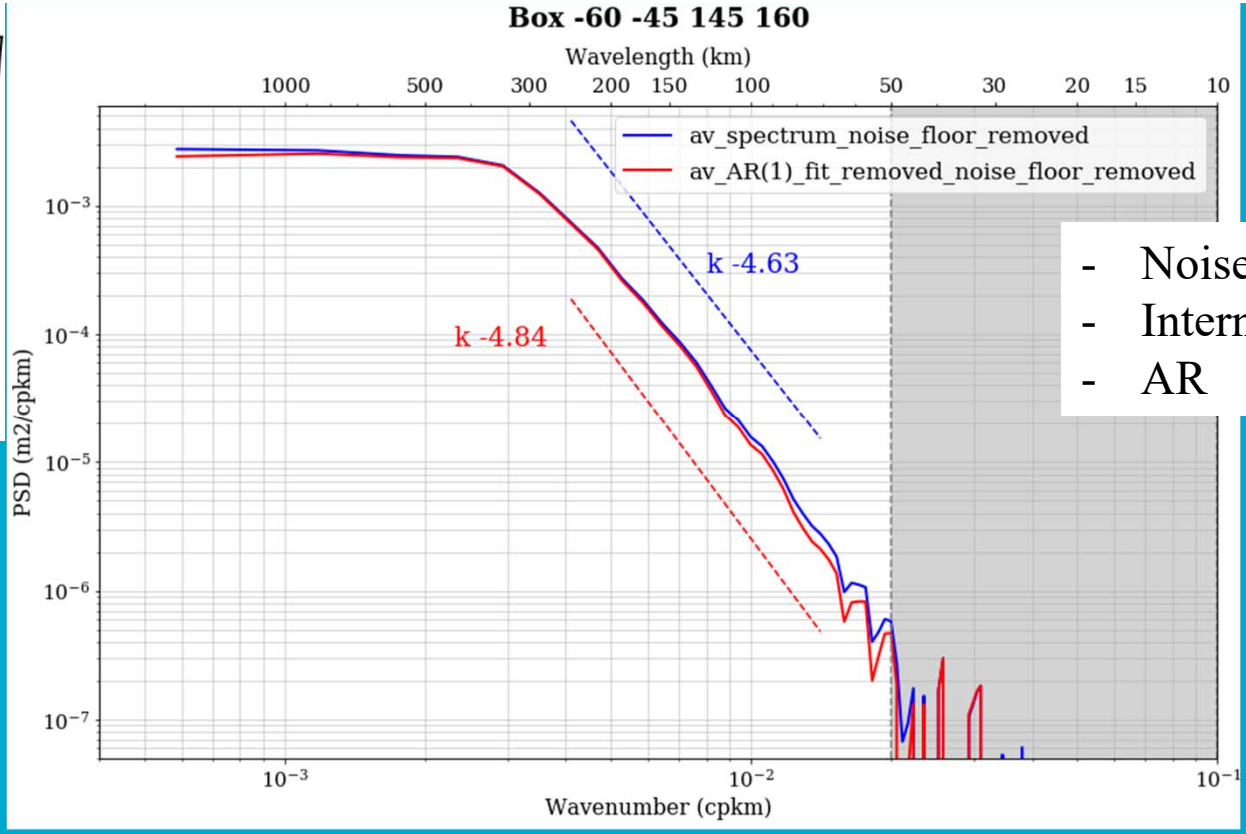
Spectrum

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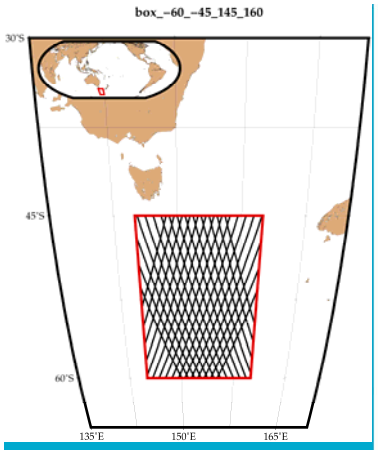


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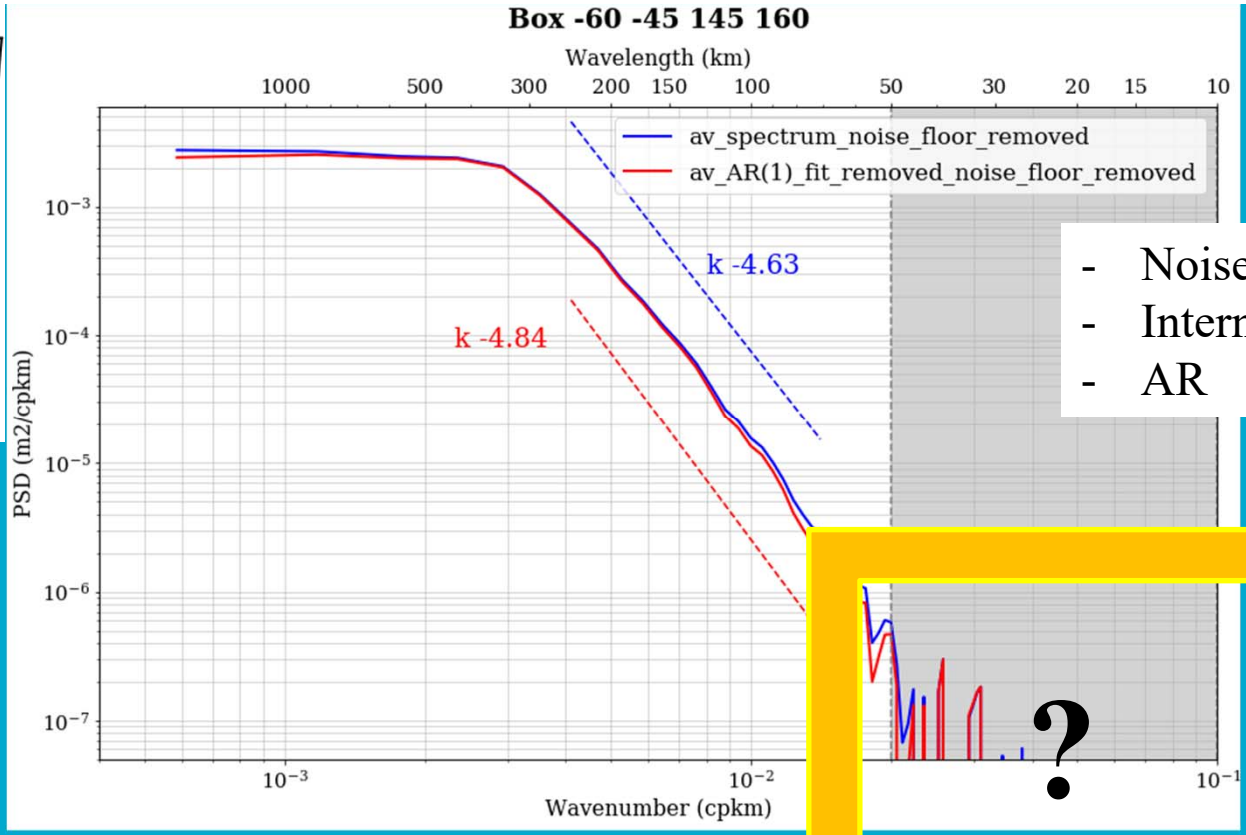


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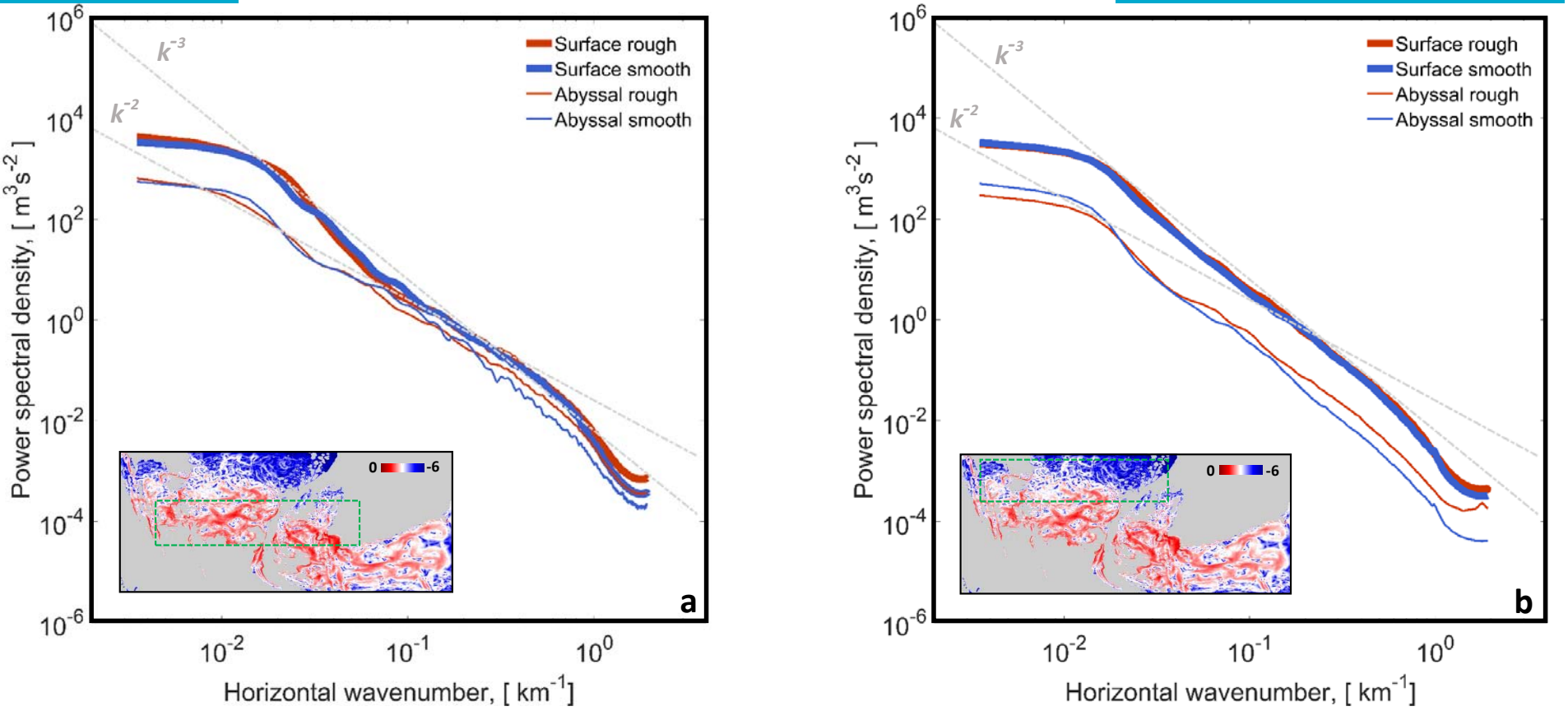
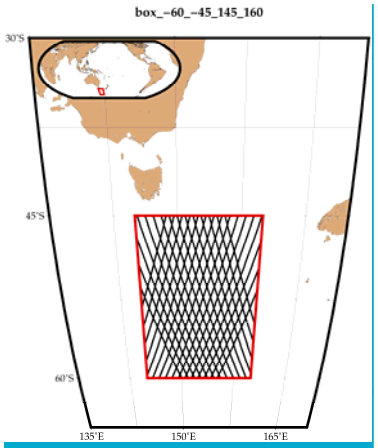
# Current speed spectra (Zhang and Nikurashin in rev.)



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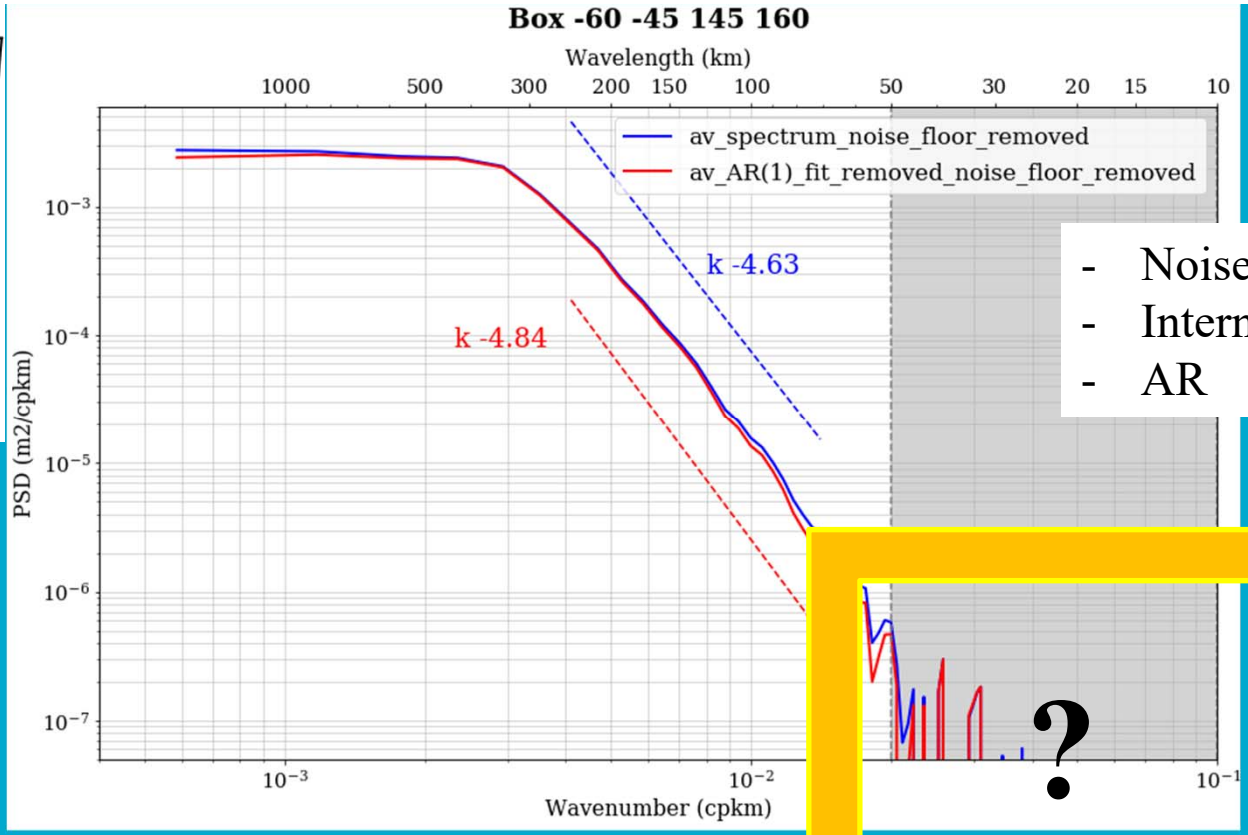
Spectrum

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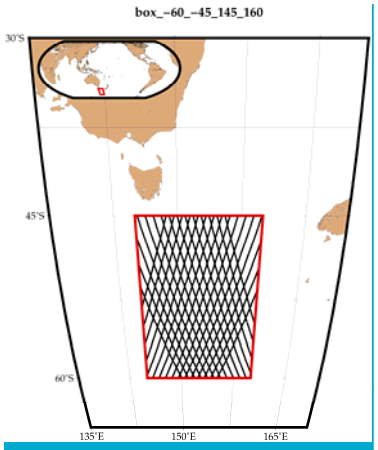


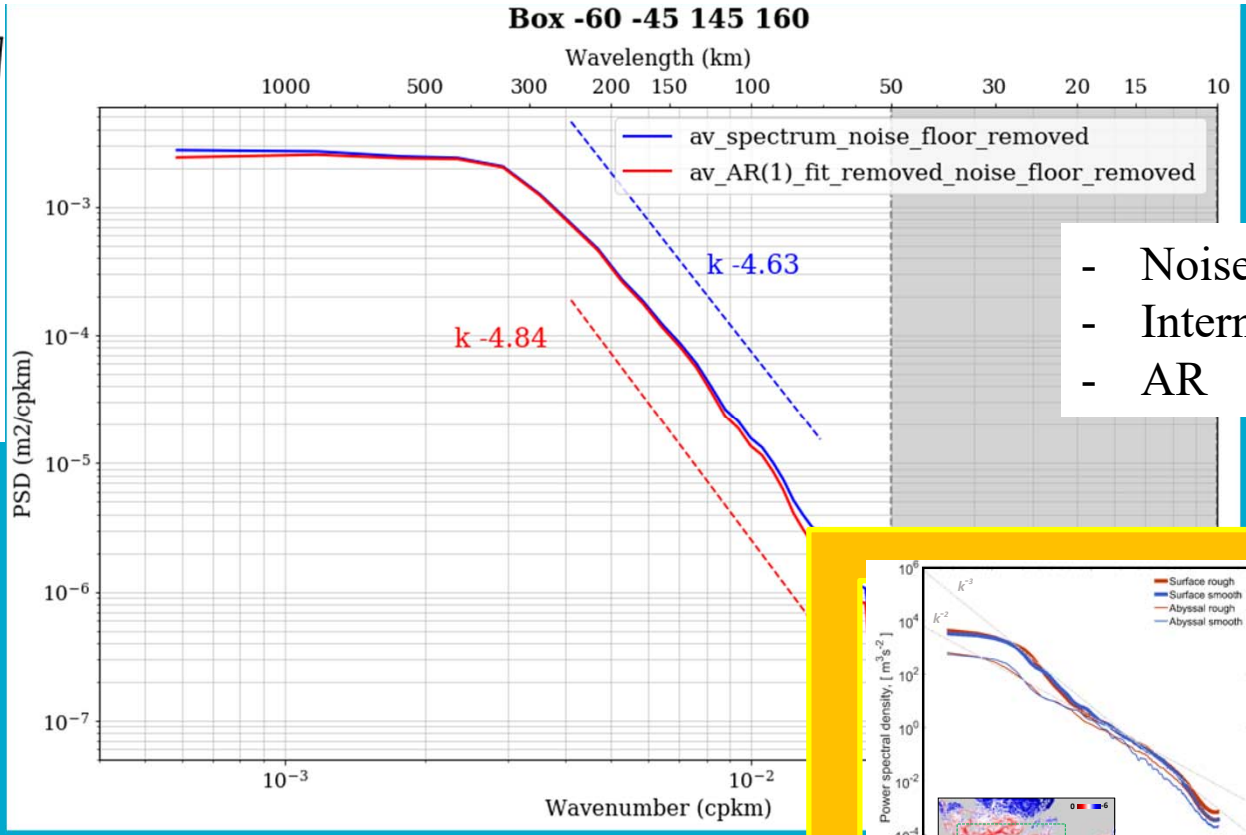


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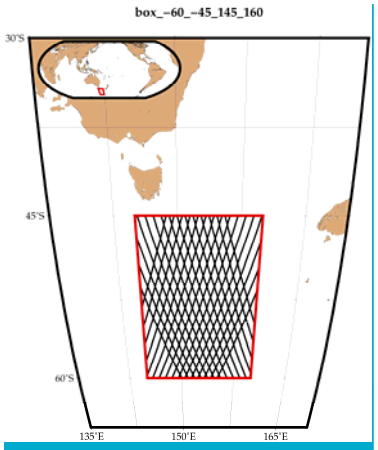


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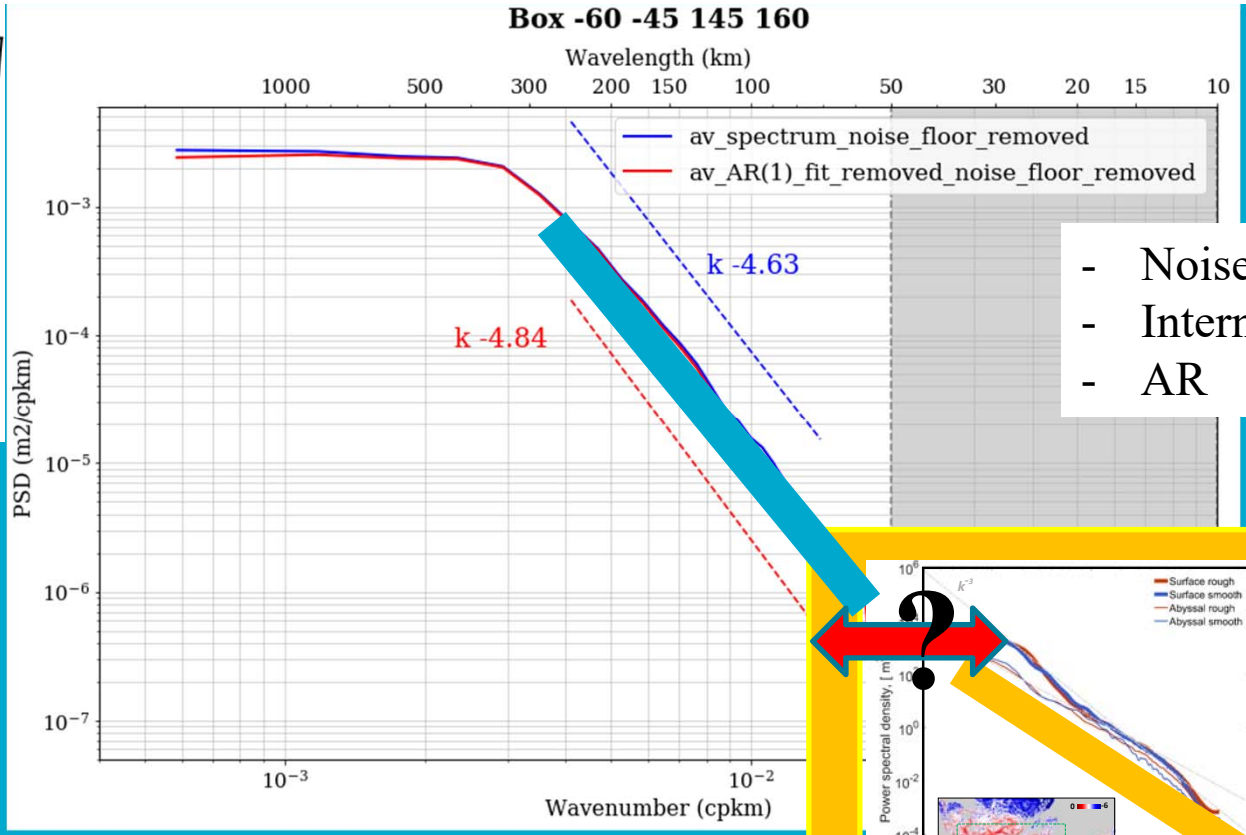


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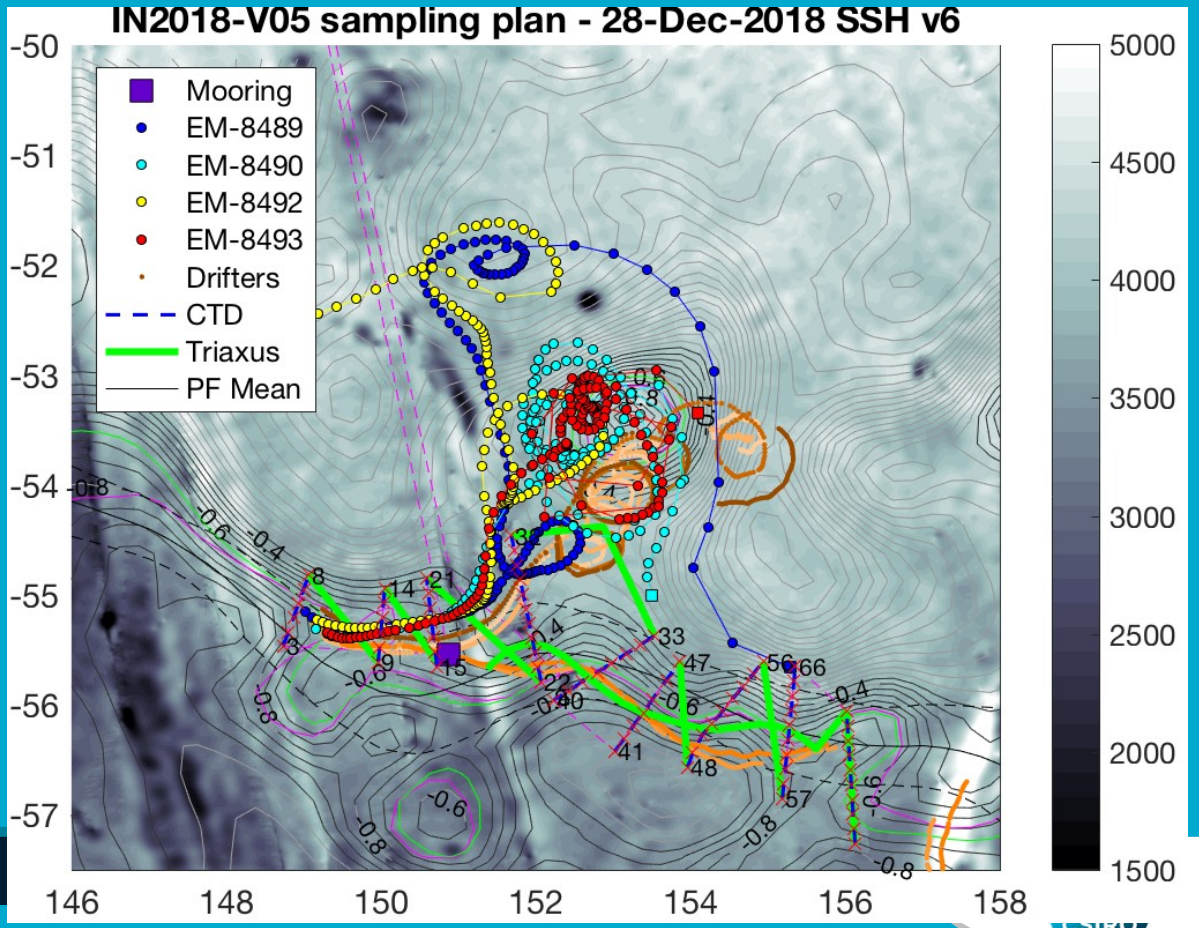
Oct-Nov 2018 Cruise observations

Can we detect signals that SWOT would “see”?



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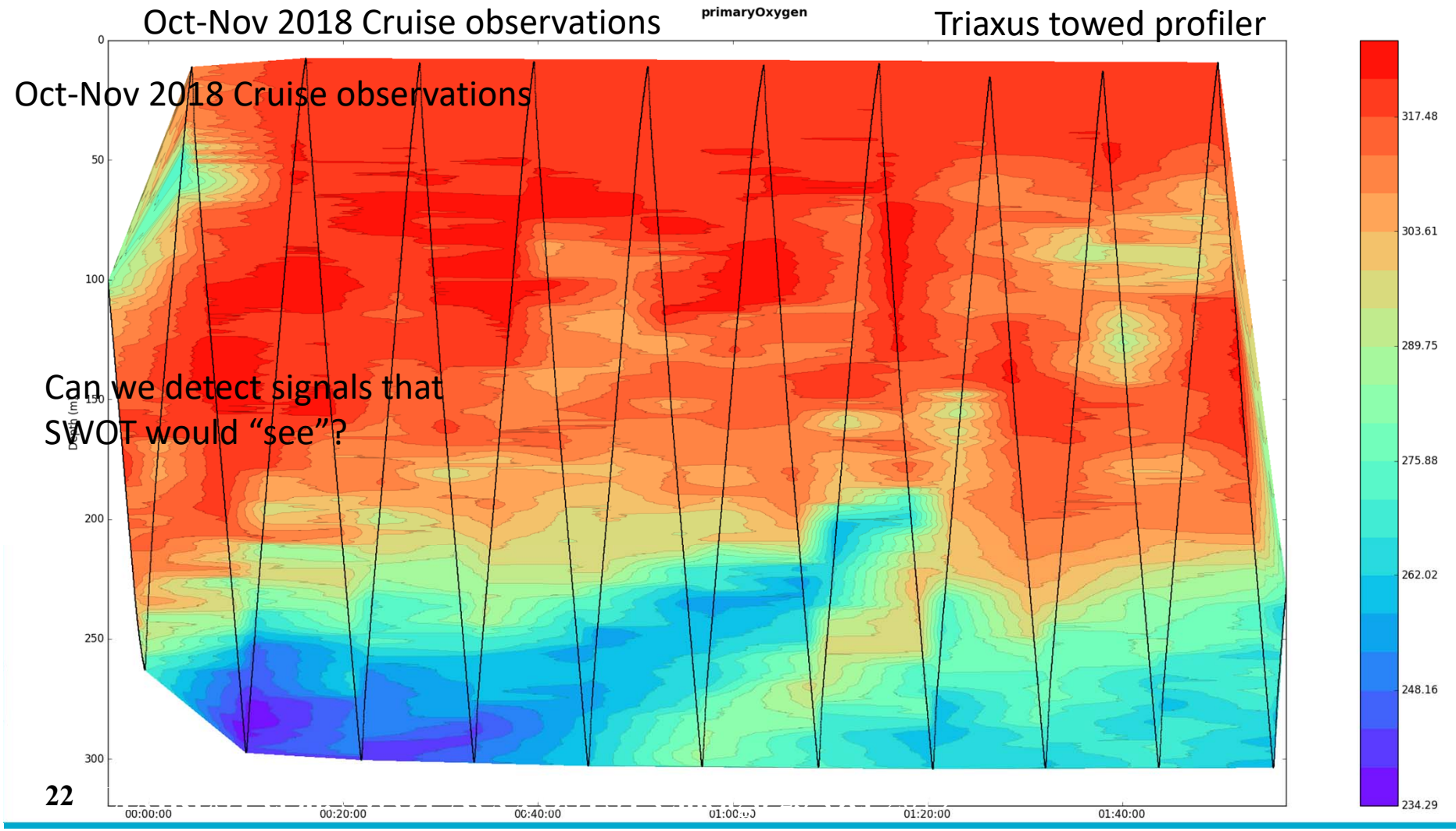

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Triaxus towed profiler

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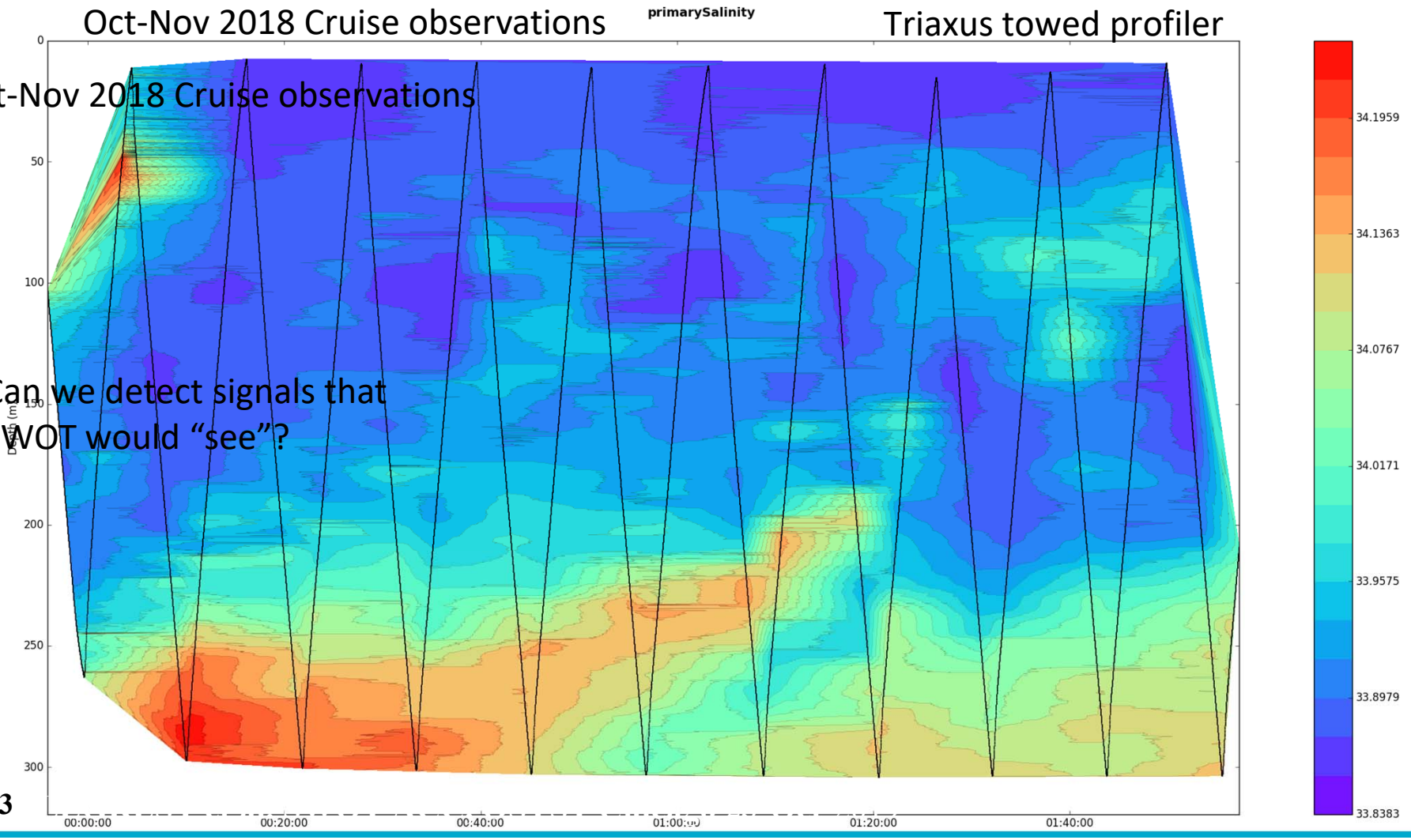

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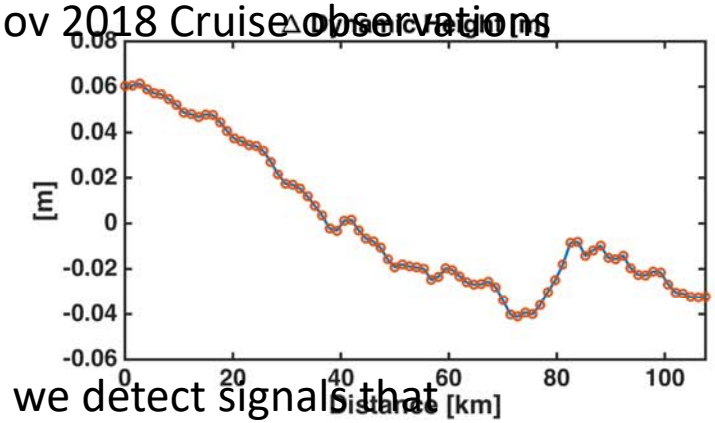


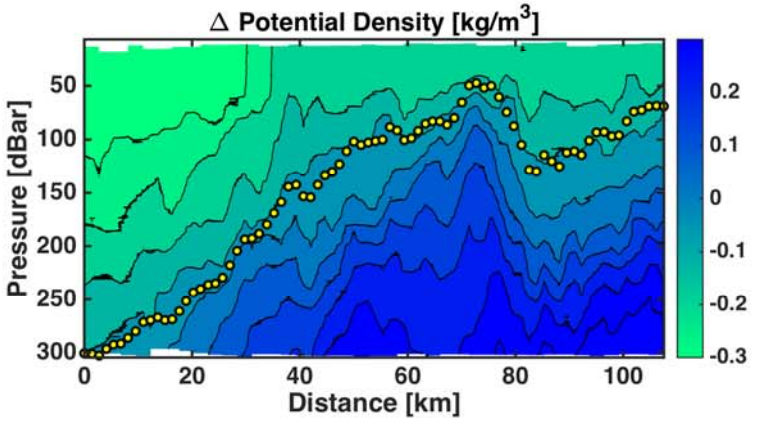


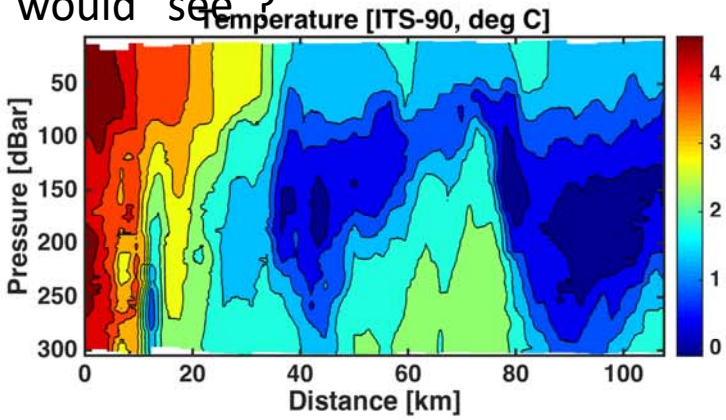


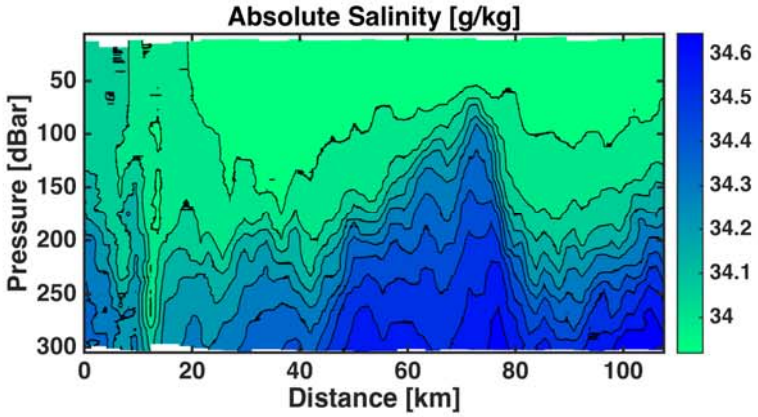

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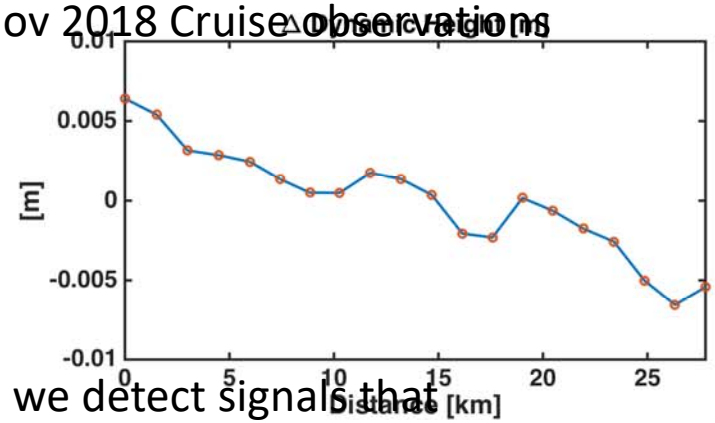
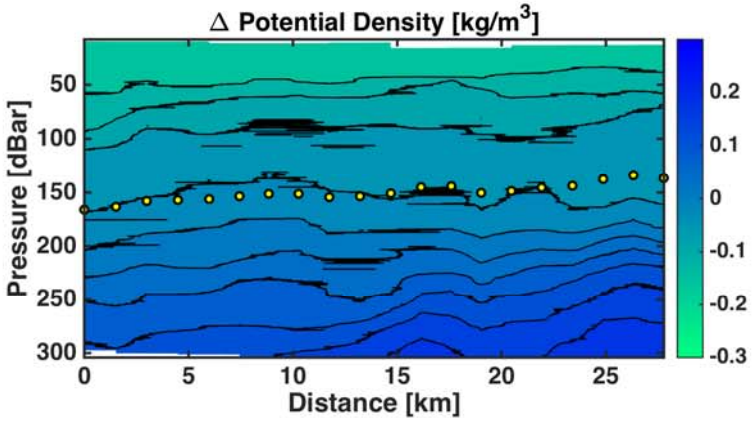
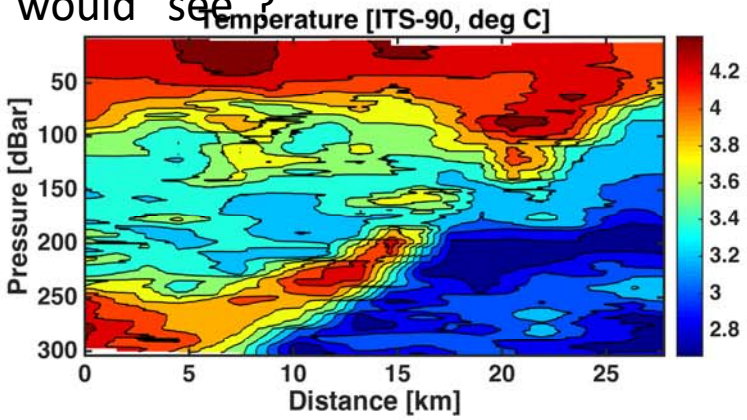
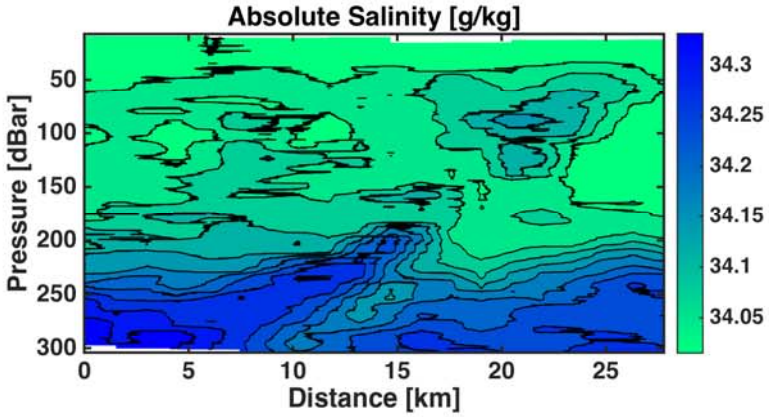


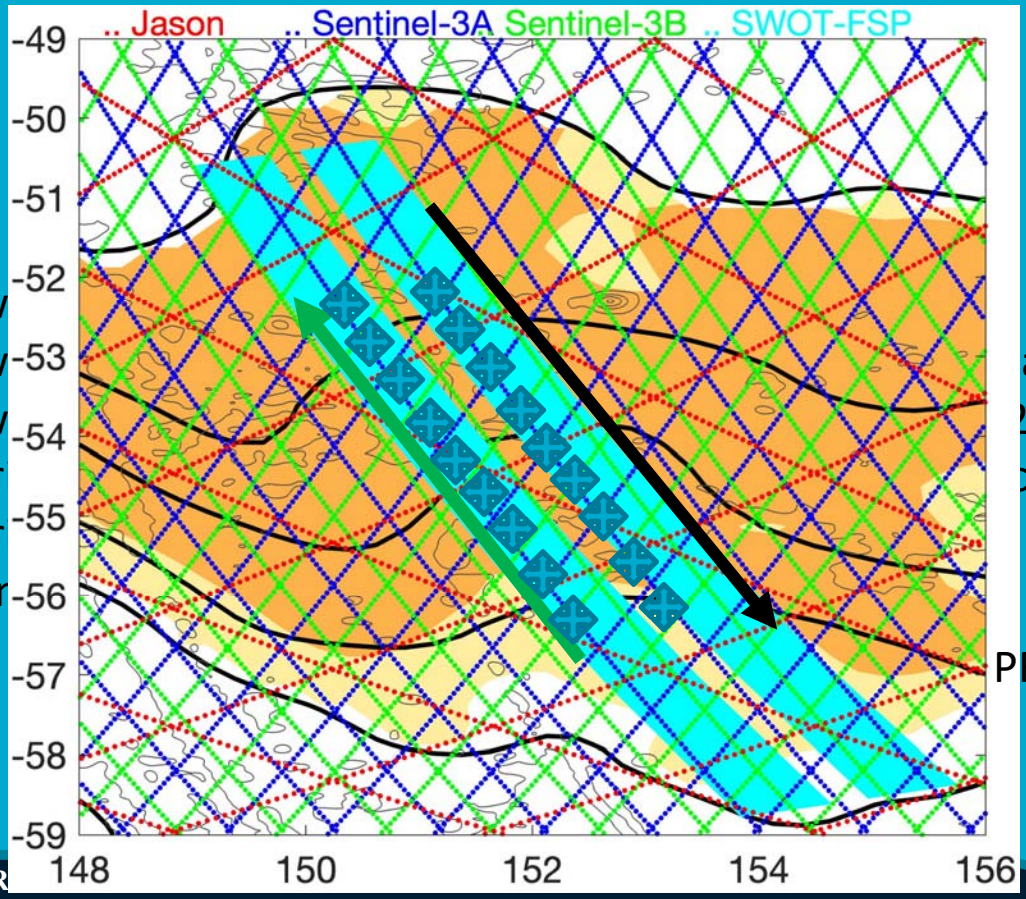



# 2022 Cruise Plan

- Timing :
  - Cope with the satellite launch delay risk
  - Cope with ship planning (besides getting a successful application)
  - Cope with satellite and ship speeds (<30s versus 14-15h x~20000)
- Having the right observation instruments sets for targeted science outcomes
- Having the right sampling plan for targeted science outcomes
  - Sampling versus processes space-time
- Usual logistic constrains of southern ocean cruises

- Timing :
  - Cope w
  - Cope w
  - Cope w
- Having the r
- Having the r
  - Samplir

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20000)
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PF

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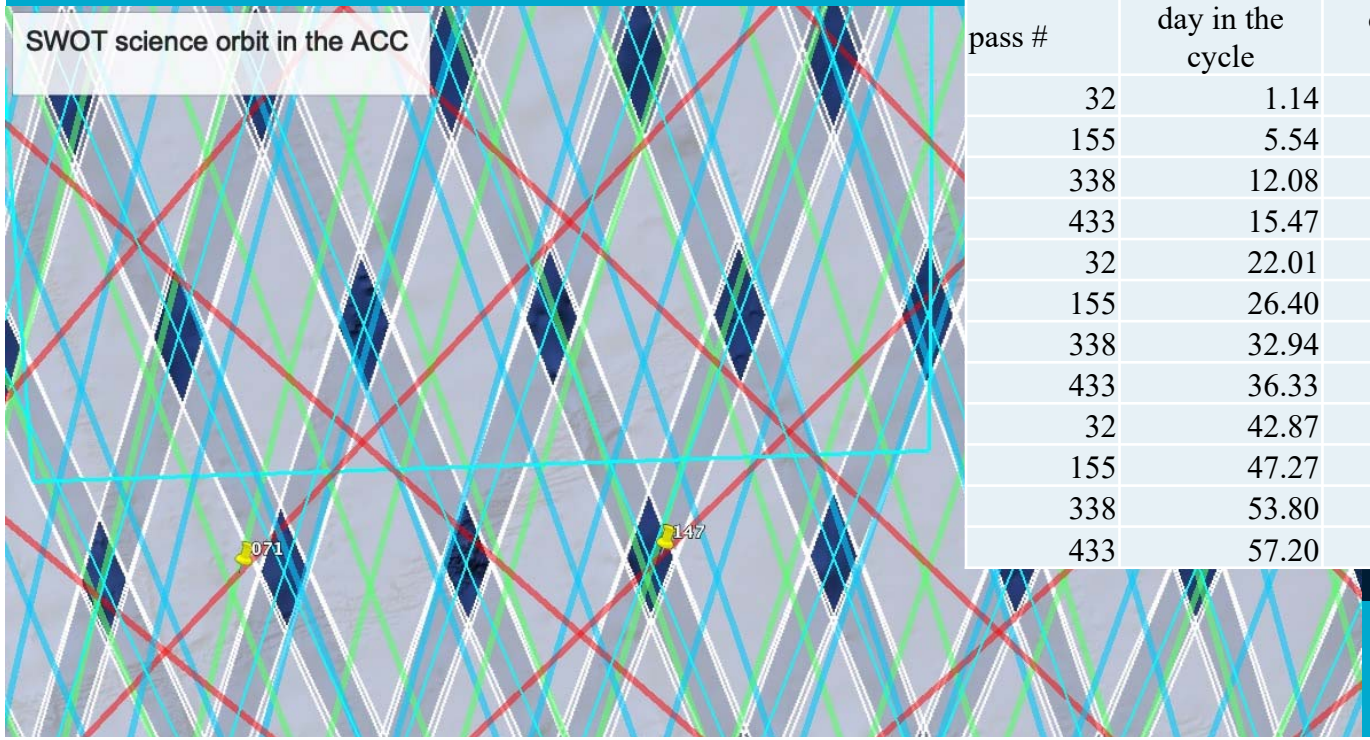
## Cal/Val 90day phase
## i.e. 30 repeats in 30 days of in situ sampling

| | |
|---|---|
| total nb of pass /cycle | 28 |
| total nb of days /cycle | 0.99349 |

## Science 3+ years phase i.e. ~6 repeat in 30days

| | |
|---|---|
| total nb of pass /cycle | 584 |
| total nb of days /cycle | 20.8646 |




| pass # | day in the cycle | day from first pass overflight for various sampling start | | | |
|---|---|---|---|---|---|
| 32 | 1.14 | 0.00 | | | |
| 155 | 5.54 | 4.39 | 0.00 | | |
| 338 | 12.08 | 10.93 | 6.54 | 0.00 | |
| 433 | 15.47 | 14.33 | 9.93 | 3.39 | 0.00 |
| 32 | 22.01 | 20.86 | 16.47 | 9.93 | 6.54 |
| 155 | 26.40 | 25.26 | 20.86 | 14.33 | 10.93 |
| 338 | 32.94 | 31.80 | 27.40 | 20.86 | 17.47 |
| 433 | 36.33 | 35.19 | 30.80 | 24.26 | 20.86 |
| 32 | 42.87 | 41.73 | 37.33 | 30.80 | 27.40 |
| 155 | 47.27 | 46.12 | 41.73 | 35.19 | 31.80 |
| 338 | 53.80 | 52.66 | 48.27 | 41.73 | 38.34 |
| 433 | 57.20 | 56.06 | 51.66 | 45.12 | 41.73 |

CSIRO

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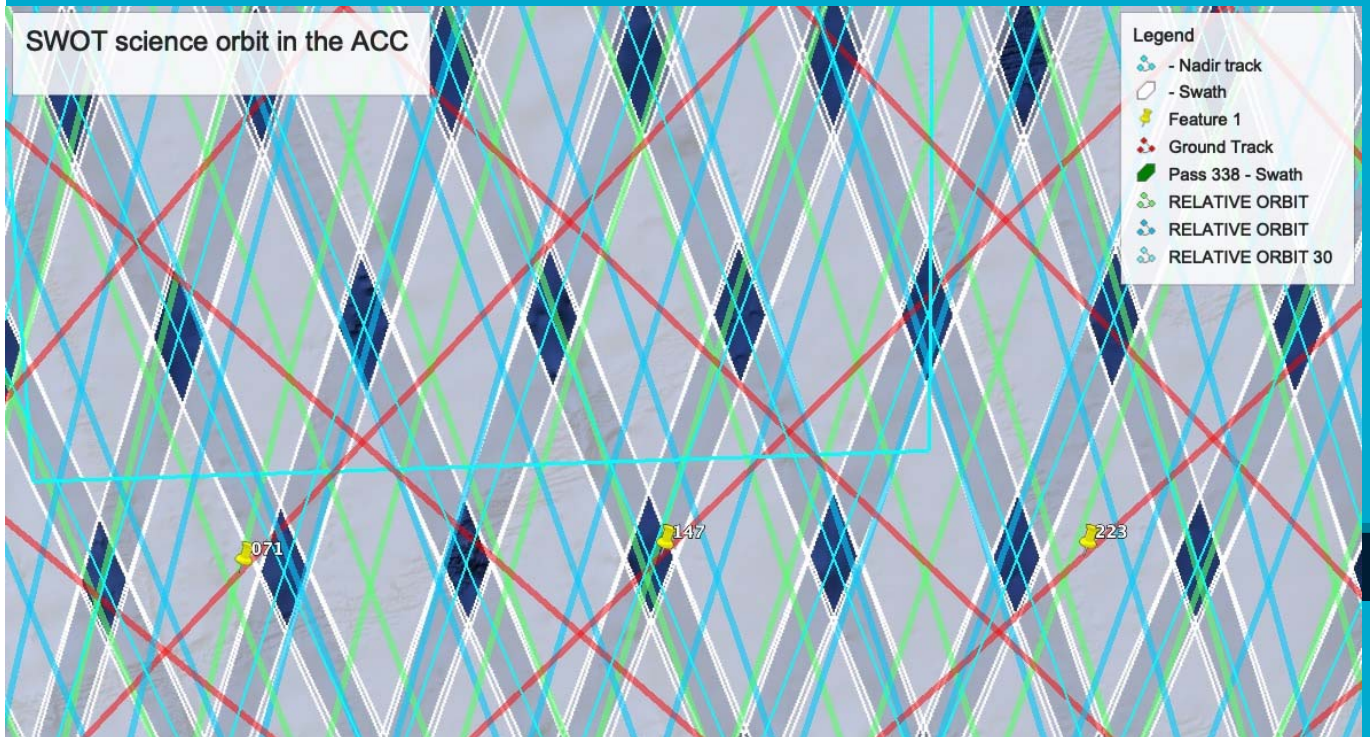

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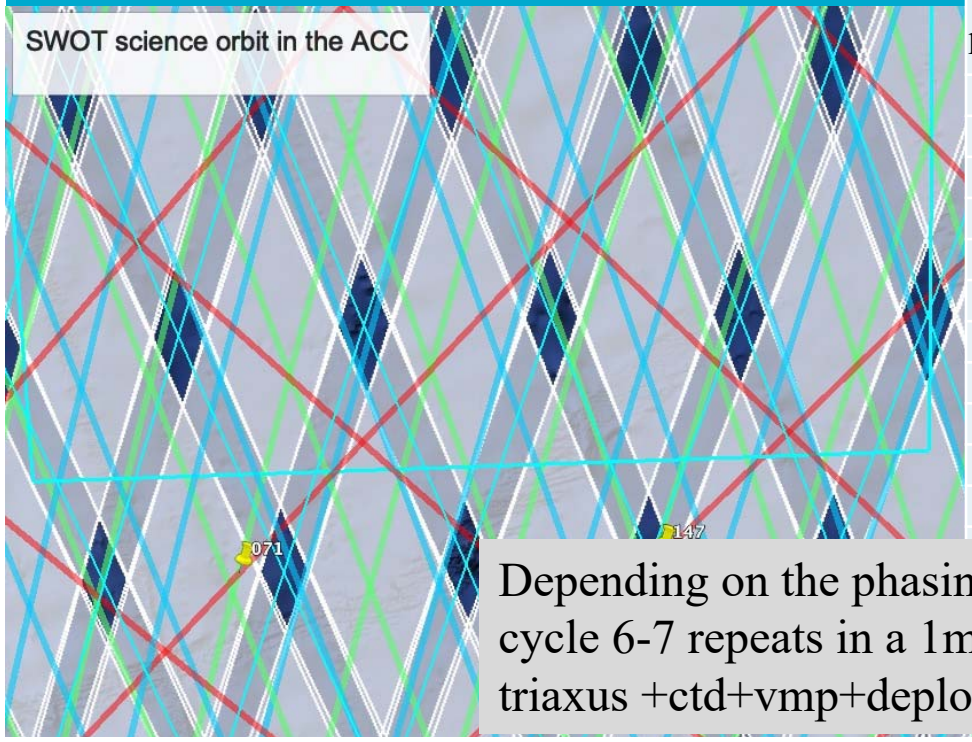


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Depending on the phasing of the cruise sampling with the swot repeat cycle 6-7 repeats in a 1month cruise. Which is about max possible with triaxus +ctd+vmp+deployments+weather…

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  - Sampling versus processes space-time
- Usual logistic constrains of southern ocean cruises

Target Oct 2022 :
- Benefit from SWOT regional dynamics description
  (the FSP would only get the classic low res altimetry maps)
- Benefit from the SWOT FSP statistics to refine/optimize the sampling plan

Summary

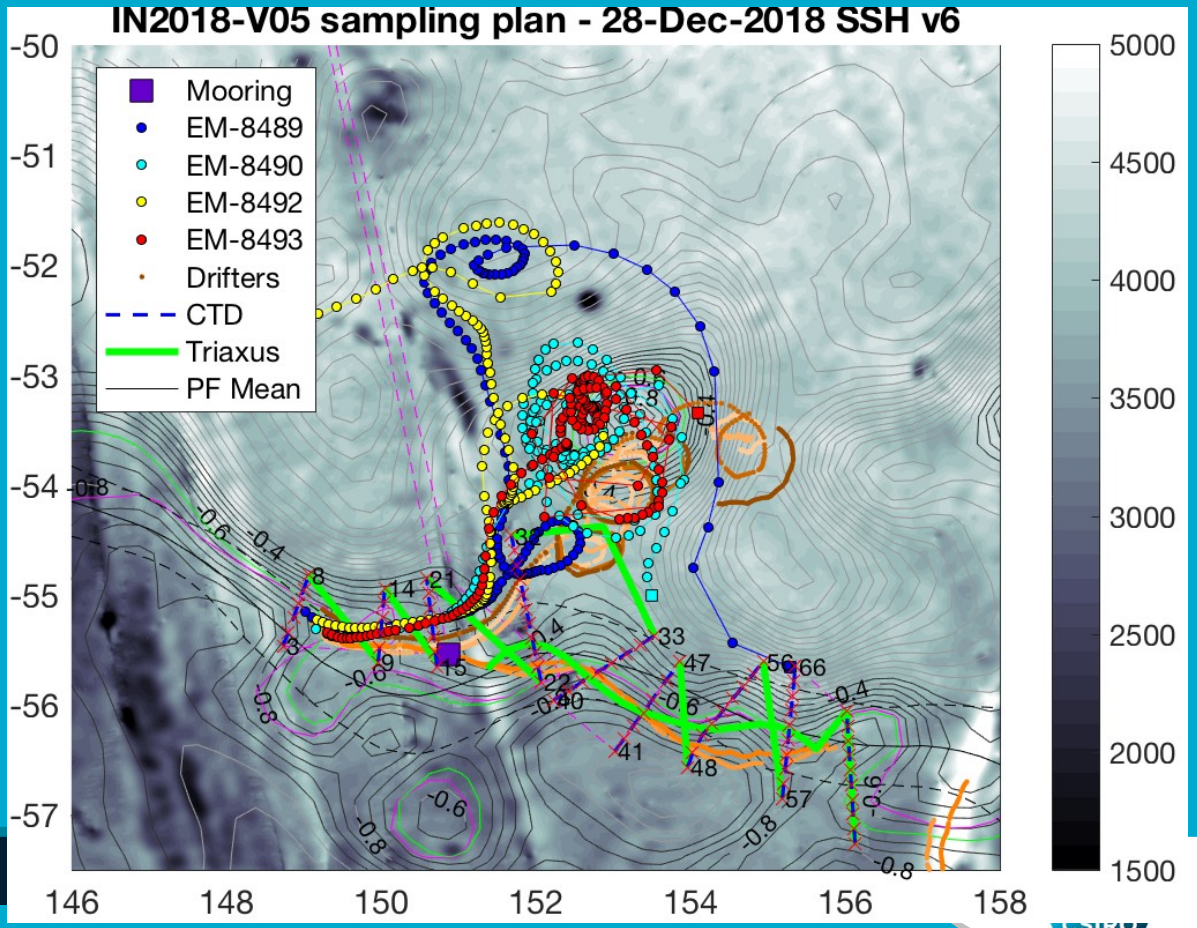
- We developed the capability to analyze cleaner spectra
  (internal tides, AR and noise level handling)
- Altimetry SSH conform to the QG/SQG in mesoscale, still limited in smaller scales
- Smaller scale processes observed in situ and show amplitudes large enough to be “seen” by SWOT
- 2022 cruise plan being developed to combine with / validate / use SWOT in the ACC to address Heat/Carbon transfers and smaller scale processes of the ACC dynamics.

***Thank you***


CSIRO

- Interesting Meandering target with sub-mesoscale activity

Oct-Nov 2018 Cruise observations

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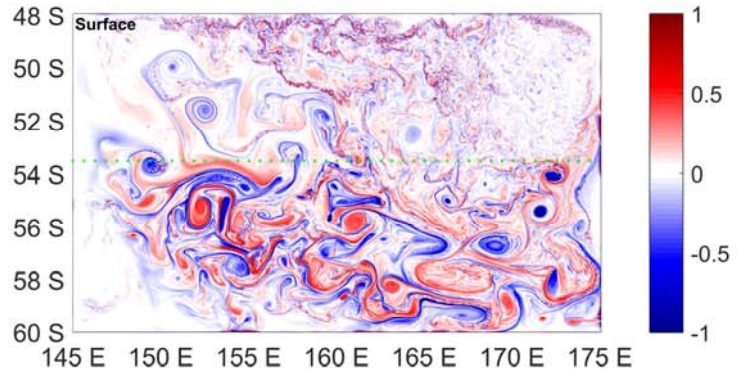
Surface
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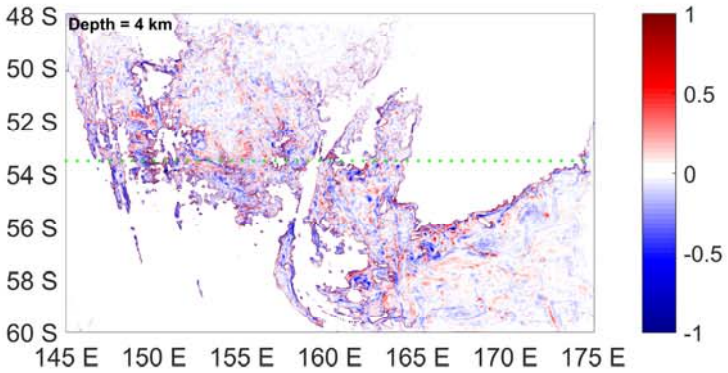
50 S
52 S
54 S
56 S
58 S
60 S
145 E
150 E
155 E
160 E
165 E
170 E
175 E
1
0.5
0
-0.5
-1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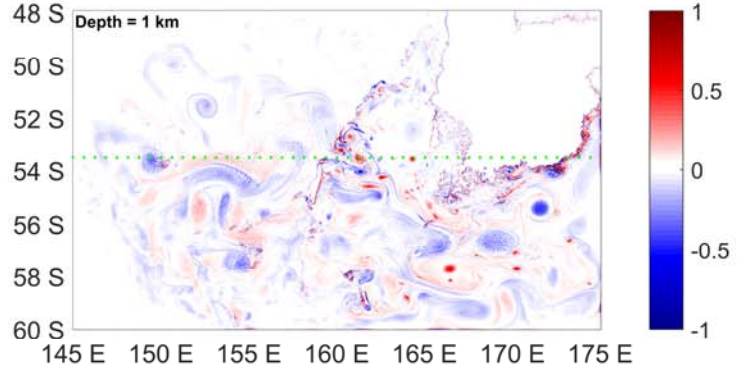
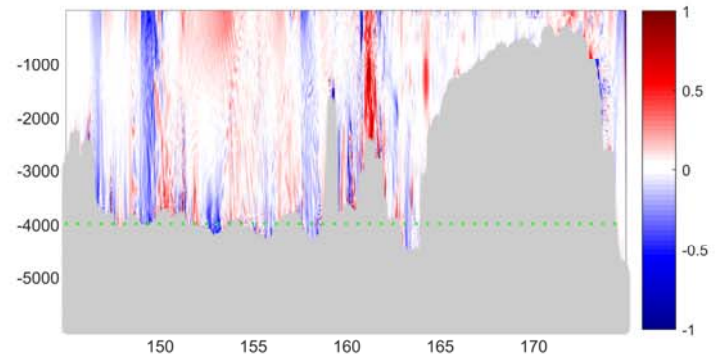
50 S
52 S
54 S
56 S
58 S
60 S
145 E
150 E
155 E
160 E
165 E
170 E
175 E
1
0.5
0
-0.5
-1


Depth = 1 km
48 S
50 S
52 S
54 S
56 S
58 S
60 S
145 E
150 E
155 E
160 E
165 E
170 E
175 E
1
0.5
0
-0.5
-1


-1000
-2000
-3000
-4000
-5000
150
155
160
165
170
1
0.5
0
-0.5
-1