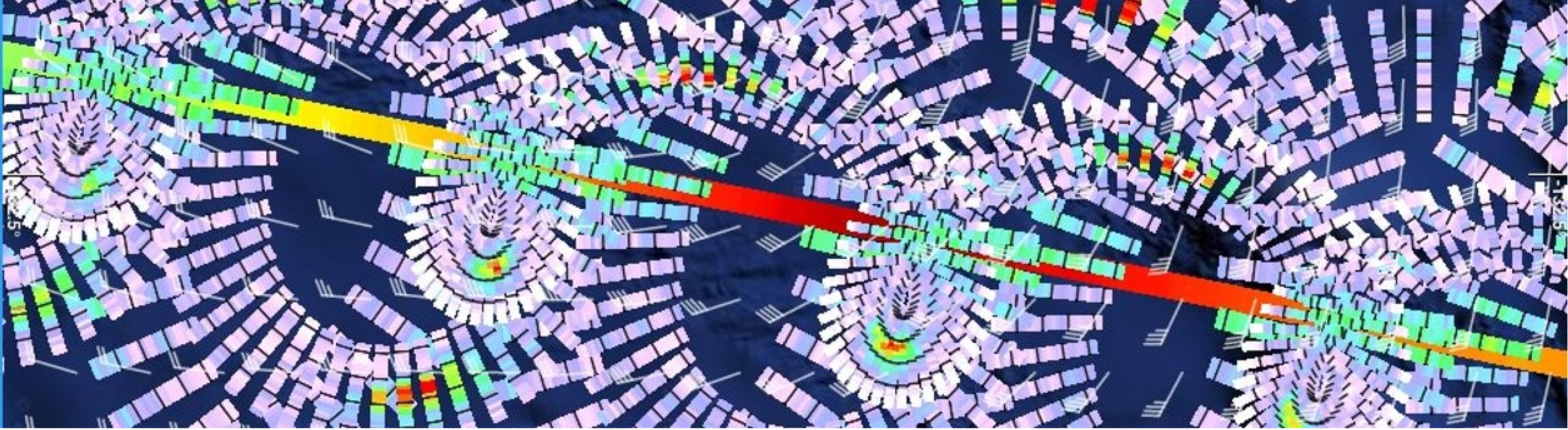


SWIM ocean waves spectra

Illustration of performances

C. Peureux[1], A. Ollivier[1], S. Guillot[1], C. Tourain[2]

and CLS Teams

1 CLS – Collecte Localisation Satellites

2 cnes

cpeureux@groupcls.com

16/03/2021
09:45

Outline

1. Introduction
2. Diagnostics
3. Results (overall and case studies)

Introduction

Identify issues in data provision

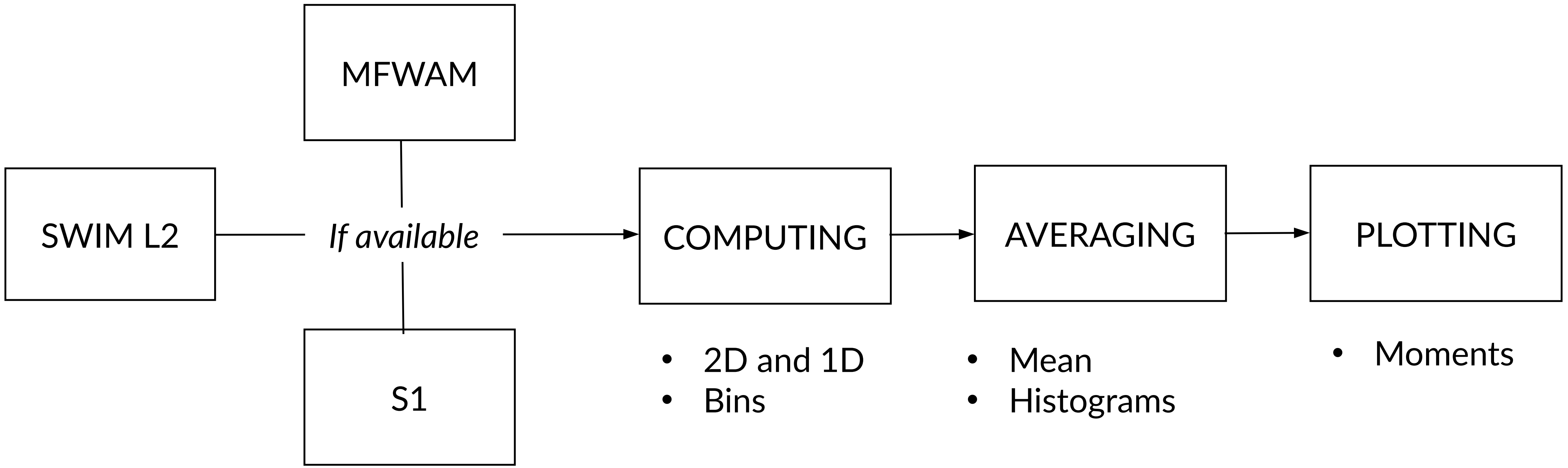
Qualify L2 processing

Promote SWIM data

based on simple statistics over wave spectra (averages, bins, etc ...)

- Develop a generic tool (not problem specific)
- Ingesting large amounts of L2 spectra
- Choose relevant diagnostics

Diagnostics – overview (current state)



- 2D and 1D
- Bins

- Mean
- Histograms

- Moments

Diagnostics - computing

SWIM L2

Slopes spectra
6, 8, 10° and combined
posneg =0,1 distinguished
+partitions

Colocated spectra

MFWAM model
Sentinel 1 SAR
when available
(<1.5 hours, <100 km)

Symmetric elevation spectrum

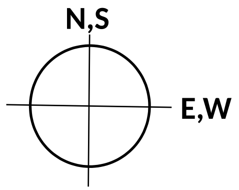
$$E^S(k,\phi) = E(k,\phi) + E(k,\phi+\pi)$$

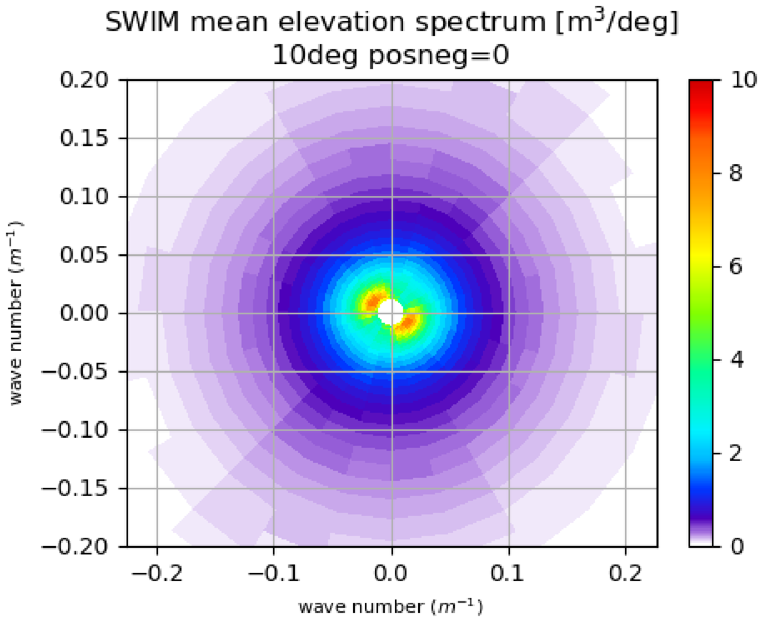
+ Flagging
+ H_s, U_{10} from ECMWF

link

Diagnostics - averaging

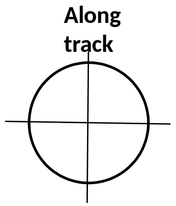
$$\langle E^S(k,\phi)\rangle$$

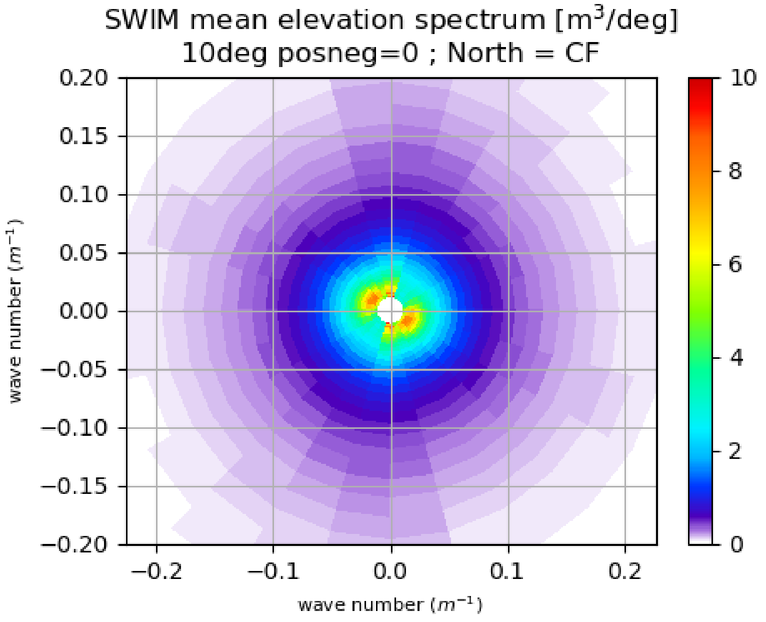




Raw data

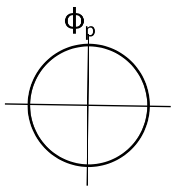
$$\langle E^S(k,\phi)\rangle$$

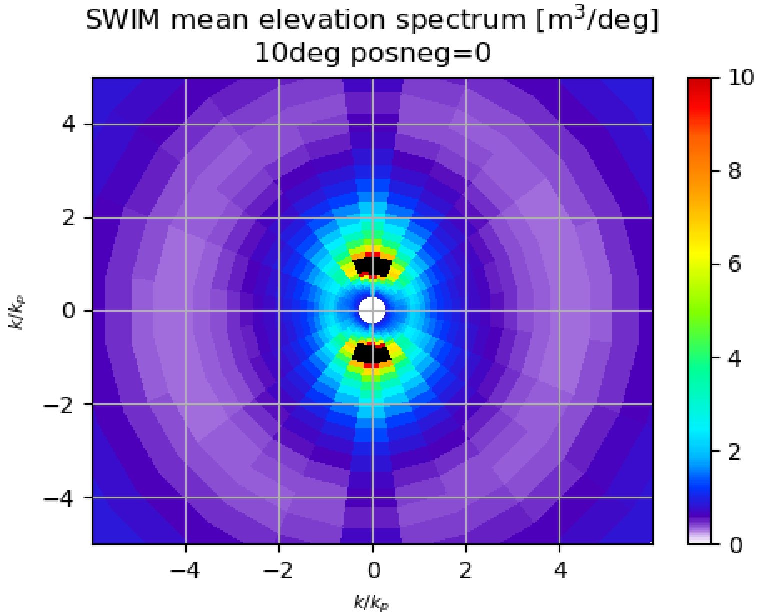




Cone Fatal

$$\langle E^S(k/k_p,\phi-\phi_p)\rangle$$





Geophysical signal

+ detailed by sea-state

Diagnostics - plotting

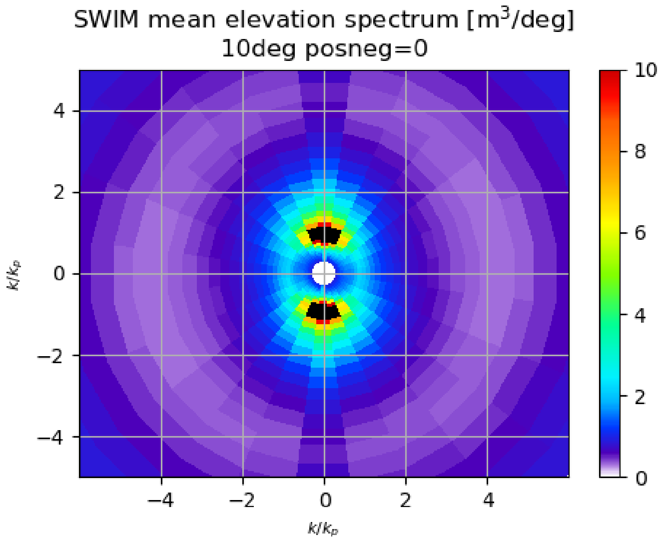
Dimensionality ←

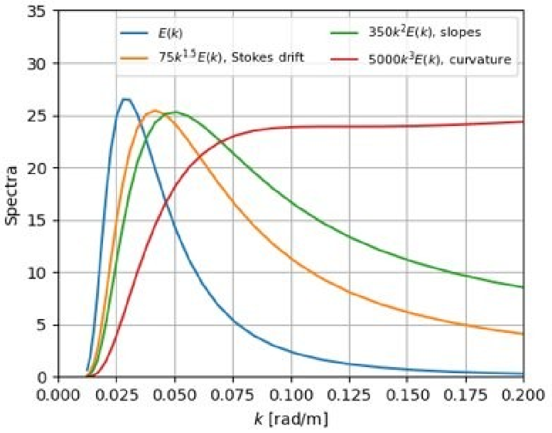
Mean 2D spectra

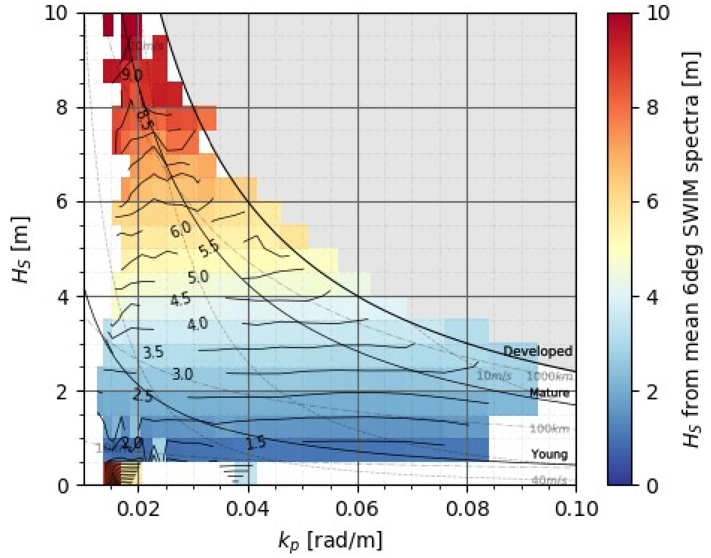
Mean 1D spectrum moments

Mean 0D moments

Ease of display & interpretation →



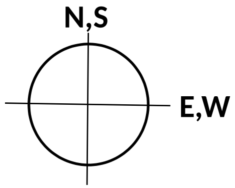




Overall performances

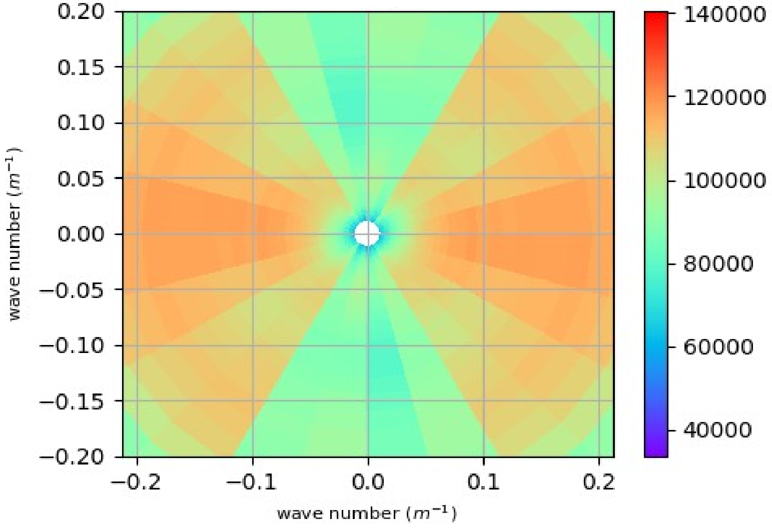
Worldwide data from 01/01/2021 to 01/03/2021

Valid points histogram

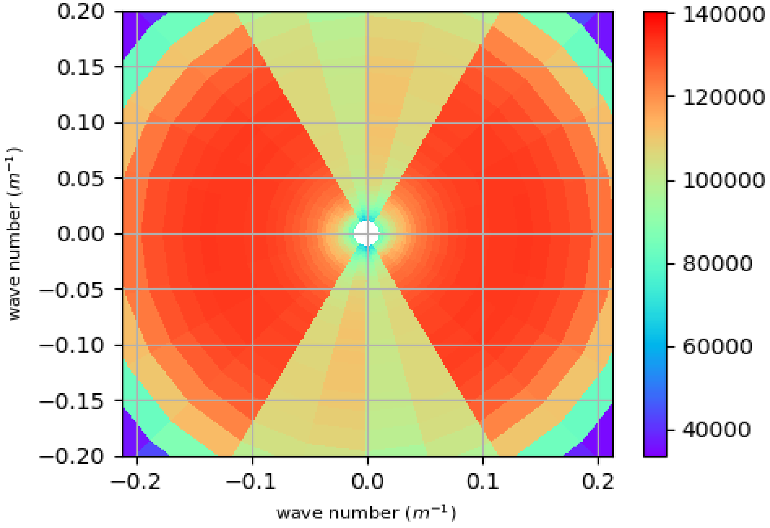


Flagged data :
6°>8°>10°>combined

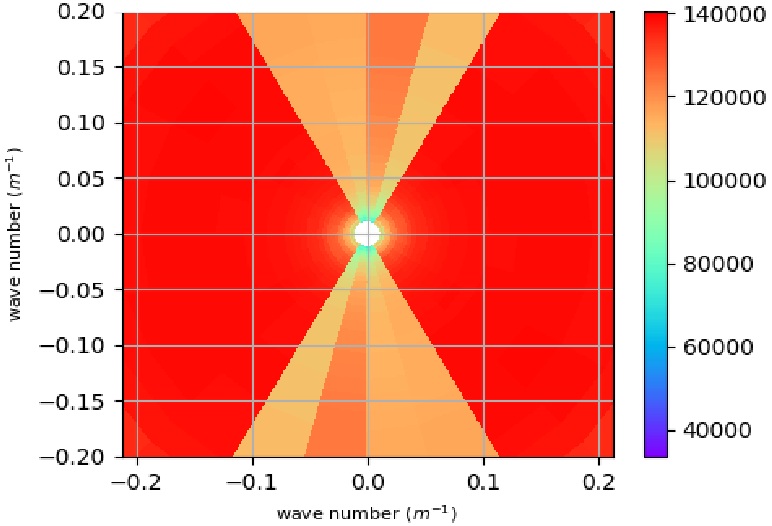
SWIM 6°



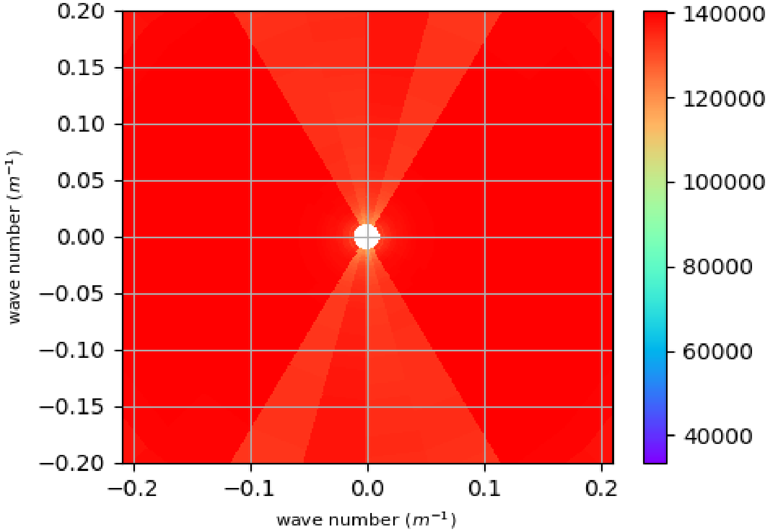
SWIM 8°



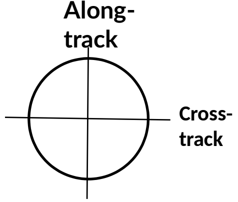
SWIM 10°



SWIM combined



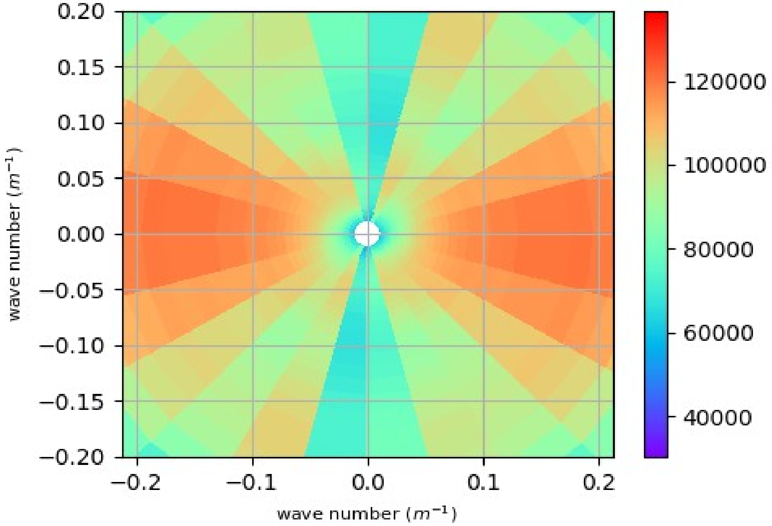
Valid points histogram



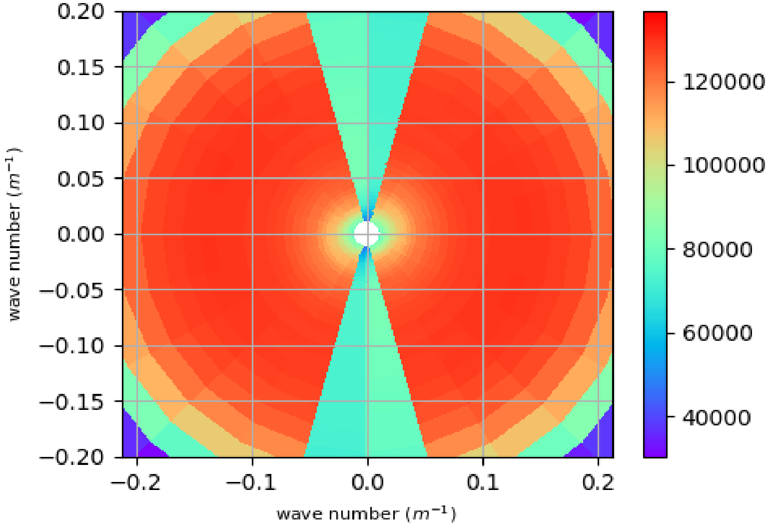
Flagged data :
6°>8°>10°>combined

Mostly located around
the along-track direction

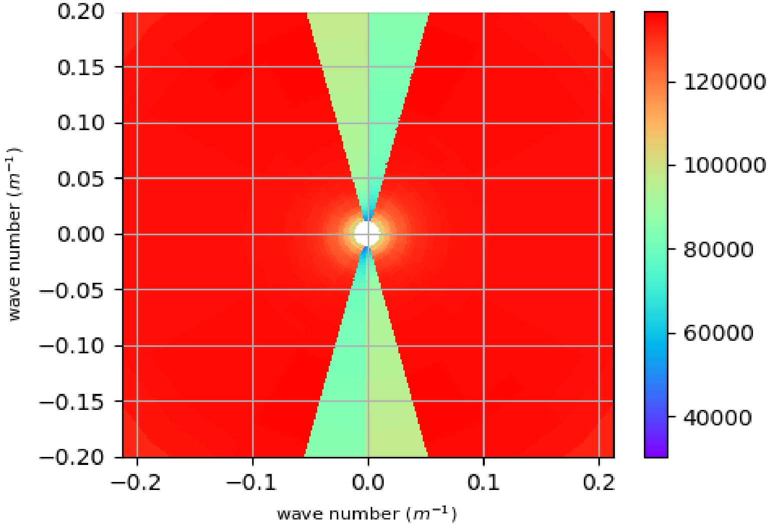
SWIM 6°



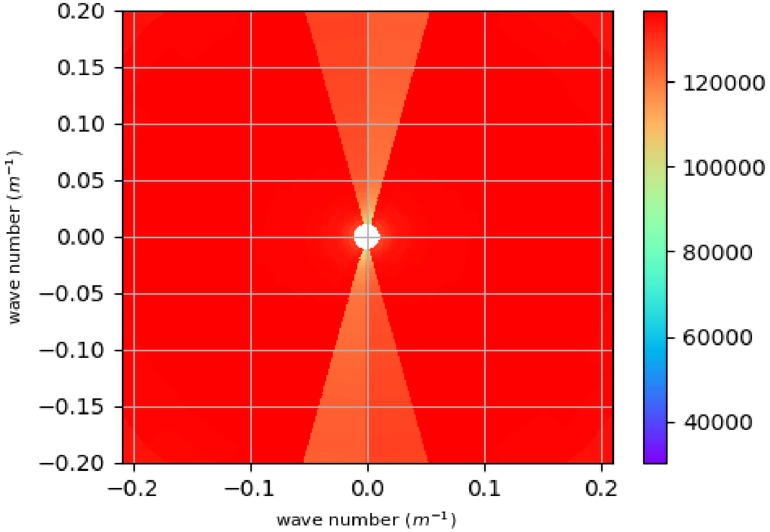
SWIM 8°



SWIM 10°

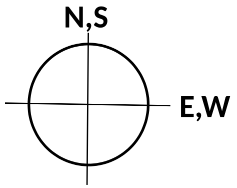


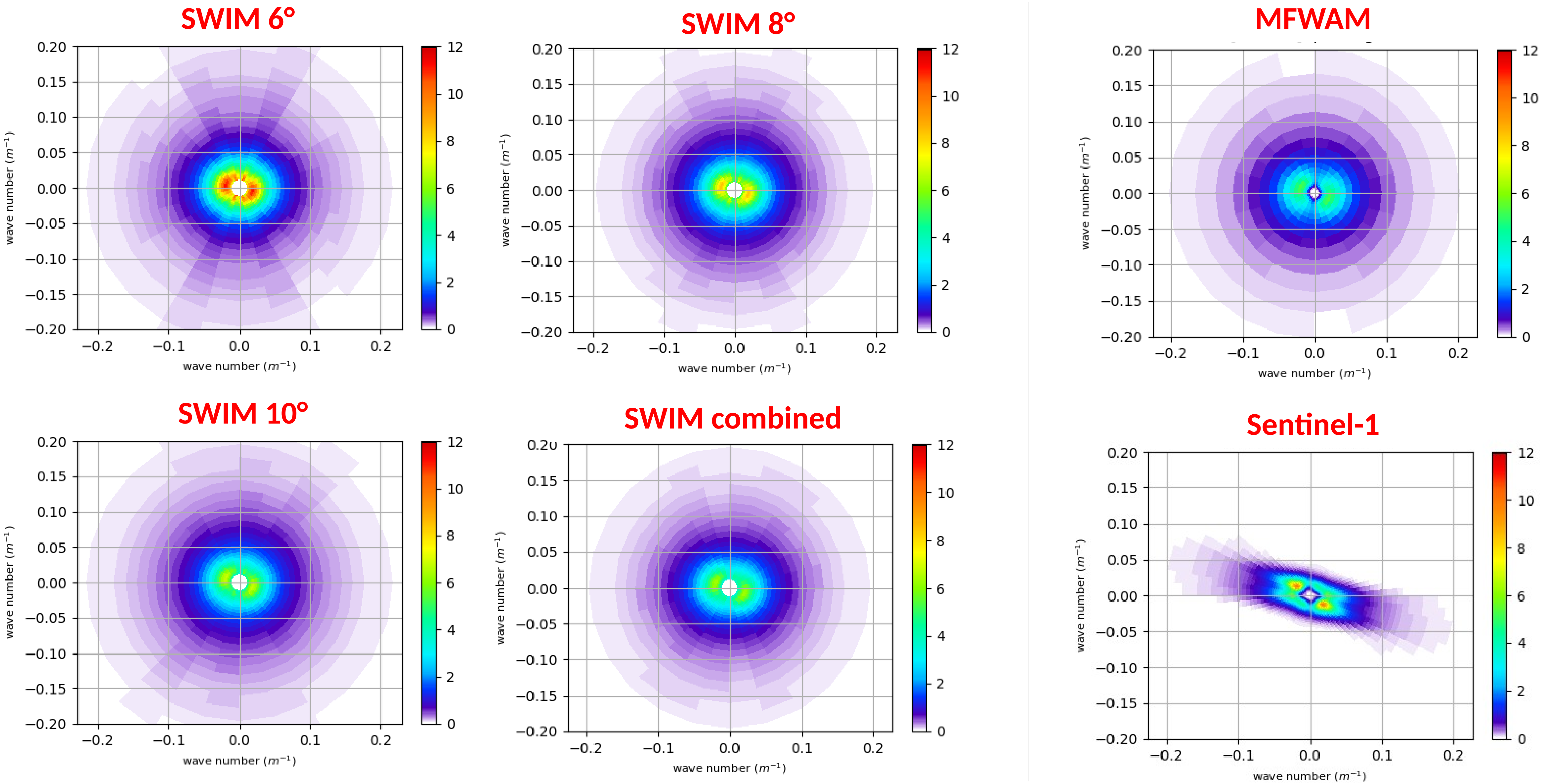
SWIM combined



Mean 2D spectra

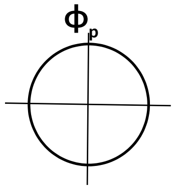
$$\langle E^S(k, \phi) \rangle$$



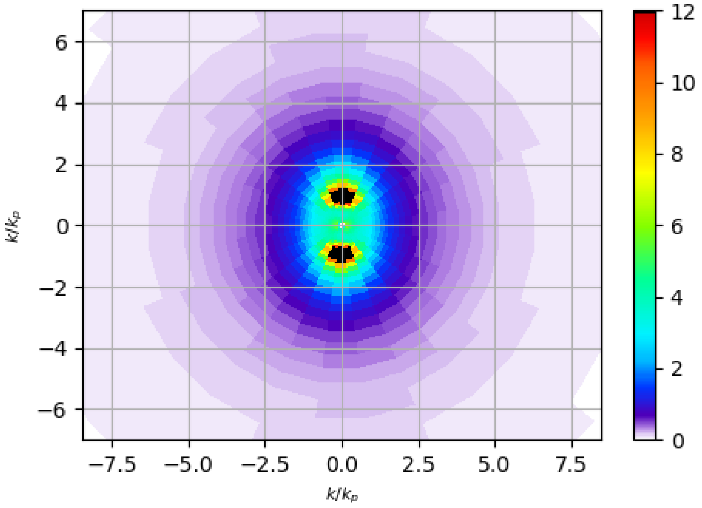


Mean 2D spectra

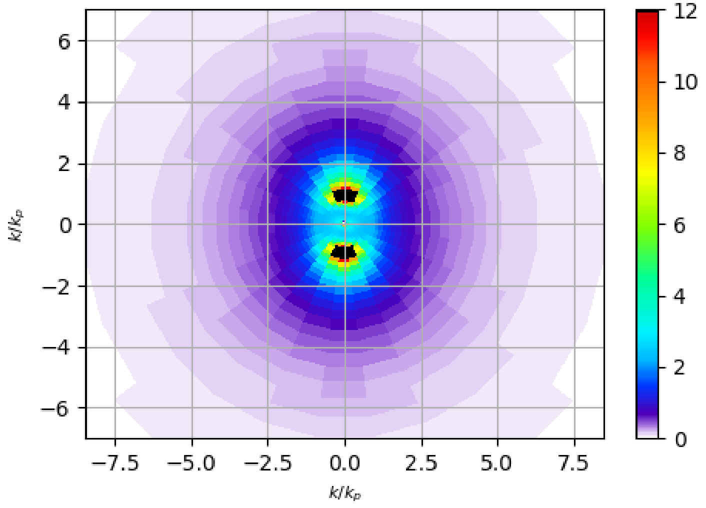
$$\langle E^S(k/k_p, \phi - \phi_p) \rangle$$



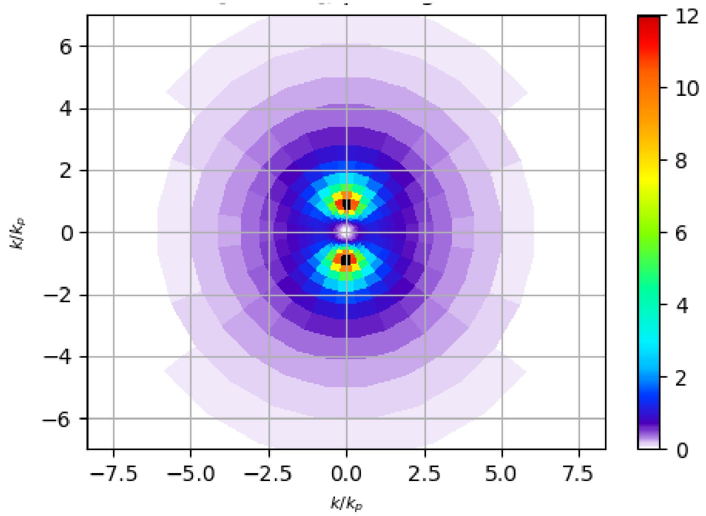
SWIM 6°



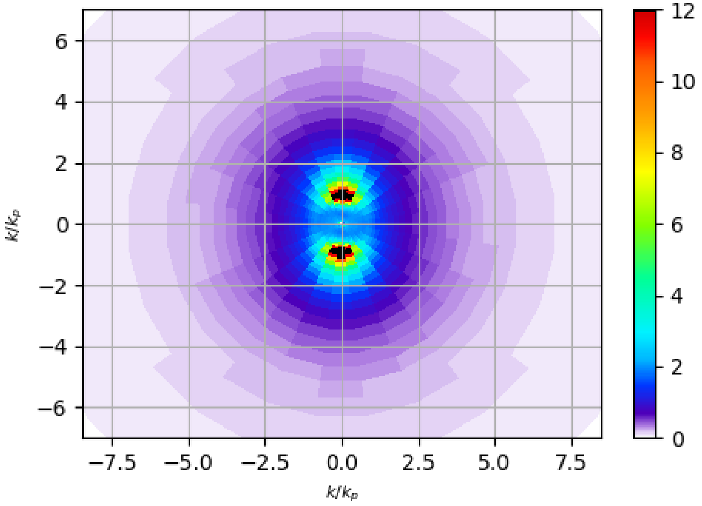
SWIM 8°



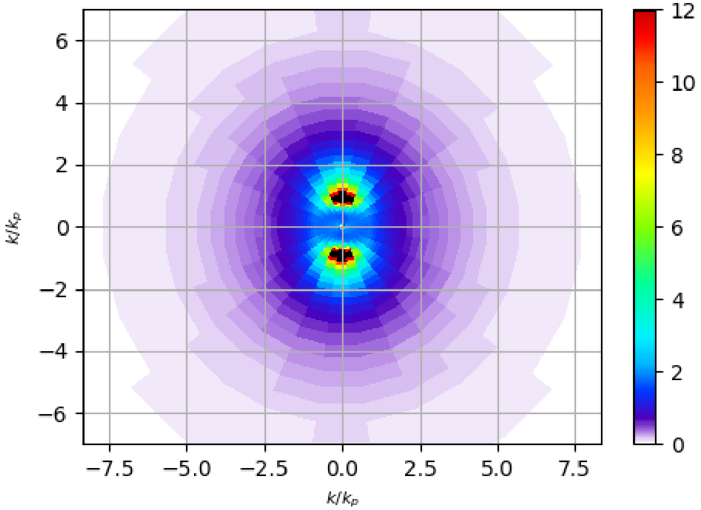
MFWAM



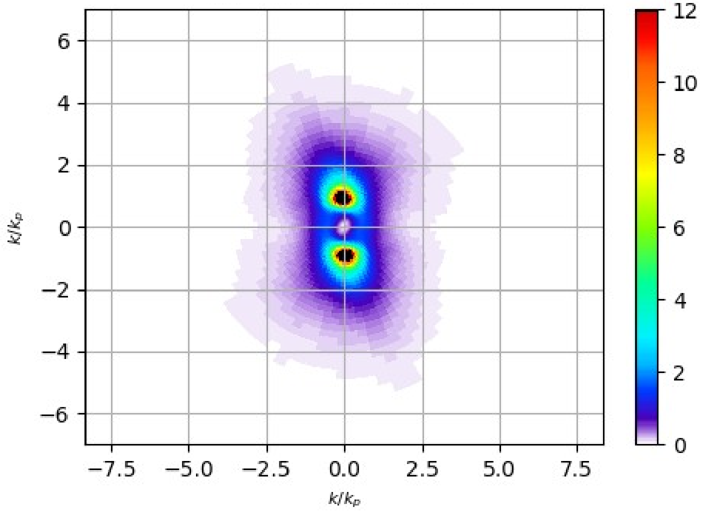
SWIM 10°



SWIM combined



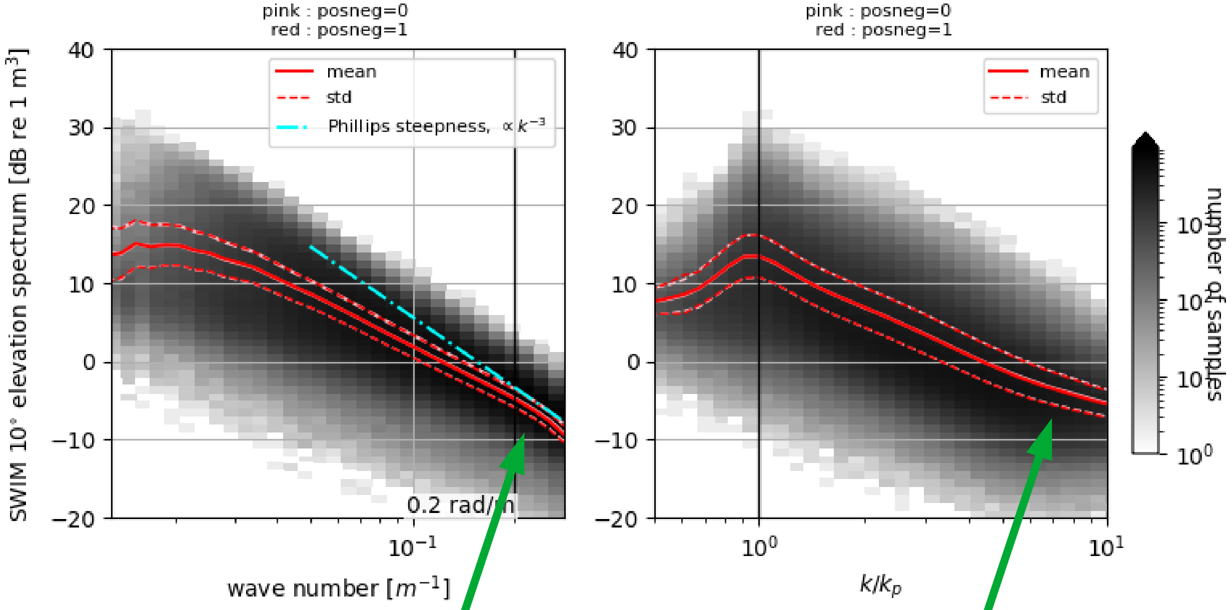
Sentinel-1



1D spectra

$$E(k) = \frac{1}{2}\int_0^{2\pi} E^S(k,\phi)d\phi\,[\mathrm{m}^3]$$

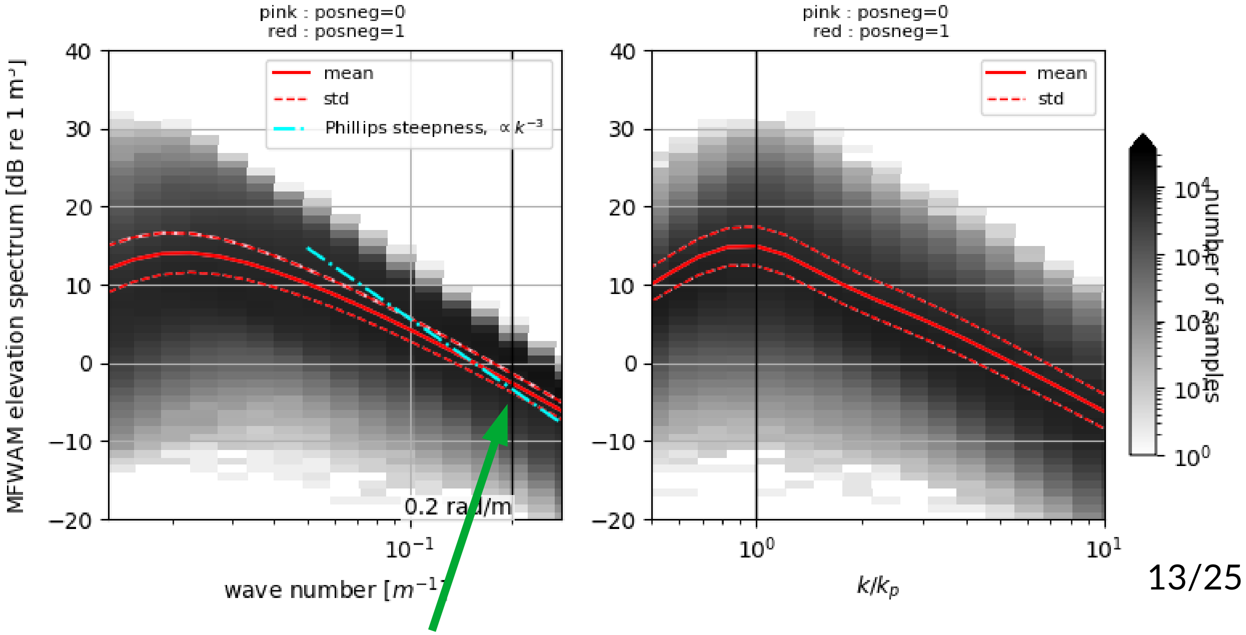
SWIM 10°



Short waves generally less energetic than MFWAM

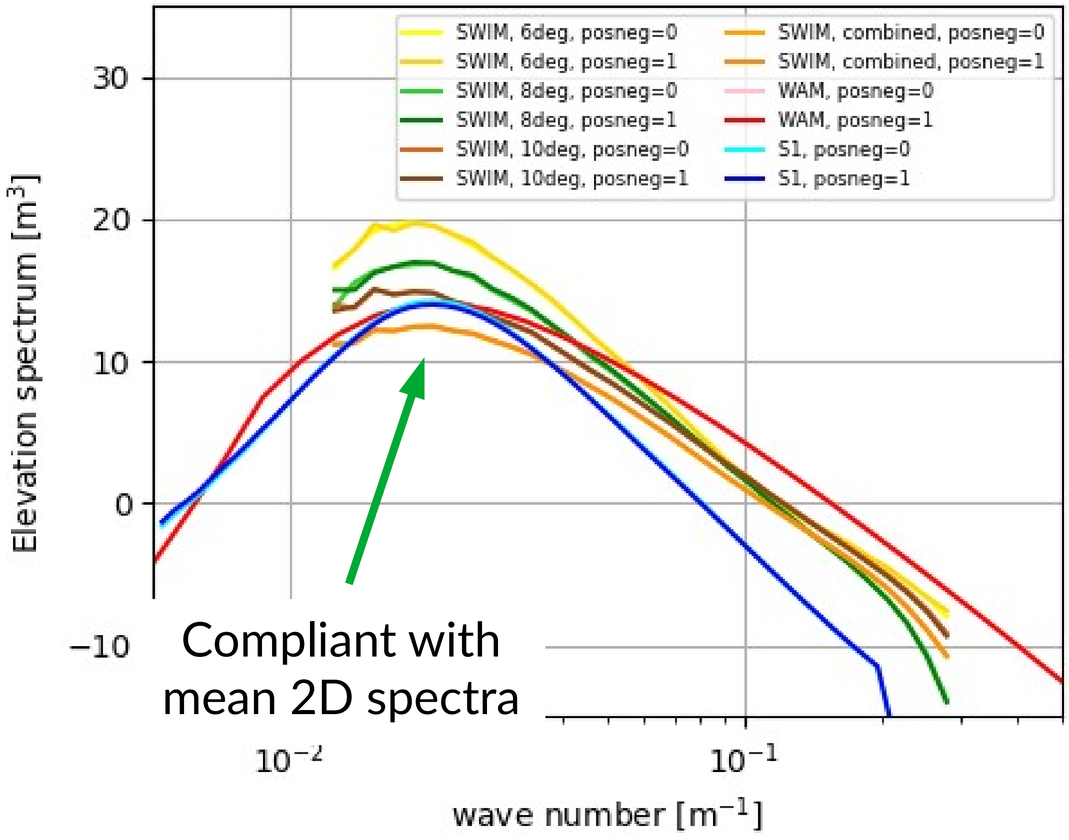
Above 4-5 k_p : mostly noise

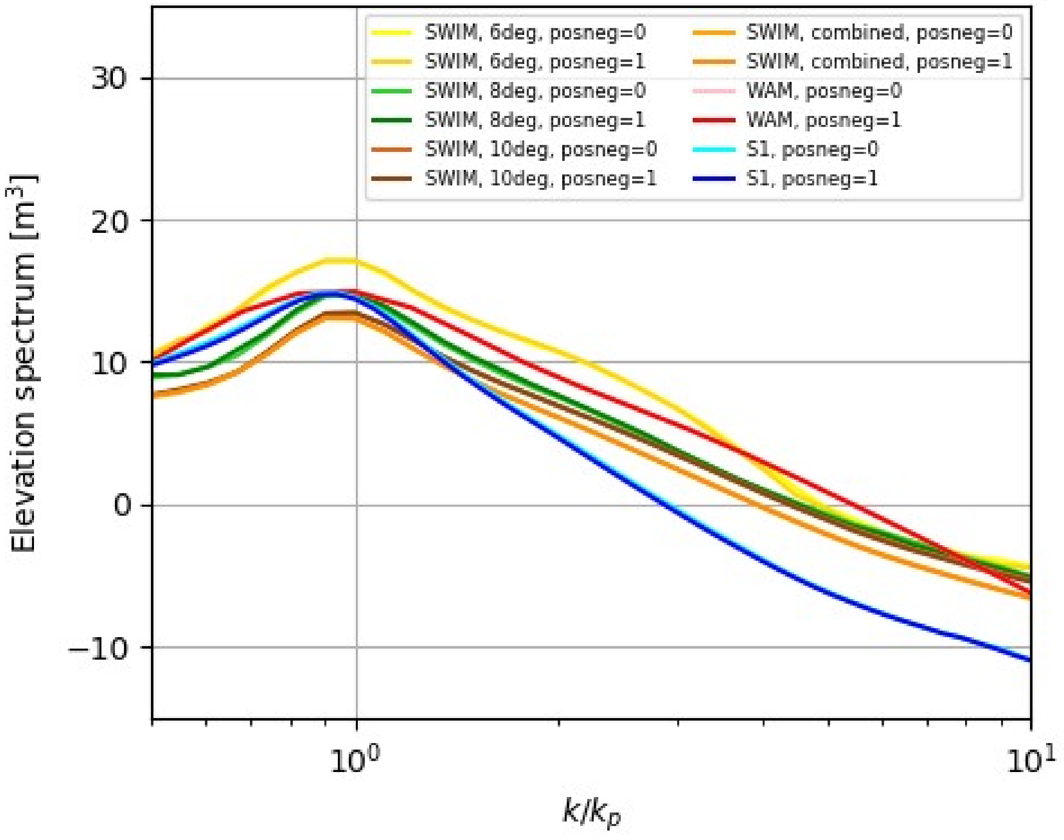
MFWAM



Mean 1D spectra overlay

$$E(k) = \frac{1}{2}\int_0^{2\pi} E^S(k,\phi)d\phi\,[\mathrm{m}^3]$$



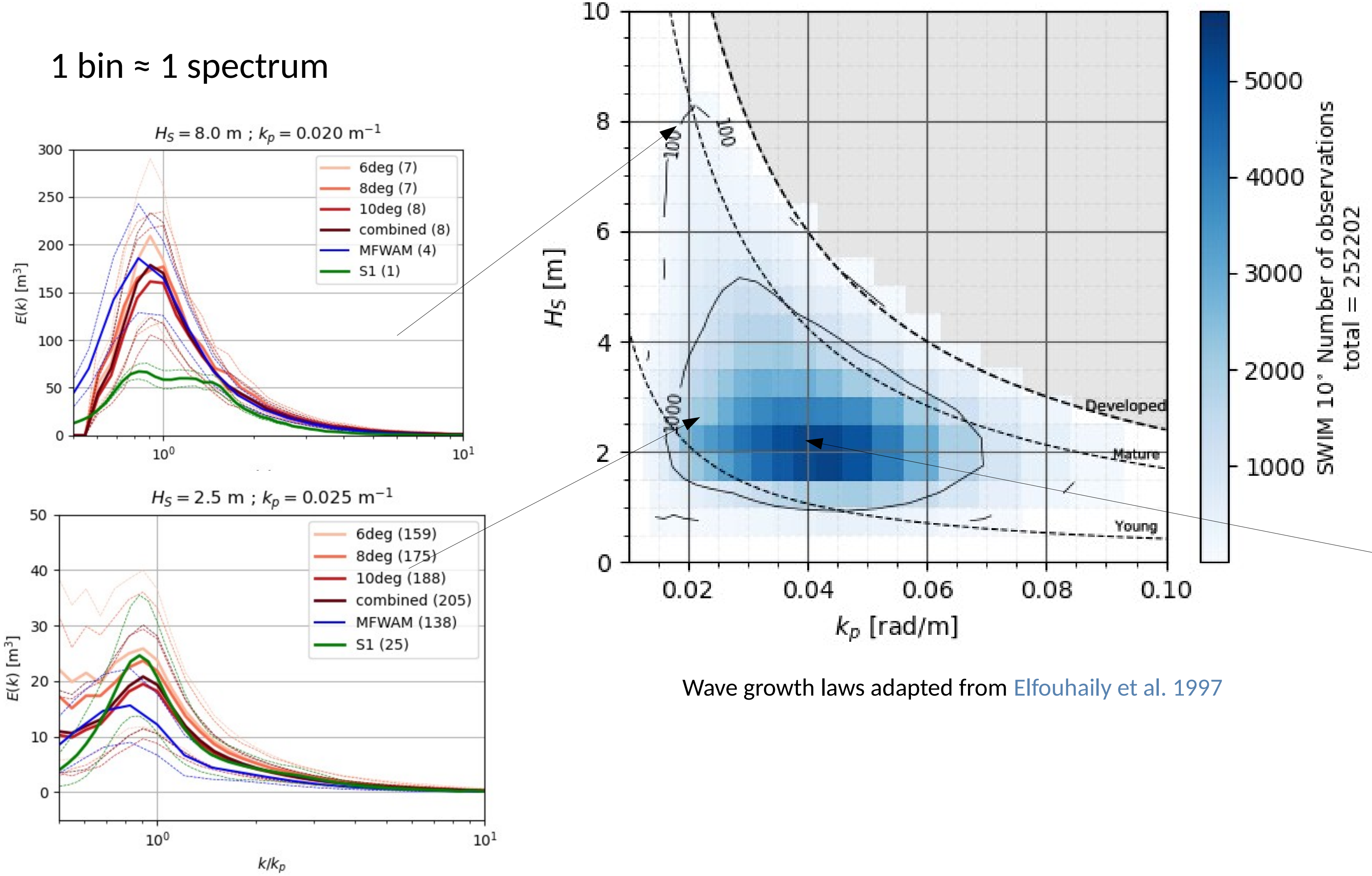


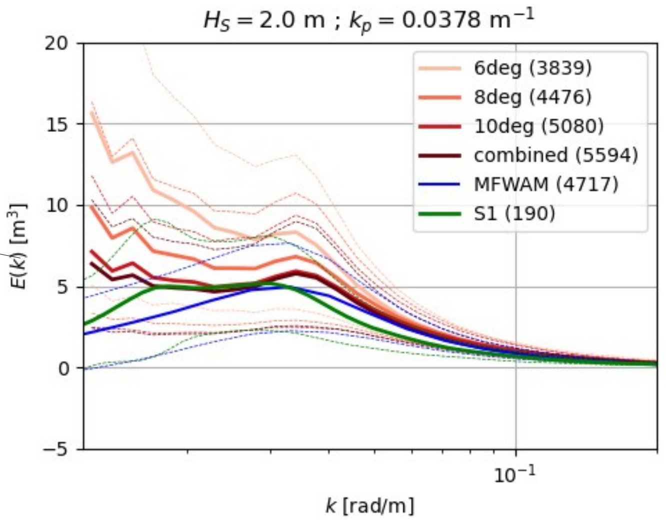
Abacus - principle

- Detail by sea-state
- Abstract cartography

1 bin ≈ 1 spectrum

SWIM – H_S, k_p abacus



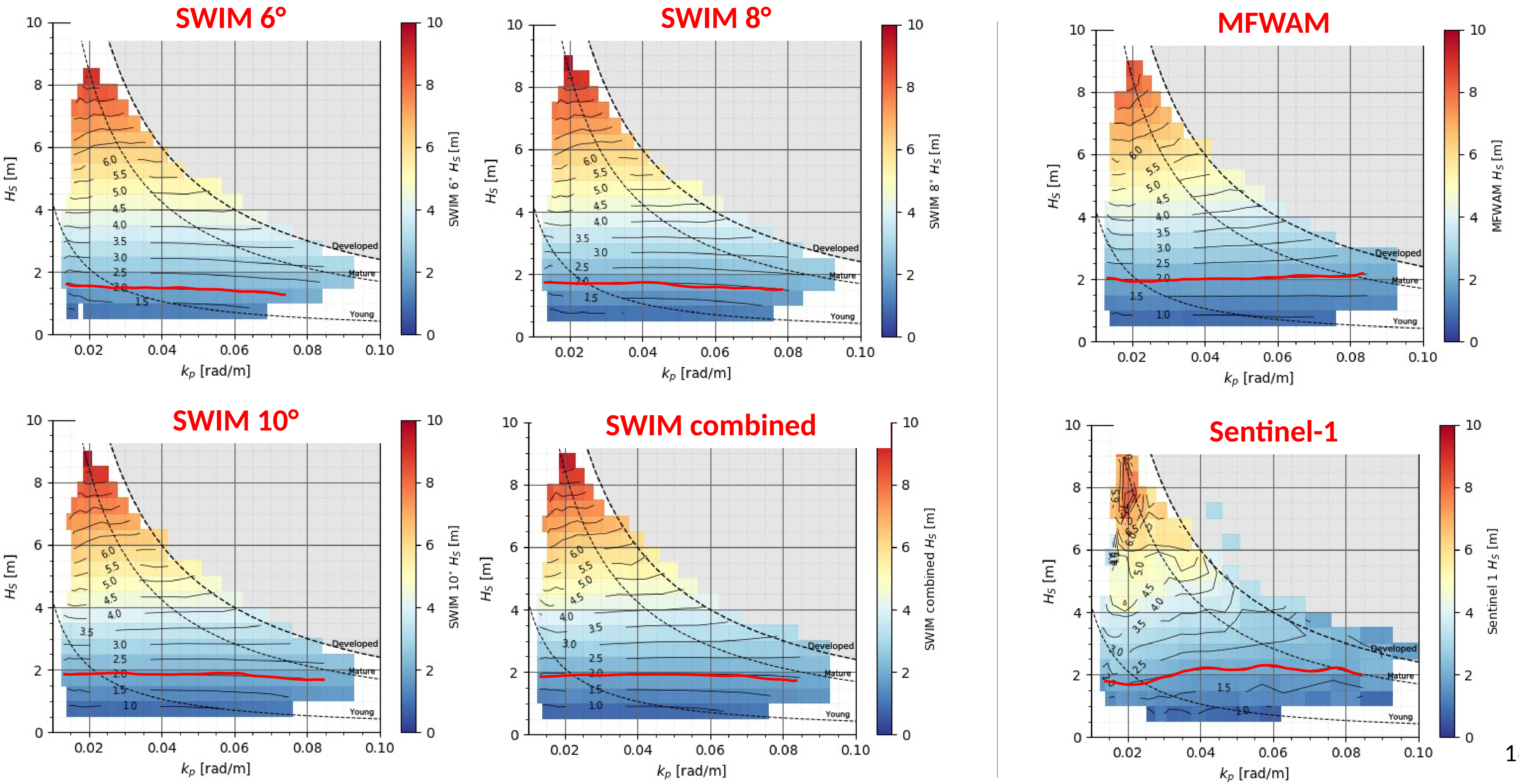


Wave growth laws adapted from Elfouhaily et al. 1997

Pseudo H_s abacus

$$4\sqrt{\int^{0.2\mathrm{rad/m}} dk\langle E(k)\rangle}$$

Compliant with mean 2D spectra

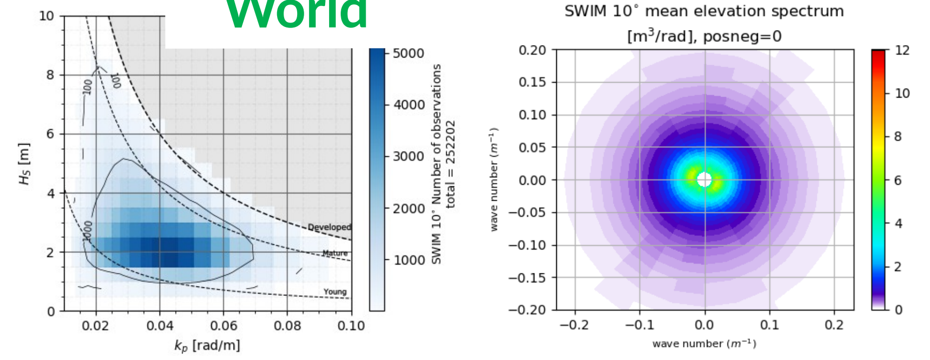


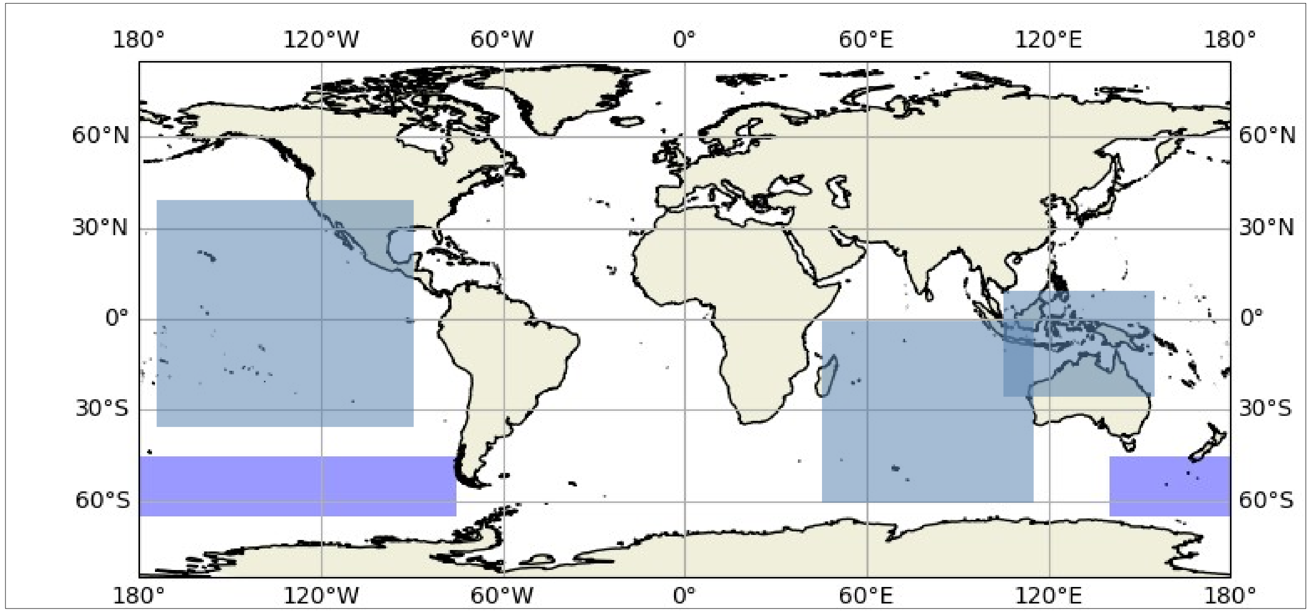
Specific addresses

Regional studies

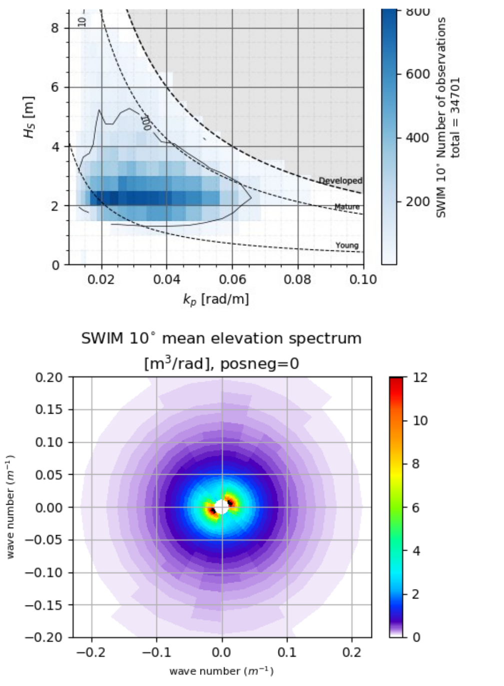
SWIM 10°

World

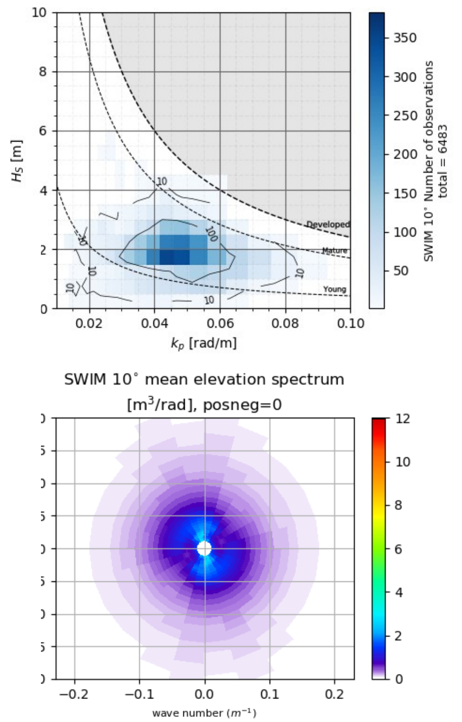




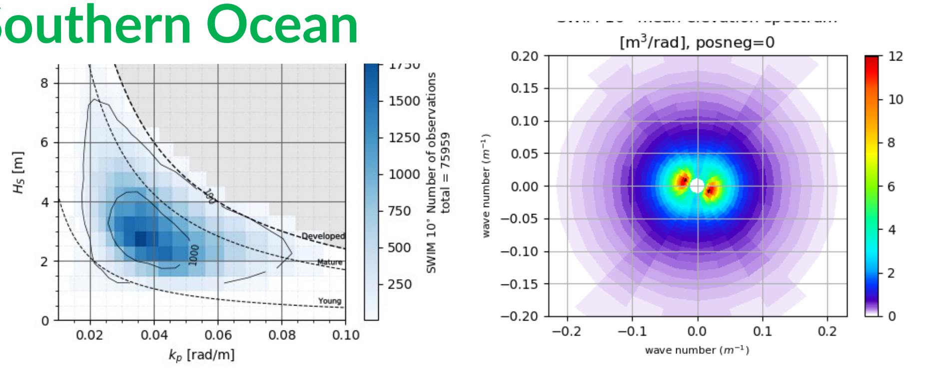
North Pacific



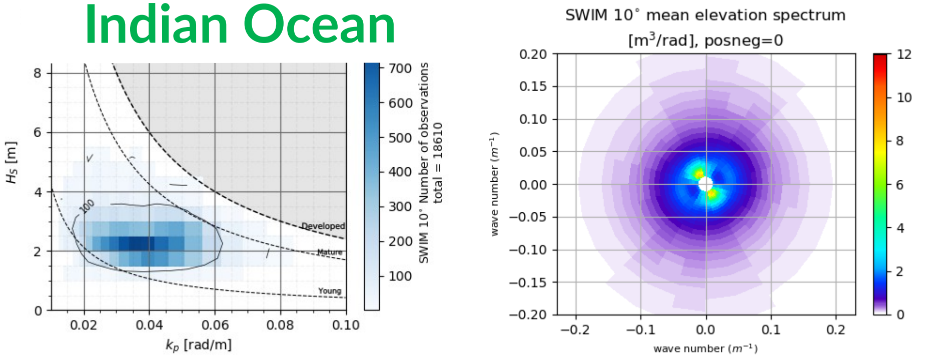
SE Asia



Southern Ocean



Indian Ocean

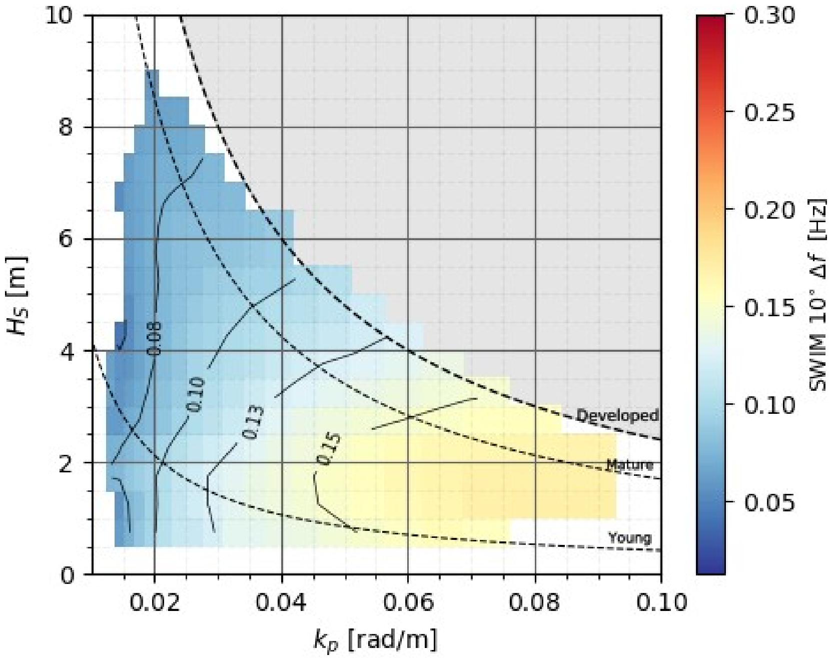


Frequency width

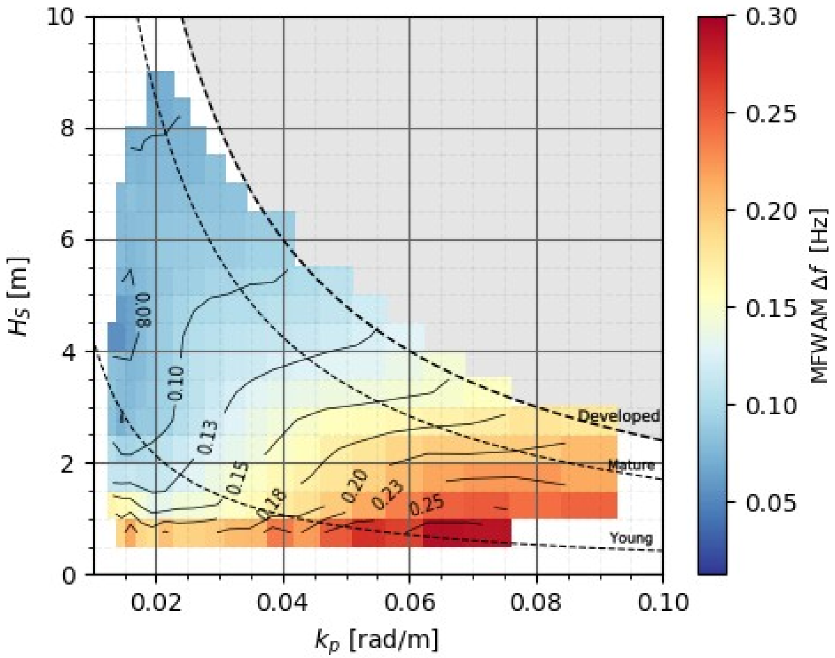
$$\Delta f = \frac{\left[\int E(f)df\right]^2}{\int E^2(f)df}$$

→ D. Hauser presentation

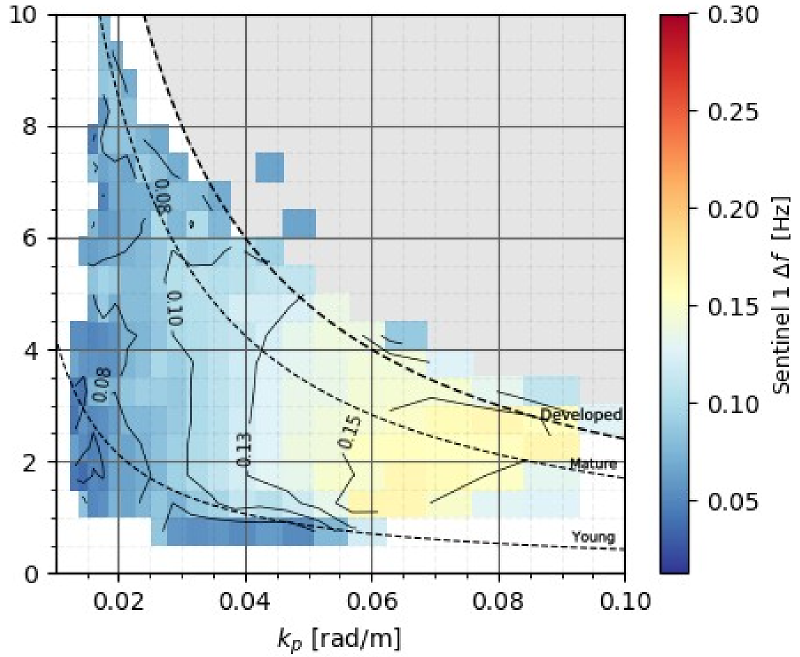
SWIM 10°



MFWAM



Sentinel-1



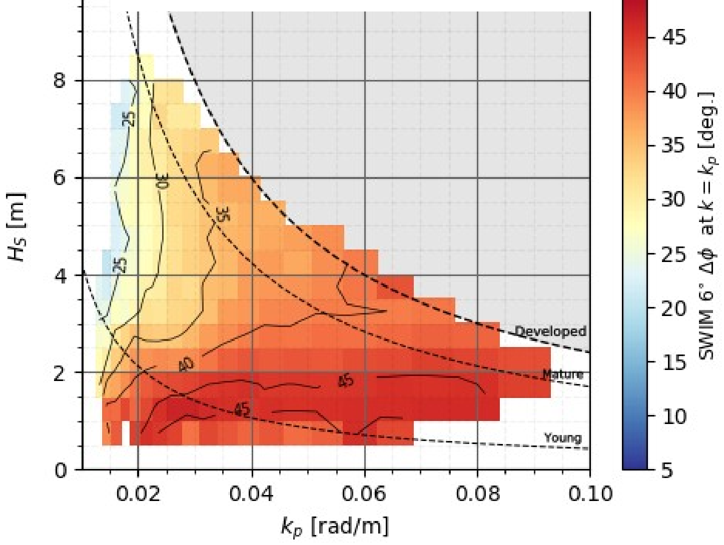
SWIM markedly more peaked than MFWAM, especially at low sea-states

Directional spread at peak

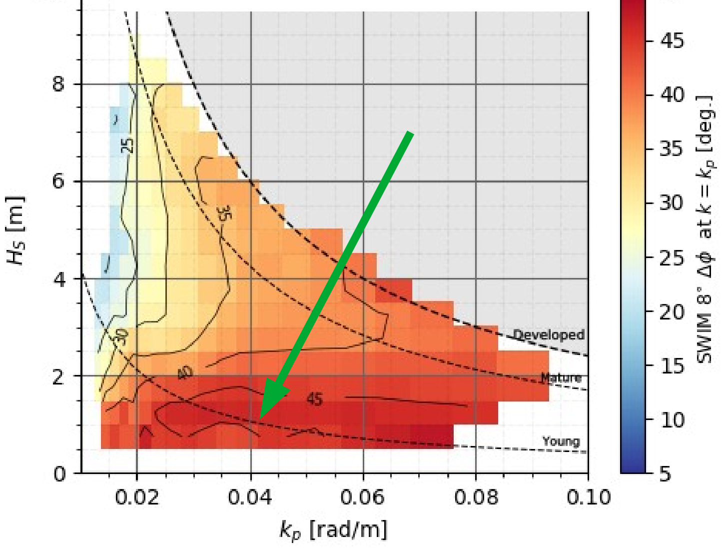
$$\sigma_1 = \sqrt{2\left(1-\sqrt{a_1^2+b_1^2}\right)}$$

→ D. Hauser presentation

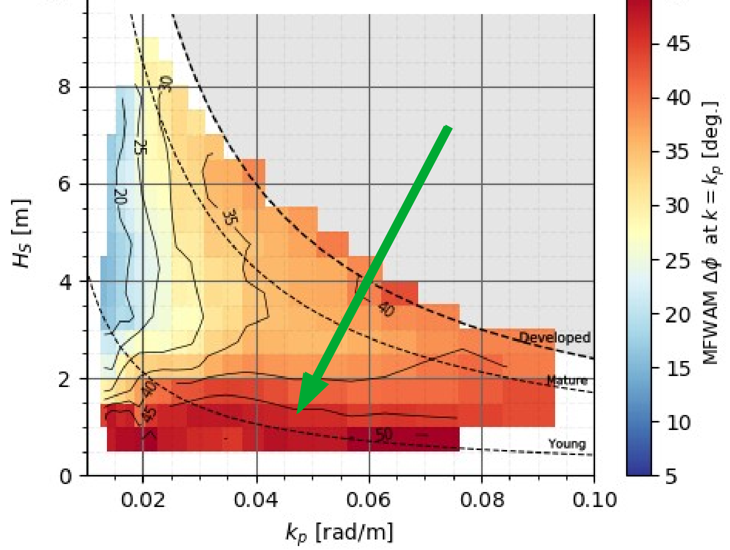
SWIM 6°



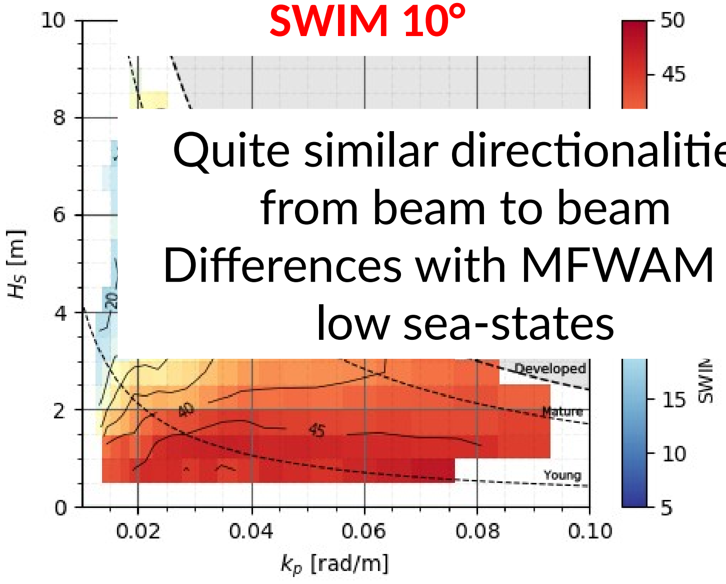
SWIM 8°



MFWAM

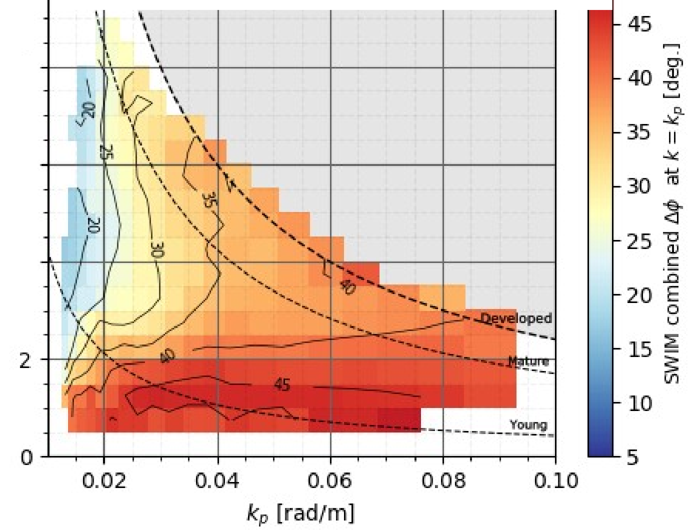


SWIM 10°

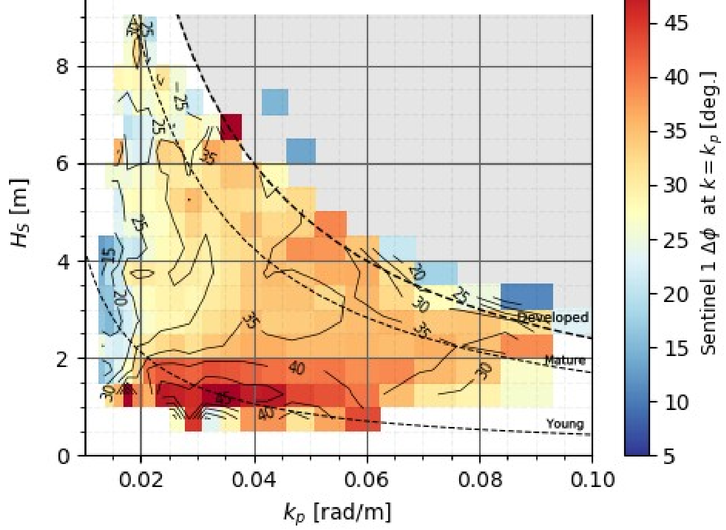


Quite similar directionalities from beam to beam
Differences with MFWAM at low sea-states

SWIM combined



Sentinel-1



MTF1 vs MTF3

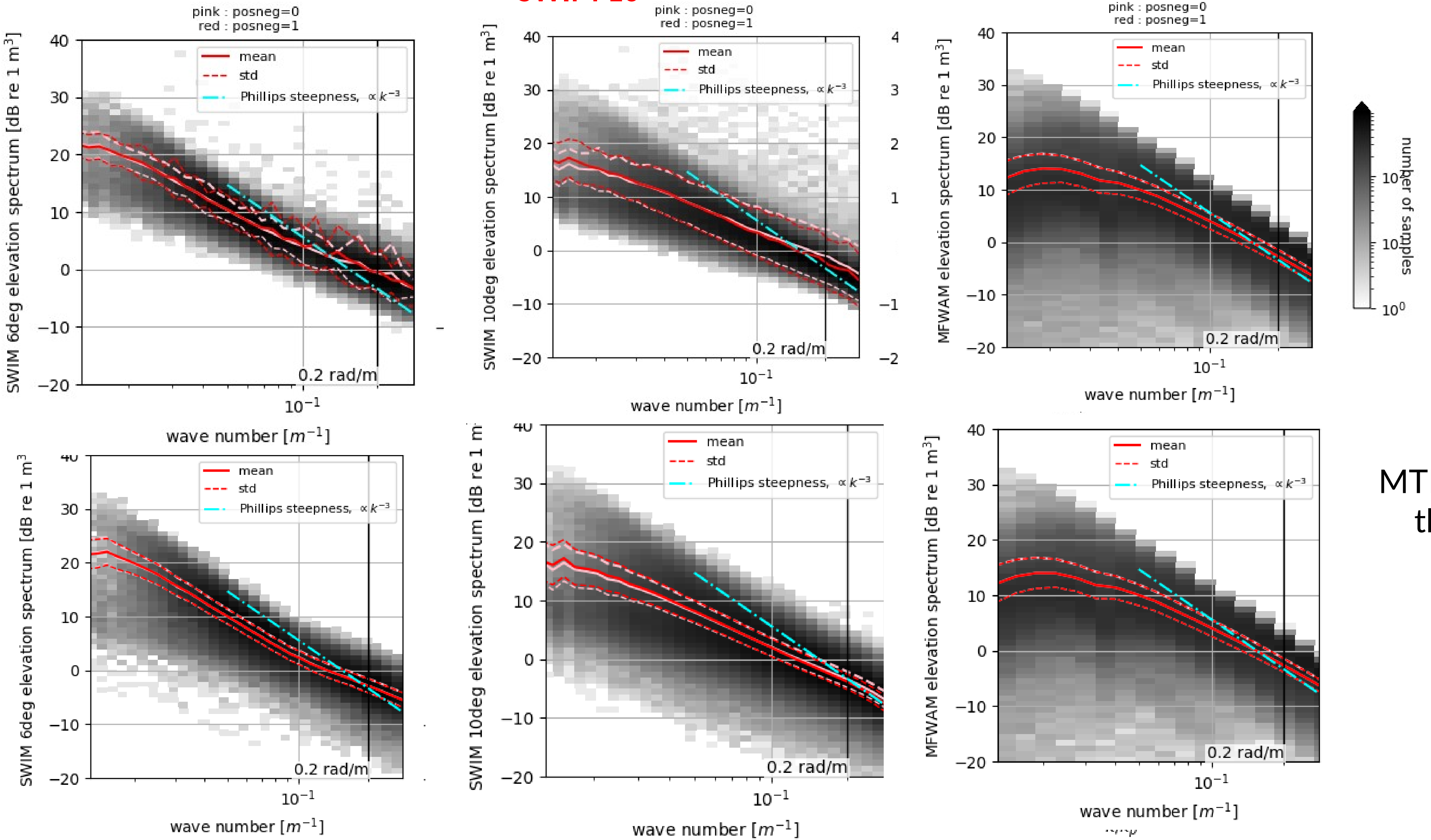
$$E(k) = \frac{1}{2}\int_0^{2\pi} E^S(k,\phi)d\phi\,[\mathrm{m}^3]$$

→ C. Tourain presentation

SWIM 6° SWIM 10° MFWAM

MTF1

MTF3



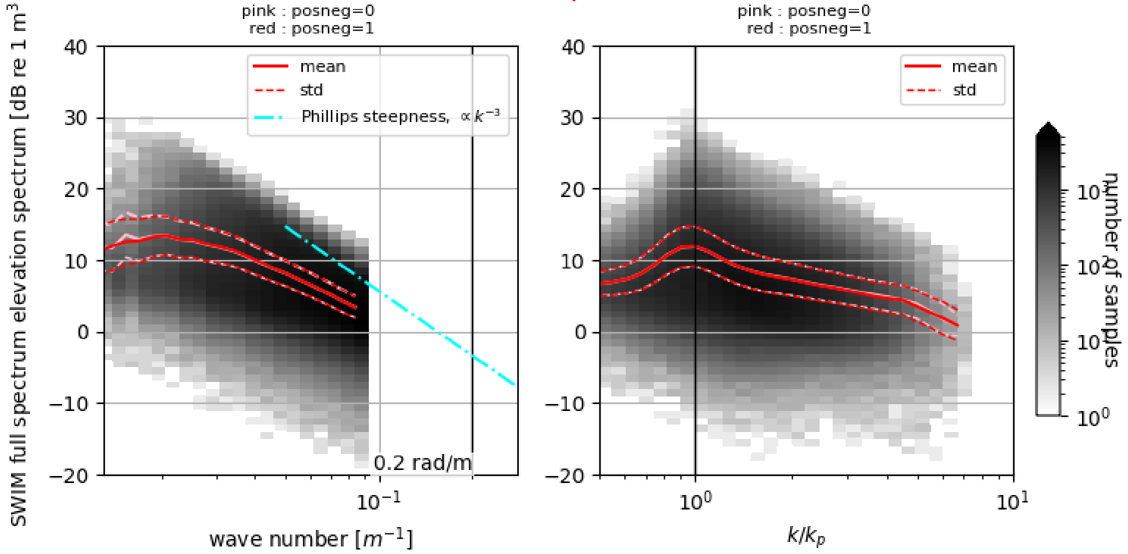
MTF3 less noisy than MTF1

Partitioning (on going work)

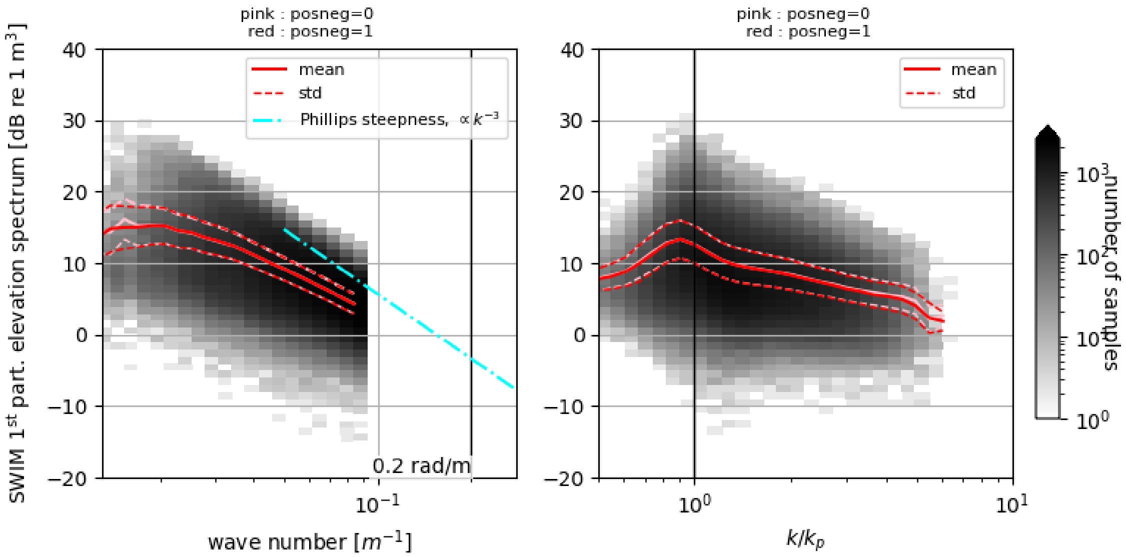
$$E(k) = \frac{1}{2}\int_0^{2\pi} E^S(k,\phi)d\phi \, [\mathrm{m}^3]$$

→ A. Ollivier presentation

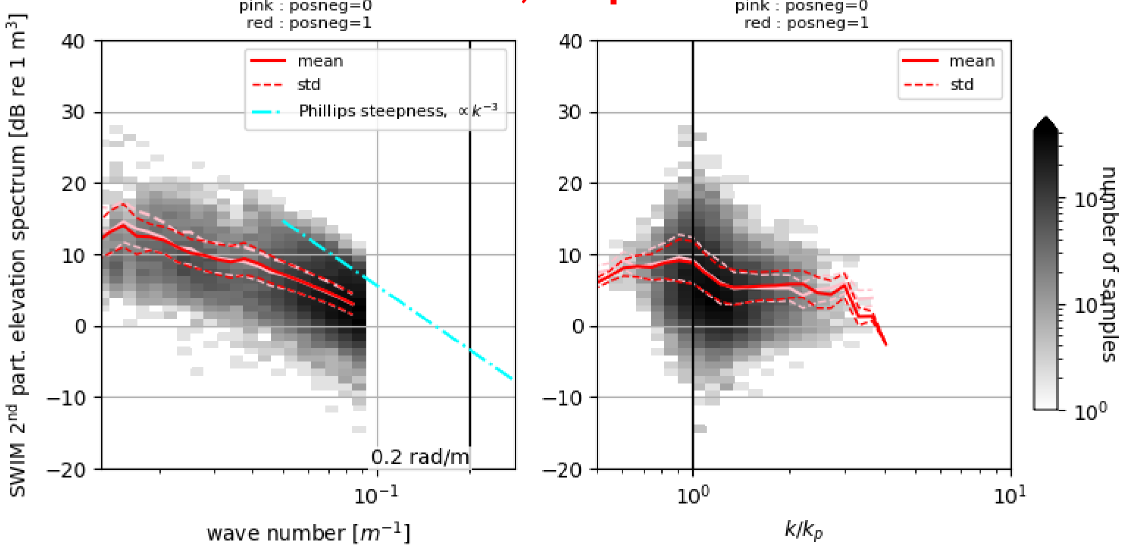
SWIM 10°, full



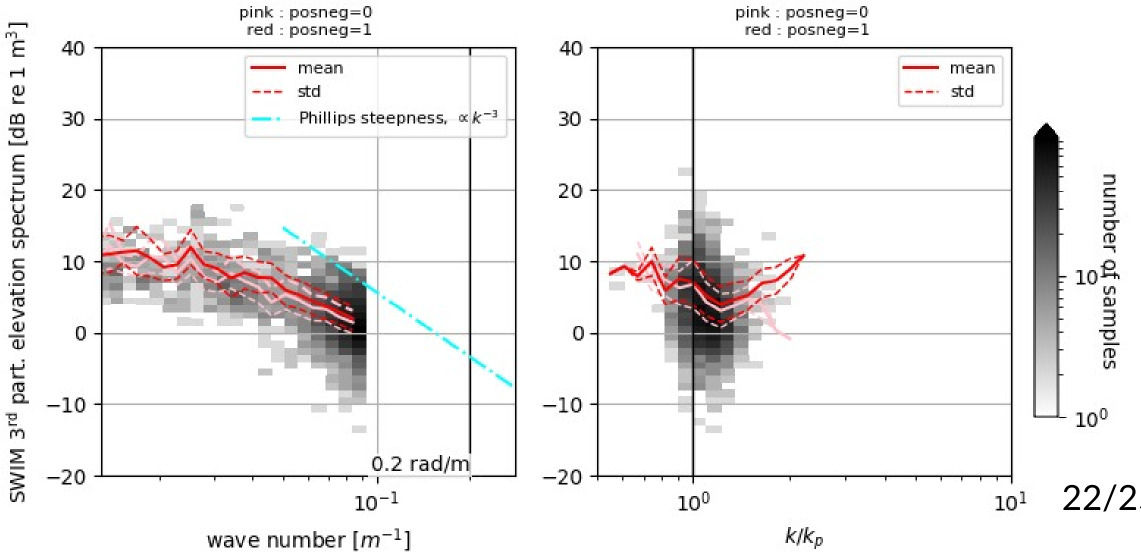
SWIM 10°, 1st partition



SWIM 10°, 2nd partition



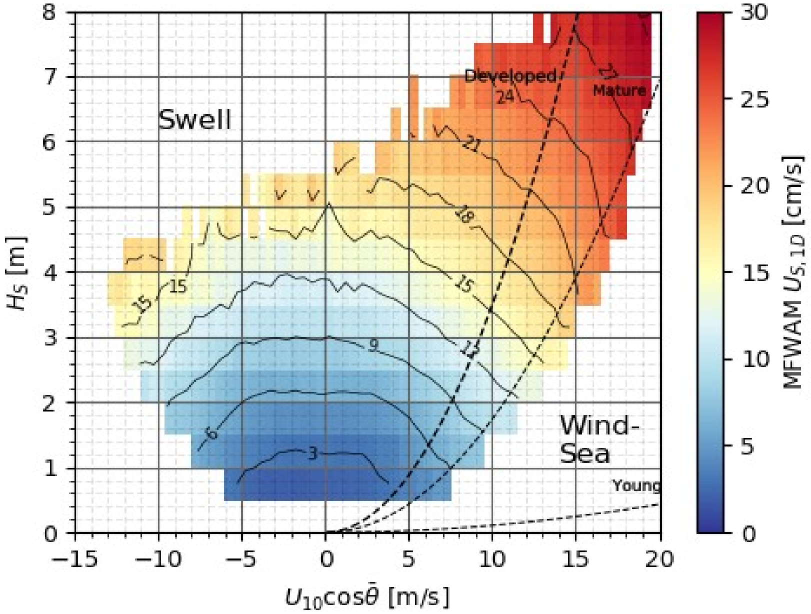
SWIM 10°, 3rd partition



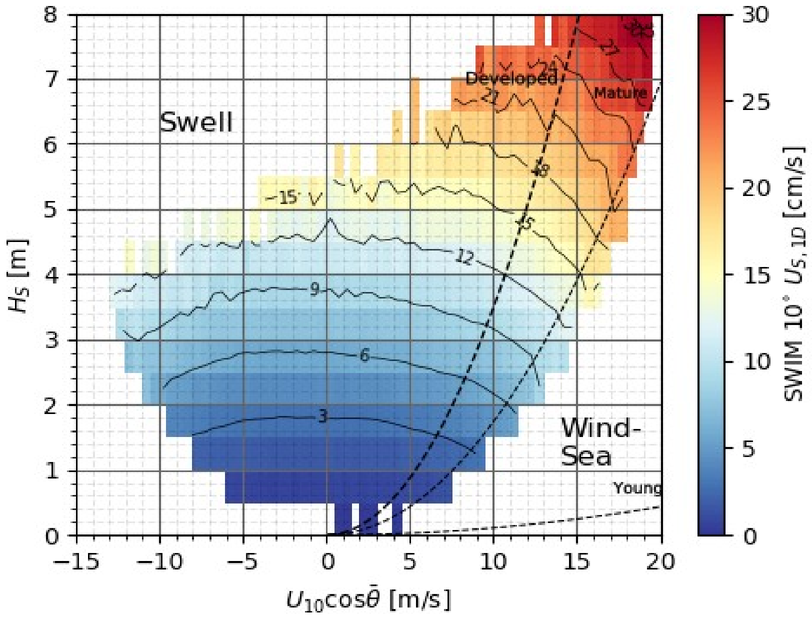
Pseudo 1d Stokes drift

$$2\sqrt{g}\int^{0.2\mathrm{rad/m}} dk\, k^{1.5}\langle E(k)\rangle$$

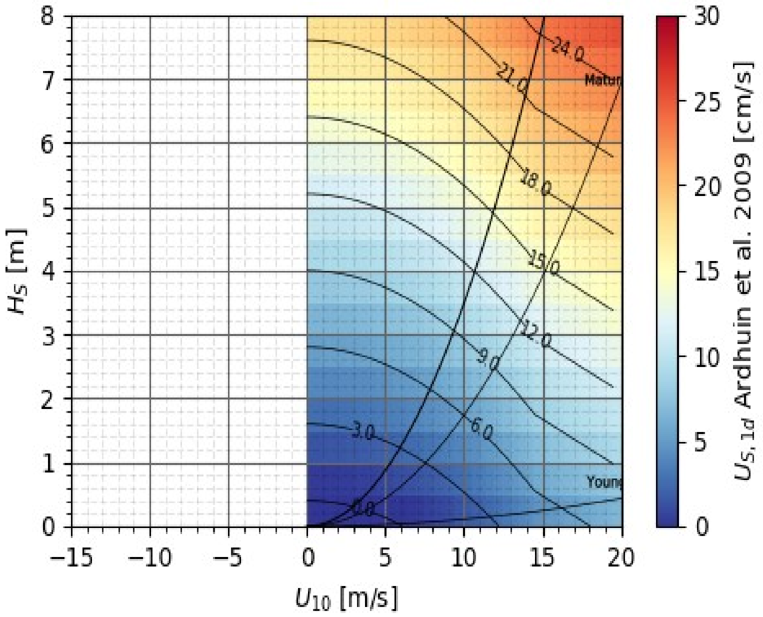
SWIM 10°



MFWAM



Ardhuin et al. 2009



There is some geophysical signal at scales smaller than the peak : interesting to investigate

Conclusions

cpeureux@groupcls.com

➔ Diagnostic tool for the investigation of SIM ocean waves spectra scientific performance

- Visualize large amounts of 2D spectra
- Trigger CAL/VAL and scientific investigations
- Illustrate SWIM performances

➔ Main observations

- Beam qualities compliant with known performances
- Spectrum noisy above 4-5 k_p
- SWIM spectra markedly more peaked both in frequency and direction than modeled ones (especially low sea-states)

➔ Further investigations

- Characterize variability (noise and geophysical)
- Add diagnostics

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