

Observing and understanding internal solitary waves in the Maluku Sea with SWOT

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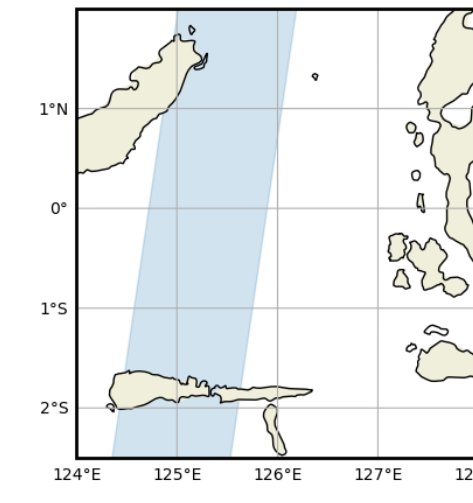
context & goals

Context: SWOT provides stunning pictures of energetic internal solitary waves and Indonesia provides a wealth of case studies.

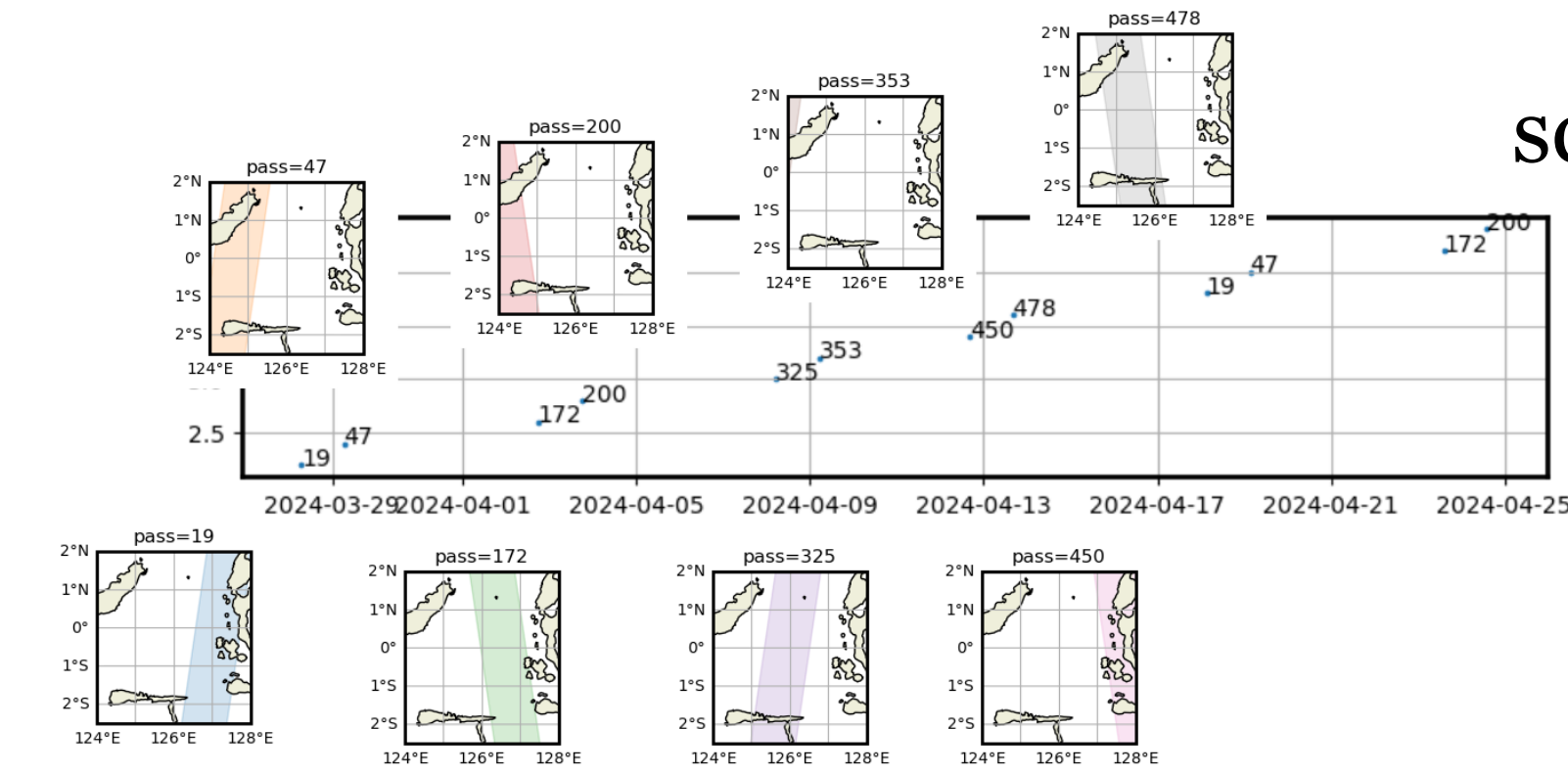
We focus here on the Maluku's Sea which is an area of low ocean and atmospheric energy, thus providing conditions for favorable observations of these features.

Main goal: extract internal solitary wave properties and describe them in light of available theoretical theories

Material: about 300 cycles over the Maluku's Sea distributed over the fast sampling phase (1/3 of the dataset) and the science phase (2/3)



fast sampling phase

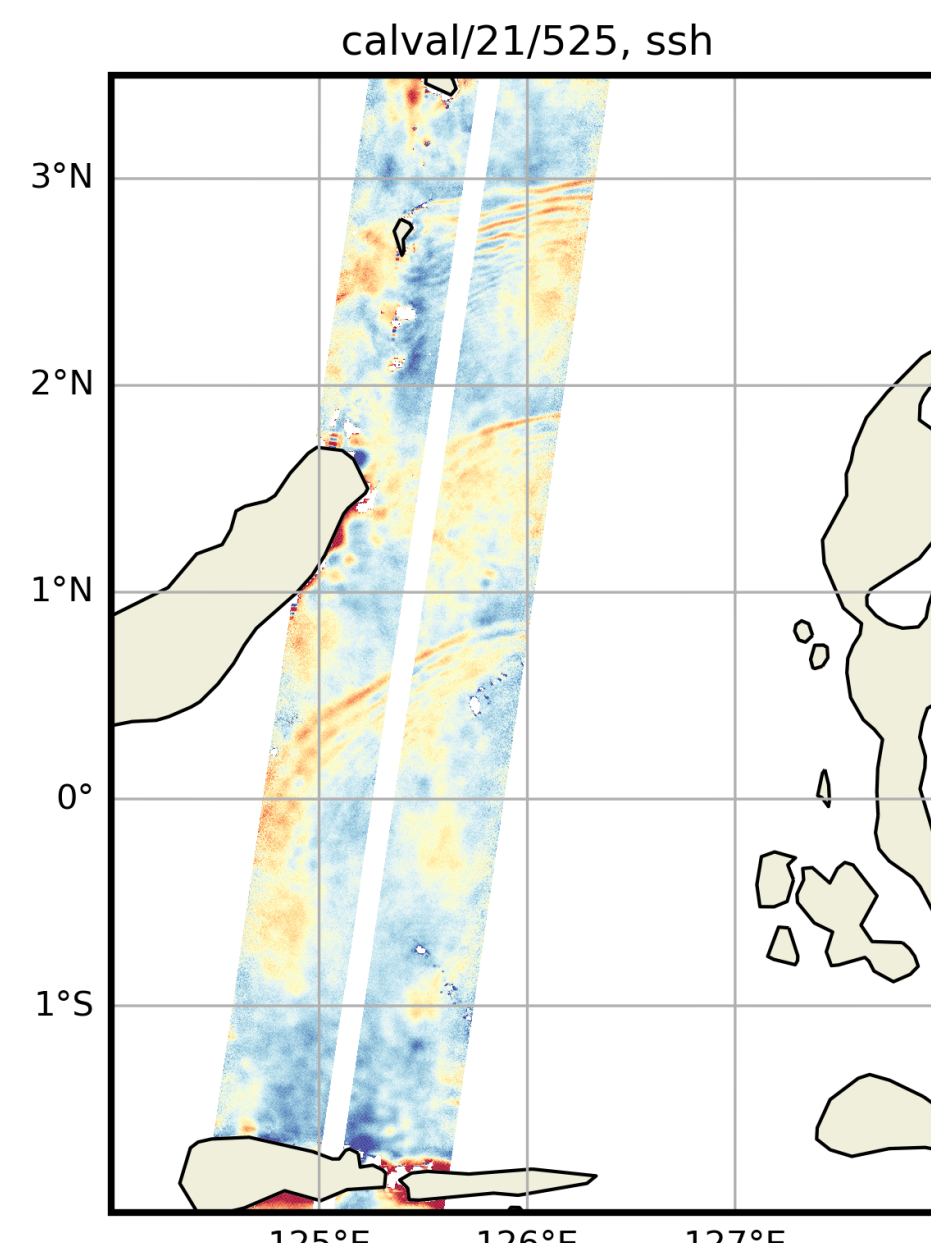


science phase

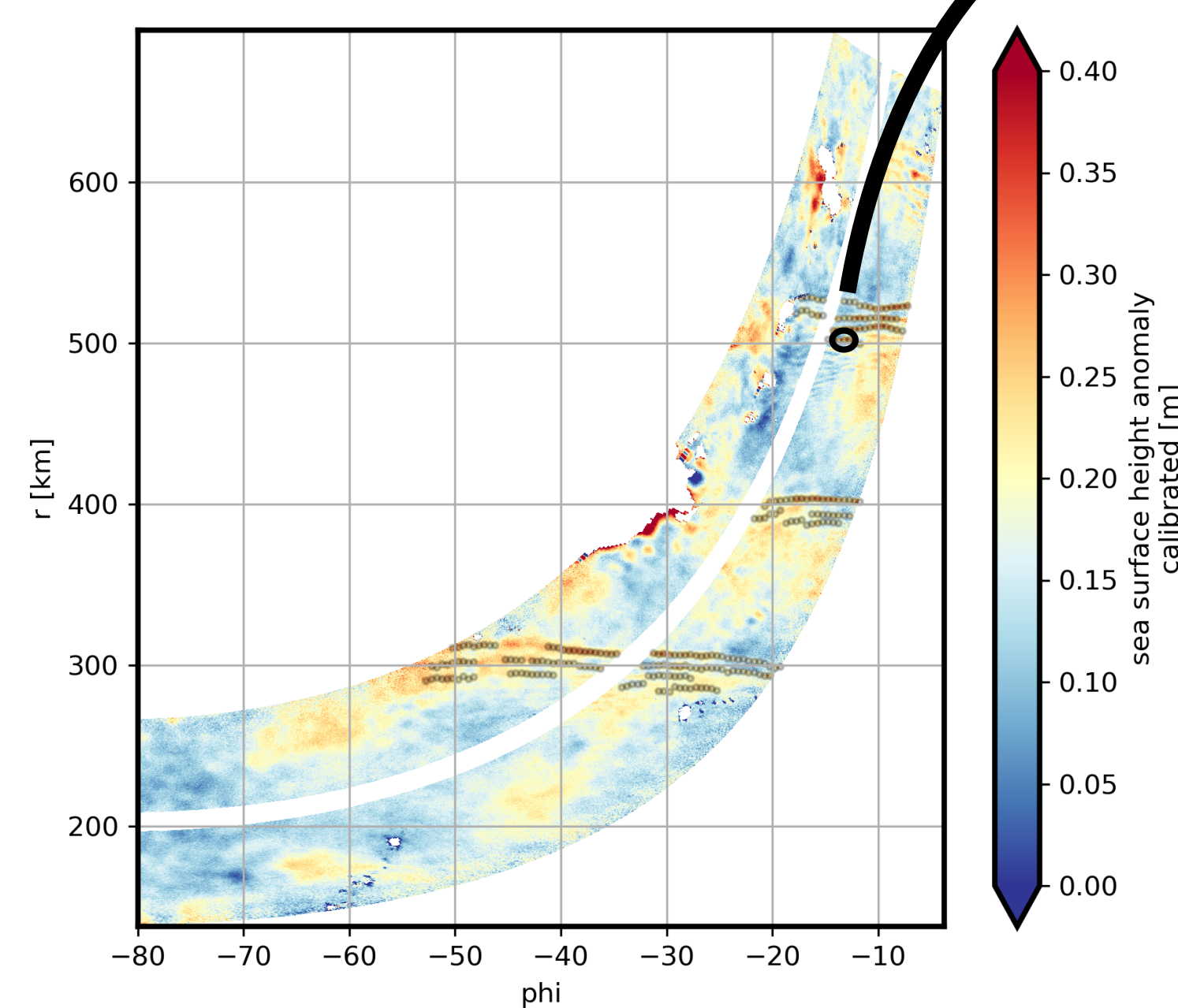
Wave detection and characterization

cylindrical projection
peak detection
manual editing

L3 SWOT SSH

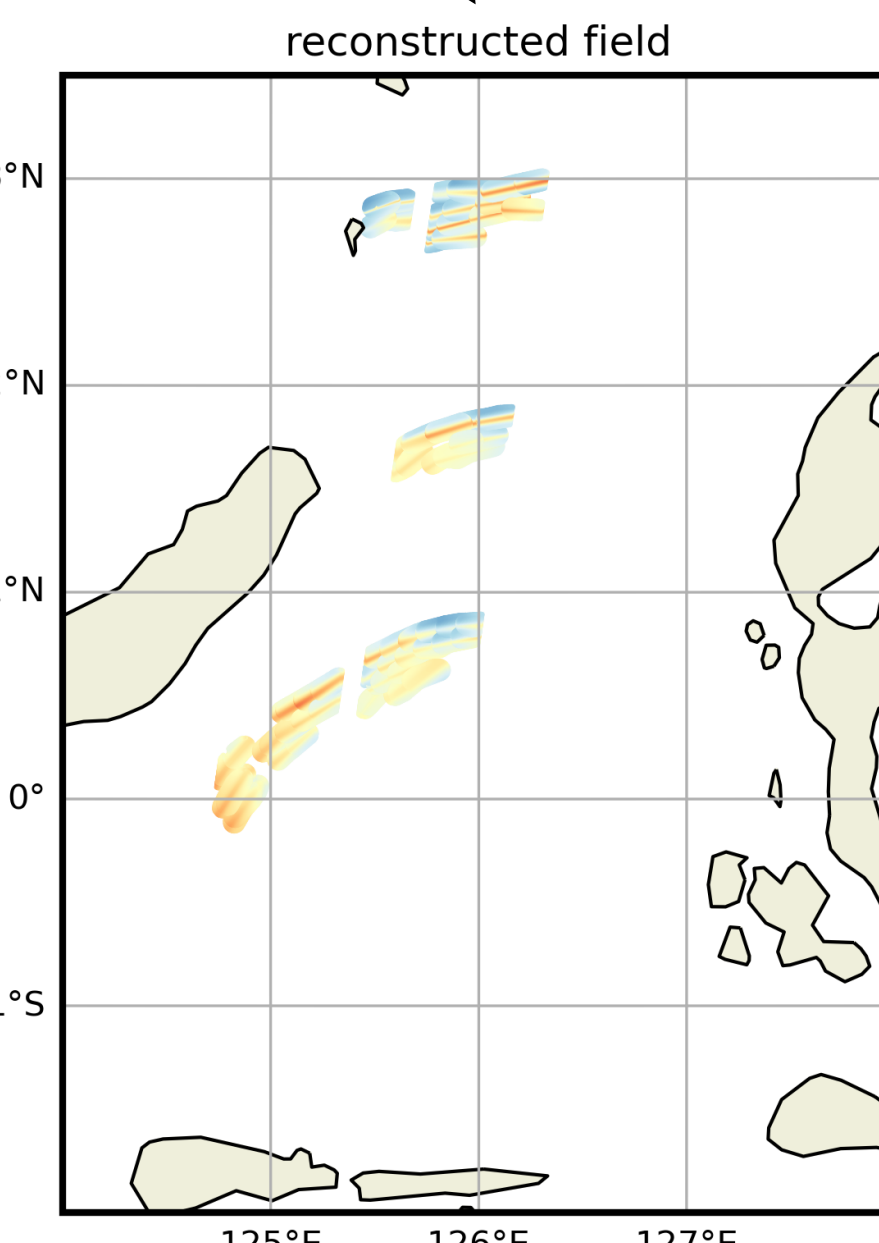
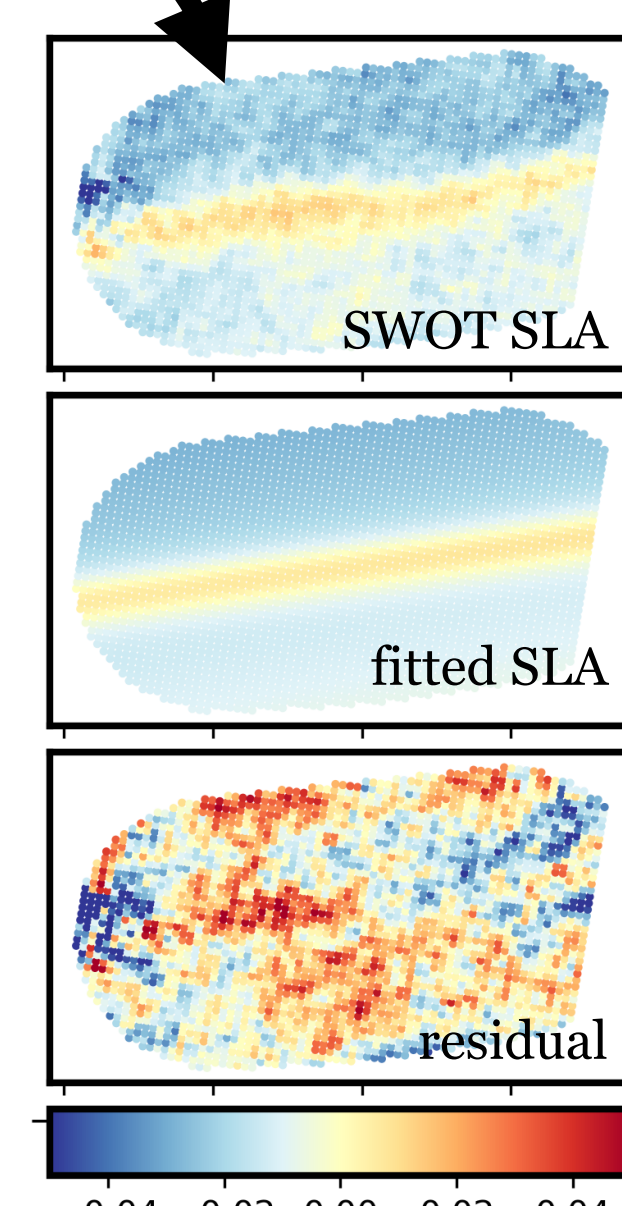


wave peaks



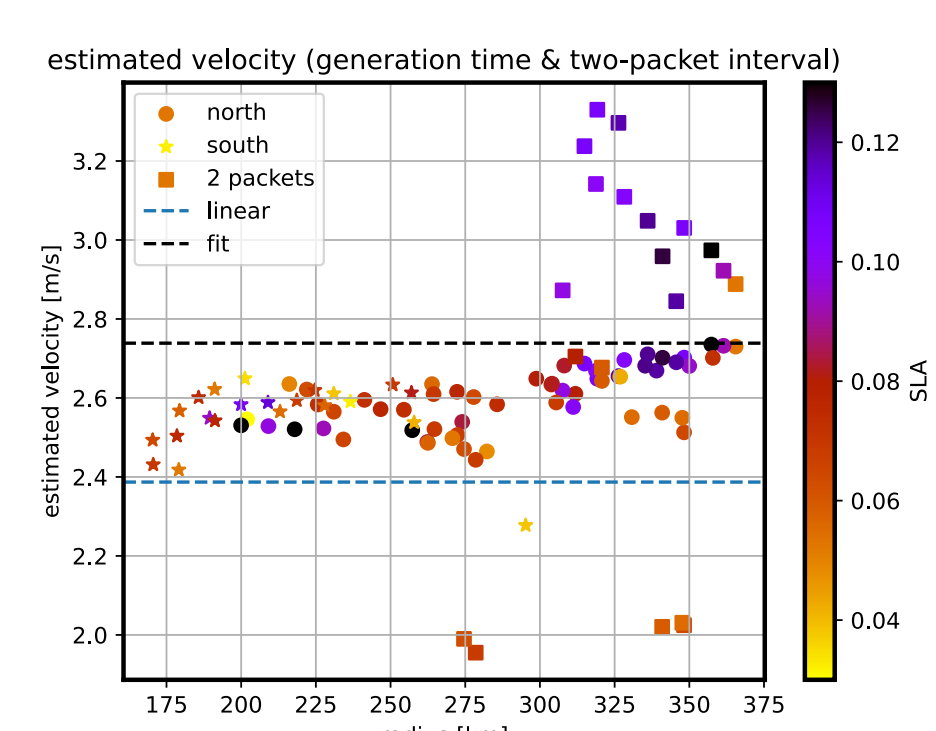
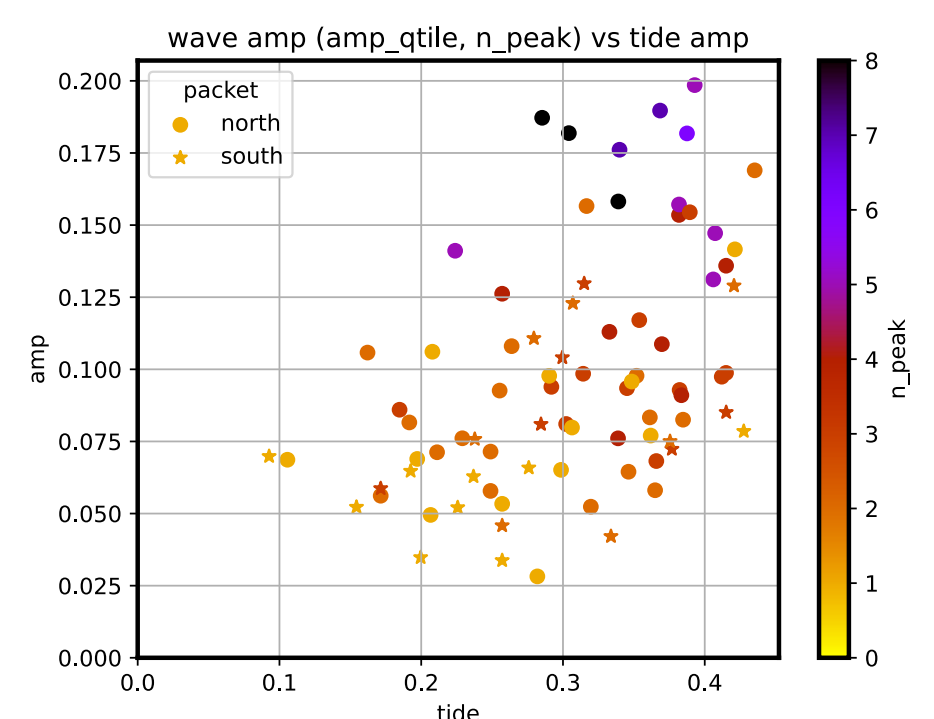
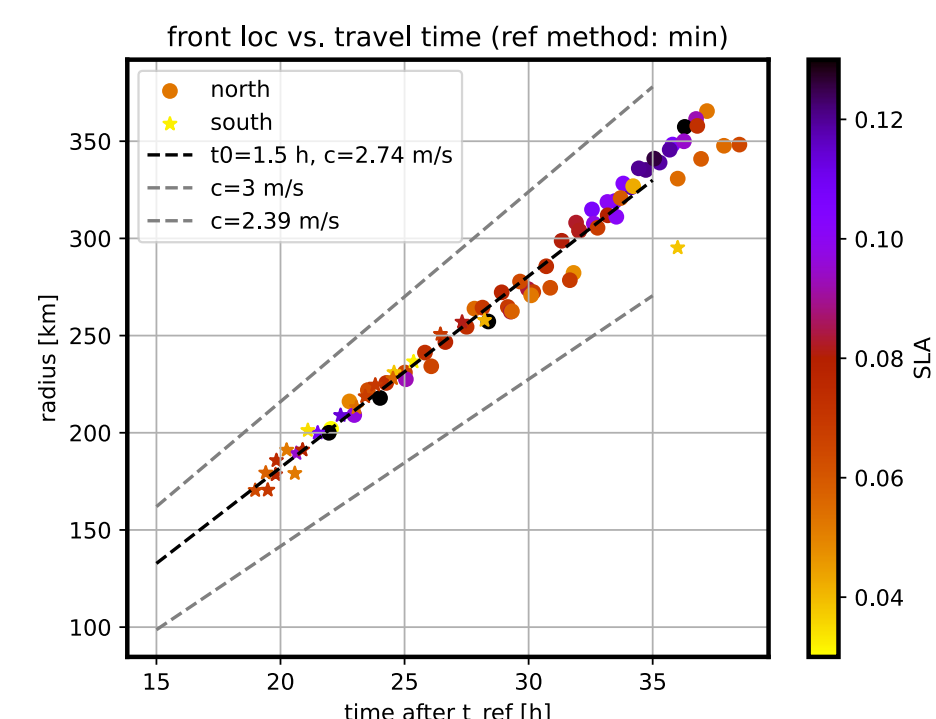
shape inference
Bayesian MC

collection of wave properties:
width/amplitude/position/orientation



Theoretical framework: KdV

- weakly-nonlinear long wave regime
- mode 1 vertical mode: $\eta(x, z, t) = A(x, t)\Phi(z)$
- $\partial_t A + c\partial_x A + \alpha A\partial_x A + \beta\partial_{xxx} A = 0$
- SLA given by $\eta(0) = A\Phi(0)$
- Surface horizontal divergence: $\partial_x u = g\partial_x \eta / (c - U_{bg})$
- solution: $A = A_0 / \cosh^2[(x - Vt)/L]$ with: $V = c + \alpha A_0/3$, $L = \sqrt{12\beta / (\alpha A_0)}$

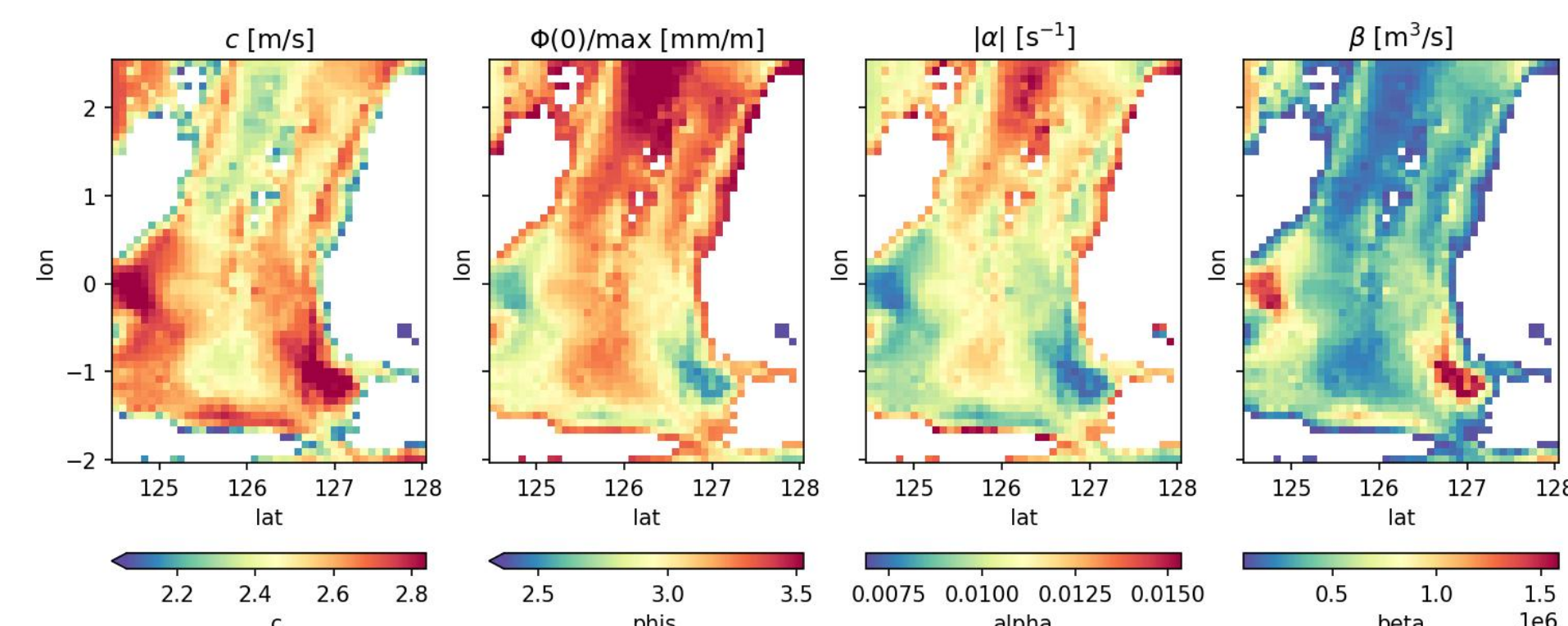


Averaged properties from inference

- generation time (w.r.t tide) fairly regular
- amplitude & speed increases with distance
- stronger tide $\Rightarrow$ higher amplitude, more peaks
- large uncertainties on speed estimation

Parameters from vertical mode computation

- space variability is non negligible
- time variability is weak



$$\alpha = \frac{3c}{I} \int_z (d\Phi/dz)^3 dz, \quad \beta = \frac{c}{I} \int_z \Phi^2 dz, \quad I = 2 \int_z (d\Phi/dz)^2 dz$$

Theory / observation discrepancies

Several possible sources:

- vertical mode inappropriate? Variability?
- KdV: weakly-nonlinear, long-wave approximations

