

Progress Report on a High-Resolution Empirical Tide Model: *HRET v8.1*

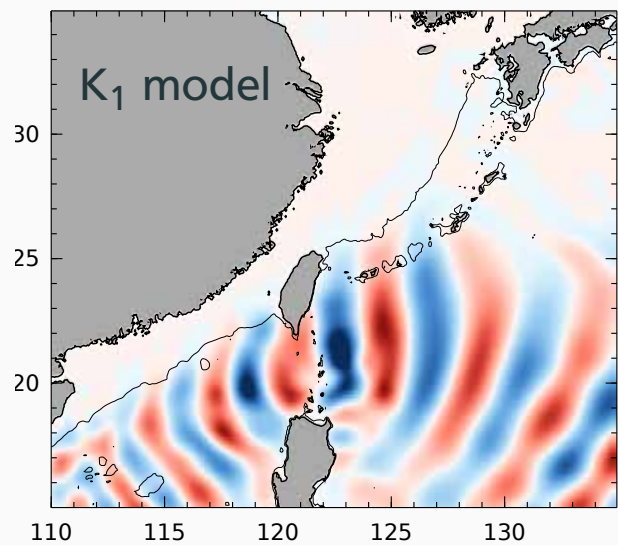
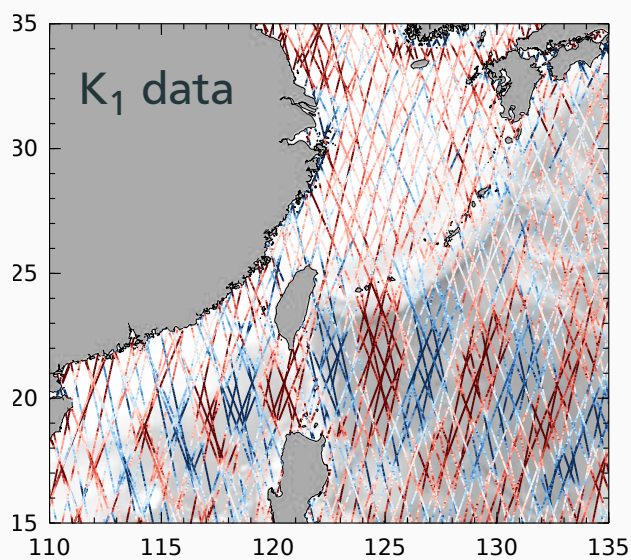
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SWOT Science Team Meeting
Montreal, Quebec

Outline

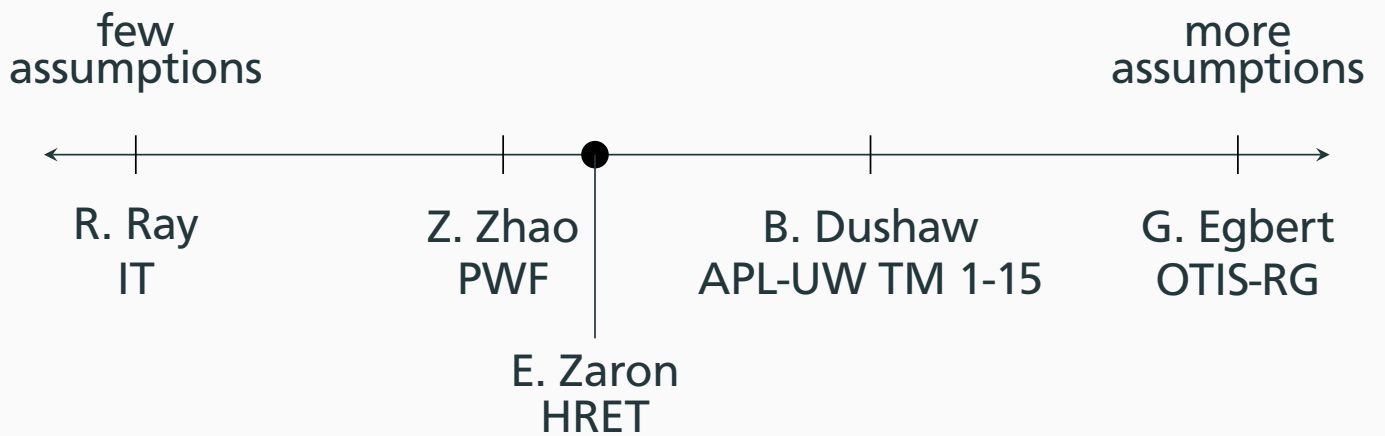
1. What is *HRET*? How was it computed? How does it differ from other efforts?
2. Validate HRET by comparing with CryoSat-2 and drifter-derived surface currents.
3. Estimate a scattering time by optimizing explained variance w.r.t. surface currents.

High-Resolution Empirical Tide Model



- smoothly interpolate
- filter "bad tracks"
- mask nearshore/continental shelf

HRET Compared to Other Efforts

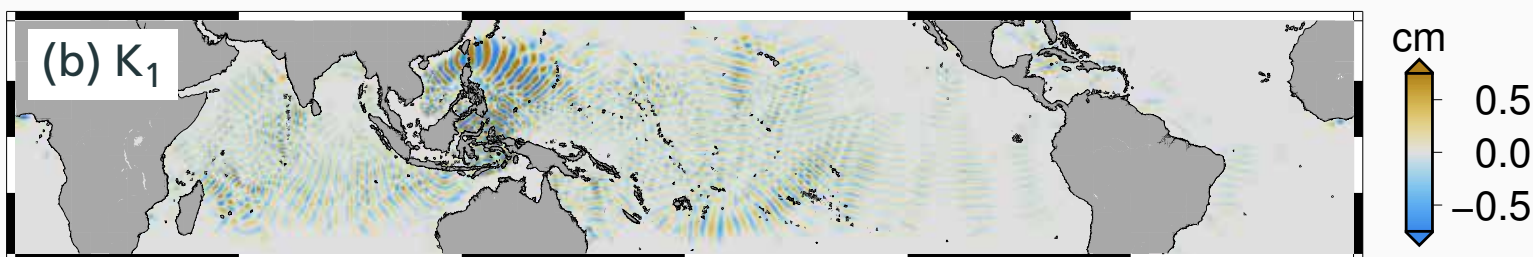
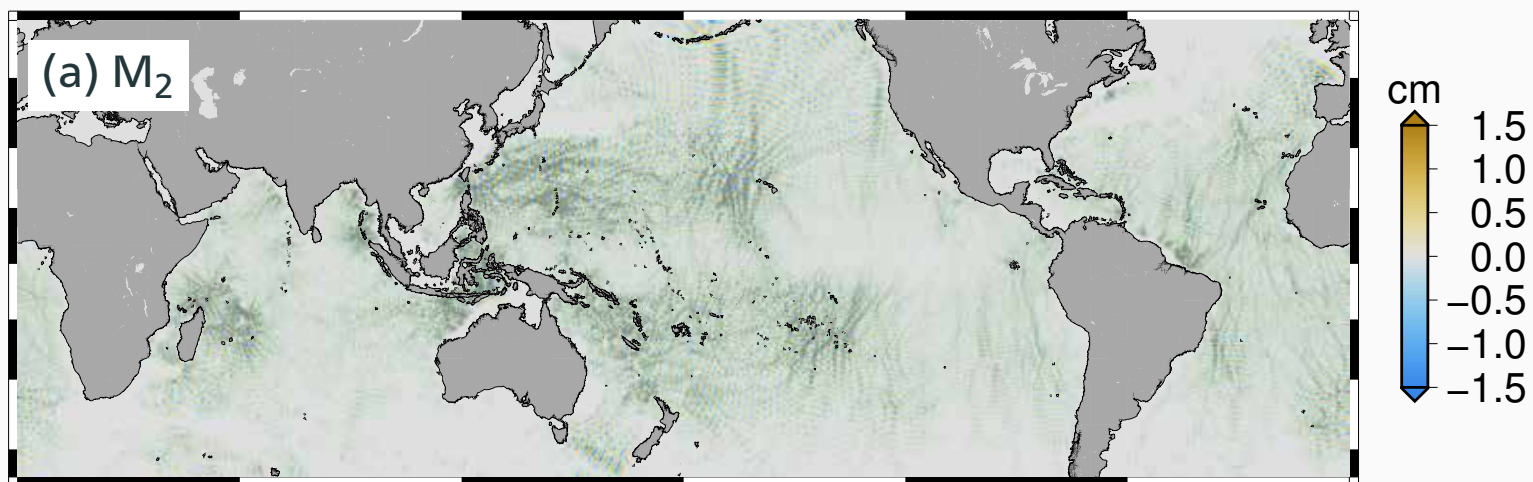


$$\eta(x, y) = \sum_{n=1}^N \sum_{p+q=0}^P x^p y^q (a_{pqn} \cos(\mathbf{k}_n \cdot \mathbf{x}) + b_{pqn} \sin(\mathbf{k}_n \cdot \mathbf{x}))$$

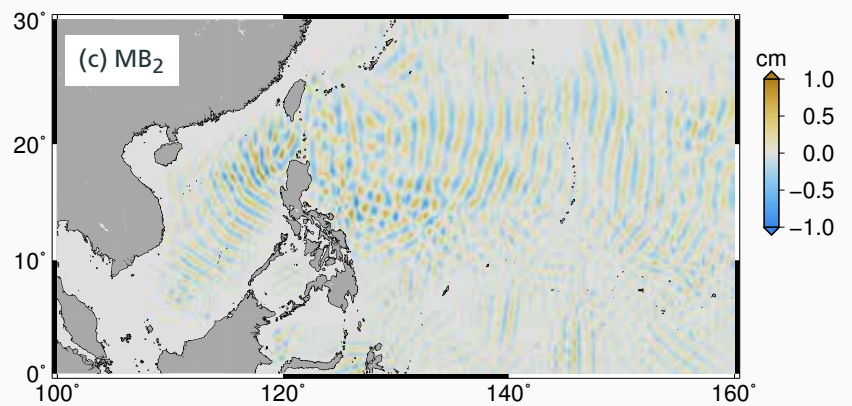
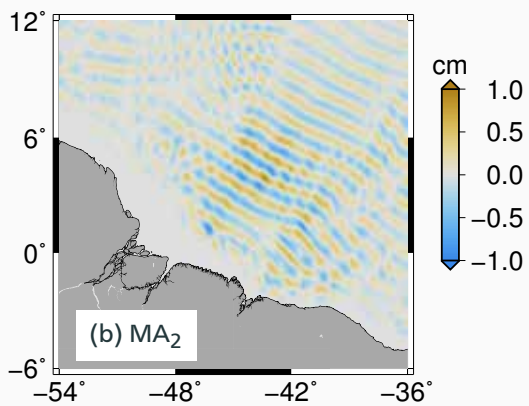
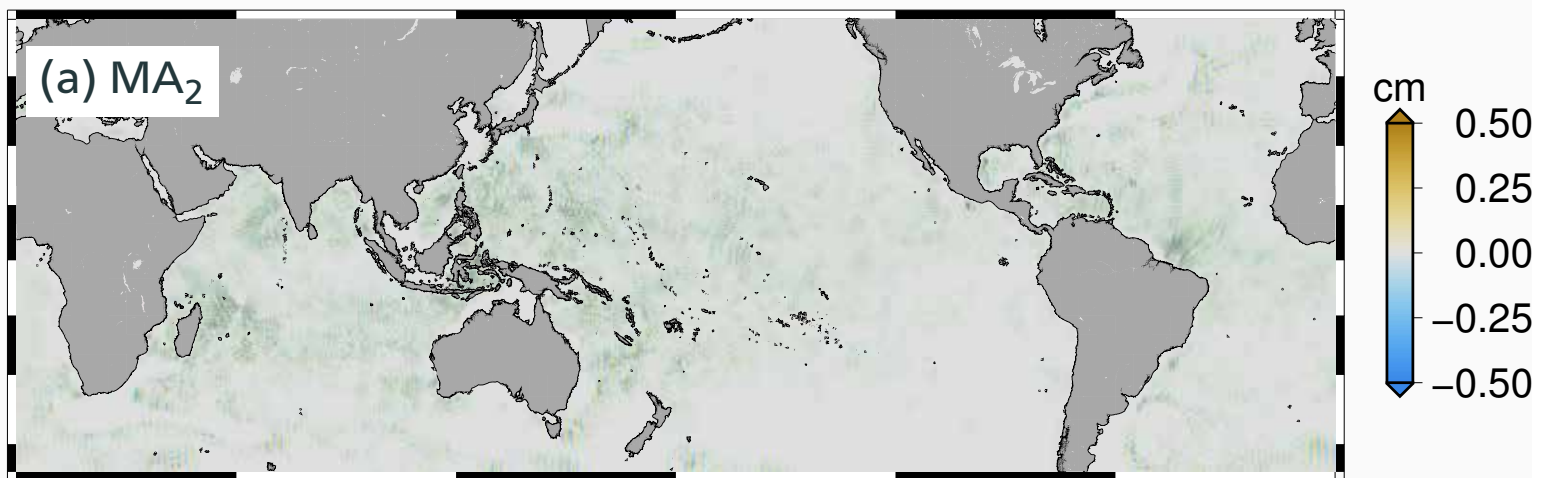
- A plane-wave fit with quadratic amplitude modulation ($P = 2$).
- N and k_n determined by data. No along-track filter.

For details see manuscript submitted to JPO.

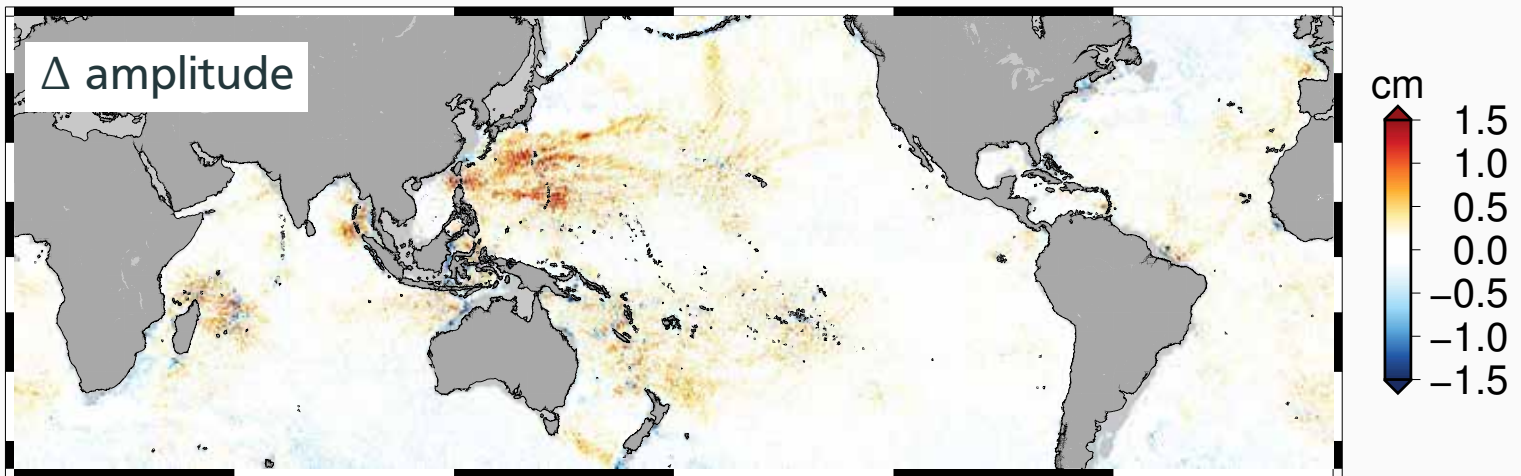
Tidal elevation snapshots



Annual modulates of M_2



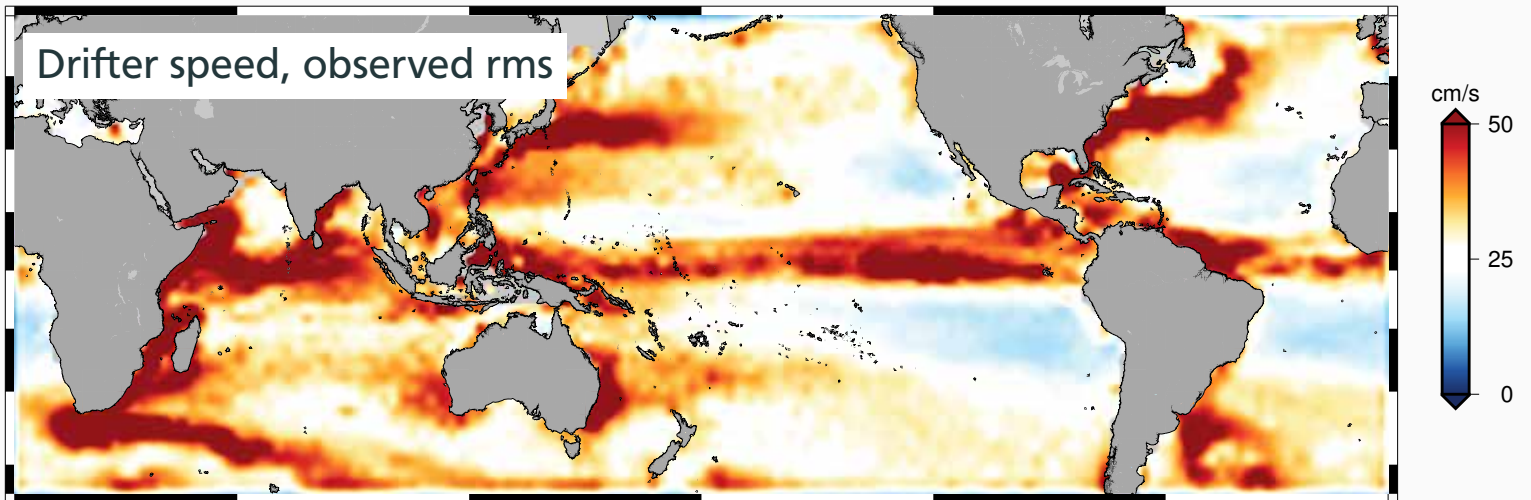
M_2 : HRET minus IT



M_2 , S_2 , K_1 , O_1 , MA_2 , and MB_2 models validated using CryoSat-2:

- Explained variance continuing to improve: 13 cm² maximum.
- S_2 & O_1 have regions where explained variance is negative.
- MA_2 & MB_2 may be useful in some regions.
- Mask needs improvement.

Comparison with Surface Drifters (*thanks NOAA GDP*)

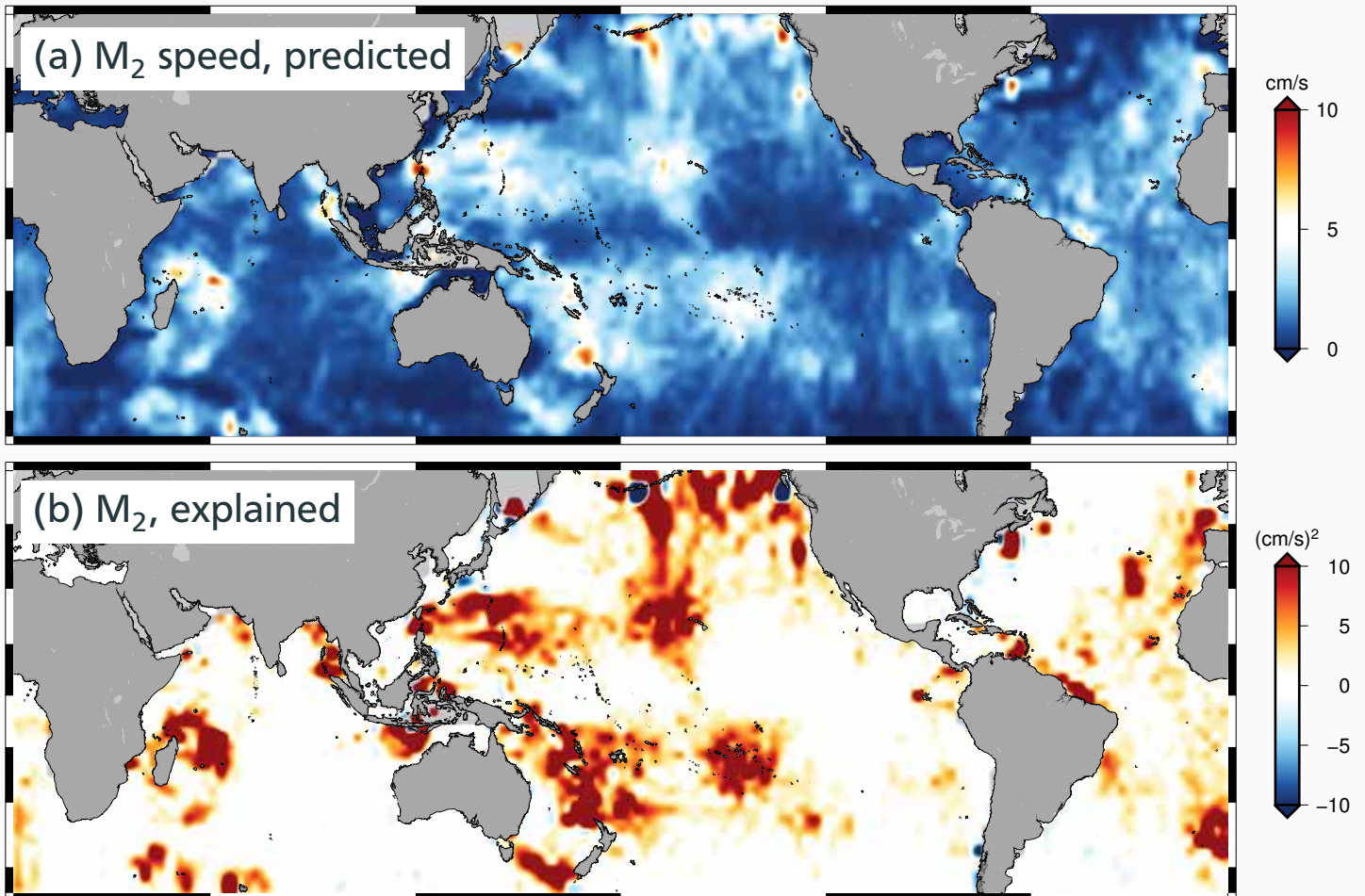


12,000 drifters, 1995–2015, 96 million hourly vector currents.

Simplest dynamics to relate tidal current u and tidal SSH η :

$$-i\omega u + f\hat{k} \times u = -\nabla\eta$$

Comparison with Surface Drifters



Add dissipation to dynamics

Treat scattering as a diffusive process,

$$-i\omega u + f\hat{k} \times u = -\nabla\eta + \nu\nabla^2 u,$$

with $\nu = c_o L_o$ where c_o and L_o are the phase speed perturbation and correlation scale of mesoscale eddies.

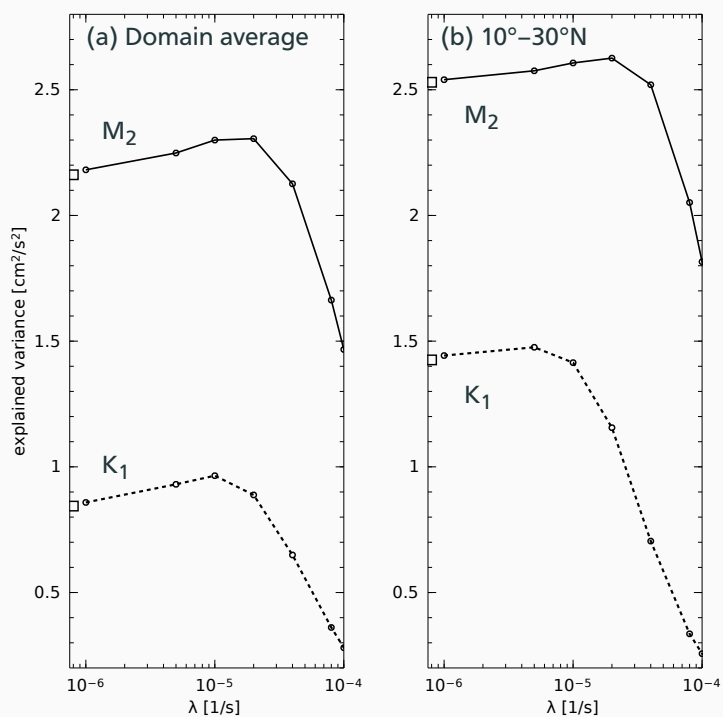
Let $\lambda = \nu k^2$ where k is mode-1 wavenumber, then

$$-i\omega u + f\hat{k} \times u = -\nabla\eta - \lambda u.$$

Plug in estimates for c_o and L_o :

λ is 5% to 50% of the M_2 frequency. Expect λ to be a factor of 4 smaller for K_1 .

Explained variance vs. λ



Damping time scale for M₂:

$$\lambda^{-1} \approx 1 \text{ day}$$

Next steps re: SWOT –

- Systematic comparisons.
- Fewer d.o.f. dynamics.
- GFO MA₂ & S₂.
- Coastal MA₂ & MB₂.