Global M_2, S_2, O_1 and K_1 internal tides from satellite altimetry

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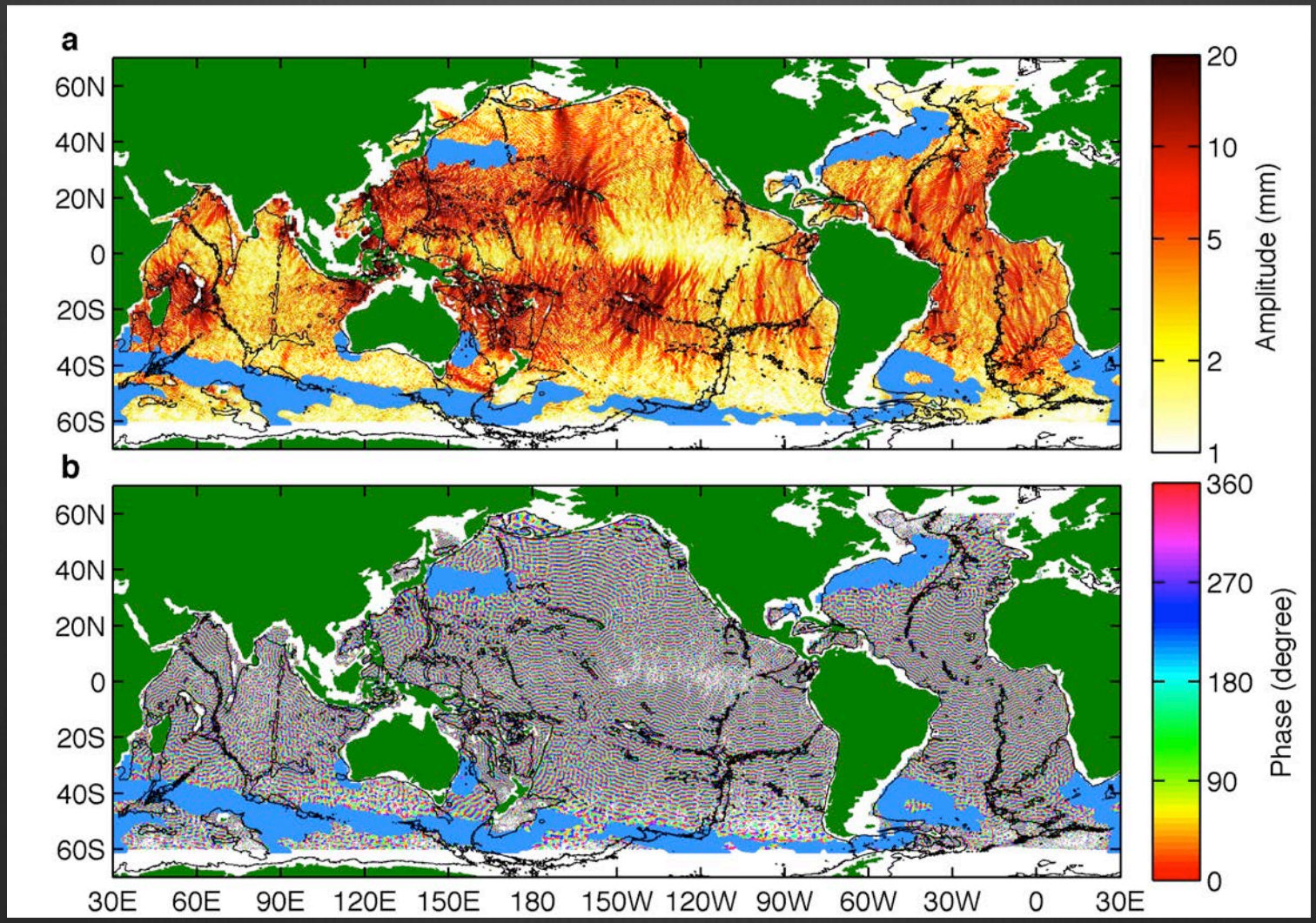
Goal

A global internal tide model from satellite altimetry

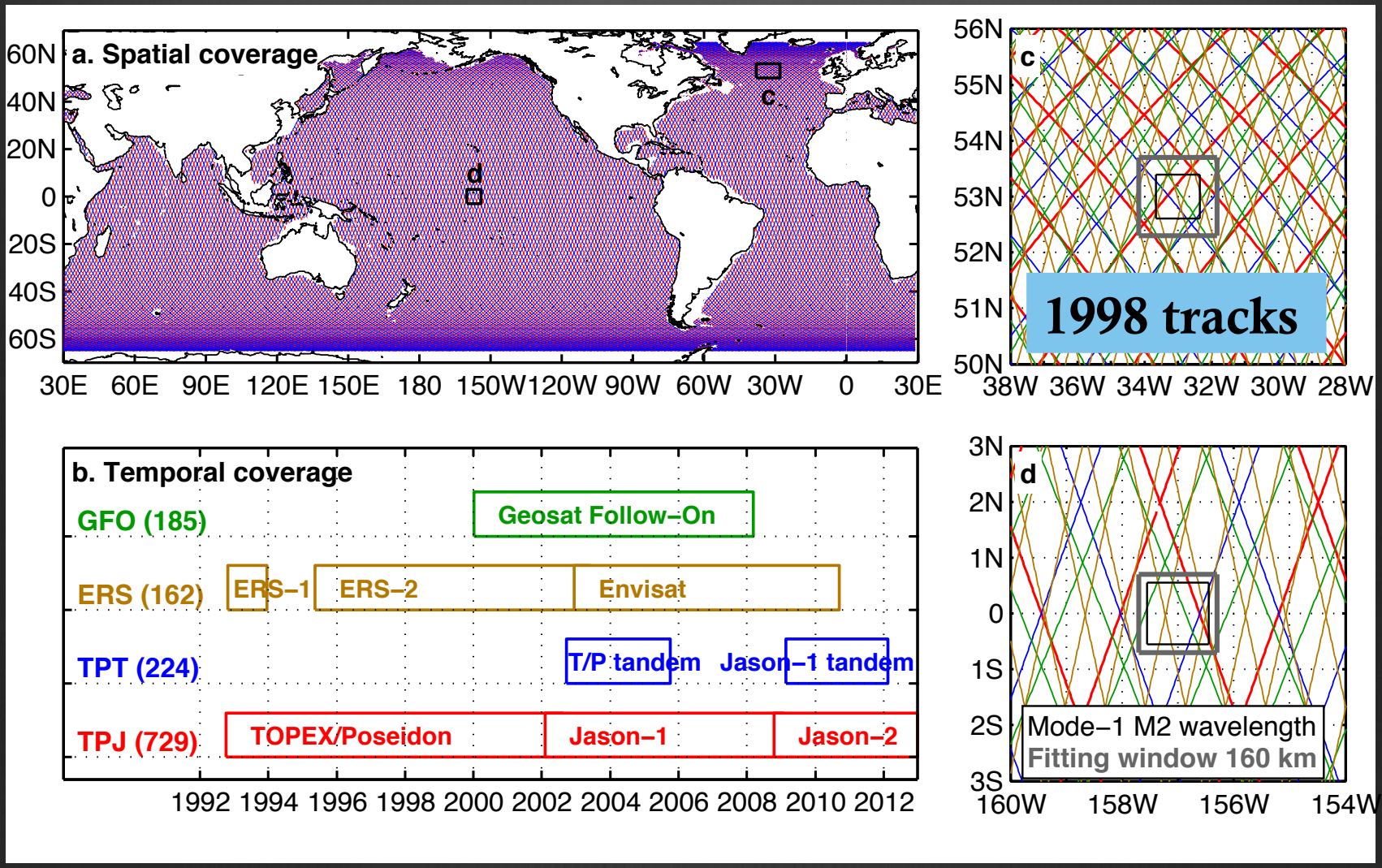
Motivation

- Internal tide correction for SWOT
- Tidal energy budget and ocean mixing
- Constraints for numerical internal tide models

Global mode-1 M_2 internal tide



Satellite altimeter data



Method

Harmonic analysis

$$A\cos(\omega t - \phi)$$

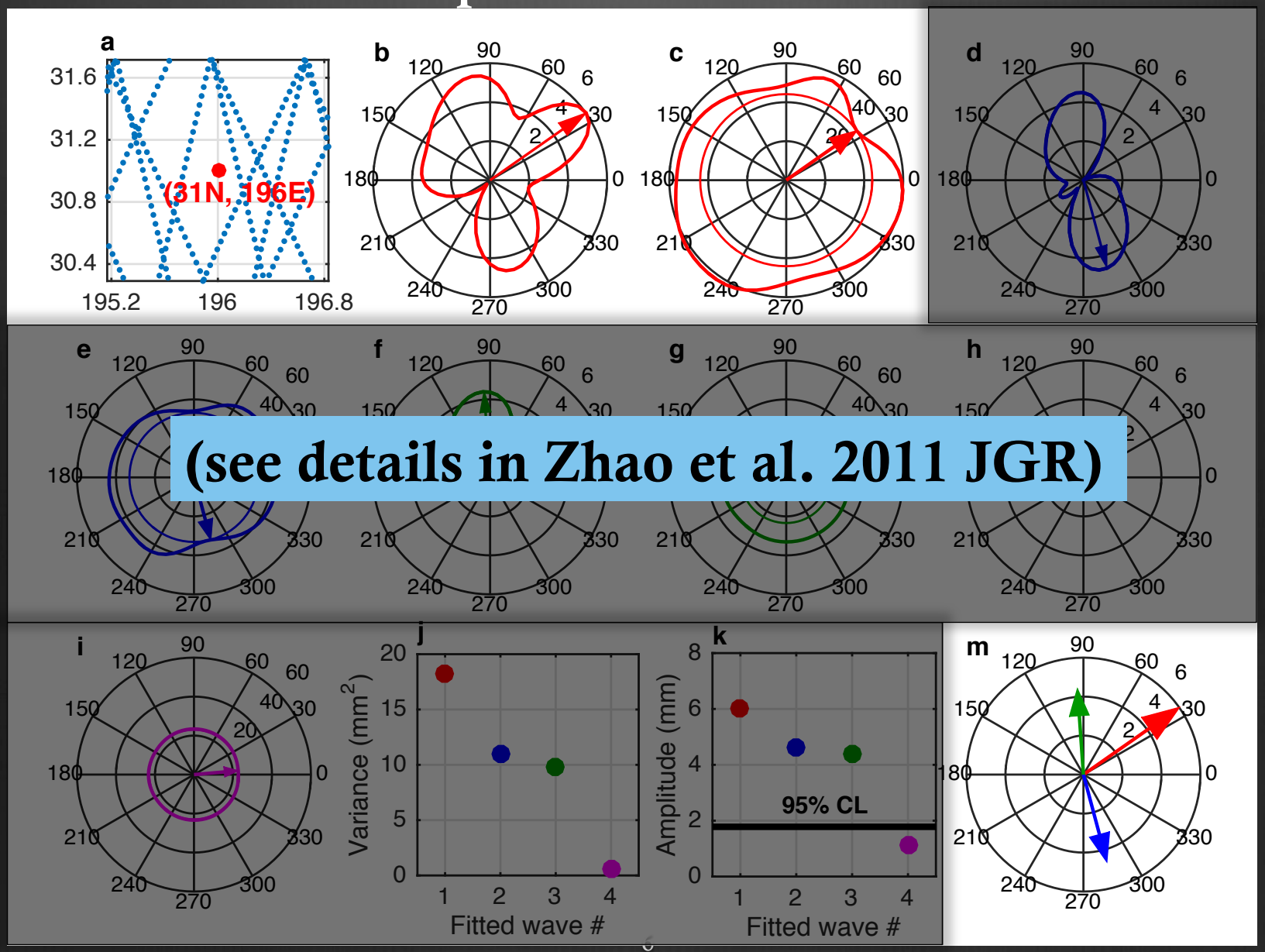
- ssh (x_0, y_0, t) at a single site (x_0, y_0)
- 800 SSH data (prior AVISO correction)

Plane wave fit

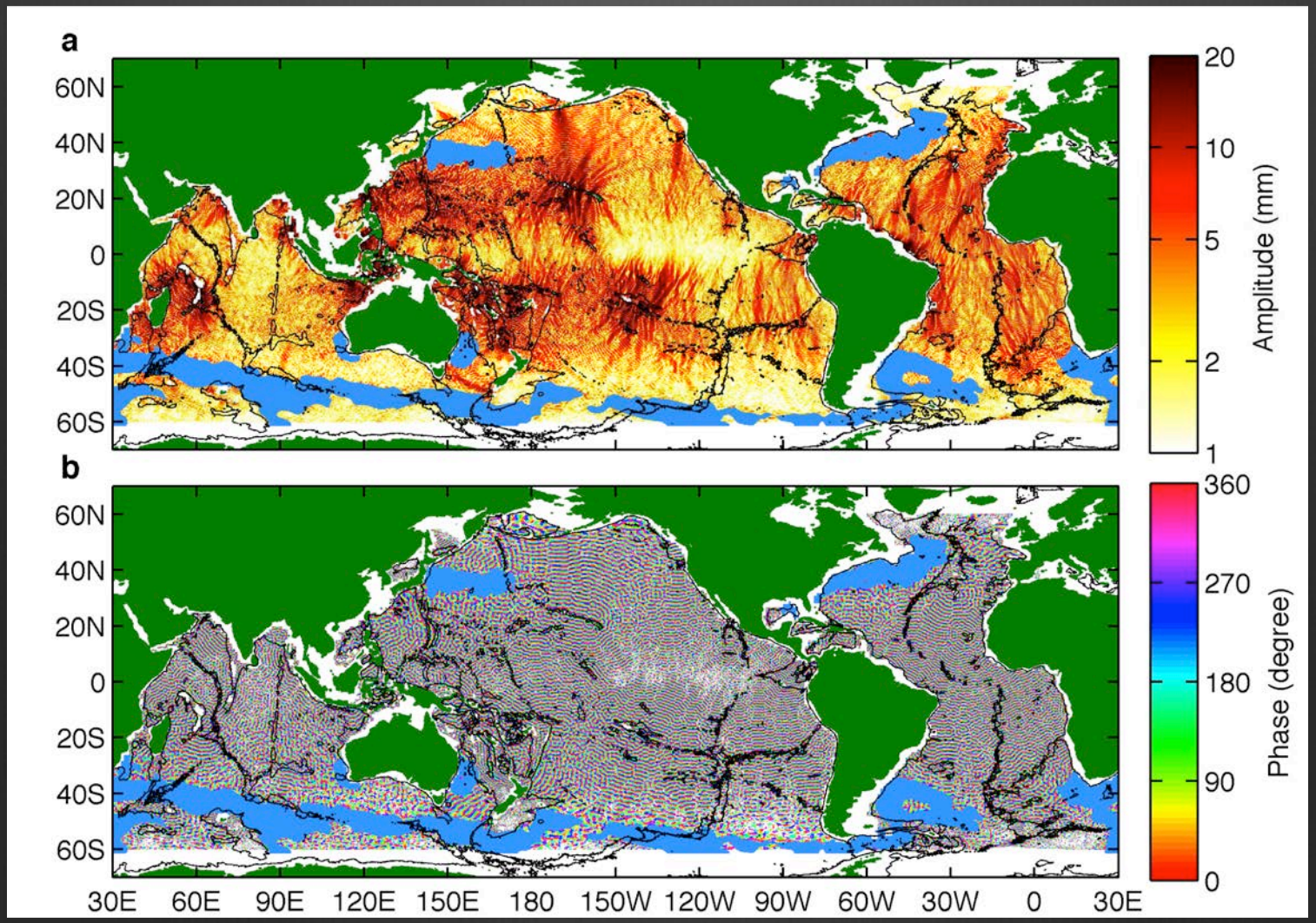
$$\Sigma_{m=1}^{M} A_m \cos(kx\cos\theta_m + ky\sin\theta_m - \omega t - \phi_m)$$

- ssh (x, y, t) in a fitting window (160 km for M_2)
- 30,000 – 40,000 SSH data (reduce non-tide noise)
- wavenumber *k* from World Ocean Atlas 2013

Amplitude Variance

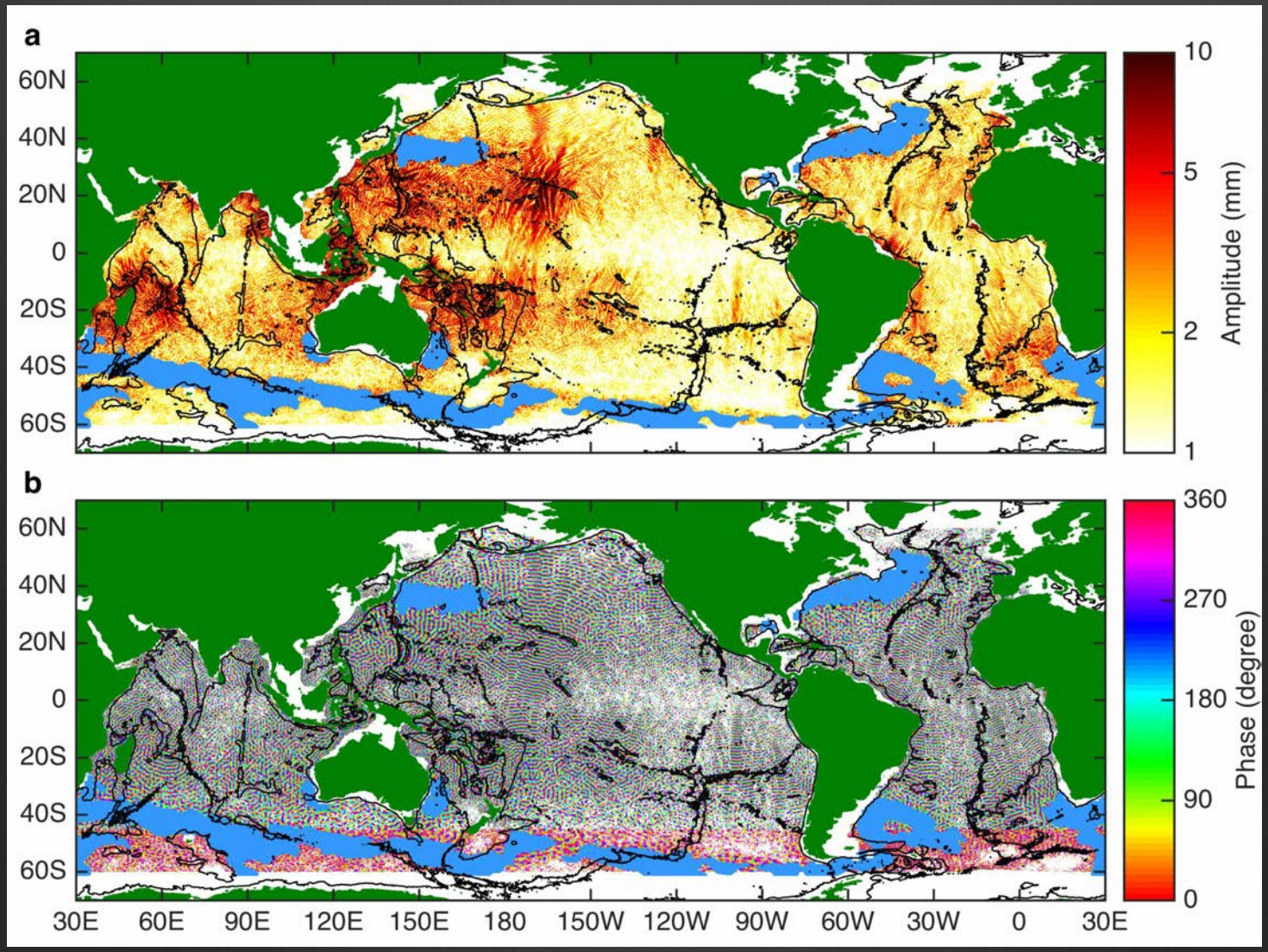


Global mode-1 M_2 internal tide



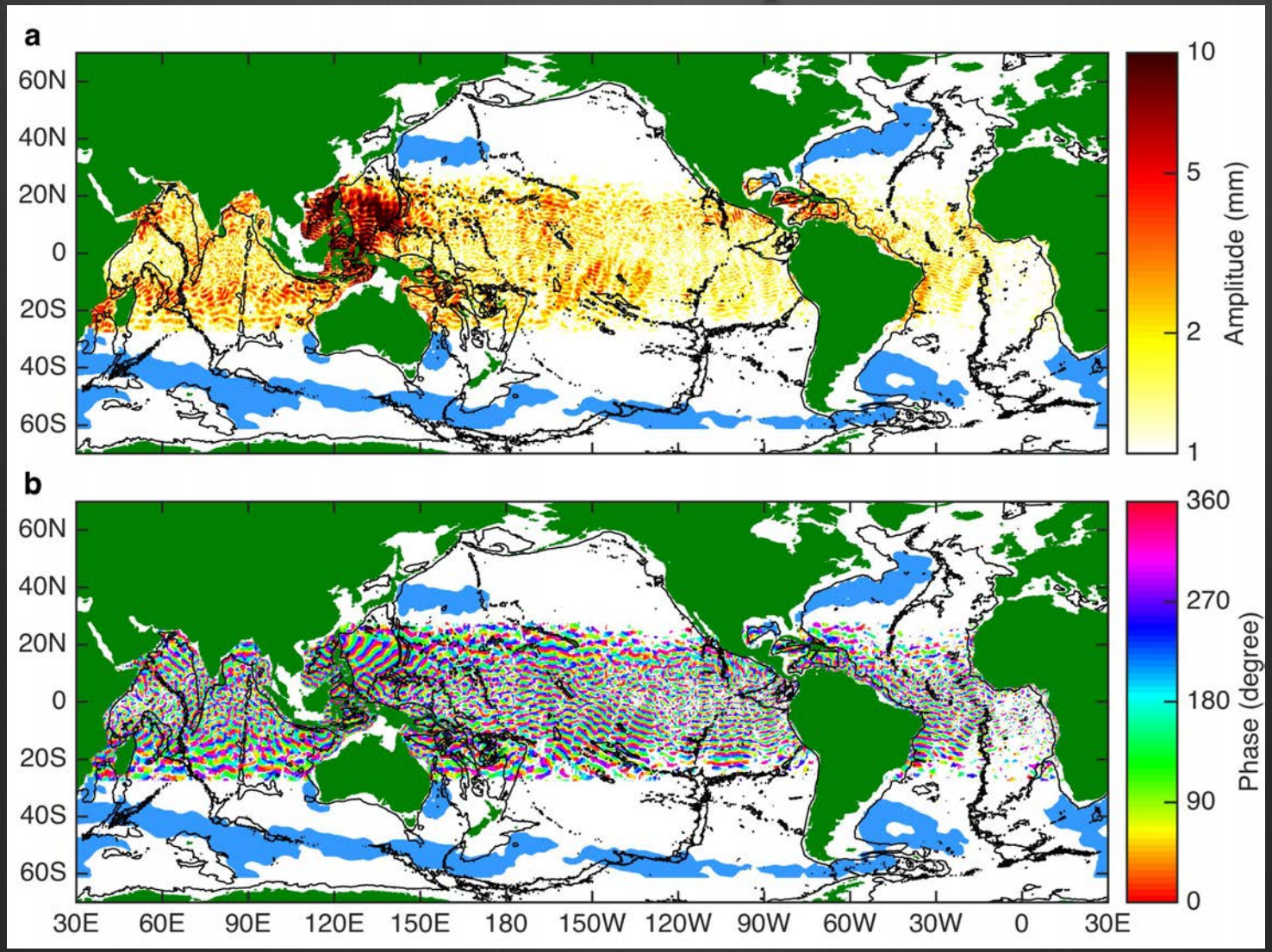
Mask: highly energetic regions

Global mode-1 S_2 internal tide



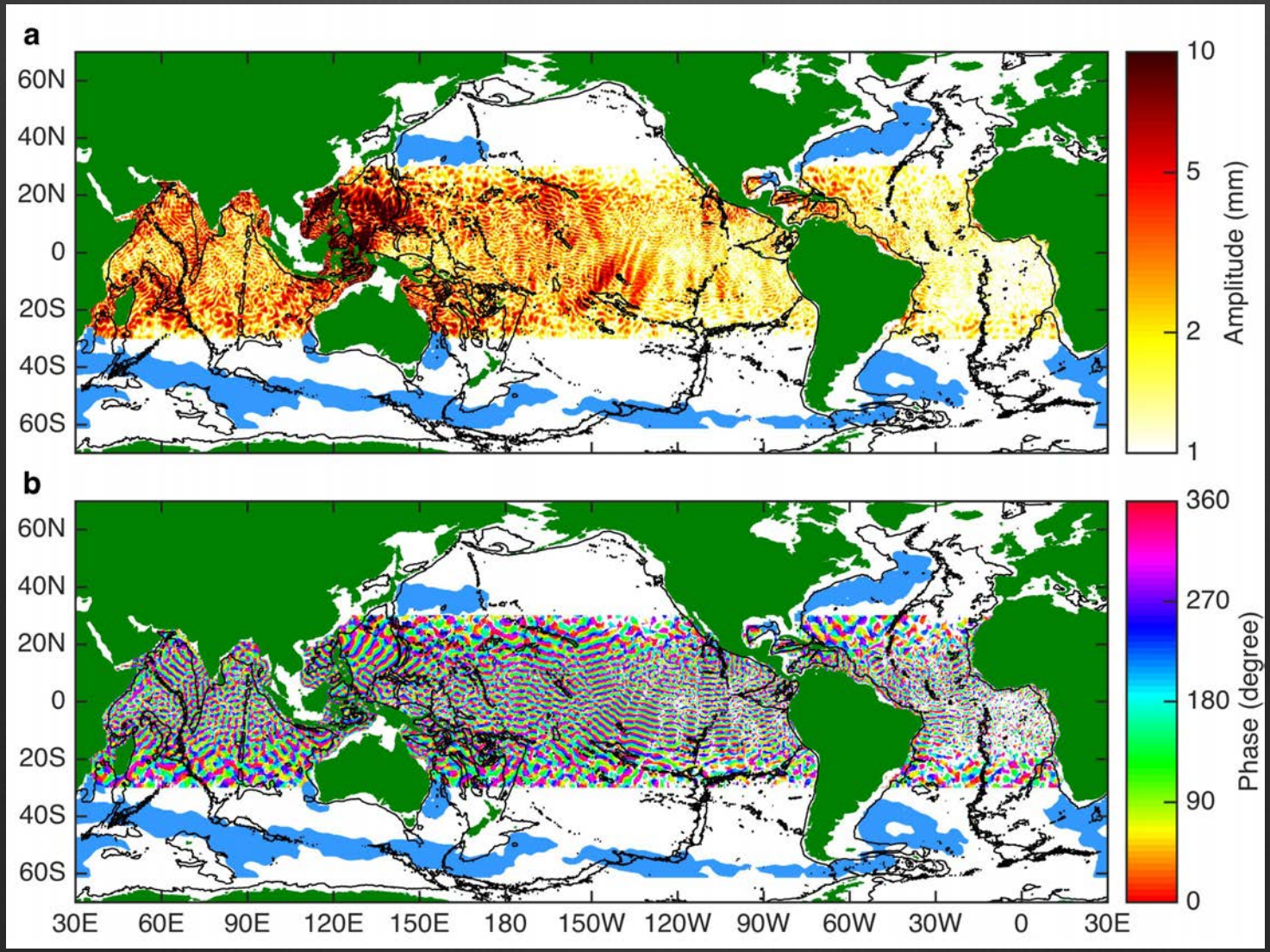
ERS-1/2 and Envisat data not used

Global mode-1 O_1 internal tide



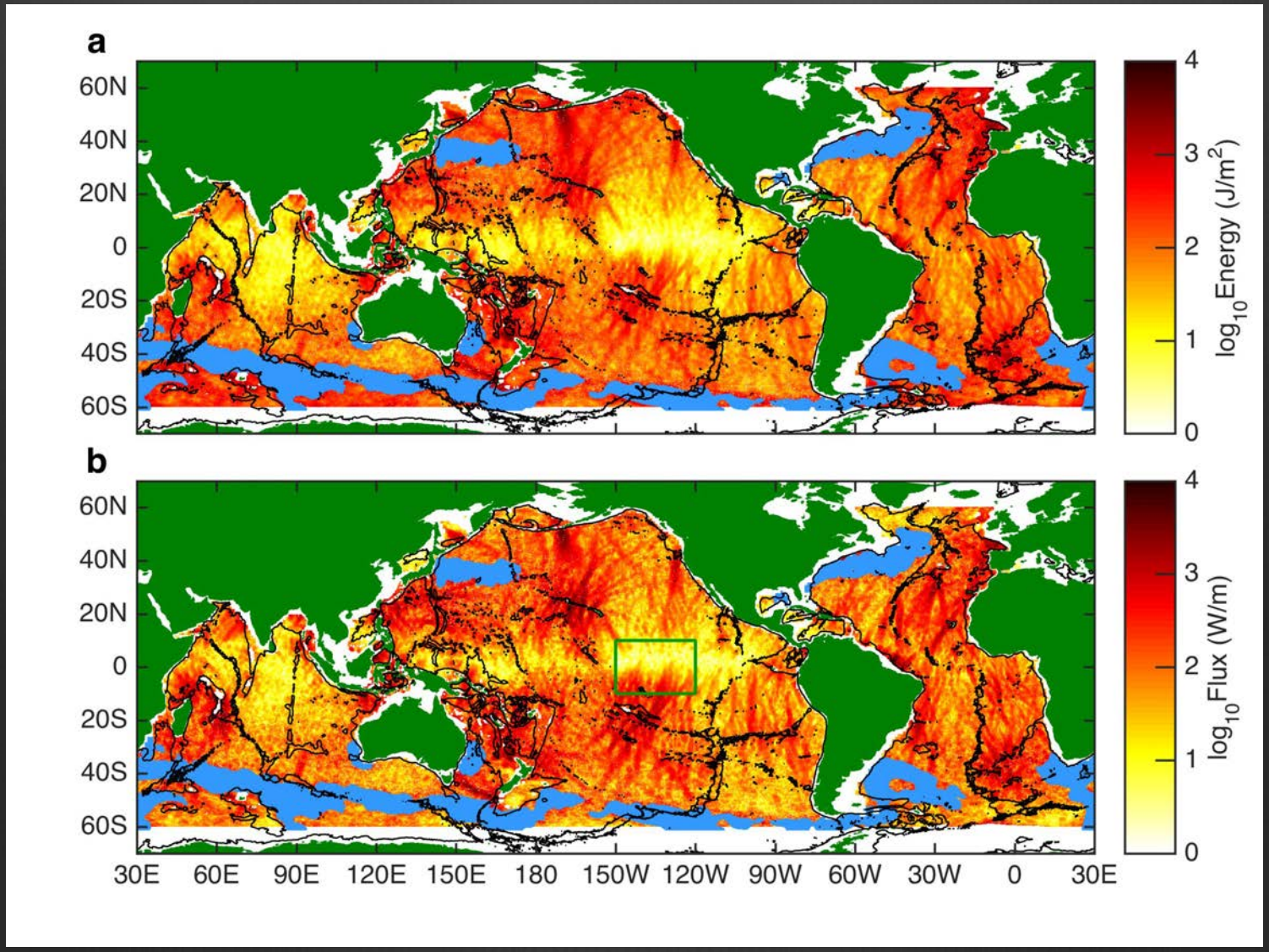
28 S/N equatorwards

Global mode-1 K_1 internal tide

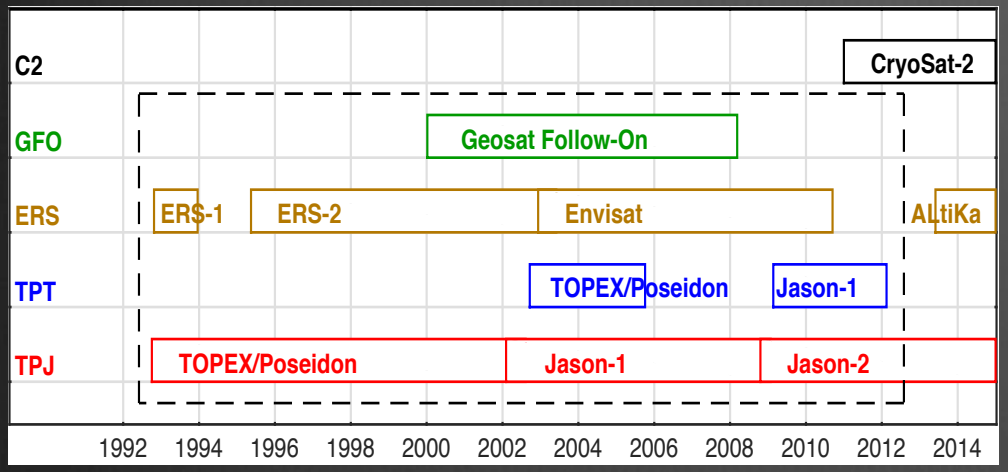


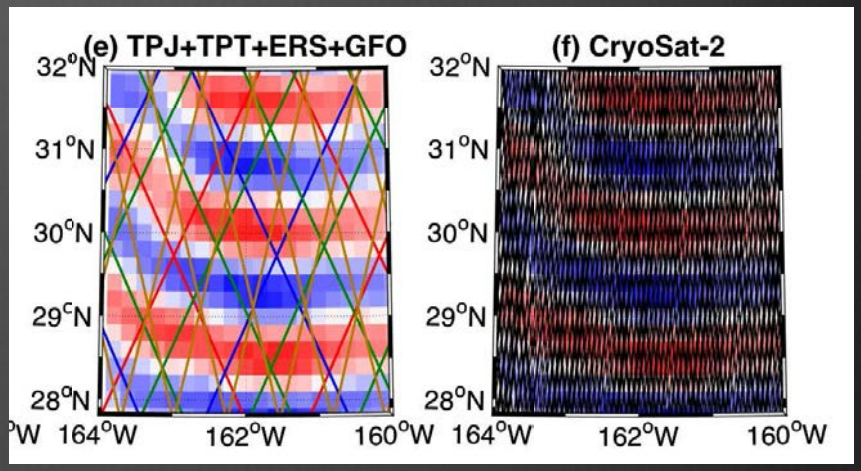
30 S/N equatorwards

Global M_2 internal tide energy and flux

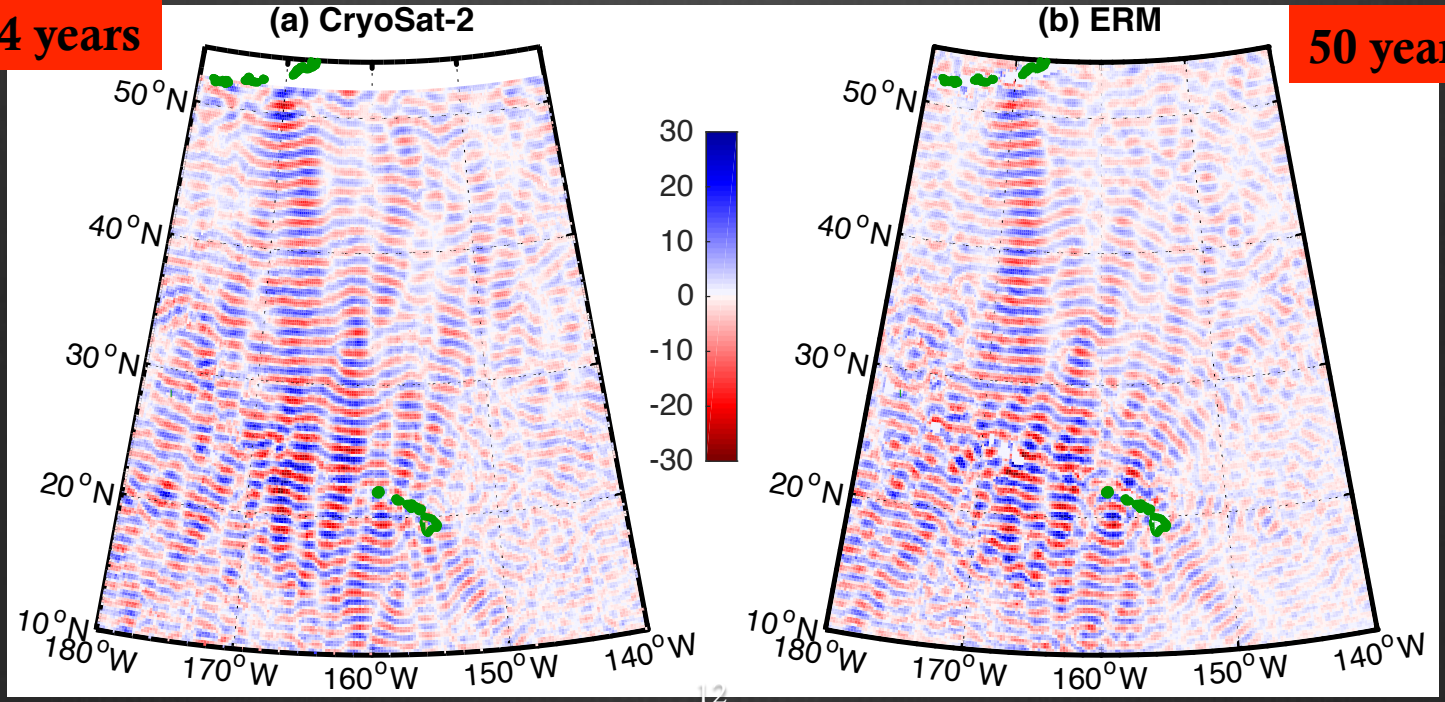


M_2 internal tides from CryoSat-2



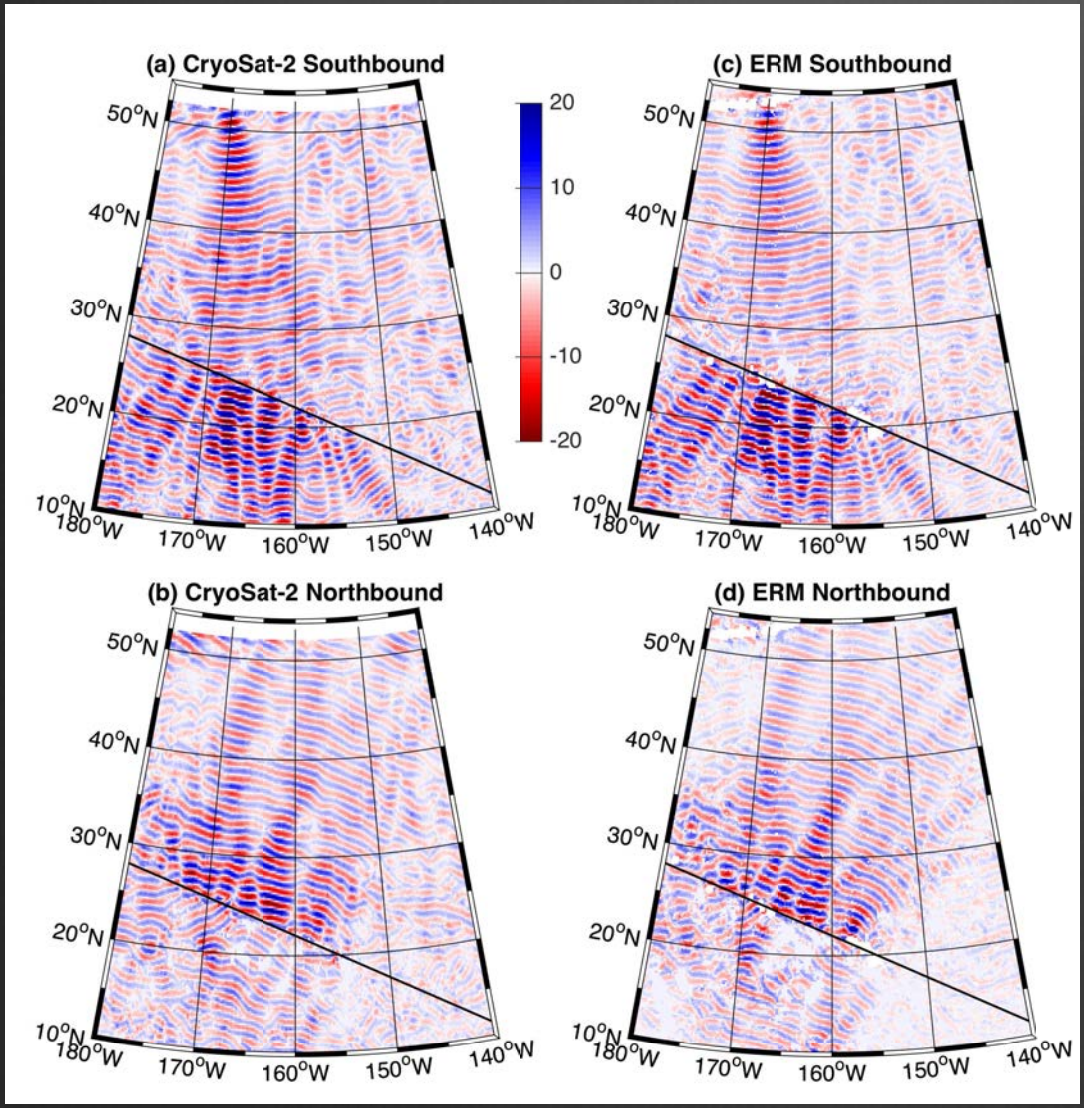


4 years



50 years

Southbound and northbound components

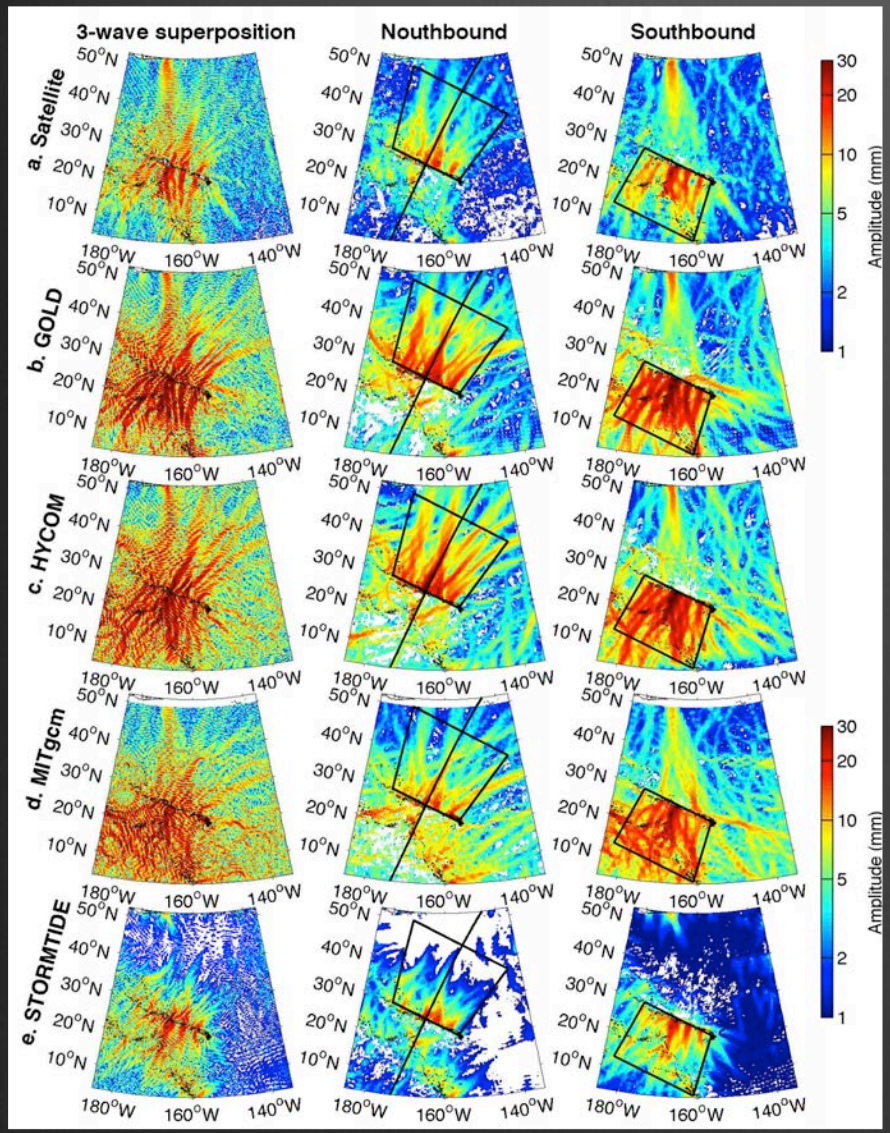


To the north of Hawaii, some discrepancies

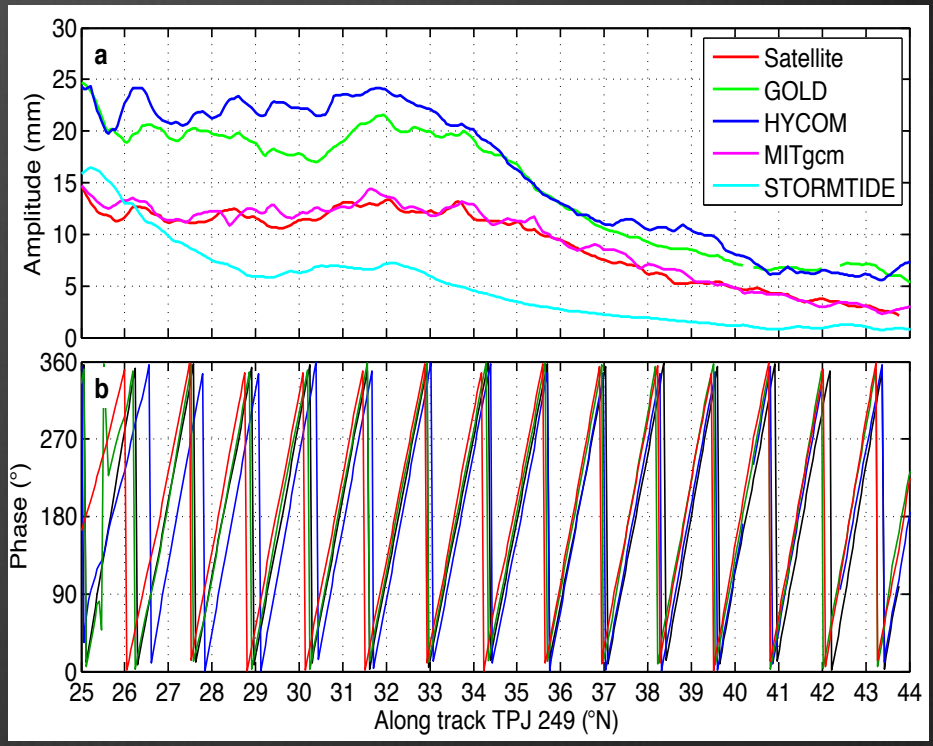
To the south of Hawaii, agree very well !!

Explain this difference
Will help understand variability of the global Internal tide field.

Comparisons with a suite of numerical models



GOLD: H. Simmons et al.
HYCOM: B. Arbic et al.
MITgcm: D. Menmenlis et al.
STORMTIDE: M. Müller



Summary

- A global internal tide model version 0.0
- This technique is applied to CryoSat-2 and a suite of numerical models

- A lot of work ahead
  - Objective metrics
  - Optimal parameters
  - Incoherence
  - Seasonal modulation
  - Inter-annual modulation
  - Model comparisons
  - ……