Studying Internal Tides from Satellite Altimetry

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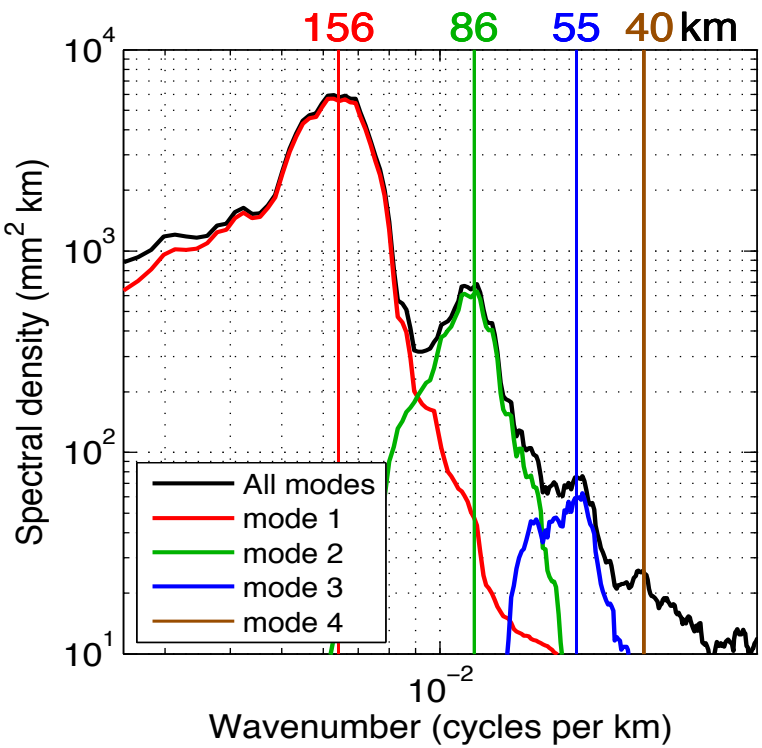
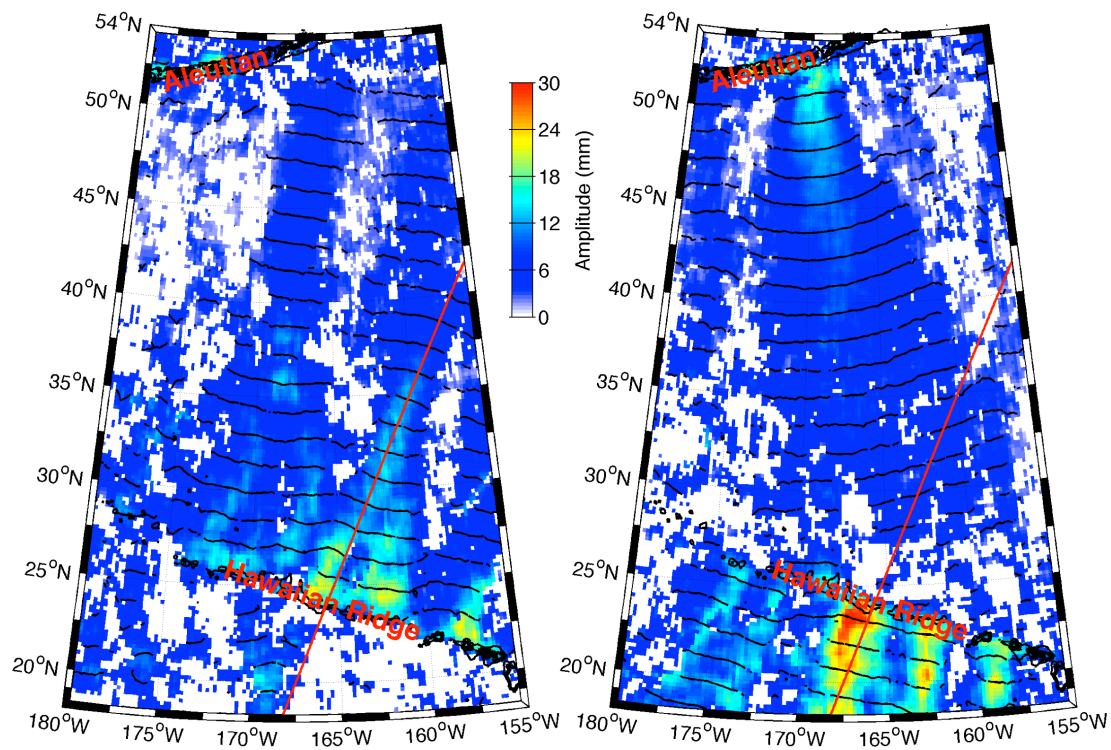
BACKGROUND: Internal tides—waves generated by tidal flow over bathymetry

- Thermocline displacements of 10–100 m *vs.* SSH variations of several mm–cm
- Horizontal scales of tens of km *vs.* thousands of km for surface tide
- Ocean mixing by wave breaking; energy dissipation of ~1 TW over the globe



Along-track SSH wavenumber spectrum



Mode-1 M_2 internal tides in the North Pacific Ocean

OBJECTIVES

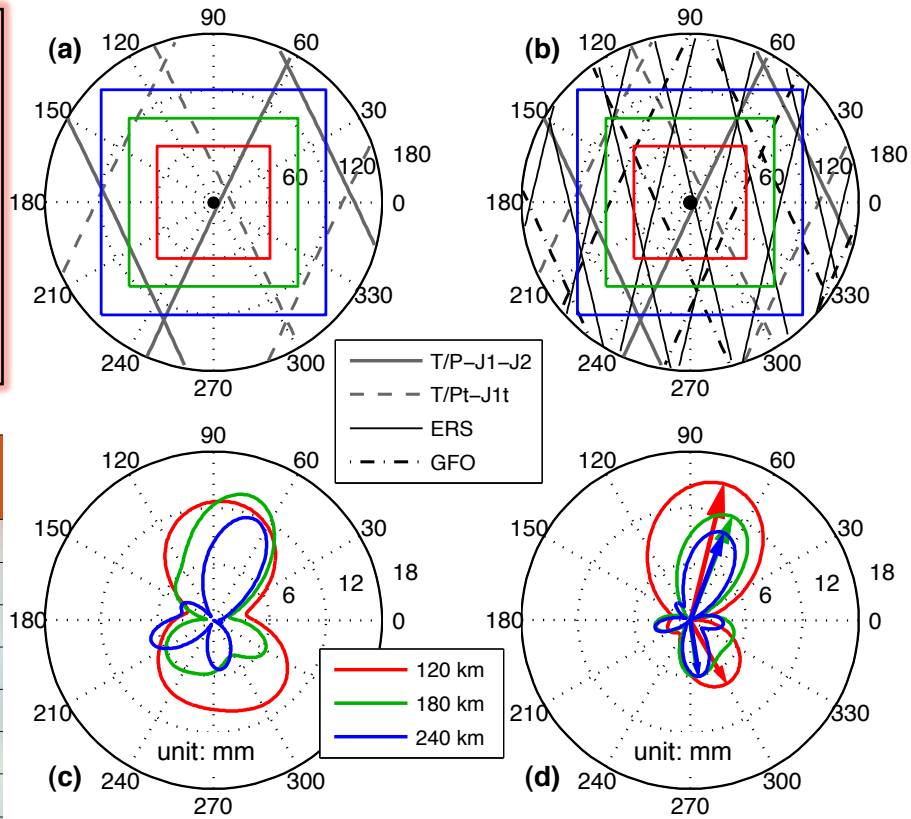
- Internal tide energy and energy transport
- Internal tide dynamics: generation, propagation, and dissipation
- Interactions with other meso-scale dynamic processes
- Internal tide model (correction for SWOT SSH data, as for surface tide)

APPROACHES

- 2-D plane-wave fitting for baroclinic modes using multiple-satellite altimetry
- Selecting significant "beams" over noise
- Validation using a database of global subsurface mooring time-series

Dataset	Satellite Altimeter	Repeat Period (day)	Total Tracks	Track Spacing (km)*	Data Period (mm/yyyy)
T/P-J1-J2	T/P	9.9156	254	315	10/1992–08/2002
	J1				02/2002–01/2009
	J2				07/2008–now
T/Pt-J1t	T/P tandem				10/2002–10/2005
	J1 tandem				02/2009–now
GFO	GFO	17.0505	488	164	10/2000–03/2008
ERS	ERS-1	35	1002	80	10/1992–12/1993
	ERS-2				05/1995–06/2003
	Envisat				07/2003–10/2010

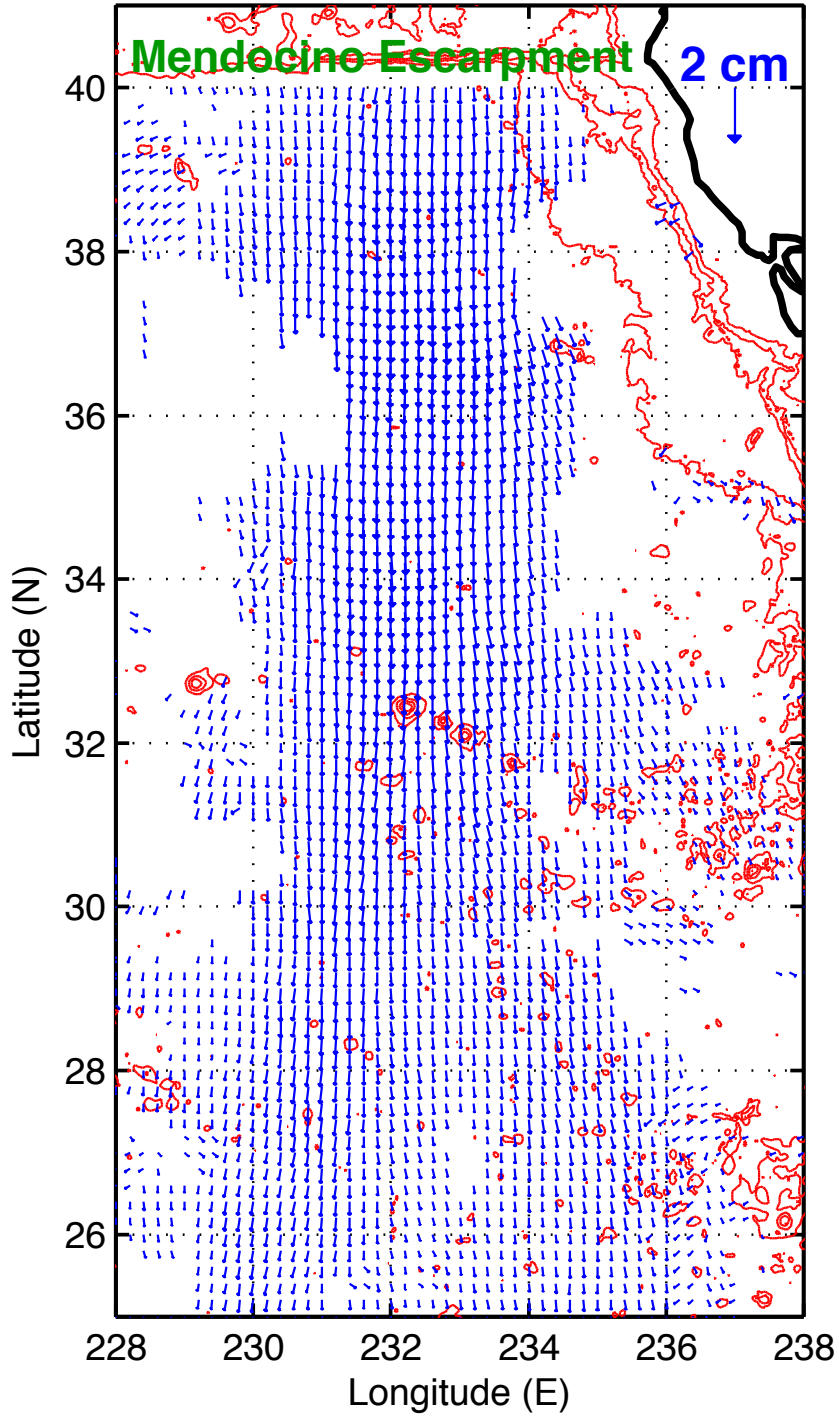
Four sets of satellite altimeter data



2-D plane-wave fitting applied to multiple-satellite altimetry

KEY PHASE-A SWOT ISSUES

- ✗ Requirements of accuracy of ground track
- ✔ Tide aliasing period
- ✔ Sub-cycle choices
- ✗ Requirements of higher-resolution data (better than 1 km spatial resolution)
- ✔ Error budget (depends on SWOT's operation length)
- ✔ High-level gridded data products
- ✔ **Fast-repeat cycle track selection**
  - **Mendocino Escarpment**
  - **Southbound propagation**
  - **Full-profiling moorings**



Mode-1 M_2 internal tides off the West Coast ↗