Internal waves, tides, eddies and wind-driven currents across the inner shelf

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Inner Shelf: Opening the Black Box Connecting the Coastal Ocean and the Surf Zone

Nonlinear internal waves and bores

Rip currents and eddies

Wind-driven cross-shelf circulation

Fedderson (SIO)
Internal wave convergence lines & influence on biology

“bait balls” in echosounder

murrès lined up offshore

feeding dolphins

foam line
OBJECTIVES: INNER SHELF (5-50 m)

• measure & understand processes that contribute to exchange
  1. shoreward transport of material by **nonlinear internal waves and bores**
  2. cross-shelf eddy flux from current instabilities

• Use in-water data to interpret and understand **remotely-sensed data** (X-band radar, aircraft, satellite)

• produce an inner-shelf data set that will be used to verify and advance **numerical ocean circulation models**

field worked: calm conditions in September; increasing waves in October
Inner Shelf Experiment
September – October 2017
north of Point Conception, California
Deploy a high-spatial resolution moored array – in collaboration with ISDRI colleagues – from the mid-shelf to the edge of the surfzone

**OSU**: 8 bottom landers w/ADCPs; 11 temperature string moorings with pressure, GusTs, & chipods (total of 80 moorings on shelf; another 80 in surfzone)
Internal Tide Generation

\[ \gamma = |\nabla h| \left( \frac{\omega^2 - f^2}{N_b^2 - \omega^2} \right)^{-0.5} \]

\( \gamma < 1 \) transmission
\( \gamma = 1 \) generation
\( \gamma > 1 \) reflection

Kumar et al. 2018
Repeatedly measure the cross-shelf and vertical distribution of hydrographic and velocity fields across the mid to inner shelf and relate them to wind forcing

CTD, ADCPs (hull & pole), GusTs, bowchain, radiometer, radar
But what about the subtidal hydrography & circulation ...

repeated flux box around mooring array
~10 times around box; ~2.5 tidal cycles

removes internal tide &
Nonlinear Internal Waves/bores

Surface-intensified, southward upwelling jet overriding weak northward flow

Classic wind-driven Ekman layer offshore, onshore return flow beneath
Summary

- Internal bore fronts coherent along-shore ~40 km
  - internal waves can vary <1 km along shore
- 2 internal bores every semidiurnal period
  - 80% of them are observable to the 15m isobath
  - 30% can be tracked to the 9m isobath
- Changes in the wave guide within the shoaling region and over the 2 months
  = upwelling and wind relaxation
- Next up: flux estimates from ship and moorings

Collaborators: Mick Haller, Alex Simpson, Jen MacKinnon, Amy Waterhouse, John Colosi, Jim Moum, Johannes Becherer, Jamie MacMahan and many others