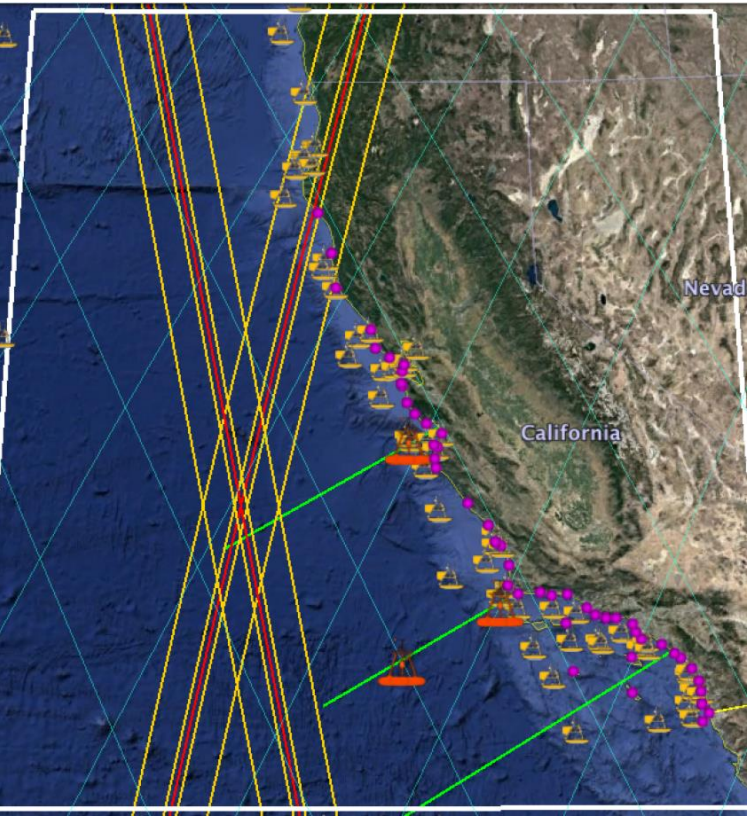
Regional modeling challenges in the California Current



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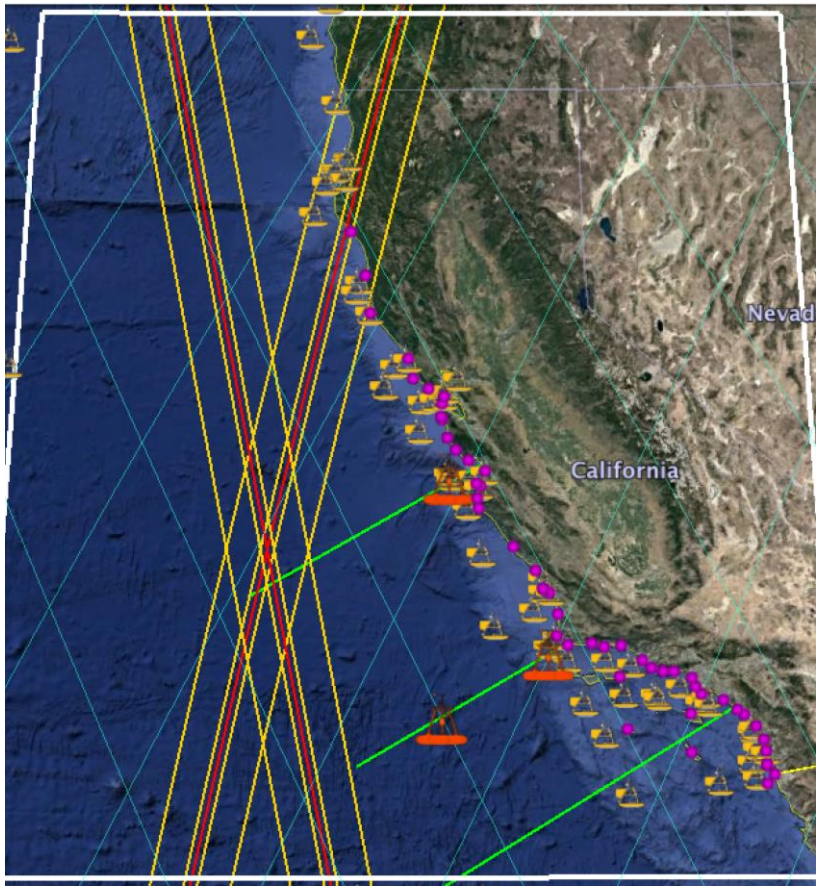
[1]Scripps Institution of Oceanography,
[2]Jet Propulsion Laboratory, California Institute of Technology

California Current: Test bed for SWOT



Goal: Develop regional version of MITgcm to assimilate SWOT data, resolving small-scale features including tides and internal waves

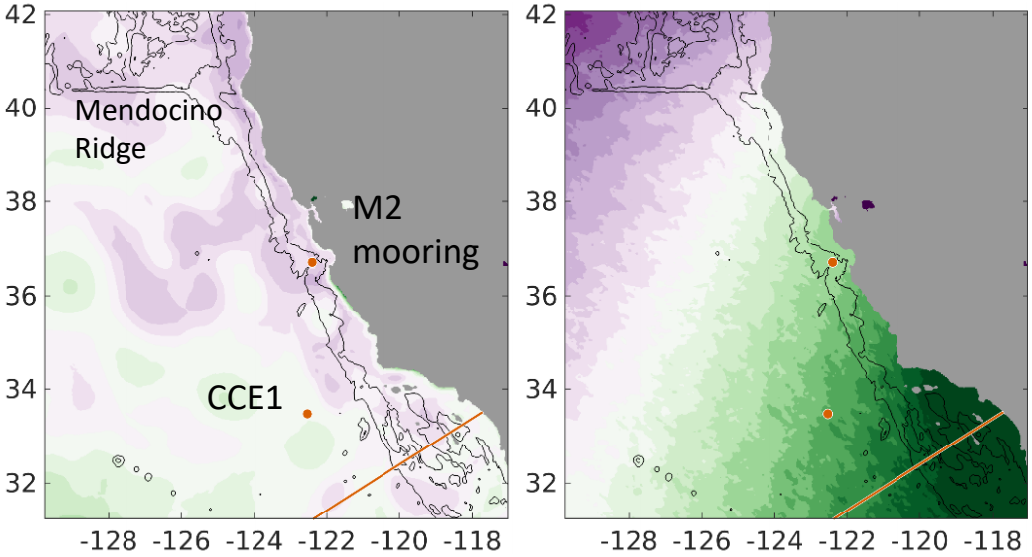
Build on existing regional ECCO machinery and network of observations

- Moorings
- HF radar
- Buoys (NDBC)
- Glider lines
- Nadir altimetry (Jason)
- SWOT (swath boundaries)

Building models with internal wave propagation

- MITgcm
- ~2 km resolution
- Tidal forcing
- 90 vertical levels allows internal waves to propagate
- Global model: expensive to run

Global model ("llc4320")



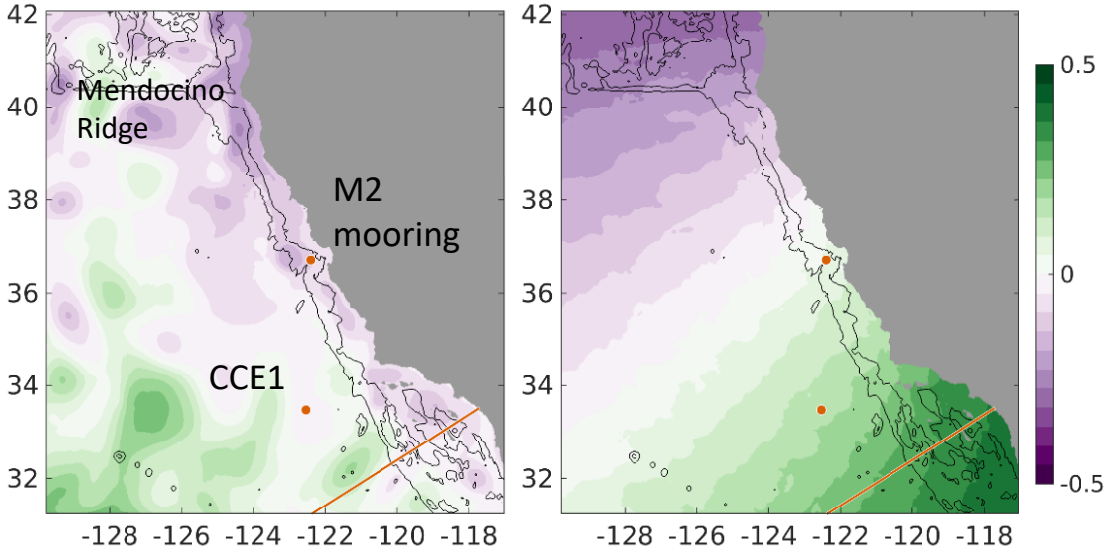
Low-pass filter: slowly-varying field

High-pass filter: rapid tidal motions

Building (regional) models with internal wave propagation

- MITgcm in regional form
- ~2 km resolution
- Tidal forcing on boundaries and surface
- 90 vertical levels allows internal waves to propagate

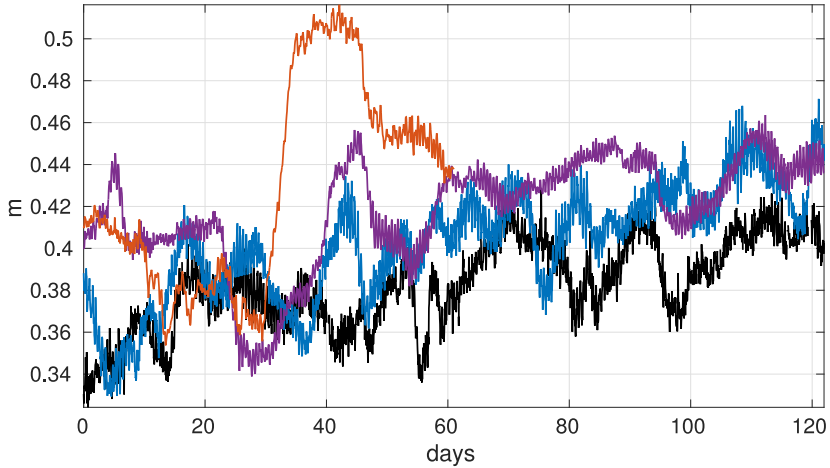
Regional model (MITgcm at 2 km)



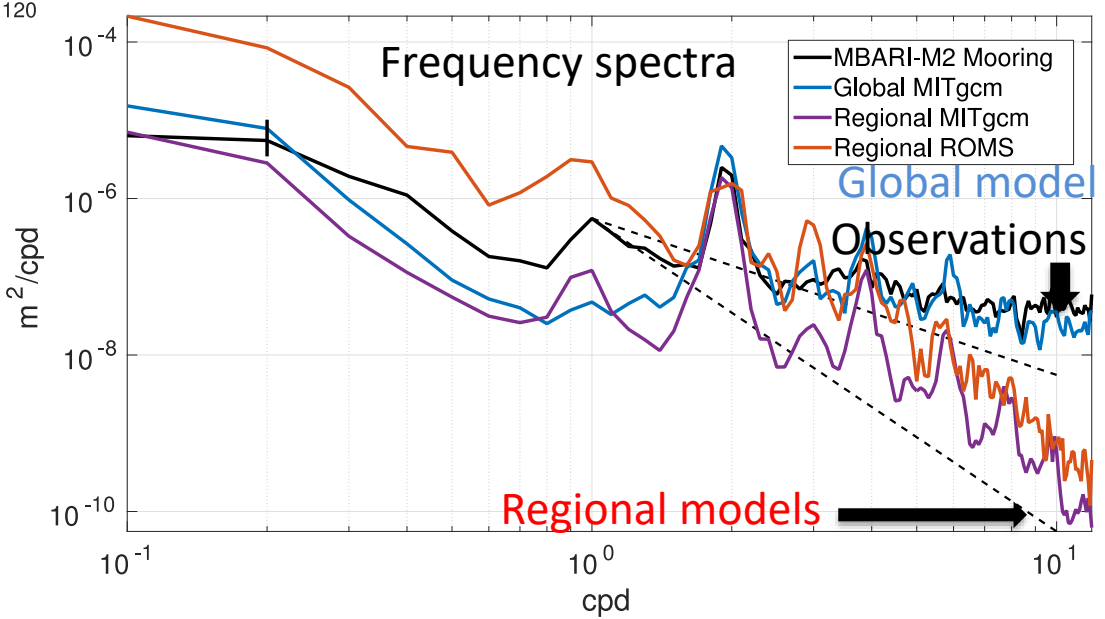
Low-pass filter: slowly-varying field

High-pass filter: rapid tidal motions

MBARI M2 mooring (June-Sept)
Dynamic height



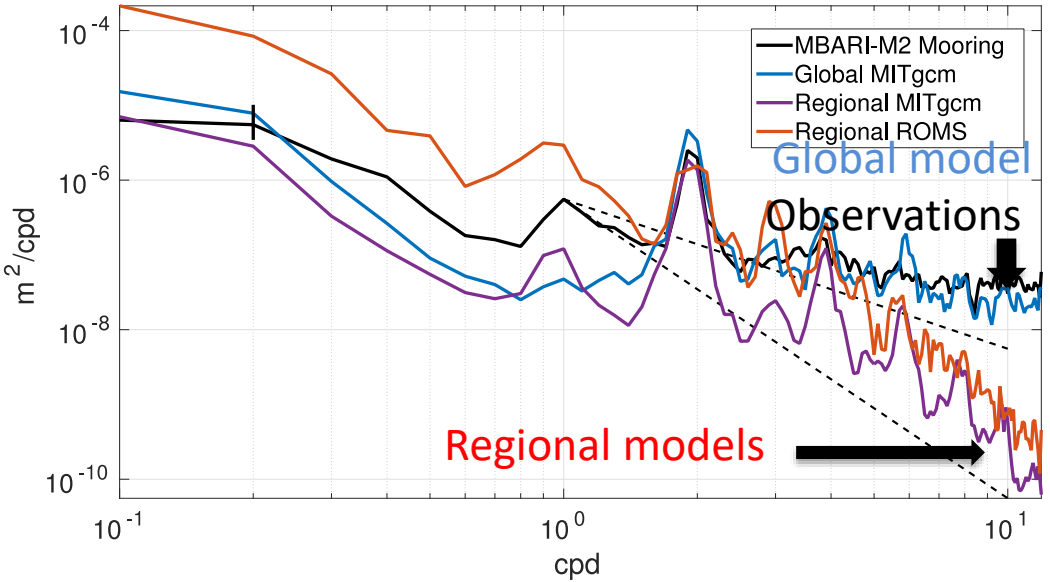
Time (days from 1 June)



Can a regional model generate enough internal wave energy?

Regional tests

- **Mooring** has high-frequency energy
- Global model (llc4320 MITgcm) replicates mooring energy
- Regional MITgcm and ROMS missing high-frequency energy
- Checked other moorings; ruled out interannual variability



Hypotheses:

- Mooring data noisy; global model too energetic
- Open boundaries don't let in enough energy

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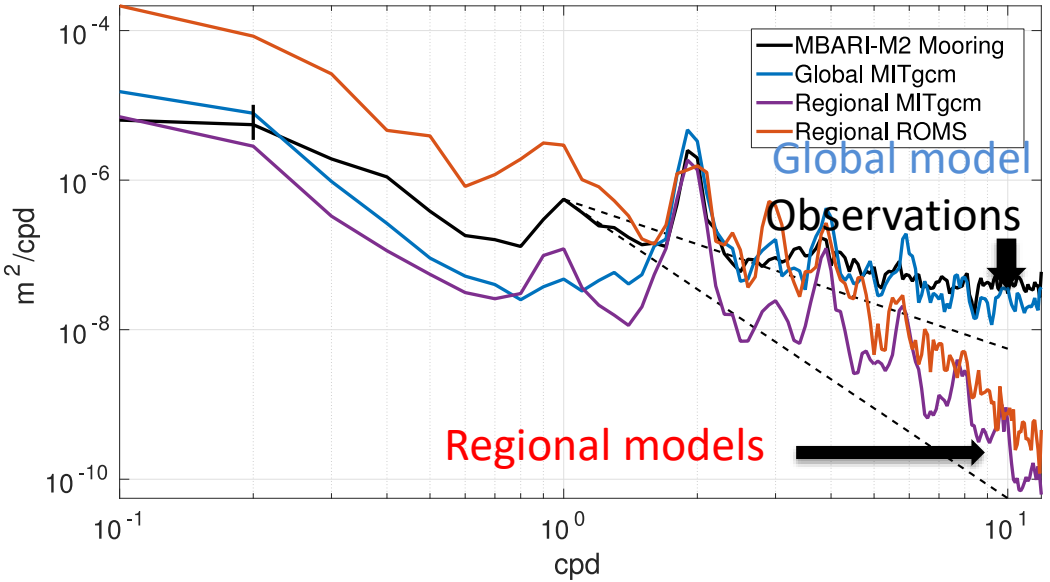

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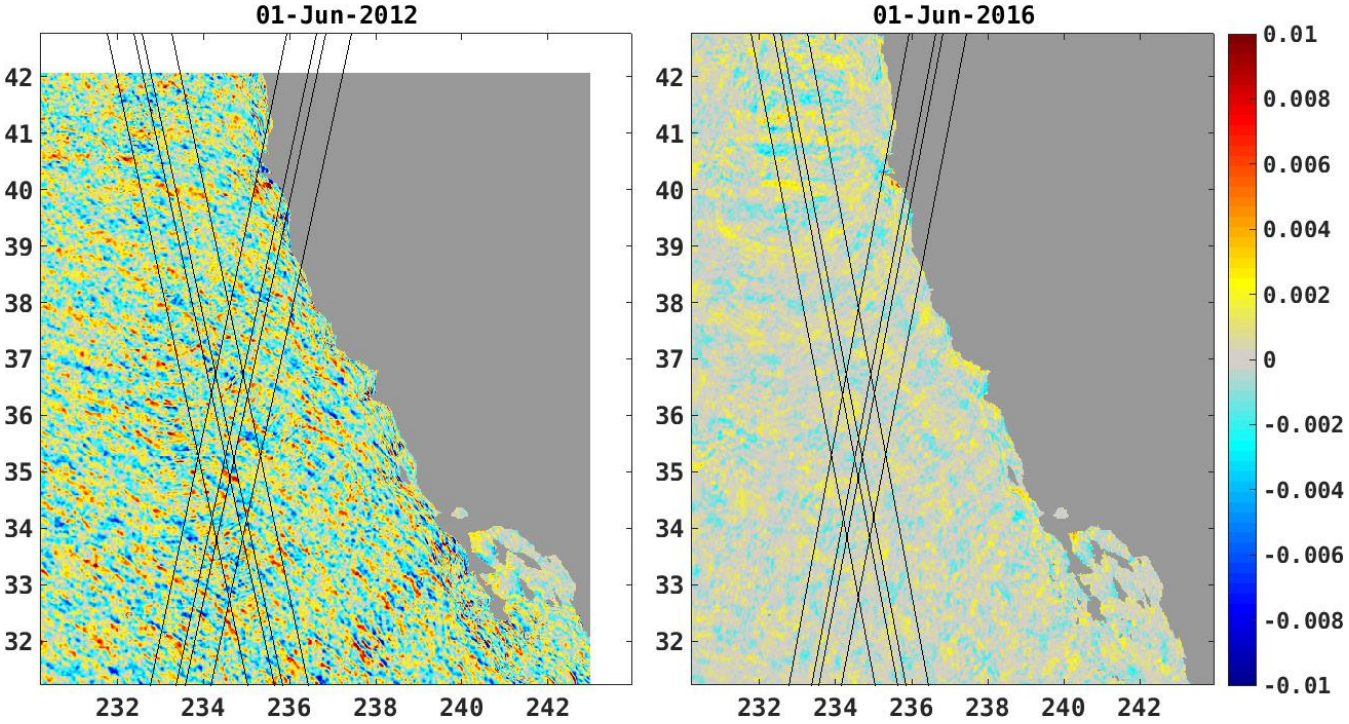
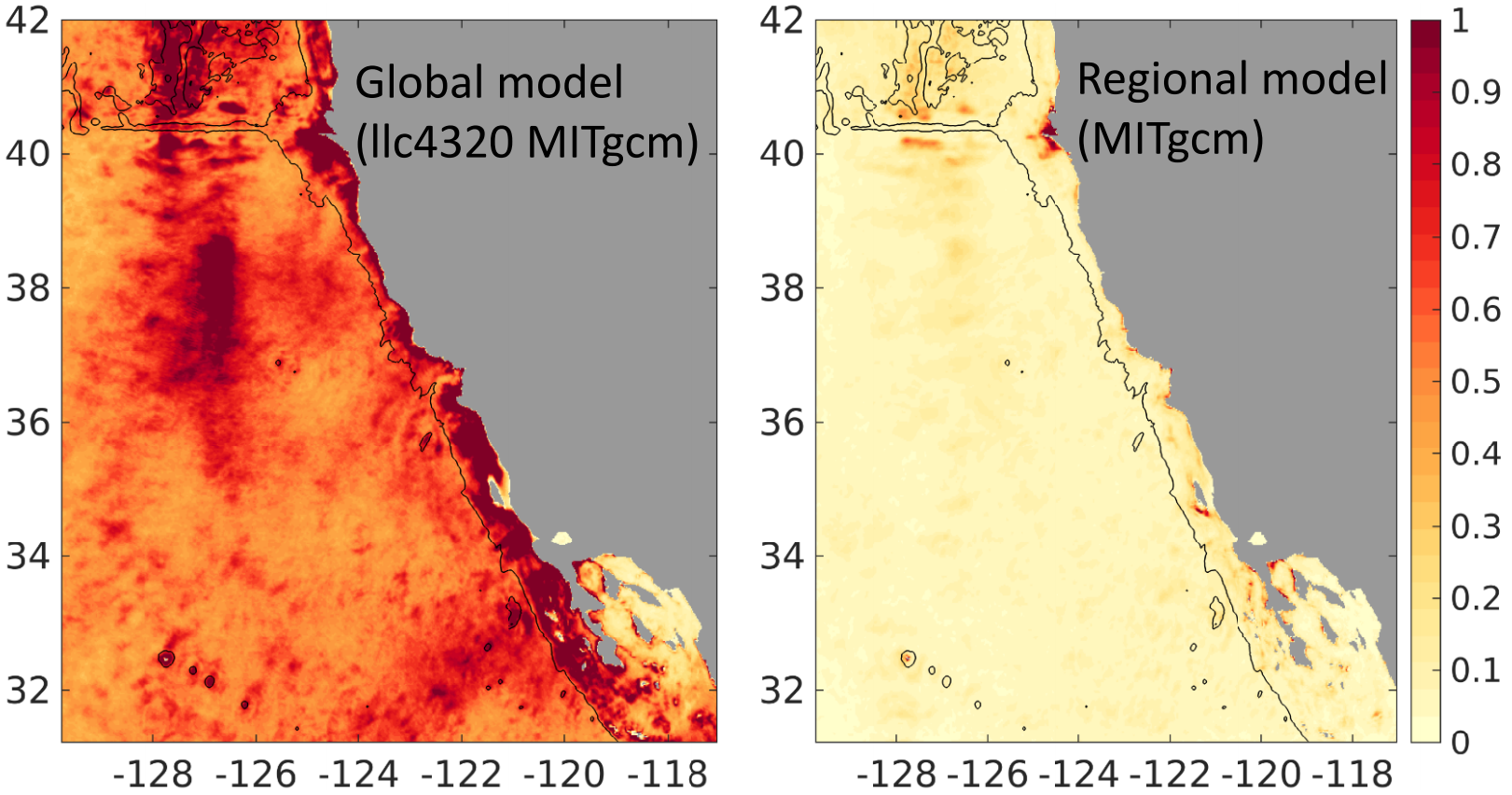
Vertical velocity



Global model: llc4320

Regional model: MITgcm with open boundaries

Larger vertical velocity variance in global model

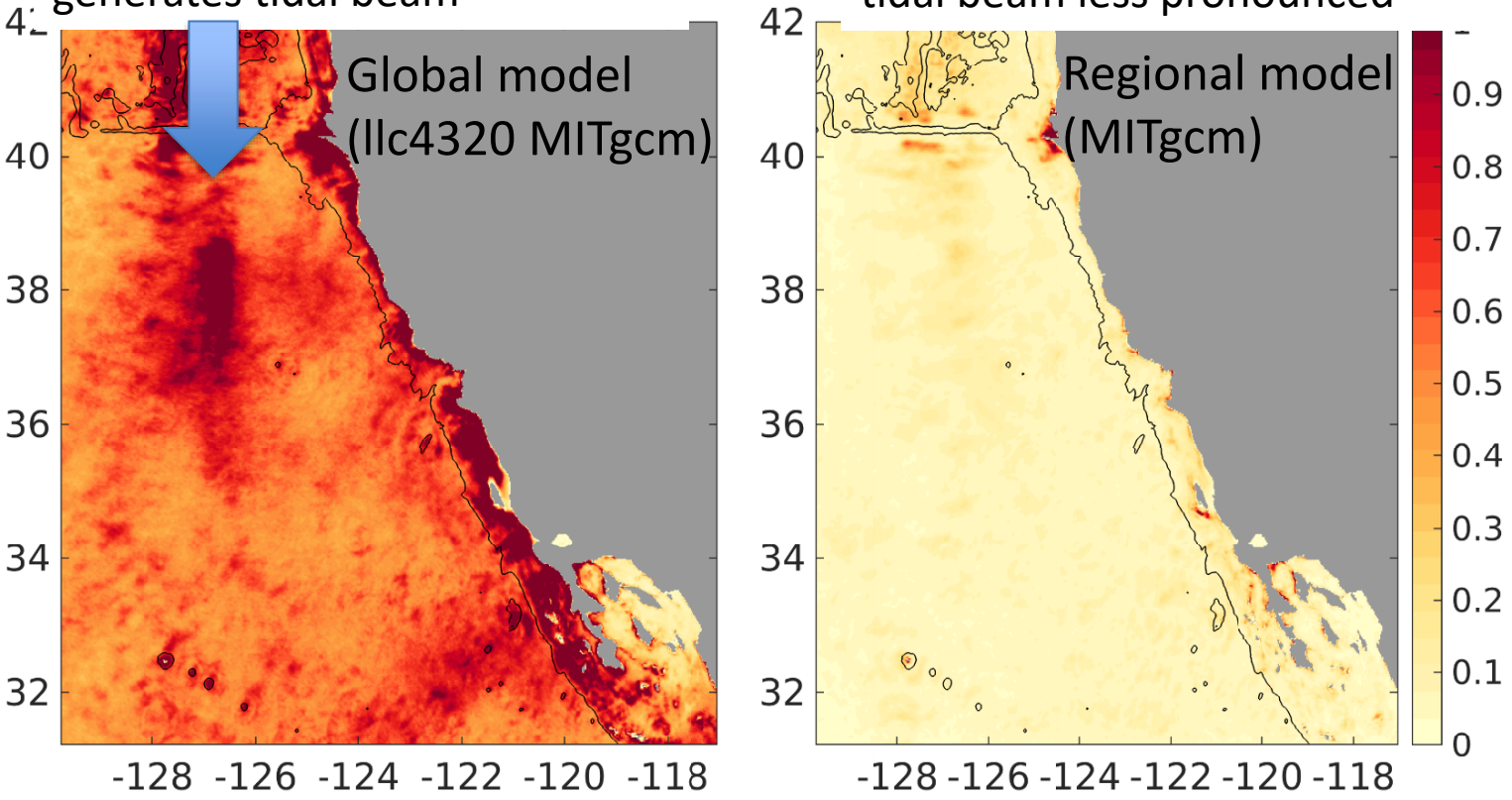


W variance at 500 m; black contour = 3000 m bathymetry

Larger vertical velocity variance in global model

Mendocino escarpment generates tidal beam

Mendocino escarpment tidal beam less pronounced



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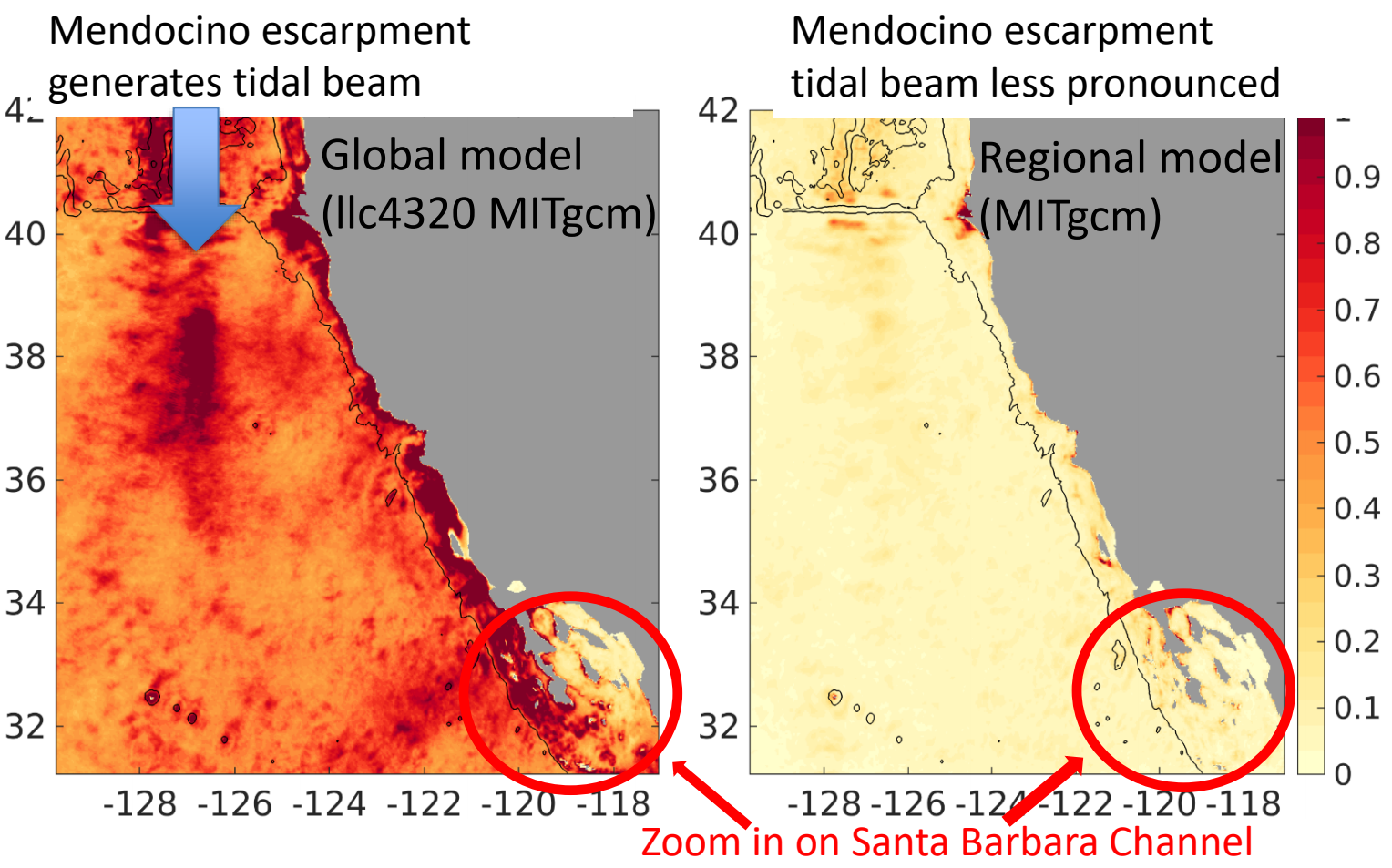
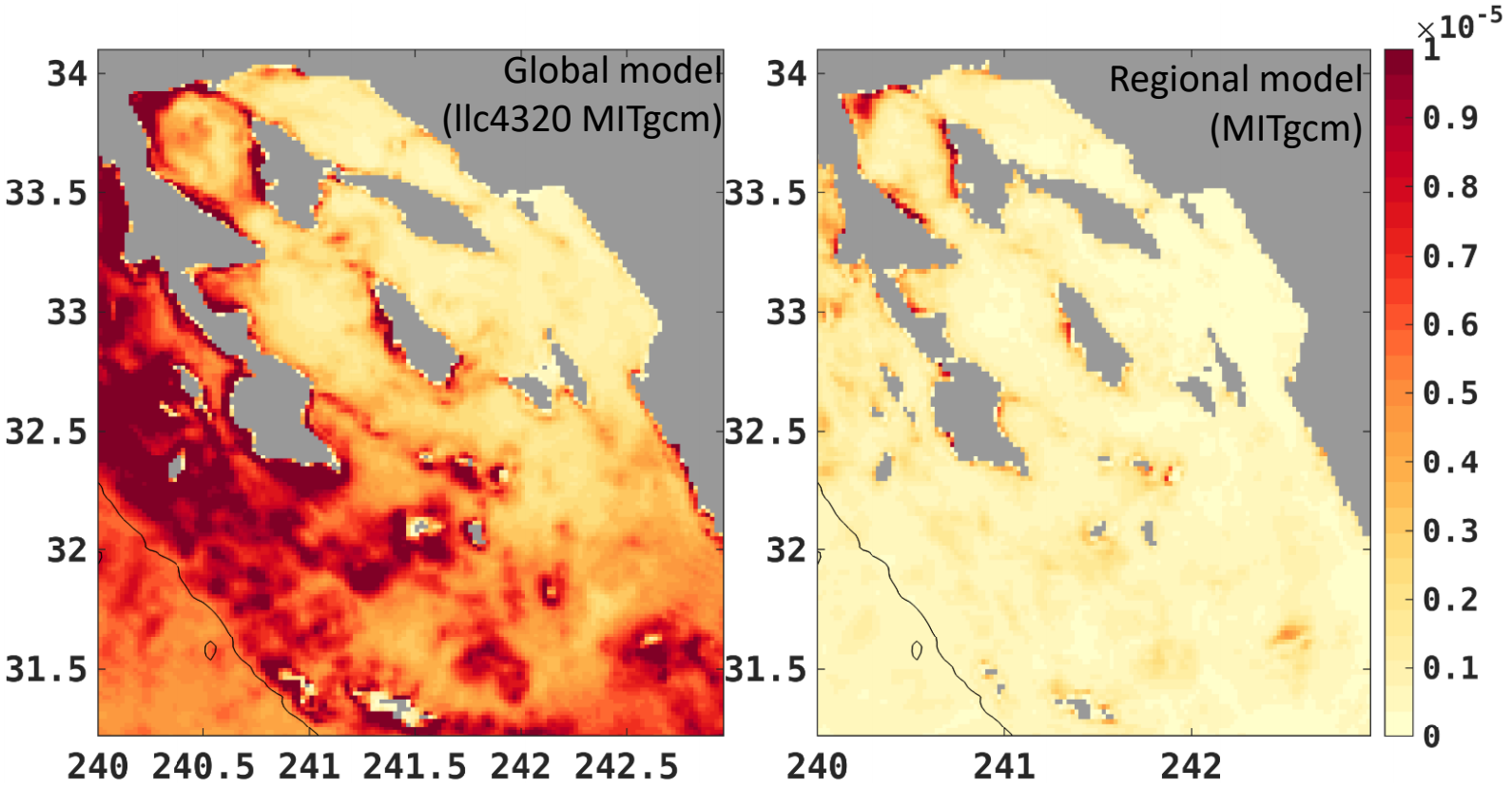
Larger vertical velocity variance in global model

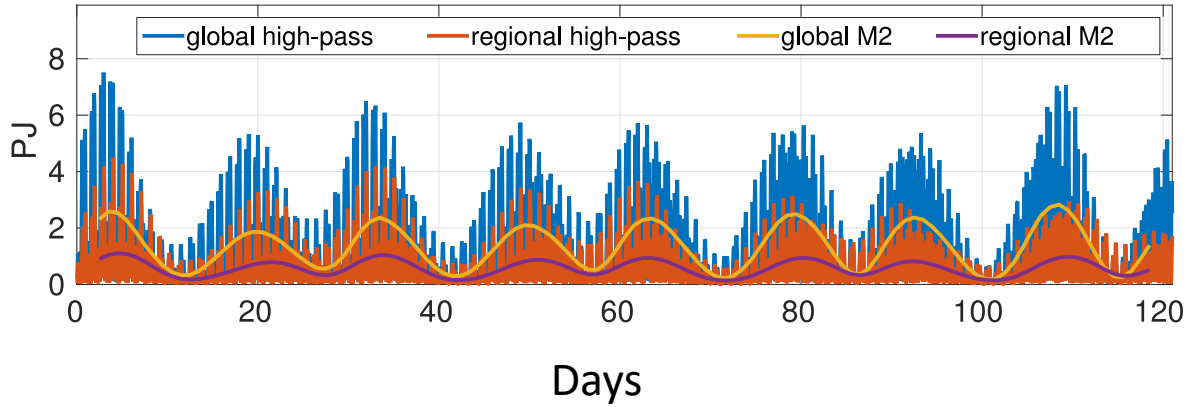


Vertical velocity comparable in SoCal Bight, in lee of islands



Barotropic energy varies with spring tide

Barotropic energy



Global average: 1.40 PJ

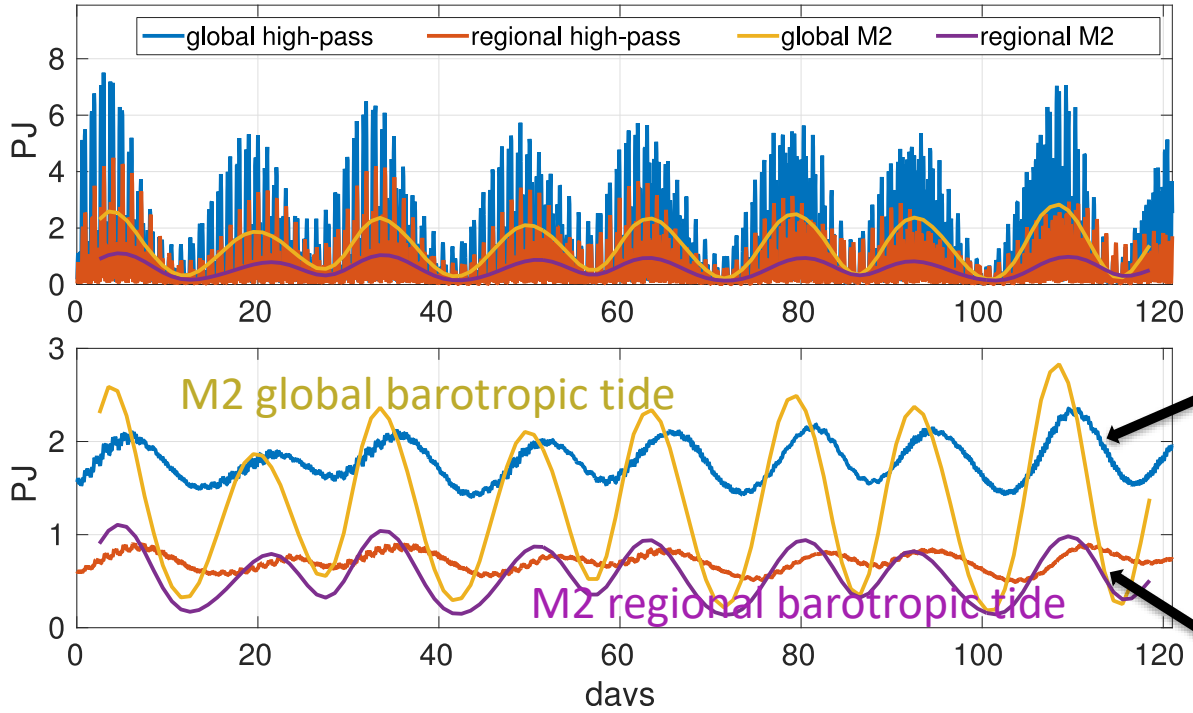
Regional average: 0.71 PJ

Global model (llc4320) M2 tides are known to be too energetic, which accounts for difference.

Baroclinic energy proportionally greater in global model

Barotropic energy

Baroclinic energy (lags barotropic M2 tide)



Global baroclinic energy exceeds barotropic energy by 0.39 PJ.

Regional baroclinic energy matches barotropic.

High-frequency energetics

Global model

Barotropic: 1.40 PJ
Barotropic (M2): 1.33 PJ
Baroclinic: 1.79 PJ

Regional model

Barotropic: 0.71 PJ
Barotropic (M2):0.57 PJ
Baroclinic: 0.71 PJ

Ratios (global/regional)

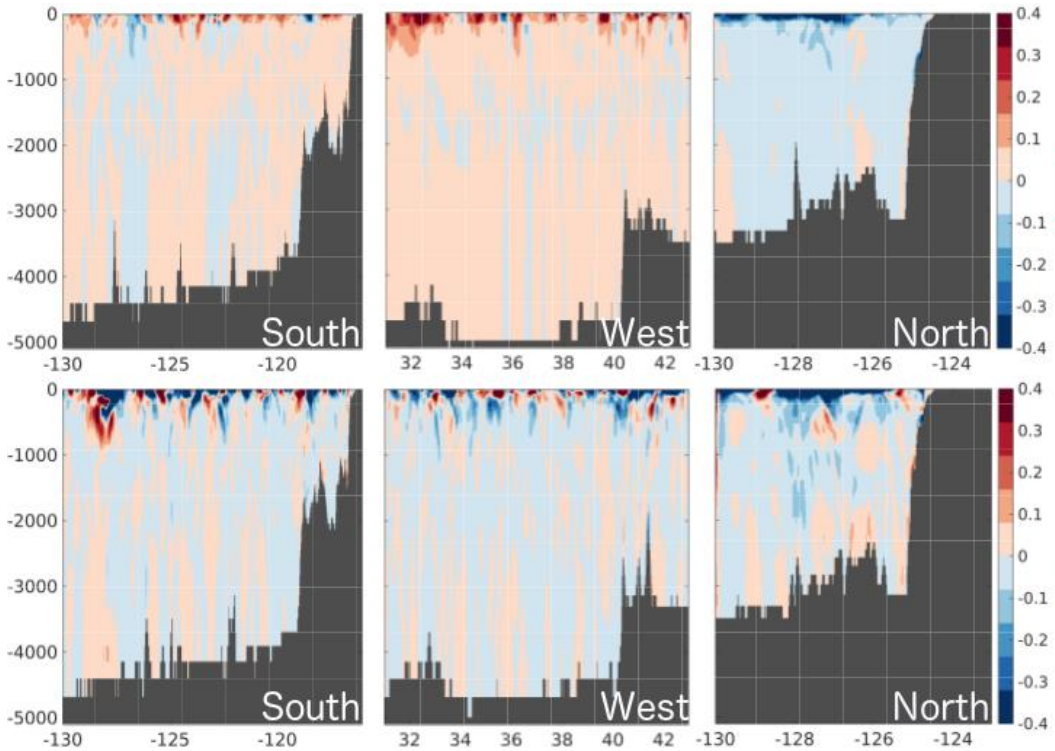
Barotropic: 2.0
Barotropic (M2): 2.3
Baroclinic: 2.5

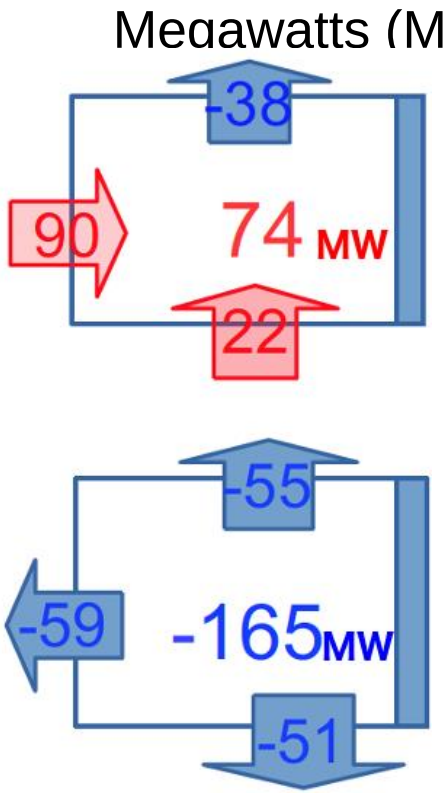
Hypothesis: If dynamics linear, extra baroclinic energy in global model consistent with source outside regional domain

Internal wave energy flux (u'p')

Global

Regional





Positive: energy into the domain. Negative: energy out of the domain.

Summary and Conclusions

- Small-scale and high-frequency processes occur in the California Current region in observations and global model, but not in regional model
- Energy originates outside of regional domain (e.g. western Pacific).
- Discrepancies of 239 MW in flux and 0.39 PJ in energy consistent with 18.9-day residence time for kinetic energy
- Future work: Regional models that represent internal waves will need a new strategy to input energy at open boundaries.