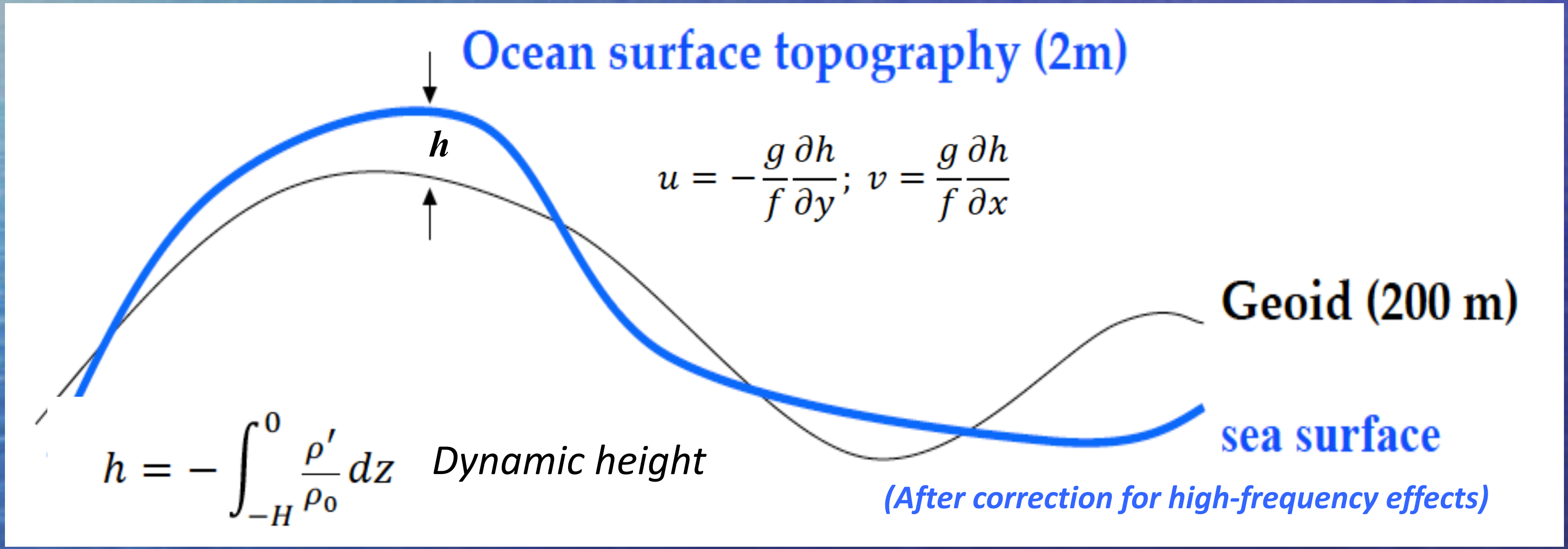
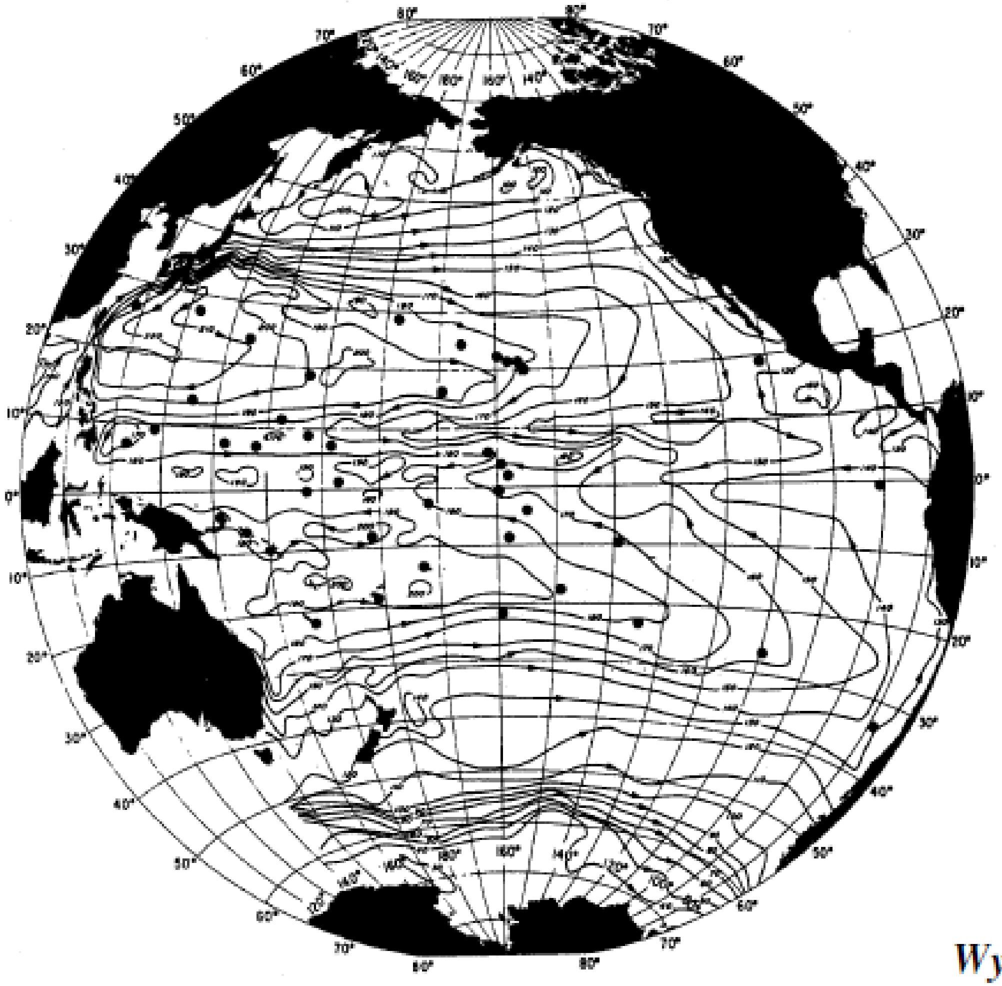
Ocean in-situ calval

Lee-Lueng Fu
Jet Propulsion Laboratory
California Institute of Technology

Ocean surface topography and dynamic height



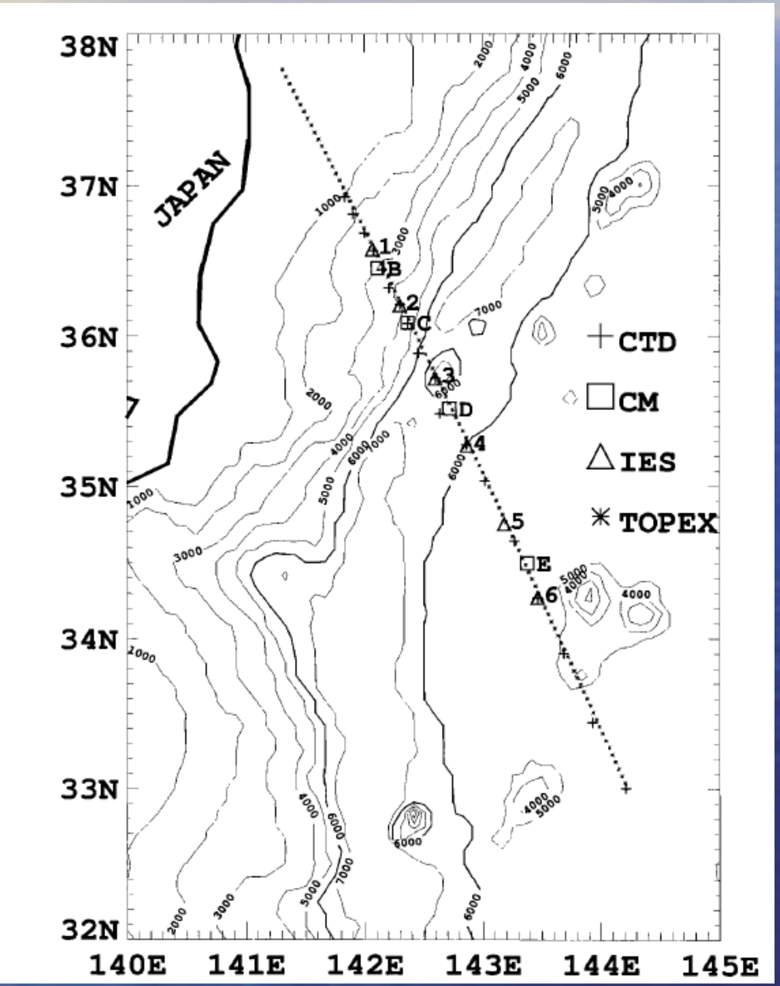
Ocean surface topography computed from temperature and salinity data collected in the ocean (relative 1000 db surface).

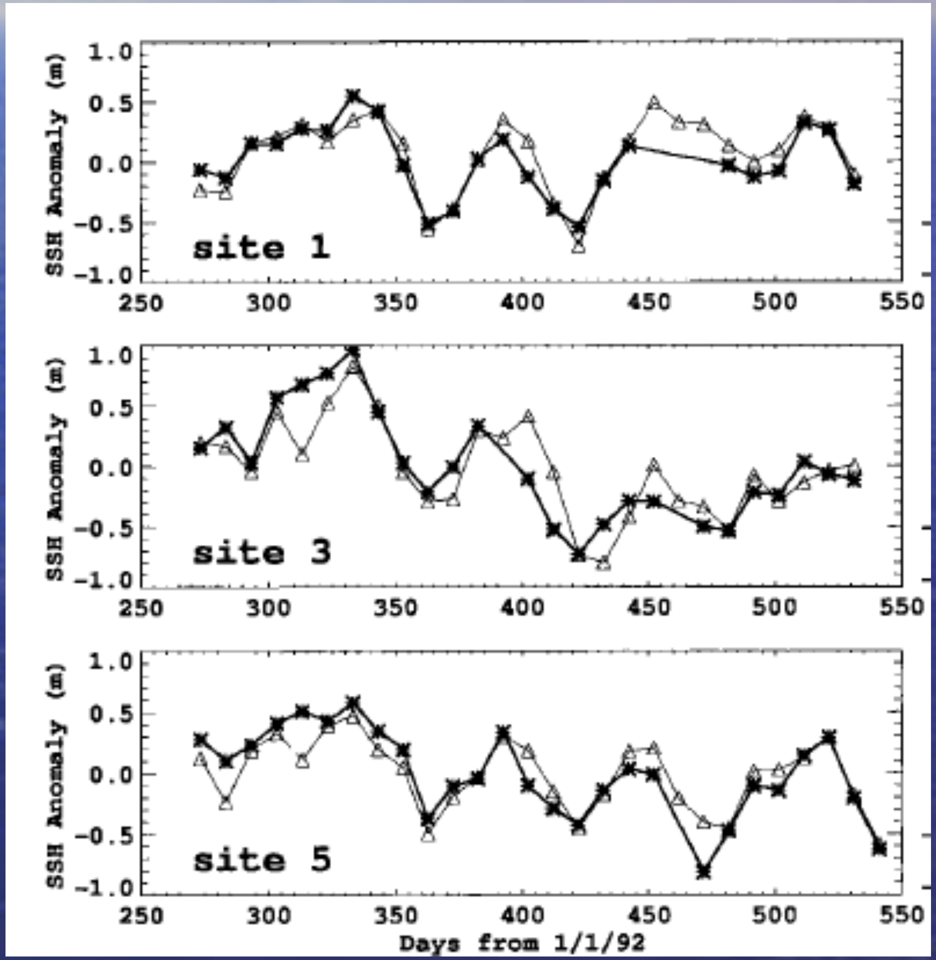


Wyrtki (1979)

Examples of Conventional Altimetry

Comparison of TOPEX/Poseidon SSH to the dynamic height estimated by Inverted Echo Sounder observations

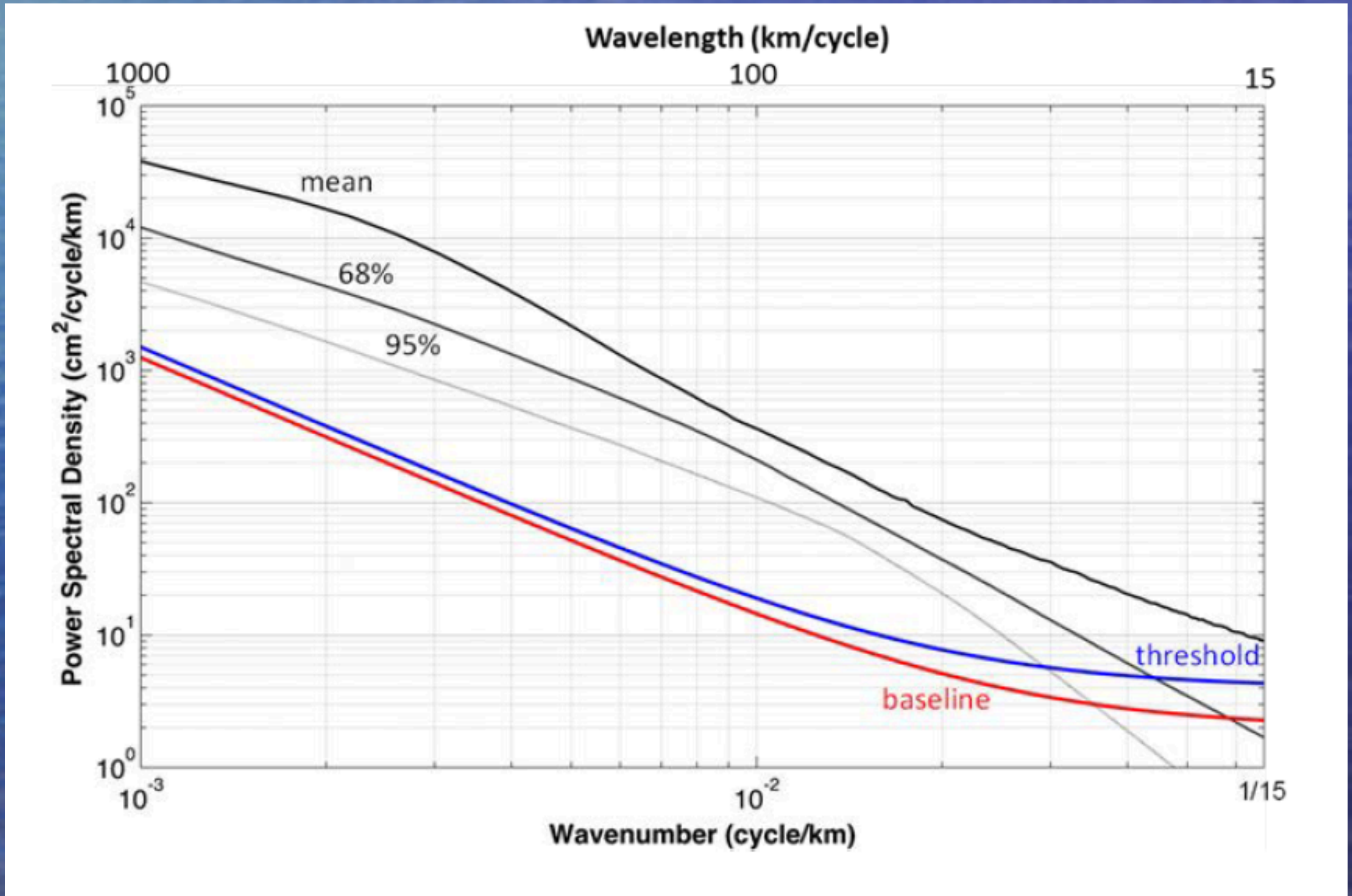




Teague et al, 1995

SWOT oceanographic objectives

The primary oceanographic objectives of the SWOT mission are to characterize the ocean mesoscale and submesoscale circulation determined from the ocean surface topography at spatial resolutions of 15 km (for 68% of the ocean).



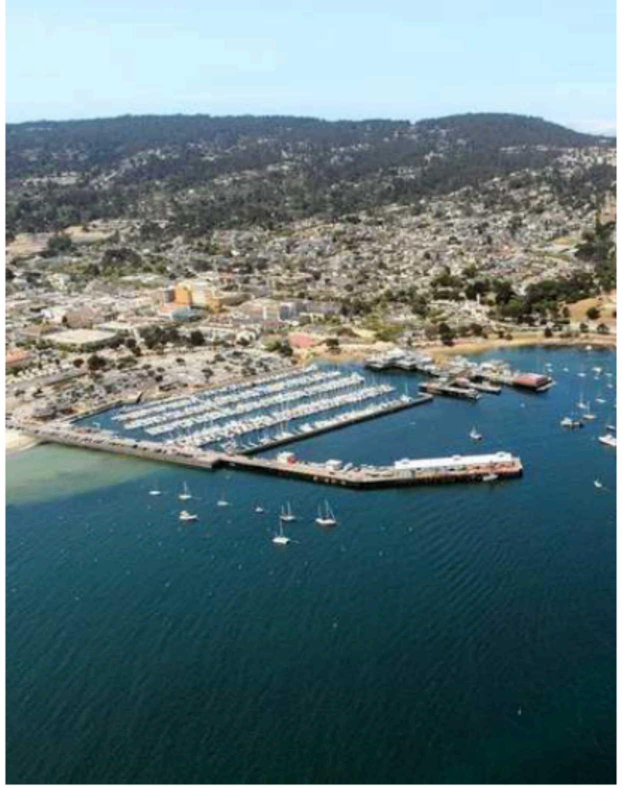
SWOT ocean calval objectives

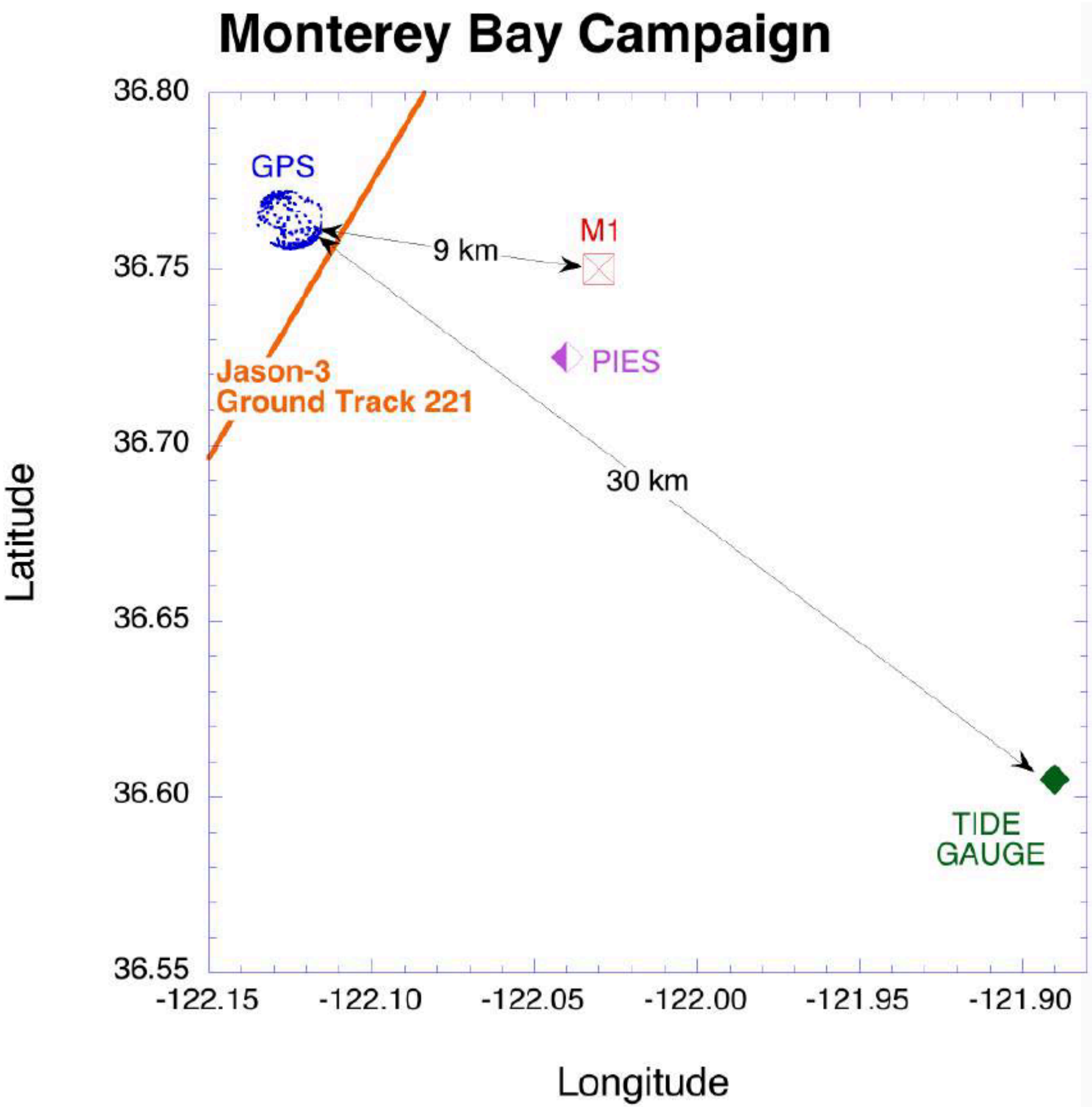
- Geodetic validation - validate the measurement of SSH to meet the wavenumber spectrum requirement
- Oceanographic validation – validate the utility of the SSH measurement to meet the science objectives

The GPS experiment in the Monterey Bay campaign

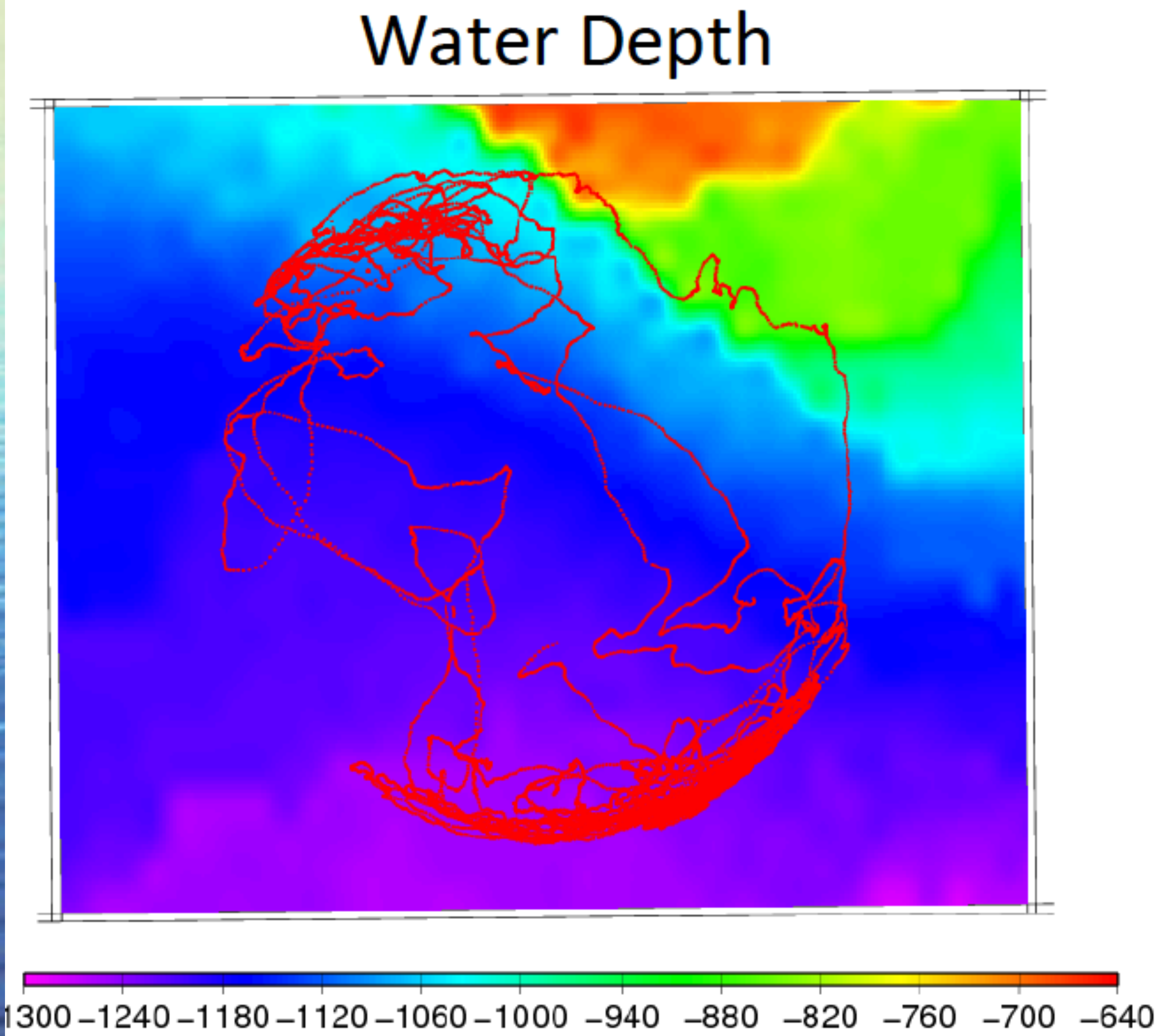
Bruce Haines
Jinbo Wang
Lee-Lueng Fu

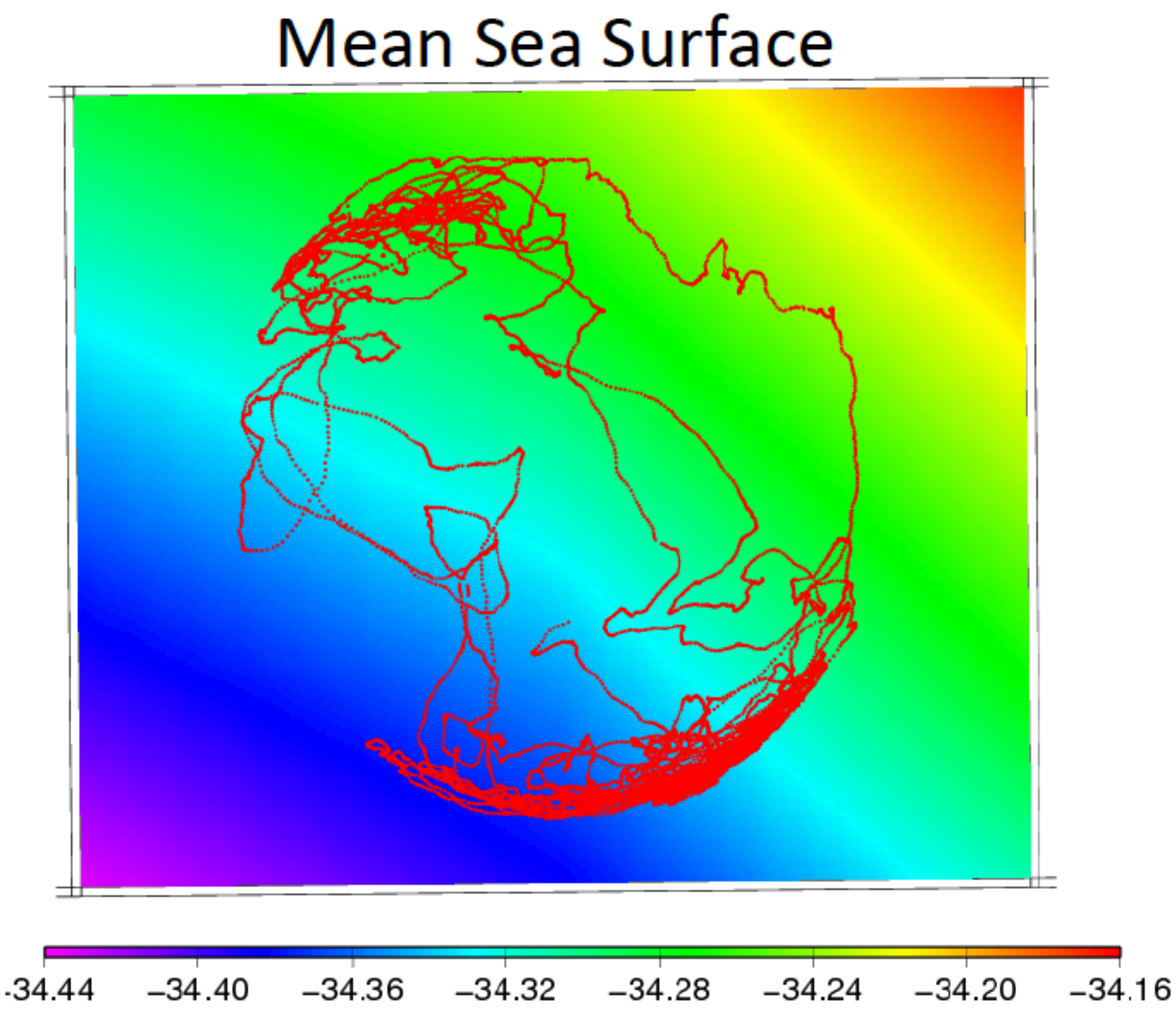
Jet Propulsion Laboratory
California Institute of Technology




Monterey Bay Campaign
36.80
36.75
36.70
36.65
36.60
36.55
Latitude
-122.15
-122.10
-122.05
-122.00
-121.95
-121.90
Longitude
GPS
M1
9 km
PIES
Jason-3
Ground Track 221
30 km
TIDE
GAUGE

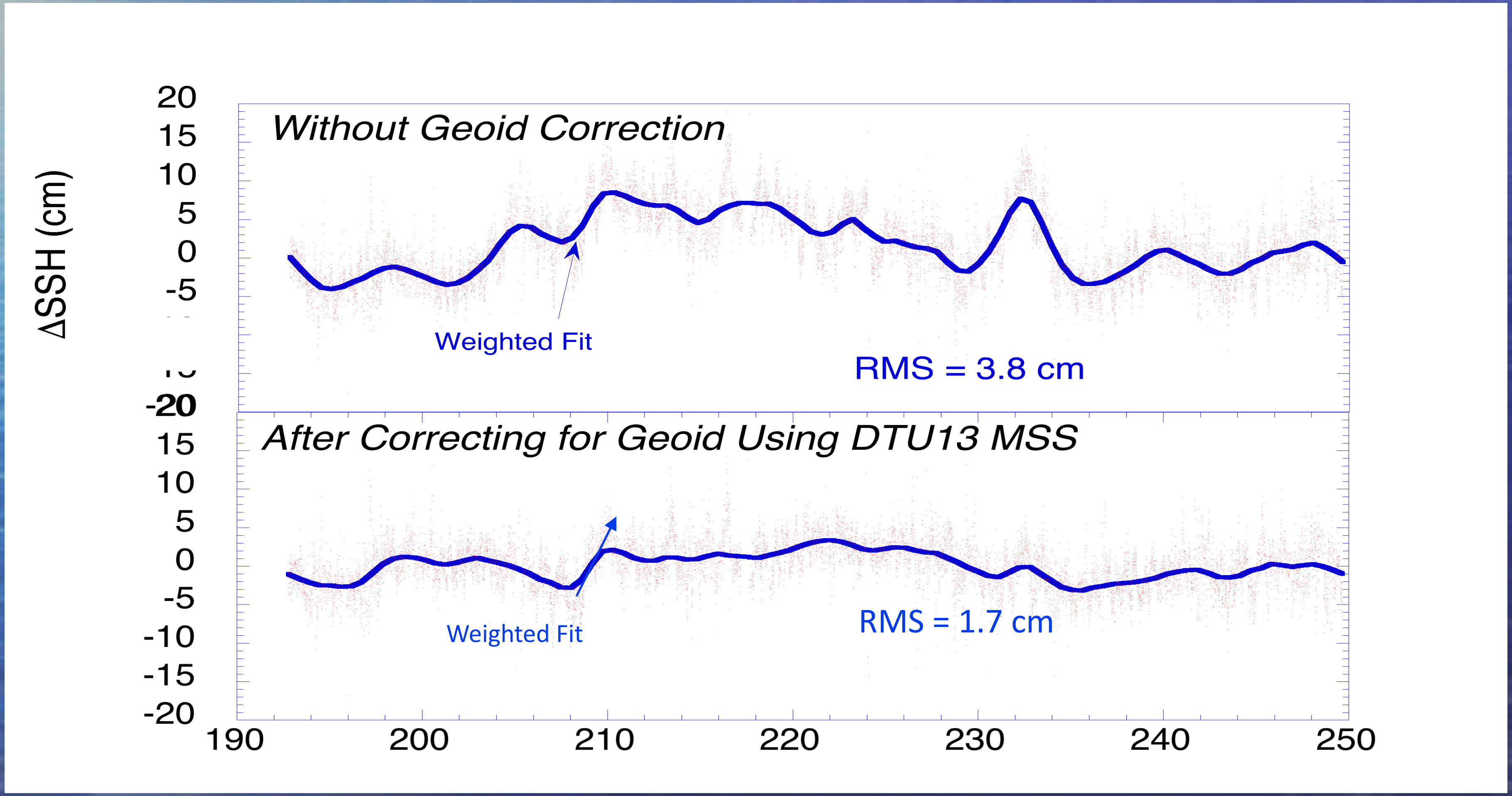
GPS mooring watch circle





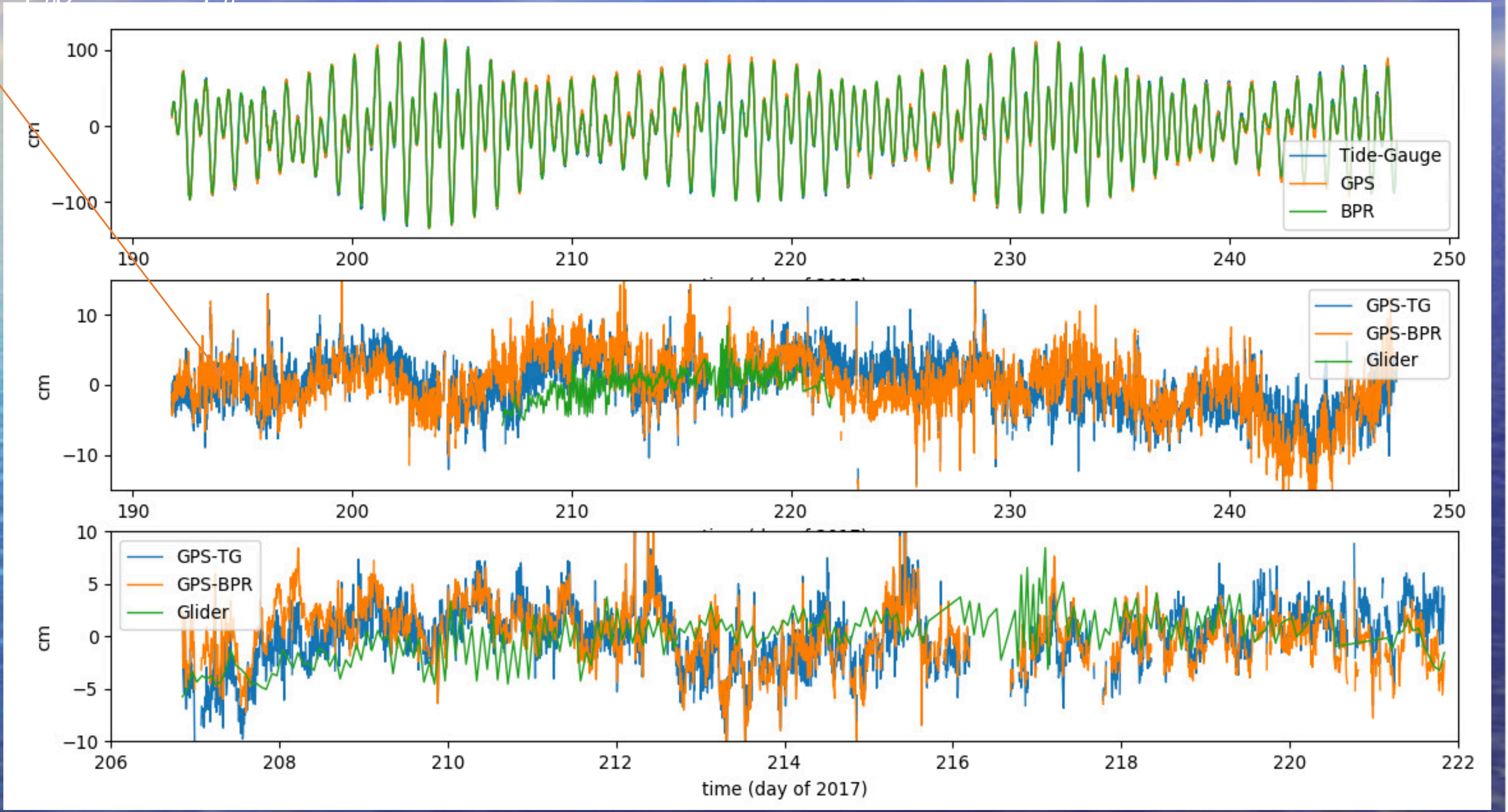
Monterey Bay: GPS Buoy vs. Tide Gauge (30 km)

- Based on 6-min averages of 1-Hz SSH estimates
- Variance of long-period differences reduced by 80% with simple geoid correction from DTU13 MSS
- Geoid signals (unresolved from MSS) remain in corrected time series.
- Differences also show high-frequency content (~2 cm) and differential tides (~1 cm).



Comparisons of GPS, Tide gauge, and BPR

$$\eta - \frac{p'_b}{\rho_o g} + \frac{pa}{\rho_o g} = \int_{-H}^{0} \frac{\rho'}{\rho_o}$$



Scenarios of the post-launch campaign

Lee-Lueng Fu
Jet Propulsion Laboratory
California Institute of Technology

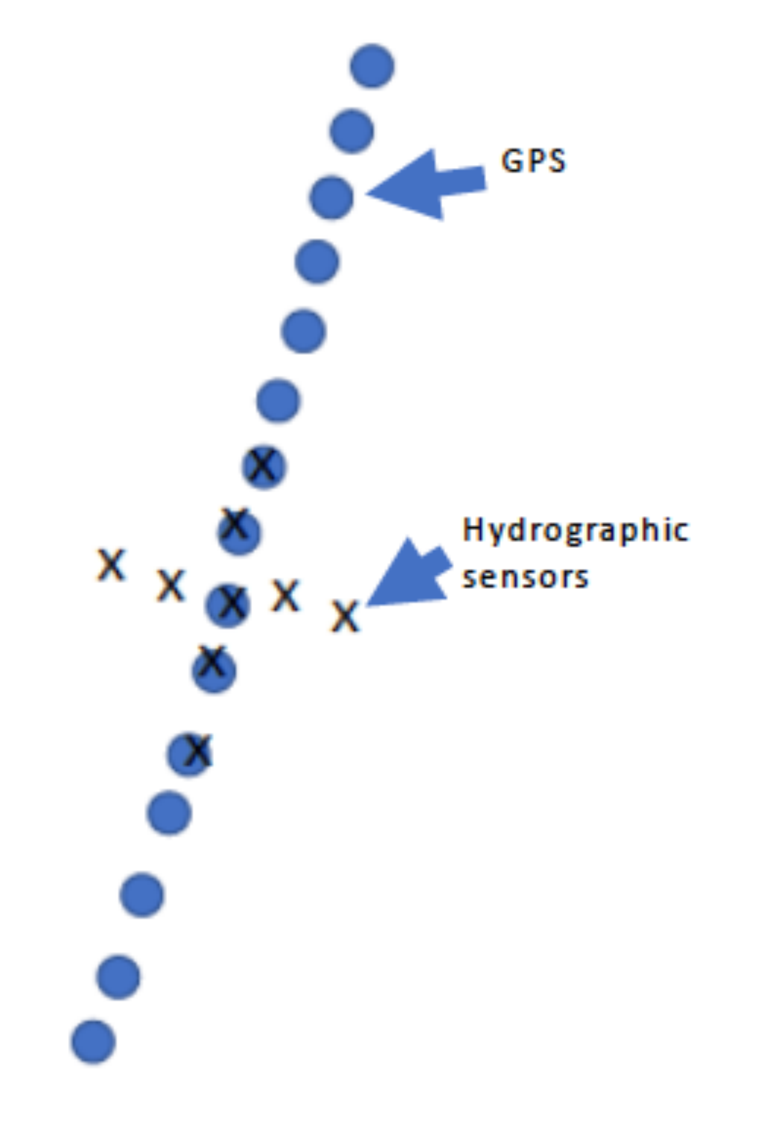
A strawman scenario of the post-launch ocean in-situ observing system

Pending on the outcome of the pre-launch experiment, the post-launch campaign might include:

An along-track array of GPS buoys for the geodetic objective;

A two-dimensional array of hydrographic sensors (gliders, wirewalkers, possibly some deep CTDs, or combination of them), shown on the right (a strawman), which is linking the mission's calval plan to the development of the post-launch science campaign.

The minimum length of the GPS array needs to be ~ 110 km, according to a modeling study of the long-wavelength calval by the SWOT nadir altimeter (Jinbo Wang's presentation later)



A recap of the proposed calval site experiment

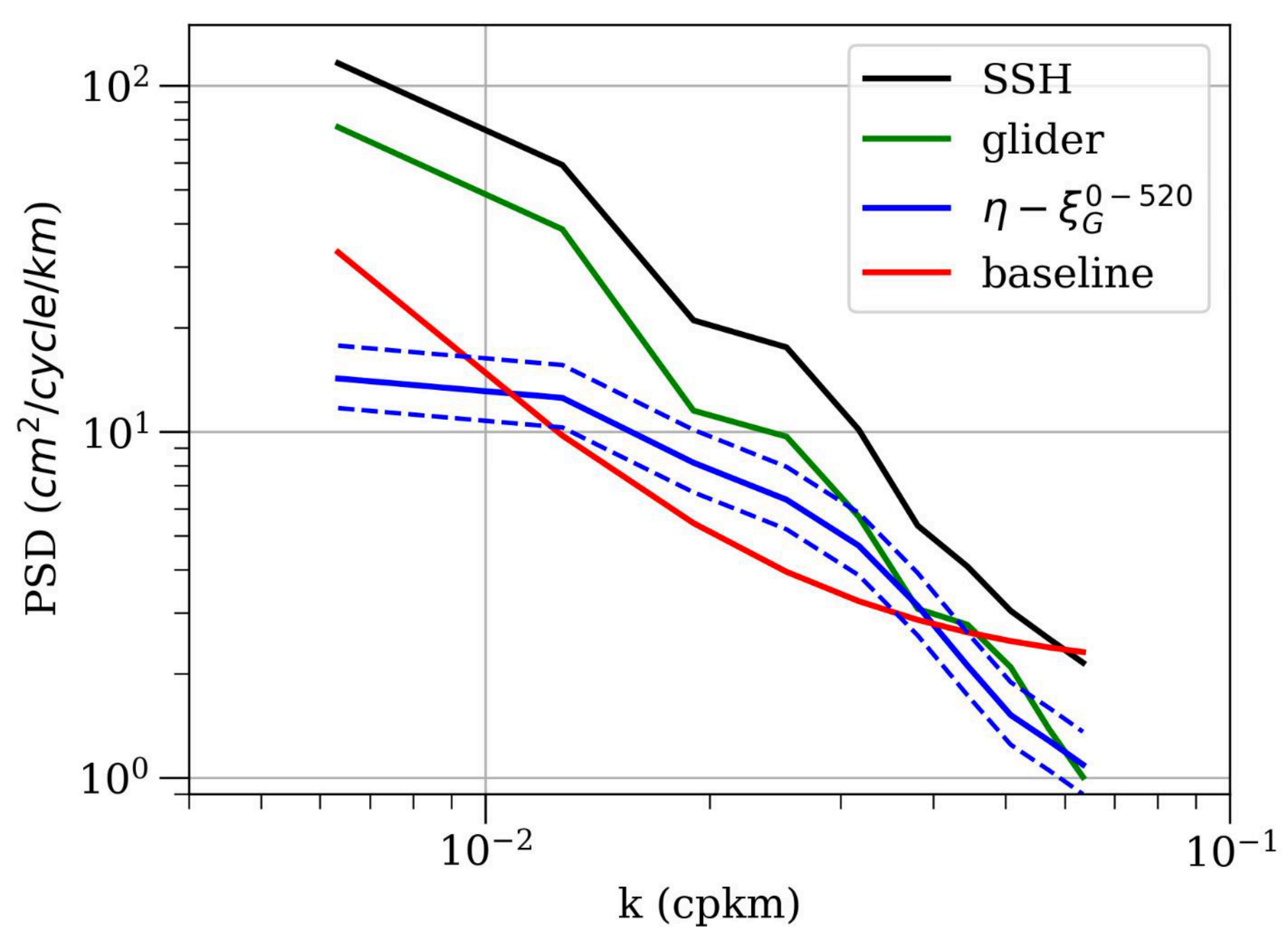
1. Can we reach a closure of the equivalence of the GPS – BPR to the full-depth dynamic height at the calval site where the ocean bottom is fairly flat?
2. What is the extent of the upper ocean sampling required to represent the full-depth dynamic height?
3. What is the feasibility of station-keeping gliders?
4. How is the performance of the faster wire-walker vs station-keeping gliders in sampling the upper ocean?

The proposed instrumentation is composed of four separate moorings plus two gliders:

A deep CTD mooring (reaching 1700 m with ~30 CTDs), addressing #1,2,4
A GPS buoy mooring, addressing #1
A BPR mooring addressing #1
A wire-walker mooring addressing #4

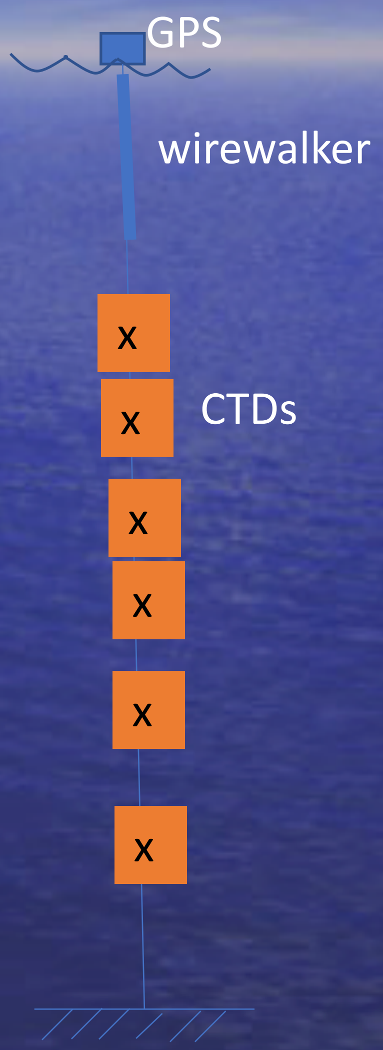
The gliders will address #3,4.

Model simulation of the glider performance



Oceanographic objectives by an array of hydrographic sensors

- Pending the results of the pre-launch experiment, we might replace gliders with moored wirewalkers.
- If the variability below 500 m is significant, we might need to add CTDs below the wirewalker.
- If GPS proves able to meet the requirement for validating the SSH spectrum, a GPS sensor will be mounted on top of the wirewalker.



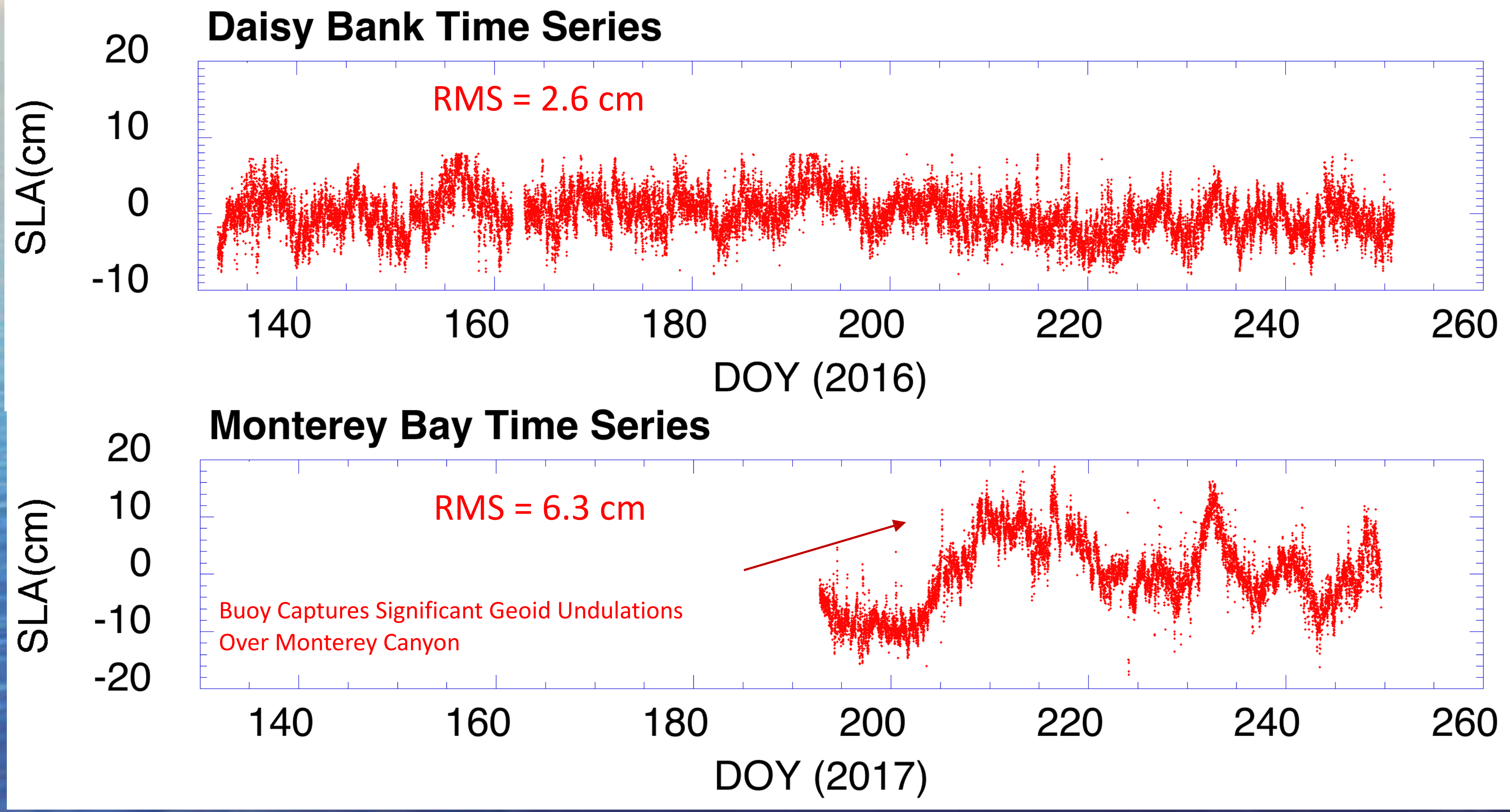
A few remarks on the comparison of the GPS SSH with dynamic height

- The GPS SSH might have significant residual errors from the MSS errors.
- The dynamic height estimated from the glider might suffer from sampling errors due to the slow dive.
- Both issues will be addressed by the next experiment being planned for the California calval site.

A synergistic approach to SWOT Ocean Calval

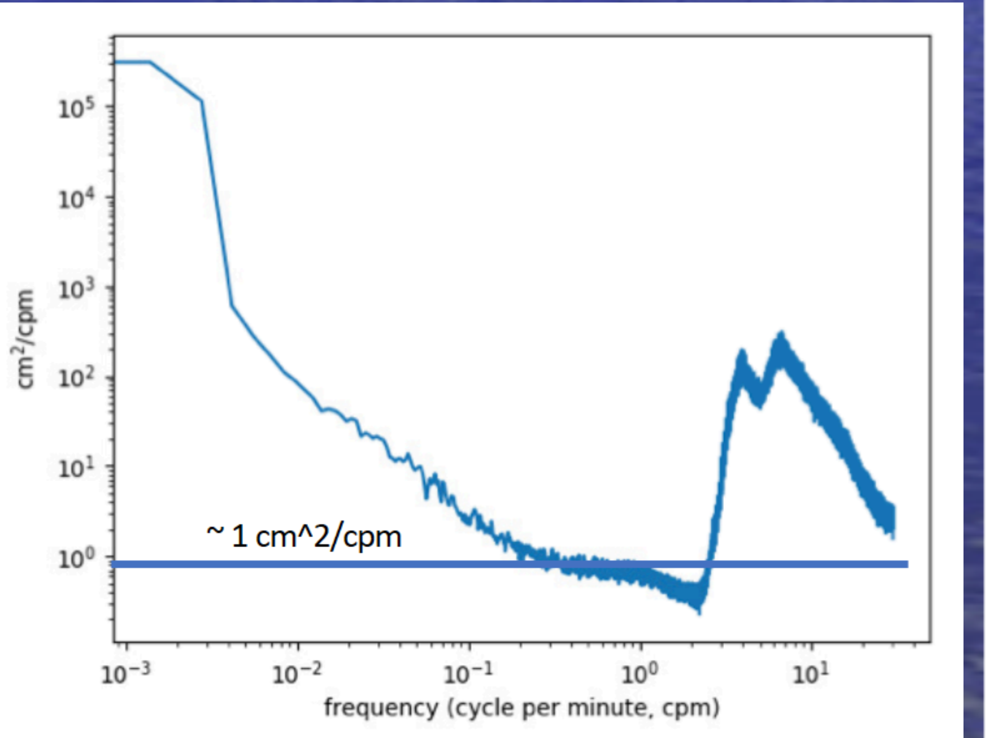
Lee-Lueng Fu
Jet Propulsion Laboratory
California Institute of Technology

Sea Level Anomaly from 6-minute GPS Buoy Data:
Daisy Bank (2016) vs. Monterey Bay (2017)

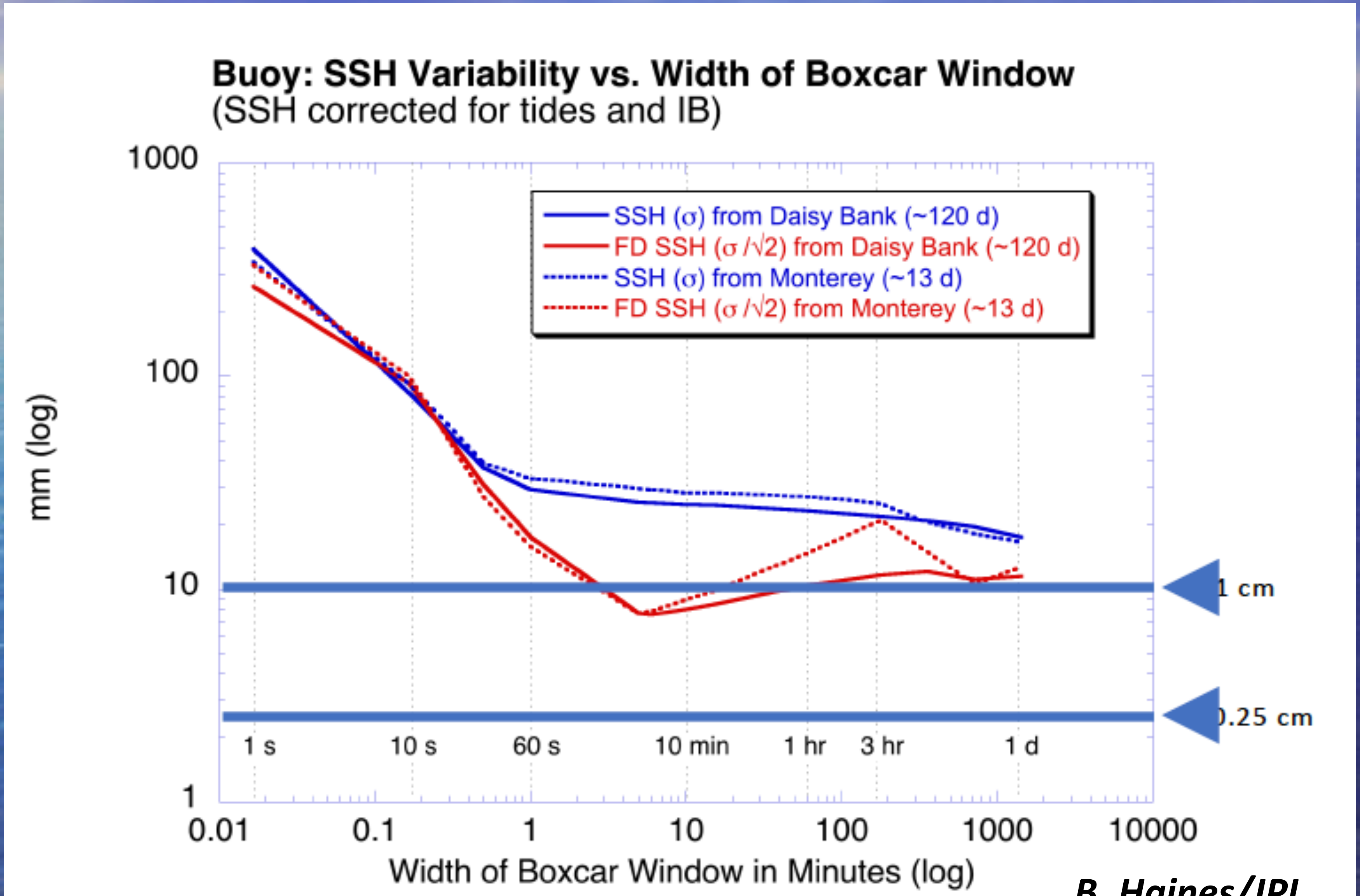


Geodetic Objectives by an array of GPS buoys

- Using an array of GPS buoys acting as open ocean tide gauges
- Each buoy is anchored to the bottom to provide time series at a fixed location.
- The dense SWOT sampling allows collocation between SWOT and buoys.
- To meet the SWOT SSH accuracy on the 7.5 km x 7.5 km nominal grids, the in-situ measurement must meet 0.4 cm (rms) accuracy.
- The wave signals are band-limited and can be mostly removed by low-pass filtering.
- The noise floor leads to errors less than 1 cm (rms) at periods >1 min, or, ~ 0.25 cm at >15 min
- Minimal MSS error over the scale of the watch circle (~ 4 km radius).



Residual high-frequency variability after tamporal smoothing



B. Haines/JPL

High-resolution SSH by airborne laser

Reciprocal passes across the Loop Current

SCRIPPS INSTITUTION OF OCEANOGRAPHY UC San Diego

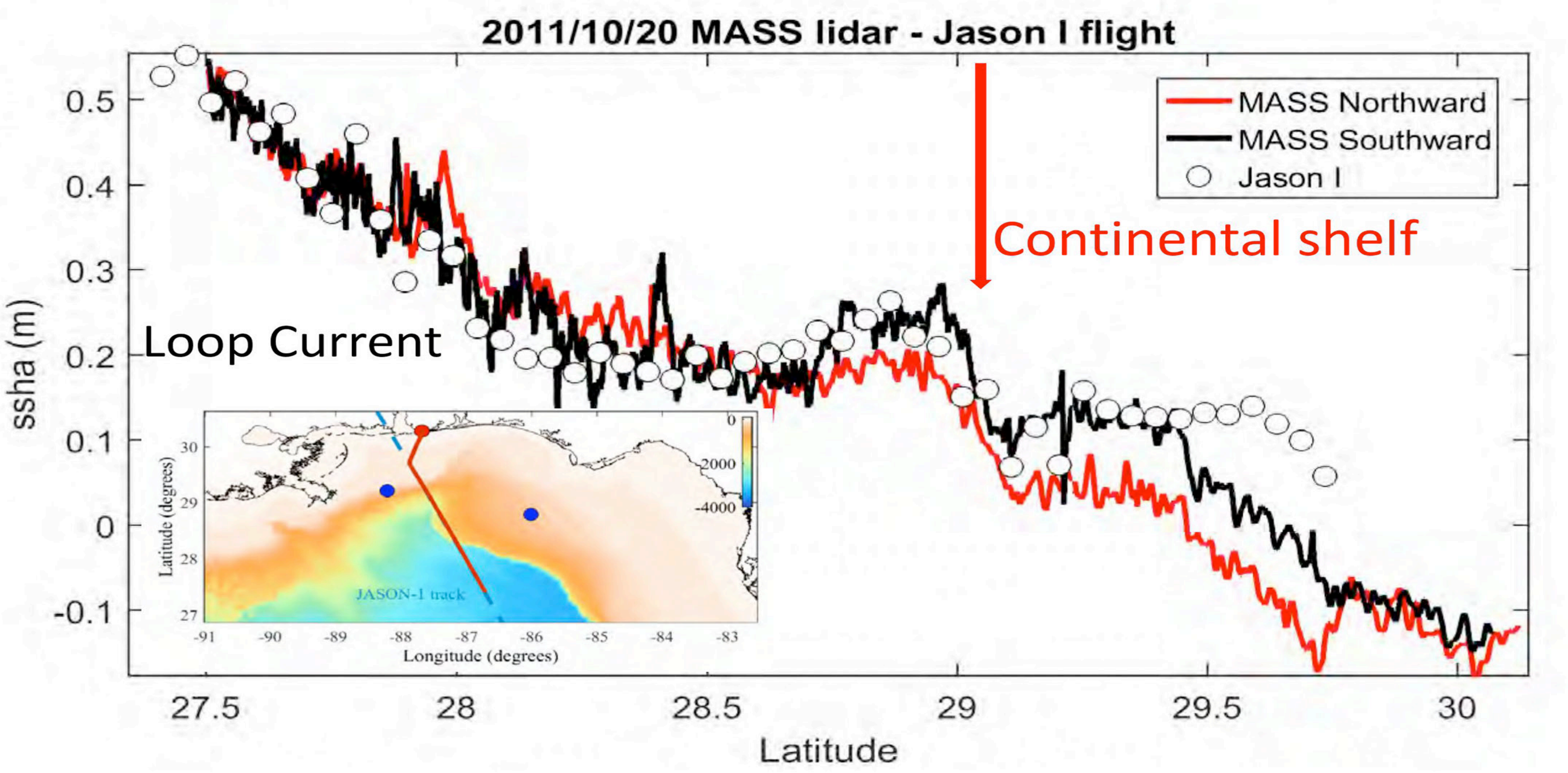


Fig. 6: SSHA estimated from two MASS lidar passes ("northbound" and "southbound") over the same Jason-I track (see insert). Note that the satellite pass occurred in the middle of the southbound lidar pass (black).

K. Melville and L. Lenain /SIO

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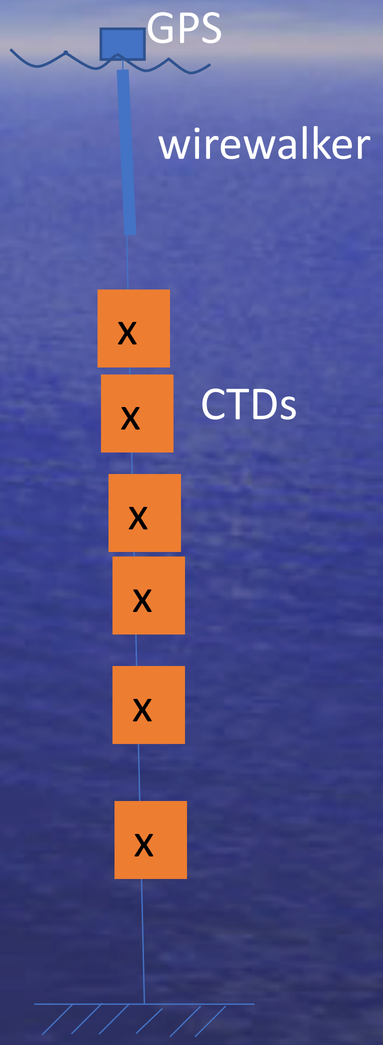

Possible configurations of the ocean in-situ arrays