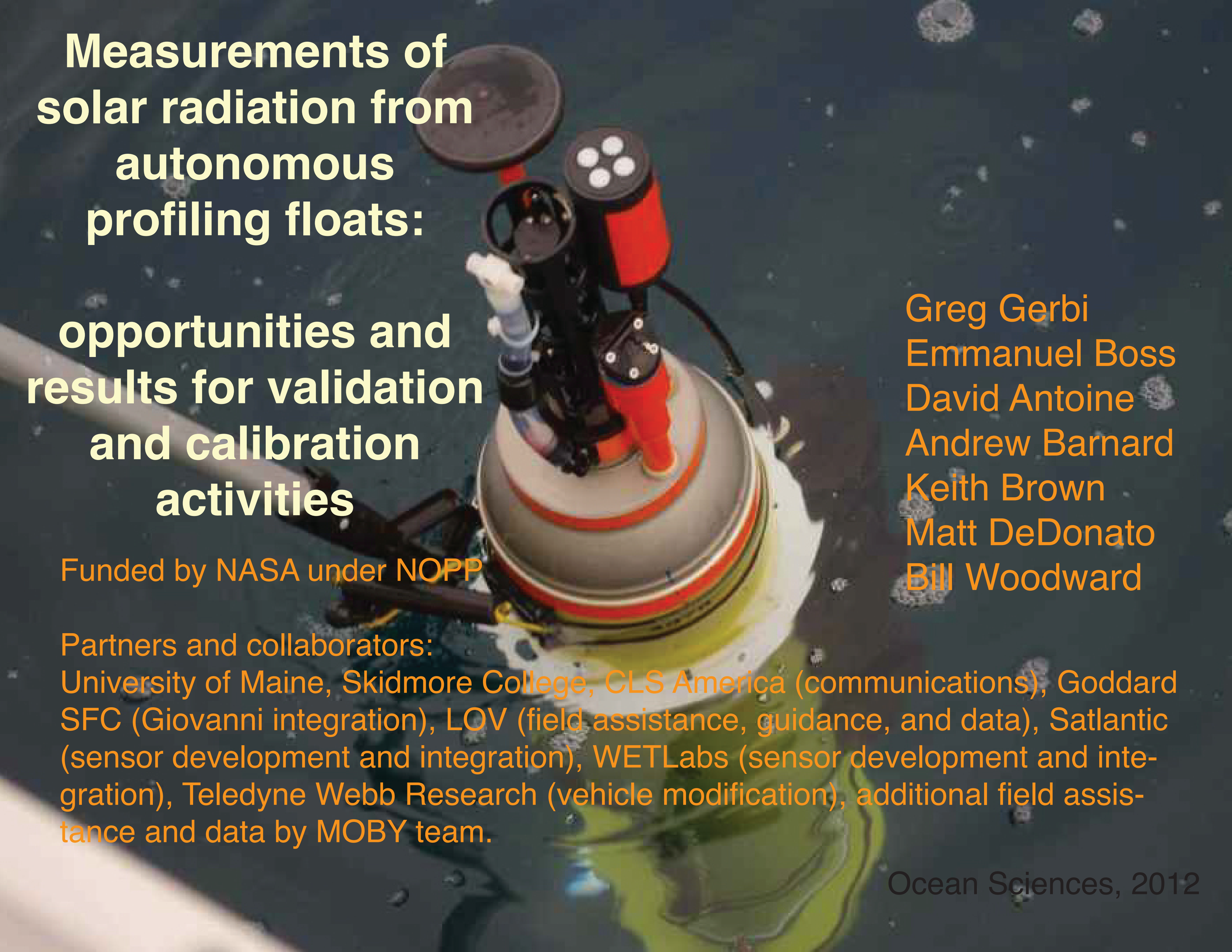

Measurements of solar radiation from autonomous profiling floats:

opportunities and results for validation and calibration activities

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Funded by NASA under NOPP

Partners and collaborators:
University of Maine, Skidmore College, CLS America (communications), Goddard SFC (Giovanni integration), LOV (field assistance, guidance, and data), Satlantic (sensor development and integration), WETLabs (sensor development and integration), Teledyne Webb Research (vehicle modification), additional field assistance and data by MOBY team.

Ocean Sciences, 2012

Goals

Project Goals:

Development of an integrated autonomous platform for measuring inherent optical properties and radiometric quantities

This Talk:

Potential for use in validation and calibration of satellite observations

Can a float do as well as a buoy? (Probably)
For how long? (No answer yet)

Current limitations on Calibration and Validation

Optical buoys are rare (MOBY and BOUSSOLE)

Good days for matchups with satellites are rare (< 10 per year for SeaWiFS and MOBY). Gain estimates require years.

Shipboard observations can be used (Franz, Baily, Werdell, Voss et al) but are expensive, sparse, and difficult.

Vehicle and payload

Teledyne Webb Apex float controls ascent, CTD, and Aanderaa Optode

Optics hub controls data storage and IOP (WETLabs) and radiometer (Satlantic) sampling

Two-way communication via Iridium Satellite to CLS America

Advantages and limitations of autonomous floats

Advantages

"Inexpensive" (~$80,000)

Wide geographic coverage and dynamic range

More observations give more matchups early in satellite missions

Limitations

Self-shading

no strong evidence of heading-dependant Lu values

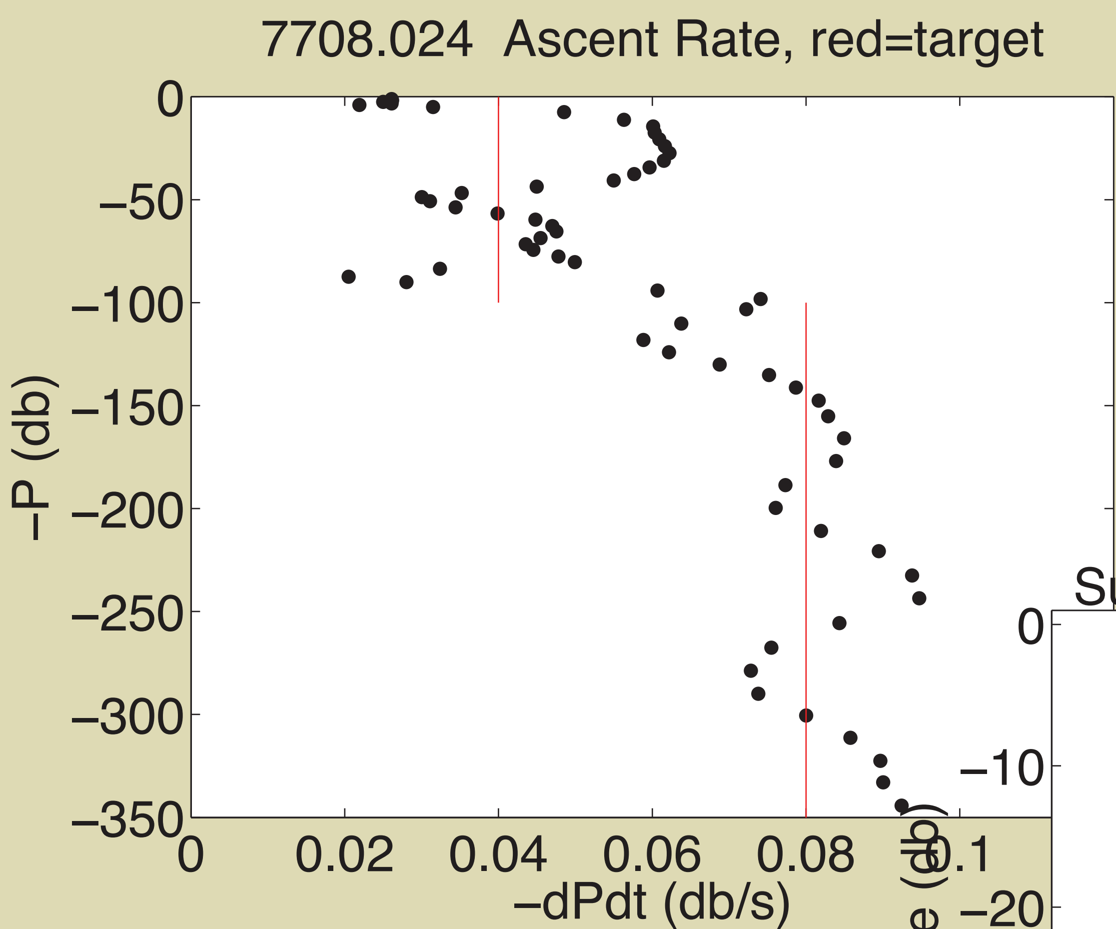
Fouling

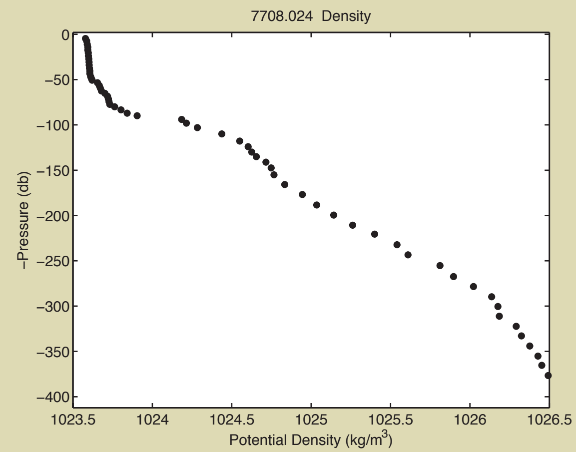
park deep to minimize fouling

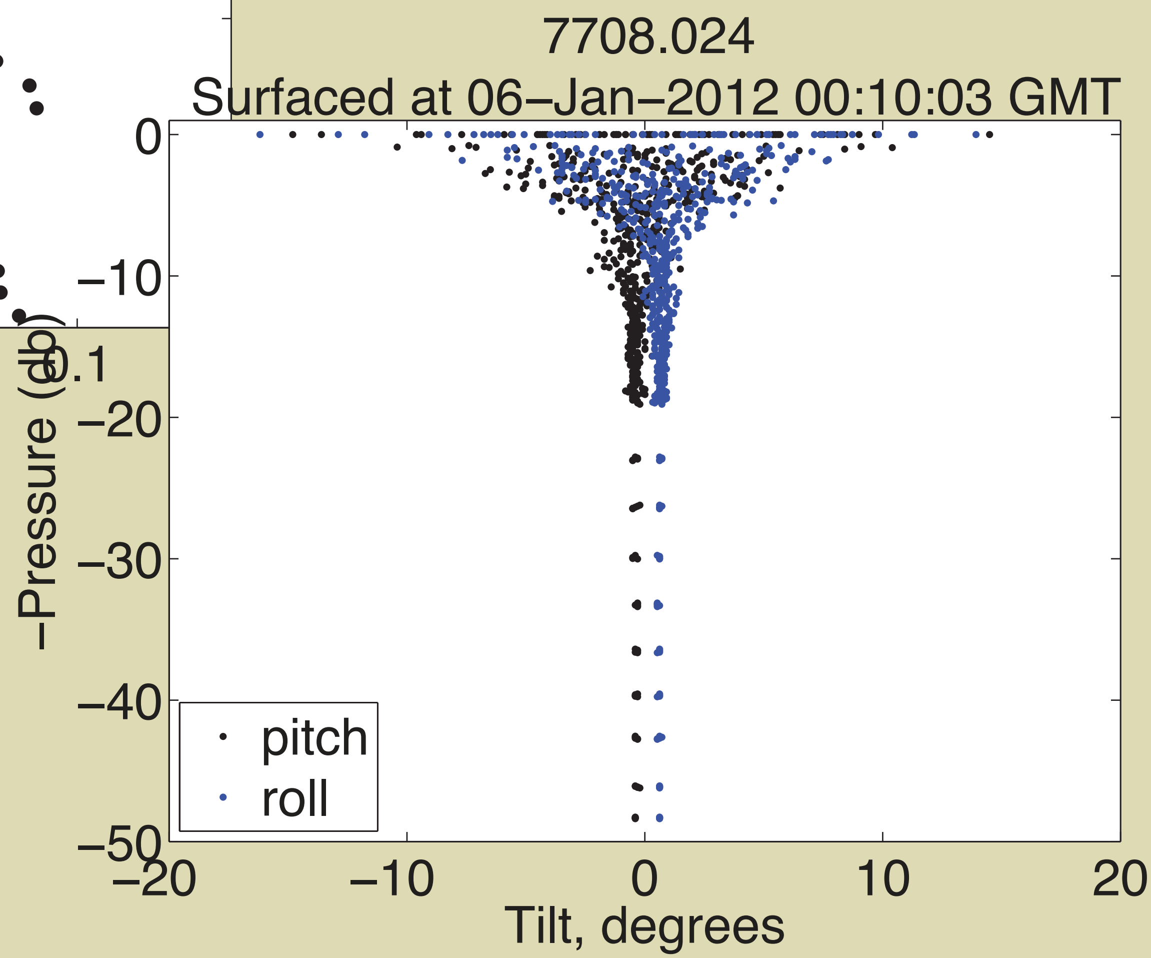
IOP sensors to monitor long term data quality

Identifying clouds, eliminating waves

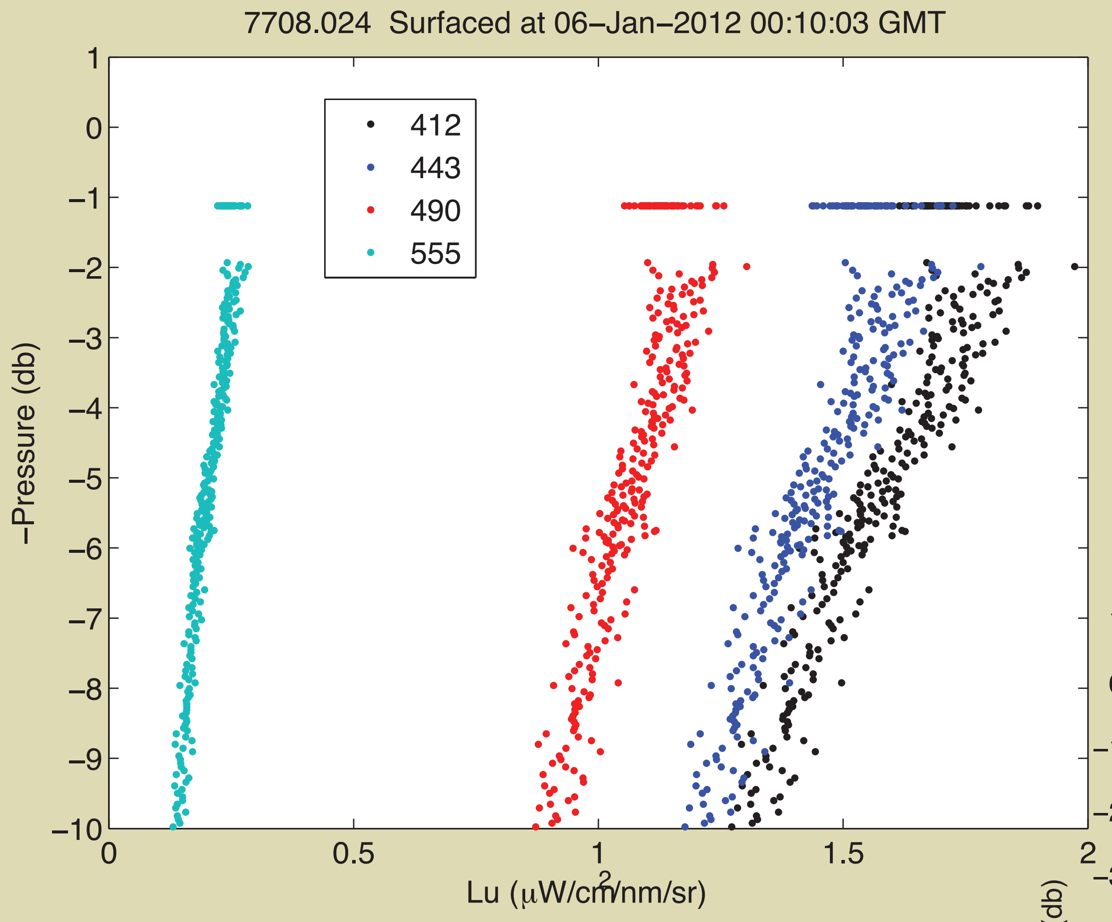
Engineering results: Ascent rate and Tilt

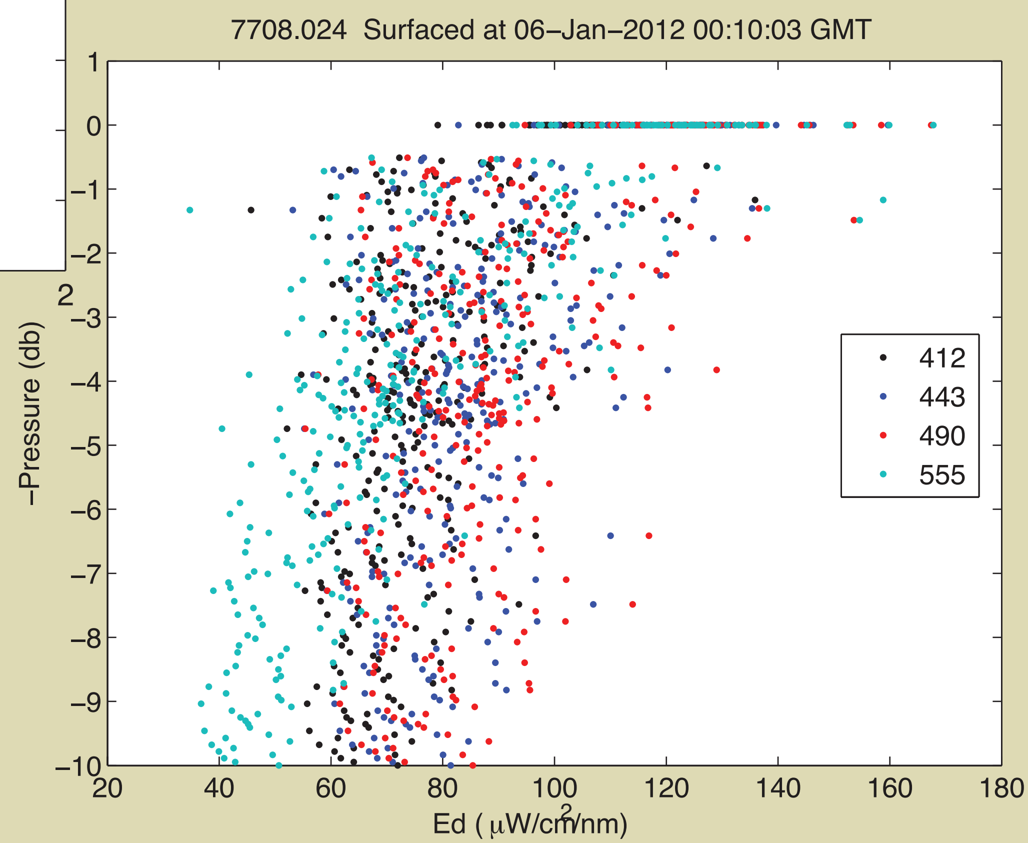




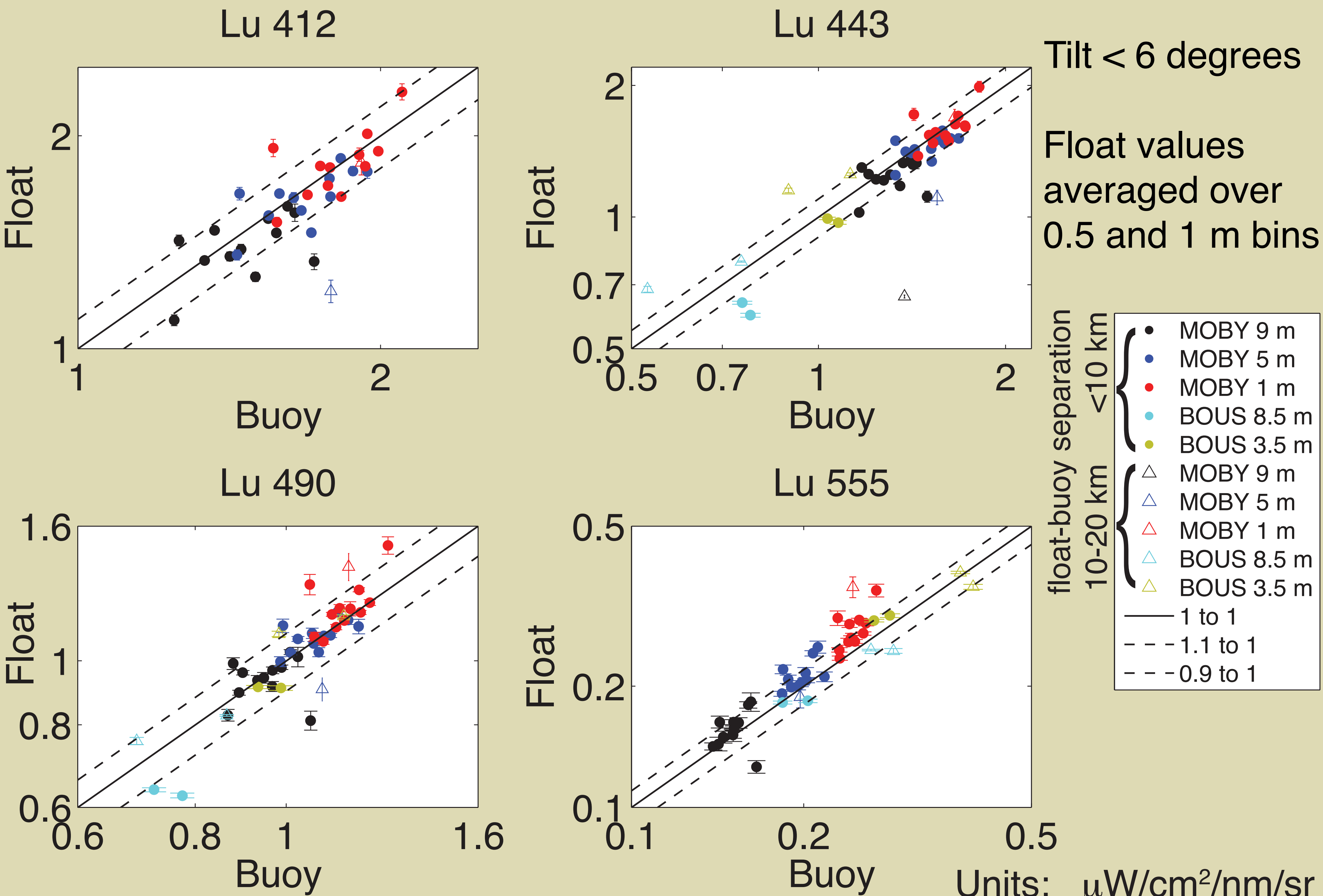


Near-surface L_u and E_d (Hawaii, 6 January, 2012)





Radiometry comparison: float vs buoys in-water



Tilt < 6 degrees

Float values averaged over 0.5 and 1 m bins

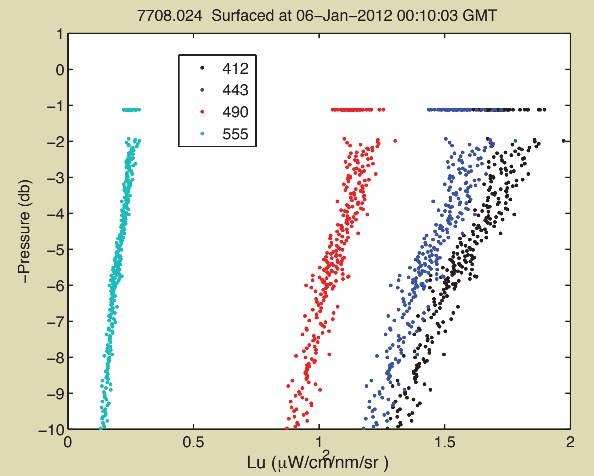
Units: μW/cm²/nm/sr

Extrapolating Lu to Lw

Estimate k_d using nonlinear least squares fit of exponential model to all obeservations with small tilts in a specified depth bin.

$$L_u(z) = L_u(z_c)e^{k_d(z-z_c)}$$

Bin is currently between 3 and 7 m.



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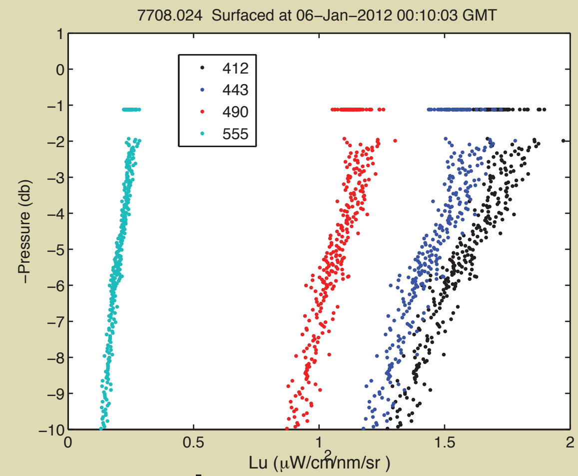
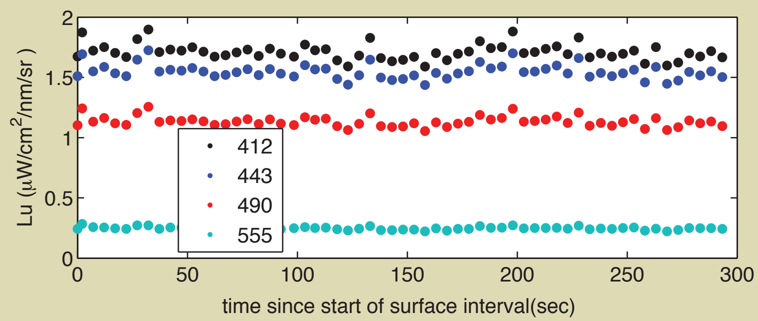


$$L_u(z) = L_u(z_c)e^{k_d(z-z_c)}$$

Bin is currently between 3 and 7 m.

Measure L_u at 1.2 m depth (median over 1-5 min) and extrapolate to subsurface; use Fresnel reflectance to extrapolate through surface.

$$L_u(0-) = \frac{L_u(z_s)}{e^{k_d z_s}}$$



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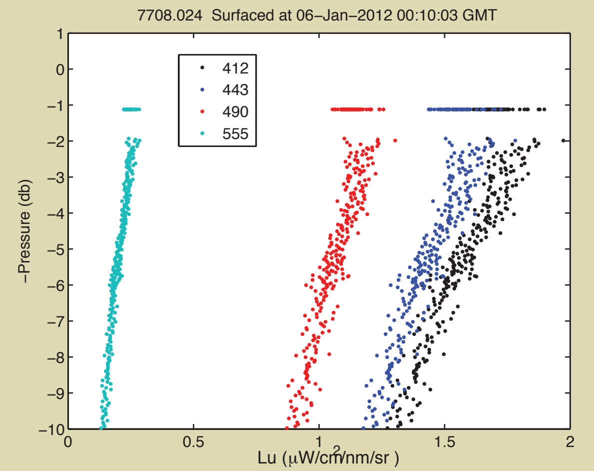

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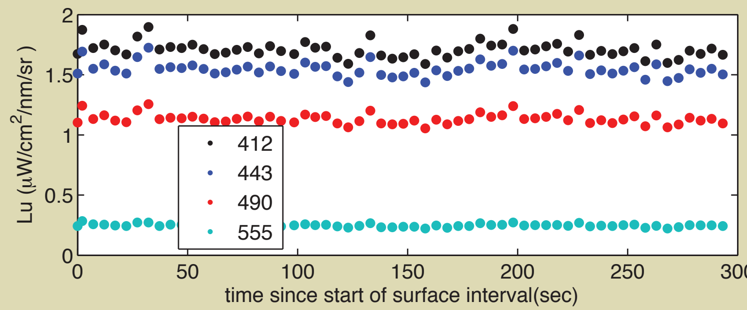


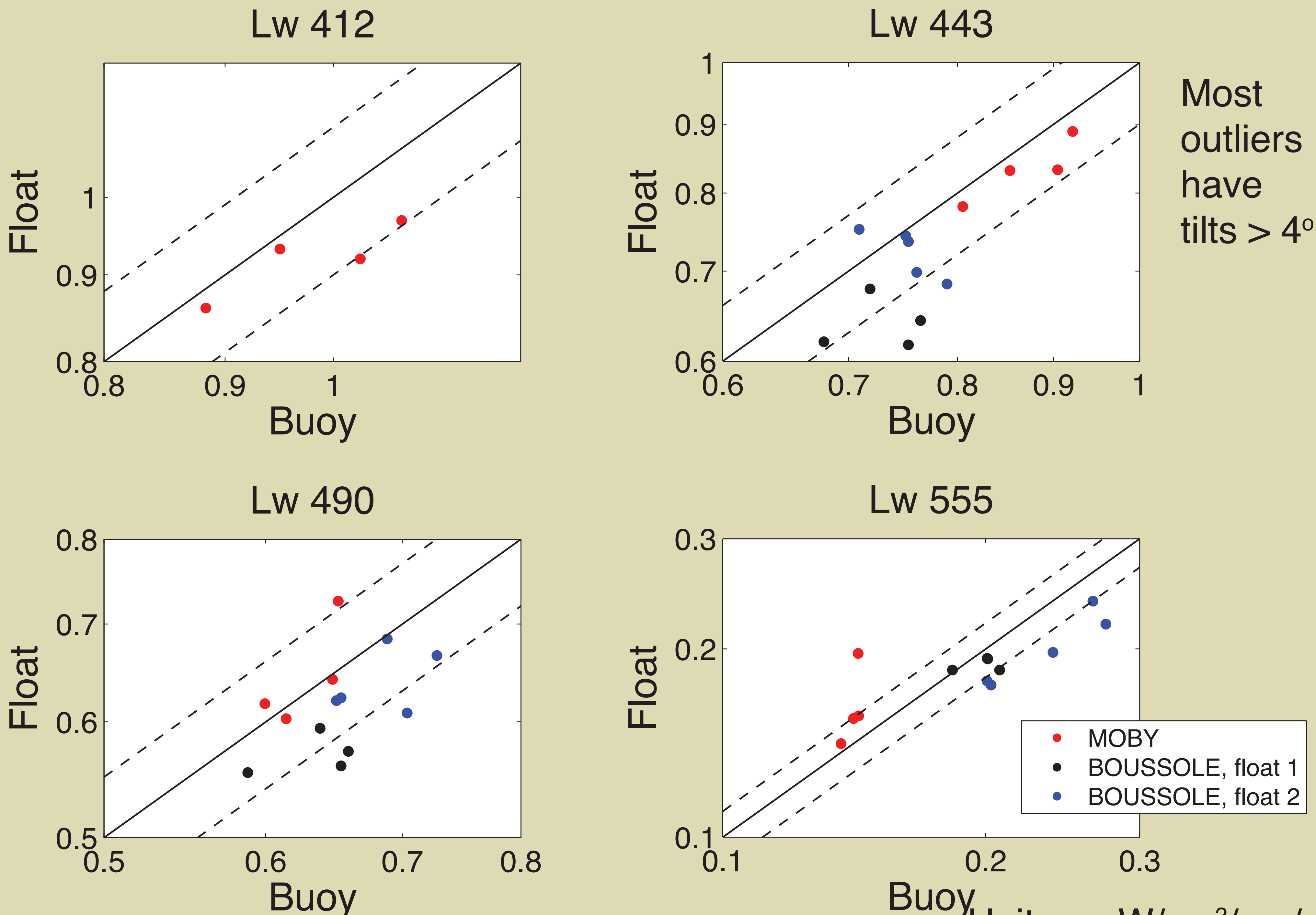
Small $z_s k_d$ means that propagation errors are small, but nonnegligible. (20% error in k_d gives $< \sim$ 2% error in L_w).

Reject if:

$L_u(z_s) < L_u(z_c)$

E_s is less than 70% of Frouin et al (1989) prediction

Water-leaving radiance: floats vs buoys



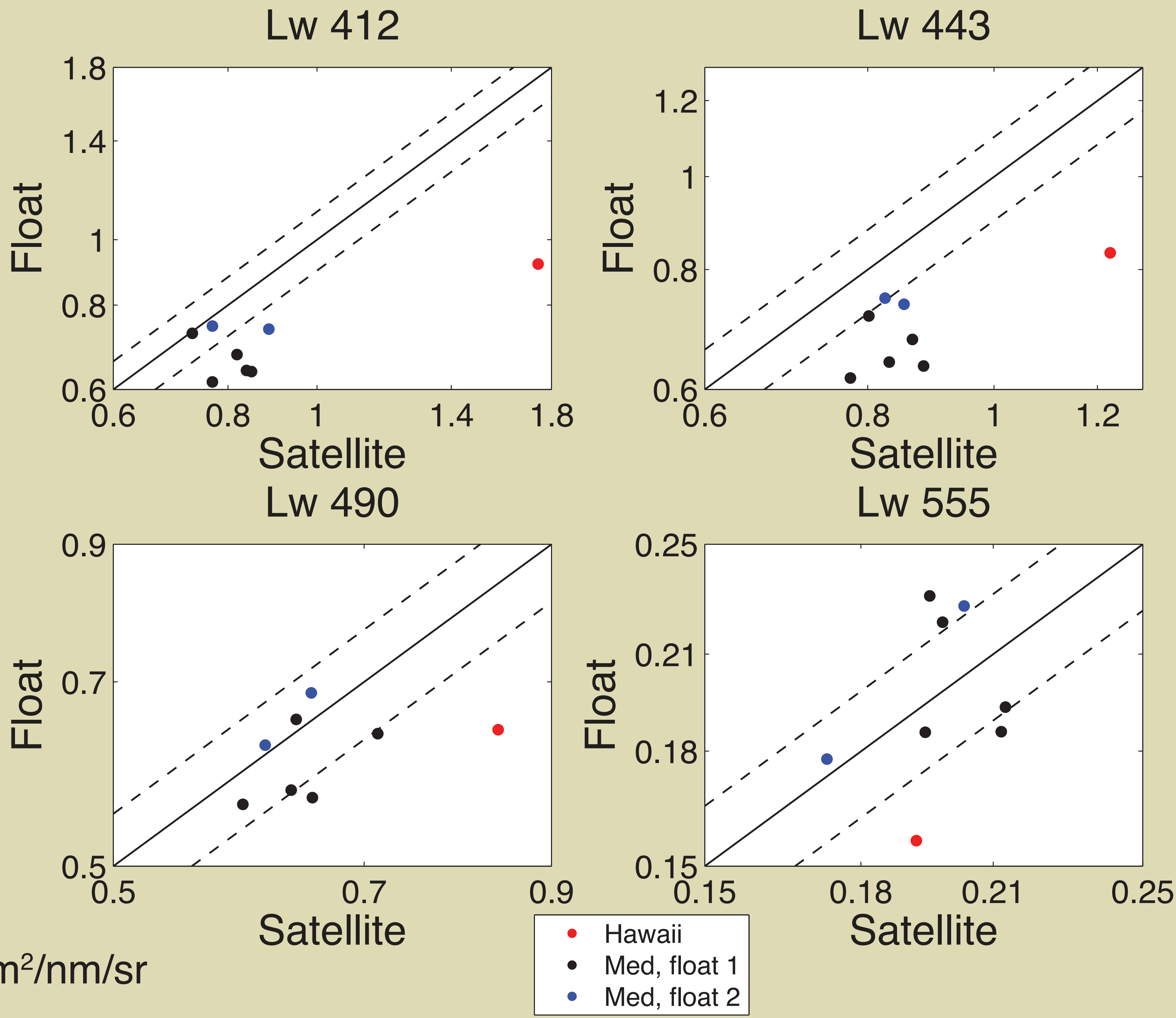
Most outliers have tilts > 4°

Units: μW/cm²/nm/sr

Water-leaving radiance: floats vs MODIS

satellite quality controls: 5x5 box around float.

no cloud, glint, stray light, bad atm corrections in any pixels



Units: $\mu W/cm^2/nm/sr$

Conclusions

Float observations match
- buoys: well
- MODIS: not terribly

Need more matchups, more refined quality control

We're improving buoyancy control and near surface measurements