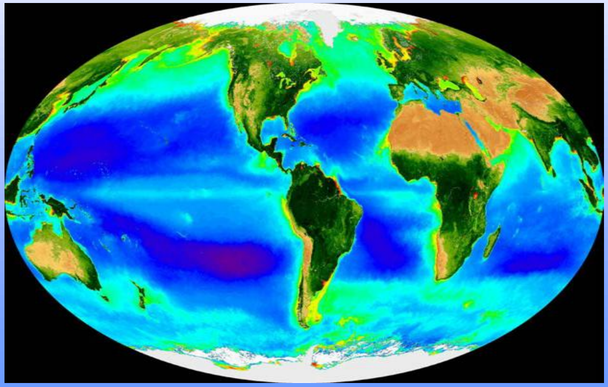
The Johns Hopkins University
APPLIED PHYSICS LABORATORY

Requirements for vicarious calibration systems for future ocean color sensors

International Ocean Colour Science Meeting
Darmstadt, Germany
May 6-8, 2013

Carlos E. Del Castillo
The Johns Hopkins University
Applied Physics Laboratory



Rational

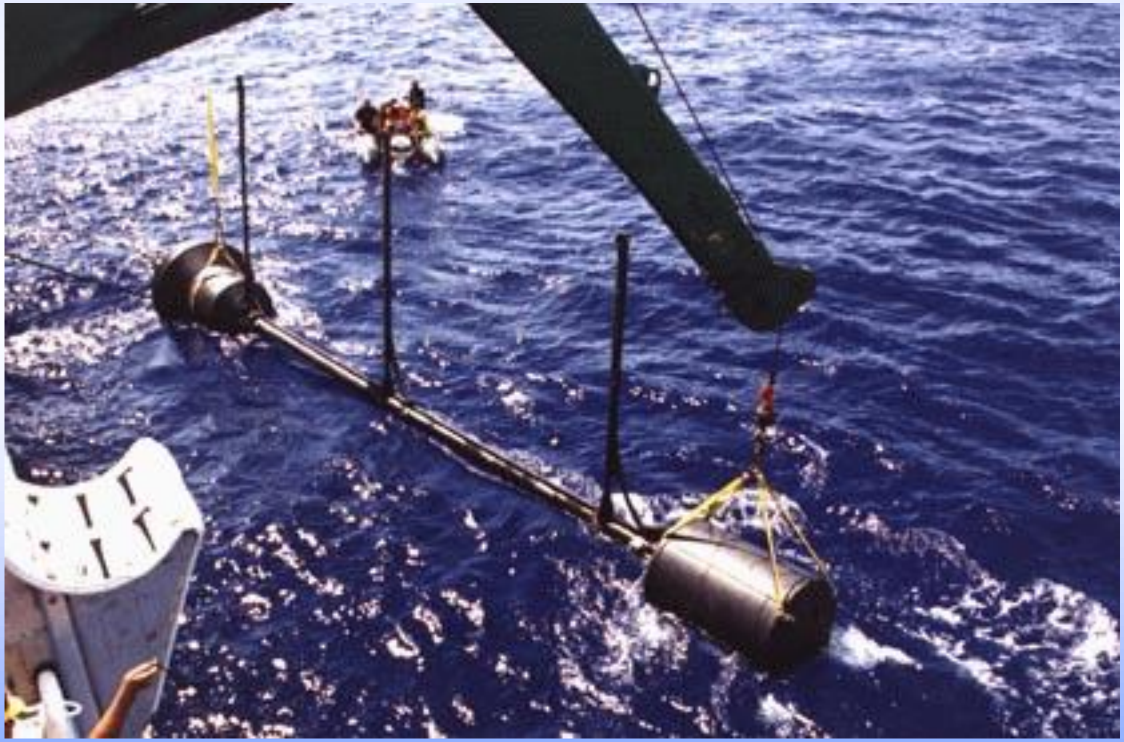
Future ocean color missions should ensure continuation of ocean biology climate data records.

Vicarious calibration is necessary to maintain climate data records.

Therefore, the vicarious calibration system should be an integral part of any future ocean color mission.

Current Vicarious Calibration Paradigm

Values of Rrs(λ) for vicarious calibration of ocean color satellites has been obtained from semi-permanent moorings with fixed spars.



MOBY

BOUSSOLE

Current vicarious calibration paradigm is problematic because:

1- prototypes (1-2 copies)
2- expensive to build
3- expensive to operate
4- requires specialized personnel with <u>institutional memory</u>

Few systems collecting data at any time = takes years to develop vicarious calibration

System is expensive and has a <u>**small constituency**</u> = susceptible to funding problems and cancellation - <u>**single-point-of-failure**</u>.

I submit that we need a new paradigm

<u>Vicarious Calibration Requirements for PACE</u>

1)Spectral range from 340-900 nm at ≤ 3 nm resolution
2) Total spectral accuracies ≤ 5% including contributions from all instrument calibrations and data processing steps (with NIST traceability)
3) Temporal spectral stability ≤ 1% per deployment (with NIST traceability)
4) Continuous deployment beginning one year pre-launch and extending throughout the life of the PACE mission
5) Sufficient data acquisition rates to reduce vicarious gain standard errors to ≤ 0.2% within one year of launch **(implying the need for multiple systems that are simultaneously deployed**)
6) A **centralized organization** to maintain and deploy the vicarious calibration instrument(s) (preferably, NASA supported with NASA oversight)
7) **Routine field campaigns to the instrument site(s)** to verify instrument radiometric quality and revise uncertainty budgets (preferably, NASA-supported with NASA oversight)

“To meet these minimum requirements, we strongly recommend that NASA release a highly specific announcement of opportunity or research announcement for vicarious calibration concept development in support of PACE.” –NASA did!

A new paradigm for a vicarious calibration program

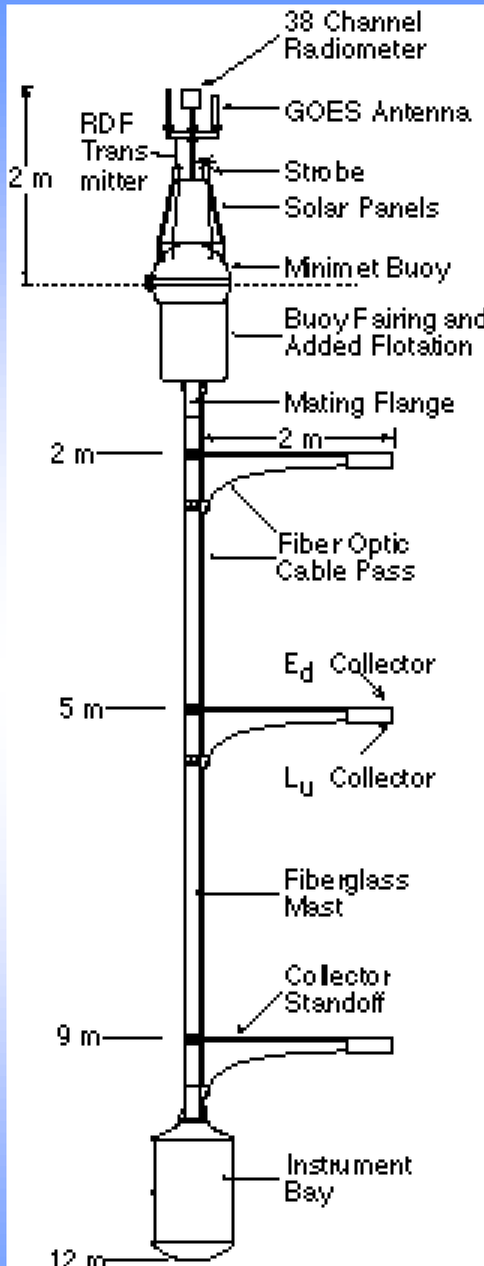
- Affordable
- Small
- Simple logistics

Multiple copies – faster vicarious calibration

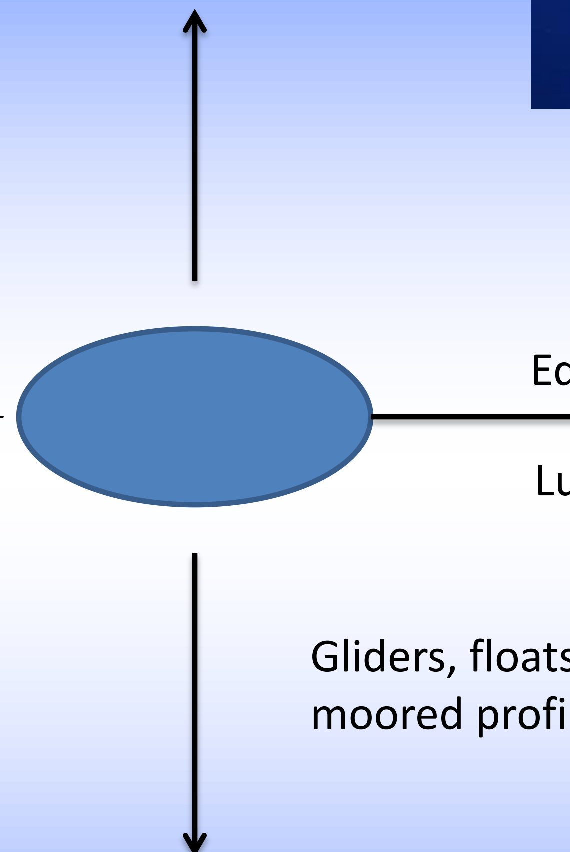
Redundancy

Robust

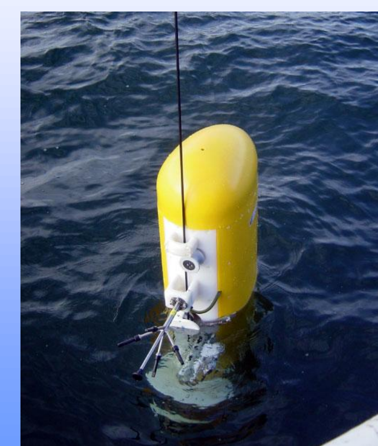
Deployable in support of field campaigns



medium-term deployment



Gliders, floats, moored profilers



Engineering challenges? yes...but

we put people on the Moon

landed rovers on Mars inside oversized beach balls

deploy 5 km-log hydrophone chains from moving submarines

parked a satellite on an asteroid

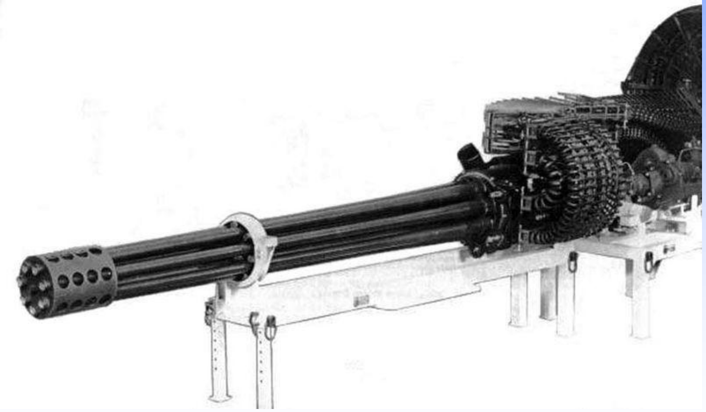
lifted a Russian submarine from the bottom of the sea (and kept it secret...)

fixed a myopic space telescope

etc...

Nothing a proper engineering shop cannot handle. However, it has to be handled in the same way we handle any other large, complex contract.

for example:



In the 1960 the USA Air force asked contractors to build a plane around this cannon, and, by the way, the plane must also be:

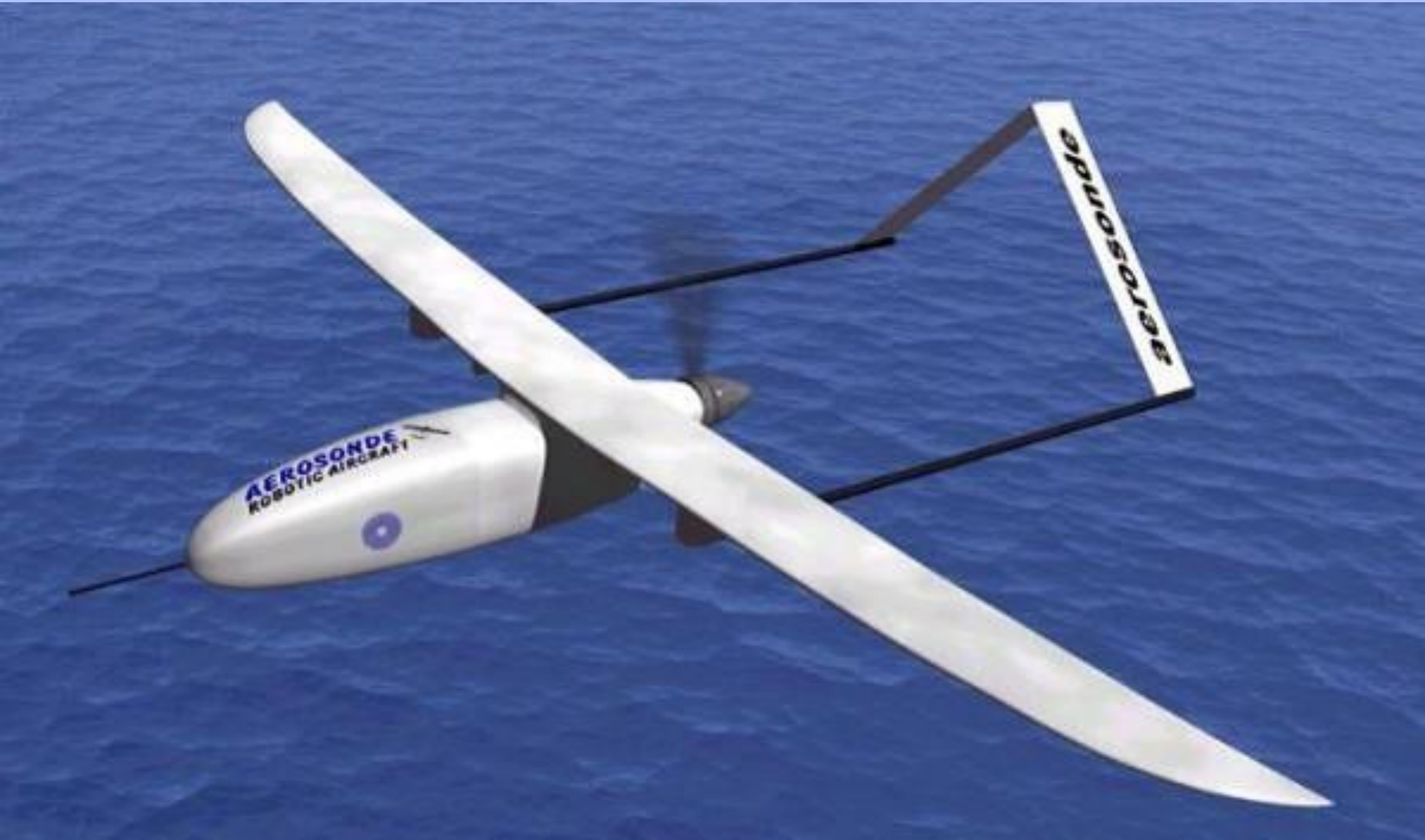
fairly silent

capable of flying very slow

nearly impervious to small arms fire (including 23 mm cannon)

capable of flying while missing all hydraulic power, one engine, one aileron, half a wing etc....all at the same time

UAV's as platforms for vicarious calibration?



Example of operation mode

- Check weather report to determine possibility of clear sky...if so.
- Get to lab in the morning ~ 9nish...check weather.
- Check calibration of the instrument.
- Check avionics, fly systems, fuel.
- Check weather, if clear sky, launch UAV and go to have lunch.
- UAV fly to target, collects data under the satellite, and returns home.
- Catch UAV on net, download data, check calibration of the instrument, do maintenance, go home.