SeaWiFS Calibration & Validation Strategy & Results

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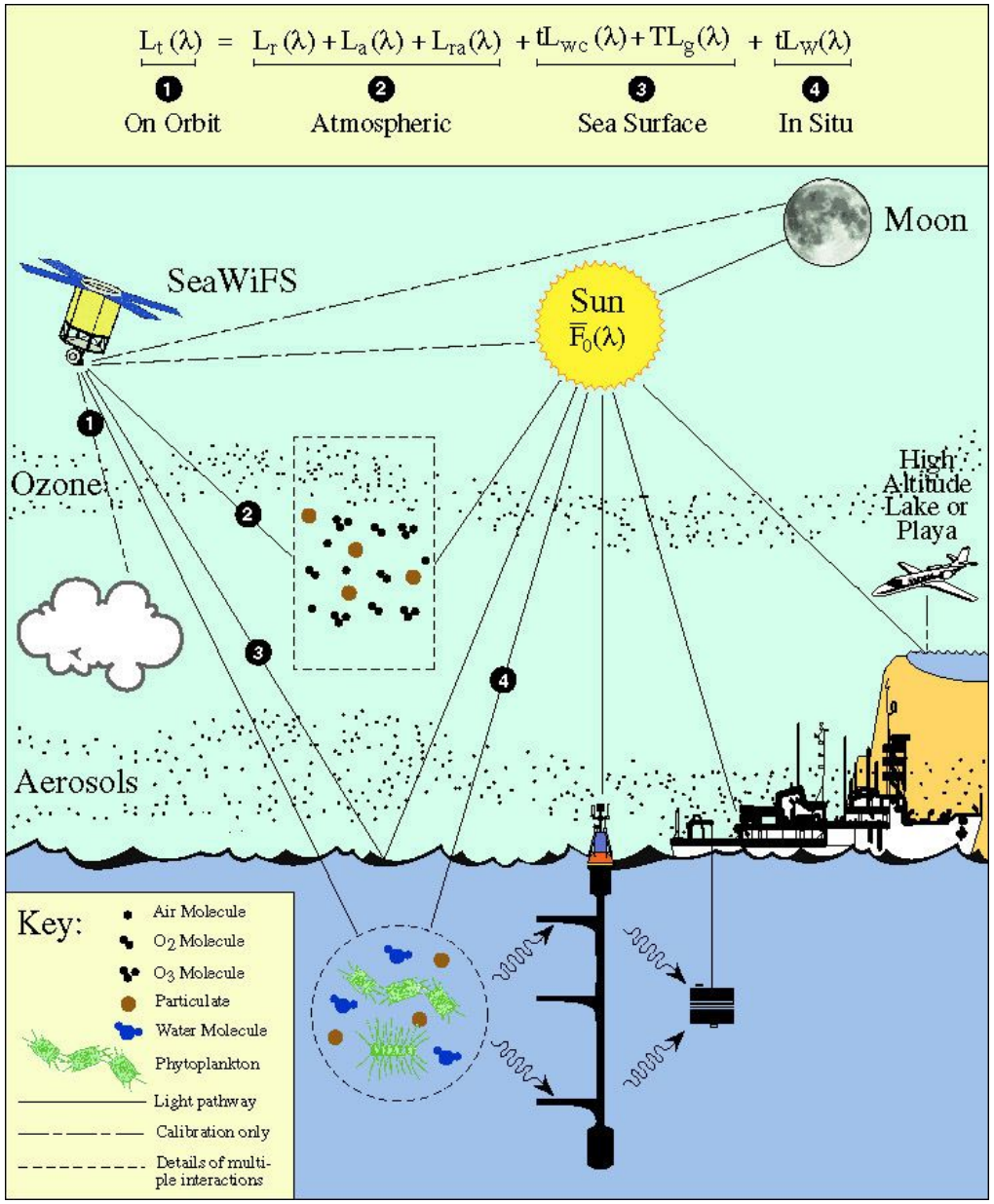
Calibration Validation Paradigm

SeaWiFS Project uses a variety of calibration approaches:

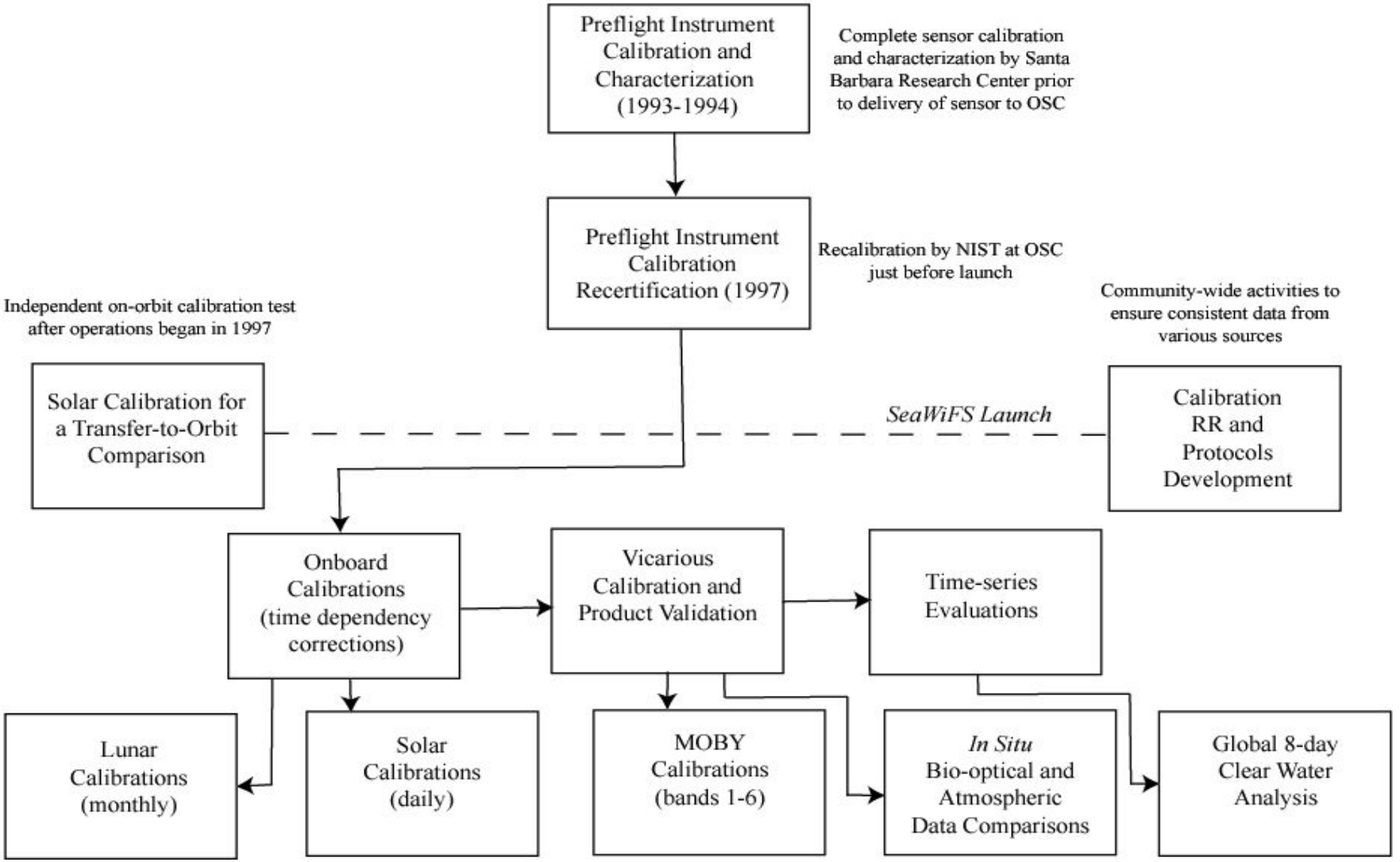
- **Laboratory** - before launch, sensor is calibrated in lab
- **On-orbit** - daily solar and monthly lunar observations are used to track changes in sensor response
- **Vicarious** - comparison of data retrievals to in-water, ship, and airborne sensors is used to adjust instrument gains



Ocean Color Measurement Accuracy Goals (SeaWiFS & MODIS)

- **Total Radiances:** 5% absolute; 1% relative
- **Water-leaving Radiances:** 5% absolute
- **Chlorophyll-a:** 35% within range of 0.05-50 mg/m^3

SeaWiFS Calibration Strategy

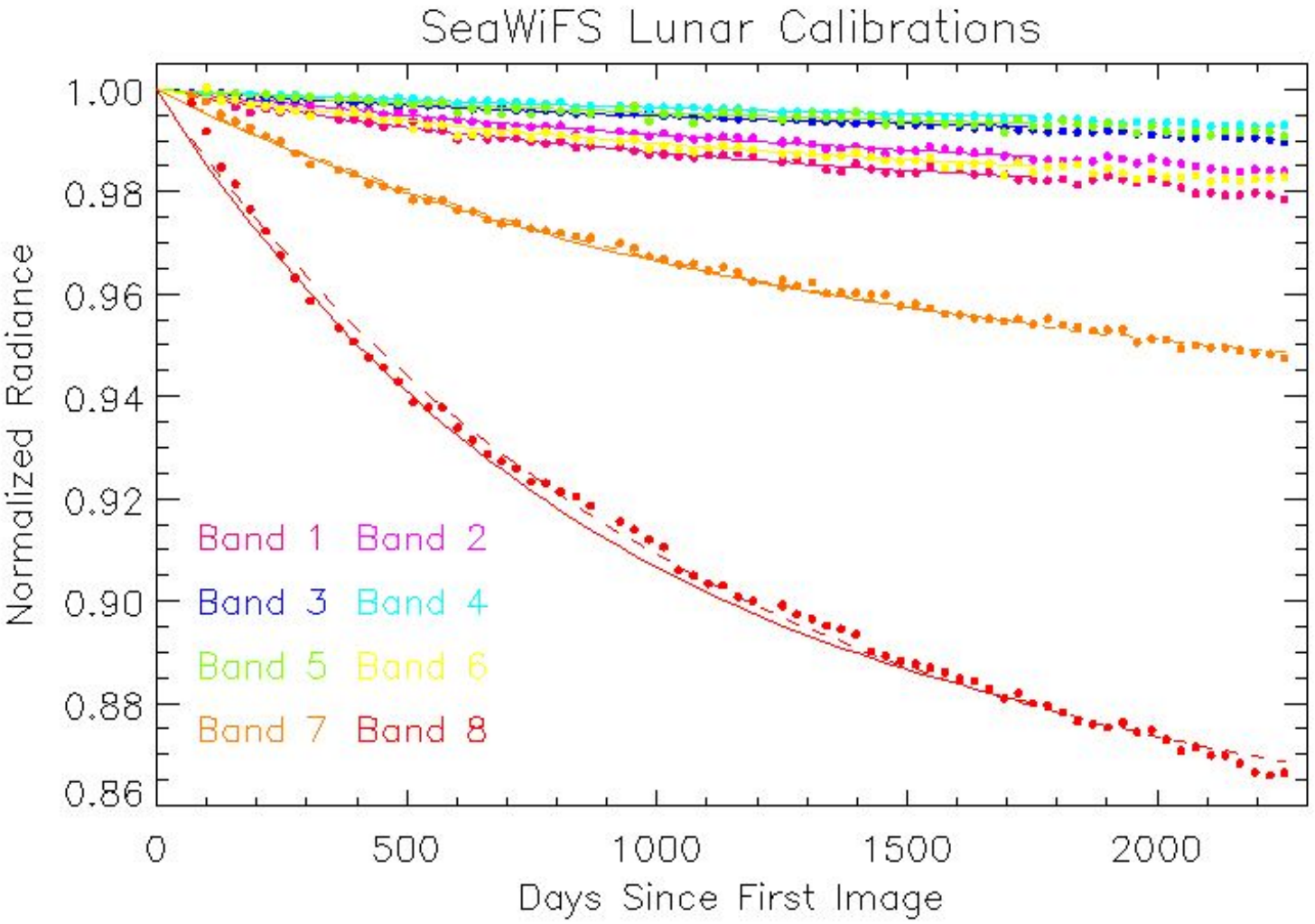


SeaWiFS Sensor Calibration

- Prelaunch
  - Laboratory sensor characterization & calibration
    - Johnson et al., 1999: "The 1997 Prelaunch Radiometric Calibration of SeaWiFS", Vol. 4, NASA TM 1999-206892.
  - Solar calibration for a *transfer-to-orbit* comparison
    - Barnes et al., "The SeaWiFS Transfer-to-Orbit Experiment", *Appl. Opt.*, **39**, 5620-5631, 2000
      - On-orbit vs. predicted radiance values within about 2%.
- Postlaunch Operational Adjustments:
  - Solar calibration (daily) for time dependence (bands 7 & 8) and fine resolution check of lunar correction
  - Lunar calibration (monthly) for time dependence correction
  - Open ocean vicarious calibration of band 7 relative to band 8 using a fixed aerosol model
  - MOBY L_{WN} time series for vicarious calibration (bands 1-6)

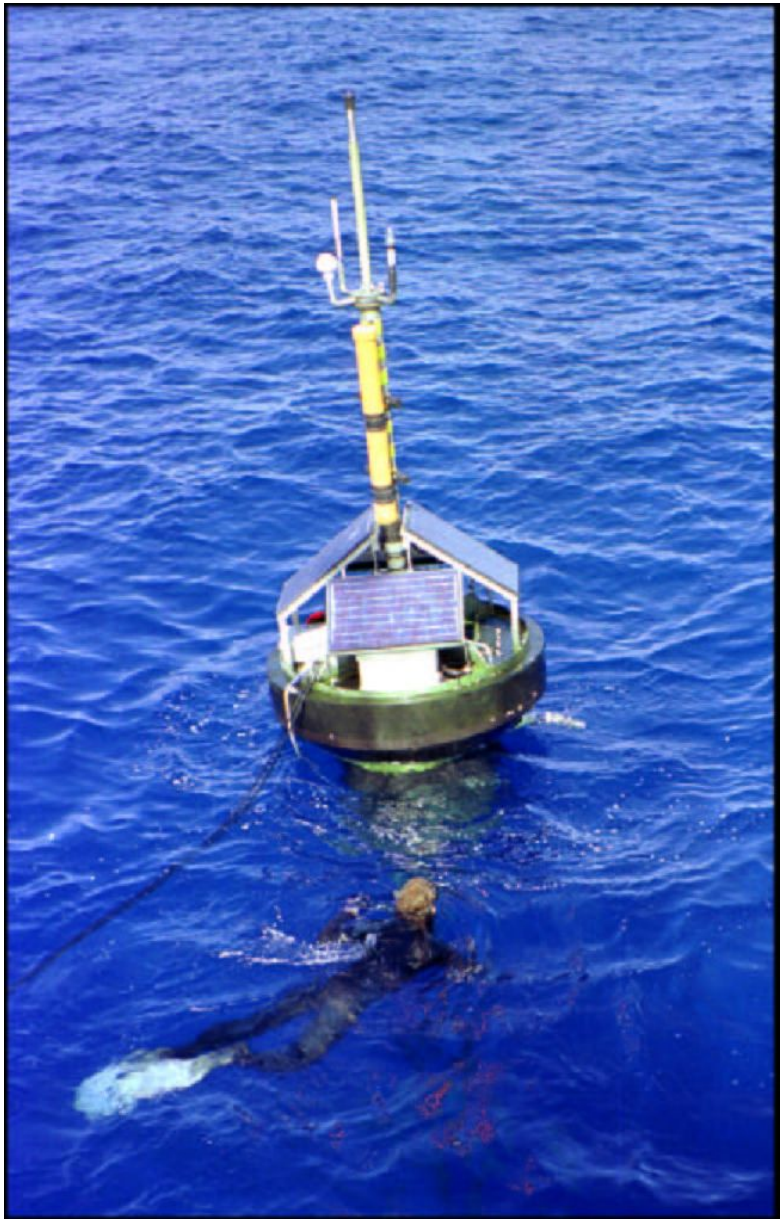
Lunar Calibration

Once a month, the SeaWiFS satellite (Orbview-2) is rotated to observe the Moon at a phase angle ~ 7°.



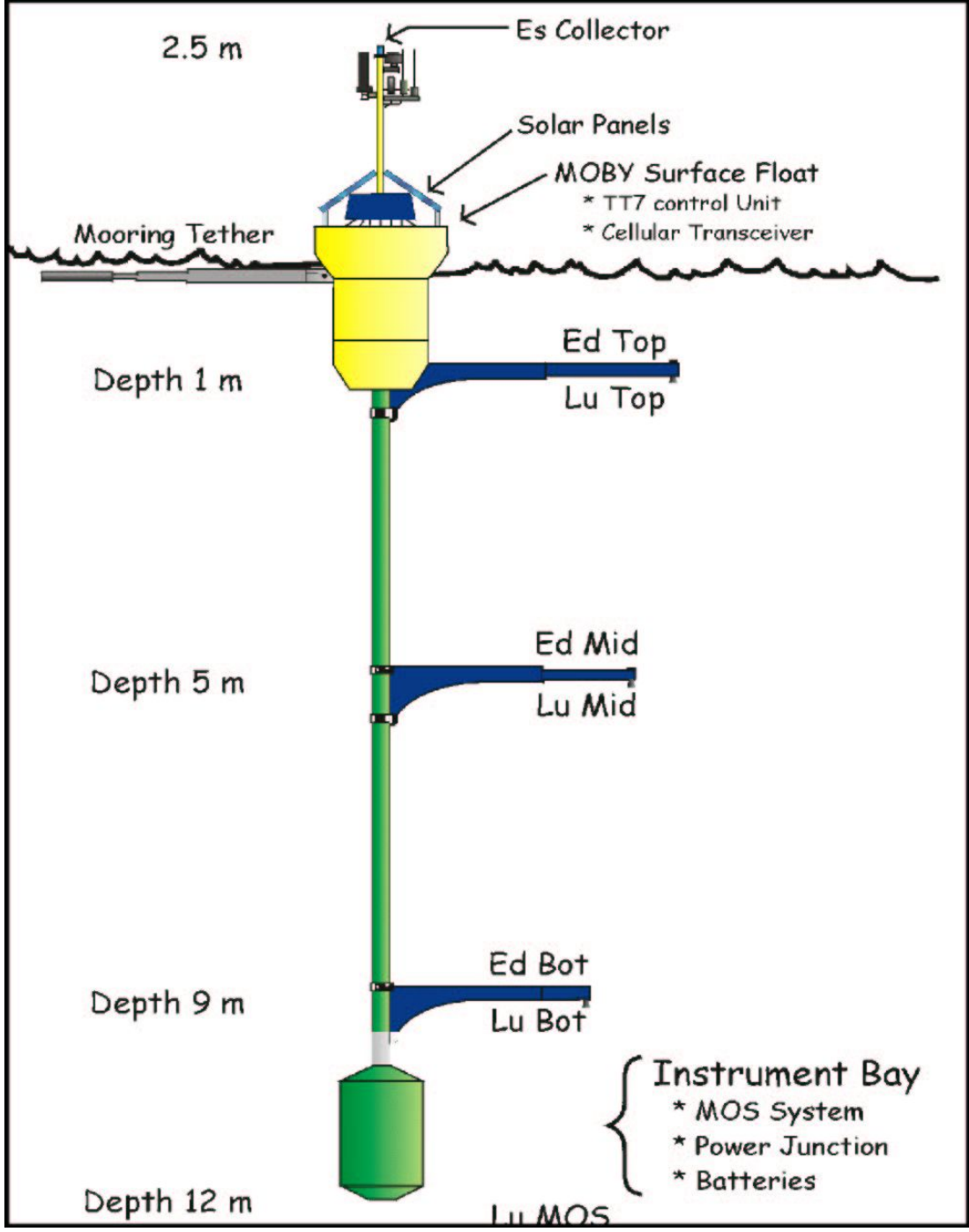
MOBY

- **The Marine Optical Buoy (MOBY)**
  - In-water system moored off the coast of Lanai, Hawaii in "clear water".
  - Time series since 1996.
- **Buoy rotation/refurbishment every 3-4 months.**
- **Routine in-water diver calibrations**
- **MOBY measurements used to vicariously calibrate SeaWiFS, MODIS, OCTS, POLDER, OSMI.**
- **MOBY developed under MODIS & SeaWiFS support.**



Features:

- Characterized using portable NIST SIRCUS facility
- NIST-traceable pre- & post-calibrations on each deployment
- Sources recalibrated every 50 hr
- Monthly measurements with stable,diver-deployed lamps
- Diver sources verified using NIST designed radiometers
- Daily scans of three internal sources

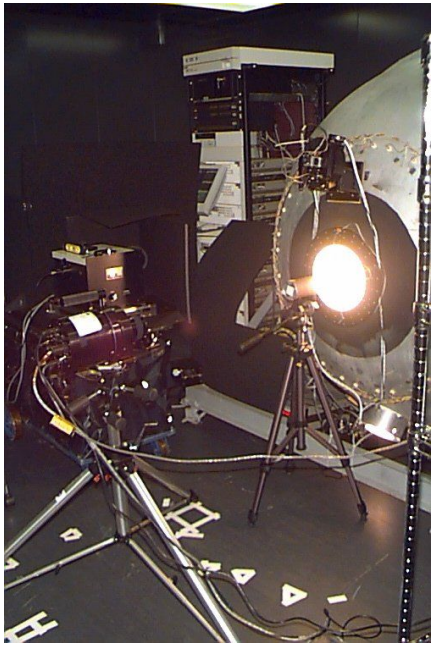


SeaWiFS & SIMBIOS Calibration Round Robins

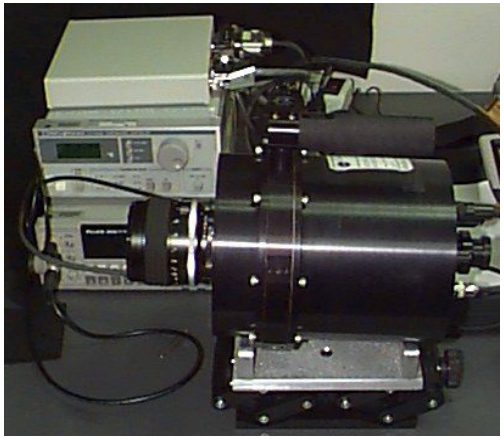
(RR experiments in 1992, 1993, 1996, 1998, 1999, 2001, & 2002)

Goals

- Verify that all labs are on the same radiometric scale
- Document calibration protocols
- Encourage the use of standardized calibration protocols
- Identify where the protocols need to be improved



Radiance Calibrations (spheres & plaques)



SeaWiFS Transfer Radiometer (SXR-1 & -2)

Ocean Optics Protocols for Satellite Ocean Color Sensor Validation

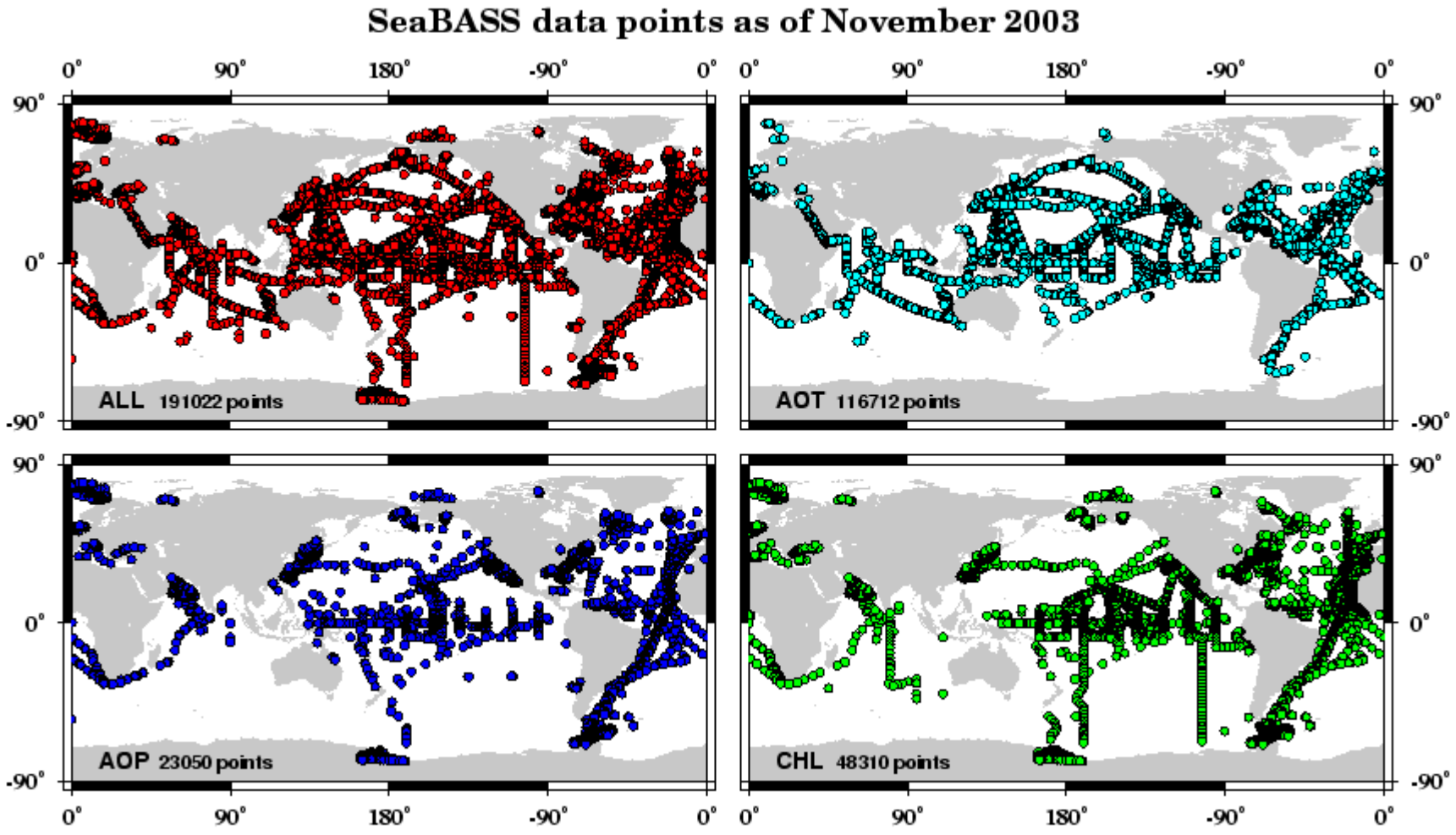
Original Protocols:

- Mueller & Austin 1992, Ocean Optics Protocols for SeaWiFS Validation, NASA TM 104566, Vol. 5, 43 pp.

Revisions and Other Protocols:

- Mueller & Austin 1995, Revision 1, Volume 25 in the SeaWiFS Technical Report Series.
- Fargion & Mueller 2000, Revision 2, NASA TM 2000-209966.
- Fargion et al., 2001, AOT Protocols, NASA TM 2001-209982.
- Mueller et al., 2002, Revision 3, NASA TM 2002-21004 (Vol. 1-2).
- Mueller et al., 2003, Revision 4, NASA TM 2003-211621 (Vol. 1-6).

SeaWiFS Bio-optical data Archive & Storage System (SeaBASS)

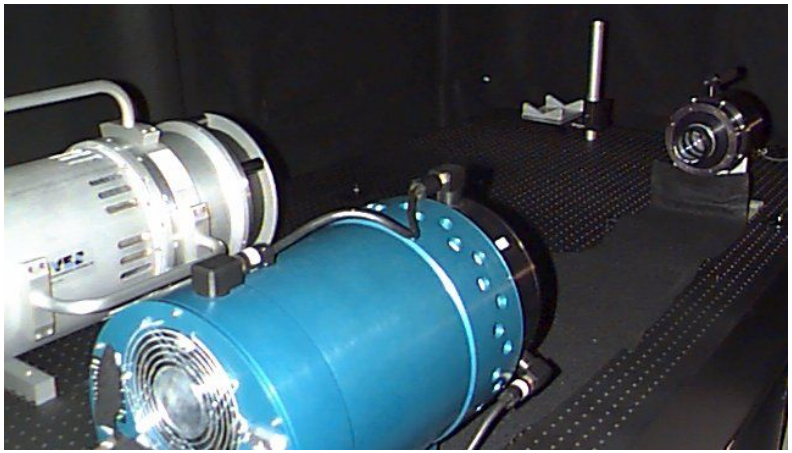


Data from over 1250 cruises

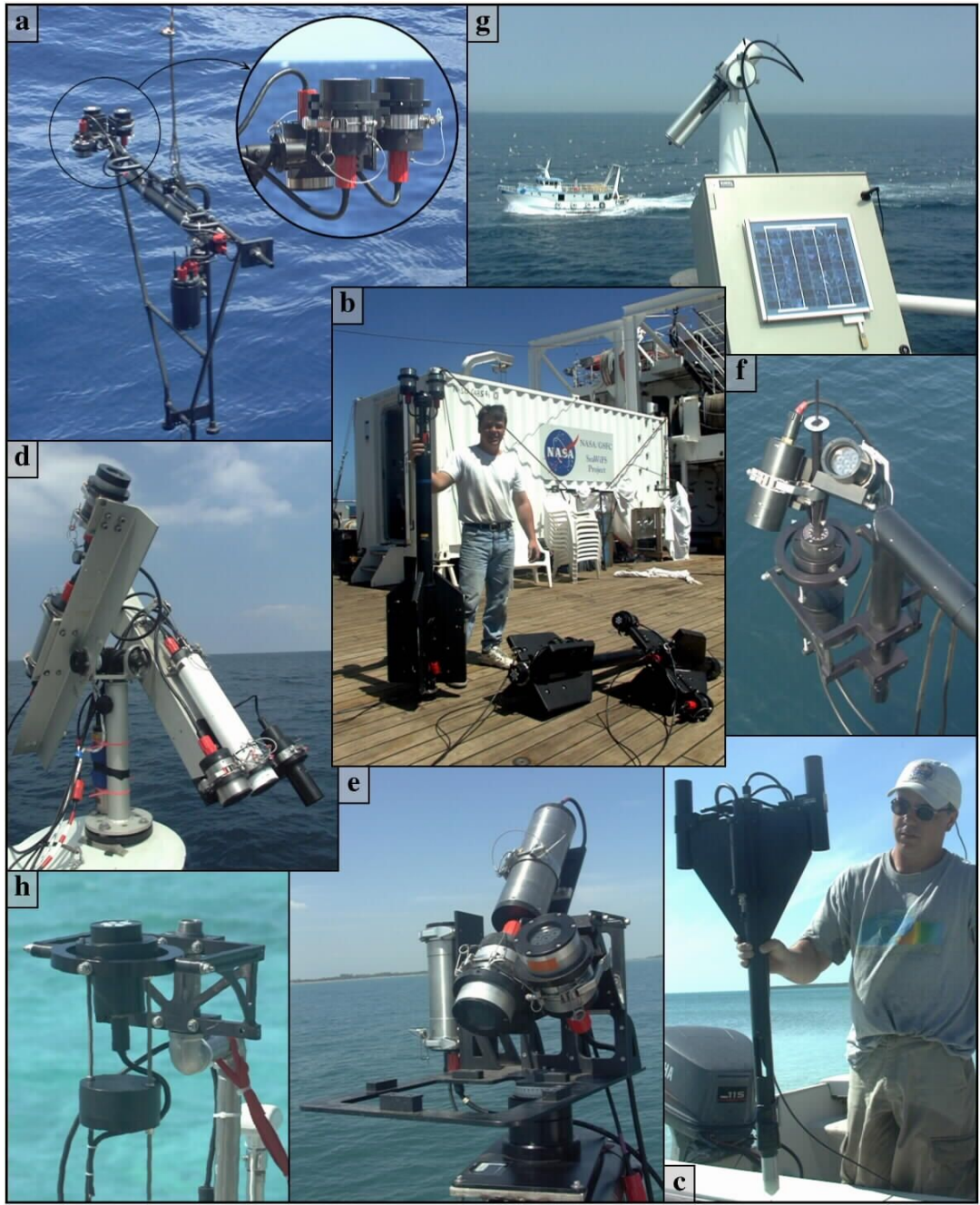
Apparent Optical Property (AOP); Chlorophyll-a (CHL); Aerosol Optical Thickness (AOT)

Field Measurement Technology Development

Various in-water & above water radiometers d



SeaWiFS Quality Monitor (SQM)
(NIST/NASA-developed portable field source for stability monitoring)



Atlantic Meridional Transect (AMT) Program

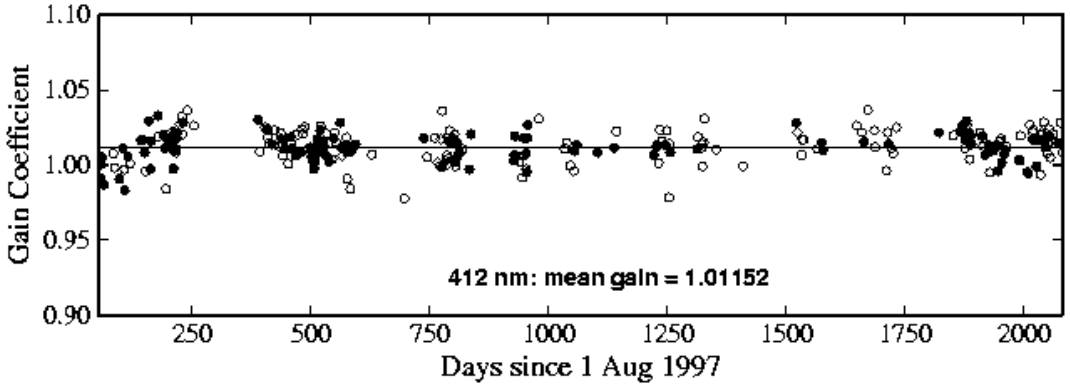
- 9 cruises with NASA participation (1995-1999)
- Semi-annual transects between Great Britain & Falkland Islands

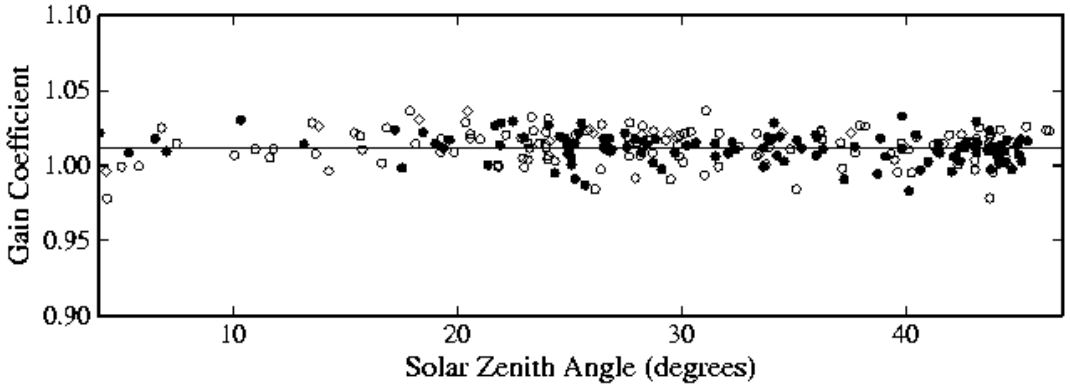
on the British Antarctic Survey vessel, *James Clark Ross*

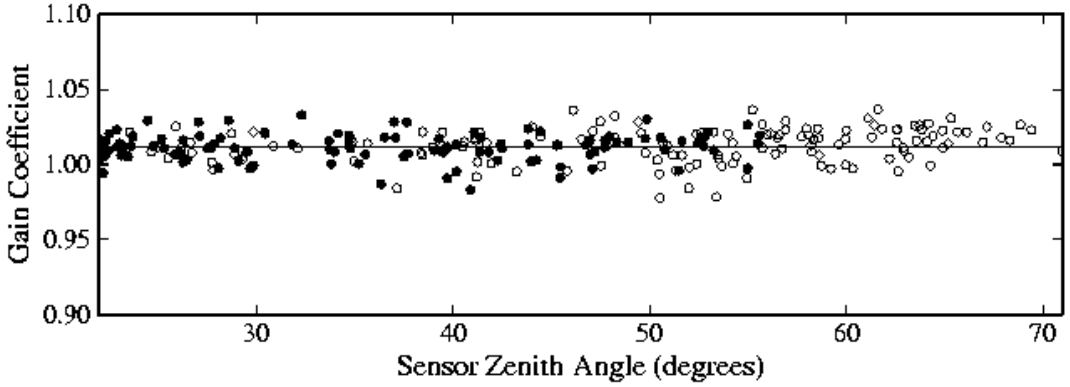
MOBY-based Vicarious Band 1 Gain Factors

- Overpasses used in operational gain determination

) Overpasses that failed gain analysis Q/C criteria



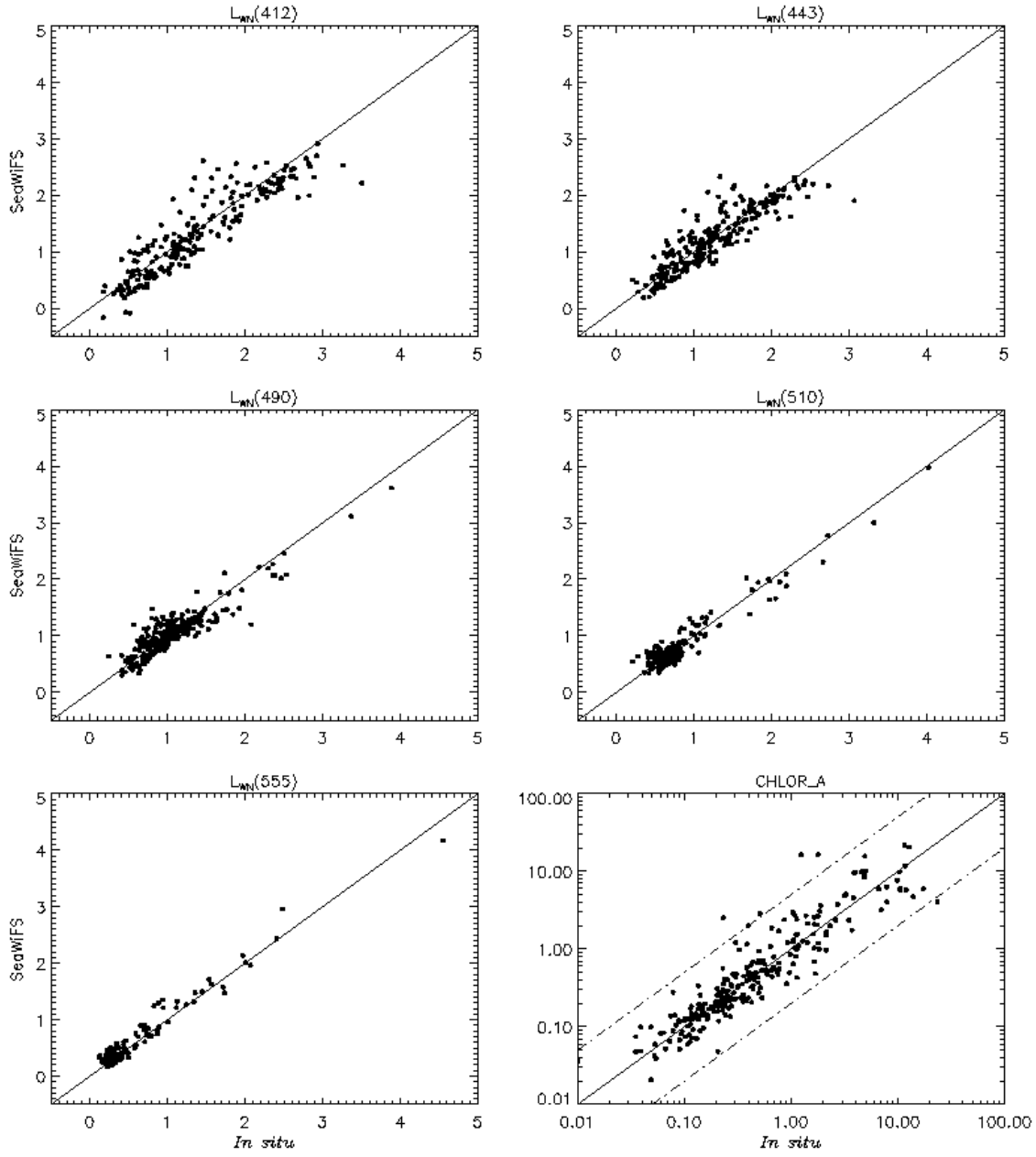




SeaWiFS 865 nm Band: No Vicarious Calibration

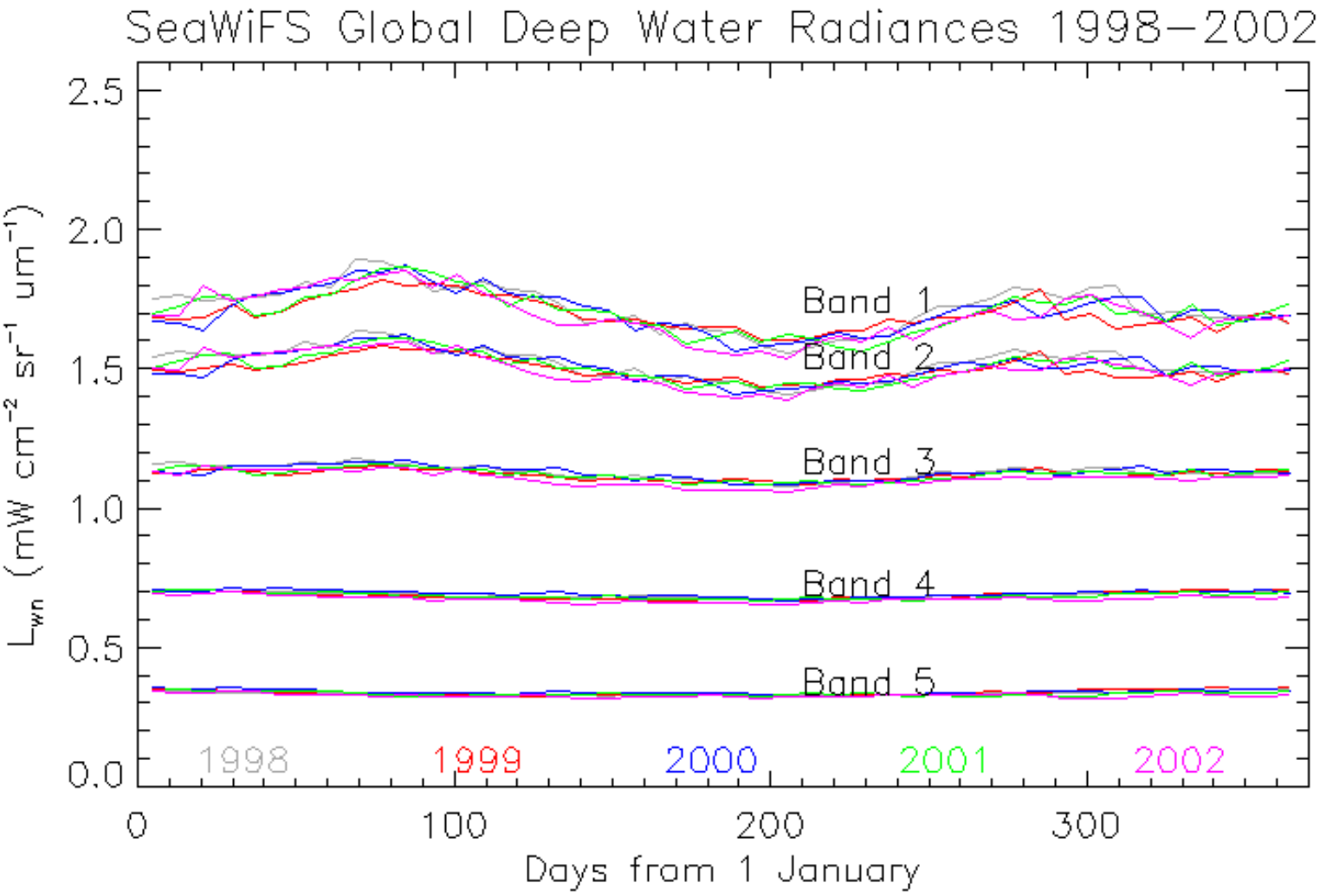
- 865 nm measurements are used provide aerosol amounts in the atmospheric correction algorithm
- Comparisons suggest that band 8 calibration may be 5-10% too high
  - Southern Ocean band 8 gain study (~5-6%)
  - Comparisons with University of Arizona ground measurements (within 10%)
  - Comparisons with aerosol optical thickness data (AERONET & cruise data)
    - Scatter in results is large
    - SeaWiFS appears high

SeaWiFS-In Situ Match-up Comparisons

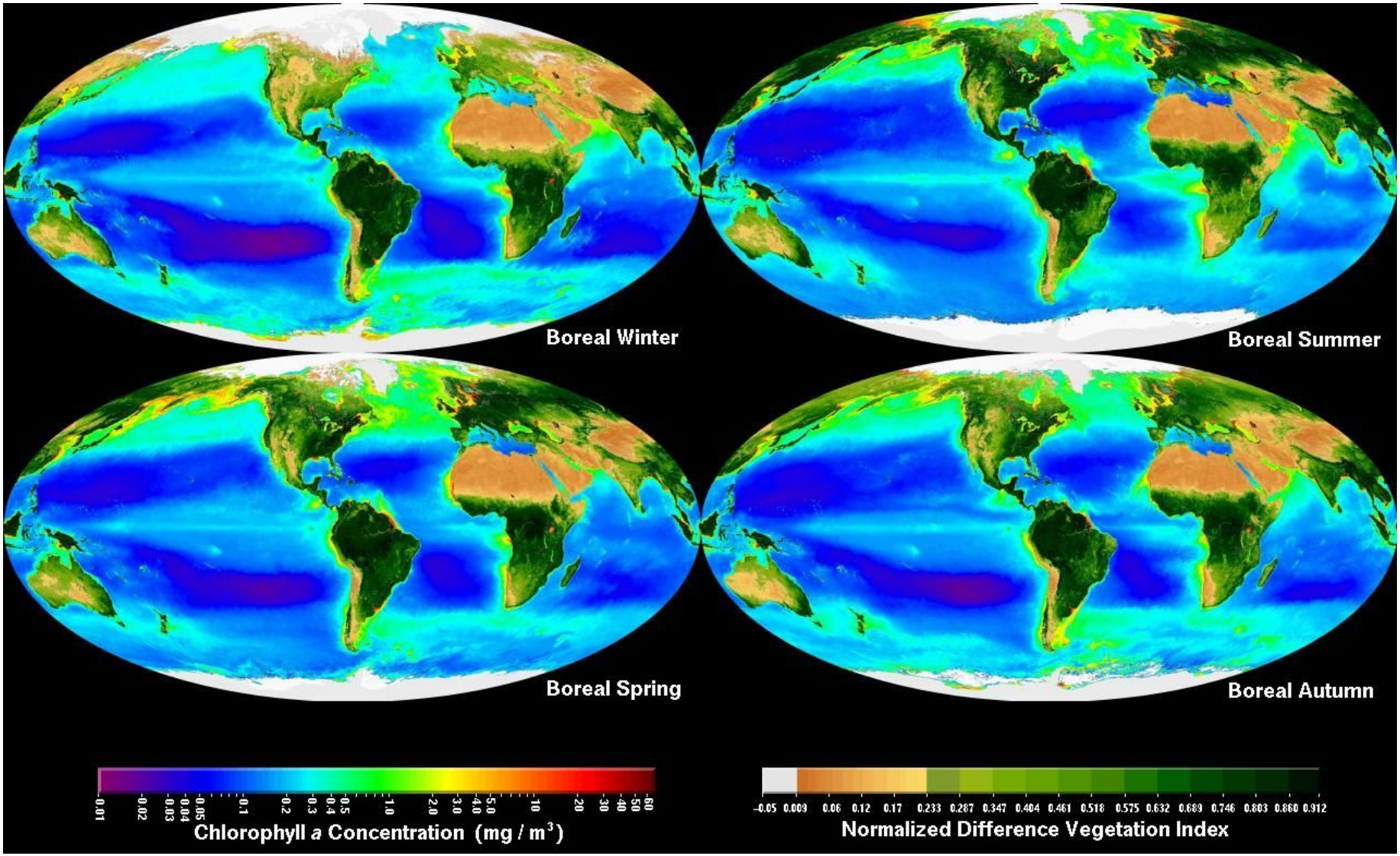


SeaWiFS Interannual Stability

(global monthly mean water-leaving radiances for depths > 1000 m)

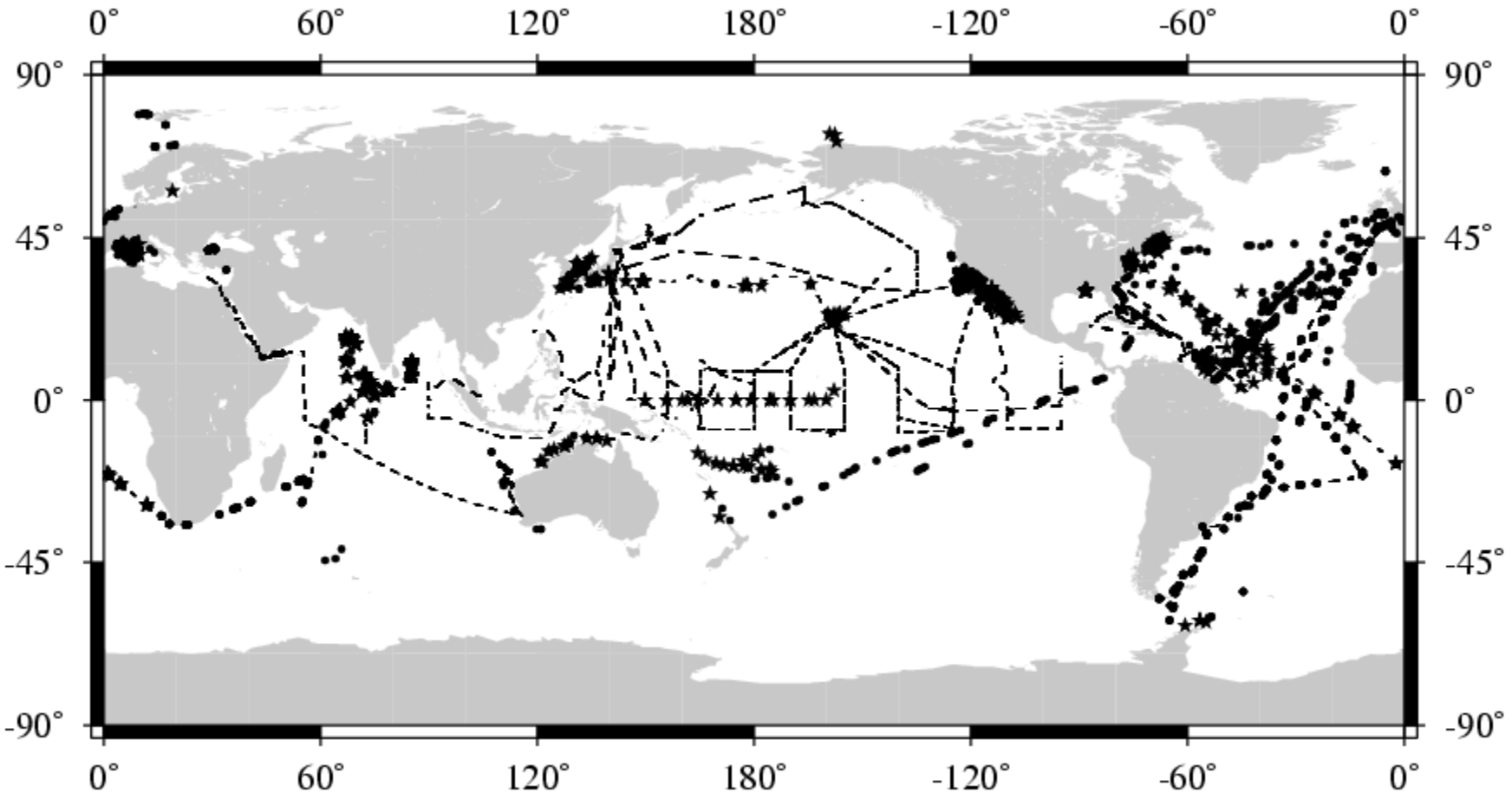


SeaWiFS Seasonal Biospheres



Back-up Slides

SeaBASS Atmospheric Data Set



Stars: Microtops Dots: SIMBAD Dashed Lines: Shadowband