RECOMMENDED PRACTICES FOR SHIPBOARD RADIOMETERS

SHAWN R SMITH AND KATIE WATKINS-BRANDT

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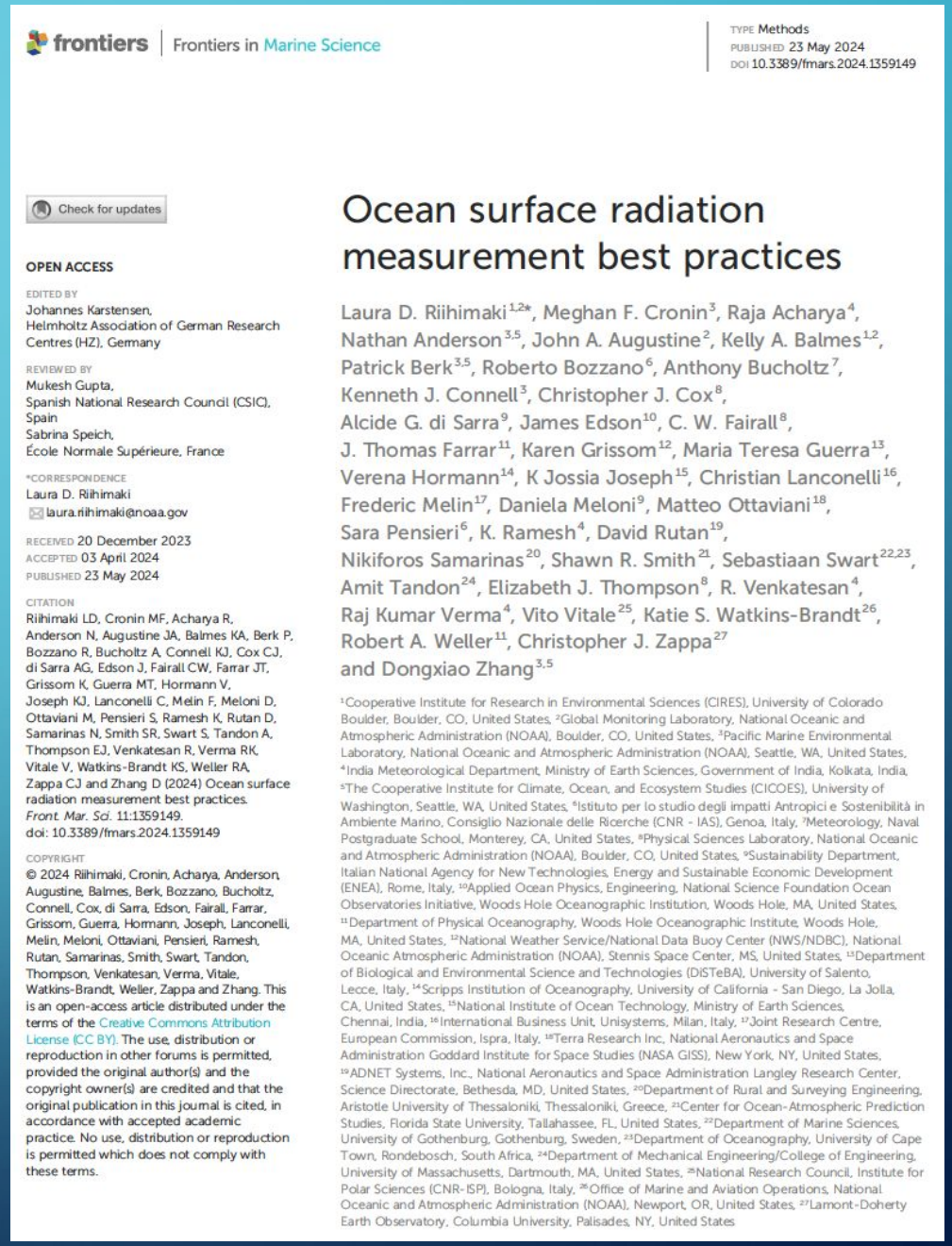

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Ocean surface radiation measurement best practices

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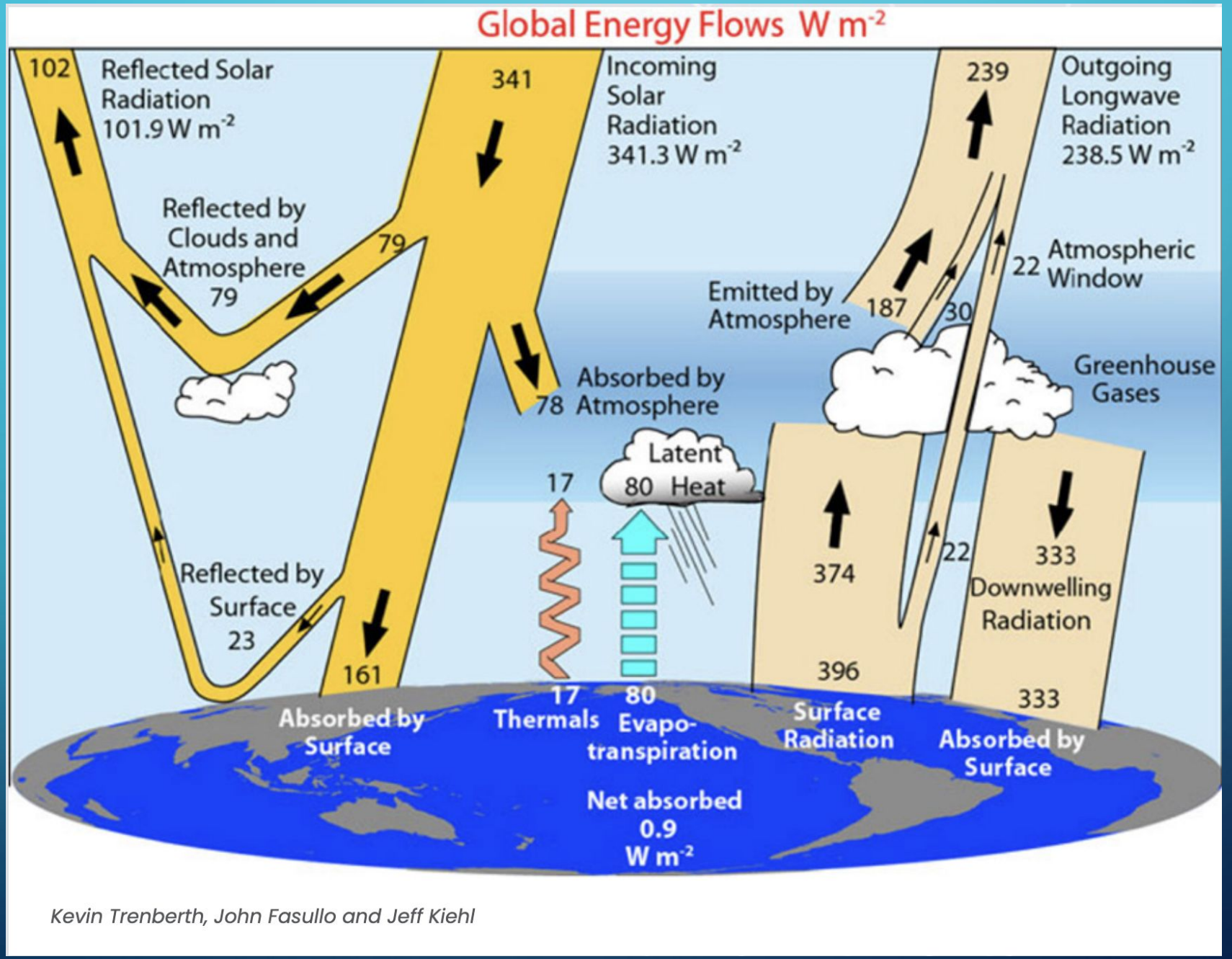
WHY WE CARE!

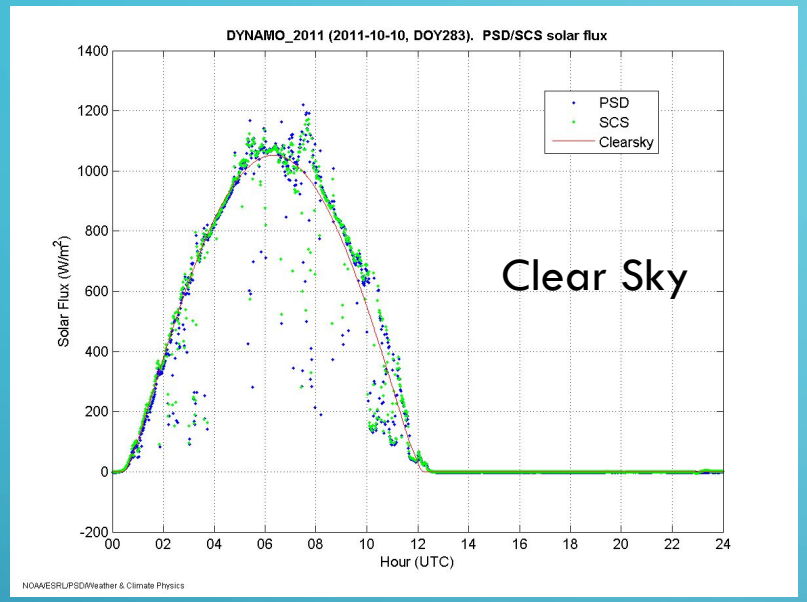
- Focus here on shortwave (SW) and longwave (LW) radiometers
- Understanding atmosphere and ocean energy balance is key to weather forecasting, ocean process, chemical and aerosol cycles, and life on Earth

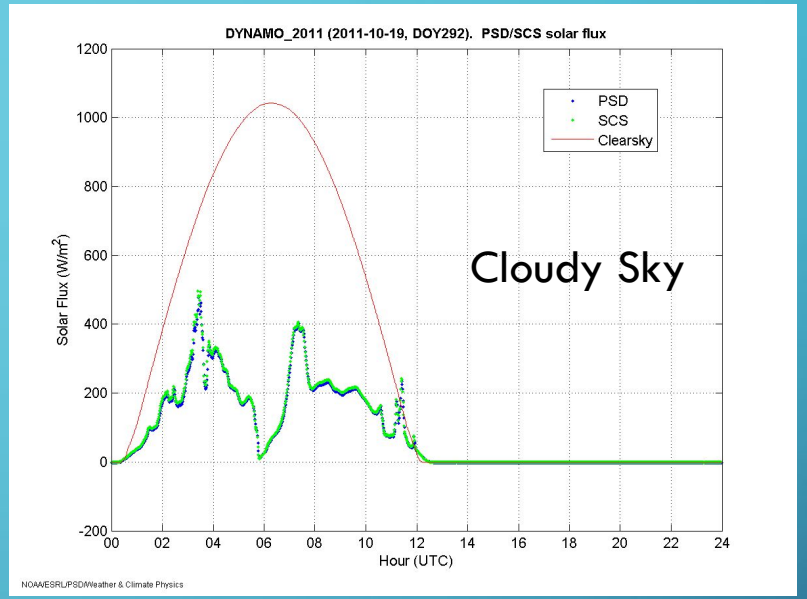
- Users
  - Air-sea flux community (energy exchange)
  - Satellite and model developers
  - Process studies (biological and chemical)



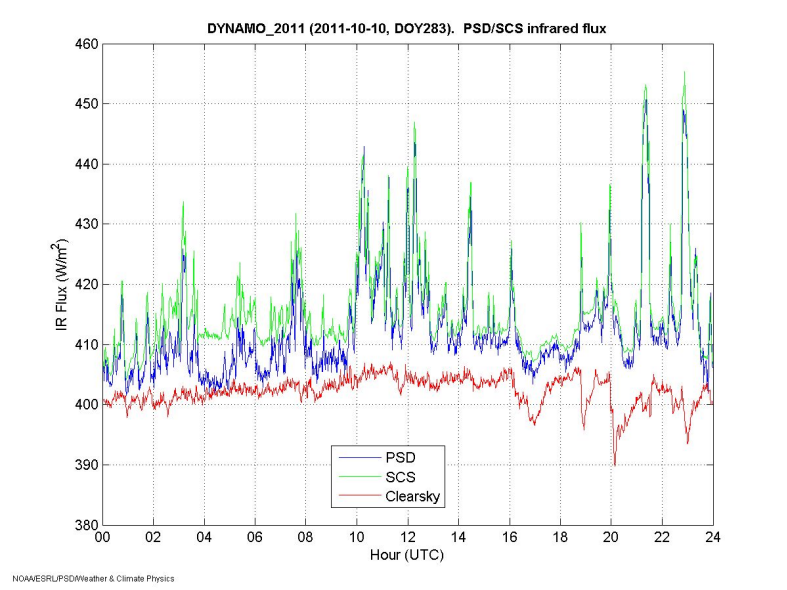
Kevin Trenberth, John Fasullo and Jeff Kiehl

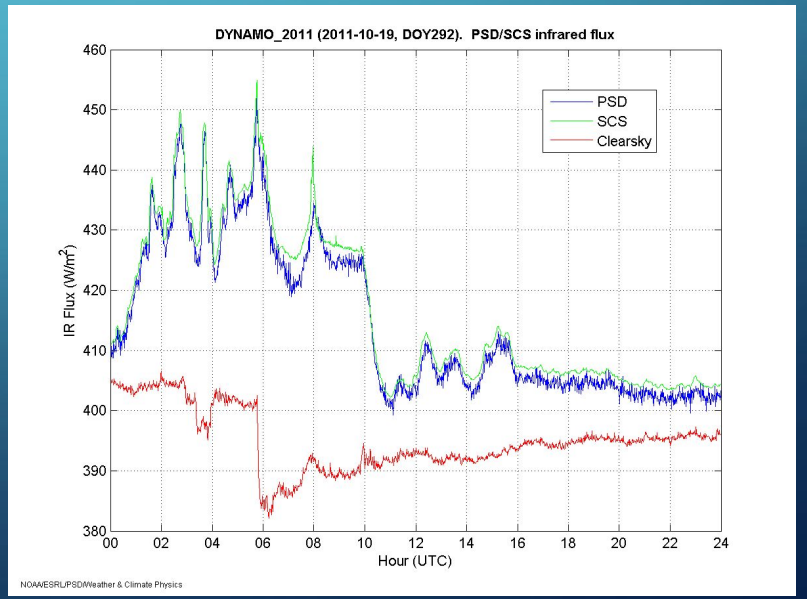
RADIATION OVER ONE DAY





SW

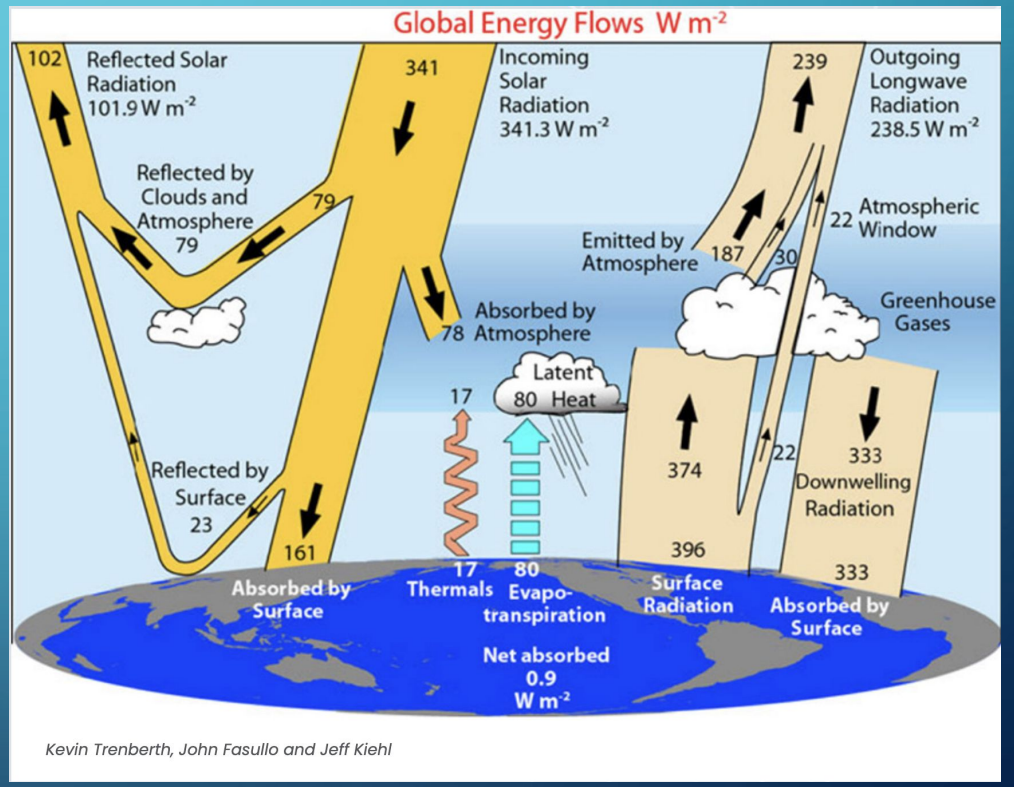




LW

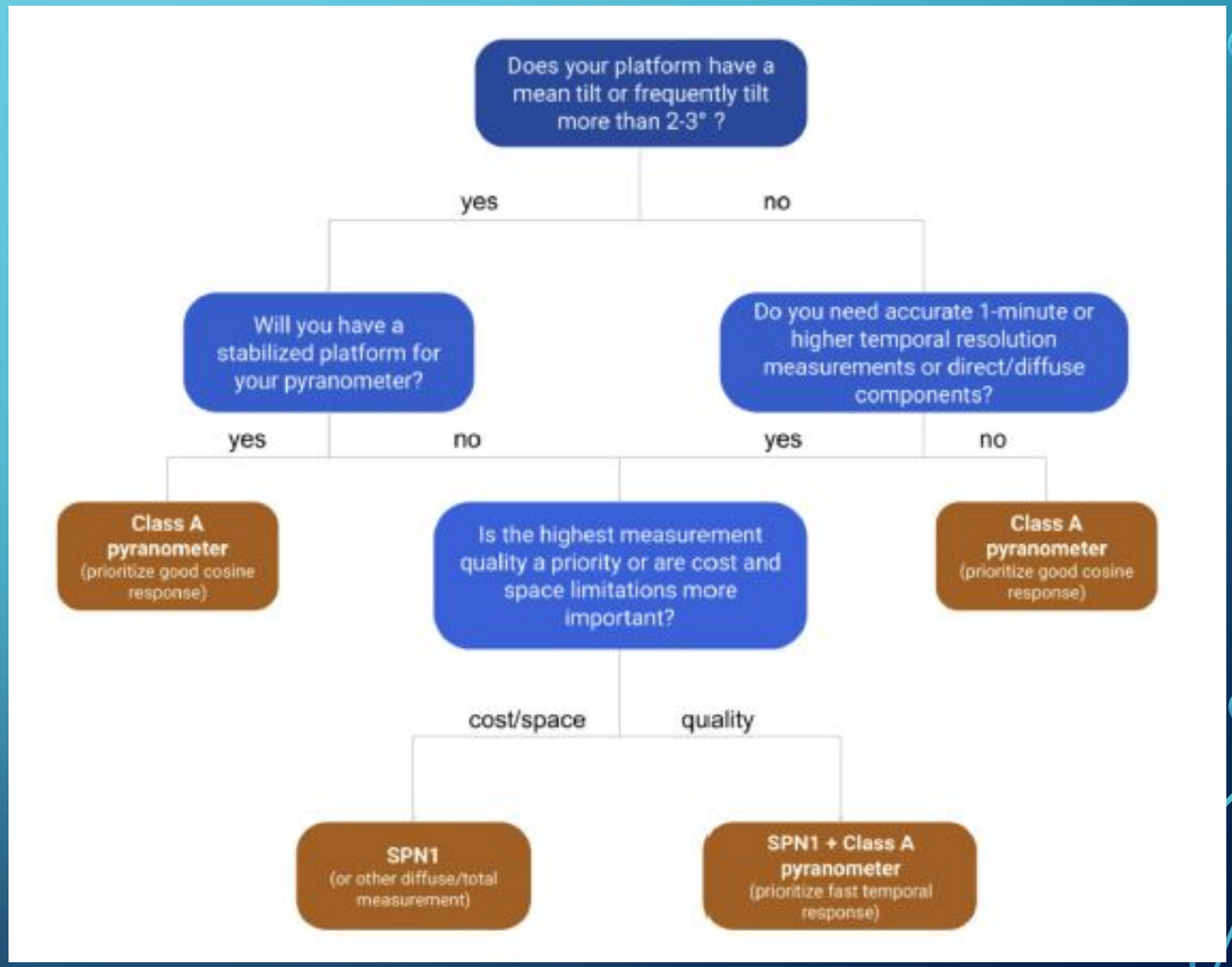
SENSOR SELECTION

- What can we easily measure from RVs?
  - Direct SW incoming (downwelling)
    - Pyranometer
  - Diffuse SW (downwelling)
    - Ex. SPN1
  - LW incoming (downwelling)
    - Pyrgeometer
  - LW outgoing (upwelling)
    - IR SST sensor



SENSOR SELECTION

- SW
  - Review decision tree
  - DeltaT, Kipp & Zonen, Hukseflux, EKO, Eppley
  - Minimize thermal (IR) offsets
    - Ventilation helps
    - Corrections can be applied using LW data



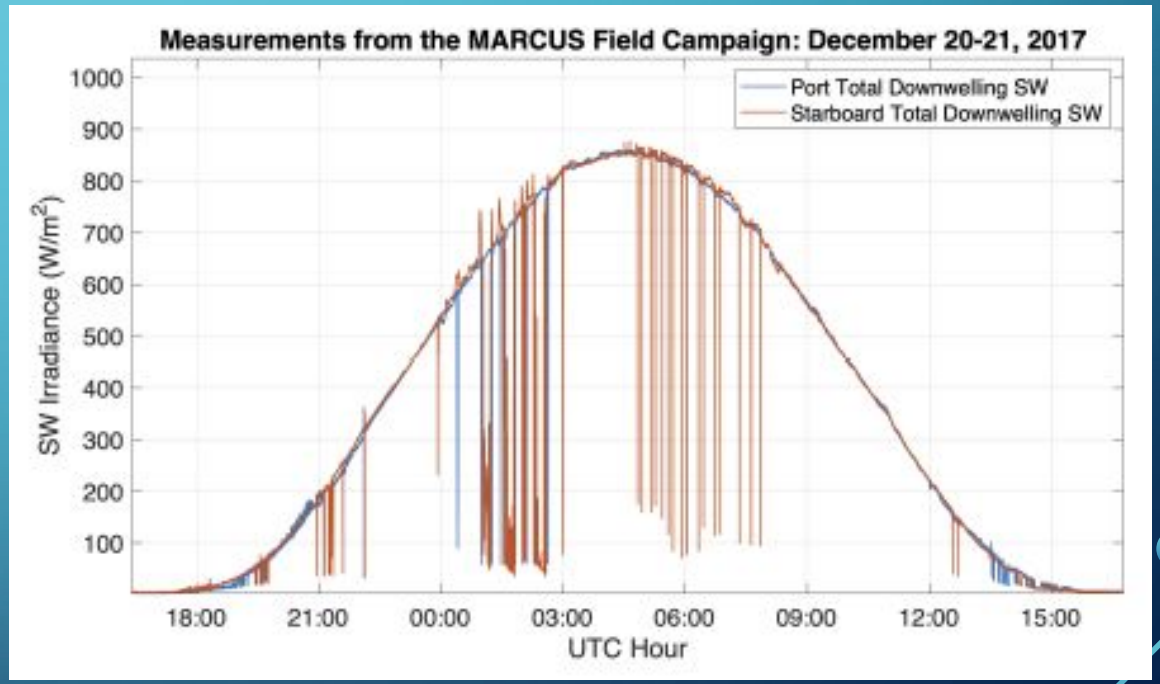
SENSOR SELECTION

- LW
  - Kipp & Zonen, Hukseflux, EKO, Eppley
  - Less industry standards
  - Ventilation helps reduce anomalous heating and debris build up
  - Nearby IR emitting structures can influence measurements

BREAK: HANDS ON TIME WITH RADIOMETERS

LOCATION, LOCATION, LOCATION!

- Forward and high as possible to avoid shadows
- Forward of exhaust stacks
- Redundancy helps
- Leveling is important
  - Recording motion of vessel/platform supports tilt correction
  - Careful alignment with waterline removes “mean tilt” error
- Avoid EMI cloud



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- Operational Reality: Location is a trade off between best location for measurement that provides good access for cleaning and maintenance.

WHAT DATA TO RECORD?

- Full raw data sentences from sensor
  - Collect round the clock
  - These go to R2R post cruise
- Case/dome temps from some sensors help detect errors
- Sensor diagnostics (if available)
- Vessel motion at radiometer sampling rate (1Hz recommended for both)

Essential measurements:

- LW, SW irradiance (Wm^{-2})
- Raw Thermopile voltage (uV)
- Any available thermistor temperatures (°C or °K)
- Thermopile calibration values (uV/Wm^{-2})

WHAT METADATA TO RECORD?

- Serial numbers
- Calibration values and history
- Log of problems, cleanings, maintenance, repairs, etc.
- Installation location, photos of sensor and 360° field of view for sensor
- Existence of bird deterrence or ventilation

MAINTENANCE

- Shipping – pack to avoid damage
- Desiccants – Weekly or as often as possible
- Check ventilation, cables, connectors
- Cleaning
  - Recommended: Daily, prior to dawn
  - Minimum: Weekly
  - Practical: As often as possible, but at least before and after each cruise.

Photograph of Eppley PIR pyrgeometers with broken domes from improper packing when shipping. Photo credit L. Riihimaki

BREAK: RADIOMETER CLEANING/MAINTENANCE DEMO

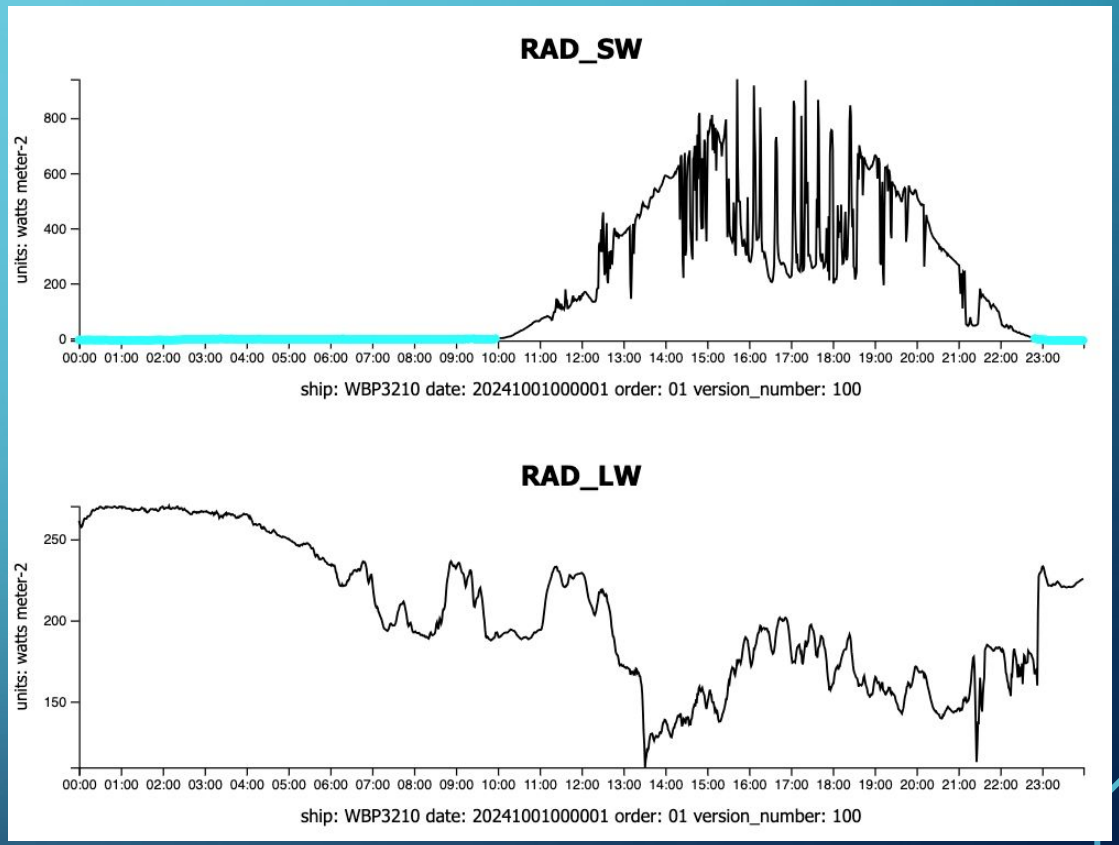
DOCUMENTATION

CALIBRATION

- At least every 1-2 years
- Generally done by manufacturer
  - Can operators leverage regional centers?
- Facility should calibrate to available standards
  - SW – Traceable to World Radiometric Reference
  - LW – Traceable to World Infrared Standards Group
- Shipboard radiometer community still developing standard calibration procedures

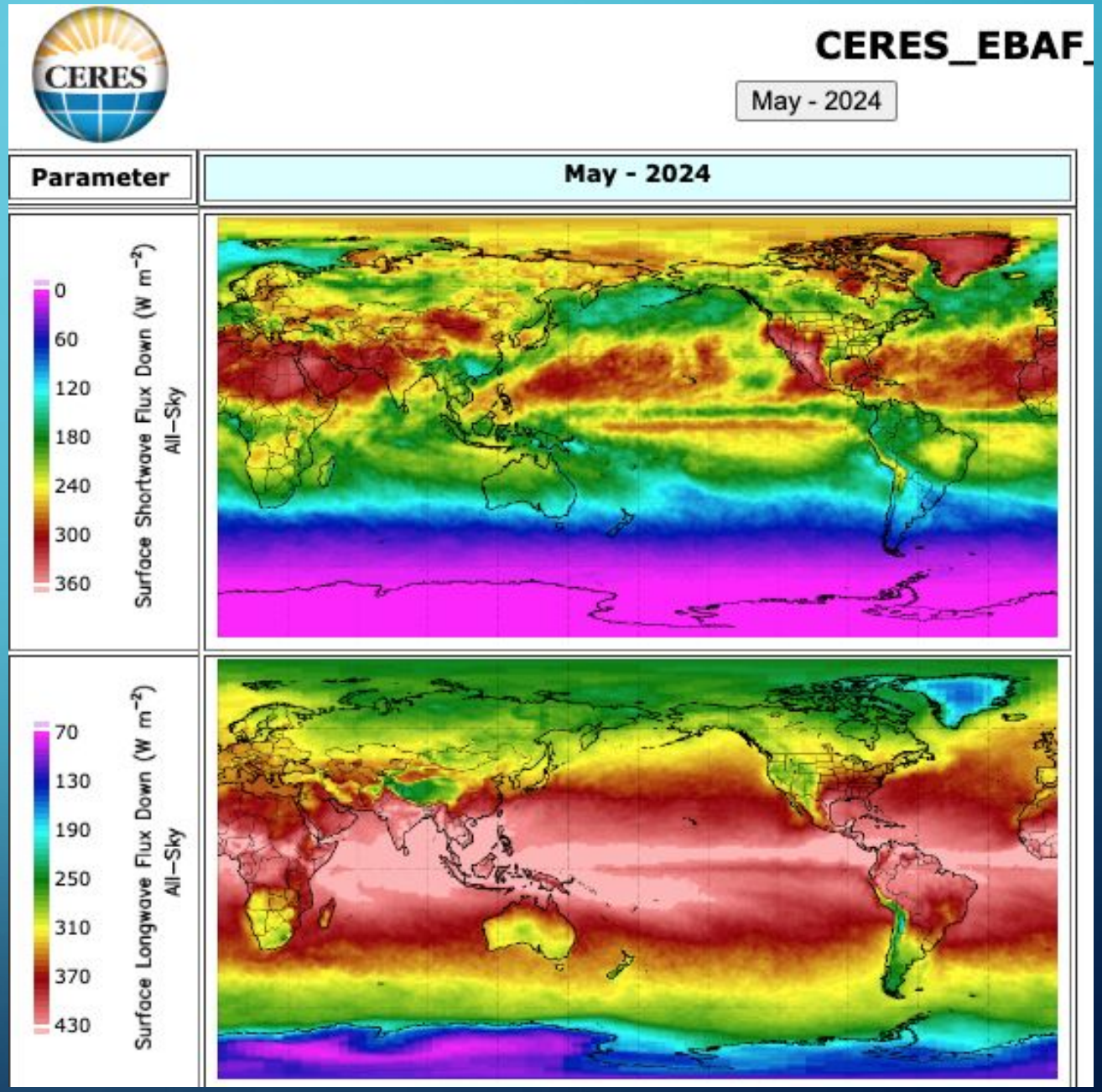
MONITORING

- Verify nighttime offsets for SW sensors
  - No more than a few Wm^{-2} for newer pyranometers
  - Up to 10 Wm^{-2} for older Eppley PSP
- Plausible data ranges:
  - SW
    - 0 – 1200 Wm^{-2}, up to 1500 Wm^{-2} on partly cloudy days
  - LW
    - 40 – 700 Wm^{-2}
    - Higher in tropics, presence of low clouds



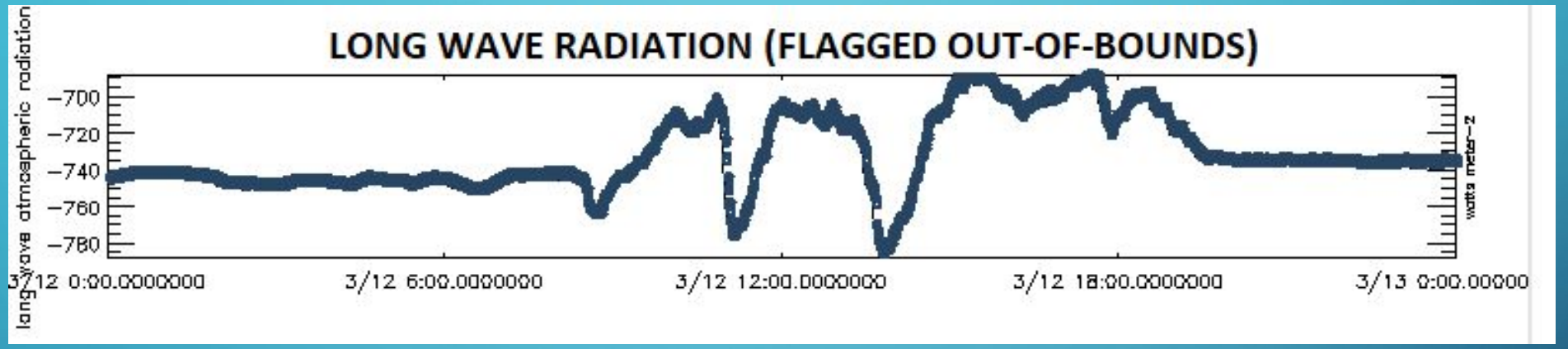
MONITORING

- Compare to climatology
- Monthly:CERES_EBAF_Ed4.2
  - https://ceres-tool.larc.nasa.gov/ord-tool/jsp/EBAF42Selection.jsp
- Daily: CERES_SYN1deg_Ed4.1
  - https://ceres-tool.larc.nasa.gov/ord-tool/jsp/SYN1degEd41Selection.jsp



EXAMPLES OF SUSPECT DATA

UNDERSTANDING DATA MESSAGES

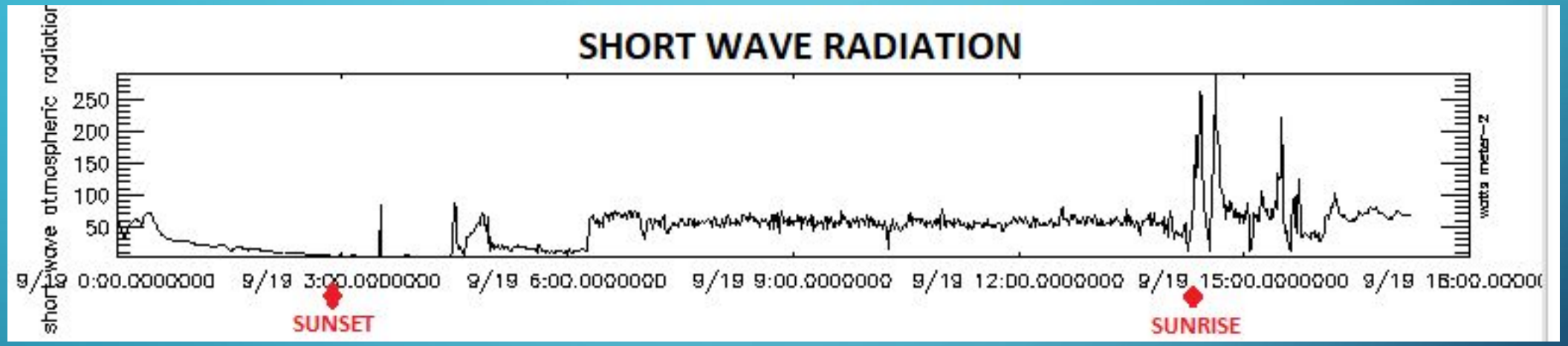


- Negative long wave radiation data (physically unrealistic)
- Examination of data messages revealed a temperature issue:

$WIR35,23/03/17,00:10:30, 176, -13.2, -712.82, 28.04, 67.12, -0.88, 34.0, 11.5

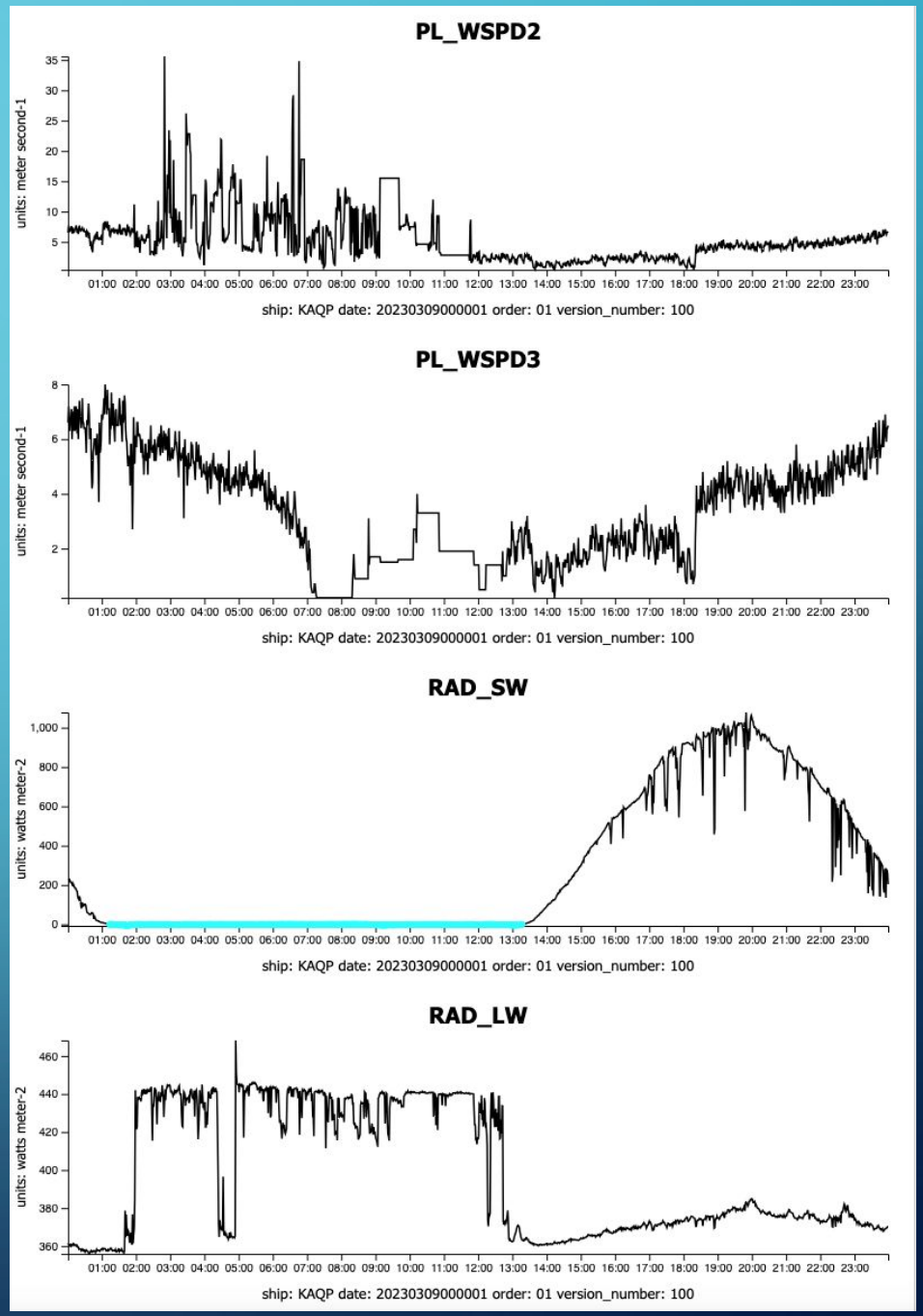
  - PIR case temperature = 28.04 ℃
  - PIR dome temperature = 67.12 ℃
  - dome and case temperatures usually about the same

ARTIFICIAL LIGHT SOURCES



- SW should be near zero at night
- Sometimes bright lights in a port or from trawling operations appear in data.
- This would be a case where a note in an electronic log would be helpful.

BIRD IS THE WORD!



QUESTIONS

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