Hi Matt!

Great to hear from you. A more complete and final *Ride* data quality report is coming your way soon. Over the past year I redid the way we process our own data, so it's just taken a long time to be sure of our own measurements. In case you are interested in the headlines / heads-up now... and sorry for the resulting long email... The problems I noticed on *Ride* that I have in a document so far are:

**- the not-very-sensitive rain gauge**... We recommend an optical one. I attached a spec sheet of the one we have and regularly recommend to ships. The rain gauge installed on *Ride* as of last year is not very sensitive in time or in magnitude. It is known to be subject to under-catchment by design. The sampling resolution of the instrument was only 0.2 mm per second, so the effective resolution in mm/hr is only 5 mm/h, which is relatively coarse. It picked up rain events once it was raining for several minutes and at rates of several mm/hour. But this means the gauge misses parts of raining events and also several light rain events entirely. These are important for climate, weather, and ocean studies. The current gauge's data were also hard to quality control and use because rain evaporates out of the catchment, leading to decreasing values with time in an erratic way.

**- the T/RH air sensor**... it was off during PISTON 2019, but on the last 1-2 day you or Daniel fixed the calibration coefficients to be correct, and that fixed things compared to our NOAA sensors.

**- WaMoS**... Ken Hughes at OSU did comparisons between Surf Otter and WaMoS wave statistics of height and period. Please see attached graph from Ken. They show that WaMoS wave period was fine but wave height was not good. Tom Cook at SIO was not confident in WaMoS at the time of PISTON 2019, but it'd be good to check in with him and make sure he knows something was still off. I don't remember whether we followed up with Tom or not. Last I heard he was planning on trying to reprocess the data once he got the raw files during a port stop.

**- the long wave radiation sensor**.... it looked off during the cruise but it is not yet clear whether this instrument is fine afterall or not because we had to fix some things from our own sensors. TBD - I will get back to you on this. The outside lens should probably be gently cleaned regularly, or at least every cruise, to avoid build up of sea spray. Rain normally cleans off the lens, but perhaps it should still be cleaned more often. On our cruises, I wipe the radiometers off with a paper town or spray them lightly with water daily. I'm not sure if this applies to your models, but it should be checked to make sure water has not gotten inside (we have a desiccant in ours that turns blue if it gets wet). In order to accommodate all this maintenance, it doesn't need to be on the foremast. It should ideally have an unobstructed view in 360 deg directions and be higher than everything else. Perhaps there is a sufficient place for it that also allows it to be periodically cleaned?

**- anemometer**... I haven't finished my wind comparisons yet but it would probably be better to mount the ship's 2-D sonic anemometer further forward of the foremast and higher up on the foremast. This will reduce flow distortion effects. Currently, the wind speeds appear to be biased high relative to the NOAA measurement when wind direction is +/- 50 deg port or starboard of the bow. Wind and all other measurements are most accurate when wind is flowing directly into the bow. TBD - I will get back to you on a final report.

- documentation on sea level pressure... the values were fine but the documentation describing how it was calculated was difficult to find. The steps are repeated here for reference, and could be added to the reference material provided by the ship. To calculate mean sea level pressure, the measured barometric pressure is measured at the unit and then corrected based on its altitude relative to water line.   
zpim = 15.24 ; elevation of ship’s pressure sensor  
p\_correction [mb] = 1013.25 \*( 1 - ( 1 - zpim/44307.69231 ) ^5.253283 )  
p\_sealevel [mb] = p\_measured + p\_correction

**- the TSGs**... it's not an optimal setup on the *Ride* since they share plumbing; they cannot both run independently from different water sources. We discussed this issue on board and it sounded like that wouldn't be fixed in the future. **The documentation in the MET files and readmes needed improving so that science users know what data they were really obtaining, from what depths, and how best to use or interpret the data. I made documentation on this and it is attached, along with recommendations on how to do calibrations for TSGs on all ships**. This would ideally be added to your ship's MET / seawater documentation provided to scientists, and also in the readme files for the data. Applies to both *Ride* and *Revelle*. For the PISTON 2019 cruise dataset, I ended up only using data from the aft seachest port side TSG. The bow starboard side pump was unreliable because when water was pumped from that location, the pump would lose its prime during inevitably high pitching and rolling. The flow rate of both TSGs/pumps (?) needs to be tracked and saved in the data streams to quality control the TSG data after the fact. Enough flow, and consistent flow, is needed to get a good dataset. I ended up needing to correct the T and S data of the aft seachest port side TSG. I did the comparisons relative to the Surf Otter deployed by OSU, since they had measurements at similar depths as the TSG. The offsets at the time are likely irrelevant now, but at the time were 0.2887 C for T before the switch in TSG pumps, and 0.0644-0.0674 deg C afterwards. S corrections were 0.0827 psu before the switch in TSG pumps, and 0.724-0.0507 psu afterwards.

All the other *Ride* data from the ship looked good based on my comparisons to NOAA gear! Chris Fairall (my supervisor) was impressed that *Ride* logged and saved the "speed log" values in the ship data stream. It's the recorded speed through the water in 2 directions (E-W, N-S). I found them in the MET data. This data is really useful and should be kept. Other ships don't normally record or save this but it's useful for determining what the surface currents are. The ADCPs only start sampling around 13-14 m depth on *Ride* (they can't get good data right at the ship, or where a lot of bubbles are present). Instead, one can compute what the 0-5 ish m currents are based on the ship's cog, sog, heading, and the speed log values. I compared these to the upper most ADCP data and they look consistent, but really the speed-log derived "surface" currents are best. We use this derived variable to calculate air-sea fluxes more accurately, since that's actually dependent on both the surface water velocity and the surface air velocity.

I compared *Revelle's* underway TSG data during SPURS-2 2016 and 2017. The pumps were redone between the 2 cruises, so the 2017 comparison is the only relevant one now. I compared the 2, 3, and 5 m port data for T and S, and also compared these to the experiment's floating sea snake T and S measurements collected a few cm below the surface. I'm not sure if my findings are relevant now since I'm assuming that the TSG have been calibrated at least a few times since fall 2017? There was a drifting bias (i.e. a bias that increased with time) in the 5 m S data. There was a T bias that was not constant with time. It actually seemed somewhat dependent on the ship speed and the latitude... perhaps changing as a result of heating in the bow thruster room (when the ship was going faster) and also heating from the warm tropical water around the ship when we were at 10 N vs. San Diego? We couldn't quite figure this mystery out. We think this issue of offsets was also complicated by flow distortion of seawater being dragged underneath the ship and flowing past the TSG intakes. This flow distortion around the ship changes depending on ship speed, so the differences between water characteristics observed from the ports at 2, 3, and 5 m below water line was not constant with time. The water that flowed past each sensor was dragged from somewhere near the surface along the hull and past each sensor, and how much dragging and vertical displacement of water along the hull that takes place depends on the ship speed.

Has more work been done on the *Revelle* undreway through-flow system since 2017? You probably remember that the 2 and 3 m ports were installed by my close colleagues at APL-UW, Kyla Drushka and Bill Asher. They took enough of that down for the midlife refit to take place. Our understanding is that the *Revelle* did not keep these two extra ports after refit? Is that true? Are the ports just covered up but not instrumented anymore?

Jim Edson and Carol Anne Clayson (both at WHOI now) were in charge of the air-sea flux, sea snake for T, and surface met data on *Revelle* during SPURS-2 2016 and 2017. They were the funded party aboard to do that work. For a complete comparison of the *Revelle* met data performance during the cruises, I'd recommend contacting them. I can reach out to them and cc you if you like? Just let me know. I'm sure they compared ship vs. WHOI sensors and could let you know what they found. I only worked with their final quality controlled dataset so I don't know how the *Revelle* instruments compared at the time.