ASOPOS 2.0 Panel: Wednesday 19 September 2018 at WMO, Geneva, Switzerland

(Minutes prepared by Ryan Stauffer)

Items to be discussed:

1) Background current

2) Pump Efficiency

3) Radiosonde Corrections

4) Metadata and data formats

5) SSTs and time responses

6) Solution Volume Correction

7) Review existing SOP for new sondes

8) SOP for reusing sondes

9) What about uncertainties? Measurements + Uncertainties + QA Flags

Tarasick, Thompson, Smit: Seems the consensus is to not drastically change SOPs at this point, particularly SSTs, but potentially in a couple of years after more testing.

Brief conversations as we review the list of items to discuss:

Background currents: **Tarasick** will work more on background currents using existing JOSIE data and his model w/two time constants (presented Tuesday afternoon)

Querel: What is the ultimate goal? Will existing stations apply these recommendations? Clearly new stations should implement our latest best practices.

Tarasick: Issues like the background current can be used in reprocessing of data at existing stations.

Witte: The less alterations/adjustments I have to make when reprocessing the better, so metadata should be reported and stations should closely follow best practices.

Pump Efficiencies: There are several data sets of pump efficiencies (JMA, WFF, NOAA) to analyze.

Pump efficiencies are something we need to at least periodically evaluate given step changes and trends in pump efficiencies shown at the JOSIE workshop.

Radiosonde Corrections: We need to make clear to the community that pressure needs to be corrected using the GPS data, but the surface pressure initialization must be accurate.

Going back in the time series to adjust old radiosondes will be a bit more difficult, but **Voemel** is working with his ascent rate model.

Metadata and Data Formats: **Voemel**: Collecting the data is the first priority, we can figure out the final format later.

Witte: More information! We shouldn't be relying on just the paper check sheets

Stuebi: If we can pass the metadata on to WOUDC as well, then we should.

Tarasick: ALL metadata needs to be in the files, not just on paper.

SSTs and Solution Volume: **Van Malderen**: It does not seem like we should change station SSTs yet based on JOSIE-17, but we can make recommendations in our report.

Tarasick/Voemel: We would like to change to true pump efficiencies and sensor response, but it is not yet clear our data will be any better than it is now. However, it seems new stations would want to follow new solution type and true pump efficiencies.

Morris: In JOSIE, the 2%, 1/10B looked better than 1%, 1/10B in the stratosphere. So we need to do more tests.

Johnson: Agreed, and a new BESOS would be nice.

Voemel: We have not yet found the "golden nugget." We need to fully understand the processes (chemistry, absorption of ozone in the solution, solution boiling and freezing) before we make these changes.

SOPs for Reused Sondes: **Querel**: The manufacturers have shown interest in providing SOPs for reusing sondes.

Side Discussion on the Cathode Bypass:

Johnson: NOAA follows a 1996 (?) Komhyr paper that uses the cathode bypass.

Morris: It's true that it saves time.

Voemel: In the 4 month period when Costa Rica did the cathode bypass they recorded the lowest UT/LS ozone of the record, so they stopped.

What is the process of saturating the ion bridge?

Smit: High ozone conditioning is to destroy contaminants, and maybe some pumps, tubing, and cathode cells are dirty and thus we get a negative effect when the cathode cell is bypassed.

Tarasick: We need to collect more evidence on the ion bridge issue. We currently have only anecdotal evidence.

Voemel: Is there any evidence that conditioning the cathode cell with high ozone causes problems?

1) Background currents (Leads: Tarasick, input from Voemel and others):

Voemel: The measured “background” current keeps dropping when running the sonde on zero air, and the measurement is not constant thanks to secondary reactions.

Can we measure the background by using a known amount of ozone? We can reverse the ozone equation to get the background current. They did an experiment with 1% full buffer and a TEI ozone photometer.

In their experiment, the calculated “background” increases linearly with ozone amount. They use a regression equation, with the intercept of 0.0145, which could be interpreted as a background of 0.015 uA. The same experiment was repeated for ½ buffer and 1/10 buffer. The slopes and intercepts are lower, but oddly the half buffer and 1/10 buffer results look the same.

“What we currently call a constant background, is not a constant background”

Morris: What about solution volume over this ~6-8 hour experiment? Something to consider

Conclusions: Constant Background is poorly defined and it depends on ozone exposure and stoichiometry

Recommendation: Use one background for all soundings. The intercepts measured in these experiments of 0.006 to 0.015 uA may be too low. Costa Rica uses a fixed number of 0.02 uA. Do not use an ozone destruction filter! We should not be measuring the quality of our air filters.

Much of the group agrees that the Costa Rica 0.02 uA is a pretty good idea.

We should use the JOSIE data to estimate the best value to use for the constant background current.

Tarasick: That 0.02 uA comes from somewhere, perhaps the ion bridge, so it probably varies from sonde to sonde.

Should we use a “yes/no” threshold to ensure proper operation? If the sonde passes this threshold test, we then use the accepted background value.

Voemel/Stauffer: The external NOAA filter placed on the EN-SCI KTU preparation unit with drierite and desiccant works great.

Tarasick: A good thing about the NOAA filter is that we can have spares and that they are easy to replace.

Van Malderen presents background tests with EN-SCI 0.5%, 1/2B, and other tests with 1.0% full B EN-SCI and SPC. These are similar experiments to the ones **Tarasick** showed earlier.

Van Malderen shows a lot of variability in the data, and agrees that more experiments are needed with the JOSIE data. In their tests, they supplied the sonde with ozone for 10 minutes, then shut down the sonde and waited an hour and a half, then measured the background current with zero air. **Morris** notes that all the intercepts are at less than 0.02 uA.

Coffee Break

Back from break, more discussion on background currents

Stuebi notes that there may be biases among test units (and what the test unit reads vs. the true cell current) when trying to measure background current. **Smit** says he doesn't believe anything below 0.01 uA.

More discussion on testing the current readings of the test units/verifying the test units.

Some stations record background current IB2 from the test unit (in the lab), others from the radiosonde communication (in the field). Should we standardize this?

The uncertainty in the test units probably argue for going with a constant, fixed background value with a threshold test.

Tarasick: Right now we have three background currents. Why? What do we use to decide the sonde is no good?

The panel seems to be coming to agreement that IB1 should be used for the threshold test.

Van Malderen: Uccle requires IB1 to be < 0.1 uA after 5 min of zero air to determine a good vs. bad sonde

2) Pump efficiency (Leads: Nakano, Johnson, Van Malderen):

We believe we can officially declare in the SOPs that the Nakano/Johnson pump efficiencies are to be used. Nakano shows a standard deviation of 1.3% in the pump efficiencies, which we will treat that as a random error.

But, before declaring an accepted pump efficiency, we need a paper, and to agree among the Uccle, Deshler, Johnson, Nakano, etc. measurements.

We need a site flying SPC to test pump efficiencies. Canadian sites? Maybe SPC will send some to NOAA to test, but this is not a long-term solution.

We could ask a few sites to send SPC sondes as a random sample to test in the WCCOS, but again, this is not a long-term solution.

Voemel: If Lindenberg wants to test the pumps, then maybe these tests could be incorporated into GRUAN operations.

3) Radiosonde issues (Leads: Holger and Stauffer)

Not much additional discussion. This issue was extensively covered on Tuesday afternoon.

4) Metadata (Leads: Witte and Holger)

Recall the three categories: Mandatory, Essential, Nice to Have

We are expecting to give these recommendations to the software providers, and this should not be a major challenge to incorporate in the data files.

Can software be expandable to include more metadata if we decide it becomes important?

Discussing specific variables/parameters that software providers should include:

Should all stations report the 4 to 1.5 uA decay time? Or should we record the 1, 3, and 5 minute currents? The function of the 4 to 1.5 uA decay is to quantify the e-folding time response.

Changing from pump correction factors to true pump efficiencies will be a big change for the software providers, and manufacturers should spit out the numbers.

Morris suggests that we could rename K86 and K95, but it may be best to leave them alone for continuity.

The group will send the list of metadata suggestions and categories out to all ozonesonde experts for review, and will get an endorsement from GAW

Smit will be contact for approval and liaison for GAW, other networks

Lunch Break

Quick discussion: **Querel** will collect used sonde reconditioning procedures, compare them, and come up with an evaluation (Item #8). **Van Malderen** and **von der Gathen** will review the current SOPs (Item #7).

5) Sensing Solutions and Time Responses (Leads: Tarasick; Herman SST experiments; Stuebi, Johnson, Querel, and Van Malderen experiments after evaluation of existing results)

Stuebi shows various slides on time responses, solution tests, and other experiments that the Swiss are doing.

In the fast and slow response time histograms (in seconds), the downward and upward time constants appear to be different. Downward fast is quicker than upward fast, and upward slow is quicker than downward slow, i.e. the time responses are *not symmetric.*

In other tests, sondes were cascaded to see what ozone is not absorbed by the solution in the first sonde. Surprisingly, the 3 cc cathode solution still leaves 2-3% of the ozone unabsorbed. The absorption efficiency increases with altitude (decreasing pressure).

Steubi shows differences among 0.5%, 1%, 1.5%, and 2.0% KI solutions. 1% KI ozone is 5% higher than 0.5% KI, 2% KI is 10% higher than 0.5% KI, similar to past JOSIE results.

Do we continue to recommend the WMO-accepted SST/sonde combinations? Perhaps instead of using K86 and K95 pump corrections, stations could all use the same pump efficiencies, but vary the

conversion efficiency based on the sonde/SST combination. This will probably only be used for new stations.

What about the 1.0%, 1/10B response to the UT/LS gradients? It wasn't completely clear in the JOSIE tests if it was significantly better than WMO. We will need to do more tests.

There is concern that we are combining effects of the pump and the stoichiometry and complicating the slow time response issue. Again, more research is needed.

Quick discussion on 1%, 1/10B. **Johnson** notes that it is difficult to make this solution because of the very small amounts of buffer.

Smit suggests that the buffer solution should be made first, and then combined with the KI solution.

Stuebi shows huge effects based on different dilutions of the buffer. 1%, full buffer, vs. ¼ buffer and 1/16 buffer. Perhaps the NOAA 1/10th buffer solution is getting close to when you would consume all the buffer and the stoichiometry goes crazy. **Braathen** adds his concern about low buffer solutions. Herman says we should continue laboratory tests on 1%, 1/10B.

Voemel wonders how many tests we really need, since many lab and field tests have been completed by many people. The solution testers should get together and determine what has been done, and if anything else needs to be tested (**Stuebi** and **Johnson** to communicate test results).

On the solution KBr: **Tarasick** believes that KBr suppresses the second time constant, but no one is quite sure what the role of KBr is. Even the "real chemists" decades ago did not explain why they added KBr to the sensing solution.

How do we collect all of this information? **Smit** suggests a wiki page might be useful.

6) Solution Volume Correction (Leads: Jonathan Davies and Stuebi)

Reunion and Irene use 2.5ml cathode, so we should look into their JOSIE data and compare with the 3ml stations. Not much more discussion on this.

7) Review existing SOPs (Leads: Van Malderen and von der Gathen)

Not much additional discussion.

8) SOP for used sondes (Lead: Querel)

Querel actually sent out a request for used sonde reconditioning SOPs in 2016, so he already has some of this info. This information that he received is essentially what people already know.

Smit says you need to replace the rubber rings at the pump. **Allaart** agrees and has done some research on the rubber rings for the pump.

How do we determine the best practices for reused sondes?

What does the performance of reused ozonesondes look like? BESOS had reused sondes, but we need to quantify differences among new and reused sondes.

Morris will look at sonde comparisons with OMI overpasses for new vs. refurbished sondes to see if there is a difference.

What do we do with the ones that come back? First we need to figure out the quality of the reused sondes. Are they statistically significantly different in performance vs. new sondes? Then we can move on to SOPs for reused sondes.

9) What about uncertainties? Measurements + Uncertainties + QA Flags (Lead: Tarasick w/input from Witte)

Smit: We need a measurement with an uncertainty and a QA flag. This should be generated automatically, so the operator does not need to be involved in the calculation. We need a random error associated with every point in the profile.

Tarasick: What about the radiosonde uncertainty? There may be some people who do not want to consider the radiosonde uncertainty and only the ozonesonde uncertainty.

Tarasick did add radiosonde error into his ozone uncertainty equation. He used the quoted 0.25 hPa random error for RS80s. This may be conservative, at least compared to the systematic radiosonde pressure biases. Should we report two uncertainties, one with and one without the radiosonde?

Voemel: GRUAN assigns an uncertainty for every point and every measurement. GRUAN frost point uncertainty does not include the radiosonde. What is the uncertainty used for? Would adding the reported uncertainty help someone who wants to do trend analysis? Will they read it and understand it?

Tarasick: We need to at least put in the random error. People do not understand how low the random uncertainty is now for sondes (obviously except in the Tropical West Pacific UT/LS). Errors can beome large at the top of the profile because of the pressure offset. The radiosondes have a random and systematic error (sometimes greater than 1 hPa for RS80s).

Systematic uncertainty –

Smit: Leave in the raw, uncorrected pressure, and also report the recalculated pressure

Voemel: What is the uncertainty on my calculation of rise rate-based pressure recalculation?

Unknown uncertainties: radiosonde pressure prior to GPS, conversion efficiency, others?

Tarasick: There is no tropospheric trend in ECC ozone compared to the uncertainties of the measurements (traced to the UV photometer standard; his TOAR paper)

Discusson on QA Flags – A simple yes or no? Most people do not care about anything but the “good” data.

Discussion on what is really considered bad data. Should we base it on the ozone uncertainty?

Smit: Don’t throw any data out, just flag it.

What about doubtful data? How do we approach that?

It appears the group wants to have flags for good, doubtful, and bad data, with the vast majority of data being flagged good and bad.

Strategy/Timetable for Updates on Progress:

- **AGU Fall Meeting DC, December 2018**
- **EGU Vienna, April 2019**
- **Next Panel Meeting late summer/early fall 2019 (exact dates TBD at AGU 2018)?**
- **By QOS 2020 a lot of these issues are hopefully wrapped up**

End of ASOPOS 2.0 Panel Workshop.