Reviewer 2:

Comment 2.1: This manuscript provides a highly detailed description of a new mobile lab for in situ atmospheric observations. The English is good and the style and number of figures is appropriate. It is suitable for publication after considering the following minor revisions.

> **Response**: We would like to thank the Editor for all the efforts in this review process, and the helpful comments which we have addressed below.

Comment 2.2: Is data publicly available, or are there plans to make it so? If so, please provide details.

> **Response**: At present, the main drive dataset is not publicly available. This is due to the preparation of numerous other manuscripts using it that are not yet published. It is our goal to release the relevant data publicly with each manuscript that follows this one. However, data for the electrical system is available within the GitHub repository, as is some sample data to demonstrate the GPS processing pipeline. Should something specific be of interest prior to the publication of other manuscripts, data can be requested from the corresponding authors. This has been clarified in the code and data availability section.
>
> "**Code and data availability**
>
> See https://github.com/CalMAPLab for both VanDAQ and post-processing pipelines. Data output from the Victron electrical system, and test data for the GPS processing module is available within the same repository. The main drive dataset will be made publicly available following the publication of further manuscripts or can be requested from the corresponding authors. "

Comment 2.3: Given how detailed the description is, I think including some photos in the supplement would help readers visualize the system.

> **Response**: We agree with this comment and have added some photographs to the supplementary as suggested.

Figure S1: Side on view of the CalMAPLab through the passenger cargo door. On the left is the gas phase rack containing the Aeris CH_4/C_2H_6, Aeris CO/N_2O, 2BTech O_3, CAPS NO_2 and EcoPhysics NO_x and on the right is the Vocus PTR-ToF-MS in the yellow rack. Sample lines can be seen entering through the roof inlet plates and distributed to the different instruments.

Figure S2: View of the CalMAPLab through the rear cargo doors. On the left is the mostly particle phase rack containing the TSI CPC, Magee AE33, Spider Magic, Palas Fidas, DMT PAX and the Licor CO_2 instruments. It also hosts the van server wired into the router and rooftop antennae through the white cables. On the right is the battery electric system with batteries on the bottom and inverters, busbars and fuse boxes above.

Figure S3: Front-on view of the CalMAPLab in its indoor parking space featuring the gas and particle phase inlet lines mounted to an extruded aluminium rail. Also visible are the Airmar WX200 weather station and MetOne pyranometer.

Comment 2.4: L253 mentions compressed gas cylinders. Are you required to have a DOT permit for these?

Response: CalDOT requires that drivers follow the safe storage, handling, and use of compressed gas cylinders as detailed in Title 8, Subchapter 7, §4650 of the Cal/OSHA code of regulations. There are no specific permitting requirements.

Comment 2.5: What's the typical gas mileage?

Response: We average around 11 MPG for a range of 250-270 miles. A comment has been added to Section 2.3 to highlight this.

“The gasoline model chosen has a 25 gallon fuel tank with an average range of 260 miles under our operating conditions which is generally dominated by urban stop/start driving.”

Comment 2.6: L453: there are some new research-grade NO2 instruments that might meet your needs (e.g., https://amt.copernicus.org/articles/17/5903/2024/, https://amt.copernicus.org/articles/15/6643/2022/). No need to respond to this, just encouraging you to consider making friends instead of relying on COTS for everything.

Response: Very nice. Thank you for the information.

Comment 2.7: Lines 71 – 80: Suggest moving this up to be in Sect. 2 instead of 2.1.

Response: Moved as suggested.

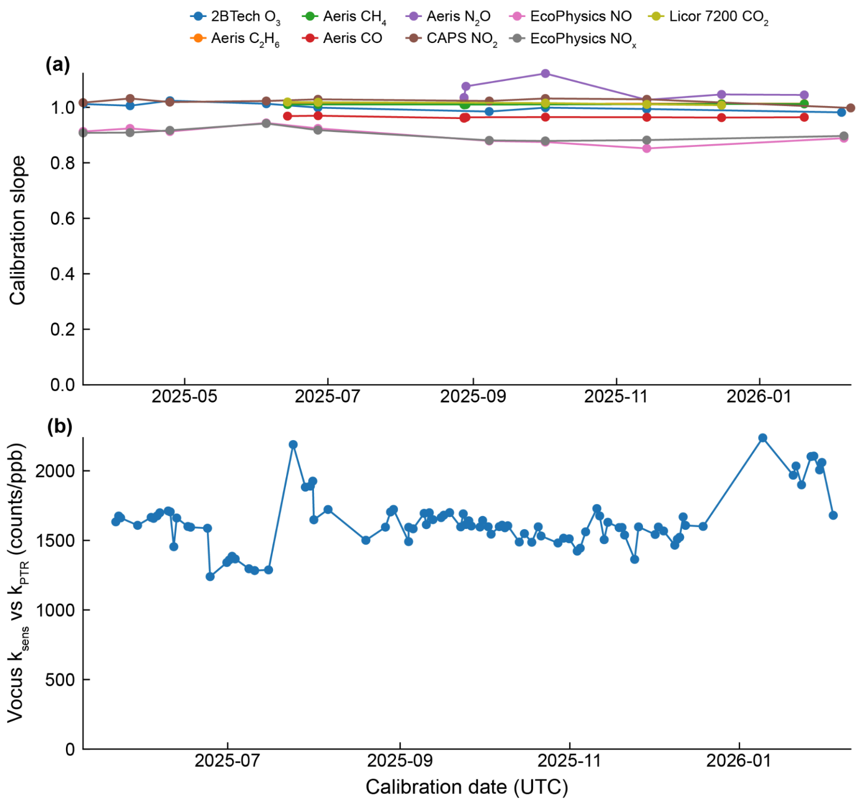
Comment 2.8: L146: It is known that Molybdenum converters also convert other forms of NOy to NO, not just NO2 (e.g., https://www.sciencedirect.com/science/article/pii/S1352231024000505). Is it fair then to call this measurement NOx?

Response: This is a good point which requires clarification in the text. As you say, the biases of the Molybdenum converter are well known. Fortunately, we can calculate a more accurate NO_x from the sum of NO from the EcoPhysics and NO_2 from the CAPS, which is what we actually do for the finalized dataset. The text has been edited to highlight this.

“NO_2 was measured with a cavity attenuated phase shift (CAPS) analyzer (Aerodyne, Billerica, USA) which ran an internal baseline reading taken every 30 minutes. In addition, NO was measured with a chemiluminescence analyzer (model nCLD 855Y, EcoPhysics, Duernten, Switzerland), and total NO_x was calculated from the sum of this NO and the CAPS NO_2 measurement. We chose to calculate total NO_x this way, rather than use the NO_x output from the chemiluminescence analyzer due to its use of a molybdenum catalyst, which can lead to biases from the catalysis of additional NO_y species (Cowan et al., 2024).”

Comment 2.9: L130: how stable are the calibrations? I do not see any example calibrations here or in the supplement.

Response: Calibrations are very stable across 8 months of testing and a figure has been added to the SI to highlight this.



"Figure S12: Stability of calibration slopes over ~8 months of operation for a) O_3, CH_4, C_2H_6, N_2O, CO, NO, NO_2, NO_x and CO_2, and b) the Vocus k_{sens} vs k_{PTR}."

"Much of the instrument payload was chosen based on past reliability in mobile applications (Apte et al., 2017; Harlass et al., 2024; Ma, 2021; Padilla et al., 2022; Shah et al., 2023) and long-term stability was observed in the calibration factors across the testing time period (see Fig. S12)."

Comment 2.10: L207: What is the inverter efficiency? Most of the instruments probably have internal DC supplies, so I wonder what could be saved by doing a direct DC tap to those.

Response: Maximum inverter efficiency is listed as 93%, although it is variable with temperature. We measure our efficiency losses through the inverter system as 15% as discussed in the text, although this is in part due to inverter self consumption that would occur irrespective of load. Of the instruments in the payload, the Licor CO_2, CAPS NO_2 and 2BTech O_3 could easily run off DC. This only accounts for a very small fraction of the total electrical load (80 W vs 2400W) and so would make negligible difference to the total power draw. The ease of power through the mains sockets makes it attractive to not change this. However, should this balance vary significantly in a different build, perhaps it is worth consideration. A note has been added to the text discussing this.

"It is noted that some efficiency gains could be made by wiring DC instrumentation (e.g. Licor CO_2, CAPS NO_2, 2BTech O_3) directly into the DC supply rather than use supplied adapters. With this payload, the savings are negligible (~10W) compared to the total power draw. However, should the payload contain a large fraction of DC powered equipment, this is worth consideration"

Comment 2.11: L245: I do not think there is any such thing as a "standard aircraft rack." Standard for what aircraft?

Response: We agree that this wording is poor. It was originally referring to the standard aircraft L-track mounting hardware, but this is mentioned later and so we have reworded this sentence.

"The Vocus PTR-ToF-MS was built into a custom steel rack with similar shock rope isolators"

Comment 2.12: L382: Have you considered performance under cold conditions (e.g., SLC in winter)?

Response: We have not had a chance to test very cold conditions yet. The coldest temperatures the CalMAPLab has been operated in so far is around 4 °C. This colder-conditions data was collected after the original drafting of this manuscript and Figure 6 has been updated to include this greater range. However, the HVAC system has the capacity to heat the interior via the RecPro air conditioner/heat pump should sampling under sub-zero conditions be required. We do note that one issue already encountered under cooler conditions is condensation within the Vocus water bottle and reagent line which affects the reagent ion flow into the reactor. Both the bottle and line are therefore warmed with heating tape to alleviate these issues. This has been added to the text.

"The mobile laboratory was not tested in sub-zero conditions. However, the RecPro HVAC system can heat the interior via a heat pump if required. In addition, temperature sensitive components in the Vocus reagent ion delivery system like the water bottle and reagent line are heated with heat tape to prevent condensation and irregular delivery flows."

Comment 2.13: L479-480: suggest deleting this sentence.

Response: Removed as suggested since it was a repetition of what is in the main text body.

Comment 2.14: L149: “flow rates”

Response: Corrected as suggested.

“with regards to size range, resolution, and flow rates, and its ability to use multiple neutralization sources”

Comment 2.15: L208: “after-market”

Response: Corrected as suggested.

“12 V secondary, after-market alternator”

Comment 2.16: L232: might consider renaming this section to “Mechanical and Thermal”

Response: Changed as suggested.

“2.5 Mechanical and thermal engineering”

Comment 2.17: L260: “secured on”

Response: Corrected as suggested.

“fitted to custom machined plates secured on either side of the aluminium roof”

Comment 2.18: L265 and on: please specify whether tube diameters are ID or OD. The former is more important for flow considerations.

Response: Clarification has been added to convey the OD given.

“Vocus lines are ¼” OD”, “Licor-7200RS samples from a separate ⅜” OD line”, “particle inlet consists of a ½” OD stainless steel line”

Comment 2.19: L285: probably worth also giving driving speeds in mph or kmph, as that’s what readers are calibrated to.

Response: Added speed in kph as suggested for better context.

“This increase can be as high as 40% for $PM_{2.5}$ when driving at speeds of 25 m s^{-1} (90 kph). Under these conditions, an isokinetic inlet is clearly desirable. However, the majority of driving undertaken by the CalMAPLab is carried out at 10 m s^{-1} (36 kph)"

Comment 2.20: L352: replace != (which is code) with "is not equal to" or something similar

Response: Changed as suggested.

"GPS is not equal to NA"

Additional author edits of note:

1. Changed the dashboard design for a sleeker look. See below the new supplementary figures that replaced Figure S2.

Figure S5: VanDAQ time series dashboard for key measured species by instrument. Individual panels can be configured to show multiple species on different axis (e.g. Aeris instruments). Standard operations display the last 5-minutes of data. Should a measured parameter be out of range (e.g. Aeris CO/N_2O), that instrument flashes red to alert the operator.

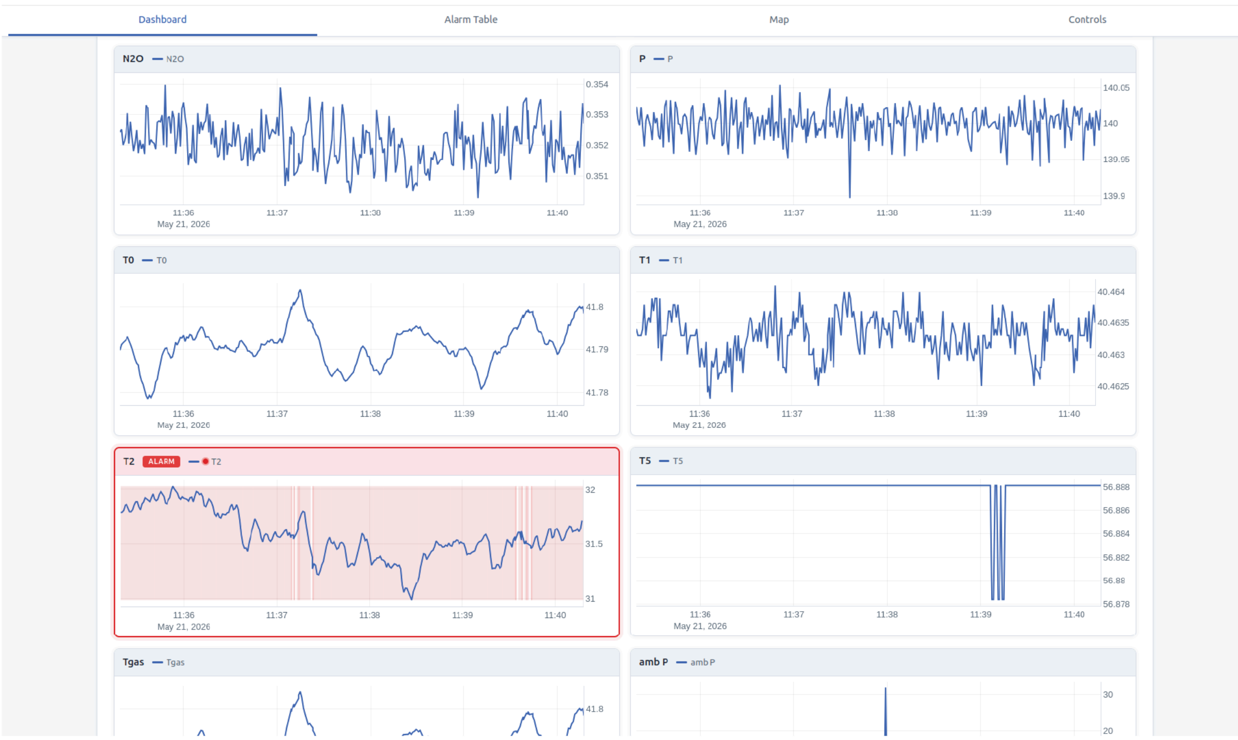
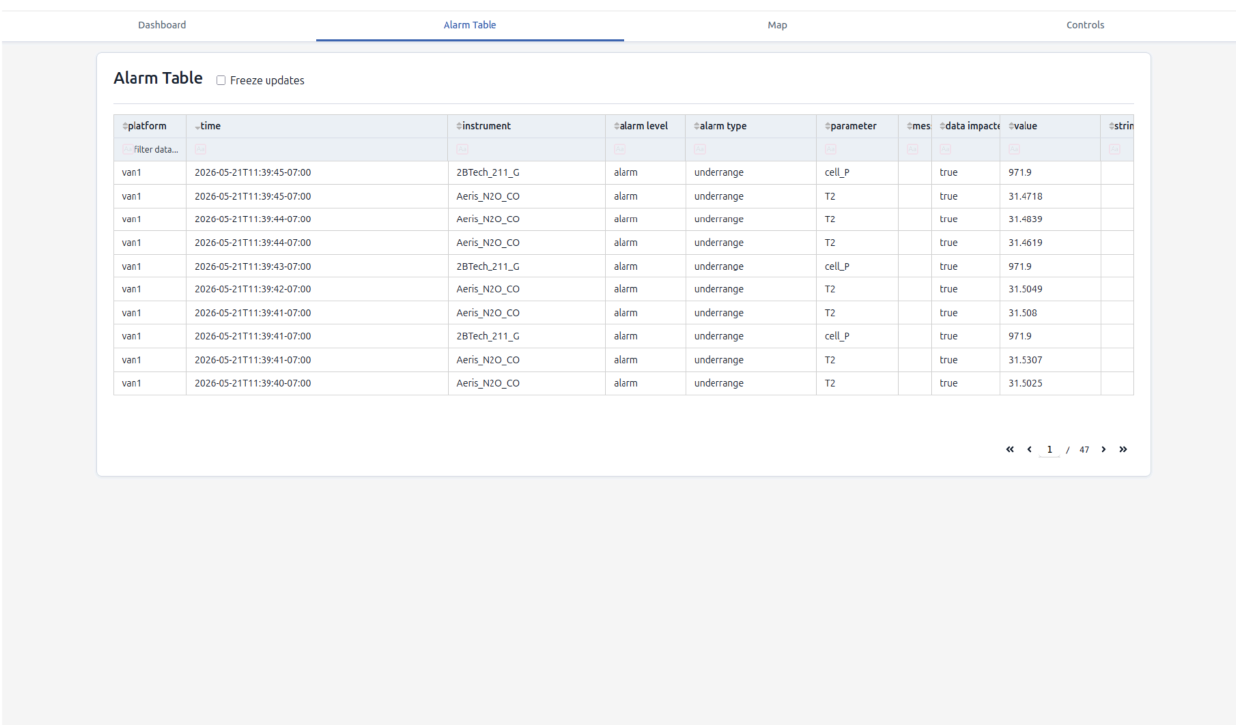


Figure S6: Measured engineering parameters can be studied by clicking on each instrument to open a second set of time series. As with Figure S5, parameter alarms triggered due to a measurement being out of range flash red. The example here is T2 on the Aeris CO/N_2O instrument.



platform	time	instrument	alarm level	alarm type	parameter	mes	data impacte	value	strin
van1	2026-05-21T11:39:45-07:00	2BTech_211_G	alarm	underrange	cell_P		true	971.9	
van1	2026-05-21T11:39:45-07:00	Aeris_N2O_CO	alarm	underrange	T2		true	31.4718	
van1	2026-05-21T11:39:44-07:00	Aeris_N2O_CO	alarm	underrange	T2		true	31.4839	
van1	2026-05-21T11:39:44-07:00	Aeris_N2O_CO	alarm	underrange	T2		true	31.4619	
van1	2026-05-21T11:39:43-07:00	2BTech_211_G	alarm	underrange	cell_P		true	971.9	
van1	2026-05-21T11:39:42-07:00	Aeris_N2O_CO	alarm	underrange	T2		true	31.5049	
van1	2026-05-21T11:39:41-07:00	Aeris_N2O_CO	alarm	underrange	T2		true	31.508	
van1	2026-05-21T11:39:41-07:00	2BTech_211_G	alarm	underrange	cell_P		true	971.9	
van1	2026-05-21T11:39:41-07:00	Aeris_N2O_CO	alarm	underrange	T2		true	31.5307	
van1	2026-05-21T11:39:40-07:00	Aeris_N2O_CO	alarm	underrange	T2		true	31.5025	

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Figure S7: Alarm tables panel within the VanDAQ dashboard. Here, the same Aeris CO/N_2O example as in Figure S5/6 is presented with T2 out of range.

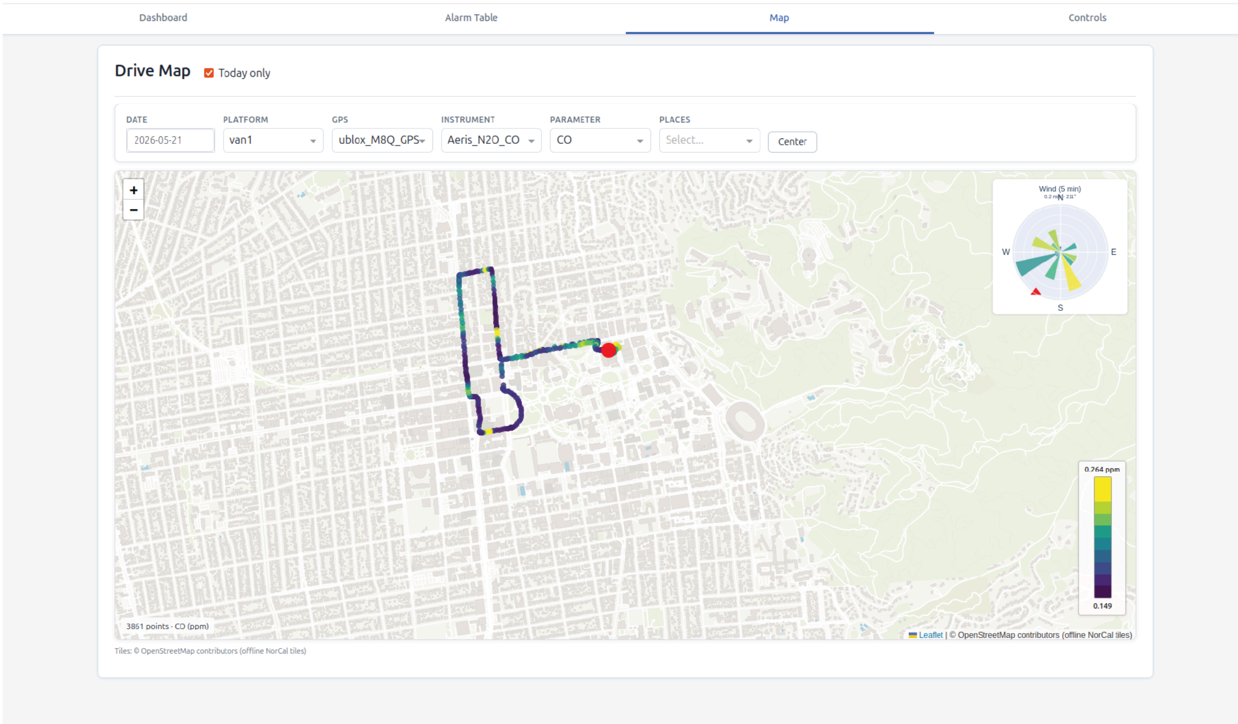

Figure S8: VanDAQ live-updating map of GPS coordinates colored by a choice of instrument parameter values which are toggled in the dropdown menus. Different shape files of polygons or points of interest can be added through the places tab. Historical drive data in the database can be viewed by changing the date field in the calendar dropdown. Also shown is a 5-minute average wind rose from the weather station.

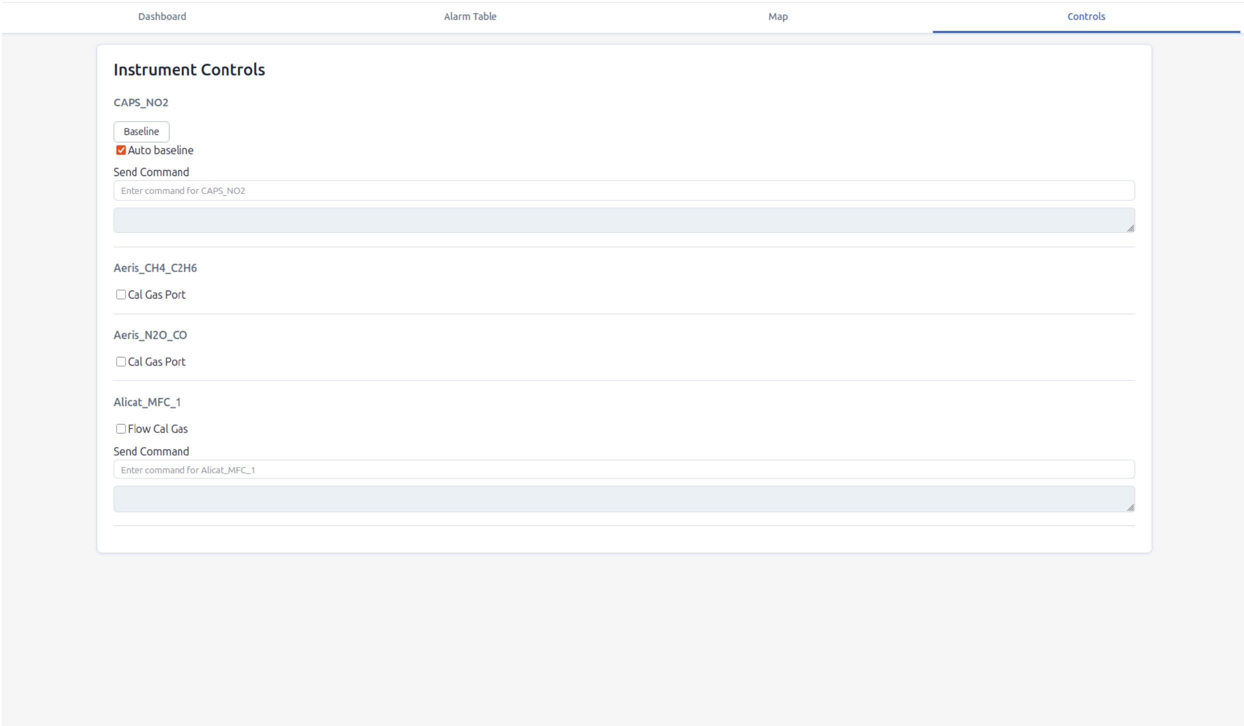

Figure S9: VanDAQ controls tab for triggering valves configured within the system. Here, buttons exist to control the CAPS NO_2 auto baseline, change the Aeris instrument ports, and adjust settings on a mass flow controller.