pySAS User Guide

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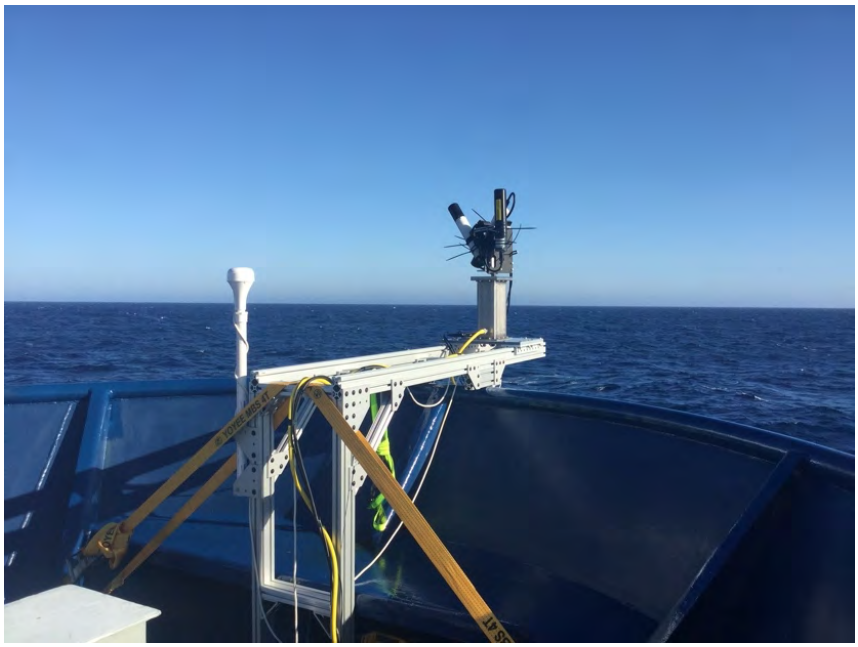

This guide contains instructions to install the pySAS on a ship, make measurements with the radiometers and offload the data from the pySAS system to a computer.

Prerequisites:

- This guide assumes the pySAS is being used with the Sea-Bird Scientific HyperSAS sensors with cables modified to connect to the system's box
- To connect and control the pySAS, a device with wi-fi *connectivity* and an web browser is required (e.g. laptop, tablet, smartphone). Note that an internet connection is *not* needed.

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1 Hardware Overview

Figure 1. Hardware Overview as installed on the RSS James Cook (left) and R/V Roger Revelle (right)

The pySAS system's main parts:.

- a tower (also referred as an indexing table) with mounting brackets for the radiometers
- a tower frame (build specifically to the ship)
- a controller box with GPS antennas
- Sea-Bird Scientific's sensors (e.g. HyperOCRs and THS)
- four cables (HyperSAS, Es, Tower, Power)

Instructions on how to build your own controller box and tower are provided in the "Tower Drawings" and "Controller Box Assembly" documents.

2 Hardware Setup

2.1 Mounting Radiometers on the Tower

1. Screw the radiometers' mounting bracket to the back of the metal plate attached to the top of the tower such that the hole of the mounting bracket aligns with the gap on the metal plate.
2. Set the radiometers' mounting bracket such that the HyperOCR sensors point at 40º from horizontal (Figure 2.a).
3. Feed the three heads of the HyperSAS cable through the mounting bracket (Figure 2**Error! Reference source not found.**.b), then connect the labeled cords to the respective HyperOCR sensors and THS head. If labels were to be missing, the master sensor - typically the THS - should be plugged to the middle cable while the slave sensors - typically the HyperOCRs - should be plugged to either side cable (please refer to Sea-Bird's Scientific manual to find the SatNet master and salve sensors). It's easier to attach the cables prior to mounting the HyperOCR/THS on the mounting bracket.
4. Fasten the HyperOCRs and THS with zip ties (Figure 2.c). It is recommended to leave the excess zip-tie to discourage seabirds from landing on the system.
5. Bind the cables running from the HyperSAS together in such a way that the tower has 360º degrees of freedom (180º degrees to each side). Make sure that cables won't be snagged on the edge of the tower. Once you communicate with the tower, turn it to both sides to insure it can freely move.

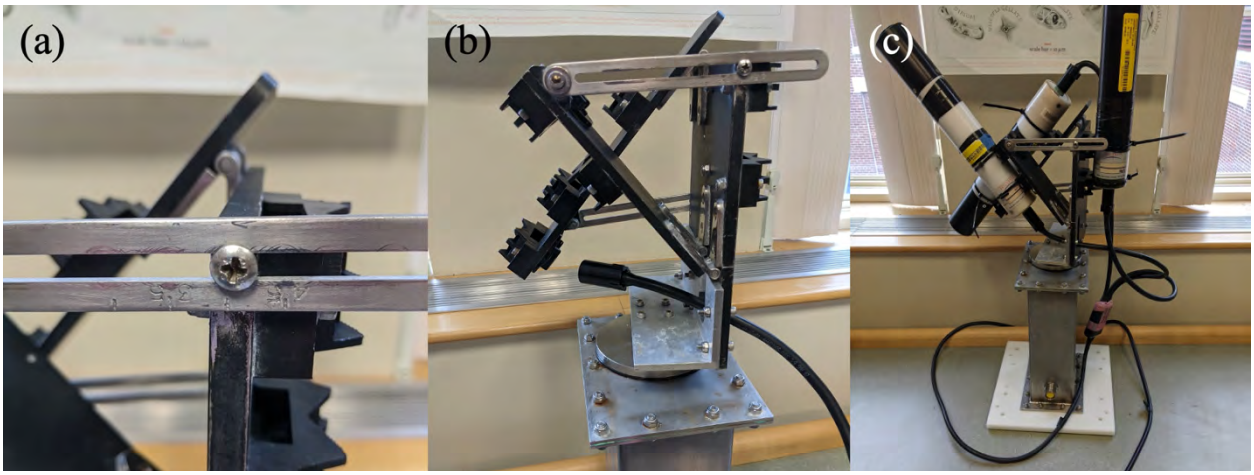

Figure 2. Mounting radiometers on the tower.

2.2 Mounting the Tower on the Vessel/Platform

1. A mounting frame (not provided) is required (e.g. Figure 3). An unobstructed view of the body of water of interest is needed avoid the ship's shadow and wake. The software allows you to bound the directions where such view is possible. The bow of the ship is usually the best place.
2. The tower must be well secured. In the event of strong winds or seas forecast, we recommend removing the system: the system is only splash-proof.
3. Plug the yellow cable to the tower and make sure to leave enough slack in the HyperSAS cable (black) to leave room for the system to rotate.
4. Mount the Es sensor at a location with an unobstructed view of the sky ideally above any shadowing platform, facing upright (use a level to insure it is upward facing). Remember

that shadowing the sky is a problem. Don't forget to remove the protective caps from the radiometers when sampling.

5. Mount the GPS antennas.
    a. The system can be configured such that the antennas are aligned at any angle relative to the ship, though it is recommended the antennas be positioned at an easily referenced angle.
    b. The antennas need to be positioned at least 1.5 m apart on metal plates with a clear view of the sky.
    c. The orientation of the system is the relative position of the antenna label ‘Rover’ from the antenna labeled ‘Base’. (Figure 4)
6. Secure the controller box to the vessel/platform such that the mounting position of the antennas, radiometers, and Es sensor are within reach by cables. When possible, the case should be positioned in the shade to prevent over-heating in sunny locations and protected from water exposure.
7. On the controller box, connect cables from the HyperSAS (5-pin on the right), Es sensor (5-pin on the left), tower (7-pin in the center), two GPS antennas (interchangeable antenna screws on the far left), and power (3-pin on the far right) to the labeled ports (Figure 5).

WARNING: Power cable must first be connected to the controller box and then to the power source.

8. To power on the system, connect the power cable to a power supply. The system accepts 110 or 230 V at 50 or 60 Hz. The system takes about one minute to start. To power off the system, use the ‘halt’ button on the software user interface and wait at least 30 seconds before unplugging power.

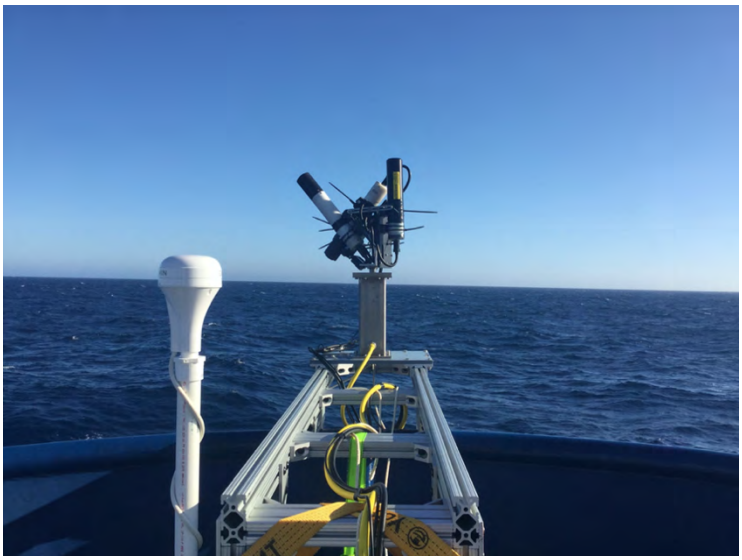

Figure 3. HyperSAS system mounted at the bow of R/V Roger Revelle.

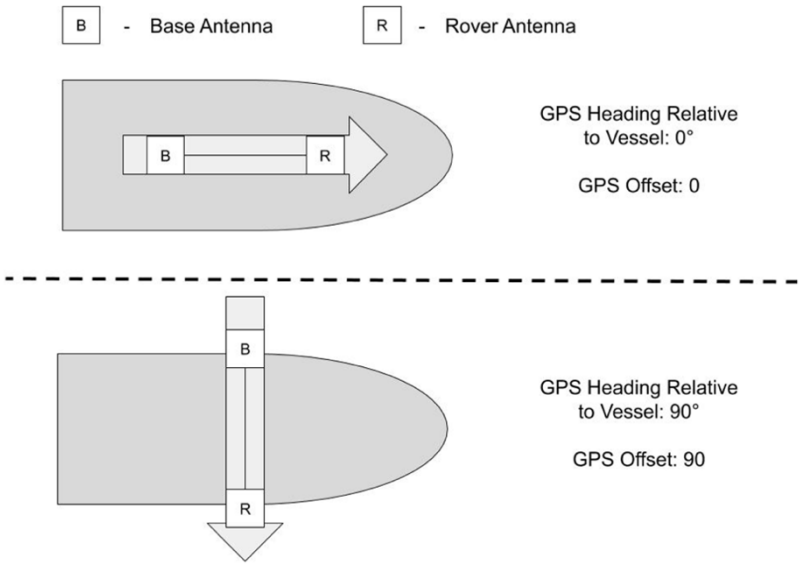

Figure 4. Setting the orientation of the GPS with respect to the ship.

Figure 5. Connectors located on the side of the control box.

3 Software Overview

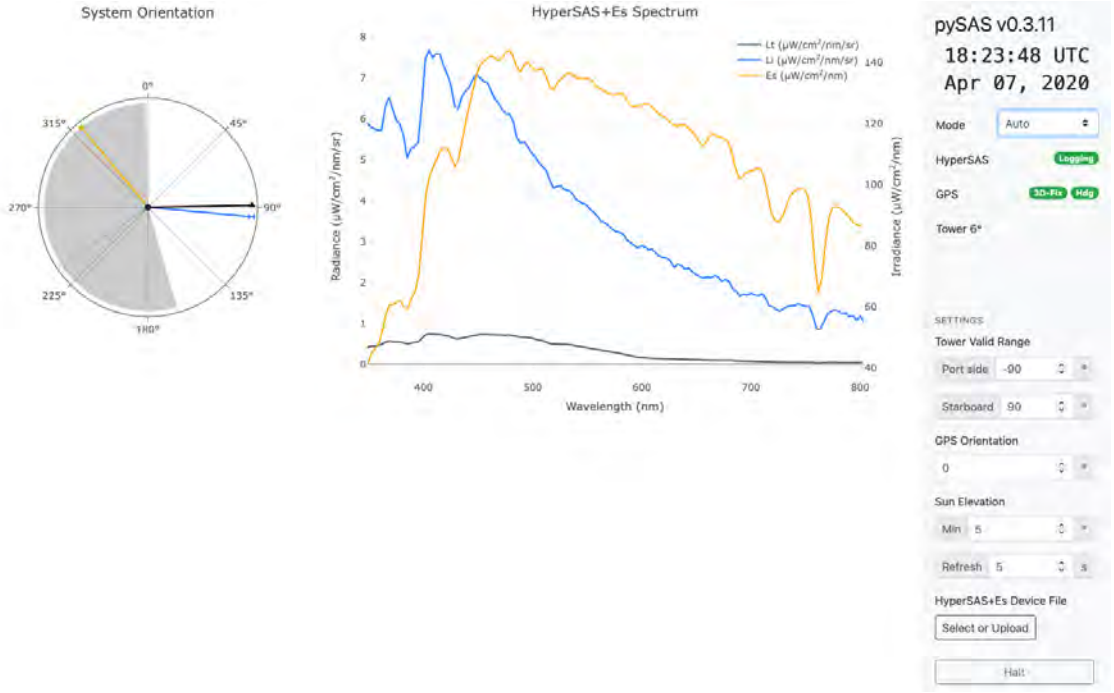

Figure 6. Screenshot of the user interface. On the left is the diagram of the azimuth orientation of the tower (and radiometer, blue) as well as the azimuthal orientation of the ship (black), and the sun (orange). Magnetic orientation based on the THS is also provided for indication (not used by the software). The range of orientation not available to the system (e.g. vessels deck) are shown in gray. At the center are displayed the radiance and irradiance spectra. The control panel is located on the right and is used to configure and control the system.

4 Software Operation

4.1 Access the User Interface

The pySAS has a web interface accessible through its wi-fi. The user needs to connect to the wi-fi hotspot emitted by the pySAS and then use a web browser to open the pySAS user interface.

1. Connect to the pySAS' wi-fi hotspot from a computer or tablet as you usually do to connect to any wi-fi network. The name of the wi-fi network (SSID) is "pysas###", with ### being the serial number of the system (e.g. 001). Both the SSID and wi-fi password are written inside the controller box under the label "Network". Note: if the wi-fi network is not showing, the pySAS might still be booting (you need to wait approximately one minute after plugging the power).
2. To access the user interface, open a web browser (Google Chrome is recommended) on your computer or tablet. The URL to enter in the web browser is: pysas###.local:8050 (replacing ### by your system's serial number). If the page cannot load look inside the box for the label 'URL' and enter that one into your browser. The user interface should now appear in your browser (c.f. screenshot in Figure 6).

4.2 Setup the User Interface

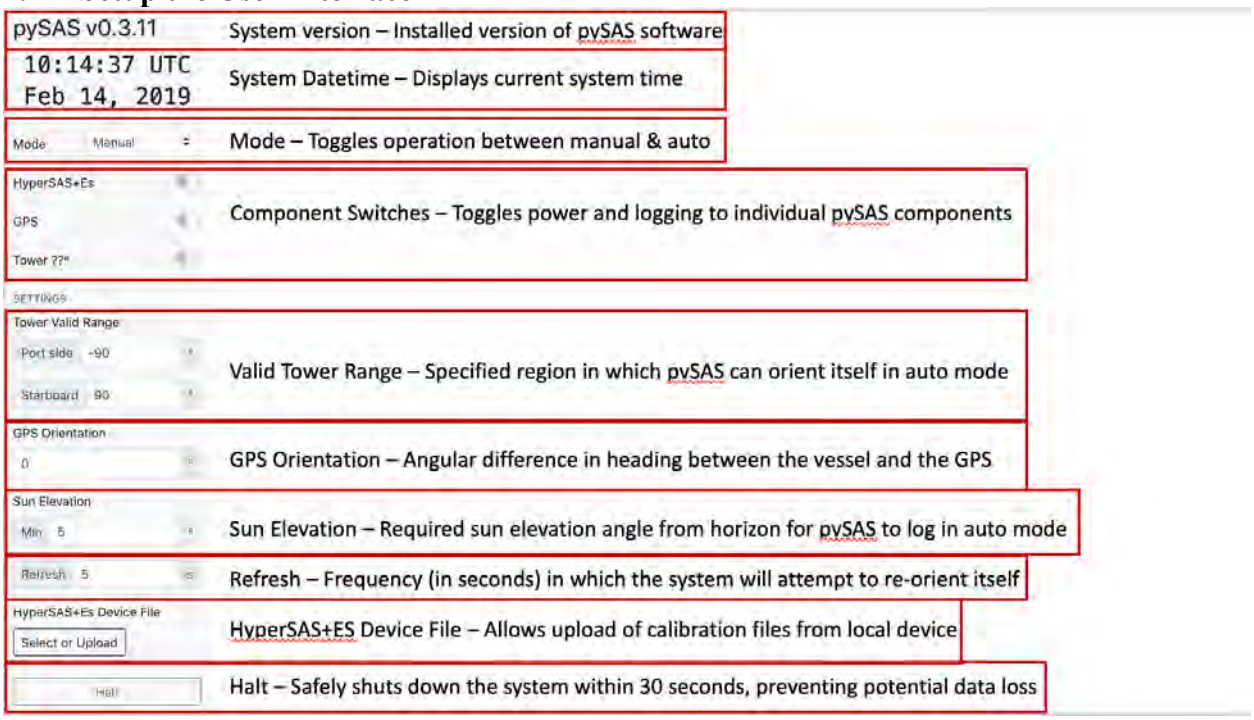

Figure 7. Manual Mode Control Panel. Note that the button to reset the tower position to zero is hidden in the present screenshot as the tower needs to be "on" for it to show.

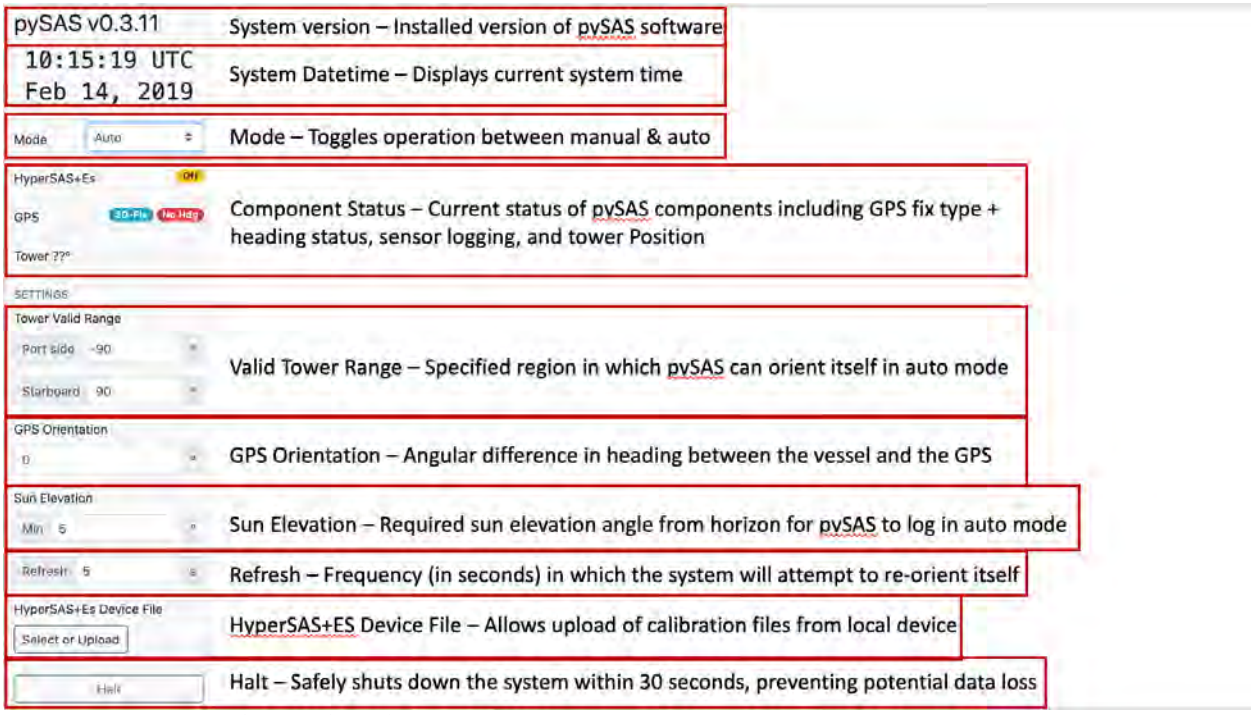

Figure 8. Automatic mode control panel.

When installing the system on a vessel for the first time the system's software must be configured to reflect the hardware configuration. Hence, the calibration files from the HyperSAS and Es sensors must be provided, the orientation of the GPS antennas and tower with respect to the ship must be set, and the minimum sun zenith angle at which the system should record data must also be set.

1. Upload or select HyperSAS and Es calibration files. Click on the 'Select or Upload' button at the bottom of the control panel under the HyperSAS Device File section. Form the pop-up dialog box, either upload a calibration file or select a previously uploaded calibration file corresponding to the HyperSAS and Es sensor currently mounted on the system. Only .sip files are supported to date (provided by Sea-Bird Scientific when sensors are calibrated). The .sip files must contain the calibration files (.cal) of all Sea-Bird Scientific sensors connected (HyperOCRs, THS).
2. Set the GPS offset. In the field "GPS offset" of the control panel set the orientation of the GPS antennas with respect to the zero of the tower: typically the vessel's heading (0º: GPS antennas point in the same direction as the ship; 90º: GPS antenna points at starboard of the ship; Figure 4).
3. Set the zero and valid range of observations of the tower. The zero of the tower should be in the middle of the unobstructed range of orientations. For example, if the tower was setup at the bow of a ship, the tower 0 should be pointing the same direction as the ship, giving a valid range of orientations between -120º and + 120º looking at the water and an obstructed range of observation beyond which it would be looking at the ship's deck and wake. To set the zero of the tower, switch the system to manual mode (use dropdown list labelled Mode in the control panel) and turn the tower on (Figure 7, component switches), move the tower (use the cursor just below the Tower label in the control panel) to reach the desired zero orientation. Once in the desired zero orientation register this position as the new zero of the system (click on the zero button to the right of the Tower label). If the tower stalls, free it by clicking on the red button 'stall' after checking that the physical system is free. The valid range of observations corresponding to the angular range in which the system makes good observation of the water body (unshaded, no wake, actually measuring water and not the deck or any other structure) is set with the two cursors below the "Tower Valid Range" label under the settings section of the control panel. The system orientation panel (top left) indicates the orientation of the tower as a gray line, and the range of orientation unavailable is marked as a shaded area. Note: every time the tower is powered back on, the zero position is reset to the current position of the Tower. Hence every time the tower is powered back the zero should be re-adjusted unless the tower didn't move since it was last powered off.
4. Set the desired minimum sun elevation angle. The system will auto-start/stop when the sun reaches the provided elevation (when operating in auto-mode).

4.3 Operating the System

In manual mode, the user turns on and off each component (HyperSAS, GPS, and Tower) via the switches on the control panel (Figure 7) and sets the orientation of the tower. When a component is on it automatically logs its data.

In auto mode, the recommended way of operation, the system will determine the sun elevation and azimuth based on the GPS reading (both time and location). If the sun elevation is above the threshold set by the user and the system can be oriented 135º away (angle set by user) from the sun then the system will orient the tower with the radiometers adequately, turn on the power to the radiometers, and start recording measurements from the radiometers, the GPS feed, and the orientation of the tower. If any of the requirements to record measurements failed, the system will stop logging and turn off power to the radiometers.

In either mode a red 'Stall' flag will appear next to the Tower's display on the control panel in the event of a stall. Clicking this flag will resolve the stall and resume tower operation. There is a known bug involving the stall flag on startup, see 'Known Software Bugs' section for details.

To switch the system from Manual to Auto mode and inversely, use the dropdown list labelled 'Mode' in the control panel.

When the radiometers are on (green label "logging" in auto mode, and switch colored in blue in manual mode) the spectra should be displaying in the middle panel of the system. If no spectra are showing and the radiometers are on, check the troubleshooting section immediately as no data from the radiometers is logged! Data is logged as soon as the radiometers are on.

To shut-down, select the 'Halt' button at the bottom of the control panel and confirm shut-down on the pop-up menu. Allow 30 seconds for the system to halt before removing power from the pySAS.

The configuration of pySAS is saved in a text file (pysas_cfg.ini). Hence, if the system was to be set on different platforms a configuration could be saved for each platform. The configuration file is accessible at /mnt/data_disk/ through SFTP (c.f. Section 4.4 Download Data for instructions on how to access that directory). To back up the current configuration simply copy this configuration file (pysas_cfg.ini). If you want to restore the configuration from a previous deployment replace the configuration file by the one you saved earlier (make sure it has the same exact name). pySAS software automatically loads the configuration file /mnt/data_disk/pysas_cfg.ini when started. If you update the configuration file outside of the pySAS software, make sure to restart pySAS. To restart pySAS: halt the system via the user interface and turn it back on. If you are more comfortable with Linux you could restart pySAS by restarting its service via ssh (sudo systemctl restart pysas.service).

4.4 Download Data

To download the data from pySAS, a SFTP (SSH File Transfer Protocol) client is required (i.e. Cyberduck, Filezilla). This user guide will guide you with Cyberduck, which can be downloaded at https://cyberduck.io/. Instructions should be similar for other FTP clients.

1. Connect to the pySAS with your SFTP client. Select 'Open Connection' and choose the protocol SFTP. Use the following settings (Figure 10):
    a. Server: pySAS###.local with ### being the serial number of the pySAS. You can also use the ip address of the system. For your system the URL or IP address are labelled inside the box.
    b. Port: 22
    c. User: Labeled inside the box as 'Default User'
    d. Password: Labeled inside the box as 'Default Password'

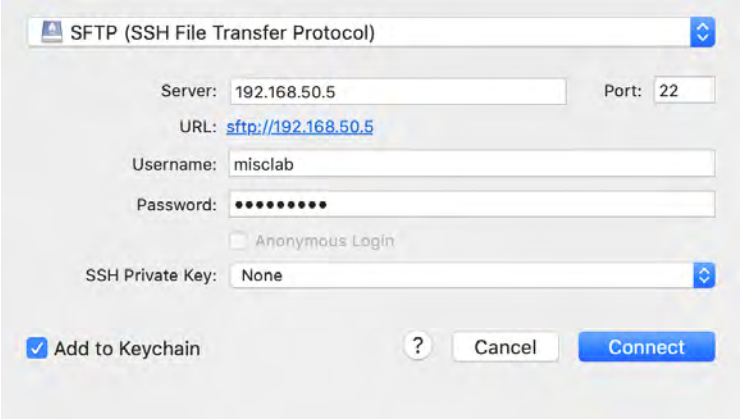

Figure 9. Cyberduck new sftp connection window

2. Once connected, navigate to '/mnt/data_disk/data' and select data to save. Three types of files should be present: GPS, HyperSAS, and IndexingTable. The GPS records the orientation of the ship, the indexing table records the orientation of the tower with respect to the ship, and the HyperSAS file is a standard Satlantic file that can be parsed with Satlantic's SatCon software. Files are written hourly. Note that if the system is actively recording data the latest files might contain incomplete data frames.

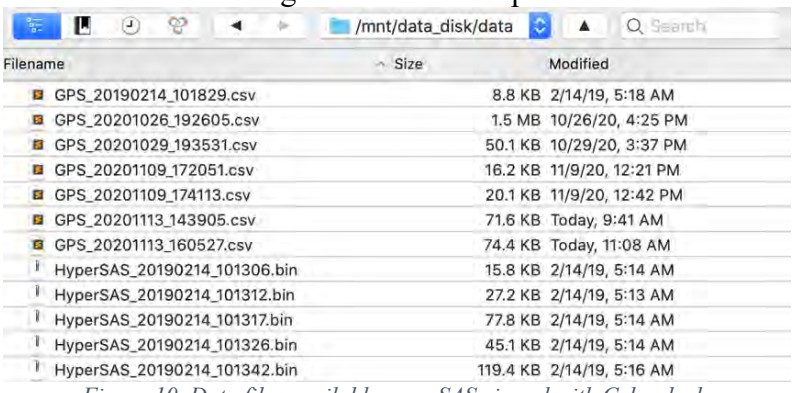

Figure 10. Data files available on pySAS viewed with Cyberduck.

3. We then recommend processing the data with HyperInSPACE (https://github.com/nasa/HyperInSPACE). To format the data from pySAS for HyperInSPACE, the utility prepSAS can be used.

5 Troubleshooting

5.1 Common Problems

When I use the web browser to connect to the user interface nothing shows up:

1. Verify the system has power & has been given at least 2 minutes to boot.
   To check that the system is powered, open the lid and look for illuminated/blinking LEDs along the edge of the Raspberry Pi.
2. Check that you are connected to the wi-fi network "pysas###" (for systems built by UMaine check label inside the case).
   Some devices may reject the pySAS network. This is due to the lack of internet access on the pySAS's network.
3. Double check that ':8050' was appended at the end of the URL
4. Try using a different browser or device.

No spectra are displayed when the radiometers are on?

1. In the user interface check that the HyperSAS is enabled. In auto mode there will be a green label "logging" on the side of HyperSAS, otherwise it means there is no configuration available to log proper data. In manual mode, make sure the HyperSAS is turned on.
2. Ensure your cables are properly connected to the HyperSAS. The cables connecting to the radiometers and compass are labeled with the corresponding serial numbers and won't display if not properly connected.
3. Check the cables are working properly with another computer using a serial console such as TeraTerm. A loose or damaged wire can prevent data logging/plotting.

My system is displaying an incorrect date/time:

1. Currently time-sync only occurs during automatic mode. Briefly changing the system to automatic mode should sync the system time.
2. Ensure your GPS has a fix. Any fix will be adequate to provide a system time but will be unable to sync the time if there is no fix.

5.2 Known Software Bugs

- On the control panel on the right side of the screen, at times the text might be hidden on the right of the bar. This does not affect the behavior of the system; however, it can be impractical to read the parameters. A temporary fix is to reload the web page.
- When the system starts the tower might have a red "stalled" flag appear while it's not actually stalled. This flag seems to appear for no reason only on the user interface. The system still knows that the tower is not stalled, hence the system will keep orienting the radiometers as it should. The temporary fix consists of first checking that the tower is not blocked by any object, then click on the stall flag and it will disappear.