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Metadata for the HiWASE instrumentation deployed on the OWS *Polarfront* between September 2006 and December 2009

B I Moat, M J Yelland, R W Pascal & J Prytherch

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National Oceanography Centre, Southampton
University of Southampton, Waterfront Campus
European Way
Southampton
Hants SO14 3ZH
UK

Author contact details
Tel: +44 (0)23 8059 7739
Email: bim@noc.soton.ac.uk

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AUTHOR
MOAT, B I, YELLAND, M J, PASCAL, R W & PRYTHERCH, J

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ABSTRACT

Between 1978 and 2009 the Norwegian weather ship *Polarfront* made continuous meteorological and surface wave measurements at Station M (66°N 2°E). In September 2006, as part of the UK-SOLAS HiWASE project (Brooks et al., 2009) the ship's existing systems were complemented by the AutoFlux system (Yelland et al., 2009) to measure the transfers of momentum, heat and CO_2 between the atmosphere and the ocean. Similarly, the ship's existing ship-borne wave recorder (SBWR) was supplemented by installing a commercial directional wave radar "WAVEX" made by the Norwegian firm MIROS.

This report describes the metadata for the HiWASE instrumentation deployed on the OWS *Polarfront* between September 2006 and December 2009. Sensor serial numbers, dates of sensor changes and problems with sensors are contained in the associated tables.

KEYWORDS

AutoFlux; Station M; Weather ship; air-sea fluxes; SBWR; WAVEX; Polarfront; metadata

ISSUING ORGANISATION

National Oceanography Centre, Southampton
University of Southampton, Waterfront Campus
European Way
Southampton SO14 3ZH
UK

LIST OF FIGURES.

Metadata for the HiWASE instrumentation deployed on the OWS *Polarfront* between September 2006 and December 2009

Moat, B. I., M. J. Yelland, R. W. Pascal and J. Prytherch.
National Oceanography Centre, Southampton, UK.

1. Introduction

Between 1978 and 2009 the Norwegian weather ship *Polarfront* made continuous meteorological and surface wave measurements at Station M (66°N 2°E). The ship was operated by Misje Rederi AS under contract to the Norwegian Meteorological Institute (DNMI). In 2005, the University of Bergen (BCCR) installed an underway system to obtain CO_2 concentration in the surface water and atmosphere. In September 2006, as part of the UK-SOLAS HiWASE project (Brooks et al., 2009) the ship's existing systems were complemented by the AutoFlux system (Yelland et al., 2009) to measure the transfers of momentum, heat and CO_2 between the atmosphere and the ocean. Similarly, the ship's existing ship-borne wave recorder (SBWR) was supplemented by installing a commercial directional wave radar "WAVEX" made by the Norwegian firm MIROS. After installation of the HiWASE systems, two NOCS staff took part in an initial shake-down cruise. Details of the setup and operation of all the systems and sensors can be found in the cruise report (Yelland and Pascal, 2010). The HiWASE systems were demobilised in December 2009, when DNMI withdrew the *Polarfront* from Station M.

The *Polarfront* occupied Station M all year round. Once every 4 weeks the ship spent about 8 hours in port, usually Aalesund, to exchange crew and load stores. Every year in early September the ship spent 5 or 6 days in port in Maloy for refit etc. The instrumentation was usually left running during port calls so care should be taken to remove data when the ship was not on, or near, Station M. NOCS staff visited the ship during every visit to Maloy, and during 17 of the port calls in Aalesund.

Data are stored on the NOCS UNIX system. With the exception of the fast sampling raw data, all raw data were periodically archived to "RODIN" the NOCS data catalogue. Mean meteorological and wave data were routinely sent to BODC.

This report details the metadata associated with the measurements made during the HiWASE project. The sensors used and dates sensors were changed are documented in Section 2. Section 3 describes orientation and alignments of the main flux sensors.

2. Instrumentation

In this section, each of the sensors is described in turn along with their tables of metadata. Table F gathers all the data streams together so that the performance of the system as a whole can be seen. In this table, port calls are highlighted in red and problems with sensors are highlighted in grey. Days of similar situations are grouped together, e.g. if the psychrometer water bottle was frozen for 3 days and no other problems had occurred then these days are grouped together.

The sensor sampling frequencies are summarised in Table E. Yearly time series plots of various parameters are given in Appendix F. Note that the data used here have only had basic QC applied, if any.

2.1 Fast response instrumentation

A Gill R3A Ultrasonic anemometer (Table A.1) and two open path Licor 7500 Gas Analysers (Tables A.2 and A.3) were located on the foremast (Figure 1, 2 and 3).

Licor1 was mounted forward of the foremast platform and Licor2 was mounted to starboard of the platform. The Licors were shrouded in turn, with the crew moving the shroud from one sensor to the other during port calls (see Table F). A washing system was installed during the 2007 September refit in Maloy to improve the quality of the Licor data. This system automatically washed the un-shrouded Licor once a day.

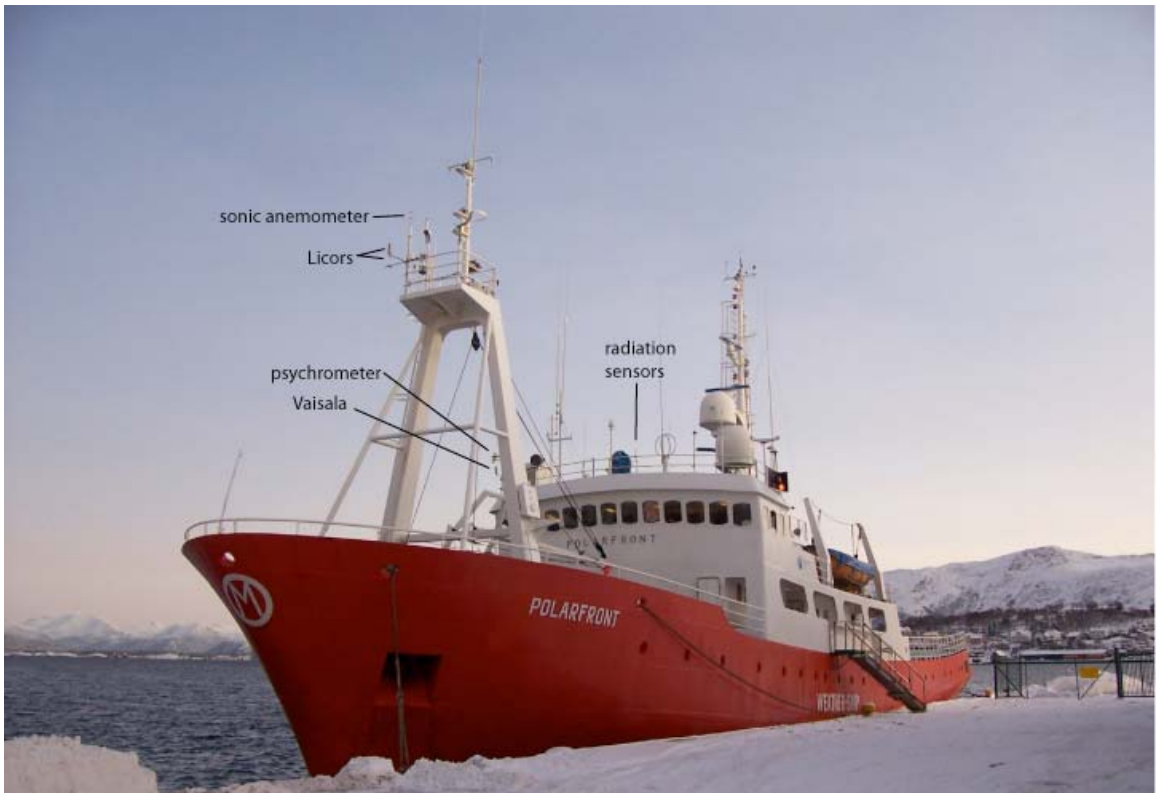

Figure 1. The locations of the instrumentation on the OWS *Polarfront*. The radiation, psychrometer (wet and dry bulb air temperature) and the Vaisala (air temperature and humidity) sensors are located on the bridge top.

Figure 2. The foremast sensors looking from the bridge. The WindObserver anemometer is part of the DNMI system. The photograph was taken during the yearly refit in Maloy, Norway 2009.

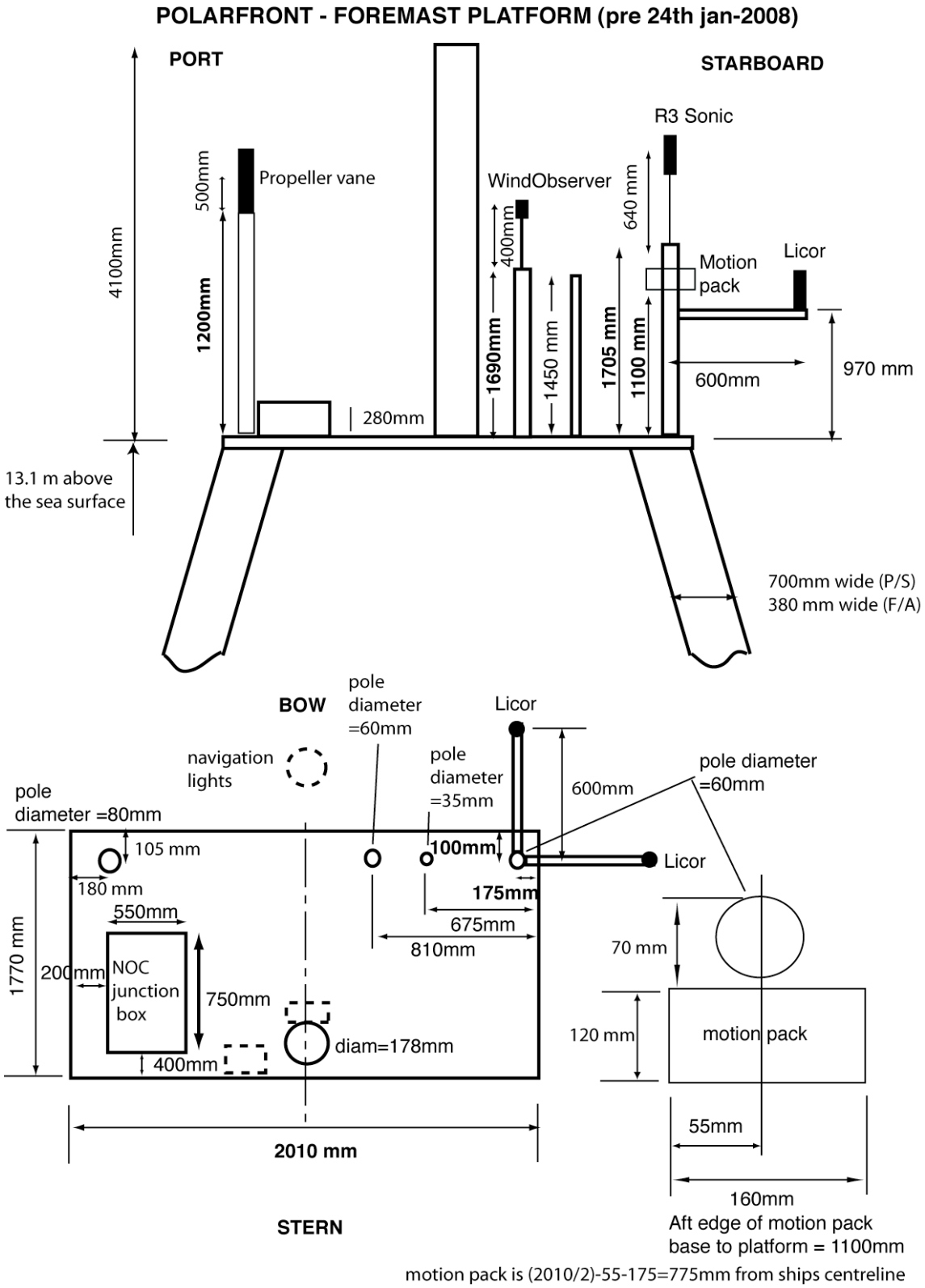

Figure 3. Layout of the foremast instrumentation from September 3rd 2006 24th January 2008. The top panel shows the view from the bridge looking forwards. The drawing on the bottom left shows the dimensions of the motion pack.

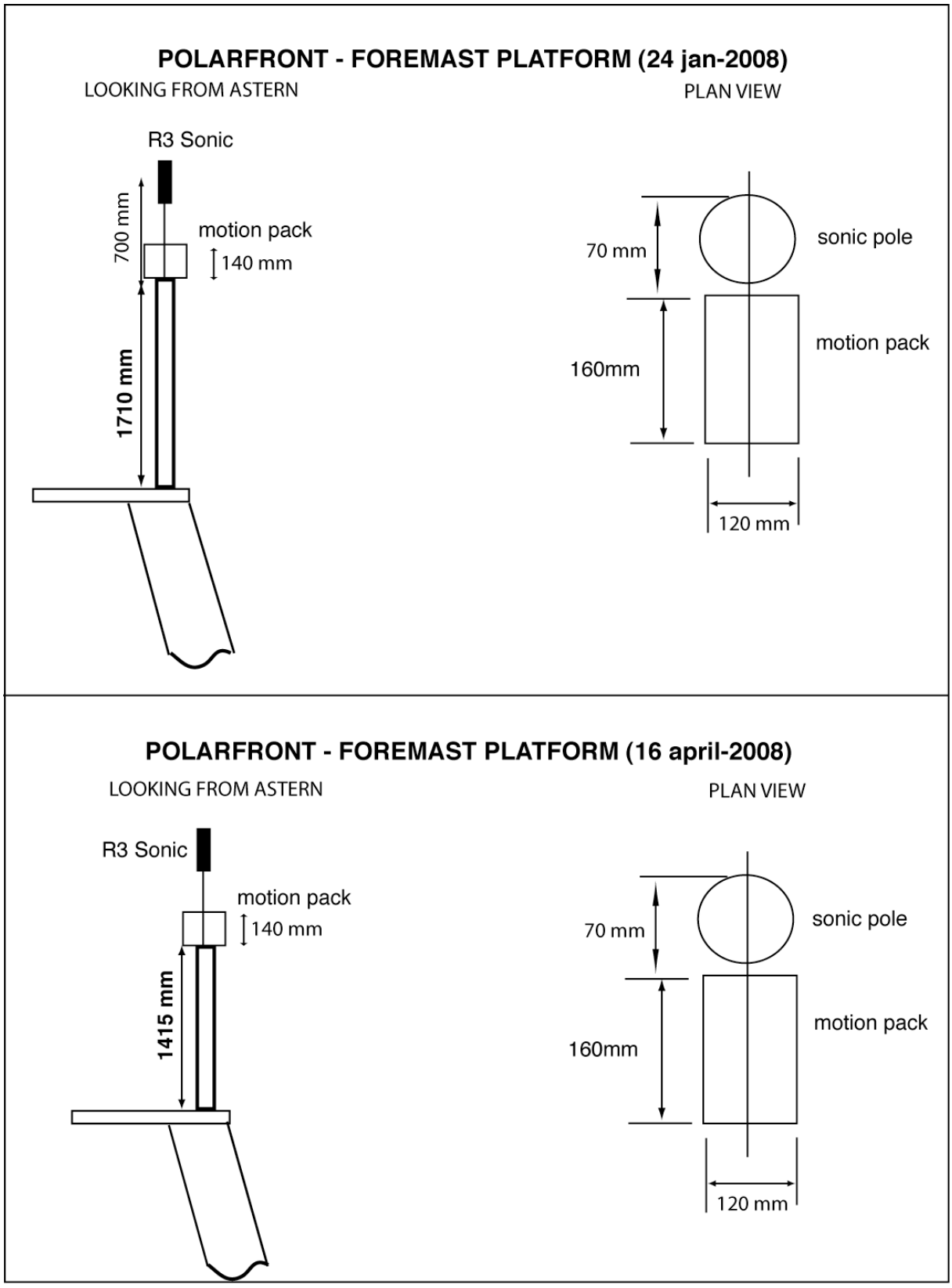

Figure 4. Changes in the sonic and motion pack configuration from January 24th 2008 to April 24th 2008 (top panel) and April 24th 2008 to November 30th 2009 (bottom panel).

A SYSTRON DONNER MotionPak used 3 accelerometers and 3 rate gyros to record ship motion and was located close to the anemometer. All systems logged data at 20Hz. Slight alterations were made to the position of the anemometer and motion pack during the deployment. In January 2008 the motion pack was moved up by 0.61 m to the base plate of the R3 sonic. In April 2008 the sonic and motion pack were moved down by 0.3 m. These are shown in Figure 4. Details of the sensor changes can be found in Table A.1. Motionpak calibrations are given in Appendix A and B. Licor calibrations and sonic calibrations are contained in Appendix C and D respectively.

On the 28th November 2008 the sea-spray aerosol flux sensor "CLASP" was installed, in collaboration with Ian Brooks of Leeds University, UK. The sensor was mounted so that the intake was 0.7 m below, and 20 cm to starboard of, the base of the R3 anemometer (figure 2). Details are given in Table A.4.

2.2 HiWASE Mean meteorological sensors

Wet and dry bulb air temperatures were measured using a NOCS aspirated psychrometer, mounted above the bridge (figure 5). The wet bulb water reservoir occasionally ran dry, froze or in one instance blew away in a storm, and was refilled when necessary by the crew (Table B.1). Relative humidity was calculated from the psychrometer and pressure data in near real time. In addition to the psychrometer, a Vaisala HMP45A sensor was also used to measure air temperature and relative humidity (Table B.2): the Vaisala sensor was mounted close to the psychrometer. When the psychrometer failed, the Vaisala measurements were sometimes used instead of the psychrometer data in the calculation the calculation of U10n (wind speed corrected to 10 m and neutral atmospheric stability). The two periods when the Vaisala data were used to calculate U10n are listed in Table F: these were from day 285 in 2007 to day 003 in 2008, and again between days 301 and 322 of 2008. The psychrometer and Vaisala sensors were located at heights of 10.5 m and 10.0 m above the sea surface respectively.

Two radiation sensors were located above the bridge at a height of 11 m above the sea surface. An Eppley Precision Infrared (PIR) Pyrgyometer (Table B.3) was used to measure the downwelling long wave radiation (3.5 to 50 μm). Short wave radiation was measured using a Kipp and Zonen CM11 (310-2800nm) sensor (table B.4).

A seabird SBE45 MicroTSG thermosalinograph was used to calculate underway SST and salinity in real time. The TSG was integrated into the BCCR CO2 system, which obtained water from an intake located in the forward hold at a depth of 3 m. The salinity was calibrated against surface CTD, Nansen bottle and underway bottle salinity measurements (Moat, B. I., 2010): the corrected data are available from the British Oceanographic Data Centre (BODC- http://www.bodc.ac.uk/). The corrected salinity data has a residual difference from the calibration data, which is generally less than ±0.1 psu except for the summer months when this increases ±0.2 psu. This is sufficient for this study since salinity was only used for the calculation of CO_2 solubility in the surface water.

The TSG system was cleaned as part of BCCRs routine cleaning of their underway CO2 system during port calls. Details of the cleaning regime are given in Table B.5. It should be noted that the SST data from the TSG are not as good as those from the hull-mounted DNMI sensors described in Section 2.3.

Sky and sea temperature measurements were made using Tasco IR radiometers. The instruments powered down sporadically and very little data was obtained. The Tascos were removed during the September 2008 port call. No more metadata is available.

With the exception of the MicroTSG, all the mean meteorological data stream were logged every 10 seconds. Instrument sampling rates are found in Table E.

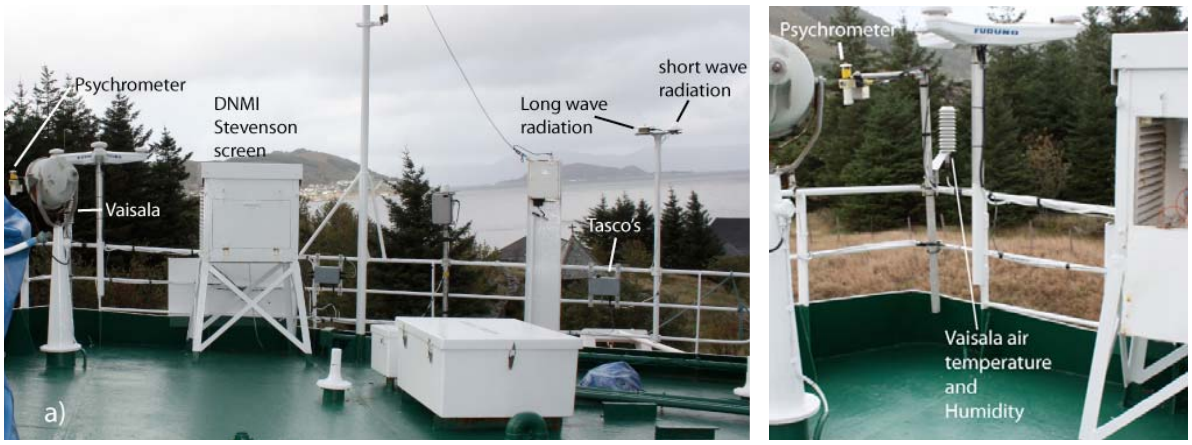

Figure 5. The positions of the bridge top mean meteorological instrumentation. (a) View looking from port to starboard. The Vaisala is obscured so a close up view of the AutoFlux psychrometer and Vaisala air temperature and humidity sensors is shown in more detail in (b). Note that the DNMI air temperature and humidity sensor in the Stevenson screen is also shielded by the "stack of plates" shielding. The photographs were taken during the yearly refit in Maloy, Norway 2009.

2.3 DNMI sensors

Atmospheric pressure was measured by a Vaisala PTB220ACA243 sensor (serial number W1430022) located in the Meteorological Lab at a height of 5 m above sea level. No height correction to sea level was applied to the measurements. No other metadata data are available.

Sea surface temperature was measured using two DNMI hull mounted PRT100 sensors located within the wells which contain the Ship Borne Wave Recorder (SBWR) pressure sensors at a depth of about 1.4 m.

Wind speed was measured using a WindObserver sonic anemometer located on the foremast (Figure 2). DNMI replaced the WindObserver sonic on the 3rd September 2008 with a similar WindObserver sonic. This change is important as the WindObserver sonic was used as a fixed reference for the HiWASE Sonic and motion pack yaw alignments (Section 3).

Air temperature and humidity was measured using a PRT100 and a Vaisala HMP45D located in a Stevenson screen on the bridge top (figure 5). Note that these sensors were encased by "stack of plates" shielding: this may cause problems with ventilation of the sensors. No other metadata data for these sensors are available.

Sampling rates for the DNMI systems are included in Table E.

2.4 Navigation Systems

The navigation data was acquired from the ship's systems at 1 Hz. These corresponded to a Furuno GPS Navigator GP-50 Mark 3 for position and a Gyrostar No. 0308 GSII (Sphere No. 6363A) for ship's heading. The AutoFlux data stream logs two navigation data streams called 'NAV' and 'NAV2'. Both include the position from the Furuno GPS-50, but 'NAV' includes heading from the Gyrostar whilst 'NAV2' takes the heading from Furuno satellite compass (model: SC-10. Serial Number 4404-0372). The NAV data stream was used in the near real time processing.

2.5 Digital camera systems

Two Nikon CoolPix 8800 digital cameras were located on the port side of the ship's bridge (figure 6) to measure the whitecap fraction of the breaking waves. One camera faced forwards whilst the second looked out directly abeam of the ship. The cameras were set at various configurations (Table B.6).

A third CoolPix 8800 camera was located in a weather proof box on the bridge top. It was installed during the April 2009 port call and looked out directly abeam of the ship like the beam bridge camera. Unlike the bridge camera which moved with the ship the bridge top camera was gimbled, so ship motion was minimised and pictures of the same area of the ocean were taken. The camera was set at various configurations (Table B.7).

Figure 6. The bridge camera systems located on the port side of the bridge. The camera on the left is facing directly abeam, whilst the right hand camera is looking forwards. The displays are closed during normal operation.

2.6 Wave systems

A ship borne wave recorder (SBWR) used the motion of the ship to derive wave data from the ship's heave (from accelerometers) and roll (from pressure sensors at a depth of 1.4 m). DNMI set the SBWR to sample for a 30 minute period once every 45 minutes. NOCS staff calibrated the SBWR during the September 2006 refit in Maloy, Norway. Output parameters are detailed in Table B.8 and problems with the system are noted in Table F. SBWR calibrations are given in Appendix E.

During September 2006 a WAVEX directional wave radar was installed as part of the HiWASE project. The x-band scanner was installed on the ships's mast at a height of 17 m above the sea surface. The WAVEX software was set up to sample for a 2 minute period out of every 5 minutes. Spectra and mean parameters were recorded every 5 minutes and raw data were recorded twice per hour. The WAVEX software allows up to eight mean parameters to be output over a serial link, which were recorded by the AutoFlux acquisition system. These are detailed with the SBWR output in Table B.8. Software problems are noted in Table B.9.

2.7 BCCR CO_2 system

A fully automated underway CO_2 system was located in the forward hold of the ship. The system obtained water samples at 3 minute intervals. Air samples are obtained about once every 3 hours and four gas standards are run every 3 hours. The water intake is the same as the TSG and is 3 m below the surface. Routine cleaning of the underway CO_2 system was undertaken system during port calls. Details of the cleaning regime are given in Table B.5.

3. Alignments of the R3 sonic and the MotionPak relative to each other and to the ship.

The AutoFlux automated processing assumes that the R3 is aligned perfectly with the ship. Any offset will affect the true wind speed calculation since the measured wind velocity will be offset from the ship velocity. However, this effect will be small since most of the time the ship speed is less than 2 m/s, so a 5° yaw offset (rotation in the horizontal plane) would cause a bias of less than 0.01 m/s. When the ship is on passage to/from port, a ship speed of 6 m/s and a 5° offset would result in a bias of less than 0.025 m/s.

In contrast, small offsets do need to be taken into account during the calculation of the turbulent air-sea fluxes using the eddy correlation (EC) method. The anemometer data need to be aligned as closely as possible

with the MotionPak (MP) data, by rotating the frames of reference to allow for any physical misalignments between the two sensors. Once the anemometer data have been corrected for ship motion, the corrected data then need to be rotated in to the ship frame or reference to allow for any significant yaw offset before correcting the data again for mean ship speed. As before, this latter correction for ship speed has only a very marginal impact on the resulting wind speeds. Here we look first at the yaw offset. Then we will briefly discuss the alignments in the fore-aft and port/starboard directions.

To aid the EC flux processing, metadata from the various tables in this report has been brought together in Table I. This table shows port call dates, changes to and problems with the fast response sensors, periods when the Licors were shrouded, whether processed (rather than raw) delta pCO2 data are available (at the time of writing: all are expected eventually) and any other problems relevant to the calculation of fluxes. Table H summarises the orientation of the R3 and MotionPak relative to the ship and their relative positions.

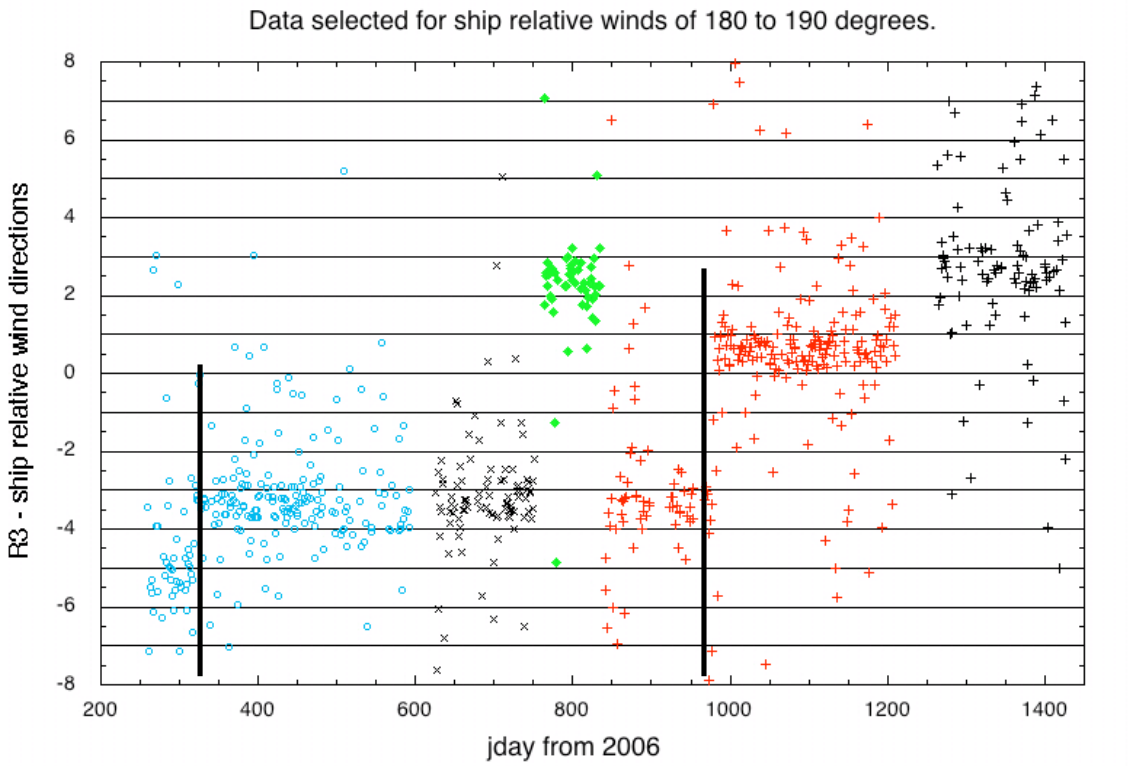

Figure 7. Difference in relative wind direction (R3 sonic - ship sonic) against jday for the period September 2006 to December 2009. Thick vertical lines indicate a) an unexplained change in the difference from about -5.5° to about -3.5° just before day 320, and b) when the ship sonic was replaced in September 2008. See text for details. Only bow-on winds ± 5° are used: an offset in the ship sonic orientation means relative wind directions of 180 to 190° have been used.

Pale blue (7th September 2006 to 6th September 2007) : R3 391 mounted on top of the pole, facing fore-aft, and MP 791 mounted separately lower down the pole. The automated processing assumes the R3 is aligned fore-aft.

Black x (6th September 2007 to 24 January 2008): Rotated R3 to point about 60° to starboard. MP unchanged. Automated processing assumes R3 is 60° to starboard from here onwards.

Green (24the January 2008 to 16 April 2008): Replaced R3 with 227 and MP with 682. MotionPak raised by about 60 cm and joined with R3 using a slotted mounting plate.

Red (16 April 2008 to 19 May 2009): R3 and MP are lowered by 30 cm, but remained joined together as before.

Black + (19the May 2009 to end November 2009): R3 391 and MP 682 installed, joined together.

3.1 Yaw Offsets

The ship's sonic anemometer (the DNMI WindObserver mentioned in Section 2.3) was mounted about 65 cm to port of the R3 sonic. The ship's anemometer remained unchanged until September 2008 when it was replaced by a new sensor. Until that point, the ship's sonic can be used as a reference for the R3 sonic which was changed on a number of occasions (Table A.1). It is difficult to align sensors on a ship since there are no straight structures which can be used as a reference. Various methods were used to try to align the R3 and MotionPak (MP) sensors, both relative to each other and to the ship: see below for notes extracted from various visit reports. The most difficult aspect to quantify is the yaw offset, i.e. rotation about the vertical axis. Figure 7 shows a comparison of the relative wind direction as measured by the R3 with that from the ship's sonic. Only data within ±5° of the bow are used (other wind directions are influenced by flow distortion etc) and each point represents the average difference in each day. The data span the period from installation in Sept 2006 to de-mobilisation in December 2009: Jday begins at 1.5 at noon GMT in the 1st January 2006 and is incremented by 365 or 366 each successive year as appropriate. The data are classed into different periods which correspond to a single unchanged setup of the R3 and MP, i.e. when either was replaced, or moved for some reason, a new class is created.

Between September 2006 and January 2008 the R3 and MP were mounted separately from each other, and both were aligned by eye, usually by someone standing on the bridge top at the same distance from the centre line as the instruments. The MP is mounted in a rectangular box whose straight sides are used to align the sensor visually. The head of the sonic anemometer has three struts, one directly "aft" of the sensor volume and two more located at 60° either side of the aft strut. The aft strut was used to align the sonic fore/aft in the initial installation then in September 2007 the head was rotated 60° to port, using the side strut in the visual alignment.

After that time, the two sensors were joined together as one unit using a mounting plate. This allowed the two to be aligned closely in the horizontal plane, and the yaw offset could be quantified using the method of Brooks (2008). During experiments in the laboratory, Prytherch et al., (2010) examined the various combinations of sensors as used on the Polarfront: these are summarised in Table G. The MP was located in a fixed position on the horizontal mounting plate, and the sonic attached to the plate using slotted screw holes. The yaw offsets were determined for the sonic rotated as far as the slots allowed in either direction, with an anticlockwise rotation (as viewed from above) corresponding to the anemometer being rotated hard to port when on the ship. This allowed the offset between the R3 and MP to be known. When the pair were installed on the ship, the sonic was again rotated hard to port and the pair were aligned so that the R3 strut was oriented fore/aft (when time and conditions allowed).

3.2 Summary of yaw offsets:

Using data from Prytherch et al (2010), notes from the visit report and the wind direction comparison in Figure 7, it is concluded that:

From installation in **September 2006 to day 320 2006**, the wind direction comparison differs by 2° compared to the period after day 320. The ship was at sea on day 320 so no instrument changes would have been made. It is not clear what caused this offset, but one possibility is that the thin string used to stay the Licor sensors was originally attached at the base of the sonic. At some point it was noticed that the string had worked between the base of the sonic and the mounting plate - this may have loosened the fitting enough for the sonic orientation to have changed when the ship slammed in heavy weather for example. That it was the R3 that changed rather than the ship sonic tallies with the visit notes, i.e. at installation the R3 was aligned fore/aft, the ship sonic was 5° to port and the old ship sonic (which the R3 replaced) had been aligned a couple of degrees to starboard. The MP was pointing 1.5° to starboard. NOTE that the EC processing done to date assumed that the R3 was pointing 5, rather than 0, degrees to port and applied a rotation of 6.5° (rather than 1.5°) to get the R3 data into the MP frame of reference. The effect of the 5° error should be borne in mind when analysing the results. No allowance was made for the 1.5° misalignment between the MP and the ship.

From day **320 2006 to 24 January 2008**, the R3 was pointing 2° to port (after allowing for either a fore/aft or 60° to starboard orientation) and that the MP was pointing 1.5° to starboard. NOTE that the EC processing done to date assumed that the R3 was pointing 5, rather than 2, degrees to port and applied a rotation of 6.5° (rather than 3.5°). The effect of the 3° error should be borne in mind when analysing the results. No allowance was made for the 1.5° misalignment between the MP and the ship.

On 24th January 2008 the first joined R3/MP pair were installed. The weather was very bad and it was not possible to make a visual alignment, but using the ship sonic as reference suggests that the R3 was pointing about 8° to port. The lab yaw offset of 51.7° (compared to the sonic orientation of 60° to starboard) means that the MP was pointing about 0.5° to starboard.

On 16th April 2008 the same joined pair were lowered, and this time the R3 was aligned as closely as possible to the 60 starboard orientation. However, comparison with the ship sonic suggests that the R3 was again pointing 2° to port, meaning that the MP was pointing about 6.5° to starboard. This sensor pair was left unchanged until May 2009. Note that the ship sonic was changed in September 2008, which accounts for the step change seen in Figure 7 at about day 975. This arrangement was unchanged until May 2009. No data for 2008 has been processed at the time of writing. However, the first 5 months of 2009 data were processed using a 5° offset between the R3 and MP, rather than the actual offset of 8.5°. No allowance was made for the 6.5° misalignment between the MP and the ship

On May 2009 a new R3/MP pair was installed. No visual alignment checks were possible since only one member of staff took part in this visit. Comparison with the ship sonic suggests that the R3 was pointing 4° to port. Lab tests for this pair showed a yaw offset of 52.4°, which means the MP was pointing about 3.6° to starboard. The correct offset of about 7.7° was used in rotating the R3 data to the MP frame of reference. No allowance was made for the 3.6° misalignment between the MP and the ship when processing the Licor 2 data, but for Licor 1 the data were rotated into the ship frame prior to removing the slow components of ship speed.

These results are documented in Tables G, H and I.

3.3 Lessons for the future:

1) Align the R3 and MP in the lab with zero yaw offset. Find a way to fix them in this position when installing on the ship, using marks on the R3/MP to indicate the zero position, or some mechanical method to provide a "stop" at the zero position.

2) On the ship use the parallax method to orient the R3 using the appropriate strut. The parallax method means that the distance X of the sonic from the centreline, and the distance Y between the sonic and a viewer standing aft (also at X from centreline) need to be measured accurately. Binoculars should be used by the viewer to guide the person installing the R3/MP pair.

3.4 Fore/aft and port/starboard alignments.

Tables C show the tilts of the various foremast sensors as measured using a hand-held electronic inclinometer during port calls. The inclinometer has an accuracy of about 0.1 deg, but an offset of 0.1 can be caused if the feet of the inclinometer are not correctly placed. Much larger errors are introduced by changes in the trim of the ship: since the measurements were taken in port the trim of the ship could change while the measurements were being made as stores and fuel etc were loaded. Prior to 16 April 2008 it was not realised accurately misalignments needed to be measured, so the data in the early Tables is not as reliable as those obtained after April 2008. In addition, prior to January 2008 the R3 and MP were not physically linked, so misalignments between them will be greater, as well as less well known. This is reflected in Table H which summarises the estimates of the alignments, along with an estimated uncertainty. After April 2008 the R3 and MP were joined on the same flat metal base plate. In addition, the method of obtaining the fore/aft and port/stbd tilts was improved by measuring the tilts of the ship sonic before all the other sensors were measured, and again afterwards. Comparison of the two measurements of the ship sonic showed if the trim of the ship had changed significantly. Data have been selected on the basis of no significant change in the ship's trim and used in the summary Table H. The data used are highlighted in bold in Tables C.

3.5 Extracts from reports made during visits to the ship.

July 2006.

R3 installed. Middle ship sonic clearly pointing to port, the one on the starboard pole points a tad to starboard possibly. Directions from middle sonic 5 to 10° larger than the starboard one, i.e. pointing to port by say 4 to 9 deg. Starboard sonic removed and replaced by our R3 - R3 alignment looks good.

7 Sept 2006.

R3 needed rewiring so sonic and pole marked before sonic was removed to do this. Replaced as it was before. R3 alignment still looks good.

Sept cruise report 2006.
Did a comparison of the ship sonic with the R3 and with the ship's sonic that was replaced by the R3. For bow-on the ship sonic reads high by 5° compared to R3 and 7° compared to the replaced sonic. This suggests ship sonic points to port by 5 deg, assuming the R3 is OK and the replaced one pointed 2° to starboard.

29 November 2006.
No changes. Power outs on 21 and 25 November but these happened after the jump in the bow-on wind direction comparison between the ship and R3 sonics.
******* NOTE added later. The jump happened during, or just before, day 320 - prior to that the ship sonic read high by 5° and afterwards this reduced to 3 deg. On day 320 the winds were very strong, so maybe one of the sonics suffered transducer damage (although Gill say the R3 transducers were probably OK when it was returned for cal), or shifted in its mount. *******

4-7 Sept 2007
R3 is 83 cm to starboard of centreline. Before R3 was rotated. Stood on bridge top at 83 cm – lined binocular sights on strut – bearing about 220°. Looked like sonic pointing a bit to port. Stepped to starboard until aligned, distance about 115 from centreline – bearing now 215 deg, so pointing to port about 5 deg. NB have to look up at quite an angle so compass in bins does not work. Have to line vertical site while lowering bins to point where compass works.
R3 rotated by RWP while MJY stood on bridge top 83 cm from centreline. Used bins to make sure that the outside strut was aligned OK. Total rotation probably more like 65° – correct the 5° to port of the original position plus 60° separation of struts.
******* NOTE added later. If the R3 looked aligned before (rotation) at 115 cm from centreline, this suggests R3 was pointed to port by about 2 deg, i.e. tan-1(32/1060) - see notes for 28 November below. A 5° offset would need 97/1060 or 32/365, both well outside error limits. ******

28 Nov 2007.
Trying to find yaw alignment – first used compass in binoculars but all 3 of us got different answers, depending on how close you are to the binnacle and how tall/short. Also have the problem of the compass sticking when you look up at the mast – have to be very careful lowering them vertically until the compass frees up. Next tried holding v thin string next to the front edge of the side of the MotionPak – extended taut back to the bridge top. Walked the bridge end of the string until flush with side of box. From this get angle from true for-aft orientation. Side of MP about 78 cm (maybe less) from centreline – string at bridge 50 cm from centreline. Distance from bridge to MP is (2*482.5)+95 cm. Give MP pointing to stbd y 1.5 deg. yaw angle = tan-1 (28/1060) = 1.5 deg. Errors – say 10 cm, gives ± 0.5 deg. Plus any bias between output from MotionPak compared to side of MotionPak box.

24 Jan 2008.
Replaced R3 391 and MP 791 with R3 227 and MP 682. Note that until now, the MP and R3 were mounted separately. The replacement has MP fixed to base plate of R3 (with inclinometer, unlike the old one), so MP moved up about 60 cm and the R3 is 6 cm taller. Although the MP box was rotated 90 deg, the MP inside the box kept the same orientation relative to the ship. Weather was dreadful so no alignment measurements or photos were made.

16 April 2008
Sonic lowered 30 cm and rotated so that sonic now 60° to bow, i.e. back strut now inline fore and aft. MP is cocked over pointing to stbd of bow. MP/R3 relation to each other UNCHANGED. i.e. wound hard over on bolts at 51.7 deg.

1-5 Sept 2008
Ship sonic was replaced on Wednesday.

19 May 2009
Replaced sonic. Removed 227 and put up sonic 391. Sonic was rotated hard to port. Motion pack plate was threaded. Note that this was a 1-man visit so alignments could not be checked by someone on the bridge top.

4. Summary

This report describes the metadata for the HiWASE instrumentation deployed on the OWS *Polarfront* between September 2006 and December 2009. Sensor serial numbers, dates of sensor changes and problems with sensors are contained in the associated tables.

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TABLES A Fast response sensors: Instrument serial numbers and sensor changes

A.1 Sonic anemometer and MotionPak

year	sensor	location	Old serial number	New serial number	jday	month	day	Motion pack	comment
2006	sonic	foremast	-	391	250	September	7	0791	Sonic inline with the bow.
2007	sonic	foremast			249	September	6	0791	rotated sonic ~ 60to65 degrees starboard
2008	sonic	foremast	391	227	024	January	24	0682	sensor logging at 5Hz, not 20Hz new motion pack and sonic fitted. sonic now 6 cm higher.motion pack now 61cm higher. ~ 60to65 degrees starboard
2008	sonic	foremast			032	February	01	0682	sensor fixed: logging at 20Hz ~ 60to65 degrees starboard.
2008	sonic	foremast			107	April	16	0682	R3/motion pack lowered by 0.30 m
2008	sonic	foremast			108	April	17	0682	Sonic Interface Unit failed about 16:20hr GMT.No motion pack data logged.
2008	sonic	foremast			246	September	2	0682	Sonic Interface Unit replaced
2009	sonic	foremast			114	April	24	0682	transducer failure
2009	sonic	foremast	227	391	139	May	19	0682	sonic replaced
2009	sonic	foremast	removed	removed	344	December	10	0682	removed sensor

A.2 Licor 1 (Forward of the foremast)

year	sensor	location	Old serial number	New serial number	jday	month	day	Sensor calibration	comment
2006	licor1	starboard forward	-	1114	250	September	7	Appendix C	
2007	licor1	starboard forward	1114	1264	249	September	6	Appendix C	Licor wash system introduced
2008	licor1	starboard forward			044	February	13		Licor lost during storm
2008	licor1	starboard forward	1264	1114	052	February	21	Appendix C	replaced as Licor lost during storm
2008	licor1	starboard forward			163	June	11		Licor chemicals changed
2009	licor1	starboard forward	1114	0614	83	March	24	Appendix C	Licor chemicals changed in 0614 before installation
2009	licor1	starboard forward	0614	1114	252	September	9	Appendix C	
2009	licor1	starboard forward	1114	removed	344	December	10		

A.3 Licor 2 (starboard of the foremast)

year	sensor	location	Old serial number	New serial number	jday	month	day	sensor calibration	comment
2006	licor2	starboard	-	1113	250	September	7	Appendix C	
2007	licor2	starboard			249	September	6		replaced chemicals Licor wash system introduced
2008	licor2	starboard	1113	0825	245	September	1	Appendix C	
2009	licor2	starboard			83	March	24		replaced chemicals
2009	licor2	starboard	0825	1113	111	April	21	Appendix C	
2009	licor2	starboard			251	September	8		replaced chemicals in 1113
2009	licor2	starboard	1113	removed	344	December	10		removed sensor

A.4 CLASP

year	sensor	location	Old Serial number	New Serial number	jday	month	day	Sensor calibration	comment
2008	CLASP	foremast	-	board 5 (55552)	333	November	28		installed CLASP
2009	CLASP	foremast	board 5 (55552)	board 1 (39763)	055	February	24		removed unit
2009	CLASP	foremast	board 1 (39763)	board 4 (32529)	083	March	24		installed new unit
2009	CLASP	foremast	board 4 (32529)	board 8 (55556)	139	May	19		replaced unit
2009	CLASP	foremast	board 8 (55556)	board 4 (57511)	251	September	8		replaced unit
2009	CLASP	foremast	removed	removed	344	December	10		Removed system

TABLES B Mean met systems: Instrument serial numbers and sensor changes

B.1 Psychrometer

year	sensor	location	Old Serial number	New Serial number	jday	month	day	New sensor calibration	comment

2006	psychrometer	bridge top	-	2003	250	September	7	DRY-10.90536, 4.055126E-2, -9.616976E-7, 1.271695E-9,0 WET: -10.78525, 4.120784E-2, -1.935707E-6, 1.718843E-9,0	
2006	psychrometer	bridge top	2003	2001	333	November	29	DRY: -10.248026, 3.830177E-2, 1.92624E-6, 5.1600365E-11,0 WET: -10.294559, 3.831128E-2, 2.005968E-6, 1.022872E-11,0	
2007	psychrometer	bridge top			024	January	24		lost sun hat.installed fan from 1019
2007	psychrometer	bridge top	2001	2002	250	September	7	DRY -10.61338, 3.902898E-2, 1.196562E-6, 3.114855E-10,0 TW-10.58212, 3.974472E-2, 5.132515E-7, 5.566312E-10,0	
2007	psychrometer	bridge top	2002	1030	331	November	28	DRY: -1.314590, 3.856463e-2, 1.953858E-6, -4.215725E-11,0 WET: -1.252705, 3.867569E-2, 1.874366e-6, 3.986027e-11,0	
2008	psychrometer	bridge top	1030	1028	052	February	21	Sensor changed, but calibration was not changed.	Junction box fault so no data logged
2008	psychrometer	bridge top	1028		079	March	19	DRY: -1.207699e+1, 3.81719e-2, 1.876603E-6, -1.070046E-10,0 WET: -1.036600e+1, 3.902701E-2, 1.466650e-6, 1.868955e-10,0	
2008	psychrometer	bridge top	-	-	191	July	7		replaced fan
2008	psychrometer	bridge top		2004	245	September	1	DRY:-1.040408e+1, 3.822227e-2,	

								2.224682E-6, -1.378698E-10,0 WET:-1.024837e+1, 3.869249E-2, 1.728779e-6, 4.767174e-11,0	
2008	psychrometer	bridge top	2004	1028	333	November	28	DRY: -1.225153e+1, 3.910999e-2, 5.411647E-7, 4.485326E-10,0 WET: -1.037088e+1, 3.914122E-2, 1.250447e-6, 2.783538e-10,0	
2009	psychrometer	bridge top			139	May	19		replaced fan
2009	psychrometer	bridge top			185	July	4		not wicking from the 4-11 July inclusive
2009	psychrometer	bridge top			254	September	11		replaced fan and wick on 1028
2009	psychrometer	bridge top		removed	344	December	10		removed

B.2 Vaisala air temperature and Humidity

year	sensor	location	Old serial number	New serial number	jday	month	day	New Sensor calibration	comment
2006	vaisala	bridge top	-	X395?	250	September	7	AIR:-40,0.1,0,0,0 RH:0,0.1,0,0,0	
2007	vaisala	bridge top	X395?	B4440006	108	April	18	AIR:-40,0.1,0,0,0 RH:0,0.1,0,0,0	
2007	vaisala	bridge top	B4440006	X395?	164	June	13	AIR:-40,0.1,0,0,0 RH:0,0.1,0,0,0	
2007	vaisala	bridge top	X395?	B4440006	108	April	18	AIR:-40,0.1,0,0,0 RH:0,0.1,0,0,0	
2007	vaisala	bridge top	B4440006	X395?	164	June	13	AIR:-40,0.1,0,0,0 RH:0,0.1,0,0,0	
2008	vaisala	bridge top	X395?	B4440006	052	February	21	AIR:-40,0.1,0,0,0 RH:0,0.1,0,0,0	not logging:problem with junction box
2008	vaisala	bridge top	B4440006	X4120001	245	September	r1	AIR:-40,0.1,0,0,0 RH:0,0.1,0,0,0	
2009	vaisala	bridge top	X4120001	brown	251	September	8	AIR:-40,0.1,0,0,0 RH:0,0.1,0,0,0	
2009	vaisala	bridge top	brown	removed	334	December	10		removed

B.3 Long wave sensors

year	sensor	location	Old Serial	New Serial	jday	month	day	New Sensor	comment

			number	number				calibration	
2006	lw	bridge top	-	31172	250	September	7	E1:0,1,0,0,0 Td1:0,1,0,0,0 Ts1:0,1,0,0,0	
2008	lw	bridge top	31172	31171	245	September	1	E1:0,1,0,0,0 Td1:0,1,0,0,0 Ts1:0,1,0,0,0	
2008	lw	bridge top			333	November	28		replaced one 7663 chip on CCT board with 7600
2009	lw	bridge top			111	April	21		cleaned dome
2009	lw	bridge top	31171	removed	344	December	10		sensor removed

B.4 Short wave sensors

year	sensor	location	Old serial number	New serial number	jday	month	day	New sensor calibration	comment
2006	tir	foremast	-	903289	250	September	7	0,0.2,0,0,0	
2008	tir	foremast	903289	902368	107	April	16	0,0.22026,0,0,0	
2009	tir	foremast			111	April	21		dome cleaned
2009	tir	foremast	902368 902836?	removed	344	December	10		December visit notes say sensor is 902836. check serial number and sensitivity

B.5 MicroTSG

year	sensor	location	Old serial number	New serial number	jday	month	day	New sensor calibration	comment
2006	tsg	forward hold	-	4543156-0181	247	September	04		tsg installed
2006	tsg	forward hold			305	November	01		ordinary clean
2006	tsg	forward hold			333	November	29		ordinary clean
2007	tsg	forward hold			024	January	24		ordinary clean
2007	tsg	forward hold			052	February	21		ordinary clean
2007	tsg	forward hold			080	March	21		ordinary clean
2007	tsg	forward hold			108	April	18		ordinary clean
2007	tsg	forward hold			164	June	13		ordinary clean
2007	tsg	forward hold			192	July	11		ordinary clean
2007	tsg	forward hold			249	September	06		extended clean

2007	tsg	forward hold			276	October	03		extended clean
2007	tsg	forward hold			332	November	28		extended clean
2008	tsg	forward hold		4540927-0159	052	February	21		new tsg installed
2008	tsg	forward hold			107	April	16		extended clean
2008	tsg	forward hold			135	May	14		extended clean
2008	tsg	forward hold			191	July	09		extended clean
2008	tsg	forward hold			247	September	03		extended clean
2008	tsg	forward hold			274	September	30		extended clean.SST High. Problem with flow. Solved January 2009
2008	tsg	forward hold			333	November	28		extended clean
2009	tsg	forward hold			27	January	27		extended clean
2009	tsg	forward hold			55	February	24		extended clean
2009	tsg	forward hold			83	March	24		extended clean
2009	tsg	forward hold			111	April	21		extended clean
2009	tsg	forward hold			139	May	19		extended clean
2009	tsg	forward hold			195	July	14		extended clean
2009	tsg	forward hold			253	September	10		extended clean
2009	tsg	forward hold			279	October	06		extended clean
2009	tsg	forward hold			307	November	03		extended clean
2009	tsg	forward hold	sensor removed	sensor removed	344	November	30		

B.6 Bridge Camera systems

year	sensor	location	jday	month	day	comment
2006	camera	port bridge	250	September	7	pictures taken every 30 mins. 2 Mpixel. Fine compression
2007	camera	port bridge	108	April	18	pictures taken every 10 mins.2 Mpixel. Fine compression
2007	camera	port bridge	250	September	07	pictures taken every 10 mins.2 Mpixel. Fine compression Both cameras adjusted so the horizon is at the top of the image. beam-on camera adjusted to be more square to the ship
2008	camera	port bridge	024	January	24	pictures taken every 5 mins @ 3 Mpixel. fore:Fine resolution. port:normal compression Using 16GB flash cards
2008	camera	port bridge	163	June	11	pictures taken every 5 mins @ 3 Mpixel. both cameras at Normal compression. Using solenoid timing system.

2008	camera	port bridge	333	November	28	pictures taken every 1 mins @ 3 Mpixel. Normal compression.ISO 400.focus INF and F2.8.timer on between 10:30hr to 13:20hr GMT Beam camera removed. UV filter removed from forward camera.
2009	camera	port bridge	188	July	7	Both cameras changed from 'M' to 'P'.
2009	camera	port bridge	251	September	8	Solenoid systems replaced with hard wire to camera. pictures taken every 5 mins @ 3 Mpixel. Normal compression.ISO 400.focus INF and F2.8.timer on between 06:00hr to 17:00hr GMT

B.7 Gimbled camera system

year	sensor	location	jday	month	day	comment
2009	gimbled	port bridge top	111	April	21	Camera installed pictures taken every 5 mins @ 3 Mpixel. Normal compression.ISO 400.focus INF and F2.8.
2009	gimbled	port bridge top	251	September	8	Solenoid systems replaced with hard wire to camera. pictures taken every 5 mins @ 3 Mpixel. Normal compression.ISO 400.focus INF and F2.8.timer on between 06:00hr to 17:00hr GMT

B.8 SBWR output and WAVEX serial output parameters

SBWR	WAVEX 7th September 2006 to 24th January 2007	WAVEX 24th January 2007 to 10th December 2009	comment
Hmax	Hm0	Hm0	Hs = Hm0 = significant wave height
Hs	Tm02	Tm01	Tm02=(m0/m2)**0.5=zero-upcrossing. Tm01 = Te =period of peak energy
Te	Tp1	Tp1	Tp1 = Primary wave peak period
m-2	Dp1-t	Dp1-t	Dp1-t = primary wave peak direction
m-1	(m4 upto J272 2006) SPRt	m4 (4dec. p.)	$SPRI_t$ = total energy directional spread
m0	Tp2	m1 (4dec. p.)	Tp2 = secondary wave peak period
m1	Dp2-t	m2 (4dec. p.)	Dp2-t = secondary wave peak direction
m2	Dpt-t	Dpt-t	Dpt-t = total energy peak direction

B.9 WAVEX system

year	sensor	location	jday	month	day	comment
2007	WAVEX	main mast	024	January	24	software change: replaced version 1.2.0 with 1.2.5
2008	WAVEX	main mast	134	May	14	WAVEX system service

2008	WAVEX	main mast	303	October	29	hard disc replaced. Unfortunately, the software versions were reinstalled as the September 2006 setup. Serial output was outputting to 1 dec. place. mo was set instead of m1.
2008	WAVEX	main mast	333	November	28	setting put back to October pre-hard disc crash.
2009	WAVEX	main mast	055	February	24	WAVEX system service: power supply failure

TABLE C Instrument tilts by ship visit

Tilts indicated by **bold type** show measurements which were used to estimate the relative tilts between the R3 and MotionPak sensors

2006

7th September 2006

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	**Leaning aft 1.3**	**0.0**	
R3 pole			not measured
MP top	**Leaning aft 2.0**	**Leaning to stb 0.3**	
Starboard Licor	Leaning aft 0.3	Leaning to port 1.9	
foreward Licor	Leaning aft 1.4	0.0	
Wind Sonic			not measured

4th October 2006

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	Leaning aft 1.4	Leaning to port 1.0	
R3 pole			not measured
MP top			
Starboard Licor	Leaning aft 1.0	Leaning to port 1.9	
foreward Licor	Leaning aft 3.0	Leaning to port 0.3	
Wind Sonic			not measured

2007

18th April 2007

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	**Leaning aft 2.5**	**Leaning to port 1.2**	not measured
R3 pole			not measured
MP top	**Leaning aft 1.7**	**Leaning to port 0.8**	
Starboard Licor	Leaning aft 3.7	Leaning to stb 1.0	
foreward Licor	Leaning aft 2.5 t	Leaning to stb 2.0	
Wind Sonic			not measured

4th September 2007
In Maloy

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3			not measured
R3 pole	Leaning aft 4.0	Leaning to stb 0.3	on the slip in Maloy
MP top			
Starboard Licor	Leaning forward 3.0	Leaning to sbt 2.5	
foreward Licor	Leaning aft 6.0	Leaning to stb 2.0	
Wind Sonic			not measured

after rotating sonic 60(65) degrees and replacing forward Licor

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured

R3		**Leaning to port 0.4**	on slip in Maloy
R3 pole		Leaning to stb 0.2	on the slip in Maloy
MP top	Leaning aft 4.4	**Leaning to stb 0.6**	on the slip in Maloy
Starboard Licor	Leaning forward 3.0	Leaning to stb 2.5	on the slip in Maloy
foreward Licor	Leaning aft 4.5	0.0	on the slip in Maloy
Wind Sonic			not measured

replaced chemicals in starboard Licor

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	**Leaning aft 3.2**	**Leaning port 0.4**	on slip in Maloy
R3 pole	Leaning aft 4.0	Leaning stb 1.8	on the slip in Maloy
MP top	**Leaning aft 4.4**	**Leaning stb 0.7**	on the slip in Maloy
Starboard Licor	Leaning aft 2.2	Leaning stb 3.3	on the slip in Maloy
foreward Licor	shrouded	shrouded	on the slip in Maloy
Wind Sonic			not measured

2008

24th January 2008

bim measurements of existing setup

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	**Leaning aft 1.4**	**Leaning to port 0.3**	
R3 pole	Leaning aft 1.4	Leaning to stb 0.3	
MP top	**Leaning aft 0.8**	**Leaning stb 0.7**	
Starboard Licor			not measured
foreward Licor			not measured
Wind Sonic			not measured

jzp measurements of existing setup

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	**Leaning aft 1.5 t**	**Leaning to port 0.9**	
R3 pole	Leaning aft 1.4	0.0	
MP top	**Leaning aft 1.3**	**Leaning to atb 0.4**	
Starboard Licor			not measured
foreward Licor			not measured
Wind Sonic			not measured

new setup

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	**Leaning aft 1.5**	**Leaning to port 0.2**	
R3 pole	Leaning aft 1.4	Leaning to stb 0.6	
MP top	**Leaning aft 1.6**	**Leaning to port 0.3**	
Starboard Licor			not measured
foreward Licor			not measured
Wind Sonic			not measured

16th April 2008

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	**Leaning aft 1.0 t**	**Leaning to port 1.3**	
R3 pole	Leaning aft 1.3	0.0	
MP top	**Leaning aft 1.3**	**Leaning to port 0.9**	

Starboard Licor	Leaning forwards 12	Leaning to stb 6.0	
foreward Licor	shrouded	shrouded	not measured
Wind Sonic	0.0	Leaning to port 0.1	

Re-measured

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	Leaning aft 1.8 t	Leaning to port 2.0	
R3 pole	Leaning aft 1.7	Leaning to port 1.2	
MP top	Leaning aft 2.0	Leaning to port 1.7	
Starboard Licor			not measured
foreward Licor			not measured
Wind Sonic	0.0	Leaning to port 1.8	not measured

Cut pole and lowered sonic

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 0.1	Leaning stb 0.3	
R3	**Leaning aft 1.6**	**Leaning to port 0.2**	
R3 pole	Leaning aft 1.6	Leaning to stb 0.2	
MP top	**Leaning aft 1.7**	**Leaning to stb 0.2**	
Starboard Licor			not measured
foreward Licor	Leaning aft 1.0	Leaning to stb 0.7	
Wind Sonic	Leaning aft 0.1	Leaning to stb 0.3	**TRIM OK**

11th June 2008

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			not measured
R3	Leaning aft 1.3	Leaning to atb 0.5	
R3 pole	Leaning aft 1.2	Leaning to stb 0.8	
MP top	Leaning aft 0.5	Leaning to port 1.3	
Starboard Licor	shrouded	shrouded	
foreward Licor	Leaning aft 0.4	Leaning to stb 1.3	not measured
Wind Sonic			not measured

9th July 2008

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 1.7	Leaning to port 0.6	
R3	**Leaning aft 1.7**	**Leaning to port 0.6**	
R3 pole	Leaning aft 1.5	Leaning to port 0.5	
MP top	**Leaning aft 1.7**	**?**	
Starboard Licor	Leaning aft 0.1	Leaning to stb 2.6	
foreward Licor	Leaning aft 0.7	Leaning to stb 0.2	not measured
Wind Sonic	Leaning aft 1.7	Leaning port 0.6	**TRIM OK**

5th September 2008

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 0.4 t	Leaning to stb 0.9	WindOberver sonic replaced on the 3rd September 2008.
R3	Leaning aft 1.9	Leaning to stb 1.5	
R3 pole	Leaning aft 1.9	Leaning to stb 2.0	
MP top	Leaning aft 1.3	Leaning to stb 2.4	
Starboard Licor	Leaning aft 6.2	Leaning to stb 0.2	
foreward Licor	Leaning aft 0.7	Leaning to stb 6.0	not measured
Wind Sonic	Leaning aft 0.0	Leaning to stb 2.5	**TRIM changed**

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment

Wind Sonic	Leaning aft 0.1	Leaning to port 0.3	WindOberver sonic replaced on the 3rd September 2008. ship bobbing about
R3	Leaning aft 1.4	Leaning to port 0.4	ship bobbing about
R3 pole	Leaning aft 1.8	Leaning to port 0.1	ship bobbing about
MP top	Leaning aft 1.5	Leaning to stb 0.3	ship bobbing about
Starboard Licor	Leaning aft 6.0	Leaning to port 1.3	ship bobbing about
foreward Licor	0.0?	Leaning to port 4.0	ship bobbing about
Wind Sonic	0.0	0.0	ship bobbing about. repeated to check trim

29th November 2008

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 1.7	Leaning to stb 0.4	
R3	**Leaning aft 1.5**	**Leaning to stb 0.5**	
R3 pole	Leaning aft 2.0	Leaning to port 0.1	
MP top	**Leaning aft 1.7**	**Leaning to stb 0.4**	
Starboard Licor	Leaning aft 3.6	Leaning to port 0.4	
foreward Licor	shrouded	shrouded	not measured
Wind Sonic	Leaning aft 1.5	Leaning to stb 0.3	**TRIM OK**

2009

24th February 2009

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic			
R3	Leaning aft 1.0	Leaning to stb 0.5	
R3 pole	-	-	
MP top	Leaning aft 1.1	Leaning to port 0.6	
Starboard Licor	Leaning aft 3.7	0.0	
foreward Licor	Leaning aft 0.7	Leaning to stb 4.5	
Wind Sonic			

24th March 2009

existing setup

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning forwards 0.4	Leaning stb 1.0	
R3	**Leaning aft 1.0**	**Leaning stb 1.2**	
R3 pole	-	-	
MP top	**Leaning aft 1.1 aft**	**Leaning to stb 1.0**	
Starboard Licor	Leaning aft 4.0 aft	Leaning to stb 1.0	
foreward Licor	Leaning forward 0.5	Leaning to stb 2.8	
Wind Sonic	Leaning forward 0.5	Leaning to stb 0.7	**TRIM OK**

after replacing licor

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	0.0	Leaning to port 0.3	
R3	**Leaning aft 1.4**	**0.0**	
R3 pole	-	-	
MP top	**Leaning aft 1.4**	**0.0**	
Starboard Licor	Leaning aft 4.0	Leaning to port 0.4	
foreward Licor	Leaning forwards 0.8	Leaning to stb 2.5	
Wind Sonic	0.0	Leaning to port 0.3	**TRIM OK**

21st April 2009

existing setup

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning forwards 0.5	Leaning to port 0.7	
R3	**Leaning aft 1.1 aft**	**Leaning to port 0.5**	
R3 pole	-	-	
MP top	**Leaning aft 1.2**	**Leaning to stb 0.4**	
Starboard Licor	Leaning aft 3.1	Leaning to port 0.7	
foreward Licor	Leaning aft 0.2	Leaning to stb 2.8	
Wind Sonic	Leaning forwards 0.4	Leaning to port 0.5	**TRIM OK**

After swapping licor

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning forwards 0.4	Leaning to port 0.3	
R3	**Leaning aft 1.1**	**Leaning to port 0.6**	
R3 pole	-	-	
MP top	**Leaning aft 1.3**	**Leaning to port 0.5**	
Starboard Licor	Leaning aft 2.7	Leaning to port 0.6 t	
foreward Licor	Leaning aft 0.5	Leaning to stb 3.0	
Wind Sonic	Leaning forwards 0.4	Leaning to port 0.5	**TRIM OK**

19th May 2009

existing setup

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 1.6	Leaning to port 1.1t	
R3	Leaning aft 1.0 aft	Leaning to stb 0.4	
R3 pole	-	-	
MP top	Leaning aft 1.5 aft	Leaning to port 0.5	
Starboard Licor	Leaning aft 3.0 aft	Leaning to stb 0.4	
foreward Licor	Leaning aft 1.8 aft	Leaning to stb 4.0	
Wind Sonic	Leaning aft 1.4 aft	Leaning to stb 0.3	TRIM changed

after new sonic installed

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 2.0	Leaning to port 0.4	
R3	Leaning aft 1.3	Leaning to stb 0.3	
R3 pole	-	-	
MP top	Leaning aft 1.7	Leaning to stb 0.1	
Starboard Licor	Leaning aft 3.0	Leaning to stb 0.9	
foreward Licor	Leaning aft 0.3	Leaning to stb 3.5	
Wind Sonic	Leaning aft 1.4	Leaning to stb 0.3	TRIM changed

8th September 2009

On the slip in Maloy. Existing setup

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 2.8	Leaning to port 0.5 t	on slip in Maloy
R3	**Leaning aft 4.3**	**Leaning to stb 0.6 d**	on slip in Maloy
R3 pole	-	-	
MP top	**Leaning aft 4.5**	**Leaning to stb 1.6**	on slip in Maloy
Starboard Licor	Leaning aft 6.0	Leaning to stb 0.2	on slip in Maloy
foreward Licor	Leaning aft 3.6	Leaning to stb 4.0	
Wind Sonic	Leaning aft 2.9	Leaning to port 0.4	**TRIM OK**

10th September 2009

On the slip in Maloy.After licor was replaced

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 2.8	Leaning to port 0.2	on slip in Maloy

R3	**Leaning aft 4.4**	**Leaning to stb 0.3**	on slip in Maloy
R3 pole	-	-	
MP top	**Leaning aft 4.4**	**Leaning to stb 0.5**	on slip in Maloy
Starboard Licor	Leaning aft 6.2	Leaning to stb 1.4	on slip in Maloy
foreward Licor	Leaning aft 5.7	Leaning to stb 4.0	
Wind Sonic	Leaning aft 2.6	Leaning to port 0.4	**TRIM OK**

11th September 2009

In the Shed in Maloy.

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 0.3	Leaning stb 0.3	
R3	**Leaning aft 1.1**	**Leaning stb 0.3**	
R3 pole	-	-	
MP top	**Leaning aft 1.4**	**Leaning to stb 0.3**	
Starboard Licor	Leaning aft 2.9	Leaning to stb 1.1	
foreward Licor	Leaning aft 0.9	Leaning to stb 3.3	
Wind Sonic	Leaning aft 0.3	Leaning to stb 0.3	**TRIM OK**

11th December 2009

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 0.3	Leaning to port 1.2	
R3	Leaning aft 1.7	Leaning to port 0.2	
R3 pole	-	-	
MP top	Leaning aft 1.9	Leaning to port 0.3	
Starboard Licor	Leaning aft 3.5	Leaning to port 0.5	
foreward Licor	Leaning aft 0.9	Leaning to stb 2.7	
Wind Sonic	Leaning aft 0.1	Leaning to port 0.1	TRIM changed

measured tilts with no break in between

measurement position	fore/aft (degrees)	port/starboard (degrees)	Comment
Wind Sonic	Leaning aft 0.1	Leaning to port 0.1	
R3	**Leaning aft 1.5**	**Leaning to stb 0.7**	
R3 pole	-	-	
MP top	**Leaning aft 1.7**	**Leaning to stb 0.8**	
Starboard Licor			
foreward Licor			
Wind Sonic	Leaning aft 0.1	Leaning to stb 0.3	**TRIM OK**

Table D Instrument tilts by instrument

LICOR1 forward

numbers/names in brackets indicate more than one measurement made during a port call.

year	JDAY	day	month	fore/aft (degrees)	port/starboard (degrees)	measurement point
2006	250	7	Septmeber	leaning aft 1.4	0	instrument
2006	277	4	October	leaning aft 3	leaning to port 0.3	instrument
2007	108	18	April	leaning aft 2.5	leaning to starboard 2	instrument
2007	247	4	Septmeber	shrouded	shrouded	instrument
2008	107	16	April	leaning aft 1.0	leaning to starboard 0.7	instrument
2008	163	11	June	leaning aft 0.4	leaning to starboard 1.3	instrument
2008	191	09	July	leaning aft 0.7	leaning to starboard 0.2	instrument
2008	249	05	September	leaning aft 0.7(1) leaning aft 0.0(2)	leaning to starboard 6.0(1) leaning to port 4.0(2)	instrument
2008	333	28	November	shrouded	shrouded	instrument
2009	055	24	February	leaning aft 0.7	leaning to starboard 4.5	instrument
2009	083	24	March	leaning forward 0.5(1) leaning	leaning to starboard 4.0(1) leaning to	instrument

				aft 0.8(2)	stb 2.5(2)	
2009	111	21	April	leaning aft 0.2(1) leaning aft 0.5(2)	leaning to starboard 2.8(1) leaning to stb 3.0(2)	instrument
2009	139	19	May	leaning aft 1.8(1) leaning aft 0.3(2)	leaning to starboard 4.0(1) leaning to stb 3.5(2)	instrument. note: replaced sonic
2009	251	8	September	leaning aft 3.6	leaning to starboard 4.0	instrument. note: exisiting setup. on slip
2009	253	10	September	leaning aft 5.7	leaning to starboard 4.0	instrument. note: after replacing forward licor. on slip
2009	254	11	September	leaning aft 0.9	leaning to starboard 3.3	instrument. alongside
2009	345	11	December	leaning aft 0.9	leaning to starboard 2.7	instrument

LICOR2 starboard

numbers/names in brackets indicate more than one measurement made during a port call.

year	JDAY	day	month	fore/aft (degrees)	port/starboard (degrees)	measurement point
2006	250	7	Septmeber	leaning aft 0.3	leaning to port 1.9	instrument
2006	277	4	October	leaning aft 1	leaning to port 0.3	instrument
2007	108	18	April	leaning forwards 3.7	leaning to starboard 1	instrument
2007	247	4	Septmeber	leaning aft 2.2	leaning to starboard 3.3	instrument
2008	107	16	April	leaning forward 12.0	leaning to starboard 6.0	instrument
2008	apporx. 155	03	June	licor straightened by crew	licor straightened by crew	during cruise
2008	163	11	June	shrouded	shrouded	instrument
2008	191	09	July	leaning aft 0.1	leaning to starboard 1.6	instrument
2008	249	05	September	leaning aft 6.2(1) leaning aft 6.0(2)	leaning to starboard 0.2(1) leaning to port 1.3(2)	instrument
2008	333	28	November	leaning aft 3.6	leaning to port 0.4	instrument
2009	055	24	February	leaning aft 3.7	0	instrument
2009	083	24	March	leaning aft 4.0(1) leaning aft 4.0(2)	leaning to starboard 1.0(1) leaning to port 0.4(2)	instrument
2009	111	21	April	leaning aft 3.1(1) leaning aft 2.7(2)	leaning to port 0.7(1) leaning to port 0.6(2)	instrument
2009	139	19	May	leaning aft 3.0(1) leaning aft 3.0(2)	leaning to starboard 0.4(1) leaning to starboard 0.9(2)	instrument. note: replaced sonic
2009	251	8	September	leaning aft 6.0	leaning to starboard 0.2	instrument. note: exisiting setup. on slip
2009	253	10	September	leaning aft 6.2	leaning to starboard 1.4	instrument. note: after replacing forwrd licor. on slip
2009	254	11	September	leaning aft 2.9	leaning to starboard 1.1	instrument. alongside
2009	345	11	December	leaning aft 3.5	leaning to port 0.5	instrument

R3 sonic

Numbers/names in brackets indicate more than one measurement made during a port call.

year	JDAY	day	month	fore/aft (degrees)	port/starboard (degrees)	yaw (degrees)	measurement point	F/A R3-motion pack	P/S R3-motion pack
2006	250	7	Septmeber	leaning aft 1.3	0	port 5	unknown	-0.7	0.3
2006	277	4	October	leaning aft 1.4	leaning to port 1	port 5	unknown		
2007	108	18	April	leaning aft 2.5	leaning to port 1.2	port 5	unknown	0.8	0.4
2007	247	4	Septmeber	leaning aft 3.2	leaning to port 0.4	port 65	instrument	-1.2	1.1
2007	247	4	Septmeber	leaning aft 4.0	leaning to starboard 1.8	port 65	pole	-0.4	-1.1
2007	332	28	November	leaning aft 1.4	leaning to port 0.6	port 65	instrument	-0.3	1.1
2007	332	28	November	leaning aft 1.5	leaning to starboard 0.1	port 65	pole	-0.2	0.4
2008	024	24	January	leaning aft 1.4(bim) leaning aft 1.5(jzp)	leaning to port 0.3(bim) leaning to port 0.8(jzp)	port 65	instrument	0.6(bim) 1.0(jzp)	0.2(bim) 1.2(jzp)
2008	024	24	January	leaning aft 1.4(bim) leaning aft 1.4(jzp)	leaning to starboard 0.3(bim) leaning 0.0(jzp)	port 65	pole	0.6(bim) 1.0(jzp)	0.2(bim) 1.2(jzp)
2008	107	16	April	leaning aft 1.0(1) leaning aft 1.8(2) leaning aft 1.6(new	leaning to port 1.3(1) leaning to port 2.0(2) leaning to starboard 0.2(new installation)		instrument	-0.3(1) -0.2(2) -0.1 (new)	0.4(1) 0.3(2) 0(new)

				installation)					
2008	107	16	April	leaning aft 1.3(1) leaning aft 1.7(2) leaning aft 1.6(new installation)	leaning 0.0(1) leaning to port 1.2(2) leaning to starboard 0.2(new installation)		pole	0.0(1) -0.3(2) -0.1 (new)	-0.9(1) -0.5(2) 0(new)
2008	163	11	June	leaning aft 1.3	leaning to starboard 0.5		instrument	0.8	-1.8
2008	163	11	June	leaning aft 1.2	leaning to starboard 0.8		pole	0.7	-2.1
2008	191	09	July	leaning aft 1.7	leaning to port 0.6		instrument	0.0	-
2008	191	09	July	leaning aft 1.5	leaning to port 0.5		pole	-0.2	
2008	249	05	September	leaning aft 1.9(1) leaning aft 1.4(2)	leaning to stb 1.5(1) leaning to port 0.4(2)		instrument	0.6(1) -0.1(2)	0.9(1) 0.7(2)
2008	249	05	September	leaning aft 1.9(1) leaning aft 1.8(2)	leaning to stb 2.0(1) leaning to port 0.1(2)		pole	0.6(1) 0.3(2)	0.4(1) 0.4(2)
2008	333	28	November	leaning aft 1.5	leaning to stb 0.5		instrument	-0.2	-0.1
2008	333	28	November	leaning aft 2.0	leaning to port 0.1		pole	0.3	0.5
2009	055	24	February	leaning aft 1.0	leaning to stb 0.5		instrument	-0.1	-1.1
2009	083	24	March	leaning aft 1.0(1) leaning aft 1.4(2)	leaning to stb 1.2(1) 0.0(2)		instrument	-0.1(1) -0.2(2)	0(1) 0(2)
2009	111	21	April	leaning aft 1.1(1) leaning aft 1.1(2)	leaning to port 0.5(1) leaning to port 0.6(2)		instrument	-0.1(1) 0.9(2)	-0.2(1) 0.1(2)
2009	139	19	May	leaning aft 1.0(1) leaning aft 1.3(2)	leaning to starboard 0.4(1) leaning to starboard 0.3(2)		instrument. note: replaced sonic	-0.5(1) -0.9(2)	-0.4(1) -0.1(2)
2009	251	8	September	**leaning aft 4.3**	**leaning to port 0.5**		**instrument. on slip**	**-0.2**	**2.1**
2009	251	8	September	leaning aft 2.8(before) leaning aft 2.9(after)	leaning to port 0.5(before) leaning to port 0.4(after)		wind sonic check. on slip		
2009	253	10	September	leaning aft 4.4	leaning to port 0.2		instrument. on slip	0.0	0.5
2009	253	10	September	leaning aft 2.8(before) leaning aft 2.6(after)	leaning to port 0.2(before) leaning to port 0.4(after)		wind sonic check. on slip		
2009	254	11	September	leaning aft 1.1	leaning to port 0.3		instrument. alongside	-0.3	0.1
2009	254	11	September	leaning aft 0.3(before) leaning aft 0.3(after)	leaning to stb 0.3(before) leaning to stb 0.3(after)		wind sonic check. alongside		
2009	345	11	December	leaning aft 1.7	leaning to port 0.2		instrument	-0.2	0.1
2009	345	11	December	leaning aft 0.3(before) leaning aft 0.1(after)	leaning to port 1.2(before) leaning to stb 0.1(after)		wind sonic check.		
2009	345	11	December	leaning aft 1.5	leaning to stb 0.7		instrument	-0.2	0.1
2009	345	11	December	leaning aft 0.1(before) leaning aft 0.1(after)	leaning to port 0.1(before) leaning to stb 0.3(after)		wind sonic check.		

Motion pack

numbers/names in brackets indicate more than one measurement made during a port call.

year	JDAY	day	month	fore/aft (degrees)	port/starboard (degrees)	yaw (degrees)	measurement point
2006	250	7	Septmeber	leaning aft 2	leaning to starboard 0.3		instrument
2007	108	18	April	leaning aft 1.7	leaning to port 0.8		instrument
2007	247	4	Septmeber	leaning aft 4.4	leaning to starboard 0.7		instrument
2007	332	28	November	leaning aft 1.7	leaning to starboard 0.5	starboard 1.5	instrument
2008	024	24	January	leaning aft 0.8(bim) leaning aft 1.3(jzp)	leaning to starboard 0.7(bim) leaning to starboard 0.4(jzp)	-	instrument
2008	107	16	april	leaning aft 1.3(1) leaning aft 2.0(2) leaning aft 1.7(new installation)	leaning to port 0.9(1) leaning to port 1.7(2) leaning to starboard 0.2(new installation)	-	instrument
2008	163	11	June	leaning aft 0.5	leaning to port 1.3	-	instrument
2008	191	09	July	leaning aft 1.7	leaning to ?		instrument
2008	249	05	September	leaning aft 1.3(1) leaning aft 1.5(2)	leaning to stb 2.4(1) leaning to stb 0.3(2)		instrument
2008	333	28	November	leaning aft 1.7	leaning to stb 0.4		instrument
2009	055	24	February	leaning aft 1.1	leaning to port 0.6		instrument
2009	083	24	March	leaning aft 1.1(1) leaning aft 1.4(2)	leaning to stb 1.0(1) 0.0(2)		instrument
2009	111	21	April	leaning aft 1.2(1) leaning aft 1.3(2)	leaning to stb 0.4(1) leaning to port 0.5(2)		instrument

2009	139	19	May	leaning aft 1.5(1) leaning aft 1.7(2)	leaning to port 0.5(1) leaning to stb 0.1(2)		instrument
2009	251	8	September	leaning aft 4.5	leaning to stb 1.6		instrument. on slip
2009	253	10	September	leaning aft 4.4	leaning to stb 0.3		instrument. on slip
2009	253	10	September	leaning aft 1.4	leaning to port 0.2		instrument.along side
2009	345	11	December	leaning aft 1.9(1) leaning aft 1.7(2)	leaning to port 0.3(1) leaning to stb 0.8(2)		instrument

Table E Sensor sampling frequencies

system	time period	comment
Thermosalinograph TSG	3 seconds	
Bergen CO2 system	Water sample: 3 minutes Air sample: every 3 hours Standard: every 3 hours	
Navigation	1 second	
AUTOFLUX mean met	10 seconds	SW, LW, air temp, humidity
DNMI ship's wind speed	1 second	Gill WindObserver sonic
DNMI ship's mean meteorology	1 minute	
R3A sonic	20 Hz	
Licors	20 Hz	
WAVEX	2 minutes out of every 5 minutes	
SBWR	30 minutes out of every 45 minutes	

TABLE F Sensor problems (red = port call, grey = sensor problem, n/i=not installed)

2006

year	jday	psychrometer	vaisala	licor1 foreward	licor2 starboard	CLASP	sbwr	WAVEX	sonic	ship's met	navigation	CO2	tsg	Fore camera	Port camera	Gimbled camera	Other sensors
2006	251 to 257			unshrouded	unshrouded	n/i				wind speed				7 days of images	4 days of images	Not installed	no lw,sky tasco
2006	258 to 268			unshrouded	unshrouded	n/i								10 days of images	3 days of images	Not installed	no lw,sky tasco
2006	269 to 272			unshrouded	unshrouded	n/i								1 days of images	1 days of images	Not installed	sky tasco
2006	273			unshrouded	unshrouded	n/i						no intemp		no images	no images	Not installed	sky tasco
2006	274			unshrouded	unshrouded	n/i						no intemp		no images	no images	Not installed	sky tasco
2006	275	no data	no data	unshrouded	unshrouded	n/i								no images	no images	Not installed	sky tasco
2006	276			unshrouded	unshrouded	n/i								no images	no images	Not installed	sky tasco
2006	277																
2006	278 to 302			shrouded	unshrouded	n/i								25 days of images	25 days of images	Not installed	
2006	303			shrouded	unshrouded	n/i		absent						1 day of images	1 day of images	Not installed	
2006	304			shrouded	unshrouded	n/i		absent						1 day of images	1 day of images	Not installed	
2006	305																
2006	306 to 311			unshrouded	shrouded	n/i		absent						no images	no images	Not installed	
2006	312 to 318			unshrouded	shrouded	n/i								no images	no images	Not installed	
2006	319			unshrouded	shrouded	n/i								no images	no images	Not installed	atmos. pressure
2006	32 to	no water bottle		unshrouded	shrouded	n/i								no images	no images	Not installed	atmos. pressure

	324																
2006	325	no water bottle		unshrouded	shrouded	n/i			no data	wind speed				no images	no images	Not installed	
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLASP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2006	326	no water bottle. dry bulb faulty		unshrouded	shrouded	n/i			no data	wind speed				no images	no images	Not installed	
2006	327 to 331	no water bottle. dry bulb faulty		unshrouded	shrouded	n/i								no images	no images	Not installed	
2006	332	no water bottle		unshrouded	shrouded	n/i								no images	no images	Not installed	no sky tasco
2006	333																
2006	334			shrouded	unshrouded	n/i								I day of images	no images	Not installed	no sky tasco
2006	335			shrouded	unshrouded	n/i							no data	I day of images	no images	Not installed	no sky tasco
2006	336			shrouded	unshrouded	n/i				wind speed			no data	I day of images	no images	Not installed	atmos. pressure, both tascos
2006	337			shrouded	unshrouded	n/i				wind speed			no data	I day of images	no images	Not installed	atmos. pressure, both tascos
2006	338 to 343			shrouded	unshrouded	n/i								6 days of images	6 days of images	Not installed	both tascos
2006	344			shrouded	unshrouded	n/i							no data	I day of images	I day of images	Not installed	both tascos
2006	345			shrouded	unshrouded	n/i							no data	I day of images	I day of images	Not installed	both tascos
2006	346 to 350			shrouded	unshrouded	n/i								5 days of images	5 days of images	Not installed	both tascos
2006	351	frozen		shrouded	unshrouded	n/i								1 day of images	1 day of images	Not installed	both tascos
2006	352	frozen		shrouded	unshrouded	n/i								1 day of images	1 day of images	Not installed	both tascos
2006	353			shrouded	unshrouded	n/i								1 day of	1 day of	Not installed	both

														images	images		tascos
2006	354 to 360	loose connector	loose connector	shrouded	unshrouded	n/i								7 days of images	7 days of images	Not installed	no SW,LW or Tasco
2006	361																
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLASP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2006	362 to 365	loose connector	loose connector	unshrouded	hrouded	n/i								4 days of images	4 days of images	Not installed	no SW,LW or Tasco

2007

2007	1 to 3	loose connector	loose connector	unshrouded	shrouded	n/i								3 days of images	3 days of images	Not installed	no SW,LW or Tasco
2007	4 to 7	loose connector	loose connector	unshrouded	shrouded	n/i						no intemp	no sst,salinity	4 days of images	4 days of images	Not installed	no SW,LW or Tasco
2007	8 to 10	loose connector	loose connector	unshrouded	shrouded	n/i								3 days of images	3 days of images	Not installed	no SW,LW or Tasco
2007	11 to 23	loose connector	loose connector	unshrouded	shrouded	n/i								13 days of images	no images	Not installed	no SW,LW or Tasco
2007	24																
2007	25 to 32			shrouded	unshrouded	n/i								8 days of images	8 days of images	Not installed	
2007	33 to 40	dried out		shrouded	unshrouded	n/i								8 days of images	8 days of images	Not installed	
2007	41	frozen		shrouded	unshrouded	n/i								1 day of images	1 day of images	Not installed	
2007	42 to 50			shrouded	unshrouded	n/i								2 days of images	2 days of images	Not installed	
2007	51	frozen		shrouded	unshrouded	n/i								no images	no images	Not installed	
2007	52																
2007	53			unshrouded	shrouded	n/i								no images	no images	Not installed	

	to 60																
2007	61	frozen		unshrouded	shrouded	n/i								no images	no images	Not installed	
2007	62	frozen		unshrouded	shrouded	n/i								no images	no images	Not installed	
2007	63 to 74			unshrouded	shrouded	n/i								no images	no images	Not installed	
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLA SP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2007	75			unshrouded	shrouded	n/i		absent						no images	no images	Not installed	
2007	76			unshrouded	shrouded	n/i		absent						no images	no images	Not installed	
2007	77	frozen		unshrouded	shrouded	n/i		absent						no images	no images	Not installed	
2007	78			unshrouded	shrouded	n/i		absent						no images	no images	Not installed	
2007	79	frozen		unshrouded	shrouded	n/i								no images	no images	Not installed	
2007	80																
2007	81			shrouded	unshrouded	n/i								no images	no images	Not installed	
2007	82			shrouded	unshrouded	n/i								no images	no images	Not installed	
2007	83 to 88			shrouded	unshrouded	n/i	absent	absent						3 days of images	3 days of images	Not installed	
2007	89	frozen		shrouded	unshrouded	n/i	absent	absent						1 day of images	1 day of images	Not installed	
2007	90 to 94			shrouded	unshrouded	n/i	absent	absent						5 days of images	5 days of images	Not installed	
2007	95 to 97	frozen		shrouded	unshrouded	n/i	absent	absent						3 days of images	3 days of images	Not installed	
2007	98			shrouded	unshrouded	n/i	absent	absent						1 day of images	1 day of images	Not installed	
2007	99			shrouded	unshrouded	n/i	absent	absent						1 day of images	1 day of images	Not installed	
2007	100 to 107			shrouded	unshrouded	n/i								8 days of images	8 days of images	Not installed	
2007	108																
2007	109			unshrouded	shrouded	n/i								1 day of images	1 day of images	Not installed	

year	jday	psychrometer	vaisala	licor1 foreward	licor2 starboard	CLASP	sbwr	WAVEX	sonic	ship's met	navigation	CO2	tsg	Fore camera	Port camera	Gimbled camera	Other sensors
2007	110	frozen		unshrouded	shrouded	n/i								1 day of images	1 day of images	Not installed	
2007	111			unshrouded	shrouded	n/i								1 day of images	1 day of images	Not installed	
2007	112 to 123		no data	unshrouded	shrouded	n/i								9 days of images	11 days of images	Not installed	
2007	124 to 128		no data	unshrouded	shrouded	n/i				wind speed				no images	4 days of images	Not installed	TG1,2
2007	129 to 131	no data	no data	unshrouded	shrouded	n/i			no data	wind speed				no images	no images	Not installed	
2007	132 to 134		no data	unshrouded	shrouded	n/i								no images	3 days	Not installed	
2007	135		no data	unshrouded	shrouded	n/i				wind speed				no images	1 day of images	Not installed	TG1,2
2007	136																
2007	137 to 151		no data	shrouded	unshrouded	n/i								no image	15 days of images	Not installed	
2007	152 to 157		no data	shrouded	unshrouded	n/i								no image	6 days of images	Not installed	sky tasco
2007	158 to 161		no data	shrouded	unshrouded	n/i	absent	absent						no image	4 days of images	Not installed	sky tasco
2007	162		no data	shrouded	unshrouded	n/i								no image		Not installed	sky tasco
2007	163		no data	shrouded	unshrouded	n/i								no image		Not installed	sky tasco
2007	164																
2007	165 to 170			unshrouded	shrouded	n/i								6days of images	no images	Not installed	sky tasco
2007	171	no data	no data	unshrouded	shrouded	n/i			no data	wind speed			no data		no images	Not installed	sky tasco
2007	172	no data	no data	unshrouded	shrouded	n/i			no data	wind speed			no data		no images	Not installed	sky tasco

2007	173 to 187			unshrouded	shrouded	n/i								14 days of images	no images	Not installed	sky tasco
2007	188 to 190	no data	no data	unshrouded	shrouded	n/i						no intemp	no data	3 days of images	no images	Not installed	no SW,LW,atmos. pressure, or Tasco
2007	191			unshrouded	shrouded	n/i									no image	Not installed	sky tasco
2007	192			shrouded	unshrouded										1 image		sky tasco
2007	193 to 195			shrouded	unshrouded	n/i								3 days of images	no image	Not installed Not installed	sky tasco
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLA SP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2007	196 to 197	no data	no data	shrouded	unshrouded	n/i								2 days of images	no image	Not installed	sky tasco
2007	198 to 201	dried out?		shrouded	unshrouded	n/i								4 days of images	no image	Not installed	sky tasco
2007	202 to 203			shrouded	unshrouded	n/i								2 days of images	no image	Not installed	sky tasco
2007	204 to 216	dried out?		shrouded	unshrouded	n/i								11 days of images	no image	Not installed	sky tasco
2007	217	no data	no data	shrouded	unshrouded	n/i						no intemp	no data	1 day of images	no image	Not installed	SW,LW,atmos. pressure, or Tasco
2007	218	dried out?		shrouded	unshrouded	n/i	date 1980					no intemp	no data	1 day of images	no image	Not installed	SW,LW,atmos. pressure, or Tasco
2007	219			shrouded	unshrouded	n/i	date 1980							1 day of images	no image	Not installed	sky tasco
2007	220																
2007	221 to 227	dried out?		unshrouded	shrouded	n/i	date 1980							7 days	no images	Not installed	sky tasco
2007	228	raw data only	raw data only	1/2 days data	1/2 days data	n/i	date 1980		water ingress into fm					1 day	no images	Not installed	sky tasco

									junction box							
2007	229	raw data only	raw data only	unshrouded	shrouded	n/i	date 1980		water ingress into fm junction box					1 day	No images	Not installed	sky tasco
2007	230	raw data only	raw data only	missing 7 hours	missing 7 hours	n/i	date 1980		water ingress into fm junction box					1 day	No images	Not installed	sky tasco
2007	231 to 233	raw data only	raw data only	unshrouded	shrouded	n/i	date 1980		water ingress into fm junction box					3 days	no images	Not installed	sky tasco
2007	234	raw data only	raw data only	missing 6 hours	missing 6 hours	n/i	date 1980		water ingress into fm junction box					1 day	no images	Not installed	sky tasco
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLASP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2007	235 241	raw data only	raw data only	water ingress into fm junction box	water ingress into fm junction box	n/i	date 1980		water ingress into fm junction box					7 days	No imagess	Not installed	sky tasco
2007	242	raw data only	raw data only	water ingress into fm junction box	water ingress into fm junction box	n/i	date 1980		water ingress into fm junction box					1 day	No imagess	Not installed	sky tasco
2007	243 to 245	raw data only	raw data only	water ingress into fm junction box	water ingress into fm junction box	n/i			water ingress into fm junction box					3 days	no imagess	Not installed	sky tasco
2007	246 to 250								Sonic rotated 60 to 65 degrees starboard								MALOY
2007	251 to 253			shrouded	unshrouded	n/i			Sonic processing should be +240 no data					no images	no images	Not installed	sky and sea tasco. no intemp
2007	254			shrouded	unshrouded	n/i			Sonic processing should be +240					no images	no images	Not installed	sky and sea tasco. no intemp
2007	255 to 256			shrouded	unshrouded	n/i								no images	no images	Not installed	sky and sea tasco no intemp
2007	257 to 258			shrouded	unshrouded	n/i								no images	no images	Not installed	sky and sea tasco.

year	jday	psychrometer	vaisala	licor1 foreward	licor2 starboard	CLA SP	sbwr	WAVEX	sonic	ship's met	navigation	CO2	tsg	Fore camera	Port camera	Gimbled camera	Other sensors
2007	259 to 260			shrouded	unshrouded	n/i				wind data. atmos. pressure				no images	no images	Not installed	sky and sea tasco.no TG1,TG2
2007	261 to 275			shrouded	unshrouded	n/i								no images	no images	Not installed	sky and sea tasco
2007	276			shrouded	unshrouded									1 image	1 image		sky and sea tasco
2007	277 to 281			shrouded	unshrouded	n/i								no image	no image	Not installed	sky and sea tasco
2007	282 to 284	no dry bulb		shrouded	unshrouded	n/i								no image	no image	Not installed	sky and sea tasco
2007	285 to 303	no dry bulb		shrouded	unshrouded	n/i								no image	no image	Not installed	sky and sea tasco. using visala for air temperature and humidity
2007	304	no dry bulb	no data	unshrouded	shrouded				unplugged					In port	In port		sky and sea tasco.using visala for air temperature and humidity
2007	305 to 309	no dry bulb	no data	unshrouded	shrouded	n/i			unplugged					no images	no images	Not installed	sky and sea tasco. using visala for air temperature and humidity
2007	310 to 311	no dry bulb		unshrouded	shrouded	n/i								no1 images	no images	Not installed	sky and sea tasco. using visala for air temperature and humidity
2007	312	no dry bulb	no data	unshrouded	shrouded	n/i			no data	no data				no images	no images	Not installed	sky and sea

	to 313																tasco.using visala for air temperature and humidity
2007	314 to 331	no dry bulb		unshrouded	shrouded	n/i								no images	no images	Not installed	sky and sea tasco.using visala for air temperature and humidity
2007	332																
2007	333 to 334			shrouded	unshrouded	n/i								no image	no image	Not installed	sky and sea tasco. using visala for air temperature and humidity
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLASP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2007	335 to 337			shrouded	unshrouded	n/i			no raw					No images	No images	Not installed	sky and sea tasco. using visala for air temperature and humidity
2007	338			shrouded	unshrouded	n/i			sonic temp noisy					no image	no image	Not installed	sky and sea tasco. using visala for air temperature and humidity. SW
2007	339 to 341			no data	no data	n/i			sonic temp noisy					no image	no image	Not installed	sky and sea tasco. using visala for air temperature and humidity. SW
2007	342 to			shrouded	unshrouded	n/i			sonic temp noisy					No images	No images	Not installed	sky and sea tasco.

	357																using visala for air temperature and humidity. SW
2007	358 to 360			shrouded	unshrouded	n/i	no data		sonic temp noisy					No images	No images	Not installed	sky and sea tasco. using visala for air temperature and humidity. SW
2007	361																
2007	362 to 364		bad data	unshrouded	shrouded	n/i	no data		sonic temp noisy					1 image	1 image	Not installed	sky and sea tasco. using visala for air temperature and humidity. SW
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLA SP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2007	365		bad data	unshrouded	shrouded	n/i			sonic temp noisy					1 image	1 image	Not installed	sky and sea tasco. using visala for air temperature and humidity. SW

2008

2008	1 to 3		bad data	unshrouded	shrouded	n/i			sonic temp noisy					No images	No images	Not installed	sky and sea tasco. using visala for air temperature and humidity. SW
2008	4		bad data	unshrouded	shrouded	n/i			sonic temp					No images	No images	Not installed	sky and sea

	to 14								noisy								tasco.. SW
2008	15 to 17	frozen	bad data	unshrouded	shrouded	n/i			sonic temp noisy					No images	No images	Not installed	sky and sea tasco. SW
2008	18 to 23		bad data	unshrouded	shrouded	n/i			sonic temp noisy					No images	No images	Not installed	sky and sea tasco. SW
2008	24								Sonic changed. Serial number 227								Motion pack changed, serial number 682
2008	25 to 26		bad data	shrouded	unshrouded	n/i			sampling 5 Hz. sonic temp noisy					No data	1 day of images	Not installed	sky and sea tasco. SW
2008	27		bad data	shrouded	unshrouded	n/i			sampling 5 Hz. sonic temp noisy		no data		no data	No data	No data	Not installed	sky and sea tasco. SW. UNIX box hung
2008	28		bad data	shrouded	unshrouded	n/i			sampling 5 Hz. sonic temp noisy		no data		no data	1 day	No data	Not installed	sky and sea tasco. SW. UNIX box hung
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLA SP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2008	29 to 31		bad data	shrouded	unshrouded	n/i			sampling 5 Hz. sonic temp noisy					No data	1 day of images	Not installed	sky and sea tasco. SW
2008	32 to 34		bad data	shrouded	unshrouded	n/i			sonic temp noisy					1 day of images	1 day of images	Not installed	sky and sea tasco. SW
2008	35 to 43		bad data	shrouded	unshrouded	n/i			sonic temp noisy					2 days of images	4 days of images	Not installed	sky and sea tasco. SW
2008	44	frozen	bad data	lost	unshrouded	n/i			sonic temp noisy					No images	No images	Not installed	sky and sea tasco. SW
2008	45	frozen	bad data	lost	unshrouded	n/i			sonic temp noisy					No images	No images	Not installed	sky and sea tasco. SW
2008	46 to 51		bad data	lost	unshrouded	n/i			sonic temp noisy					2 days of images	2 days of images	Not installed	sky and sea tasco. SW
2008	52																
2008	53			unshrouded	unshrouded	n/i								no data	9 days of	Not installed	sky and sea

	to 78														images		tasco. LW
2008	79																
2008	80 to 106			shrouded	unshrouded	n/i								10 days of images	7 days of images	Not installed	sky and sea tasco. LW
2008	107																
2008	108 to 134			unshrouded	shrouded	n/i								10 days of images	11 days of images	Not installed	sky and sea tasco. LW
2008	135																
2008	136			shrouded	unshrouded	n/i								No data	No data	Not installed	sky and sea tasco. LW
2008	137			shrouded	unshrouded	n/i								1 day of images	1 day of images	Not installed	sky and sea tasco. LW
2008	138 to 151			no data	no data	n/i								7 days of images	6 days of images	Not installed	sky and sea tasco. LW
2008	152 to 162			shrouded	unshrouded	n/i								5 days of images	4 days of images	Not installed	sky and sea tasco. LW
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLA SP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2008	163																
2008	164 to 170			unshrouded	shrouded	n/i								7 days of images	7 days of images	Not installed	sky and sea tasco. LW
2008	171 to 190	Unix box down	Unix box down	Unix box down	Unix box down	n/i			Unix box down	Unix box down	Unix box down	Unix box down	Unix box down	18 days of images	17 days of images	Not installed	Unix box down
2008	191																
2008	192 to 218			shrouded	unshrouded	n/i								26 days of images	26 days of images	Not installed	sky and sea tasco. LW
2008	219																
2008	220 to 244			unshrouded	shrouded	n/i								25 days of images	18 days of images	Not installed	sky and sea tasco. LW
2008	245 to																MALOY

	249																
2008	250 to 273			unshrouded	shrouded	n/i							sst high	18 days of images	15 days of images	Not installed	LW suspect: circuit board wrong
2008	274 to 277																
2008	278 to 287			shrouded	unshrouded	n/i							sst high	7 days of images	5 days of images	Not installed	LW suspect: circuit board wrong
2008	288 to 293	no wet bulb		shrouded	unshrouded	n/i							sst high	5 days of images	5 days of images	Not installed	LW suspect: circuit board wrong
2008	294 to 299	no wet bulb		unshrouded	shrouded	n/i		system down					sst high	4 days of images	2days of images	Not installed	LW suspect: circuit board wrong
2008	300	no wet bulb		unshrouded	no data	n/i		system down					sst high	2 days of images	1 day of images	Not installed	LW suspect: circuit board wrong
2008	301 and 302	no wet bulb		unshrouded	no data	n/i		system down					sst high	1 day of images	1 day of images	Not installed	LW suspect: circuit board wrong. using Vaisala for air temperature and humidity
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLA SP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2008	303																
2008	304 to 332	no wet bulb		hrouded	no data	n/i		m4, m0 m2 set to1 dec place. m0 set instead of m1					sst high	16 days of images	9 days of images	Not installed	LW suspect: circuit board wrong. using Vaisala for air temperature and humidity
2008	333																
2008	334			unshrouded	shrouded	n/i							sst high	1day	removed	Not installed	
2008	335			unshrouded	shrouded	n/i							sst high	1day	removed	Not installed	
2008	336	frozen		unshrouded	shrouded	n/i							sst high	1 day	removed	Not installed	
2008	337 to			unshrouded	shrouded	n/i							sst high	27 days	removed	Not installed	

	363																	
2008	364																	
2008	365			unshrouded	shrouded	n/i							sst high	1day	removed	Not installed		

2009

year	jday	psychrometer	vaisala	licor1 foreward	licor2 starboard	CLASP	sbwr	WAVEX	sonic	ship's met	navigation	CO2	tsg	Fore camera	Port camera	Gimbled camera	other sensors
2009	1 to 7	frozen		unshrouded	shrouded	n/i							sst high	no images	removed	Not installed	
2009	8 to 12			unshrouded	shrouded	n/i							sst high	no images	removed	Not installed	
2009	13 to 15	frozen		unshrouded	shrouded	n/i							sst high	no images	removed	Not installed	
2009	16 to 26			unshrouded	shrouded	n/i							sst high	no images	removed	Not installed	
2009	27																
2009	28 to 33			unshrouded	shrouded	n/i								no images	removed	Not installed	
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLASP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**other sensors**
2009	34			unshrouded	shrouded	n/i		power supply failure						no images	removed	Not installed	
2009	35	frozen		unshrouded	shrouded	n/i		power supply failure						no images	removed	Not installed	
2009	36			unshrouded	shrouded	n/i		power supply failure						no images	removed	Not installed	
2009	37 to 41	frozen		unshrouded	shrouded	n/i		power supply failure						no images	removed	Not installed	
2009	42			unshrouded	shrouded	n/i		power supply failure						no images	removed	Not installed	
2009	43 to 45	frozen		unshrouded	shrouded	n/i		power supply failure						no images	removed	Not installed	

2009	46 to 54			unshrouded	shrouded	n/i		power supply failure						no images	removed	Not installed	
2009	55																
2009	56			unshrouded	unshrouded	n/i								no images	no images	Not installed	unix box fan fault
2009	57	frozen		unshrouded	unshrouded	n/i								no images	no images	Not installed	unix box fan fault
2009	58	frozen		unshrouded	unshrouded	n/i								no images	no images	Not installed	unix box fan fault
2009	59 to 68			unshrouded	unshrouded	n/i								no images	no images	Not installed	unix box fan fault
2009	69			unshrouded	unshrouded	n/i			no data					no images	no images	Not installed	unix box fan fault
2009	70			unshrouded	unshrouded	n/i			no data					no images	no images	Not installed	unix box fan fault
2009	71 to 82			unshrouded	unshrouded	n/i								no images	no images	Not installed	unix box fan fault
2009	83																
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLASP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2009	84 to 88			shrouded	unshrouded	n/i						hard disk fault		no images	no images	Not installed	
2009	89 to 91	no data	no data	shrouded	unshrouded	n/i						hard disk fault		no images	no images	Not installed	
2009	92 to 110			shrouded	unshrouded	n/i						hard disk fault		no images	no images	Not installed	
2009	111															installed	
2009	112			unshrouded	shrouded	n/i								no images	1 day of images	No images	
2009	113			unshrouded	shrouded	n/i								no images	1 day of images	No images	
2009	114 to 130			unshrouded	shrouded	n/i n/i			transducer failure					no images	no images	1day of images	

2009	131 to 138			unshrouded	shrouded	n/i			transducer failure					no images	no images	no images	unix disk failure
2009	139 to 140								Sonic changed. Serial number 391								
2009	141			unshrouded	unshrouded	n/i			R3 air temp high					no images	No images	no images	unix disk failure
2009	142 to 144			unshrouded	unshrouded	n/i			R3 air temp high					no images	No images	no images	
2009	145			unshrouded	unshrouded	n/i			R3 air temp high					no images	1 day of images	no images	unix disk failure
2009	146			unshrouded	unshrouded	n/i			R3 air temp high					no images	No images	no images	unix disk failure
2009	147			unshrouded	unshrouded	n/i			R3 air temp high					no images	1 day of images	no images	
2009	148 to 166			unshrouded	unshrouded	n/i			R3 air temp high					no images	No images	no images	unix disk failure
2009	167																
2009	168 to 184			unshrouded	unshrouded	n/i			R3 air temp high					No images	no images	no images	
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLASP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2009	185 to 188	reservoir dry		unshrouded	unshrouded	n/i			R3 air temp high					No images	no images	no images	
2009	189 to 192	reservoir dry		unshrouded	unshrouded	n/i			R3 air temp high					4 days of images	no images	no images	
2009	193 to 194			unshrouded	unshrouded	n/i			R3 air temp high					2days of images	no images	no images	
2009	195																
2009	196 to 197			unshrouded	unshrouded	n/i			R3 air temp high					2days of images	no images	no images	
2009	198 to	reservoir dry		unshrouded	unshrouded	n/i			R3 air temp high					4 days of images	2 days of images	no images	

	201																
2009	202 to 220			unshrouded	unshrouded	n/i			R3 air temp high					19 days of images	10 days of images	no images	
2009	221	reservoir dry		unshrouded	unshrouded	n/i			R3 air temp high					1 day of images	no image	1 day of images	
2009	222			unshrouded	unshrouded	n/i			R3 air temp high					1 day of images	1 day of images	No images	
2009	223																
2009	224 to 230	reservoir dry		unshrouded	unshrouded	n/i			R3 air temp high					7 days of images	4 days of images	no images	
2009	231 to 243	reservoir dry	suspect	unshrouded	unshrouded	n/i			R3 air temp high					11 days of images	6 days of images	no images	
2009	244	reservoir dry	suspect	unshrouded	shrouded	n/i			R3 air temp high					1 day of images	1day o images	no images	
2009	245		suspect	unshrouded	shrouded	n/i			R3 air temp high					I day of images	no images	no images	
2009	246 to 249			unshrouded	shrouded	n/i			R3 air temp high					4 days of images	3 days of images	no images	
2009	250 to 259																MALOY
2009	260			unshrouded	unshrouded	n/i			R3 air temp high				suspect	1 day of images	1 day of images	1 day of images	
year	**jday**	**psychrometer**	**vaisala**	**licor1 foreward**	**licor2 starboard**	**CLASP**	**sbwr**	**WAVEX**	**sonic**	**ship's met**	**navigation**	**CO2**	**tsg**	**Fore camera**	**Port camera**	**Gimbled camera**	**Other sensors**
2009	261 to 268			unshrouded	unshrouded	n/i			R3 air temp high				suspect	no images	8 days of images	1days of images	
2009	269 to 271			unshrouded	unshrouded	n/i			R3 air temp high					no images	3days of imges	no images	
2009	272																
2009	273 to 278			unshrouded	unshrouded	n/i			R3 air temp high					no images	6 days of images	no images	
2009	279																

2009	280 to 285			shrouded	unshrouded	n/i			R3 air temp high					no images	6 days of images	no images	
2009	286	reservoir dry		shrouded	unshrouded	n/i			R3 air temp high					no images	1 day of images	no images	
2009	287	reservoir dry		shrouded	unshrouded	n/i			R3 air temp high			broken pump	broken pump	no images	1 day of images	no images	
2009	288	reservoir dry		shrouded	unshrouded	n/i			R3 air temp high			broken pump	broken pump	no images	1 day of imaes	no images	
2009	289	reservoir dry		shrouded	unshrouded	n/i			R3 air temp high			broken pump	broken pump	no images	1 day of images	no images	
2009	290 to 306			shrouded	unshrouded	n/i			R3 air temp high			broken pump	broken pump	no images	17 days of images	no images	
2009	307																
2009	308 to 331			shrouded	unshrouded	n/i			R3 air temp high					no images	24 days of images	no images	
2009	332	reservoir dry		unshrouded	shrouded	n/i			R3 air temp high					no images	1 day of images	no images	
2009	333	reservoir dry		unshrouded	shrouded	n/i			R3 air temp high					no images	1 day of images	no images	
2009	334	**LAST PORT CALL. All systems removed jday 344.**															

MotionPak	R3 sonic	Deployment	R3 Alignment	Pitch (º)	Roll (º)	Yaw (º)
682	227	*RRS Discovery* to Sep' 07	-	-0.11 ±0.03	0.19 ±0.03	6.92 ±0.1
791	391	*Polarfront* Sep' 06 to Jan'08	Clockwise	0.24 ±0.02	-0.06 ±0.01	-62.12 ±0.41
			Anticlockwise	0.19 ±0.01	-0.09 ±0.01	-49.21 ±0.34
682	227	*Polarfront* from Jan 08 to May '09	Clockwise	+0.07 ±0.03	-0.35 ±0.08	-65.9 ±1.2
			Anticlockwise	-0.06 ±0.08	-0.23 ±0.06	-51.7 ±0.09
682	391	*Polarfront* May' 09 to Dec'09	Anticlockwise	-0.04 ±0.02	-0.08 ±0.02	52.4 ±0.50
BROOKS	BROOKS	*RRS Discovery* March-April 07	-	-1.25 ±0.04	-0.06 ±0.05	-6.7 ±0.2

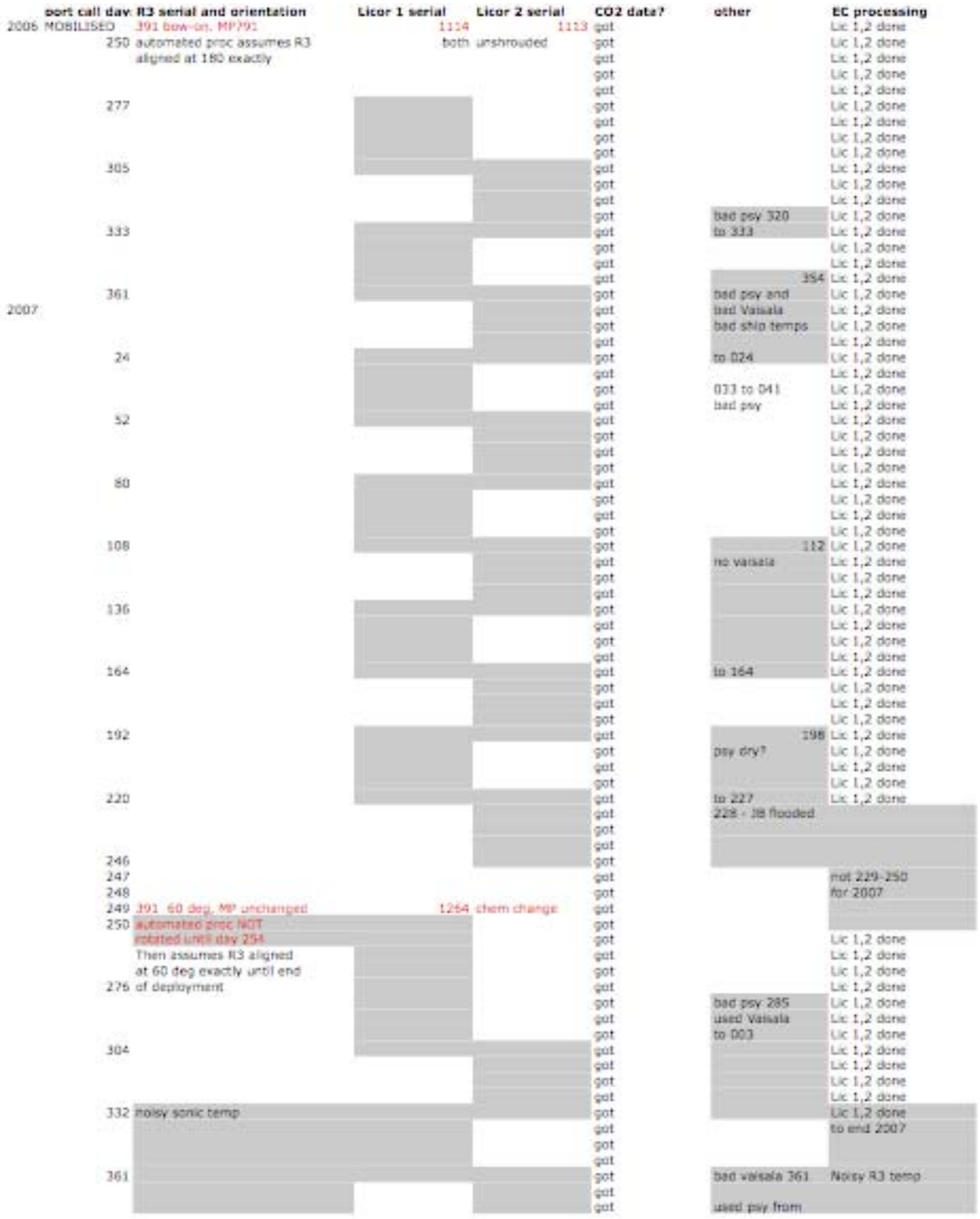
Table G. Anemometer and motion instrument offsets determined in the lab.

Data from Prytherch et al., (2010) using the method of Brooks (2008). R3 alignment refers to the instruments positioning against its mounting bolts when viewed from above. Pitch corresponds to the fore/aft direction and roll to the port/starboard direction. Uncertainties are plus or minus one standard deviation. The R3 and MP pairs were NOT joined together on *Polarfront* prior to January 2008, and so the lab offsets were not applied to those data - instead offsets were estimated from on-board parallax measurements.

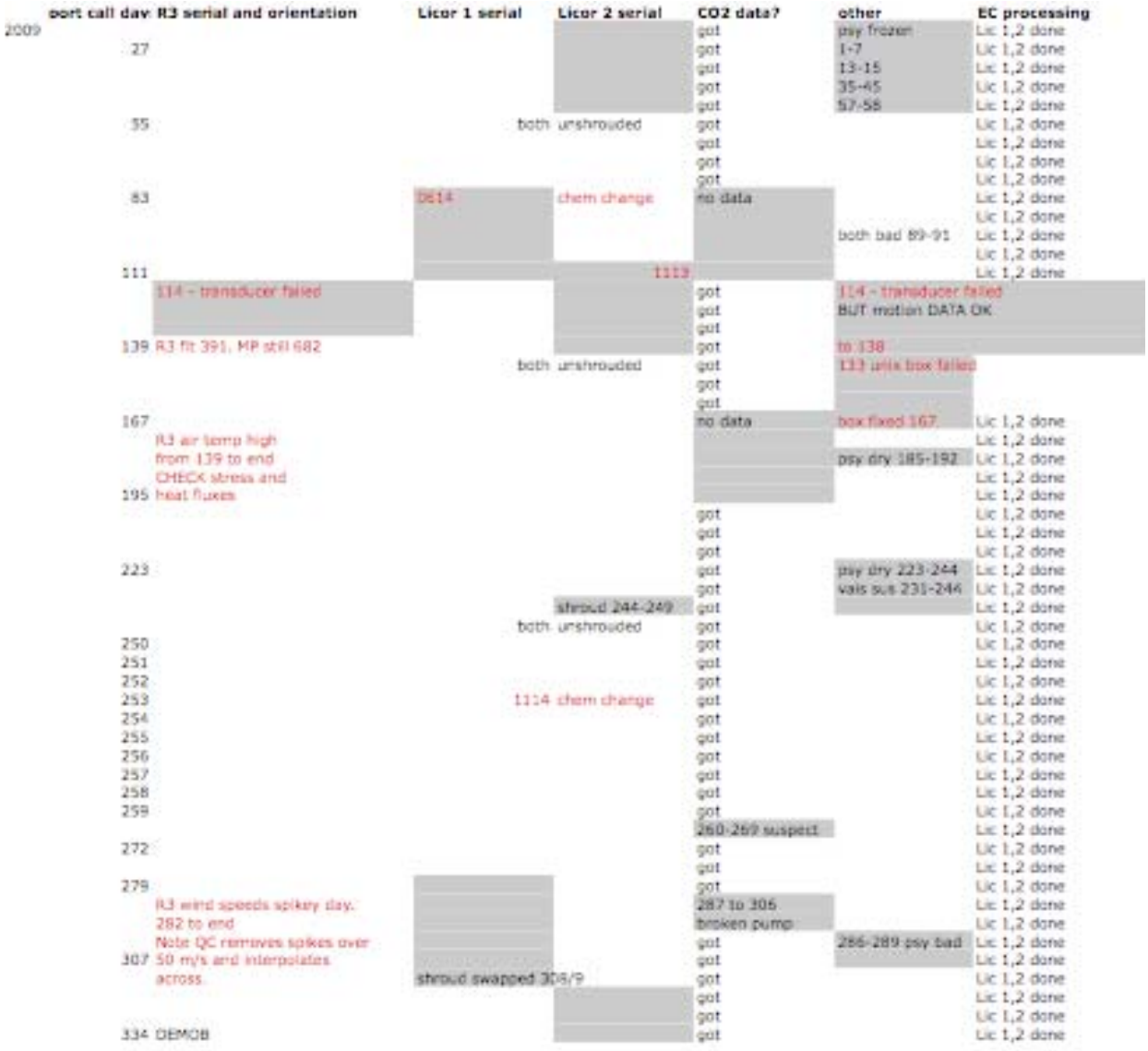
FROM date	FROM jday	actual R3 yaw (S/N)	actual MP yaw (S/N)	R3 yaw correction applied.	Rotated to ship frame?	R3-MP tilt to AFT	R3 - MP tilt to PORT	nominal R3 orientation (Z height)	actual height difference (R3 - MP)	EC - height difference used
7 Sept 2006	**250**	**0° (391)**	**1.5° to stbd (791)**	6.5° to stbd **(1.5° to stbd)**	NO	**0 ±1.0 NO TRIM**	**0.3±?? NO TRIM**	**fore/aft (15.45 m)**	**1.195 m**	1.29 m
16 Nov 2006	**320**	**2° to port (391)**	**1.5° to stbd (791)**	6.5° to stbd **(3.5° to stbd)**	NO	**0 ±1.0 NO TRIM**	**0.3±?? NO TRIM**	**fore/aft (15.45 m)**	**1.195 m**	1.29 m
6 Sept 2007	**614 (249, 2007)**	**2° to port (391)**	**1.5° to stbd (791)**	1.5° to stbd **(3.5° to stbd)**	NO	**0.2 ±0.6 NO TRIM**	**1.1±0.3 NO TRIM**	**60° to stbd (15.45 m)**	**1.195 m**	1.29 m
24 Jan 2008	**754 (24, 2008)**	**8° to port (227)**	**0.5° to stbd (682)**	no EC for 2008 yet	no EC for 2008 yet	**-0.2 ± 0.1 NO TRIM**	**0.2±0.2 NO TRIM**	**60° to stbd (15.51 m)**	**0.65 m**	no EC for 2008 yet
16 April 2008	**837 (107, 2008)**	**2° to port (227)**	**6.5° to stbd (682)**	5° to stbd for early 2009 **(8.5° to stbd)**	NO for early 2009	**-0.1±0.1**	**0.0±0.4**	**60° to stbd (15.22 m)**	**0.65 m**	
19 May 2009	**1235 (139, 2009)**	**4° to port (391)**	**3.7° to stbd (682)**	7.7° to stbd **(7.7° to stbd)**	YES Licor 1 NO Licor 2	**-0.2±0.2**	**0.0±0.3**	**60° to stbd (15.22 m)**	**0.65 m**	0.65 used for all 2009

Table H. R3 and MP orientations relative to the ship

Columns 3 and 4 show best estimate of R3 and MP yaw offsets relative to the ship (and serial number of sensor). Column 5 shows the yaw rotation used to bring the R3 data in the MP frame of reference: this is often wrong and the correct value is given in brackets. Column 6 shows whether the winds have been rotated again to bring them in to the ship frame of reference. Columns 7 and 8 show the possible R3 and MP tilt offsets relative to each other. The nominal orientation of the R3 is shown next, along with the height Z of the R3 above the water line. Note that Z is the actual height, i.e. no allowance for vertical displacement is made here (Moat and Yelland, 2009). The vertical distance separating the centre of the MotionPak and the centre of the R3 sensing volume is given second last. The horizontal separation of the two sensors was unchanged throughout, being zero port/stbd and MP 0.95 m aft of sonic. The final column gives the vertical separation used in the intial EC processing.


port call day
R3 serial and orientation
Licor 1 serial
Licor 2 serial
CO2 data?
other
EC processing
2006 MOBILISED
391 bow-on, MP791
1114
1113
got
Lic 1,2 done
250
automated proc assumes R3
aligned at 180 exactly
both unshrouded
277
305
333
bad psv 320
to 333
354
361
bad psv and
bad Vaisala
bad ship temps
2007
to 024
033 to 041
bad psv
24
52
80
108
112
no vaisala
136
164
to 164
192
198
psy dry?
220
to 227
228 - 38 flooded
246
247
248
not 229-250
for 2007
249
391 60 deg, MP unchanged
1264 chem change
250
automated proc NOT
rotated until day 254
Then assumes R3 aligned
at 60 deg exactly until end
276
of deployment
bad psv 285
used Vaisala
to 003
304
332
noisy sonic temp
to end 2007
361
bad vaisala 361
Noisy R3 temp
used psy from


port call day
R3 serial and orientation
Licor 1 serial
Licor 2 serial
CO2 data?
other
EC processing
2008
24
227 R3 up 6.5 cm, MP 682 up 61 cm
5 Hz - bad
032 - fixed
52
temp fixed
1264 lost
1114 install
both unshrouded
got
day 003
process but
check drag etc
bad Vaisala
to 052
temp fixed
both psy and
Vaisala bad 52
to 086
79
107
lowered MP+R3 20.5 cm
108 - SIU failed
no motion data
107
no motion data
days 107-249
so no EC fluxes
135
138-151
no data
138-151
no data
163
chem change
from 171
unix box dead
191
to 191
no motion data
days 107-249
so no EC fluxes
219
228
bad psy
245
246
SIU replaced
825 install
249
247
248
249
274
275
276
277
288
293/4
300 no data
bad psy
300
303
not licor2
333
fixed 333
333
333
364



2009	port call day	R3 serial and orientation	Licor 1 serial	Licor 2 serial	CO2 data?	other	EC processing
					got	psy frozen	Lic 1,2 done
	27				got	1-7	Lic 1,2 done
					got	13-15	Lic 1,2 done
					got	35-45	Lic 1,2 done
					got	57-58	Lic 1,2 done
	55			both unshrouded	got		Lic 1,2 done
					got		Lic 1,2 done
					got		Lic 1,2 done
					got		Lic 1,2 done
	83		0614	chem change	no data		Lic 1,2 done
							Lic 1,2 done
						both bad 89-91	Lic 1,2 done
							Lic 1,2 done
	111			1113			Lic 1,2 done
		114 - transducer failed			got	114 - transducer failed	
					got	BUT motion DATA OK	
					got		
	139	R3 fit 391, MP still 682			got	to 138	
				both unshrouded	got	133 unix box failed	
					got		
					got		
	167				no data	box fixed 167	Lic 1,2 done
		R3 air temp high					Lic 1,2 done
		from 139 to end				psy dry 185-192	Lic 1,2 done
		CHECK stress and					Lic 1,2 done
	195	heat fluxes					Lic 1,2 done
					got		Lic 1,2 done
					got		Lic 1,2 done
					got		Lic 1,2 done
	223				got	psy dry 223-244	Lic 1,2 done
					got	vais sus 231-244	Lic 1,2 done
				shroud 244-249	got		Lic 1,2 done
				both unshrouded	got		Lic 1,2 done
	250				got		Lic 1,2 done
	251				got		Lic 1,2 done
	252				got		Lic 1,2 done
	253			1114 chem change	got		Lic 1,2 done
	254				got		Lic 1,2 done
	255				got		Lic 1,2 done
	256				got		Lic 1,2 done
	257				got		Lic 1,2 done
	258				got		Lic 1,2 done
	259				got		Lic 1,2 done
					260-269 suspect		Lic 1,2 done
	272				got		Lic 1,2 done
					got		Lic 1,2 done
	279				got		Lic 1,2 done
		R3 wind speeds spikey day.			287 to 306		Lic 1,2 done
		282 to end			broken pump		Lic 1,2 done
		Note QC removes spikes over			got	286-289 psy bad	Lic 1,2 done
	307	50 m/s and interpolates			got		Lic 1,2 done
		across	shroud swapped 306/9		got		Lic 1,2 done
					got		Lic 1,2 done
					got		Lic 1,2 done
	334	DEMOB			got		Lic 1,2 done

Table I The metadata relevant to the calculation of the EC fluxes

From left to right: year; jday in port; R3 serial number and nominal orientation; Licor1 and Licor 2 serial numbers and periods when shrouded (grey); whether processed delta pCO2 data are available at the time of writing; other relevant problems; EC flux processing completed at the time of writing.

Appendix A Motion pack 0791

MotionPak Factory Details: 10/7/2006

Accels	X axis	Yaxis	Z axis	Spec
Scale factor	1.276	1.279	1.309	1.300 ±10%
0g bias	0.86	-4.34	0.80	±12
RSS align	0.81	0.85	0.27	<1.00
Pen Align (°)	0.09	-0.80	-0.20	
Hin Align (°)	0.81	0.28	-0.18	

Rates	X axis	Yaxis	Z axis	Spec
S/F (mV/°/S)	49.898	49.995	50.112	50.000 ±1%
Bias	0.04	-0.18	0.03	±1.8
RSS align	0.36	0.55	0.14	<1.00
Align1 (°)	-0.32	0.54	0.02	
Align2 (°)	0.14	0.05	0.13	

Appendix B Motion pack 0682

MotionPak Factory Details: 8/8/2003

Accels	X axis	Yaxis	Z axis	Spec
Scale factor	1.270	1.296	1.299	1.300 ±10%
0g bias	3.66	4.05	3.35	±12
RSS align	0.03	0.03	0.03	<1.00
Pen Align (°)	0.01	0.01	-0.03	
Hin Align (°)	-0.03	0.03	0.01	

Rates	X axis	Yaxis	Z axis	Spec
S/F (mV/°/S)	49.823	50.190	50.113	50.000 ±1%
Bias	0.00	0.11	-0.14	±1.8
RSS align	0.52	0.12	0.22	<1.00
Align1 (°)	-0.50	0.05	-0.19	
Align2 (°)	0.12	0.11	0.11	

Appendix C Licor calibrations

75H-0614

	75H-0614		
	23-Jun-03	28-Jul-05	11-Jun-08
CO2			
A	1.46722E+02	1.48959E+02	1.617720E+02
B	9.17028E+03	6.81639E+03	-3.318770E+04
C	4.28852E+07	4.58741E+07	8.473450E+07
D	-1.32324E+10	-1.40085E+10	-2.883290E+10
E	1.79769E+12	1.87077E+12	3.806110E+12
XS	1.50000E-03	1.20000E-03	1.800000E-03
Z	6.00000E-04	4.00000E-04	4.000000E-04
H2O			
A	4.66765E+03	4.65536E+03	4.896680E+03
B	4.15604E+06	4.26315E+06	3.984990E+06
C	-1.39683E+08	-2.20559E+08	-1.314120E+08
XS	-5.00000E-04	-1.00000E-03	-8.000000E-04
Z	1.67000E-02	1.27000E-02	9.300000E-03
Pressure			
A0			1.058800E+01
A1			2.603600E+01
Zero/Span			
CO2 zero	9.24600E-01	9.25100E-01	9.251000E-01
CO2 span	1.00160E+00	1.00110E+00	9.982000E-01
H2O zero	7.19500E-01	7.27600E-01	7.323000E-01
H2O Span	9.91300E-01	9.95000E-01	9.978000E-01

CO2 abs/kPa	mmol/m3/kPa	mmol/m3/kPa	Diff	%
8.38E-04	0.150373	0.149376	**0.000996**	**0.67**
H2O				
6.27E-04	4.540513	4.604442	**-0.063929**	**-1.39**

	75H-0825		
	25-Jan-05	5-Jun-08	15-Jun-09
CO2			
A	1.30869E+02	1.46146E+02	1.397630E+02
B	1.44519E+04	-2.16892E+04	-3.741580E+03
C	2.60842E+07	5.88330E+07	4.463380E+07
D	-6.73129E+09	-1.79119E+10	-1.343830E+10
E	8.43984E+11	2.16918E+12	1.688310E+12
XS	1.60000E-03	1.30000E-03	3.000000E-03
Z	2.80000E-03	2.60000E-03	2.900000E-03
H2O			
A	4.50452E+03	4.51498E+03	4.669280E+03
B	3.32272E+06	3.74952E+06	3.704450E+06
C	9.89638E+07	-1.29123E+08	-7.034610E+07
XS	-4.00000E-04	-1.10000E-03	-4.000000E-04
Z	2.40000E-02	1.42000E-02	1.730000E-02
Pressure			
A0		1.04790E+01	1.060600E+01
A1		2.60360E+01	2.603600E+01
Zero/Span			
CO2 zero	9.83700E-01	9.83600E-01	9.819000E-01
CO2 span	1.00000E+00	1.00000E+00	9.983000E-01
H2O zero	7.27300E-01	7.47900E-01	7.456000E-01
H2O Span	9.87500E-01	9.91800E-01	9.934000E-01

CO2 abs/kPa	mmol/m3/kPa	mmol/m3/kPa	Diff	%
8.38E-04	0.133836	0.134741	**-0.000905**	**-0.67**
H2O				
6.27E-04	4.273110	4.366626	**-0.093516**	**-2.14**

	75H-1113	
	31-Jul-06	6-Apr-09
CO2		
A	1.48438E+02	1.50466E+02
B	-5.26643E+03	-6.67083E+03
C	5.30750E+07	5.67693E+07
D	-1.66528E+10	-1.84491E+10
E	2.14891E+12	2.45252E+12
XS	1.70000E-03	2.40000E-03
Z	-2.00000E-04	0.00000E+00
H2O		
A	5.07357E+03	5.26040E+03
B	3.80152E+06	3.66483E+06
C	-1.15045E+08	-6.51934E+07
XS	-1.80000E-03	-1.20000E-03
Z	2.11000E-02	1.70000E-02
Pressure		
A0	1.05560E+01	1.04310E+01
A1	2.60360E+01	2.60360E+01
Zero/Span		
CO2 zero	9.08000E-01	9.07900E-01
CO2 span	1.00000E+00	1.00470E+00
H2O zero	9.16000E-01	9.28500E-01
H2O Span	9.96000E-01	1.00410E+00

CO2 abs/kPa	mmol/m3/kPa	mmol/m3/kPa	Diff	%
8.38E-04	0.144505	0.146630	**-0.002125**	**-1.45**
H2O				
6.27E-04	4.647258	4.722952	**-0.075694**	**-1.60**

	75H-1114	
	31-Jul-06	9-Jun-09
CO2		
A	1.55021E+02	1.57928E+02
B	-5.35142E+03	-1.08867E+04
C	5.93488E+07	6.71827E+07
D	-1.93517E+10	-2.29411E+10
E	2.58283E+12	3.14962E+12
XS	1.90000E-03	4.00000E-03
Z	-1.50000E-03	-9.00000E-04
H2O		
A	5.07675E+03	5.29671E+03
B	4.00700E+06	3.68981E+06
C	-1.68006E+08	-3.93517E+07
XS	-1.80000E-03	-1.20000E-03
Z	2.13000E-02	1.73000E-02
Pressure		
A0	1.05560E+01	1.06070E+01
A1	2.60360E+01	2.60360E+01
Zero/Span		
CO2 zero	8.82200E-01	8.80600E-01
CO2 span	1.00100E+00	1.00000E+00
H2O zero	9.40600E-01	9.51400E-01
H2O Span	9.95300E-01	1.00130E+00

CO2 abs/kPa	mmol/m3/kPa	mmol/m3/kPa	Diff	%
8.38E-04	0.152495	0.154117	**-0.001622**	**-1.05**
H2O				
6.27E-04	4.716978	4.761909	**-0.044931**	**-0.94**

75H-1264
26-Apr-07

CO2	
A	1.56393E+02
B	1.92950E+03
C	5.35917E+07
D	-1.66151E+10
E	2.17756E+12
XS	1.50000E-03
Z	-1.00000E-04

H2O	
A	5.39384E+03
B	4.16943E+06
C	-1.04626E+08
XS	-2.00000E-03
Z	1.54000E-02

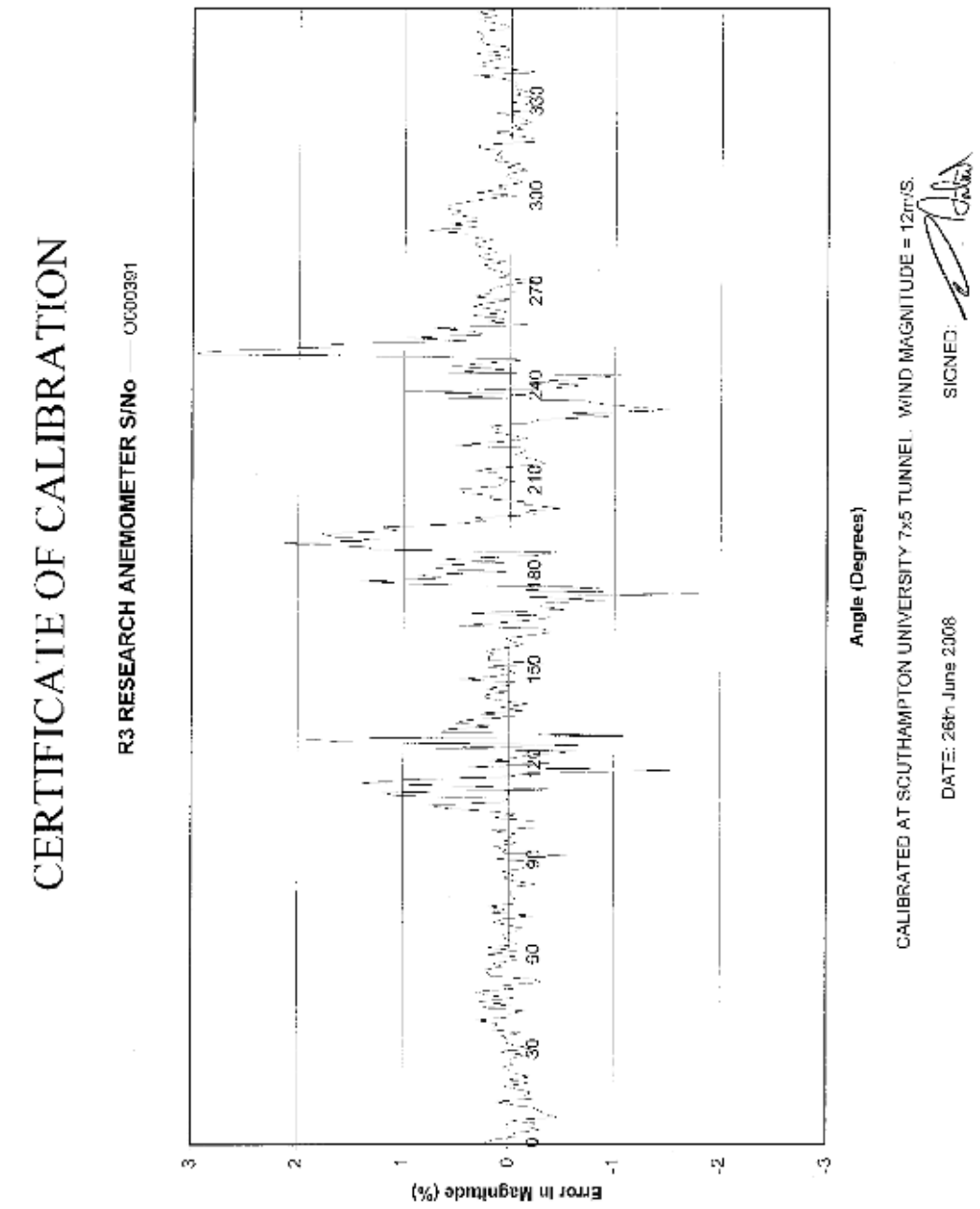
Pressure	
A0	1.05040E+01
A1	1.60360E+01

Zero/Span	
CO2 zero	8.99700E-01
CO2 span	1.00000E+00
H2O zero	8.78400E-01
H2O Span	9.92000E-01

CO2				
abs/kPa	mmol/m3/kPa	mmol/m3/kPa	Diff	%
8.38E-04	0.156549	0.000000	**0.156549**	**#DIV/0!**
H2O				
6.27E-04	4.995272	0.000000	**4.995272**	**#DIV/0!**

APPENDIX D Sonic anemometer calibrations

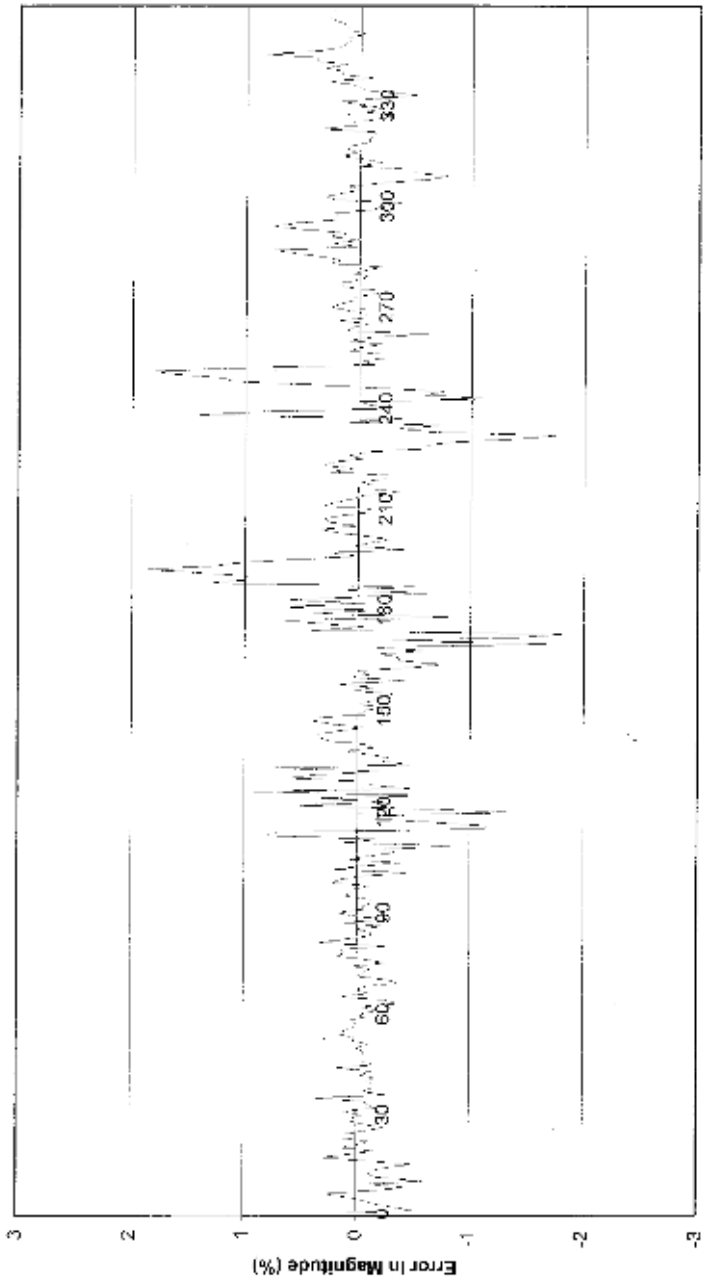
Sonic 0391



Sonic 0277

CERTIFICATE OF CALIBRATION

R3 RESEARCH ANEMOMETER S/No ---: 000227



CALIBRATED AT SOUTHAMPTON UNIVERSITY 7x5 TUNNEL. WIND MAGNITUDE = 12m/S.

DATE: 22nd July 2008

SIGNED:

APPENDIX E. SBWR calibrations

Accelerometers

OCEAN ENGINERING DIVISION
NATIONAL OCEANOGRAPHY CENTRE
SOUTHAMPTON

SHIPBORNE WAVE RECORDER
ACCELEROMETER
CALIBRATION SHEET

SYSTEM S/N: SBWR POLARFRONT

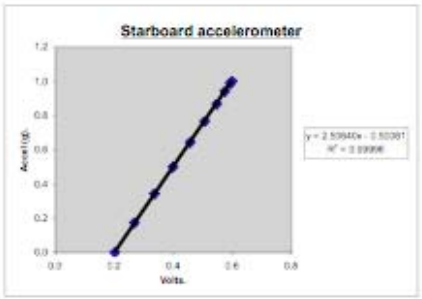
CALIBRATION DATE: 5th SEPT 2006.

STBD ACCELEROMETER S/N: 10303

PORT ACCELEROMETER S/N: 6005

STBD ACCELEROMETER DATA

O/P(Volts)	Ref.Accel.(g)	Calc.Accel.(g)	Error.(g)
0.599	1.0000	1.0007	0.0007
0.592	0.9848	0.9832	-0.0016
0.574	0.9397	0.9381	-0.0016
0.546	0.8660	0.8679	0.0019
0.506	0.7660	0.7676	0.0016
0.457	0.6428	0.6448	0.0020
0.399	0.5000	0.4994	-0.0006
0.335	0.3420	0.3390	-0.0030
0.268	0.1736	0.1711	-0.0025
0.201	0.0000	0.0032	0.0032



Maximum permitted acceleration error = 0.01 g.

CALIBRATION COEFFICIENTS.

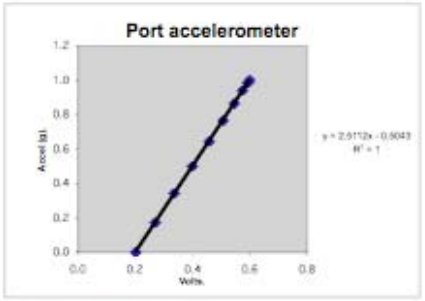
A	-0.50061
B	2.50640

SOFTWARE COEFFICIENTS.

Units	ms^{-2}/Volt
Value	24.58777

PORT ACCELEROMETER DATA

O/P(Volts)	Ref.Accel.(g)	Calc.Accel.(g)	Error.(g)
0.599	1.0000	0.9999	-0.0001
0.592	0.9848	0.9824	-0.0025
0.575	0.9397	0.9397	0.0000
0.546	0.8660	0.8668	0.0008
0.507	0.7660	0.7689	0.0029
0.458	0.6428	0.6459	0.0031
0.399	0.5000	0.4977	-0.0023
0.336	0.3420	0.3395	-0.0025
0.269	0.1736	0.1713	-0.0024
0.202	0.0000	0.0030	0.0030



Maximum permitted acceleration error = 0.01 g.

CALIBRATION COEFFICIENTS.

A	-0.50425
B	2.51116

SOFTWARE COEFFICIENTS.

Units	ms^{-2}/Volt
Value	24.63453

DIGITAL LEVEL (S/N) : PRO 360

SIGNED CALIBRATION ENGINEER: Robin Pascal
Thor Erik

APPROVED Q.A. MANAGER :

Pressure sensors

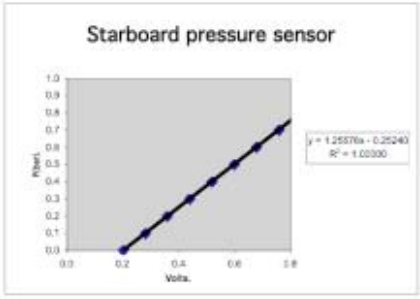
OCEAN ENGINERING DIVISION
NATIONAL OCEANOGRAPHY CENTRE
SOUTHAMPTON

SHIPBORNE WAVE RECORDER
PRESSURE SENSOR
CALIBRATION SHEET

SYSTEM S/N:	SBWR POLARFRONT	STBD SENSOR S/N:	854416
CALIBRATION DATE:	5th Sept 2006.	PORT SENSOR S/N:	854415

STBD SENSOR DATA

O/P(Volts)	Ref.Press.(bar)	Calc.Press.(bar)	Error.(bar)
0.201	0.0000	0.0002	0.0002
0.281	0.1000	0.1007	0.0007
0.360	0.2000	0.2000	0.0000
0.439	0.3000	0.2993	-0.0007
0.519	0.4000	0.3999	-0.0001
0.598	0.5000	0.4991	-0.0009
0.678	0.6000	0.5997	-0.0003
0.758	0.7000	0.7002	0.0002
0.838	0.8000	0.8008	0.0008
0.917	0.9000	0.9000	0.0000



Maximum permitted pressure error = 0.001 bar.

CALIBRATION COEFFICIENTS.

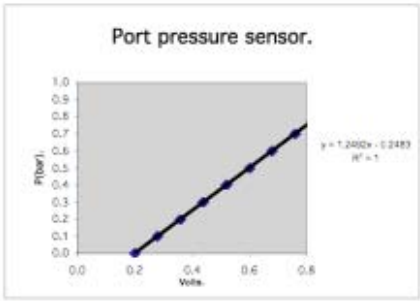
A	-0.25240
B	1.25676

SOFTWARE COEFFICIENTS.

Units	dbar(g)/volt
Value	12.56756

PORT SENSOR DATA

O/P(Volts)	Ref.Press.(bar)	Calc.Press.(bar)	Error.(bar)
0.199	0.0000	0.0003	0.0003
0.279	0.1000	0.1002	0.0002
0.358	0.2000	0.1989	-0.0011
0.438	0.3000	0.2988	-0.0012
0.520	0.4000	0.4013	0.0013
0.600	0.5000	0.5012	0.0012
0.678	0.6000	0.5987	-0.0013
0.760	0.7000	0.7011	0.0011
0.840	0.8000	0.8010	0.0010
0.918	0.9000	0.8985	-0.0015



Maximum permitted pressure error = 0.001 bar.

CALIBRATION COEFFICIENTS.

A	-0.24832
B	1.24922

SOFTWARE COEFFICIENTS.

Units	dbar(g)/volt
Value	12.49224

DRUCK PD601 CALIBRATOR (S/N) : 257/88-1

SIGNED CALIBRATION ENGINEER: Robin Pascal
Thon Eric

APPROVED Q.A. MANAGER :

Pressure raw data

sbbd press	252688	21/1/06 rawdata			
Druck1	druck2	av druck	o/p V1	o/p v2	av o/p v
0.001	0	0.0005	0.201	0.201	0.201
0.099	0.102	0.1005	0.278	0.28	0.279
0.2	0.202	0.201	0.357	0.357	0.357
0.298	0.302	0.3	0.434	0.436	0.435
0.4	0.4	0.4	0.512	0.512	0.512
0.5	0.5	0.5	0.589	0.59	0.5895
0.6	0.6	0.6	0.668	0.667	0.6675
0.7	0.7	0.7	0.745	0.744	0.7445
0.8	0.8	0.8	0.822	0.823	0.8225
0.9	0.901	0.9005	0.9	0.901	0.9005

Port press	s/n 16279	21/1/06 rawdata			
Druck1	druck2	av druck	o/p V1	o/p v2	av o/p v
0.001	0.001	0.001	0.209	0.209	0.209
0.1	0.103	0.1015	0.29	0.292	0.291
0.201	0.202	0.2015	0.372	0.373	0.3725
0.3	0.301	0.3005	0.452	0.451	0.4515
0.402	0.402	0.402	0.533	0.532	0.5325
0.5	0.501	0.5005	0.612	0.613	0.6125
0.6	0.602	0.601	0.692	0.695	0.6935
0.7	0.699	0.6995	0.773	0.772	0.7725
0.801	0.801	0.801	0.853	0.854	0.8535
0.899	0.899	0.899	0.932	0.934	0.933

APPENDIX F – Time series plots

Air temperatures

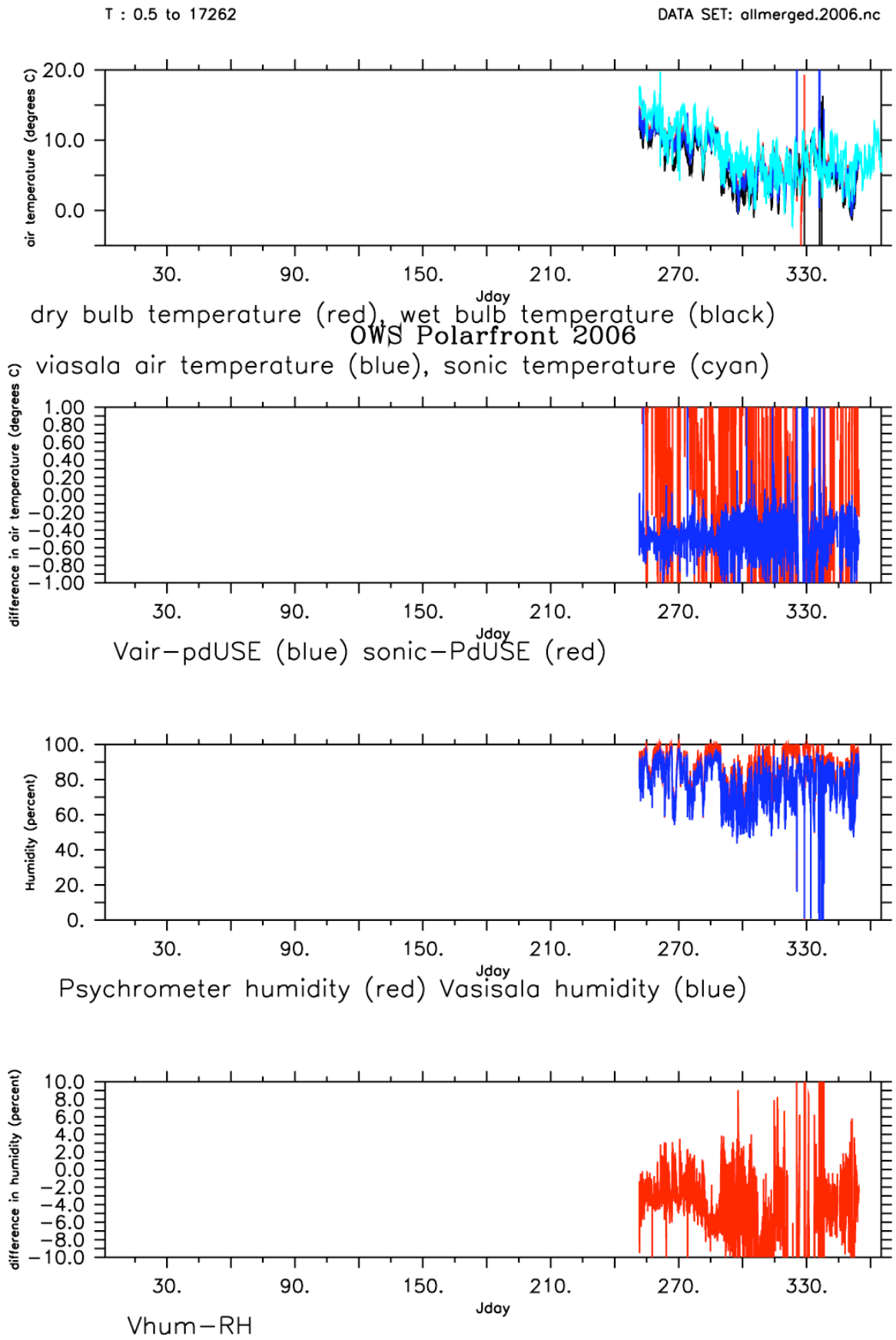
The figures show yearly time series of 10 minute spot values. Only basic quality control criteria have been applied to these data. Each page contains four plots showing different variables over each year.

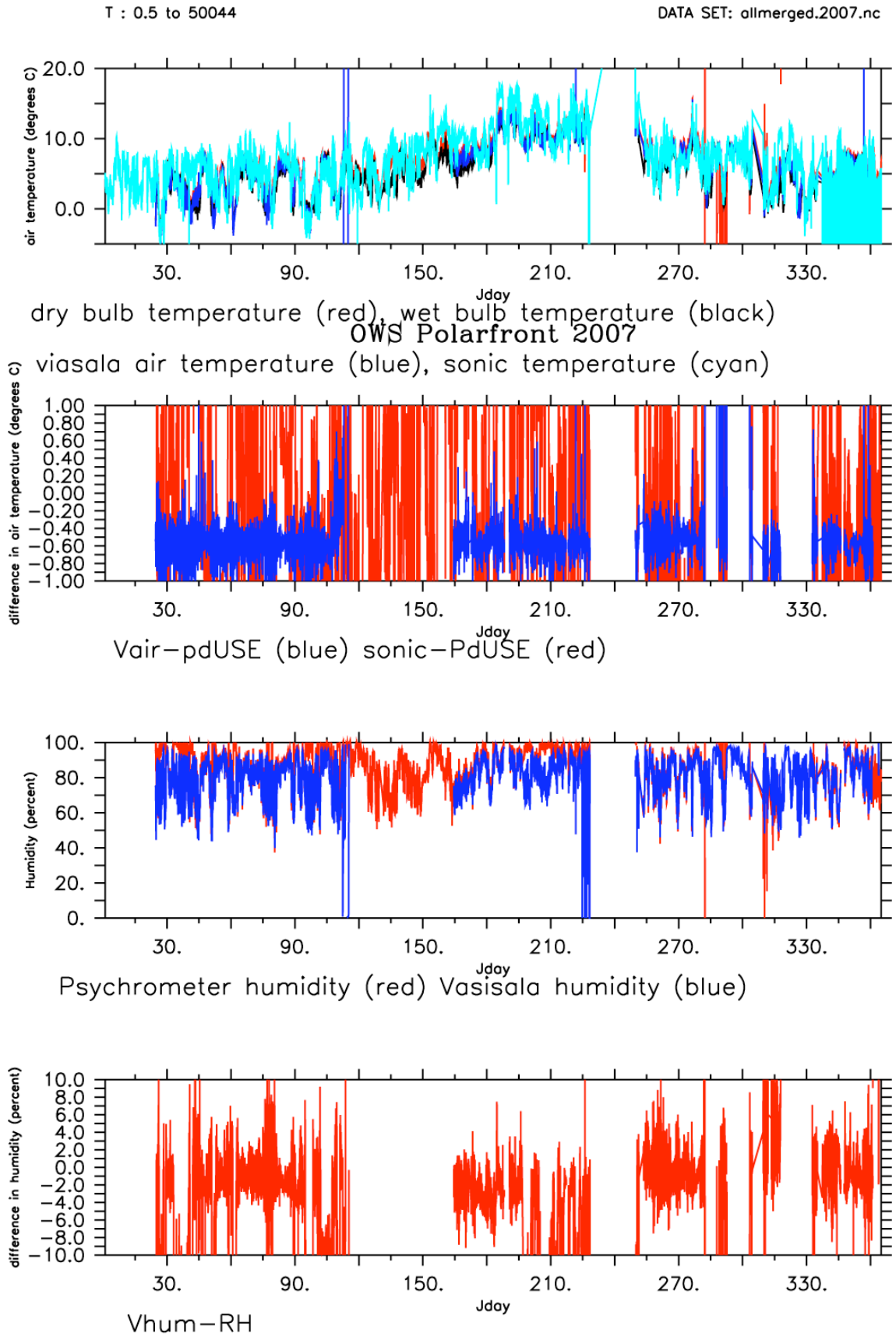
Top panel - the wet and dry air temperature from the psychrometer, the Vaisala sensor and the sonic.

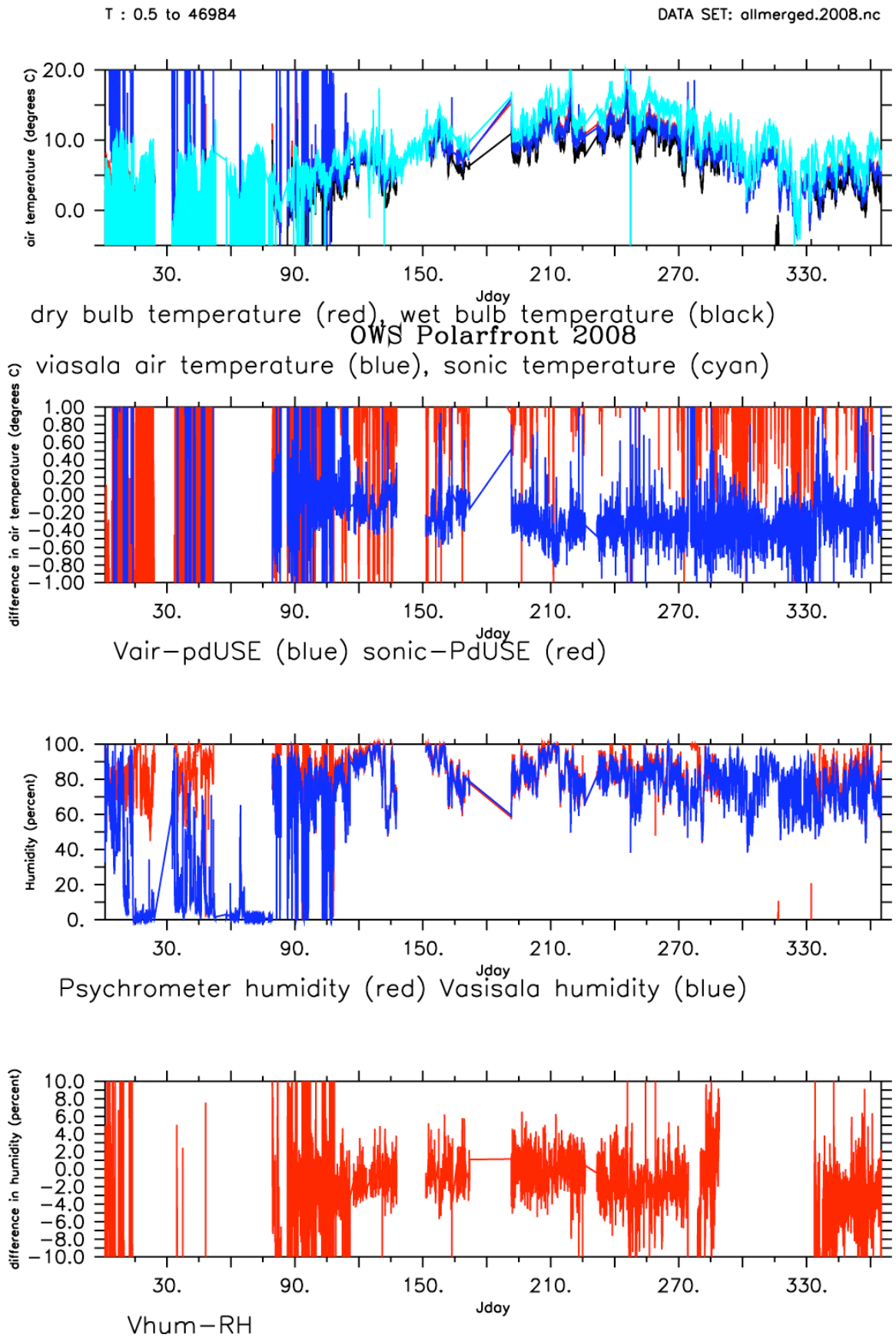
Upper middle panel – the difference in air temperature between the psychrometer dry bulb, and the Vaisala and sonic temperatures.

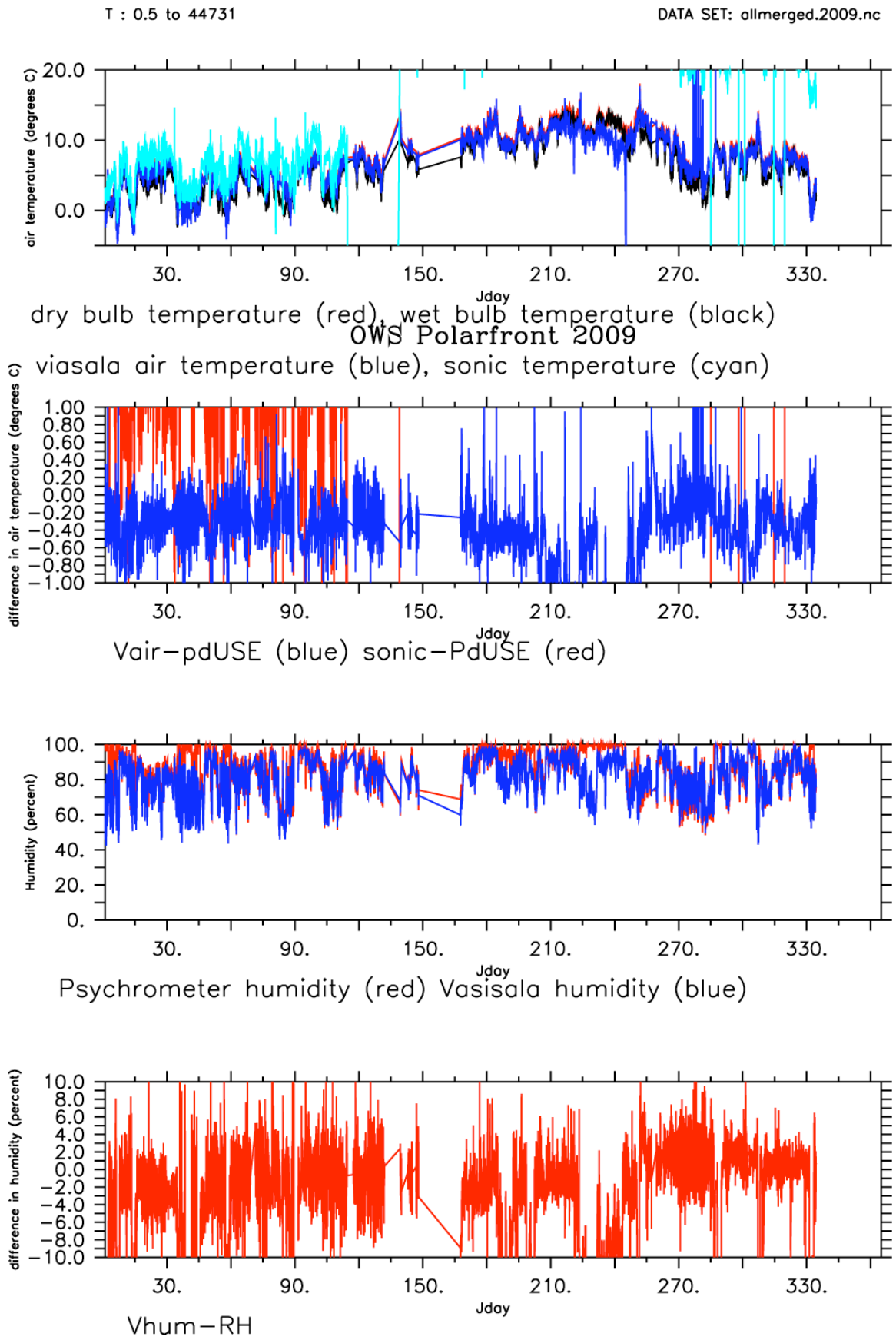
Lower middle panel – relative humidity from the Vaisala and calculated using the Psychrometer.

Bottom panel – difference in humidity between the Vaisala and psychrometer.


T : 0.5 to 17262
DATA SET: allmerged.2006.nc
air temperature (degrees C)
20.0
10.0
0.0
30.
90.
150.
210.
270.
330.
Jday
dry bulb temperature (red), wet bulb temperature (black)
OWS Polarfront 2006
viasala air temperature (blue), sonic temperature (cyan)
difference in air temperature (degrees C)
1.00
0.80
0.60
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
−1.00
Vair−pdUSE (blue) sonic−PdUSE (red)
Humidity (percent)
100.
80.
60.
40.
20.
0.
Psychrometer humidity (red) Vasisala humidity (blue)
difference in humidity (percent)
10.0
8.0
6.0
4.0
2.0
0.0
−2.0
−4.0
−6.0
−8.0
−10.0
Vhum−RH

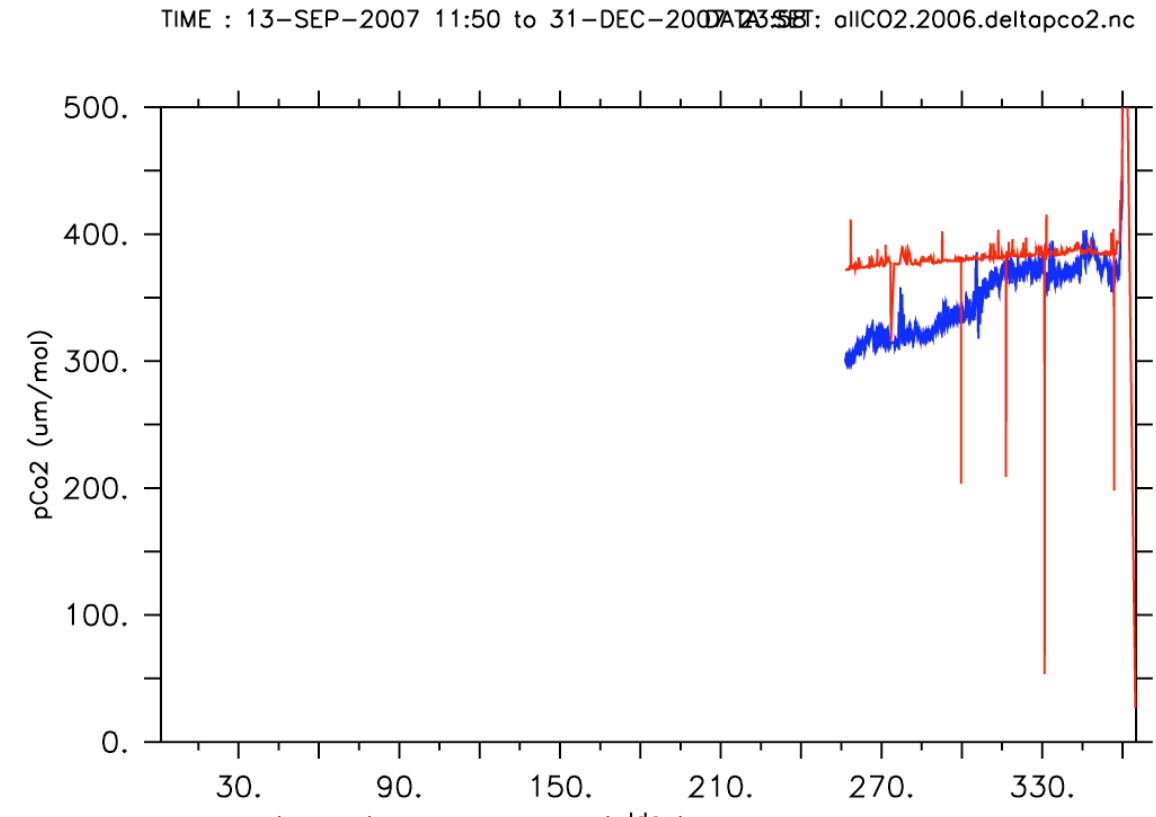

T : 0.5 to 50044
DATA SET: allmerged.2007.nc
air temperature (degrees C)
20.0
10.0
0.0
30.
90.
150.
210.
270.
330.
Jday
dry bulb temperature (red), wet bulb temperature (black)
OWS Polarfront 2007
viasala air temperature (blue), sonic temperature (cyan)
difference in air temperature (degrees C)
1.00
0.80
0.60
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
−1.00
Vair−pdUSE (blue) sonic−PdUSE (red)
Humidity (percent)
100.
80.
60.
40.
20.
0.
Psychrometer humidity (red) Vasisala humidity (blue)
difference in humidity (percent)
10.0
8.0
6.0
4.0
2.0
0.0
−2.0
−4.0
−6.0
−8.0
−10.0
Vhum−RH


T : 0.5 to 46984
DATA SET: allmerged.2008.nc
air temperature (degrees C)
20.0
10.0
0.0
30.
90.
150.
210.
270.
330.
Jday
dry bulb temperature (red), wet bulb temperature (black)
OWS Polarfront 2008
viasala air temperature (blue), sonic temperature (cyan)
difference in air temperature (degrees C)
1.00
0.80
0.60
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
−1.00
Vair−pdUSE (blue) sonic−PdUSE (red)
Humidity (percent)
100.
80.
60.
40.
20.
0.
Psychrometer humidity (red) Vasisala humidity (blue)
difference in humidity (percent)
10.0
8.0
6.0
4.0
2.0
0.0
−2.0
−4.0
−6.0
−8.0
−10.0
Vhum−RH

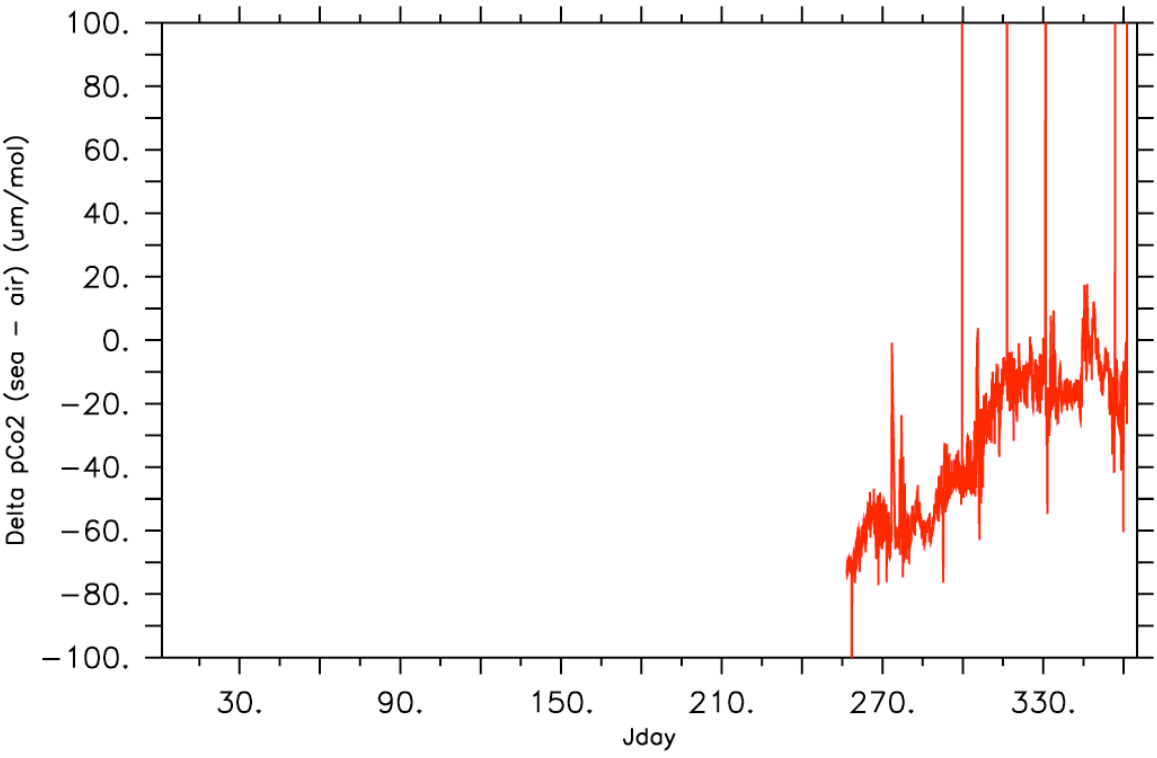

T : 0.5 to 44731
DATA SET: allmerged.2009.nc
air temperature (degrees C)
20.0
10.0
0.0
30.
90.
150.
210.
270.
330.
Jday
dry bulb temperature (red), wet bulb temperature (black)
OWS Polarfront 2009
viasala air temperature (blue), sonic temperature (cyan)
difference in air temperature (degrees C)
1.00
0.80
0.60
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
−1.00
Vair−pdUSE (blue) sonic−PdUSE (red)
Humidity (percent)
100.
80.
60.
40.
20.
0.
Psychrometer humidity (red) Vasisala humidity (blue)
difference in humidity (percent)
10.0
8.0
6.0
4.0
2.0
0.0
−2.0
−4.0
−6.0
−8.0
−10.0
Vhum−RH

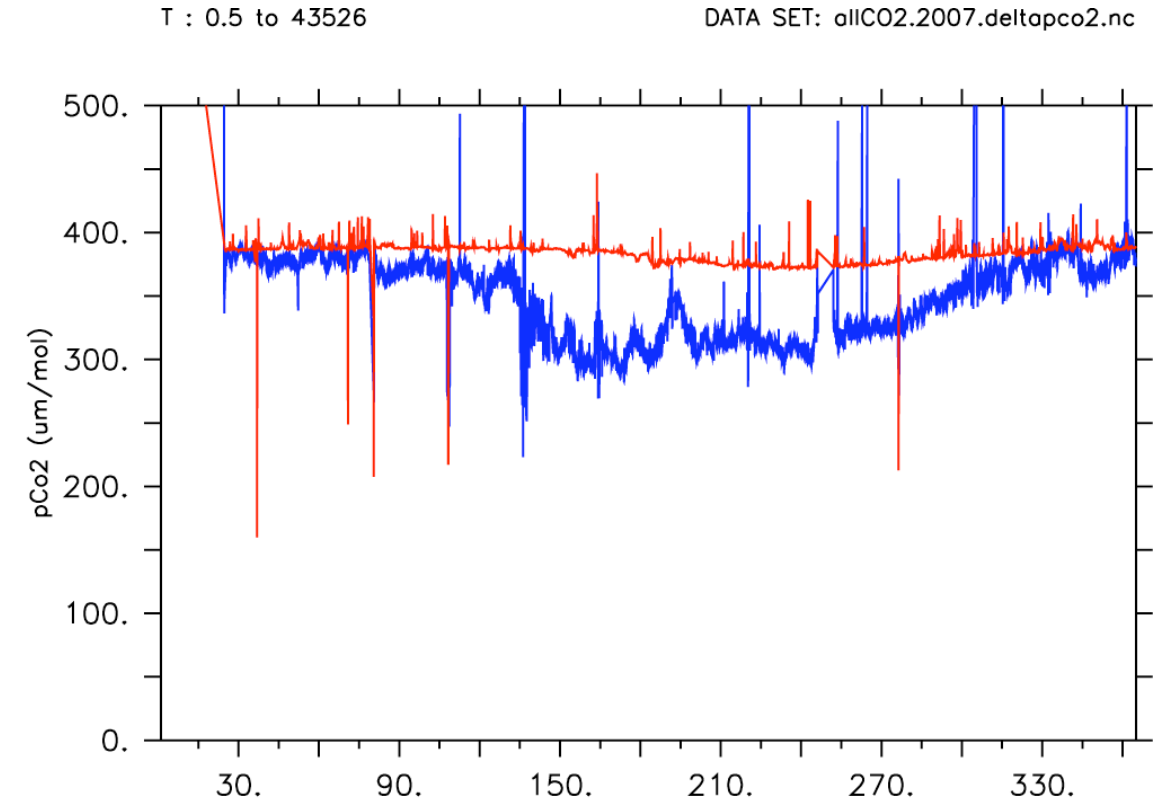
Delta pCO_2

The figures show yearly time series of 10 minute spot values. Only basic quality control criteria have been applied to these data. Each page contains two plots showing different variables over each year.
Top panel - the pCO_2 measured in the air and sea surface.
Bottom panel – difference in pCO_2 between the air and sea surface.

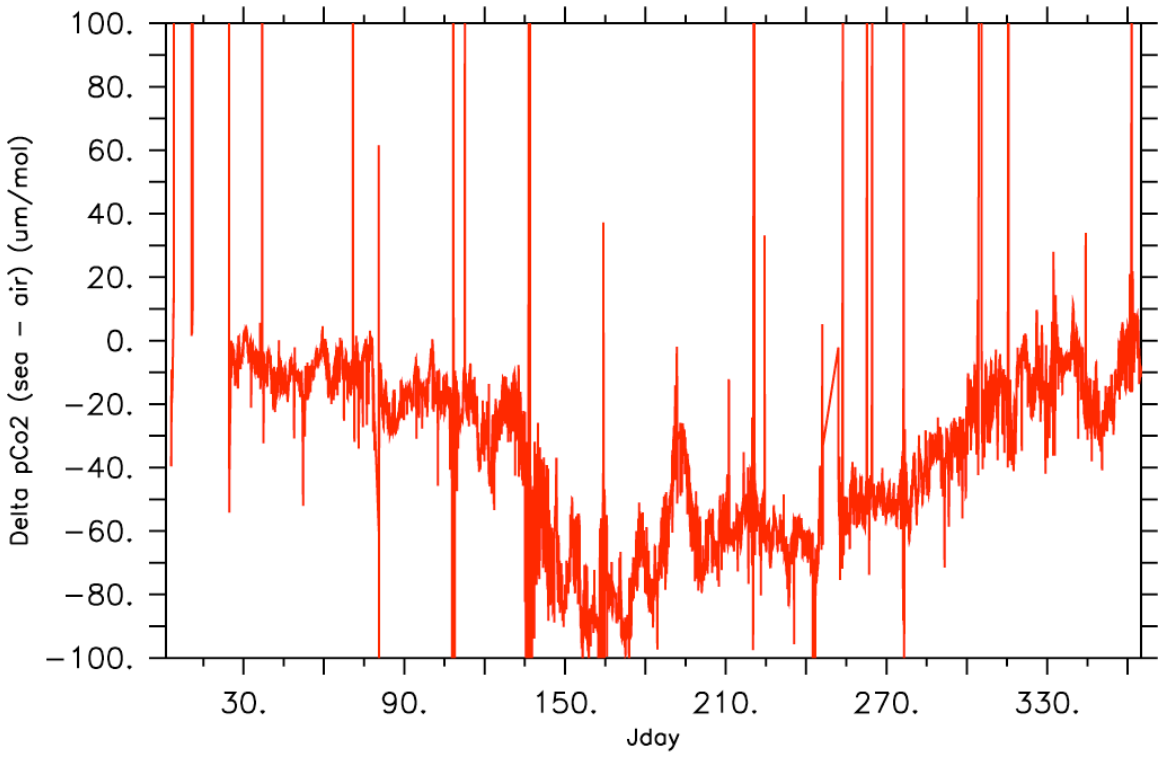


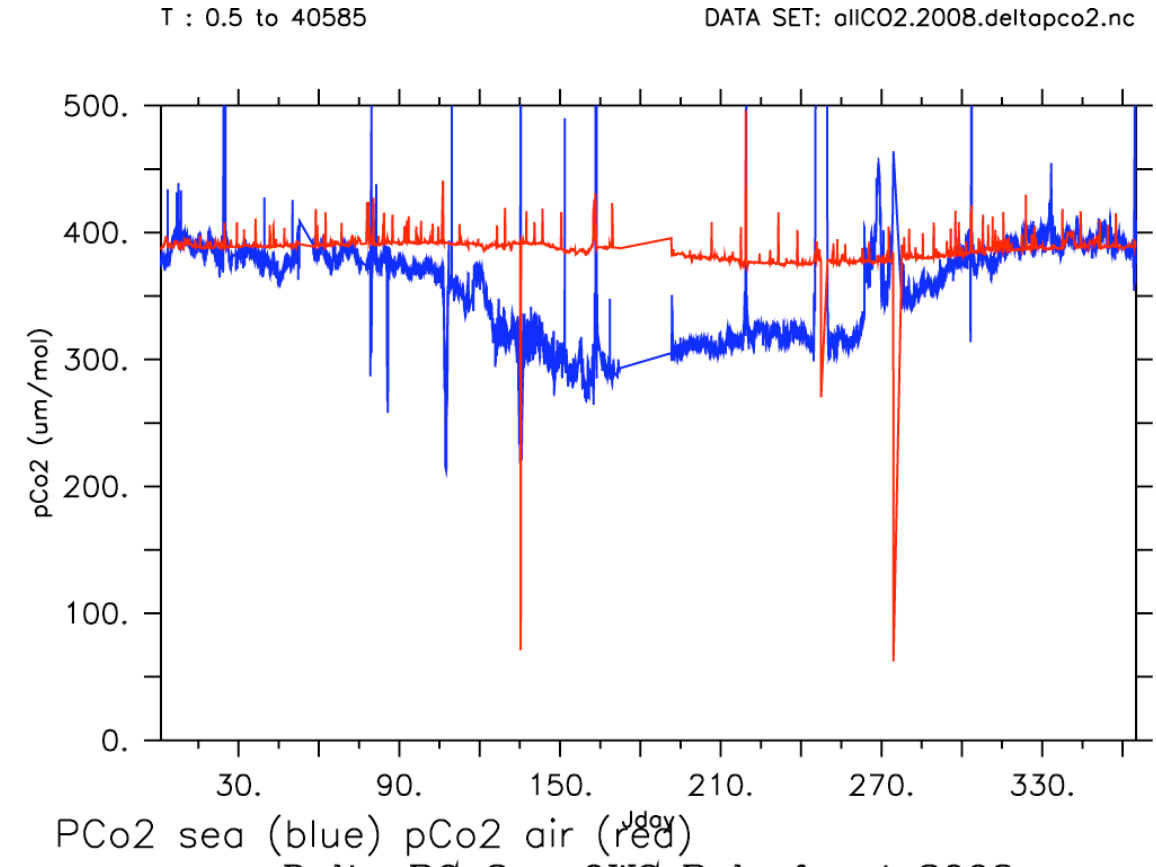
Delta PCo2 – OWS Polarfront 2006



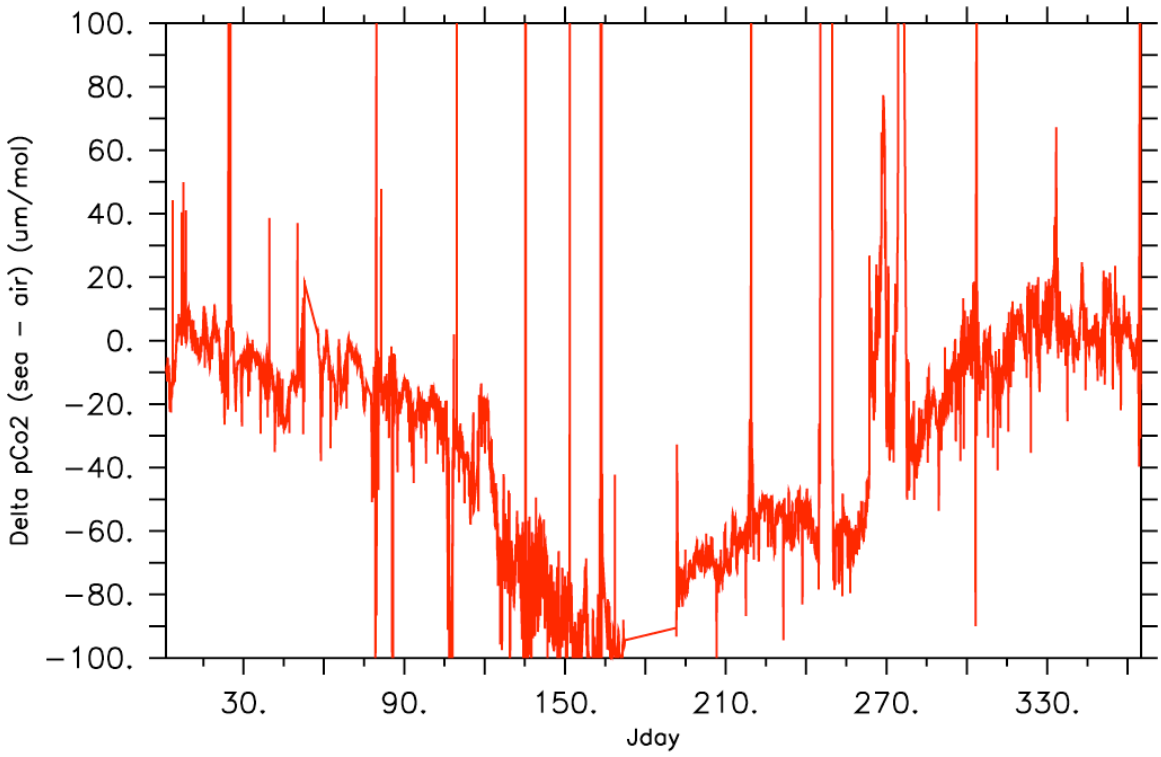


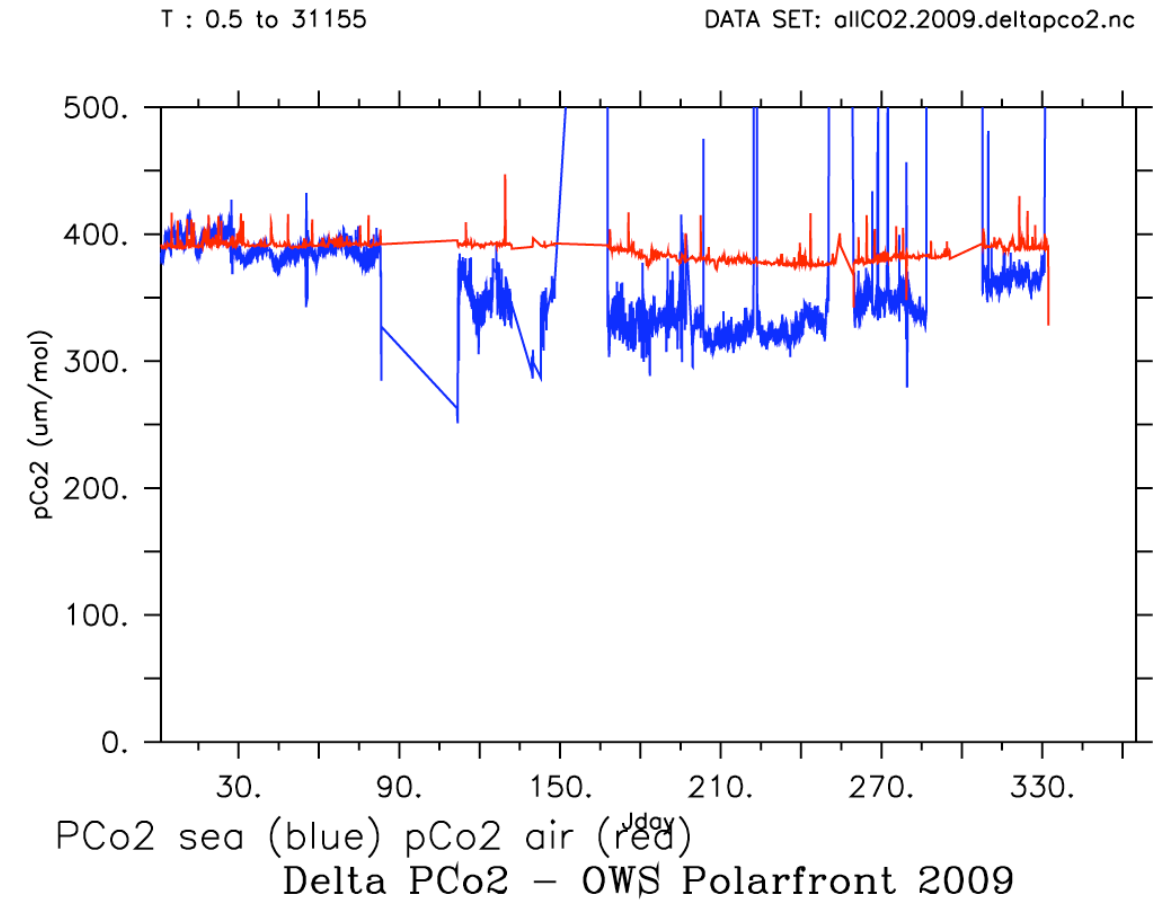
Delta PCo2 – OWS Polarfront 2007



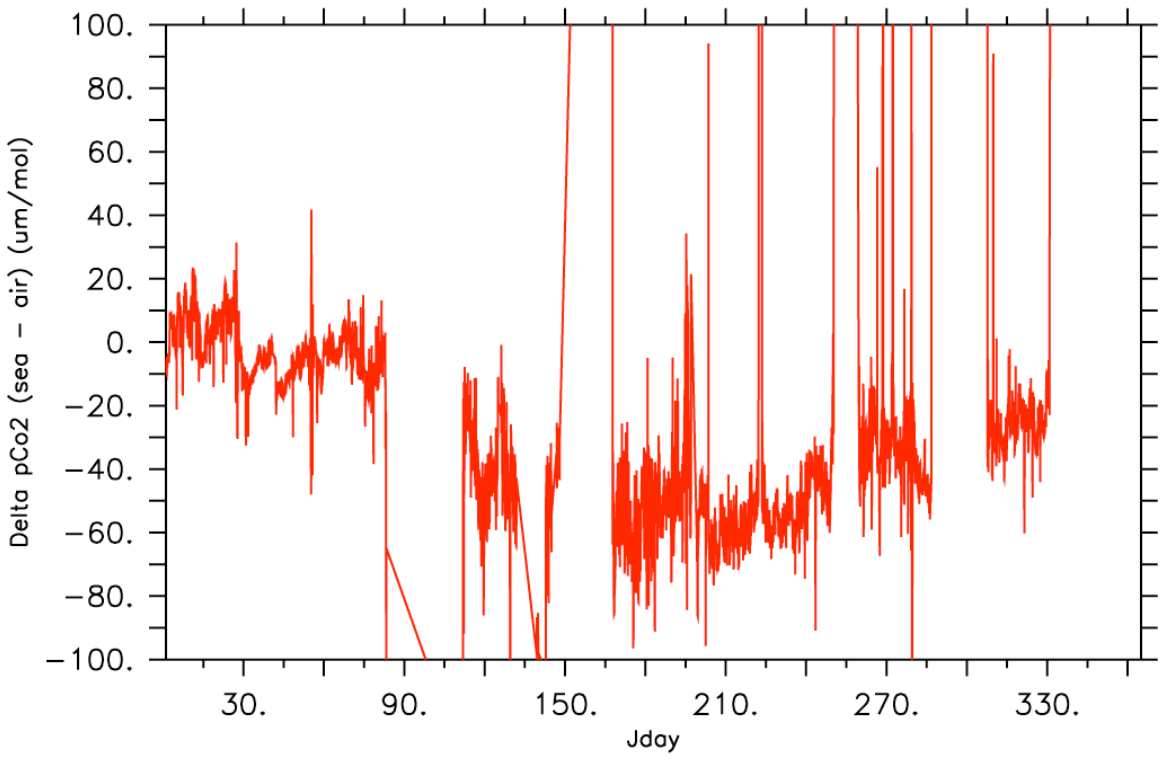


Delta PCo2 – OWS Polarfront 2008



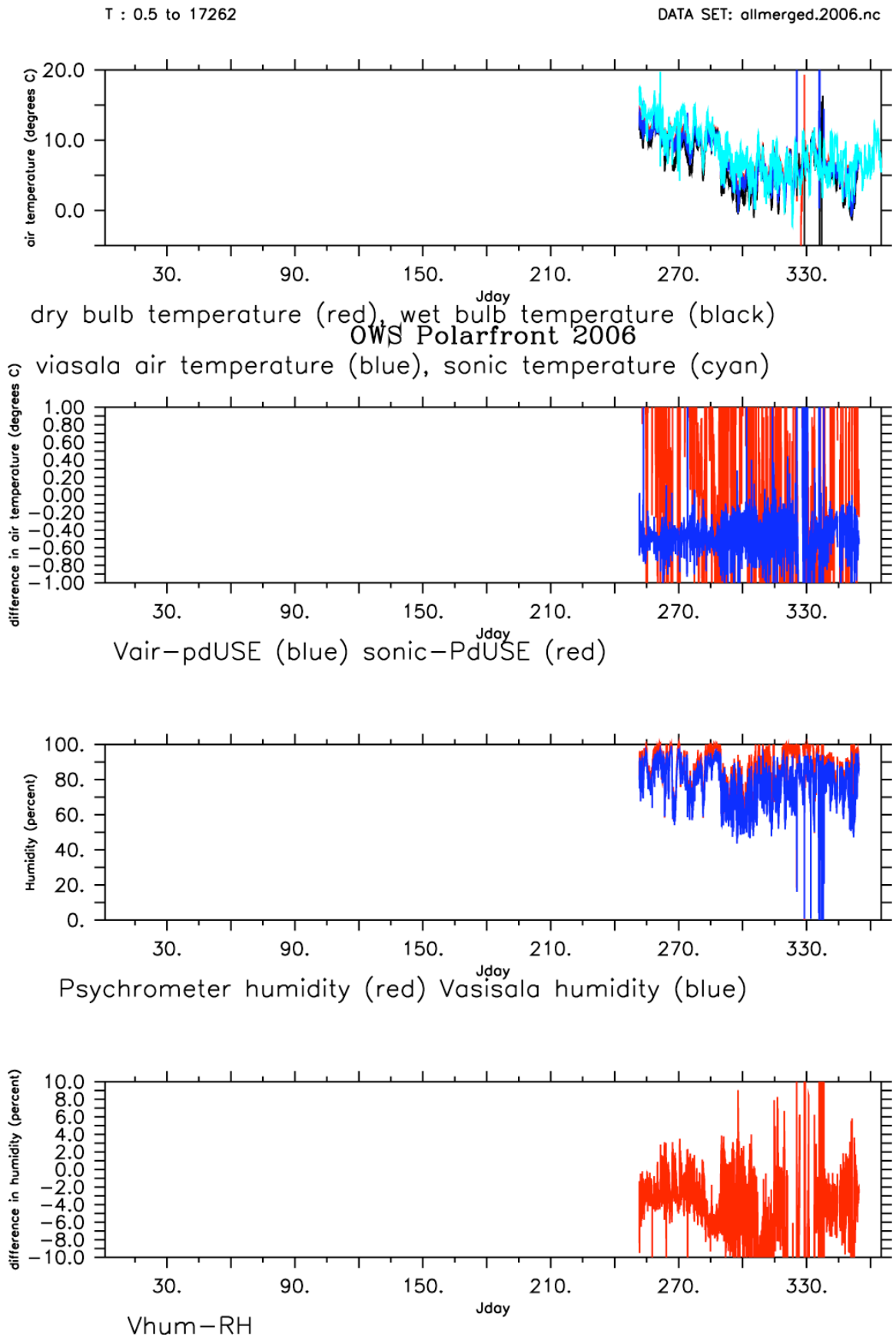


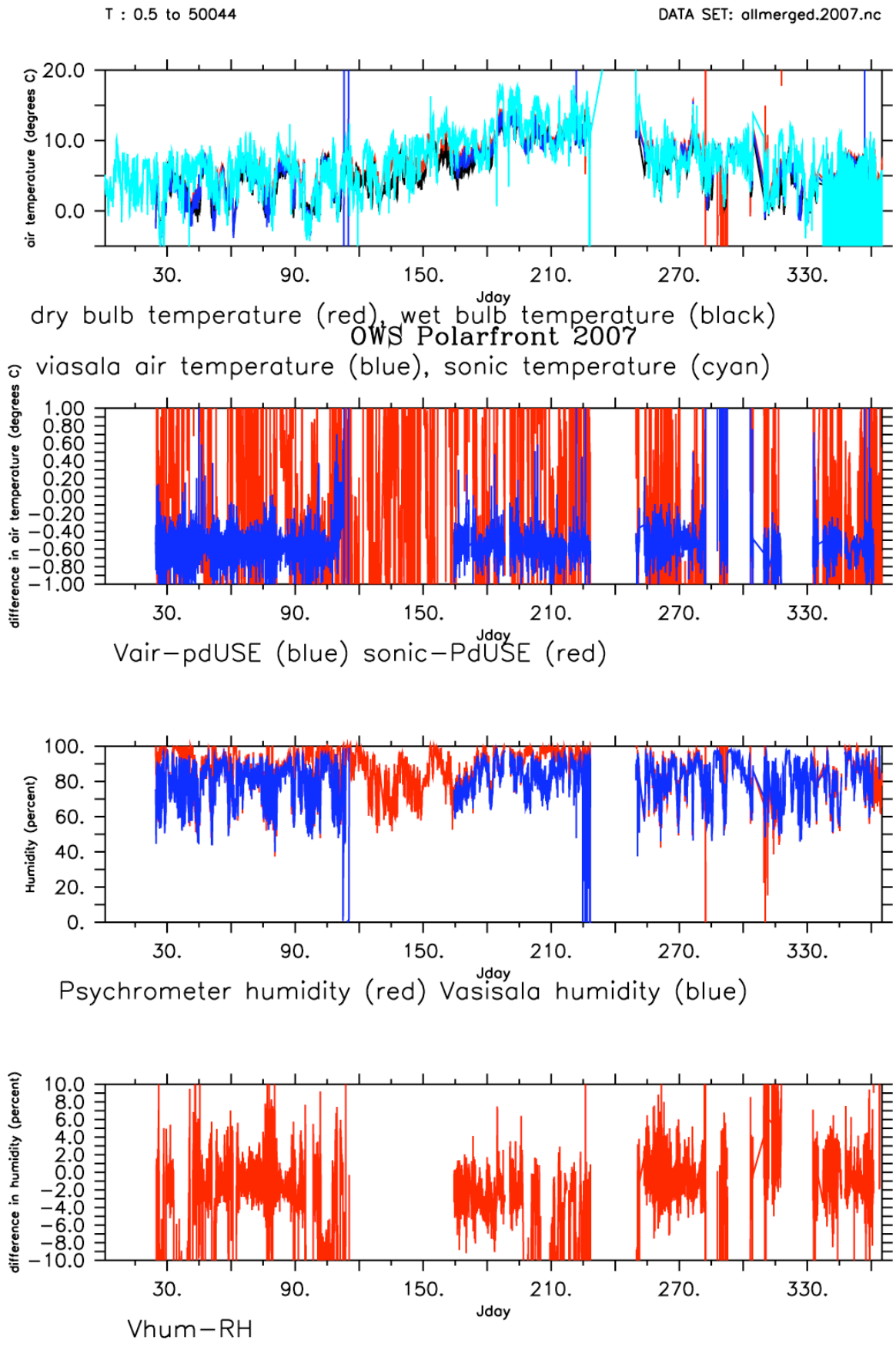
Delta PCo2 – OWS Polarfront 2009

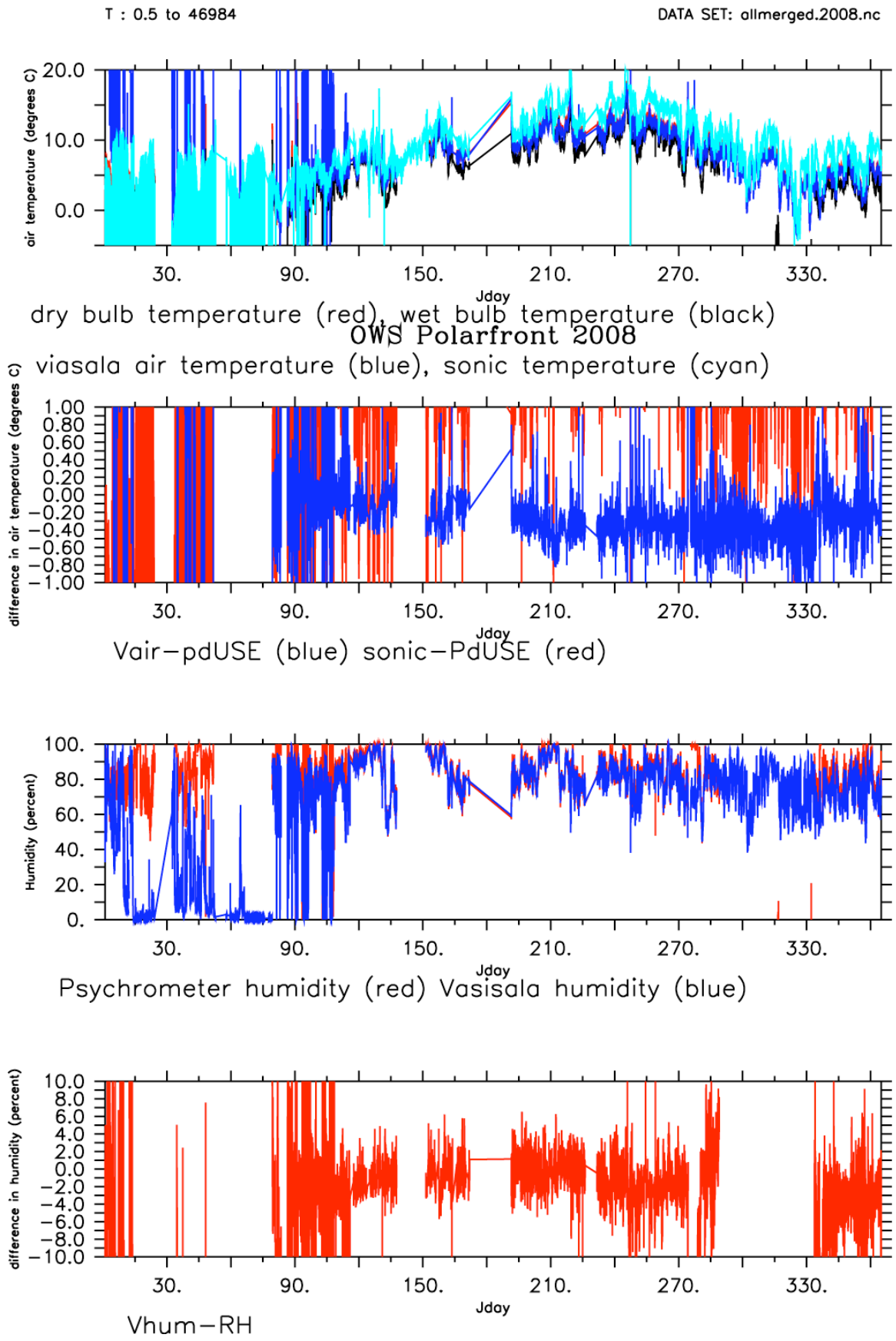


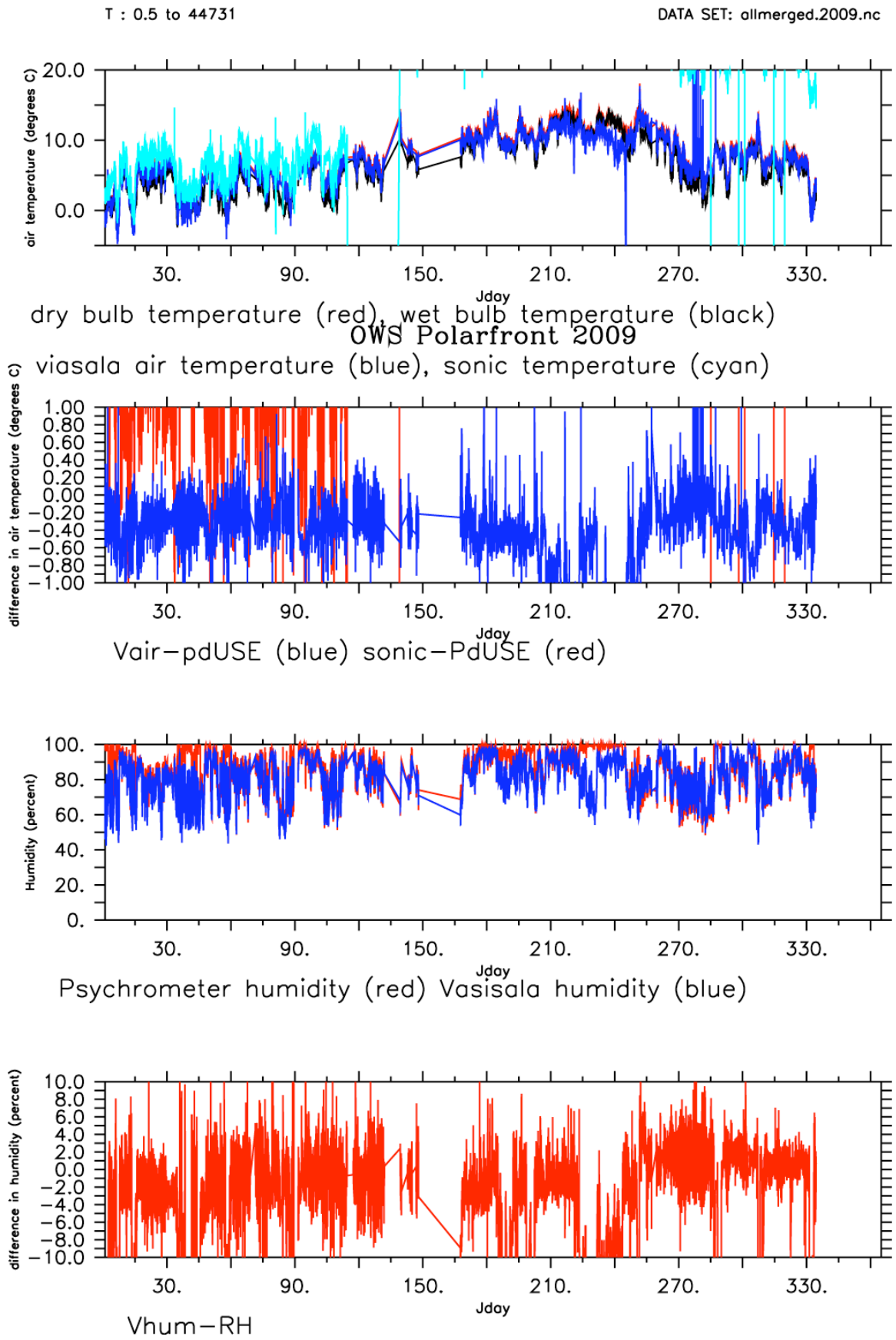
Sea surface temperature and uncorrected salinity

The figures show yearly time series of 10 minute spot values. Only basic quality control criteria have been applied to these data. Each page contains three plots showing different variables over each year.
Top panel - the sea surface temperature from two DNMI hull mounted Sensors (TG1 and TG2), the thermosaliograph (TSG) and the CO2 system (intemp).
the psychrometer, the Vaisala sensor and the sonic.
middle panel – the difference in air temperature between the CO2 system (intemp) and the three other systems (TSG, TG1 and TG2).
Bottom panel – the uncorrected sea surface salinity.


T : 0.5 to 17262
DATA SET: allmerged.2006.nc
air temperature (degrees C)
20.0
10.0
0.0
30.
90.
150.
210.
270.
330.
Jday
dry bulb temperature (red), wet bulb temperature (black)
OWS Polarfront 2006
viasala air temperature (blue), sonic temperature (cyan)
difference in air temperature (degrees C)
1.00
0.80
0.60
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
−1.00
Vair−pdUSE (blue) sonic−PdUSE (red)
Humidity (percent)
100.
80.
60.
40.
20.
0.
Psychrometer humidity (red) Vasisala humidity (blue)
difference in humidity (percent)
10.0
8.0
6.0
4.0
2.0
0.0
−2.0
−4.0
−6.0
−8.0
−10.0
Vhum−RH


T : 0.5 to 50044
DATA SET: allmerged.2007.nc
air temperature (degrees C)
20.0
10.0
0.0
30.
90.
150.
210.
270.
330.
Jday
dry bulb temperature (red), wet bulb temperature (black)
OWS Polarfront 2007
viasala air temperature (blue), sonic temperature (cyan)
difference in air temperature (degrees C)
1.00
0.80
0.60
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
−1.00
Vair−pdUSE (blue) sonic−PdUSE (red)
Humidity (percent)
100.
80.
60.
40.
20.
0.
Psychrometer humidity (red) Vasisala humidity (blue)
difference in humidity (percent)
10.0
8.0
6.0
4.0
2.0
0.0
−2.0
−4.0
−6.0
−8.0
−10.0
Vhum−RH

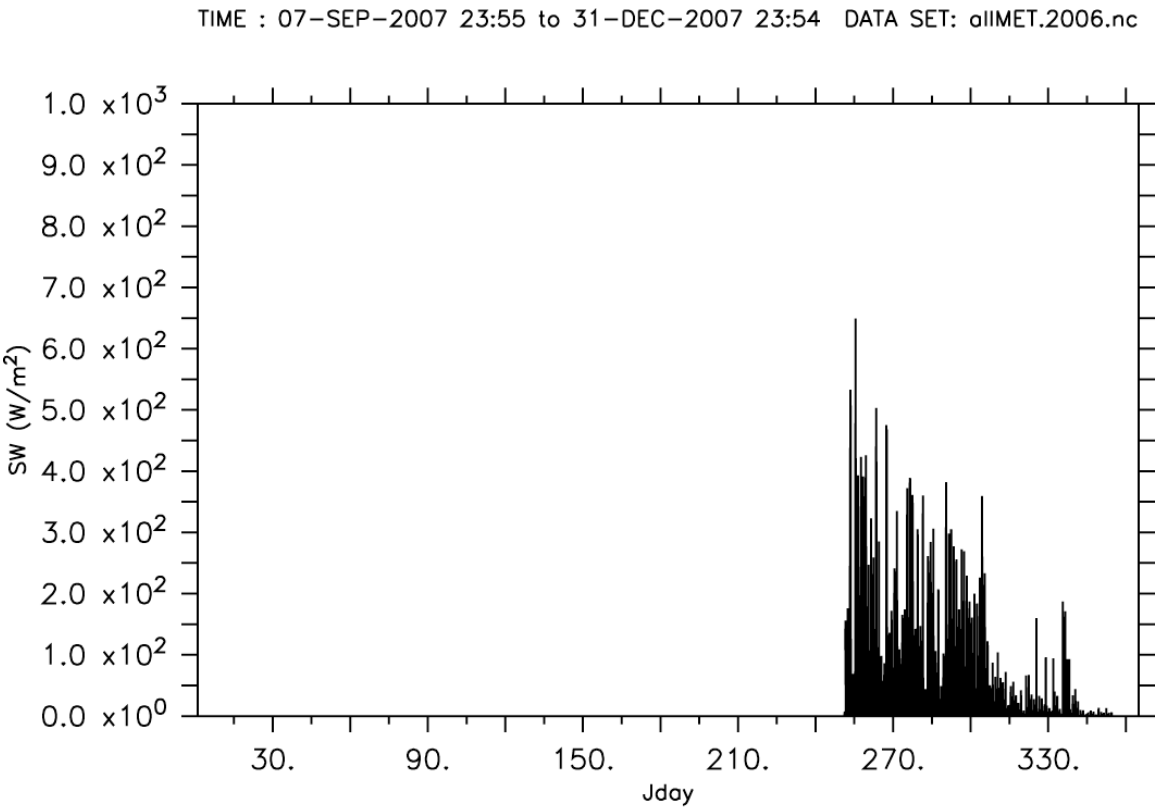

T : 0.5 to 46984
DATA SET: allmerged.2008.nc
air temperature (degrees C)
20.0
10.0
0.0
30.
90.
150.
210.
270.
330.
Jday
dry bulb temperature (red), wet bulb temperature (black)
OWS Polarfront 2008
viasala air temperature (blue), sonic temperature (cyan)
difference in air temperature (degrees C)
1.00
0.80
0.60
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
−1.00
Vair−pdUSE (blue) sonic−PdUSE (red)
Humidity (percent)
100.
80.
60.
40.
20.
0.
Psychrometer humidity (red) Vasisala humidity (blue)
difference in humidity (percent)
10.0
8.0
6.0
4.0
2.0
0.0
−2.0
−4.0
−6.0
−8.0
−10.0
Vhum−RH


T : 0.5 to 44731
DATA SET: allmerged.2009.nc
air temperature (degrees C)
20.0
10.0
0.0
30.
90.
150.
210.
270.
330.
Jday
dry bulb temperature (red), wet bulb temperature (black)
OWS Polarfront 2009
viasala air temperature (blue), sonic temperature (cyan)
difference in air temperature (degrees C)
1.00
0.80
0.60
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
−1.00
Vair−pdUSE (blue) sonic−PdUSE (red)
Humidity (percent)
100.
80.
60.
40.
20.
0.
Psychrometer humidity (red) Vasisala humidity (blue)
difference in humidity (percent)
10.0
8.0
6.0
4.0
2.0
0.0
−2.0
−4.0
−6.0
−8.0
−10.0
Vhum−RH

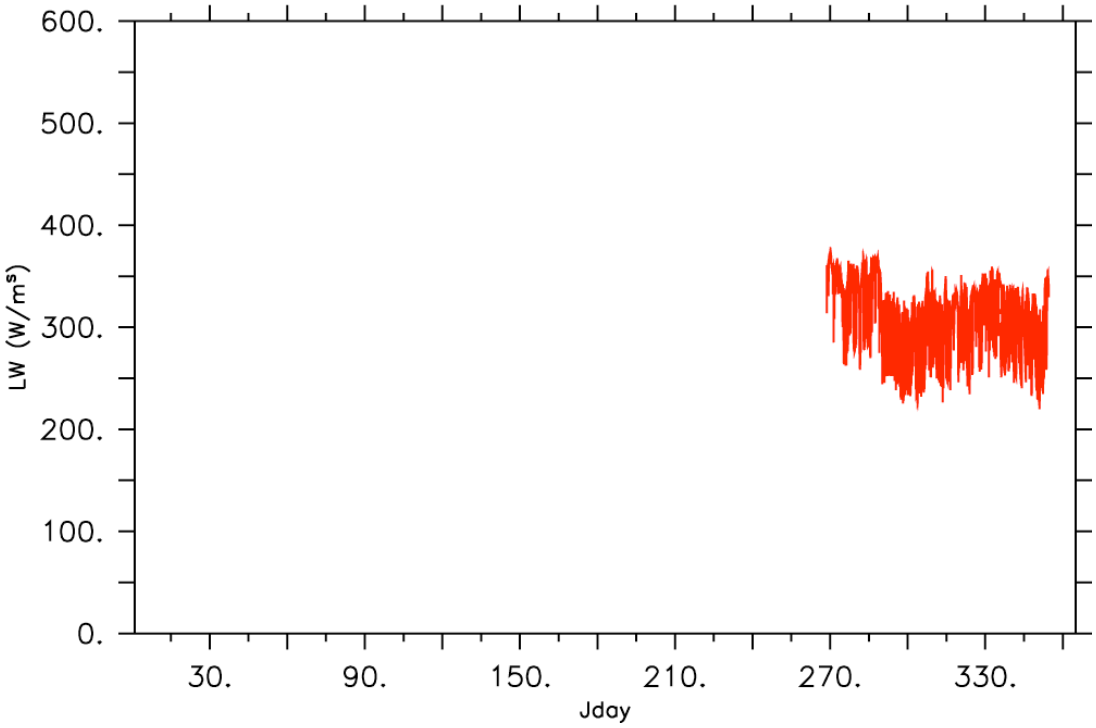
Radiation sensors

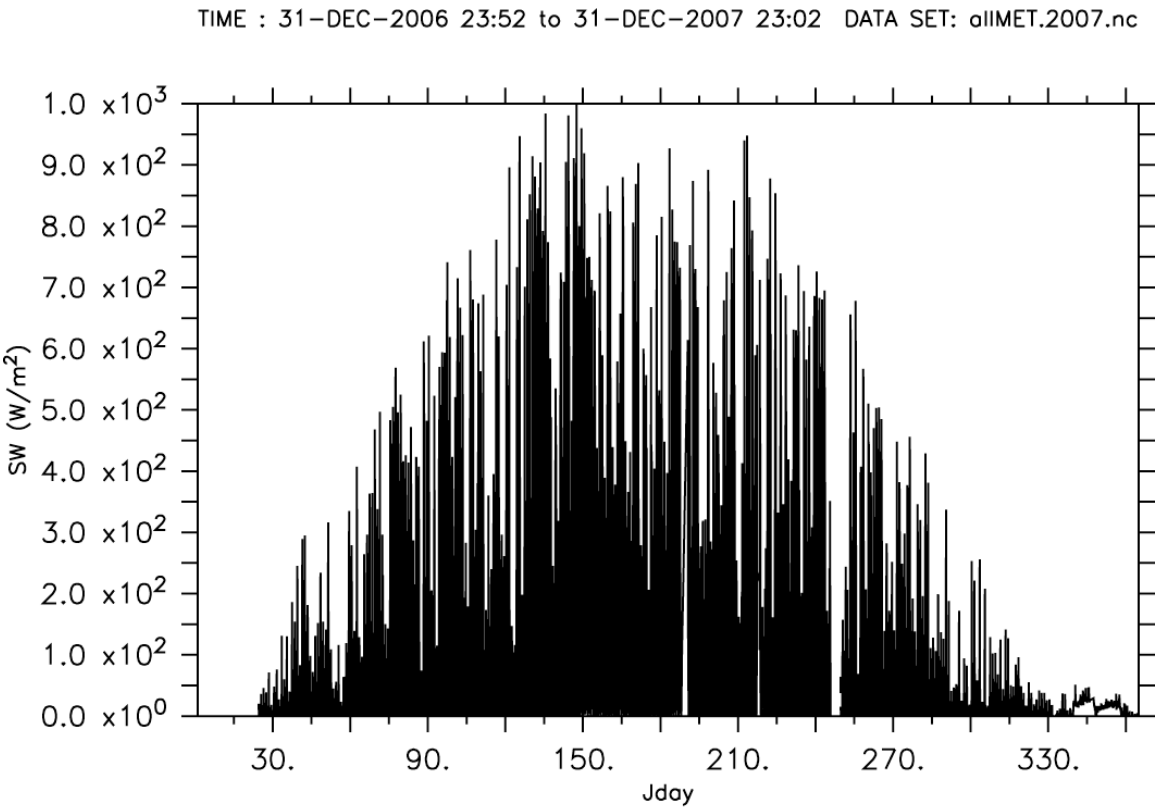
The figures show yearly time series of 10 minute spot values. Only basic quality control criteria have been applied to these data. Each page contains two plots showing different variables over each year.
Top panel - the short wave radiation (W/m^2)
Bottom panel – the long wave radiation (W/m^2)

During 2008 the LW signal between Jday 52 and 333 is incorrect due to a faulty circuit board, see Table F.

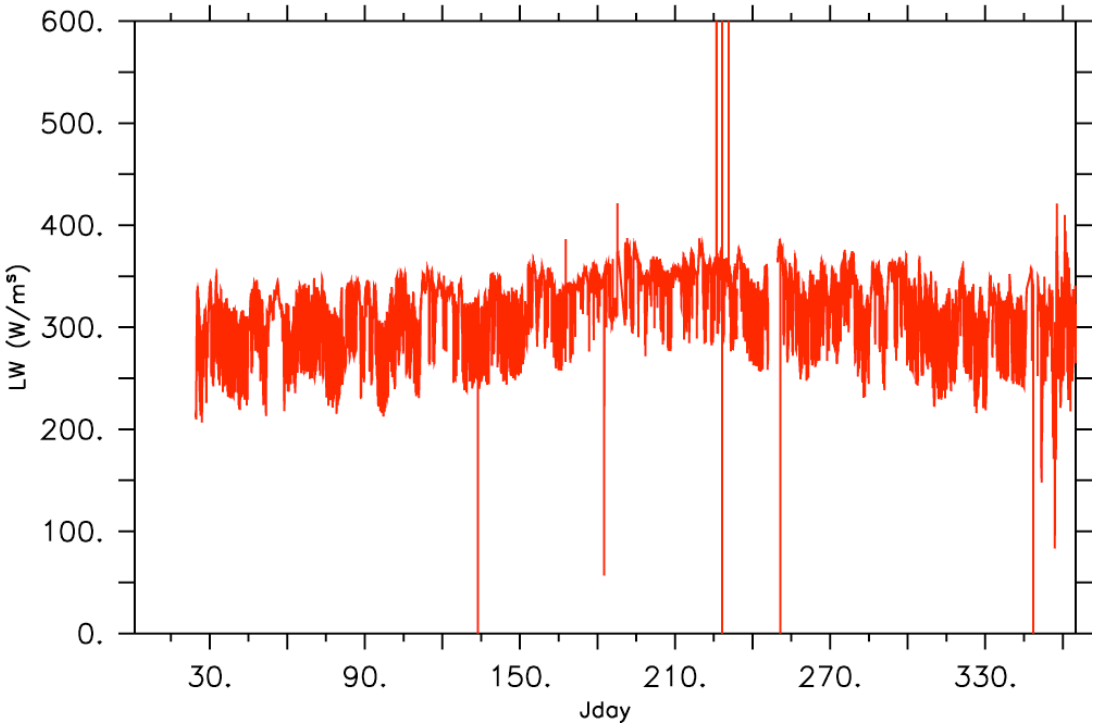


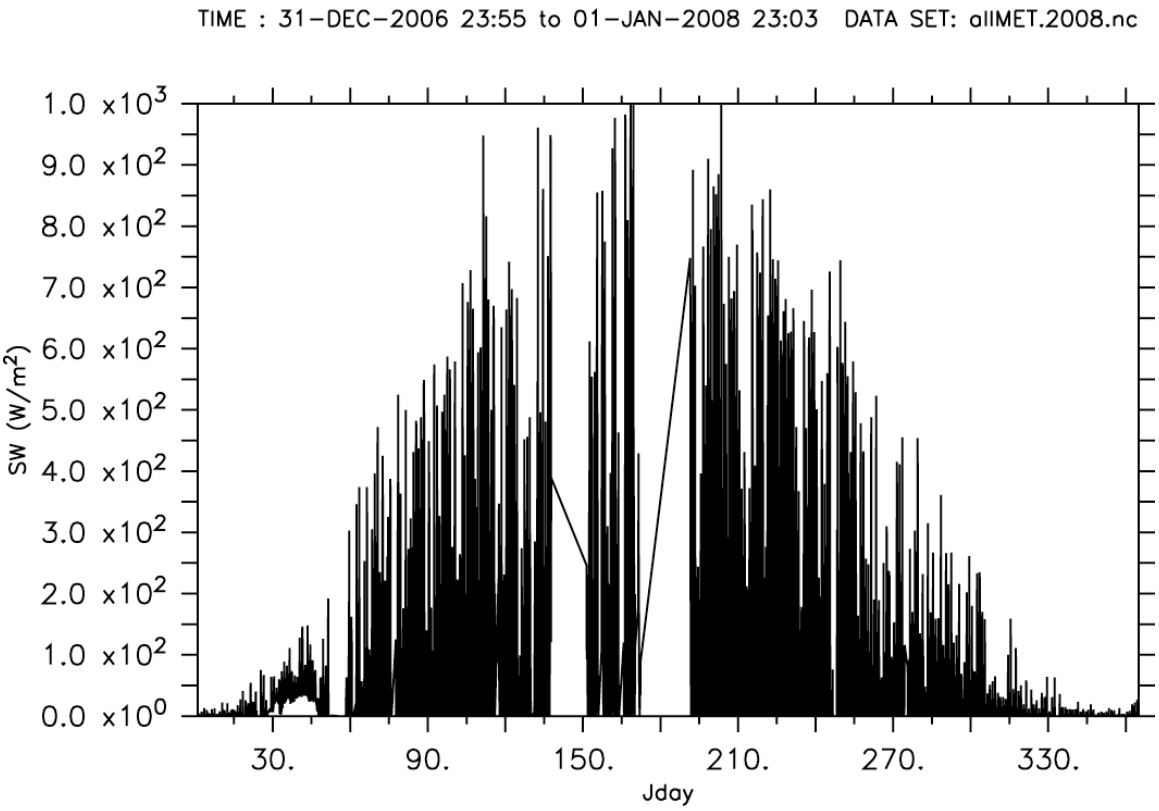
Radiation sensors – OWS Polarfront 2006



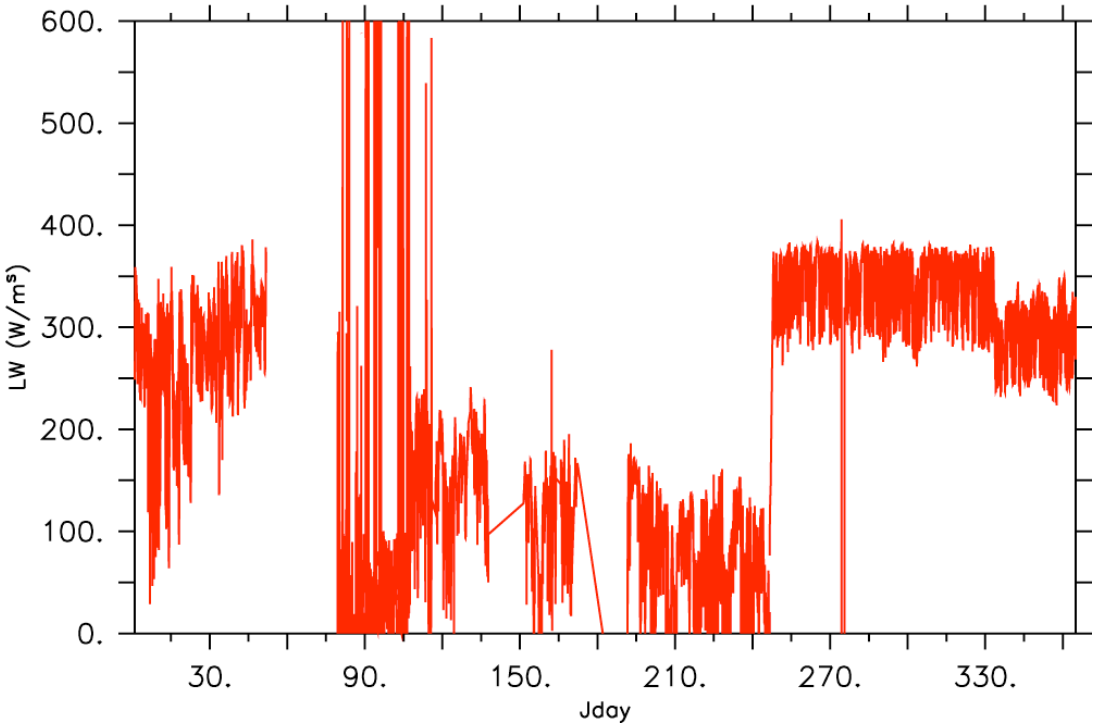


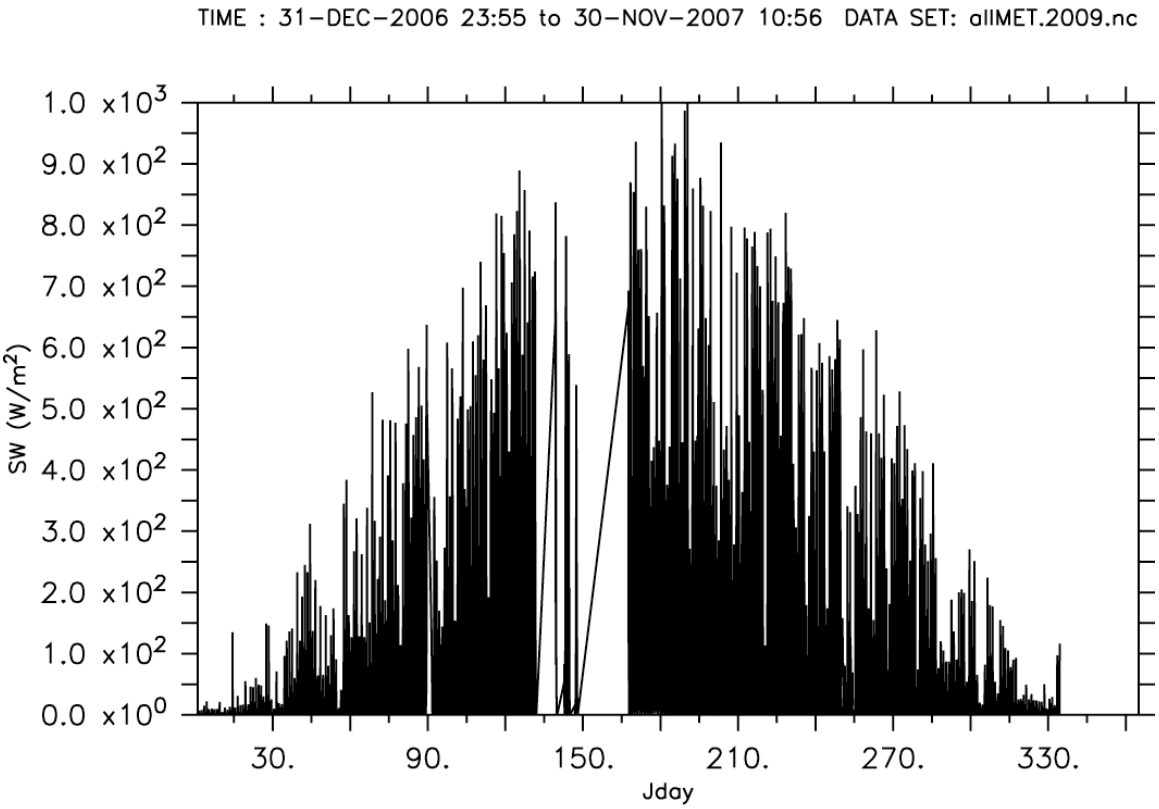
Radiation sensors – OWS Polarfront 2007



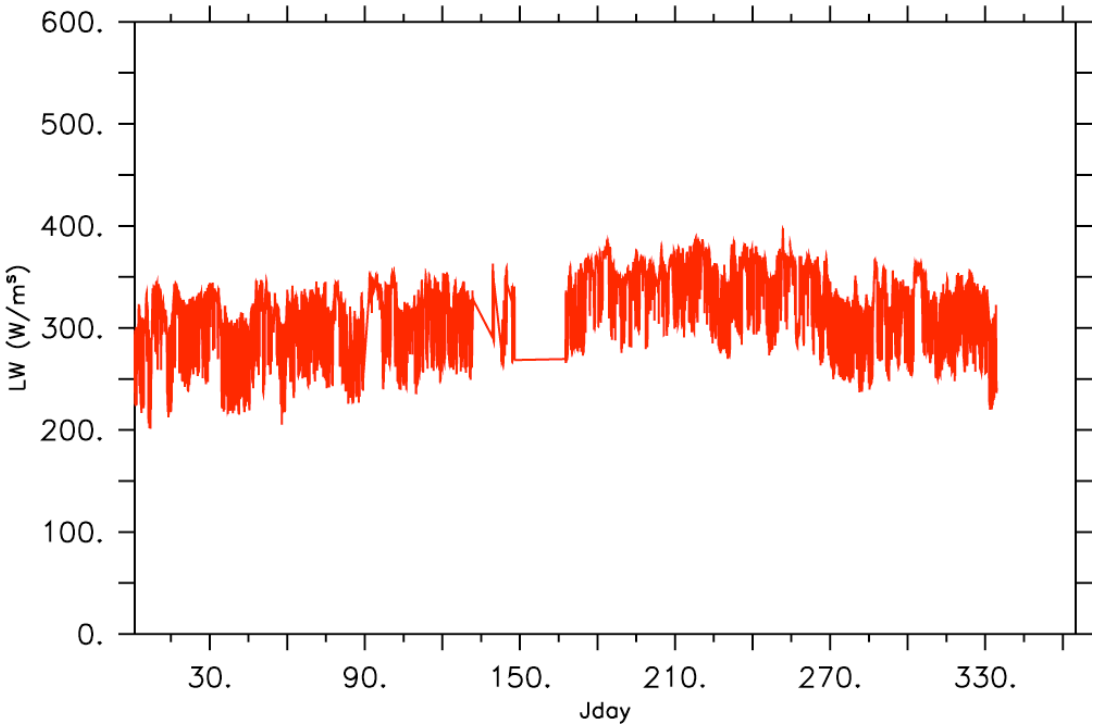


Radiation sensors – OWS Polarfront 2008





Radiation sensors – OWS Polarfront 2009



Wave systems

The figures show a yearly time series of 10 minute spot values. Only basic quality

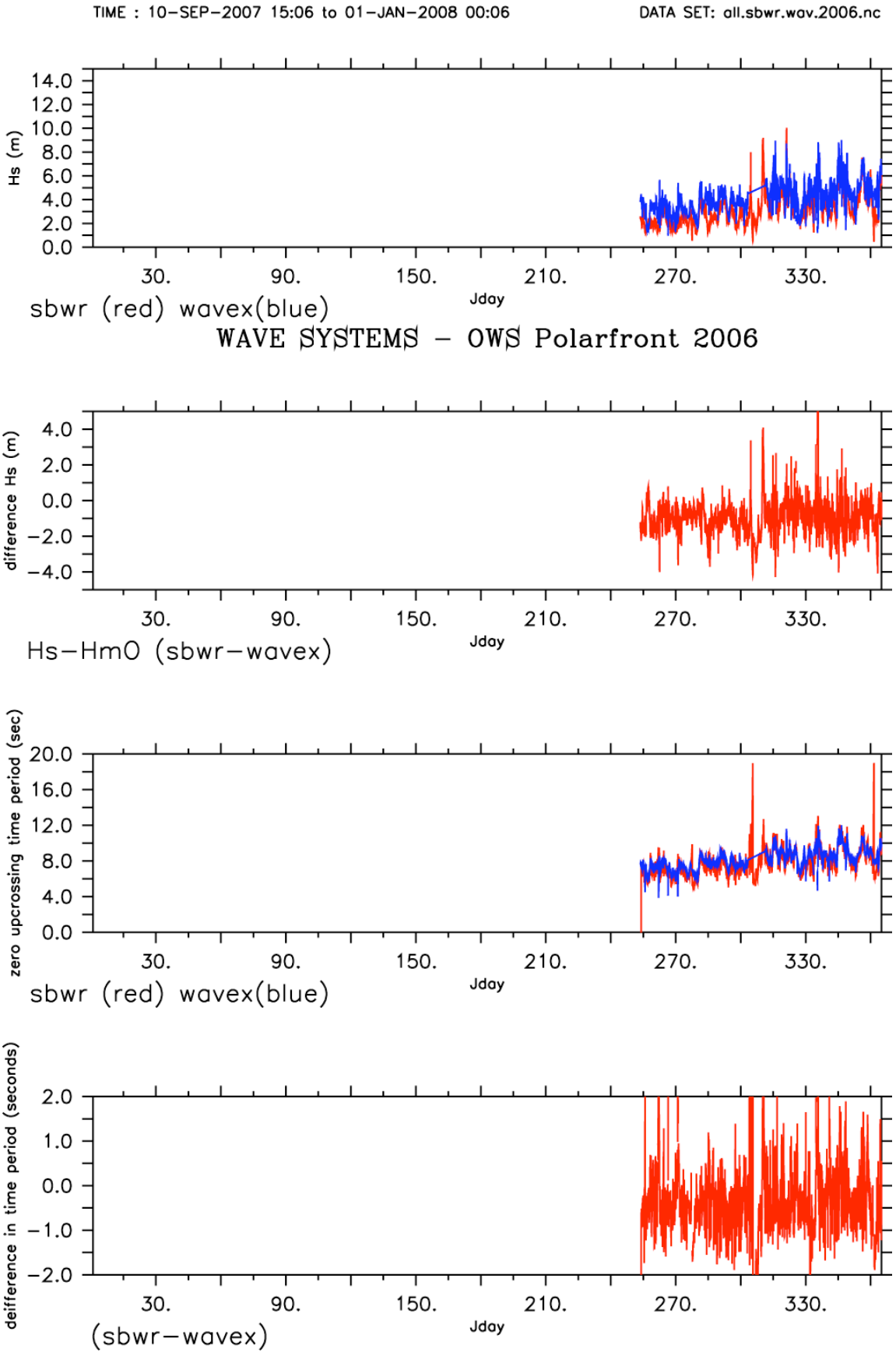
control criteria have been applied to these data. Each page contains four plots showing different variables over each year.

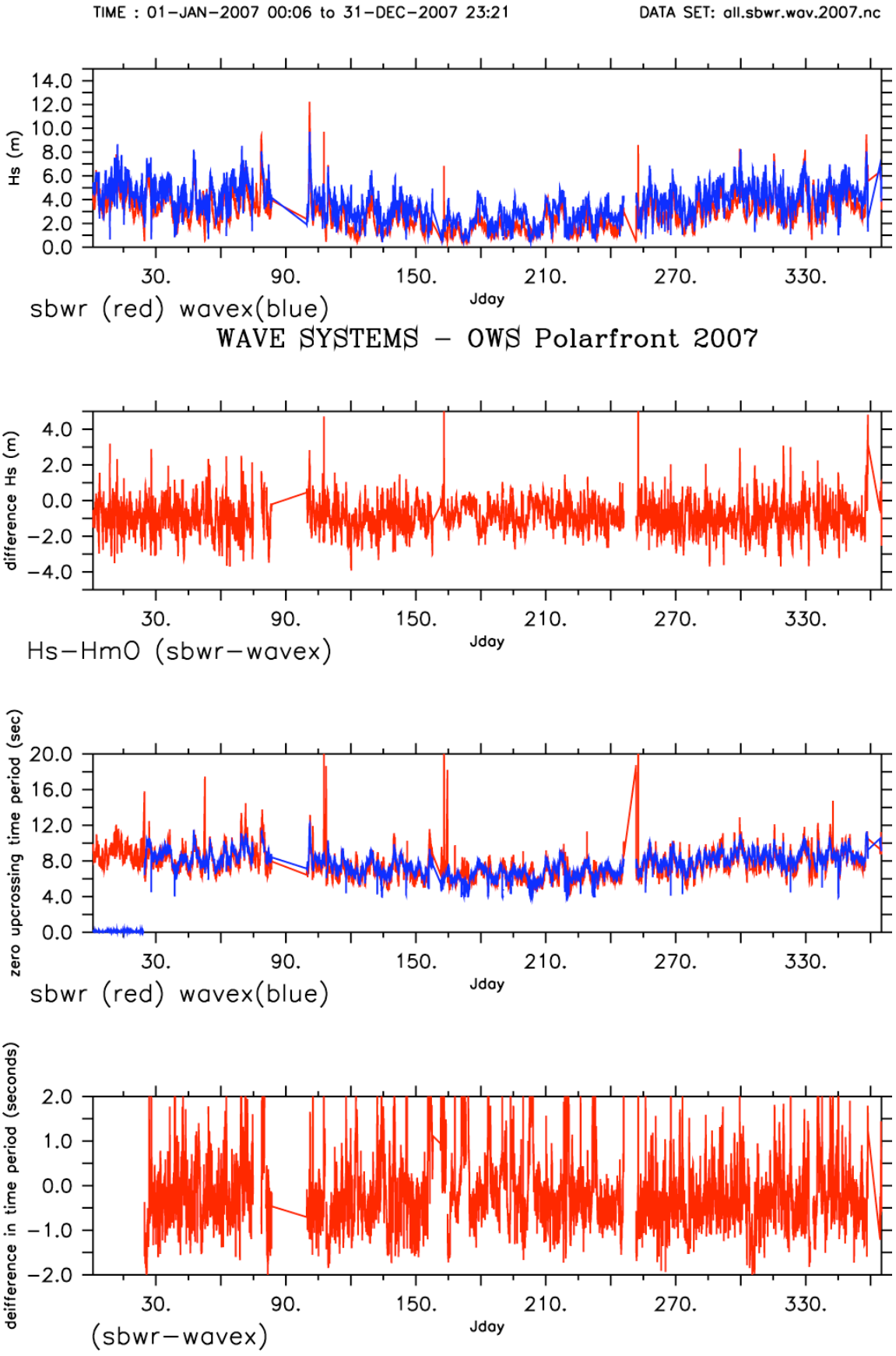
Top panel - the significant wave height (Hs) measured by the ship borne wave recorder (sbwr) and the WAVEX wave radar.

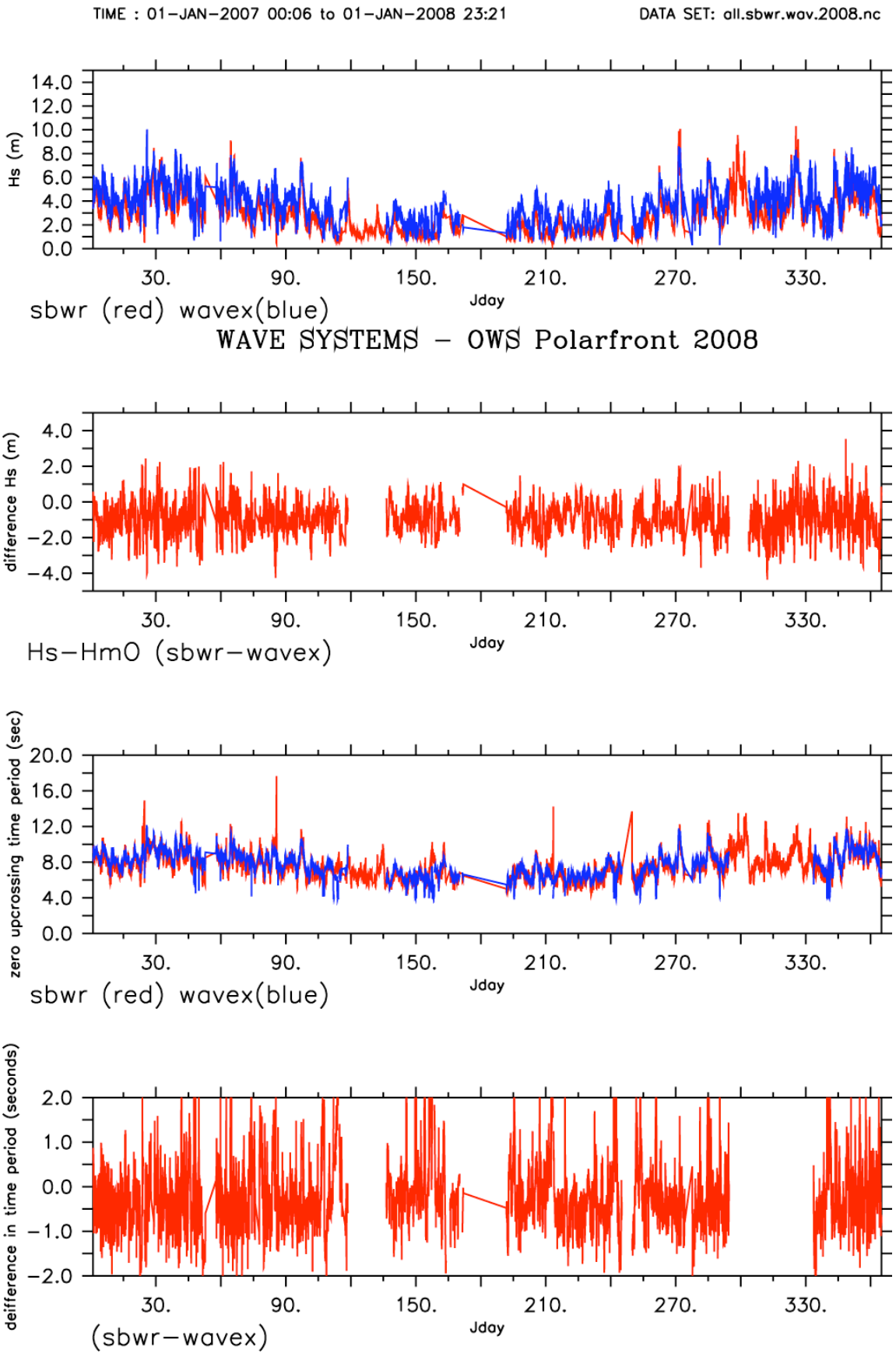
Upper middle panel – the difference in significant wave height between the two systems.

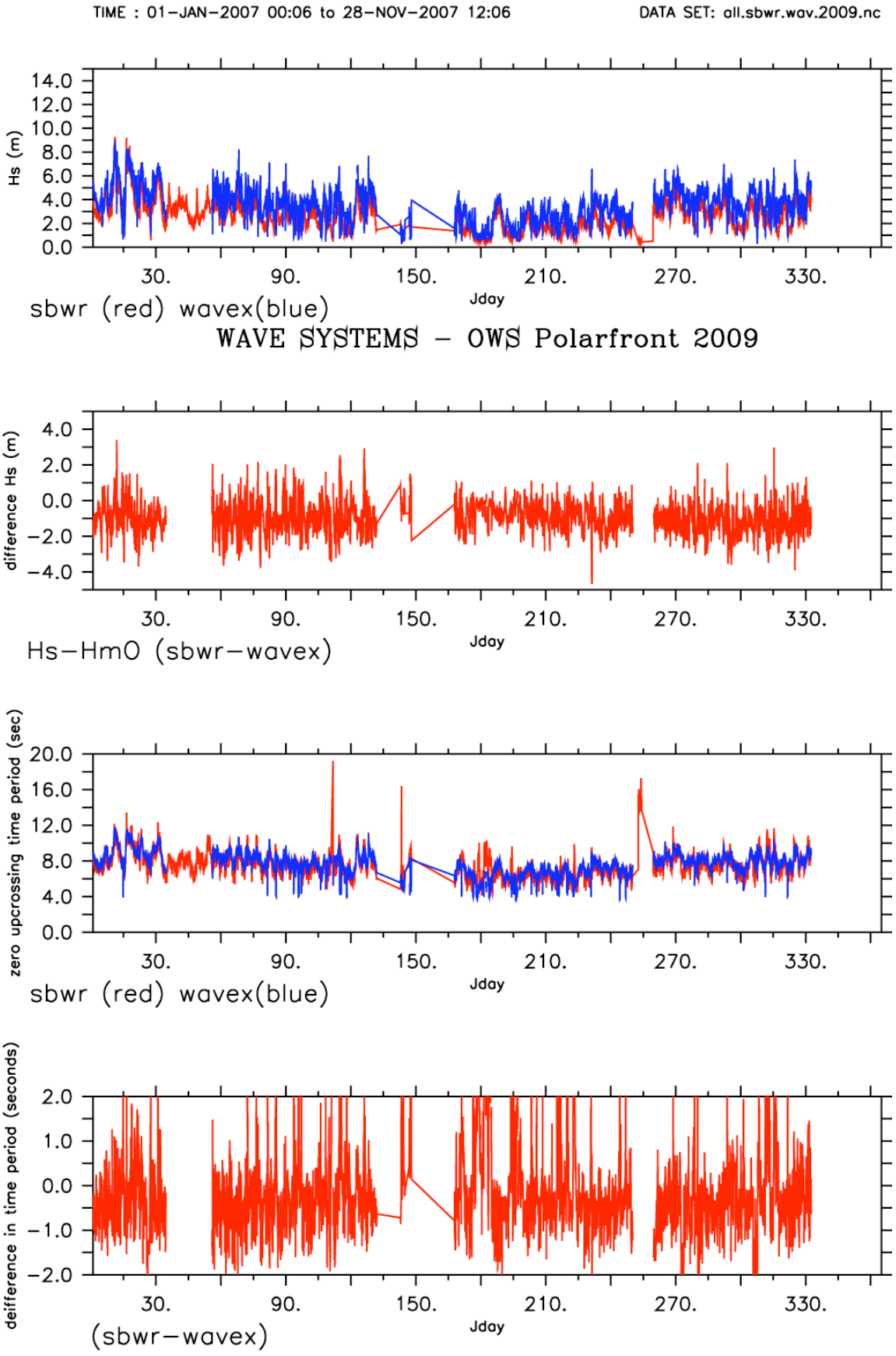
Lower middle panel – the zero upcrossing period measured by the ship borne wave recorder and the WAVEX wave radar.

Bottom panel – the difference in zero upcrossing period between the two systems.


TIME : 10-SEP-2007 15:06 to 01-JAN-2008 00:06
DATA SET: all.sbwr.wav.2006.nc
Hs (m)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
30.
90.
150.
210.
270.
330.
Jday
sbwr (red) wavex(blue)
WAVE SYSTEMS - OWS Polarfront 2006
difference Hs (m)
4.0
2.0
0.0
-2.0
-4.0
Hs-Hm0 (sbwr-wavex)
zero upcrossing time period (sec)
20.0
16.0
12.0
8.0
4.0
0.0
sbwr (red) wavex(blue)
deifference in time period (seconds)
2.0
1.0
0.0
-1.0
-2.0
(sbwr-wavex)


TIME : 01-JAN-2007 00:06 to 31-DEC-2007 23:21
DATA SET: all.sbwr.wav.2007.nc
Hs (m)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
30.
90.
150.
210.
270.
330.
Jday
sbwr (red) wavex(blue)
WAVE SYSTEMS - OWS Polarfront 2007
difference Hs (m)
4.0
2.0
0.0
-2.0
-4.0
Hs-HmO (sbwr-wavex)
zero upcrossing time period (sec)
20.0
16.0
12.0
8.0
4.0
0.0
sbwr (red) wavex(blue)
deifference in time period (seconds)
2.0
1.0
0.0
-1.0
-2.0
(sbwr-wavex)


TIME : 01-JAN-2007 00:06 to 01-JAN-2008 23:21
DATA SET: all.sbwr.wav.2008.nc
Hs (m)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
30.
90.
150.
210.
270.
330.
Jday
sbwr (red) wavex(blue)
WAVE SYSTEMS - OWS Polarfront 2008
difference Hs (m)
4.0
2.0
0.0
-2.0
-4.0
Hs-HmO (sbwr-wavex)
zero upcrossing time period (sec)
20.0
16.0
12.0
8.0
4.0
0.0
sbwr (red) wavex(blue)
deifference in time period (seconds)
2.0
1.0
0.0
-1.0
-2.0
(sbwr-wavex)


TIME : 01-JAN-2007 00:06 to 28-NOV-2007 12:06
DATA SET: all.sbwr.wav.2009.nc
Hs (m)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
30.
90.
150.
210.
270.
330.
Jday
sbwr (red) wavex(blue)
WAVE SYSTEMS - OWS Polarfront 2009
difference Hs (m)
4.0
2.0
0.0
-2.0
-4.0
Hs-HmO (sbwr-wavex)
zero upcrossing time period (sec)
20.0
16.0
12.0
8.0
4.0
0.0
sbwr (red) wavex(blue)
deifference in time period (seconds)
2.0
1.0
0.0
-1.0
-2.0
(sbwr-wavex)

Wind speed and direction

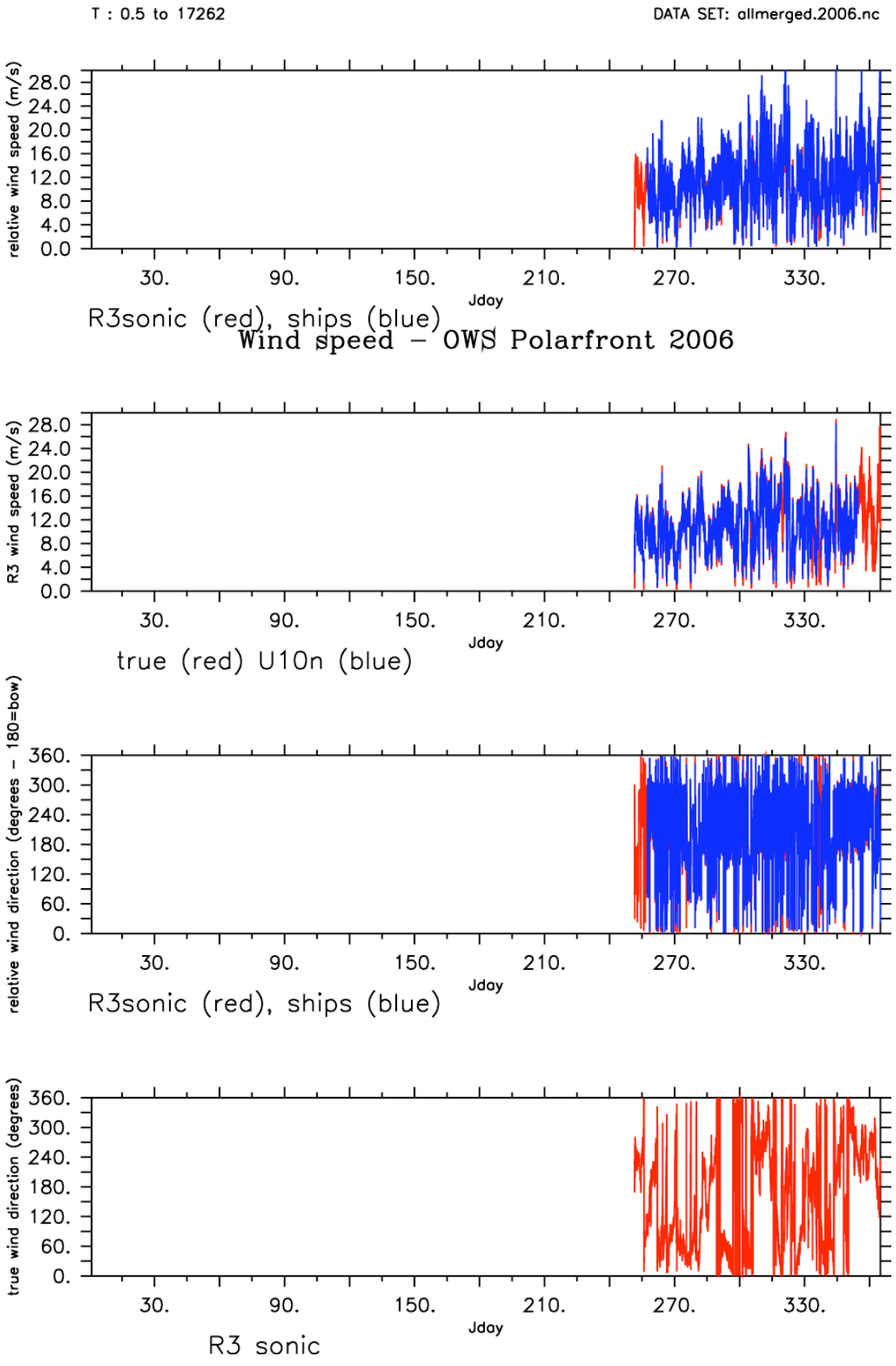
The figures show a yearly time series of 10 minute spot values. Only basic quality control criteria have been applied to these data. Each page contains four plots showing different variables over each year.

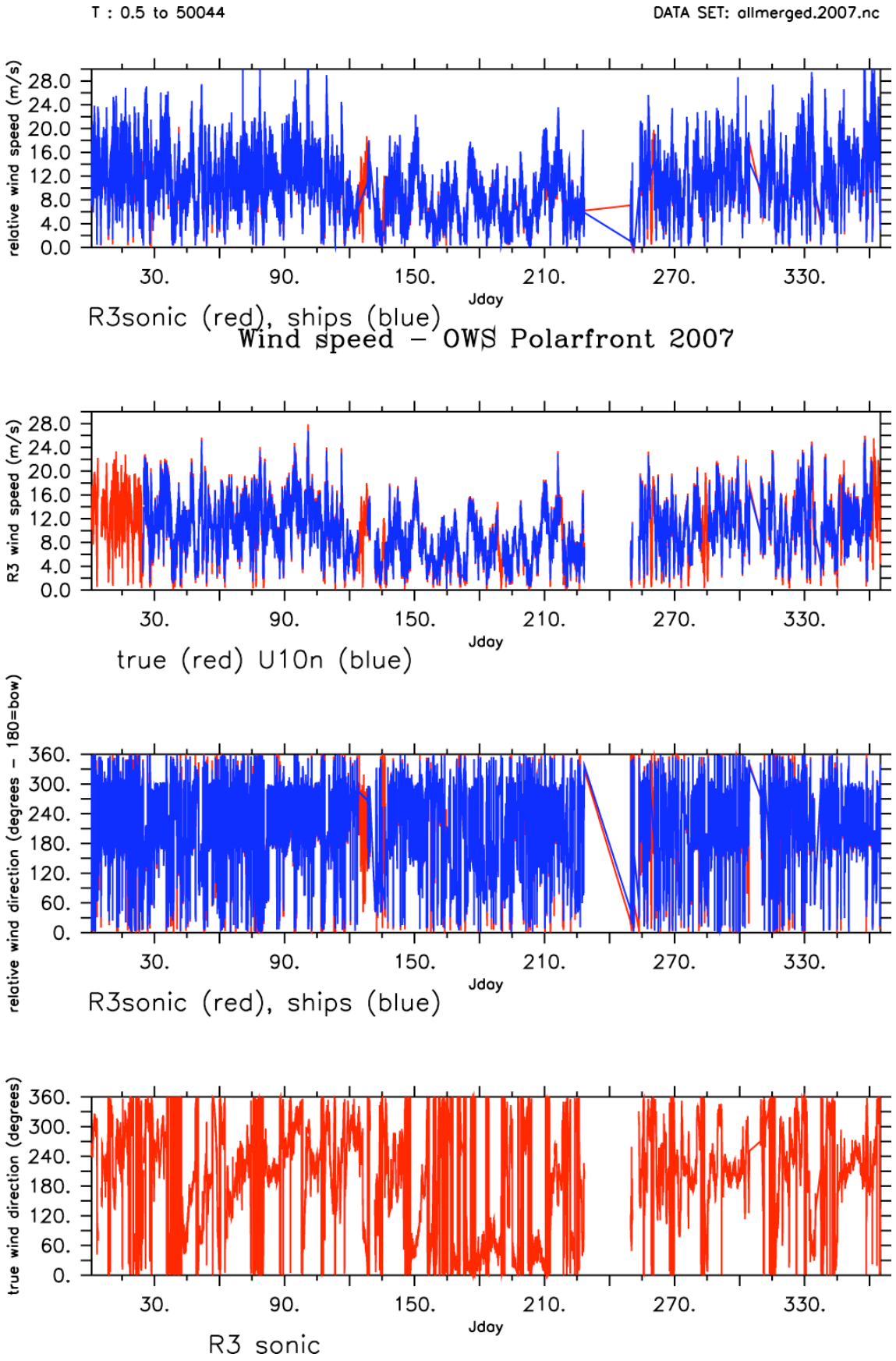
Top panel - the relative wind speed measured by the AutoFlux R3 sonic and the DNMI WindObserver anemometer.

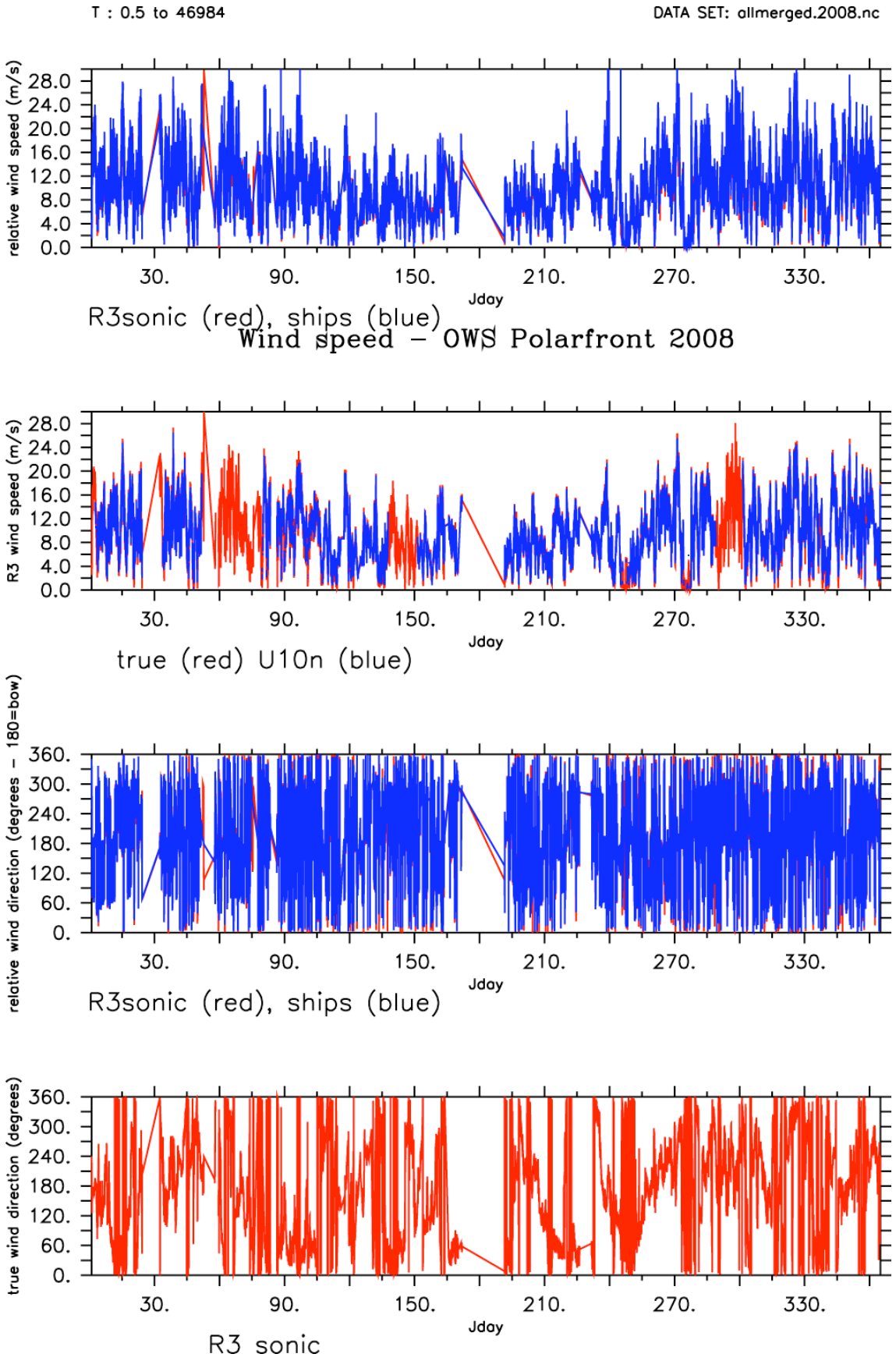
Upper middle panel – the true wind speed measured from the R3 anemometer and the R3 anemometer wind speed speed corrected to a height of 10 m and neutral atmospheric stability.

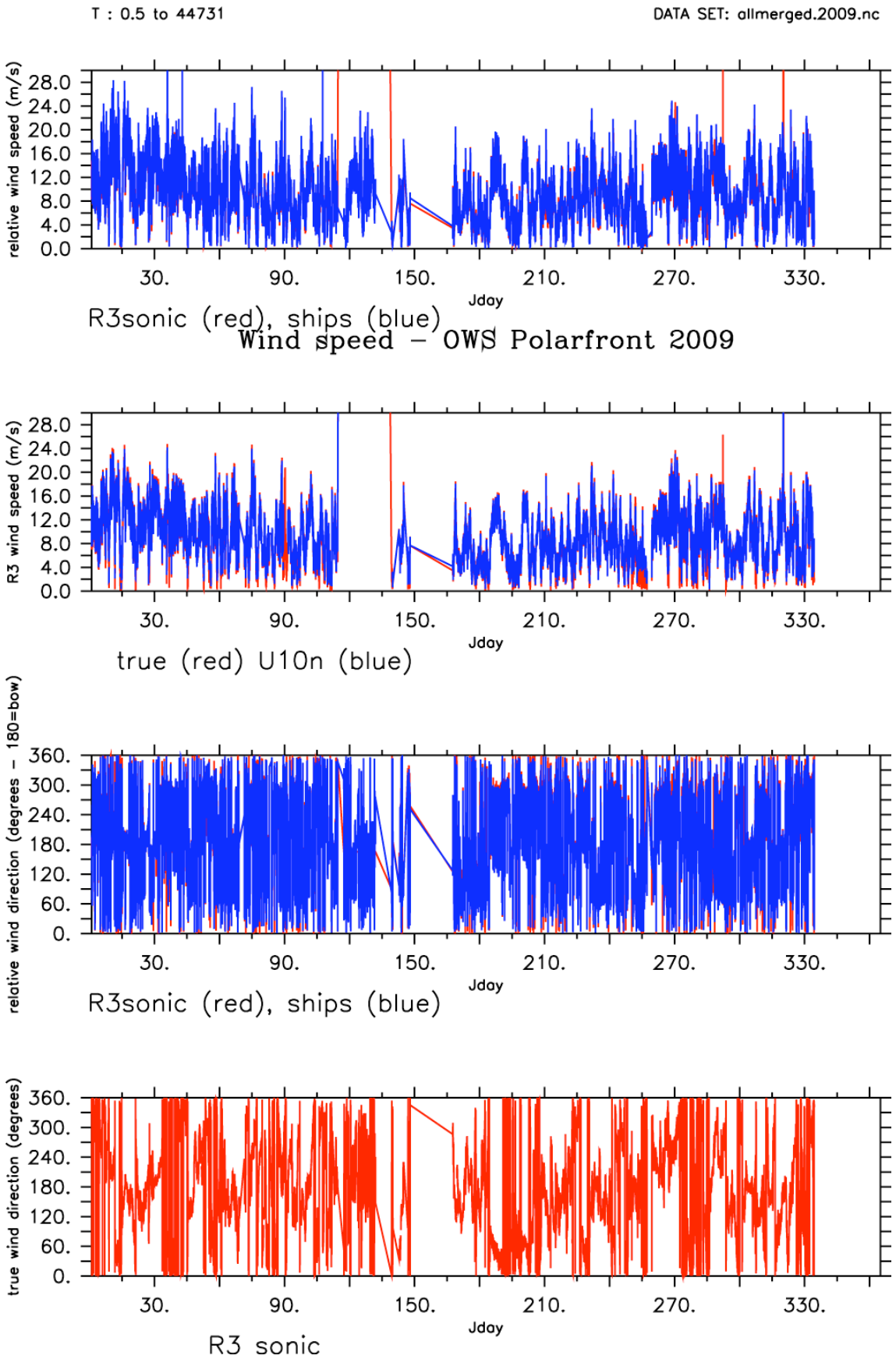
Lower middle panel –wind direction relative to the ship measured using the AutoFlux R3 sonic and the DNMI WindObserver anemometer. Note: the relative wind direction for flows directly over the bow is 180 degrees.

Bottom panel – the true wind direction from the R3 sonic. Note: direction is from, e.g. 180 degrees is from the South.


T : 0.5 to 17262
DATA SET: allmerged.2006.nc
relative wind speed (m/s)
28.0
24.0
20.0
16.0
12.0
8.0
4.0
0.0
30.
90.
150.
210.
270.
330.
Jday
R3sonic (red), ships (blue)
Wind speed – OWS Polarfront 2006
R3 wind speed (m/s)
true (red) U10n (blue)
relative wind direction (degrees - 180=bow)
360.
300.
240.
180.
120.
60.
0.
R3sonic (red), ships (blue)
true wind direction (degrees)
R3 sonic


T : 0.5 to 50044
DATA SET: allmerged.2007.nc
relative wind speed (m/s)
28.0
24.0
20.0
16.0
12.0
8.0
4.0
0.0
30.
90.
150.
210.
270.
330.
Jday
R3sonic (red), ships (blue)
Wind speed – OWS Polarfront 2007
R3 wind speed (m/s)
true (red) U10n (blue)
relative wind direction (degrees - 180=bow)
360.
300.
240.
180.
120.
60.
0.
R3sonic (red), ships (blue)
true wind direction (degrees)
R3 sonic


T : 0.5 to 46984
DATA SET: allmerged.2008.nc
relative wind speed (m/s)
28.0
24.0
20.0
16.0
12.0
8.0
4.0
0.0
30.
90.
150.
210.
270.
330.
Jday
R3sonic (red), ships (blue)
Wind speed – OWS Polarfront 2008
R3 wind speed (m/s)
28.0
24.0
20.0
16.0
12.0
8.0
4.0
0.0
30.
90.
150.
210.
270.
330.
Jday
true (red) U10n (blue)
relative wind direction (degrees - 180=bow)
360.
300.
240.
180.
120.
60.
0.
30.
90.
150.
210.
270.
330.
Jday
R3sonic (red), ships (blue)
true wind direction (degrees)
360.
300.
240.
180.
120.
60.
0.
30.
90.
150.
210.
270.
330.
Jday
R3 sonic


T : 0.5 to 44731
DATA SET: allmerged.2009.nc
relative wind speed (m/s)
28.0
24.0
20.0
16.0
12.0
8.0
4.0
0.0
30.
90.
150.
210.
270.
330.
Jday
R3sonic (red), ships (blue)
Wind speed – OWS Polarfront 2009
R3 wind speed (m/s)
28.0
24.0
20.0
16.0
12.0
8.0
4.0
0.0
30.
90.
150.
210.
270.
330.
Jday
true (red) U10n (blue)
relative wind direction (degrees - 180=bow)
360.
300.
240.
180.
120.
60.
0.
30.
90.
150.
210.
270.
330.
Jday
R3sonic (red), ships (blue)
true wind direction (degrees)
360.
300.
240.
180.
120.
60.
0.
30.
90.
150.
210.
270.
330.
Jday
R3 sonic