WMO SPICE

SITE COMMISSIONING PROTOCOL

V3.1 (JUL, 23 2013)

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1. ORGANIZATION OF THE DOCUMENT

The Commissioning Protocol is organized into four parts:

1. **The site components,** data transfer and sharing pathways, and project organizational structure are outlined in Section 3;
2. **The site commissioning procedures**, including pre-commissioning activities and the Interaction with the Instrument Providers, Sections 4 to 6;
3. **SPICE Data Archive,** Section 7**.**
4. **Appendix A: the template for the Proof of Performance (POP) Report**, in which all site configuration details and commissioning activities are documented.

Appendix B outlines the SPICE Data Levels and Data Sets, and Appendix C includes a list of acronyms used throughout the document.

The first two sections are intended to provide background information on the commissioning process within the scope of the SPICE project, while the Appendix A contains the forms which are required to be filled out as part of the commissioning of the site. Once completed, these forms become the Commissioning Report.

The SPICE data archive section outlines the requirements regarding the SPICE data levels and datasets and the planned strategy for the archival of SPICE data to a central location(s).

2. PURPOSE AND SCOPE

This document is prepared by the WMO SPICE IOC. It outlines the procedures for post-installation testing and commissioning of the sites participating in the WMO SPICE experiment and documents the responsibilities for each aspect of the commissioning process.

Commissioning of a WMO SPICE site refers to the act of "turning it on" and marking the start of the collection of the "official" observations and measurements from the instruments included in the intercomparison (reference, instruments under test, ancillary measurements), and their archival on the designated Site Data Archive.
For this purpose, each site will designate a location for the Site Data Archive, which must protect the integrity of the intercomparison data.

End-to-end data quality and integrity for each instrument on each SPICE site will be verified before the commissioning can take place. It is essential that:

- Only agreed upon instruments are to be installed, in an accepted and standardized configuration;

- Each component be properly tested, and its performance verified, prior to commissioning;
- The transfer of instrument data to the Site Data Archive is validated and the archive secured.

Various individuals and organizations are referred to in this document as having responsibilities.

- SPICE IOC
- SPICE Project Team
- SPICE Data Analysis Team
- Site Manager
- Site (SPICE) Project Team
- ER refers to the Evaluation Representative, an individual named by the SPICE IOC
- IR, the Installation Representative, is identified by the Site Manager, responsible for the site configuration.
- Instrument Providers

3. CONFIGURATIONS AND ASSOCIATED COMMISSIONING REQUIREMENTS

3.1 SPICE SITE COMPONENTS

The SPICE Components include all or some of the following components:

- Field working reference systems (R3, and where applicable R2, and R1: site-specific)
- Reference measurements for snow on the ground (where applicable)
- Instruments under test provided by the host;
- Instruments under test supplied by the Instrument Providers;
- Ancillary measurements (both required and desired measurements listed):
  - Precipitation occurrence/intensity/size/type
  - Station pressure
  - Temperature/dew point
  - Relative humidity
  - Wind speed/direction (2-D and/or 3-D): different heights;
  - Manual observations
  - Vertical particle velocity
  - Net radiation
  - Snow Water Equivalent (SWE)
  - Icing occurrence
  - Visibility
  - Sky condition
- Derived or modeled ancillary parameters: wet bulb temperature, upper air temperature, snow particle density;

- Photography and video equipment for recording and archival of site conditions;

3.2 COMMUNICATION INTERFACES

The SPICE site teams are led by their respective Site Managers and are responsible to setup and manage an effective data communication system collecting, transmitting and archiving the site dataset, continuously, or at predefined intervals (e.g. daily) on the Site Data Archive.

As stated in the report of the SPICE IOC-2 meeting (Boulder), it is recommended that 6 s data be collected for gauges in reference systems and instruments under test, where possible; alternatively, 10 s or 60 s sample intervals can be used.
The frequency of the collection of ancillary measurements will be similar to that of the instruments under test, to the extent possible.

Data communication for SPICE includes the following components:

- Instrument to data logger (site specific);
- Instrument to a site data acquisition system located on site, site specific;
- Transmission of SPICE data from the site to a designated Site Data Archive;
- Transmission of SPICE data from the Site Data Archive to SPICE Archive(s) (See Section 7);
- Transmission of gauge-specific and requisite ancillary SPICE data to Instrument Providers for review.

The communication components and any future changes that may impact the availability of instruments will be documented. Any change to the configuration will be subject to a period of testing to ensure that the availability of instrument data is not affected. The IOC will review and accept the final configuration.

3.3 SPICE SITE PROJECT TEAM

The Site Manager will document the membership of the SPICE Site Project Team, including the names of the individuals who are engaged in the SPICE experiment on the respective site. This information will include reference to the roles relative to the SPICE experiment.
During the project, the participation in the SPICE Site Project Team could change. The Site Manager will to update the Site Documentation to reflect the changes (people, roles).

4. PRE-COMMISSIONING ACTIVITIES

The pre-commissioning activities are an integral part of the process of ensuring the quality of the experiment. The following sections detail the pre-commissioning activities ensuring that site infrastructure and procedures are properly managed and documented.

4.1 STATION INSTALLATION AND SCHEDULING

The IOC and the Site Managers will develop target dates for the installation and commissioning of each SPICE Site. An Installation Representative will be identified by the Site Manager to manage the installation.

Site drawings, instrument siting and installation according to national standards, IOC agreed guidelines, or manufacturer recommendations, and exceptions will be documented as part of the POP Report.

4.2 TESTING OF INSTRUMENTS INCLUDED IN THE INTERCOMPARISON

The testing of instruments is conducted by the SPICE Site Project Team. Based on the results, the Site Manager will determine the readiness of instruments and the site for the formal phase of the experiment.

4.2.1 SITE DOCUMENTATION

Technical documentation for each SPICE component will include, but not limited to, the site layout, instruments details and configuration, data collection (including the data format), number of similar instruments, installation details, maintenance standards.
Specific information on the Site Documentation is provided in Appendix A.

4.2.2 MONITORING OF PERFORMANCE

The Site Manager will establish feasible procedures for monitoring the performance of instruments, identifying problems with the data, and initiating and tracking remedial actions. This may include:

- Review data, diagnostic data, quick view plots, QC reports, etc.
- Establishing Site Journals/Blogs documenting the performance and intervention on the instruments (directly – e.g. snow clearing - or indirectly – e.g. system reset -)

4.2.3 SITE MAINTENANCE

The SPICE Site Manager will ensure that site maintenance is available to limit the periods or data outage.

5. COMMISSIONING ACTIVITIES

The commissioning of a SPICE site is led by the Site Manager. The SPICE POP Report will document the status of the site operation at the start of the intercomparison.

The site commissioning process consists of the following steps:

- Determine the instrument readiness, including;
  - ⇒ Installation and configuration of the instruments participating in the experiment;
  - ⇒ Data integrity confirmation at the Site Data Archive;
- Review and approval of the POP Report by the IOC;
- Agreement on the official start of the experiment on the site.

5.1 DETERMINATION OF SITE READINESS

This sub-section details the activities to be conducted following the installation of instruments, and which are completed prior to the official start of the SPICE experiment on the site.

5.1.1 SITE READINESS EVALUATION

The Site Manager will initiate the evaluation of the SPICE Site and will provide to the IOC adequate notice of the SPICE site commissioning.

The IOC will name a representative (the ER) to conduct the evaluation of the Site Documentation prepared by the Site Manager. The ER will work with the Site Manager on the evaluation of the POP Report.

The site readiness evaluation should be sufficient to ensure proper operation of all instruments and interfaces. The assessments will include:

- Satisfactory performance of the field reference system(s).
- Satisfactory performance of each instrument under test.
- Satisfactory performance of instruments providing ancillary measurements.
- Satisfactory performance of site communication components and interfaces.
- Satisfactory performance of the data transmission to the Site Data Archive;
- Proper functioning of service backup capabilities for that particular site, if available.
- Maintenance capacity.

5.1.2 COMPLETION OF POP REPORT

The SPICE Site POP Report documents the readiness of the site and is approved by the IOC.

The POP Report includes:

- A form for recording station information and configuration, including the site layout;
- A form for documenting the configuration of SPICE field working reference configurations, including both manual and automatic measurements;
- Forms for recording the specifications of instruments under test and instruments used to provide ancillary measurements ;
- Details of tests conducted for instrument data validation;
- Details of tests conducted for end-to-end data validation;
- A checklist for all additional documentation to be recorded and submitted ;
- A table for recording commissioning milestones.

The Site Manager will provide the POP Report to the IOC, for final review.

5.1.3 INVOKING WORKAROUNDS

A workaround is a temporary solution to a system limitation that requires special attention and will be removed eventually. Any workarounds will be documented and included as part of the POP Report. Each work-around will be tracked as an open item until resolved.

5.2 APPROVAL OF SITE COMMISSIONING

The Site Manager will notify and update the IOC on the organization and completion of the tests outlined in Appendix A. Once all tests results are verified, the IOC and the Site Manager will agree on the start date of the formal experiment on the site.

In case some of the instruments under test are not ready for the start of the experiment as planned (currently Nov. 15, 2012), the experiment could commence in steps, provided that all field references and key ancillary parameters (wind speed and direction, temperature) have been commissioned.

Commissioning of additional instruments would follow as their configurations are finalized; this will allow for their inclusion in the experiment as early as feasible, with no compromise to the data quality. The Data Analysis Team will take into consideration the commissioning data for each instrument.

5.3 Implementation of Approved SPICE Site Commissioning

Upon commissioning, the site will commence the official collection of the SPICE project dataset and ancillary measurements/observations.

6. Interaction with the Instrument Providers

Instrument Providers are responsible for the delivery of their instruments to the SPICE Sites and for supporting the Site Managers in verifying their proper functioning before and during SPICE.

6.1 Pre-Commissioning Activities: Engagement of the Instrument Providers

During the installation, the Site Manager or a representative will engage the Instrument Provider regarding the preparation of their instruments, to ensure the operation within recommended standards.

The Site Manager would confirm with the Instrument Provider the functioning of the instrument prior to the commissioning of the site. This could be done by the sharing of instrument and/or ancillary data and pictures, coordinated site visits, or any other method agreed upon by the two parties.

The Site Manager should be able to indicate in the Commissioning Report the confirmation from the Instrument Provider that the instrument operates as expected.

6.2 Engagement of Instrument Providers during the Experiment

During the experiment, each Instrument Provider will be given access to the unprocessed output from its own instrument(s), and a minimum set of corresponding ancillary data consisting of air temperature, relative humidity, and wind speed. These data are provided only for ensuring the proper functioning of the instruments, and will neither be reported nor published prior to publication of the SPICE Final Report.

The Site Manager will coordinate the data transfer to the Instrument Provider(s), including such aspects as the frequency, methodology, etc. It is desired that this data transfer is in place prior to the start of the experiment. The Instrument Provider is expected to alert the Site Manager in the event that a

malfunction of an instrument is noted, and provide support to the Site Project team (including site visits), if needed, to address the failure.

The Instrument Providers could visit the intercomparison sites, after prior arrangements are made with the Site Manager.

7. SPICE DATA ARCHIVAL

The SPICE Project Team will establish and maintain a SPICE Archive on at least one SPICE designated Server where the Site Intercomparison Datasets and the Input Documentation will be stored. This will facilitate the preparation of data for the individual and comparative data analysis and the preparation of the Final Report. A description of the data levels and datasets for SPICE, as currently defined, is provided in Appendix B.

The National Centre for Atmospheric Research (NCAR), USA, will host the SPICE Archive and provide quick view capabilities of (near) real time data. Options for a second SPICE Archive are being explored by Environment Canada, Canada.

Each Site Manager will work towards preparing the transfer of Level 1 and Level 2a datasets to the SPICE Archive(s). The IOC will provide to the Site Managers the requirements regarding the data transfer to enable the preparation of datasets (format change, setup of data uploads/availability, etc…)

The data transfer between the Site Data Archive and the SPICE Archive is expected to be established and validated within 3 months of the official start of the experiment, and implemented based on site specific conditions and limitations.

APPENDIX A: PROOF OF PERFORMANCE (POP) FORMS

SECTION A1: STATION INFORMATION

Station name	Mueller Hut, New Zealand
Reference town	N/A
Station latitude	43.72154 °S
Station longitude	170.06493 °E
Station elevation in metres	1818 Meters

General Exposure of Station:

The station is situated in a gently, north-west sloping shallow basin which is part of a much greater and steep north-south running ridge. From the station, the ground slopes down gently to the west and north-west. After approximately 200m, the ground drops sharply into the valley. The main ridge crest runs from high above the station to the south in a northerly direction, crossing the same elevation as the station approximately 100m north-east of the site. This crest passes to the east of the station approximately 150m away, beyond which, the ground drops very steeply to the valley floor. The summit (Mt Olliver) at 1933m is to the south, approximately 500m. Mueller Hut (DoC) is about 40m west of the mast, at a lower elevation.

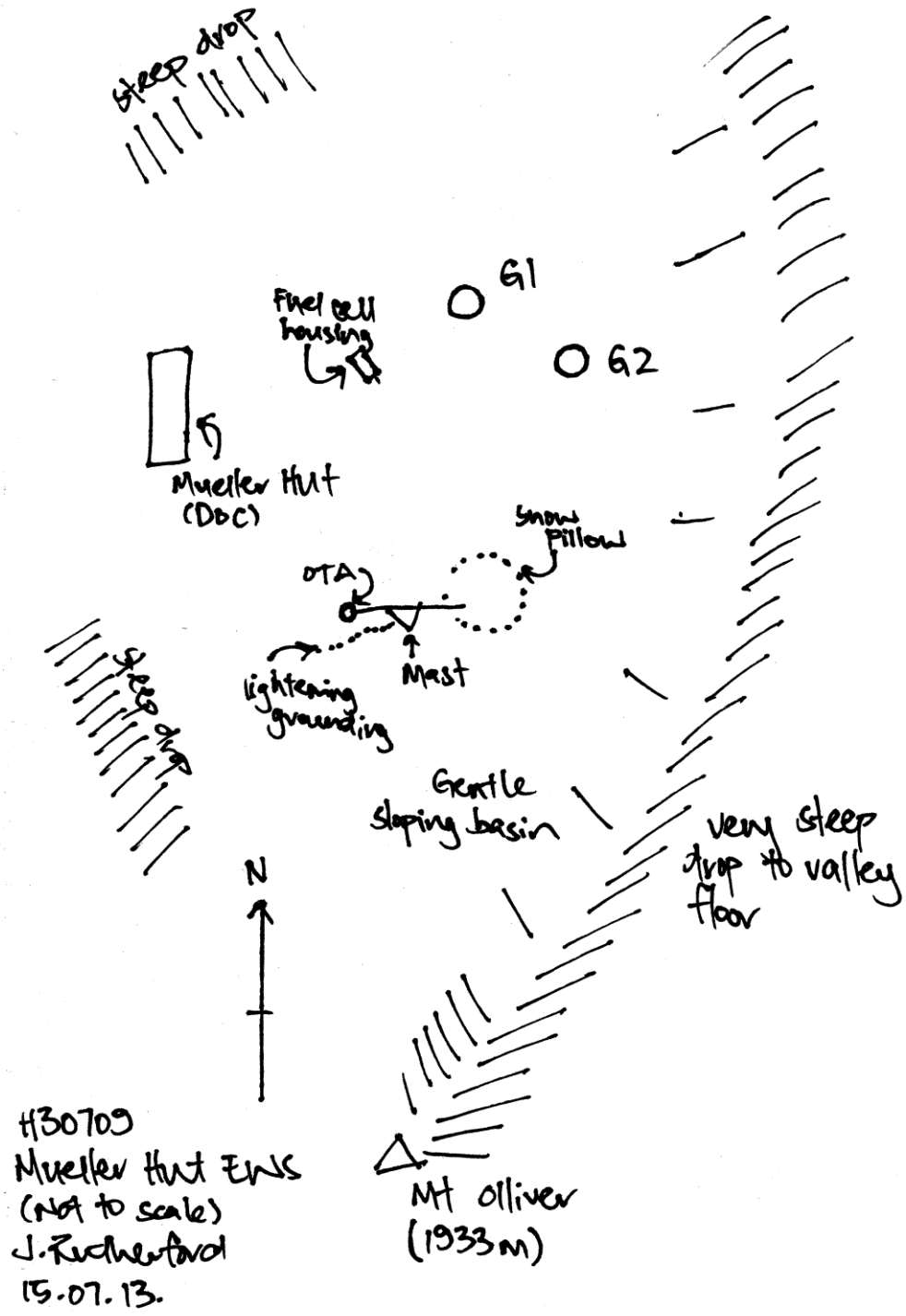
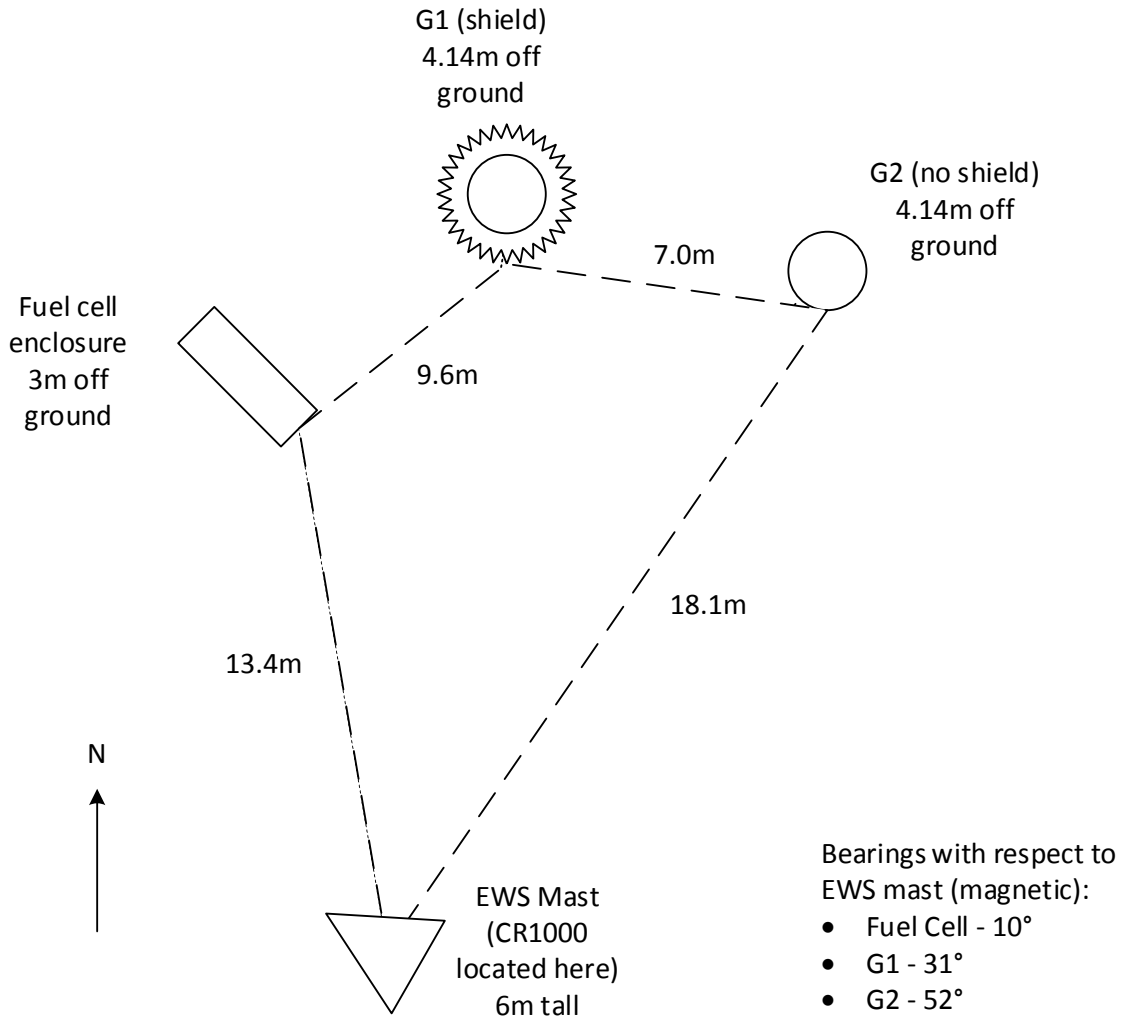


Figure 1: Site layout Mueller Hut climate station



Muller Hut installation – instrument layout detail (not to scale)
J. Rutherford
19.09.13

Figure 2: Mueller Hut climate station site layout detail

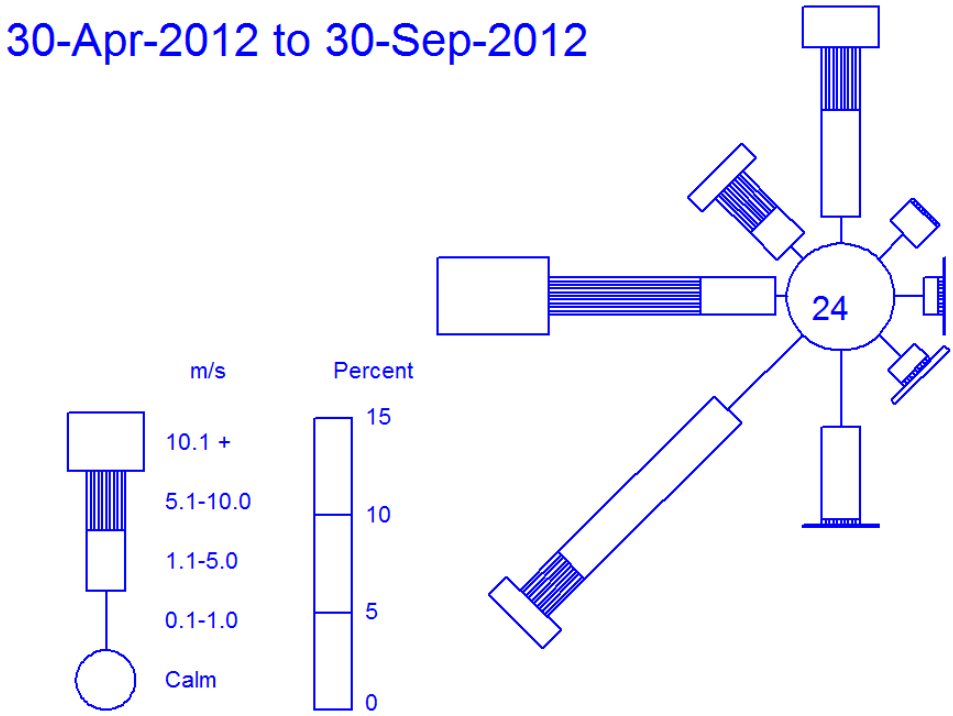


Figure 3: Wind rose plot for the winter of 2012 (30/4/2012 to 30/9/2012) from the Mueller Hut climate station, showing the direction of the prevailing winds.

Photo 1: Looking North 13 July 2013

Photo 2: Looking North-West 13 July 2013

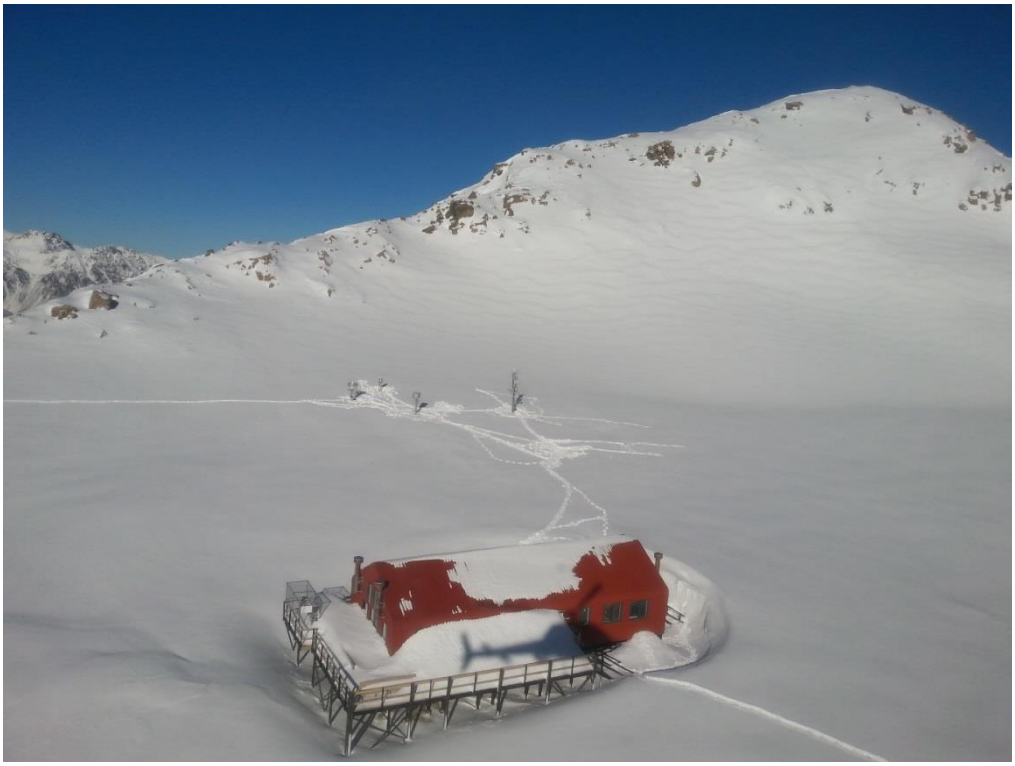


Photo 3: Looking South-East 13 July 2013

Photo 4: Looking South 13 July 2013

Photo 5: Looking West 23 April 2013

Photo 6: Site overview – from left G2, G1, Efoy fuel cell housing, EWS mast. (looking south-east) 13 July 2013

SECTION A2: SPICE FIELD WORKING REFERENCE SYSTEM CONFIGURATION

Field Reference Type R3 (Automatic)

Presence of a WG with a single Alter shield?	☒ Yes ☐ No
Presence of a WG with no shield?	☒ Yes ☐ No
Description of surrounding obstacles (including distance/direction from, height, and type)	Refer to general exposure of station comment and Figure 2 in section A1
Distance between WGs (as close as possible, but exceeding minimum distance between gauges for a Class 1 siting configuration (as per WMO guidelines): Generally a flat area within 10m of instrument. This area surrounded by generally open space with a slope of less than 1:3 (19°) that is considered to be representative of the large scale area.	Refer to Figure 2 in section A1

Weighing gauge G1 (1 of 2)

Make and model	GEONOR T-200B (1500mm capacity) – Single alter shield
Serial number	VW transducers 20913 (G1-S1), 21013 (G1-S2), 21113 (G1-S3)
Firmware version (if applicable)	N/A
Number of transducers (if applicable)	3
Height of installation (measured from the top of the gauge)	4.14 above ground
Heater configuration and algorithm	EFOY fuel cell power supply. 2 heaters on inlet as per NOAA installation manual. Both heaters on simultaneously for 4 minutes in each 15 minute period when temperature is below 2°C
Output data message format	csv file
Frequency of data sampling	hourly

Weighing gauge G2 (2 of 2)

Make and model	GEONOR T-200B (1000mm capacity) – No alter shield
Serial number	VW transducers 21213 (G2-S1), 21313 (G2-S2), 21413 (G2-S3)
Firmware version (if applicable)	N/A
Number of transducers (if applicable)	3
Height of installation (measured from the top of the gauge)	4.14
Heater configuration and algorithm	EFOY fuel cell power supply. 2 heaters on inlet as per NOAA installation manual. Both heaters on simultaneously for 4 minutes in each 15 minute period when temperature is below 2°C
Output data message format	csv
Frequency of data sampling	hourly

Single Alter shield

According to the SPICE instructions?	☒ Yes ☐ No
Attached to the post of the weighing gauge?	☒ Yes ☐ No
If different, provide details:	

Precipitation detector

Make and model	Campbell CR1000
Data output format	csv file
Data sampling frequency	Hourly
Height of installation.	4.5m above ground
Location of installation relative to WGs in reference system.	Refer to Figure 2 in section A1

Pictures: Field Reference Type R3 (Automatic).

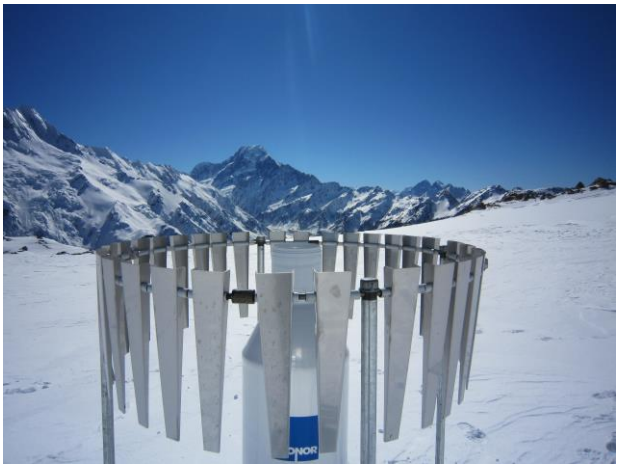


Photo 7: Weighing Gauge 1 (G1)

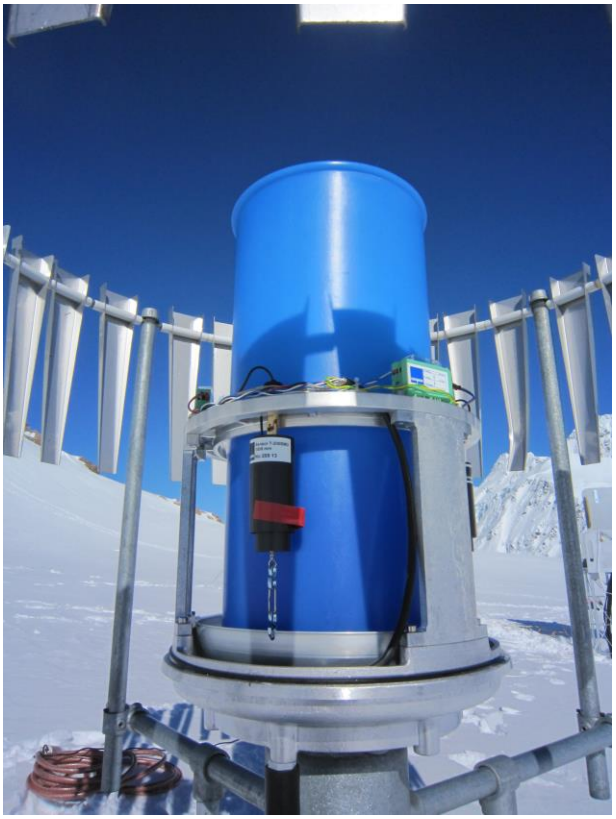


Photo 8: Weighing Gauge 1 – cover removed

Photo 9: Weighing Gauge 2 (G2)

Photo 10: Weighing Gauge 2 – cover removed

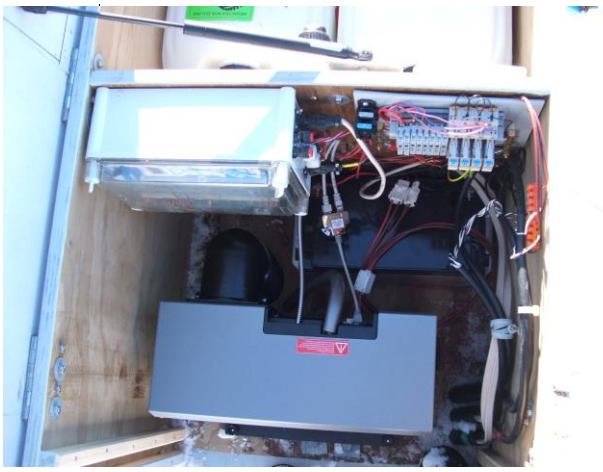


Photo 11: Geonor heater control and EFOY generator

Photo 12: EFOY generator fuel cells (2x M28 Ethanol)

Table: Field Calibration of Reference Type R3 (Automatic) Weighing Gauges 1 and 2

Table 1: Calibration precipitation volumes, sensor values and variances for WG G1

	Transducer value (mm)			Variance (%)		
Precipitation amount (mm)	G1-S1	G1-S2	G1-S3	G1-S1	G1-S2	G1-S3
0	1.4	0.1	-0.5			
75	67.4	68.4	69.3	-10.19	-8.83	-7.55
150	141.6	143.1	144.5	-5.60	-4.60	-3.67
225	215.5	218.0	219.8	-4.22	-3.11	-2.31
300	289.9	293.5	295.5	-3.37	-2.17	-1.50
375	363.1	367.9	369.8	-3.17	-1.89	-1.39
450	437.5	442.7	445.3	-2.78	-1.62	-1.04
525	511.8	518.2	521.1	-2.51	-1.30	-0.74
600	584.9	592.2	595.6	-2.52	-1.30	-0.73
675	659.5	667.1	671.6	-2.30	-1.17	-0.50
750	733.5	742.4	746.6	-2.20	-1.01	-0.45

Table 2: Precipitation and sensor increments and variances for WG G1

	Transducer increments			Variance (%)		
Precipitation incremental increase (mm)	G1-S1	G1-S2	G1-S3	G1-S1	G1-S2	G1-S3
75.0	66.0	68.3	69.8	-11.99	-8.98	-6.88
75.0	74.2	74.7	75.2	-1.01	-0.37	0.21
75.0	73.9	74.9	75.3	-1.47	-0.13	0.40
75.0	74.4	75.5	75.7	-0.80	0.67	0.93
75.0	73.2	74.4	74.3	-2.40	-0.80	-0.93
75.0	74.4	74.8	75.5	-0.80	-0.27	0.67
75.0	74.3	75.5	75.8	-0.93	0.67	1.07
75.0	73.1	74.0	74.5	-2.53	-1.33	-0.67
75.0	74.6	74.9	76.0	-0.53	-0.13	1.33
75.0	74.0	75.3	75.0	-1.33	0.40	0.00

Table 3: Laboratory calibration sensor frequencies and observed sensor frequencies for WG G1

	Calibration frequency			Observed frequency			Variance (%)		
Precipitation amount (mm)	G1-S1	G1-S2	G1-S3	G1-S1	G1-S2	G1-S3	G1-S1	G1-S2	G1-S3
0	1085.2	1099.2	1092.4	1090	1099	1091	0.44	-0.02	-0.13
150	1501.9	1513.5	1502.5	1484	1500	1492	-1.19	-0.89	-0.70
300	1816.7	1828.3	1814.9	1799	1817	1808	-0.97	-0.62	-0.38
450	2079.8	2091.9	2077.0	2060	2081	2070	-0.95	-0.52	-0.34
600	2310.8	2323.1	2306.9	2288	2312	2300	-0.99	-0.48	-0.30
750	2518.4	2531.5	2514.2	2496	2521	2509	-0.89	-0.41	-0.21

Table 4: Calibration precipitation volumes, sensor values and variances for WG G2

	Transducer value (mm)			Variance (%)		
Precipitation amount (mm)	G2-S1	G2-S2	G2-S3	G2-S1	G2-S2	G2-S3
0	7.6	0.5	1.0			
75	82.3	73.2	75.8	9.73	-2.35	1.01
150	150.8	148.9	150.7	0.53	-0.73	0.47
225	225.6	223.7	225.8	0.27	-0.58	0.36
300	300.6	298.4	301.1	0.20	-0.53	0.37
375	374.7	371.4	375.5	-0.08	-0.96	0.13
450	450.1	445.1	451.1	0.02	-1.09	0.24
525	525.4	518.3	526.8	0.08	-1.28	0.34
600	600.0	590.4	601.9	0.00	-1.60	0.32
675	675.4	662.8	678.2	0.06	-1.81	0.47
750	750.4	734.4	754.1	0.05	-2.08	0.55

Table 5: Precipitation and sensor increments and variances for WG G2

	Transducer increments			Variance (%)		
Precipitation incremental increase (mm)	G2-S1	G2-S2	G2-S3	G2-S1	G2-S2	G2-S3
75.0	74.7	72.7	74.8	-0.36	-3.05	-0.30
75.0	68.5	75.7	74.9	-8.67	0.88	-0.08
75.0	74.8	74.8	75.1	-0.27	-0.27	0.13
75.0	75.0	74.7	75.3	0.00	-0.40	0.40
75.0	74.1	73.0	74.4	-1.20	-2.67	-0.80
75.0	75.4	73.7	75.6	0.53	-1.73	0.80
75.0	75.3	73.2	75.7	0.40	-2.40	0.93
75.0	74.6	72.1	75.1	-0.53	-3.87	0.13
75.0	75.4	72.4	76.3	0.53	-3.47	1.73
75.0	75.0	71.6	75.9	0.00	-4.53	1.20

Table 6: Laboratory calibration sensor frequencies and observed sensor frequencies for WG G2

	Calibration frequency			Observed frequency			Variance (%)		
Precipitation amount (mm)	G2-S1	G2-S2	G2-S3	G2-S1	G2-S2	G2-S3	G2-S1	G2-S2	G2-S3
0	1076.8	1084	1092.8	1110	1086	1097	3.08	0.18	0.38
75	1370.0	1375.4	1382.2	1395	1371	1386	1.82	-0.32	0.27
150	1604.5	1610.6	1616.2	1608	1609	1620	0.22	-0.10	0.24
225	1806.0	1813.0	1817.8	1808	1811	1821	0.11	-0.11	0.18
300	1985.6	1993.1	1997.3	1987	1990	2000	0.07	-0.16	0.14
375	2148.8	2157.2	2161.0	2148	2150	2162	-0.04	-0.33	0.05
450	2299.4	2308.5	2312.0	2299	2299	2314	-0.02	-0.41	0.09
525	2440.1	2449.9	2453.0	2440	2437	2456	0.00	-0.53	0.12
600	2572.5	2582.9	2585.8	2572	2566	2589	-0.02	-0.65	0.12
675	2697.7	2709.0	2711.5	2698	2688	2716	0.01	-0.78	0.17
750	2817.0	2828.9	2831.3	2817	2804	2837	0.00	-0.88	0.20

NOTE: In the above tables, the column “Precipitation amount” is a running total of additions of 75mm (1.500 kg) of water, with each addition being measured separately.

The transducer readings for G1 at 75mm of precipitation (Table 1) would suggest an error in the volume of water added to the bucket. All three transducers under-recorded by a similar amount. This error is somewhat nullified by Table 2 where the transducer increments are compared with the calibration increase (75mm of precipitation).

All transducer values are 5 minute means.

48h Plots. Field Reference Type R3 (Automatic). Weighing Gauges 1 and 2

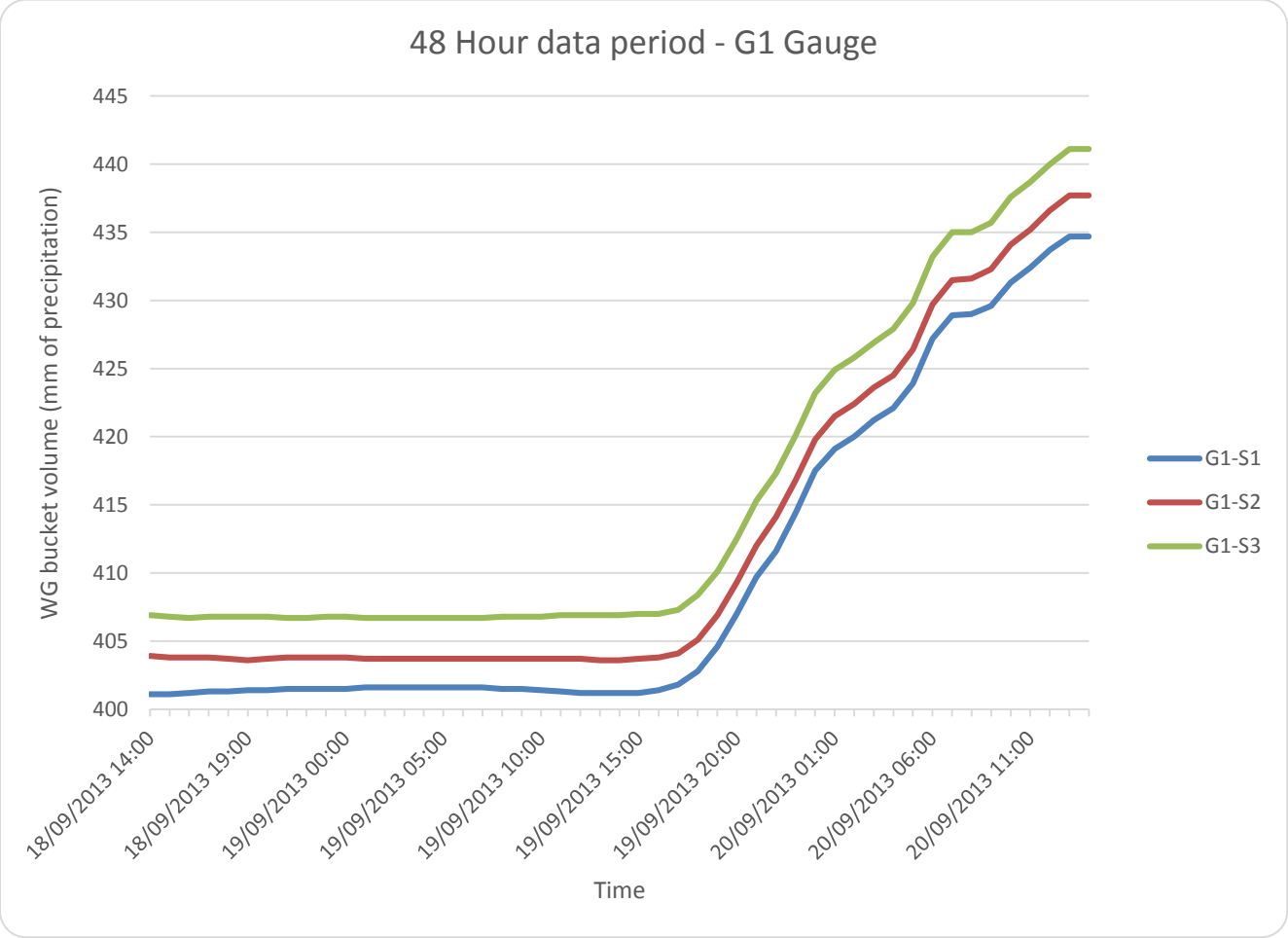


Figure 4: 48 hour period of data following installation and field calibration - WG G1

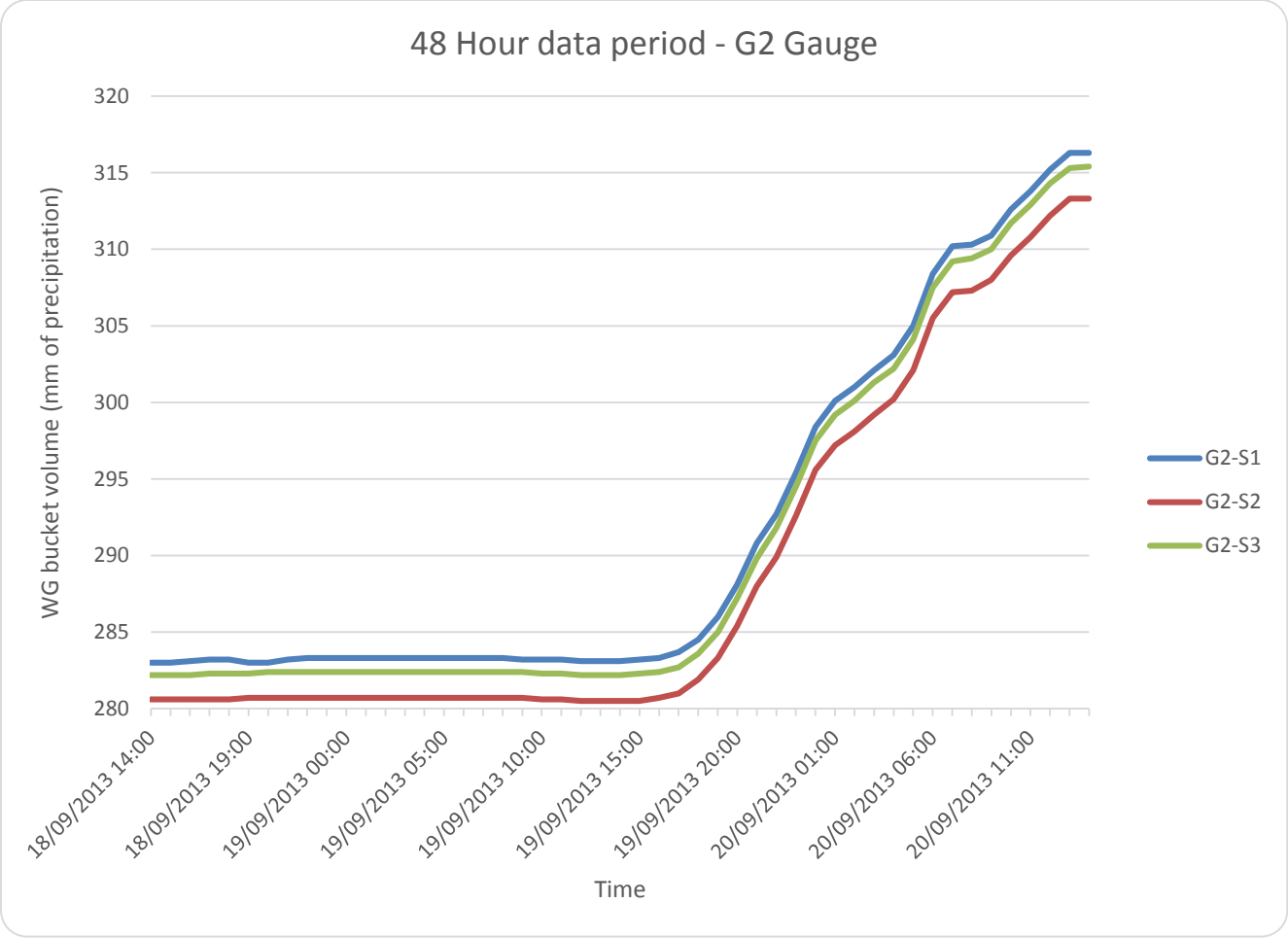


Figure 5: 48 hour period of data following installation and field calibration - WG G2

Field Reference for the Measurement of Snow on the Ground

Method used	Downward facing ultra-sonic sensor on the adjacent mast
Equipment used	Campbell Scientific SR50A and CR1000
Frequency of measurement	Hourly

Picture. Field Reference for the Measurement of Snow on the Ground

Photo 13: General mast layout (Vega radar and Vaisala wind sensor no longer present – December 2012). SR50A located on the right-hand protruding arm.

Photo 14: SR50A detail – Vega radar no longer used (December 2012)

Table. Field Calibration for the Measurement of Snow on the Ground

Table 7: Field calibration values for SR50A snow depth sensor

Date	Measured distance (Sensor to snow) (m)	Sensor distance (m)	Derived snow depth (m)
17.09.2013	1.34	1.34	2.55
12.07.2013	2.40	2.40	1.49

48h Observation Plot. Field Reference for the Measurement of Snow on the Ground

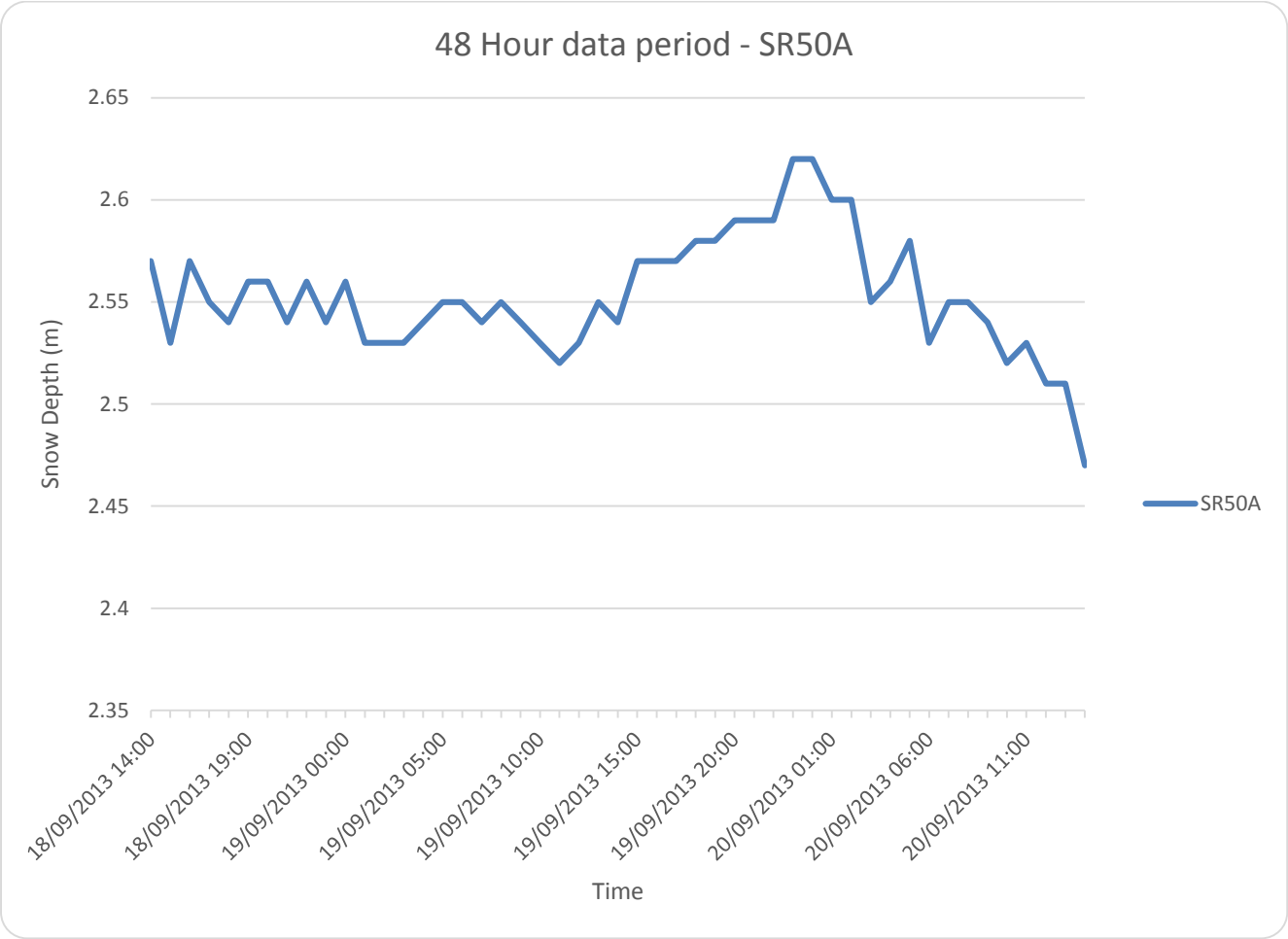


Figure 6: 48 hour period of data from SR50A snow depth sensor

SECTION A3: INSTRUMENT METADATA REPORT

For each instrument under test and each instrument used to provide ancillary measurements, an Instrument Metadata Report should be completed in full and submitted as part of the POP Report.

Instrument Metadata Report

> *IMPORTANT: Please copy this form (as necessary) and complete separately for each instrument under test and each instrument that will be used to provide ancillary measurements during WMO SPICE.*

Instrument Name: Wind Sensor
Instrument number 1 of 3

Manufacturer	RM Young
Model	Wind monitor
Serial number	WM93682
Firmware version (if applicable)	N/A

Field configuration

Location on site	On top of EWS mast
Orientation	True north (340°N magnetic)
Height (measured at top)	6m above ground
Shield (if applicable)	N/A
Heating (if applicable)	N/A

Data output

Data communication protocol	UDP
Output data message format (include description of fields)	Wind speed (m/s): 10 min mean, max gust and standard deviation, 1 hour mean, max gust and standard deviation. Wind direction (° True): 10 min mean, max gust direction and standard deviation, 1 hour mean, max gust direction and standard deviation.
Data sampling frequency	Hourly

Instrument Picture.

Photo 15: RM Young Wind Monitor. Vaisala ultra-sonic wind sensor (right hand instrument in this picture) no longer used

Field calibration (if any).

Table 8: Field calibration of wind sensor - wind speed

Reference	Sensor (m/s)
0.00 (stopped)	0.00
Very light air	0.21

Table 9: Field calibration of wind sensor - wind direction

Reference (true bearing)	Sensor (true bearing)
N (0)	1.52
E (90)	90.00
S (180)	179.36
W (270)	273.36

48h Plot.

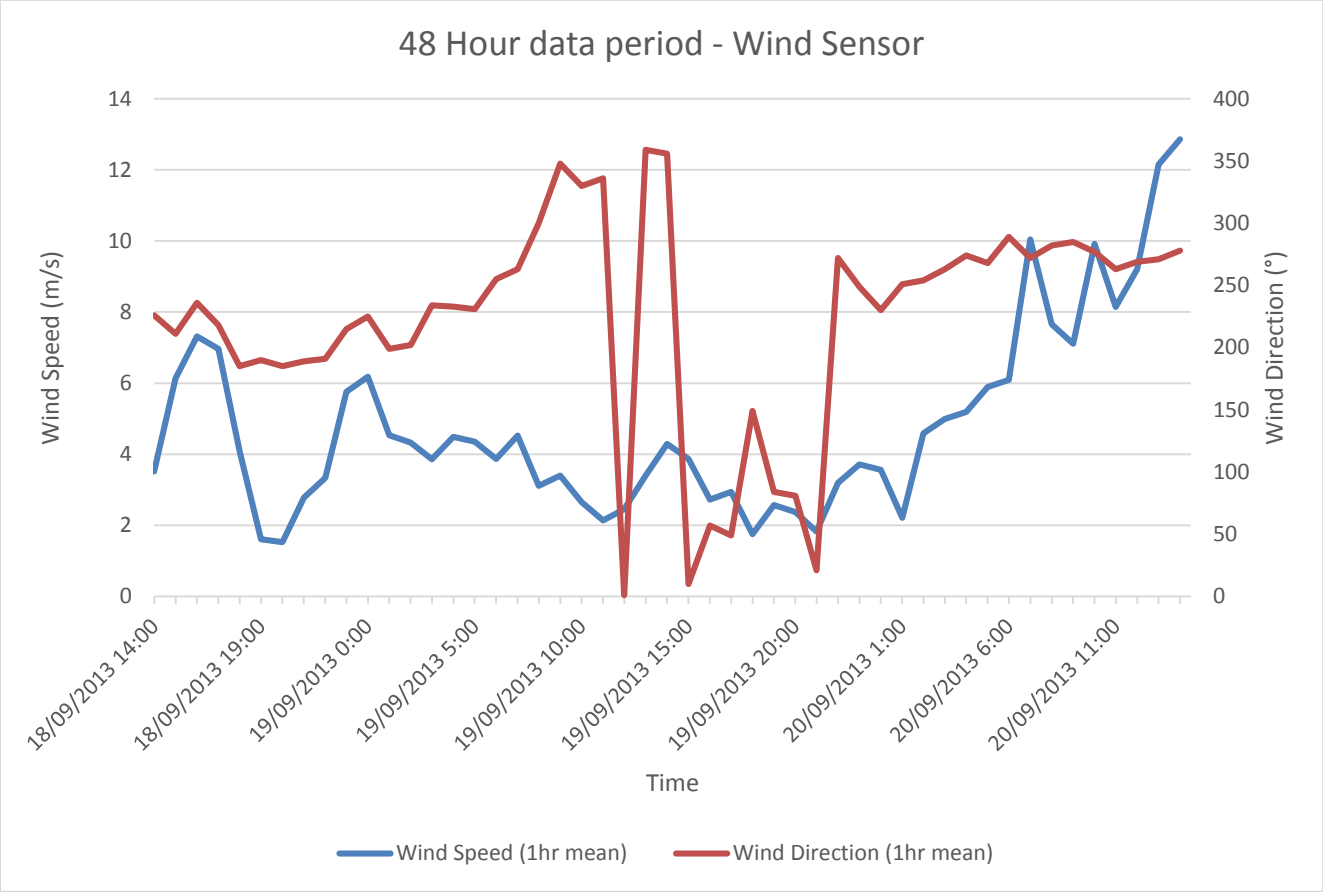


Figure 7: 48 hour period of data from wind sensor (wind speed and direction, 1 hour means)

Instrument Name: Air Temperature and Humidity
Instrument number 2 of 3

Manufacturer	Vaisala
Model	HMP45D
Serial number	U4120008
Firmware version (if applicable)	N/A

Field configuration

Location on site	On EWS mast
Orientation	
Height (measured at top)	4m above ground
Shield (if applicable)	Radiation disc
Heating (if applicable)	N/A

Data output

Data communication protocol	UDP
Output data message format (include description of fields)	Air temperature (°C): 1 minute mean, 1 hour mean, max and min. Relative humidity (%): 1minute mean, 1 hour mean
Data sampling frequency	Hourly

Instrument Picture.

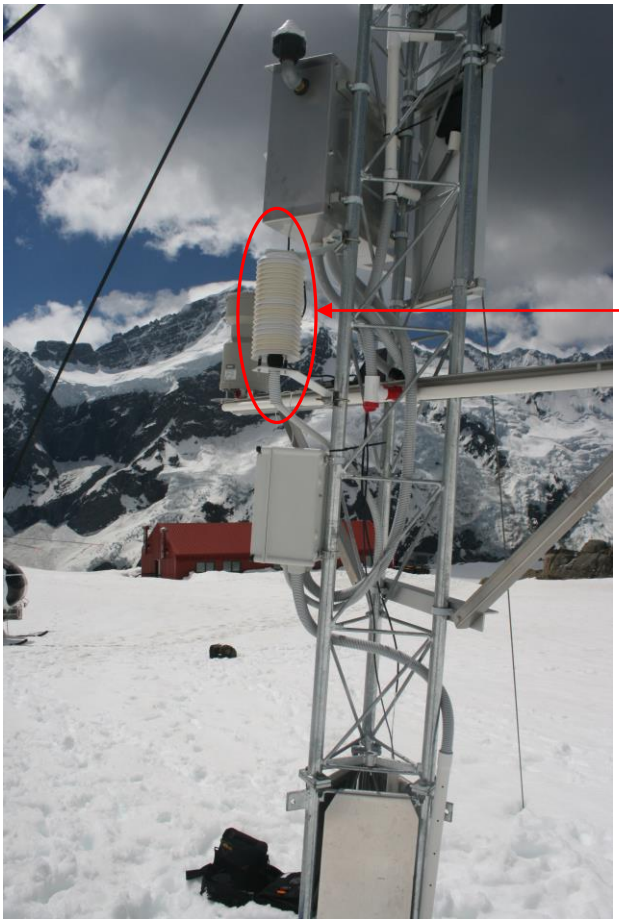


Photo 16: Air temperature and relative humidity sensor location on mast

Field calibration (if any).

Table 10: Field calibration of temperature sensor

Reference (°C)	Sensor (°C)
2.2	2.50
2.5	2.80
2.7	2.95
2.8	3.08

Table 11: Field calibration of humidity sensor

Reference (%)	Sensor (%)
12.6	12.12
11.6	11.30
10.7	10.63
10.8	10.15

48h Plot.

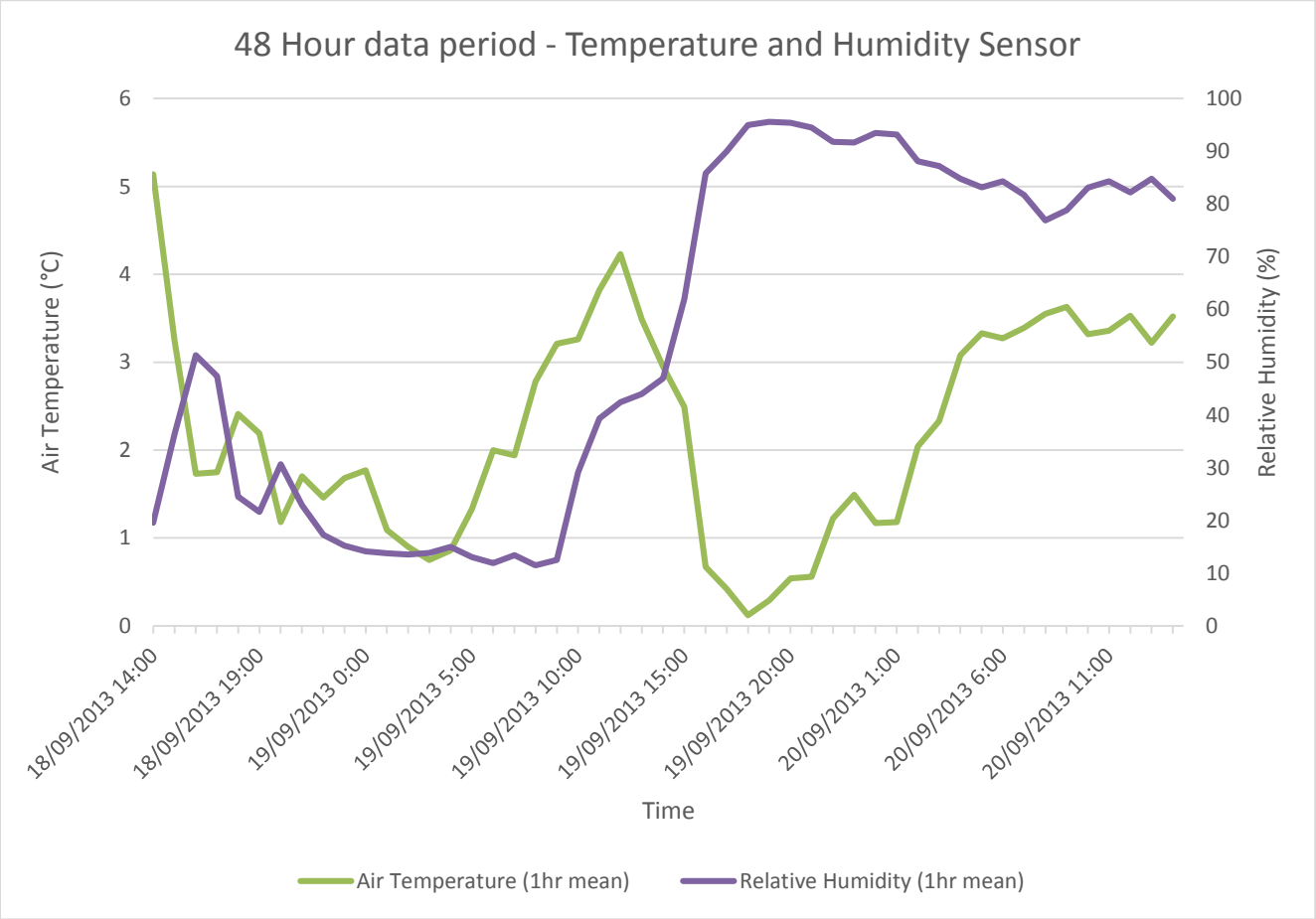


Figure 8: 48 hour period of data from the air temperature and relative humidity sensor (1 hour means)

Instrument Name: Solar Radiation
Instrument number 3 of 3

Manufacturer	Li-Cor
Model	Pynarometer LI 200
Serial number	PY67723
Firmware version (if applicable)	N/A

Field configuration

Location on site	On top of EWS mast
Orientation	
Height (measured at top)	6m above ground
Shield (if applicable)	N/A
Heating (if applicable)	N/A

Data output

Data communication protocol	UDP
Output data message format (include description of fields)	Solar Radiation (w/m^2)
Data sampling frequency	Hourly

Instrument Picture.

Photo 17: Solar radiation sensor location viewed from the base of the mast

Field calibration (if any).

Table 12: Field calibration of the solar radiation sensor

Reference (w/m²)	Sensor (w/m²)
0.00 (sensor covered)	-0.49
229.35	231.97

48h Plot.

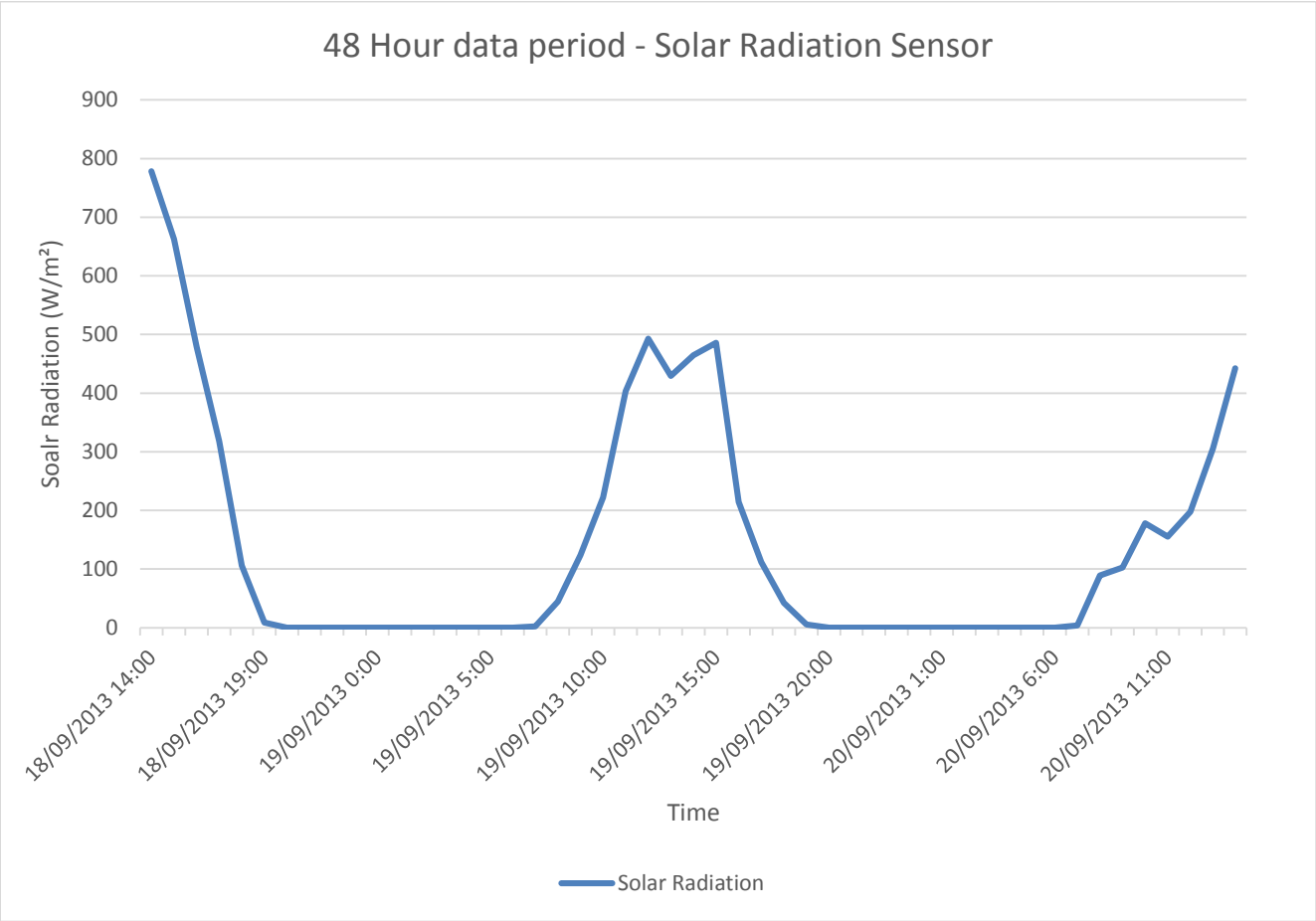


Figure 9: 48 hour period of data from the solar radiation sensor

SECTION A4: CONFIRMATION OF EXPERIMENT CONFIGURATION

TEST 1: INSTRUMENT CALIBRATION AND CHECKS

The Site Manager will organize the check and calibration of each instrument included in the experiment (as part of the reference, or as an instrument under test). The check sheets and calibration results will be included in the designated areas of Sections A2 and A3.

- The calibration and check of the WG used as part of the reference will be conducted based on the guidelines adopted by the SPICE IOC.
- The calibration and check of the instruments under test will be conducted as specified by the manufacturer prior to the installation on the SPICE site, as well as following the installation in the field.

TEST 2: INSTRUMENT VALIDATION

After the field installation of each instrument (both those that are part of the reference and those that are instruments under test), at the minimum, a **continuous 48 hour data set** of the entire test setup will be stored and examined as an indication of instrument performance**.** The data sets for each instrument included in the intercomparison will be reviewed for data integrity and representativeness, against the predefined data format.

The evaluation of the instrument performance at this stage will be conducted using the 48 hour time series plots provided in Sections A2 and A3. The readiness state of each instrument will be reported in the Instrument Data Validation table below.

Any discrepancies will be investigated, addressed, and documented. Following the resolution of the discrepancies, the 48-hour end to end (e2e) test will be repeated. Notes, plots, logs, will be appended to the POP table of the reference/instrument under test, and the readiness state and date will be updated in the Instrument Data Validation table.

TEST 3: SITE-TO-ARCHIVE TRANSFER VALIDATION

Once the transfer of site data files to the SPICE Data Archive at NCAR has been initiated, compare the site data with those received at the SPICE Data Archive for a 24 hour period to ensure that no errors occurred during archival or transmission.
If any errors occur, log them and following the resolution of the discrepancies, repeat the 24-hour validation test.

When the Test 3 is passed mark the check box YES in the Instrument Data Validation table below (this means that they have been also validated), with the starting date of the data transfer.

If Test 3 is not passed at the time of the Commissioning Report tick the checkbox NO and provide the expected date.

(Plots, datasets, errors logs, referred to Test 3 are **NOT** included in this document but archived by the site manager if further tests or analysis are required),

IMPORTANT: *Test 2 and Test 3 may be conducted simultaneously, depending on the site configuration.*

Instrument Data Validation

Instrument	Readiness (if Yes, indicate the date)	Data transfer to NCAR archive (**Test 3**) (If the answer is No report the expected date)	Comments
	☐ Yes ☐ No Date:	☐ Yes ☐ No Date:	

SECTION A5: SITE DOCUMENTATION CHECKLIST

A **Site Documentation Checklist** is provided below to track the inclusion of requisite documentation, data plots, and photos in sections A1 to A4.

Site Documentation Checklist

Site information and layout (Section A1)	☑ Included
Complete set of pictures documenting the overall site installation - views from N, E, S, W (Section A1)	☑ Included
Details of manual measurement procedure (Section A2)	☑ Included ☐ Not Applicable
Instrument Metadata Reports for all instruments under test and all instruments used to provide ancillary measurements (Section A3)	☑ Included
Calibration results and check sheets for all instruments (Sections A2, A3)	☑ Included
Instrument data validation:, 48h time series plots (Sections A2, A3)	☑ Included
Instrument data validation table (Section A4)	☑ Included
48h Instrument data validation: discrepancy reports (Section A4)	☐ Included ☑ Not Applicable
Pictures of installations of all reference instruments, instruments under test, and instruments used to provide ancillary measurements (Sections A2, A3)	☑ Included
End-to-end data validation (Section A4; see Instrument data validation table).	☐ Full (all gauges) ☐ Partial (some gauges) ☐ No
SPICE archive end-to-end data validation: discrepancy reports (Section A4)	☐ Yes ☑☐ No

Details of any workarounds (Sections A2, A3, A4)	☐ Included ☑☐ Not Applicable

APPENDIX B: SPICE DATA LEVELS AND DATASETS

Details of the different levels of data and associated datasets for SPICE are included below. **The present document addresses only data up to and including Level 2a.** Data of higher levels, and the associated datasets, are tentatively defined here for completeness.

Data Levels:

Level 1 data: are those collected as the output of each individual instrument, which have been converted into geophysical measurements (e.g. weight, mass, intensity), generally with high temporal resolution, and before any significant data quality control has been applied. A **Level 1** dataset contains data from only one instrument at one site.

Level 2a data: are time-synchronized data resulting from the sampling, averaging or some other signal/data processing having been applied to **Level 1** data from an individual instrument in order to separate signal from noise. These data have not been quality controlled, and should be used only for monitoring an instrument's status. A **Level 2a** dataset contains data from only one instrument at one site.

Level 2b data: are time-synchronized **Level 2a** data after a basic data quality control procedure has been applied. Basic data quality flags for validity and quality have been added. Missing records have been created and filled with a missing data quality indicator. A **Level 2b** dataset contains data from only one instrument at one site.

Level 3 data: derived by combining and further processing all **Level 2b** datasets from a site. At this level, advanced and multiple instrument data quality techniques have been applied. A **Level 3** dataset contains data from all instruments at an individual site.

Level 4 data: derived after performing an intercomparison of the **Level 3** data from one or more sites, taking into account snow climatology, wind regimes, temperatures, etc., and where applicable, differences in these from one site to another.

Datasets:

SPICE Site Dataset: A dataset comprising all **Level 1, 2a, 2b and 3** datasets from that Intercomparison Site.

SPICE Intercomparison Dataset: this is the Level 4 dataset that combines the **Level 3** data from all SPICE intercomparison sites. The **Project Team** will develop the **SPICE Intercomparison Dataset** using the Level 3 datasets from each **Intercomparison Site.** It contains summary Level 3 data and intercomparison data for all instruments and all sites.

The SPICE Dataset: The total SPICE dataset including all **SPICE Site Datasets**, **Site Documentation** and **Instrument Documentation** for all participating sites and instruments, the **SPICE Intercomparison Dataset,** and all SPICE analysis and assessment documentation.

APPENDIX C: ACRONYMS AND ABBREVIATIONS

DFIR	Double-Fence Intercomparison Reference
e2e	End-to-end
ER	Evaluating Representative
IOC	International Organizing Committee
IR	Installation Representative
NCAR	National Center for Atmospheric Research (USA)
POP	Proof of Performance
QC	Quality control
R0	Working field reference configuration 0: manual or automatic precipitation gauge in bush
R1	Working field reference configuration 1: manual precipitation gauge in DFIR
R2	Working field reference configuration 2: automatic weighing gauge in DFIR
R3	Working field reference configuration 3: two automatic weighing gauges; one shielded (single-Alter), one unshielded
SPICE	Solid Precipitation Intercomparison Experiment
SWE	Snow water equivalent
WG	Weighing gauge
WMO	World Meteorological Organization