WMO SPICE

SITE COMMISSIONING PROTOCOL

V3.1 (JUL, 23 2013)

TABLE OF CONTENTS

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	Guthega Dam Weather Station
Reference town	Jindabyne
Station latitude	36.3773° S
Station longitude	148.3706° E
Station elevation in metres	1586 m

Insert here a Site Layout indicating the location of SPICE references and all instruments, including distances and the direction of the prevailing winter winds.

Synoptically, the prevailing winds are from the west during winter. Winds at the site are influenced by local topography and are most frequently from directions between the north and the southwest.

Instruments not referenced in the legend:

Location	**Additional instruments**
½ DFIR – ETI NOAH II	NRG IceFree3 anemometers inside the inner fence and outside the outer fence
DFIR – ETI NOAH II	NRG IceFree3 anemometer and Thies Precipitation Sensor inside the inner fence
Tipping Bucket Gauge Hut	Vaisala HMP45A humidity and temperature probe
ETI NOAH II Alter shield	NRG IceFree3 anemometer and wind vane

Guthega Dam

Weather Station configuration for WMO-SPICE

Asset Detail

Easting: 622,937mE
Northing: 5,973,327mN
Latitude: -36.377323
Longitude: 148.370551
Elevation: 1,586m

- 1/2 DFIR - ETI NOAH II
- 10m Anemometer Mast
- DFIR - ETI NOAH II
- Geonor T-200BM3 No Shield
- Geonor T-200BM3 Alter Shield
- Tipping Bucket Gauge Hut
- ETI NOAH II Alter Shield

snowy hydro
renewable energy

Insert here a set of pictures documenting the overall site installation (views from N, E, S, W).

It is suggested to submit here also a horizon / sky view diagram taken with a camera., if available

FROM THE NORTH:

FROM THE WEST:

FROM JUST WEST OF SOUTH:

FROM THE EAST:

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)	The weather station is located on a raised outcrop running approximately north-south between Guthega Reservoir on the western side and the Snowy River on the eastern side. The gauge with the Alter shield has full exposure to westerly and southerly winds. The unshielded gauge is on the eastern boundary of the site, and is located 10-15 m from the DFIR and Half DFIR fences.
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.	Approximately 50 m. The two R3 gauges are located on opposite sides of the DFIR fence.

Weighing gauge (1 of 2)

Make and model	Geonor T-200BM3
Serial number	Sensor 1: 69613; Sensor 2: 69413; Sensor 3: 69913
Firmware version (if applicable)	N/A
Number of transducers (if applicable)	3
Height of installation (measured from the top of the gauge)	3 m

Heater configuration and algorithm	Two 12 V, 5.1 Ohm heating elements have been applied to the outer surfaces of the gauge inlet (with the lower element being within the main housing of the gauge). A thermistor is attached to the outside of the upper inlet, and the heater is turned on when the inlet temperature is between -5 and +2 °C.
Output data message format	Data are logged in four buffers: Buffer 0 (1 min): Sensor 1 frequency, Sensor 2 frequency, Sensor 3 frequency; Buffer 1 (1 min): Inlet temperature Buffer 2 (15 s, event logging): Inlet heater status Buffer 3 (3 hour): Battery voltage
Frequency of data sampling	1 minute. (Data logger has a scan rate of 15 s. The values logged once per minute are the average sensor frequencies over the past 15 s.)

Weighing gauge (2 of 2)

Make and model	Geonor T-200BM3
Serial number	Sensor 1: 69713; Sensor 2: 69513; Sensor 3: 69813
Firmware version (if applicable)	N/A
Number of transducers (if applicable)	3
Height of installation (measured from the top of the gauge)	3 m
Heater configuration and algorithm	Two 12 V, 5.1 Ohm heating elements have been applied to the outer surfaces of the gauge inlet (with the lower element being within the main housing of the gauge). A thermistor is attached to the outside of the upper inlet, and the heater is turned on when the inlet temperature is between -5 and +2 °C.
Output data message format	Data are logged in four buffers: Buffer 0 (1 min): Sensor 1 frequency, Sensor 2 frequency, Sensor 3 frequency; Buffer 1 (1 min): Inlet temperature Buffer 2 (15 s, event logging): Inlet heater status

	Buffer 3 (3 hour): Battery voltage
Frequency of data sampling	1 minute. (Data logger has a scan rate of 15 s. The values logged once per minute are the average sensor frequencies over the past 15 s.)

Single Alter shield

According to the SPICE instructions?	☒ Yes ☐ No
Attached to the post of the weighing gauge?	☒ Yes ☐ No
If different, provide details:	The gauge is mounted on a steel pedestal, which contains a data logger, battery and associated electrical and measurement components. The Alter shield is attached to this pedestal. The shield itself was fabricated according to the SPICE specifications.

Precipitation detector

Make and model	Thies Precipitation Monitor 5.4103.10.000 (serial no. 05132391)
Data output format	Binary (0 = no precipitation, 1 = precipitation). The sensor is configured to switch on following 3 particles within 50 s and switch off following a period of 25 s with no incidences.
Data sampling frequency	15 s event logging
Height of installation.	40 cm below the top of inner DFIR fence, approximately 260 cm above the ground. This height was chosen so that the sensor sits above and is not sheltered by the horizontal railing on the fence.
Location of installation relative to WGs in reference system.	The precipitation detector is located on the inside of the inner DFIR fence on the northern side. The DFIR fence is located between the shielded and unshielded gauges of

	the R3 reference.

Pictures. Field Reference Type R3 (Automatic).

Weighing Gauge 1

Weighing Gauge 2

Precipitation detector

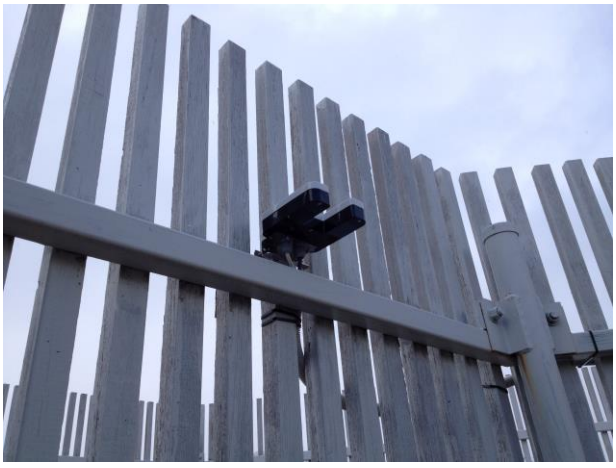


Table. Field Calibration of Reference Type R3 (Automatic) Weighing Gauges 1 and 2

Calibration checks were performed on the R3 gauges based on the SPICE guidelines, using approximately 1.5 kg of water. Kern 440-45N scales (maximum: 1000 g, resolution and repeatability: 0.1 g, linearity 0.2 g) were used, so the water was poured into the gauge in two, approximately equal, amounts.

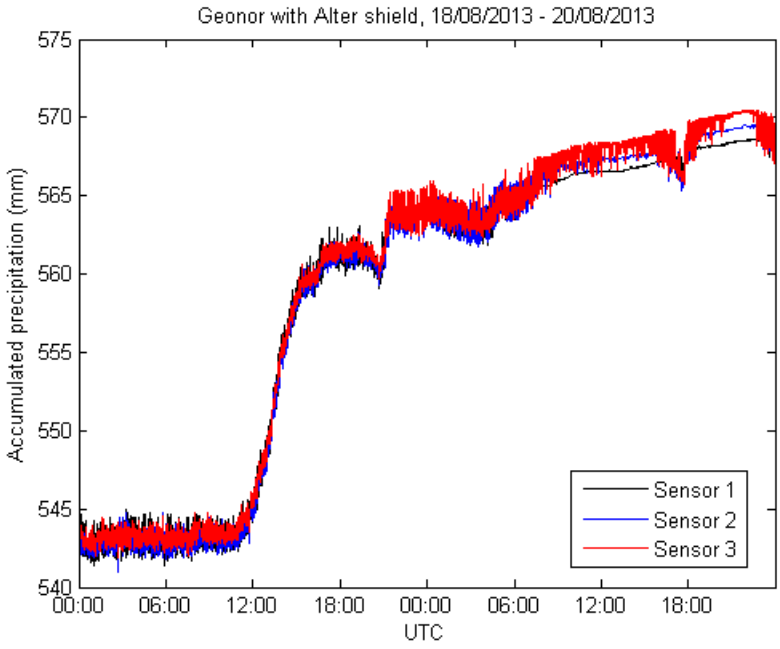
Calibration check of Weighing Gauge 1 (with Alter shield), 10/07/13

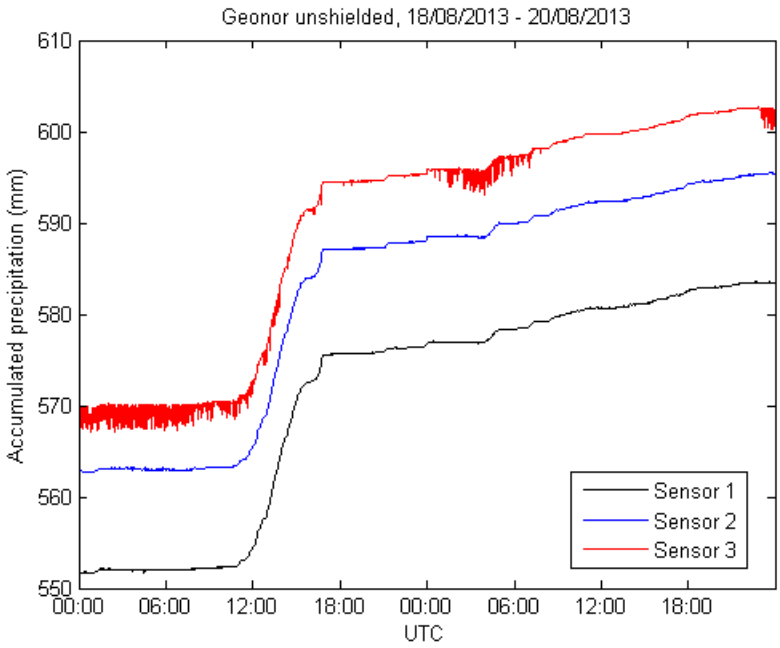
	Check amount	Measured amount	Error
Sensor 1, 69613	1437.0 g / 7.185 cm	7.033 cm	-2.1%
Sensor 2, 69413	1437.0 g / 7.185 cm	7.120 cm	-0.91%
Sensor 3, 69913	1437.0 g / 7.185 cm	7.253 cm	+0.95%
Average of three sensors	1437.0 g / 7.185 cm	7.135 cm	-0.69%

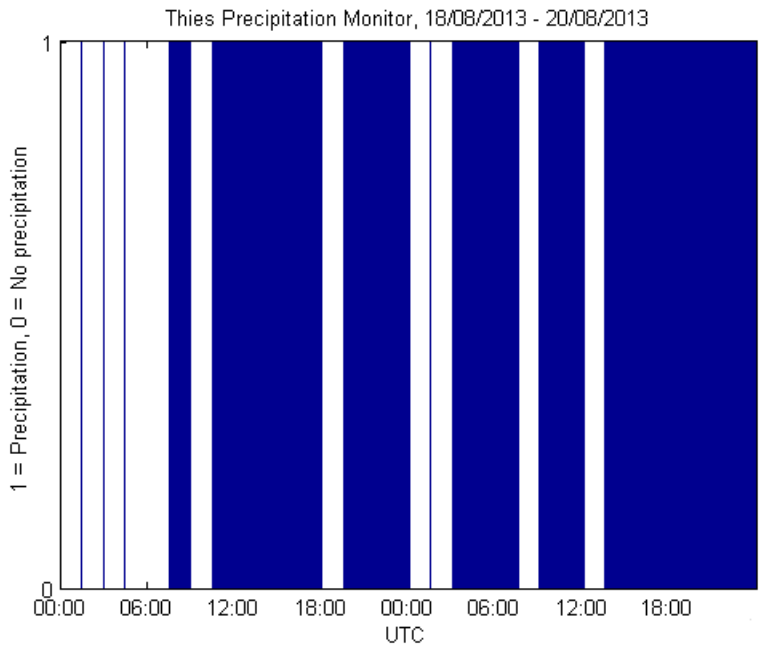
Calibration check of Weighing Gauge 2 (unshielded), 31/07/13

	Check amount	Measured amount	Error
Sensor 1, 69713	1410.0 g / 7.05 cm	6.961 cm	-1.3%
Sensor 2, 69513	1410.0 g / 7.05 cm	7.024 cm	-0.37%
Sensor 3, 69813	1410.0 g / 7.05 cm	7.079 cm	+0.41%
Average of three sensors	1410.0 g / 7.05 cm	7.021 cm	-0.41%

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







Discrepancy Report

As can be seen in the 48 hour plots, significant noise has been observed in the signals from the sensors in both Geonor gauges. The cause of this noise has not yet been determined (it has, for example, been observed in both calm and windy conditions) and investigations into possible electrical and mechanical causes are ongoing. The noise is much less common at the unshielded gauge, but is still present at times. The field calibration checks performed in July 2013 lie outside the target range for several sensors, and it is expected that the signal noise made a significant contribution to these results.

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: ETI NOAH II in DFIR fence
Instrument number 1 of 11

Manufacturer	ETI Instrument Systems Inc
Model	NOAH II Total Precipitation Gauge
Serial number	427
Firmware version (if applicable)	N/A

Field configuration

Location on site	See Site Layout in Section A1: 'DFIR – ETI NOAH II'
Orientation	N/A
Height (measured at top)	3 m
Shield (if applicable)	Alter shield. Located inside a DFIR fence, with timber slats 1.5 m long and 50 mm wide (50% spacing). Top of outer fence is 3.5 m above the ground. Top of inner fence is 3.0 m above the ground.
Heating (if applicable)	None

Data output

Data communication protocol	RS-232
Output data message format (include	Precipitation (mm). [NB: The logged variables are chamber fluid depth (mm) and sensor temperature (K).

description of fields)	These data are post processed to remove the effect of wind and temperature on the sensor. The final dataset consists of precipitation pulses of 0.254 mm (0.01 inch) resolution.
Data sampling frequency	1 minute

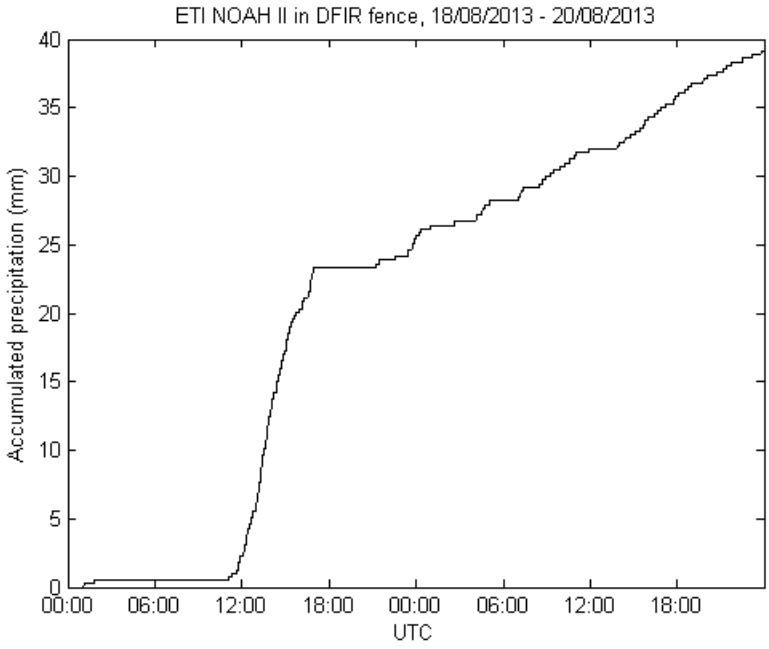
Instrument Picture.

Field calibration (if any).

A full range (30 inch) calibration of the Weight Measurement Assembly (WMA) is performed in the laboratory prior to deployment in the field. WMAs are replaced in the field annually (or more frequently, if required) by units that have been recently calibrated.

WMA 427 was calibrated on 23/05/12 and measured within 0.01 inches of the expected value for each addition of 1 inch of water.

48h Plot.


ETI NOAH II in DFIR fence, 18/08/2013 - 20/08/2013
Accumulated precipitation (mm)
0
5
10
15
20
25
30
35
40
00:00
06:00
12:00
18:00
00:00
06:00
12:00
18:00
UTC

Instrument Name: ETI NOAH II in Half DFIR fence
Instrument number 2 of 11

Manufacturer	ETI Instrument Systems Inc
Model	NOAH II Total Precipitation Gauge
Serial number	425
Firmware version (if applicable)	N/A

Field configuration

Location on site	See Site Layout in Section A1: '1/2 DFIR – ETI NOAH II'
Orientation	N/A
Height (measured at top)	3 m
Shield (if applicable)	Alter shield. Located inside Half DFIR fence, with steel slats (made from Stramit ceiling battens) 1.5 m long and 64 mm wide (50% spacing). Top of outer fence is 3.1 m above the ground. Top of inner fence is 3.0 m above the ground.
Heating (if applicable)	None

Data output

Data communication protocol	RS-232
Output data message format (include description of fields)	Precipitation (mm). [NB: The logged variables are chamber fluid depth (mm) and sensor temperature (K). These data are post processed to remove the effect of wind and temperature on the sensor. The final dataset consists of precipitation pulses of 0.254 mm (0.01 inch) resolution.
Data sampling frequency	1 minute

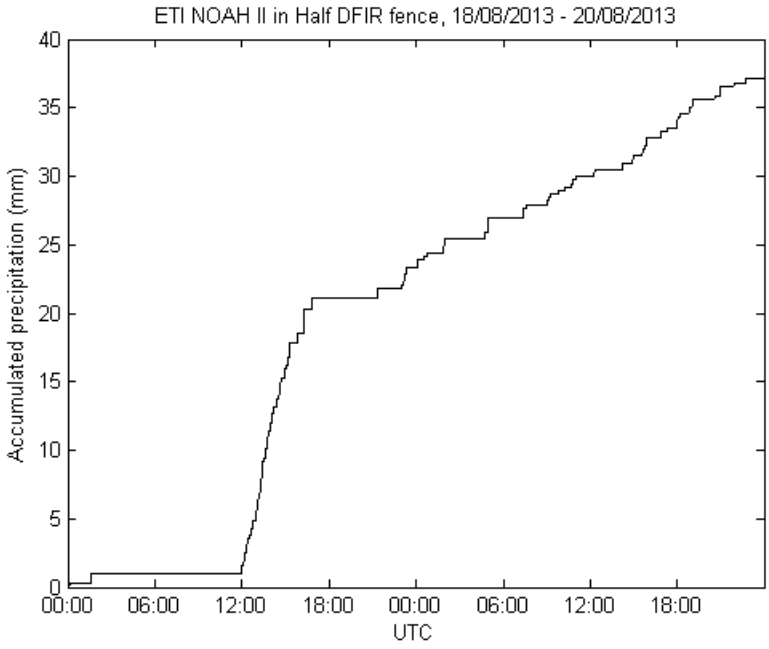
Instrument Picture.

Field calibration (if any).

A full range (30 inch) calibration of the Weight Measurement Assembly (WMA) is performed in the laboratory prior to deployment in the field. WMAs are replaced in the field annually (or more frequently, if required) by units that have been recently calibrated.

WMA 425 was calibrated on 29/11/12 and measured within 0.01 inches of the expected value for each addition of 1 inch of water.

48h Plot.


ETI NOAH II in Half DFIR fence, 18/08/2013 - 20/08/2013
Accumulated precipitation (mm)
0
5
10
15
20
25
30
35
40
00:00
06:00
12:00
18:00
00:00
06:00
12:00
18:00
UTC

Instrument Name: ETI NOAH II with Alter shield
Instrument number 3 of 11

Manufacturer	ETI Instrument Systems Inc
Model	NOAH II Total Precipitation Gauge
Serial number	429
Firmware version (if applicable)	N/A

Field configuration

Location on site	See Site Layout in Section A1: 'ETI NOAH II Alter Shield'
Orientation	N/A
Height (measured at top)	3 m
Shield (if applicable)	Alter shield.
Heating (if applicable)	None

Data output

Data communication protocol	RS-232
Output data message format (include description of fields)	Precipitation (mm). [NB: The logged variables are chamber fluid depth (mm) and sensor temperature (K). These data are post processed to remove the effect of wind and temperature on the sensor. The final dataset consists of precipitation pulses of 0.254 mm (0.01 inch) resolution.
Data sampling frequency	1 minute

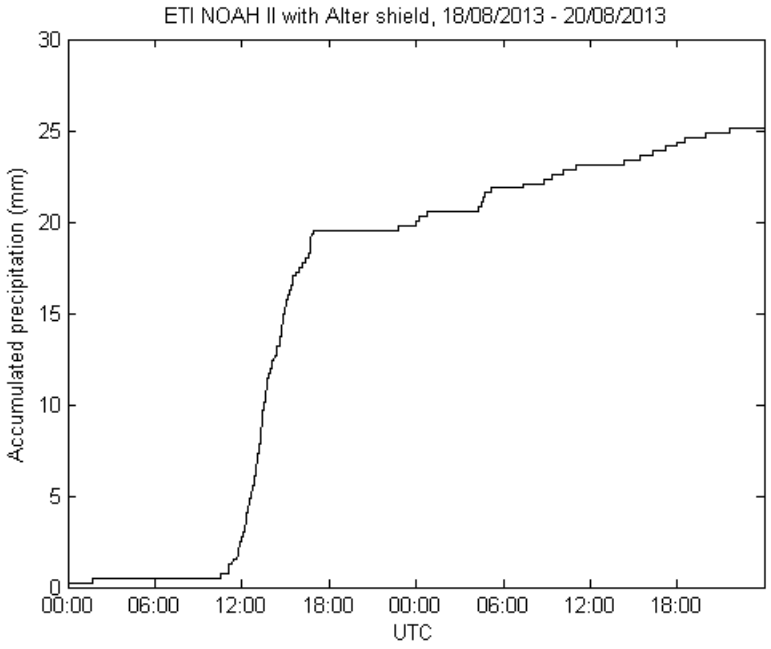
Instrument Picture.

Field calibration (if any).

A full range (30 inch) calibration of the Weight Measurement Assembly (WMA) is performed in the laboratory prior to deployment in the field. WMAs are replaced in the field annually (or more frequently, if required) by units that have been recently calibrated.

WMA 429 was calibrated on 31/05/10 and measured within 0.02 inches of the expected value for each addition of 1 inch of water (and then spent a period of time in storage).

48h Plot.


ETI NOAH II with Alter shield, 18/08/2013 - 20/08/2013
Accumulated precipitation (mm)
30
25
20
15
10
5
0
00:00
06:00
12:00
18:00
00:00
06:00
12:00
18:00
UTC

Instrument Name: NRG IceFree3 anemometer unshielded
Instrument number 4 of 11

Manufacturer	NRG Systems, Inc
Model	IceFree3 Anemometer
Serial number	2440-1C860
Firmware version (if applicable)	N/A

Field configuration

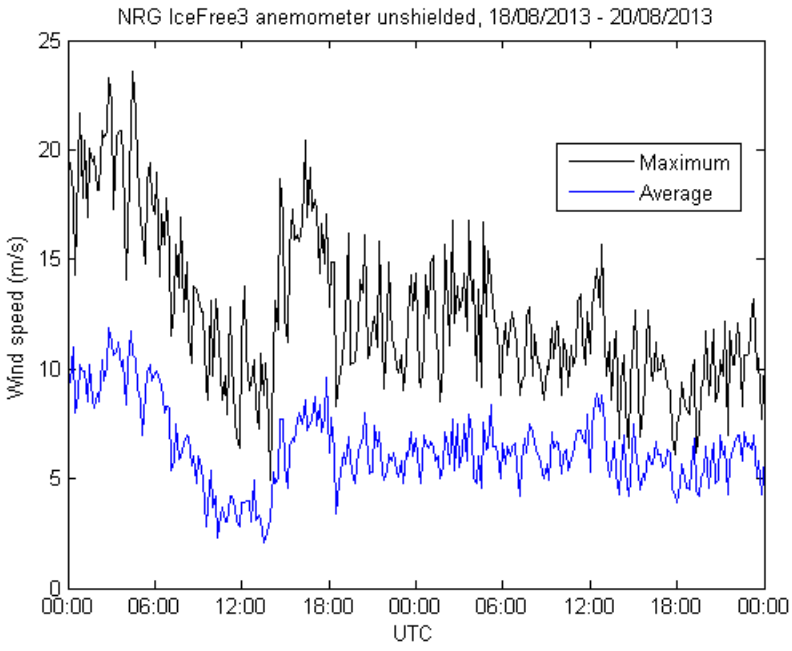
Location on site	Adjacent to ETI NOAH II with Alter shield
Orientation	N/A
Height (measured at top)	Approx. 3.1 m
Shield (if applicable)	None
Heating (if applicable)	24 V, initial current 8 A max., steady state current 4 A max.

Data output

Data communication protocol	Instrument output is a variable amplitude sine wave, with frequency proportional to wind speed. Connected to a frequency to voltage converter.
Output data message format (include description of fields)	Average windspeed (m/s); Maximum wind speed (m/s)
Data sampling frequency	3 s scan rate, 10 minute logging interval

Instrument Picture.

48h Plot.



Instrument Name: NRG IceFree3 anemometer inside DFIR fence
Instrument number 5 of 11

Manufacturer	NRG Systems, Inc
Model	IceFree3 Anemometer
Serial number	2440-18213
Firmware version (if applicable)	N/A

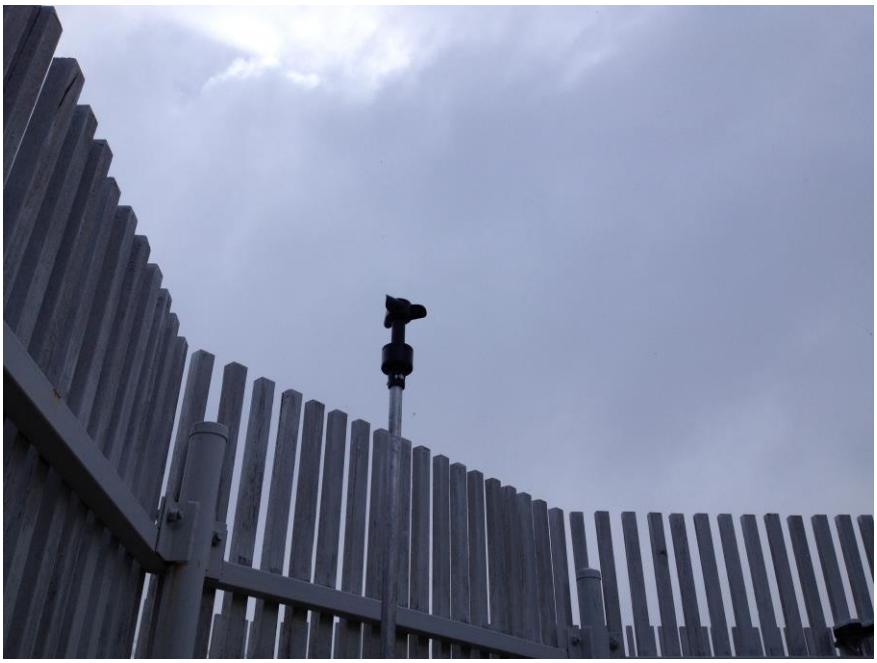
Field configuration

Location on site	Mounted between the inner fence and the Alter shield, on the western side
Orientation	N/A
Height (measured at top)	3 m
Shield (if applicable)	Inside DFIR fence
Heating (if applicable)	24 V, initial current 8 A max., steady state current 4 A max.

Data output

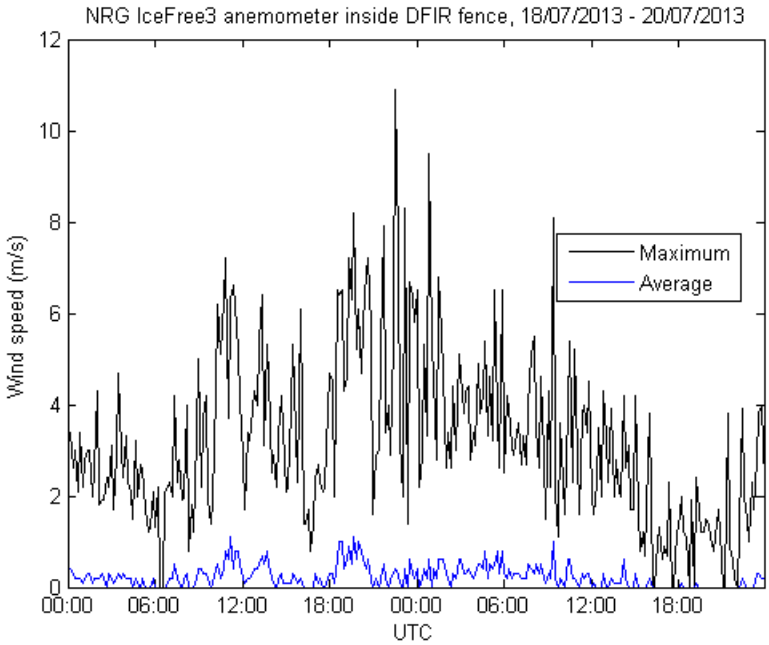
Data communication protocol	Instrument output is a variable amplitude sine wave, with frequency proportional to wind speed. Connected to a frequency to voltage converter.
Output data message format (include description of fields)	Average windspeed (m/s); Maximum wind speed (m/s)
Data sampling frequency	3 s scan rate, 10 minute logging interval

Instrument Picture.



48h Plot.

(NB: Data from 18/07/2013 – 20/07/2013 are displayed here as data from 18/08/2013 – 20/08/2013 are not available)



Instrument Name: NRG IceFree3 anemometer inside Half DFIR fence
Instrument number 6 of 11

Manufacturer	NRG Systems, Inc
Model	IceFree3 Anemometer
Serial number	2440-18215
Firmware version (if applicable)	N/A

Field configuration

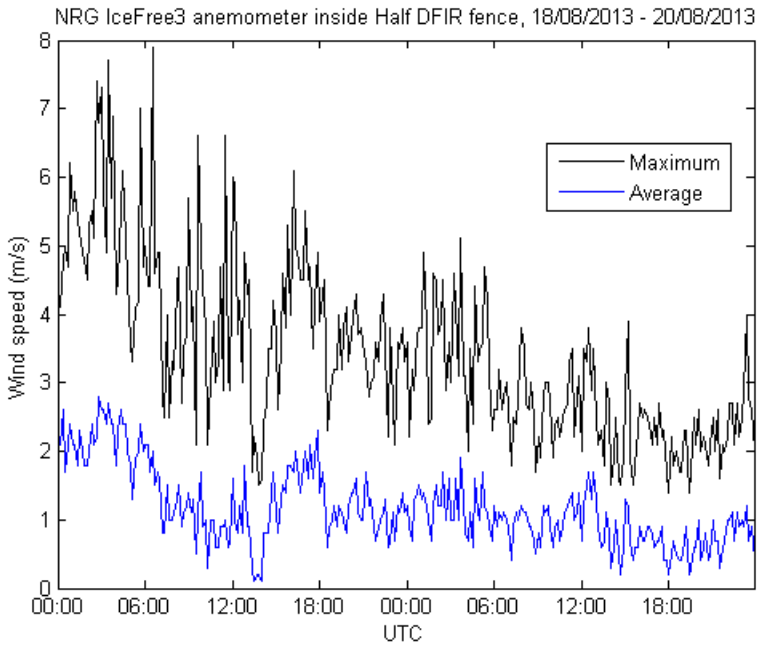
Location on site	Mounted between the inner fence and the Alter shield, on the western side
Orientation	N/A
Height (measured at top)	3 m
Shield (if applicable)	Inside Half DFIR fence
Heating (if applicable)	24 V, initial current 8 A max., steady state current 4 A max.

Data output

Data communication protocol	Instrument output is a variable amplitude sine wave, with frequency proportional to wind speed. Connected to a frequency to voltage converter.
Output data message format (include description of fields)	Average windspeed (m/s); Maximum wind speed (m/s)
Data sampling frequency	3 s scan rate, 10 minute logging interval

Instrument Picture.

48h Plot.



Instrument Name: NRG IceFree3 anemometer outside Half DFIR fence
Instrument number 7 of 11

Manufacturer	NRG Systems, Inc
Model	IceFree3 Anemometer
Serial number	2440-14047
Firmware version (if applicable)	N/A

Field configuration

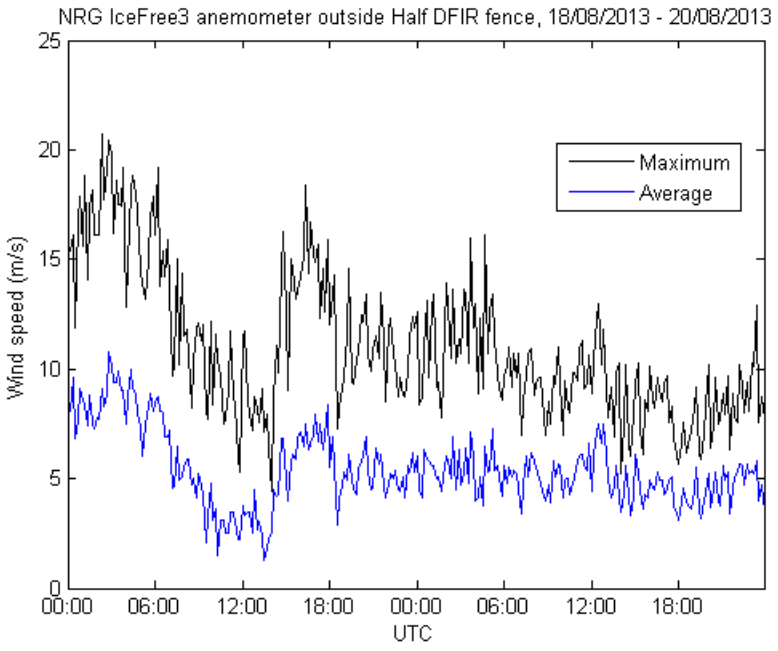
Location on site	Mounted on the outside of the outer fence, on the western side
Orientation	N/A
Height (measured at top)	3 m
Shield (if applicable)	Outside Half DFIR fence
Heating (if applicable)	24 V, initial current 8 A max., steady state current 4 A max.

Data output

Data communication protocol	Instrument output is a variable amplitude sine wave, with frequency proportional to wind speed. Connected to a frequency to voltage converter.
Output data message format (include description of fields)	Average windspeed (m/s); Maximum wind speed (m/s)
Data sampling frequency	3 s scan rate, 10 minute logging interval

Instrument Picture.

48h Plot.



Instrument Name: NRG IceFree3 wind vane unshielded
Instrument number 8 of 11

Manufacturer	NRG Systems, Inc
Model	IceFree3 Wind Vane
Serial number	2442-30892
Firmware version (if applicable)	N/A

Field configuration

Location on site	Adjacent to ETI NOAH II with Alter shield
Orientation	N/A
Height (measured at top)	Approx. 3.6 m
Shield (if applicable)	None
Heating (if applicable)	24 V, initial current 8 A max., steady state current 4 A max.

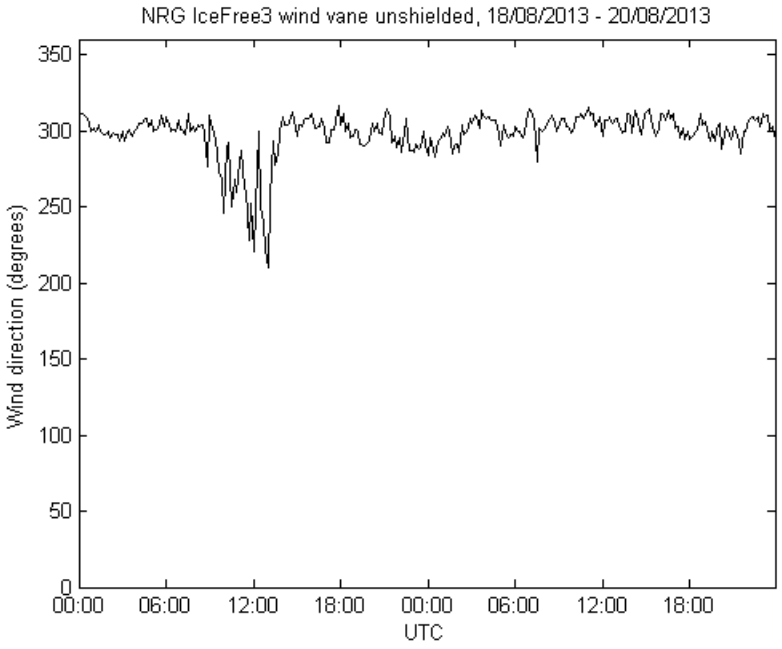
Data output

Data communication protocol	Analog DC voltage
Output data message format (include description of fields)	Average wind direction (degrees)
Data sampling frequency	3 s scan rate, 10 minute logging interval

Instrument Picture.

See photo under Instrument 4: NRG IceFree3 anemometer unshielded

48h Plot.


NRG IceFree3 wind vane unshielded, 18/08/2013 - 20/08/2013
Wind direction (degrees)
350
300
250
200
150
100
50
0
00:00
06:00
12:00
18:00
00:00
06:00
12:00
18:00
UTC

Instrument Name: Vaisala WAA252 anemometer 10 m
Instrument number 9 of 11

Manufacturer	Vaisala
Model	VAA252 Heated Anemometer
Serial number	J05204
Firmware version (if applicable)	N/A

Field configuration

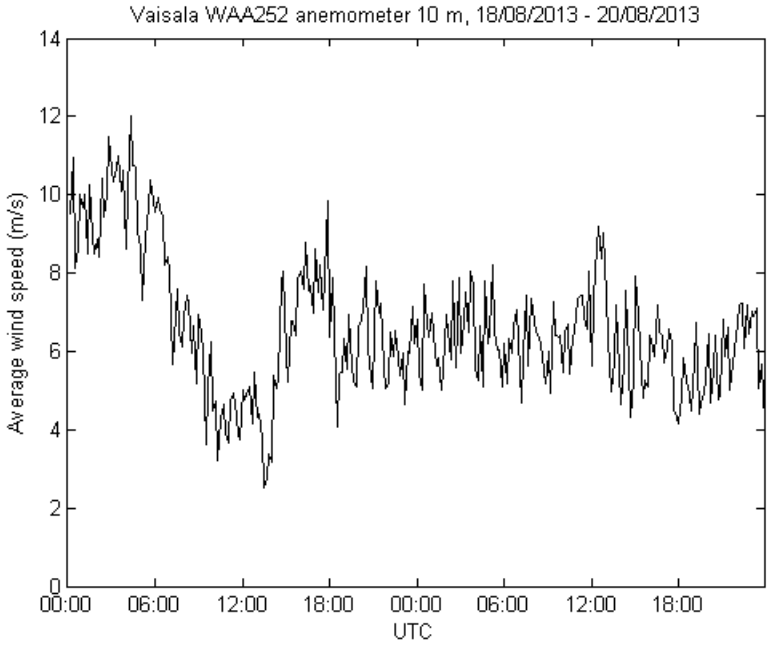
Location on site	10 m mast between DFIR fence and tipping bucket gauge hut
Orientation	N/A
Height (measured at top)	10 m
Shield (if applicable)	None
Heating (if applicable)	24 V, 3.2 A (approx.) max.

Data output

Data communication protocol	Instrument output is a square wave, with frequency proportional to wind speed.
Output data message format (include description of fields)	Average wind speed (m/s)
Data sampling frequency	Approx. 1 s sampling frequency (SCADA), 10 minute averaging interval

Instrument Picture.

48h Plot.



Instrument Name: Vaisala WAV252 wind vane 10 m
Instrument number 10 of 11

Manufacturer	Vaisala
Model	WAV252 Heated Wind Vane
Serial number	J02301
Firmware version (if applicable)	N/A

Field configuration

Location on site	10 m mast between DFIR fence and tipping bucket gauge hut
Orientation	N/A
Height (measured at top)	10 m
Shield (if applicable)	None
Heating (if applicable)	24 V, 2.1 A (approx.) max.

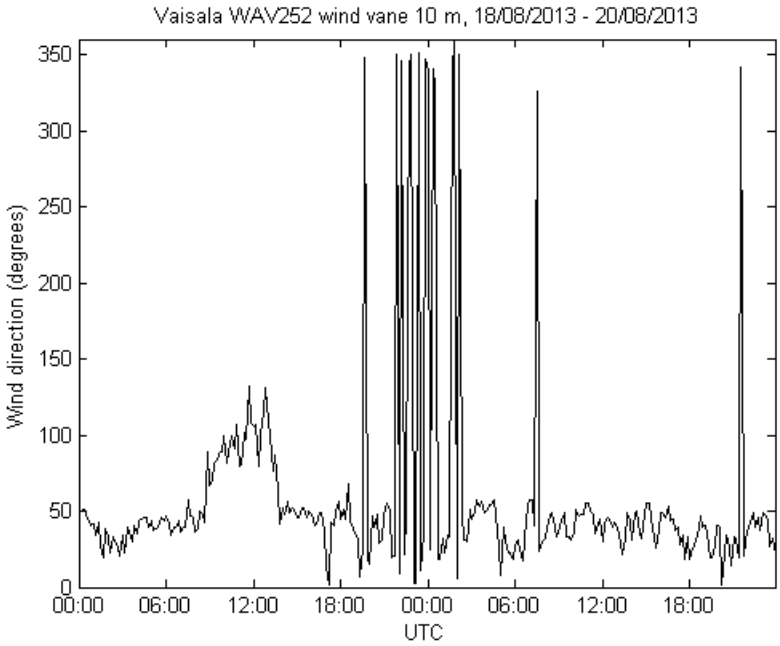
Data output

Data communication protocol	6-bit parallel GRAY code
Output data message format (include description of fields)	Average wind direction (degrees)
Data sampling frequency	Approx. 1 s sampling frequency (SCADA), 10 minute averaging interval

Instrument Picture.

See photo under Instrument 9: Vaisala WAA252 anemometer 10 m

48h Plot.


Vaisala WAV252 wind vane 10 m, 18/08/2013 - 20/08/2013
Wind direction (degrees)
350
300
250
200
150
100
50
0
00:00
06:00
12:00
18:00
00:00
06:00
12:00
18:00
UTC

Instrument Name: Vaisala HMP45A humidity and temperature probe
Instrument number 11 of 11

Manufacturer	Vaisala
Model	HMP45A Humidity and Temperature Probe
Serial number	D2310015
Firmware version (if applicable)	N/A

Field configuration

Location on site	Eastern side of tipping bucket gauge hut
Orientation	N/A
Height (measured at top)	Approx. 2.7 m
Shield (if applicable)	Radiation shield
Heating (if applicable)	None

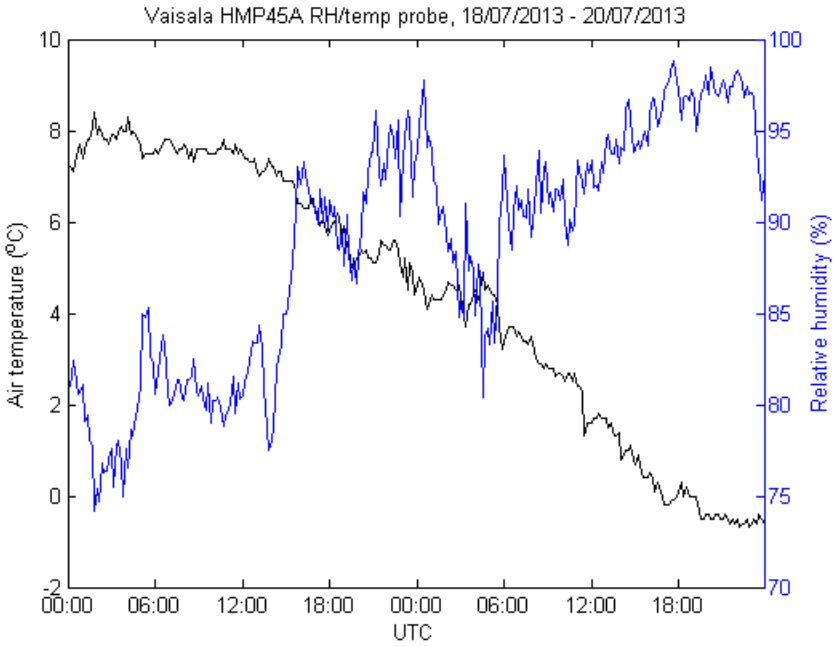
Data output

Data communication protocol	Analog DC voltage
Output data message format (include description of fields)	Instantaneous air temperature (°C); instantaneous relative humidity (%)
Data sampling frequency	10 minute logging interval

Instrument Picture.

48h Plot.

(NB: Data from 18/07/2013 – 20/07/2013 are displayed here as data from 18/08/2013 – 20/08/2013 are not yet available)



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
Geonor T-200BM3 with Alter shield	☐ Yes ☒ No Date:	☐ Yes ☒ No Date: End of 2013	The signals from the sensors in this gauge exhibit noise frequently but intermittently. This issue is currently being investigated.
Geonor T-200BM3 unshielded	☐ Yes ☒ No Date:	☐ Yes ☒ No Date: End of 2013	The signals from the sensors in this gauge exhibit intermittent noise (less frequently than the sensors in the gauge with the Alter shield). This issue is currently being investigated.
Thies Precipitation Monitor	☒ Yes ☐ No Date: 16/08/2013	☐ Yes ☒ No Date: End of 2013	

ETI NOAH II in DFIR fence	☒ Yes ☐ No Date: 01/05/2013*	☐ Yes ☒ No Date: End of 2013	* Nominal start date. This instrument was operational prior to the start of winter 2013.
ETI NOAH II in Half DFIR fence	☐ Yes ☒ No Date:	☐ Yes ☒ No Date: End of 2013	Chamber fluid depth signal failed prior to winter 2013. Cause has not yet been determined. Default ETI precipitation pulse signal is available.
ETI NOAH II with Alter shield	☒ Yes ☐ No Date: 01/05/2013*	☐ Yes ☒ No Date: End of 2013	* Nominal start date. This instrument was operational prior to the start of winter 2013.
NRG IceFree3 anemometer unshielded	☒ Yes ☐ No Date: 01/05/2013*	☐ Yes ☒ No Date: End of 2013	* Nominal start date. This instrument was operational prior to the start of winter 2013.
NRG IceFree3 anemometer inside DFIR fence	☒ Yes ☐ No Date: 01/05/2013*	☐ Yes ☒ No Date: End of 2013	* Nominal start date. This instrument was operational prior to the start of winter 2013.
NRG IceFree3 anemometer inside Half DFIR fence	☒ Yes ☐ No Date: 01/05/2013*	☐ Yes ☒ No Date: End of 2013	* Nominal start date. This instrument was operational prior to the start of winter 2013.
NRG IceFree3 anemometer outside Half DFIR fence	☒ Yes ☐ No Date: 01/05/2013*	☐ Yes ☒ No Date: End of 2013	* Nominal start date. This instrument was operational prior to the start of winter 2013.
NRG IceFree3 wind vane unshielded	☒ Yes ☐ No	☐ Yes ☒ No	* Nominal start date. This instrument was operational prior to the

	Date: 01/05/2013*	Date: End of 2013	start of winter 2013.
Vaisala WAA252 anemometer 10 m	☒ Yes ☐ No Date: 11/06/2013	☐ Yes ☒ No Date: End of 2013	
Vaisala WAV252 wind vane 10 m	☒ Yes ☐ No Date: 11/06/2013	☐ Yes ☒ No Date: End of 2013	
Vaisala HMP45 humidity and temperature probe	☒ Yes ☐ No Date: 11/06/2013	☐ Yes ☒ No Date: End of 2013	

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 (Precipitation gauges only)
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