NEON ALGORITHM THEORETICAL BASIS DOCUMENT: TOTAL AND DIFFUSE PYRANOMETER

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1 DESCRIPTION

Contained in this document are details concerning measurements of total and diffuse shortwave radiation made at all NEON sites. Specifically, the processes necessary to convert "raw" sensor measurements into meaningful scientific units and their associated uncertainties are described. This document focuses on measurement of total and diffuse shortwave by the Delta-T Devices SPN1 Sunshine Pyranometer. Measurements of total and diffuse shortwave radiation (SW) and sun presence will be made at the tower top.

1.1 Purpose

This document details the algorithms used for creating NEON Level 1 data product from Level 0 data, and ancillary data as defined in this document (such as calibration data), obtained via instrumental measurements made by the Delta-T Devices SPN1 Sunshine Pyranometer (i.e., total and diffuse shortwave radiation). It includes a detailed discussion of measurement theory and implementation, appropriate theoretical background, data product provenance, quality assurance and control methods used, approximations and/or assumptions made, and a detailed exposition of uncertainty resulting in a cumulative reported uncertainty for this product.

1.2 Scope

The theoretical background and entire algorithmic process used to derive Level 1 data from Level 0 data for the total and diffuse pyranometer are described in this document. The pyranometer employed is the Delta-T Devices SPN1 Sunshine Pyranometer. This document does not provide computational implementation details, except for cases where these stem directly from algorithmic choices explained here.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

AD[01]	NEON.DOC.000001	NEON OBSERVATORY DESIGN
AD[02]	NEON.DOC.005003	NEON Scientific Data Products Catalog
AD[03]	NEON.DOC.005004	NEON Level 1-3 Data Products Catalog
AD[04]	NEON.DOC.005005	NEON Level 0 Data Products Catalog
AD[05]	NEON.DOC.000782	ATBD QA/QC Data Consistency
AD[06]	NEON.DOC.011081	ATBD QA/QC plausibility tests
AD[07]	NEON.DOC.000783	ATBD De-spiking and time series analyses
AD[08]	NEON.DOC.000746	Evaluating Uncertainty (CVAL)
AD[09]	NEON.DOC.000610	C^3 Total and Diffuse Pyranometer
AD[10]	NEON.DOC.002002	Engineering Master Location Sensor Matrix
AD[11]	NEON.DOC.000785	TIS Level 1 Data Products Uncertainty Budget Estimation Plan
AD[12]	NEON.DOC.000751	CVAL Transfer of standard procedure
AD[13]	NEON.DOC.000927	NEON Calibration and Sensor Uncertainty Values
AD[14]	NEON.DOC.000794	SPN1 Sunshine Pyranometer Calibration / Validation Procedure
AD[15]	NEON.DOC.000810	NEON ATBD-Primary Pyranometer

2.2 Reference Documents

RD[01]	NEON.DOC.000008	NEON Acronym List
RD[02]	NEON.DOC.000243	NEON Glossary of Terms

2.3 Acronyms

Acronym	Explanation
ATBD	Algorithm Theoretical Basis Document
CVAL	NEON Calibration, Validation, and Audit Laboratory
DAS	Data Acquisition System
DP	Data Product
GRAPE	Grouped Remote Analog Peripheral Equipment
L0	Level 0
L1	Level 1
UQ	Unquantifiable uncertainty
$\#_{CI}$	Value derived by CI given the equations within this document
$\#_{CVAL}$	Value provided by CVAL
WMO	World Meteorological Organization
SW	Short wave

2.4 Verb Convention

"Shall" is used whenever a specification expresses a provision that is binding. The verbs "should" and "may" express non-mandatory provisions. "Will" is used to express a declaration of purpose on the part of the design activity.

3 DATA PRODUCT DESCRIPTION

3.1 Variables Reported

Table 1. List of total and diffuse SW radiation-related L1 DPs that are produced in this ATBD.

Data product	Averaging Period	Units	Data Product ID
1-minute Mean Total SW Radiation ($Mean\_T_{SW_1}$)	1-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.001.001.001
1-minute Min Total SW Radiation ($Min\_T_{SW_1}$)	1-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.002.001.001
1-minute Max Total SW Radiation ($Max\_T_{SW_1}$)	1-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.003.001.001
1-minute Variance Total SW Radiation ($\sigma^2\_T_{SW_1}$)	1-min	(W m^{-2})^2	NEON.DXX.XXX.DP1.00014.001.004.001.001
1-minute QA/QC Summary Total SW Radiation ($Qsum\_T_{SW_1}$)	1-min	Text	NEON.DXX.XXX.DP1.00014.001.005.001.001
30-minute Mean Total SW Radiation ($Mean\_T_{SW_{30}}$)	30-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.001.001.002
30-minute Min Total SW Radiation ($Min\_T_{SW_{30}}$)	30-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.002.001.002
30-minute Max Total SW Radiation ($Max\_T_{SW_{30}}$)	30-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.003.001.002
30-minute Variance Total SW Radiation ($\sigma^2\_T_{SW_{30}}$)	30-min	(W m^{-2})^2	NEON.DXX.XXX.DP1.00014.001.004.001.002
30-minute QA/QC Summary Total SW Radiation ($Qsum\_T_{SW_{30}}$)	30-min	Text	NEON.DXX.XXX.DP1.00014.001.005.001.002
1-minute Mean Diffuse SW Radiation ($Mean\_D_{SW_1}$)	1-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.006.001.001
1-minute Min Diffuse SW Radiation ($Min\_D_{SW_1}$)	1-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.007.001.001
1-minute Max Diffuse SW Radiation ($Max\_D_{SW_1}$)	1-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.008.001.001
1-minute Variance Diffuse SW Radiation ($\sigma^2\_D_{SW_1}$)	1-min	(W m^{-2})^2	NEON.DXX.XXX.DP1.00014.001.009.001.001
1-minute QA/QC Summary Diffuse SW	1-min	Text	NEON.DXX.XXX.DP1.00014.001.010.001.001

Radiation ($Qsum\_D_{SW_1}$)			
30-minute Mean Diffuse SW Radiation ($Mean\_D_{SW_{30}}$)	30-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.006.001.002
30-minute Min Diffuse SW Radiation ($Min\_D_{SW_{30}}$)	30-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.007.001.002
30-minute Max Diffuse SW Radiation ($Max\_D_{SW_{30}}$)	30-min	W m^{-2}	NEON.DXX.XXX.DP1.00014.001.008.001.002
30-minute Variance Diffuse SW Radiation ($\sigma^2\_D_{SW_{30}}$)	30-min	(W m^{-2})^2	NEON.DXX.XXX.DP1.00014.001.009.001.002
30-minute QA/QC Summary Diffuse SW Radiation ($Qsum\_D_{SW_{30}}$)	30-min	Text	NEON.DXX.XXX.DP1.00014.001.010.001.002
1-minute Sun Presence (S_1)	1-min	Boolean (0 or 1)	NEON.DXX.XXX.DP1.00014.001.011.001.001
30-minute Sun Presence (S_{30})	30-min	Boolean (0 or 1)	NEON.DXX.XXX.DP1.00014.001.011.001.002

3.2 Input Dependencies

Table 2. List of total and diffuse SW radiation-related L0 DPs that are transformed into L1 DPs in this ATBD.

Data product	**Sample Frequency**	**Units**	**Data Product ID**
Total SW Radiation	1 Hz	W m^{-2}	NEON.DXX.XXX.DP0.00014.001.001.001.00N.001
Diffuse SW Radiation	1 Hz	W m^{-2}	NEON.DXX.XXX.DP0.00014.001.002.001.00N.001
Sun Presence	1 Hz	Boolean (0 or 1)	NEON.DXX.XXX.DP0.00014.001.003.001.00N.001

3.3 Product Instances

One Delta-T Devices SPN1 Sunshine Pyranometer will be deployed at each NEON tower site. The SPN1 Sunshine Pyranometer will be mounted on the tower top.

3.4 Temporal Resolution and Extent

One- and thirty-minute averages of total SW and diffuse SW radiation, as well as sunshine presence will be calculated to form L1 DPs.

3.5 Spatial Resolution and Extent

One Delta-T Devices SPN1 Sunshine Pyranometer will be deployed at each NEON tower site. See AD[10] for detail on sensor placement at a specific core site.

4 SCIENTIFIC CONTEXT

Solar radiation is a basic driver of many physical, chemical and biological processes, with the sun providing 99.98 % of all energy reaching Earth. Direct and diffuse radiation between 400 nm and 2700 nm, comprise components of this total energy. Of the total incoming solar radiation reaching Earth, 30 % is reflected back to space, 51 % is absorbed by land and water, and the clouds and atmosphere absorb the remaining 19 % (Rösemann 2011). Quantifying the diffuse radiation, total radiation and sunshine presence are critical to understanding energy balances, local climate and the drivers of many important ecological processes at NEON sites.

4.1 Theory of Measurement

The SPN1 Sunshine Pyranometer measures short wave (SW) radiation between 400 nm and 2700 nm, outputting data in units of W m^{-2}. The sunshine status output (i.e. 'sunshine presence') indicates whether the energy in the direct beam exceeds the WMO standard threshold value of 120 W m^{-2}. The SPN1 has seven thermopile corrected sensors under cosine-corrected diffusers (Figure 1).

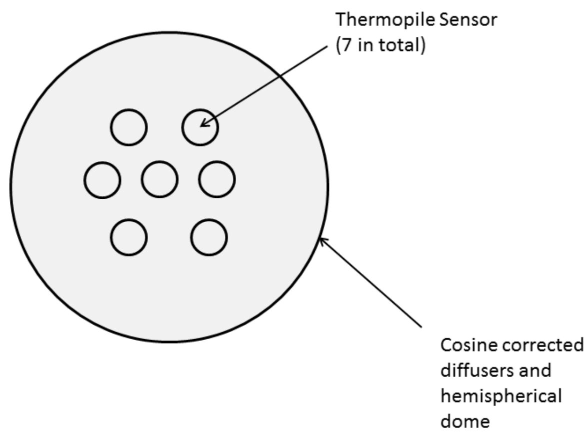

Figure 1. Depiction of the SPN1 sensor layout. Each of the seven thermopile sensors operates individually, and is housed under the hemispherical dome.

The SPN1 Sunshine Pyranometer is an intelligent sensor that operates using *proprietary algorithms* that have not been provided to NEON. Broadly, the outputs (i.e. total SW radiation, diffuse SW radiation and sunshine presence) generated by the SPN1 are, quoting the manual, derived sequentially (and internally) as follows:

$$\mathrm{SW}_{Diff} = 2 * \mathrm{MIN} \tag{1}$$

$$\mathrm{SW}_{Dir} = \mathrm{MAX} - \mathrm{MIN} \tag{2}$$

$$\mathrm{SW}_{tot} = \mathrm{SW}_{Diff} + \mathrm{SW}_{Dir} = \mathrm{MAX} + \mathrm{MIN} \tag{3}$$

Where:

MAX	= largest thermopile reading of the seven thermopiles
MIN	= smallest thermopile reading of the seven thermopiles
SW_{Diff}	= uncorrected diffuse SW radiation
SW_{Dir}	= uncorrected direct SW radiation
SW_{Total}	= uncorrected total SW radiation

A series of corrections are then applied *internally* to account for instrument bias:

$$\mathrm{SW}_{diff} = 2 * \mathrm{MIN} * 1.02 \tag{4}$$

Note: the 2 % adjustment accounts for inherent instrument bias (Delta-t Devices Ltd. 2007)

$$\textbf{IF } \mathrm{SW}_{diff} > \mathrm{SW}_{tot} \quad \textbf{THEN} \quad \mathrm{SW}_{diff} = \mathrm{SW}_{tot} \tag{5}$$

A further correction is required to adjust the spectral responses of the sensors for their different sensitivity to direct and diffuse light:

$$\mathrm{DIR}_{swc} = (\mathrm{SW}_{tot} - SW_{diff}) * 0.99 \tag{6}$$

$$\mathrm{D}_{swc} = \mathrm{SW}_{diff} * 1.14 \tag{7}$$

$$\mathrm{T}_{swc} = \mathrm{DIR}_{swc} + \mathrm{SW}_{diff} \tag{8}$$

Sunshine presence is calculated using the ratio of Total and Diffuse, and is registered:

$$\textbf{IF } (\mathrm{SW}_{tot}/SW_{diff}) > 1.35 \quad \textbf{AND} \quad \mathrm{SW}_{tot} > 24\, W\, m^{-2} \tag{9}$$

The 24 W m^{-2} threshold value is used to acknowledge instances when direct sunshine is weak as a result of low sun angle, but the TOTAL/DIFFUSE value may be high due to noise or offsets dominating the low reading values. Sun presence undergoes no further calibrations or processing by algorithms prior to becoming an L1 DP.

Following the internal processing explained above, the SPN1 outputs total SW radiation (T_{SW}), diffuse SW radiation (D_{SW}) and sun presence (S).

4.2 Theory of Algorithm

Following internal sensor processing (i.e. equations 1-9), values of total and diffuse SW radiation are exported in units of W m^{-2} and are further processed using the following equations:

$$D_{SWC_i} = D_{SW_i} * C_{d1} \tag{10}$$

$$T_{SWC_i} = T_{SW_i} * C_{t1} \tag{11}$$

Where:

D_{SW_i}	=Diffuse shortwave radiation (W m^{-2})
D_{SWC_i}	=Corrected diffuse shortwave radiation (W m^{-2})
C_{d1}	=Diffuse Radiation Scaling coefficient provided by CVAL
T_{SW_i}	=Total shortwave radiation (W m^{-2})
T_{SWC_i}	=Corrected total shortwave radiation (W m^{-2})
C_{t1}	=Total Radiation scaling coefficient provided by CVAL

After the L0 DPs are corrected using scaling coefficients provided by CVAL, one-minute total (T_{SW_1}) and diffuse (D_{SW_1}), SW radiation and thirty-minute total ($T_{SW_{30}}$) and diffuse ($D_{SW_{30}}$), averages will be determined accordingly to create L1 DPs:

$$D_{SW_1} = \frac{1}{n}\sum_{i=1}^{n} D_{SWC_i} \tag{12}$$

$$T_{SW_1} = \frac{1}{n}\sum_{i=1}^{n} T_{SWC_i} \tag{13}$$

where, for each minute average, *n* is the number of measurements over time and the averaging period is defined as 0 ≤ n < 60 seconds.

$$D_{SW_{30}} = \frac{1}{n}\sum_{i=1}^{n} D_{SWC_i} \tag{14}$$

$$T_{SW_{30}} = \frac{1}{n}\sum_{i=1}^{n} T_{SWC_i} \tag{15}$$

where, for each thirty-minute average, *n* is the number of measurements over time and averaging periods are defined as $0 \le n < 1800$ seconds.

One- and thirty-minute sun presence will be calculated as follows:

If the SPN1 reports sun presence (i.e. Boolean value of 1) for ≥ 75% of the readings in a one minute period (i.e., 45 readings) S_1 will be recorded as present for that one minute period.

If the SPN1 reports sun presence (i.e. Boolean value of 1) for ≥ 75% of the readings in a thirty-minute period (i.e., 1350 readings) S_{30} will be recorded as present for that thirty minute period.

5 ALGORITHM IMPLEMENTATION

Data flow for signal processing of L1 DPs shall be treated in the following way.

1. 1 Hz sensor outputs (W m^{-2}) shall be calibrated using NEON derived scaling coefficients provided by CVAL (Eq. (10) and (11))
2. QA/QC Plausibility tests will be applied to the data stream in accordance with AD[06]. The details are provided below.
3. Signal de-spiking and time series analysis will be applied to the data stream in accordance with AD[07].
4. One- and thirty-minute total and diffuse averages will be calculated using Eq. (12) through (15). Sun presence for one- and thirty-minute periods will be calculated as described in section 4.2.
5. Descriptive statistics, i.e. minimum, maximum, and variance, will be determined for both one- and thirty-minute averages.

QA/QC Procedure:

1. **Plausibility Tests** AD[06]
   - All plausibility tests will be determined for total and diffuse radiation with the exception of the Gap Test. Test parameters will be provided by FIU and maintained in the CI data store. All plausibility tests will be applied to the sensor's converted L0 DP and an associated pass/fail flag will be generated for each test.

2. **Sensor -** Delta-T Devices SPN1 Sunshine Pyranometer has no associated devices or sensor health related flags.

3. **Signal De-spiking and Time Series Analysis** – – The de-spiking QA/QC routine will be run on defined time segments of data, as specified by FIU and maintained in the CI data store. Utilizing the flags from the plausibility tests in addition to median absolute deviation for a segment of

data, the routine will identify and disregard large spikes from the time series. For data values that are "de-spiked" a de-spiking flag will be applied according to AD[07].

4. **Consistency Analysis** – Currently, there is no plan to run a consistency analysis on the L1 DPs for the SPN1 pyranometer. However, a time series consistency analysis may be explored in the future.

Notes:

1. L1 DPs from the SPN1 pyranometer will have an associated QA/QC summary DP ($Qsum_{1min}$ and $Qsum_{30min}$) that summarizes any flagged data that went into the computation of the L1 DP. This summary will offer transparency to the data user, who will be able to determine whether any of the DPs used generate a specific L1 DP were flagged (e.g., plausibility flags and details on the number of points flagged in the L0 data).
2. A datum flagged by any of the following six flags, f_R, f_σ, f_δ, f_S, f_N, f_D, as a result of plausibility or de-spiking tests, will not be used to compute the L1 DP. If the number of data points flagged by these tests exceeds 20 % of the data for an averaging period, i.e. 12 points for T_{SW_1} or D_{SW_1} or 360 points for $T_{SW_{30}}$ or $D_{SW_{30}}$, that time period will not be calculated due to insufficient reliable data. Note that a datum can only contribute to this total once, i.e. multiple flags on the same datum do not contribute more than once to the percentage of flagged data. Likewise, if the number of points flagged as null, f_N, exceeds 20% for an averaging period it will not be computed due to too many missing data points.
3. The eight fags that may be associated with total and diffuse SW radiation measurements as well as information maintained in the CI data store can be found below in the following Table.

Table 3. Information maintained in the CI data store.

Tests/Values	CI Data Store Contents	Flags
Range	Minimum and maximum values	f_R
Sigma (σ)	Time segments and threshold values	f_σ
Delta (δ)	Time segments and threshold values	f_δ
Step	Threshold values	f_S
Null	Test limit	f_N
Signal De-spiking and Time Series Analysis	Time segments and threshold values	f_D, f_O
Calibration	CVAL sensor specific calibration coefficients	NA
Uncertainty	CVAL and ENG uncertainty	NA
Sensor Test	F_{min} and t_h as described in AD[09]	f_H, f_F
Consistency	Redundancy test limits	f_V

6 UNCERTAINTY

Uncertainty of measurement is inevitable (ISO 1995; Taylor 1997). It is crucial that uncertainties are identified and quantified to determine statistical interpretations about mean quantity and variance structure; both are important when constructing higher level data products (e.g., L1 DP) and modeled processes. This portion of the document serves to identify, evaluate, and quantify sources of uncertainty relating to L1 total and diffuse DPs. It is a reflection of the information described in AD[11], and is explicitly described for the pyranometer assembly in the following sections.

6.1 Uncertainty of Total and Diffuse SW Radiation Measurements

Uncertainty of the primary pyranometer assembly is discussed in this section. Sources of uncertainties include those arising from the sensor, calibration procedure, heater, digital resolution of the sensor, and round off errors from algorithms (Figure 2).

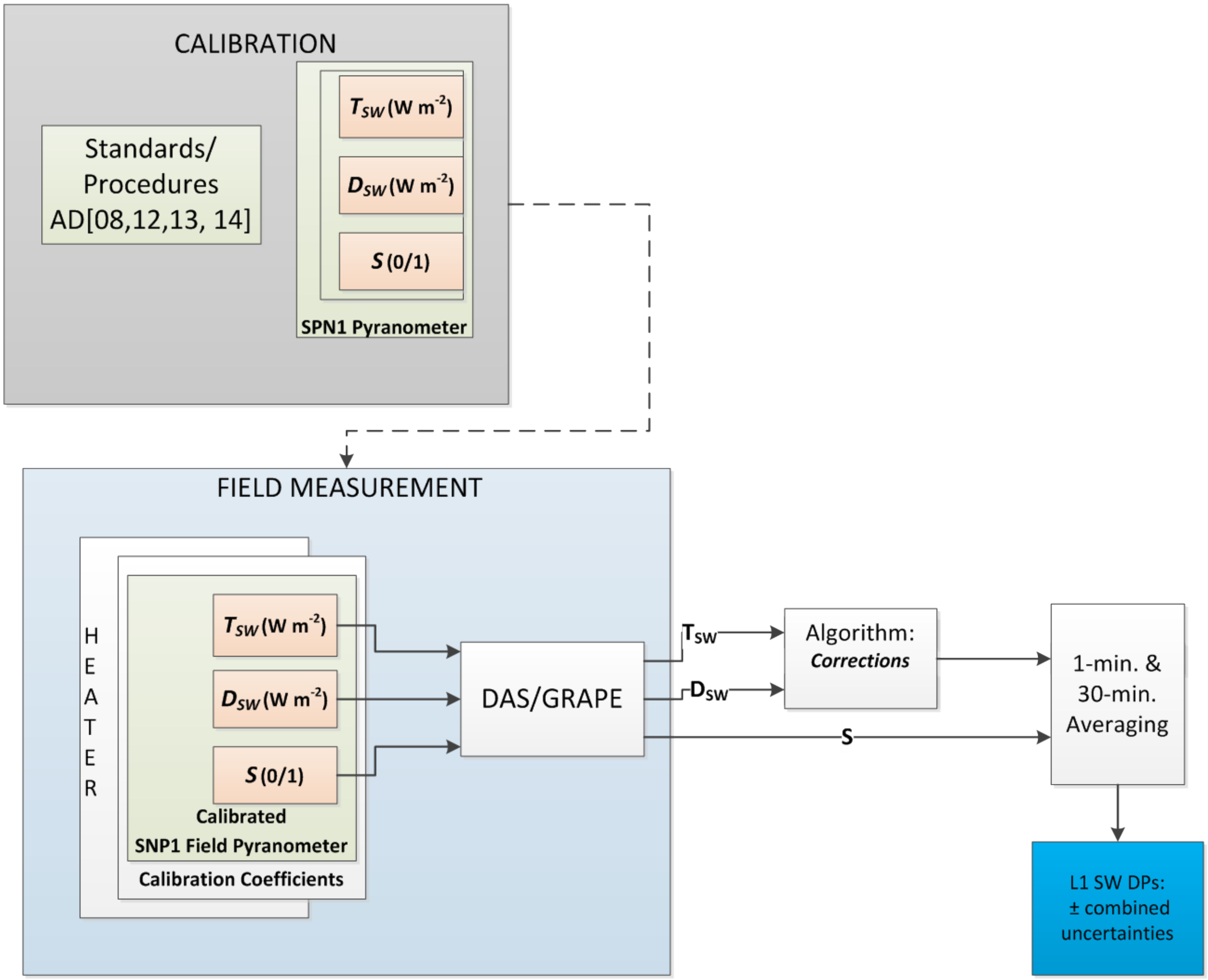

Figure 2: Displays the data flow and associated uncertainties of L1 SW radiation DPs. Salmon colored boxes represent direct measurement of incoming SW radiation based on the theory of passive radiation sensor resistance (*i.e.,* use of thermopile as a transducer). For a detailed explanation of pyranometer calibration procedures, please refer to AD[08,12,13,14].

6.1.1 Calibration:

Uncertainties associated with the sensor and calibration process will be given as a single combined uncertainty by CVAL for each measured component (i.e. diffuse radiation, total radiation, and sunshine presence). It is a constant value that will be applied to all radiation measurements (that is, it does not vary with any specific sensor, DAS component, etc.). Please refer to AD[08] for the value of the specific individual standard uncertainty.

$$u_c(X_{CAL}) = \pm \#_{CVAL} \, W \, m^{-2} \tag{16}$$

Where *X* represents either total (*T*) or diffuse (*D*) SW radiation.

6.1.2 DAS

SNP1 pyranometers have an internal Analog to Digital (A/D) converter and output data in digital form. Thus, uncertainty related to measurement noise of the DAS can be considered negligible. Please refer to AD[11] for further information.

6.1.3 Heater

The SPN1 pyranometer is equipped with an internal heater to prevent frost and condensation buildup. The heater is automatically controlled and operates (powered) as a function of ambient temperature (Delta-T Devices 2007). Although use of the heater improves measurement accuracy by preventing moisture buildup, it affects the variability of the measurement, thus adding uncertainty to the measurement. At this time we cannot quantify the extent of this variability and related uncertainties. Unfortunately, even with sufficient operational experience such uncertainties will most likely remain unquantifiable, as we have no way of determining when the heater is actually on or off.

6.1.4 Resolution of the digital indication

As noted by Delta-T Devices Ltd (2007), their SPN1 pyranometers have a digital resolution of 0.6 W m^{-2}. Given that it is reasonable to assume the value of the measurand lies with equal probability between the bounds of this resolution and it is unlikely that it resided outside these bounds, we can assume uniform distribution (ISO 1995) and an uncertainty of:

$$u(X_R) = \frac{0.6 \text{ W m}^{-2}}{\sqrt{3}} = \pm\, 0.34641 \text{ W m}^{-2} \tag{17}$$

Note: This type of uncertainty will be accounted for by CVAL and will be reflected in $u_c(X_{CAL})$ (refer to Section 6.1.1.)

6.2 Combined Uncertainty

The combined uncertainties for L1 incoming SW radiation DPs are displayed below:

$$u_c(X_{L1}) = u_c(X_{CAL}) \text{ W m}^{-2} \tag{18}$$

Note: Combined and expanded uncertainties will not be computed for sunshine presence since it is a non-numeric value.

6.3 Expanded Uncertainty

The expanded uncertainty for L1 SW radiations DPs can be derived with the following equations:

$$V_{eff}(X_{L1}) = Veff_{X_{CAL}} \tag{19}$$

where $Veff_{X_{CAL}}$ results from a type A analyses and its value will be based on the number of tests run by CVAL (refer to AD[08]).

The expanded uncertainty of L1 incoming SW radiation DPs will be given at 95% confidence:

$$U_{95}(X_{L1}) = k_{95}u_c(X_{L1}) \; W\,m^{-2} \tag{20}$$

where k_{95} is the coverage factor at 95% confidence obtained with the aid of Table 5 from AD[11] as a function of the resulting effective degrees of freedom $V_{eff}(X_{L1})$ from Eq. (19).

6.4 Uncertainty Budget

The uncertainty budget is an outline of all sources of uncertainty, means by which these uncertainties are derived, and the resulting combined and expanded uncertainties. It is provided here to display specific, individual sources of uncertainty that propagate into a combined and expanded uncertainty. Individual uncertainty values denoted in the following table are either provided here (in this document) or will be provided by other NEON teams (*e.g.,* CVAL) and maintained in the CI data store. Each L1 DP will be reported twice, once accompanied by a value of combined uncertainty, and again with a value of expanded uncertainty. Effective degrees of freedom and the *coverage* factor (k) for each computed L1 DP will be stored in the CI data store, but do not need to be presented.

Table 2: Uncertainty budget for L1 total and diffuse SW radiation DPs.

Source of uncertainty	Standard uncertainty component u(X_i)	Type of eval.	Value of standard uncertainty [W m^{-2}]	$c_i \equiv \frac{\partial f}{\partial x_i}$	$u_i(Y) \equiv \lvert c_i \rvert u(x_i)$ [W m^{-2}]	Degrees of freedom
Calibration	$u_c(X_{CAL})$	A	Eq. (16)	1	Eq. (16)	AD[13]
$u_c(X_{,L1})$: Eq. (18) $X_{L1} = \text{L1 DP} \pm u_c(X_{L1})\ \text{W m}^{-2}$						
$v_{eff(X_{L1})}$: Eq. (19) k_{95}: $v_{eff(X_{L1})}$ and Table 5 of AD[11] $U_{95}(X_{L1})$: Eq. (20) $X_{L1_{95}} = \text{L1 DP} \pm U_{95}(X_{L1})\ \text{W m}^{-2}$						

Note: Here we assume that any uncertainty related to the use of these averaging algorithms is due to round-off errors. Since a majority of significant figures from L0 data will be preserved during conversions to L1 data, the uncertainty produced from round off errors will be smaller than the sensitivity of the sensor, and is considered negligible.

7 FUTURE PLANS AND MODIFICATIONS

Future system flags may be incorporated into the data stream and included in the QA/QC summary DP ($Qsum_{1min}$ and $Qsum_{30min}$) that summarizes any flagged data that went into the computation of the L1 DP.

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