Soil CO_2 Profile Sensor Configuration and Command and Control

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1 DESCRIPTION

1.1 Purpose

This document specifies the configuration and command and control structure for the soil CO_2 sensors.

1.2 Scope

The expectation is that the Vaisala CARBOCAP® Carbon Dioxide Probe GMP343 sensor will be used to make the soil CO_2 profile measurements (AD[01]).This document specifies the command and control that is needed for the soil CO_2 sensors. It does not describe how this will be achieved by ENG or other NEON teams.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

AD[01]	NEON.DOC.004605 CLASS ACQUISITION PLAN - ENTERPRISE SENSOR ACQUISITION
AD[02]	NEON.DOC.005005 NEON Level 0 Data Products Catalog
AD[03]	NEON.DOC.011083 ATBD_Soil CO2 profile (FIU.1.0093) Algorithm Theoretical Basis Document

2.2 Reference Documents

RD[01]	NEON.DOC.000008 NEON Acronym List
RD[02]	Vaisala. 2007. User's Guide: Vaisala CARBOCAP Carbon Dioxide Probe GMP343. Vaisala Oyj, Helsinki.
RD[03]	NEON.DOC.000243 NEON Glossary of Terms

2.3 Acronyms

Acronym	**Explanation**
ATBD	Algorithm Theoretical Basis Document
CO_2	Carbon dioxide
FIU	Fundamental Instrument Unit
QA/QC	Quality Assurance/Quality Control
TIS	Terrestrial Instrument System
L0	Level 0
L1	Level 1
ENG	NEON Engineering group
CI	NEON Cyberinfrastructure group
DPS	NEON Data Products group
CVAL	NEON Calibration, Validation, and Audit Laboratory

3 INTRODUCTION

The sensor configuration and sensor command and control described here are related to the soil CO_2 profile data product (FIU.0.0093) (AD[02]). A description of how sensor readings shall be converted to soil air CO_2 concentration is presented in the associated ATBD (AD[03]).

4 SENSOR CONFIGURATION

The CO_2 data from the sensor shall be unfiltered, uncompensated, and uncorrected CO_2 concentration (hereafter called *RAWUC*), as well as sensor headspace temperature (T), and error status (ERR) (RD[02]). Sensor configuration settings are shown in the table below.

Table 1. Sensor configuration settings.

Parameter	Default Setting
Heater	Off
Temperature compensation	Off
Oxygen compensation	Off
Pressure compensation	Off
Relative humidity compensation	Off
Median filter	Off
Averaging filter	Off
Smoothing filter	Off
Linearization	Off
Linear correction	Off
Multipoint correction	Off
CO_2 measurement: Acquisition rate	1 Hz
Sensor headspace temperature: Acquisition rate	1 Hz
Sensor error message: Acquisition rate	1 Hz
Data acquisition streams	CO_2 concentration (RAWUC); Temperature (T); Error status (Err)
Measurement mode	Run

5 COMMAND AND CONTROL

5.1 Error handling

If an error message occurs (*i.e.*, error status = failed) the sensor must be stopped, queried, have the error state reset, and restarted (Table 2).

Table 2. Truth table for sensor error status.

Control parameter(s)	Condition	Data acquisition system action	Output to CI
Sensor error status	Not failed	Do nothing	Sensor error flag (FIU.0.0093.003)
Sensor error	Failed	Stop the sensor, query for error	Sensor error flag (FIU.0.0093.003) and

status		code, reset error status, restart sensor measurements	sensor error code (FIU.0.0093.004)

When queried the sensor will respond with a detailed error code (Table A1). The error codes will be used during QA/QC procedures (AD[03]) and will be reported to the problem resolution and tracking system.

5.2 Heater control

No control is required at this time. However, if errors are generated due to the lack of control, FIU will develop the command and control structure to determine when the heater should be automatically switched on/off.

When there is (a risk of) condensation on the sensor optics window and mirror, the heater must be turned on to prevent/remove condensation within the sensor headspace. When the risk of condensation occurring is low, the heater shall be turned off to minimize the effect of sensor heating on the soil microclimate. Initially the heater shall be configured as always switched off, since the sensor generates some heat even with the heater off, which we expect will prevent condensation occurring within the sensor headspace.

In case heater control needs to be implemented in the future, FIU has developed a preliminary command and control structure to determine when the heater should be automatically switched on/off (Table 3). It is likely that the criteria for turning the heater on/off would be site and depth specific (and possibly season specific). The criteria will likely depend on soil temperature and soil moisture at the same depth and in the same plot as the soil CO_2 sensor. Each time the heater is switched on or off it must be logged and streamed so that it can be included in the metadata and used to determine the heater flag status.

Table 3. Truth table to control sensor heater.

Control parameter	Condition	Data acquisition system action	Output to CI
TBD	TBD	Turn heater off	Heater flag (FIU.0.0093.005)
TBD	TBD	Turn heater on	Heater flag (FIU.0.0093.005)

6 APPENDIX

6.1 Sensor error codes as of January 2012

Table A1. Codes and interpretation of sensor error messages as of January 2012 (RD[02]).

Error code	Error description	Interpretation	Action
E01	EEPROM checksum failure	Internal transmitter failure	Return the device to Vaisala Service
E02	IR source failure	Internal transmitter failure	Return the device to Vaisala Service.
E03	FPI failure	Internal transmitter failure	Return the device to Vaisala Service.
E04, E05	Heater failure	Internal transmitter failure	Return the device to Vaisala Service.
E06	Temperature measurement failure	Operation temperature is out of allowed range. Analog output: Error level is shown if temperature compensation is enabled. Otherwise, output is normal.	Ensure that the operating temperature is -45...+85 °C (-49...185 °F). In case of constant error, return the device to Vaisala Service.
E07	Measurement signal level too low	Measurement chamber is contamined or the lamp is degraded.	Clean the optics and the filter according to the instructions in section Cleaning the Optics (Diffusion Model Only) on page 71. In case of constant error, return the device to Vaisala Service.
W01	Watchdog reset occured	Software defect	In case this warning appears frequently, return the device to Vaisala Service.
W02	Stack overflow	Software defect	In case this warning appears frequently, return the device to Vaisala Service.