EasyFlux-DL 软件:

系列介绍，传感器配置，应用设置，自动控制及在线数据

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Campbell Scientific, US

第14次 ChinaFLUX 通量理论与技术培训

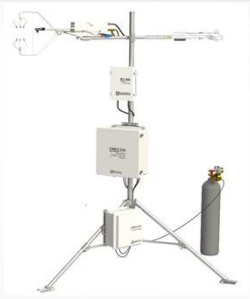
2019年8月7日

Campbell Scientific Inc. (CSI) Integrated Eddy-Covariance (EC) Systems

IRGASON or EC150 w/CSAT3A
+ CR6 + CDM-A116 + slow sensors

CPEC300 series
CR6 + CDM-A116 + slow sensors

IRGASON or EC150 w/CSAT3A
CR3000 + slow sensors

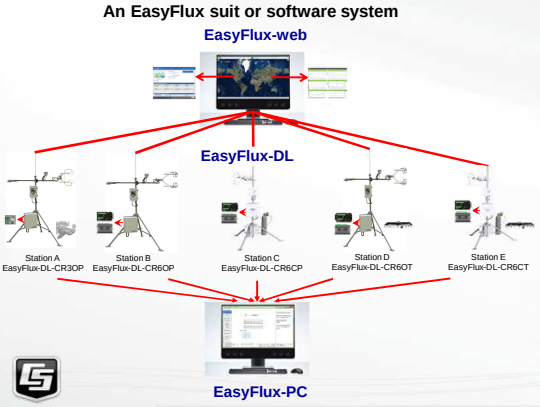


1. Continuous measurements at high frequency
2. Huge data sets
3. Field stations yearly run in network

An EasyFlux software system needed to support individual EC stations and EC Networks

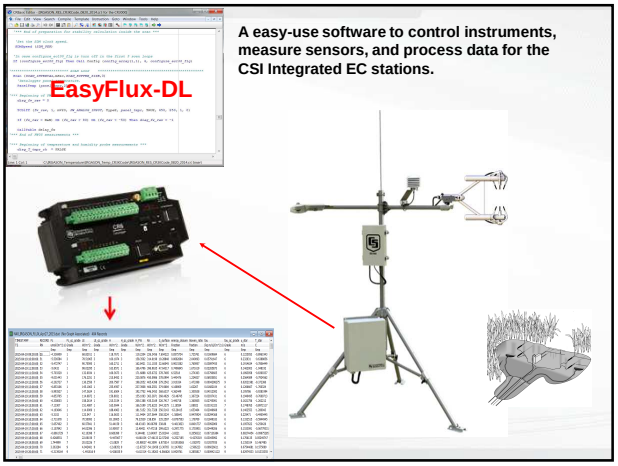
1. EasyFlux-DL to Control the operations of EC stations
   - Measure sensors
   - Collect data
   - Process data
2. EasyFlux-PC for data post-processing if needed
3. EasyFlux-WEB to manage a EC network
   - Show station map
   - Monitor individual stations
   - Communication with stations
   - Collect data

An EasyFlux suit or software system

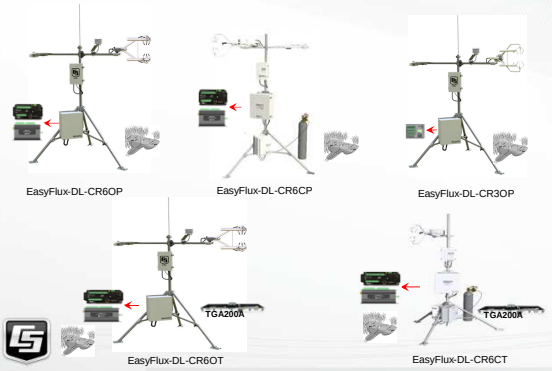


EasyFlux-DL

A easy-use software to control instruments, measure sensors, and process data for the CSI Integrated EC stations.



DataLogger Series (DL Series)
Five software packages for EC individual stations of five configurations



Advantages of DL series:

1. Correcting flux, analyzing footprint, and classifying data quality while measuring.
2. Most suitable correction algorithms were identified and used for CSI EC systems.
3. AmeriFlux and conventional data formats are available

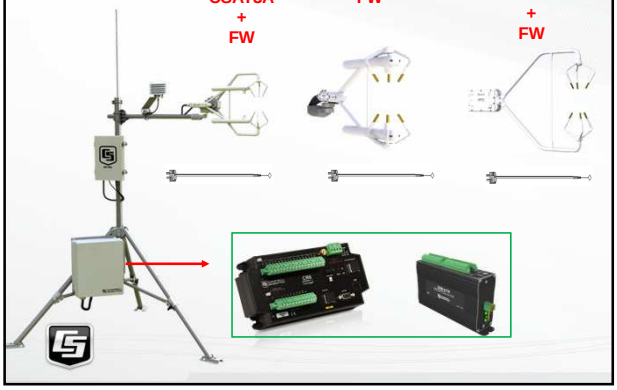
Example: Rn
NETRAD

EasyFlux-DL-CR6OP

EC150 + CSAT3A + FW

IRGASON + FW

CSAT3B + XXXX + FW



EasyFlux-DL-CR6OT

EC150 + CSAT3A + TGA200A

IRGASON + TGA200A

CSAT3B + XXXX + TGA200A

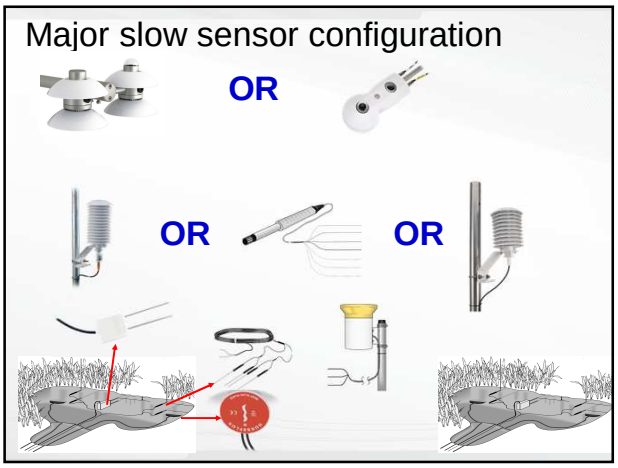
EasyFlux-DL-CR6CP supports CPEC300 series

CPEC310 CPEC306 CPEC300

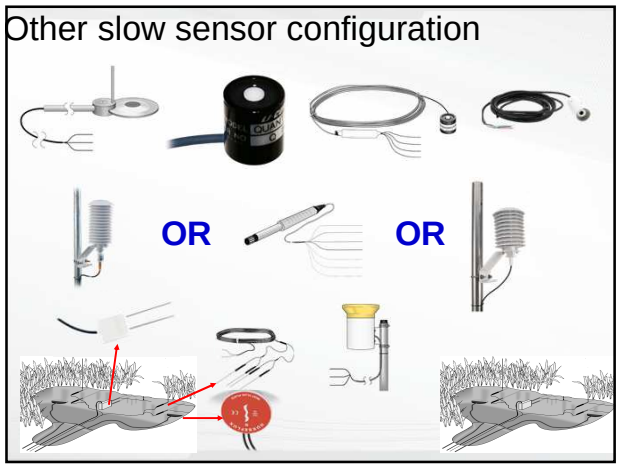
EasyFlux-DL-CR6CT

CPEC300 series + TGA

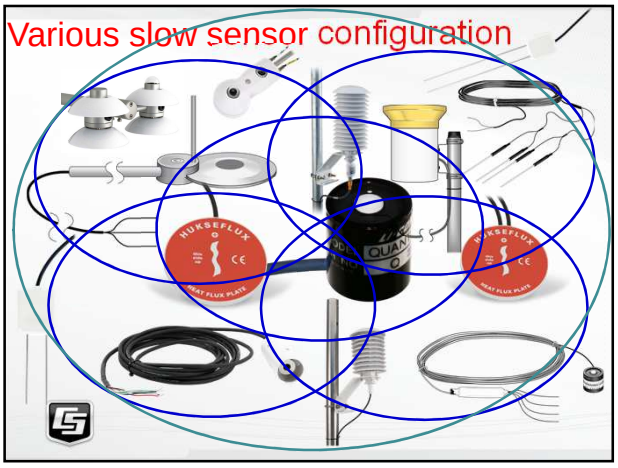
Major slow sensor configuration



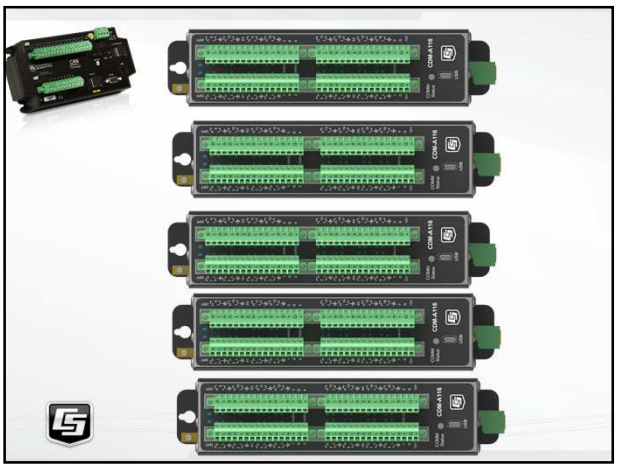
Other slow sensor configuration



Various slow sensor configuration



Any number of slow sensors in configuration

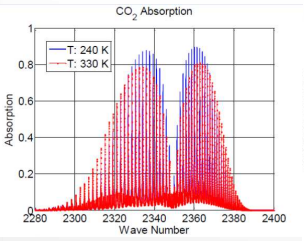


Major corrections and data processing

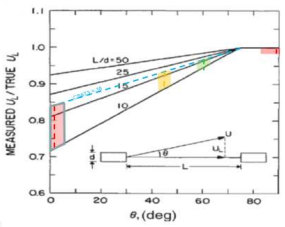
1. Despike using sensor diagnosis code
2. Covariance with various lags
3. Coordinate rotation
   a. double or triple rotations
   b. planar fit
4. Maximization of lagged covariance values
5. Frequency corrections
   a. line averaging
   b. block averaging
   c. sensor separation
   d. time constant
6. Sonic sensible heat flux correction
7. WPL correction
8. Fluxes of H_2O, CO_2, trace gases, and momentum
9. Soil heat flux at surface
10. Radiation flux
11. Footprint characteristics
12. Data qualification grading

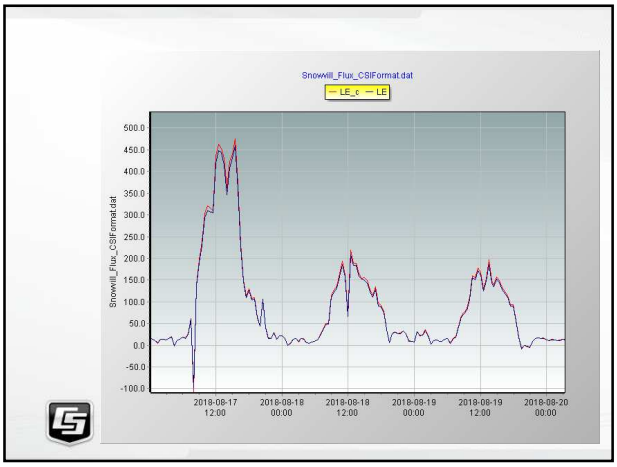
Two Optional Features

Spectroscopic effect for OPEC



Transducer-Shadow Correction





Special Functionality

Field-standing auto zero/span

Cycle
1. CO_2/H_2O zeroing
2. CO_2 span

Zero only
CO_2 Span only

Attendant-auto zero/span

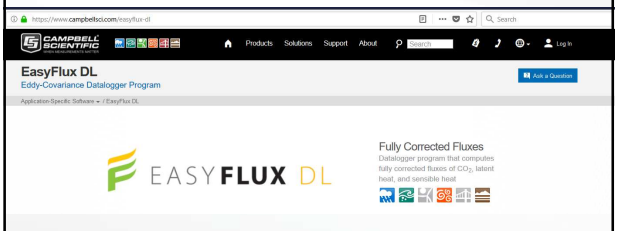
Cycle
1. CO_2/H_2O zeroing
2. CO_2 span
3. H2O span

Zero only
CO_2 span only
H_2O span only
Combinations

Flow-chart Auto Zero/Span

1st step to EasyFlux-DL

https://www.campbellsci.com/easyflux-dl



Download
Manual and code

2nd step: Constant Table

(Configure the system and sensors)

Set up system Configuration (Frequency, output intervals, file sizes)

```
ConstTable (Const_Table)
  '* PROGRAM FUNCTION
  Const SCN_INTV                  = 100
  Const SLW_SCN_INTV              = 6000
  Const OUTPUT_INTV               = 30
  Const DAY_FlUX_CRD              = 30
  Const DAY_TSRS_CRD              = 2
  Const NTCH_FRQ_SLW   As Long    = 60
  Const ONE_FL_TABLE   As Boolean = FALSE

  '*EC100 SETTINGS.
  Const SDM_CLCK_SPD   As Long    = 30
  Const EC100SDM_ADR   As Long    = 1
  Const BANDWIDTH                 = 500/SCN_INTV
```

Configure Auto Zero/Span

```
'* CPEC CONFIGURATIONS
Const CEL_PRSS_TYP    As Long      = 1

Const CPEC300         As Boolean   = FALSE
Const CPEC306         As Boolean   = FALSE
Const CPEC310         As Boolean   = TRUE
Const CPEC310SCRUB    As Boolean   = TRUE
#If (CPEC310) Then
  Const ZRO_SPN_INTV              = 2
  Const ZRO_SPN_OFST              = 32
  Const TIME_ZRO_SPN              = 60
  Const CHECK_ZERO    As Boolean  = TRUE
  Const SET_ZERO      As Boolean  = TRUE
  Const CHECK_CO2SPN  As Boolean  = TRUE
  Const SET_CO2SPN    As Boolean  = TRUE
  Const CHECK_H2OSPN  As Boolean  = TRUE
  Const SET_H2OSPN    As Boolean  = TRUE
#EndIf
```

Configure sensors

```
'*TEMP/RH PROBE
Const SENSOR_T_RH    As Boolean   = TRUE
#If (SENSOR_T_RH)    Then
  Const TMPR_MULT As Float       = 0.14
  Const TMPR_OFST As Float       = -80.0
  Const RH_MULT   As Float       = 0.1
  Const RH_OFST   As Float       = 0.0
#EndIf

'*NRLITE 2 NET RADIOMETER
Const SENSOR_NRLIT    As Boolean  = FALSE
#If (SENSOR_NRLIT)    Then
  Const NRLIT_SNSTVT As Float     = 16.0
#EndIf

'*PYRANOMETER
Const SENSOR_CS301    As Boolean  = FALSE
#If (SENSOR_CS301)    Then
  Const PYRAN_MULT    As Float    = 5
#EndIf

Const SENSOR_CS320    As Boolean  = FALSE
#If (SENSOR_CS320)    Then
Const CS320SDI_ADR                = "A"
#EndIf
```

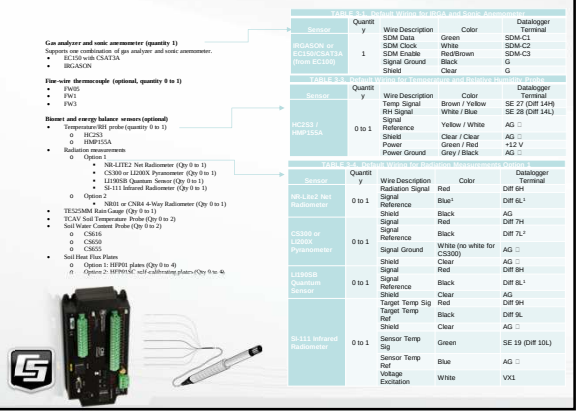
```
'*NR01/CNR4/SN500 4-COMPONENT NET RADIOMETER
  Const SENSOR_NR01 As Boolean    = TRUE
  Const SENSOR_CNR4 As Boolean    = FALSE
  Const SENSOR_CNF4 As Boolean    = FALSE
#If (SENSOR_NR01 OR SENSOR_CNR4) Then
  Const SW_IN_SNSTVT As Float     = 15.0
  Const SWOUT_SNSTVT As Float     = 15.0
  Const LW_IN_SNSTVT As Float     = 8.0
  Const LWOUT_SNSTVT As Float     = 8.0
#EndIf

Const SENSOR_SN500 As Boolean     = FALSE
#If (SENSOR_SN500) Then
 Const SN500SDI_ADR               = "B"
#EndIf

'*RAIN GAGE
Const SENSOR_TE525  As Boolean    = TRUE
#If (SENSOR_TE525)
  Const TE525_MULT  As Float      = 0.1
#EndIf

'*TCAV SOIL TEMPERATURE PROBE
Const SENSOR_TCAV   As Boolean    = TRUE
#If (SENSOR_TCAV) Then
  Const NMBR_TCAV   As Long       = 3
#EndIf
```

Sensor calibrations

```
#If (SENSOR_NR01 OR SENSOR_CNR4) Then
  Const SW_IN_SNSTVT As Float    = 15.0
  Const SWOUT_SNSTVT As Float    = 15.0
  Const LW_IN_SNSTVT As Float    = 8.0
  Const LWOUT_SNSTVT As Float    = 8.0
#EndIf
```

```
#If (SENSOR_HFP01) OR (SENSOR_HFPSC) Then
  Const NMBR_HFP                 = 4
  Const HFP_SNSTVT_1   As Float = 62.0
  #If (NMBR_HFP > 1) Then
    Const HFP_SNSTVT_2 As Float = 62.0
  #EndIf
  #If (NMBR_HFP > 2) Then
    Const HFP_SNSTVT_3 As Float = 62.0
  #EndIf
  #If (NMBR_HFP > 3) Then
    Const HFP_SNSTVT_4 As Float = 62.0
  #EndIf
#EndIf
#If (SENSOR_HFPSC) Then
  Const CAL_INTV                 = 1440
#EndIf
```

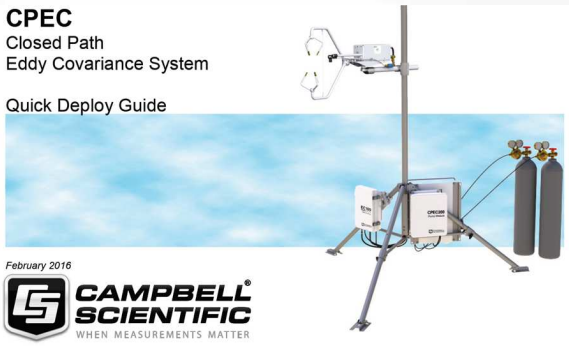
3rd step: Print out Wiring instruction



4th step: field installations

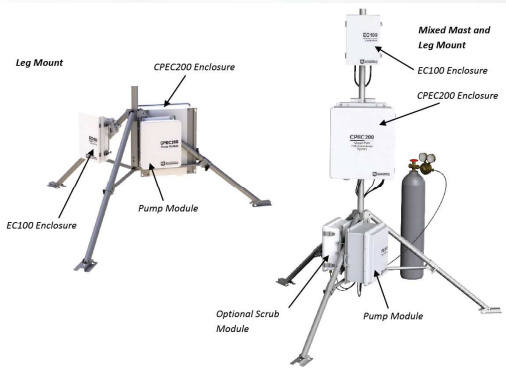
CPEC
Closed Path
Eddy Covariance System

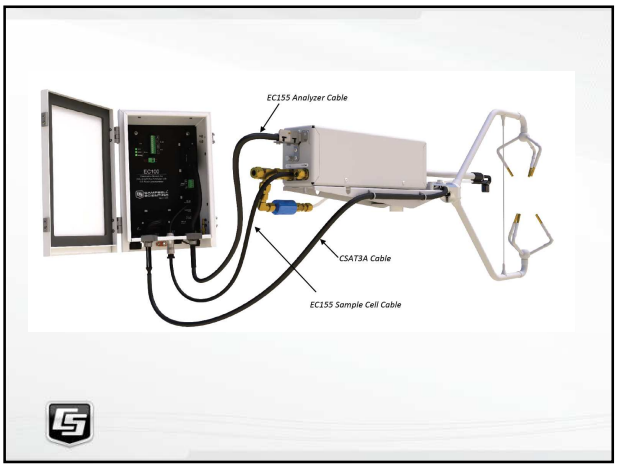
Quick Deploy Guide

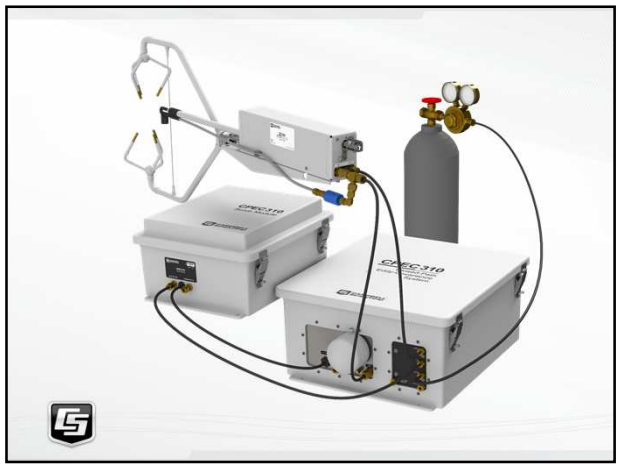


February 2016

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER



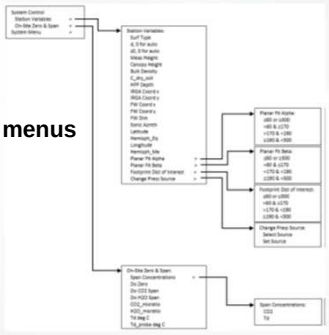


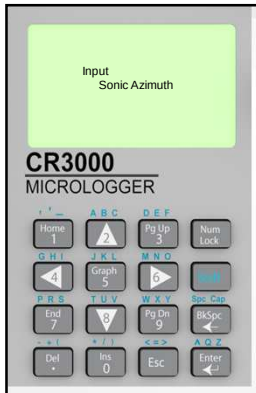


5th step: Field wiring

6th step: Upload EasyFlux™-DL into Datalogger

7th step: Input station variables using keypad menus





Input geographic information

latitude
hemisphere_NS

longitude
hemisphere_EW

altitude

CR3000
MICROLOGGER

Input
surface_type

crop = 1
grass = 2
forest = 3
shrub = 4
bare land = 5
water = 6
Ice = 7

CR3000
MICROLOGGER

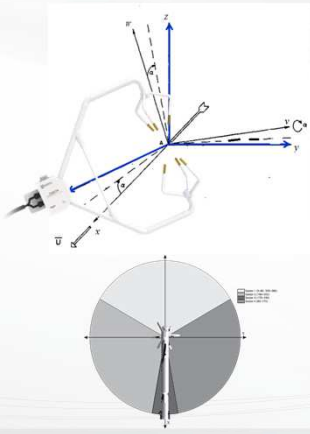
Input
height_measurement
displacement_user
height_canopy
roughness_user

CR3000
MICROLOGGER

Input PlanarFitAlpha
0~60 300~360
>60 & <=170
>170 & <190
>=190 & <300

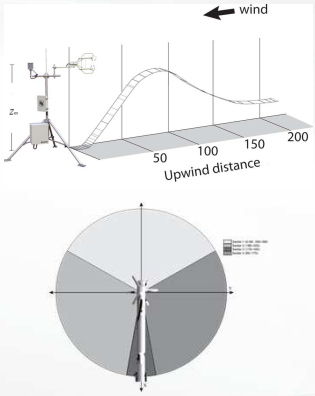
Input PlanarFit Beta
0~60 300~360
>60 & <=170
>170 & <190
>=190 & <300

CR3000
MICROLOGGER



Footprint Dis Intrst
<60° or >300 °
≥60 ° and ≤ 170 °
>170 ° and <190 °
≥ 190 ° and <300 °

CR3000
MICROLOGGER



Input
IRGA Separation
Coord x
Coord y

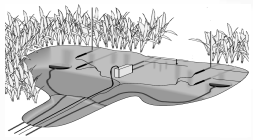
FW Separation
Coord x
Coord y

FW Dim

CR3000
MICROLOGGER

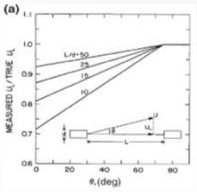
Input
soil_bulk_density
specific heat of dry mineral soil
thick_abv_SHFP

CR3000
MICROLOGGER



Shadow correction
on
off

CR3000
MICROLOGGER



Select CO2 for Comp
CO2 fast T
FAST_ON
FAST_OFF

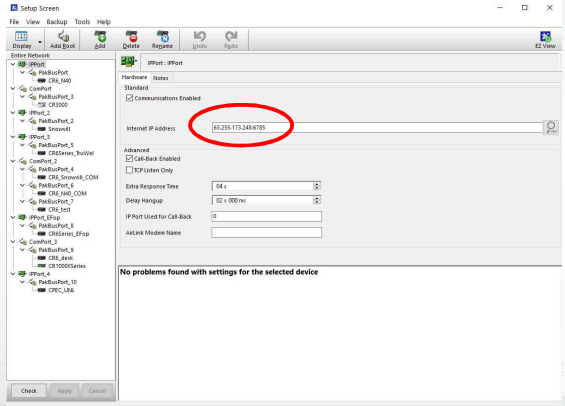
CR3000
MICROLOGGER

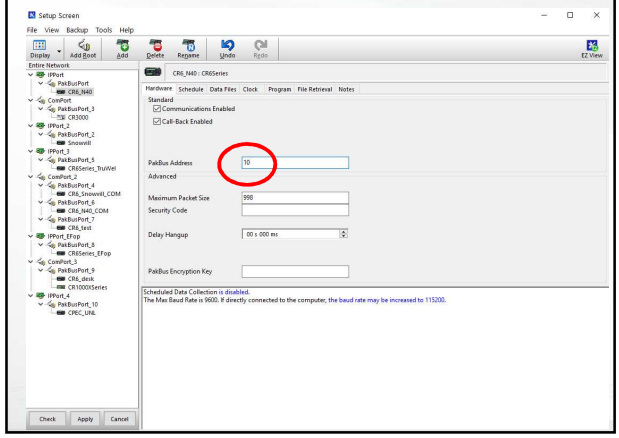
Spectroscopic Correction

Select Auto Zero/Span
Auto Z/S on

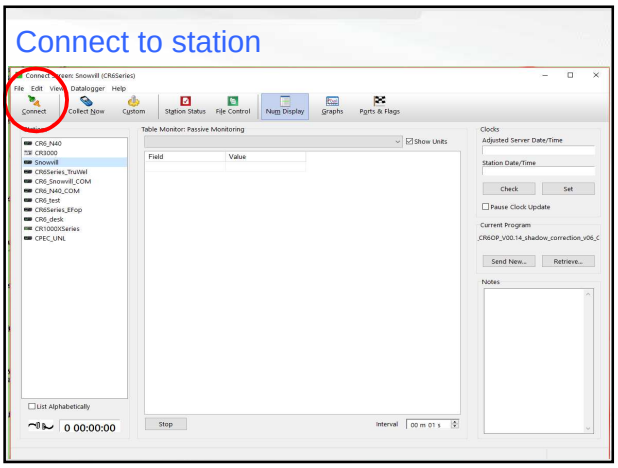
CR3000
MICROLOGGER

Configure communication between LoggerNet to the OPEC/CPEC station (i.e. CR6 Datalogger)

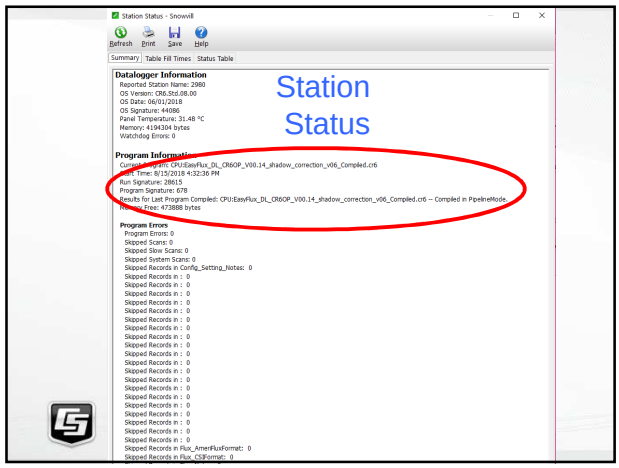




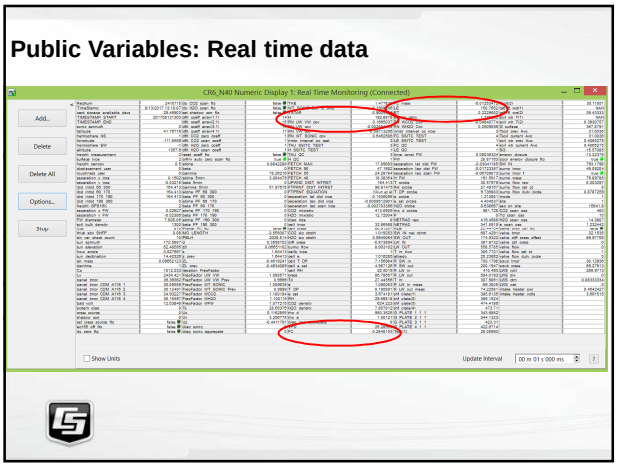
Connect to station



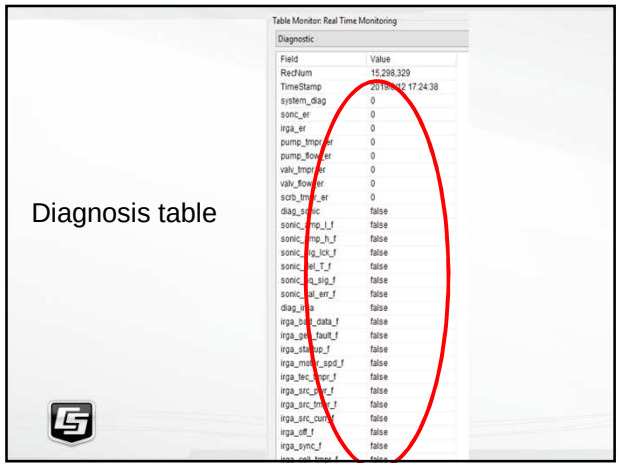
Station Status



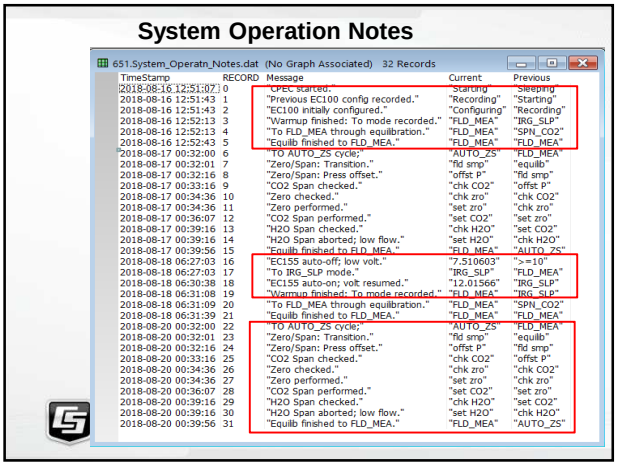
Public Variables: Real time data



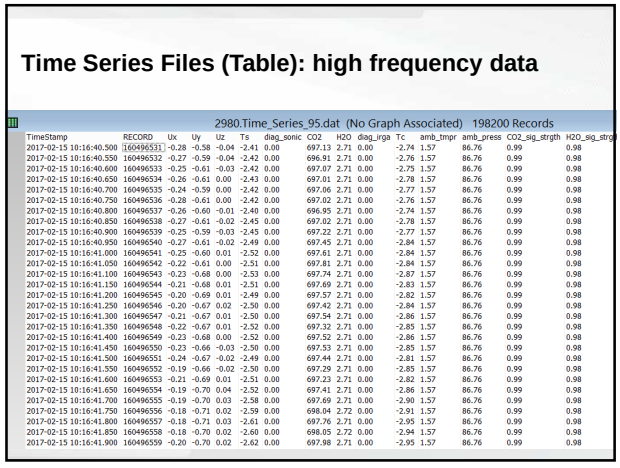
Diagnosis table



System Operation Notes



Time Series Files (Table): high frequency data



Flux File in AmeriFlux format: Hourly data