



Chinese FLUX Observation and Research Network
ChinaFLUX

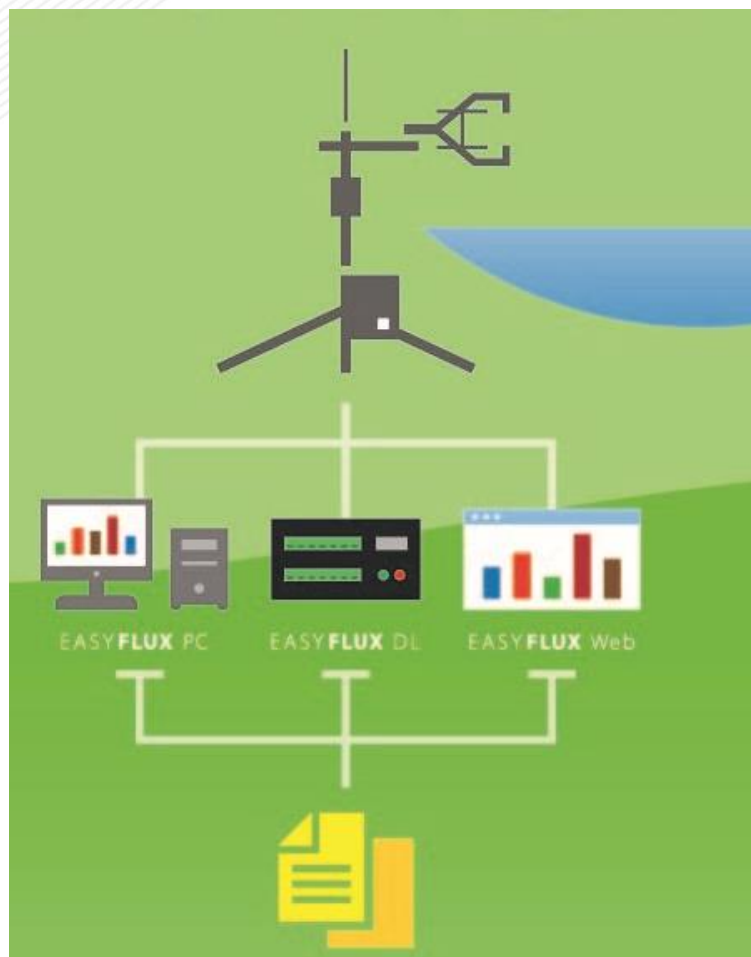


ChinaFLUX第十八次通量观测理论与技术培训

涡动相关系统常用的软件

李彦磊 (yanlei.li@Campbell.com.cn)
Campbell Scientific Inc.

EasyFlux Suit



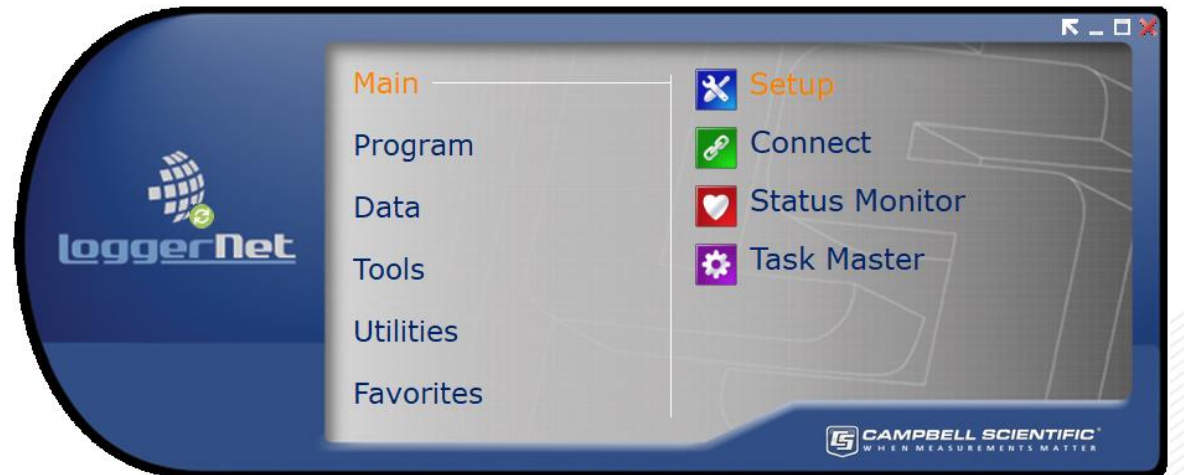
- EASYFLUX DL
 - 采集器端处理在线处理
- EASYFLUX PC
 - 电脑端数据后处理
- EASYFLUX WEB
 - 数据管理和可视化



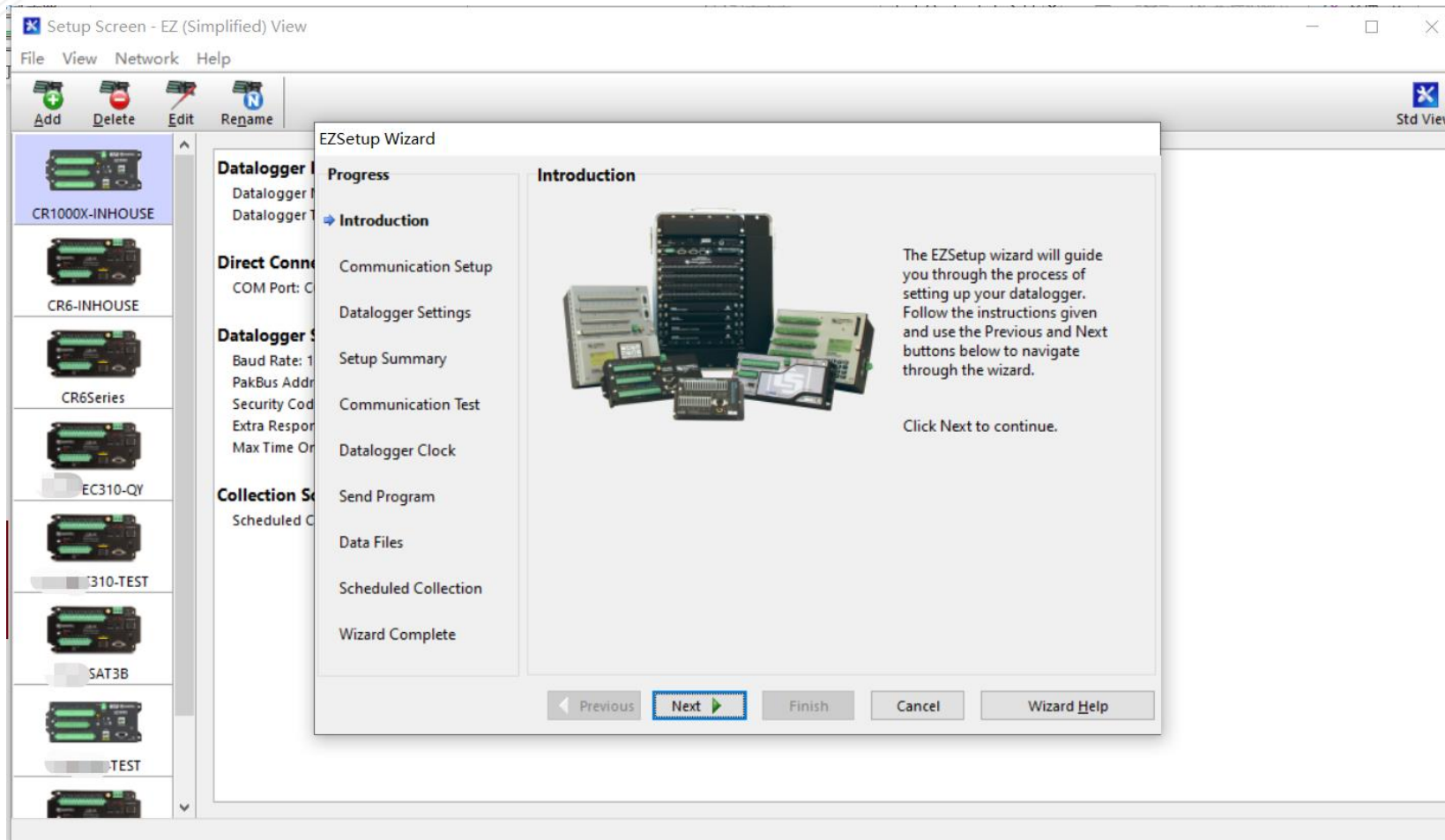
EasyFlux DL



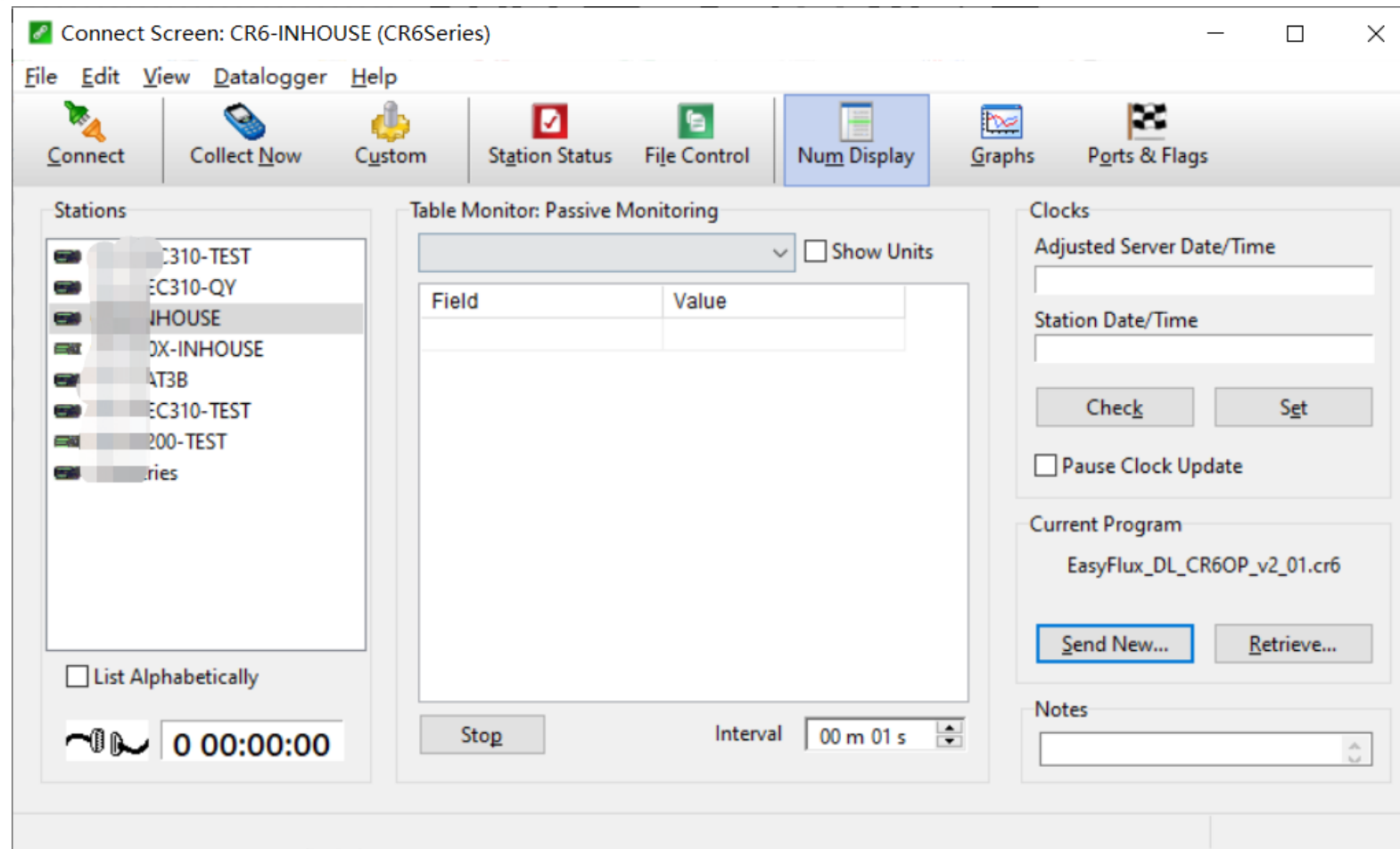
LoggerNet的基本操作



Loggernet的基本操作演示



Loggernet的基本操作演示





EasyFlux DL是运行在采集器端的程序，利用文献中常用的算法，可实时得到完全修正的通量结果。为了便于用户对通量结果进行质量控制，数据插补等，EasyFlux DL支持多种传感器的组合配置

程序结构：

变量区，存储区，采集和运算区

适用系统：CPEC310, IRGASON, EC150&CSAT3A

适用采集器：CR6,CR1000X

```
'Declare Public Variables
```

```
'Example:  
Public PTemp, Batt_volt
```

变量区

```
'Declare Private Variables
```

```
'Example:  
'Dim Counter
```

```
'Define Data Tables
```

```
DataTable (Test,1,-1) 'Set table size to # of records, or -1 to autoallocate.  
  DataInterval (0,15,Sec,10)  
  Minimum (1,batt_volt,FP2,False,False)  
  Sample (1,PTemp,FP2)  
EndTable
```

存储区

```
'Define Subroutines
```

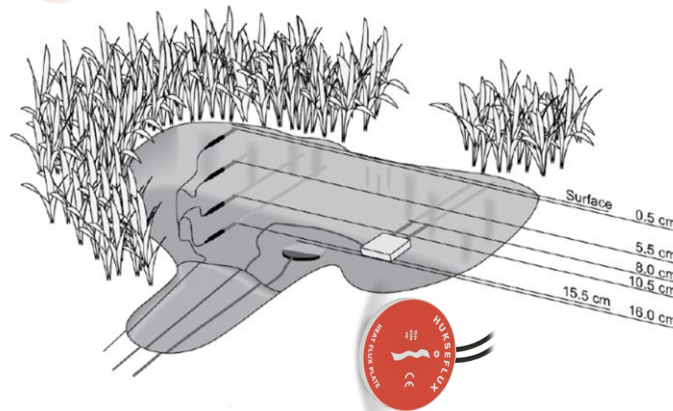
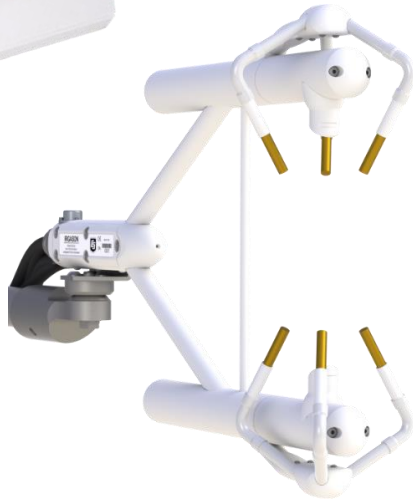
```
'Sub  
  'EnterSub instructions here  
'EndSub
```

```
'Main Program
```

```
BeginProg  
  Scan (1,Sec,0,0)  
  PanelTemp (PTemp,15000)  
  Battery (Batt_volt)  
  'Enter other measurement instructions  
  'Call Output Tables  
  'Example:  
  CallTable Test  
  NextScan  
EndProg
```

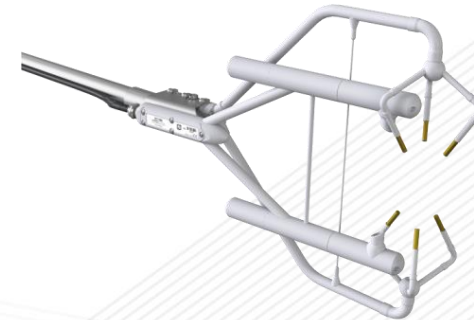
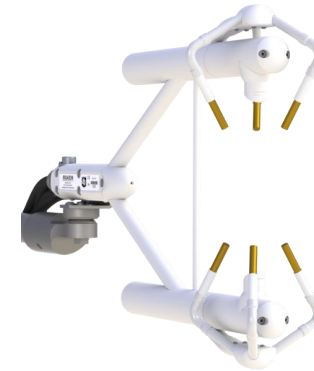
采集和运算区

EasyFlux DL 参数配置, 编译和上传



1.1 IRGA & CSAT3

```
27  '*PROGRAM FUNCTION CONSTANTS
28  Const SCN_INTV           = 100      'Unique: measurement rate (m
29  Const SLW_SCN_INTV      = 5000     'Unique: slow sequence measu
30  Const OUTPUT_INTV       = 30       'Unique: online flux data ou
31  Const DAY_FLUX_CRD      = 30       'Unique: number of days of F
32  Const DAY_TSRS_CRD      = 1        'Unique: number of days of 1
33  Const NTCH_FRQ_SLW As Long = 60     'Unique: slowsequence analog
34  Const ONE_FL_TABLE As Boolean = FALSE 'Unique: Whether or not all
35
36  '*PERIPHERAL
37  Const CDM_VOLT_116 As Boolean = FALSE 'Unique: A CDM-A116 is being
38  #If (CDM_VOLT_116) Then
39  Const CDM_VOLT_SN As Long = 1001    'Unique: CDM-A116 serial num
40  Const CDM_VOLT_CPI As Long = 1      'Unique: CPI address for CDM
41  Const CPI_DEVICE As String = "CDMA116" 'Unique: CDM Module name or
42  #EndIf
43
44  '* GAS ANALYZER AND SONIC ANEMOMETER
45  Const IRGASON As Boolean = TRUE     'Unique: IRGASON. TRUE as de
46  Const CSAT3A_EC150 As Boolean = FALSE 'Unique: CSAT3A + EC150. FAI
47  Const SDM_CLK_SPD As Long = 30      'Unique: default SDM clock s
48  Const EC100SDM_ADDR As Long = 1     'Unique: SDM address for EC1
49  Const BANDWIDTH         = 20       'Unique: in Hz. For spectral
```



1.2 空气温湿度

```
/*TEMP/RH PROBE
Const SENSOR_T_RH As Boolean = FALSE
#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
#EndIf
```



Air Temp & Humidity Sensor

空气温湿度传感器：用来测量空气温度和空气相对湿度

$$\text{饱和水汽压: } e_s = 6.11 \times 10^{\frac{a \times T}{T+b}}$$

$$\text{实际水汽压: } e_a = 6.11 \times 10^{\frac{a \times T}{T+b}} \times RH$$

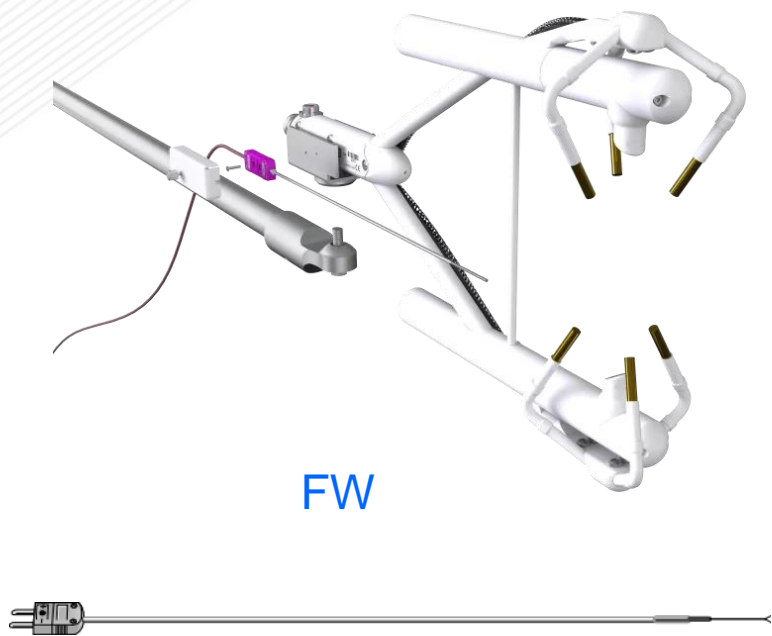
$$\text{水汽压差: } VPD = 6.11 \times 10^{\frac{a \times T}{T+b}} \times (1 - RH)$$

$$\text{露点温度: } t_d = \frac{\log \frac{e_a}{6.11} \times b}{a - \log \frac{e_a}{6.11}}$$

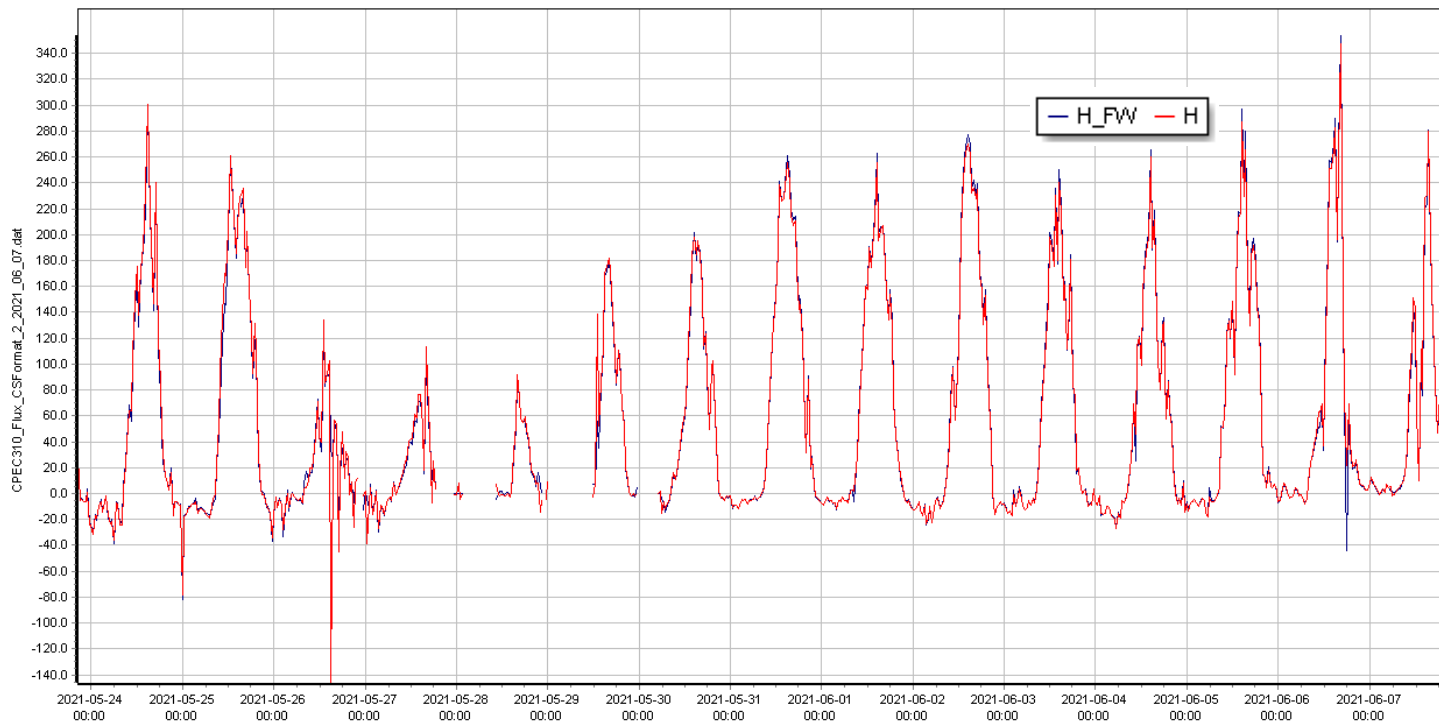
$$\text{水汽密度: } \rho_v = \frac{e_a}{R_v T}$$



1.3 热电偶



```
'*FINE WIRE THERMOCOUPLE  
Const SENSOR_FW As Boolean = FALSE
```



分别利用CSAT3A 与FW3测量值计算得到的感热通量



1.4 降雨量

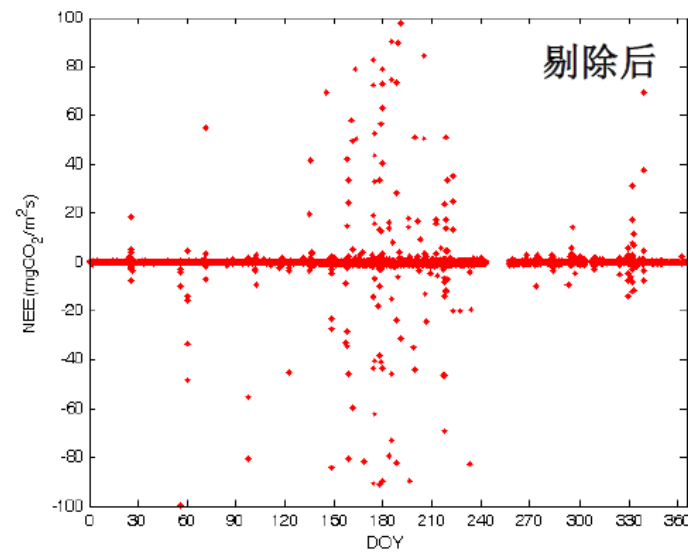
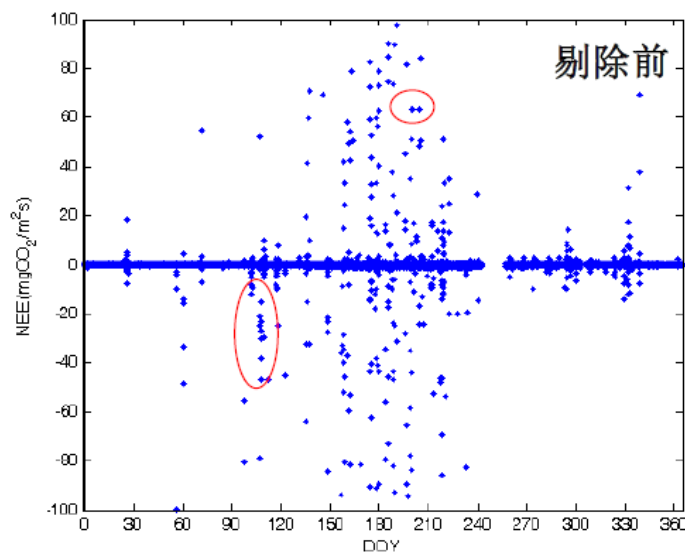
```
67  '*RAIN GAGE
68  Const SENSOR_TE525  As Boolean = FALSE
69  #If (SENSOR_TE525) Then
70  Const TE525_MULT    As Float   = 0.1
71  #EndIf
```



RainVUE雨量传感器

降水影响数据剔除（主要是针对于开路）

- ▶ 需要高频降水观测资料作为依据
- ▶ 剔除降水过程及前后一段时间的通量数据



1.5 光合有效辐射

光合有效辐射 (PAR, photosynthetically active radiation) : 太阳辐射中对植物光合作用有效的光谱成分, $0.4\sim 0.7\mu m$, 单位有 $\mu mol/m^2s^{-1}$, W/m^2 和lux

```
'*QUANTUM SENSOR
Const SENSOR_CS310 As Boolean = FALSE
#If (SENSOR_CS310) Then
Const QUNTM_MULT As Float = 100
#EndIf
```



CS310

非线性回归法 (Non-Linear Regression, **NLR**)

$$NEE_{day} = \frac{\alpha \times PAR \times P_{max}}{\alpha \times PAR + P_{max}} - RE_{daytime}$$

Michaelis-Menten 光响应方程

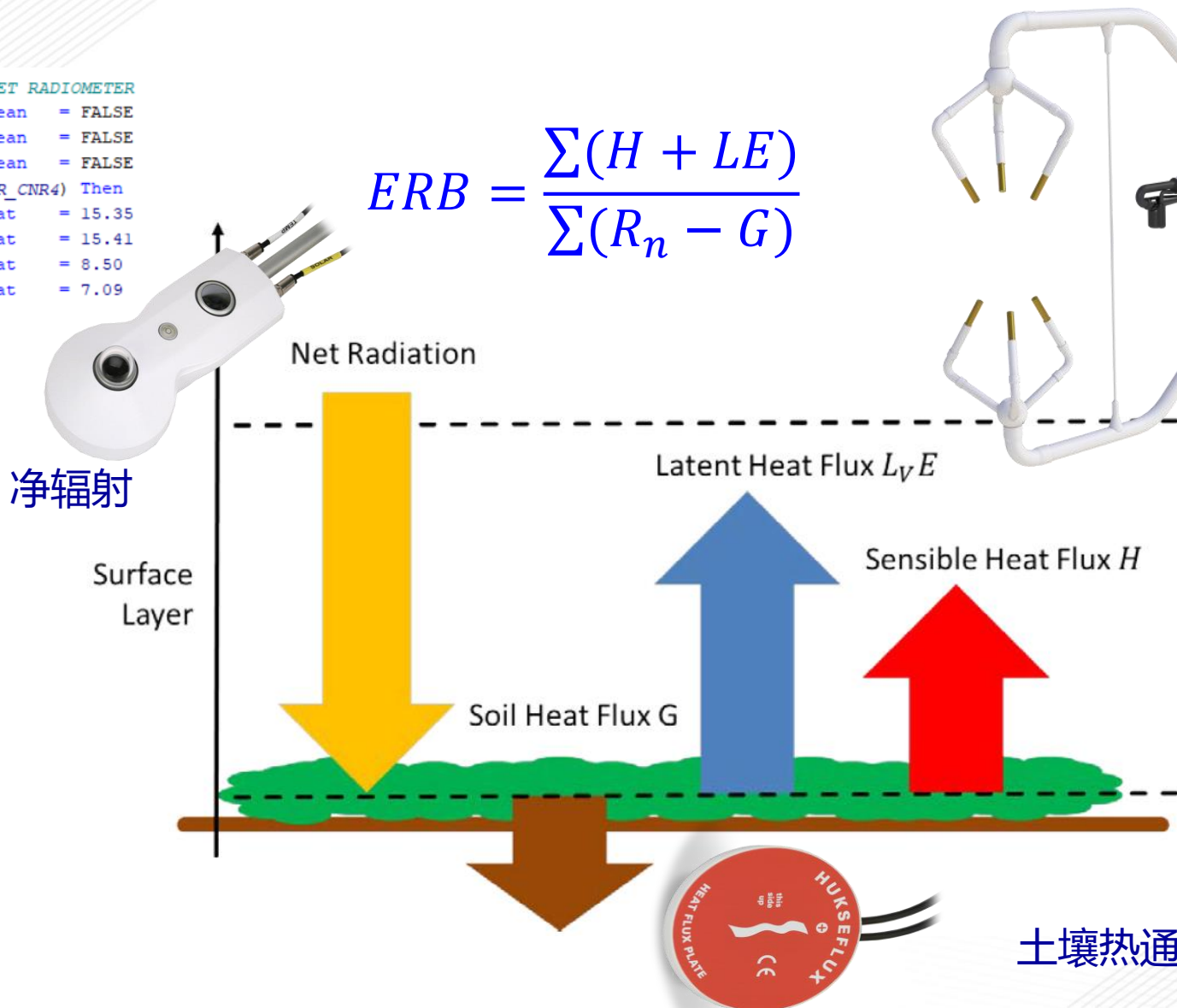


1.6 能量平衡

```

111  '*NR01/CRR4/SN500 4-WAY NET RADIOMETER
112  Const SENSOR_NR01 As Boolean = FALSE
113  Const SENSOR_CNR4 As Boolean = FALSE
114  Const SENSOR_CNF4 As Boolean = FALSE
115  #If (SENSOR_NR01 OR SENSOR_CNR4) Then
116  Const SW_IN_SNSTVT As Float = 15.35
117  Const SWOUT_SNSTVT As Float = 15.41
118  Const LW_IN_SNSTVT As Float = 8.50
119  Const LWOUT_SNSTVT As Float = 7.09
120  #EndIf
    
```

$$ERB = \frac{\sum(H + LE)}{\sum(R_n - G)}$$



能量闭合是检验涡动相关数据质量的重要标准之一。

```

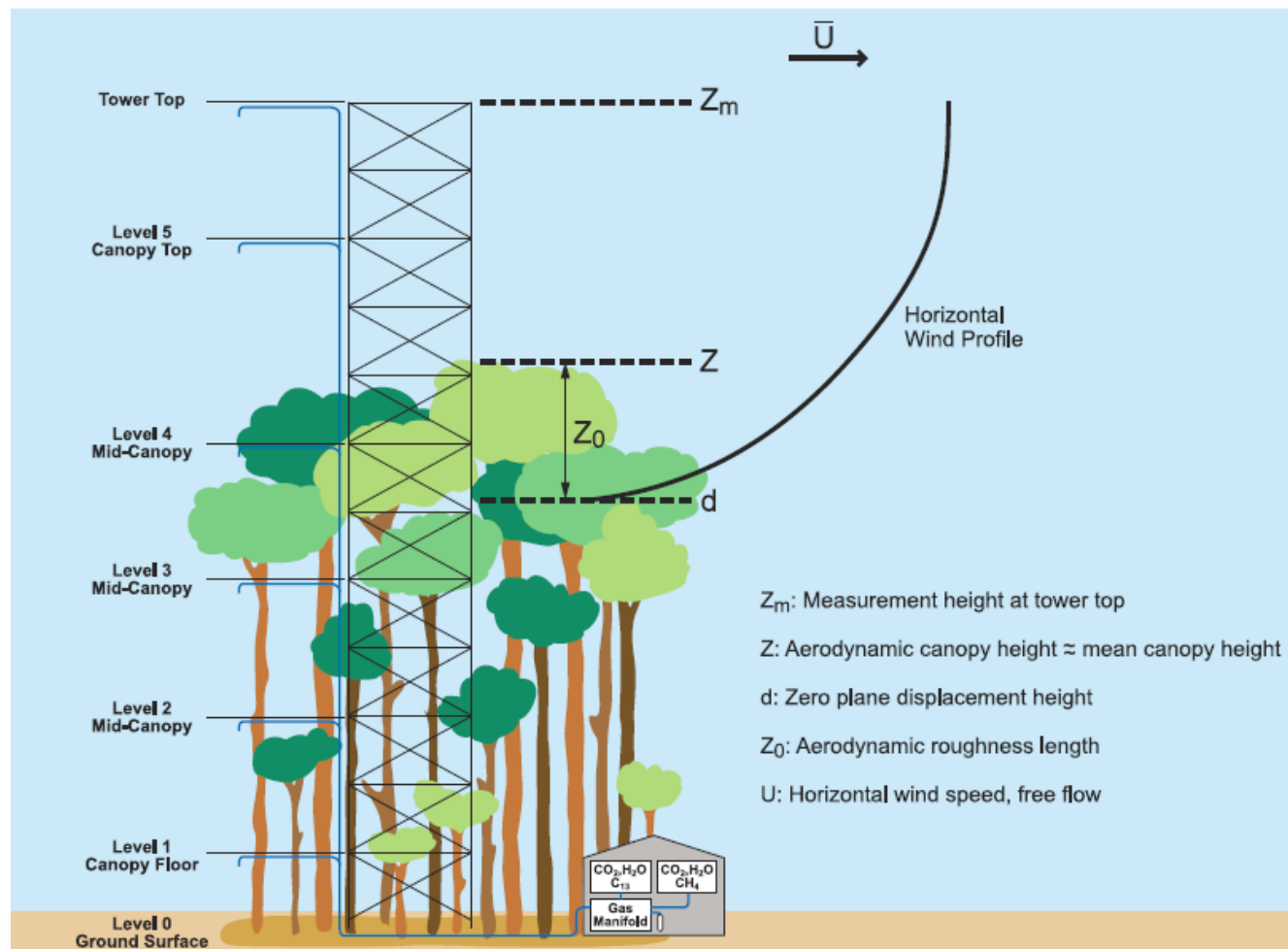
'* SOIL HEAT FLUX PLATE
Const SENSOR_HFP01 As Boolean = FALSE
Const SENSOR_HFPSC As Boolean = FALSE
#If (SENSOR_HFP01 OR SENSOR_HFPSC) Then
Const NMBR_HFP As Long = 3
Const HFP_SNSTVT_1 As Float = 62.0
#If (NMBR_HFP > 1) Then
Const HFP_SNSTVT_2 As Float = 62.0
#EndIf
#If (NMBR_HFP > 2) Then
Const HFP_SNSTVT_3 As Float = 62.0
#EndIf
    
```

站点参数

```
' Set default values of station var
sonic_azimuth      = 0
latitude           = 41.766
hemisphere_NS     = NORTH
longitude          = -111.855
hemisphere_EW     = WEST
altitude           = 1356.0
height_measurement = 2.0
surface_type       = GRASS
height_canopy      = 0.5
displacement_user  = 0
roughness_user     = 0
separation_x_irga  = 0.15020
separation_y_irga  = - 0.03218

#If (SENSOR_GPS) Then
  height_GPS16X    = 2
#EndIf

#If (SENSOR_FW) Then
  separation_x_FW  = 0.36427-0.338
  separation_y_FW  = -0.02408
  FW_diameter      = FW3_DIA
#EndIf
```



EasyFlux PC



站点参数

EasyFlux PC

File Help

Project

Select Files

Site Information

File Definition

Despike and Rotation

Corrections

Output Options

Output Console

Output Files

Instruments

IRGASON

EC150 with CSAT3A

EC100 Bandwidth: 20 Hz

Site Description

Wind Offset [°]	135
Measurement Height [m]*	2
Canopy Height [m]*	0.3
Displacement Height [m]	0.2
Roughness Length [m]	0.1
Elevation [m]*	100

* = required input

Site Information

Instruments

Select the Campbell Scientific instrumentation used in the eddy-covariance station.

Bandwidth

Select the instrument filter bandwidth. The factory default bandwidth is 20 Hz.

Wind Offset

The compass azimuth of the sonic anemometer's negative x-axis relative to local

Previous Next



数据文件信息描述

EasyFlux PC

File Help

Project	Variable	Column
Select Files	Horizontal x wind*	Ux
Site Information	Horizontal y wind*	Uy
File Definition	Vertical z wind*	Uz
Despike and Rotation	Sonic Temperature*	T_SONIC
Corrections	Sonic Diagnostic	diag_sonic
Output Options	CO2 Density*	CO2_density_fa
Output Console	H2O Density*	H2O_density
Output Files	IRGA Diagnostic	diag_irga
	Ambient Temperature	TA_1_1_1
	Ambient Pressure	PA
	CO2 Signal Strength	CO2_sig_strgth
	H2O Signal Strength	H2O_sig_strgth
	Fine Wire TC Temp	NA

* = required input

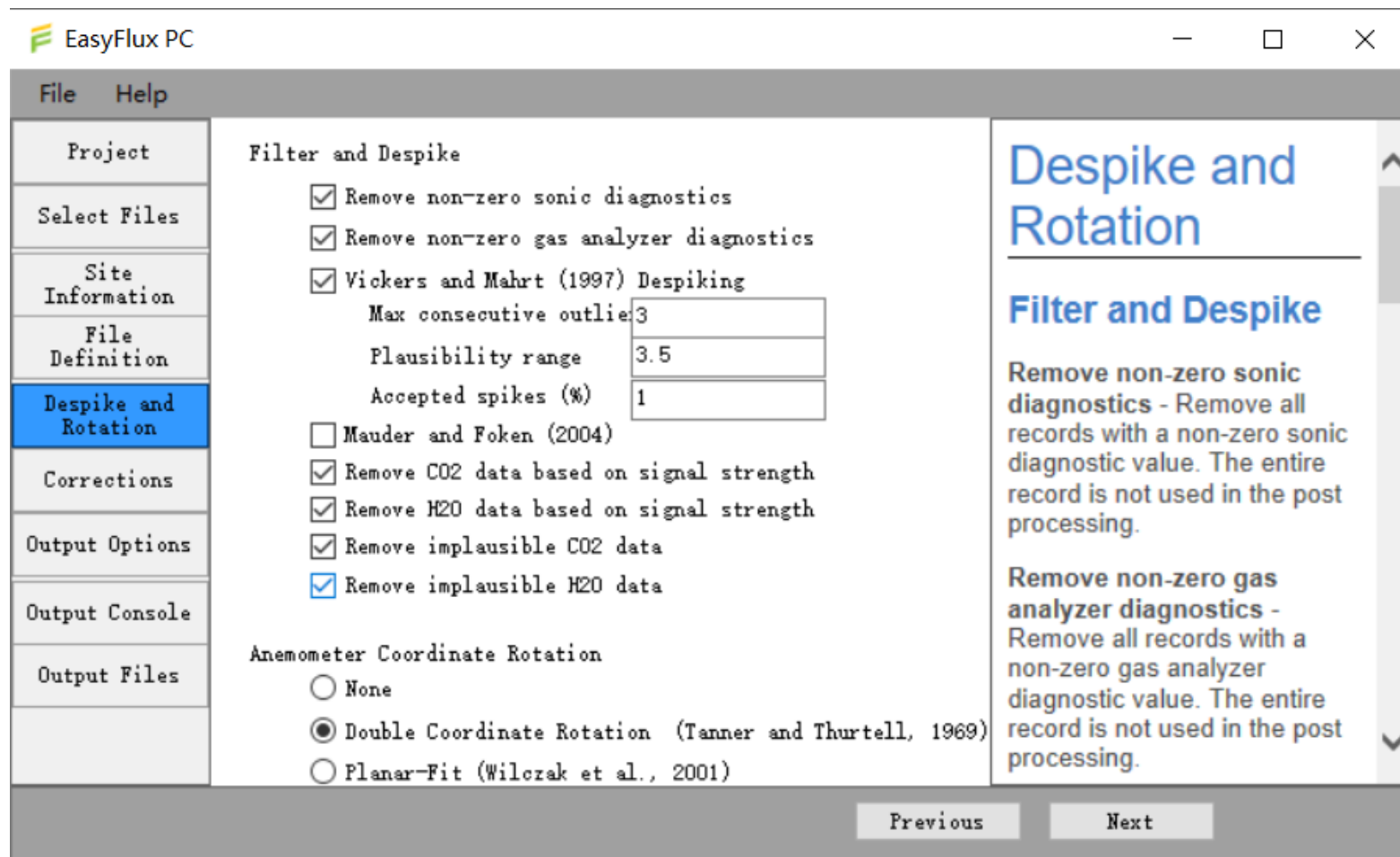
File Definition

In this list, each variable name is paired with a column name from the input data file. The column name field is populated automatically if the data was collected with a Campbell Scientific datalogger. If necessary, select the correct column name.

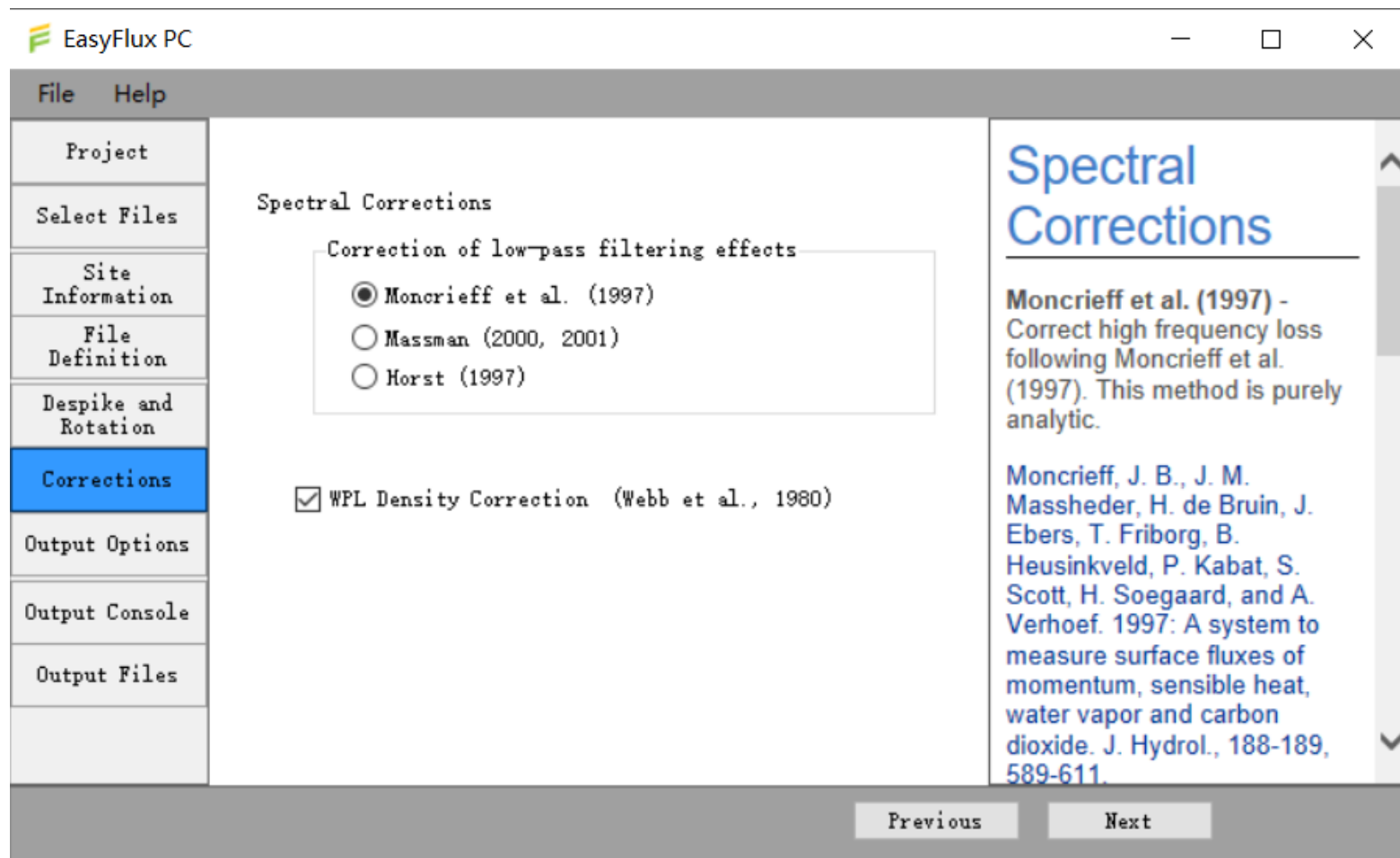
Previous Next



野点去除和坐标旋转



频率响应和密度效应校正



The screenshot displays the 'EasyFlux PC' software window. On the left is a vertical navigation menu with the following items: Project, Select Files, Site Information, File Definition, Despike and Rotation, Corrections (highlighted in blue), Output Options, Output Console, and Output Files. The main window area is titled 'Spectral Corrections' and contains the following settings:

- Spectral Corrections**
 - Correction of low-pass filtering effects
 - Moncrieff et al. (1997)
 - Massman (2000, 2001)
 - Horst (1997)
 - WPL Density Correction (Webb et al., 1980)

On the right side of the window, there is a 'Spectral Corrections' panel with a scroll bar. It contains the following text:

Spectral Corrections

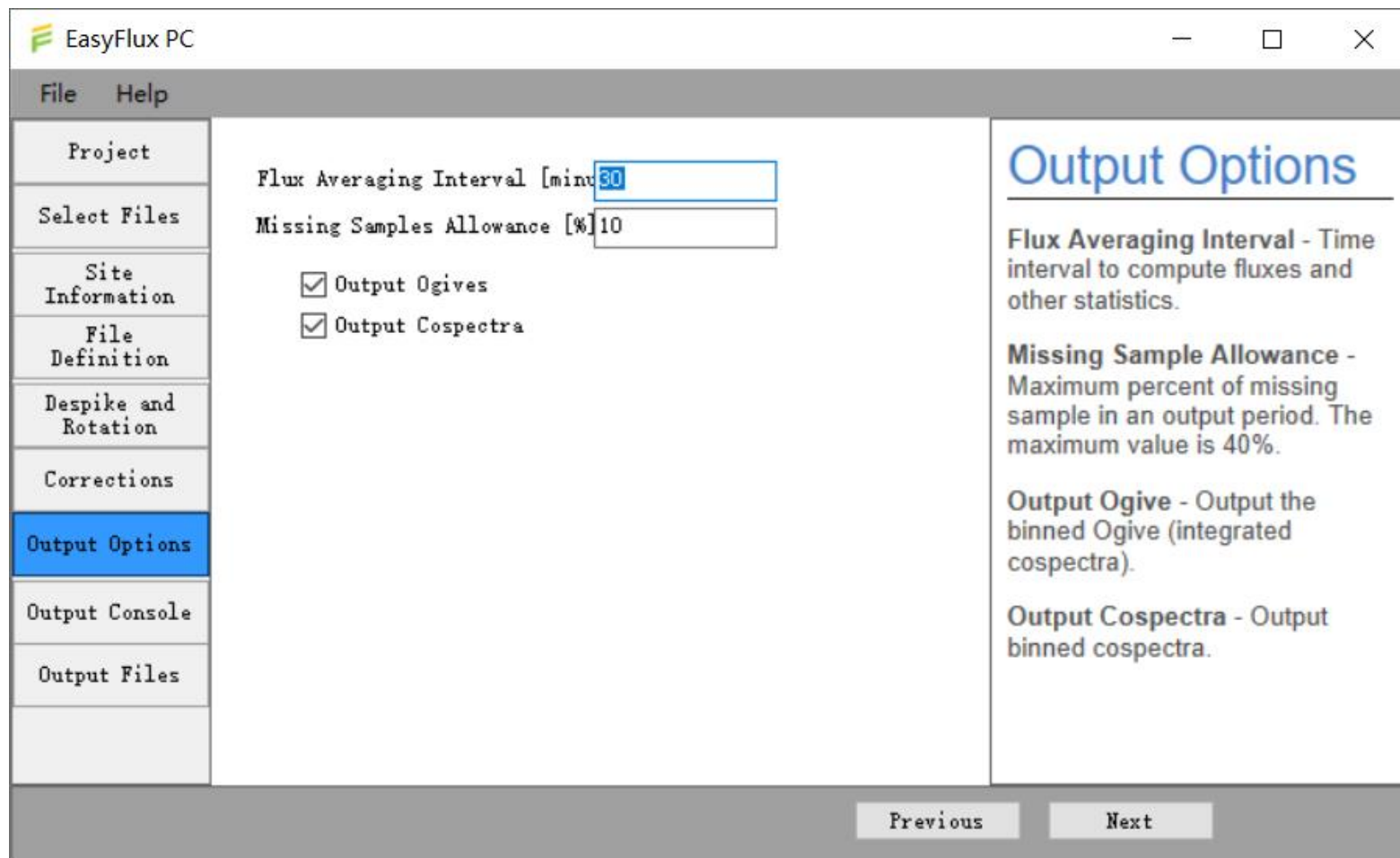
Moncrieff et al. (1997) - Correct high frequency loss following Moncrieff et al. (1997). This method is purely analytic.

Moncrieff, J. B., J. M. Massheder, H. de Bruin, J. Ebers, T. Friberg, B. Heusinkveld, P. Kabat, S. Scott, H. Soegaard, and A. Verhoef. 1997: A system to measure surface fluxes of momentum, sensible heat, water vapor and carbon dioxide. *J. Hydrol.*, 188-189, 589-611.

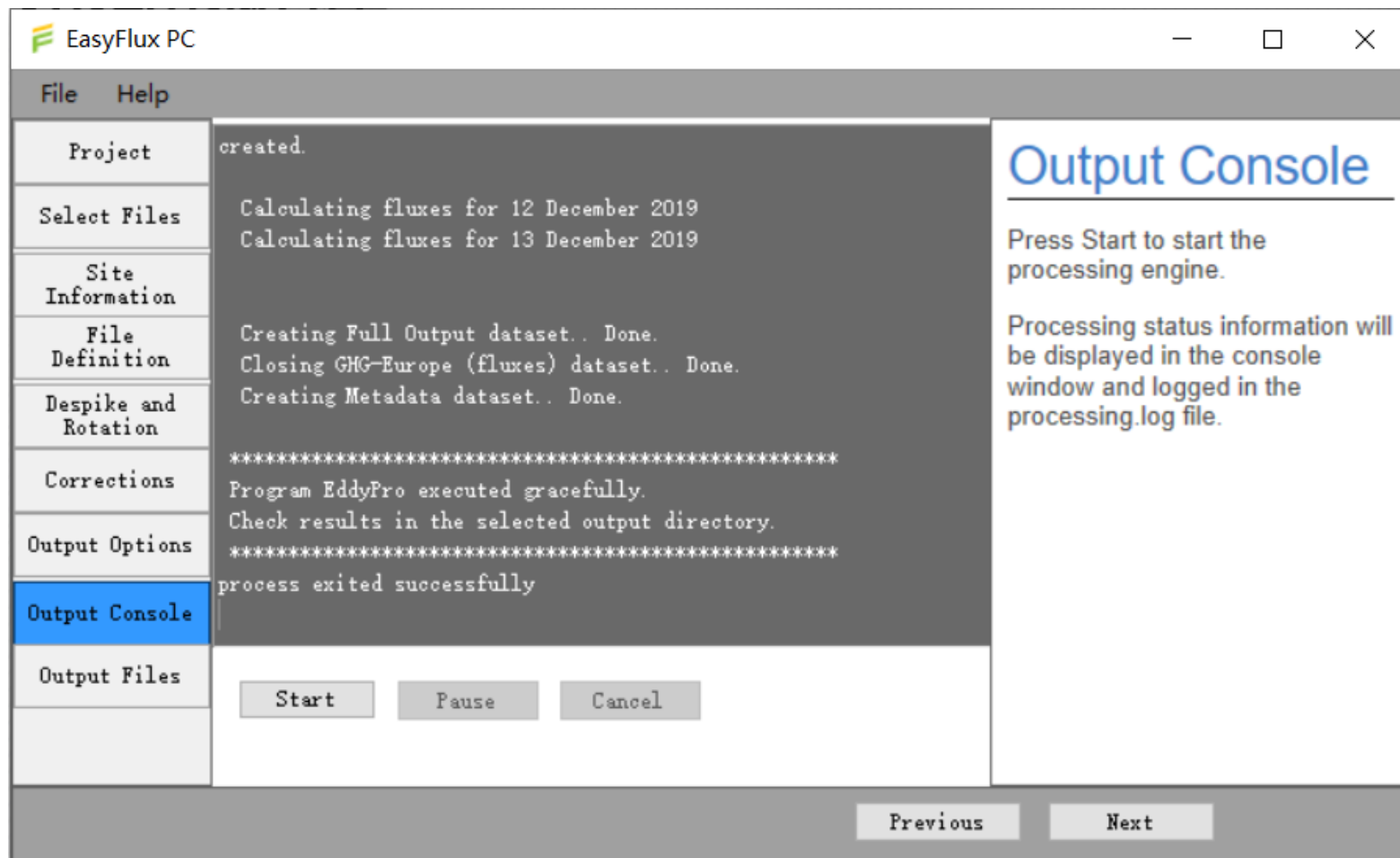
At the bottom of the window, there are two buttons: 'Previous' and 'Next'.



输出项设置

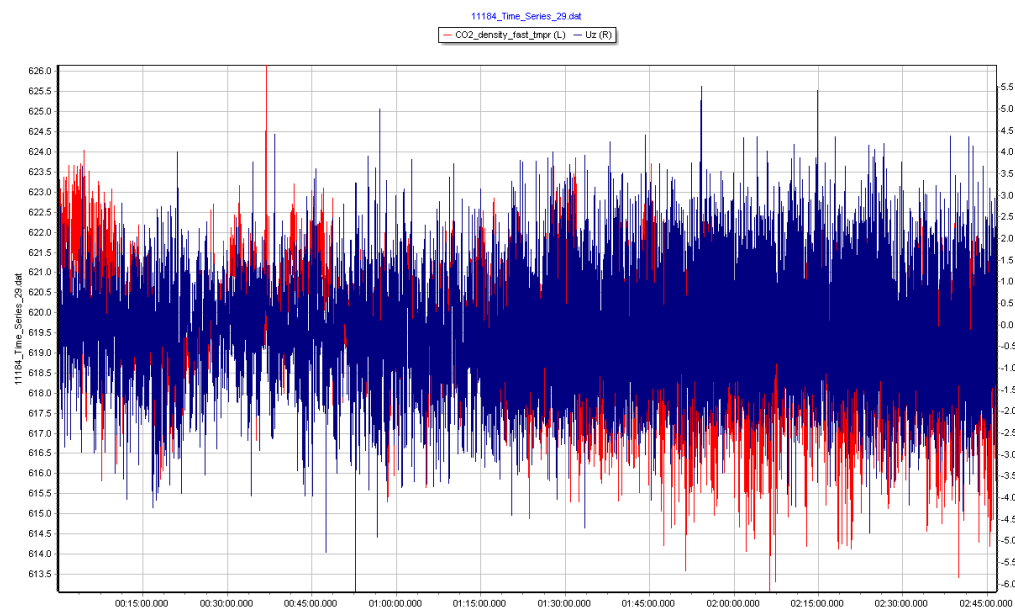


数据自动处理

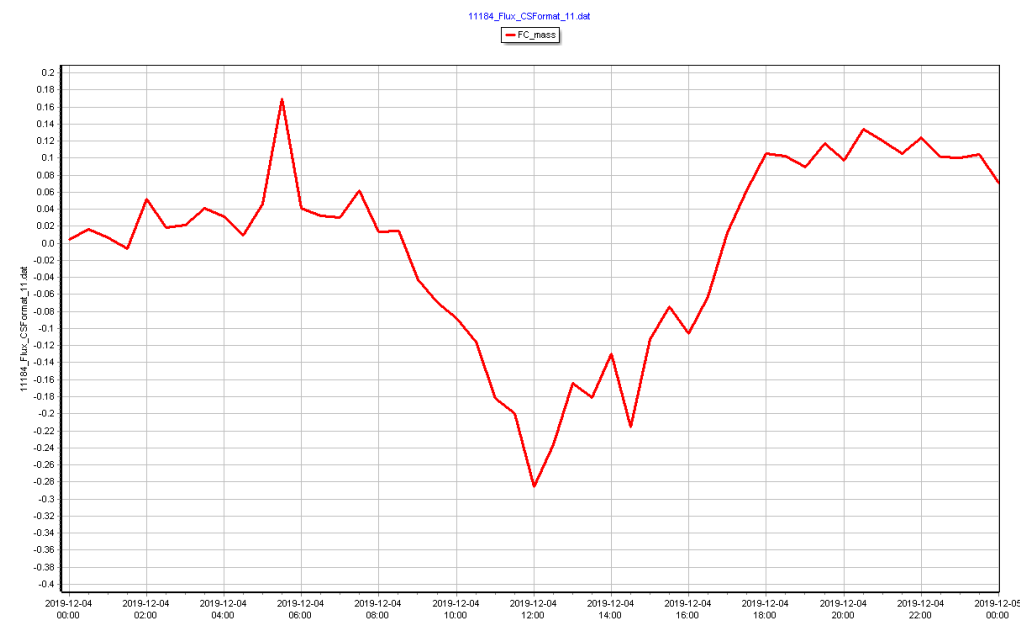


EasyFlux PC数据输出

10Hz原始数据



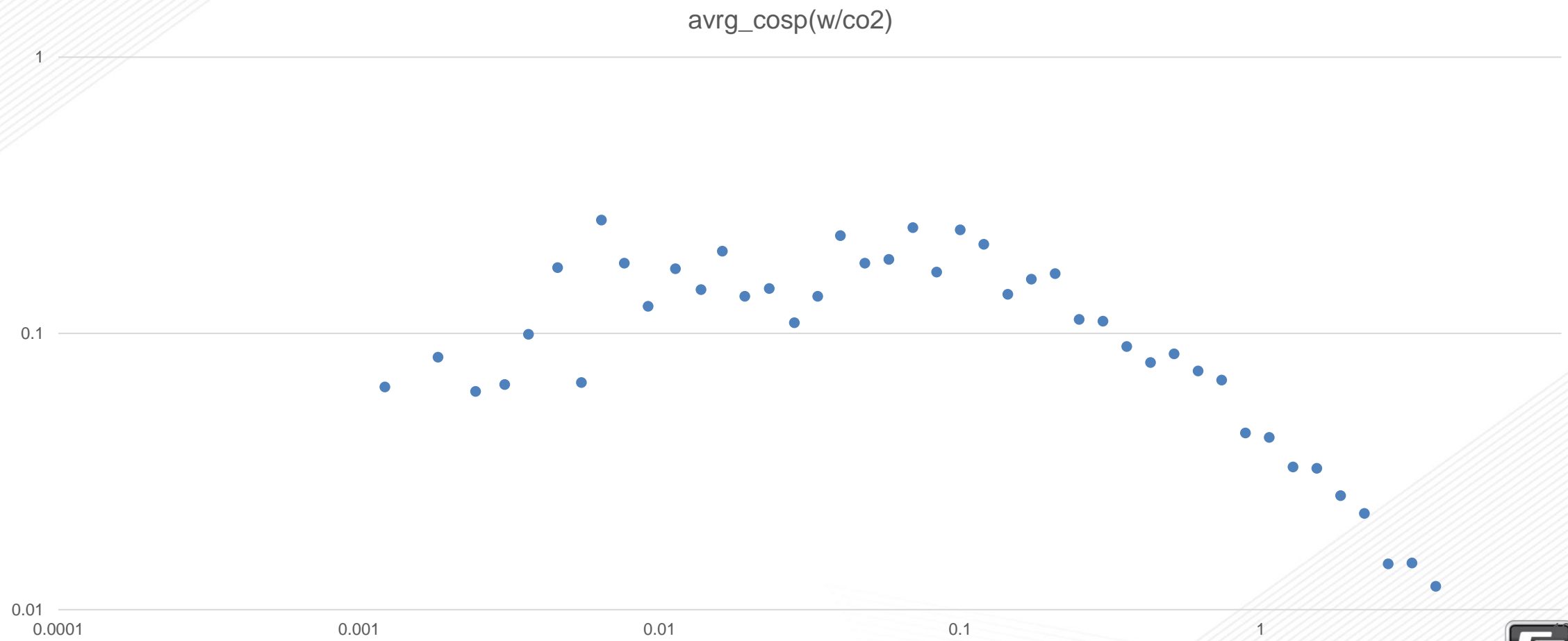
30min通量数据



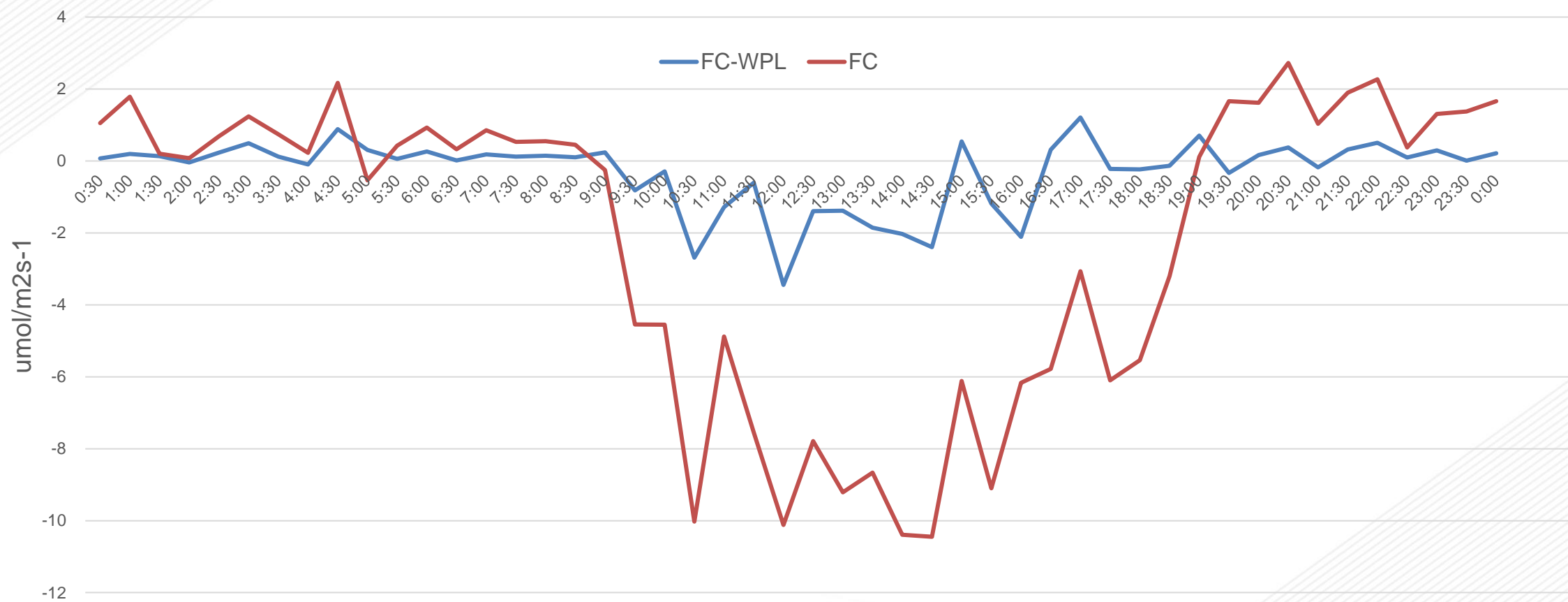
EasyFlux PC通过常用的数据质量控制和校正方法，将10Hz原始数据处理得到30min通量数据



协谱



WPL校正

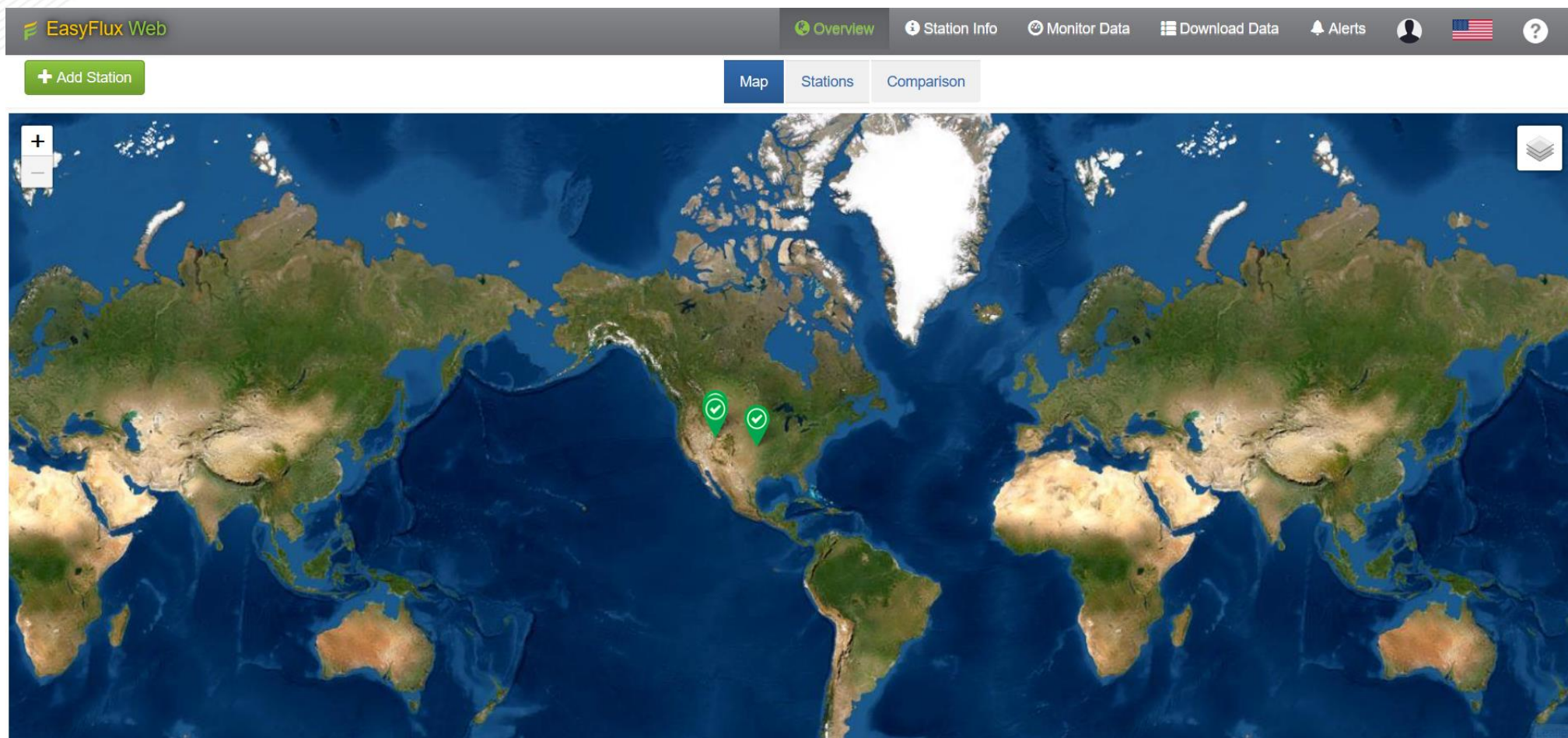


EasyFlux Web



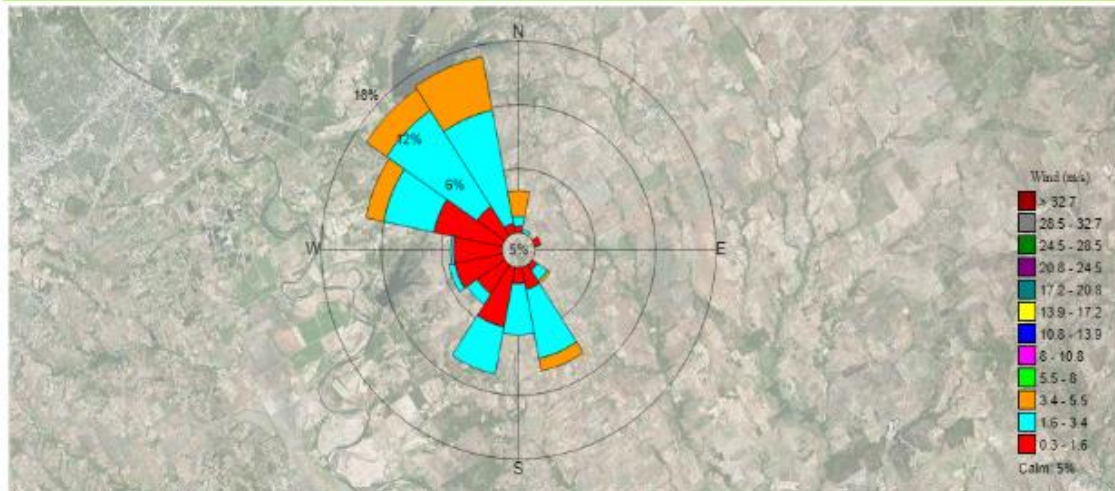
EasyFlux Web

数据可视化及数据管理



数据图形化展示

Wind Rose



LE



CO₂ Mix Ratio



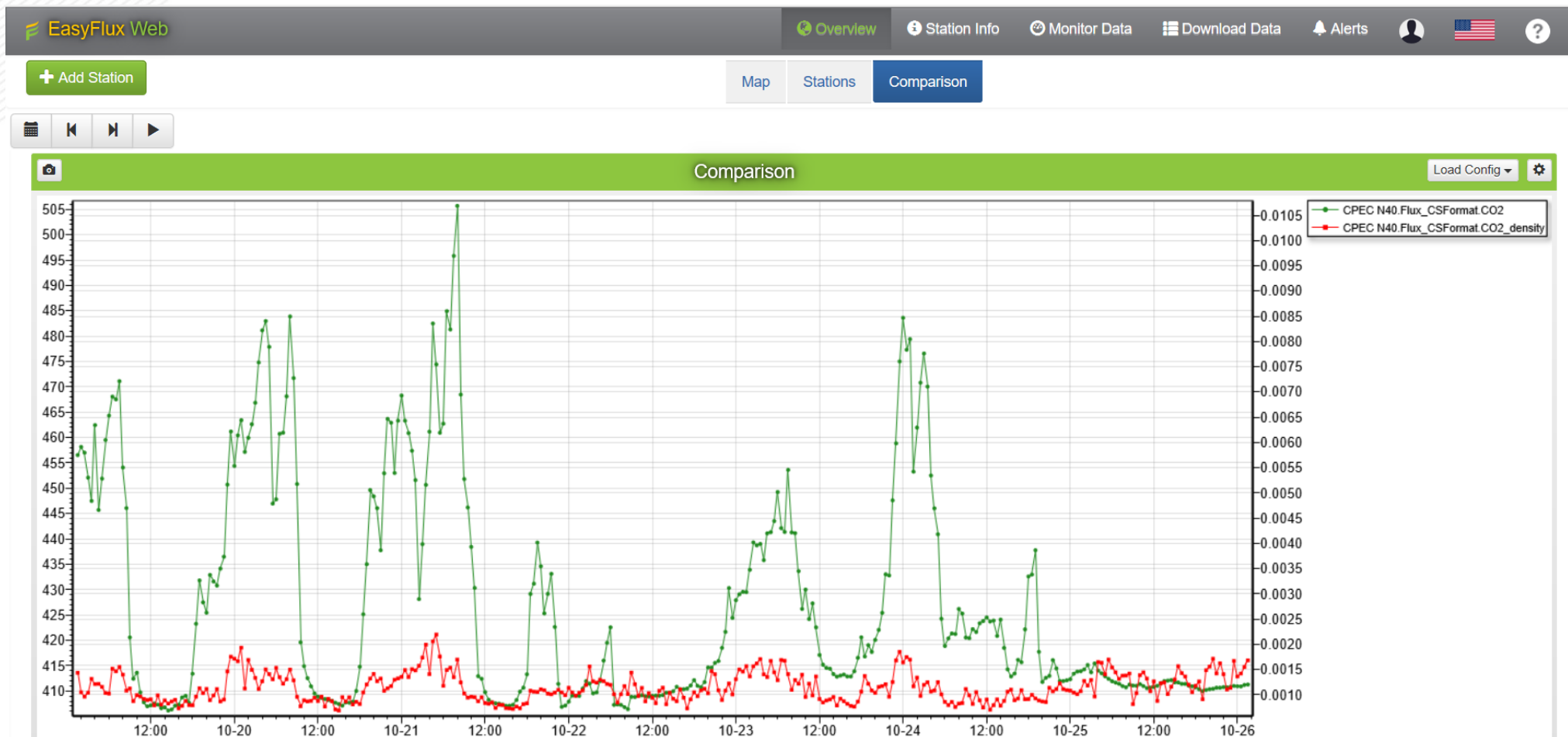
H



H₂O Mix Ratio



数据对比



实时图像

Edit Station Monitors: CPEC N40

+ Add Monitor

CCFC Live Video

Title CCFC Live Video

Type Live Video

Camera Address ip-181.campbellsci.com

Camera Type CCFC

Video Resolution 640 x 480

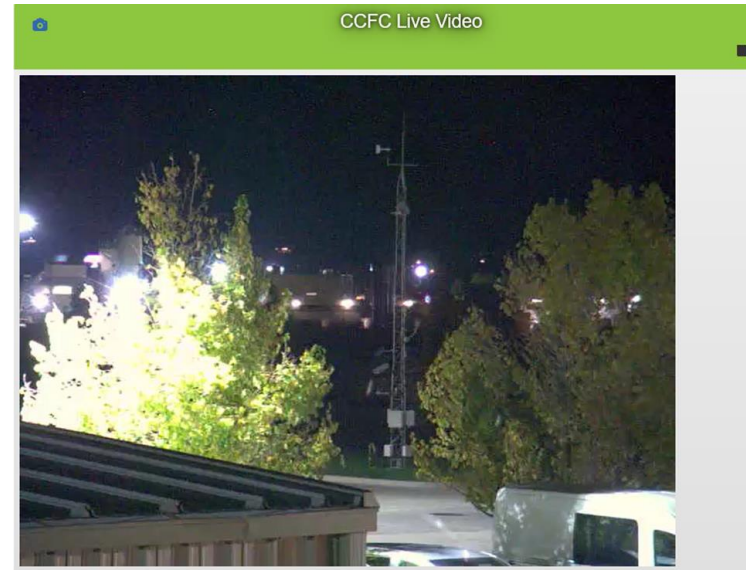
CO₂ Mix Ratio

H₂O Mix Ratio

Sonic Temperature

Wind Rose

Cancel Apply



数据下载

Station: CR6-10927 ▾

Download Data

Select the Table to Collect

 ▾

Data File Format

 ▾

Collection Mode

 ▾

↓ Download Now

Select the Table to Collect

选择要下载的数据表

Data File Format

选择输出数据的格式


Collection Mode

下载数据的方式

所下载的数据来源于数据库



故障预警

Title	Status	Value	Threshold	Message	Subscribed	Actions
Skipped Scans	✔	0	value > 0		<input type="checkbox"/>	⚙️
Watchdog Errors	✔	0	value > 0		<input type="checkbox"/>	⚙️
INNER BATTERY	✖	0.9512704	value < 3	THE DATALOOGER'S INTERNAL BATTERY IS LOW?!??	<input checked="" type="checkbox"/> 	⚙️

SMTP

Use CSI Email Relay

Server Address

User Name

Password

From Address

This free service allows up to 100 emails to be sent per day.

