2013/14

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McMurdo LTER Blue Box Documentation

A guide to sensor installation and programming of LTER limnological stations.
Updated Dec 15, 2013

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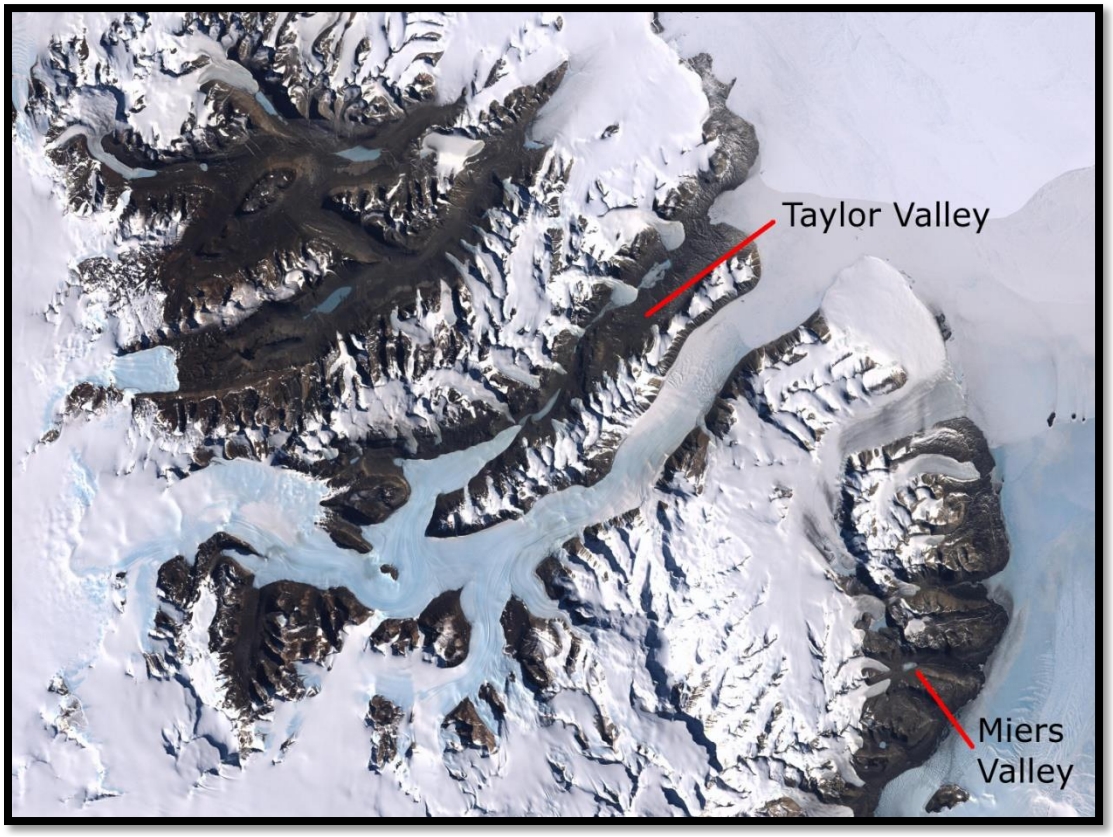
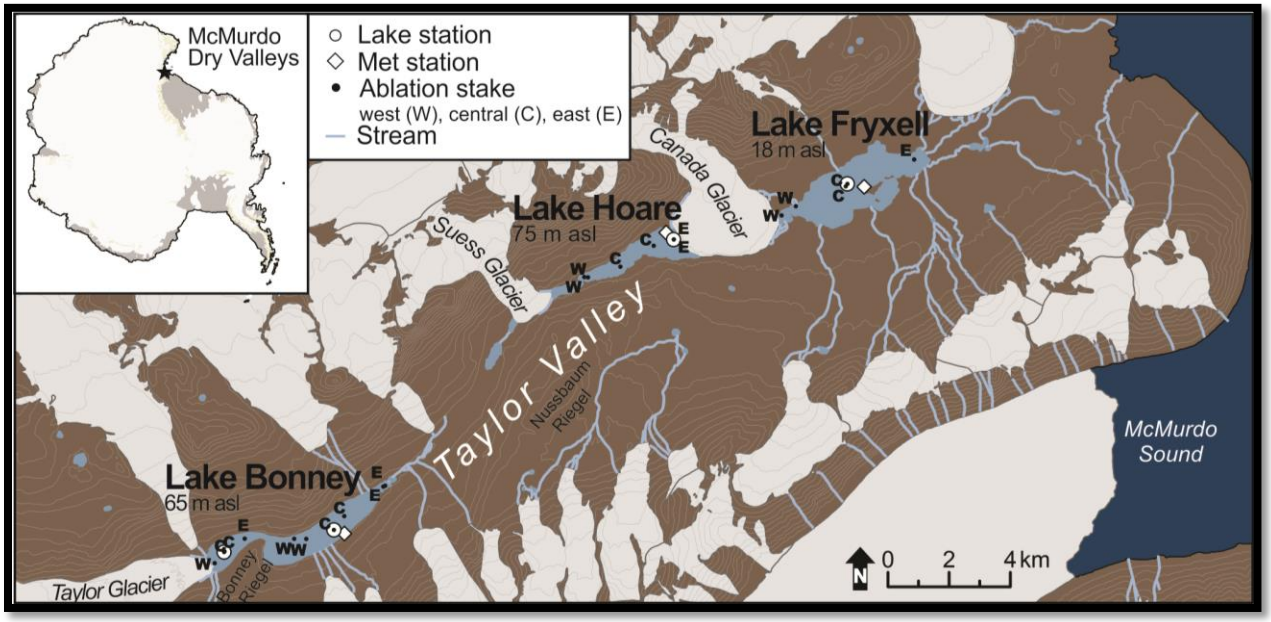
1. Map



McMurdo Dry Valleys, Antarctica



Locations of lake stations in Taylor Valley, Antarctica. Lake Miers not shown.

1.1) GPS locations

Lake Fryxell	Central AS	-77.6109	163.1445394
	Old West AS	-77.6198	163.0577323
	Brancker	-77.6101	163.1470667
	East AS	-77.6027	163.2372371
	AS with par @ BB	-77.6102	163.1468012
	New West AS	-77.617	163.07705
	New Benchmark	-77.6056	163.1194333
Lake Hoare	Bob 1 - GPS bechmark	-77.6236	162.9048831
	Brancker	-77.6272	162.9118
	old AS near BB	-77.6273	162.9111486
	AS close to Camera	-77.6309	162.8550709
	West AS	-77.6388	162.7945657
	Camera Box	-77.0629	162.8608
	AS with par @ BB	-77.6274	162.911031
	LH_ E_Cntr AS	-77.6293	162.8837178
	West Central AS	-77.6356	162.8386133
	New West AS	-77.6387	162.7894078
East Lake Bonney	East AS	-77.7004	162.519748
	East central	-77.7094	162.4638229
	West AS	-77.7162	162.411897
	AS with par	-77.7135	162.4489294
West Lake Bonney	old AS @ BB	-77.7199	162.299439
	East AS	-77.7161	162.3269119
	AS with par @ BB	-77.7201	162.2988916
	West AS by Glacier	-77.7151	162.3395048
	Brancker		
Miers	BB	-78.0969	163.8516167
	ABL East	-78.0979	163.8843333
	ABL West	-78.0955	163.8221
Lake Miers	Benchmark	-78.0936	163.8580926
Don Juan Pond	Benchmark	-77.56336154	161.1800056
Lake Vanda	Old Benchmark	-77.5269	161.6800115
	New Benchmark	-77.5262	161.6888056
Lake Vida	Benchmark	-77.3823	161.8178701

2. Sensors

2.1) Available Sensors

SENSORS	SENSOR TYPE	Applications	Company	Units
Surface PAR	LI190 SB Quantum	Measures incedent Photosynthetically Active Radiation	LI-COR Biosciences 4421 Superior St. Lincoln, NE 68504 Phone: 800-447-3576 Fax: 402-467-2819	micromoles of quanta per second per square meter (µmol s-1 m-2)
Underwater PAR	LI-193 Spherical Quantum Sensor	Measures PAR coming from all directions.	LI-COR Biosciences 4421 Superior St. Lincoln, NE 68504 Phone: 800-447-3576 Fax: 402-467-2819	
Ablation Transducer (pressure transducer)	CS455 (at LF, LH, ELB) and Druck Pressure Transducer PDCR 1830 (at WLB and Miers)	Continuous lake ice ablation measurement	Campbell Sci. Logan, UT	m
Lake Lavel (Stage) Transducer		Continuous lake level measurements	Campbell Sci. Logan, UT	m
Water Temperature	CS455 (at LF, LH, ELB) and Druck Pressure Transducer PDCR (at WLB)	Continuous water temperature measurements	Campbell Sci. Logan, UT	^{o}C
Ice Thickness	Benthos PSA-916 Sonar Altimeter	Narrow beam acoustic signal	Benthos, Inc. 49 Edgerton Drive North Falmouth, MA 02556	m
Surface Temperature	Campbell Scientific CS107	Surface temperature	Campbell Sci. Logan, UT	^{o}C

2.2) Programming Information and Manuals

(1) LI190 SB Quantum

Sensor details:
http://www.licor.com/env/Products/Sensors/190/li190_description.jsp
Instruction Manual from Campbell Scientific:
http://www.campbellsci.com/documents/manuals/li190sb.pdf

(2) LI-193 Spherical Quantum Sensor

Sensor details:
http://www.licor.com/env/Products/Sensors/193UW/li193_description.jsp
http://www.licor.com/env/PDF_Files/193SA.pdf

(3) Druck Pressure Transducer (WLB and Lake Miers only)

Sensor details:
http://www.gesensing.com/products/resources/datasheets/PDSA065june02.pdf
Instruction Manual from Campbell Scientific
http://www.campbellsci.com/documents/manuals/cs420-l.pdf

Note: Ablation Transducer (frequently called Pressure Transducer) and Lake Level Transducer (also known as Stage Transducer) are both the same type of transducers. The only difference between two is that they are differently programmed – one for measuring the Ice ablation and the other for measuring the lake level.

(4) CS455 Pressure Transducer (LF, LH, ELB,WLB)

Instruction Manual from Campbell Scientific
http://s.campbellsci.com/documents/us/manuals/cs450-cs455.pdf

(5) CR1000 DataLogger

Measurements and Control Module Operator's Manual
http://s.campbellsci.com/documents/us/manuals/cr1000.pdf

(6) Benthos PSA-916 Sonar Altimeter

Sensor Manual
www.benthos.com/pdf/PSA900_916.pdf

(6) CS107 Temperature Sensor

Sensor Manual
http://s.campbellsci.com/documents/us/manuals/107.pdf

2.3) Field Setup

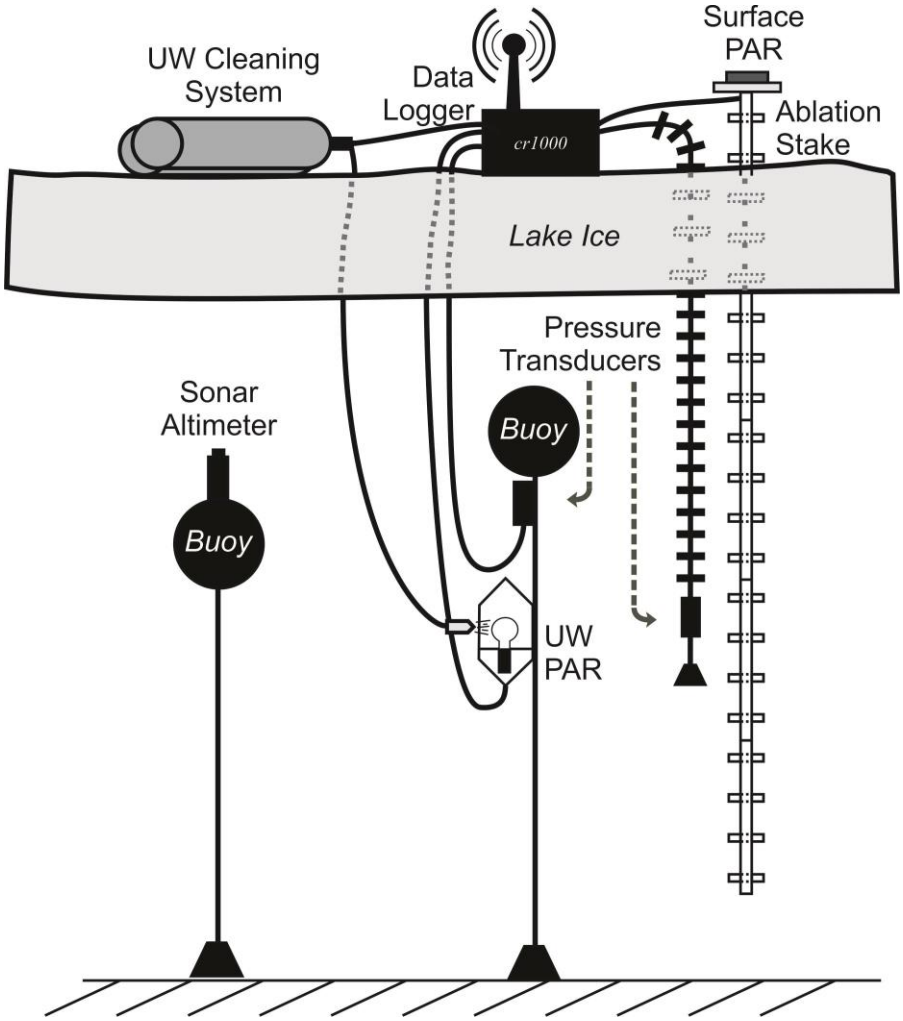
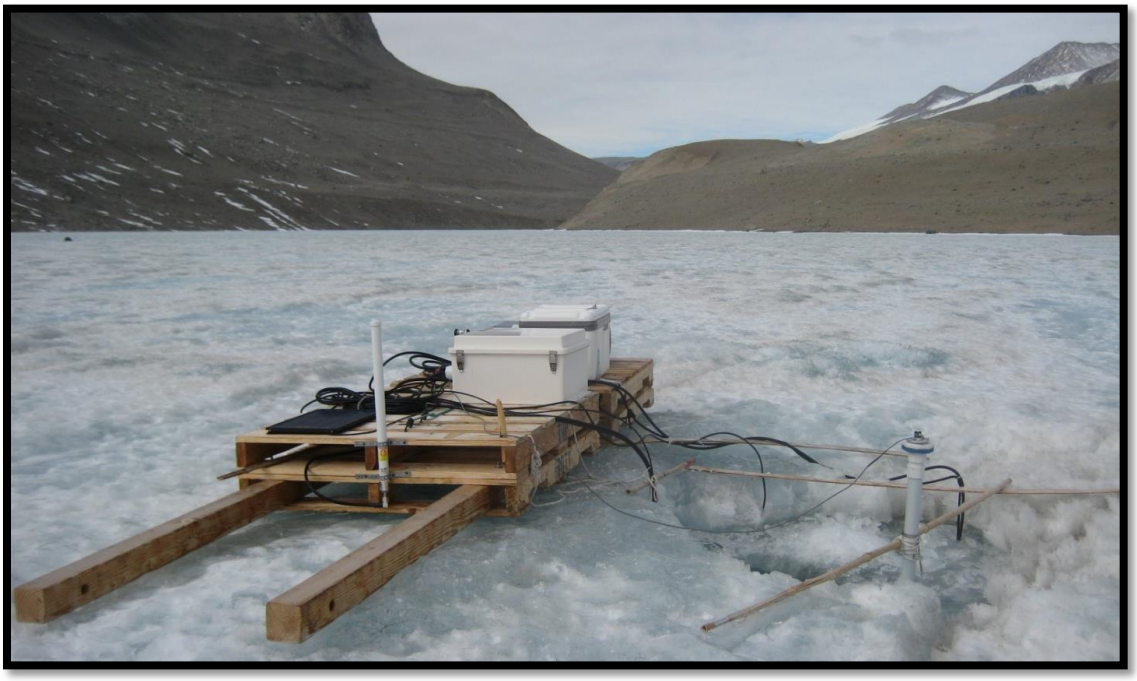


Figure 1. Setup of datalogger and sensors housed on the ice surface of each lake. The moored and hanging pressure transducers are used to calculate changes in stage and surface ice ablation. Note: Lake Miers does not have a sonar altimeter or UW cleaning system.

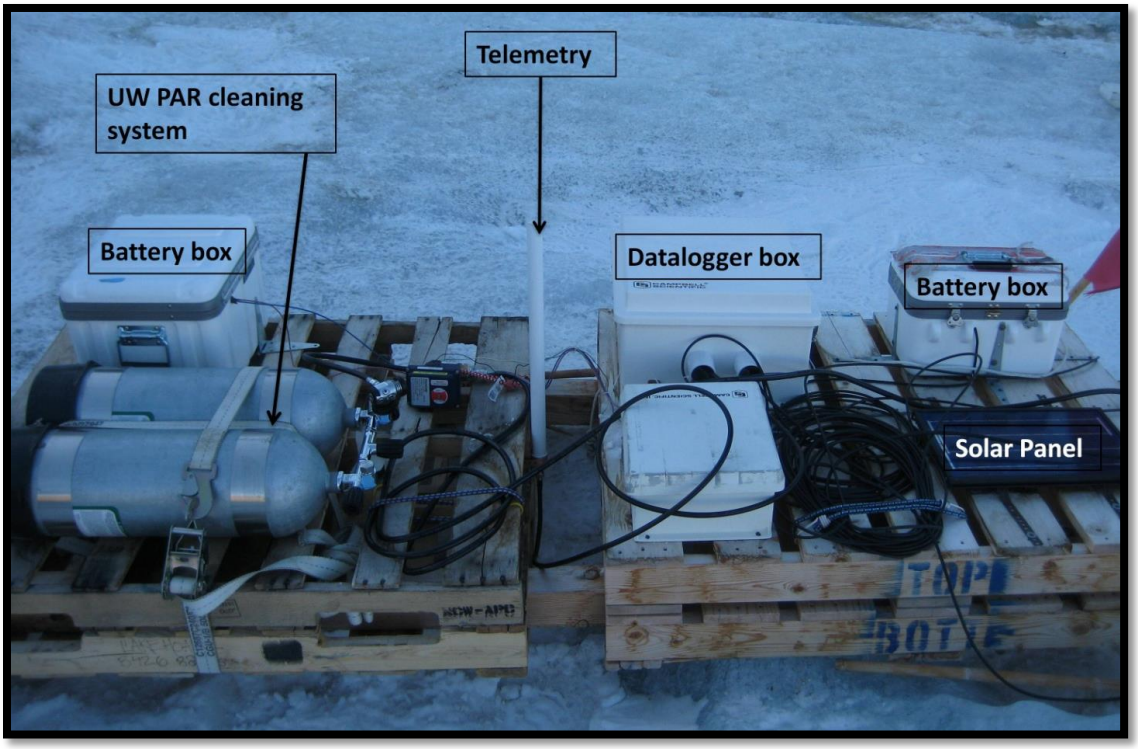
UW PAR is fixed to the buoy. However, due to continuous lake level change, depth corrections are necessary for UW PAR data. Deployment depths are measured from piezometric water level:
Lake Fryxell: 8 m (2013)
Lake Hoare: 10.1 m (2012)
ELB: 10.06 m (2012)
WLB: 9.86 m (2012)
Lake Miers: 10 m (2013 hanging)

As of 2013/14.
Telemetry working at all lakes.
UW PAR cleaning system has been installed at Fryxell, Hoare, ELB, and WLB.
Surface temperature sensors/sonar altimeters installed at Fryxell, Hoare, ELB, and WLB.
A second set of UW PAR sensors has been added hanging from the ice. Two hanging sensors at Miers.

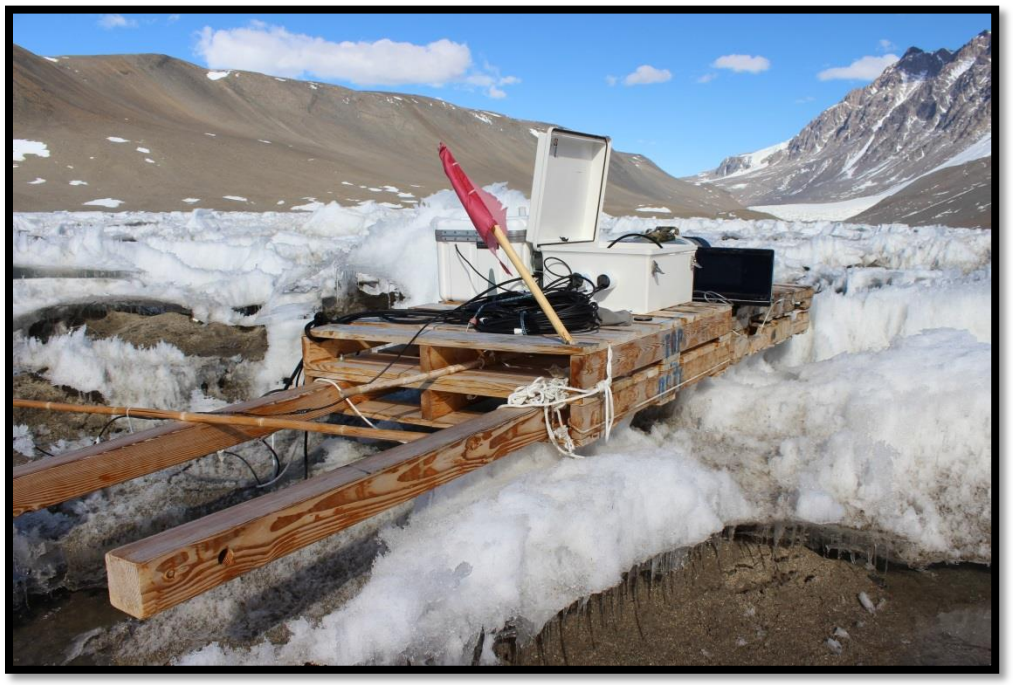
Blue box at West Lobe Bonney.
Outriggers are facing main wind direction to prevent box from flipping.



Blue box surface instrumentation

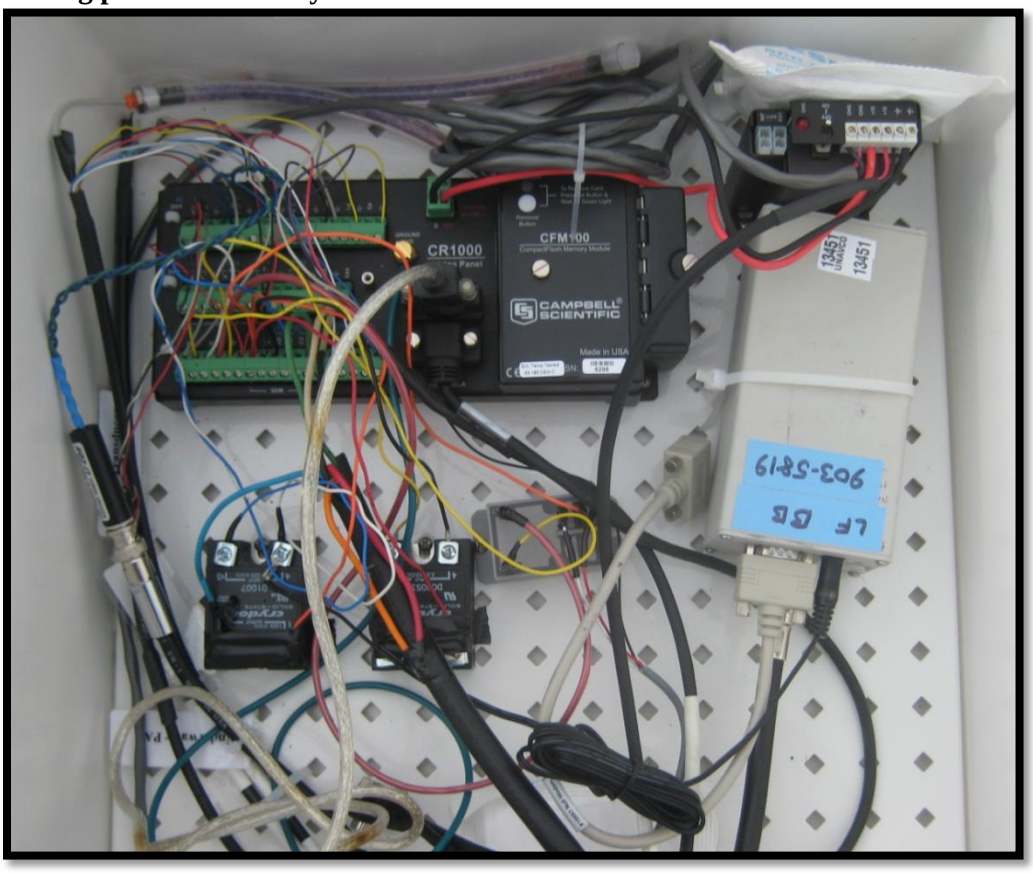


Pallets must be repositioned each year to prevent ablation mesas from forming. This is especially true at Lake Hoare and Lake Miers. Try to keep orientation East-West.



3. Wiring

Wiring panel at Lake Fryxell.

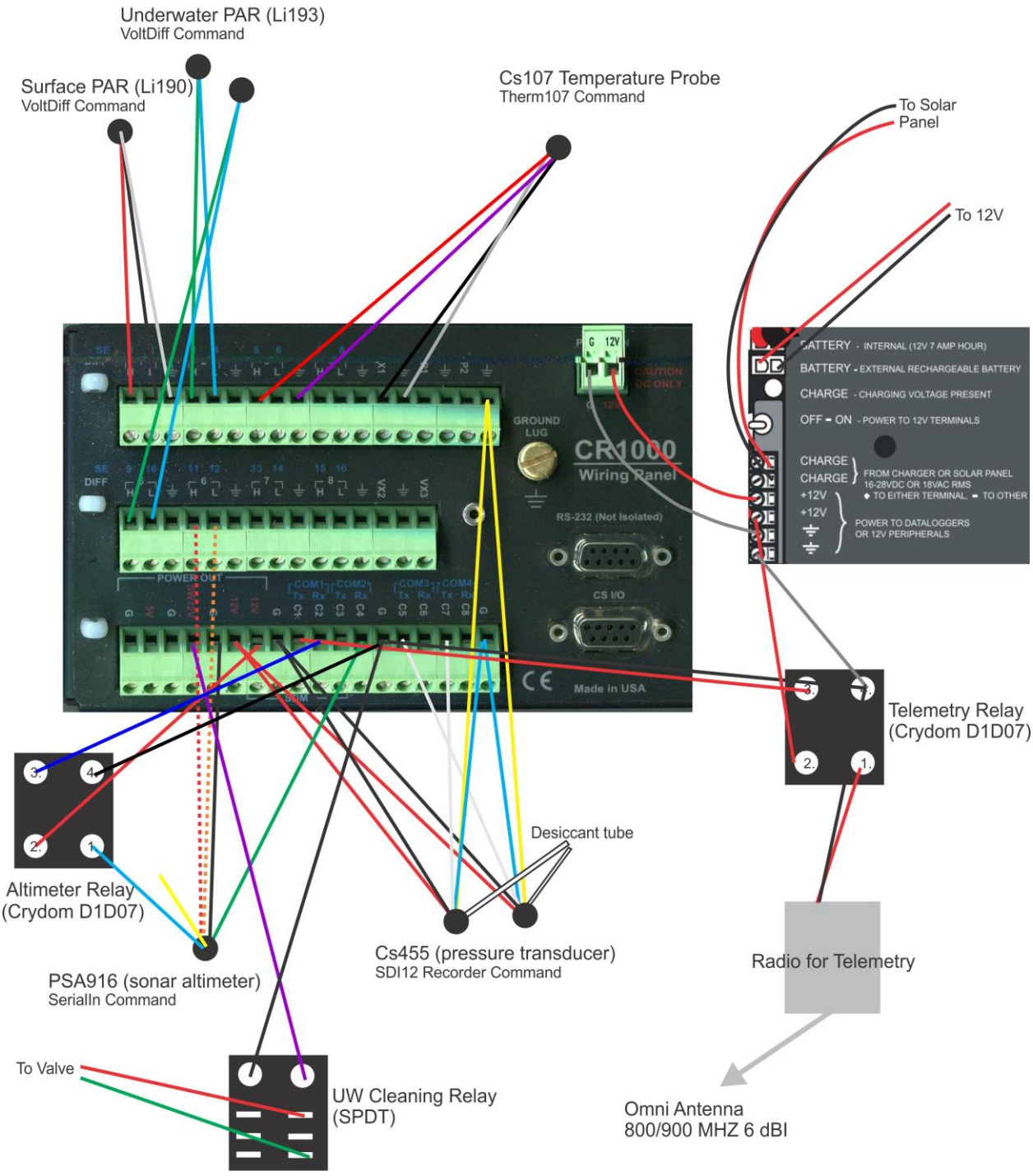


Relays at Lake Hoare.

1) **Crydom DC60S3 relay (normally open). 12V input on terminal 1.**
2) **Crydom D1D07 relay (normally open). 12V input on terminal 2.**

Cr1000 Wiring Diagram for TV Blue Boxes

by: Hilary Dugan Dec 2013



3.1) Fryxell, Hoare, ELB Wiring

Stage transducer (instrument with desiccant-filled vent tube)

Red	12V
Black	G
Yellow	G
Blue	G
White	C5
Clear	G

Ablation transducer (instrument with desiccant-filled vent tube)

Red	12V
Black	G
Yellow	G
Blue	G
White	C7
Clear	G

Underwater PAR_Moored (diff channel)

Green	2H
Blue	2L

Underwater PAR_Hanging (diff channel)

Green	5H
Blue	5L

Surface PAR (diff channel)

Red	1H
Black	1L
Silver	G

Sonar Altimeter

Blue	12v on relay
Black	G
Green	C4
Org/Red	Not used

Temperature Sensor (CS107)

Black	VX1
Red	SE5
Purple	G
Clear	G

3.2) WLB Wiring

Same as above, except for ablation transducer

Ablation transducer (DRUCK)

Red	VX2
Black	G
Yellow	8H
Blue	8L
White	G
Orange	not used
Clear	G

3.3) Lake Miers Wiring

Stage transducer (instrument with desiccant-filled vent tube)

Red	EX1
Black	3L
Yellow	4H
Blue	4L
White	G
Orange	3H
Clear	G

Ablation transducer (instrument with desiccant-filled vent tube)

Red	EX2
Black	5L
Yellow	6H
Blue	6L
White	G
Orange	5H
Clear	G

Underwater PAR_Moored (diff channel)

Green	2H
Blue	2L

Underwater PAR_Hanging (diff channel)

Green	5H
Blue	5L

Surface PAR (diff channel)

Black	1L
Red	1H

4. Sensor Changes

4.1) UNDERWATER PAR sensors. Li-193.

2012/13:
i) Reset all depths except for Lake Miers
ii) New bulbs installed on moorings at Lake Hoare, West Lobe Bonney
iii) A second set of UW PAR sensors was installed at each lake. Cables were hung from the ice.

Lake	**S/N**	**Deployment Date**	**Deployment Time**	**Deployed Depth**	**Calibration date**	Multiplier **Water**	**Attachment**
Fryxell	SPQA 4628	29/11/2013		8.05m		-182.22	Moored
Fryxell	SPQA 4968	29/11/2013		8m	16/08/2012	-190.81	Hanging
Hoare	SPQA 1694	27/10/2012	18:00	10.1m		-171.92	Moored
Hoare	SPQA 4967	14/12/2012	11:00	10 m	16/08/2012	-187.46	Hanging
ELB	SPQA 4629	14/11/2012		10.06m	24/11/2010	-171.16	Moored
ELB	SPQA 4965	13/12/2012	12:00	10m	16/08/2012	-186.35	Hanging
WLB	SPQA 2870	13/11/2012	18:00	9.86 m	29/06/2012	-196.80	Moored
WLB	SPQA4996	13/12/2012	12:00	10m	16/08/2012	-180.35	Hanging
Miers	SPQA 4630	29/11/2013	18:00	10m	24/11/2010	-171.36	Hanging
Miers	SPQA 4417	29/11/2013	18:00	10m	16/10/2009	-183.53	Hanging

4.2) SURFACE PAR sensors. Li-190.

2012/13:
i) Newly calibrated sensors were replaced at every station

Lake	**Season**	**Deployment Date**	**S/N**	**Multiplier ($\mu m\ s^{-1}\ m^{-2}$)**
Fryxell	2012/13	02-Nov-12	Q30805	221.3408
Hoare	2012/13	24-Oct-12	Q33694	272.4
ELB	2013/14	19-Nov-13	Q30804	232.97
WLB	2012/13	13-Nov-12	Q20275	238.2
Miers	2011/12	28-Nov-11	Q22174	345.6428

4.3) Sonar altimeters. Benthos PSA-916

2012/13:
i) Sensors were installed at Fryxell, Hoare, ELB and WLB.

Lake	**Installation Date**	**S/N**	**Depth below water level**
Fryxell	02-Nov-12	40138	5.45m
Hoare	22-Oct-12	40266	10.2m
ELB	14-Nov-11	40265	4.52m
WLB	13-Nov-12	?	4.40m

4.4) CR1000 Programs

New programs were uploaded at all stations. See section 5.
Note: In the blue box programs, we always have multiplier value of:

- 100 for UW PAR
- 200 for Surface PAR

Real values must be updated in post-processing

Table outputs:
15min: Values are measured every 1-min and recorded as 15-min averages. Begins Jan 1st, 2013.
Minute: Stage and ablation values are recorded at 1-min intervals.
Sonar: Measured at every six hours

5. CR1000 Programs

5.1) Lake Fryxell

```
'CR1000  Datalogger
'Lake Fryxell
'Sensors installed: Stage, Ablation, UW PAR, surface PAR, surface temp, sonar altimeter
'Additional equipment: UW cleaning system, telemetry radio
'Program written on: Oct 28 2010 by Maciej Obryk
'Program updated on Nov 14, 2013  by Hilary Dugan

'Declare Public Variables
Public PTemp
Public batt_volt As Float
Public CS455(2) As Float
Public ablation As Float
Public UW_PAR_uncorr As Float
Public UW_PAR_backup As Float
Public SUR_PAR_uncorr As Float
Public MilitaryTime As Float
Public DecTime As Float
Public DecTime_2 As String * 16
Public SonarString As String * 30
Public IceThickness As Float
Public rTime(9) As Float
Public SUR_Temp As Float

'Declares aliases. rTime = array for Julian time and decimal time
Alias rTime(1) = Year
Alias rTime(4) = Hour
Alias rTime(5) = Minutes
Alias rTime(8) = Day_of_Week
Alias rTime(9) = Day_of_Year
Alias CS455(1) = stage
Alias CS455(2) = W_Temp

'Declare Units
Units ablation = m
Units stage = m
Units W_Temp = degC
Units UW_PAR_uncorr = µmol/s/m²
Units UW_PAR_backup = µmol/s/m²
Units SUR_PAR_uncorr = µmol/s/m²
Units batt_volt = volts
Units PTemp = degC
Units IceThickness = m
Units SUR_Temp = degC

DataTable (LF15,true,-1) 'store data points every 15min, will start in 2013, only holds one week on internal
memory.
  DataInterval (0,15,Min,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
```

```
  Sample (1,MilitaryTime,IEEE4)
  Sample (1,DecTime,IEEE4)
  Sample (1,DecTime_2,String)
  Average (1,ablation,IEEE4,False)
  Average (1,stage,IEEE4,False)
  Average (1,W_Temp,FP2,False)
  Average (1,UW_PAR_uncorr,FP2,False)
  Average (1,UW_PAR_backup,FP2,False)
  Average (1,SUR_PAR_uncorr,IEEE4,False)
  Minimum (1,batt_volt,FP2,False,False)'changed to minimum battery voltage
  Sample (1,PTemp,FP2)
  Average (1,SUR_Temp,FP2,False)
EndTable

DataTable (Sonar,true,-1) 'store sonar altimeter measurements every 12 hours
  DataInterval (1,6,Hr,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,IceThickness,IEEE4)
EndTable

DataTable (Minute,true,2880) 'store data points every 1min, only holds two days on internal memory.
  DataInterval (0,1,Min,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Average (1,ablation,IEEE4,False)
  Average (1,stage,IEEE4,False)
EndTable

'Main Program
BeginProg
  'measurments every 60 seconds
  Scan (60,Sec,1,0)
    RealTime (rTime)
    MilitaryTime = (Hour*100)+Minutes
    'multiplier of "0.704088" is used to covert psi to m, i.e
    'psi to feet = 2.31; feet to m = 0.3048; hence 2.31*0.3048 = 0.704088
    SDI12Recorder (ablation,7,0,"M!",0.704088,0) 'pressure transducer - ablation
    SDI12Recorder (CS455,5,0,"M!",0.704088,0)    'pressure transducer - stage
    'surface PAR - Licor 190
    VoltDiff (SUR_PAR_uncorr,1,mV25,1,True ,0,_60Hz,200,0)
    'underwater PAR - Licor 193 hanging sensor
    VoltDiff (UW_PAR_backup,1,mV2_5,5,True,0,_60Hz,-100,0)
    'surface Temperature - CS107 Temperature Probe
    Therm107 (SUR_Temp,1,5,Vx1,0,_60Hz,1.0,0)
    'datalogger's temp
    PanelTemp (PTemp,_60Hz)
    'battry voltage
    Battery (batt_volt)
    'To get high resolution on decimal date, process decimal time in two steps
    If (Year/4 - INT(Year/4)) = 0 Then
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/367) 'for leap year
    Else
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/366) 'for normal year
    EndIf
    DecTime_2 = Year + Replace (DecTime,"0.",".")

    'underwater PAR - Licor 193
```

```
  If (Day_of_Year >= 213) OR (Day_of_Year <= 121) Then 'SUMMER
    VoltDiff (UW_PAR_uncorr,1,mV2_5,2,True,0,_60Hz,-100,0)
  Else,
    UW_PAR_uncorr = "NAN"
  EndIf

  CallTable LF15
  CallTable Minute
 NextScan

 SlowSequence 'allows for concurent sequence scanning
 Scan (1,Hr,1,0)
  If (batt_volt > 12.4) Then
   If TimeIntoInterval(0,6,Hr) Then 'turn on at 0600, 1200,1800,and 0000
     PortSet (2,1)
     Delay(0,3,sec)
     SerialOpen(Com2,9600,0,0,1000) 'UNDERWATER SONAR every hour
     SerialIn (SonarString,Com2,300,13,30)
     'VoltDiff (AnalogOut2,1,mV5000,1,True ,0,_60Hz,1.0,0)
     Delay(0,10,sec)
     SerialClose (Com2)
     PortSet (2,0)
     SplitStr(IceThickness,SonarString,CHR(9),1,0)

     PortSet (1,1)
     SerialOpen (ComRS232,9600,0,0,2000) 'enables CR1000 comms
     Delay (0,2,sec)'delay for Iridium comms
    EndIf

    If TimeIntoInterval(1,168,hr) Then 'turns on UW PAR cleaning system once a week
      SW12(1) 'activates 12V switch port to open SPDT switch
      Delay (0,2,Sec)
      SW12(0) 'closes SPDT switch
    EndIf
  EndIf

  If TimeIntoInterval(1,6,Hr) Then 'turn off at 0700, 1300, 1900, and 0100
    PortSet (1,0)
    PortSet (2,0)
    SerialClose (ComRS232) 'EDIT: If you remove the serial open, you can remove this too
    IceThickness = "NAN"
  EndIf

  CallTable Sonar
 NextScan

EndProg
```

5.2) Lake Hoare

```
'CR1000  Datalogger
'Lake Hoare
'Sensors installed: Stage, Ablation, UW PAR, surface PAR, surface temp, sonar altimeter
'Additional equipment: UW cleaning system, telemetry radio
'Program written on: Oct 28 2010 by Maciej Obryk
'Program updated on Dec 14, 2012 by Hilary Dugan

'Declare Public Variables
Public PTemp
Public batt_volt As Float
Public CS455(2) As Float
Public ablation As Float
Public UW_PAR_uncorr As Float
Public UW_PAR_backup As Float
Public SUR_PAR_uncorr As Float
Public MilitaryTime As Float
Public DecTime As Float
Public DecTime_2 As String * 16
Public SonarString As String * 30
Public IceThickness As Float
Public rTime(9) As Float
Public SUR_Temp As Float

'Declares aliases. rTime = array for Julian time and decimal time
Alias rTime(1) = Year
Alias rTime(4) = Hour
Alias rTime(5) = Minutes
Alias rTime(8) = Day_of_Week
Alias rTime(9) = Day_of_Year
Alias CS455(1) = stage
Alias CS455(2) = W_Temp

'Declare Units
Units ablation = m
Units stage = m
Units W_Temp = degC
Units UW_PAR_uncorr = µmol/s/m²
Units UW_PAR_backup = µmol/s/m²
Units SUR_PAR_uncorr = µmol/s/m²
Units batt_volt = volts
Units PTemp = degC
Units IceThickness = m
Units SUR_Temp = degC

'Define Data Tables - what is being stored
DataTable (LH20,true,-1) 'store data points every 20min, averages where indicated below
  DataInterval (0,20,Min,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  Sample (1,DecTime,IEEE4)
  Sample (1,DecTime_2,String)
  Average (1,ablation,IEEE4,False)
```

```
  Average (1,stage,IEEE4,False)
  Average (1,W_Temp,FP2,False)
  Average (1,UW_PAR_uncorr,FP2,False)
  Average (1,UW_PAR_backup,FP2,False)
  Average (1,SUR_PAR_uncorr,IEEE4,False)
  Minimum (1,batt_volt,FP2,False,False)'changed to minimum battery voltage
  Sample (1,PTemp,FP2)
  Average (1,SUR_Temp,FP2,False)

EndTable

DataTable (LH15,Year>2012,672) 'store data points every 15min, will start in 2013, only holds one week on internal
memory.
  DataInterval (0,15,Min,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  Sample (1,DecTime,IEEE4)
  Sample (1,DecTime_2,String)
  Average (1,ablation,IEEE4,False)
  Average (1,stage,IEEE4,False)
  Average (1,W_Temp,FP2,False)
  Average (1,UW_PAR_uncorr,FP2,False)
  Average (1,UW_PAR_backup,FP2,False)
  Average (1,SUR_PAR_uncorr,IEEE4,False)
  Minimum (1,batt_volt,FP2,False,False)'changed to minimum battery voltage
  Sample (1,PTemp,FP2)
  Average (1,SUR_Temp,FP2,False)
EndTable

DataTable (Sonar,true,-1) 'store sonar altimeter measurements every hour
  DataInterval (0,1,Hr,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Average (1,IceThickness,IEEE4,False)
EndTable

DataTable (Minute,true,2880) 'store data points every 1min, only holds two days on internal memory.
  DataInterval (0,1,Min,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Average (1,ablation,IEEE4,False)
  Average (1,stage,IEEE4,False)
EndTable

'Main Program
BeginProg
  'measurments every 60 seconds
  Scan (60,Sec,1,0)
    RealTime (rTime)
    MilitaryTime = (Hour*100)+Minutes
    'multiplier of "0.704088" is used to covert psi to m, i.e
    'psi to feet = 2.31; feet to m = 0.3048; hence 2.31*0.3048 = 0.704088
    SDI12Recorder (ablation,7,0,"M!",0.704088,0) 'pressure transducer - ablation
    SDI12Recorder (CS455,5,0,"M!",0.704088,0)    'pressure transducer - stage
    'surface PAR - Licor 190
    VoltDiff (SUR_PAR_uncorr,1,mV25,1,True ,0,_60Hz,200,0)
```

```
    'underwater PAR - Licor 193 hanging sensor
    VoltDiff (UW_PAR_backup,1,mV2_5,5,True,0,_60Hz,-100,0)
    'surface Temperature - CS107 Temperature Probe
    Therm107 (SUR_Temp,1,5,Vx1,0,_60Hz,1.0,0)
    'datalogger's temp
    PanelTemp (PTemp,_60Hz)
    'battry voltage
    Battery (batt_volt)
    'To get high resolution on decimal date, process decimal time in two steps
    If (Year/4 - INT(Year/4)) = 0 Then
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/367) 'for leap year
    Else
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/366) 'for normal year
    EndIf
    DecTime_2 = Year + Replace (DecTime,"0.",".")

    'underwater PAR - Licor 193
    If (Day_of_Year >= 213) OR (Day_of_Year <= 121) Then 'SUMMER
    VoltDiff (UW_PAR_uncorr,1,mV2_5,2,True,0,_60Hz,-100,0)
    Else,
      UW_PAR_uncorr = "NAN"
    EndIf

    CallTable LH20
    CallTable LH15
    CallTable Minute
  NextScan

SlowSequence 'allows for concurent sequence scanning
  Scan (1,Hr,1,0)
    If (Day_of_Year >= 274) OR (Day_of_Year <= 60) Then 'SUMMER

      PortSet (2,1)
      Delay(0,3,sec)
      SerialOpen(Com2,9600,0,0,1000) 'UNDERWATER SONAR every hour
      SerialIn (SonarString,Com2,300,13,30)
      'VoltDiff (AnalogOut2,1,mV5000,1,True ,0,_60Hz,1.0,0)
      Delay(0,10,sec)
      SerialClose (Com2)
      PortSet (2,0)
      SplitStr(IceThickness,SonarString,CHR(9),1,0)

      If TimeIntoInterval(60,360,min) Then 'turn on at 0700, 1300, 1900, and 0100
        If (batt_volt > 12.4) Then
          PortSet (1,1)
          SerialOpen (ComRS232,9600,0,0,2000) 'enables CR1000 comms
          Delay (0,2,sec)'delay for Iridium comms
        EndIf
      EndIf
      If TimeIntoInterval(120,360,min) Then 'turn off at 0800, 1400, 2000, and 0200
        PortSet (1 ,0)
        SerialClose (ComRS232)
      EndIf

      If TimeIntoInterval(1,168,hr) Then 'turns on UW PAR cleaning system once a week
        If (batt_volt > 12.4) Then
```

```
        SW12(1) 'activates 12V switch port to open SPDT switch
        Delay (0,2,Sec)
        SW12(0) 'closes SPDT switch
       EndIf
      EndIf

    EndIf

    If (Day_of_Year < 274) AND (Day_of_Year > 60) Then 'WINTER
      If TimeIntoInterval(7,24,hr) Then 'turn on once a day at 0700
        If (batt_volt > 12.4) Then       'turn on if above 12V
          PortSet (1,1)
          SerialOpen (ComRS232,9600,0,0,2000) 'enables CR1000 comms
          Delay (0,2,sec)'delay for Iridium comms
          PortSet (2,1)'UNDERWATER SONAR once a day
          Delay(0,3,sec)
          SerialOpen(Com2,9600,0,0,1000)
          SerialIn (SonarString,Com2,300,13,30)
          Delay(0,10,sec)
          SerialClose (Com2)
          PortSet (2,0)
          SplitStr(IceThickness,SonarString,CHR(9),1,0)
        EndIf
      EndIf
      If TimeIntoInterval(8,24,hr) Then 'turn off at 0800,
        PortSet (1 ,0)
        SerialClose (ComRS232)
        Icethickness = "NAN"
      EndIf

    EndIf
    CallTable Sonar
  NextScan

EndProg
```

5.3) East Lake Bonney

```
'CR1000  Datalogger
'East Lake Bonney
'Sensors installed: Stage, Ablation, UW PAR, surface PAR, surface temp, sonar altimeter
'Additional equipment: UW cleaning system, telemetry radio
'Program written on: Oct 28 2010 by Maciej Obryk
'Program updated on Nov 25, 2013 by Hilary Dugan

'Declare Public Variables
Public PTemp
Public batt_volt As Float
Public CS455(2) As Float
Public ablation As Float
Public UW_PAR_uncorr As Float
Public UW_PAR_backup As Float
Public SUR_PAR_uncorr As Float
Public MilitaryTime As Float
Public DecTime As Float
Public DecTime_2 As String * 16
Public SonarString As String * 30
Public IceThickness As Float
Public rTime(9) As Float
Public SUR_Temp As Float

'Declares aliases. rTime = array for Julian time and decimal time
Alias rTime(1) = Year
Alias rTime(4) = Hour
Alias rTime(5) = Minutes
Alias rTime(8) = Day_of_Week
Alias rTime(9) = Day_of_Year
Alias CS455(1) = stage
Alias CS455(2) = W_Temp

'Declare Units
Units ablation = m
Units stage = m
Units W_Temp = degC
Units UW_PAR_uncorr = µmol/s/m²
Units UW_PAR_backup = µmol/s/m²
Units SUR_PAR_uncorr = µmol/s/m²
Units batt_volt = volts
Units PTemp = degC
Units IceThickness = m
Units SUR_Temp = degC

DataTable (ELB15,true,-1) 'store data points every 15min, will start in 2013, only holds one week on internal
memory.
  DataInterval (0,15,Min,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  Sample (1,DecTime,IEEE4)
  Sample (1,DecTime_2,String)
  Average (1,ablation,IEEE4,False)
```

```
  Average (1,stage,IEEE4,False)
  Average (1,W_Temp,FP2,False)
  Average (1,UW_PAR_uncorr,FP2,False)
  Average (1,UW_PAR_backup,FP2,False)
  Average (1,SUR_PAR_uncorr,IEEE4,False)
  Minimum (1,batt_volt,FP2,False,False)'changed to minimum battery voltage
  Sample (1,PTemp,FP2)
  Average (1,SUR_Temp,FP2,False)
EndTable

DataTable (Sonar,true,-1) 'store sonar altimeter measurements every hour
  DataInterval (0,6,Hr,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,IceThickness,IEEE4)
EndTable

DataTable (Minute,true,2880) 'store data points every 1min, only holds two days on internal memory.
  DataInterval (0,1,Min,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Average (1,ablation,IEEE4,False)
  Average (1,stage,IEEE4,False)
EndTable

'Main Program
BeginProg
  'measurments every 60 seconds
  Scan (60,Sec,1,0)
    RealTime (rTime)
    MilitaryTime = (Hour*100)+Minutes
    'multiplier of "0.704088" is used to covert psi to m, i.e
    'psi to feet = 2.31; feet to m = 0.3048; hence 2.31*0.3048 = 0.704088
    SDI12Recorder (ablation,7,0,"M!",0.704088,0) 'pressure transducer - ablation
    SDI12Recorder (CS455,5,0,"M!",0.704088,0)    'pressure transducer - stage
    'surface PAR - Licor 190
    VoltDiff (SUR_PAR_uncorr,1,mV25,1,True ,0,_60Hz,200,0)
    'underwater PAR - Licor 193 hanging sensor
    VoltDiff (UW_PAR_backup,1,mV2_5,5,True,0,_60Hz,-100,0)
    'surface Temperature - CS107 Temperature Probe
    Therm107 (SUR_Temp,1,5,Vx1,0,_60Hz,1.0,0)
    'datalogger's temp
    PanelTemp (PTemp,_60Hz)
    'battry voltage
    Battery (batt_volt)
    'To get high resolution on decimal date, process decimal time in two steps
    If (Year/4 - INT(Year/4)) = 0 Then
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/367) 'for leap year
    Else
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/366) 'for normal year
    EndIf
    DecTime_2 = Year + Replace (DecTime,"0.",".")

    'underwater PAR - Licor 193
    If (Day_of_Year >= 213) OR (Day_of_Year <= 121) Then 'SUMMER
      VoltDiff (UW_PAR_uncorr,1,mV2_5,2,True,0,_60Hz,-100,0)
    Else,
      UW_PAR_uncorr = "NAN"
```

```
  EndIf

  CallTable ELB15
  CallTable Minute
 NextScan

 SlowSequence 'allows for concurent sequence scanning
 Scan (1,Hr,1,0)

  ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
  'Turn on radio if conditions apply
  If batt_volt > 12.4 AND TimeIntoInterval(1,6,Hr) Then 'turn on at 0700, 1300, 1900, and 0100
   'Radio relay is connected to C1
   PortSet (1,1)
  EndIf

  ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
  'Turn off radio
  If TimeIntoInterval(2,6,Hr) Then 'turn off at 0800, 1400, 2000, and 0200
   PortSet (1,0)
  EndIf

  ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
  'Run Underwater SONAR
  If batt_volt > 12.4 AND TimeIntoInterval(0,6,Hr) Then 'turn on at 0600, 1200, 1800, and 0000
   PortSet (2,1)
   Delay(0,3,sec)
   SerialOpen(Com2,9600,0,0,1000) 'UNDERWATER SONAR every hour
   SerialIn (SonarString,Com2,300,13,30)

   Delay(0,10,sec)
   SerialClose (Com2)
   PortSet (2,0)
   SplitStr(IceThickness,SonarString,CHR(9),1,0)
  Else
   'Set IceThickness to NAN if we are not sampling
   IceThickness = "NAN"
  EndIf

  ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
  'If UW PAR cleaning system
  If batt_volt > 12.4 AND TimeIntoInterval(1,168,hr) Then 'turns on UW PAR cleaning system once a week
   SW12(1) 'activates 12V switch port to open SPDT switch
   Delay (0,2,Sec)
   SW12(0) 'closes SPDT switch
  EndIf

  CallTable Sonar
 NextScan

EndProg
```

5.4) West Lake Bonney

```
'CR1000  Datalogger
'West Lobe Bonney
'Sensors installed: Stage, Ablation, UW PAR, surface PAR, surface temp, sonar altimeter
'Additional equipment: UW cleaning system, telemetry radio
'Program written on: Oct 28 2010 by Maciej Obryk
'Program updated on Nov 8, 2012 by Hilary Dugan

'Declare Public Variables
Public PTemp
Public batt_volt As Float
Public CS455(2) As Float
Public ablation_druck As Float
Public ablation_CS455 As Float
Public UW_PAR_uncorr As Float
Public UW_PAR_backup As Float
Public SUR_PAR_uncorr As Float
Public MilitaryTime As Float
Public DecTime As Float
Public DecTime_2 As String * 16
Public SonarString As String * 30
Public IceThickness As Float
Public rTime(9) As Float
Public SUR_Temp As Float

'Declares aliases. rTime = array for Julian time and decimal time
Alias rTime(1) = Year
Alias rTime(4) = Hour
Alias rTime(5) = Minutes
Alias rTime(8) = Day_of_Week
Alias rTime(9) = Day_of_Year
Alias CS455(1) = stage
Alias CS455(2) = W_Temp

'Declare Units
Units ablation_druck = m
Units ablation_CS455 = m
Units stage = m
Units W_Temp = degC
Units UW_PAR_uncorr = µmol/s/m²
Units UW_PAR_backup = µmol/s/m²
Units SUR_PAR_uncorr = µmol/s/m²
Units batt_volt = volts
Units PTemp = degC
Units IceThickness = m
Units SUR_Temp = degC

DataTable (WLB15,true,-1) 'store data points every 15min, will start in 2013, only holds one week on internal
memory.
  DataInterval (0,15,Min,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  Sample (1,DecTime,IEEE4)
```

```
  Sample (1,DecTime_2,String)
  Average (1,ablation_druck,IEEE4,False)
  Average (1,ablation_CS455,IEEE4,False)
  Average (1,stage,IEEE4,False)
  Average (1,W_Temp,FP2,False)
  Average (1,UW_PAR_uncorr,FP2,False)
  Average (1,UW_PAR_backup,FP2,False)
  Average (1,SUR_PAR_uncorr,IEEE4,False)
  Minimum (1,batt_volt,FP2,False,False)'changed to minimum battery voltage
  Sample (1,PTemp,FP2)
  Average (1,SUR_Temp,FP2,False)
EndTable

DataTable (Sonar,true,-1) 'store sonar altimeter measurements every hour
  DataInterval (0,6,Hr,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,IceThickness,IEEE4)
EndTable

DataTable (Minute,true,2880) 'store data points every 1min, only holds two days on internal memory.
  DataInterval (0,1,Min,10) 'data to storage module; CFM100
  CardOut (0 ,-1)
  Average (1,ablation_CS455,IEEE4,False)
  Average (1,stage,IEEE4,False)
EndTable

'Main Program
BeginProg
  'measurments every 60 seconds
  Scan (60,Sec,1,0)
    RealTime (rTime)
    MilitaryTime = (Hour*100)+Minutes
    'multiplier of "0.704088" is used to covert psi to m, i.e
    'psi to feet = 2.31; feet to m = 0.3048; hence 2.31*0.3048 = 0.704088
    SDI12Recorder (ablation_CS455,7,0,"M!",0.704088,0) 'pressure transducer - ablation
    SDI12Recorder (CS455,5,0,"M!",0.704088,0)   'pressure transducer - stage
    'CS420/CS425 Druck PDCR 1830/1230 Pressure Tansducer (4-wire) measurement Lvl_m:
    BrFull(ablation_druck,1,mV2500,8,Vx2,1,2500,True,True,0,_60Hz,101.53,0.0)
    'surface PAR - Licor 190
    VoltDiff (SUR_PAR_uncorr,1,mV25,1,True ,0,_60Hz,200,0)
    'underwater PAR - Licor 193 hanging sensor
    VoltDiff (UW_PAR_backup,1,mV2_5,5,True,0,_60Hz,-100,0)
    'surface Temperature - CS107 Temperature Probe
    Therm107 (SUR_Temp,1,5,Vx1,0,_60Hz,1.0,0)
    'datalogger's temp
    PanelTemp (PTemp,_60Hz)
    'battry voltage
    Battery (batt_volt)
    'To get high resolution on decimal date, process decimal time in two steps
    If (Year/4 - INT(Year/4)) = 0 Then
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/367) 'for leap year
    Else
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/366) 'for normal year
    EndIf
    DecTime_2 = Year + Replace (DecTime,"0.",".")
```

```
  'underwater PAR - Licor 193
  If (Day_of_Year >= 213) OR (Day_of_Year <= 121) Then 'SUMMER
    VoltDiff (UW_PAR_uncorr,1,mV2_5,2,True,0,_60Hz,-100,0)
  Else,
    UW_PAR_uncorr = "NAN"
  EndIf

  CallTable WLB15
  CallTable Minute
 NextScan

 SlowSequence 'allows for concurent sequence scanning
 Scan (1,Hr,1,0)

  ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
  'Turn on radio if conditions apply
  If batt_volt > 12.4 AND TimeIntoInterval(0,6,Hr) Then 'turn on at 0600, 1200, 1800, and 0000
    'Radio relay is connected to C1
    PortSet (1,1)
  EndIf

  ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
  'Turn off radio
  If TimeIntoInterval(1,6,Hr) Then 'turn off at 0700, 1300, 1900, and 0100
    PortSet (1,0)
  EndIf

  ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
  'Run Underwater SONAR
  If batt_volt > 12.4 AND TimeIntoInterval(0,6,Hr) Then 'turn on at 0600, 1200, 1800, and 0000
    PortSet (2,1)
    Delay(0,3,sec)
    SerialOpen(Com2,9600,0,0,1000) 'UNDERWATER SONAR every hour
    SerialIn (SonarString,Com2,300,13,30)

    Delay(0,10,sec)
    SerialClose (Com2)
    PortSet (2,0)
    SplitStr(IceThickness,SonarString,CHR(9),1,0)
  Else
    'Set IceThickness to NAN if we are not sampling
    IceThickness = "NAN"
  EndIf

  ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
  'If UW PAR cleaning system
  If batt_volt > 12.4 AND TimeIntoInterval(1,168,hr) Then 'turns on UW PAR cleaning system once a week
    SW12(1) 'activates 12V switch port to open SPDT switch
    Delay (0,2,Sec)
    SW12(0) 'closes SPDT switch
  EndIf

  CallTable Sonar
 NextScan

EndProg
```

5.5) Lake Miers

```
'CR1000  Datalogger
'Lake Miers
'Sensors installed: Stage, Ablation, UW PAR, surface PAR
'Program written on: Nov 15 2011 by Maciej Obryk
'Updated on Nov 15, 2012 by Hilary Dugan

'Declare Variables
Public batt_volt As Float
Public stage As Float
Public ablation As Float
Public UW_PAR_uncorr As Float
Public UW_PAR_backup As Float
Public surface_PAR_uncorr As Float
Public Ptemp_C
Public flag As Boolean

'Declares array for Julian time and decimal time
Public rTime (9)
Alias rTime(1) = Year
Alias rTime(8) = Day_of_Week
Alias rTime(9) = Day_of_Year
Alias rtime(4) = Hour
Alias rtime(5) = Minutes
Public Dec_Time As Float
Public MilitaryTime As Float
Public DecTime As Float
Public DecTime_2 As String * 16

'Declares Units
Units batt_volt = volts
Units UW_PAR_uncorr = µmol/s/m²
Units UW_PAR_backup = µmol/s/m²
Units surface_PAR_uncorr = µmol/s/m²
Units stage = cm
Units ablation = cm
Units PTemp_C = Deg C

'Defines Data Tables
DataTable(LM20,True,-1)
  'store data points every 20min
  DataInterval(0,20,Min,10)
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  Sample (1,DecTime,IEEE4)
  Sample (1,DecTime_2,String)
  Average(1,stage,IEEE4,False)
  Average(1,ablation,IEEE4,False)
  Average(1,UW_PAR_uncorr,IEEE4,False)
  Average(1,UW_PAR_backup,IEEE4,False)
  Average(1,surface_PAR_uncorr,IEEE4,False)
  Average(1,batt_volt,FP2,False)
  Average(1,Ptemp_C,FP2, False)
```

```
EndTable

DataTable(LM15,Year>2012,672) 'store data points every 15min, will start in 2013, only holds one week on internal memory.
  'store data points every 20min
  DataInterval(0,15,Min,10)
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  Sample (1,DecTime,IEEE4)
  Sample (1,DecTime_2,String)
  Average(1,stage,IEEE4,False)
  Average(1,ablation,IEEE4,False)
  Average(1,UW_PAR_uncorr,IEEE4,False)
  Average(1,UW_PAR_backup,IEEE4,False)
  Average(1,surface_PAR_uncorr,IEEE4,False)
  Average(1,batt_volt,FP2,False)
  Average(1,Ptemp_C,FP2, False)
EndTable

'Main Program
BeginProg
  Scan(60,Sec,1,0)
    RealTime rTime()
    MilitaryTime = (Hour*100)+Minutes
    'surface PAR - Licor 190
    VoltDiff(surface_PAR_uncorr,1,mV25,1,True,0,_60Hz,200,0)
    'underwater PAR - Licor 193
    VoltDiff (UW_PAR_backup,1,mV2_5,8,True ,0,_60Hz,-100,0)
    'CS420/CS425 Druck PDCR 1830/1230 Pressure Tansducer (6-wire) measurement:
    BrFull6W (stage,1,mV2500,mV25,3,Vx1,1,2500,True ,True ,0,_60Hz,1.0,0)
    BrFull6W (ablation,1,mV2500,mV25,5,Vx2,1,2500,True ,True ,0,_60Hz,1.0,0)
    PanelTemp (Ptemp_C,_60Hz)
    Battery (batt_volt)

    'underwater PAR - Licor 193
    If (Day_of_Year >= 213) OR (Day_of_Year <= 121) Then 'SUMMER
      VoltDiff (UW_PAR_uncorr,1,mV2_5,2,True,0,_60Hz,-100,0)
    Else,
      UW_PAR_uncorr = "NAN"
    EndIf

    'To get high resolution on decimal date, process decimal time in two steps
    If (Year/4 - INT(Year/4)) = 0 Then
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/367) 'for leap year
    Else
      DecTime = (Day_of_Year + (Hour + Minutes*(1/60))*(1/24))*(1/366) 'for normal year
    EndIf
    DecTime_2 = Year + Replace (DecTime,"0.",".")

    CallTable LM20
    CallTable LM15
  NextScan

  SlowSequence 'allows for concurent sequence scanning
```

```
  Scan (1,Hr,1,0)
    If (Day_of_Year >= 274) OR (Day_of_Year <= 60) Then 'SUMMER
      If TimeIntoInterval(180,360,min) Then 'turn on at 0900, 1500, 2100 and 0300
        If (batt_volt > 12.4) Then
          PortSet (1,1)
          SerialOpen (ComRS232,9600,0,0,2000) 'enables CR1000 comms
          Delay (0,2,sec)'delay for Iridium comms
        EndIf
      EndIf
      If TimeIntoInterval(240,360,Min) Then 'turn off ComRS232 at 1000, 1600, 2200 and 0400
        PortSet (1 ,0)
        SerialClose (ComRS232)
      EndIf
    EndIf

    If (Day_of_Year < 274) AND (Day_of_Year > 60) Then 'WINTER
      If TimeIntoInterval(9,24,hr) Then 'turn on once a day at 0900
        If (batt_volt > 12.4) Then       'turn on if above 12V
          PortSet (1,1)
          SerialOpen (ComRS232,9600,0,0,2000) 'enables CR1000 comms
          Delay (0,2,sec)'delay for Iridium comms
        EndIf
      EndIf
      If TimeIntoInterval(10,24,hr) Then 'turn off at 1000,
        PortSet (1,0)
        SerialClose (ComRS232)
      EndIf
    EndIf
  NextScan

EndProg
```