Precipitation measurements at Rothera research station in Antarctica

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Background

- Solid precipitation is very hard to measure in Antarctica.
- The World Meteorological Organisation (WMO) is currently running a project called the Solid Precipitation Intercomparison Experiment (SPICE).
  - SPICE is trying to evaluate the best way to make electronic measurements of solid precipitation.
  - The WMO are using a double fence reference gauge
- BAS is trialling several precipitation measuring devices at Rothera station but does not have space for the reference gauge.

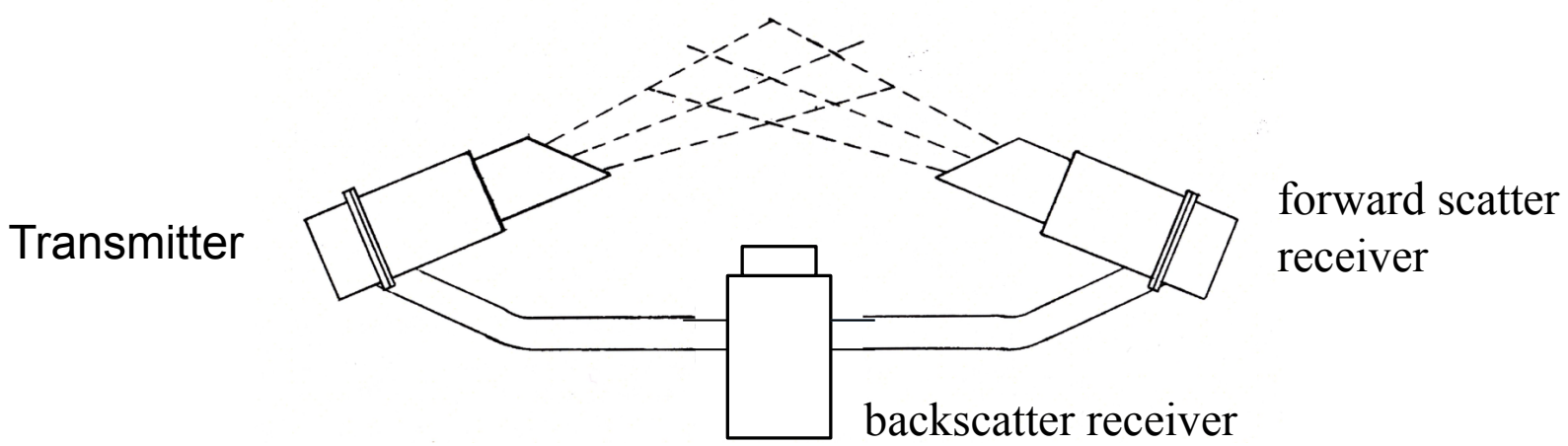

0 kilometres 1000
South America
Falkland Islands
Bird Island
King Edward Point
South Georgia
Larsen
Rothera
60°S
Fossil Bluff
Butler
Limbert
Sky-Blu
Halley
75°
West Antarctica
East Antarctica
Baldrick
120°W
105°
90°
75°
60°
45°
30°
15°
0°
15°E

Biral VPF 730 combined precipitation and visibility sensor

Mode of Operation of the VPF 730

The sensor uses an 850nm infrared light source that is then detected using a forward scatter receiver and also a backscatter receiver. The forward scatter is used to calculate visibility.

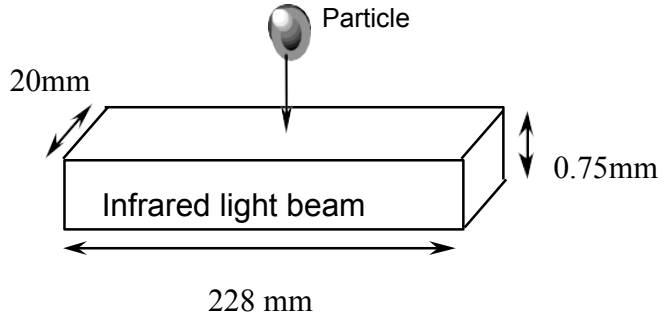
The backscatter receiver gives the sensor the ability to discriminate between liquid and frozen precipitation, liquid precipitation scatters very little of the transmitted light towards the backscatter receiver, whilst frozen precipitation scatters a significant amount in this direction.



Thies Laser Precipitation Monitor

Mode of Operation of the Laser Precipitation Monitor

A laser-optical beaming source of wavelength 780nm produces a parallel light-beam. A photo diode with a lens is situated on the receiver side in order to measure the optical intensity by transforming it into an electrical signal.



When a precipitation particle falls through the light beam the receiving signal is reduced and the diameter of the particle is calculated from the amplitude of the reduction.

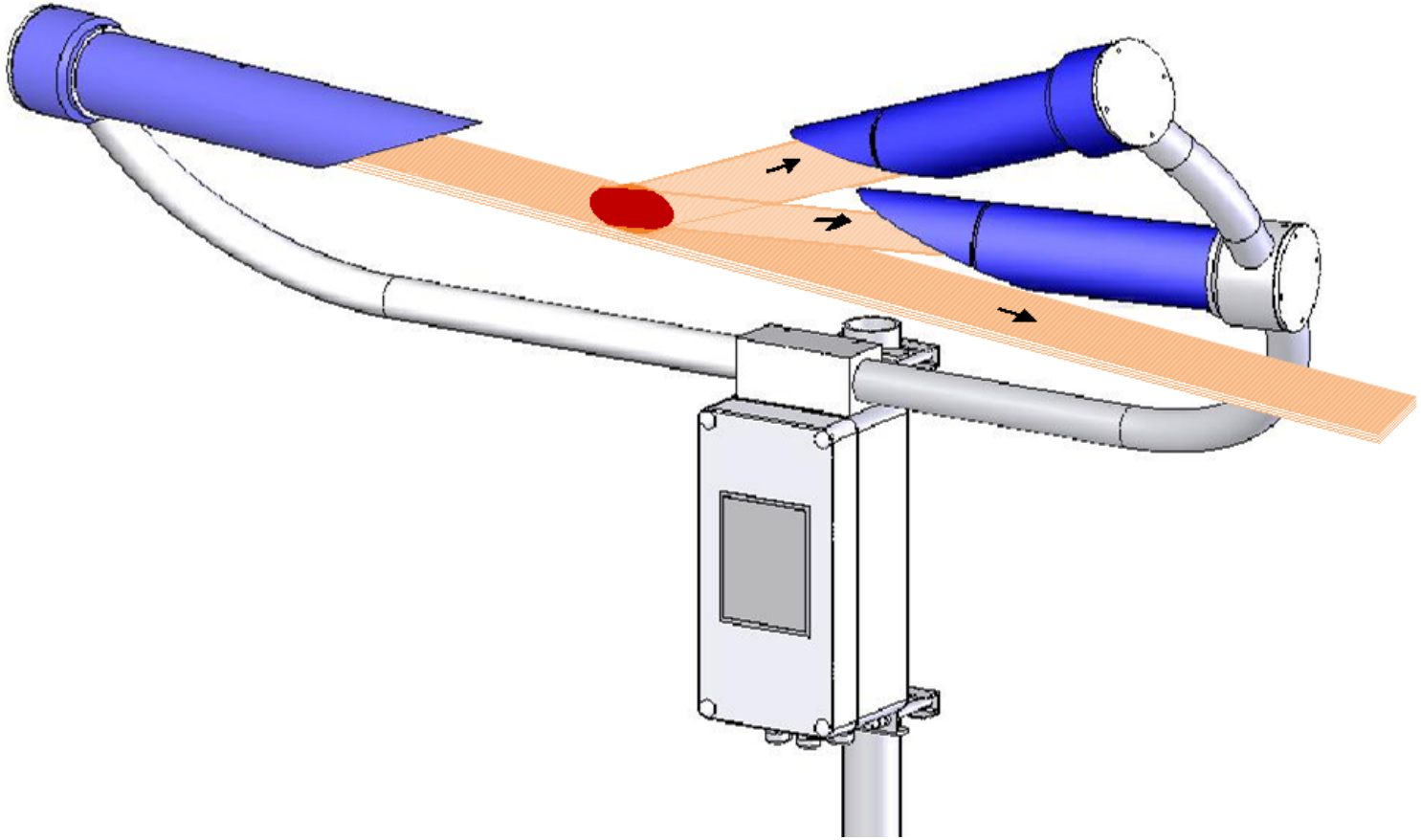
The fall speed of the particle is determined from the duration of the reduced signal.

The measured values are processed by a signal processor, and checked for plausibility (e.g. edge hits).

Calculation comprises the intensity, quantity, and type of precipitation (drizzle, rain, snow, soft hail, hail as well as mixed precipitation)

PWS100 present weather sensor

PWS100 general arrangement

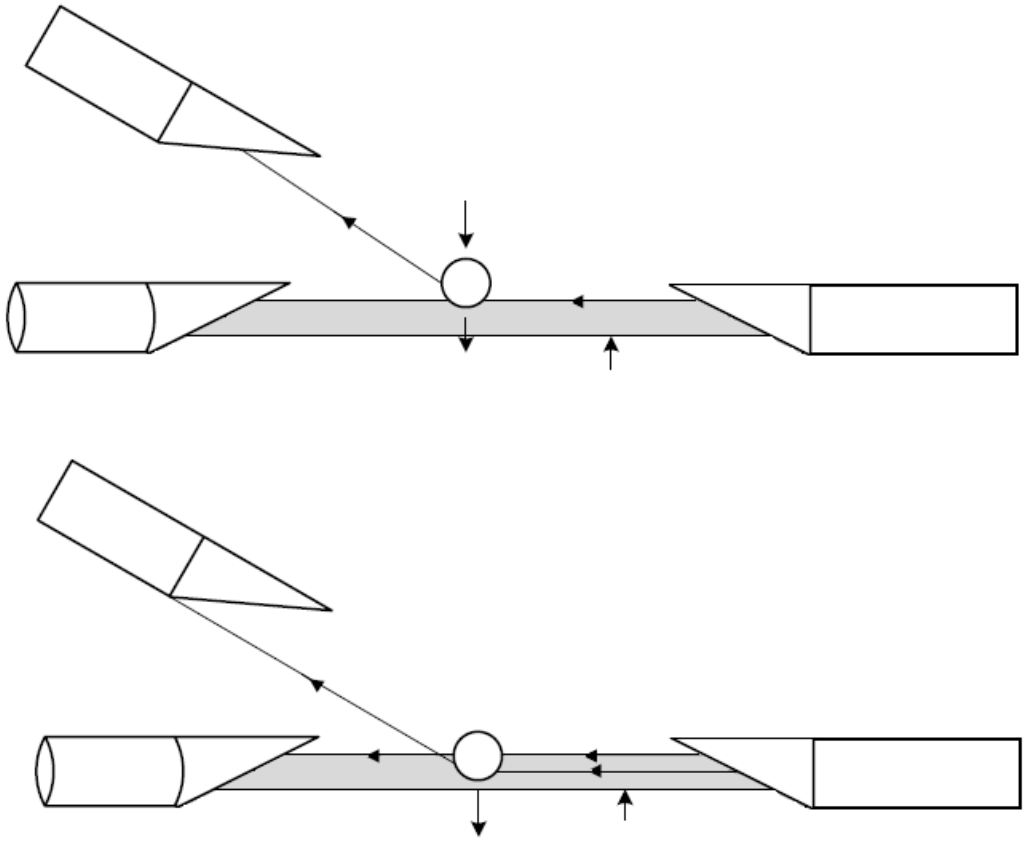


Delayed refraction to horizontal sensor

The sensor comprises one laser head and two sensor heads. Each of the sensor heads is 20°off axis to the laser unit axis, one in the horizontal plane, the other in the vertical plane

When a particle enters the beam it is first detected by the off axis receiver in the vertical plane and then a short time later by the second receiver in the horizontal plane.

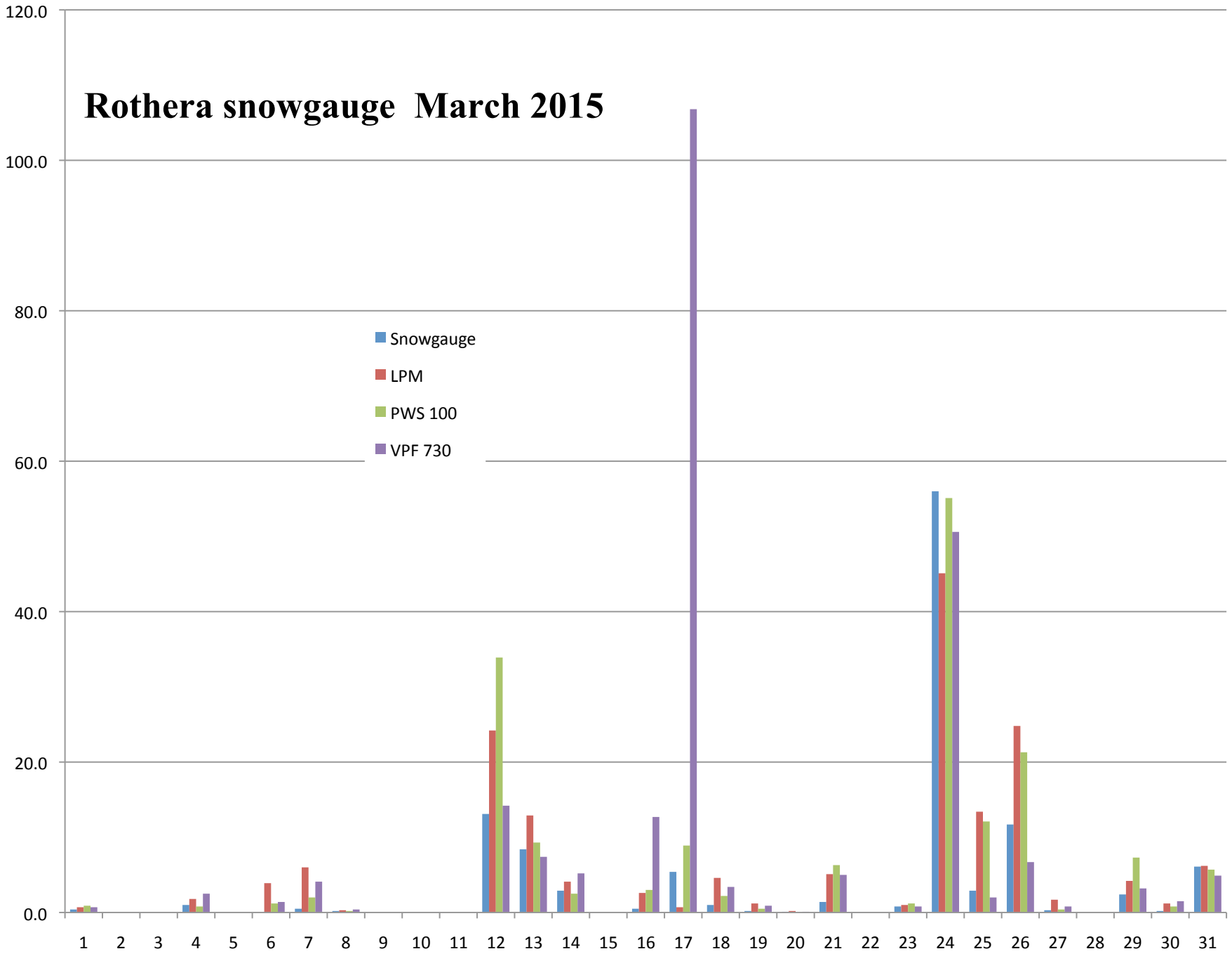
This allows the size and fall speed to be calculated.

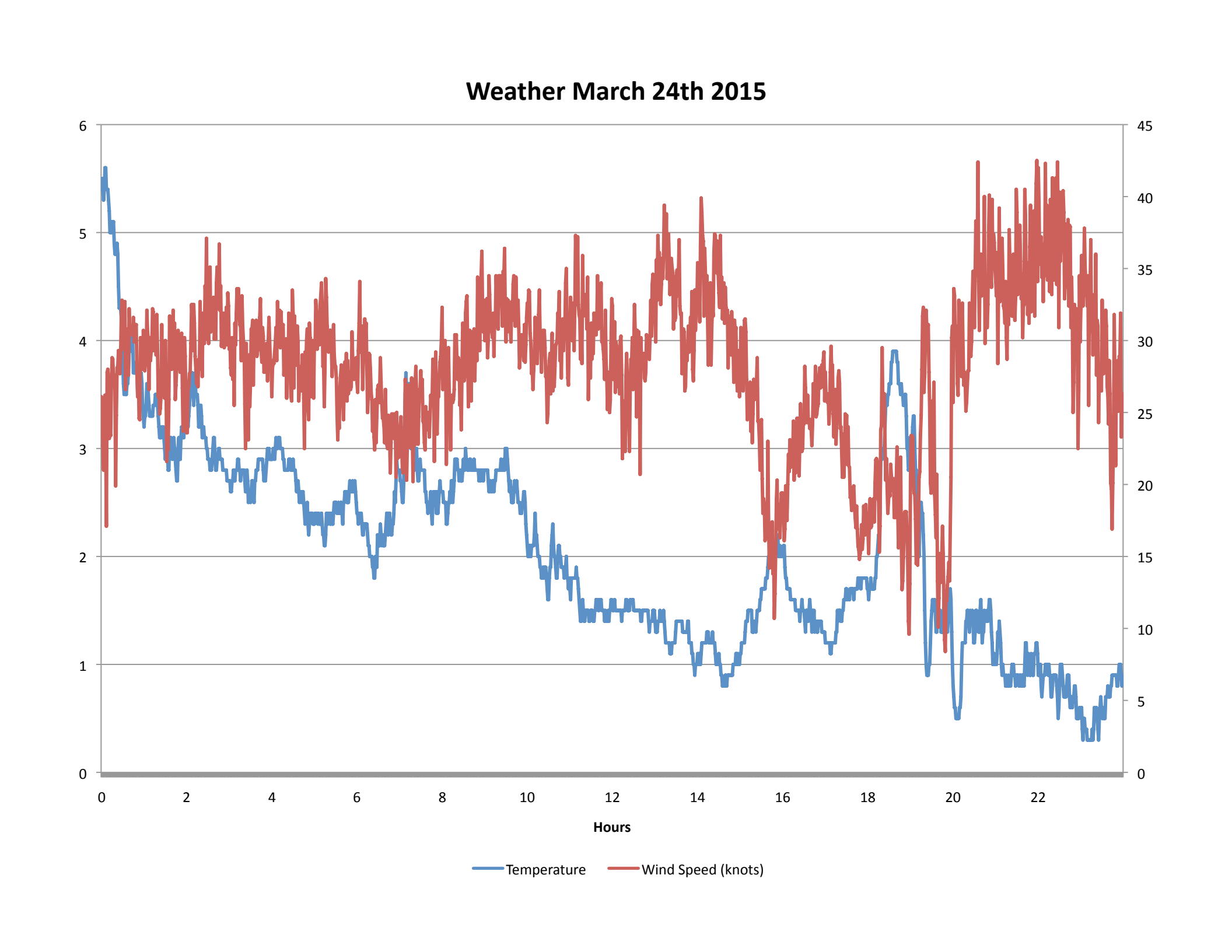


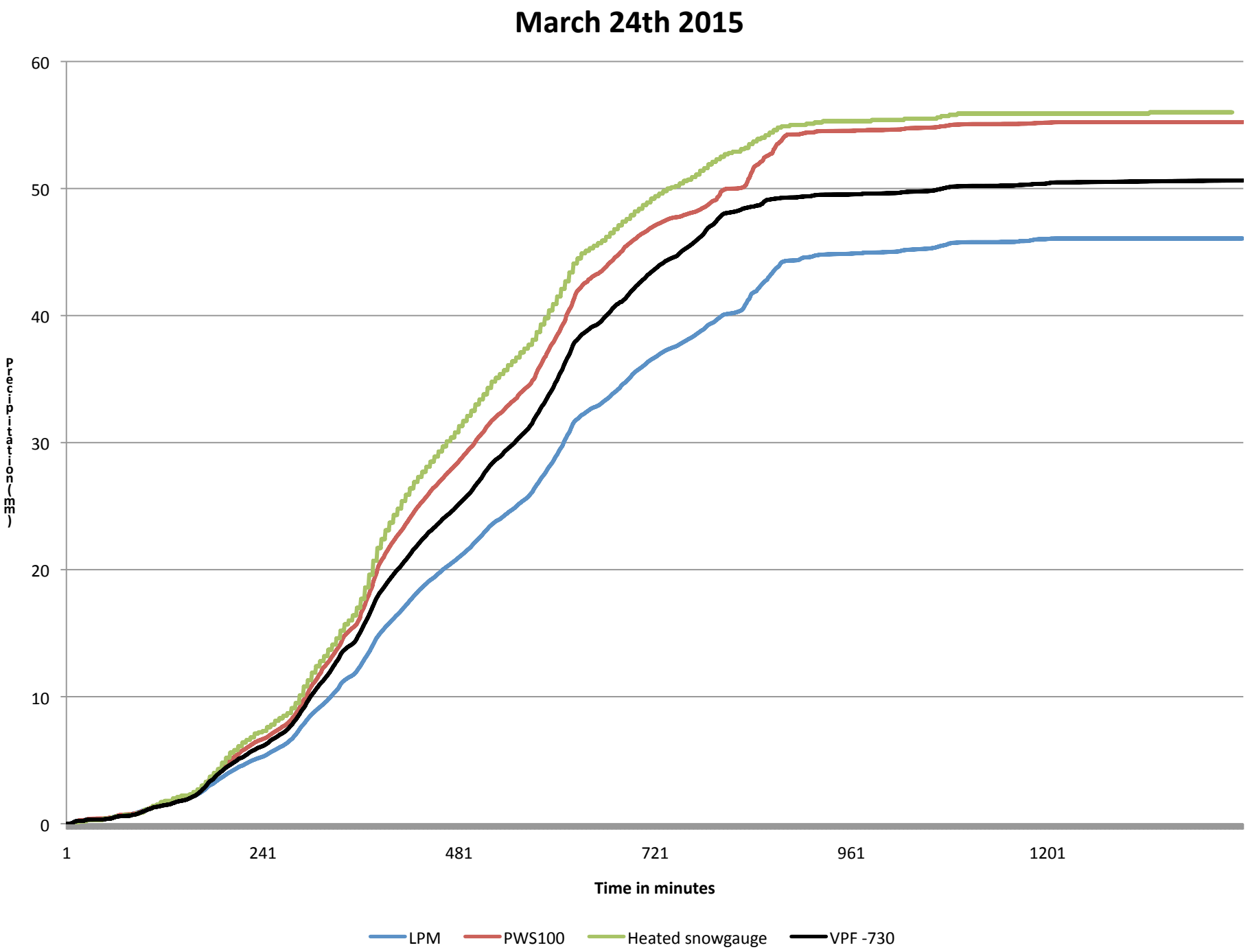
Environmental Measurements Ltd Universal Precipitation Gauge (UPG1000)

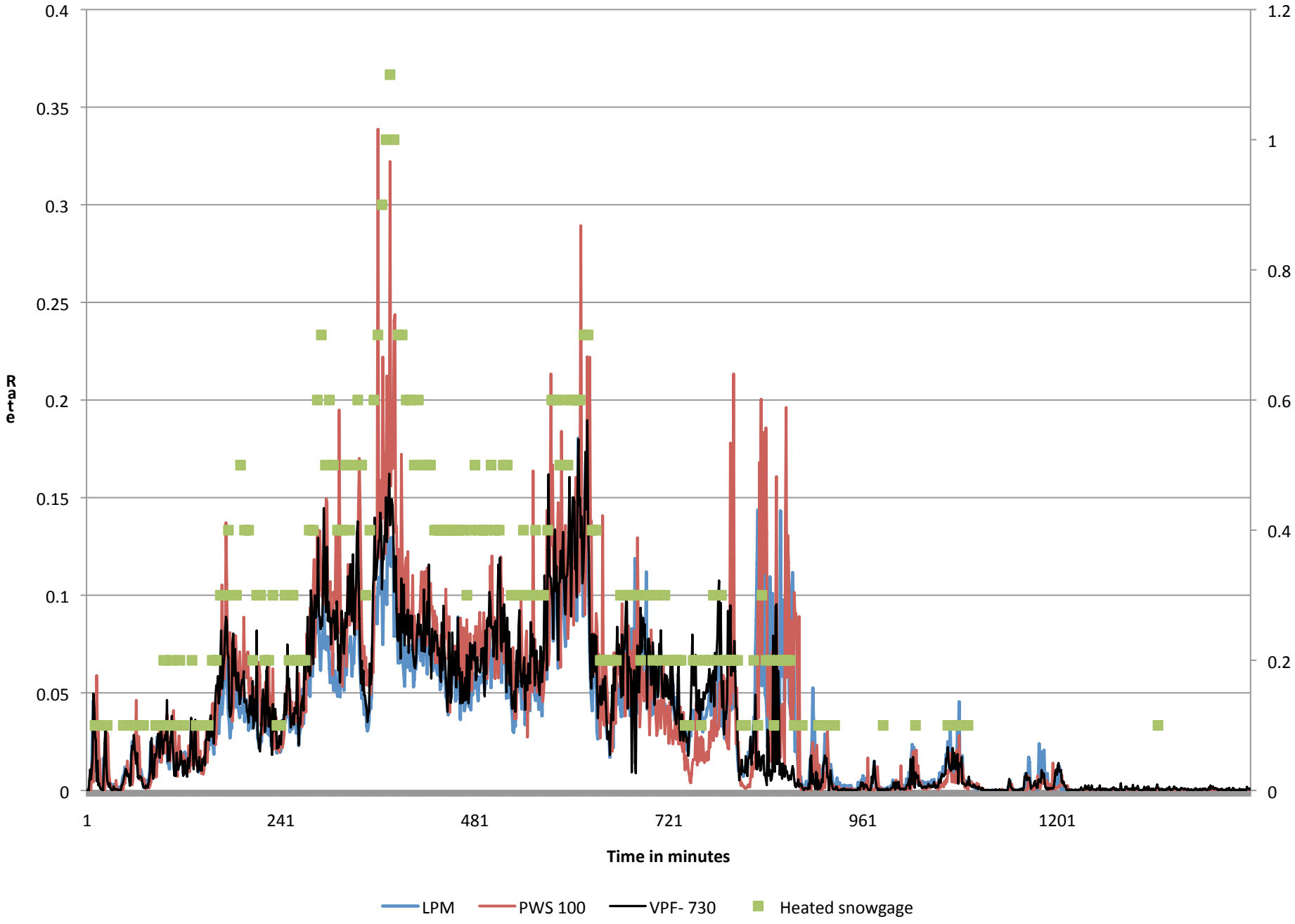
Universal Precipitation Gauge

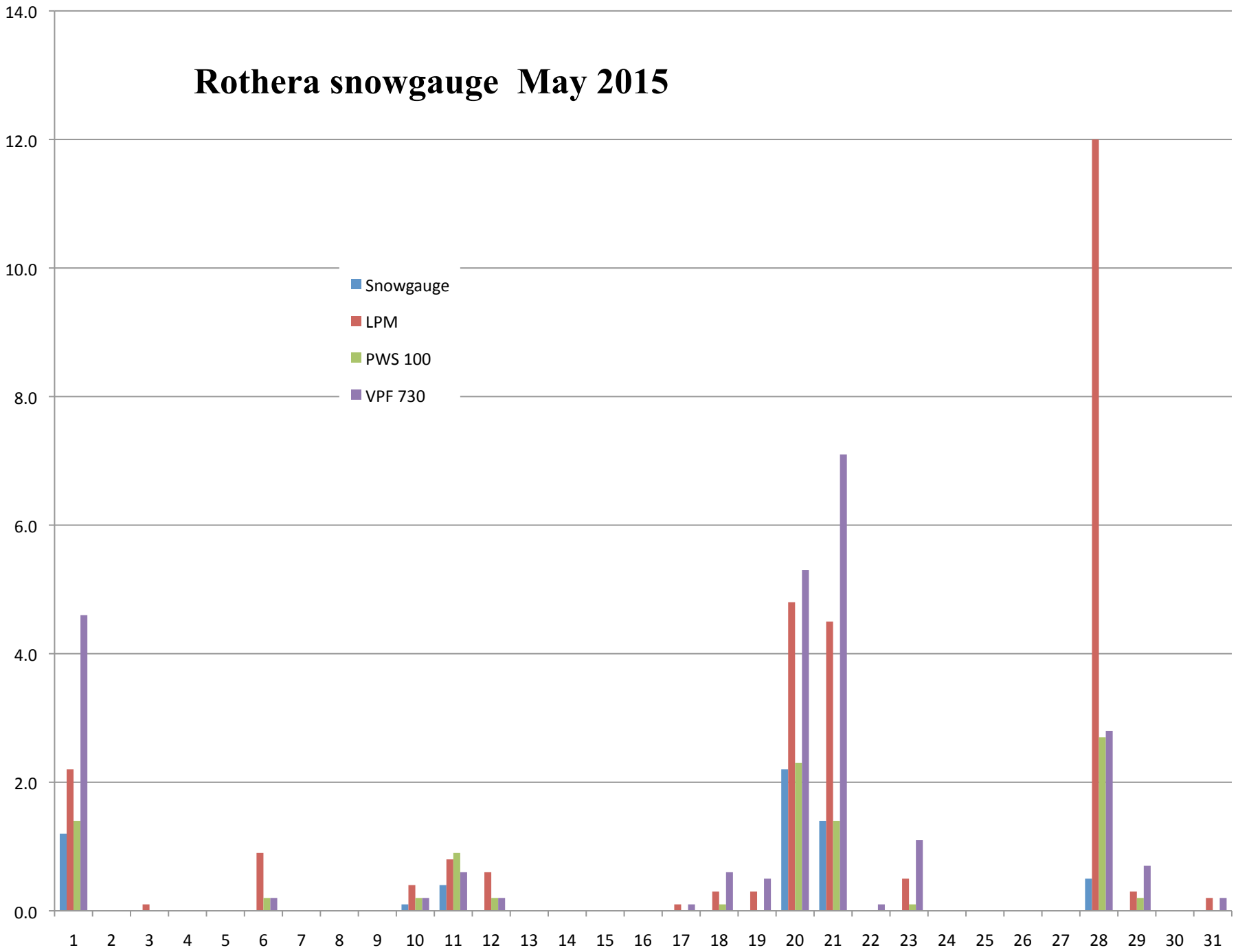
- Initially the gauge was located up by the meteorological tower.
- The a wind shield was installed round the gauge a year later.
- Finally the gauge and wind shield were relocated behind one of the buildings to give some extra wind shielding.
- Each of the changes increased the amount of precipitation that was captured.

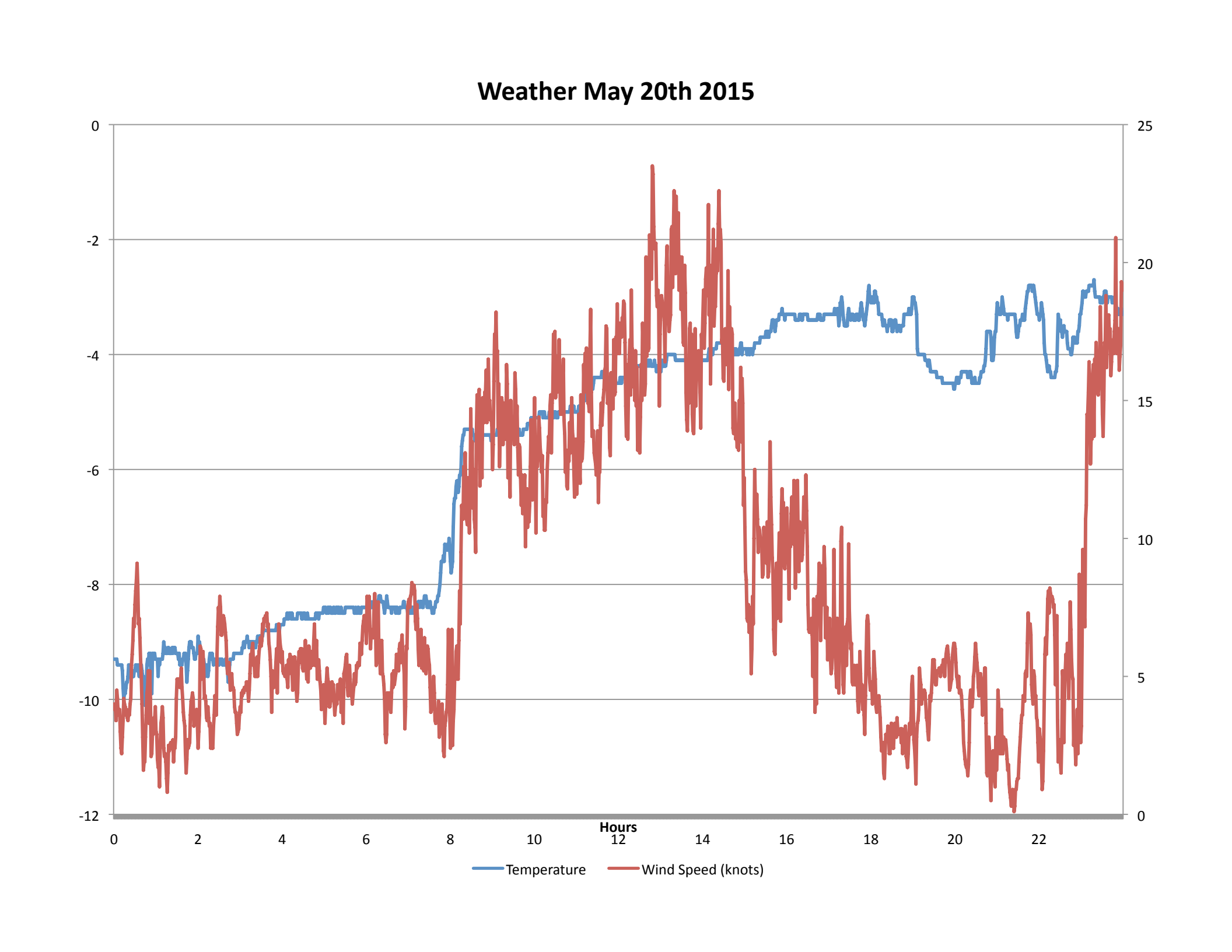

Rothera snowgauge March 2015
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Snowgauge
LPM
PWS 100
VPF 730
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

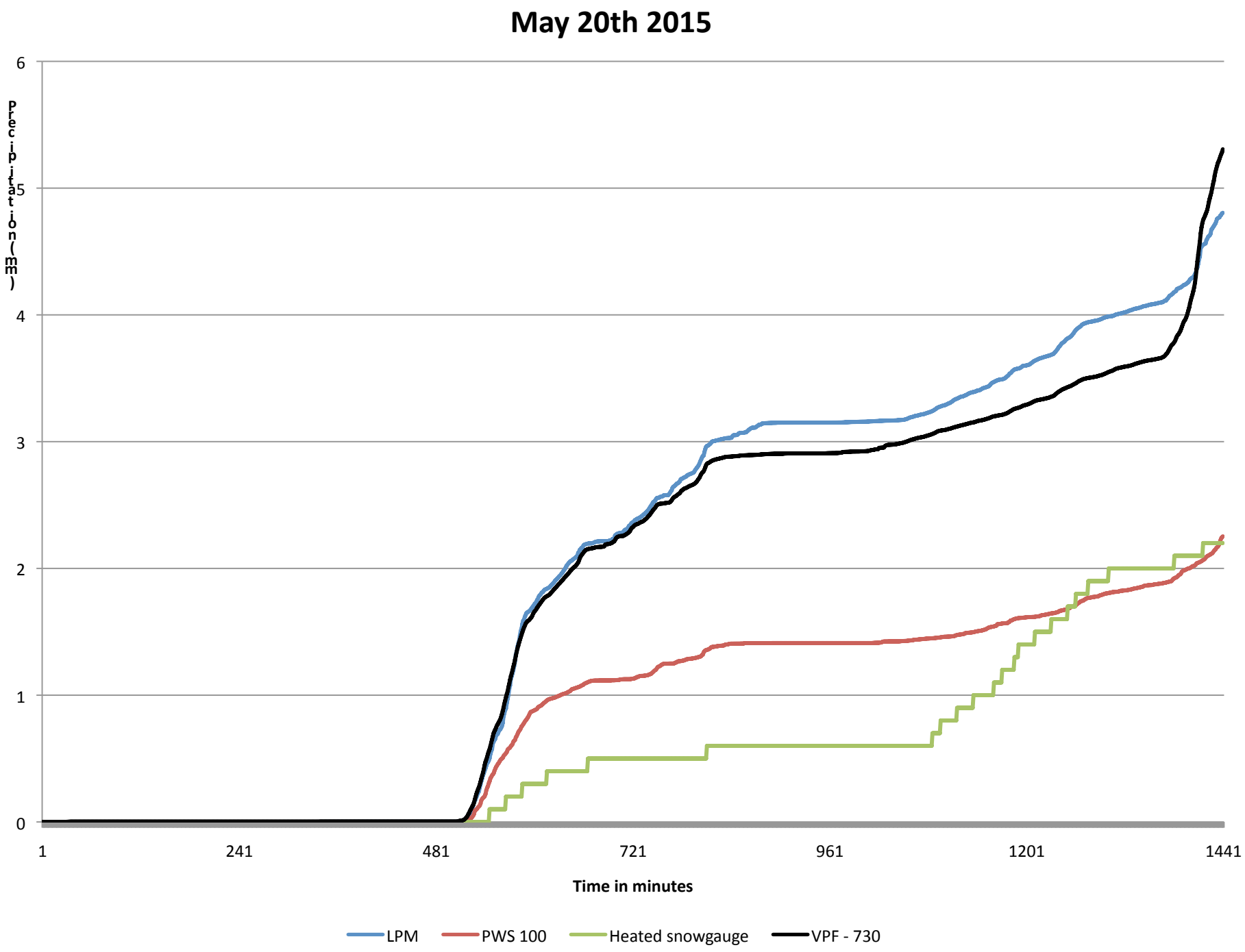

Weather March 24th 2015
6
5
4
3
2
1
0
45
40
35
30
25
20
15
10
5
0
0
2
4
6
8
10
12
14
16
18
20
22
Hours
Temperature
Wind Speed (knots)

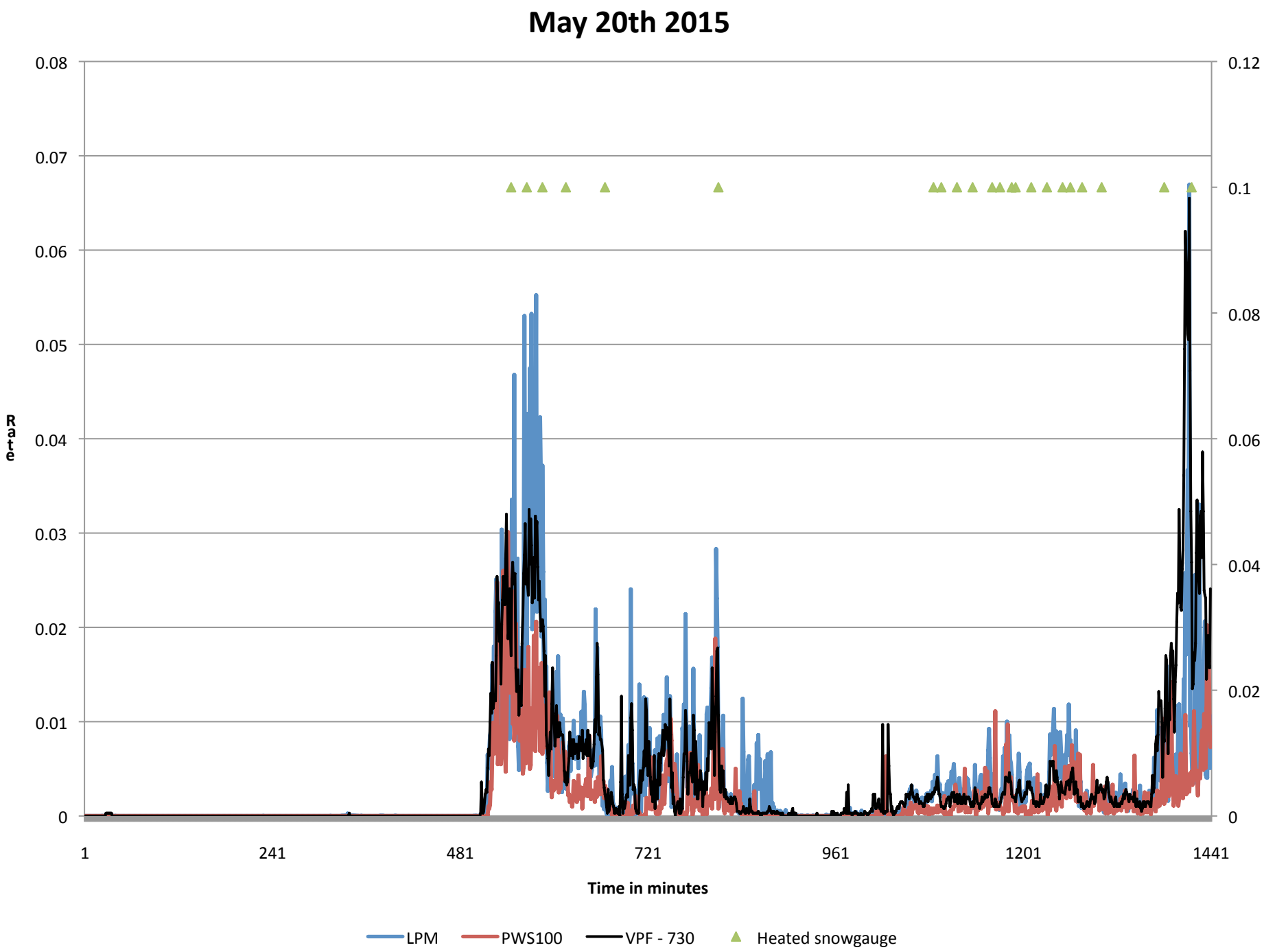

March 24th 2015
60
50
40
30
20
10
0
Precipitation (mm)
1
241
481
721
961
1201
Time in minutes
LPM
PWS100
Heated snowgauge
VPF -730

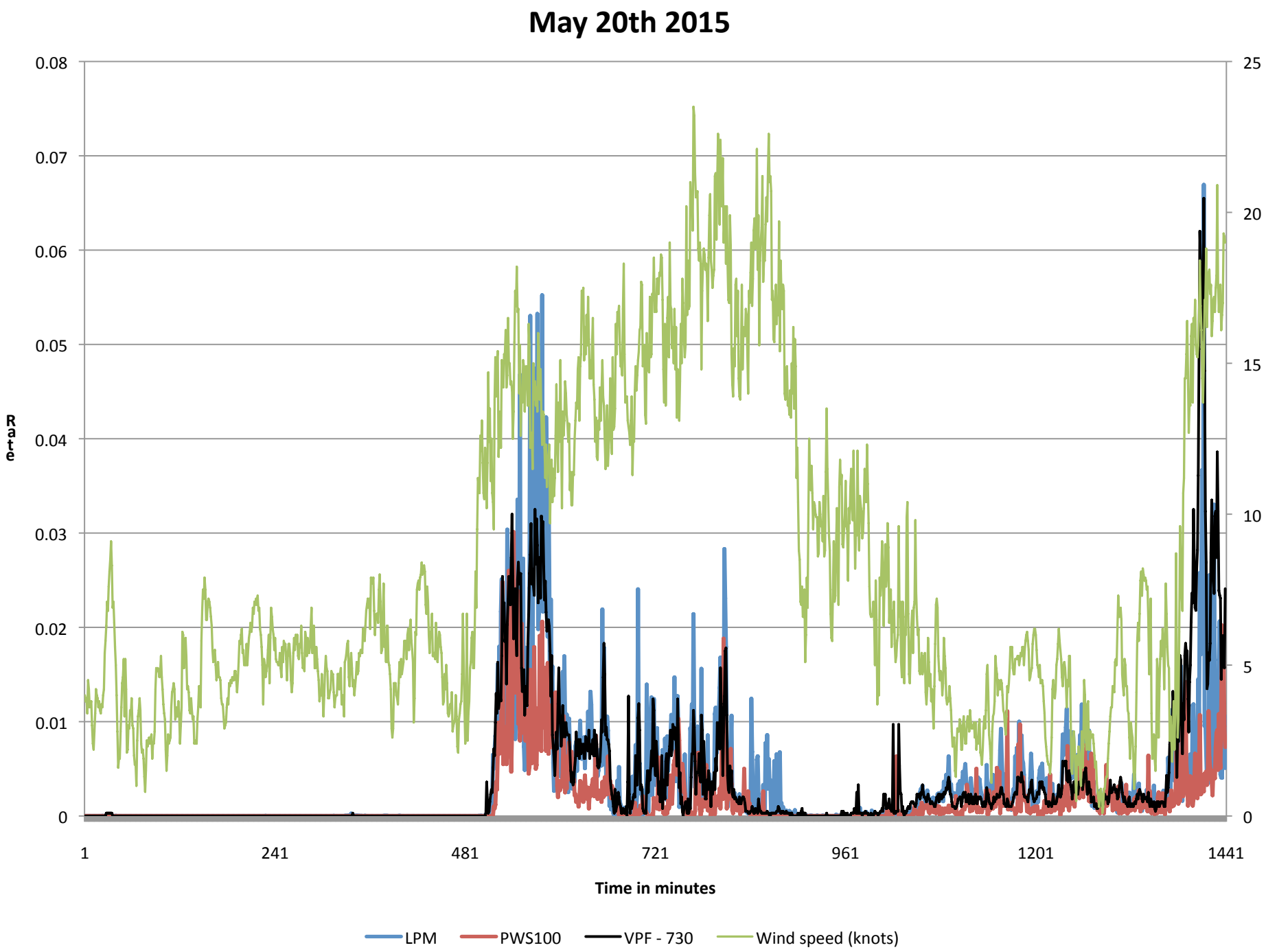

March 24th 2015
Rate
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1.2
1
0.8
0.6
0.4
0.2
0
1
241
481
721
961
1201
Time in minutes
LPM
PWS 100
VPF- 730
Heated snowgage

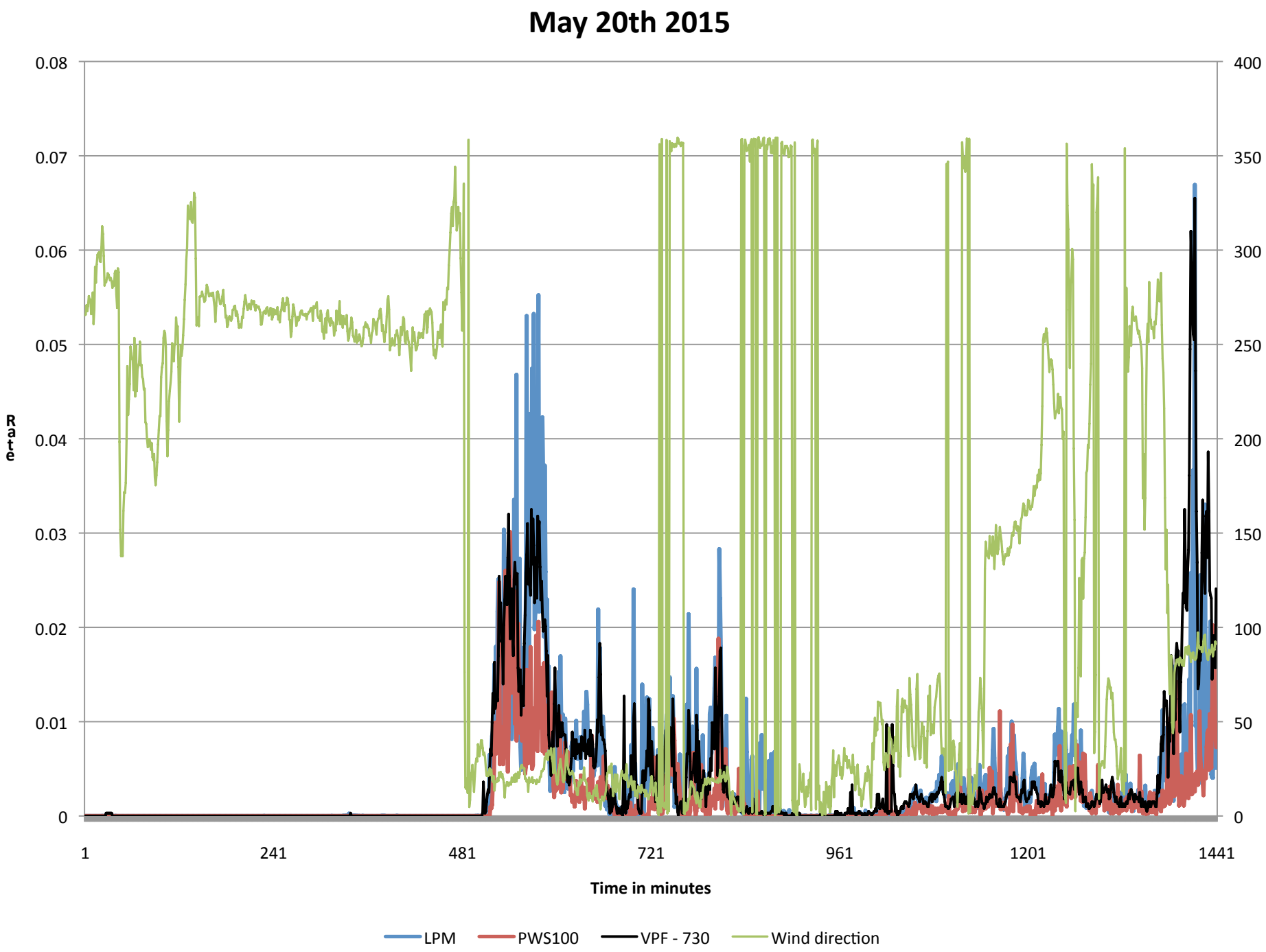

Rothera snowgauge May 2015
Snowgauge
LPM
PWS 100
VPF 730
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

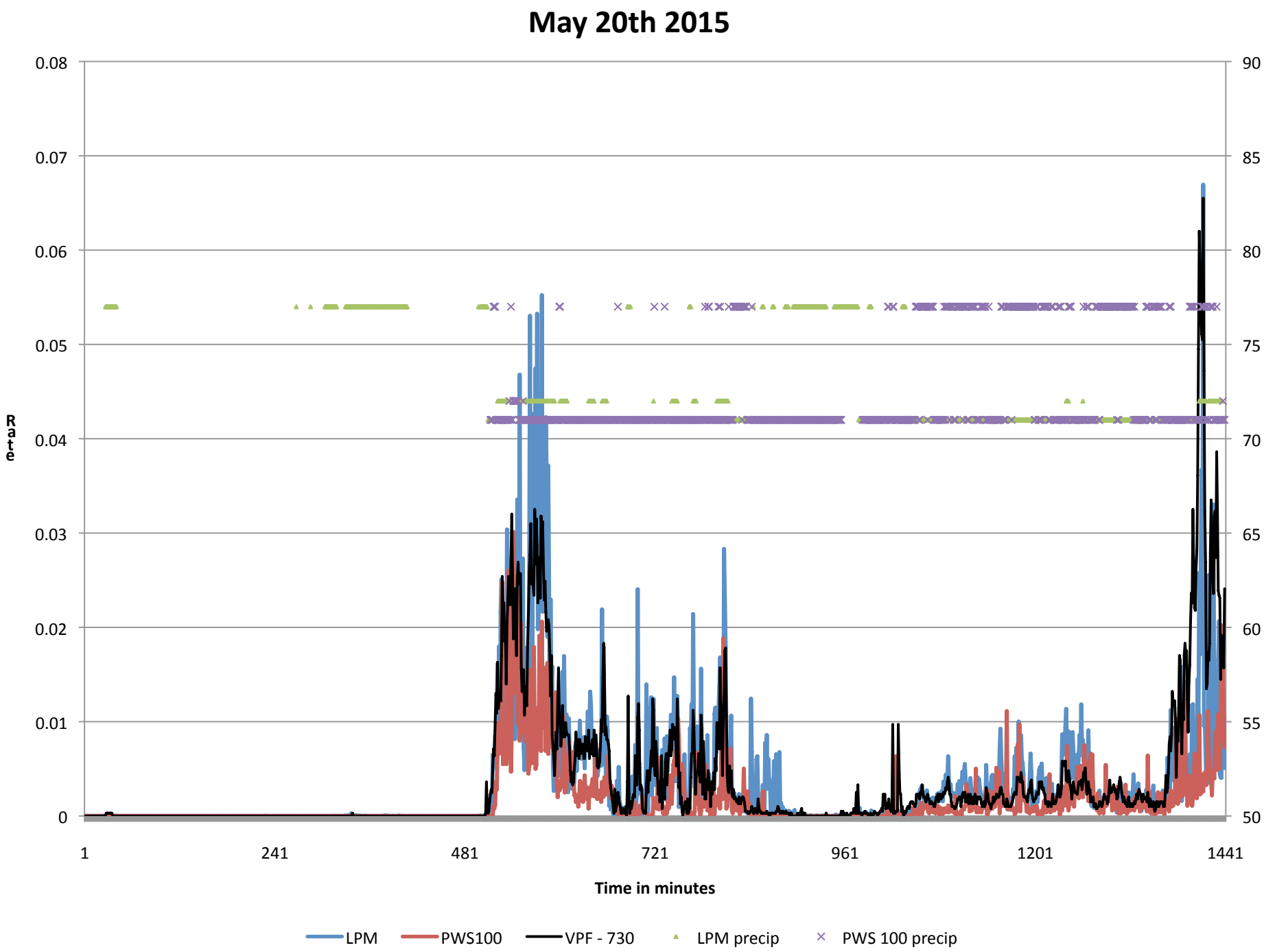

Weather May 20th 2015
0
-2
-4
-6
-8
-10
-12
25
20
15
10
5
0
0
2
4
6
8
10
12
14
16
18
20
22
Hours
Temperature
Wind Speed (knots)


May 20th 2015
Precipitation (mm)
6
5
4
3
2
1
0
1
241
481
721
961
1201
1441
Time in minutes
LPM
PWS 100
Heated snowgauge
VPF - 730


May 20th 2015
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.12
0.1
0.08
0.06
0.04
0.02
0
Rate
1
241
481
721
961
1201
1441
Time in minutes
LPM
PWS100
VPF - 730
Heated snowgauge

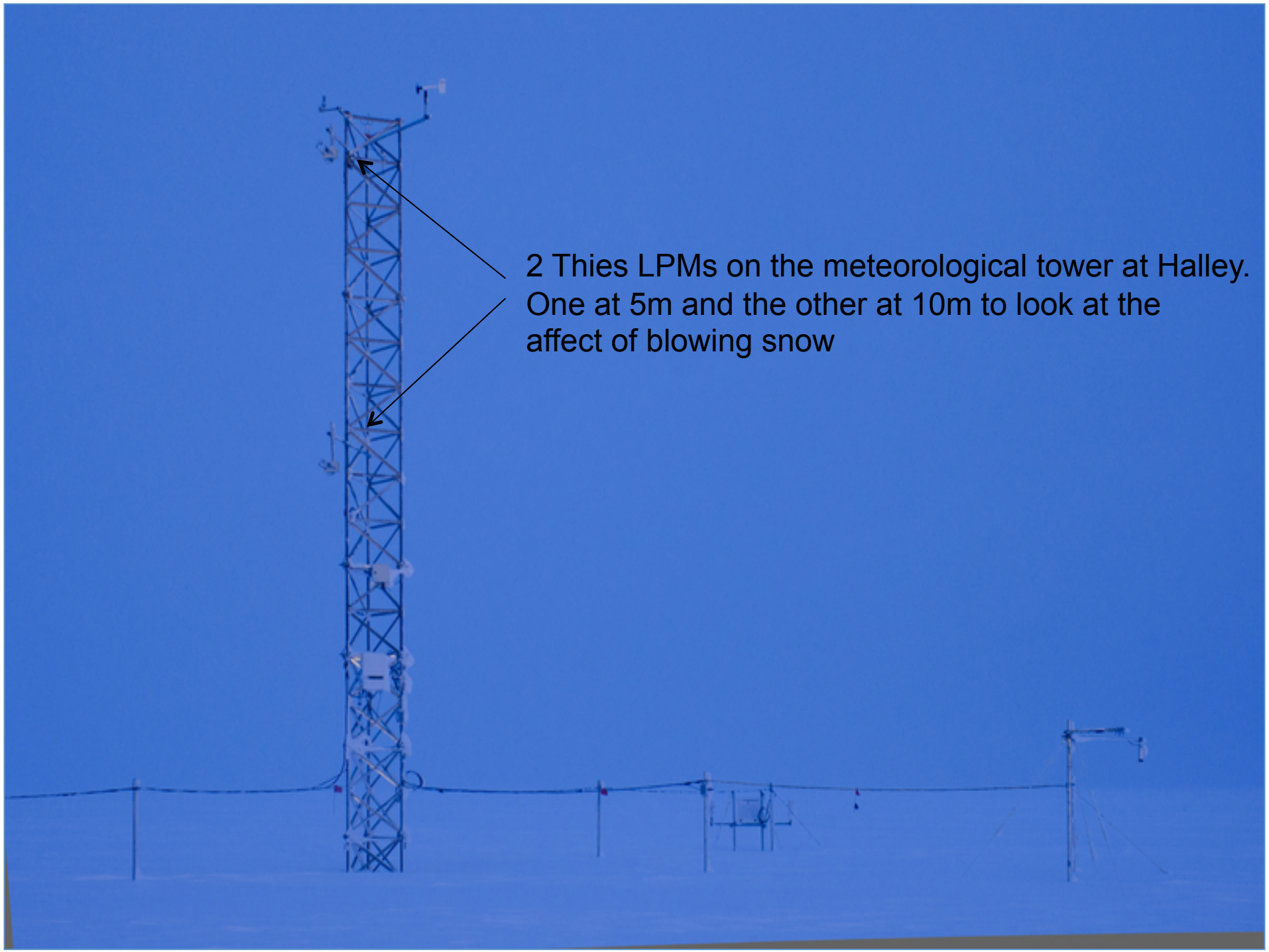

May 20th 2015
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Rate
25
20
15
10
5
0
1
241
481
721
961
1201
1441
Time in minutes
LPM
PWS100
VPF - 730
Wind speed (knots)


May 20th 2015
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Rate
400
350
300
250
200
150
100
50
0
1
241
481
721
961
1201
1441
Time in minutes
LPM
PWS100
VPF - 730
Wind direction


May 20th 2015
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Rate
90
85
80
75
70
65
60
55
50
1
241
481
721
961
1201
1441
Time in minutes
LPM
PWS100
VPF - 730
LPM precip
PWS 100 precip

Conclusions

- For rain there is good agreement between all of the sensors.
- During solid precipitation events both the LPM and VPF-730 can at times over read.
- Most of the time there is disagreement between all of the sensor and as there is no ground truth it is impossible to say which is the most accurate.
- The data needs to be examined in more detail to try and identify why there is a discrepancy in the readings.


2 Thies LPMs on the meteorological tower at Halley.
One at 5m and the other at 10m to look at the affect of blowing snow

Questions