



A New Future in Meteorological Measurements



**Incorporating Quality Checks into
Vertical Temperature and Wind
Measurements**

Vertical Temperature and Wind Measurements in networks

- **Every air quality network must have boundary layer information to understand daily variations in pollution levels.**
- **Many networks do not have suitable measurements**
- **New more affordable and portable technologies are now available and the opportunity to improve networks is real.**

Systems Menu

- **A number of choices exist:**
- **Fixed RASS and RWP systems**
 - Vaisala
 - MiniSodar
 - others
- **Portable Temperature profilers**
 - Kipp & Zonen MTP (series)
 - Radiometrics
- **Radiosonde systems**
 - InterMet
 - Vaisala
 - others

MTP 5-HE

Harsh, Extended range

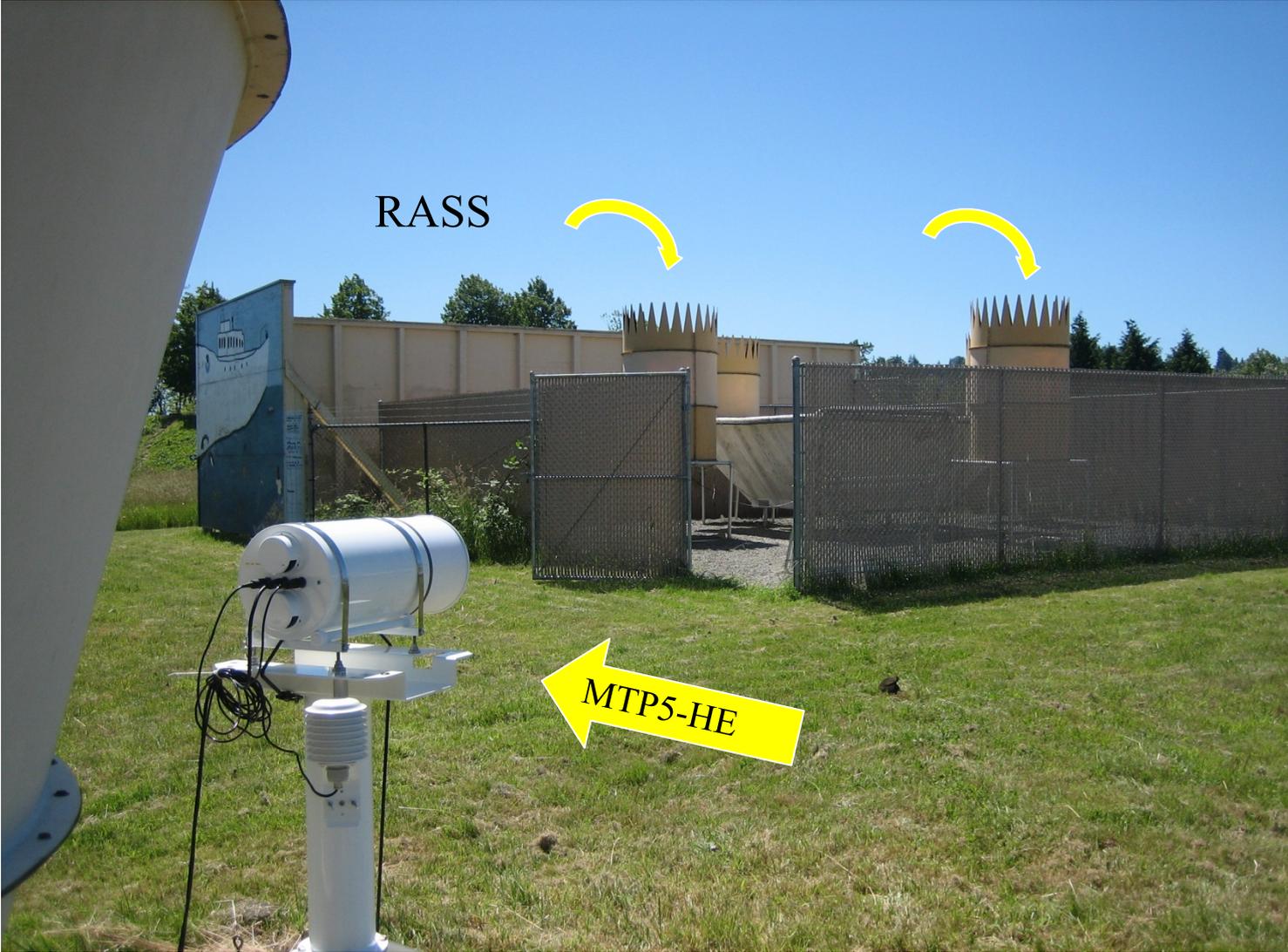


- Height range up to 1,000 m
- Height resolution varies from 50 m to 120 m
- Frequency 56.7 GHz, 3° view, narrower bandwidth, Single Side-Band (SSB)
- Improved specification of radiometer to maintain signal to noise performance
- Mist, cloud and heavy rain slightly degrades accuracy of temperature measurement

MTP5-HE on Pedestal



Technology Comparison



MTP5-HE

Roof Mount



Thermistor



Quality Checks for vertical measurement systems

Radiosondes are the gold standard!

- **Long considered too hard and costly**
 - Labor intensive
 - Can't capture temporal details well
- **Audit vs. QC ?**
 - What criteria?
 - Qualitative based on DQO's
- **What do you do with the results**
 - How do stimulate corrective action?
- **Bottom line is we have to do something.**

Tools to perform QA/QC Checks

➤ **Lessons Learned**

- **Conducted a calibration test in Feb 09**
- **Kipp & Zonen arranged for radiosondes to compare**

➤ **Procured a tool to support QC and Special Studies**

- **Affordable**
 - **< \$10K for the down station and software**
- **Cost effective**
 - **Each flight is only \$ 250**

➤ **Operational considerations**

- **No FAA concerns- small payload**
- **One person operation**
- **Portable and set up is less than 1 hour.**
- **Immediate access to data**

iMet-3050

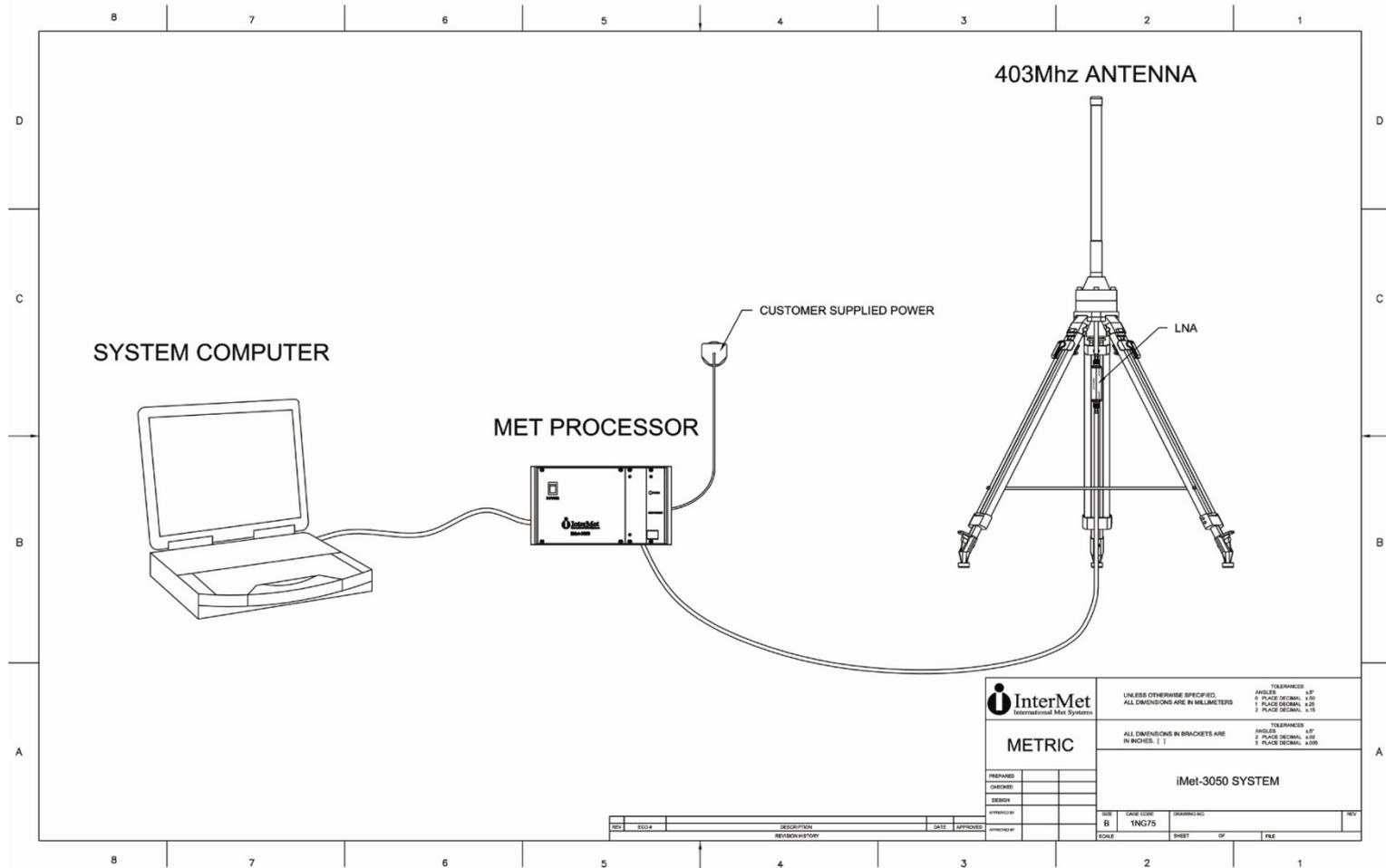
- **Redesigned in 2009 to significantly reduce costs while maintaining complete functionality**
- **Suitable for fixed synoptic installations or field research**
- **Includes iMetOS meteorological operating system**
- **Differential GPS available as a system option, but not required by most users**
- **Compatible with any Windows PC (user supplied)**
- **Compatible with iMet-1 family of radiosondes**
- **Meets all WMO specifications**

Description	Range	WMO Std.	iMet-1
Pressure	Surface to 100 hPa 100 to 10 hPa	1 hPa to 2 hPa 2 percent	0.5 hPa across entire range
Temperature	Surface to 100 hPa 100 to 10 hPa	0.5 K 1.0 K	0.2 K across entire range
Humidity	Troposphere	5% RH	5% RH
Wind Direction	Surface to 100 hPa 100 to 10 hPa	5 deg < 14 m/s 2.5 deg > 14 m/s 5 deg	≤ 5 deg ≤ 2.5 deg ≤ 5 deg
Wind Speed	Surface to 100 hPa 100 to 10 hPa	1 m/s 2 m/s	0.1 m/s across range
Geopotential height	Surface to 100 hPa	1% near surface decreasing to 0.5% at 100 hPa	1% to 0.5%



InterMet
International Met Systems

iMet-3050



➤ iMet-1

- **State of the art performance exhaustively tested by U.S. National Weather Service**
- **Lightweight, easy to use**
- **Available with or without solid state pressure sensor**
- **For research or synoptic use**
- **Only radiosonde built in the U.S.A**



Component

Temperature Sensor

Humidity Sensor

Pressure Sensor (optional)

GPS Receiver

De-Reeler (optional)

Batteries

Protective case

Signal processor

Transmission type

Data Rate

Preflight and Balloon Inflation

➤ **Easy to use software interface**

- Site information

➤ **200 gram Balloon**

- Easy and quick inflation
- Helium Bottle
 - ~ 4 Flights per bottle

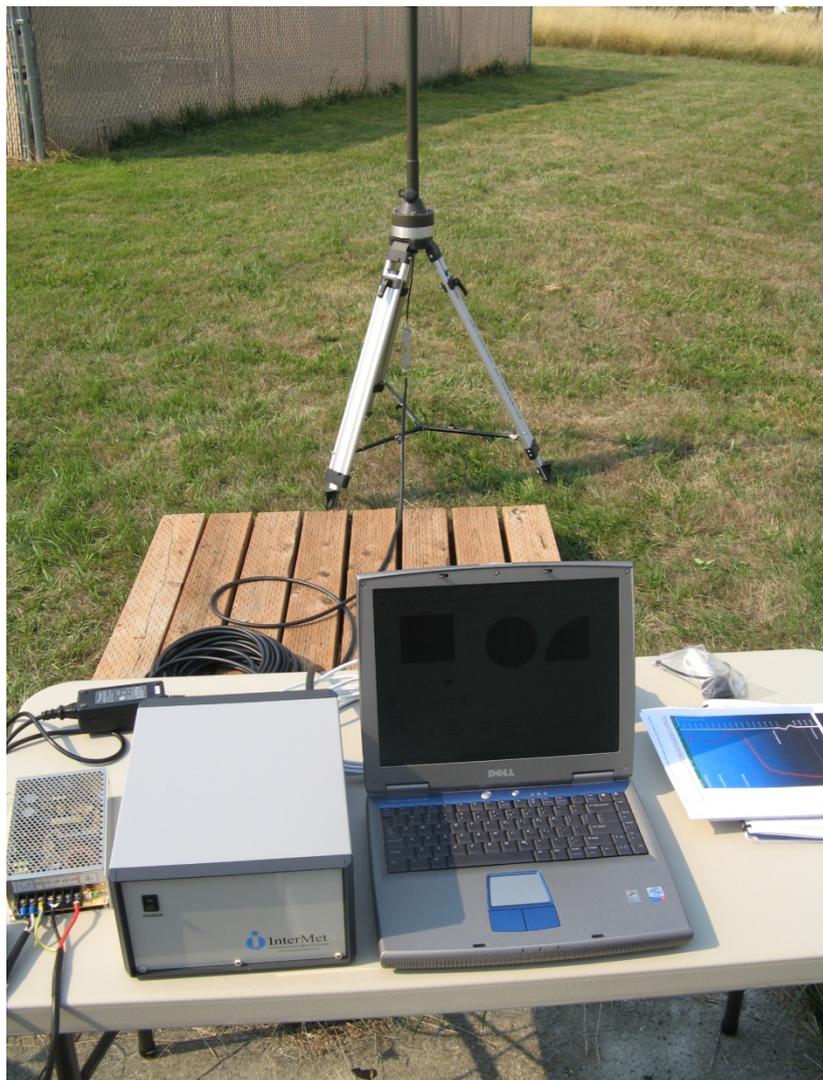
➤ **Radiosonde Train**

- Power on for initialization
- Easy connection to balloon, parachute, and dereeler

➤ **Onsite to Flight**

- Less than 30 minutes

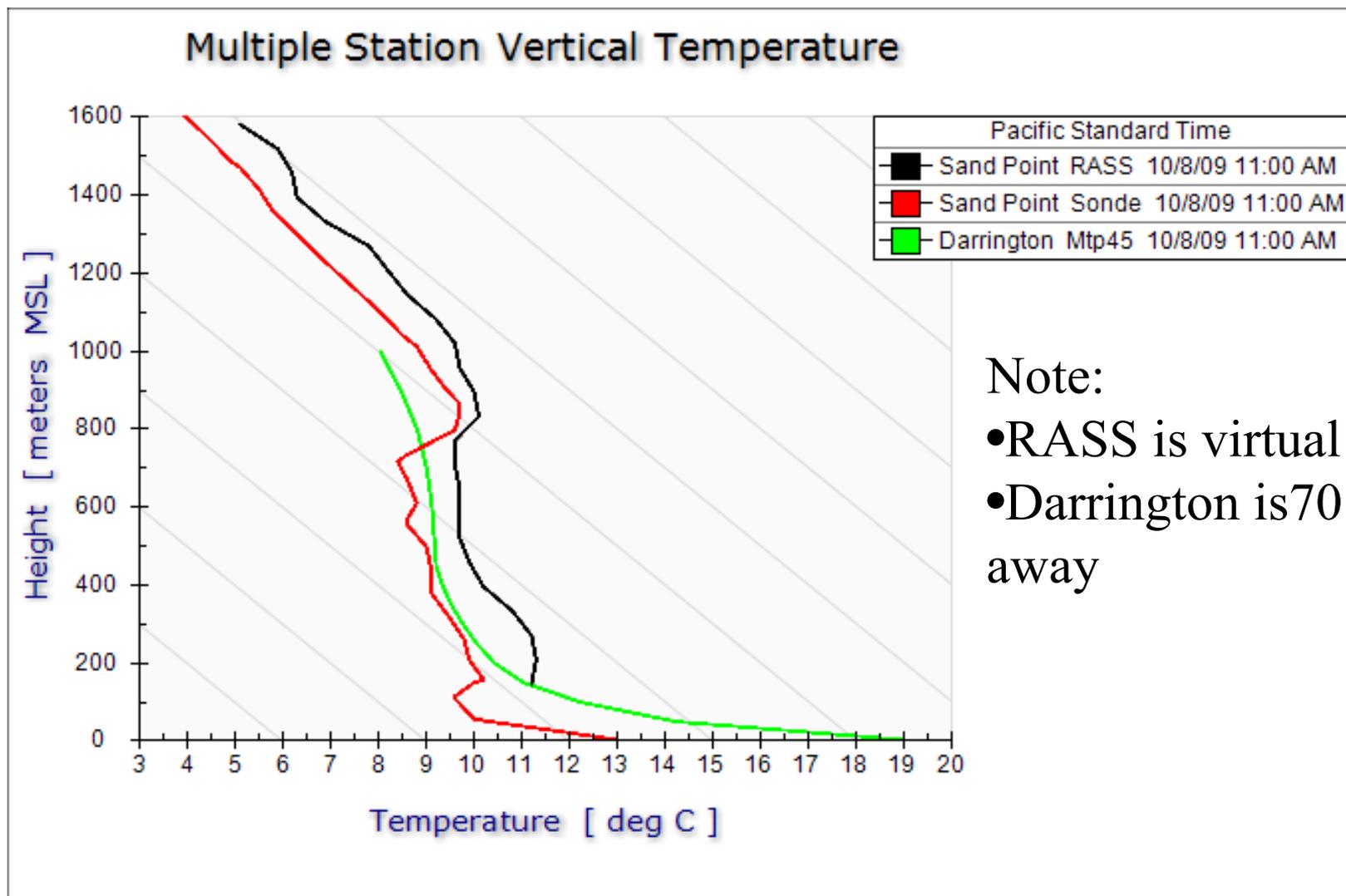
Radiosonde system-InterMet



Radiosonde Release

- [C:\Users\MikeG\Desktop\Radiosonde-100709002.AVI](#)
- [C:\Documents and Settings\Itrinca\Desktop\Wednesday\Radiosonde-100709 002.AVI](#)

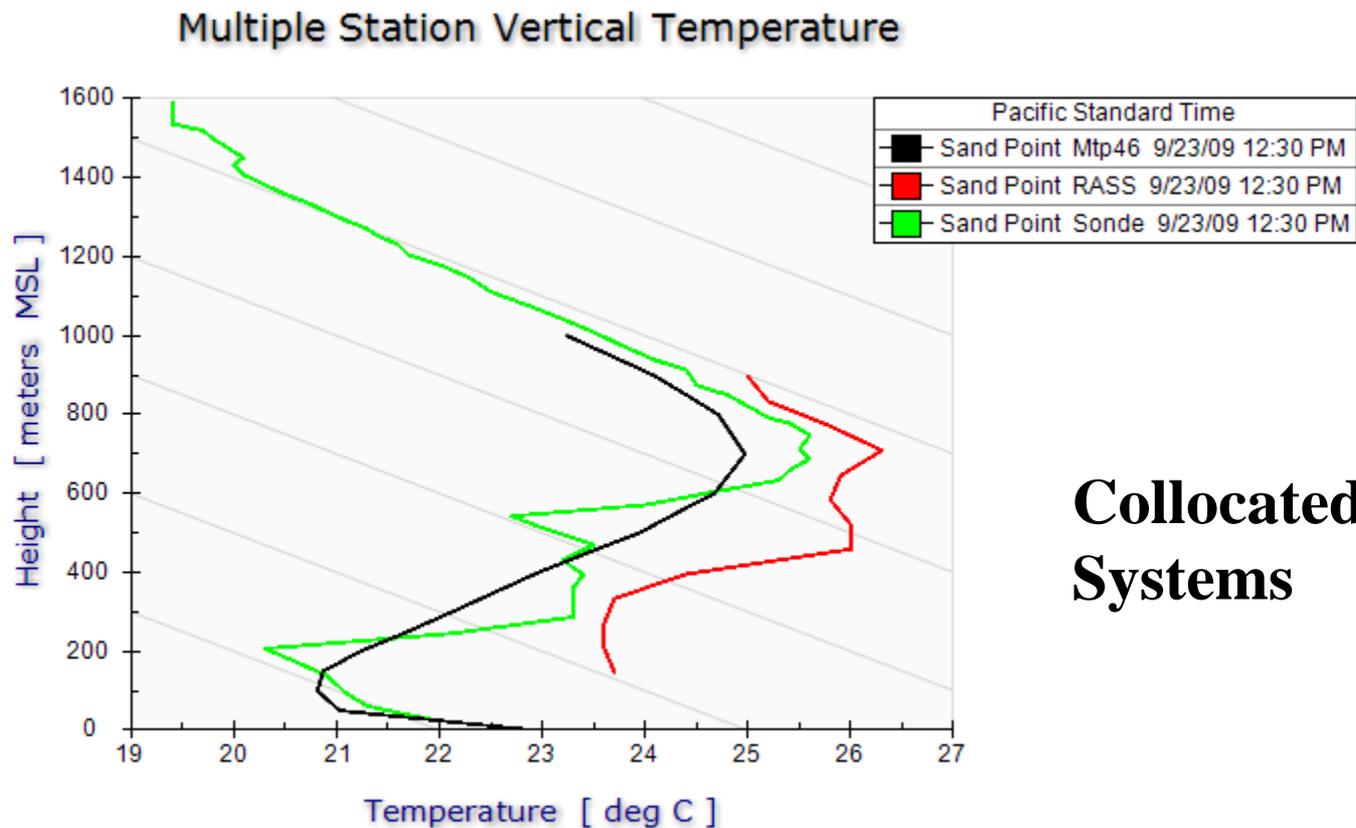
Data results



Note:

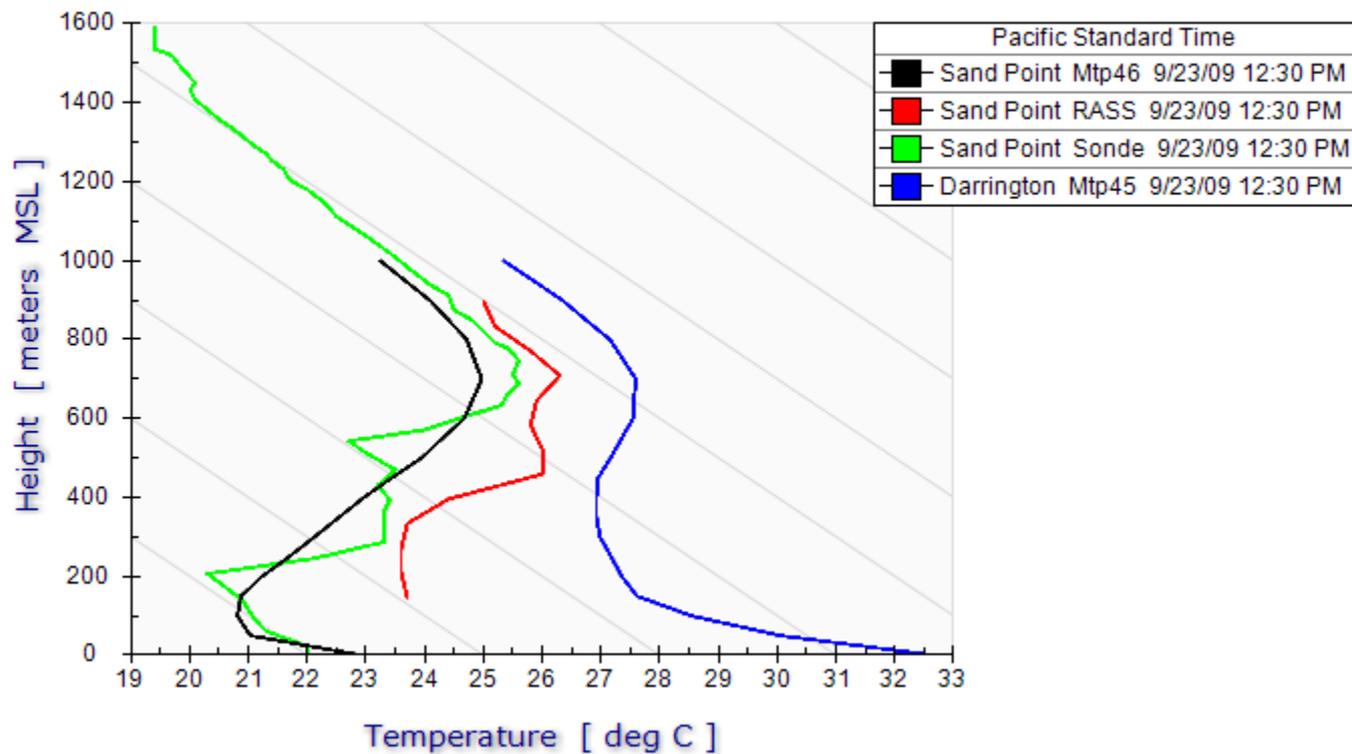
- RASS is virtual temp
- Darrington is 70 miles away

Data Results



**Collocated
Systems**

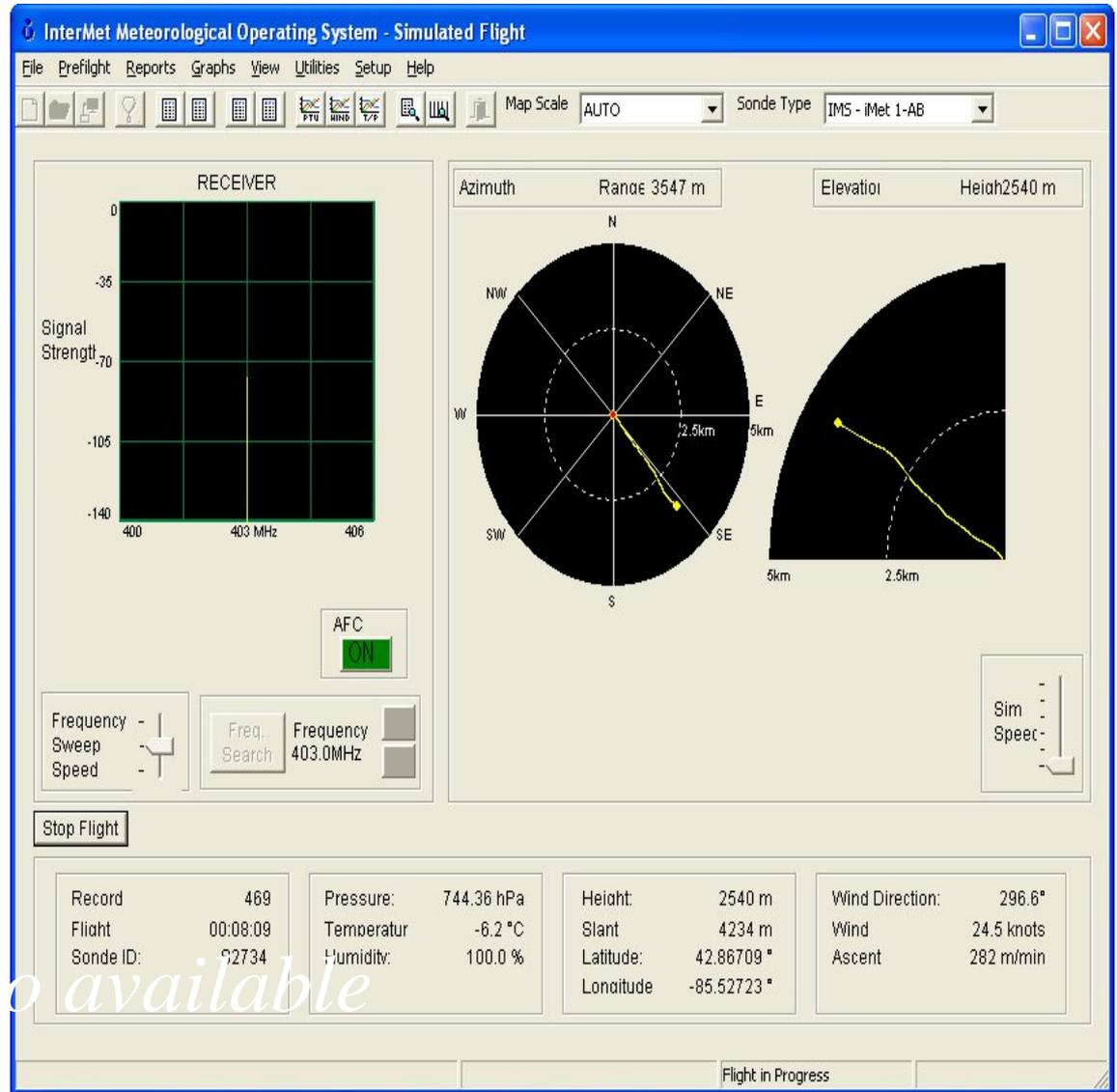
Multiple Station Vertical Temperature



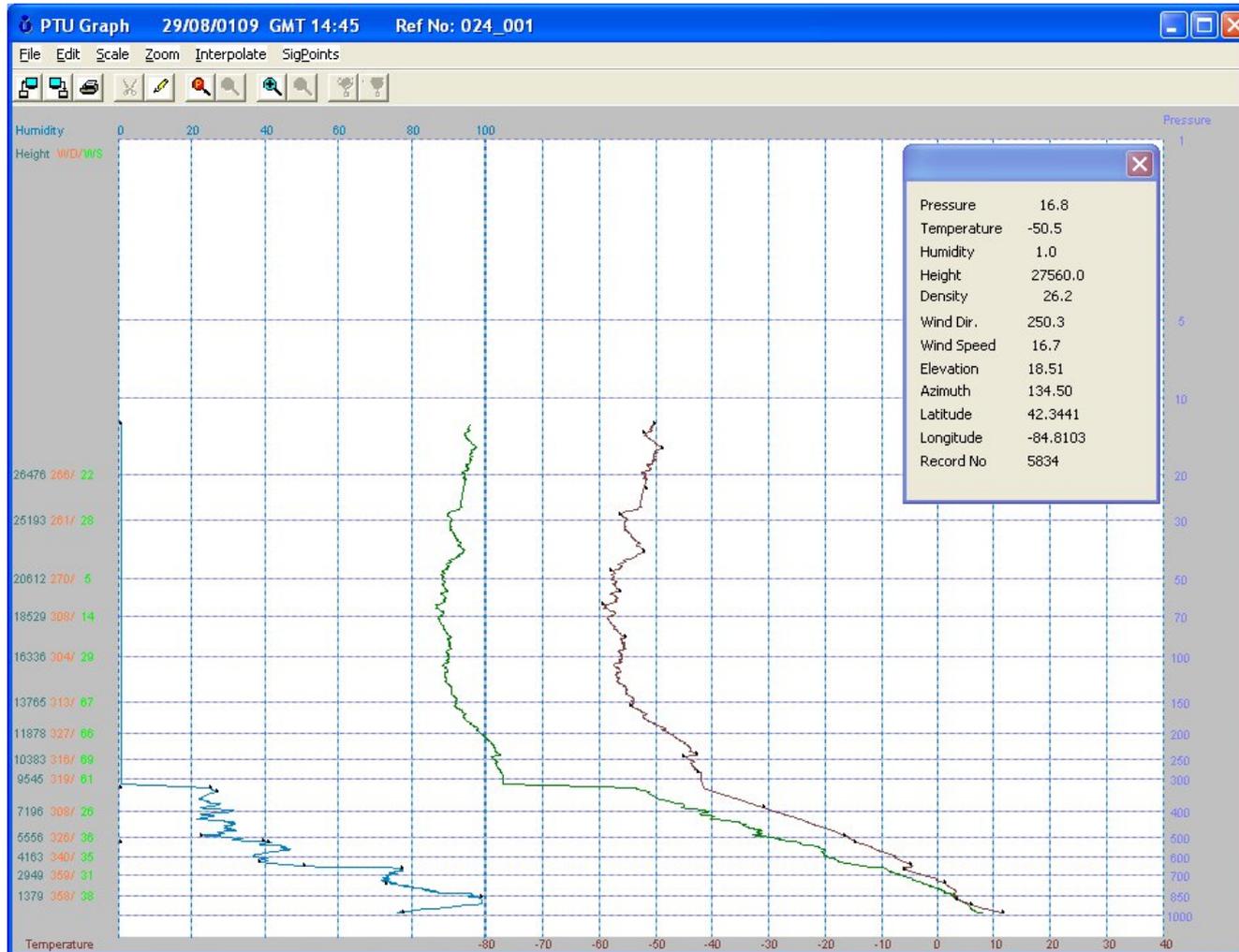
iMetOS Software

➤ Flight Management, Graphical Displays & Standard Reports

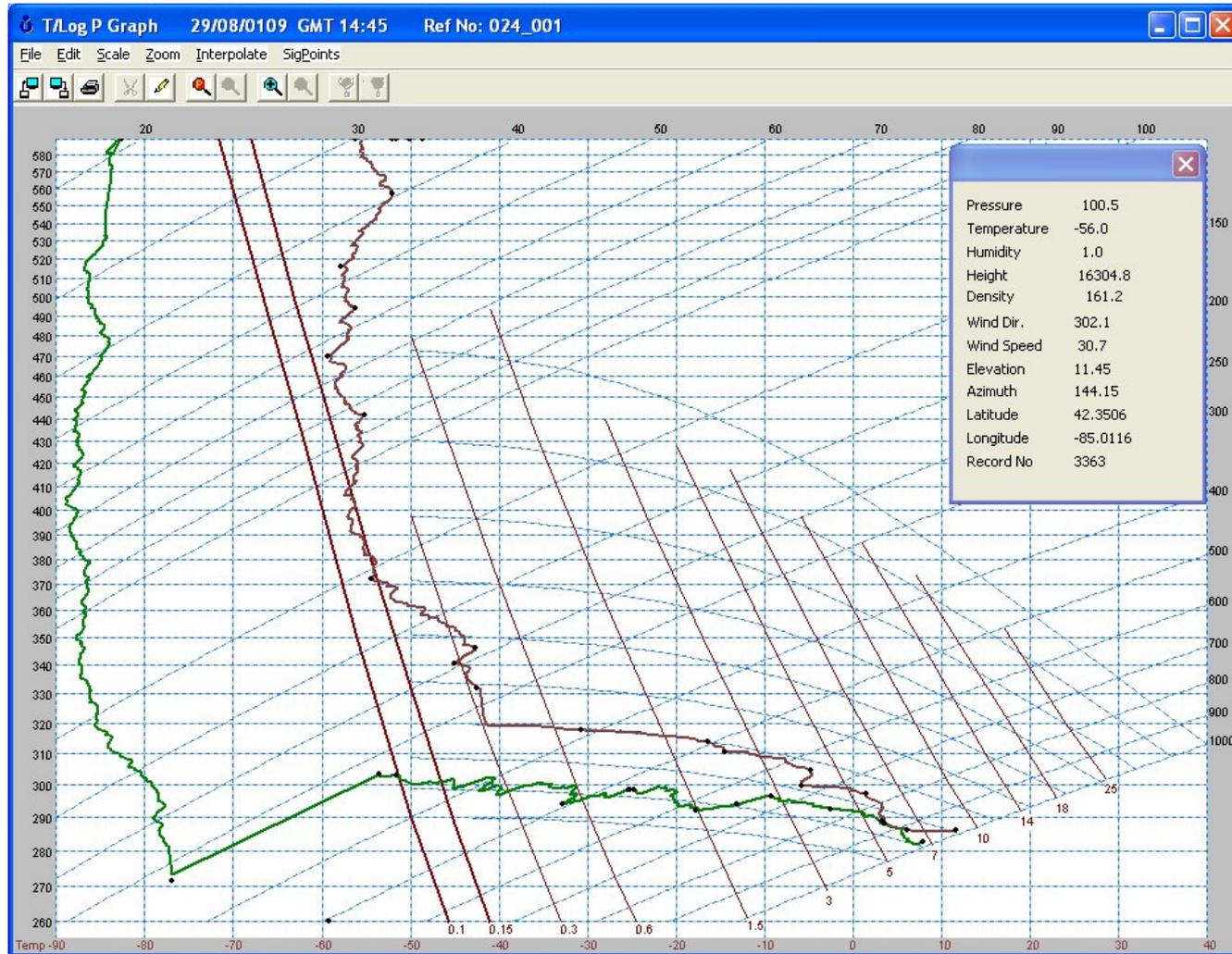
- One second data for analysis
- Real time output during flight
- Data editing capabilities
- Compatible with all Windows peripherals



iMetOS Software



iMetOS Software



iMetOS Software

024_001.PYS - WordPad

File Edit View Insert Format Help

PHYSICAL VALUES Date: 29/09/2009 Time: 14:45 GMT Ref No. : 024_001
LOCATION: OCT - 3 42.891N 85.556W

Surface Observations Sonde Details

PRESSURE : 982.5 mb
HEIGHT : 230.2 Meter
TEMPERATURE : 11.7 Deg SONDE TYPE : IMET1 BB
HUMIDITY : 78.0 % SONDE No. : S6160
WIND DIR. : 330.0 Deg
WIND VEL. : 11.0 Knot
CLOUD CODE : 784//
STATION No. : 59000
STATION NAME : KIMS

Time Sec.	Temp °C	DewP. °C	RH %	Press. hpa	H-Sur. Meter	H-Msl. Meter	EL. deg.	AZ. deg.	U.D deg.	W.S Knots
00:00:00	11.7	8.0	78	982.5	0.0	230.2	0	0	330	11
00:00:10	10.9	7.0	77	976.7	-3.4	226.8	0	0	305	11
00:00:20	10.4	6.9	79	971.1	44.7	275.0	41	113	307	12
00:00:30	9.8	6.6	81	964.9	96.8	327.1	44	121	306	11
00:00:40	9.3	6.2	81	958.4	151.5	381.7	45	121	311	13
00:00:50	8.7	6.2	84	951.9	208.1	438.4	43	124	318	16
00:01:00	8.1	6.1	87	945.0	269.1	499.3	42	129	320	17
00:01:10	7.4	5.9	90	937.6	337.1	567.3	42	131	317	19
00:01:20	6.8	5.7	93	928.0	423.0	653.2	42	131	323	20
00:01:30	6.3	5.4	94	920.6	492.0	722.2	41	134	334	23
00:01:40	6.0	5.6	97	913.5	557.7	787.9	40	139	336	25
00:01:50	5.7	5.6	99	907.9	612.3	842.5	38	141	337	25
00:02:00	5.2	5.1	99	901.9	666.8	897.1	36	142	339	27
00:02:10	5.0	4.9	99	897.4	707.8	938.1	35	145	342	29
00:02:20	4.8	4.6	99	892.3	754.4	984.7	33	147	343	31
00:02:30	4.5	4.4	99	886.9	804.0	1034.3	32	149	344	32
00:02:40	4.2	4.1	99	881.2	855.4	1085.7	30	150	343	32
00:02:50	3.9	3.8	99	875.2	910.2	1140.4	30	152	342	32
00:03:00	3.7	3.5	99	869.5	965.4	1195.6	30	152	344	32
00:03:10	3.5	3.4	99	864.4	1012.4	1242.7	29	153	348	33
00:03:20	3.3	3.1	99	858.4	1068.9	1299.1	28	155	352	36

For Help, press F1

NUM

View Physical Values

File Edit Interpolate

Item	Press	Temp	RH	Dew...	V.Temp	Height	W.D	W.S	EL	AZ
00:00:00	982.50	11.70	78.00	8.00	286.05	230.24	330.00	11.00	0.00	0.00
00:00:01	981.44	11.47	74.48	7.09	285.75	187.27	305.66	11.24	0.00	0.00
00:00:02	980.81	11.38	74.85	7.08	285.66	191.33	305.23	11.17	0.00	0.00
00:00:03	980.54	11.31	74.93	7.03	285.58	193.82	304.83	11.08	0.00	0.00
00:00:04	980.26	11.24	75.01	6.98	285.51	196.32	304.61	11.03	0.00	0.00
00:00:05	979.69	11.12	75.35	6.93	285.38	201.13	304.59	11.02	0.00	0.00
00:00:06	979.07	11.10	76.08	7.05	285.37	205.96	304.78	11.03	0.00	0.00
00:00:07	978.40	11.10	76.63	7.15	285.38	211.06	304.88	11.05	0.00	0.00
00:00:08	977.83	10.99	76.97	7.12	285.28	216.63	304.89	11.06	0.00	0.00
00:00:09	977.31	10.89	76.91	7.01	285.17	221.99	304.82	11.08	0.00	0.00
00:00:10	976.70	10.87	77.10	7.03	285.15	226.84	304.72	11.12	0.00	0.00
00:00:11	976.02	10.84	77.09	7.00	285.12	231.81	304.72	11.22	0.00	0.00
00:00:12	975.30	10.71	77.24	6.90	284.98	237.33	304.77	11.33	20.79	57.08
00:00:13	974.58	10.73	77.65	6.99	285.01	243.26	304.85	11.44	41.59	114.16
00:00:14	973.98	10.68	77.95	7.00	284.96	249.41	305.00	11.54	43.66	114.74
00:00:15	973.45	10.56	77.98	6.89	284.83	255.23	305.27	11.60	42.91	115.82
00:00:16	973.11	10.52	78.15	6.88	284.79	257.56	305.60	11.61	42.40	115.74
00:00:17	972.77	10.47	78.33	6.87	284.74	259.89	305.90	11.63	41.95	114.71
00:00:18	972.16	10.51	78.63	6.96	284.79	264.49	306.15	11.66	41.95	113.77
00:00:19	971.55	10.45	78.77	6.93	284.73	269.88	306.43	11.73	41.57	112.85
00:00:20	971.10	10.40	78.75	6.88	284.68	274.96	306.80	11.83	41.31	112.91
00:00:21	970.53	10.38	78.81	6.87	284.66	279.63	307.27	11.94	41.60	114.08
00:00:22	969.83	10.31	78.94	6.83	284.58	284.68	307.79	12.06	42.50	115.04
00:00:23	969.14	10.26	79.04	6.80	284.53	290.12	308.27	12.18	43.10	116.09
00:00:24	968.49	10.14	79.17	6.70	284.40	295.75	308.63	12.31	43.37	117.07
.....

Logistics

➤ **Versatile and mobile**

- **Universal PC type power supply, 110 – 220 VAC**
- **System carried in three cases making it easy to transport and secure**
- **iMetOS can be run on any Windows 2000 + PC* including Netbooks**
 - **Windows 7 (?)**
- **Easy data access for reporting and analysis**
- **200gram balloons don't need much helium**
 - **~ \$ 190.00 per standard bottle**

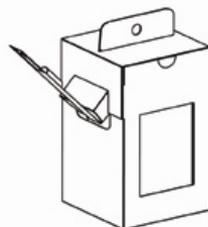
iMet-3150 Portable

iMet-3150

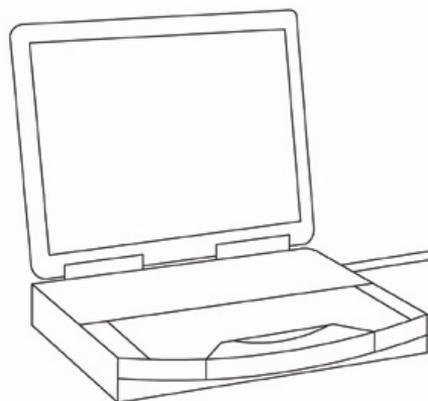
- **Lost-cost, handheld sounding system for reduced range applications (< 50 km slant range)**
- **Suitable for boundary layer research, remote sensor calibration, tropical observations**
- **Up to 90 km range with optional whip antenna**
- **Full-function iMetOS operating system with complete data output**
- **Compatible with iMet-1 family of radiosondes**
- **Compatible with any Windows PC**
- **Ultra portable**

iMet-3150

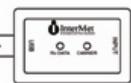
InterMet
International Met Systems



iMET-1 RADIOSONDE



SYSTEM COMPUTER



DECODER



RECEIVER

AC ADAPTER





InterMet
International Met Systems

iMet-1-RS **Purpose Research Sonde**

- **Designed for integration with any atmospheric sensor**
- **Includes Serial Data Port that allows custom sensors to transmit data over the sonde's data stream**
- **User programmable functions**
- **Successfully used with Ozone, Particulates and Frost Point Hygrometers**
- **Can be integrated with UAV and glider applications**

Meteorological Assimilation Data Ingest System--MADIS

➤ **Great site.**

➤ **QA for wind folding**

➤ **http://madis.noaa.gov/madis_qc.html**

Summary

- **Include Meteorological measurements in your network assessment!**
- **Portable radiosonde systems can easily and affordably support QA/QC activities**
 - **Must now develop what that looks like for national consistency**
 - **What criteria, how often?**
- **Special studies, emergency response may now be supported more effectively**

Special Study- Winter 2009

➤ **EPA Region 10**

- Found funds to buy an inventory of balloons and Radiosondes
- Helium provided by Washington State Department of Ecology
- Hardware and Training provided by PSCAA

➤ **Eastern Washington high PM**

- Winter
- Uncertainty regarding boundary layer
- Adjacent to Yakama Nation lands

➤ **EPA Region 10 and Yakima Clean Air Agency**

- Using InterMet radiosondes and MTP5 He
 - Conduct ~8 flights over a two day period
- Compare to predicted mesoscale boundary layer predictions

Recommendations

- **EPA should provide grant funds for procurement**
 - **Special application, not necessarily via 105/103**
 - **Provide resources for consumables for long term operation**
- **Encourage procurement of profilers to provide more detailed and efficient data collection**
- **Establish a goal of one system per region**
 - **QA operation, special studies, emergency response**
- **Expect meteorological measurements to be included in 5 year assessments**

Thanks

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