



Product Testing and Research Capabilities with Mount Washington Observatory

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Director of Summit Operations
April 4, 2013 Polar Technology Conference

Introduction



- About Mount Washington
 - Introduction
 - Lay of the land
 - Meteorological summary
- Product Testing and Research
 - Past projects
 - Current facilities and services
- Mesonet Details

Introduction

Ken Rancourt- DSO Emeritus



Cyrena Briede- DSO



Introduction



What is Mount Washington?



- **New Hampshire**
- **6288' (1917 m) ASL**
- **Home of the non-profit Observatory since 1932**
- **Measured World Record wind speed 231 mph on April 12, 1934**
- **Five separate entities on summit**

Mount Washington Observatory



Mount Washington State Park,
Sherman Adams Visitor Center



White Mountain National Forest



Mount Washington Auto Road



Mount Washington Auto Road



Mount Washington Cog Railway



Meteorology

- Annual average temperature: 27°F (-3°C)
 - Record low: -47°F (-44°C)
 - Average winter temp: 10°F (-12°C)
- Wind: Annual average 35 mph (16 m/s)
 - Record high: 231 mph (103 m/s)
- Precipitation: 100" liquid annually (254 cm)
 - Average 281" of frozen precipitation (714 cm)
 - In the fog 60% of the time annually
- Icing: Perfect combination of subzero temperatures, moisture, and high winds provide ample rime ice (freezing fog) and glaze ice (clear ice) in spring, fall, and winter

Meteorology- Rime



Meteorology- Oct 2012

LATITUDE 44 DEGREES 16 MINUTES NORTH						LONGITUDE 71 DEGREES 18 MINUTES WEST						GROUND ELEVATION (H) 6280 FT		STANDARD TIME EASTERN			
TEMPERATURE (°F)						DEGREE DAYS			PRECIPITATION (IN.)			WIND (MPH)		SUNSHINE (MINUTES)		SKY COVER (TENTHS)	WEATHER OCCUR.
DAY	MAX	MIN	AVG	NORM	DEPART	HEAT	COOL	TOTAL (EQUIV)	SNOW & ICE	SNOW/ICE ON GROUND-8AM	AVG SPEED	FASTEST MILE SPEED	DIR	TOTAL	% POSS		
1	39	31	35	35	0	30	0	0.92	0.9	1	47.5	79	W	0	0	10	1246
2	51	38	45	35	10	20	0	0.08	0.0	0	32.6	56	W	228	32	9	12
3	56	50	53	35	18	12	0	0.28	0.0	0	22.3	38	W	0	0	10	12
4	54	41	48	34	14	17	0	0.29	0.0	0	24.9	55	NW	0	0	10	12
5	47	37	42	34	8	23	0	0.00	0.0	0	39.9	59	W	285	40	8	12
6	46	25	36	33	3	29	0	0.34	0.0	0	44.8	70	W	0	0	10	126
7	33	22	28	33	-5	37	0	0.25	3.4	T	25.7	60	W	85	12	10	126
8	29	19	24	33	-9	41	0	0.07	0.8	3	24.5	45	W	85	12	9	126
9	34	22	28	32	-4	37	0	0.00	0.0	3	19.2	38	W	0	0	10	126
10	39	24	32	32	0	33	0	0.64	0.3	3	39.5	80	NW	0	0	10	1269
11	25	18	22	32	-10	43	0	0.05	0.1	1	53.7	88	W	0	0	10	1269
12	26	9	18	31	-13	47	0	0.38	2.7	2	55.4	85	W	0	0	10	1269
13	20	7	14	31	-17	51	0	0.03	0.5	2	38.8	72	NW	85	13	10	1269
14	46	18	32	31	1	33	0	0.19	1.2	3	48.1	78	W	0	0	10	12469
15	47	35	41	30	11	24	0	0.17	0.0	0	44.3	73	SW	20	3	10	12
16	36	17	27	30	-3	38	0	0.08	0.5	0	45.0	80	W	0	0	10	126
17	41	23	32	30	2	33	0	0.00	0.0	T	30.9	51	NW	648	97	4	
18	42	35	39	29	10	26	0	0.00	0.0	T	27.0	55	S	537	81	8	
19	49	34	42	29	13	23	0	1.86	0.0	0	46.5	78	SE	0	0	10	12
20	48	31	40	29	11	25	0	0.15	0.0	0	33.7	55	S	45	7	9	12
21	32	27	30	29	1	35	0	0.00	0.0	T	58.7	106	W	0	0	10	126
22	29	25	27	28	-1	38	0	0.00	0.0	T	76.9	107	W	0	0	10	126
23	35	23	29	28	1	36	0	0.00	0.0	T	49.8	85	NW	636	98	6	126
24	38	32	35	28	7	30	0	0.00	0.0	T	20.5	39	NW	646	100	4	
25	47	32	40	27	13	25	0	0.00	0.0	T	22.0	35	W	623	97	1	12
26	55	45	50	27	23	15	0	0.00	0.0	0	6.6	18	W	546	85	3	12
27	47	36	42	27	15	23	0	0.00	0.0	0	20.9	41	SE	0	0	10	12
28	41	30	36	26	10	29	0	0.02	0.0	0	38.5	65	E	10	2	10	12
29	42	33	38	26	12	27	0	1.84	0.0	0	74.1	140	E	0	0	10	12
30	44	39	42	26	16	23	0	2.96	0.0	0	54.8	110	E	0	0	10	123
31	43	27	35	26	9	30	0	0.96	0.8	0	43.4	80	SE	0	0	10	126
SUM	1261	885	---	---	---	933	0	11.57	11.2	---	1210.5	---	---	4479	---	271	---
AVG	40.7	28.5	---	---	---	---	---	---	---	---	39.0	FASTEST	DIR	POSS	%		---
											MISC. ->	140	E	20805	22%	8.7	---

Meteorology- Jan 2013

TEMPERATURE (°F)					PRECIPITATION (IN.)				WIND (MPH)			SUNSHINE (MINUTES)		SKY COVER	WEATHER		
DAY	MAX	MIN	AVG	NORM	DEPART	DEGREE DAYS		TOTAL (EQUIV)	SNOW & ICE	SNOW/ICE ON GROUND-6AM	AVG SPEED	FASTEST MILE		TOTAL	% POSS	(TENTHS)	OCCUR.
						HEAT	COOL					SPEED	DIR				
1	10	-18	-4	6	-10	69	0	0.20	1.8	22	74.8	102	W	5	1	10	1269
2	3	-20	-8	6	-14	73	0	0.00	0.0	22	65.9	98	NW	17	3	10	1269
3	5	-6	0	6	-6	65	0	0.17	1.1	22	40.8	69	NW	490	89	6	1269
4	9	0	5	5	0	60	0	0.40	3.9	23	71.3	95	W	0	0	10	1269
5	11	-4	4	5	-1	61	0	0.45	1.6	24	66.1	119	NW	101	18	9	1269
6	13	4	9	5	4	56	0	0.07	1.0	25	45.0	66	W	0	0	10	1269
7	13	2	8	5	3	57	0	0.05	0.7	26	46.9	69	NW	438	79	1	1269
8	20	0	15	5	10	50	0	0.00	0.0	25	63.1	99	W	451	81	6	12
9	24	4	19	5	14	46	0	0.18	2.5	25	50.1	108	W	211	38	8	1269
10	26	9	18	5	13	47	0	0.12	2.6	25	71.0	109	NW	0	0	10	1269
11	32	24	28	5	23	37	0	0.10	0.1	25	27.5	56	SW	25	4	9	12469
12	40	25	33	5	28	32	0	0.01	0.0	24	36.7	54	W	10	2	10	126
13	48	37	43	5	38	22	0	T	0.0	15	41.3	91	W	160	28	8	12
14	43	8	26	5	21	39	0	0.04	0.0	8	62.9	98	W	69	12	9	126
15	16	5	11	5	6	54	0	0.00	0.0	6	34.0	48	NW	488	86	4	126
16	18	8	13	5	8	52	0	0.41	2.3	6	32.5	73	W	0	0	10	1269
17	12	-15	-1	4	-5	66	0	0.40	3.6	7	58.4	96	W	60	11	9	1269
18	-5	-22	-13	4	-17	78	0	T	T	9	62.2	89	NW	301	53	8	126
19	21	6	8	4	4	57	0	0.54	3.8	11	57.1	90	W	0	0	10	1269
20	20	-12	4	4	0	61	0	0.18	2.0	11	68.3	104	W	76	13	9	1269
21	-5	-17	-11	4	-15	76	0	0.02	0.8	10	49.1	91	W	240	42	9	1269
22	-4	-28	-16	4	-20	81	0	0.06	0.8	11	43.3	92	NW	40	7	10	1269
23	-26	-35	-30	4	-34	95	0	0.00	0.0	10	61.5	85	NW	285	49	8	126
24	-15	-29	-22	4	-26	87	0	0.00	0.0	10	73.2	111	NW	340	58	8	1269
25	3	-17	-7	4	-11	72	0	0.01	0.1	10	50.0	111	NW	460	79	8	126
26	-3	-19	-11	4	-15	76	0	0.03	0.7	10	41.4	87	NW	440	75	6	126
27	4	-11	-6	5	-11	71	0	0.00	0.0	10	64.7	100	NW	583	99	1	126
28	22	0	11	5	6	54	0	0.15	5.4	10	26.9	50	NW	5	1	10	126
29	32	20	26	5	21	39	0	T	0.2	13	20.0	52	W	385	65	9	126
30	43	27	35	5	30	30	0	0.34	0.0	11	60.3	107	SW	0	0	10	126
31	42	-5	19	5	14	46	0	1.59	1.1	7	74.8	118	W	0	0	10	12469
SUM	472	-76	---	---	---	1809	0	5.52	36.1	---	1641.1	---	---	5680	---	255	---
AVG	15.2	-2.5	---	---	---	---	---	---	---	---	52.9	FASTEST	DIR	POSS	%	---	---
											MISC. ->	119	NW	17658	32%	8.2	---

Meteorology- Feb 2013

TEMPERATURE (°F)						PRECIPITATION (IN.)			WIND (MPH)			SUNSHINE (MINUTES)		SKY COVER	WEATHER		
DAY	MAX	MIN	AVG	NORM	DEPART	DEGREE DAYS		TOTAL (EQUIV)	SNOW & ICE	SNOW/ICE ON GROUND-6AM	AVG SPEED	FASTEST MILE		TOTAL	% POSS	(TENTHS)	OCCUR.
						HEAT	COOL					SPEED	DIR				
1	-5	-15	-10	5	-15	75	0	0.15	0.9	7	69.3	113	W	0	0	10	1269
2	-4	-17	-10	5	-15	75	0	0.08	1.5	7	40.0	75	NW	153	25	9	126
3	3	-7	-2	5	-7	67	0	T	0.3	8	12.5	28	W	199	33	8	126
4	-5	-18	-11	5	-16	76	0	0.28	2.7	9	54.5	83	W	0	0	10	1269
5	0	-19	-9	5	-14	74	0	0.01	0.2	9	45.2	80	NW	602	98	4	126
6	4	-18	-7	5	-12	72	0	0.09	1.5	10	55.5	93	NW	0	0	10	1269
7	2	-18	-8	5	-13	73	0	0.01	0.4	9	46.5	87	NW	570	92	4	126
8	3	-3	0	5	-5	65	0	0.59	13.8	7	28.5	55	E	0	0	10	1269
9	6	-9	-1	5	-6	66	0	0.47	10.3	10	50.3	88	NE	0	0	10	1269
10	20	-1	10	5	5	55	0	T	T	7	41.8	81	N	627	100	4	1269
11	27	14	21	6	15	44	0	0.29	3.3	5	42.2	77	S	0	0	10	1269
12	16	8	12	6	6	53	0	0.08	1.8	6	68.2	96	W	0	0	10	1269
13	11	5	8	6	2	57	0	0.03	0.4	6	31.1	74	NW	40	6	10	1269
14	15	4	10	6	4	55	0	T	0.1	6	18.7	34	NW	568	89	3	126
15	19	9	14	6	8	51	0	0.04	0.5	6	35.4	64	W	0	0	10	126
16	12	2	7	6	1	58	0	0.03	0.6	7	18.3	51	W	40	6	9	126
17	4	-16	-6	6	-12	71	0	0.60	3.6	8	50.8	99	NW	0	0	10	1269
18	12	-19	-3	7	-10	68	0	0.00	0.0	9	87.3	129	NW	224	34	8	1269
19	27	11	19	7	12	46	0	0.19	1.5	9	41.5	75	NW	235	36	9	1269
20	20	-2	9	7	2	56	0	0.50	5.2	11	49.3	102	NW	0	0	10	1269
21	11	-10	1	7	-6	64	0	0.23	3.1	11	48.0	95	NW	10	2	10	1269
22	23	10	17	7	10	48	0	0.00	0.0	11	20.5	54	N	556	84	5	129
23	22	12	17	7	10	48	0	0.08	2.5	11	24.2	40	SW	5	1	10	1269
24	26	12	19	8	11	46	0	0.38	6.0	12	17.5	38	N	0	0	10	1269
25	17	10	14	8	6	51	0	0.03	0.6	14	16.1	41	N	365	54	6	1269
26	26	10	18	8	10	47	0	0.00	0.0	13	10.5	25	S	180	27	9	126
27	25	11	18	8	10	47	0	1.48	12.7	13	50.1	95	E	0	0	10	1269
28	27	13	20	8	12	45	0	0.16	2.7	21	17.0	73	SE	140	21	9	1269
SUM	364	-41	----	----	----	1653	0	5.80	76.2	----	1090.8	----	----	4514	----	237	----
AVG	13.0	-1.5	----	----	----	----	----	----	----	----	39.0	FASTEST	DIR	POSS	%	8.5	----
											MISC. ->	129	NW	17905	25%		----

Research and Product Testing

- **Research Disciplines**

- Cloud physics
- Mountain meteorology
- Cosmic ray flux
- Rime and glaze ice formation
- Boundary layer dynamics
- High elevation climate change
- Atmospheric chemistry
- Tree-line elevation maintenance
- Alpine and subalpine flora and fauna

- **Partners**

- NASA
- Cold Regions Research and Engineering Laboratory (CRREL)
- University of New Hampshire
- Massachusetts Institute of Technology (MIT)
- United States National Forest Service
- Appalachian Mountain Club
- National Weather Service (NWS)
- National Oceanic and Atmospheric Administration (NOAA)

Research and Product Testing

- **One day from Boston, New York City, Montreal, Portland, Providence**
- **Subarctic environment**
- **NWS Station, staffed 24 hours a day, 7 days a week**
 - **Computer programmers**
 - **Accomplished meteorologists**
 - **Educational specialists**
- **State-of-the-art facility**
 - **High-speed internet**
 - **Phone and video conferencing**
 - **Exterior tower and deck testing space**
 - **Climate-controlled indoor testing space**
- **All the comforts of home**
 - **Fully-stocked kitchen**
 - **Bunkrooms**
- **Products: tents, coffee makers, dialysis, wind turbines, clothing...**
- **Procedures, techniques, implementation...**
- **If it can survive Mount Washington, it can survive anywhere!**

Research and Product Testing



Research and Product Testing



Research and Product Testing



Mesonet

- Summit Hourly METAR
 - Wind speed (heated pitot)
 - Wind direction
 - Temp and RH (psychrometer)
 - Max and min temperature
 - Sky cover
 - Precipitation
 - Pressure
 - Visibility



Mesonet

KMWN 040254Z 31078G89KT OSM -SHSN FZFG BLSN VV000 M16/M16 RMK PK WND 32096/18 SHSNB25 VRY LGT ICG
KMWN 040151Z 32079G90KT OSM FZFG VV000 M15/M15 RMK PK WND 31099/31 VRY LGT ICG
KMWN 040053Z 31084G91KT OSM FZFG VV000 M15/M15 RMK PK WND 31095/17 VRY LGT ICG
KMWN 032350Z 32079G88KT 1/16SM FZFG VV000 M15/M15 RMK PK WND 31091/49 VRY LGT ICG 4/024 11133 21155
KMWN 032251Z 31074G80KT 1/16SM FZFG VV001 M15/M15 RMK VRY LGT ICG
KMWN 032155Z 31072G76KT 35SM FEW000 FEW001 FEW005 BKN015 BKN240 M14/M16 RMK VIRGA NW-NE BLSN
FEW000 HZ DSNT ALQDS
KMWN 032057Z 31066G76KT 35SM VCSH FEW000 OVC015 M13/M16 RMK VIS E-SE 1 VIRGA NW-N VCSH N-SE BLSN
FEW000 BINOVC
KMWN 031954Z 30069G79KT 100SM FEW000 SCT005 SCT015 BKN240 M13/M17 RMK CCSL NW-SE BLSN FEW000
KMWN 031859Z 31073G80KT 100SM FEW000 FEW002 SCT005 SCT015 BKN240 M14/M19 RMK PK WND 31090/1759
CCSL N-SE BLSN FEW000
KMWN 031755Z 30078G82KT 100SM SCT000 SCT002 SCT015 BKN240 M14/M18 RMK PK WND 31093/02 BLSN SCT000
4/029 11145 21184
KMWN 031655Z 31086G90KT 100SM SCT000 SCT002 BKN240 M15/M18 RMK PK WND 30096/32 BLSN SCT000
KMWN 031555Z 30071G82KT 1/16SM FZFG BLSN BKN000 M16/M16 RMK PK WND 31087/19 FZFG BKN000 FZFG INTMT
VRY LGT ICG
KMWN 031453Z 30074G83KT 1/16SM FZFG BLSN BKN000 M17/M17 RMK FZFG BKN000 VRY LGT ICG
KMWN 031357Z 30075KT OSM FZFG BLSN VV000 M18/M18 RMK VRY LGT ICG
KMWN 031252Z 30068G76KT OSM FZFG BLSN VV000 M18/M18 RMK PK WND 30089/09 VRY LGT ICG SUN DMPLY VSBL
KMWN 031149Z 00075G85KT OSM FZFG BLSN VV000 M18/M18 RMK PK WND 30091/43 VRY LGT ICG 70042 4/030
11175 21190
KMWN 031057Z 30069G78KT OSM FZFG BLSN VV000 M18/M18 RMK PK WND 30087/01 VRY LGT ICG
KMWN 030953Z 30074G83KT OSM FZFG BLSN VV000 M19/M19 RMK PK WND 30089/30 VRY LGT ICG

Mesonet

- 18 Additional Sites
 - Temperature
 - Humidity
 - Wind Speed
 - CR10X or CR1000 loggers
 - Webcam
 - Radio or wifi data transmission
 - Solar powered
 - 600' asl to 5000'
 - East, south, and west of summit





2006 8 13

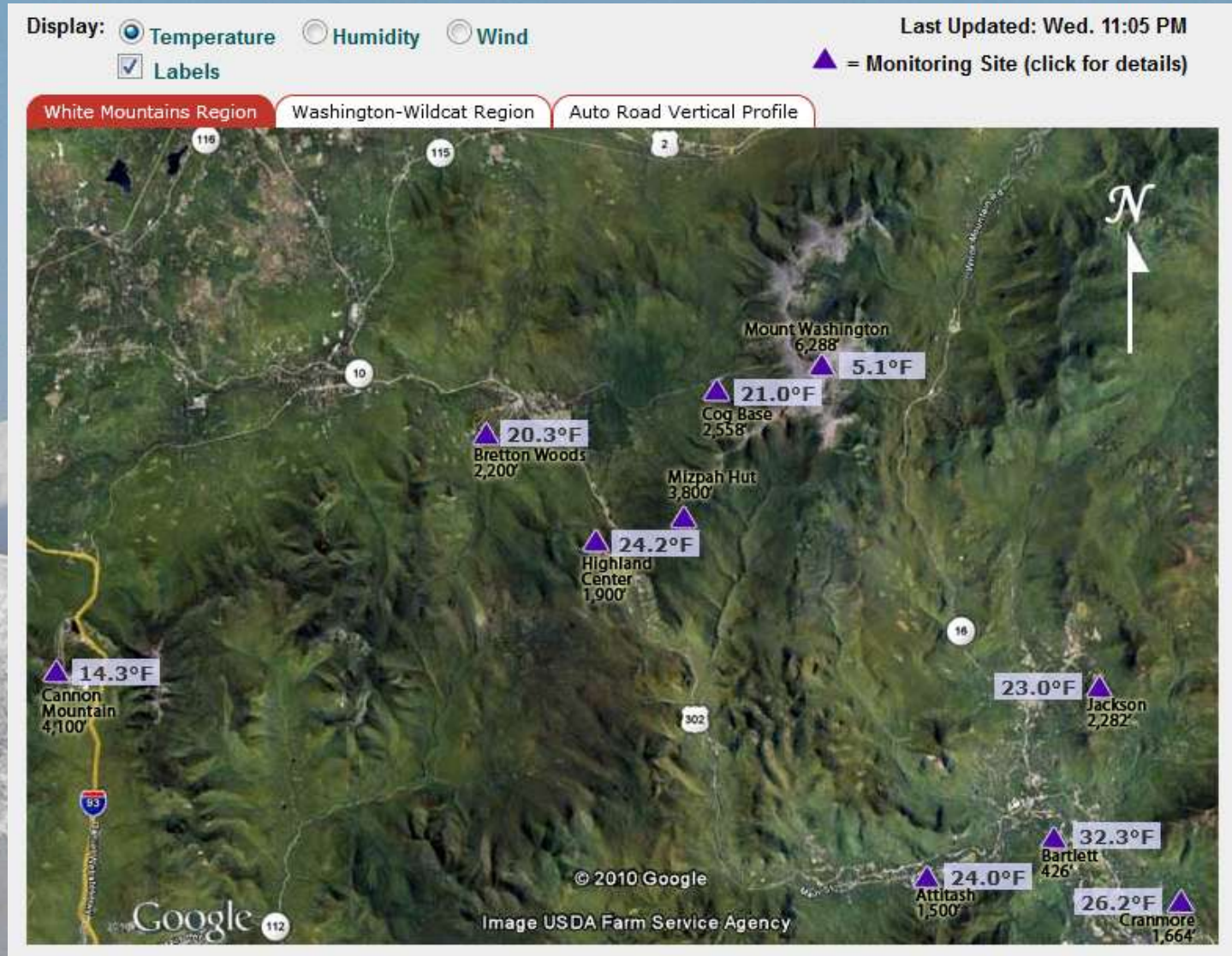






HALF WAY HOUSE
ELEV 4500'

Mesonet



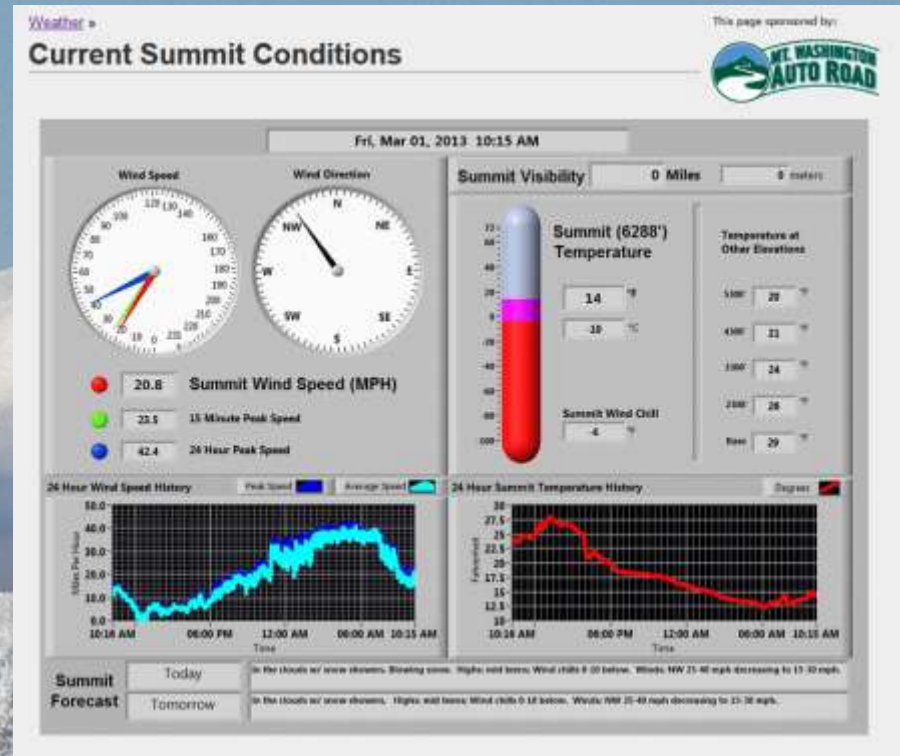
Mesonet

- Auto Road Vertical Profile
 - 6288'
 - 5300'
 - 4300'
 - 4000'
 - 3300'
 - 2300'
 - 1600'
 - Temperature
 - Humidity



Mesonet

- Extreme Conditions: Summit
- Various Conditions: mesonet
- Looking to expand mesonet
- Only WMO Regional Instrument Center (RIC) in the USA



Mesonet



- www.MountWashington.org
 - Weather tab
 - Current Summit Conditions
 - Auto Road Vertical Profile
 - Mesonet
- Research.MountWashington.org
 - Product Testing
 - Research

Conclusion

- Familiar with Mount Washington
- Extreme meteorology (140 mph, -35°F)
- Experienced in testing and research
- Natural Laboratory (we break stuff!)
- Mesonet of 18 weather stations
- Planning 2013-2014 testing now

Questions?



Research and Product Testing

Mesonet Inventory as of 11-30-2012

Mesonet Site	Trango Radio	Deliber-ant Radio	Free wave Radio	Ubiq-uiti Radio	CR100 0 Logge r	CR10 X Logge r	Axis 213 Webca m	Toshiba IK- WB21A Webcam	HMP45	T107	RM Young	Hydrotec h	Ice Detector (Type)	Solar Panels (Qty)	Batteries (Qty)	Router - Firewall	Network Switch	UPS	Tower Mast Tripod
ARVP 2300			X			X			X	X				1	1				TRIPOD
ARVP 3300			X			X			X	X				2	1				TRIPOD
ARVP 4000			X			X			X	X				2	2				TRIPOD
ARVP 4300			X			X			X	X				1	1				TRIPOD
ARVP 5300			X			X			X	X				2	2				TRIPOD
Attitash	X	X			X		X	X	X	X				X(2)	X(8)		X		
Bartlett					X				X	X	X					X	X	X	
Bretton Woods	X				X		X*	X*	X	X	X						X	X	MAST
Cannon		X (2)			X		X*	X*	X	X		X	Rose mount				X		TOWER
Cog Base	X				X				X	X	X						X	X	TOWER
Cog 4500	X				X		X*	X*	X	X	X		Camp bell	X(4)	X(10)		X		MAST
Cranmore	X	X			X				X	X							X	X	
Glen House/Auto Rd		X							X	X						X	X		
Highland Center				X	X				X	X	X							X	MAST
Lakes of the Clouds	X				X				X	X							X		
Mizpah Hut		X			X				X	X									
Jackson	X	X			X		X	X	X	X	X			X(2)	X(3)		X		MAST
Tucks	X				X				X	X	X						X		TOWER
Wildcat	X				X		X	X	X	X	X			X(5)	X(6)		X		TOWER