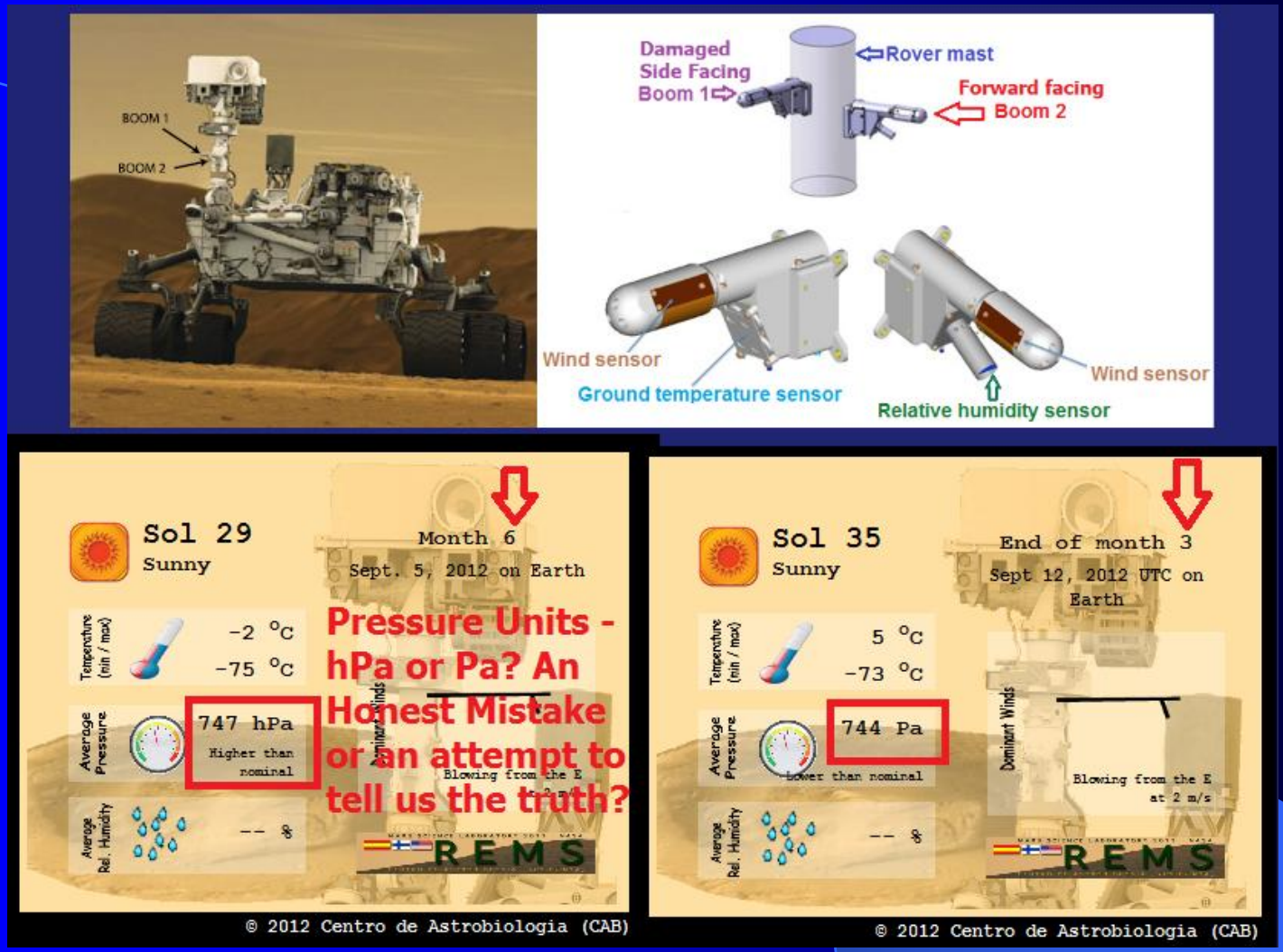
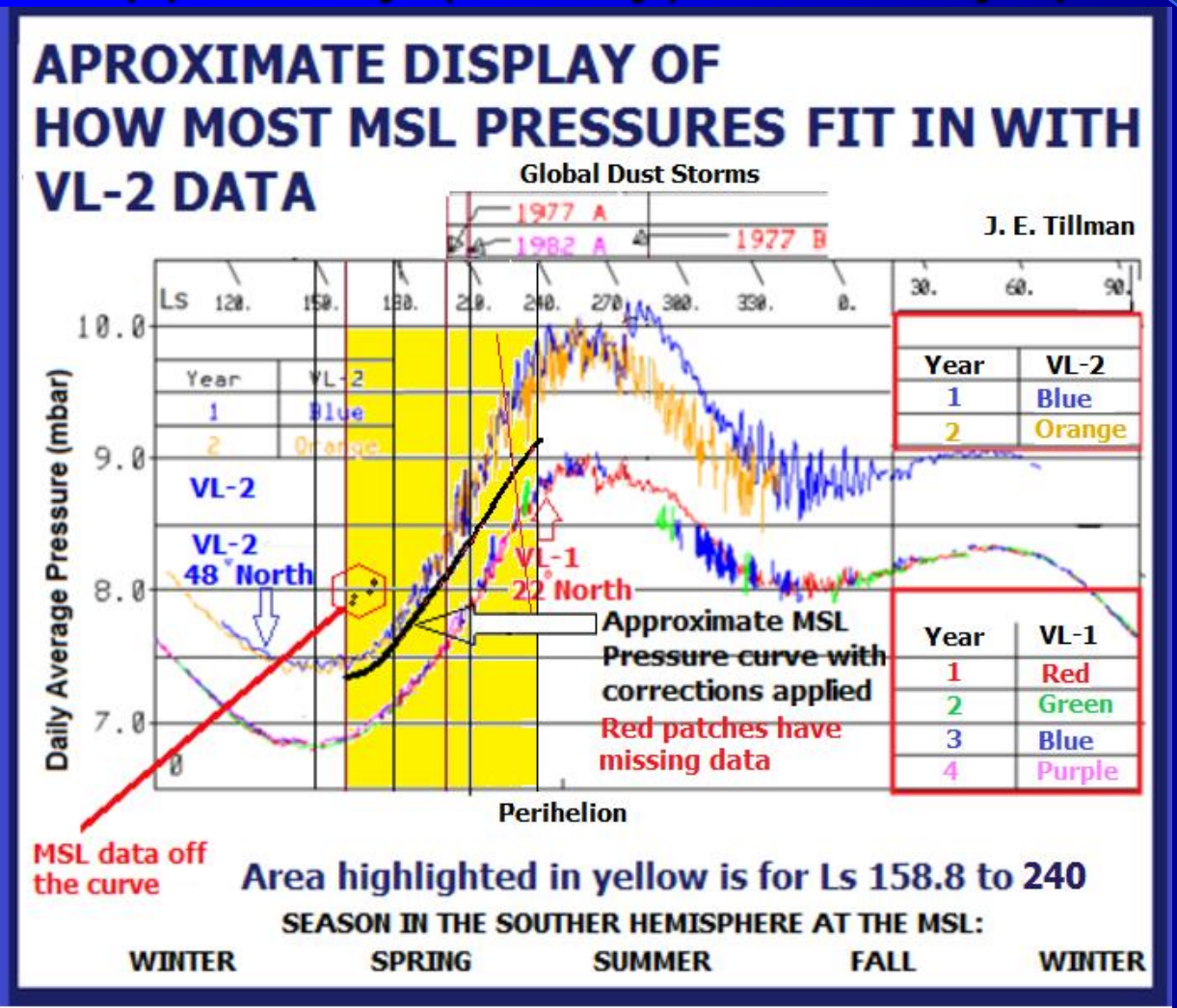
HIGHER THAN ADVERTISED MARTIAN AIR PRESSURE

Part 3: MSL Weather Blunders and Their Implications

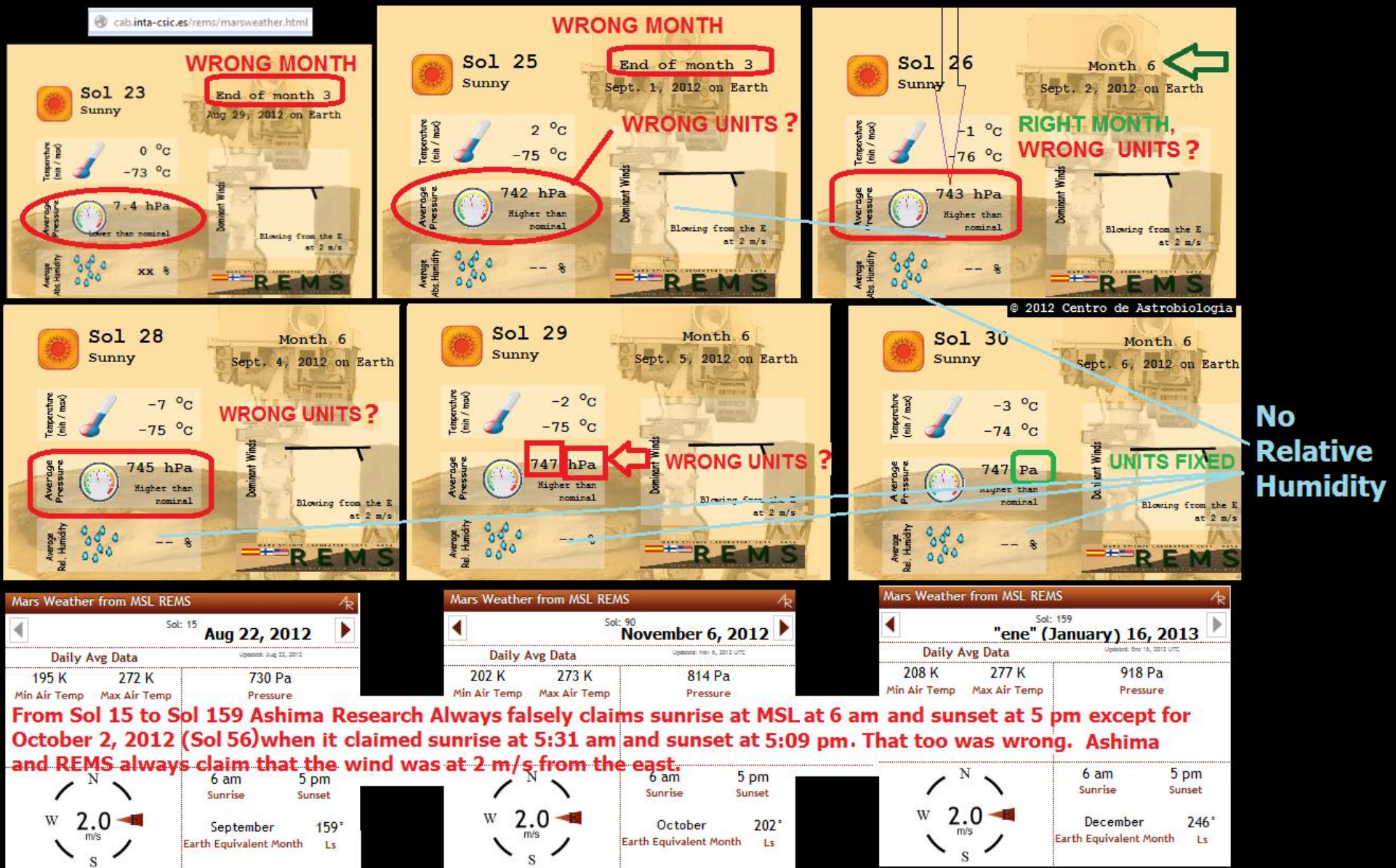


By Barry S. Roffman, Lieutenant, USCG – Retired (January 17, 2013)

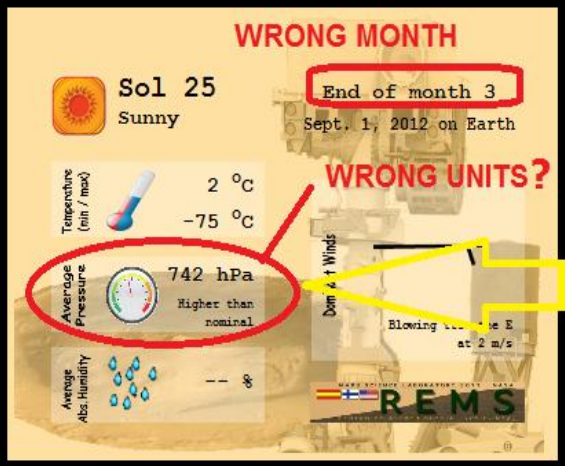
MSL landed at 4,400 m below Mars Areoid, Viking 2 was at -4,495 m, and Viking 1 was at -3,367 m. MSL was expected to feel pressures like VL2, and so far it supposedly (mostly) has. Why question JPL's honesty?



Data Reporting Fiasco

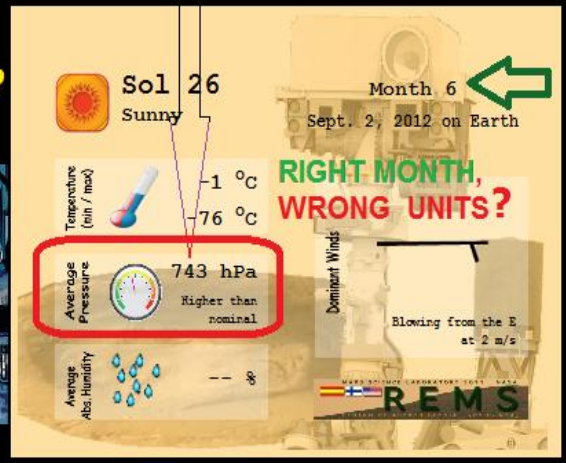


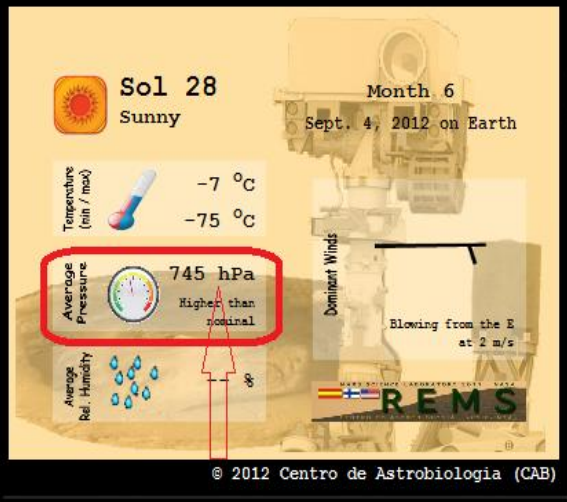
Why Question MSL Pressure? REMS Reported 5 Days of Earth-like Pressure

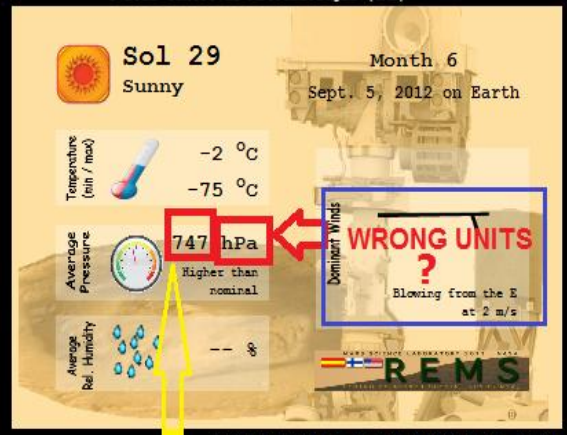


DID MSL LAND AT GALE ON MARS OR VAIL IN COLORADO?

Pressure like Earth at 8,367.8 feet above sea level







Pressure like Earth at 8,192.6 feet above sea level.

Who Is screwing Up the Data?

1. **The Remote Environmental Monitoring (REMS) Station Team at the Centro de Astrobiologia (CAB) in Spain.**

2. Ashima research who works with the REMS Team.

3. **The Finnish Meteorological Institute (FMI) is part of the REMS Team. They designed Vailsala pressure transducers for Phoenix and MSL.**

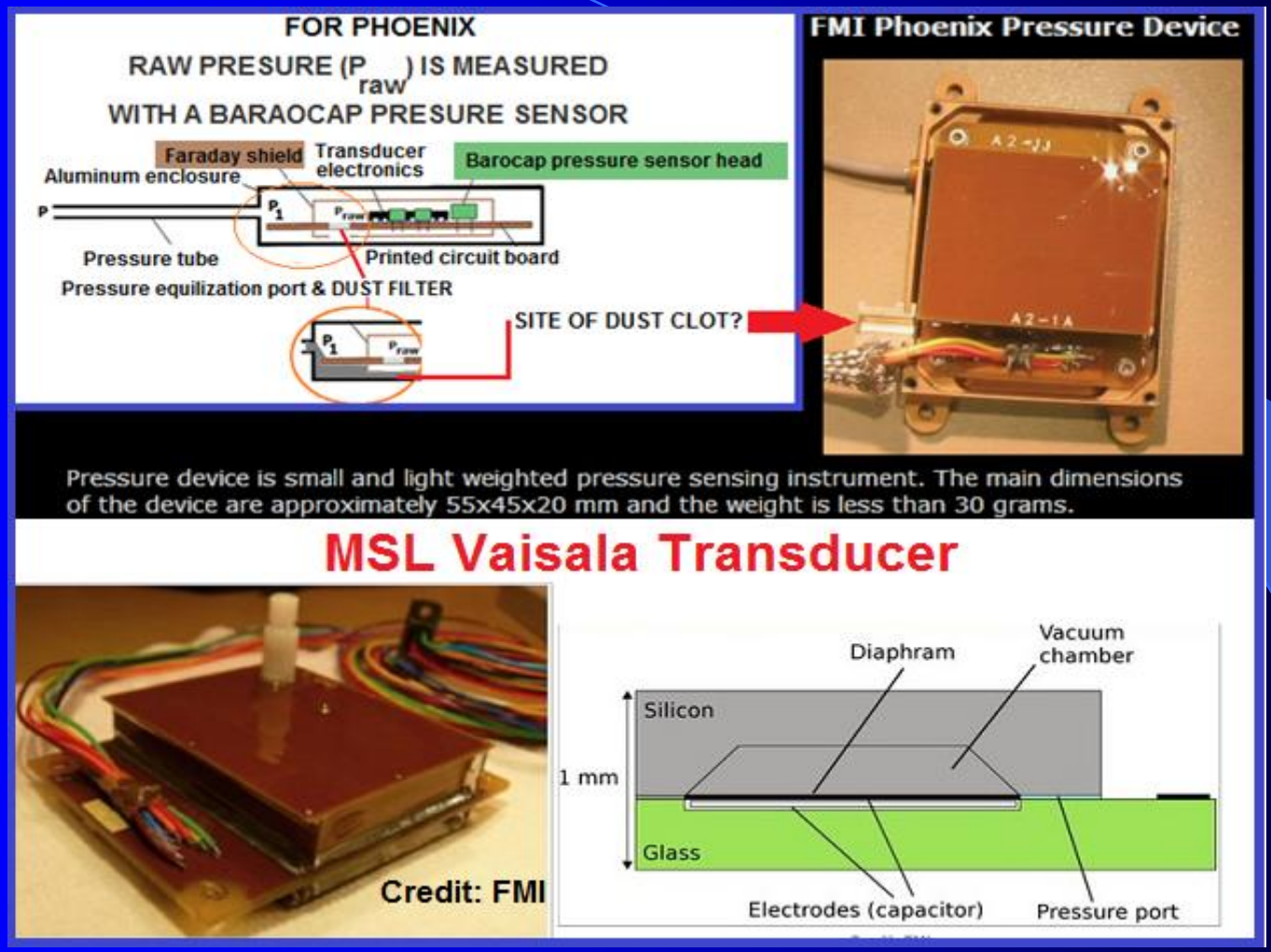
Finnish Meteorological Institute

VAISALA

4. **JPL – Who has been informed of all errors and who has chosen to largely let them pass.**

NASA JPL

FMI knew something was wrong & protested.



An FMI report (2009) states, *"We should find out how the pressure tube is mounted in the spacecraft and if there are additional filters etc."* FMI designed the sensor.

International Traffic in Arms Regulations (ITAR)

- *"After Phoenix landed it appeared that the actual thermal environment was worse than the expected worse case…* ***Information on re-location of the heat source had not been provided initially due to ITAR restrictions."*** (Taylor, P.A., et al, 2009)

International Traffic in Arms Regulations (ITAR)

"That we at FMI did not know how our sensor was mounted in the spacecraft and how many filters there were shows that the exchange of information between NASA and the foreign subcontractors did not work optimally in this mission!"

(Kahanpää [FMI]
Personal communication,
December 15, 2009)

REMS reporting efforts have been pathetic. REMS confused hPa and Pa Pressure units and months on Mars.

www-mars.lmd.jussieu.fr/mars/time/martian_time.html

Earth Date and Time

Date Year / Month / Day	UTC Time (hh:mm:ss)
2012 / 8 / 29	5 : 17 : 57

Some shortcuts to (re-)set Date to: Today

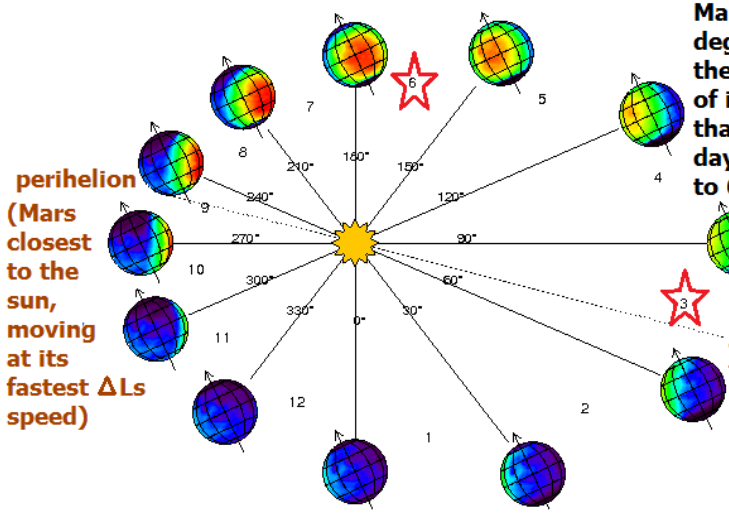
Use landing dates of: Curiosity, Phoenix, Opportunity, Spirit, Beagle 2, Pathfinder, Viking Lander 2, Viking Lander 1, Mars 6, Mars 3, Mars 2

Some shortcuts to (re-)set Time to: 00:00:00, 06:00:00, 12:00:00, 18:00:00, now (UTC)

Earth date above corresponds to Julian Date: 2456168.7207

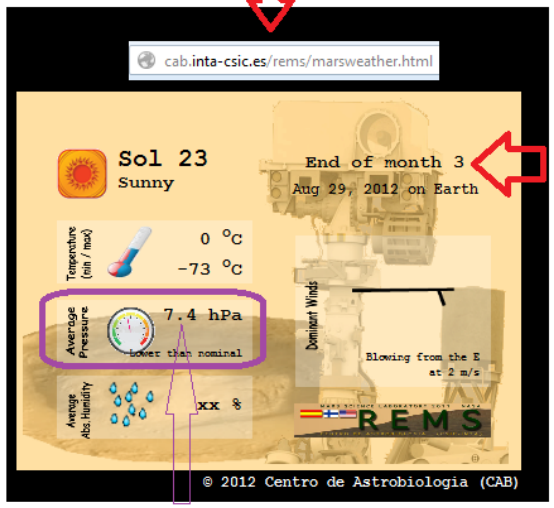
Convert Earth Date and time to Martian Date and Solar Longitude

Martian Year:	31	Martian Month:	6
Solar longitude Ls:	162.6	Sol number:	342

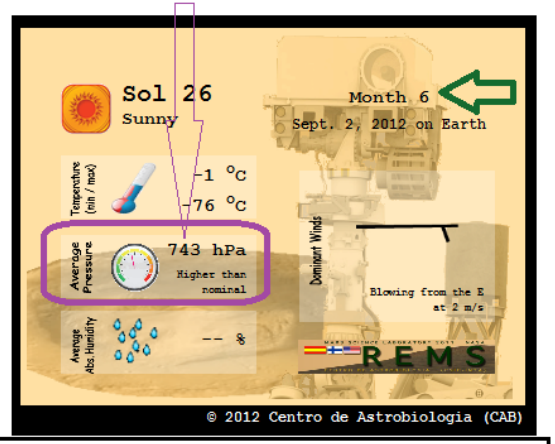


Mars moves 30 degrees around the sun for each of its 12 months that vary from 46 days (Month 8) to 66 days (Months 2 and 3)

cab.inta-csic.es/rems/marsweather.html



REMS Incorrectly labelled the month on Mars as 3 until I pointed out the problem to JPL's Guy Webster.

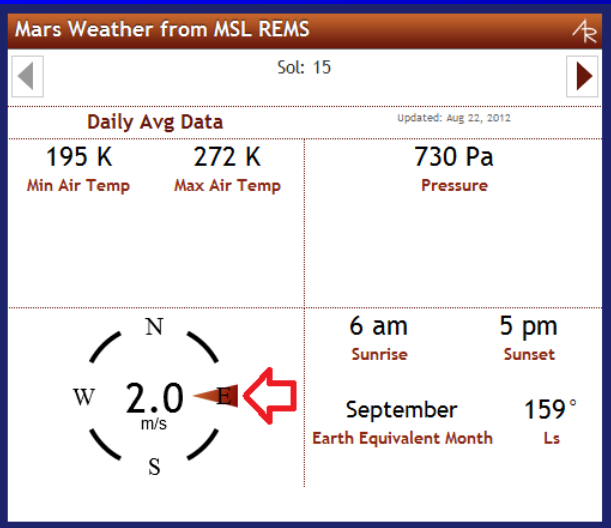


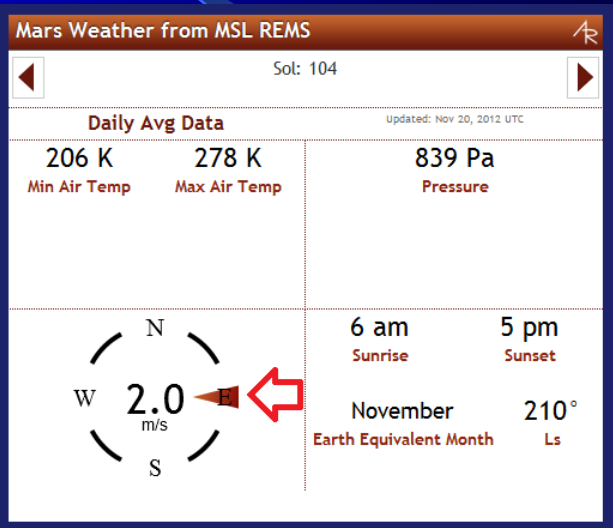
The month was then corrected to 6.

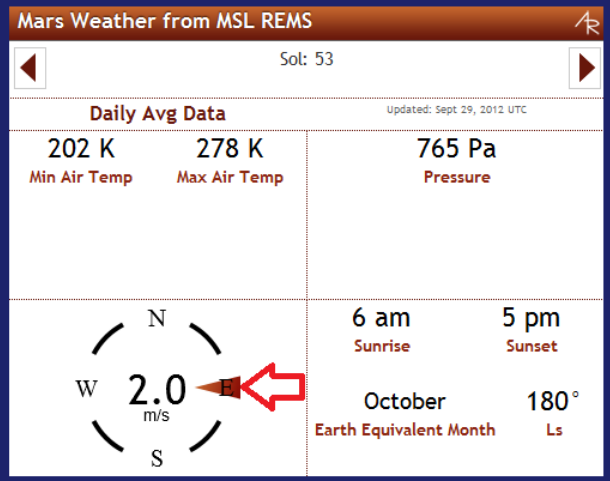
However REMS next apparently confused units for pressure, using hPA for Pa.

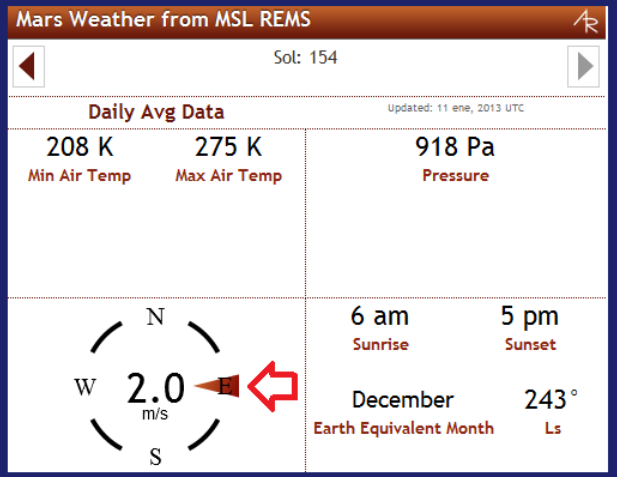
100 Pascals (Pa) = 1 Hecto Pascal (hPa) and 1 hPa = 1 mbar

REMS & Ashima always report wind at MSL at 2 m/s from the East with no variation ever. This is unrealistic.

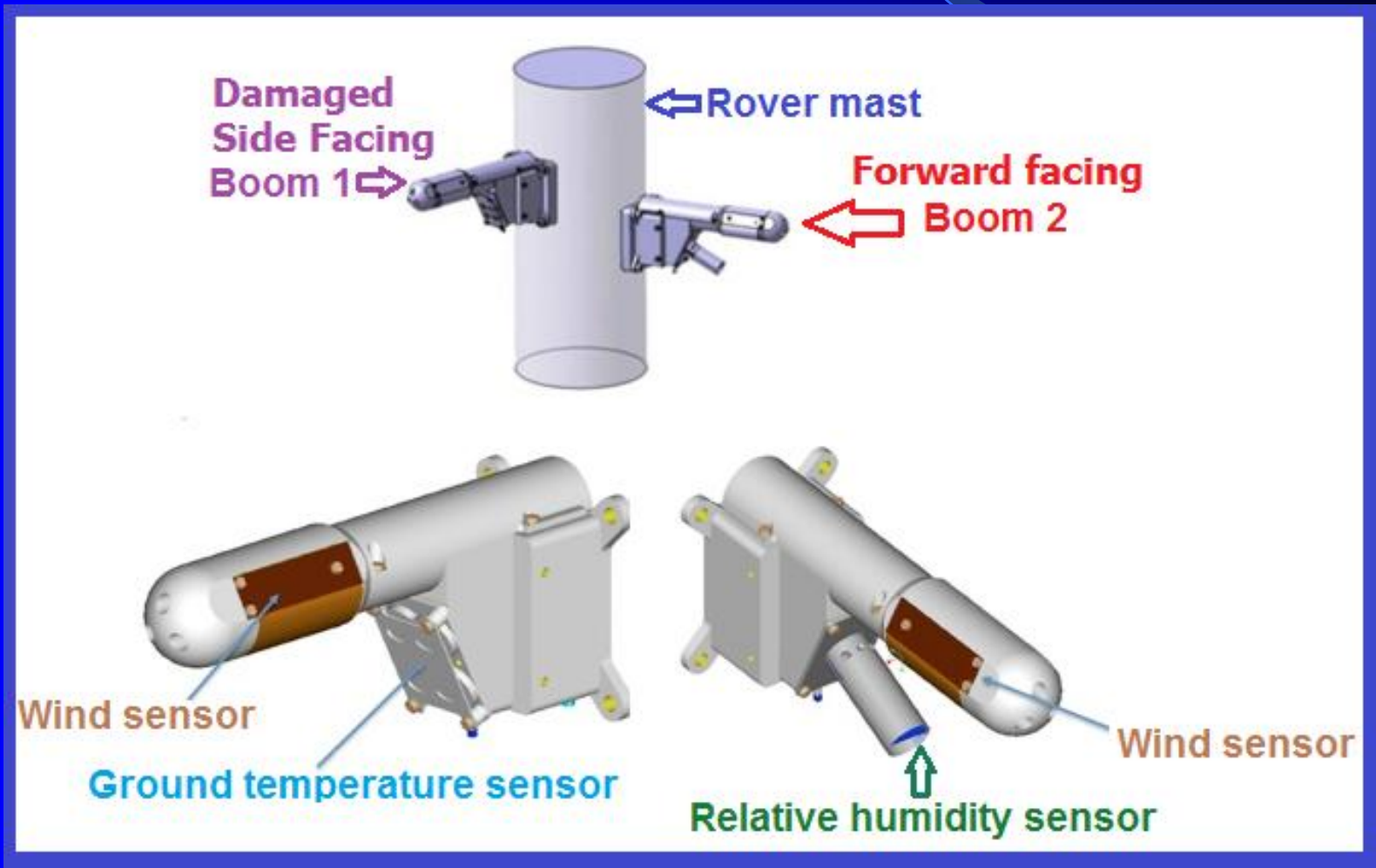








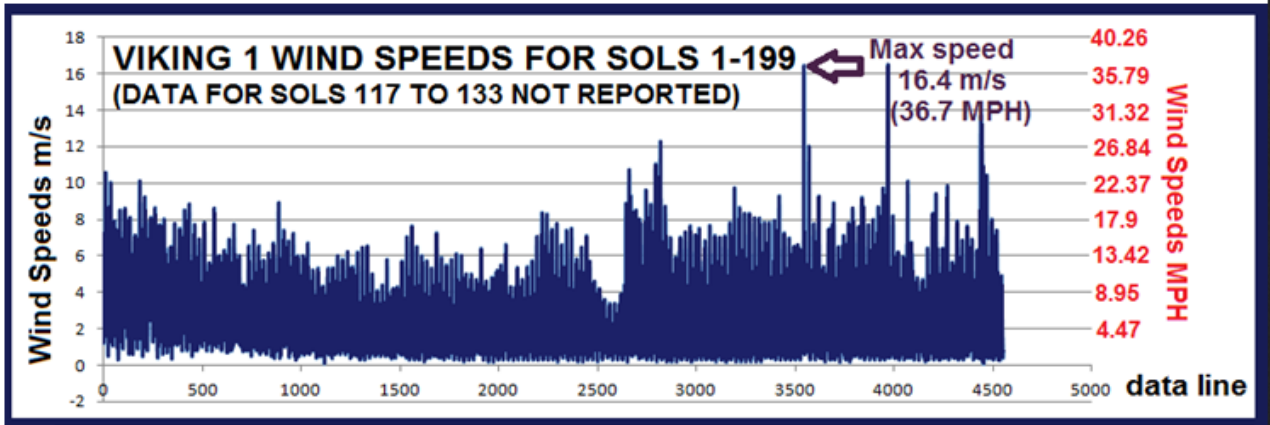
One of the REMS Booms broke on Landing. It would have been more honest to list winds as *Not Available*.

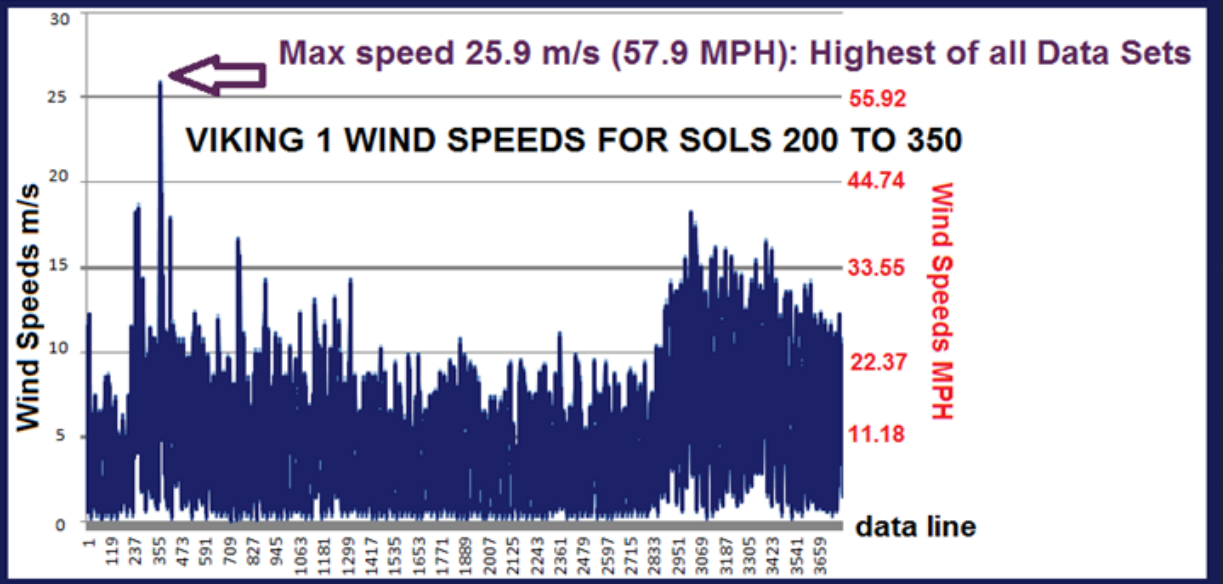


We know from the Vikings that there is an enormous amount of variation in winds.

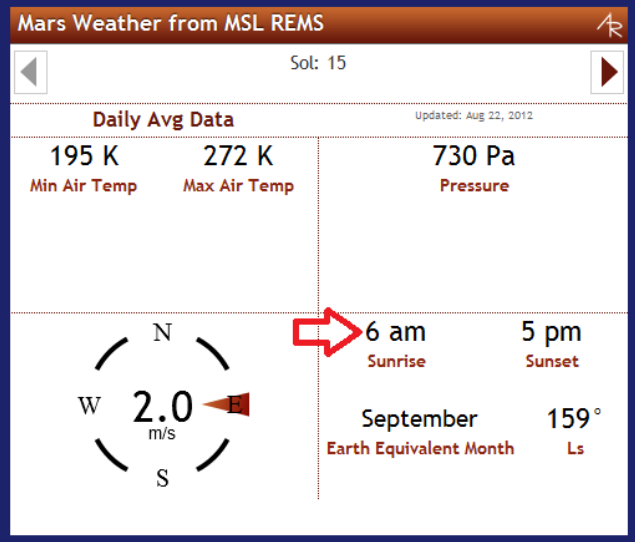
VL-1 SOL	LS`	Wind direction	Wind Speed M/S	Wind Speed MPH
214.38	210.621	290	1.2	2.68
214.42	210.646	249	2.6	5.82
214.46	210.671	254	4.6	10.29
214.5	210.696	283	7.6	17.00
214.54	210.721	305	9.4	21.03
214.58	210.746	331	19.9	44.52
214.62	210.771	343	22.5	50.33
214.66	210.796	356	22.6	50.55
214.7	210.821	6	21.2	47.42
214.74	210.847	19	17.8	39.82
214.78	**210.872**	**19**	**25.9**	**57.94**
214.82	210.897	24	25.2	56.37
214.86	210.922	25	18.8	42.05
214.9	210.947	29	13.8	30.87
214.94	210.972	33	9.2	20.58
214.98	210.997	355	4.9	10.96

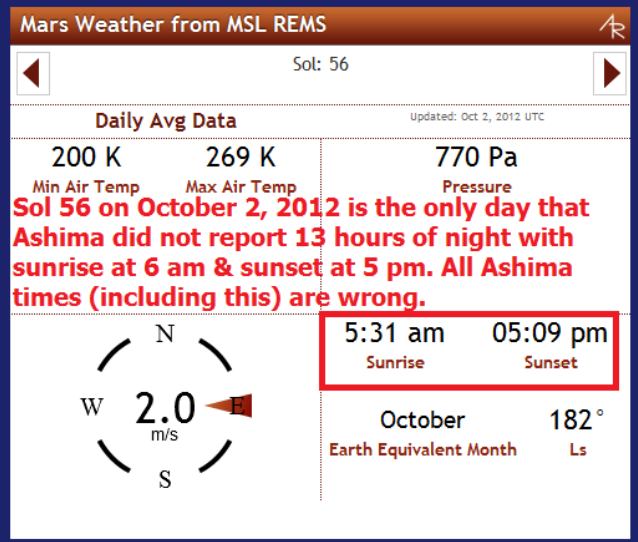
Profile of the windiest Viking day on Mars with the greatest wind gust recorded at VL-1 sol 214.78.

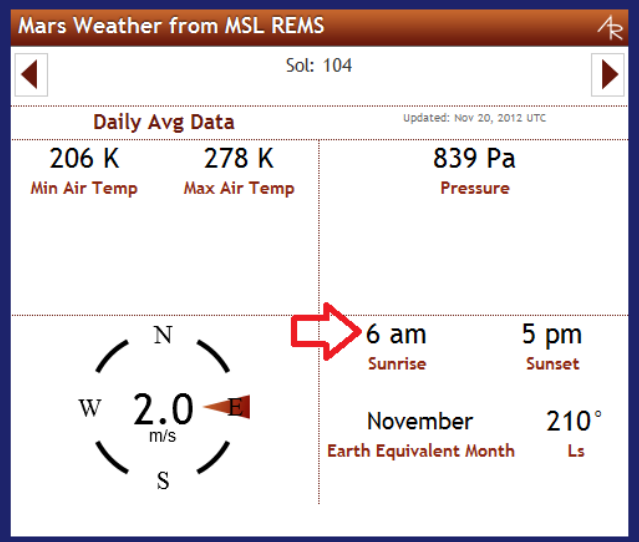


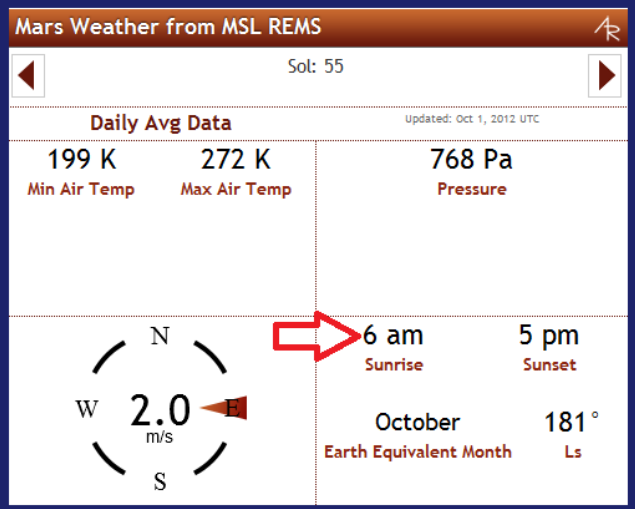


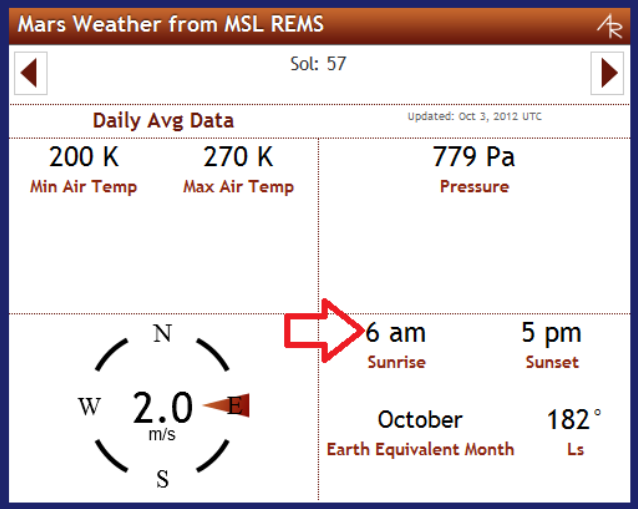
Ashima most obviously published known errors about sunrise and sunset times.

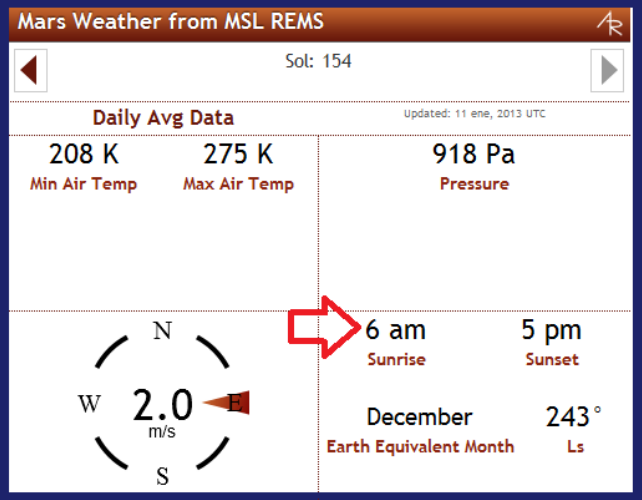












This kind of disinformation raises concerns about basic competence.

MARS CURIOSITY LATITUDE AT GALE CRATER
4.59° S

TILT OF EARTH'S AXIS = 23.44°

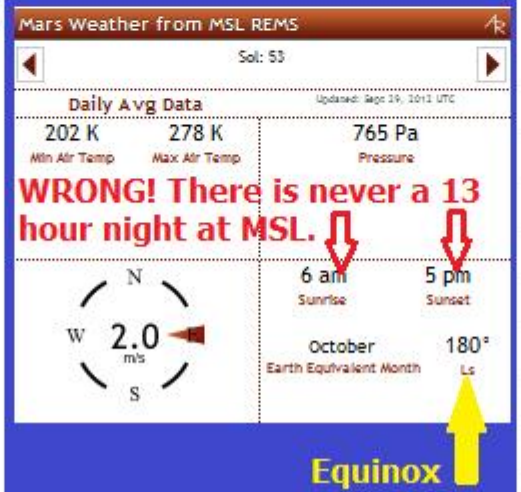
TILT OF MARTIAN AXIS = 25.19°

SUNRISE AND SUNSET TIMES FOR MARS TIMES SHOULD VARY IN A MANNER SIMILAR TO JAKARTA.

This is how sunrise and sunset time vary at cities with similar latitudes on Earth (12/26/2012)

MOMBASA KENYA LATITUDE
4.0500° S

Date	Sunrise	Sunset	Length	Change
Today	06:11	18:33	12:22	
+1 day	06:12	18:33	12:21	00:01 shorter
+1 week	06:15	18:36	12:21	00:01 shorter
+2 weeks	06:18	18:39	12:21	00:01 shorter
+1 month	06:25	18:43	12:18	00:04 shorter
+2 months	06:29	18:41	12:12	00:10 shorter
+3 months	06:24	18:30	12:06	00:16 shorter
+6 months	06:28	18:21	11:53	00:29 shorter



JAKARTA, INDONESIA LATITUDE: 6.1333 ° S

Date	Sunrise	Sunset	Length	Change
Today	05:39	18:08	12:29	
+1 day	05:39	18:08	12:29	00:00 equal length
+1 week	05:42	18:11	12:29	00:00 equal length
+2 weeks	05:46	18:14	12:28	00:01 shorter
+1 month	05:53	18:17	12:24	00:05 shorter
+2 months	05:58	18:13	12:15	00:14 shorter
+3 months	05:56	18:01	12:05	00:24 shorter
+6 months	06:03	17:49	11:46	00:43 shorter

Notes: *Daylight saving time*

We notified JPL and Ashima that there could not be only 11 hours of daylight at MSL. Finally we did the math. There is as much as 12 hours 19 minutes of daylight and little as 11 hours 43 minutes.

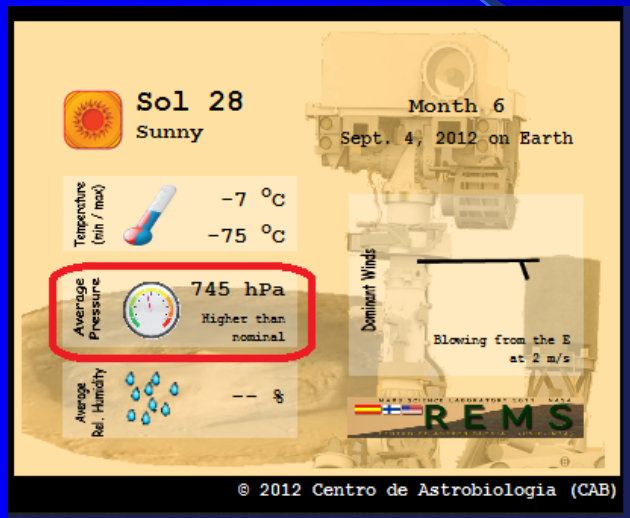
	A	B	C	D	E	F	G	H	I
1	λsun	Latitude			Day Length =	Daylight	Half Sol	difference	DAVID'S
2	(0 for spring	(phi)	δdegrees =	H = arccos((SIN(-.17) - SIN(lw)*SIN(δ))/(COS(lw)*COS(δ)))	2*1.027491*H/360	In Hours	in Hours	Half day -	Mars
3	in northern		arcsin((sin(25.19)*sin(λsun))			David's		Daylight	Daylight
4	hemisphere)					Calculation		(G-F)	Hours
5	(Ls)					(=E value * 24)			
6	0	-4.59	0	90.17054697	0.51471903	12.35325673	12.3299	0.0233617	12:01.4
7	150	-4.59	12.28711642	89.17267137	0.509022874	12.21654897	12.3299	-0.113346	11:53.2
8	180	-4.59	2.98768E-15	90.17054697	0.51471903	12.35325673	12.3299	0.0233617	12:01.4
9	210	-4.59	-12.28711642	91.17647243	0.520461138	12.49106731	12.3299	0.1611723	12:09.7
10	240	-4.59	-21.62923453	92.00779835	0.525206582	12.60495796	12.3299	0.275063	12:16.5
11	270	-4.59	-25.19	92.35267298	0.527175224	12.65220537	12.3299	0.3223104	12:19.3
12	300	-4.59	-21.62923453	92.00779835	0.525206582	12.60495796	12.3299	0.275063	12:16.5
13	330	-4.59	-12.28711642	91.17647243	0.520461138	12.49106731	12.3299	0.1611723	12:09.7
14	0	-4.59	0	90.17054697	0.51471903	12.35325673	12.3299	0.0233617	12:01.4
15	30	-4.59	12.28711642	89.17267137	0.509022874	12.21654897	12.3299	-0.113346	11:53.0
16	60	-4.59	21.62923453	88.35931782	0.504380021	12.10512051	12.3299	-0.2247745	11:46.5
17	90	-4.59	25.19	88.02453664	0.502468995	12.05925589	12.3299	-0.2706391	11:43.8
18	120	-4.59	21.62923453	88.35931782	0.504380021	12.10512051	12.3299	-0.2247745	11:46.5

There is never a day at MSL with only 11 hours of daylight and with 13 hours of darkness.

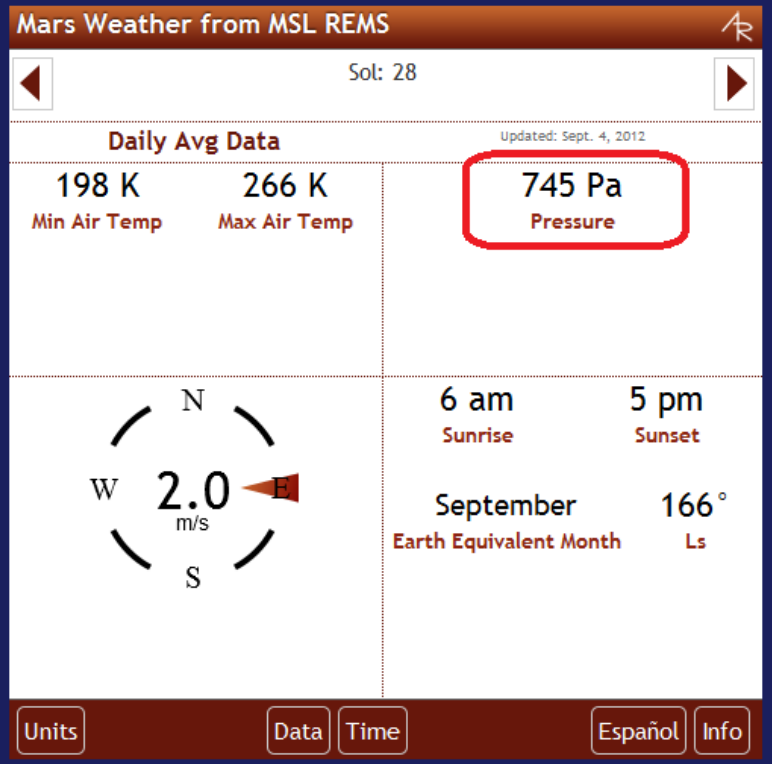
Best estimate of the length of daylight at MSL (4.59 South on Mars)

Attitudes at Ashima

- **After someone asked, "Where was I when Mars was terraformed?," Ashima changed their record of pressures for September 1 to 5 from 742 to 747 hPa to 742 to 747 Pa (7.42 to 7.47 hPa). They kept all other REMS mistakes on the Ashima site.**



Ashima publishes a correction of a REMS pressure of 745 hPa, making it 745 Pa. This correction matches expectations, but it doesn't explain Martian weather.



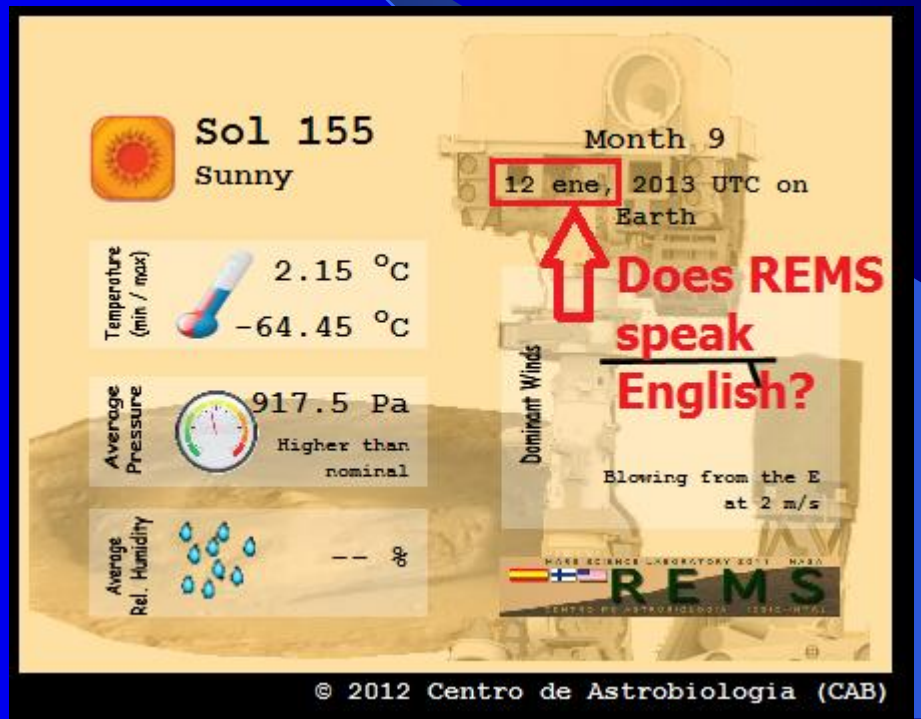
Attitudes at Ashima

- **Never acknowledged any suggestion for improvement after the first week in September 2012.**
- **Deleted all blogs by me and others asking hard questions or offering corrections to errors published.**
- **Continued to publish clearly wrong sunrise and sunset data for at least 5 months.**

Attitudes at REMS

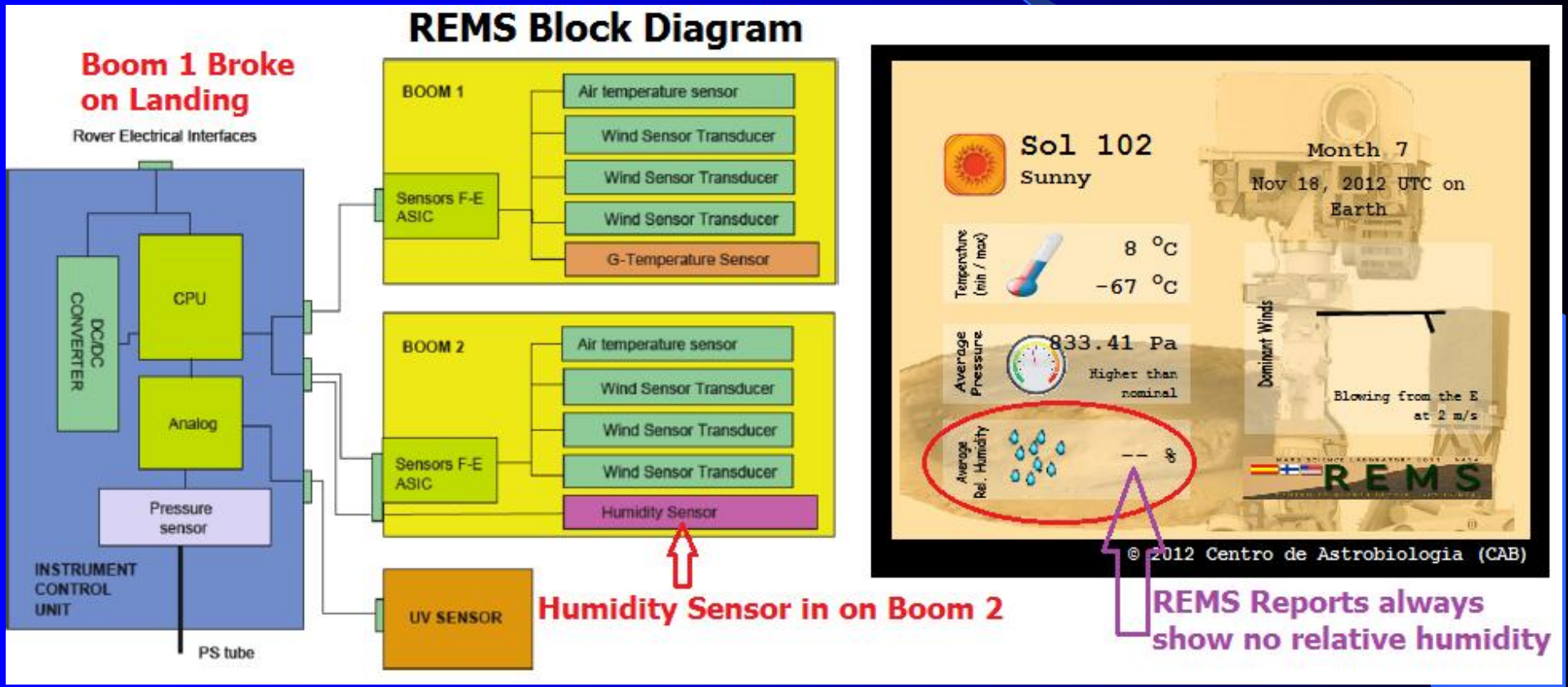
- **Seems oblivious to mistakes pointed out.**

- **May have a real problem understanding English. In January, 2013 its "English" reports started having abbreviations for the month that read "ene" (a Spanish abbreviation for Enero (January).**



REMS Relative Humidity Sensor

If only Boom 1 broke on Landing, why do we never see relative humidity reported from Boom 2?

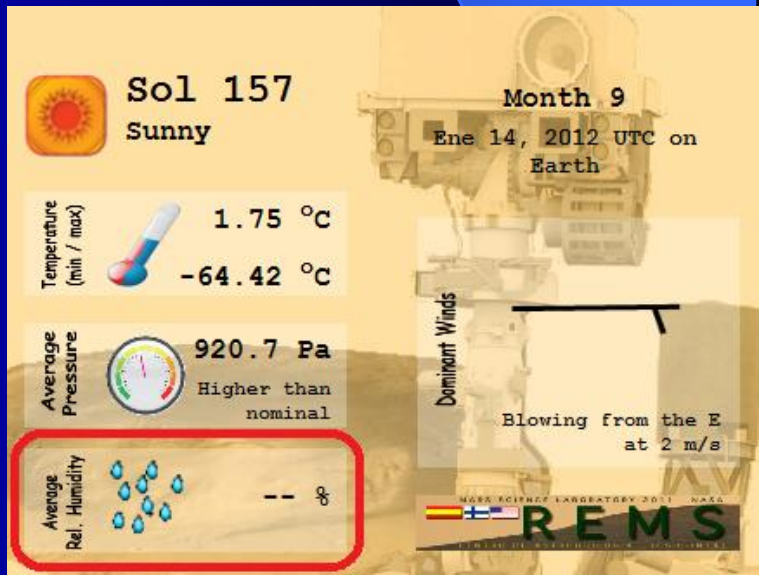


Ashima on the Relative Humidity Sensor:

August 31st, 2012 at 4:38 pm

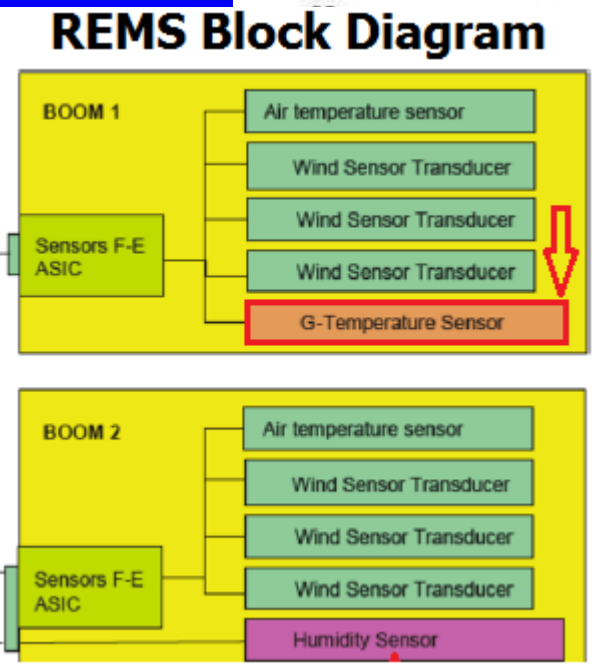
The humidity sensor is working great and has no problem that I know of. The data haven't been "pushed" yet since the team at FMI is currently in the process of getting the calibration and characterization done – some numbers have been pushed out from CAB, but my sense is that these are very preliminary and one should not be surprised if they change quite a bit after the FMI team pushes a "certified" data product.

REALITY: As of January 14, 2013 REMS still publishes no relative humidity data.



Questionable JPL Ground Temperatures

Boom 1 broke on landing & only it could measure ground temperature, so how can JPL publish MSL ground temperatures at http://mars.jpl.nasa.gov/msl/images/PIA16081_gomez3-br2.jpg ?



About 1/3 of REMS and Ashima Daily Reports are numbered wrong, out of sequence when comparing terrestrial dates with Martian Sols, or missing entirely. Do they know how to count?

DATE	SOL	DATA BELOW TAKEN FROM THE ASHIMA AND REMS SITES
23-Aug	16	
25-Aug	19	2 days forward, 3 sols forward.
29-Aug	23	
28-Aug	22	right info, wrong order
1-Sep	25	Data days Aug 28, 29, (missing 30 and 31) and Sep 1 (5 days), Sols over period 22, 23, 24 (missing) and 25 (4 Sols)
1-Sep	25	Same date and Sol, but different pressure & temperature. Ls changes from 165 to 162 (too much and wrong way).
9 Sep	33	Missing Sol 33, but spacing is correct.
11-Sep	35	
12-Sep	35	Same Sol number as 11 Sep
13-Sep	37	Sol number consistent with 11 Sep.
11-Oct	65	Ls 186
11-Oct	66	Ls 187, 2 days in a row 11 Oct
13-Oct	67	Ls 187. This date and Ls is consistent with the 1st 11 Oct.
15- Oct	70	15 Oct and Sol 69 missing
20-Oct	74	
22-Oct	75	Date changes by 2, Sol by 1.
23-Oct	76	
5-Nov	89	4 Nov and sol 88 missing. Ls 202.

DATE	SOL	DATA BELOW TAKEN FROM THE ASHIMA AND REMS SITES
8-Nov	92	
10-Nov	89	2 days forward, 3 sols back? Ls 205, Pressure 8.22 hPa
11-Nov	89	Ls 205 (third Sol 89). Pressure 8.16 hPa
12-Nov	96	1 day forward, 7 sols forward. Ls 205, Pressure 8.27 hPa
18-Nov	102	Nov 16 & 17, Sols 100 and 101 missing.
20-Nov	104	Nov 19, Sol 103 missing.
25-Nov	108	Nov 21 (Sol 105), 22 (Sol 106), 23 (Sol 107) and 24 (Sol 108) Missing. Nov 25, shown as Sol 108 should be Sol 109. Both Ashima and REMS report Sol 108 as November 25. Sol 109 and 110 missing.
28 Nov	111	Missing.
Nov 29	111	
1 Dec	113	LATER SOL 144 WAS ALSO LABELED AS DEC 1
2 Dec	114	
2 Dec	115	
9 Dec	122	No report
23 Dec to 29 Dec	136 to 143	No reports – Vacation?

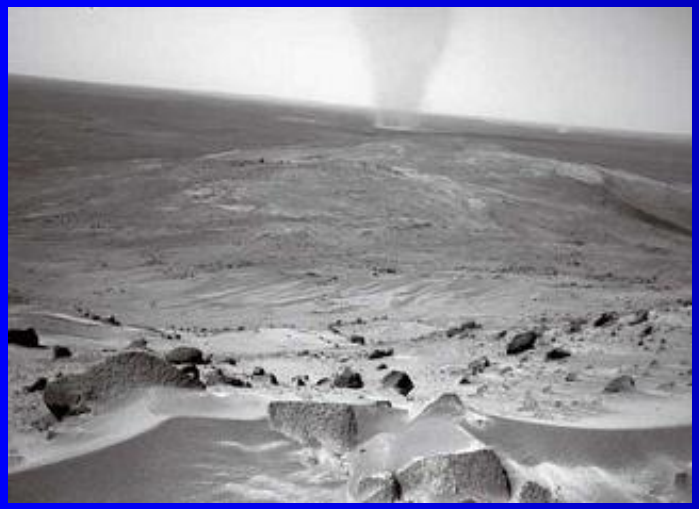
DATE	SOL	DATA BELOW TAKEN FROM THE ASHIMA AND REMS SITES
31 Dec	144	A SECOND REPORT LABELED SOL 144 WAS DATED DEC 1, BUT PRESSURE DROPPED ON IT TO 851 FROM 907 HPA.
1 Jan	145	No reports
2 Jan	146	Date labeled as ene (Spanish for January). All January reports now use ene for the month.
3 Jan	147	No reports
4 Jan	148	No reports
5 Jan	149	No reports
6 Jan	149	Should be sol 150
7 Jan	150	
8 Jan	150	
9 Jan	152	
12 Jan	155	
12 Jan	156	
14 Jan	157	

So what aspects of MSL Weather Reports are known to be flawed?

1. Sunrise and Sunset Times by Ashima.
2. Constant winds from the east at 2 m/s.
3. Relative Humidity.
4. Sol numbering.
5. Early month labeling (3 vs. 6).
6. Ground temperatures issued when the sensor measuring them was broken.
7. Pressure units used in September, 2012 (confusion by REMS between hPa and Pa) and pressures off the curve in August.

Now that we know JPL can publish nonsense, let's review why we should also question accepted Pressure.

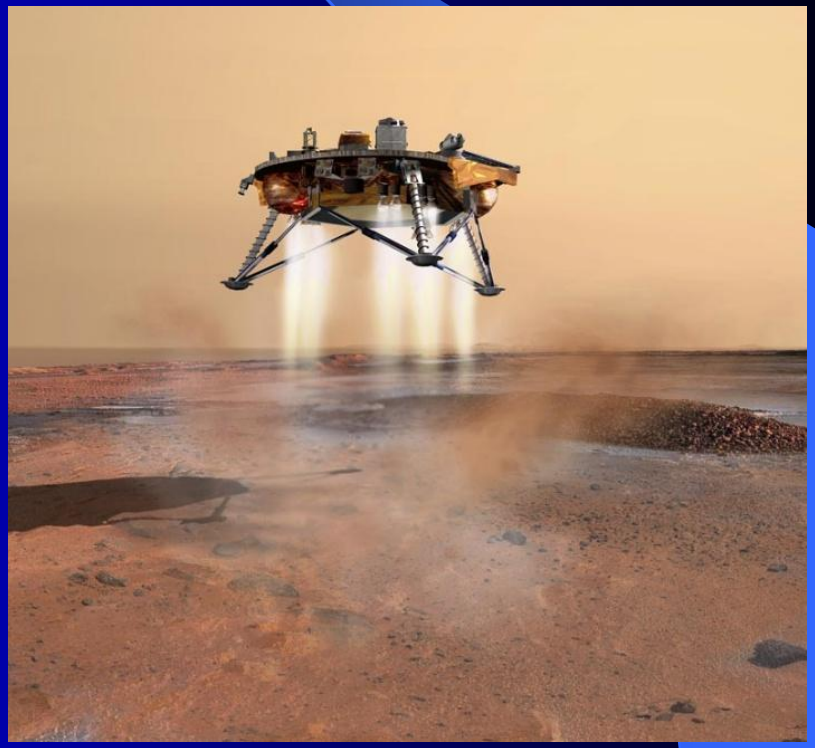
- **Similarities in Martian & Terrestrial dust devils.**



http://www.lpl.arizona.edu/~lemmon/mer_dd/dd_enhanced_587a.gif

DUST DEVILS ARE THE MOST OBVIOUS WEATHER ANOMALY

- If there is so little air on Mars, how can there be enough Δp to generate them at all?



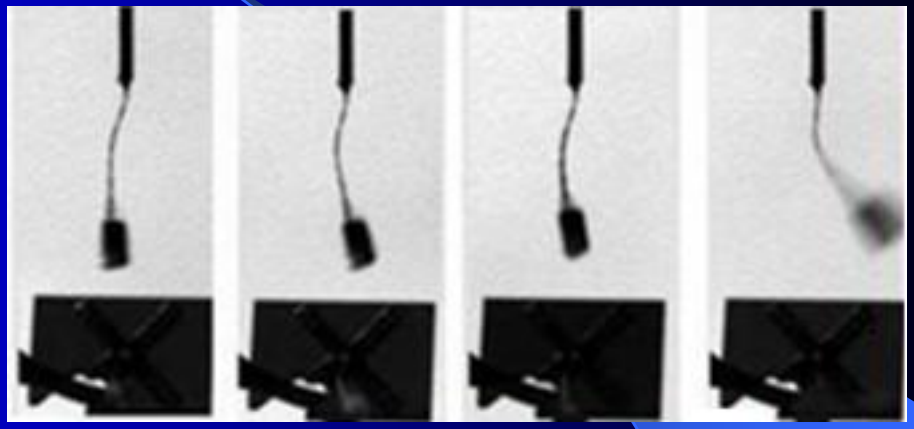
- Over 30 dust devils hit the Phoenix lander in just 150 days.

  Pathfinder detected ~79 in 86 days.

Why Question Accepted Pressure?

Mars dust devils typically have speeds of 6m/s (~13 MPH), but during an Ames experiment at 10 mbar, a wind speed of 70 m/s (~156 MPH) was needed to form a dust devil.

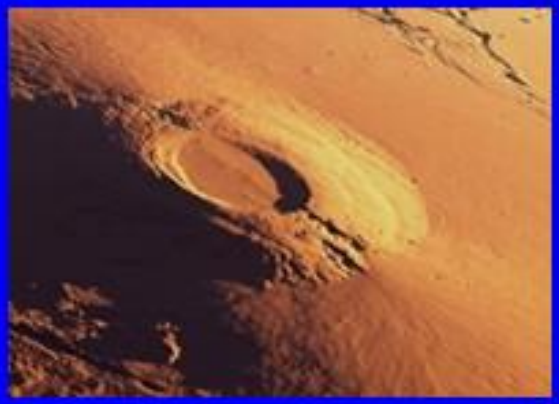
Similarities between Terrestrial and Martian Dust Devils



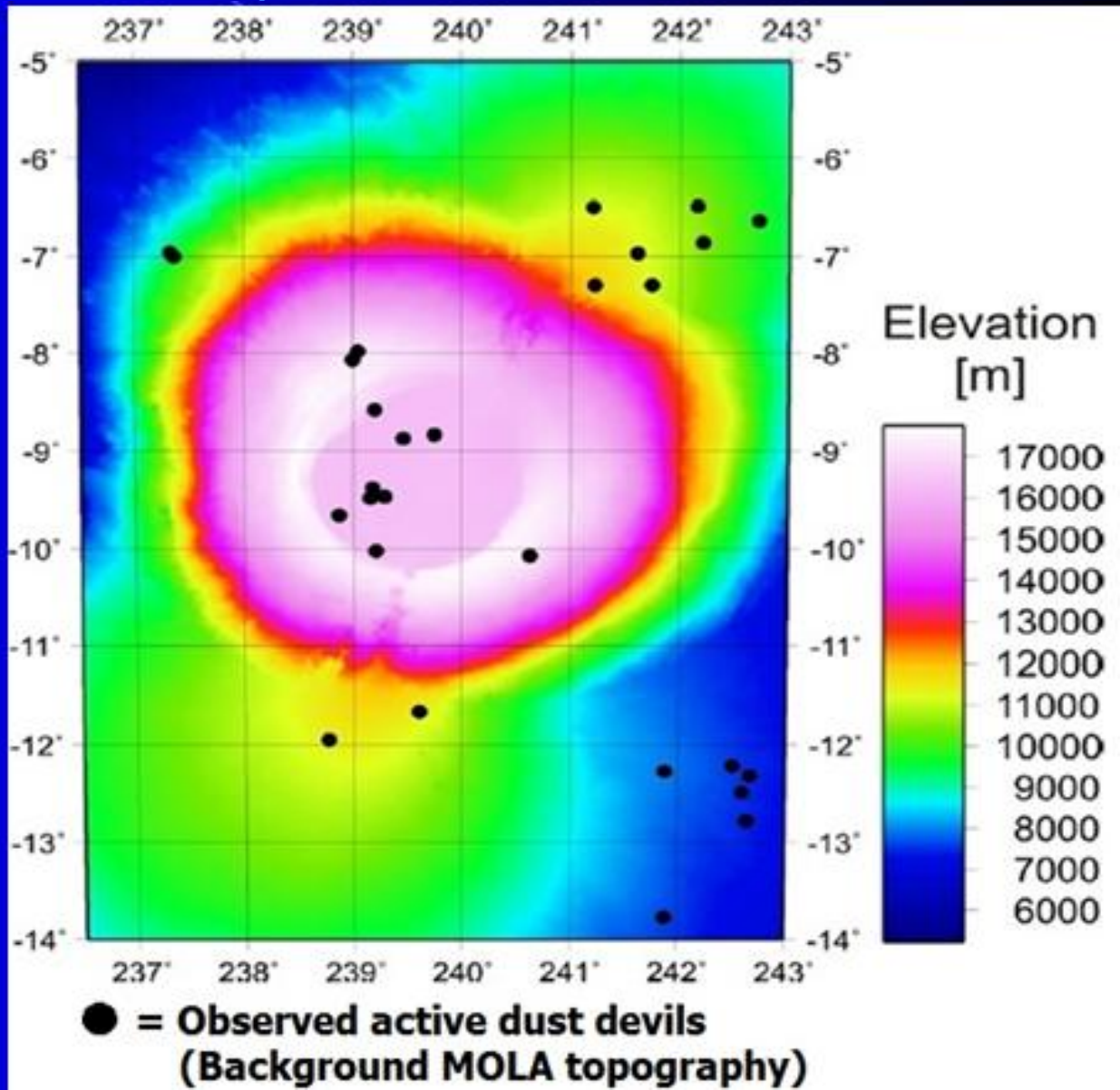
- dust particle size (1 μm typical). But with low 6.1 mbar pressure, 500 m/s (1,118 mph) wind required to lift 1 μm dust. (Read & Lewis, 2004)

Why Question Accepted Pressure?

Dust devils on Mars even form at 17 km on Arsia Mons.



Pressure there should be only about 1 mbar!



Why Question Accepted Pressure?

- **No way to change small dust filters on Vikings, Pathfinder, Phoenix, or MSL. Rapid clogging is likely.**

DIME SURFACE AREA = ~251.9 mm^2

TAVIS DUST FILTER FOR VIKING = ~40 mm^2

TAVIS DUST FILTER FOR PATHFINDER= ~ 3.14 mm^2

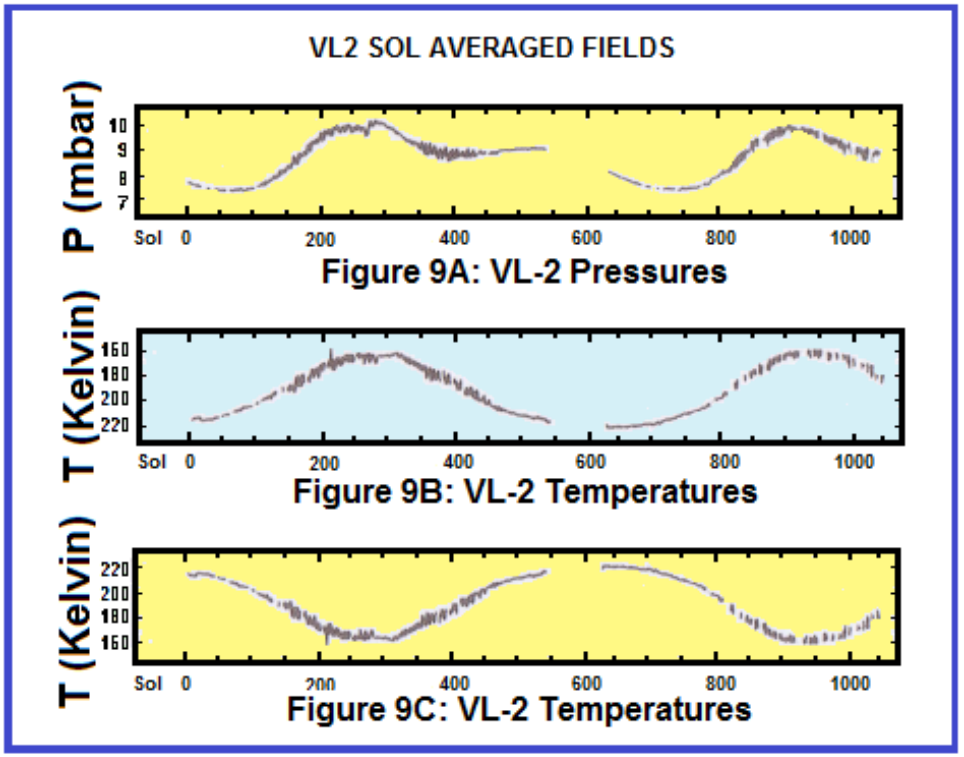
VAISALA DUST FILTER FOR PHOENIX OR MSL = ~10 mm^2

Only Viking-2 provided published pressure data for over a Martian year

Figures 9A and 9C show that as temperature fell pressure recorded rose.

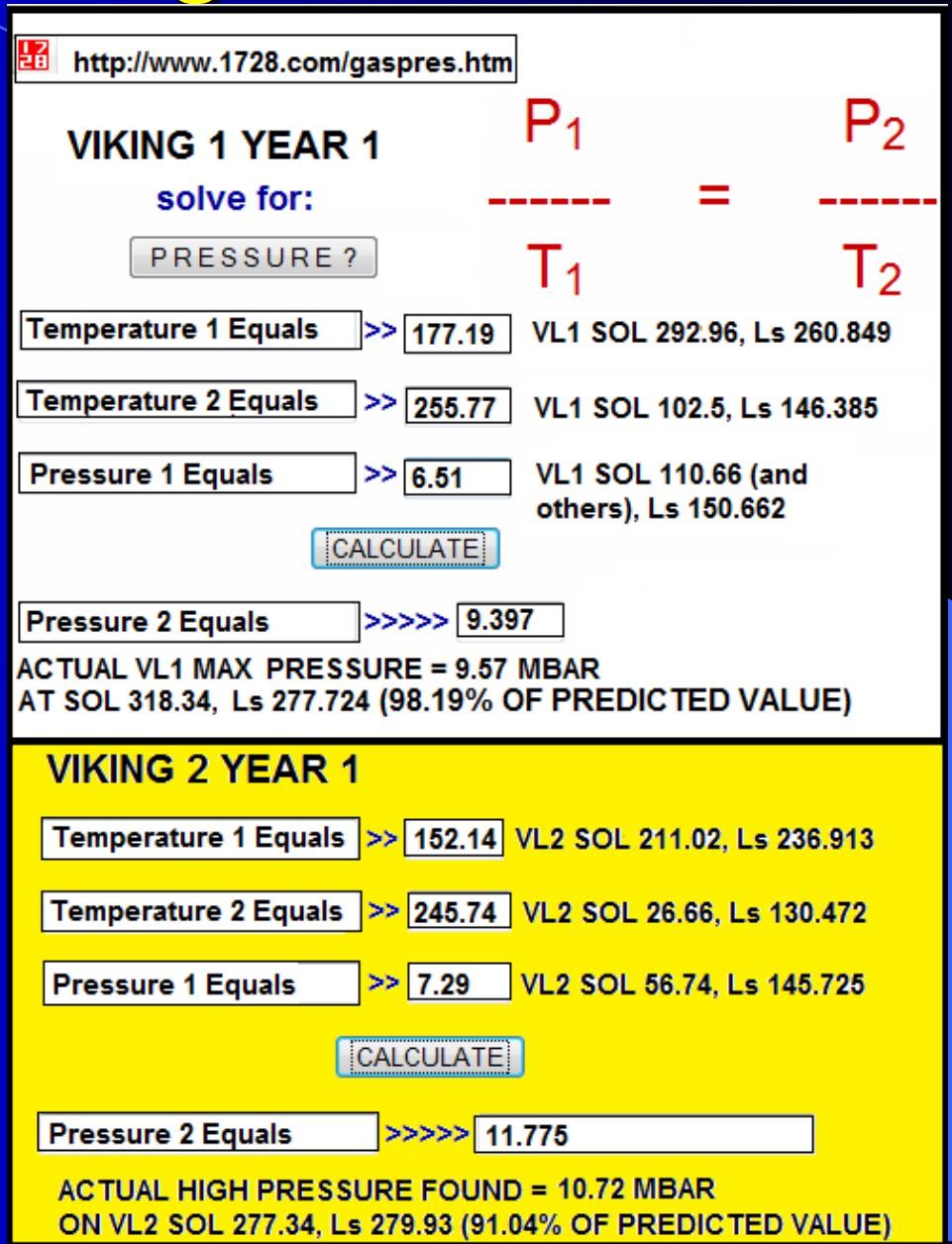
Figure 9B is 9C inverted to show quality of pressure and temperature link.

Hypothesis: Above annual trend will be matched at the hourly level when RTG heaters are on & increasing pressure behind a dust clot.



Problems with Viking Pressures

When pressures weren't stuck, they varied with laws for gases in sealed containers **(not in contact with the ambient air of Mars).**



Cyclic nature of accurate prediction times showed a slow drift as seasons changed

VL1 SOL	0.02	0.06	0.1	0.14	0.18	0.22	0.26	0.3	0.34	0.38	0.42	0.46	0.5	0.54	0.58	0.62	0.66	0.7	0.74	0.78	0.82	0.86	0.9	0.94	0.98	Vl1 SOL
228	198							194									215			204						228
229								196	199									215	210	204			200	199	202	229
230								192	197									209	204	201	198	196	198	199	198	230
231	196							192	196									210	206	202	200					231
232								193	199									209		203	200			197	199	232
233								193	199									211		203	200	198	198	200	198	233
234	197							193	199									211		304	201	200				234
235								195	201									211	205	203	201	198	196	197	198	235
236	195							191	197									213	207	203	200	197	197	195	198	236
237	198	197						192										212	207	204	201	198	198	200		237
238	195	193					193	192	192										206	203	200	197	197	196	194	238
239	195	196						192										213	205	203	200	197	195	196	196	239
240	197	193						190										209	205	202	198	195	194	194	193	240
241	195	195						189												203	200	197	195	195	197	241
242	196	194						191											206			197	196			242
243	194	191						190											206			197	195	197		243
244	197	197						191											206	203	200	197	197	196	195	244
245	196	196	195					192													199	197	194	192	191	245
246	190	189					186	189														195	193			246
247		193	189				187	189													198	196	194	192	190	247
248	192	194	192					189										208			199	196	195	194	192	248
249	193	194	191					189															193	192	191	249
250	190	189	187				185	187													197	194			194	250

BLOCKS IN RED ARE WITHIN 2% OF PREDICTIONS BASED ON GAY-LUSSAC/AMONTON'S GAS LAWS.

FORMULA USED IS

$$P = \frac{6.51\ \text{mbar} * 255.17\text{K}}{T_K\ \text{Measured in cell}}$$

28K Temperature range for accurate pressure predictions this page (185 to 213K)

Why Question Accepted Pressure?

Dust storms enormously increase opacity and atmospheric density. Can block 99% of light.

Mars_dust_opacities_MER-B_Sol_1205_to_1235.jpg (800 × 533 pixels, file size: 39 KB, MIME type: image/jpeg)

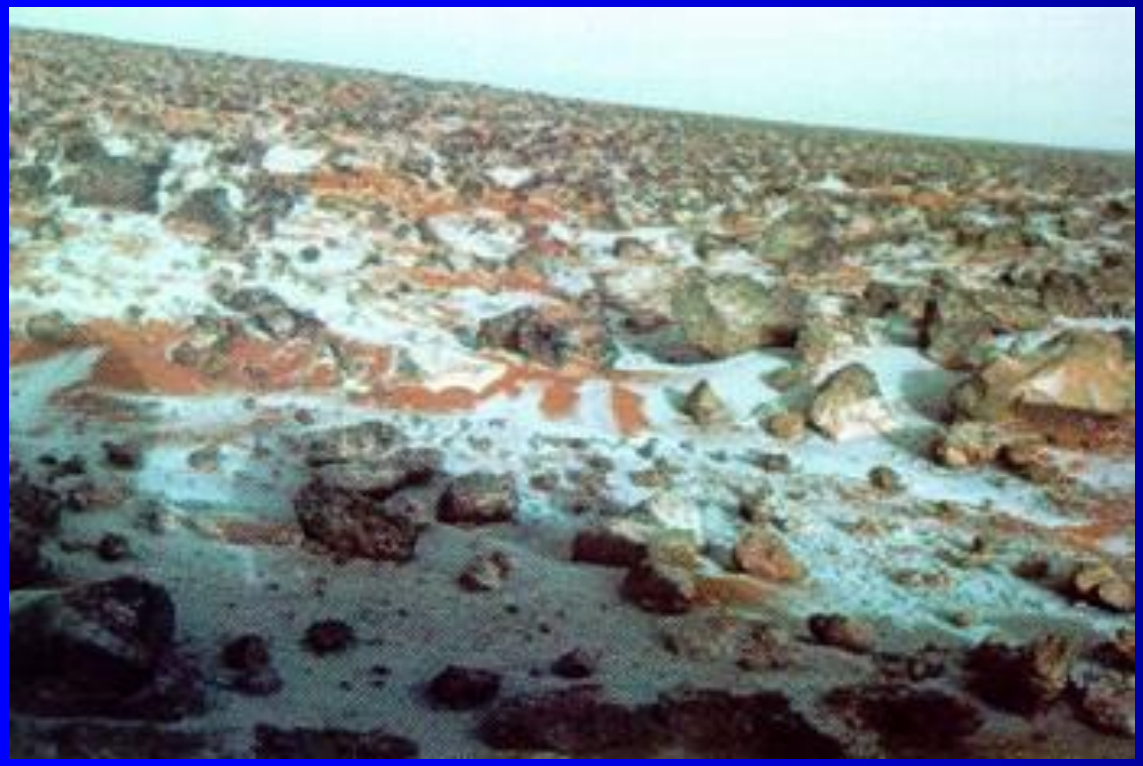
Phoenix, AZ Dust Storm of 5 July 2011

- **Pressure at nearby Luke Air Force Base increased during the dust storm by 6.6 mbar – that's more than average pressure (6.1 mbar) at areoid on Mars.**

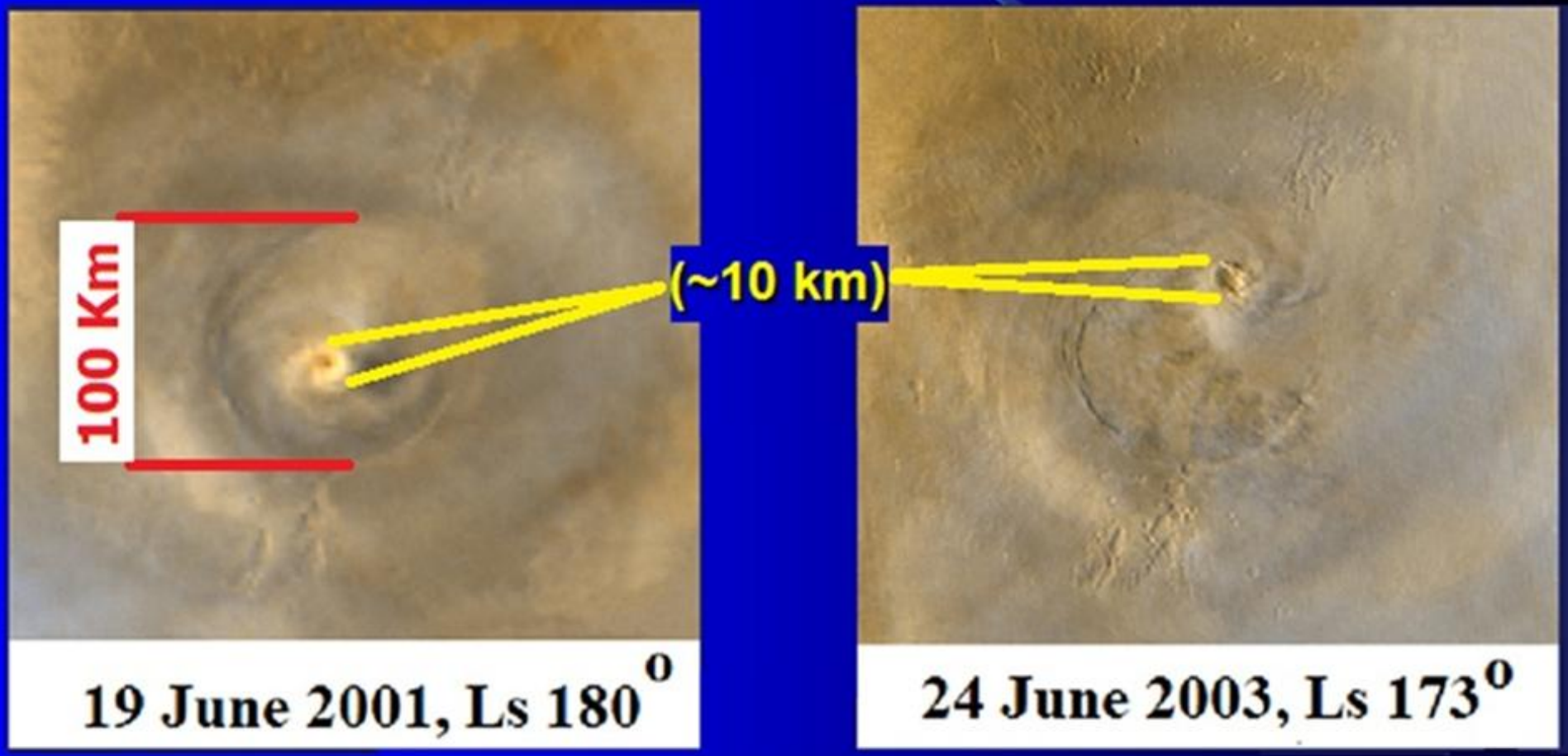
- **The pressure measured on MSL on 8/23/2012 was 7.4 mbar. 7.4 mbar + 6.6 mbar = 14 mbar. MSL's Vaisala pressure transducer can't even measure over 11.5 mbar.**

Why Question Accepted Pressure?

- **Snow. Ice particles in clouds an order of magnitude too small for GCMs – 2 μm vs. 20 to 30 μm (Richardson, et al., 2002)**



Spiral Clouds on Arsia Mons (only) look like Hurricane Eye Walls. 1.17 mbar seems too low.



These clouds extend 15-30 km above the mountain, where scale height calculations indicate pressures of 0.29 to 0.07 mbar. This is like what's seen for Earth at >34.9 km (>21 miles) above sea level.

Stratus clouds on Mars suggest higher than advertised air pressure.

CIRROSTRATUS CLOUDS ON EARTH AT UP TO 13,000 METERS

www.csgnetwork.com/pressurealtcalc.html

Meteorology Calculator

Earth Pressure Altitude Required Data Entry

Station Pressure: 163.33 ○ in of mercury ○ mm of mercury ● millibars (hPA)

Calculate | Clear Values

Minimum pressure for status clouds on Earth = ~163.33 mbar

Calculated Results

Pressure Altitude Calculation = 42651.1 ft

Pressure Altitude Calculation = 13000 m

Version 1.5.9

mars.jpl.nasa.gov/MPF/ops/82381_full.jpg

How can these clouds form on Mars at such high altitude if the surface pressure is < 10 mbar?

STRATUS CLOUDS ON MARS AT ALTITUDE OF ABOUT 16,000 METERS

Mars pic from Pathfinder

7/19/1997 @ Ls 150.2. Taken 1 hr 40 min before sunrise.

Occam's Razor

- (1) Entities must not be multiplied beyond necessity.
  (2) The simplest solution is usually the correct one.

- The Razor suggests that repeatable Viking pressure data should be believed. However, the consistent Viking-Pathfinder-Phoenix-MSL pressures may only exist because they all had pressure sensor air access tubes clog in similar fashion .

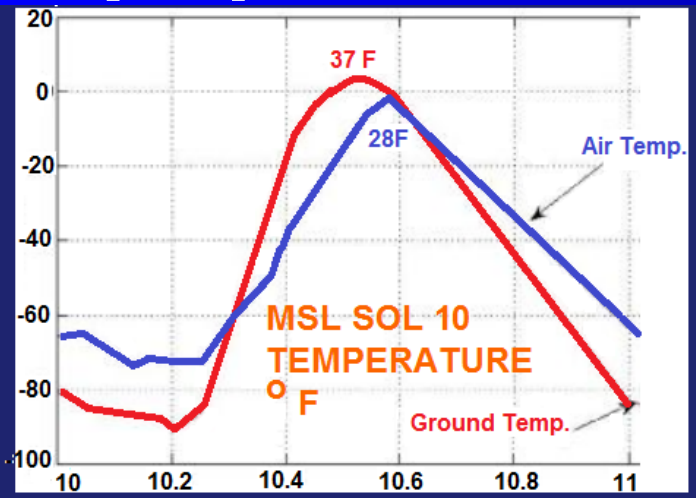
Why Trash Occam?

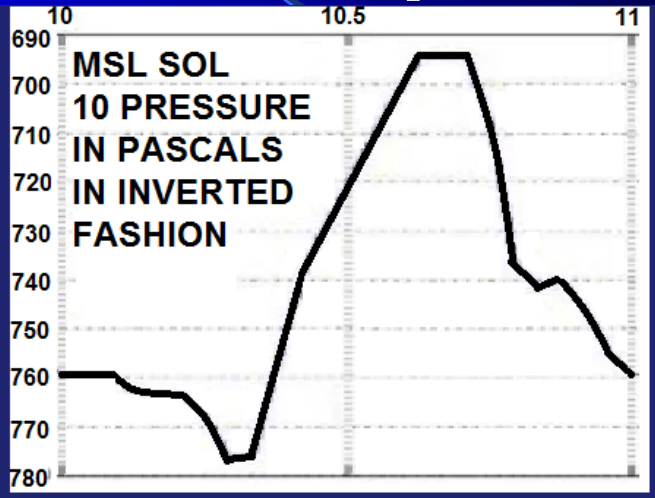
- **OVERALL Viking pressures vary in inverse proportion to ambient temperature and in direct proportion to heat required by RTGs to keep internal temperatures stable.**

- **Viking 1 Pressures for Year 1 are 98.19% in agreement with predictions based on Gay-Lussac's Law. This implies the transducer only measured internal, not external pressures.**

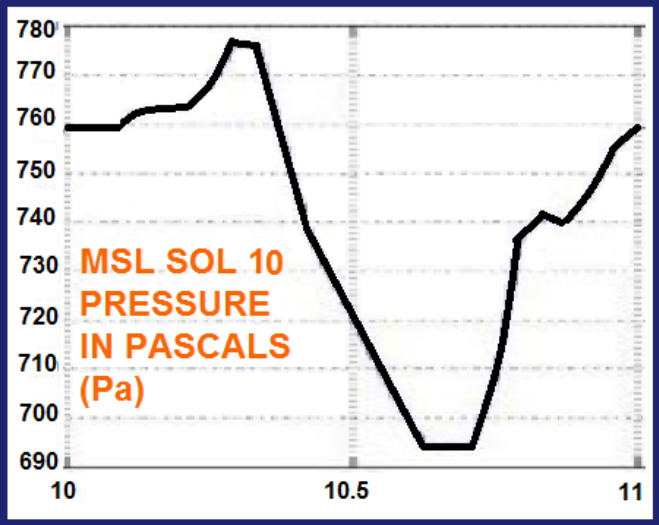
Why Trash Occam?

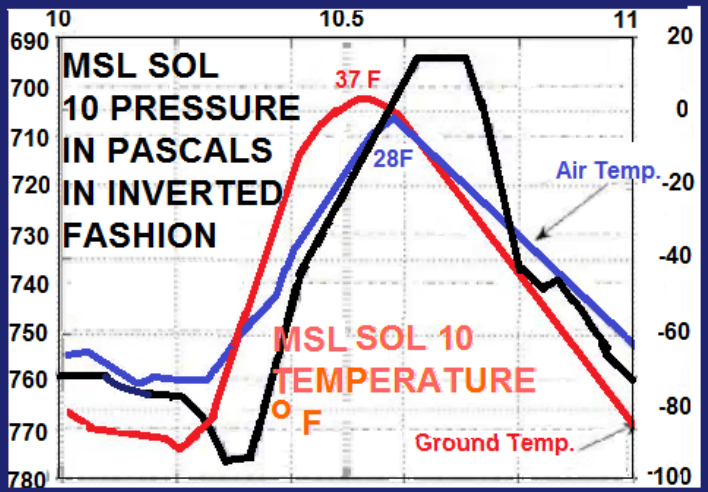
Initial MSL daily pressure also varied in inverse proportion to ambient temperature.





ARE DAILY PRESSURE CYCLES RELATED TO THE INVERSE OF TEMPERATURES OUTSIDE THE MSL AS WITH VIKINGS?

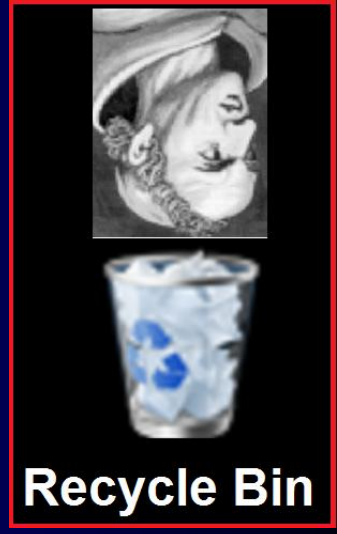




Why Trash Occam?

- **Weather doesn't match low pressure values**
  - **Dust Devils**
  - **Dust Storms**
  - **Eye walls on huge storms over Arsia Mons**
  - **Stratus clouds at 16 km.**

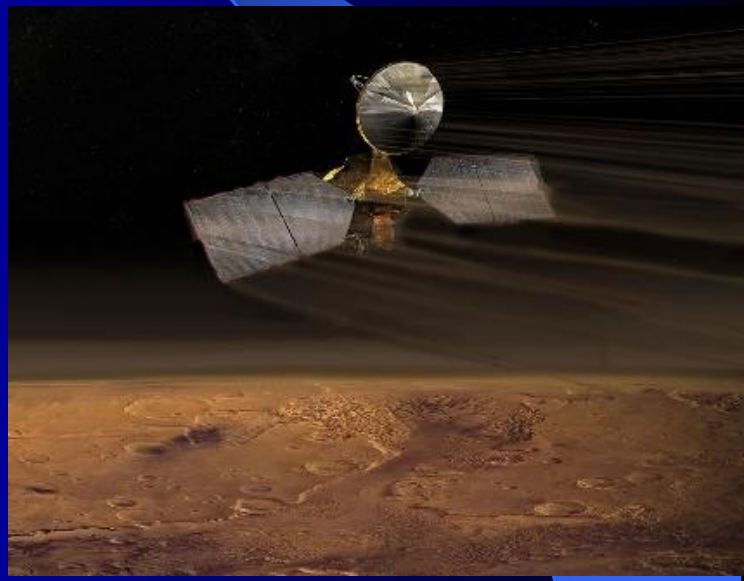
Why Trash Occam?



- **No way to change Viking, MPF, Phoenix & MSL dust filters that could clog.**
- **Viking data suspicious due to exact repeat over 4 yrs.**
- **Audit of Viking data shows huge patterns of exactly the stuck pressures for up to 6 days (see Part 2 Presentation). Data shows no justification for continuing the pressure curves.**

WHY TRASH OCCUM?
MRO AEROBRAKING

"At some points in the atmosphere, we saw a difference in the atmospheric density by a factor of 1.3, which means it was 30% higher than the model, but ...



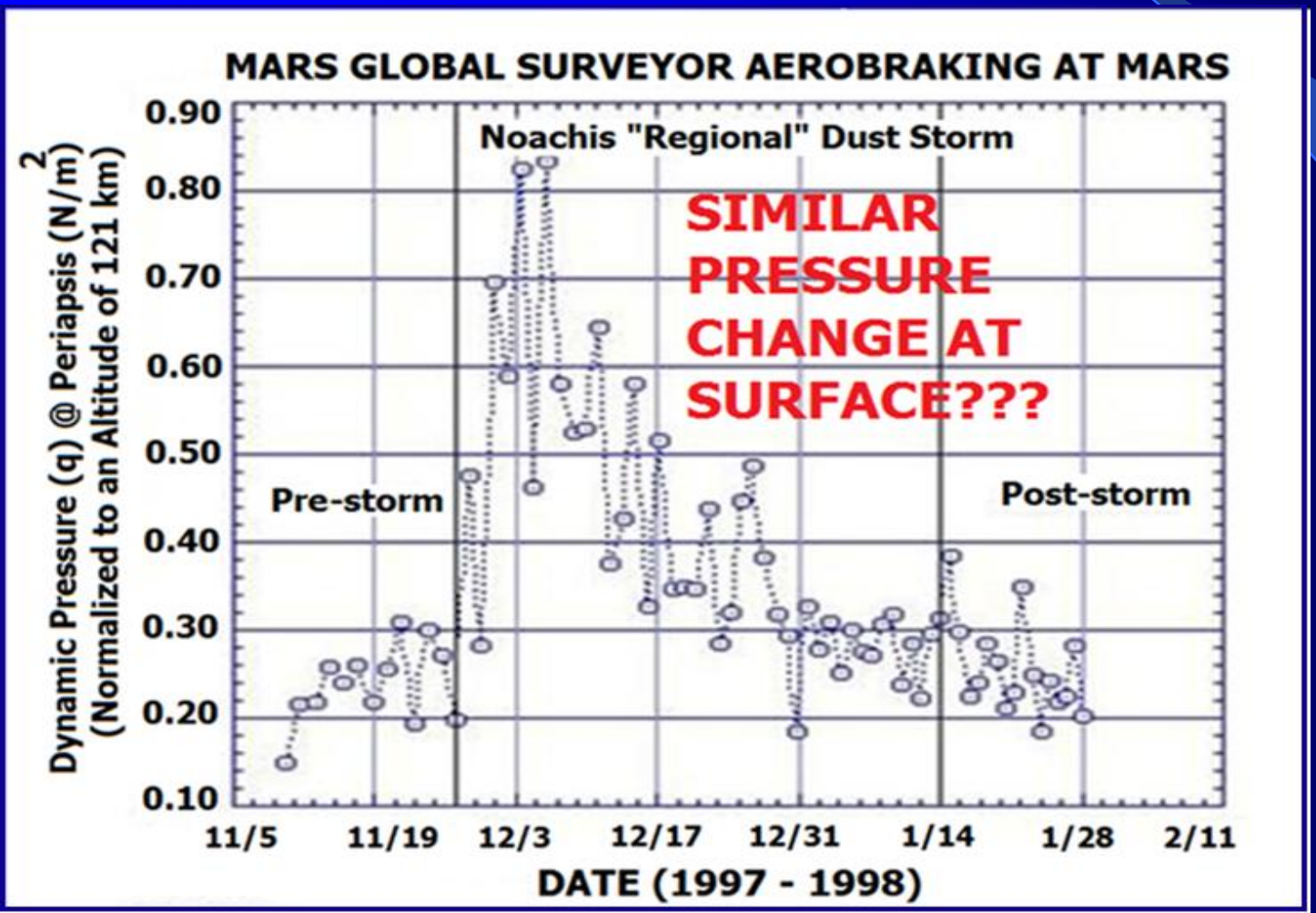
around the south pole we saw an even larger scale factor of up to 4.5, so that means it was 350% off of the Mars GRAM model."

Han You, Navigation Team Chief for MRO.

WHY TRASH OCCAM?

MGS Dynamic Pressure Spike @ 121 km Due to Dust Storms.

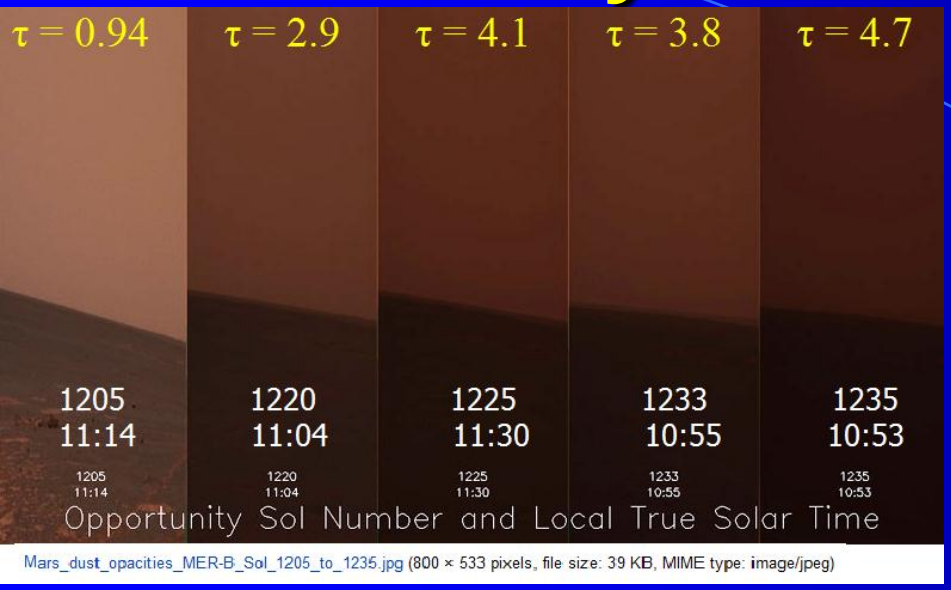
Pressure Doubles in 48 Hours, Up 5.6 Fold in 4 Weeks.



Why Trash Occam?

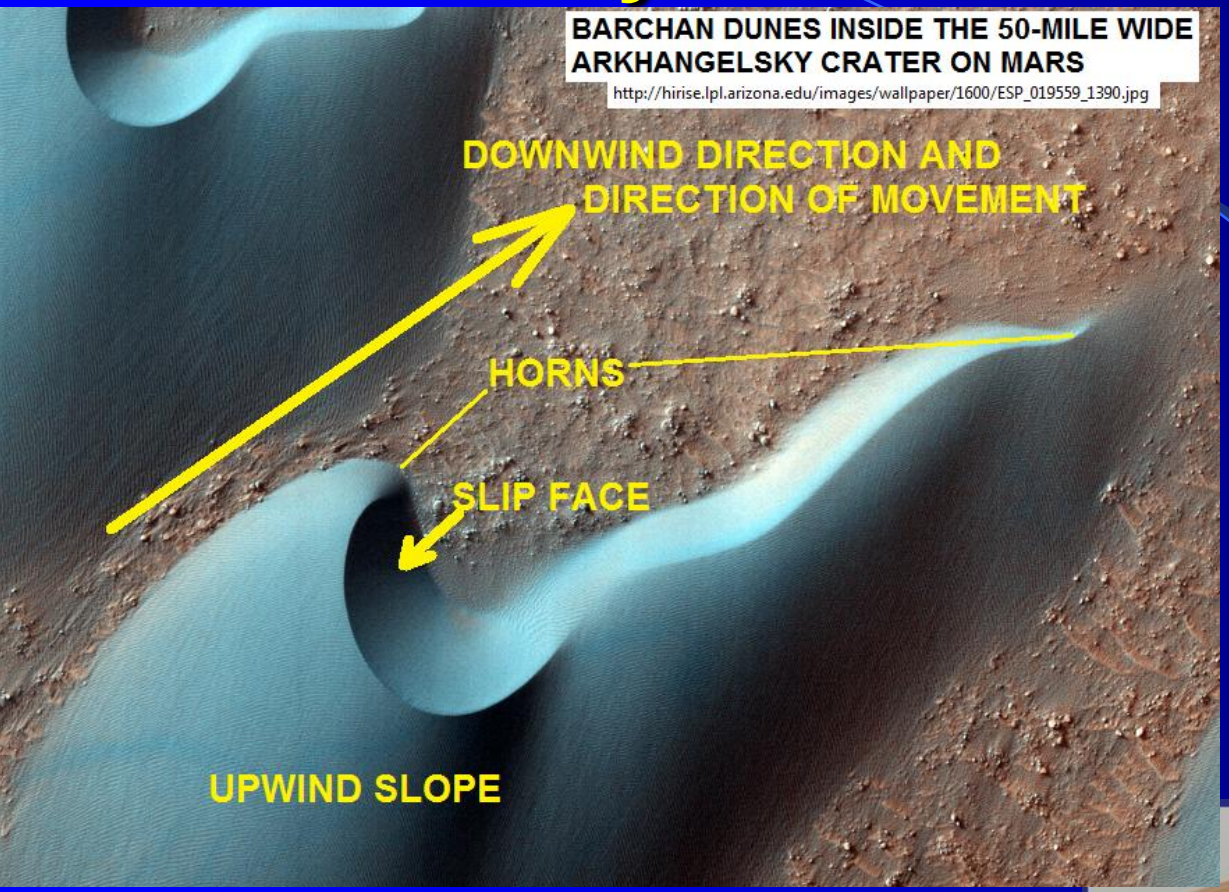
- **Pathfinder anemometers could not be calibrated.**
  - **True again so far with MSL.**
- **Phoenix transducer design problems. ITAR at fault.** Note: MSL/Curiosity's 2011 Rover Environmental Monitoring Station (REMS) was built by the Spanish Ministry of Education with **FMI still as a partner. FMI delivered the MSL pressure sensor to NASA in 2008 (before ITAR problems could be fixed)!**
- **No pressure sensors could measure > 18 mbar (two could only go up to 12 mbar, and MSL is limited to 11.5 mbar.)**

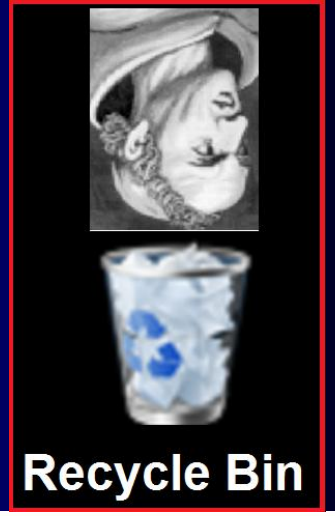
Why Trash Occam?



- **An MSL 11.5 mbar max pressure capability can't handle a 6.6 mbar pressure increase due to dust storms like that at Luke AFB.**

Why Trash Occam?





Difficulty in explaining Barchan and other sand dune features, especially in craters on Mars if pressure is as low as advertised.

Why Trash Occam?

"Mars either has more gusts of wind than we knew about before, or the winds are capable of transporting more sand."

Nathan Bridges,
Planetary scientist, Johns Hopkins University's Applied Physics Laboratory

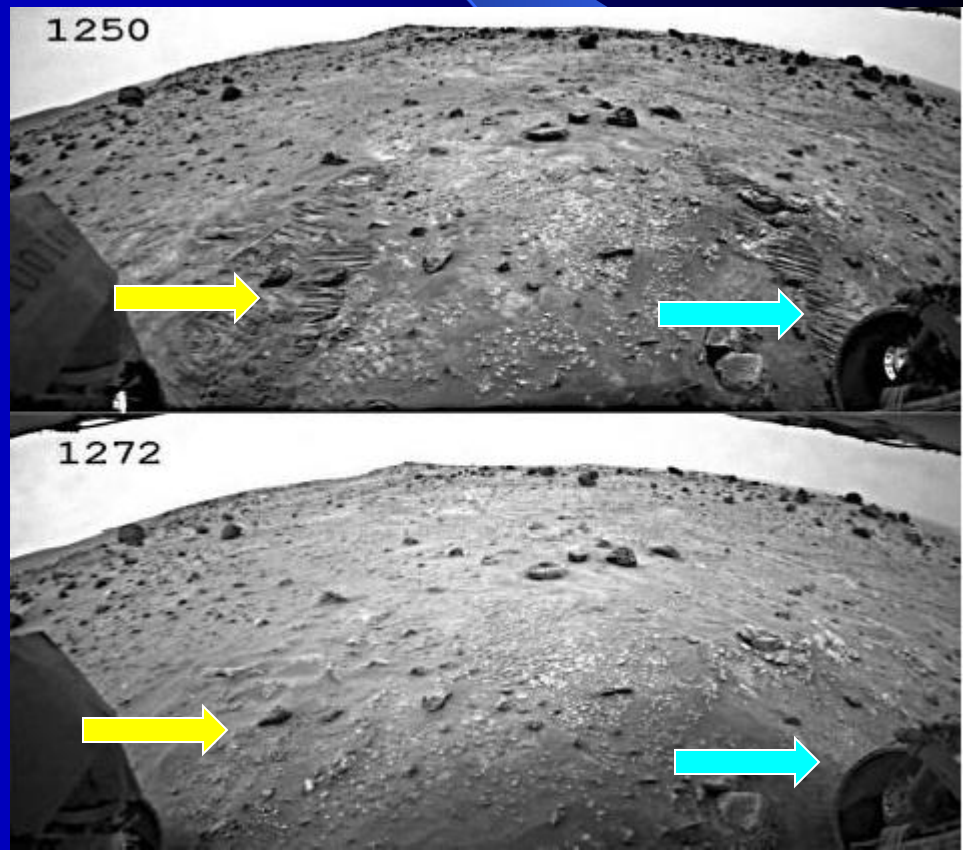
http://www.nasa.gov/mission_pages/MRO

Why Trash Occam?

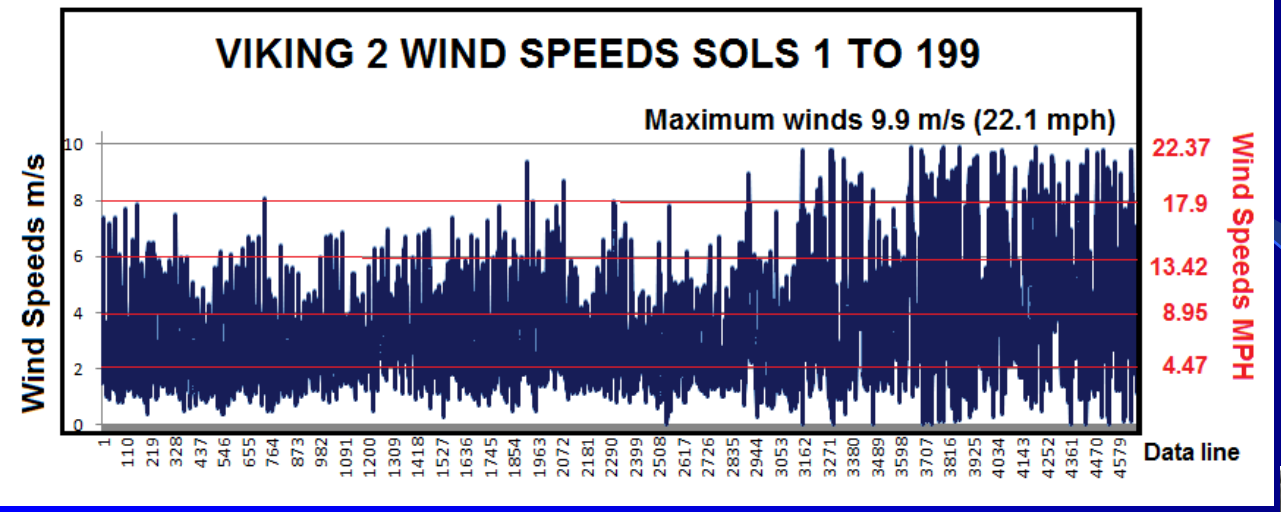
- **Wind-tunnel trials show a patch of sand would take winds ~80 mph to move on Mars (vs. 10 mph on Earth). Viking landers and climate models showed such winds should be rare on Mars.**

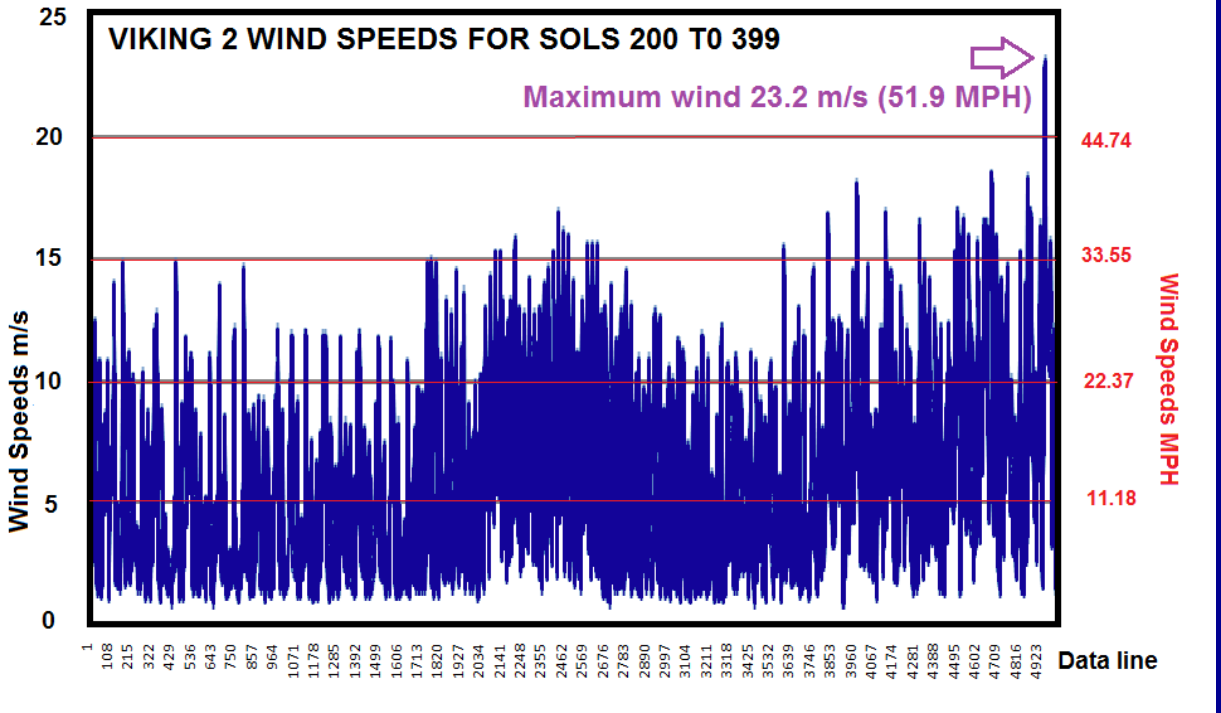
JPL: Mars Exploration Rover Spirit detected shifting sand in 2004.

- **Grains of sand dotting the rovers' solar panels**
- **Rovers' track marks filling in with sand.**

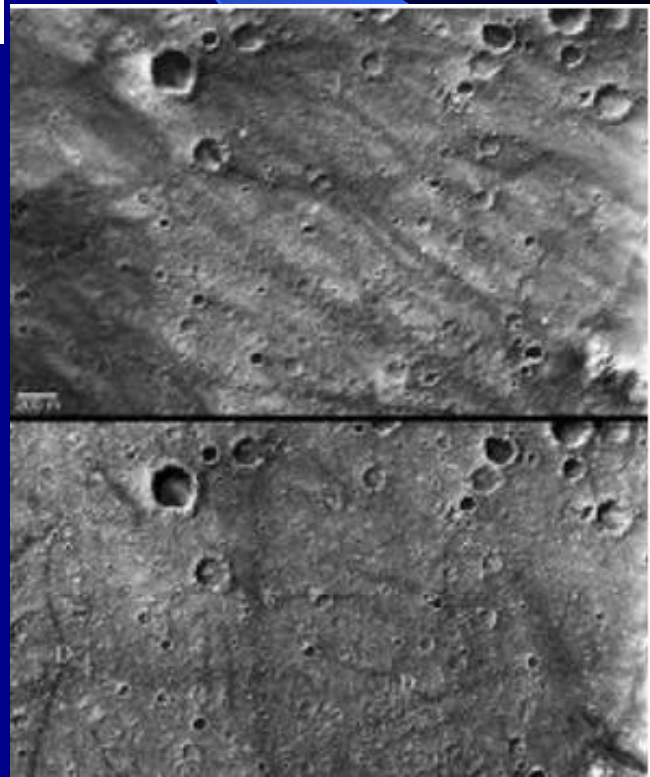


IF THE WINDS DID NOT REACH 80 MPH NEEDED TO MOVE SAND, WHAT WERE THEY ON VIKING 2?





Erasure of earlier spirit Tracks



Why Trash Occam?

Transport of water vapour in the Martian atmosphere.
Credit: ESA/AOES Medialab

SPICAM spectrometer on ESA's Mars Express spacecraft reveal Mars air is supersaturated with water vapor (29 Sep 2011).

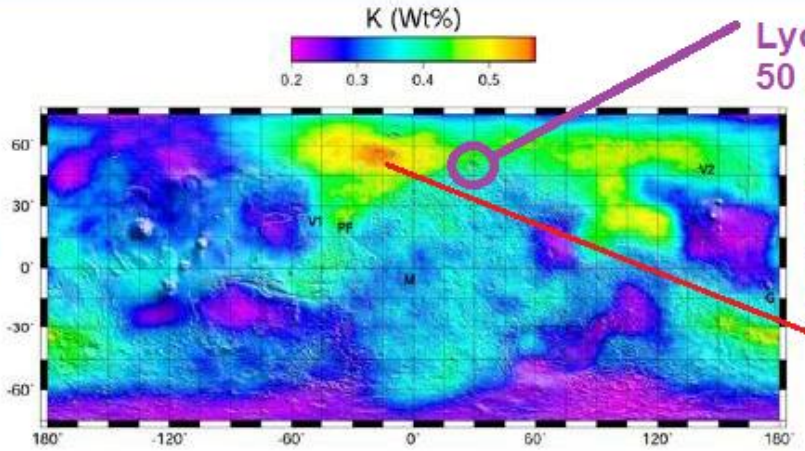
Previous models underestimated H_2O at heights of 20–50 km.

10 to 100 times more H_2O than expected at this altitude. Partial pressures imply denser air too.

- http://sci.esa.int/science-e-media/img/be/MEx_water_vapour_animation_400.gif

Are JPL errors just mistakes, or deliberate? Disinformation requires a motive. Do radioactive isotopes on Mars point to it?

Adapted from Brandenburg, 2011, to relate radioactive hot spots to landers that had meteorlogy capabilities, Cydonia "face" location and few geographic landmarks



Lyot Impact crater at 50 N, 29.3 East (330.7West)

This site is where Dr. Brandenburg thinks the asteroid hit that destroyed the Martian oceans.

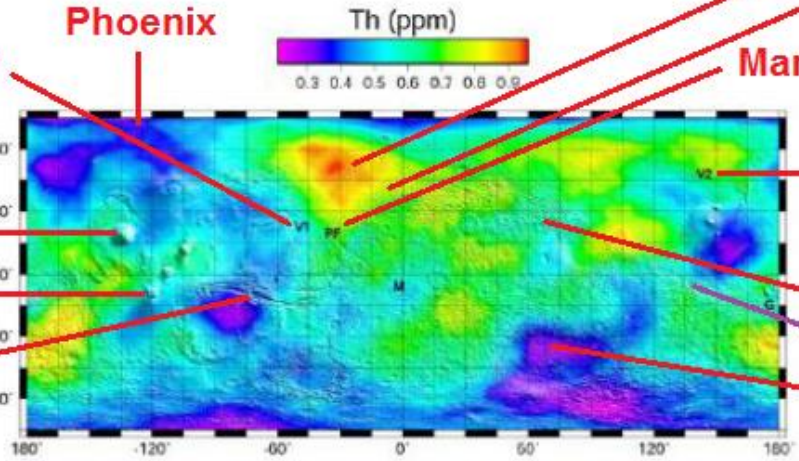
Radioactive Hot spot

Figure 1. Distribution of radioactive K on Mars

Cydonia "Face" in Mare Acidalium

Phoenix

Viking 1



Mars Pathfinder

Viking 2

Olympus Mons

Arsia Mons

Valles Marineris

Syrtis Major

MSL Curiosity

Hellas Basin

Figure 2. Distribution of Th on Mars

Slide References

- **Slide 1: Wind boom photo adapted from http://msl-scicorner.jpl.nasa.gov/Instruments/REMS/.**
- **REMS reports from http://cab.inta-csic.es/rems/marsweather.html.**
- **REMS block diagram adapted from http://rd.springer.com/article/10.1007/s11214-012-9921-1/fulltext.html**
- **Slide 2** Adapted from the Tillman, Viking Computer Facility, University of Washington.
- **Slide 3: REMS reports from http://cab.inta-csic.es/rems/marsweather.html.**
- **Ashima reports from http://marsweather.com/data,**
- **Slide 4: REMS reports from http://cab.inta-csic.es/rems/marsweather.html.**

  Vail from http://www.etraveltrips.com/blog/vail-colorado-an-insiders-travel-tips-vail-colorado/#sthash.O8EDPDVQ.dpbs

Slide References

- **Slide 6:** Kahanpaa, H., Polkko J., 2009-02-26. The Time Response of the PHOENIX Pressure Sensor, Finnish Meteorological Institute. Doc. No. FMI_S-PHX-BAR-TN-002-FM-99.
- **Slide 7:** Taylor, P.A., Weng, W., Kahanpää, H., Akingunola, A., Cook, C., Daly, M., Dickinson, C., Harri, A., Hill, D., Hipkin, V., Polkko J., and Whiteway, J. (2009). On Pressure Measurement and Seasonal Pressure Variations at the Phoenix landing site, Submitted to *Journal of Geophysical Research (Planets).*

  Vailsala picture adapted from http://www.space.fmi.fi/phoenix/?sivu=instrument.
- **Slide 8**: Personal communication with H. Kahanpää, FMI
- **Slide 9: Calendar from http://www-mars.lmd.jussieu.fr/mars/time/martian_time.html**

  REMS reports from http://cab.inta-csic.es/rems/marsweather.html.

  Orbital diagram from http://www-mars.lmd.jussieu.fr/mars/time/solar_longitude.html

Slide References

- **Slide 10: Ashima reports from http://marsweather.com/data,**
  Slide 11: Wind boom photo adapted from http://msl-scicorner.jpl.nasa.gov/Instruments/REMS/.
  Slide 12: Higher than Advertised Martian Air Pressure by David and Barry Roffman
- **Slide 13: Ashima reports from http://marsweather.com/data**
- **Slides 14: Ashima report from http://marsweather.com/data**
  Jakarta times from http://www.gaisma.com/en/location/jakarta.html
  Mombasa times from http://www.gaisma.com/en/location/mombasa.html
- **Slide 15: Calculations by David A. Roffman, Physics PhD candidate at the University of Florida.**
- **Slide 16: REMS report from http://cab.inta-csic.es/rems/marsweather.html.**
  Ashima report from http://marsweather.com/data

Slide References

- **Slide 18: REMS reports from http://cab.inta-csic.es/rems/marsweather.html.**
- **Slide 19: REMS block diagram adapted from http://rd.springer.com/article/10.1007/s11214-012-9921-1/fulltext.html**

  REMS report from http://cab.inta-csic.es/rems/marsweather.html.
- **Slide 20: REMS report from http://cab.inta-csic.es/rems/marsweather.html.**
- **Slide 21: REMS report from http://cab.inta-csic.es/rems/marsweather.html.**
- **Ground and air temperatures from:** http://mars.jpl.nasa.gov/msl/images/PIA16081_gomez3-br2.jpg
- **Slide 22: http://davidaroffman.com/photo4_28.html**

Slide References

- **Slide24:** http://www.lpl.arizona.edu/~lemmon/mer_dd/dd_enhanced_587a.gif
- **Slide 25:** Balme, M., Greeley R. (2006), Dust devils on Earth and Mars, *Review Geophysics.*, 44, RG3003,doi:10.1029/2005RG000188.
- **Slide 26**: NASA, (2005). *NASA simulates small Martian 'dust devils' and wind in vacuum tower*. Retrieved from http://www.nasa.gov/centers/ames/research/exploringtheuniverse/vaccumchamber_prt.htm
- **Slide 27:** Read, P. L., & Lewis, S. R. (2004). *The Martian Climate Revisited, Atmosphere and Environment of a Desert Planet*, Chichester, UK: Praxis.
- **Slide 28:** Reis, D., Lüsebrink, D., Hiesinger, H., Kel-ling, T., Wurm, G., and Teiser, J. (2009). High altitude dust devils on Arsia Mons, Mars: Testing the greenhouse and thermophoresis hypothesis of dust lifting. *Lunar Planetary Science.* [CD-ROM], *XXXII*, Abstract 2157. Retrieved from http://www.lpi.usra.edu/meetings/lpsc2009/pdf/1961.pdf

Slide References

- **Slide 29:** http://www.stevenhobbsphoto.com.au
- **Slide 30:** Top and bottom graphs by Tillman and Johnson as found on page 832 of MARS (1992) edited by Kieffer, H, Jakowsky, B, Snyder, C., and Matthews, M. Middle graph by David and Barry Roffman.
- **Slide 31:** Calculator from http://www.1728.com/gaspres.htm.
- **Slide 33:** http://www.jpl.nasa.gov/news/news.cfm?release=2007-080.
- **Slide 34:** http://www.nachi.org/forum/f11/awesome-phoenix-dust-storm-62232/
- **Slide 35: :** Richardson, M., Wilson, R. J., and Rodin, A. V. Water ice clouds in the Martian atmosphere: General circulation model experiments with a simple cloud scheme, J. Geophys. Res., 107(E9), 5064, doi:10.1029/2001JE0011804, 2002.
- **Slide 36:** NASA/JPL/MSSS, (2005). *PIA04294: Repeated Clouds over Arsia Mons*. Retrieved from http://photojournal.jpl.nasa.gov/catalog/PIA04294

Slide References

- **Slide 37: Pressure altitude calculator from http://www.csgnetwork.com/pressurealtcalc.html**

  Mars clouds from http://mars.jpl.nasa.gov/MPF/science/clouds.html

  Earth cirrostratus clouds from http://www.pilotfriend.com/training/flight_training/met/clouds.htm
- **Slide 40: http://www.spaceflight101.com/msl-rems-science-reports.html.**

  Slide 43: http://www.universetoday.com/2006/09/21/aerobraking-mars-orbiter-surprised-scientists

  Slide 44: http://www.universetoday.com/2006/09/21/aerobraking-mars-orbiter-surprised-scientists/

- **Slide 45:** http://www.atm.ox.ac.uk/main/Science/posters2005/2005cw.pdf and
- http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=WINDSOCK&INSTRUMENT_HOST_ID=MPFL
- and http://en.wikipedia.org/wiki/Mars_Science_Laboratory
- and http://space.fmi.fi/solar.htm
- **Slide 46:** http://www.jpl.nasa.gov/news/news.cfm?release=2007-080.
- **Slide 47:** Greeley, R; Lancaster, N; Lee, S. and Thomas, P. Martian Aeolian Processes, Sediments, and Features (Chapter 12 of Mars [1992] edited by Kieffer, H.H. et al). Mars photo from http://lightsinthedark.wordpress.com/2011/01/26/beautiful-barchans/

  Namibian and Moroccan dunes from http://www.bukisa.com/articles/44523_worlds-most-amazing-cliffs-and-fascinating-dunes

Slide References

- **Slide 48:** http://www.nasa.gov/mission_pages/MRO
- **Slide 49:** http://www.nasa.gov/mission_pages/MRO
- **Slide 50:** http://www.agu.org/pubs/crossref/2010/2010JE003674.shtml
- **Slide 51:** http://sci.esa.int/science-e-media/img/be/MEx_water_vapour_animation_400.gif
- **Slide 52: Adapted from http://www.lpi.usra.edu/meetings/lpsc2011/pdf/1097.pdf**