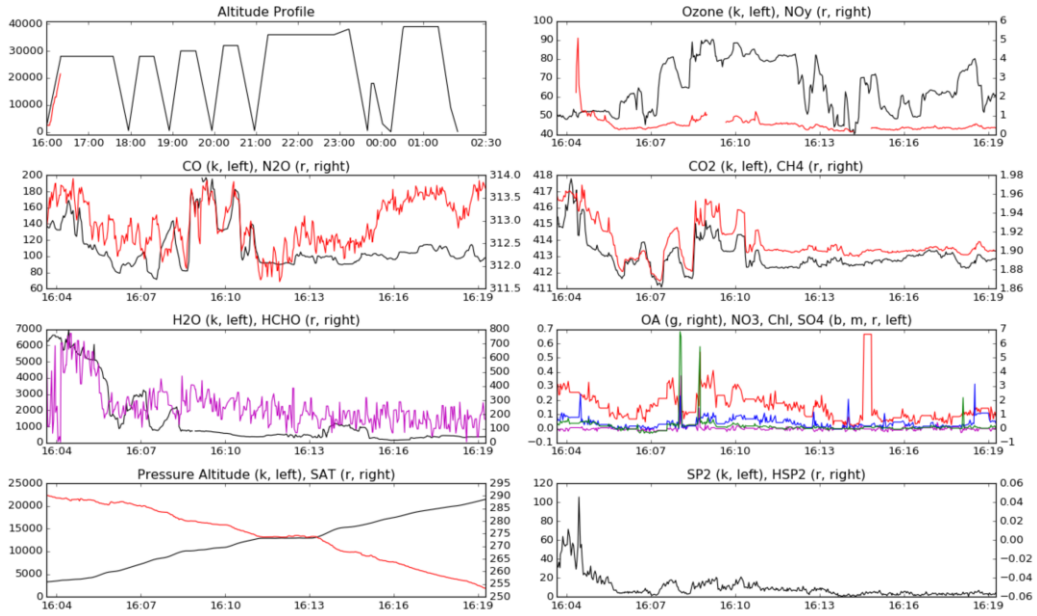
Prather's Log ATom-4, RF02, 2018-04-27
1604 Takeoff heading NW

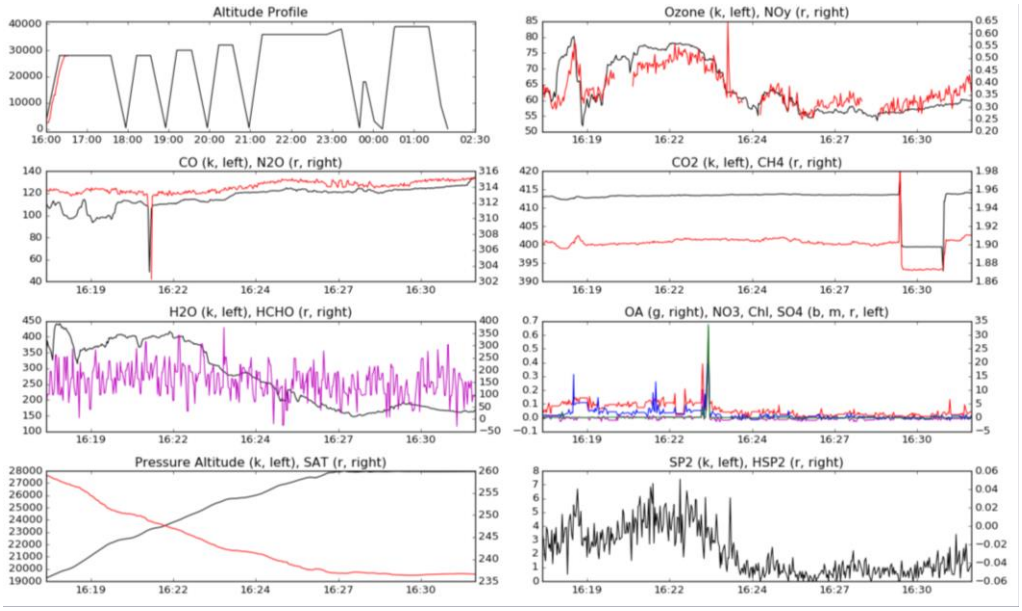
1608-1613 hit 80 ppb O3, dropping, CO ranging 80-180, not corr with O3, SP2 is high for background and looks to be corr with O3

117 16:12:09.012					
Latitude	+34 47.7	deg min	Static Air Temp	-0.0	deg C
Longitude	-118 16.6	deg min	Total Air Temp	18.5	deg C
Pressure Altitude	12879	ft	Potential Air Temp	312.8	K
Radar Altitude	10883	ft	IR Surface Temp	23.3	deg C
GPS Altitude (WGS84)	13353	ft	Dew Point Temp	-36.6	deg C
True Heading	310.2	deg			
			Solar Zenith Angle	50.1	deg
Ground Speed	379	knots	Sun Elevation-Grd	36.6	deg
True Airspeed	378	knots	Sun Elevation-AC	39.9	deg
Indicated Airspeed	310	knots	Sun Azimuth-Grd	98.6	deg
Mach	0.588		Sun Azimuth-AC	150.5	deg
Vertical Velocity	-128	ft/m			
			Water Vapor (DLH)	448.56	ppmv
Pitch	1.4	deg	RH/Water	4.57	%
Roll	3.6	deg	RH/Ice	4.57	%
Drift Angle	3.0	deg			
Wind Speed	20	knots	NO	0.043	ppb
Wind Direction	218	deg	NOy	0.591	ppb
			O3	81.58	ppb
Dist To Go	0.1	nm	CO (QCLS)	91.7505	ppb
Time To Go	0.0	min	CH4 (QCLS)	1884.83	ppb
			N2O (QCLS)	312.063	ppb
Cabin Altitude	2826	ft	CO2 (PICARRO)	412.331	ppm

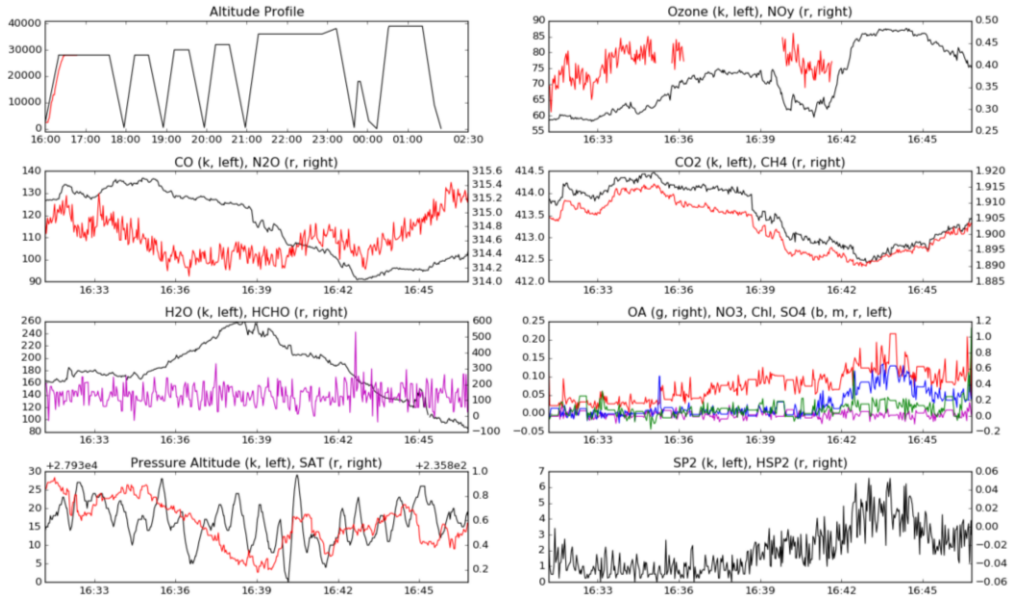
1614 FL 150 - Lot of O3 action, very high
1618 very dry, RHw 11% still dropping.



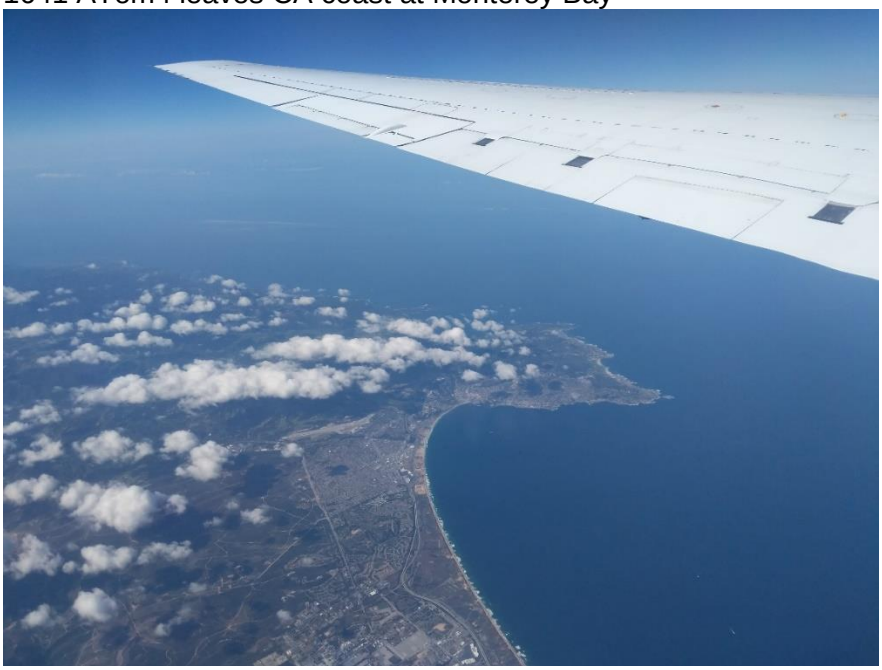
1619-1623 big burst of O3 (75) and SP2 (4-5), CO off scale. from 20-25 kft, nice slug of air, dry.



1633 FL280 O3, NOy, SP2 all tightly corr –
1636 still FL2800 - O3 climbing 55 to 75, CO dropping from 135 to 110. ?strat influence,
1639 still FL280 - but O3 drops to 60; SP2 and CO rise, quite different from shift before.



1641 ATom4 leaves CA coast at Monterey Bay



1642 rapid rise in O3 to 85, RHw 16%, SP2/sulfate/nitrate rises, 10 micron particles found by CAPS1642-

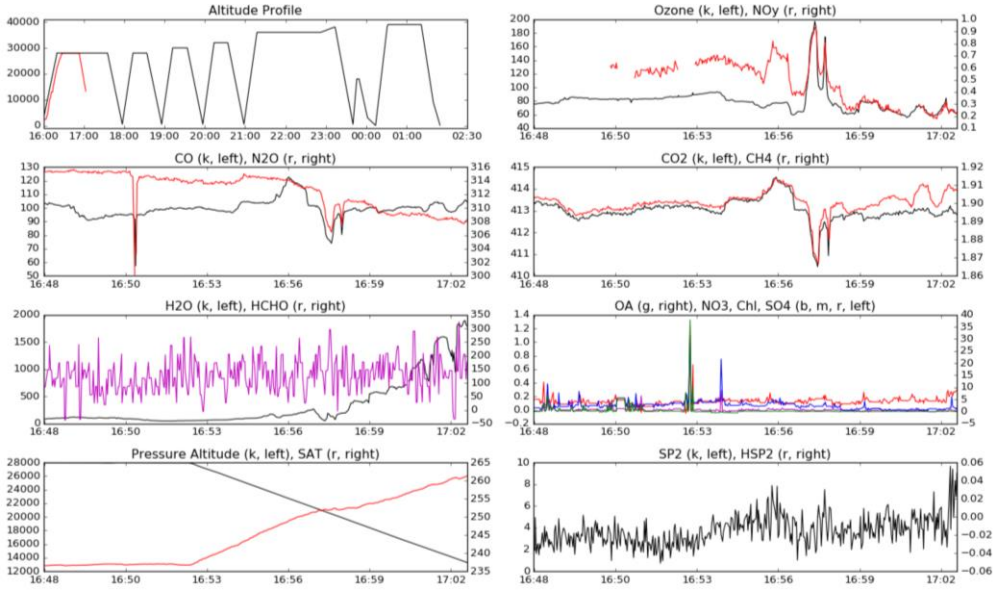
1645 as O3 peaks , so do aerosols and SP2, but these fall after 1645, while CO (90 to 100) and N2O continue to rise (high lat trop, but not dirty?)

1651 Dust continues RHw = 6%, only 50 ppm ----VERY dry, but O3 pegged at 85

1653 start dip from FL280,

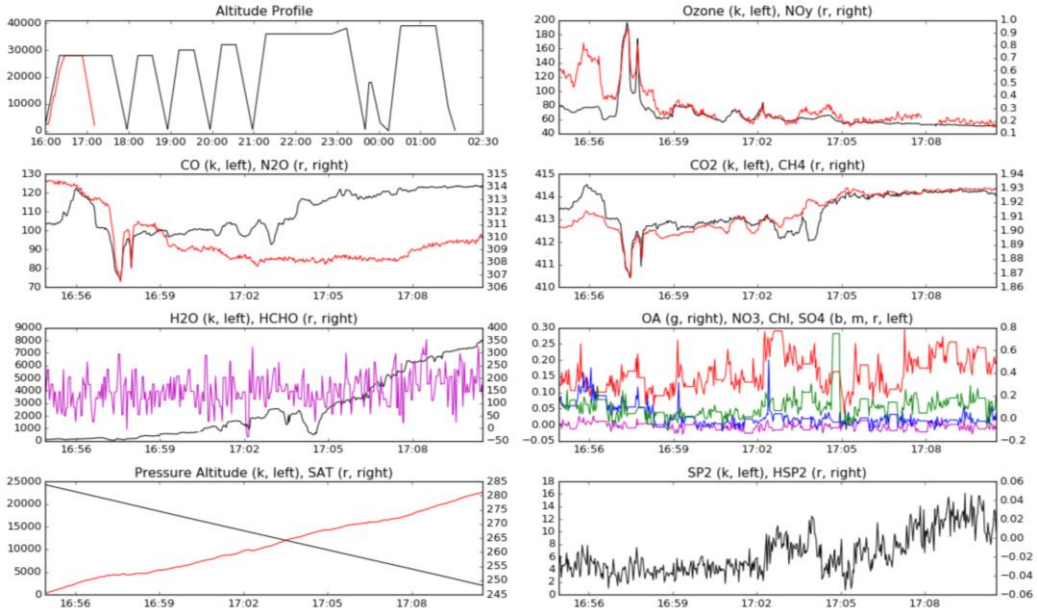
1655+ seeing large particles, also dust, estimated to be Asian desert dust but mixed with industrial (Antimony, Tin). Pass thru very dry strat, O3

1658 on descent, hit 180 ppb O3, double spike, anti-corr with CO/CO2/CH4, more H2O, at about 20-24 kft. Estimate these strat layers to be about 30 sec = 750 ft thick, smaller one is <250 ft?



1659 descent below FL200 is smooth and boring, O3 flat, CO2 and CH4 slowly increasing, CO mostly flat, but sulfate high and SP2 increasing.

1704 CO2-CH4 anti-corr. AGAIN, as seen in RF01. Where from?



1711 [Not Shown]

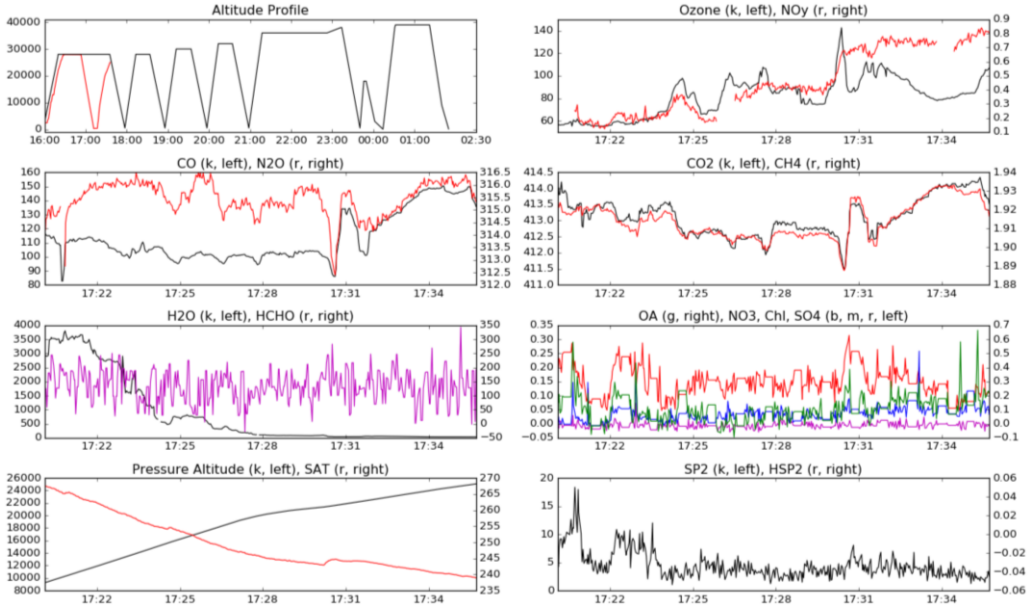
On the deck for dip 1, bouncy, drop in CO 110 to 100, dropping CO2, but CH4 is up, no gradient in SP2.

1716 coming out of dip

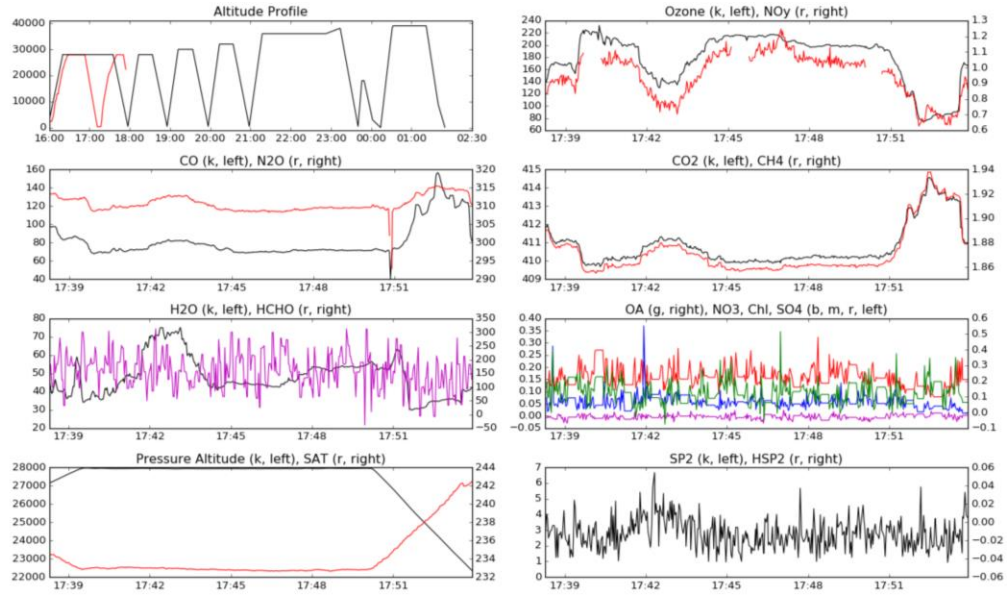
1721 unusual very thin filament spike – N2O/CO down, high SP2, OA

1724 FL140 - ice particles, but RHi 55%

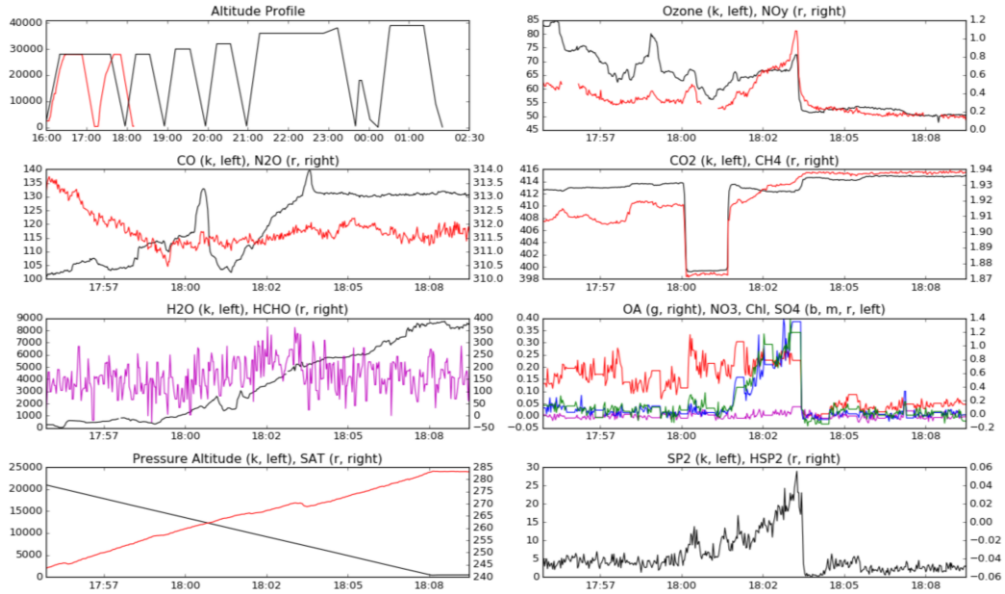
1725 strat filament again, O3 spike to 90, FL150, double peak again at 1727 FL 180, NOy tracks O3, N2O inverse tracks, so does CO
1728 FL200, NOy separates, rises faster than O3,
1730 O3 spike (140) at FL 210 same level as the big one seen going down.
1731-1735 (FL 210 – 250) CO, N2O, CO2, CH4, NOy all increase, but O3 drops on this climb out



1731-1739 Perfect linear? correlation between CO, N2O, CO2, CH4, with O3 opposite
1740 as reach FL280 cross into very high O3 (200!) H2O at 45, RHw 8%
but nowhere near strat as SP2 at 3-4 –
1739-1750 a lot of horizontal structure here flying at FL280
1750 going down. constant strat mix for first 2 kft descent, well mixed vertically.
1751 come out of high O3 air, but andothr 1 min layer at 1754.

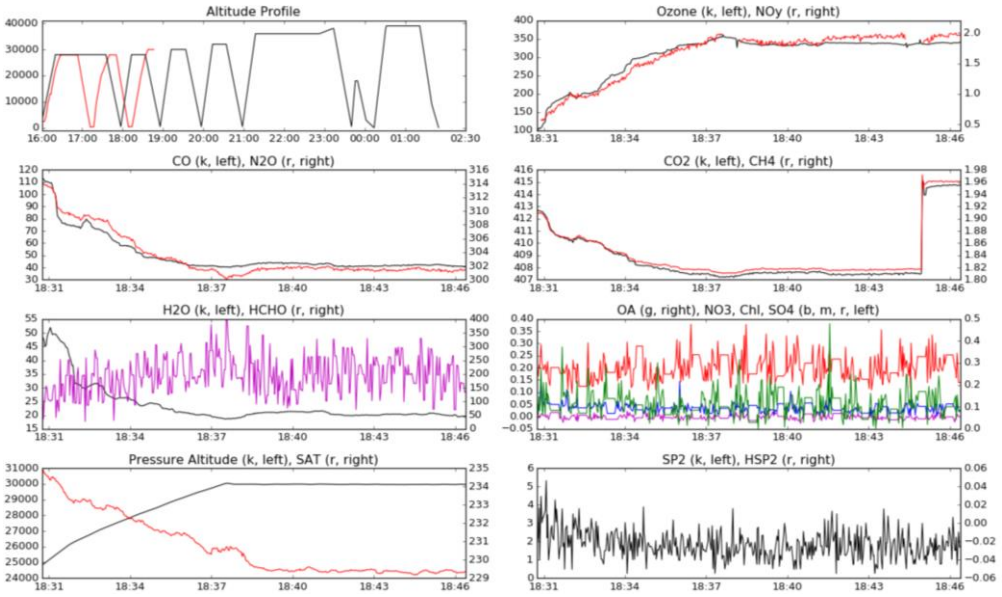


1755 – another CO2-CH4 glitch
1800-1804 – pollution layer intensifies as descend to 10 kft, then clear below, lots of NOy,

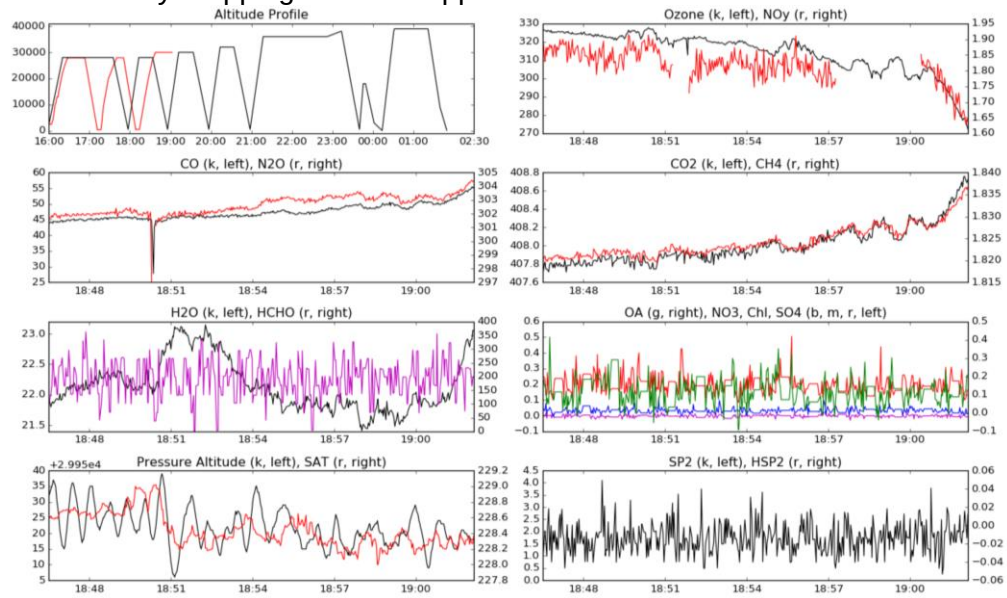


1808 on the deck, bouncy but now white caps., O3 flat at 50 ppb, 75% RHw, CO 130, NOy 0.12, no NO.
1819 Just cleared 7.5 kft cloud top, RHw hit 100% at 4 kft, stayed until 7.5 kft. Iimmediately have the shcmutz layer of aerosols and CO, but CO2 and CH4 drop (3 ppm & 30 ppb!), layer of particles still to 12kft
1825 still a lot of dirty NOY y & particles in layers, up to 18 kft, particles now dropping above 18 kft, but O3 and NOy rising - strat influence
1831 – the strat is back, jump to 200 ppb, 250 , started at 25 kft, 300 ppb with 25 ppm H2O! @FL280, 20 ppm & 335 ppb, CO at 41 ppb, lot of trop still.
1838 FL300 – stiil uniform strat-like air @ 355 O3, but SP2 still large at 2 , NOy at 1.9 ppb NO at 100 ppt (5% ratio looks like strat chemistry.

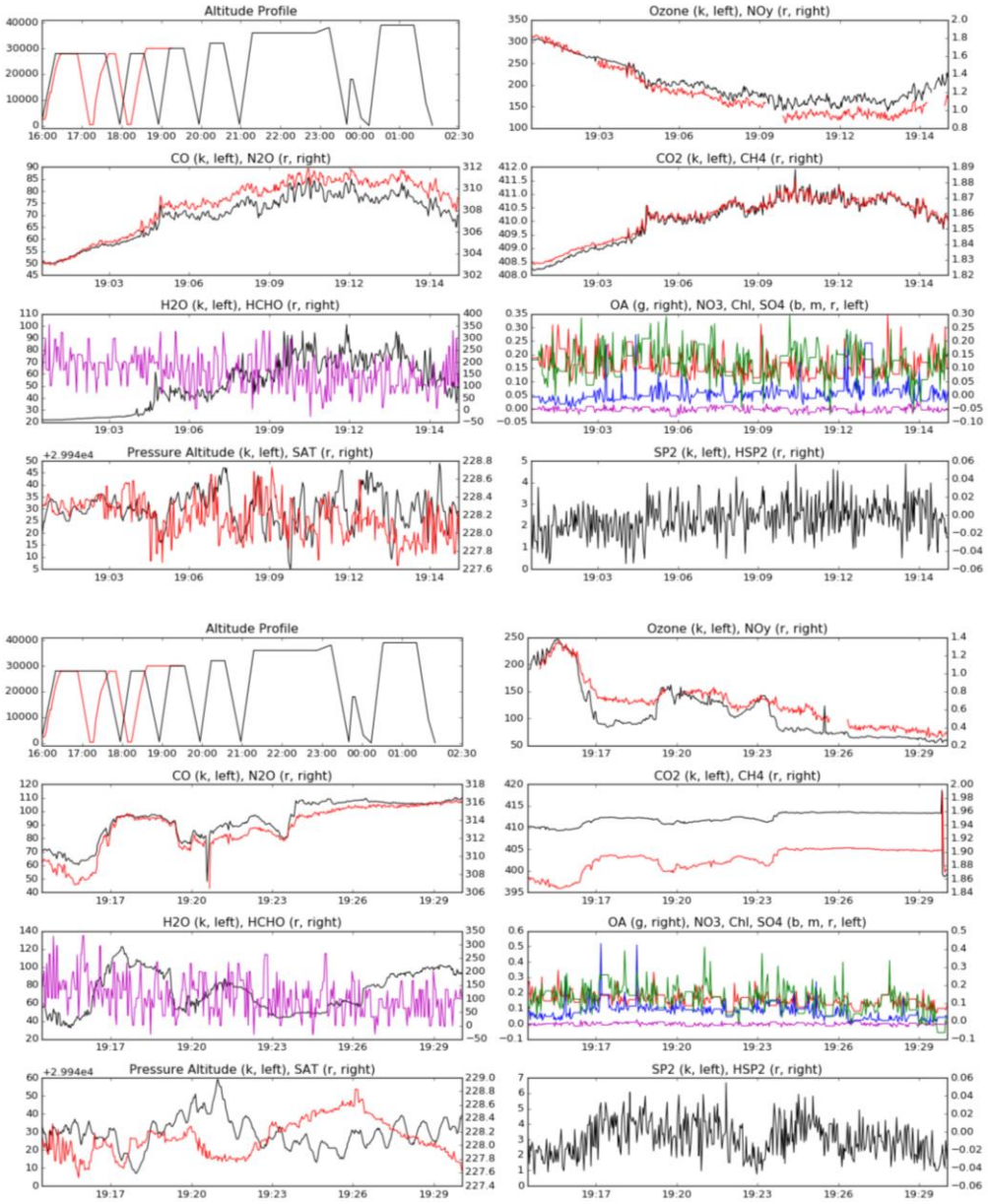
Water Vapor (DLH)	19.881	ppmv
RH/Water	4.79	%
RH/Ice	7.41	%
NO	0.098	ppb
NOy	1.939	ppb
O3	339.75	ppb
CO (QCLS)	41.3828	ppb
CH4 (QCLS)	1789.22	ppb
N2O (QCLS)	301.249	ppb
CO2 (PICARRO)	414.735	ppm



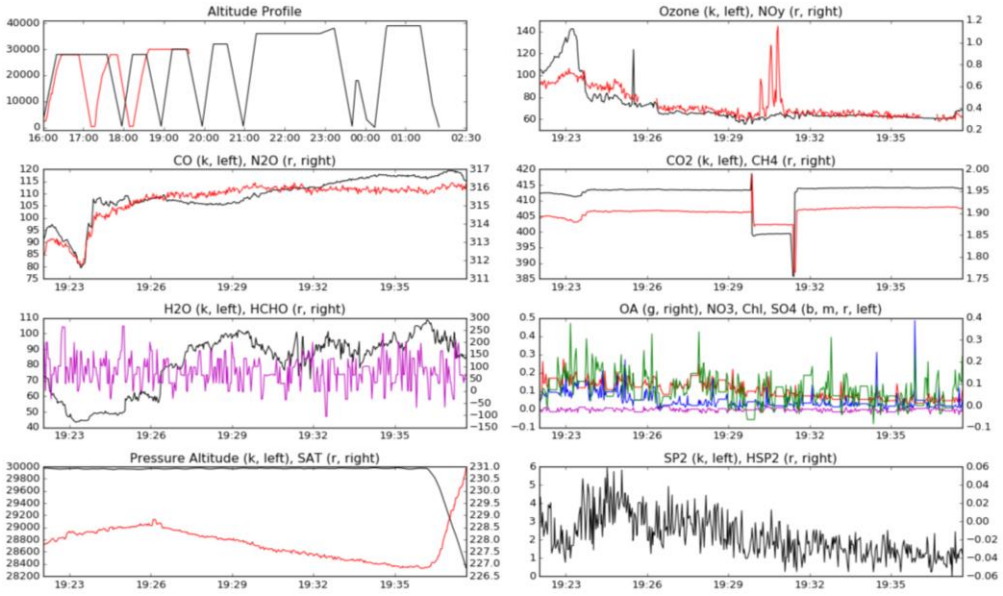
1857 –slowly dropping out of 300 ppb O3



1905 – 1914 + moderate turbulence over the low pressure system, visible in the gas species, turbulence drops at 1916 and then the air mass changes, O3 down to 100 after peaking again at 240 ppb at 1915



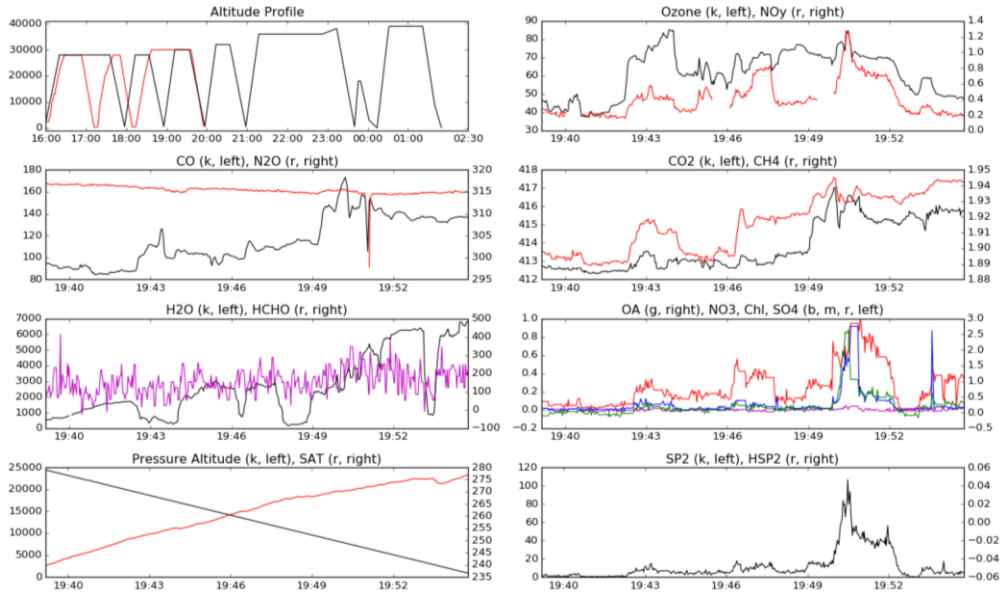
1931 – multiple, 10-sec spikes in NOy at 0.6 to 1.1 ppb, mostly NOx, and seen also in small particles – possible flight tracks ? H2O spikes 80-100 ppm maybe coincide.



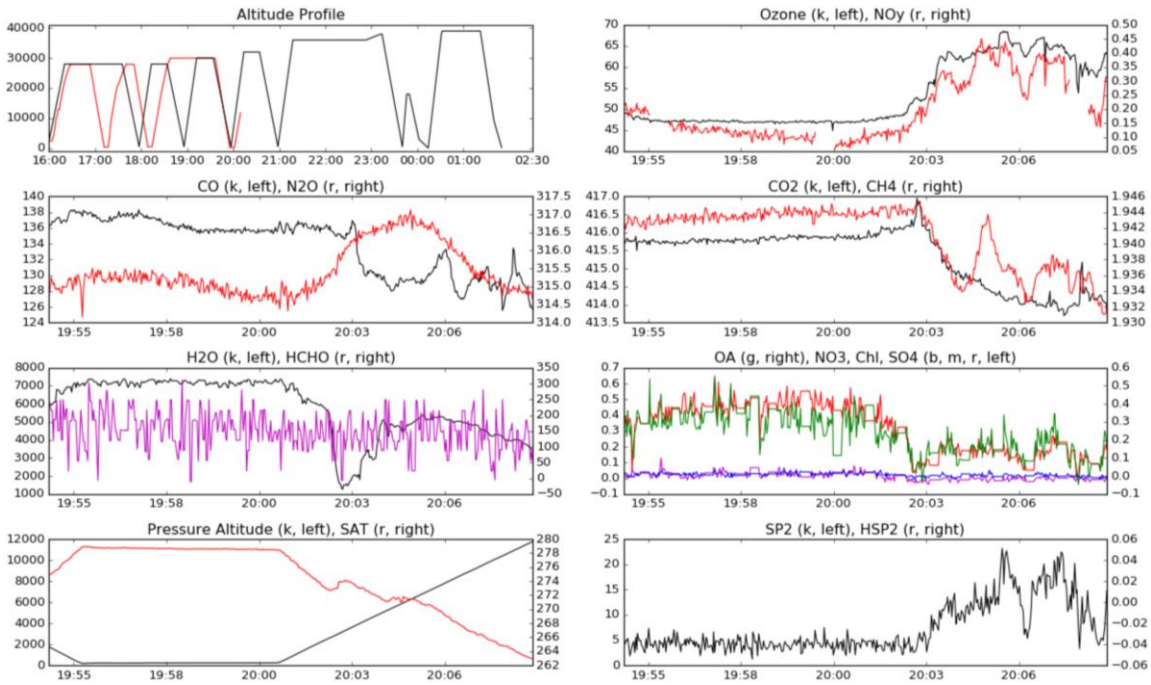
1936 begin descent for dip 3

1942 hit high O3, SP2 at 20 kft to 14 kft, then a second high layer, this also has high CO/CO2/CH4 tends to be dryer air. Note that SP2 maps tightly to H2O. Really dirty air above, at 2500 ft pollution looks scrubbed, turbulence, cloud tops.

1950-1953 SP2 large plume 50-100!! at 5-9 kft on way down, not as symmetric or intense on way out at 2006, but it is still there at higher altitude (8-10 kft) and less intense (15-20)



1955 at 500ft, MBL abundances persist until ~3 kft, (at 2003) then big drop in absol H2O (6000 to 1500), OA and sulfate, but sudden rise in SP2! (less intense than on the way down).



2014 Large CO spike, 1+ min wide, from 120 to 150, chem forecast says CO there, but should not other species respond? Comes with small particles (AMPS) and CO2/CH4

2028 reach FL320, RHi ~100% and H2O at 80 ppm

2030 level flight, diving into stratosphere, 2031, O3 at 265 ppb, NOy at 1.4 ppb, H2O at 27 burst of SP2 (1 to 3) as O3 increases, also burst of OA and sulfate.but drop in CO/CO2/CH4 at 2029, H2O does final drop from 80 to 20 ppm, O3 increases from 100 to 300, that region has particles.

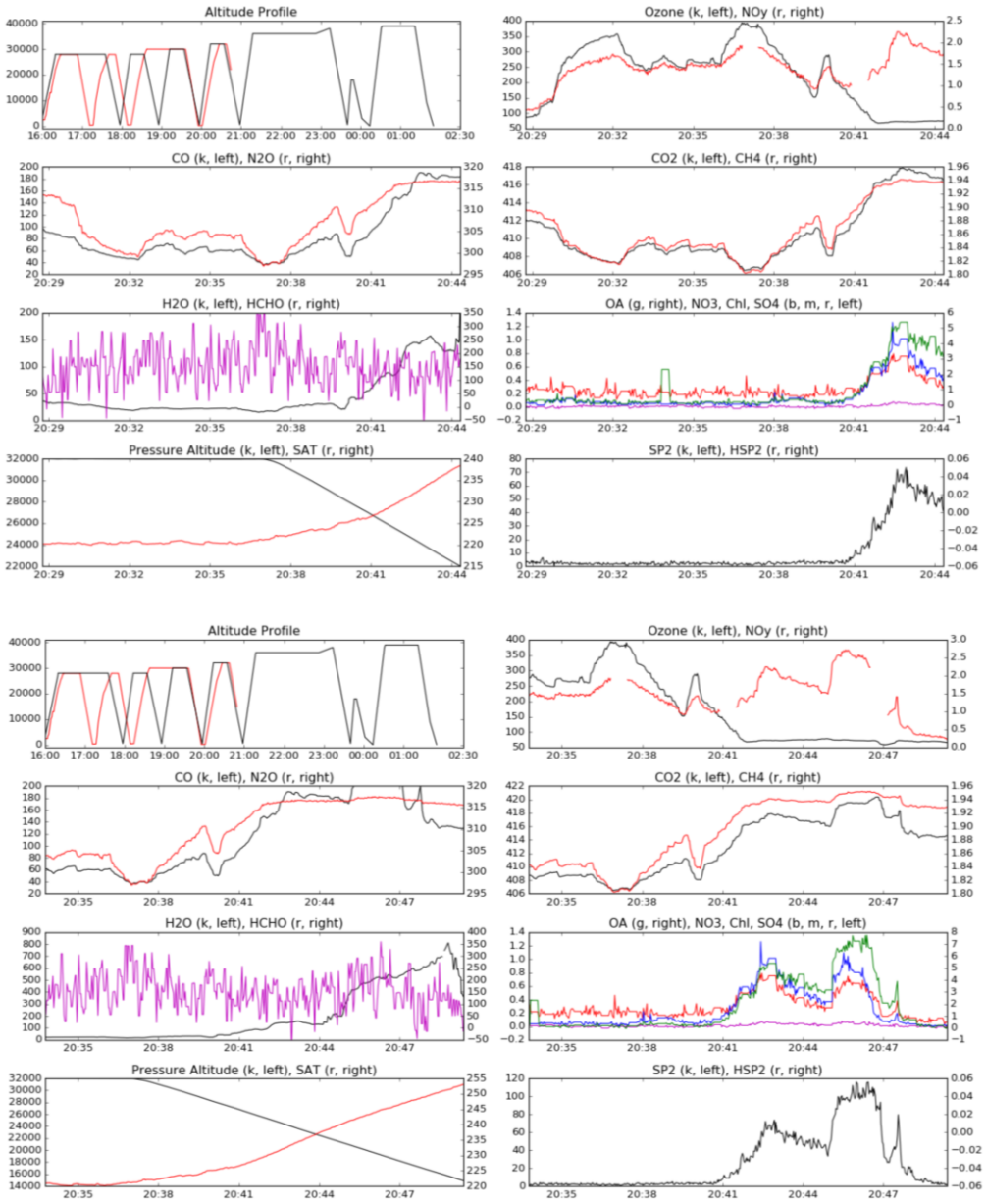
2037 strat descent into dip 4. 15 ppm H2O.

Sun Azimuth Ac	175.1	deg
Water Vapor (DLH)	17.405	ppmv
RH/Water	9.18	%
RH/Ice	15.32	%
NO		ppb
NOy		ppb
O3	383.36	ppb
CO (QCLS)	39.5979	ppb
CH4 (QCLS)	1769.8	ppb
N2O (QCLS)	297.457	ppb
CO2 (PICARRO)	406.736	ppm

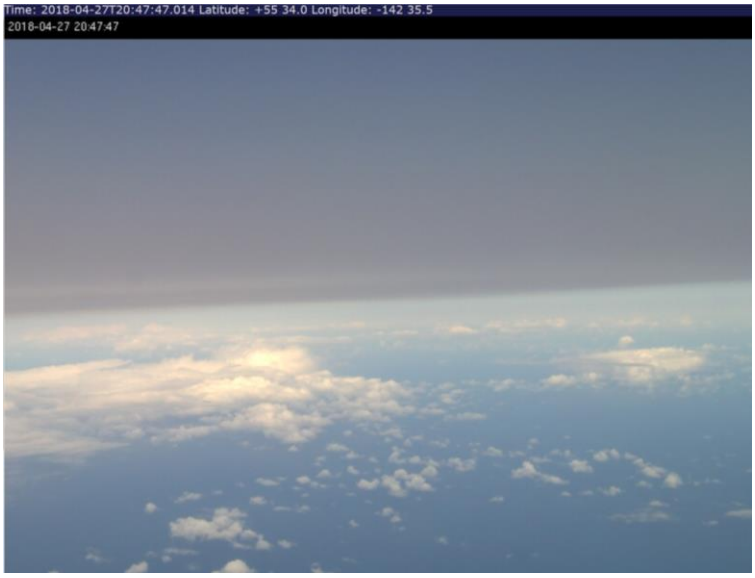
2040 obvious haze layer approaches, brown in nadir cam

coming into haze layer at FL250

2041 (25 kft) large amounts of PAN, formic acid, BB particles (high proportion). HCN elevated, most PAN ever seen. some Pb in particles, benzene up, CO off top at 200+, comparable to African BB, higher nitrate, NOy at 3 ppb

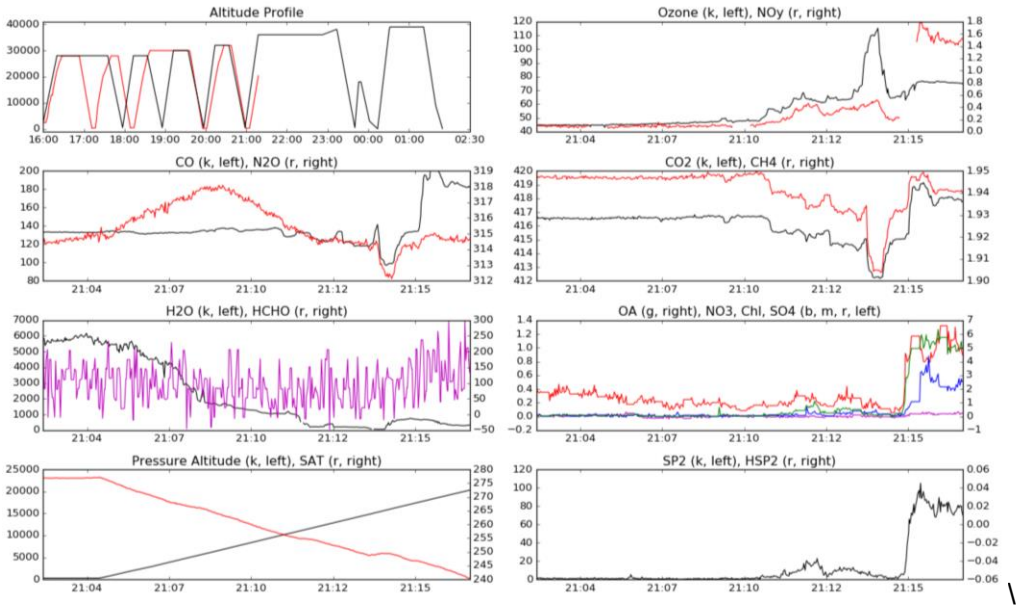


2047? just dropped out at 17.5 kft, O3 bouncing about 70 above 10 kft, now solid at 45 below it.
2047 haze layer obvioua above.

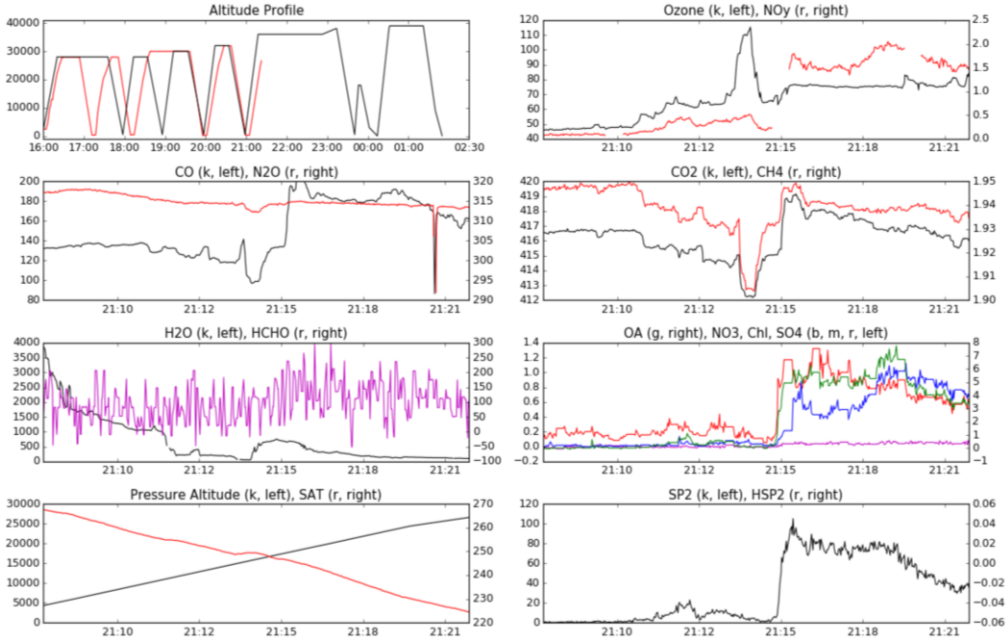


2059 level at 500 ft
2104 climb to FL360, haze layer obvious at 2015

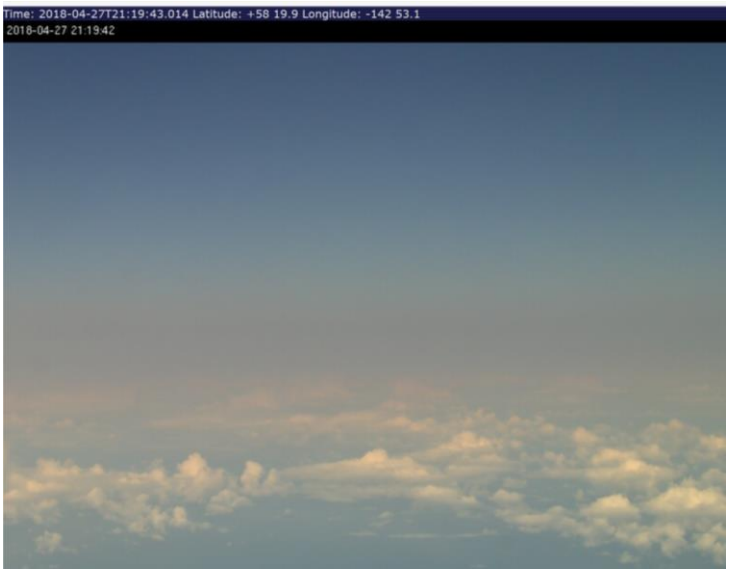
2111 coming out of dip 4 at about 10 kft, we hit the NOy, particles, then at 17kft we hit the big pollution layer (as coming down). A layer of strat (O3=110) just below this massive pollution plume. O3 again stable at 75 ppb in plume.



2114 climbing out of dip, funny O3 jump layers about a minute wide
2115 hit the big plume as in way down (17 kft) extends to 28 kft



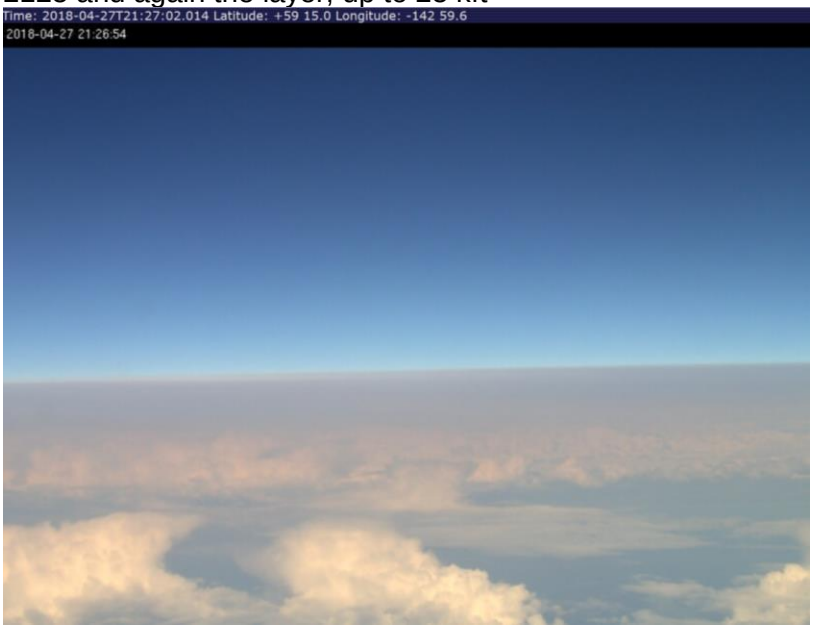
2119 looking down on haze layer



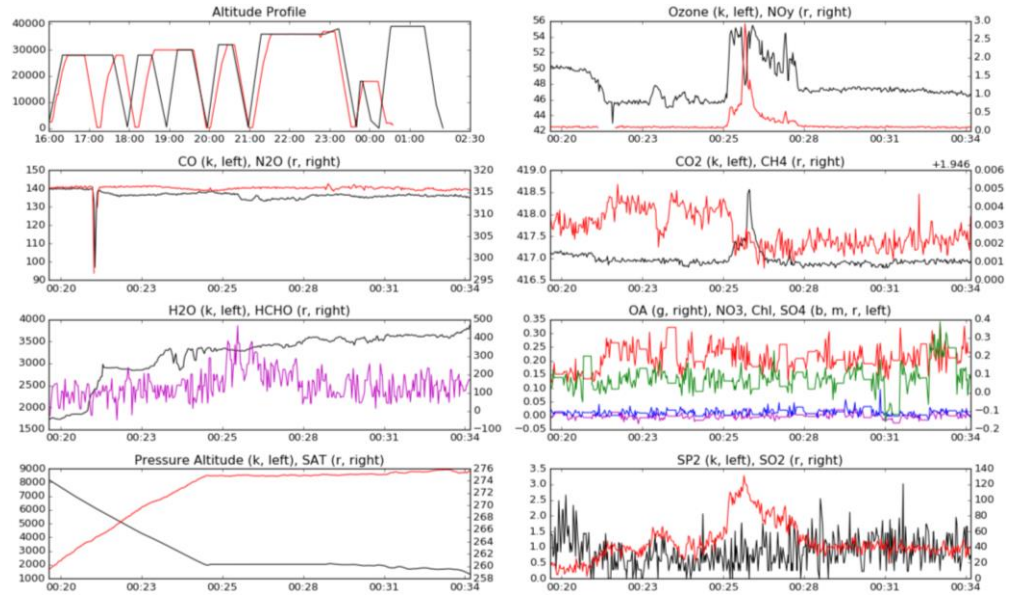
2124 sudden rise in O3 first to 250 (2124) and then to 550 (2129)

Water Vapor (DLH)	6.351	ppmv
RH/Water	2.31	%
RH/Ice	3.75	%
NO	0.131	ppb
NOy	2.663	ppb
O3	548.91	ppb
CO (QCLS)	17.6306	ppb
CH4 (QCLS)	1714.34	ppb
N2O (QCLS)	287.372	ppb
CO2 (PICARRO)	404.398	ppm

2125 and again the layer, up to 25 kft

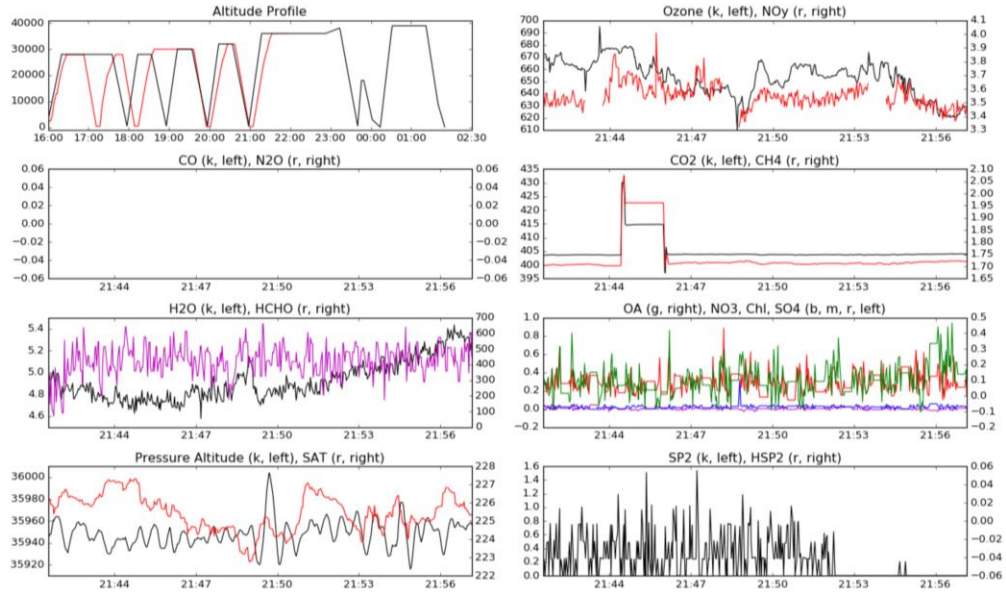


2133 level at FL360

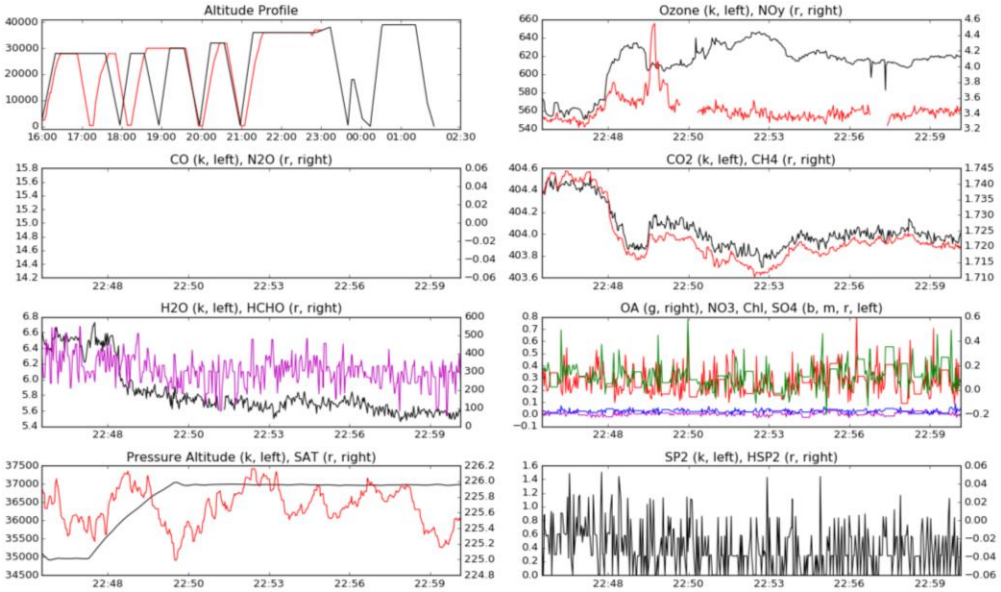


2134-2136 cross into Alaska

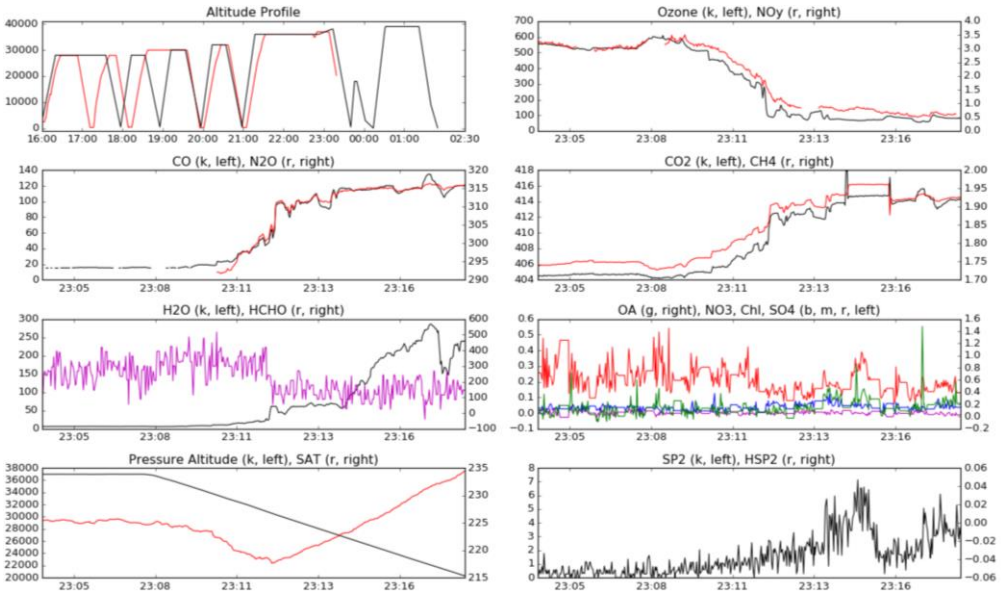
2144 – 2200 FL 360, welcome to the stratosphere! H2O = 5.6, O3 = 580!, clear strat SO4 aerosols, CO = 14, still some OA and SO4 (in proportion 1:3 as Dan has found)



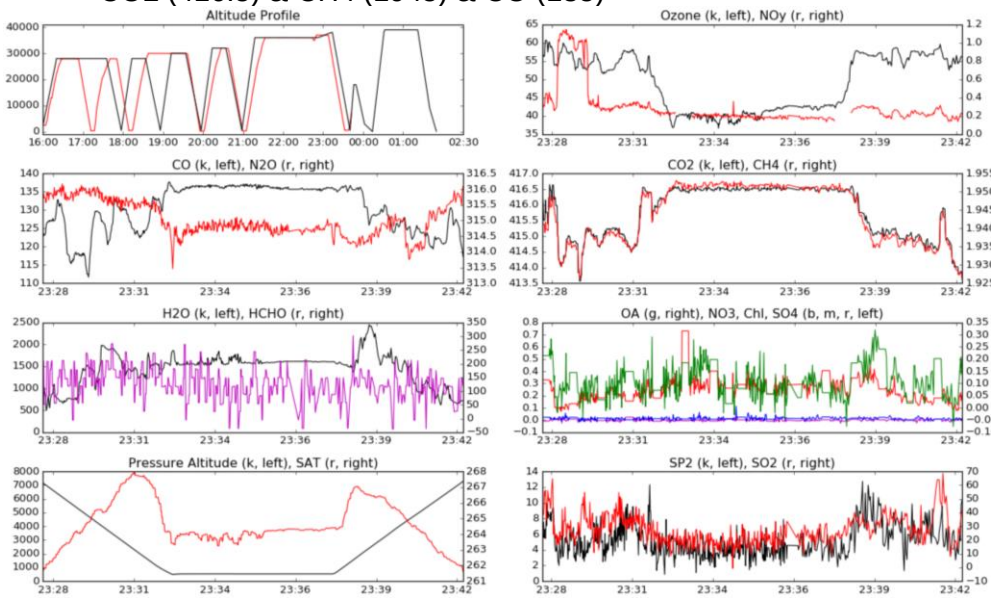
2230 dip to FL350 for air traffic, now flat at FL370, Quiet across the Brooks Range.
2248 – O3 level at 620, NOy 3.4, but spike to 4.5 when O3 dropped 630 to 600 (CO2/CH4 small jump up). Background strat levels of OA and sulfate (1:3), typical.



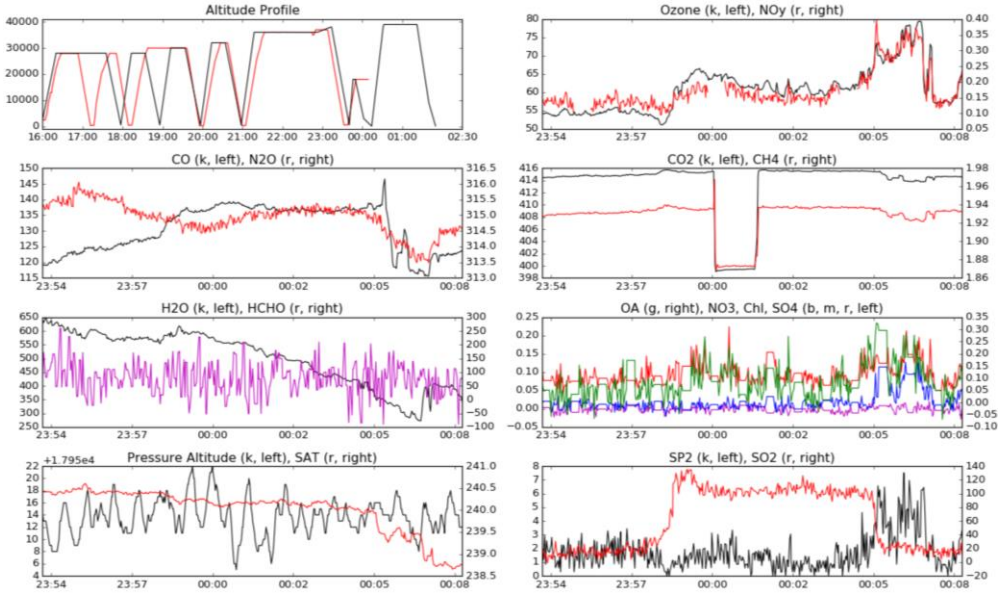
2308 – heading down from FL370 to 500ft over Arctic ocean nothing new with strat chemistry, thick cloud below over ocean.FL290, RHi at 80% FL 250 reach RHi 100% over extensive region at 130% !!!



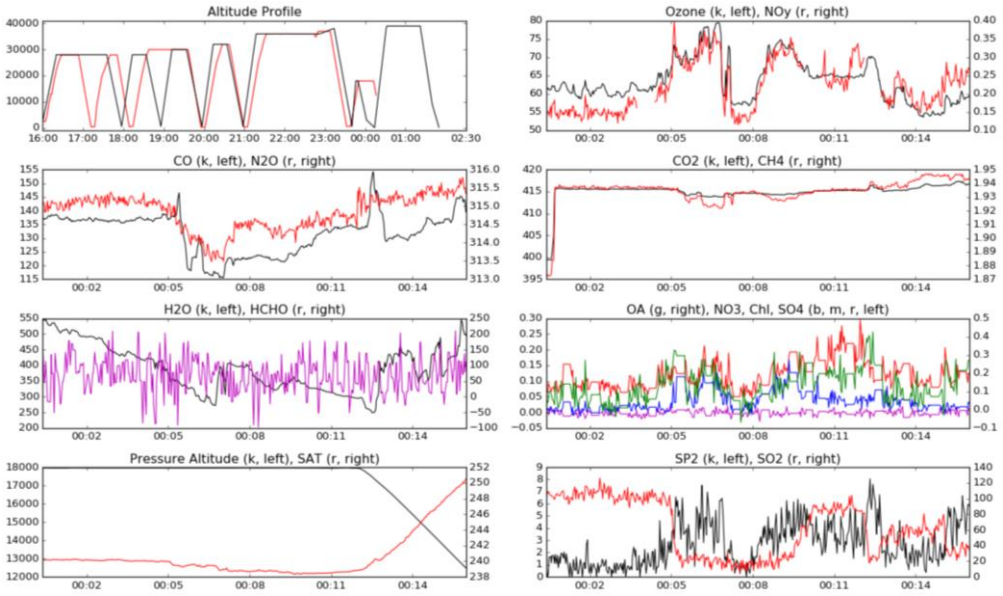
2332-2337 Arctic sea ice at 500 ft, perfect radiative inversion, very calm, low O3 (40) but high CO2 (416.5) & CH4 (1945) & CO (135)



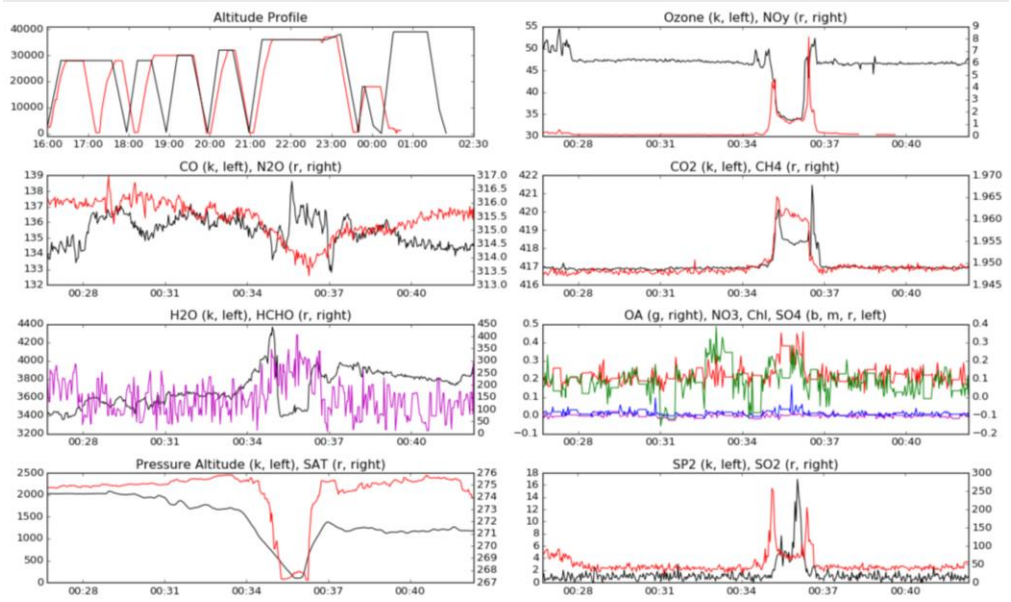
2350 on our way to Barrow at FL180, Ice Clouds CAPS gets very nice ice crystals. RHi > 100%
2354 still RHi >100%
2358 at FL180, suddenly SO2 (Prudhoe?) It goes along with an O3 jump from 55 to 65, so different air mass.



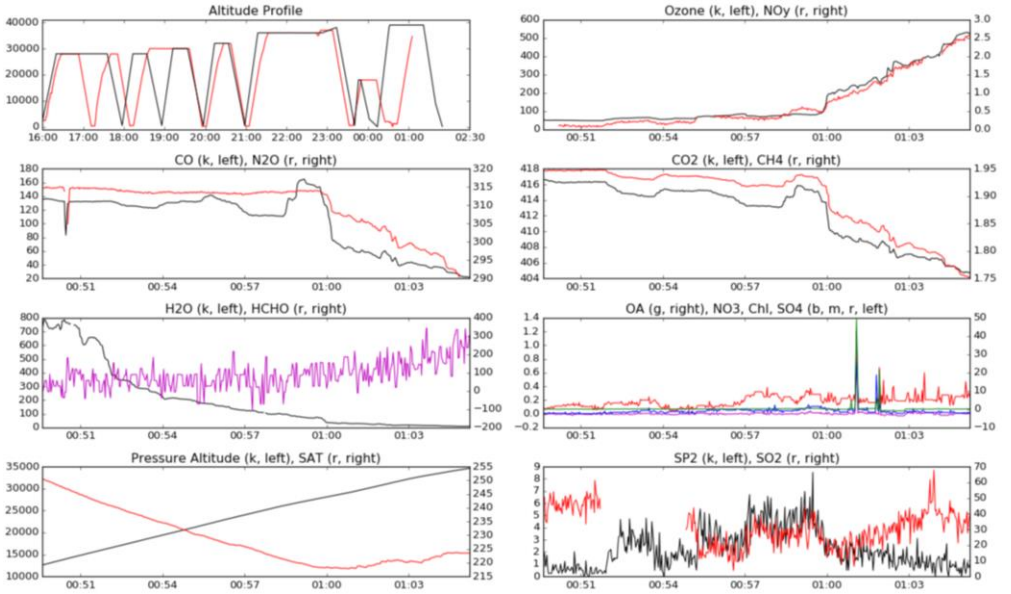
0012 start descent to Barrow, lots of variability in O3, CO and particles.



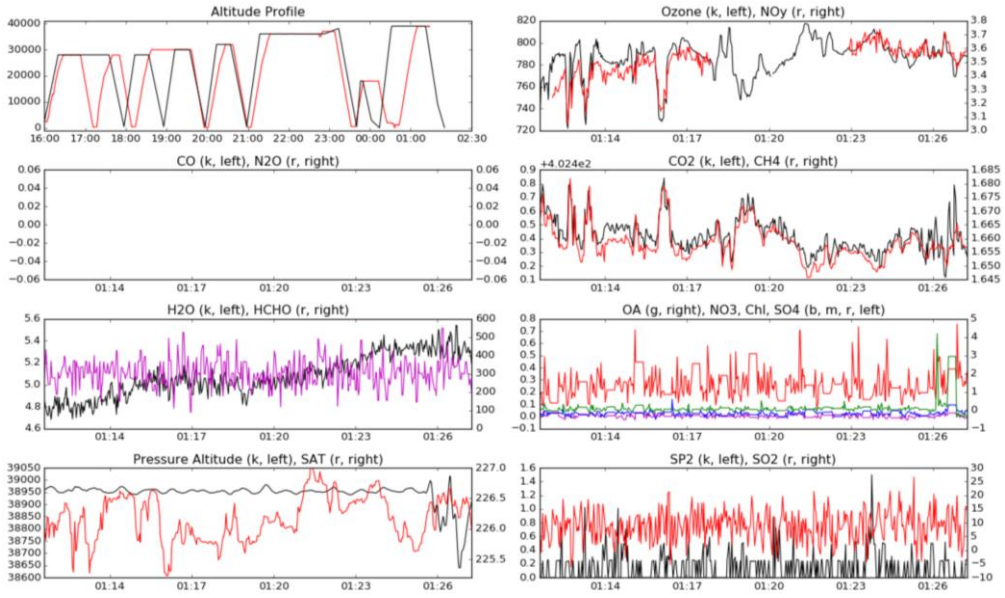
0036 Barrow, high PAN at Barrow (well what else would you expect)



0100 A new type of stratosphere: SO2 galore even at 35 kft with 550 O3. small particles seen at 0105 with the SO2

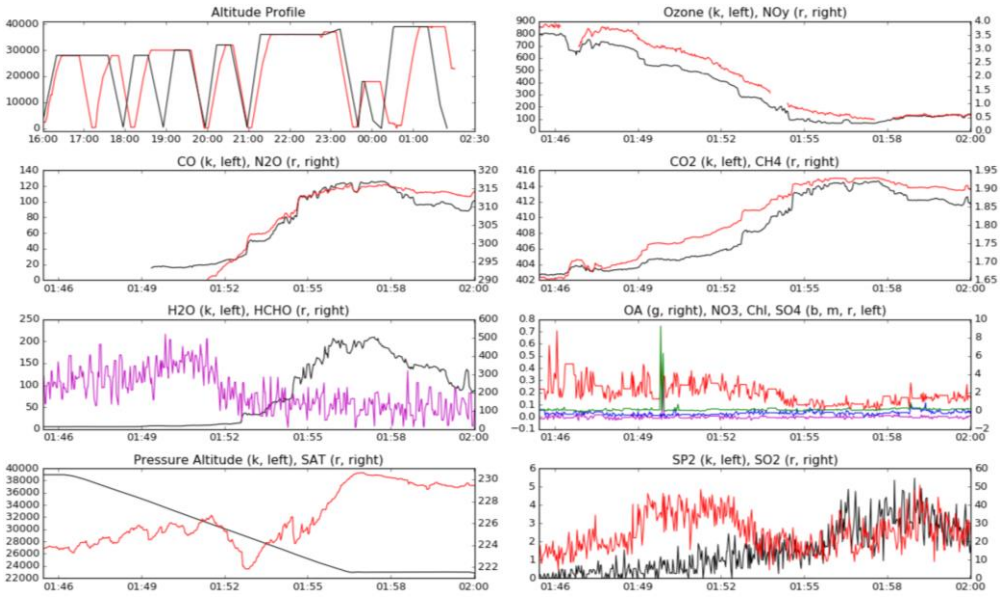


0114-0126 CO2 drops below 403, very low for particles, almost nothing in CAPS

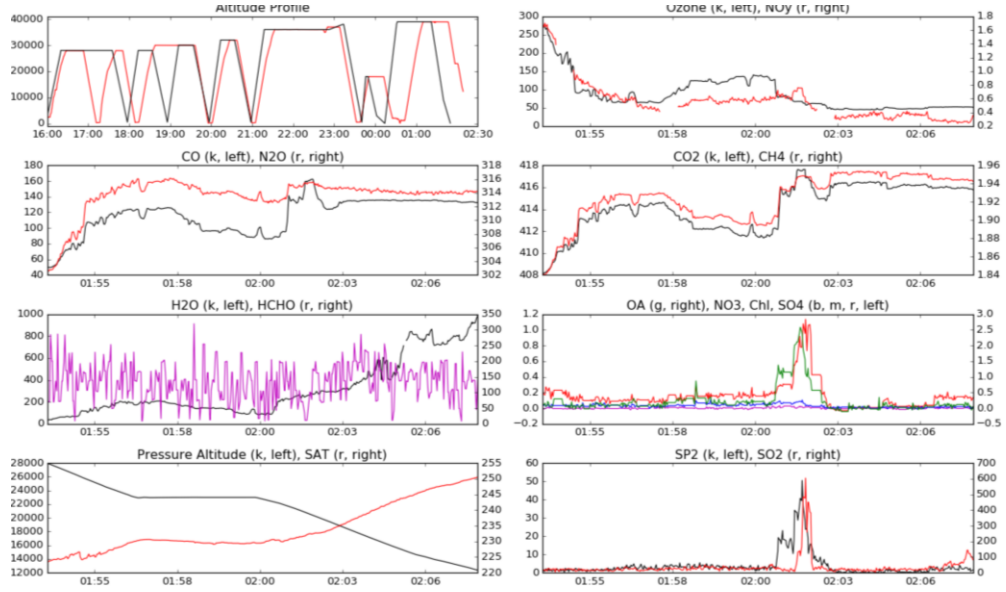


118 01:32:35.013								
Latitude	+65 53.2	deg min	Static Air Temp	-47.2	deg C	Sulfate	0.33	ug/m^3
Longitude	-152 03.8	deg min	Total Air Temp	-19.0	deg C	Nitrate	0.017	ug/m^3
Pressure Altitude	38974	ft	Potential Air Temp	359.3	K	Total Organic	0.242	ug/m^3
Radar Altitude	35598	ft	IR Surface Temp	-1.3	deg C	Chloride	-0.008	ug/m^3
GPS Altitude (WGS84)	37451	ft	Dew Point Temp	-64.5	deg C	NH4	0.034	ug/m^3
True Heading	170.8	deg						
			Solar Zenith Angle	62.9	deg	SF6 (PANTHER)	8.7	ppt
Ground Speed	457	knots	Sun Elevation-Grd	28.0	deg	HCHO (ISAF)	300.75	ppt
True Airspeed	464	knots	Sun Elevation-AC	27.1	deg	BUTANE	0.135	ppt
Indicated Airspeed	245	knots	Sun Azimuth-Grd	-120.8	deg	METHANOL	26.815	ppt
Mach	0.792		Sun Azimuth-AC	67.9	deg	ACETONE	58.434	ppt
Vertical Velocity	32	ft/m				ACETONITRILE	126.576	ppt
			Water Vapor (DLH)	5.353	ppmv	ISOPRENE	1.229	ppt
Pitch	1.7	deg	RH/Water	1.2	%	DMS	2.364	ppt
Roll	-0.2	deg	RH/Ice	1.91	%	CH2CL2	33.028	ppt
Drift Angle	-2.1	deg				BENZENE	0.135	ppt
Wind Speed	16	knots	NO		ppb	TOLUENE	0.791	ppt
Wind Direction	243	deg	NOy	3.711	ppb	CHBR3	0.913	ppt
			O3	803.42	ppb	MVK	2.274	ppt
Dist To Go	256.1	nm	CO (QCLS)	11.3043	ppb	CHCL3	0	ppt
Time To Go	33.6	min	CH4 (QCLS)	1633.01	ppb			
			N2O (QCLS)	265.286	ppb	JNO2 Nadir	0.00504	/sec
Cabin Altitude	6612	ft	CO2 (PICARRO)	402.658	ppm	JNO2 Zenith	0.00934	/sec
Static Pressure	197.0	mb						
						AO2 O2	31.38	per meg
						AO2 CO2	429.035	ppm

0146 START descend to ANC
0150 odd OA spike, from where?
0152 leave the true strat at 24 kft as H2O jumps to >20 and O3 falls below 400, large amount of SO2 in this strat.



0202 – caught the same 20 kft pollution layer as seen over before



End of flight debrief: all instruments had a good flight, but NOyO3 had problem with O3 generator box, QCLS had cal-gas injection problem, ATHOS lost early-fight zero-air (fixed), SO2 lost 5 min mistuning laser, CIT-CIMS had a minor electrical problem in mid-flight. CAPS has a 'most interesting flight for cloud particles.

End