Atmosphere Considerations and Advantages

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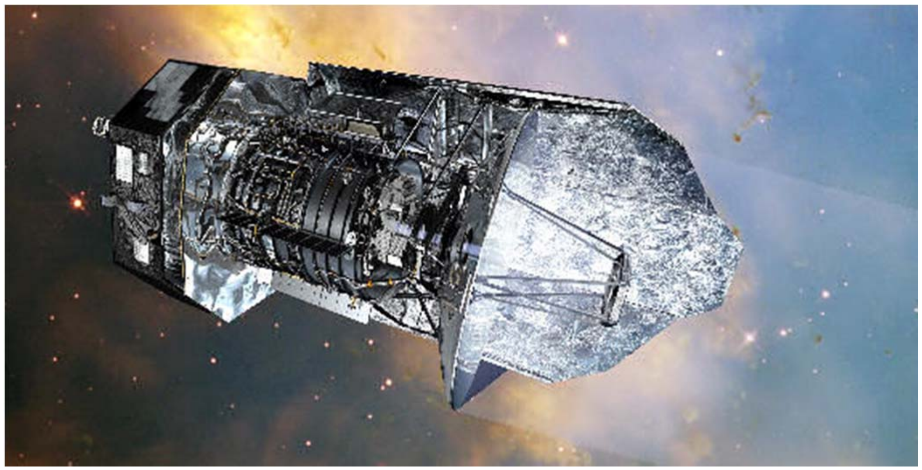
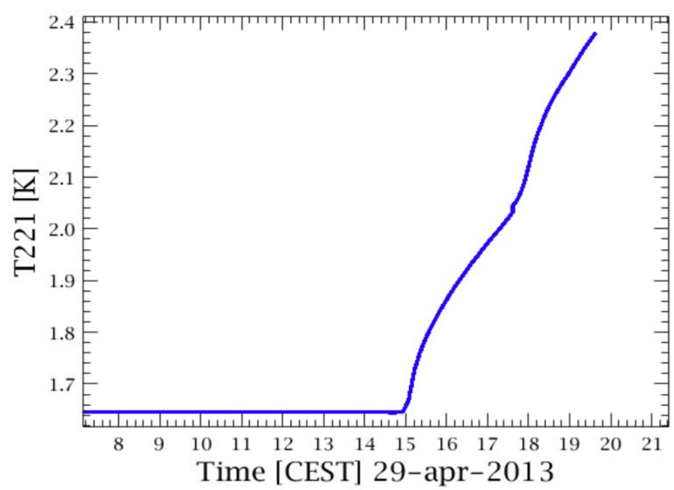
(Ah, Goodbye, Herschel....)





Scope of this talk

- I have modeled the atmosphere in the FIR using a program I wrote at NASA-Ames – ATRAN.
- ATRAN is about one of 4 such programs available
- For a comparison see Guan, X, Stutzki, J et al 2012
- They do differ by several percent, but this is not relevant for the purposes of this talk.

X. Guan et al.: GREAT/SOFIA atmospheric calibration

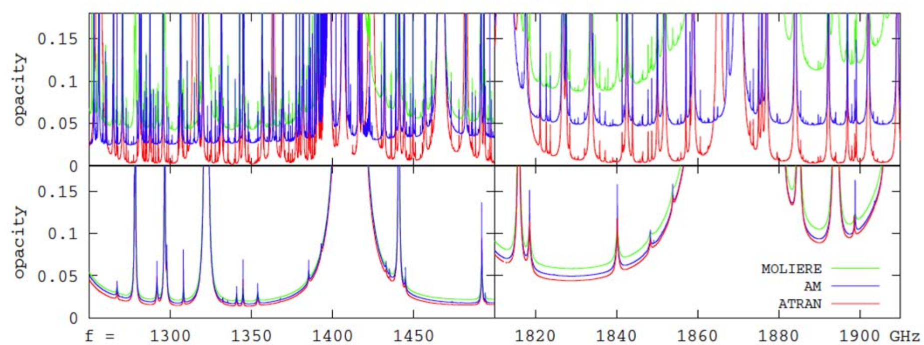
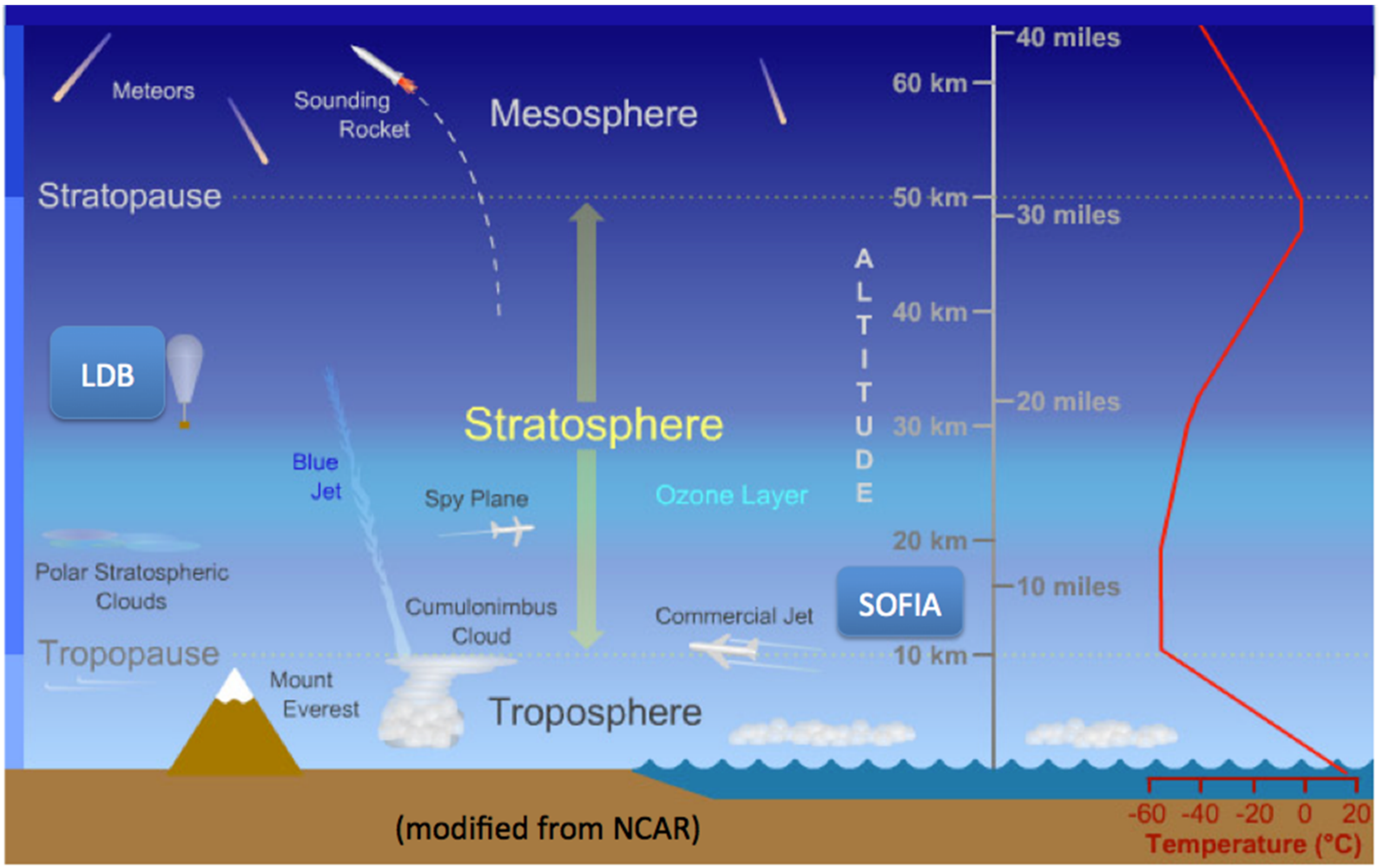


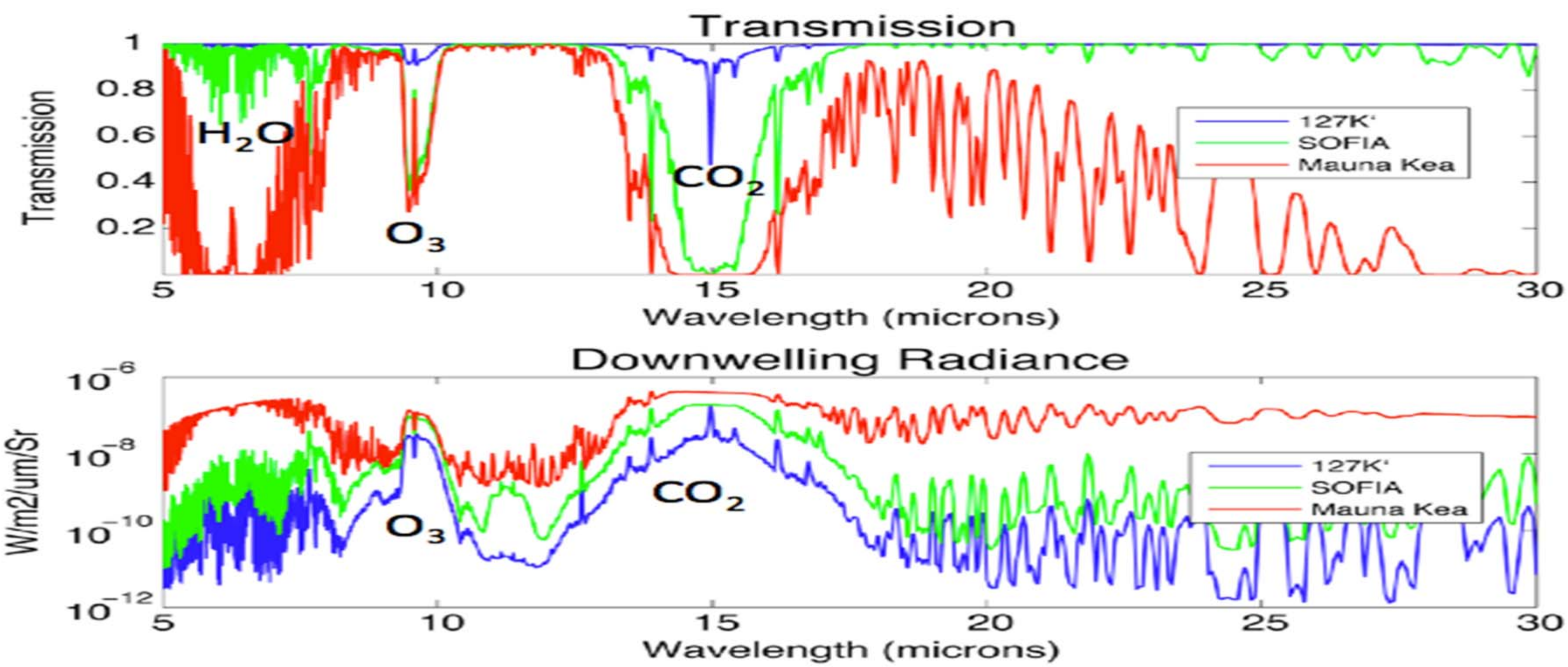
Fig. 1. Comparison of the dry (*top*) and wet (*bottom*) opacity coefficients as defined in Eqs. (6), (A.29) and (A.27) for the frequency range of GREAT channels *L1* (*left*) and *L2* (*right*), calculated from the atmospheric models AM, ATRAN and MOLIERE (see text), showing the opacity for a pressure altitude of $p_{\rm amb}$ = 133 Torr and a *pwv* = 10 μm. The largest discrepancy is in the quasi-continuous dry-atmospheric opacity due to collision-induced absorption (CIA), which is completely neglected in ATRAN and differs by about a factor of 2 between MOLIERE and AM.

The regime: 20,000' to 95,000'



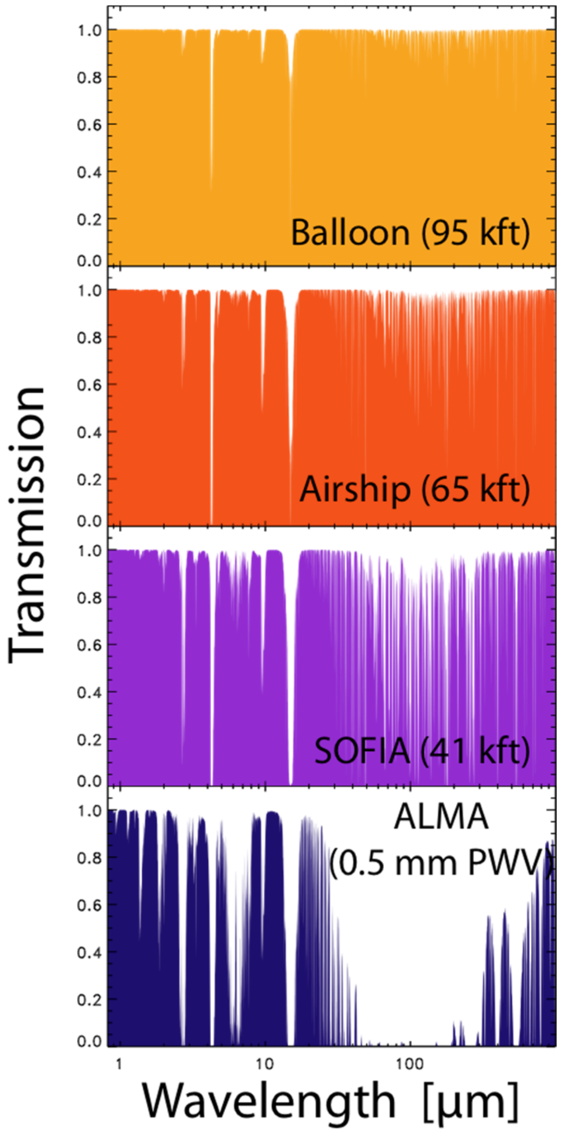
Scope (Continued)

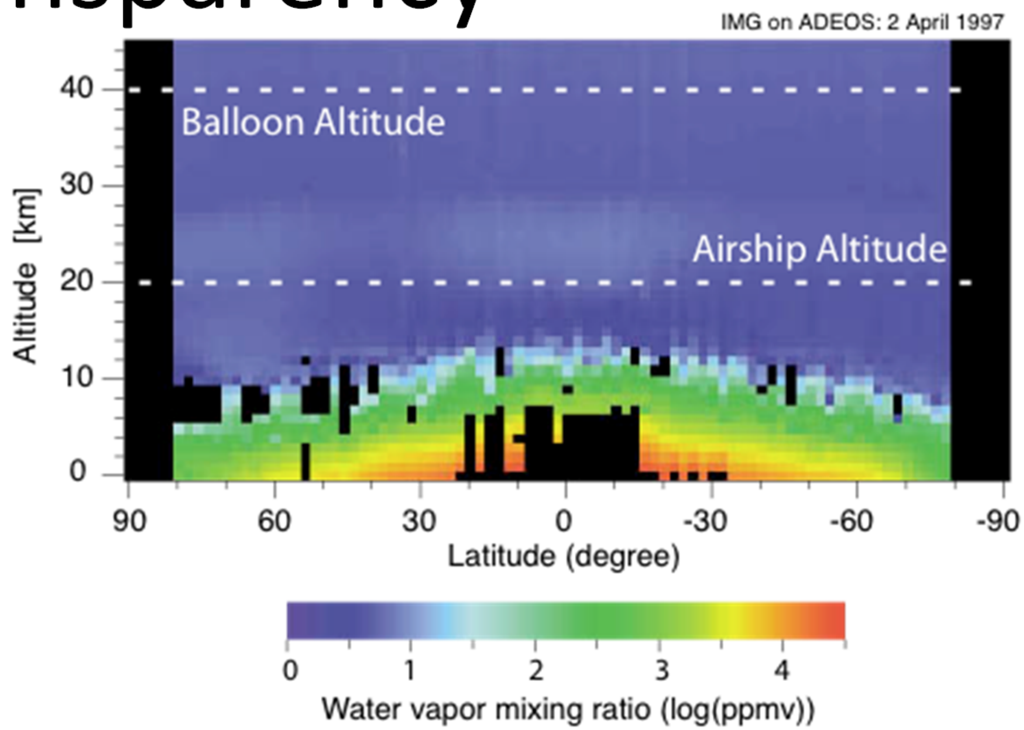
- I will show models (that I have used) for astronomical investigations, and apply them at various altitudes. I only consider emission below: (c/o E. Young)
- Relevant to BLIP NEP of detectors



St

Astronomy: Atmospheric Transparency

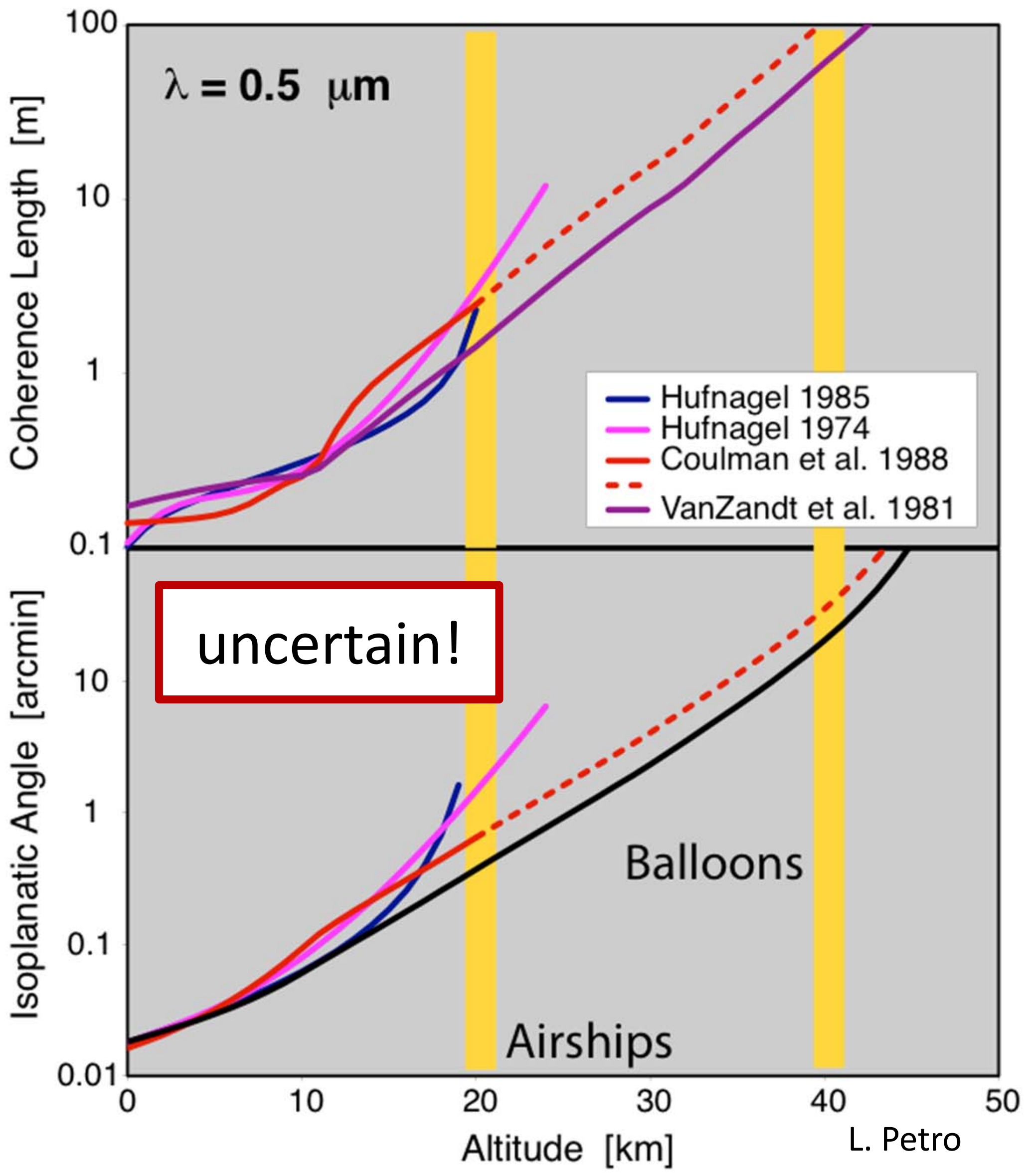




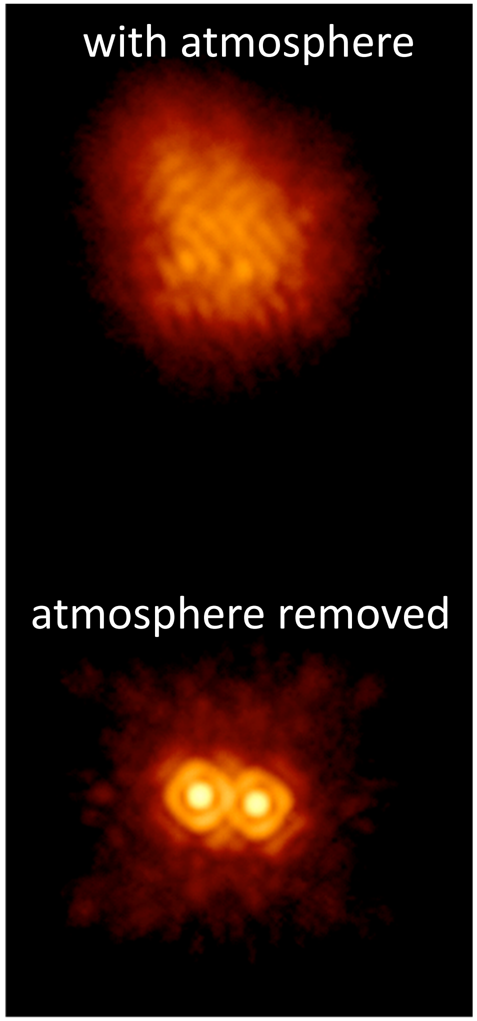
Steven Lord, Caltech
(custom made)

balloons and airships are
above most water

Astronomy: Image Quality



L. Petro



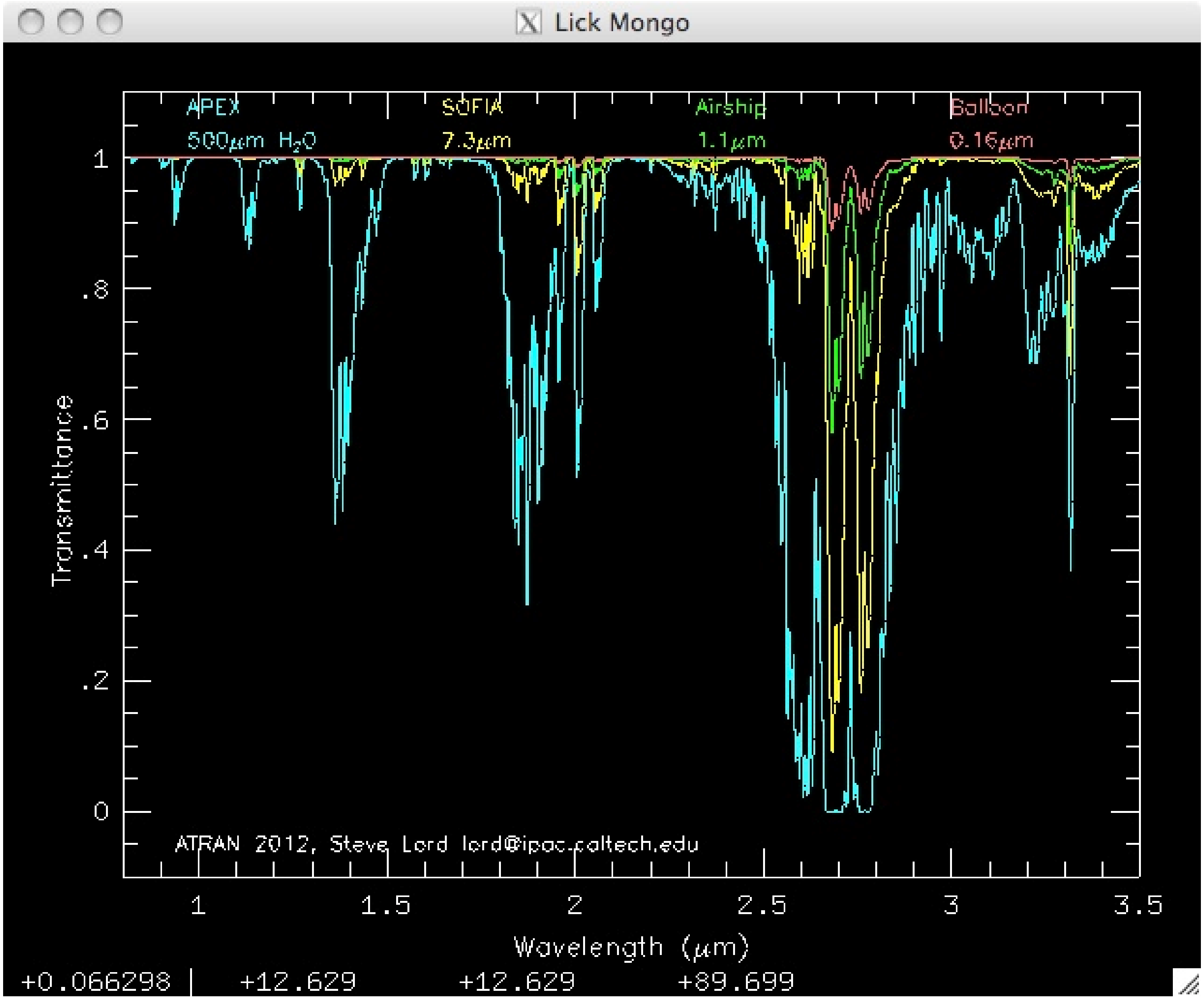
IW Tau: Beichman & Tanner

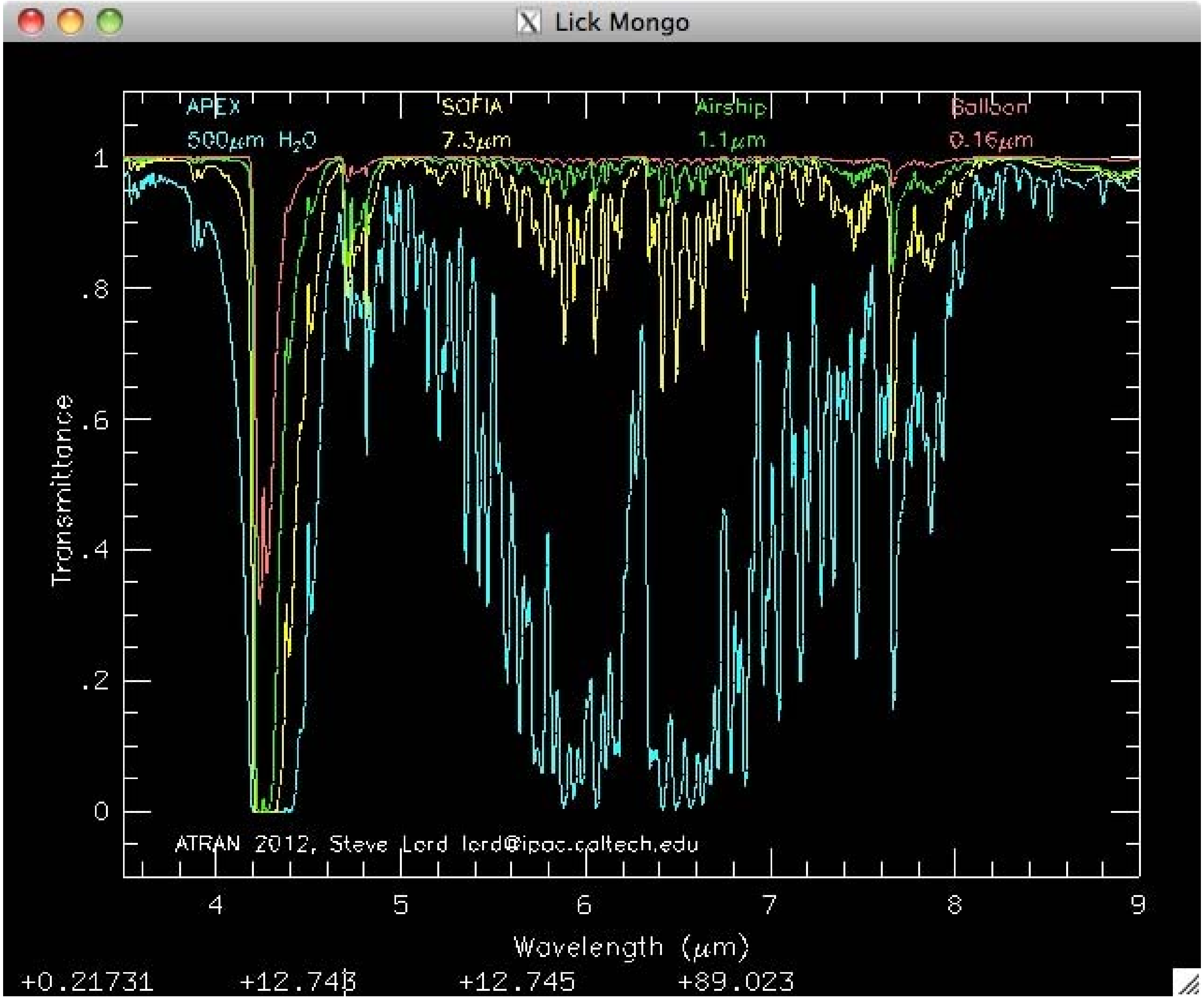
Modeling the Transmittance for 3 Observatories:

Obs	alt (ft)	H2O um	O3 (cm2)	ZA
Alma	16597.	500.000	0.91E+19	0.
SOFIA	41000.	7.300	0.91E+19	0.
Airship	65000.	1.100	0.91E+19	0.
Balloon	95000.	0.157	0.38E+19	0.

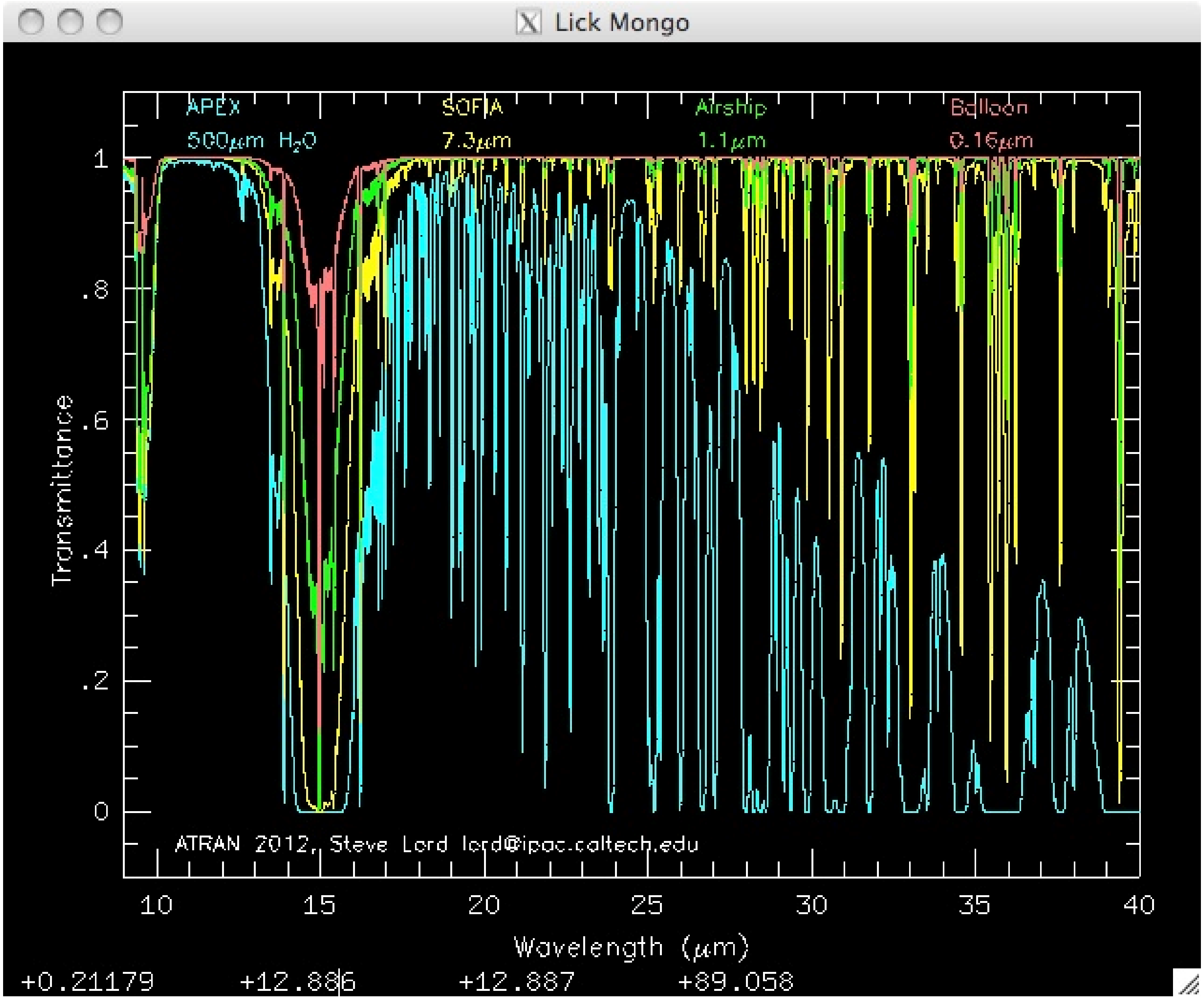
Resolution used for the plots below:

lam 1 (um)	lam 2 (um)	resolution (um)
0.82	3.5	0.005
3.5	9	0.01
9	40	0.05
40	100	0.1
100	160	0.5
150	300	0.5
300	1000	1.0

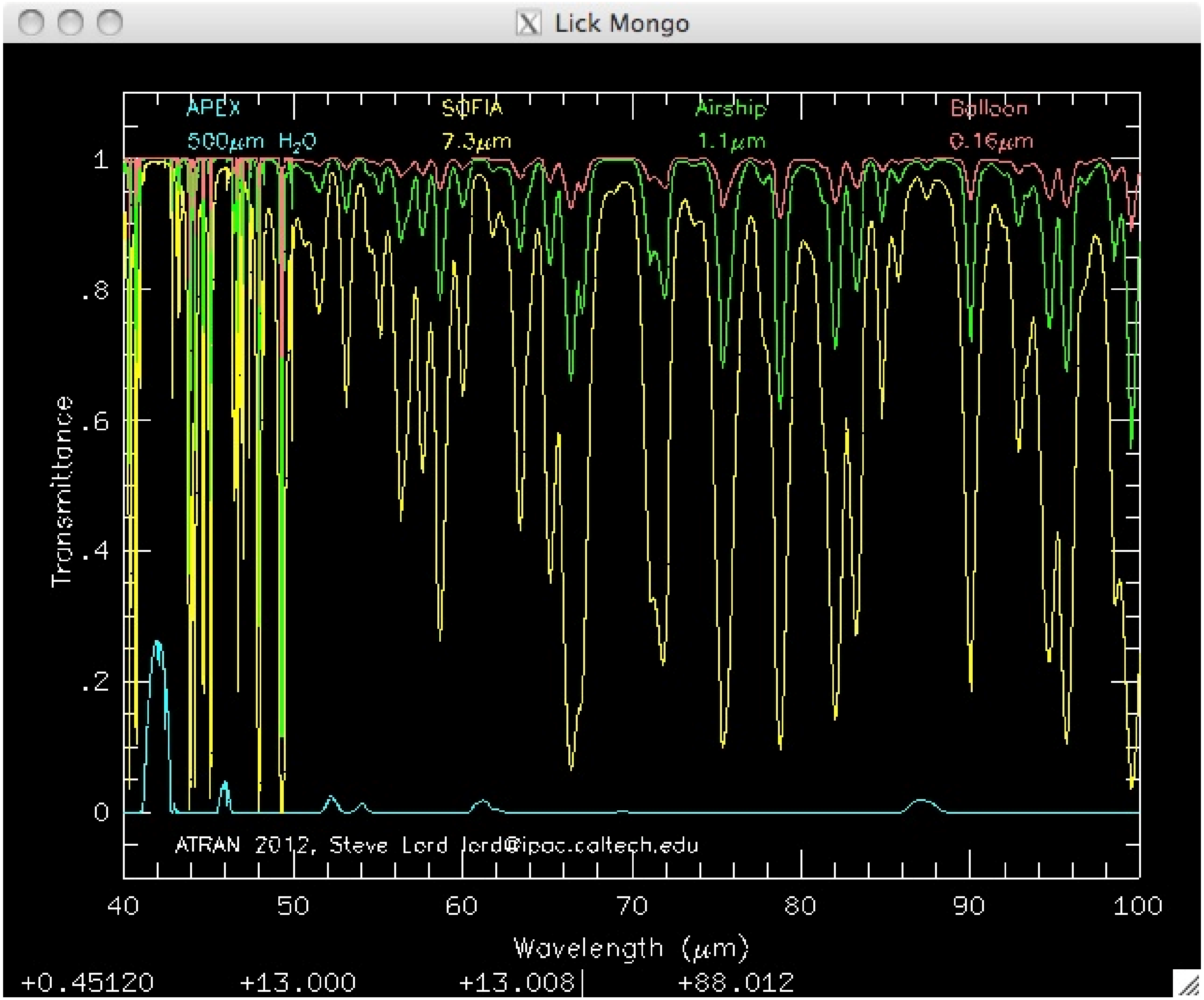

Lick Mongo
APEX
500μm H2O
SOFIA
7.3μm
Airship
1.1μm
Balloon
0.16μm
Transmittance
1
.8
.6
.4
.2
0
ATRAN 2012, Steve Lord lord@ipac.caltech.edu
1
1.5
2
2.5
3
3.5
Wavelength (μm)
+0.066298
+12.629
+12.629
+89.699

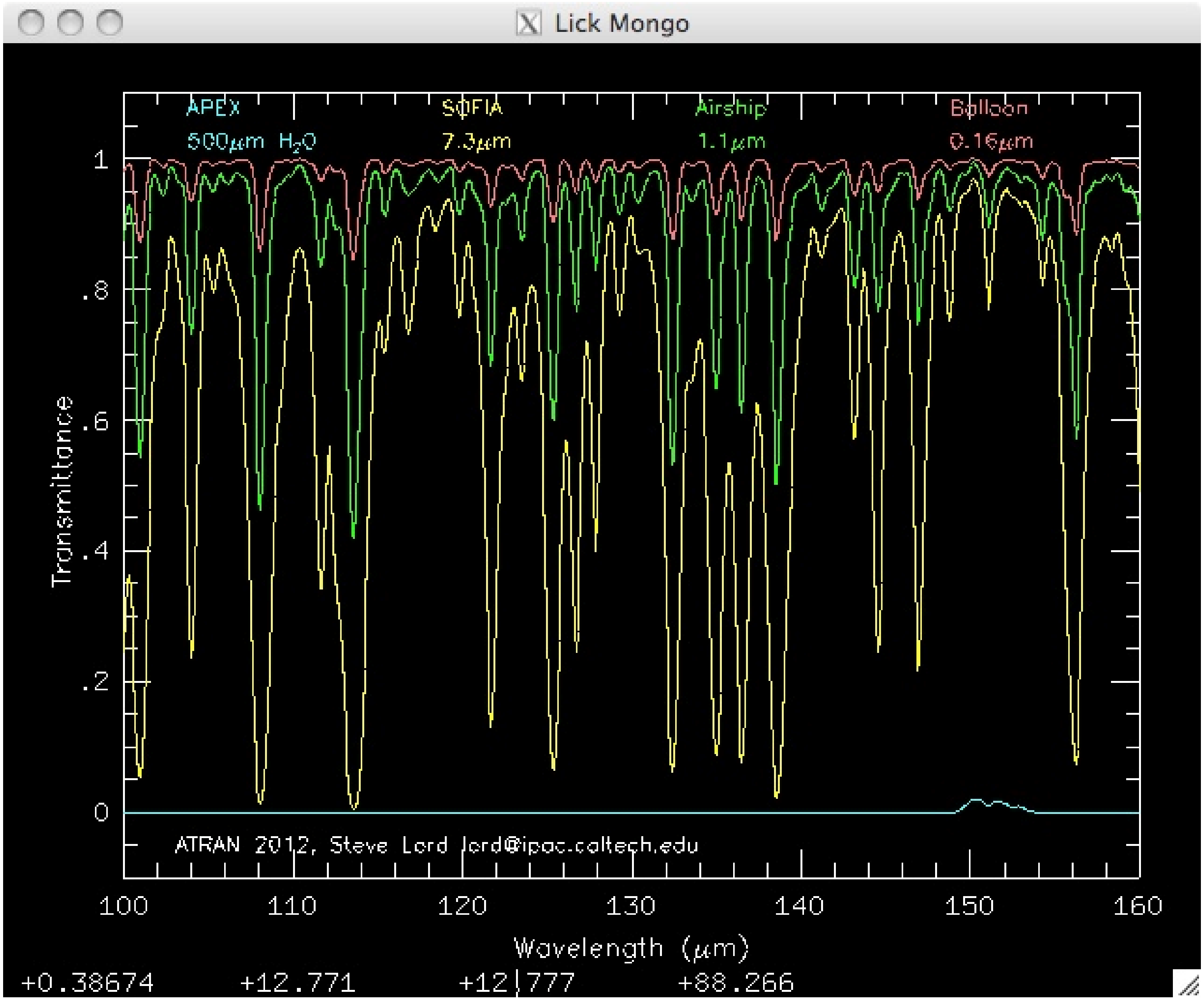


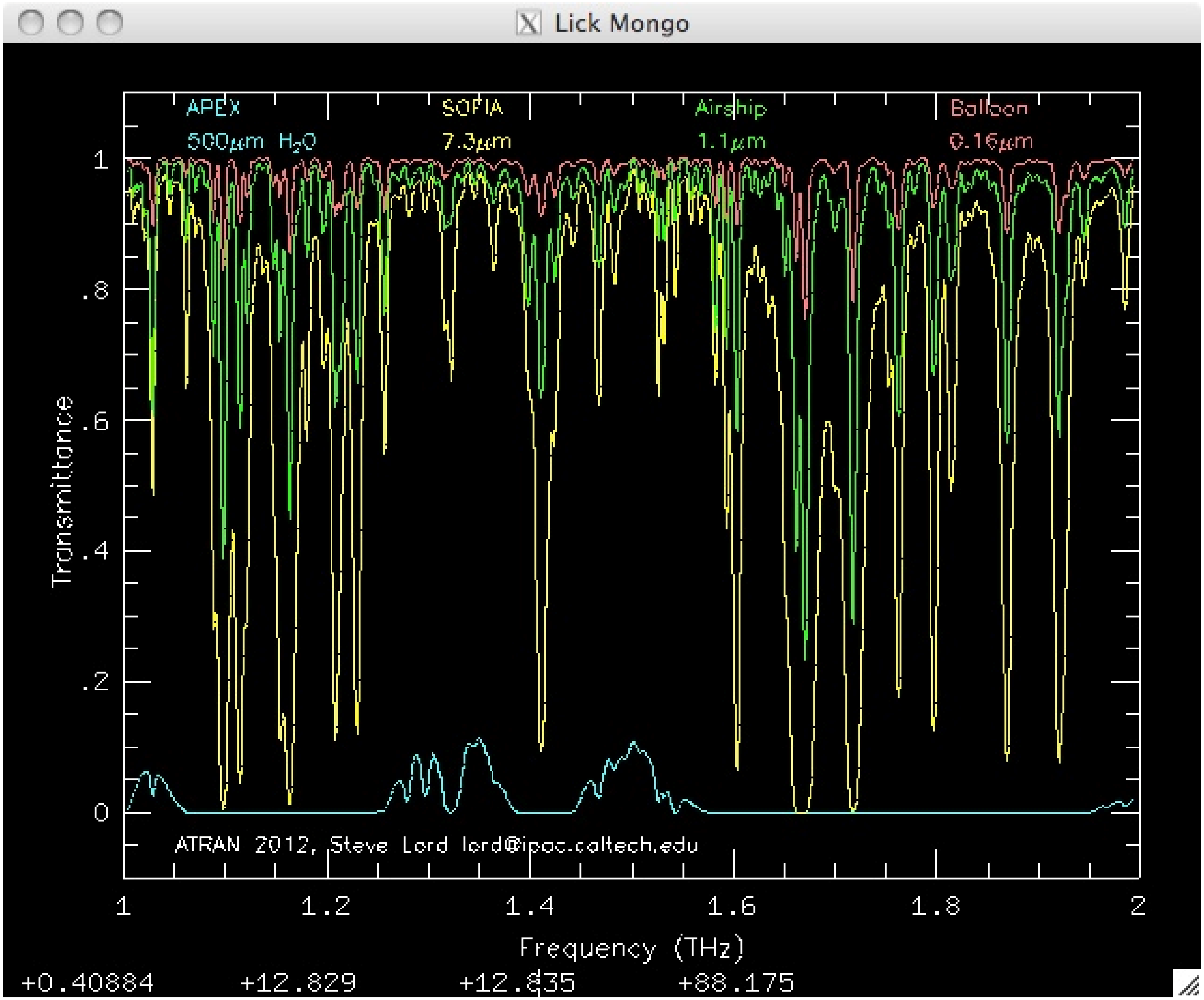
Lick Mongo
APEX
500μm H2O
SOFIA
7.3μm
Airship
1.1μm
Balloon
0.16μm
Transmittance
1
.8
.6
.4
.2
0
ATRAN 2012, Steve Lord lord@ipac.caltech.edu
4
5
6
7
8
9
Wavelength (μm)
+0.21731 +12.743 +12.745 +89.023

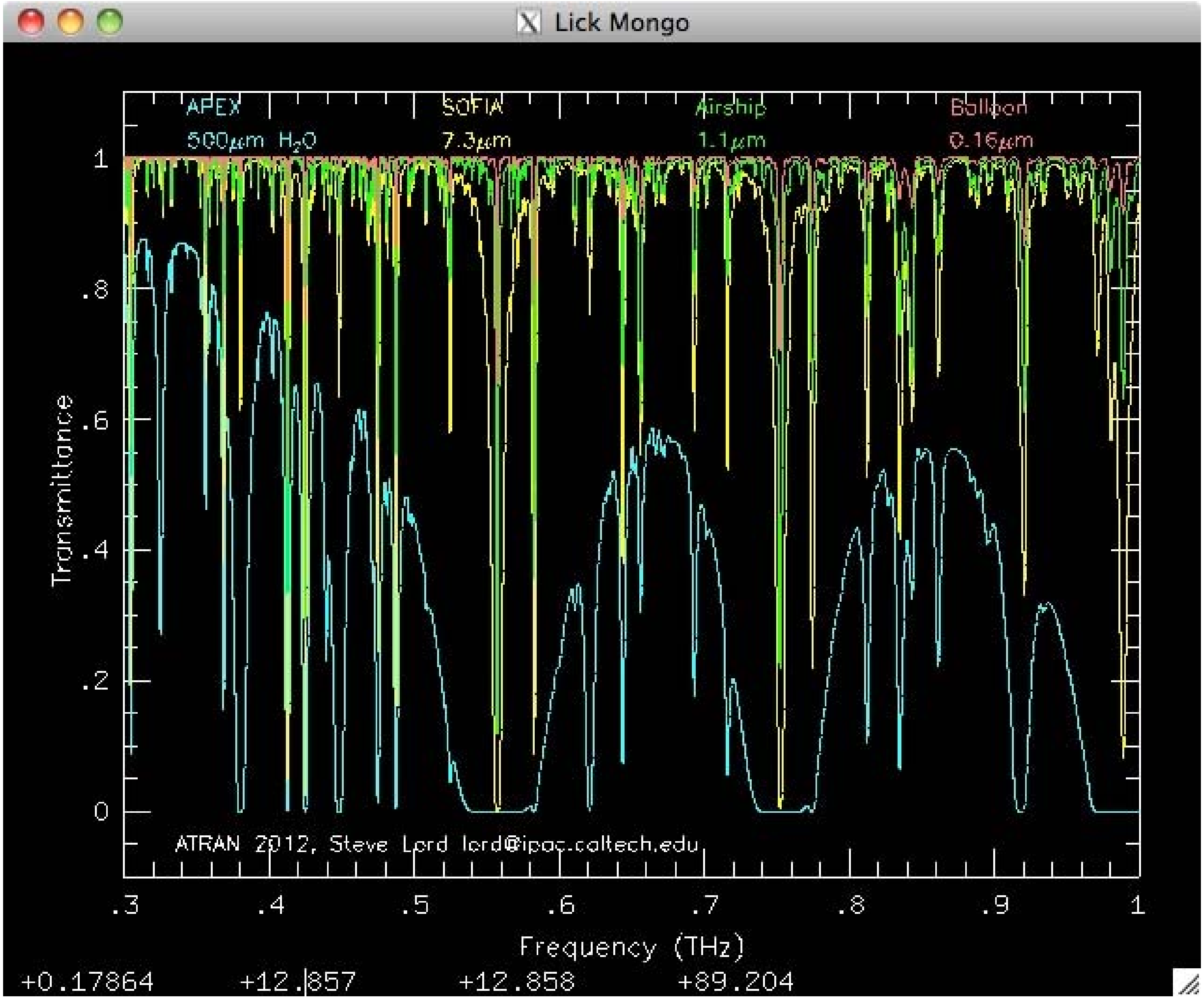


Lick Mongo
APEX
500μm H2O
SOFIA
7.3μm
Airship
1.1μm
Balloon
0.16μm
Transmittance
1
.8
.6
.4
.2
0
ATRAN 2012, Steve Lord lord@ipac.caltech.edu
10
15
20
25
30
35
40
Wavelength (μm)
+0.21179
+12.886
+12.887
+89.058


Lick Mongo
APEX
500μm H2O
SOFIA
7.3μm
Airship
1.1μm
Balloon
0.16μm
1
.8
.6
.4
.2
0
Transmittance
ATRAN 2012, Steve Lord lord@ipac.caltech.edu
40
50
60
70
80
90
100
Wavelength (μm)
+0.45120
+13.000
+13.008
+88.012


Lick Mongo
APEX
500µm H2O
SOFIA
7.3µm
Airship
1.1µm
Balloon
0.16µm
Transmittance
1
.8
.6
.4
.2
0
ATRAN 2012, Steve Lord lord@ipac.caltech.edu
100
110
120
130
140
150
160
Wavelength (µm)
+0.38674
+12.771
+12.777
+88.266


Lick Mongo
APEX
500μm H2O
SOFIA
7.3μm
Airship
1.1μm
Balloon
0.16μm
Transmittance
1
.8
.6
.4
.2
0
ATRAN 2012, Steve Lord lord@ipac.caltech.edu
1
1.2
1.4
1.6
1.8
2
Frequency (THz)
+0.40884 +12.829 +12.835 +88.175


Lick Mongo
APEX
500μm H2O
SOFIA
7.3μm
Airship
1.1μm
Balloon
0.16μm
Transmittance
Frequency (THz)
ATRAN 2012, Steve Lord lord@ipac.caltech.edu
+0.17864 +12.857 +12.858 +89.204

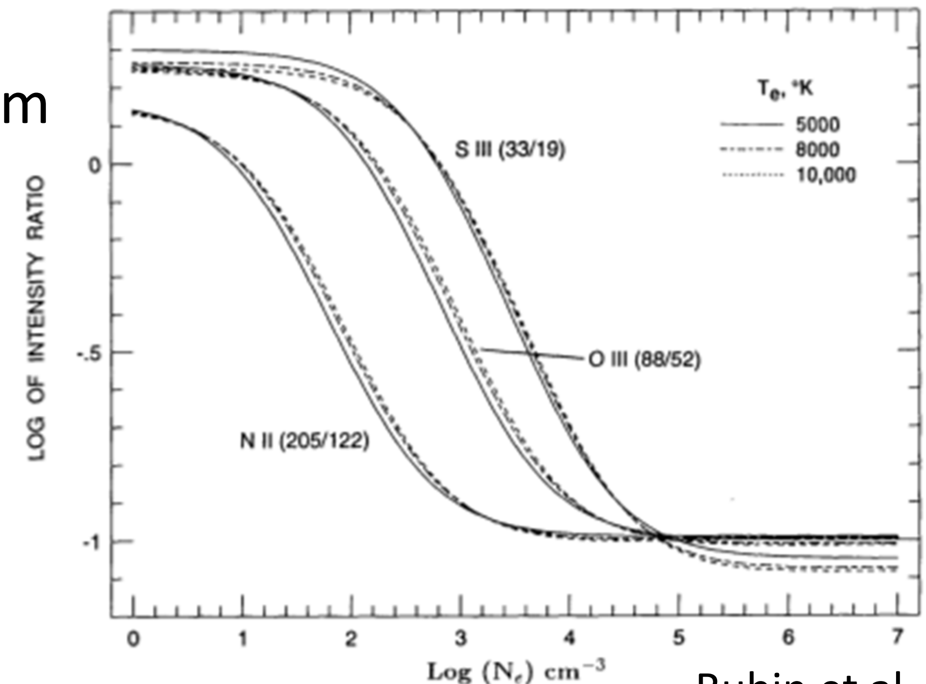
Lines Presented in the next slides:

1. SIII at wavelength 18.71300 HII region
2. FeIII at wavelength 22.93000 HII region
3. OIV at wavelength 25.87000 AGN
4. FeII at wavelength 25.98820 HII region
5. SIII at wavelength 33.48000 HII region
6. SiII at wavelength 34.81400 HII region, PDR
7. NeIII at wavelength 36.01000 HII region
8. OIII at wavelength 51.81500 HII region
9. NIII at wavelength 57.33000 HII region
10. <u>OI at wavelength 63.18372 PDR</u>
11. OIII at wavelength 88.35600 HII region
12. NII at wavelength 121.89760 Diffuse ISM
13. OI at wavelength 145.52548 PDR
14. <u>CII at wavelength 157.74100 PDR and HII region(+)</u>
15. NII at wavelength 205.17830 Diffuse ISM

(Underlined lines at high redshift too)

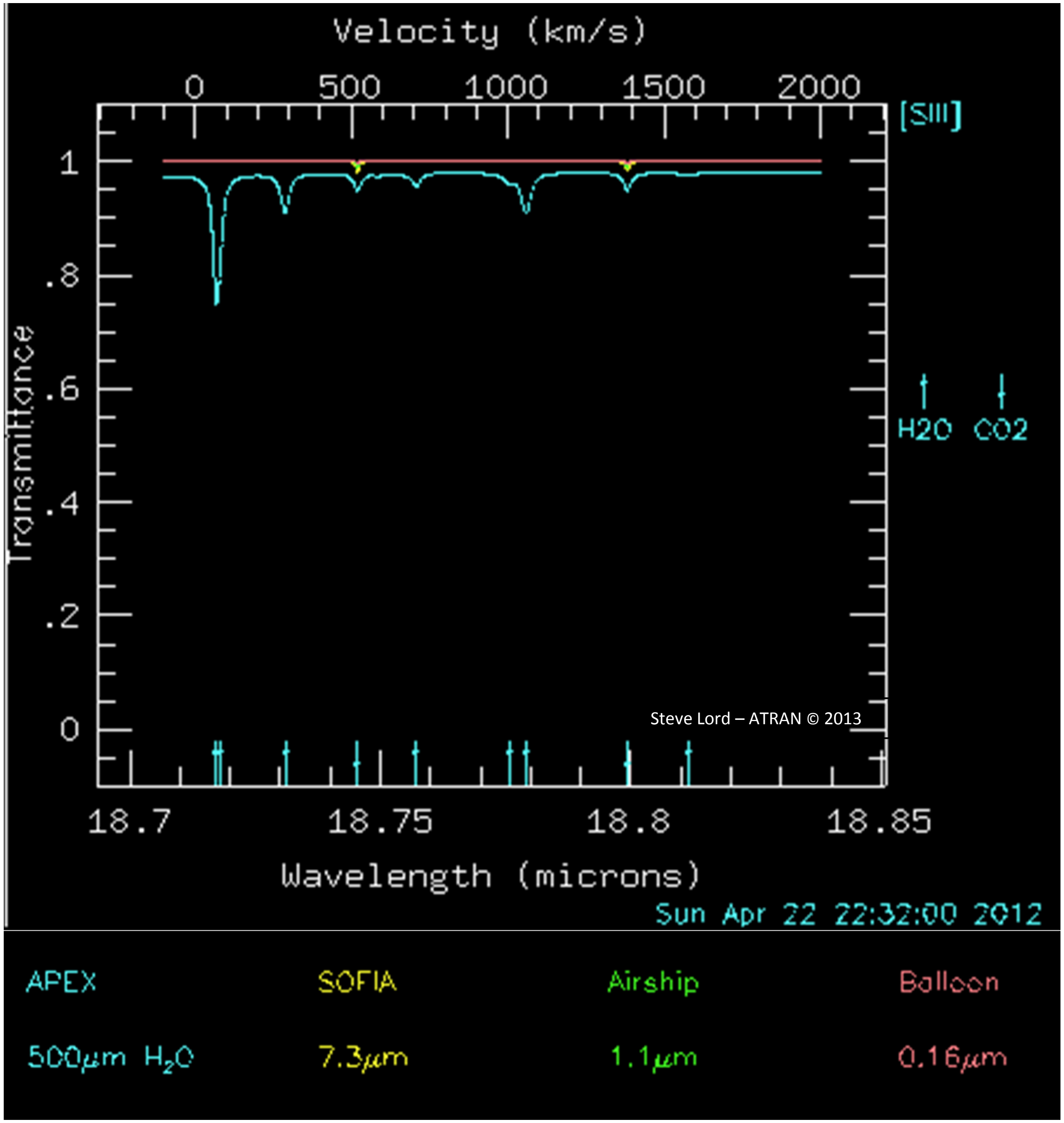
Atomic Fine-Structure HII Region Diagnostics

- [SIII] 18μm and 33μm
- [FeII] 26μm and [FeIII] 23μm
- [NeIII] 36μm
- [OIII] 52μm and 88μm
- [NIII] 57μm

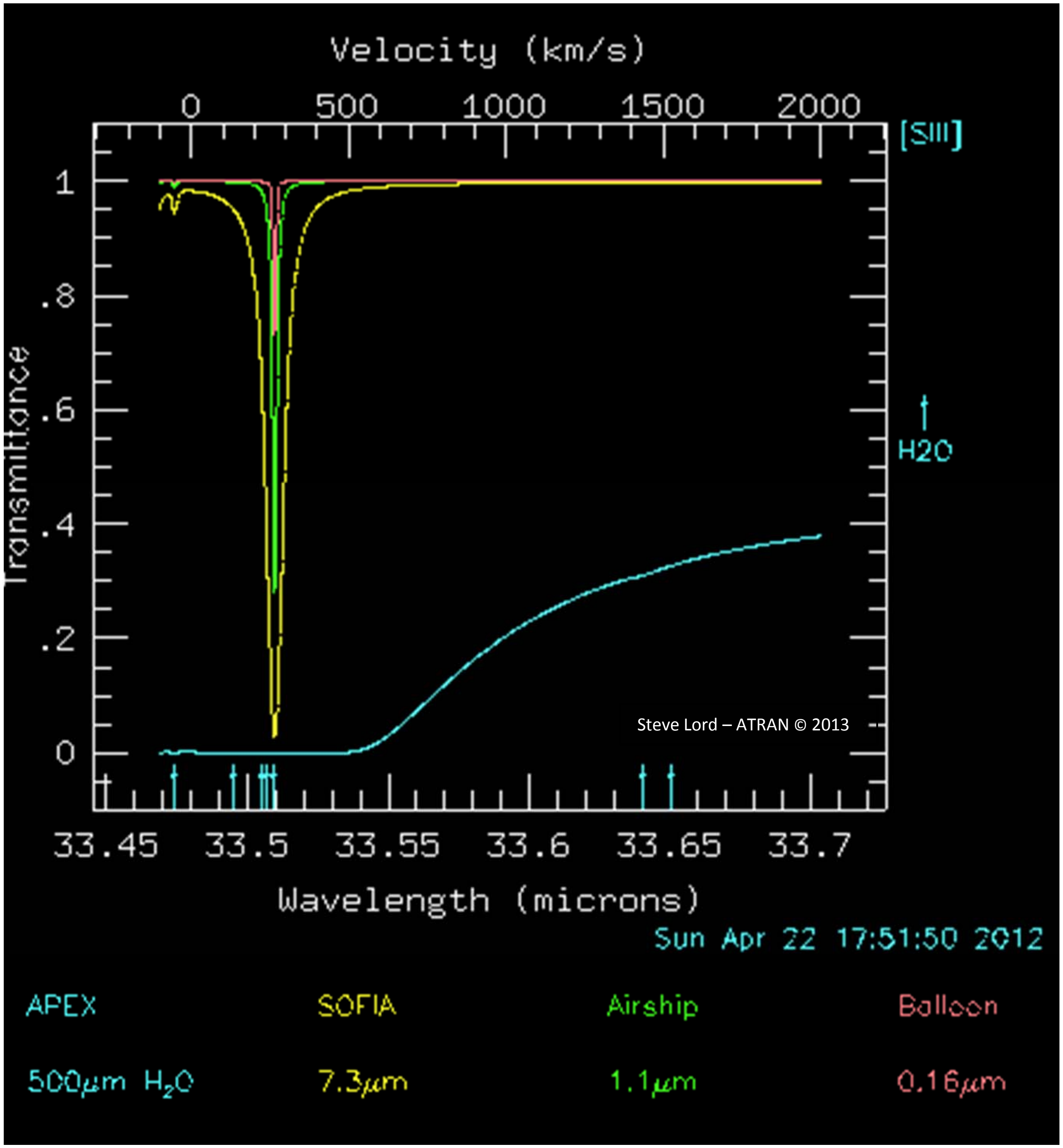


Rubin et al.

Measure electron density, stellar effective temperature, abundance ratios, abundance gradients, PNe properties, SNRs...

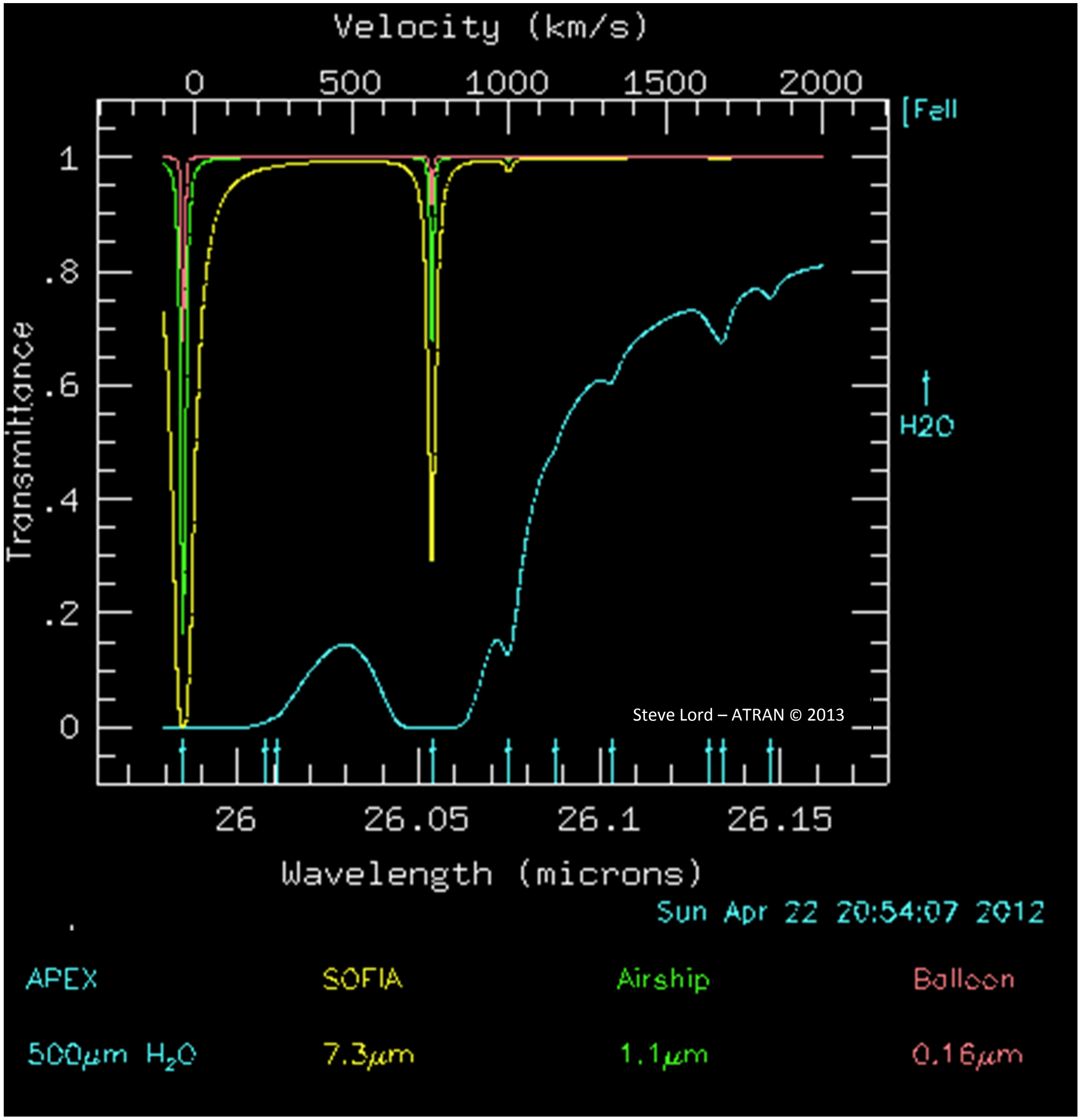

Velocity (km/s)
0
500
1000
1500
2000
[SIII]
1
.8
.6
.4
.2
0
Transmittance
H2O
CO2
Steve Lord – ATRAN © 2013
18.7
18.75
18.8
18.85
Wavelength (microns)
Sun Apr 22 22:32:00 2012
APEX
SOFIA
Airship
Balloon
500µm H2O
7.3µm
1.1µm
0.16µm

[SIII] 19um



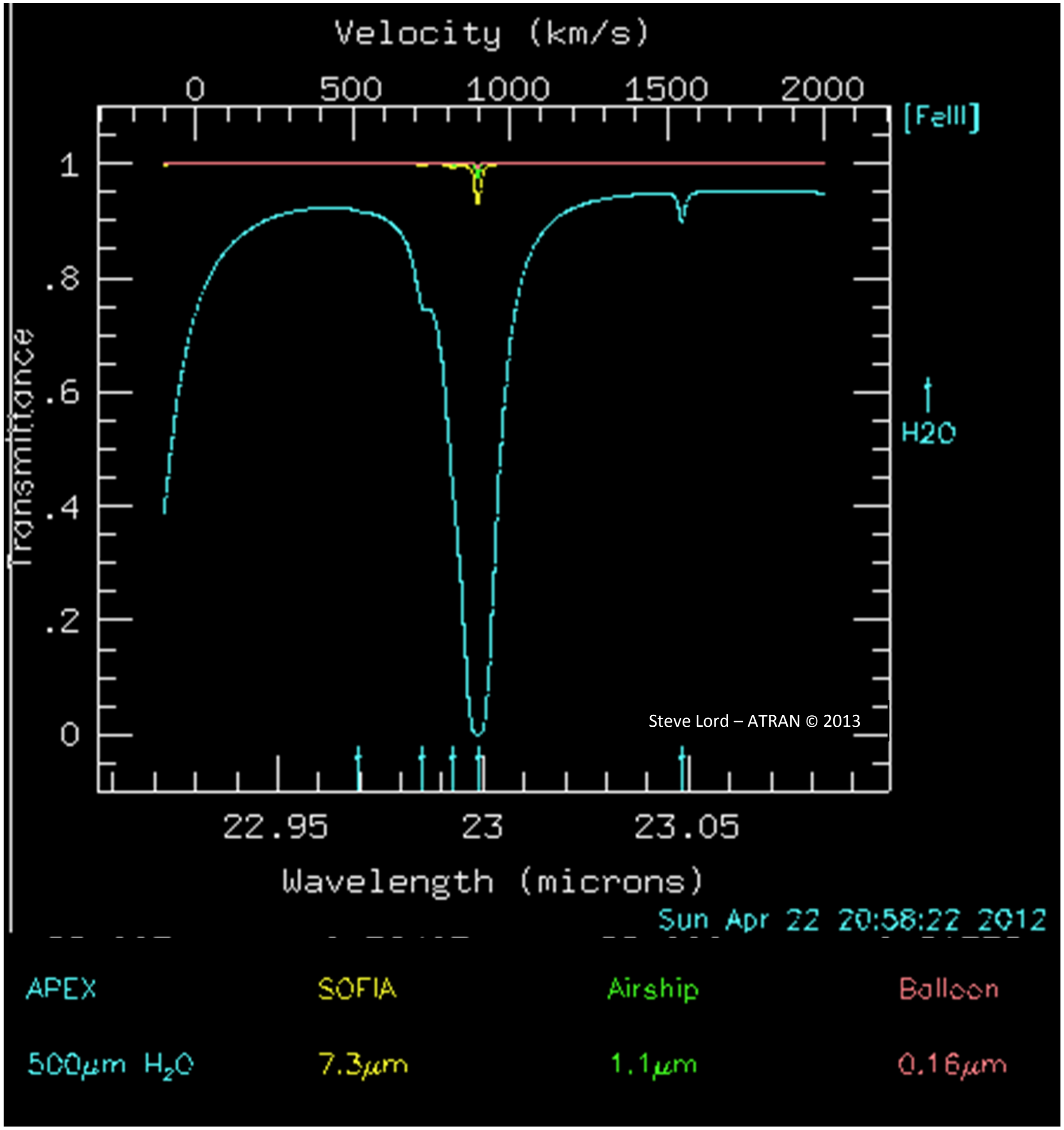
Velocity (km/s)
0
500
1000
1500
2000
[SIII]
1
.8
.6
.4
.2
0
Transmittance
H2O
Steve Lord – ATRAN © 2013
33.45
33.5
33.55
33.6
33.65
33.7
Wavelength (microns)
Sun Apr 22 17:51:50 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

[SIII] 33um

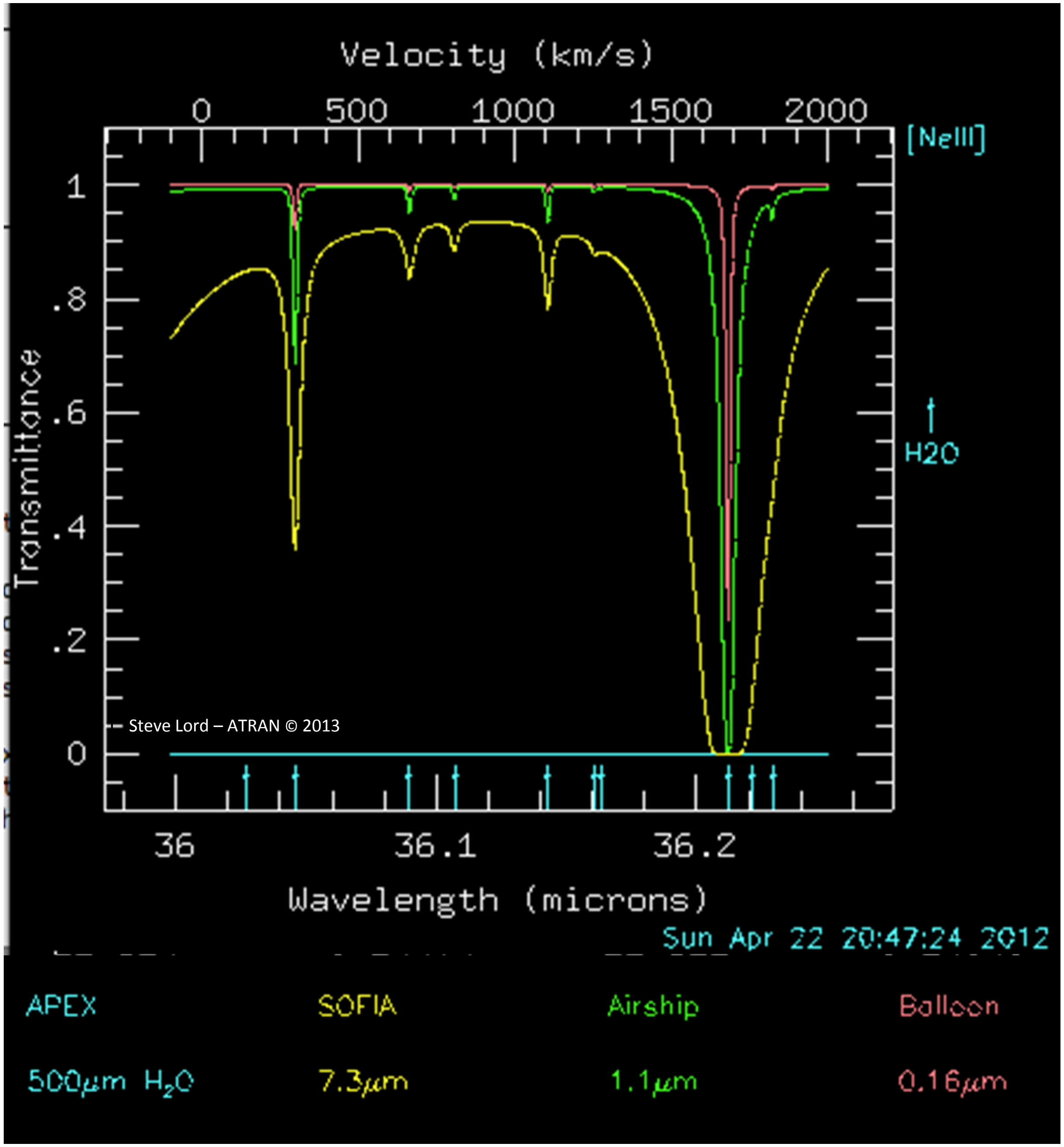


Velocity (km/s)
0
500
1000
1500
2000
[FeII
1
.8
.6
.4
.2
0
Transmittance
H2O
Steve Lord – ATRAN © 2013
26
26.05
26.1
26.15
Wavelength (microns)
Sun Apr 22 20:54:07 2012
APEX
SOFIA
Airship
Balloon
500µm H_2O
7.3µm
1.1µm
0.16µm

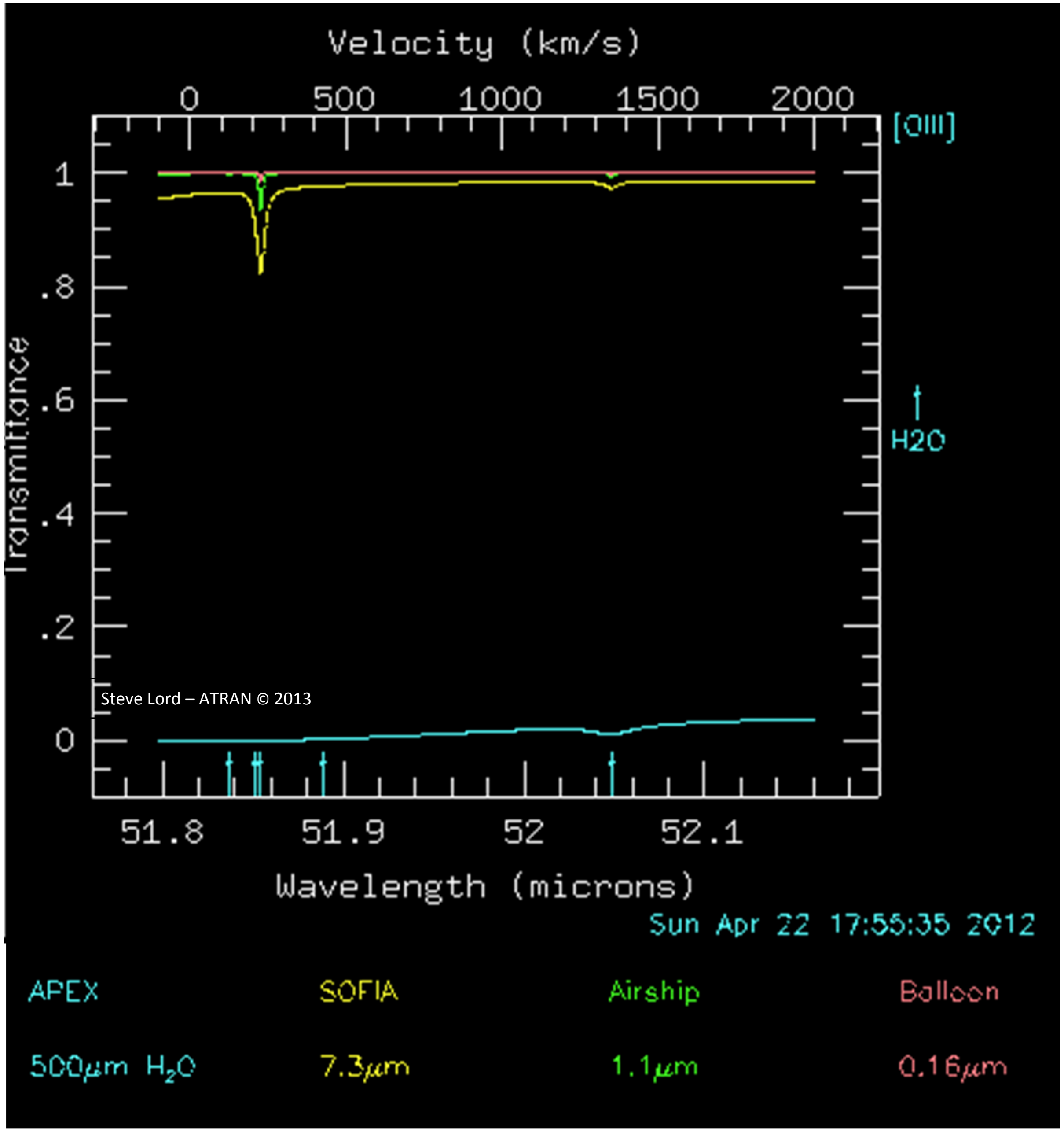
[FeII] 26um


Velocity (km/s)
0
500
1000
1500
2000
[FeIII]
1
.8
.6
.4
.2
0
Transmittance
H2O
Steve Lord – ATRAN © 2013
22.95
23
23.05
Wavelength (microns)
Sun Apr 22 20:58:22 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

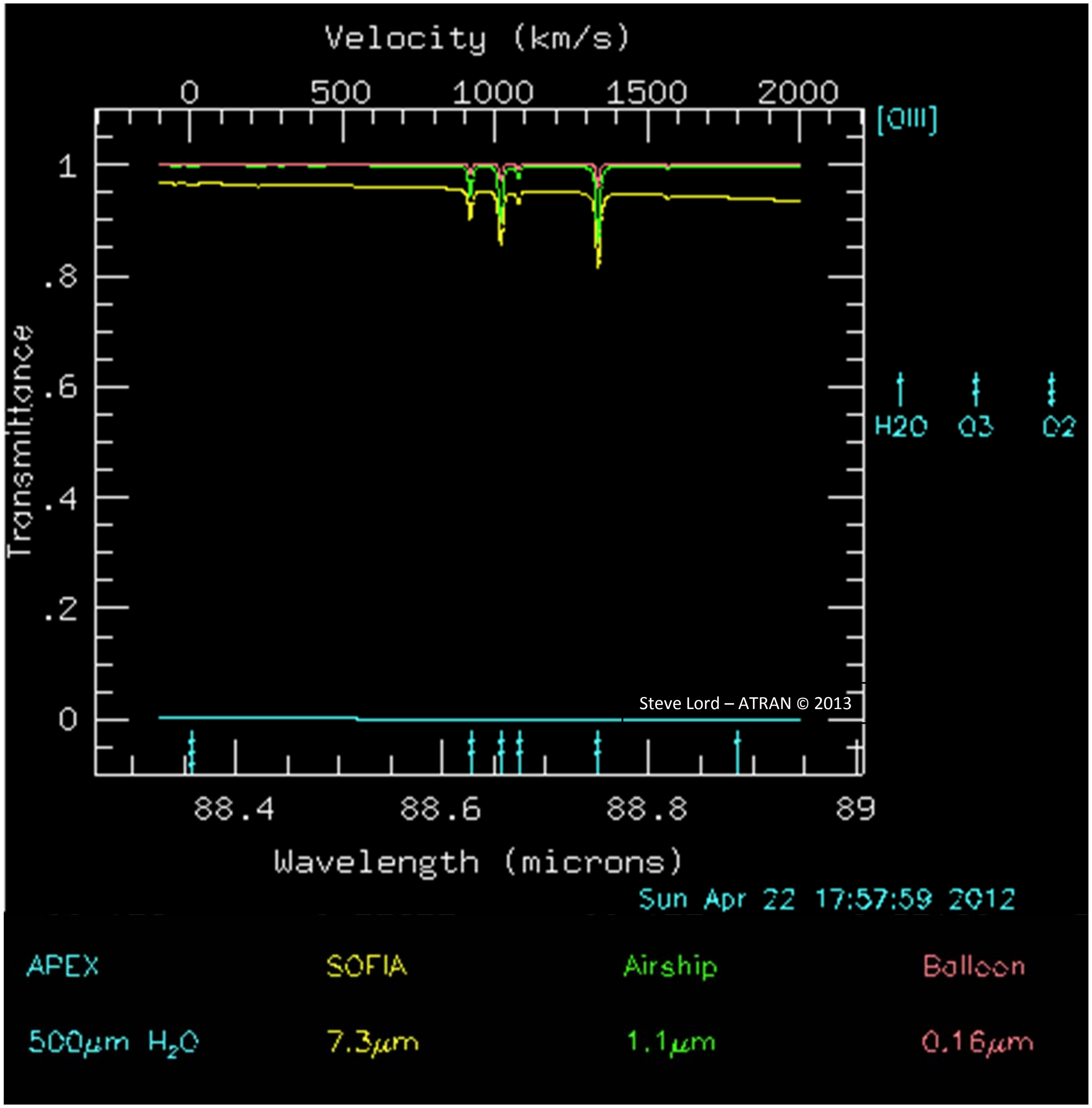
[FeIII] 23um


Velocity (km/s)
0
500
1000
1500
2000
[NeIII]
Transmittance
1
.8
.6
.4
.2
0
H2O
Steve Lord – ATRAN © 2013
36
36.1
36.2
Wavelength (microns)
Sun Apr 22 20:47:24 2012
APEX
SOFIA
Airship
Balloon
500µm H2O
7.3µm
1.1µm
0.16µm

[NeIII] 36um

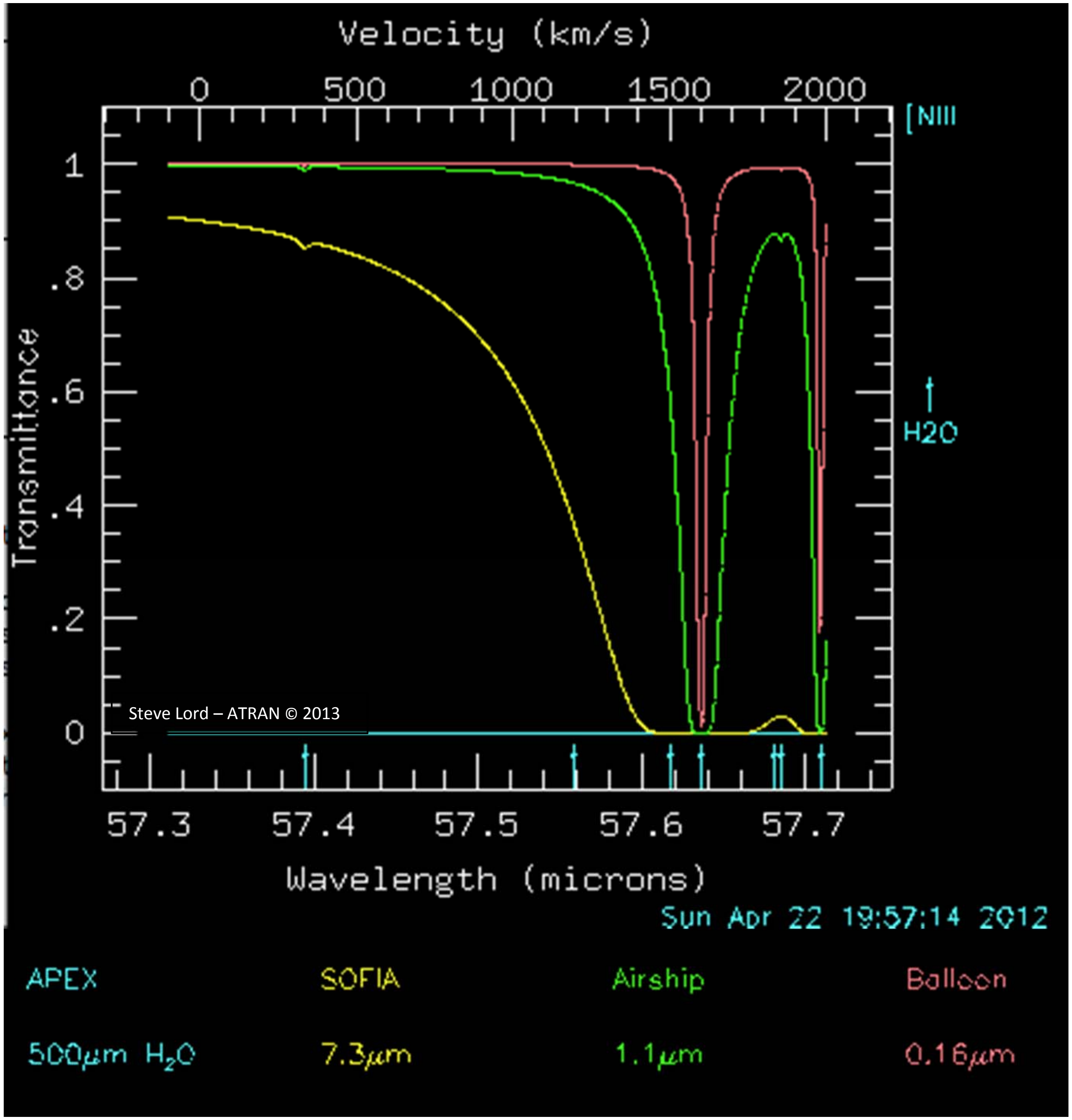

Velocity (km/s)
0
500
1000
1500
2000
[OIII]
1
.8
.6
.4
.2
0
Transmittance
H2O
Steve Lord – ATRAN © 2013
51.8
51.9
52
52.1
Wavelength (microns)
Sun Apr 22 17:55:35 2012
APEX
SOFIA
Airship
Balloon
500μm H_2O
7.3μm
1.1μm
0.16μm

[OIII] 52um



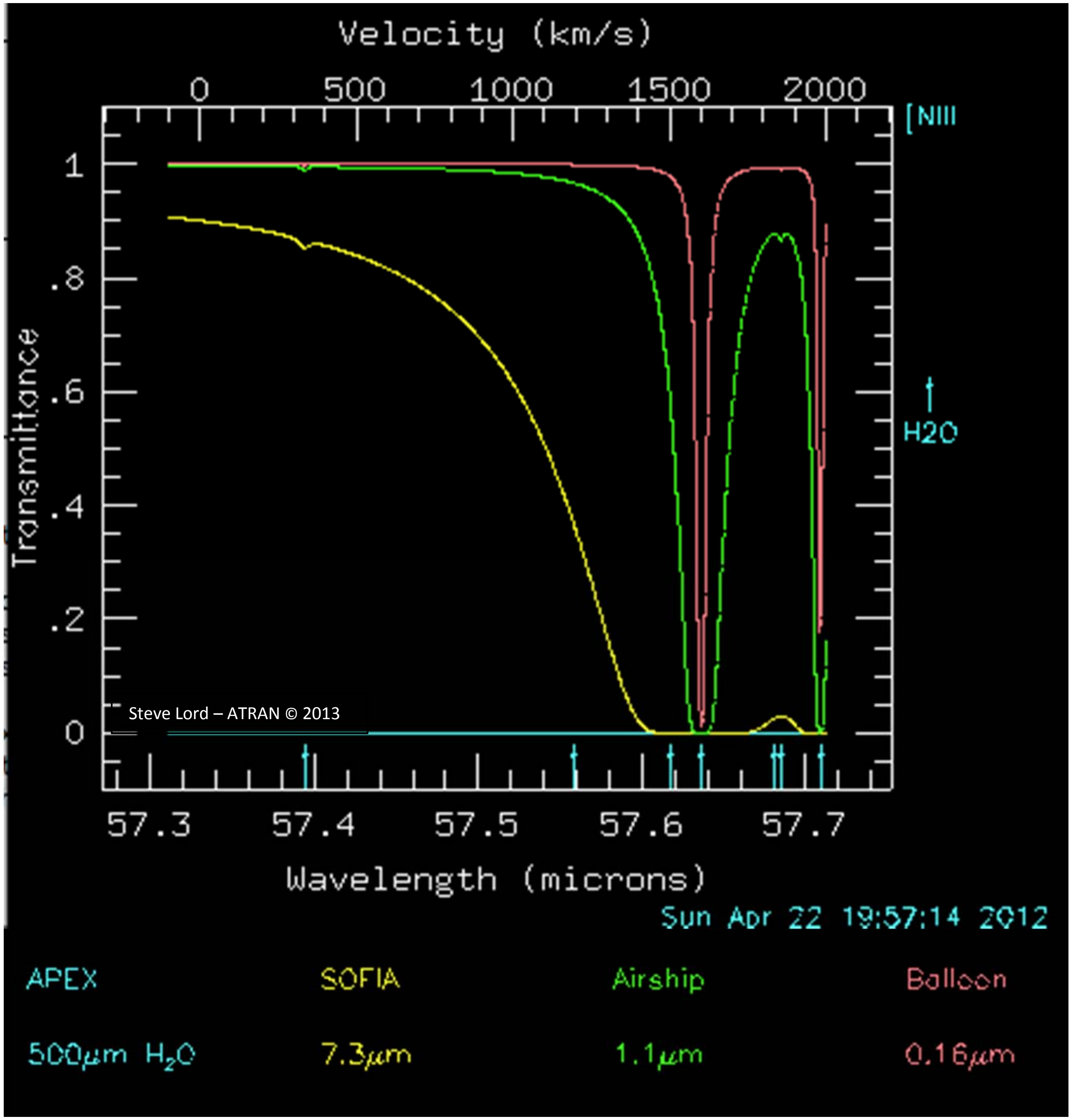
Velocity (km/s)
0
500
1000
1500
2000
[OIII]
Transmittance
1
.8
.6
.4
.2
0
H2O
O3
O2
Steve Lord – ATRAN © 2013
88.4
88.6
88.8
89
Wavelength (microns)
Sun Apr 22 17:57:59 2012
APEX
SOFIA
Airship
Balloon
500μm H_2O
7.3μm
1.1μm
0.16μm

[OIII] 88um



Velocity (km/s)
0
500
1000
1500
2000
[NIII
1
.8
.6
.4
.2
0
Transmittance
H2O
Steve Lord – ATRAN © 2013
57.3
57.4
57.5
57.6
57.7
Wavelength (microns)
Sun Apr 22 19:57:14 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

[NIII] 57um

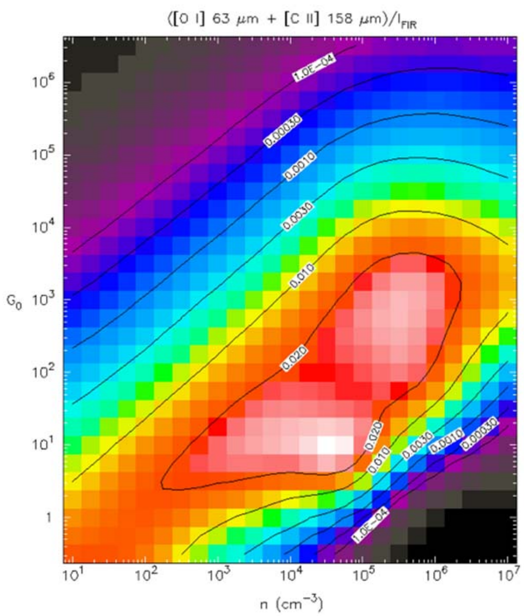


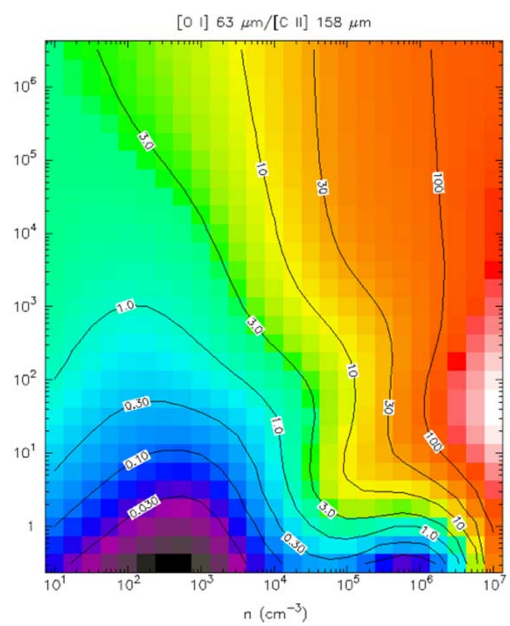
Velocity (km/s)
0
500
1000
1500
2000
[NIII
1
.8
.6
.4
.2
0
Transmittance
H2O
Steve Lord – ATRAN © 2013
57.3
57.4
57.5
57.6
57.7
Wavelength (microns)
Sun Apr 22 19:57:14 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

[NIII] 57um

Photodissociation Region Diagnostics (PDRs)

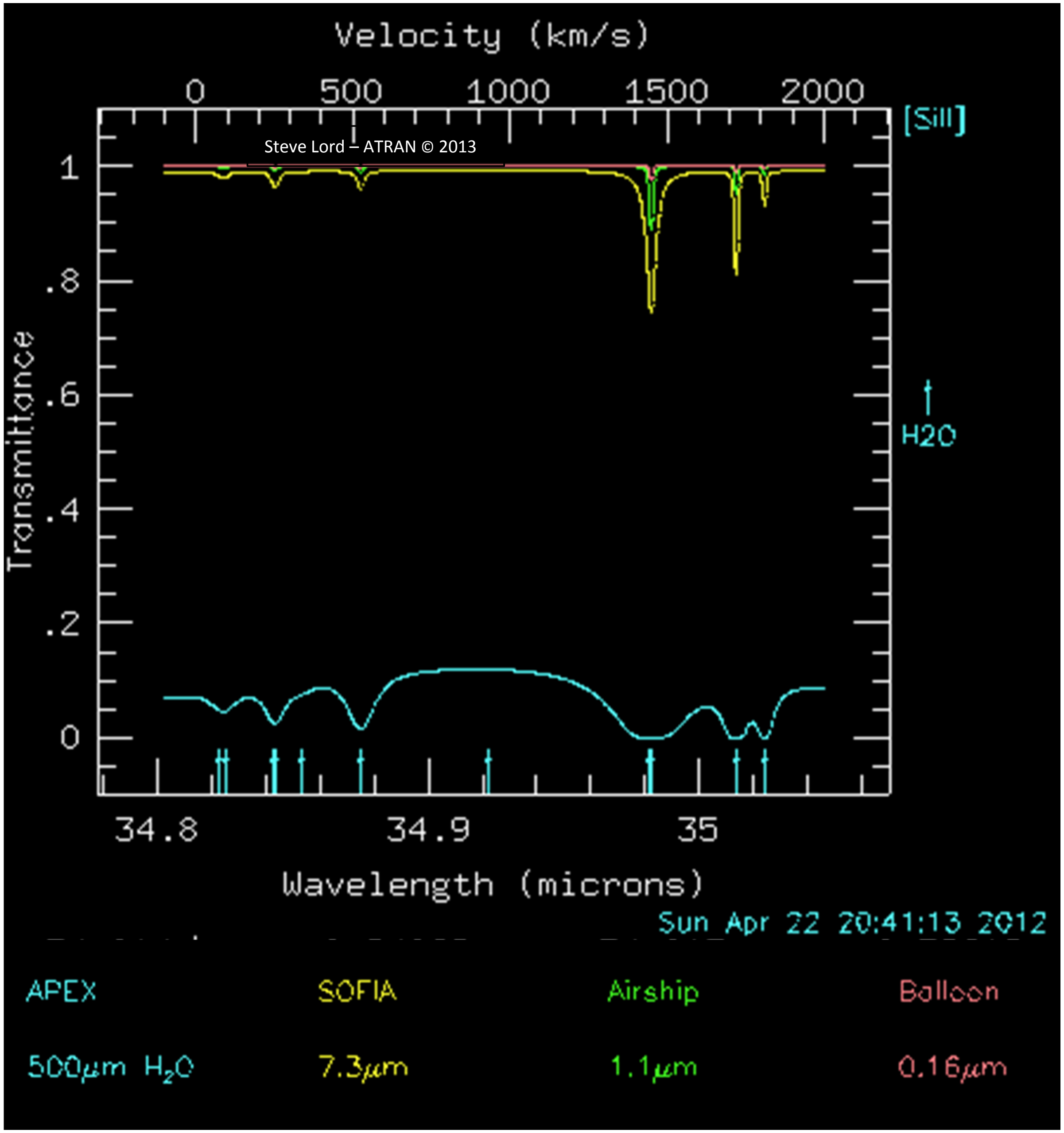
- [SiII] 35μm (present in PDRs and HII regions)
- [OI] 63μm and 145μm
- [CII] 158μm (present in PDRs, HII regions, and the diffuse ISM) – must be sorted out....



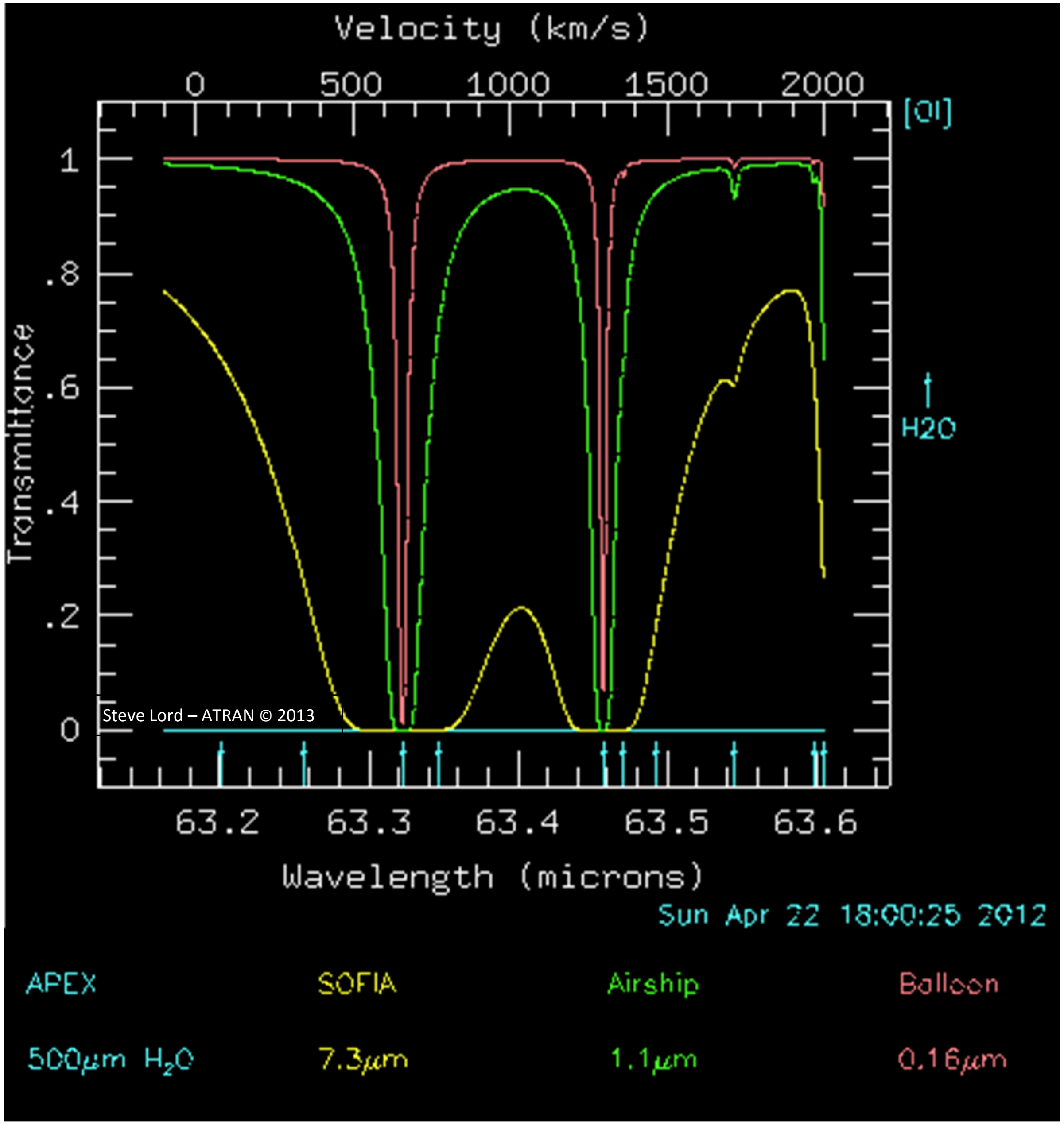


Give for the warm neutral ISM:
n (atomic density)
G_0 (incident UV field)

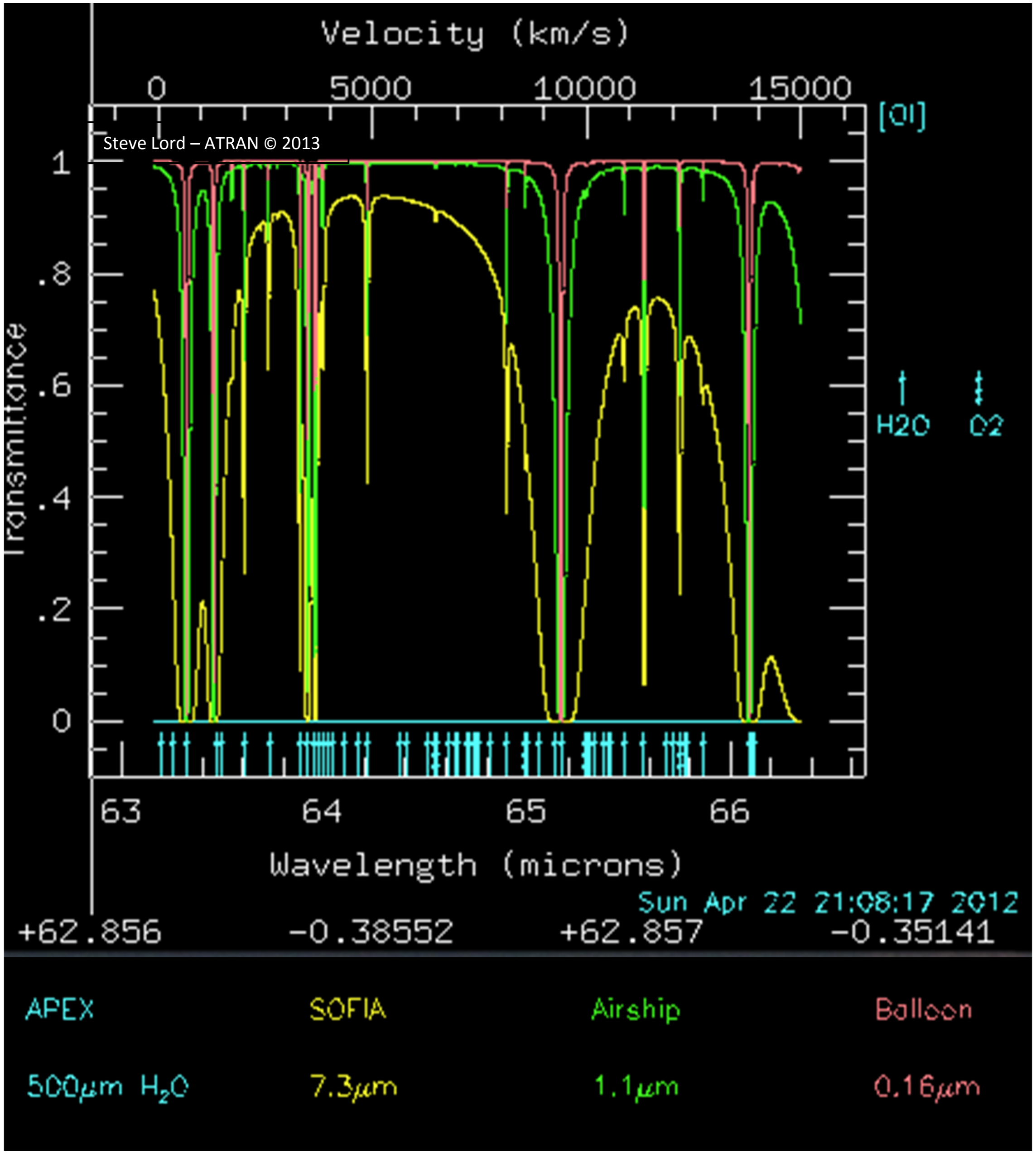
Along with CO:
cloud sizes
cloud filling factors...


Velocity (km/s)
0
500
1000
1500
2000
[SiII]
Steve Lord – ATRAN © 2013
1
.8
.6
.4
.2
0
Transmittance
H2O
34.8
34.9
35
Wavelength (microns)
Sun Apr 22 20:41:13 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

[SiII] 35um

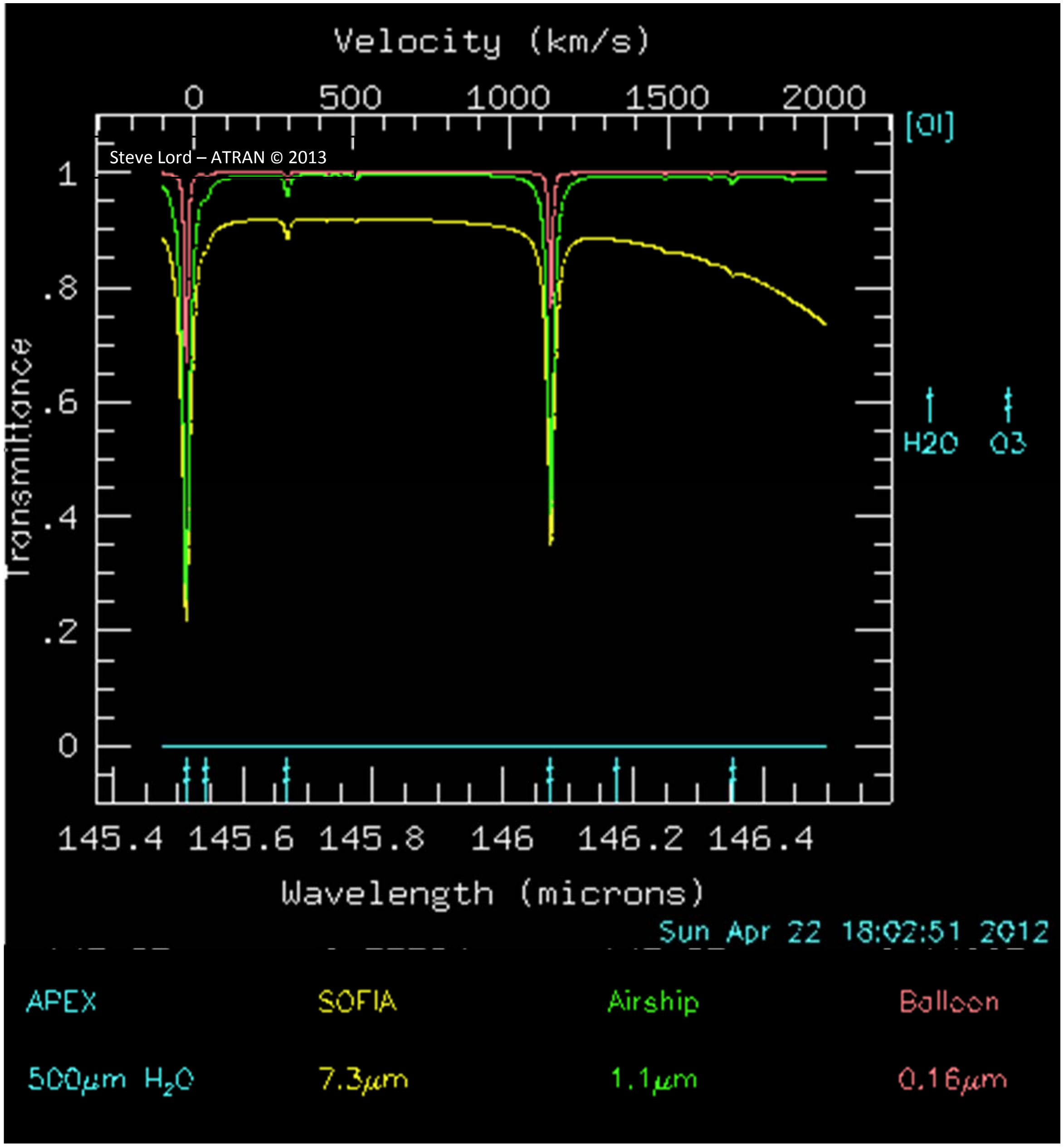

Velocity (km/s)
0
500
1000
1500
2000
[OI]
1
.8
.6
.4
.2
0
Transmittance
H2O
Steve Lord – ATRAN © 2013
63.2
63.3
63.4
63.5
63.6
Wavelength (microns)
Sun Apr 22 18:00:25 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

[OI] 63um

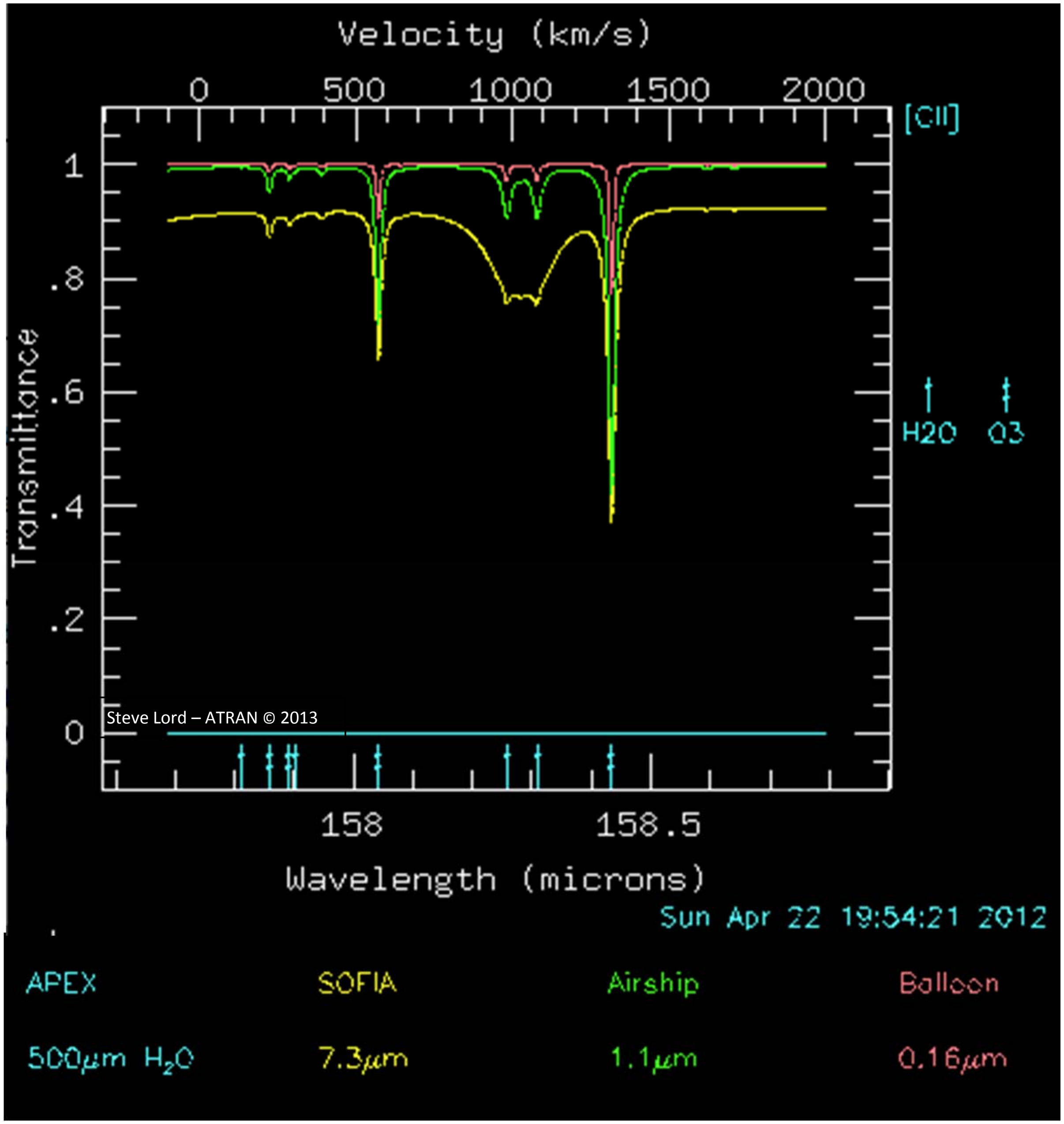


[OI] 63um

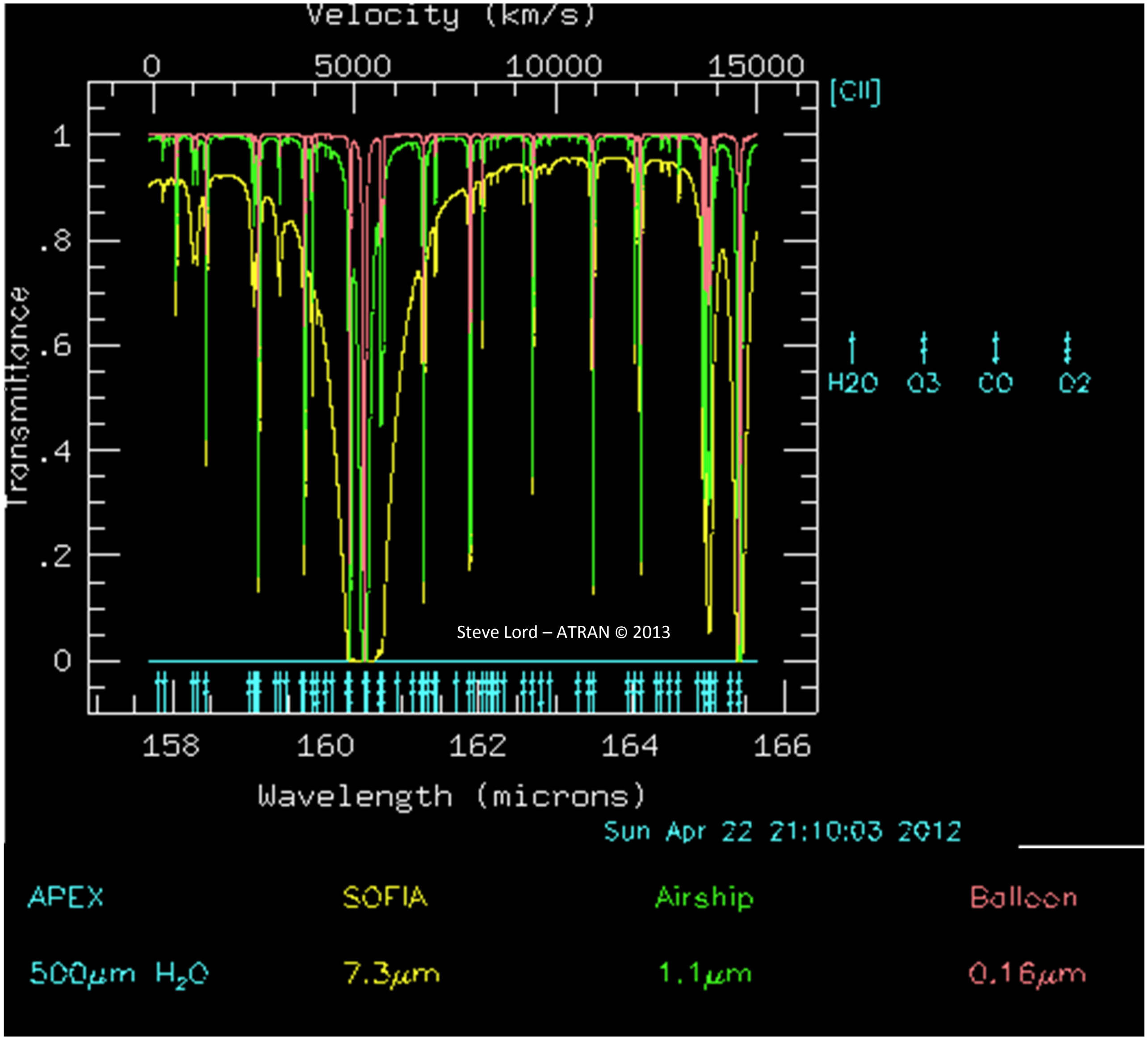
To:
v=15,000 km/s


Velocity (km/s)
0
500
1000
1500
2000
[OI]
Steve Lord – ATRAN © 2013
1
.8
.6
.4
.2
0
Transmittance
H2O
O3
145.4
145.6
145.8
146
146.2
146.4
Wavelength (microns)
Sun Apr 22 18:02:51 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

[OI] 145um


Velocity (km/s)
0
500
1000
1500
2000
[CII]
1
.8
.6
.4
.2
0
Transmittance
H2O
O3
Steve Lord – ATRAN © 2013
158
158.5
Wavelength (microns)
Sun Apr 22 19:54:21 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

[CII] 158um



[CII] 158um

To:

v=15,000 km/s

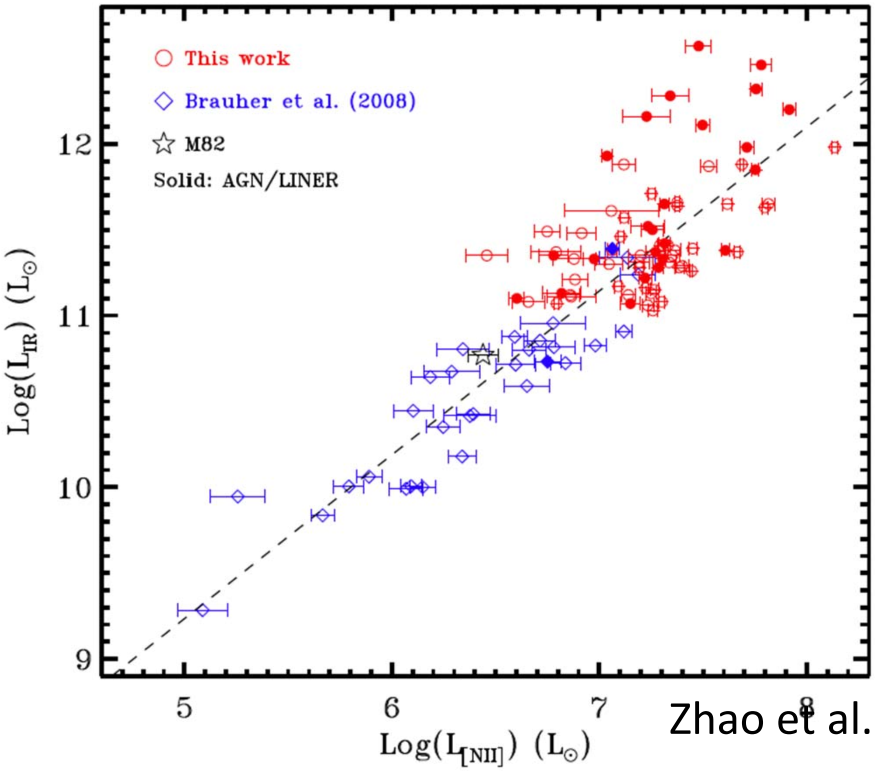
Diffuse ISM Diagnostics

- [NII] 122μm and 205μm

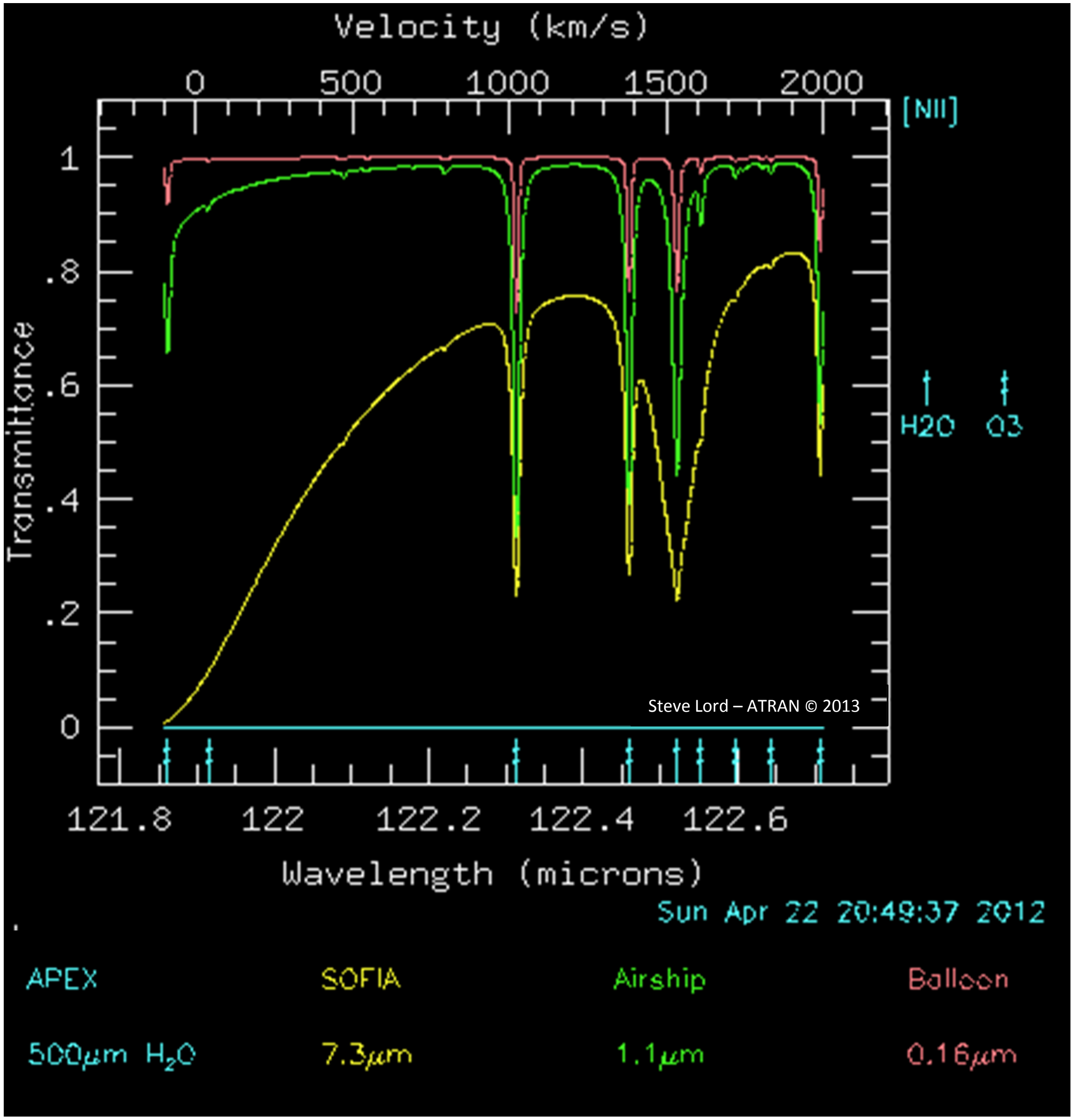
Can measure of the density of diffuse ISM.

Can be used to subtract the diffuse [CII] component for PDR modeling.

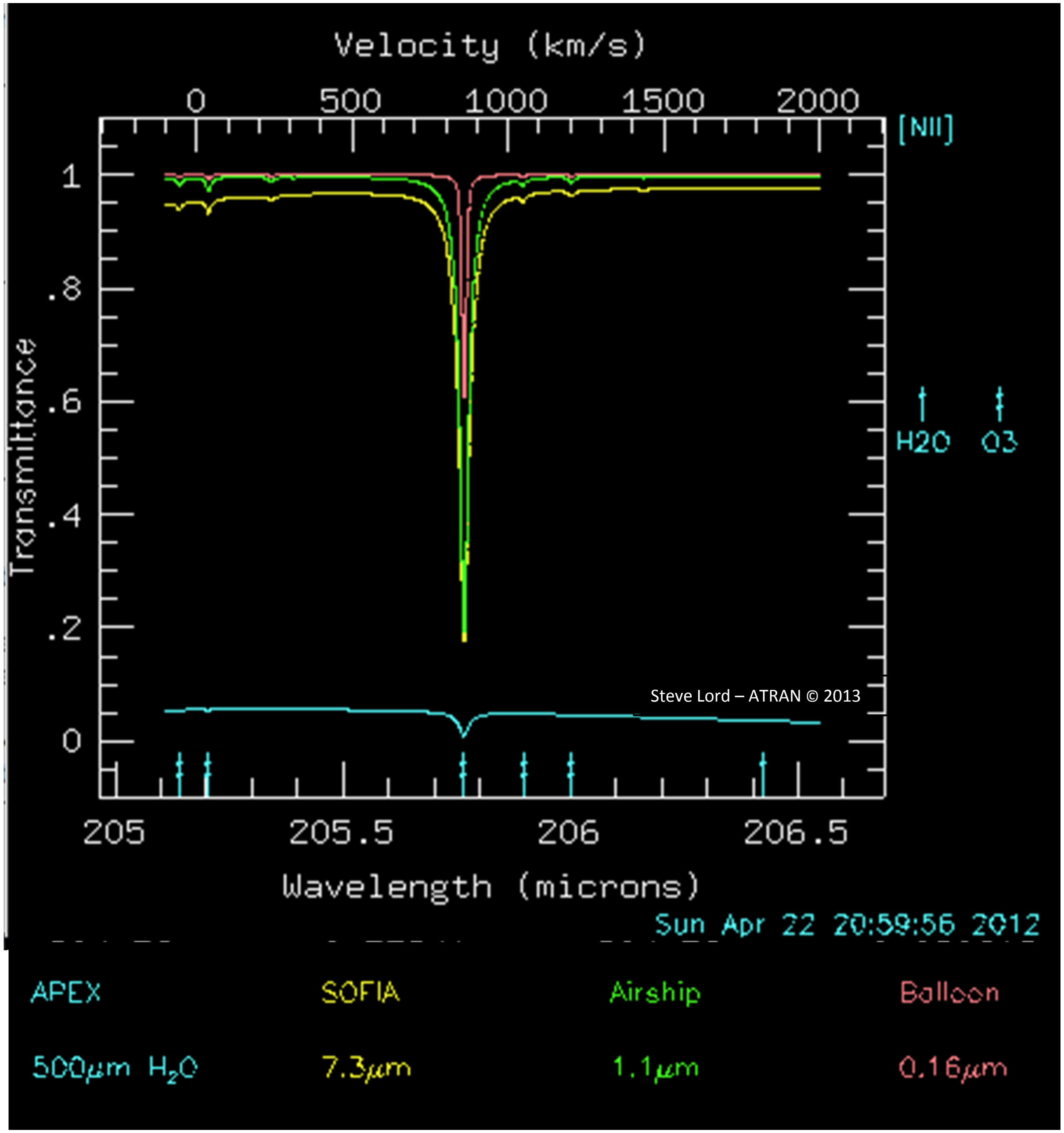
Can serve as a proxy for L_{IR} and perhaps SFR (useful at high-z).



Zhao et al.


Velocity (km/s)
0
500
1000
1500
2000
[NII]
1
.8
.6
.4
.2
0
Transmittance
H2O
O3
Steve Lord – ATRAN © 2013
121.8
122
122.2
122.4
122.6
Wavelength (microns)
Sun Apr 22 20:49:37 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

[NII] 122um


Velocity (km/s)
0
500
1000
1500
2000
[NII]
1
.8
.6
.4
.2
0
Transmittance
H2O
O3
Steve Lord – ATRAN © 2013
205
205.5
206
206.5
Wavelength (microns)
Sun Apr 22 20:59:56 2012
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

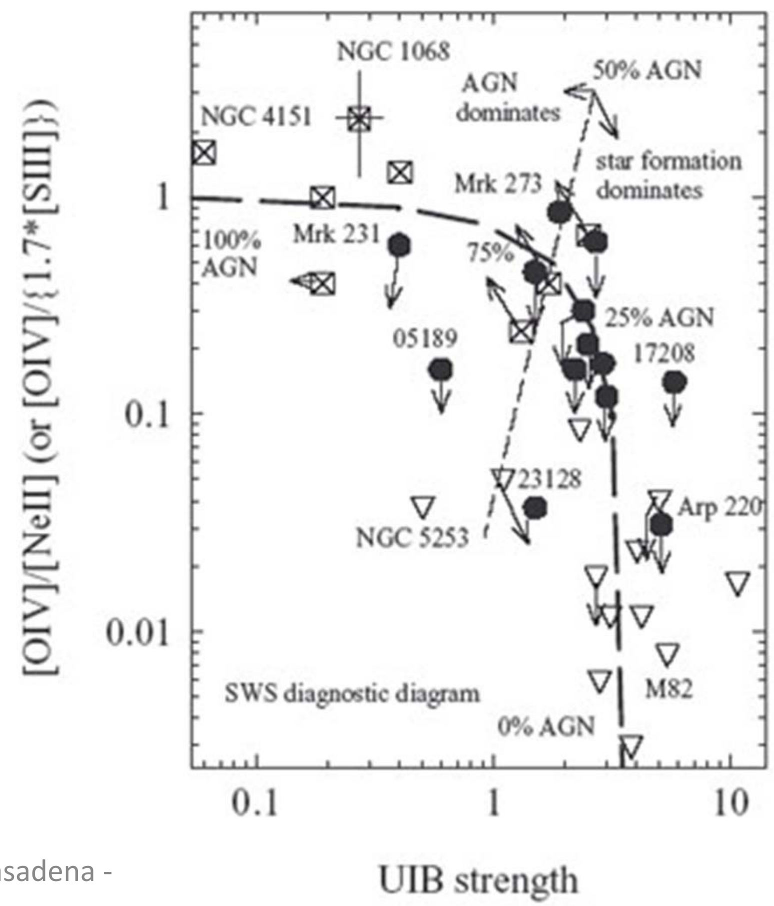
[NII] 205um

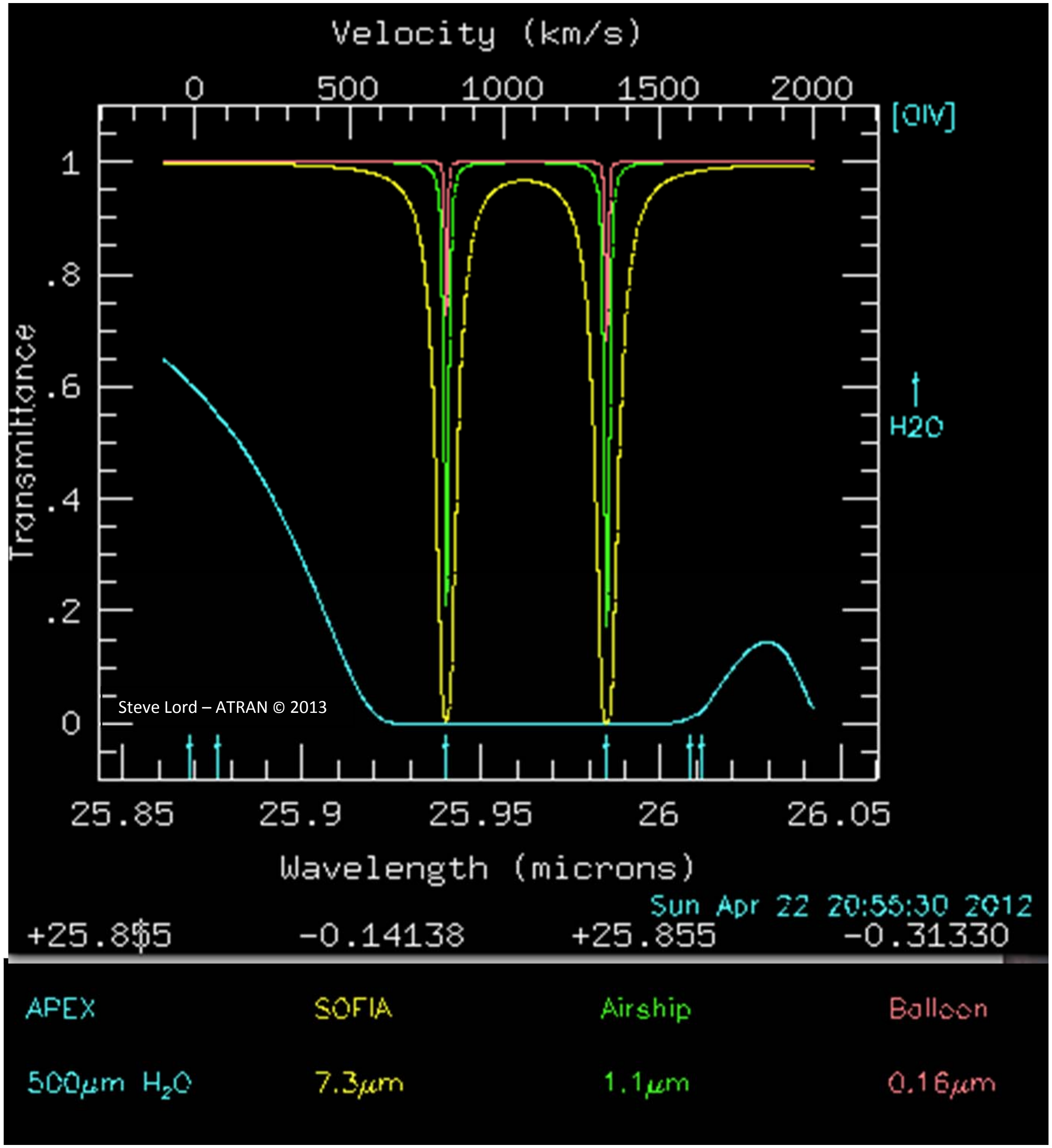
AGN Diagnostics

- [OIV] 26μm (along with [NeII] 13μm and PAHs)

Measure hardness of radiation field

Distinguish AGNs and Starbursts





Velocity (km/s)
0
500
1000
1500
2000
[OIV]
1
.8
.6
.4
.2
0
Transmittance
H2O
Steve Lord – ATRAN © 2013
25.85
25.9
25.95
26
26.05
Wavelength (microns)
Sun Apr 22 20:55:30 2012
+25.8$5
-0.14138
+25.855
-0.31330
APEX
SOFIA
Airship
Balloon
500μm H2O
7.3μm
1.1μm
0.16μm

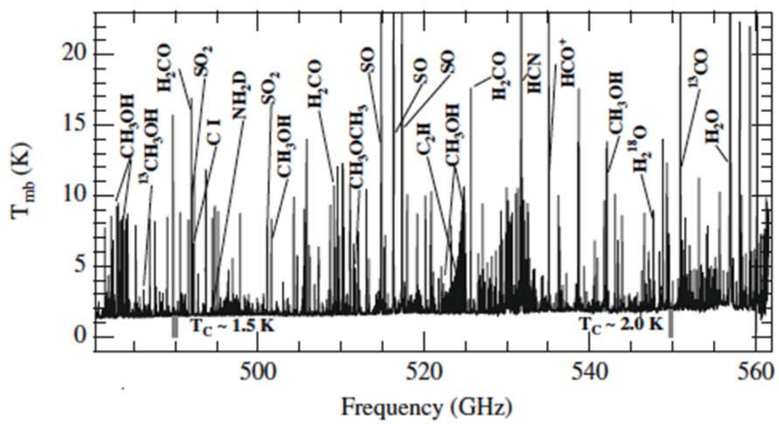
[OIV] 26um

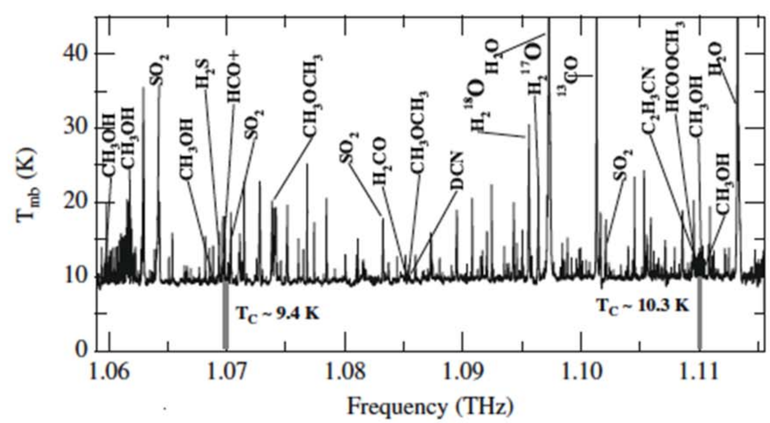
Molecular Transitions

Example: HEXOS (Herschel Observations of Extraordinary Sources) – T. Bergen, P.I. – including full coverage of Orion KL from 0.6-1.9 THz

Resolves the dust continuum and dozens of lines in many hundreds of transitions (a line forest) allowing radiative transfer modeling of temperature, velocity, and density - specie by specie.

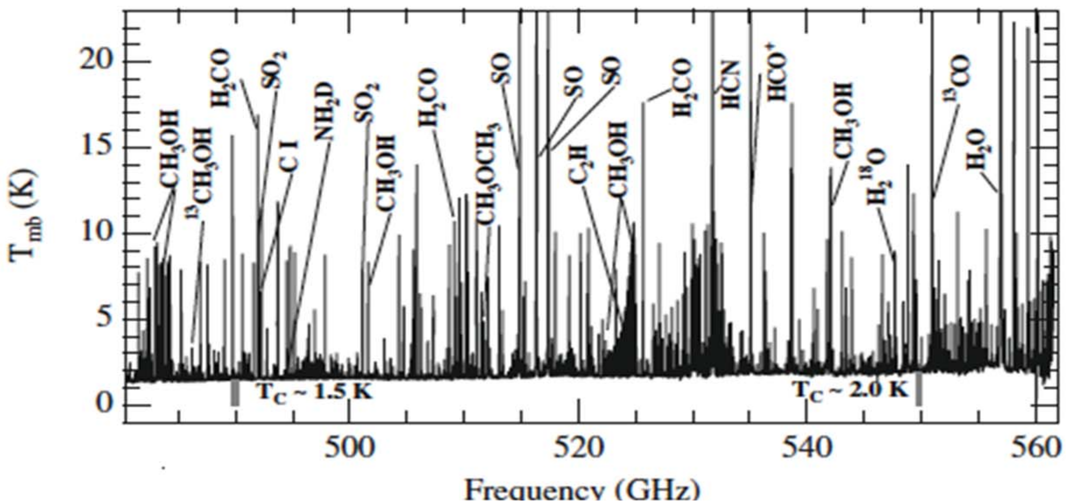
Look at these two samples – and look at the transmission through the Earth atmosphere.



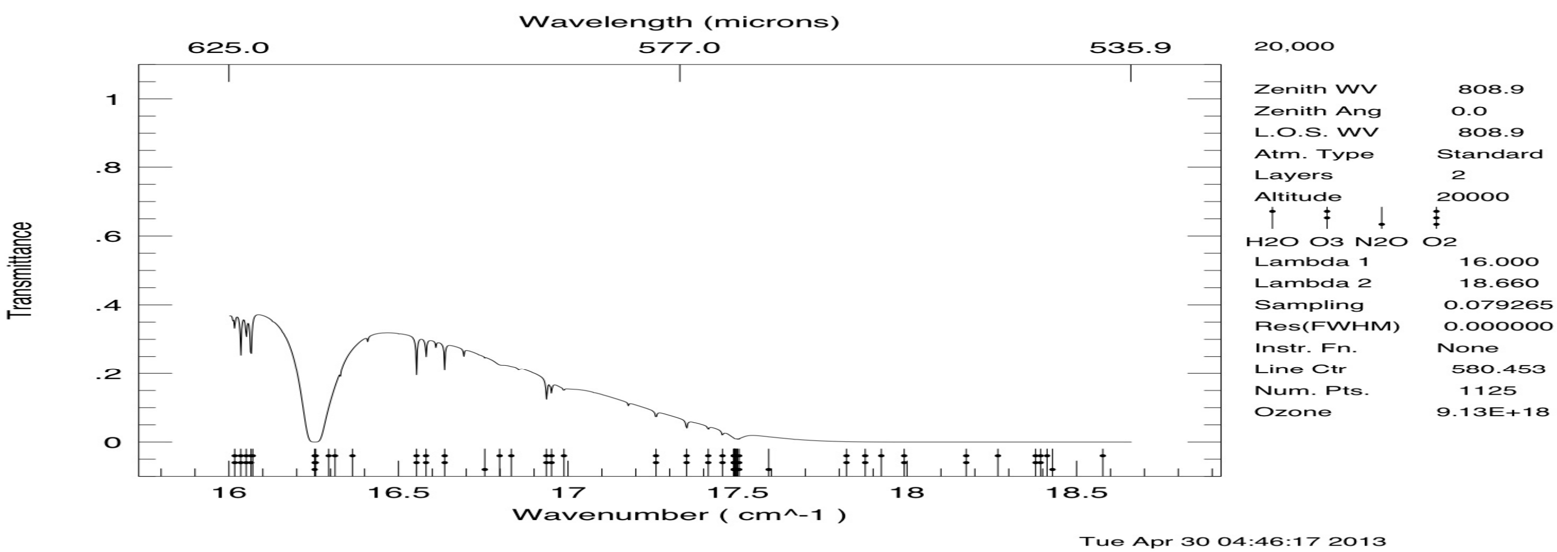


These are Space Observations

20,000' (577 µm)

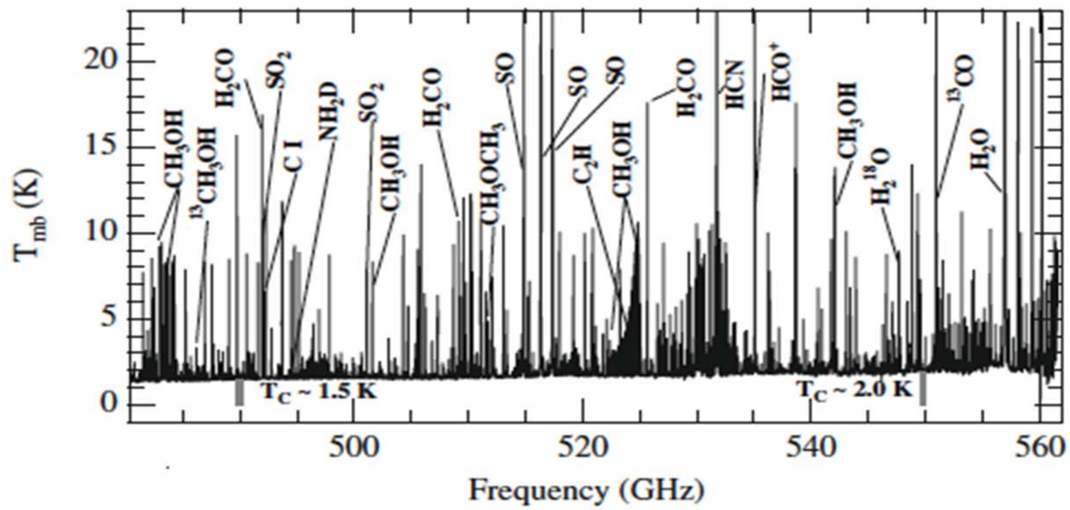


T_mb (K)
Frequency (GHz)
500
520
540
560
CH3OH
13CH3OH
H2CO
SO2
C I
NH2D
CH3OCH3
SO
C2H
HCN
HCO+
H2 18O
13CO
H2O
TC ~ 1.5 K
TC ~ 2.0 K

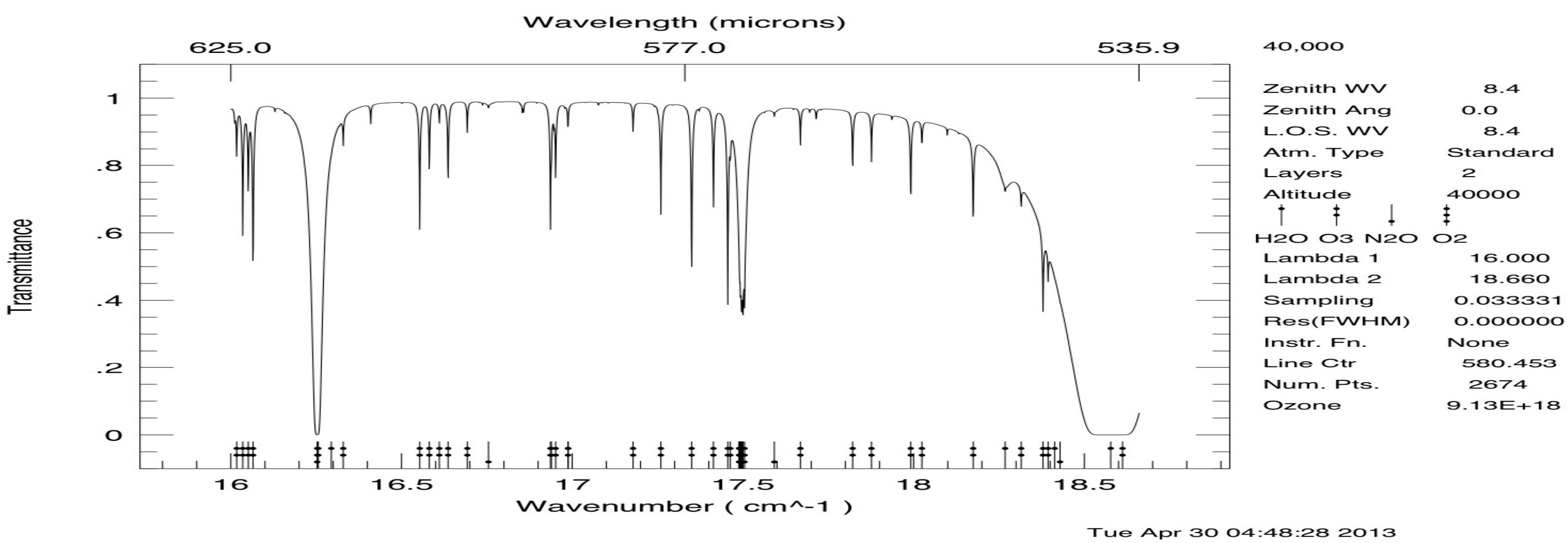


Wavelength (microns)
625.0
577.0
535.9
Transmittance
Wavenumber (cm^-1)
16
16.5
17
17.5
18
18.5
20,000
Zenith WV 808.9
Zenith Ang 0.0
L.O.S. WV 808.9
Atm. Type Standard
Layers 2
Altitude 20000
H2O O3 N2O O2
Lambda 1 16.000
Lambda 2 18.660
Sampling 0.079265
Res(FWHM) 0.000000
Instr. Fn. None
Line Ctr 580.453
Num. Pts. 1125
Ozone 9.13E+18
Tue Apr 30 04:46:17 2013

40,000' (577 µm)

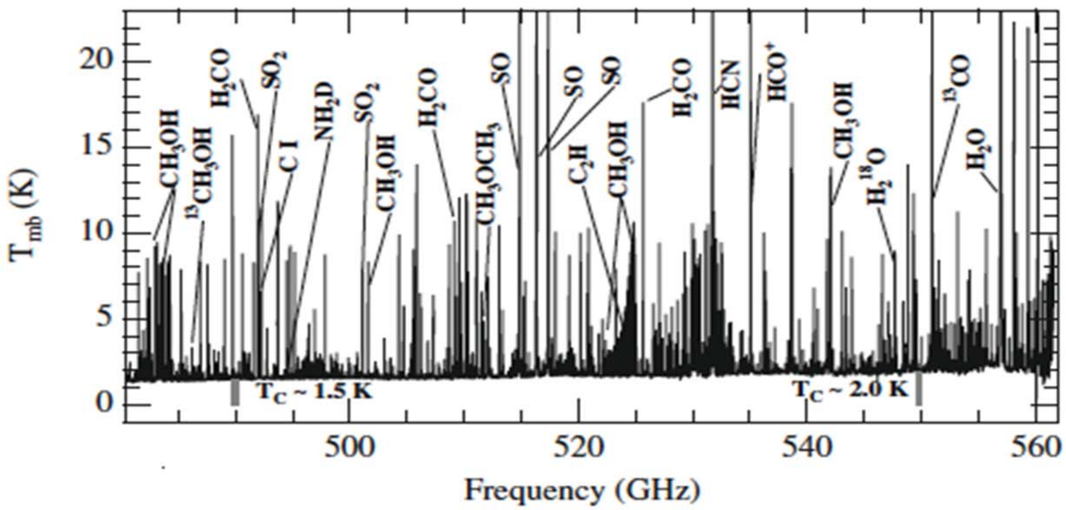


Tmb (K)
Frequency (GHz)
500
520
540
560
0
5
10
15
20
CH3OH
13CH3OH
H2CO
SO2
C I
NH2D
SO2
CH3OH
H2CO
CH3OCH3
SO
SO
SO
C2H
CH3OH
H2CO
HCN
HCO+
CH3OH
H2 18O
13CO
H2O
TC ~ 1.5 K
TC ~ 2.0 K

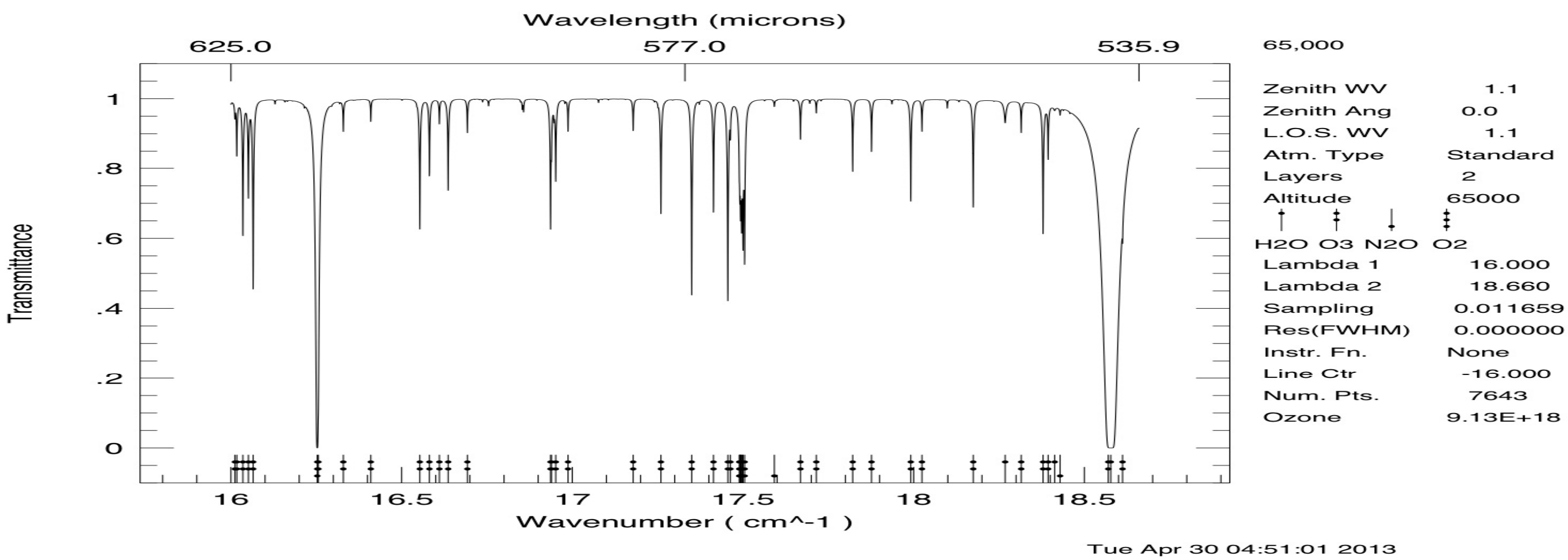


Wavelength (microns)
625.0
577.0
535.9
Transmittance
Wavenumber (cm^-1)
16
16.5
17
17.5
18
18.5
0
.2
.4
.6
.8
1
40,000
Zenith WV 8.4
Zenith Ang 0.0
L.O.S. WV 8.4
Atm. Type Standard
Layers 2
Altitude 40000
H2O O3 N2O O2
Lambda 1 16.000
Lambda 2 18.660
Sampling 0.033331
Res(FWHM) 0.000000
Instr. Fn. None
Line Ctr 580.453
Num. Pts. 2674
Ozone 9.13E+18
Tue Apr 30 04:48:28 2013

65,000' (577 µm)

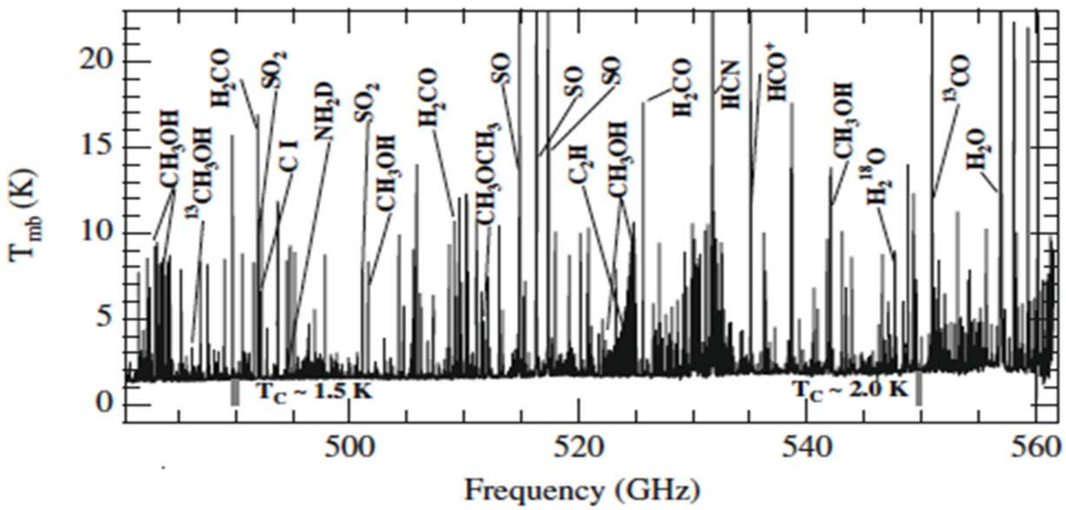


T_{mb} (K)
Frequency (GHz)
CH_3OH
$^{13}CH_3OH$
H_2CO
SO_2
C I
NH_2D
SO_2
CH_3OH
H_2CO
CH_3OCH_3
SO
SO
SO
C_2H
CH_3OH
H_2CO
HCN
HCO^+
CH_3OH
$H_2^{18}O$
^{13}CO
H_2O
T_C ~ 1.5 K
T_C ~ 2.0 K

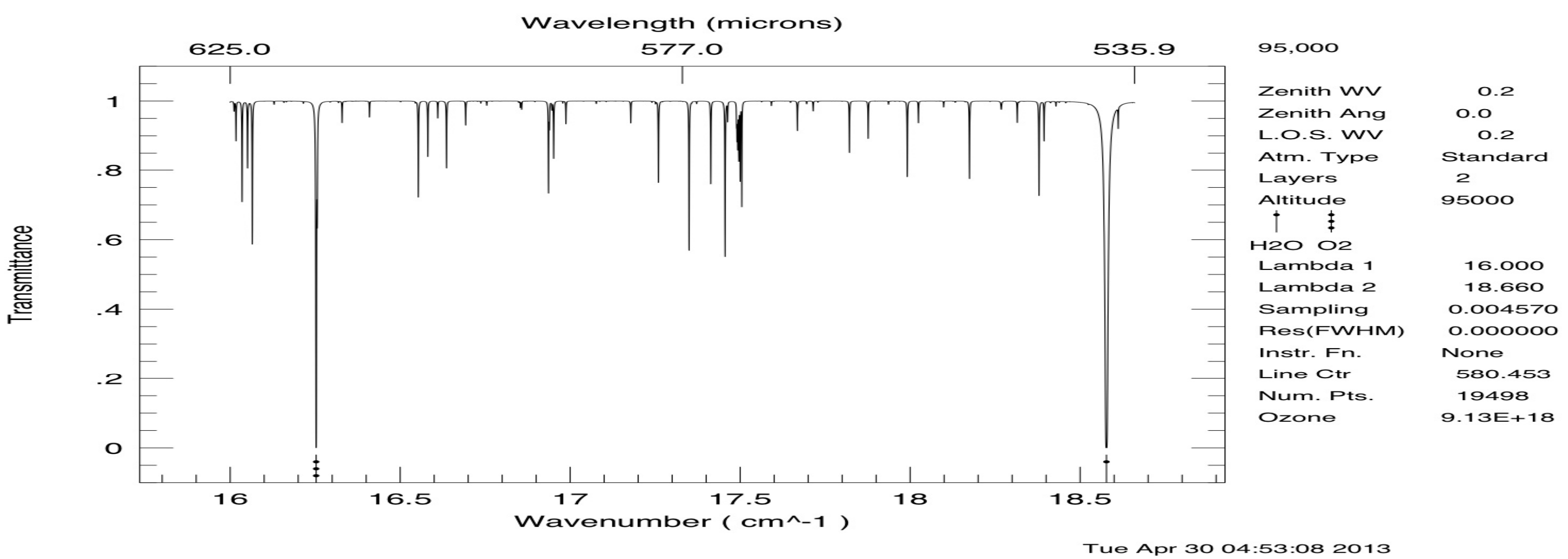


Wavelength (microns)
625.0
577.0
535.9
Transmittance
Wavenumber (cm^-1)
65,000
Zenith WV 1.1
Zenith Ang 0.0
L.O.S. WV 1.1
Atm. Type Standard
Layers 2
Altitude 65000
H2O O3 N2O O2
Lambda 1 16.000
Lambda 2 18.660
Sampling 0.011659
Res(FWHM) 0.000000
Instr. Fn. None
Line Ctr -16.000
Num. Pts. 7643
Ozone 9.13E+18
Tue Apr 30 04:51:01 2013

95,000' (577 µm)

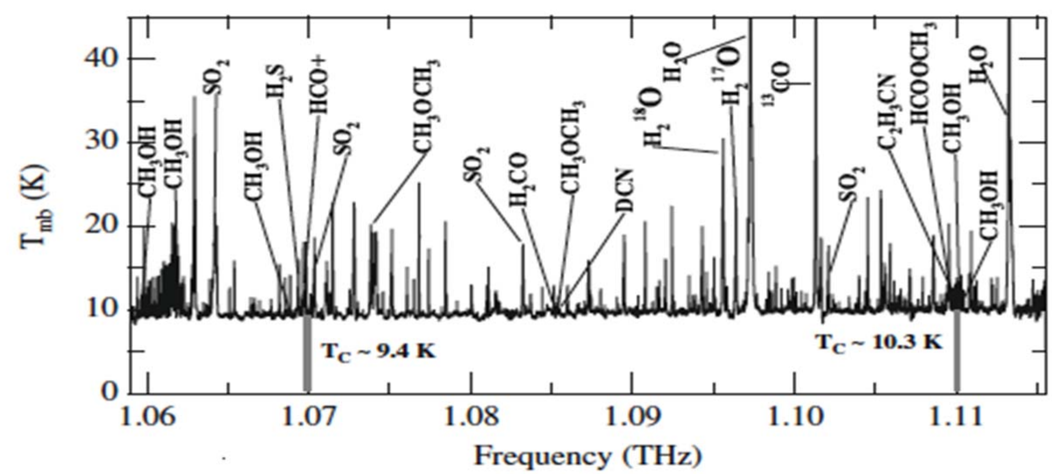


T_{mb} (K)
Frequency (GHz)
T_C ~ 1.5 K
T_C ~ 2.0 K
CH_3OH
$^{13}CH_3OH$
H_2CO
SO_2
C I
NH_2D
CH_3OCH_3
SO
C_2H
HCN
HCO^+
$H_2^{18}O$
^{13}CO
H_2O

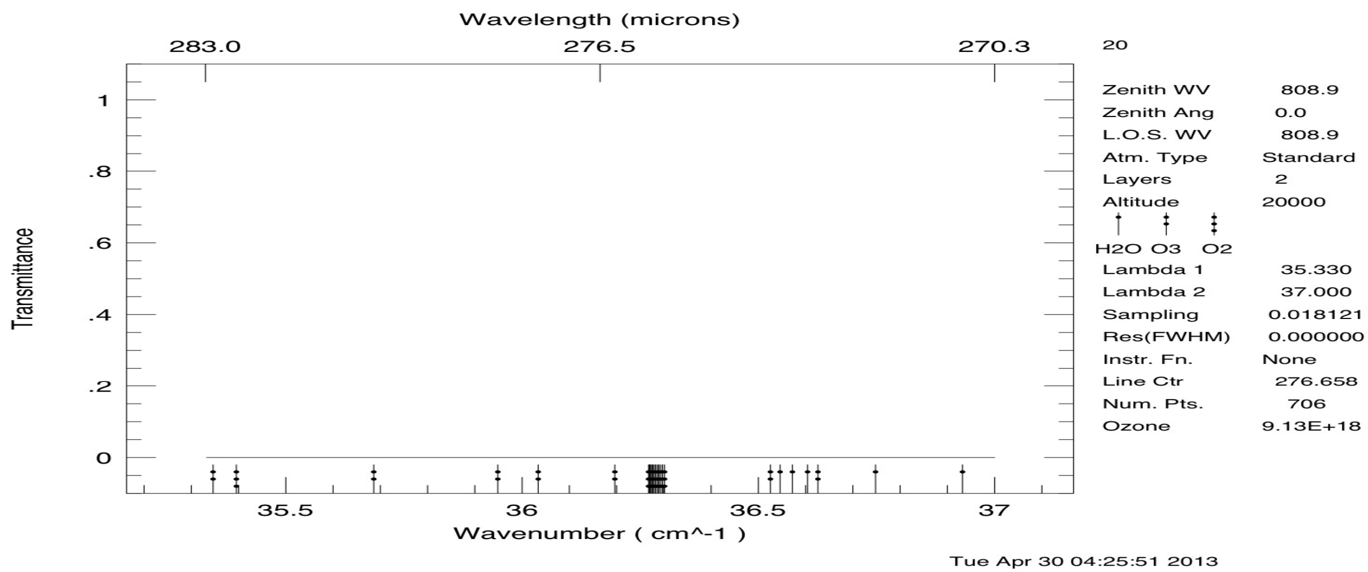


Wavelength (microns)
625.0
577.0
535.9
Transmittance
Wavenumber (cm^-1)
95,000
Zenith WV 0.2
Zenith Ang 0.0
L.O.S. WV 0.2
Atm. Type Standard
Layers 2
Altitude 95000
H2O O2
Lambda 1 16.000
Lambda 2 18.660
Sampling 0.004570
Res(FWHM) 0.000000
Instr. Fn. None
Line Ctr 580.453
Num. Pts. 19498
Ozone 9.13E+18
Tue Apr 30 04:53:08 2013

20,000' (276μm)

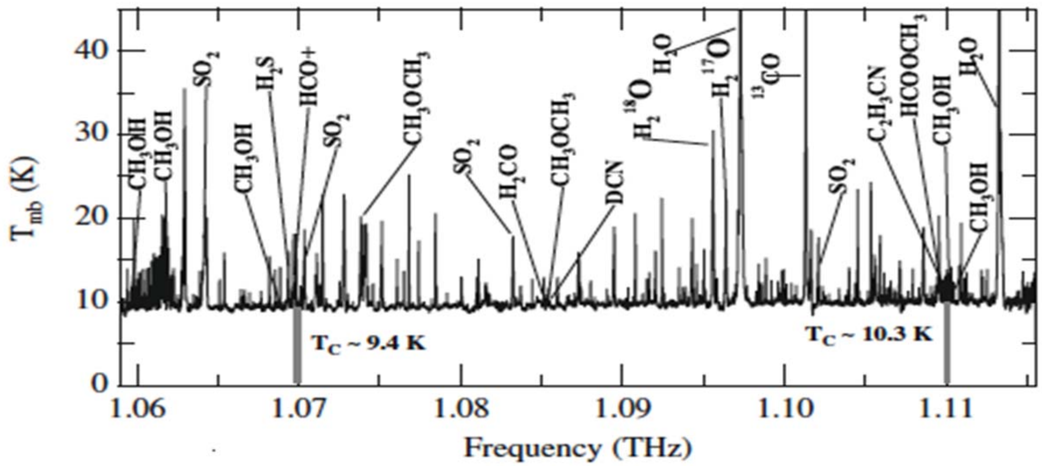


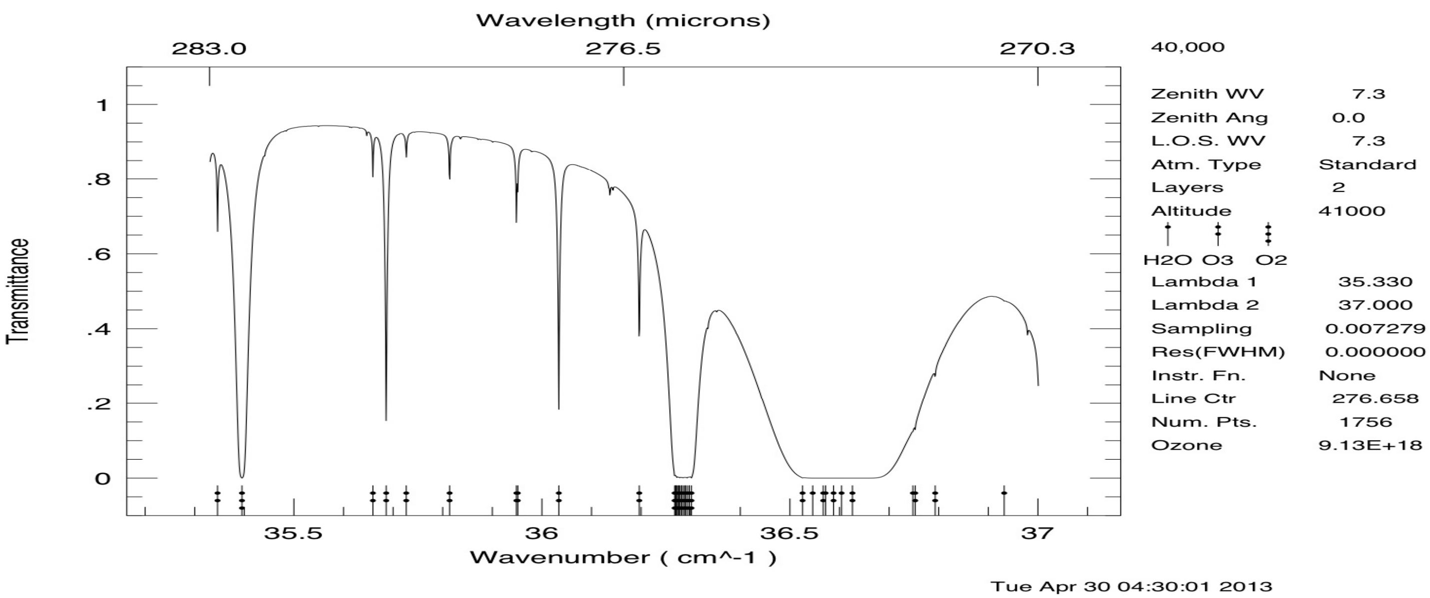
Tmb (K)
Frequency (THz)
1.06
1.07
1.08
1.09
1.10
1.11
0
10
20
30
40
CH3OH
CH3OH
SO2
CH3OH
H2S
HCO+
SO2
CH3OCH3
SO2
H2CO
CH3OCH3
DCN
H2 18O
H2O
H2 17O
13CO
SO2
C2H5CN
HCOOCH3
CH3OH
H2O
CH3OH
TC ~ 9.4 K
TC ~ 10.3 K



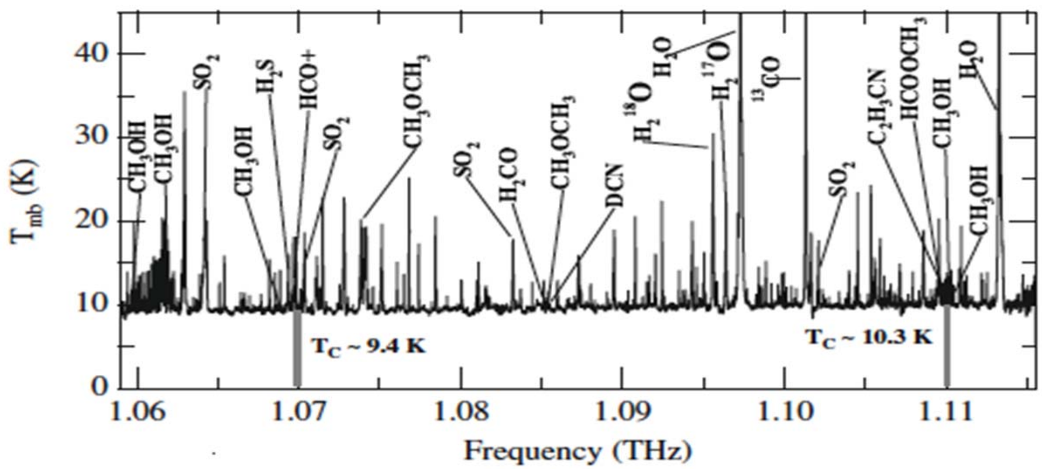
Wavelength (microns)
283.0
276.5
270.3
Transmittance
1
.8
.6
.4
.2
0
35.5
36
36.5
37
Wavenumber (cm^-1)
20
Zenith WV 808.9
Zenith Ang 0.0
L.O.S. WV 808.9
Atm. Type Standard
Layers 2
Altitude 20000
H2O O3 O2
Lambda 1 35.330
Lambda 2 37.000
Sampling 0.018121
Res(FWHM) 0.000000
Instr. Fn. None
Line Ctr 276.658
Num. Pts. 706
Ozone 9.13E+18
Tue Apr 30 04:25:51 2013

40,000' (276µm)

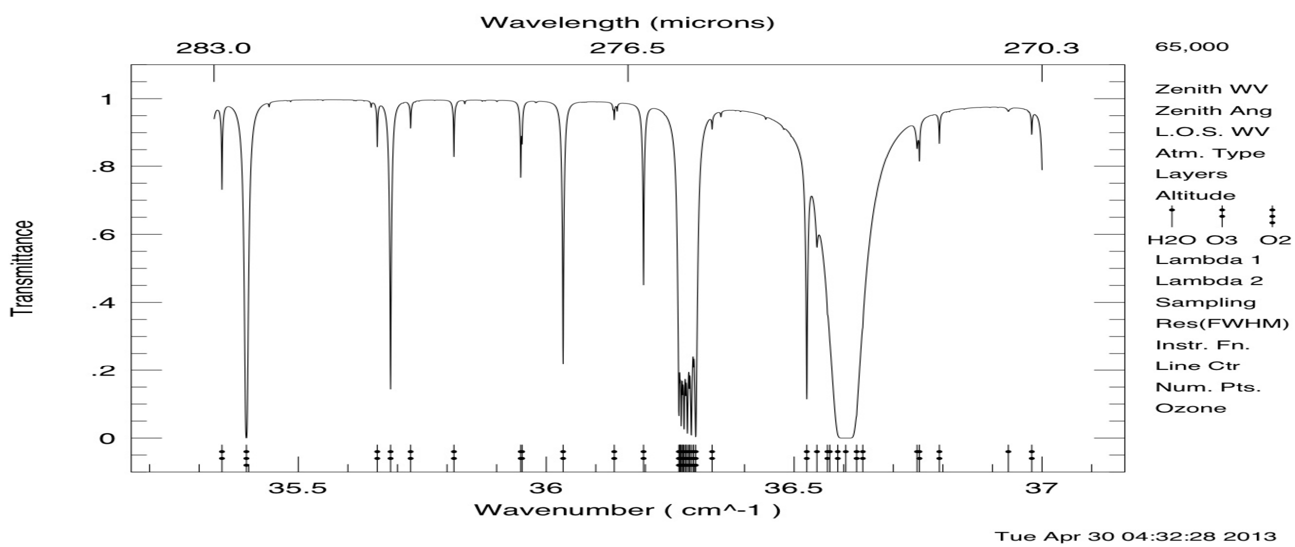

T_{mb} (K)
Frequency (THz)
1.06
1.07
1.08
1.09
1.10
1.11
0
10
20
30
40
CH_3OH
CH_3OH
SO_2
CH_3OH
H_2S
HCO^+
SO_2
CH_3OCH_3
SO_2
H_2CO
CH_3OCH_3
DCN
$H_2{}^{18}O$
H_2O
$H_2{}^{17}O$
^{13}CO
SO_2
C_2H_3CN
$HCOOCH_3$
CH_3OH
CH_3OH
H_2O
T_C ~ 9.4 K
T_C ~ 10.3 K


Wavelength (microns)
283.0
276.5
270.3
Transmittance
0
.2
.4
.6
.8
1
35.5
36
36.5
37
Wavenumber (cm^-1)
40,000
Zenith WV 7.3
Zenith Ang 0.0
L.O.S. WV 7.3
Atm. Type Standard
Layers 2
Altitude 41000
H2O O3 O2
Lambda 1 35.330
Lambda 2 37.000
Sampling 0.007279
Res(FWHM) 0.000000
Instr. Fn. None
Line Ctr 276.658
Num. Pts. 1756
Ozone 9.13E+18
Tue Apr 30 04:30:01 2013

65,000' (276µm)

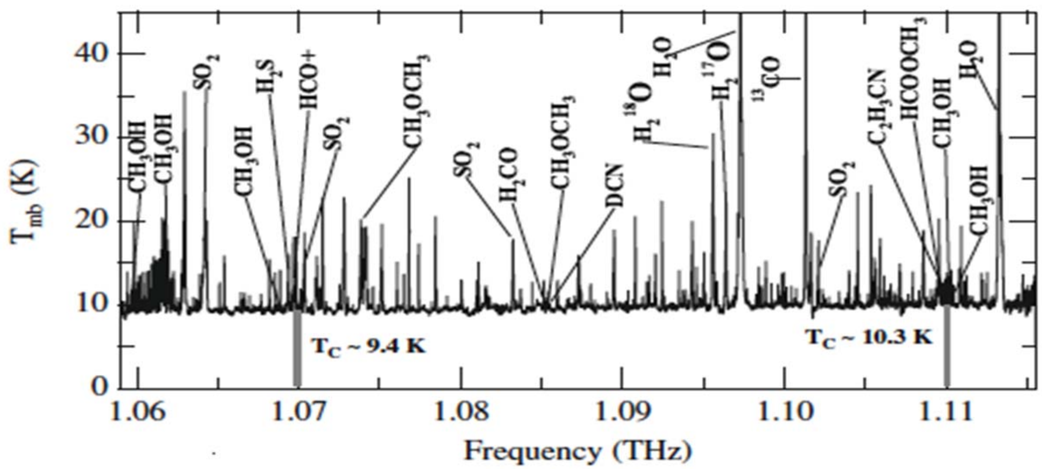


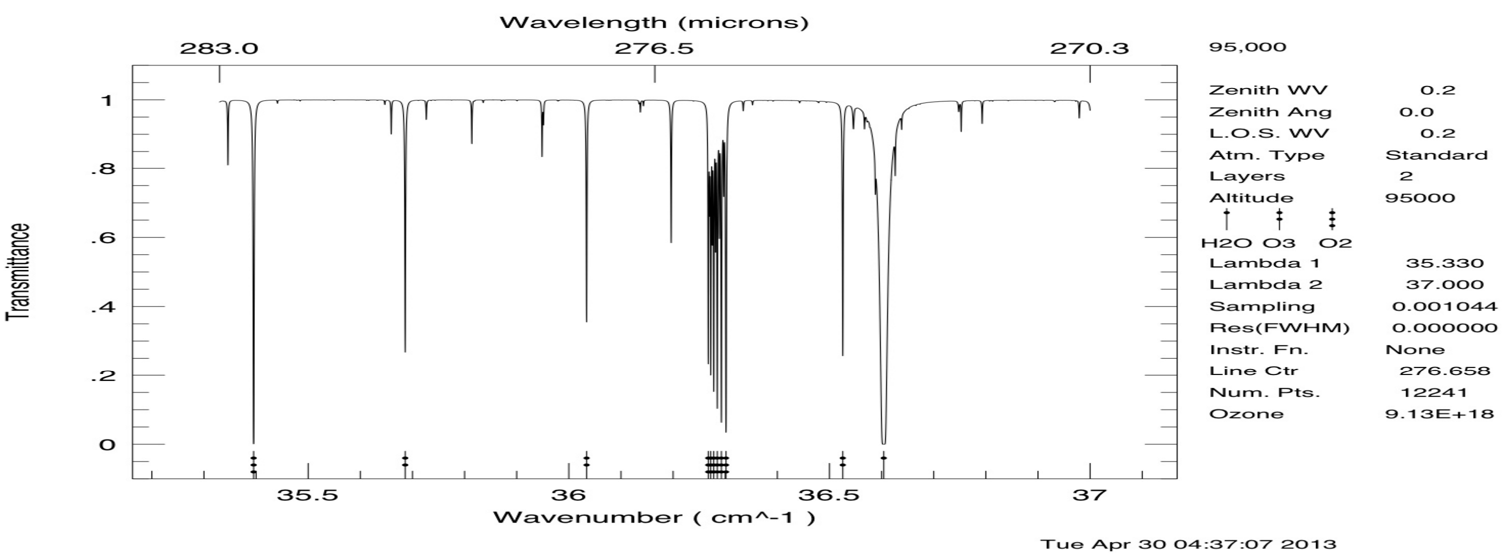
Frequency (THz)
T_{mb} (K)
T_C ~ 9.4 K
T_C ~ 10.3 K



Wavelength (microns)
Wavenumber (cm^-1)
Transmittance
65,000
Zenith WV 1.1
Zenith Ang 0.0
L.O.S. WV 1.1
Atm. Type Standard
Layers 2
Altitude 65000
H2O O3 O2
Lambda 1 35.330
Lambda 2 37.000
Sampling 0.002663
Res(FWHM) 0.000000
Instr. Fn. None
Line Ctr 276.658
Num. Pts. 4798
Ozone 9.13E+18
Tue Apr 30 04:32:28 2013

95,000' (276µm)


Tmb (K)
Frequency (THz)
0
10
20
30
40
1.06
1.07
1.08
1.09
1.10
1.11
CH3OH
SO2
H2S
HCO+
CH3OCH3
H2CO
DCN
H2 18O
H2O
H2 17O
13CO
C2H3CN
HCOOCH3
TC ~ 9.4 K
TC ~ 10.3 K


Wavelength (microns)
283.0
276.5
270.3
Transmittance
1
.8
.6
.4
.2
0
35.5
36
36.5
37
Wavenumber (cm^-1)
95,000
Zenith WV 0.2
Zenith Ang 0.0
L.O.S. WV 0.2
Atm. Type Standard
Layers 2
Altitude 95000
H2O O3 O2
Lambda 1 35.330
Lambda 2 37.000
Sampling 0.001044
Res(FWHM) 0.000000
Instr. Fn. None
Line Ctr 276.658
Num. Pts. 12241
Ozone 9.13E+18
Tue Apr 30 04:37:07 2013

Hi-GAL

Molinari et al. 2010

Herschel infrared Galactic Plane Survey

Hi-GAL Team / ESA / PACS / SPIRE

PACS/SPIRE 70-160-350μm composite

Toward a Predictive Global Model of Galactic Star Formation

The *Hi-GAL* Team Institutes [PI: S. Molinari, INAF-IAPS Rome]
Italy: INAF-IAPS (*Rome)*, Univ. Roma "Tor Vergata", Univ. Roma "La Sapienza", INAF-Oss. Arcetri, INAF-Oss. Catania, Univ. Salento. ***USA***: Caltech-SSC-IPAC (*Pasadena)*, Univ. Colorado (*Boulder)*. ***UK***: STFC-RAL (*Chilton)*, Univ. Cardiff, Liverpool John Moores Univ., UCL (*London)*, Univ. Hertfordshire, Univ. Leeds, Univ. Manchester, Univ. Exeter. ***France***: CNRS-IRAP (*Toulouse)*, LAM (*Marseille)*, IAS (*Orsay*), CEA-SAp (*Saclay*). ***Canada***: Univ. Toronto, Univ. Calgary, Univ. Laval (*Montreal*). ***Germany***: MPIfR (*Bonn*). ***Japan***: Nagoya University. ***China***: NAO-CAS (*Beijing*) . ***ESO-HQ*** (Munich). ***ESA-ESTEC*** (*Noordwijk*). ***ESA-ESAC*** (*Madrid)*

HI-GAL data processing is carried out at INAF-IAPS (Rome) thanks to support from Agenzia Spaziale Italiana under Contract I/038/08/0

Transmission of Herschel Continuum Filters (approx.)

	PACS	PACS	SPIRE
Filter	70um	160um	350um
65,000'	0.8	0.8	0.9
41,000'	0.6	0.6	0.7
20,000'	0	0	0.4