Aerosol optical depth retrieval in 300nm-380nm spectral range using UV-RSS at Table Mt., Boulder, Colorado

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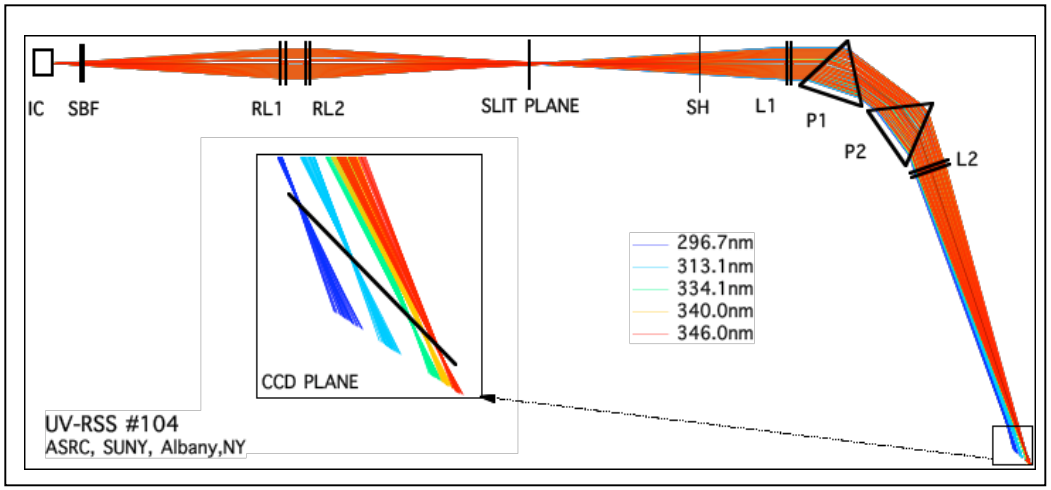
UV-RSS at Table Mt., Boulder, Colorado

RSS104 at Table Mountain, Colorado since June 2003

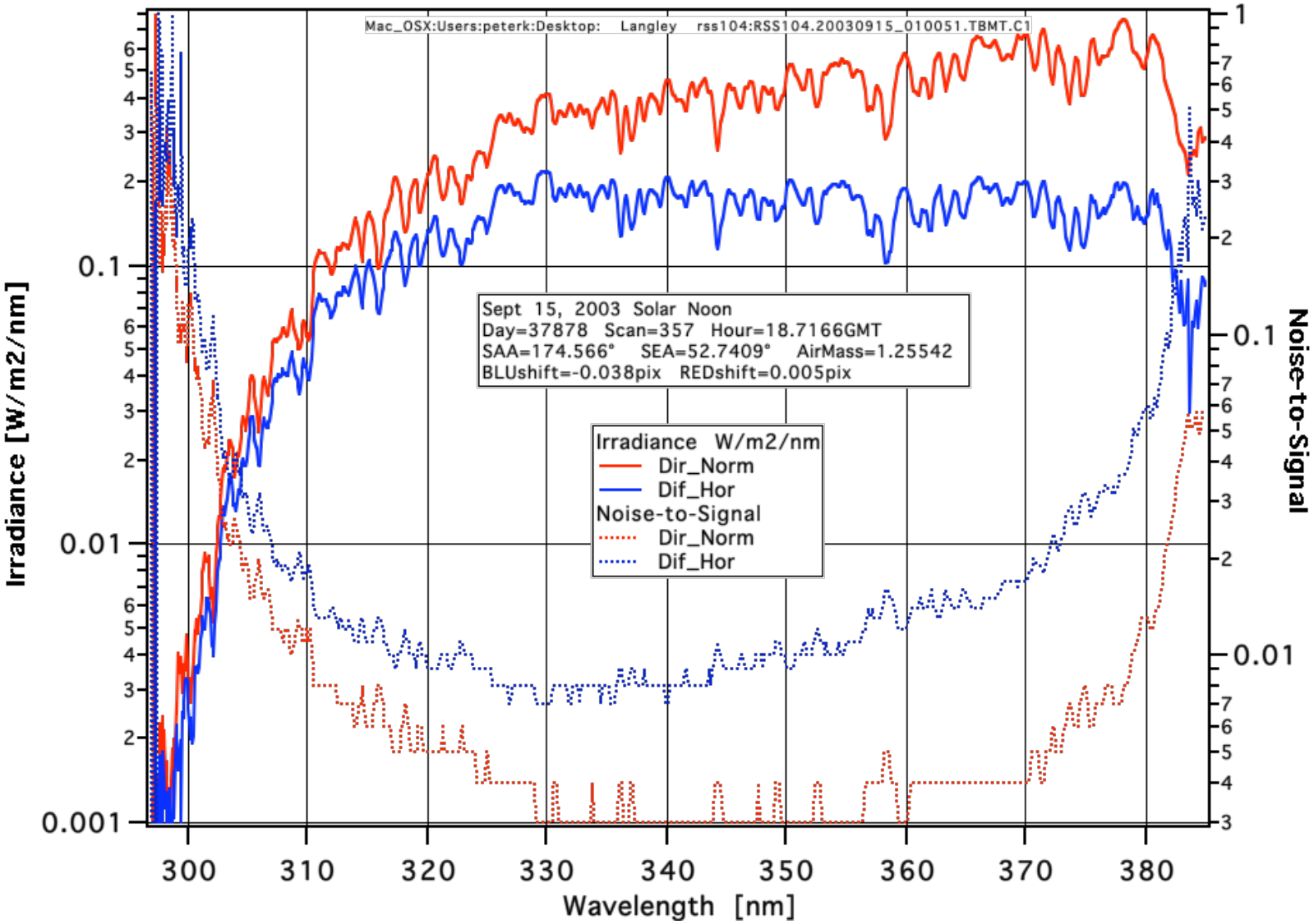


Nominal range: 297nm-385nm =734 pixels
Noise limited at 297 and filter limited at 385nm

At 300nm fwhm=0.311nm=3.69pix
At 380nm fwhm=0.613nm=3.57pix

Stray light =0.5 *10^{-5} from 325nm HeCd laser
Slit function is approximately Gaussian

Examples of irradiance and noise-to-signal from RSS
Log Scale

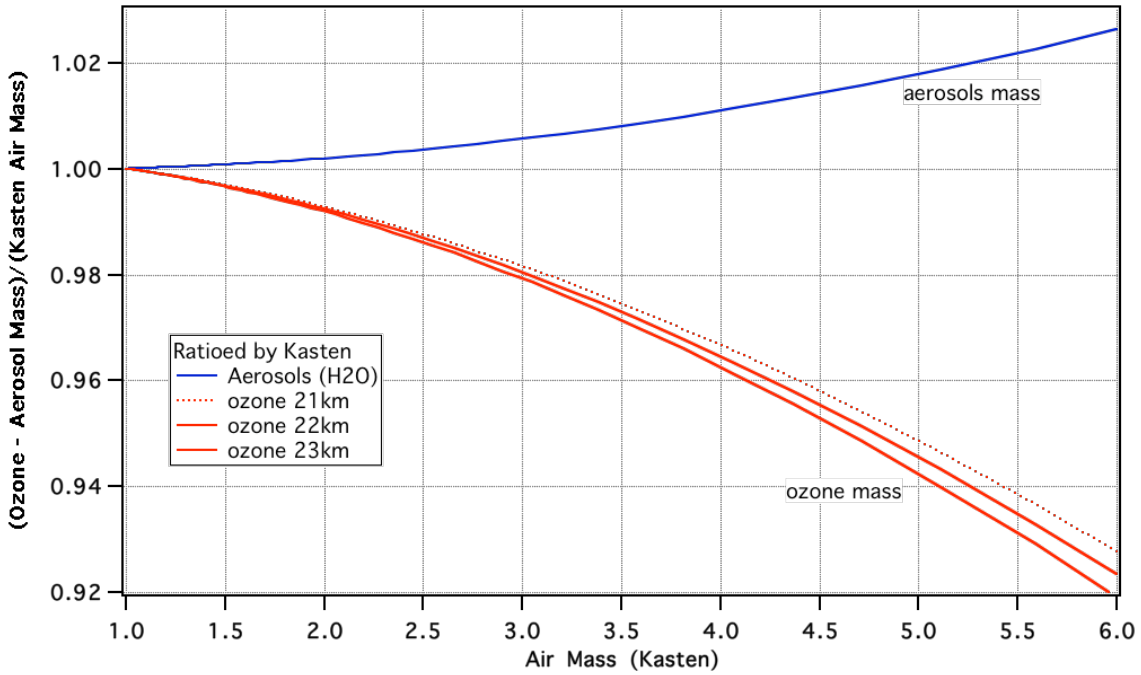


Langley regression: Methods 1, 2 and 3

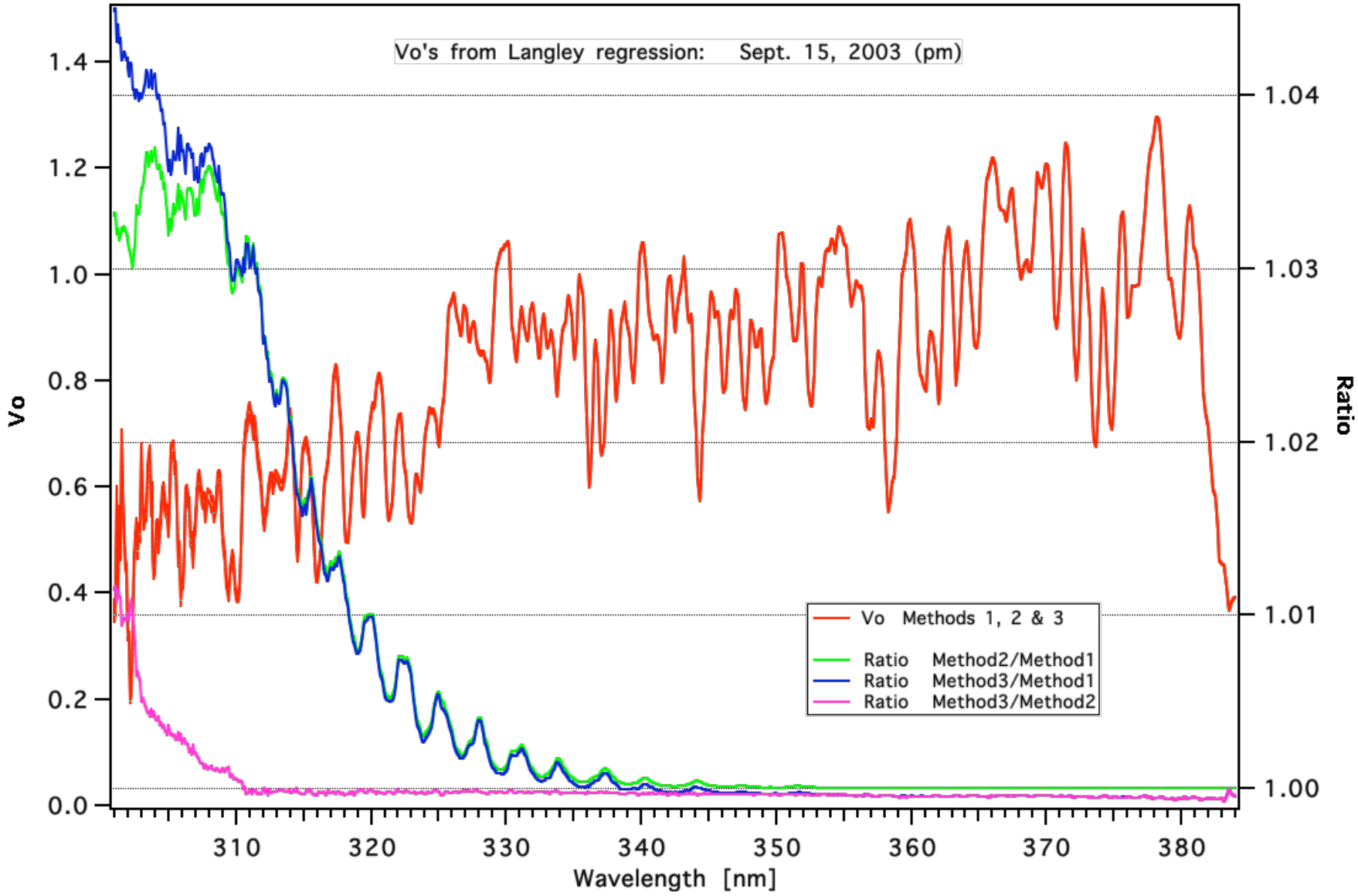
$$\ln V = \ln\left(\frac{V_0}{r^2}\right) - \tau \cdot m_{air}$$

$$\ln V + DU_{est} \cdot \bar{a}_{O_3} \cdot m_{O_3} = \ln\left(\frac{V_0}{r^2}\right) - \tau \cdot m_{air}$$

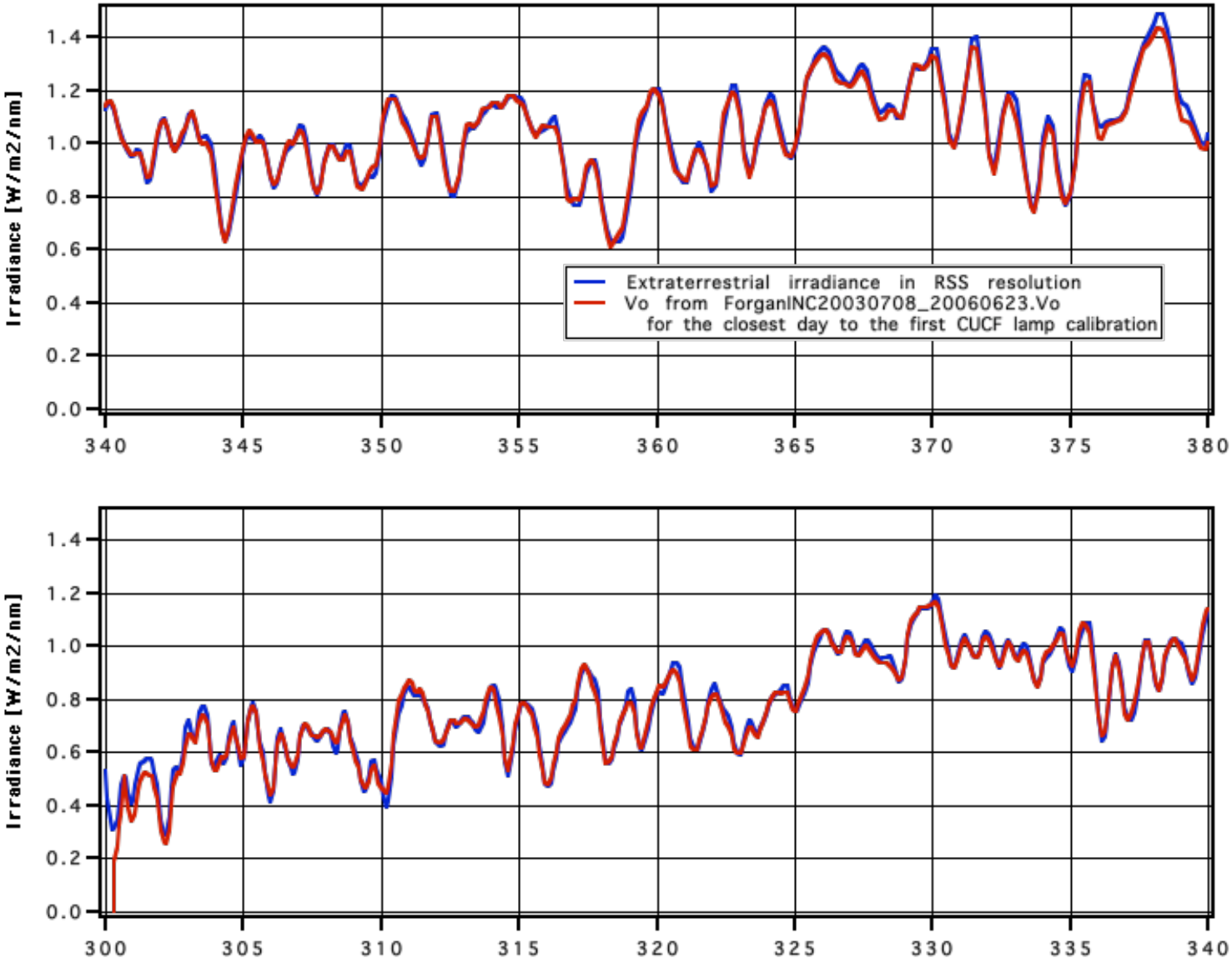
$$\ln V + DU_{est} \cdot \bar{a}_{O_3} \cdot m_{O_3} + \tau_{air} \cdot m_{air} = \ln\left(\frac{V_0}{r^2}\right) - \tau \cdot m_{aer}$$



Comparison of Vo's from Method 1, 2 and 3

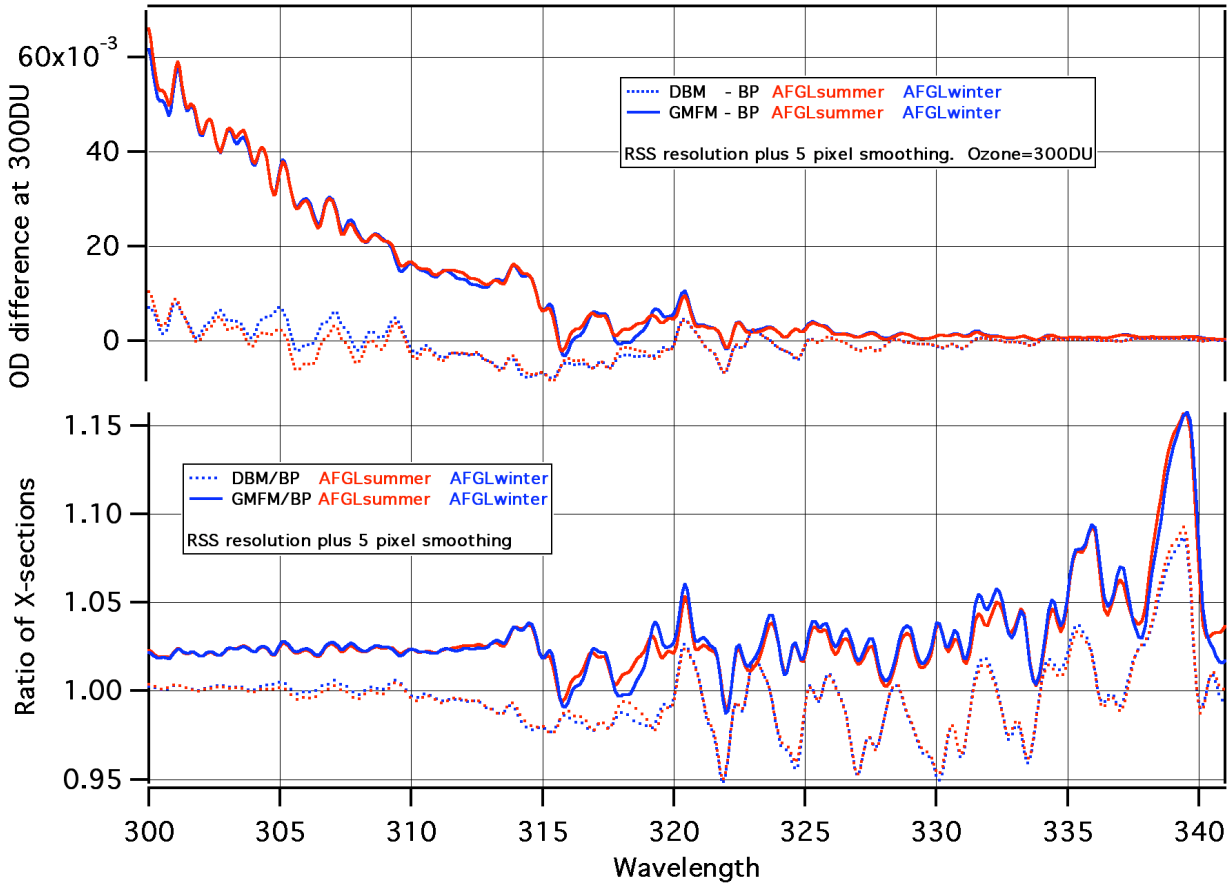


Comparison of Vo with ET spectrum



ET Spectrum from: G. Bernhard et al. (2004). *J. Geophys. Res.*, *109*, D21207, doi:10.1029/2004JD004937
http://www.biospherical.com/nsf/Version2/JGRpaper.asp

Differences among BP, DBM and GMFM
O3 X-section as used in retrievals with RSS data



BP:	**Bass and Paur 1985**
DBM:	**Daumont, Brion and Malicet 1992, 1993 and 1995**
GMFM:	**Burrows, et al, 1999**

Simultaneous ozone and aerosols retrievals

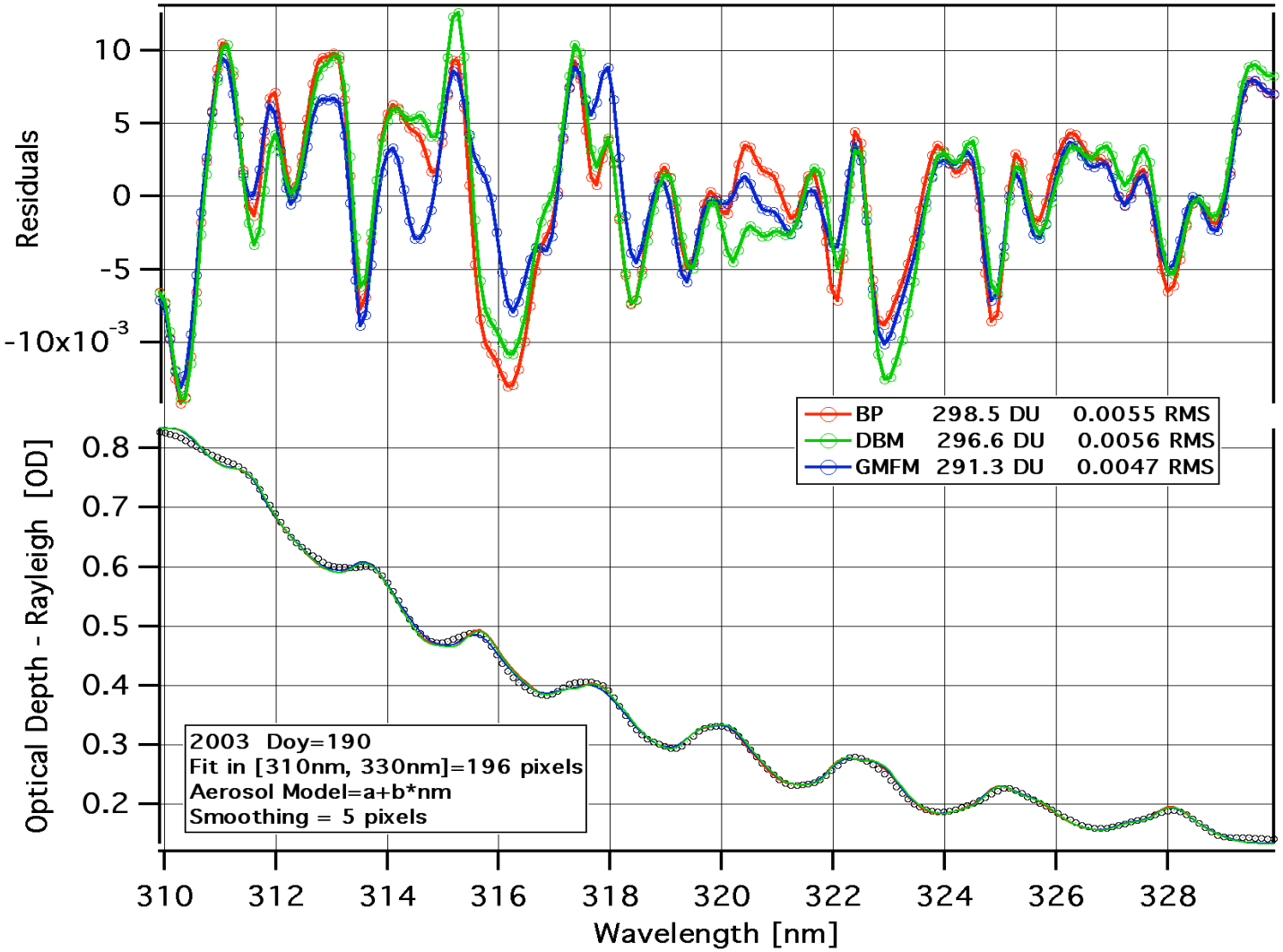
$$\tau(\lambda) = -\frac{1}{m_{air}} \ln r^2 \frac{V(\lambda)}{V_0(\lambda)} - \tau_{air}(\lambda)$$

$$\min_{DU,\alpha,\beta} \int_{\lambda_1}^{\lambda_2} \left| \tau(\lambda) - DU \cdot \overline{a}_{O_3}(\lambda) \frac{m_{O_3}}{m_{air}} - A(\lambda:\alpha,\beta) \frac{m_{aer}}{m_{air}} \right|^2 M(\lambda) d\lambda$$

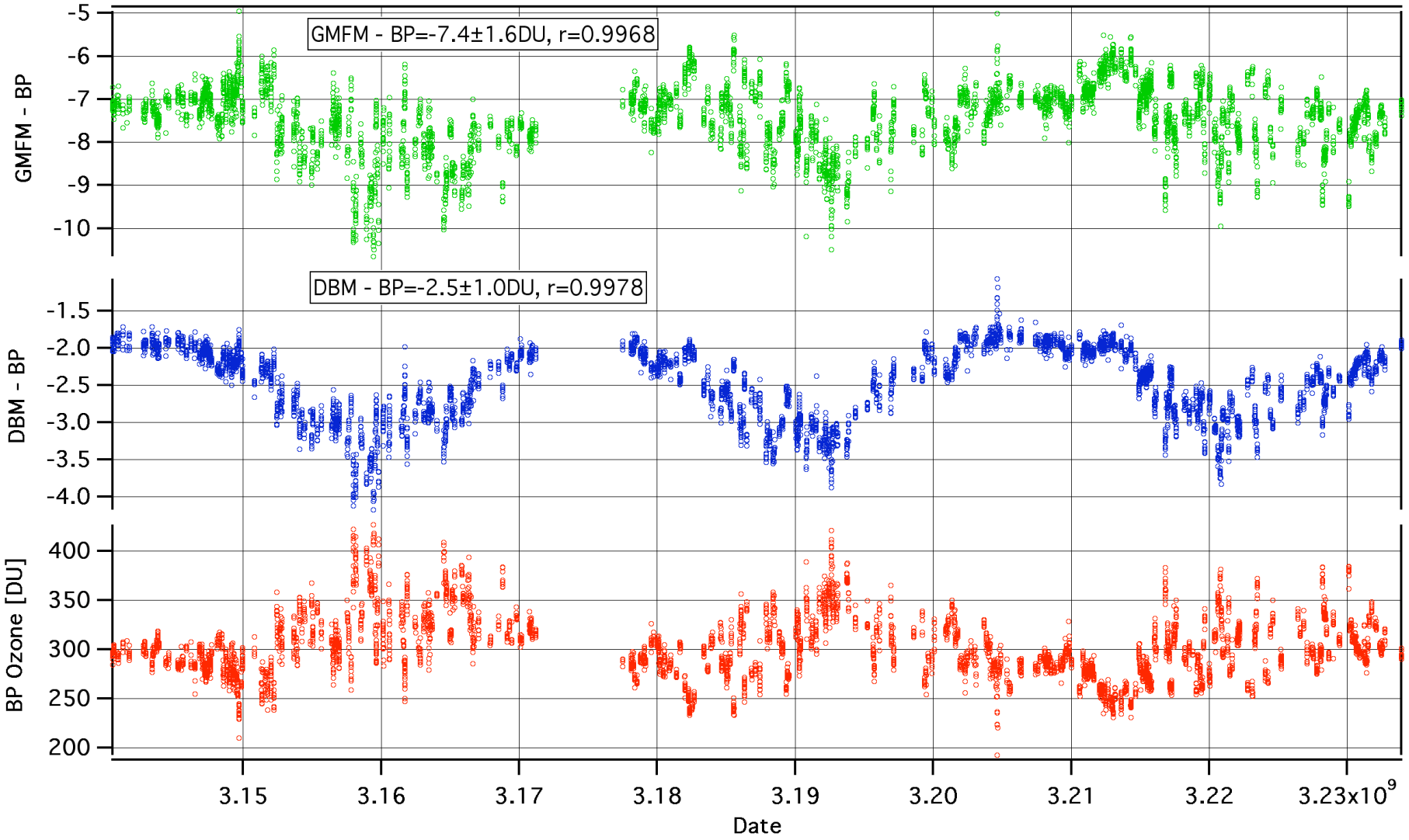
$$A(\lambda:\alpha,\beta) = \beta + \alpha \cdot \lambda \quad or \quad A(\lambda:\alpha,\beta) = \beta \cdot \lambda^{-\alpha}$$

$M(\lambda)$ - mask and/or weight

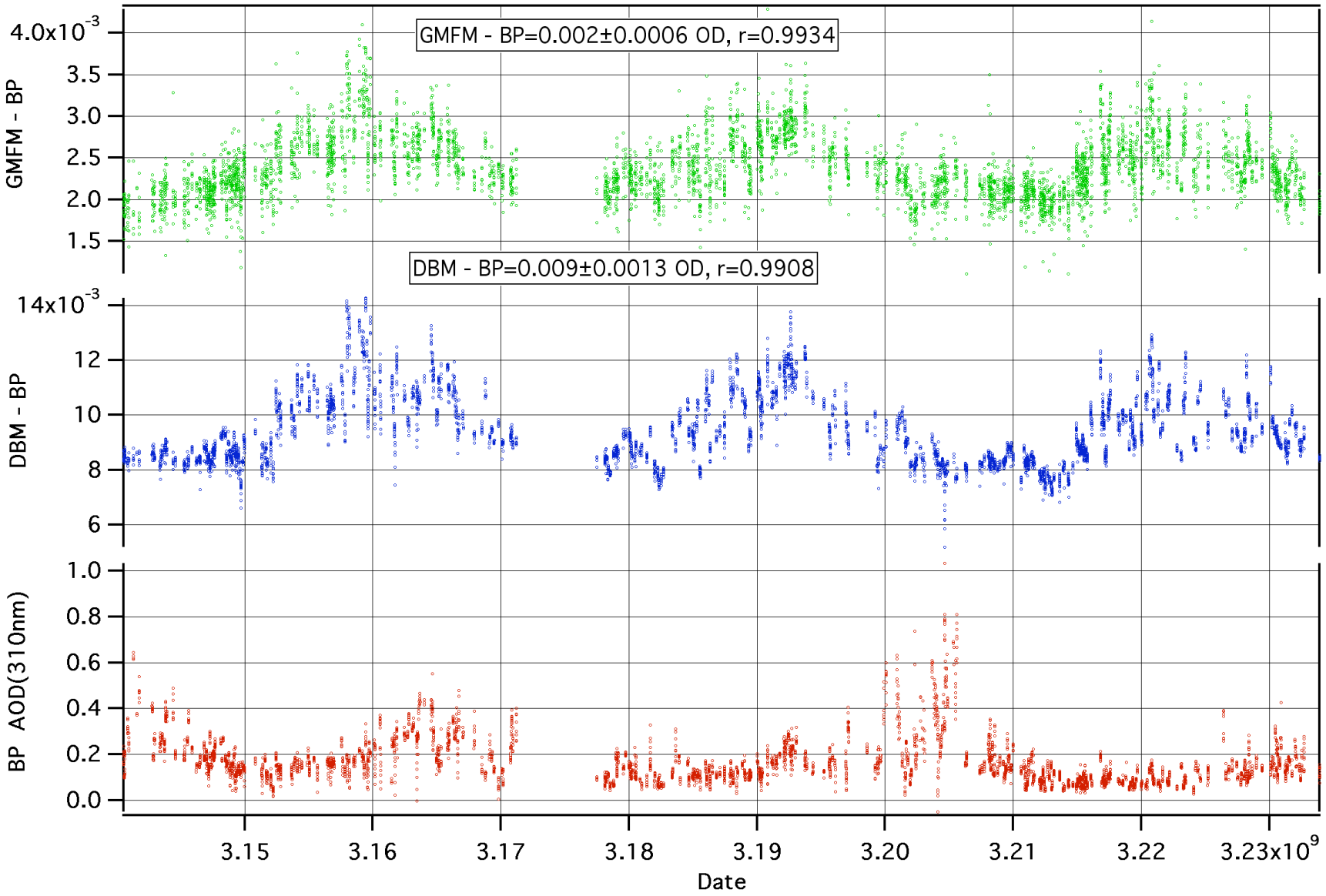
Comparison of retrievals with O3 X-sections according to BP, DBM and GMFM



O3 retrievals with BP, DBM and GMFM X-sections

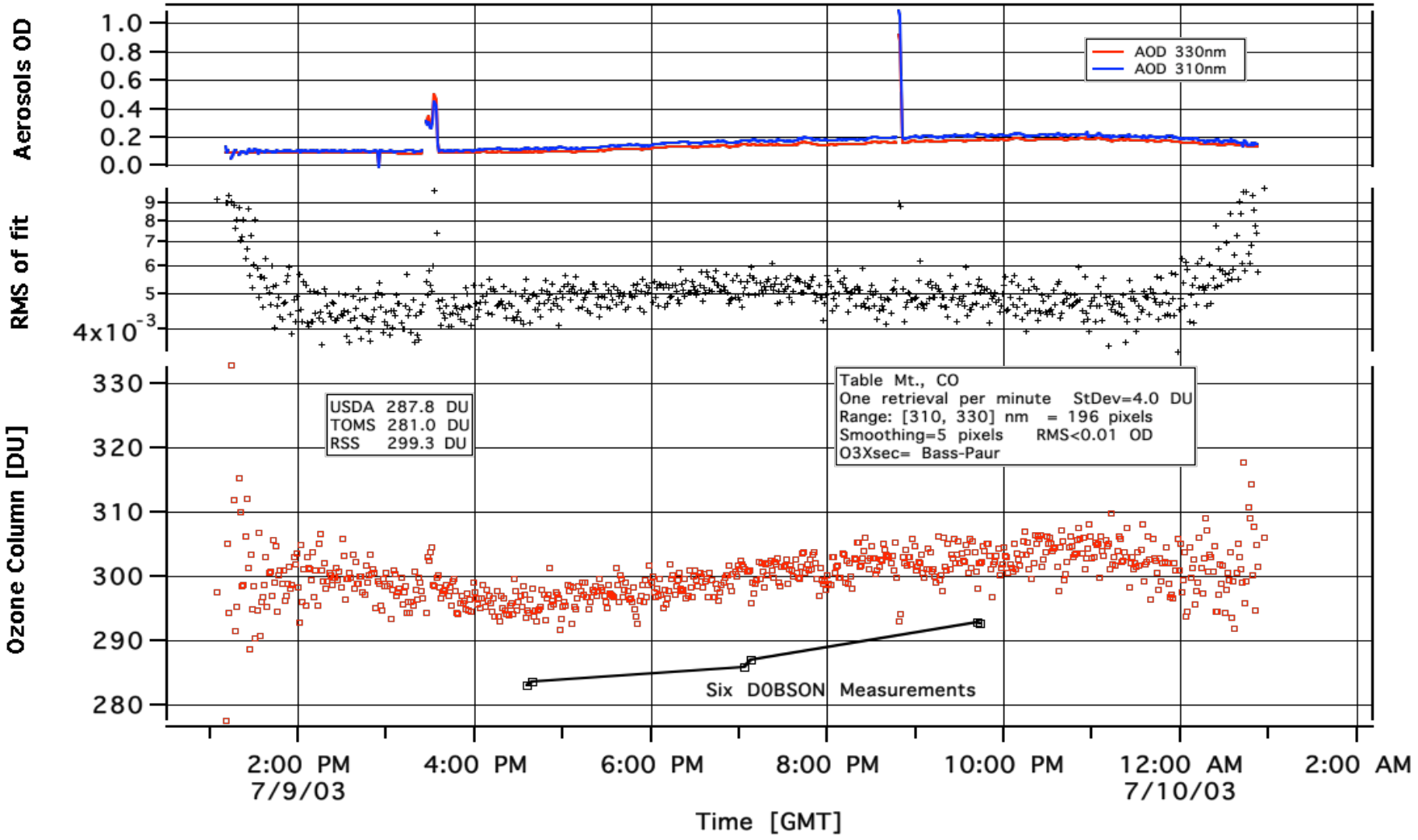


AOD retrievals with BP, DBM and GMFM X-sections



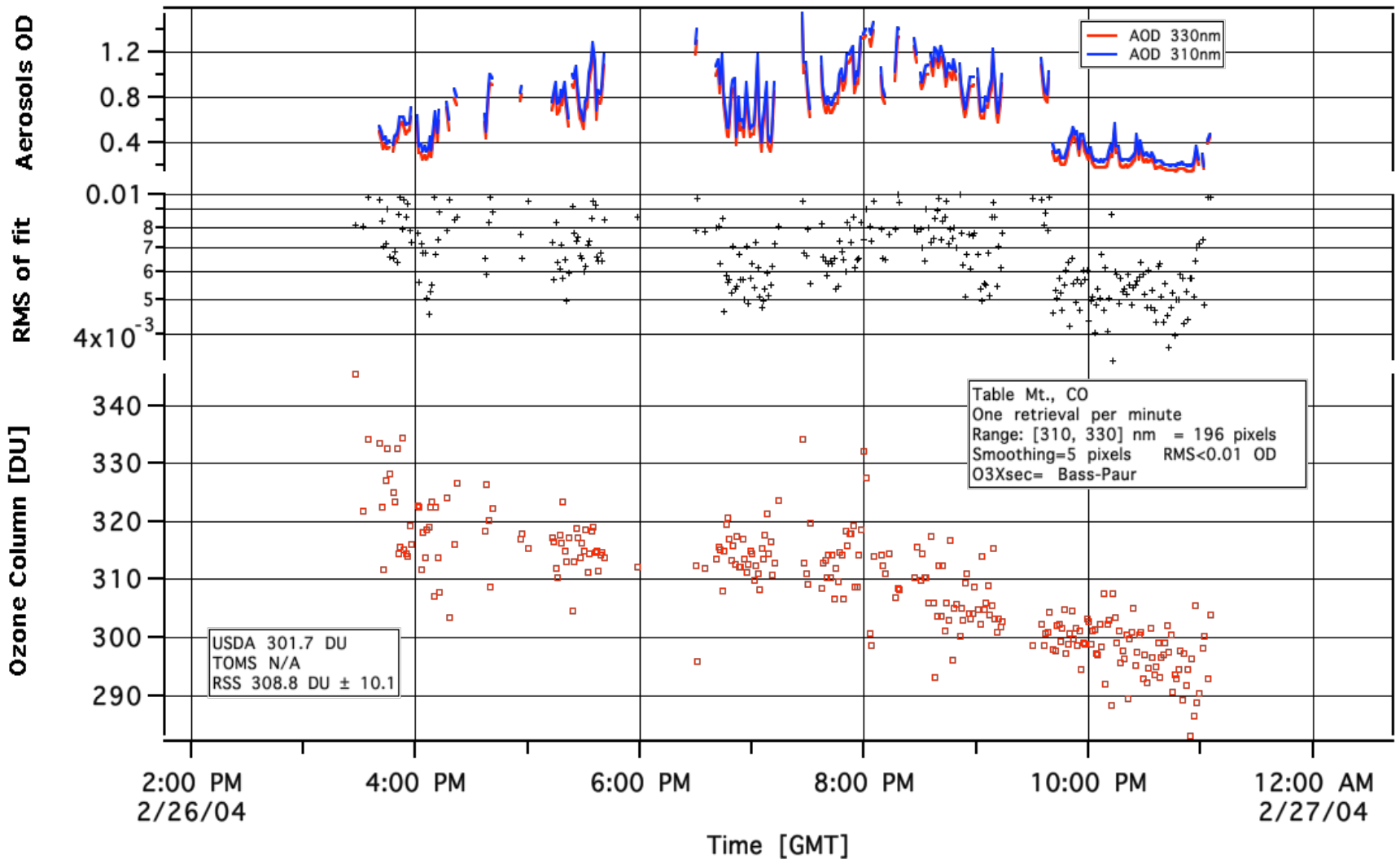
Examples of scan by scan daily ozone and AOD retrievals

Clear day with a slow ozone trend case



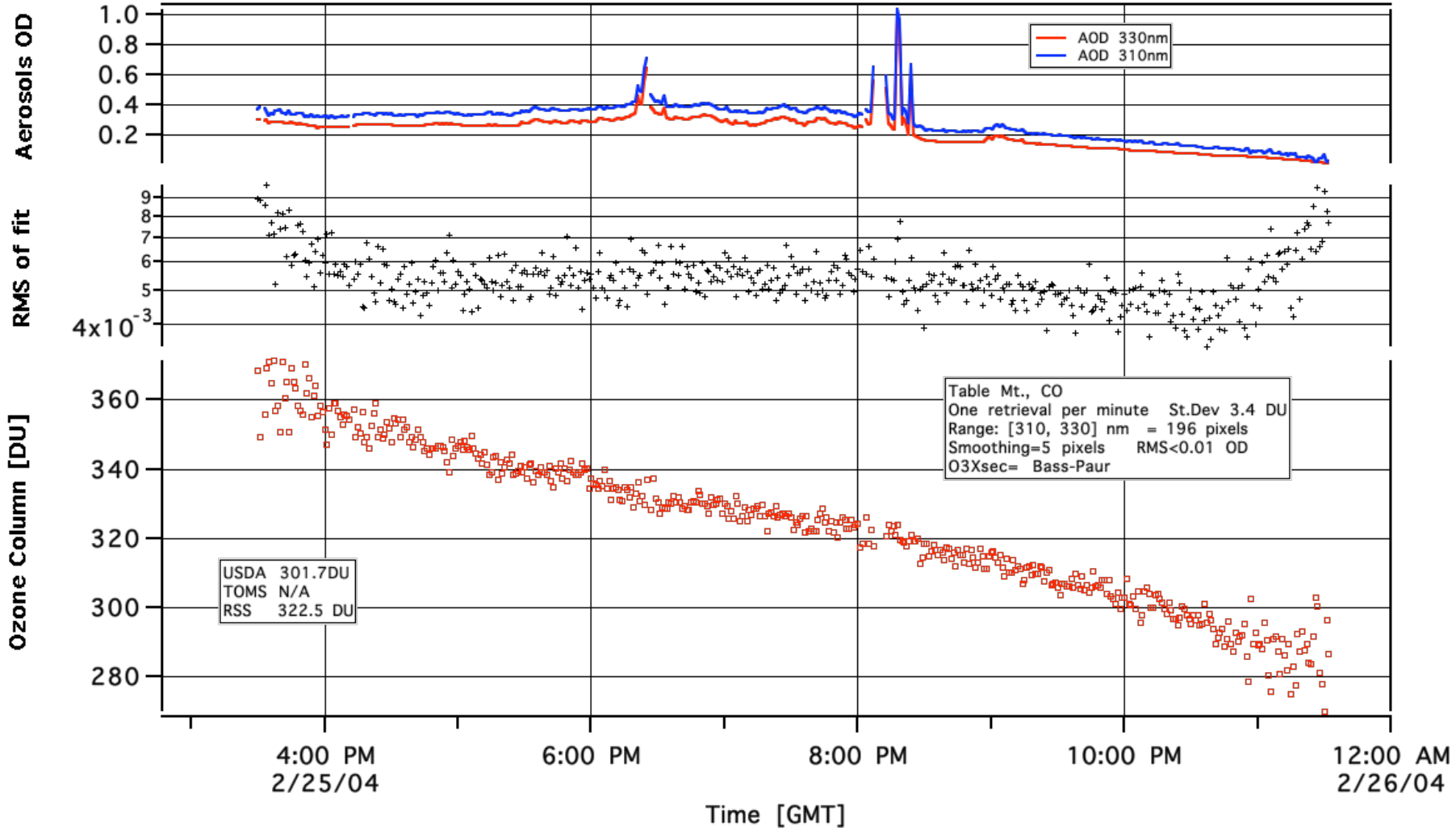
Examples of scan by scan daily ozone and AOD retrievals

Large OD and choppy sky (suitable case for retrieval from total horizontal)



Examples of scan by scan daily ozone and AOD retrievals

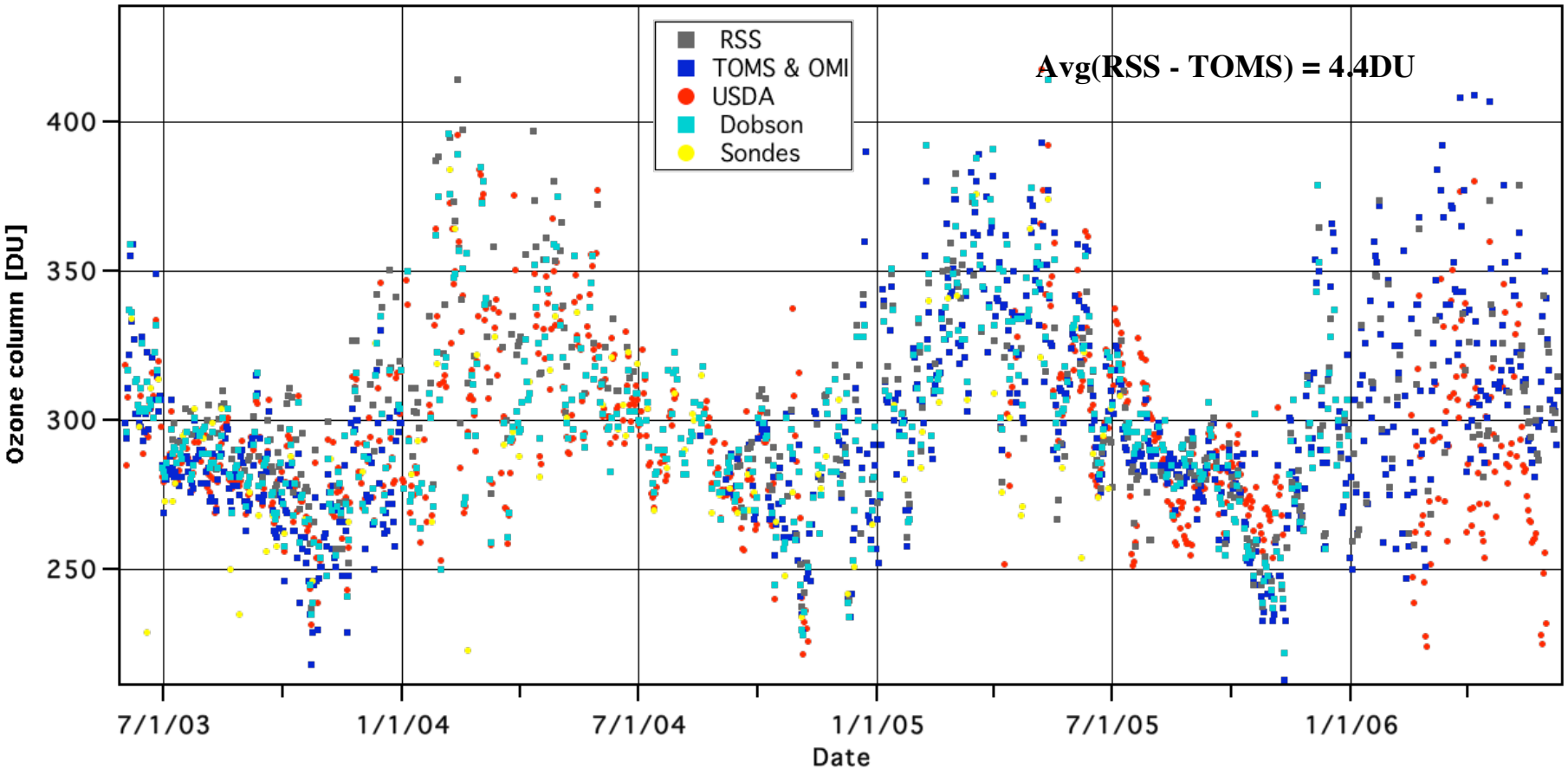
Extremally rapid ozone trend case



Comparison with TOMS & OMI, USDA and Sondes

All data displayed

RSS daily (410 days) ozone values are averages of successful (RMS<0.01) retrievals from 10-30 scans for air mass<4.



TOMS & OMI O_3 data came from the anonymous ftp site ftp://jwocky.gsfc.nasa.gov
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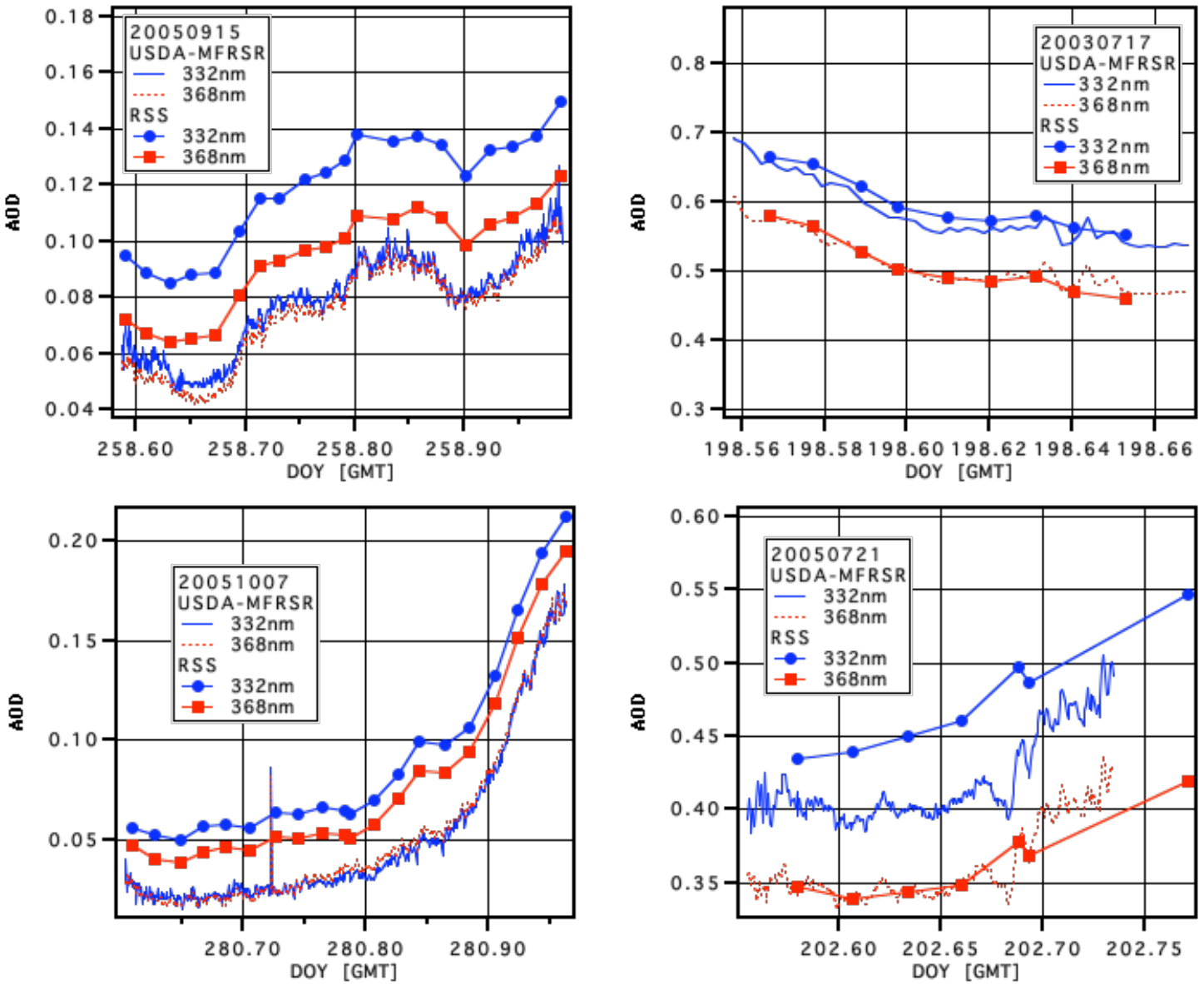
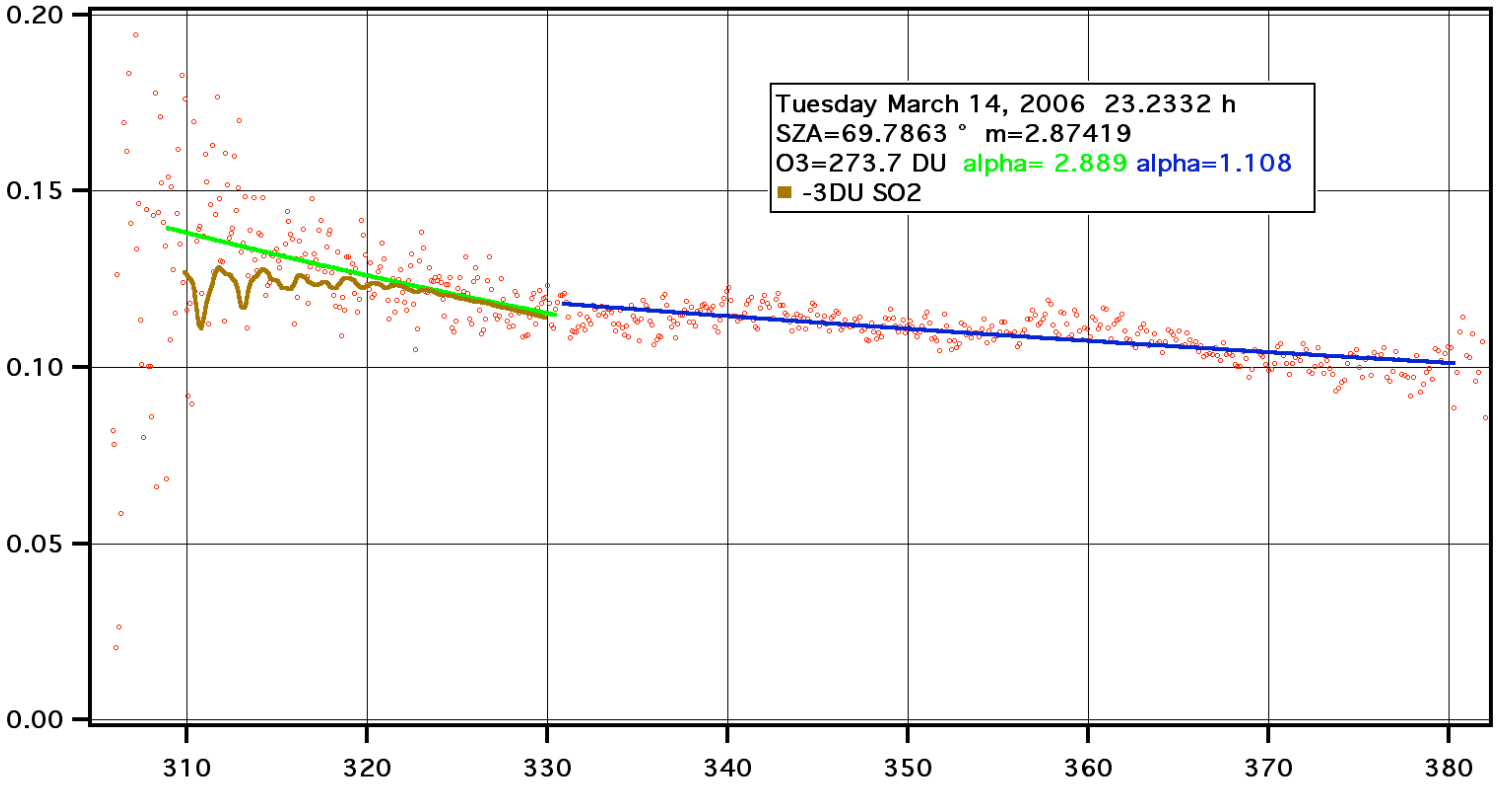
USDA (MFRSR) O_3 came from http://uvb.nrel.colostate.edu/
The Sonde's O3 data came from the CMDL site: ftp://140.172.192.211/ozwv/ozone

AOD at 332nm and 368nm from UV-MFRSR compared with RSS



AOD retrieval (GMFM X-section)
Angstrom coefficient issue



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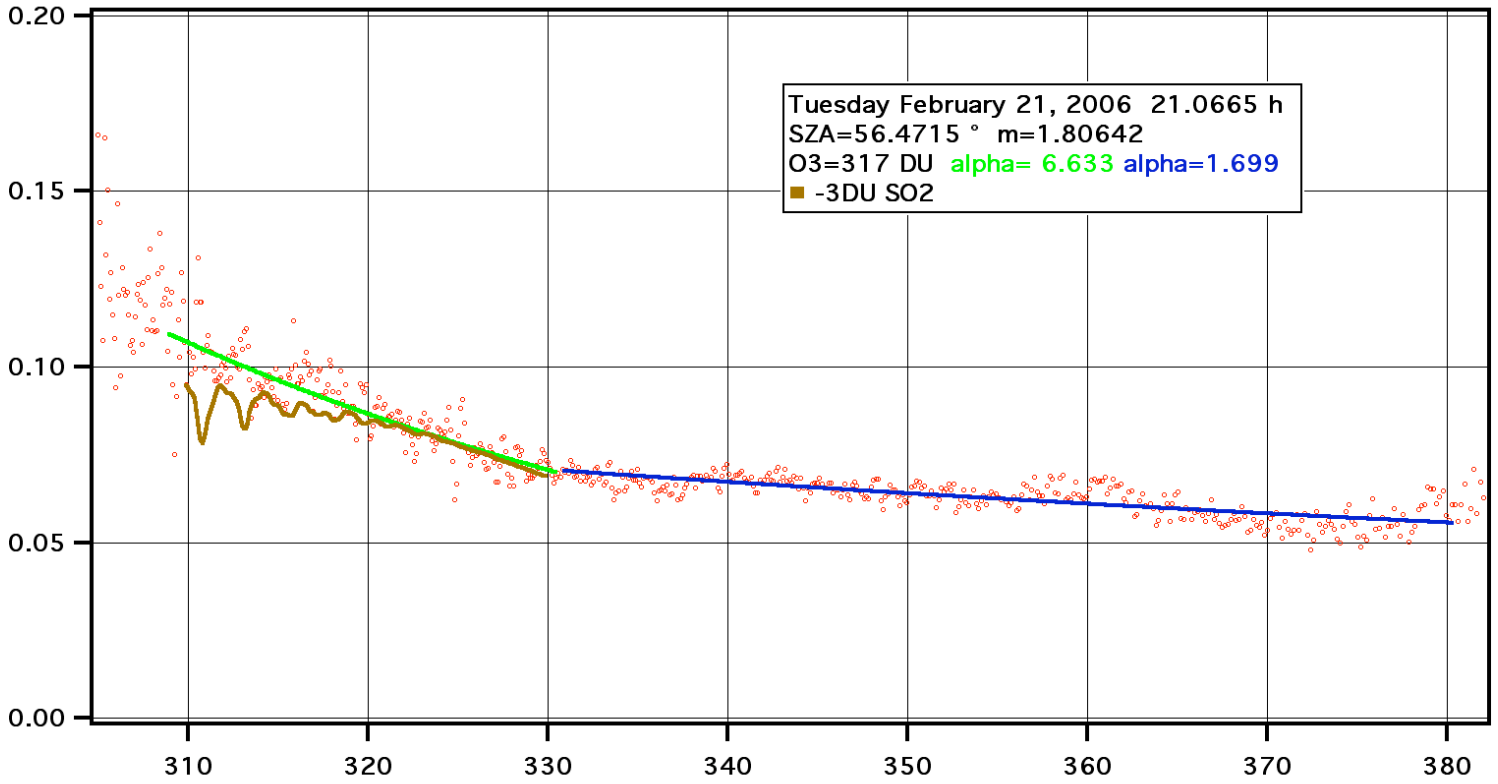

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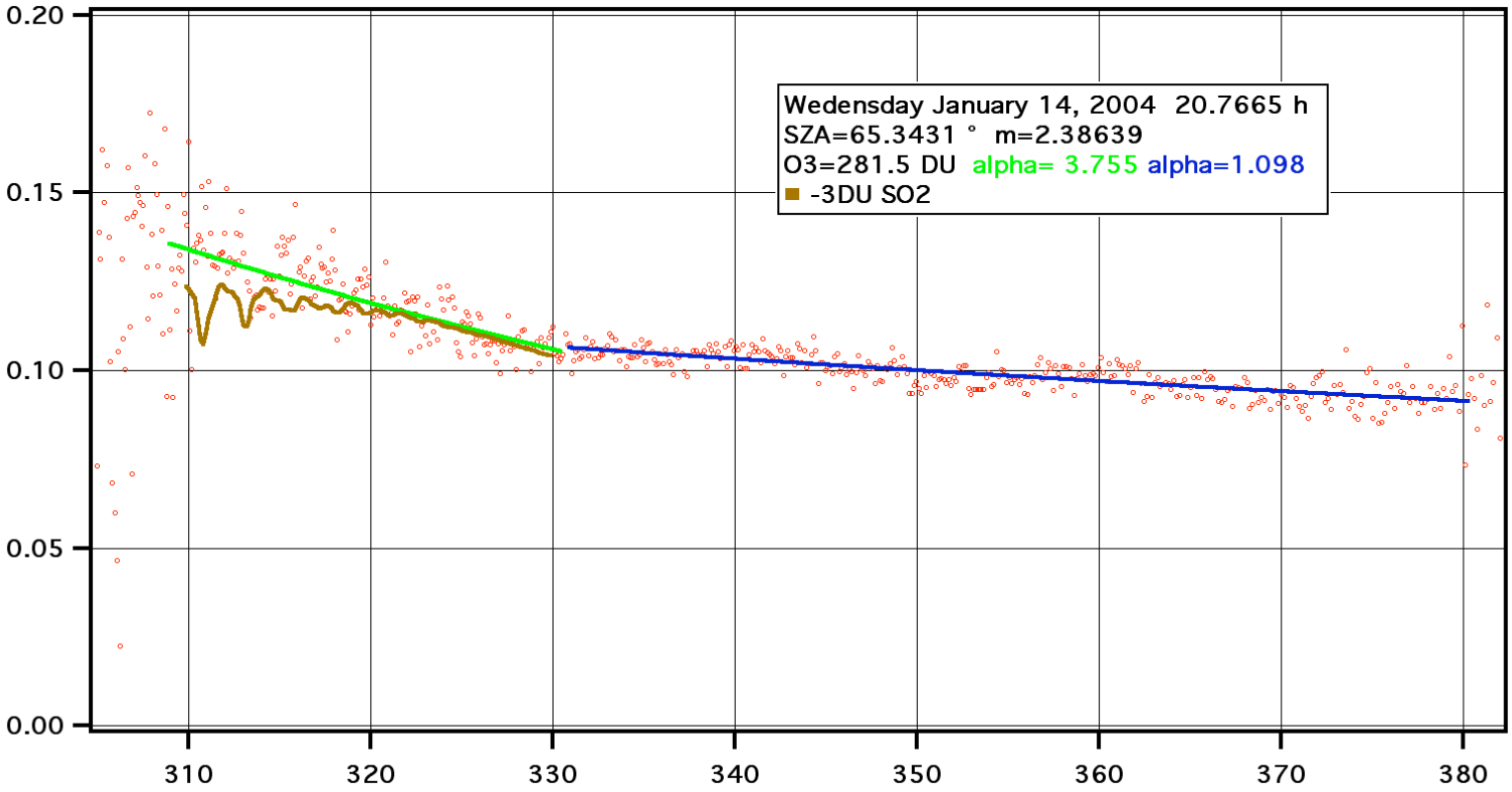
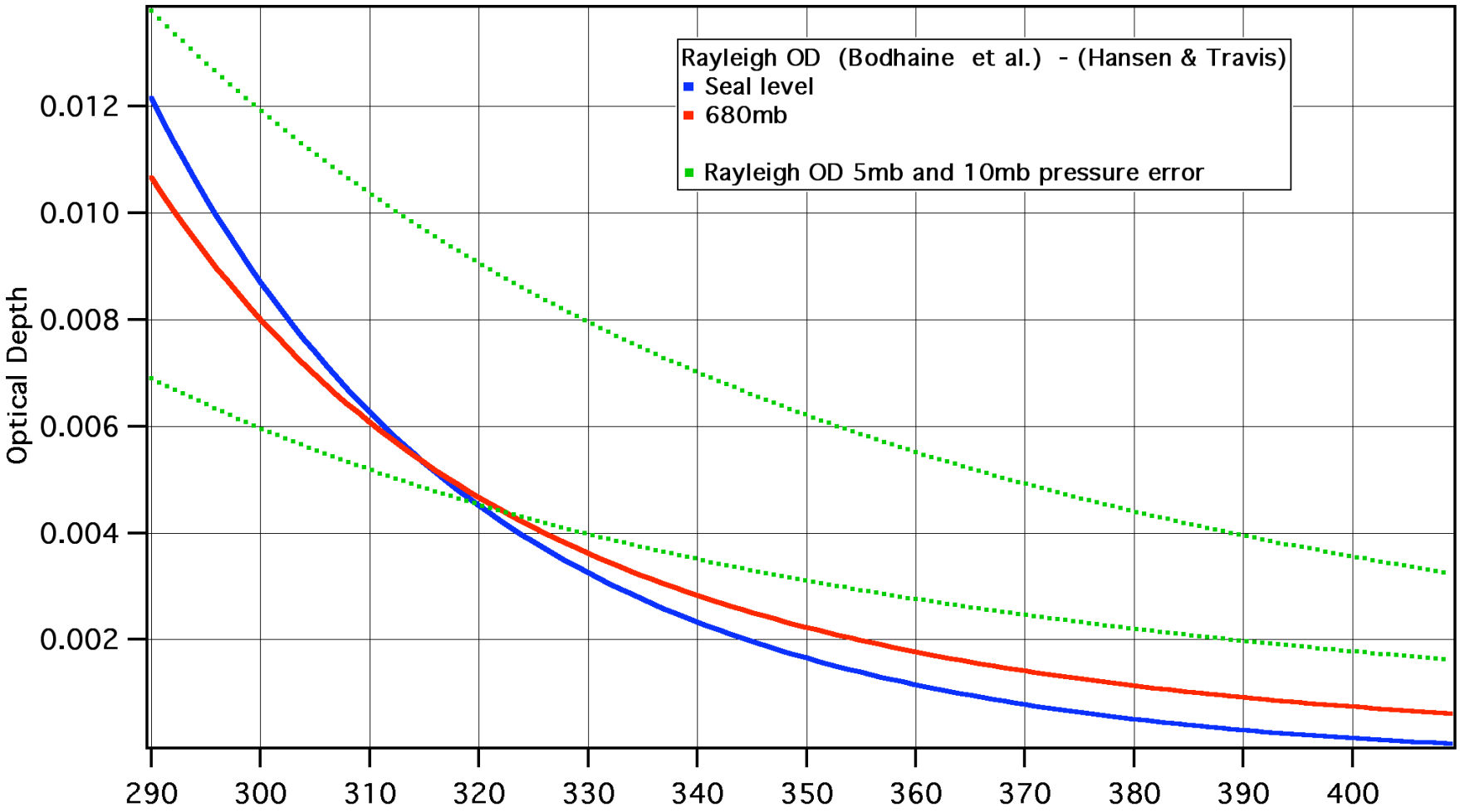
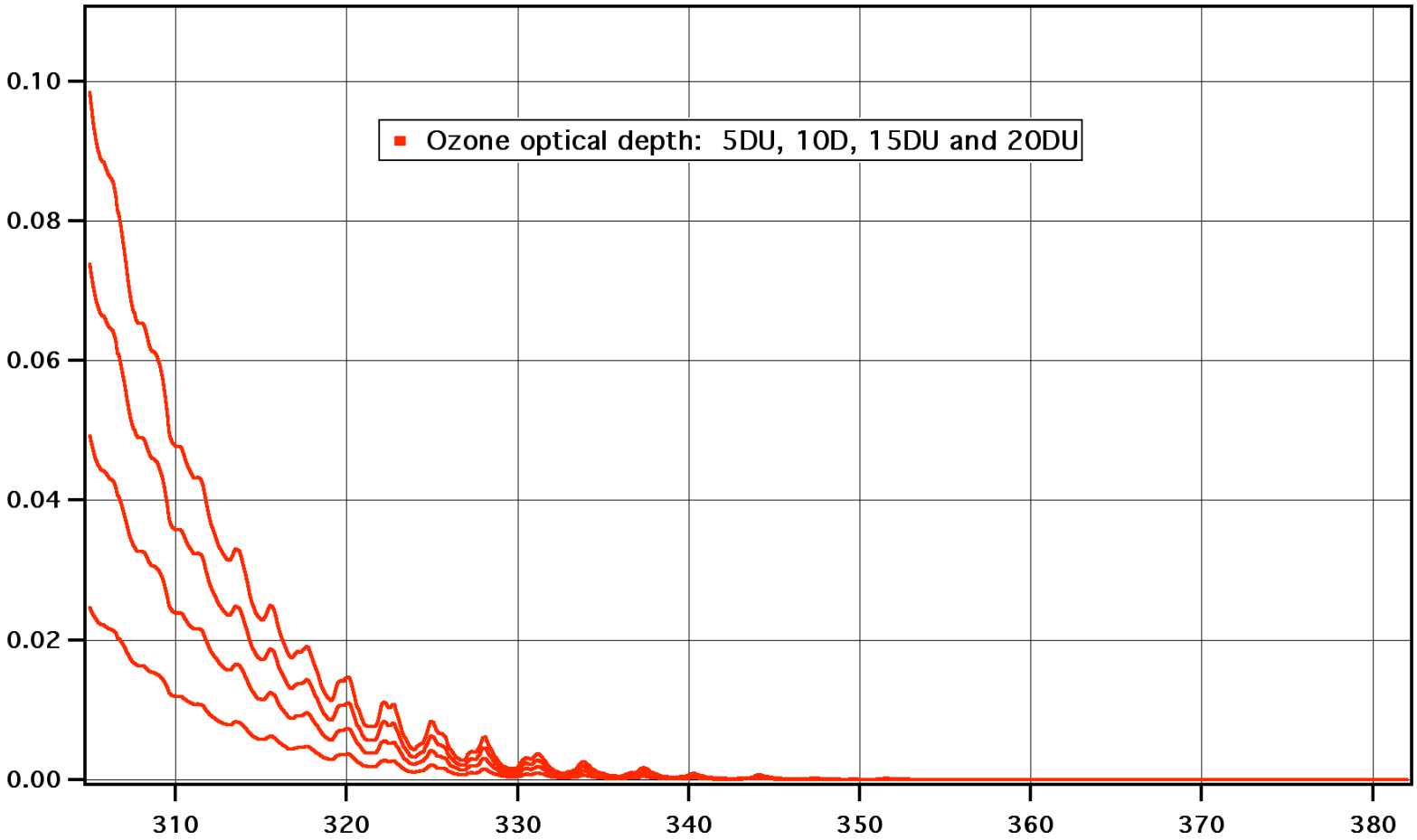


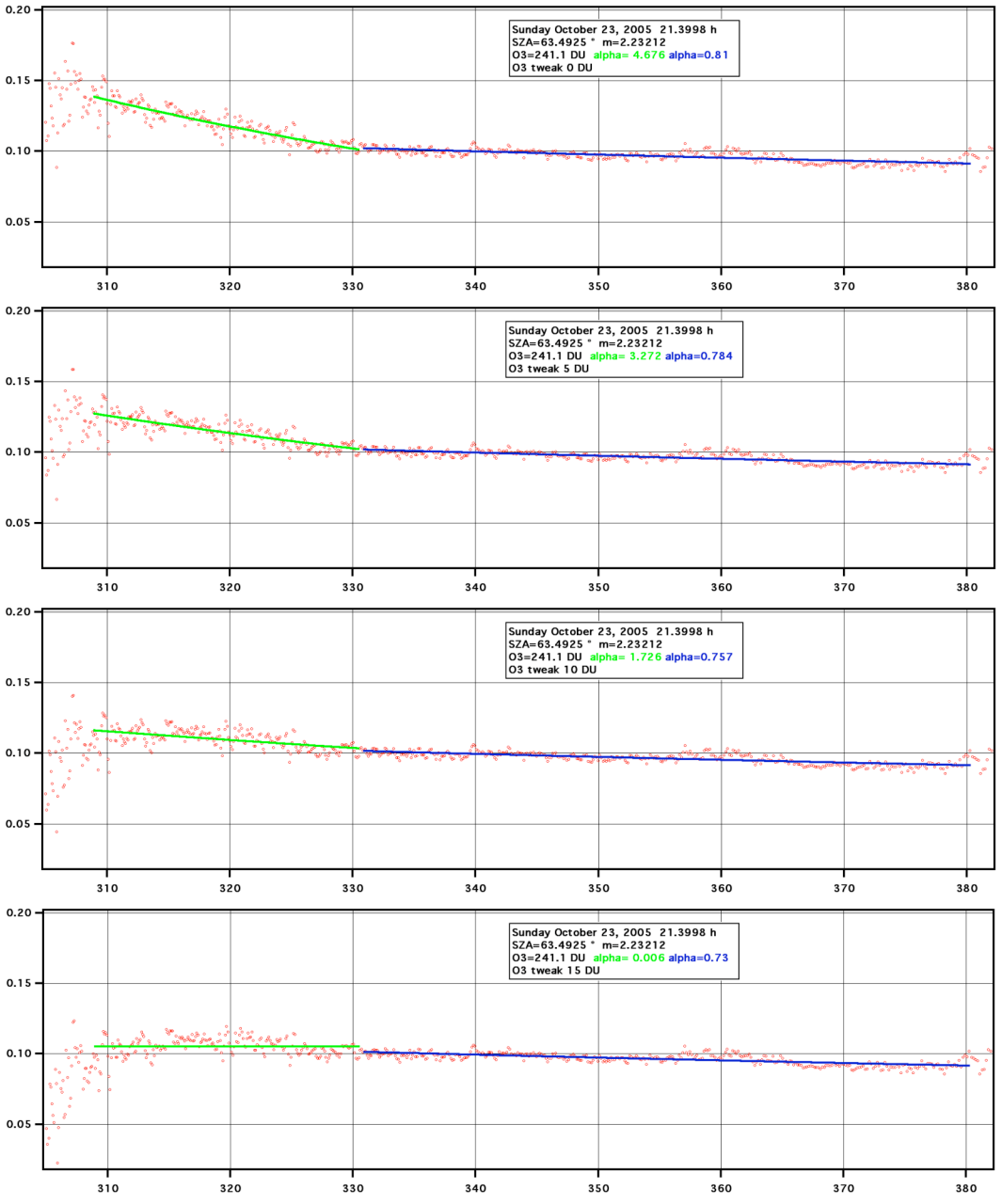
Rayleigh optical depth uncertainty?



Ozone optical depth uncertainty?

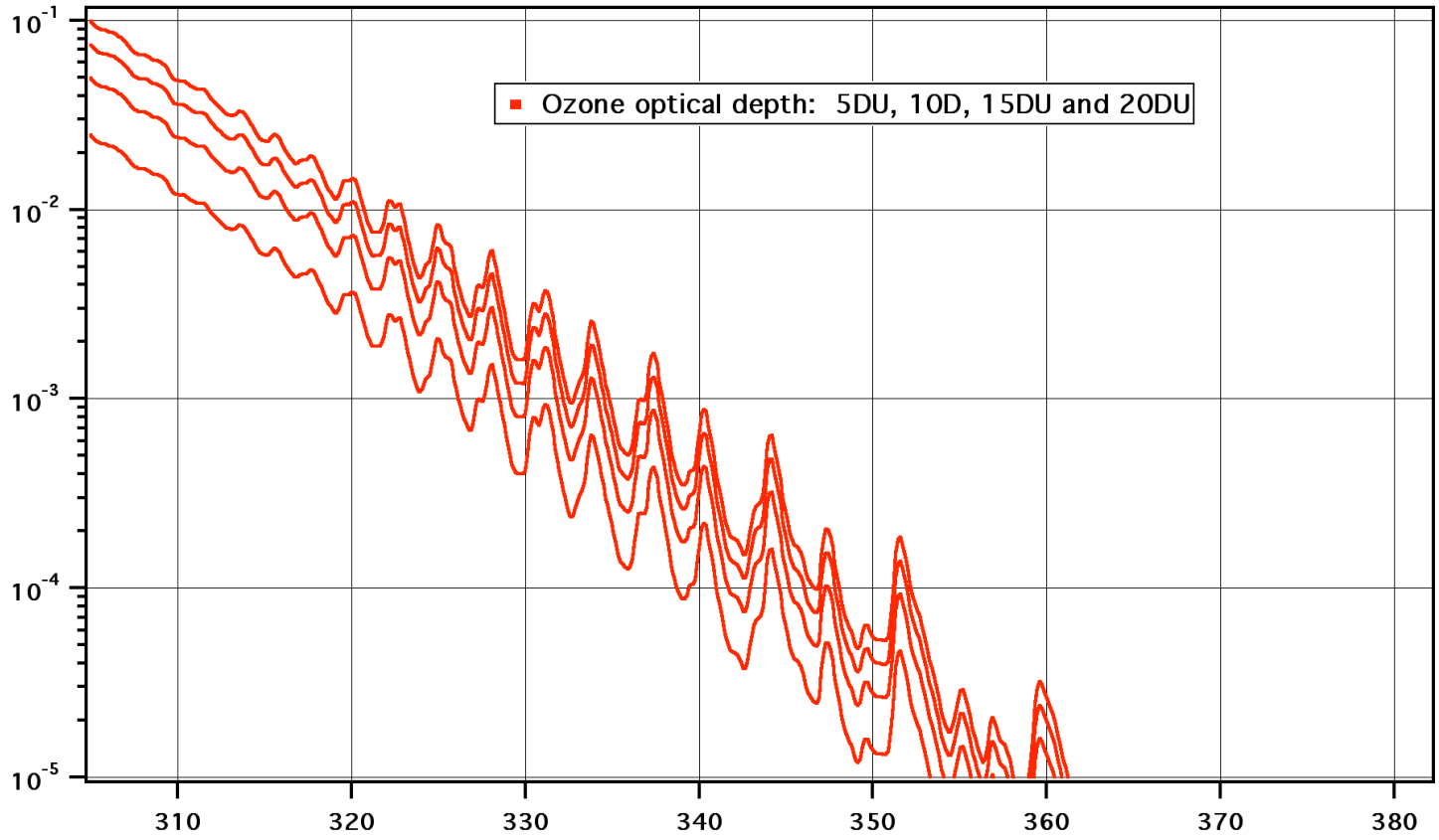


Post retrieval ozone adjustment?



(extras)

Ozone optical depth uncertainty?



Statistical comparison with TOMS & OMI, USDA and Sondes

O3 – O3	N	Avg	StDev	Min	Max	Corr	b	a
RSS - USDA	285	10.7	18.2	-46.2	101.5	0.811	30.4	0.931
RSS - TOMS	325	4.4	13.3	-33.2	49.5	0.893	52.0	0.837
RSS -SONDES	40	16.8	19.4	-13.8	89.6	0.807	86.2	0.761
RSS - DOBSON	241	6.0	13.0	-34.0	46.4	0.915	3.58	1.008
RSSi - DOBSON	160	6.6	11.6	-27.5	34.4	0.939	-1.06	1.026
USDA - TOMS	502	-2.8	19.9	-109.8	50.6	0.766	94.7	0.665
USDA - DOBSON	421	-0.9	10.5	-57.0	48.6	0.926	28.7	0.899
USDA - SONDES	80	5.4	18.7	-22.9	73.4	0.810	79.5	0.746
TOMS - SONDES	87	4.7	18.9	-26.0	94.0	0.849	56.2	0.824
TOMS - DOBSON	528	-3.9	8.0	-38.0	28.0	0.973	3.7	0.974

RSS daily (410 days) ozone values are averages of successful (RMS<0.01) retrievals from 10-30 scans for air mass<4.
RSSi values are single scan retrievals that were found to be within 15 minutes of reported time for DOBSON retrievals

TOMS & OMI O_3 data came from the anonymous ftp site ftp://jwocky.gsfc.nasa.gov
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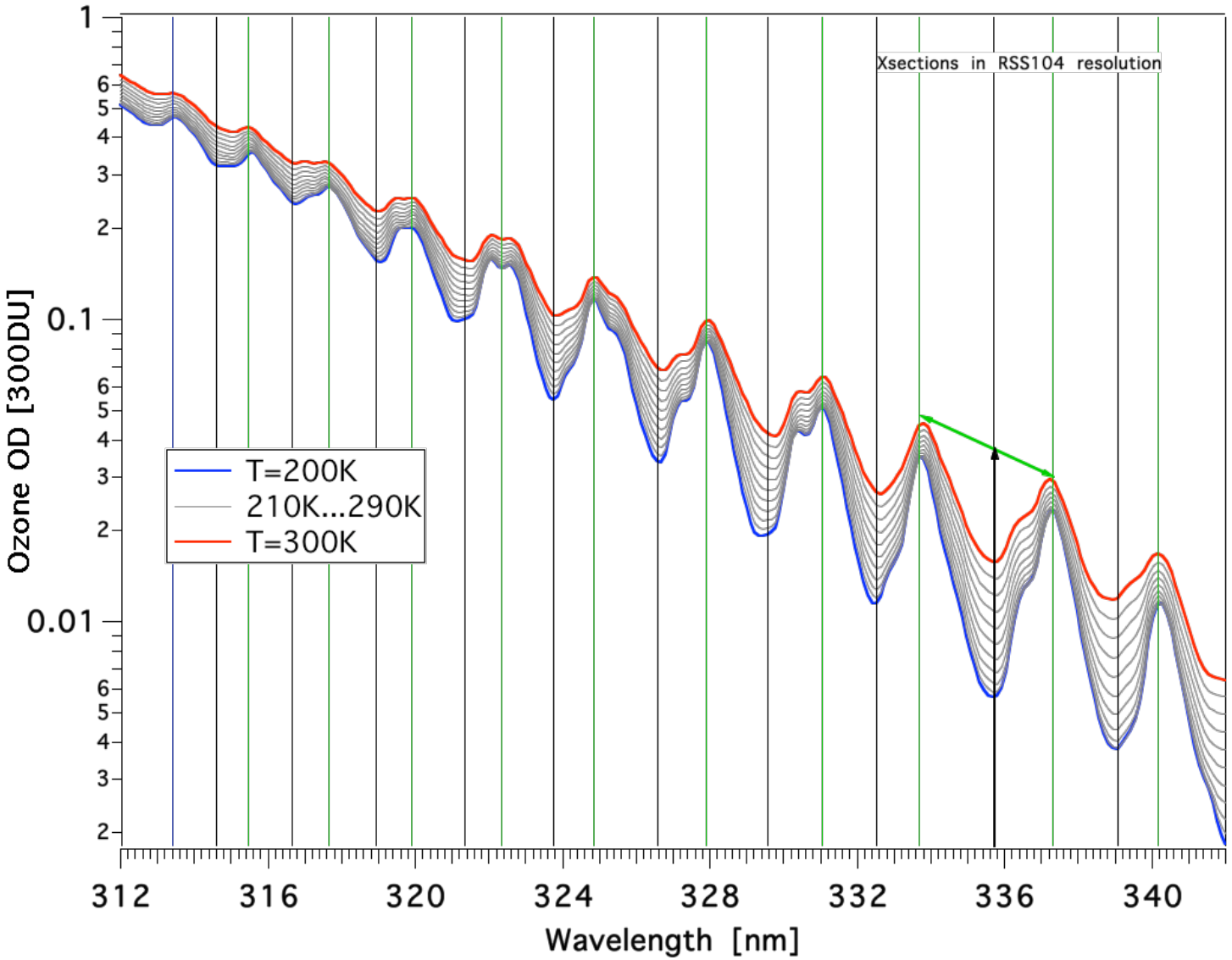
Ozone X-section for various temperatures

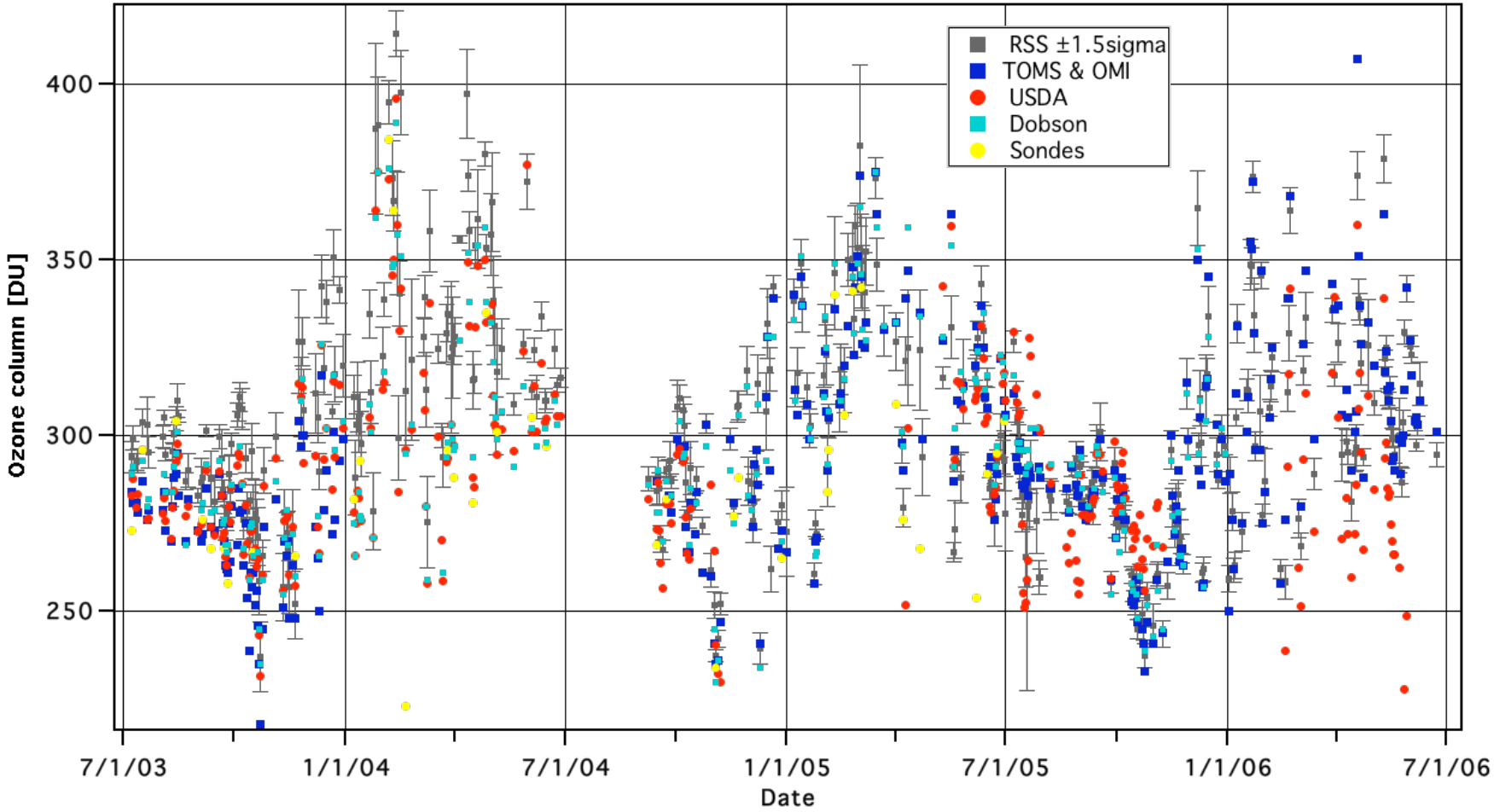
Temperature from local minima



Comparison with TOMS & OMI, USDA and Sondes

Only data coincident with RSS data displayed

RSS daily (410 days) ozone values are averages of successful (RMS<0.01) retrievals from 10-30 scans for air mass<4.
The ±1.5 sigma of successful retrievals within one day is marked on the graph



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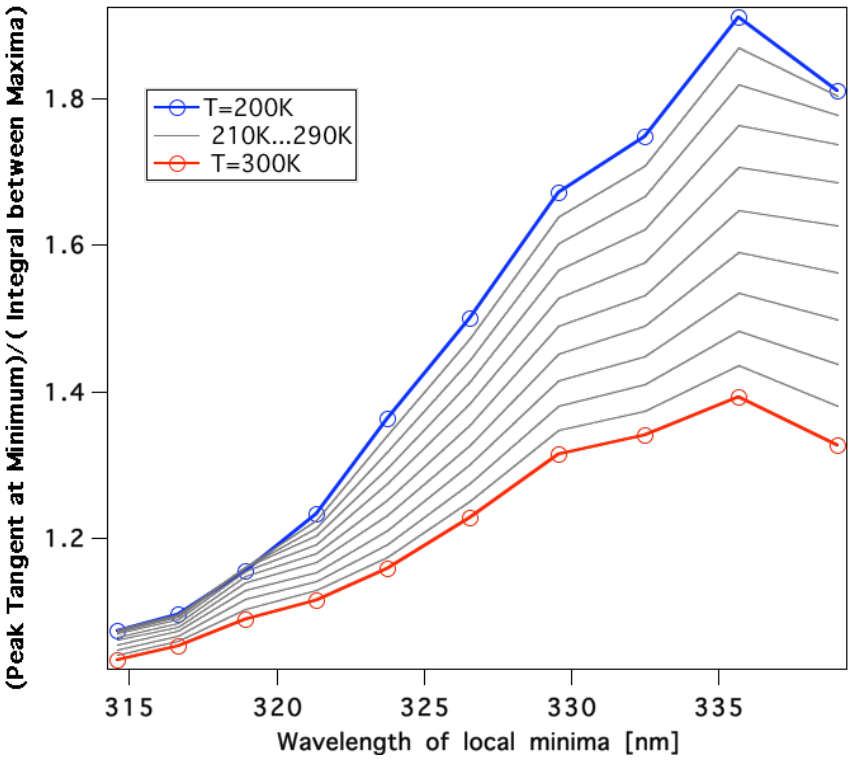
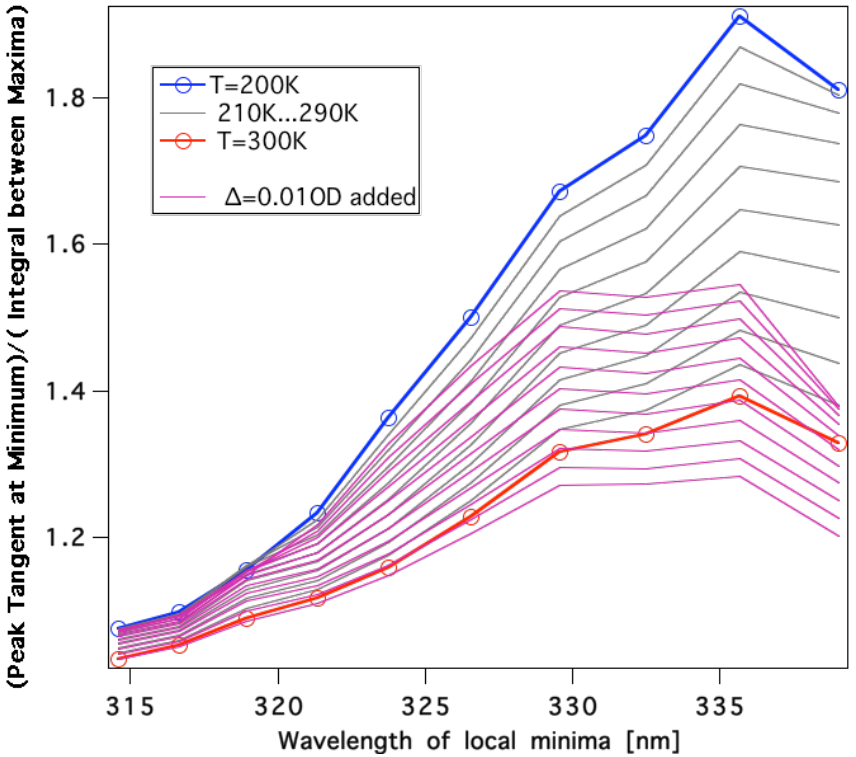
Ozone temperature retrieval from local minima





Ozone profile effective temperature

Ozone profile effective temperature

$$T_{O_3} = \frac{\int T(z) \cdot p(z) dz}{\int p(z) dz}$$

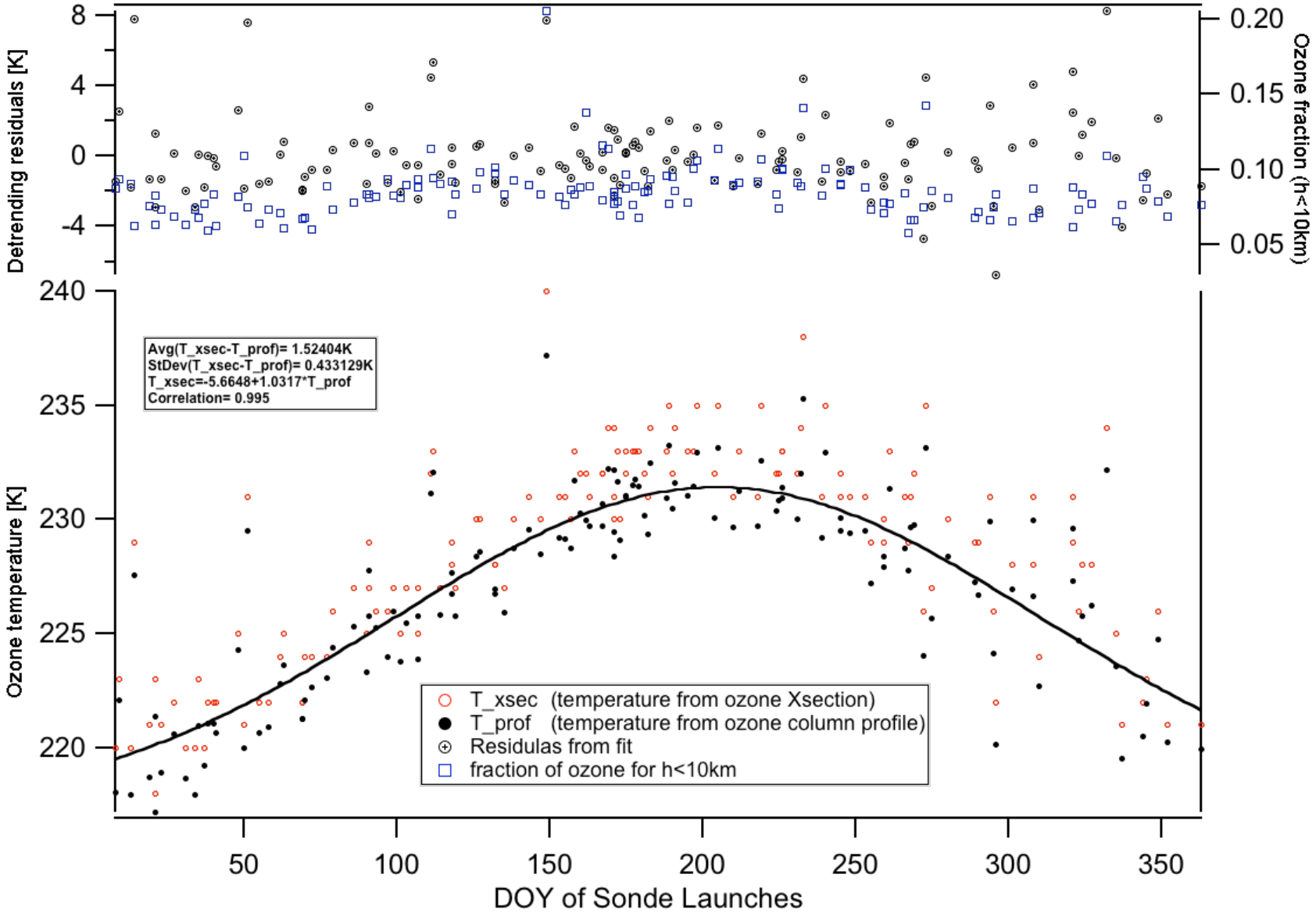
Relation between temperatures

$$\overline{T}_{O_3} \neq T_{O_3} \quad but \quad \overline{T}_{O_3} \propto T_{O_3}$$

Ozone profile temperature retrieved from X-section

$$\overline{T}_{O_3} \quad \Leftarrow \quad \min_{T} \int \left| \overline{a}_{O_3}(\lambda) - a_{O_3}(T, \lambda) \right|^2 d\lambda > 0$$

Ozone profile X-section

$$\overline{a}_{O_3} = \frac{1}{m_{O_3}} \int \frac{a_{O_3}(T(z)) \cdot p(z)}{\sqrt{1 - \left(\frac{1 + h/R}{1 + z/R} \right)^2 \sin^2 \zeta}} dz$$

Ozone temperature retrieval from X-section for sondes data