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*Supplement of*

## **A sensitivity study on the retrieval of aerosol vertical profiles using the oxygen A-band**

**Santo Fedele Colosimo et al.**

*Correspondence to:* S. F. Colosimo (fedele@atmos.ucla.edu)

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## Supplement

In this Supplement, table charts for the complete set of resolutions are shown.

Urban scenario geometry test									
Resolution		nadir				30° off-nadir			
$\Delta\nu$	FWHM	SZA				SZA			
[cm <sup>-1</sup> ]	[cm <sup>-1</sup> ]	30°	45°	60°	75°	30°	45°	60°	75°
1	5	1.39	1.59	1.78	1.87	1.57	1.73	1.88	1.96
0.2	1	1.77	1.98	2.24	2.45	1.96	2.14	2.36	2.55
0.1	0.5	2.27	2.50	2.75	2.94	2.49	2.67	2.87	3.03
0.02	0.1	3.67	3.88	4.14	4.36	3.89	4.05	4.27	4.47
0.01	0.05	4.49	4.71	4.98	5.22	4.74	4.90	5.13	5.33

**Table S1.** Urban scenario nadir and 30° off-nadir complete set of resolutions DoF for four different SZA (30°, 45°, 60°, 75°) as in Fig.4.

Resolution		$S_a$ (relative error) <b>Highly polluted</b> scenario					
$\Delta\nu$	FWHM	0.7	0.5	0.2	0.1	0.05	0.01
[cm <sup>-1</sup> ]	[cm <sup>-1</sup> ]	(83.7%)	(70.7%)	(44.7%)	(31.6%)	(22.4%)	(10.0%)
1	5	1.94	1.82	1.51	1.29	1.12	0.78
0.2	1	2.72	2.54	2.06	1.74	1.46	1.00
0.1	0.5	3.22	3.05	2.60	2.26	1.92	1.25
0.02	0.1	4.89	4.68	4.08	3.62	3.13	2.07
0.01	0.05	5.94	5.68	4.97	4.44	3.89	2.59

**Table S2.** Highly polluted scenario complete set of resolutions DoF for different aerosol extinction profile uncertainties  $S_a$ , as in Fig.5(a).

Resolution		$\omega$ <b>Highly polluted</b> scenario			
$\Delta\nu$ [cm <sup>-1</sup> ]	FWHM [cm <sup>-1</sup> ]	0.8	0.85	0.9	0.95
1	5	1.10	1.51	1.80	1.94
0.2	1	1.50	2.06	2.31	2.42
0.1	0.5	1.98	2.60	2.83	2.93
0.02	0.1	3.34	4.08	4.27	4.36
0.01	0.05	4.19	4.97	5.15	5.24

**Table S3.** Highly polluted scenario complete set of resolutions DoF for the single scattering albedo test, as in Fig.5(b).

		Aerosol scenario					
		Urban	Highly polluted	Elevated layer	Vegetation	Marine	Arctic
Resolution		$k_{ext}=0.1 \text{ km}^{-1}$	$k_{ext}=0.2 \text{ km}^{-1}$	$k_{ext}=0.2 \text{ km}^{-1}$	$k_{ext}=0.05 \text{ km}^{-1}$	$k_{ext}=0.05 \text{ km}^{-1}$	$k_{ext}=0.05 \text{ km}^{-1}$
$\Delta\nu$	FWHM	BLH=1 km	BLH=1 km	Height=2-4 km	BLH=0.4 km	BLH=0.4 km	BLH=0.4 km
[ $\text{cm}^{-1}$ ]	[ $\text{cm}^{-1}$ ]	AOD=0.5	AOD=1	AOD=0.44	AOD=0.12	AOD=0.12	AOD=0.12
		albedo=0.1	albedo = 0.1	albedo = 0.1	albedo=0.3	albedo=0.05	albedo=0.9
1	5	1.73	2.01	1.40	0.73	1.19	0.34
0.2	1	2.14	2.54	1.89	0.99	1.56	0.70
0.1	0.5	2.67	3.03	2.33	1.32	1.92	1.32
0.02	0.1	4.05	4.49	3.76	2.62	3.09	2.64
0.01	0.05	4.90	5.38	4.60	3.43	3.84	3.43

**Table S4.** Complete set of resolutions DoF for all the scenarios, as in Fig.6.

Altitude range <b>Urban</b> scenario						
Resolution			I	II	III	IV
$\Delta\nu$ [cm <sup>-1</sup> ]	FWHM [cm <sup>-1</sup> ]	Total DoF	0 - 2 [km]	2 - 5 [km]	5 - 15 [km]	15 - 50 [km]
1	5	1.73	0.33	0.60	0.16	0.64
0.2	1	2.14	0.42	0.68	0.25	0.78
0.1	0.5	2.67	0.54	0.89	0.38	0.85
0.02	0.1	4.05	0.97	1.48	0.60	1.00
0.01	0.05	4.90	1.40	1.78	0.67	1.05

**Table S5.** Complete set of resolutions DoF for the urban scenario, as in Fig.7(a).

Altitude range <b>Highly polluted</b> scenario						
Resolution			I	II	III	IV
$\Delta\nu$ [cm <sup>-1</sup> ]	FWHM [cm <sup>-1</sup> ]	Total DoF	0 - 2 [km]	2 - 5 [km]	5 - 15 [km]	15 - 50 [km]
1	5	2.01	0.36	0.65	0.20	0.80
0.2	1	2.54	0.48	0.79	0.35	0.92
0.1	0.5	3.03	0.59	1.01	0.45	0.98
0.02	0.1	4.49	1.03	1.65	0.68	1.13
0.01	0.05	5.38	1.48	1.96	0.75	1.19

**Table S6.** Complete set of resolutions DoF for the highly polluted scenario, as in Fig.7(b).

Altitude range <b>Elevated layer</b> scenario						
Resolution		Total DoF	I	II	III	IV
$\Delta\nu$ [cm <sup>-1</sup> ]	FWHM [cm <sup>-1</sup> ]		0 - 2 [km]	2 - 5 [km]	5 - 15 [km]	15 - 50 [km]
1	5	1.40	0.15	0.26	0.05	0.93
0.2	1	1.89	0.31	0.43	0.06	1.09
0.1	0.5	2.33	0.46	0.55	0.08	1.24
0.02	0.1	3.76	0.87	1.17	0.18	1.53
0.01	0.05	4.60	1.27	1.46	0.22	1.65

**Table S7.** Complete set of resolutions DoF for the elevated layer scenario, as in Fig.7(c).

Resolution		Altitude range <b>Vegetation</b> scenario				
$\Delta\nu$ [cm <sup>-1</sup> ]	FWHM [cm <sup>-1</sup> ]	Total DoF	I 0 - 2 [km]	II 2 - 5 [km]	III 5 - 15 [km]	IV 15 - 50 [km]
1	5	0.73	0.24	0.41	0.03	0.05
0.2	1	0.99	0.34	0.51	0.04	0.10
0.1	0.5	1.32	0.45	0.63	0.10	0.14
0.02	0.1	2.62	0.85	1.20	0.27	0.29
0.01	0.05	3.43	1.25	1.47	0.34	0.37

**Table S8.** Complete set of resolutions DoF for the vegetation scenario, as in Fig.7(d).



Altitude range <b>Marine</b> scenario						
Resolution		Total DoF	I	II	III	IV
$\Delta\nu$ [cm <sup>-1</sup> ]	FWHM [cm <sup>-1</sup> ]		0 - 2 [km]	2 - 5 [km]	5 - 15 [km]	15 - 50 [km]
1	5	1.19	0.24	0.44	0.08	0.42
0.2	1	1.56	0.33	0.52	0.10	0.61
0.1	0.5	1.92	0.43	0.62	0.17	0.70
0.02	0.1	3.09	0.80	1.10	0.34	0.86
0.01	0.05	3.84	1.18	1.36	0.40	0.91

**Table S9.** Complete set of resolutions DoF for the marine scenario, as in Fig.7(e).

Altitude range <b>Arctic</b> scenario						
Resolution			I	II	III	IV
$\Delta\nu$ [cm <sup>-1</sup> ]	FWHM [cm <sup>-1</sup> ]	Total DoF	0 - 2 [km]	2 - 5 [km]	5 - 15 [km]	15 - 50 [km]
1	5	0.34	0.02	0.05	0.04	0.23
0.2	1	0.70	0.09	0.15	0.07	0.38
0.1	0.5	1.32	0.36	0.43	0.08	0.46
0.02	0.1	2.64	0.80	1.02	0.19	0.64
0.01	0.05	3.43	1.18	1.31	0.23	0.71

**Table S10.** Complete set of resolutions DoF for the arctic scenario, as in Fig.7(f).

$S_a$ (relative error) <b>Highly polluted</b> scenario						
Integration time	0.7	0.5	0.2	0.1	0.05	0.01
$\Delta t$ [sec]	(83.7%)	(70.7%)	(44.7%)	(31.6%)	(22.4%)	(10.0%)
0.1	4.55	4.36	3.83	3.42	3.01	2.03
0.2	4.75	4.56	4.03	3.63	3.22	2.24
0.5	5.03	4.83	4.29	3.89	3.49	2.53
1	5.24	5.03	4.49	4.09	3.69	2.74
2	5.46	5.25	4.69	4.29	3.89	2.95
5	5.78	5.54	4.97	4.56	4.16	3.22

**Table S11.** Complete set of resolutions DoF for integration time sensitivity for the highly polluted scenario for different  $S_a$ , as in Fig.8(a).

<b>Highly polluted scenario</b>					
Integration time	FWHM [ $\text{cm}^{-1}$ ]				
$\Delta t$ [sec]	5	1	0.5	0.1	0.05
0.1	1.73	2.12	2.60	3.83	4.59
0.2	1.82	2.24	2.73	4.03	4.83
0.5	1.93	2.40	2.90	4.29	5.14
1	2.01	2.54	3.03	4.49	5.38
2	2.09	2.68	3.16	4.69	5.63
5	2.19	2.88	3.35	4.97	5.97

**Table S12.** Complete set of resolutions DoF for integration time sensitivity for the highly polluted scenario for different resolution, as in Fig.8(b).