



*Supplement of*

## **Summertime nitrate aerosol in the upper troposphere and lower stratosphere over the Tibetan Plateau and the South Asian summer monsoon region**

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## Supplementary Material

Table S1. Observed concentrations of aerosols in South Asia

Site name	Period		Sample type	Concentration ( $\mu\text{g m}^{-3}$ )					Reference
				Sulfate	Nitrate	Ammonium	OC	BC	
NCO-P, Nepal (28°N,87°E)	2006-2008	Jun-Sep	PM <sub>10</sub>	0.50	0.37	0.00	0.9		Decesari et al. (2010)
		Oct-Nov		0.50	0.00	0.08	1.4		
		Dec-Feb		0.22	0.08	0.14	1.2		
		Mar-May		1.48	0.66	0.52	2.4		
Langtang, Nepal (28.13°N, 85.60°E)	1998-2000	Oct-Jan	PM <sub>2.5</sub>	0.27±0.24	0.04±0.07	0.15±0.15	3.4		Carrico et al. (2003)
		Feb-Mar		1.41±1.30	0.78±1.00	0.54±0.56	0.8		
		Jun-Sep		0.20±0.45	0.09±0.36	0.08±0.17	1.8		
Nagarkot, Nepal (27.72°N, 85.52°E)	1998-2000	Oct-Jan	PM <sub>2.5</sub>	2.5±2.2	0.8±1.7	1.2±1.3	14		Carrico et al. (2003)
		Feb-May		3.8±1.0	1.2±1.8	1.5±1.0	2.0		
		Jun-Sep		0.8±1.2	0.08±0.18	0.25±0.29	6.3		
Rongbuk Glacier, China (28.02°N, 86.96°E)	2003	Sep	TSP	0.41	0.14				Ming et al. (2007)
Manora Peak, India (29.4°N 79.5°E)	2004	Dec	TSP	2.56±1.27	0.50±0.33	0.52±0.37	4.9±1.3	1.36±0.99	Rengarajan et al. (2007); Pant et al. (2006)
Manora Peak, India (29.4°N 79.5°E)	2005-2006	Feb-Mar	TSP				11.6±5.9		Ram et al. (2008)
		Apr-Jun					8.6±2.7		
		Jun-Jul					5.7±0.2		
		Sep-Nov					10.8±6.7		

		Dec-Mar					11.0±2.3		
Hisar, India (29.2°N 75.7°E)	2004	Dec	TSP	12.68±6.23	13.34±6.64	6.33±4.24	33.0±17.9		Rengarajan et al. (2007)
Mt. Abu, India (24.6°N 72.7°E)	2000-2002	Jan-Apr	TSP	3.08	0.43				Rastogi and Sarin (2005)
		Sep-Dec		2.71	0.74	0.73			
Mt. Abu, India (24.6°N 72.7°E)	2005-2006	May-Jun	TSP				3.5±2.7		Ram et al. (2008)
		Jul-Aug					2.2±0.7		
		Sep-Nov					4.9±2.2		
		Dec-Mar					3.6±2.8		
Mumbai, India (19.4°N, 72.8°E)	1999	Jan-Feb	PM <sub>10</sub>	7.3±2.6	4.7±1.7				Venkataraman et al. (2002)
		Feb-Mar		6.2±1.0	6.0±3.0				
	2001-2002	Mar-Apr					9.5		Chowdhury et al. (2007)
Pune, India (18.5°N, 74°E)	1998	Mar-Apr	TSP	2.98	2.91	2.14			Momin et al. (1999)
	2005	Dec-Feb	TSP					7.38	Safai et al. (2007)
		Oct-Nov						6.04	
		Mar-May						3.25	
Jun-Sep						1.31			
Agra, India (27.15°N 78°E)	1992-1993	Dec-Mar	TSP	14.7	8.37	6.52			Kulshrestha et al. (1998)
Ahmedabad, India (23.0°N, 72.6°E)	2000-2002	Jan-Apr	TSP			0.05			Rastogi and Sarin (2005)
		Sep-Dec				0.48			
Ahmedabad, India	2003-2005	Dec-Mar	TSP					5.5±2.8	Ganguly et al.

(23.0°N, 72.6°E)		Apr-May						2.2±1.0	(2006)
		Jun-Dec						1.5±0.8	
		Oct-Nov						7.3±3.7	
Ahmedabad, India (23.0°N, 72.6°E)	2002	Jun	TSP	3.38	0.73		7.20		Rastogi and Sarin (2009)
		Jul		4.27	0.43		5.00		
		Aug		4.90	0.60		5.40		
Dhaka, Bangladesh (24°N, 90.6°E)	2001	Apr	TSP	11.3	3.63	1.86	45.7		Salam et al. (2003)
Kayamkulam (KLM), India (9.17°N, 76.5°E)	2004	Feb	TSP	6.4	2.4				Nair et al. (2006)
Tellicherry (TLY), India (9.17°N, 76.5°E)	2004	Feb	TSP	9.8	3.6				Nair et al. (2006)
Kumbla (KUM), India (12.63°N, 74.92°E)	2004	Feb	TSP	10.5	7.2				Nair et al. (2006)
Dandebag (DAN), India (14.88°N, 74.01°E)	2004	Feb	TSP	2.4	0.5				Nair et al. (2006)
Ainapur (AIN), India (16.83°N, 75.77°E)	2004	Feb	TSP	3.5	2.0				Nair et al. (2006)
Maslakhurd (MSK), India (17.79°N, 76°E)	2004	Feb	TSP	4.3	2.3				Nair et al. (2006)
Satwar (SAT), India (17.7°N, 77.51°E)	2004	Feb	TSP	5.6	3.6				Nair et al. (2006)

Shadnagar (SHD), India (17.00°N, 78.18°E)	2004	Feb	TSP	7.0	2.3				Nair et al. (2006)
Ananthpur (ANA), India (14.61°N, 77.64°E)	2004	Feb	TSP	5.8	1.9				Nair et al. (2006)
Navani (NAV), India (11.38°N, 78.13°E)	2004	Feb	TSP	5.4	1.6				Nair et al. (2006)
Kuttikkanam (KUT), India (9.57°N, 76.97°E)	2004	Feb	TSP	10.1	3.2				Nair et al. (2006)
Vazhathoppu (VAZ), India (9.01°N, 76.89°E)	2004	Feb	TSP	8.8	2.9				Nair et al. (2006)
Thenmala (TML), India (8.97°N, 77.01°E)	2004	Feb	TSP	4.7	1.0				Nair et al. (2006)
Trivandrum, India (8.55°N, 77°E)	2003-2005	Mar-May	TSP	4.9±0.5	1.6±0.3	1.2±0.4			George et al. (2008)
		Jun-Nov		3.9±0.3	1.8±0.2	0.2±0.03			
		Dec-Feb		6.2±0.5	1.5±0.1	1.6±0.3			
Trivandrum, India (8.55°N, 77°E)	2005	Jun	TSP					2.00	Nair et al. (2012)
		Jul						1.19	
		Aug						2.07	
Kanpur, India (26.4°N, 80.3°E)	2004	Dec	PM <sub>10</sub>	14.9±3.3	15.7±5.58	8.76±4.3			Tare et al. (2006)
	2004	Dec	TSP					12.3	Tripathi et al. (2005)
Kathmandu, Nepal (27.7°N, 85.3°E)	2004-2005	Sep	PM <sub>2.5</sub>	1.75					Adhikary et al. (2007)
		Oct		1.93					

		Nov		1.25					
Darjeeling, India (27°N, 88.25°E)	2005	Jun	PM <sub>2.5</sub>	0.51	1.10				Chatterjee et al. (2010)
		Jul		0.32	0.90				
		Aug		0.38	0.39	0.06			
Darjeeling, India (27°N, 88.25°E)	2008	Jun	TSP					0.90	Chatterjee et al. (2012)
		Jul					1.09		
		Aug					0.76		
Kaashidhoo, India (4.97°N, 73.47°E)	1999	Feb-Mar	TSP	6.08					Verma et al. (2012)
Hanimadhoo (6.78°N, 73.18°E)	2004-2005	Jun	PM <sub>2.5</sub>	1.18			0.09	0.01	Ramanathan et al. (2007); Adhikary et al. (2007)
		Jul		1.10			0.16	0.03	
		Aug					0.52	0.03	
Mt. Yulong, China (27.1°N, 100.2°E)	2010	Jan-Feb	TSP	1.78	0.58	0.37			Zhang et al. (2012)
Mangalore, India (12.82°N, 74.93°E)	2000	Feb-Mar	TSP	3.6	1.7	1.0			Hegde et al. (2007)
		Apr-May		1.7	0.31	0.64			
Delhi, India (28.62°N, 77.22°E)	2001-2002	Mar-Apr	PM <sub>2.5</sub>				37.8		Chowdhury et al. (2007)
		Jun-Jul					16.1		
		Oct-Nov					57.4		
		Dec-Jan					95.8		
Delhi, India (28.62°N, 77.22°E)	2006-2007	Dec-Feb	TSP					25.5	Bano er al. (2011)
		Mar-May						9.4	
		Jul-Sep						7.7	

		Oct-Nov						13.7		
Kolkata, India (22.57°N, 88.03°E)	2001-2002	Mar-Apr	PM <sub>2.5</sub>					18.8	Chowdhury et al. (2007)	
		Jun-Jul					7.8			
		Oct-Nov					17.6			
		Dec-Jan					146.7			
Chandigarh, India (30.7°N, 76.8°E)	2001-2002	Oct-Nov	PM <sub>2.5</sub>					20.1	Chowdhury et al. (2007)	
		Dec-Jan					33.6			
Bay of Bengal (13.09°N, 80.30°E)	2003	Feb	TSP					2-8	Sudheer and Sarin (2008)	
	2006	Mar-Apr	TSP					0.3-5.5		
Kathmandu, Nepal (27.7°N, 85.3°E)	2004-2005	Aug	PM <sub>2.5</sub>					2.29	0.47	Adhikary et al. (2007)
		Sep					1.61	0.69		
		Oct					2.23	0.83		
Kathmandu, Nepal (27.7°N, 85.3°E)	2009	Jun	TSP					5.3	Sharma et al. (2012)	
		Jul					3.0			
		Aug					3.2			
Lahore, Pakistan (31.57°N, 74.37°E)	2005-2006	Dec-Jan	TSP					21.7	Hussain et al. (2007)	
Goa University, India (15.42°N, 74.98°E)	1999	Dec-Feb	TSP					3.0±0.7	Leon et al. (2001)	
		Mar					1.5±0.7			
Dharwar, India (15.42°N, 74.98°E)	1999	Feb	TSP					3.0	Leon et al. (2001)	
Bangalore, India (13°N, 77°E)	2001	Nov	TSP					4.2 ± 0.03	Babu and Moorthy (2002)	

Shadnagar, Inland (17.03°N, 78.18°E)	2002	Feb	TSP					2.21	Jayaraman et al. (2006)
Kharagpur, India (22.5°N, 87.3°E)	2007	Jun	TSP					2.20	Nair et al. (2012)
		Jul						2.08	
		Aug						1.97	
Karachi, Pakistan (24.8°N, 67.0°E)	2006	Apr	TSP					4.0	Dutkiewicz et al. (2009)
		Nov						10.1	
	2007	Jan	TSP					9.1	
Hyderabad, India (17.5°N, 78.5°E)	2003	Jun	TSP					4.27	Latha and Badrinath (2005)
		Jul						4.38	
		Aug						5.18	

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