

Dust Storms over the Arabian Gulf: A possible indicator of climate changes consequences

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Supplemental Material

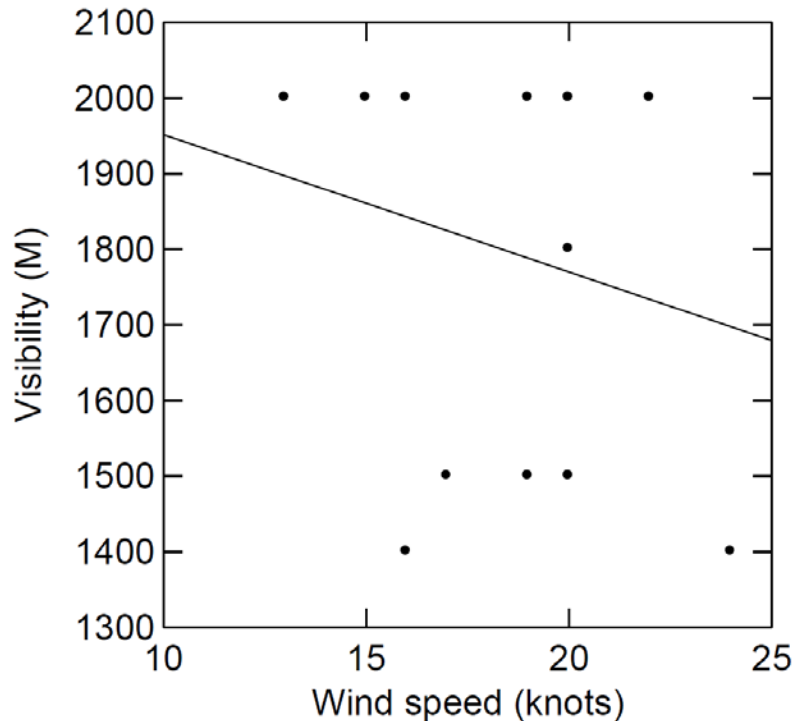


Figure 2: Results of statistical correlations between Wind speed and Horizontal visibility during the period (2004-2009).

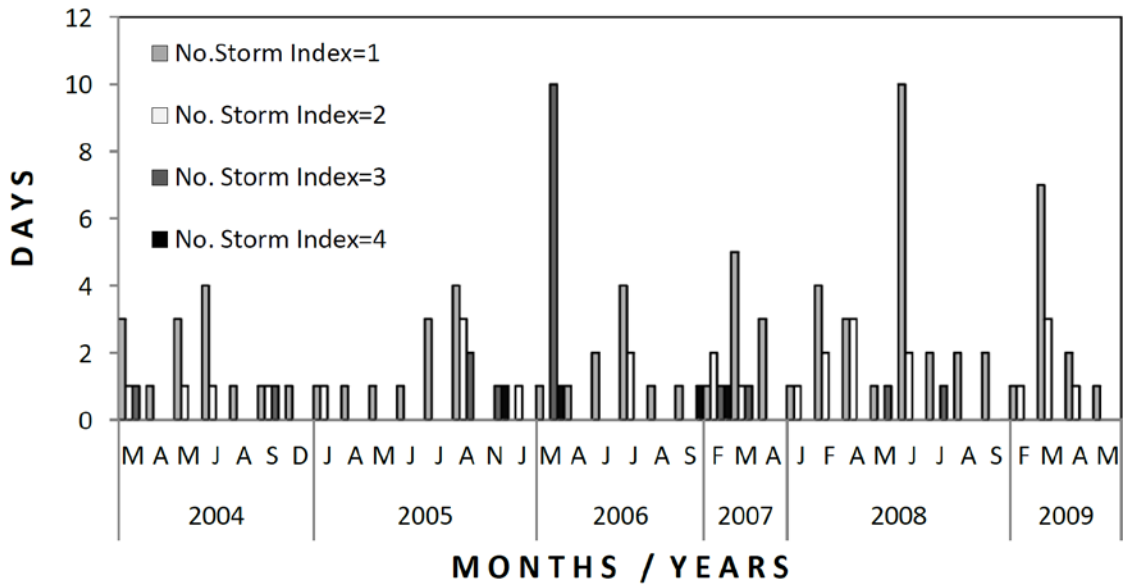
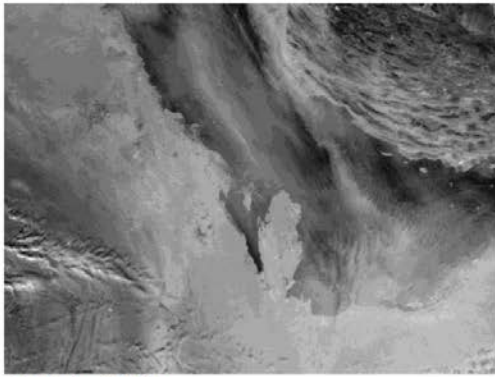
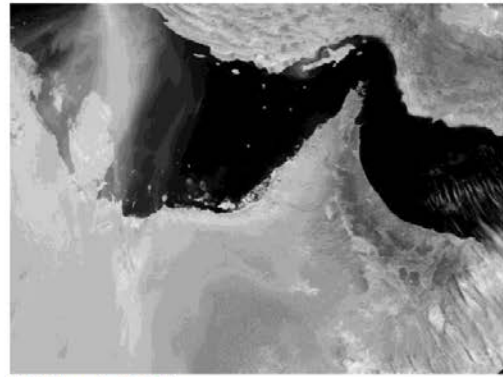


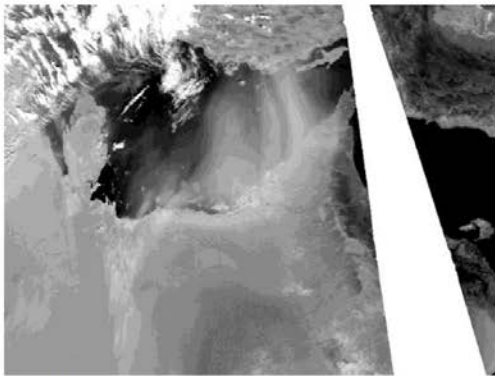
Figure 3: Dust Storms strength indices and its frequencies over Abu-Dhabi coastal area during the period 2004-2009.



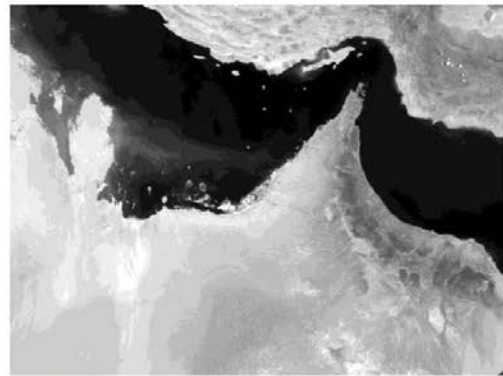
12 Feb., 2009



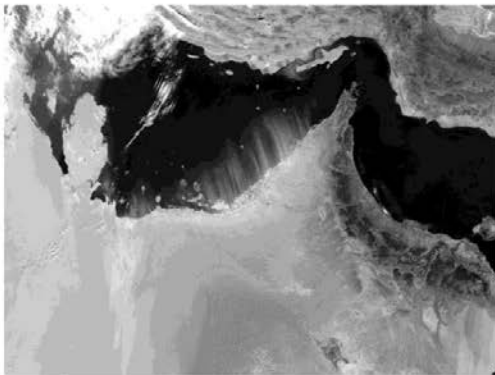
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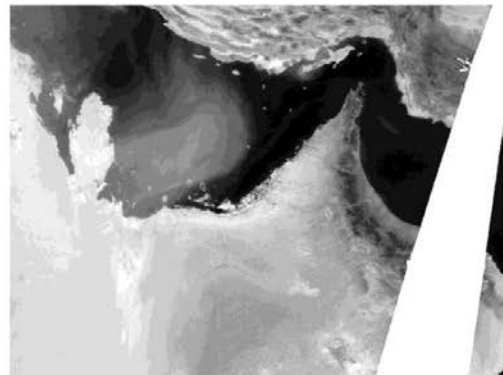
28 Feb 2009



14 May, 2009



28 Feb 2009



7 June 2009

Figure 4: Satellite images of Dust storms blown along the Arabian Gulf coastal areas during winter and summer months of 2009 (AREONET-NCMS-UAE).

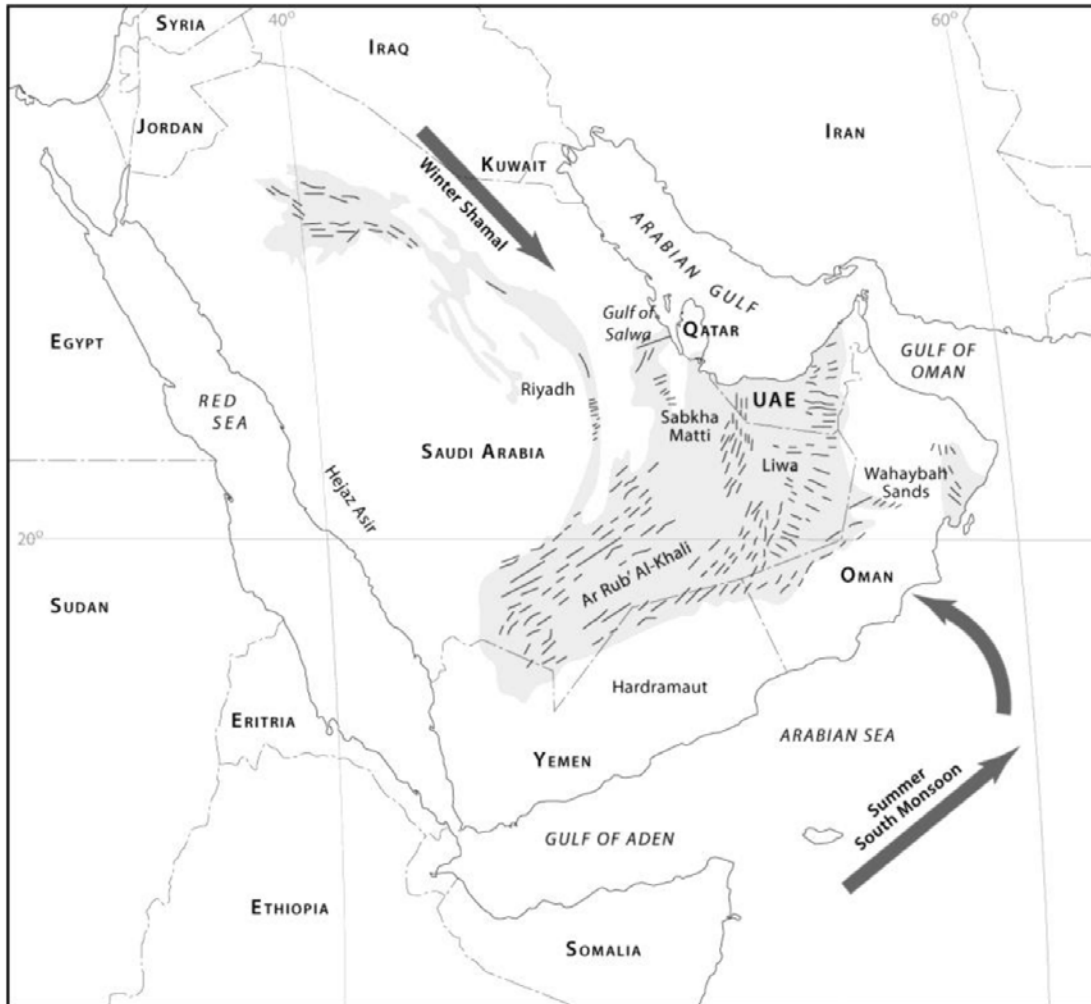


Figure 5: Map of the Arabian Peninsula with the major wind directions responsible about dust storms during winter and summer seasons (modified from Gelinnie, 2005).

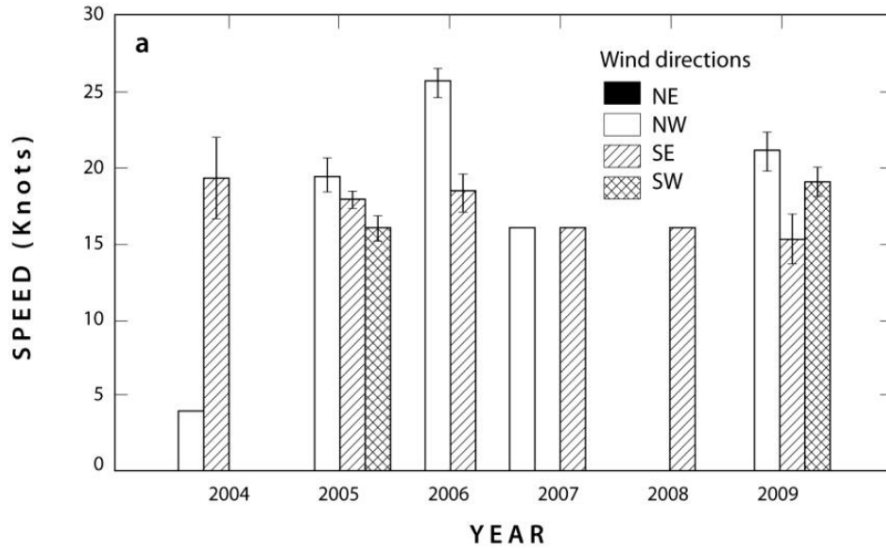


Figure 6a: Results of Statistical ANOVA of wind speeds and their directions during 2004-2009.

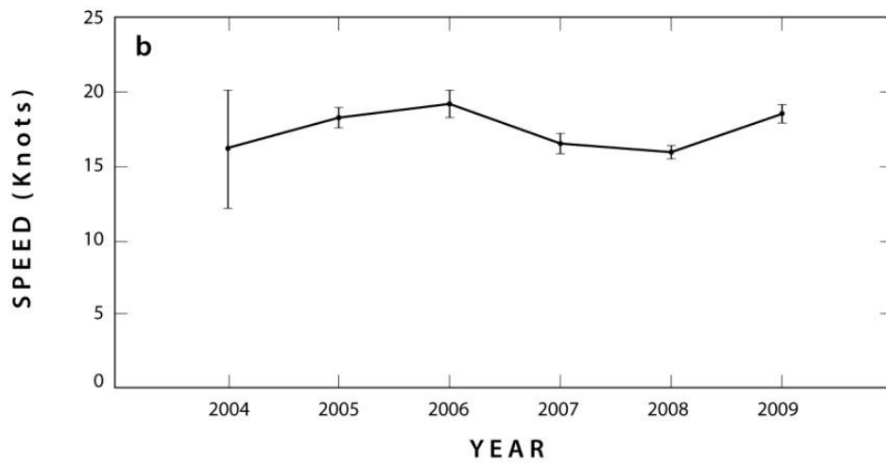


Figure 6b: Results of statistical variations of Wind speeds during the period 2004-2009.

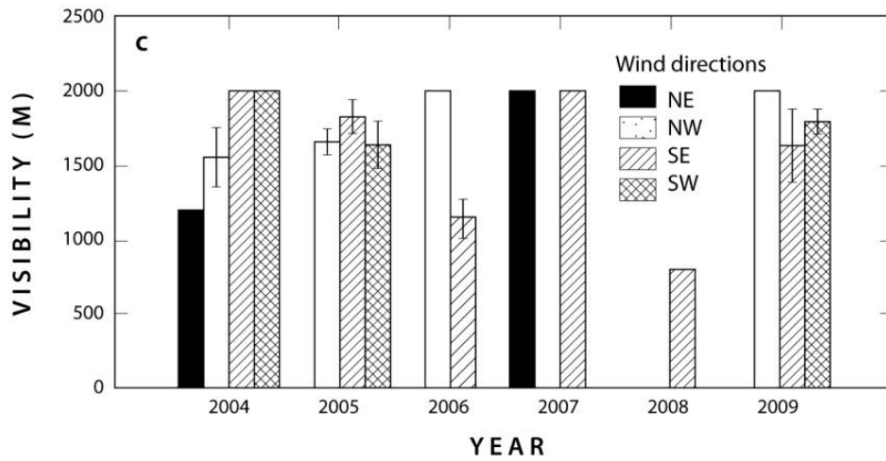


Figure 6c: Results of Statistical ANOVA of horizontal visibility and wind directions during 2004-2009.

Table 2: XRD- Mineralogical analysis of dust samples collected from the different stations along the UAE coastal area during summer months (May and August, 2009). SS1*= Source Sample 1, SS2*= Source Sample 2

Site	Date	XRD Results (Passive Dry Dust)		Minor Mineral(s)
		Major Mineral(s)	Subordinate Mineral(s)	
Abu Dhabi	05/09	Quartz (SiO ₂), Calcite (CaCO ₃)	Plagioclase (CaAl ₂ Si ₂ O ₈)	Dolomite (CaMg(CO ₃) ₂)
	08/09	Quartz (SiO ₂), Calcite (CaCO ₃)	-	Plagioclase (CaAl ₂ Si ₂ O ₈), Dolomite (CaMg(CO ₃) ₂), Clay Minerals, Serpentine (Mg ₃ Si ₂ O ₅ (OH) ₄)
Fujairah	05/09	Quartz (SiO ₂), Calcite (CaCO ₃)	Plagioclase (CaAl ₂ Si ₂ O ₈), Amphibole(Ca ₂ (Mg,Fe) ₅ Si ₈ O ₂₂ (OH) ₂)	Serpentine (Mg ₃ Si ₂ O ₅ (OH) ₄), Talc (Mg ₃ Si ₄ O ₁₀ (OH) ₂)
	08/09	Quartz (SiO ₂), Calcite (CaCO ₃)	Plagioclase (CaAl ₂ Si ₂ O ₈),	Serpentine (Mg ₃ Si ₂ O ₅ (OH) ₄), Dolomite (CaMg(CO ₃) ₂), Amphibole (Ca ₂ (Mg,Fe) ₅ Si ₈ O ₂₂ (OH) ₂), High Magnesium Calcite (CaMg (CO ₃), Olivine? ((Mg, Fe) ₂ SiO ₄)
Dibba	05/09	Pyroxene (CaMg(Si,Al) ₂ O ₆),	-	Plagioclase (CaAl ₂ Si ₂ O ₈), Talc (Mg ₃ Si ₄ O ₁₀ (OH) ₂)
	08/09	Pyroxene (CaMg(Si,Al) ₂ O ₆), Feldspar	-	Serpentine (Mg ₃ Si ₂ O ₅ (OH) ₄), Dolomite (CaMg(CO ₃) ₂)
U.A.Q	08/09	Quartz (SiO ₂)	Calcite (CaCO ₃)	Dolomite (CaMg(CO ₃) ₂)
Jebel Al Dhanna	05/09	Quartz (SiO ₂), Aragonite (CaCO ₃)	Plagioclase (CaAl ₂ Si ₂ O ₈),	Dolomite (CaMg(CO ₃) ₂), Hematite (Fe ₂ O ₃)
	08/09	Quartz (SiO ₂), Calcite (CaCO ₃)	Dolomite (CaMg(CO ₃) ₂), Plagioclase (CaAl ₂ Si ₂ O ₈),	Serpentine (Mg ₃ Si ₂ O ₅ (OH) ₄), Pyroxene (CaMg(Si,Al) ₂ O ₆), Gypsum (CaSO ₄ !2H ₂ O), Halite (NaCl), Hematite (Fe ₂ O ₃)
SS1*		Quartz (SiO ₂)	Calcite (CaCO ₃)	Plagioclase (CaAl ₂ Si ₂ O ₈), Dolomite (CaMg(CO ₃) ₂), Clay Minerals, Serpentine (Mg ₃ Si ₂ O ₅ (OH) ₄ ,
SS2*		Quartz (SiO ₂), Calcite (CaCO ₃)	-	Plagioclase (CaAl ₂ Si ₂ O ₈), Dolomite (CaMg(CO ₃) ₂), Clay Minerals,

Table 3: XRD-Mineralogical analysis of dust samples collected from the different stations along the UAE coastal area during winter months (January - March, 2009).

Site	Date (mm/yy)	XRD of wet samples		Minor Mineral(s)
		Major Mineral(s)	Subordinate Mineral(s)	
U.A.Q	01/09	Calcite (CaCO ₃)	Talc (Mg ₃ Si ₄ O ₁₀ (OH))	Plagioclase (CaAl ₂ Si ₂ O ₈), Dolomite (CaMg(CO ₃) ₂), Serpentine (Mg ₃ Si ₂ O ₅ (OH) ₄ , Clay Minerals
	03/09	Pyroxene	-	Iron Oxides
Abu Dhabi	03/09	Calcite (CaCO ₃), Quartz (SiO ₂)	Plagioclase (CaAl ₂ Si ₂ O ₈), Dolomite (CaMg(CO ₃) ₂)	Clay Minerals, Iron Oxides, Serpentine (Mg ₃ Si ₂ O ₅ (OH) ₄ , Talc (Mg ₃ Si ₄ O ₁₀ (OH) ₂)
Dibba	03/09	Pyroxene	Olivine (Mg, Fe, Silicate)	-
Fujairah	02/09	Plagioclase (CaAl ₂ Si ₂ O ₈), Calcite (CaCO ₃), Quartz (SiO ₂)	-	Serpentine (Mg ₃ Si ₂ O ₅ (OH) ₄ , Clay Minerals

Table 4: XRF-elemental analysis of dust samples collected from the different stations along the UAE coastal area during summer months (May and August, 2009). SS1* = Source Sample 1, SS2* = Source Sample 2

Location Date (mm/yy)	Abu Dhabi		J. Al-Dhanna		Dibba		Fujairah		U.A.Q		SS1*	SS2*
	05/09	08/09	05/09	08/09	05/09	08/09	05/09	08/09	05/09	08/09		
Si	33.64	31	16.2	22.6	21.7	27.2	29.8	27.2	-	28.5	57.8	37.35
Ca	48.2	51.2	71.7	38.1	46.2	40.7	39.23	36.96	-	35.75	28	51.2
Al	5.39	4.92	2.37	7.25	5.47	6.45	8.25	8.25	-	5.01	3.43	2.6
Mg	4.3	4.44	2	4.52	9.88	10.5	8.03	8.39	-	3.2	3.12	2.17
Fe	5.37	5.23	2.11	10.2	10.9	9.6	13.4	13.4	-	18.5	3.14	3.1
Cl	0.341	0.285	1.68	4.04	1.76	1.32	1.16	2.25	-	1.93	0	0.11
S	0.24	0.44	0.598	7.01	2.05	2.48	0.985	1.63	-	3.85	0.764	0
Sr	0.184	0.185	1.97	0.135	0.154	0	0	0.19	-	0	0.132	1.4
K	2.33	2.18	1.26	2.99	1.71	1.57	1.23	1.16	-	3.26	0.114	0.17
Na	0	0	0	3	0	0	0	0	-	0	3.49	1.9
P	0	0.146	0.125	0.197	0.218	0.206	0.565	0.565	-	0	0	0

Table 5: XRF-Mineralogical analysis of rain filtered dust samples collected from the different stations along the UAE coastal area during winter months (January - March, 2009).

Location	Abu Dhabi	U.A.Q		Dibba	Fujairah
Date	03/09	01/09	03/09	03/09	02/09
Si	22.6	30	28.2	31.9	42.3
Ca	56.3	42.03	37.9	34	21.1
Al	4.1	7.66	8.13	9.27	12.2
Mg	4.0	5.09	7.68	8.88	9.16
Fe	9.29	5.9	9.55	11	6.54
Cl	0.936	0.471	0.193	0.323	0.109
Na	0.0	1.3	0.0	0.0	2.54
S	0.13	1.12	0.273	0.128	0.38
Zn	0.0	2.2	3.74	1.44	2.78
Zr	0.0	0.124	0.073	0.062	0.08
Sr	0.287	0.0	0.0	0.0	0.0
K	2.21	2.9	2.63	2.79	2.49
Cu	0.0	0.0	1.36	0.0	0.0
Ni	0.0	0.0	0.0	0.0	0.175
P	0.148	1.2	0.273	0.179	0.118

Table 6: ICP-Analysis results of leached (Dry) and dissolved (Rain) elements from samples collected at the different stations along the UAE coastal area during summer and winter months (January - August, 2009).

Location	Abu Dhabi		U.A.Q		Fjairajh		J. Dhanna		Control Sea Water
	Date	03/09	06-08/09	01/09	01-03/09	01-02/09	06-07/09	05/09	
Dry/Rain	Rain	Dry	Rain	Rain	Rain	Dry	Rain	Dry	
Al	-	0.010	-	-	-	0.078	1.82	0.025	0.01
Fe	0.038	0.026	-	-	-	0.056	0.111	0.038	0.026
Mn	0.095	0.050	-	0.01	-	0.123	0.31	0.012	<0.009
P	0.047	0.007	0.017	0.42	0.025	0.084	0.14	0.047	0.032
NO ₃	36.7	-	2.55	4.89	15.5	-	-	-	-