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An Effective Algorithm for Estimating the Dust Density of Ahwaz and Abadan Cities in Iran using MODIS Imagery

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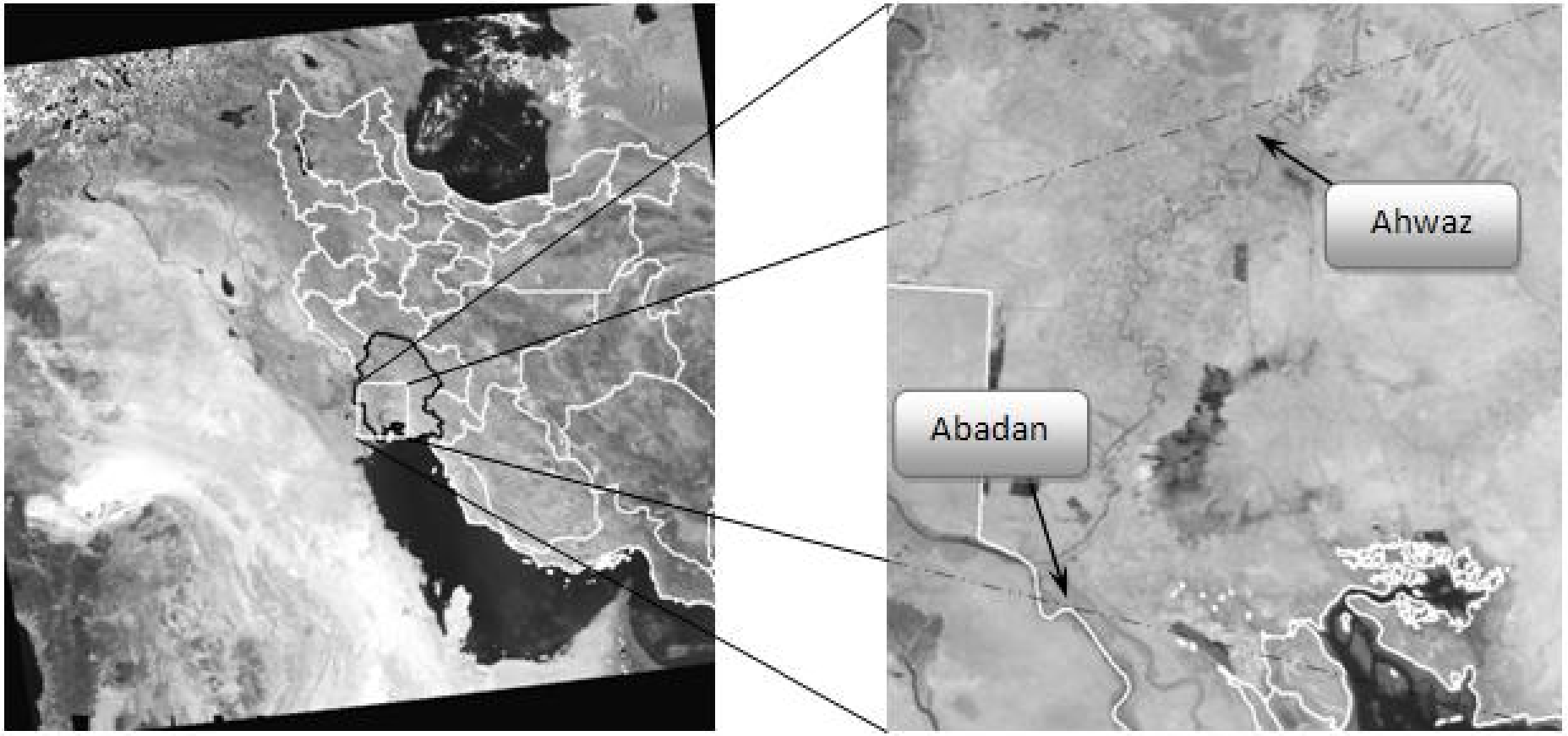
Region of Study

The region of study includes two cities of Ahwaz ($31°20'\text{N}$ and $48°\ 40'E$) and Abadan ($30°20'\text{N}$ and $48°\ 15'E$) both located in the south-west of Iran.



Data & Satellite Images

- Ground based measured dust density in Ahwaz and Abadan stations

- Seventeen MODIS images downloaded from website

  "http://ladsweb.nascom.nasa.gov/data/search.html".

✓ The images used for dust density estimation are selected based on the availability of ground measured dust density in Ahwaz and Abadan concurrent with satellite over-passing.

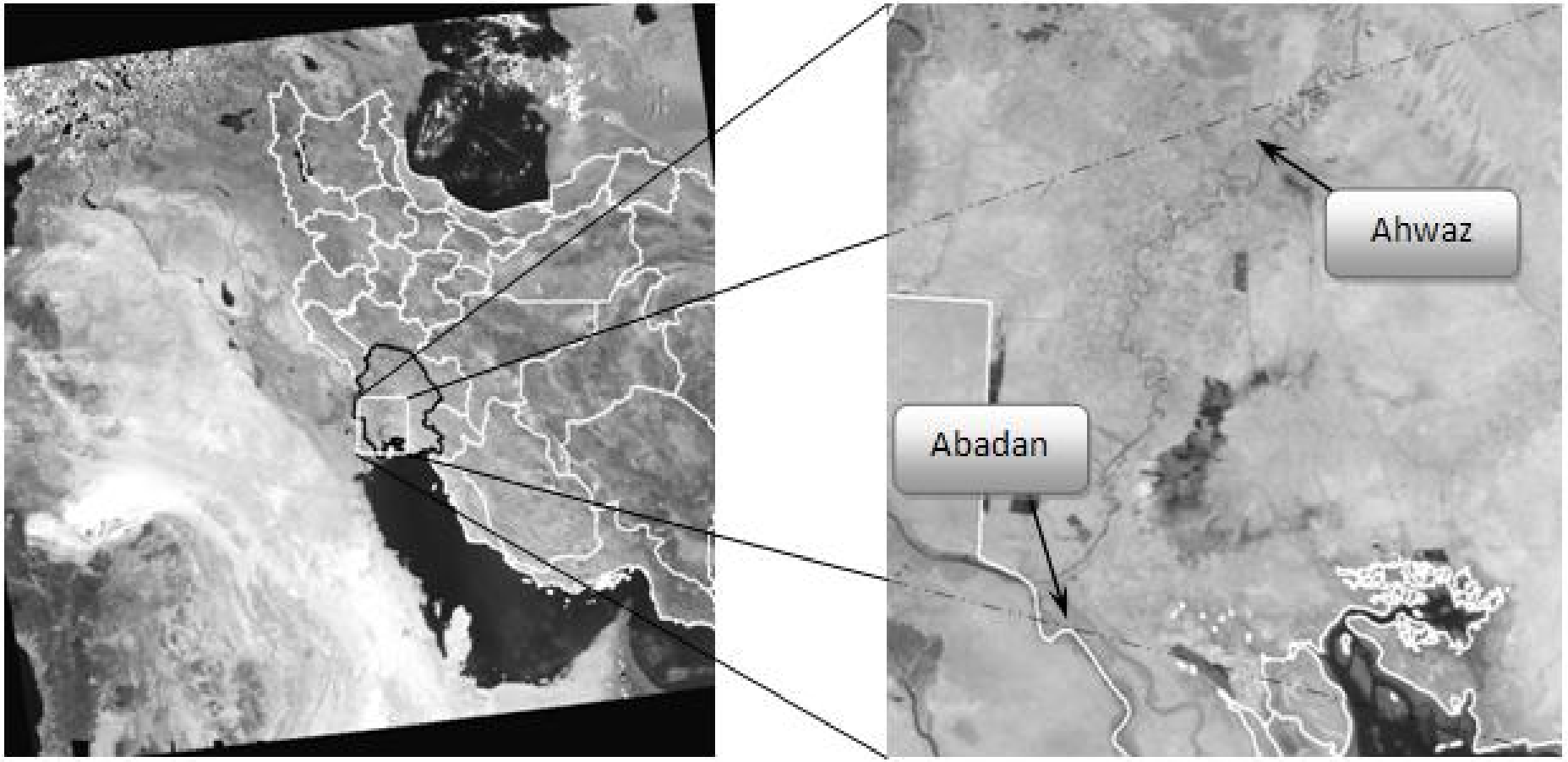
Table 1: The average reflectance values of the selected samples for 17 images in year 2009 for cities of Ahwaz and Abadan. Those marked with " x " denotes that there were no dust measurements for that day.

Platform	DOY (Date)	Ahwaz		Platform	DOY (Date)	Abadan	
		Red	NIR			Red	NIR
Terra	168 (17 Jun)	0.2354	0.2963	x	x	x	x
Terra	180 (29 Jun)	0.2182	0.3009	Terra	180 (29 Jun)	0.2017	0.3029
Terra	185 (4 Jul)	0.3390	0.3921	x	x	x	x
Terra	186 (5 Jul)	0.4402	0.5103	x	x	x	x
Terra	188 (7 Jul)	0.2185	0.2933	Terra	188 (7 Jul)	0.1747	0.2722
Terra	195 (14 Jul)	0.2867	0.3528	Terra	195 (14 Jul)	0.2166	0.3064
Terra	196 (15 Jul)	0.2403	0.3050	Terra	196 (15 Jul)	0.2149	0.3078
Terra	197 (16 Jul)	0.2152	0.2901	Terra	197 (16 Jul)	0.1799	0.2826
Terra	204 (23 Jul)	0.2088	0.2799	Terra	204 (23 Jul)	0.1592	0.2545
Aqua	168 (17 Jun)	0.2082	0.2871	x	x	x	x
Aqua	182 (1 Jul)	0.2004	0.3161	Aqua	182 (1 Jul)	0.1488	0.2936
Aqua	185 (4 Jul)	0.2890	0.3441	Aqua	185 (4 Jul)	0.2408	0.3159
Aqua	186 (5 Jul)	0.4382	0.5025	x	x	x	x
Aqua	194 (13 Jul)	0.2381	0.3145	x	x	x	x
Aqua	195 (14 Jul)	0.2964	0.3628	Aqua	195 (14 Jul)	0.2382	0.3274
Aqua	196 (15 Jul)	0.2465	0.3301	Aqua	196 (15 Jul)	0.2060	0.3226
Aqua	197 (16 Jul)	0.2247	0.2936	x	x	x	x

Methodology

Step 1: Determination of dust and vegetation reflectance

Summary: Ground based measured dust density along with the first and second bands of MODIS centered near 0.550 and 0.860 μm are used for dust detection and quantification. This method is applied to few Terra and



Methodology

Step 2: Pixel Selection

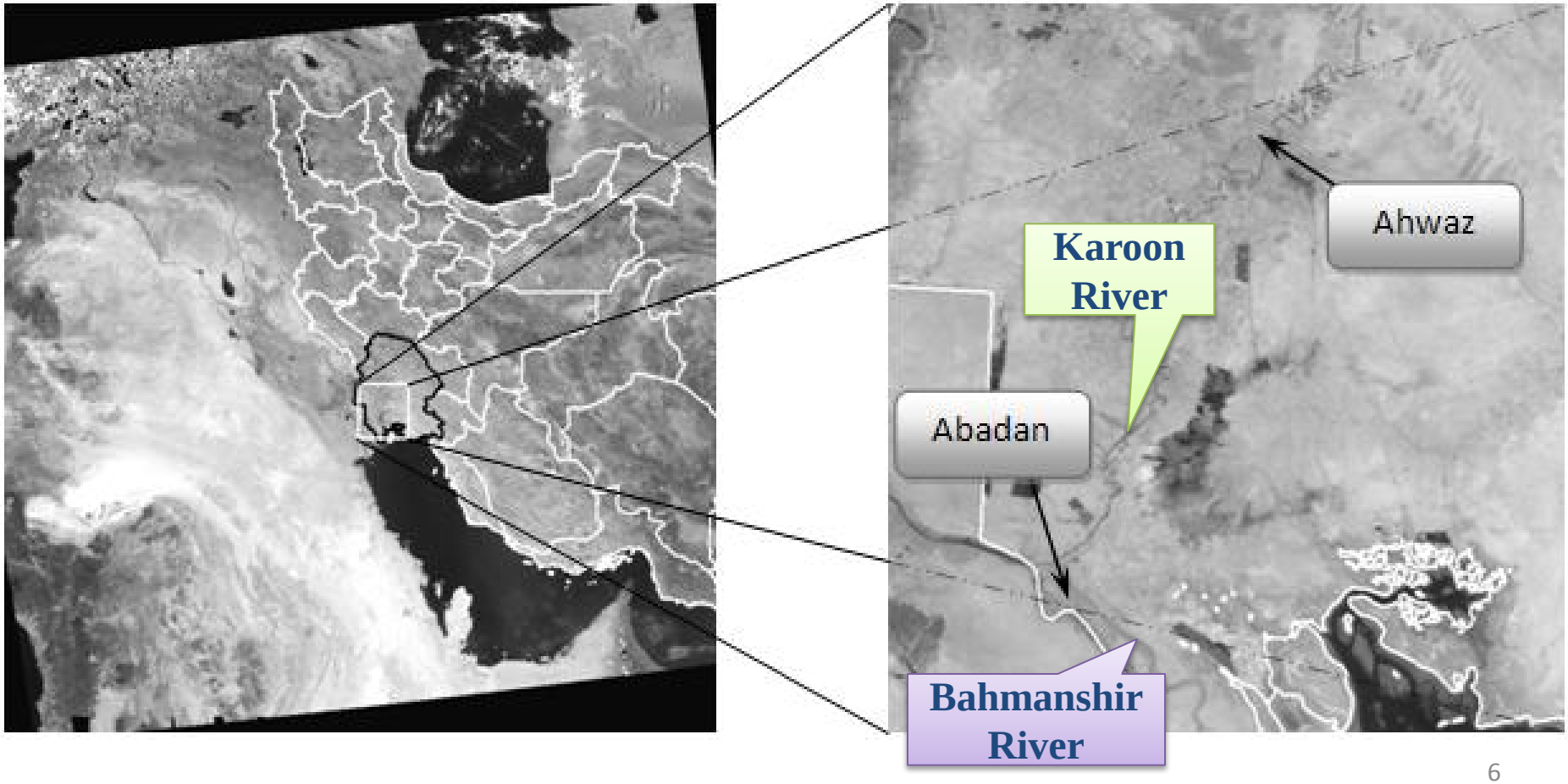


Table 2: The averaged reflectance values for dust and the riverside vegetation covers in the first two MODIS channels.

Band / **Object**	Red	NIR
Vegetation	0.12	0.30
Dust	0.49	0.56

Methodology

Step 3: Linear Unmixing

$$R^{Pixel} = \alpha_D R^D + \alpha_V R^V$$

$$NIR^{Pixel} = \alpha_D NIR^D + \alpha_V NIR^V$$

α_D and α_V are the shares of dust and vegetation in the reflectance of the mixed pixel

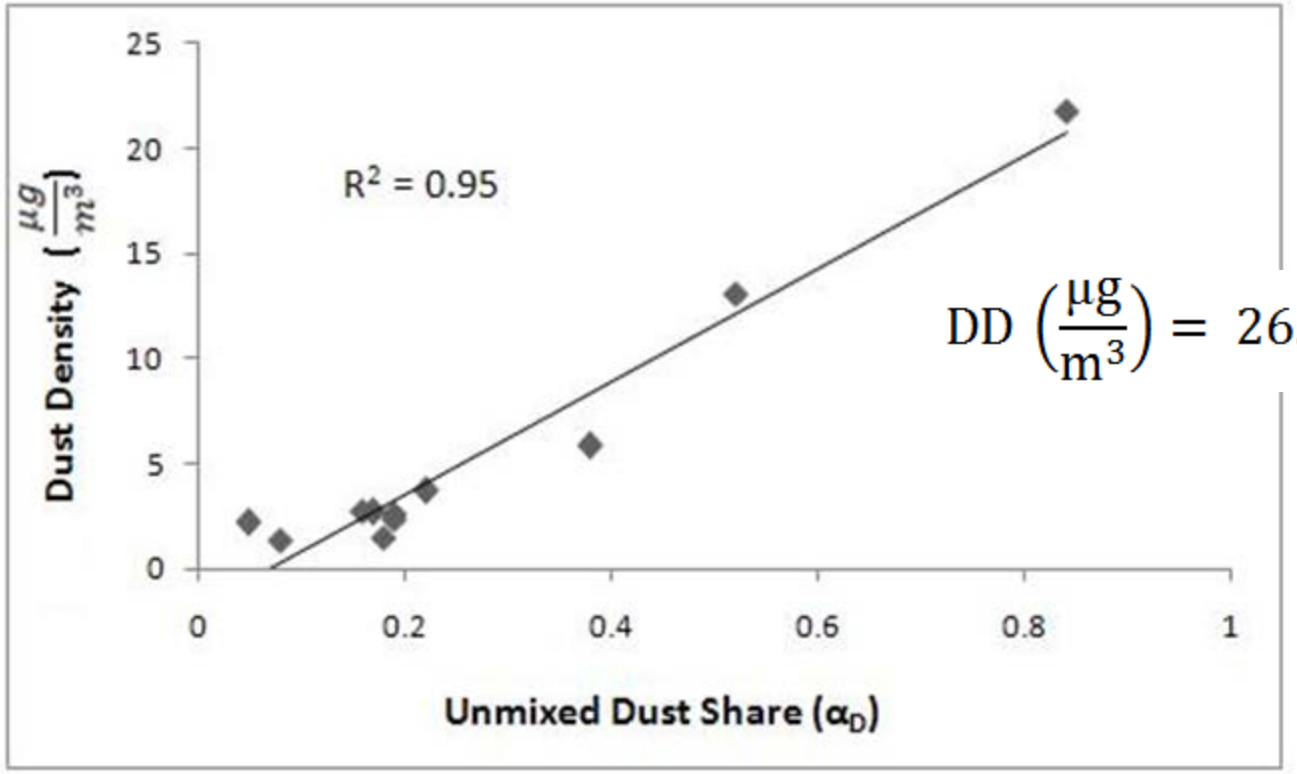
Table 3: The frequencies (shares) of dust and vegetation retrieved from unmixing for two cities of Ahwaz and Abadan in year 2009. Those marked with "x" denotes that there were no dust measurements for that day.

Platform	DOY (Date)	Ahwaz		Platform	DOY (Date)	Abadan	
		α_D	α_V			α_D	α_V
Terra	168 (17 Jun)	0.22	0.78	x	x	x	x
Terra	180 (29 Jun)	0.20	0.80	Terra	180 (29 Jun)	0.16	0.84
Terra	185 (4 Jul)	0.52	0.48	x	x	x	x
Terra	186 (5 Jul)	0.85	0.15	x	x	x	x
Terra	188 (7 Jul)	0.18	0.82	Terra	188 (7 Jul)	0.08	0.92
Terra	195 (14 Jul)	0.38	0.62	Terra	195 (14 Jul)	0.19	0.81
Terra	196 (15 Jul)	0.24	0.76	Terra	196 (15 Jul)	0.20	0.80
Terra	197 (16 Jul)	0.17	0.83	Terra	197 (16 Jul)	0.10	0.90
Terra	204 (23 Jul)	0.15	0.85	Terra	204 (23 Jul)	0.03	0.97
Aqua	168 (17 Jun)	0.16	0.84	x	x	x	x
Aqua	182 (1 Jul)	0.17	0.83	Aqua	182 (1 Jul)	0.05	0.95
Aqua	185 (4 Jul)	0.38	0.62	Aqua	185 (4 Jul)	0.25	0.75
Aqua	186 (5 Jul)	0.84	0.16	x	x	x	x
Aqua	194 (13 Jul)	0.25	0.75	x	x	x	x
Aqua	195 (14 Jul)	0.41	0.59	Aqua	195 (14 Jul)	0.26	0.74
Aqua	196 (15 Jul)	0.28	0.72	Aqua	196 (15 Jul)	0.19	0.81
Aqua	197 (16 Jul)	0.19	0.81	x	x	x	x

Methodology

Step 4: Regression

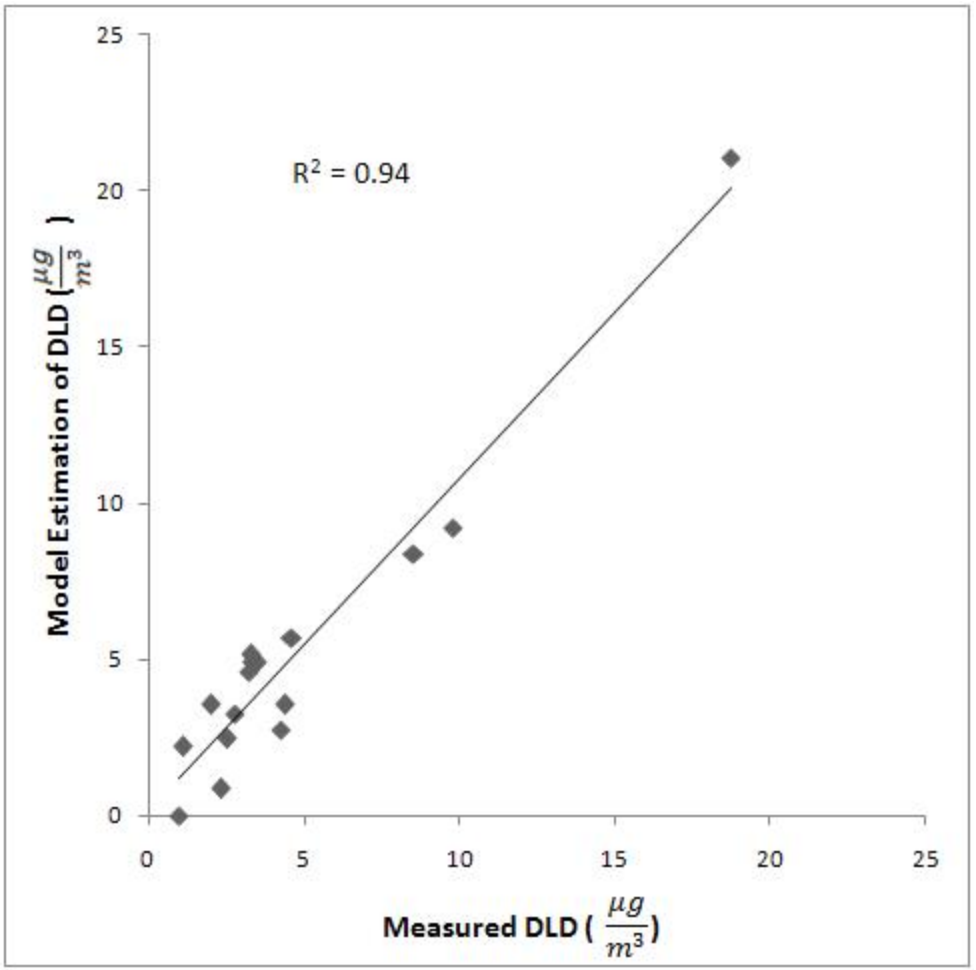
A linear regression between dust frequencies calculated in the previous step and the dust densities (DD) measured at the stations concurrently with the satellite over passing was run for randomly selected 11 out of 27 samples.



$$DD\left(\frac{\mu g}{m^3}\right) = 26.931\,\alpha_D - 1.8486$$

Evaluation & Conclusion

Now to evaluate the obtained equation, it is applied to another 16 samples where the predicted results are plotted against the measured dust density (DD) values.



Evaluation & Conclusion

- The RMSE between model predicted and field measured DD was found to be of the order of 1.28 (ug/m^3).
- The maximum readable value for DDs is around 25 (ug/m^3) after which it is believed that AOT gets high and the pixel gets saturated from the dust load.
- In the clear sky when the sky is believed to be dustless, the obtained model gives a minimum value of about 0.07 for dust density that is equivalent to more than 95% transparency of the atmosphere.
- It is found that the dust share of the reflectance is highly correlated to the field dust density measurements.

Thanks for your attention !

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