Dust Observations in El Paso, Texas during the 2005 North American Monsoon Season

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Introduction

- El Paso Del Norte (EPDN) is a region within the Chihuahuan desert; it is centered near the US - Mexico border. It comprises the cities of El Paso, TX, Las Cruces, NM, and Ciudad Juárez, Chih, in México (Figure 1).
- EPDN has numerous dust sources which favor dust storms (Figure 3).
- EPDN gets 60 to 70% of precipitation during the North American Monsoon (NAM).
- During monsoon season, convective systems generate strong winds to EPDN creating huge dust storms (Figures 4, 5).
- Precipitation during NAM appears to be significantly reduced in the presence of dust storms.
- Statistical analyses (1996 – 2003) suggest a decrease in precipitation amounts, an increase in the number of dust storms, and an anti-correlation between precipitation and dust storm frequency data (Figures 6, 7, and 8).

Figure 1. El Paso del Norte region (EPDN)


Figure 2. Samalayuca desert

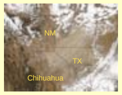

Figure 3. Dust storm on 04/15/03 from the MODIS sensor onboard Aqua

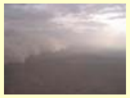
Figure 4. Dust storm image captured from an airplane

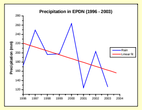

Figure 5. Precipitation decrease

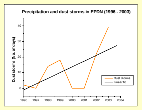

Figure 6. Dust storm frequency increase

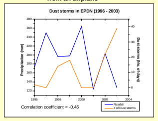

Figure 7. Anti-correlation between dust storms and rainfall

Methodology

- Surface observations of mineral aerosols, aerosol optical depth, and precipitation were collected and analyzed during July - September, 2005.
- Case studies were selected among clear and dusty days and the differences in precipitation amounts, aerosol optical depths, and surface dust concentrations were compared.
- Statistical analyses were performed to find correlations between precipitation and dust concentrations, precipitation and optical depth, and dust concentrations and optical depth.
- Wind trajectories were computed with NOAA ARL HYSPLIT model to investigate if precipitation events/dust storms were associated with inflow of moist air parcels from the Gulf of California.
- Surface aerosol number densities were obtained using the CLIMET CI-550 laser particle counter (Six size channels; 0.3, 0.5, 1, 3, 5, 10 μm) (Figure 8).
- Optical depths (cloud + aerosols) were inferred from spectral measurements of solar irradiances utilizing the MFRSR multi-filter rotating shadow-band radiometer (Figure 9).
- In-situ precipitation data was obtained from the National Weather Service (NWS), and Comisión Nacional del Agua (CNA, México) (Figure 10).
- United States and Mexican real-time precipitation analysis from the Climate Prediction Center was also used (Figure 11).


Figure 8. CLIMET CI-550, laser particle counter


Figure 9. MFRSR rotating shadow-band radiometer

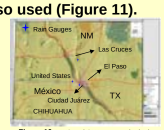

Figure 10. NWS and CNA meteorological stations location

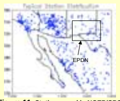

Figure 11. Stations used in NCEP/CPC real time precipitation analysis

Objectives

- To investigate a possible link between precipitation and dust storms
- To evaluate the evolution of aerosol number densities during NAM
- To determine if summertime precipitation was suppressed when dust concentrations where elevated

Results

- The analysis of dust concentrations from the CLIMET instrument and precipitation data from NWS and CNA suggested that the strongest anti-correlations between dust and rainfall occurred with the 3 and 5 μm channels (Figures 12, 13, 14).

Size Channel (mm)	Correlation, Dust and Rain (NWS/CNA data)	Correlation, Dust and Rain (CPC data)	Correlation, Dust and Optical Depth
0.3	0.05	-0.12	0.09
0.5	0.06	-0.24	0.007
1.0	-0.19	-0.44	-0.25
3.0	-0.33	-0.46	-0.40
5.0	-0.34	-0.44	-0.43
10.0	-0.23	-0.30	-0.33

Figure 12. Correlations table

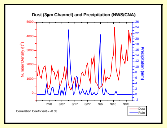
Figure 13. 3μm dust concentration and precipitation during NAM

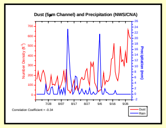
Figure 14. 5μm dust concentration and precipitation during NAM

- The analysis of dust concentrations from the CLIMET instrument and precipitation data from NCEP/CPC real time analysis suggested that the strongest anti-correlations between dust and rainfall also occurred with the 3 and 5 μm channels (Figures 12, 15, 16).

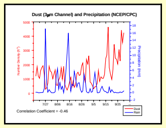
Figure 15. 3μm dust concentration and precipitation during NAM

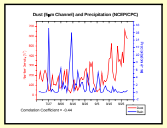
Figure 16. 5μm dust concentration and precipitation during NAM

- The strongest anti-correlation between optical depth (cloud + aerosol) and dust concentrations took place with the 3 and 5 μm channels (Figures 12, 17, 18).
- There is a positive correlation between optical depth (cloud + aerosol) and precipitation data (Figure 19).

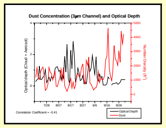
Figure 17. 3μm dust concentration and optical depth during NAM

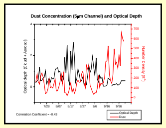
Figure 18. 5μm dust concentration and optical depth during NAM

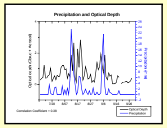
Figure 19. 3μm dust concentration and precipitation during NAM

- Wind trajectory analysis with HYSPLIT revealed that air parcels were coming from the Gulf of California in about 70% of the dates in which dust storms and precipitation took place in EPDN (Figures 20, 21).

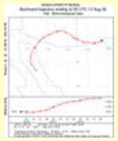
Figure 20. Backward wind trajectory 08/12/05

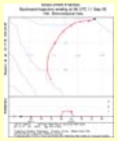
Figure 21. Backward wind trajectory 09/11/05

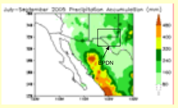

Figure 22. Precipitation accumulation in EPDN during NAM

- The total precipitation received in EPDN during the 2005 monsoon season was 137.8 mm according to NWS/CNA, and 132.5 mm according to NCEP/CPC real time analysis (Figure 22).

Results Continued

Case Studies

August 11, 2005

- A convective system generated high wind gusts (35 mph) in the region creating a huge dust storm (Figures 23, 24, 25).
- Air parcels were associated with the monsoon bringing up moisture from the Gulf of California (Figure 20).
- Dust concentrations from the CLIMET particle counter peaked around 7:40 PM (MST) (Figure 26).
- Precipitation amounts in the region averaged 5 mm that day.


Figure 23. Web-cam image of dust layer Approaching El Paso, TX at 6:32 PM


Figure 24. Web-cam image of dust Storm in El Paso, TX at 6:46 PM


Figure 25. Webcam image of dust Storm in El Paso, TX at 7:01 PM

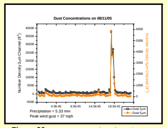

Figure 26. Dust concentrations from CLIMET Peaking around 7:00 PM

August 12, 2005

- This was the rainiest day of the 2005 NAM season in EPDN with rainfall amounts of 23 mm on average.
- Dust concentrations from the CLIMET particle counter were low throughout the day (Figure 27).
- Air parcels were associated with NAM bringing up moisture from the Gulf of California (Figure 28).
- Rain clouds are observable from the web-cam at Ranger Peak in El Paso, TX (Figure 29).


Figure 27. Wind backward trajectory

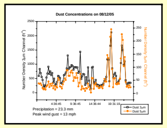

Figure 28. Low dust concentrations in a rainy day


Figure 29. Rain clouds in El Paso, TX on 08/12/05

Conclusions

- The statistical analyses carried out is this study suggest that dust concentrations (3 and 5 μm) and precipitation in the EPDN region are negatively correlated during NAM season.
- Optical depth (cloud + aerosol) and precipitation data are positively correlated.
- Optical depth (cloud + aerosol) and dust concentrations are anti-correlated.
- Dust concentrations seem to be more anti-correlated to NCEP/CPC precipitation data than to NWS/CNA precipitation data.
- Approximately 70% of the air parcels that bring moisture and dust storms to EPDN during NAM come from the Gulf of California.

Sources

www.arl.noaa.gov/ready/hysplit4.html

http://www.srh.noaa.gov/elp/climat/wxclim.shtml

http://uvb.nrel.colostate.edu/UVB/home_page.html

http://www.tceq.tx.us

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CNA

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TCEQ

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