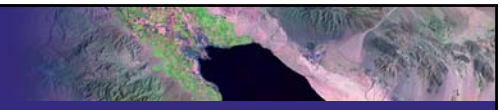


Mapping Salton Sea bottom characteristics using dual frequency acoustics with application to identifying potential new dust sources

Pat Chavez, Karl Rhynas, Miguel Velasco, and Cheryl Rodriguez

United States Geological Survey, Flagstaff, Arizona;
Quester Tangent Corporation, Sidney, B.C., Canada; and
Bureau of Reclamation, Boulder City, Nevada

Little is known about the airborne suspension potential of sediments in the Salton Sea which covers approximately 375 square miles/240,000 acres.

A map showing surface characteristics can be used to help assign dust emissivity coefficients to areas that will be exposed in the future. These types of coefficients are a critical parameter required by most dust emission models to predict the impact to local and regional air quality.

USGS

•As a result of several workshop one study conducted was to collect over 800 grab samples within the Sea beginning with sediments close to the shoreline and extending to approximately the 15 foot depth contour.

•The sampling effort was completed in 2003 and provided sediment type data at the sample location/point for the sediments of the Sea and were used to generate interpolated sediment maps (Agrarian Research Ltd., 2003).

USGS

- A second study, conducted by the USGS in collaboration with the Bureau of Reclamation, included a task to use dual frequency acoustics to investigate getting information about the characteristics of the Sea's bottom.

- Two differences between the studies are the amount of data collected and used in the analyses (there were 800 grab samples compared to 3,000,000 acoustic returns), and the acoustic survey covered deeper areas of the Sea.

USGS

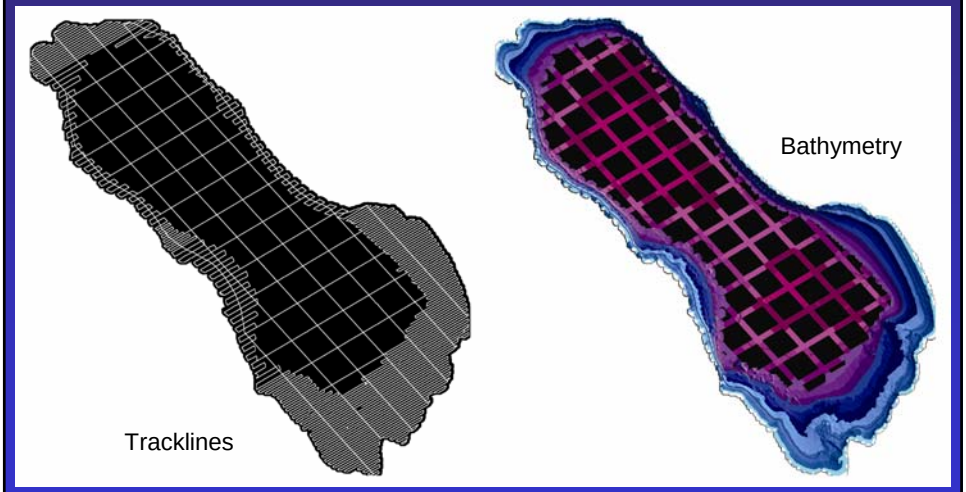
Objective

The main objective of this task was to detect and map potential new dust sources within the Sea when the water level is lowered from an ACOUSTICS point of view.

The acoustic backscatter signal is typically highly correlated to surface particle size and texture/roughness, so the resulting map will be based heavily on these characteristics.

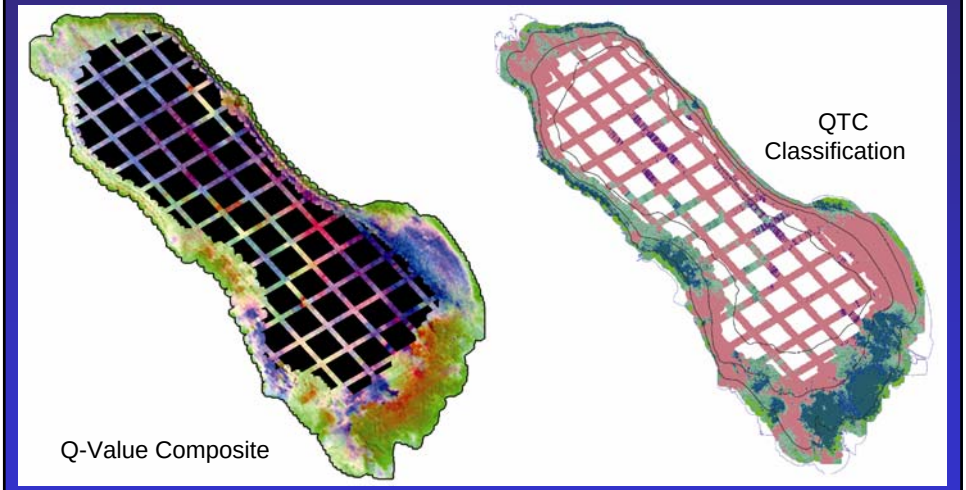
USGS

Tracklines and Bathymetry



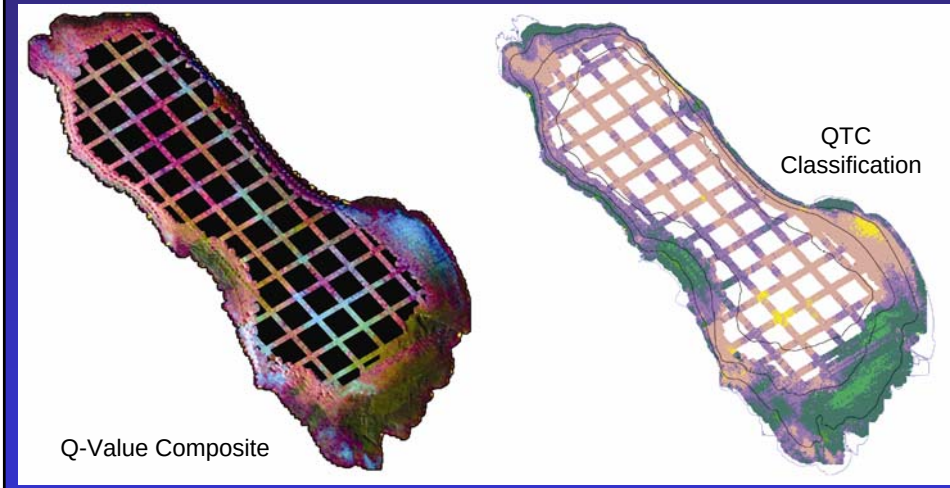
USGS

Low Frequency (50 kHz) Acoustics



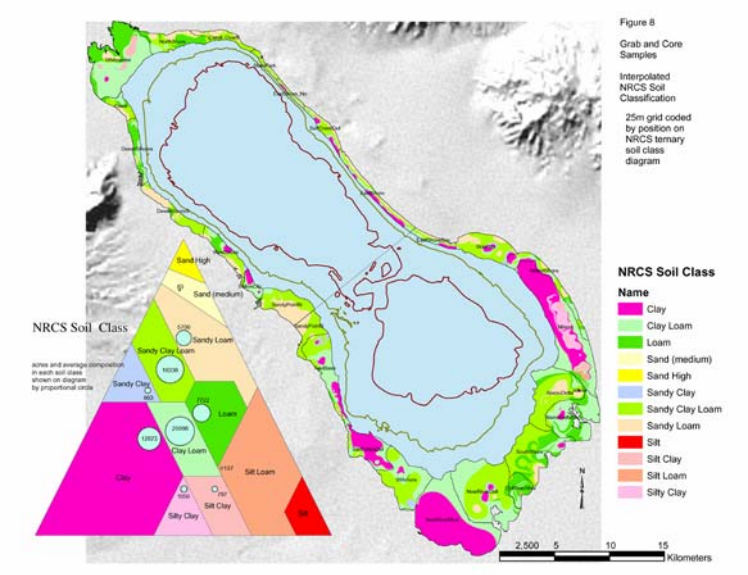
USGS

High Frequency (200 kHz) Acoustics

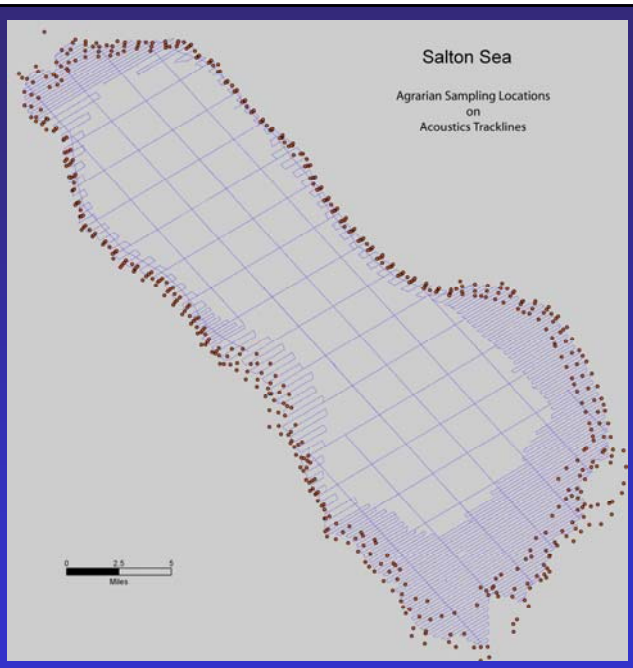


USGS

Agrarian's Interpolated NRCS Soil Classification

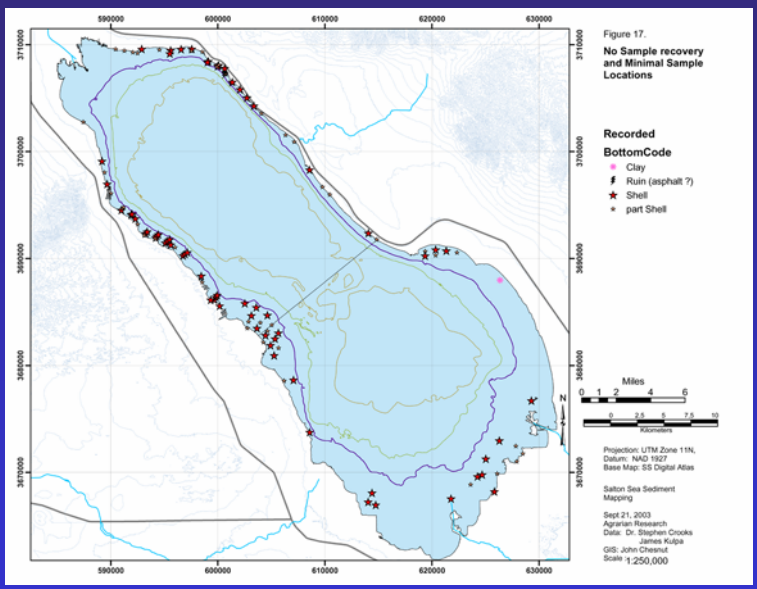


USGS



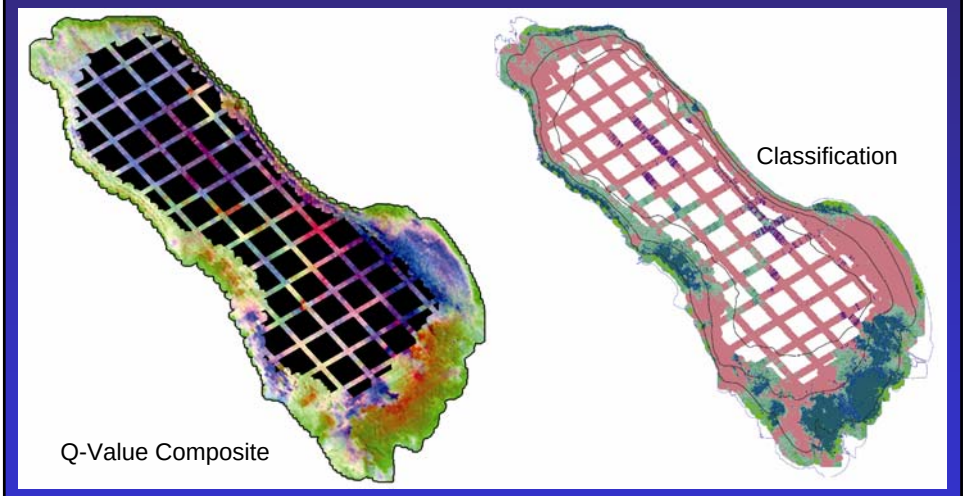
USGS

Agrarian's Research Shell Sample Locations



USGS

Low Frequency (50 kHz) Acoustics

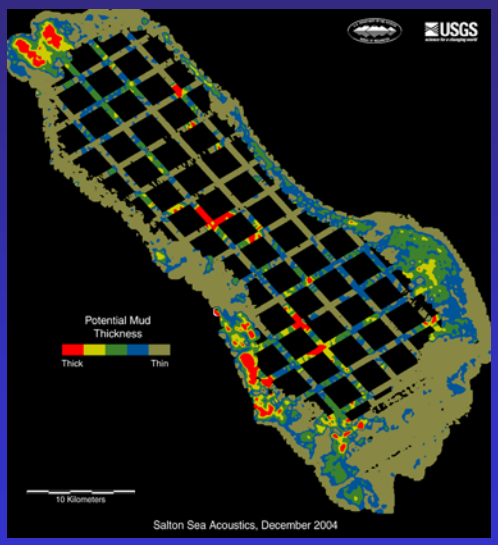


USGS

Salton Sea 3D Image

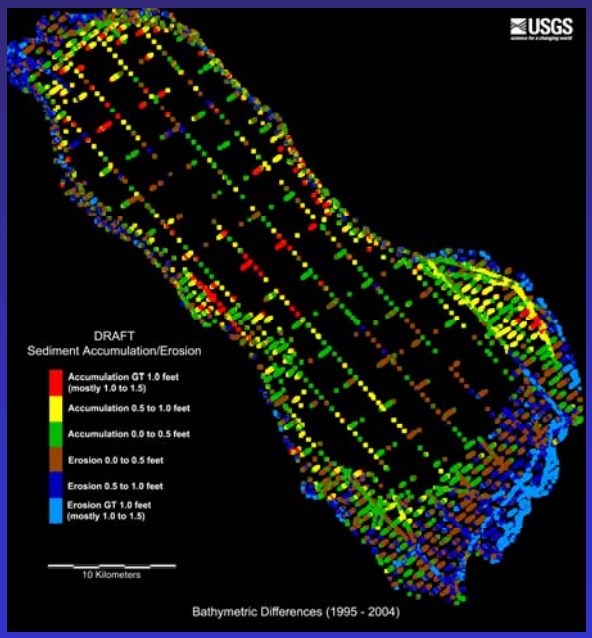
USGS

Draft --- Potential Soft Mud Thickness Map



USGS

Bathymetric Differences (1995 – 2004)



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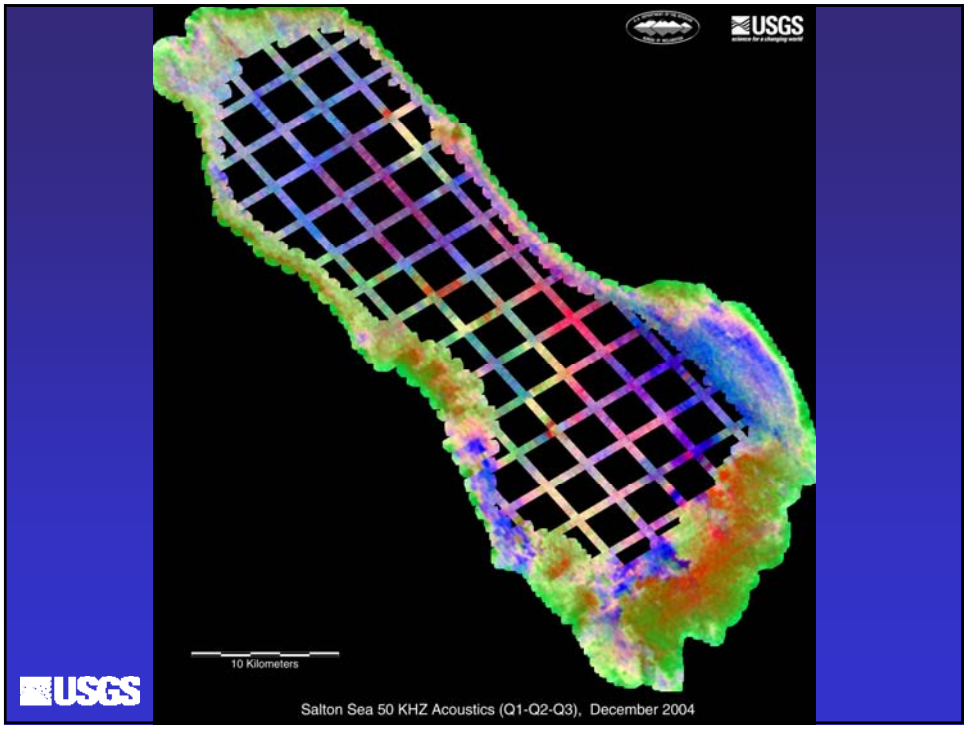
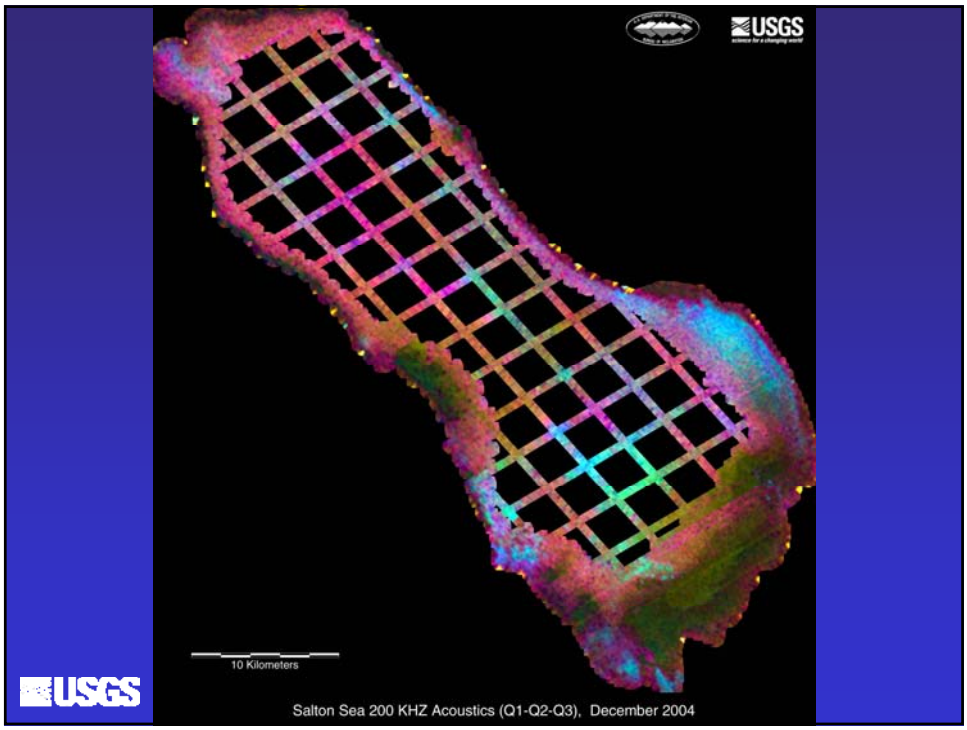
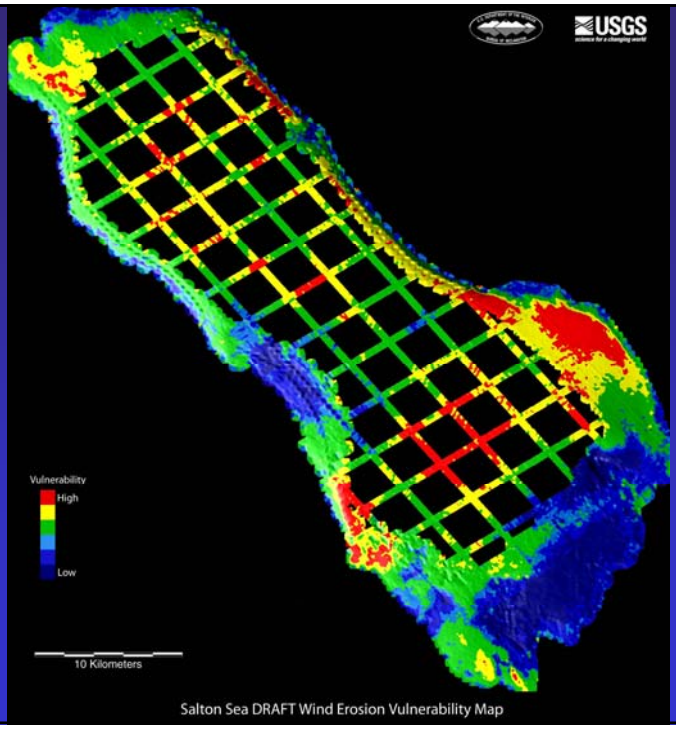

USGS
10 Kilometers
USGS
Salton Sea 50 KHZ Acoustics (Q1-Q2-Q3), December 2004


USGS
10 Kilometers
USGS
Salton Sea 200 KHZ Acoustics (Q1-Q2-Q3), December 2004



USGS

Acoustic Particle Size/Vulnerability Map

Color	Particle Size	Relative Vulnerability	Area (acres)	Percent Of Total	
Red	Fine	High	12,830	9.26%	
Yellow	Fine	High	29,568	21.34%	30.6%
Green	Intermediate	Moderate	50,962	36.78%	36.8%
Blue 1	Coarse	Low	14,313	10.33%	
Blue 2	Coarse	Low	15,269	11.02%	
Blue 3	Coarse	Low	15,615	11.27%	32.6%

The amount of area covered by the interpolated acoustic image is 138,557 acres and the acoustic survey started at approximately –232 feet elevation (five feet water depth), so the area from -227 to –232 feet is not included.

USGS

• In the deeper waters the track lines were spaced further apart than in the shallow areas, so even with the interpolation there is a lot of area not included (i.e., the total number of acres of the actual lake bottom is much higher and not covered by this map).

• Also, the track lines in the deeper waters were basically expanded/fatten by the interpolation since they were further apart (i.e., did extrapolation rather than interpolation so more 'guessing' at these locations).

USGS

A study of wind characteristics and implications to air quality in the Salton Sea region using data collected by CARB and CIMIS meteorological stations

Pat Chavez, Jana Ruhlman, Rian Bogle, and Cheryl Rodriguez

United States Geological Survey, Flagstaff, Arizona, and
Bureau of Reclamation, Boulder City, Nevada

USGS

Objective

The main objective of this task was to use existing data to study wind characteristics around the Salton Sea and the potential impact to air quality due to dust emission from potential dust sources resulting from a lower Sea water level.

USGS

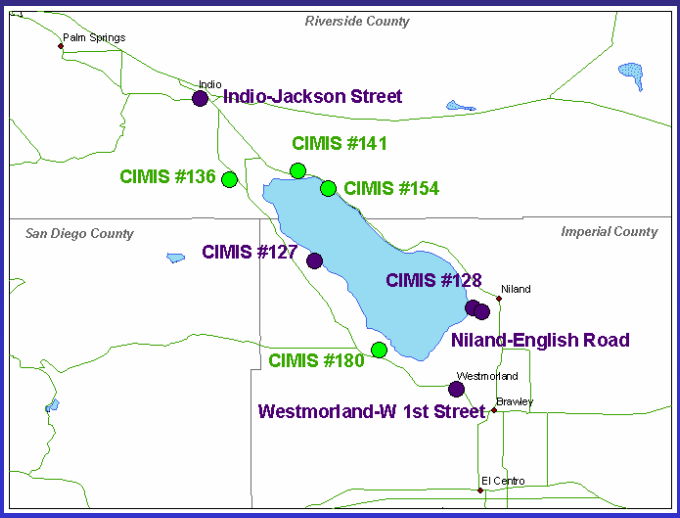
Data Analyses and Interpretation

- The parameters used in the analyses were mainly wind speed and wind direction, plus PM10 (particulate matter less-than or equal-to 10 microns in size) when available because it is often used as a general indicator of air quality.

- Wind speed and direction are recorded *hourly* at the CARB and CIMIS stations, while historical PM10 was recorded only once every six days at two of the three CARB sites and not at all at the CIMIS stations. Only the Indio-Jackson Street CARB site collected *hourly* PM10 data during the two years selected for detailed analysis; Niland and Westmorland CARB sites hourly PM10 were available starting in 2004.

USGS

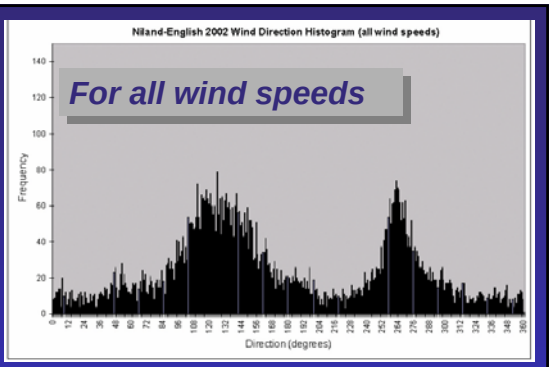
CARB and CIMIS meteorological sites used

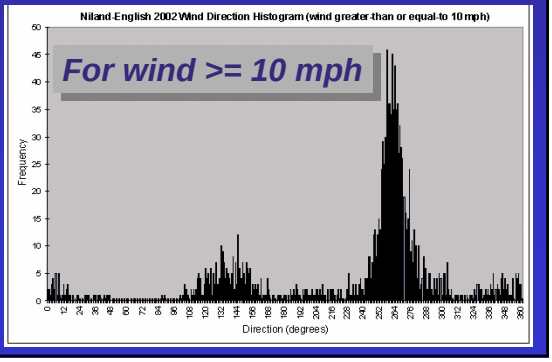


USGS

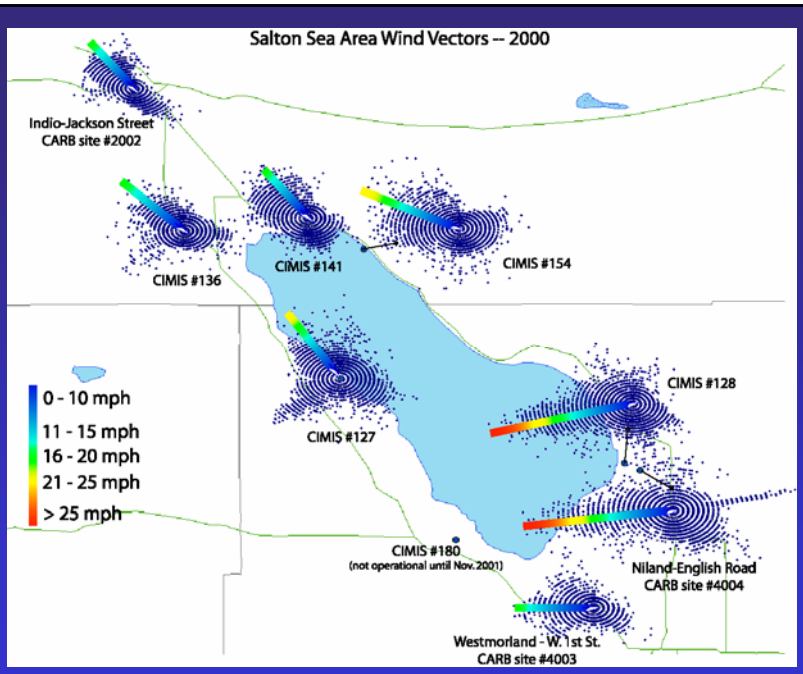
Niland-English Road

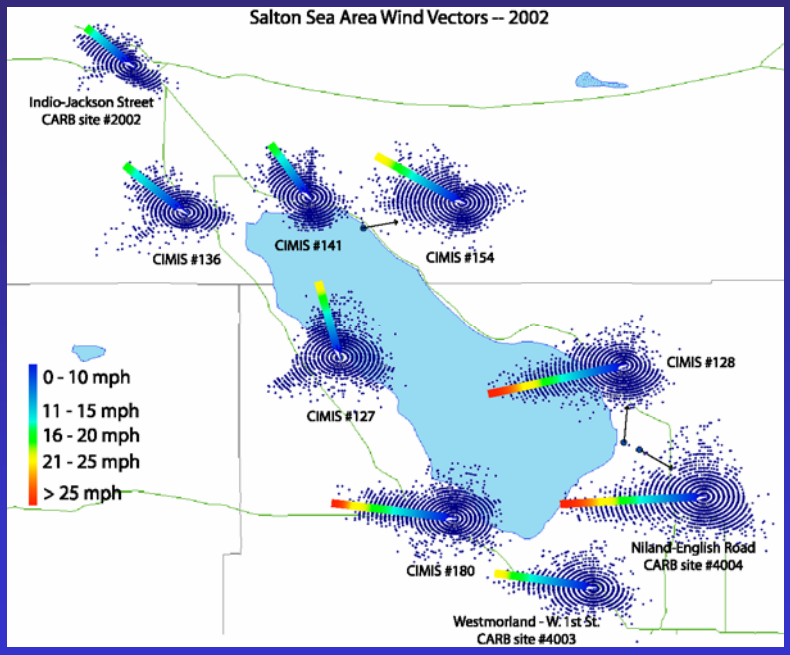
Wind direction histograms for 2002





USGS


Salton Sea Area Wind Vectors -- 2000
Indio-Jackson Street
CARB site #2002
CIMIS #136
CIMIS #141
CIMIS #154
CIMIS #128
CIMIS #127
0 - 10 mph
11 - 15 mph
16 - 20 mph
21 - 25 mph
> 25 mph
CIMIS #180
(not operational until Nov. 2001)
Niland-English Road
CARB site #4004
Westmorland - W. 1st St.
CARB site #4003


Salton Sea Area Wind Vectors -- 2002
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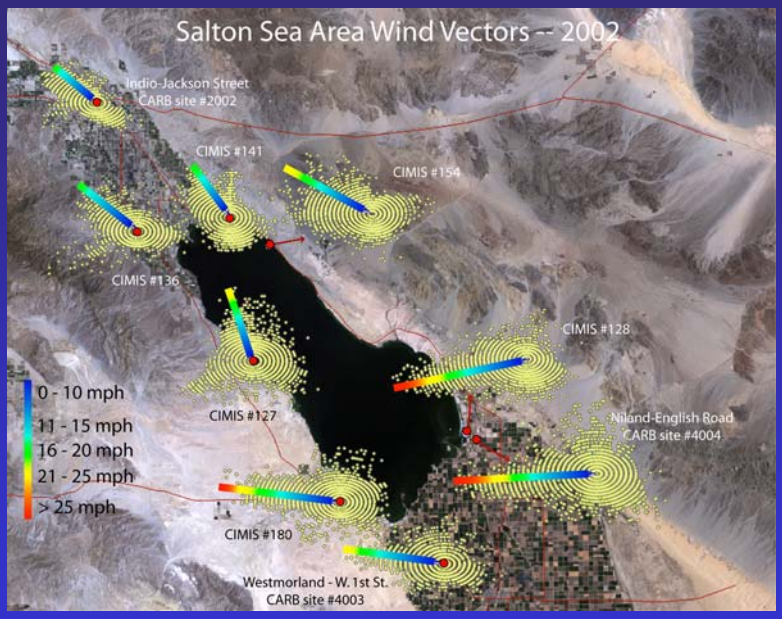
CARB site #4004
Westmorland - W. 1st St.
CARB site #4003



USGS

Frequency of Moderate to High Winds

	Niland	CIMIS #128	Westmorland	CIMIS #127	Indio-Jackson St.
Percentage of times the wind speed was greater-than or equal-to 15 mph					
2000	8.31%	7.05%	0.57%	1.83%	0.26%
2002	7.60%	6.22%	1.37%	1.56%	0.25%
Number of days the wind speed was greater-than or equal-to 15 mph for at least 3 hours of the day					
2000	82	74	6	21	1
2002	75	66	13	18	3

	CIMIS #136	CIMIS #141	CIMIS #154	CIMIS #180	
Percentage of times the wind speed was greater-than or equal-to 15 mph					
2000	0.50%	0.97%	2.49%	N/A	
2002	0.64%	0.71%	2.17%	5.41%	
Number of days the wind speed was greater-than or equal-to 15 mph for at least 3 hours of the day					
2000	16	26	60	N/A	
2002	17	20	49	79	

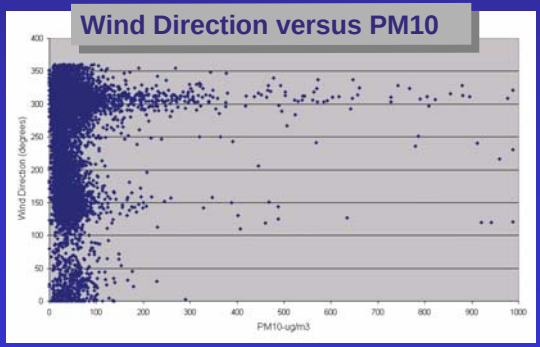
USGS

Preliminary PM10 Analyses

- There is a lack of historical *hourly* PM10 data (particulate matter less-than or equal-to 10 microns in size) in the Salton Sea region for detailed analyses and correlation with existing wind data.
- Of the three CARB station data sets used in this study only the Indio-Jackson Street had both PM10 and wind data on an *hourly* basis for 2000 and 2001. Niland and Westmorland started collecting data around 2004.

USGS

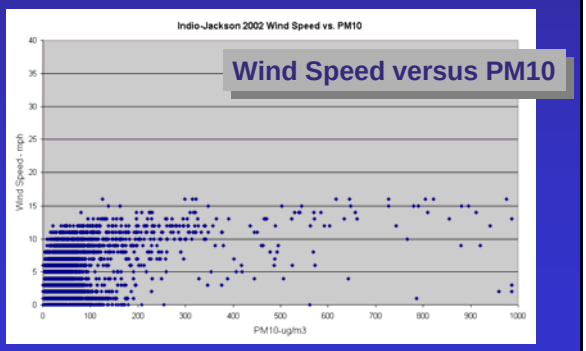
This graph shows the relationship between PM10 and wind direction at the Indio-Jackson Street site for 2002 (the only sites that has hourly PM10 data available for 2000 and 2002). Notice that for this site it seems that PM10 is elevated when winds are blowing from the NW with a secondary direction from the SE.



USGS

This graph shows the relationship between PM10 and wind speed at the Indio-Jackson Street CARB site for 2002. Note that high PM10 values, which generally indicate poor air quality, can occur when the winds are calm. This makes it more difficult to correlate and model the impact of dust sources on air quality during windy conditions. Of the nine sites used in the analyses Indio-Jackson Street is one of the least windy, so correlations between PM10 and wind speed/direction might be stronger at sites with more wind.

A weak correlation between PM10 and wind speeds greater than 10 mph can be seen, plus it appears that some of the lowest PM10 levels occur when it is breezy (5 to 6 mph range).

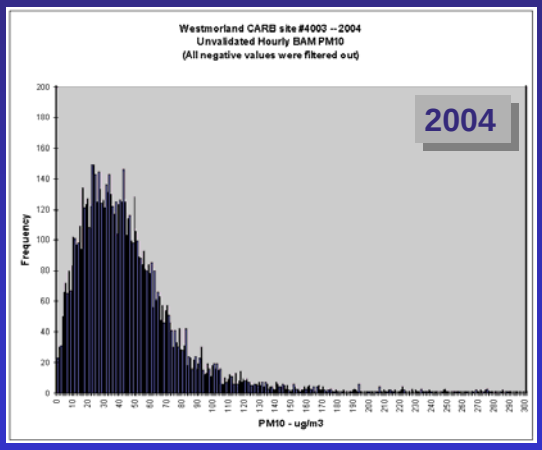


USGS

Westmorland-
W. 1st Street

CARB site #4003

Histogram of 2004 unvalidated hourly BAM PM10



USGS

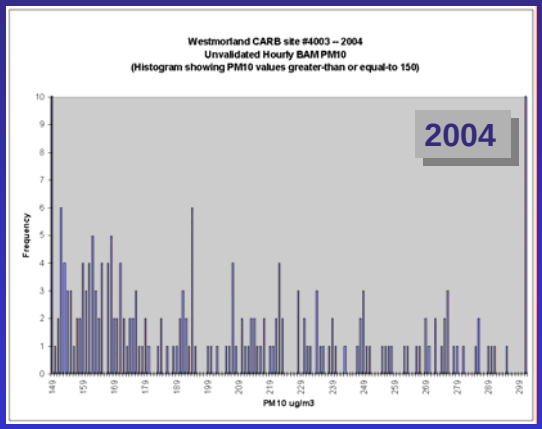
Westmorland-W. 1st Street

CARB site #4003

Histogram of 2004 unvalidated hourly BAM PM10

(values >= 150 only)

values < 150	8365	95.2%
values >=150 & <=300	188	2.1%
values > 300	231	2.7%



USGS

Dust Emission Monitoring at Other Sites

- The USGS has been actively involved for about seven years in a project that includes detecting and monitoring dust events in the southwestern United States, with the Mojave Desert being a main study site.
- Instruments have been placed at several locations to do high temporal monitoring of wind playa surfaces during high wind events.
- We have also collected satellite images to document dust events and sources. Movies have been generated using both satellite and ground-based imaging of selected dust events in the Mojave Desert.

USGS

USGS

USGS

USGS

•The following graphs were generated using data collected by met stations located at Soda Dry Lake in the Mojave Desert and show the relationship between wind speed and particle counts. The wind speed is shown in m/s and an approximate conversion to mph is to multiply the m/s times 2.24. Data for two years are shown because they represent a dry vulnerable (2000) and a relatively wet/vegetated non-vulnerable years (2001).

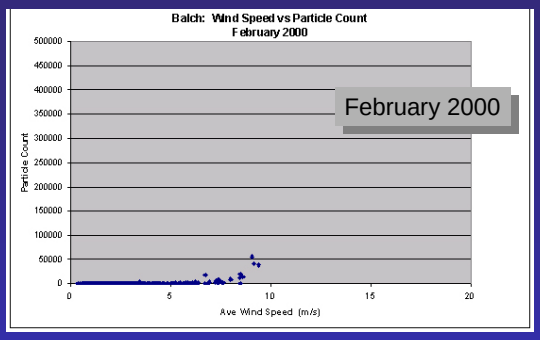
•The two things to notice are:

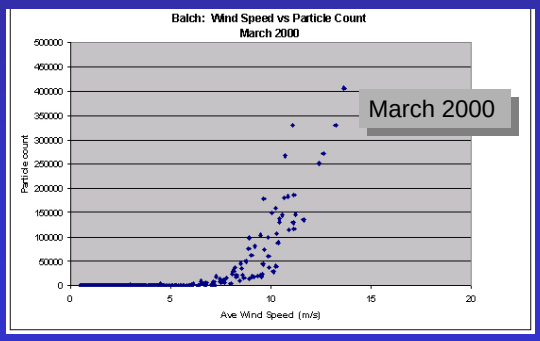
- sand/particles start to move at approximately 6 to 7 m/s (15 mph)
- the vulnerability of a site can change in a single year

USGS

Mojave Desert: Balch

Wind Speed vs Particle Count

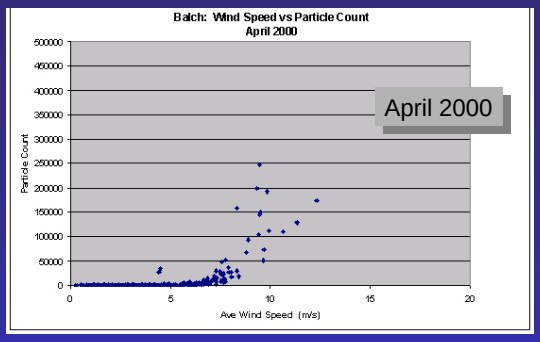


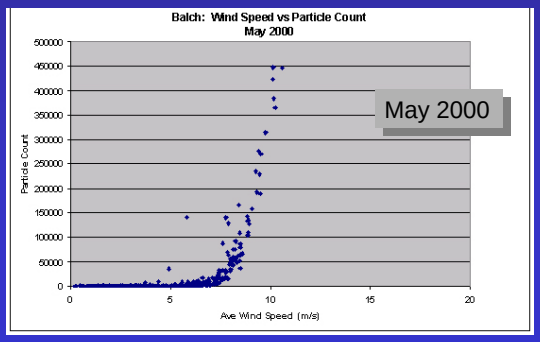


USGS

Mojave Desert: Balch

Wind Speed vs Particle Count

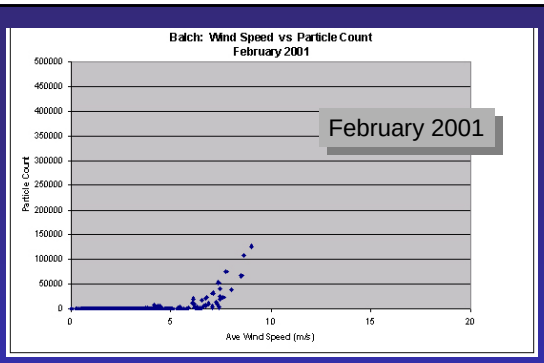


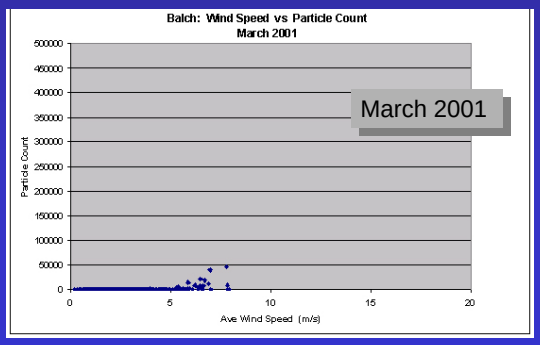


USGS

Mojave Desert: Balch

Wind Speed vs Particle Count

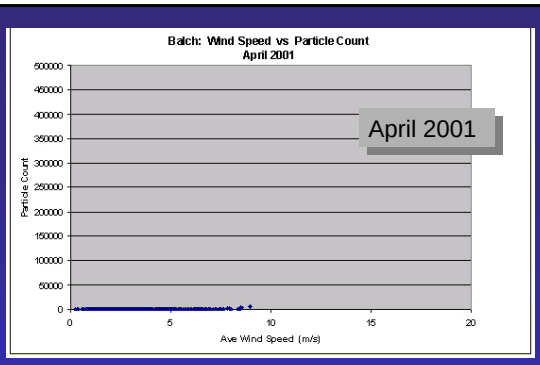


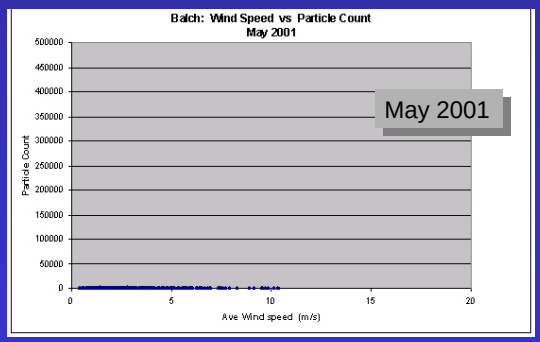


USGS

Mojave Desert: Balch

Wind Speed vs Particle Count

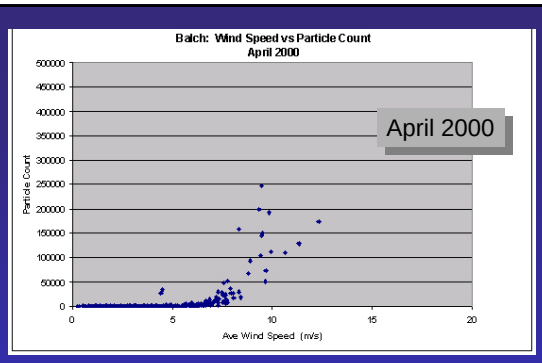


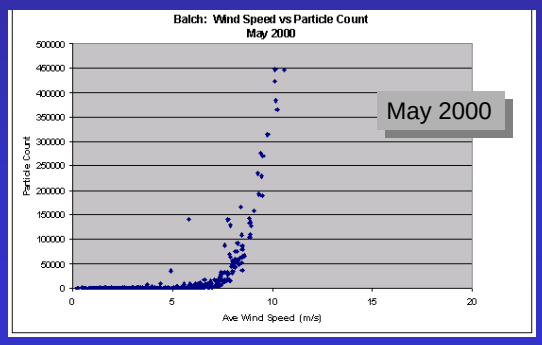


USGS

Mojave Desert: Balch

Wind Speed vs Particle Count



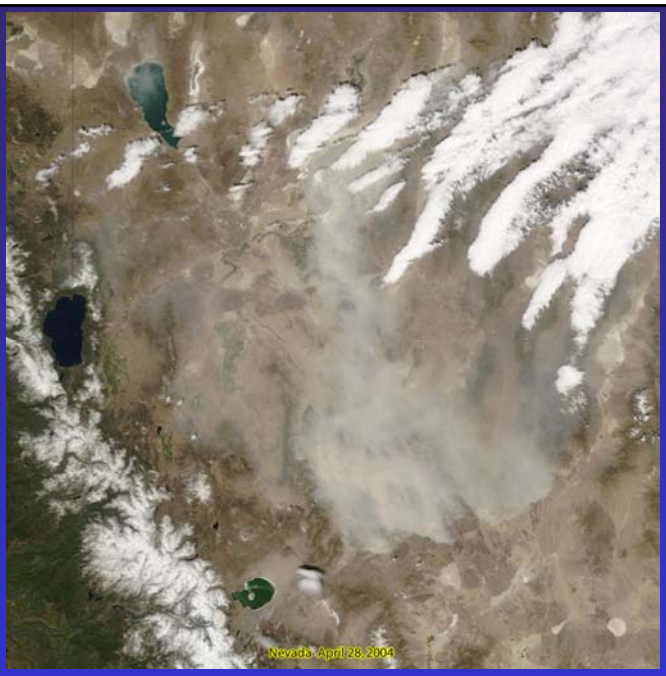


USGS

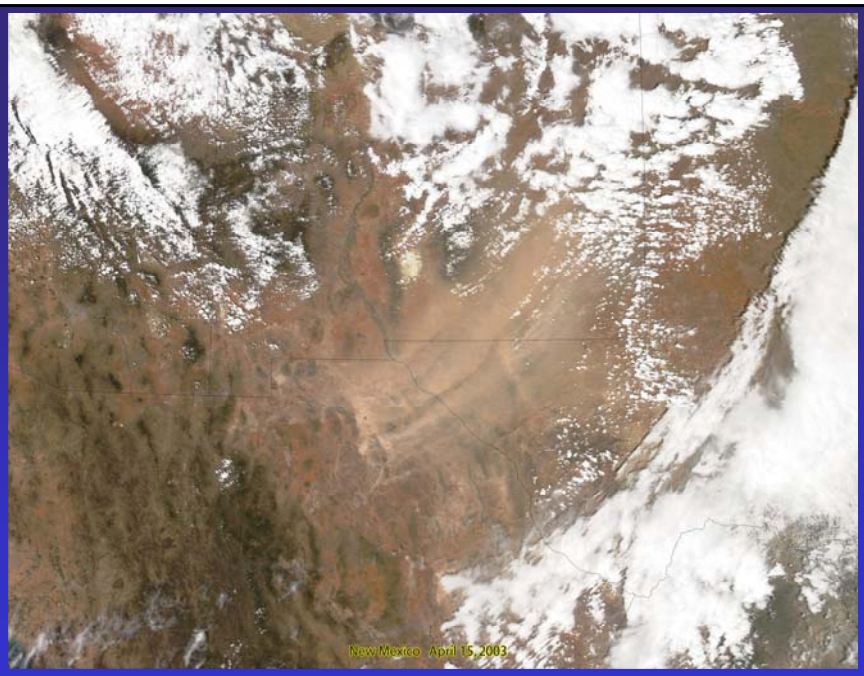
Dust Events Captured by Satellite Images

- We have been using satellite imaging to detect and identify dust sources within the southwestern United States. However, a major problem with satellite imaging is the temporal resolution (i.e., it misses many events due to not being overhead at the right time).
- The next few slides shows dust events in the New Mexico/west Texas/northern Mexico region (the first one is in the Mojave Desert). One thing to keep in mind is that the climate characteristics of some of these areas are probably more similar to the Salton Sea area than Owens Lake, which is an issue often discussed. Also note that large dust sources are on both traditional playa and non-playa surfaces.

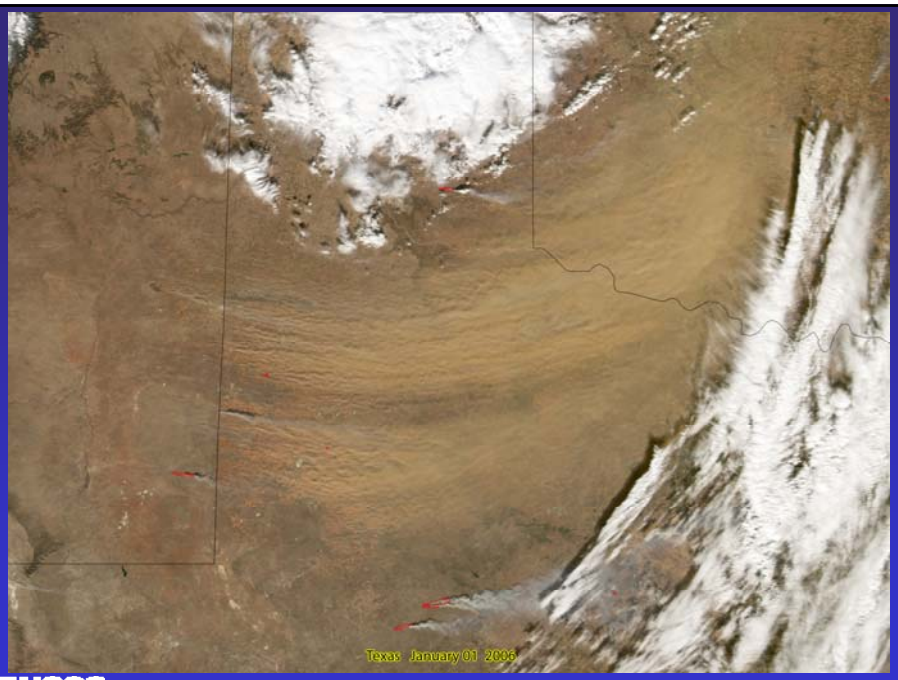
USGS



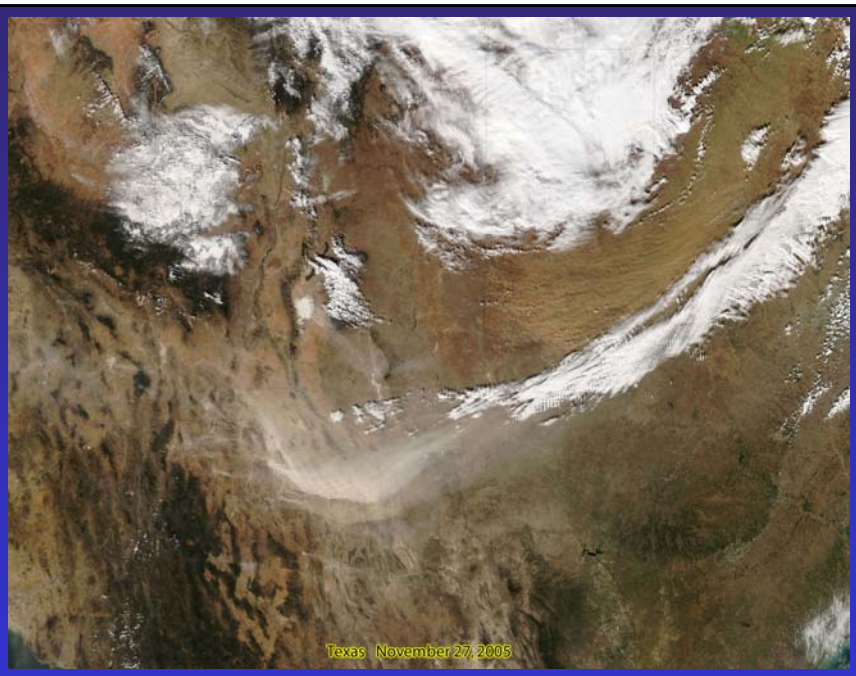
USGS



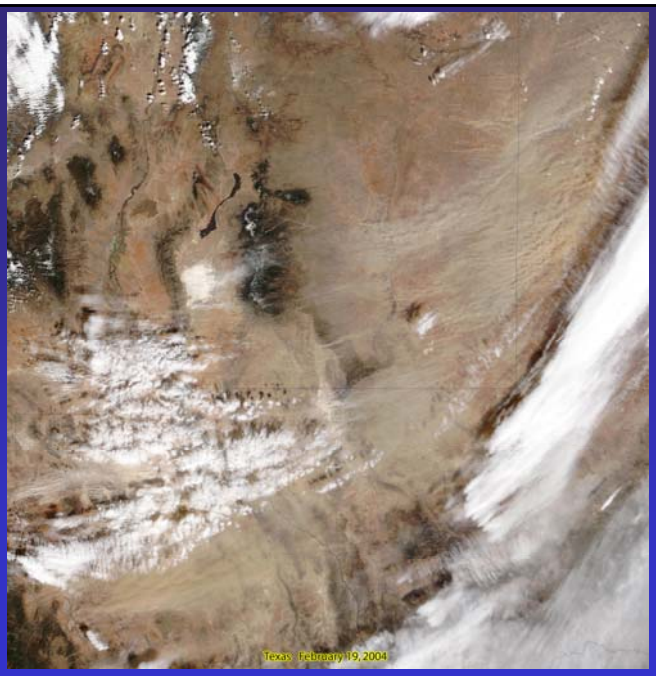
USGS



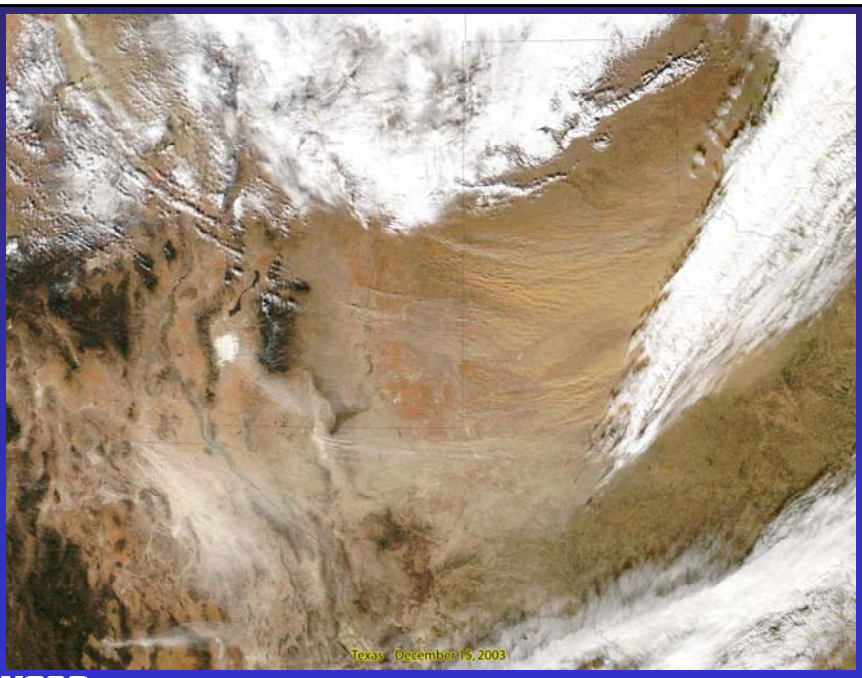
USGS



USGS



USGS



USGS

Salton Sea Landscape: Vulnerability/non-Vulnerability Questions

- A major unique characteristic of the Salton Sea is the presence of a VERY LARGE number of barnacles (billions/trillions?). Their potential impact on the vulnerability or non-vulnerability of the 'to be exposed' surface is unknown. Will it 'shelter' the fine sediment and/or when broken down to very small pieces act like sand and perhaps become 'the saltating particles' that break loose the fines?

- Thick salt crust layer: existing examples; dark albedo replaced with a very bright albedo minus the water (impact to local temp)?

- Exposed playa surface characteristics?

- Gypsum and sand input at San Felipe Creek?

USGS

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Bombay Beach 26Jan2006

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New River Delta 26Jan2006

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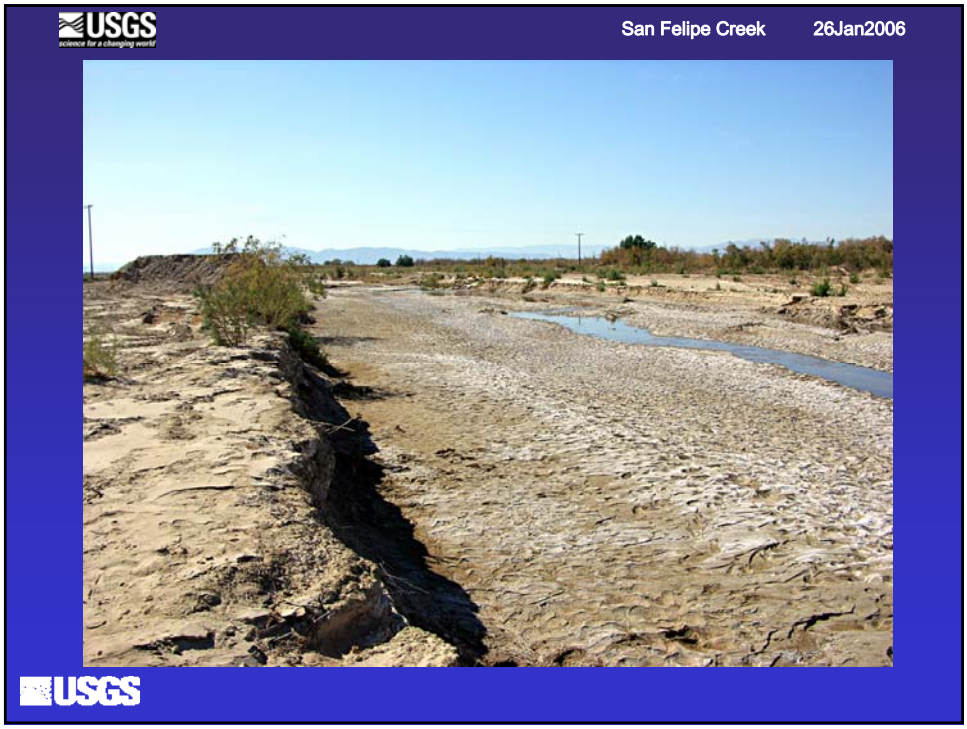
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San Felipe Creek
26Jan2006
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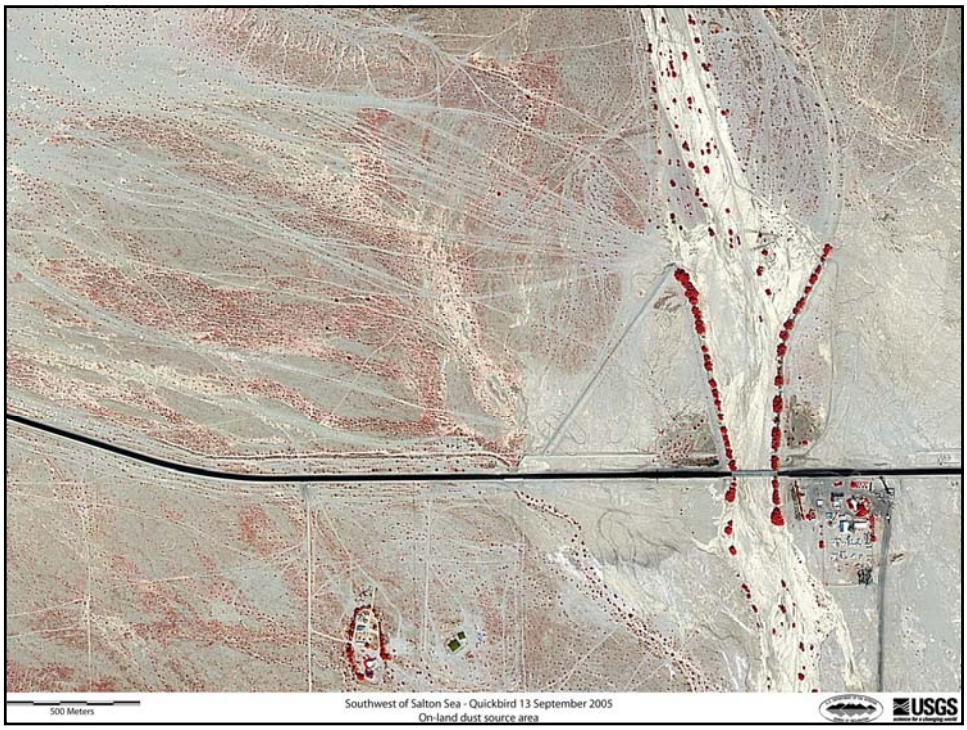
500 Meters
Southwest of Salton Sea - Quickbird 13 September 2005
On-land dust source area
USGS

Dust Event Monitoring

- Movies have been generated of some dust events in the Mojave Desert using images collected by either the satellite or ground-based systems.
    - GOES satellite movies (southwestern United States)
    - Ground-based camera station movies (Soda Dry Lake and Franklin Dry Lake)

Movie Time ?

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