Investigating Hydrometeorological Conditions Associated with Increasing Dust Events in Southwestern United States

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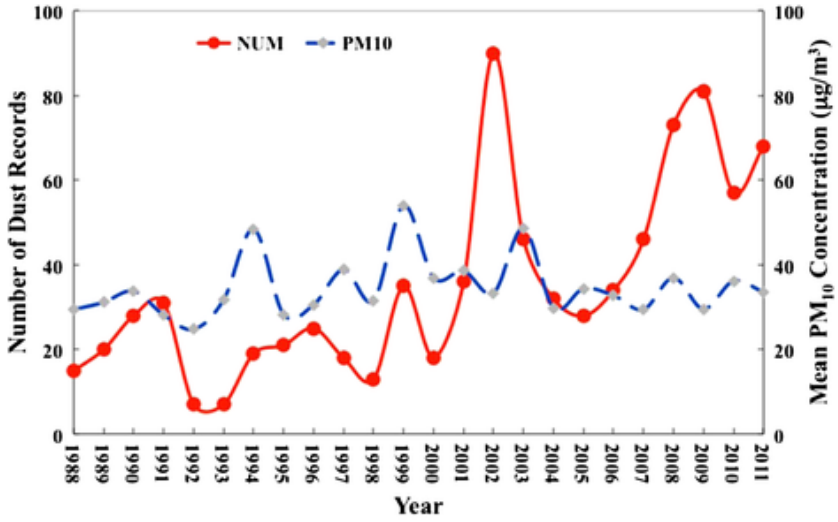
GH31A: Earth System Interactions and Implications for Geohealth I

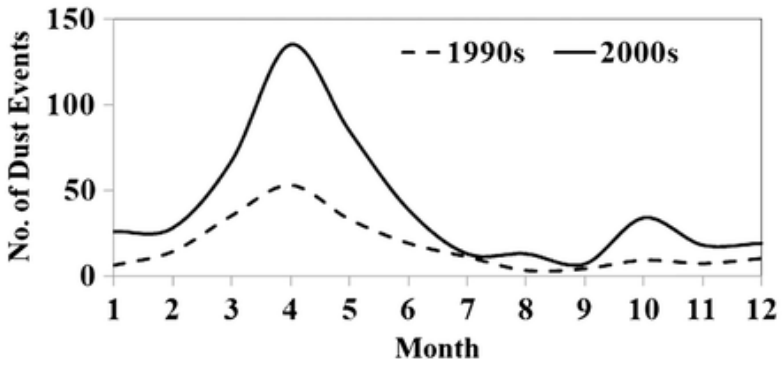
Outline

- Motivations
- Datasets
- Dust and wind time series analysis
- Analysis of hydrometeorological conditions
- More recent analysis (2010s)
- Summary
- References

Motivations

- A recent study (Tong et al. 2017) shows a rapid intensification of dust storm activity over the southwestern United States in the past decades.





Motivations (cont.)

- For example, the frequency of windblown dust storms has increased 240% from 1990s to 2000s.
- Increasing dust storms can worsen air quality in the region.
- The study also finds that the intensification of dust events has a close connection with a fast-rising infectious disease (valley fever) caused by inhaling soil-dwelling fungi (Coccidioides immitis and C. posadasii) in the southwestern United States.
- Hydrometeorological conditions play an important role in dust storm activities, including winds, precipitation, soil moisture, atmospheric boundary stability, land surface types, etc.
- Influence of large-scale environment on hydrometeorological conditions.

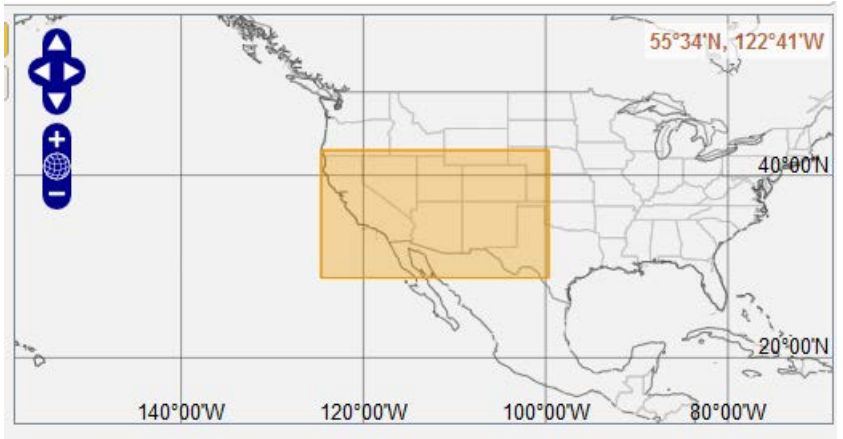
Datasets

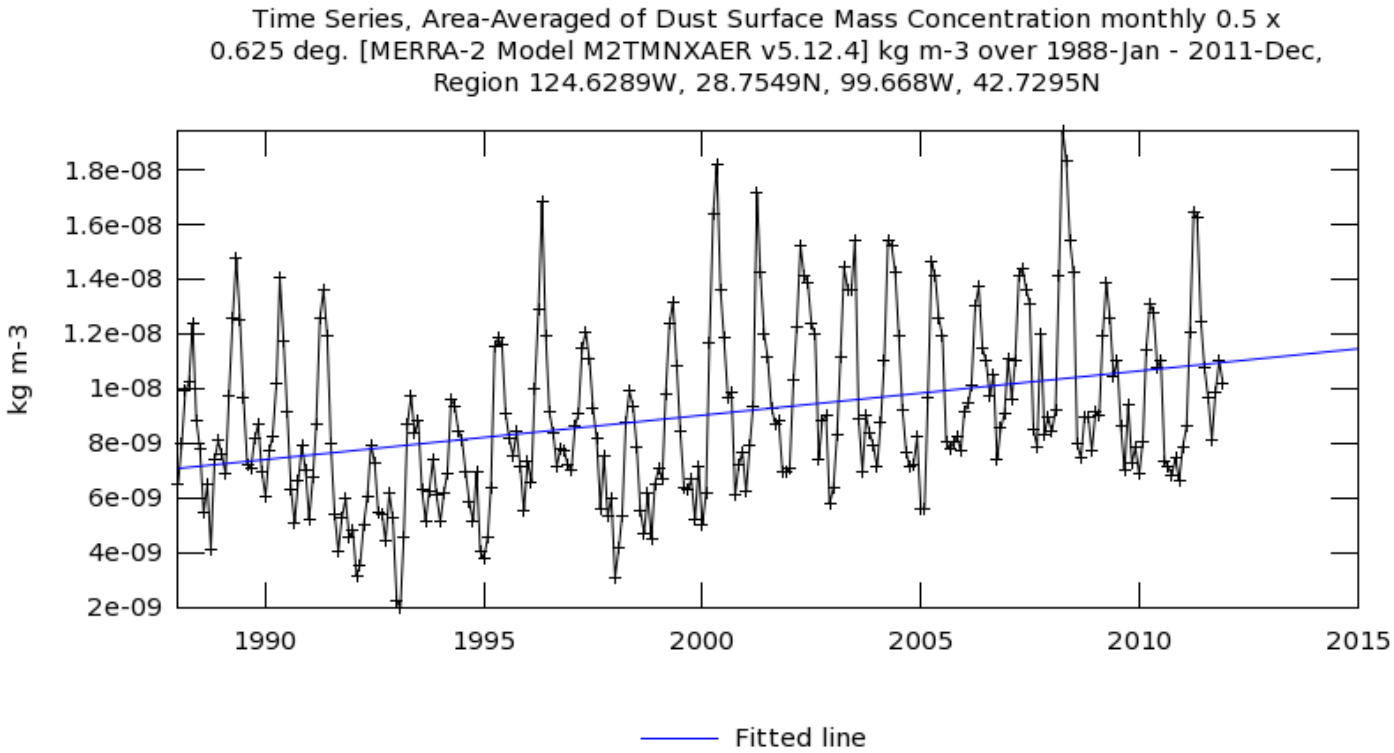
NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC), one of the 12 NASA data centers, is home to multidisciplinary data archives such as precipitation, hydrology, atmospheric chemistry, atmospheric dynamics.

- NLDAS (North American Land Data Assimilation System) datasets (1979 – present)
- MERRA-2 (Modern Era Retrospective-analysis for Research and Applications) datasets (1980 – present)
- *TRMM (Tropical Rainfall Measuring Mission) Multi-satellite Precipitation Analysis (1998 – present),*
- *Integrated Multi-satellitE Retrievals for GPM (IMERG) (2014 – present, soon 1998 – present)*

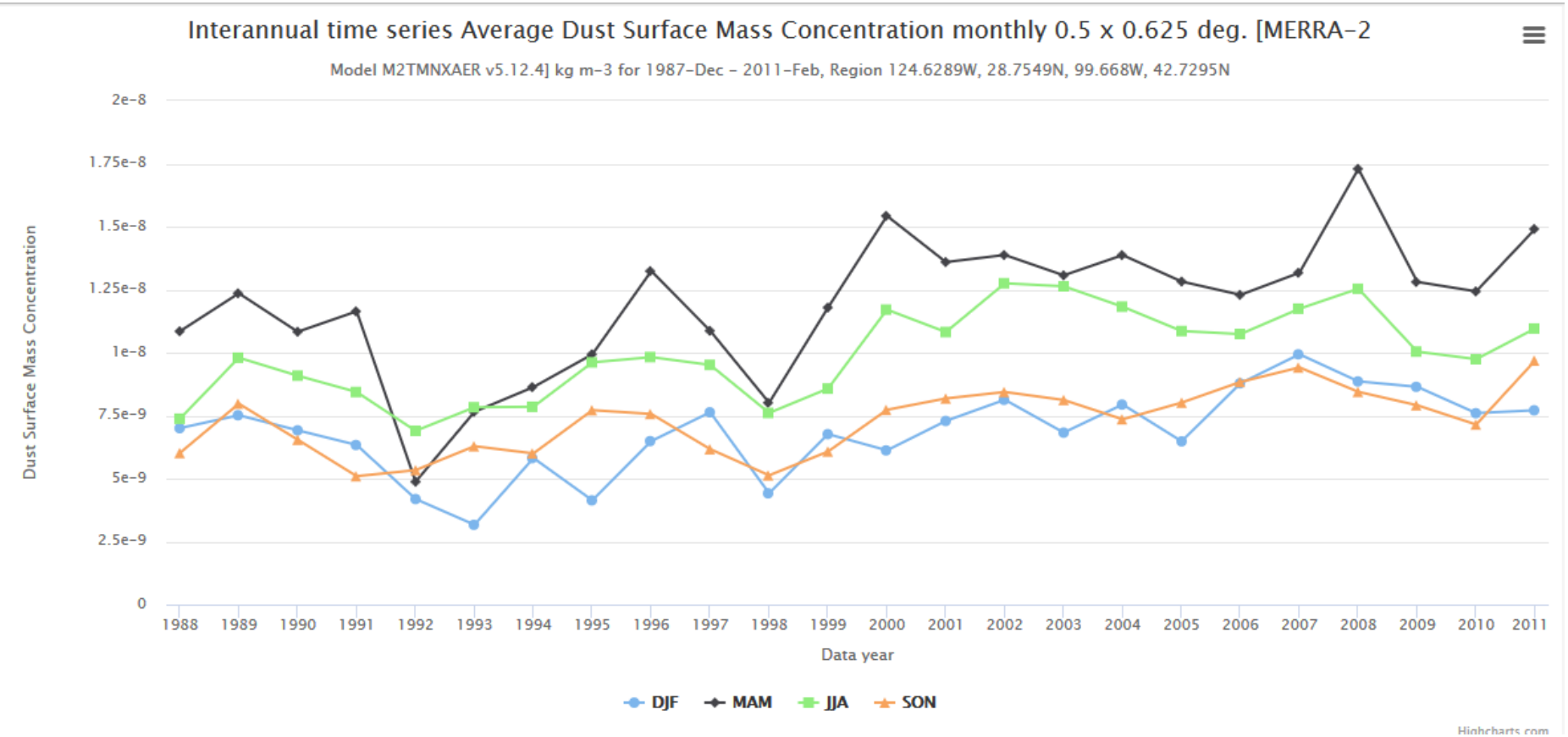
Surface Dust Time Series

- Surface dust mass concentration (MERRA2)

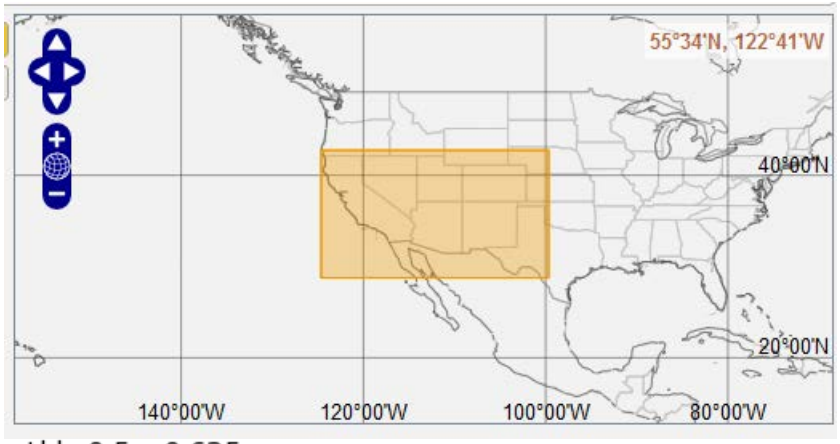




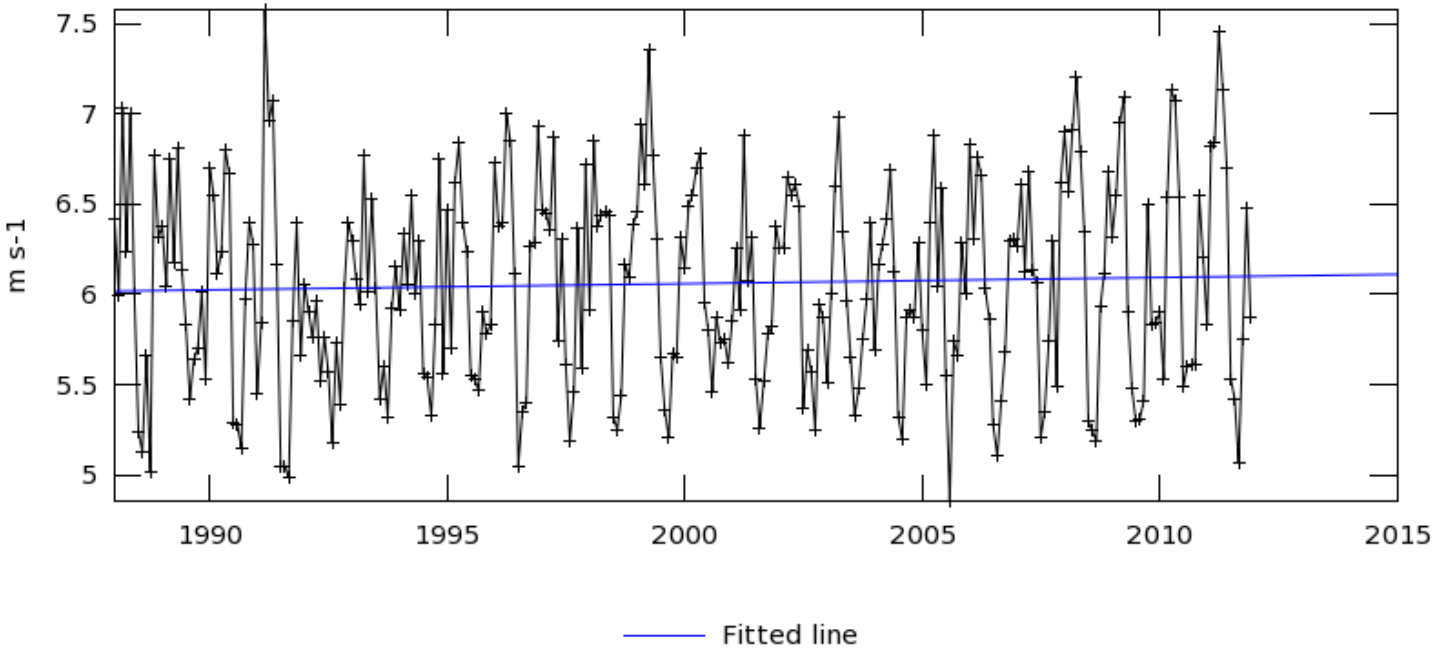
SFC Dust Time Series (cont.)



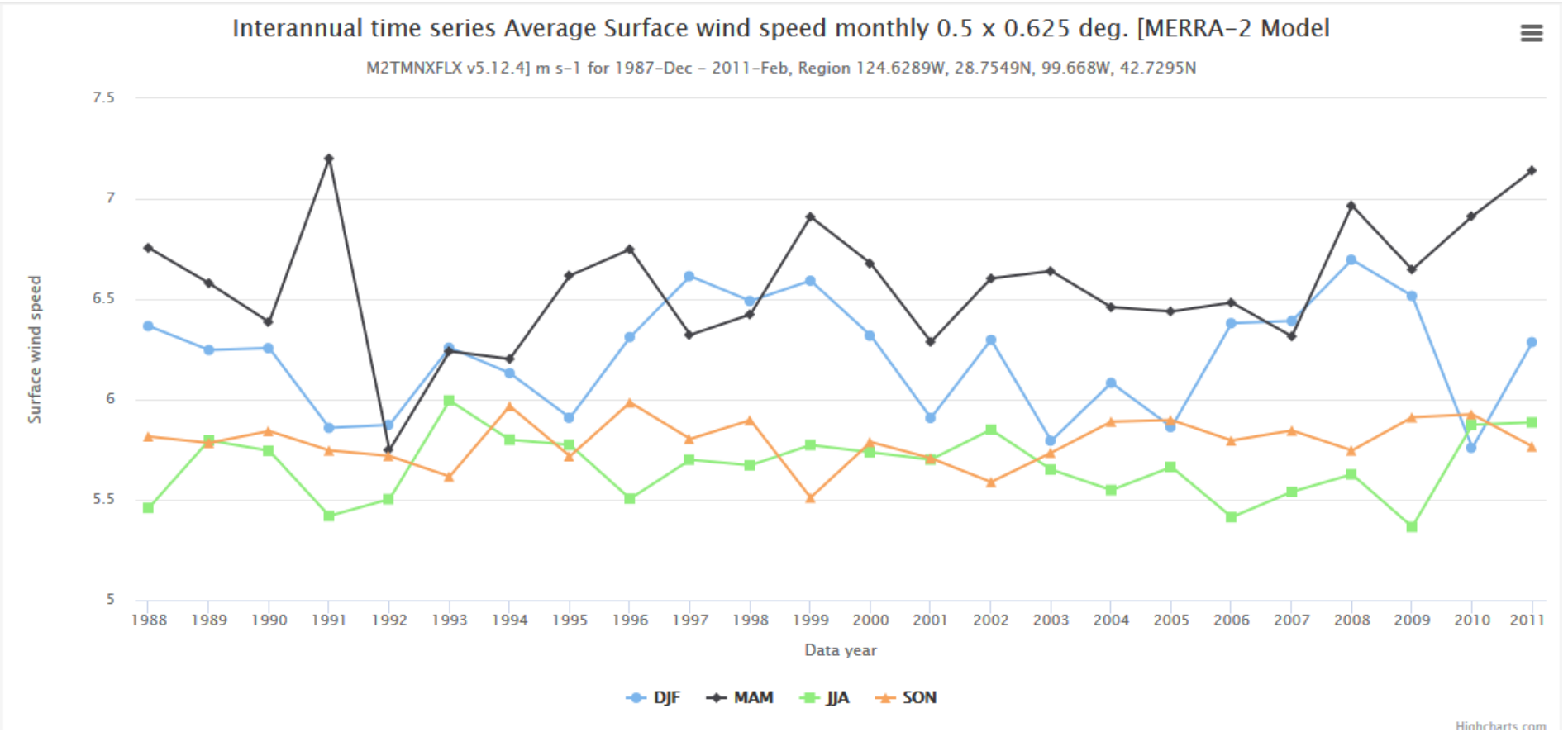
SFC Wind Speed Time Series



Time Series, Area-Averaged of Surface wind speed monthly 0.5 x 0.625 deg. [MERRA-2 Model M2TMNXFLX v5.12.4] m s-1 over 1988-Jan - 2011-Dec, Region 124.6289W, 28.7549N, 99.668W, 42.7295N

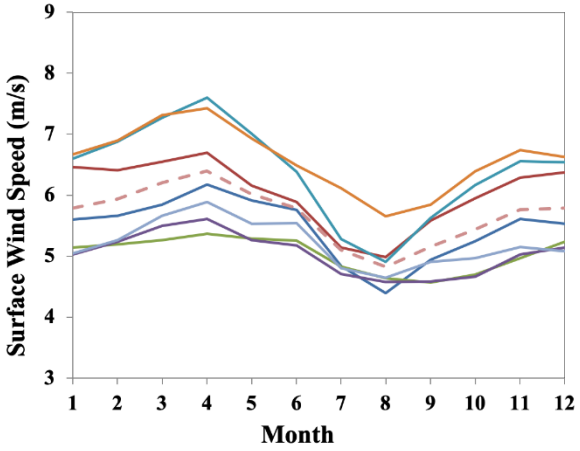


SFC Wind Speed Time Series (cont.)

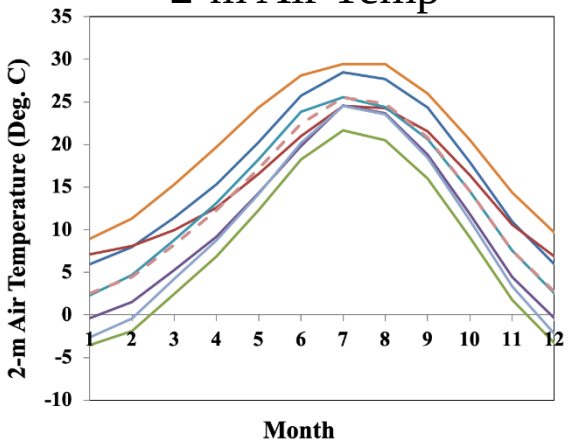


Hydrometeorological Conditions

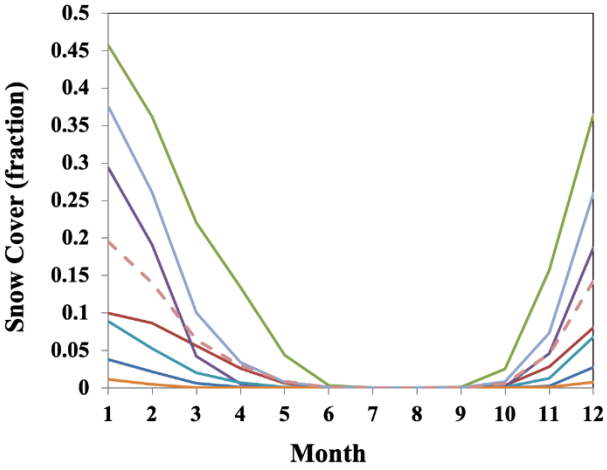
SFC Wind SP



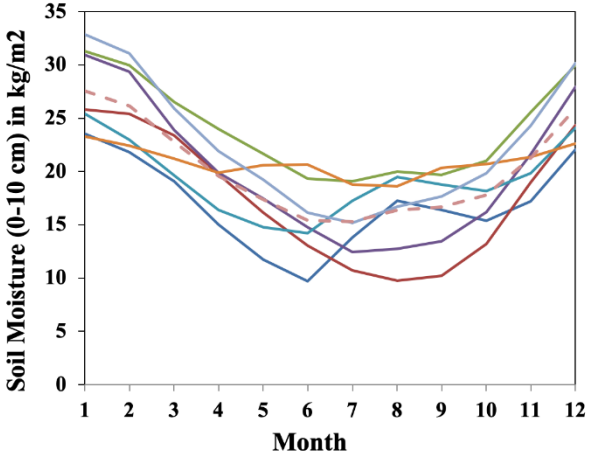
2-m Air Temp



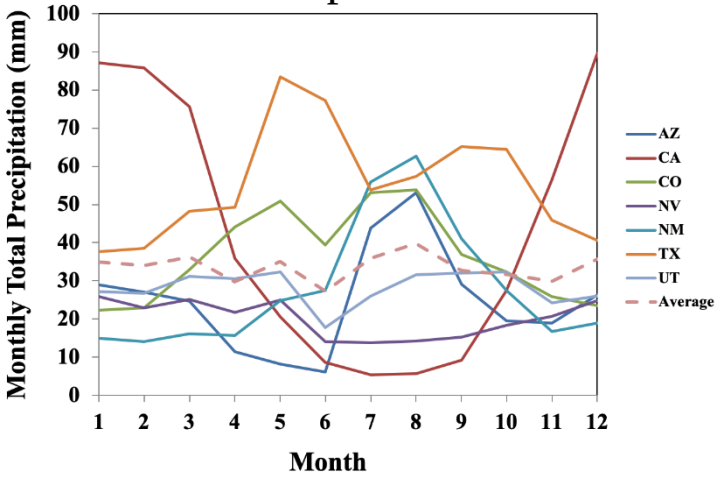
Snow Cover



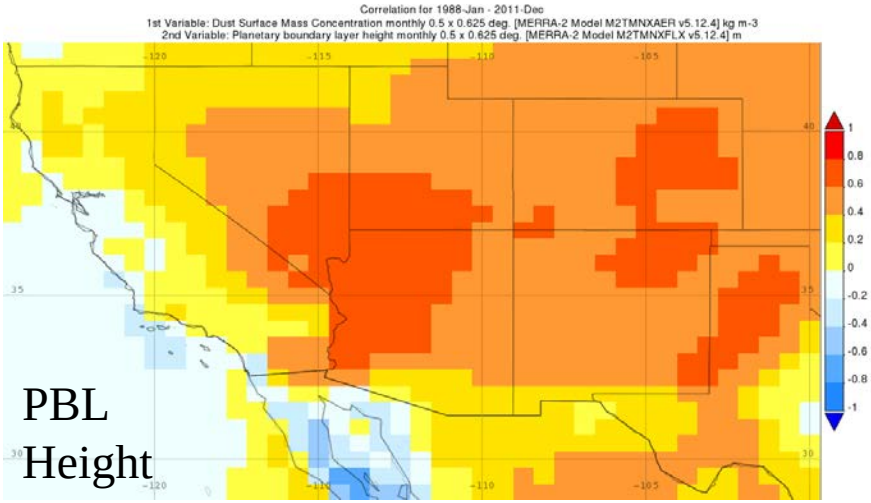
Soil Moisture



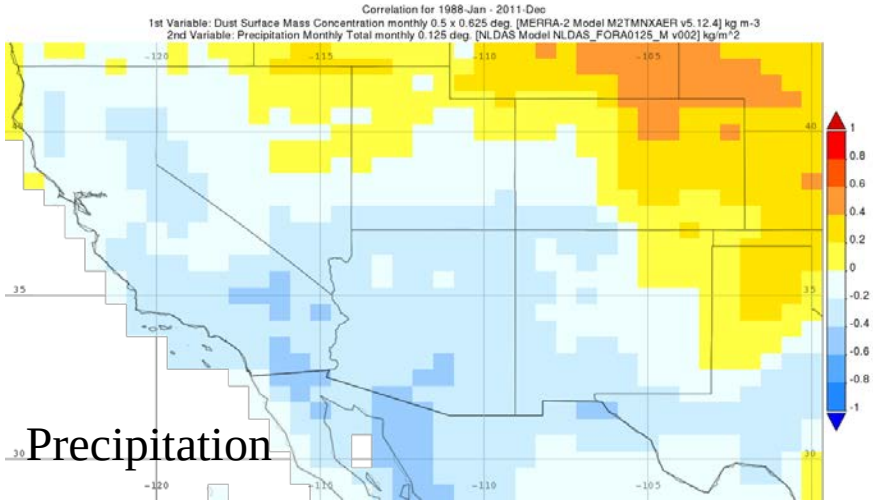
Precipitation



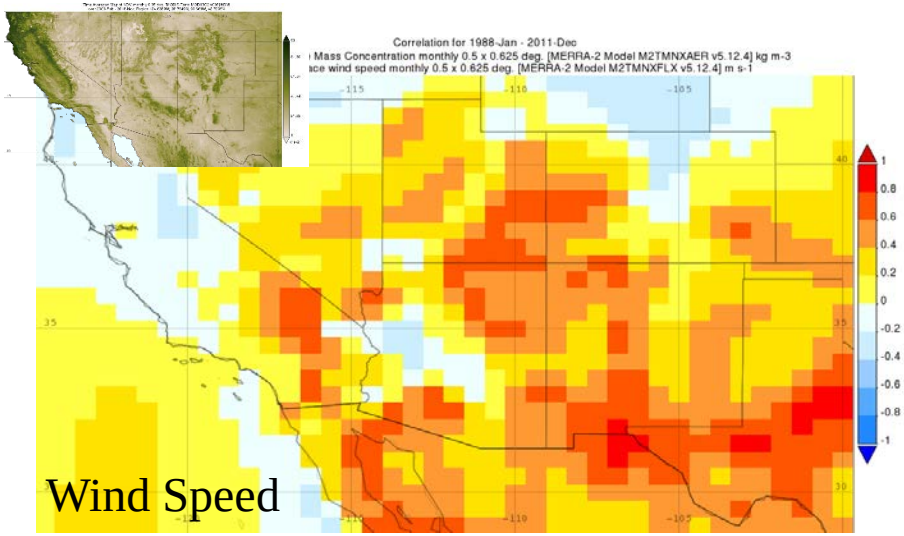
Correlation (PBL-H, P, Wind, SM)



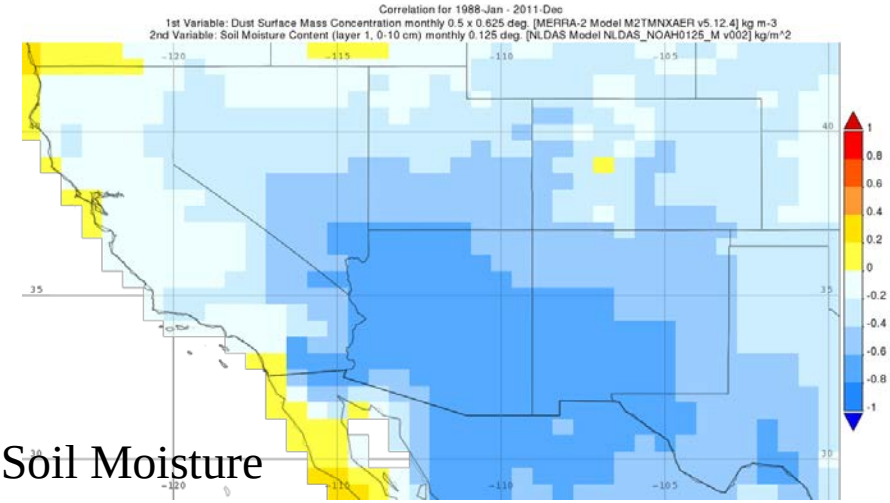
PBL Height



Precipitation

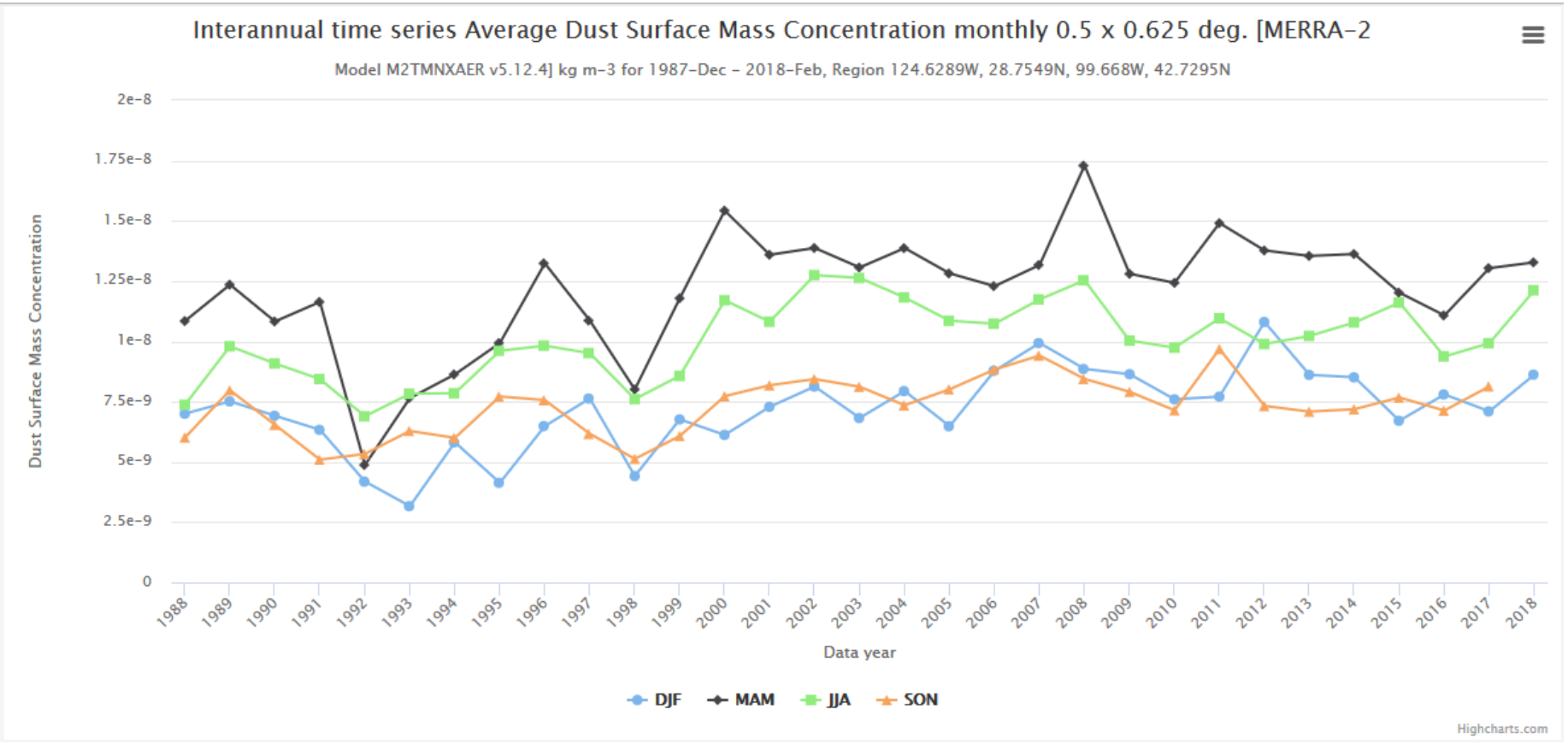


Wind Speed



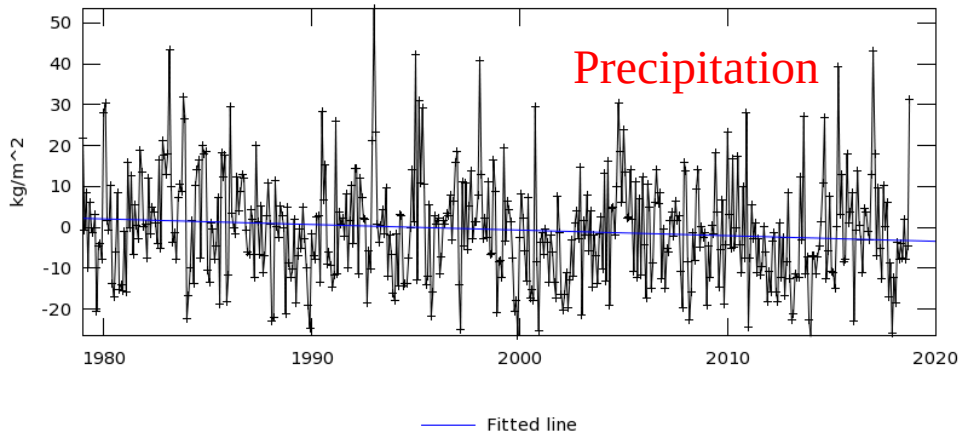
Soil Moisture

2010s

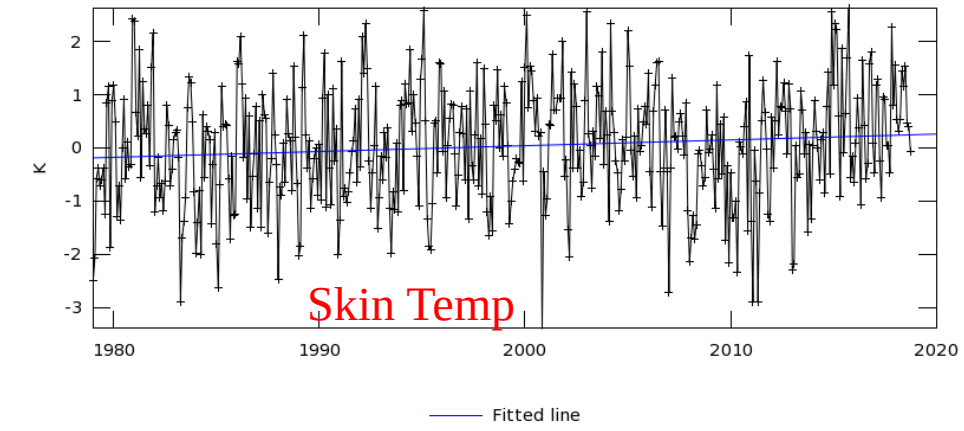

Interannual time series Average Dust Surface Mass Concentration monthly 0.5 x 0.625 deg. [MERRA-2
Model M2TMNXAER v5.12.4] kg m-3 for 1987-Dec - 2018-Feb, Region 124.6289W, 28.7549N, 99.668W, 42.7295N
Dust Surface Mass Concentration
2e-8
1.75e-8
1.5e-8
1.25e-8
1e-8
7.5e-9
5e-9
2.5e-9
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Data year
DJF
MAM
JJA
SON
Highcharts.com

2010s (cont.)

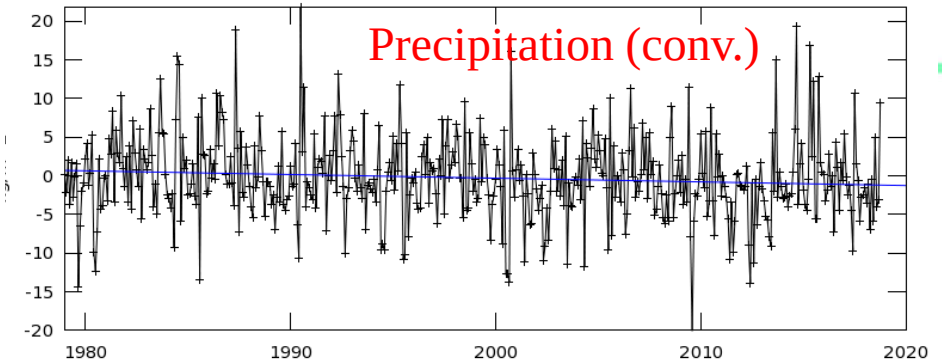
Time Series, Area-Averaged of Anomaly of Precipitation Monthly Total monthly 0.125 deg. [NLDAS Model NLDAS_FORA0125_MA v002] kg/m^2 over 1979-Jan - 2018-Oct, Region 124.6289W, 28.7549N, 99.668W, 42.7295N



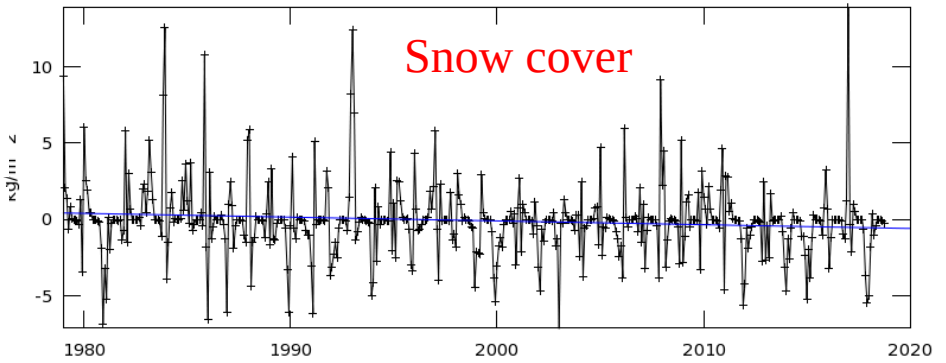
Time Series, Area-Averaged of Anomaly of Temperature (average surface skin) monthly 0.125 deg. [NLDAS Model NLDAS_NOAH0125_MA v002] K over 1979-Jan - 2018-Oct, Region 124.6289W, 28.7549N, 99.668W, 42.7295N



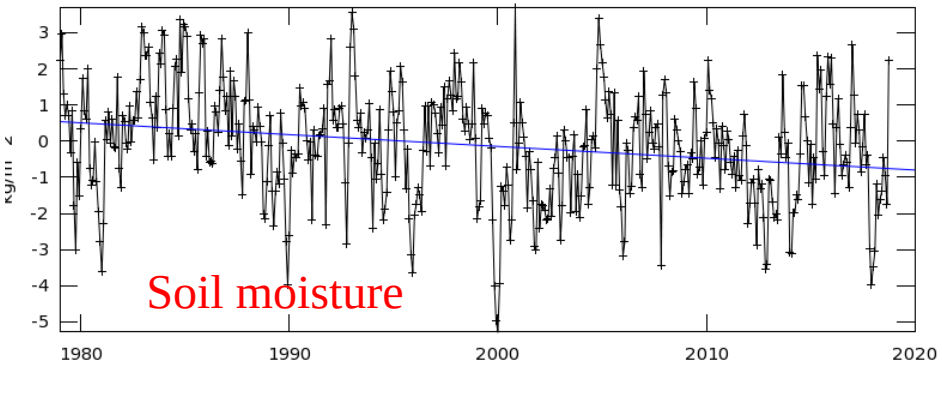
Time Series, Area-Averaged of Anomaly of Convective Precipitation Monthly Total monthly 0.125 deg. [NLDAS Model NLDAS_FORA0125_MA v002] kg/m^2 over 1979-Jan - 2018-Oct, Region 124.6289W, 28.7549N, 99.668W, 42.7295N



Time Series, Area-Averaged of Anomaly of Snowfall (frozen precipitation) monthly 0.125 deg. [NLDAS Model NLDAS_NOAH0125_MA v002] kg/m^2 over 1979-Jan - 2018-Oct, Region 124.6289W, 28.7549N, 99.668W, 42.7295N

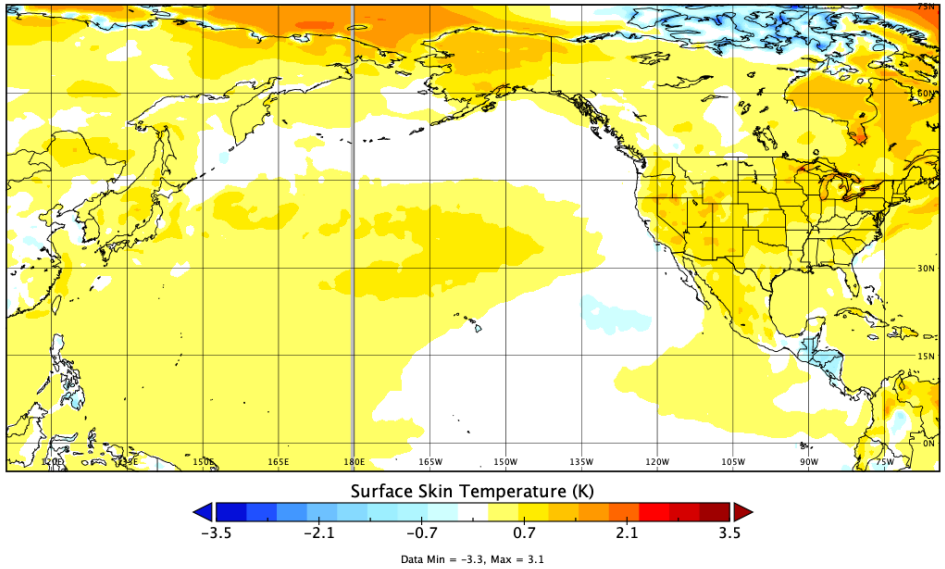


Time Series, Area-Averaged of Anomaly of Soil moisture content (layer 1, 0-10 cm) monthly 0.125 deg. [NLDAS Model NLDAS_NOAH0125_MA v002] kg/m^2 over 1979-Jan - 2018-Oct, Region 124.6289W, 28.7549N, 99.668W, 42.7295N

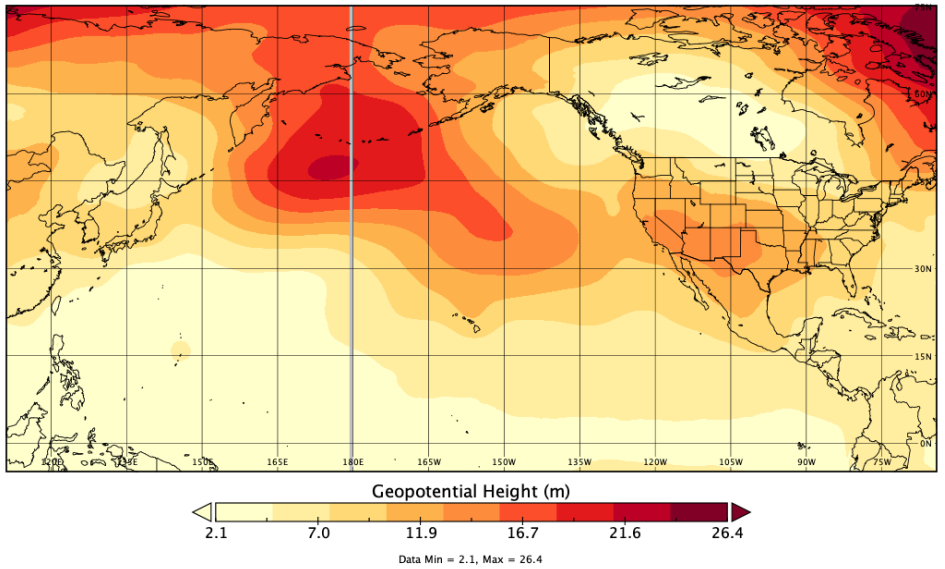


2010s (cont.)

Surface skin temperature diff (2000s – 2010s) – (1980s – 1990s)



Geopotential Height Diff. (2000s – 2010s) – (1980s – 1990s)



Summary and Future Plans

- Hydrometeorological conditions play an important role in dust events.
- Winds are not the only factor.
- Drier conditions in the SW United States and higher levels of surface dust concentration in 2000s and 2010s, compared to 1980s and 1990s.
- Further understand the connection between hydrometeorological conditions and dust events at local scale.
- Further understand the large-scale environment and its connection to dust activities.
- Include ground dust observations in the analysis.

References

- Tong, D. Q., Wang, J. X. L., Gill, T. E., Lei, H., & Wang, B. (2017). Intensified dust storm activity and Valley fever infection in the southwestern United States. *Geophysical Research Letters*, 44(9), 4304–4312. https://doi.org/10.1002/2017GL073524
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