

Trends in water, wind and solar resources over recent decades and connections with climate forcings and variability

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# Background

- Renewable energy (esp. wind and solar) is increasing rapidly
- Most forms of renewable energy vary based on weather/climate
- Appropriate forecasts are valuable, can assist with integrating renewable energy into elec grid, deploying storage and demand management
- Short-term (minute to day ahead) solar and wind forecasts are well established, longer-term forecasts not yet

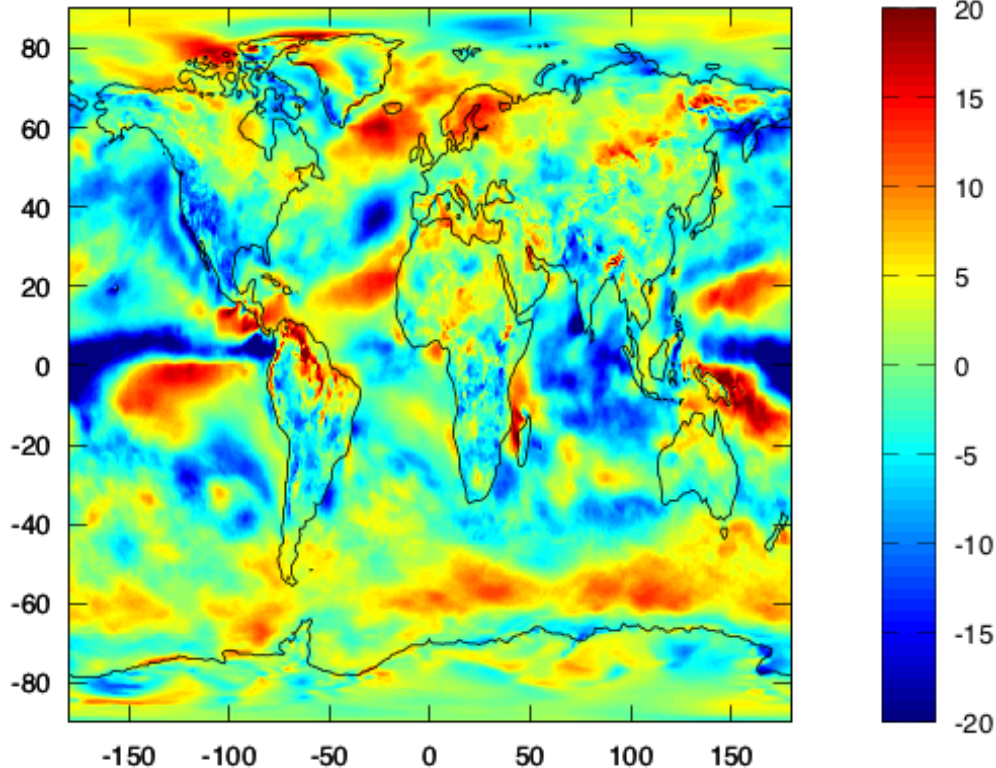
# Basic research questions

- How much do near-surface wind/solar vary over longer timescales (e.g. months)?
- What aspects of climate correlate with substantially more or less wind/sun than normal over a particular region?
- Based on these climate associations, how far ahead can we forecast wind/sun variability?

# Case study: 2015 wind drought

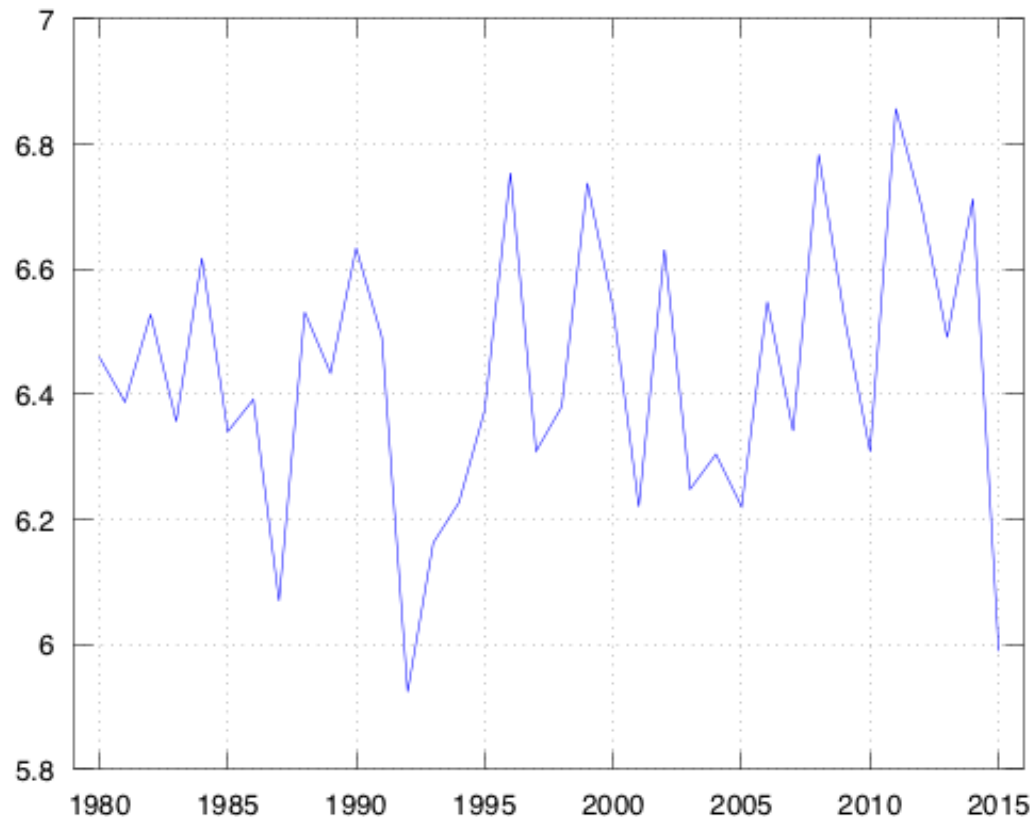
- In Jan-Jun 2015, California, Oregon, Texas, and Washington reported their lowest recorded wind speeds in more than 30 years
- Wind power generation (~10% of total electricity in those states) plummeted as result

# Wind in 2015 H1



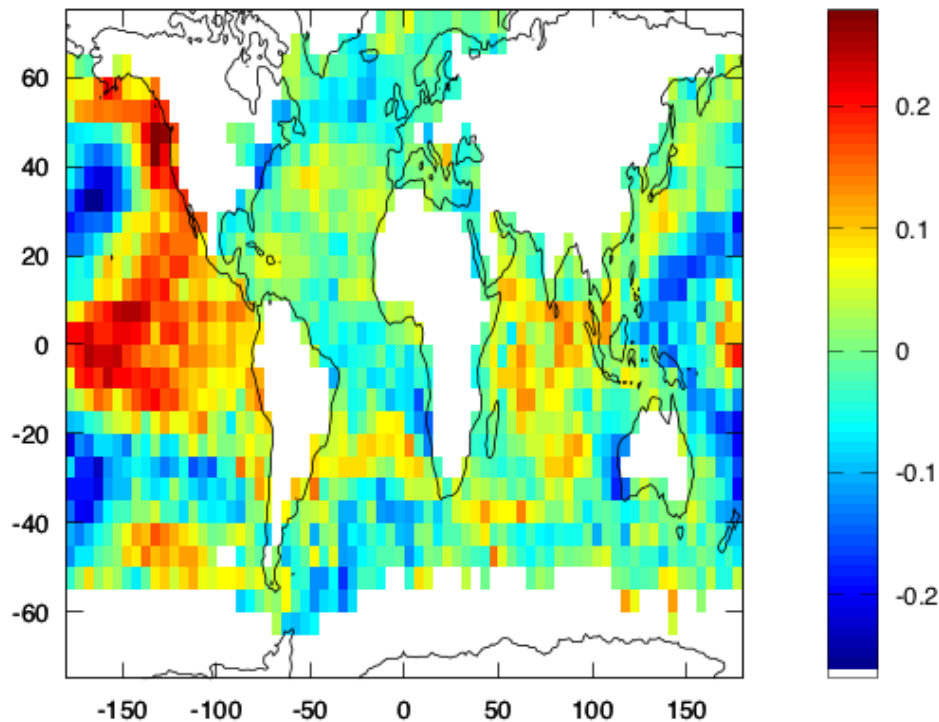
- MERRA-2 reanalysis (NASA), 0.5° resolution, estimates hourly/monthly weather since 1980
- 10-m height windspeed % departure from 1980-2014 average

# Western US H1 wind by year



- MERRA-2 average over  $90^{\circ}$ - $120^{\circ}$  W,  $30^{\circ}$ - $45^{\circ}$  N
- 10-m height windspeed (m/s)
- 2015 was one of the least windy since 1980, along with 1987 and 1992; windspeed down  $\sim 10\%$  from past few years

# How does W US wind relate to sea surface temperature?



- Monthly SST from Hadley Centre compilation of observations ( $5^\circ$  resolution)
- -Correlation coefficient of SST at each location with  $90^\circ$ - $120^\circ$  W,  $30^\circ$ - $45^\circ$  N monthly average windspeed anomaly
- Low windspeed in

# Next steps

- How well can we forecast wind and solar variability 1-3 months in advance, given their connections with SST and atmospheric circulation patterns?
  - NMME (North American Multi-Model Ensemble), coordinated by NOAA, provides monthly forecast fields of SST and other variables (but not wind/solar output directly) from different climate models



# Thanks!

- Questions?