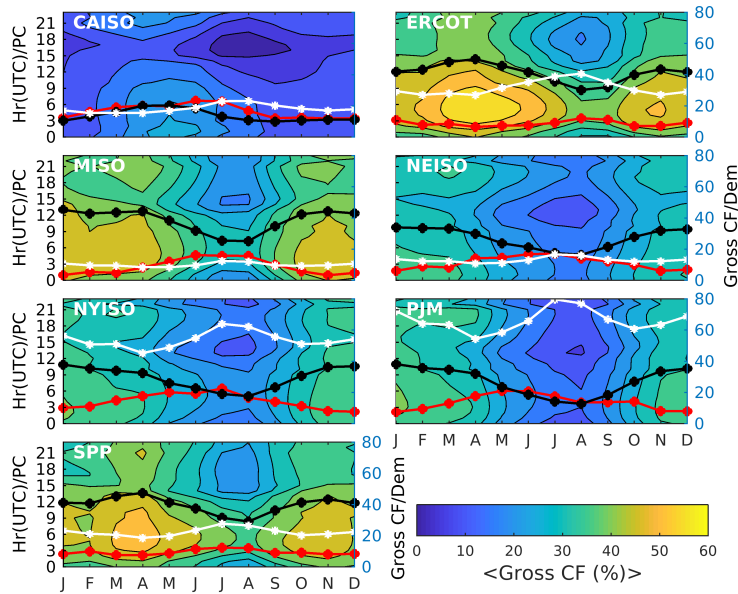


# Variability in Wind Power Generation



Seasonal and diurnal variability in gross capacity factors (CF, i.e. efficiency of electrical power production) from wind turbines in each ISO (color). Also shown are: (1) Monthly mean CF (black line, right axis). (2) Probability (in %) that a hour within a given calendar month will be part of a sequence of > 5 hours duration when the gross CF is < 20% (labeled PC, red line, left axis). (3) Mean monthly electricity demand (Dem, in million MWh) in each ISO (white line, right axis).

Pryor S.C., Letson F.W. and Barthelmie R.J. (2020): Variability in wind energy generation across the contiguous USA. *Journal of Applied Meteorology and Climatology* 59 2021-2039. DOI: 10.1175/JAMC-D-20-0162.1

## Scientific Achievement

This research quantifies the relative importance of fundamental time scales (hourly, daily, synoptic, seasonal and interannual) of wind generated electricity within the major Independent System Operators (ISOs), along with the relative frequency of low generation or ramp events with rapid declines in generation for the current wind turbine fleet. It further identifies optimal strategies for capacity expansion to reduce the probability and/or duration of such events.

## Significance and Impact

Renewable energy sources exhibit intermittency due to the geophysical drivers of the resource. Understanding the magnitudes and time scales of intermittency aids planning of grid integration and optimized expansion of wind energy electricity generation. This research quantifies key aspects of electricity generation from wind in the major ISOs and presents projections of how best to expand generation capacity to reduce intermittency.

## Research Details

This analysis employs 40 years of hourly ERA5 reanalysis output, realistic wind turbine power generation curves and verification data from the ISOs along with geospatial and time series analysis tools.

