

# Probabilistic Resource Adequacy Assessment: Extreme Weather Implications



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# What is Resource Adequacy (RA)?



**“A condition in which ... in aggregate, utilities or other load serving entities (LSE) have acquired sufficient resources to satisfy forecasted future loads reliably.”**

– Northwest Power and Conservation Council

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**“reliable”:** defined in terms of some adequacy or risk metric (e.g. planning reserve margin, LOLE)

# What is Probabilistic RA?



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- > attempt to study a comprehensive (or at least representative) set of possible system operating conditions, and quantify the likelihood of those conditions occurring
- > yield descriptive statistics for the distribution of possible outcomes (e.g. LOLE, EUE)
- > aren't usually intended to study system adequacy under a predetermined scenario or event ("conditional" resource adequacy), although the same modeling tools can often be used for that purpose

# Elements of Probabilistic RA



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# Typical probabilistic RA analysis



**Traditional generator outages are easy to model probabilistically**

- > Been doing this for 60+ years now

# Typical probabilistic RA analysis



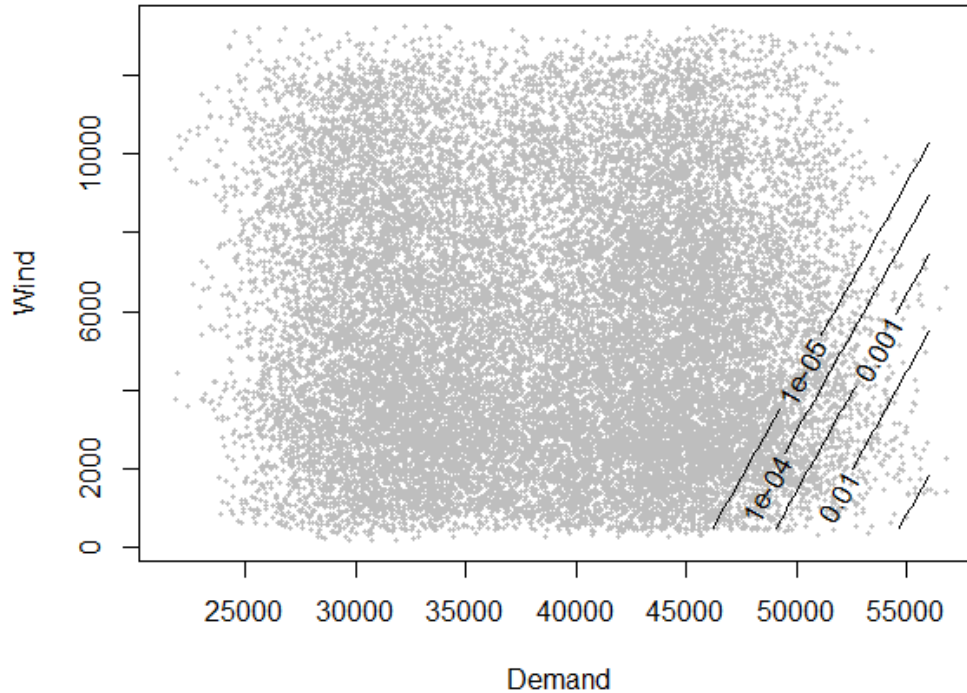
## **Traditional generator outages are easy to model probabilistically**

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## **Load and variable resources are hard to model probabilistically**

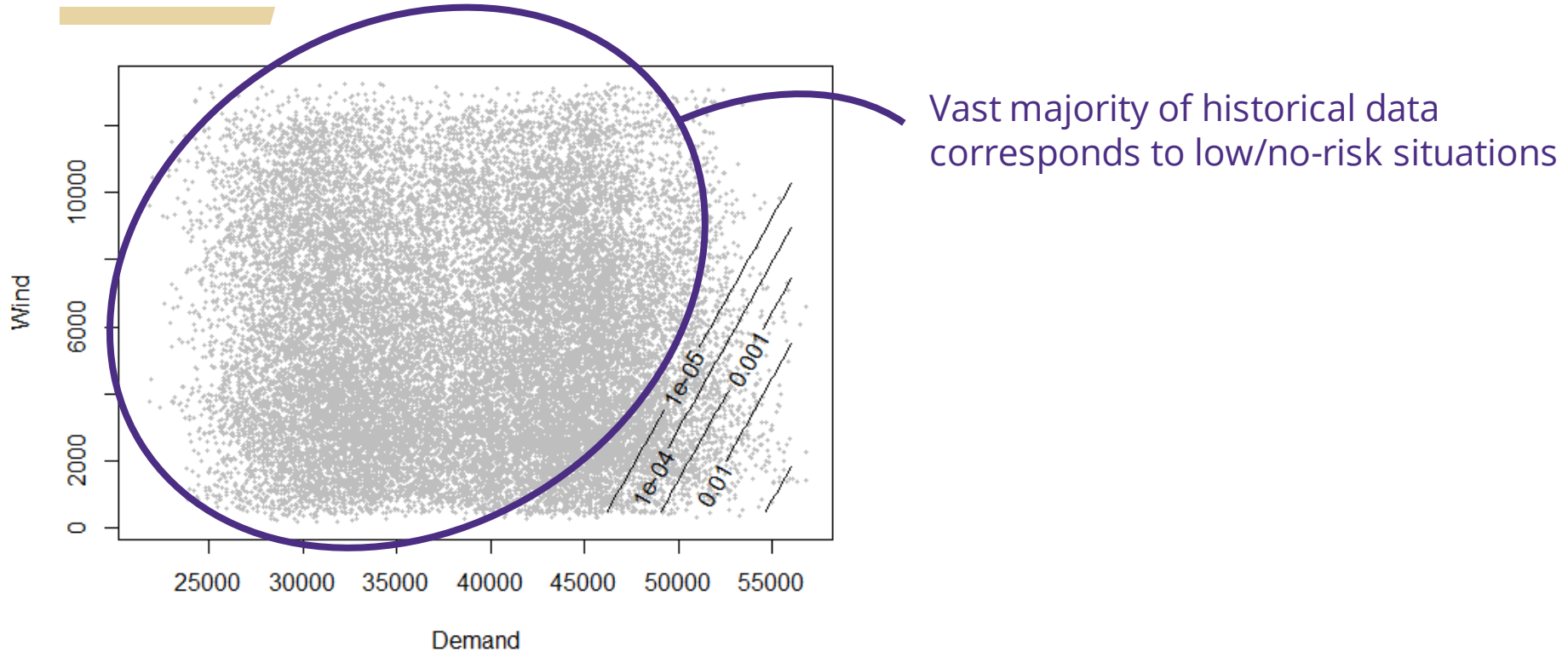
- > Need serially-correlated, hourly probabilistic forecasts, years or decades in advance (!)
- > Typical approach: assume future resembles historical load + weather
  - Pros: simple, transparent
  - Cons: limited data available (especially for risky periods of interest)

# Typical probabilistic RA analysis



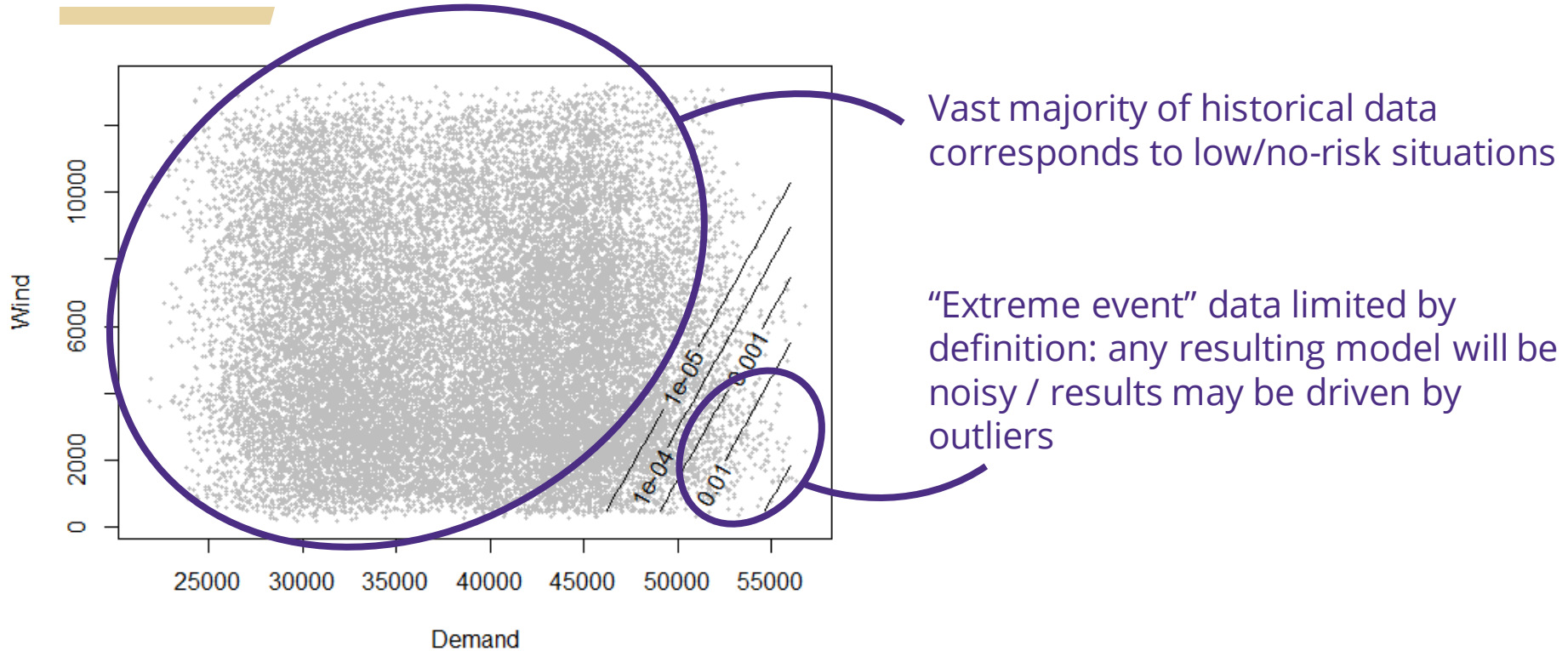
Wilson and Zachary, "Using extreme value theory for the estimation of risk metrics for capacity adequacy assessment", 2019. <https://arxiv.org/abs/1907.13050>

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# Potential solutions



## Just use more historical data

- > Useful for capturing interannual variability
- > Difficult to normalize for load growth / shifts in underlying consumption patterns

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## **Fit a statistical time series model**

- > Can draw unlimited samples!
- > Lots of new and likely-subjective assumptions involved
- > Model is still only as good as the (limited) training data

# Potential solutions



## Extrapolate tail events via Extreme Value Theory

- > Same shortcomings as any other statistical model
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## **Communicate uncertainty arising from data limitations**

- > If there's no easy fix, at least be transparent about the problem
- > Statistical bootstrap methods can help quantify potential impact of limited event data

# Elements of Probabilistic RA



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# Risk Metrics



## **Popular RA risk metrics are based on expected outcomes**

- > LOLE: Average total count of periods with dropped load
- > EUE: Average unserved energy
- > Extreme events considered, but impacts are attenuated due to lower likelihood of occurrence

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## Do we only care about “average” outcomes?

- > “How bad could it get” seems like a reasonable question to ask
- > Should we also be using tail metrics such as CVaR (expected value in worst x% of outcomes)?

# Conclusion

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# Conclusion

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- > **Lack of data around extreme weather events makes probabilistic RA assessment hard**
- > **We need to improve extreme event characterization in RA models**
- > **We need to quantify the potential impacts of our data limitations**
- > **We should consider RA metrics that communicate the possibility of extreme events**

# Stay in touch!



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