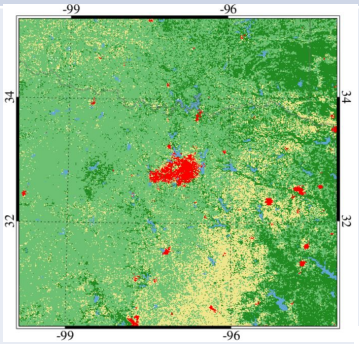
I-WRF Science Use Cases: 1= Complete, 2 = major progress, 3 = ramping up

1. Land Use/Land Cover (LULC) Δ

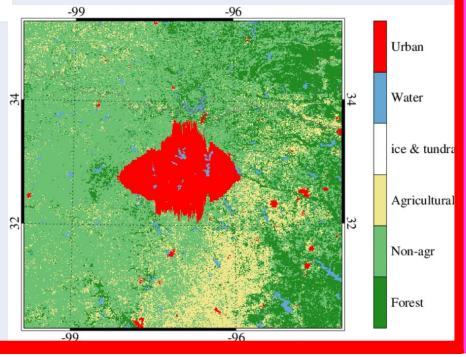
Perturbation exp. to examine urban feedback to deep convection.

- WRF. Compute demand: Modest. Short duration (days), high res. (dx ~ 1.3 km), multiple perturbations & physics settings.
- WRF (multi-node), MET-plus (1-node)



DFW
v
DFW×8

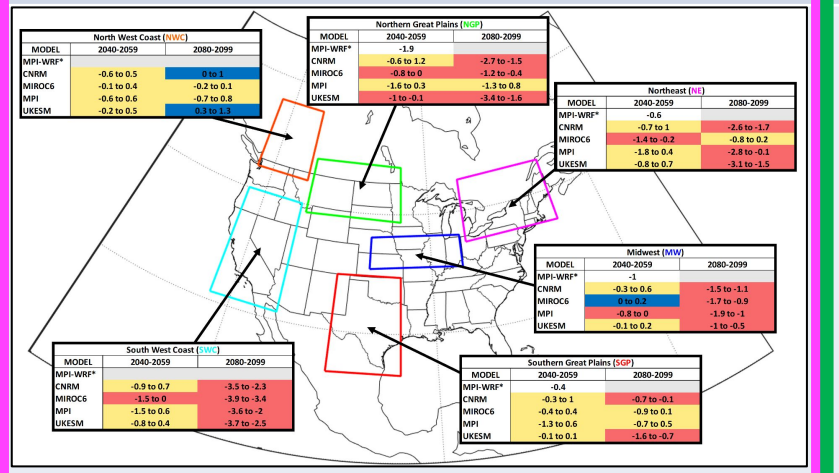
Zhou et al. (2024): *JGR* **129** 2023JD039972



2. Climate science & Renewable energy

Uniquely detailed resource projections for solar & wind under climate change.

- WRF. Compute demand: Large (many nodes). Long duration (multiple years/decades), moderate resolution (dx ~ 4 km)
- To increase IMPACT joined WCRP-CORDEX …..

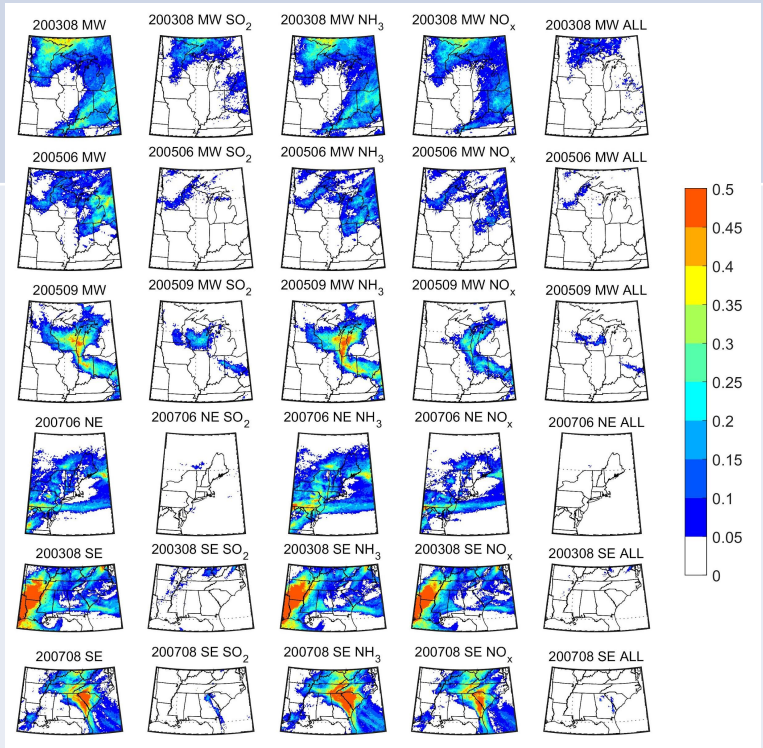


Coburn & Pryor (2023): *JAMC* **62** 81-101

3. Air quality in an evolving climate

Detailed simulations of interplay between emission changes, LULC change & climate evolution.

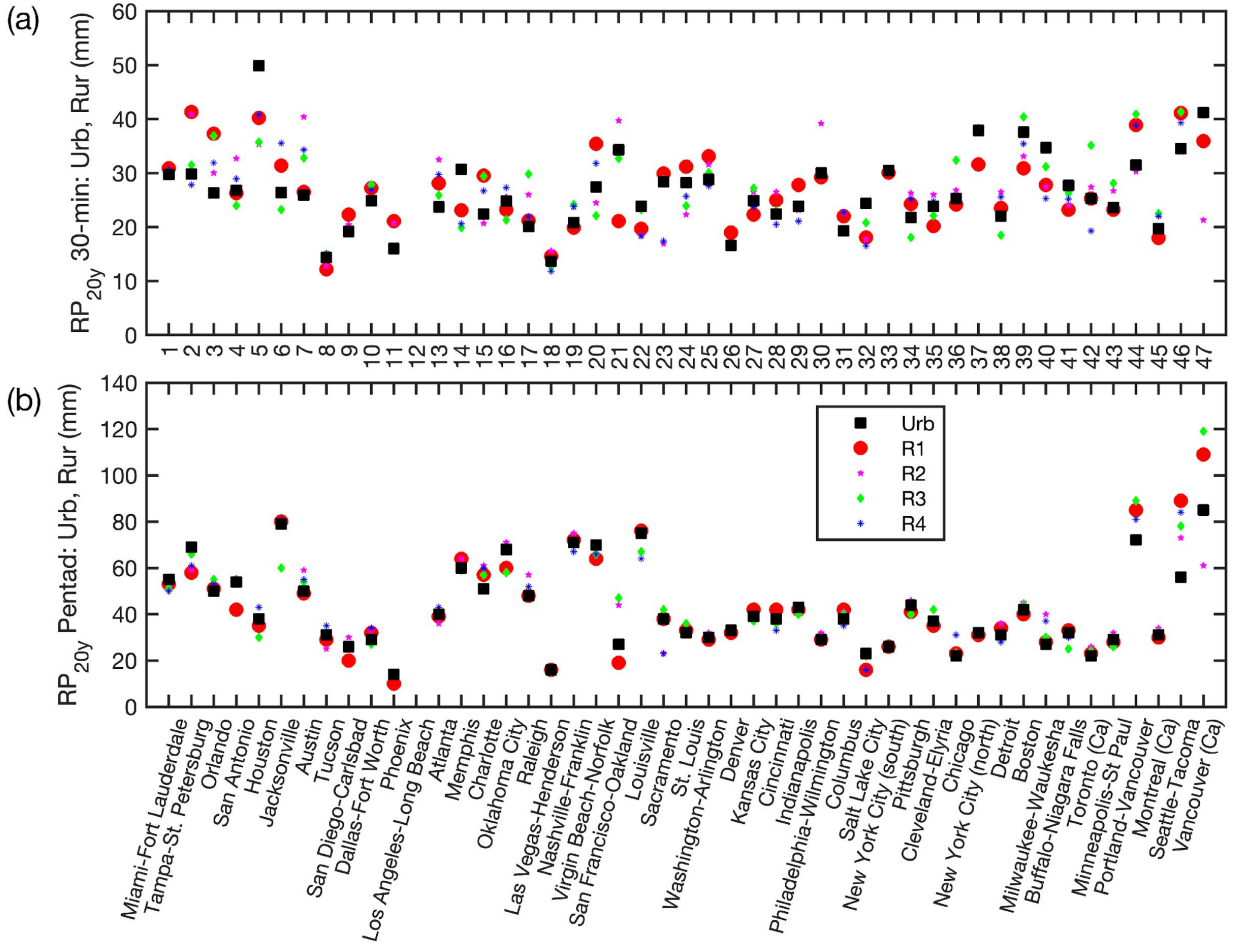
- WRF-Chem (1st time containerized). Compute complexity = high.



Guo et al. (2021): *JGR* **126** e2020JD033759

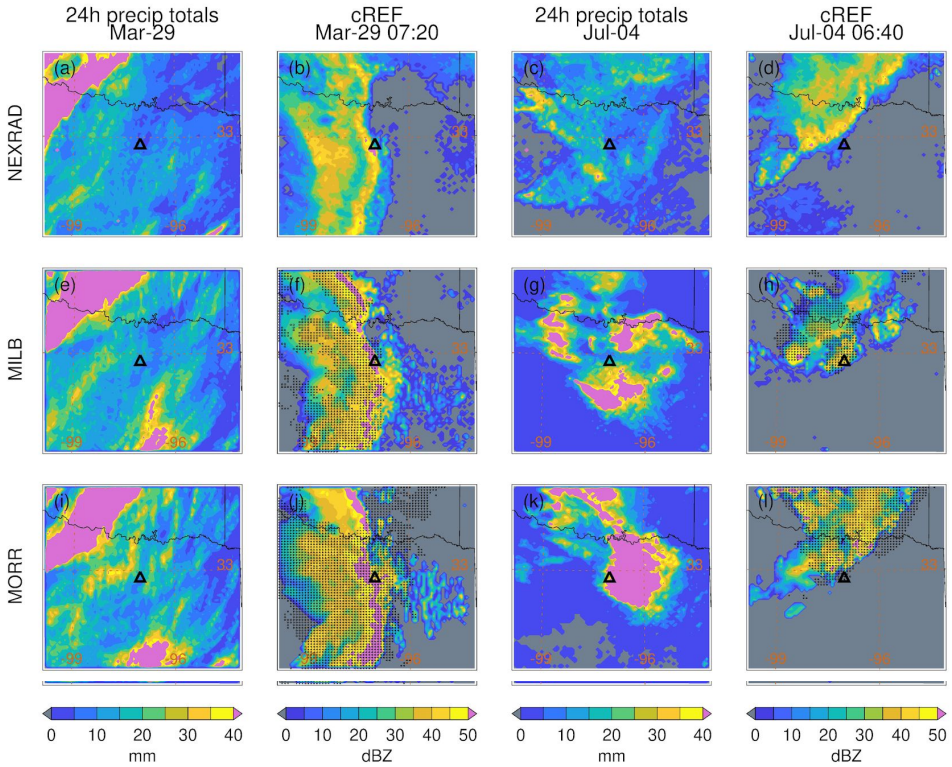
I-WRF: Science Use Case #1: Why?

- Urbanization a global trend
- SOME research has indicated urban areas intensify deep convection… but not uniform & MECHANISTIC information hard to extract from observations & models allow ‘what-if’ scenarios…
- Societal impact: urban flooding (NY declared state of emergency 31 July 2025)



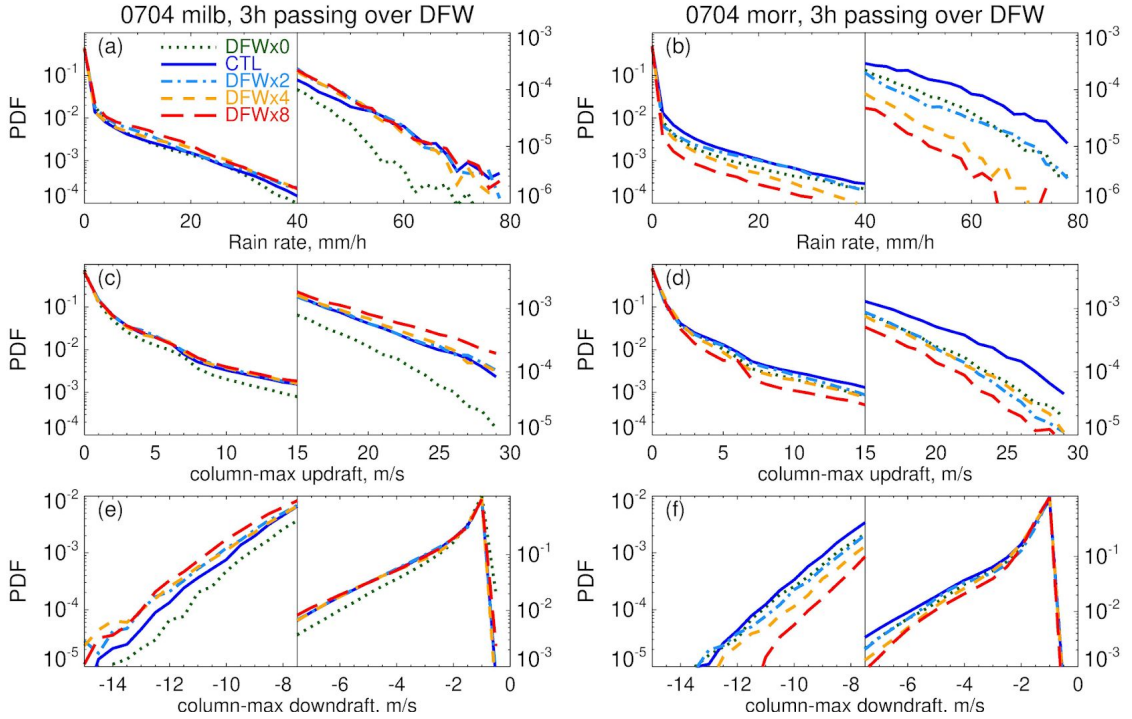
I-WRF: Science Use Case #1: Dallas Fort Worth

- Control simulations (DFW as is): Highest fidelity for MORR & MILB.



Zhou et al. (2024): *JGR* **129** 2023JD039972

- Perturbation experiments: Sign of responses to removal/expansion of DFW = f (MP scheme)



  - May explain divergent responses past LULC pert. exp. that have typically used only one MP

- **Basis of the LULC demo in container.**

I-WRF: Science Use Case #2

- What is CORDEX?
  - WCRP: Coordinated Regional Climate Downscaling Experiment https://cordex.org/
  - Why join?
    - To provision climate projections to wide audience. **("CORDEX" yields >31,000 hits on google scholar!)**
- WRF simulations (1960-1999 & 2040-2079) SSP585, LBC: MPI-ESM)
  - D01 (663 x 630): dx = 12km: NA-CORDEX
  - D02 (1369 x 898): dx = 4km: CONUS selected years to examine resolution effects & enhance fidelity of variables with high spatial variability
    - Milbrandt-Yau microphysics (double-moment)
    - MYNN PBL with EDMF (shallow convection)
    - RRTMG LW/SW (with solar irradiance partitioning)
    - Noah-MP (versatile treatments of surface properties)
    - Time varying SST & AOD
    - Nudging above PBL

WCRP
World Climate Research Programme

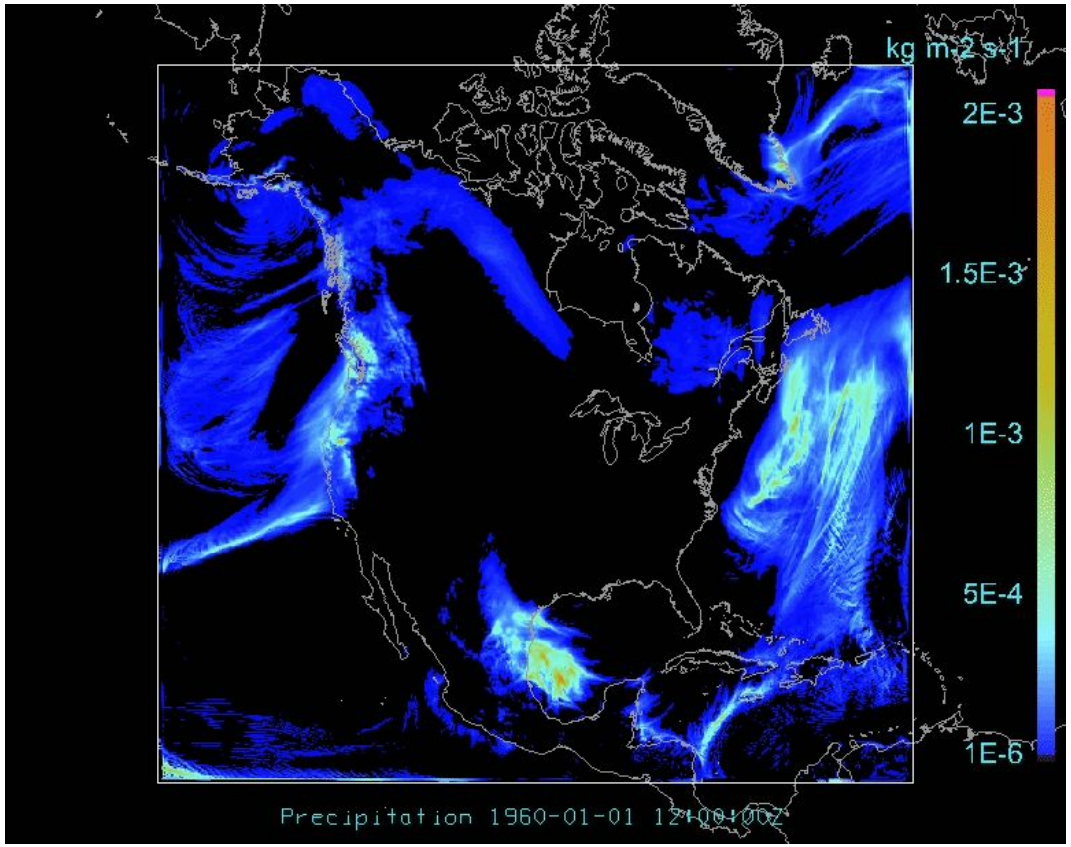
Status	NA-CORDEX	CONUS
Historical	40 years	Pending
Future	33 years	Pending

I WRF

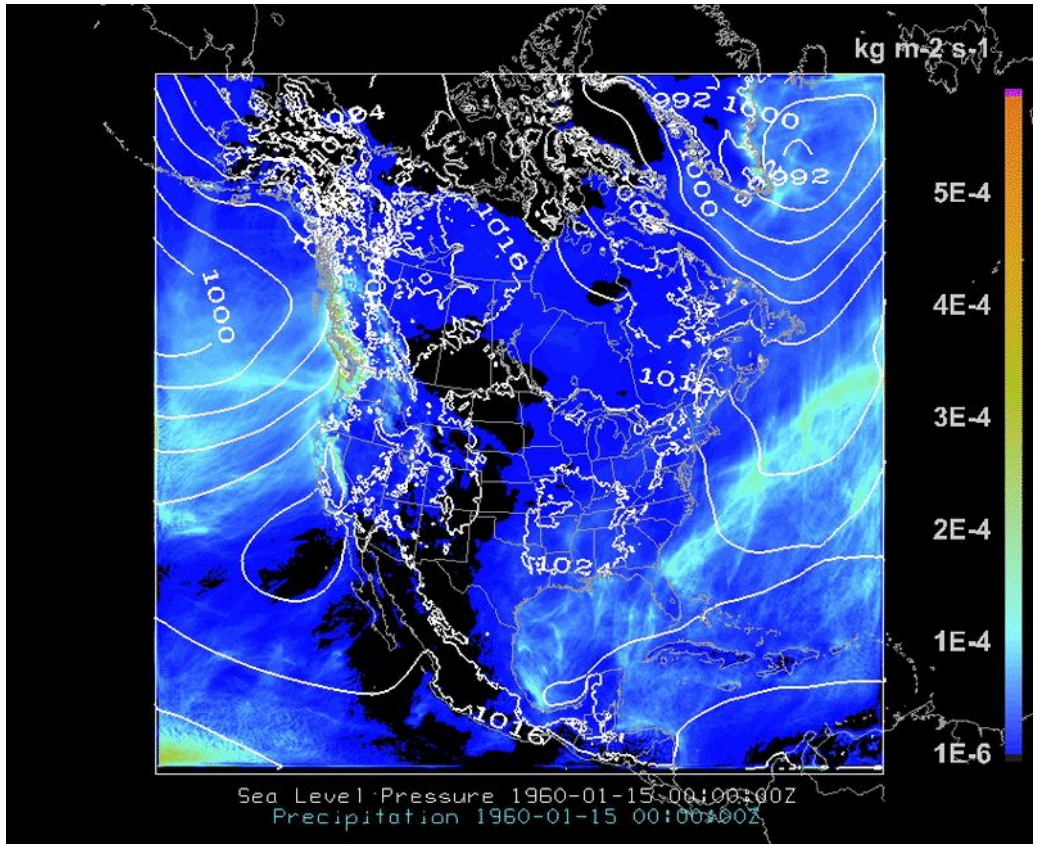
I-WRF: Science Use Case #2: CORDEX simulations

- 46TB of output for 96 variables at various temporal resolutions.
- Globally available via NCAR-GDEX & possibly ESGF

Daily Rain Rate

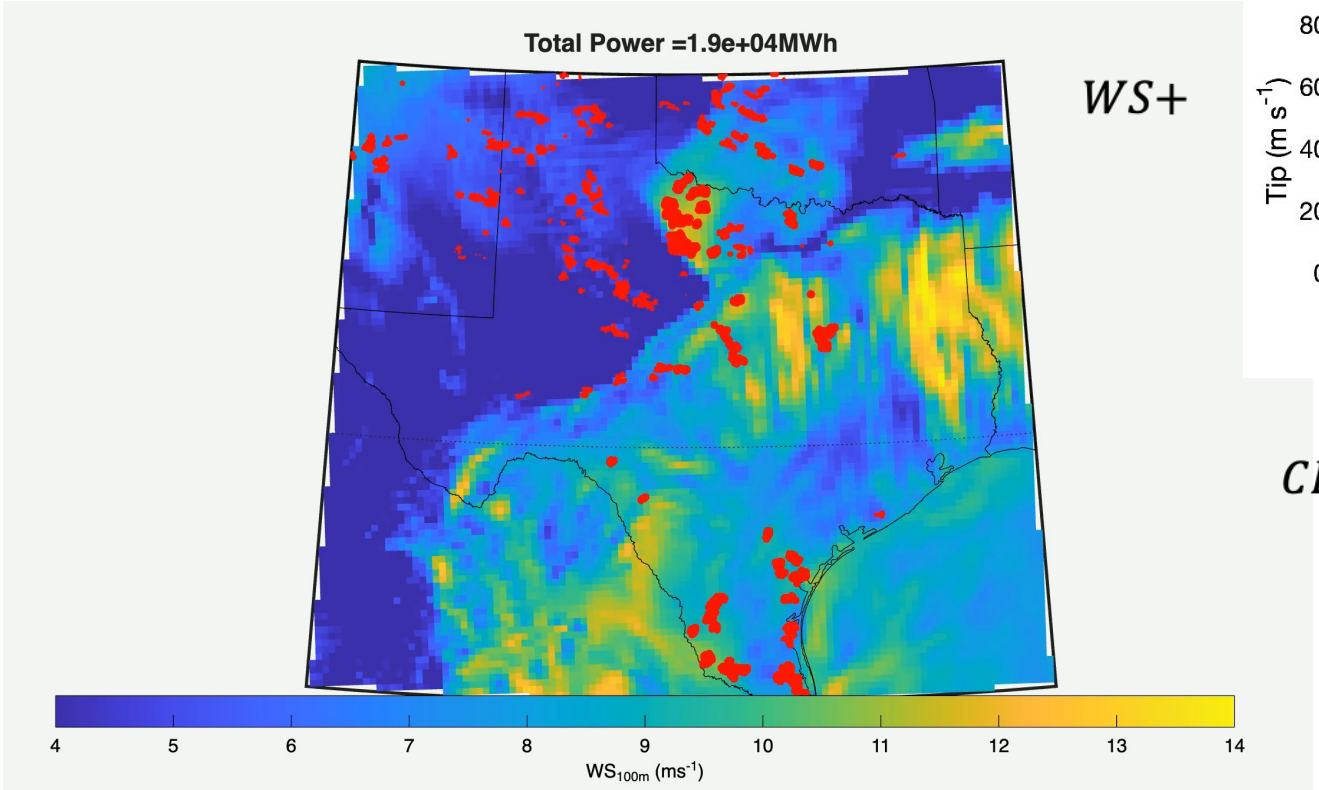


Monthly Rain Rate & Sea Level Pressure

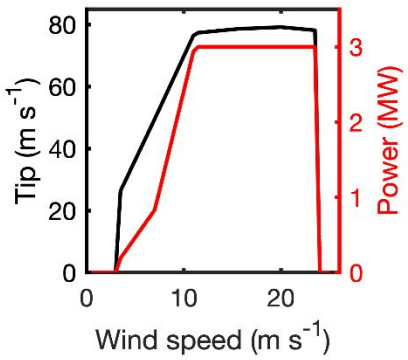


WRF

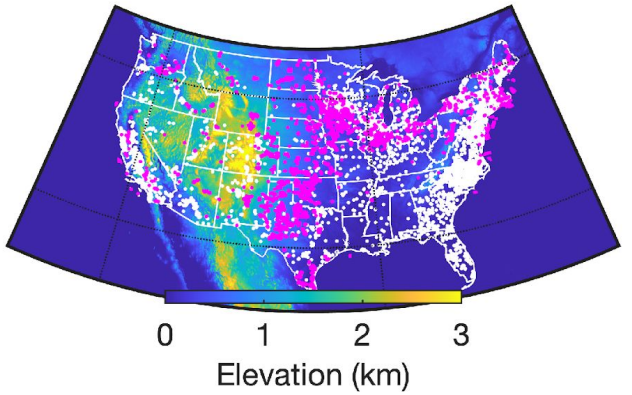
I-WRF: Science Use Case #2 : Energy applications



$WS+$

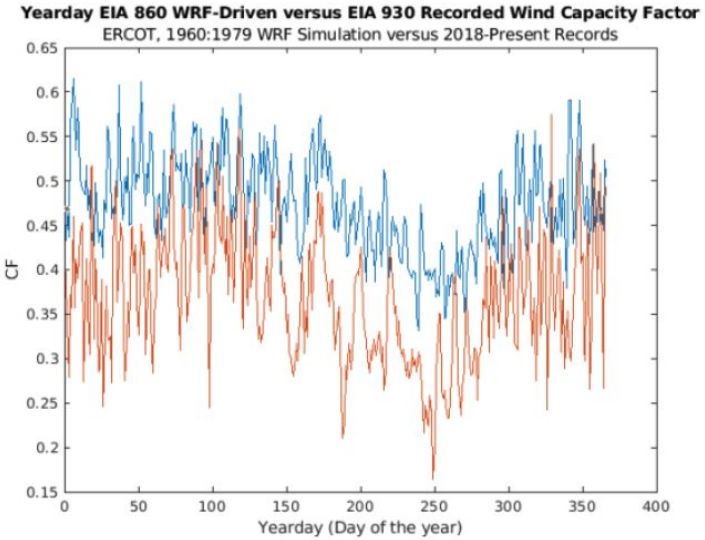


→ *Power*

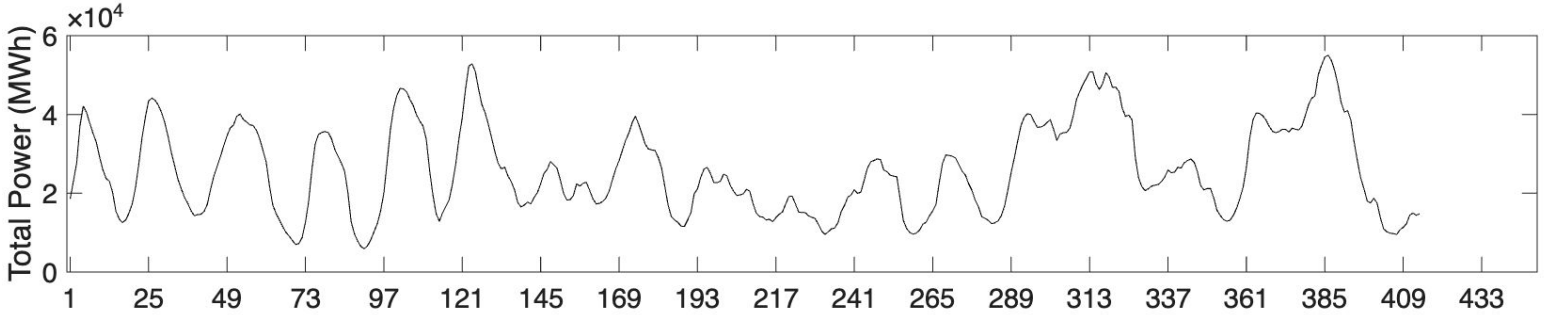


Pryor & Barthelmie (2026): *IScience* **29** 114439

$$CF = \frac{\sum_{i=1}^{n} Power_i}{\sum_{i=1}^{n} RC_i}$$



Yearday WT CF in ERCOT, EIA 860 WT database with WRF simulations (blue) ve
EIA 930 records (orange), past simulation period



MEng project: Patrick O'Connor

- **Basis of the energy demo in container**

WRF