

### Task 46 - Erosion of wind turbine blades: WP#2 Climatic conditions

#### **Products:**

- Meta-data & report hydrometeors. <u>10.5281/zenodo.5648211</u>
  - Pryor et al. (2021): Atmospheric drivers of wind turbine blade leading edge erosion: Hydrometeors IEA Report <u>https://iea-wind.org/task46/t46-results/</u>
- Meta-data & report ancillary variables (incl. wind speed). <u>10.5281/zenodo.7734765</u>
  - Pryor et al. (2023): Atmospheric drivers of wind turbine blade leading edge erosion: Ancillary variables IEA Report <u>https://iea-wind.org/task46/t46-results/</u>
- Pryor et al. (2022): Energies. 15, 8553; doi: 10.3390/en15228553
- Letson & Pryor (2023): Energies. 16, 3906; doi: 10.3390/en16093906

#### What did we 'discover' in actions 1-5?:

- That the instrumentation used to measure rainfall rates, and hydrometeor size & phase CRITICALLY dictate the inferred rate of LEE (e.g. estimated by Springer model).
- That there is NOT best practice available for data collection OR processing
- That commonly used size distributions for hydrometeors DO NOT represent observations







### Current work: Recommended Practice for measurement of LEE drivers

Transmitte

90°

iea wind

- Hydrometeor size distributions: # conc in size & velocity classes n(i,v) & fall velocities  $(v_f(i,v))$ .
- Processed to number concentration in size class (N(D<sub>i</sub>)) & closing velocity with blade, # and diameter of impacts.



## Current work: Recommended Practice for measurement of LEE drivers

4

- Example of influence of measurement technology on 'LEE estimates'
  - AKE = Accumulated Kinetic Energy of impact
  - ADF = Accumulated Distance to Failure (from Springer).















iea wind

# Current work: Roadmap for LEE atlas (w/WP5)

Best practice to convert our measurements (DSD,  $v_f$  from disdrometers and WS at hubheight from e.g. lidars) to ESTIMATE blade lifetimes. Questions we are considering:

- a. Which reference wind turbine: 3 MW NREL? Or 15 MW IEA? (RPM, tip speed)
- b. Mapping DSD & closing velocity to damage: Which model?
  - Kinetic energy of impact: No assumptions about materials BUT not a lifetime
  - Springer + Miner's rule: Accumulated distance to failure. BUT large uncertainties on coefficients & not mechanistic
  - More mechanistic models = more computational demanding, can we build emulators?
- c. How best to model co-stressors:
  - Thermal variability
  - Ultraviolet radiation (embrittlement models?)
  - Lightning strikes
  - Icing on blades
  - Blade strain



Should we focus on time to incubation or time to repair due to erosion, i.e. operators decision point? <sup>5</sup> IEA46 Webinar Dec 2023