Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

The effect of surface-obstacle geometry on maximizing air exchange over rough surfaces for use in direct air carbon capture assemblies

SIMONE STEWART, PAOLO LUZZATTO-FEGIZ, University of California Santa Barbara — Climate mitigation scenarios from integrated assessment models show it will likely be necessary to remove previously-released atmospheric CO_2. A proposed implementation of negative emission technologies is direct air capture (DAC), which consists of box-like absorbers, through which air is passed and scrubbed of CO_2. While the objective has been to scale up DAC to large arrays, the flow over these arrays has never been examined. The details of this flow are crucial; once air flows through the first row of absorbers, it must mix quickly with the surrounding atmosphere before encountering the next row, or performance will be seriously degraded. To improve CO_2 extraction from DACs, approaches to maximize the mass exchanges are investigated; exploiting the concept that flow over the DAC array is equivalent to flow over obstacles that comprise a rough surface. We perform reduced-scale experiments using model arrays in a water channel to study how the array geometry influences mass transport. We find that critical roughness spacings needed to avoid the development of recirculation regions are dependent on the aspect ratio of the obstacles. Thin obstacles have smaller critical spacings and result in stronger mixing, which supports the design of DAC arrays that minimize cost and land usage.

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Date submitted: 31 Jul 2019 Electronic form version 1.4