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Integrative data-driven approaches for characterization & prediction of aerosol-cloud processes

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Motivation: Uncertainties in aerosol-cloud processes persist due to:

- difficulties in measuring a non-idealized atmosphere
- asynchronous model-observation linkages
- missing or incomplete parameterizations.

Objective: Fusing and interpreting the vast amount of data from disjoint sources for the purpose of elevating our understanding of aerosol-cloud interaction.

Method: Leveraging recent advances in computing and analytical techniques:

1. Tailored statistical methods can account for the dynamic evolution of aerosols by handling simultaneous effects of atmospheric processes, complementary data sources, and multiple sources of uncertainty.
2. Hybrid statistical and Deep Learning approaches as surrogates of complex parameterizations of earth system processes can enable the integration of insights gleaned from statistical methods with ESMs.

Impact Potential: An improved understanding and characterization of complex aerosol-cloud-precipitation interactions would lead to:

- fewer model discrepancies
- more confident predictions of extreme events (e.g. floods and droughts)
- more informed decision making on climate policy.

Limiting Factors: Challenges include fusing large datasets and sources with complex dependencies, and accounting for spatial and temporal misalignment and varying measurement error.

AI4ESP Artificial Intelligence for Earth System Predictability