

PRESENTER:
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A Review of Satellite Cloud Condensation Nuclei Retrieval Methods for Evaluation with In-situ Measurements from Aircraft-Based Observations in the Marine Boundary Layer

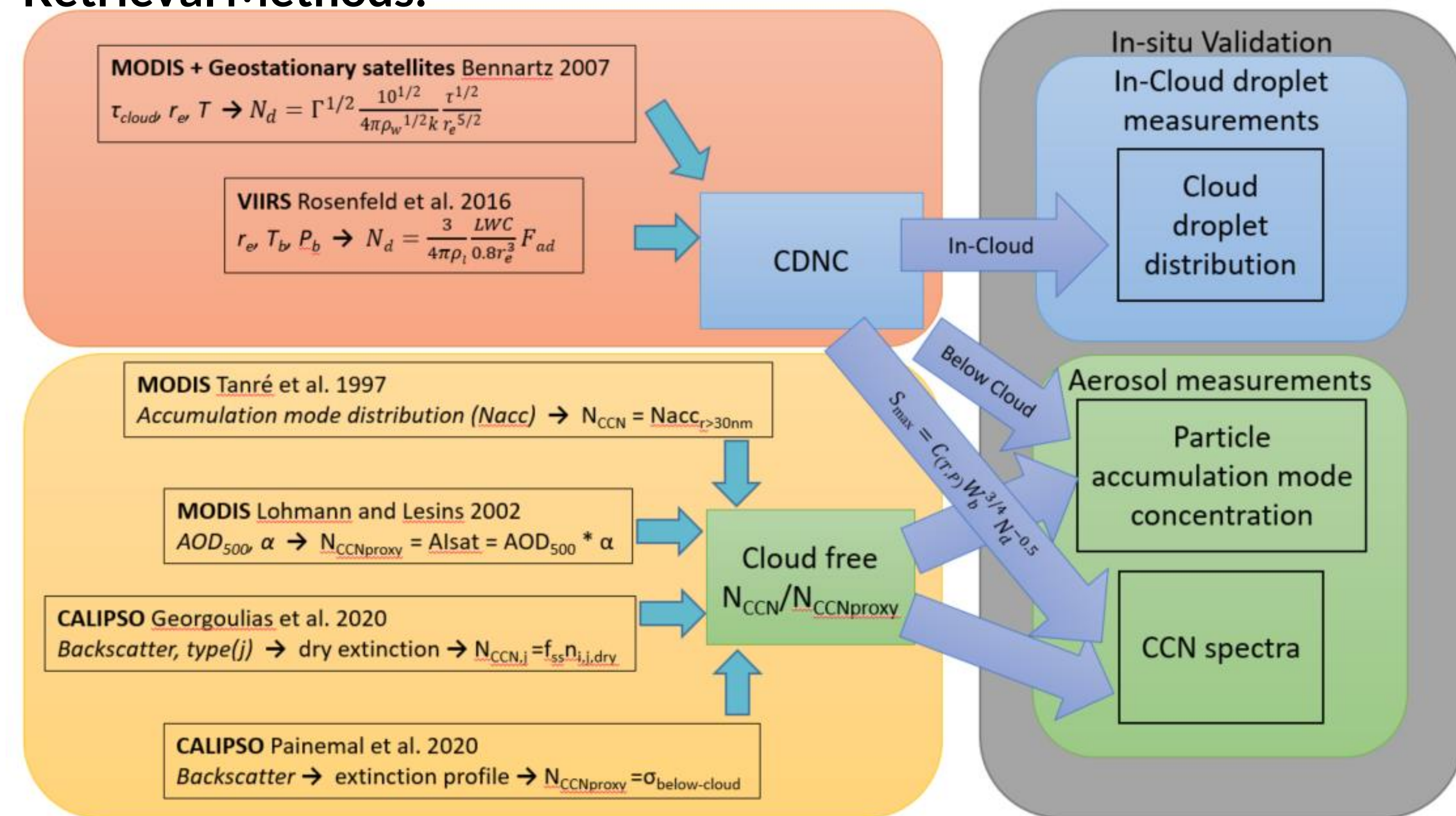
Motivation:

- Several methods exist for acquiring remote estimates of a subset of atmospheric aerosol particles known as cloud condensation nuclei (CCN) or related proxies, but few are thoroughly evaluated and intercompared using real-world observations.
- Such measurements are necessary to fill in substantial gaps in observations, particularly over the ocean, where collecting in-situ measurements are costly.

Goals:

- Test the skill of several published methods using in-situ measurements from several marine boundary layer targeted campaigns.
- Identify key sources of error for each method (possible sources: pollution, low signal, cloud type, local climate, remote sensing resolution, method assumptions, etc.)

Retrieval Methods:



Satellite Proxies (Aircraft Remote Measurements):

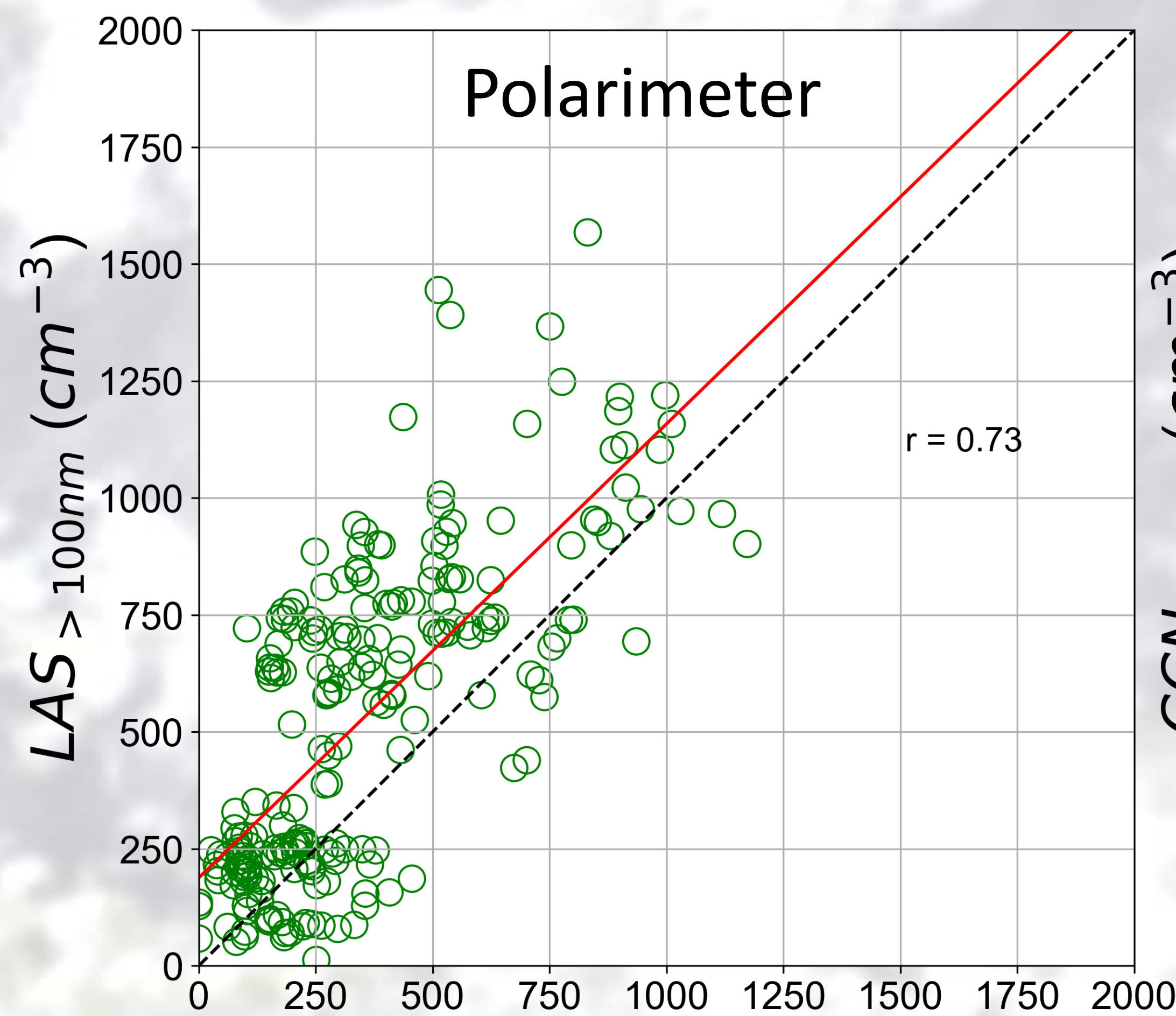
Almost all campaigns used include airborne High Spectral Resolution Lidar (HSRL) and Research Scanning Polarimeter (RSP) imaging instruments that are expected to be the basis for the next generation of space-based remote sensors and can be used as a proxy for potential future satellite.

Future Work Outline

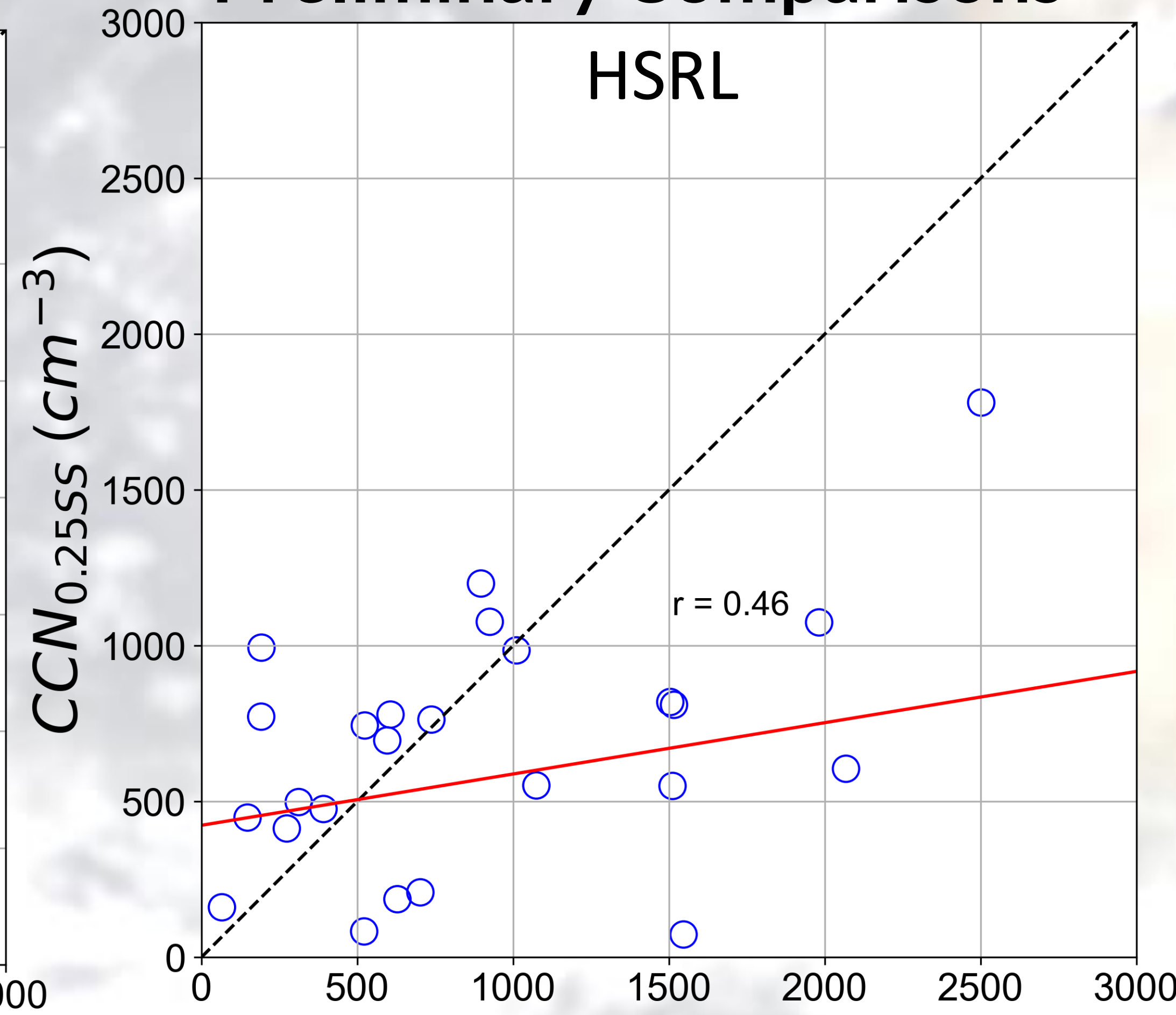
1. Complete synthesis of spatially collocated measurements.
2. Characterization relevant in-situ, CCN, aerosol and cloud microphysical observations, and describe the data, instruments, quality control details and interconnectedness of data in a **published data descriptor**.
3. Complete **implementation** of all remote CCN and CCN proxy **retrieval methods**.
4. **Assess the skill of retrievals** by region, season and overall.
5. **Evaluate sources of error** through validation of retrieval inputs and assumptions.
6. Publish results and make synthesized dataset publicly available for future use!

Remote cloud droplet and cloud condensation nuclei measurement methods need more in-situ validation.

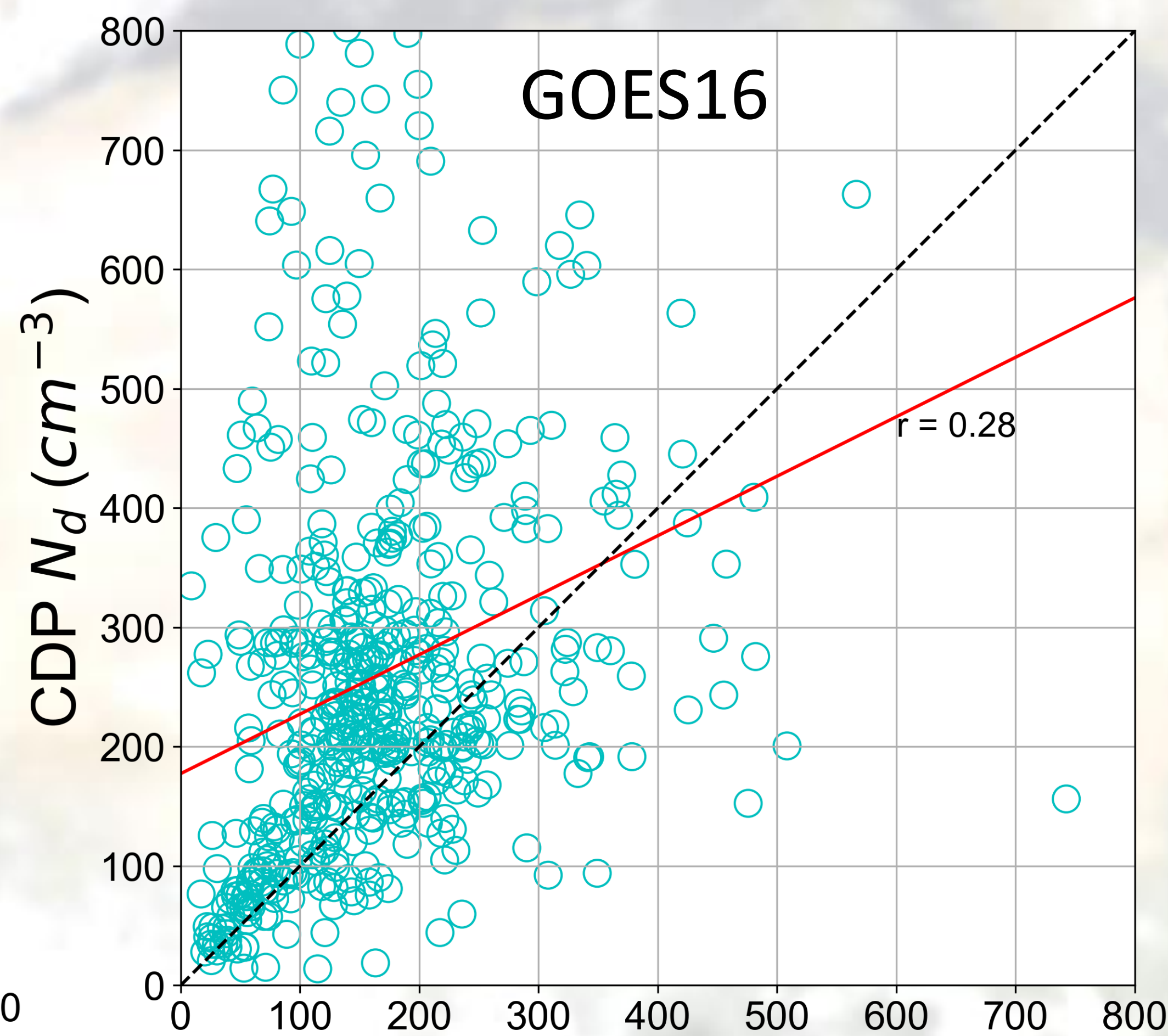
Preliminary Comparisons



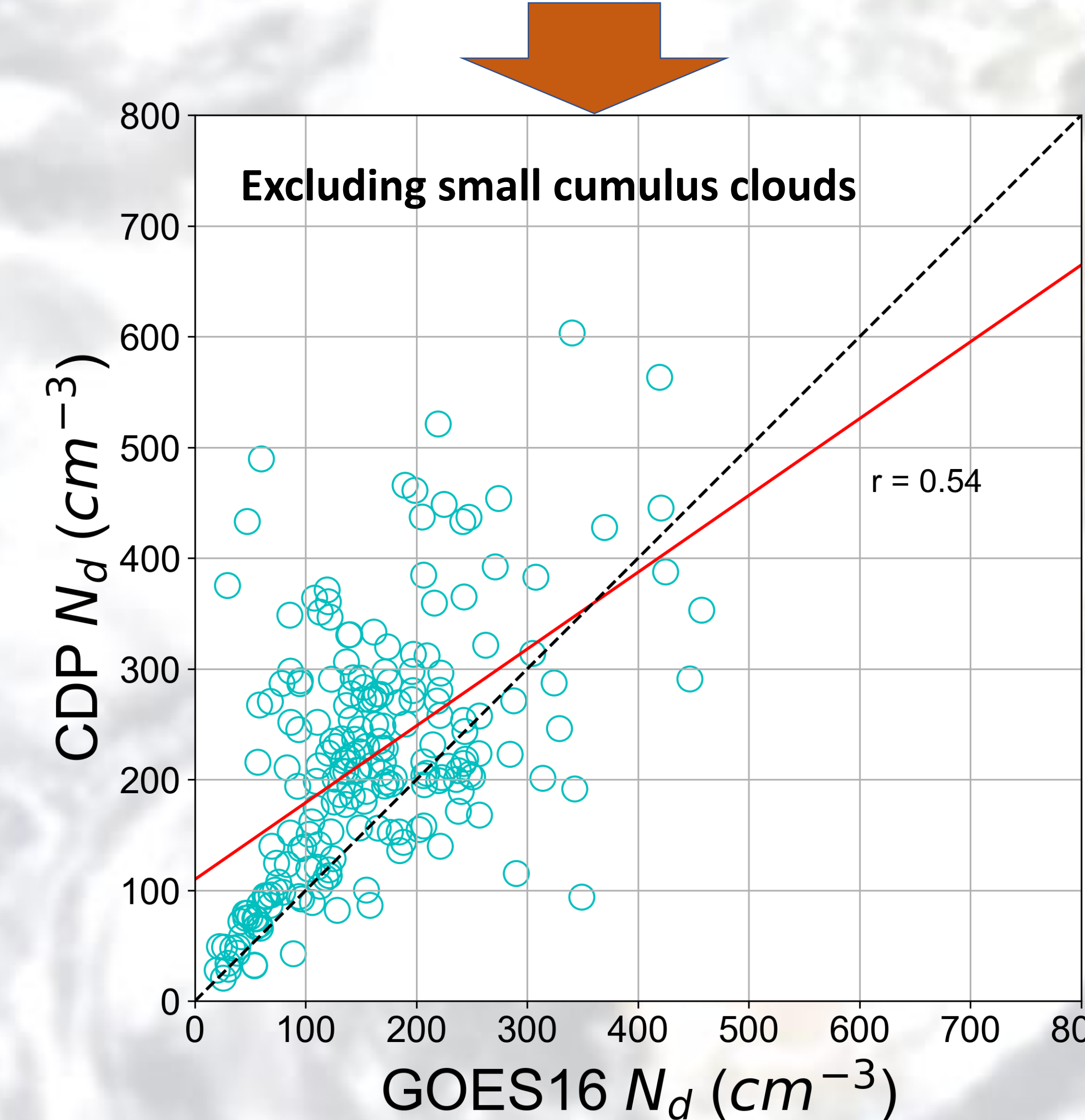
RSP > 100nm (cm^{-3})
Microphysical Aerosol Properties from Polarimetry (MAPP) Stamnes et al 2018



HSRL CCN_{0.25SS} (cm^{-3})
CCN concentrations derived from lidar Georgoulas et al. 2020



GOES16 N_d (cm^{-3})
Cloud droplet number concentration (Nd) derived from satellite Bennartz et al 2007



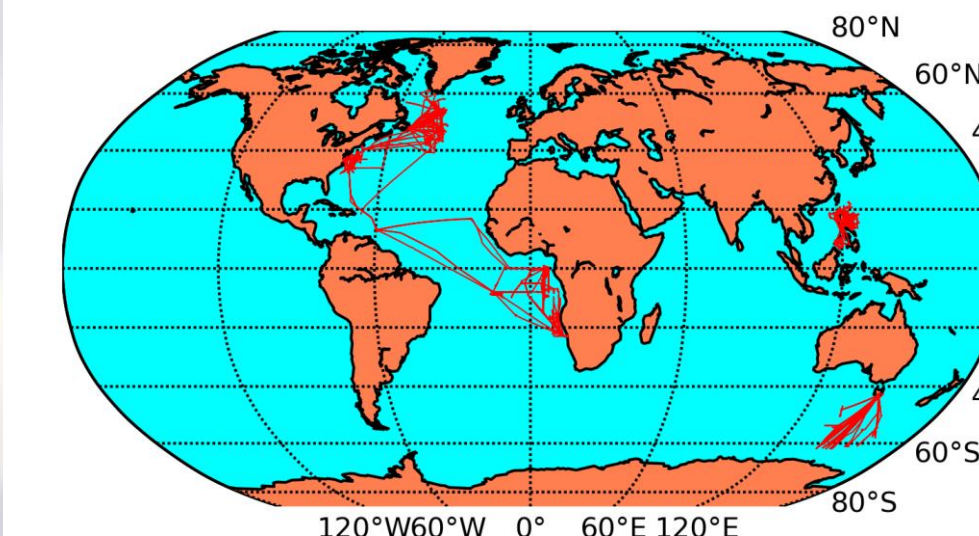
Further filtering and error source evaluation could improve some retrieval method results under certain conditions.

NASA Led Campaigns
NAAMES – North Atlantic Aerosol and Marine Ecosystem Study
ACTIVATE – Aerosol Cloud meTeorological Interactions over the western ATlantic Experiment
CAMP²EX- Clouds, Aerosol, Monsoon Processes-Philippines Experiment
ORACLES – ObseRvations of Aerosols above CLouds and their intEractiOnS

Others

SOCRATES – Southern Ocean Clouds, Radiation, Aerosol Transport Experimental Study
CAPRICORN2 (ship only) – Clouds, Aerosol, Precipitation, Radiation, and Atmospheric Composition over the Sothern Ocean

All campaign ship and flight tracks



HSRL Retrievals:

- Vertically resolved extinction (1-2 wavelengths)
- Vertically resolved aerosol backscatter (2-3 wavelengths)

RSP Retrievals:

- Aerosol and ocean upwelling total and polarized reflectance at multiple wavelengths and multiple viewing lengths
- Microphysical aerosol properties from polarimetry (MAPP) algorithm using radiative transfer and mie calculations

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