Airborne Remote Sensors Summary

- Instrumental capabilities
- Scientific capabilities
- Scientific needs
- Measurement / community challenges and requirements

Airborne Remote Sensors Summary (1)

- **Instrumental Capabilities**:
  - Many active remote sensors (single- and multi-λ radar and lidar, polarization sensitive, elastic and molecular lidars)
  - Solar and IR radiation measurements (radiance and irradiance [direct and diffuse], broadband and spectrally resolved, polarized)
  - Microwave radiometers
  - Imagers

  - Small and large
  - Many different airframes
  - Various levels of maturity.

Airborne Remote Sensors Summary (2)

- **Scientific Capabilities**:
  - Location of cloud and aerosol layers
  - Profiles of aerosol extinction, backscatter, and polarization
  - Cloud extinction profiles for $\tau < 3$
  - Cloud phase determination
  - Liquid water and ice water contents
  - Cloud particle motion
  - Spectrally resolved radiance and irradiance, radiative flux
  - Surface properties (e.g., albedo, BRDF, soil moisture, temperature)
  - Cloud optical depth and cloud effective radius (vertically integrated)
  - LWP and IWP
  - Water vapor profiles (q and RH)
  - AOT (function of λ)
  - Intrinsic aerosol parameters (e.g., ω_0, g, P(Θ), m_r and m_i, all functions λ)
  - Trace gas amounts
  - Horizontal winds.

Airborne Remote Sensors Summary (3)

- **Scientific Needs**:
  - Everything in the previous “scientific capability” can be improved
  - Wind profiles, especially vertical velocity
  - Atmospheric state profiles, especially temperature
  - Better horizontal, vertical, and temporal resolution (e.g., around cloud edges), especially $N_d(r)$ and $N_a(r)$
  - Ability to better compare in-situ and remote sensors (time/space matching)
  - Aerosol absorption (profiles, multi-λ, ambient conditions, f(RH), all λ)
  - Change in aerosol scattering at high RH
  - Ice particle size distribution and habit
  - Far-infrared spectral radiance
  - LW and SW radiative flux divergence profiles
  - Latent heat / precipitation (quantified, 3-d distribution)
  - Remotely sense regions of ice supersaturation (esp. in UT)
  - Boresighted imagers for context (like LaRC HSRL)
  - 3-d fields of cloud / aerosol / atmos state
    - Horizontal “profiles” at several levels for convection studies
  - CCN and IN.

Airborne Remote Sensors Summary (4)

- **Measurement / community challenges and requirements**:
  - Calibration key -- need standards and traceability
  - Good engineering needed (e.g., stray light suppression, cosine response, thermal stability, overlap correction)
  - Improve resolution (spatial, vertical, temporal)
  - Reduce random and correlated error
  - Quantify the correlated error in measurements
  - Full error analysis, propagating measurement and assumption uncertainties into derived product
  - Information content: what is the observations really saying relative to the assumptions built into the method
  - Algorithm comparison needed (process same real & simulated datasets)
  - Comparisons of like datasets and closure exercises to identify biases
  - Analysis of data from different sensors provides challenge to match the temporal and/or spatial sampling
    - New approaches (algorithms) needed
  - Smaller size, less power, more automated instruments
  - Forward looking remote sensors; challenges include eye-safety for lidar
  - Stacked aircraft (including towed arrays)
  - More analysis time needed; many datasets aren’t fully analyzed.