Title: High Impact Atmospheric Research to Advance Scientific Understanding of Aerosol-Cloud-Precipitation Interaction

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Abstract: Energy and water are the two largest issues facing society today. Atmospheric processes interconnect these two important issues. Energy production methods require the use of large amounts of water, which originates in precipitation. Energy production produces pollution that affects cloud properties and precipitation processes. The availability of abundant energy and water is an inter-disciplinary problem for North Dakota, and around the work, that requires additional scientific understanding of atmospheric processes. Advancing scientific understanding requires measurements on global scales down to the nanometer scale of aerosols and gas molecules. Satellites sensors and radars provide large-scale measurements, while surface stations and airborne observations are necessary for small-scale measurements. Studying aerosol-cloud-precipitation interaction requires combining different measurement techniques to span all the scales involved. For example, combining radar observations in Mali, West Africa with surface based AERONET optical depth measurements indicates that increasing aerosols affects the number of precipitation cells but not the precipitation rate, cell area or cell duration. Combining measurement techniques requires robust software, such as the Airborne Data Processing and Analysis (ADPAA) package. ADPAA enables quick analysis of atmospheric measurements such as relating Cloud Condensation Nuclei (CCN) concentrations to Cloud Droplet Number Concentration (CDNC). The low correlation of determination (R^2=0.37) between cloud base CCN and CDNC observed in North Dakota illustrates the important of variations in the cloud's maximum supersaturation. Cloud base vertical velocities measurements are the best method for inferring maximum supersaturation. While aerosol-cloud-precipitation interactions studies have advanced with new instrumentation, like the Aircraft-Integrated Meteorological Measurement System (AIMMS) and Cloud Droplet Probe (CDP), further instrument development is required to make major advances. Two important instruments are a miniaturized CCN counter and a hydrometeor residue aerosol chemical analyzer. Additionally, new field projects utilizing newly developed instruments are necessary to understand issues like convective initialization. While measurements are expensive, they have a large impact on advancing scientific understanding.