Progress in airborne polarimeter intercomparison for the NASA Aerosol/Cloud/Ecosystems Mission
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The Aerosol/Cloud/Ecosystems (ACE) mission, recommended by the National Research Council's Decadal Survey, calls for a multi-angle, multi-spectral polarimeter devoted to observations of atmospheric aerosols and clouds. In preparation for ACE, NASA funds the deployment of airborne polarimeters, including the Airborne Multi-angle SpectroPolarimeter Imager (AMSP), the Passive Aerosol and Cloud Suite (PACS), and the Research Scanning Polarimeter (RSP). These instruments have been operated together on NASA's ER-2 high altitude aircraft as part of field campaigns such as the POLARIS Deflection Experiment (PODEX) in California, early 2013 and Studies of Lower Atmosphere, Clouds, and Climate Coupling by Regional Surveys (SEAC4RS), California, early and summer 2013. Our role in these efforts has been to serve as an assessment team performing level 1 (calibrated radiance, polarization) and level 2 (retrieved geophysical parameter) instrument intercomparisons, and to promote unified and generalized calibration, uncertainty assessment and retrieval techniques. We will present our progress in this endeavor thus far and describe ongoing research in 2015.

Intercomparision Dataset: PODEX (POLARIS Deflection Experiment)
PODEX comprised eighteen flights of the NASA ER-2, deploying airborne prototypes of three types of optical polarimeters. Although they have variable characteristics, these instruments display similar reaonable properties of cloud, aerosol, and surface aerosol. The types of these instruments include POLEDER (OCE) and APS-Opto (which failed during launch). They are also prototypes for potential future instruments on ACE and PACE missions of the Decadal Survey.

PODEX was based at the NASA Dryden (now Armstrong) Aircraft Operations Facility in Palmdale, California. In addition to the three polarimeters described below, the ER-2 also flew the Autonomous Modular Sampler (AMS), Cloud Physics Lidar (CPL) and the Solar Spectral Flux Radiometer (SSFR). Flight paths are shown above. Some were coordinated with the DISCOVER-AQ field campaign, which deployed a variety of in situ sampling equipment. A tables displaying observed scans is shown at left.

PODEX dataset: www-air.larc.nasa.gov/po pne/testfree/apps/ds/data/PODEX_datasets.html

Intercomparision results
Comparison normalized by uncertainty

This work is ongoing, details and progress for the ACE mission Polarimetry Working Group (ACEPWG) can be found in an online forum:
earthscience.arc.nasa.gov/sgg/ACEPWG

Conclusions
1. AMSP and RSP reflectances agree within stated uncertainties.
2. AMSP and RSP Degree of Linear Polarization (Dolp) does NOT agree within stated uncertainties. 885nm is worse, 600/670 is best.
3. This analysis DOES NOT indicate which instrument is "right", but means that retrieved product biases between instruments is possible.
4. AMSP Dolp uncertainty is greater than ACE requirements for "Step and Stare" (multi-angle) mode, equivalent to ACE requirements for "Sweep" (single view) mode, and better than ACE requirements when downsampled to RSP spatial resolution. RSP Dolp uncertainty is smaller than both ACE requirements and AMSP uncertainty.
5. Results call for a discussion of polarimetric calibration techniques, possibly cross-calibration.
6. Analytical expressions for instrument uncertainty should be implemented in a unified manner.

There is urgent need for full PACS data availability and uncertainty characterization.