Airborne Measurements in Support of the NASA Atmospheric Carbon and Transport – America (ACT-America) Mission

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Abstract

NASA announced the research opportunity Earth Venture Suborbital-2 (EVS-2) mission in support of the NASA’s science strategic goals and objectives in 2013. Penn State University, NASA Langley Research Center (LaRC), and other academic institutions, government agencies, and industrial companies together formulated and proposed the Atmospheric Carbon and Transport – America (ACT-America) suborbital mission, which was subsequently selected for implementation. The airborne measurements that are part of ACT-America will provide a unique set of remote and in-situ measurements of CO2 over North America at spatial and temporal scales not previously available to the science community and this will greatly enhance our understanding of the carbon cycle.

ACT-America will consist of five airborne campaigns, covering all four seasons, to measure regional atmospheric carbon distributions and to evaluate the accuracy of atmospheric transport models used to assess carbon sinks and sources under fair and stormy weather conditions. This coordinated mission will measure atmospheric carbon in the three most important regions of the continental US carbon balance: Northeast, Midwest, and South. Data will be collected using 2 OCO2 instruments (NASA Wallops C-130 and NASA Langley’s B-200) with both in-situ and lidar instruments, along with instrumented ground towers and under flights of the Orbiting Carbon Observatory (OCO-2) satellite. This presentation provides an overview of the ACT-America instruments, with particular emphasis on the airborne CO2 and backscatter lidar, and the rationale, approach, and anticipated results from this mission.

Mission Overview & Goals

The overarching goal of the Atmospheric and Transport-America (ACT-America) mission is to improve regional to continental scale diagnoses of carbon dioxide (CO2) and methane (CH4) sources and sinks.

• The mission will enable and demonstrate a new generation of atmospheric inversion systems for quantifying atmospheric CO2 and CH4 fluxes.

• These inversion flux estimates will be able to:
  - Evaluate and improve terrestrial carbon cycle models, and
  - Monitor carbon fluxes to support climate-change mitigation efforts.

1. Quantity and reduce atmospheric transport uncertainties
2. Improve regional-scale, seasonal prior estimates of CO2 and CH4 fluxes
3. Evaluate the sensitivity of Orbiting Carbon Observatory-2 (OCO-2) column CO2 measurements to regional variability in tropospheric CO2

These goals address the three primary sources of uncertainty in atmospheric inversion: transport error, prior flux uncertainty and limited data density

Mission Schedule/ Locations

6 week campaign (2 weeks in each region):

- Northeast: 2 weeks (Wallops Flight Fac./Langley Research Ctr. + South: 2 weeks Lincoln, NE + Southeast: 2 weeks Shreveport, LA

14 flights per campaign (two aircraft)

- Plan: 4 flights per region + 2 OCO under flights

- Minimum: one fair and stormy weather flight in each region, for each campaign.

Measurements and Model Data

Airborne observations will be compared to and assimilated into ensembles of regional- and global-scale models to provide rigorous quantification of CO2 and CH4 fluxes, and improve transport ensembles for atmospheric inversions.

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Flight Profiles

Fair weather

- Measure winds, ABL, depth, CO2, CH4 and tracers (CO, CO2, O3) across 120 km
- Solve for regional fluxes for the days of flights directly - prune prior flux estimates
- Evaluate fair weather meteorology in atmospheric transport ensemble

UC-12 2x3hr flights
C-130 8 hr flights

Stormy weather

- Measure atmospheric state, CO2, CH4, and tracers (CO, CO2, O3) across and around frontal systems
- Evaluate atmospheric transport in our model ensemble
- Prune transport ensemble

UC-12 2x3hr flights
C-130 8 hr flight

OCO-2 Under flights

- Measure much of the atmospheric CO2 column at < 20km horizontal resolution across 100’s km below OCO2. Also measure aerosols, clouds with lidar
- Compare spatial variability in airborne CO2 to OCO-2 CO2
- Evaluate OCO-2 ability to capture tropospheric CO2 variability along-track.

UC-12 3.6hr flight
C-130 4.8hr flight

Interested in collaborating or data sets? Contact Ken Davis (kid10@psu.edu) or go to http://act-americarlarc.nasa.gov/