Scientists take to the skies in airborne NASA experiment

Field work reached new heights in Houston, USA, as NASA's SEAC⁴RS venture saw the formation of a special squadron of scientists to investigate the composition and behavioiur of our atmosphere. School of Chemistry's Dr Jenny Fisher reports.

Photo courtesy NASA

Houston in August is hot (upwards of 30°C), humid (frequently 90-100%), and prone to thunderstorms and hurricanes – not an ideal destination for most people. Nonetheless, this past August I was amongst a few hundred scientists who descended on NASA's aircraft base in Houston. We were there to take part in an ambitious airborne experiment designed to improve our understanding of the atmosphere, its current composition, and the changes it is undergoing.

The experiment was called SEAC⁴RS, short for Studies of Emissions and Atmospheric Composition, Clouds, and Climate Coupling by Regional Surveys. Our goal was to answer several diverse but related questions: How much material do we put into the atmosphere through human activity, natural vegetation, and bushfires, and how do these different sources interact to form air pollution? How do storms move this pollution from the lowest part of the atmosphere to the highest part, and what does that mean for the otherwise clean upper atmosphere? How do particles from pollution and bushfires interact with clouds, and how do those interactions impact climate change?

To address these questions, three separate airplanes were loaded with scientific instruments. The first plane (an ER-2) was designed to measure the atmosphere from above. It flew so high that the only person onboard was the pilot, who wore a special pressurised flight suit for protection. The role of the second plane (a Learjet) was to fly through stormy convection. While most of us have flown through convection before (usually triggering an illuminated seatbelt sign and some unpleasant bumps), commercial airline pilots try their best to avoid it. The Learjet pilots did the opposite, flying right through it as many times as possible. The third plane (a DC-8) served as the main "flying laboratory" of the campaign. Picture an old passenger plane (circa 1970) with most of the seats removed and replaced by high-tech equipment and you'll have a pretty good image of the DC-8 lab. Inlets that stuck out of the wings and windows sucked air from outside the plane to the main cabin, where the scientists could measure its components. There was even a laser on board that mapped particles and clouds in the air above and below the plane.

Accomplishing our ambitious objectives required flying through the "right" environments, but knowing where those were each day was a challenge. That's where my colleagues and I came into the picture. I was part of the "theory team," responsible for using forecasts of weather, pollution, and fire activity to determine where to send the planes. My role was to perform "near-real-time" analysis using the newly collected data (usually only 1-2 days after each flight) along with a state-of-the-art simulation of the atmosphere. This analysis helped us figure out what we had learned so far and where we still had big questions, enabling us to focus the flight hours on achieving our goals.

The experiment was a resounding success. The planes stayed in Houston from 7 August to 24 September, with each plane completing between 17 and 24 independent flights. They covered large swaths of the U.S., from the Gulf of Mexico to Canada and from California to Georgia. They sampled smoke from the Yosemite Rim Fire (the third largest in California's history), pollution over Atlanta and Houston (America's 4th largest city), and pristine air over national parklands. They flew through storms, clouds, and calm weather. Analysis of this uniquely comprehensive dataset is just beginning. Soon, it will provide us exciting new knowledge about the links between pollution, weather, and climate.

Report by Dr Jenny Fisher

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