Chasing clouds

Kerri Pratt and colleagues stayed calm under pressure and made friends with 'Shirley' as they flew through the clouds over Wyoming.

The aircraft (NCAR/NSF C-130) that Kerri Pratt and colleagues used to sample clouds.

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What was the objective of the work?

Our main objective was to develop a better understanding of the type and number of atmospheric particles responsible for the formation of ice crystals and water droplets in clouds. We wanted to use a newly developed mass spectrometer that could be operated on board an aircraft, in combination with an ice formation chamber and cloud probes, to study the chemical composition of individual ice-forming particles in clouds. In this way, we hoped to determine the chemistry of particles that participate in the formation of cloud ice as it happens.

Why did you choose this particular location for the fieldwork?

We chose to fly over Wyoming because of the presence of wave clouds — a cloud form created at the crest of atmospheric waves, which develop when stable air masses flow over mountain ranges. These clouds comprise both liquid water droplets and ice crystals, and therefore provide an atmospheric laboratory in which to study the formation of cloud ice.

What sorts of data were you after?

We used multiple instruments to measure the chemical composition of atmospheric particles within a wave cloud. We also measured temperature, water vapour, cloud structure, and the number and size of cloud droplets and ice crystals.

Did you encounter any difficulties?

Coordination: each of us was responsible for a different, highly complex instrument, and trying to make simultaneous measurements proved a bit challenging. What's more, the location, size and structure of clouds often changes over time, which meant we were continually changing our flight plans, abandoning one cloud for another. But perhaps the most challenging part of the project was making the new aerosol mass spectrometer aircraft-compatible — not too heavy or energy intensive — before the study began.

We were assembling and fine tuning the instrument, also known as 'Shirley', right up until the first flight.

Any low points?

During the flights, it was often difficult to meet the different requirements — for example, amount of sampling time, location of measurements — of those who were measuring cloud microphysics versus those measuring the chemical composition in and around the small wave clouds.

What was the highlight of the expedition?

Flying through the clouds with all the scientists aboard, talking excitedly over headphones about the real-time results and the next cloud we were going to sample, had to be the highlight. Particularly because this was the first time we had used our newly developed mass spectrometer to measure the chemistry of single cloud seeds.

Did you learn anything new about yourself or your team members?

Aircraft measurements require a huge amount of teamwork, with scientists, pilots and aircraft technicians working together aboard a rapidly moving, sometimes disorienting, platform. We learnt to be patient and think quickly in this sometimes stressful environment, where all decisions must be made without hesitation and under a great deal of pressure! Most of the scientists and crew seemed to thrive during these exciting aircraft measurements; however, visiting scientists, who were not regular flyers, sometimes found themselves getting travel sick. Workwise, this was a continual learning process — with a total of 16 flights during the campaign, we always worked towards improving the next flight by holding pre- and post-flight discussions.

Did the trip give you any ideas for future research projects?

Yes, this study is just the beginning! Next, we want to directly link the instruments measuring cloud activation and chemical composition, rather than making these measurements in parallel, as was the case in this study. In this way, we could directly probe the chemistry of the particles that initiate the formation of cloud ice in a single measurement sequence. Our ultimate goal is to make spatially and temporally detailed measurements within different types of clouds, to provide further insight into cloud formation and precipitation processes under a range of conditions.

This is the Backstory to the work by Kerri Pratt and colleagues, published on page 398 of this issue.