backstory

Cold case

Russell Schnell and colleagues trawled through meteorological datasets to solve the mystery of the winter ozone anomalies in Wyoming.

What was the objective of the work?

In the upper atmosphere, primarily between 10 and 30 km, ozone acts as a shield against damaging ultraviolet radiation. However, in the lower atmosphere — particularly at the Earth's surface — ozone is a significant pollutant, harmful to human health and ecosystems. Until now, the formation of surface ozone was considered to be a summer phenomenon, resulting from the action of bright sunlight on ozone precursors. For this reason, regulatory measurements in the US have been confined to the summer months between April and October, when ozone is most likely to exceed regulatory threshold levels. So, when a member of staff at the Wyoming Department of Environmental Quality (WDEQ) asked us what might be behind anomalously high levels of surface ozone observed in winter in rural Wyoming (near natural gas fields), that neither gas production companies, consultants nor WDEQ staff could adequately explain, we were hooked and went in search of an answer.

Why did you choose this particular location for the fieldwork?

We found this field location by chance. The ozone data were collected by WDEQ contractors and staff in winter near the Jonah–Pinedale Anticline natural gas field in Wyoming. One of the staff members mentioned the difficulties they were having in explaining the data to her brother, who happened to work at our observatory in Barrow, Alaska; he pointed them in our direction, and the rest is history.

What sorts of data did you use?

The WDEQ had high-quality environmental and air chemistry data from continuous monitoring stations in and around the natural gas field in Wyoming where the anomalously high ozone levels were observed. We had access to an array of meteorological data connected to the problem,

JENNIFER FRAZIER, WDEQ

Balloon-borne ozonesonde used to measure vertical profiles of near-surface ozone during winter production events.

including balloon-borne, air trajectory and satellite measurements, through the National Weather Service, the National Environmental Satellite and Information Service and NASA. Indeed, data supply was not a problem; it was finding the pieces relevant to the puzzle that was the hard part.

Did you encounter any difficulties?

Within three days of initiating the project we basically understood the cause of the exceptionally high ozone levels. As outlined in the paper: standard ozone photochemistry and unusual meteorological circumstances in a mountain basin produced a natural 'chemical retort'. Specifically, ozone precursors released from the gas field became trapped at the surface due to strong temperature inversions, and the build-up of precursors with nowhere to go resulted in high levels of ozone production. However, it took another year to acquire and analyse the supporting ancillary data, and to have our findings vetted and accepted by immediate colleagues. Initially, some fellow scientists said that the data could not be correct as ozone production in winter was not possible, but after we presented our analyses from different years and different sites within the gas field, they began to get excited too.

Any lowpoints?

During the preparation of the paper for publication, writing was interrupted when one of the main authors, key to preparing the final stages of the manuscript, was hospitalized for nearly two months with a severe internal infection — probably the result of eating a local delicacy during a recent trip to Asia-Pacific. He had been hosted by a group of mountain aborigines while setting up an air sampling site on their land — the meal, a tree-top marsupial, was one reserved for honoured guests.

Any economic implications?

The gas field at the centre of this study brings in an excess of $3.6 billon per year in gas sales, and production is scheduled to triple by 2020, with revenues expected to reach $12 billion per year. In 2008, gas production companies spent in excess of $100 million on the mitigation of fugitive emissions from natural gas processing and from combustion related to drilling and transportation. The state of Wyoming collects around $100 million per year in taxes from and related to this particular gas field. The discovery that the emission of ozone precursors from this gas field, when combined with the right meteorological conditions, generates toxic levels of ozone in the winter may mean that gas companies have to curtail some winter operations, at a huge cost to the companies and the state of Wyoming.

Did this work give you any ideas for future research projects?

We believe that there are other areas round the world with similar winter ozone production, and we expect that publication of this paper will bring them to light. We are also looking for a 'mystery ingredient' or process that helps to fire-up ozone production as the sun rises. At present, there are questions as to what the ignition 'spark' may be.

This is the Backstory to the work by Russell Schnell and colleagues, published on *page 120 of this issue.*