Readers' forum

Readers are invited to contribute short questions on any meteorological topic. We will endeavour to obtain answers to all submitted questions.

A multitude of gravity waves

At around 1100 UTC on Monday 31 May 2004, the cloudscape over Earley, Reading was as shown in Fig 1. It is not unusual to observe a 'stripe' or two in clouds, but on this particular occasion the striations completely dominated the sky in all directions. The wavy features persisted for around 15 minutes before dissipating away. What were the special conditions which allowed these wave patterns to form so ubiquitously on that particular morning? How high were they and why did they vanish so quickly?

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Fig. 1(a)

Fig. 1(b)

Jim Galvin (Met Office) replies:

The gravity waves seen by Paul Williams appear to have been both thin and of small horizontal extent, as well as short-lived. The usual conditions for the development of wave clouds were present around midday on 31 May 2004 – a stable atmosphere and wind speed increasing with height in the lee of a range, or ranges of mountains. There was a ridge of high pressure across eastern parts of the British Isles, ahead of a weather system moving steadily from the west. The north-westerly jetstream associated with this system reached a speed of more than 90 kn at a height of 11 km.

From satellite imagery and the radiosonde profile for Herstmonceux, East Sussex, the main layers within which clouds might form were 1500 m to 2000 m, 6500 m to 7500 m and 8500 m to 9300 m. The light wind speeds and direction changes in the lowest of these layers is unlikely to have formed wave clouds and wind-speed shear was greatest near 6500 m, so the height of the main cloud layer shown in Figs. 1(a) and (b) is likely to have been close to 6500 m. Given the north-westerly wind at this height, the forced uplift was probably over the Cambrian Mountains. The series of waves that formed downwind of them had a short wavelength, as indicated in Fig. 1. The temperature of –27 °C at 6500 m indicates that this cloud would have been formed mainly of ice, but with some supercooled water droplets, so can be classified as cirrocumulus.

Fig. 1(b) also shows waves in a lower cloud layer (stratocumulus, probably at around 1700 m) and in cirrus (probably above 8500 m), each with a slightly different orientation from the cirrocumulus waves. These are also likely to have been formed by the Cambrian Mountains as the layer of west to north-westerly winds deepened ahead of the frontal system to the west, displacing low-level southerlies. The difference in orientation is a product of a slightly different wind direction across each of the cloud layers.

Both atmospheric stability and wind shear have to be at an optimum to allow wave clouds to form and propagate a considerable distance downstream (c. 300 km). It is likely that conditions changed such that the short-wave atmospheric motion seen in these pictures was no longer present over Reading from about 1115 UTC.

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