BACK BOX

Charging the atmospheric heat engine

Flat, uniformly grassed, monotonously level for kilometre after kilometre — that describes the country near Conargo, in the Riverina district of New South Wales.

Country like that isn't so easy to find. In fact it's rare in the world, which is why at the time of writing nearly 40 scientists from Australia and overseas planned to converge on Conargo in October 1976.

The area is ideal for one special purpose — measuring the energy that is being pumped into the atmosphere. And, for this purpose, scientists from the U.S.S.R., Canada, U.S.A., Japan, France, and Australia arranged to bring their atmospheric-measuring instruments last month to Conargo for an experiment — organized by the CSIRO Division of Atmospheric Physics — called the third International Turbulence Comparison Experiment.

What are the scientists up to?

The atmosphere can be considered as one enormous heat engine, charged by the energy of the sun. The wind, cloud, rain, and so on that comprise weather are the visible signs of this engine at work as it pumps energy from place to place.

Weather forecasting is really a matter of predicting what that engine is going to do next. To do so, forecasters use models of the atmosphere; but, to be of much use, such models need accurate figures for the amounts of energy that drive all the atmospheric processes.

Conargo—so flat that it attracted scientists from around the world.

The atmosphere receives its energy from the sun, but not from the direction of the sun. Rather, it gets it from the opposite direction, via the earth's surface.

Air only slightly absorbs the sun's heat rays; most of the radiation passes directly through the atmosphere and hits the ground. The sun, by radiation, warms the ground and the ground, by convection, then warms the air.

So what atmospheric scientists would like to know for their models is exactly how much energy is being transferred vertically between the ground and the atmosphere.

Scientists around the world have devised various instruments for measuring the energy flow, but have had some problems in getting commonly agreed and accurate figures. One reason is the erratic way convection currents flow.

Picture a hot desert. Shimmering images produced by random eddies of rising heat can be seen. It is by means of these ephemeral swirling eddies that energy, in three forms, is transferred.

Energy associated with rise in temperature is one form. In the second form energy is expended to evaporate water. The third involves the movement of a parcel of air (wind); in this case energy is lost from the atmosphere to the earth — by friction — as the wind drags on the surface.

These energy forms can be measured using special thermometers, wind-speed recorders, humidity sensors, and other devices — mounted on the ground and on towers. It's possible to smooth out the erratic behaviour of convection currents by averaging readings over a long time. However, the answer is still uncertain because instruments may miss very fast fluctuations or over-react to sudden changes.

A flat site like Conargo has the advantage that measurements of energy flow taken there represent those for a large area. Winds are uniform, undisturbed by any obstacles.

This allows several instruments, placed at different spots, to be compared. They should give the same answer, permitting one type of instrument to be calibrated against another. They should, but then in previous experiments at other sites things haven't turned out to be so easy.

The last international comparison, held at Tsimlyansk in Russia in 1970, produced differences in measurements of up to 20%. The most troublesome quantity is the latent heat figure. However, new water-vapour sensors have been developed during the last few years and it is hoped that the Conargo expedition will have errors reduced to only a few per cent.

Dr Arch Dyer and Dr John Garratt, of the Division, chose Conargo as giving the best opportunity for minimizing errors. The Tsimlyansk site had a slope of 1°; Conargo, while similar to the Russian steppes, is flatter still.

At the time of writing, the scientists are hoping for good weather for their 4 weeks of observations — steady winds and clear sunny skies. As yet they can't predict if that's what they will get — but they're working on it.