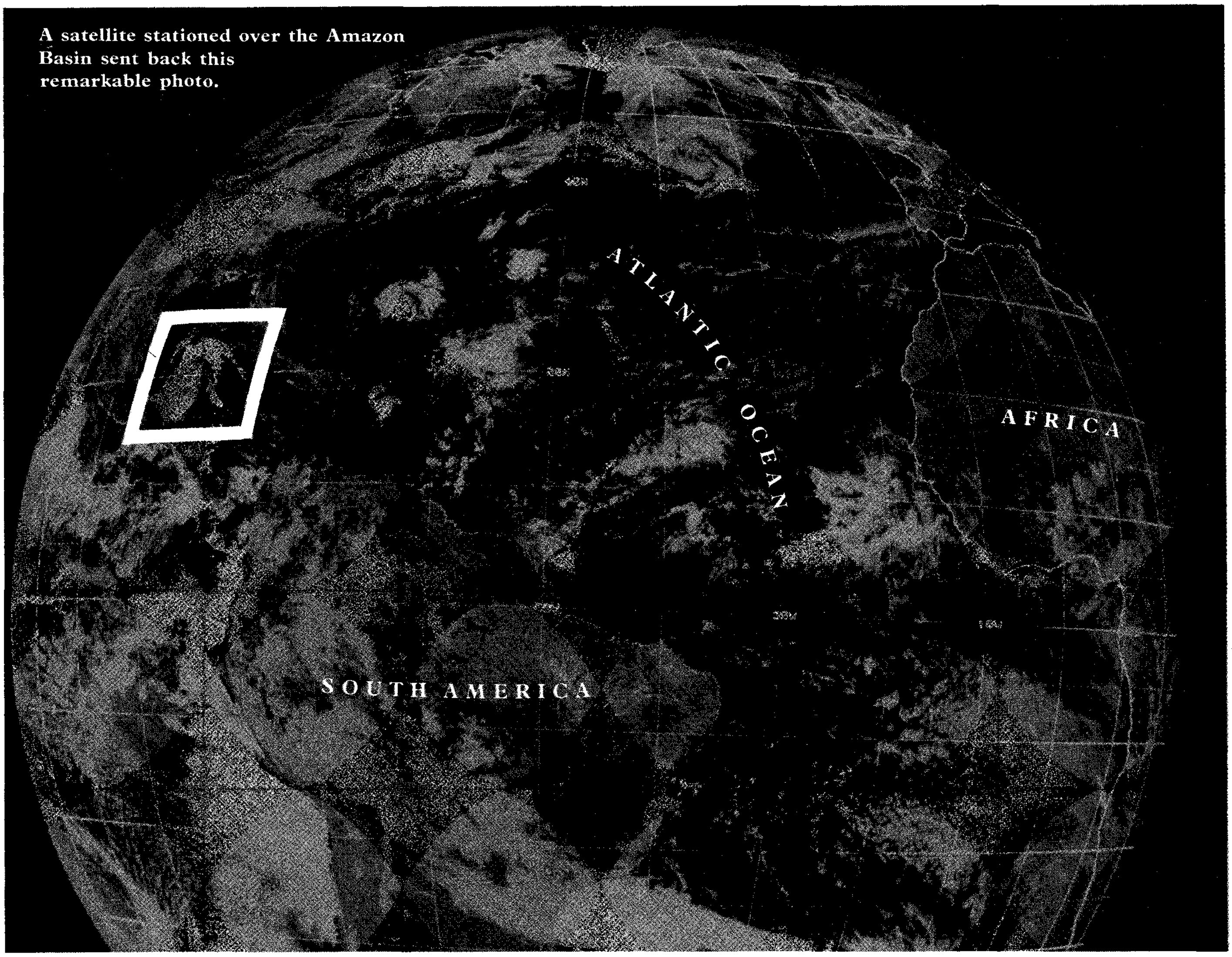


A satellite stationed over the Amazon Basin sent back this remarkable photo.

should be accompanied by a temperature rise of 0·3°C on the ground and a 1% increase in cloud cover. Observations from weather satellites confirm the cloud cover prediction; cloud increases between July and January by about 6%, and so does the radiation energy supplied to the earth—because of the decrease in the distance between the sun and the earth.

Scientists at the Division are also examining interactions between the sea and air, which may have big effects on climate. In an experiment about to begin, a buoy, designed at the Division, will be launched from the south coast of Western Australia and, hopefully, will be recovered south of Tasmania a few months later. It will send radio signals to an American satellite overhead, which will relay data back to Aspendale.

Instruments on the buoy will measure moisture and heat movement between sea and air, and the transfer of momentum from the ocean to the air when strong winds whip up the ocean surface. The buoy will keep a record of its observations, so if it is recovered the scientists will be able to check the recorded data against the information transmitted by the satellite. If the experiment works well, more buoys may follow.

Also in pursuit of information on air–sea interactions, a group from the Division took part last year in an international study in the South China Sea, setting up measuring instruments on three low-lying reefs. During the winter months the ocean surface there is 10°C warmer than the air—the biggest difference anywhere in the world—and the scientists expect to learn a lot from the study, which continues this year.

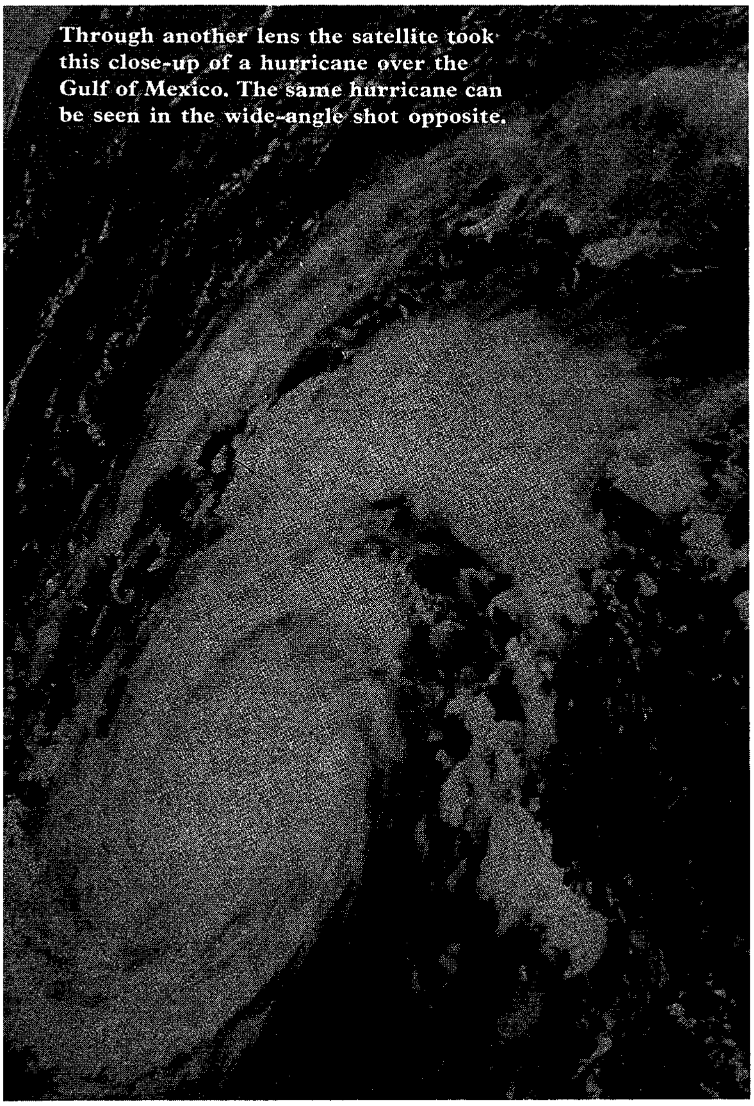
Models and maths

Mathematical modelling of the atmosphere involves representing atmospheric processes in the form of equations. Data describing atmospheric conditions are put to work in these equations. If the equations represent reality accurately and the input data are adequate, the output data will describe atmospheric conditions that can be expected to exist at some set time in the future.

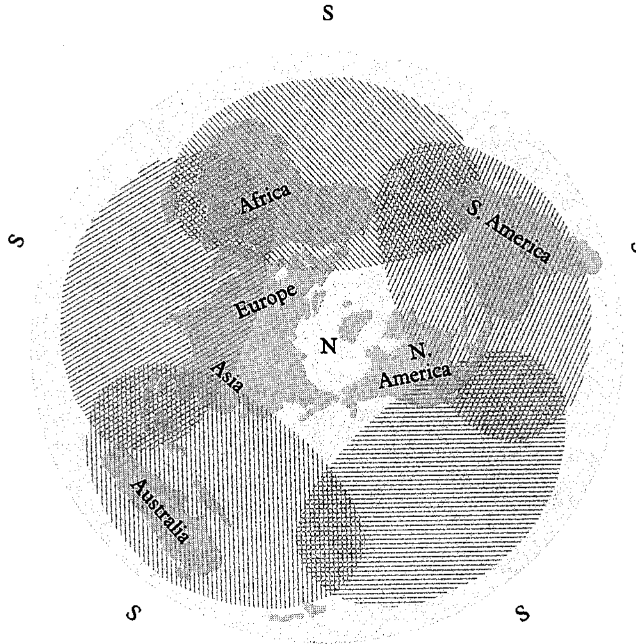
Realistic atmospheric modelling would not be possible without computers—because the atmosphere's activities are so complex. For example, the models used by the Bureau in 24-hour weather forecasting deal with several million pieces of information for each forecast. The Bureau's computer takes about 100 minutes to process all this information.

Although climate forecasting is not yet possible, models are helping to build up understanding of atmospheric processes that can lead to changed weather patterns. In one recent experiment, scientists at the Centre used a model to look at what would happen if the temperature of the ocean surface rose by up to 4°C over an area about the size of Australia centred just east of New Zealand. One outcome predicted was a big reduction in rainfall over New South Wales and Queensland.

In another experiment, they looked at possible effects of debris deposited in the upper atmosphere by a volcano erupting



Proposed satellite coverage



The shaded areas show the fields of vision of the five satellites in the G.A.R.P. project scheduled for 1977.

in the tropics. The computer output suggested that average temperatures would fall noticeably near the equator and the Poles, but hardly at all in the subtropics.

Checking against reality

The results of experiments like these can sometimes be tested by observations. When this is possible, the scientists gain a good idea of how accurate their models are. Checking against reality is a very important part of the development of atmospheric models.

Improvements in modelling techniques, as well as in observations and understanding of atmospheric processes, are bringing closer the day when climate forecasting may prove possible. Recently scientists at the Centre have excited interest around the world with their development of a way of representing the atmosphere using wave patterns rather than the normal grids of points. Trials with a wave-based weather forecasting model have proved very successful, and possible applications in climate work are being looked at.

Climate can change

Big long-term changes in climate have occurred in the past. As Dr Tucker pointed out in a recent radio talk, the North and South Poles have probably been free of ice for about 900 million of the past 1000 million years, so average temperatures have been quite a lot warmer than they are now. That big changes have happened in relatively recent times is shown by evidence of past civilizations in what is now the Sahara Desert and agricultural settlements in parts of Greenland now covered by ice.

However, he also pointed out that big changes occur in weather patterns from year to year when no long-term climatic change is under way. 'Eighteen months ago we experienced the last in a succession of pretty nasty droughts in Australia, but no drought statements have been issued since May 1973', he said. 'Recently floods have been the thing. Perhaps we can thank Dorothea MacKellar that here these variations are regarded as normal and prompt little speculation of climate change.' Her poem 'My Country', with its description of Australia as a land 'of droughts and flooding rains', is part of our folklore.

The prospects for predicting climate change? Dr Tucker believes it will become possible, but not in the near future. He expects season-to-season climate forecasting to be considerably easier to achieve than accurate year-to-year prediction. He thinks it will be some time before scientists will understand the atmosphere's processes in sufficient detail to produce models that will make accurate long-term climate prediction possible.

More about the topic

'Annual Report 1973–74.' (Australian Numerical Meteorology Research Centre: Melbourne 1974.)

Focus on Southern Hemisphere problems in dynamical meteorology, G. B. Tucker. *WMO Bulletin*, 1971, **20,** 232–7.