Clouds clearing from climate predictions

For scientists trying to forecast how the world will react to the burgeoning burden of greenhouse gases, clouds pose a vexing question mark. No one really knows how these puffy masses of ice and water droplets fit into today's climate puzzle, let alone that of the next century. Now a pioneering satellite experiment is beginning to clear the haze.

In the Jan. 6 SCIENCE, a research team reports the first set of major results from the Earth Radiation Budget Experiment (ERBE), a project using three Earth-orbiting satellites to obtain direct measurements of radiation entering and leaving the atmosphere.

"This data tells us for the first time how clouds are influencing the present-day climate," says atmospheric scientist V. Ramanathan from the University of Chicago, who worked on the ERBE project with colleagues from the State University of New York at Stony Brook, the NASA Langley Research Center in Hampton, Va., and the University of Washington in Seattle. "Many consider the cloud-climate problem the Gordian knot of the whole issue of global change, and I think our study has made a crack there," Ramanathan says.

Clouds have perplexed scientists in part because they play two opposing roles in the atmosphere. In the overall energy story, short-wave radiation from the sun continuously bombards the Earth, which absorbs the energy and emits longer-wave radiation toward space. Clouds cool the Earth by reflecting solar radiation before it penetrates the lower atmosphere. Yet they also warm the planet by trapping infrared radiation emitted by Earth's surface.

Before the first two ERBE satellites went up in 1984, climate researchers attempted to study clouds' effects using indirect inferences from other observations. ERBE, however, focuses on this specific question. Orbiting above the top of the atmosphere, its sensors measure incoming solar short-wave radiation, short-wave radiation reflected off cloud tops and long-wave radiation coming from Earth. Researchers can directly assess the role of clouds by comparing observations from clear patches of sky with those from cloudy areas.

This first report of ERBE cloud results includes one month of measurements from April 1985 and some incomplete data from three other months in 1985 and early 1986, all of which were collected before the launch of the third satellite in the project. With only parts of a single year yet analyzed, the information is still quite sketchy, and it will take years to develop a true record. Yet the team believes its initial conclusions about general relationships will not change, Ramanathan says.

The ERBE data show that on the global average, clouds cool the Earth more than they heat it. While most scientists expected this finding, none knew the size of the difference, says ERBE science team member Robert D. Cess from Stony Brook.

The data indicate the net cooling from clouds equals a substantial 13.2 watts per square meter. For comparison, a mere 4 watts per square meter in *heating* from a doubling in atmospheric carbon dioxide should warm the climate by 3.5°C to 5°C, according to computer models.

With clouds exerting such a strong effect on the present climate, they become an extremely important — yet poorly understood — variable in global warming forecasts. As the Earth warms, clouds may gain cooling power and temper the heating, or they could amplify the temperature rise through unknown feedbacks. The debate on this issue is just starting to heat up.

ERBE and other experiments measuring cloud cover and composition will help bring out a verdict. Experts are now attempting to build realistic simulations of clouds into their computer models of the atmosphere and oceans, known as general circulation models. The satellite data will give them real observations to match against their computer predictions.

Says Cess, "What these measurements from ERBE give us is a way of testing at least one aspect of the general circulation models: that is, how well they reproduce cloud radiative forcing in the present climate. If they don't do that well, then we can't trust them as far as projecting future climate changes."

The ERBE results reveal some unexpected cloud relationships that the models will have to duplicate. Over the tropics, the heating and cooling effects of clouds almost balance out, while over the ocean storm tracks in the midlatitudes, clouds do their most powerful cooling.

Some modelers are wasting no time in using the new data. Michael E. Schlesinger from Oregon State University in Corvallis says, "This has been eagerly awaited. I've been trying for years, literally, to get the ERBE team to finish their analysis and make the data available."

Schlesinger cautions, though, that in spite of their improvement over previous sources of cloud information, the ERBE measurements have problems of their own.

The satellite sensors only examine one 35-square-kilometer patch of ground at a single instant, so ERBE analysts use various techniques to estimate the radiation coming from other parts of the globe. Says Schlesinger, "That's a very large challenge to make that work — and to know if in fact you have made it work."

— R. Monastersky

Receptor gene found for brain protein

Scientists have isolated and cloned a rat gene that codes for a brain protein implicated in human cases of schizophrenia, cocaine addiction and Parkinson's disease. Biologist Olivier Civelli of the Oregon Health Sciences University in Portland and his colleagues say the finding may lead to more effective medications for psychotic and movement disorders. The discovery may also aid in the search for inherited influences in mental disorders, the investigators report in the Dec. 22/29 NATURE.

The brain protein, called the D2 dopamine receptor, can now be reproduced through genetic engineering techniques. Dopamine is a key neurotransmitter, or chemical messenger, in the brain. Dopamine and its two known receptors on the surface of brain cells — the D1 and D2 receptors — are involved in controlling movement, motivation and emotions.

Work is now underway to unravel the chemical makeup of the rat receptor gene, Civelli says, as well as that of its human counterpart, which the same scientists recently isolated. "The receptor gene provides a direct means for studying the blockage of D2 dopamine receptors, the presumed mechanism of action for antipsychotic drugs," he notes.

Overactivity of the dopamine system has been linked to schizophrenia for several decades, but the extent of its role in the disorder remains unclear. Drugs that block the D2 dopamine receptor relieve some schizophrenic symptoms but can also produce a severe movement disorder known as tardive dyskinesia (SN: 7/20/85, p.45).

Chemically defining the D2 receptor may enable scientists to locate other dopamine receptors, Civelli says. Then drugs might be designed to affect only specific receptors that relieve schizophrenic symptoms without serious side effects.

The Oregon scientists hope to investigate whether there is a surplus of messenger RNA — a molecule involved in producing proteins — from the D2 receptor gene in schizophrenics' brains. In addition, they plan to compare the chemical arrangement of the gene in schizophrenics to that observed in healthy individuals.

Reduced dopamine activity is also associated with neurological conditions such as Parkinson's disease. Moreover, cocaine and amphetamines appear to increase dopamine activity by prolonging dopamine's effects on brain cells.

Further study of the D2 receptor gene in these disorders depends on obtaining human brain tissue for laboratory experiments, Civelli says.

— B. Bower