

The proposition that Paris proved undecidable concerns numbers called Ramsey numbers—after the British mathematician and economist Frank Ramsey—that count patterns of interactions between members of a finite set. The most elementary of the Ramsey numbers concern, for instance, the numbers of ways in which people at a party can be introduced to each other. The Ramsey numbers grow very large very quickly, so rapidly in fact that they outstrip the power of the axioms of arithmetic to keep pace with them. Paris showed that the existence of certain Ramsey numbers could not be deduced from the standard axioms of arithmetic, even though their existence is guaranteed by more sophisticated reasoning dealing with infinite Ramsey numbers.

Paris's proof used methods of model theory and nonstandard analysis (SN: 2/15/75, p. 108). He discovered an atypical model for the axioms of arithmetic in which the Ramsey conjecture was false. If the Ramsey conjecture were deducible from the axioms of elementary arithmetic, then it would have to be true in every model of arithmetic. Since, as Paris showed, there is at least one model in which it is false, it cannot be provable. Yet in the ordinary model for arithmetic—that studied in school mathematics—the Ramsey conjecture is true.

There are many famous unsolved problems in arithmetic. One of the more famous is the twin prime conjecture that there are infinitely many pairs of prime numbers separated by 2, such as 17, 19; or 41, 43. The undecidability of the Ramsey conjecture makes it now likely that some of these old chestnuts may also be proved undecidable, for it may be easier to relate them to the Ramsey problem—since they both involve numbers—than directly to the axioms of arithmetic or the precepts of logic. □

## Viking biology off

The biology instruments aboard the two Viking landers on Mars, the first devices ever sent to seek signs of life on another planet, have at last been turned off. The two packages operated from July 28 to May 30 and from Sept. 11 to May 28, although scientists are still studying the results. Other lander experiments continue.

The biology instruments may be reactivated, however. Viking's inorganic-chemistry team wants the radioactivity counters in the pyrolytic-release experiments to monitor background radiation from the landers' nuclear power plants. The organic-chemistry team, meanwhile, plans to pour a heavy dose of nutrient solution onto a soil sample in the gas-exchange instrument in hopes that the water in the solution would reveal, by exothermic reaction, the possible presence of magnesium sulfate in the soil. □

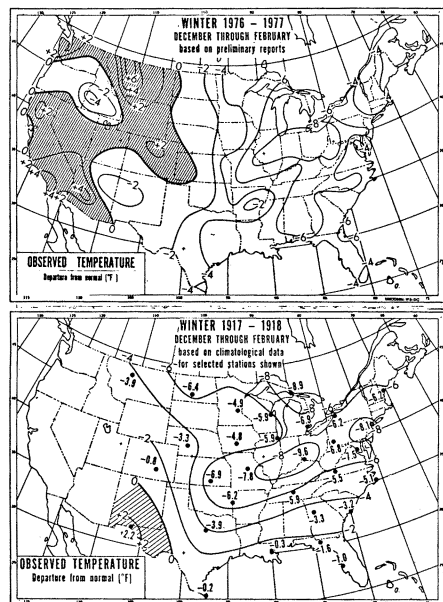
## Severe winters: Search for precursors

Some consolation to the millions of Americans victimized by this year's winter may be that studies of it have provided a better means to anticipate another like it. Meteorologist A. James Wagner has confirmed that the calamitous winter was in part caused by an abnormally high pressure cell above the Arctic. Its persistence further aggravated the devastating effects.

Together with this polar high, an anomalous global pressure pattern conspired to directly channel this frigid Arctic air to eastern North America. This phenomenon attained its greatest ferocity during January 1977, when record snow falls and low temperatures were experienced throughout eastern and southern United States.

Ironically, this same weird combination of pressure highs and lows caused the hot, dry weather over western United States, including Alaska, many parts of which recorded unprecedented mild winters. With similar consequences, warm Atlantic air was rerouted unusually northward and then westward across northern Canada. And to cap off this enormous incongruity, the Arctic was warmed due to the high-pressure cell stationed there.

But some good may come from those three months of agony. Wagner, of the National Oceanic and Atmospheric Administration, searched this century's weather records and discovered another winter, of 1917-1918, that bears a striking resemblance in severity to this year's. The similarities (see diagram) may be enough, Wagner believes, to teach us how better



Two most severe winters of 20th century.

to anticipate another harsh winter. He cautions, however, that present understanding does not yet allow forecasts with certainty. Among other things, Wagner found that the two acute winters were each preceded by an unusually cold fall season throughout eastern and southern United States. Furthermore, each was presaged by the appearance of an "unusually persistent large body of colder-than-normal water in the north-central Pacific." Even though their operation and significance are not yet fully understood, these precursors will put the forecaster on alert to future severe winters. □

## Drinking water safe? Needs research

The bad news on drinking water isn't all that bad, but it isn't good news either. Repeatedly, the final report of the National Research Council Committee on Safe Drinking Water identifies questions where insufficient data preclude reliable judgments. The 18-month study was undertaken to aid the federal officials responsible for establishing water standards. About one hundred scientists helped examine evidence of adverse effects for 161 different elements and compounds present, or likely to be present, in drinking water.

Some of the conclusions:

- Most of the inorganic chemicals considered are of little or no threat to human health. However, current standards for arsenic and lead afford only "meager" margins of safety and should be reexamined.

- The present limit on nitrate concentration in water leaves little margin of safety for avoiding the blood disease methemoglobinemia in some infants. On the other hand, current scientific evidence

does not indicate that nitrate in water increases risk of cancer.

- Available evidence does not support claims that fluoridation increases cancer mortality, mongolism or birth defects. The only clear effects of water fluoridation, besides the decrease in dental cavities, is discoloration of tooth enamel and increased bone density, effects not generally considered harmful.

- Chlorination of water has had unparalleled success in controlling waterborne infectious disease, especially typhoid fever. This clear benefit must be considered against the risk that chlorine may form suspected carcinogens in water. The committee concludes "much more research is required before any of the proposed substitutes can be recommended to replace it [chlorine] in water treatment."

- The study calls "plausible" the hypothesis that hard water (high in calcium and magnesium) decreases risk of heart disease, hypertension and strokes. If that hypothesis holds, optimal condition-