S&E
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EL NIÑO: THE WEATHER MAKER

This year's El Niño – which is causing disruptions in weather around the world – is one of the strongest since observations began in the first half of the century.

It is even stronger than the 1982-83 El Niño, which was called "the El Niño of the century". The effects of the current El Nino are being felt worldwide. In southeast Asia, the early arrival of the dry summer season contributed to drought and extreme forest fires that blanketed the region in smoke and haze. In Canada, Edmonton recorded the warmest December ever as well as the third driest. A dearth of snow meant a "brown" Christmas throughout most of the prairies.

Environment Canada scientists have been studying the impact of El Niño and its counterpart, La Niña, on precipitation patterns throughout Canada. Their findings were recently published in the *Journal of Climate*. They indicate that, between 1911 and 1994, there were 22 El Niño and 14 La Niña years. The study found that, across southern Canada from B.C. to the Great Lakes region, winter precipitation is about 15% below normal in El Niño years, while La Niña years tend to bring an increase of nearly 15% compared to normal winter precipitation.

The study found, however, significant year-to-year variation in precipitation associated with individual El Niño or La Niña events. Its authors note that a detailed investigation of characteristics of individual events, such as their intensity, duration, and spatial extent, as well as more detailed analyses of the regional characteristics of precipitation within Canada, could provide further insight into the relationship between Canadian precipitation and El Niño.

The scientists' findings about the links between precipitation levels and El Niño and La Niña years have led them to develop a long-range forecasting technique for Canadian precipitation. The statistical techniques developed have been incorporated

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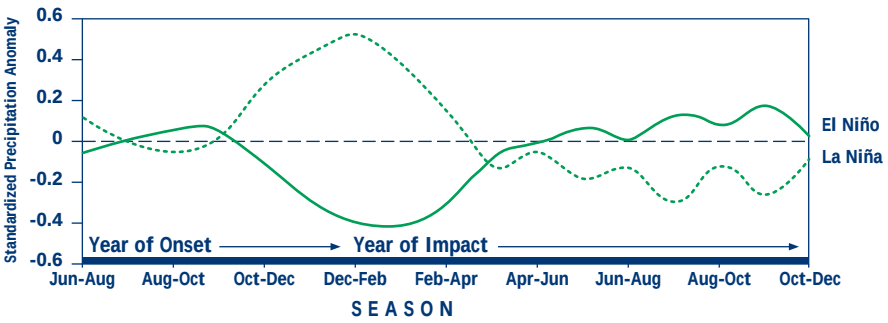
Typical behaviour of precipitation over southern Canada (averaged from southern British Colombia through the southern Prairies and into the Great Lakes region) from the onset of El Niño/La Niña events to several seasons afterwards.



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into their long-term precipitation forecasts.

El Niño and La Niña occur during the extreme phases of what climatologists call the Southern Oscillation – defined as the difference between high air pressure in the eastern Pacific, near Tahiti, and low air pressure in the western Pacific, near Australia and southeast Asia. During an El Niño year, the pattern reverses, and pressures become low in the eastern Pacific and high in the western Pacific. Normally cool waters in the eastern Pacific Ocean off the coasts of Ecuador and Peru become warmer. Scientists believe the reason lies in reduced or reversed Trade Winds, which normally drive warm water westward to Indonesia and Australia, leaving cooler water along the South American coast.

When the Trade Winds are reduced or reversed, the warmed water off Ecuador and Peru causes heat and moisture to rise from the ocean, leading to more frequent storms and torrential rainfall over these normally dry countries.

El Niño also causes the jet stream, which originates in the central Pacific, to split over North America, with a weaker branch diverted northward into the Northwest Territories and a lower branch shifted south. The southern Canadian region, located between the two arms of the jet stream, receives a milder and warmer winter.

La Niña refers to a cooler pool of ocean water off South America. It occurs when the normal pressure pattern of the Southern Oscillation intensifies. This usually brings colder winters to the Canadian west and Alaska, and drier, warmer weather to the American southeast.

El Niño on Environment Canada's Green Lane: www.ec.gc.ca

TROPOSPHERIC OZONE

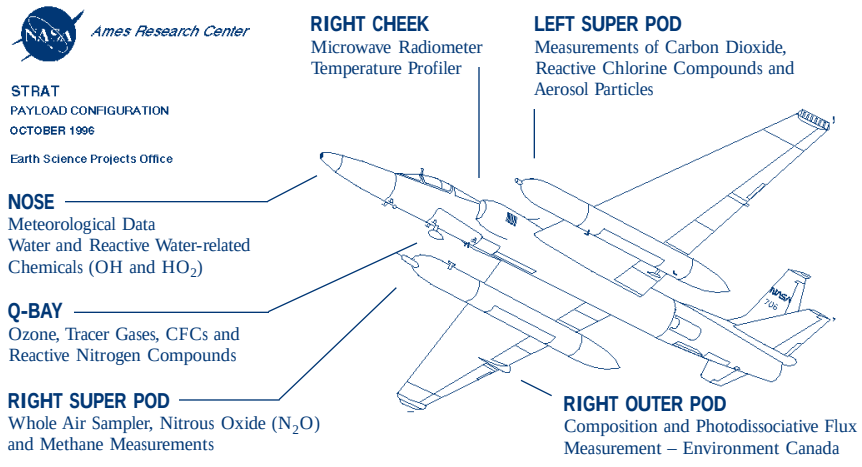
Environment Canada is participating in a scientific team that has discovered rising ozone levels in our lower atmosphere. And even though decreasing ozone levels have been a subject of concern for more than a decade, this is not good news.

The difference? The rising ozone levels are in the troposphere, between the surface and about 8 kilometres above the Earth. Rather than just protecting the Earth from ultraviolet rays, as stratospheric ozone does, this ozone could, in fact, be a contributor to global climate change – although nowhere near as great a contributor as carbon dioxide.

The scientists, led by Paul Wennberg of Harvard University, used an American high-altitude aircraft to probe the chemistry of the troposphere. They found that tropospheric ozone was being produced at a rate of about one part per billion by volume each day, a faster rate of production than had previously been assumed. Their findings were published in the January 1998 issue of *Science* magazine.

The scientists concluded that human activities that add reactive nitrogen compounds to the upper troposphere, such as emissions from airplane exhaust and land-clearing forest fires, are responsible. The presence of reactive forms of nitrogen causes each molecule of hydrogen dioxide (HO_2) in the troposphere to generate more ozone before it is destroyed than it would otherwise. As well, reactive nitrogen causes the production of more molecules of HO_2. In fact, in some air masses with very high reactive nitrogen content (possibly because of the recent passage of aircraft), the scientists predicted an ozone production rate of as high as five parts per billion per day.

Increased ozone levels can trap some of the sun's heat before it travels back out into space, and this leads to increased average global temperatures. To put it in perspective, however, the paper estimates that, since the Industrial Revolution, tropospheric ozone may have added as much as 0.4 watts per metre squared heating at the Earth's surface – compared to the 2.5 watts per metre squared that has been added by other greenhouse gases, such as carbon dioxide and CFCs.



HEALTH AND ATMOSPHERE BOTH BENEFIT FROM REDUCING SULPHUR IN GASOLINE

Reducing levels of sulphur in gasoline would cut the emission of air pollutants and prevent premature deaths, as well as a large number of other health problems, including respiratory illness in children.

In 1995, the Canadian Council of Ministers of the Environment directed Environment Canada to determine, in consultation with provinces and interested parties, an appropriate level of sulphur in gasoline. Scientific and engineering expert panels with members from industry, academia, and government worked together to determine the benefits and costs of reducing sulphur levels. Their findings are assisting Environment Canada in determining what the appropriate level should be.

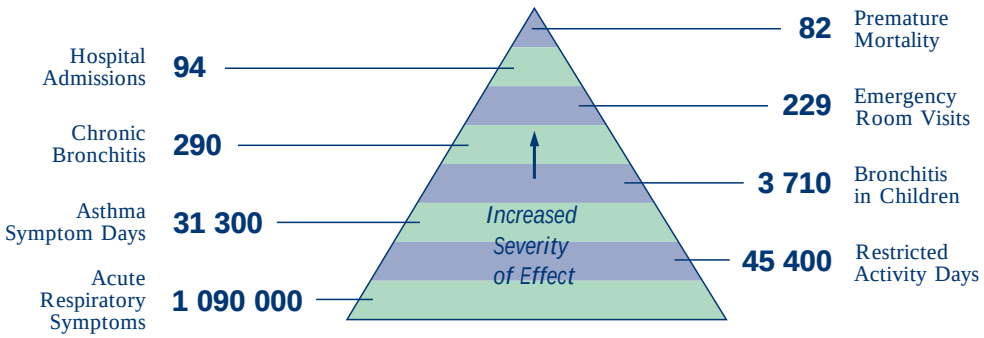
The *Atmospheric Science Experts Panel Report* evaluated emissions reductions for seven Canadian cities representing approximately 40% of the country's population. It found that reducing sulphur in gasoline and diesel fuel would significantly lower emissions of sulphur dioxide, the formation of sulphates and directly-emitted sulphates, nitrogen oxides, carbon monoxide and volatile organic compounds (VOCs). The largest declines in emissions would occur in Toronto and Montreal, where current sulphur levels in gasoline are highest and gasoline consumption is the greatest. Smaller declines were predicted for ground-level ozone (the principal component of smog).

The *Health and Environmental Impact Assessment Panel Report* estimated that, by the year 2020, for seven Canadian cities, reducing sulphur levels in gasoline to 30 parts per million (ppm) would result in approximately 82 avoided premature deaths, 3 700 avoided respiratory illness cases in children, more than 30 000 fewer acute asthma symptom days and a large reduction in other respiratory problems each year. In 1994, the average sulphur level in Canadian gasoline was 360 parts per million (ppm). Thirty ppm is the current California standard and the design basis for low-emission vehicles.

The *Cost and Competitiveness Panel Reports* estimate it would cost industry $1.8 billion in capital expenditures, and $119 million per year in operating expenses to reduce sulphur in gasoline to 30 ppm. The costs would be borne unequally amongst the 17 Canadian refineries. A varying proportion of the total costs of about one cent per litre is expected to be passed on to consumers. Those refineries experiencing higher costs and less capability to recover them may face economic challenges.

Environment Canada continues to work with its provincial counterparts, and in consultation with interested parties, to establish an appropriate level of sulphur in gasoline and diesel fuel.

Estimated health effects avoided in the year 2020, in 7 Canadian cities, by reducing sulphur in gasoline to an average of 30 ppm.



RISING GOOSE POPULATIONS ENDANGER ARCTIC HABITAT

The population of Ross' and Snow Geese nesting in the Karrak Lake area of the Queen Maud Gulf Region is increasing exponentially, according to Environment Canada scientists from the Prairie and Northern Wildlife Research Centre in Saskatoon – and this is putting the birds' Arctic habitat at risk.

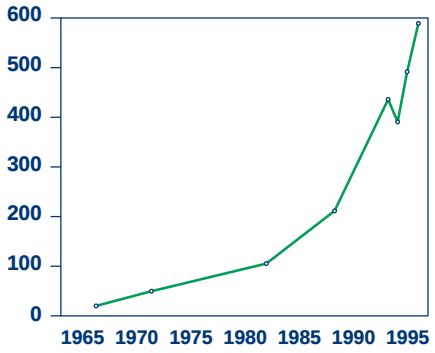
When the colony – the largest in the region – was first discovered in 1966, 17 000 nesting geese were confined to a few islands, amounting to 0.7 km^2. By 1982, nesting had spread to mainland habitats, and, by 1996, scientists counted more than 650 000 nesting geese, occupying 108.7 km^2 of terrestrial habitat.

In feeding and nesting, geese destroy vegetation and expose the underlying organic soil layer which, following erosion, leaves only exposed mineral soil. Canadian Wildlife Service scientists using Landsat imagery and Geographic Information Systems have been able to confirm that the conversion from vegetation to exposed peats and mineral soils has been extensive. By 1989 for example, 52% of plant communities within the area occupied by nesting geese at Karrak Lake had lost their vegetation and eroded to exposed peat, and a further 7% had eroded to bare mineral soils. Because erosion allows increasing amounts of soil nutrients to wash away into the surrounding watershed, loss of vegetation may ultimately lead to desertification.

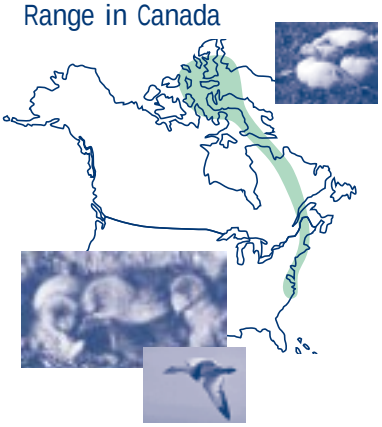
Scientists urge that the goose population be reduced to stem further destruction of Arctic habitats. It is thought that populations are increasing because the geese are able to exploit agricultural foods during winter months. As well, long-term warming of parts of the Arctic may increase reproductive rates each summer.

The research is part of a study of fluctuations in the spring and fall populations of Ross' Geese. Scientists will use the information to learn about factors that most affect goose population sizes.

Combined Number of Snow and Ross Geese (x 1000) from 1965-95



Greater Snow Goose Range in Canada



Greater Snow Goose Management Plan

The Greater Snow Goose causes estimated agricultural losses of $750 000 a year in the St. Lawrence estuary region. Determined to find a balanced solution, in the spring the 1997, Environment Canada launched an action plan involving stakeholders from the agricultural and tourism industries, local and municipal governments, naturalists, conservationists and hunters. The plan includes:

- a program to scare geese from sensitive areas without killing them;
- creating feeding grounds in the Regional Municipality of Montmagny, its archipelago and the Réserve nationale de faune du cap Tourmente;
- compensating landowners who agree to use their lands as feeding areas.

El Niño: Facts & Figures

- El Niños have been documented since the early 1700s. It was only in the 1970s, however, that scientists began linking El Niño to massive flooding and severe droughts around the world.
- El Niño is the second-largest driver of the world's weather, second only to normal seasonal warming and cooling.
- El Niños appear approximately every two to seven years, and typically last 12-18 months. In the early 1990s, a protracted El Niño persisted for four years.