AIR POLLUTION IN COLD REGIONS

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Contents

1. Introduction
2. Arctic Air Pollution
2.1. Particulate Matter
2.1.1. Introduction
2.1.2. Long Term Monitoring Programs
2.1.3. Source-Receptor Relationships
2.1.4. Concentration Trends
2.2. Arctic Photochemistry
3. Antarctic Pollution
4. Conclusions
Glossary
Bibliography
Biographical Sketch

Summary

This chapter provides an overview of the nature of the constituents in the atmosphere and the changes in concentrations of these constituents that is termed air pollution. The focus will be on the changes in the cold regions of the earth with emphasis on the polar areas, the Arctic and the Antarctic. Although there is limited anthropogenic activity in these areas, there are concentrations of atmospheric constituents that are above those levels that are likely to have been present before the start of the industrial revolution. These changes can be both qualitative and quantitative. The nature of the sources, transport, and chemical processes that lead to the pollution of these regions is described.

1. Introduction

The atmosphere is a complex chemical system that has evolved through interactions with the lithosphere, hydrosphere and biosphere. Gases and particles are exchanged between the surfaces of the land and water. There are gaseous and particulate emissions from plants and animals as well as from anthropogenic activities. They undergo complex chemical processing driven primarily by sunlight so that the cold regions of the world present unique circumstances because there are periods with no or so little sunlight as to halt photochemical processing. Although the atmosphere is not partitioned, there are physical impediments to vertical and horizontal mixing that permits the consideration of compartments that exhibit different physical and chemical behavior.

The troposphere is the lowest layer of the atmosphere; it begins at the surface and extends to between 7 km (23,000 ft) at the poles and 17 km (60,000 ft) at the equator, with some variation due to weather factors. The stratosphere extends from the troposphere's 7 to 17 km (23,000 – 60,000 ft) range to about 50 km (160,000 ft) with temperature increasing with height. The stratosphere contains the ozone layer, the part of the Earth's atmosphere that contains ozone in relatively high concentrations (parts per million levels). Above the stratosphere are the mesosphere and thermosphere, but these regions will not be discussed here.

The bulk of the atmosphere consists of nitrogen (78.0842%), oxygen (20.9463%), and argon (0.93422%) with significantly lower concentrations of CO_2 (0.03811%), CH_4 (0.0001745%), N_2O (0.00005%), and varying concentrations of water vapor (~0.25% over full atmosphere, typically 1% to 4% near surface). There are a number of minor species with much higher variability in their concentrations where the variability of the concentrations is inversely related to the reactivity. In cold regions, there are generally limited sources and at the lower temperatures, chemical reactions occur at lower rates. Thus, these regions, the Arctic and Antarctic, are generally thought to be relatively pristine in terms of the air quality. However, over the past 3 decades, measurements have been made characterizing the air quality in these regions and it has been found to have greater air pollution than had originally been believed. This chapter summarizes the nature of air quality in the Arctic and the Antarctic regions.

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Biographical Sketch

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