# The 2000 Aljoya Consensus Statement on Long-Range Transport in the North Pacific

**Long-Range Atmospheric Transport and Effects of Contaminants in the North Pacific Region:**

**Knowledge, Concerns & Research Needs**

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### THE PROBLEM

Long-range atmospheric transport of contaminants in the Pacific Ocean region north of the equator, as elsewhere in the world, increases the risk of adverse effects to wildlife, ecosystems, climate, and human health and livelihood. Current levels of contaminants transported to and deposited in the north Pacific region are of concern. Unless preventative measures are taken, levels will increase due to continued economic growth in the region and the rest of the world.

Long-range transport of contaminants in the north Pacific is one of many inter-continental and trans-oceanic pathways of concern within a larger context of global atmospheric exchange of contaminants in which all countries participate as both sources and receptors. Other pathways of concern include Saharan dust transport over the tropical Atlantic to the Americas, North American pollutant movement across the North Atlantic, European pollution carried to Asia, and the transport of northern Eurasian contaminants over the frozen Arctic Ocean.

There are numerous atmospheric routes by which contaminants can be carried to and across the Pacific Ocean basin. Research on these "Pacific pathways" and our understanding of attendant physical, chemical, and biological effects due to natural and anthropogenic emissions, transport, transformation, and deposition of contaminants in the region is still in the formative stages. Existing knowledge is scattered among a wide variety of disciplines, programs, and individual research projects. To date, no attempt has been made to synthesize, summarize, and evaluate the various strands of research.

For this reason, an international and multidisciplinary group of over 100 experts gathered at the Aljoya Conference Center in Seattle, Washington, USA, 27-29 July 2000 for the First International Conference on Trans-Pacific Transport of Atmospheric Contaminants. Participants included experts in the fields of energy and emissions, atmospheric sciences, marine sciences, biogeochemistry, forestry, biological sciences, and international environmental policy. The objectives of the conference were to:

1. Discuss the state of science on long-range atmospheric transport of contaminants in the North Pacific region, including identifying initial conclusions to be drawn from existing data;
2. Discuss scientific research needs required to clarify uncertainties and gaps in our knowledge;

3. Promote a network of individuals and organizations in the Pacific and other regions interested in addressing the emission, transport, transformation, deposition, and effects of atmospheric contaminants transported in the Pacific region.

The conference Steering Committee (Appendix 1) finalized this consensus statement, which was developed with input from all conference participants (Appendix 2) acting in an individual and unofficial capacity. The three-day conference included presentations, small group discussions broken out by specialty, a plenary session of open discussion on a draft of the statement, and finalizing of the statement by the conference Steering Committee.

## OUR KNOWLEDGE

· A large number of contaminants released into the global atmosphere as a result of human activity and natural processes can affect the Pacific region. Contaminants include: gaseous species such as ozone; aerosols such as sulfates; persistent organic pollutants (POPs) such as DDT; heavy metals such as mercury; and radionuclides such as cesium-137.

· Lower atmospheric circulation patterns that carry contaminants in the Pacific region north of the equator include the equatorial northeasterly trade winds and the mid-latitude westerlies. In the middle to upper troposphere, west to east concentric atmospheric flows around the pole tend to prevail. Persistent climatological features—such as the Siberian High, the Aleutian Low, sub-tropical high pressure cells, and the inter-tropical convergence zone (ITCZ)—and topographically affected winds, vertical mixing, and precipitation, result in highly variable contaminant pathways across the Pacific.

· Patterns of long-range transport and deposition of atmospheric contaminants in the Pacific region are modulated in large part by variations in emissions and meteorological conditions, and by global ocean circulation.

· On a seasonal basis, gaseous and aerosol contaminants introduced into the north Pacific airshed can be transported thousands of kilometers in less than a week. For example, during the winter-spring period at latitudes greater than 20° N, eastward transport of atmospheric contaminants occurs off the land masses in the western portion of the Pacific Rim, while during the summer months westward transport on the tradewinds occurs from North and Central America.

· Evidence shows that some of the contaminants transported in the north Pacific region originate outside the region.

· Rates of deposition of contaminants are influenced by meteorological and topographical conditions, and air-surface exchange processes.

· Visible contaminant layers have been detected over remote and pristine continental areas and tracked to long-range transport in the north Pacific region.

· Mineral dust aerosols originating primarily in the deserts and drylands of Asia are periodically transported long distances through the atmosphere into and across the Pacific Ocean basin. There is great seasonal (strongest in winter and spring) and inter-annual variation modulated by synoptic and mesoscale weather patterns. Atmospheric dust events in downwind areas are highly episodic.

· Long-range atmospheric transport of biomass burning contaminants emitted to the Pacific region from Southeast Asia, Siberia, and North and Central America represents a significant source of contaminants to the north Pacific. It varies significantly from year to year.

## OUR CONCERNS

· The nature, magnitude, and spatial distribution of effects of airborne chemicals transported in the Pacific region, including changes in visibility, are largely unknown.

· The chemistry of the troposphere above the Pacific Ocean and of the ocean itself, and contaminant concentrations in terrestrial and aquatic systems, could be significantly impacted due to long-range atmospheric transport.

· Some airborne chemicals, especially organochlorines and mercury, have the potential to enter foodwebs and biomagnify thereby increasing the toxicological risk to top predators, including humans.

· Ocean productivity could be altered by airborne chemicals (for example, nutrients like nitrates and iron) carried from continents and deposited to the Pacific Ocean. Changes in air-surface exchange processes could follow.

· The radiative forcing of the atmosphere over the Pacific Ocean could be changed by airborne contaminants, with implications for global climate change. In turn, global climate change could shift and alter the sources and sinks of contaminants in the Pacific region.

· The suspension, transport, and deposition of dust-borne chemicals to the Pacific and surrounding regions may increase due to desertification exacerbated by human activities.

· Air quality in some areas of the Pacific region, including remote locations, may be negatively affected due to primary or incremental burdens of windblown dust and contaminants transported from distant sources.

· Seasonally and annually varying biomass burning events could contribute to long-term alteration of atmospheric, and possibly marine, chemistry in the Pacific region.

## OUR RESEARCH NEEDS

Key questions, together with recommended research, that address the above concerns are:

A. What are the contributions of anthropogenic emissions in Asia, Europe, and North America to atmospheric contaminant concentrations and deposition in the Pacific region and how will these change in the future?

To answer this question we need to:

1. Develop improved contaminant emission inventories with particular emphasis on those substances for which no inventories now exist;

2. Conduct integrated process studies to better understand transport, transformation, and air-surface exchange of contaminants;
3. Broaden the geographical range and temporal coverage of systematic atmospheric measurements in the Pacific region to include as many contaminants as necessary, as well as vertical profiles, while standardizing and coordinating between programs and nations.

B. How do atmospheric concentrations and deposition of contaminants affect terrestrial and marine ecosystems and human health in the Pacific region?

To answer this question we need to:

1. Study deposition processes of contaminants in the Pacific region and the associated feedback of deposition on atmospheric composition;
2. Undertake "whole system" studies that follow contaminants from atmospheric deposition through terrestrial and aquatic pathways to biological exposure and toxicological effects;
3. Determine geographic distributions and trends of contaminants in freshwater, marine, and terrestrial biota in the Pacific region, and the forces that cause the observed variability;
4. Quantify the risks to humans and marine and terrestrial ecosystems in the Pacific region due to exposure to contaminants.

C. How do atmospheric contaminants in the Pacific region affect regional and global climate?

To answer this question we need to:

1. Conduct process oriented closure experiments of the direct radiative forcing of contaminants and dust in the Pacific basin;
2. Apply satellite and other observations to the analysis of radiative perturbations from anthropogenic aerosols and greenhouse gases over the Pacific;
3. Investigate the impact of aerosols on cloud distributions, radiative properties, and precipitation in the Pacific region.

In conclusion, the widespread distribution of contaminants in the Pacific region, coupled with the expected expansion of human activities, requires that we develop a common scientific understanding of the complex dynamics of long-range transport of atmospheric contaminants in the region. We recommend a "Pacific Environmental Research Strategy" be developed to promote cooperation and coordination between disciplines, programs, countries, and international organizations.

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APPENDIX 1: Steering Committee

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