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Analysis of aircraft and satellite measurements from the Intercontinental Chemical Transport Experiment (INTEX-B) to quantify long-range transport of East Asian sulfur to Canada

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Abstract. We interpret a suite of satellite, aircraft, and ground-based measurements over the North Pacific Ocean and western North America during April–May 2006 as part of the Intercontinental Chemical Transport Experiment Phase B (INTEX-B) campaign to understand the implications of long-range transport of East Asian emissions to North America. The Canadian component of INTEX-B included 33 vertical profiles from a Cessna 207 aircraft equipped with an aerosol mass spectrometer. Long-range transport of organic aerosols was insignificant, contrary to expectations. Measured sulfate plumes in the free troposphere over British Columbia exceeded 2 μg/m^3. We update the global anthropogenic emission inventory in a chemical transport model (GEOS-Chem) and use it to interpret the observations. Aerosol Optical Depth (AOD) retrieved from two satellite instruments (MISR and MODIS) for 2000–2006 are analyzed with GEOS-Chem to estimate an annual growth in Chinese sulfur emissions of 6.2% and 9.6%, respectively. Analysis of aircraft sulfate measurements from the NASA DC-8 over the central Pacific, the NSF C-130 over the east Pacific and the Cessna over British Columbia indicates most Asian sulfate over the ocean is in the lower free troposphere (800–600 hPa), with a decrease in pressure toward land due to orographic effects. We calculate that 56% of the measured sulfate between 500–900 hPa over British Columbia is due to East Asian sources. We find evidence of a 72–85% increase in the relative contribution of East Asian sulfate to the total burden in spring off the northwest coast of the United States since 1985. Campaign-average simulations indicate anthropogenic East Asian sulfur emissions increase mean springtime sulfate in Western Canada at the surface by 0.31 μg/m^3 (~30%) and account for 50% of the overall regional sulfate burden between 1 and 5 km. Mean measured daily surface sulfate concentrations taken in the Vancouver area increase by 0.32 μg/m^3 per 10% increase in the simulated fraction of Asian sulfate, and suggest

current East Asian emissions episodically degrade local air quality by more than 1.5 μg/m^3.

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