The NASA Atmospheric Tomography Mission

A Global-Scale Survey of Composition, Reactivity, and Transport in the Remote Amtosphere

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NASA ATOM EVS-2 ATMOSPHERIC TOMOGRAPHY MISSION

Project Overview

ATom was an extensive, global-scale airborne mission funded through NASA's Earth Venture Subortibal – 2 program (EVS–2) combining intensive in-situ measurements of 100s of trace gases and aerosols with in-depth modeling to characterize the human imprint on the remote atmosphere.

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https://espo.nasa.gov/atom

- ATom utilized the fully instrumented NASA DC-8 research aircraft to collect a broad suite of measurements of trace gases, aerosols, meteorological parameters, and key radical species from the remote troposphere and lower stratosphere.
- Four complete pole-to-pole global circuits (one in each season) were conducted; each circuit included long meridional transects of the Pacific and Atlantic Ocean Basins as well as transects across the Southern Ocean and the Arctic.
- The ATom dataset provides new types of tests for global CCMs, with a focus on data-constrained rates of ozone (O_3) production and loss, methane (CH_4) loss, statistical distributions of species driving these rates, and their links to distant pollution.

Mission Goals & Objectives

GOALS

Improve understanding of atmospheric production and destruction of O_3, and removal of CH_4 and BC, at global scales

Improve the representation of these processes in CCMs

Provide critical data for satellite remote sensing validation

OBJECTIVES

1. Quantify the chemical processed and rates controlling CH_4 and tropospheric O_3 abundances
2. Determine how CH_4 and O_3 are affected by urban, industrial, agricultural, and natural emissions from major source regions
3. Determine the large-scale distributions and size spectra of different aerosol species
4. Determine the mechanisms primarily responsible for new particle formation in the remote atmosphere
5. Determine how aging that occurs during transport affects aerosol removal from the atmosphere
6. Measure greenhouse gases and ozone-depleting substances to identify pollution influences on photochemical reactivity
7. Measure numerous vertical profiles for validation of satellite retrievals and assimilate satellite data into ATom analyses

Mission Characteristics

Defining Characteristics of the ATom Mission Strategy

Comprehensive Measurement Payload

In situ measurements of reactive and long-lived gases, radical precursors, key radical species, aerosols, radiation, and meteorological parameters.

Tomographic, Global-scale Sampling

Continuous airborne profiling from near-surface to ~13 km altitude along pole-to-pole flight tracks in the Pacific and Atlantic Ocean Basins and across the Southern and Arctic Oceans.

Objective Sampling

ATom came as close as possible to achieving a representative ensemble of the background atmosphere by objectively sampling along predefined transects rather than targeting specific airmasses

Focus on the Remote Atmosphere

Flight transects were performed over the remote oceans where in situ observations have been historically sparse

Daytime Flights

Flight times were chosen to maximize solar radiation to evaluate photochemistry and test photochemical models

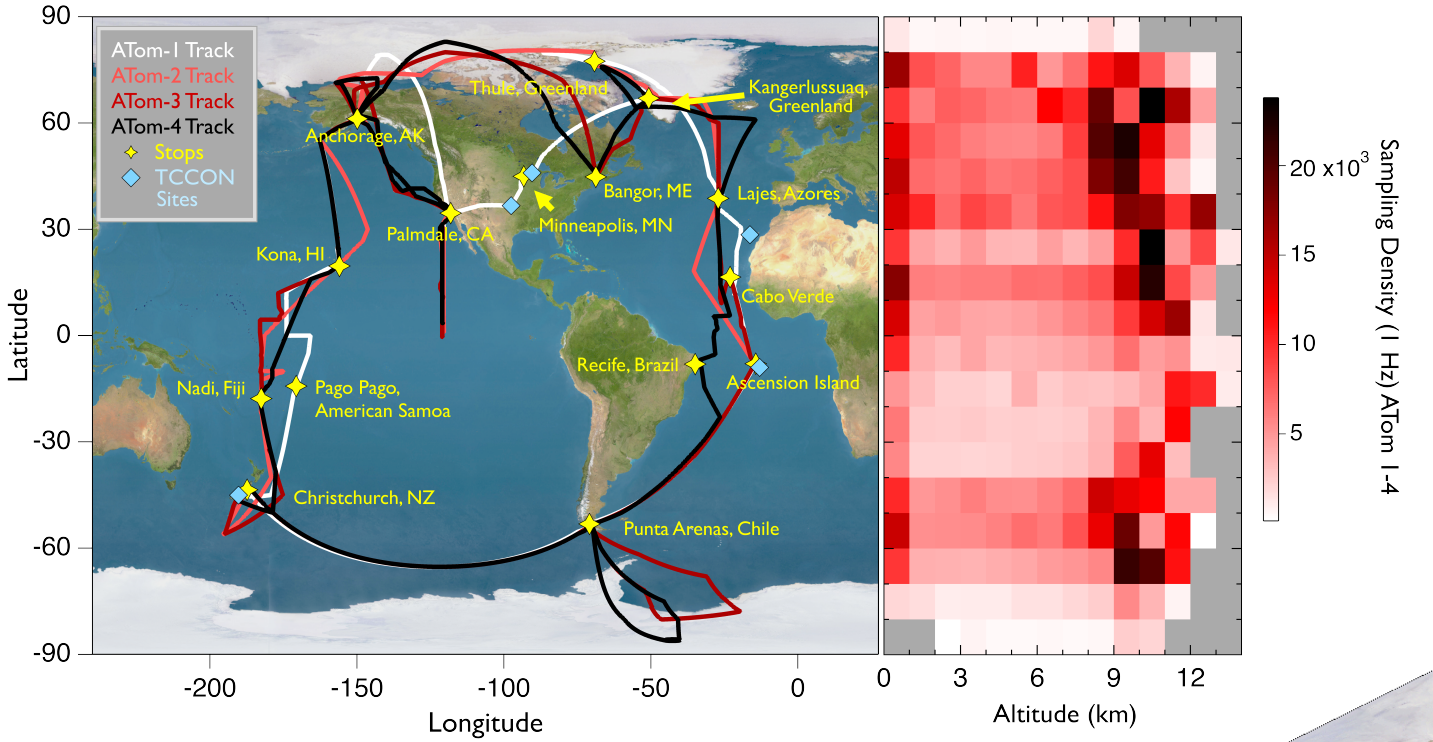
Repeated Deployments

Four complete global circuits performed in the four different seasons to investigate the seasonal variability in composition and reactivity.

Complete Investigation

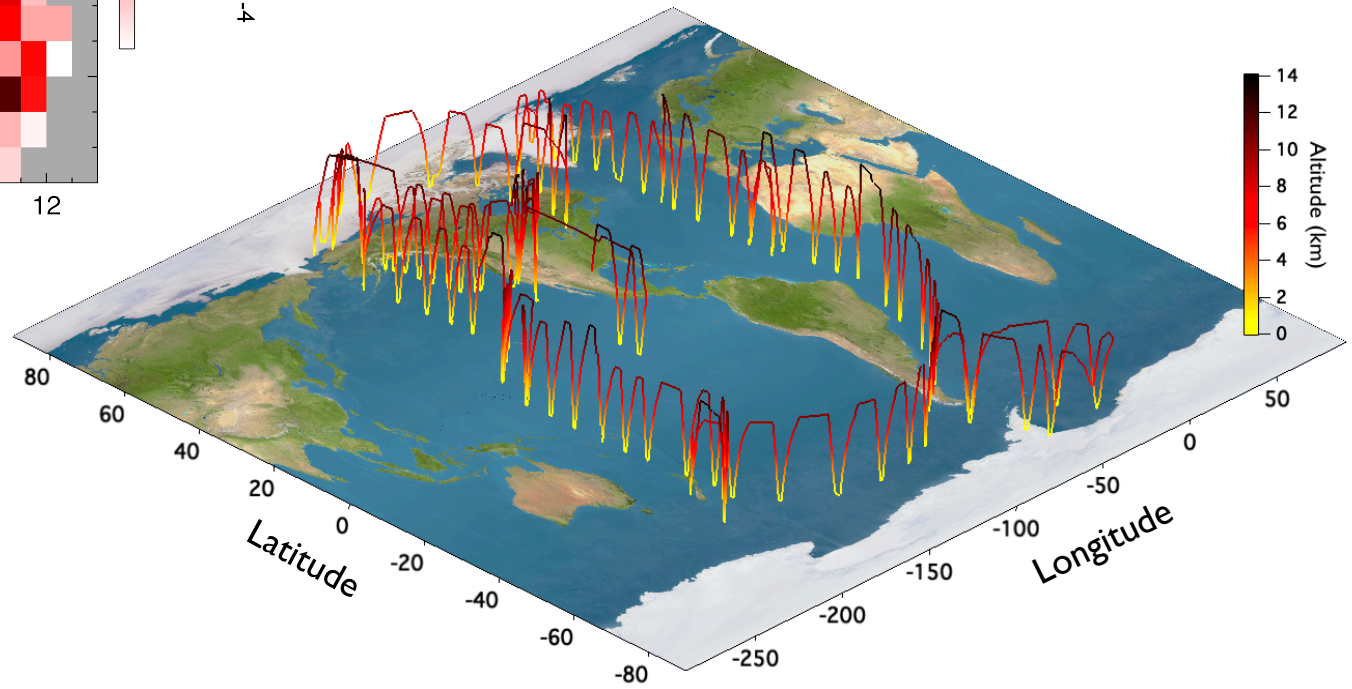
Holistic approach that incorporates chemical and physical measurements, meteorology, photochemical and transport modeling, and satellite validation

Flight Coverage



Four complete global circuits, one in each season:

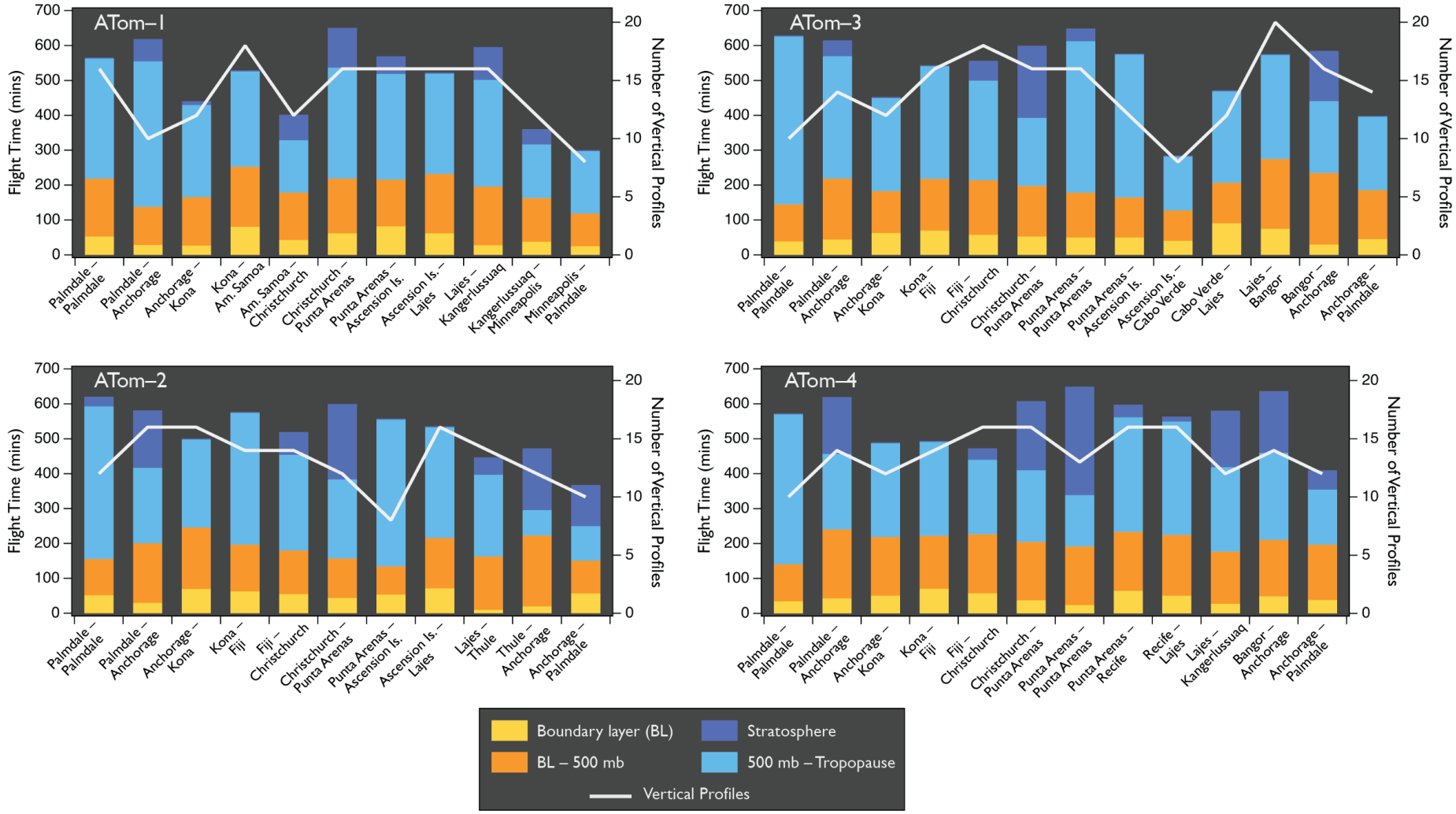
- ATom 1 : 28 Jul – 22 Aug, 2016
- ATom-2 : 26 Jan – 22 Feb, 2017
- ATom-3 : 28 Sept – 26 Oct, 2017
- ATom-4 : 24 Apr – 21 May, 2018



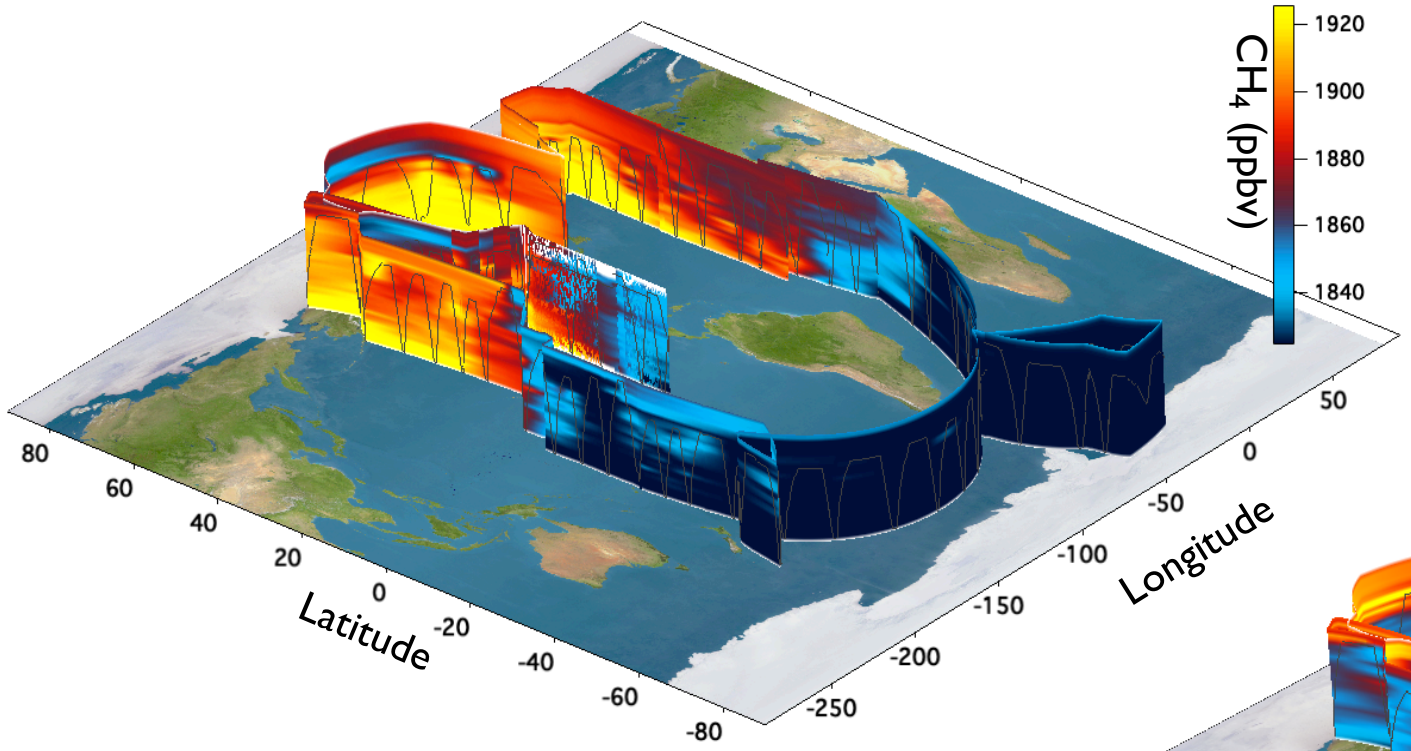
Near-continuous vertical profiling from 0.2 km – 14 km altitude permitted sampling from the marine boundary layer to the lower stratosphere

Flight Details

- Total flight for each research flight, categorized by time within altitude layer
- Also shown are the number of vertical profiles performed for each flight



Sample Curtain Plots



Sample curtain plots of methane and ozone interpolated from measurements collected during ATom-3