Stratospheric Aerosol processes, Budget, and Radiative Effects

SABRE

SABRE is a multi-year airborne observations program led by NOAA's Chemical Sciences Laboratory in partnership with NASA. This mission is using the NASA WB-57 high-altitude research aircraft to fly high into the stratosphere to study the transport, chemistry, microphysics, and radiative properties of aerosols and trace gases. These research flights help us study how aerosols form, move, and change across different seasons and regions, giving us the scientific data and tools needed to create better climate models and support data-driven decision making.

Scientific Motivation:

Tiny particles in the stratosphere, known as aerosols, play a large role in our climate by reflecting sunlight and acting as surfaces for chemical reactions that can affect the protective ozone layer. To understand the current baseline state and variability of our atmosphere, the SABRE project is collecting detailed measurements of these particles and the gases around them.

The data we collect is vital for understanding Earth's energy balance, which directly controls weather patterns and surface climate across the globe, and how the stratosphere reacts to perturbations from human activity and natural events like space traffic and volcanic eruptions. Understanding current stratospheric conditions and sensitivities is also crucial for evaluating the potential risks of proposed "climate intervention" approaches that would involve the intentional release of reflective particles into the stratosphere to cool surface temperatures.

Science Goals:

- Characterize the physical and chemical properties of stratospheric aerosols -including their size, composition, and light-scattering behavior- and how these vary geographically and over time.
- Constrain the stratospheric sulfur cycle by identifying the sources of sulfur compounds and tracing how they are chemically transformed into aerosol particles.
- Determine the frequency and impact of new particle formation at the upper troposphere / lower stratosphere boundary, and how it shapes the broader aerosol population.
- Study the evolution of aerosol properties following major injection events -volcanic eruptions, wildfires, rocket launches, and aviation- and quantify their cumulative impact on Earth's energy budget.
- Quantify the effects of stratospheric aerosols on ozone chemistry and atmospheric circulation, including downstream consequences for surface weather and climate.

For more information: csl.noaa.gov/projects/sabre
espo.nasa.gov/sabre

Flight Operations:

2026 Base of Operations: Panama Pacifico International Airport

Aircraft operations range: 1000 nautical miles. Allows sampling +/- 17° providing access to outflow from deep tropical convection over northern South America -some of the deepest continental convection on Earth.

The SABRE flight schedule and flight plans depend on the large-scale dynamical situation, both as forecast and as it develops during the flights. Flight plans are based on meteorological and global model chemical forecasts developed 24-48 hours prior to flight

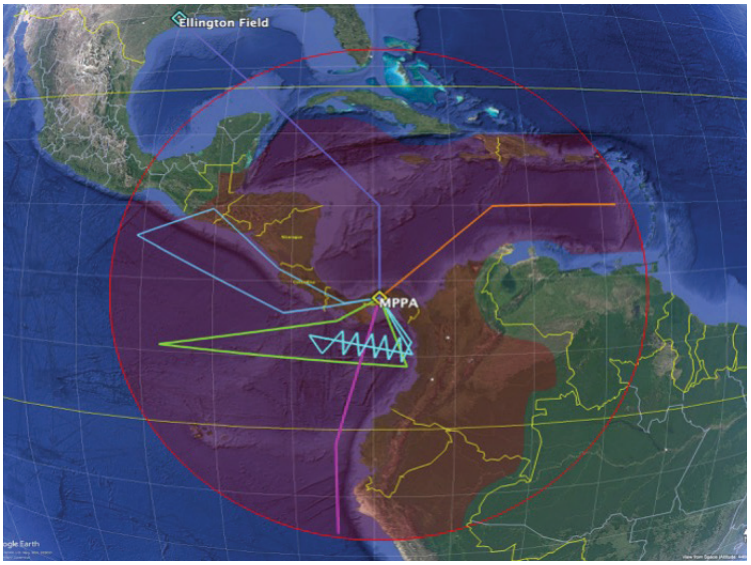
The NASA WB-57 aircraft operates at altitudes between 13 to 19 Km with a duration of approximately 6 hours.

Typically, SABRE flights will be during daytime, with morning take-off and afternoon landing at a frequency of 3 flights per week.

Why Panama?

Convection in the tropics is the primary means by which surface emissions enter the stratosphere and form new stratospheric aerosols. Basing in Panama allows:

- Sampling convectively lofted volcanic sulfur emissions
- Sampling outflow of deep continental convection to study aerosol formation in the tropical upper troposphere
- Flights to ~8 °S -across the ITCZ and into the southern hemisphere to examine inter-hemispheric gradients



NASA WB-57

HIGH ALTITUDE RESEARCH AIRCRAFT

About the Aircraft:

The NASA Johnson Space Center (JSC) in Houston, Texas is the home of the NASA WB-57 High Altitude Research Program.

The WB-57 research aircraft is based on the Martin/General Dynamics RB-57F, a specialized strategic reconnaissance aircraft developed in the 1960s for the United States Air Force from the Martin B-57 Canberra tactical bomber.

NASA operates the only remaining three WB-57 aircraft still in service. The aircraft have been flying research missions since the early 1970's, and continue to be an asset to the scientific community.

The WB-57 is a mid-wing, long-range aircraft capable of operation for extended periods of time from sea level to altitudes in excess of 63,000 feet. Two crew members are positioned at separate tandem stations in the forward section of the fuselage. The pilot station contains all the essential equipment for flying the aircraft while the sensor equipment operator (SEO) station contains both navigational equipment and controls for the operation of the payloads that are located throughout the aircraft.

Aircraft Specifications:

Owner/Operator: NASA Johnson Space Center

Type: Conventional Aircraft

Duration: 6.5 hours (payload and weather dependent)

Useful Payload: 8,800 lbs

Gross Take-off Weight: 72,000 lbs

Onboard Operators: 2 (Pilot and SEO)

Max Altitude: 63,000 ft and above (payload dependent)

Air Speed: 410 knots

Range: up to 2,500 Nautical miles

The stratosphere is a "space equivalent zone" where low atmospheric pressure causes rapid hypoxia without 100% oxygen. The WB-57 crew members wear full-pressure suits to survive in stratospheric conditions above 50,000 ft. Weighing approximately 31 pounds, the suit functions as an independent life-support system and pressures automatically if cabin pressure is lost.

About the Payload:

The aircraft carries a payload of over 17 science instruments to measure aerosols, atmospheric trace gases, and meteorological conditions. Many of these instruments were designed and built by NOAA scientists to operate remotely and withstand the low temperatures and pressures of the stratosphere.