Measurement of Air Pollution from Satellites (MAPS) Space Shuttle Payload

Carbon monoxide (CO), a colorless and odorless gas, is produced when carbon-based fuels and biomass are burned. Once released into the atmosphere, CO can be transported over long distances. It eventually transforms to carbon dioxide (CO_2) when it reacts with the hydroxyl radical (OH). Increasing amounts of atmospheric CO are part of increased reactions with the OH radical, thus leaving less OH available to break down other atmospheric compounds. For this reason, it is hypothesized that lower OH levels can have long-term consequences on stratospheric ozone and the levels of greenhouse gases, potentially influencing Earth's climate. In this sense, CO can be related to the atmosphere's ability to cleanse itself of greenhouse gases and other pollutants.

MAPS was the first Space Shuttle science payload. It measured CO concentrations in the lower atmosphere (approximately 3 km to 16 km altitude) from 57° N to 57° S. Its flight hardware consisted of an optical box, an electronics box, a tape recorder, and an IR camera, all attached to a single baseplate. This assembly was mounted on a Multi-Purpose Experiment Support Structure near the forward end of the Shuttle cargo bay. The instrument was about 91 cm long, 76 cm wide, and 58 cm high. It weighed 92 kg and used about 125 watts of electrical power.

MAPS was operated in four Shuttle missions: STS-2 (November 1981), STS-41G (October 1984), STS-59 (April 1994) and STS-68 (October 1994). During those flights, MAPS observations were made, and the astronauts could consult preliminary nearly real-time CO charts. The IR camera provided some images of the regions of measurement. The crew watched for and noted areas of special interest, such as industrial pollution from smokestacks, gas flares from oil fields, and smoke from biomass burning. After the flights, the data were processed in detail and the MAPS measurements were compared with those from a global network of some 25 ground-based sites, including stations in the United States, South Africa, Russia, Germany, Bermuda, Ireland, Hong Kong, Australia, and New Zealand. Aircraft from NASA, INPE Brazil, CSIRO Australia, the University of Maryland, and NOAA, also provided intercomparison data.

The first MAPS flight, in November 1981, showed that CO is highly variable from region to region. A more surprising result was that the greatest CO concentrations

were found in Earth's tropical regions rather than in the industrialized Northern Hemisphere as had been expected. It was hypothesized that that maximum was caused by a maximum amount of biomass burning in the Southern Hemisphere spring. The subsequent MAPS flight (in October 1984) confirmed that the burning of forests in South America and grasslands in Africa is a significant source of global lower atmospheric CO during the Southern spring. The April 1994 flight (during the Southern autumn) showed low CO concentrations (clean air) in the Southern Hemisphere and a gradual increase in CO levels toward the Northern Hemisphere, with the highest CO levels north of 40° north latitude. The October 1994 flight (in the Southern spring) provided the opportunity to make a season-to-season comparison of CO changes from the Southern autumn (April 1994 measurements) to the Southern spring (October 1994 measurements). Those measurements also allowed a seasonal intercomparison to be made in areas near and downwind from the industrial source regions of the Northern Hemisphere. At the time, the MAPS observations formed the only database that made such intercomparisons possible.