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STRATO 2C – A New Stratospheric Research Aircraft Under Development

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ABSTRACT

STRATO 2C is a high altitude research aircraft which is currently under development. This paper gives a description of the state of development of the aircraft (as of July 1995), the instruments and the planned applications.

KEYWORDS

Research aircraft, chemistry, climate, instruments.

INTRODUCTION

Changes in stratospheric ozone, climate changes related to clouds, stratospheric-tropospheric exchange, and impact of high flying aircraft are among the many obvious reasons which call for measurements in the stratosphere.

The STRATO 2C is designed as a German contribution to international research cooperation. It is based on science initiatives raised since the end of the 1980s expressing the demand of the scientific community for a high-flying research aircraft, in particular for ozone and climate research. The STRATO 2C programme involves the development and construction of the aircraft. It also includes the establishment of the necessary instrumentation and flight operations. The decision to realize STRATO 2C was made in 1992. This paper gives a description of the state of development of the aircraft, the instruments and the planned applications.

DESCRIPTION OF STRATO 2C

STRATO 2C is constructed as an instrument for ozone and climate research by the company Grob in Germany. Its construction is part of the Ozone and Climate Research Programme funded by the German Ministry of Education and Technology (BMBF). The project is lead by the DLR (German Air and Space Research Agency) which provides the project management, the flight operations and the scientific instrumentation and mission preparation.

The aircraft is designed for altitude up to 24 km and for long endurance operation in the stratosphere. It will carry a scientific payload of 800 to 1000 kg for in-situ and remote sensing measurements depending on flight profile. The aircraft is built using fiber composite materials. The wingspan is 56.50 m, length and height are 23.98 m and 7.76 m, respectively.

The first successful test flight of the STRATO 2C took place on March 31, 1995 from Mattsies, where the aircraft company GROB is located, see Figure 1. By May 1995, the low altitude test program was successfully completed including 6 test flights. Until autumn 1995 in the order of 30 test flights are scheduled to test and further develop the flight performance of the aircraft, in particular the maximum cruise altitude. After this period the aircraft will be converted for its use as a carrier of scientific instruments. In spring 1997 the aircraft will be handed out to the DLR, that will operate the aircraft.

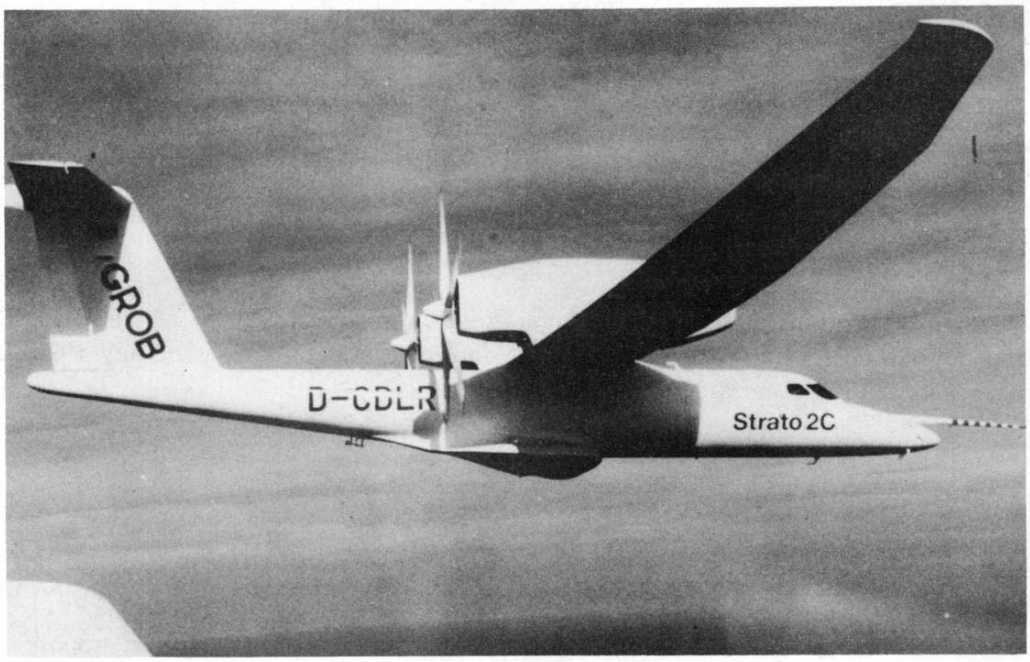

Fig. 1. Photo of the STRATO 2C, with call-sign D-CDLR, as under construction by the company Grob. The photo was made during the first test flight, March 31, 1995. One clearly notes the two pushing propeller engines, the long wing, and the pressurized cabin with a nose boom for turbulence measurements. The construction underneath the fuselage contains the wheels for landing and take-off. Windows for the instruments and observers are still to be installed in this test version.

From the test results obtained so far, it can be expected that the presently built version of STRATO 2C will reach altitudes above 21 km and ranges of more than 8000 km at 18 km altitude. This is less than planned originally, because the presently built version is heavier than anticipated. Weight reduction possibilities exist and are presently under consideration. The completion of the mission aircraft is expected for 1997. Obviously, one cannot exclude changes in these project plans because of considerable risks existing with this new kind of technology.

MISSION PLANS AND INSTRUMENTATION

STRATO 2C is foreseen as a research instrument for the following areas (see Schumann et al., 1993, for details):

- physics and chemistry of the stratosphere

- impact of emissions from sub- and supersonic aircraft on the atmosphere
- stratosphere-troposphere exchange
- tropical deep convection
- impact of volcanic eruptions on the stratosphere
- investigation of land and sea surface processes
- validation of satellite measurements
- test or calibration of satellite sensors

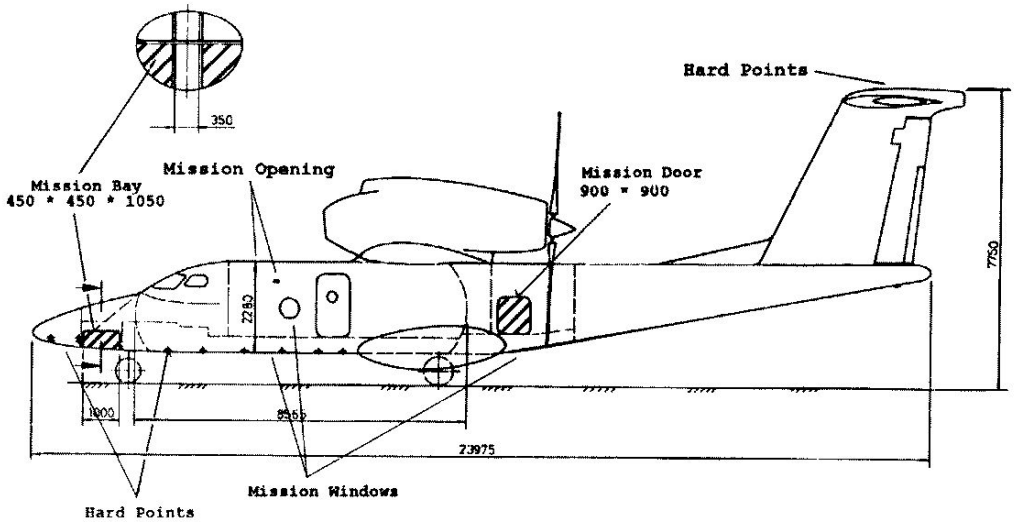

Fig. 2. Left hand side view of the aircraft construction, showing the length and height of the aircraft, and the mission bays in the front and behind the pressurized cabin.

STRATO 2C offers many opportunities for scientific measurements. The pressurized cabin, see Figure 2, may take 8 instrument racks (482 mm width, 500 mm, 950 mm height), 7 feed-throughs for instrument in- and outlets (each up to 150 mm in diameter), 6 provisions for optical windows in the floor (2), ceiling (1), and at both sides (1 left, 2 right side) with a diameter of about 500 mm. The unpressurized payload bays include 2 front bays (450 x 450 x 1050 mm), and 1 tail bay (volume 4 m^3) with 6 openings. The fuselage provides 4 underwing stations (maximum load of 250 kg each), see Figure 3, 8 hard points in the upper front section, 12 hard points in the lower front section (each with a static load of 10 kg), 2 hard points at the wing tips (for a static load of 5 kg), and 1 hard point at the top of the tail unit.

The electrical power availabale for instruments is 8.4 kW (6 kW in the pressurized cabin). Navigation and aircraft-system data are accessible on-line for experiments via VME-bus-computers. The scientific payload may amount to 800 kg for the top altitude and 1000 kg for the long-range missions. The instruments may be operated by 2 scientists in addition to the 2 pilots, but the mass of the scientists reduces the instruments payload. The pilots have switching panels in the cockpit available for mainly automatically operating instruments.

The first STRATO 2C demonstration mission is planned to be CHORUS "Chemistry of Ozone Reduction in the Lower Stratosphere." Details of this experiment are prepared by the project scientists within the German Ozone research programme and coordinated with European projects. The scientific objectives of CHORUS are the determination of the mass balance and horizontal/vertical distribution for the key trace gas families involved in ozone depletion

- at middle and high northern latitudes
- as a function of season
- inside and outside the polar vortex
- in the presence of PSC's
- as a function of sulphuric acid aerosol loading, composition and state of aggregation.

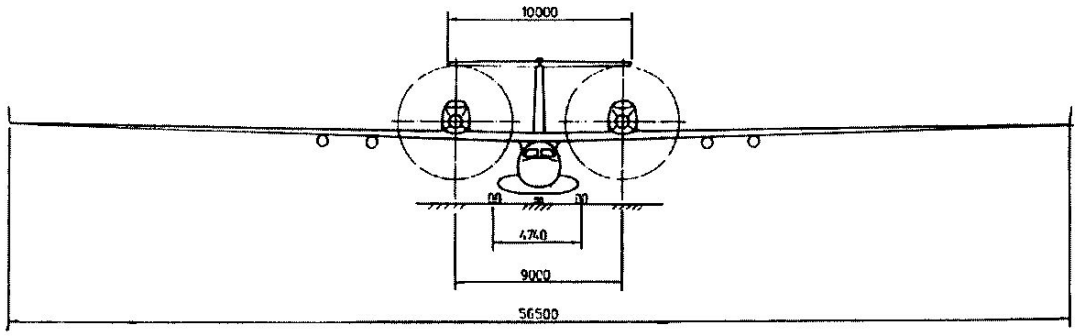

Fig. 3. Front view with wing span and propeller dimensions, and with the mounting positions for underwing instruments.

For this mission, as set of instruments is under preparation; some are available already now. Figure 4 shows the set of instruments with respect to the mounting positions. Listed are the instrument names and the organisations of the principal investigators. The instruments are designed to measure insitu:

- Reservoir species (HCl, HNO_3, NO_y),
- Reactive species (OH, ClO, BrO, NO),
- Tracer species (N_2O, H_2O, CFC12, O_3),
- Atmospheric parameters (aerosols, condensation nuclei, pressure, temperature, wind, UV-radiation flux)

Remote sensing instruments will measure

- O_3, NO_2, OClO, BrO (column densities and vertical profiles)
- $ClONO_2$, N_2O_5, HNO_3, and other parameters (with respect to large-scale distributions)

Also under preparation is a Lidar-instrument for aerosol and water vapour measurements and a dropsonde system for measurements of vertical profiles of wind and temperature, and for humidity in the troposphere.

When STRATO 2C has successfully demonstrated its measurement capabilities during the CHORUS missions, it will be made available for further applications.

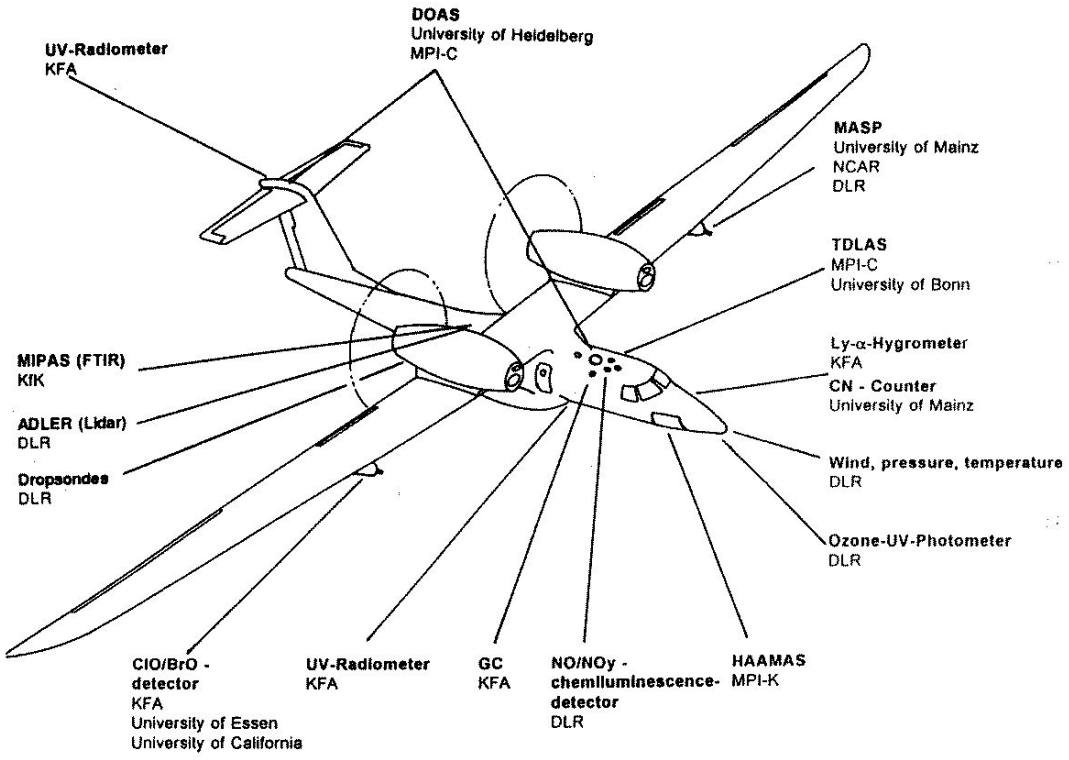

Fig. 4. First set of STRATO 2C instruments and their mounting positions.

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