WEATHER MODIFICATION, INC.

ATMOSPHERIC RESOURCES MANAGEMENT TECHNOLOGIES
FOR THE 21ST CENTURY

ATMOSPHERIC RESEARCH

Weather Modification, Inc. excels in providing airborne atmospheric research platforms, and also offers diverse remote-sensing instrumentation. We have many years' experience installing cloud physics instrumentation and aircraft data systems. Additional instrumentation for atmospheric chemistry and to quantify atmospheric aerosols is available. We also do special-purpose aircraft modifications.

WMI's Learjet 35A is shown here, rigged for cloud microphysical measurements. The Lear is also used as a high performance on-top seeder for hail mitigation damage control, and most recently as the dropsonde aircraft for **BAMEX, the Bow Echo and Mesoscale Vortex Experiment**.

CLOUD PHYSICS

We configure and install all our instrumentation and the aircraft data acquisition systems. Each system is specifically designed to make the measurements needed by the client, and includes those instruments best-suited to the client's needs. The most commonly used instruments are described briefly below.

1. Cloud Liquid Water Measurement System

The WMI-LWC100 cloud liquid water measurement system consists of the control unit, the power supply, and a sensor head (shown here). The sensor head holds the wire-wound element between two prongs that position it three inches away from the outside aircraft skin. The sensing element, in conjunction with a remotely mounted power supply, is interfaced with the display module. The display is mounted within the WMI-DAS-300 data acquisition system and is interfaced with the computer for recording and displaying liquid water content measurements.

2. Total Temperature Sensor

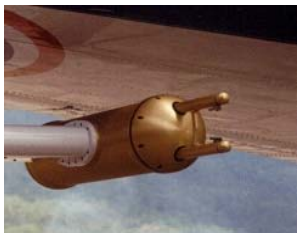
The WMI-RT105 is a de-iced platinum resistance-type total temperature sensor for high performance aircraft applications where accurate total temperature measurements are required. The sensing element is protected from small foreign particles such as sand, ice and insects. The sensor features a de-icing heater that dissipates 270 watts under in-flight conditions with 28 volts DC applied. The WMI-RT105 is interfaced with the WMI-DAS-300 and will accurately measure and display temperatures from -50°C to +50°C.

3. Dew Point Temperature Sensor

The WMI-137 Dew Point Sensor is a complete optical dew point system for monitoring in-flight atmospheric dew and frost points. It is the only aircraft instrument that provides two stages of thermoelectric cooling. It can reach frost points between –60°C and -70°C, depending on mounting configuration and operating conditions. No auxiliary coolants are required. Included in the WMI-137 system are a water-excluding inlet probe and a pressure tap for monitoring static pressure. A digital

display with resolution to 0.1°C is provided as well as an analog D.C. voltage output that is interfaced with the WMI-DAS-300 for display and recording purposes.

4. Cloud Particle Probe



Study of complete microphysics requires knowledge of the sizes, number, and shapes of the hydrometeors (water and ice particles) within the cloud. This probe does exactly that. A laser shines from one "arm" of the probe onto a row of photodetectors in the other (see photo to the right). When any particle passes between the arms, it shadows the detectors, and high-speed processing records which of the 32-element detector array were shadowed, and in which order. The image shape can then be accurately reconstructed, and the maximum dimension determined.

The WMI-2D2-C two-dimensional optical array probe (OAP) stores complete two-dimensional images of encountered particles for shape analysis in addition to one-dimensional sizing.

5. Precipitation Probe

This probe complements the Cloud Particle Probe, and is recommended for cloud microphysics studies requires knowledge of the sizes, number, and shapes of larger hydrometeors within and beneath the cloud. A laser shines from one "arm" of the probe onto a row of photodetectors in the other (see photo to the right). Physical measurement principles are the same. The arms are spread to increase the depth of field, and allow a larger sampling volume to ensure representative measurement of the larger, but fewer, precipitation-sized particles. The image shapes are reconstructed, and the maximum dimensions determined. The number of particles of each size and shape are also tabulated.

The 2D2-P Precipitation Probe is an aircraft-borne instrument that utilizes photo diode array and photo detection electronics.

6. Cloud Droplet Spectrometer Probe

The Foreward-Scattering Spectrometer Probe or FSSP, is used to measure the sizes and numbers of cloud droplets. This instrument focuses specifically on these very small droplets, and does not measure larger (precipitation-sized) drops, or ice particles. The primary purpose of this instrument is to determine in real-time the character of the sampled clouds, that is, whether they be maritime or continental.

The WMI-FSSP-100 is a one-dimensional laser probe that provides sizing of particles up to 45 microns diameter. The probe outputs a parallel digital size code along with a strobe pulse for each acceptable particle encountered. The output is interfaced with the WMI-DAS-300 for collecting, displaying and recording the data provided. The available ranges of the WMI-FSSP-100 are controlled by the WMI-DAS-300 and can easily be selected by the user.

7. Instantaneous Vertical Speed Indicator or Linear Acceleration

An aircraft configured for level flight will climb or descend only as the air through which it is flying rises or falls. In studying clouds, we take advantage of this fact by flying cloud penetrations with the aircraft at constant attitude. The pilot does not worry about maintaining constant altitude, but rather allows the aircraft's motion to be sensed and recorded, thus providing a measure of cloud up- and downdrafts. Updrafts are particularly important, for they mark the location of the developing cloud volume, produce additional cloud condensate, and are often used to transport seeding agent upward into cloud when treatment is done from cloud base. The WMI-BV4.0 is an electric instantaneous rate of climb indicator that features smooth action, rapid response rate and very high accuracy.

AEROSOLS

Passive Cavity Aerosol Spectrometer Probe

The Passive Cavity Aerosol Spectrometer Probe (PCASP) is an airborne probe, similar in size to the Cloud Particle Probe, Precipitation Probe, and FSSP (see Cloud Physics instrumentation). A sampling cone extends out from the forward end cap, oriented in the direction of flight. A hollow rake at the rear of the cone creates a venturi that draws a large volume of air flow into the small opening at the tip of the cone during

flight. The expanding cone decelerates the input ram air to become iso-kinetic, with the small volume of actual sample air flow drawn straight into the inlet jet. The WMI-PCASP has 15 size channels, and measures particles from 0.10 to 3.00 microns in diameter.

Cloud Condensation Nuclei Counter

The Cloud Condensation Nucleus Counter (CCNC) used by WMI is designed for the measurement of the activity spectra of condensation nuclei over the range of supersaturation from approximately 0.2 to 2%. This range is not hardware limited and to a large degree depends on the calibration techniques and the relative concentrations and activity of the nuclei in the same.

The WMI-CCNC employes a static diffusion chamber in which a controlled supersaturation is created by means of a temperature gradient between two plates having moist surfaces. The instrument incorporates an automatic light scattering detection system, which is calibrated by photographic means and includes aerosol-handling capabilities.

Instrument control is provided by an internal microprocessor, which provides temperature control and state sequencing necessary to acquire and process successive samples. A standard (RS-232) serial port is provided to allow system parameter modification as well as system diagnostic capabilities.

DATA SYSTEMS

Our most basic data recording package allows very affordable recording of aircraft position (latitude, longitude, and altitude), as well as the status (off or on) of cloud seeding equipment. Outside air temperature and cloud liquid water content can also be recorded. If needed, all these data can be telemetered to a ground site in real-time via radio modem.

The M-300 data acquisition system is the latest in high-speed, high-volume data collection platforms, handling input from all kinds of sensors. The power of the M-300 ensures high-frequency recording of data from a full instrumentation suite, including position, aircraft motion (heading, true air speed, pitch, roll), temperature, dew point, pressure, cloud liquid water content, derived and observed winds, and data streams from cloud physics, aerosol, and chemistry instrumentation, including FSSP, PCASP, 2D-C, 2D-P, IN, CN and CCN counters, and NO_x, O_3, and CO detectors, among others.

ATMOSPHERIC CHEMISTRY

Atmospheric chemistry is of interest to many, especially those studying cloud development and air pollution. Certain gases are usually of greatest interest in this regard, among them ozone (O_3), sulfur dioxide (SO_2), and nitrous oxides (NO_x).

- **Nitrogen Oxide (NO_x) Analyzer**
- **Sulfur Dioxide (SO_2) Analyzer**
- **Ozone (O_3) Analyzer**

Contact us for pricing and detailed specifications.

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