Emerging Technology for Measuring Atmospheric Aerosol Properties

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Introducing Droplet Measurement Technologies

- **Founded in 1987**
- **Specializing in aerosol and cloud particle instrumentation**
- **35 employees**
  Scientists: 5
  Engineers: 5
  Technicians 13
  Support Staff 8
- **Services**
  Calibration and repair
  Training
  Project support (scientific and technical)
- **Products**
  Cloud Probes (CAPS, CCP, CDP, CAS,CAS-POL, CIP, CIP-Gray
  Fog monitor, Hotwire LWP)
  Aerosol Probes (CCN, UHSAS, PASS, SP2)
- **Research and Development**
  SBIR and STTRs (NSF, ONR, NOAA, DOE)
  SBIR/STTR Phase IIs - 5
  All leading to commercial products (CAPS, SP2, CDP, PASS, CSI)
  University collaborations: U. Colorado, UCSD, DRI, Georgia Tech
  Field Projects: NASA, NSF, DOE

Emerging Measurement Technologies Under Development at DMT

- **Black Carbon Mass**
- **Hygroscopic Properties**
- **Optical Properties**
- **Size Distributions**

DMT already has experience in building compact instruments for UAV applications

Black Carbon Measurements:
The Miniature Single Particle Soot Spectrometer
mini-SP2

The SP2 was developed with an ONR SBIR Phase I and II in 2002.

In the past four years there have been 18 publications in the international peer reviewed literature.

The current SP2 weighs 36 kg (79 lb), occupies a volume of 110 liters (4 ft^3) and consumes approximately 400 W (@110V).

A new, mini-SP2 is under development, funded through the NSF STTR program (partnering with the University of California, San Diego) that has a weight of 1.8 kg (4 lbs), a volume of less than 2 liters (0.07 ft^3) and consumes less than 100 W.

The mini-SP2 is specifically designed for UAVs but will have multiple applications in climate change research, air quality monitoring and combustion studies.

Aerosol Hygroscopicity:
A Miniature CCN Counter

The DMT, single column, continuous flow CCN counter was developed with internal funds in 2003 in a collaboration with Greg Roberts (UCSD) and Thanos Nenes (Ga. Tech).

In the past five years there have been dozens of publications in the international peer reviewed literature and researchers continue to find new applications.

The current, single column instrument weighs 28 kg (61 lb), occupies a volume of 200 liters (4.5 ft^3) and consumes approximately 400 W (@28Vdc).

A new, mini-CCN is under development, funded through the NSF STTR program (partnering with the University of California, San Diego). The design goal is a weight of 2 kg (4.5 lbs), a volume of less than 4 liters (0.14 ft^3) and consumption of less than 100 W.

The mini-CCN is specifically designed for UAVs but will have application in climate change research and air quality monitoring where weight, volume & power are considerations.

Aerosol Optical Properties:
A Miniature Photoacoustic Soot Spectrometer (MPASS)

The DMT photoacoustic soot spectrometer (PASS) was developed in a collaboration with Patrick Arnott (University of Nevada) and with funding from the Office of Naval Research STTR program.

The PASS has a much faster response and is more accurate than filter techniques (Radiance Research PSAP; McGee aethalometer) for measuring the absorption coefficient of aerosols. It can be calibrated directly and is much more sensitive.

The current instrument weighs 25 kg (58 lb), occupies a volume of 110 liters (4 ft^3) and consumes approximately 300 W (@28Vdc).

A new, mini-PASS is under development with funding through the NSF STTR program (partnering with the University of Nevada) and it has a weight of 2 kg (4.5 lbs), a volume of less than 4 liters (0.14 ft^3) and consumes less than 100 W.

The mini-PASS is specifically designed for UAVs but will have multiple applications in climate change research and air quality monitoring.

Aerosol Optical Properties:
A Dropsonde OPC/nephelometer

DMT has received an SBIR I award from NOAA to develop a lightweight, low power and volume, frangible instrument for measuring the optical properties of aerosols from dropsondes.

During the Phase I development, a single particle optical spectrometer and a multi-wavelength nephelometer will be built and tested to select the optimum instrument for a dropsonde.

The designs for the spectrometer and nephelometer incorporate some recent advances in optical and electronic technology that will allow the development of a compact system that would not have been possible five years ago.

The minimum information that will be provided by the dropsonde system will be a vertical profile of the aerosol scattering coefficient from which optical depth is derived.

Aerosol Optical Properties:
A Drag-sonde OPC/nephelometer

DMT is developing a lightweight, low power and volume instrument for measuring the aerosol flux from a drag-sonde.

The ONR SBIR program is developing a dragsonde that will be towed by an aircraft that will deploy it within several meters of the ocean surface. The dragsonde will have a 3-D wind and turbulence system, high rate aerosol measurements and a sensor to derive wave height.

The objective of the system is to measure fluxes of momentum, heat, moisture and particles in the surface layer of the ocean. This is a goal that has not been achievable with standard aircraft or ship measurements.

DMT will be involved with developing the complete flux system in collaboration with the University of California-Irvine and CIRPAS. An OPC or nephelometer, similar to the instrument being developed for the NOAA dropsonde program will be integrated into the dragsonde system.

Cable extendable and retractable up to 10 km length

DMT-CIP (battery operated)

Maiden flight AIRTOSS 070904

Aerosol Properties:
Size Distributions

DMT is participating with NASA headquarters funding in the first Global Hawk research mission with the Ultra High Sensitivity Aerosol Spectrometer (0.06 to 1.0 µm) that will be installed in Bay 25 of the aircraft

Aerosol Properties:
Nano-particle Size Distributions

In collaboration with Brookhaven Laboratory and with funding from the DOE STTR program. DMT is developing a new technique for measuring aerosol size distributions in the sub-0.1 um size range.

The “Fast Integrated Mobility Spectrometer” (FIMS) utilizes a unique approach for separating and sizing nanometer-size aerosol particles.

The FIMS is described in greater detail by Jian Wang in the next presentation.