Proposal to Provide
Cloud Seeding & Atmospheric Research Operations
In the Islamic Republic of Mauritania

Proposal prepared for

Minister of Equipment & Transports
Mohamed Abdallahi OUDAA

On request from

Office National de la Météorologie
Mohamed Batta Cheikh Mohamed El Mamy, Director Général
Boite Postale 1330, Nouakchott-Mauritanie

Prepared by

Weather Modification International
3802 20th Street North
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December 28, 2017

EXECUTIVE SUMMARY

Weather Modification International (WMI), is pleased to present this proposal for Cloud Seeding Operations in the Islamic Republic of Mauritania for the 2018 season from July 1 – September 30, 2018.

WMI was founded in 1961 and over the past 55+ years has become the world leader in cloud seeding and atmospheric research technologies. Whether identifying the potential benefits of cloud seeding or monitoring air quality, Weather Modification is dedicated to providing sound, scientific atmospheric solutions. Our veteran meteorologists, experienced pilots and radar engineers conduct valuable work around the world in support of climatological studies, precipitation enhancement, hail damage mitigation, fog dissipation, weather forecasting, and many other specialized projects.

The proven success of Weather Modification in atmospheric operations is evident by our lengthy client list that includes private and public insurance companies, private and public water resource management organizations, as well as federal and state government research organizations. Weather Modification has completed contracts in Antigua, Argentina, Australia, Burkina Faso, China, Canada, Greece, Gabon, India, Indonesia, Jordan, Korea, Mali, Mexico, Morocco, Saudi Arabia, Senegal, Spain, Thailand, Turkey, United Arab Emirates, and dozens of locations in the USA.

Weather Modification and Fargo Jet Center headquarters on Hector International Airport, Fargo, ND

Weather Modification headquarters, shown, are located in Fargo, ND USA on Hector International Airport. Its headquarters are co-located with its sister company - Fargo Jet Center LLC (FJC).

Fargo Jet Center, Weather Modification, and additional owned companies – Exclusive Aviation (aircraft sales) and Premier Jet Center (FBO located on Flying Cloud Airport in Eden Prairie, MN) employ approximately +150 staff in North Dakota, Minnesota, and at project sites worldwide. The operating companies frequently share resources, skills, talents, and equipment – each contributes to the success of the others. The synergy realized from several multi-faceted operating companies highlights a strong aviation enterprise that continues to grow in size, professionalism and service.

Fargo Jet Center's US Federal Aviation Administration (FAA)-approved repair station works extensively with its affiliated companies to maintain and modify all of the 45+ aircraft owned by the companies in addition to providing support and maintenance management service to more than 100 local and regional aircraft operators. The Fargo facility devotes about 40,000 square feet to aircraft maintenance, and over 200,000 square feet of total campus size.

FJC's repair station is an Authorized Service Center for Pilatus, Cessna, Beechcraft and Dallas Airmotive providing line maintenance and troubleshooting expertise on Pratt & Whitney JT15D and PT6A engines. FJC is enrolled in Flight Safety's Aviation Maintenance Technician training program and has received the coveted FAA "Diamond Award" recognizing FJC's commitment to the FAA Aviation Technician Training Program. Fargo Jet Center's maintenance and avionics repair stations have worked with foreign repair stations around the world in support of WMI programs.

WMI is the recognized global leader in providing atmospheric operational projects, weather research execution and associated aviation support services and equipment.

We look forward to providing services for the Islamic Republic of Mauritania and will be contacting you in the near future to discuss this information. If you have additional questions, please do not hesitate to contact me.

Sincerely,

James P. Sweeney, Vice President

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PROPOSED PRELIMINARY BUDGET

YEAR #1 – 2018

WEATHER MODIFICATION LLC
2018 PRICE PROPOSAL
MAURITANIA CLOUD SEEDING & RESEARCH
JULY 1 THROUGH SEPTEMBER 30

Program Specifications:	**Program Price (USD)**
MOBILIZATION	**222,400**
AIRCRAFT FOR SEEDING & RESEARCH	
Cloud Seeding Aircraft - King Air C90	**1,248,000**
All maintenance, parts, insurance, oil included	
Includes cloud seeding equipment	
Ferry to and from Mauritania / Fargo, ND	
30 flight hours per month included, additional hours @ $800/hr.	
Research Aircraft - Citation Jet	
All maintenance, parts, insurance, oil included	
Includes all research equipment	
Ferry to and from Mauritania / Fargo, ND	
30 flight hours per month included, additional hours @ $800/hr.	
CLOUD SEEDING FLARES	
Cloud Seeding Flares Included:	**443,117**
(QTY 6000) 20 Gram Ejectable Flares	
(QTY 462) 150 Gram Burn-In-Place Flares	
(QTY 480) 1000 Gram Hygroscopic Flares	
2 C BAND WMI RADARS WITH PEDESTAL, ANTENNAE ON LEASE	**609,600**
Includes shipping and installation	
Client responsible for tower and installation site prep	
Client responsible for power and high speed internet to site	
PERSONNEL- FIELD PROGRAM	**1,113,600**
Weather Modification LLC Personnel	
2 Captain (Multi-engine, IFR)	
2 Copilots (Multi-engine, IFR)	
1 Meteorologist/Program Mgr.	
1 Radar Technician	
1 Aircraft Mechanic	
DEMOBILIZATION	**222,400**
Total Program $	**3,859,117**

OPTIONAL WEATHER RADAR PURCHASE - $912,000 each

TIME FRAME- FIELD PROGRAM
3 Month Field Program
12 hours per day, 7 days per week

CLOUD SEEDING MATERIAl - ADDITIONAL PURCHASES
20 Gram Ejectable Flares @ $33.00 each
150 Gram Burn-In-Place Flares @ $94.00 each
1000 Gram Hygroscopic Flares @ $74 each

Prices valid for 60 days
12/28/2017

WEATHER MODIFICATION LLC
2018 PRICE PROPOSAL
MAURITANIA CLOUD SEEDING & RESEARCH
3 MONTH PROGRAM PRICING
WMI PAYMENT SCHEDULE

	Percent	Amount
Contract Signing Payment #1	25%	$ 964,779
Prior to Ferry and Mobilization - Payment #2	25%	$ 964,779
Project Payment #3 - May 31, 2018	20%	$ 771,823
Project Payment #4 - June 30, 2018	10%	$ 385,912
Project Payment #5 - July 31, 2018	10%	$ 385,912
Project Payment #6 - Final Report	10%	$ 385,912
	100%	$ 3,859,117

PROPOSED PRELIMINARY BUDGET

YEAR #2-5, 2019-2022

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www.weathermodification.com

WEATHER MODIFICATION LLC
2019-2022 PRICE PROPOSAL
MAURITANIA CLOUD SEEDING & RESEARCH
JULY 1 THROUGH SEPTEMBER 30

Program Specifications:	Year 2 Program Price (USD)	Year 3 Program Price (USD)	Year 4 Program Price (USD)	Year 5 Program Price (USD)
MOBILIZATION	129,368	133,249	137,247	141,364
AIRCRAFT FOR SEEDING & RESEARCH				
Cloud Seeding Aircraft - King Air C90	1,285,440	1,324,003	1,363,723	1,404,635
All maintenance, parts, insurance, oil included				
Includes cloud seeding equipment				
Ferry to and from Mauritania / Fargo, ND				
30 flight hours per month included, additional hours @ $800/hr.				
Research Aircraft - Citation Jet				
All maintenance, parts, insurance, oil included				
Includes all research equipment				
Ferry to and from Mauritania / Fargo, ND				
30 flight hours per month included, additional hours @ $800/hr.				
CLOUD SEEDING FLARES				
Cloud Seeding Flares Included:	456,410	470,103	484,206	498,732
(QTY 6000) 20 Gram Ejectable Flares				
(QTY 462) 150 Gram Burn-In-Place Flares				
(QTY 480) 1000 Gram Hygroscopic Flares				
2 C BAND WMI RADARS WITH PEDESTAL, ANTENNAE ON LEASE	Purchased by Client	Purchased by Client	Purchased by Client	Purchased by Client
Annual Radar Maintenance	48,000	49,440	50,923	52,451
Client responsible for tower and installation site prep				
Client responsible for power and high speed internet to site				
PERSONNEL- FIELD PROGRAM	1,147,008	1,181,418	1,216,861	1,253,367
Weather Modification LLC Personnel				
2 Captain (Multi-engine, IFR)				
2 Copilots (Multi-engine, IFR)				
1 Meteorologist/Program Mgr.				
1 Radar Technician				
1 Aircraft Mechanic				
DEMOBILIZATION	129,368	133,249	137,247	141,364
**** PRICE ASSUMES CLIENT PURCHASED 2 WEATHER RADAR SYSTEMS IN YEAR #1 - 2018***				
Total Program	**$ 3,195,594**	**$ 3,291,462**	**$ 3,390,206**	**$ 3,491,912**

TIME FRAME- FIELD PROGRAM
3 Month Field Program
12 hours per day, 7 days per week

CLOUD SEEDING MATERIAI - ADDITIONAL PURCHASES
20 Gram Ejectable Flares @ $33.00 each
150 Gram Burn-In-Place Flares @ $94.00 each
1000 Gram Hygroscopic Flares @ $74 each

Prices valid for 60 days
12/28/2017

Weather Modification International – WEST AFRICA EXPERIENCE

Weather Modification International has a long history and valuable experience in providing a wide range of services to countries in West Africa. WMI has been involved in multiple programs with the goal of identifying the potential benefits derived from the application of cloud seeding techniques and deploying advanced technologies and equipment.

The following examples demonstrate WMI's capabilities and experience in the region since 2001:

BURKINA FASO, Programme Saaga (2001 - Present)
Objective: Rainfall Enhancement & Atmospheric Assessment and Evaluation
Products and Services Provided:

- Atmospheric Research & Technical Training
- TITAN Installation Upgrade and Weather Radar Technical Consulting
- Technical Training on Maintenance of Cloud Seeding Equipment
- Multiple Aircraft Modifications for Cloud Seeding & Atmospheric Research Equipment
- Training on Cloud Seeding Operations

REPUBLIC OF MALI, Programme Sanji (2006-2009)
Objective: Rainfall Enhancement
Products and Services Provided:

- Sale of Cloud Seeding Aircraft and Ground Based Weather Radars
- Program Operations
- Atmospheric Research Operations

REPUBLIC OF SENEGAL, Programme Bawaan (2010-Present)
Objective: Rainfall Enhancement & Atmospheric Assessment and Evaluation
Products and Services Provided:

- Sale of Cloud Seeding and Atmospheric Research Aircraft
- Technology Transfer Training
- Program Consulting and On-Site Operations
- Weather Radar System Maintenance

KINGDOM OF MOROCCO, Programme Al Ghait (2002-Present)
Objective: Rainfall Enhancement
Products and Services Provided:

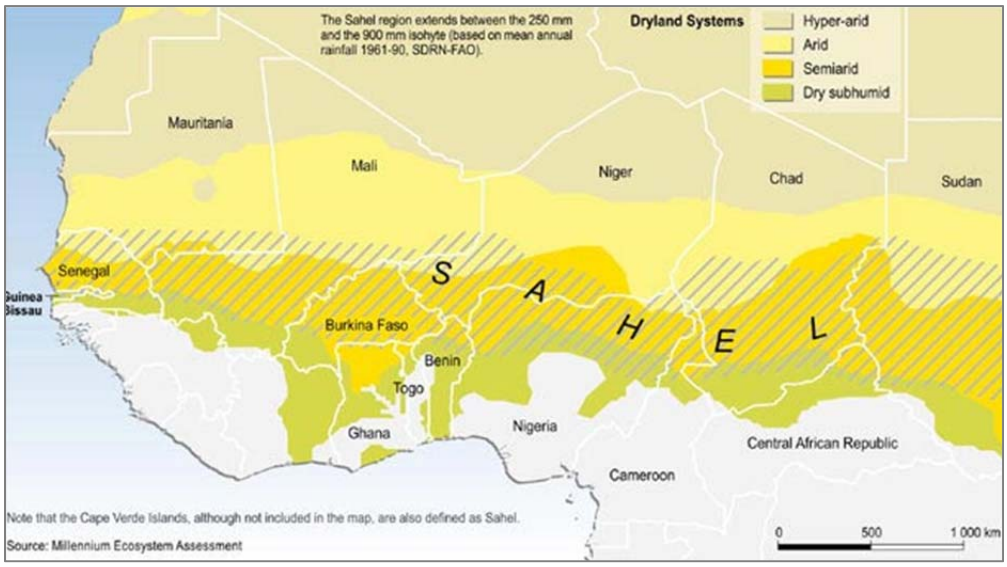
- Technology Transfer Training
- Multiple Aircraft Modification for Cloud Seeding & Atmospheric Research Equipment
- Atmospheric Research Equipment Maintenance Training
- Cloud Physics Data Analysis Training

SCOPE OF WORK – Operational Program

ISLAMIC REPUBLIC OF MAURITANIA

WMI proposes conducting an Operational Program from **July 1-September 30, 2018**. During the 3-month Operations Period, one Intensive Operations Period (IOP) 60-days in duration would be conducted to gather atmospheric research data using the WMI Atmospheric Research Citation II Jet.

Famine, extreme heat, intense dust storms, and drought have plagued the Sahel region causing severe hardship. The Sahel belt, as shown, extends 1,000 km in width from Senegal in the West to Eritrea in the East. The severity of the situation includes – desertification of soil from over farming and a lack of precipitation, extremely high market prices due to a lack of food commodities, wide spread famine, and decreased economic trade.



Application of scientific concepts and extensive scientific experimentation has proven that cloud seeding can increase the amount of precipitation if properly conducted.

Cloud seeding services would be conducted throughout the 3-month Operational Period, including during the IOP. Operations will be no more than twelve (12) hours per day, or similar based upon aviation facilities such as ILS, runway and taxiway lights, etc. WMI will staff these operations with only qualified personnel including: Additional personnel are available upon request.

- One (01) Program Scientist/IOP Operations Director (during research period)
- One (01) Flight Crew (one (01) pilot-in-command and one (01) co-pilot)
- One (01) Project Meteorologist
- One (01) Aircraft Mechanic
- One (01) Weather Radar Technician

SCOPE OF WORK – Aerial Operations

WMI proposed using one (01) Beechcraft King Air C90A for Cloud Seeding Operations and one (01) Cessna Citation II and Atmospheric Research Measurements.

The C90A aircraft will be modified for cloud seeding, as follows:

- 24-place Burn-in-place Flare Racks – Wing Mounted (01 set, 48 total carrying capacity)
- 102-count Ejectable Flare Racks w/Baskets – Fuselage Mounted (03, 306 total carrying capacity)
- Data logger unit for Telemetry measurements and weather radar tracking ability

The Cessna Citation aircraft will be modified for atmospheric measurements, as follows:

- Cloud Physics Installation – Hard points, wiring, interior equipment racks

*****Atmospheric Research equipment and modification specifications to be mutually agreed upon under separate cover; it is most valuable for measurement parameters to be carefully examined based on geographic region and program objects. The instrumentation described herein, is for sample purposes only.*****

Experienced WMI engineers will install the kit on the aircraft. The supplied flare racks, mounting brackets, control boxes, annunciators and wire harnesses will be installed per United States Federal Aviation Administration (US FAA) Supplemental Type Certificate (STC) instructions. Weather Modification International is the exclusive provider of US Federal Aviation Administration Supplemental Type Certificates approved cloud seeding and atmospheric research modifications for Beechcraft King Air 90, 200, and 300 Series aircraft. WMI-provided STC product and services assures approval by any Civil Aviation entity around the world, using FAA-PMA parts.

US FAA STC approved paperwork provided includes the following: US FAA approved Flight Manual Supplement, Instruction for continued airworthiness, and installation drawings and instruction, wiring diagrams that would be needed to route and interface to the aircraft.

All hardware and electrical connectors are included in the kit. The interior configuration is also installed at this time. All systems are tested for function and fit and the aircraft is test flown for safety and quality checks. The WMI STC modifications equip your aircraft with wing and fuselage mounted cloud seeding racks to dispense different types of flares. This creates a versatile platform capable of both cloud-base and in-cloud seeding missions – whatever the situation demands. All equipment is operated from the pilot's position, allowing single-crew flexibility when desired.

All work to be performed at WMI's modification center in Fargo, North Dakota at Hector International Airport (KFAR). Weather Modification staff can begin the modification process immediately to coincide with any require phase inspections on the aircraft.

Convertible, the modified aircraft can be switched quickly between standard and special mission configurations. This allows the aircraft to be utilized for normal passenger-carrying operations when not in use as a special mission aircraft (see VIP interior pictures).

Beechcraft King Air King C90A & Citation II
Cloud Seeding and Atmospheric Research Aircraft

A WMI Beechcraft King Air C90 takes off for a mission in Alberta, Canada during the summer of 2017. Currently, the WMI aircraft fleet consists of seven (07) Beechcraft King Series aircraft.

WMI Citation II, N555DS equipped with NASA Field Mill sensors (black round circles) prior to a deployment in cooperation with the Research Application Laboratory and Aerospace Corporation in August 2017.

Introduction to Atmospheric Research Equipment

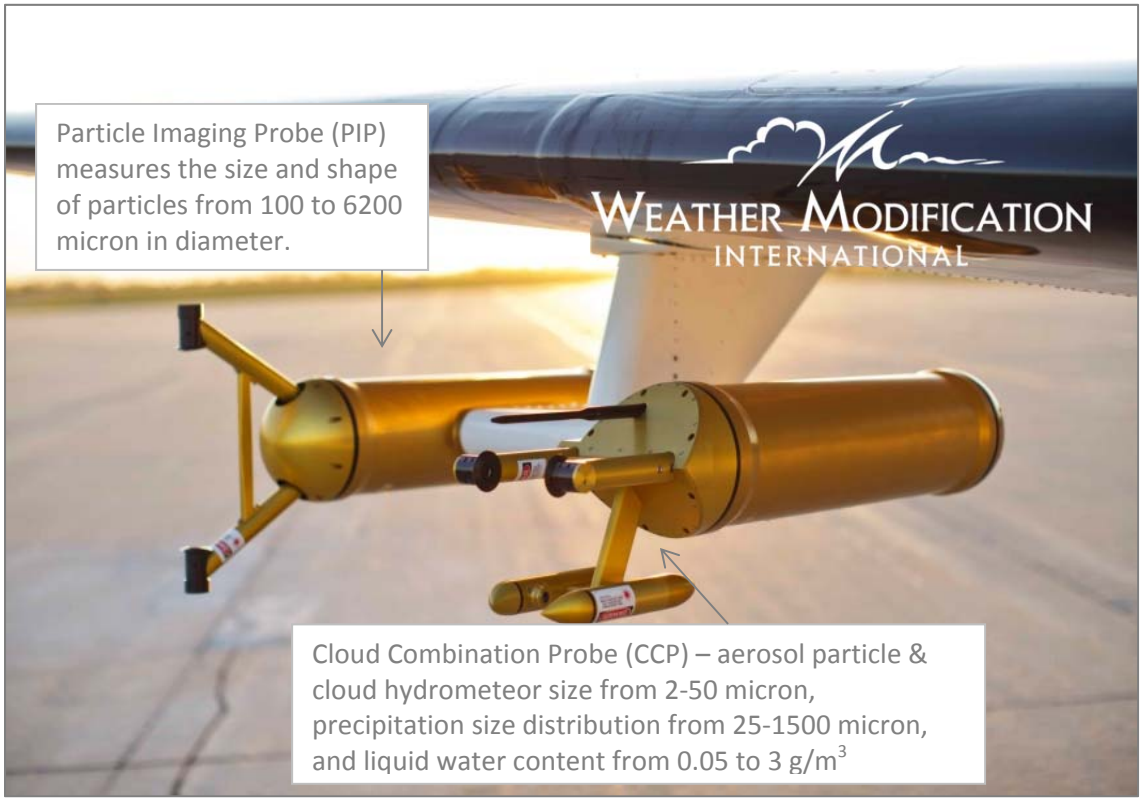
- A full-capability data acquisition system.
- Real-time aircraft data telemetry to the project operations center.
- Complement of basic cloud physics sensors, including temperature, dew point temperature, pressure, cloud liquid water content, cloud and precipitation particle imaging, and cloud droplet spectra.
- GPS-based aircraft position recording and telemetry.
- Accurate environmental wind sensing.
- Additional instrumentation to quantify atmospheric aerosols.

Rosemount 102b Total Temperature Sensor
-70°C to +~~3~~50°C

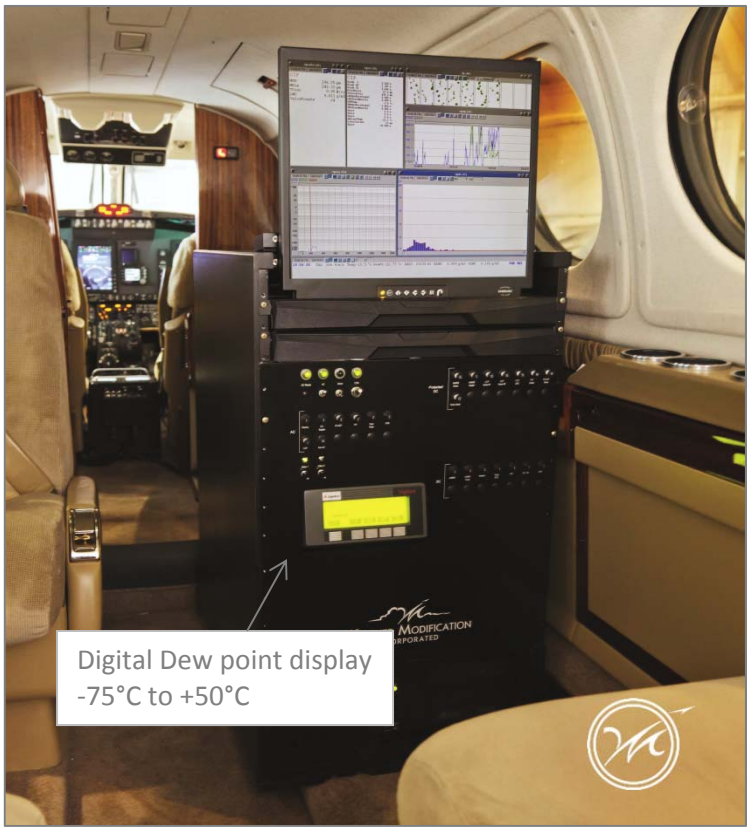
The WMI datalogger is a small sleek box installed in the rear of the aircraft, as shown. It fits securely in the seat track and has been engineered to withstand rugged cloud seeding missions. The telemetry antenna is mounted on the rear exterior fuselage of the aircraft. The GPS antenna is mounted near the engine nacelle on the top side of the wing.

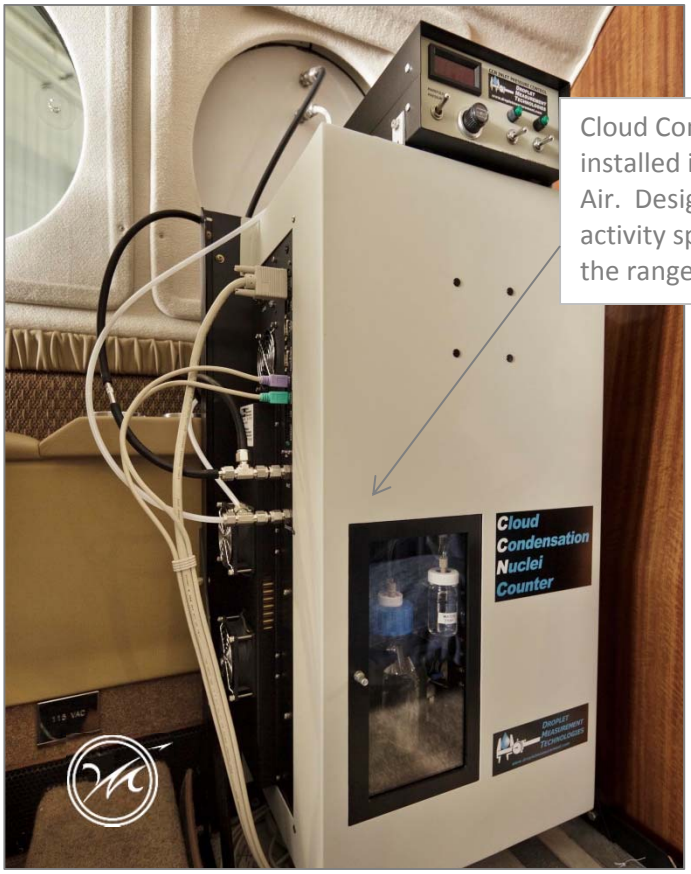
A WMI datalogger installed in the rear cabin of a cloud seeding aircraft.

WMI dual canister pylons mount; (left) Passive Cavity Aerosol Spectrometer Probe (PCASP) for measurement of aerosol particle size distribution from 0.1 to 3 micron, (right) AIMMS 20 Probe for measurement of real-time 3D wind measurements.

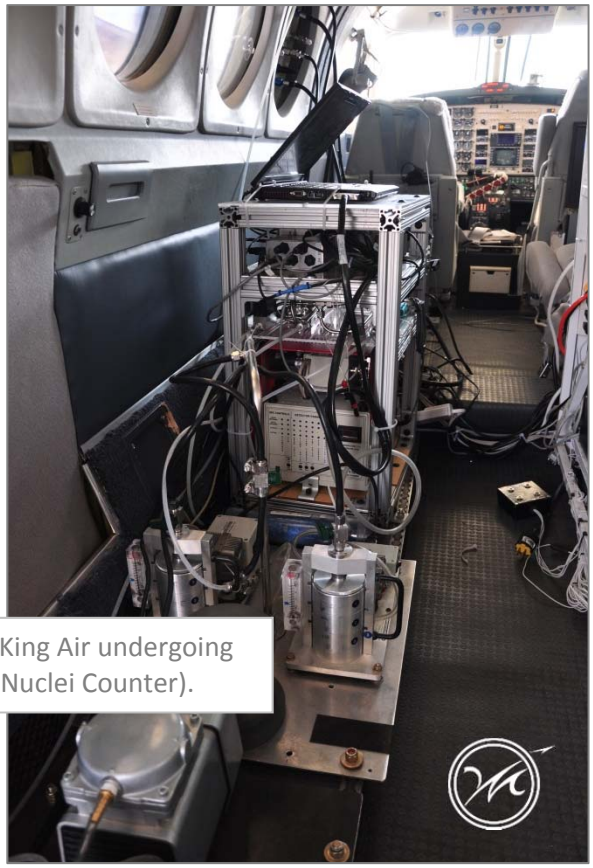



WMI Aircraft Data Acquisition System, input analog, digital and serial data for collection and processing.
WEATHER MODIFICATION
INTERNATIONAL


Digital Dew point display
-75°C to +50°C



Cloud Condensation Nuclei Counter (CCNC) installed in the rear cabin of a research King Air. Designed for the measurement of the activity spectra of condensation nuclei over the range of supersaturation from approx. 0.2



Aerosol instrumentation rack (left) and (right) a King Air undergoing installation of air quality sensors (Condensation Nuclei Counter).

Trace Gas Detection, Aerosol, and Air Quality Options:

- Carbon monoxide (CO)
- Carbon dioxide (CO_2) gas analyzers
- Nitrous oxide (NO, NO_2, NOx) analyzers
- Sulfur dioxide (SO_2) analyzer
- Ozone (O_3) analyzer
- Volatile Organic Compounds (VOC) detector
- UV absorption ozone analyzer

Additional aerosol sample tubes available through a WMI window inlet specially designed.

King Air Series Cloud Seeding Modifications

The installed seeding equipment consists of ejectable type flare racks and burn-in-place type flare racks. Three ejectable flare racks can be installed on the underside of the fuselage- each rack is capable of holding 102 ejectable flares. The magazine is detachable- removed for replacing spent with charged cartridges. The fuselage mounted racks are designed to eject/drop flares into storm cells from above.

WMI 102-count 20 gram ejectable flare racks (total flare capacity = 306) mounted to the belly of a cloud-top seeding aircraft.

There are two burn-in-place flare racks installed- one on each wing aft of the engine nacelles. Each rack is capable of holding 24 burn-in-place flares (48 total aircraft flare carrying capacity). The flare racks are designed to house AgI or hygroscopic type flares. Either type of flare is easily fastened to the rack using the hardware provided and wired to the ignition system by means of two spring-loaded binding posts. The burn-in-place flares are designed to burn while mounted on the rack, allowing the seeding agent to be released in areas for optimal updraft utilization.

Burn-in-place (BIP) flare racks for dual use of hygroscopic & glaciogenic cloud seeding pyrotechnics.

Main control box for cloud seeding systems.

Ejectable flare rack controller.

Both of the flare rack systems are operated by control units mounted in the forward cabin, which is accessible by both the pilot and copilot (see images above). An annunciator indicating ARMED and READY status of the flare firing systems is installed in the instrument panel and is easily visible from flight crew positions. The entire system is protected by a 7.5 amp circuit breaker. The power system is also protected from lightning strikes by means of transient voltage suppressors.

Weather Modification annunciator installed neatly on the co-pilot dash.

Dual flare rack capable of carrying 24 Burn-in-place (BIP) flares.

Ice Crystal Engineering $CaCl_2$ hygroscopic flares installed on a WMI 24-position Burn-in-place flare rack.

SCOPE OF WORK – Weather Radar System

WMI proposes two C-band weather radar systems. Radar is used to 1) continuously collect information on natural cloud characteristics and rainfall, 2) to help direct the cloud seeding and atmospheric research operations, and 3) provide general information to Mauritanian forecast personnel. Radar data is essential to understanding the natural and seeded cloud characteristics, precipitation distribution, and to evaluate and quantify the seeding. The WMI C-band weather radar has been deployed on several similar projects.

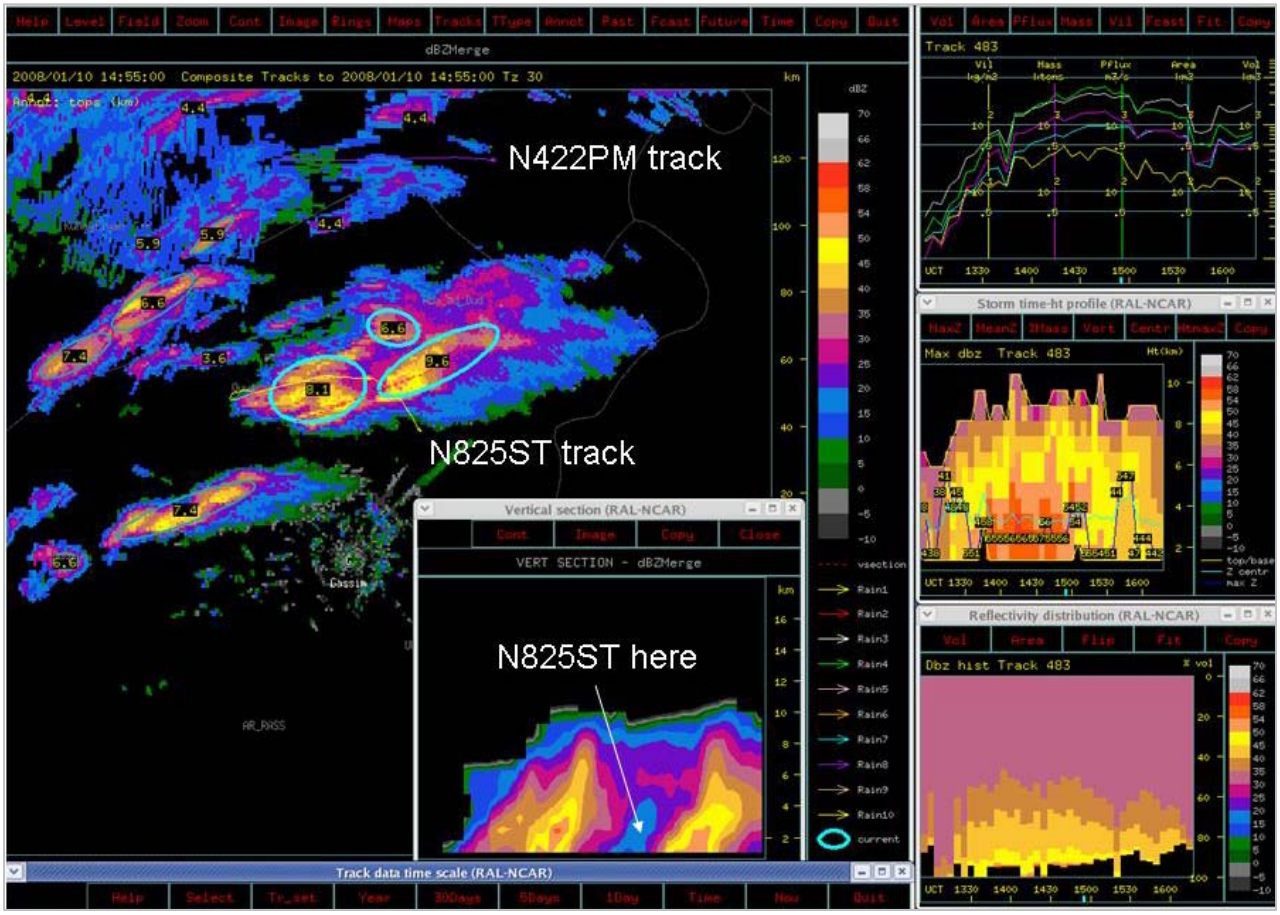
It consists of the following components:

- Antenna Pedestal
- Circular Parabolic Antenna
- Radome
- Transmitter/Receiver
- Antenna Controller
- TITAN Display and Processing Software

The WMI C-band weather radars use TITAN as its primary display processor. TITAN (an acronym for Thunderstorm, Identification, Tracking, Analysis, and Nowcasting) software automatically identifies and tracks convective storms using weather radar data. The TITAN system (shown above) provides 16 levels on contoured color radar reflectivity data, zoom, custom target overlays, instant playback and real-time aircraft flight track/seeding event superimposition.

The TITAN system identifies each storm seen by the radar, tags it with a specific identifies, determines the storm properties (such as height, volume, area, intensity, rainfall, speed of motion), and tracks it. TITAN can also be

used to predict the future location and intensity of a storm by following its trend history. TITAN data is routinely archived for analysis and evaluation making it extremely useful. WMI has used TITAN software exclusively on many weather modification programs worldwide since 1997.



TITAN display showing the ability to track cloud seeing aircraft during operations.

Preliminary communications has suggested the Nema and Tidjikja be used for the radars. These locations, approximately 475 km (256 nautical miles) apart, would cover a significant fraction of the region of interest. Coverage of the radars will not overlap, except perhaps for the largest mesoscale convective systems. Significant topography, specifically mountains east of Nema, might impose beam blockage concerns. WMI will assist in selecting radar sites that provides for optimal project area coverage.

SCOPE OF WORK – Personnel & Training

Personnel

WMI proposes program with personnel that may include – an electronics technician, a program meteorologist, and pilots to be on site for assistance and technical operations training in Mauritania from July to September. WMI personnel would work alongside Mauritanian personnel with the ultimate goal of establishing a successful cloud seeding program for the Islamic Republic of Mauritania. Operations would be conducted out of a locations agreed upon by both the client and WMI.

Training - Additional Option

Weather modification training is found most helpful when starting a new program or upgrading an existing program. We are flexible and will tailor the training to fit the final program needs, considering the specific program objectives in addition to the target area climate, topography, infrastructure, population density and logistical considerations. In designing our training, we consider specifically the number of trainees and their education. Copies of all written training materials will be provided in binder form, and these items will be the attendees' property after the completion of the training. Instruction is provided in English.

Curriculum & Participants

The following is a brief list of personnel WMI suggests for training during specified periods. Training may be completed either on site in Mauritania and/or offsite at locations beneficial to the trainees, such as, but not limited to flight schools in the United States.

- Meteorologists
- Flight Crew – Pilots & Copilots
- Aircraft Maintenance Engineers (Airframe & Power plant)
- Aircraft Avionics Technicians
- Weather Radar Technicians
- Data Acquisition & Instrument Personnel

Our experience clearly indicates that the best projects result from the best teamwork. It is therefore important that all project personnel understand not only their own jobs, but that they also have a good understanding of each other's jobs to the maximum extent possible. Such understanding improves communication and helps personnel recognize and convey information that others will find useful. Toward that objective, each of the training sessions mentioned below should be of interest to all attendees.

- Flight training on the aircraft and aircraft systems.
- Cloud seeding training- scientific background, theoretical, and simulation.
- Basic aviation meteorology for pilots: The pilot's viewpoint is examined to heighten the meteorologist's understanding of airborne operations. The basic procedures for safely flying convective clouds are presented.
- Maintenance of the aircraft.
- Seeding equipment calibration and maintenance.

SCOPE OF WORK – Feasibility Study

Precipitation Process

Clouds in the lower troposphere form when, in cooling air, water vapor condenses upon cloud condensation nuclei (CCN), forming cloud droplets. The sizes of the droplets thus produced depend somewhat on the amount of water vapor present, but more on the character of the CCN. If the CCN are large or have properties that attract water (such as containing salt), the resulting droplets will be larger. If not, the droplets will be smaller. All this happens on a very small scale. About one million (10^6) typical cloud droplets are required to produce just one 1 mm raindrop.

Precipitation forms in only two ways. The simpler process involves the collision and coalescence of cloud droplets until the droplet becomes large enough to fall as precipitation. Thus, the initially tiny cloud droplets grow in size, becoming drizzle, and with continued growth, rain. This process is known as the *collision-coalescence* or *warm rain* process. The alternative path to precipitation is through the formation of ice. For this to happen the cloud must of course become colder than 0°C. In regions having warm surface temperatures such as Mauritania this is only possible when clouds grow tall enough to reach the colder upper atmosphere.

Cloud seeding intends to modify cloud processes by accelerating either the collision-coalescence or ice-phase precipitation processes, or both. When warm clouds are comprised primarily of smaller cloud droplets, the collision-coalescence process is slow and less efficient. In such cases, the clouds, while still growing, can be treated with hygroscopic (water-attracting) CCN, which result in the immediate formation of large numbers of larger droplets, effectively-jump-starting the collision-coalescence process. The primary hygroscopic seeding method is through the use of salty pyrotechnics (flares) that are burned at or near cloud base.

When clouds grow colder than about -5°C but do not immediately form ice, they can be treated with silver iodide-based ice nuclei which immediately initiate ice formation, thus starting the ice-phase precipitation process. This ice-forming (glaciogenic) seeding is done with silver iodide (AgI) pyrotechnics that can be burned while flying through cloud tops, at convective cloud bases, or dropped into cloud tops.

Analysis Process & 60-Day Research Period

A field program will be conducted during a 60-day period corresponding to the period when convective clouds occur most frequently. The objective will be to obtain coordinated measurements with the research aircraft and the operational radar(s) in the Islamic Republic of Mauritania. The research aircraft (proposed Citation II) will carry a comprehensive set of cloud physics and chemistry instrumentation. The cloud seeding aircraft will also conduct measurements in seeded clouds in a case-study approach to look directly for microphysical effects.

The selected instrument package will be designed such that all parameters related to evaluating the seeding potential for Mauritanian clouds could be assessed. These include instruments to assess aerosols and trace gases that contribute to the formation of droplets and ice in clouds, the microphysical instruments to assess the natural and seeded precipitation processes, and instruments to characterize the local thermodynamic structure of the atmosphere in which clouds develop. The cloud physics aircraft will also conduct measurements in seeded clouds to identify direct microphysical effects.

The characteristics of the rainstorms will be monitored by radar to understand: (1) the large-scale organization of the storms, (2) their frequency of occurrence and spatial distribution around the area of study, and (3) the temporal history, sizes, and intensities of individual storms.

An Operations Director will direct the day-to-day operations during the experiment. This person will direct the aircraft operations, including guiding the aircraft to suitable clouds for seeding, and ensuring that the proper coordination with the radar data collection is taking place. The Operations Director will be a scientist familiar with running field programs. The Operations Director will also be responsible for scheduling all operations, and will take into consideration all available meteorological data, including local soundings and weather forecasts. A radar echo monitor showing the TITAN display will be available to the Operations Director.

Pilots will be in constant radio contact with the Operations Director in order to direct the aircraft to the proper cloud for seeding. The aircraft track will be displayed at the operations center, and real-time microphysical, temperature, and pressure data from the aircraft will also be displayed.

These operations may be conducted in partnership with select research universities.

The final result of the feasibility study will be a report with recommendations to determine the suitability of seeding in the Islamic Republic of Mauritania. If the clouds seem suitable from the standpoint of their physical characteristics, and if their frequency of occurrence is high enough to make the option of operational seeding seem viable from a cost effectiveness viewpoint, then a recommendation would be made to move on to a second phase of scientific demonstration and aircraft purchase.

THANK YOU!

For more information, please contact:

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