Measurements of Atmospheric Radiation on Small Unmanned Aerial Vehicles and AircraftT at NASA Armstrong Flight Research Center (AFRC)

MARS UAV AT AFRC


Introduction
Observations lead the way to understanding the complexities of our environment. Concerns regarding space weather impacts to flight crew, avionics, electronics, communications and navigation led NASA in taking atmospheric radiation observations in 1997 to support high altitude supersonic commercial flights [1]. With the increase of commercial flights on polar routes, the Mission to Mars and high altitude/latitude Unmanned Aerial Vehicle (UAV) flights, the need for more observations was addressed by the Upper-atmospheric Space and Earth Weather eXperiment (USEWX) and the space weather community. Space weather forecasts are heavily model dependent with little verification. Given AFRC's experience and unique flight assets, teams of scientists and engineers collaborated to reinvigorate observing space weather from several different aircraft. During instrument integrations onto AFRC aircraft, ideas ignited to combine weather and space weather observations with a hazard detection capability that will not only warn but also provide mitigation strategies to pilots and operators in real time [2]. This poster identifies what has been accomplished so far and future plans to develop this technology.

Methods

- HAWK
  - Industry standard Tissue Equivalent Particle Counter
  - First flight on ER-2 1997
  - Large, heavy, dated
  - Data storage in instrument

- ARMAS
  - Automated, available in flight
  - Small, lightweight, new
  - Data stored and transmitted
  - Communications via Iridium
  - Available via smartphone at with 3-minute data latency

- TAMDAR
  - Atmospheric measurements plus humidity, turbulence and icing
  - Communications via Iridium
  - Data entered into weather models
  - TAMDAR Edge for UAV applications

- TINMAN
  - Thermal neutron detector
  - Thermal neutrons disruptive to sensitive electronics

Data

ARMAS flies on a space available basis on AFRC aircraft in locations of high interest, e.g., the poles, South Pacific, New Zealand, Iceland, and Canada. Radiation observations were taken by ARMAS during the OLYMPEX field campaign (Fig. 1). AFRC USEWX-equipped ER-2 also supported the Radiation and Dosimetry eXperiment (RaD-X) [4].

Fig. 1a  
Dose rate increases/decreases associated with aircraft climb/descent, respectively.
Large variability in observed dose rate while NAIRAS model shows climatology
ARMAS data used to improve NAIRAS model

Fig. 1b  
Higher dose rate correlated with lower cutoff rigidities
ARMAS provides 3-Dimensional rendering of GFL location and altitude

Conclusions
More weather/space weather observations are key to understanding weather/space weather; their interactions, model improvements and warning decisions
ARMAS detected probable radiation linked to Van Allen radiation belts interaction at aviation altitudes
Utilizing aircraft and radiosondes to observe weather and space weather are key to better understanding and modeling of the environment and at above flight altitudes

References

Future work
Weather Hazard Alert and Awareness Technology Radiosonde (WHAATRR) Glider (Fig. 2)
- Performs radiosonde observations to 100,000 feet and Return To Base (RTB) for reuse
- Launched on a weather balloon and RTB for reuse
- NASA technologies enable autonomous soaring, ground/airborne collision avoidance during RTB
- Targetable to weather/radiation hazards
- Dropsonde version will swarm weather and space weather hazards, release from DC-8/Glak
- Inspired by AFRC’s Prandtl-M (M) Glider designed to fly in Martian atmosphere (Fig. 3)
- WHAATRR Glider instrument development facilitates Prandtl-M instrumentation needs

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