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

MARS UAV AT AFRC

Scott Wiley[1], W. Kent Tobiska[2], Justin Bailey[2], Leonid Didkovsky[2], Kevin Judge[2], Seth Wieman[2], William Atwell[2], Brad Gersey[3], Richard Wilkins[3], Stephen Bacon[3], Laura Dominik[4], Chris Mertens[5], Robert Singleterry[5], Albion Bowers[6], Dave Berger[6], Luke Bard[6], Ed Teets[6], Bryn Jones[7], Geoff Crowley[8], Irfan Azeem[8], Matthias Meyer[9], Tomas Fokert[9], Antti Pulkkinen[10], Tom Conroy[11], Derek Abramson[1], Justin Hall[1], Kim Bestul[1], Robert Jensen[1], Geoffrey Bland[12], Paul Marinello[13], Mary Lockhart[14], [1]*Jacobs, Inc. at NASA Armstrong Flight Research Center*, [2]*Space Environment Technologies*, [3]*Prairie View A&M University*, [4]*Honeywell*, [5]*NASA Langley Research Center*, [6]*NASA Armstrong Flight Research Center*, [7]*SolarMetrics*, [8]*ASTRA*, [9]*DLR*, [10]*NASA Goddard Space Flight Center*, [11]*Far West Technology, Inc.*, [12]*NASA Wallops Flight Facility*, [13]*Panasonic Aerospace*, [14]*PEMDAS Technologies*

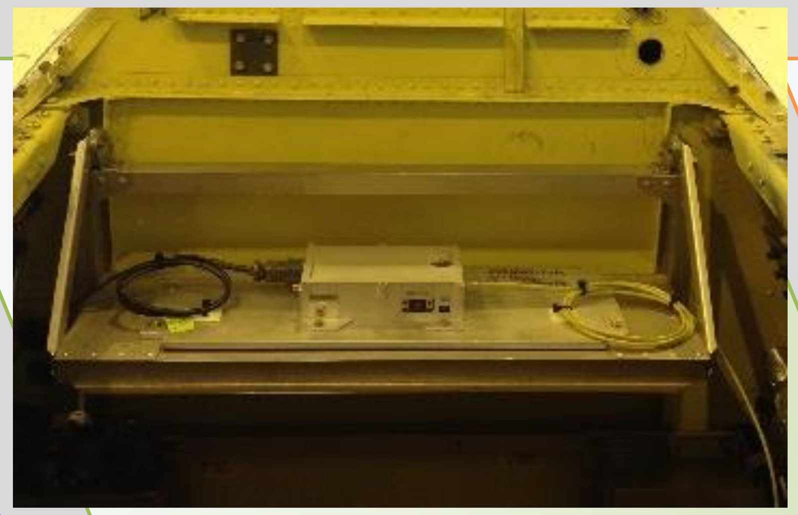
Introduction

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

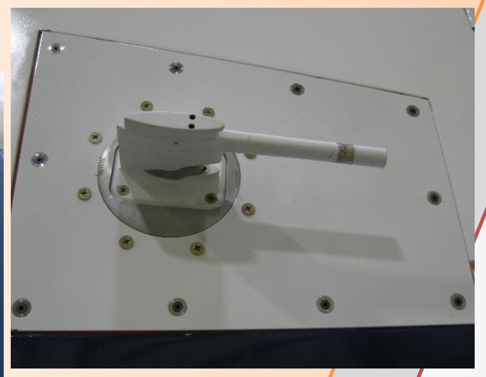


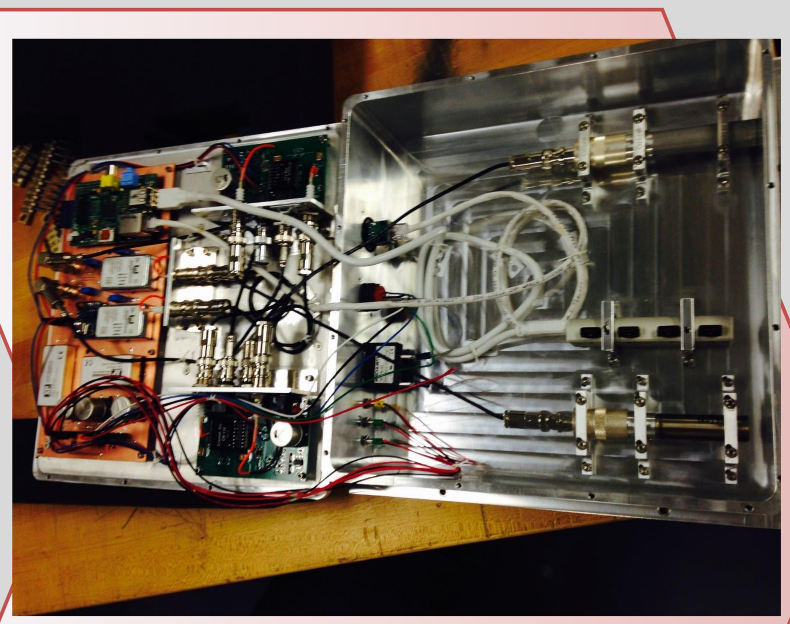
ARMAS

- Automated, available in flight
- Small, lightweight, new
- Data stored and transmitted
- Communications via Bluetooth and 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

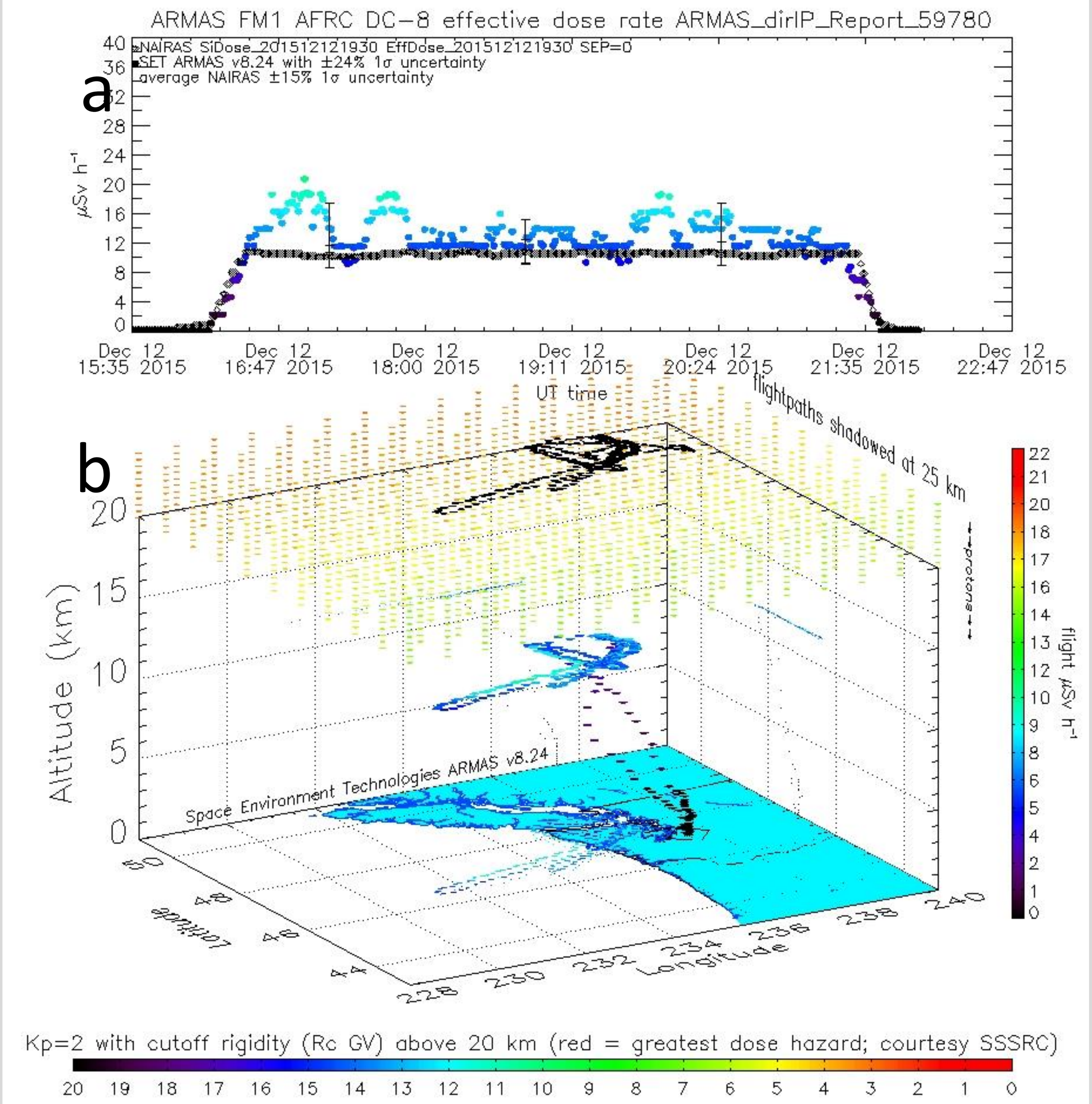


Figure 1. ARMAS observations from AFRC DC-8 flight on 10 Dec 2015 [3]. Effective dose rate is shown in color and NAIRAS model in black.

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 GPS 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 at and above flight altitudes

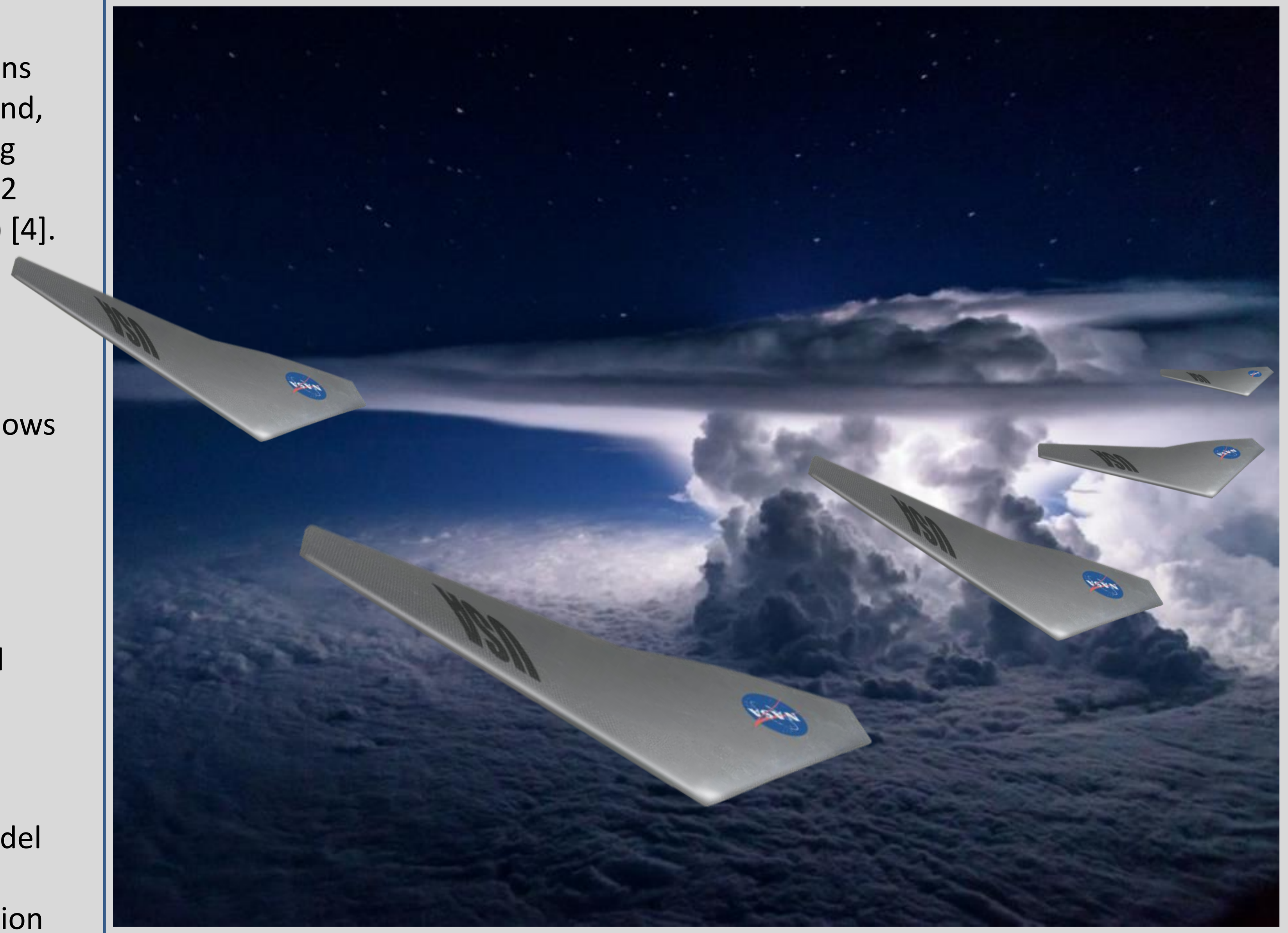


Figure 2. Future use of a WHAATRR Glider formation around a thunderstorm, i.e., *Twister* on steroids with better aerodynamics
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Future work

Weather Hazard Alert and Awareness Technology Radiation 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/Global Hawk
- Inspired by AFRC's Prandtl-Mars (M) Glider designed to fly in Martian atmosphere (Fig. 3)
- WHAATRR Glider instrument development facilitates Prandtl-M instrumentation needs

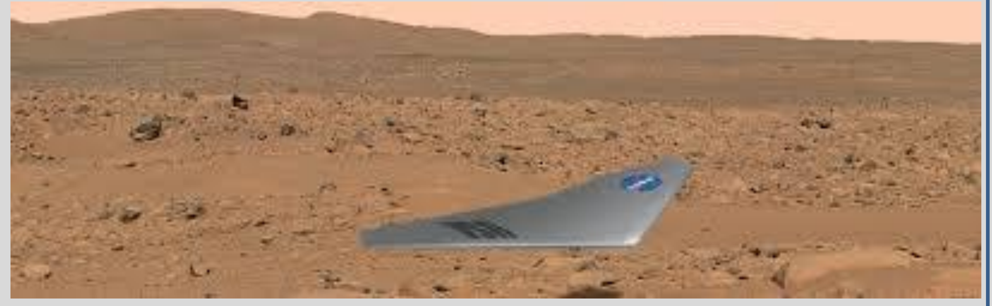

Figure 3. Prandtl-M glider

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