Progress Towards Real-Time Radiation Measurements on Aircraft

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Progress Towards Real-Time Radiation Measurements on Aircraft

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ARMAS builds on NAIRAS

• ARMAS (Automated Radiation Measurements for Aviation Safety) evolved from the highly successful NAIRAS (Nowcast of Atmospheric Ionizing Radiation System)
  ○ NAIRAS was a NASA LWS TRT funded Applied Sciences Program (2008-2011)
  ○ It developed an operational prototype for a global, real-time, data driven predictive system needed to assess biologically harmful radiation exposure levels for aviation.

• Objectives:
  ○ Deploy and obtain real-time data from a dosimeter flown at commercial air traffic altitudes
  ○ Integrate real-time data into the NAIRAS modeled radiation environment
  ○ Improve the accuracy of radiation dose and dose rates along flight paths
  ○ Improve aviation safety by laying the groundwork for automated, reliable monitoring of the natural radiation environment at commercial aviation flight levels.

• Team:
  ○ Space Environment Technologies
  ○ Prairie View A&M University
  ○ Boeing
  ○ Utah State University Space Weather Center
  ○ FPS
  ○ Collaborators: NASA LaRC, Aerospace Corp., ASTRA, Teledyne, aviation pilots

Flight Module

• NASA Dryden Flight Research Center provided 29 flights aboard DC-8
  ○ DC-8 flights occurred over a range of magnetic latitudes and longitudes, obtaining GCR dose measurements.

Calibrations with TEPC

• Tissue Equivalent Proportional Counter (TEPC)
  ○ TEPC is the community standard for tissue equivalent dosimetric measurements
  ○ TEPC collects data as a function of time
  ○ Measures the dose and estimates the dose equivalent by making spectral measurements of the linear energy loss of the radiation as it passes through the detector volume
  ○ Omni-directional detector is surrounded by tissue equivalent plastic and internal propane gas to provide an energy deposition response similar to human tissue
  ○ Detector gas is at very low pressure (mass of gas is similar to a human cell)

  ○ TEPC HAWK instrument is maintained and operated by Prairie View A&M University

Vision and Progress

• ARMAS will utilize airborne micro dosimeters, calibrated to TEPC, to make dose and dose rate measurements in real-time, transmit the data to the ground for data implementation into NAIRAS, and then distribute the updated information on to the end user

Data Integration and Test

• Preliminary Ground Test plan
  ○ Sunset flight experiment on DC-8 will measure real-time ambient dose rate with at least 1-minute time granularity and GPS position to within 200m (1s)
  ○ Use GPS on DC-8 and Iridium satellite link to transmit data in 5-minute packets
  ○ TEPC will fly simultaneously for cross comparison but will record data
  ○ CASES GPS will fly simultaneously for cross comparison of position
  ○ Pressure level flight logs will be used for NAIRAS post analysis
  ○ Sunset accumulated ambient dose and DC-8 GPS will be transmitted to the ground via Iridium satellite link
  ○ Ground data packet receipt will be verified by FPS and SET

  ○ Data will be assembled into ambient dose rate time series for each channel of data (uGy/minute) and inserted into database as archival and most recent files
  ○ SET database will separately contain most recent NAIRAS global ambient dose equivalent rate data
  ○ USU SWC will extract most recent NAIRAS and files from SET database

  ○ Sunset flight data will be reported as a difference from 3D NAIRAS cells (1°x1°x1km) using a flight tracking radius filter
  ○ Small-sized difference files will be returned to database for NAIRAS extraction and conversion to effective dose rate
  ○ Goal is real-time update latency of less than 1/2 hour
  ○ Successfully accomplished all the above and successful real-time update latency of 15-minutes achieved

• ARMAS micro dosimeter (Sunset) – TEPC Calibration
  ○ First-time exposure of Teledyne dosimeter to neutrons
  ○ 1 hour of neutron beam time ~ 30,000 hours at 40,000 feet
  ○ Dose per neutron of a given energy measured (8.1-800 Mev)
  ○ 12 separate tests were done to determine Sunset susceptibility to neutrons
    ▪ Background (g): 777 ft. (237 m)
    ▪ Background (g): 3719 ft. (2231 m)
    ▪ Without shielding
    ▪ With thin Al cover 0.21 g/cm²
    ▪ With "airplane" Al 5.2/cm² and HDPE 3 g/cm³
    ▪ With scattering 20° off-beam axis

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