# HARP radiation instrumentation on the NCAR/NSF G-V aircraft

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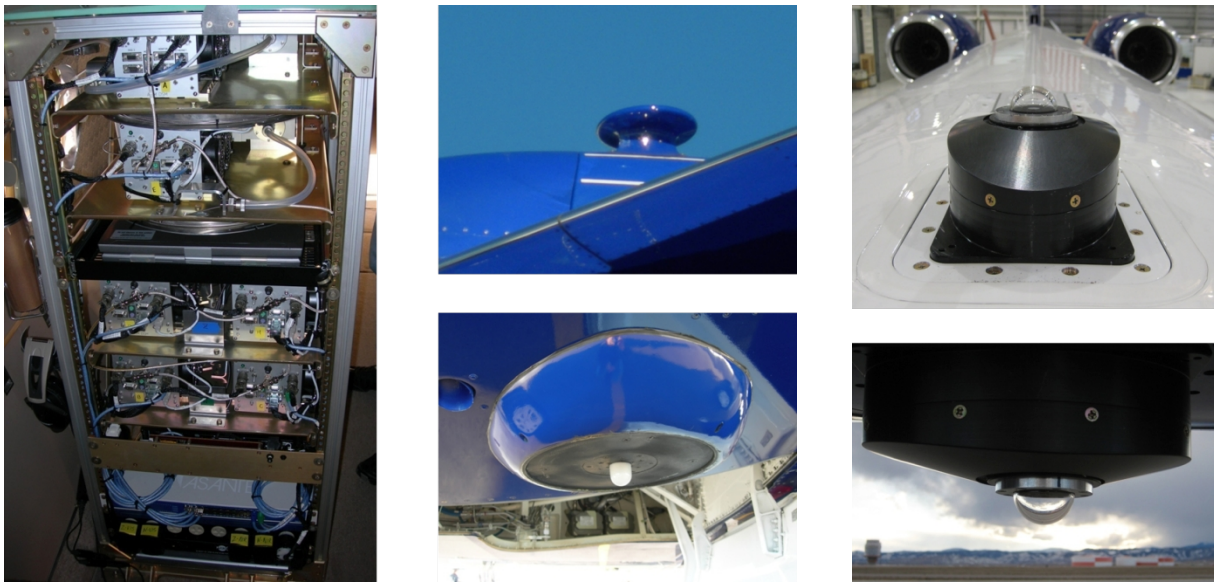
**Instrument Summary**

The HIAPER Airborne Radiation Package (HARP) instrumentation is a comprehensive atmospheric radiation suite to measure spectrally resolved actinic flux and horizontally stabilized irradiance. HARP was developed in a collaborative effort between NCAR, the University of Colorado, the Leibniz-Institute for Tropospheric Research, Metcon, Inc and Enviscope GmbH. The package is part of the HIAPER Aircraft Instrumentation Solicitation (HAIS), funded by NSF.



*HARP G-V rack (left), actinic flux optics on the T-tail fairing and rear fuselage (center) and horizontally stabilized irradiance optics on the fuselage (right).*

**Actinic Flux**

CCD actinic flux spectroradiometers provide *in situ* down- and up-welling actinic flux density spectra from approximately 280 to 680 nm at a data frequency of up to 1 Hz. From the measured flux, the NCAR Atmospheric Radiation and Measurements (ARIM) group calculates photolysis frequencies for important atmospheric trace gases including $O_3$, $NO_2$, $CH_2O$, HONO, $HNO_3$, $N_2O_5$, $HO_2NO_2$, PAN, $H_2O_2$, $CH_3OOH$, $CH_3ONO_2$, $CH_3CH_2ONO_2$, $CH_3COCH_3$, $CH_3CHO$, $CH_3CH_2CHO$, CHOCHO, $CH_3COCHO$, $CH_3CH_2CH_2CHO$, $CH_3COCH_2CH_3$, $Br_2$, BrO, $Br_2O$, $BrNO_3$, BrCl, HOBr, $BrONO_2$, $Cl_2$, ClO, and $ClONO_2$ using a modified version of the Tropospheric Ultraviolet and Visible (TUV) radiative transfer model. Similar NCAR/ARIM instruments have an excellent record of performance during NASA AVE (2004 and 2005), PAVE, CR-AVE, TC-4 and ARCTAS, and the NSF OASIS campaign.

**Irradiance**

Silicon and InGaAs irradiance detectors provide down- and up-welling flat plate irradiance from 300 to 2400 nm with a data frequency of 1 Hz. The irradiance optical collectors are mounted on actively stabilized platforms to maintain horizontal stability up to 5 degrees in aircraft pitch and roll. From the stabilized irradiance, the University of Colorado Atmospheric Radiation Group (ARG) determine layer properties, such as reflectance, transmittance and absorbance, surface albedo and other properties using radiative transfer modeling.

The irradiance detectors have an excellent record of performance on the SAFARI, CRYSTAL-FACE, ICARTT, GoMACCS, INTEX-B, TC4 missions (operated by the ARG), and on the G-V PACDEX mission.

**Calibration**

The absolute spectral sensitivity of the instruments is determined in the laboratory with 1000 watt NIST-traceable tungsten-halogen lamps with an uncertainty of 2-4%, depending on the wavelength. In addition, the optical collectors are characterized for angular and azimuthal response and the effective planar receptor distance. During deployments, spectral sensitivity and wavelength assignment calibrations are performed using secondary quartz-tungsten-halogen calibration lamps and Hg line sources in a field calibration unit that attaches directly to the optical collector assembly of the actinic flux instruments. Final primary calibrations are performed in the laboratory after each mission. In addition, comparisons to extraterrestrial flux have been used to ensure proper wavelength assignment throughout the spectra.

**References**

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