Contamination

MSX Instrumentation

Contamination instruments, UVISI, and reference sphere

Objective

The MSX mission will provide a unique opportunity to extend the thermospheric models and improve predictions of satellite and debris orbital decay using coordinated orbital and ground-based observations.

Calibrated on-board mass spectrometers and a pressure gauge will accurately measure the neutral and ionic densities at MSX's 900-km altitude. Data acquired at all latitudes and over several annual cycles will provide insight into diurnal, seasonal, solar, latitudinal, and other dynamic variabilities, e.g., winds. Current models such as MSIS90 and the International Reference Ionosphere are uncertain by 25 to 50% at this altitude; the dependencies on geomagnetic and solar activities are not well understood. MSX provides the capability to expand and improve the accuracy of those models. Figure 1 is an MSIS90 prediction of the neutral species densities at 75N latitude over one year for two representative solar activity levels. Helium, the dominant constituent for most of the year, decreases by over an order of magnitude while oxygen increases during the summer period. This dramatically alters the atmospheric mixing ratios, wind patterns, and drag. The MSX instruments are being configured to provide understanding of these variations on all thermoscales by periodic pole-to-equator collection of data for a range of solar zenith angles.

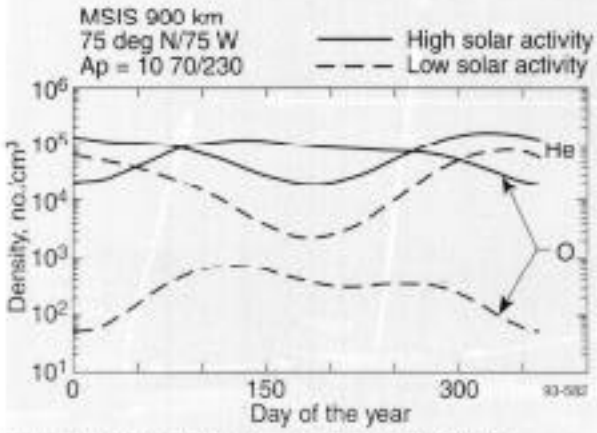

Figure 1. Annual density variations at 900 km.

Description

The reflective reference sphere released by MSX will be tracked using the Haystack radar on a routine basis, as depicted in Figure 2, and the orbitally averaged drag measured. This drag reflects accommodation of the energy of collisions with the variable composition atmosphere. Preflight ground-based measurements will provide these accommodation coefficients for the reference sphere material. By tracking the sphere over many seasons, the drag effects of helium, hydrogen, and oxygen will be isolated, using the orbital mass spectrometer composition determinations coupled with the improved atmospheric models. Drag predictions are currently limited by an accurate knowledge of both the variabilities of the atmospheric composition and the accommodation coefficients. MSX data will improve the accuracy of prediction of orbit decay as a function of atmospheric variability and will increase our understanding of the dynamics of the processes that dominate the upper atmosphere at altitudes just below the radiation belts.

Principal Investigator

O. Manuel Uy, JHU/Applied Physics Laboratory

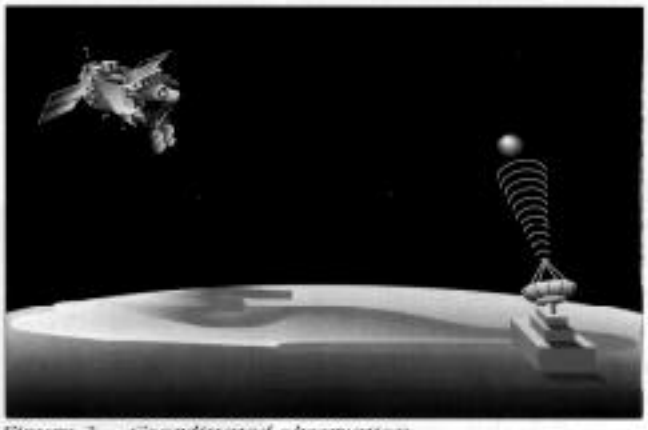

Figure 2. Coordinated observation.

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Data Certification & Technology Transfer

MSX Instrumentation: All

Objective

The absolute radiometric and goniometric calibrations of infrared observations are limited by the imprecision in the knowledge of irradiance and position of standard reference objects. The MSX legacy will be an improved knowledge of the irradiance and position of absolute standard stars and a proven methodology for radiometric and goniometric calibration for high spatial resolution infrared instruments.

Description

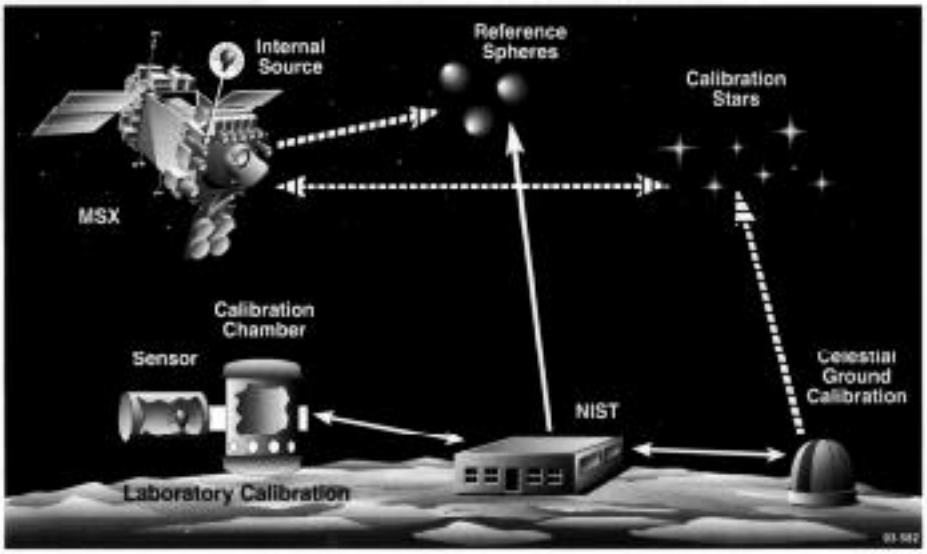
The absolute calibration for the MSX infrared observations will be based upon three independent measurements, all traceable to NIST:

- The absolute irradiance of these sources is known to within 1.5% at low flux and better than 1% at high flux.
- The infrared sensor has built-in reference sources, shown to be radiometrically stable (±1%) over a duty cycle longer than the MSX mission. They monitor detector stability and relate ground calibrations with those conducted on-orbit.
- The on-orbit radiometric calibrations will be based on two different types of reference sources:

1. Celestial standard sources selected from the traditional calibration source lists and monitored by contemporary ground-based observations in the atmospheric window bands. The data from the ground-based measurements will verify stellar emission models that predict the irradiance within the MSX sensor passbands. The measurements are accurate to within ±1% in the window bands; the model predictions are accurate to within ±3%.
2. Specially constructed calibration reference spheres deployed from the spacecraft five times during the mission. Based upon a detailed error analysis, the reference sphere irradiances should be known to within ±3% over the 4- to 28-μm spectral range of the sensor.

The errors in each type of on-orbit external calibration measurements are largely independent and should result in a significant improvement of the absolute calibration for the celestial standard objects. The result of this activity will be a set of radiometrically calibrated standard objects that will be accessible to the entire infrared community.

Principal Investigator

Thomas Murdock, General Research Corporation

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