THE POSSIBLE EFFECTS OF THE NATURAL AND INDUCED SPACE ENVIRONMENT ON THE OPTICAL AND THERMAL PROPERTIES OF EOS SURFACES

PRESENTED AT

5th EOS Investigator Working Group
Calibration/Data Product Validation Panel Meeting
AM Observatory Splinter Group

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INTRODUCTION

- SPACE MISSIONS, INCLUDING THAT OF EOS, WILL CONTINUE TO BE SUBJECTED TO BOTH THE NATURAL AND INDUCED SPACE ENVIRONMENT. THE CONCERNS ASSOCIATED WITH THIS FACT WILL NOT GO AWAY

- THE NASA AND DOD HAVE RECOGNIZED THE NEED FOR LONG-LIFE STABILITY OF MATERIALS AND STRUCTURES TO THE SPACE ENVIRONMENT

- THE MAJOR AREAS OF INTEREST INCLUDE:

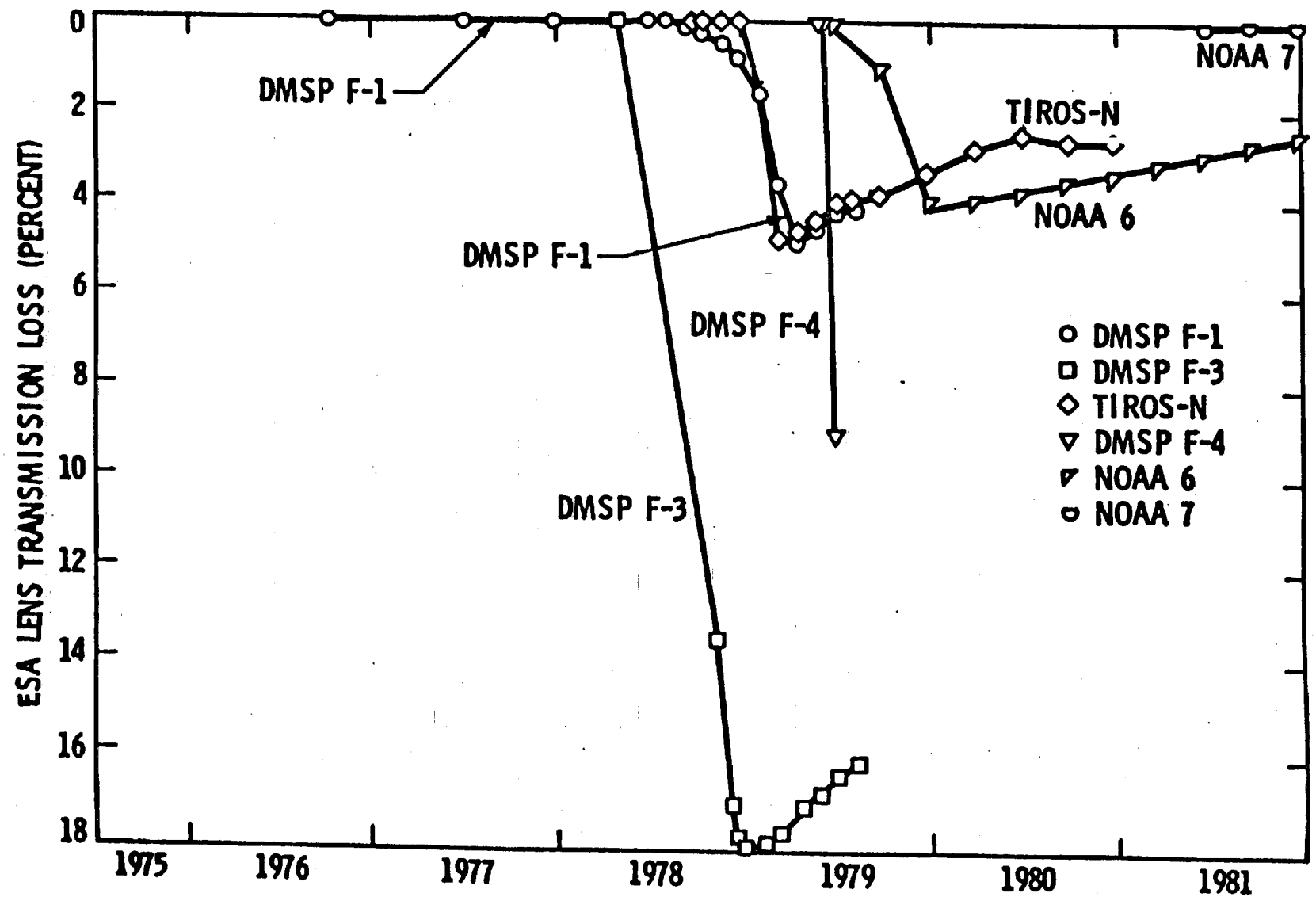
  - THERMAL CYCLING
  - UV DEGRADATION
  - SPACE RADIATION EXPOSURE
  - ORBITAL DEBRIS
  - ATOMIC OXYGEN EROSION
  - CONTAMINATION CONTROL

- HAVING FLOWN A NUMBER OF SPACE ENVIRONMENTAL EFFECTS MONITORS, SAIC HAS DEVELOPED BOTH A DATA BASE TO UNDERSTAND THE MAGNITUDE OF THIS PROBLEM AND MITIGATION TECHNIQUES TO REDUCE THE IMPACT

CONTAMINATION FLIGHT EXPERIENCE

- RETURN FLUX
  - EARTH SCAN ASSEMBLY (ESA) ON TIROS/NOAA/DMSP SHOWED SIGNIFICANT DEGRADATION (UP TO 20%)
  - RADIATIVE COOLER ON DMSP SHOWED SIGNIFICANT DEGRADATION (>400%)
  - CONTAMINATION MONITORS (TQCMs) ON NOAA-7 EXHIBITED HIGH CONTAMINATION ACCRETION (~1300 Å/2 YEARS) IN NADIR DIRECTION
  - CONTAMINATION MONITORS ON STS-3 AND OTHER SHUTTLE MISSIONS EXHIBITED HIGH CONTAMINATION ACCRETION (~15-20%) IN RAM DIRECTION
  - IECM ON STS-3 AND -4 MEASURED HIGH RETURN FLUX RATES

TRANSMISSION LOSS OF THE EXOSPHERIC ATMOSPHERE VIEWING ESA OBJECTIVE LENSES ON DMSP, TIROS-N, NOAA-6, AND NOAA-7 SATELLITES



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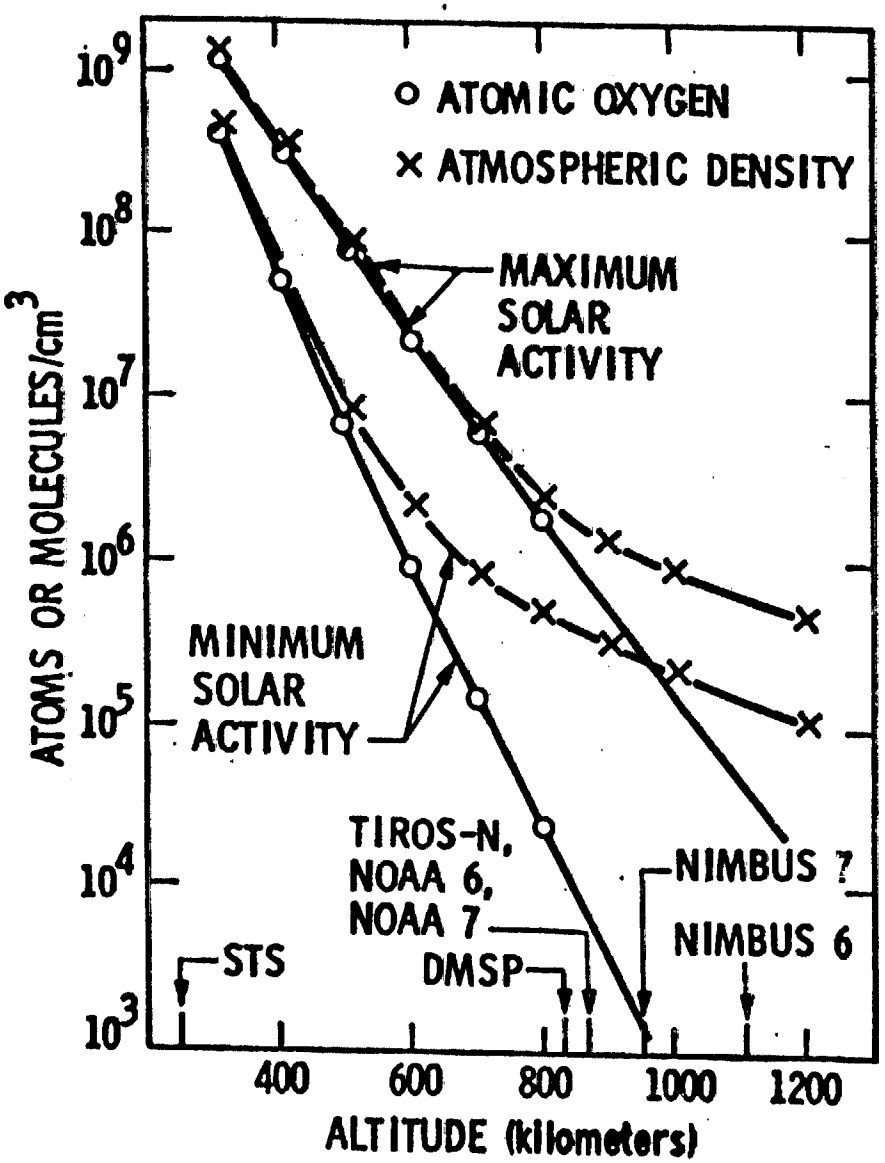
ATOMIC OXYGEN CONCENTRATION AND ATMOSPHERIC DENSITY AS A FUNCTION OF ALTITUDE



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CONTAMINATION FLIGHT EXPERIENCE (CONT)

- COLUMN DENSITIES
  - SPACE SHUTTLE MOLECULAR COLUMN DENSITY REQUIREMENTS ESTABLISHED BY NASA WERE EXCEEDED DURING SHUTTLE MISSIONS BY FACTOR OF 100
    - VIOLATED ON MOST MISSIONS
    - OPTICAL INSTRUMENTS WERE IMPACTED
- PARTICLE RELEASE
  - SPACE SHUTTLE REQUIREMENTS ESTABLISHED BY CRDG WERE EXCEEDED BY A FACTOR OF OVER 600 PER ORBIT.
    - VIOLATED ON MOST MISSIONS
    - OPTICAL INSTRUMENTS WERE IMPACTED

NOAA/CMI OBJECTIVE AND INSTRUMENTATION

- OBJECTIVE WAS TO MEASURE CONTAMINATION FROM
  - SRM (TE-M-364-15) PLUME BACKFLOW
  - HYDRAZINE RCS THRUSTERS
  - REFLECTION OF SRM OUTGASSING FROM SOLAR ARRAY
  - LONG-TERM SPACE VEHICLE OUTGASSING

- SENSORS
  - TQCMs
  - UV PHOTODIODE (FILTERED)
  - BLACK CALORIMETERS ($\alpha/\varepsilon = 1.04$)
  - DIELECTRIC MIRROR CALORIMETER
  - DIFFUSE SURFACE CALORIMETER

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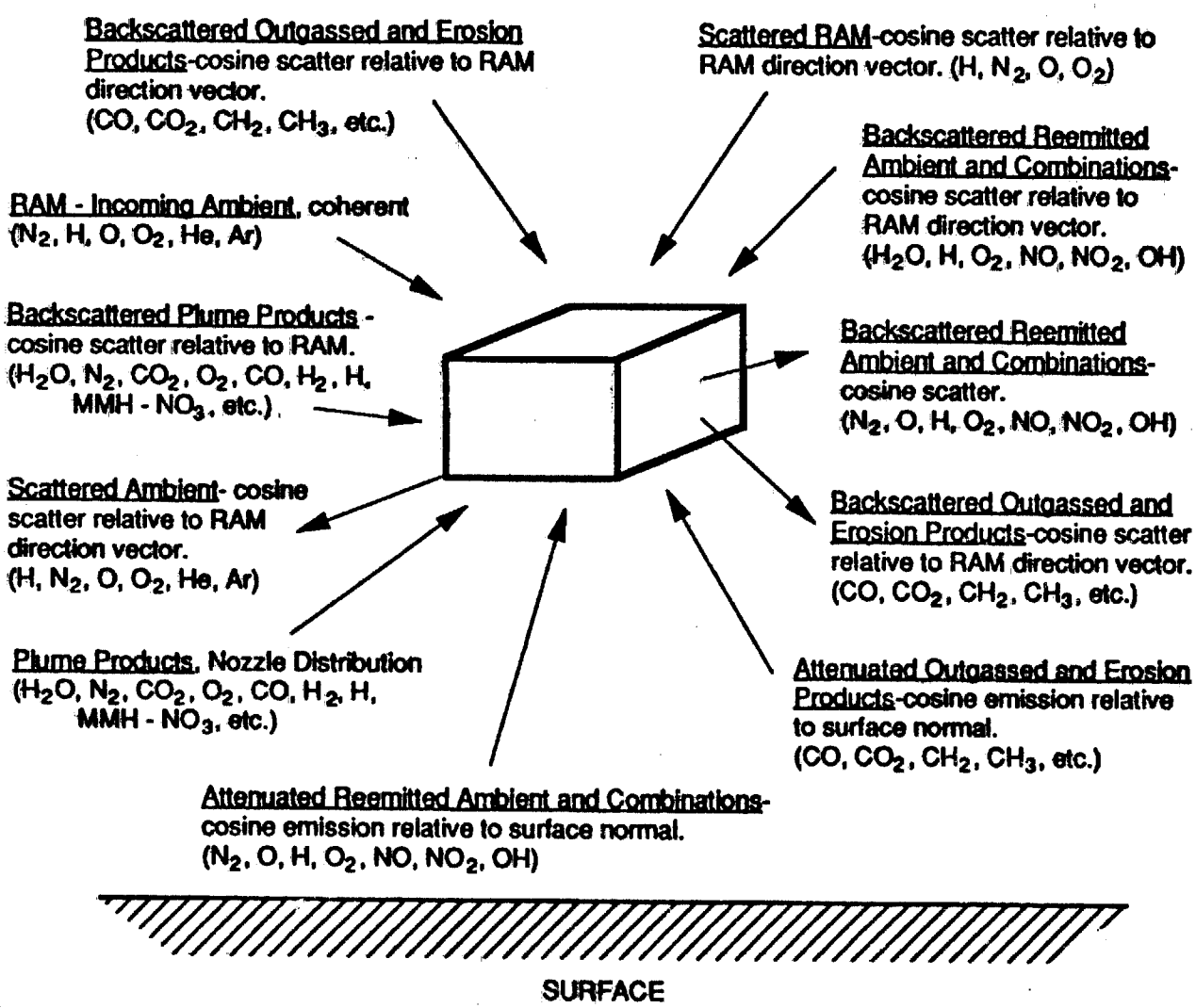
IOCM OBJECTIVE AND FLIGHT INSTRUMENTATION

- OBJECTIVE WAS TO DETERMINE ANY ADDITIONAL CONTAMINANT FLUX OCCURRING TO PRIMARY PAYLOADS AND INSTRUMENTS FROM PAYLOAD INSERTION THROUGH REMOVAL FROM THE STS ORBITER. IN ADDITION, ORBITAL DEBRIS IMPACTS AND ATOMIC OXYGEN FLUENCE WERE ALSO MEASURED.

- SENSORS
  - TQCMs/QCPMs/AOMs
  - OSR CALORIMETERS
  - PRESSURE GAUGES
  - FLUX SENSORS (UV, VIS)
  - INTACT PARTICLE CAPTURE
  - IMPACT SENSORS (PASSIVE)
  - PASSIVE WITNESS SAMPLES (AO, CONTAMINATION)

CONTAMINANT INTERACTION WITH THE AMBIENT ATMOSPHERE



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IMPLICATIONS AND RECOMMENDATIONS

- THE EOS PLATFORMS WILL BE SUBJECTED TO THE EVER PRESENT "CONTAMINATION CLOUD"
- IF NO MITIGATION TECHNIQUES ARE EMPLOYED, REFRACTIVE/REFLECTIVE OPTICAL ELEMENTS AND THERMAL SURFACES WILL MOST LIKELY BE AFFECTED
- A CONTAMINATION MONITOR PACKAGE, WITH DISTRIBUTED SENSORS, SHOULD BE INCORPORATED WITHIN THE INSTRUMENT COMPLEMENT TO AID IN THE PROTECTION OF THE SENSITIVE SUBSYSTEMS OR INSTRUMENTS

PERFORMANCE OF SUGGESTED EOS SPACE ENVIRONMENTAL EFFECTS SENSORS

MEASUREMENT	SENSOR	TYPICAL OPERATING RANGE	TYPICAL SENSITIVITY
TOTAL PRESSURE	IONIZATION GAUGE	2×10^{-10} to 2×10^{-3} Torr	±0.1 Torr
MOLECULAR DEPOSITION	TQCM	+80°C to -50°C	1.56×10^{-9} g/cm^2/Hz
PARTICULATE DEPOSITION	QCPM	+80°C to -50°C	3.5×10^{-9} g/cm^2/Hz
MOLECULAR SPECIES	MASS SPECTROMETER	8×10^{-11} to 6×10^{-4} Torr For AMU 1-150	± 1 AMU
CHANGE IN SOLAR ABSORPTANCE, α_s	THERMAL COATING CALORIMETER	-40°C to +60°C	± 0.005
CHANGE IN OPTICAL SCATTER, BRDF	SCATTEROMETER	10^{-4} to 10^{0} Sr^{-1}	TBD
DEBRIS IMPACT	IMPACT DETECTOR	0.05 to 1.0 mm	± 0.001 mm

TQCM - TEMPERATURE CONTROLLED QUARTZ CRYSTAL MICROBALANCE
QCPM - QUARTZ CRYSTAL PARTICLE MICROBALANCE
BRDF - BI-DIRECTIONAL REFLECTANCE DISTRIBUTION FUNCTION

[redacted]

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