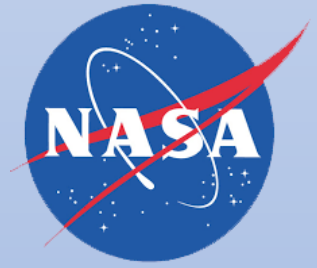
NASA Langley's Explorer Satellite Program Discoveries in the 60's and 70's Relevant Today

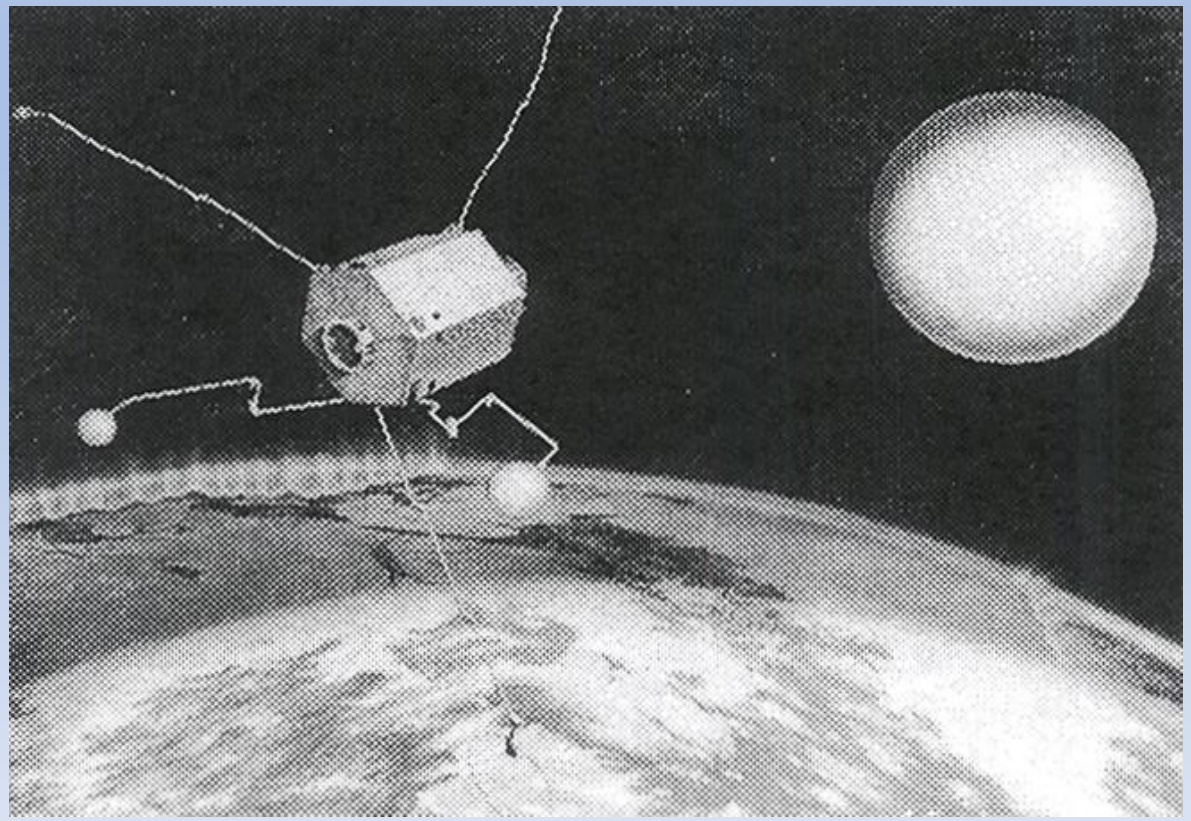


Ed Prior

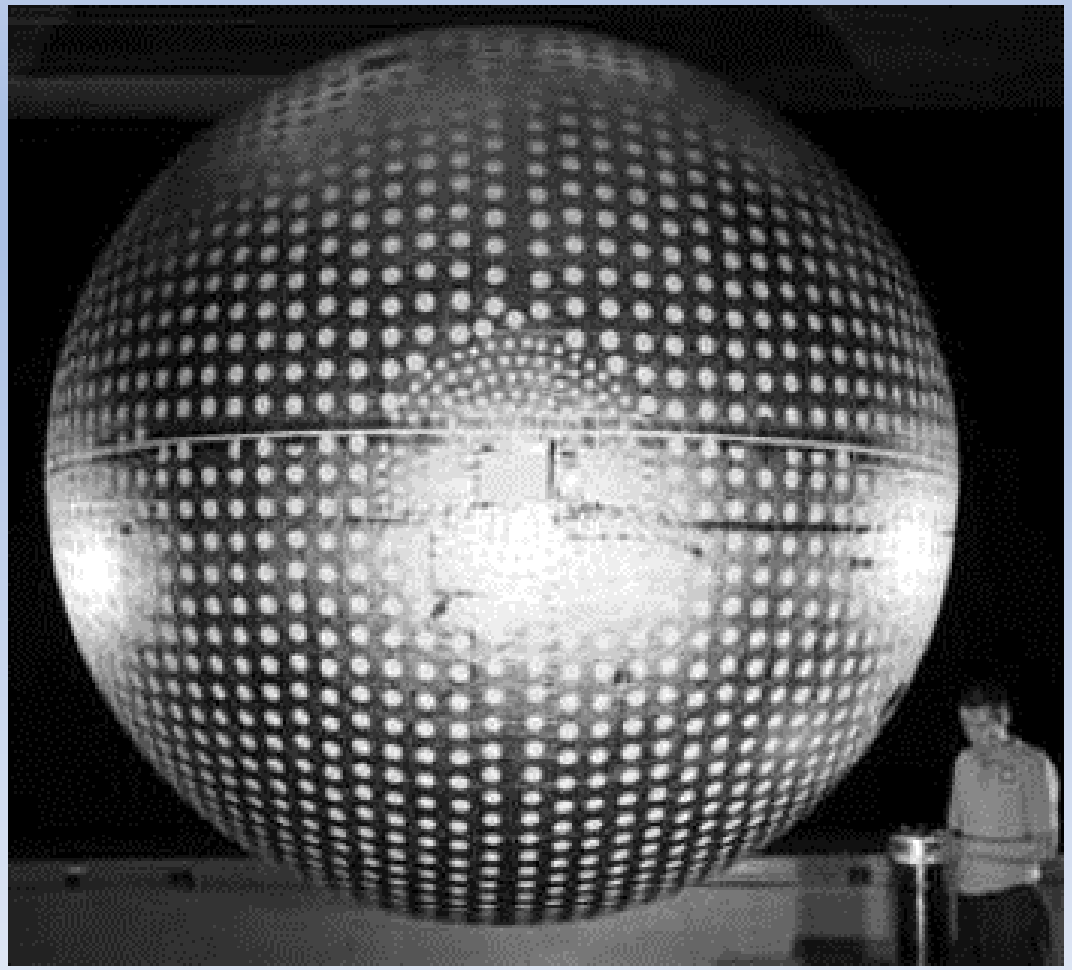
www.edwinprior.com

Overview

- **The Air Density Explorer Satellites and van Allen's Cosmic Detector**
- **Some "Space Science" personnel**
- **Major Langley Discoveries**
  - **Solar Activity Dependence**
  - **The Winter Helium Bulge**
  - **North-South Asymmetry (Reid Award)**
  - **Earthshine effect on Satellite Orbits**
  - **PAGEOS Hydrogen Measurement**
  - **Highest atmospheric rotation measurement**
  - **Venus Pioneer Orbiter Drag**



Air Density/Injun satellites



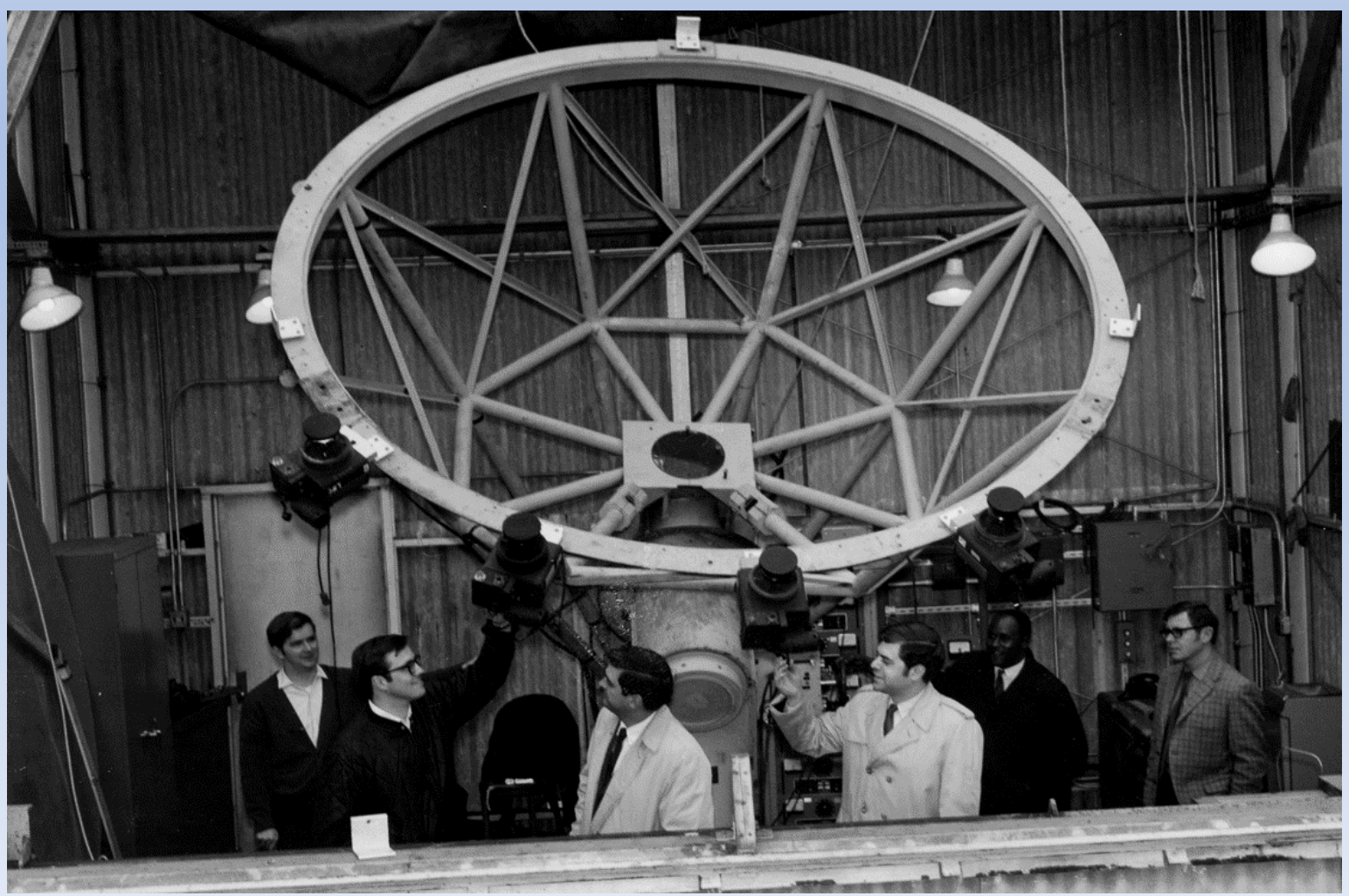
Air Density Explorer – Explorer 24

The three men responsible for the success of Explorer 1, America's first Earth satellite which was launched January 31, 1958. At left is Dr. William H. Pickering, former director of JPL, which built and operated the satellite. Dr. James A. van Allen, center, of the State University of Iowa, designed and built the instrument on Explorer that discovered the radiation belts which circle the Earth. At right is Dr. Wernher von Braun, leader of the Army's Redstone Arsenal team which built the first stage Redstone rocket that launched Explorer 1.

Credits: NASA

	Dual Satellites	Launch Date	Measurement Altitudes (KM)	Measurement Techniques
	Explorer 9, Hawkeye	2-16-61	330 to 880	Drag, Cosmic Detector
	Explorer 19, Hawkeye	12-19-63	630 to 1100	Drag, Cosmic Detector
	Explorer 24, Hawkeye	11-21-64	510 to 680	Drag, Cosmic Detector
	Explorer 39, Hawkeye	8-8-68	720 to 880	Drag, Cosmic Detector
Scout Failed	Dual Air Density: 30-Inch Diameter Sphere	1975	400 to 1500	Drag and Mass Spectrometer
Scout Failed	Dual Air Density: 12-Foot Diameter Sphere	1975	700 to 1500	Drag and Mass Spectrometer

Air Density Explorer series of aeronomy satellites



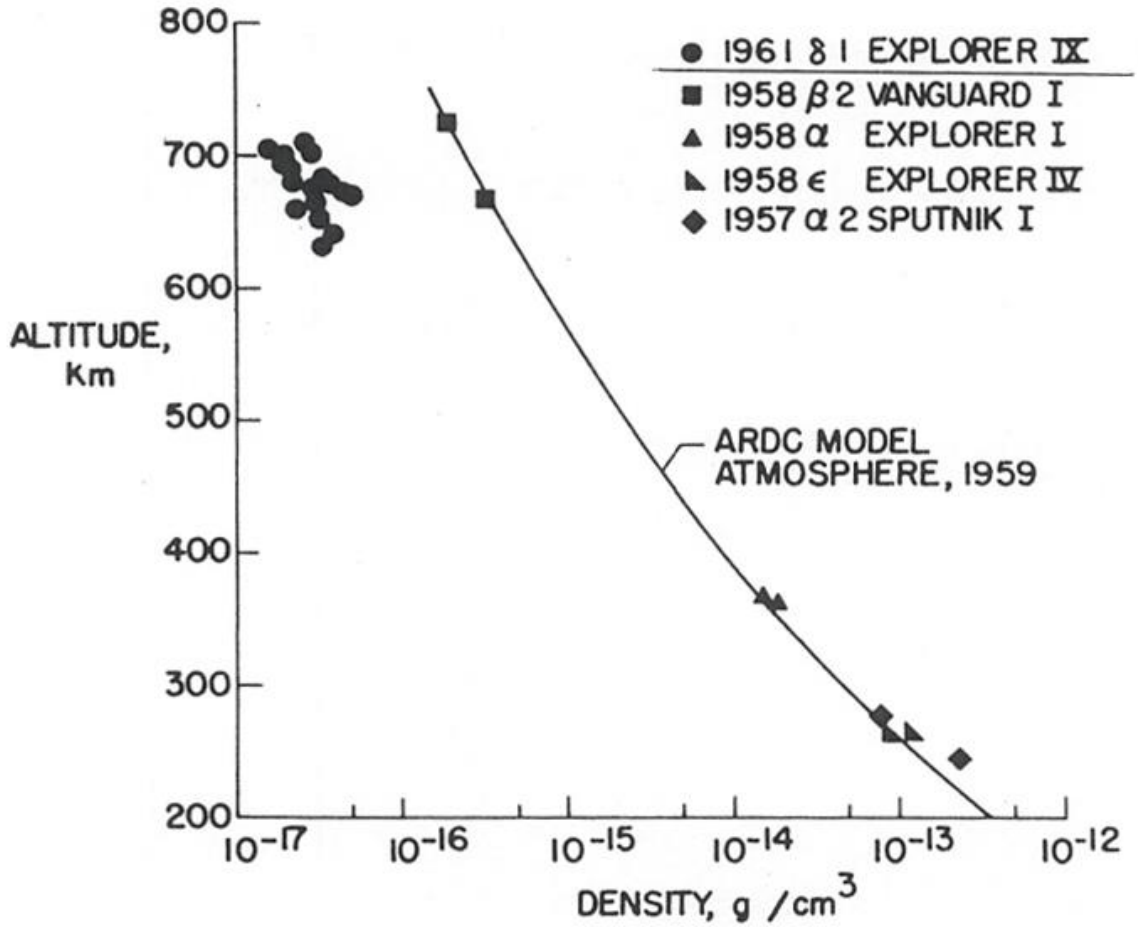
Langley Space Scientists Observe
1970 Solar Eclipse

Major Discoveries from Langley's Space Science Research

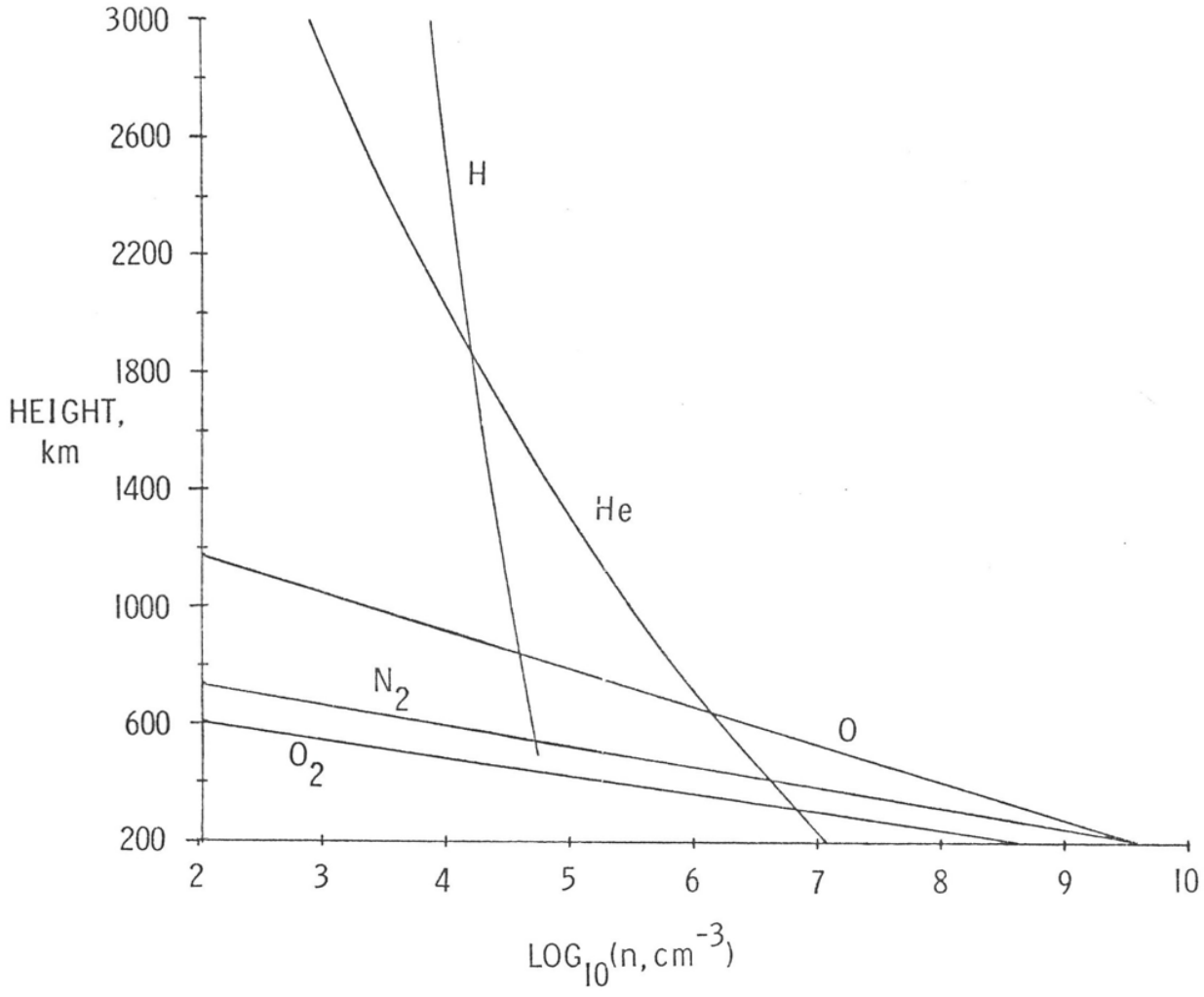
- **Explorer 9 drag data discovered satellite altitude atmospheric density dependence on solar activity (Keating, Mullins, McDougal)**
- **Explorers 19, 24, 39 discovered the "Winter Helium Bulge," "The most striking" result in Significant Achievements in Space Science, NASA Special Service Award for Science, cited by Space Science Board Report (Keating, Prior)**
- **North-South Asymmetry of the Thermosphere: received Reid Award; remains unexplained (Keating, Prior, McDougal, Levine)**
- **Langley's PAGEOS drag revealed hydrogen exosphere levels 200 percent greater than US Standard, confirmed by Air Force 36 years later; required removing earth albedo radiation pressure orbit perturbations (Prior)**
- **Using Orbital data from Explorer 24, the average rotation rate of the earth's atmosphere was determined at (what is still) the highest altitude, 550 km (.81 Earth's, or average east-to-west winds of 200 mph) (Prior, presented at AGU, *unable to publish due to Hearth termination*)**
- **Venus Pioneer Orbiter Drag studies of Venus thermosphere (Keating, Taylor, Nicholson, Hinson) (Prior, Tolson, Mauersberger)**

The **ARDC Model Atmosphere**, 1959 constitutes a revision of the **ARDC Model Atmosphere**, 1956, made necessary by the accumulation of considerable new ...

CIA



Atmospheric density variation



Neutral atmospheric constituents during average solar activity

UNITED STATES

SPACE SCIENCE PROGRAM

Report to COSPAR

Thirteenth Meeting
Leningrad, USSR
May 1970

Submitted by SPACE SCIENCE BOARD

NATIONAL ACADEMY OF SCIENCES–NATIONAL RESEARCH COUNCIL

WASHINGTON, D.C. 1970

Keating, Mullins, and Prior of NASA Langley analyzed the distribution and composition of the lower exosphere near solar maximum (1967-1968) using density measurements from the Explorer 19 and 24 Air-Density Explorer drag satellites (1963-53A, 1964-76A) and considered the diffusive separation of atmospheric constituents. Explorer 24, near 550 km in a predominantly atomic oxygen atmosphere, measured the global distribution of atomic oxygen, including the first definitive drag measurements of this atmospheric constituent near the poles. As a result, latitudinal, seasonal, diurnal, and semiannual variations were determined for atomic oxygen. The winter helium bulge discovered by Keating and Prior from drag measurements near solar minimum continued to be observed in the helium-rich atmosphere near 900 km using Explorer 19 (Figure 7-2). A comparison of the high-altitude drag data with low-altitude mass spectrometer measurements indicated that the winter helium bulge amplitude decreases with increasing altitude.

Jacchia at SAO has continued his work on the construction of models of the thermosphere and lower exosphere for incorporation into the new COSPAR International Reference Atmosphere (CIRA). His models are now completed and will be integrated with the models of the lower regions (from 20 to 110 km) that have been prepared by Cole (U.S.), Groves (U.K.), and Champion (U.S.). The new CIRA should be ready for publication in 1970.

5. SPACECRAFT TRACKING

In a study of the orbital motion of the Echo 1 (1960 Iota 1) and Pageos balloon satellites, Prior of NASA Langley isolated, for the first time, the orbital perturbations due to earth albedo radiation pressure. For these two satellites, the albedo perturbations were large enough to affect drag studies and the determination of the earth's gravitational field from orbital data. During the 500-day observation period, the albedo perturbation was found to decrease the argument of perigee of Echo 1 by approximately 15°.

AGU PUBLICATIONS

Journal of Geophysical Research: Space Physics

RESEARCH ARTICLE

10.1002/2016JA023482

Special Section:
Major Results From the MAVEN Mission to Mars

He bulge revealed: He and CO_2 diurnal an variations in the upper atmosphere of M as detected by MAVEN NGIMS

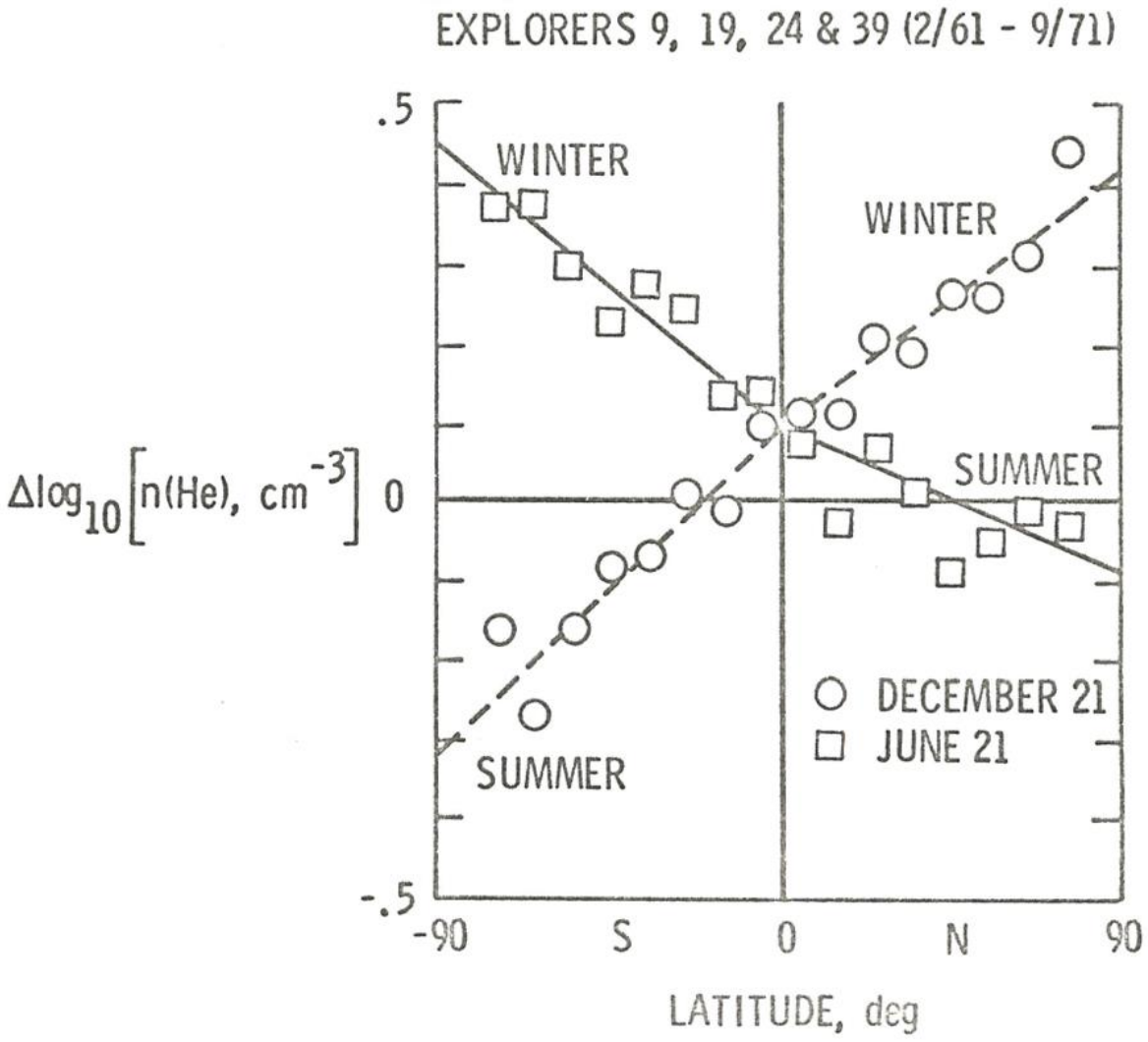
M. K. Elrod[1,2], S. Bougher[3], J. Bell[4], P. R. Mahaffy[1], M. Benna and B. Jakosky[7]

[1]NASA Goddard Space Flight Center, Greenbelt, Maryland, USA, [2]CRESST, Unive USA, [3]Climate and Space Sciences and Engineering Department, University of M [4]National Institute of Aerospace, Hampton, Virginia, USA, [5]CRESST, University of Maryland, USA, [6]Lunar and Planetary Laboratory and Department of Planetary S Arizona, USA, [7]Laboratory for Atmospheric and Space Physics, University of Col

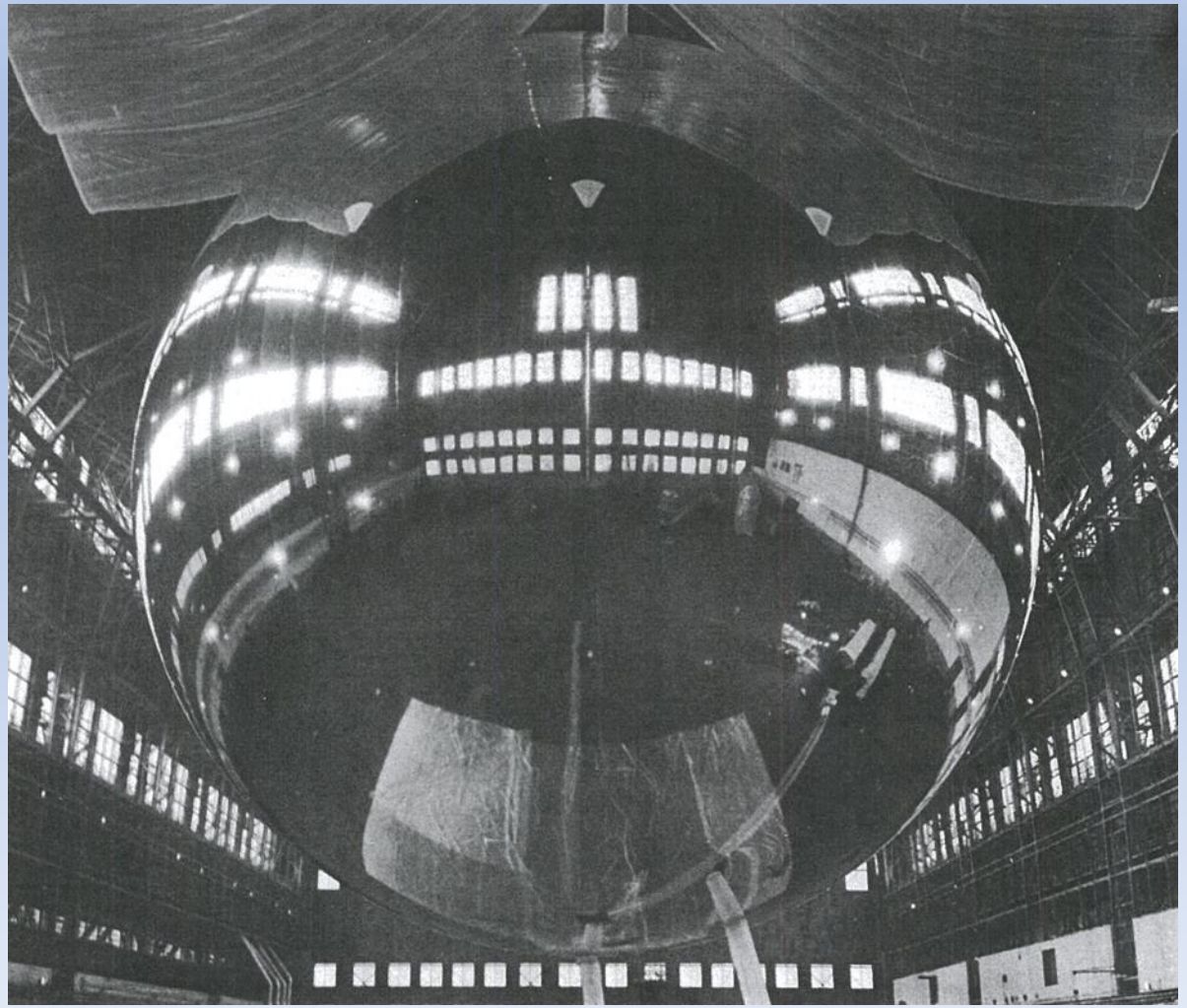
Key Points:

- Data using MAVEN NGIMS for 1 Martian year reveal diurnal and seasonal variations in He and CO_2 indicating a changing He bulge in upper atmosphere
- Observed He bulge is found to agree preliminarily with M-GITM modeling efforts
- He bulge found at Mars is similar to those found at Earth and Venus

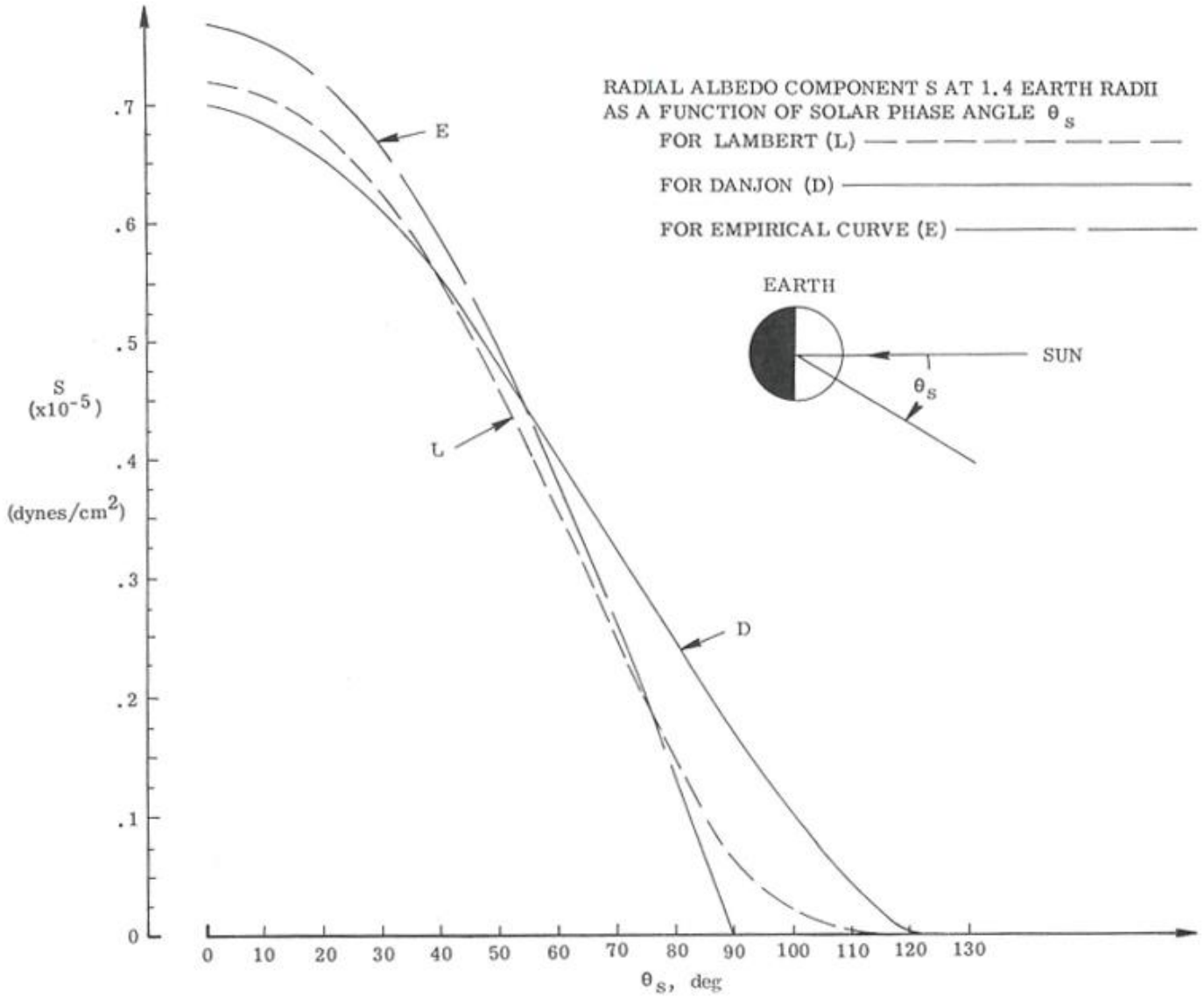
Abstract Analysis of the Neutral Gas and Ion Mass Spectromete Volatiles and EvolutioN (MAVEN) spacecraft closed source data from al an enhanced Helium [He] density on the nightside orbits and a depresse



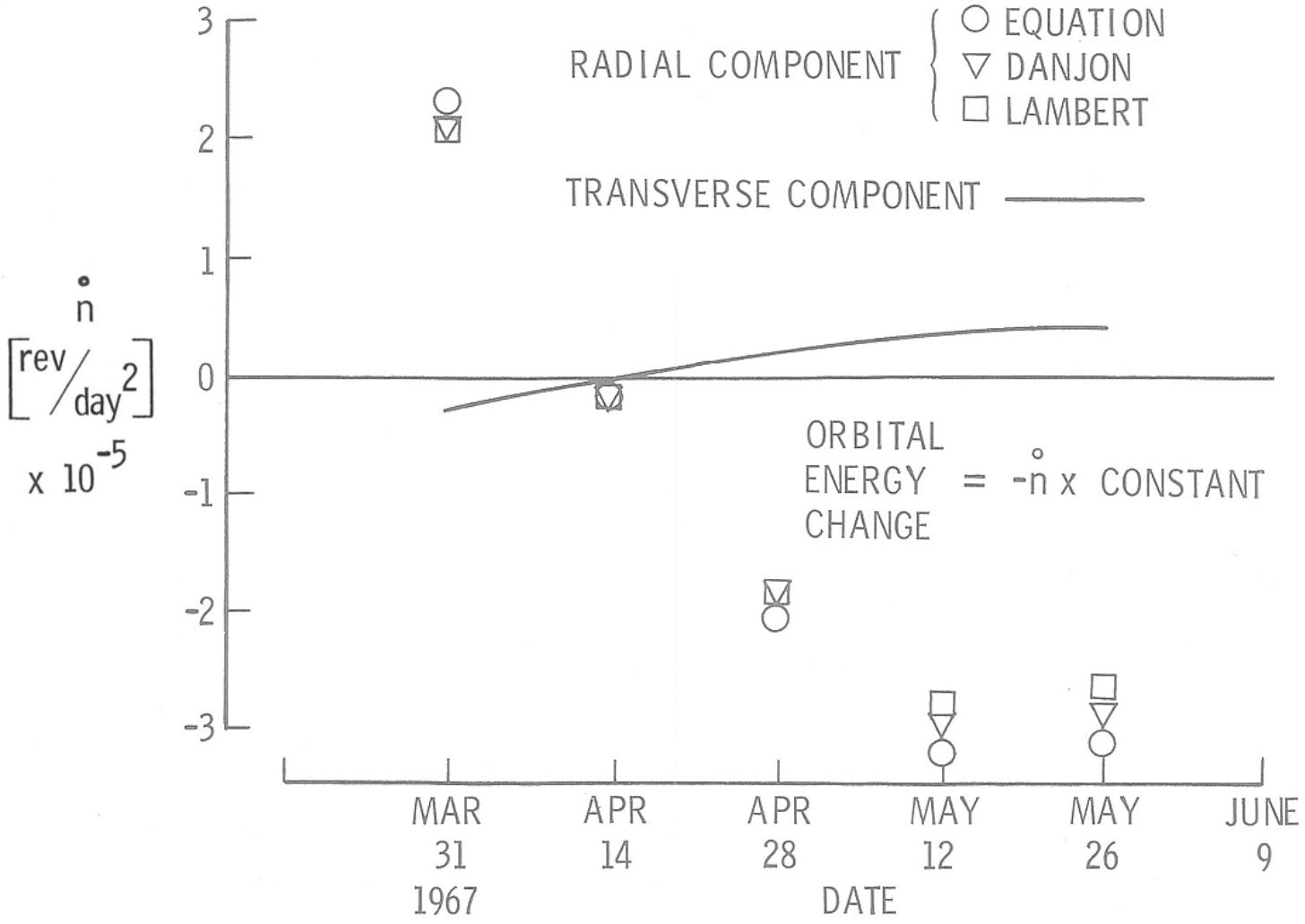
Seasonal variation for 10° latitude increments



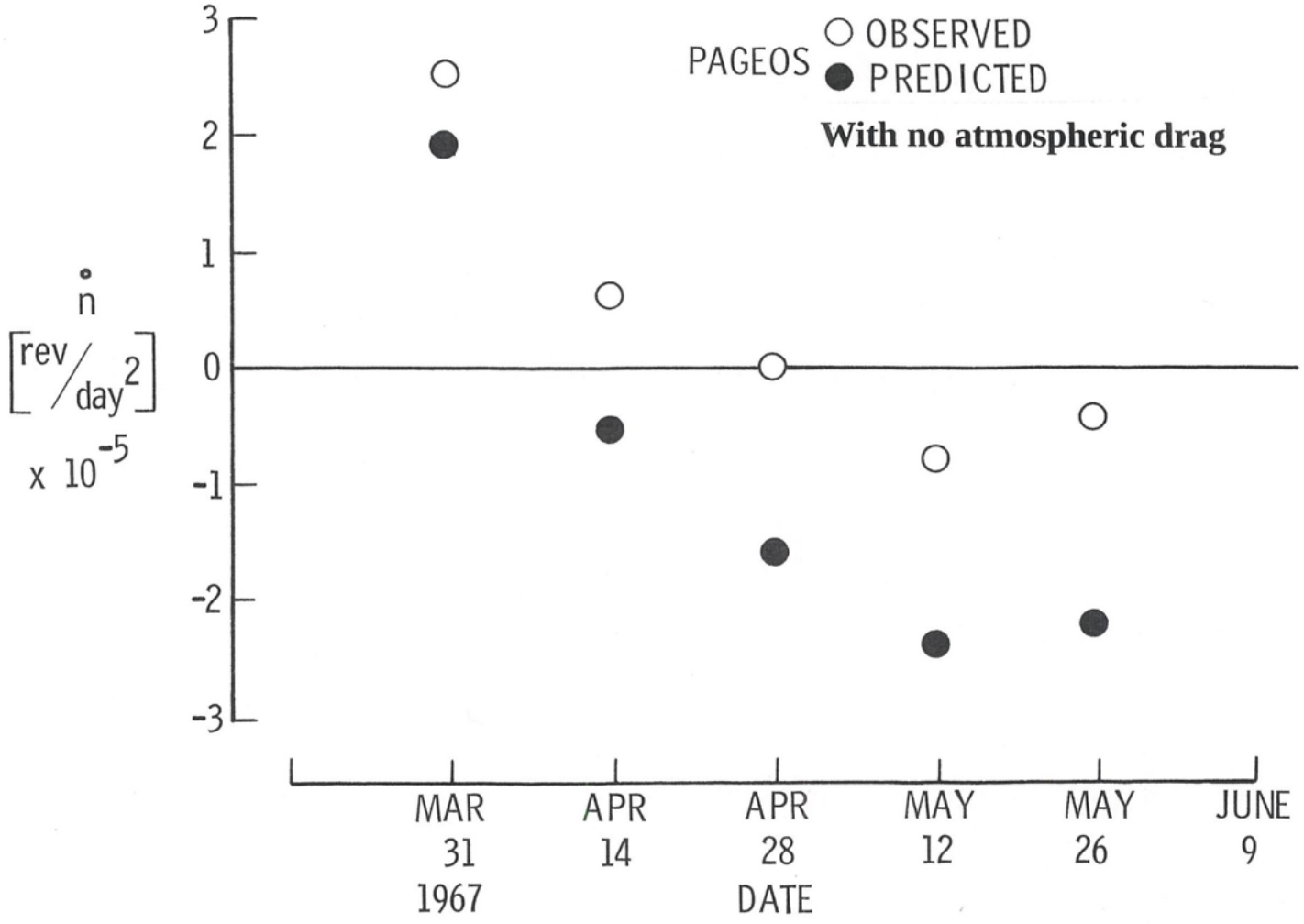
Langley's 100 ft. Diameter PAGEOS Satellite



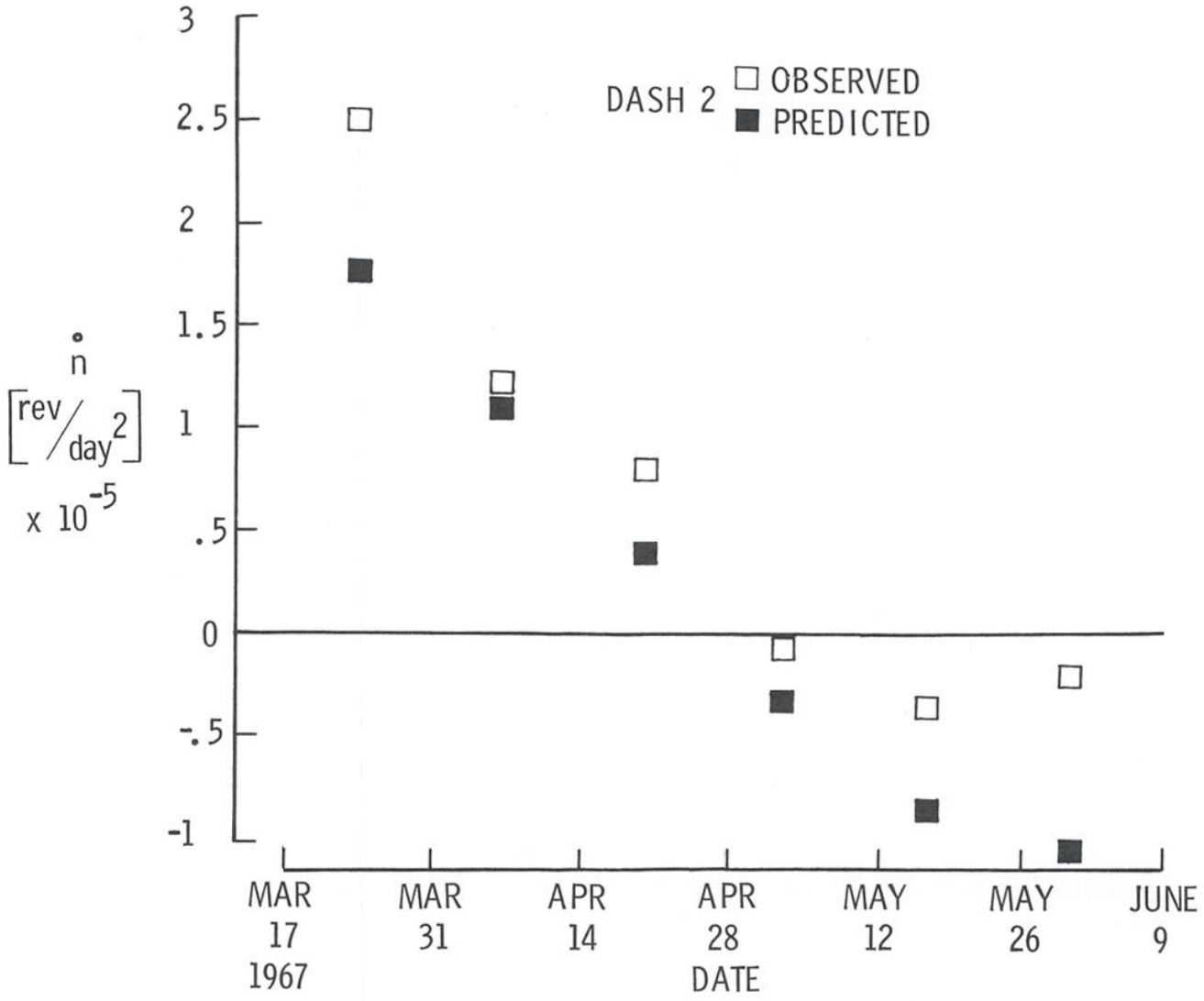
Radial Component of albedo radiation pressure for different models



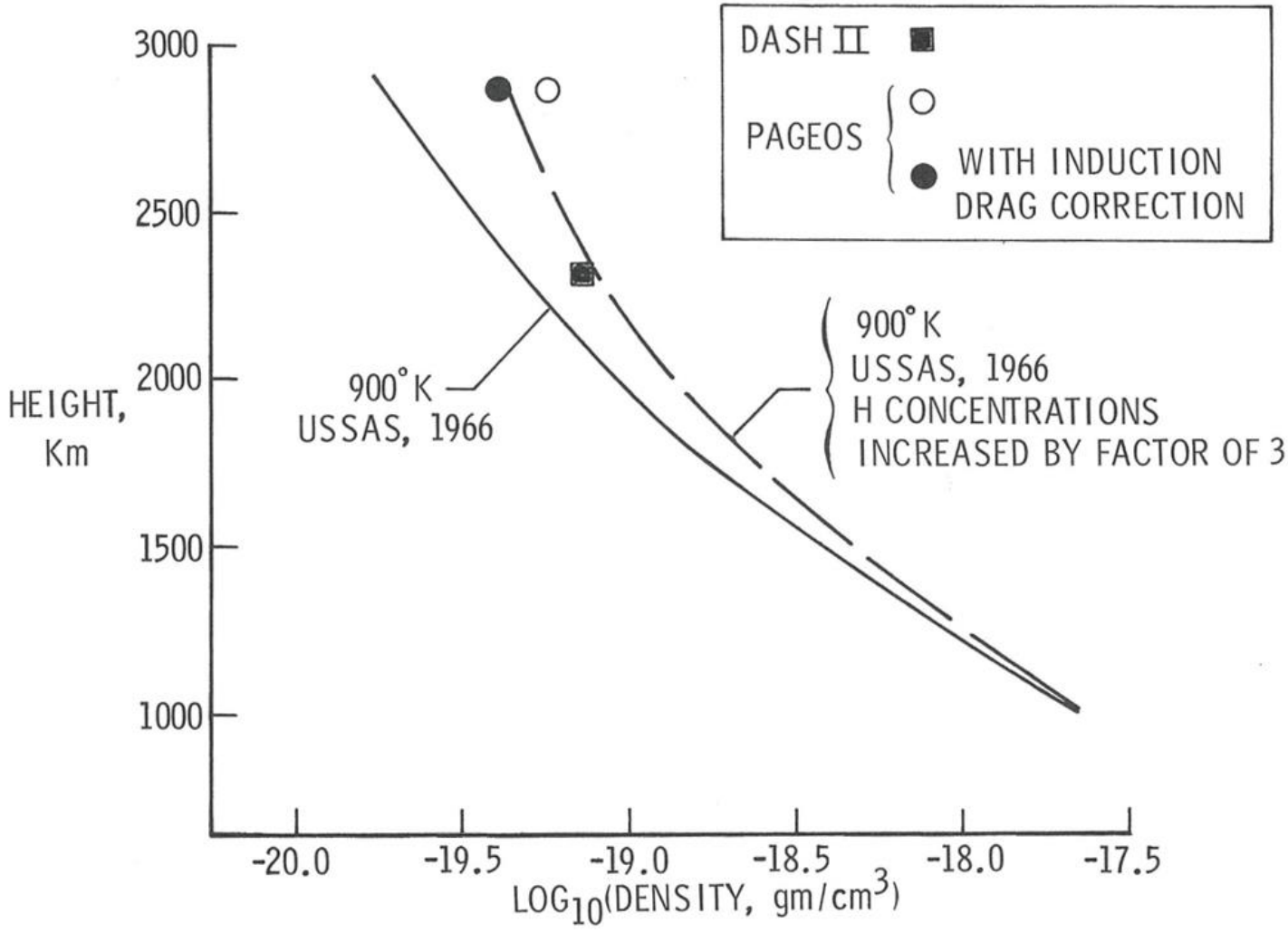
Orbital Perturbations of PAGEOS due to components of albedo radiation force



Variation of mean motion for PAGEOS



Variation of mean motion for DASH 2



Mean neutral exospheric densities near 0600 hours LST at low latitudes April-May 1967

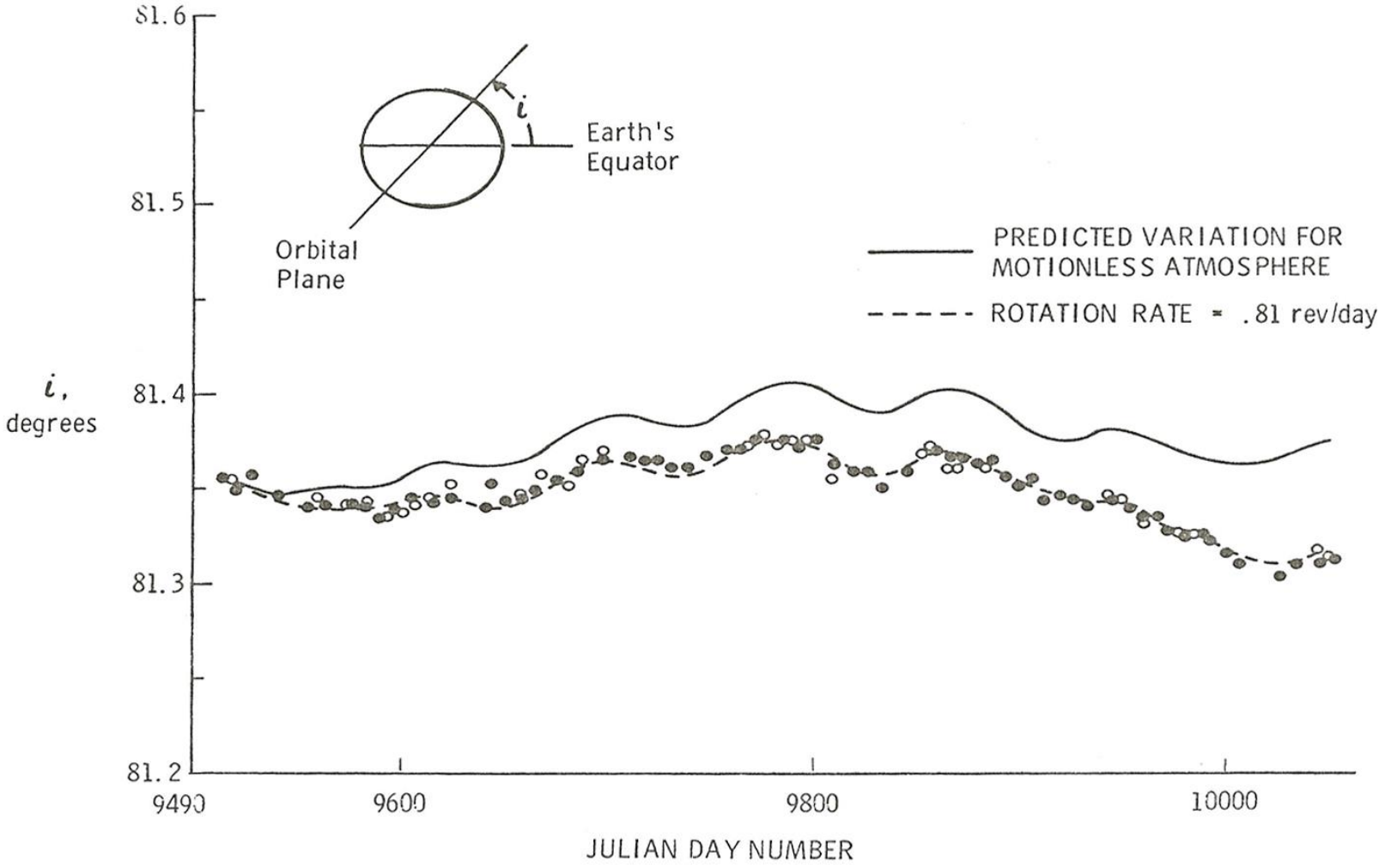
LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA 23365

REPLY TO
ATTN OF:

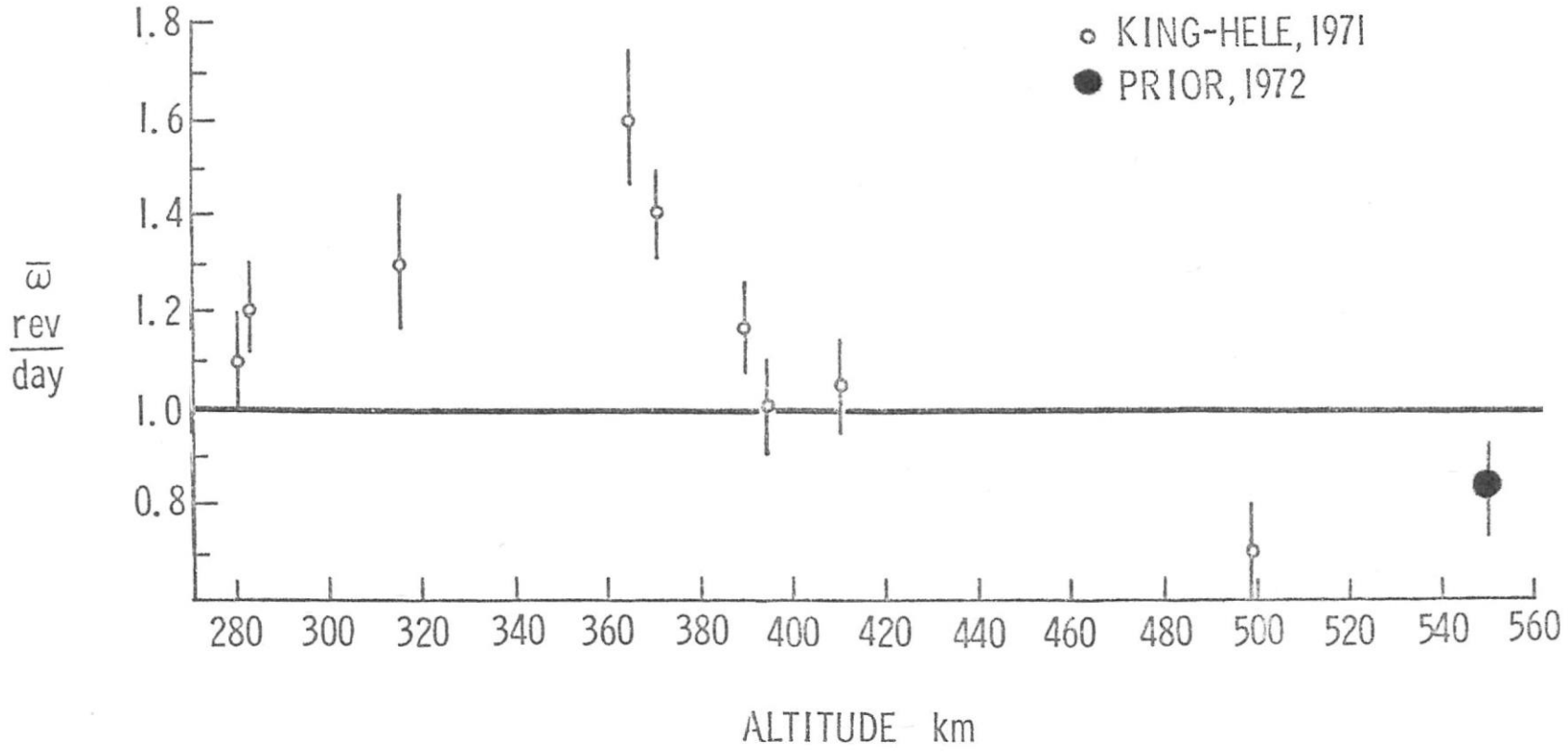
For immediate release
April 19, 1972
Wednesday morning
AGU Paper No. SA-63

NEW ALTITUDE RECORD FOR WIND MEASUREMENTS

From changes in the orbit of the Explorer 24 satellite, NASA's Langley Research Center scientist Edwin J. Prior has obtained measurements of the wind at higher altitudes than ever before achieved. He presented the results at the Fifty-third Annual Meeting of the American Geophysical Union on April 19, 1972. By studying how the orbit of the satellite changed position relative to the earth's equator, it was found that average winds at the equator were moving at approximately 200 miles per hour in a westward direction 340 miles (1,800,000 feet) above the earth's surface. In the past, it has generally been assumed that winds moved in an eastward direction at satellite altitudes, based on measurements at lower altitude levels. This phenomenon has been referred to as "super-rotation" because average eastward winds would indicate the atmosphere is rotating more rapidly than the earth



Orbital inclination of Explorer 24



Mean atmospheric rotation rates above 280 kilometers

TECHNICAL SECTION

DETERMINATION OF THERMOSPHERIC PROPERTIES FROM ATMOSPHERIC DRAG EFFECTS ON THE PIONEER VENUS 1978 ORBITER

Atmospheric Studies - Category B

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Co-Investigator:
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Phone: (804) 827-2541

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