National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

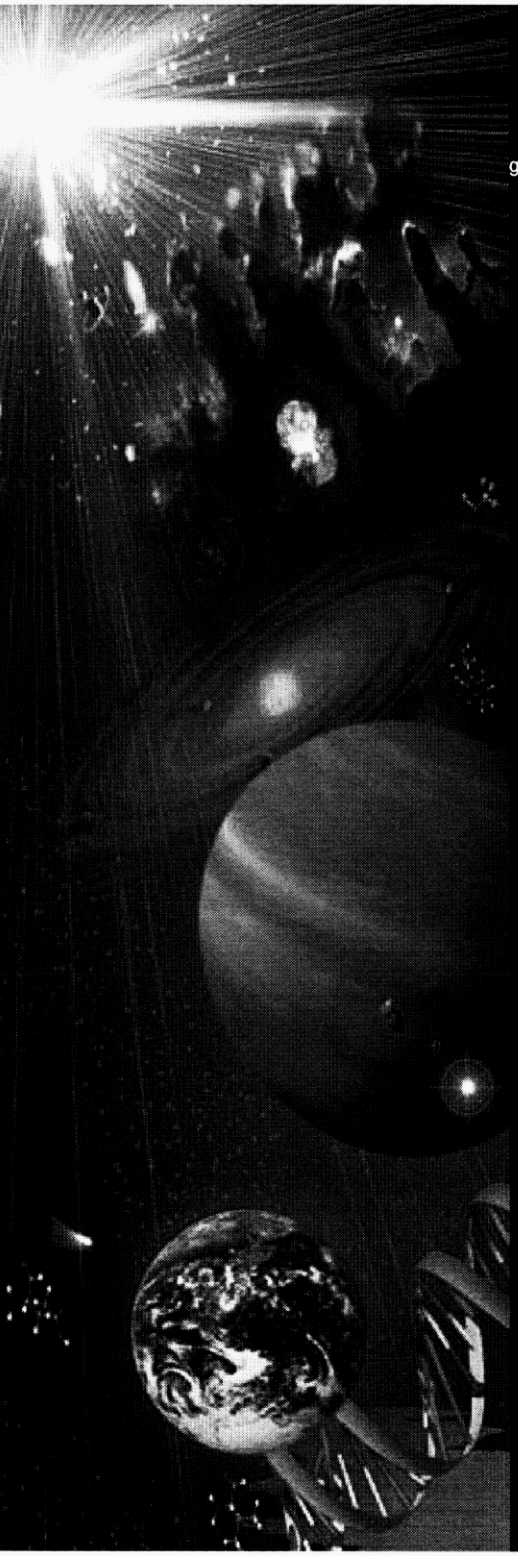
NASA and JPL
An history and overview of major NASA space programs

November 18, 2004

Thomas S. Pagano

Jet Propulsion Laboratory,
California Institute of Technology
4800 Oak Grove Drive, Pasadena, CA, USA 91109-8099

tpagano@jpl.nasa.gov



gy

NASA Vision and Mission

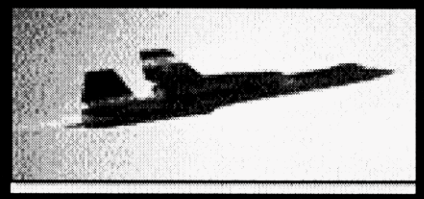
- *NASA Vision:*
  - *To improve life here;*
  - *To extend life to there;*
  - *To find life beyond.*
- *NASA Mission:*
  - *To understand and protect our home planet;*
  - *To explore the universe and search for life;*
  - *To inspire the next generation of explorers as only NASA can.*

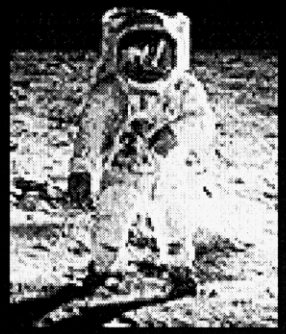
National Aeronautics and
Space Administration

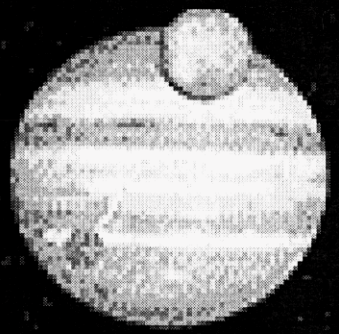
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

NASA DOES MANY THINGS

- Aeronautics Technology
- Human Exploration and Development of Space
- Earth Science
- Space Science
- Biological and Physical Research







National Aeronautics and
Space Administration

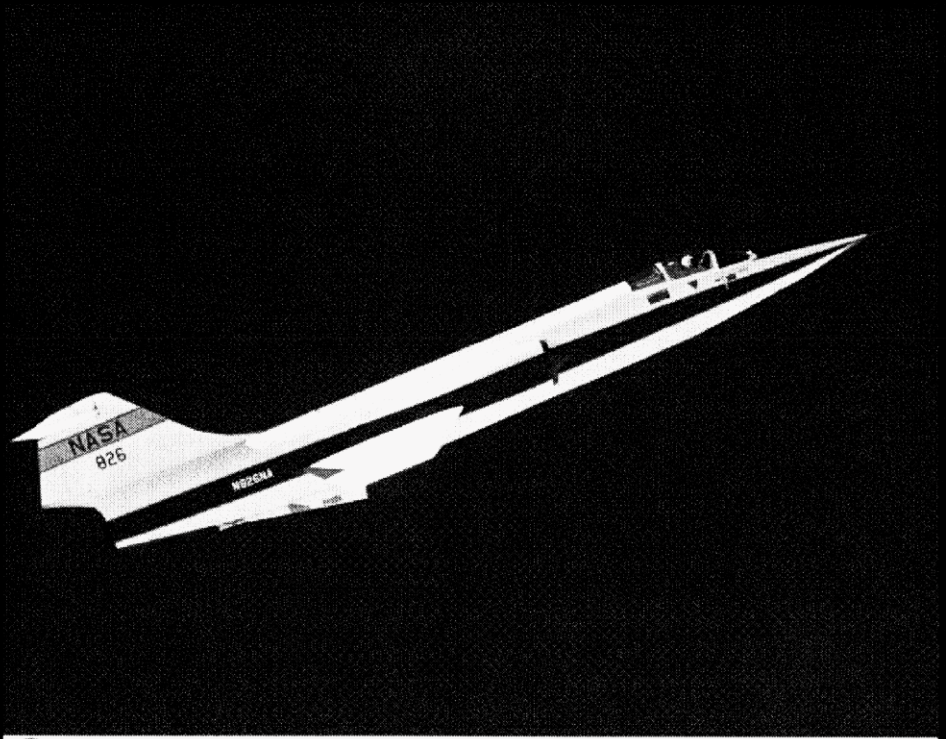
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

AERONAUTICS

National Aeronautics and
Space Administration

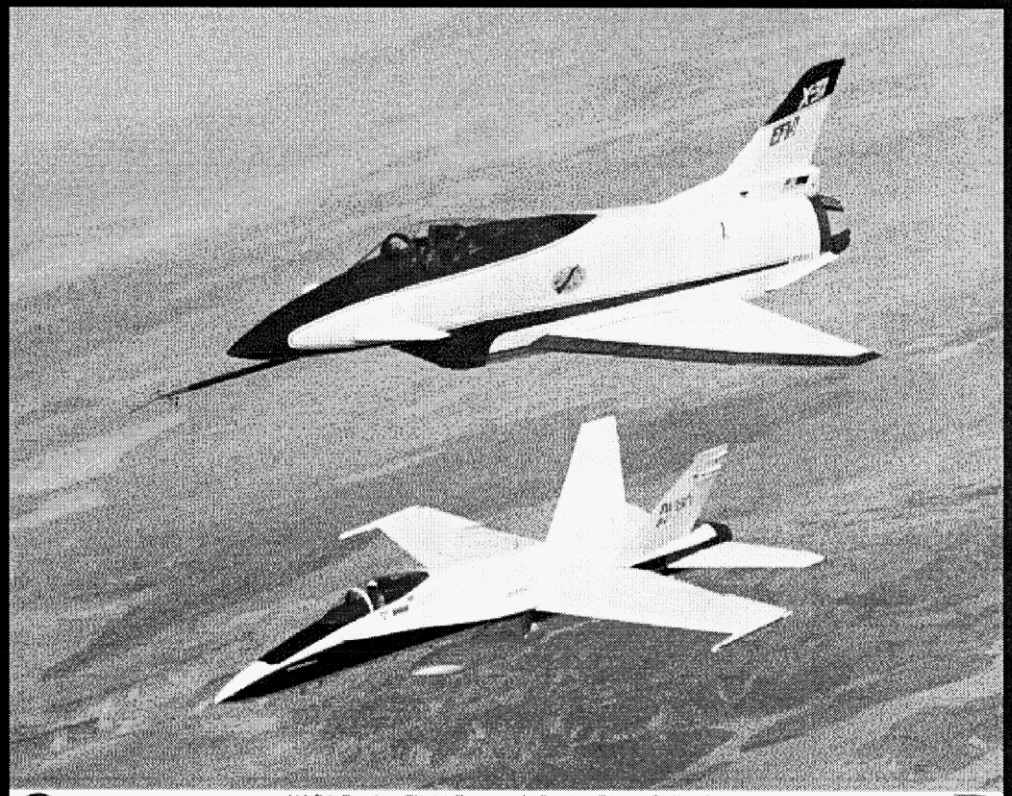
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

AEROSPACE TECHNOLOGY



NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/gallery/photo/index.html
NASA Photo: ECN-8023 Date: 1977

F-104 in flight



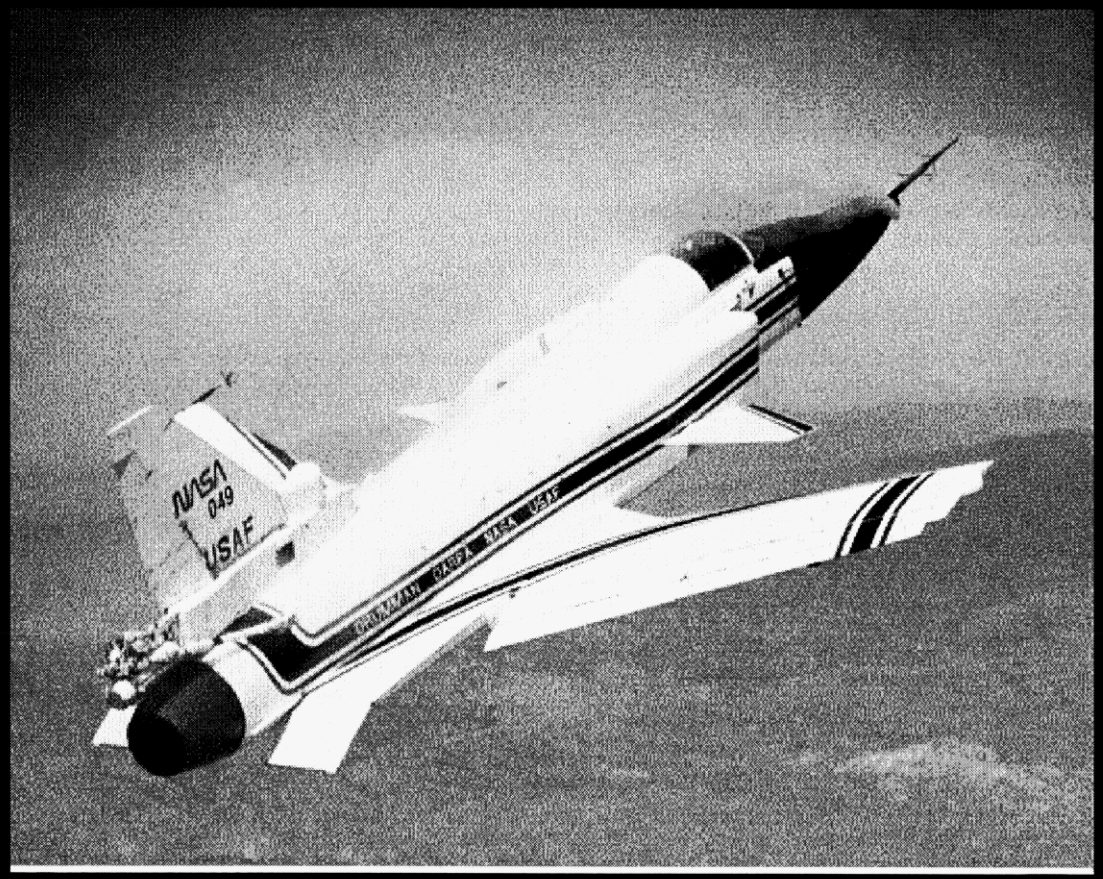
NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/gallery/photo/index.html
NASA Photo: EC94-42478-8 Date: 1994 Photo by: NASA

X-31 in Flight with F-18 Chase

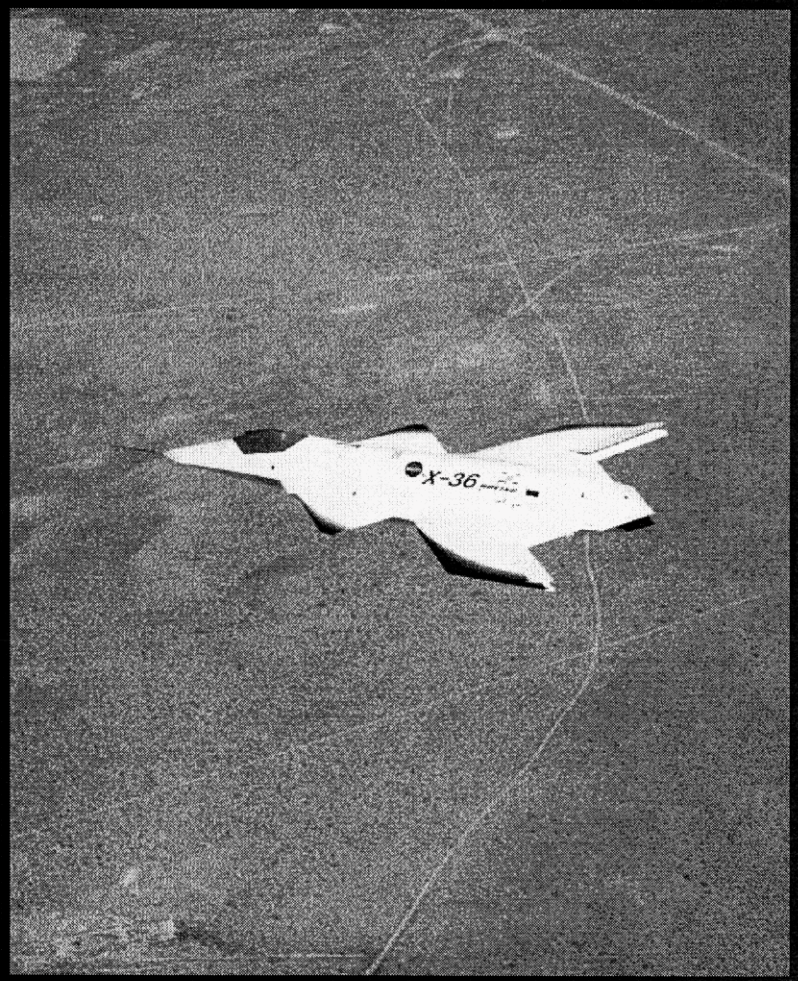
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

EXPERIMENTAL AIRCRAFT



X-29
1991
FOWARD WING



X-36
1997
TAIL-LESS

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

EARLY HIGH SPEED AIRCRAFT

X-1
1947
MACH 1 (FIRST TO BREAK SOUND BARRIER)
43,000 FEET

X-15
1965
MACH 5.65
354,200 FEET
ROCKET POWER

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

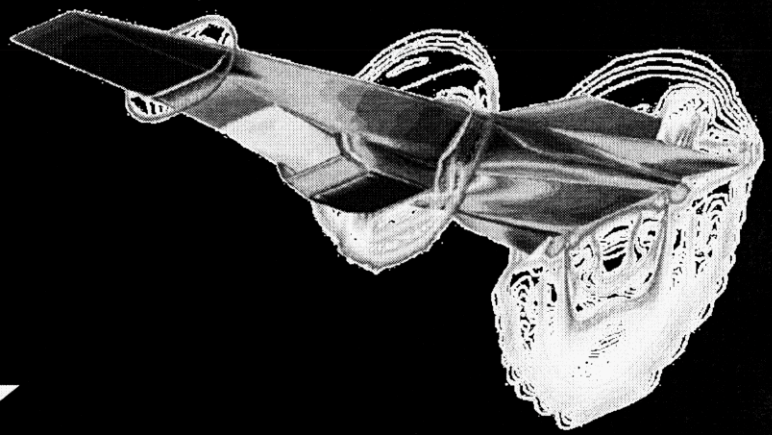
X-43. Mach 10. Non-Rocket Powered

NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/gallery/photo/index.html
NASA Photo: ED99-45243-01 Date: 1999 Photo by: NASA

X-43A Hypersonic Experimental Vehicle - Artist Concept in Flight

NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/Gallery/Photo/index.html
NASA Photo: EC04-0029-50 Date: January 26, 2004 Photo By: Carla Thomas

The black X-43A rides on the front of a modified Pegasus booster rocket hung from the special pylon under the wing of NASA's B-52B mother ship. The photo was taken during a captive carry flight Jan. 26, 2004 to verify systems before an upcoming launch.



Successful Test Flight:
November 16, 2004
10 seconds at Mach 10
Point Magu, Ca.

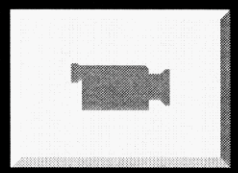
National Aeronautics and
Space Administration

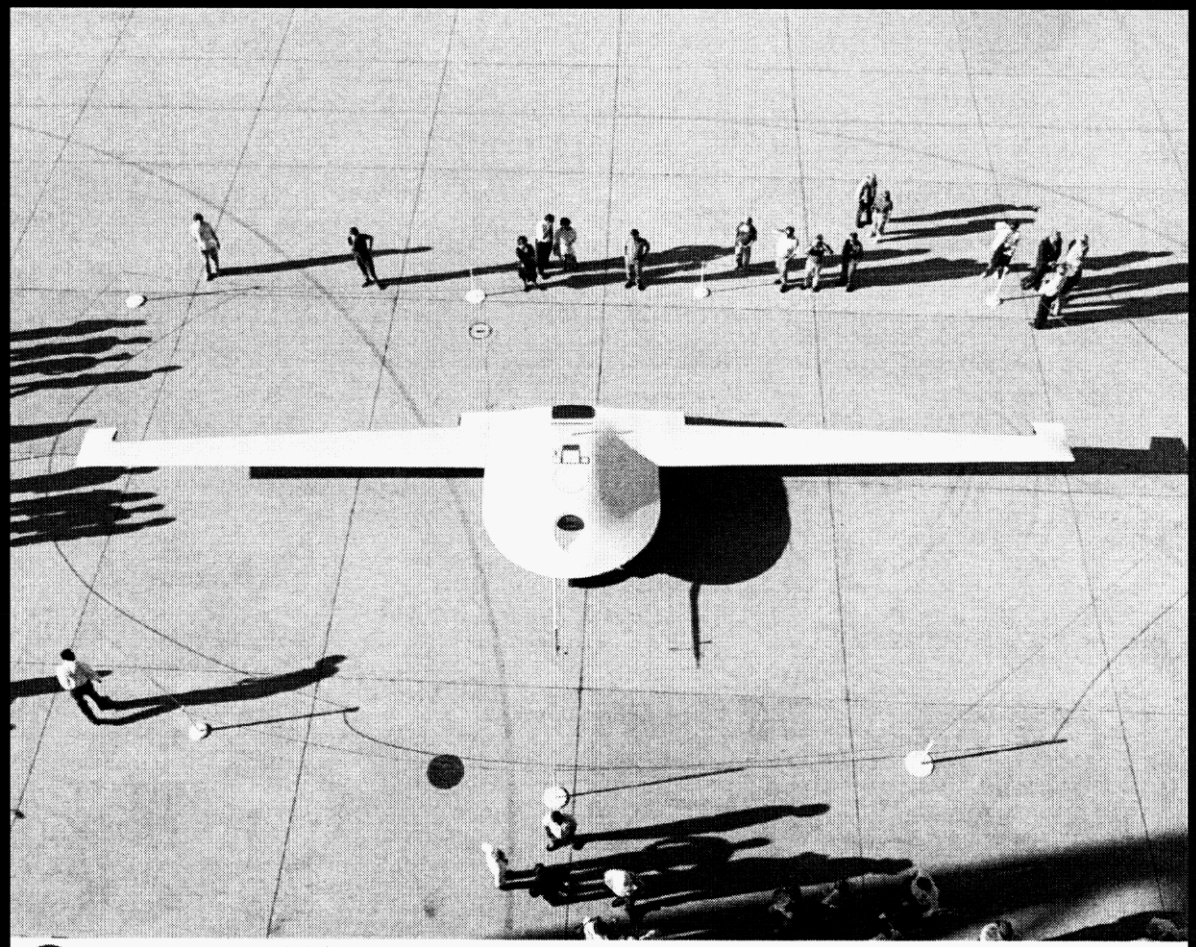
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Un-manned Remotely Piloted Vehicles

- **Tier-3 Darkstar**

SOLAR POWERED, Centurion





NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/gallery/photo/index.html
NASA Photo: EC95-43271-5 Date: September 14, 1997 Photo by: Tony Landis

Tier 3- DarkStar on ramp from above

National Aeronautics and
Space Administration

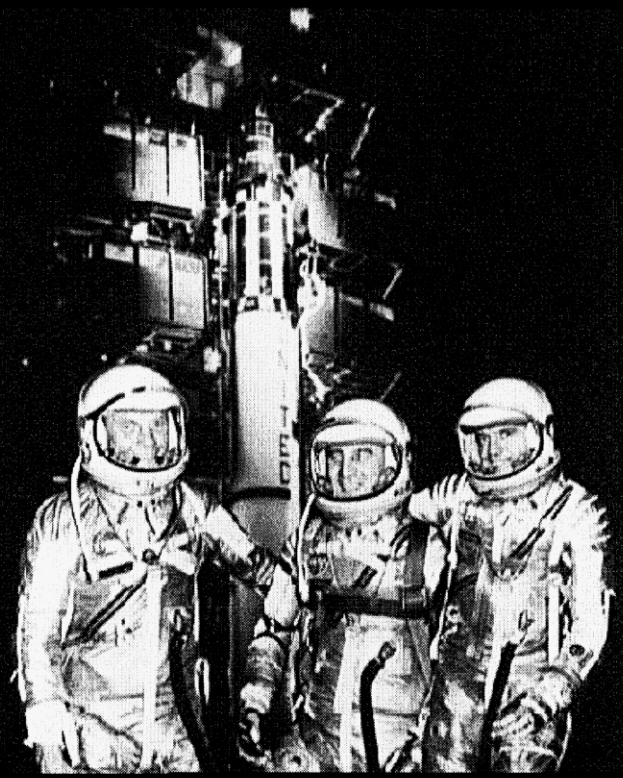
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

HUMAN EXPLORATION AND DEVELOPMENT OF SPACE

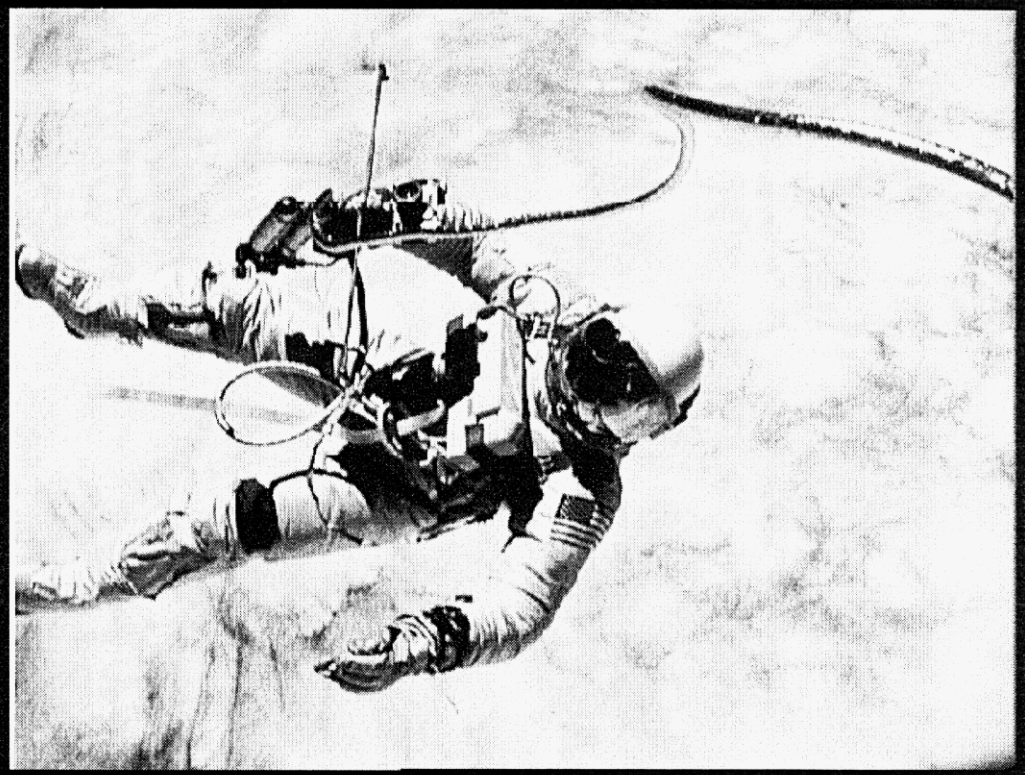
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

FIRSTS IN SPACE



1961
John H. Glenn, Virgil I. Grissom and Alan B. Shepard Jr.
AMONG FIRST ASTRONAUTS

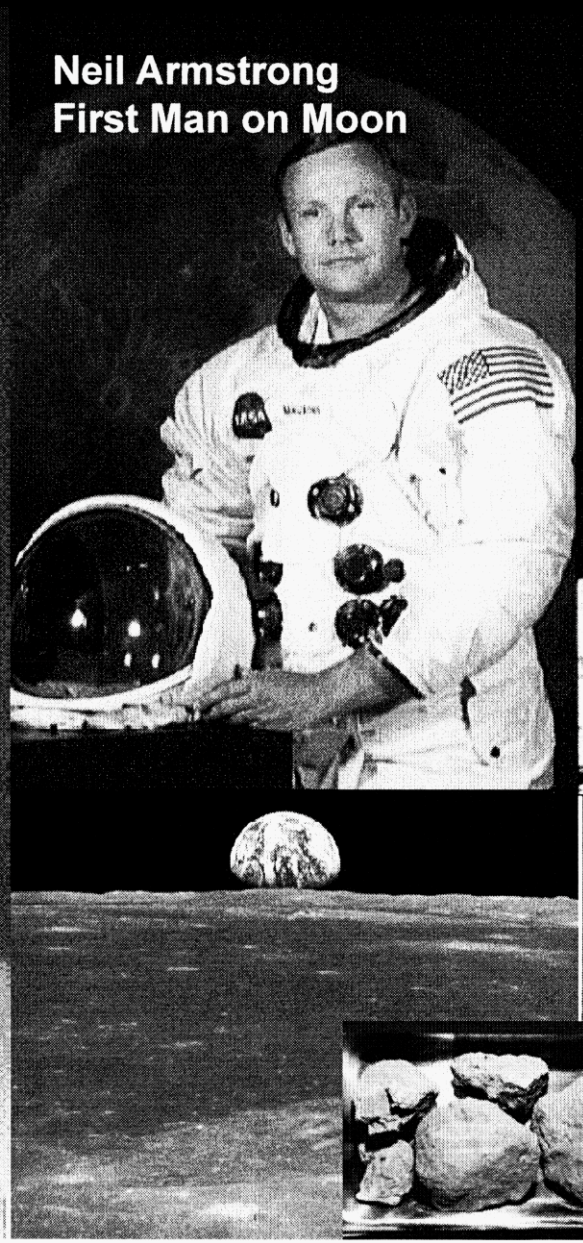


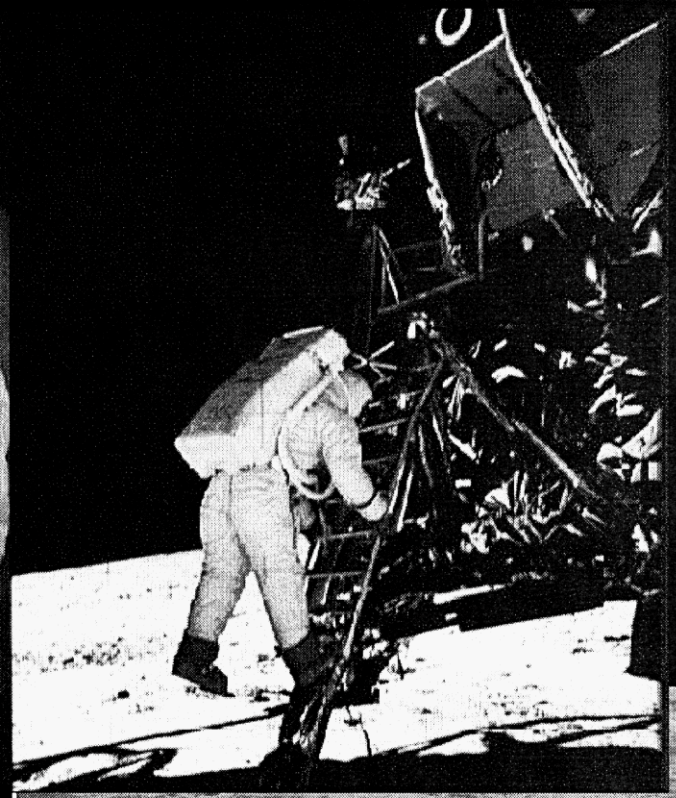
1965
Edward White
FIRST GEMINI SPACE WALK

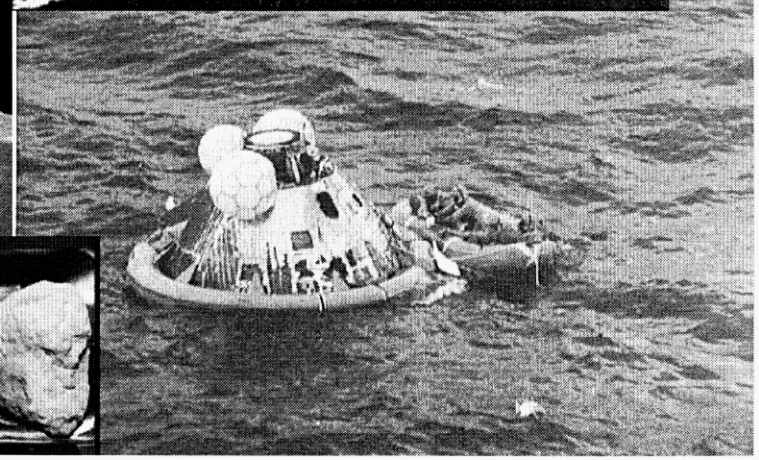
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

1969: MAN WALKS ON THE MOON!



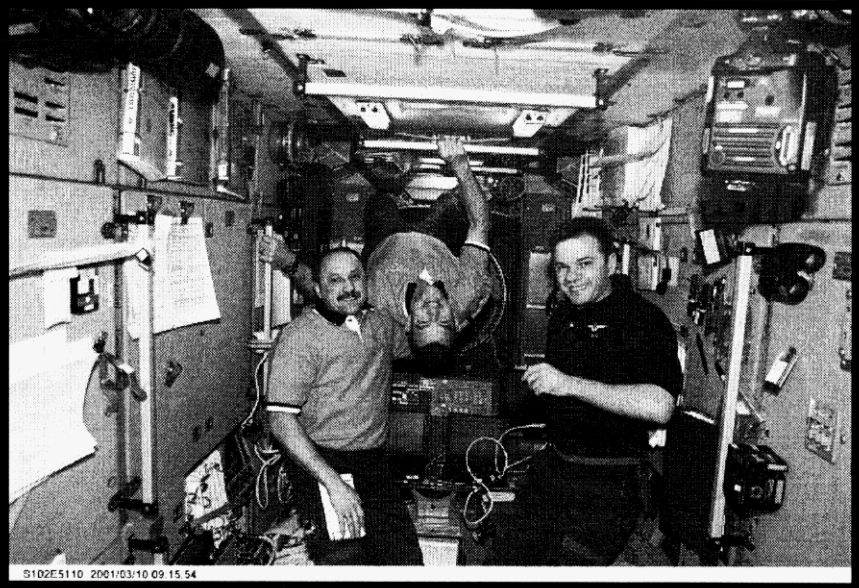


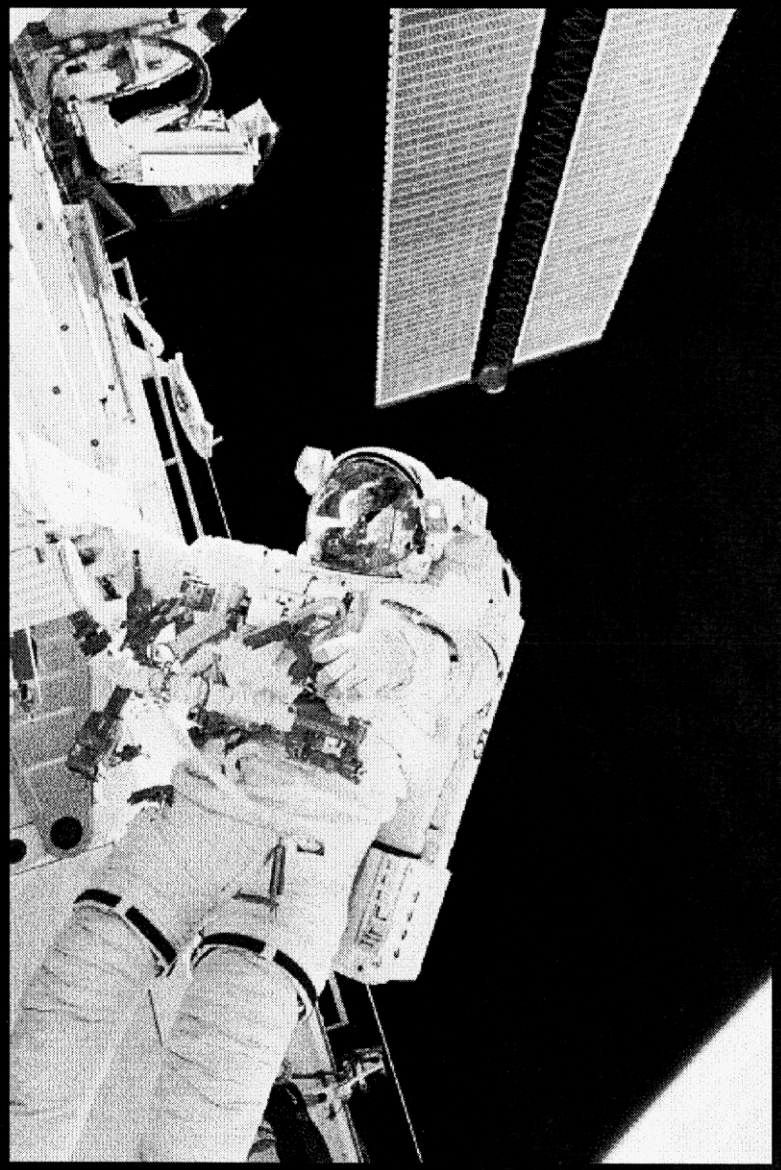


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

ASTRONAUTS TODAY

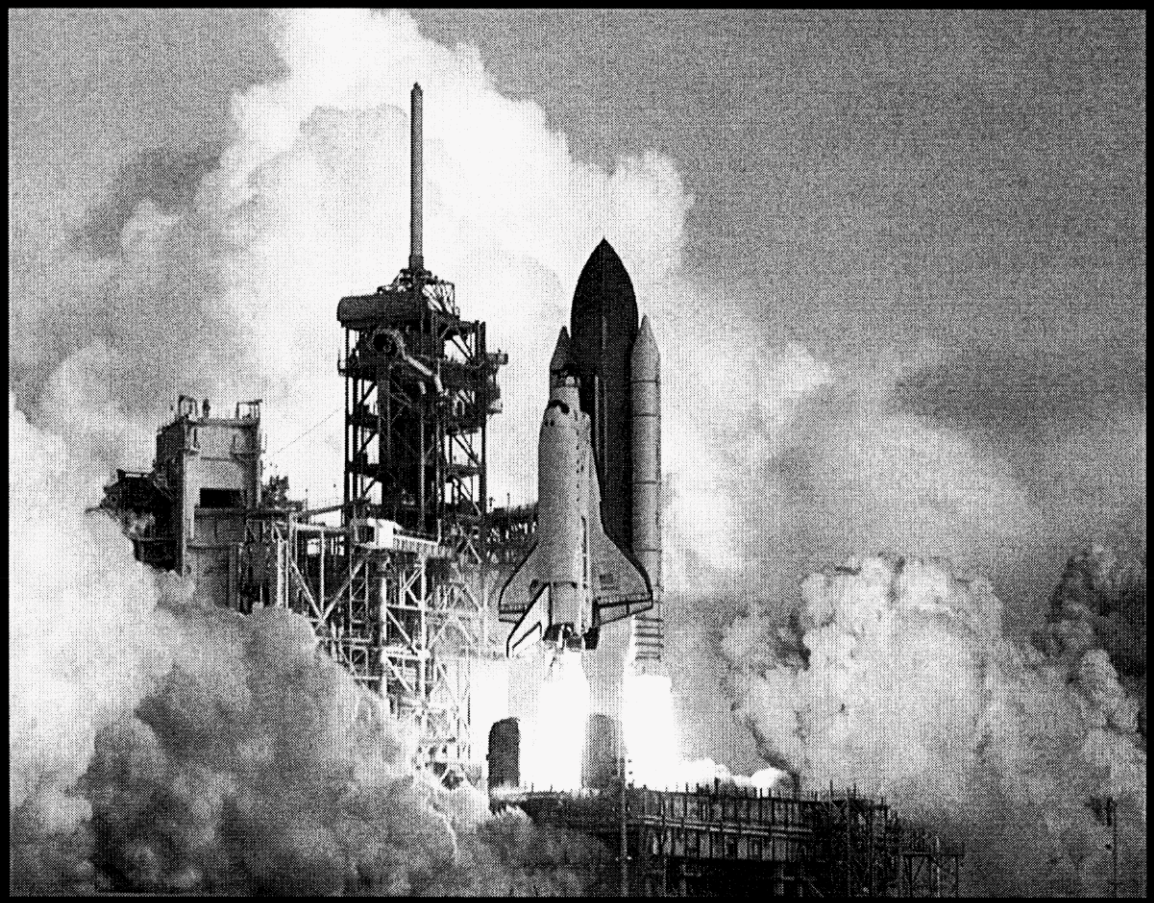


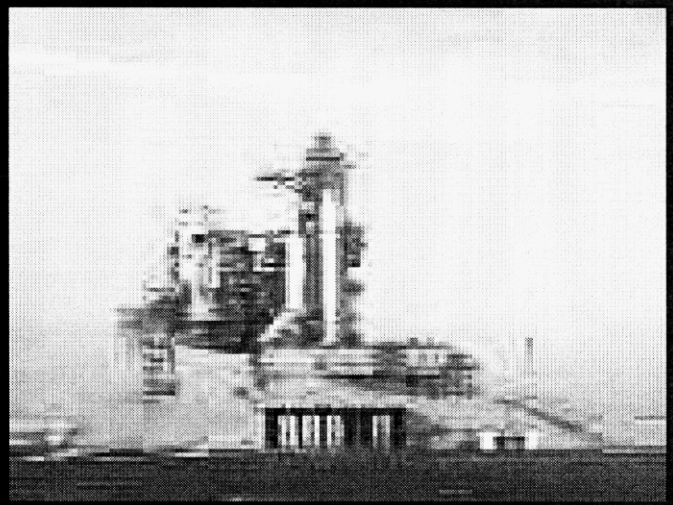


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

The Space Shuttle

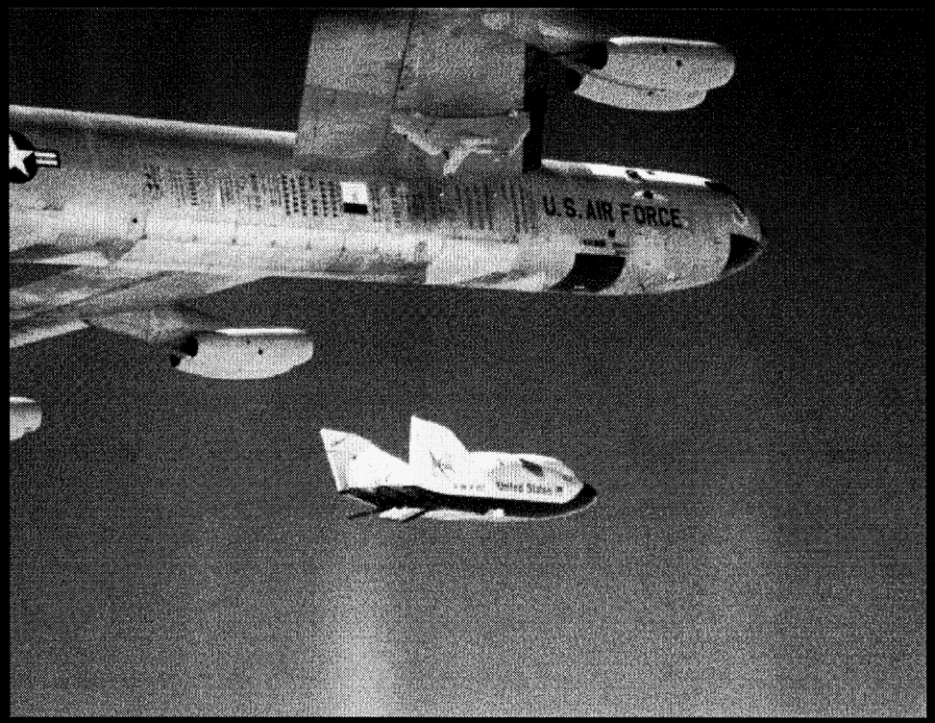




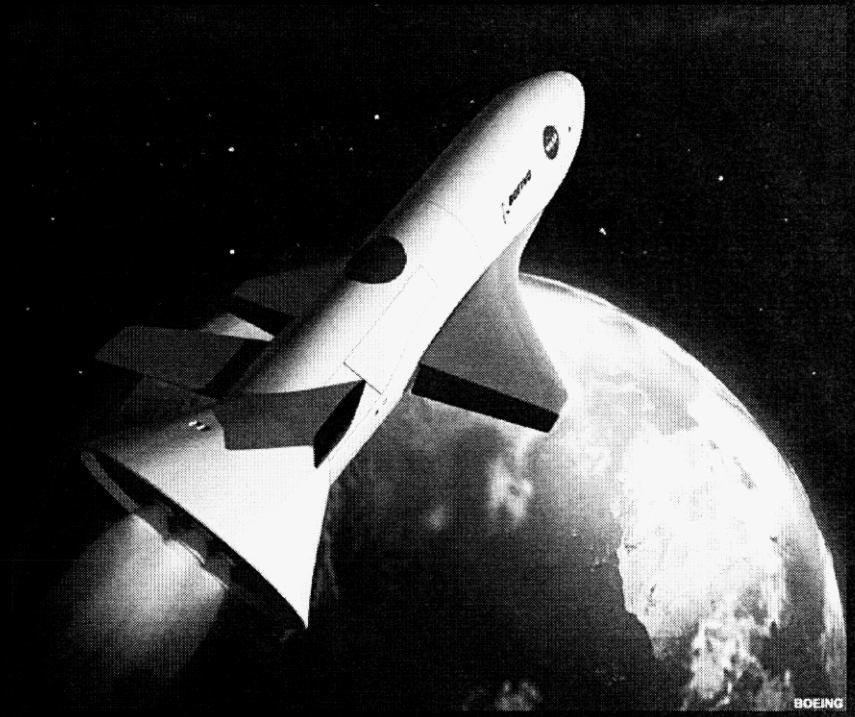
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

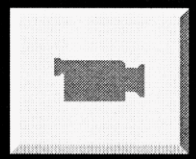
FUTURE SPACE PLANES



1999
X-38
SPACE STATION EMERGENCY RETURN VEHICLE PROTOTYPE



Boeing Orbital Space Plane
Crew Rescue or Transfer

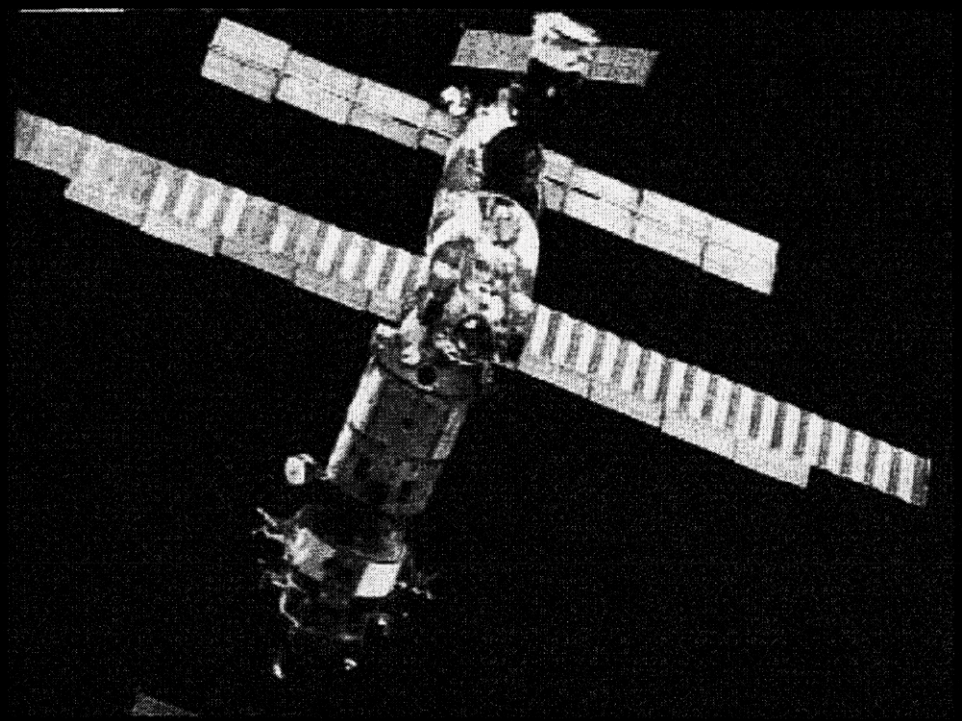


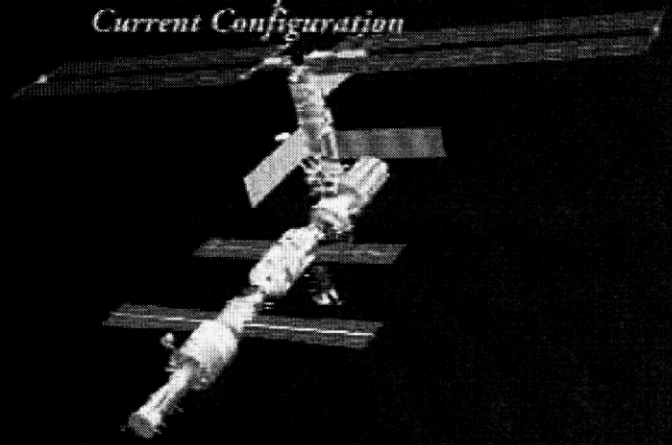
2001
X-40A
NEXT GENERATION SPACE CARGO PLANE

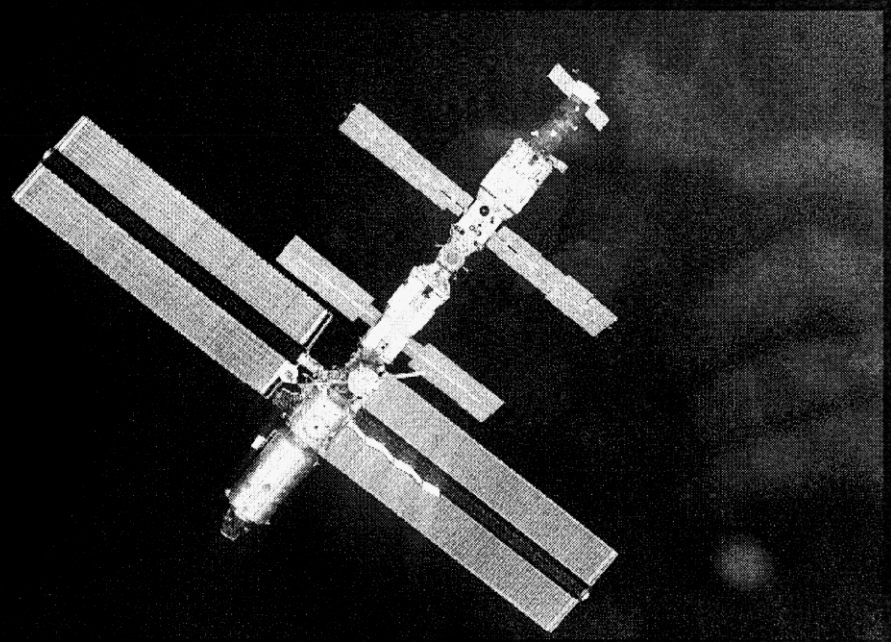
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

THE INTERNATIONAL SPACE STATION (ISS)



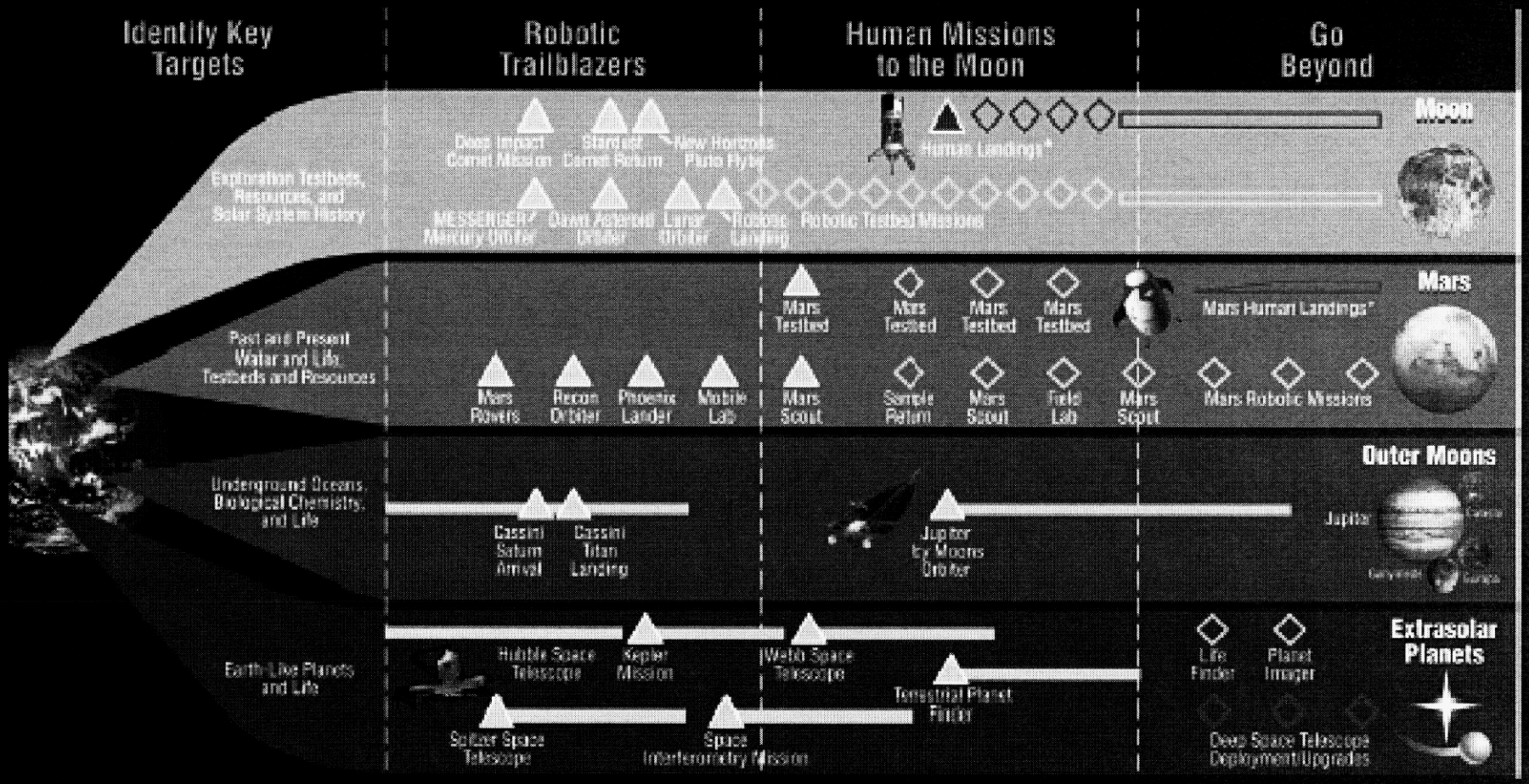




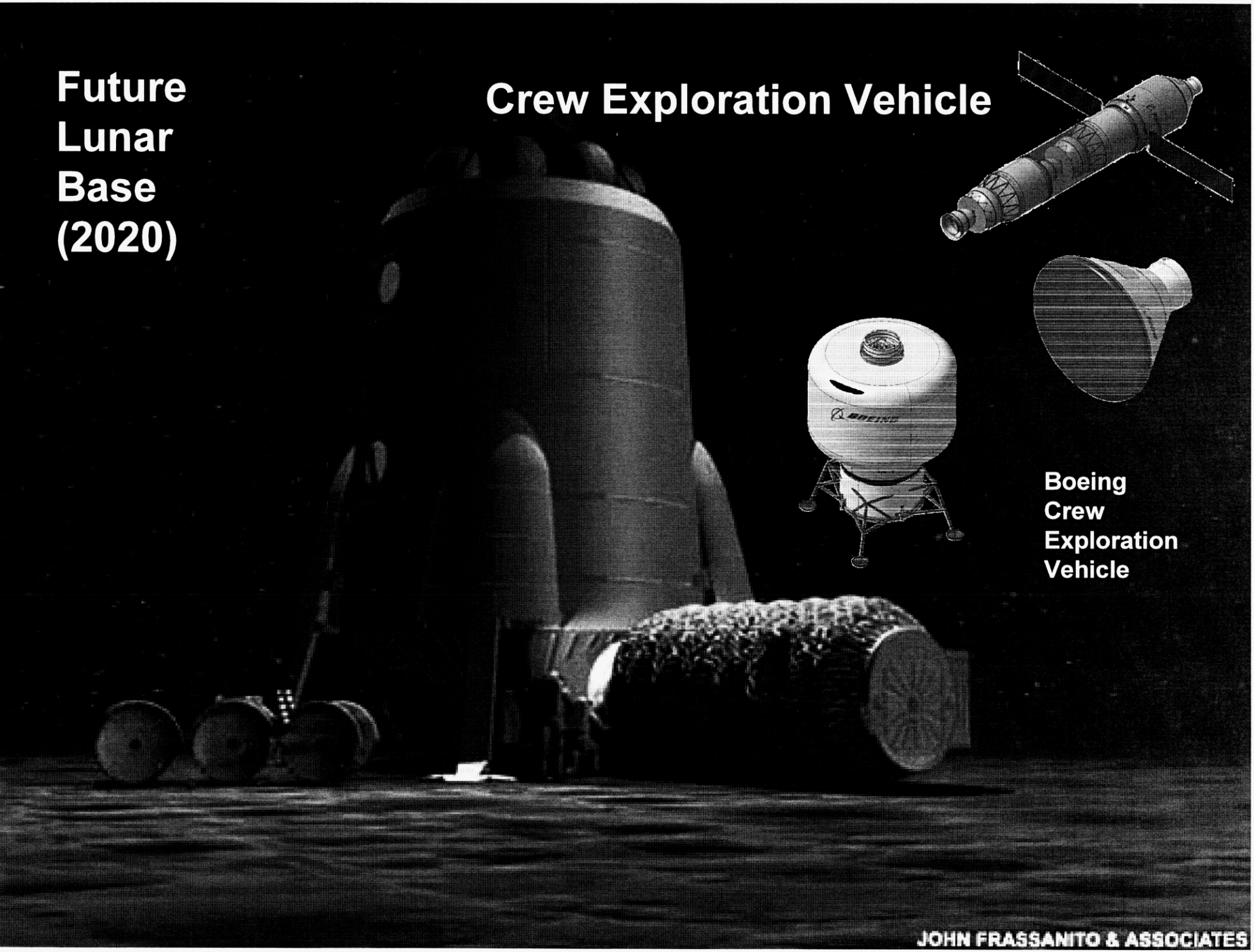
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

NASA's Vision for Space Exploration
January 2004



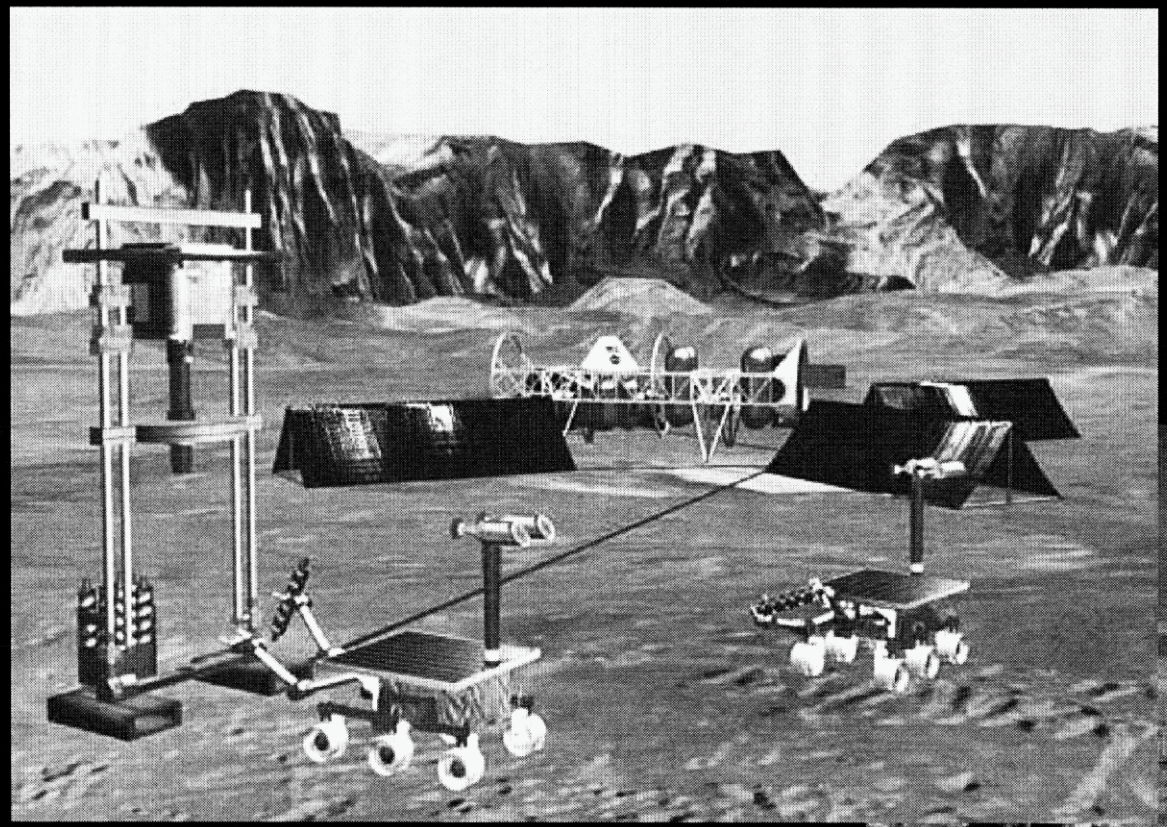
	2nd Grade	4th Grade
2000-2010: Robotic Trailblazers	4-14	6-16
2010-2020: Human Missions to the Moon	14-24	16-26
2020-2030: Human Missions to Mars	24-34	26-36

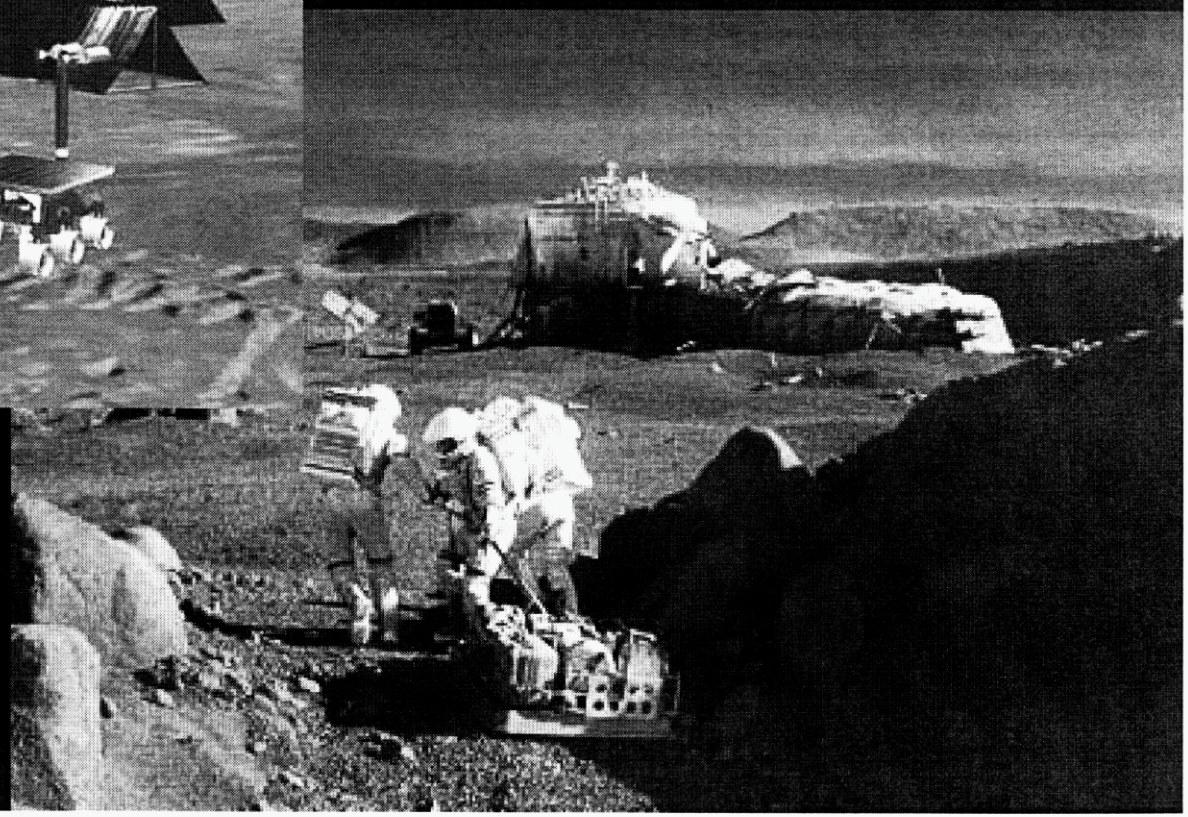

Future
Lunar
Base
(2020)
Crew Exploration Vehicle
Boeing
Crew
Exploration
Vehicle
JOHN FRASSANITO & ASSOCIATES

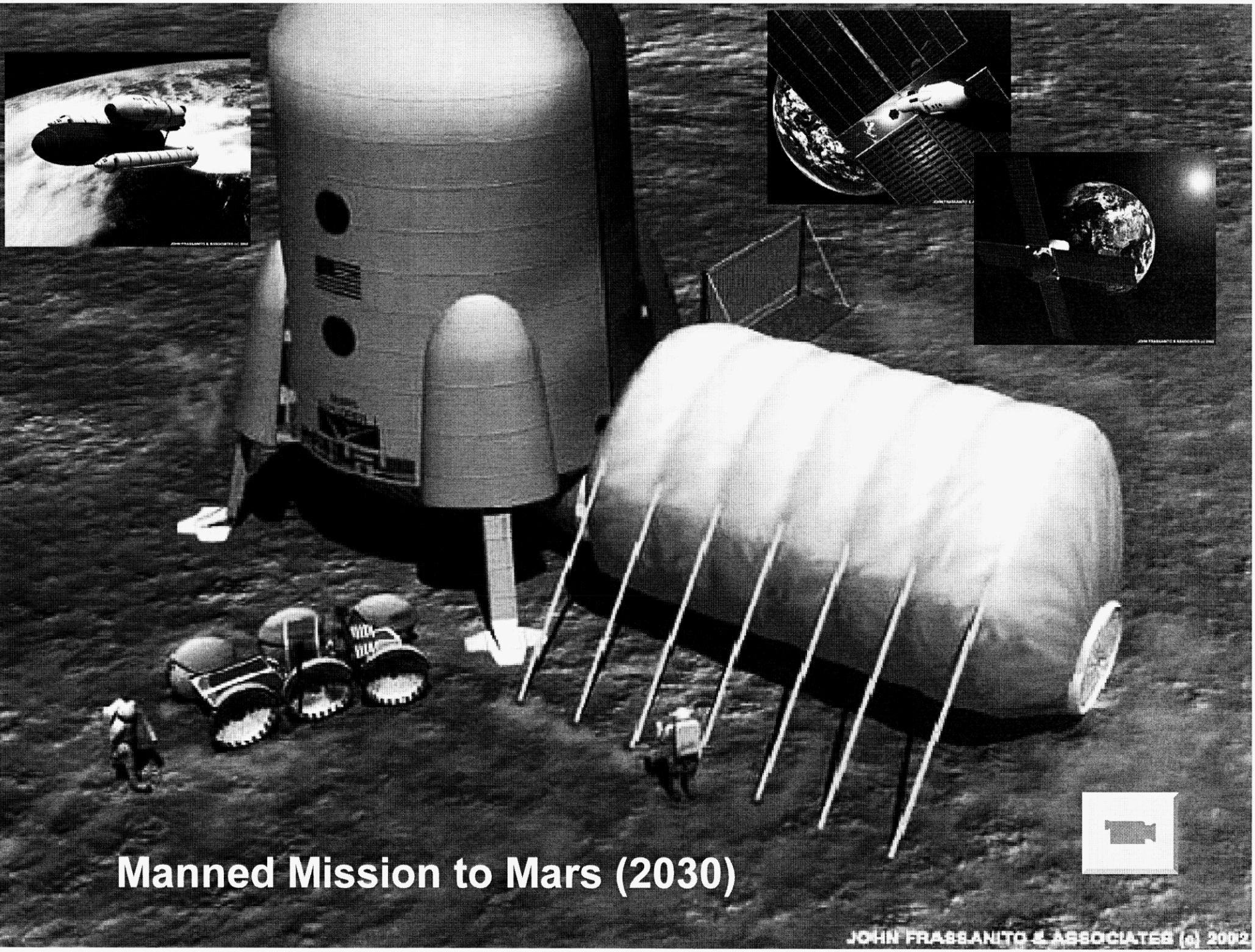
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Robotic missions leading to robotic and human Mars outposts in the Vision for Space Exploration






Manned Mission to Mars (2030)
JOHN FRASSANITO & ASSOCIATES (c) 2002

National Aeronautics and
Space Administration

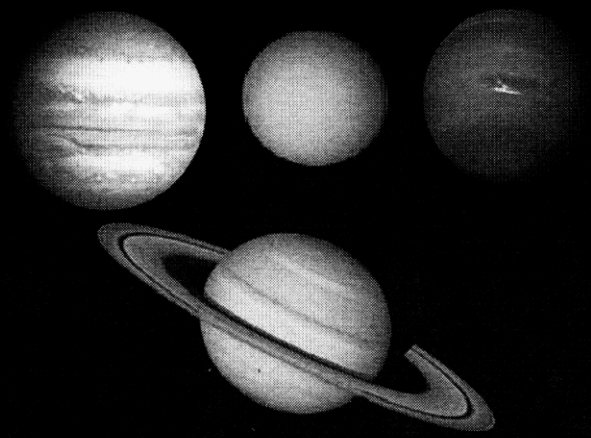
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

SPACE SCIENCE

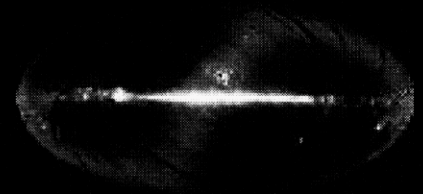
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

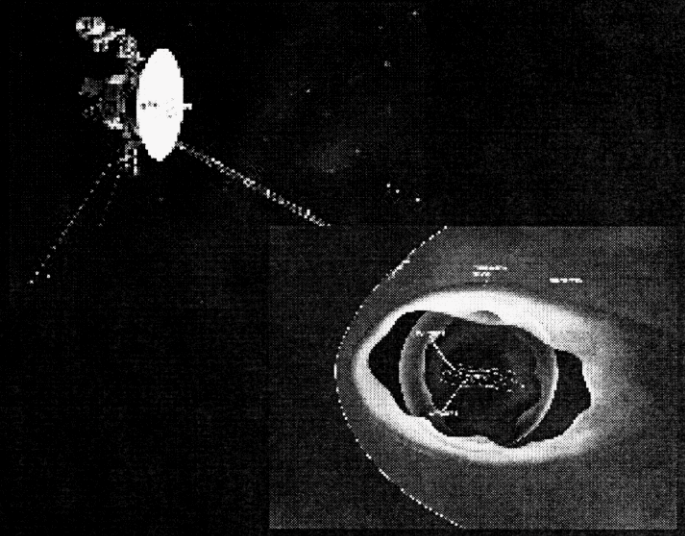
Forty-six years of exploration



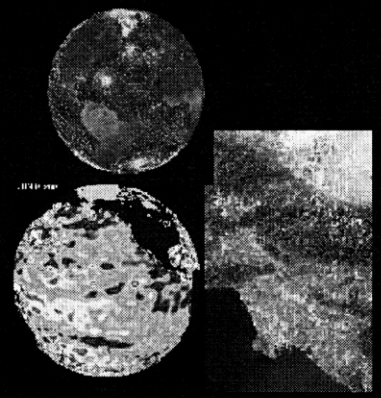
Giant Planets



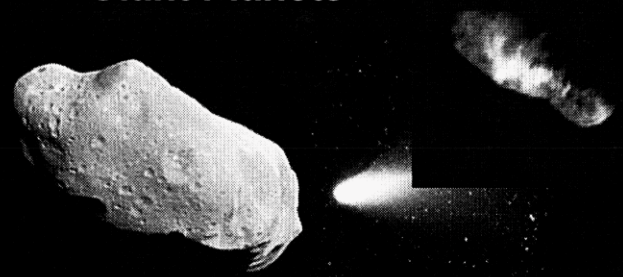
Astrophysics



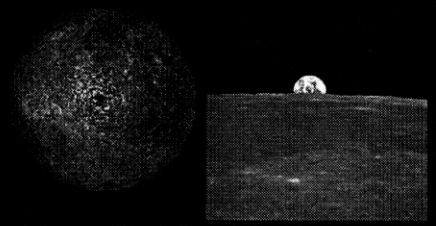
Interstellar space



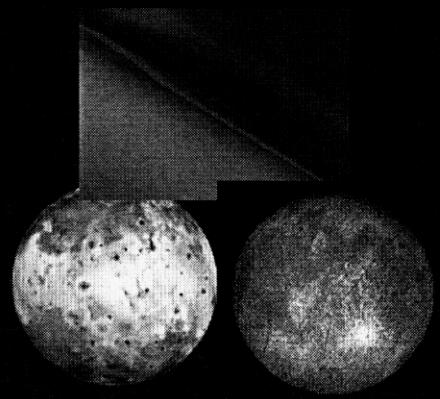
Earth



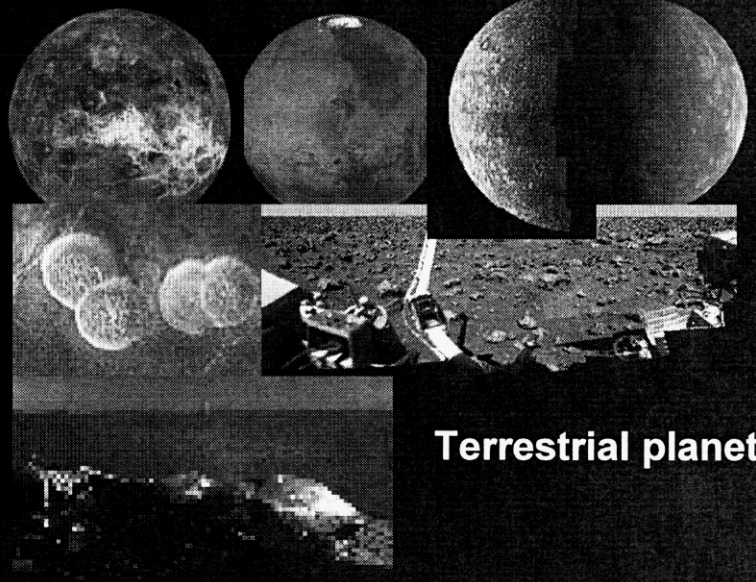
Small bodies



Earth's moon



Planetary satellites

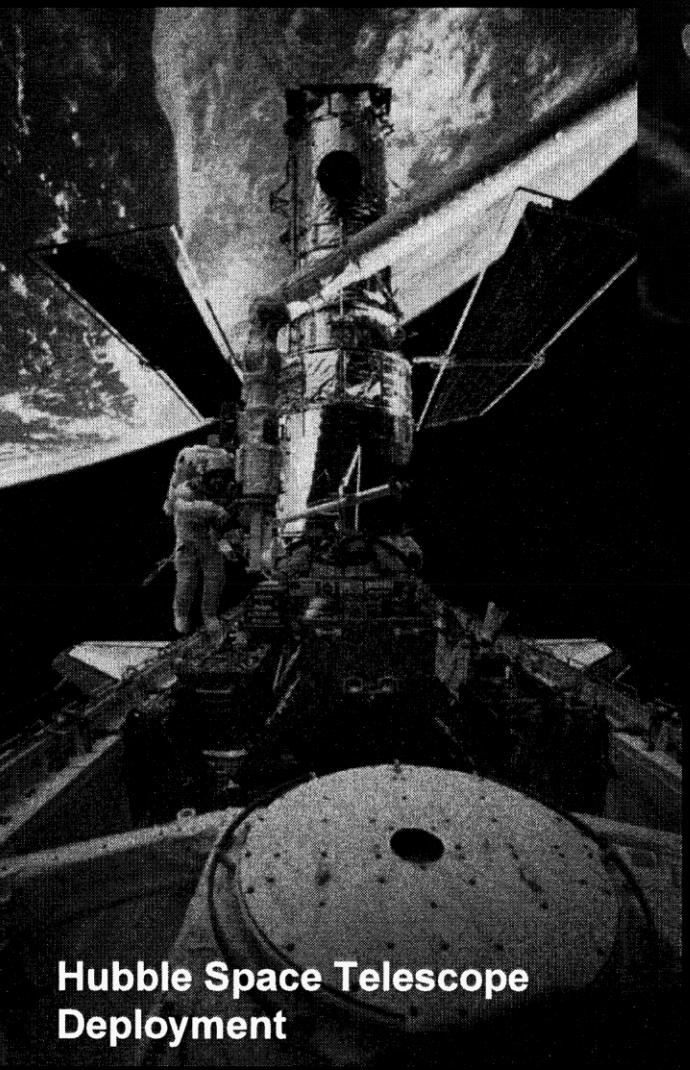


Terrestrial planets

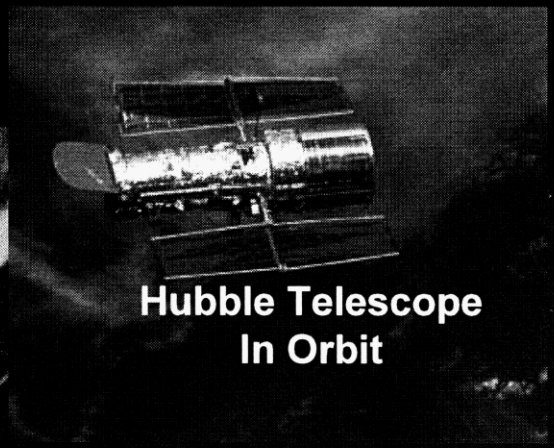
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

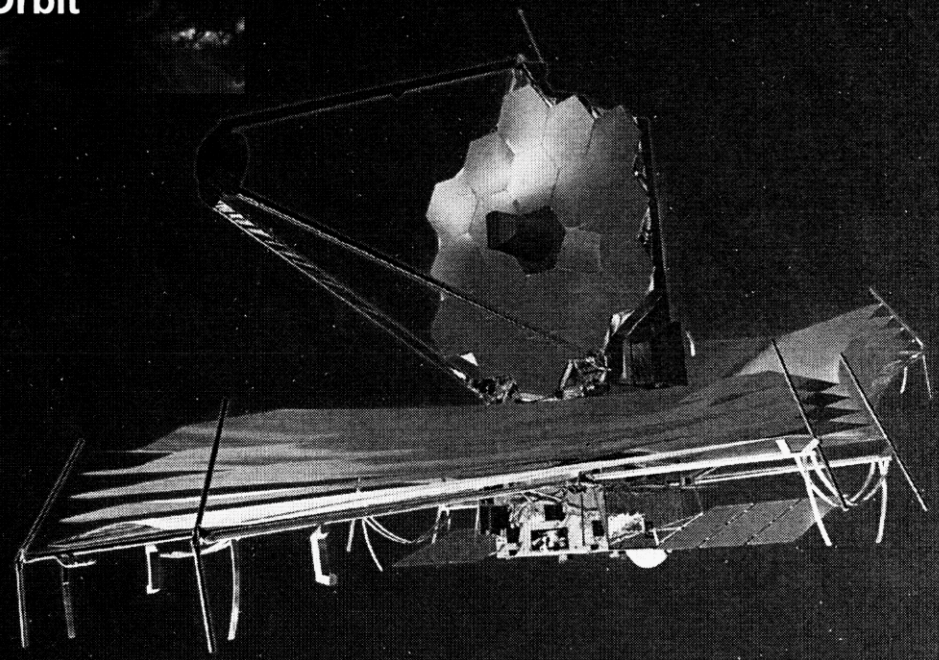
NASA's ORBITING OBSERVATORIES



Hubble Space Telescope
Deployment



Hubble Telescope
In Orbit

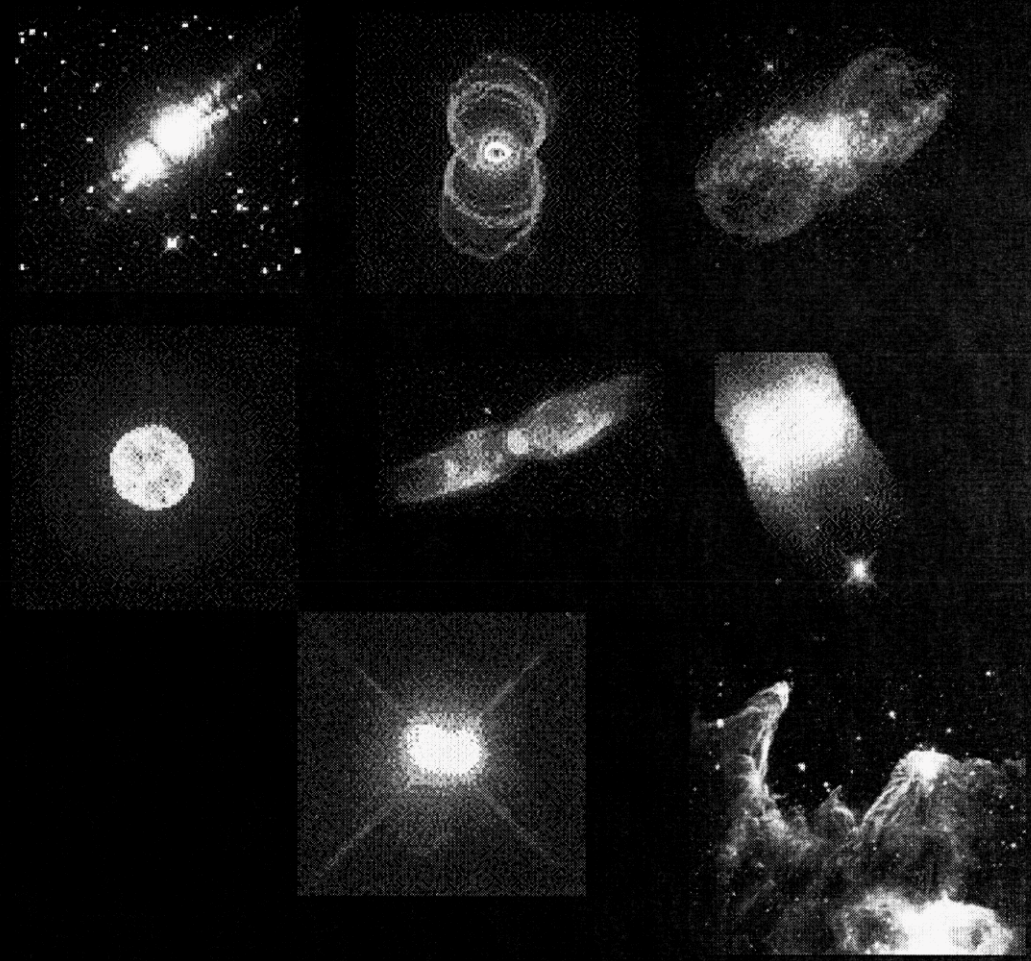


James Webb Telescope. Artist Concept

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

AMAZING PICTURES OF OUR UNIVERSE

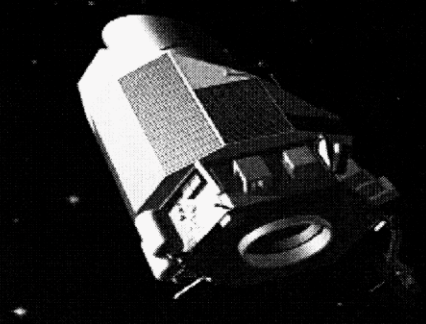


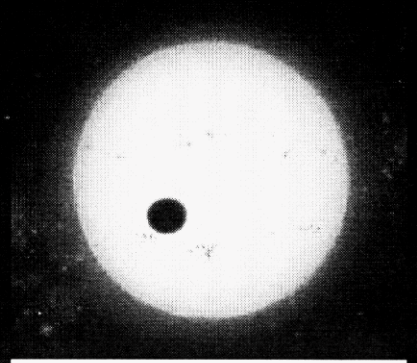
STAR BIRTH
IN THE TRIFID NEBULA

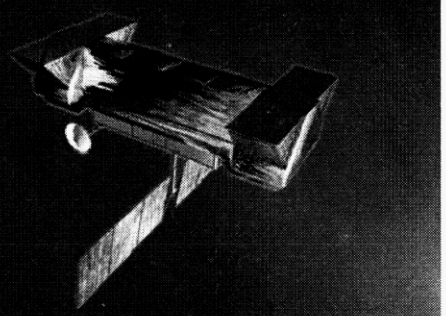
National Aeronautics and Space Administration

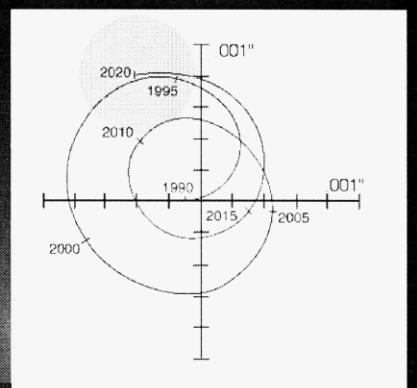
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

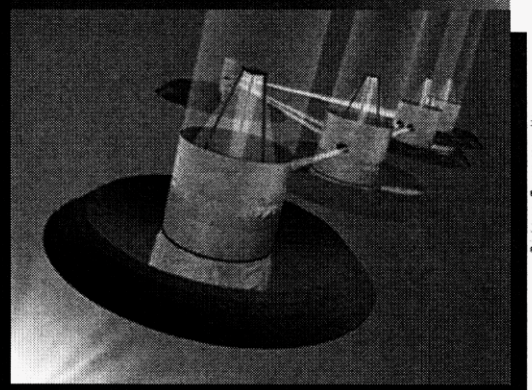
Future exploration of extrasolar planetary systems

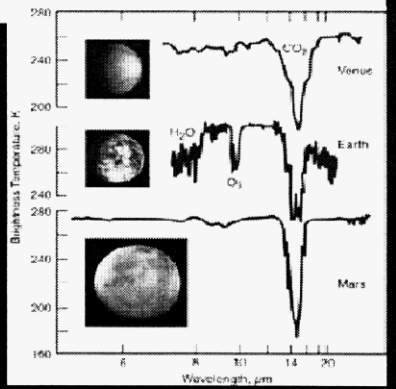








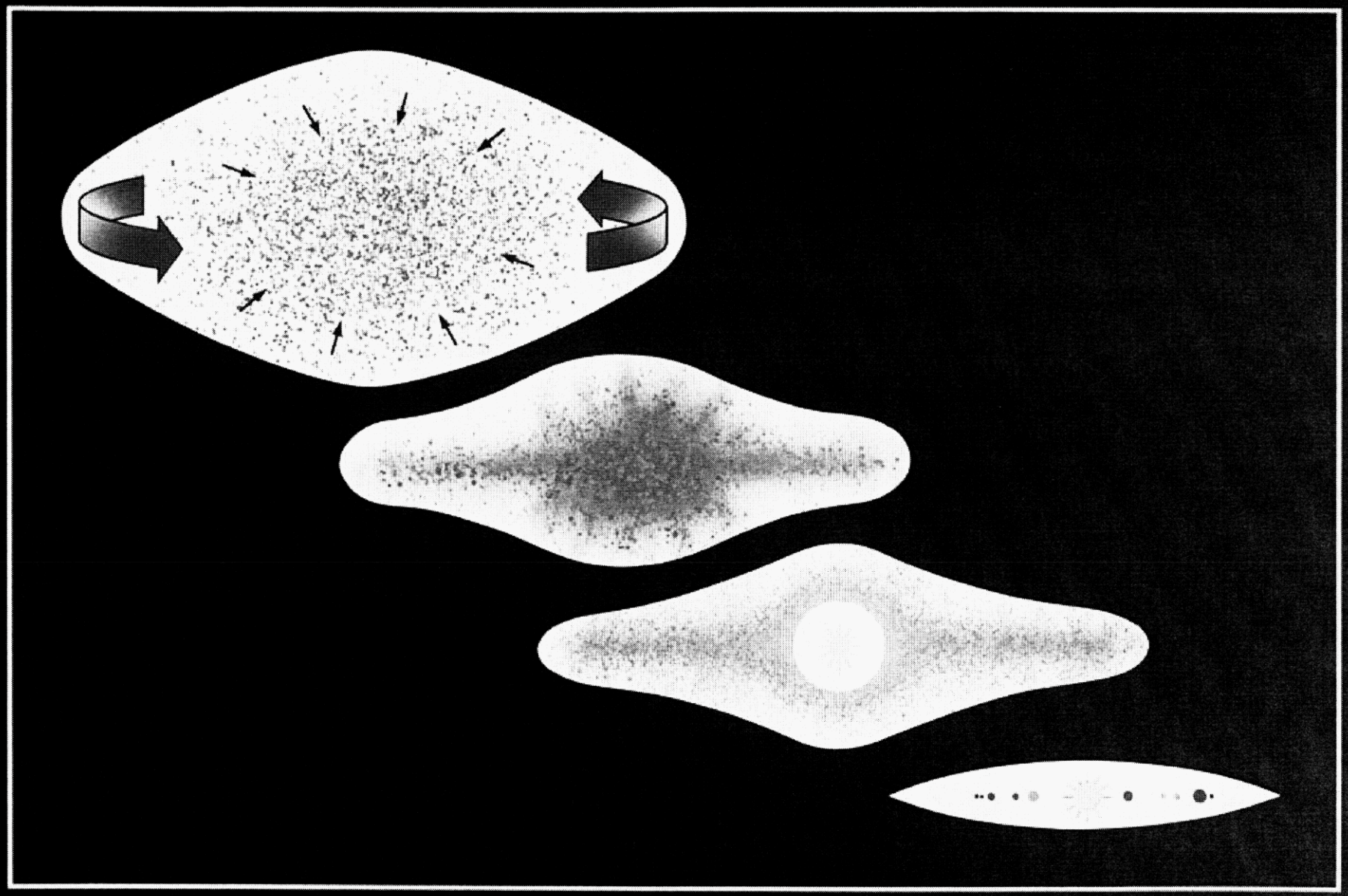




- Kepler Discovery mission in 2007 to observe transits of planets across stars
- Space Interferometry Mission (SIM), to launch in 2009, performs astrometry of extra-solar planets.
- Terrestrial Planet Finder (TPF), to launch in 2015, performs spectroscopy of extra-solar planets.

FORMATION OF STARS AND PLANETS

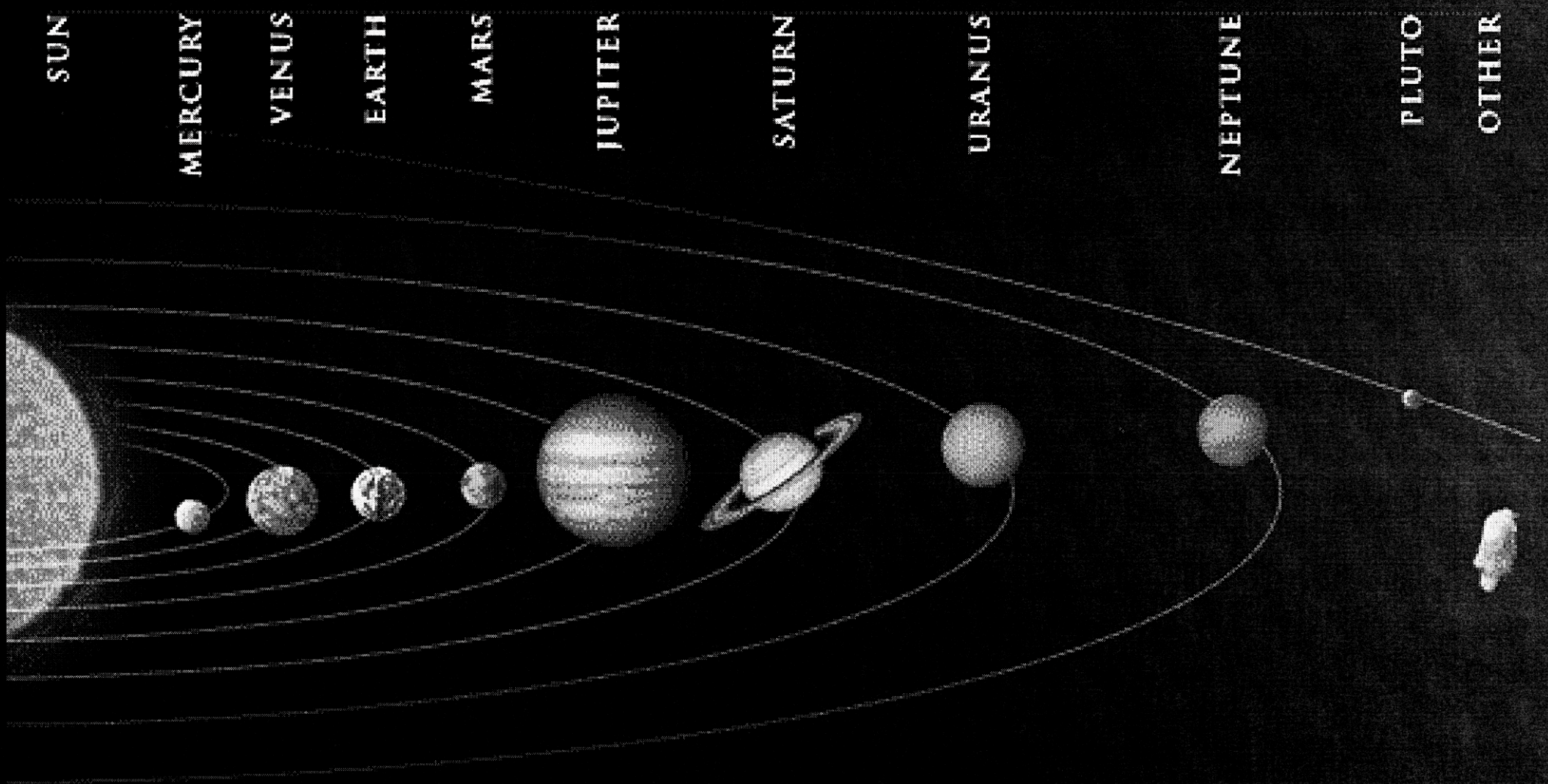
SLOW-ROTATING CLOUD



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

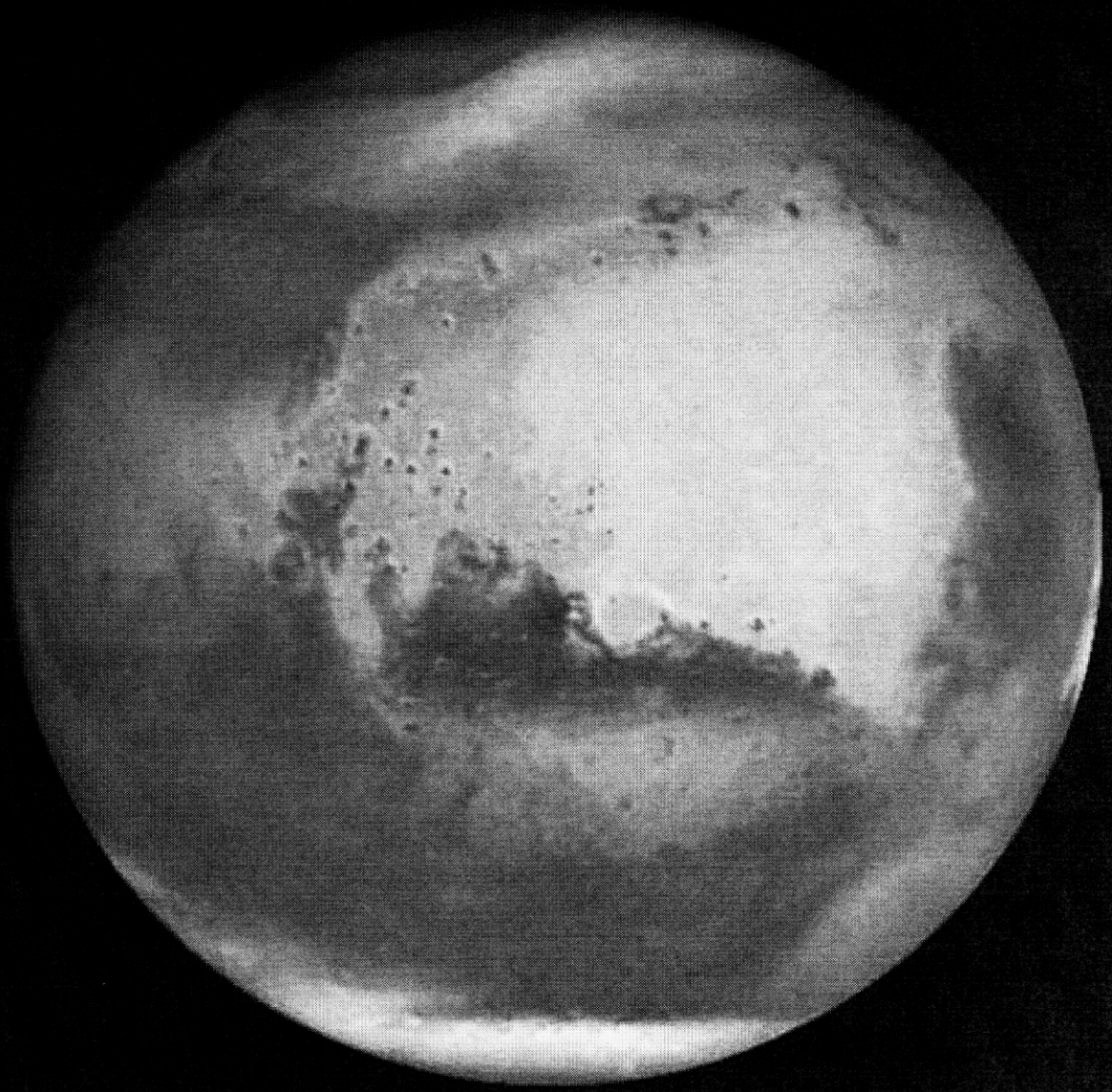
OUR SOLAR SYSTEM



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

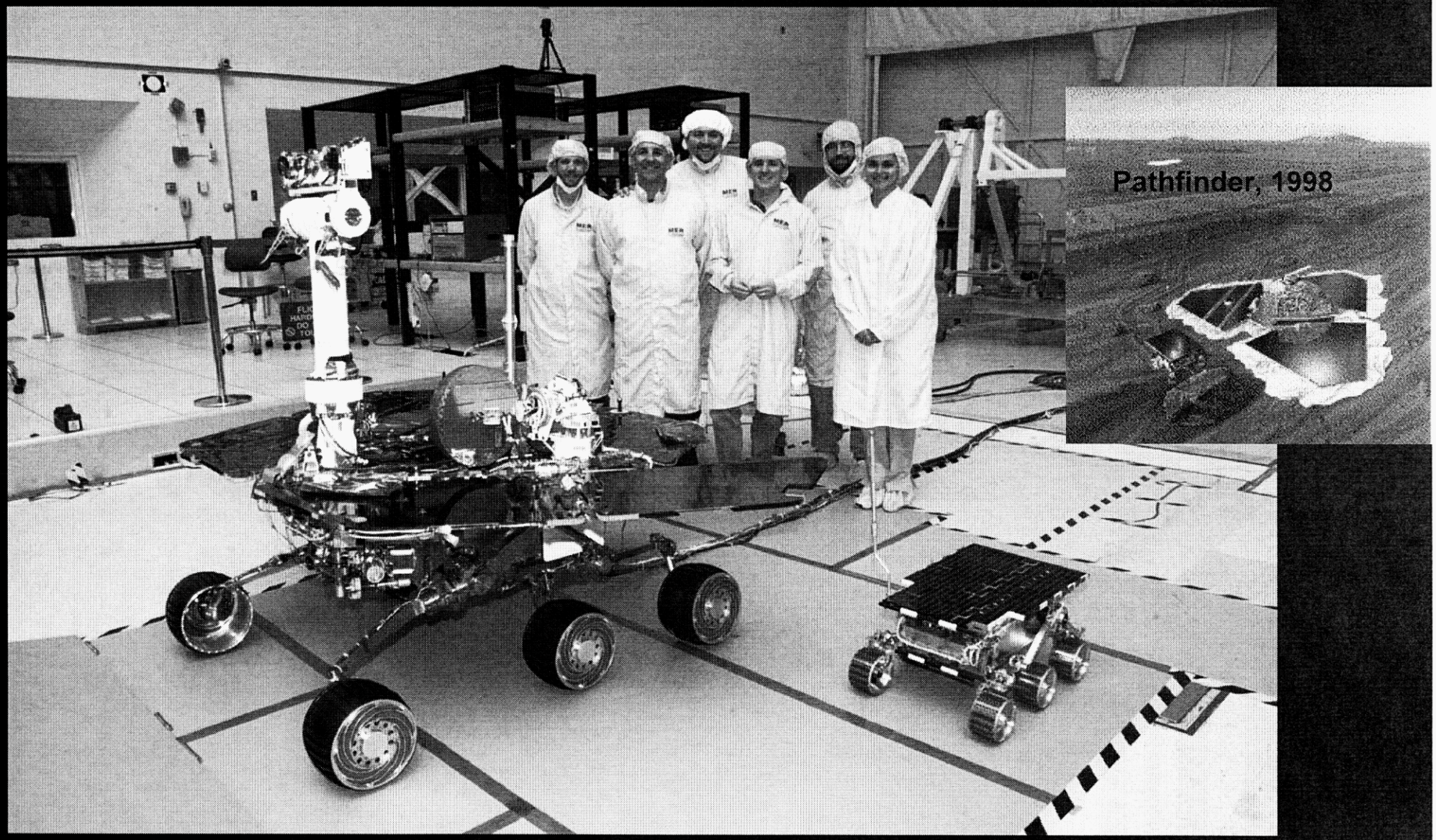
NASA SCIENTISTS STUDY MARS GEOLOGY AND WATER CYCLE



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

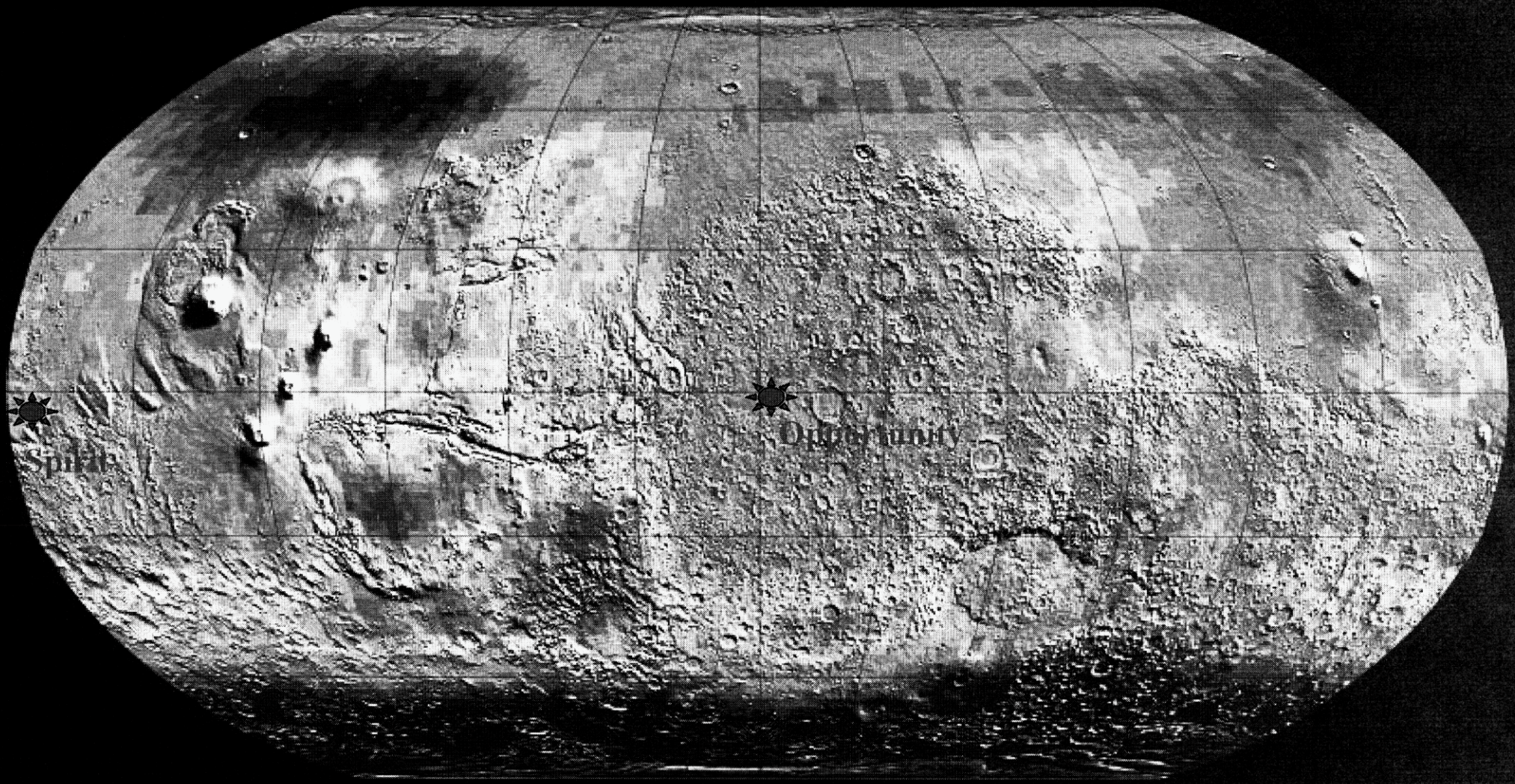
SPIRIT AND OPPORTUNITY BUILT AT JPL IN PASADENA, CA



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

LANDERS PICK SITES MOST PROBABLE FOR WATER NEAR EQUATOR

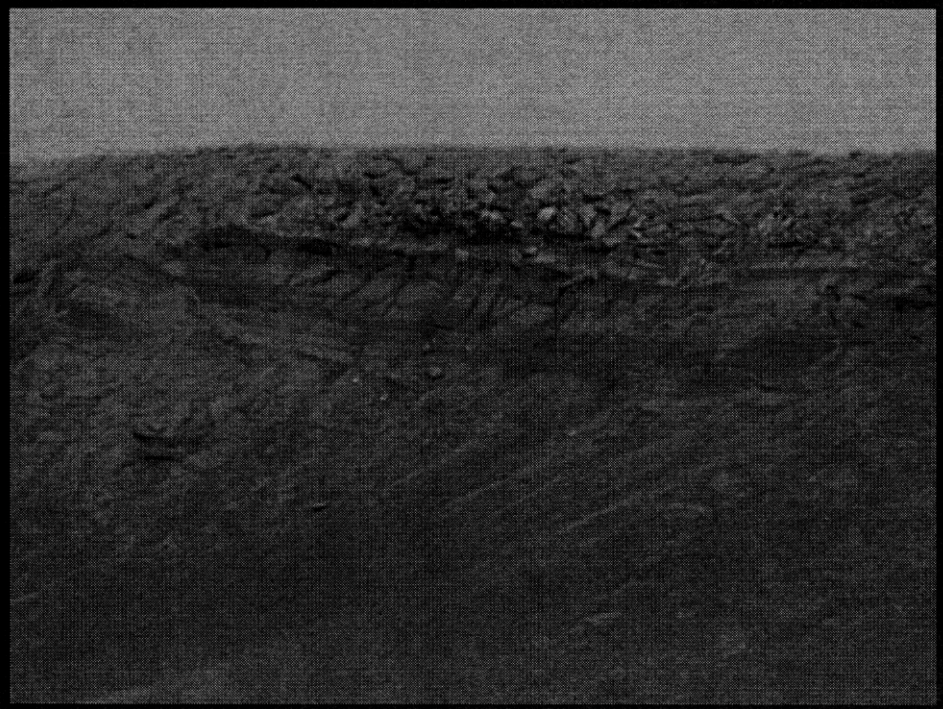


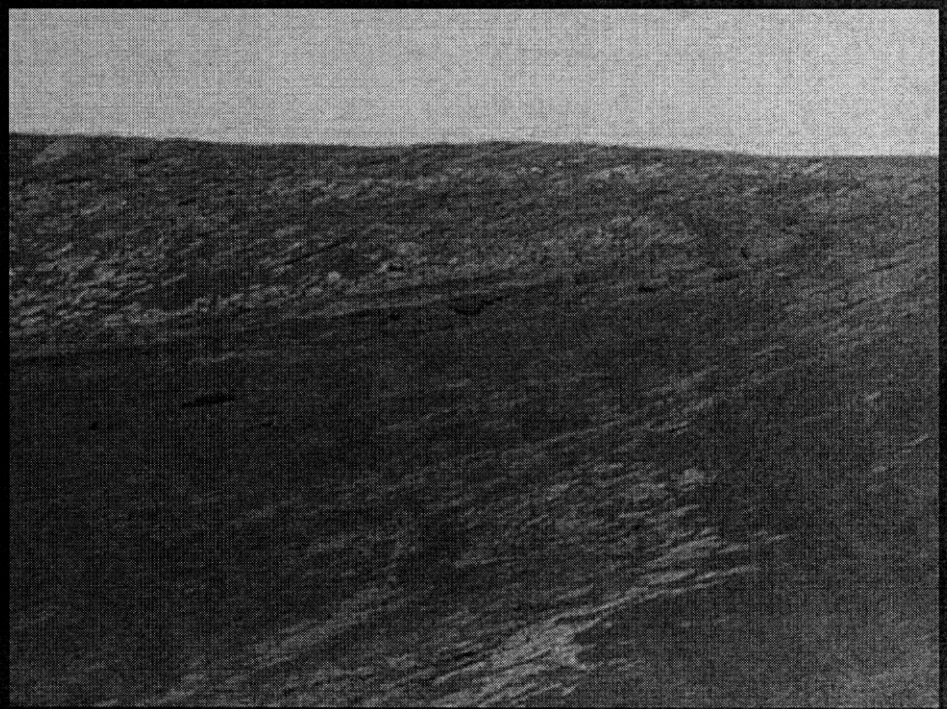
2001 Mars Odyssey global Mars map of epithermal neutrons implying high water concentrations in blue regions

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Opportunity's first look at Endurance crater, May 3, 2004





National Aeronautics and
Space Administration

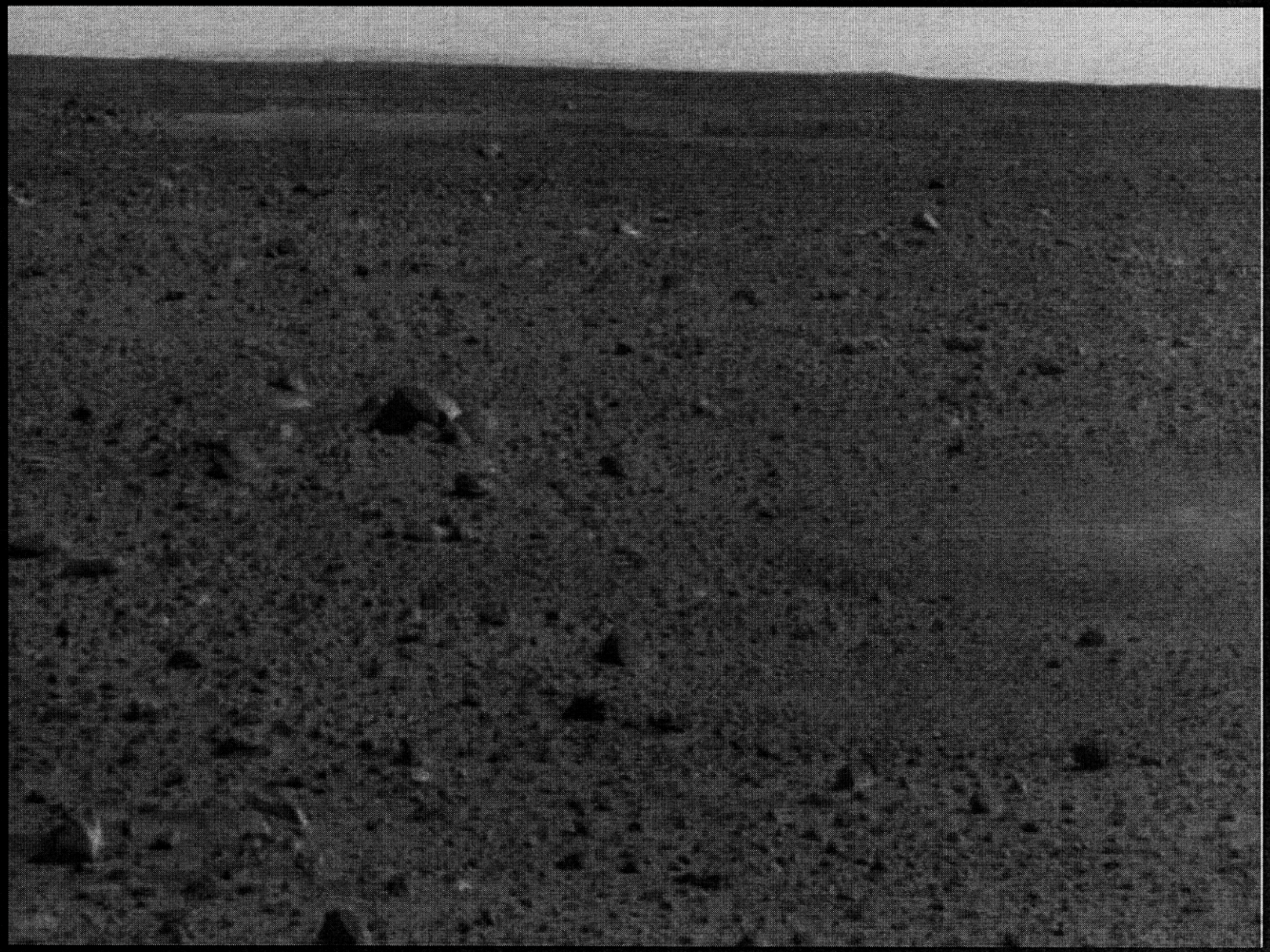
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Geologists in action

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

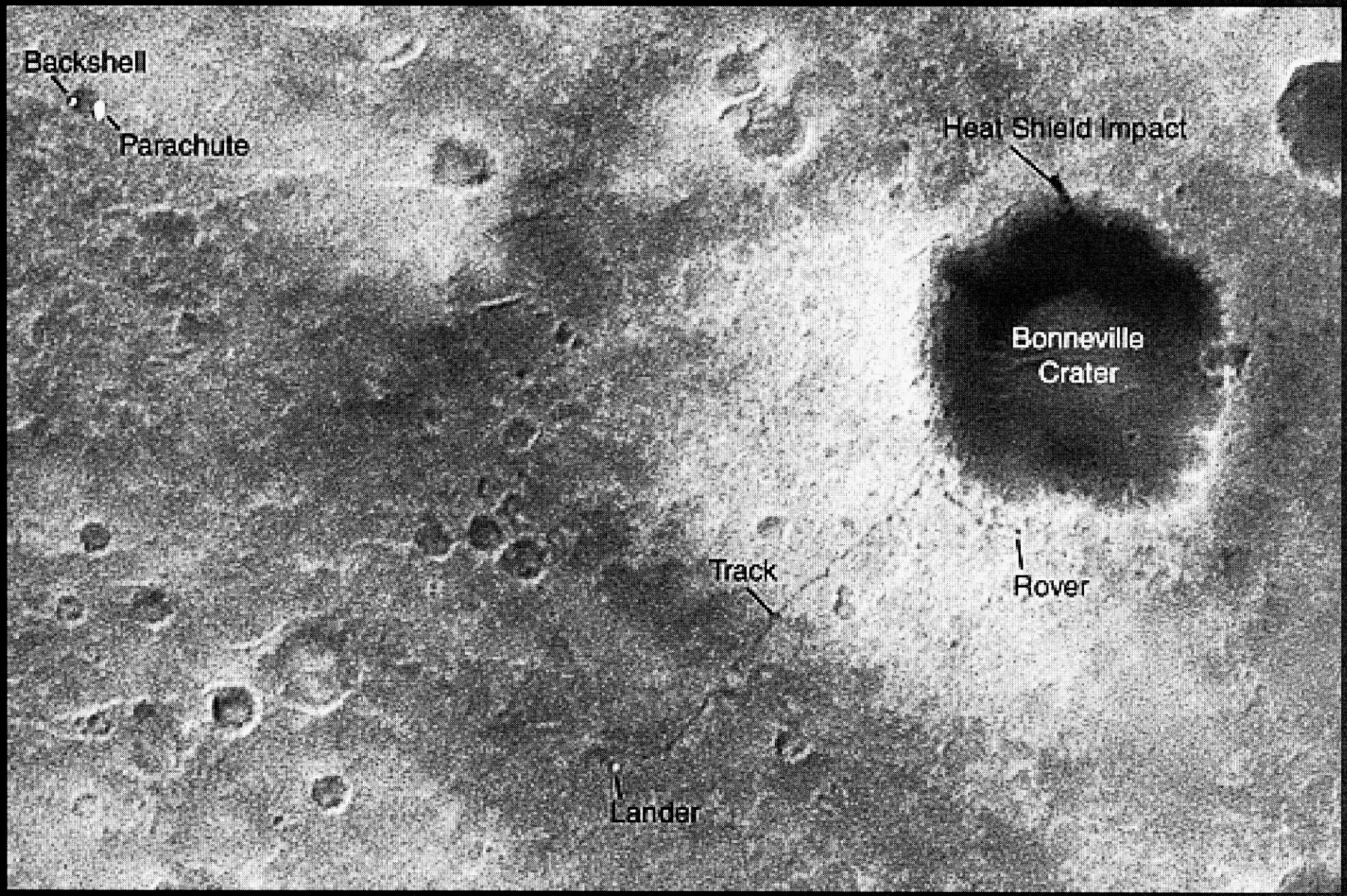
MARS. TWIN ROVERS NOW SAFELY LANDED



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

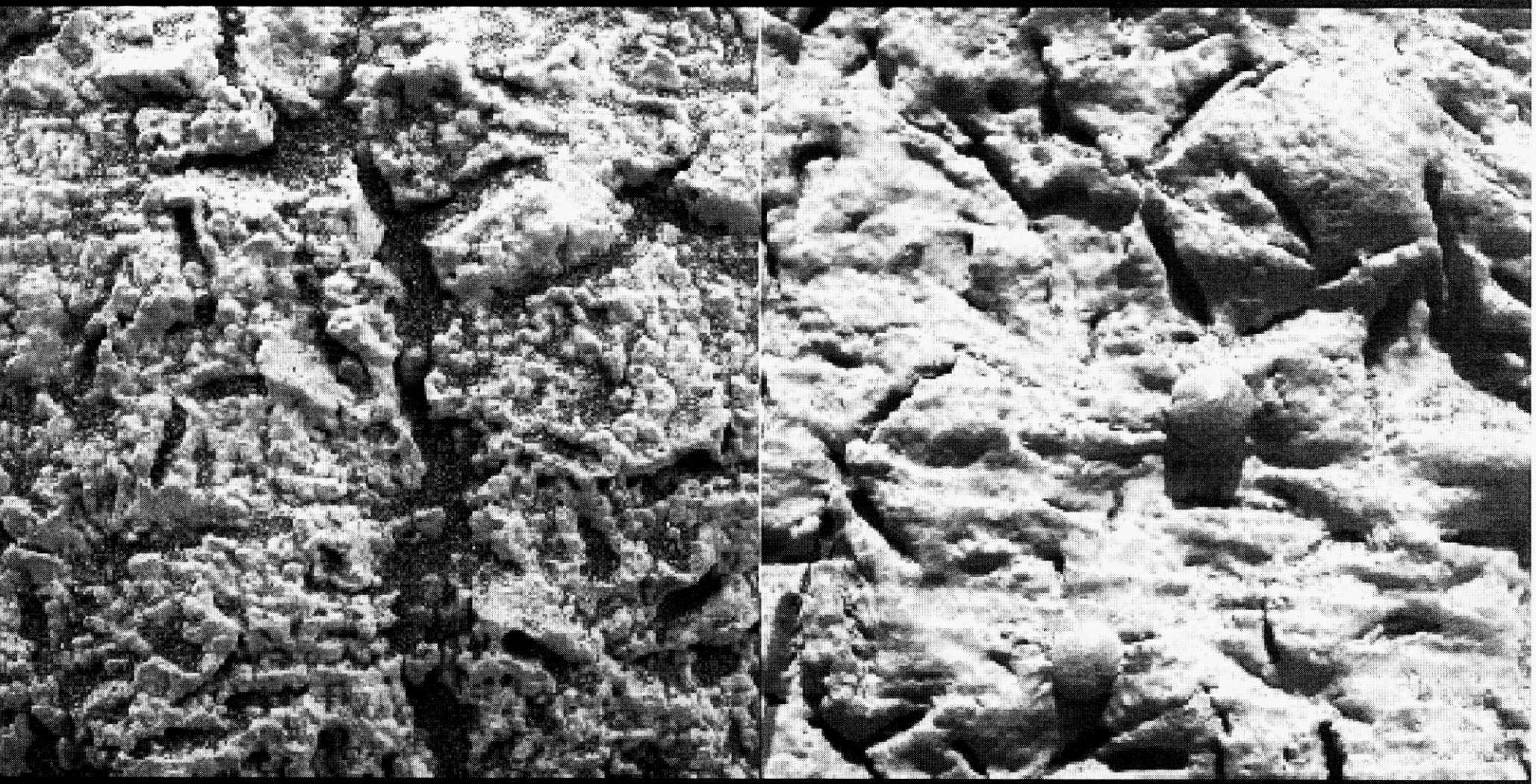
Mars Global Surveyor spots Spirit's tracks from landing to Bonneville



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

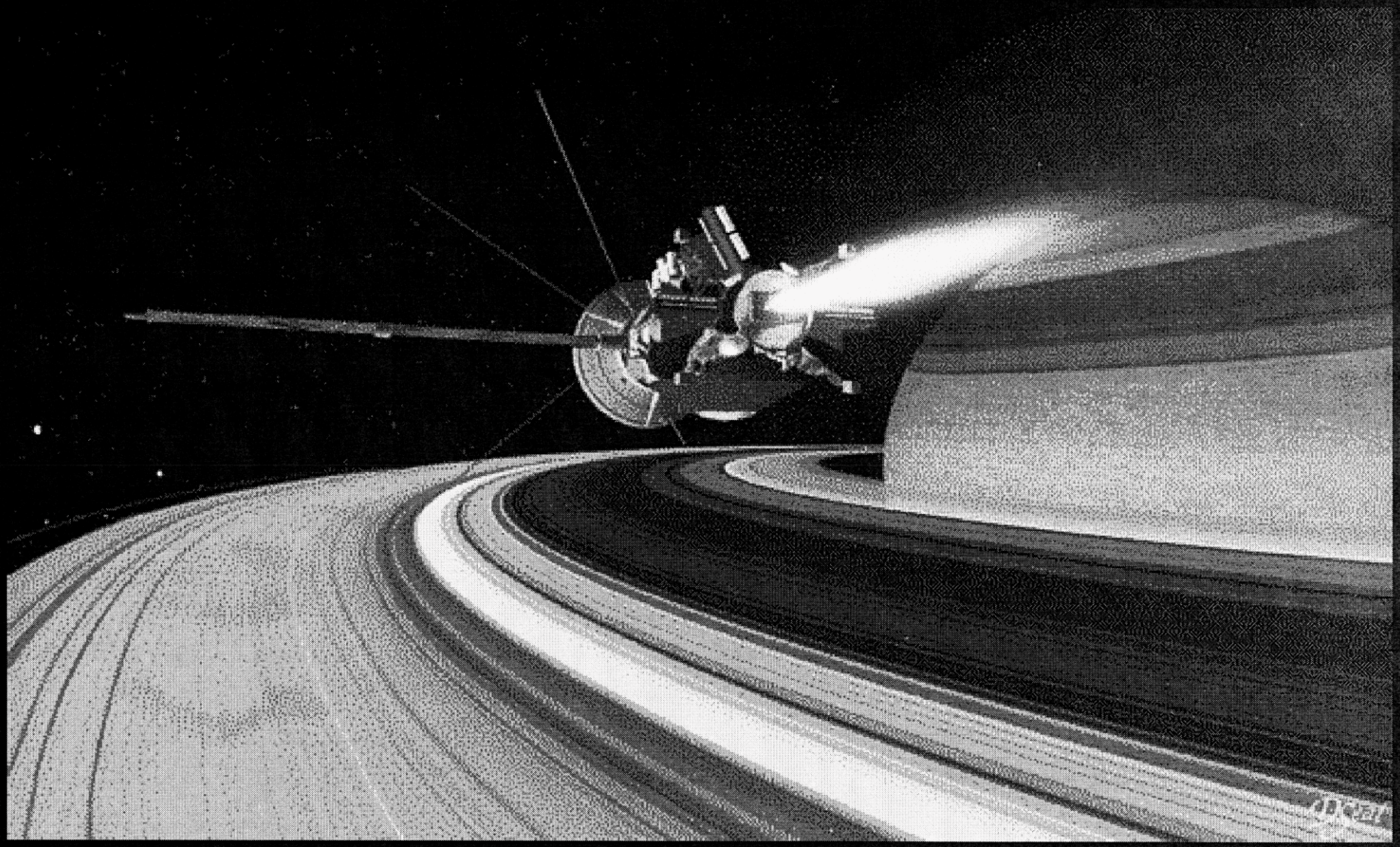
Voids, layers and spherules in Meridiani Planum from Opportunity, possibly implying dissolved crystals in sediments



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

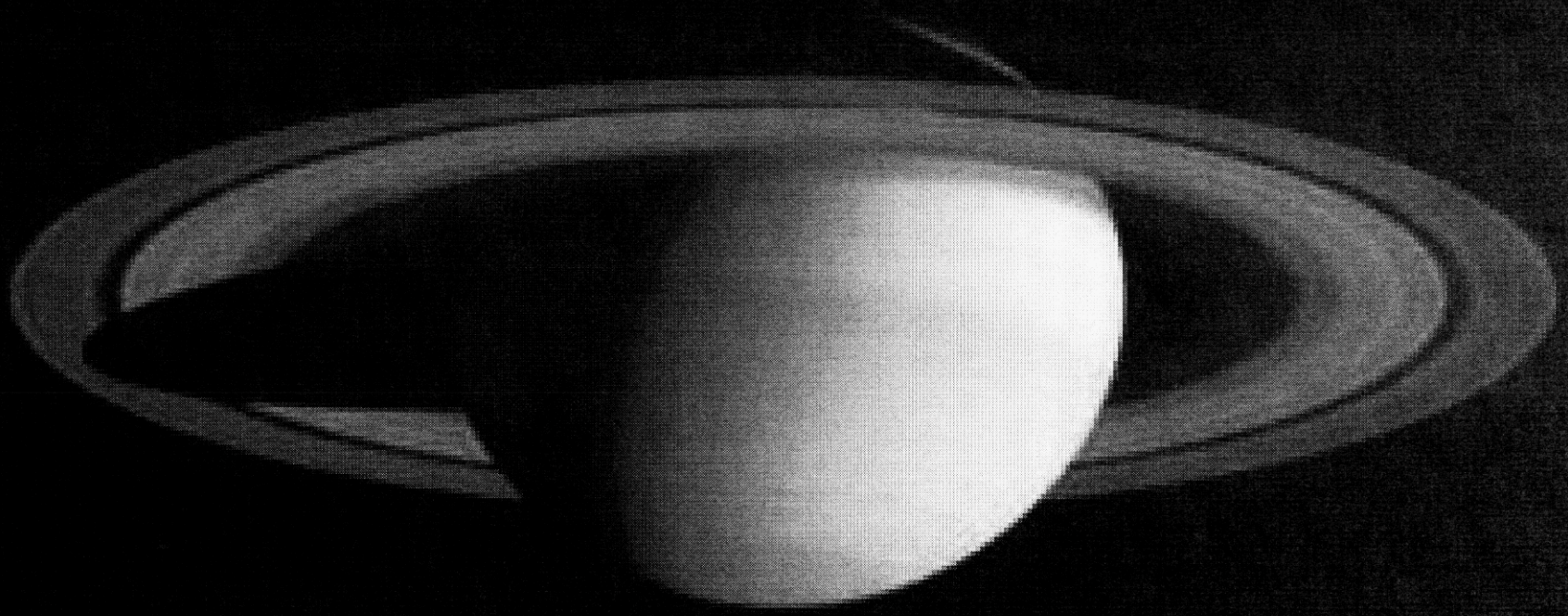
CASSINI TO ARRIVE AT SATURN IN JULY, 2004



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Saturn from Cassini, April 2004



National Aeronautics and
Space Administration

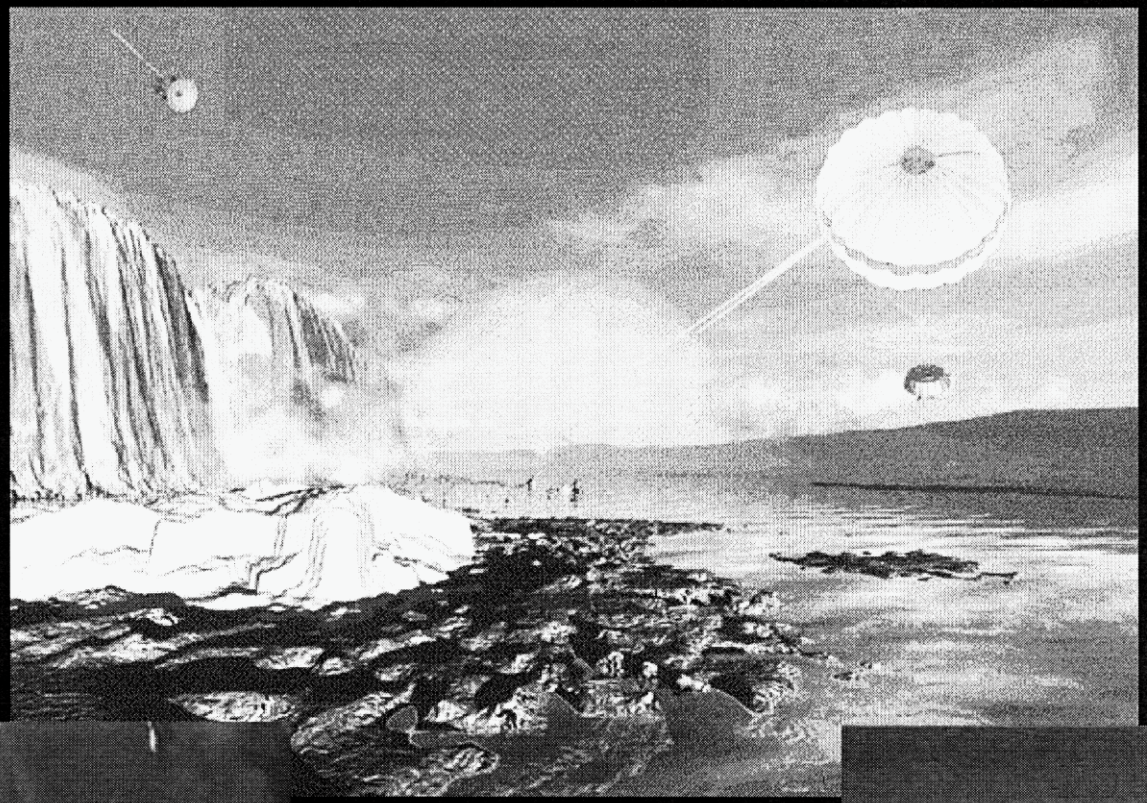
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

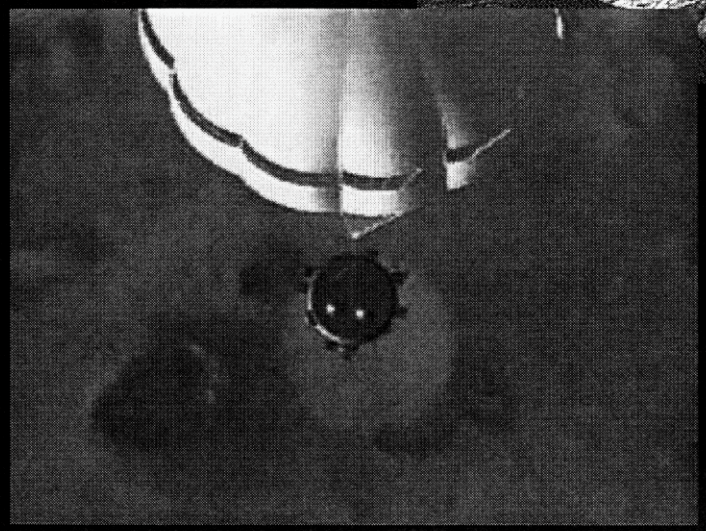
Saturn's rings from Cassini-Huygens, near closest approach, July 1, 2004

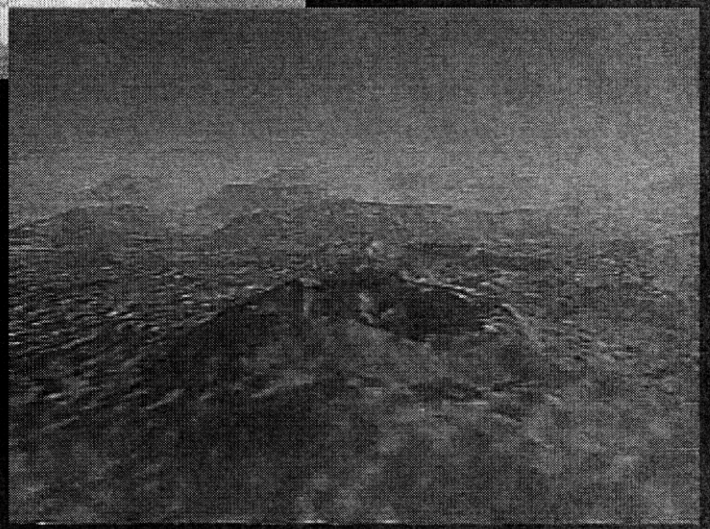
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

CASSINI WILL ALSO VISIT TITAN



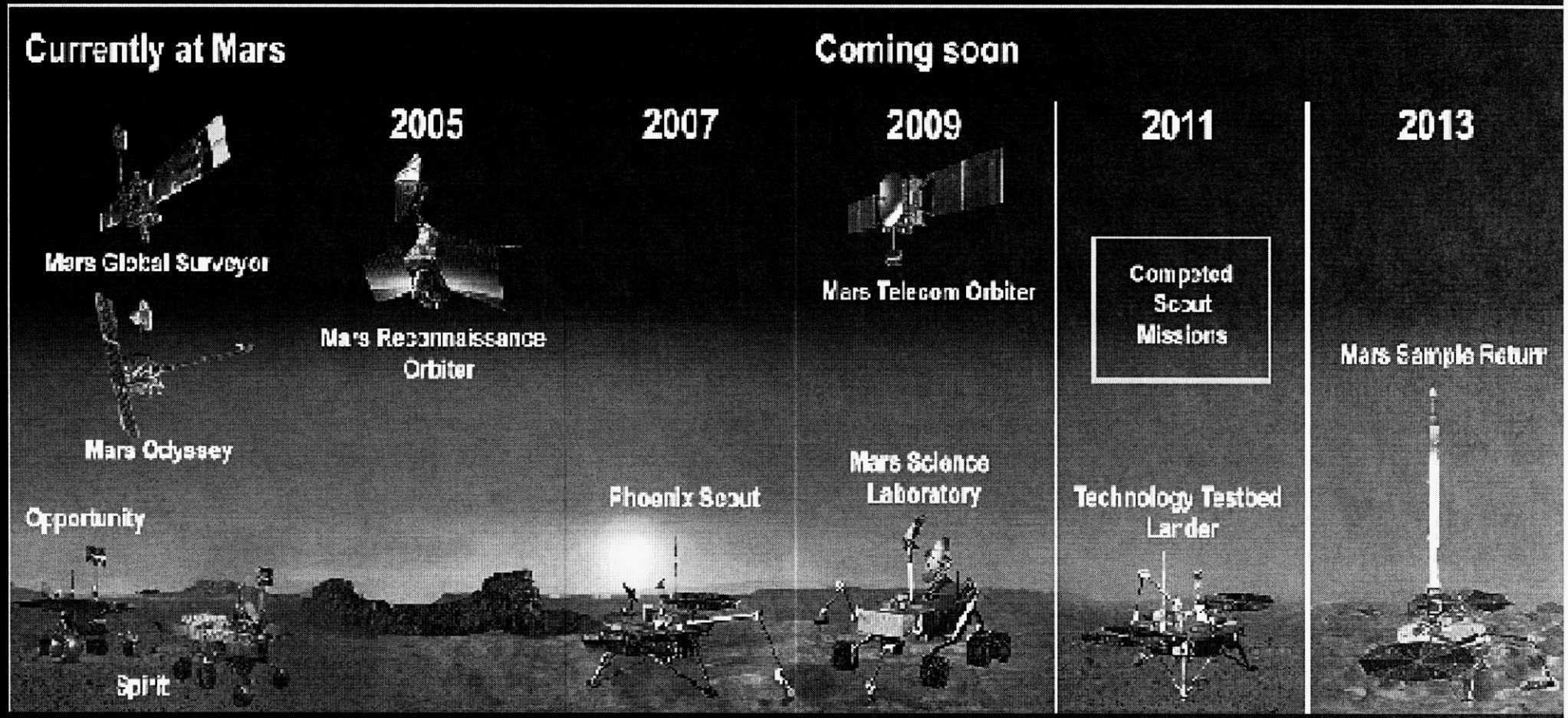




National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Mars exploration in the Vision for Space Exploration



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

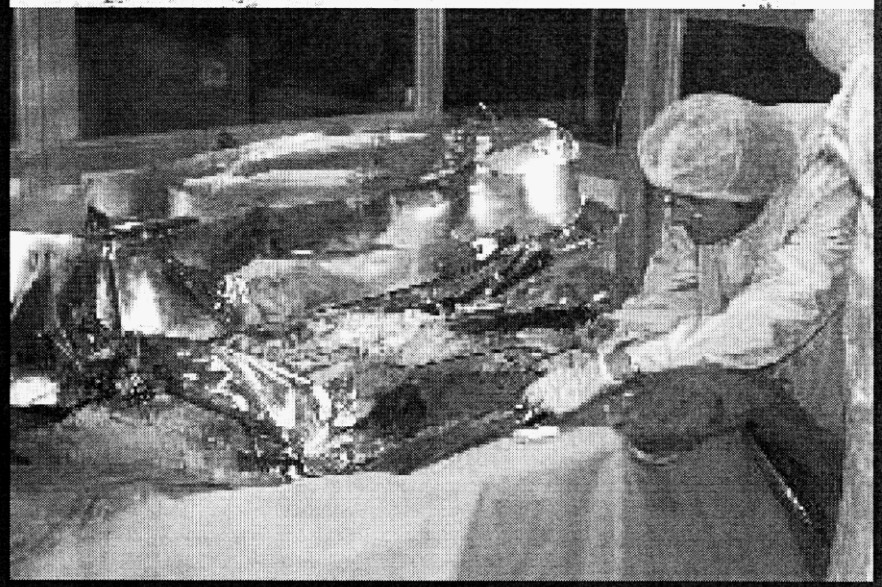
Successful Stardust encounter with comet Wild-2, January 2, 2004

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Genesis

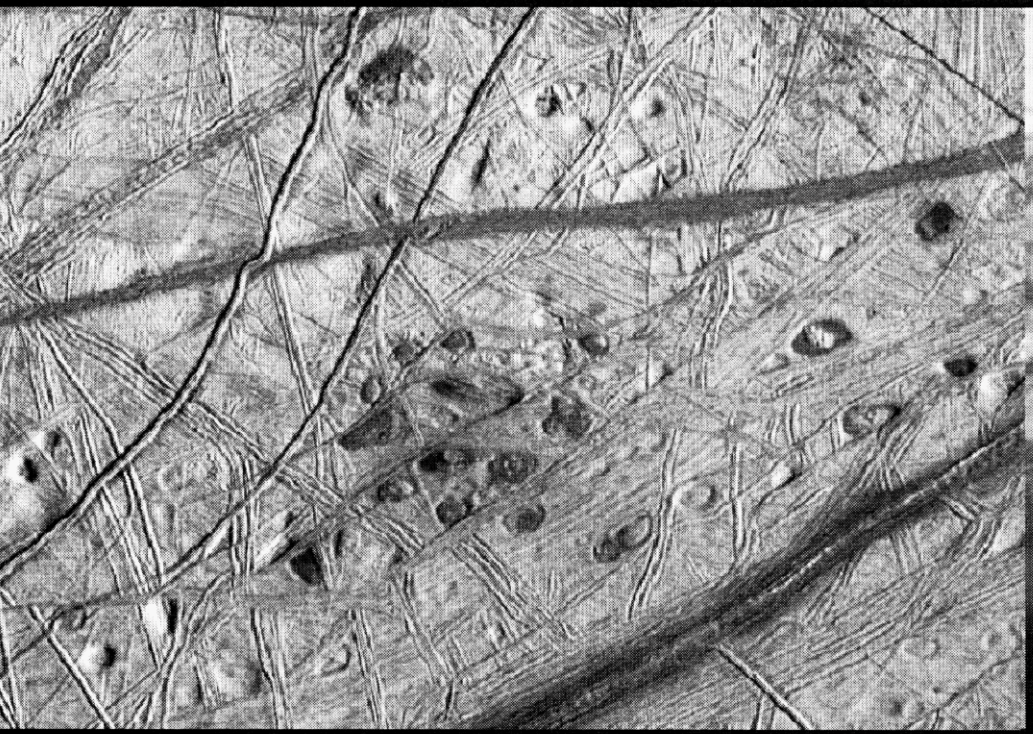
- Completed 27 months of solar wind collection.
- Earth return mishap led to hard-impact landing at Utah Test and Training Range on September 8.
- Work ongoing to recover science results from damaged sample canister.
- High likelihood that most of the highest priority science will be recovered.

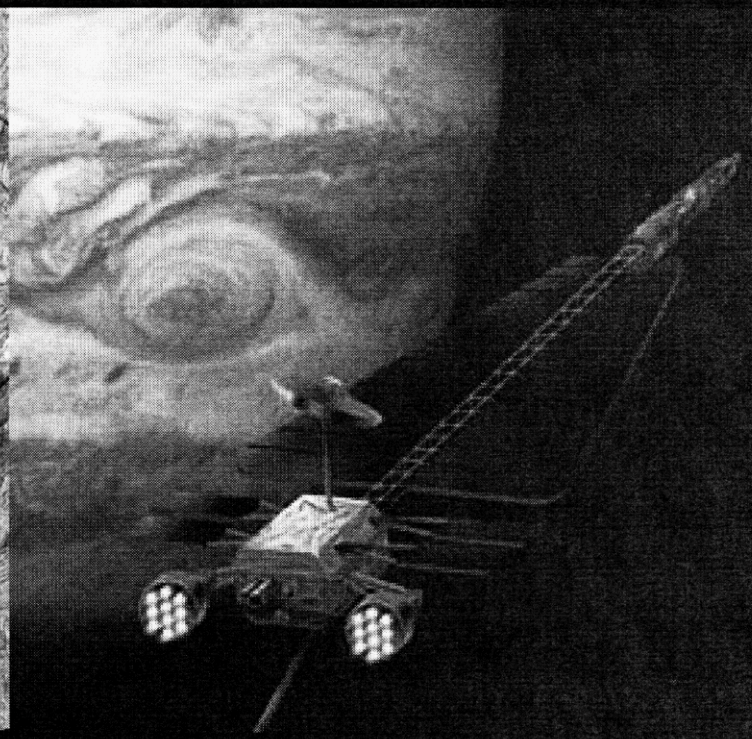


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

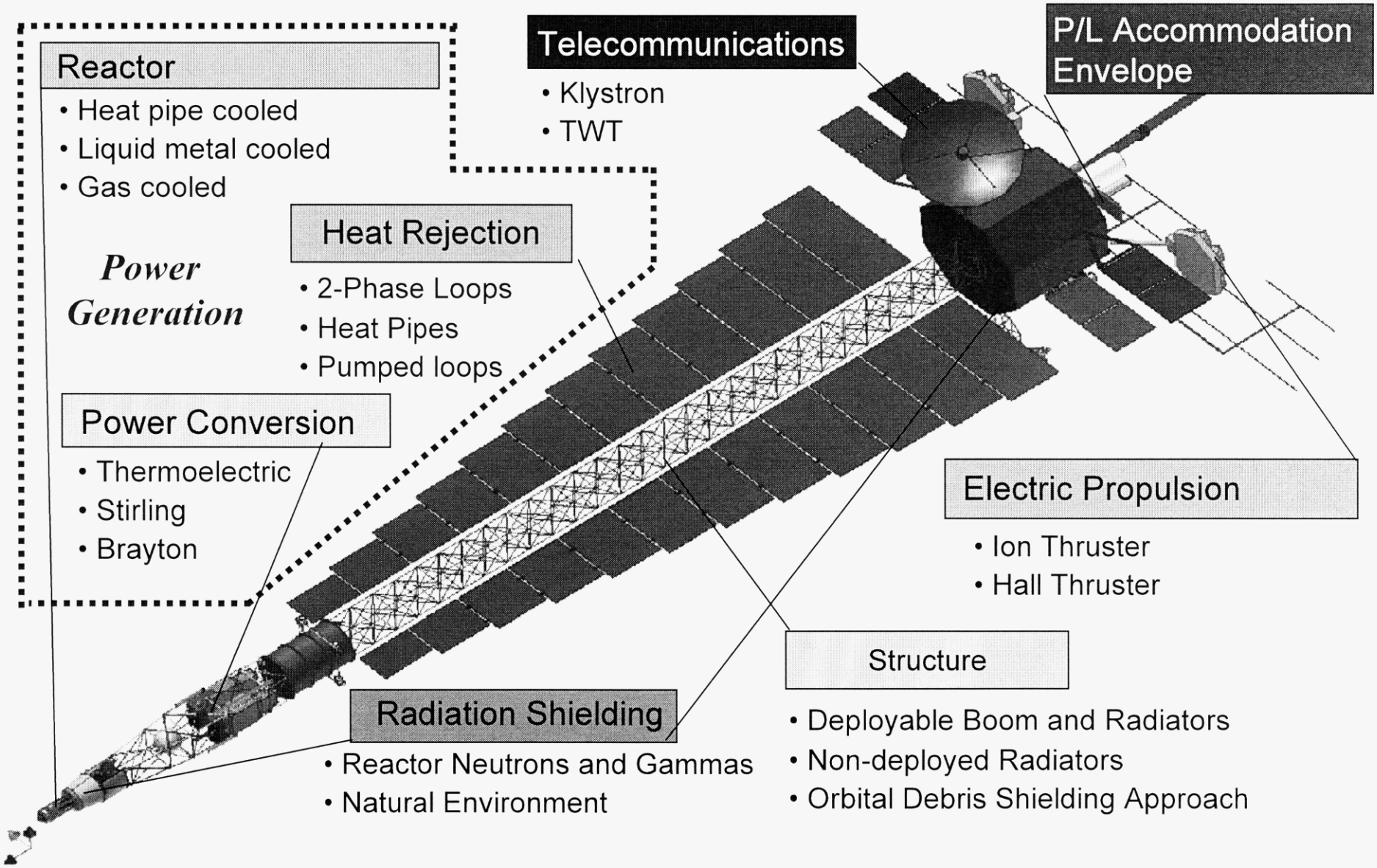
"Lenticulae" on ice surface of Jupiter's moon Europa





Jupiter Icy Moons Orbiter using 100kW fission reactor nuclear electric propulsion to conduct long-term reconnaissance

JIMO Concept

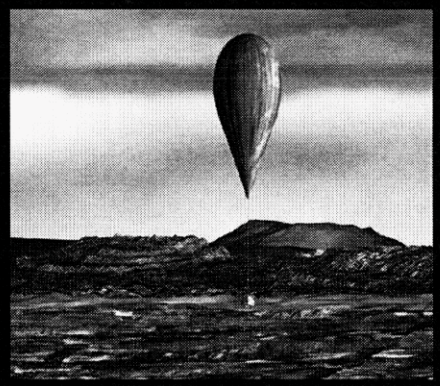


National Aeronautics and Space Administration

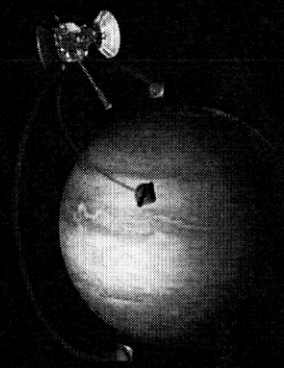
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

New Frontiers program plans and status

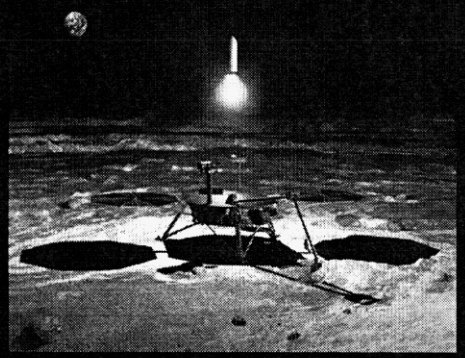
- **US National Research Council conducted decadal survey of solar system exploration:**
  - ***Identified five key exploration objectives for medium-size missions: New Frontiers program;***
  - ***New Horizon mission to explore Pluto/Kuiper Belt selected as first New Frontiers mission;***
  - ***NASA issued New Frontiers Announcement of Opportunity for remaining 4 objectives***
- **First launch by 6/2010:**



Venus *in situ*



Jupiter structure



Lunar sample return

Comet sample

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

EARTH SCIENCE

EARTH, OUR HOME (TERRA) FROM SPACE

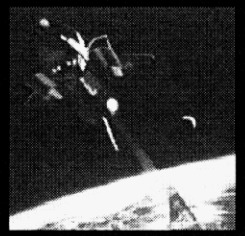
Image by: **Stockli**, Nelson, Hasler
Laboratory for Atmospheres
Goddard Space Flight Center
http://rsd.gsfc.nasa.gov/rsd

Hurricane Linda west of Mexico
September 9, 1997 17:45 UTC
Data from: NASA, NOAA, USGS

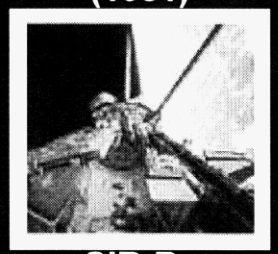
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

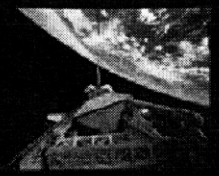
JPL Earth Science flight missions



SIR-A
(1981)

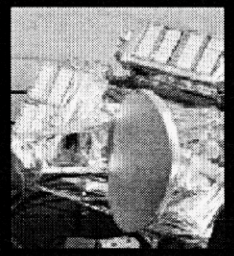


SIR-B
(1984)

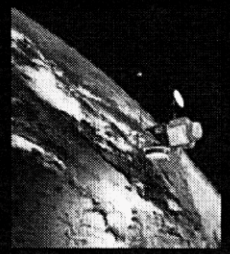


SIR-C
(1994)

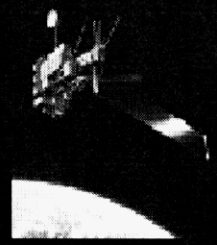
ATMOS
(1985)



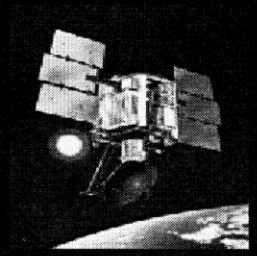
UARS MLS
(1991-Present)



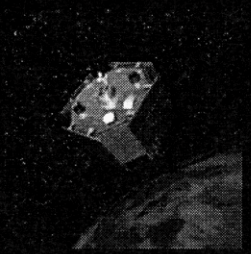
TOPEX / Poseidon
(1992-Present)



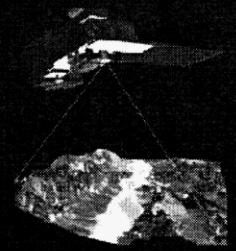
NSCAT
(1996)



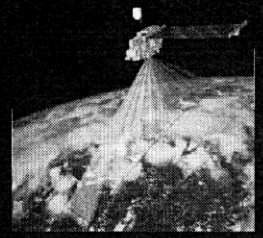
QuikSCAT
(1999-Present)



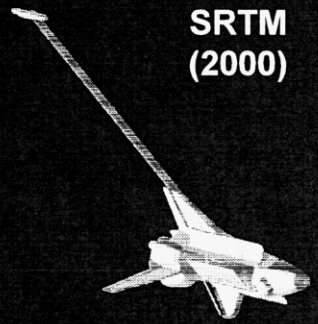
ACRIMSAT
(1999-Present)



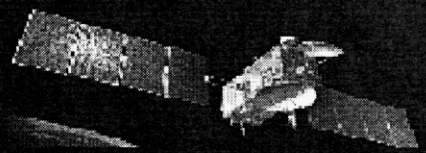
ASTER
(1999-Present)



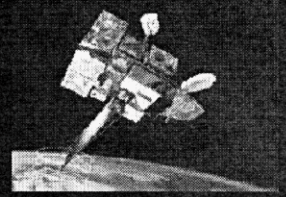
MISR on TERRA
(1999-Present)



SRTM
(2000)

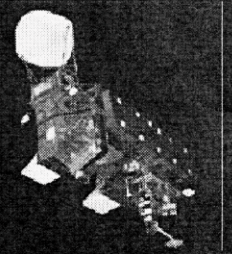


Jason-1
(2001-Present)



SeaWinds
on Midori-II
(2002)

GRACE
(2002-Present)

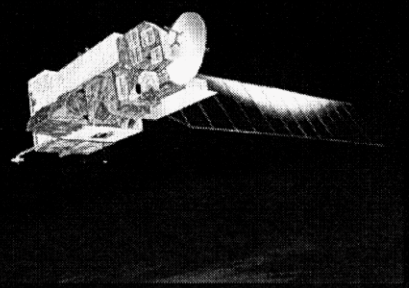


AIRS on AQUA
(2002-Present)

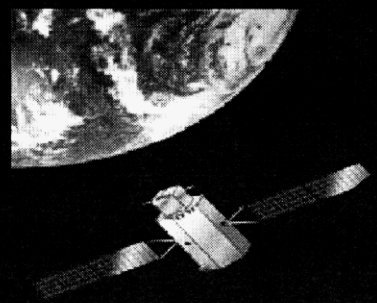
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

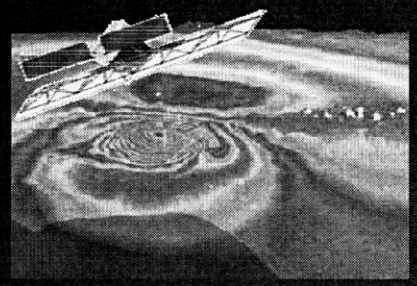
JPL Earth Science planned missions



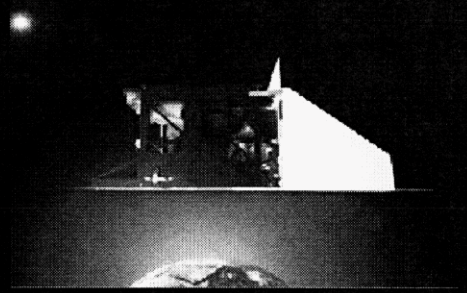
MLS
(2004)



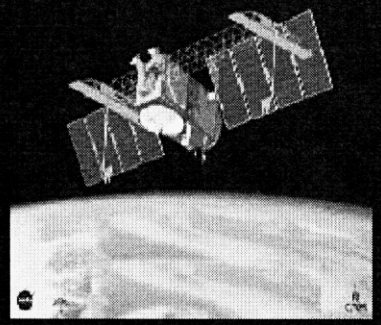
Carbon Cycle:
OCO
(2007)



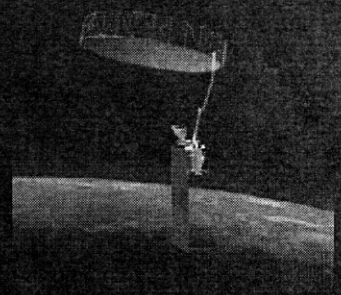
L-Band InSAR
(2010)



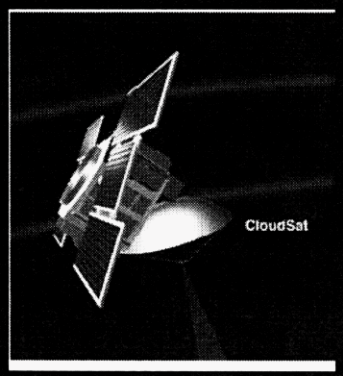
TES
(2004)



Ocean Surface
Topography
Mission
(2007)

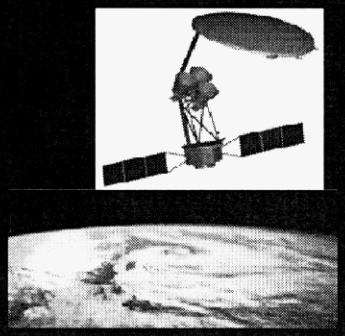


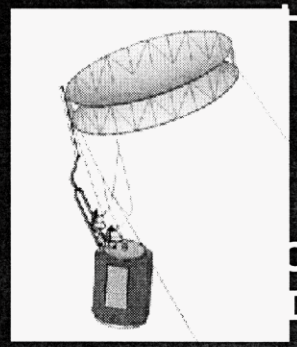
Soil Moisture &
Phase:
HYDROS
(2010)



CloudSat
(2005)

Sea Surface
Salinity:
Aquarius
(2008)

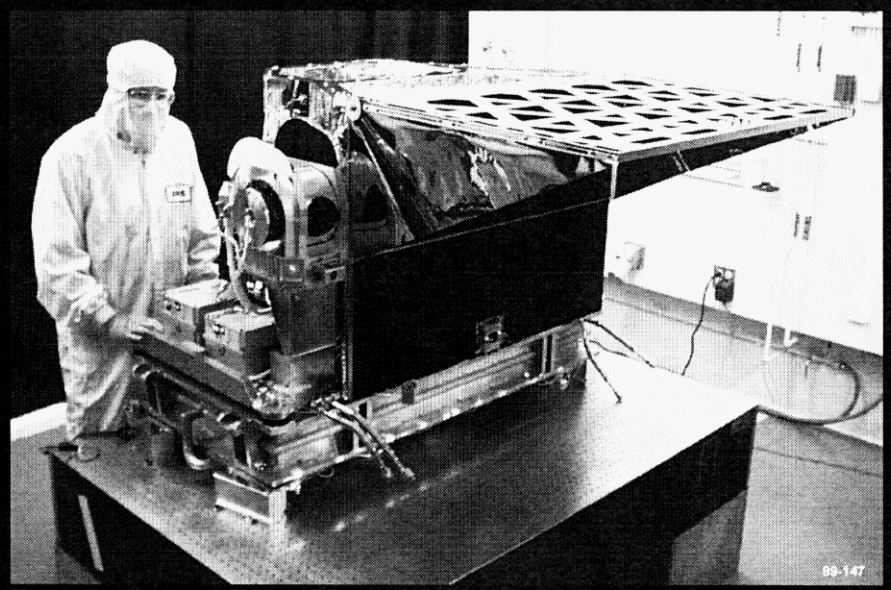




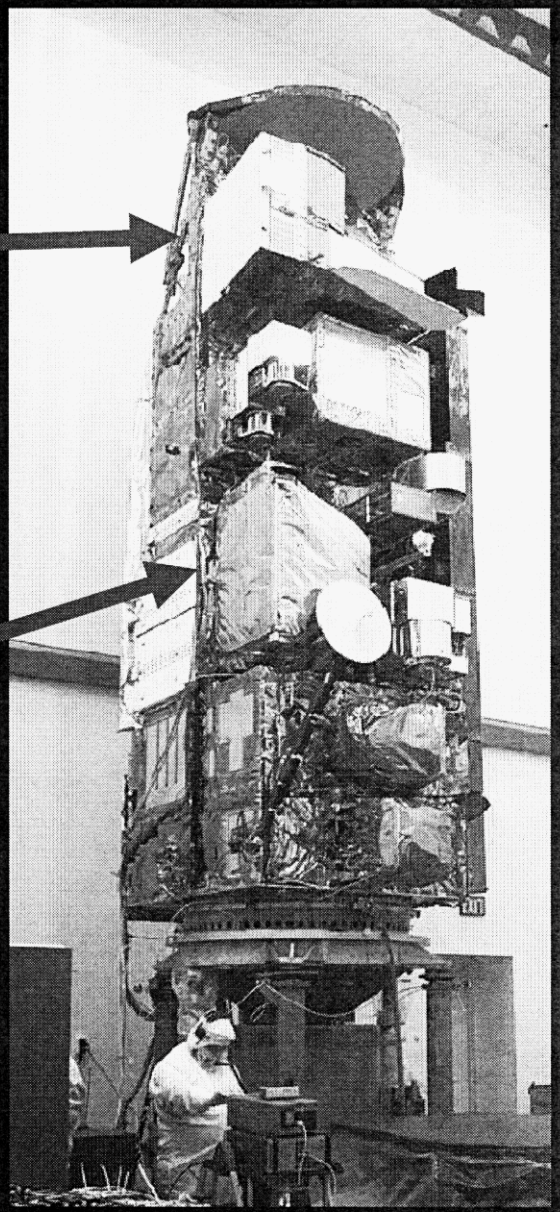
OScat
D)

NASA's AQUA SPACECRAFT

MODIS



AIRS

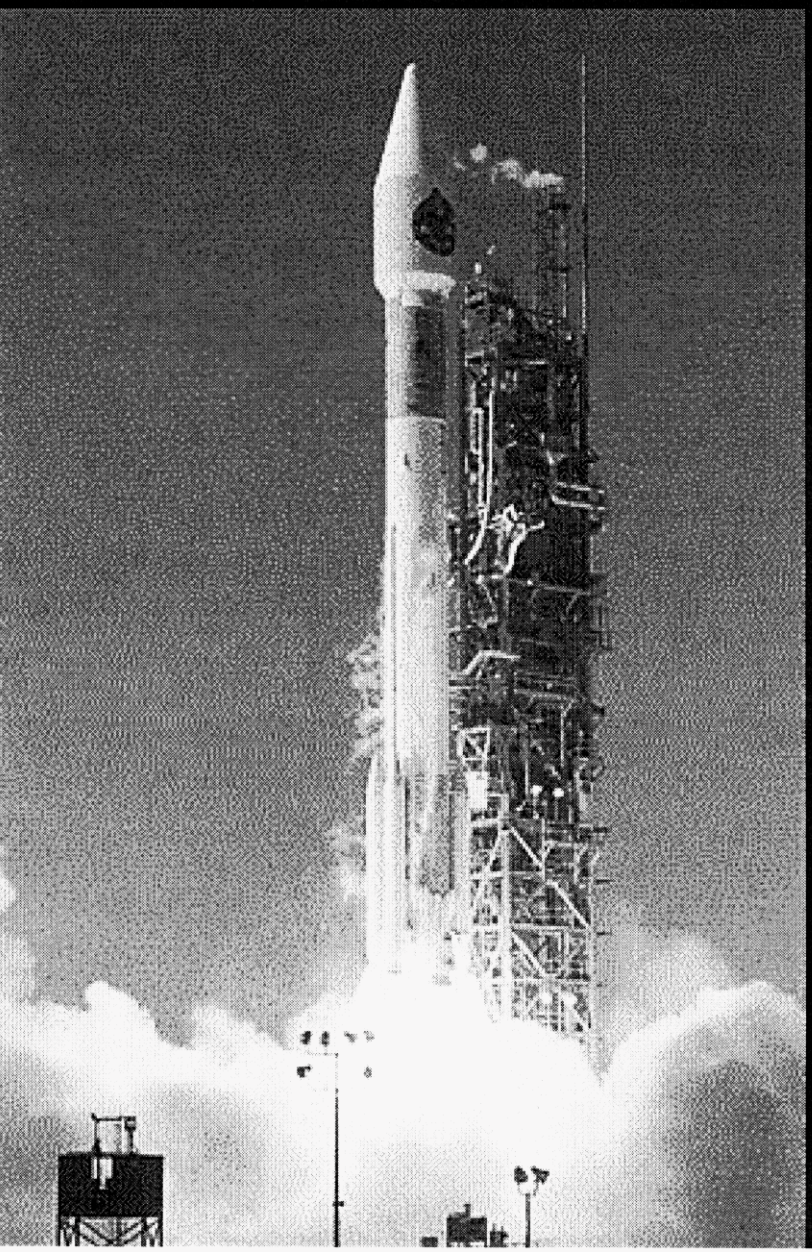


THE AQUA SPACECRAFT

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

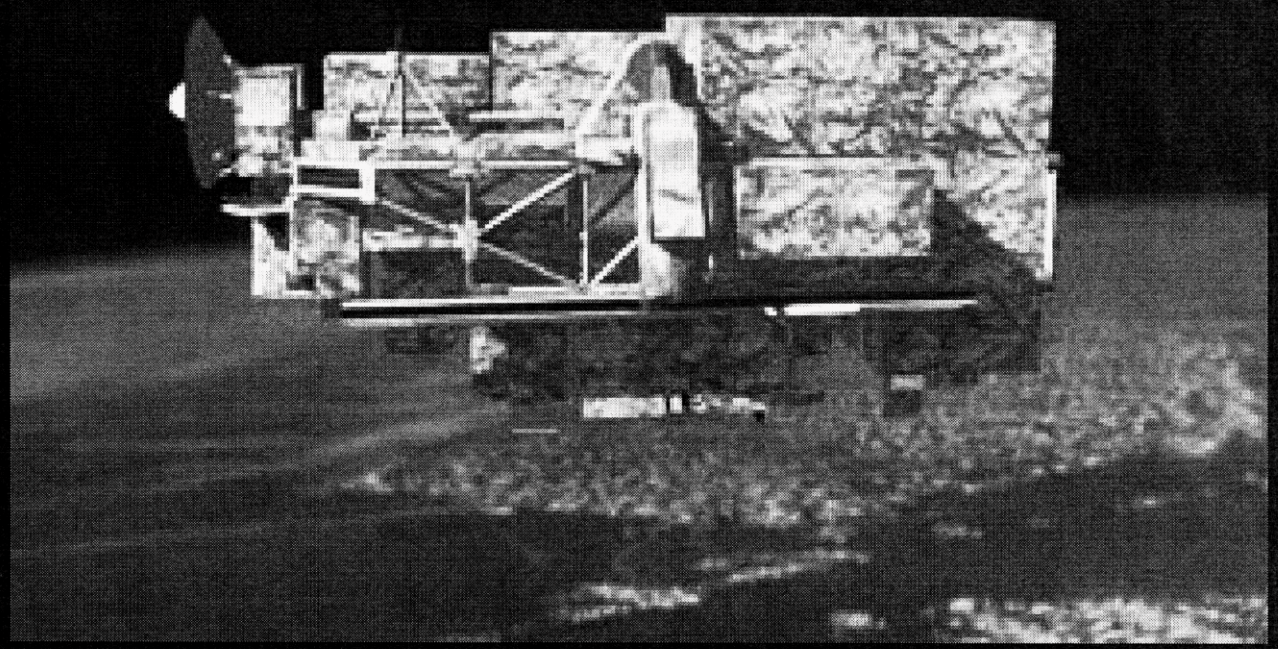
MODIS WAS LAUNCHED ON AN ATLAS ROCKET

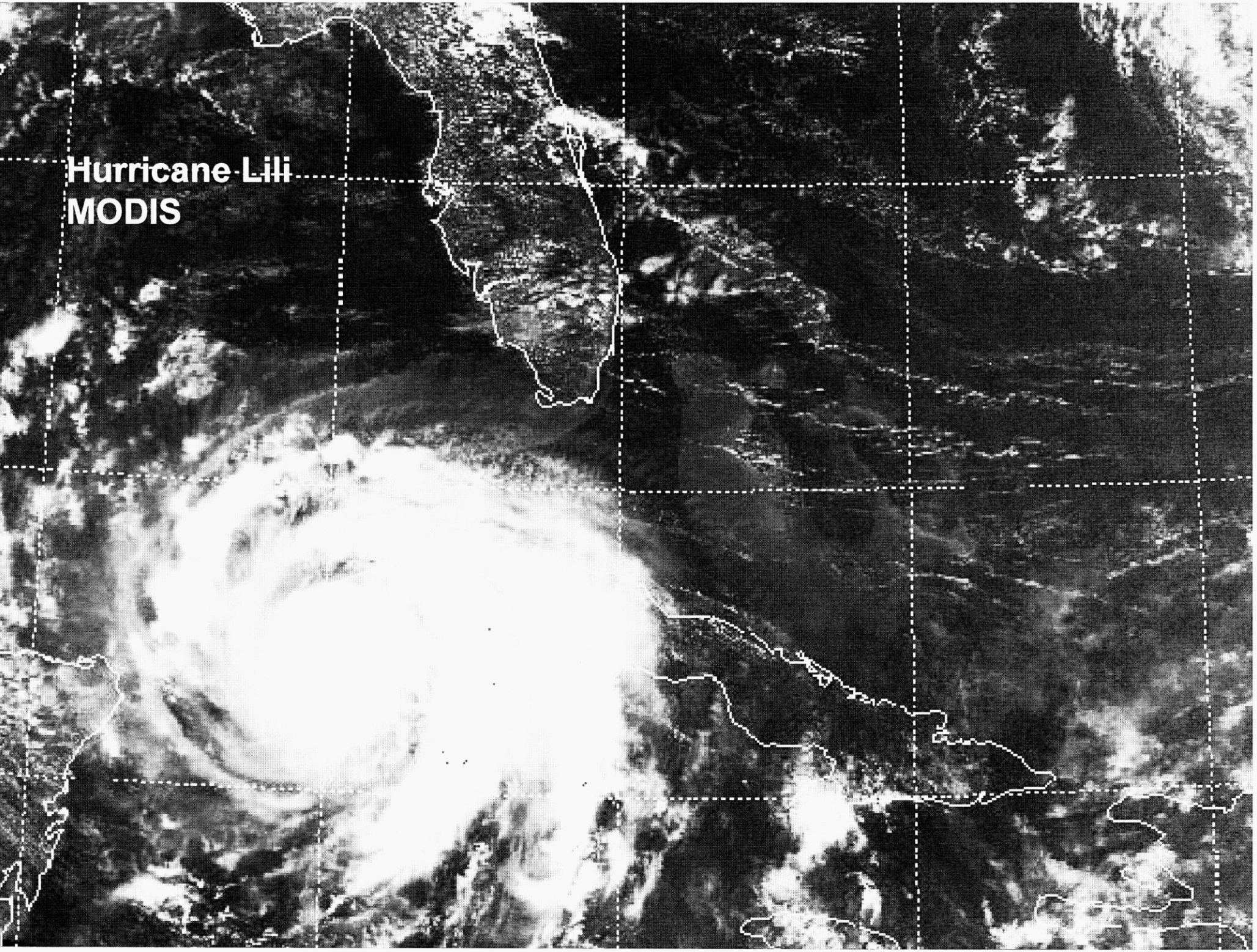


National Aeronautics and
Space Administration

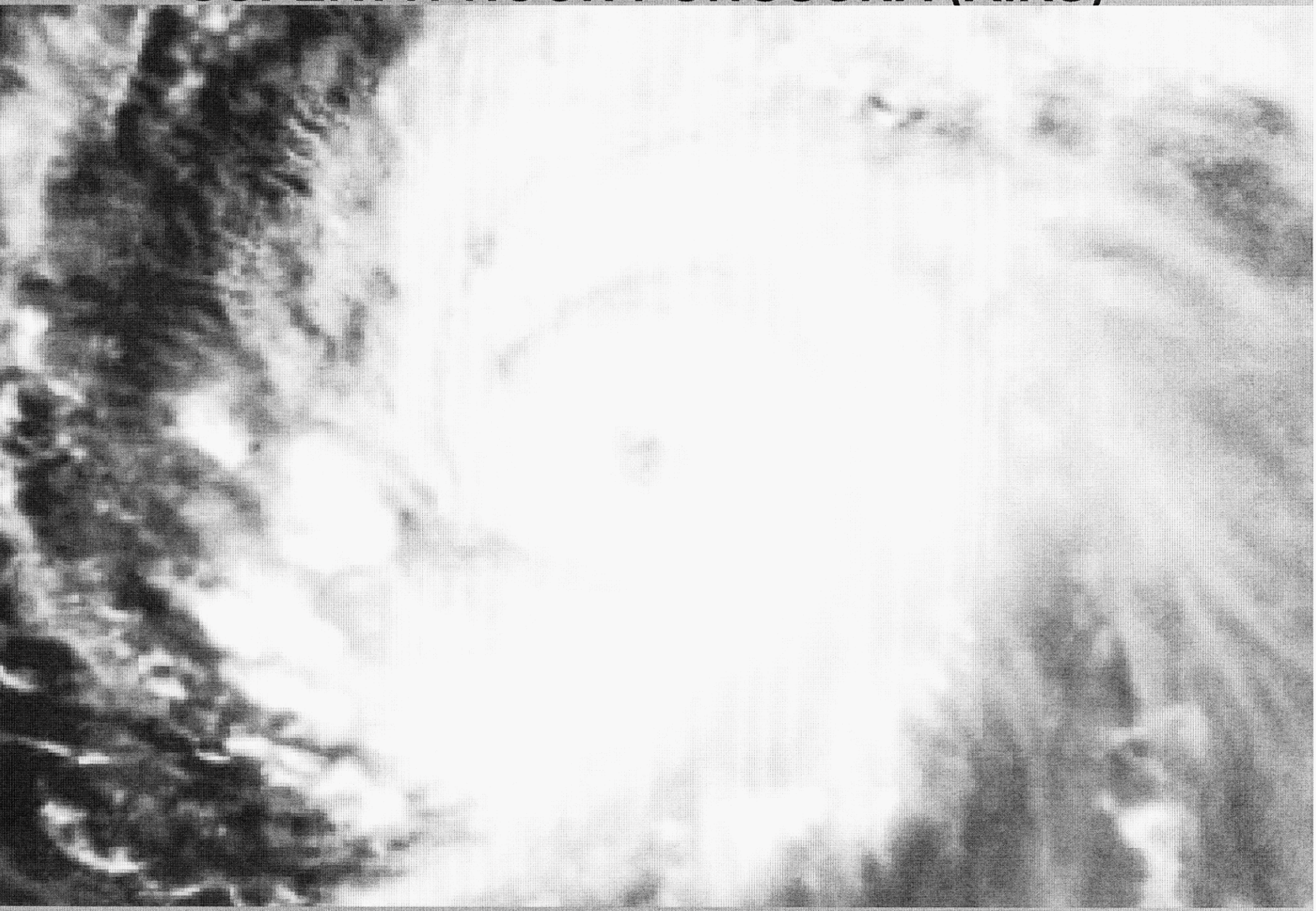
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

MODIS RIDES ON A BUS THE "TERRA" SATELITE




Hurricane Lili
MODIS

SUPERTYPHOON PONGSONA (AIRS)

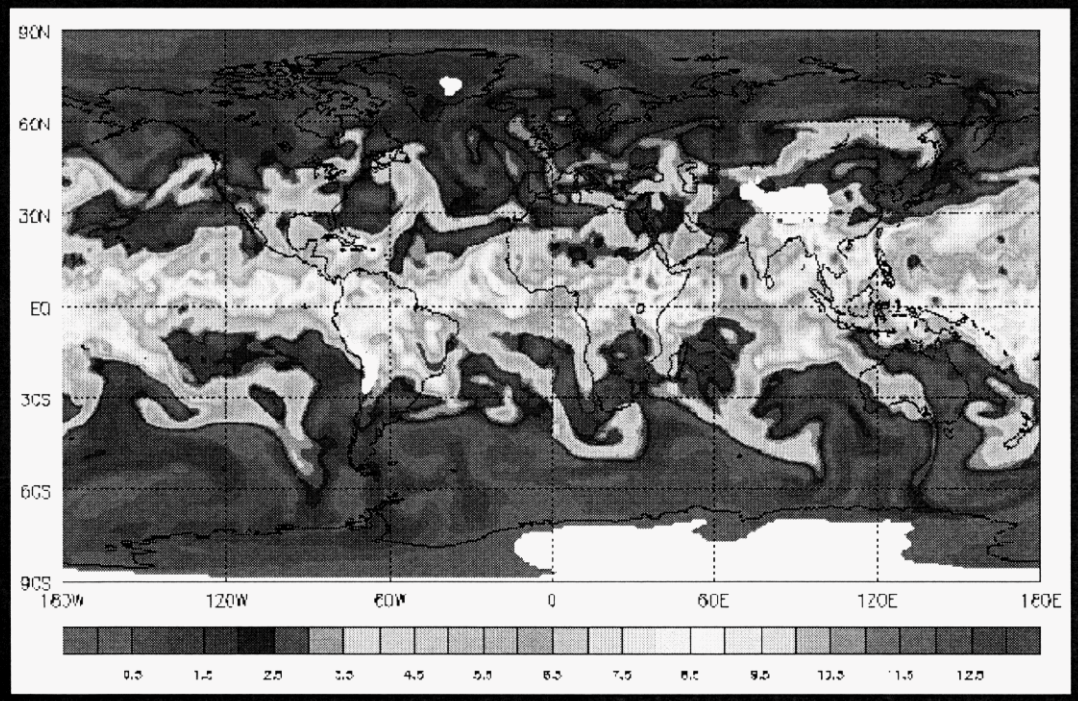


V. Realmuto, JPL

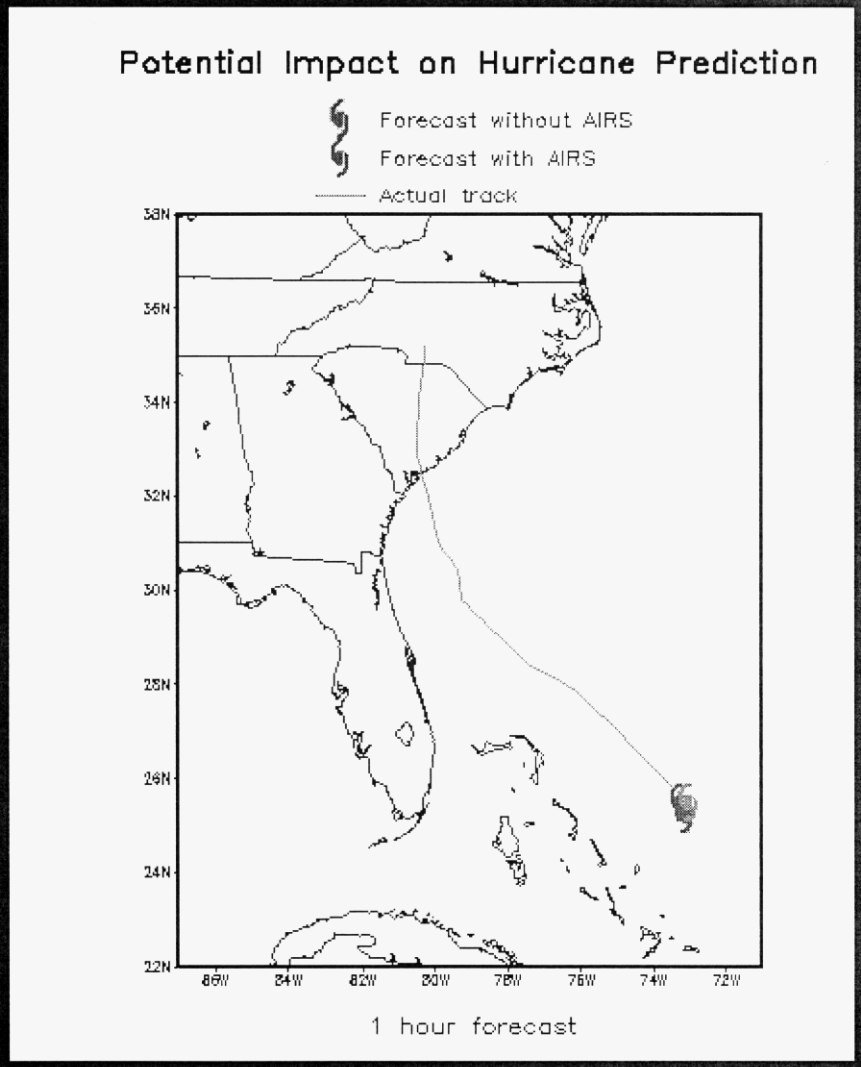
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

WEATHER PREDICTION INVOLVES COMPUTER MODELING



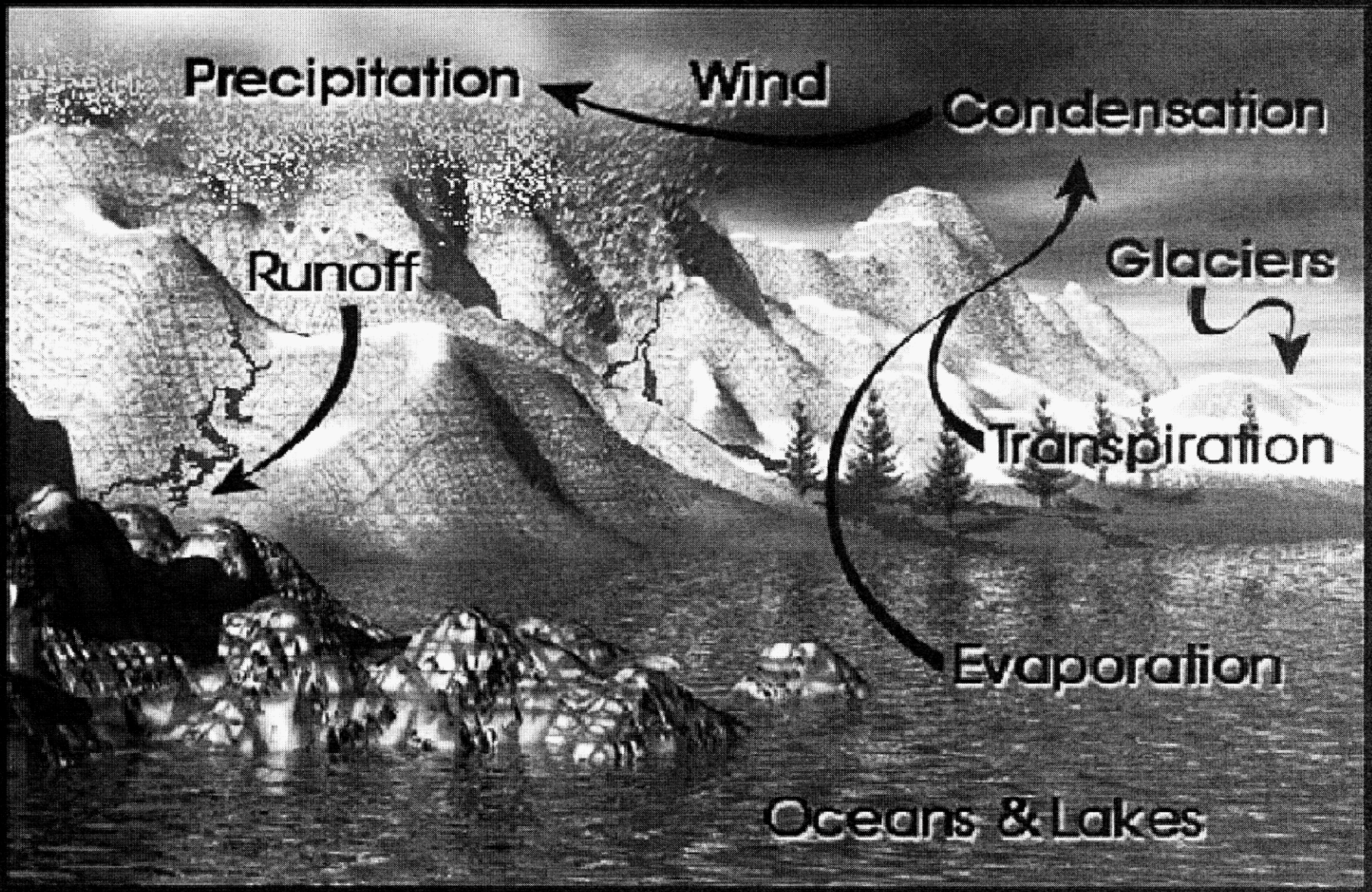
Modeled Water Vapor



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

THE WATER CYCLE



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

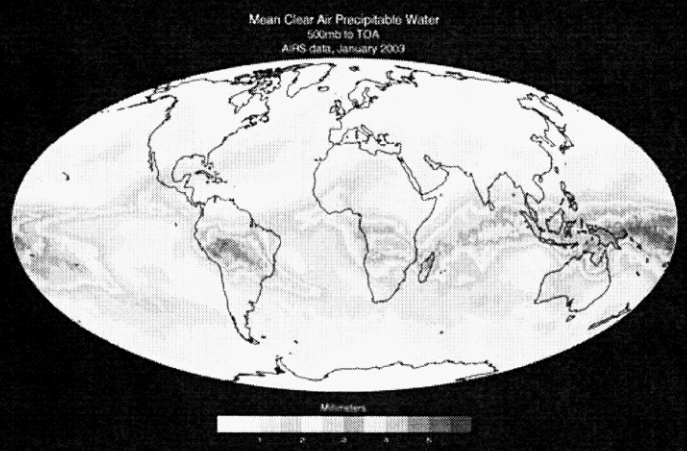
AIRS Mean Monthly Precipitable water Vapor

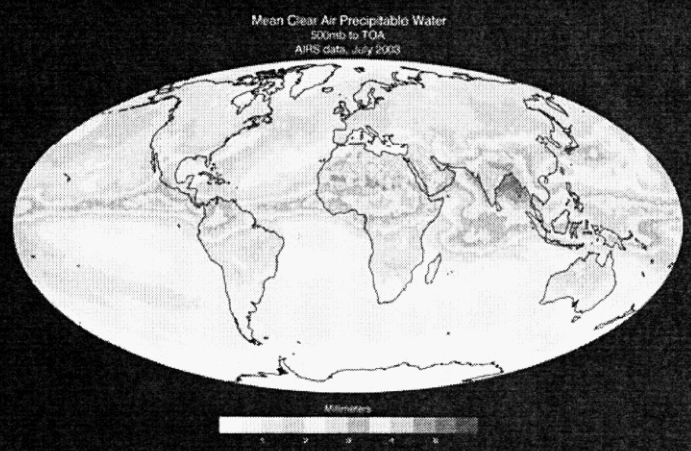
Atmospheric Infrared Sounder (AIRS)

January 2003

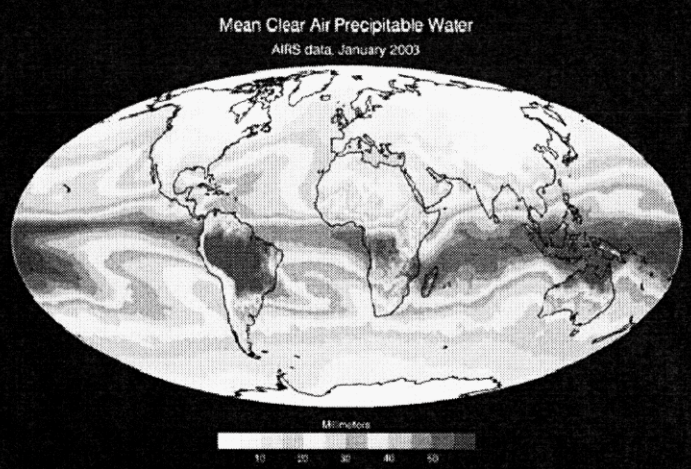
July 2003

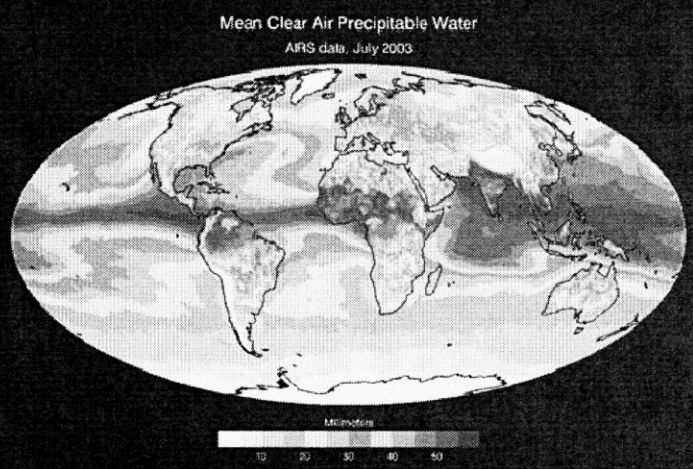
Water Vapor *Above 500 mb*





Water Vapor *Total*



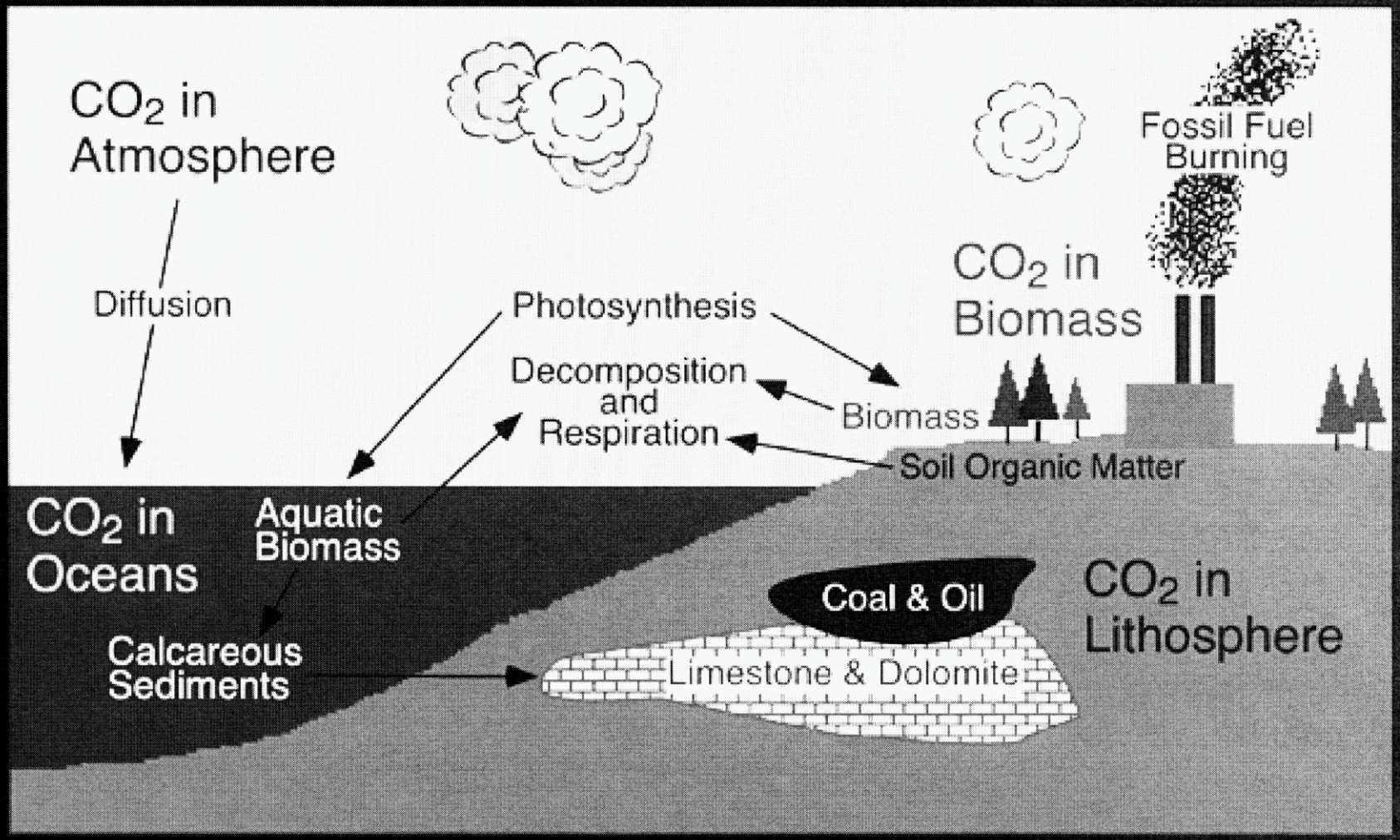


Is the <u>Ratio</u> of Upper Atmospheric Water vapor to the Total WV increasing or decreasing?

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

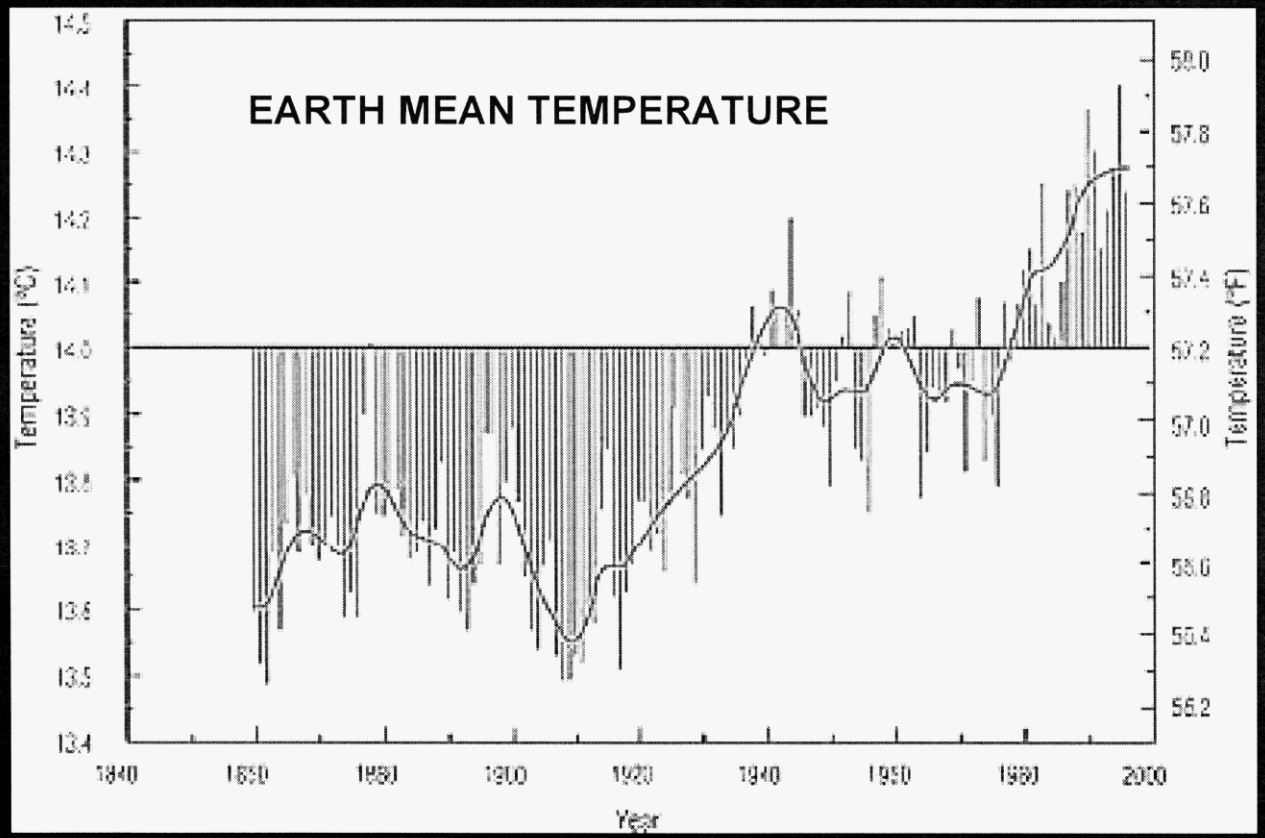
THE CARBON CYCLE

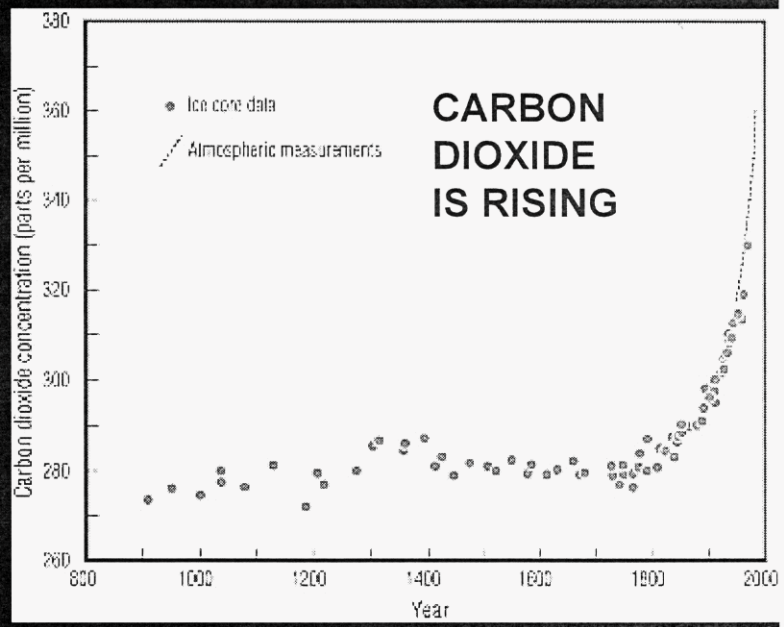


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

THE EARTH IS GETTING WARMER





www.grcio.org

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

GLOBAL WARMING?

National Aeronautics and
Space Administration

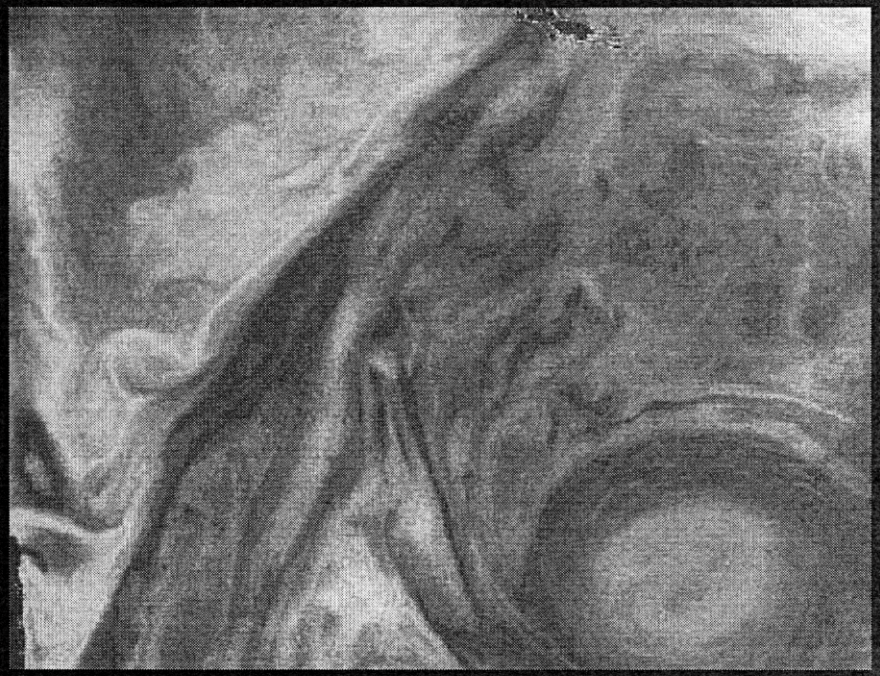
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

GLOBAL WARMING LEADS TO SEVERE WEATHER

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

MODIS MEASURES LAND AND OCEAN PLANT LIFE



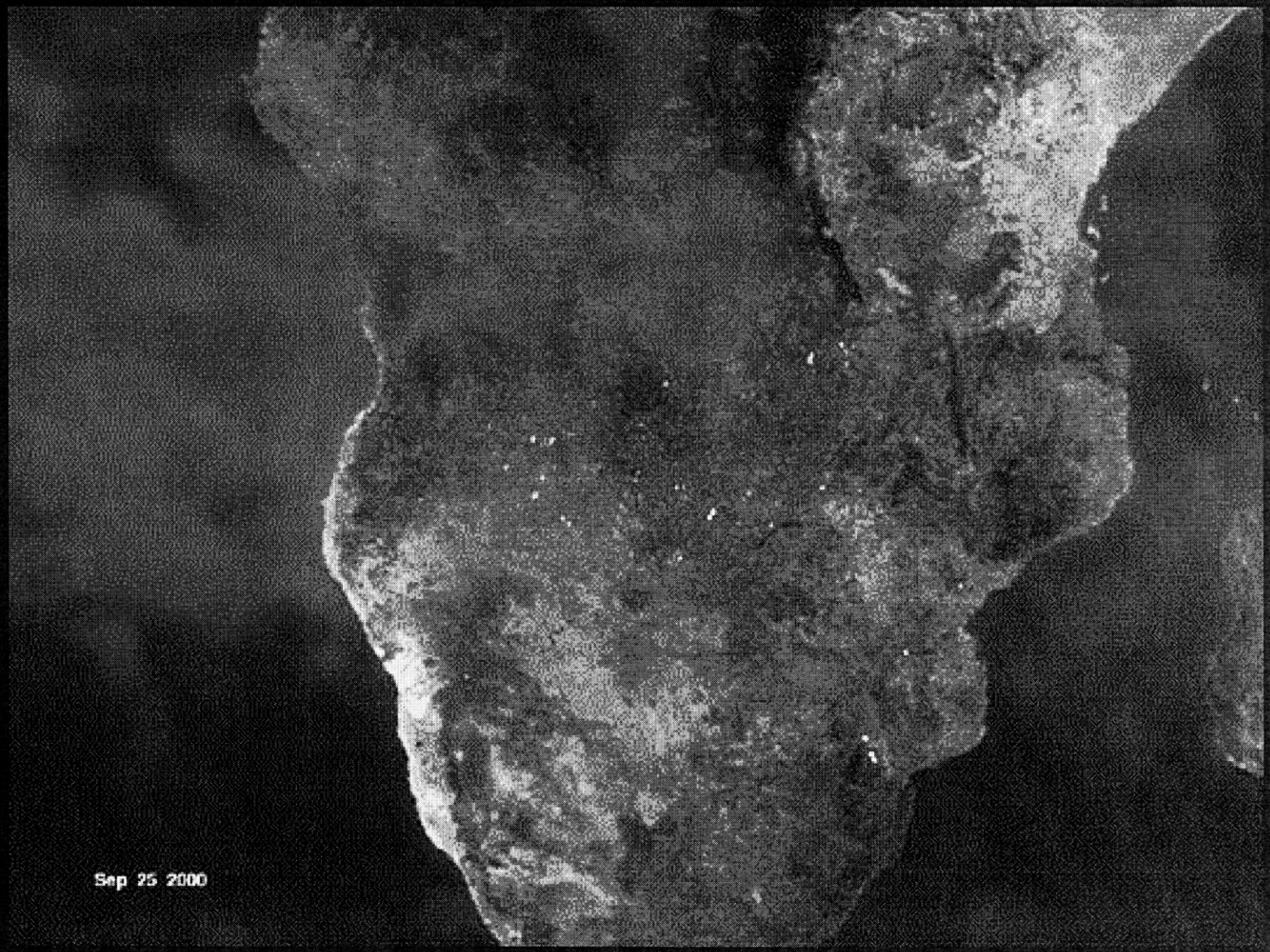
Ocean Color

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

BURNING FORESTS CONTRIBUTES TO GLOBAL WARMING

MODIS



National Aeronautics and
Space Administration

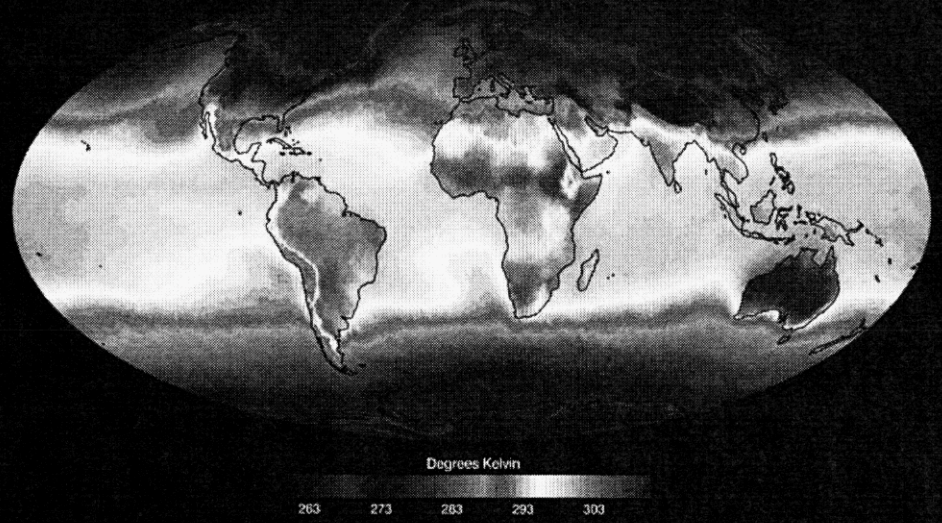
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

MONTHLY SURFACE AIR TEMPERATURE

Atmospheric Infrared Sounder (AIRS)

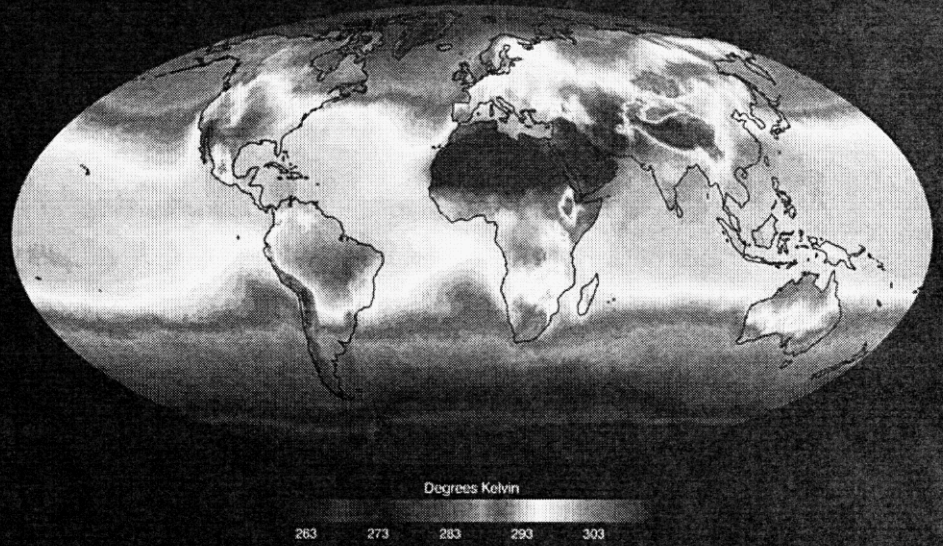
January

Mean Surface Air Temperature
AIRS data, January 2003



July

Mean Surface Air Temperature
AIRS data, July 2003



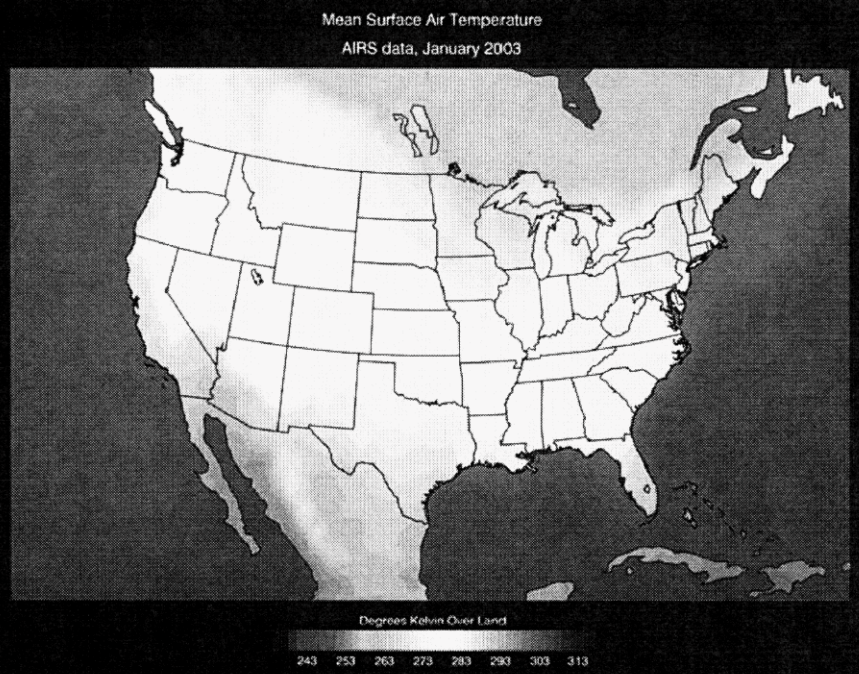
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

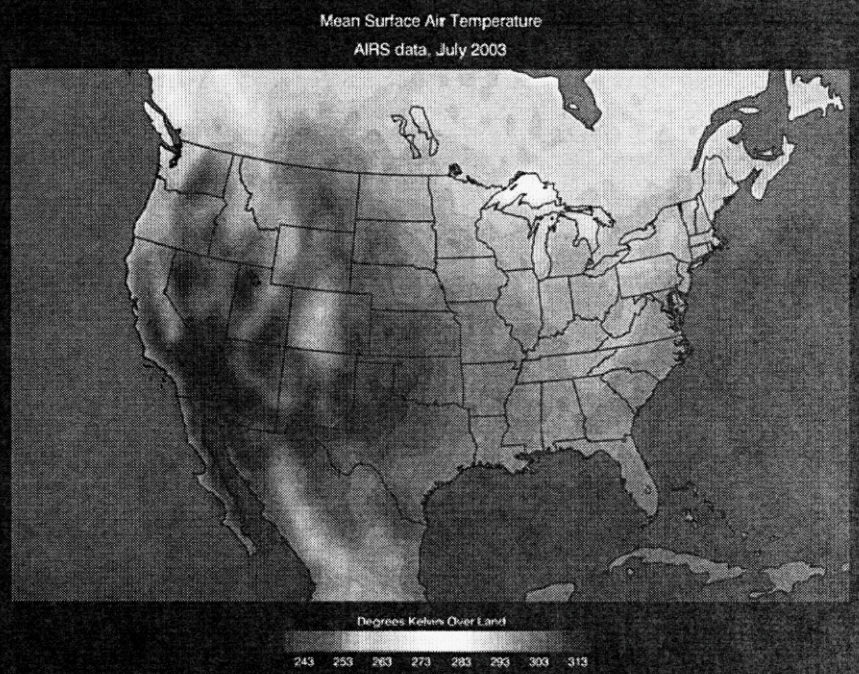
MONTHLY CONUS SURFACE AIR TEMPERATURES

Atmospheric Infrared Sounder (AIRS)

January



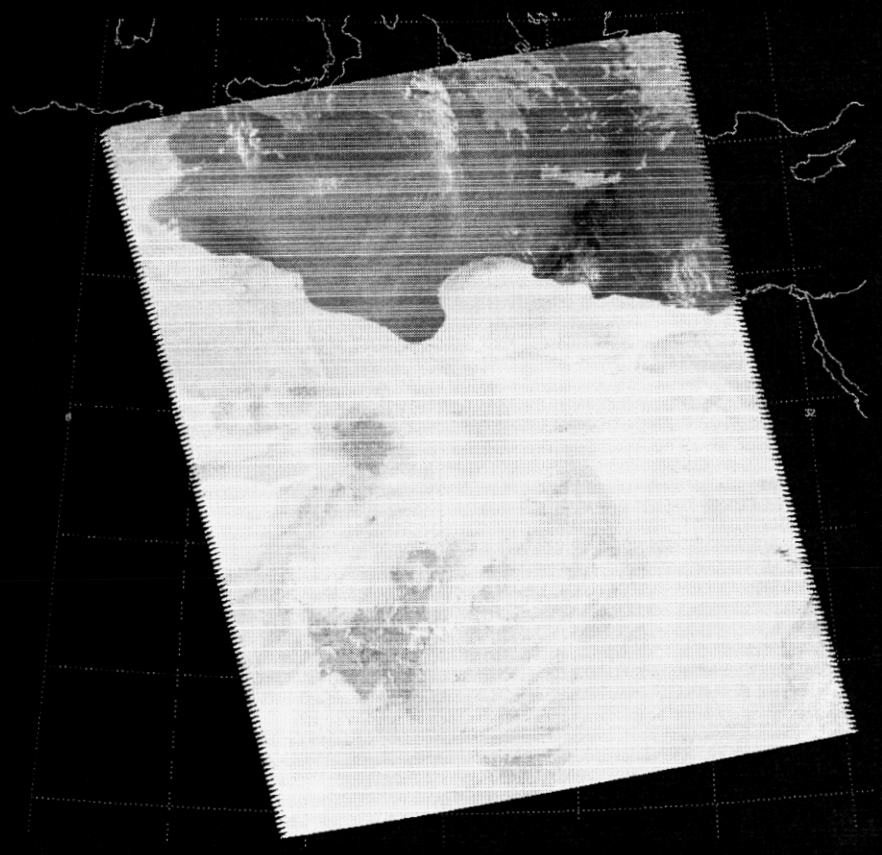
July

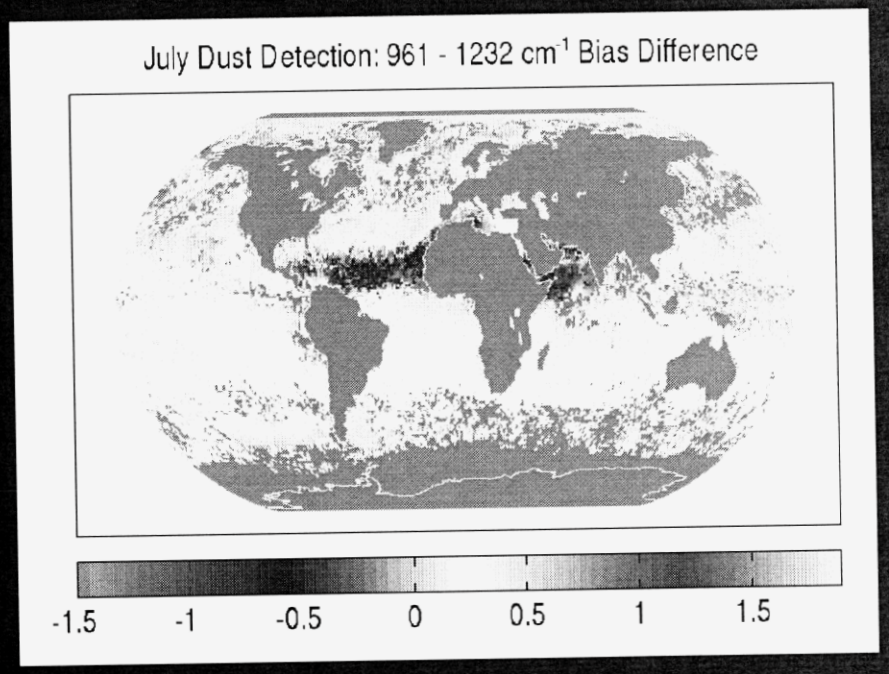


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

SAHARAN DUST TRAVELS ACROSS PACIFIC OCEAN

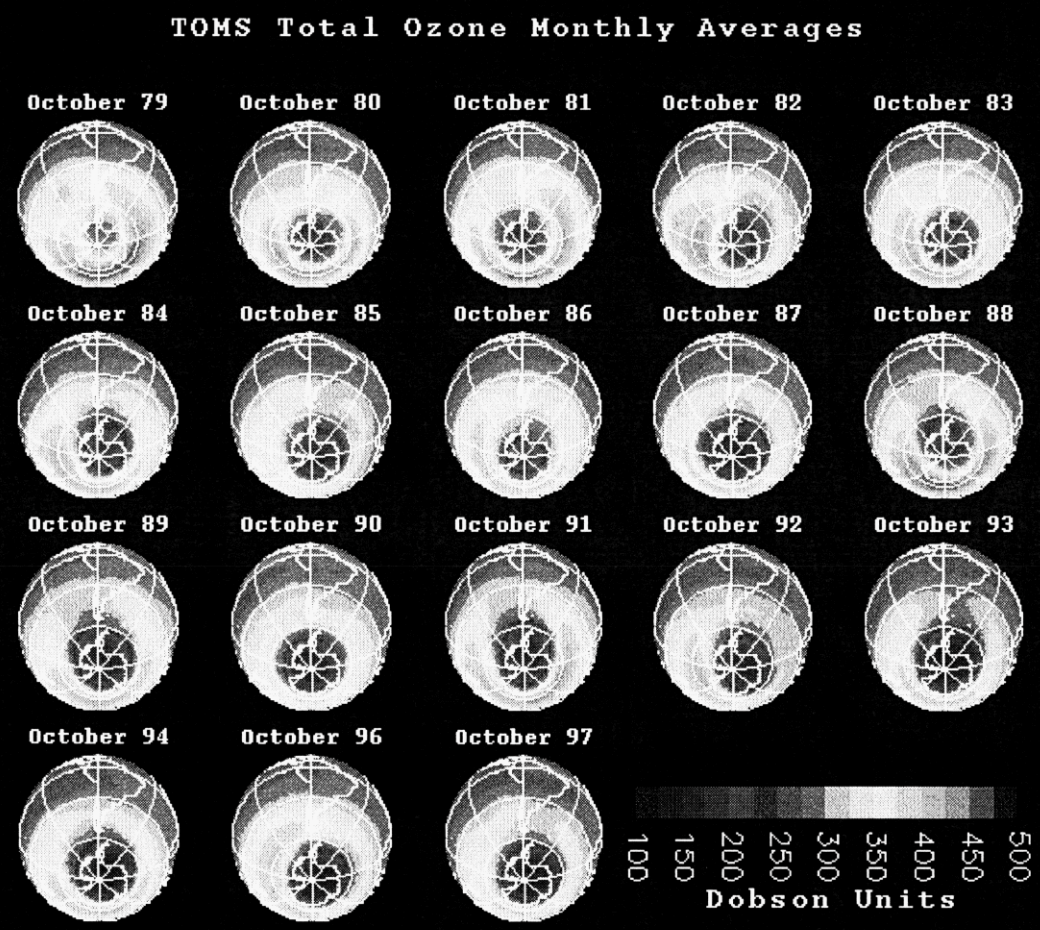


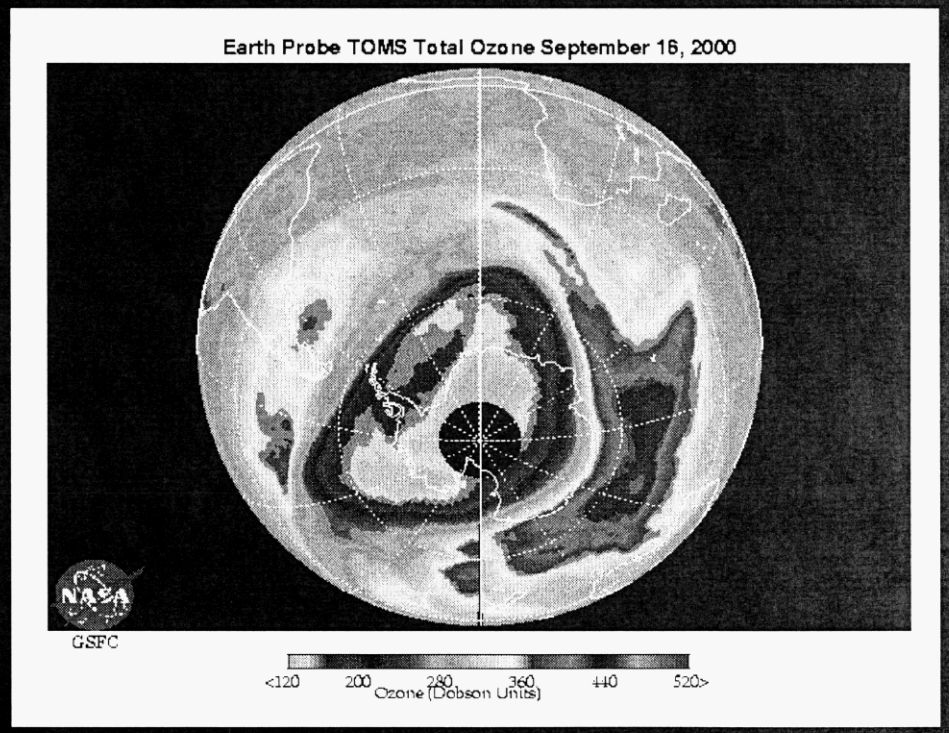


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

THE OZONE HOLE IS NOT GROWING ANYMORE





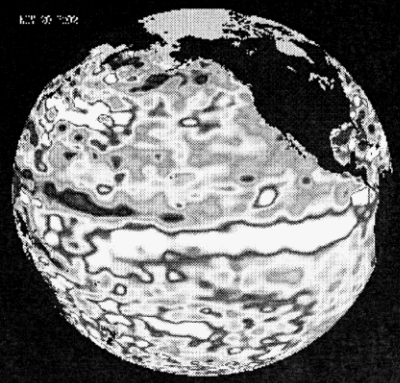
WEAR SUNSCREEN THIS SUMMER

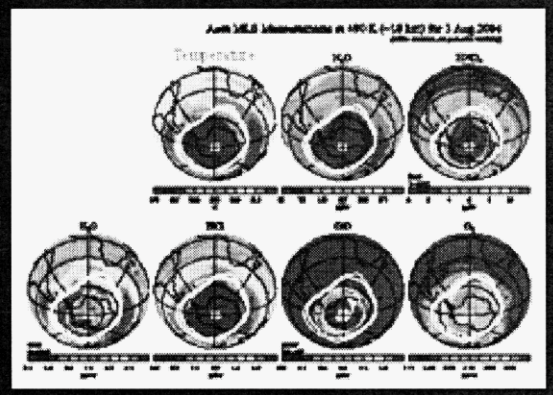
National Aeronautics and
Space Administration

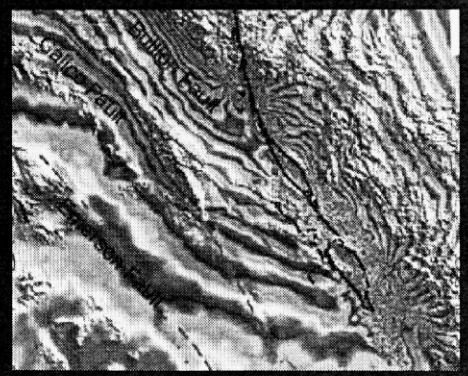
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Other JPL Earth Science Missions

- Ocean studies from Topex/Poseidon and Jason 1
- Atmospheric ozone studies from Microwave Limb Sounder (MLS) on NASA Aura spacecraft (launched July 2004)
- Solid Earth studies using interferometric synthetic aperture radar







National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

WHAT CAN YOU DO TO STOP GLOBAL WARMING?

- **Save Energy (Electricity)**
  - ***Turn off the lights when not in use***
  - ***Turn down the heater and air conditioner***
  - ***Close the fridge door quickly***
  - ***Carpool or take public transportation***
- **Save trees. Plant trees. They absorb carbon**
  - ***Recycle Paper***
- **Recycle Cans and Bottles**
  - ***Save electricity used to make them***

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

NASA NEEDS YOUNG ENGINEERS AND SCIENTISTS

- **THOUSANDS OF PEOPLE WORK WITH NASA AND THEIR SUBCONTRACTORS**
- **WE NEED YOU!**
  - ***Have fun with science***
  - ***Study Mathematics***
  - ***Learn how to use a computer***
  - ***Learn how to program a computer***
  - ***Learn how to type well***
  - ***Learn how to write well and speak well in front of people***
  - ***Be inventive and creative***
- **Advanced (College) degrees in the sciences are a big plus!**