



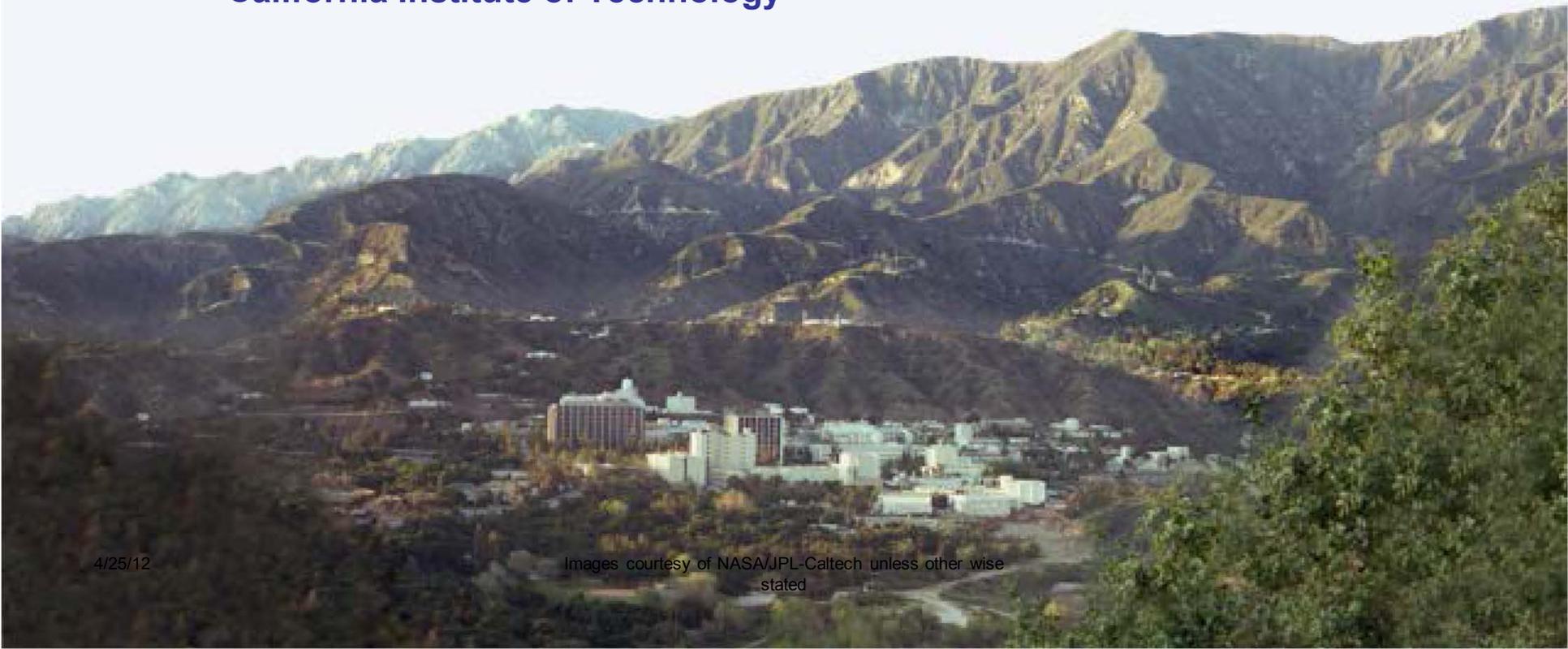
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

JPL – Bringing Wonder to the World

April 25, 2012

Karla Clark
NASA Jet Propulsion Laboratory
California Institute of Technology

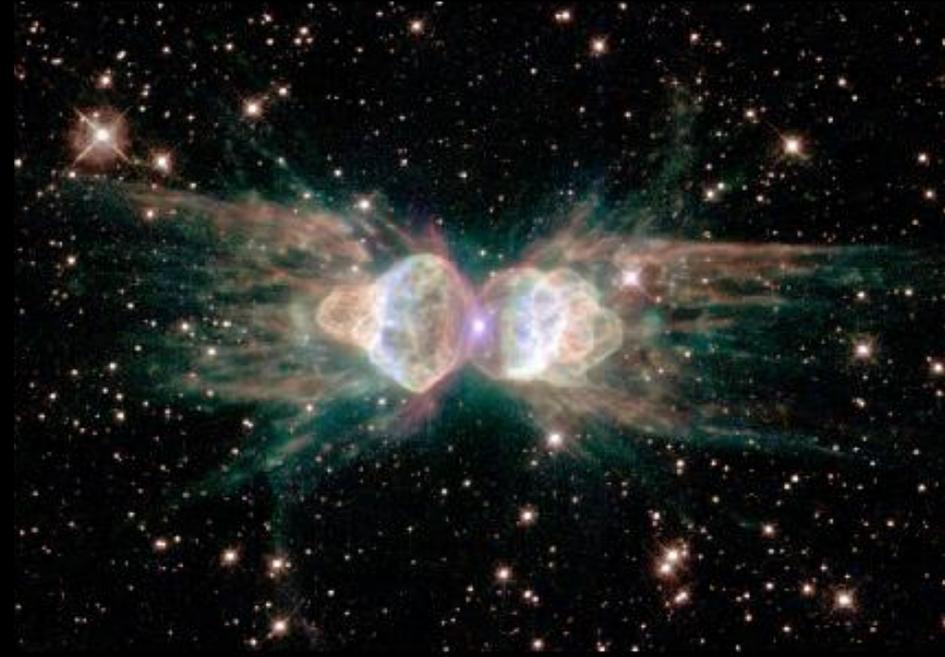
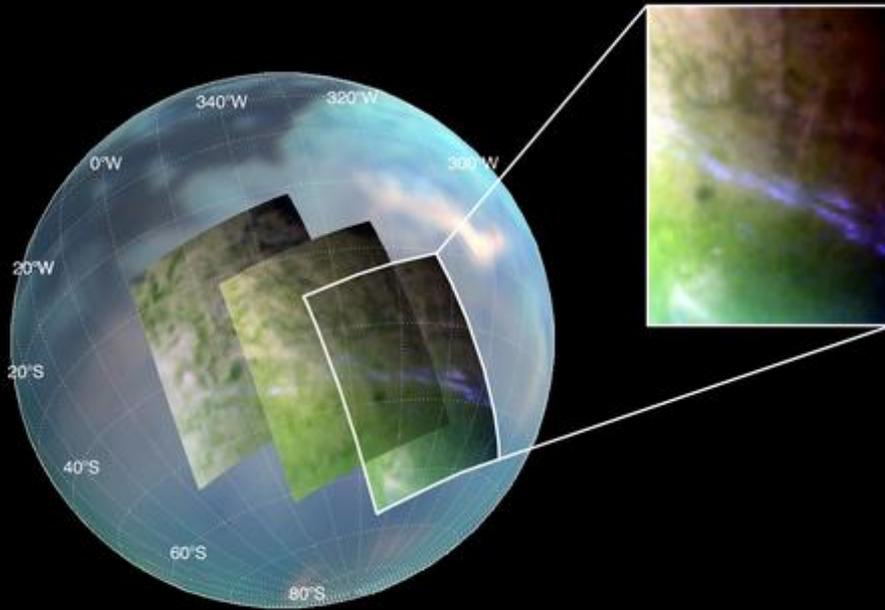




National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

JPL – Across the Universe

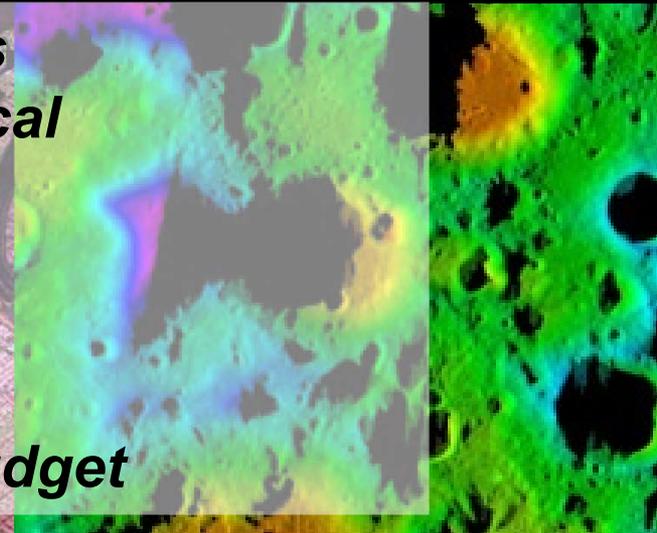


4/25/12

Images courtesy of NASA/JPL-
Caltech unless other wise stated

~5000 Employees
~4000 technical
~30% BS/BA
~35% MS
~35% PhD

~\$1.5B annual budget



JPL Mission Statement

As part of the NASA team, JPL enables the nation to explore space for the benefit of humankind by developing robotic space missions to:

Explore our own and neighboring planetary systems.

Search for life beyond the Earth's confines.

Further our understanding of the origins and evolution of the universe and the laws that govern it.

Make critical measurements to understand our home planet and help protect its environment.

Enable a virtual presence throughout the solar system using the Deep Space Network and evolving it to the Interplanetary Network of the future.

Apply JPL's unique skills to address problems of national significance.

Inspire the next generation of explorers.





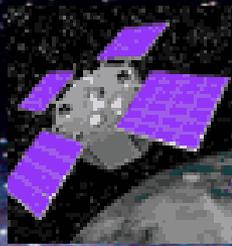
National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Over twenty spacecraft and ten instruments across the solar system (and beyond).



Spitzer



ACRIMSAT



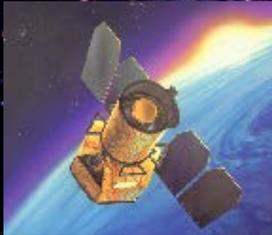
Mars Odyssey



Cassini



GRACE



GALEX



Dawn



Mars Science Laboratory

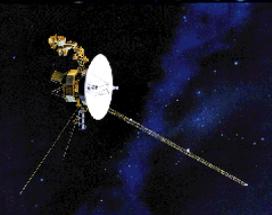


Stardust-NEXT

CloudSat



GRAIL



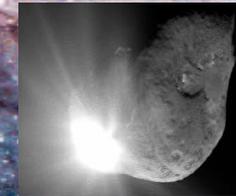
Two Voyagers



Wide Field Planetary Camera 2



Opportunity



Deep Impact-Epoxi



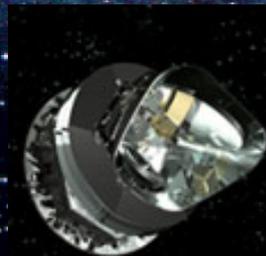
Kepler



Juno



Mars Reconnaissance Orbiter



ESA Herschel/Planck with JPL instruments



QuikSCAT



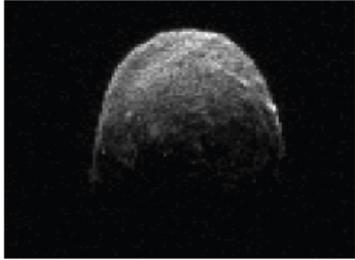
Jason 1 and Jason 2

(Plus ASTER, MISR, TES, MLS, AIRS, M³, and MIRO instruments)

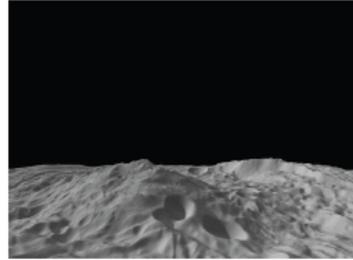
Images courtesy of NASA/JPL-Caltech unless otherwise stated



A Few Recent Science Highlights



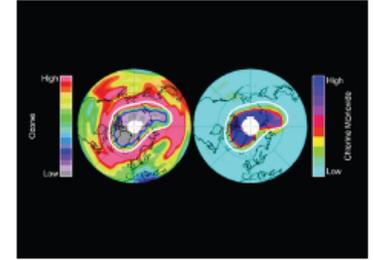
DSN captures new images of the largest asteroid passing Earth



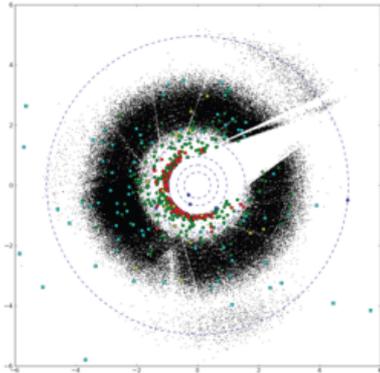
Dawn Image shows oblique view of Vesta's South polar region



Herschel finds oceans of water in disk of nearby star



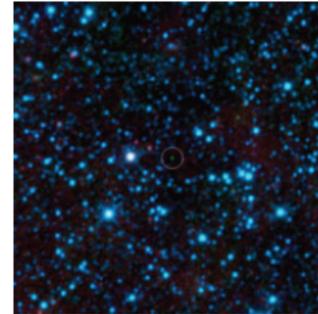
The MLS observed the first ever Arctic ozone hole



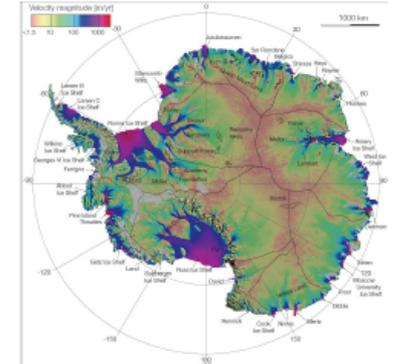
NEOWISE discovered significant numbers of Near Earth Objects



Cassini Chronicles Life of Saturn's Giant Storm



WISE discovers the first-ever Y-class Brown Dwarf



Research Leads to First Complete Map of Antarctic Ice Flows



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Deep Space Network – Connecting Us to Space



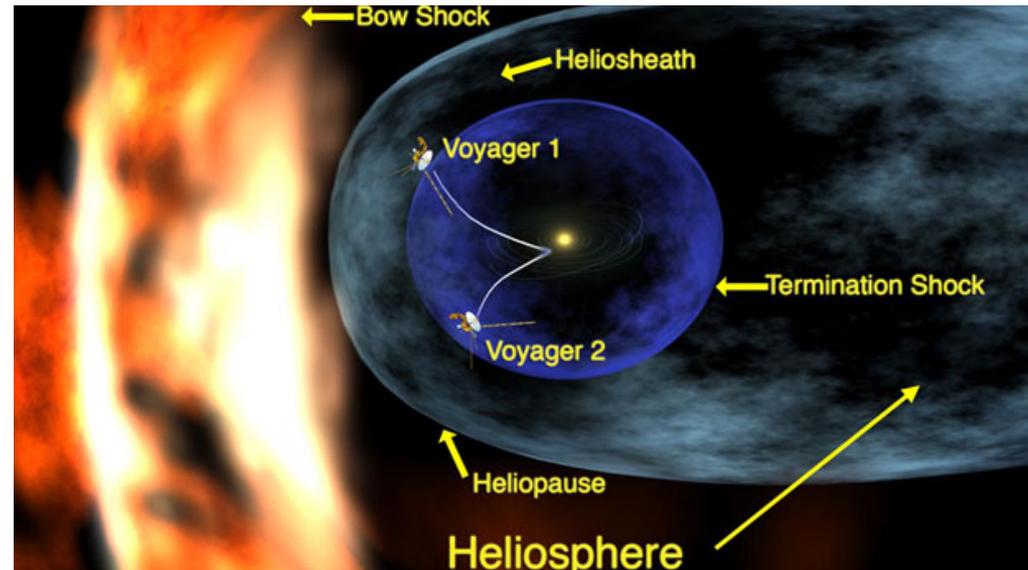


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

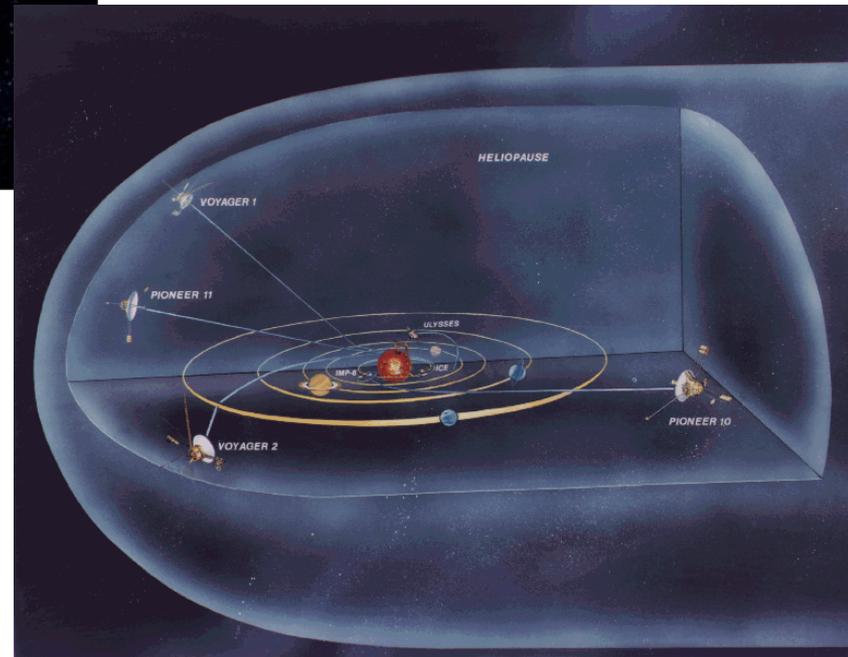
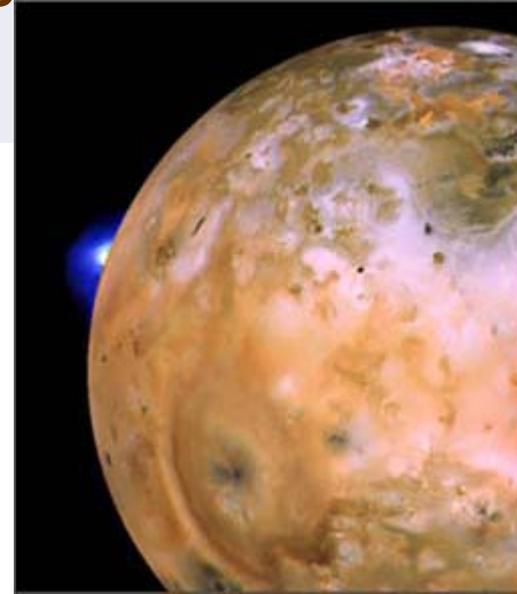
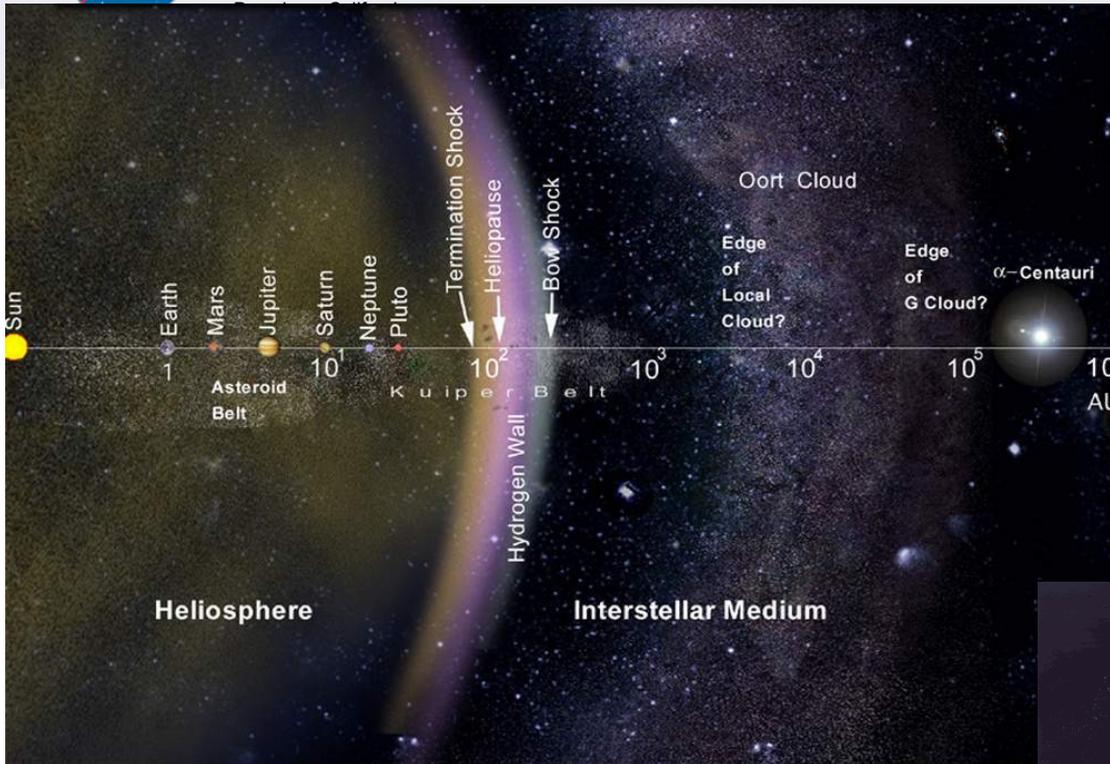
Voyager Mission

- **Two spacecraft, launched in 1977 to explore Jupiter and Saturn**
 - Five year lifetime requirement
- **Now in their 35th year**
- **Voyager 1 and 2 are now in the "Heliosheath" - the outermost layer of the heliosphere where the solar wind is slowed by the pressure of interstellar gas.**
- **Voyager Interstellar Mission (VIM): to extend the NASA exploration of the solar system beyond the neighborhood of the outer planets to the outer limits of the Sun's sphere of influence, and possibly beyond.**
- **Operations challenges:**
 - Legacy ground system
 - Dated flight system with few people with intimate knowledge
 - Long round trip light-time (33+ hours for Voyager 1, 27+ hours for Voyager 2)





Voyager Science Highlights



- **Rewrote the planetary science and astrophysics books**
 - observed nine erupting volcanoes on Io: first evidence in the solar system of active volcanism on a body other than Earth
 - Discovered moons, rings, magnetic fields, atmospheres, storms etc of Jupiter, Saturn, Uranus and Neptune
 - Found first direct evidence of the heliopause
 - Provided estimate for the location of the termination shock

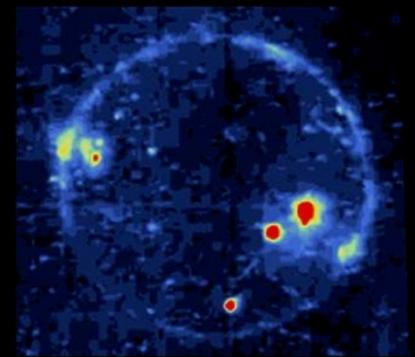
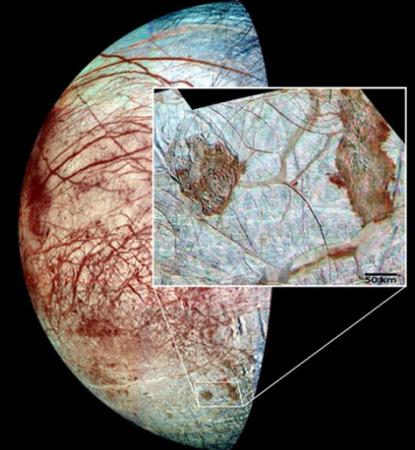
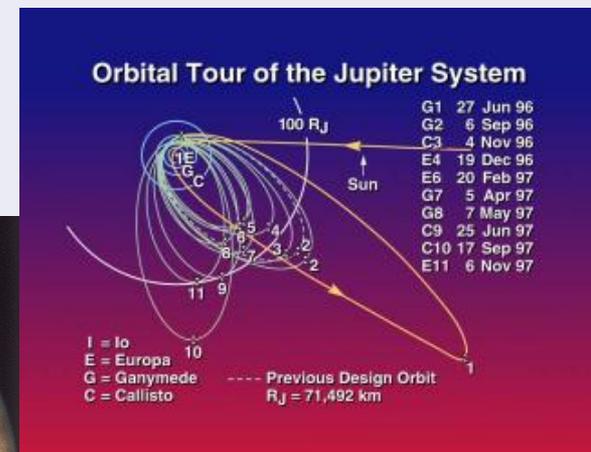
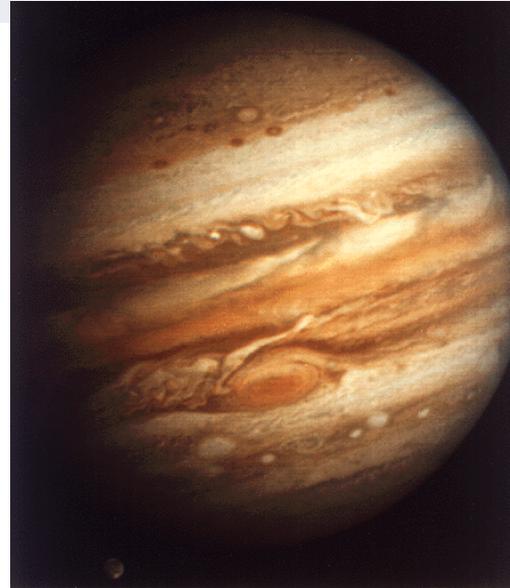


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Galileo Mission

- **Explore the Jupiter System**
- **International Mission**
 - Galileo orbiter : NASA's JPL
 - Propulsion System : Germany
 - Probe : Ames Research Center and Hughes Aircraft Company
 - More than 100 scientists worldwide
- **Jupiter :**
 - Giant Gas planet comprised mostly of Hydrogen and Helium
 - Galileo Galilei discovered original 4 moons (Io, Europa, Ganymede and Callisto)
 - Now over 63 moons known
 - Small ring system
 - Average distance from Sun : 5.2 AU
- **Operations challenges**
 - **Maneuver/encounter rich trajectory in system with 3-body effects**
 - **Unexpected behaviors in radiation environment**
 - **Failed Antenna caused mission redesign due to lower data return capability**
 - **Mission design modified to protect possible ocean on Europa**



4/25/12

Images courtesy of NASA/JPL-Caltech unless other wise stated

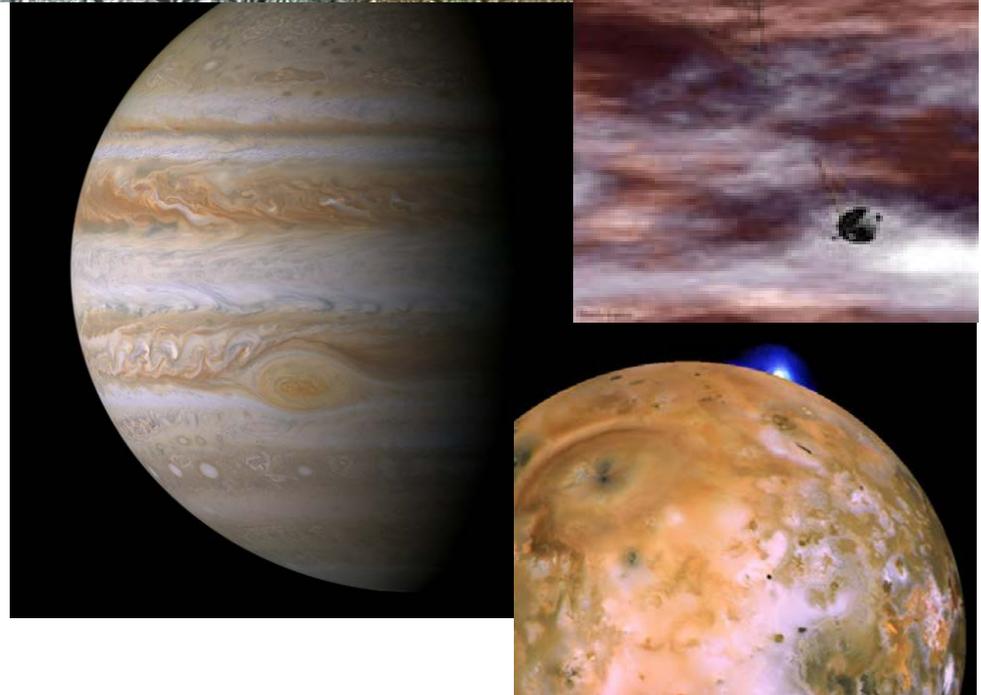
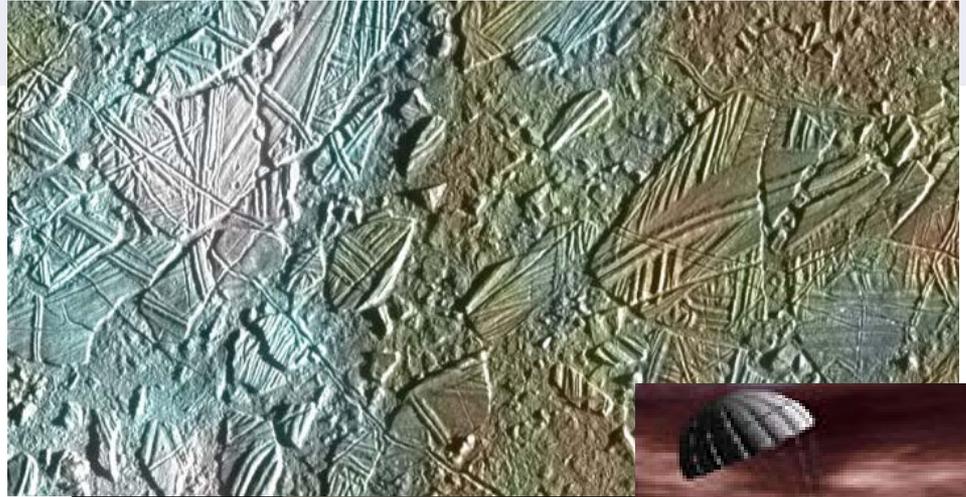


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Galileo Science Highlights

- **Discovered evidence of sub-surface saltwater oceans on Europa, Ganymede and Callisto**
- **First direct probe measurements of the clouds and atmosphere of Jupiter**
- **Conducted long term observations of the Jovian system including atmosphere, rings, moons and magnetosphere.**
- **Revealed the intensity of volcanic eruptions on Io**



Images courtesy of NASA/JPL-Caltech
unless other wise stated

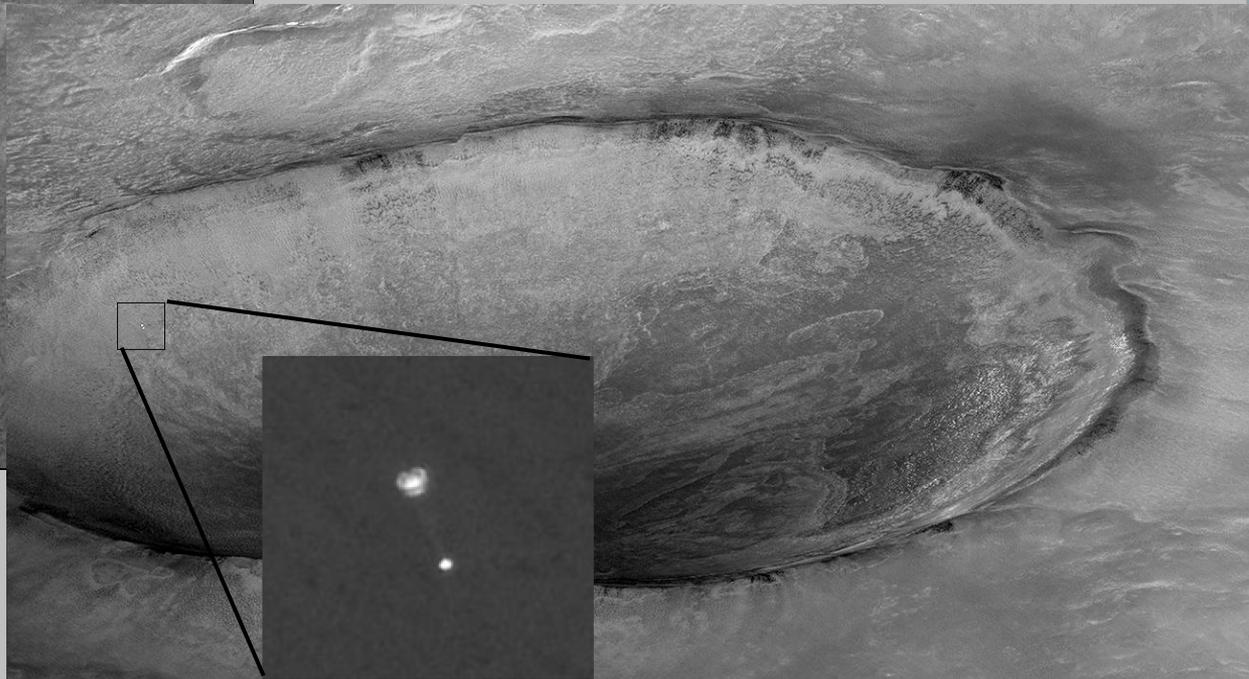


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Robust successes on Mars

- Mars Exploration Rover Opportunity
- Mars Reconnaissance Orbiter and Odyssey continue to reveal Mars secrets while preparing to support Mars Science Laboratory operations



4/25/12

Images courtesy of NASA/JPL-Caltech
unless other wise stated



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Phoenix makes it official: There is water on Mars

(Clean your glasses if you think Phoenix saw a Mars
polar bear)



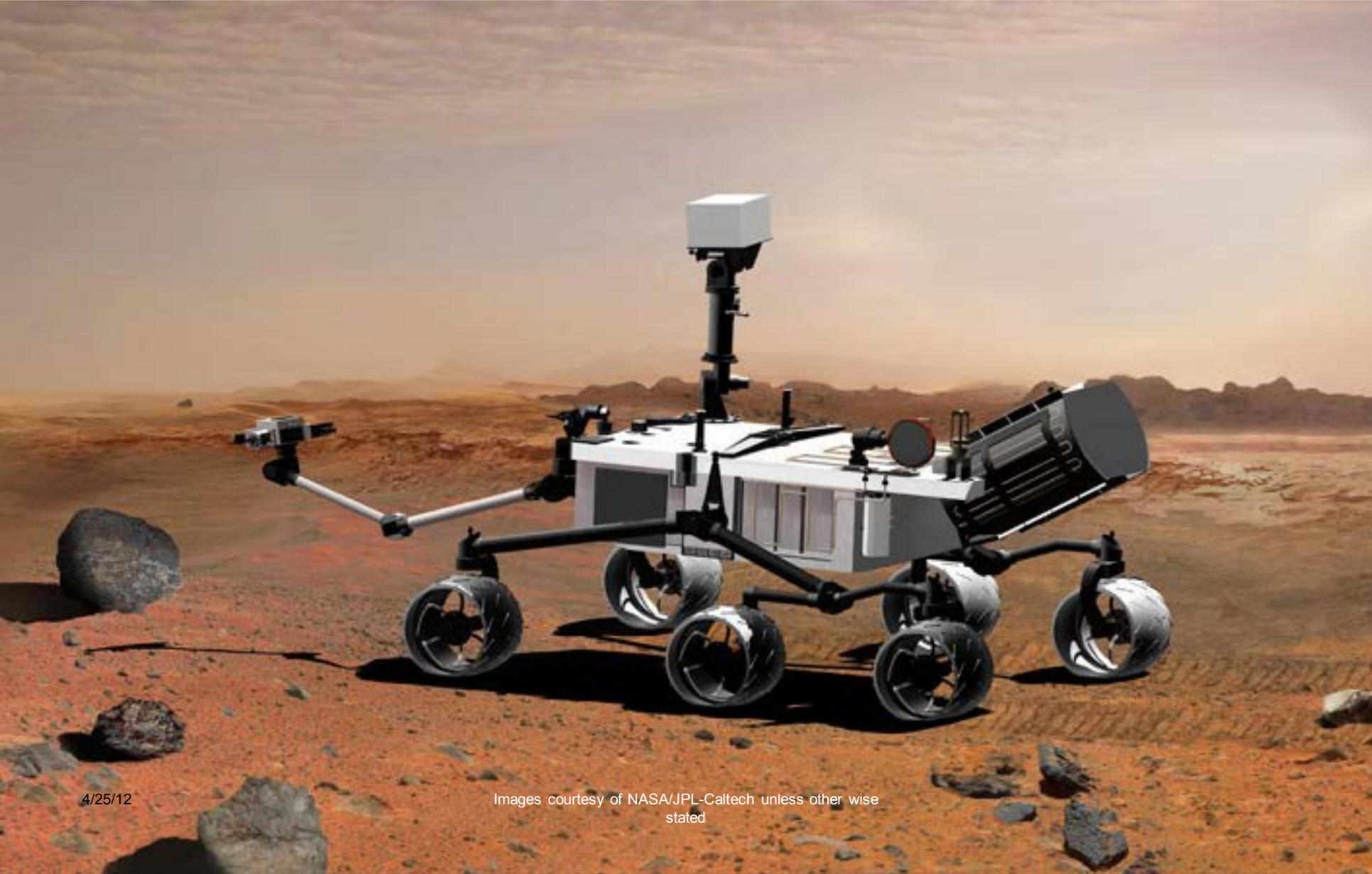
Images courtesy of NASA/JPL-Caltech
unless other wise stated



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Curiosity – Mars Science Laboratory



4/25/12

Images courtesy of NASA/JPL-Caltech unless other wise
stated

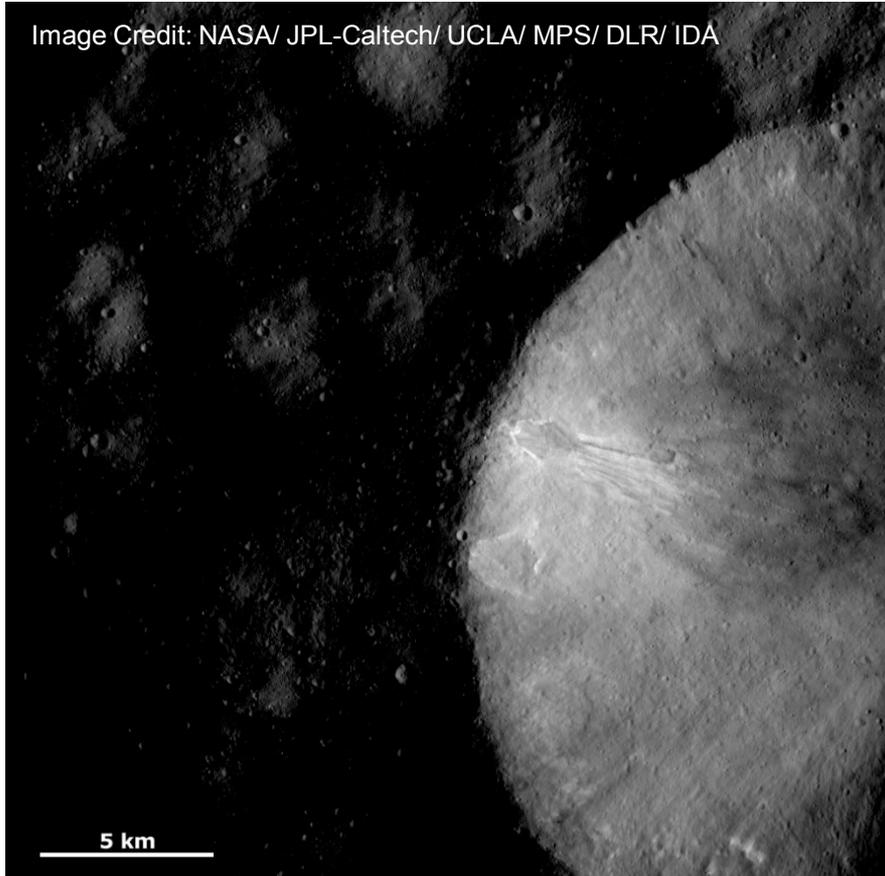


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

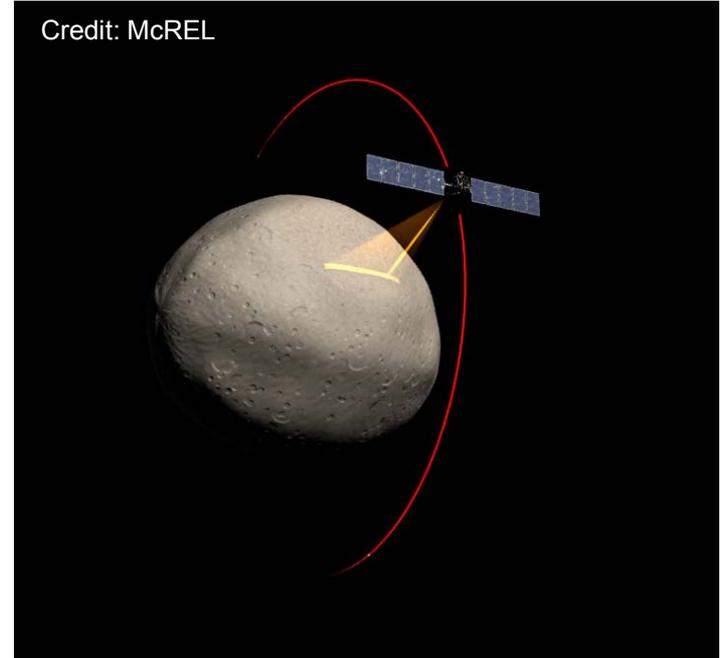
Dawn uses Ion Engines to orbit Vesta

Image Credit: NASA/ JPL-Caltech/ UCLA/ MPS/ DLR/ IDA



Crater wall with sinuous features

Credit: McREL



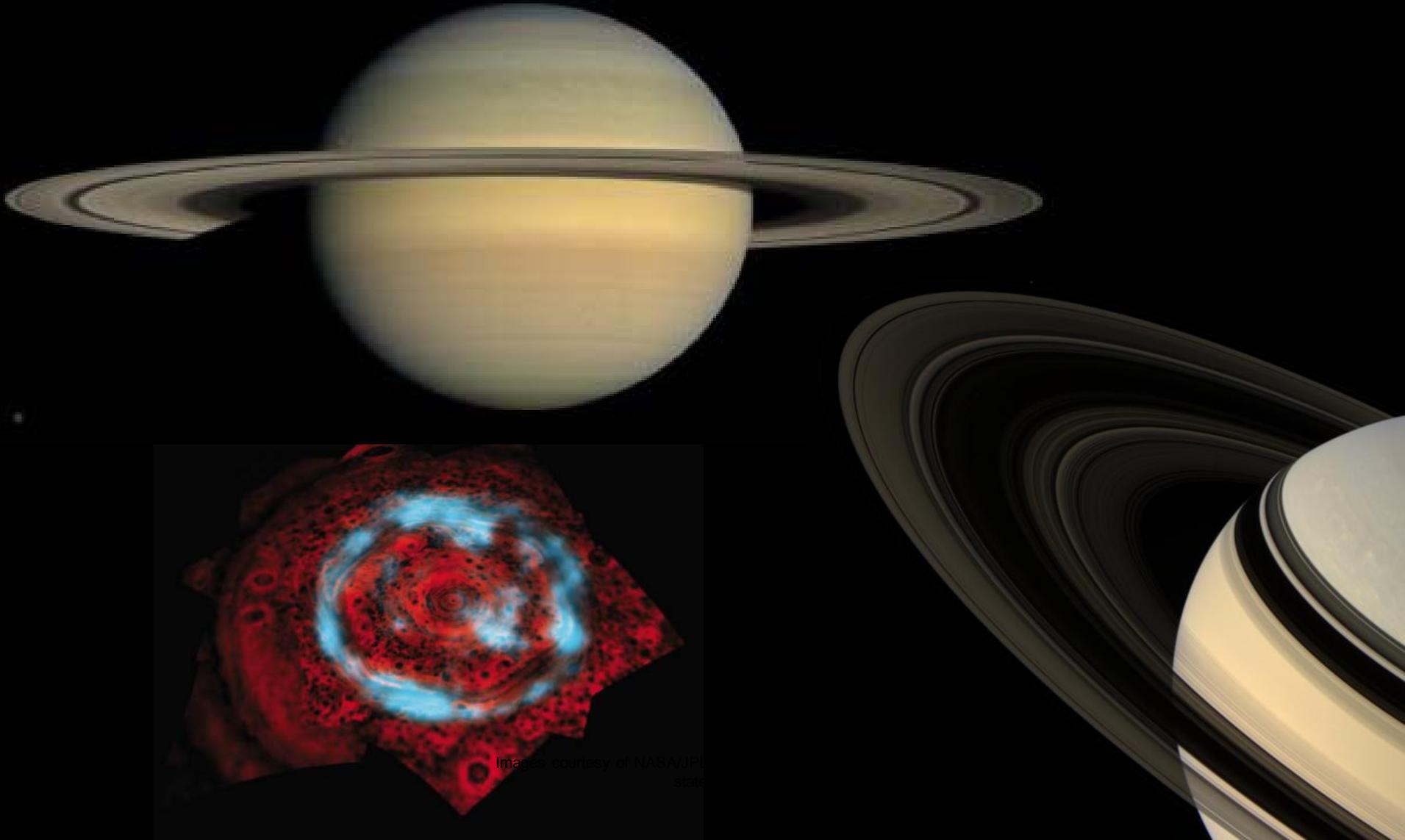
Artist rendition of Dawn spacecraft
gathering spectral data from Vesta



National Aeronautics and
Space Administration

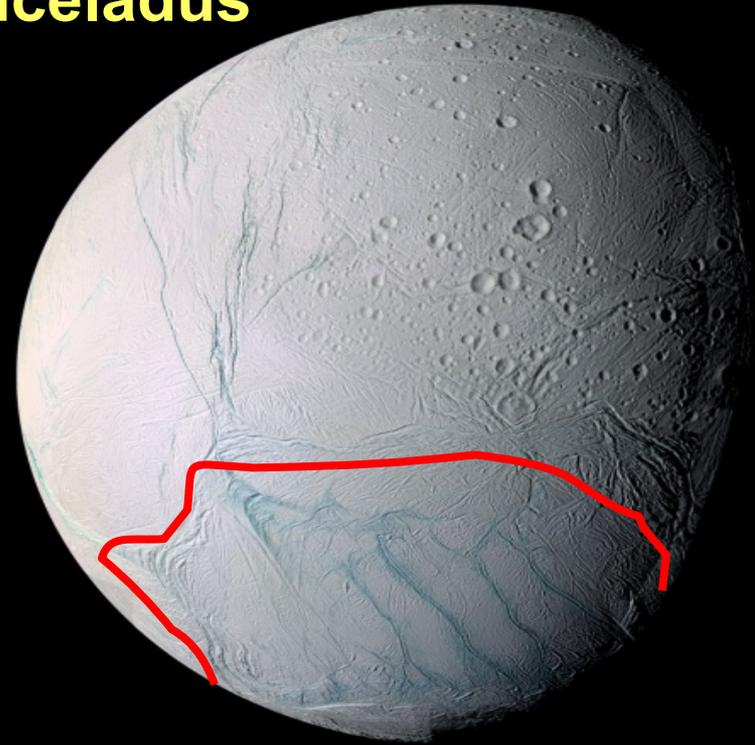
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Cassini-Huygens Studies the Saturnian System

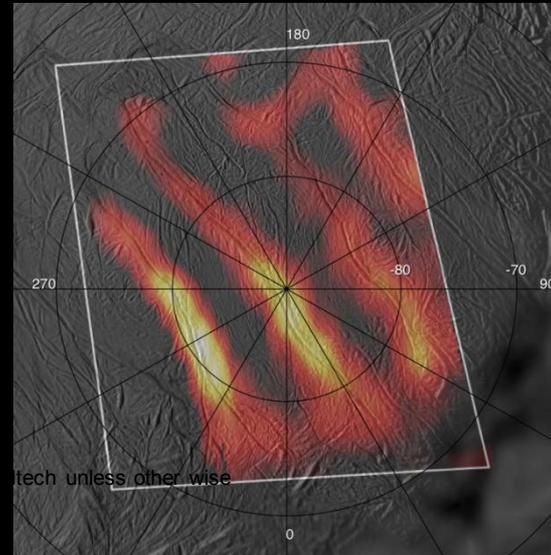


Images courtesy of NASA/JPL
Space Science Institute

Spouting Enceladus



Yellowstone



Tiger Stripes

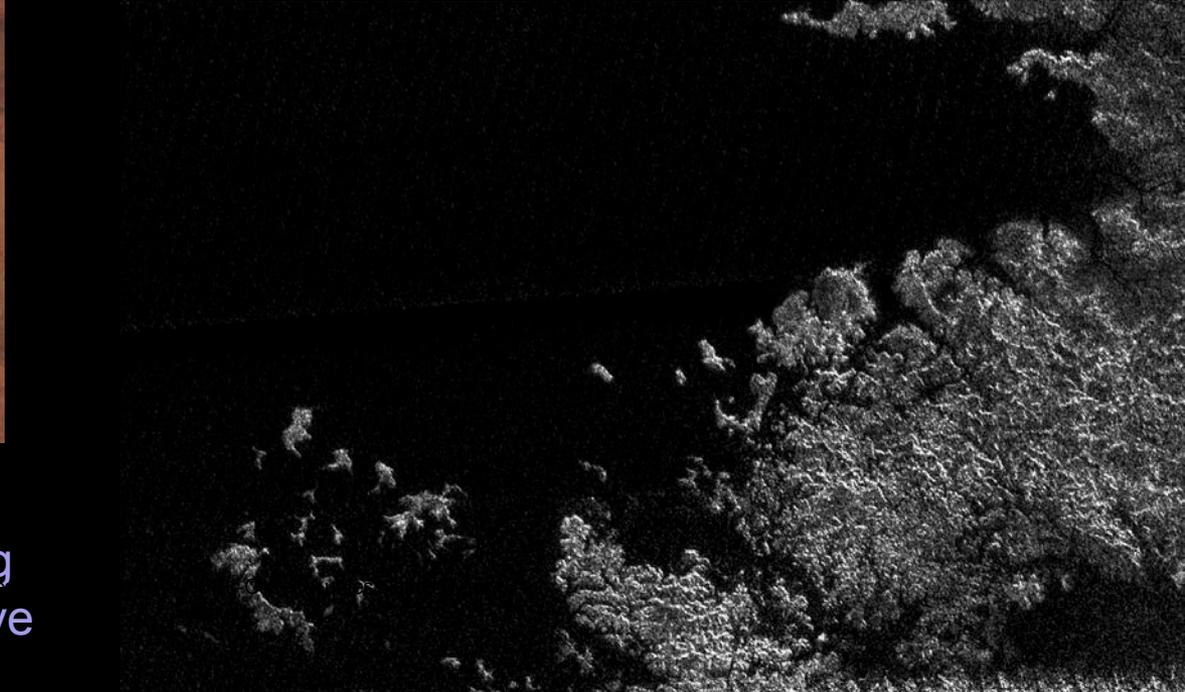
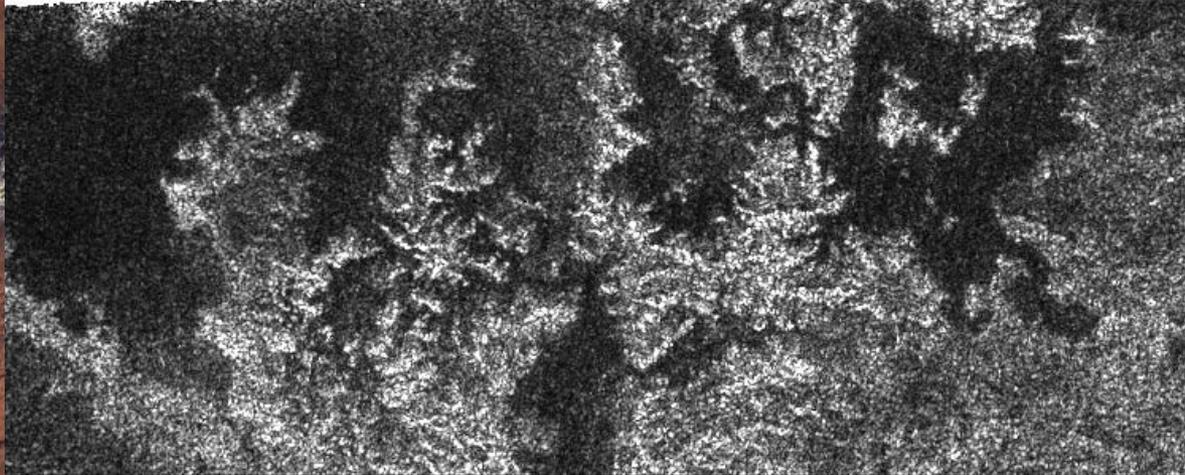
tech unless other wise



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Titan Northern Lakes



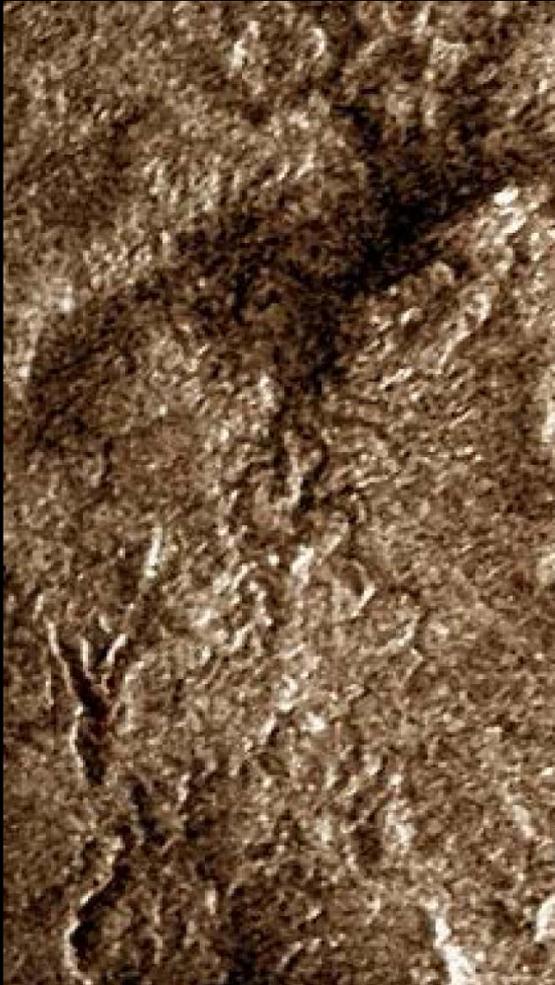
Cassini RADAR passes show
Ethane/Methane lakes with strong
resemblance to Lake Powell above



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

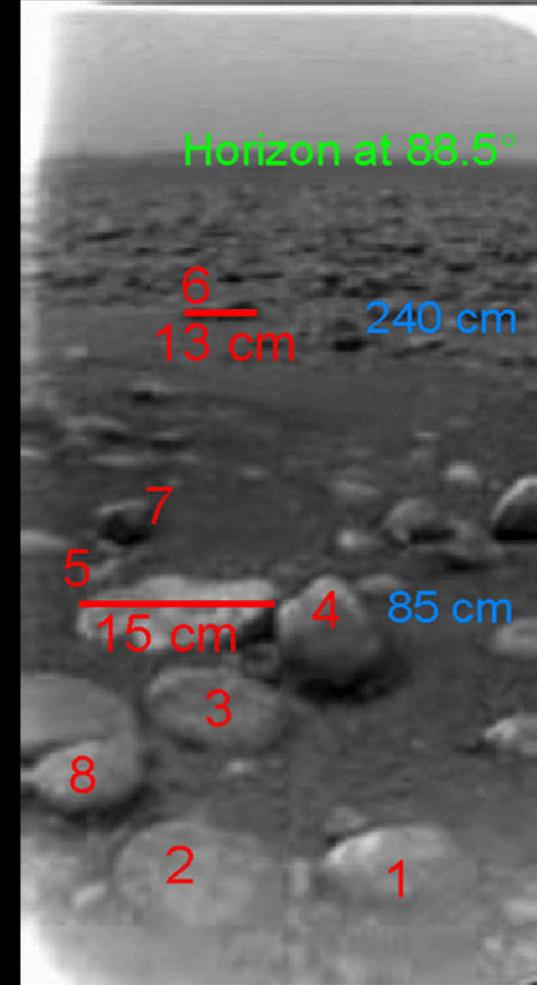
Titan: A mystery unveiled but not solved



Cassini Radar Image
500 meter resolution
Broad fluvial channels



Huygens Descent Image
50 meter resolution
Small-scale sapping



Huygens Landed Image
5 cm resolution
Fluvial outflow



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Challenges for Deep Space Missions

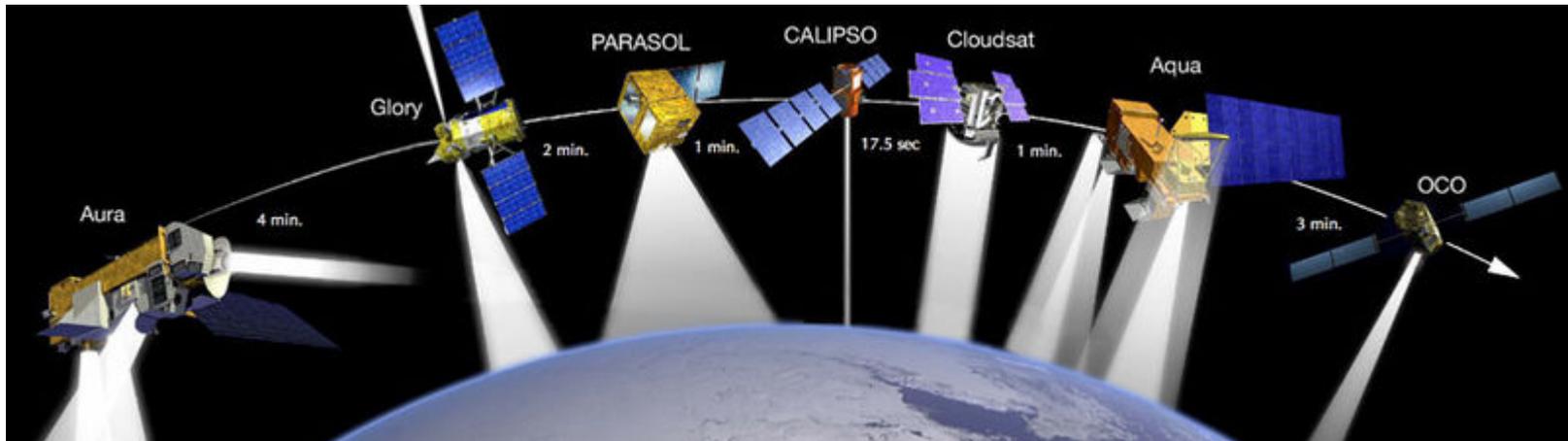
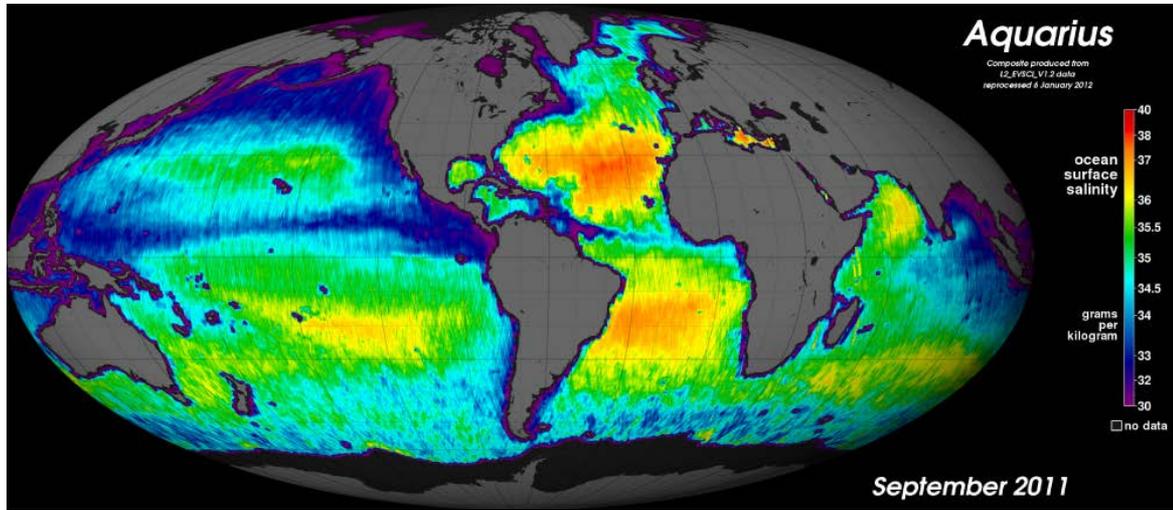
- **Budget constraints require more and more cost efficiencies**
 - **Smaller teams**
 - **Streamlined processes and multi-mission systems**
- **Maintaining the operational rigor and flight team expertise throughout the operational mission.**
 - **Lessons Learned from operational and command file errors being incorporated back into the current and planned mission set.**



Earth Orbiting Missions

Operations Challenges

- International cooperation
- Downlinking and processing large data volumes
- Fast data access for immediate use



4/25/12

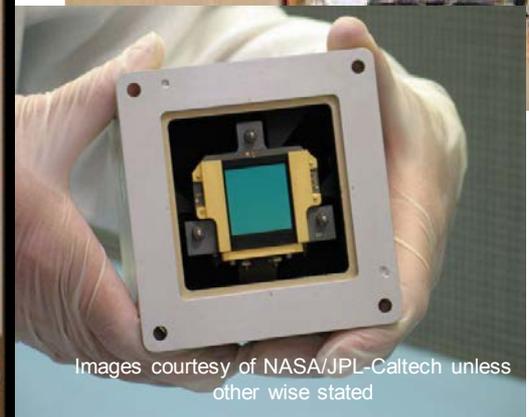
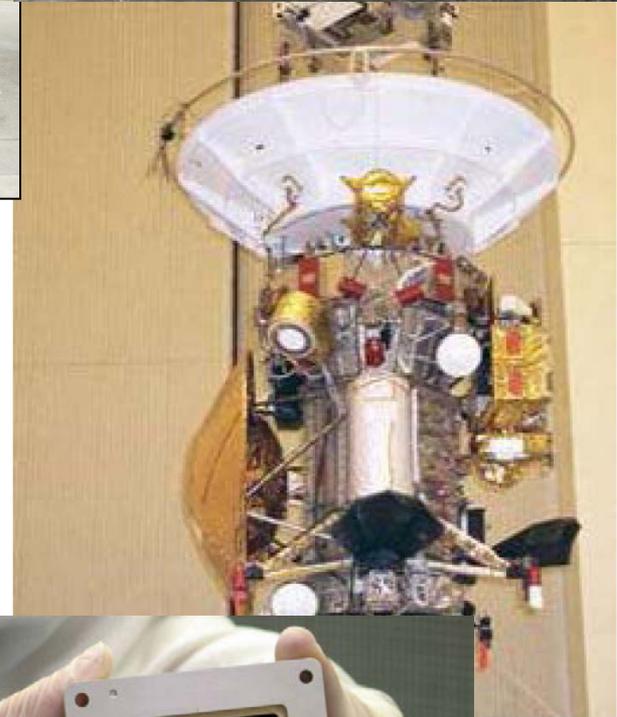
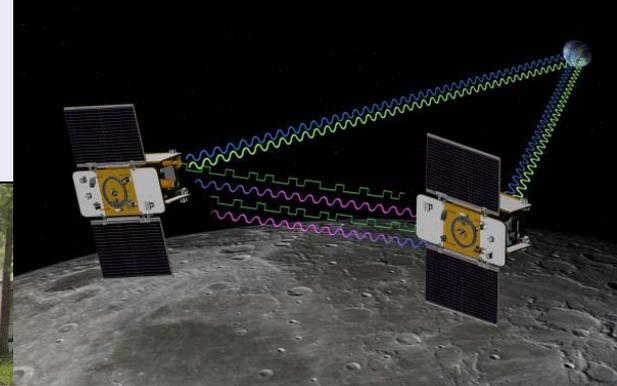


National Aeronautics and Space Administration

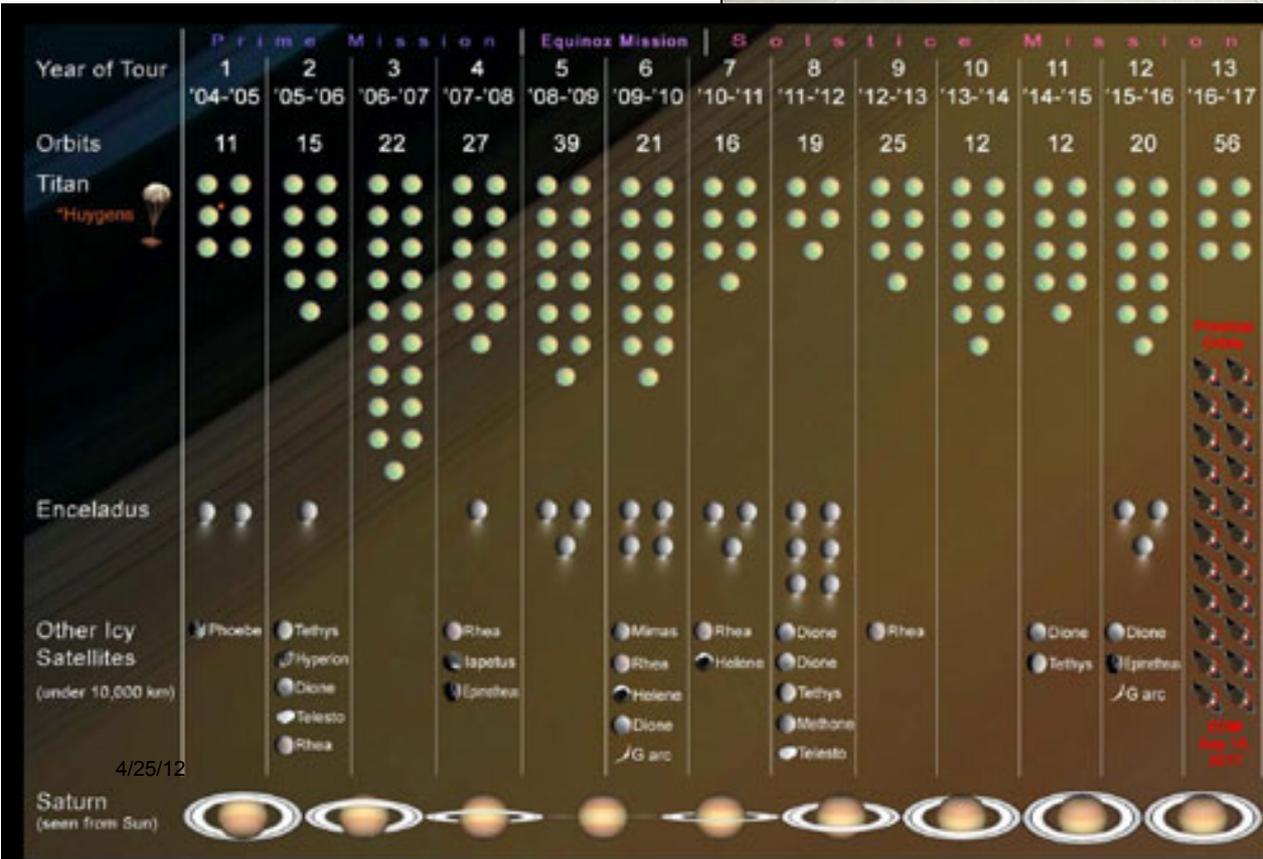
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Why Do I Do This?

- Science knowledge
- Engineering challenge



Images courtesy of NASA/JPL-Caltech unless otherwise stated



4/25/12

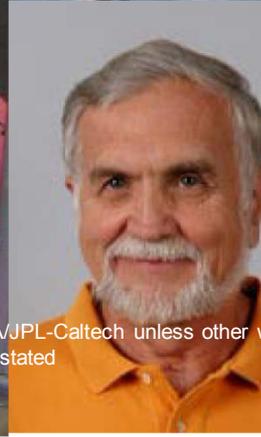
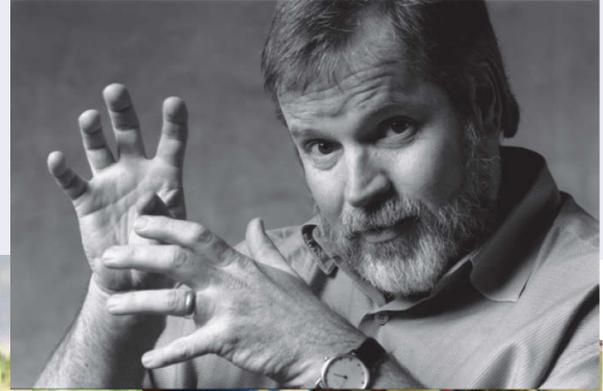
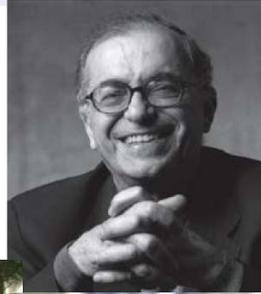


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Why Do I Do This?

- Science knowledge
- Engineering challenge
- People



4/25/12

Images courtesy of NASA/JPL-Caltech unless other wise stated



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Challenges Ahead

- **Cyber Defense**
 - On-board embedded systems
 - Ground systems
 - Use of web-based distributed systems
- **Reaching distant stars**
 - Increased autonomy
 - Data return
- **Understanding our own Earth**
 - Coordinated measurements by multiple agencies and multiple nations
 - Collecting, distributing and analyzing immense data volumes