FUTURE VENUS PROBE MISSIONS

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Most Visited Planet

- 23 space missions: 5 USA; 18 USSR
- Mariner 2,5,10; Pioneer Venus; Magellan
- Venera 1-16; VEGA 1,2
- Descent and landing at 17 locations
VENERA

- Soft landings: Venera 7 - VEGA 2
- Black-and-white and color panoramas of Venus surface
- Cloud properties and the elemental composition of surface rocks
- Radio mapping of the Northern hemisphere, with resolution 1-2 km.
Orbiter, bus; large and 3 small probes

- Spectral, radiometric, and polarimetric studies of the upper cloud; UV images
- Atmospheric structure and chemical composition; net flux, winds; spatial variability among the descent paths
MAGELLAN

• Radar mapping of entire surface at better than 300m resolution
• Global topography, crater distribution, tectonics, volcanism
• Evidence for global cataclysm; indirect information on bulk composition, crust-mantle interactions and surface evolution
• High dielectric mountain tops
GALILEO, CASSINI & GROUND-BASED

- Observation in NIR windows show thermal emission from surface, atmosphere below clouds, lower and middle clouds
- Some higher resolution studies from the flybys extend spacecraft results
HST

• Hubble observations show continuing decline of sulfur dioxide at cloud tops 1978-1995
• This visible change highlights sensitivity of Venus climate to volcanic activity and surface-atmosphere feedbacks
VENUS FROM HUBBLE 1995
DISCOVERY PROPOSALS

• Emphasize chemistry or dynamics or surface
• Some have gone to ‘Step 2’, but none selected for flight
• Discovery is too focused to answer the coupled chemistry/radiation/dynamics and the surface-atmosphere interactions?
PLANNED FUTURE MISSIONS

• VEX: ESA’s Venus Express
  – Reflight of Mars Express bus and experiments in 2005

• VCO: Japan’s Venus Climate Orbiter
  – Orbiter emphasizes dynamics and lightning
  – Planned 2009 launch
DECADAL SURVEY MEASUREMENT GOALS

• Composition: trace gases and isotopes
• Noble gas isotopes
• Cloud level winds
• Near IR descent images of surface
• Surface elemental abundance and mineralogy
• Surface texture and weathering
CURRENT STATUS

• Multiple past missions to Venus leave key questions unanswered
• Better sensitivity is essential for atmospheric and surface measurements
• Discovery can’t address couplings
• Entry probes are essential and complement planned international missions
PROBE SURFACE OBJECTIVES

• Elemental and mineral composition and its variation for bulk and interior properties
• Visit tessera and high reflectivity areas for history and weathering
• Surface ages define timescale of volcanic emplacement
• Surface images for context, texture for current processes
PROBE ATMOSPHERIC OBJECTIVES

- Noble gas abundances and isotopic ratios for formation, history and escape
- Vertical profiles of reactive gases for chemistry, clouds and radiation
- Wind profiles for dynamics, stability
- Thermal structure for energy balance
- Surface winds for aeolian processes
SURFACE-ATMOSPHERE INTERACTIONS

• Simultaneous atmospheric chemistry and surface mineralogy
• Horizontal variations in atmospheric composition
• Current rates for volcanic re-surfacing, and atmospheric injections
LONG LIVED LANDERS

- Measure heat flow for interior processes
- Magnetic field for core properties, remnant magnetism
- Seismology for current activity and interior structure
- Laboratory investigations of surface samples
IMPLICATIONS FOR OTHER PLANETARY SYSTEMS

• History and detectability of terrestrial planets
• Identify Venus-like planets (are these really ‘false positives’)
• Understand why Earth and Venus diverged
• Is Venus Earth’s fate?
SUMMARY

- Probes are essential to understanding Venus
- Direct implications for Earth’s formation and history, origin of life, extra solar planets
- Range of desired capability includes
  - Multiprobes
  - Descenders
  - Landers
  - Balloons
  - Long-lived landers