NASA's Science and Technology Definition Team: A Flagship Mission to Venus

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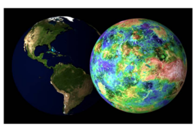
Summary

The Venus Science and Technology Definition Team (STDT) was formed by NASA to look at science objectives, mission architecture, science investigations, and instrument payload for a Flagship-class mission to Venus. This $3-4B mission, to launch in the 2020-2025 timeframe, should revolutionize our understanding of how climate works on terrestrial planets, including the close relationship between volcanism, tectonism, the interior, and the atmosphere. It would also be capable of resolving the geologic history of Venus, including the existence and persistence of an ancient ocean. Achieving all these objectives will be necessary to understand the habitability of extrasolar terrestrial planets that should be detected in the next few years. The Venus STDT is comprised of scientists and engineers from the United States, the Russian Federation, France, Germany, the Netherlands, and Japan. The team began work in January 2008, gave an interim report at NASA headquarters in May, and will deliver a final report in December 2008. The Venus STDT will also produce a technology roadmap to identify crucial investments to meet the unique challenges of in situ Venus exploration.

Here we discuss the mission architecture and payload that have been designed to address the science objectives, and the methods we used. Most of the science objectives in the latest VEXAG white paper can be addressed by a Venus Flagship mission, and equally importantly, NASA can fly a large mission to another Earth-sized planet with the explicit intention of better understanding our own.



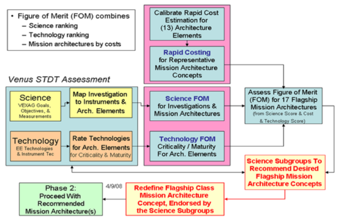
Major Science Questions: Why is Venus so Different From Earth?

What does the Venus greenhouse tell us about climate change?
Did Venus diverge from an early Earth-like state?
How is the climate forced by the Sun and influenced by the clouds?
How do the surface and atmosphere interact chemically?

How active is Venus?
Is Venus currently geologically active?
What caused the extensive resurfacing of Venus during the past Gy?
What is the nature of Venus' magnetic field, if any?

When and where did the water go?
Was there ever an ocean on Venus, and if so, when did it exist andhow did it disappear?
Did conditions for life ever exist on Venus?
How does the upper atmosphere interact with the space environment?

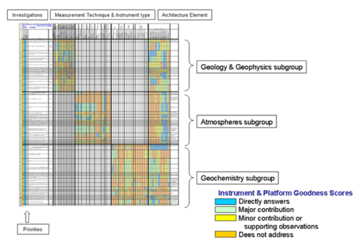
Venus STDT Process



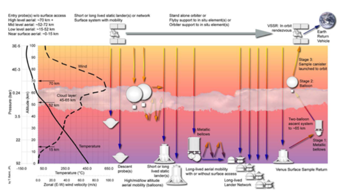
Guiding Assumptions

Launch 2020-2025
Technology Maturity TRL 6 by 2015
Mission Cost $3B to $4B
Launch Vehicle Capability <= Delta IVH eq.
DSN Capability up to 34m, Ka band
International Contribution No foreign contribution

Science Traceability



Architecture Elements



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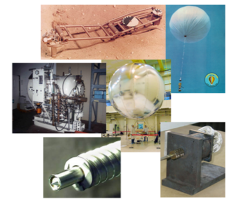
Technology Development

The chosen architecture combines TRL 6 elements with moderate technology development requirements

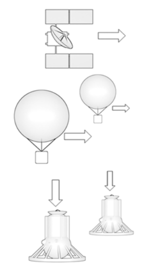


System level
Environmental testing
P, T mitigation
Sample acquisition & handling

Instrument technology
InSAR
High T in situ instrumentation

Science enhancement
High P,T seismometers
HIgh T power generation
High T electronics

Design Reference Mission



Highest science Figure of Merit:

1 Highly capable orbiter
2 Mid-level (45-60 km) balloons
2 Landers with descent science

Possible long-lived element with 2 seismometer/meteorology packages

Preliminary Payload

Orbiter

InSAR
INMS
Vis-IR-UV spectral imaging
Submm sounder
Magnetometer
Langmuir probe
Radio subsystem
170 kg instruments
$200M payload

Balloons

Mass spectrometer
Nephelometer
Net flux radiometer
Atmospheric structure
Optical lightning detector
Magnetometer
Radio subsystem
23 kg instruments
$33M payload

Landers

Mass spectrometer
Nephelometer
Net flux radiometer
Atmospheric structure
Descent, panoramic cameras
Magnetometer
Radio subsystem
Sample handling
XRD/XRF
Microscopic imager
Instrinsic γ-ray spectrometer
Microwave corner reflector
Heat flux plate
105 kg instruments
$115M payload

Long Duration Package

Seismometer
Meteorology station
Radio subsystem