VEXAG @ CAPS

September 28, 2022

Noam Izenberg , VEXAG Chair

I: Preliminary Evaluation on the New Decadal Survey

II: Evaluation of the Fifth Community Announcement on New Frontiers 5

VEXAG Steering Committee

Noam Izenberg	Applied Physics Laboratory, Chair
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Jeff Balcerski	Ohio Aerospace Institute
Paul Byrne	North Carolina State University
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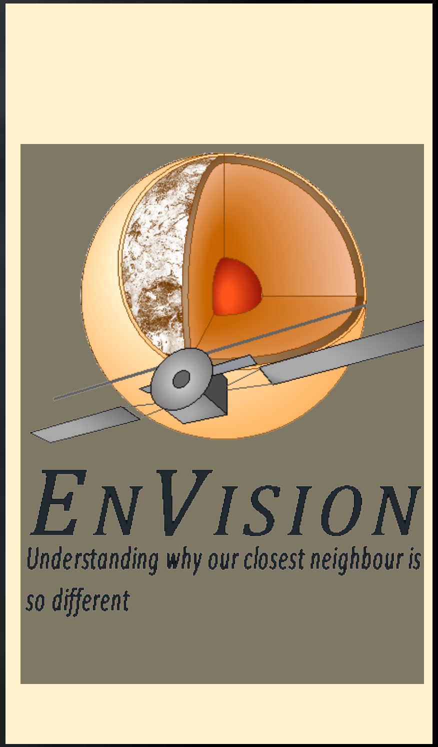
V3NUS

The three major Venus missions NASA is supporting in the coming decade

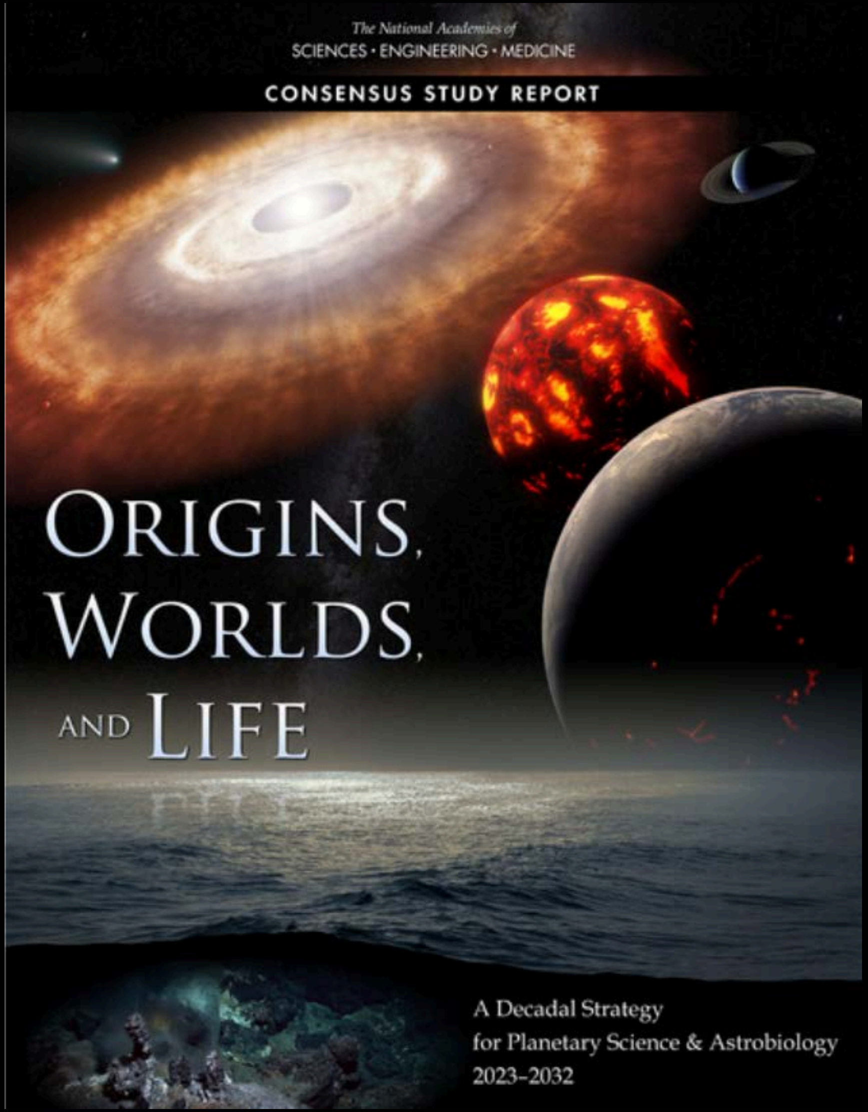


V3NUS will fundamentally change the way we understand Venus, Venus-like worlds, and more.

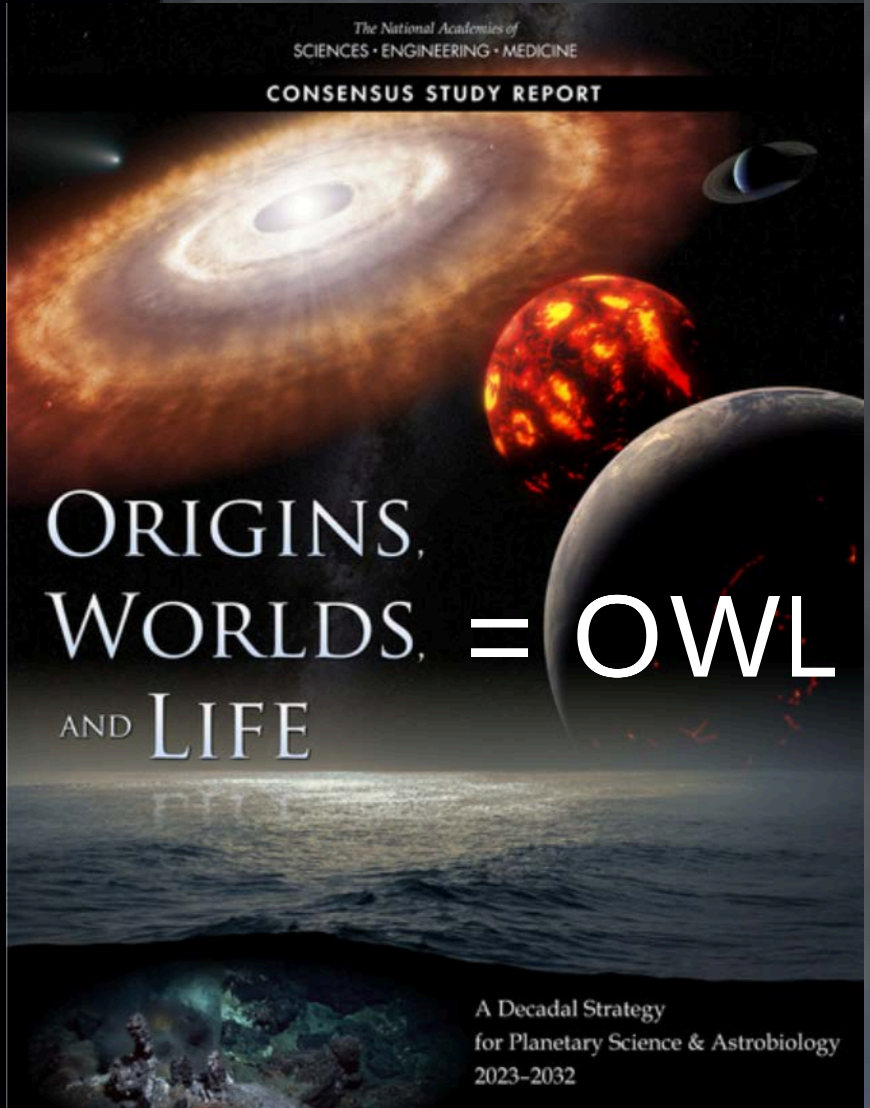
*Visions into Voyages(**V&V**) is the 2013-2022 Decadal Survey

OWL

Origins, Words, and Life, the 2023-2032 Decadal Survey*



Venus in the Decadal Survey



= OWL

Q #	OWL Theme with Venus Relevance
1.1	What Were the Initial Conditions in the Solar System?
1.2	How Did Distinct Reservoirs of Gas and Solids Form and Evolve in the Protoplanetary Disk?
1.3	What Processes Led to the Production of Planetary Building Blocks?
3.1	How and When Did Asteroids and Inner Solar System Protoplanets Form?
3.3	How Did the Earth-Moon System Form?
3.4	What Processes Yielded Mars, Venus, and Mercury and Their Varied Initial States?
3.5	How and When Did the Terrestrial Planets and Moon Differentiate?
3.6	What Established the Primordial Inventories of Volatile Elements and Compounds in the Inner Solar System?
4.2	How Did Impact Bombardment Vary with Time and Location in the Solar System?
4.4	How Do the Physics and Mechanics of Impacts Produce Disruption of and Cratering on Planetary Bodies?
5.1	How Diverse Are the Compositions and Internal Structures Within and Among Solid Bodies?
5.2	How Have the Interiors of Solid Bodies Evolved?
5.3	How Have Surface/Near-Surface Characteristics and Compositions of Solid Bodies Been Modified by, and Recorded, Interior Processes?
5.4	How Have Surface Characteristics and Compositions of Solid Bodies Been Modified by, and Recorded, Surface Processes and Atmospheric Interactions?
5.6	What Drives Active Processes Occurring in the Interiors and on the Surfaces of Solid Bodies?
6.1	How Do Solid-Body Atmospheres Form and What Was Their State During and Shortly after Accretion?
6.2	What Processes Govern the Evolution of Planetary Atmospheres and Climates Over Geologic Timescales?
6.3	What Processes Drive the Dynamics and Energetics of Atmospheres on Solid Bodies?
6.4	How Do Planetary Surfaces and Interiors Influence and Interact with Their Host Atmospheres?
6.5	What Processes Govern Atmospheric Loss to Space?
6.6	What Chemical and Microphysical Processes Govern the Clouds, Hazes, Chemistry and Trace Gas Composition of Solid Body Atmospheres?
10.1	What Is “Habitability”?
10.3	Water Availability: What Controls the Amount of Available Water on a Body Over Time?
10.5	What Is the Availability of Nutrients and Other Inorganic Ingredients to Support Life?
11.3	Life Detection: Is or Was There Life Elsewhere in the Solar System?
11.4	Life Characterization: What Is the Nature of Life Elsewhere, If It Exists?
12.1	Evolution of the Protoplanetary Disk
12.2	Accretion in the Outer Solar System
12.3	Origin of Earth and Inner Solar System Bodies
12.6	Atmosphere and Climate Evolution on Solid Bodies
12.10	Dynamic Habitability
12.11	Search for Life Elsewhere

Venus Exploration Strategy

The current Venus mission selections are not a "Program," but they may form the *basis* of one in the decade following.

Recommendation by OWL: A Venus Strategy

- *"NASA should develop scientific exploration strategies, as it has for Mars, in areas of broad scientific importance, e.g., Venus [...], that have an increasing number of U.S. missions and international collaboration opportunities."* **[OWL, 22-10**]

Response by NASA: Community-Generated Strategy

- *"...specific scientific exploration strategies should be community-generated by bodies such as the Analysis Groups, advisory committees, and NASEM's standing boards and commissioned studies."* **[NASA initial response**]

VEXAG takes on that mantle, beginning an iterative process:

1. Current: Steering committee conceptualization, assessment of 2019 Strategic Documents
2. November 2022: 20th VEXAG Meeting, community discussion, input, working group creation
3. 2023 Strategy development within VEXAG, iterated with NASA HQ

1: Assessment of Impact of V3NUS and OWL on VEXAG 2019 GOI

GOI: VEXAG Goals, Objectives, Investigations doc., 2019

"Partially to Substantially Addressed"

The Investigation will or could be be substantially incremented/revised after V3NUS completion. Does not mean completed or resolved

"Unaddressed to First Look"

The V3NUS missions will minimally or not at all increment these investigations.

Nearly all Future GOI Investigations have key in-situ components

Most significant measurements a VISE-like mission (V&V or OWL version) could achieve that are outside V3NUS objectives

New data all areas will expose new questions in most categories.

Goal	Objective	Investigation	Achieved by end of V3NUS	Future Achievement
I. Understand Venus' early evolution and potential habitability to constrain the evolution of Venus-size (exo)planets	A. Did Venus have temperate surface conditions and liquid water at early times? BP2,3,4,5	HO. Hydrous Origins	Near-IR emissivity maps, searching for widespread felsic crust.	Multilocation measurement of surface rock composition, particularly in tesserae.
		RE. Recycling	Radar maps, subsurface sounding, Near-IR emissivity maps.	Multilocation measurement of surface rock composition. Follow-up high-res radar & high res NIR surface imaging. Age dating.
		AL. Atmospheric Losses	-	Orbital measurements of ionosphere & solar wind interaction; measure winds and transport through lower thermosphere.
		MA. Magnetism	-	Magnetic fields measured from orbit, balloon, near surface
	B. How does Venus elucidate possible pathways for planetary evolution in general? BP1,2,4,5	IS. Isotopes	Comprehensively addressed by DAVINCI.	Next generation MS instruments on long-lived cloud platform may be able to achieve even higher sensitivity
		LI. Lithosphere	Comprehensively addressed by VERITAS & EnVision's SAR & gravity.	Seismometry; Magnetotelluric sounding; Multi-location measurements of surface material & bulk composition. Follow-up high-res radar & high res NIR surface imaging. Age dating.
		HF. Heat flow	Constraints from gravity/ topography & from detection, characterization of volcanism & tectonism.	Seismometry; in situ heat flow in different provinces.
		CO. Core	Strongly constrained by gravity measurements & spin vector variation monitoring.	Seismometry. Higher accuracy gravity from e.g. gradiometry Magnetic field measurements from orbit and/or aerobot.

Goal	Objective	Investigation	Achieved by end of V3NUS	Future Achievement
II. Understand atmospheric dynamics and composition on Venus.	A. What processes drive the global atmospheric dynamics of Venus? BP4,6	DD. Deep Dynamics	Vertical profile of P, T, wind, from; cloud-level winds & waves from cloud tracking; gas mapping & radio occultation from; surface winds from SAR aeolian features.	Cloud-level 3-D winds & waves from aerobot. Long-life surface meteorological station. Next-generation cloud tracking from orbit. Sat-to-Sat radio occultations for frequent T profiles at 40 – 90 km.
		UD. Upper Dynamics	-	Ionosphere / magnetosphere / plasma / solar wind interaction orbital measurements. Sub-mm heterodyne to measure winds & transport at 70 – 140 km, or thermal IR sounding of mesosphere (60 – 100 km).
		MP. Mesoscale Processes	Constraints on winds & waves. Winds from camera elements.	Cloud-level 3-D winds & waves from aerobot. Simultaneous orbital & in situ atmospheric observations. Long-life meteorological station.
	B. What processes determine the baseline and variations in Venus atmospheric composition and global and local radiative balance? BP3,5,6	RB. Radiative Balance	Radiative flux measurement from descent probe. New spectroscopy from orbit.	Radiative flux measurements from descent probes. Cloud-level radiative flux measurements from aerobot. Long-life radiometric/meteorological station.
		IN. Interactions	Chemical profiles, and maps of key volatile gases, and links to volcanic activity.	In situ characterization of cloud particles, radiation, microphysics. Search for lighting (aerobot, orbiter). Aeolian processes (lander, sampler, orbiter).
		AE. Aerosols	Orbital mapping of aerosol distributions. Measurement of gaseous volatile species which participate in condensational cloud formation.	In situ cloud-level aerobot measuring cloud and gas composition, and particle size & shape. Characterization of dust at surface.
		UA. Unknown Absorber	Orbital UV observations. In-situ chemical inventory in clouds.	In situ cloud-level aerobot measuring cloud, gas, aerosol composition, especially at altitudes > 60 km, and UV/blue fluxes.
		OG. Outgassing	Vertical profile of composition including outgassed volatiles; Mapping outgassed volatile species.	In situ measurements of surface and cloud materials to search for signatures of outgassed volatiles.

Goal	Objective	Investigation	Achieved by end of V3NUS	Future Achievement
III. Understand the geologic history preserved on the surface of Venus and the present-day couplings between the surface and atmosphere	A. What geologic processes have shaped the surface of Venus? BP2,3,5	GH. Geologic History	Global SAR imaging & topography, NIR emissivity, gravity & subsurface mapping + high-res imaging.	Detailed surface properties & composition multiple locations. Follow-up high-res radar & high res NIR surface imaging.
		GC. Geochemistry	Constraints from NIR emissivity maps (& SAR & radiometry).	Multisite measurement of surface composition.
		GA. Geologic Activity	Change detection (repeat SAR imagery), searches for NIR & RF thermal anomalies, volcanic plumes, volcanic tracers.	Systematic surface monitoring with repeat-pass InSAR & radiometry (NIR & RF). Seismometry (surface, aerobot, or orbital).
		CR. Crust	Addressed by SAR & gravity, sub-surface sounding, and descent imaging.	Seismometry; Magnetotelluric sounding; In situ measurements of surface material composition.
	B. How do the atmosphere and surface of Venus interact? BP3,5	LW. Local Weathering	Constraints from NIR emissivity maps (& SAR & radiometry). Also measurements of near-surface atmospheric composition.	Measurement of surface & near-surface atmosphere composition at multiple localities.
		GW. Global Weathering	Constraints from NIR emissivity maps (& SAR & radiometry) & SAR imagery.	Measurement of surface & atmosphere composition, global patterns.
		CI. Chemical Interactions	Measurements of near-surface atmospheric composition. Measurements of tropospheric gas abundances. Maps of clouds & low-altitude water vapor. Radar anomaly.	Surface landers & meteorological stations. Follow-up high res radar and other surface mapping.

2: VEXAG 2022

The 20th Meeting of the Venus Exploration Analysis Group

November 7-9, 2022, Albuquerque New Mexico
- New Mexico Museum of Natural History and Science
- Fully hybrid, in person attendance limited to 100
- Focus on Missions, Policy, Priorities and Strategy for the 2023-2032 decade and beyond.

SAW 1: Organization Documentation
SAW 2: VEXAG 2022 Meeting
SAW 3: Exoplanets in our Backyard (2022)
SAW 4: Venus Flyby & Opportunistic Science
SAW 5: Venus Science Nuggets
SAW 7: Technology & Laboratory studies
SAW 8: Outreach/Advocacy
SAW 9: Social Media
SAW 10:VEXAG Website
SAW 11: IDEA
SAW 12: Aerial Platform Science and Technology
SAW 13: Early Career Venus Scientists

3: Strategic Concepts

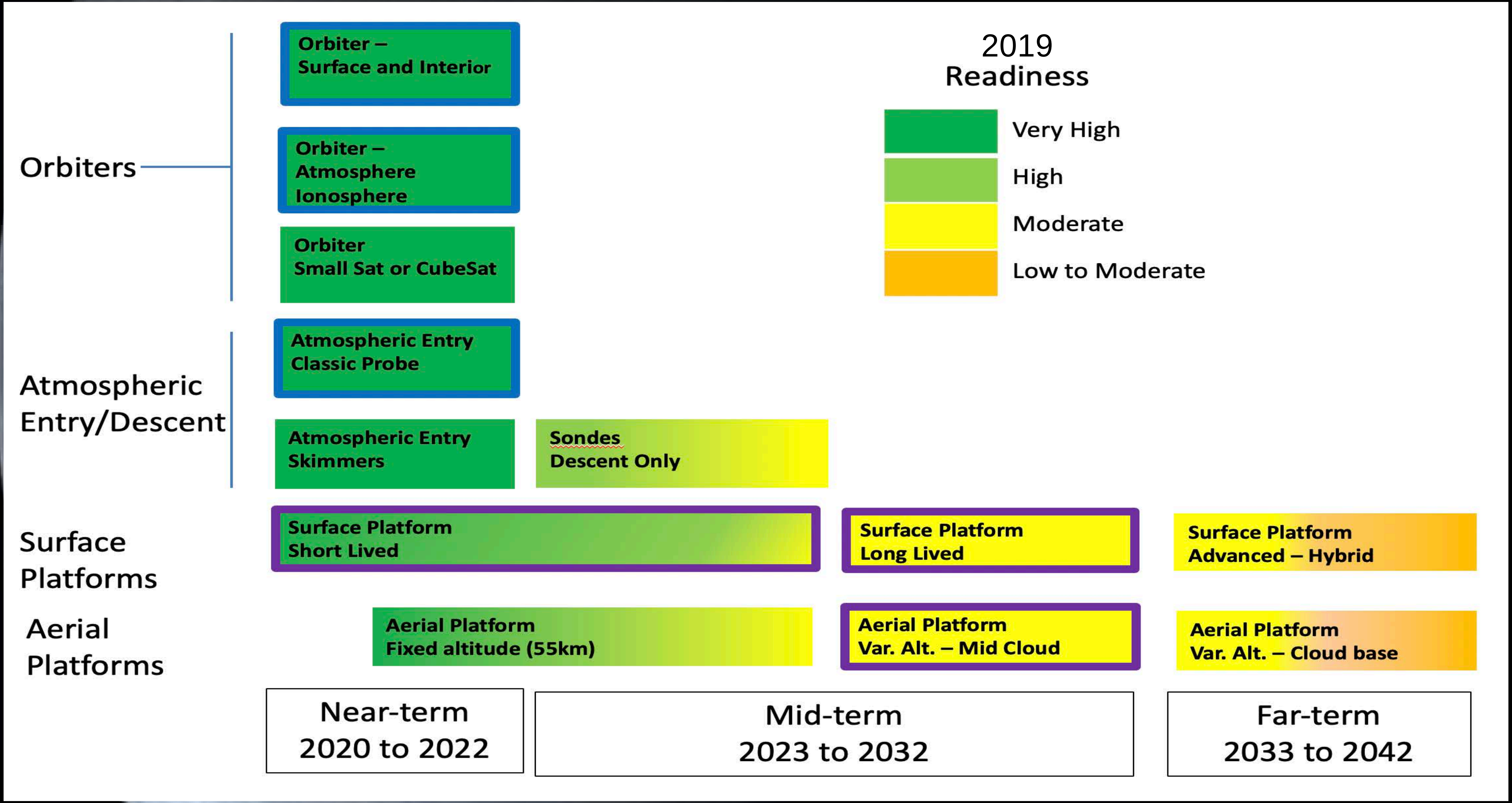
Preliminary, to be iterated and ranked

- **R&A**: Preparatory Science Investigations for Venus
  - Dedicated science in direct support of upcoming missions
- **R&A**: Venus Fundamental Research
  - Laboratory work, Mapping, Modeling
  - Separate ROSES call or specific language in existing calls (e.g. SSW)
- **T&D**: Fundamental Venus Technology Advancement
  - High temperature systems; Aerial, landed capabilities
  - HOTTech, PESTO, others
- Next decade **mission architecture development**
  - Multiplatform systems
- Next generation **scientist and engineer development**

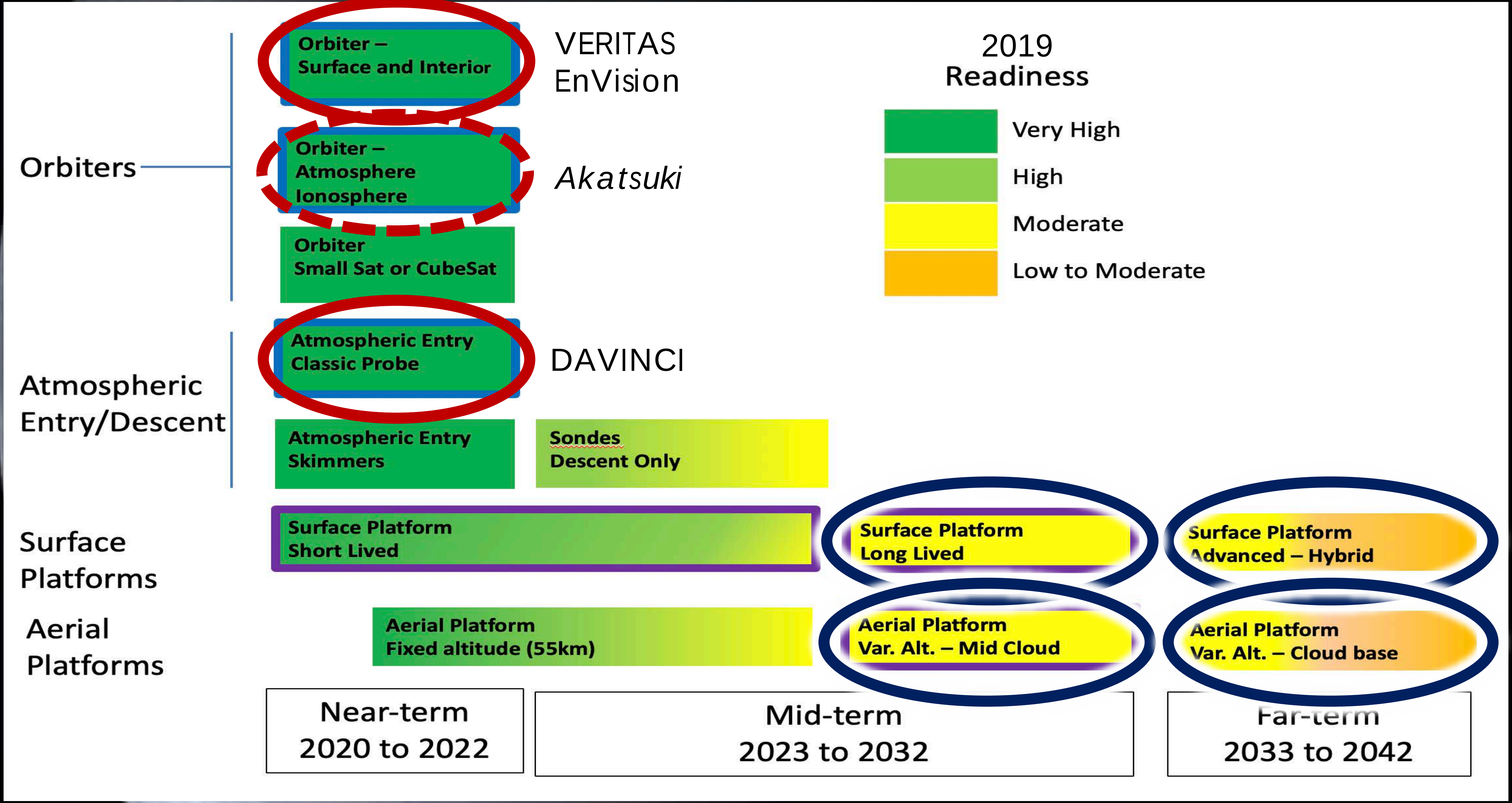
Request for Preparatory Science

- "Preparatory Science Investigations for Europa" call: Europa Clipper launches in ~ 2 years with science phase beginning in 2030.
- VERITAS launches in 5 years with Science phase beginning in 2028, launching a sustained influx of new Venus data that will last 5+ years.
- "Preparatory Science Investigations for Venus" is warranted: Target Roses 2023 or 2024 to account for the shorter cruise phase.

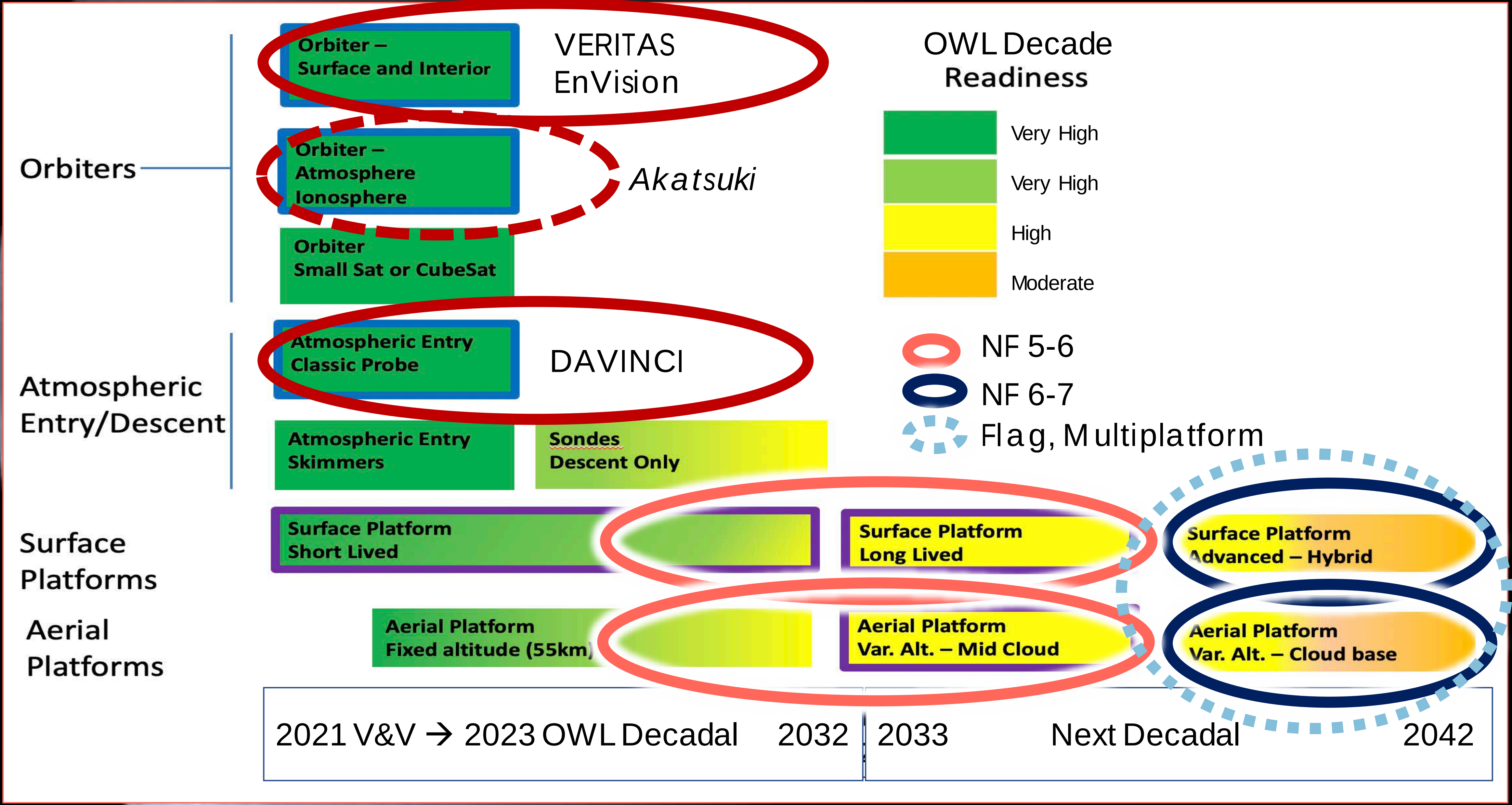
Venus Mission Roadmap (2019)



Venus Mission Roadmap (2019)



Venus Roadmap, extended



Venus and New Frontiers 5

- **Since 5th Community Announcement on NF 5:**
- VEXAG Steering Committee discussions
- Letters to NF5 PO, NASA HQ on community's behalf
- Community web survey distributed to Mail lists
- Individual letters addressed or cc'd to VEXAG

- **Four points of broad Venus community consensus:**
- Call for re-inclusion of VISE in the NF 5 list
- Community recognition of reasoning for VISE omission
- Dissatisfaction with the mode in which the omission was presented
- Call for NASA to engage CAPS and the science community to vet and recommend any changes

Impact of V3NUS and OWL on Venus In Situ Explorer (VISE)

“Partially to Substantially Addressed”

The Investigation will or could be be substantially incremented/revised after V3NUS completion.

“Unaddressed to First Look”

The V3NUS missions will minimally or not at all increment these Investigations.

Major components of NF5 (V&V) and OWL version of VISE objectives are largely unaddressed by V3NUS

V&V VISE Objectives

1. Understand the physics and chemistry of Venus’s atmosphere; abundances of its trace gases, sulfur, light stable isotopes, and noble gas isotopes;
2. Constrain the coupling of thermochemical, photochemical, and dynamical processes in Venus’s atmosphere and between the surface and atmosphere to understand radiative balance, climate, dynamics, and chemical cycles;
3. Understand the physics and chemistry of Venus’s crust;
4. Understand the properties of Venus’s atmosphere down to the surface and improve our understanding of Venus’s zonal cloud-level winds;
5. Understand the weathering environment of the crust of Venus in the context of the dynamics of the atmosphere and the composition and texture of its surface materials
6. Look for planetary-scale evidence of past hydrological cycles, oceans, and life and for constraints on the evolution of the atmosphere of Venus.

VISE in V&V

1. Understand the physics and chemistry of Venus's atmosphere; abundances of its trace gases, sulfur, light stable isotopes, and noble gas isotopes;
2. Constrain the coupling of thermochemical, photochemical, and dynamical processes in Venus's atmosphere and between the surface and atmosphere to understand radiative balance, climate, dynamics, and chemical cycles;
3. Understand the physics and chemistry of Venus's crust;
4. Understand the properties of Venus's atmosphere down to the surface and improve our understanding of Venus's zonal cloud-level winds;
5. Understand the weathering environment of the crust of Venus in the context of the dynamics of the atmosphere and the composition and texture of its surface materials
6. Look for planetary-scale evidence of past hydrological cycles, oceans, and life and for constraints on the evolution of the atmosphere of Venus.

V&V VISE Objectives	OWL Q	OWL VISE Objectives
1, 2, 3, 4	1.1	B, C
1, 3	1.2	A, B, C
2, 5	1.3	B, C
1, 2, 3, 4, 5	3.1	B, C
1	3.3	B
1	3.4	B, C
3, 5	3.5	C
1, 2, 3	3.6	A, B, C
2,3	4.2	B
2,3	4.4	B, C
3	5.1	A, C
2, 3	5.2	C
3	5.3	B, C
3, 5, 6	5.4	A, B
3	5.6	B, C
1, 2, 4, 6	6.1	A, C
3, 4, 6	6.2	A, B, C
1, 2, 3, 4, 5, 6	6.3	A, B
1, 2, 3, 4, 5, 6	6.4	A, B, C
1, 2, 4, 6	6.5	A
1, 2, 4	6.6	A, B, C
1, 2, 3, 4, 5, 6	10.1	A, B
1, 2, 3, 4, 5, 6	10.3	A, B, C
1, 2, 4, 6	10.5	A, B, C
6	11.3	B
2	11.4	B, C
1, 2, 4, 5, 6	12.1	A, B, C
1, 2, 4, 5, 6	12.2	C
1, 2, 5	12.3	B, C
1, 2, 4, 5, 6	12.6	A, B, C
3, 5, 6	12.10	A, B
6	12.11	A, B, C

"Substantially Addressed" "First Look"

VISE in OWL

A. Characterize past or present large-scale spatial and temporal (global, longitudinal and/or diurnal) processes within Venus's atmosphere.
B. Investigate past or present surface-atmosphere interactions at Venus.
C. Establish past or present physical and chemical properties of the Venus surface and/or interior.

Numbers/letters do not denote priority

Venus and New Frontiers 5

Gathered from feedback, community letters, webforms, etc. quotes and paraphrases

- The new Decadal Survey is target-agnostic and processes/phenomena-based, and Venus happens to be a location where a great number of critical, Decadal-level questions can be tackled.
- Removing VISE has detrimental effects for the community extending beyond just a single missed proposal opportunity, e.g. technology pushes within centers, mission design, fundamental and supporting Venus science, diversion of expertise.
- The proposal process itself helps develop missions and sustains the push for technology development.

Venus and New Frontiers 5

Gathered from feedback, community letters, webforms, etc. quotes and paraphrases

- Even with vetting and communication, the decision to remove Venus from the NF 5 theme list "would weaken the tradition for NASA's competed planetary mission lines that mission selection is made primarily on the basis of the strength of the mission concept proposal. The key criteria for evaluation of proposal strength, by that tradition, are the importance and novelty of the mission's scientific promise and the technical readiness of the spacecraft and payload, while recognizing that presumably secondary programmatic factors – such as balance across solar system targets, scientific community segments, and implementing organizations – also play a role." (Sean C. Solomon)

VEXAG Community-based Findings Regarding New Frontiers

- VEXAG finds NASA should restore VISE to NF 5 target list for Draft NF 5 AO, currently expected November, 2022.

- VEXAG finds NASA should provide specific, timely considerations and rationale to the community for removal or modification of any target from any New Frontiers theme list, and engage CAPS in a transparent vetting process (c.f the 2020 NF 5 CAPS report) before the release of any draft AO.

Backup

The Big Questions (VEXAG Ed.)

Goal	Objective	Investigation	Achieved by end of V3NUS	Future Achievement	V&V VISE Objectives
I. Understand Venus' early evolution and potential habitability to constrain the evolution of Venus-size (exo)planets	A. Did Venus have temperate surface conditions and liquid water at early times? **BP2,3,4,5**	**HO. Hydrous Origins**	Near-IR emissivity maps, searching for widespread felsic crust.	Multilocation measurement of surface rock composition, particularly in tesserae.	3, 5
		RE. Recycling	Radar maps, subsurface sounding, Near-IR emissivity maps.	Multilocation measurement of surface rock composition. Follow-up high-res radar & high res NIR surface imaging. Age dating.	3, 5, 6
		AL. Atmospheric Losses	-	Orbital measurements of ionosphere & solar wind interaction; measure winds and transport through lower thermosphere.	1
		MA. Magnetism	-	Magnetic fields measured from orbit, balloon, near surface	3
	B. How does Venus elucidate possible pathways for planetary evolution in general? **BP1,2,4,5**	**IS. Isotopes**	Comprehensively addressed by DAVINCI.	Next generation MS instruments on long-lived cloud platform may be able to achieve even higher sensitivity	1, 4
		LI. Lithosphere	Comprehensively addressed by VERITAS & EnVision's SAR & gravity.	Seismometry; Magnetotelluric sounding; Multi-location measurements of surface material & bulk composition. Follow-up high-res radar & high res NIR surface imaging. Age dating.	3, 5
		HF. Heat flow	Constraints from gravity/topography & from detection, characterization of volcanism & tectonism.	Seismometry; in situ heat flow in different provinces.	3, 5
		CO. Core	Strongly constrained by gravity measurements & spin vector variation monitoring.	Seismometry. Higher accuracy gravity from e.g. gradiometry Magnetic field measurements from orbit and/or aerobot.	3, 5

VISE Objectives in blue denote most significant measurements a VISE-like mission (NF 5 or OWL version) could achieve that are outside V3NUS objectives

Goal	Objective	Investigation	Achieved by end of V3NUS	Future Achievement	V&V VISE Objectives
II. Understand atmospheric dynamics and composition on Venus.	A. What processes drive the global atmospheric dynamics of Venus? **BP4,6**	**DD. Deep Dynamics**	Vertical profile of P, T, wind, from; cloud-level winds & waves from cloud tracking; gas mapping & radio occultation from; surface winds from SAR aeolian features.	Cloud-level 3-D winds & waves from aerobot. Long-life surface meteorological station. Next-generation cloud tracking from orbit. Sat-to-Sat radio occultations for frequent T profiles at 40 – 90 km.	1, 2, 4, 5
		UD. Upper Dynamics	-	Ionosphere / magnetosphere / plasma / solar wind interaction orbital measurements. Sub-mm heterodyne to measure winds & transport at 70 – 140 km, or thermal IR sounding of mesosphere (60 – 100 km).	2
		MP. Mesoscale Processes	Constraints on winds & waves. Winds from camera elements.	Cloud-level 3-D winds & waves from aerobot. Simultaneous orbital & in situ atmospheric observations. Long-life meteorological station.	1, 2, 4, 5, 6
	B. What processes determine the baseline and variations in Venus atmospheric composition and global and local radiative balance? **BP3,5,6**	**RB. Radiative Balance**	Radiative flux measurement from descent probe. New spectroscopy from orbit.	Radiative flux measurements from descent probes. Cloud-level radiative flux measurements from aerobot. Long-life radiometric/meteorological station.	2
		IN. Interactions	Chemical profiles, and maps of key volatile gases, and links to volcanic activity.	In situ characterization of cloud particles, radiation, microphysics. Search for lighting (aerobot, orbiter). Aeolian processes (lander, sampler, orbiter).	2, 4, 5
		AE. Aerosols	Orbital mapping of aerosol distributions. Measurement of gaseous volatile species which participate in condensational cloud formation.	In situ cloud-level aerobot measuring cloud and gas composition, and particle size & shape. Characterization of dust at surface.	2, 5, 6
		UA. Unknown Absorber	Orbital UV observations. In-situ chemical inventory in clouds.	In situ cloud-level aerobot measuring cloud, gas, aerosol composition, especially at altitudes > 60 km, and UV/blue fluxes.	2, 6
		OG. Outgassing	Vertical profile of composition including outgassed volatiles; Mapping outgassed volatile species.	In situ measurements of surface and cloud materials to search for signatures of outgassed volatiles.	1, 2, 6

Goal	Objective	Investigation	Achieved by end of V3NUS	Future Achievement	V&V VISE Objectives
III. Understand the geologic history preserved on the surface of Venus and the present-day couplings between the surface and atmosphere	A. What geologic processes have shaped the surface of Venus? **BP2,3,5**	**GH. Geologic History**	Global SAR imaging & topography, NIR emissivity, gravity & subsurface mapping + high-res imaging.	Detailed surface properties & composition multiple locations. Follow-up high-res radar & high res NIR surface imaging.	All
		GC. Geochemistry	Constraints from NIR emissivity maps (& SAR & radiometry).	Multisite measurement of surface composition.	3, 6
		GA. Geologic Activity	Change detection (repeat SAR imagery), searches for NIR & RF thermal anomalies, volcanic plumes, volcanic tracers.	Systematic surface monitoring with repeat-pass InSAR & radiometry (NIR & RF). Seismometry (surface, aerobot, or orbital).	3, 5
		CR. Crust	Addressed by SAR & gravity, sub-surface sounding, and descent imaging.	Seismometry; Magnetotelluric sounding; In situ measurements of surface material composition.	3, 5, 6
	B. How do the atmosphere and surface of Venus interact? **BP3,5**	**LW. Local Weathering**	Constraints from NIR emissivity maps (& SAR & radiometry). Also measurements of near-surface atmospheric composition.	Measurement of surface & near-surface atmosphere composition at multiple localities.	5
		GW. Global Weathering	Constraints from NIR emissivity maps (& SAR & radiometry) & SAR imagery.	Measurement of surface & atmosphere composition, global patterns.	3, 5, 6
		CI. Chemical Interactions	Measurements of near-surface atmospheric composition. Measurements of tropospheric gas abundances. Maps of clouds & low-altitude water vapor. Radar anomaly.	Surface landers & meteorological stations. Follow-up high res radar and other surface mapping.	2, 3, 4, 5

Venus and New Frontiers 5

The Decadal Midterm Report (2018) and NAS summaries from 2021 leave NF5 targets unchanged, and call on NASA to vet changes with CAPS.

- 12-5-2021 NASA Community Announcement on NF-5 indicated the results of the Decadal Survey would guide NF-5, and the Decadal Committee responded (25-5-2021) **it would not adjust the mission themes for NF-5** [OWL, p22-30].

- 2020 CAPS addressed new information regarding ocean worlds, evaluation for NF5 (March-June 2020) evaluated Ocean Worlds, Trojan Tour and Rendezvous, Io Observer and Lunar Geophysical Network, **did not ask for evaluation of Venus In Situ Explorer** (VISE). [CAPS : Options for the Fifth New Frontiers Announcement of Opportunity (2020)]

- The CAPS midterm review of V&V recommended “If scientific discoveries or external factors compel NASA to reassess decadal survey priorities, such as the list of New Frontiers missions, **NASA should vet these changes** via the Committee on Astrobiology and Planetary Science and allow for input from the community via assessment and analysis groups as time permits” [V&V Midterm Review p68, 2018].

Venus and New Frontiers 5

- The Fifth Community Announcement would have benefitted from
  - More specific rationale in the announcement and community feedback solicitation on this potential change specifically – **Which is not to late to do before release of draft NF 5 AO in November, 2022**
  - A following the same transparent, established vetting process before the fact as in the 2020 CAPS report – **which it is not too late to do between draft and final NF 5 AO in November 2023**

- Science Merit guides New Frontiers. Elimination without explanation or discussion created unintended consequences of uncertainty in the Venus and planetary community. Programmatic clarification in following days helped, but dramatically affects the context of the NF 5 announcement evaluation in the community

Venus In Situ Explorer (VISE) in OWL

Venus In Situ Explorer (VISE) investigates the processes and properties of Venus that cannot be characterized from orbit or from a single descent profile. These include:

1. Complex atmospheric cycles (e.g., radiative balance; chemical cycles, atmospheric dynamics, variations of trace gases, light stable isotopes, and noble gas isotopes, and the couplings between these processes);
2. Surface-atmosphere interactions (e.g., physical and chemical weathering at the surface, near-surface atmospheric dynamics, and effects upon the atmosphere by any ongoing geological activity); and
3. Surface properties (e.g., elemental and mineralogical composition of surface materials, heat flow, seismic activity, and any magnetization).

VISE will provide breakthrough information on the origin of the terrestrial planets, the evolution of their interiors and surfaces, atmospheric evolution and climate, and critical insights into the nature and habitability of exoplanets. Science objectives:

- Characterize past or present large-scale spatial and temporal (global, longitudinal and/or diurnal) processes within Venus's atmosphere.
- Investigate past or present surface-atmosphere interactions at Venus.
- Establish past or present physical and chemical properties of the Venus surface and/or interior.

The mission shall address at least two of these three objectives.

OWL p22-35