

#Unveil Venus:
Why is Earth's sister
planet so different?



VEXAG Update PSS September 30, 2016

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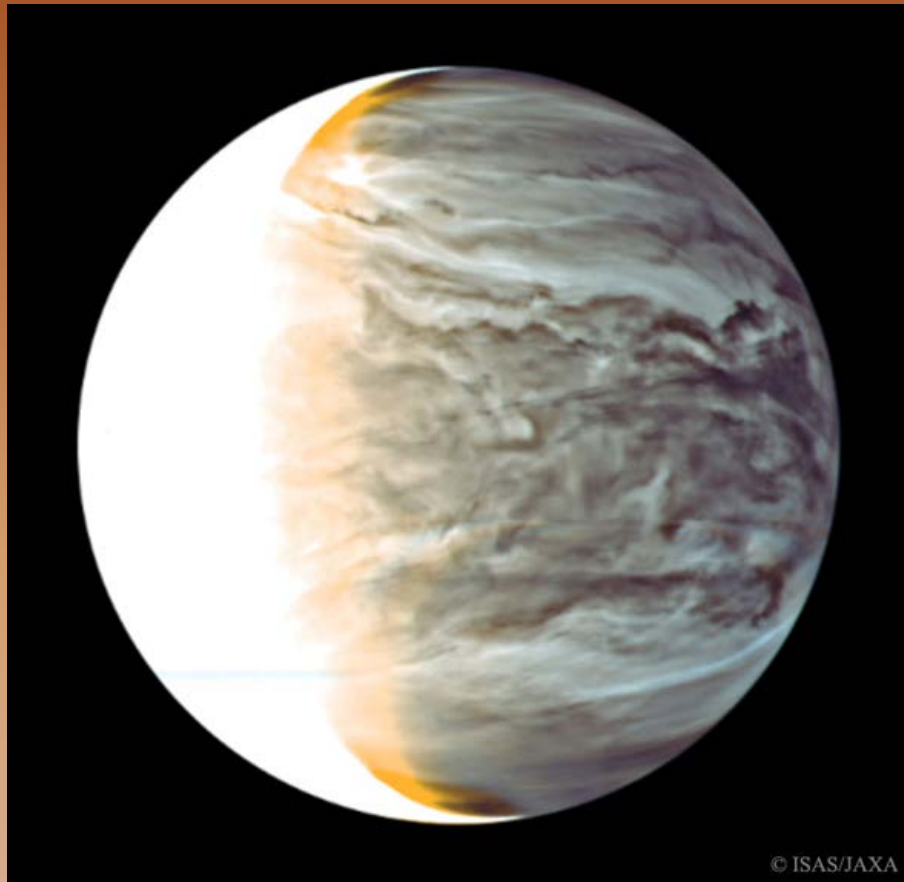
VEXAG/Venus activity since 3/16 PSS meeting

- VEXAG Town Hall at LPSC, 24 Mar.
 - Briefing on Venus Discovery missions and GOI update; discussion of PSD R&A.
- Update to Venus Goals, Objectives, and Investigations (GOI) to include aeronomy and space physics.
- Hashtag & slogan development lead by Venus Early Career Scholars.
- International Venus Conference, Oxford, 4-8 Apr.
- Participated in NRC SSB Review of NASA R&A Programs, 13 May.
- Short course on Venus science, technology, and mission architecture at 13th Int'l Planetary Probe Workshop, 13-17 Jun.
- HOTTech NRA released – originally advocated as part of Venus Technol. Develop.
- Venera-D Joint Science Definition Team
 - Interim report completed; final mtg Oct 2016 in Moscow; final report release Jan 2017.

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Akatsuki Update



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- Orbit insertion on Dec 7, 2015
 - 9-day period, near-equatorial, apoapsis ~350,000 km
 - Routine ops began Apr 2016.
 - All instruments in good condition
- Minimum science goals achieved.
- Full science goals achievable, albeit at reduced imaging resolution and cadence of radio occultations and lightning search.
 - NASA Participating Scientist program has 2 Scientists in Residence (Limaye & McGouldrick) and 6 Participating Scientists (Acton, Bullock, Lorenz, Jessup-Lea, Schubert, Young)

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US Science Results

- Cloud-ocean feedback on early Venus could have sustained Earth-like temperatures for up to 2 Gyr (Way et al., 2016)
- Steep-sided lava domes on Venus consistent with basaltic andesite (Quick et al., 2016)
- IR emissivity and gravity anomalies in Themis Regio may indicate active, hot mantle upwellings (Stofan et al., 2016)
- S-band radar could detect surface lava effusions from an Etna-like volcano on Venus (Lorenz et al., 2016)

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Upcoming Mission Activities

- Akatsuki
- Envision (ESA M-Class)
- Discovery Mission Selection
 - Impacts GOI, Tech, Roadmap
- NF-4 opportunity for Venus In Situ Explorer
- Decadal Survey mid-term assessment
- Venera-D 2023/25
- VEGASO
- Cubesats and smallsats

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Upcoming Meetings and Other Activities

- VEXAG #14, 29 Nov to 1 Dec, NASA HQ
- Website update to better align with other AGs and highlight Venus promotional and scientific materials.
- Lab/Modeling/Simulation Workshop, June 2017, near GRC.
- ESLAB Symposium on Comparative Aeronomy, Spring 2018
- Comparative Climate of the Terrestrial Planets 3, mid-2018
 - CCTP series originally conceived by VEXAG and supported by all 4 NASA science divisions was instrumental in new ROSES element for Comparative Climatology

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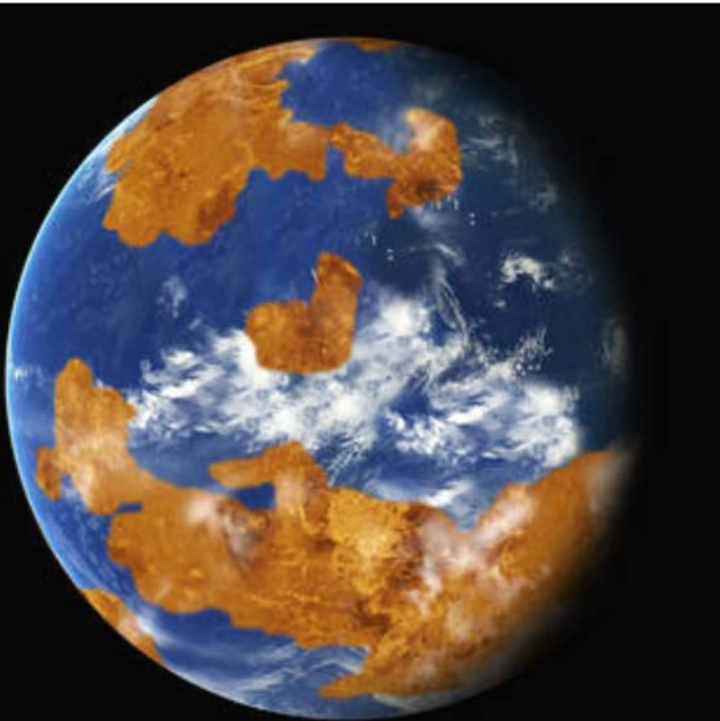
Conclusion

- Despite no US Venus missions launched in 27 years, the VEXAG community remains active in international missions, research, workshops, annual meetings, and mission development.
- The Venus community is poised for critical advances in understanding our sister planet that would be enabled by Discovery, New Frontiers, or Flagship missions.

Was Ancient Venus A Habitable World?

Way, Del Genio, Kiang, Sohl, Grinspoon, Aleinov, Kelley, Clune, 2016, GRL "Was Venus the first habitable world of our solar system?"

- Venus may have had a shallow water ocean and habitable climate for up to 2 billion years in its early history
- 3-D climate model simulations assume an Earth-like atmosphere, Venus' current 117 day solar day, a shallow ocean based on Pioneer spacecraft data, topography from the Magellan mission, and 30% dimmer ancient sun
- Slow rotation produces clouds on the day-side of Venus keeping the surface as cool as present day Earth, while Venus received 40% stronger sunlight 3 billion years ago than Earth today



Left: Artist representation of habitable paleo-Venus

Right: Cloud cover (white) plays a decisive role in shielding the side of the planet facing the sun by reflecting much of the incident sunlight to space so it does not reach the surface and heat it up

An early habitable Venus expands the potential environments for the origins of life in the Solar System and exoplanet targets in the search for life elsewhere

