Venus Sample Return Using In-situu Propellant

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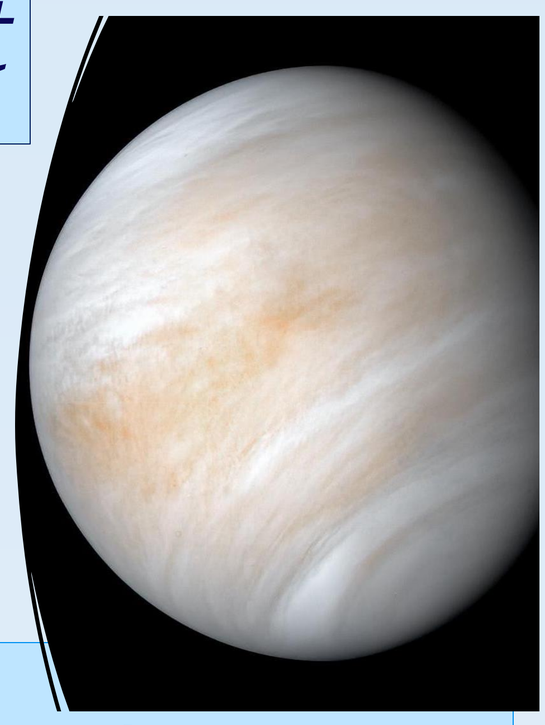


Why Venus?

- Venus is Earth's evil twin: nearly the same size at Earth, yet in many ways very different.

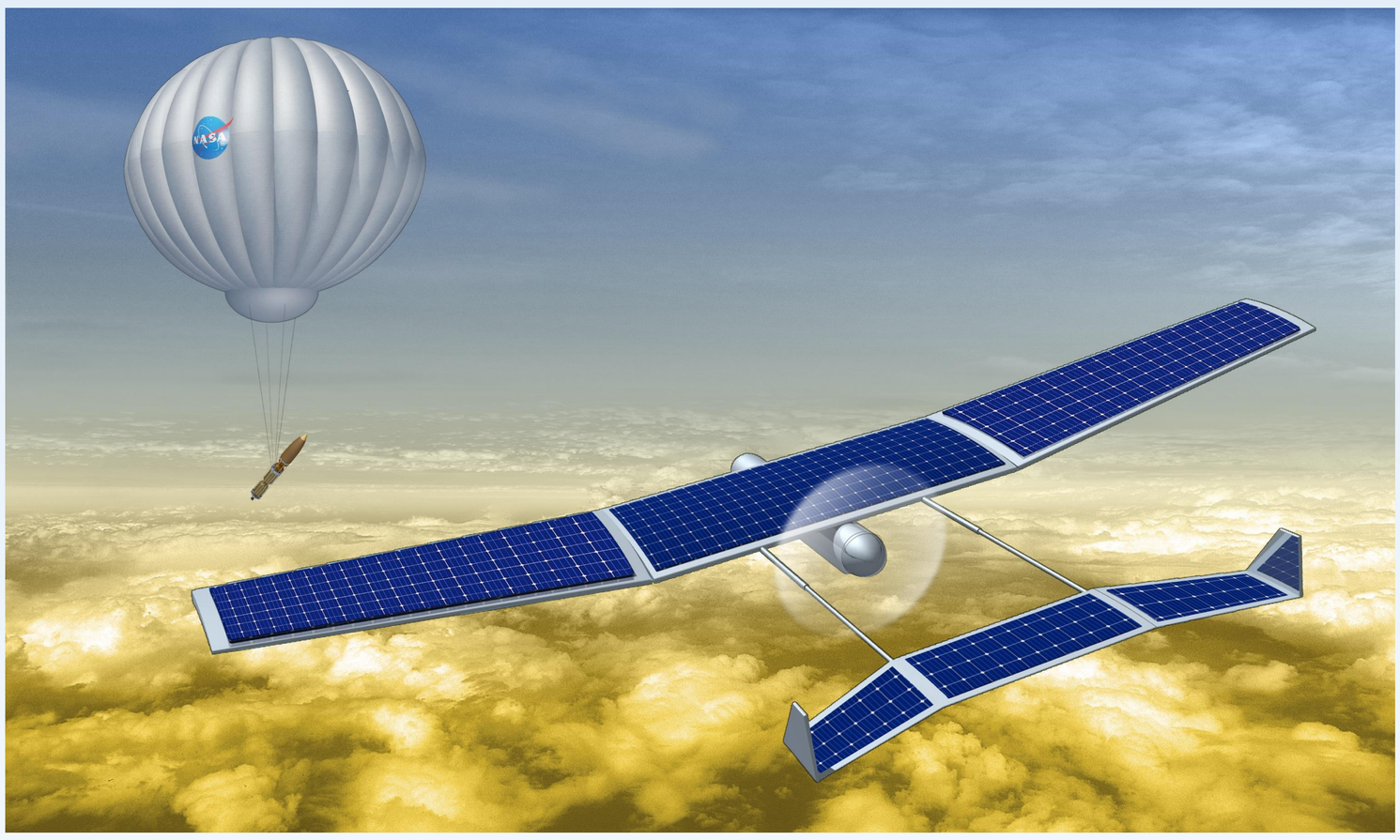
Our knowledge of the geology and mineralogy of the surface of Venus is very slight. Beneath the clouds, the surface of Venus is mostly unknown.

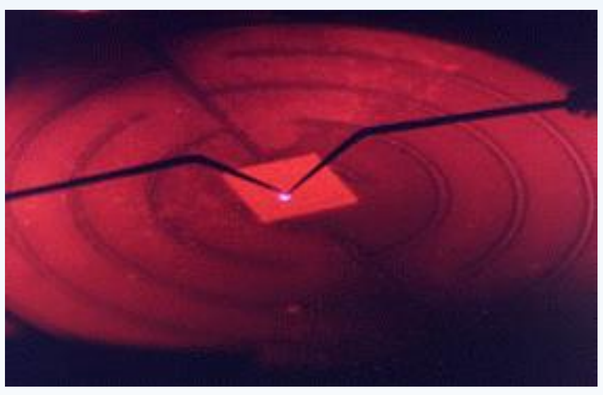
- Only one NASA mission has even entered the atmosphere.
- The Soviet Venera and VeGa missions did slightly better, but the longest-lived Venera transmitted for only two hours after reaching the surface
- To really understand geology and minerology of Venus, we need to bring surface samples back to Earth
- But the surface of Venus is one of the most hostile environments in the solar system: fiercely hot, high pressure, and corrosive.

Why Venus? Not because it is easy, but because it is hard

Solution using multiple technologies

- High-temperature solar airplane with SiC electronics gathers surface sample and bring sample to:
- Orbital launch rocket floats ~60 km above the surface
- Rocket launches with sample to rendezvous with in-space return vehicle waiting in orbit





NASA Glenn SiC devices have demonstrated operation at temperatures as high as 650 C.

An early conceptual design of the balloon platform was a toroidal balloon, shown here with the launch vehicle suspended beneath the central aperture

At a surface temperature of 450C, we don't want to land the fully-fueled sample return rocket on the surface!

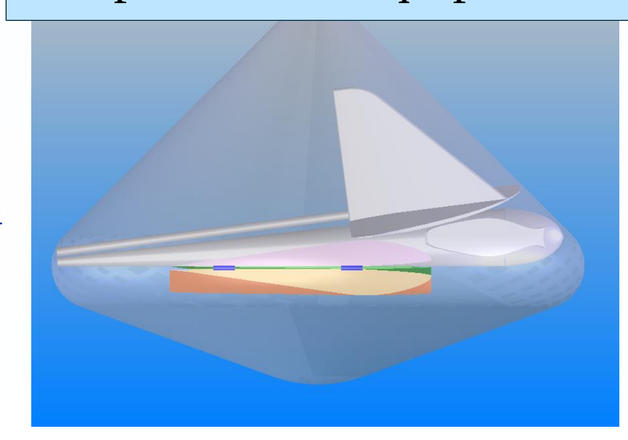
- Solution: Float the rocket high above the surface in a balloon

Launching from the atmosphere of Venus to orbit is as hard as launching from the surface of Earth

To reduce the amount of mass we need to carry to Venus, we will examine the possibility of using *in-situ propellant production* to make rocket propellant from the Venus atmosphere

- We have working technology to make carbon monoxide and oxygen from carbon dioxide
- Technology developed at NASA Glenn uses carbon monoxide and oxygen as rocket fuel
- Use of ISRU fuel production means we bring to Venus only the empty weight of the vehicle, not the fully-fueled rocket.
- Question to be answered: does mass we save by not bringing fuel outweigh the mass of the fuel production equipment and power system?

SS-520 orbital booster, at 2.6 tons, the smallest vehicle to launch to Earth orbit



Solidworks model of solar airplane folded into aeroshell for Venus atmospheric entry

Question to be answered
How difficult will it be to keep the cryogenic propellants liquid?

Mission design and engineering by the NASA Glenn Compass current engineering team