



White Paper Title: **Terrestrial Planets Comparative Climatology (TPCC) Mission**

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The white paper would describe a mission concept to compare the climatology of the terrestrial planets by sending a single spacecraft to both Mars and Venus or possibly sending twin spacecraft, one to each planet. It would be based on our 2019 Mission Concept proposal and as such is mostly written. Below is a brief description of the concept. **If interested in reviewing or supporting, please sign up on the TPCC\_White\_Paper\_Interest google sheet, here:**

<https://docs.google.com/spreadsheets/d/1gJTSmeRvZfOEEdhamhLAJo40sY9Z7LoAyiDKF2qtDihU/edit#gid=0>

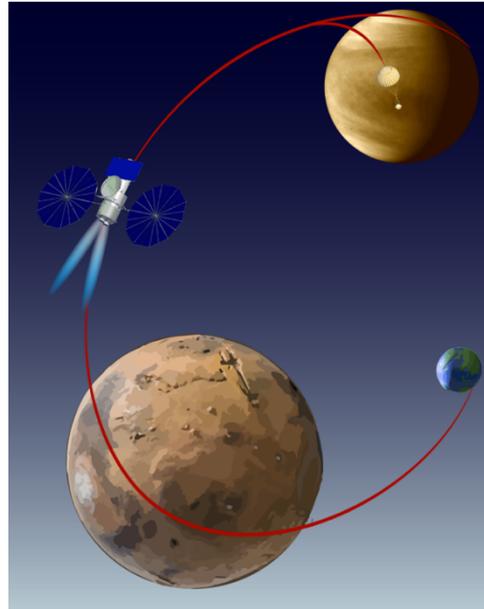
*Mission Concept Goals and Objectives:*

- **The overall goal of the TPCC mission** is to increase our knowledge of terrestrial planet formation history and climate evolution by sending a single orbiter to both Mars and Venus.
- **The science objectives are:** (1) Determine the loss of the Venus atmosphere over time, (2) Determine the net energy input above 90 km in the Venus atmosphere and the spatial and temporal variations in chemical abundances in the Mars atmosphere, (3) Determine the net energy input to the Martian atmosphere (0–100 km), (4) Determine the net energy input to the top of the Venus cloud deck, (5) Measure the net energy to the Martian surface, and (6) Determine the dynamical behavior of Venus' atmospheric transition region (60–100 km) and the lower & middle Martian atmosphere (0–100 km).

*Mission Concept Description:*

- The TPCC mission concept is a **single orbiter, with one drop-off probe**. The drop-off probe is intended for the Venus atmosphere, to probe within and below the cloud deck. A **trade** would be to consider two identical orbiters.

- The single orbiter would use **solar-electric propulsion** to travel to both Mars and Venus.
- The TPCC mission is envisioned to obtain measurements of both Mars and Venus near the same part of the solar cycle.
- This dual-purpose concept has the following advantages:
  - 1) Solar conditions affect the energy input to the planets, so observing both planets near the same part of the solar cycle reduces uncertainty associated with input energy
  - 2) Observing both planets with the exact same instrumentation reduces uncertainty due to different techniques or technologies
  - 3) Allows for a more direct comparison of terrestrial planet climates, for comparison to Earth, and for consideration in exoplanet studies



**Implementation details:**

- *Instruments-orbiter: it would carry mid-UV to EUV spectrometers, NIR spectrometer, and sub-mm and IR limb sounders.*
- *Instruments-probe: it would carry a neutral mass spectrometer, temperature and pressure sensors, and a net flux radiometer.*
- *The spacecraft would use solar-electric propulsion to achieve Mars orbit, stay for one Mars year, and then exit Mars orbit to fly to Venus, enter orbit around Venus, and stay for 1+ Venus years.*
- *The sub-mm instrument would provide the first atmospheric wind profiles on either planet. There is no specific launch date target, but it would be constrained by solar cycle predictions.*

**Development Plan:** We plan to develop this white paper over April- May, with a full draft for signature collection by June 5. **Final delivery will be June 26.**

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