EnVision Science Operations Activities Targeted Observations Scenario

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EnVision - Why is Venus so different from Earth?

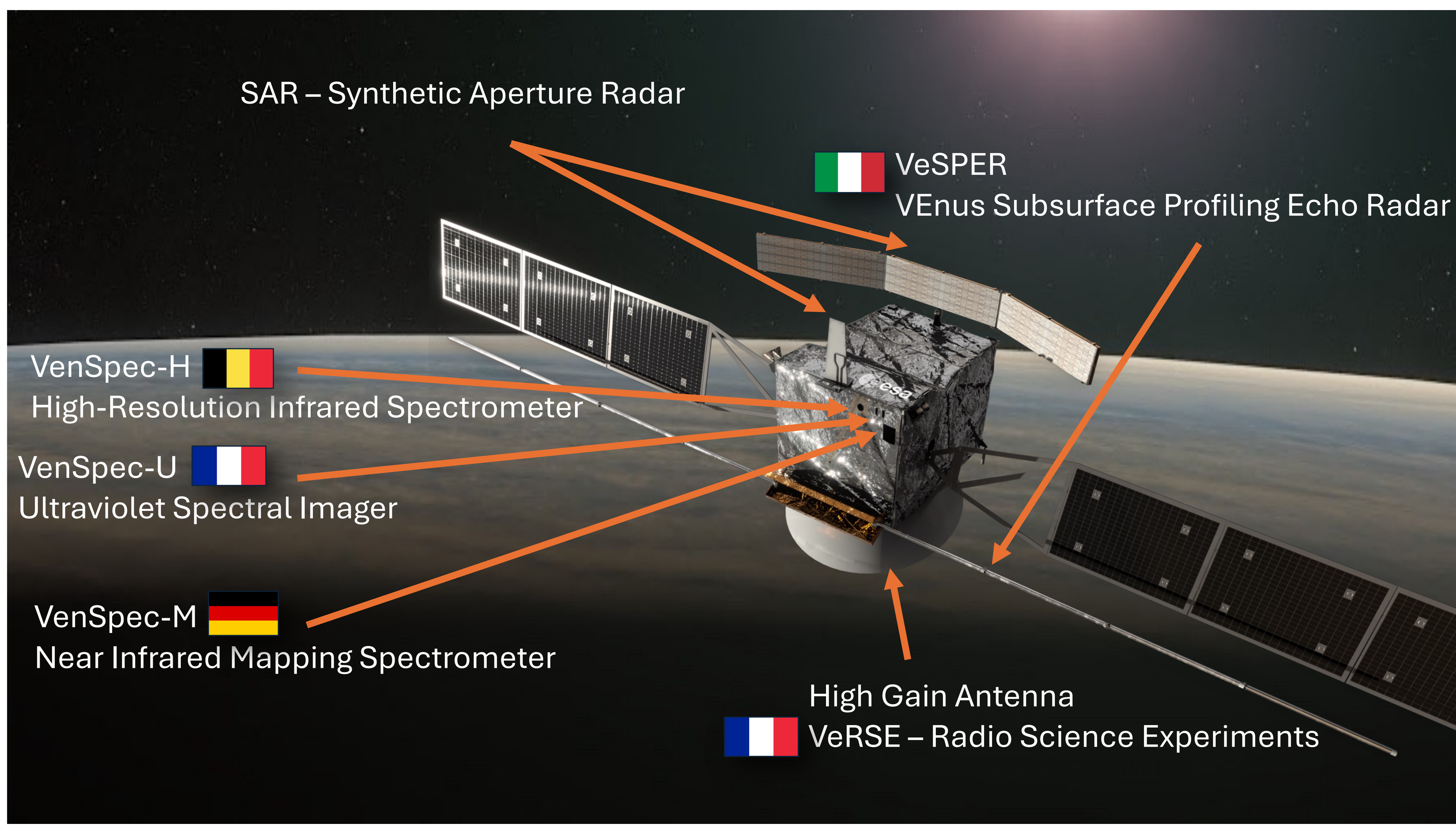
EnVision is ESA's 5th M-class mission of the Cosmic Vision Programme and was adopted in Jan. 2024. It is scheduled to launch in Nov. 2031 (TBC) on Ariane 64.

Its science objectives are articulated around three themes:
- History: How have the surface and interior evolved?
- Activity: How geologically active is Venus?
- Climate: How do geological processes shape the atmosphere and climate?

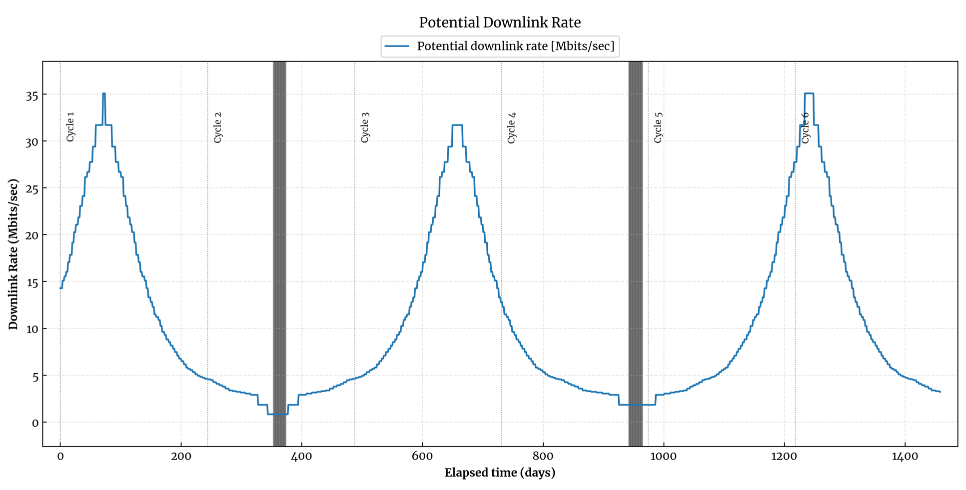
EnVision's comprehensive payload (see figure on the right) will enable **global mapping** (see EPSC2026-507) of Venus' surface, monitoring of its atmosphere in different wavelengths from UV to Infrared and sounding of its subsurface. But the most challenging operations to plan are the targeted observations which we discuss in this presentation. The main challenge is the SAR imaging which also greatly impacts SAR high-resolution, off-nadir radiometry and VeSPER high-density observations of regions of interest.

→ Overall, EnVision will deliver a holistic view of Venus, enabling better understanding of conditions for habitability in our solar system and beyond.

Important: The figures and timelines presented in this poster are an example of operational scenario analysis based on current knowledge and assumptions to assess the performance of the mission.

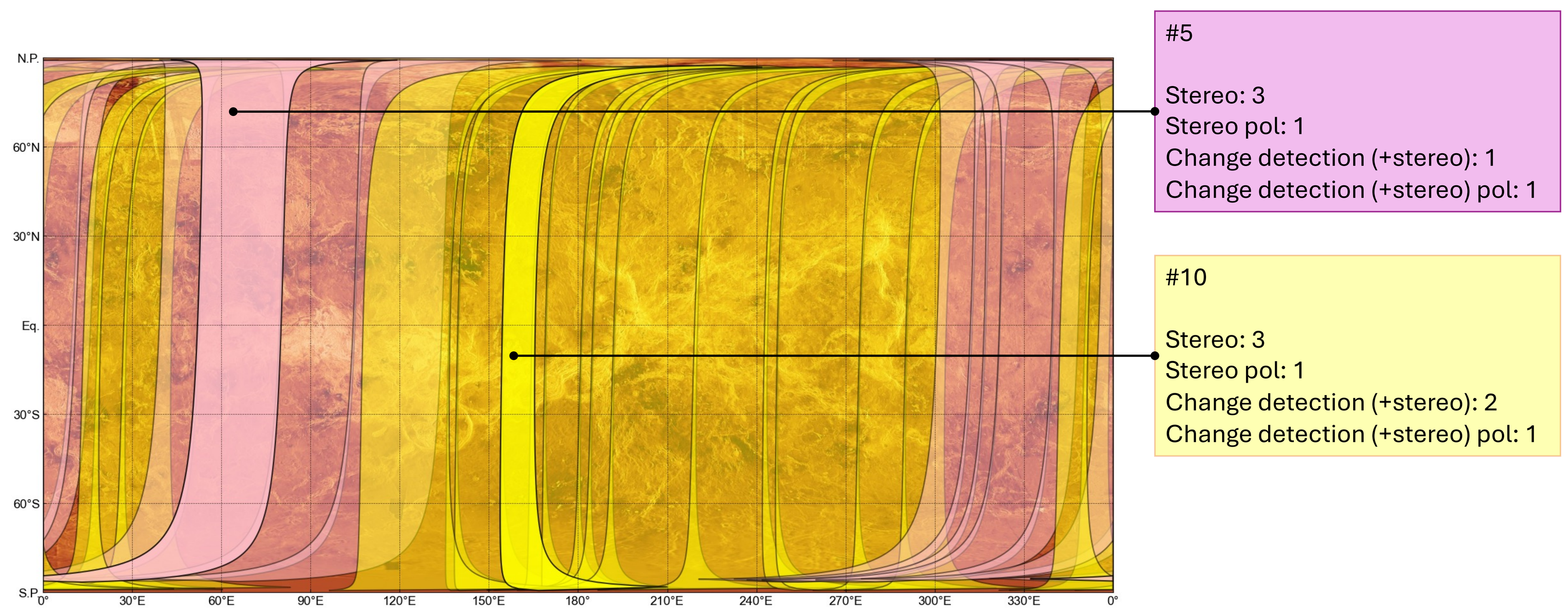


Science Planning driven by trajectory and data rate



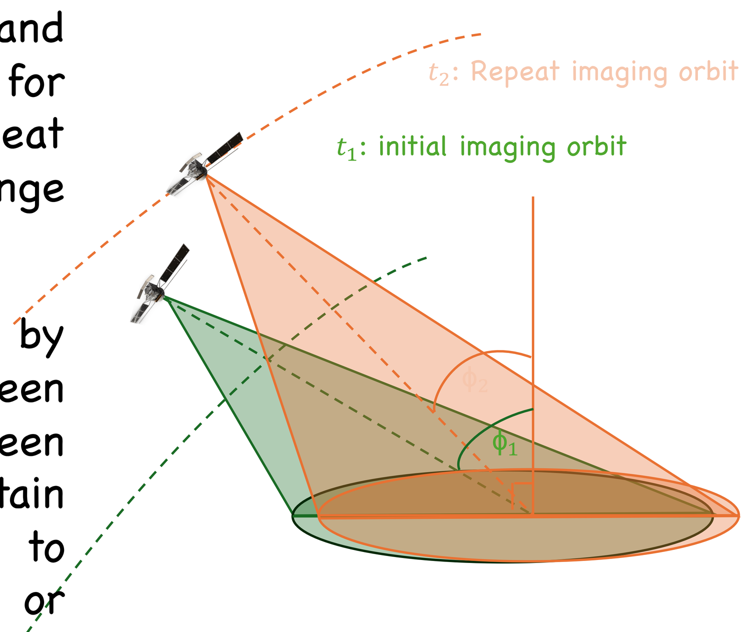
Science Operations planning for EnVision is mostly driven by the variable downlink rate throughout the mission. To maximise the science return of the mission and based on the requirements of the different parts of the payload, a SAR imaging "budget" is established.

This results in a longitudinal distribution of said budget, creating "longitude bands" with different opportunities in number and type. The distribution depends on the start of the science phase which depends on how long the aerorbraking phase will last on arrival. The SAR imaging observation types are: stereo (topography), stereo polarimetry (surface textures), and stereo + change detection (activity).



The complexity of planning the SAR imaging and optimising the budget throughout the mission for all instruments is driven by the need for repeat observations (x2 for stereo, x3 for change detection (+stereo)).

These repeat observations need to abide by constraining rules such as swath overlap between individual acquisitions or the difference between incidence angles ($\phi_2 - \phi_1$) being within a certain range. These constraints will vary according to whether we are targeting stereo imaging or change detection.



Type of observation	Mission requirement (% of Venus surface)
Stereo standard	18 %
Stereo polarimetry	5 %
Change detection	2 %

Note that the sketch shows the incidence difference at the center of the swath but that the problem is exacerbated at the edges and will become increasingly challenging with the difference in altitude between the two observations.

Come to the ESA community room Mon 7th at 13:00 to meet the team and learn more about the definition and planning of EnVision Regions of Interest!

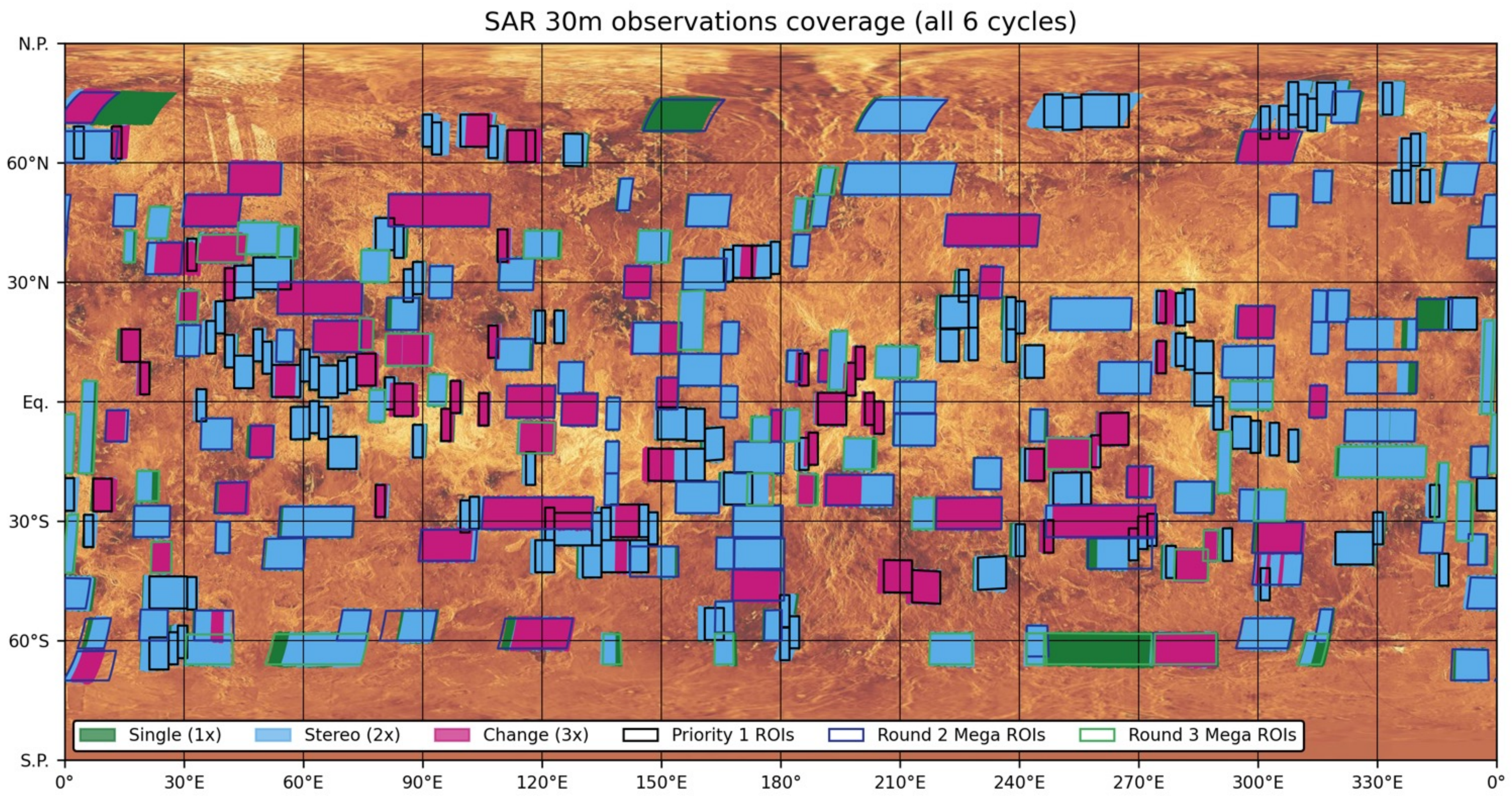
Interdependent planning of observations

Step 1: plan the regions with the highest science priority

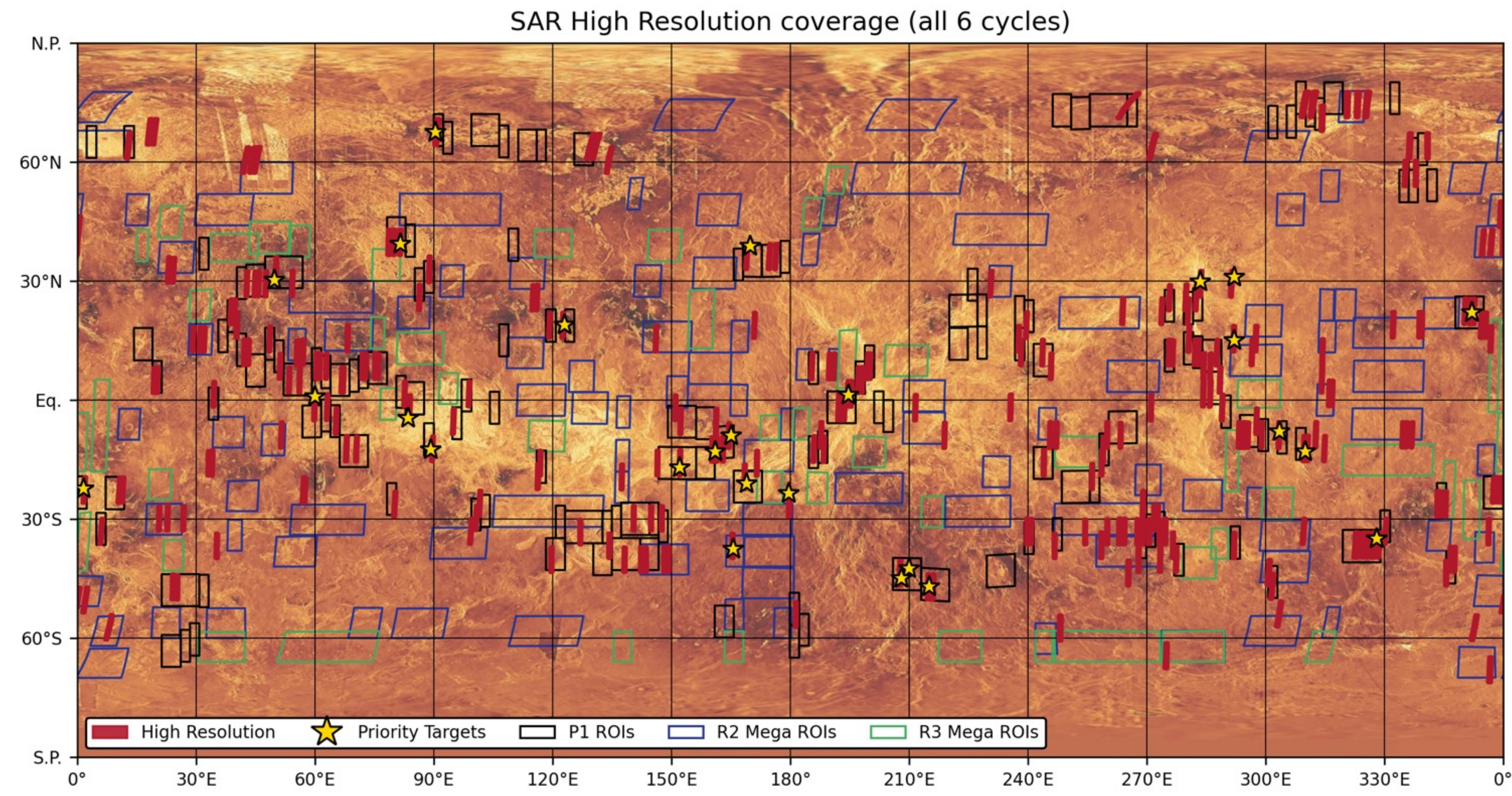
a) Establish rules that will ensure these regions are plannable in any mission scenario.
b) Collect prioritised targets from the science team.
c) Build regions of interest around the highest concentration of high-priority targets within planning guidelines to ensure feasibility in any scenario (see EPSC2026-406).

Step 2: build larger "mega-rois" to optimize the spending of the available budget in areas of interest identified and prioritized by science team

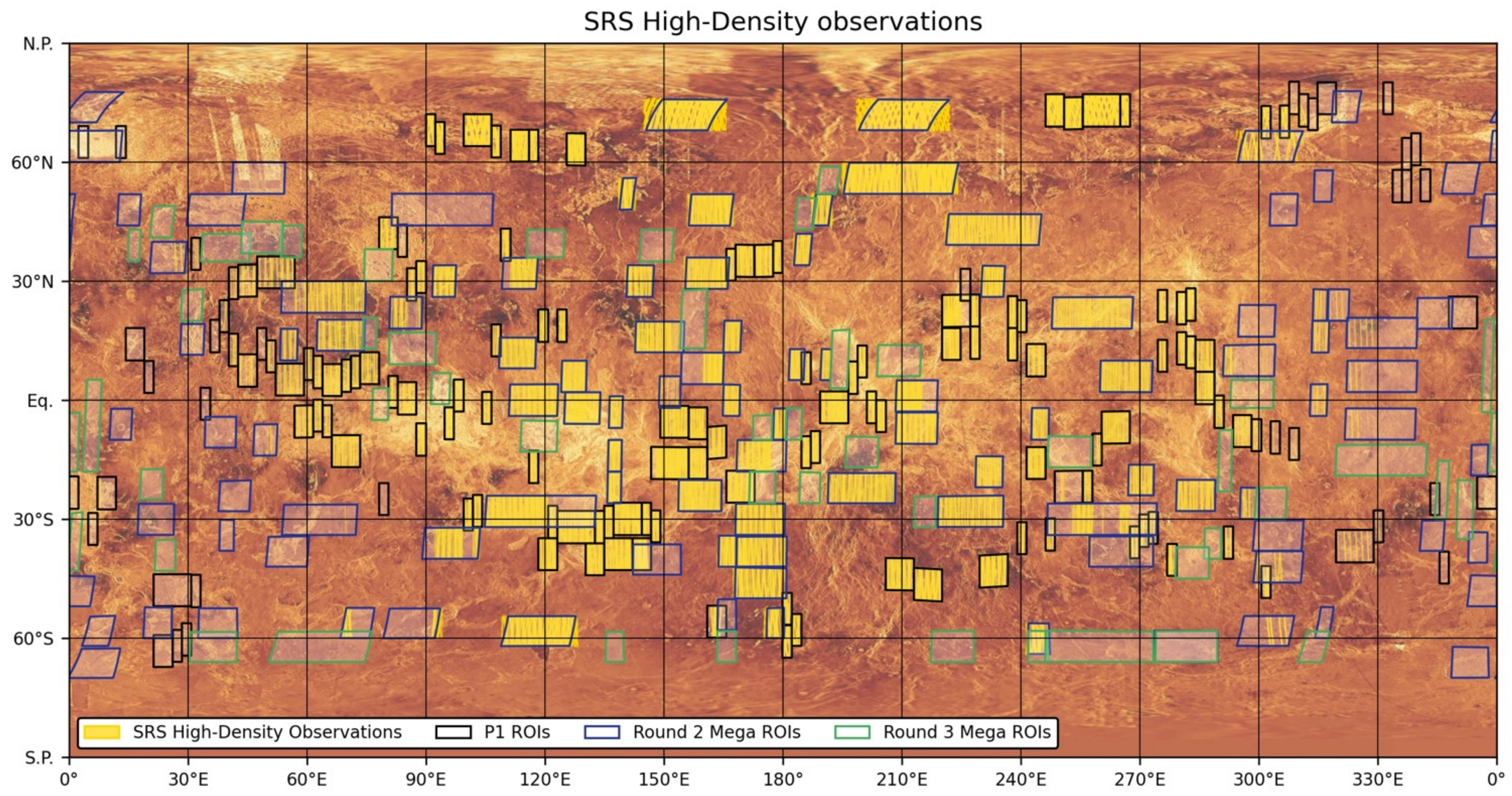
a) Maximise surface coverage weighed by priority for each observation opportunity in a given longitude band.
b) Iteration with science team to refine placement.



Step 3: plan high-resolution observations on a subset of the observed regions



Step 4: plan VeSPER high density observations on high priority targets intersecting with planned SAR imaging.



References
[1] ESA BR-247, Cosmic Vision, Space Science for Europe 2015-2025, [2] Straume-Lindner et al. (EPSC2026-613), [3] Mahieux et al. (EPSC2026-507), [4] Mason et al. (EPSC2026-406), [5] ESA (2021), "EnVision, Understanding why Earth's closest neighbour is so different", Definition Study Report for the mission adoption (Red Book).