# QCHFM – Mars Canyon Example

This example shows how QCHFM (Quantum-Coherent Hybrid Flow Modeling) can be applied to simulate wind flow and turbulence inside a massive canyon on Mars—specifically, the Valles Marineris region.

## Objective

To model Martian wind dynamics in a canyon with thermal gradients, terrain-induced turbulence, and regions of uncertainty. The goal is to help robotic missions or drones navigate safely and efficiently.

## Simulation Setup

- Domain: 1000m x 500m 2D canyon slice

- Grid: 100 x 50 points

- Terrain: Gaussian-shaped canyon depression

- Temperature: Day-to-night gradient across the canyon

- Wind driver: Thermally induced horizontal flow

## QCHFM Layers Applied

- Theoretic Core: Navier-Stokes equations simulate baseline wind flow

- Practice Layer: Grid adapts to canyon edges, includes viscous effects

- Quantum Overlay: Adds stochastic gusts and computes confidence maps

## Output

- Wind vector field with terrain overlay

- Temperature contour map

- Confidence heatmap (low-trust zones flagged)

## Insights

QCHFM identified regions of chaotic airflow and sharp instability near cliff edges. These areas had low confidence values, warning that predictions here may not be reliable. Navigation algorithms can avoid or adjust for these areas in real time.

This use case demonstrates QCHFM’s ability to model real planetary conditions and advise mission planning tools.