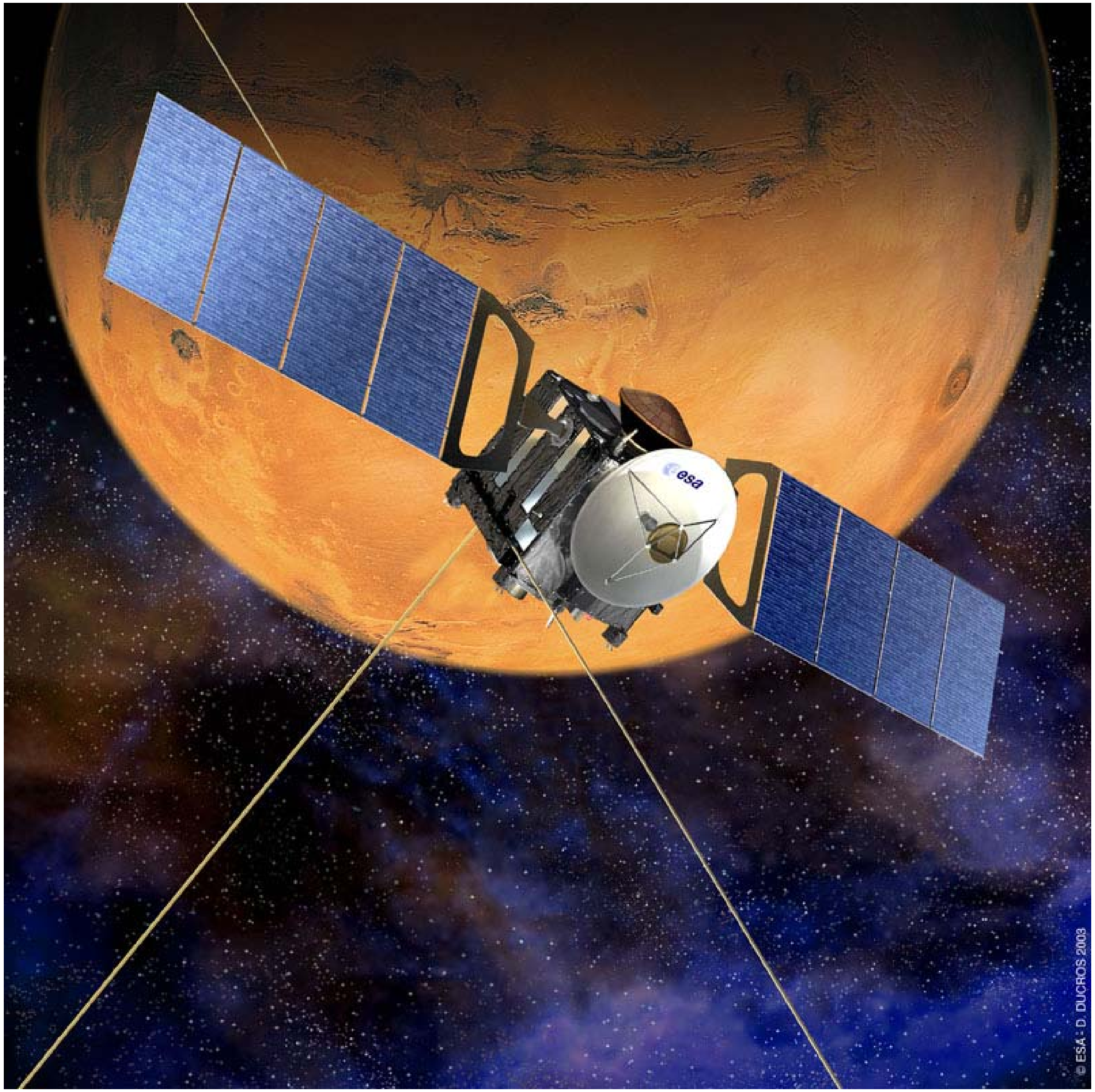
MARSIS Expected Results



J. J. Plaut
G. Picardi
and the
MARSIS
Team

MARSIS

Mars Advanced Radar for Subsurface and Ionospheric Sounding

Science Objectives

Primary

Detect, map and characterize subsurface material discontinuities in the upper crust of Mars. These may include boundaries of:

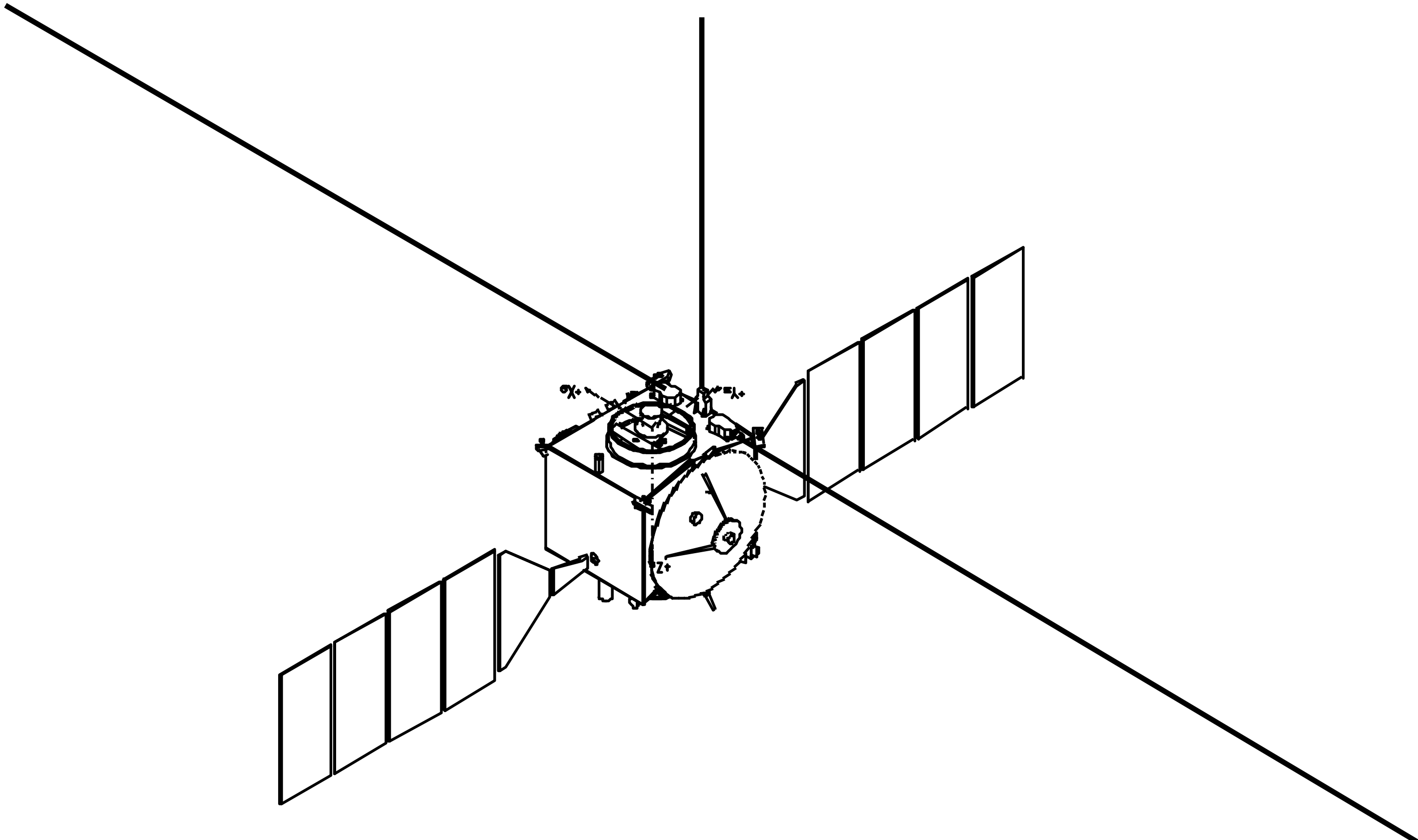
- Liquid water-bearing zones
- Icy layers
- Geologic units
- Geologic structures

Secondary

Characterize and map the elevation, roughness and electromagnetic properties of the surface.

Probe the ionosphere of Mars to characterize the interaction of the atmosphere and solar wind.

MARSIS
Deployed on Mars Express



- **Antenna Sizes**

  Dipole: 40 meters tip-to-tip.

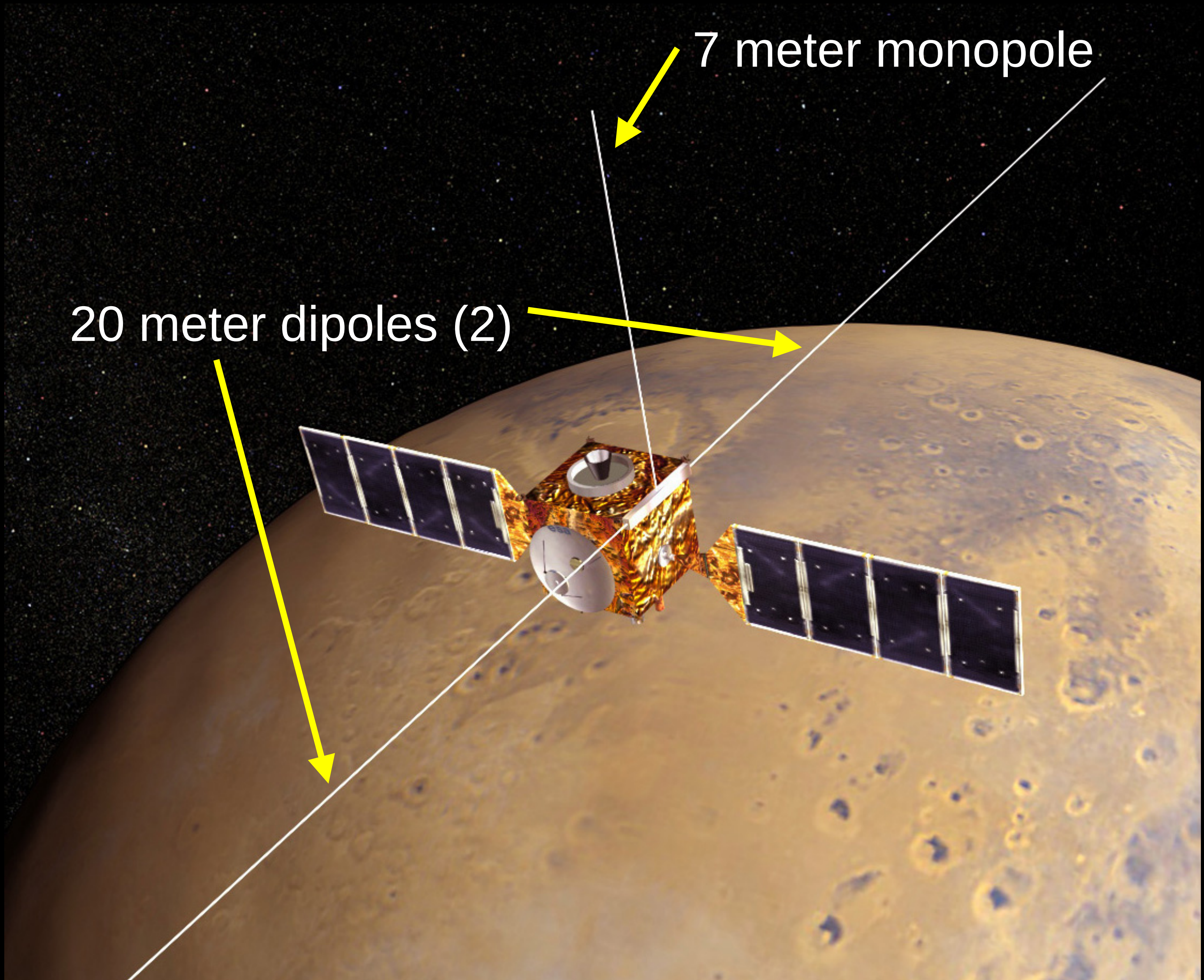
  Monopole: 7 meters.

- **Radar Channels**

  1.8, 3.0, 4.0, 5.0 MHz

  (166, 100, 75, 60 m)

MARSIS Antennas



MARSIS
Science Themes

- Global reconnaissance, subsurface sounding
- Aquifer search
- Polar region studies
- Stratigraphy and geologic structure
- Ionospheric sounding

MARSIS
Science Themes

Global reconnaissance, subsurface sounding

- Detect, map and characterize subsurface interfaces with global sampling, optimized performance
- Surface roughness and reflectivity mapping
- Ionospheric and magnetic field "spin-off" data from subsurface sounding modes

Aquifer search

- Focus on areas suspected to contain aquifers
  - Shallow melting isotherm (low elevation and low latitude).
  - Geologic evidence of aquifers (adjacent to chaotic outflow sources, gullies; polar layered deposits and ice-rich soils).
- Revisit aquifer suspects from prior MARSIS observations

MARSIS
Science Themes

Polar region studies

- Polar layered deposits:
  - Stratigraphy; depth and nature of basal contact (melt zone?); structure/unconformities.
  - Composition.
- Ground ice abundance and thickness
- Seasonal variations (composition, thickness of seasonal deposits; thermal effects – melting)

Stratigraphy and geologic structure

- General mapping of subsurface dielectric constants for compositional constraints:
  - Volatile- and non-volatile-related interfaces.
  - Relationship to surface geologic mapping.
- Sedimentary deposits:
  - Search for aqueous sediments (northern plains "ocean"; outflow deposits; crater and valley floors; hydrothermal deposits).
  - Mobile materials (dust layer thickness; sand seas and dune fields; "stealth" materials).
- Impact materials and structure
- Geologic structure:
  - Global dichotomy expressed in subsurface.
  - Wrinkle ridges (folds and thrust faults in subsurface).
  - Faulting associated with Tharsis, Valles Marineris, and other tectonic zones.

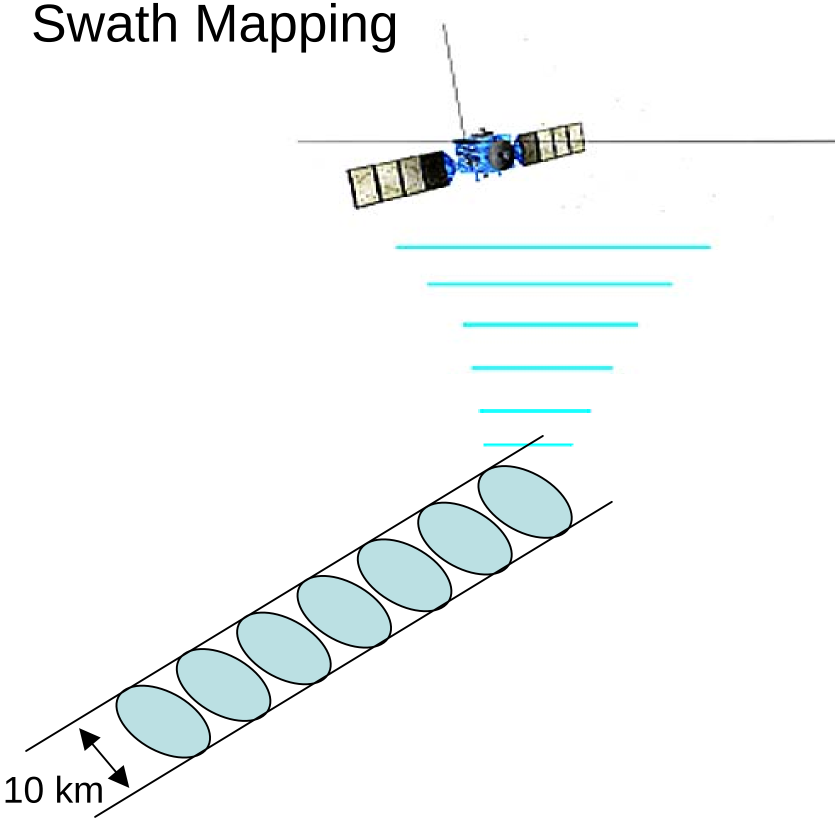
MARSIS
Science Themes

Ionospheric sounding

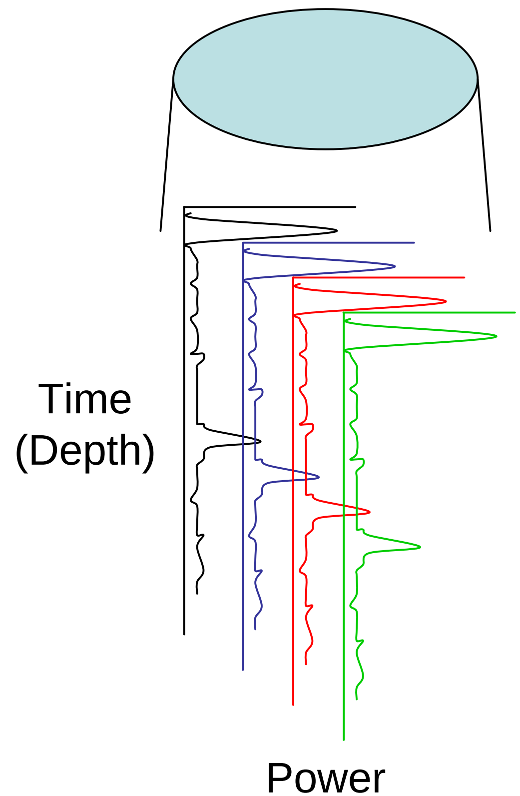
- Reconnaissance of ionosphere under varying conditions:
  - Solar zenith angle, latitude, season.
  - Solar activity/cycle and distance.
  - Crustal magnetic field.
- Nightside behavior (“holes”; other variations)
- Crustal magnetism:
  - Effect on ionosphere.
  - Active ionospheric and subsurface sounding to map crustal fields.

MARSIS
Data Acquisition Scheme

Swath Mapping



Single Footprint

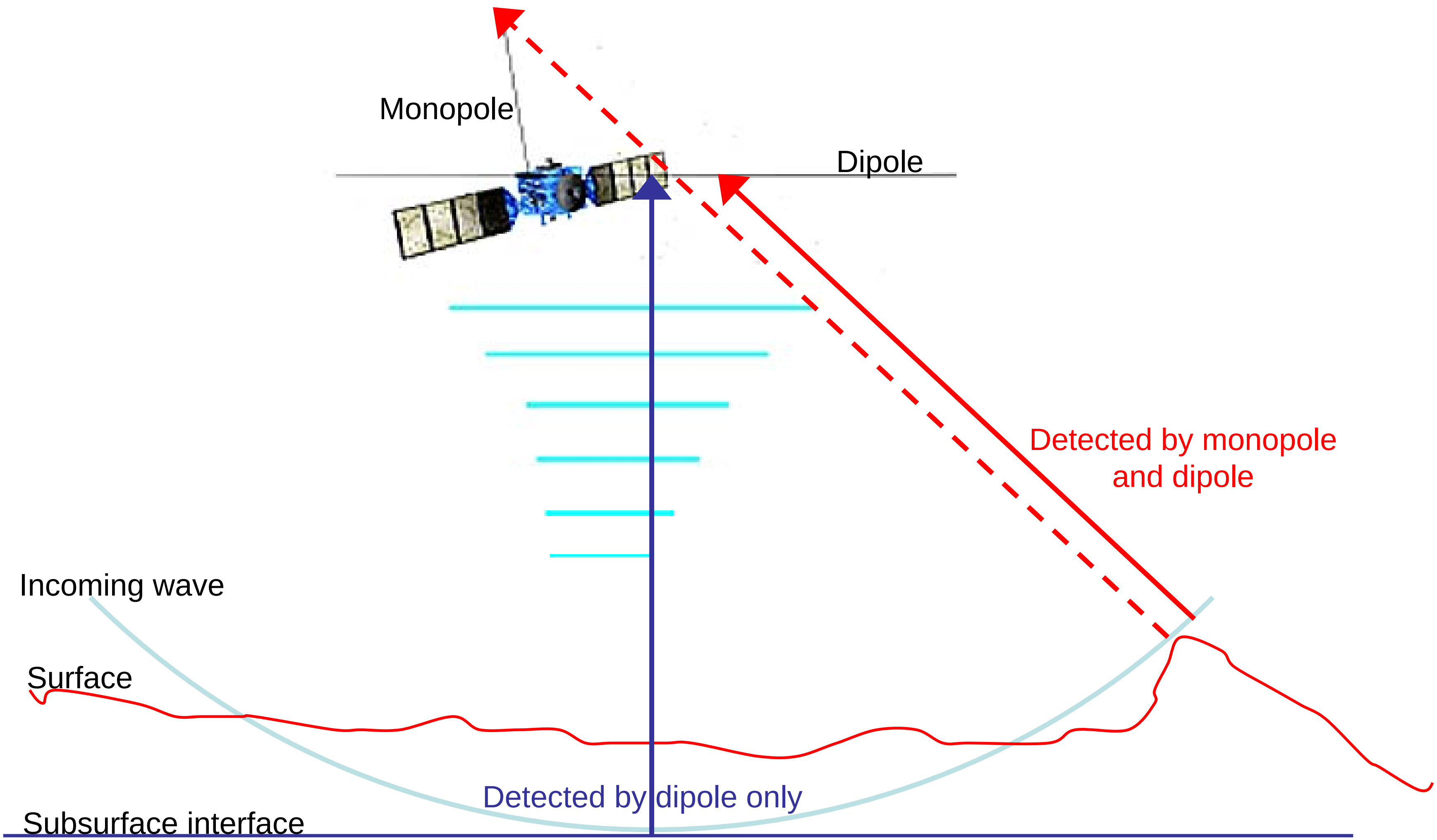


~ 500 contiguous footprints per orbit

Up to 4 profiles for each footprint

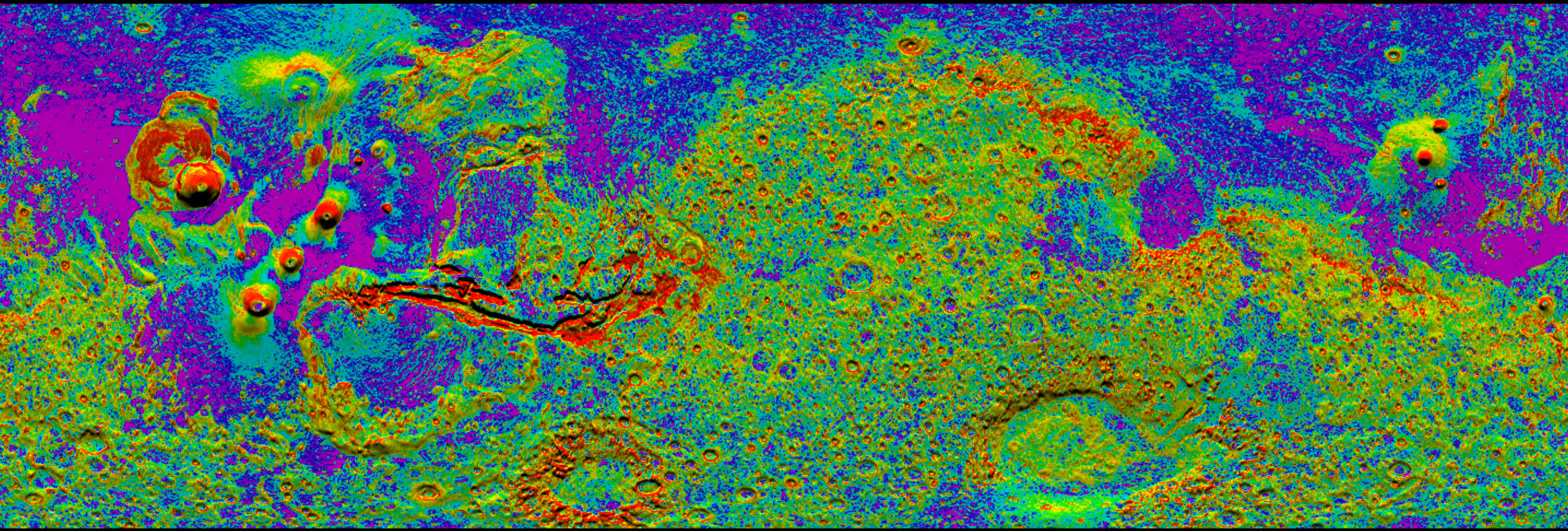
MARSIS

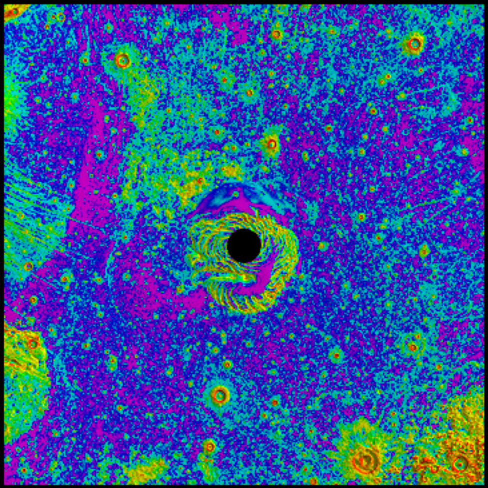
Clutter Cancellation

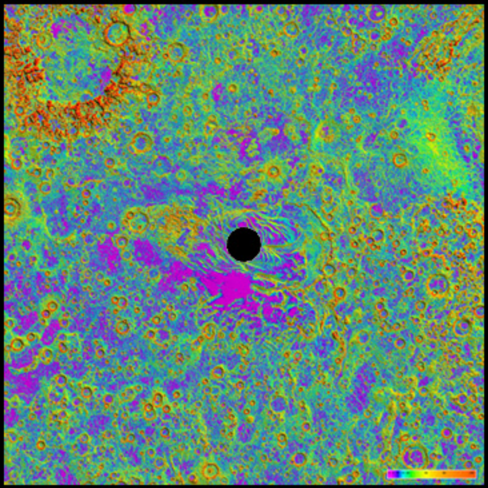


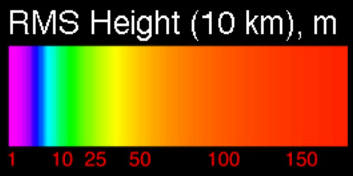
MARSIS

Surface Clutter Prediction



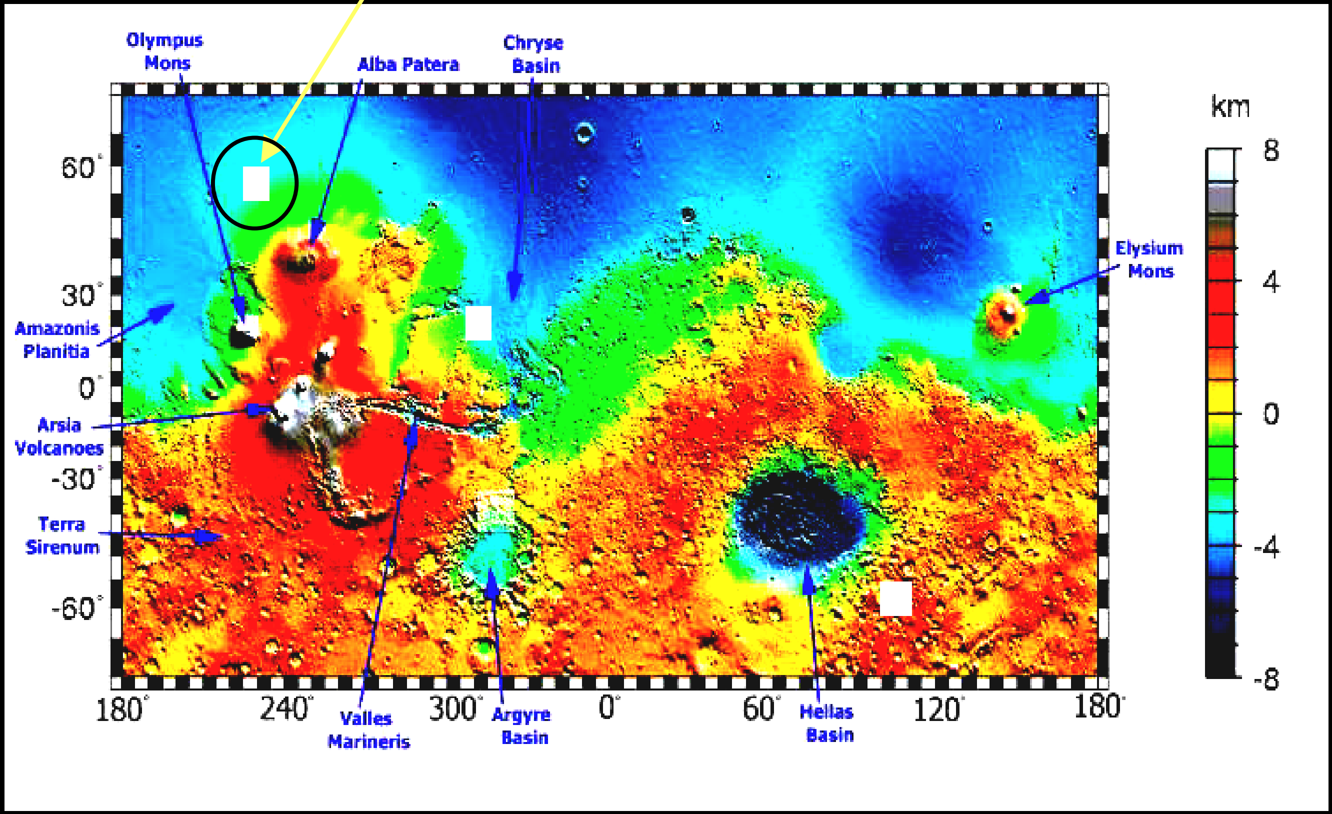






MARSIS
Interface Detection

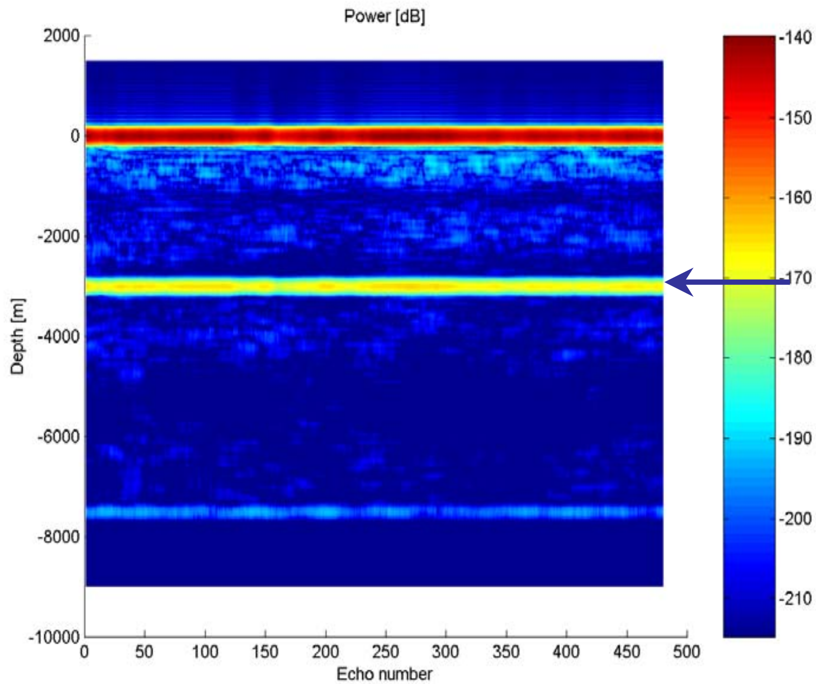
Area North of Alba Patera, centered at 59°N 232°E



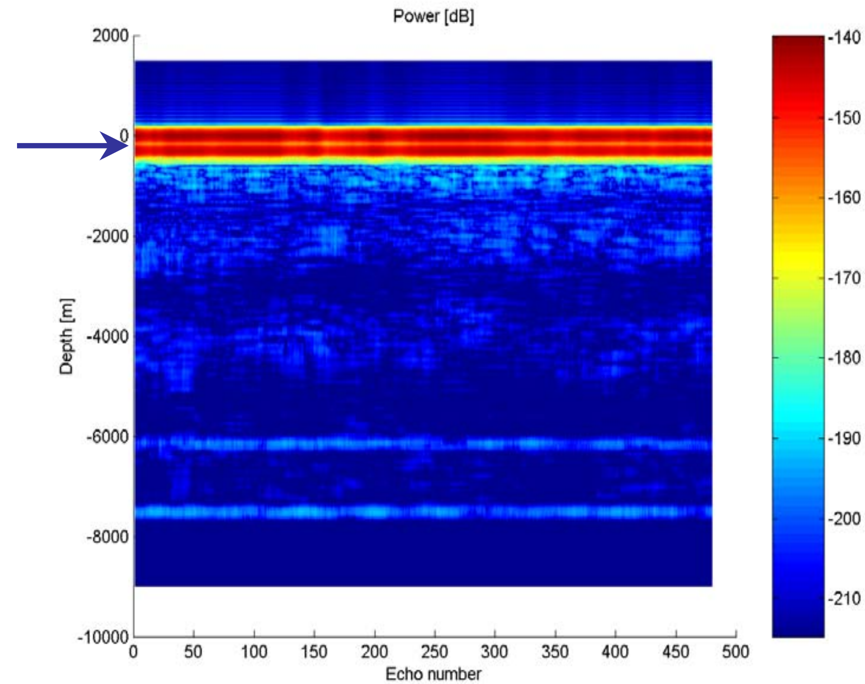
Results from J-F Nouvel

MARSIS
Interface Detection

With subsurface layer : 3000 m deep



With subsurface layer : 300 m deep (F_0=5Mhz)



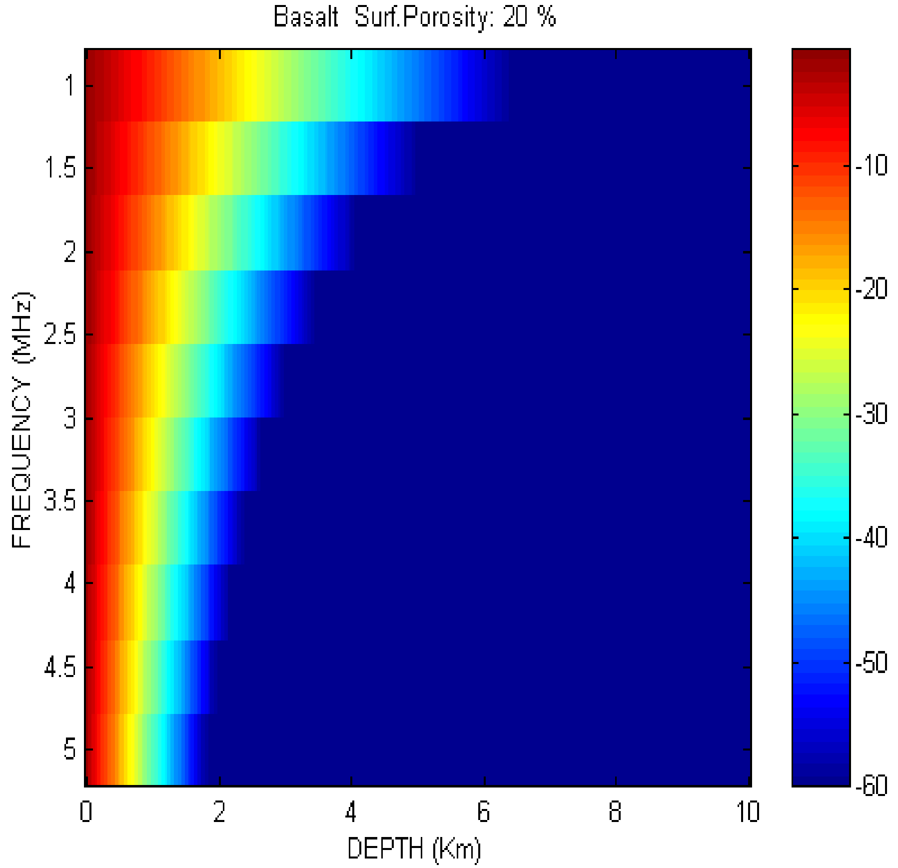
Coherent summation of 2s

Results from J-F Nouvel

MARSIS
Ice/Water Interface Detection

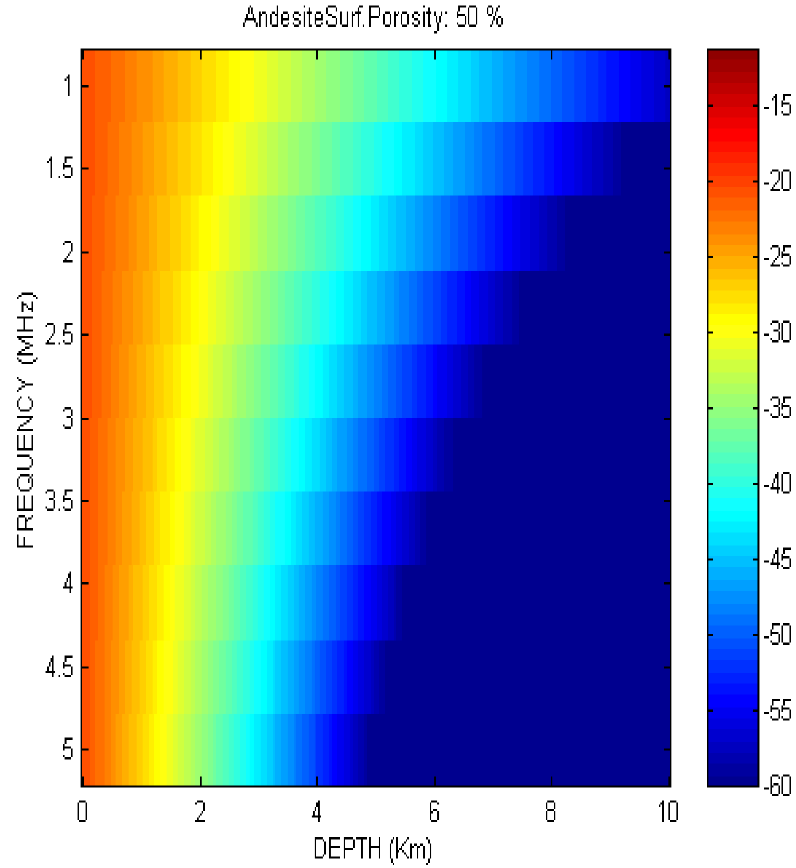
Worst Case Dielectric Terms (Basalt, 20% porosity)

Best Case Geometric Terms



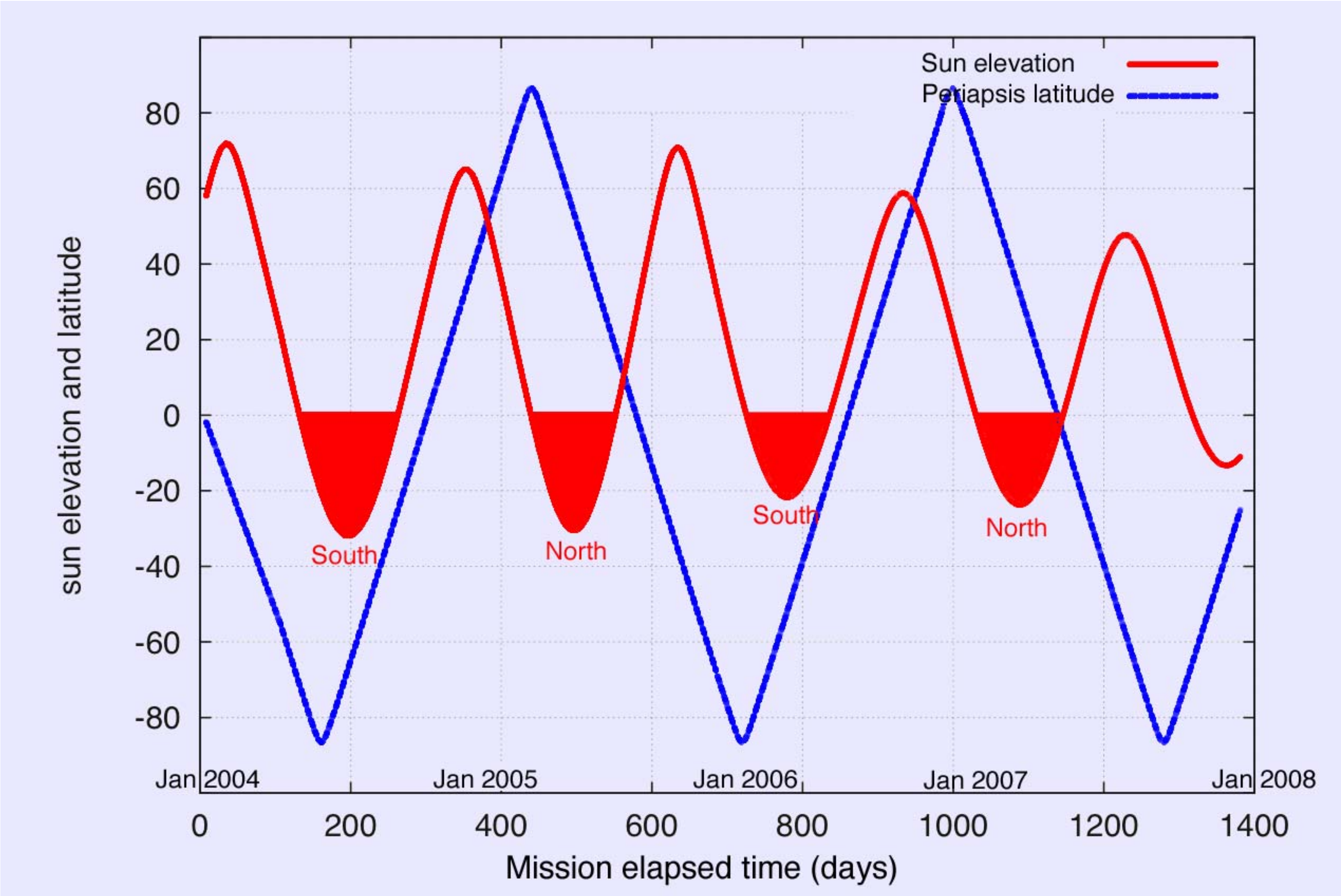
Best Case Dielectric Terms (Andesite, 50% porosity)

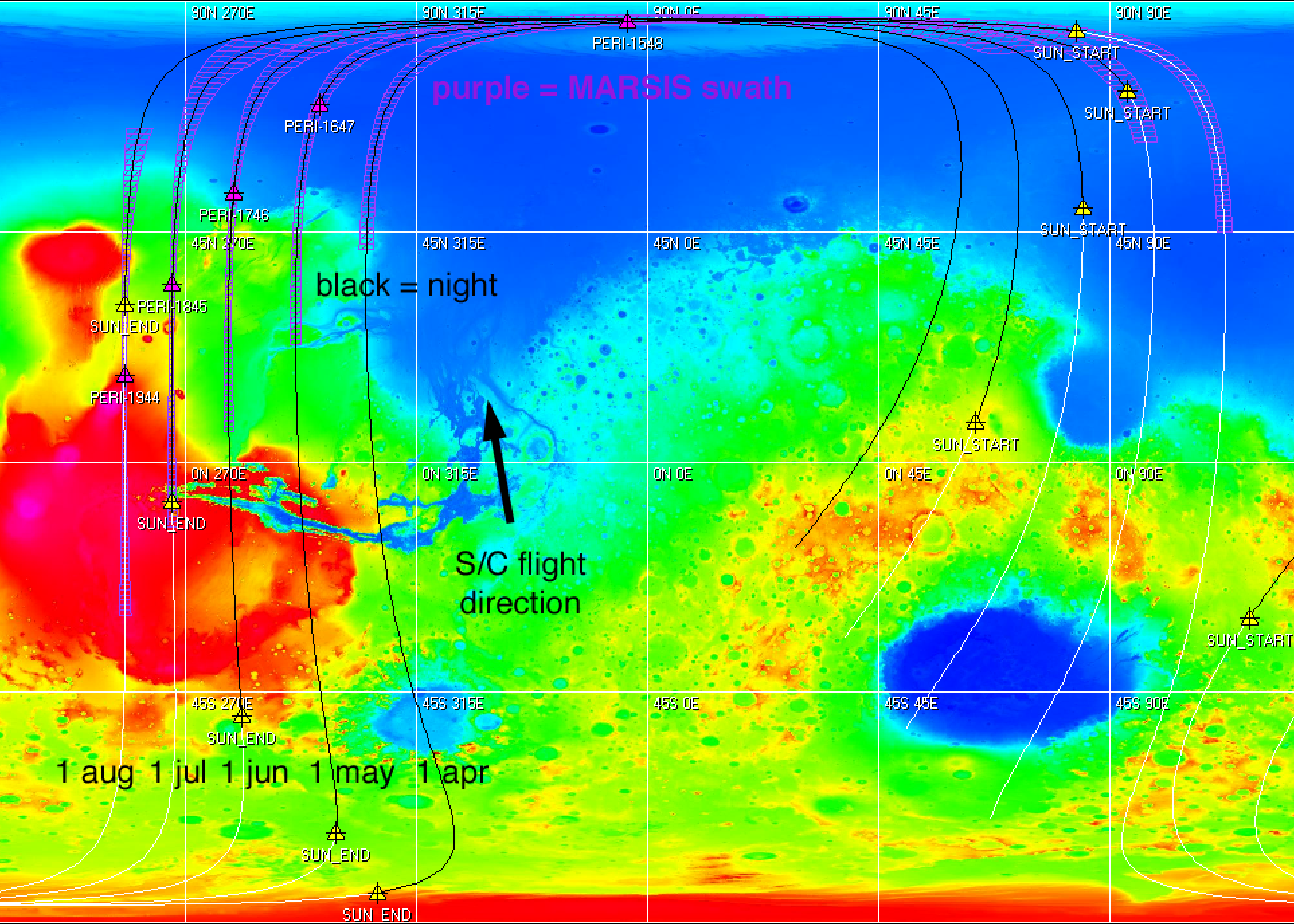
Worst Case Geometric Terms



MEX Orbital Evolution - Sun Elevation and Latitude of Periaps

MARSIS night side observing periods in red





purple = MARSIS swath
black = night
S/C flight direction
1 aug 1 jul 1 jun 1 may 1 apr
90N 270E
90N 315E
90N 0E
90N 45E
90N 90E
45N 270E
45N 315E
45N 0E
45N 45E
45N 90E
0N 270E
0N 315E
0N 0E
0N 45E
0N 90E
45S 270E
45S 315E
45S 0E
45S 45E
45S 90E
PERI-1548
PERI-1647
PERI-1746
PERI-1845
PERI-1944
SUN_START
SUN_END

Nightside Phase 2005

• March to August is the last nightside phase of the Mars Express mission.

• Most favorable orbits for MARSIS:
22 April to 28 June
- Sun elevation is < 0° when S/C is below 500 km altitude.
6 May to 21 June
- Sun elevation is < 0° for the entire pass below 800 km altitude.

• By 1 August, the nightside is only reached at altitudes > 500 km, where MARSIS performance is poorer.
- No nightside data after 14 August.

• The entire Northern hemisphere will be surveyed during this phase, including many prime targets for the MARSIS experiment:
- North polar residual ice, layered deposits, sand sea and ground-ice terrains
[Is there basal melting below NPLD? How deep is the ground ice?]
- Vastitas Borealis Formation
[Very smooth surface ideal for subsurface sounding. Are these deposits from an ancient ocean? How deeply buried are the "MOLA" craters?]
- Deposits at the mouths of the outflow channels
[What is the 3D form of these deposits? Are there "marine" deltas?]
- Radar-stealth terrain of Medusae Fossae Formation
[What is this material (ash, dust, etc.)? How thick? Is it stealthy for MARSIS?]
- Crustal dichotomy boundary
[What is the cause (impact, subsidence, tectonism)? Can boundary structures be traced in the subsurface?]

MARSIS
Summary

- MARSIS is an experiment!
- First objective: Detect something in the subsurface. (Mars must cooperate.)
- Second objective: Characterize that "something".
- Critical phases coming up: deployment, check-out, data(!!!)
- Unambiguous aquifer detection will be a challenge, but…
- …models suggest that if aquifers are present within the upper ~3 km, we have a good chance of seeing them.