# Actuación 7.2

# Space instrumentation for Mars exploration

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IAA-CSIC

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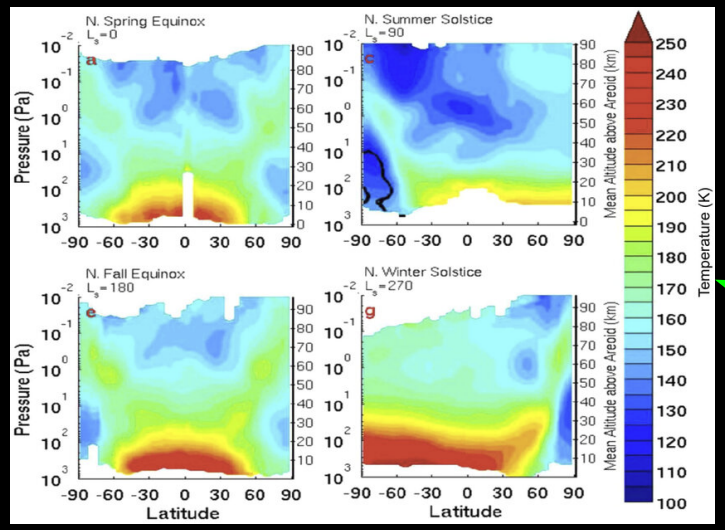
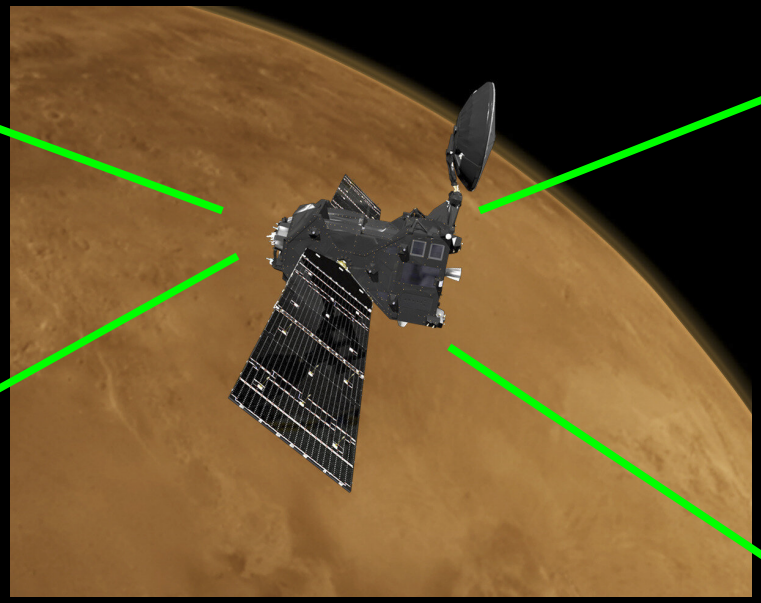
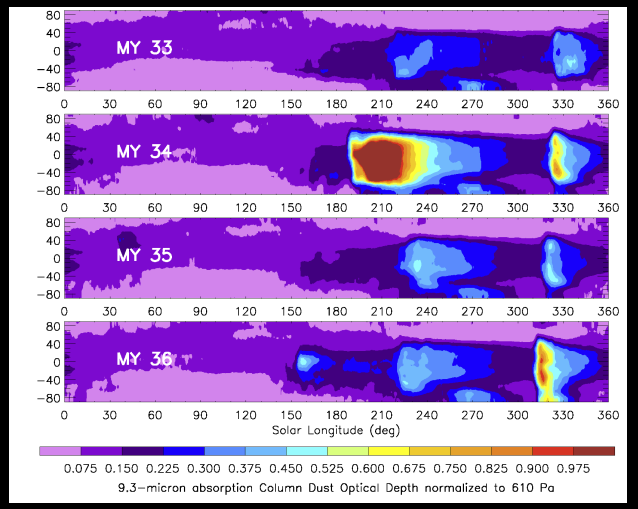
# Motivation

## Temperature

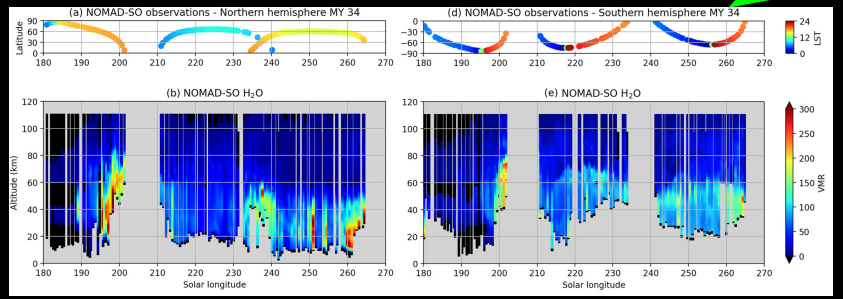


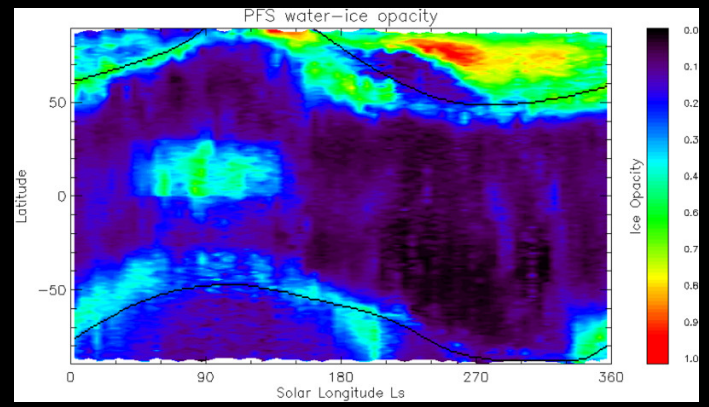
## Dust abundance




## Composition




## Clouds




## Winds??

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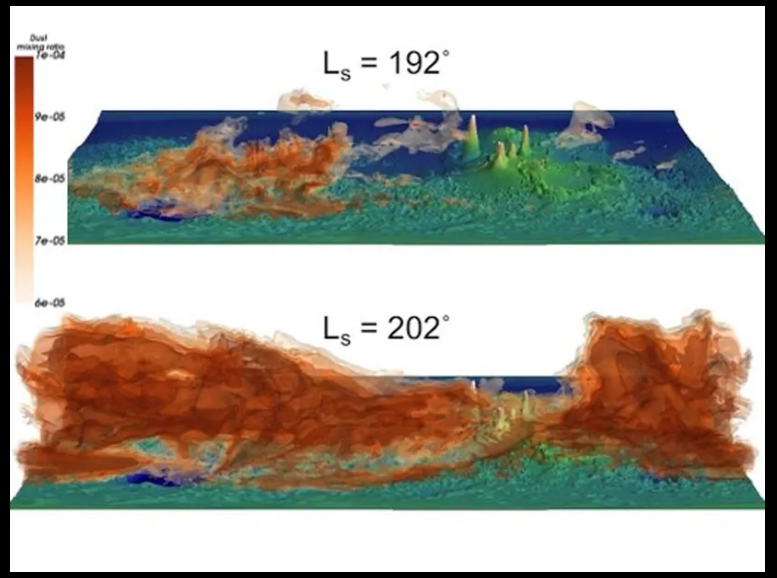
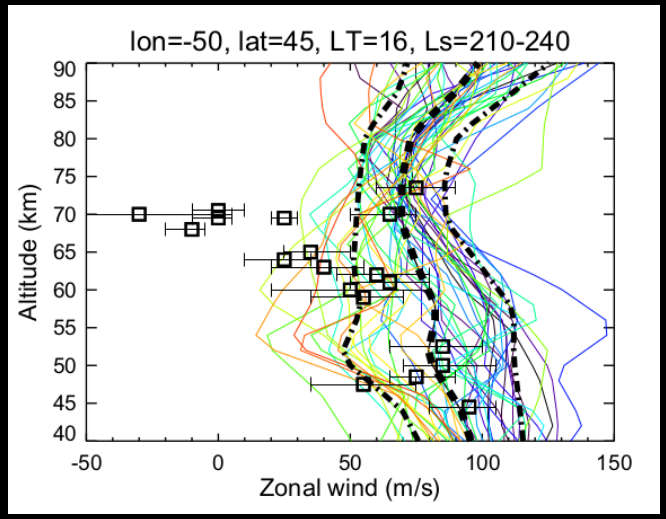
# Motivation

- Wind strongly affects geological and atmospheric processes on current Mars
- Winds impact entry-descent landing maneouvers
- Wind measurements scarce, most knowledge comes from unvalidated models

# Motivation

- Wind strongly affects geological and atmospheric processes on current Mars
- Winds impact entry-descent landing maneouvers
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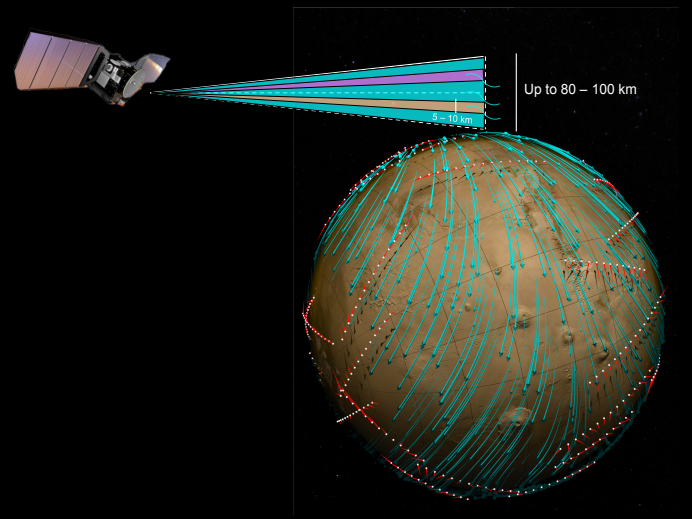
**Dedicated instrument on Mars orbit for wind measurements needed to fill this gap**

**MAWI**



# MAWI

- MArs WInd limb microwave spectrometer (MAWI): Airbus Spain + IAA, PRODEX ESA programme
- Main scientific case: determination of wind velocity from Doppler shift of microwave emission lines by limb observations from Martian orbiter:

$$\Delta\nu = \frac{v_{\mathrm{LOS}}}{c}\nu_0$$

- CO emission lines: well mixed gas, little seasonal and geographical variations
- Two isotopes (different line intensities) to maximize altitude range
- Secondary scientific objectives: CO abundances + temperature profiles

# MAWI requirements and characteristics

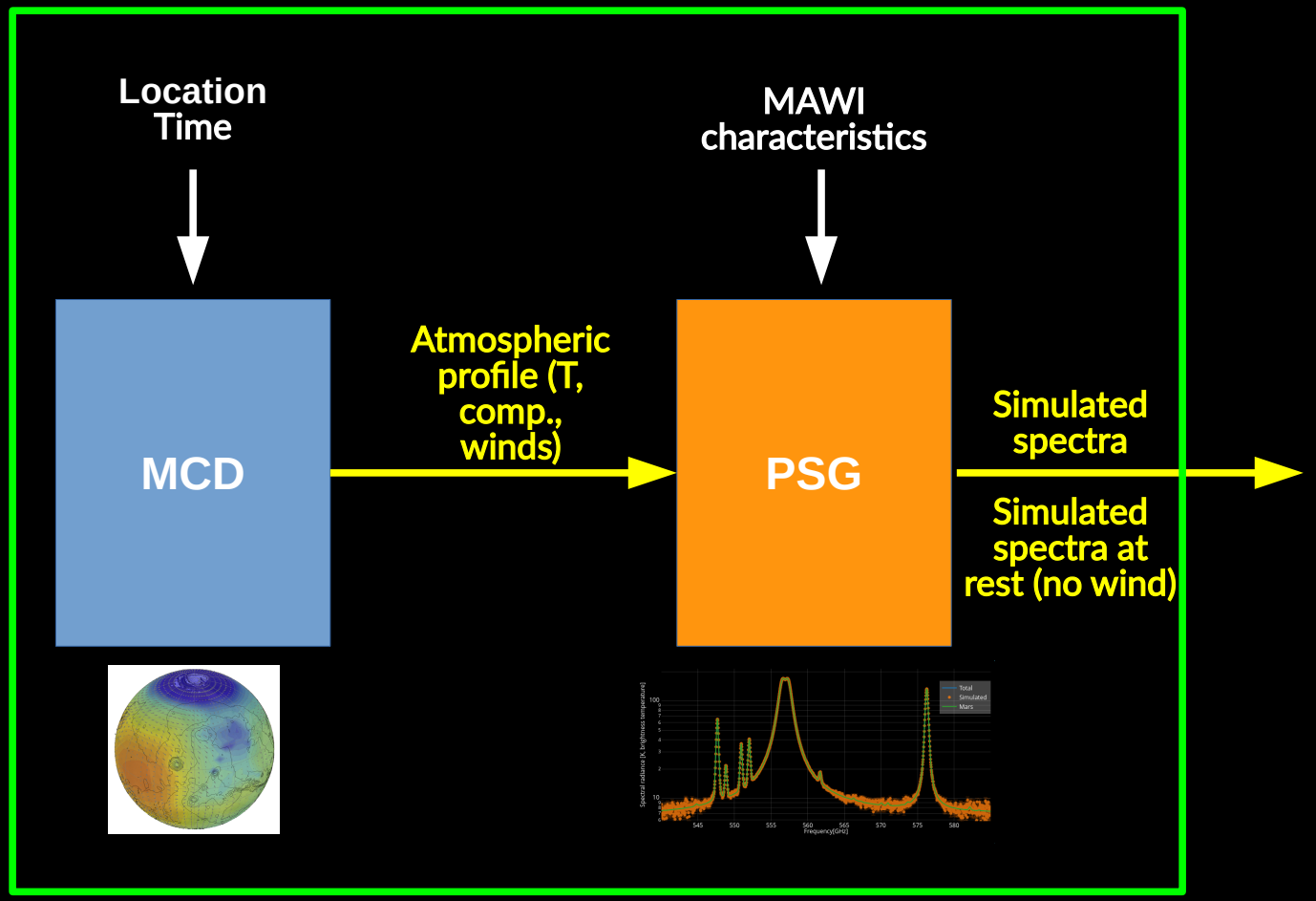
- Wind measured between 20 and 100 km altitude, with:
  - Error < 10 m/s between 40 y 100 km
  - Resolution: horizontal < 300 km; vertical < 10km
  - Ideally 2 wind components (E-W + N+S)
- Temperature @ alt <100 km, accuracy < 5 K
- [CO] @ alt <60 km, accuracy < 100 ppm

- Baseline: orbiter @ 450 km circular orbit
- Observation of CO (576.268) and $^{13}$CO (550.926) lines
- Spectral resolution: 100 kHZ in 40 MHz band @ line center + 2 MHz in 2 GHz band for line wings
- Antenna vertical footprint < 10 km (5 km goal)
- Mechanical vertical scanning
- Integration time <1 to 10 s
- Two orthogonal views (goal)
- Current estimation: ~20 kg, 35 W, 65x55x39 cm

# MAWI and PPCC

- Programatic goal: propose a **Spanish-led instrument** for future mission opportunities
- Main scientific/technological goal: develop tools to
  - **Simulate MAWI measurements**
  - **Derive physical information from MAWI measurements**
- Scientific support to the technological instrument design
- Main science output: Characterize the **expected precision of the retrieved winds** (+ T , [CO]) as a function of altitude, Local Time, season, and latitude

# Tools adaptation and development



# Tools adaptation and development

Location
Time

MAWI
characteristics

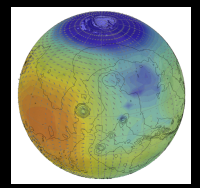
MCD

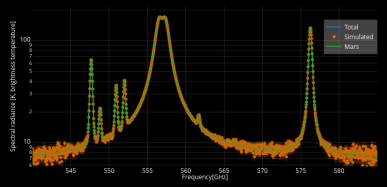
Atmospheric profile (T, comp., winds)

PSG

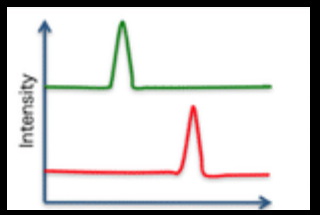
Simulated spectra

Simulated spectra at rest (no wind)





MAWI simulator

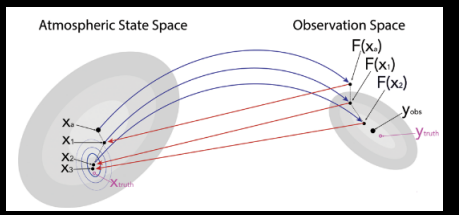



Cross-correlation

Derived wind

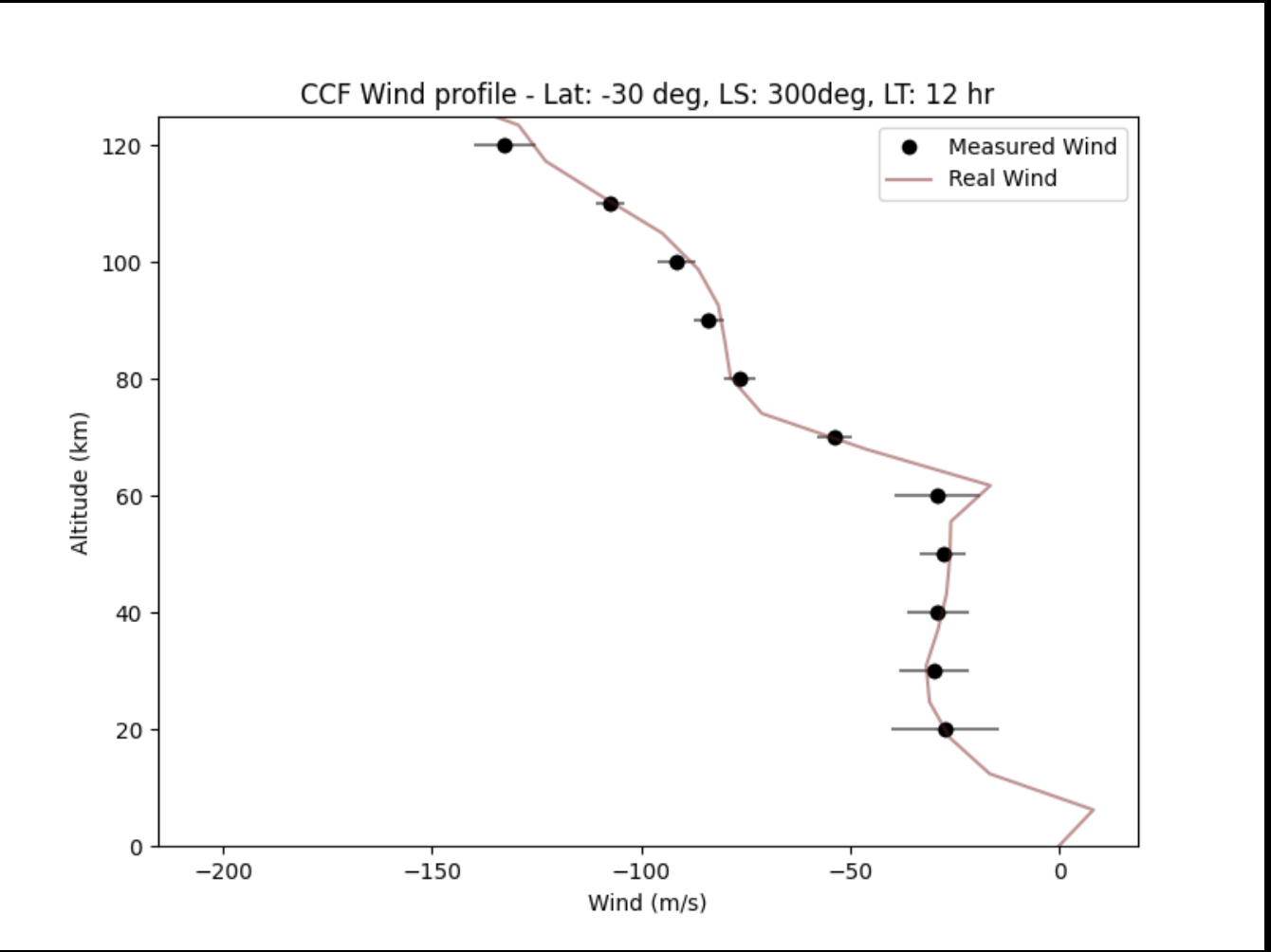
Retrieval scheme

Derived Wind, T, [CO]




MAWI analyzer

# Some preliminary results



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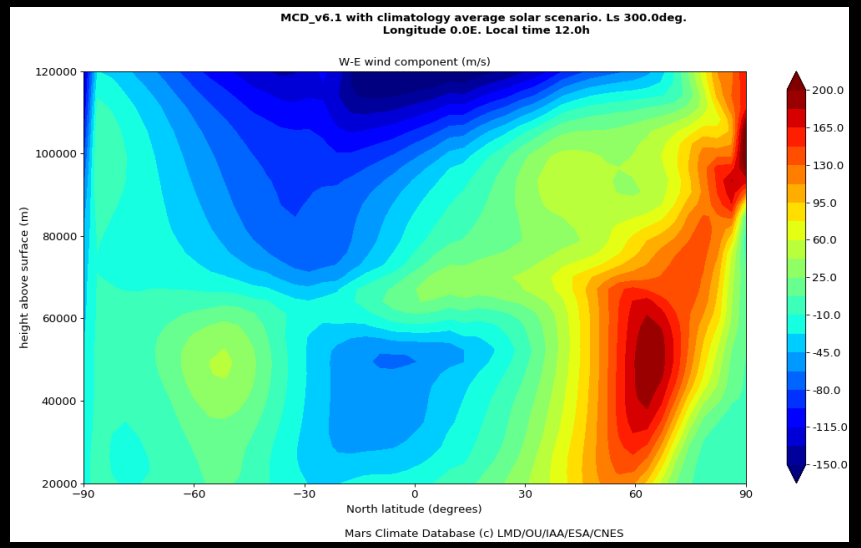


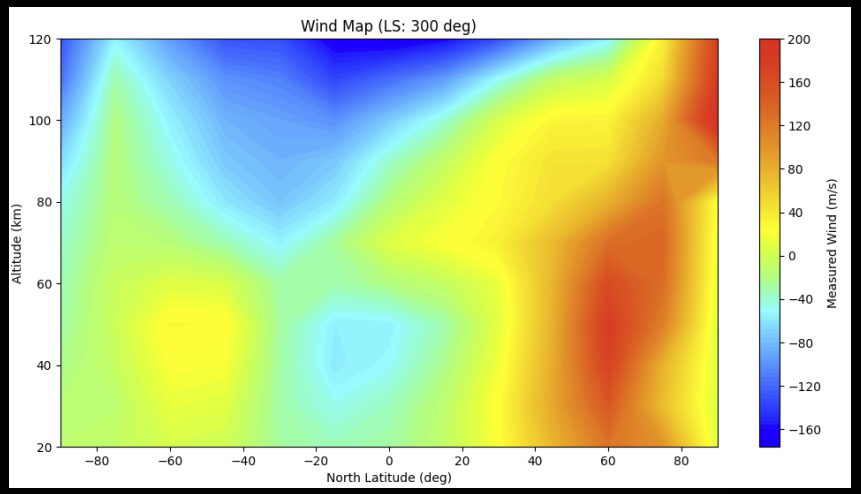


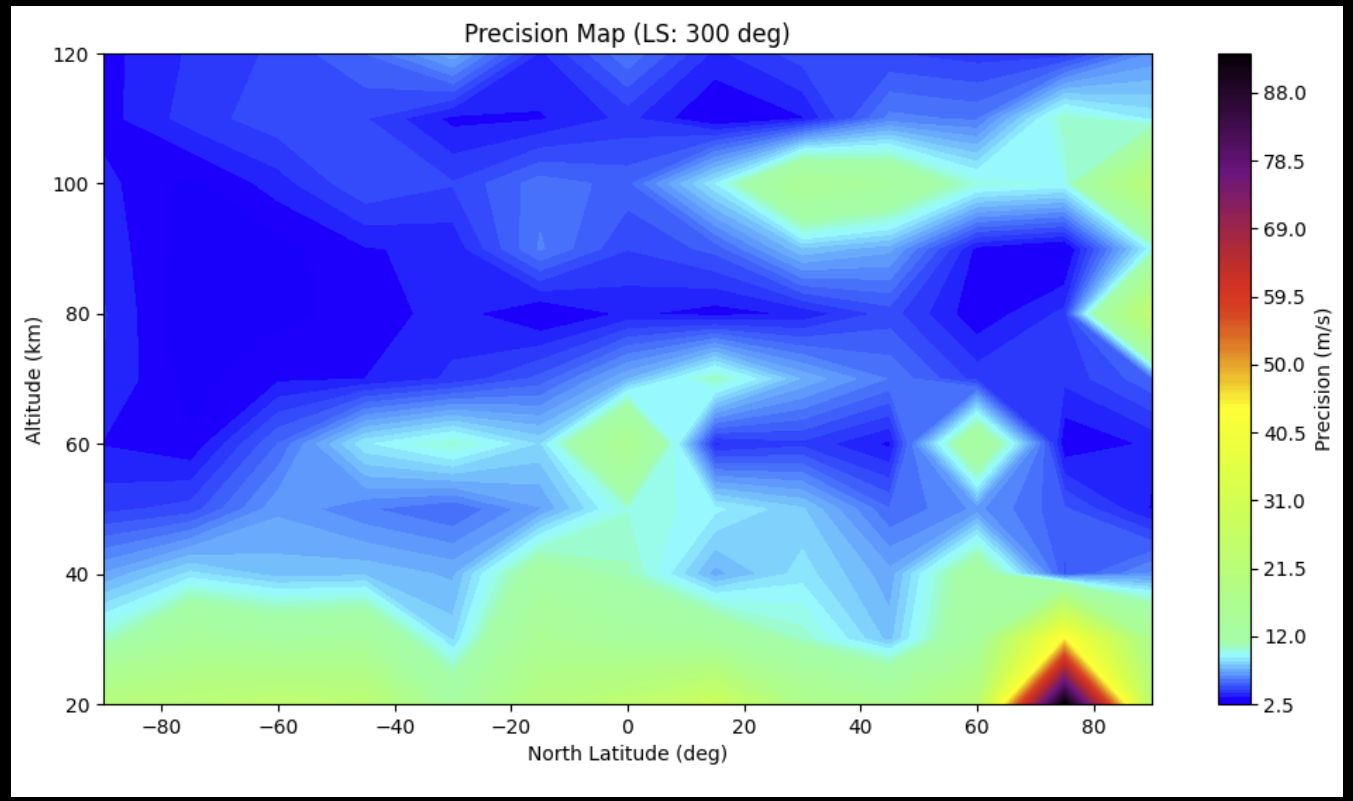


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# Current status and perspectives

- **MAWI submitted in response to ESA's RFI** on Mars orbital observational payloads (March 2024) for a potential future Mars mission
- Continue **collaboration with Airbus Spain**: scientific implications of potential instrument modifications
- Potential future opportunities:
  - ESA's M8 and F3 calls
- Adaptation to Venus feasible