## Introduction

During local spring, the south polar region of Mars exhibits a host of exotic phenomena associated with sublimation of the seasonal CO\textsubscript{2} polar cap. Images from the Mars Reconnaissance Orbiter (MRO) High Resolution Imaging Science Experiment (HiRISE) document this activity well, best described by the “Kieffer” (2007) model:

In winter, the CO\textsubscript{2} forms a translucent slab of impermeable ice. Penetration of sunlight through the ice, which warms the ground below, results in basal sublimation of the ice. Trapped gas escapes to form a translucent slab that warms the ground below, resulting in the formation of diurnal sublimation albedo. This process is enhanced by the presence of CO\textsubscript{2} dust, which contributes to total early spring polar atmospheric aerosol, and thus to its thermal budget and circulation, at latitudes thought to receive minimal dust.

## Science objectives explained

- **Observe active CO\textsubscript{2} jets**
  - Predicted by most widely accepted hypothesis (Kieffer model, see Intro box) **but never been observed in action!**
  - Time of day eruption currently unknown (predicted to be between sunrise and noon, depending on weakly constrained CO\textsubscript{2} ice properties)
  - Current jet models do not predict observed fan deposit lengths; those are a convolution between jet height and wind strengths. Observation of jet heights can disentangle this!
- **Constrain amount of dust entering the atmosphere**
  - Piqueux and Christensen (2008) estimated that jets displace 2 orders of magnitude more dust per year than typical global dust storms.
  - Dust contributes to total early spring polar atmospheric aerosol, and thus to its thermal budget and circulation, at latitudes thought to receive minimal dust.
- **Monitor diurnal development of albedo of jet deposits and environment**
  - Deposits change their appearance over time, we don’t know if this is a state of diurnal subl.-refrosting cycle or a general trend over days.
  - Dust is observed to be removed, we don’t know if it sinks in or is blown away (most likely both).
- **Observe local weather in form of trough clouds to estimate water flux across spiral troughs**

## MEPAG Objective

### MEPAG Investigation

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<td>Goal II, A4: Constrain the processes by which volatiles and dust exchange between surface and atmospheric reservoirs.</td>
<td>1. Measure the turbulent fluxes of dust and volatiles between surface and atmospheric reservoirs.</td>
<td>• Confirm Kieffer model by observing active CO\textsubscript{2} jets</td>
<td>• Determine eruption time of day</td>
<td>• Orbit insertion at local sunrise (=noon at beginning of spring)</td>
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<tr>
<td>Goal II, A1: Constrain the processes that control the present distributions of dust, water, and carbon dioxide in the lower atmosphere, at daily, seasonal and multiannual timescales.</td>
<td>3. Measure the forcings that control the dynamics and thermal structure of the lower atmosphere.</td>
<td>• Constrain amount of dust entering atmosphere</td>
<td>• Determine surface reflectivity changes over time</td>
<td>• Scan one full day of local time to confirm/exclude diurnal subl.-refrosting cycle</td>
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## Mission Measurement

**Mission concept**

- **Spacecraft bus:** Ion-driven SmallSat for continuous orbit adaptation (16 U in last iteration)
- **Orbit:** Precessing orbit with south-pole perhaps, approx 350 km altitude. Precess from noon-midnight to dusk-dawn orbit within 6 months (local spring)
- **Mission duration:** 6 months to cover local Martian spring
- **Comms**
  - 1 image, lossless compression, takes 7 s via 1 MBit/s (IRIS CubeSat relay module from NASA)
  - 5 mins relay could transfer 42 images
- **Challenges**
  - Relay satellites have no experience and no willingness to do relay form moving target
  - Detector needs to cope with ground spot speed of 3.4 km/s
  - Either do TDI, frame let approach, or slew S/C to cancel ground motion

## MAPSE (MArs Polar Smallsat Explorer)

### Instrument Basic Concept

- **Specifications and performance**
  - Design: Ritchey-Chrétien Cassegrain-style telescope
  - Focal length: 1300 mm
  - Entrance aperture: 80 mm diameter
  - Pixel scale (complied): 4 mm/pix
  - Spatial res.: * 10-13 m
  - FOV*: 4056 m (0.08°)
  - Wavelength range: 325-1000 nm
  - Mass (CHAS): 1.1 kg
  - Power (CHAS): 4 W operating
  - Read noise: 6 e- at 1 MHz
  - Digitization: 14 bits
  - Dark Current: 250 e- /px/sec at 25°C
  - Image read-out time: 1 ms at 1 MHz
  - Signal: 7.3 x10\textsuperscript{15} e- /pix
  - S/N: 270 to 100
- **Projected distance are based on an assumed 8-Ch altitude of 400 km**

## References