The Aeolus Mission Concept
an innovative mission to study the winds and climate of Mars

SSC18-V-06
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David Mauro, SGT Inc. a KBRwyle business unit / NASA Ames Research Center
Why measure the winds on Mars
Why measure the winds on Mars
With the exception of 3 point measurements at the surface, the winds of Mars have never been measured directly.
Melinda Kahre’s Work (NASA Ames)

- Modeled Winds
- Winds Derived from Temperature
- Modeled Minus Derived
Aeolus Payloads
Spatial Heterodyne Spectrometer

Modeled Spectrum Difference for Shifted and Un-shifted CO$_2$ emission line

Englert et al. 2015
Harlander et al. 2010
Yi et al. 2017
Thermal Limb Sounder

Filter Passband | Targeted Measurement
--- | ---
9.1 μm | Dust
12 μm | Water Ice Clouds
15.1 μm | Atmospheric Temperature
15.6 μm | Atmospheric Temperature
17.4 μm | Atmospheric Temperature
19 μm | Atmospheric Temperature, Dust, & H₂O Clouds
Surface Radiometric Sensor Package (SuRSeP)

Filter Passband | Targeted Measurement
--- | ---
0.3 - 3.5 μm | Visible Reflectance ("solar")
0.3 - 100 μm | Total Energy ("open")
7 μm | Surface Temperature
9.1 μm | Dust
12 μm | Water Ice Clouds
15.1 μm | Atmospheric Temperature
15.6 μm | Atmospheric Temperature
25 μm | Surface Temperature
Mission Concept
Mission Concept

Launch
Cruise
15 months
Mission Concept

Launch 15 months
NeMO LTT 10 months
Mission Concept

Launch
Cruise
15 months
NeMO LTT
10 months
Aeolus
Stowed

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The Aeolus Mission Concept – SSC18-V-06
Mission Concept

Aeolus

Launch
15 months

Cruise
10 months

NeMO LTT

Aeolus Stowed

Aeolus Deploy

15 months

10 months

15 months

10 months

10 months
Mission Concept

Launch
Cruise 15 months
NeMO LTT 10 months
Aeolus Stowed
Aeolus Deploy
Orbit Transfer

15 months
10 months
Mission Concept

Launch
Cruise 15 months
NeMO LTT 10 months
Aeolus Stowed
Aeolus Deploy
Orbit Transfer
Commiss. 3 months
Mission Concept

Launch

Cruise 15 months

NeMO LTT 10 months

Aeolus Stowed

Aeolus Deploy

Orbit Transfer

Commiss. 3 months

Science 24 months

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The Aeolus Mission Concept – SSC18-V-06
Mission Concept

- **Launch**: 15 months
- **Cruise**: 10 months
- **NeMO LTT**: 10 months
- **Aeolus Stowed**: 15 months
- **Aeolus Deploy**: 10 months
- **Orbit Transfer**: 3 months
- **Commiss. Science**: 24 months
- **Decommission**:

**Total Mission Duration**: 52 months
2 weeks operation cycle

1 orbit = 40 science measurements
- Science Meas. [30 sec]
- Solar Array gimbal between measurements to track the Sun [2.5 min]

1 day = 12 orbits
- Science orbits [10 orbits per day]
- Daily S/C Activities [2 orbits per day]

Daily S/C Activities:
- NeMO X-Link ~1x every 8 days (5-20 min)
- DTE Comm ~1x every 7 days (1 hr)
- RW Desat ~1x every 3.5 days (1 min)
- Yaw ~1x every 5 days (15 min)
Orbit Design

Orbit precesses over all *local times* within 120 days

Global spatial coverage every 10 days
Flight System Capabilities

+Z (Zenith)

+X (along track)

-Y

(cross-track)
CML 1
“Cocktail Napkin”
Meaningfulness & Uniqueness
Identify Knowledge Gaps

State Broad Science Objective

One-sentence description of measurement(s)
Concept Maturity Levels (CML)

CML 1
“Cocktail Napkin”

CML 2
Feasibility
Does any solution exist?
CML 2: Feasibility Study

Draft of Science Traceability Matrix
Mission Architecture – main elements
Environmental driving parameters
Identify required tech development
Launch opportunities
Delta-V calculations
Orbital solutions
Mission ops
Spacecraft CAD model
Rough cost estimate
Rough schedule
Initial risks & mitigation identified
Future trades identified

<table>
<thead>
<tr>
<th>Resource</th>
<th>CBE</th>
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<tbody>
<tr>
<td>Volume</td>
<td>45 x 35 x 52 cm</td>
</tr>
<tr>
<td>Total Launch Mass</td>
<td>37.6 kg</td>
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<tr>
<td>Total Power</td>
<td>53 W</td>
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<tr>
<td>Spacecraft Delta-V</td>
<td>237.5 m/s</td>
</tr>
<tr>
<td>Solid State Data Storage (Vol)</td>
<td>8GB</td>
</tr>
<tr>
<td>Data Throughput (UHF Downlink)</td>
<td>1Mbps</td>
</tr>
</tbody>
</table>
Concept Maturity Levels (CML)

CML 1
“Cocktail Napkin”

CML 2
Feasibility
Does any solution exist?

CML 3
Expanded Trade Space
What other solutions exist?
CML 3: Expanded Trade Space

Divergent Phase:
- Explore different mission architectures
- primary vs. secondary launch options
- number of spacecrafts
  *et cetera*

Convergent Phase:
- Identify rejection criteria & pick architectures to pursue.

Iteration:
- Repeat CML 2 as needed on selected architectures
CML 1
“Cocktail Napkin”

CML 2
Feasibility
Does any solution exist?

CML 3
Expanded Trade Space
What other solutions exist?

CML 4
Point Design
What is a good approach, given our circumstances?
CML 4: Point Design

Science Traceability Matrix
Mission Architecture
  Driving environmental parameters
  Launch vehicle
  Delta-V calculations
  Orbital solution
Radiation ANalysis
Mission ops
  Identify required tech development
Spacecraft CAD model
Power Analysis
Thermal Analysis
Better Cost Estimate
Refined Schedule
Risks Matrix & Mitigation
Summary & Conclusion

• Aeolus offers a potential opportunity to perform a much needed science mission to determine the wind on Mars leveraging a cost effective approach

• Aeolus reliance on NeMO both for transfer and communication relay represents both its major asset and hindrance

• The team is currently pursuing other alternative architectures options that emerged during CML 3
A mission to study the winds and climate of Mars

Questions?