Atmospheric Science Community Input for the Decadal Survey

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On behalf of a long list of contributors…

MEPAG Meeting

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Questions Posed

Primary Question:

What are the key scientific questions that will be driving Mars atmospheric science in the coming decade?

Supplemental Questions:

–What progress can be made in the next decade to answer these questions, and how? What do we need to understand to make progress?

–What types of missions are necessary to obtain answers to these questions?

Science Questions

The key, unanswered scientific questions can be divided into two separate ‘themes’

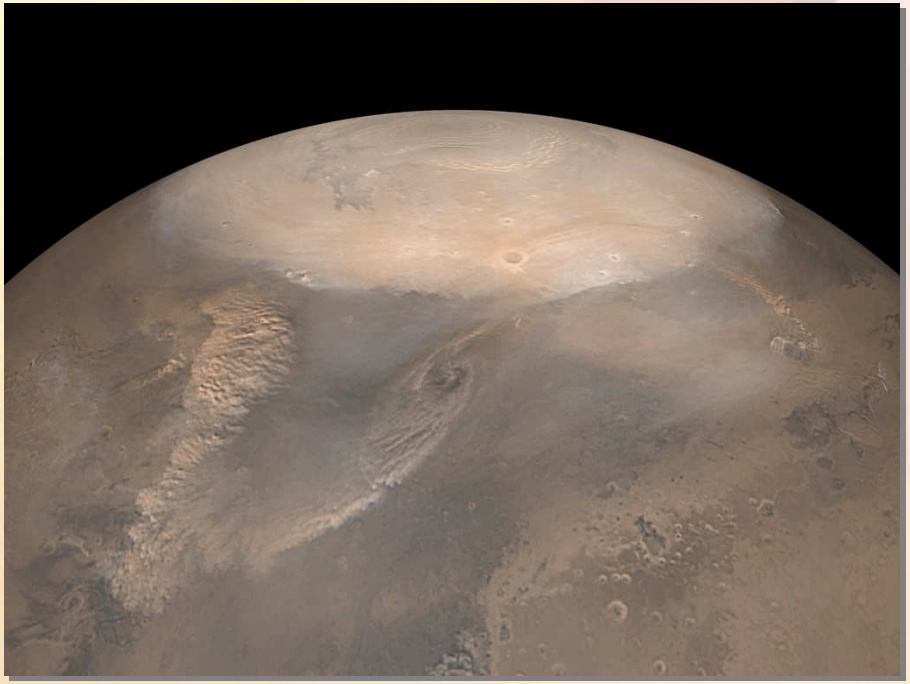
Composition: What is the atmosphere made of?

Structure: How does the atmosphere behave and change with space and time?

Key Questions of Composition

Dust

- Vertical distribution?
  - Local to global scale
- Root causes behind initiation, growth and decay of global dust events?
- Why do some storms remain small and some grow to global scale?



Key Questions of Composition

Water Vapor

- Abundance of atmospheric water vapor
  - Diurnal/seasonal/annual cycles?
  - What contributes to variations?
- Role of the regolith?
  - Surface vapor flux?
- Vertical distribution of water, as vapor and ice?

Key Questions of Composition

Trace Gases

- Distribution and abundance of trace gases (e.g. CH_4, O_3, SO_2)?
  - Sources and sinks?
  - Indicative of past/present life?
  - Linkages to geology, astrobiology
- What are the processes we are missing in our models?
  - Heterogeneous chemistry? Missing species?

Key Questions of Structure

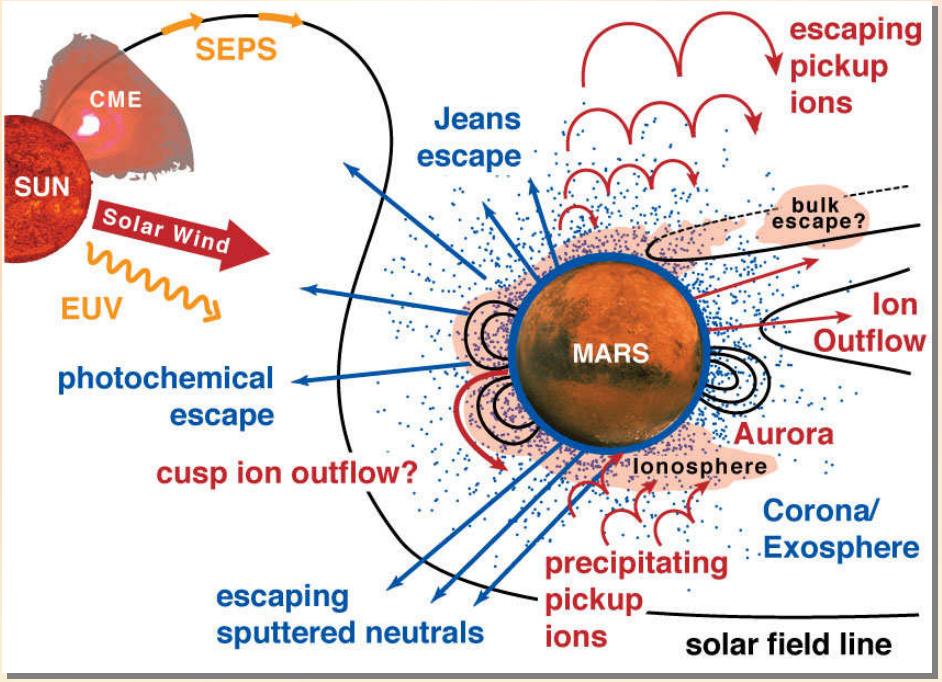
Middle/Upper Atmosphere

- 4-D structure of the upper atmosphere?
  - Density, temperature, winds
- Lower/upper atmosphere interactions
- Interactions with solar wind
  - Over solar cycle?

Key Questions of Structure

Atmospheric Erosion and Evolution

- Are current erosion processes consistent with a substantially thicker early martian atmosphere
- Liquid water through history?
- Isotopic ratios?
  - Erosion rates
  - Past/present life?



Key Questions of Structure

Winds

- 4-D wind structure of atmosphere?
- Strength of the global (Hadley) circulation?
  - Seasonal changes

Summary of Responses

Strong advocacy for three 'Science Investigation Areas':

1. Surface in situ measurements (single or network)
2. Continued orbital observations of basic atmospheric state (temperature, dust/ice opacity, vapor, etc.)
   - Nadir/limb observations
   - Good time of day coverage (high inclination, circular orbit)
3. Comprehensive trace gas observations (distribution, sources/sinks)
   - Mars has an active surface environment, rich chemical interaction with atmosphere

Future Progress

What progress can we make answering these questions in the coming decade?...

- Advances in climate modeling (e.g. data assimilation)
- Identification of trace gas sources from orbital data
- Advances in instrumentation
  - Winds
  - See through dust clouds

Mission Types

SIA #1: Networked lander mission for high-frequency observations of PBL

SIA #2: Means to observe dust, water ice, CO_2 for profiling. Should have nadir/limb scanning. Better local time coverage. Should be a baseline requirement.

SIA #3: Remote sensing with high sensitivity to a broad suite of important trace gases. Continuous spatial mapping of these species and of atmospheric state

Contact Information

White paper will continue to be developed through mid-Sep. Contributions are welcome

Draft white paper available at:

http://mepag.jpl.nasa.gov/decadal/

Comments on white paper welcome

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Science Investigation Area #1

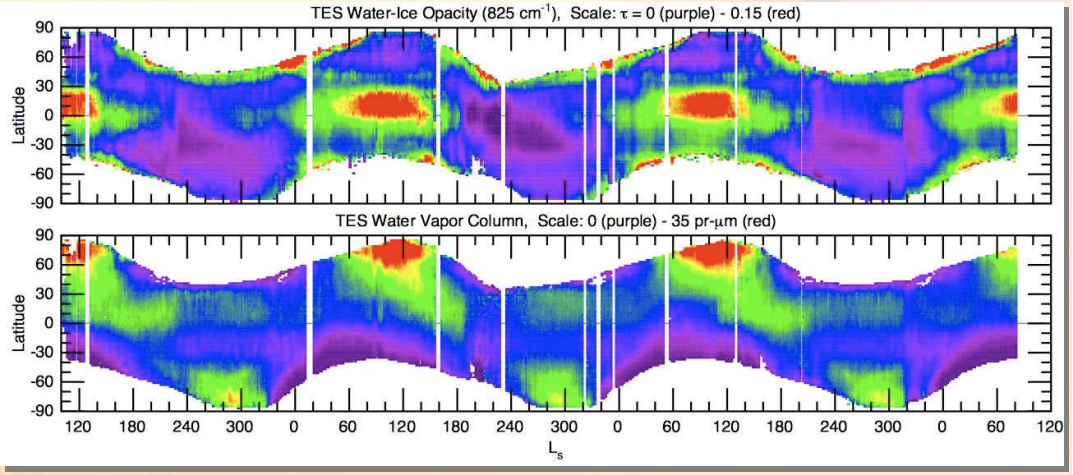
Surface in situ measurements

- Minimum one lander, ideally a global network
- Provide global, diurnal and synoptic coverage of PBL.
- Best way to get in situ information in lowest scale height
- What is considered globally representative?

Science Investigation Area #2

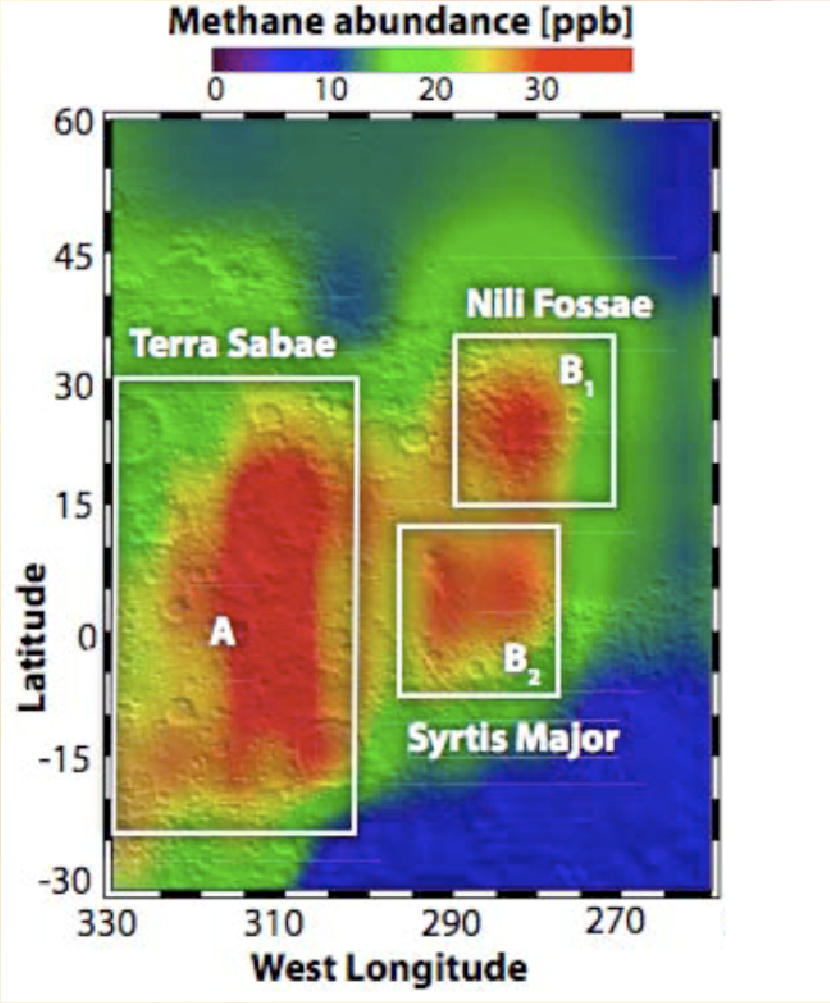
Continued orbital observations

- Extend coverage of TES and MCS indefinitely
  - Temperature
  - Dust/ice column opacity
  - Water vapor abundance



- Nadir and limb observations
- Best resource of atmospheric data we have
- Time of day coverage?

Science Investigation Area #3

Trace gas observations

- Repeat observations of methane indicate an active surface environment
- Basic maps of other species (ozone, peroxide) have been made
- Catalyst for reanalysis of martian atmospheric chemistry
  - Incorporation of heterogeneous processes