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MEASUREMENTS OF DUST ON MARS TO BE OBTAINED FROM UPCOMING MISSIONS. Bruce M. Jakosky, Laboratory for Atmospheric and Space Physics and Department of Geological Sciences, University of Colorado, Boulder, CO 80309-0392.

Measurements of dust on the Mars surface and in its atmosphere will be made from several upcoming missions. The best-defined missions are Mars Observer, the Soviet Mars 94 mission, and the Mars Environmental Survey (MESUR) mission. Following is a discussion of what measurements pertaining to airborne or surface dust will be made and what properties can be inferred from them. The payloads for the latter two missions are, of course, not yet determined or absolutely known. In all cases, only that information which pertains to dust is included; each mission contains additional instruments that provide no information on this topic. Following the discussion of individual instruments is a summary of the types of measurements and observations that will be made from the ensemble collection of instruments and missions, and a brief discussion of the types of measurements of dust which will not be made. This revised abstract contains the results of the group discussion from the workshop.

Observations of dust to be made from upcoming missions:

Mars Observer (MO):

Pressure Modulator Infrared Radiometer (PMIRR):

Vertical profile of dust absorption coefficient
Column abundance, spatial and vertical distribution of dust amount in atmosphere
Thermal emission from surface
Some information on surface structure
Vertical profiles of temperature
Clues to dust-induced atmospheric dynamics

Thermal Emission Spectrometer (TES):

Emission spectrum of dusty atmosphere
Particle-size distribution of airborne dust
Composition of airborne dust
Vertical profile of emission spectrum of airborne dust
Vertical distribution of dust
Variations in composition or particle size with height
Emission spectrum of surface
Surface structure (thermal inertia, block abundance, etc.)
Composition and mineralogy of dust on the surface

Gamma-Ray Spectrometer (GRS):

Relative numbers of atoms at the surface
Surface composition, global variability of dust

Camera (MOC):

High-resolution images of the surface
Surface structure, block abundance, etc.
Clues to ongoing geomorphological processes pertaining to sand and dust
Moderate-resolution images of the surface
Temporal changes in surface albedo related to deposition or removal of dust from the surface
Low-resolution (daily) global images in two colors
Spatial information on dust distribution, with clues to the genesis of global and local dust storms

Laser Altimeter (MOLA):

Altitude of whatever reflects at 1.06 microns
Possible heights of discrete dust clouds or local dust storms

Radio Science (RS):

High-vertical-resolution atmospheric structure in polar regions
Clues to dust-induced atmospheric dynamics

Mars Environmental Survey (MESUR):

Atmospheric structure experiment:

Entry profile of temperature and winds in lower atmosphere
Clues to dust-induced atmospheric dynamics

Descent/surface imaging:

High-resolution images of surface
Surface structure, block abundance, etc.
Clues to ongoing geomorphological processes pertaining to sand and dust

Meteorology at surface:

Diurnal variation in atmospheric pressure
Clues to dust-induced atmospheric dynamics
Winds at surface
Clues to dust-induced atmospheric dynamics
Information on ability of wind to raise dust or to saltate sand

Atmospheric opacity at surface:

Atmospheric opacity of dust at surface
Atmospheric opacity of dust at surface

Surface composition experiment:

Elemental abundances at surface
Composition and mineralogy of surface

Differential thermal analysis experiment:
Volatile content of surface materials

Mars 94:

(Orbiter)

Overall mission
Diurnal variability at local times other than will be obtained from other missions, due to different orbit

TV camera:

High-resolution images of the surface (about 10 m/pixel, four-color, stereo)
Clues to ongoing geomorphological processes pertaining to sand and dust
Three-dimensional structure at scales larger than 10 m

Omega (Infrared Spectrometer):

Surface reflection spectra between 1 and 5 microns
Surface mineralogy

Fourier spectrometer:

Thermal emission spectra between 1.2 and 40 microns
Particle-size distribution of airborne dust
Composition of airborne dust
Surface structure (thermal inertia, blocks, etc.)
Composition and mineralogy of dust on the surface

Stellar occultation atmospheric spectrometer:

Vertical profiles of stellar radiance through the atmosphere
Vertical profiles of atmospheric dust absorption, and column opacity

Gamma-Ray Spectrometer:

Relative number of atoms at the surface
Surface composition, global variability of dust

Termoskan:

Broadband thermal emission from surface

Surface thermal inertia and spatial variability

Radar sounder (at multiple frequencies near 1 Mhz):

Electrical properties of surface (if ionosphere is absent)
Density of near-surface layer
Possible vertical structure of surface
Possible presence of liquid water

(Balloon)

Gondola

TV camera:

High-resolution images of the surface
Spatial variability of surface features and dust clouds

Meteorology package:

Structure of atmosphere within diurnal boundary layer
Clues to dust-induced atmospheric dynamics

Infrared Spectrometer:

Dust composition and mineralogy

Aerosol sensor:

Column dust opacity

Electromagnetic induction sounder:

Electrical properties of subsurface
Structure of subsurface at kilometer scale
Possible presence of liquid water

Snake

Gamma-ray Spectrometer:

Same as above

Accelerometers:

Structure and cohesion of surface at small scales

Ground-penetrating radar (approx. 1 m wavelength in ground)

Electrical properties of surface layer
Structure of top 100 m of regolith
Possible presence of liquid water

Rover

TV camera:

Images of the surface at high spatial resolution

Alpha-proton spectrometer:

Numbers of atoms in surface materials
Composition and mineralogy of surface

Reflection and fluorescence spectrometer:

Surface composition and mineralogy

Mossbauer spectrometer:

Surface mineralogy

Electrostatic instrument:

Electrostatic properties of dust/atmosphere

Penetrator

TV camera, viewing over 360 degrees:

Same as above

Gamma-ray Spectrometer:

Same as above

The following is a list of the types of information that will be obtained from the above instruments, sorted by type of information rather than by instrument or mission. The missions which will measure each piece of information are listed (MO = Mars Observer, M94 = Mars 94, MSR = MESUR; S indicates that some type of synoptic coverage will be obtained, and L indicates that information will be obtained only at discrete or small number of times/locations, where appropriate).

ATMOSPHERIC DUST

1. Vertical profiles of temperature and dust absorption through the atmosphere.
   MO/S, M94/S, MSR/L

2. Particle size distribution of airborne dust, within range of about 1 to 10 microns; less-detailed information on sizes down to about 0.1 micron.
   MO/S, M94/S

3. Some information on vertical profiles of particle size distribution.
   MO/S, M94/S

4. Some information on composition of dust and on vertical profiles of compositional variation.
   MO/S, M94/S

5. Spatial distribution of atmospheric dust clouds or storms.
   MO/S, M94/?

6. Column opacity of airborne dust, and spatial variations.
   MO/S, M94/S, MSR/L

7. Direct measure of winds/dynamical properties at some locations and times.
   MO/S, M94/S, MSR/L

SURFACE DUST

1. Information on sources and sinks of atmospheric dust.
   MO/S, M94/S

2. Elemental composition of surface materials.
   MO, M94, MSR/L

3. Mineralogy of surface materials.
   MO, M94

4. Thermal inertia, block abundance and size distribution.
   MO, M94, MSR/L

5. Geologic information at high spatial resolution over some fraction of the surface (and clues to ongoing geological processes).
   MO, M94, MSR/L

6. Some information on cohesion of the surface at a single location (from Mars 94 penetrator).
   M94/L

7. Some information on trafficability of surface at a single location (from Mars 94 rover).
   M94/L

8. Some information on thickness of dust deposits and structure of near-surface layer.
M94

9. Presence or absence of liquid water within regolith, at varying vertical scales.
M94

10. Some information on electrostatic properties of surface dust.
M94/?

The following list includes information that is pertinent to the properties or evolution of dust on the surface and in the atmosphere but which will not be obtained by any of these missions or instruments. Notice that some information could be obtained by instruments which could still find their way onto the payload of MESUR or Mars 94. Also listed is the type of instrument which could make the desired measurements, if possible and if known.

1. Actual particle size and shape distribution of dust in the atmosphere and on the ground (particle counters; sky brightness and polarization measurements; optical and electron microscopes).

2. Global information on cohesion of surface dust or fine materials and on trafficability of surface materials (could be obtained from a small number of landed packages, in conjunction with global remote-sensing observations).

3. Electrostatic properties of surface/airborne dust and atmospheric breakdown of electrical conductivity (in-situ (landed) DC voltmeter).

4. Chemical properties of surface dust (such as chemical reactivity, corrosiveness) (essentially same experiment as electrostatic properties).

5. Detailed information on incremental and net motion of surface and airborne dust over the course of a year (sounding board particle counter for movement of sand-sized grains; yardstick stuck into ground; observations over many years).

6. Direct measure of shear stress at surface (wind velocity at three heights above surface).

7. Direct measure of mineralogy (currently to be done possibly on one landed package) (XRD; Infrared spectrometer; cross-polarized optical microscope).

8. Toxicity (send a rabbit).

9. Dust-deposit thickness (cores; EM sounding; penetrator; seismometer).