Diviner Lunar Radiometer Experiment – temperature, mineralogy & rock abundance (with ground truth)

Carlton Allen\textsuperscript{1}, Josh Bandfield\textsuperscript{2}, Rebecca Ghent\textsuperscript{3}, Ben Greenhagen\textsuperscript{4}, David Paige\textsuperscript{5}, Matt Siegler\textsuperscript{5}, Ashwin Vasavada\textsuperscript{4}, and the Diviner Science Team

\textsuperscript{1}JSC, \textsuperscript{2}U. Washington, \textsuperscript{3}U. Toronto, \textsuperscript{4}JPL, \textsuperscript{5}UCLA
LRO Diviner Overview

<table>
<thead>
<tr>
<th>Observation Strategy</th>
<th>Primarily nadir pushbroom mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detectors</td>
<td>Nine 21-element linear arrays of uncooled thermopile detectors</td>
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<tr>
<td>Fields of view</td>
<td>Detector Geometric IFOV: 6.7 mrad in-track 3.4 mrad cross track 320 m on ground in track for 50 km altitude 160 m on ground cross track for 50 km altitude Swath Width (Center to center of extreme pixels): 67 mrad; 3.4 km on ground for 50 km altitude</td>
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Science Goals

1. Characterize the Moon’s surface thermal environments:
   • Daytime
   • Nighttime
   • Polar
2. Map properties of the lunar surface:
   • Bulk thermal properties
   • Rock abundance
   • Composition
3. Characterize polar cold traps:
Measuring temperature from orbit

Planck curves

Spectral Exitance (W/cm²μm)

Wavelength (microns)
Measuring temperatures of the entire Moon from orbit
Ground truth

Apollo 15
Hadley Rille
Apollo 15 landing site

~3:30 PM

Brightness Temperature

Temperature differences dominated by topography
Apollo 15 landing site

~5:10 PM

Brightness Temperature

225 K
Apollo 15 landing site

~4:20 AM

Brightness Temperature

97 K
Apollo 17 landing site

Brightness Temperature

~2:00PM

370 K
Apollo 17 landing site

320 K

Brightness Temperature

~3:35 PM
Apollo 17 landing site

~2:43 AM

Brightness Temperature

97 K
Ground truth

Apollo 15/17 Heat Flow Experiment
Apollo 15 – Diviner data on thermal models

Graph showing brightness temperature (K) over time of day ("Moon Hours").

- Keihm (1984) Apollo 15 Specific Model
- A15 Channel 6 Data
- A15 Channel 7 Data
- A15 Channel 8 Data
- A15 Channel 9 Data

Annotation: 2:15PM 50 deg off Nadir
Apollo 17 – Diviner data on thermal models

Graph showing brightness temperature (K) plotted against time of day (Moon Hours). The graph includes data from Vasavada et al. (1999) General Model, Keihm (1984) Apollo 17 Specific Model, and various channels of Apollo 17 (Channels 6, 7, 8, and 9).
Measuring mineralogy from orbit

Diviner 8 \( \mu m \) Bands

Christiansen feature

Highland Mare

62231

71061
Basaltic Lava
15016
Anorthosite 15415

Highland Crust
Christiansen feature
Measuring rock abundance from orbit ~4:20 AM

Rocks larger than ~1 m retain some of their heat thru the lunar night.

Hadley rille and craters are warmer than adjacent regolith.
Rock Abundance Model – Diviner nighttime temperatures
Surveyor 3
(Apollo 12)
The Diviner Lunar Radiometer Experiment was specifically designed to measure the full range of surface temperatures across the Moon.

Diviner spectral bands near 8 µm were selected to provide mineral characterization.

Diviner nighttime temperatures and spectral temperature differences are sensitive to rock abundance.

Initial results, compared to “ground truth” from Apollo and Surveyor landing sites, demonstrate that these data can be confidently used to derive temperature, mineralogy, and rock abundance in support of lunar science and exploration objectives.