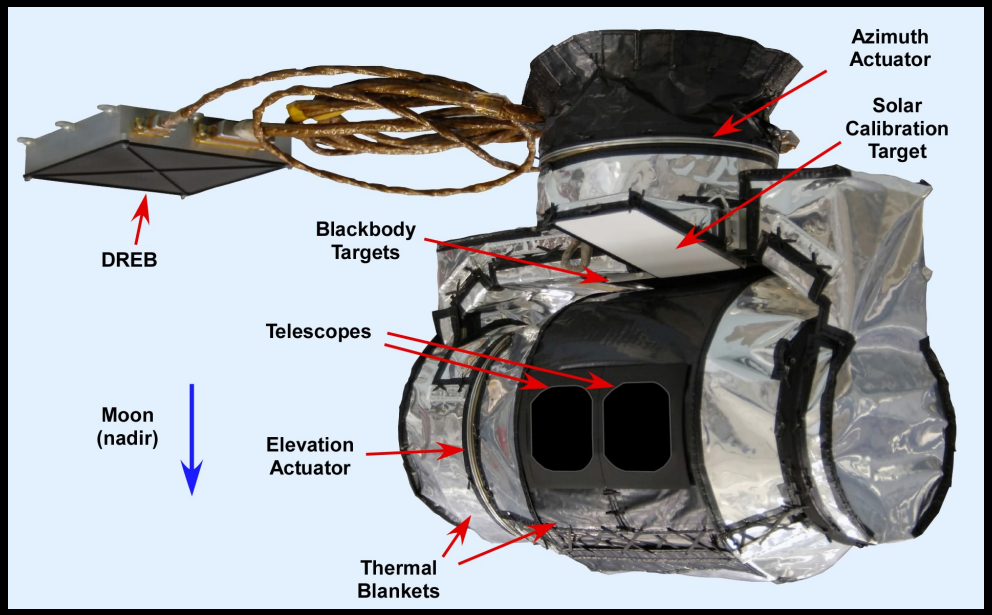
Diviner Experiment and Dataset Overview

David Paige – UCLA

LRO LPSC Data Users Workshop
3/16/15

http://diviner.ucla.edu

LRO Diviner Overview

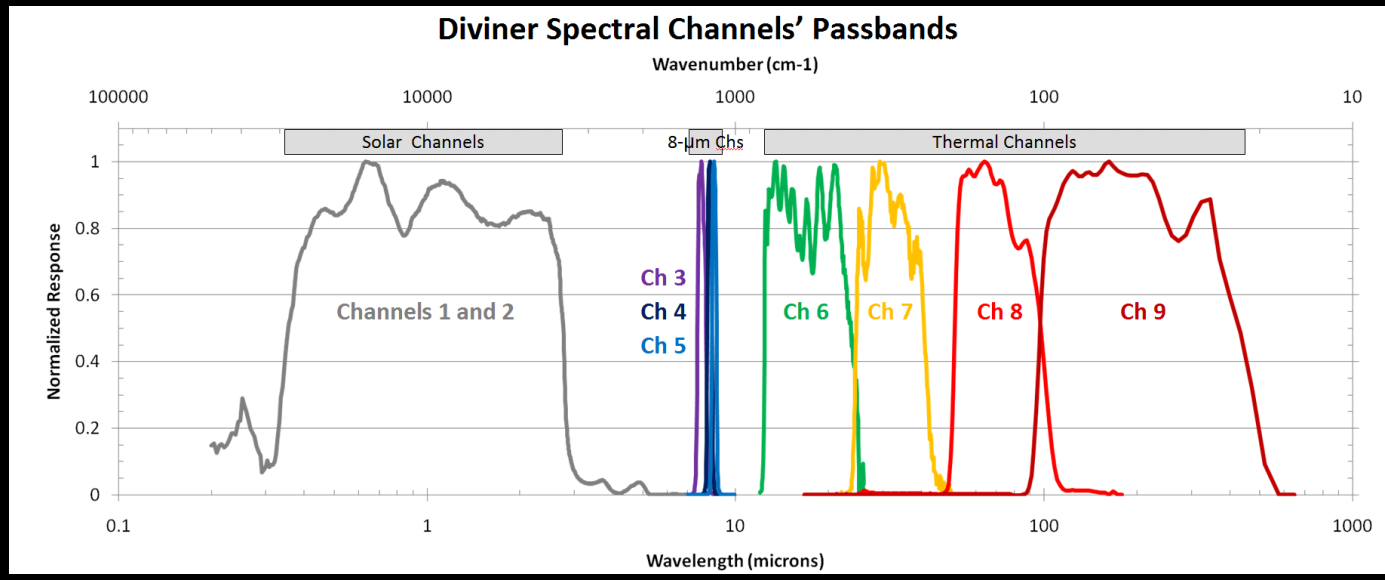


Parameter	Property
Instrument Type	Infrared and solar radiometer
Spectral Range	0.35 to 400 μm in nine spectral channels
Telescopes	Two identical three-mirror, off-axis, f/1.7 telescopes with 4cm apertures
Detectors	Nine 21-element linear arrays of uncooled thermopile detectors Pixel size 240 μm x 480 μm
Fields of view	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
Instrument Articulation	Two-axis azimuth/elevation, Range 270º, resolution 0.1º
Operating Modes	Single operation mode, 0.128 s signal integration period
Observation Strategy	Primarily nadir pushbroom mapping

Science Goals

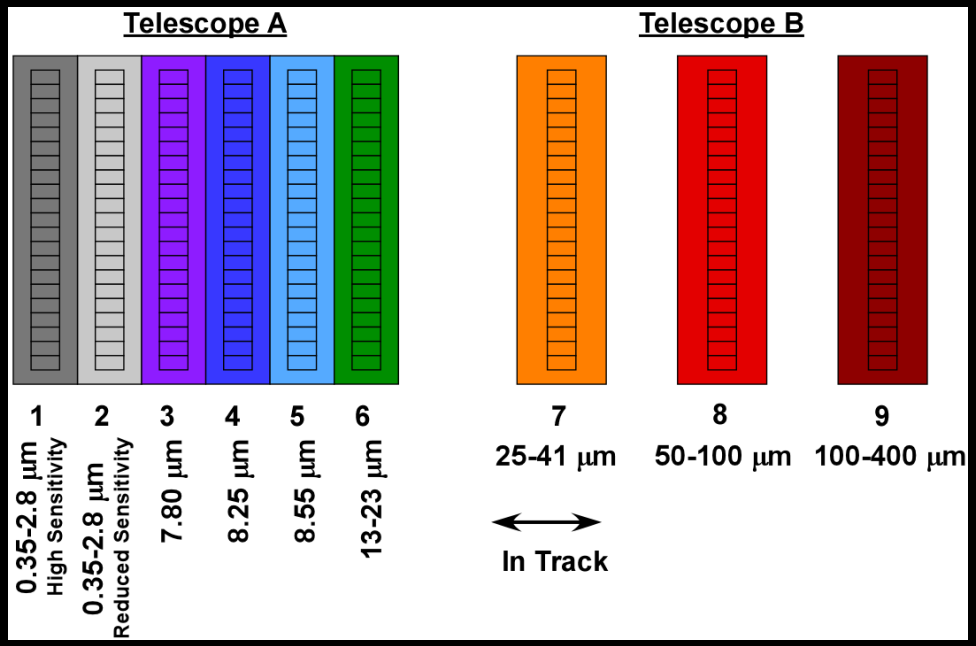
1. Characterize the Moon's surface thermal environments:
   - Daytime
   - Nighttime
   - Polar
2. Map properties of the lunar surface:
   - Bulk thermal properties
   - Rock abundance
   - Composition
3. Characterize polar cold traps:
   - Map cold trap locations
   - Determine their temperatures and thermophysical properties
   - Assess potential lunar volatile resources

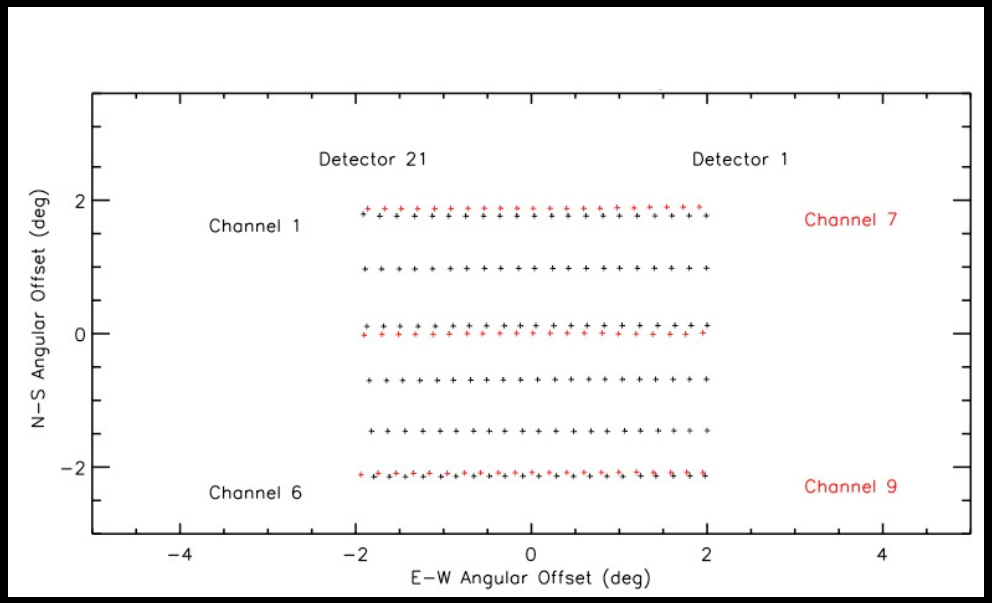
Diviner Spectral Channels

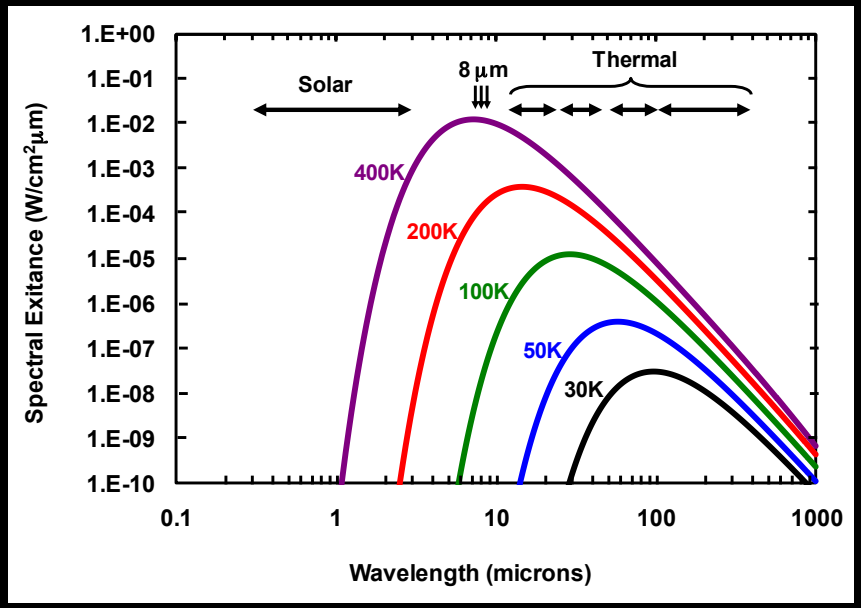


Channel Number	Channel Type	Channel Name	Passband µm	Measurement Function	Minimum Detectable Temperature (K)
1	Solar	High Sensitivity Solar	0.35-2.8	Reflected solar radiation, high sensitivity	-
2	Solar	Reduced Sensitivity Solar	0.35-2.8	Reflected solar radiation, reduced sensitivity	-
3	8 µm	7.8 µm	7.55-8.05	Christiansen feature	150
4	8 µm	8.25 µm	8.10-8.40	Christiansen feature	150
5	8 µm	8.55 µm	8.38-8.68	Christiansen feature	150
6	Thermal	13-23 µm	13-23	Surface Temperature (most sensitive channel for >178 K)	85
7	Thermal	25-41 µm	25-41	Surface Temperature (most sensitive channel for 69-178K)	55
8	Thermal	50-100 µm	50-100	Surface Temperature (most sensitive channel for 43-69 K)	40
9	Thermal	100-400 µm	100-400	Surface Temperature (most sensitive channel for <43 K)	30

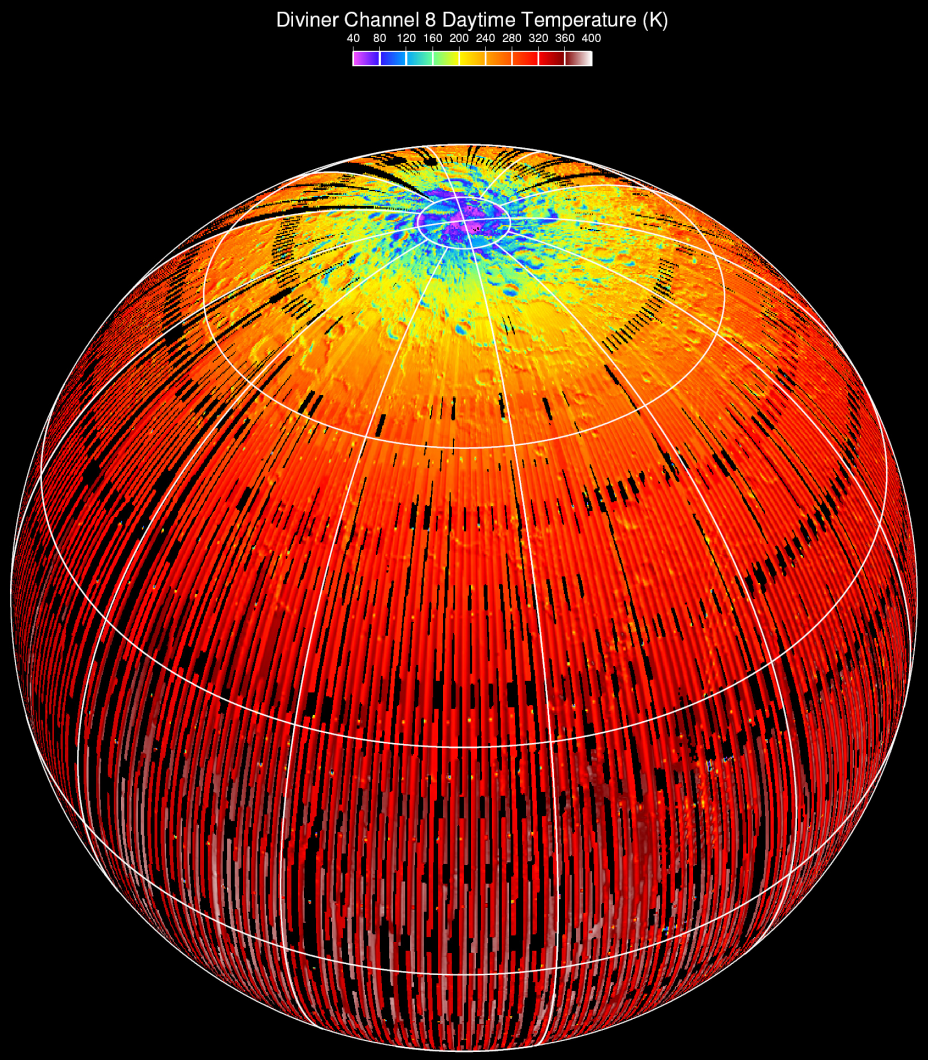
Diviner Fields of View

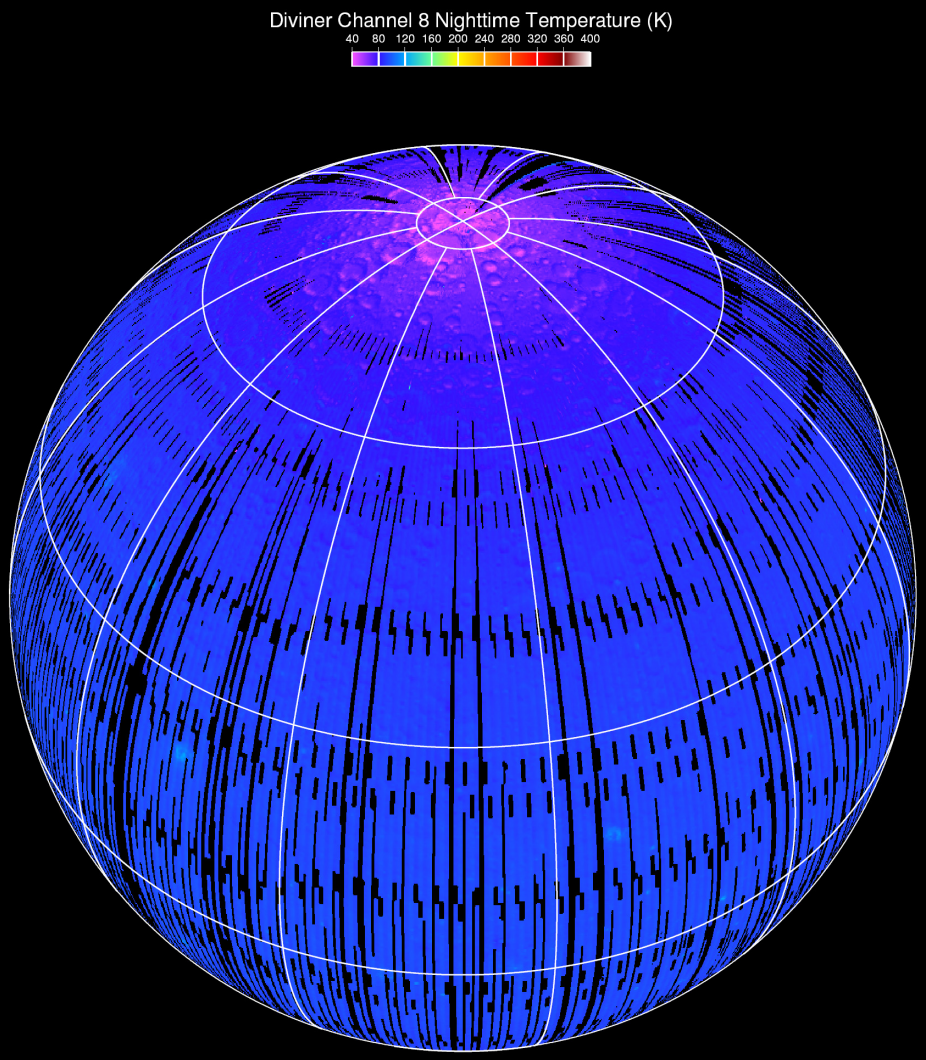




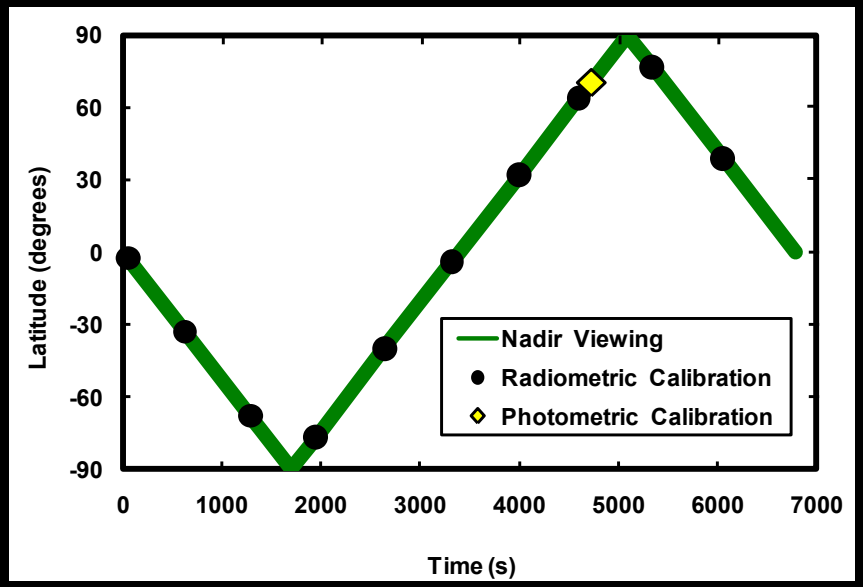


First Diviner Day and Night Global Thermal Maps

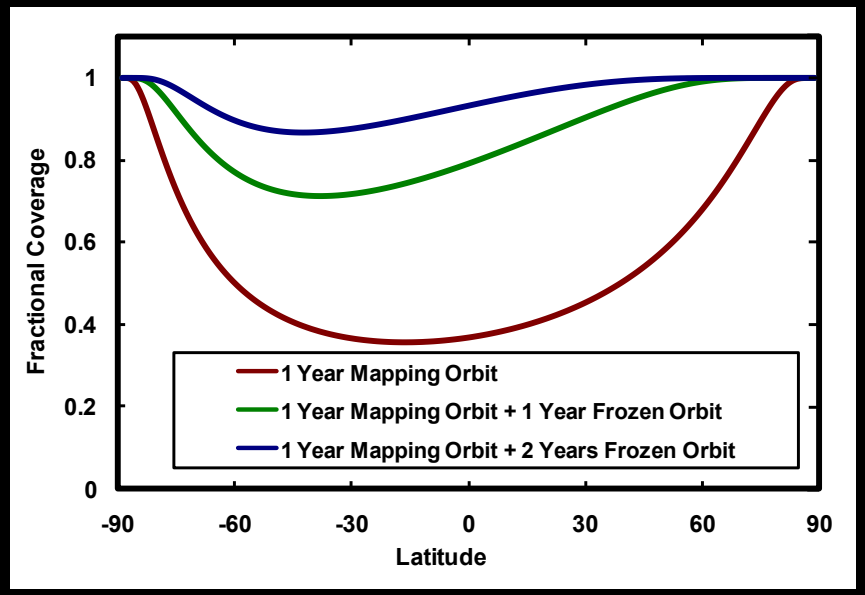




Observation Strategy



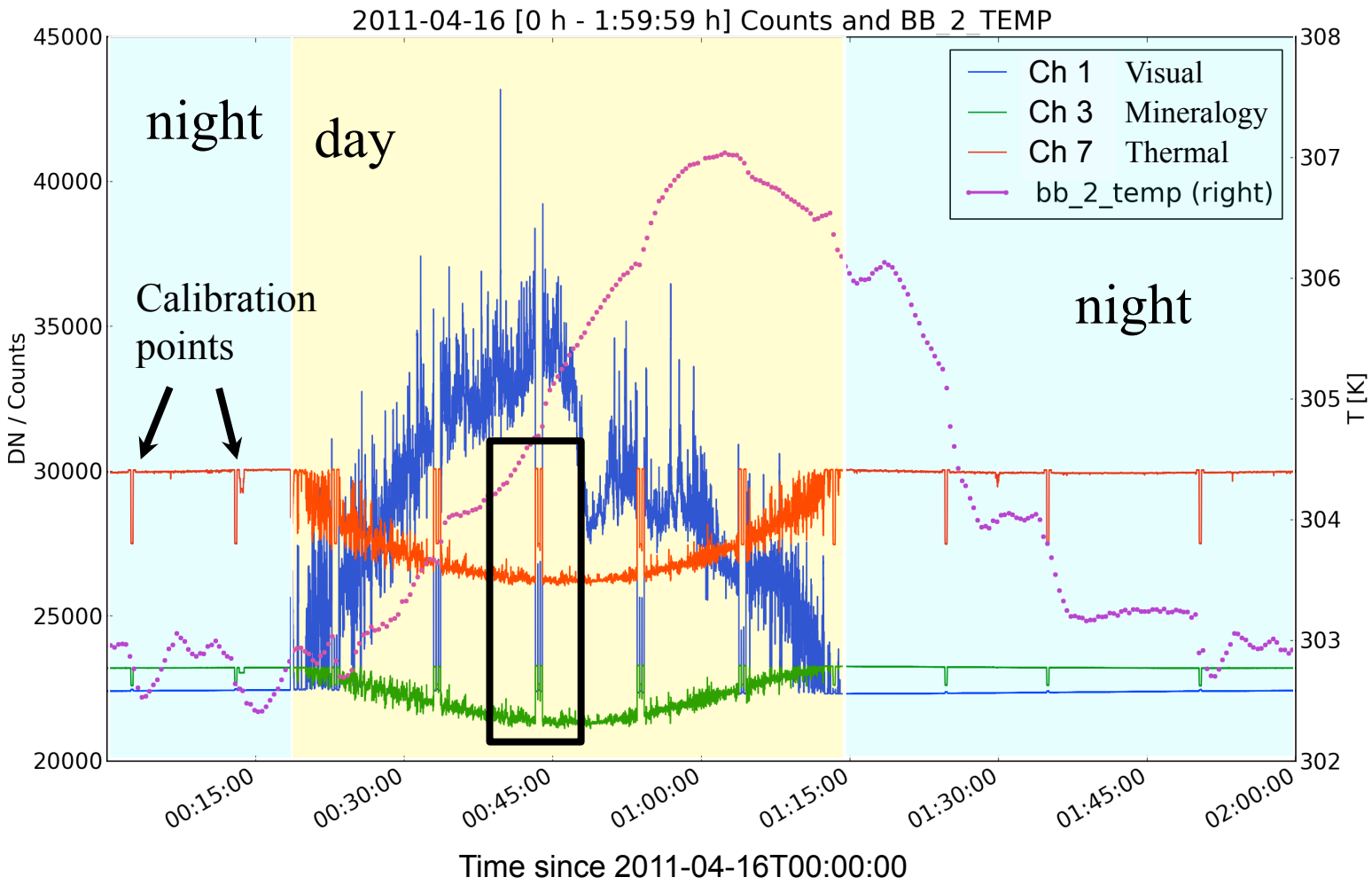
Calibration Strategy



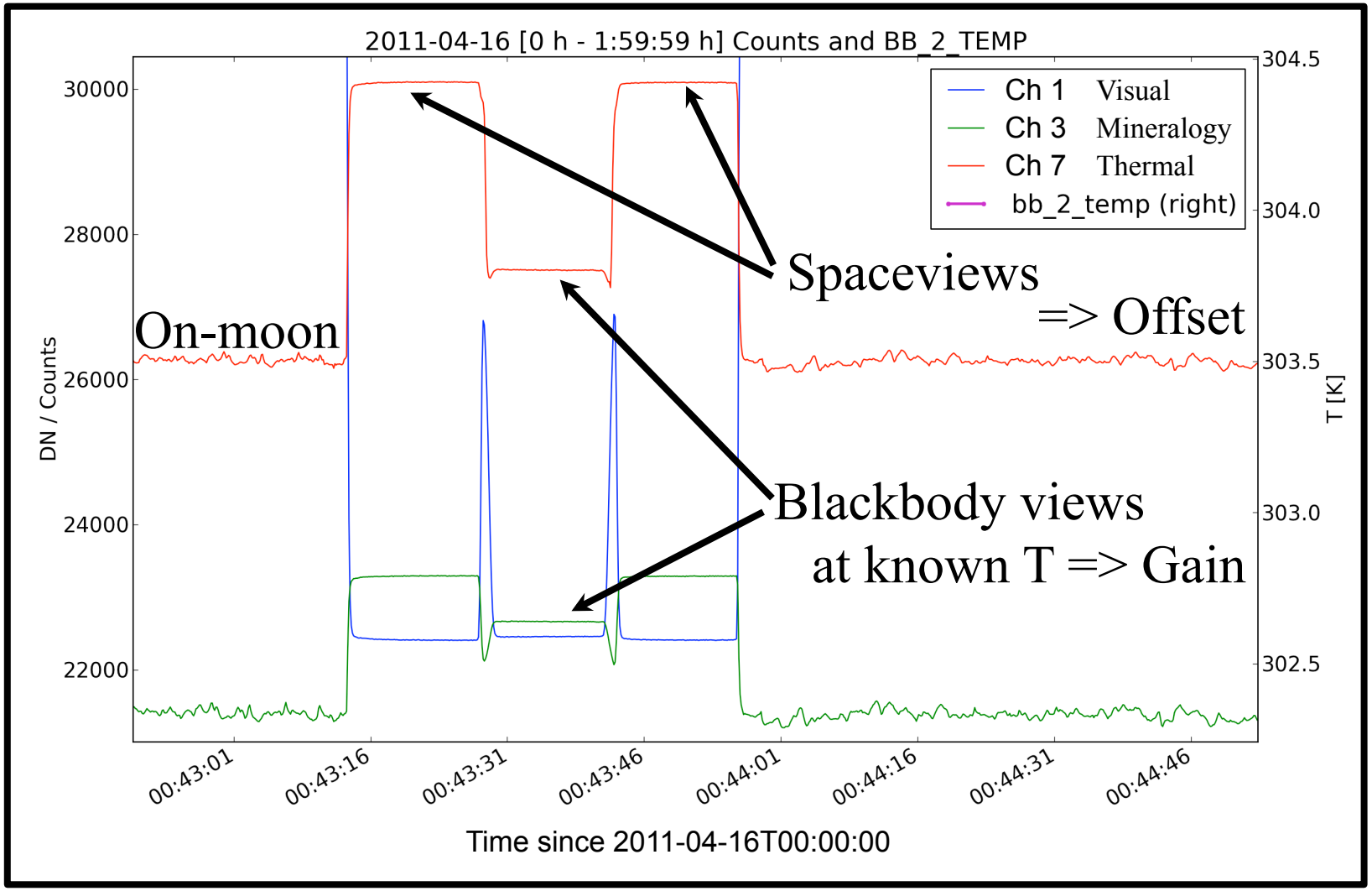
Statistical Coverage Model

Diviner has been mapping the Moon nearly continuously since July, 2009. Since this time, it has acquired ~200 Billion radiometric observations of the Moon – the most complete mapping of an airless body in the solar system. In total, we will create ~3 Million Data Products, in ~30 Million Files

Example of raw data



Calibration block



Data Product Level	Archived Data Product Name	Description	Format	Accessibility	Value to Science and Exploration	PDS Delivery Schedule	Data Volume
Current Data Products							
CAL	Pre-Flight Calibration Data	Pre-flight calibration data (Spectral Response, Blackbody Response, Solar Target Reflectance, Fields of View)	Ascii	PDS Download	Primary reference for calibration/recalibration	9-Dec-09	10 Mbytes
NOTEBOOK	Experimenter's Notebook	Chronological text description of instrument operation and performance	Ascii	PDS Download	Primary reference for dataset validation and interpretation	6 months after receipt	54 MBytes/3 months
0	Experimenter Data Records	Depacketized time-sequenced raw science and housekeeping data	Binary	PDS Download	Primary reference	6 months after receipt	1 MByte/3 months
1	Reduced Data Records	Calibrated radiances and housekeeping data merged with project-supplied geometry and timing information	Ascii	PDS Download, PDS Lunar Orbital Data Explorer	Lowest level of processing that is useful for science, No information loss	6 months after receipt	2 TBytes/3 months
2	Gridded Data Products	3-D Projected and Gridded (Lat, Lon, Month, Day/Night) global and polar brightness temperature and visual brightness. Multi-Resolution, LOLA compatible.	IMG and JPEG2000	PDS Download, PDS Lunar Orbital Data Explorer, LMMP	More highly processed dataset that can be overlain on other mapped datasets, GIS	6 months after mission phase completion	2 Tbytes/ delivery
3	Gridded Derived Data Products	Gridded (Lat, Lon, Month) global CF, Rock Abundance, Nighttime Soil Temperature, Bolometric Temperature	IMG and JPEG2001	PDS Download, PDS Lunar Orbital Data Explorer, LMMP	Derived lunar properties through comparison with physical models, Can be easily overlain with other mapped datasets, GIS	6 months after mission phase completion	1 TByte/ delivery
4	Polar Products	Model-Calculated Annual Min/ Max/Average polar surface temperature, water ice stability depth	Ascii	PDS Download	Loations of permanent shadow, cold traps, comparisons with other lunar polar datasets	6 months after mission phase completion	4 Mbytes
4	Global Thermal Model Product	Model-calculated surface temperatures every 3 hours from 2000-2025	Binary	PDS Download	Lunar thermal environment model for future mission planning	6 months after mission phase completion (Not yet delivered)	45 Tbytes

New Foundation Data Products	Archived Data Product Name	Description	Format	Accessibility	Value to Science and Exploration	PDS Delivery Schedule	Data Volume
1	Recalibrated Reduced Data Records	Recalibrated and reflagged radiances and housekeeping data merged with project-supplied geometry and timing information	Ascii	PDS Download, PDS Lunar Orbital Data Exporer	More accurate results at low temperatures for heat flow and polar illumination studies. Reduces systematic calibration issues at high temperatures and flaggs data contaminated by spectral leaks and noise.	9 months after mission phase completion	48 TBytes/ delivery
2	Diviner Map Tiles	Geographically Tiled 3-D Projected and Gridded (Lat, Lon, Month, Day/Night) global brightness temperature and visual brightness	IMG and JPG2000	PDS Download, PDS Lunar Orbital Data Explorer, LMMP	Improved access to Diviner mapped data for comparion with physical models and other lunar datasets and GIS. Includes higher accuracy 3-d gridding, and preservation of original geometric and temporal metadata for photometric corrections.	9 months after mission phase completion	2 TBytes/ delivery
3	Diviner Summary Maps	Gridded annual and/or cumulative maps of minimum/ maximum/average maps of brightness temperatures, visual brightness, rock abundance, nighttime soil temperature, CF and bolametric brightness temperature.	IMG and JPG2000	PDS Download, PDS Lunar Orbital Data Explorer, LMMP	Defines the measured extrema of the lunar thermal and illumination environments, and subsurface temperatures.	9 months after mission phase completion	1 Tbyte/ delivery
3	Diviner Earth Scans	Projected and mapped Earth brightness temperatures and visual brightness	IMG and JPG2000	PDS Download	Unique analog dataset valuable for detection and characterization of extrasolar Earthlike planets	9 months after mission phase completion	100 Mbytes/ delivery
4	Diviner Special Data Collection	Off-nadir datasets acquired during eclipses, emission phase function observations, landing sites, and the LCROSS impact	Ascii, IMG and JPG2000	PDS Download	Compendium of Diviner's most valuable non-routine datasets with additional documentation for detailed analysis	9 months after mission phase completion	10 Gbytes

Lunar Reconnaissance Orbiter

Diviner Lunar Radiometer Experiment
Reduced Data Record
Software Interface Specification

Version 1.6

December 1, 2009

Prepared by:

Mark Sullivan
UCLA

Approved by:

David Paige
UCLA
Principal Investigator, DLRE

Raymond E. Arvidson
Washington University
Director, PDS Geosciences Node

Edwin Grayzeck
GSFC
PDS Program Manager

UCLA

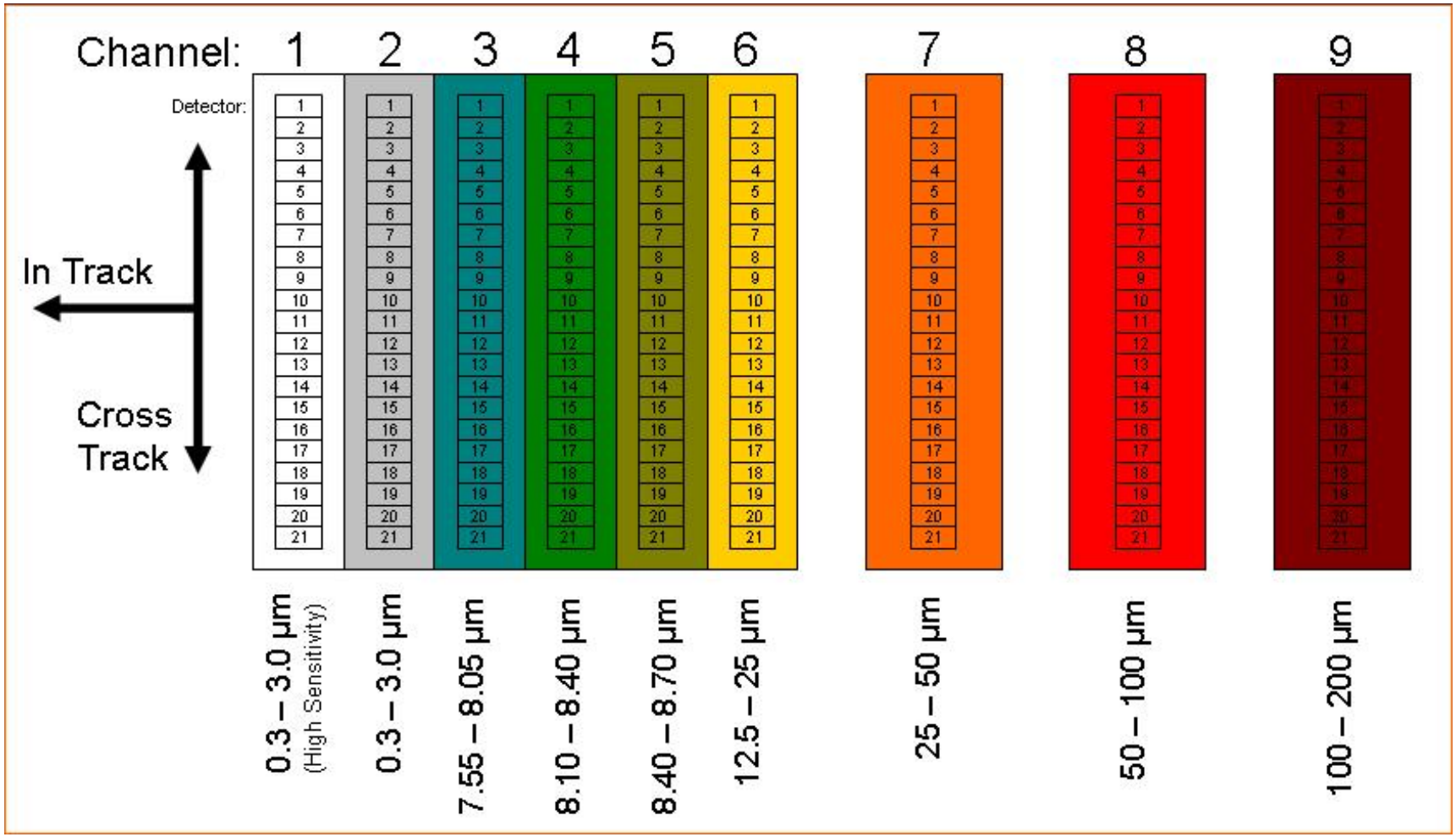
University of California at Los Angeles

Diviner RDR ASCII Filenames

200907082000_RDR.TAB
200907082010_RDR.TAB
200907082020_RDR.TAB
200907082030_RDR.TAB
200907082040_RDR.TAB
200907082050_RDR.TAB
200907082100_RDR.TAB

Each file contains 10-minutes of data

Diviner Channel Layout



- 189 Detectors (9*21)
- 0.128 Seconds Integration Period

Diviner RDR ASCII Data

33 Columns

```
# Header
# Header
# Header
#        date,            utc,             jdate, orbit, sundist,   sunlat,    sunlon,             sclk,     sclat,     sclon,       scrad,       scalt,  el_cmd,  az_cmd,   af,  vert_lat,  vert_lon,
c, det,    vlookx,    vlooky,    vlookz,   radiance,        tb,      clat,      clon,     cemis,   csunzen,   csunazi, cloctime, qca, qge, qmi
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,   1, -0.391943,  0.899803,  0.191957,     0.0064,    0.000,  -7.74097, 294.76688,   3.56572, 104.54717,  92.76888, 18.98556, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,   2, -0.395038,  0.898441,  0.191994,     0.0307,    0.000,  -7.74094, 294.76205,   3.50446, 104.54242,  92.76817, 18.98528, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,   3, -0.398129,  0.897068,  0.192028,     0.0138,    0.000,  -7.74090, 294.75726,   3.45365, 104.53766,  92.76745, 18.98500, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,   4, -0.401199,  0.895692,  0.192060,    -0.0103,   -0.000,  -7.74087, 294.75247,   3.41392, 104.53293,  92.76673, 18.98472, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,   5, -0.404409,  0.894241,  0.192092,     0.0340,    0.000,  -7.74083, 294.74747,   3.38430, 104.52798,  92.76599, 18.98417, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,   6, -0.407614,  0.892778,  0.192123,     0.0201,    0.000,  -7.74079, 294.74246,   3.36726, 104.52303,  92.76524, 18.98389, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,   7, -0.410558,  0.891423,  0.192149,    -0.0156,   -0.000,  -7.74075, 294.73785,   3.36286, 104.51846,  92.76456, 18.98361, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,   8, -0.413609,  0.890005,  0.192174,    -0.0229,   -0.000,  -7.74072, 294.73306,   3.36976, 104.51373,  92.76384, 18.98333, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,   9, -0.416799,  0.888511,  0.192199,    -0.0175,   -0.000,  -7.74068, 294.72806,   3.38944, 104.50878,  92.76309, 18.98306, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  10, -0.419729,  0.887125,  0.192220,    -0.0140,   -0.000,  -7.74064, 294.72345,   3.41861, 104.50423,  92.76241, 18.98278, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  11, -0.422830,  0.885647,  0.192241,    -0.0168,   -0.000,  -7.74060, 294.71857,   3.46080, 104.49939,  92.76168, 18.98250, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  12, -0.425941,  0.884151,  0.192259,    -0.0055,   -0.000,  -7.74055, 294.71365,   3.51446, 104.49454,  92.76095, 18.98195, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  13, -0.428984,  0.882675,  0.192276,    -0.0214,   -0.000,  -7.74051, 294.70886,   3.57750, 104.48978,  92.76023, 18.98167, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  14, -0.431880,  0.881259,  0.192290,     0.0300,    0.000,  -7.74047, 294.70428,   3.64673, 104.48524,  92.75954, 18.98139, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  15, -0.435040,  0.879700,  0.192304,     0.0194,    0.000,  -7.74043, 294.69928,   3.73200, 104.48029,  92.75880, 18.98111, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  16, -0.438068,  0.878194,  0.192316,    -0.0214,   -0.000,  -7.74038, 294.69446,   3.82270, 104.47553,  92.75808, 18.98083, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  17, -0.440949,  0.876749,  0.192325,    -0.0541,   -0.000,  -7.74034, 294.68988,   3.91666, 104.47099,  92.75739, 18.98056, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  18, -0.444093,  0.875158,  0.192333,     0.0073,    0.000,  -7.74029, 294.68484,   4.02710, 104.46603,  92.75665, 18.98000, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  19, -0.447231,  0.873558,  0.192340,    -0.0363,   -0.000,  -7.74025, 294.67984,   4.14501, 104.46107,  92.75590, 18.97972, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  20, -0.450238,  0.872010,  0.192344,     0.0087,    0.000,  -7.74020, 294.67502,   4.26466, 104.45631,  92.75517, 18.97944, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
1,  21, -0.453055,  0.870439,  0.192848,     0.0037,    0.000,  -7.73943, 294.67044,   4.40727, 104.45181,  92.75430, 18.97917, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
2,   1, -0.393087,  0.902065,  0.178532,     0.0543,   -0.000,  -7.76023, 294.76672,   2.81944, 104.54610,  92.77385, 18.98556, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
2,   2, -0.396184,  0.900702,  0.178569,     0.0216,   -0.000,  -7.76020, 294.76190,   2.74151, 104.54134,  92.77313, 18.98528, 000, 012, 000
"15-Dec-2009", "23:50:00.055", 2455181.493056196,  2163, 0.98159, -0.71623, 189.98106, 0282613800.02752,  -7.82076, 294.73764,  1780.03541,    42.46889, 180.000, 240.000,  910,  -1.92879,  25.81281,
2,   3, -0.399405,  0.899272,  0.178604,     0.0609,   -0.000,  -7.76016, 294.75690,   2.67377, 104.53638,  92.77238, 18.98500, 000, 012, 000
```

Channel 1

Channel 2

#	Field name	Data Type and Width[.Precision]	Description
1	date	Character 13	Date at the midpoint of observation (SCET, UTC). E.g. "25-Jun-2009"
2	utc	Character 14	Time at the midpoint of observation (SCET, UTC). E.g. "19:35.37.440"
3	jdate	Real 17.9	Julian Date at the midpoint of observation (SCET, UTC). E.g. 2454102.123456789
4	orbit	Integer 5	Orbit number. 0 to 99999
5	sundist	Real 7.5	The distance from the center of the moon to the sun (AU). E.g. 1.00001
6	sunlat	Real 8.5	Subsolar Latitude (deg). E.g. -1.54333
7	sunlon	Real 9.5	Subsolar East Longitude (deg). 0.00000 to 360.00000
8	sclk	Real 16.5	Spacecraft clock at midpoint of observation (seconds.subseconds). The seconds are relative to the 2001 epoch. The numbers to the right of the decimal point are not decimal fraction of a second but rather subseconds. Each second is divided into 65536 subseconds, thus the range for subseconds is 0 – 65535. Example: 123456789.00001
9	sclat	Real 9.5	Subspacecraft Latitude (deg). -90.00000 to 90.00000
10	sclon	Real 9.5	Subspacecraft East Longitude (deg). 0 to 360.00000
11	scrad	Real 11.5	Distance from the center of moon to the spacecraft (km). E.g.: 11000.00000
12	scalt	Real 11.5	Distance from the surface of the moon to the spacecraft (km). E.g.: 11000.00000. Uses spherical Moon with a radius of 1737.4

13	el_cmd	Real 7.3	Last Elevation Command (deg). 0 to 270.000
14	az_cmd	Real 7.3	Last Azimuth Command (deg). 0 to 270.000
15	af	Integer 4	Activity Flag. See Appendix B of DLRE RDR SIS for description
16	orientlat	Real 9.5	Orientation Latitude (deg). The latitudinal component of the "orientation vector", a vector from the center of the moon in the direction of the detector array direction (defined as from detector 21 to detector 1). Provides angular orientation of the FOV's. -90.00000 to 90.00000
17	orientlon	Real 9.5	Orientation Longitude (deg). The east longitudinal component of the "orientation vector", a vector from the center of the moon in the direction of the detector array direction (defined as from detector 21 to detector 1). Provides angular orientation of the FOV's. 0 to 360.00000
18	c	Integer 1	Diviner Channel Number. 1 to 9
19	det	Integer 3	Diviner Detector Number. 1 to 21
20	vlookx	Real 9.6	The X component of the Diviner Look Unit Vector, using the lunar coordinate system described in Section 2.4.3. E.g. -0.999999
21	vlooky	Real 9.6	The Y component of the Diviner Look Unit Vector, using the lunar coordinate system described in Section 2.4.3. E.g. -0.999999
22	vlookz	Real 9.6	The Z component of the Diviner Look Unit Vector, using the lunar coordinate system described in Section 2.4.3. E.g. -0.999999

23	radiance	Real 10.4	Calibrated Radiance (W m^{-2} sr^{-1}). Range is -1000.0000 to 1000.0000
24	tb	Real 8.3	Calibrated Brightness Temperature (K). Except for Channels 1 and 2, which is radiance relative to normally illuminated Lambert surface at sun-moon distance. Range is -450.000 to 450.000, where negative tb values correspond to negative radiance values.
25	clat	Real 9.5	Latitude of FOV center (deg). Undefined if off planet. Uses ellipsoidal moon approximation as described in Section 2.4.3. -90.00000 to 90.00000
26	clon	Real 9.5	East longitude of FOV center (deg). Undefined if off planet. Uses ellipsoidal moon approximation as described in Section 2.4.3. 0 to 360.00000
27	cemis	Real 9.5	Emission Angle at FOV center (deg). This is the angle between the vector from the surface FOV center to Diviner and a “normal” vector drawn perpendicular to the Moon’s surface. Undefined if off planet. Uses ellipsoidal moon approximation as described in Section 2.4.3. 0 to 90.00000
28	csunzen	Real 9.5	Solar Zenith angle at FOV center (deg). This is the angle between the vector from the surface FOV center to the Sun and a "normal" vector drawn perpendicular to the Moon's surface. Undefined when off planet except during solar calibrations when it is defined as the angle between the vector to the Sun and the normal vector of the solar calibration target. Uses ellipsoidal moon approximation as described in Section 2.4.3. 0 to 180.00000

29	csunazi	Real 9.5	Solar Azimuth Angle at FOV Center (deg). 0 degrees when aligned with the solar vector and measured counter-clockwise when looking down at the planet. Undefined when off planet except during solar calibrations when it is defined as the angle between the projection of the vector to the sun onto the solar calibration target plane and the X-axis of the solar calibration target reference system (STS) . The X-axis direction of the STS is roughly parallel to the outward edge of the solar calibration target panel. Uses ellipsoidal moon approximation as described in Section 2.4.3. 0 to 360.00000
30	cloctime	Real 8.5	Local time at FOV Center (hours past midnight). Undefined if off planet. Uses ellipsoidal moon approximation as described in Section 2.4.3. 0 to 24.00000
31	qca	Integer 3	Quality Flag for Calibration. A 3-digit decimal integer representing an 8-bit binary quality flag. Bits set to 1 represent various conditions which compromise data quality. A value of zero represents best quality and increasing values indicate lower quality. Range is 0 to 255. See Appendix C of the RDR SIS for more details.
32	qge	Integer 3	Quality Flag for Geometry. A 3-digit decimal integer representing an 8-bit binary quality flag. Bits set to 1 represent various conditions which compromise data quality. A value of zero represents best quality and increasing values indicate lower quality. Range is 0 to 255. See Appendix C of the RDR SIS for more details.
33	qmi	Integer 3	Quality Flag for Miscellaneous. A 3-digit decimal integer representing an 8-bit binary quality flag. Bits set to 1 represent various conditions which compromise data quality. A value of zero represents best quality and increasing values indicate lower quality. Range is 0 to 255. See Appendix C of the RDR SIS for more details.