Mars Magnetic Microdomains and Life

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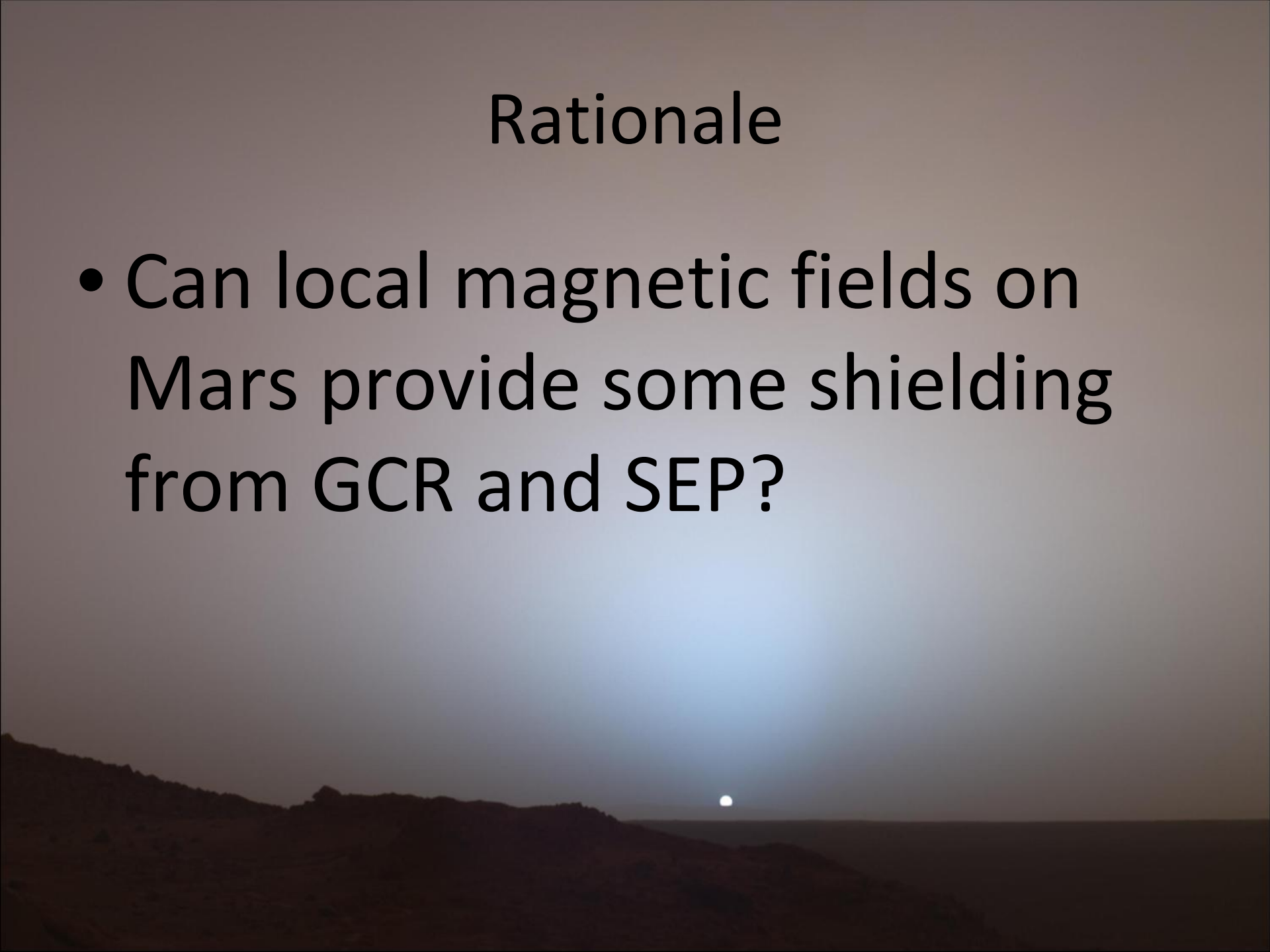
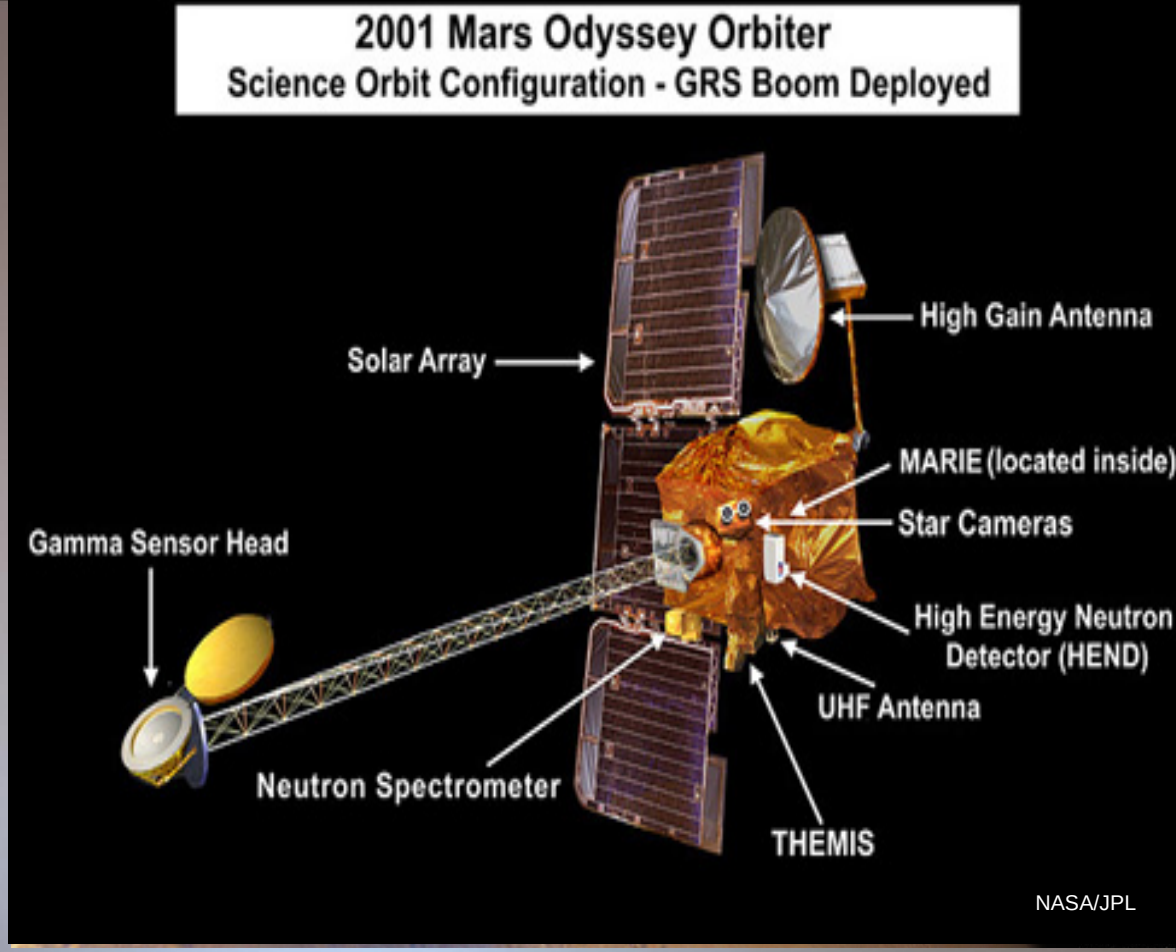
Rationale

- Can local magnetic fields on Mars provide some shielding from GCR and SEP?



2001

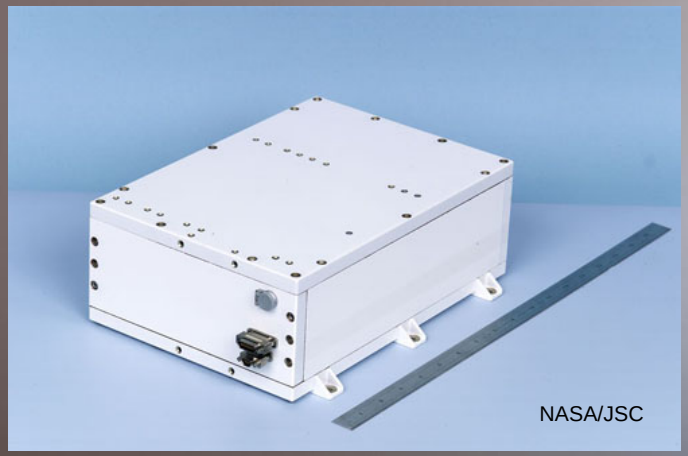
- Mission: “to find out what the planet is made of, detect water and shallow buried ice and study the radiation environment.”

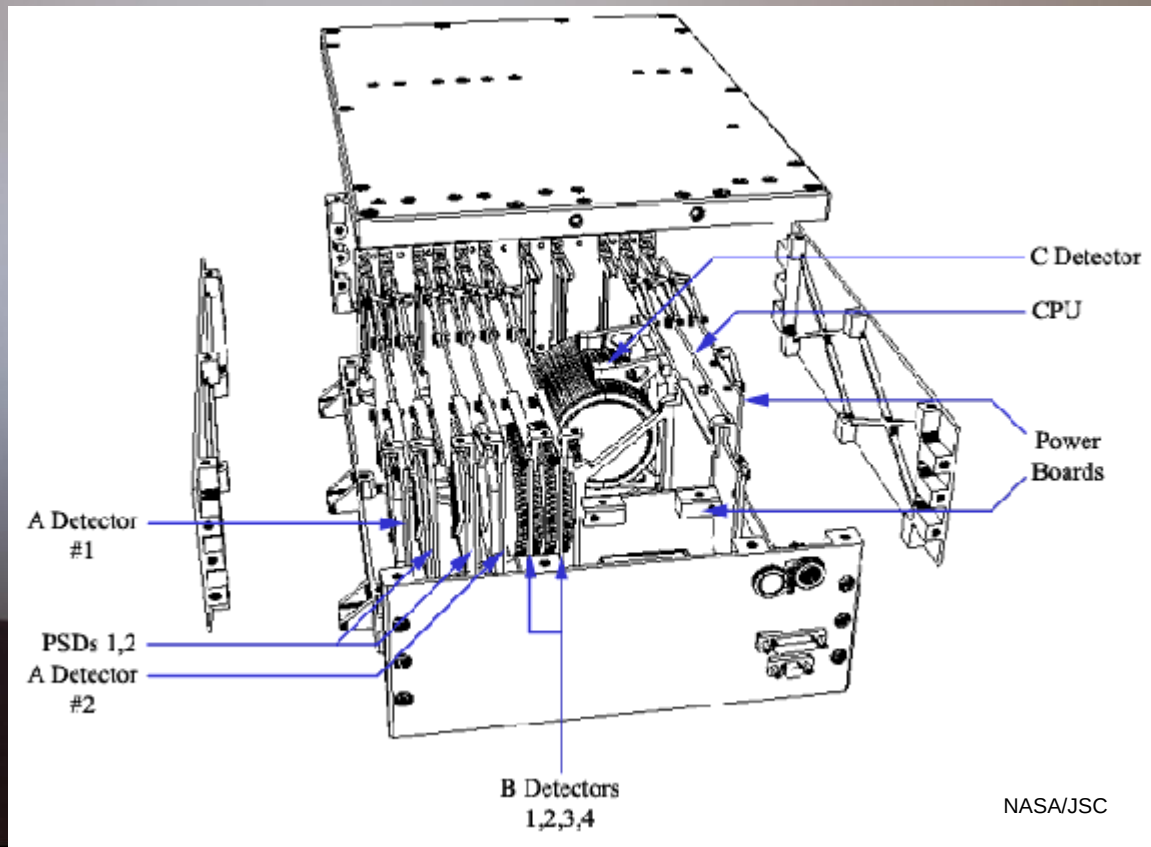


- Instruments:
  - THEMIS (Thermal Emission Imaging System)
  - GRS (Gamma-Ray Spectrometer)
  - MARIE (Mars Radiation Environment Experiment)

MARIE

- Objectives: “characterize specific aspects of near-space radiation environment, characterize the surface radiation environment as related to radiation-induced risk to human exploration, and determine and model effects of the atmosphere in an attempt to predict anticipated doses and assess its radiobiological effectiveness.”

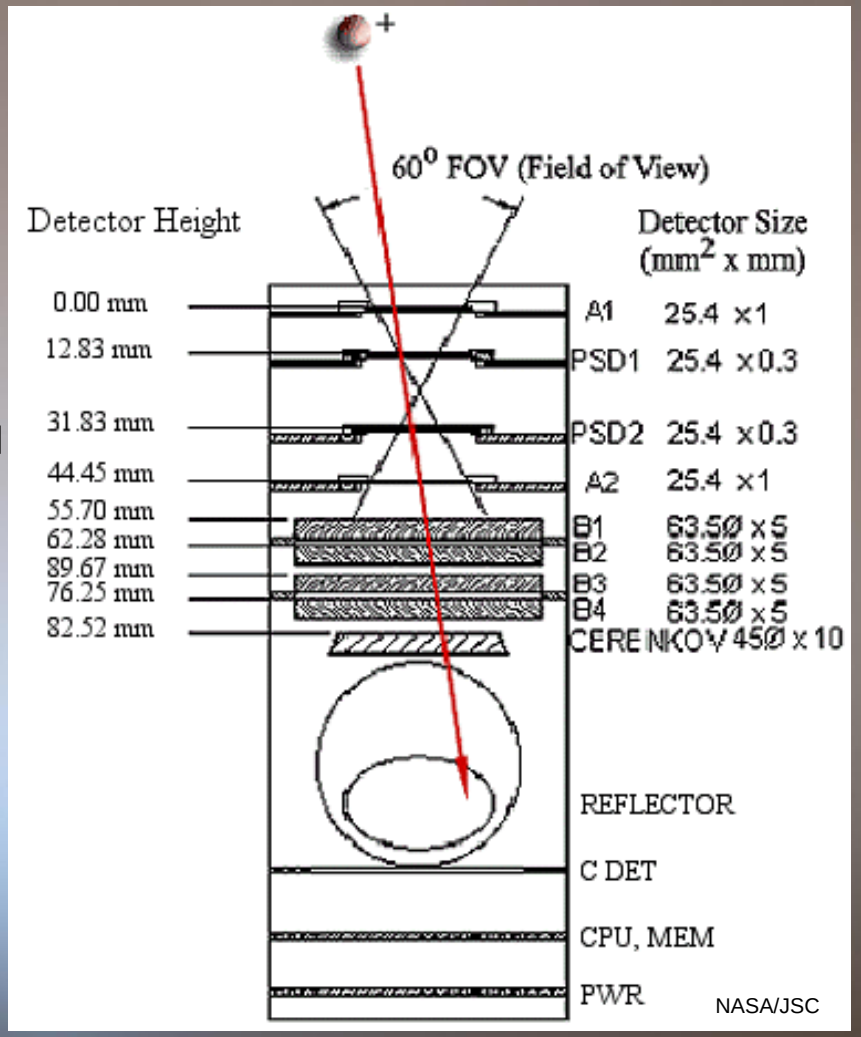




MARIE detectors

- The MARIE instrument was an energetic particle spectrometer.
- It consisted of six silicon detectors, two position sensitive detectors (PSDs), and a Cerenkov detector.
- Starting from the top, detector A1 was a square silicon detector.
- Next were the position sensitive detectors PSD1 and PSD2. Each consisted of two silicon strip detectors placed one on top of the other, with the strips oriented perpendicular to one another for *x*-y position sensitivity.
- The next detector, A2, was identical to A1.
- The four B detectors (B1, B2, B3, B4) were identical circular silicon detectors.
- The last detector was the C detector complex, which consisted of a Cerenkov detector, made of sapphire followed by a reflector and a photomultiplier tube.

  The C detector never worked properly.
- The trigger for this instrument was an A1-A2 detector coincidence.



MARIE data

- MARIE acquired data between March 2002 and October 2003, when contact was lost.
- In that period, about 30 million data records were acquired.
- The column structure of each record is summarized in the following table:

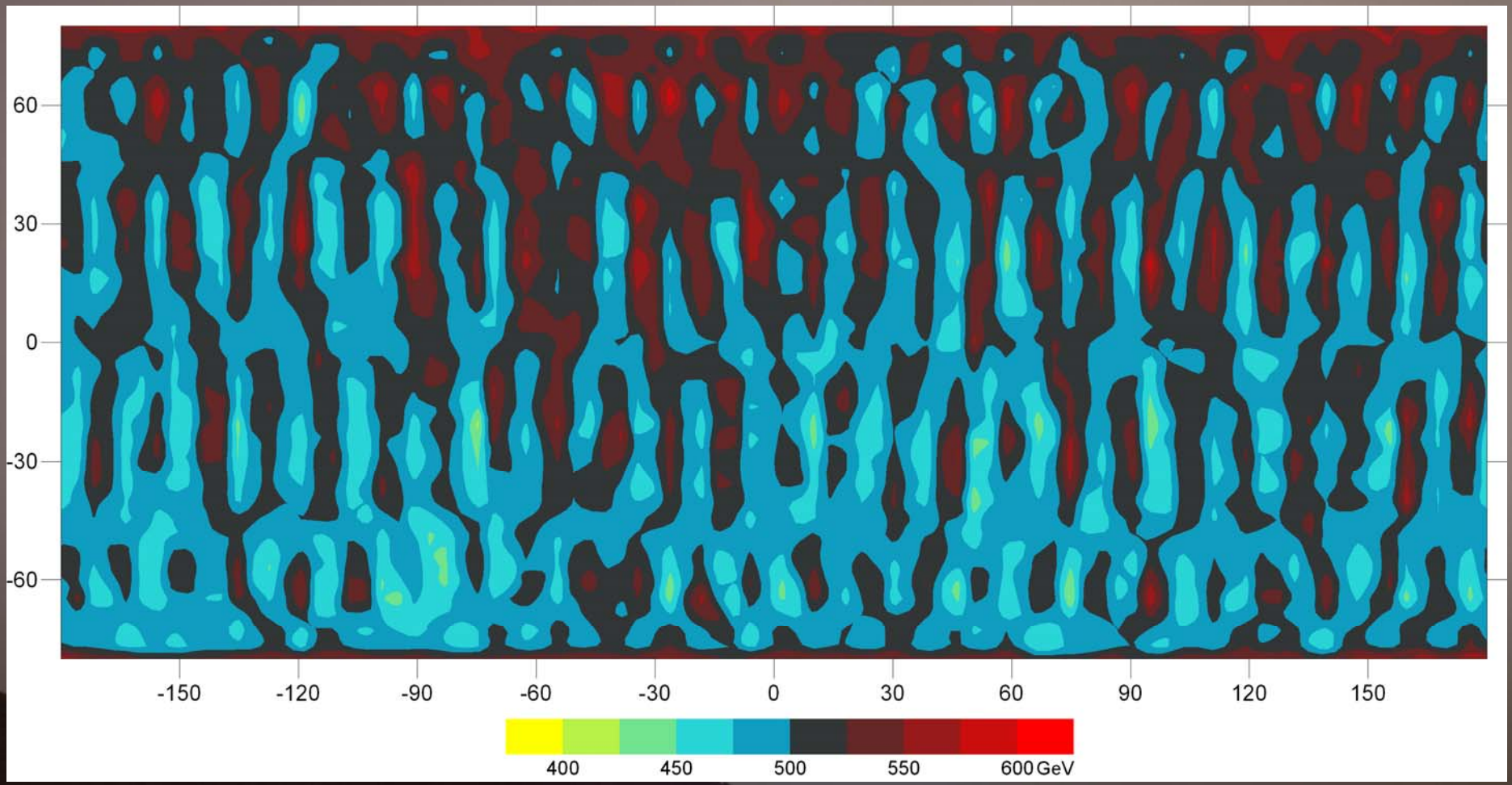
Column	Data Type	Description
1	Character	Time (2 fields, year and decimal day, with beginning of Jan. 1 = 1.0)
2	Real	Event number (with events numbered sequentially)
3	Real	Energy deposited in A1
4	Real	Energy deposited in A2
5	Real	Energy deposited in B1
6	Real	Energy deposited in B2
7	Real	Energy deposited in B3
8	Real	Energy deposited in B4
9	Real	Cerenkov detector pulse height (uncalibrated)
10	Real	Row magnitude from PSD1
11	Real	Row position from PSD1
12	Real	Column magnitude from PSD1
13	Real	Column position from PSD1
14	Real	Row magnitude from PSD2
15	Real	Row position from PSD2
16	Real	Column magnitude from PSD2
17	Real	Column position from PSD2
18	Real	Sum of energies deposited in A1, A2, and B1-B4
19	Real	Incident angle of particle (calculated)
20	Character	Uncorrected time (same format as column 1, but time tag corrections not applied)
21	Character	Error flags for record

Where are lon & lat?

MARIE data georeferencing

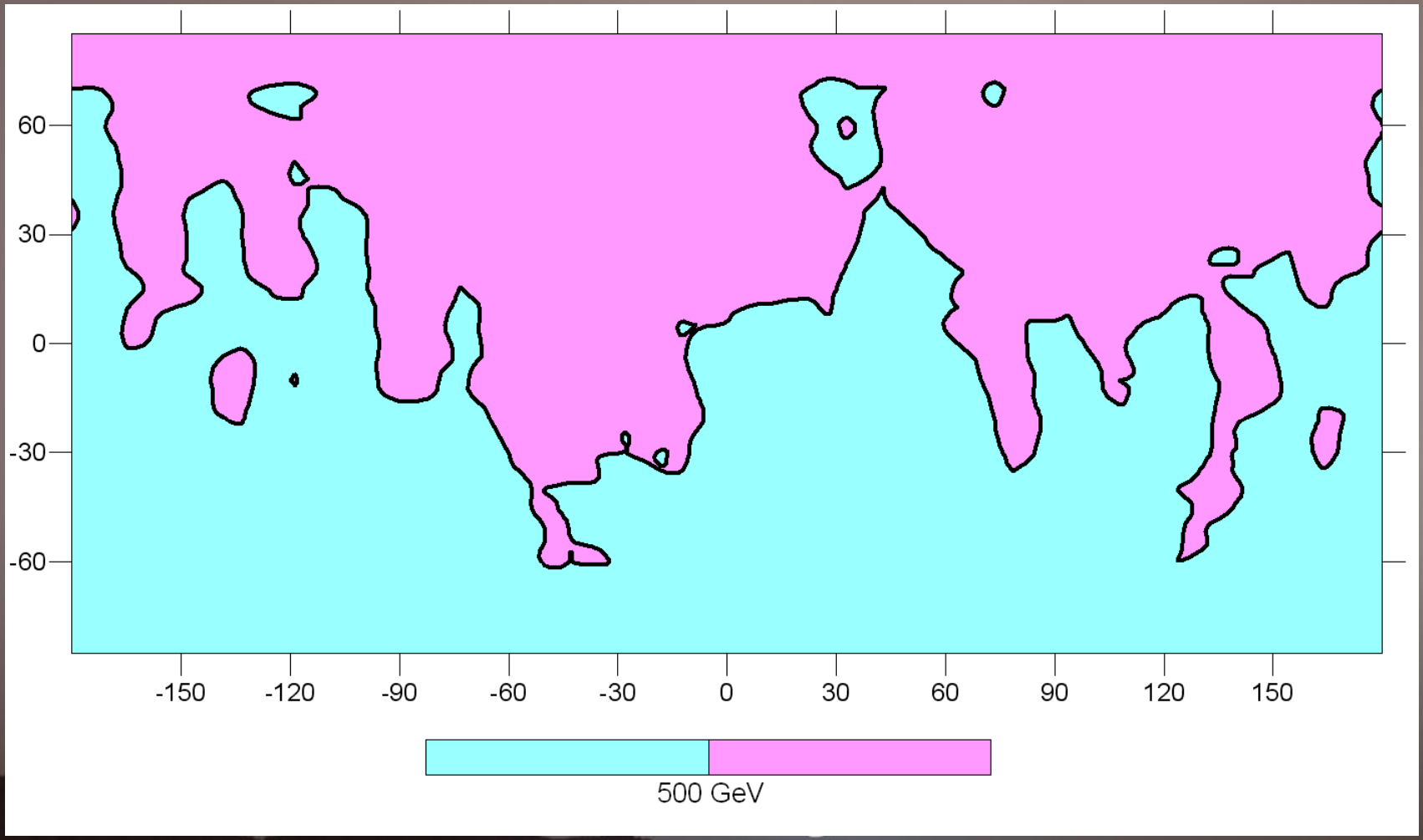
- In an earlier test (Alves and Baptista, 2004) we interpolated MARIE timestamps between GRS observations, which were georeferenced, for a solar-calm period of seven days .
- The large errors only allowed rough estimates of locations, which were then binned and adjusted to a 3rd degree surface.
- For the present work we used SPICE C++ libraries to georeference all 22,924,065 “good” MARIE records available.

Incident radiation



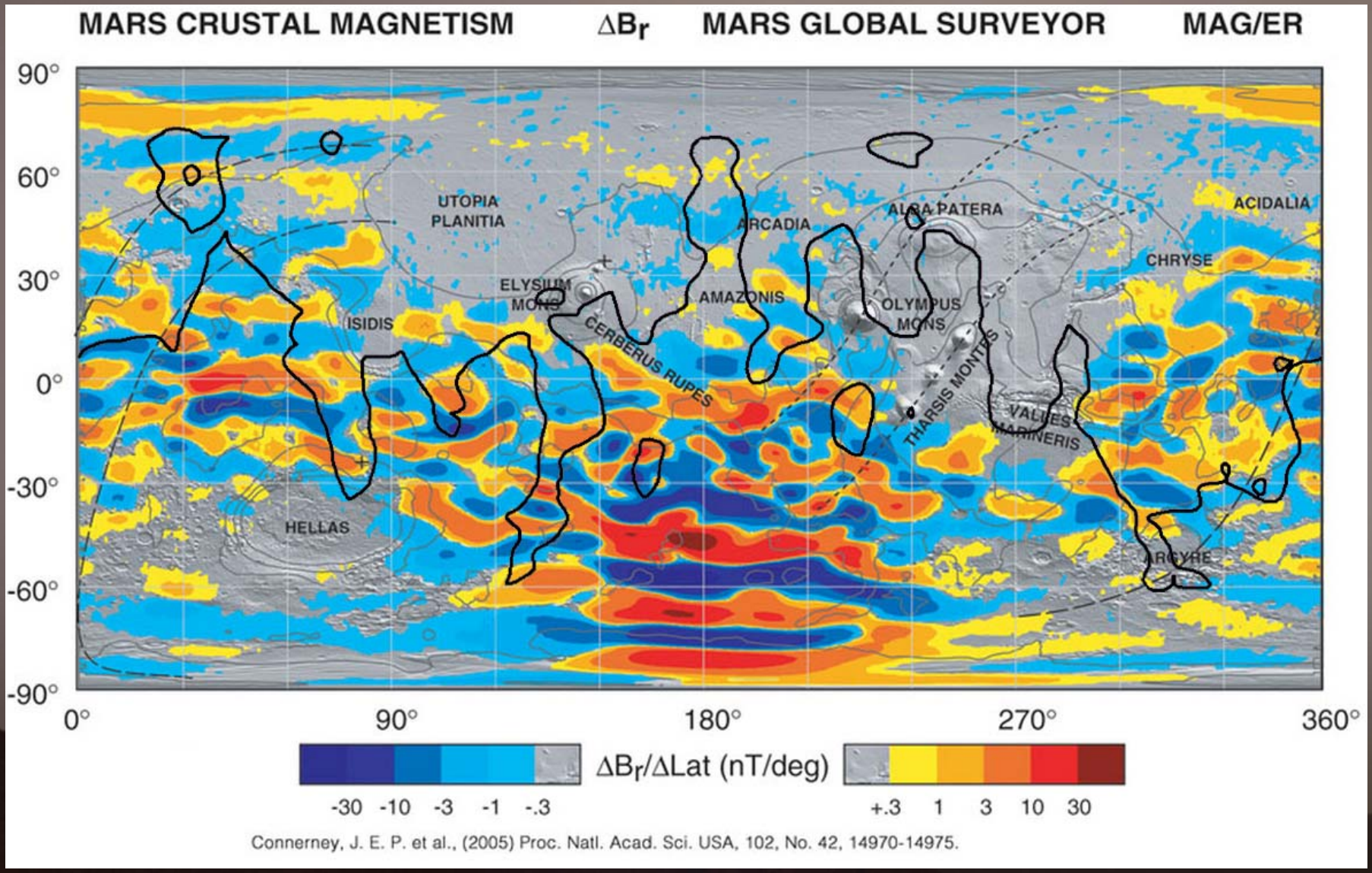
Total energy collected by the A and B detectors of the MARIE spectrometer during 536 Earth days on the mission mapping phase, summed over 5° x 5° bins. Interpolation by kriging.

Incident radiation



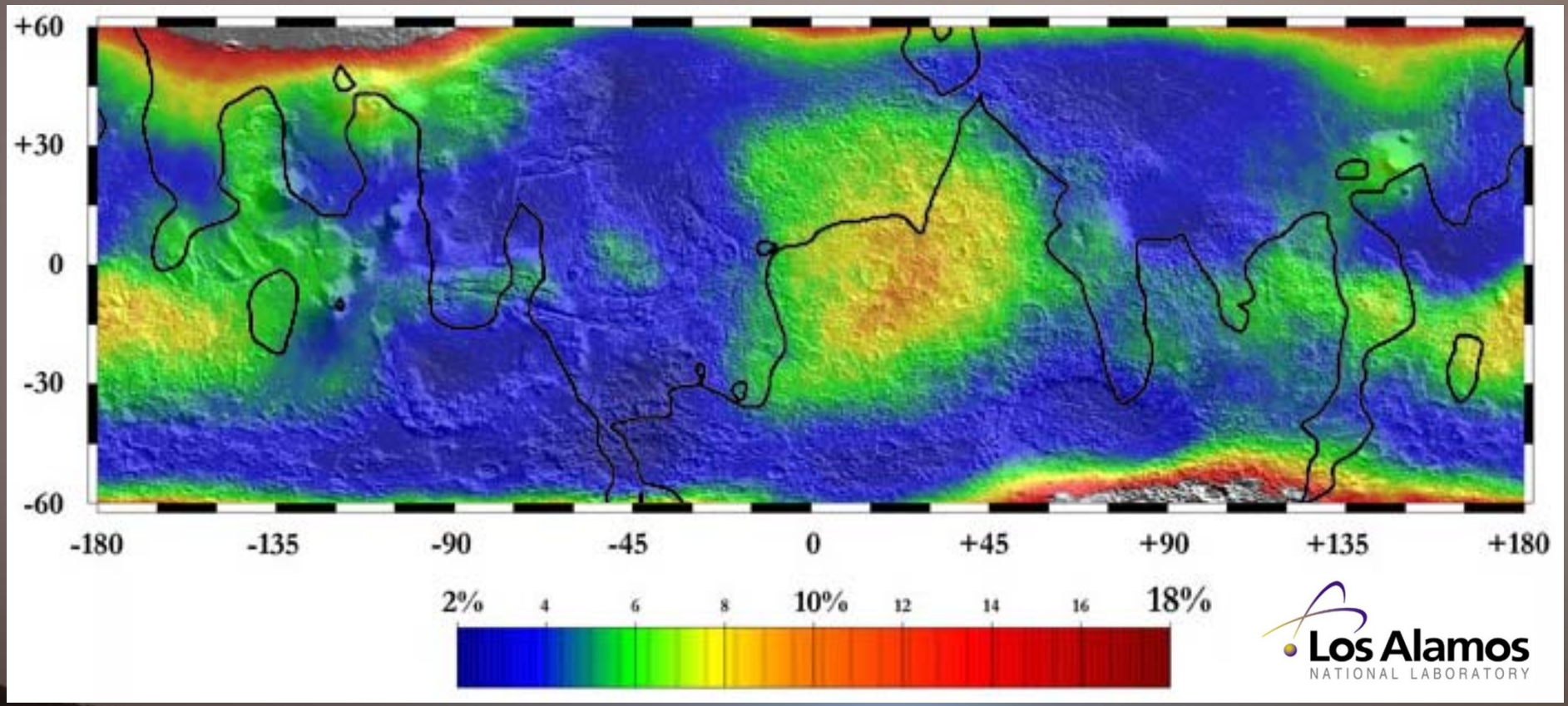
Total energy collected by the A and B detectors of the MARIE spectrometer during 536 Earth days on the mission mapping phase, summed over 5° x 5° bins. Interpolation by 3rd degree local polynomia.

Comparison with remnant magetism



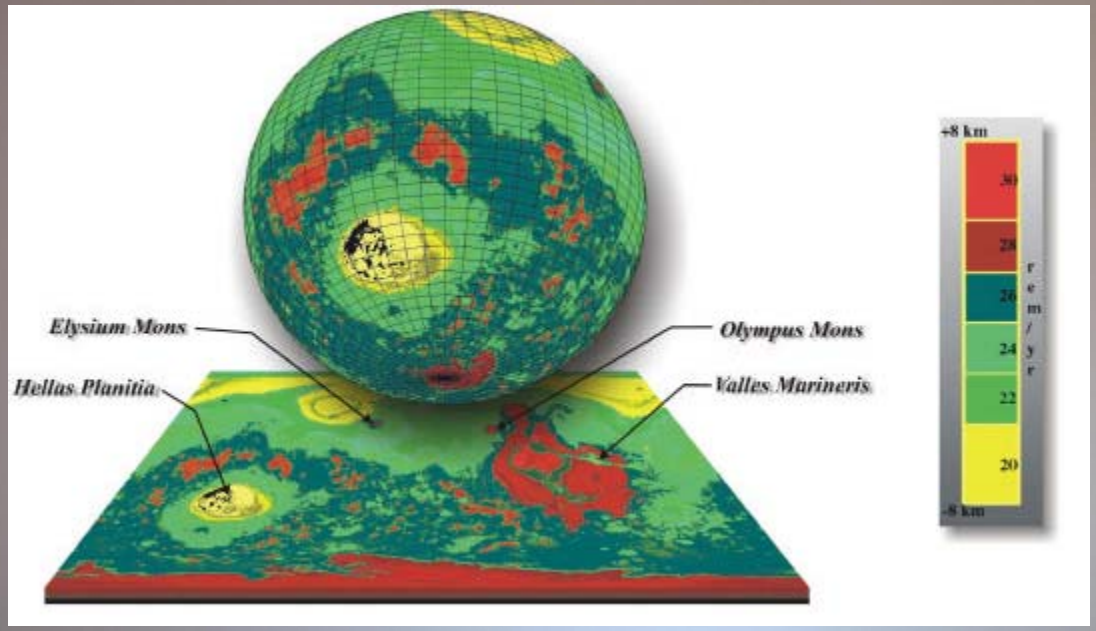
500 GeV line overlayed on radial component of magnetic field

Comparison with water abundances



500 GeV line overlayed on water equivalent hydrogen abundance
(Feldman *et al*., 2003)

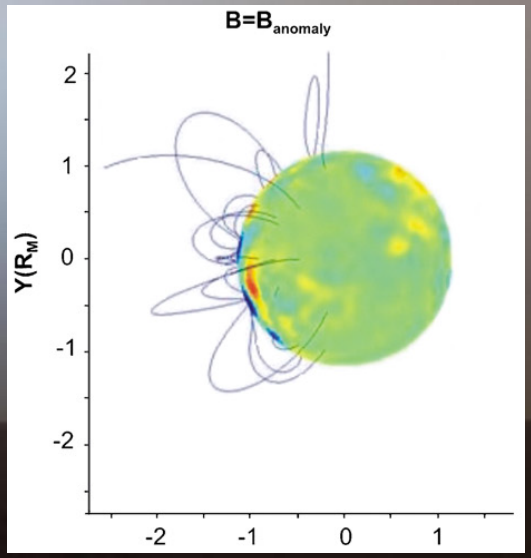
Radiation doses



"Calculations of the skin dose equivalent for astronauts on the surface of Mars near solar minimum. The variation in the dose with respect to altitude is shown" (Saganti *et al*., 2004).

Questions:

1. Can we compute, from these data, true radiation ***doses*** on the surface?
2. Can radiation dose maps be used as “treasure maps” for areas of greatest probability of finding extant life?
3. Should we build separate maps for day- and night-time incidence?
4. Would a 3-D model of the remnant fields (e. g. Frahm *et al*., 2008) help to interpret the radiation incidence maps?
5. Would you find it useful to have access to the full areo-referenced dataset?




Thank you!
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