Mercury Thermal Model & Polar Mapping Tool

Peter van der Plas - D/TOS-EMM
Andrea Santovincenzo - D/TOS-MCT
Hans Peter de Koning - D/TOS-MCV

Mercury Surface Element Study

The work has been performed within the frame of the ESTEC internal study for a Mercury Surface Element (MeSE)

MeSE is a soft lander part of the ESA BepiColombo mission to Mercury
The Landing problem

The temperature on the Mercury surface is:
- 700 K at subsolar point (perihelion)
- 600 K at subsolar point (aphelion)
- 100 K on the dark side
- 100 K at the poles

Is there any “thermally benign” area on the planet surface such that the Thermal Control for a landing probe is simplified?

The Landing problem (2)

To find a sufficiently large zone on the surface of Mercury with the following characteristics:

- Temperature within the range \((-50 \, ^\circ\text{C}/+50 \, ^\circ\text{C})\) during all the permanence time
- Permanence time = 7 days
- Solar illumination for photovoltaic use
Mercury Thermal Model - Assumption

No heat generated inside the planet
No atmosphere effect
Smooth surface (crater effects disregarded)
Heat transferred only via conduction along the crust thickness (1-D model)
Inclination of the Mercury equator to the planet orbit = 0

Mercury physical properties

Albedo = 0.07
Emissivity = 0.9
Density (regolith type) = 1300 Kg/m³
Specific heat = 800 J/KgK
Thermal Conductivity variable with temperature and depth
Mercury ESARAD model

Nodes:
90 lat
36 long
50 depth

Mercury Surface Temperature
ESATAN computation

Mercury thermal model temperature during 2 Mercury years
Lat = 65 deg, West longitudes
Long = 0: Subsolar point at perihelion
Time = 0: Mercury perihelion

Temperature (°C)

14th European Workshop on Thermal and ECLS Software
ESTEC - 7-8 November 2000
Mercury Surface Temperature
ESATAN computation (2)

Mercury Thermal Model
Surface Temperature during 2 Mercury years
Lat = 85 deg, West longitudes
Long = 0: Subsolar point of perihelion
time = 0: Mercury perihelion

Mercury Surface Element Study (2)
Results obtained using simulation
Visualisation of orbit and descend phases
Visualisation of the operations timeline
Mercury terrain generation and properties analysis, effects of craters
Support the selection of the location of the landing site
Mercury Surface Element Study (3)

Visualisation of orbit and descend phases

Mercury Surface Element Study (4)

Visualisation of the operations timeline
Mercury Polar Mapping Tool

1 degree latitude/longitude
- covering Mercury thermal cycle (2 Mercury years)

Mercury thermal data (ASCII file)

C data structure (using text editor macros)

Simulator data
- date/time
- landing sites
- Sun position

Mariner-10 image data
Mercury Thermal model - Preliminary selection

Landing site: 84-87 lat S, 115 long E

Mercury Terrain simulation

What is the chance of landing into a shadowed area?

Mercury terrain generation and property analysis

Sun angle effect on terrain lighting

Crater effect on terrain lighting

14th European Workshop on Thermal and ECLS Software
ESTEC - 7-8 November 2000