PARKER SOLAR PROBE & SOLAR PROBE 2005

Add-On for Orbiter 2016 v.180828

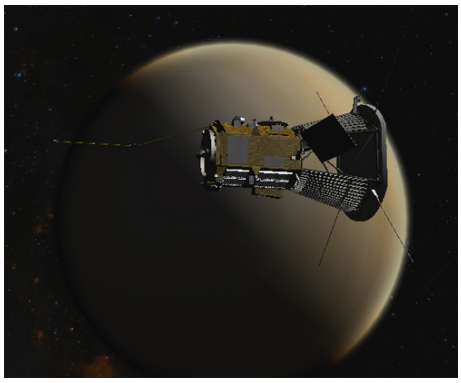
REQUIREMENTS
Parker Solar Probe launch scenario requires:

“Delta IV Launch Vehicles 3.0”
https://www.orbithangar.com/searchid.php?ID=5556

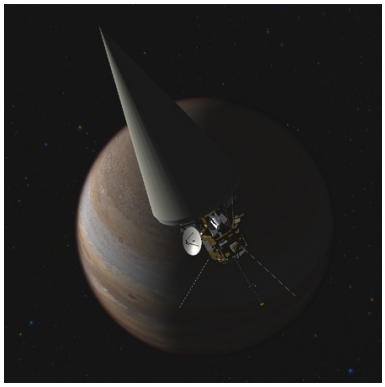
Solar Probe 2005 launch scenario requires:

"Multistage2015 for Orbiter2016"
https://www.orbithangar.com/searchid.php?ID=7010

"MRO"
https://www.orbithangar.com/searchid.php?ID=3711


Parker Solar Probe

RECOMMENDED
“Sun Texture for Solar Probe”
https://www.orbithangar.com/searchid.php?ID=6474


Solar Probe 2005

INSTALLATION
Extract all files to the root of your Orbiter program directory, preserving the directory structure. This should NOT overwrite anything in the standard Orbiter package.

WHAT'S IN THIS ADD-ON?
"Parker Solar Probe" spacecraft, launch and post-launch scenarios.
"Solar Probe 2005" spacecraft, AtlasV551 launcher with Star48BV 3rd stage, launch and post-launch scenarios.

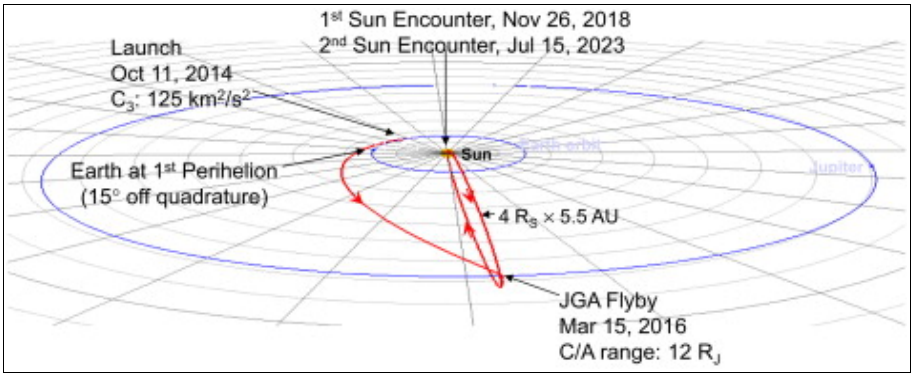
SCENARIOS
Scenarios are in the respective "Parker Solar Probe" or "Solar Probe 2005" folders on your Orbiter launchpad list.

Parker Solar Probe – launch scenario starts at 07:15 UTC 12 Aug 2018, lift-off at 07:31 UTC, 94° azimuth. Delta IV onboard autopilot unreliable/non-functional.

Solar Probe 2005 – launch scenario starts at 12:10 UTC 11 Oct 2014, launch at 12:14 UTC. Press P at T-10s to start the ascent autopilot (if required).

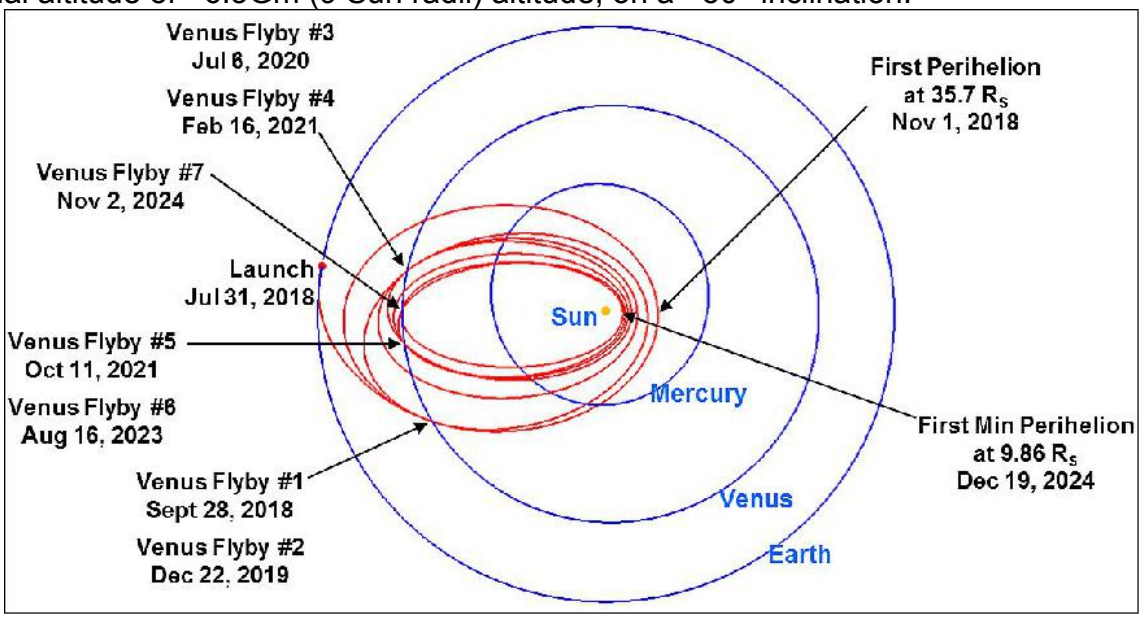
MISSION DESCRIPTION
"Parker Solar Probe" is NASA's mission to study the Sun's corona, photosphere, magnetic field and solar wind. “Solar Probe 2005” was the original spacecraft design.

SOLAR PROBE 2005
"Solar Probe 2005" was due to launch in 2014. A gravity assist fly-by of Jupiter in 2016 was to be used to sling the spacecraft back toward the Sun for a close approach of ~2.1Gm (3 Sun radii) altitude, on a polar ~90° inclination (ecliptic) in 2018.



Solar Probe 2005 Trajectory

PARKER SOLAR PROBE
"Parker Solar Probe", has a very different trajectory and mission profile. Launched on 12 Aug 2018. The trajectory design uses multiple Venus gravity assist to lower Perihelion to its final altitude of ~6.3Gm (9 Sun radii) altitude, on a ~30° inclination.



Parker Solar Probe Trajectory

More info here.....

Solar Probe 2005
https://solarprobe.gsfc.nasa.gov/SolarProbe_STDT2005.pdf

Parker Solar Probe
https://directory.eoportal.org/web/eoportal/satellite-missions/p/psp
https://www.nasa.gov/content/goddard/parker-solar-probe
https://en.wikipedia.org/wiki/Parker_Solar_Probe

SPACECRAFT CONTROLS & INFO

Solar Probe 2005
Dry Mass = 612kg
Propellant = 60kg
Propellant ISP = 2150Ns/kg
Available dV = 201m/s

12 x 25N RCS thrusters total
Main Engine = 4 x RCS = 100N

Rotation RCS is unbalanced (pitch/yaw will give small dV)
Linear RCS in +Z direction only (equivalent to Main Engine)

Solar Probe 2005 also has Reaction Wheels for attitude control
Use [Shift]+[NumPad] controls to use Reaction Wheels
[Shift]+[NumPad 2/8] = Pitch
[Shift]+[NumPad 1/3] = Yaw
[Shift]+[NumPad 4/6] = Bank
[Shift]+[NumPad 5] = KillRot (status displayed on HUD)

Available dV info on HUD
Available commands on HUD
Thermal Status on HUD

G = Deploy HGA
K = Deploy Magnetometer Boom, Fast Plasma Instrument & EF Antennae
V = Deploy Periscope (1 imaging cycle)
B = Activate Auto Sun Pointing Attitude
(Spacecraft will automatically turn Thermal Protection Shield towards the Sun.)

Timeline:

Launch	12:14:00 UTC, 11 Oct 2014, 94° azimuth
Jupiter Fly-by	15 Mar 2016, MJD57462
Sun perihelion	26 Nov 2018, MJD58448 (~90° inclination, 2.1Gm min.altitude)

AtlasV551 (AV099)
J = Jettison Stage/Payload
F = Jettison Fairing
P = Ascent Auto-pilot
Ascent Auto-pilot includes automatic fairing and stage seperation after burnout, will target 94° launch azimuth, 200km circular parking orbit.
Press P to start the auto-pilot countdown at T-10 seconds

Star48BV Kick Motor
Star48BV will give 3564.3m/s dV. This version is MS2015 based, so *can* be throttled or reignited.

Parker Solar Probe
Dry Mass = 557kg
Propellant = 53kg
Propellant ISP = 2150Ns/kg
Available dV = 195m/s

12 x 25N RCS thrusters total
Main Engine = 4 x RCS = 100N

Rotation RCS is unbalanced (pitch/yaw will give small dV)
Linear RCS in +Z direction only (equivalent to Main Engine)

Parker Solar Probe also has Reaction Wheels for attitude control
Use [Shift]+[NumPad] controls to use Reaction Wheels
[Shift]+[NumPad 2/8] = Pitch
[Shift]+[NumPad 1/3] = Yaw
[Shift]+[NumPad 4/6] = Bank
[Shift]+[NumPad 5] = KillRot (status displayed on HUD)

Available dV info on HUD
Available commands on HUD
Thermal Status on HUD

G = Deploy / Retract Solar Panels
K = Deploy Magnetometer Boom and EF Antennae
V = Open Hemispherical Imager (HI) cover
B = Activate Auto Sun Pointing Attitude
(Spacecraft will automatically turn Thermal Protection Shield towards the Sun.)

Flight Info:

Launch	07:31 UTC, 12 Aug 2018, 94° azimuth
Venus Fly-by 1	03 Oct 2018 MJD58394
Venus Fly-by 2	26 Dec 2019 MJD58843
Venus Fly-by 3	11 Jul 2020 MJD59040
Venus Fly-by 4	20 Feb 2021 MJD59265
Venus Fly-by 5	15 Oct 2021 MJD59502
Venus Fly-by 6	20 Aug 2023 MJD60176
Venus Fly-by 7	05 Nov 2024 MJD60619

Final perihelion altitude 6.6Gm (9.5 Sun Radii), 3.4° inclination(ecliptic)

DeltaIVHeavy
See DeltaIVHeavy manual for controls. Autopilot is not functional / malfunctioning.
Upper stage has tendency to ignite after separation and while trajectory is sub-orbital.

Star48BV Kick Motor
TheStar48BV is a solid-fuel motor and once ignited will burn at 100% throttle until depletion. This gives a fixed dV of 3510m/s. Star48BV has RCS for attitude control.

THERMAL MODEL
I have attempted to make a rough simulation of the spacecraft thermal state. The various temperature and thermal flow values are displayed on the spacecraft HUD.

The spacecraft are treated as two elements - the Bus and Thermal Protection Shield(TPS). For the calculation of insolation and radiation, each spacecraft element shape was assumed to be a simple cylinder or cone of the same general dimensions as the spacecraft Bus and TPS.

I've made a guess at the following parameters:

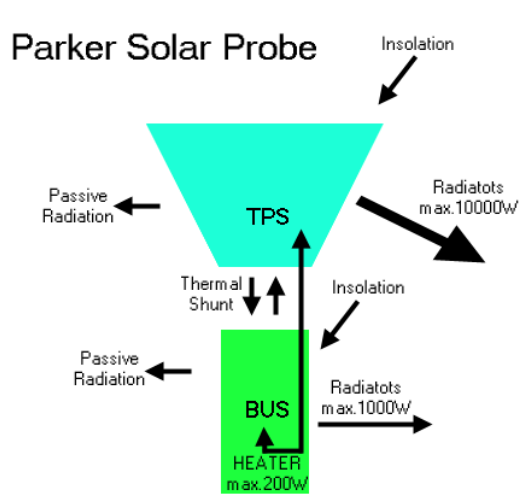
Spacecraft average Specific Heat Capacity	750J/kg
Spacecraft Bus/TPS surface insolation absorbtivity	0.075
Spacecraft TPS surface radiation emissivity	0.100
Spacecraft Bus surface radiation emissivity	0.050

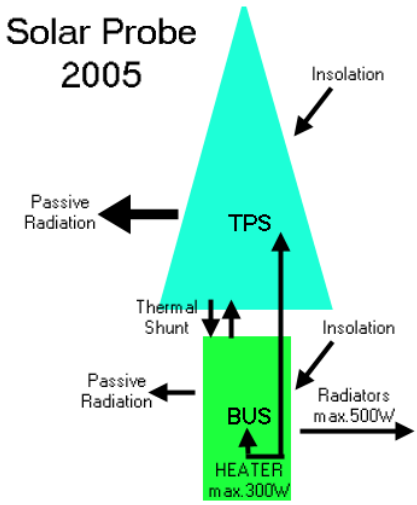
The spacecraft are equipped with heaters and radiators which will automatically try to regulate the temperature to a comfortable 20 °C.

Solar Probe 2005 Thermal Control	
Heaters (Bus & TPS)	300W
Radiators (BUS)	500W

Parker Solar Probe Thermal Control	
Heaters (Bus & TPS)	200W
Radiators (BUS)	1000W
Radiators (TPS)	10000W

Total shadowing of the Bus by the TPS is assumed if the Sun is within 5° of the spacecraft +Z axis.
Enable the spacecraft "Automatic Sun Pointing" function [B] to ensure a safe attitude during Perihelion.
If the Bus temperature rises to more than 300 °C, the spacecraft will fail and the mission lost!
The thermal simulation is temporarily disabled if time acceleration >10000 is used - it can't handle the large step-time.





Big Thanks
.....to Graham2001 for the "Solar Probe" idea and source documents, and also to Dr.Schweiger and all Orbiter developers, on whose work this project relies.

BrianJ
July 2018