Kerbal Space Program - Bug #25474

Bad Convection Occlusion Calculations (Heatshields)

05/31/2020 06:00 PM - DRVeyl

Status:	Ready to Test		**Start date:**	05/31/2020
Severity:	Low		**% Done:**	80%
Assignee:	Technicalfool			
Category:	Aerodynamics			
Target version:	1.12.0			
Version:	1.9.1		**Language:**	English (US)
Platform:	Windows		**Mod Related:**	No
Expansion:	Breaking Ground, Core Game			

Description

KSP 1.9.1, Breaking Ground. Only mod is HyperEdit.

BLUF: Heatshields can shield parts from almost directly behind them. You can re-enter with the heatshield *behind* a nearby part and protect it, as long as your travel direction is not perfectly prograde/retrograde.
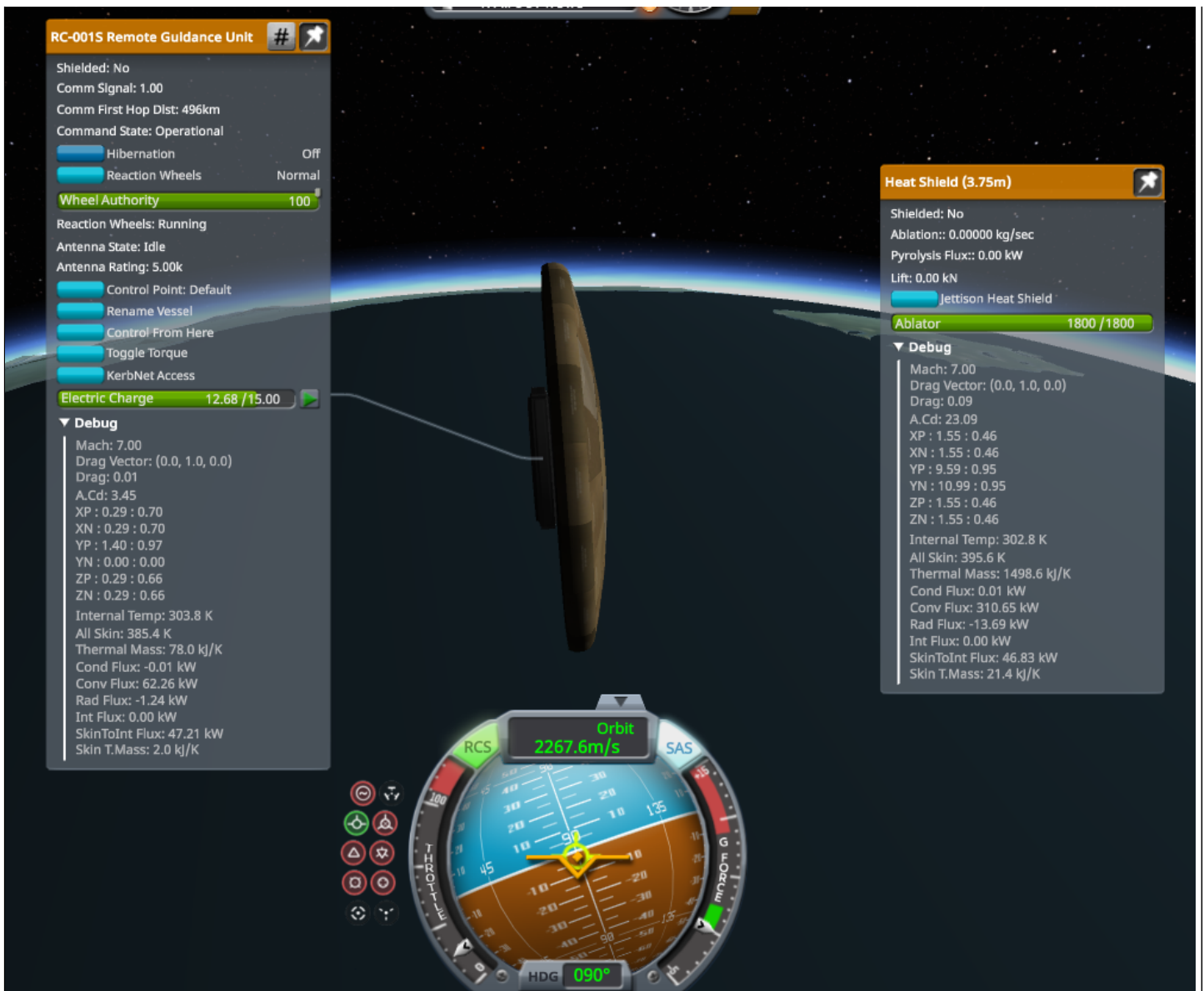
Detail:

The calculations for the convection occlusion cone are incorrect for any velocity not aligned with a primary axis (prograde/radial/normal and anti-prograde/radial/normal).

Test craft (pictured) is the 1.25m guidance unit (probeStackSmall) and a 3.75m heatshield. Parts are placed in stack attachment, no rotation or offset. Hyperedit / cheat into any orbit, begin re-entry, and observe convection flux at different orientations.

Direction of travel is to the left in all pics.
With travel aligned to any primary axis, convection occlusion area is valid. The control unit has convective flux:

RC-001S Remote Guidance Unit

Shielded: No
Comm Signal: 1.00
Comm First Hop Dist: 496km
Command State: Operational

Hibernation — Off
Reaction Wheels — Normal
Wheel Authority — 100

Reaction Wheels: Running
Antenna State: Idle
Antenna Rating: 5.00k

Control Point: Default
Rename Vessel
Control From Here
Toggle Torque
KerbNet Access

Electric Charge — 12.68 / 15.00

▼ Debug
Mach: 7.00
Drag Vector: (0.0, 1.0, 0.0)
Drag: 0.01
A.Cd: 3.45
XP : 0.29 : 0.70
XN : 0.29 : 0.70
YP : 1.40 : 0.97
YN : 0.00 : 0.00
ZP : 0.29 : 0.66
ZN : 0.29 : 0.66
Internal Temp: 303.8 K
All Skin: 385.4 K
Thermal Mass: 78.0 kJ/K
Cond Flux: -0.01 kW
Conv Flux: 62.26 kW
Rad Flux: -1.24 kW
Int Flux: 0.00 kW
SkinToInt Flux: 47.21 kW
Skin T.Mass: 2.0 kJ/K

Heat Shield (3.75m)

Shielded: No
Ablation:: 0.00000 kg/sec
Pyrolysis Flux:: 0.00 kW
Lift: 0.00 kN

Jettison Heat Shield
Ablator — 1800 / 1800

▼ Debug
Mach: 7.00
Drag Vector: (0.0, 1.0, 0.0)
Drag: 0.09
A.Cd: 23.09
XP : 1.55 : 0.46
XN : 1.55 : 0.46
YP : 9.59 : 0.95
YN : 10.99 : 0.95
ZP : 1.55 : 0.46
ZN : 1.55 : 0.46
Internal Temp: 302.8 K
All Skin: 395.6 K
Thermal Mass: 1498.6 kJ/K
Cond Flux: 0.01 kW
Conv Flux: 310.65 kW
Rad Flux: -13.69 kW
Int Flux: 0.00 kW
SkinToInt Flux: 46.83 kW
Skin T.Mass: 21.4 kJ/K

Orbit
2267.6m/s

RCS   SAS

HDG   090°

At travel slightly off-axis in any direction, convection area goes to 0. Pictured: the heatshield is occluding the guidance unit even from almost directly behind:

RC-001S Remote Guidance Unit

Shielded: No
Comm Signal: 1.00
Comm First Hop Dist: 558km
Command State: Operational

Hibernation — Off
Reaction Wheels — Normal
Wheel Authority — 100
Reaction Wheels: Running
Antenna State: Idle
Antenna Rating: 5.00k

Control Point: Default
Rename Vessel
Control From Here
Toggle Torque
KerbNet Access
Electric Charge — 12.68 / 15.00

▼ Debug
Mach: 6.94
Drag Vector: (0.2, 1.0, 0.0)
Drag: 0.09
A.Cd: 3.37
XP : 0.29 : 0.70
XN : 0.29 : 0.70
YP : 1.40 : 0.97
YN : 0.00 : 0.00
ZP : 0.29 : 0.66
ZN : 0.29 : 0.66
Internal Temp: 345.3 K
All Skin: 544.2 K
Thermal Mass: 78.0 kJ/K
Cond Flux: -0.34 kW
Conv Flux: 0.00 kW
Rad Flux: -5.08 kW
Int Flux: 0.00 kW
SkinToInt Flux: 115.24 kW
Skin T.Mass: 2.0 kJ/K

Heat Shield (3.75m)

Shielded: No
Ablation:: 0.06271 kg/sec
Pyrolysis Flux:: 150.51 kW
Lift: 0.00 kN

Jettison Heat Shield
Ablator — 1799 / 1800

▼ Debug
Mach: 6.94
Drag Vector: (0.2, 1.0, 0.0)
Drag: 0.60
A.Cd: 22.50
XP : 1.55 : 0.46
XN : 1.55 : 0.46
YP : 9.59 : 0.95
YN : 10.99 : 0.95
ZP : 1.55 : 0.46
ZN : 1.55 : 0.46
Internal Temp: 307.3 K
All Skin: 942.1 K
Thermal Mass: 1498.4 kJ/K
Cond Flux: 0.34 kW
Conv Flux: 1226.44 kW
Rad Flux: -473.80 kW
Int Flux: 0.00 kW
SkinToInt Flux: 321.22 kW
Skin T.Mass: 21.4 kJ/K

Orbit
2273.6m/s

RCS   SAS
Stability Assist

HDG   080°

Any relatively thin part attached directly to the heatshield will essentially always be occluded, except for a very narrow range of orientations aligned with the primary axes.

Adding space between the part and the shield reduces this issue, but does not eliminate; orientations further off-axis will still result in occlusion from behind. The field of "correct convection occlusion" is just larger. Pictured: Greater off-axis orientation producing no convective flux on more distant leading part.
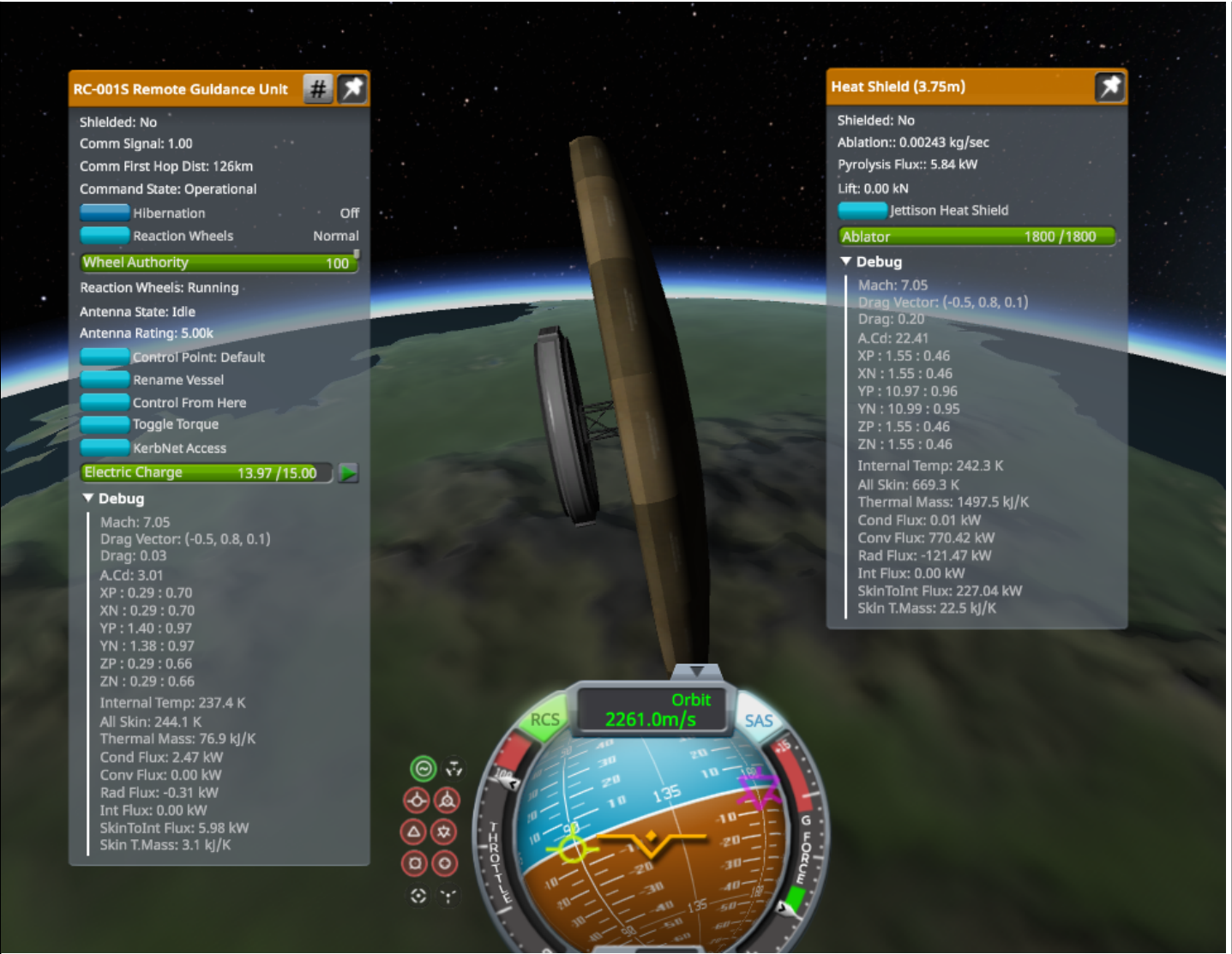
I believe that when the FlightIntegrator is attempting to translate/re-orient the plane for the heatshield's convection occlusion cone origin [interpolating the drag cube depth for each face?], it is doing this awkwardly and starting the cone projection at an inappropriate plane. This allows the bounds of parts that should not be occluded to intersect with the misplaced convection occlusion cone.

History

#1 - 06/01/2020 06:34 PM - Technicalfool

- Status changed from New to Investigating

- Assignee set to Technicalfool

- % Done changed from 0 to 20

#4 - 06/24/2021 10:45 PM - victorr

- Status changed from Investigating to Ready to Test

- Target version set to 1.12.0

- % Done changed from 20 to 80

We have made some changes in this last 1.12.0 release and would like some feedback on this issue. Thanks.

Files

Craft.png	189 KB	05/31/2020	DRVeyl
ProperConvection.png	473 KB	05/31/2020	DRVeyl
BadConvection.png	589 KB	05/31/2020	DRVeyl
BadConvectionOffset.png	748 KB	05/31/2020	DRVeyl