**Description of the GOES-R ABI Solar Zenith Angle calculation in the Ground System**

The solar zenith angle is angle between the zenith and the center of the Sun’s disc. It is calculated with spherical trigonometry using the equation below:

cos θ = sin φ sin δ + cos φ cos δ cos h

where:

θ = solar zenith angle (in radians)

φ = local latitude (in radians)

δ = current declination of the Sun in the ecliptic (in radians)

h = hour angle, in local solar time (in radians)

The individual terms in the above equation are calculated as shown below, then the solar zenith angle is calculated using the individual terms.

Declination

δ = (23.4856 \* Radians\_In\_One\_Degree \* sin((0.9683 \* Day\_of\_Year – 78.00878) \* Radians\_In\_One\_Degree))

where:

Radians\_In\_One\_Degree = π radians/180.0

Day\_of\_Year = 1 for Jan.1, and 365/366 for Dec.31 (depending if leap year)

Hours Into Day

DateTime = number of micro-seconds since the epoch starting on Noon January 1, 2000.

A function then breaks apart DateTime into component parts (year, month, day, hours).

These component parts are then differenced from the DateTime to obtain the fractional amount of hours for the current observation. This fractional amount is added to the component ‘hours’ to obtain a decimal number of the number of hours into the day (Hours\_Into\_Day).

Adjust the time related to the longitude of the current observation:

Hours\_Into\_Day = Hours\_Into\_Day + ( (Hours\_Per\_Day \* ψ) / (2.0 \* π) )

where:

Hours\_Per\_Day = 24.0

ψ = local longitude (in radians)

Adjust the time if it is less than 0 or more than 24 hours:

if Hours\_Into\_Day > Hours\_Per\_Day then:

Hours\_Into\_Day = Hours\_Into\_Day – Hours\_Per\_Day

if Hours\_Into\_Day < 0 then:

Hours\_Into\_Day = Hours\_Into\_Day + Hours\_Per\_Day

Hour Angle

angleA = Radians\_In\_One\_Degree \* (1.00554 \* Day\_of\_Year – 6.28306)

angleB = Radians\_In\_One\_Degree \* (1.93946 \* Day\_of\_Year + 23.35089)

Equation\_of\_Time = -7.67825 \* sin(angleA) – 10.09176 \* sin(angleB)

h = π \* ( (Hours\_Into\_Day / Half\_Day) – 1.0 + (Equation\_of\_Time / Twice\_Circle\_Degrees) )

where:

Half\_Day = 12.0

Twice\_Circle\_Degrees = 720.0

Solar Zenith Angle

cos(θ) = sin(φ)\*sin(δ) + cos(φ)\*cos(δ)\*cos(h)

Bound the cos(θ) before the solar zenith angle is calculated:

-1 ≤ cos(θ) ≤ 1

θ = acos(cos(θ))