User manual, Orientation data extractor

The trajectory and orientation information to extract are stored in external files in the \inp-folder, and a program have been created to extract the data. The program is compiled for Windows XP – Windows 8.

1 Extract Data view

You may here specify a single point of time, or a range of points.

For a range of points, specify:

- **Starttime**
- **Endtime**
- **Frequency:** number of points per second.

Quantities possible to extract are:

- **X-axis (X_B):**

Orientation of the longitudinal axis of the rocket, positive forward, marked as X_B in figure 3.

- **User vector:**

Orientation of the vector specified by the user, described in *3, User vector view*.

- **Position:**

The position of the rocket during flight, given as latitude [deg], longitude [deg] and altitude [m].

- **Velocity vector:**

Orientation of velocity-vector and speed [m/s] of the rocket.

- **Magnetic field vector:**

Orientation of the theoretical magnetic field vector at the position of the rocket, given by WMM-2005[1] model.

- **Sun and moon position vectors:**

Orientation of the vector pointing towards the sun[2] or moon from the position of the rocket.

- **Measured radial acceleration:**

Radial acceleration measured by ARR telemetry stations, unit $g = 9.81\ m/s^2$.

- **Apparent spin**

Apparent spin frequency based on magnetometer measurements.

- **Magnetometer output:**

The direction of the magnetic field vector measured by on-board magnetometer expressed as angles against the magnetometer axis.

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[1] Visit http://www.ngdc.noaa.gov/geomag/WMM/DoDWMM.shtml for details.

[2] See http://aa.usno.navy.mil/software/novas/novas_info.php and links, in particular JPL DE405 planetaty ephemeris, for details.

2 Coordinate system view:

Here you may choose coordinate system for the output. Where the output consist of angles the unit is degrees.

The options are:

- **Earth system:**

Cartesian coordinate system with with origo at center of earth, X-axis pointing at the the point of longitude 0° and latitude 0°, Y-axis pointing at 90° longitude and Z-axis pointing at the north pole.

The output consist of the angles

$0° < \theta_E < 180°$ and

$0° < \varphi_E < 360°$,

as seen in figure 1 below.

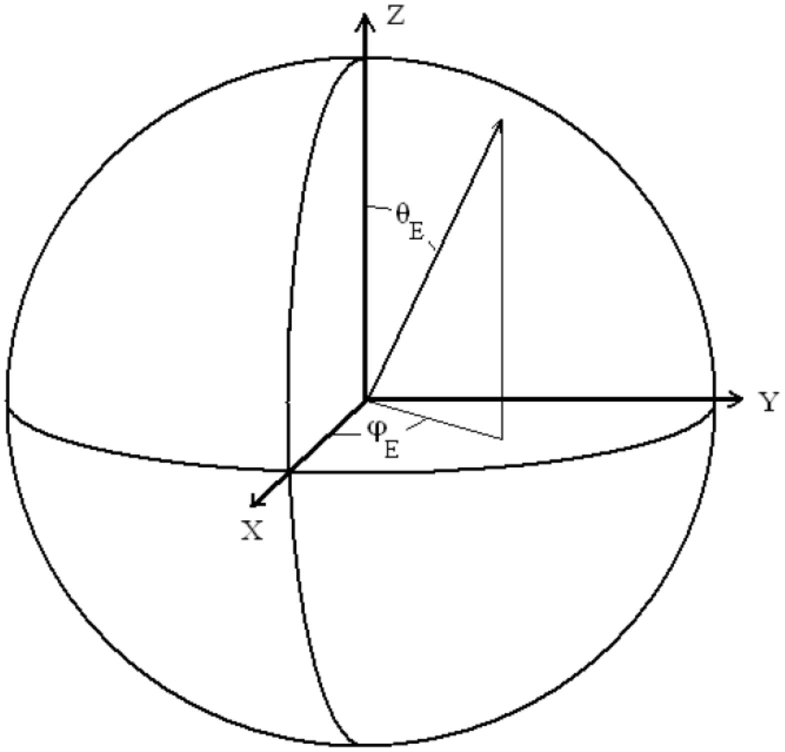


Figure 1: Earth coordinate system, with output angles 0° < θ_E < 180° and 0° < φ_E < 360°.

- **Local topocentric coordinate system:**

Azimuth and Elevation given with respect to the specified Latitude and Longitude.

- **User-defined coordinate system:**

With this option checked the orientation-vectors are given in the user-defined coordinate system, fixed in the rocket body and thus spinning with it, described below:

Let Z_U be along the User defined vector described in section 3, *User vector view*. Let X_U be ortogonal to Z_U, lying in the $X_B - Z_U$ symmetric plane, positive downwards, away from X_B. Let Y_U be the vector fulfilling a right-hand system. The output consist of

$0° < \theta_U < 180°$,

where θ_U is the angle between the orientation-vector we would like to extract and Z_U, and

$0° < \varphi_U < 360°$

where φ_U is the angle measured from positive X_U-axis to the orientation-vector projected on the X_U-Y_U plane, as shown in figure 2 below.

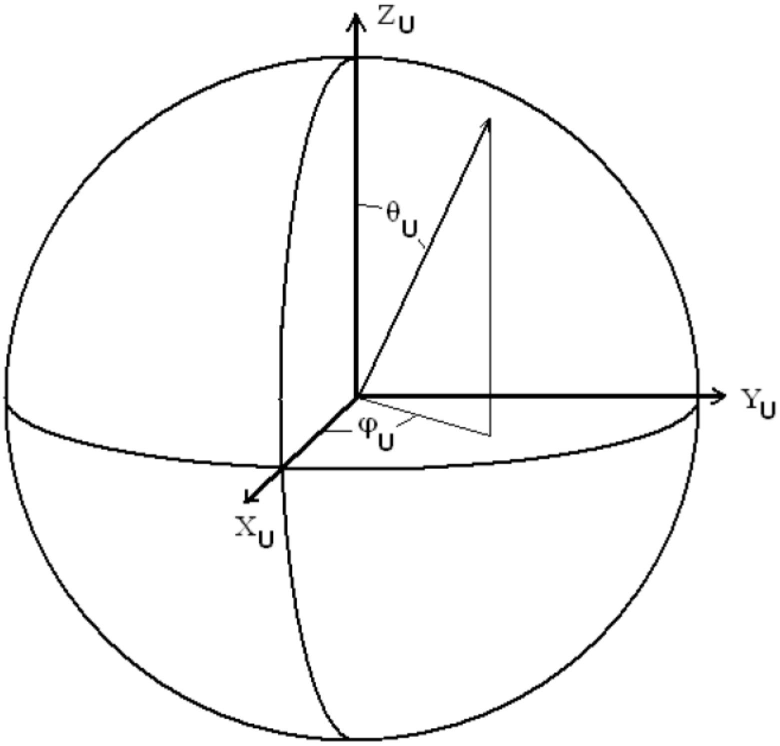


Figure 2: User defined body coordinate system, with output angles $0° < \theta_U < 180°$ and $0° < \varphi_U < 360°$.

In the Earth system and User-defined body coordinate system the cartesian components are given by:

$X = \sin(\theta)\cos(\varphi)$

$Y = \sin(\theta)\sin(\varphi)$

$Z = \cos(\theta)$

- **Aspect angles**

With this option checked the angles between user vector and the extracted orientation vectors are calculated.

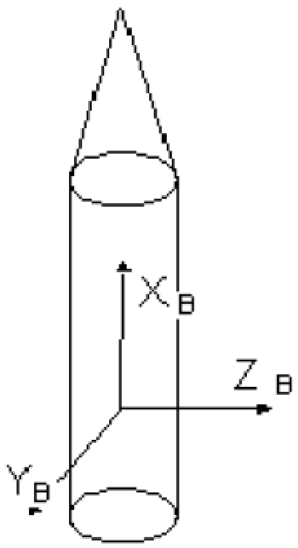
3 User vector view:

You may here specify a vector fixed to the rocket body with the quantities:

$0° < \delta < 180°$, and

$0° < \lambda < 360°$,

where δ is the angle between X-axis of the rocket, X_B in figure 3, and the user-specified vector, and λ as shown in figure 3 below. In the figure 3 right, { $\delta = 90°$, $\lambda = 270°$} corresponds to ICI4 ASC Magnetometer Z-axis and { $\delta = 90°$, $\lambda = 180°$} corresponds to ASC Magnetometer Y-axis.



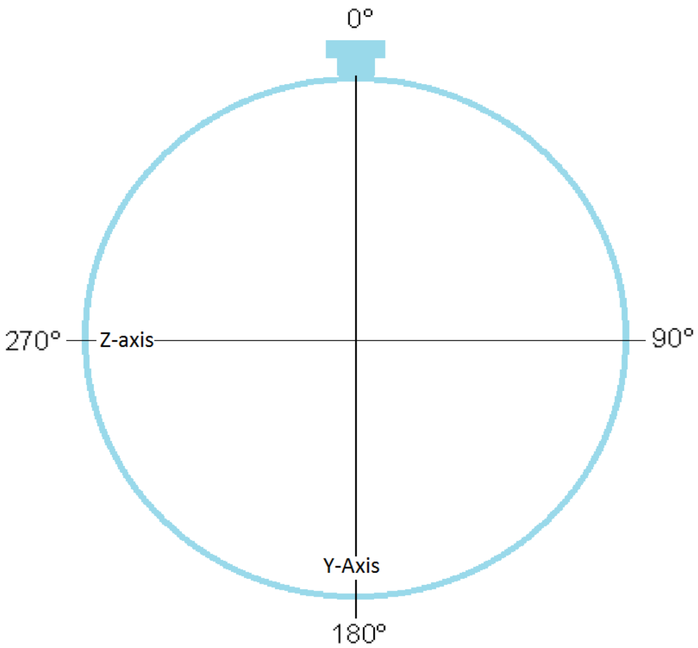


Figure 3, Left: The body coordinate system X_B, Y_B, Z_B.

Figure 3, Right: In instrument orientation view you may specify the angle λ as shown above. $\lambda = 0$ is pointing towards the launcher at $t = 0$.