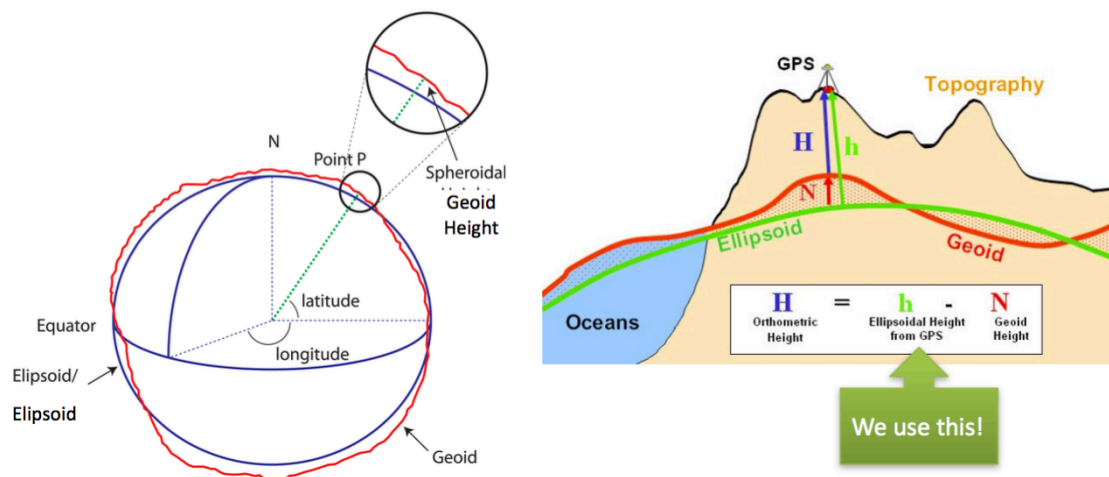# Apollo's Coordinate System

You are welcome to join the Apollo development. In Apollo, it involves all kinds of different coordinate systems as an autonomous driving system. In this manual, we discuss the definitions of these coordinate systems we use in the Apollo project.

1. The Global Geographic coordinate system

In Apollo, we use a global geographic coordinate system to represent the geometric position of the elements in the high-definition map (HD Map). A common choice of the global geographic coordinates is latitude, longitude, and elevation. In Apollo, we use WGS-84, the World Geodetic System dating from 1984, as the standard coordinate reference system for representing latitude and longitude of objects. By using this standard coordinate reference system, it is possible to uniquely identify any point on the Earth's surface – except the North Pole – by two numbers, the x- coordinate and the y-coordinate of the point, where x corresponds to the longitude and y to the latitude.

WGS-84 is popularly used in GIS service, such as mapping, positioning, navigation, etc. The definition of the global geographic coordinate system we used is shown in the following figures. The elevation value is defined as the ellipsoidal height.
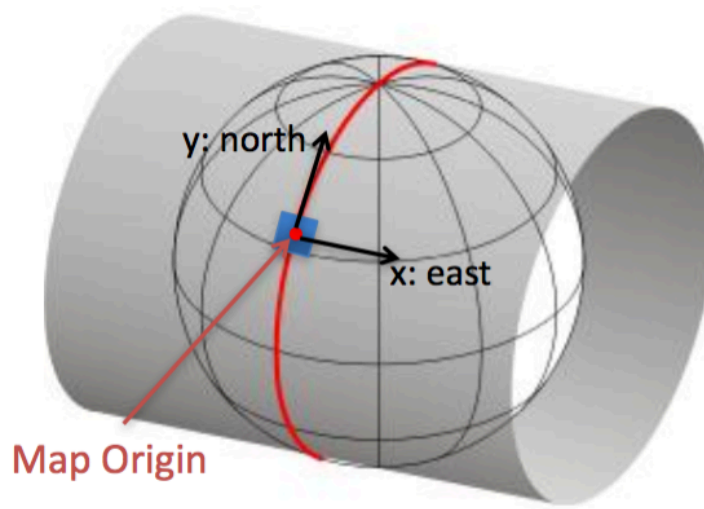

2. The Local Frame – East-North-Up (ENU)

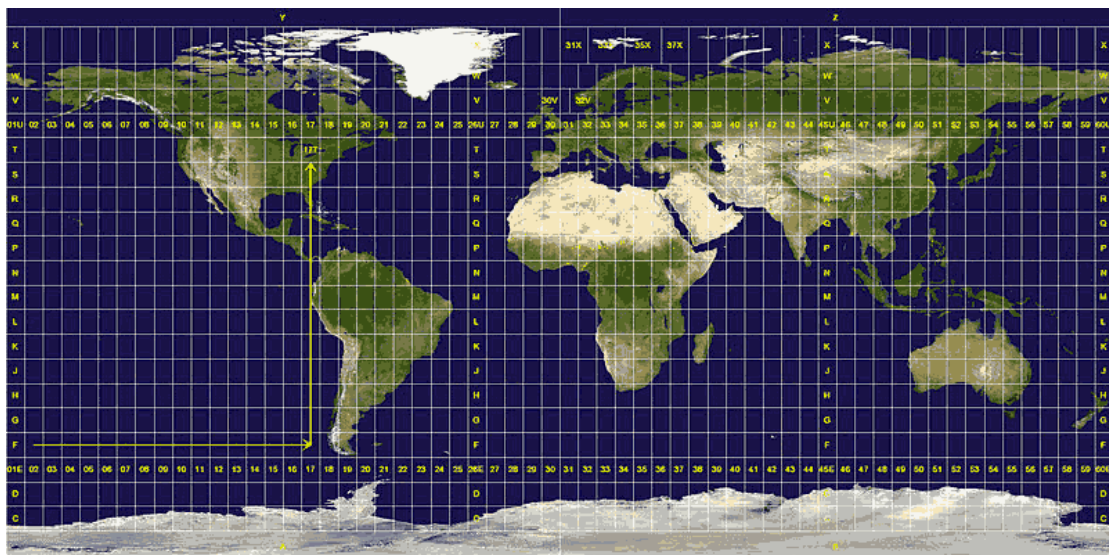In Apollo, the definition of the local frame is as follows:

- z-axis – pointing up (aligned with gravity)

- y-axis – pointing north

- x-axis – pointing east

Map Origin

The ENU local frame requires a 3D Cartesian coordinate system on the surface of the Earth.

The Universal Transverse Mercator (UTM) conformal projection uses a 2-dimensional Cartesian

coordinate system to give locations on the surface of the Earth。It's is not a single map projection. The

system instead divides the Earth into sixty zones, each being a six-degree band of longitude, and uses

a secant transverse Mercator projection in each zone. In Apollo project, UTM coordinate system is used

as the local frame in modules such as localization, planning, etc.

About the UTM system, we comply with the international standard specification, you

can refer to these websites for more details:

http://geokov.com/education/utm.aspx

3. The Vehicle Frame - Right-Forward-Up (RFU)

The definition of the vehicle frame is as follows:

z-axis – points up through the roof of the vehicle perpendicular to the ground.

y-axis – points out the front of the vehicle in the direction of travel.

x-axis – points out the right-hand side of the vehicle when facing forward.

The vehicle reference point is at the center of the rear axle.