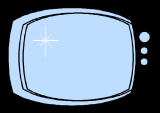
The 3D representation of the new transformation from the terrestrial to the celestial system.

Véronique Dehant, Olivier de Viron
Royal Observatory of Belgium
Nicole Capitaine
Observatoire de Paris, France

Content of my talk

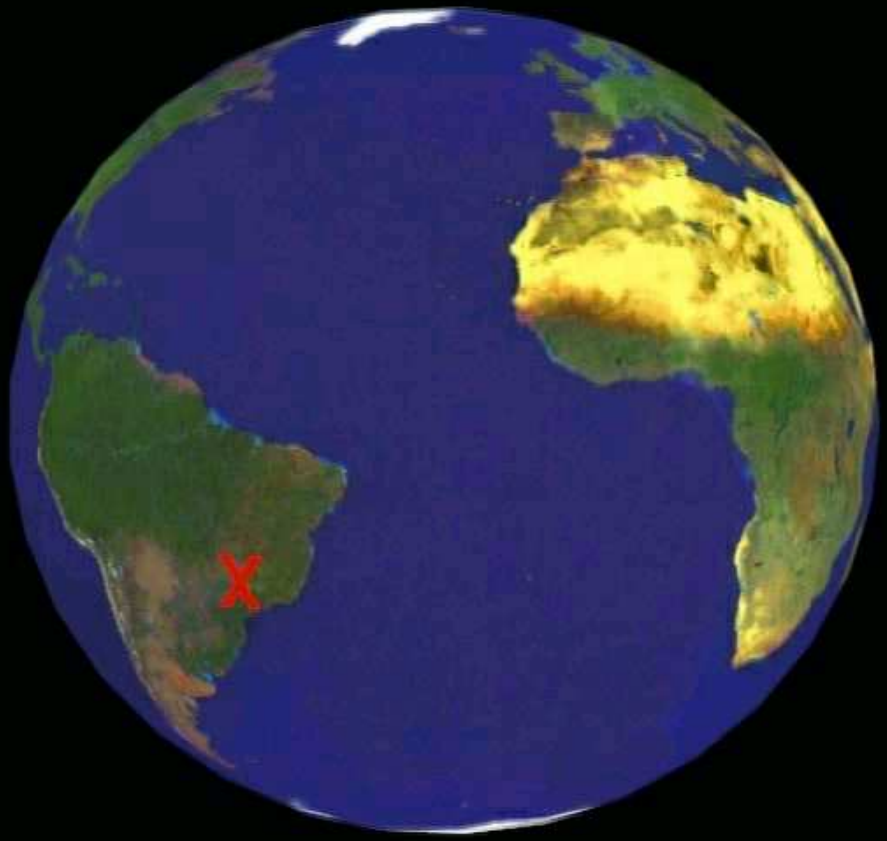
- (International) Terrestrial Reference System
- (International) Celestial reference system
- Motions of one with respect to the other
- Definition of the Celestial Intermediate pole (CIP)
- The classical transformation
- The transformation based on the Non Rotating Origins (NROs)
- Definition of the NRO and of the Earth Rotation Angle
- Conclusions

Preface

When you see this sign:  , it means that there is a movie and that you have to wait until the end of the movie before continuing the slide show

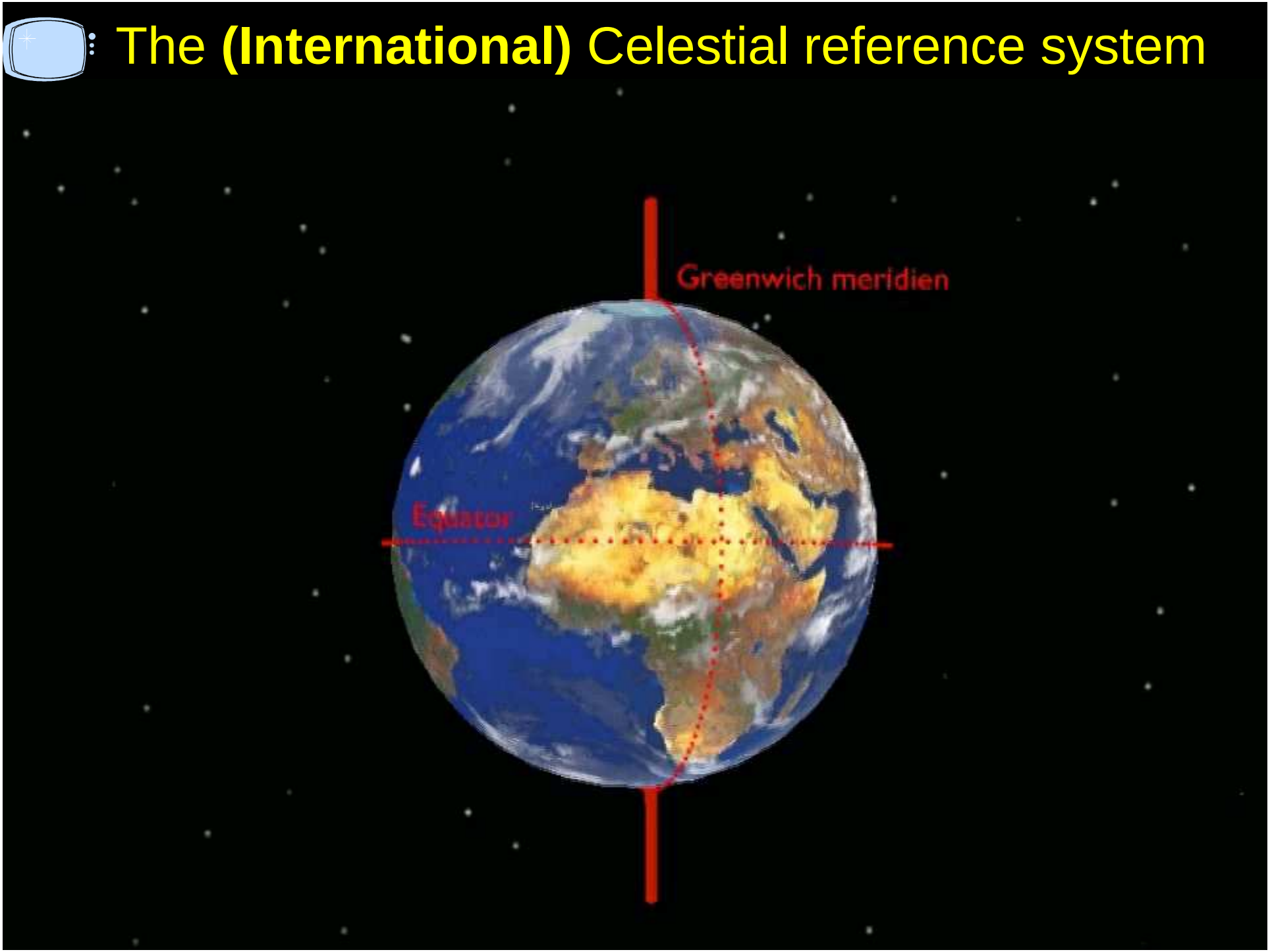
(pressing “page down”).

The **(International)** Terrestrial reference system



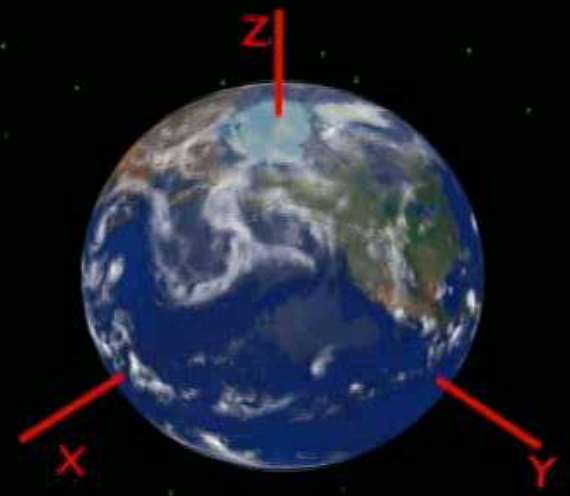
It must be noted that the "Greenwich meridian", is not called like that anymore but rather the "ITRF zero meridian".

The **(International)** Celestial reference system

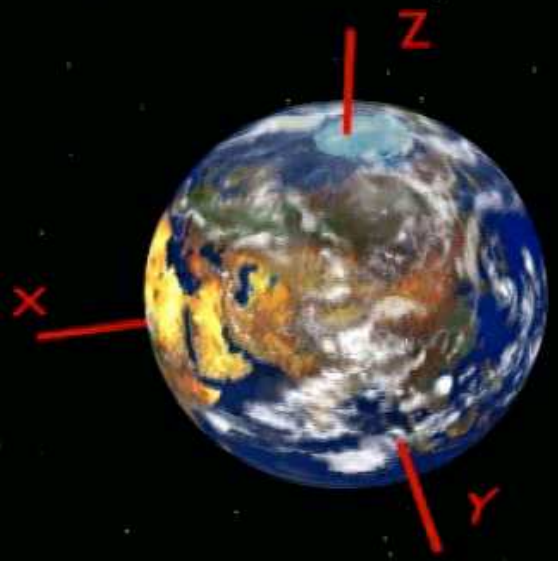


Two systems in an ideal world;

the celestial frame is fixed to the stars and the terrestrial frame is fixed to the Earth; the Earth is uniformly rotating



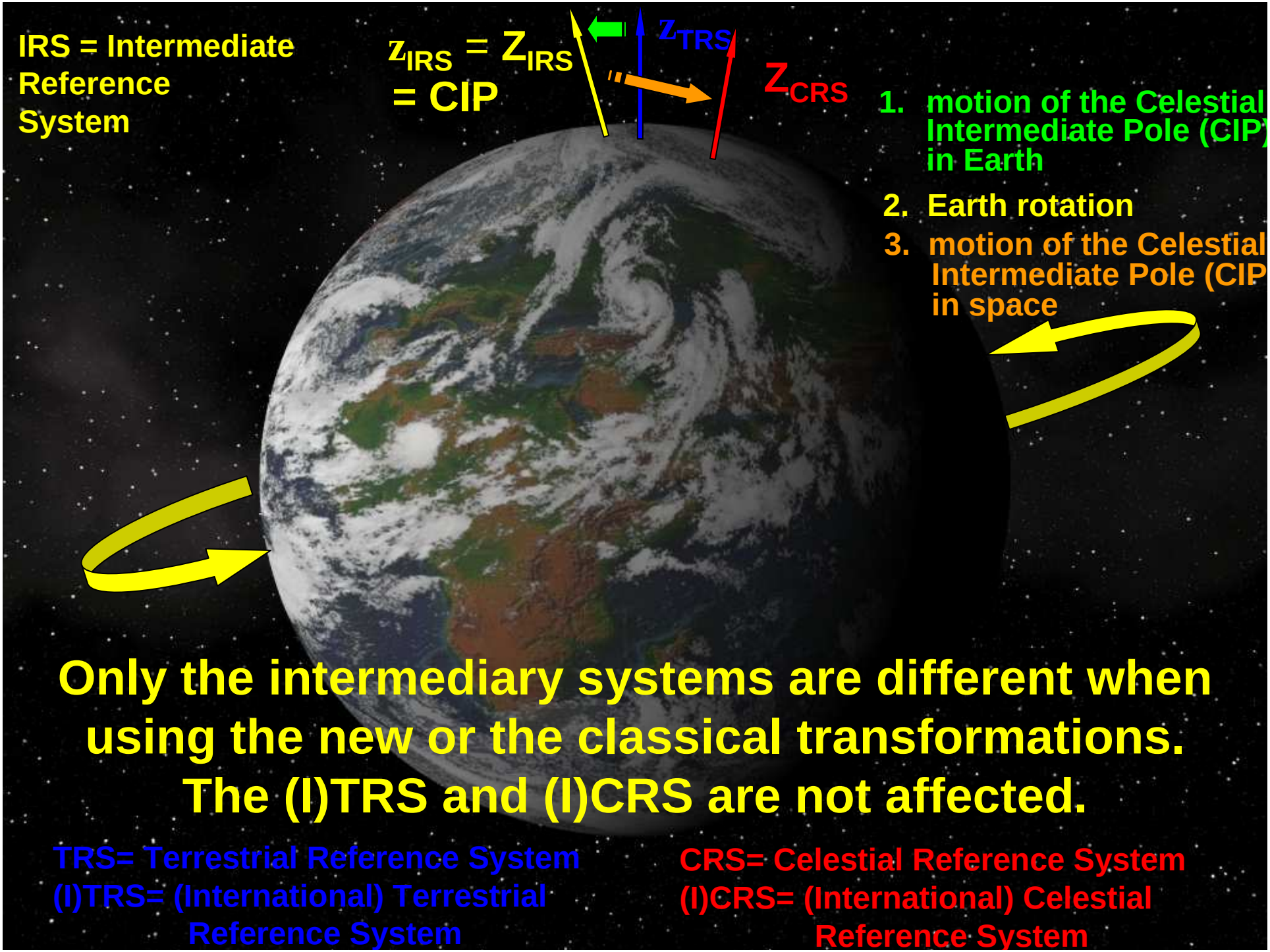
X,Y,Z:
for CRS



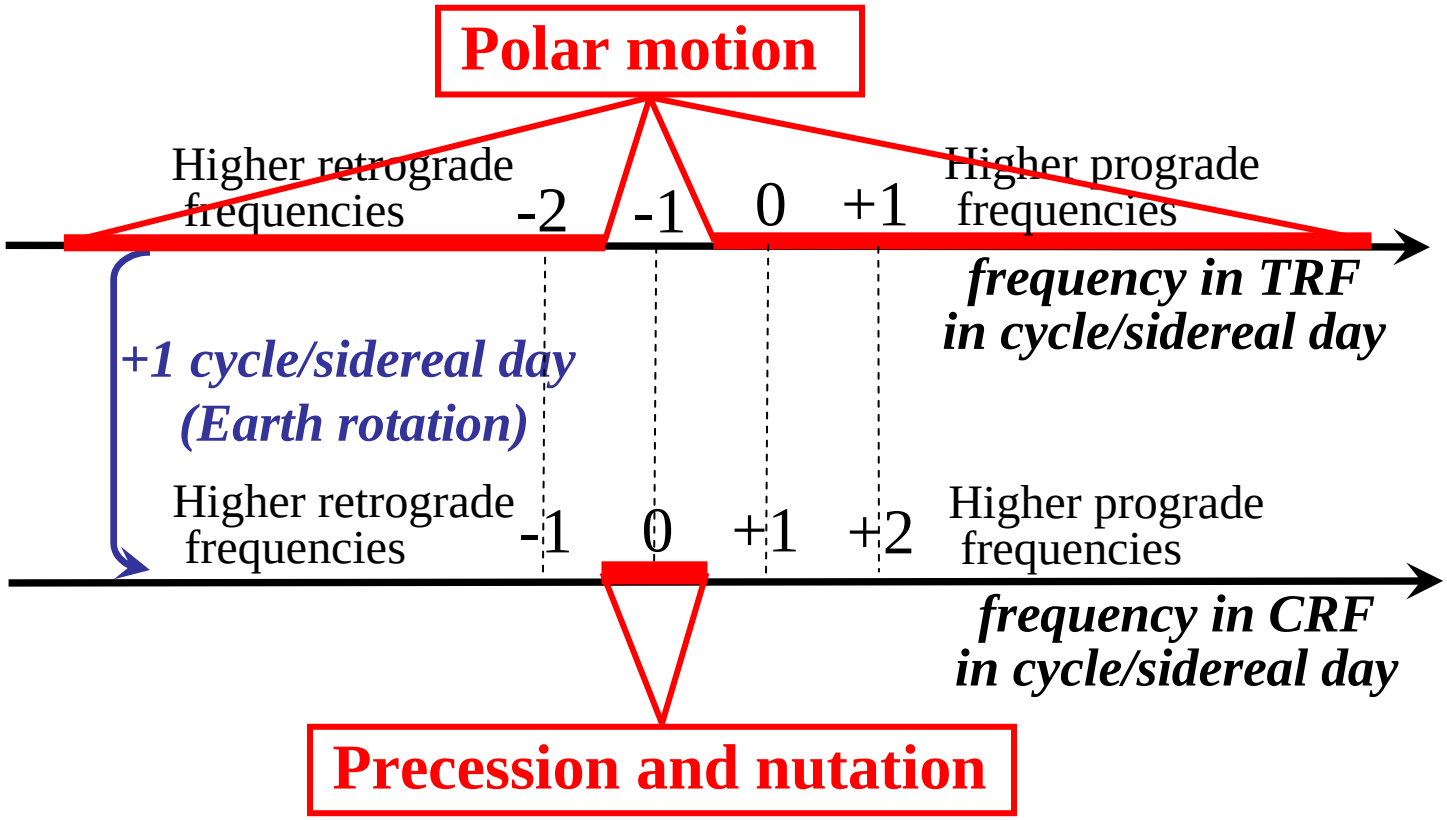
x,y,z:
for TRS

The less ideal world;

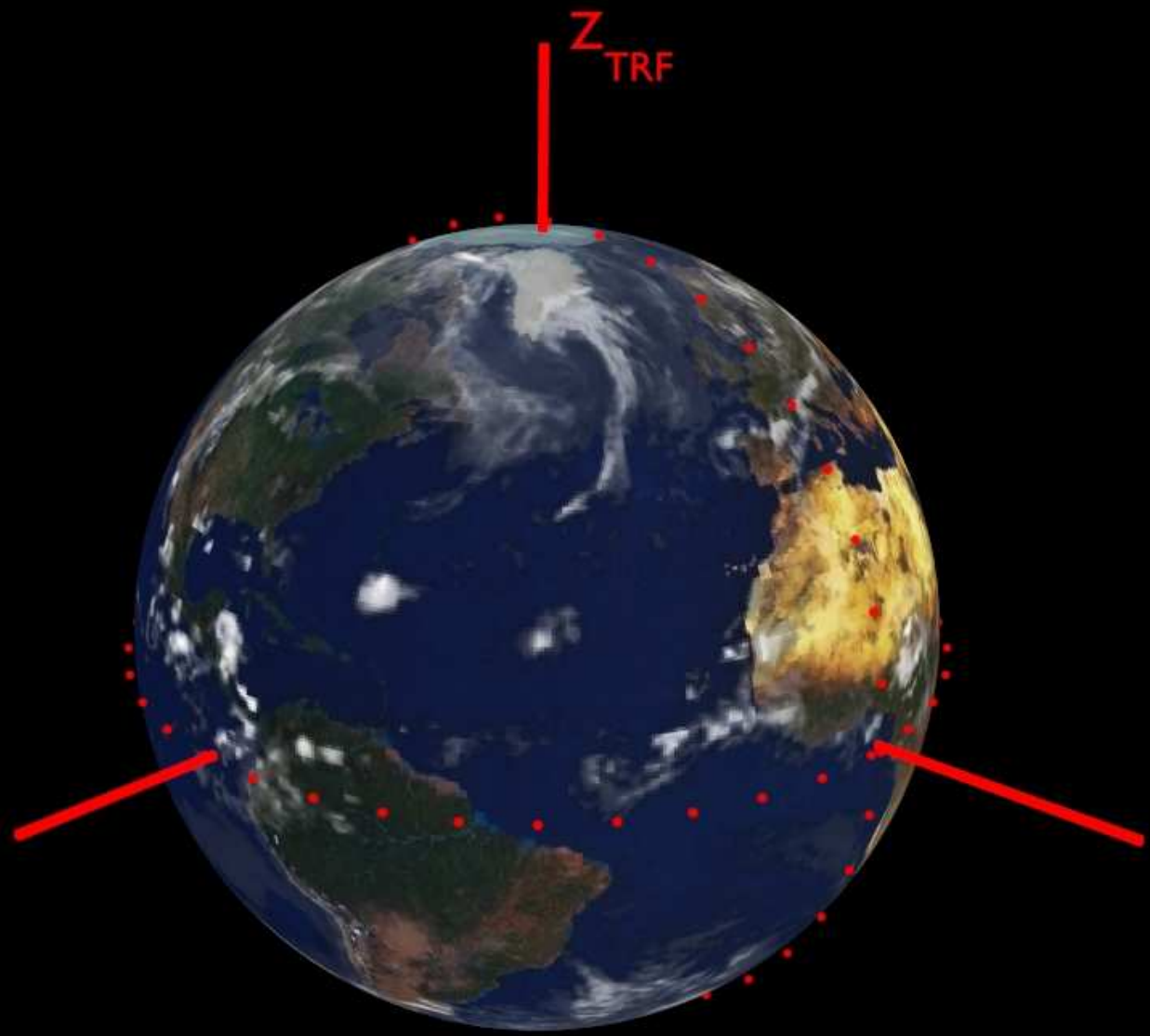
the Earth orientation is changing in space; the Earth rotation is not uniform; there is polar motion, precession, nutations, and length-of-day changes; the Earth is non-rigid, deformable, there is plate tectonics, there are oceans and atmosphere, …


IRS = Intermediate Reference System
$z_{IRS} = Z_{IRS}$ = CIP
Z_{TRS}
Z_{CRS}
1. motion of the Celestial Intermediate Pole (CIP) in Earth
2. Earth rotation
3. motion of the Celestial Intermediate Pole (CIP) in space
Only the intermediary systems are different when using the new or the classical transformations. The (I)TRS and (I)CRS are not affected.
TRS= Terrestrial Reference System
(I)TRS= (International) Terrestrial Reference System
CRS= Celestial Reference System
(I)CRS= (International) Celestial Reference System

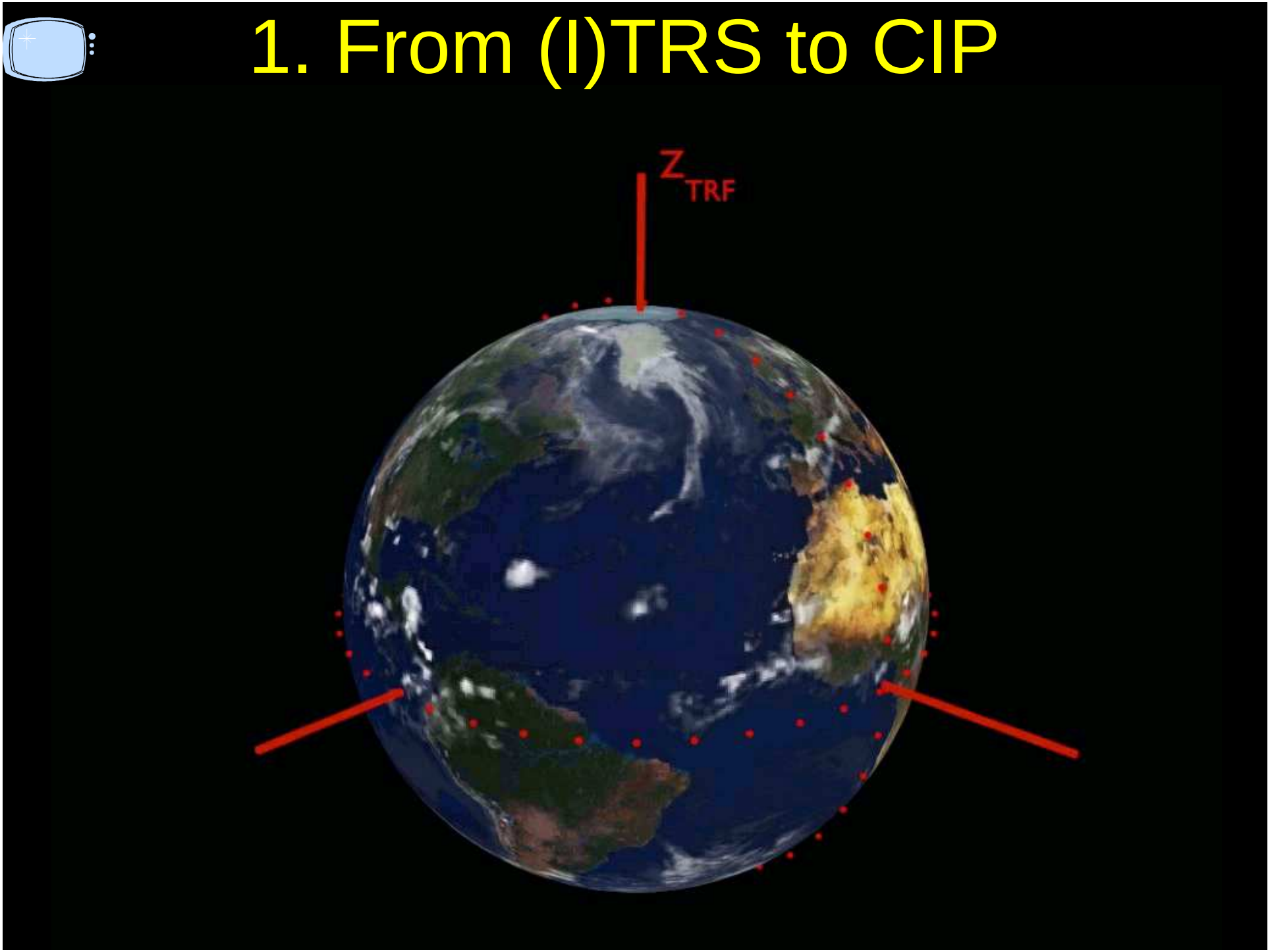
Definition of the CIP



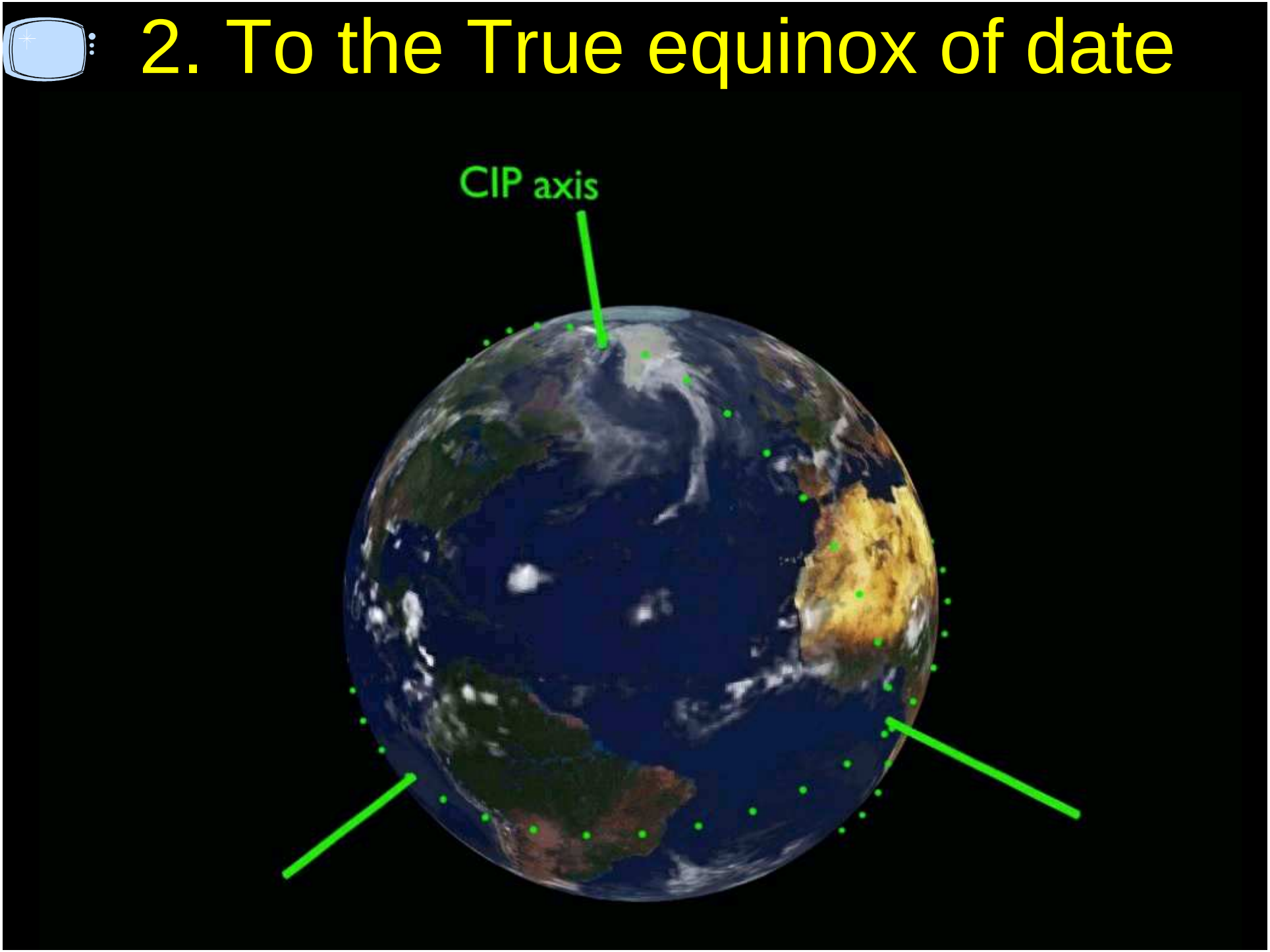
The classical transformation



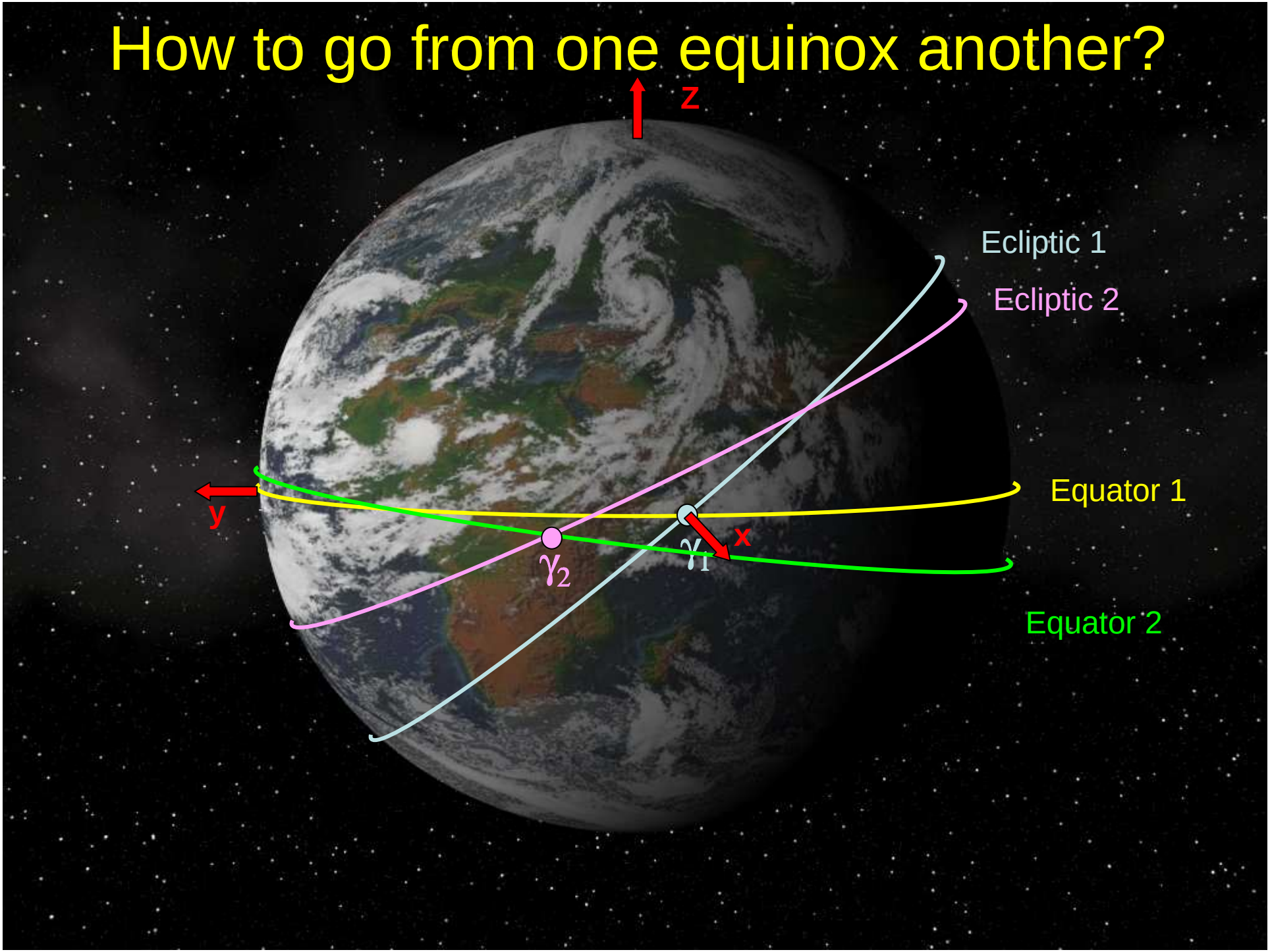
1. From (I)TRS to CIP



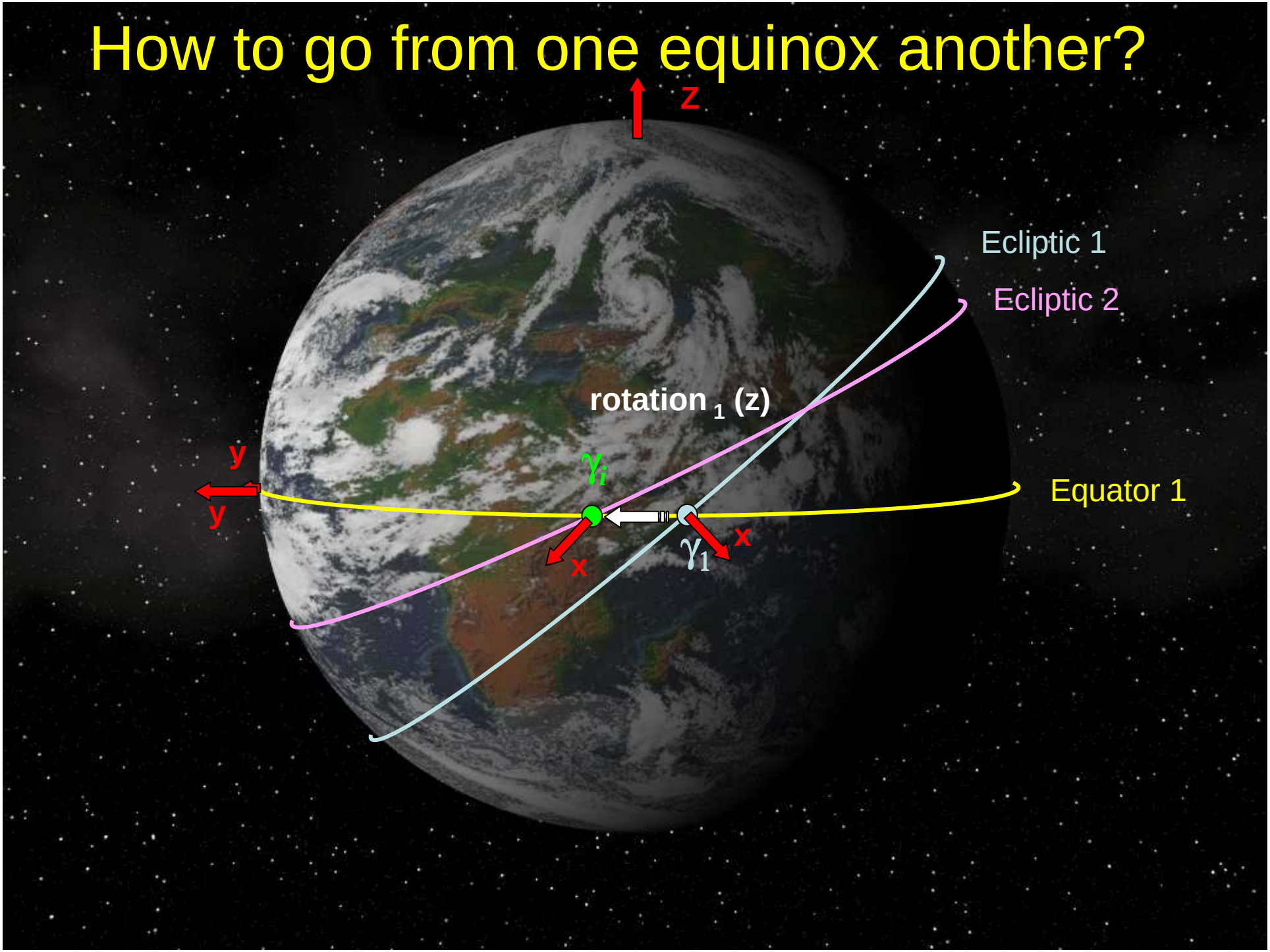
2. To the True equinox of date



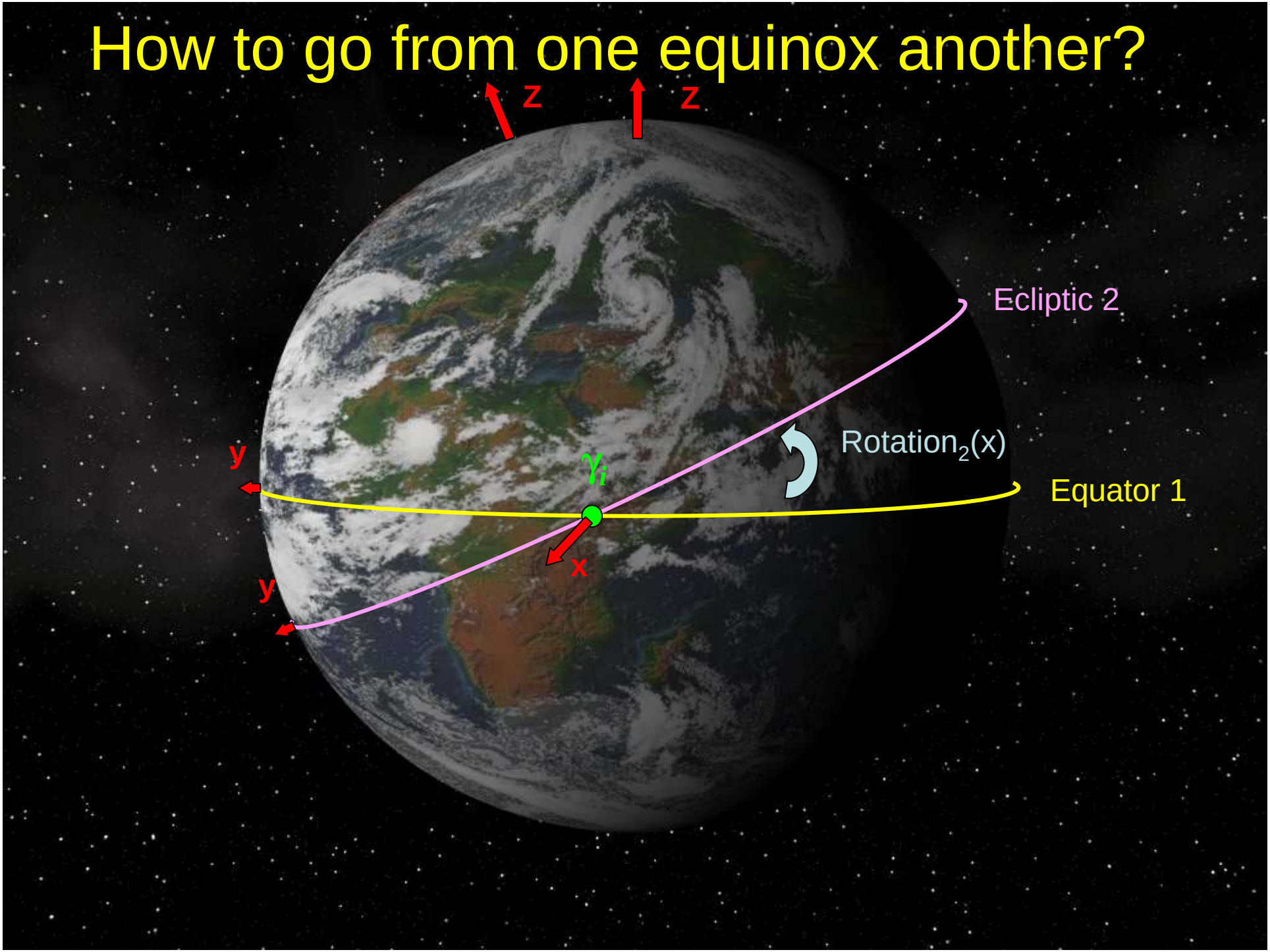
How to go from one equinox another?



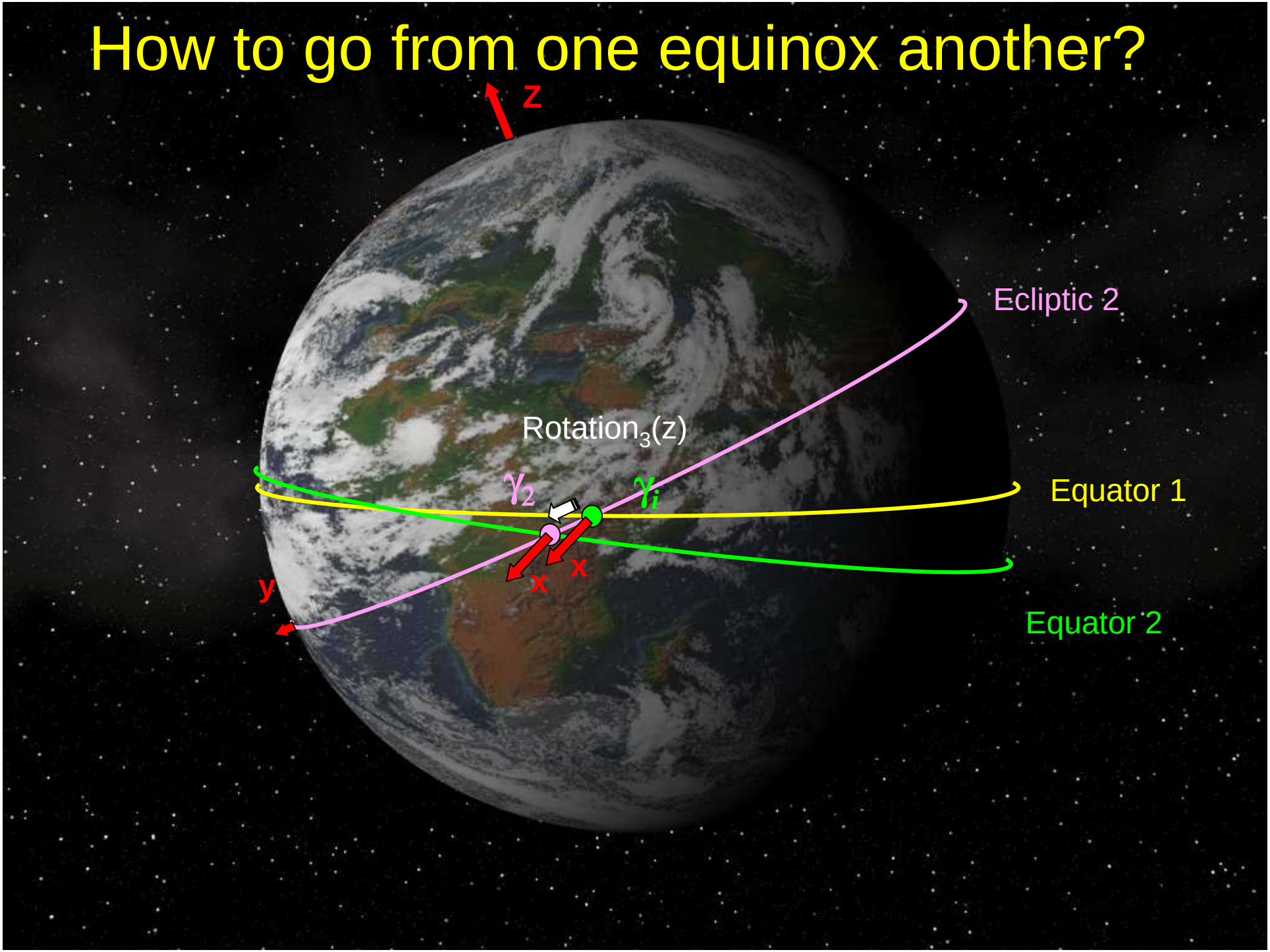
How to go from one equinox another?



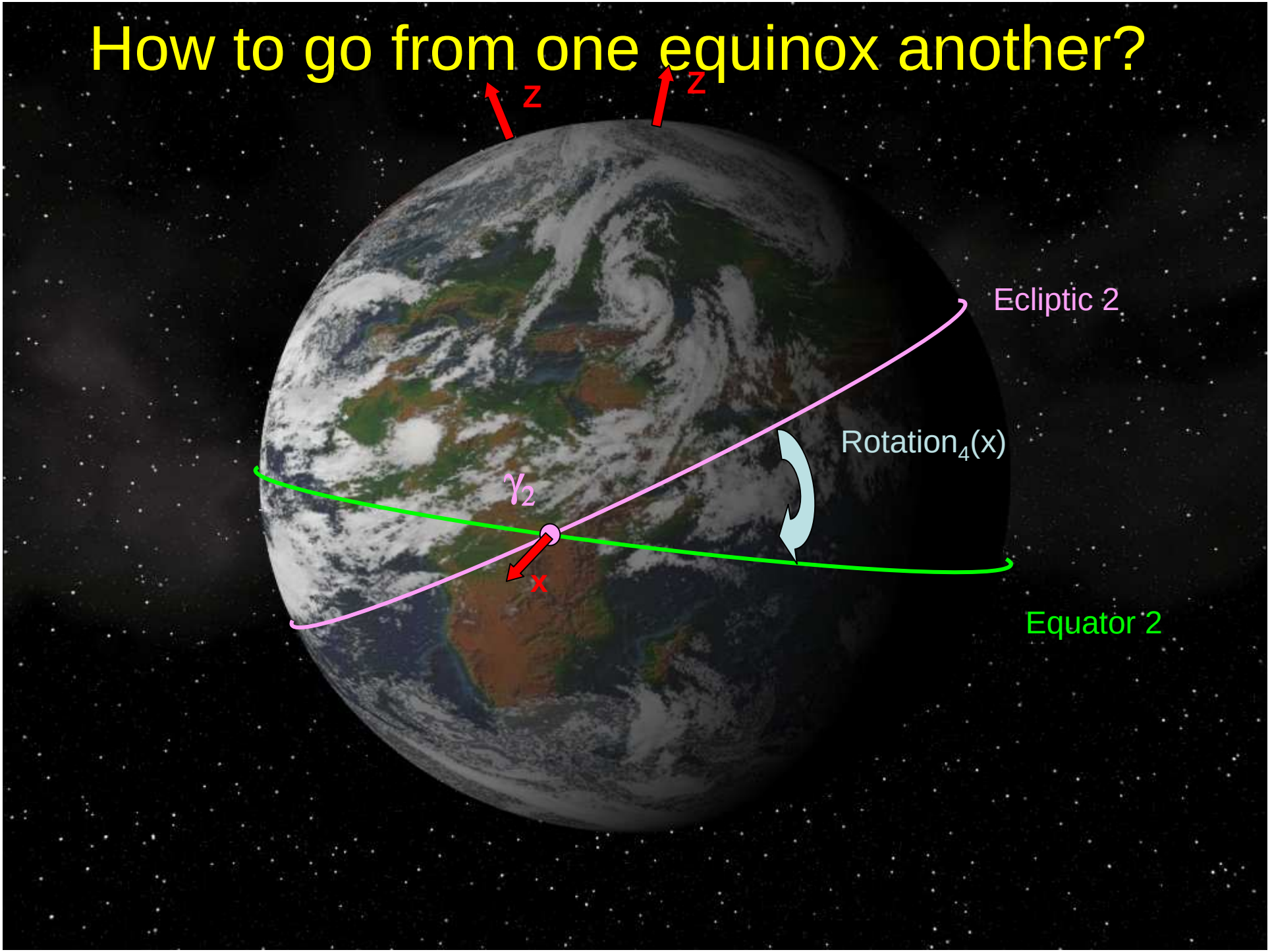
How to go from one equinox another?



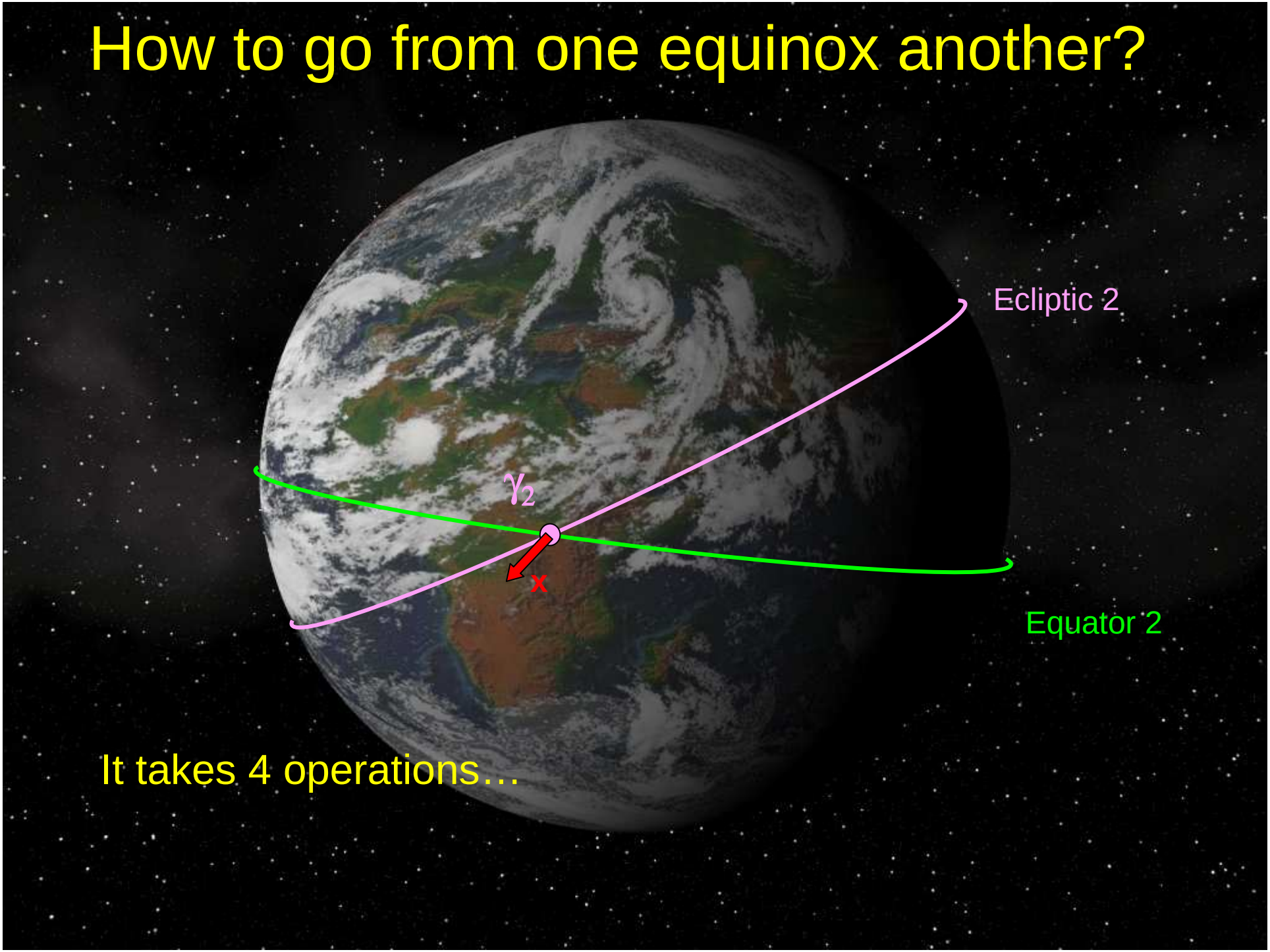
How to go from one equinox another?



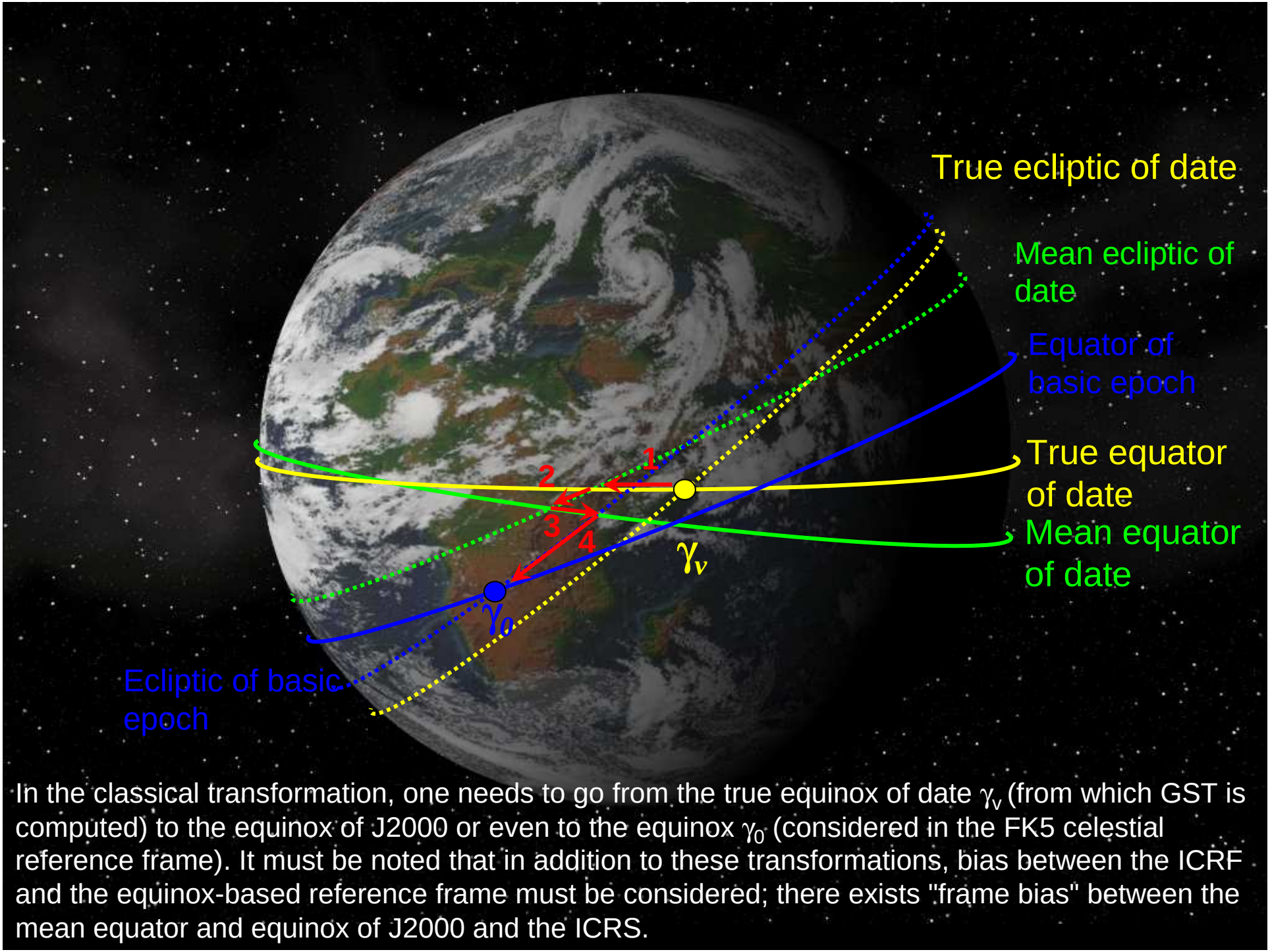
How to go from one equinox another?



How to go from one equinox another?

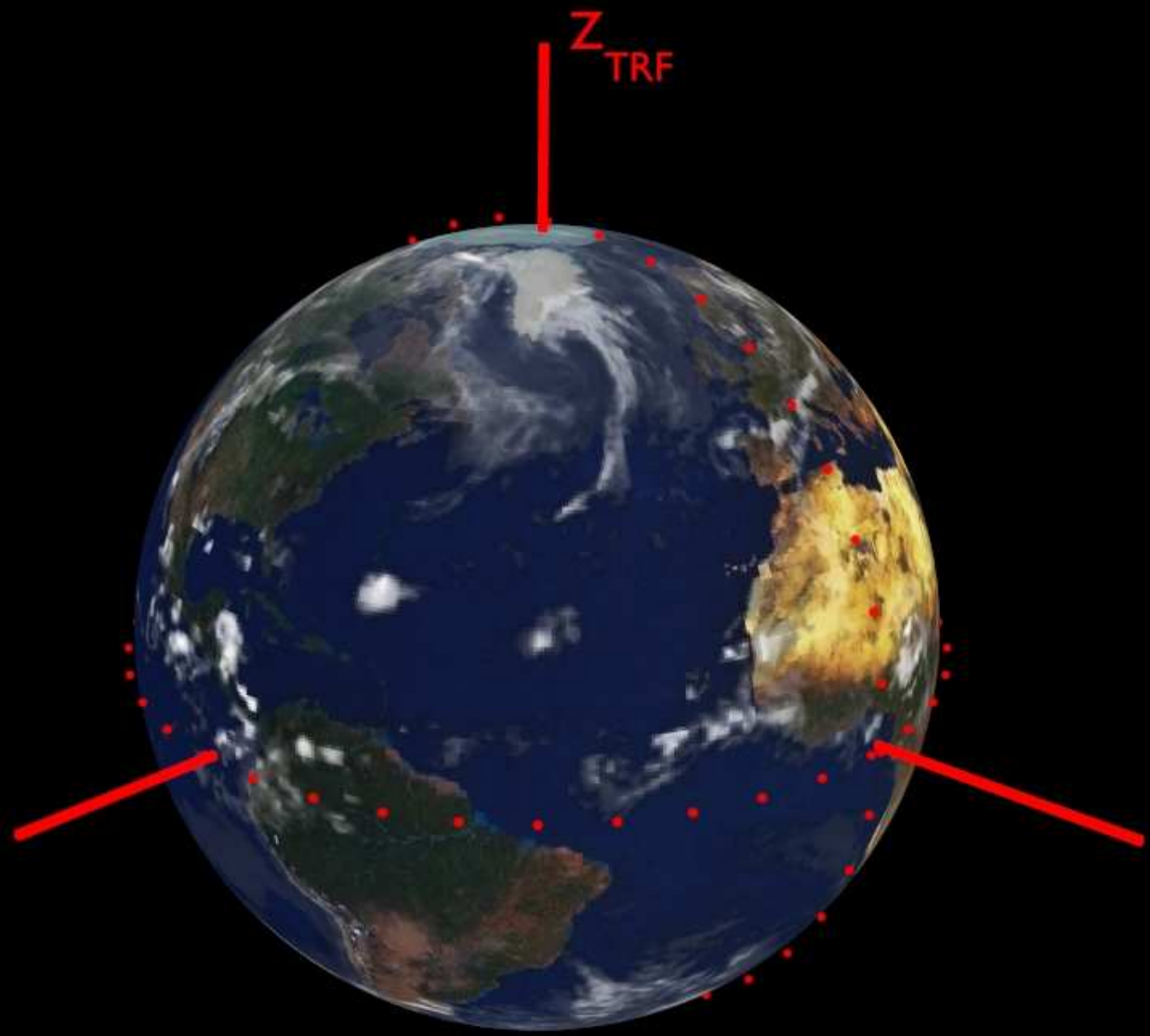


It takes 4 operations…

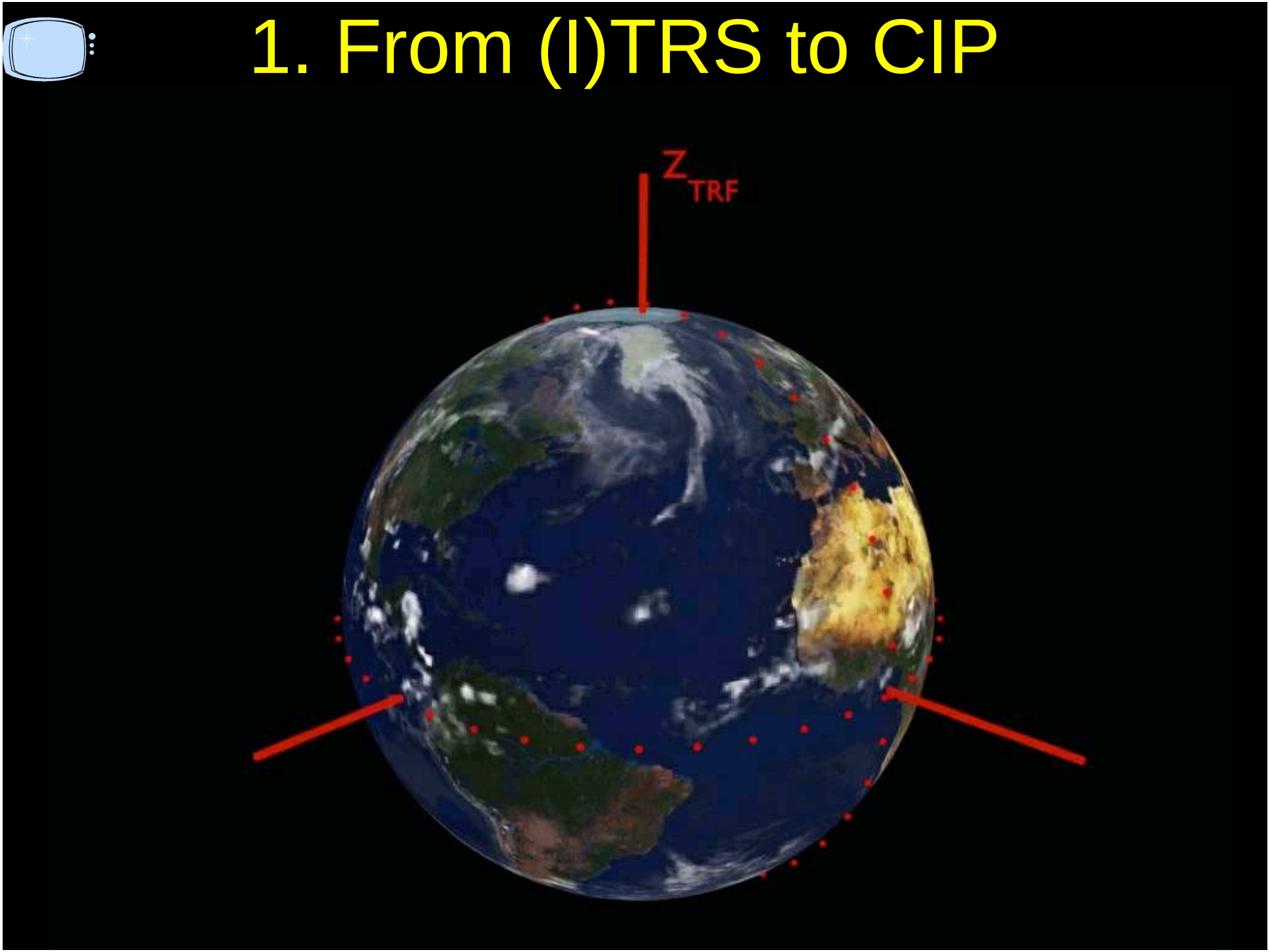


In the classical transformation, one needs to go from the true equinox of date γ_v (from which GST is computed) to the equinox of J2000 or even to the equinox γ_0 (considered in the FK5 celestial reference frame). It must be noted that in addition to these transformations, bias between the ICRF and the equinox-based reference frame must be considered; there exists "frame bias" between the mean equator and equinox of J2000 and the ICRS.

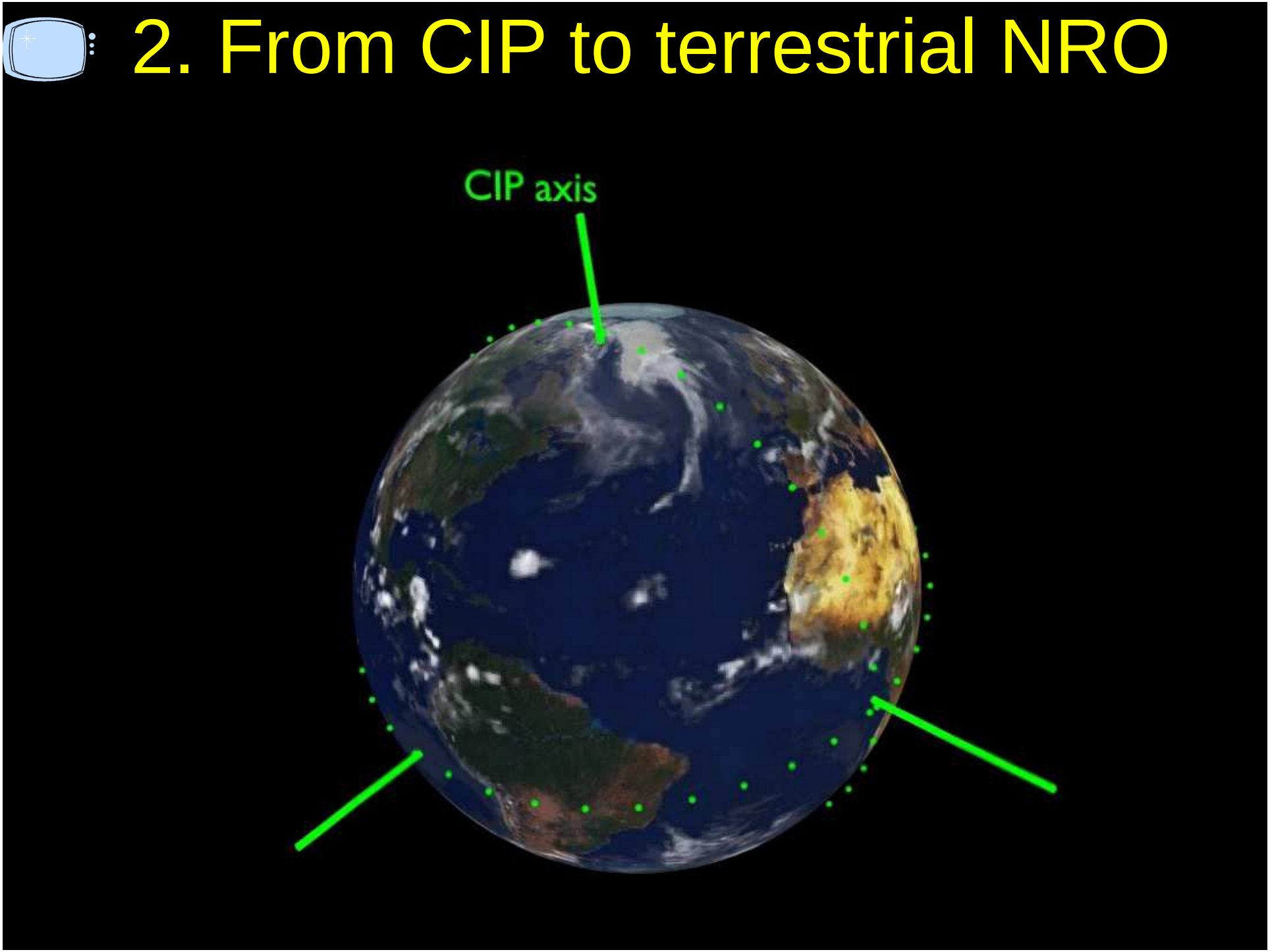
Transformation based on NROs



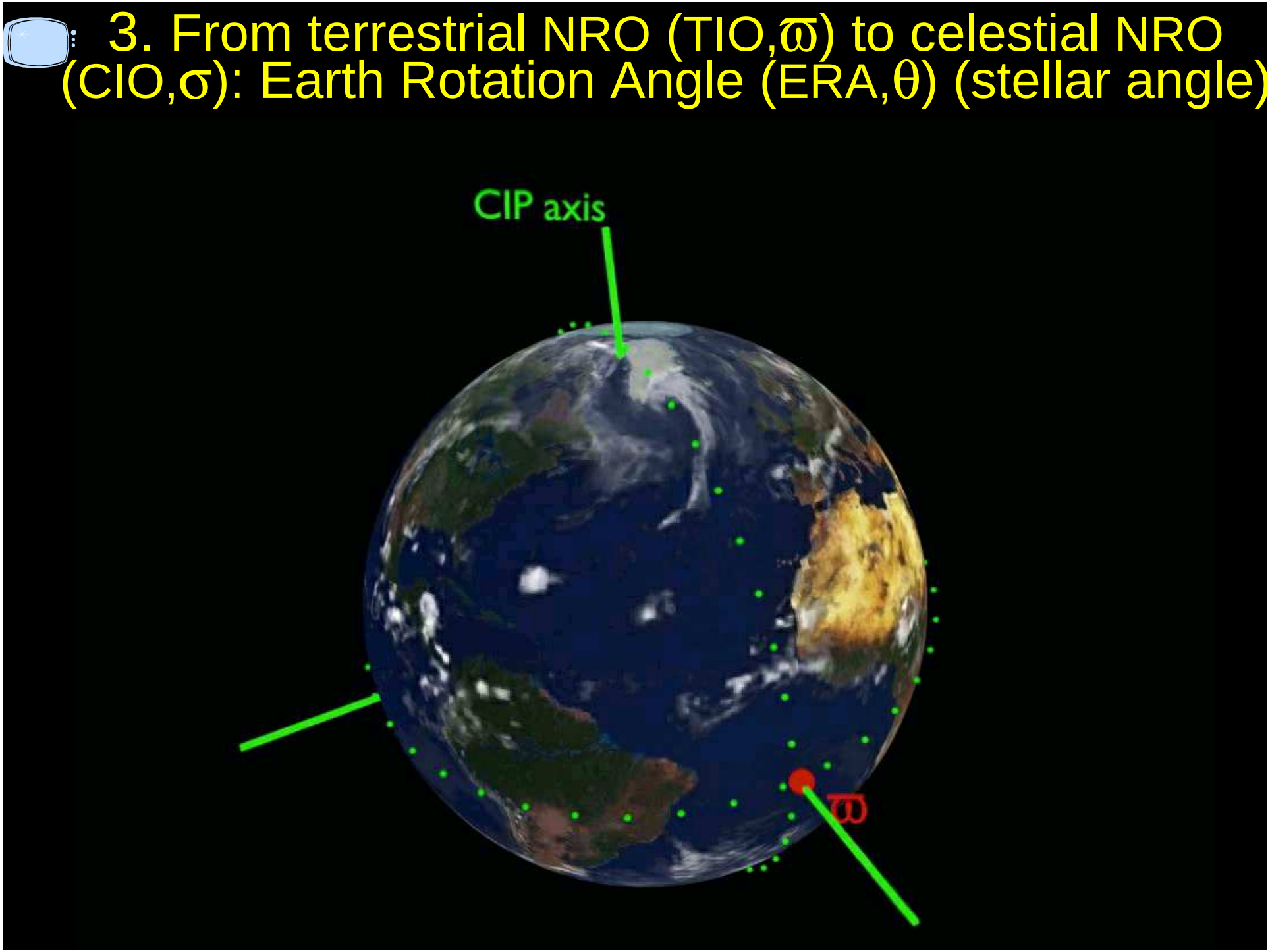
1. From (I)TRS to CIP



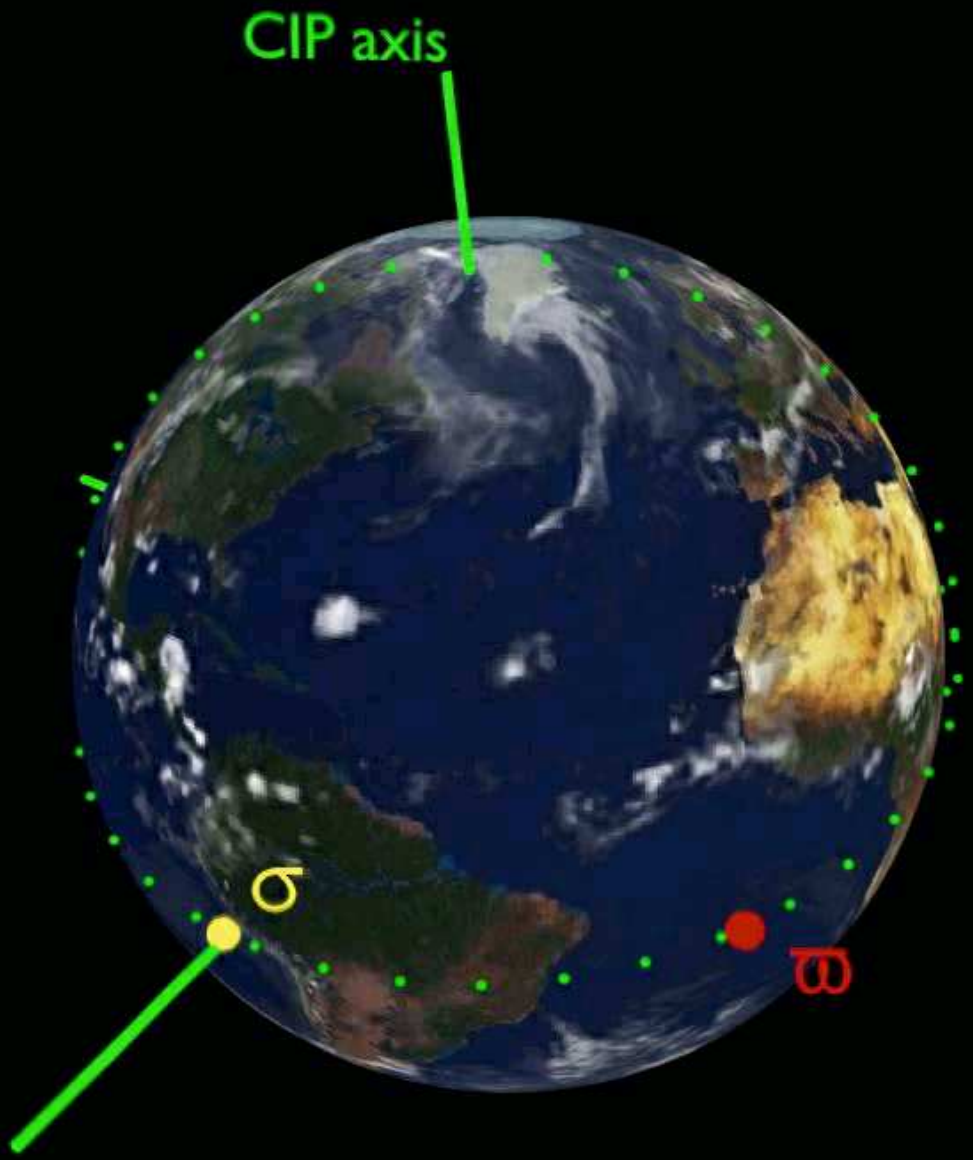
2. From CIP to terrestrial NRO



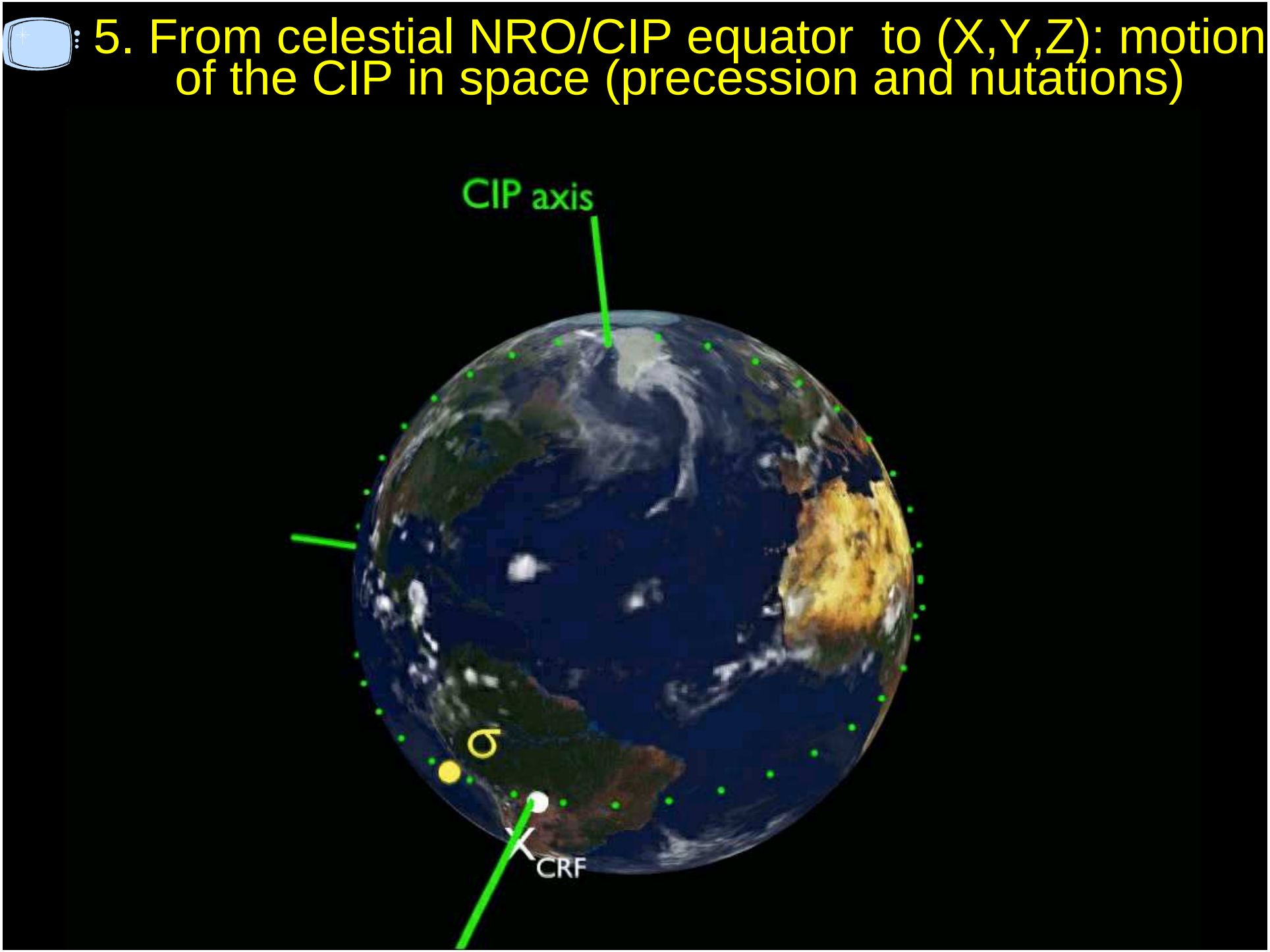
3. From terrestrial NRO (TIO,ϖ) to celestial NRO (CIO,σ): Earth Rotation Angle (ERA,θ) (stellar angle)



4. From CIO (σ) to x_{CRF} or Σ: *s*

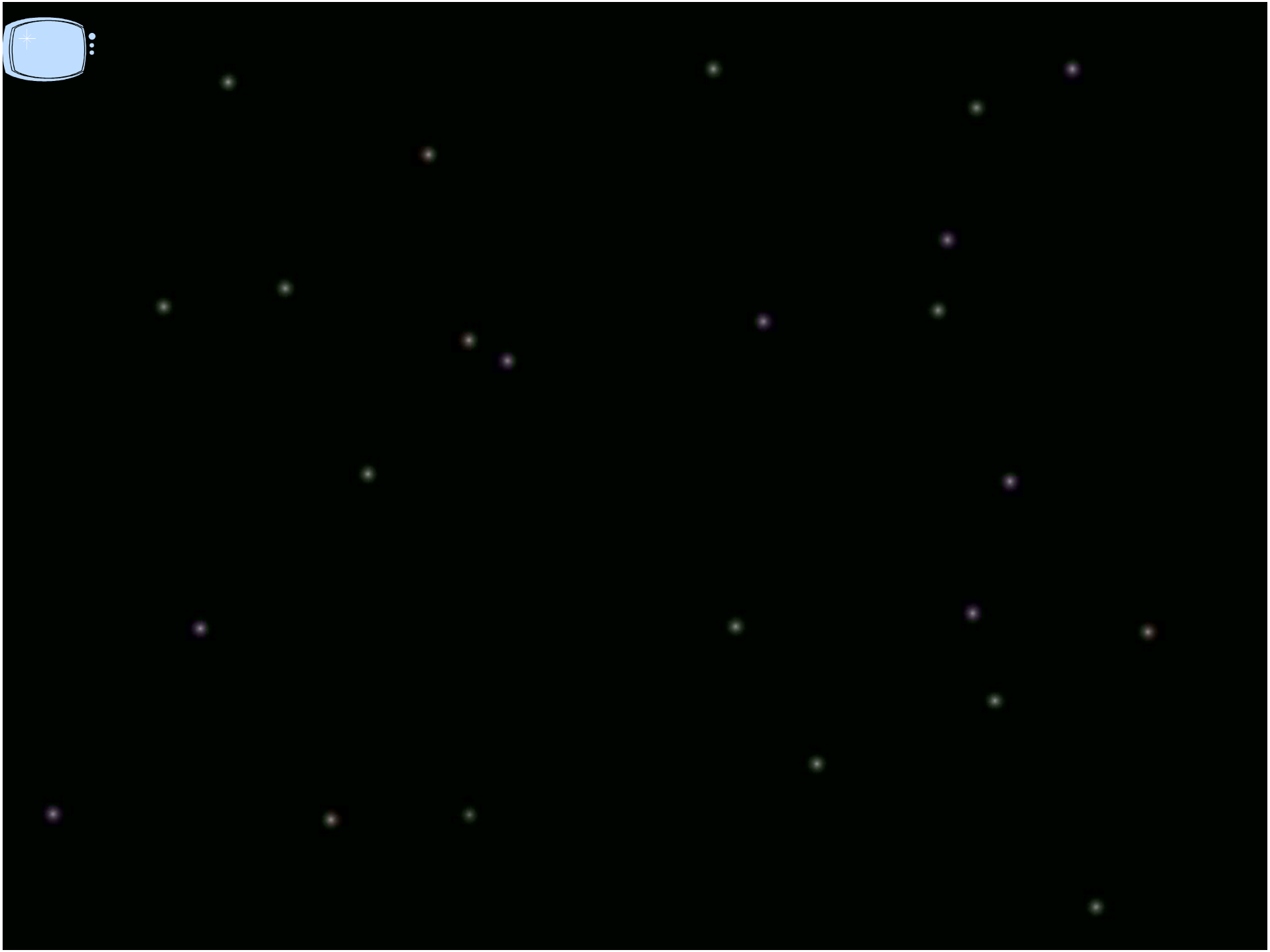


5. From celestial NRO/CIP equator to (X,Y,Z): motion of the CIP in space (precession and nutations)



What is the NRO?

1. Characterized by its motion: no rotation around the CIP associated with polar motion or precession/nutation.
2. Not one particular point, any point of the CIP equator is convenient.
3. Allows to get rid of the equinox in the change of reference system and in the definition of Earth rotation.



So, can we take any points we want?

1. Yes, it is not the point it-self that matter, but its motion.

2. But, we want the new system to be consistent with the classical one.

3. Thus, the point is chosen to insure continuity (January 2003).

Definition of NRO

1. The NRO is defined by
   its position at the basic epoch (continuity);
   its motion (no motion in the CIP equator associated with CIP motion).

2. The NRO ensures Earth rotation angle being pure rotation (no contamination from CIP motion)

Conclusions

1. No change in the definition of precession and nutation and polar motion since CIP definition.
2. The use of the NROs does only change the Intermediate system involved; no change of the ICRS or ITRS; it ensures a good definition of the Earth rotation (no contamination from polar motion of from precession and nutation).