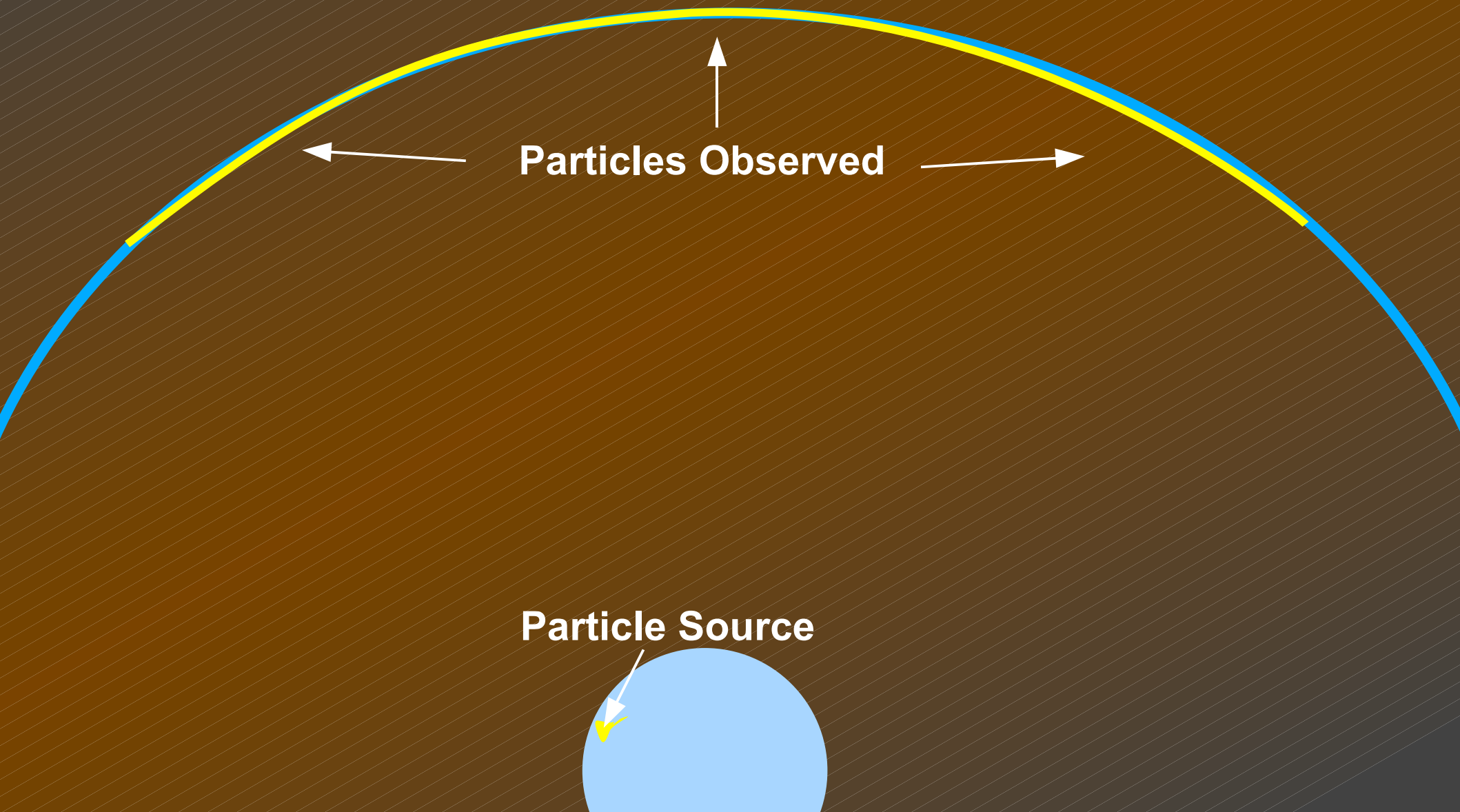
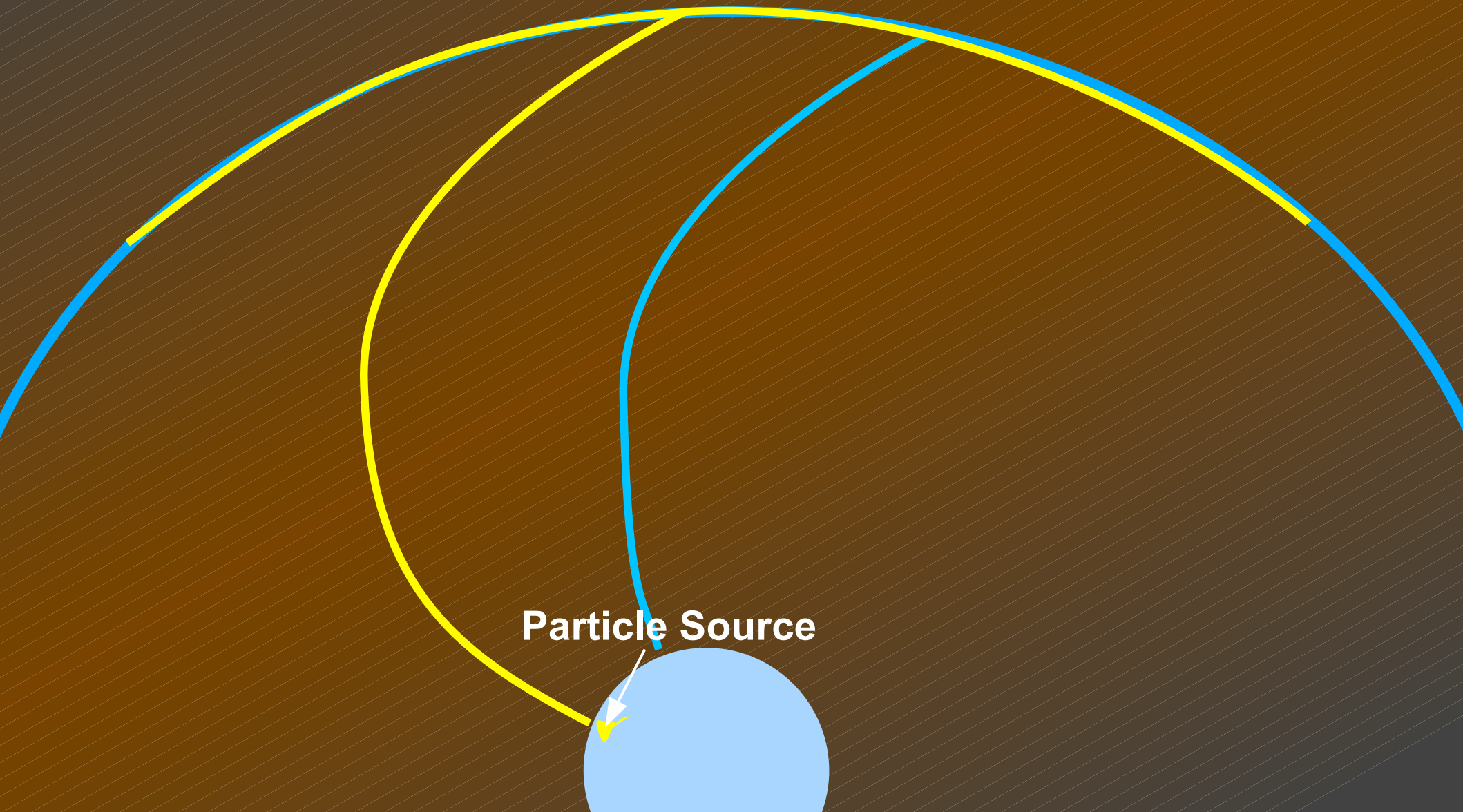
Evidence of Confinement of Solar-Energetic Particles to Interplanetary Magnetic Field Lines

Eileen Chollet, Caltech
Joe Giacalone, University of Arizona

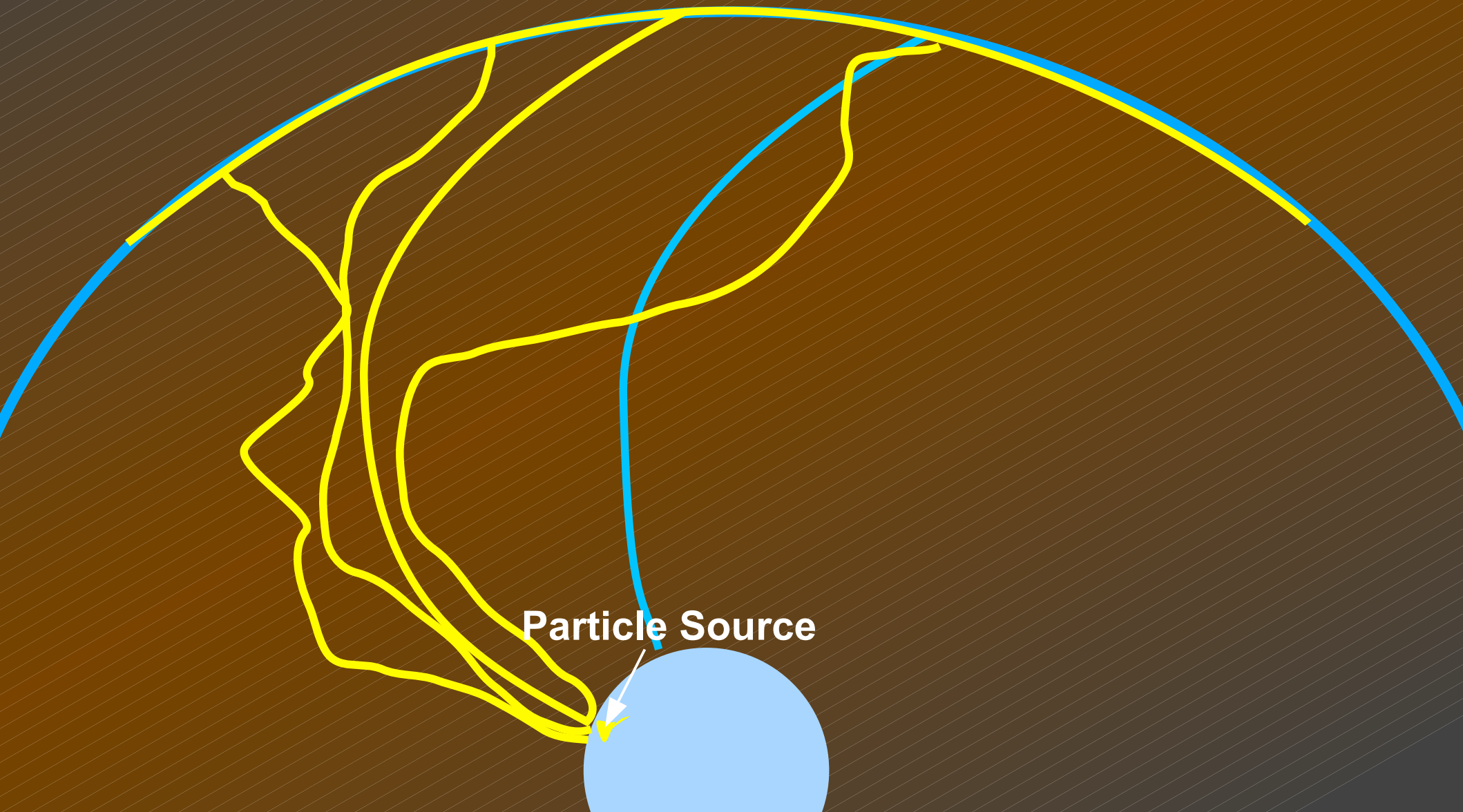
Particles injected at a small source (~ few thousand km) are observed over a wide range of latitudes and longitudes far from the Sun.



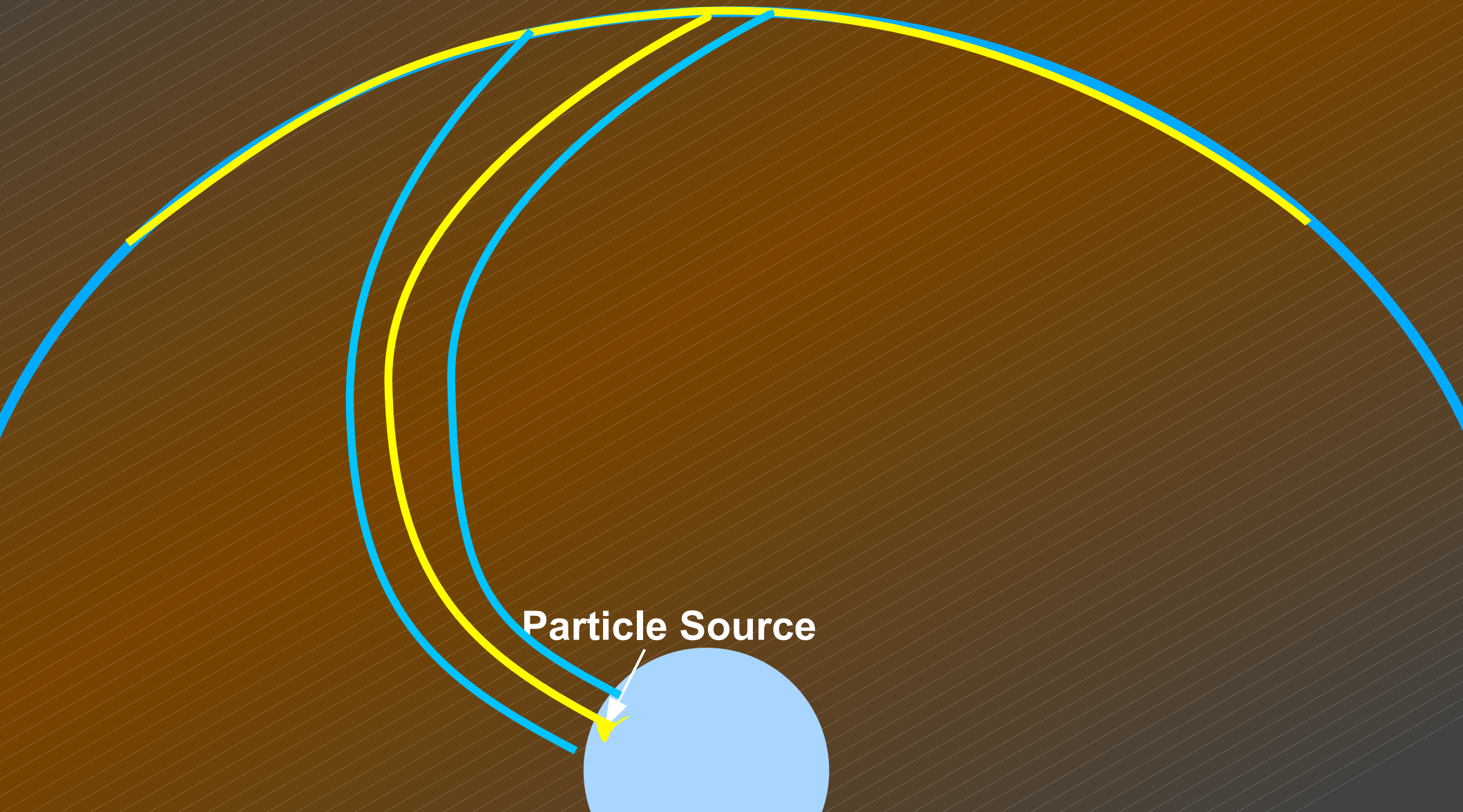
Particles spread in longitude due to field line motion.



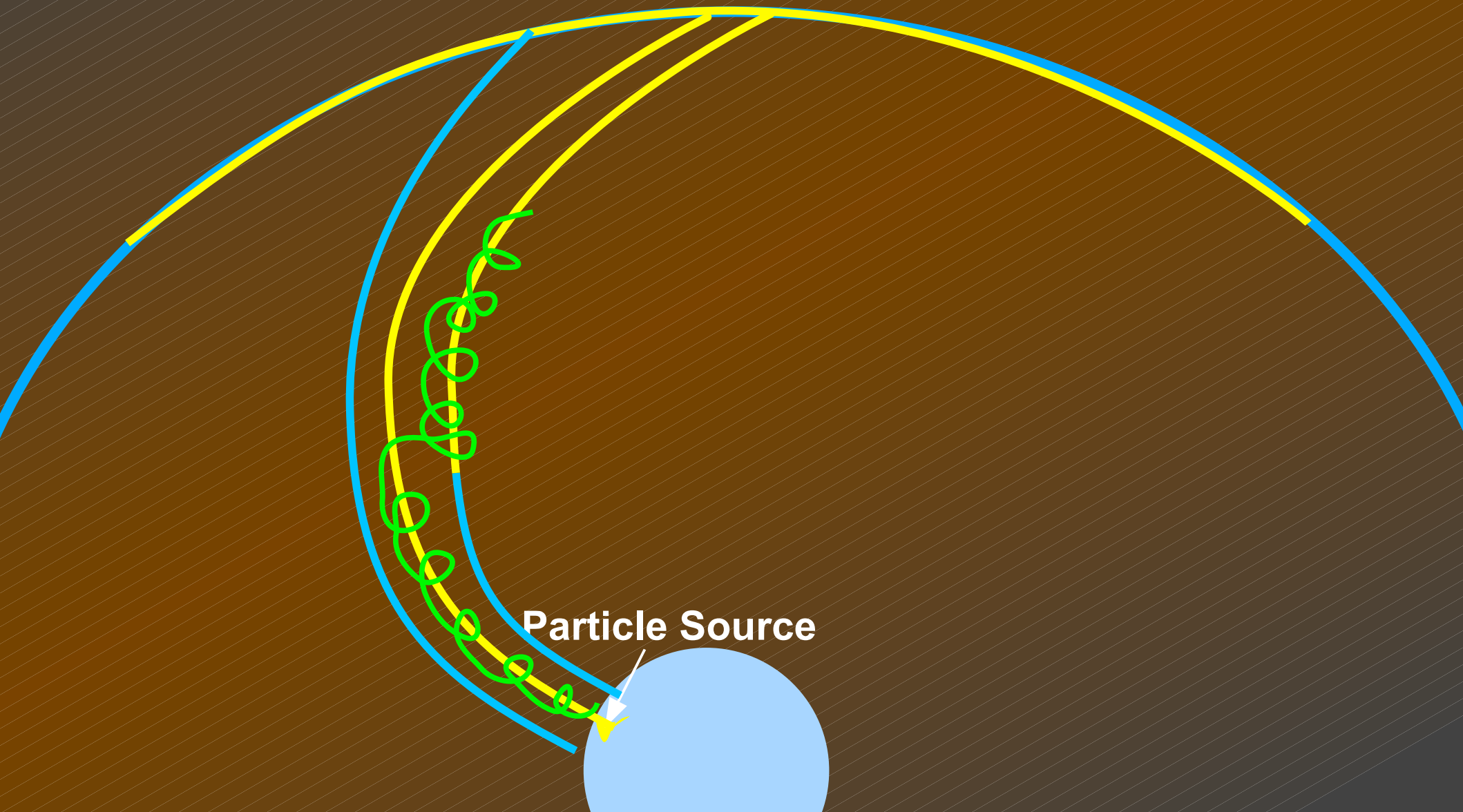
Particles spread in longitude due to field line motion.

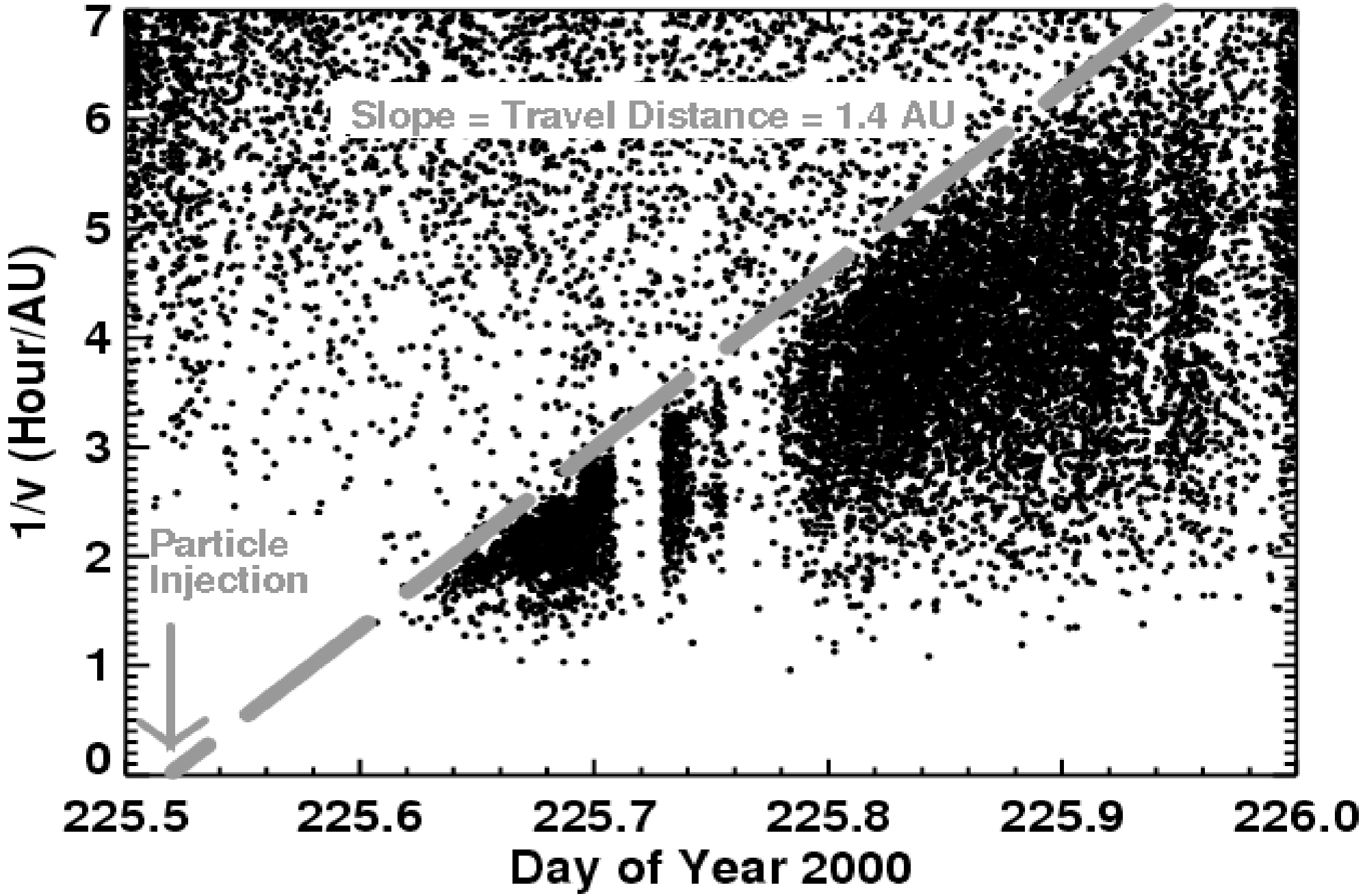


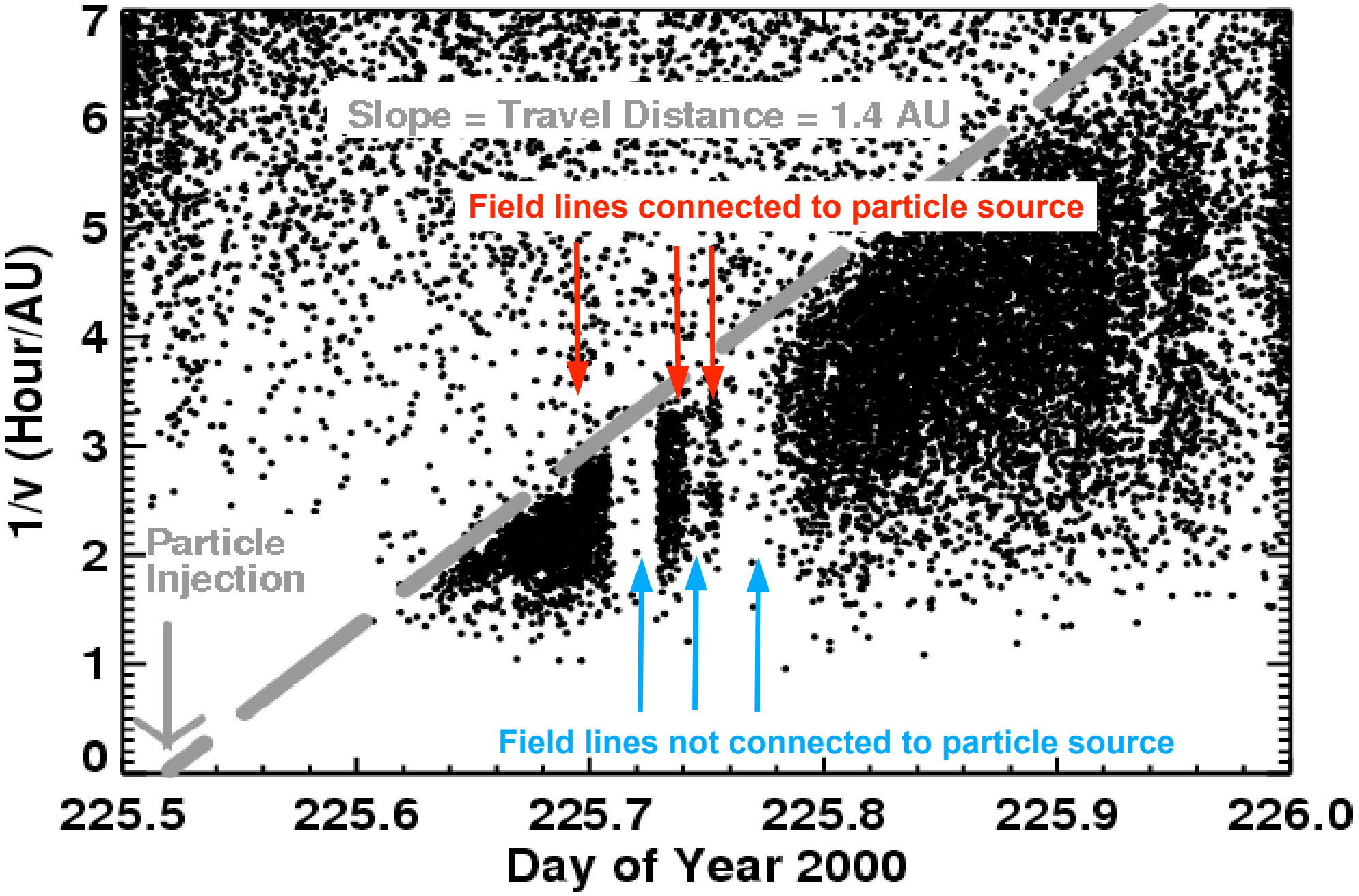
Question: How much can particles spread due to scattering-produced "hopping" from one field line to the next?

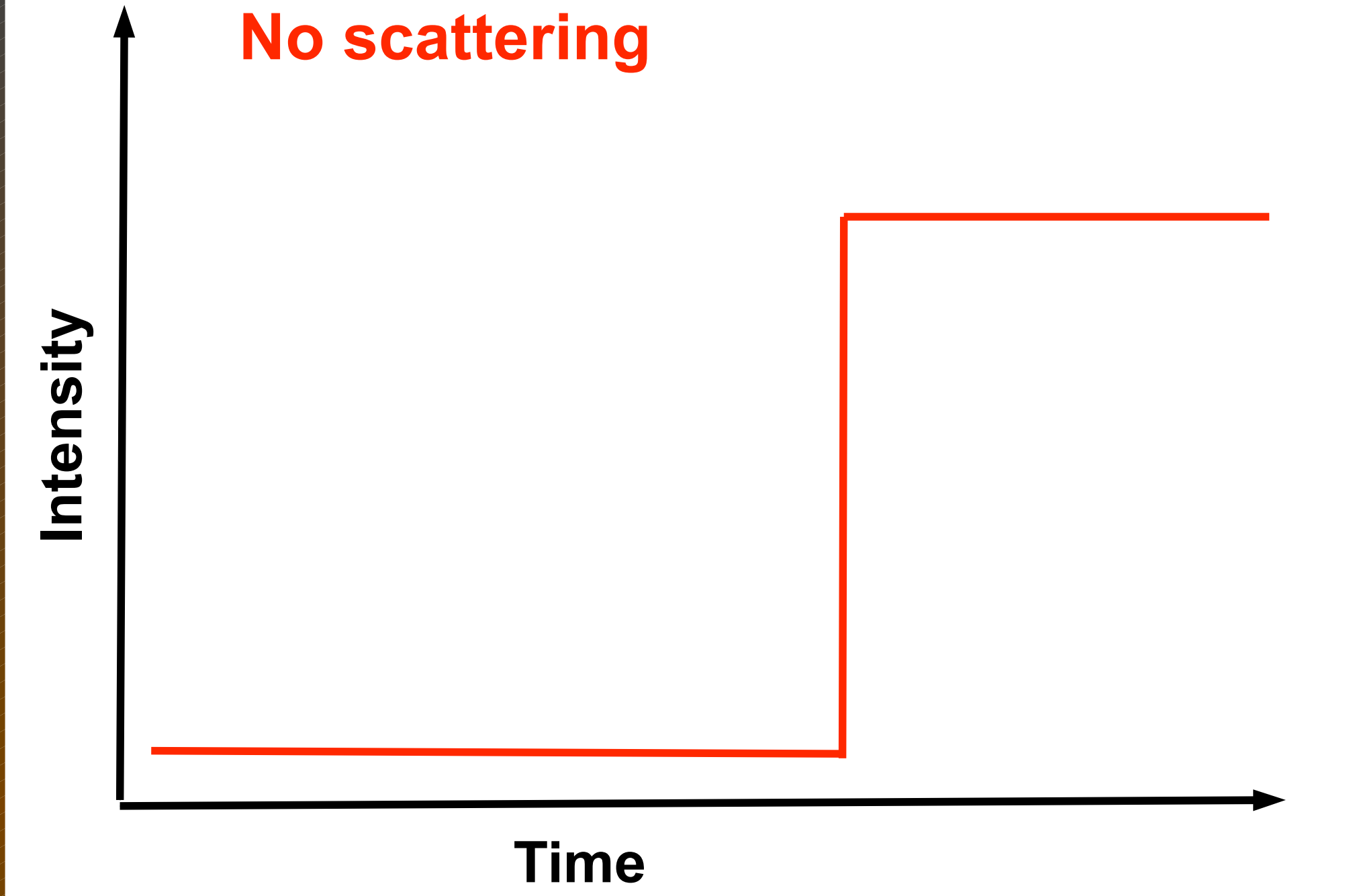


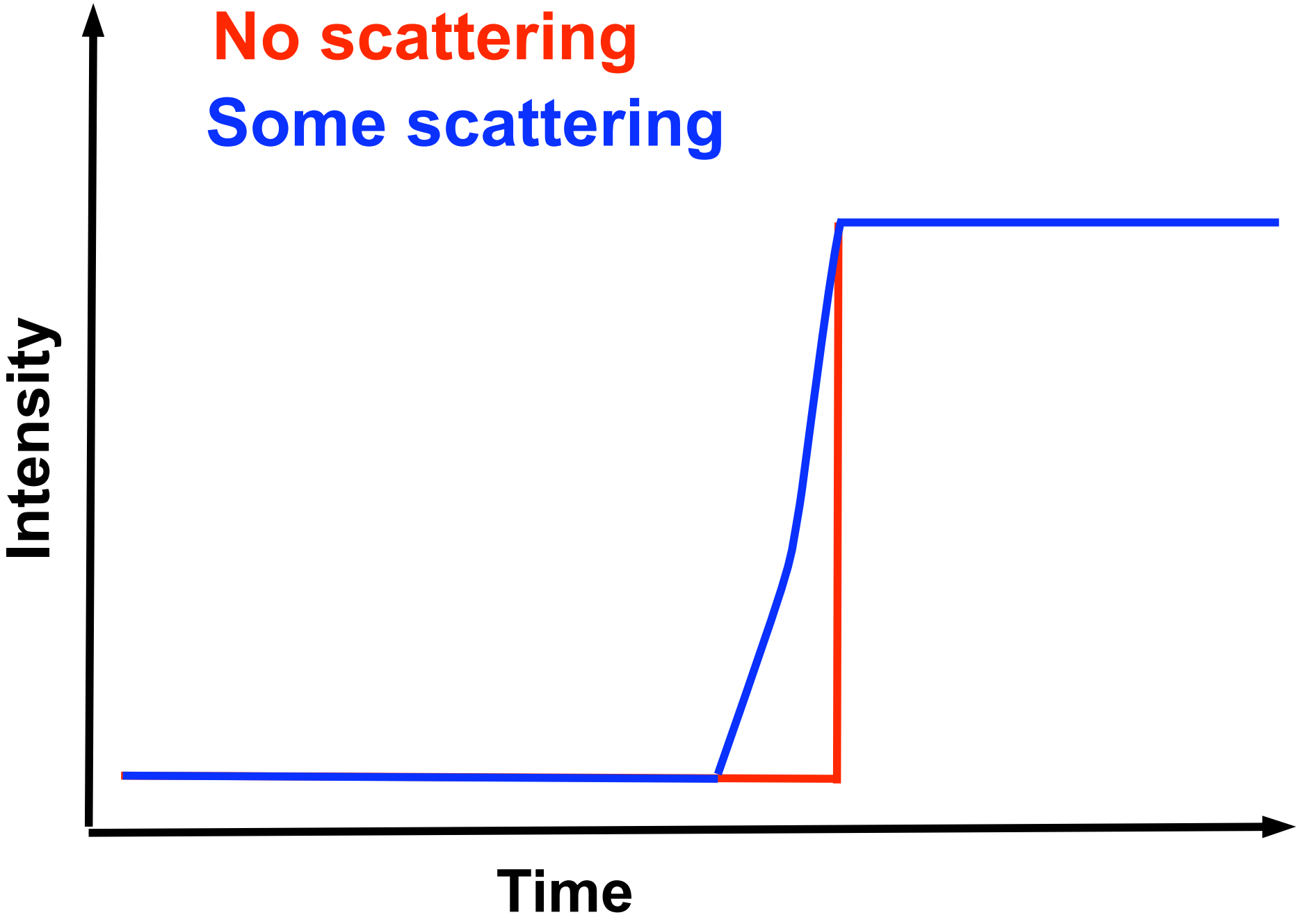
Question: How much can particles spread due to scattering-produced "hopping" from one field line to the next?

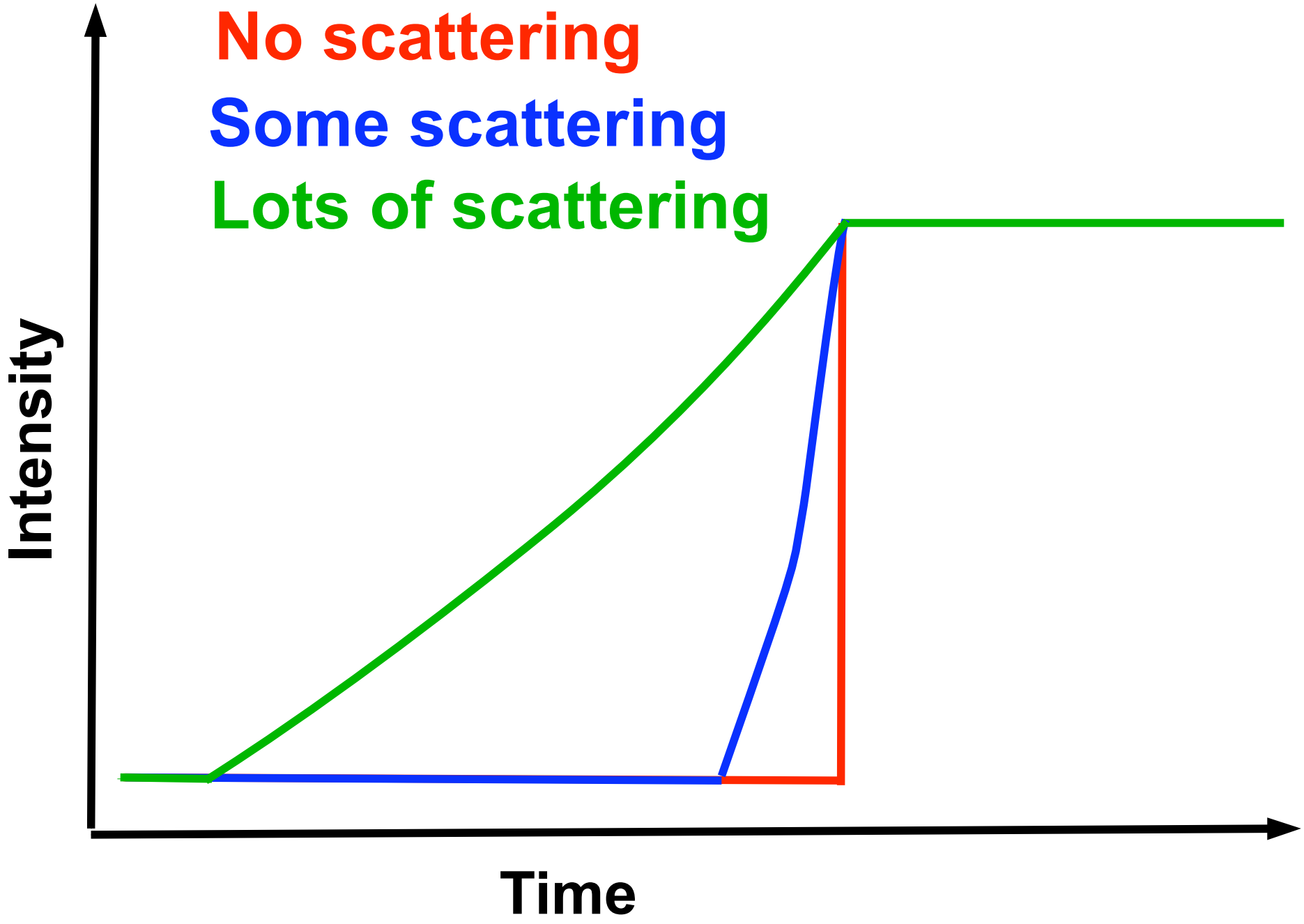


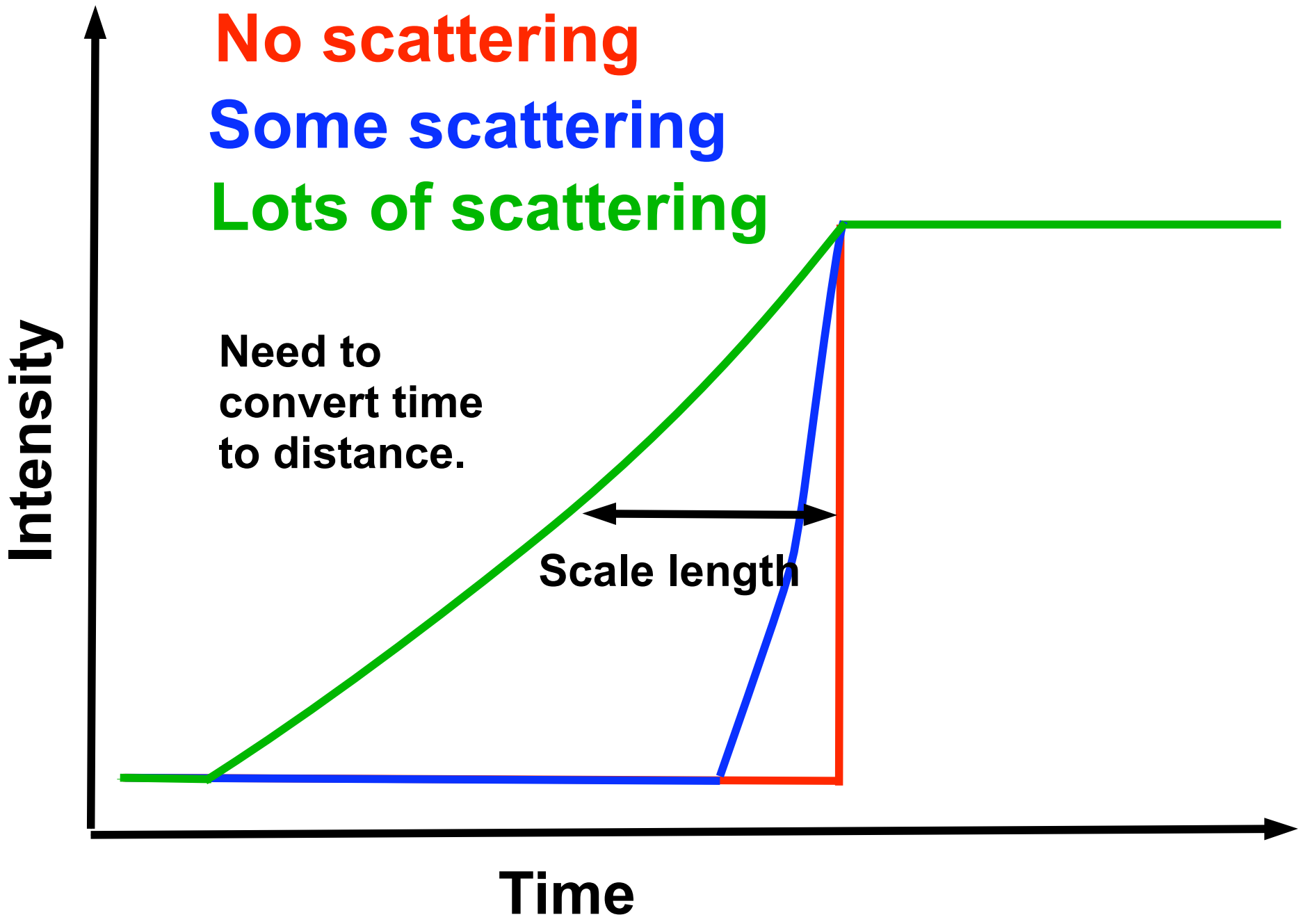

Slope = Travel Distance = 1.4 AU
Particle Injection
1/v (Hour/AU)
0
1
2
3
4
5
6
7
225.5
225.6
225.7
225.8
225.9
226.0
Day of Year 2000

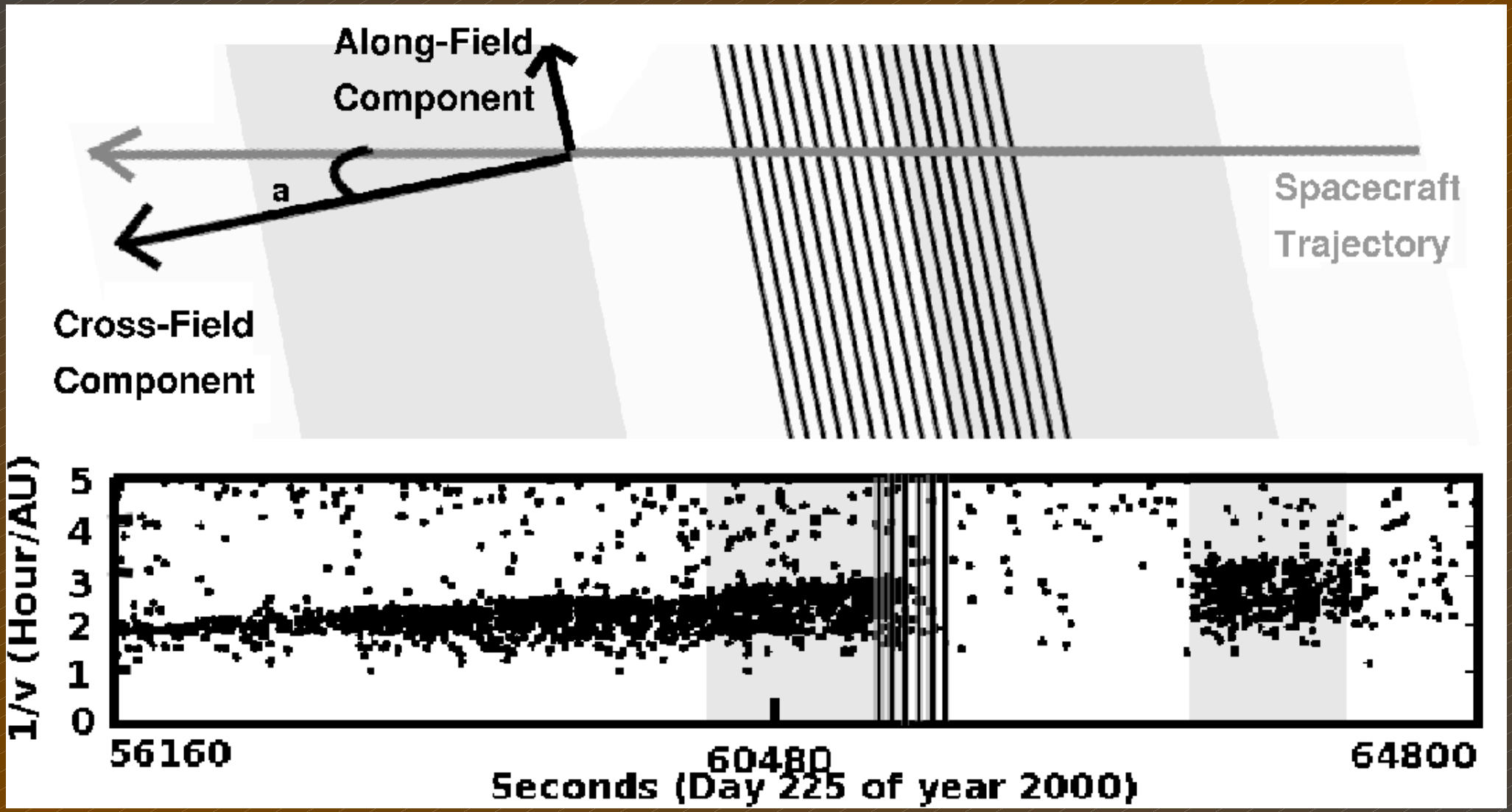

Slope = Travel Distance = 1.4 AU
Field lines connected to particle source
Particle Injection
Field lines not connected to particle source
1/v (Hour/AU)
Day of Year 2000
0
1
2
3
4
5
6
7
225.5
225.6
225.7
225.8
225.9
226.0


No scattering
Intensity
Time

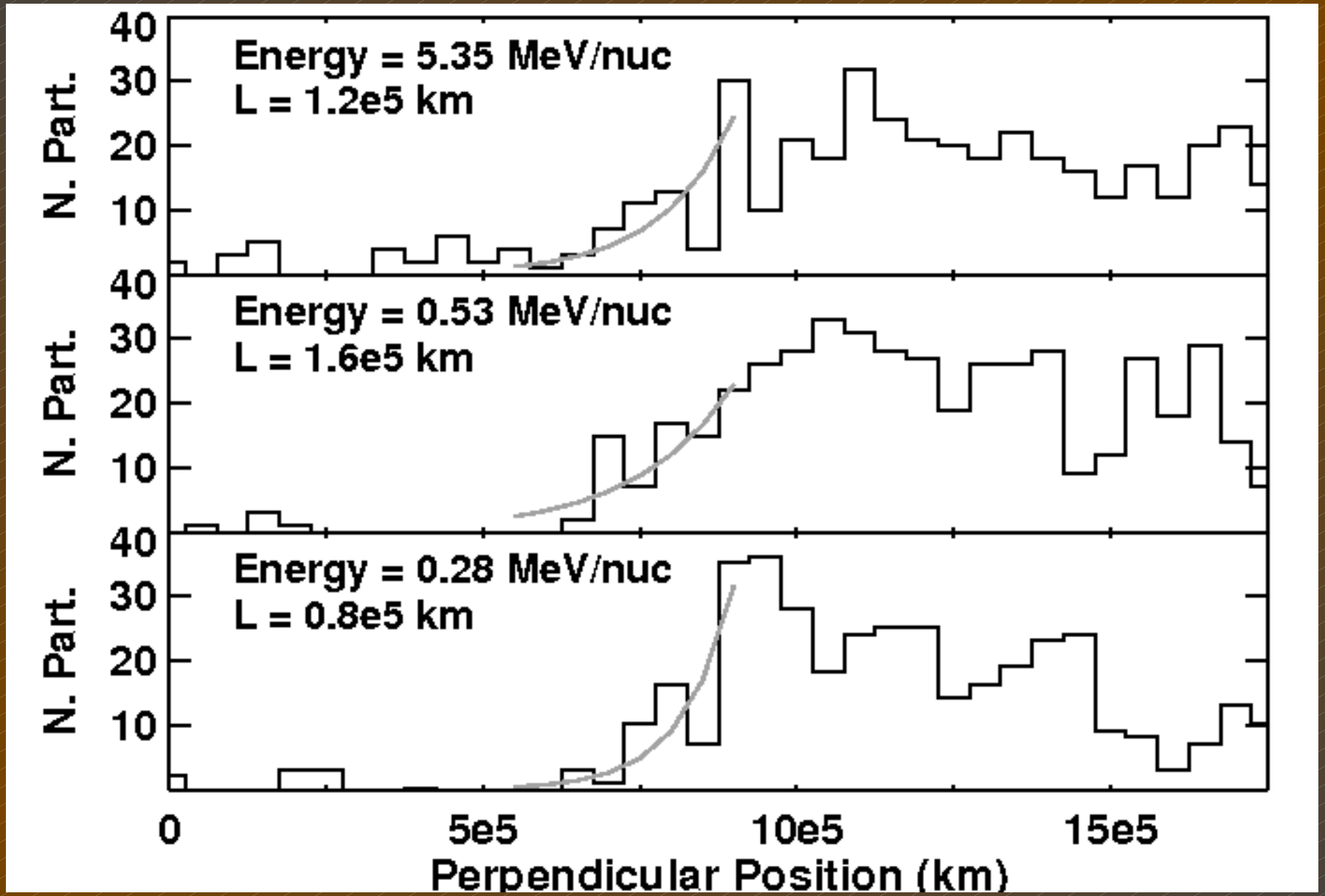

No scattering
Some scattering
Intensity
Time


No scattering
Some scattering
Lots of scattering
Intensity
Time


No scattering
Some scattering
Lots of scattering
Need to convert time to distance.
Scale length
Intensity
Time


Along-Field
Component
a
Spacecraft
Trajectory
Cross-Field
Component
1/v (Hour/AU)
0
1
2
3
4
5
56160
60480
64800
Seconds (Day 225 of year 2000)

Superposition of all events in the undisturbed solar wind



Gyroradius ~ 10^4-10^5 km

What to Take Away

- The edges of intensity dropouts can be used to determine if particles “hop” from one field line to the next.

- In this study, we can only say that the particles appear to be highly confined to field lines inside 1 AU, moving less than a gyroradius onto adjacent field lines.

- Future studies with better statistics (more events, more intense events) will be able to study this process in greater detail.