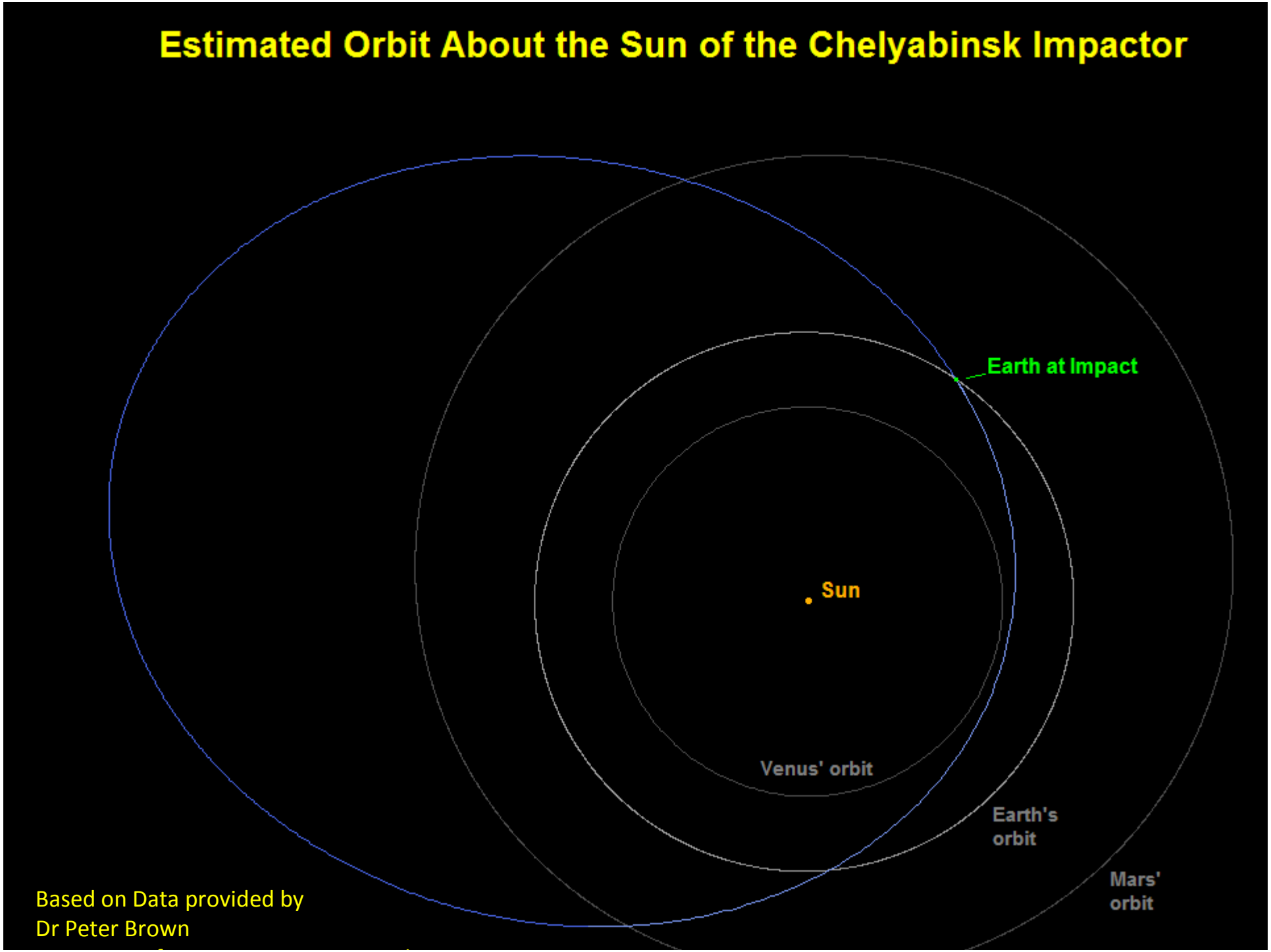
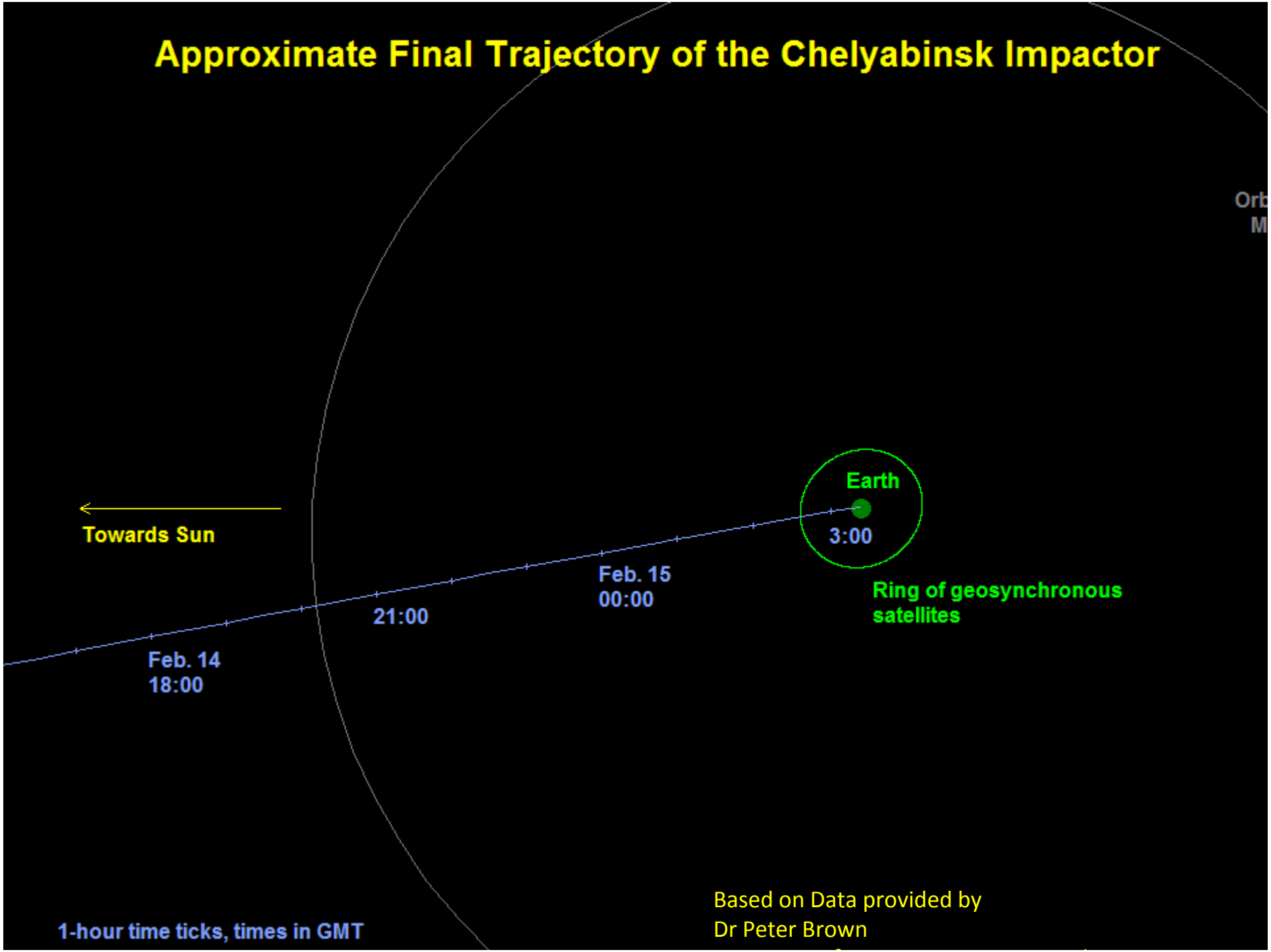
Chelyabinsk Event
15 Feb 2013

INITIAL, PRELIMINARY ANALYSIS

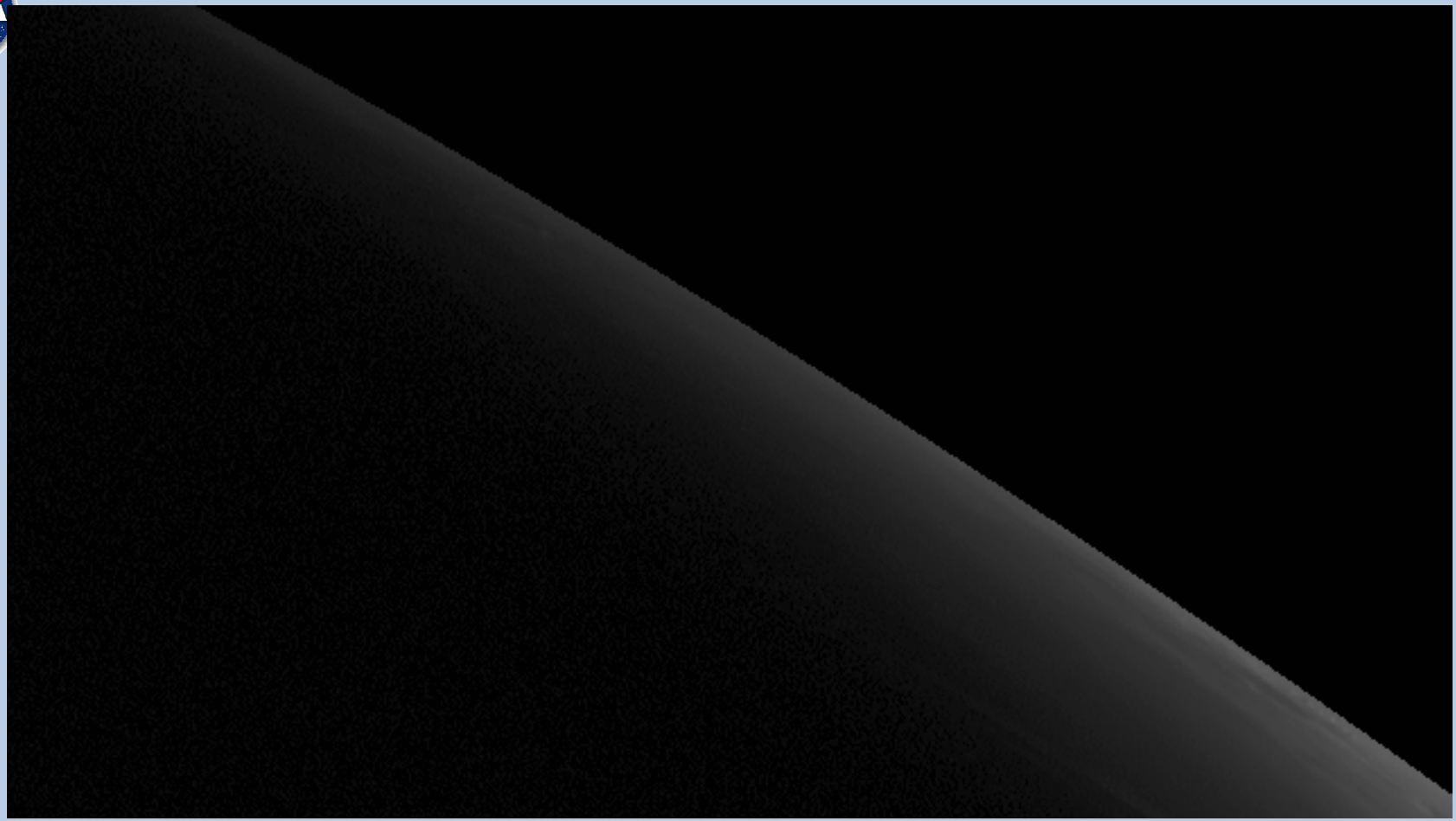
What we know now

- Impact event occurred at 3:20:26 UTC (9:20 AM local time); Trajectory was ~northeast to southwest across Chelyabinsk, Russia (Southern Urals)
  - Observed from Tyumen, Ekaterinaburg, and Northern Kazakhstan
- Size ~17 meters
  - ~ 6400 – 7700 metric tons
  - Energy of this impact released 470 of kilotons equivalent TNT
  - Altitude of explosion at 20 +/- 10 km
  - Velocity of impact 18 km/s (> 40,200 mph)
  - Not related to 2012 DA_{14} flyby [15 Feb 2013; that flyby was South to North]
- Largest reported fireball since Tunguska impact (on 30 Jun 1908)
- Much larger than 2008 TC_3 (which impacted in the Sudan) and ~1/10 the size of 2012 DA_{14}
- Reports that a few fragments have been recovered ~80 km west of Chelyabinsk (near a village called Satka)
- Blast wave damaged 4000+ structures (shallow graze ~15° entry; airburst and subsequent shockwaves from explosion)
- Report of 1200+ injured (no deaths), largely due to broken glass

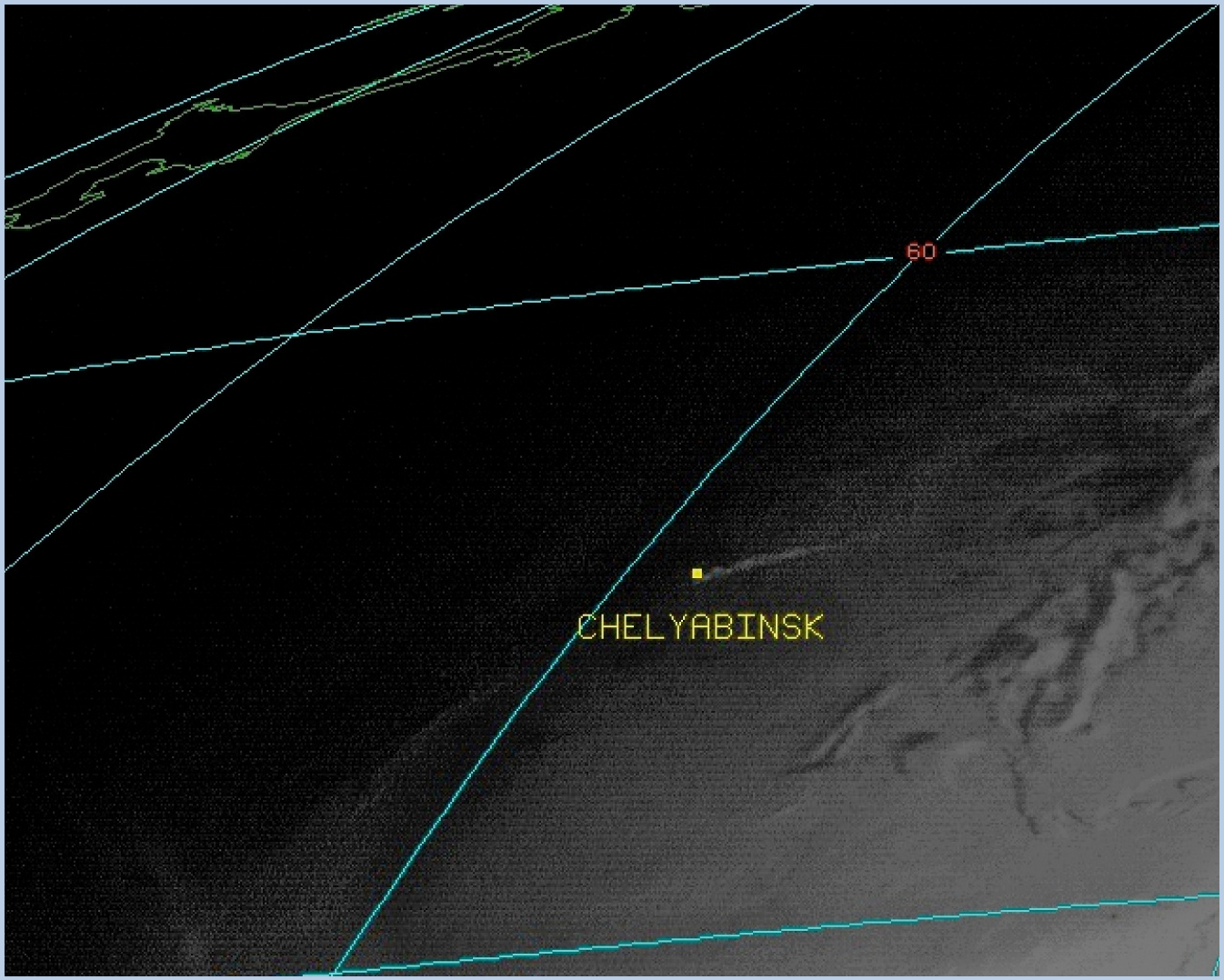

Estimated Orbit About the Sun of the Chelyabinsk Impactor
Earth at Impact
Sun
Venus' orbit
Earth's orbit
Mars' orbit
Based on Data provided by
Dr Peter Brown


Approximate Final Trajectory of the Chelyabinsk Impactor
Towards Sun
Earth
3:00
Feb. 15
00:00
21:00
Feb. 14
18:00
Ring of geosynchronous satellites
1-hour time ticks, times in GMT
Based on Data provided by
Dr Peter Brown


Russia
0
800 km
0
800 mi
0°
30°
90°E
150°
180°
Svalbard (Norway)
Arctic Ocean
Barents Sea
East Siberian Sea
Laptev Sea
Kara Sea
Novaya Zemlya
Baltic Sea
Black Sea
Caspian Sea
Aral Sea
Sea of Okhotsk
Yellow Sea
Persian Gulf
Lake Baikal
Arctic Circle
Lena
Volga
Ob
Yenisey
Amur
Pechora
Kama
Aldan
Vilyuy
Kolyma
Irtysh
U.K.
Dublin
London
Amsterdam
Neth.
Den.
Norway
Oslo
Sweden
Stockholm
Copenhagen
Finland
Helsinki
Tallinn
Estonia
Riga
Latvia
Lithuania
Vilnius
Russia
Poland
Warsaw
Prague
Vienna
Slovakia
Bratislava
Minsk
Belarus
Ukraine
Kiev
Romania
Moldova
Chişinău
Turkey
Ankara
Georgia
T'bilisi
Armenia
Yerevan
Azerb.
Azerbaijan
Baku
Iraq
Tehran
Iran
Kuwait
Turkmenistan
Ashgabat
Uzbekistan
Tashkent
Kazakhstan
Astana
Almaty
Bishkek
Kyrgyzstan
Dushanbe
Tajikistan
Afghanistan
Kabul
Pakistan
Mongolia
Ulaanbaatar
China
Beijing
N.Korea
Pyongyang
Seoul
S.Korea
U.S.
Murmansk
Belomorsk
St. Petersburg
Arkhangel'sk
Novgorod
Konosha
Vologda
Smolensk
Tver'
Moscow
Kotlas
Bryansk
Orel
Ryazan'
Nizhniy Novgorod
Voronezh
Kazan'
Perm'
Penza
Samara
Saratov
Rostov na Donu
Volgograd
Novorossiysk
Armavir
Astrakhan'
Ufa
Chelyabinsk
Orenburg
Orsk
Yekaterinburg
Tyumen'
Kurgan
Omsk
Novosibirsk
Tomsk
Krasnoyarsk
Novokuznetsk
Barnaul
Abakan
Kyzyl
Tayshet
Irkutsk
Ulan Ude
Bratsk
Ust' Ilimsk
Ust' Kut
Lesosibirsk
Chita
Borzya
Naryan Mar
Pechora
Vorkuta
Salekhard
Nadym
Tazovskiy
Urengoy
Igarka
Noril'sk
Dickson
Tiksi
Nizhnevartovsk
Tobol'sk
Lensk
Vilyuysk
Yakutsk
Aldan
Berkakit
Tynda
Komsomol'sk
Urgal
Khabarovsk
Blagoveshchensk
Izvestkovyy
Vladivostok
Sovetsk
Sakhalin
Okha
Okhotsk
Magadan
Evensk
Cherskiy
Pevek
Anadyr'
Provideniya
Approximate
direction of travel



This animated GIF image shows the meteor that entered the atmosphere above Chelyabinsk, Russia the morning of February 15, 2013 around 9:20 am local time, 0320Z. The GIF consists of 8 separate images starting at 0300Z and proceeding in 15 minute increments until 0445Z, at which time the vapor trail blends into the reflected light of the morning sun. The images show the horizon taken at the farthest extent of the EUMETSAT METEOSAT-10 satellite's high resolution visible channel, near latitude 55 north, longitude 61 west. Courtesy European Organisation for the Exploitation of Meteorological Satellites, and NOAA



A Meteor entered the Earth's atmosphere over the Ural Mountains of western Russia today at approximately 0320 UTC (09:20 AM local time). The visible image from just after sunrise, above, from the Chinese FY-2D satellite shows an east-west plume, likely from the meteor, near Chelyabinsk.


2013/02/15 092030