Near-Earth Objects: Current Threat Level

Airbursts

Secure World Foundation
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Outline

1) Low-altitude airburst modeling
2) Probabilistic risk assessment
3) Airburst-generated tsunami
4) Chelyabinsk airburst

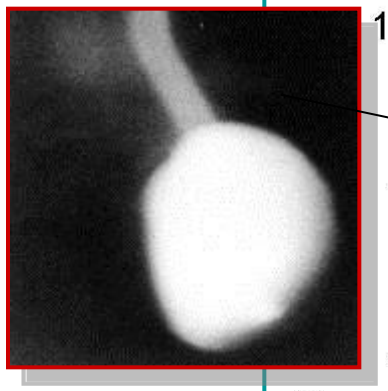

1. Low-Altitude Airbursts

Low-Altitude Airbursts (LAAs)

- The relative threat from LAAs is increasing
- Our understanding of LAAs is improving
- The next destructive NEO will be an LAA
- ~100 m, ~100 Mt, has ~1/100 chance this century*
- 100 Mt will dominate threat after current survey
- Tech development similar to threat reduction time
- Mitigation should focus on small (~100m) NEOs

**"100/100/100 event"*

Nature of the Threat is Changing



Impact Energy (megatons)

10^{-1} 10^{2} 10^{5} 10^{8}

10^{10} 10^{8} 10^{6} 10^{4} 10^{2} 10^{0}

$N(<H)$

NEAs, This report
Stuart 2001
Harris 2002
Brown et al. 2002, annual bolide event
Constant power law from 2003 SDT report
Discovered to 10/31/06

DoD satellite

Tunguska

Desert glass?

Low-altitude airbursts dominate residual hazard

100/100/100 event

K-T Impactor

Great dying?

After Harris, 2008

Absolute Magnitude, *H*

31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9

0.01 0.1 1 10

Diameter (km)

10^{0} 10^{2} 10^{4} 10^{6} 10^{8}

Impact Interval, years

Two types of Low-Altitude Airburst

Tunguska tree-fall

Libyan Desert Glass

Type 1: Tunguska

Scorches and blows down trees

Type 2: Libyan Desert

Vaporizes trees and melts rocks

Type 1 LAA: “Tunguska-Type”

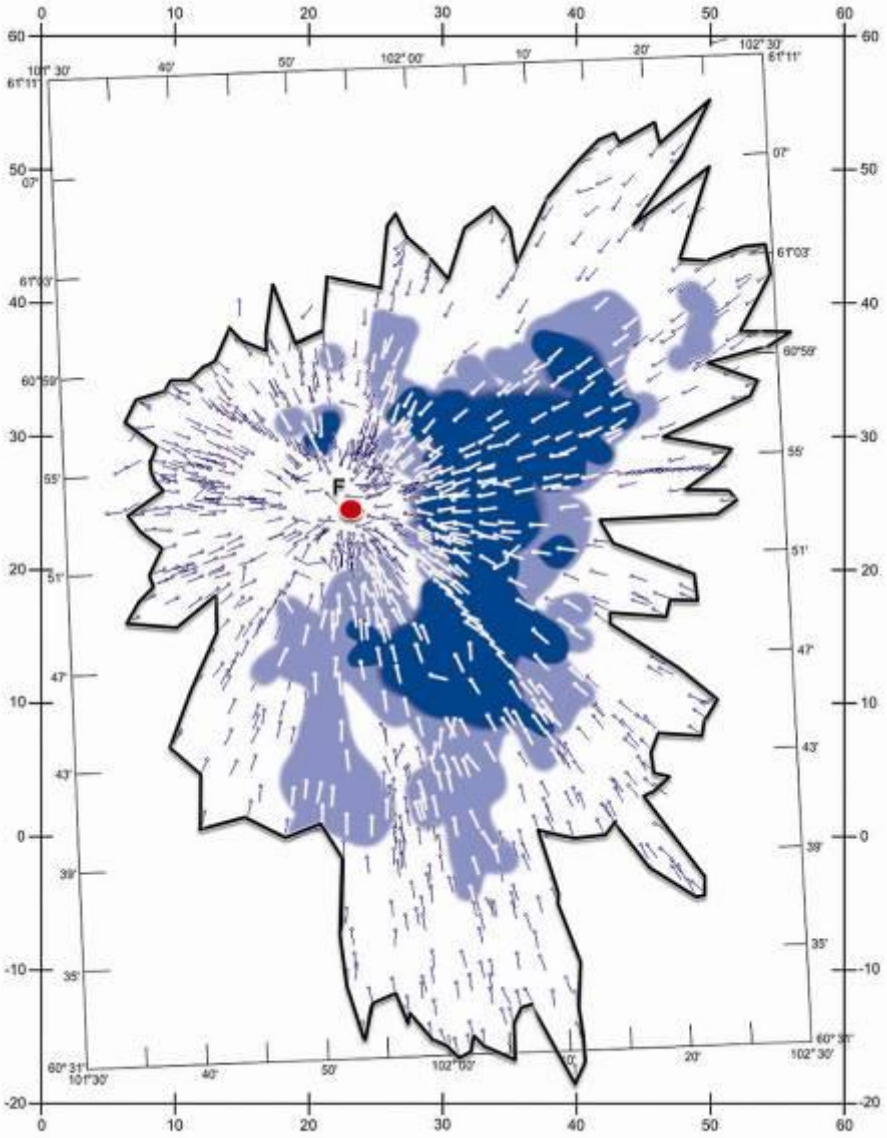
Consequences of Type 1 airburst

Krinov, 1963

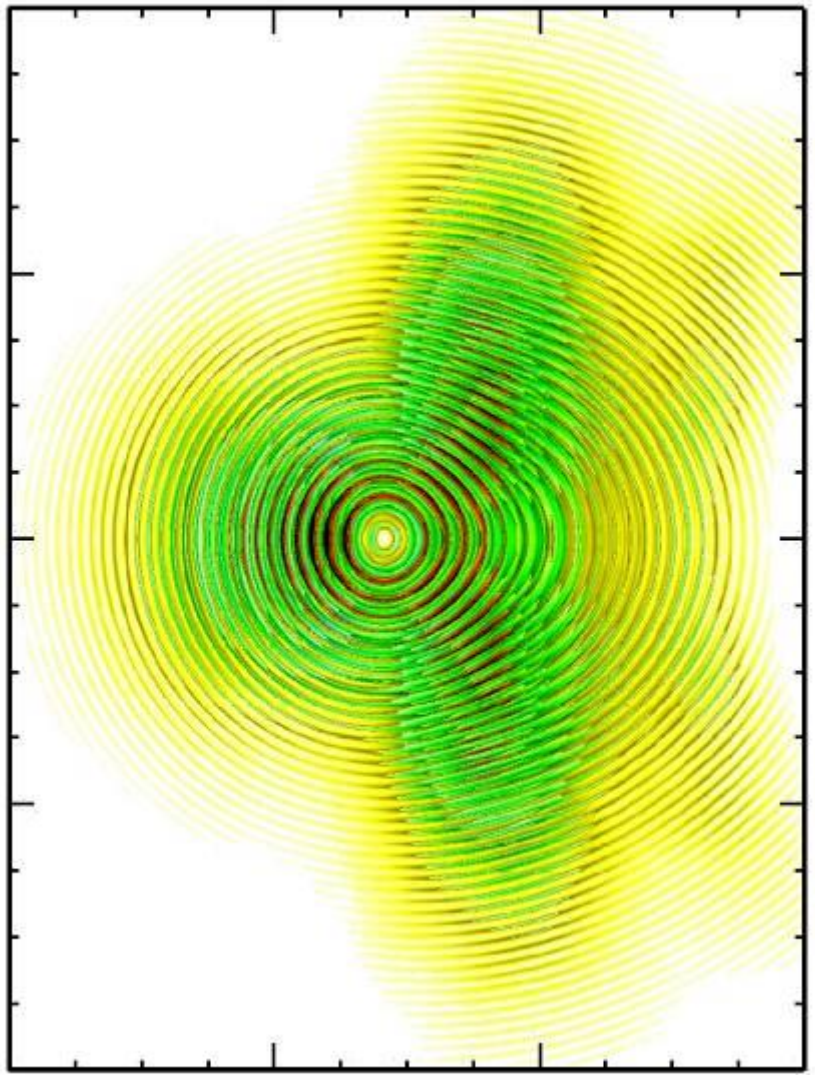
Fig. 485 — The siberian forest devastated by the blast from the meteorite of 30 june 1908.

Type 1 airburst simulation: 5 megaton

5 Mt explosion at 12 km above surface, 35° entry angle



Tunguska treefall map (Longo et al, 2005)



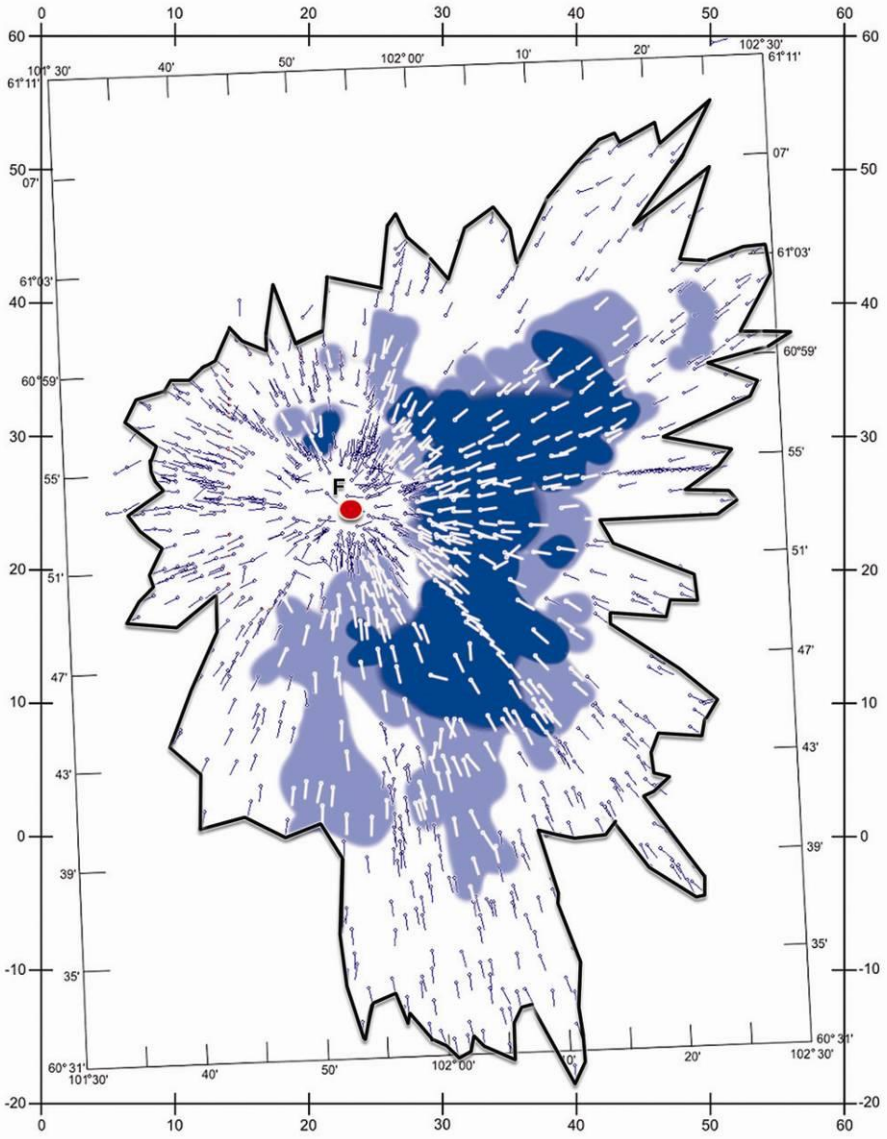
Wind speed map (this study)

Type 2 LAA: “Libyan-Desert-Type”

Consequences of Type 2 airburst

Type 2 airburst simulation: 15 megaton

15 Mt explosion at 18 km above surface, 35° entry angle



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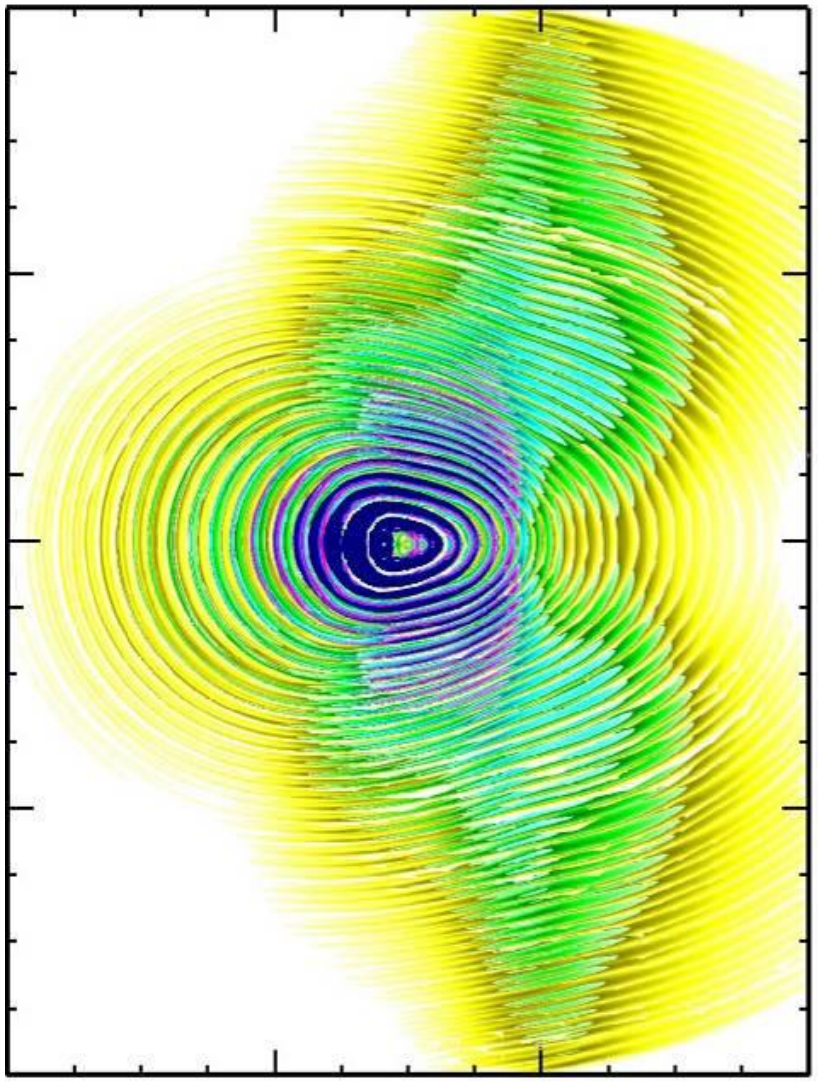
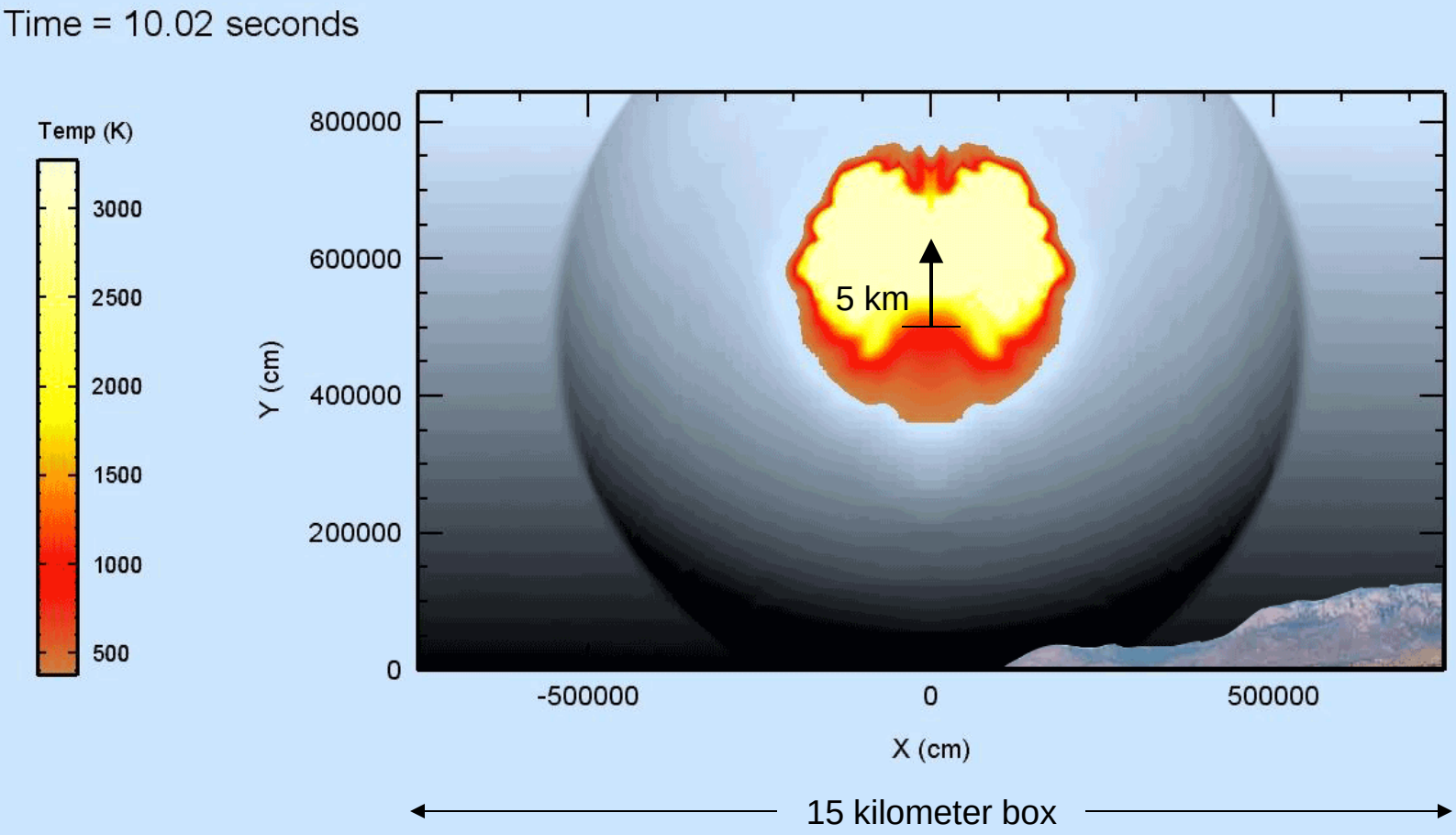


Wind speed map (this study)

Movies: Difference between explosion and impact

5 megaton point explosion at 5 km altitude: first 20 seconds



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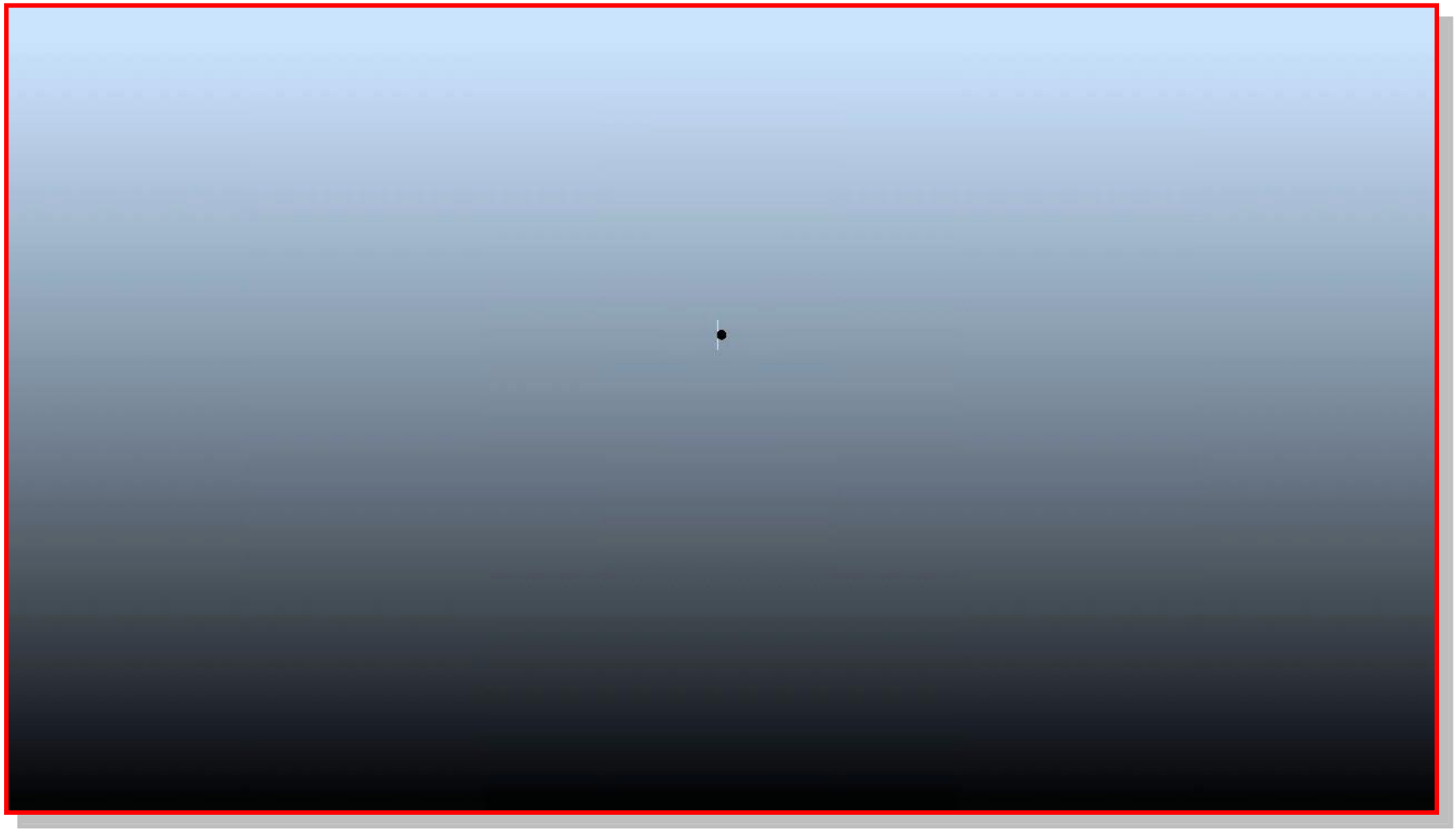
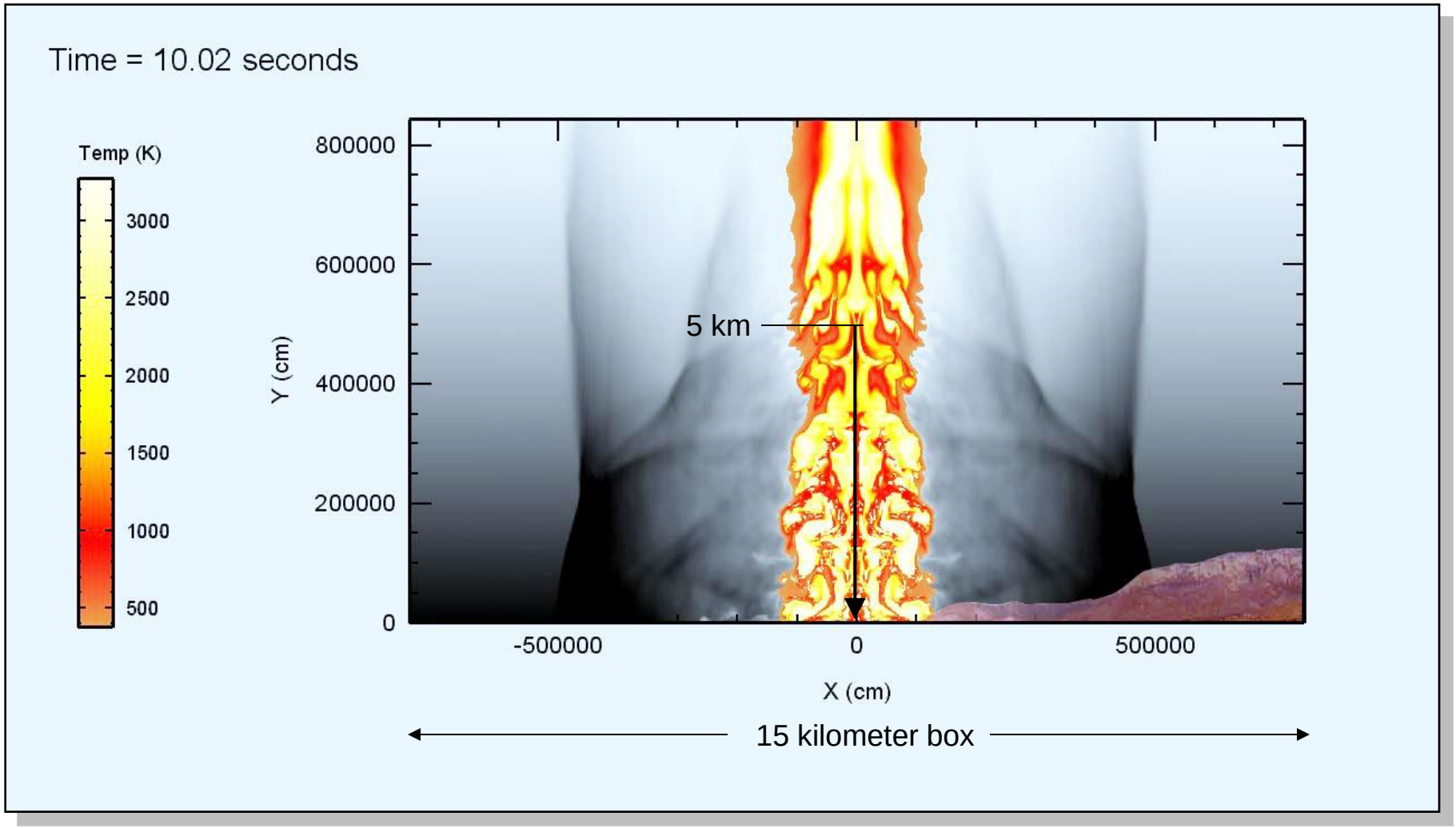


Box dimensions: 8.4 x 15 km

Movies: Difference between explosion and impact

5 megaton impact airburst at 5 km altitude: first 20 seconds



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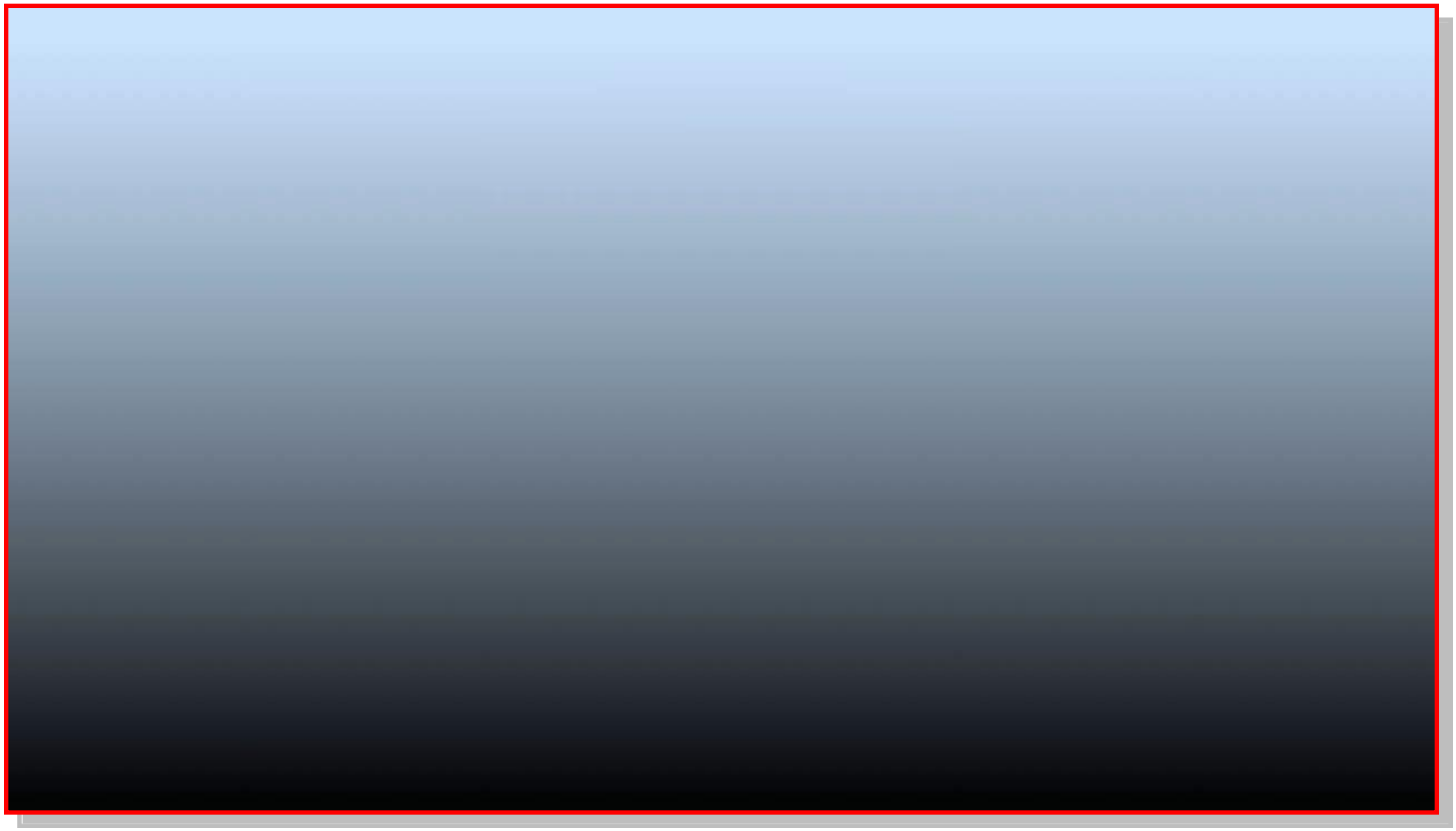

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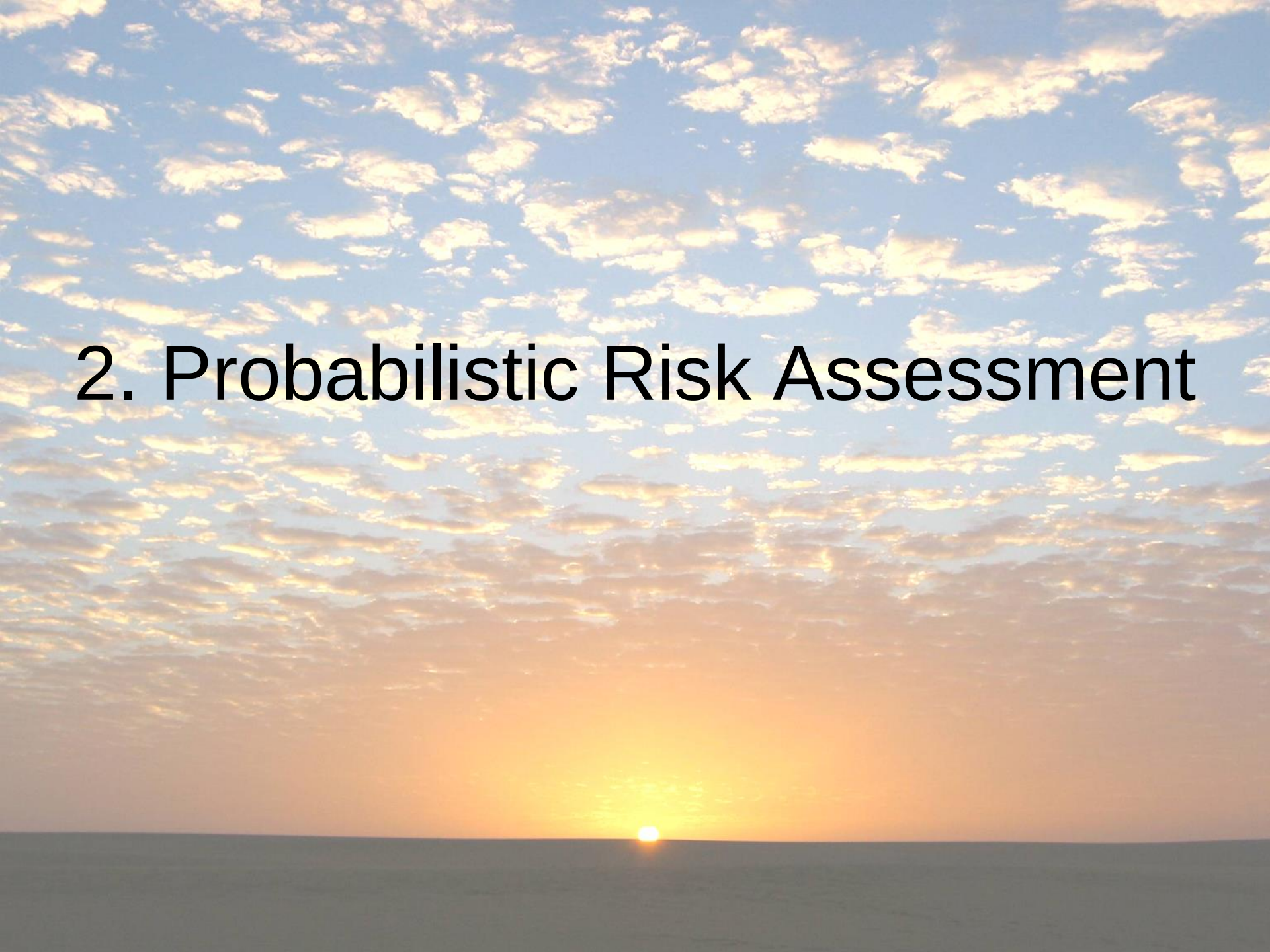
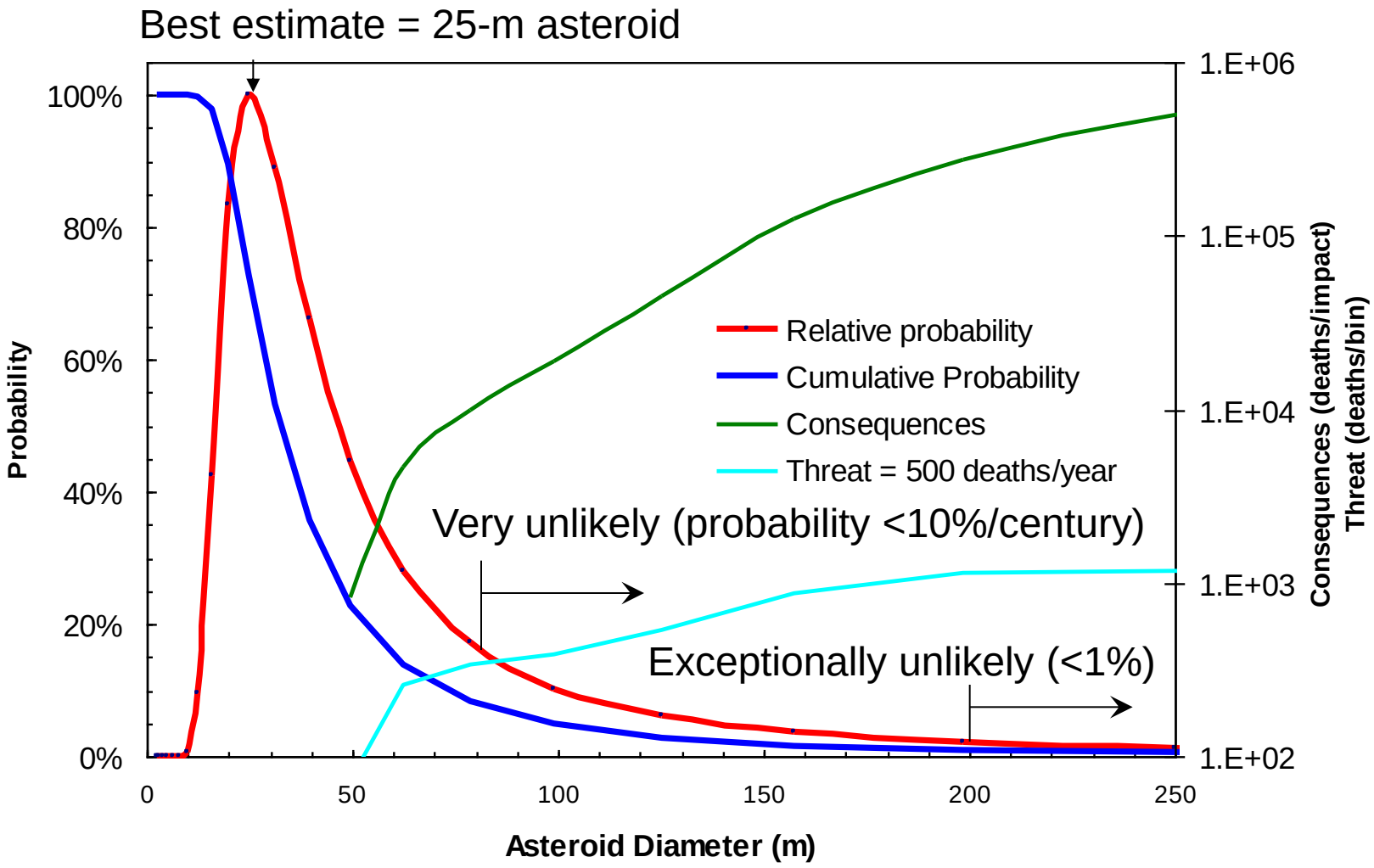
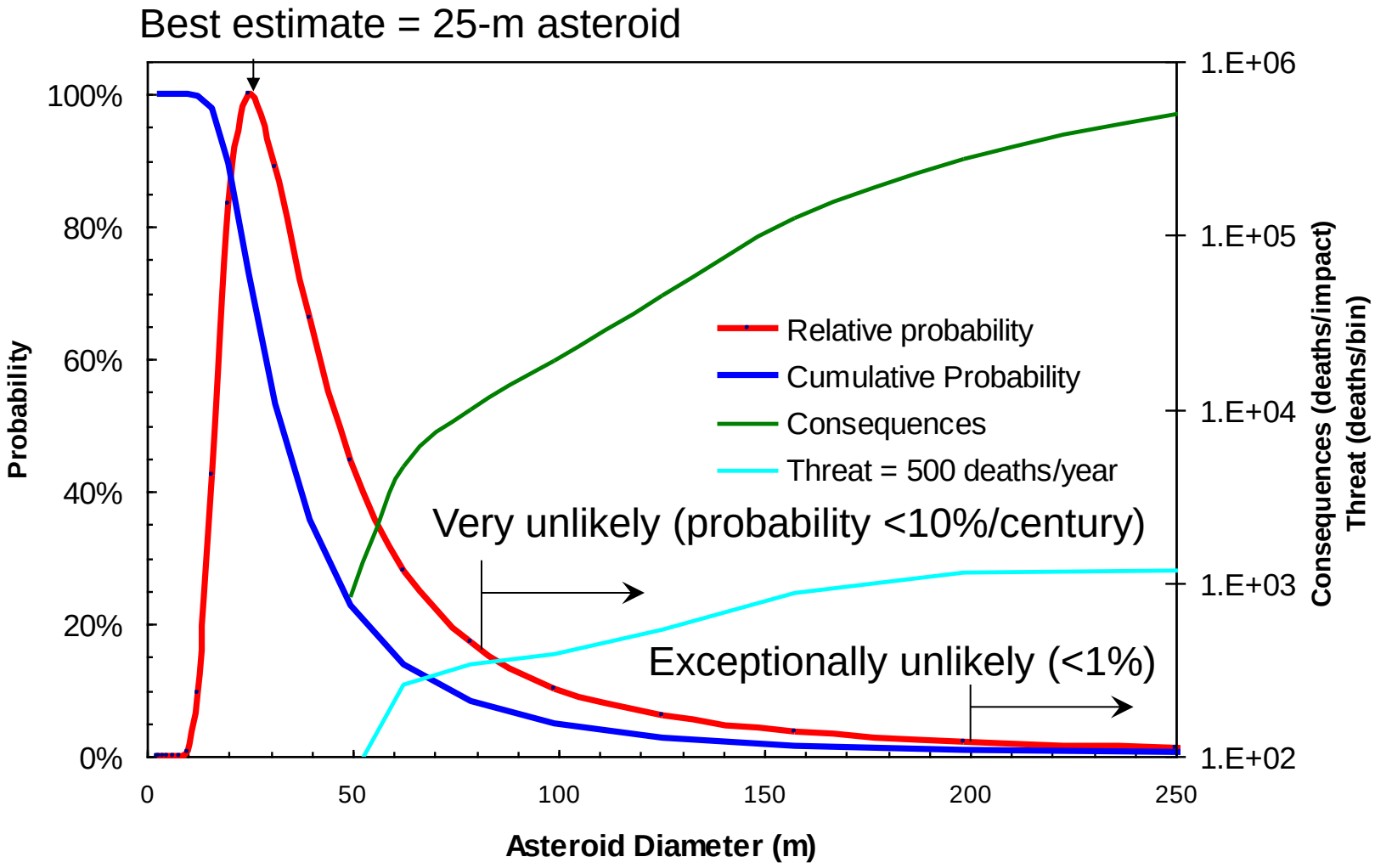


2. Probabilistic Risk Assessment

Size distribution plot can be transformed to PDF (probability density function for 100-year largest)

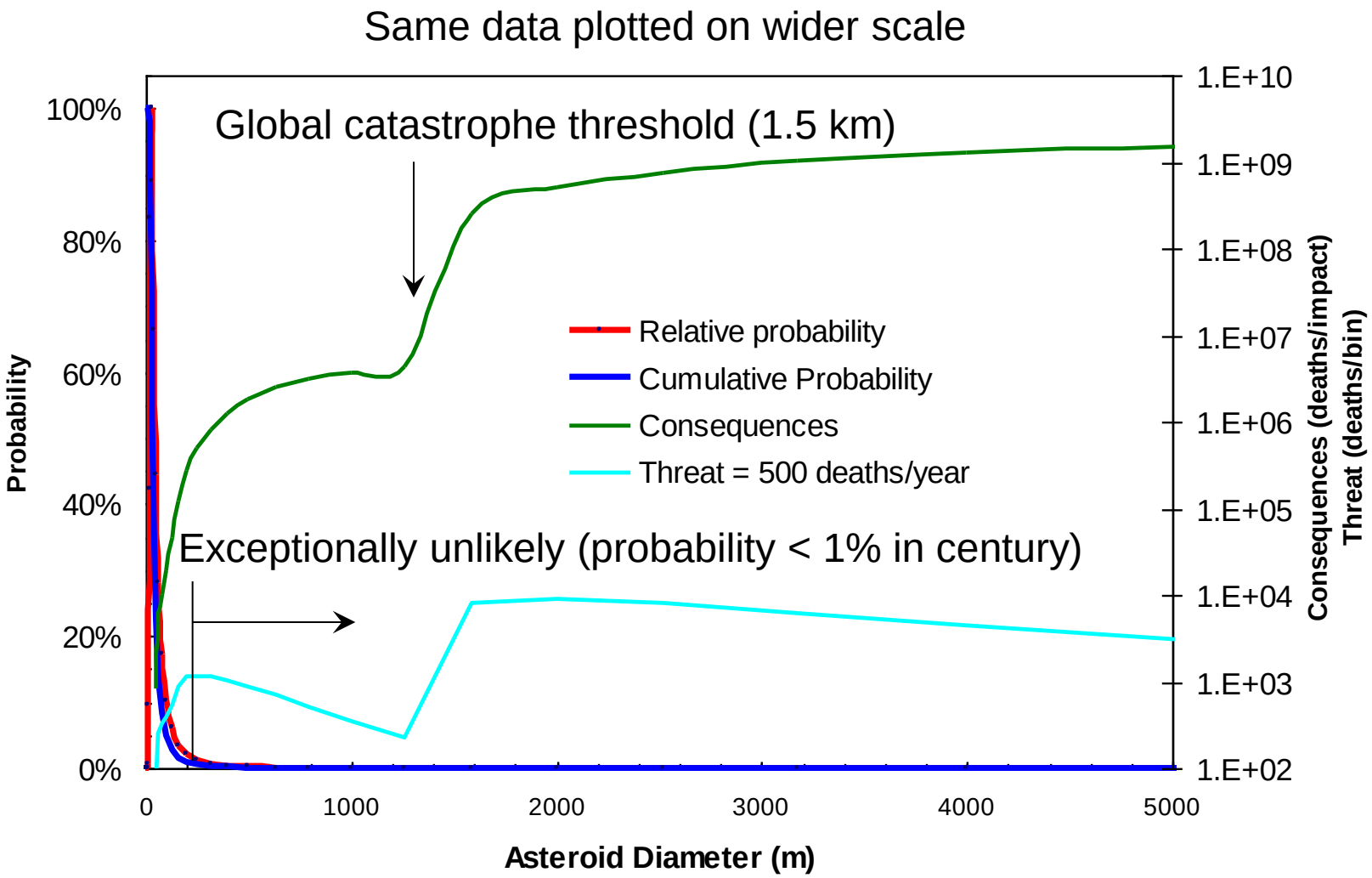


- What is the probability that the biggest impact in the next 100 years will be from an asteroid of a given size?
- How many people will die from that biggest impact?
- What is total expected number of deaths per year from asteroids?



Original asteroid threat = 500 deaths/year

Revised asteroid threat = 80 deaths/year

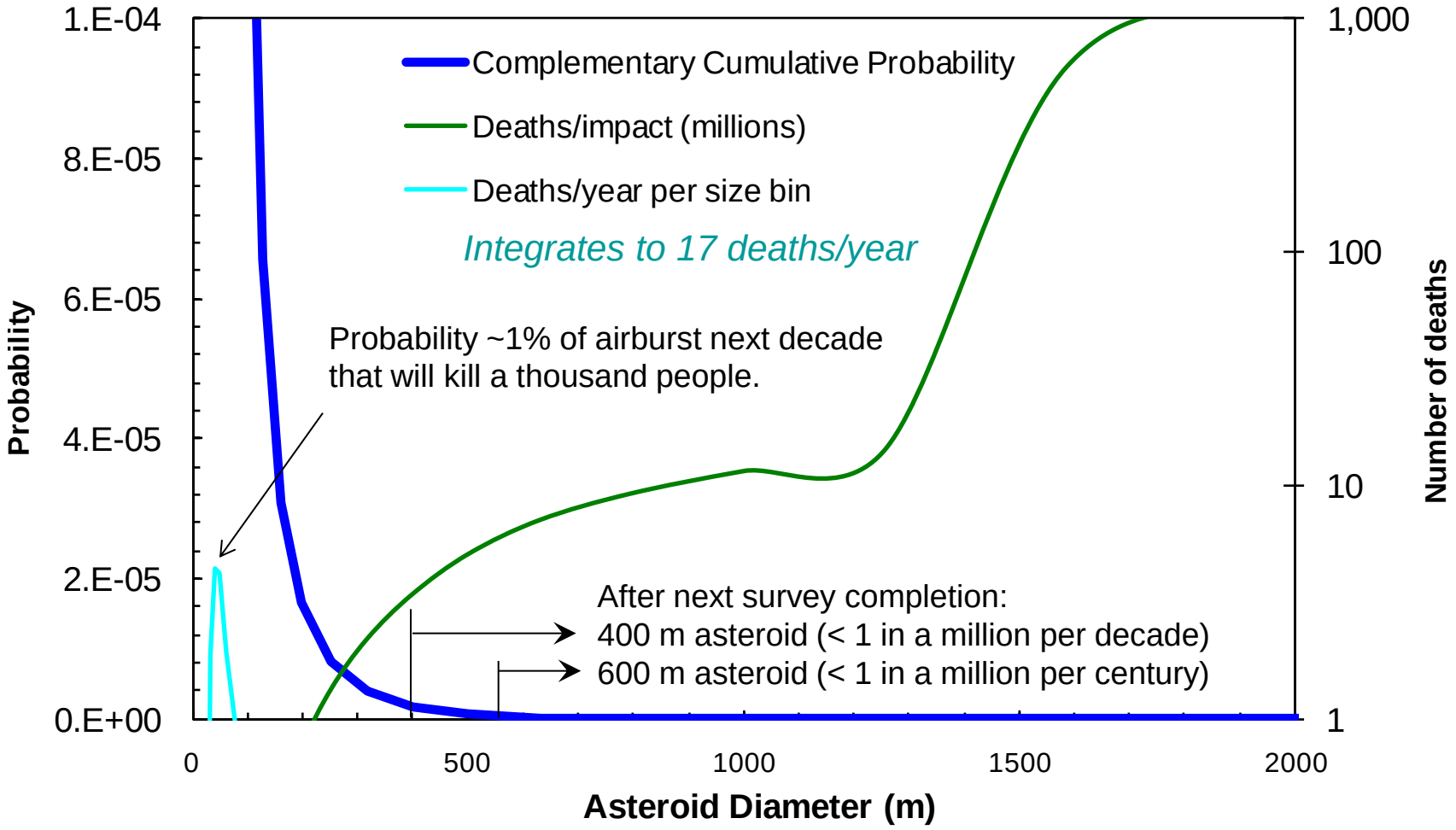


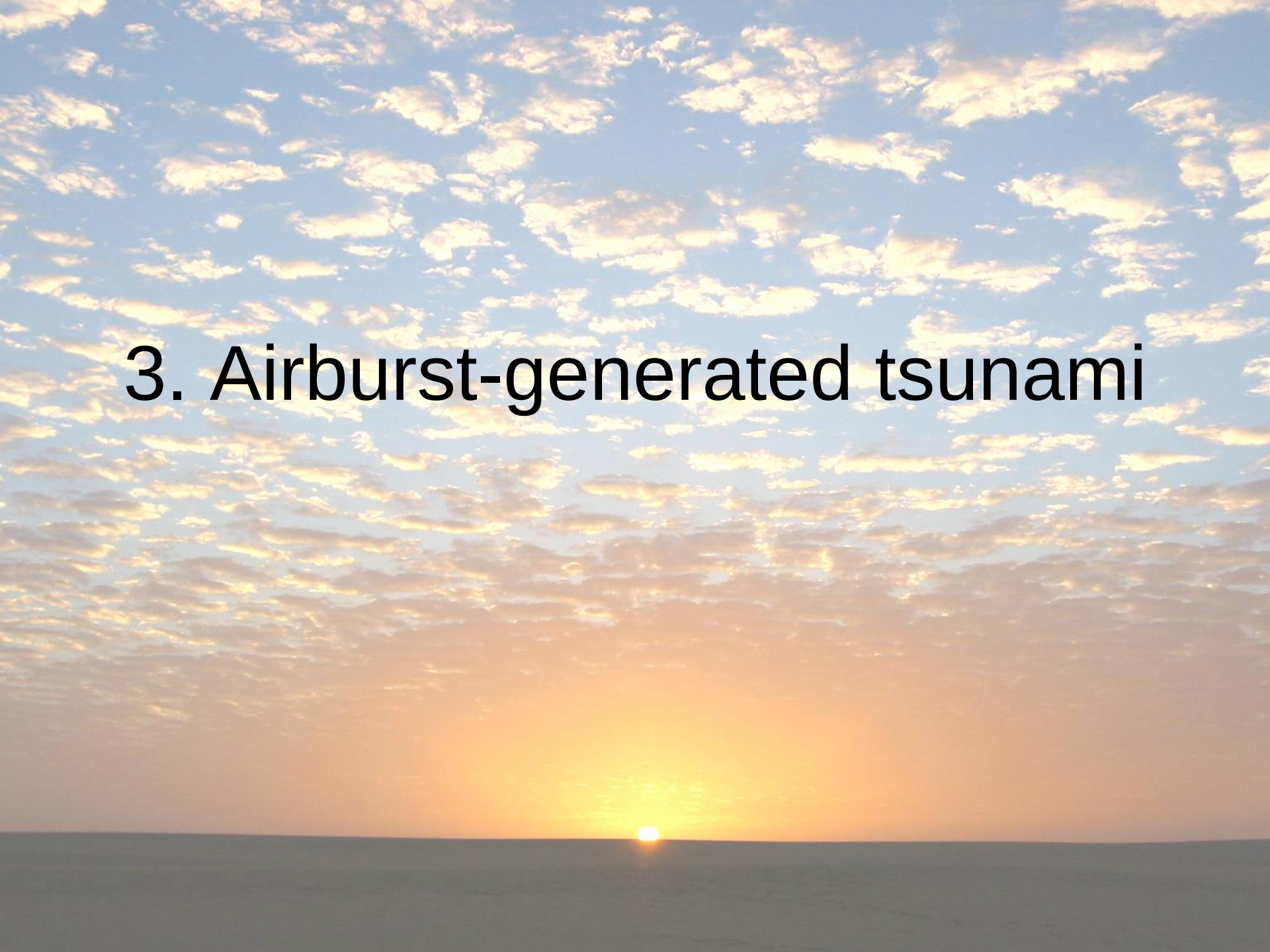
Directed-source airbursts: probability per decade

Original assessed threat = 1409 deaths/year (3% increase)

Current assessed threat = 152 deaths/year (21% increase)

Future (after next survey) threat = 17 deaths/year (240% increase)

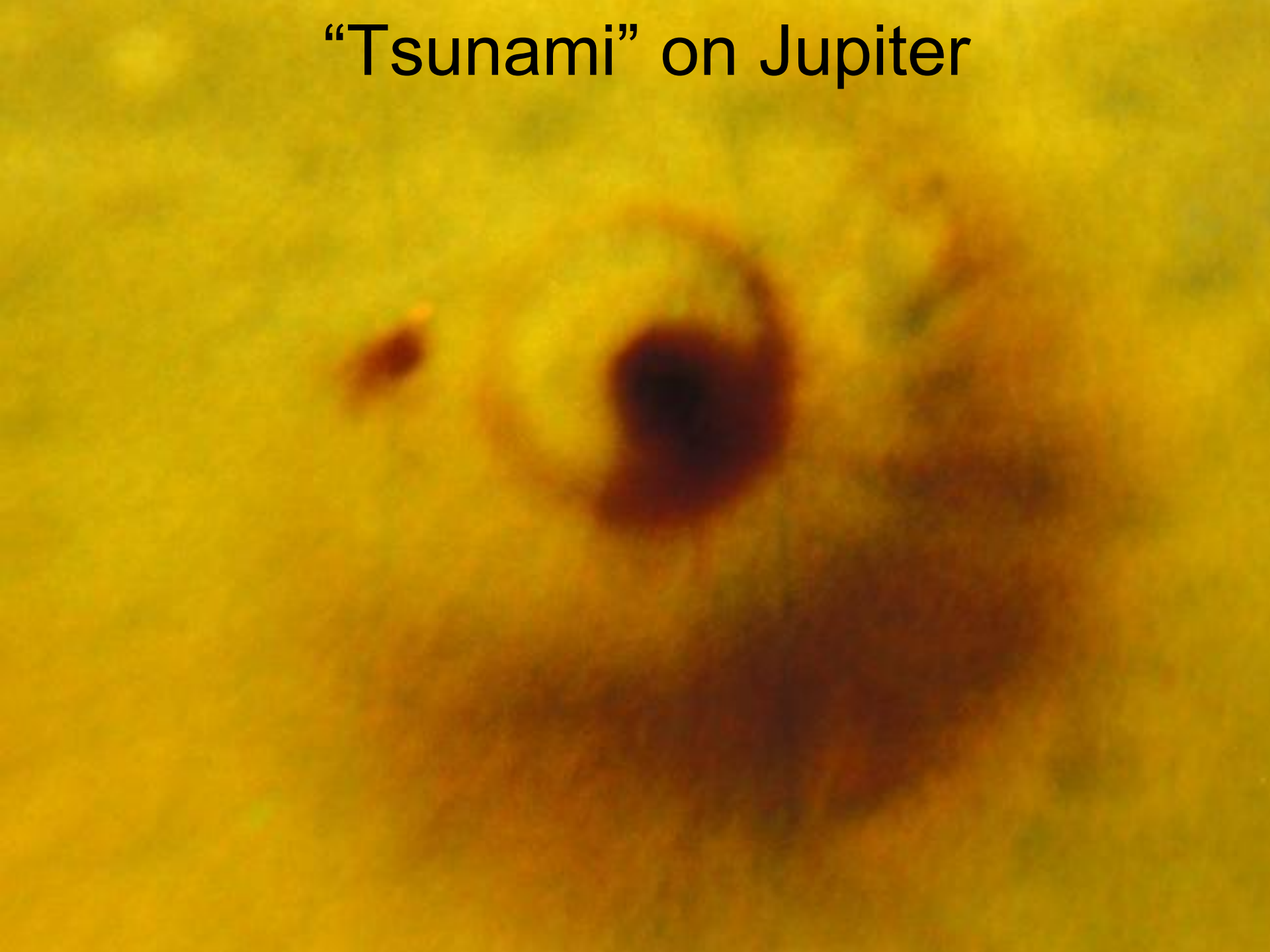



3. Airburst-generated tsunami

First direct observation of atmospheric collision: Shoemaker-Levy 9 comet crash: Jupiter, 1994

"Point source" explosion is not a good airburst approximation

“Tsunami” on Jupiter



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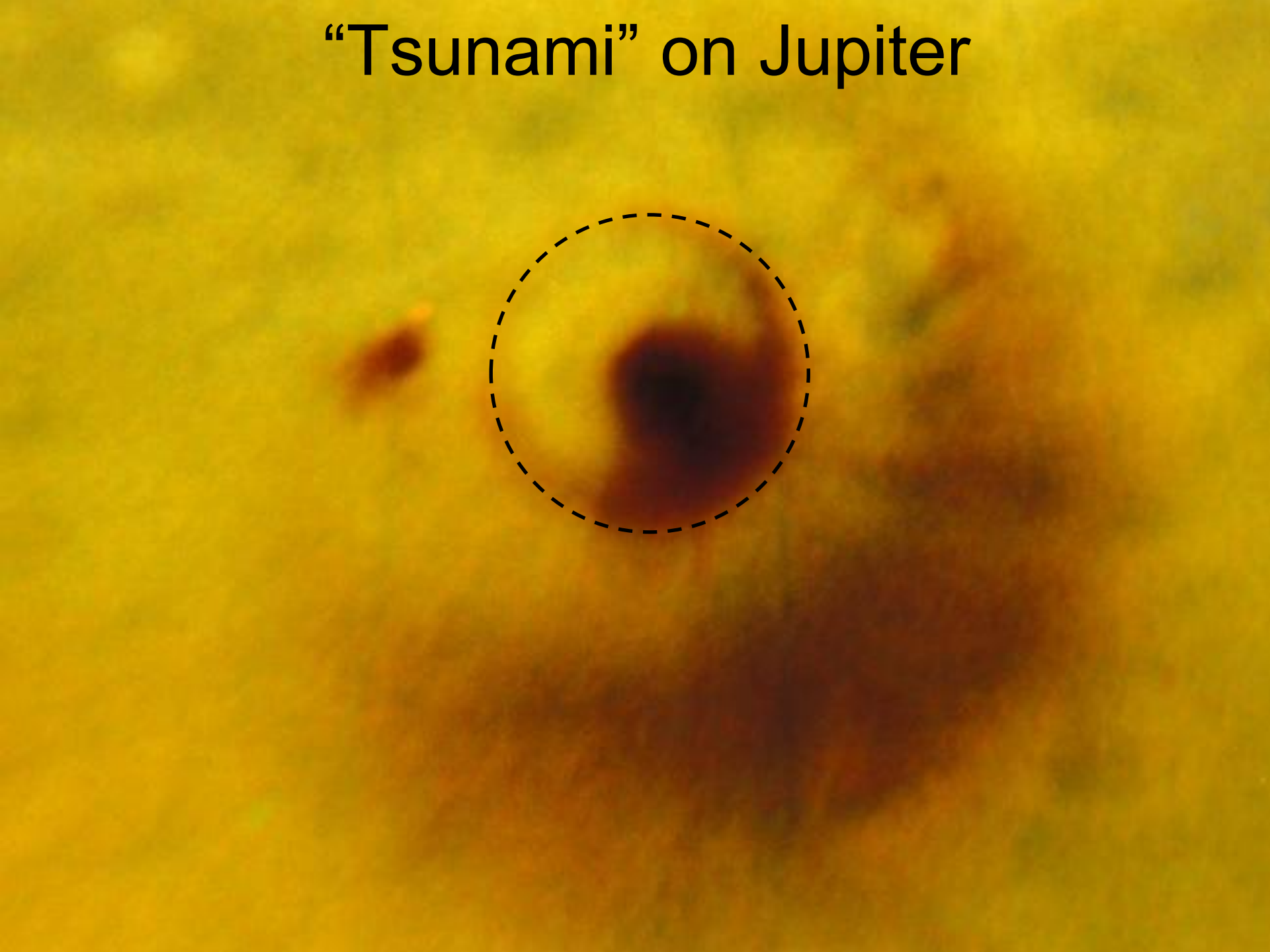

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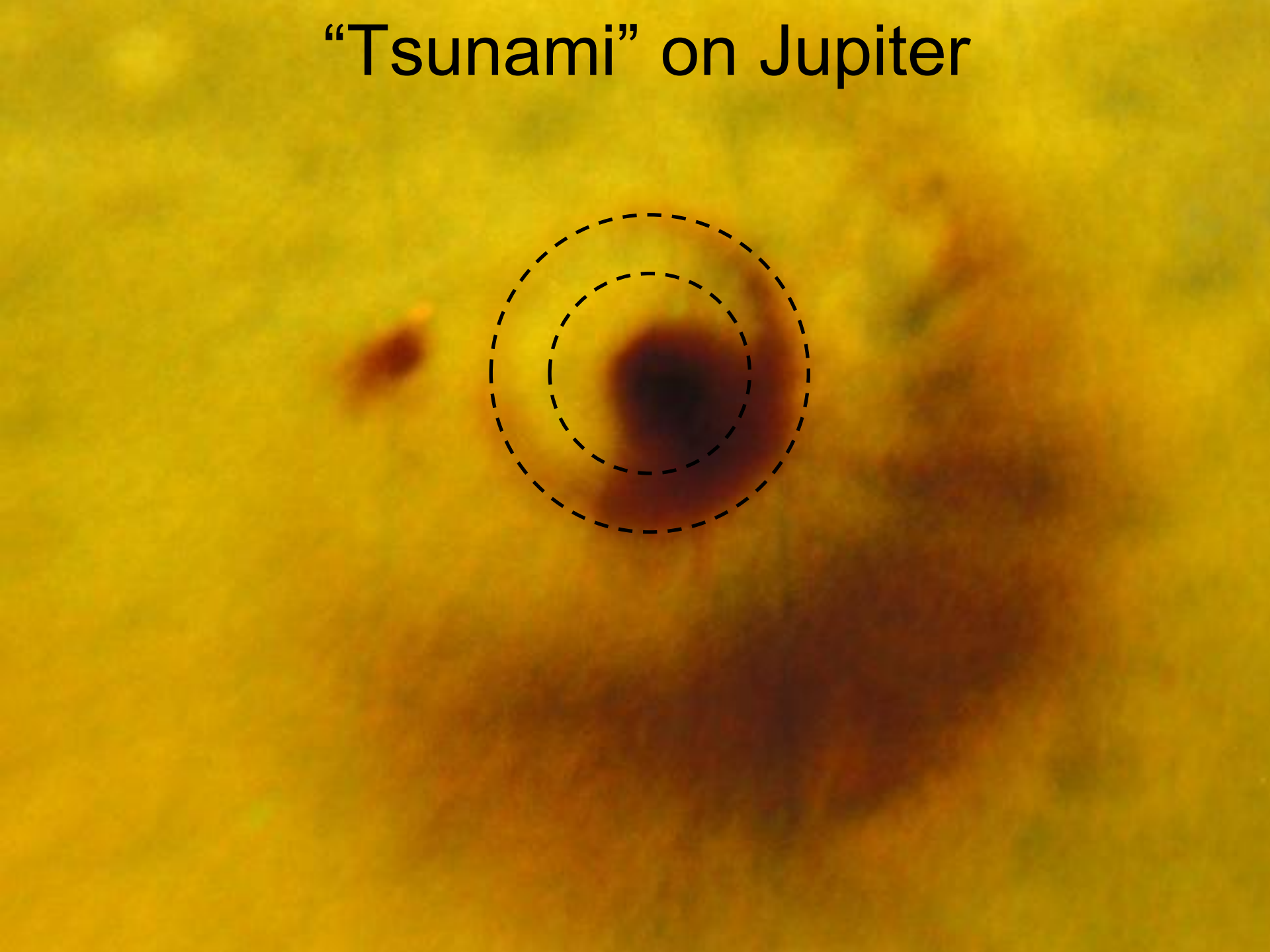


Rissaga a Ciutadella (2006)

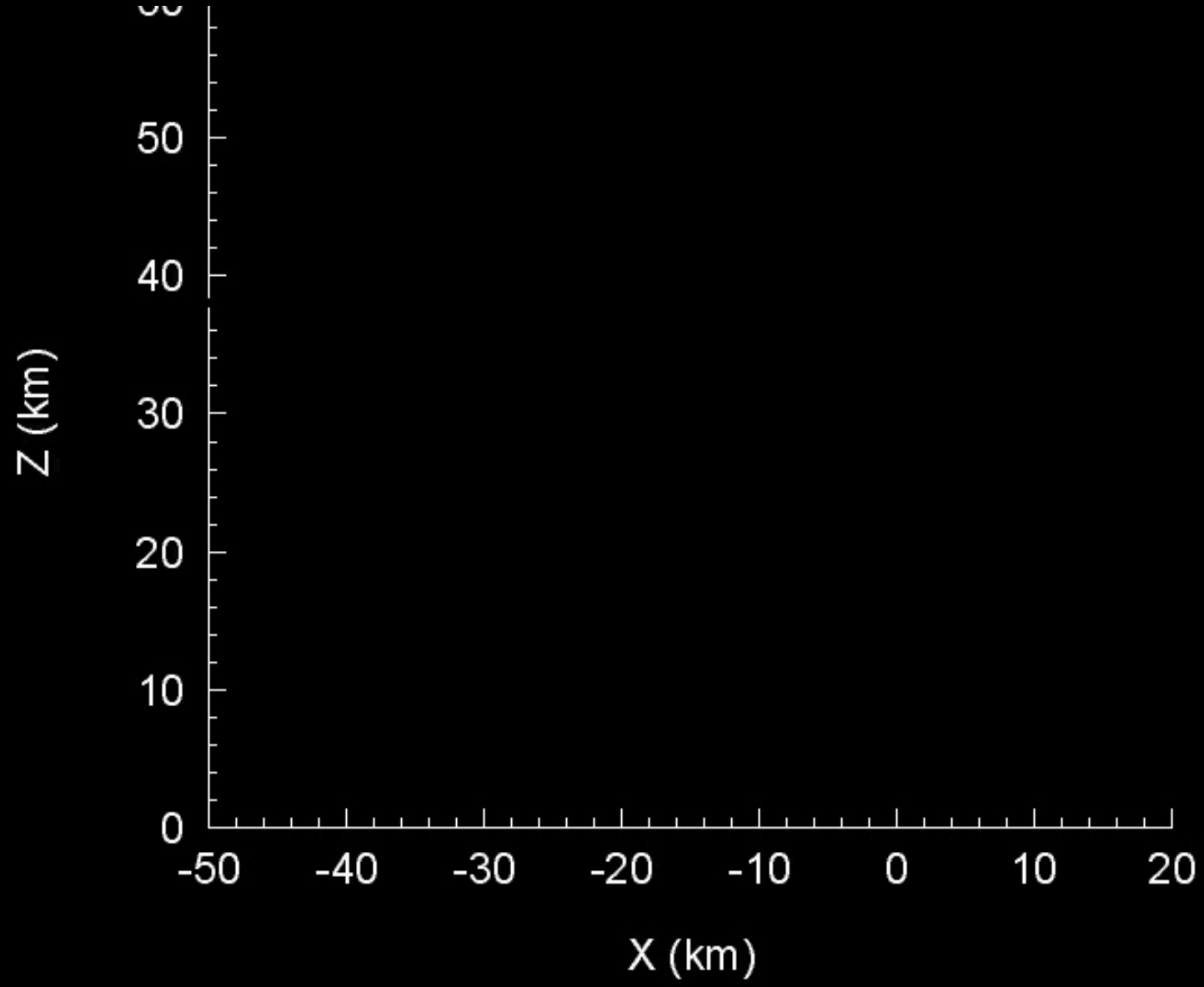

4. Chelyabinsk

Chelyabinsk narrowly escapes destruction in 2013!

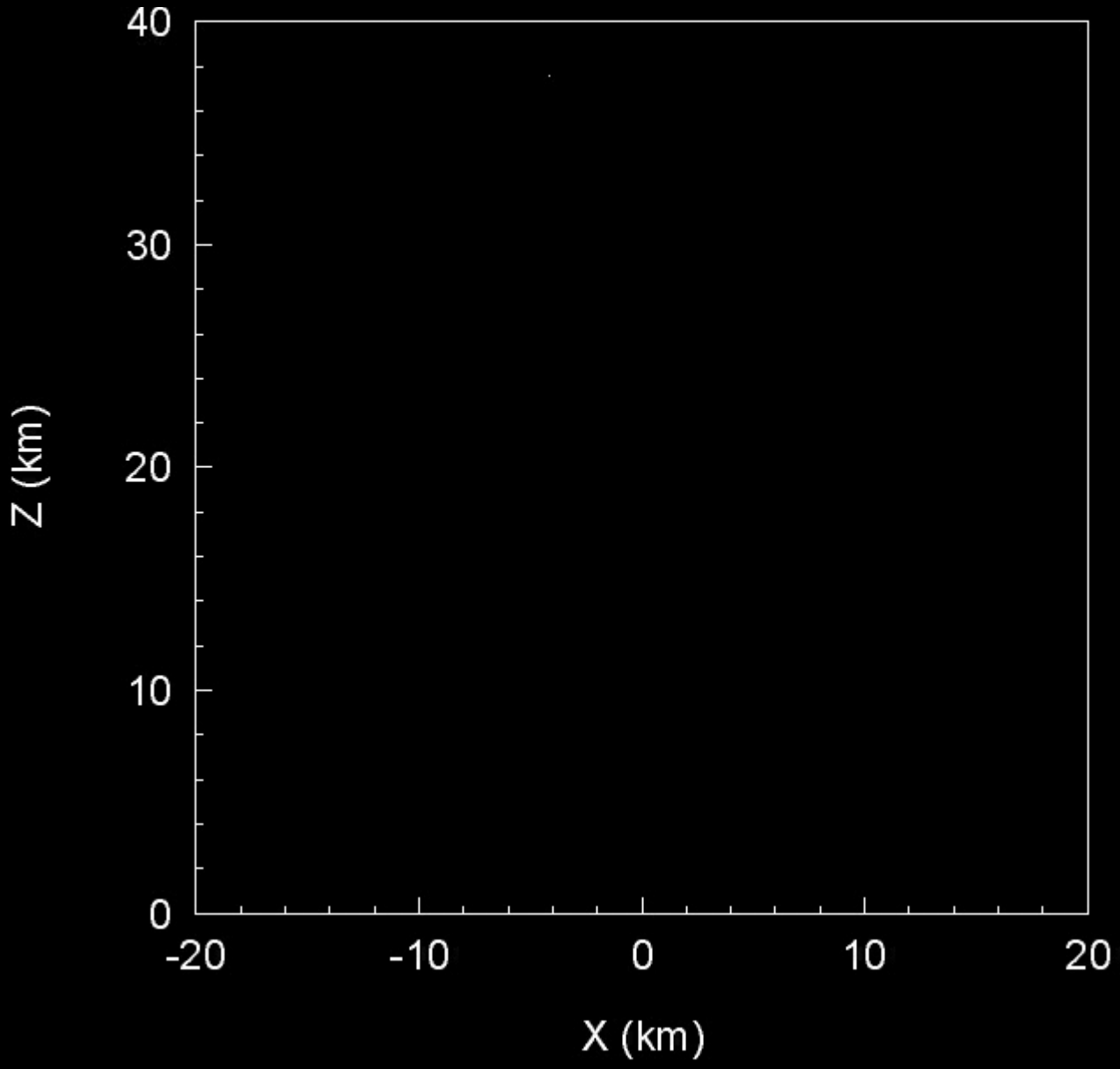
REAL!

REAL!

Chelyabinsk airburst simulation: 0.5 Mt



Steep airburst simulation: 0.5 Mt



High-fidelity validation data

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Questions?
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