

Investigating the Effects of Meteors on the Atmosphere


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Introduction

Meteorites with Mass > 10 kg

Effects:

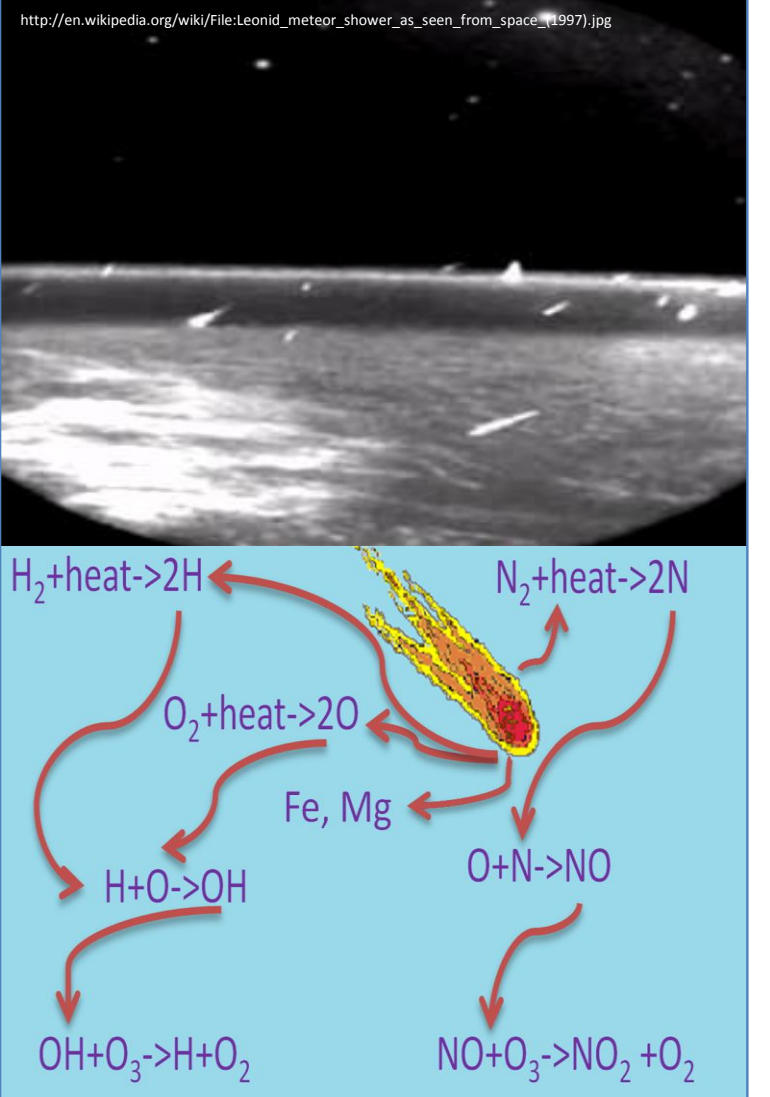
- 1) Tanguska event in Siberia (1908) ($> 3.7 \cdot 10^8$ kg)
- 2) Cretaceous-Paleogene extinction ($> 5.7 \cdot 10^{15}$ kg)
(Chicxulub crater ? (180 km))
- 3) Permian-Triassic extinction ($>> 5.7 \cdot 10^{15}$ kg)
(Wilkes Land crater?)



Meteors with Mass < 1 kg

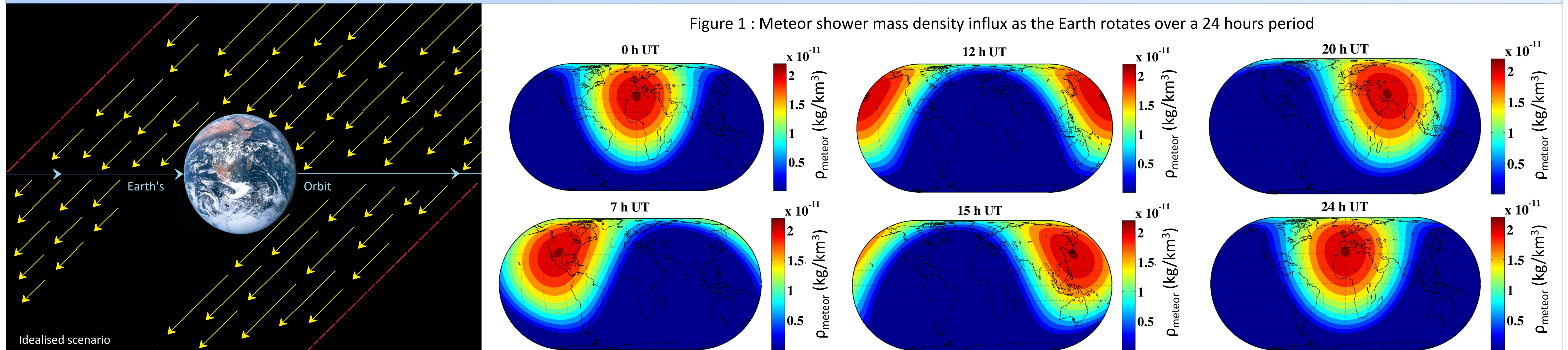
Effects:

- 1) **Heating of the atmosphere**
Atmospheric waves ↔ Circulation change
- 2) Momentum transfer to the atmosphere
- 3) O, O₂, O₃, N, N₂, NO, H, OH, Fe, Mg Chemistry change
- 4) Generation of dust & ionization



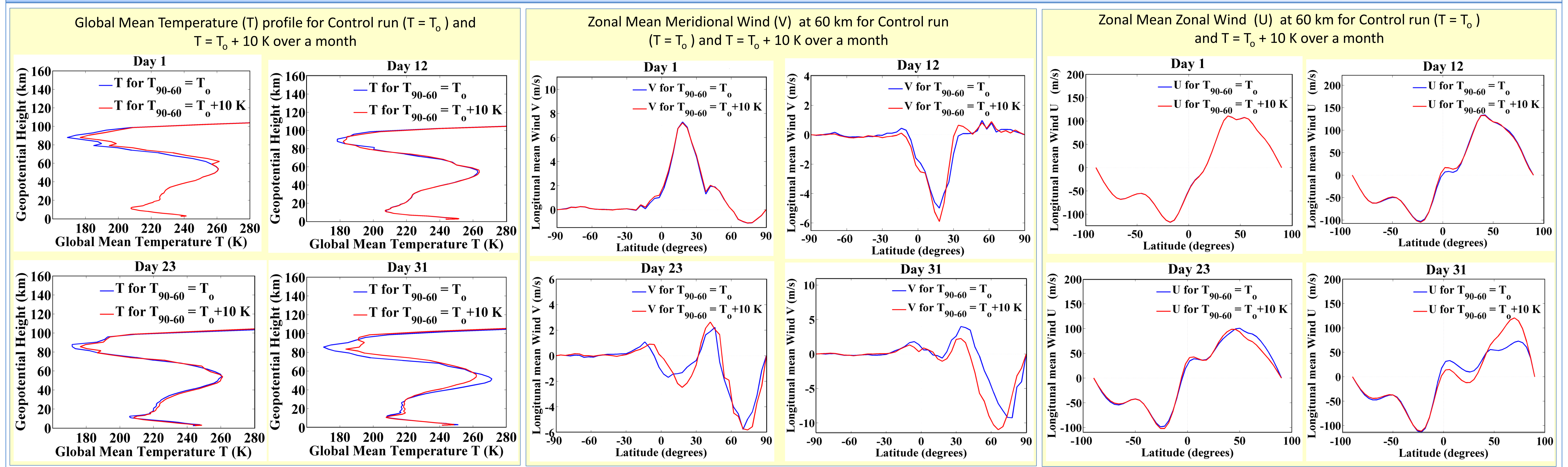
Scientific Question and Simulation Setup

- How strong is the heating of the middle atmosphere caused by a normal meteor shower?
- Shower used: Geminids. Peak (90% of meteors) lasts 24 hours approximately (ZHR = 120)
- Meteor shower particles ablate between 90 - 60 km
- Kinetic energy of the meteor shower is converted to thermal energy between 90 – 60 km



A test simulation

- Model Used: Whole Atmospheric Climate Model (WACCM) (subprogram of CESM 1.04)
- Advantages: Height range (0 – 150 km), allows 3D modelling of Chemistry, Atmospheric tides, Planetary waves, Global circulation
- A first test simulation: Effects of a temperature increase of 10 K in the middle atmosphere (90-60 km) at the beginning of the simulations (on the first hour)



Conclusions

- Initialisation of model with mesospheric temperature increase of 10 K → different wind + temperature
- The state of the mesosphere influences the temperature of the whole atmosphere for a period of at least 31 days
- The state of the mesosphere influences the Meridional and Zonal wind in the Northern Hemisphere and Equator for at least 31 days
- Does long term weather forecast require a Whole Atmospheric Model?

Outlook

- Perform a simulation of the meteor shower with the more realistic setup (Figure 1)
- Analyse the impact of the meteor shower on atmospheric circulation, thermal state, atmospheric waves and chemistry
- Does the meteor shower appear in Earth observation data?

References

- Peter Jenniskens , Meteor Showers and their Parent Comets, pp. . ISBN 0521853494. Cambridge, UK: Cambridge University Press, 2006.
- J. Correia, Metal concentrations in the upper atmosphere during meteor showers, Atmospheric Chemistry and Physics, Volume 10, Issue 3, 2010, pp.909-917