



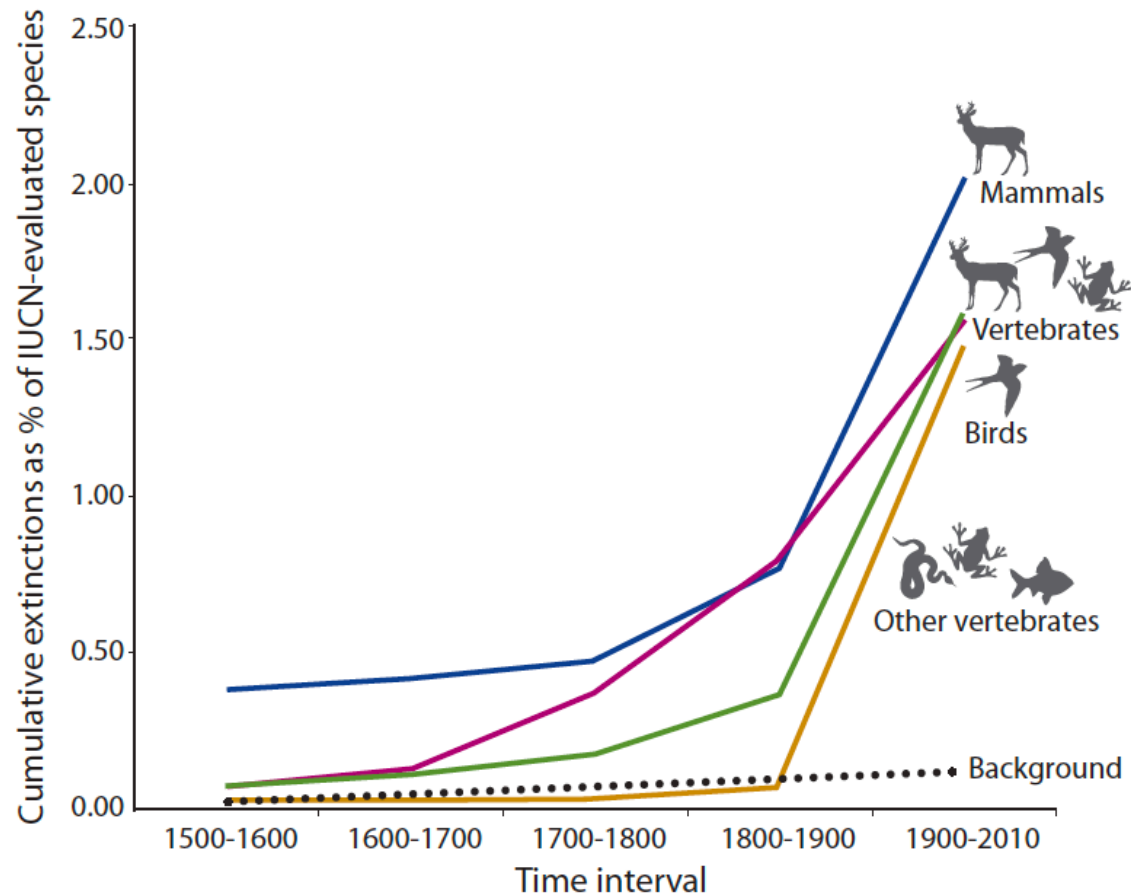
# Simulating the End-Cretaceous Impact Winter

Clay Tabor

Charles Bardeen, Bette Otto-Bliesner,  
Rolando Garcia, Brian Toon

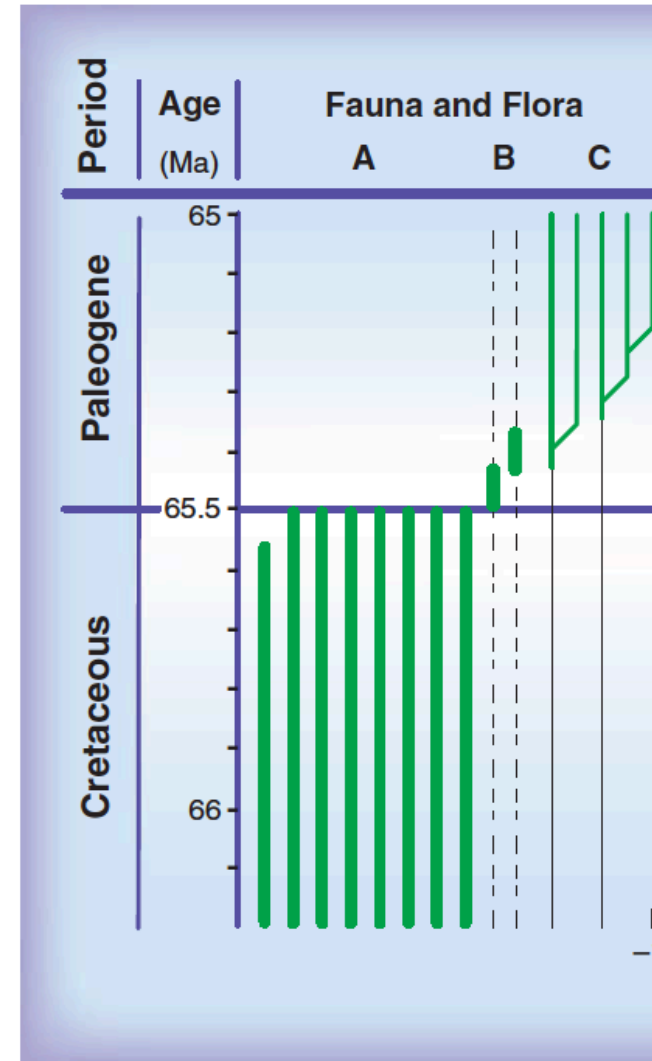
## 6<sup>th</sup> mass extinction?

- Trending towards a biodiversity crisis
- Can past extinctions inform the future?
- Need to understand the mechanisms



# End-Cretaceous Mass Extinction

- Most recent of the "Big 5" mass extinctions
- 75% of all species went extinct
- Coincident with a 10km asteroid impact and large igneous province volcanism





# Many Ways to Skin a Dino....

- Impact led to:
  - Mega tsunamis
  - Earthquakes and volcanism
  - Thermal pulse
  - **Emissions of soot, dust, CO<sub>2</sub>, sulfur, halogens**





# Impact Winter Experiments

- **WACCM4**

- 140 km model top
- CARMA aerosol model
  - Toon et al., 1988; Bardeen et al., 2008

- **SOOT: 72,200 Tg**

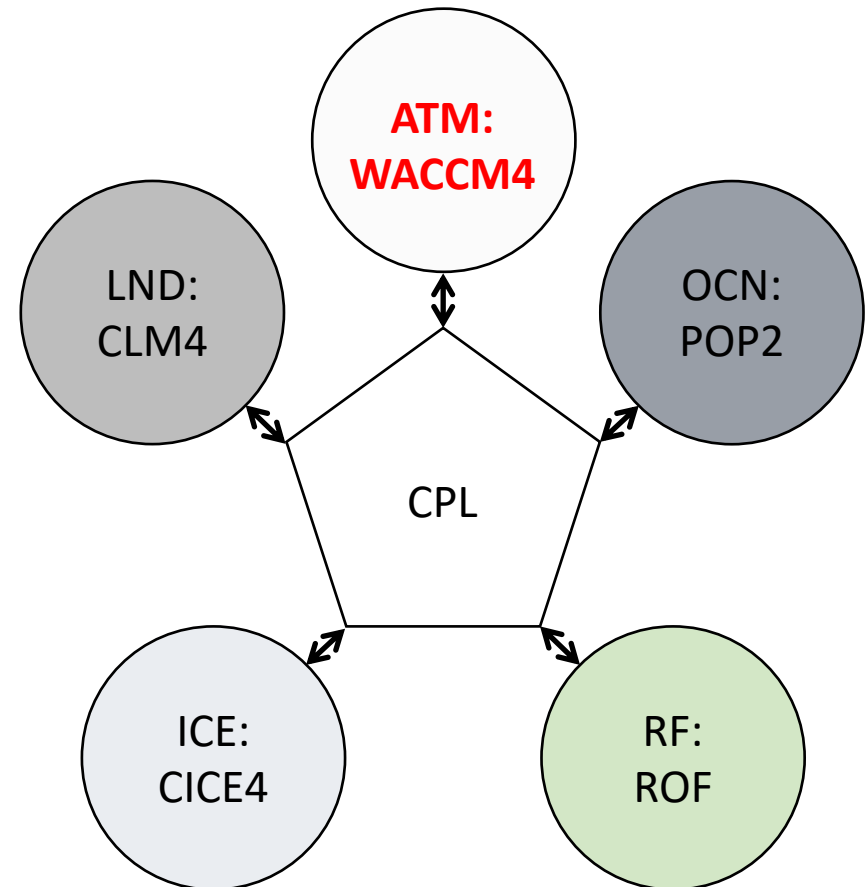
- Wolbach et al., 1990

- **SO<sub>2</sub>: 650,000 Tg**

- Artemieva et al., 2017

- **DUST: 2,000,000 Tg**

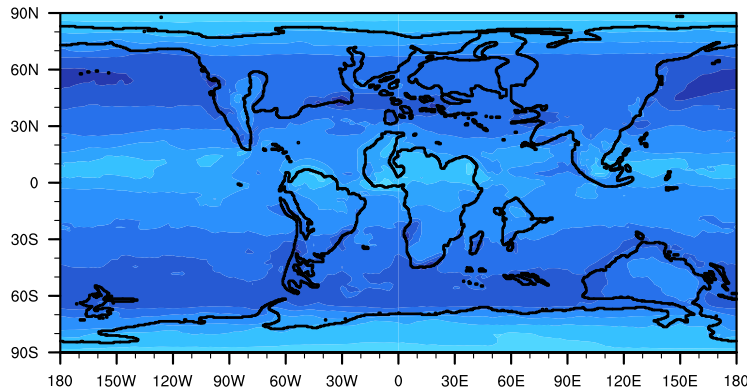
- Toon et al., 2016



## # of Days with Light Below 1% of Normal

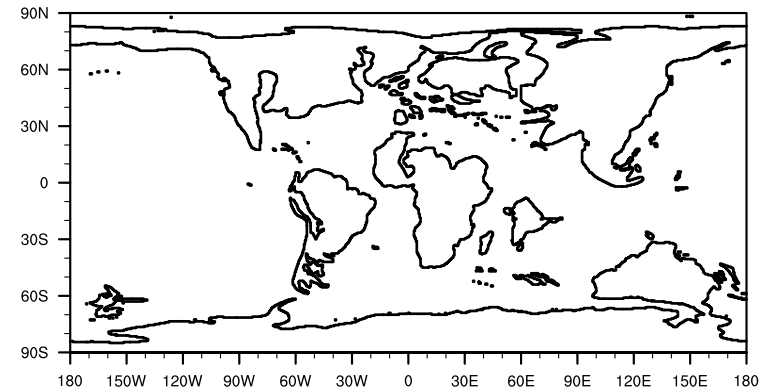
### Soot

Soot: # of Days with Surface Light Below 1% of Normal



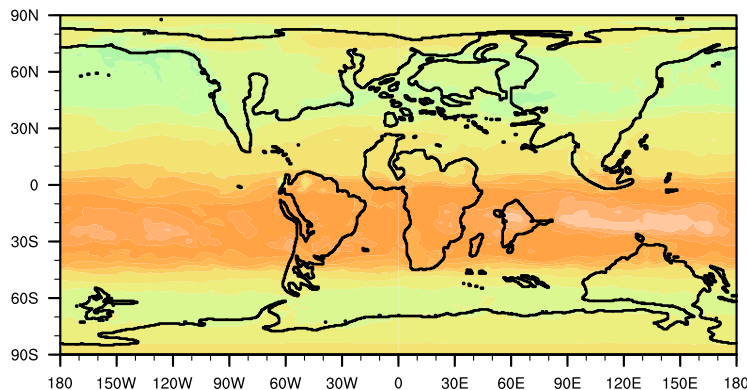
### SO<sub>2</sub>

SO<sub>2</sub>: # of Days with Surface Light Below 1% of Normal



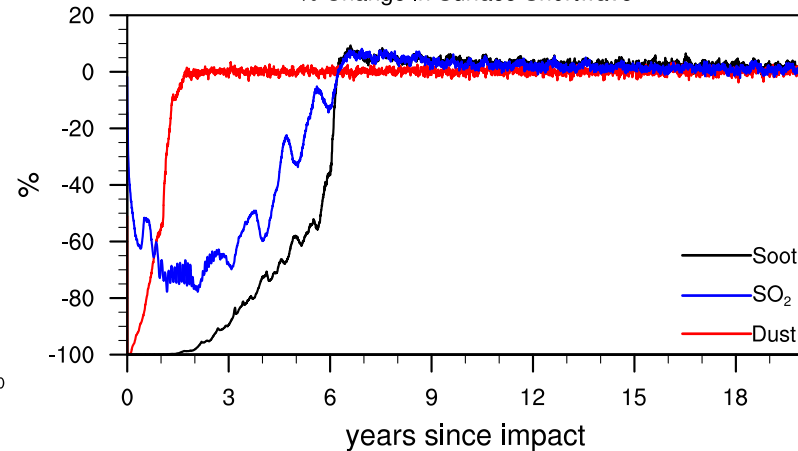
### Dust

Dust: # of Days with Surface Light Below 1% of Normal



### D.

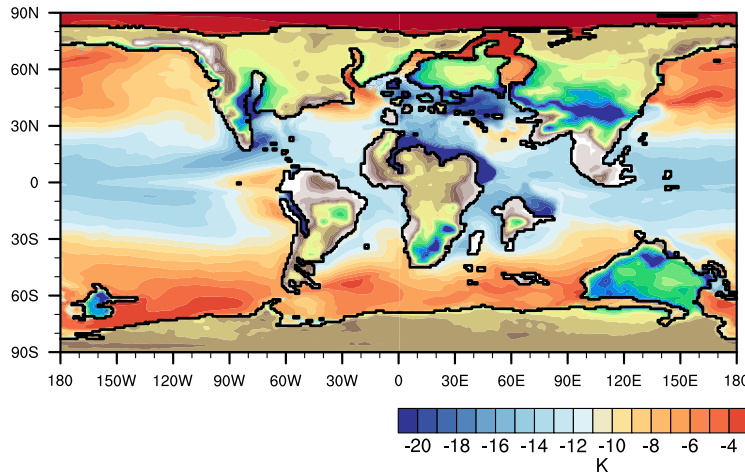
% Change in Surface Shortwave



## # of Freezing Days & Max 100m Ocean Cooling

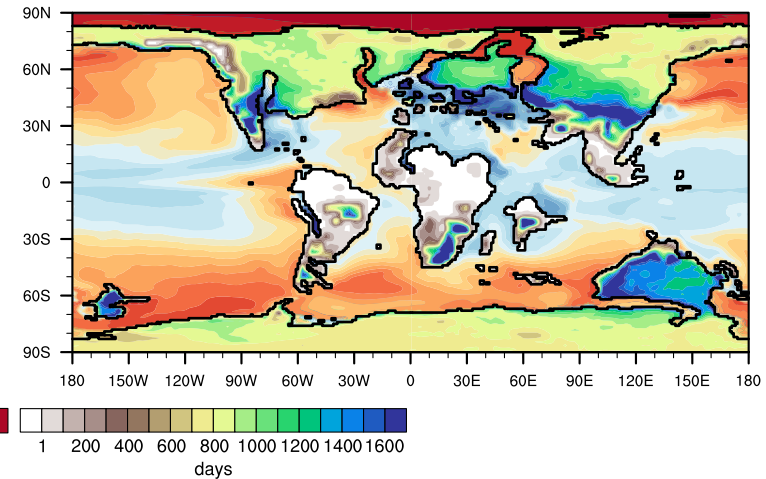
### Soot

Soot: # of Freezing Days & Upper 100m Max Ocean Cooling



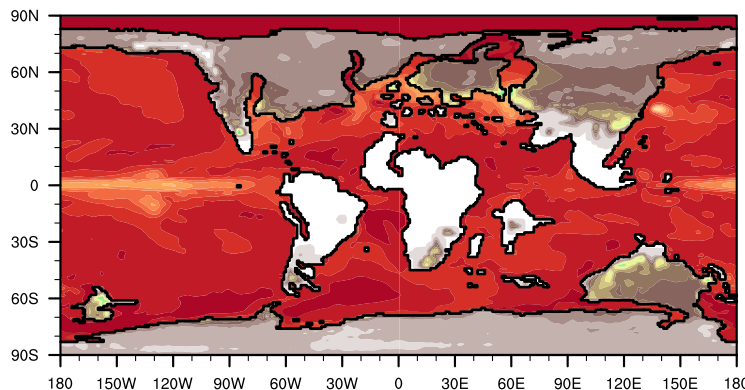
### SO<sub>2</sub>

SO<sub>2</sub>: # of Freezing Days & Upper 100m Max Ocean Cooling



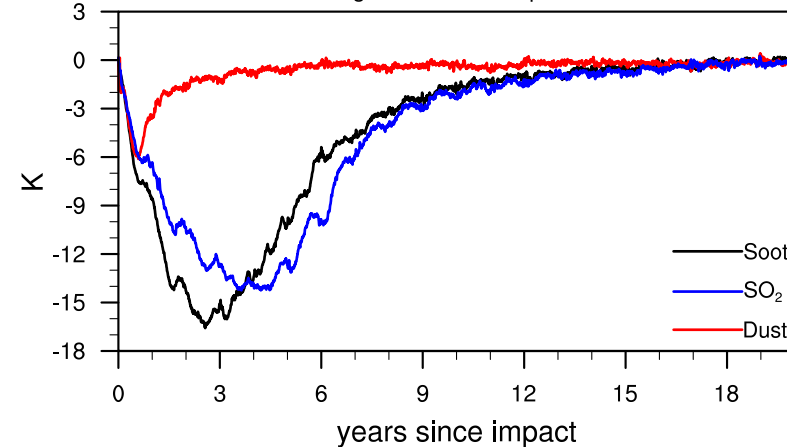
### Dust

Dust: # of Freezing Days & Upper 100m Max Ocean Cooling



### D.

Change in 2m Air Temperature





# Conclusions

- Soot produces the largest surface shortwave and temperature responses
- Soot was likely important for the marine extinction
- Greatest chance for survival in high latitude coasts
- Many other factors to explore!

