Nuclear conflict and ozone depletion

- **Quick summary**
  - Regional nuclear war could cause global cooling (anywhere from 2.25 F to 7.2F, depending on location), as well as destruction of ozone in the stratosphere
  - Increased health problems, from more UV radiation going through and a temperature inversion which traps pollutants
  - Nuclear weapons cause explosions, which then causes things around the vicinity to start burning, which in turn releases black carbon; it is not the nuclear material or fallout causing these affects but the black carbon from fires
  - Predictions based on Michael Mills + other colleagues model
    - 100 Hiroshima bombs in northern subtropics detonated
    - Released 5 Teragrams (5 x 10^12 grams or 1.1 x 10^10 lbs) of soot (black carbon) into the atmosphere
    - Black carbon absorbs solar heat, which in turn makes it goes higher and depending on factors, into the stratosphere
    - It heats the stratosphere and thus it causes faster catalytic reactions, effecting rates of odd oxygen and Chapman reactions and thus more ozone depletion
    - It also changes Brewer-Dobson circulation patterns which further adds to ozone depletion
- **The Chemistry**
  - Net: O3 + O -> 2O2 increases in rate with temperature increase
  - NOx
    - NO + O3 -> NO2 + O2
    - NO2 + O -> NO + O2
    - Net: O3 + O -> 2O2
  - HOx
    - OH + O3 -> HO2 + O2
    - HO2 + O3 -> OH + 2O2
    - Net: 2O3 -> 3O2
  - Antarctica
    - The ozone hole in spring is lessened the first 2 years because increased temperatures causes less heterogeneous activation of chlorine on polar stratospheric clouds and thus less destruction, but eventually more depletion will occur
  - Production response
    - More UV penetration in lower atmosphere=O2 increases more under 30 KM which creates more ozone and counter ozone loss
    - O2 photolysis increases highly in first year, but there is still more loss than gain in ozone

- Soot brings more N2O up and NOx creates ozone in troposphere and destroys ozone in stratosphere
- NO main catalyst in ozone destruction and has a long lifetime

- More heating allows more water into the stratosphere (usually limited by cooler temps), so more HOx, thus more O3 loss

- **The problem?**
  - Black carbon amount and distribution
    - Amount-It depends where it occurs, if there is a lot of buildings and stuff to burn, there will be more black carbon produced
    - Distribution-how dispersed is the black carbon, if it is well dispersed this won't be a problem, but more concentrated could cause it to go into the stratosphere.
  - Examples
    - For both Hiroshima and Nagasaki, there were widespread fires, but ozone depletion wasn't a problem because there was not much in the way of smoke plumes
    - 700 oil wells in Kuwait were set on fire which burned for 8 months, produced millions of tons of smoke in the atmosphere
      - TTAPS (Turco, Toon, Ackerman, Pollack, and Sagan-A team that first purposed the idea of nuclear winter in the 80's) predicted massive climate effects
      - There were none, this was due to smoke plumes being in a vast area so there wasn't enough uplift into the atmosphere
    - Mt. Pinatubo
      - 17 million tons (17 x 10^12 grams vs. 5 x 10^12 in model) put into the upper atmosphere
      - Cooler global temperatures but nothing long term
    - Regional nuclear conflicts that could occur (India and Pakistan) could produce around 1 million tons of smoke for each nuclear strike
  - We have to rely on past events and models, so there is a high level of uncertainty