What Whole Atmosphere Model Time Slice Simulations Tell Us About Thermosphere/Ionosphere Multi-Decadal Changes from the 1920s to 2010s

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Summary

- Performed WACCM-X free running simulations from the 1920s to 2010s with one five year time slice simulation at the beginning of each decade
- Change in first 3 decades is only ~15% of 9 decade change
- Effects of increasing greenhouse gases and magnetic field evolution both apparent in thermosphere and ionosphere

WACCM-X Model

- Comprehensive self-consistent numerical global climate model of the Earth's atmosphere - vertical range from the surface to the upper thermosphere at ¼ scale height
- Full thermosphere and ionosphere with electrodynamics
- See Liu et al., 2018 for more details

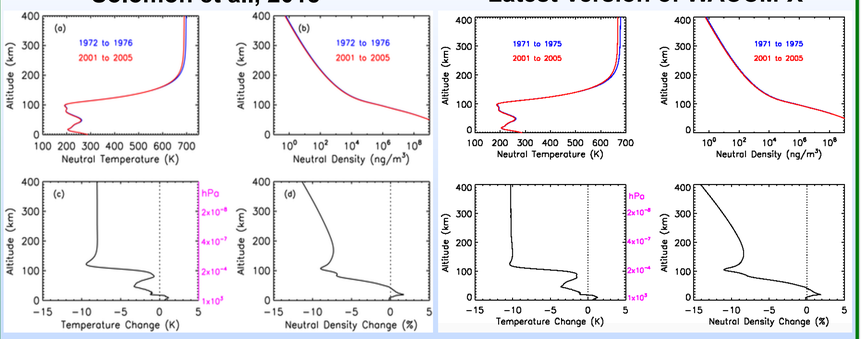
WACCM-X Simulations

- Nine sets of five year free running time slice simulations for each decade between the 1920s and 2010s
- Fixed solar minimum and geomagnetically quiet conditions
- Monthly mean output averaged annually and globally
- Five year mean of monthly means for map representations

Comparison With Previous WACCM-X Results

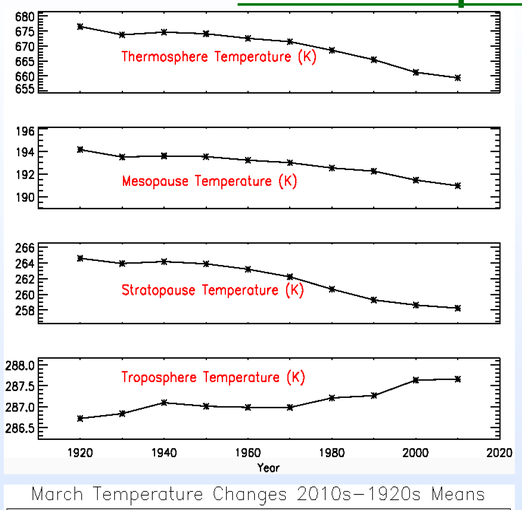
Both Are WACCM-X Solar Minimum 1970s to 2000s Temperature and Neutral Density

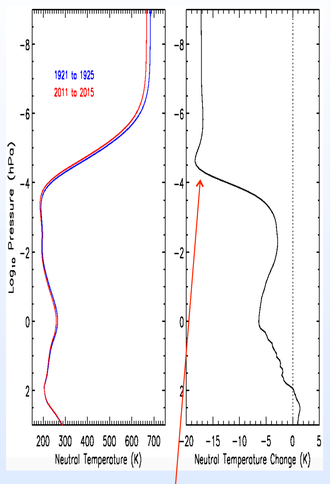
Solomon et al., 2018 | Latest Version of WACCM-X



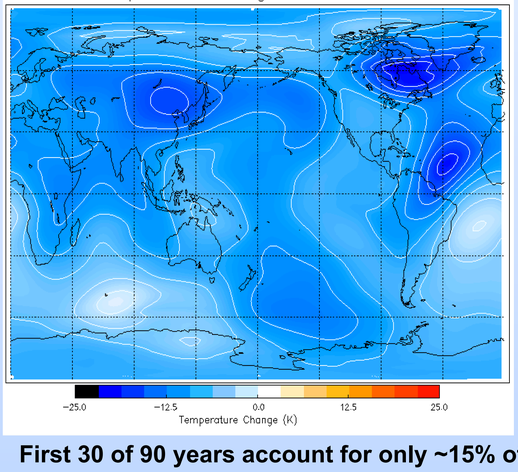
Results from 1970s to 2000s very similar to previous WACCM-X version. Slightly more cooling and density decrease in latest results.

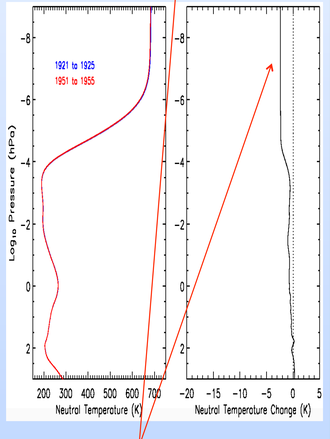
Neutral Temperature





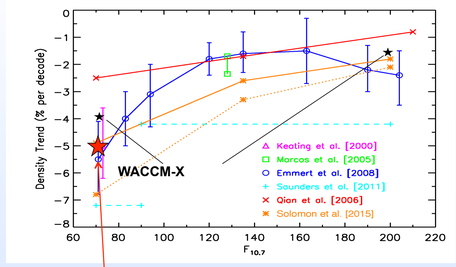
March Temperature Changes 2010s−1920s Means

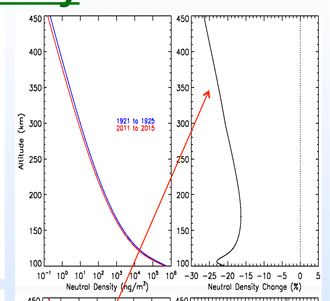


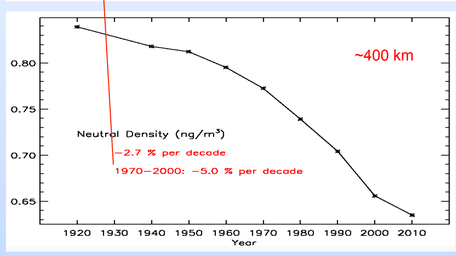


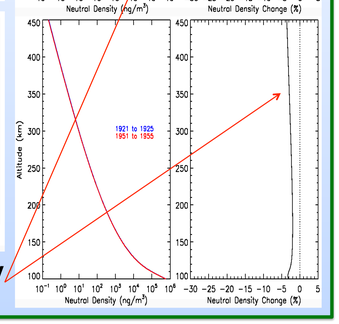
First 30 of 90 years account for only ~15% of total temperature decrease

Neutral Density



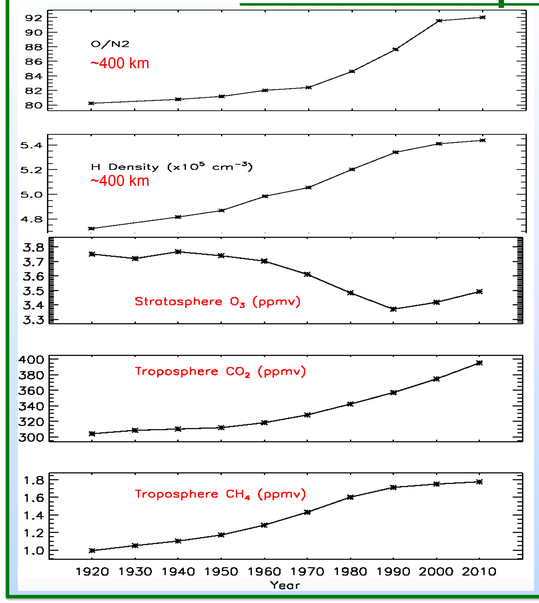


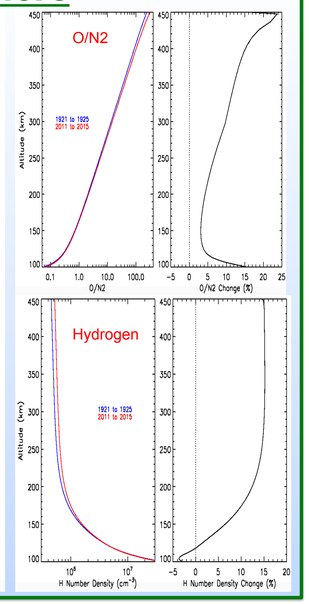




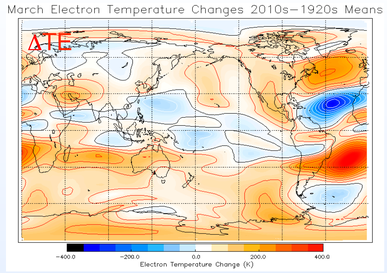
First 30 of 90 years account for only ~15% of total neutral density decrease

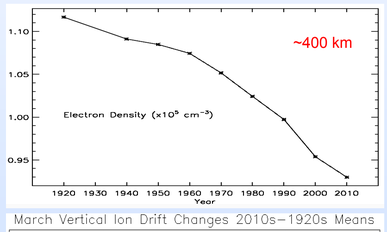
Neutral Atmosphere

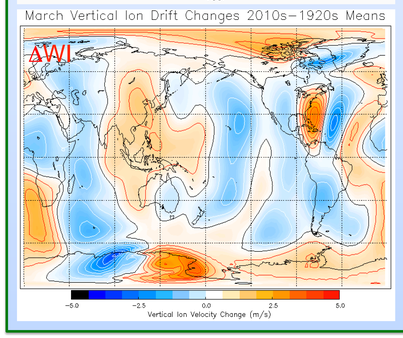


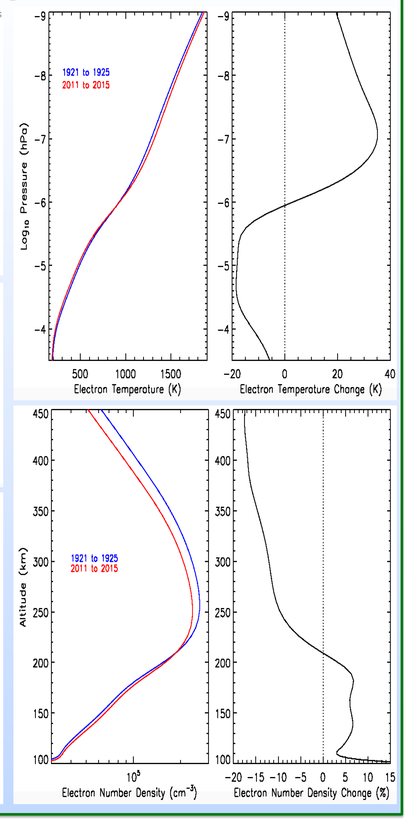


Ionosphere



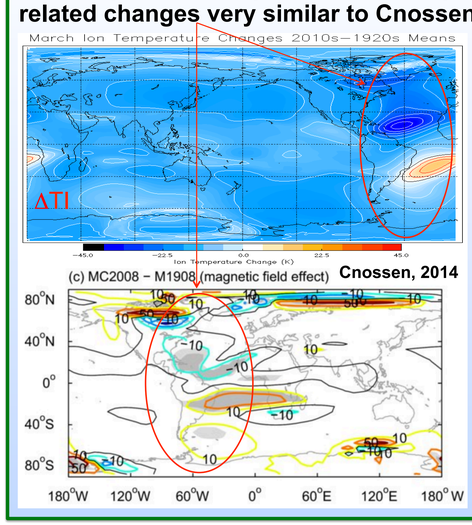


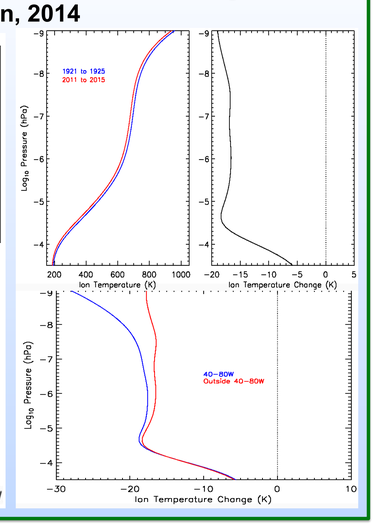




Magnetic Field and Ion Temperature

Ion temperature map and other maps shown reveal magnetic field related changes very similar to Cnossen, 2014





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Cnossen, Ingrid (2014), The importance of geomagnetic field changes versus rising CO_2 levels for long-term change in the upper atmosphere. *J. Space Weather Space Clim.*,4(2014)A18. https://doi.org/10.1051/swsc/2014016.