Analyzing Magnetospheric Conditions during a Sudden Stratospheric Warming Event in January 2013

Antonio Ruiz Núñez [1, 2], Federico Gasperini [3], Han-Li Liu [4]

1. University Corporation for Atmospheric Science, Boulder, CO, 2. Texas A&M University, College Station, TX, 3. Orion Space Solutions, Louisville, CO,
4. U.S. National Science Foundation National Center for Atmospheric Research, Boulder, CO

Introduction

Sudden Stratospheric Warming (SSW) Event

- Occurs in the northern hemisphere in the wintertime
- Interrupts the polar vortex and changes westerlies aloft to easterlies
- Known to affect the surface pushing colder air further south into the midlatitudes
- Effects to the ionosphere and magnetosphere are not precisely known

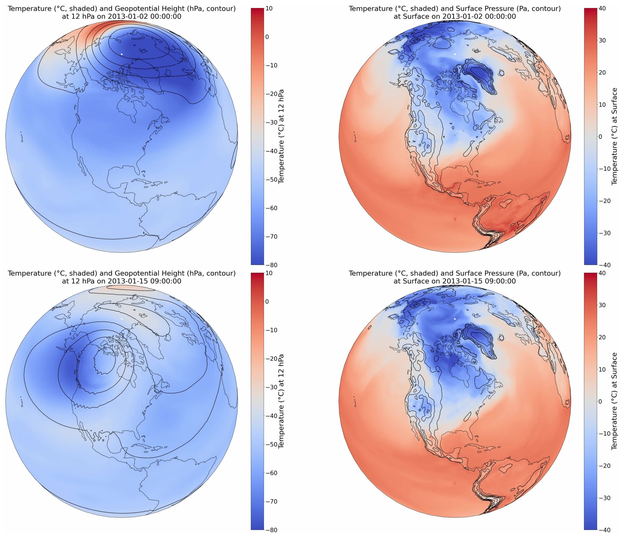


Figure 1 and 2: Temperature effects of the SSW event are shown in both the stratosphere (left column) and the surface (right column), with 'before' conditions in the top row and 'after' conditions in the bottom row.

Research Problem

- Determine changes on the magnetosphere and upper ionosphere originating from the 2013 SSW Event

Methods

- Get Kp, ap, F10.7 data during time of SSW
- Obtain SSW and climatology model runs from the Whole Atmosphere Community Climate Model with thermosphere and ionosphere eXtension (WACCM-X)
- Plot values such as Pedersen and Hall conductance, electron density, H, O, NO, O_2 concentration and temperature
- Compare values obtained from SSW run and identify changes from the climatology run

Results

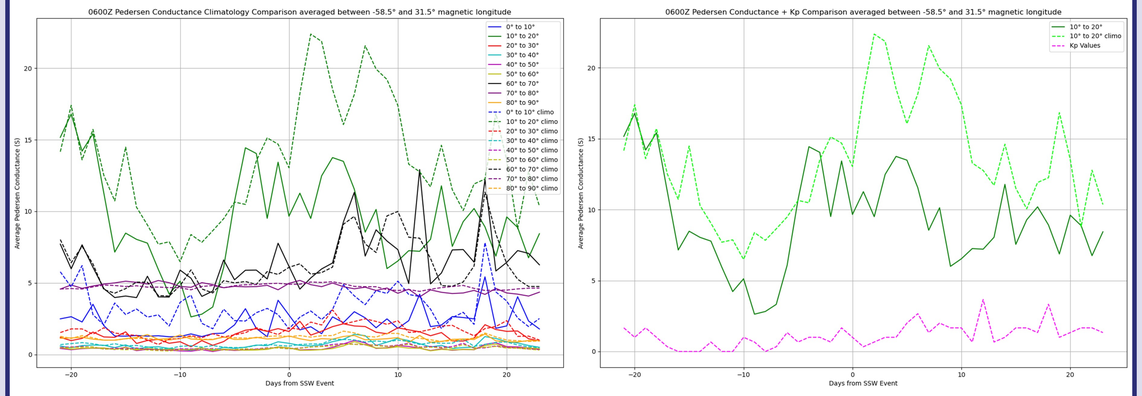


Figure 3 and 4: (Left) Pedersen Conductance at different latitudes at 06Z for the selected region of Earth compared to climatology with the latitude region with most fluctuation in Pedersen conductance isolated (right).

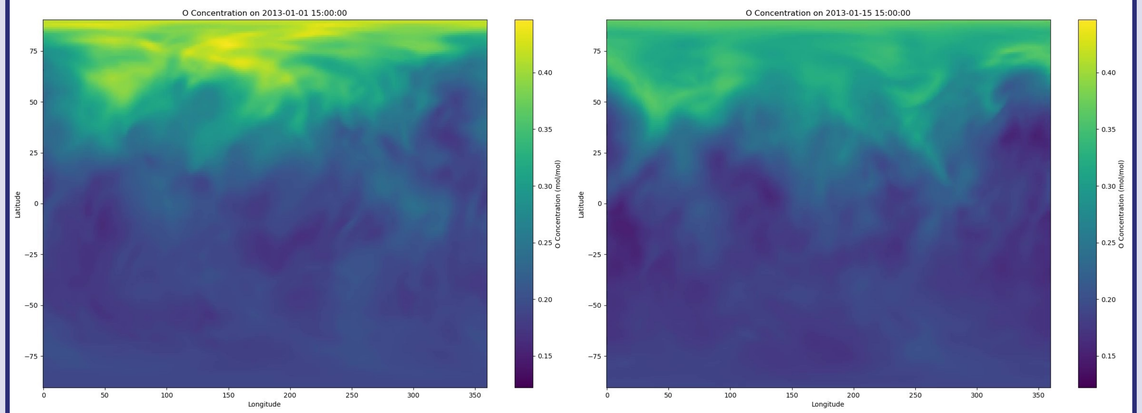


Figure 5 and 6: Global map before (left) and after (right) showing oxygen concentration depletion following the SSW event at high latitudes.

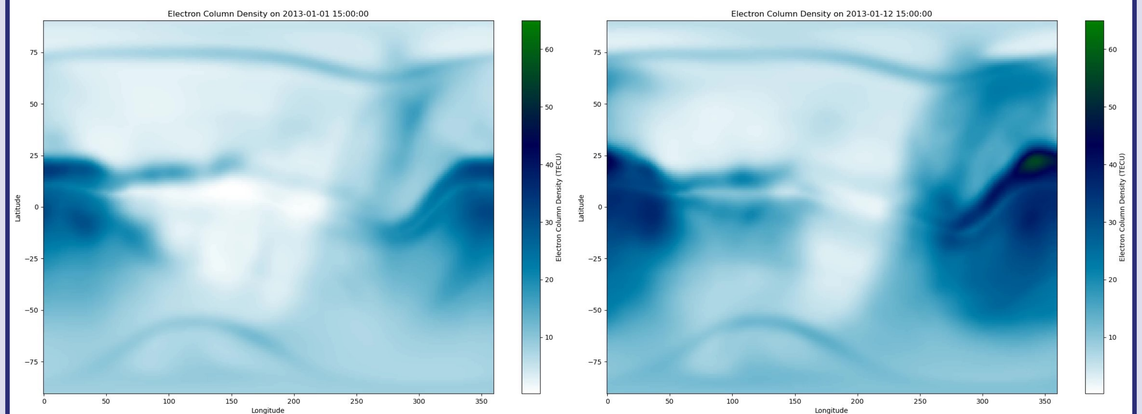


Figure 7 and 8: Global map before (left) and after (right) showing an increase in electron column density following the SSW event around 20° north.

Discussion

- SSW effects present in sector between 10° to 20° latitude when compared to climatology and are not related to solar activity as shown by Kp value.
- Oxygen concentration drops noticeably following SSW event.
- Increase in electron column density around 20° latitude following SSW event.
- In specific circumstances, SSW events do affect the ionosphere, thermosphere and magnetosphere but further research is needed to quantify it.

Next Steps

Continue current analysis from WACCM-X model runs

↓

Combine WACCM-X and TIE-GCM output into the MAGE model

↓

Validate and run MAGE model

↓

Analyze MAGE model output

↓

Validate findings from models with observations

Acknowledgements

This material is based upon work supported by the U.S. National Science Foundation under Grant No. AGS-2230301 (NSF SOARS). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the U.S. National Science Foundation.

This material is based upon work supported by the U.S. National Science Foundation under Grant No. AGS-2223930, Collaborative Research: CEDAR--Exploring the Response of the Magnetosphere to Terrestrial Weather. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the U.S. National Science Foundation.

Research Mentors: Federico Gasperini, Han-Li Liu
Computational Mentor: Kevin Pham
Writing Mentor: Louisa Nance
Community Mentor: Vanessa Vincente