

Summary and Highlights of the TREND 2010 Workshop

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NCAR



CEDAR 2010 Workshop • University of Colorado • 23 June 2010



High Altitude Observatory



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TREND 2010

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6th Workshop on Long-Term Changes and Trends in the Atmosphere

June 15–18, 2010
National Center for Atmospheric Research
Boulder, Colorado, USA



TREND 2010 AGENDA & ABSTRACTS

Tuesday, June 15, NCAR/UCAR Center Green Campus

8:00–9:00 [Registration, Continental Breakfast–\(Lobby\)](#)

MORNING SESSION I (Chairman: S.C. Solomon)

9:00–9:30 Welcome talks by LOC, NCAR, J. Lastovicka (IAGA/ICMA WG), D. Marsh (CAWSES-II TG-2)
Technical information/arrangements/logistic by LOC
Special issue information by J. Emmert

Information on International Bodies:

9:30–9:45 J. Lastovicka: IAGA/ICMA working group "Long-Term Trends in the Mesosphere, Thermosphere and Ionosphere" (invited)

9:45–10:00 D. Marsh, J. Lastovicka, G. Beig, U. Berger, S. Eckermann, J. Emmert, E. Manzini, C. Jacobi, J. Richter, K. Sato, G. Thomas, L. Qian: CAWSES-II - Task Group 2: How Will Geospace Respond to a Changing Climate? (invited)

10:00–10:15 M. Bittner, P. Espy, J. French, K. Hoepfner, J. Scheer, M.J. Taylor: The Network for the Detection of Mesopause Change (NDMC) (invited)

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Sponsors:

IAGA (International Association of Geomagnetism and Aeronomy)
ICMA (International Commission on the Middle Atmosphere)
CAWSES II (Climate and Weather of the Sun-Earth System)

Scientific Organizing Committee:

Jan Lastovicka (Chair) (IAP, Prague, CZ), jla@ufa.cas.cz
Gufran Beig (IITM, Pune, India), beig@tropmet.res.in
John Emmert (NRL, Washington, USA), john.emmert@nrl.navy.mil
Martin Jarvis (BAS, Cambridge, UK), m.jarvis@bas.ac.uk

Local Organizing Committee:

Rashid Akmaev (NOAA, Colorado, USA), rashid.akmaev@noaa.gov
Liyang Qian (Chair, NCAR/HAO, Colorado, USA), lqian@ucar.edu
Stan Solomon (NCAR/HAO, Colorado, USA), stans@ucar.edu

Attendees



Roble Symposium

Friday, 18 June, 2010

High Altitude Observatory
National Center for Atmospheric Research
Boulder, Colorado

- 9:00 "On Global Change in the Upper Atmosphere," Ray Roble
- 9:45 "Solar Proton Evens and Some Aspects of Middle Atmosphere Coupling," Susan Solomon
- 10:30 Break
- 11:00 "Geosciences: The Roble Approach," Tim Killeen
- 11:45 "Connections Between Thermospheric Dynamics and Climate Modeling: A Historical Perspective," Bob Dickinson



Some Conclusions of the Workshop

- The thermosphere is unquestionably cooling and contracting, due primarily to increasing CO₂ levels, as predicted by *Roble and Dickinson* [1989].
- The ionosphere is also cooling, but ionospheric density changes are more diverse.
- The mesosphere appears to be cooling, and polar mesospheric clouds (noctilucent clouds) appear to be increasing.
- The stratosphere is still dominated by ozone variation, and that affects all the altitudes above it.
- Model simulations of all this are not in perfect agreement with measurements, but they are generally on the same page.
- Hydrogen change in the exosphere is still an open question, due to large solar-cycle effects.
- 7th Biannual TREND workshop — Buenos Aires, 2012.

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Special Issue of *J. Geophys. Res.*

- Both *JGR – Space Physics* and *JGR – Atmospheres*
- Open to any contributed paper, whether or not it appeared at the workshop
- Notify intent by mid-July
- Articles due in the fall
- Contact John Emmert for more information

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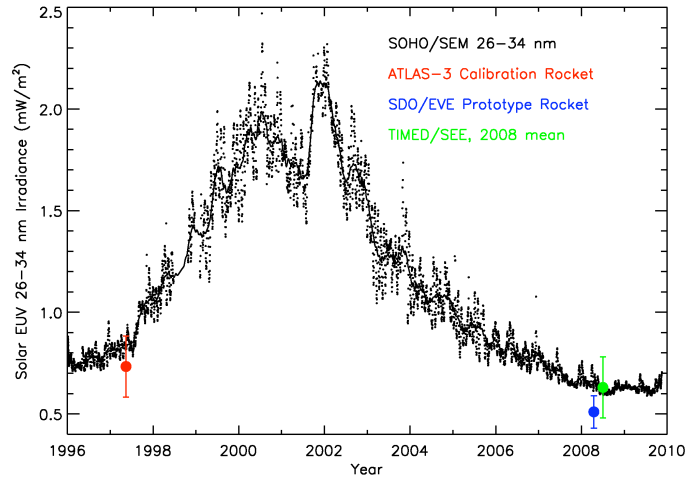
Much Speculation Concerning Solar Minimum

- The 2007-2009 solar minimum was unusually long — was it also unusually “quiet?”
 - The solar wind and interplanetary magnetic field were at times very weak
 - Terrestrial Geomagnetic activity was very low for extended periods
 - But were solar ultraviolet and X-ray irradiance also lower than “normal?”
- Also speculation about terrestrial effects
 - Unusually low ionospheric altitudes/densities [*e.g.*, *Heelis et al., 2009*]
 - Evidence of unusually low thermospheric densities
 - ...and conjecture concerning climate
- This raises a fundamental question for solar physics:
 - Are irradiance levels at solar minimum generally similar, or not?*

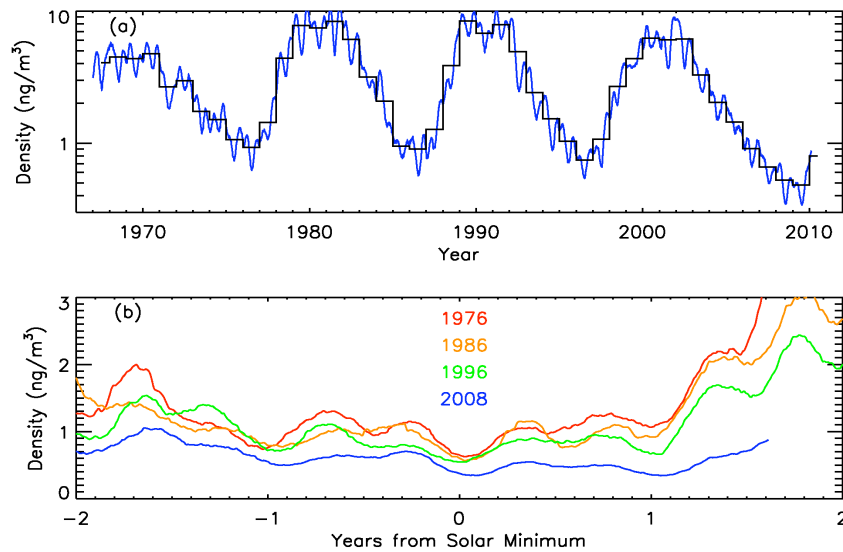
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Solar EUV Measurements from SOHO SEM

- SOHO SEM band (26-34 nm) indicates 15% less irradiance in 2008 than in 1996
[Leonid Didkovsky, *SOHO-23 Workshop Proceedings*, 2010]
Quoted uncertainty is 6%
- LASP rocket and TIMED SEE results are consistent with the SEM measurements
Uncertainty of ~20%

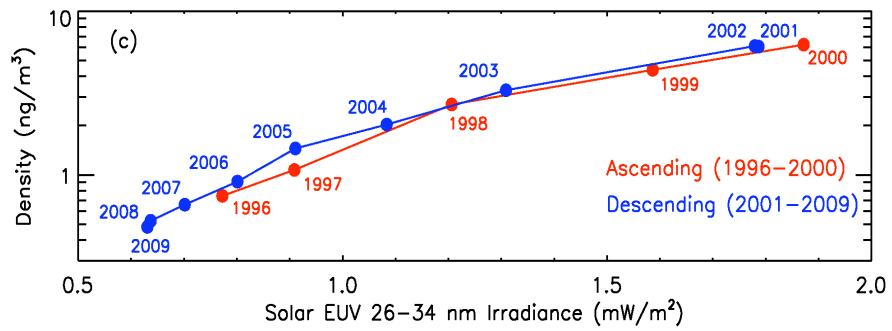


Long-Term Satellite Drag Data



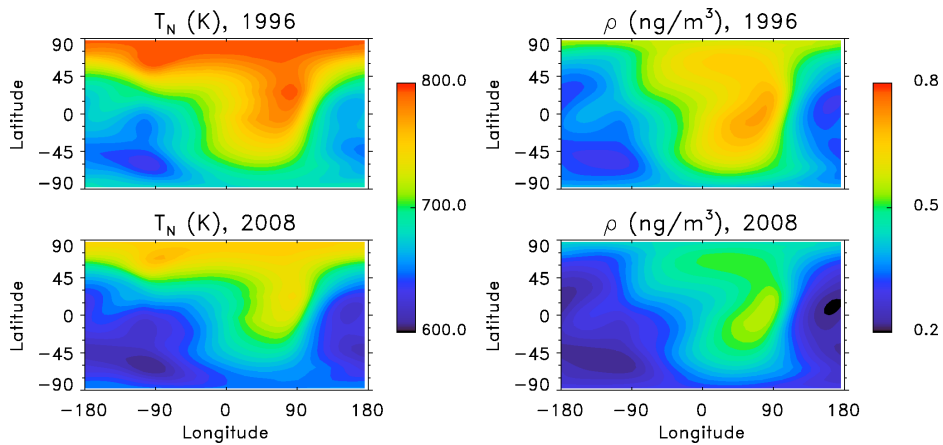
[Emmert et al., *Geophys. Res. Lett.*, in press, 2010]

Satellite Drag Data Compared to Solar EUV



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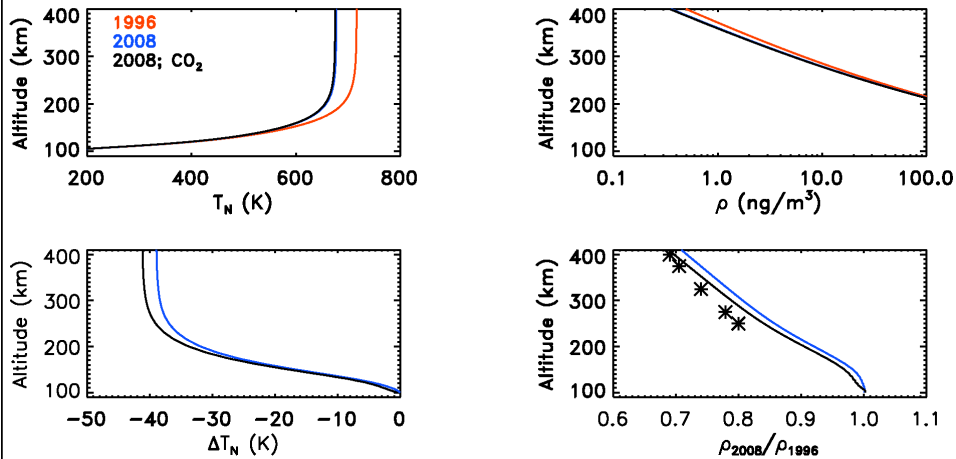
Simulations using the NCAR TIE-GCM



Temperature and Density simulations at 400 km
2008 simulation includes combined effect of solar EUV decrease and CO_2 increase

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Altitude Dependence of Simulated Changes



Temperature and Density change as a function of altitude.

Blue lines — solar EUV change only

Black lines — additional effect of CO_2 increase

Points — Altitude dependence of density change estimated by Emmert et al. [2010]

Conclusions

- The thermosphere/ionosphere system was indeed cooler, less dense, and lower, during the minimum of solar cycle 23/24 than during a “typical” solar minimum.
- The primary cause of this was lower than “usual” solar EUV irradiance, particularly coronal emissions in the soft X-ray region of the spectrum (1~30 nm).
- Future investigation of upper atmosphere climate change will be complicated by the fact that the concept of a “typical” solar minimum is no longer tenable.
- Submitted for publication [Solomon et al., *Geophys. Res. Lett.*, submitted, 2010].