Space Weather Simulation Experiments on the Earth's Upper Atmosphere

E. Turunen
EISCAT Scientific Association, Kiruna, Sweden
[esa.turunen@eiscat.se]

Abstract

The increasing computational performance and capacity available today makes it possible to construct models of various regimes in the Sun-Earth system, based on first physical principles. For ideal Space Weather simulation experiments one should couple such models physically, but also computationally efficiently. While there are already coupled models available for Space Weather simulation purposes, more detailed results still can be achieved by driving detailed stand-alone models with either results from other models or relevant data providing the description of interaction.

The introductory part of this lecture gives an overview of Space Weather simulation experiments in the upper atmosphere using various presently used upper atmospheric models, reviews the significance of excess ionisation events in ionosphere - neutral atmosphere coupling, where it appears that also the ion chemistry reactions turn out to be relevant when considering variations in neutral composition during these events, and finally points out possible existence of climatological effects due to originally Space Weather drivers.

After introduction, an example of a SW simulation tool for upper atmospheric studies, a coupled ion and neutral chemistry model for the lower ionosphere and upper stratosphere-mesosphere and lower thermosphere studies is presented in detail. Chemistry, physics, mathematics and software implementation of the model are described. Recent results of applying the model during solar proton events, auroral electron precipitation, relativistic electron precipitation and solar X-ray flares in order to study variations in ionisation and cahnges in concentrations of odd nitrogen, odd hydrogen, ozone and nitric acid, as well as comparisons with satellite, radio and radar experiments are shown.

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SHORT CV

Esa Sakari Turunen
Ph.D., Director
EISCAT Scientific Association, Kiruna, Sweden
e-mail: esa.turunen@eiscat.se
phone: +4698079153

Degrees:
M.Sc. Univ. of Oulu (1986): "Phase Transition from Hadronic Matter to Quark Matter"
Ph.D. Univ. of Oulu (1993): "High Latitude D-region Studies by Incoherent Scatter Radar Measurements"
Docent of Aeronomy, Univ. of Oulu (2009)

Career:
1977-1984 Research Assistant, Department of Theoretical Physics,University of Oulu
1985-1988 Deputy Researcher , Sodankylä Geophysical Observatory
1989 Research Assistant, Academy of Finland
1990-1992 Deputy Head of Ionospheric Station, Sodankylä Geophysical Observatory
1993-2008 Head of Aeronomy Division, Sodankylä Geophysical Observatory
2009- Director, EISCAT Scientific Association, Kiruna, Sweden

After education and working at the Department of Theoretical Physics at the University of Oulu in Finland, Dr. Turunen started his career in space physics as a Finnish user of the EISCAT incoherent scatter radars and as the PI for several Finnish EISCAT campaigns. He is the main author of the Sodankyla Ion Chemistry model for ionospheric D region and acted as the leader of the Aeronomy Research Group at Sodankyla Geophysical Observatory, before joining EISCAT Scientific Association, working currently as the director general at the EISCAT Headquarters in Kiruna, Sweden. His current main scientific interest is the interaction of precipitating particles with atmosphere and the atmospheric effects of solar-terrestrial relations as seen by ground-based and space-borne measurements, as well as long term variations of the upper atmosphere. Currently he is the coordinator of the Preparatory Phase of the ESFRI Roadmap project EISCAT_3D -The European three-dimensional imaging radar for atmospheric and geospace research.