

4th IAGA/ICMA/CAWSES Workshop Long Term Changes and Trends in the Atmosphere

The workshop, organized by the IAGA/ICMA working group “Long-term trends in the mesosphere, thermosphere and ionosphere”, the CAWSES panel on long-term trends and the Sodankylä Geophysical Observatory of the University of Oulu, was held in Sodankylä, Finland on 4-7 September 2006. The workshop was attended by 40 scientists from four continents. Altogether 42 papers were presented, out of them 20 solicited papers, 14 oral contributed papers, and 8 posters (7 orals and 1 poster were presented by young scientists of age below 35 years). Three topical discussions were organized on three topics concerning key unresolved problems in trend investigations as determined by the Program Committee of the workshop – trends in dynamics, in water-related phenomena and in the ionospheric F2 region. Workshop recommended where to concentrate research activities in the next two years, including deeper understanding of physics (and chemistry) behind long-term trends as a hint for the future analyses of observational results. The workshop provided sufficient time for group as well as personal discussions. Participants of the workshop appreciated both its high scientific level and perfect organization of the workshop by host institution, the Sodankylä Geophysical Observatory, including evening excursion to reindeer farm.

Increasing concentration of greenhouse gases in the atmosphere, stratospheric ozone depletion, as well as long-term changes of solar and geomagnetic activity can result in long-term changes and trends in the stratosphere, mesosphere, thermosphere and ionosphere. The main goal of this workshop was to discuss progress in the field and our current observational and model-simulation knowledge and understanding of such trends. The workshop was focused on the determination of long-term trends and changes, including quantification of the role of anthropogenic changes (primarily greenhouse effect but also ozone depletion and changes in water vapour concentration) versus Sun’s effects in the observed trends.

The first version of the emerging global pattern of global change in the upper atmosphere was presented at the workshop. Papers dealing with methods of trend determination stressed the problem of data quality and methods of its testing, and correct approach of eliminating strong solar cycle, seasonal cycle and diurnal cycle effects on trend determination. A few papers dealt with long-term changes in the troposphere, particularly in relation to various forcing of solar origin. Long-term trend in the stationary planetary wave activity in the troposphere was found and its propagation into the thermosphere studied using a model (leading author of the paper, A. Kanukhina, was proposed for the IAGA Young Scientist presentation award). Several papers treated present-day development of ozone layer; there are some signatures of ozone recovery as a consequence of the Montreal Protocol, but several more years of data are necessary to be able to see statistically significant chemical recovery of ozone on the background of large ozone variations of meteorological origin. Model calculations show that not only greenhouse gases (mainly CO₂ and methane) play a role in long-term trends; the effects of ozone depletion and water vapour concentration changes may expand well into the thermosphere, and their inclusion largely reduced the quantitative difference between various observational and numerical model trends. New models already succeed to reproduce almost no temperature trend in the mesopause region. Results presented at the

workshop provide a hint how probably explain the discrepancy between observed trends in noctilucent clouds and polar mesospheric clouds. Trends in winds, tides and planetary wave activity in the mesopause region (80-100 km) do not show a clear pattern; changes of zonal and meridional component are even opposite for some parameters. Investigation of trends in dynamics was indicated by workshop participants as a key issue in long-term trend studies. Neutral density in the thermosphere revealed a negative trend increasing with height from about -2 %/decade at 200 km to about -4 %/decade at 700 km; such trends might have impact on lifetime and precise positioning of low-orbiting satellites. Trends in the ionospheric E region appear to change their slope approximately at the same times as changes in total ozone trends, i.e. around 1980 and 1995. Several papers on trends in the ionospheric F2 region reflected present-day controversies, discrepancies and open questions in trends in this region, which are probably influenced by additional factor affecting trends in the upper ionosphere – geomagnetic activity and regionally also secular changes of the Earth's magnetic field. More detail information, program and abstracts of papers may be found at: <http://www.sgo.fi/Events/ltt-2006/>.

Proceedings of the workshop will be published on CD-ROM, and selected papers after passing the procedure of refereeing in the EGU journal *Annales Geophysicae*. The next workshop will be held in 2008, place and date have not yet been determined.

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