Geophysical Research Abstracts
Vol. 12, EGU2010-498, 2010
EGU General Assembly 2010

Physical mechanisms of solar variability influence on weather and climate

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Numerous researches into correlation of weather and climate characteristics with solar and geomagnetic activity confirm that such correlation does exist. However there is some uncertainty in interpretation of the Sun-weather-climate relations. The paper considers the main causes of this uncertainty which are as follows
- the lack of permanent monitoring data on ionizing solar EUV/X-ray radiation including periods of flares; and also the data on electron fluxes of keV energy precipitating from radiation belts first of all during geomagnetic storms;
- multiplicity of Sun-weather-climate links;
- the lack of understanding what are the mechanisms of solar-geomagnetic activity (flares and storms) influence on weather and climate characteristics;
By now mainly the research on galactic cosmic rays (GSR) including Forbush effects and solar cosmic rays (SCR) influences on atmosphere transparence characteristics and further on climate-weather characteristics have been carried out. The GCR flux increase causes the growth of low (usually optically thick) cloudness and therefore produces in generally cooling effect on the mean surface air temperature. The appearance of SCR causes the reduction of stratospheric and tropospheric transparence and produces also usually cooling effect
However these events are rare and corresponding variations of fluxes energy are small. At the same time such strong and frequent manifestations of solar activity as flares and magnetic storms are not so far taken into account since it is not known what physical mechanisms could be responsible for energy transfer from solar flares and magnetic storms to the lower atmosphere.
The paper describes a novel radio-optical mechanism responsible for the solar-terrestrial links which acts as a three-stage trigger and which could be useful for solving the problem “Sun- weather-climate”.
This physical mechanism is based on taking into account the excitation of Rydberg states of atoms and molecules in generation of the ionospheric microwave radiation and in realization of the dissociative recombination of cluster ions in troposphere. The mechanism enables agents of solar and geomagnetic activities affect atmospheric processes with help the flux of microwaves from ionosphere. This first agent under consideration is variation of fluxes of solar EUV and X -ray radiation during flares. The second agent is fluxes of electrons and protons which precipitate from radiation belts as a result of geomagnetic storms..
Our novel radiooptical trigger mechanism of influence of solar and geomagnetic activity on the formation of weather and climate changes consists of three stages. The first stage is an increase in generation of the microwave radiation which penetrates from the ionosphere to the earth surface. The microwave radiation arises from the transitions between Rydberg states which are exited by the energetic ionospheric electrons namely photoelectrons, secondary electrons and Auger electrons. The second stage is a change in the proportion of water vapour to water clusters caused by increased microwave radiation. The third stage is a change of the atmosphere transparence in the absorption bands of water vapour and clusters and appearance of optically-thin clouds at high and middle altitudes. These clouds cause a net warming due to their relative transparency at short wavelengths but opacity in the IR region The atmosphere transparence determines the fluxes of solar irradiance coming down as well as flux of the thermal radiation coming out from the underlying surface.
We emphasize that all stages of the proposed mechanism are experimentally confirmed: the microwave ionospheric emission, which intensifies during solar and magnetic storms, was detected; the regulation of humidity at altitude higher than 2 km by the solar microwave emission and during of solar flares was registered; a direct influence of solar flares and magnetic storms on the total cloudiness is distinctly registered at least in some geographic areas.