VarSITI — Variability of the Sun and Its Terrestrial Impact

Second VarSITI General Symposium

ABSTRACTS

Irkutsk, Russia, 10–15 July 2017

Session 6: ATMOSPHERIC RESPONSE TO SOLAR VARIABILITY AND MODULATION OF ITS IMPACT ON TIMESCALES FROM MINUTES TO DECADES

ATMOSPHERIC IMPACTS OF THE STRONGEST KNOWN SOLAR PARTICLE STORM OF 775 AD

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A severe solar energetic particle storm, which took place in 774–775 AD, was the greatest one over 11 millennia, 40–50 times stronger than the largest event directly recorded during the modern instrumental era. This offers a unique opportunity to test the existing models and assess a potential impact on the Earth's atmosphere for a realistic worst case scenario. Here we present a systematic analysis of this severe event using the available data and up-to-date models. First we reproduce, with the atmospheric climate chemistry model SOCOL and the ^{10}Be production model CRAC, the observed variability of cosmogenic isotope ^{10}Be in four different ice cores from Greenland and Antarctica, thus confirming the validity of the models and the input energy spectrum. Furthermore, important for determining the correct dynamical consequences, the model results suggest that the event likely occurred during boreal autumn. Next, we calculated the amount of nitrate deposited in different polar ice cores and compare those with the observations. We show that, contrary to some earlier claims, even such an extreme solar particle storm cannot produce a notable peak in nitrate concentration. Finally, we assess the possible effect of this uniquely strong event on the Earth's atmosphere and found statistically significant negative total ozone changes lasting for at least one and a half years after the event and changes of the surface weather in the northern hemisphere during the winter after the event.

PROPAGATION OF STATIONARY PLANETARY WAVES FROM THE LOWER TO THE UPPER ATMOSPHERE AT DIFFERENT LEVELS OF SOLAR ACTIVITY

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Changes of zonal circulation and amplitudes of stationary planetary waves (SPWs) in the atmosphere at different levels of solar activity (SA) are studied. General circulation model of the middle and upper atmosphere MUAM is used. To account for changes in solar activity in the model a set of different values of solar radio emission flux at wavelength of 10.7 cm is used. Ionospheric conductivities are also taken into account with their latitudinal, longitudinal and time dependencies calculated for different SA levels. The simulation includes general atmospheric circulation, amplitudes of SPWs with zonal wave numbers 1 and 2, refractive indices for SPWs and Eliassen-Palm fluxes corresponding to considered SPWs. Simulations are carried out for January-February and conditions of low, medium and high solar activity. It is shown that at high SA the zonal winds are larger at altitudes above 150 km and smaller at lower altitudes. At high SA SPW amplitudes are smaller at altitudes above 120 km and are larger at altitudes lower than 100 km, than those at low SA. These differences correspond to the calculated changes in the

SPW refractive index of the atmosphere and Eliassen-Palm flux. Changes in conditions of SPW propagation in the thermosphere at different levels of solar activity may affect changes in SPW amplitudes and atmospheric circulation at smaller heights in the middle atmosphere.

USING THE EMISSIONS OF EXCITED OXYGEN TO STUDY FAST [O3] VARIATIONS IN THE MESOSPHERE AND LOWER THERMOSPHERE

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In the framework of the model of electronic vibrational kinetics of excited products of O3 and O2 photolysis in the MLT of the Earth, YM2011, we study the possibilities of retrieval the [O3] altitude profiles using as proxies electronic-vibrationally excited levels of oxygen molecule, namely O_2(b1, v=0, 1), O_2(a1, v=0) and excited atom O(1D). Population of O2 (b1, v=2) doesn't depend on [O3]. Concerning the [O3] retrieval in the range of 50–100 km, the emission at 1.27 μm formed by transition from O_2(a1, v=0) and emission at 762 nm formed by transition from O_2(b1, v=0) are the most intensive ones among all emissions under consideration. However, considering the complexity of kinetics of the excited components: choosing O_2(a1, v=0) as a proxy for [O3] retrieval requires taking into account 25 aeronomical reactions. For other proxies the number of aeronomical reactions is as follows: O_2(b1, v=0)−18; O_2(b1, v=1)−13; O_2(1D, v=0)−5. Increasing the number of reactions that must be considered when using a proxy from O(1D) to O_2(a1, v=0) depends on the fact that, calculating the population of each of the underlying electronic-vibrationally excited state requires considering the mechanisms of the population of the upper levels. Therefore, O_2(b1, v=1) is the preferable proxy at the altitudes of 50−98 km. Commonly used [O3] retrieval proxy, O_2(a1, v=0), transition from which forms the 1.27 μm O2 IR Atmospheric band, has more than one hour photochemical lifetime in the MLT region. On the other hand, the O(1D) and O_2(b1, v=0, 1) lifetime in the altitude region of 50−120 km is less than 14 sec. So, the proposed O_2(b1, v=0, 1) and O(1D) proxies can be used for tracking fast variations of the O3 atmospheric concentrations generated by wave processes, electron precipitations, solar flux changes, and so on, when the O_2(a1, v=0) proxy becomes useless.

INFLUENCE OF SOLAR ACTIVITY ON INDIAN SUMMER MONSOON RAINFALL FOR THE LAST FIVE CENTURIES

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Previous studies investigating the relationship between solar activity and Indian Summer Monsoon Rainfall (ISMR) using instrumental records have been reported. Temporal scale of observed Sunspot numbers (since 1700) and recorded ISMR time series (starts from 1871) are a constraint to study any relation between solar cycle and ISMR in the multi-decadal variability scale. So, this present research effort investigates decadal and multi-decadal variability in the ISMR and its teleconnection with solar activity using proxy reconstructions for few centuries before present. Increased precipitation in the tropical region favors growth of tree rings. Speleotherm records can also yield similar rainfall estimates like tree rings. Both tree rings and speleotherm records is used as ISMR proxy data. Simulated Sunspot numbers are available to study its teleconnection with ISMR