Project of Modelling ion heating and wave - particle interaction in the magnetosphere of Earth

Imad Barghouthi,
Department of physics, Al-Quds university, Jerusalem , Palestine.
barghouthi@science.alquds.edu
Hans Nilsson,
wedish space physics institute, Kiruna, Sweden.

Specific Aims of the Project:

The purpose of the project is to advance our understanding of wave - particle interaction and resulting ion heating and escape into interplanetary space. This is achieved through computer models and spacecraft based observations. The long term goal is to build a general model of stellar wind interaction with planetary atmospheres. This project will put particular emphasis on high altitude heating of ions for magnetized planets (i.e. the Earth). The computer model of the Palestinian counter-part (i.e. Barghouthi model) will be compared to observations, and extended according to what we learn from these comparisons. The model results will almost certainly lead us to search for new details in the observations. For the observational part we will initially use the European Space Agency Cluster spacecraft, which in due time will be combined with lower altitude spacecraft such as FAST, Freja and Viking in order to get an as complete altitude coverage as possible. Our most immediate plans are to:

1. Explain the very efficient high altitude heating observed at about 10 Earth radii altitude over the polar cap (Nilsson et al, 2004, 2006, 2008a, b).
2. The Barghouthi model (Barghouthi et al., 2006, 2007, 2008) already incorporates a finite wave length effect saturating the heating

efficiency from about 3 earth radii above the polar cap. Preliminary results indicates that it also can reproduce most of the features of the efficient heating at higher altitudes of about 10 Earth radii. We will examine what it takes to explain all features observed at high altitude, and if necessary refine the model to give an accurate picture of ion heating over the entire altitude interval of interest.

3. The Barghouthi model is also a model for auroral oval outflow, whereas the most studied outflow, at least using the Cluster spacecraft, are the cusp - polar cap outflow. We will tehrefore extend the model - observations comparison to include the auroral zone outflow. We will also try to estimate if this outflow can contribute to the escape of
ions from the magnetosphere or if most of these ions will be returned to the atmosphere.

4. Combine the above to make a complete picture of the ion heating and resulting ion escape from the ionosphere until the ions escape the Earth's magnetosphere (or are returned through the effect of the magnetic field of Earth). This can be extended to model ion escape for different conditions as compared to the observations, such as the ancient Earth and other planets.

5. Generalize our understanding of wave particle interaction to other regions of space. For example the high altitude polar cap ions we observe show clear evidence for preferential energization of heavy ions. Such processes are of interest also for example in the solar wind.