

## BEHAVIOR OF VERTICAL NEUTRAL WINDS IN THE E-LAYER NEAR AURORA

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**Abstract.** Vertical neutral wind distributions in the ionospheric E-layer around auroras are presented. It is shown that the vertical winds are directed upward right over and equatorward of the auroras, while the direction is downward to the north of them. Possible mechanisms of such vertical wind behavior are discussed.

### Introduction

The neutral wind in the upper atmosphere is basically determined by global circulation. At heights of the ionospheric E-layer the vertical wind velocity is typically considered to be small. However, the energy released in the auroral zone during geomagnetic disturbances is quite comparable to the radiation energy coming from the Sun. As a result, in the auroral zone, disturbances of global circulation can arise resulting in occurrence of both horizontal and vertical winds. Measurements of the neutral winds in the E-layer (100-130 km) are not numerous, still, in recent years a few of them performed in the vicinity of aurora during periods of enhanced vertical wind, have been reported in literature. In particular, Bogdanov and Leontyev (1991) showed that while in the absence of auroras the vertical wind velocity distribution is Gaussian, in the presence of aurora at the zenith of a station it is displaced by 50 m/s. Price et al. (1995) reported large (up to 100 m/s) upward wind velocities at the poleward edge of the auroral zone. Sakurai et al. (1998) measured the upward wind of ~40 m/s with aurora being at the zenith of the station. Ishii et al. (2001) examined 14 events of the vertical wind in the presence of aurora. The authors divided all the events into cases occurred under auroras of large spatial scale and those accompanied by small-scale auroras and showed that in the events of the former group the vertical winds were directed upward to the north of the auroras and downward to the south of them. In case a bright auroral arc, i.e. a small spatial scale disturbance, occurred at a zenith of the station, the vertical wind was directed downward, at heights of both E- and F-layers.

### Data

Here we present some examples of vertical wind behavior in the vicinity of aurora. The data refer to the heights of 100-130 km at a zenith of Tumanny observatory (65.24, 116.7) in the period of November 2002 – January 2003. The vertical wind velocity was determined with a Fabry-Perrot interferometer, and the auroras were monitored with a scanning photometer and TV camera. Nine nights were selected, when the weather conditions were favorable for observations, with auroras being observed at a zenith.

In Fig. 1 the event of November 2, 2002 is illustrated. The top panel shows auroral situation as observed with a meridian scanning photometer, the second panel gives the intensity of the green (557.7 nm) emission at the zenith of the station, the third panel presents the vertical wind velocity (running average is shown by the thick line). The magnetic variation is given in the bottom panel. The analysis of TV data has shown that, first, a weak pulsating arc appears to the north of the station, which gradually moves to the south. This is accompanied by H component of the geomagnetic field decreasing. At 17:10 UT a slight drop in the magnetic field is observed and till 17:20 UT we have bright, quickly moving aurora at the zenith of the station. Then, the auroras go southward. At 18:40 UT the second break-up starts, with aurora coming to the zenith. The velocity of the vertical wind is upward till 17:20 UT, with its value gradually increasing up to ~50 m/s, then the direction turns for downward and by 18:40 UT the velocity becomes upward again.

In Fig. 2 the event of January 7, 2003 is shown, the same quantities as in Fig.1 being presented. A weak pulsating arc is observed after 19:00 UT at the zenith of the station. After 20:00 UT it slowly moves to the south, which corresponds to substorm growth phase. At 20:50 UT the expansion phase begins, with the auroras moving fast to the north passing through the zenith of the station. During the southward motion of the auroras the vertical wind velocity stays downward and slowly grows up to ~40 m/s. After aurora passing the zenith of the station on their return movement, the velocity direction becomes upward.

### Summary and discussion

As follows from the above consideration, the vertical wind velocity in the vicinity of auroras varies from 30 to 50 m/s. Right over the aurora and to the south of it, the direction of the velocity is upward, while it is downward northward the aurora. Such a distribution of the vertical wind velocity related to auroras is not consistent with the results of Ishii et al. (2001), so that further detailed examination is needed.

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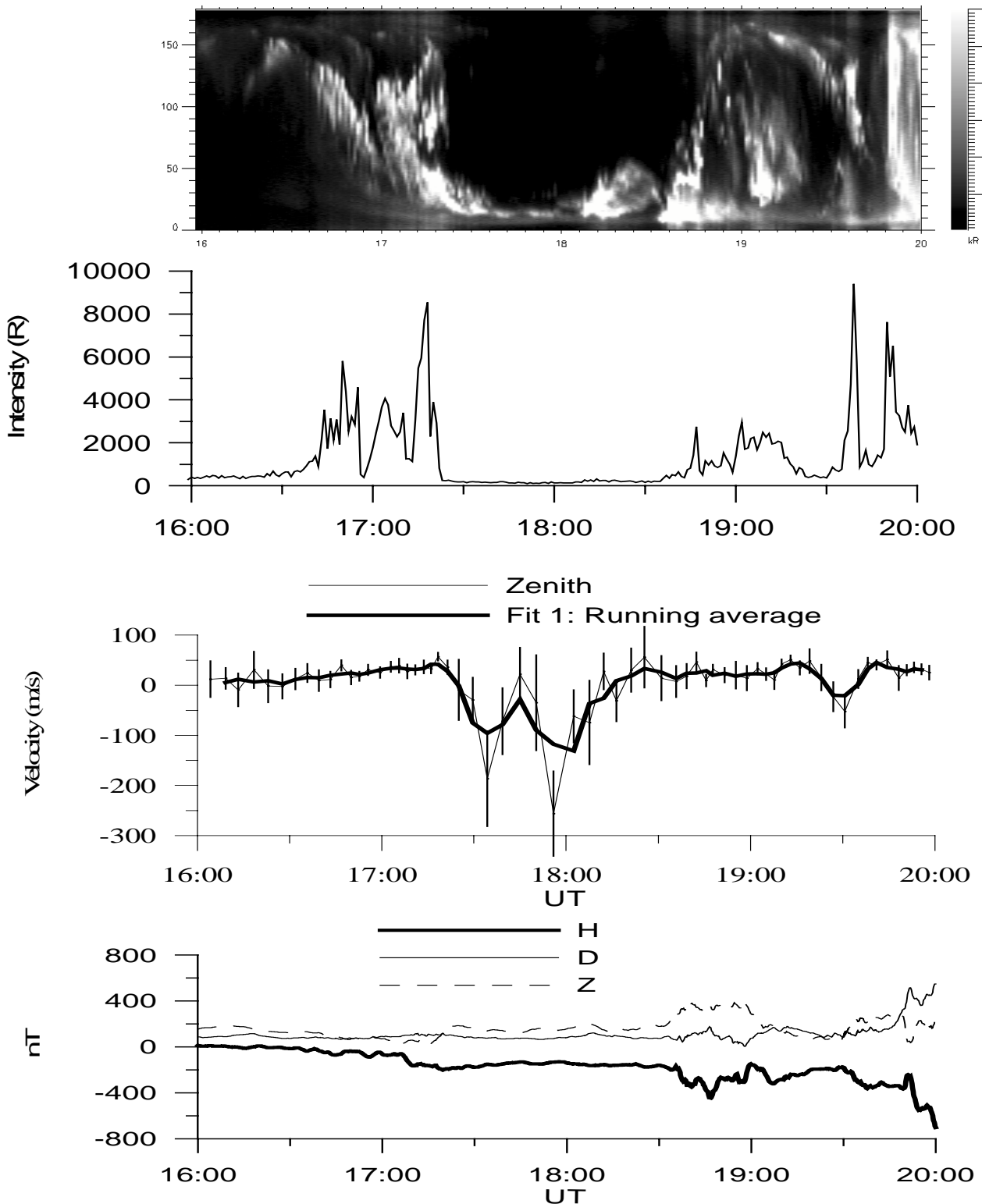


Fig. 1

Auroral and magnetic situation and the vertical wind velocity on November 02, 2002 (see the text). On the top panel zenith corresponds to  $90^{\circ}$ .

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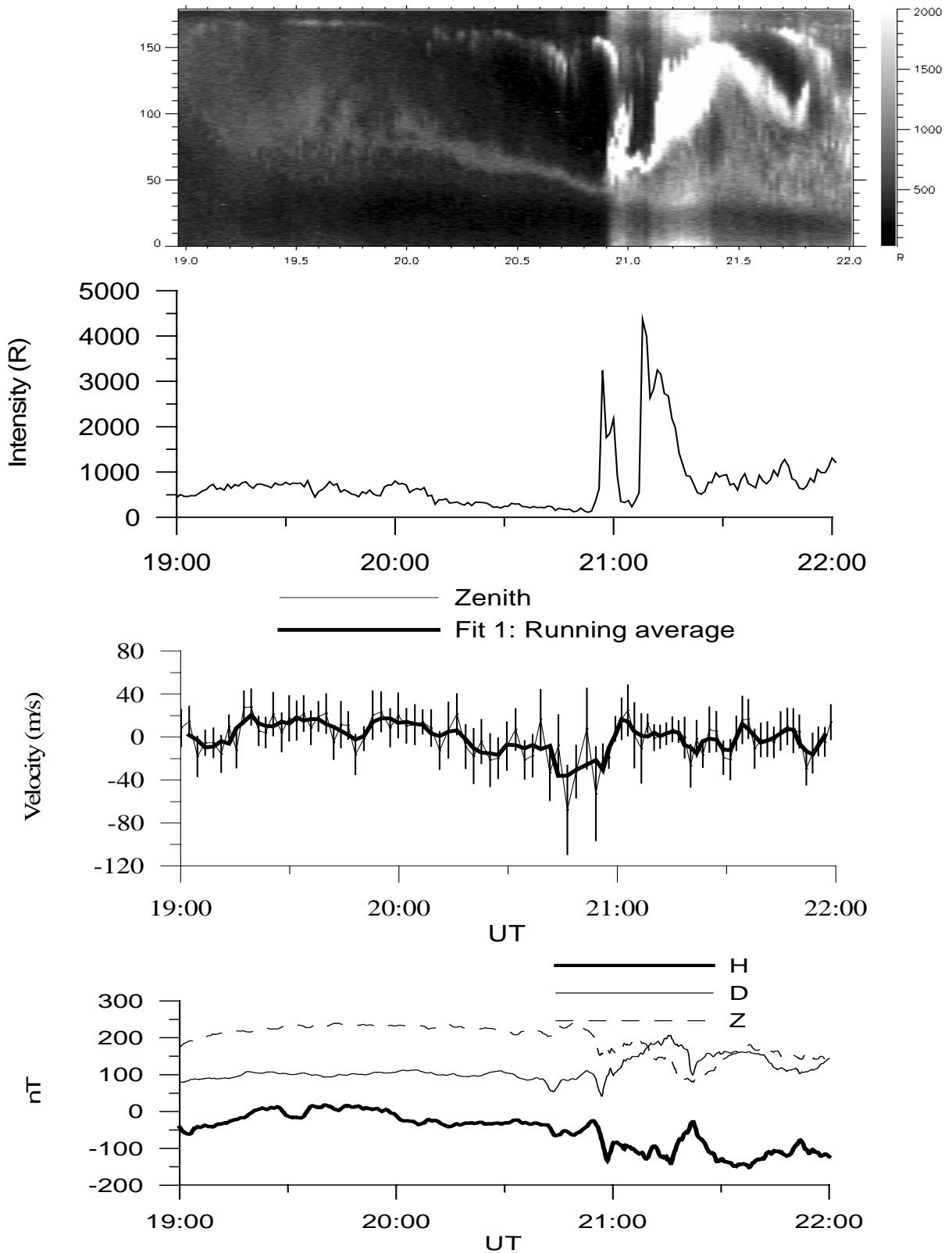


Fig. 2 The same as in Fig. 1, but for the event of January 07, 2003

The occurrence of vertical winds right over auroras is commonly interpreted in terms of Joule and precipitation particle heating of the neutral atmosphere. However, their occurrence in the adjacent regions outside the aurora requires other mechanisms, one of which was proposed by Lyatsky and Leontyev (1982). The authors

suggested that the ion density is strongly enhanced in the auroral arc. The ions move along the polarization electrical field in the ionospheric E-layer and drag neutrals. As a result, a neutral vortex arises with the opposite vertical velocities from the different sides of the arc. We note, that in the midnight sector the electric field is usually pointed to the equator, so in the arising vortex the vertical velocity should be upward to the south of the arc and downward to the north of it.

Thus, the observed behavior of vertical wind in the vicinity of aurora can be explained by joint effect of atmosphere heating over the auroral arc and dragging of neutrals by ions inside the aurora.

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