The main results of the investigations presented in this thesis are summarised as follows.

**PART I.**

1. Sudden disappearance of equatorial \( E_s \) (SDE\(_s \) event) is found to occur both on magnetically quiet and disturbed days. The occurrence of SDE\(_s \) event is maximum between 1400 and 1500 hours local time. It is found that the occurrence of SDE\(_s \) event is maximum in January, May and September months with January maximum as the highest.

2. During the SDE\(_s \) event the range of the horizontal magnetic field \( \Delta H \) goes below the average quiet day value.

3. Sudden disappearance of \( E_{sq} \) on magnetically quiet days is always associated with a decrease in the horizontal magnetic field but the converse is not true. In most of the cases, at the time of disappearance, the field value is above the night-time value. This means that the overhead eastward current in the dynamo region responsible for \( H \)
variations is not reversed in the direction at the time of disappearance for most of the cases.

4. The eastwest electric field ($E_y$) and electron drift velocity ($V$) at E-region levels are estimated using horizontal magnetic field values. $E_y$ and $V$ show similar diurnal variations and attain peak values higher than 0.6 mV/m and 600 m/sec respectively before local noon. $E_y$ and $V$ on the days of SEE event show considerable decrease during the event.

5. It is found that the sudden disappearance of $E_{sq}$ occurred when $V$ is less than 300 m/sec or equivalently when $E_y$ is less than 0.3 mV/meter. No disappearance of $E_{sq}$ has been observed when $E_y$ is above 0.3 mV/meter. When $E_s$ reappeared as blanketing $E_s$ after SDE event, $E_y$ and $V$ are found to be westward and eastward respectively. The morning onset of $E_{sq}$ is most likely to occur, in general, when $V$ is above 100 m/sec or equivalently $E_y$ is above 0.1 mV/m.

6. Theoretical calculations based on the cross-field instability mechanism showed that instabilities can grow in the equatorial E-region even when
E_y and V are quite small. It is also found that the phase velocity of propagation of the cross field instabilities does not vary with wavelength. This agrees well with the backscatter radar observations at Jicamarca.

PART II.

1. It is found that there is a close association between the east-west electric field (E_y) at the E region levels and the F region parameters. It is found that the day to day variations in constant electron density height contour shows linear relationship with E_y in the prenoon period. In the afternoon, no such clear relationship is evident between the two. It is concluded from the association of E_y with F region parameters that the ground magnetic field changes on the magnetically quiet days examined, are due to changes in E_y but not due to changes in the E region conductivity.

2. It is shown that the nighttime vertical F region velocities can be estimated from N-h profiles under certain conditions without assuming the vertical