Latitude gradients in the natural variance in stratospheric conductivity – Implications for studies of long-term changes

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Abstract

Stratospheric electrical conductivity measurements have been made from high altitude research balloons at various locations around the world for more than 40 years. In the stratosphere, conductivity changes may indicate changes in aerosol or water vapor content. In this paper, we will compare the short term variation amplitude in data taken at several latitudes from equatorial to polar cap. Short term variations that occur on time scales of weeks to months ($10^5$–$10^7$ s) can be attributed to Forbush decreases, geomagnetic storms, aerosol injections by volcanos and forest fires, etc. Variations with time scales of minutes to days ($10^3$–$10^5$ s) can have amplitudes of a factor of $\sim 2$ or more at high magnetic latitude. The variance at equatorial latitude is much smaller. The sources of these fluctuations and the latitude gradient remain unknown. Variations of all origins completely obscure any long-term climatic trend in the data taken in the previous four decades at both mid and high latitude.

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1. Introduction

Balloon-borne measurements in the past have consistently shown that the atmospheric electrical conductivity generally increases exponentially with altitude through the troposphere and stratosphere. However, there are considerable uncertainties in the nature of the conductivity because of spatial and temporal variations that are not well understood. In this paper we report measurements of the stratospheric conductivity by more than 40 high-altitude balloons, launched from eight locations widely separated in latitude over a period of nearly 40 years. The measurements provide the opportunity to investigate long-term variations in conductivity profiles on local and global scales. This paper will focus on evidence for a geographically organized latitude gradient in the natural variance of the conductivity measurements. This research was motivated by the lack of global measurements of the atmospheric conductivity and its variations, which are crucial to our understanding of the global electrical environment (Hays and Roble, 1979; Roble and Tzur, 1986).

The atmospheric conductivity is proportional to the product of the ion concentration and the ion mobility. Variations in conductivity may be caused by a variety of factors that alter either of these two basic quantities.