Correction Methodology for the Atmospheric Component of the Night Sky Polarization

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The north celestial pole (NCP) is a very special point for night sky observations since all the astronomical sources of light remain the same there all through a night or year. One source of exception would be the zodiacal light because the scattering geometry made by the Sun, interplanetary dust (IPD), and observer's line of sight change continuously with time due to the Earth diurnal motion. Since the zodiacal light is known to be the strongest source of night sky polarization, the direction of the observed polarization is expected to change at a rate of 15 ° per hour. However, observations show that the diurnal change doesn't quite follow the expected rate. We interpret the discrepancy as an evidence of the residual polarization in the atmospheric diffuse light. The optical path length over the Earth atmosphere increases only toward the horizon, but remains the same over an azimuthal circle. This symmetry/asymmetry combination would make the atmospheric polarization have its direction in the observer's meridian. On the other hand, the very nature of small particle scattering tells us that the zodiacal light should be polarized, in most part of 360 ° elongation, perpendicularly to the scattering plane. The plane of scattering by the IPDs can be calculated exactly at any moment of observations. Therefore, we know the directions of the two polarization sources as a function of time. This enables us to construct the ellipse of the observed night sky polarization as a sum of two polarization ellipses with known directions of major axes: one is for the atmospheric component and the other the zodiacal light. On the basis of the ellipse-summation we have devised a reduction methodology of night sky polarization, through which the atmospheric contamination can be corrected for. In this paper we will explain how the methodology works out by applying it to two nights of polarization observations done for the NCP.