

Sun-aligned arc の成因

田中高史¹

¹九州大学名誉教授

Generation mechanism of the sun-aligned arc

T. Tanaka¹

¹Kyushu University

From the global M-I coupling simulation, the structure of the magnetosphere-ionosphere system is calculated under the northward IMF condition. Based on this numerical solution, we examined the cause of the sun-aligned arc. In the simulation, the regions of auroral oval, sun-aligned arc, and the void are reproduced on the ionosphere. While the latitudinal width of the sun-aligned arc region is 3° in the midnight, it becomes 10° in the morning and evening sectors, to reproduce the shape of the horse collar. The magnetic field of the null-separator structure are generated from two null points and two separator lines. The entire space in this structure is divided in four types of magnetic regions, the IMF, the northern open magnetic field, the southern open magnetic field, and the dipole magnetic field. When the outmost closed field lines on the boundary between the closed magnetic field lines and northern open magnetic field lines are drawn, their projection onto the northern ionosphere is situated on the boundary between the sun-aligned arc and the void. Also projection to the southern ionosphere coincided with the separator line. The magnetic field lines of the plasma sheet inner boundary is projected to the equatorward boundary of the oval. Therefore, sun-aligned arc is situated under the closed magnetic field of the plasma sheet. An inflated structure (bulge) is generated in the plasma sheet in the process of connecting the plasma sheet, which is inclined in the distance tail, to the ring current region that does not tilt. In the northern hemisphere, the bulge is wrapped by the outmost closed magnetic field lines that are connected to the evening side ionosphere. This inflated structure (bulge) is the cause of the sun-aligned arc.

Key points

The null-separator structure is projected onto the polar ionosphere under the northward IMF condition.

Horse collar and void structures are reproduced in the polar ionosphere from the global M-I coupling simulation.

The FACs are induced by shear flow in a thick plasma sheet that connects the inclined plasma sheet to the ring current region.

Key words

Global simulation, null-separator structure, horse collar, void

グローバル M-I 結合シミュレーションによって、北向き IMF の時、磁気圏—電離圏構造を計算した。この解を基に、sun-aligned arc の成因を調べた。シミュレーションでは、電離圏上に、オーロラオーバル、sun-aligned arc、ボイドの領域が再現される。Sun-aligned arc の領域は真夜中では3度、朝夕では10度の幅になり、ホースカラーの形状を再現する。磁気圏の磁場は2つのヌル点と、2本のセパレーターラインから生成される、ヌルセパレーター構造を成す。この構造では全空間は、双極子磁場、北半球の開磁場、南半球の開磁場、IMFの4種類の磁場で分けられる。双極子磁場と北半球の開磁場との境界にある北最外郭閉磁場を描くと、その北半球電離圏への投影は、sun-aligned arc とボイドの境界になる。また南半球電離圏への投影は、セパレーターラインになる。プラズマシート内端の磁場は、オーバルの赤道端に投影される。従って、sun-aligned arc は、プラズマシートの閉磁場の下にあることになる。遠方で傾いたプラズマシートが、傾かない環電流領域に接続される過程で、プラズマシートに膨らんだ構造ができる。北半球の膨らみは北最外郭閉磁場のうち、夕方の電離圏に繋がる部分で包まれる構造になる。この膨らんだ構造が sun-aligned arc の原因となる。