

利用福衛三號觀測估算電離層空間相關距離

Spatial Correlation Distance of the Ionosphere by the FORMOSAT-3/COSMIC Measurements

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摘 要

地球電離層對於無線電波的傳播有著顯著的影響，且會因為太陽活動、太陽風、地磁活動和低層大氣擾動等外在環境作用，讓電離層呈現相當複雜的時空變化。同時，電離層觀測資料的時空解析度相對稀疏，對於建立精確的電離層預報模型或是進行資料同化都會形成相當程度的挑戰。雖然在福爾摩沙衛星三號和七號任務之後，大量提供了全球近即時電離層電子濃度剖面。不僅能夠縮短更新全球電離層結構的資料累積時間，也透過資料同化技術提升數值模式預報產品的表現。然而，透過資料同化真實的觀測資料與背景場參數結合時，空間和時間相關性對於再分析場的調整至關重要，也決定預報場能否更好地應用於分析太空天氣變化背後的物理機制。目前的電離層資料同化系統對於每筆觀測資料的影響範圍多採用各項等距的影響半徑，且不隨經、緯度位置調整。但以電離層結構實際上在中緯度地區的空間相關距離相對較大，白天的空間相關距離大於夜間，緯向空間相關距離大於經向相關距離，而應該是一個隨位置呈現不對稱的影響半徑。因此，本研究透過福爾摩沙衛星三號任務期間觀測資料，以地磁緯度搭配當地時間座標進行分析，描述電離層空間相關距離，以期進一步應用於電離層資料同化系統中試圖提升預報表現。

關鍵字：福爾摩沙衛星三號、電離層掩星、空間相關距離、資料同化

Abstract

The Earth's ionosphere significantly influences radio wave propagation and exhibits highly complex spatiotemporal variations driven by external forces, such as solar activity, solar wind, geomagnetic activity, and lower atmospheric disturbances. Concurrently, the relatively sparse spatiotemporal resolution of ionospheric observations poses a substantial challenge to constructing accurate forecasting models and executing effective data assimilation. Although the FORMOSAT-3 and FORMOSAT-7 missions have provided an abundance of near-real-time global ionospheric electron density profiles, shortening the data accumulation time required to update global structures as well as advancing model forecasts through data assimilation. While assimilating real observations into background field, spatial and temporal correlations are used to determine the size of impact area. Current systems apply an isotropic, homogeneous size for each observation at all location. Generally, the ionosphere exhibits a relatively large spatial correlation distance in mid-latitude regions, and zonal ones wide than meridional ones. This indicates that the size of impact area should be asymmetric and location-dependent. Therefore, this study analyzes observations of FORMOSAT-3 mission to estimate the ionospheric spatial correlation distance in geomagnetic latitude and magnetic local time coordinates, and to improve the forecasting performance of ionospheric data assimilation system.

Keywords: FORMOSAT-3/COSMIC, Ionospheric radio occultation, Spatial correlation distance, Data Assimilation