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# An Algorithm for 3D Modeling of Doppler Weather Radar Base Data

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**Abstract.** This paper proposed a Marching Trapezoidal Polyhedrons 3D modeling algorithm (MTPD) based on the cone-shaped spatial distribution of Doppler weather radar base data. In this algorithm, a trapezoidal polyhedron was introduced to replace the cube in the conventional modeling algorithm as a basic volume element for modelling. On the other hand, the hexahedral index or tetrahedral index was selected as the construction model for the 3D iso-surface based on the difference in spatial range for 3D radar modeling, to balance the efficiency of the algorithm and the precision of the modeling results. Based on this algorithm, a Doppler weather radar 3D visualization platform was developed using WebGL technology. The results revealed that the algorithm significantly improved efficiency without compromising the precision of 3D modeling when compared with the conventional modeling algorithm based on radar grid data. The durations for the algorithms were reduced by 1.9 seconds and 0.7 seconds, respectively under the hexahedral index mode and the tetrahedral index mode, while under the tetrahedral index mode, the 3D echo structure was more continuous with a higher level of precision. The Doppler weather 3D radar visualization platform based on the B / S architecture could provide a cross-platform 3D radar display, thus visualize the 3D structure of convective cloud effectively.

**AMS subject classifications**: 68Q25, 93A30
**Key words**: Doppler weather radar, 3D modeling, Marching trapezoidal polyhedrons, WebGL.

## 1 Introduction

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Doppler weather radar is one of the main means to detect mesoscale convective weather systems and their intensity, distribution, development and evolution. With high temporal and spatial resolution, Doppler weather radar plays an important role in improving the accuracy of severe weather warning and prediction [1-4]. It is an intuitive and effective means for meteorologists to observe the distribution and development of radar echoes and analyze weather process accurately by using computer graphics technology to display the base data generated by weather radar detection. At present, the display of weather radar data used in meteorological services in China is still dominated by two-dimensional images [5-7], but the two-dimensional display mode only reflects the distribution of echoes at a certain level, which is difficult to truly reflect the spatial structure of the cloud. 3D modeling can intuitively display and analyze the internal characteristics of radar echoes, which is helpful to understand the spatial structure of weather system and improve the forecasting ability of weather system. Therefore, 3D modeling of weather radar data is an inevitable trend of meteorological data application, and it is also an urgent need for the development of weather forecasting business.

In recent years, domestic and foreign scholars have carried out relevant research on the three-dimensional modeling of weather radar. Ernvik [8] used three algorithms of cross-section plane slice, surface extraction and stereo rendering to conduct three-dimensional modeling research on radar echoes. Kristof et al. [9] realized three-dimensional display of NEXRADII reflectivity data by CUDA ray-casting algorithm for core stereoscopic rendering. Moreno et al. [10] combined two-dimensional images of radar reflectance at each elevation Angle of radar as input to form a three-dimensional radar echo structure. Xiao et al. [11] used NVI algorithm to interpolate radar reflectance data into three-dimensional grid points of latitude and longitude. Zhang Zhiqiang et al. [12] used moving cube algorithm and ray projection algorithm to realize three-dimensional reconstruction of radar echo on this basis, and the product was applied in the Short Time Approaching Forecast System of catastrophic weather (SWAN). Luo [13] uses Proximity Clouds algorithm to improve the light projection algorithm to achieve three-dimensional radar display. Han [14] realized three-dimensional modeling of radar echoes by extracting the contour lines of PPI image faults of weather radar. The above visualization algorithms extend the radar echo display from a two-dimensional plane to a three-dimensional space, which is conducive to the in-depth analysis of radar data, but there are still certain limitations. 1) he above algorithms all use regular grid data as the data source of radar echo 3D modeling, requiring the radar base data stored in the form of polar coordinates to be interpolated into the three-dimensional grid points under the Cartesian coordinate system. Although this improves the spatial accuracy of radar data, it consumes a lot of computing resources on the one hand, and makes the visualization accuracy depend on the accuracy of the interpolation algorithm on the other hand. 2) Because the amount of 3D grid data obtained by interpolation is much larger than that of the original radar data, the calculation is more complicated, reducing the efficiency of the algorithm, and it is difficult to adapt to the scene with high real-time interaction