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Implementation of the Bessel's method for solar eclipses prediction within the WRF-ARW model

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Solar eclipses are predictable astronomical events that reduce momentarily the incoming radiation into the Earth's atmosphere inducing significant changes on the meteorological fields, such as it has been analyzed in many studies since the late 60s. Moreover, the growth of the solar renewable energy industry is increasing the interest for adding new specifications in Numerical Weather Prediction (NWP) models oriented to solar resource assessment and forecasting applications. The recent partial and total solar eclipses that occurred in USA (October 23, 2014) and Europe (March 20, 2015), respectively, are showing the necessity to incorporate these astronomical events on the current solar parameterizations, beyond the purely meteorological interest.

Although in the 90s and 2000s, some studies added solar eclipse episodes within NWP codes, they worked with basic eclipse parameterizations adapted for dealing with particular cases of study. We present a new package for the Weather Research and Forecasting-Advanced Research (WRF-ARW) model ready for considering any partial, annular, total or hybrid solar eclipse. The algorithm computes analytically the trajectory of the Moon's shadow and the degree of obscuration of the solar disk at each grid-point of the domain based on the Bessel's method and the Five Millennium Catalog of Solar Eclipses provided by NASA, with a negligible computational time. Then, the incoming radiation is modified accordingly.

This contribution is divided in two parts. First, we present a description of the implementation of the Bessel's method within the WRF-ARW model together with a validation for the period 1950-2050 of all solar eclipse trajectories with respect to NASA's values. Second, we analyze the model response in four total solar eclipse episodes. This part includes a validation of the global horizontal irradiance compared with different Baseline Surface Radiation Network sites as well as a discussion about the impact on surface temperature, pressure and wind speed.