Introduction
An in-depth analysis of numerical simulations is performed to obtain a deeper insight into the nature of various phenomena occurring in the solar atmosphere as a consequence of the eruption of unstable coronal structures. Simulations take into account only the most basic characteristics of a flux-rope eruption and reveal important information on various eruption-related effects. It is shown that the eruption can cause an observable Moreton wave and a secondary coronal front only if it is powerful enough and is preferably characterized by significant lateral expansion.

The Model
The simulations were performed employing the Versatile Advection Code (VAC; Tóth, 1996; Goedbloed, Keppens, and Poedts, 2003) and setting:
- 2.5D model: $B_{0}(x,y) \neq 0$, $v_{r} = 0$, $\beta = 0$
- vertical profile of the density: solar atmosphere
- flux-rope magnetic field is defined as:

$$B_{\rho}(r) = \frac{B_{0}}{2} \sin \left( \frac{\pi r}{r_{0}} \right)$$

- $B_{\rho}$ represents the initial magnetic field at the center of the flux rope located at $x = 0$, $y = y_{0}$
- $B_{\rho}$ represents the initial poloidal field at the flux-rope boundary
Outside the flux-rope ($r > r_{0}$):
- $B_{\rho} = 0$, $v_{r} = 0$
- poloidal field is the potential field: $B_{\phi} = B_{\rho} r/r_{0}$

The runs are performed for the values of:
- the central field: $B_{0} = 5$, 6, 7, 8, 9, 20, 50
- the initial height: $y_{0} = 0.20$, 0.25, 0.30
- the initial upward speed: $v_{0} = 1$, 2, 3, 4, 5.

Results
The modeling reveals a rich variety of eruption-driven phenomena, reproducing nicely the typically observed eruption-associated signatures:
- a fast-mode MHD shock that propagates in all directions ahead of the expanding source-region,
- the source region expansion is subsonic in the helmet streamer configuration
- the shock formation is caused by a nonlinear evolution of the large-amplitude perturbation front driven by a subsonically expanding piston.

The max. Alfvén Mach number ($M_{A}$) of the source region is reached within $t \approx 0.02$:
- for $B_{0} = 20$: $M_{A} \approx 0.5$
- shock forms at $t(x = 0.03) = 0.25$
- for $B_{0} = 10$: $M_{A} \approx 0.1$
- shock forms at $t(x = 0.07) = 0.35$

Comparison to the real situation:
- the background coronal Alfvén speed: $v_{A} = 300$ km/s
- the numerical box a size of: $A = 450$ Mm
- corresponding to the Alfvén travel time:

$$t_{A} = A/v_{A} = 1500 \text{ s}$$

shows that the corresponding shock formation times ($t = t(x)$) and distances ($x = x(t)$) are:

- $t \approx 0.45$ s; $x(t) = A$
- $t \approx 1.45$ s; $x(t) = A$

These numbers are consistent with the appearance of the coronal EUV waves, Moreton waves and the radio type II bursts.

After a phase of expanding source region:
- the coronal wave propagates as a large-amplitude “simple wave” by:
- the increasing size of the expanding wave-front,
- the evolution of the wave amplitude,
- the change of the background Alfvén speed along the direction of propagation.

The coronal shock passage:
- impulsively exerts a downward compression on the transition region and chromosphere
- perturbation propagates downward as a quasi-longitudinal MHD shock
- the strong disturbance is able to create an observable Moreton wave

Conclusion
It is shown that even a relatively simple 2.5D numerical simulation provides an in-depth insight into the nature of various phenomena occurring as a consequence of the eruption. It directly relates properties of the eruption with the characteristics and evolution of the expanding large-amplitude coronal fast-mode MHD wave (observed as fast EUV coronal waves and radio type II bursts) and the related chromospheric downward-propagating quasi-longitudinal perturbation (resulting in a Moreton wave). Moreover, it reveals the nature of secondary effects such as coronal upflows, secondary shocks, various forms of wave-trains, delayed large-amplitude slow disturbances, transient coronal dimmings, and chromospheric relaxation.

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