Investigation of seismic excitation of Martian dust devil vortices using 3D seismic wave propagation simulation

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Abstract:

Since NASA's InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) landed on Mars in November, 2018, it has been conducting observations of seismic waves, pressure, temperature, wind speed and so on (*Banerdt et al.*, 2020).

On Mars, dust devil vortices (i.e. whirlwind) occur on a daily basis due to the diurnal variation of atmospheric temperature. As observed on the Earth, when a vortex moves around, the nearby ground is deformed, generating seismic waves accordingly (*Lorenz et al.*, 2015). From the seismic and atmospheric data of the InSight, a number of seismic signals correlated with transient pressure drops have been detected, and many data among these can be connected with dust devil events (e.g. *Lognonné et al*., 2020). While the deformation of the ground gives us information about elastic properties around the landing site, seismic signals by the vortices enable us to constrain the subsurface structure of Mars.

Looking at the seismic signals by dust devil vortices, those can be categorized in 3 different families. One family is "spike" type, another is characterized by "High Frequency Oscillations (HFO)" and the other is a complex type (i.e. both spike and HFO type are mixed). However, it is still an open issue that what makes these differences and what kind of parameter plays an important role to characterize them. In this study, we started with an assumption that these differences are due to different seismic excitation, and performed 3D numerical simulations of seismic waves based on the constraints from the observations. As a first step, we focused on a reference dust devil event whose track information, pressure data, wind data and seismic data were tied with each other by *Banerdt et al.* (2020), and confirmed the overall features of the seismic data were well reproduced by our simulations (*Onodera et al.*, 2020). Then, we conducted parameter studies on input pressure model, internal structure model, track geometry of the vortex in order to discuss which factor plays an important role to characterize the seismic signals of dust devils.

In the presentation, we discuss how seismic signals by dust devils can be modeled and which parameter mainly characterizes them.

Keywords: Seismology, Geodynamics