Using Planetary Radar Sounders as Solar Observatories: Characterisation of type-III bursts with SHARAD and MARSIS

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Multi-point observations of the Sun have been providing important contributions to open research topics in heliophysics, such as the origin of different types of solar bursts [1] or the propagation effects they undergo in the interplanetary medium [2]. In this abstract we investigate the possibility of using the radar sounders SHARAD (*Shallow Radar*) and MARSIS (*Mars Advanced Radar for Subsurface and Ionosphere Sounding*), in orbit around Mars since 2006 and 2005, respectively, as solar radio-observatories in conjunction with dedicated missions.

In addition to offering an extra point of view on the ecliptic, the location of SHARAD and MARSIS away from Earth could help characterise interplanetary propagation effects of solar bursts. Their bandwidths (15-25 MHz and 0.5-5.5 MHz, respectively) are complementary to dedicated solar WAVES observations, and their data are characterised by very high temporal (hundreds of Hz) and frequency resolutions (thousands of Hz). As part of a recent effort to exploit existing SHARAD data in novel ways [3], we created an algorithm for automatic detection of type-III bursts in WIND and STEREO data, and looked for corresponding detections in existing SHARAD radargrams. We established the conditions under which detection of solar bursts is favourable while making sure the reflections of SHARAD's own active echoes off Mars are taken out of the analysis. A possible type-III burst detection with SHARAD is shown in Figure 1 along with contextual information.

Our study shows that there is a strong case for the scientific exploitation of Martian radar sounder data in heliophysics jointly with dedicated solar missions. Within existing data, challenges lie in the orientation of the radar antenna and the non-continuous nature of radar observations.

References

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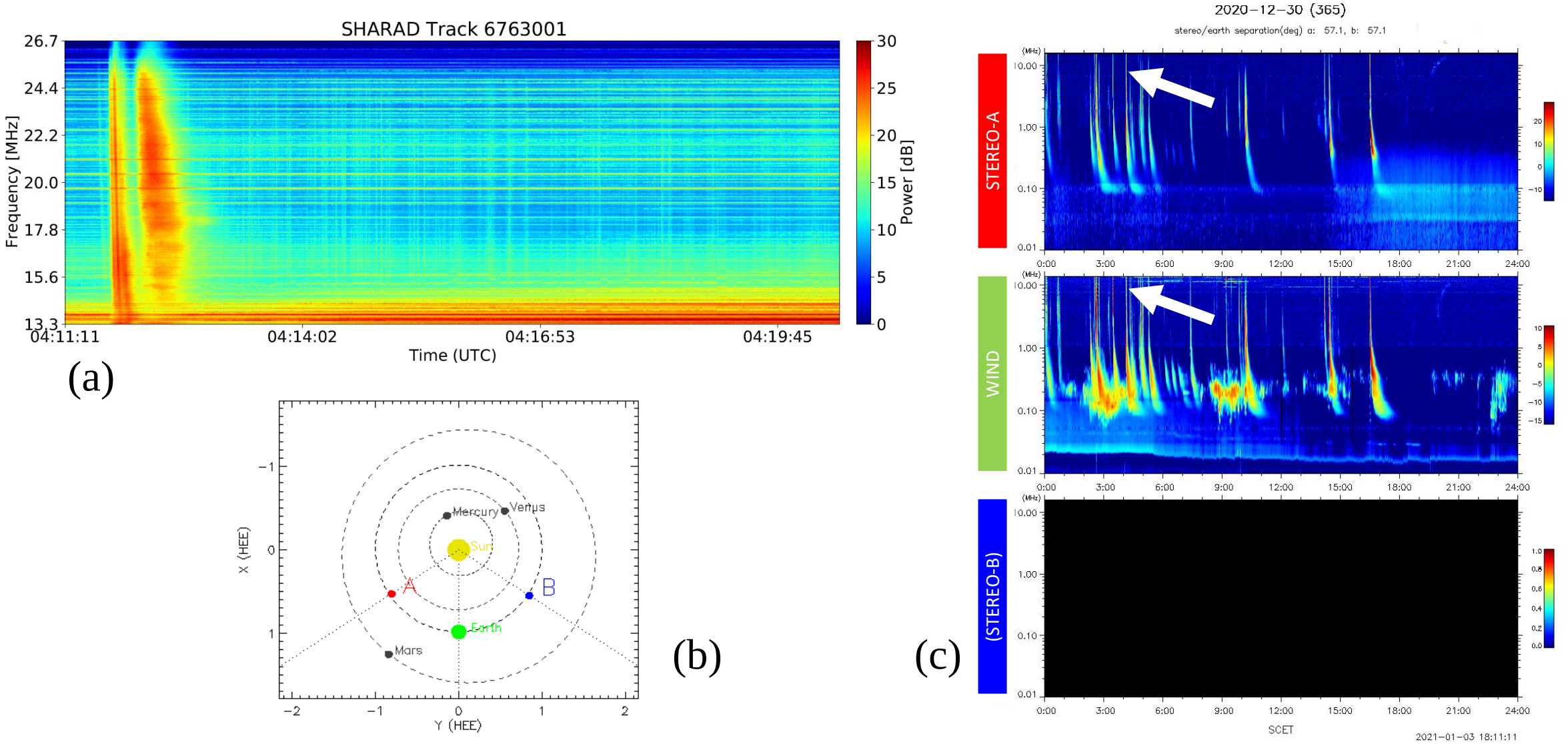

Figure 1. (a) An observation of a possible type-III solar burst in SHARAD radargram 6763001, taken on December 12, 2020 at around 04:12 UTC, shown as power spectral density. (b) A map of the solar system on that day showing the relative positions of Mars and the STEREO-A spacecraft. (c) Simultaneous observations of the Sun from, top to bottom, STEREO-A, WIND, and STEREO-B. Possible corresponding bursts are highlighted with a white arrow.