ON THE SENTINEL-1 POTENTIAL FOR SURFACE DEFORMATION MAPPING

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Even though SAR interferometry in the repeat-pass configuration is an excellent and unique tool for surface deformation mapping, the range of desired and potential applications is much wider than studies up to date have demonstrated. Consequently, the *operational* performance of surface deformation measurement and monitoring using SAR interferometry could be much improved. In this paper we show the contribution that the European Space Agency's Sentinel-1 mission, consisting of two C-band satellites, will make towards operational surface deformation mapping. Even though the mission was designed to fulfill the requirements of the GMES program, which was not tuned towards science and geophysics, it will be demonstrated that the mission can be a major contribution in terms of these fields as well.

The requirements for space-borne surface deformation monitoring cover a relatively wide spectrum. On the one hand, a potential mission should be able to provide accurate and timely information in case of a sudden, near-instantaneous event such as an earthquake or a volcanic eruption. This requires coherent phase information, sufficient resolution not to undersample the deformation signal, and a fast orbital repeat and revisit period. It has been shown that there is a clear relation between the radar wavelength and the repeat-period, meaning that a shorter repeat period can compensate for the decorrelation effects of a shorter wavelength. On the other side of the spectrum, it is important to be able to detect small but continuing motion, for example related to the build-up of tectonic stress. Knowledge about these phenomena might lead to a better understanding and localization of hazardous, earthquake or eruption prone areas. For a satellite mission, this means that the precision of the estimated parameters must be better than the noise sources in the data, such as atmosphere, orbits and decorrelation. This is only possible if the mission can acquire a long and frequent time series of data takes, which allows for the mitigation of temporally uncorrelated signal contributions such as the atmosphere.

The main characteristics of the Sentinel-1 SAR data are listed in table 1. This shows that the main SAR acquisition mode, the

Modes	Access Angle	Resolution (Range x Azimuth)	Swath Width	Polarisation
Strip Map	20-45 deg.	5 x 5 m, 1 look	> 80 km	HH+HV, VV+VH
Interferometric Wide Swath TOPS	> 25 deg.	5 x 20 m, 1 look	> 250 km	HH+HV, VV+VH
Extra Wide Swath TOPS	> 20 deg.	20 x 40 m, 1 look	> 400 km	HH+HV, VV+VH
Wave mode (Leap frog method)	23 deg. and 36.5 deg.	5 x 20 m, 1 look	> 20 x 20 km Vignettes at 100 km intervals	HH, VV

Table 1. SAR acquisition modes. The Interferometric wide swath mode will be the default mode of operation. For All Modes: Radiometric accuracy (3 σ): 1 dB; NESZ: -22 dB; PTAR: -25 dB; DTAR: -22 dB

Interferometric Wide Swath (IWS) mode, will give a comparable ground resolution to the current Envisat and ERS missions, with ground-range and azimuth directions reversed in comparison. The wide swath will ensure a complete global coverage within 12 days with one spacecraft and 6 days with two spacecraft. Figure 1 shows the average revisit time for an area in the world as a function of latitude, considering two satellites. A duty cycle of 20 minutes in both Stripmap as well as Interferometric Wide Swath mode will ensure sufficient data coverage. The satellites will remain in a 100 m rms orbital tube, to ensure the stability of the interferometric products

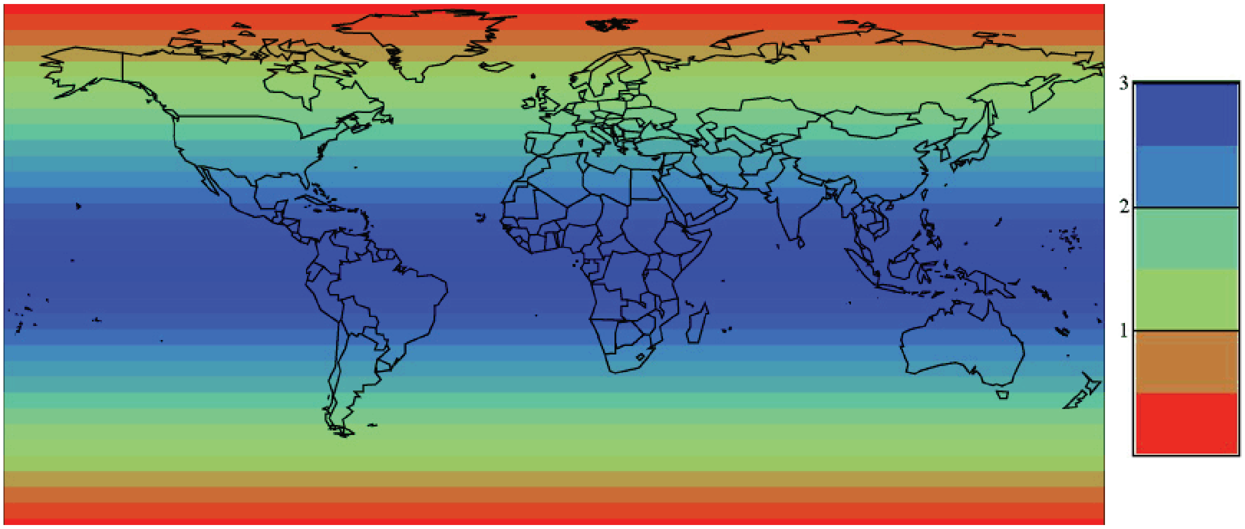

Figure 1. Sentinel 1a and 1b average revisit time as a function of latitude (2 satellites - IWS mode - interval in days).

These characteristics imply that many of the tectonically/seismically active regions in the world will be covered from different viewing geometries, aiding the three-dimensional vector decomposition of the line of sight observations, and with high repeat and revisit rates.

In this paper we present an overview of the added value and the potential of the Sentinel-1 mission for ground deformation mapping. We comment on the impact of the data distribution schemes, and show that the value of the archives built up by the mission will be unprecedented.