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Study Involved in Earth and Environmental Science Research

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Abstract

Interferometric synthetic aperture radar (InSAR) is a rapidly e evolving remote sensing technology that directly measures the phase change between two phase measurements of the same ground pixel of the Earth's surface.

Keywords: Earth; Environmental science; InSAR; Interferogram

Introduction

Two coherent synthetic aperture radar (SAR) phase images of the same portion of the Earth's surface are required to form a phase difference image that is called an interferogram, in which a fringe pattern might appear. The two coherent SAR images used to form an interferogram can be acquired either from two antennas on the same space platform and separated perpendicularly to the flight direction (azimuth direction), a technique called single pass SAR interferometry (also called simultaneous interferometry), or from different passes of the same SAR antenna at different times, known as repeat-pass interferometry [1]. Any factor that can affect the phase of the backscattered radar signal can affect the fringe pattern and the number of fringes in the interferogram, and thus can potentially be measured by the InSAR technology. These measurements include surface displacements, land topography, land changes, land subsidence/ uplift, water levels, soil moisture, snow accumulation, stem volume of forest, etc. Therefore, InSAR has found very broad applications in the field of earth and environmental sciences. Previous review articles on InSAR technology and its applications include. These review articles summarized the technical development and applications results before 2001 [2]. The present review summarizes the most recent developments of InSAR remote sensing technology and its broad applications in earth and environmental systems, especially in the past decade. In the following discussion, we first review the fundamentals of In SAR briefly and then focus on InSAR applications in seismology, volcanology, land subsidence/ lift, landslide, glaciology, hydrology, and forestry, respectively [3].

The digitized signal from a ground pixel is conveniently represented as a complex number, thus giving a complex image. Complex images are generated from the signal data received by each antenna. The amplitude of an image pixel represents the backscattering capability of the terrain of the corresponding ground pixel to send the incident energy back to the antenna. The pictorial representation of the amplitude of the EM pulses received by the antenna is called amplitude image. Backscattering and reflection are two different concepts. A very reflective calm water surface is very reflective but the least back scattering, so in a radar image, calm water surfaces correspond to the dark pixels.

In forestry, canopy height is often used to estimate forest biomass and above-ground forest carbon stock as the quantities are all metrically related. The phase of a specific pixel containing vegetation depends on vegetation structure, scattering mechanisms, and sensor characteristics (wavelength, polarization, looking angle, etc.). Because the phase of a pixel is the sum of the returns from a collection of scatterers including stems, branches, twigs, leaves or needles, trunks, and surface soil, the types of scatterers interact most strongly with the radar wave depend on the wavelength, polarization, incidence angle, and vegetation sub pixel fraction. Forest canopy height can be estimated using InSAR, including polarimetric interferometry (PolInSAR), because the interferom etric phase relates to terrain height and vegetation canopy height. Balzter provides an overview of the potential and limits of InSAR for applications to forest mapping and monitoring. Recently, polarimetric SAR interferometry (PolInSAR) has received increasing interest for forest monitoring and mapping [4].

There are several ways to further promote the potential of InSAR and possible establishment of InSAR satellites designed for operational InSAR application missions. From a technological point of view, removal of the atmospheric effect is always a hard task in applications of InSAR in deformation detection. The persistent scatterers (PS) technique seems very promising in removing atmospheric effect without knowing the atmospheric status. This technique can also enable removal of DEM and orbital errors from each interferogram. These methods rely on the existence of persistent scatters - objects that remain highly coherent through time. However, the scarcity of natural persistent scatters makes areas containing many potential coherent targets such as buildings as the most favorable region for deformation detection. Thus, an establishment of a world-wide network of PS in the future will obviously benefit the deformation mapping worldwide. Detection of rapid surface displacement using InSAR is often inhibited from the long repeat cycle. Except for bare and sparsely vegetated fields, the Interferometric correlation decreased too much after a 35-day period of ERS-1 or ERS-2. The tandem mission of ERS-1 and ERS-2 and shuttle-based SRTM mission demonstrated the necessity of contemporaneous acquisition of image pairs for quality interferogram formation by reduction of temporal de-correlation. Because of the ERS-1 payload switch off and the phase shift between ERS-2 and ENVISA T SAR sensors, the InSAR tandem acquisition is compromised for the near future. In this aspect, synergies among different satellite images should be enhanced in the future [5].

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Conflicts of Interest

None

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