PROSPECTS OF NEW REAL-TIME RADAR APPLICATIONS FOR ENVIRONMENTAL REMOTE SENSING

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1. INTRODUCTION

Direct Broadcast is increasingly necessary for Environmental Science applications, as the shift in research goals has become heavily dependent upon ensuring societal benefit. Upcoming Earth Science space missions at NASA have been listed by the National Academies Press, Space Studies Board in "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond" in 2007 [1]. The new satellite missions are meant to cover many assets of Earth Science. Each mission is designed to provide important scientific information, but also useful information for human applications. Real-time satellite data analysis becomes an indispensable need when applied to specific purposes, e.g. severe weather prediction or emergency response action, hence the importance of direct broadcast or the near-real-time availability of satellite data. Active-instrument radar data in the 1-26.5 GHz spectral region holds significant potential for derivation of real-time products to support biological ecosystem monitoring affecting decision support systems, which is the subject matter of this paper. Furthermore, this paper introduces and explores current and future active radar instruments, such as the one being carried on the Soil Moisture Active Passive mission (SMAP), and their potential Direct Broadcast applications, setting a precedent for future missions' applications and goals.

2. RADAR IN REAL-TIME

Radar [2] is the electronic means of measuring a variety of geophysical or biological factors, using electromagnetic waves to measure reflection, or backscatter, in varying frequencies. Radiation is produced and transmitted from an active radar and a detector measures the reflectance, which varies due to a target's properties. Higher frequencies are more prone to interference, such as cloud cover and therefore, radar using longer wavelengths, which are better able to penetrate through clouds, is being used for environmental monitoring. SMAP will use L-band radar (1-2 GHz) and L-band radiometer for the desired sensitivity to soil moisture. L-band frequencies are low on the spectrum and will therefore will be beneficial for penetrating-measurement remote sensing. AMSR-E [3] uses frequencies ranging from 6.9 to 89.0 GHz in order to produce products such as ocean water vapor, near surface wind speed, snow cover, etc. Radarsat [4] uses Synthetic Aperture Radar (SAR) for resource management, and data for ice, ocean and further environmental monitoring. SAR [5] produces a high resolution 2D, with little constraints from time or atmospheric conditions. This paper discusses the possible future of biomass remote sensing, exploring radar and the impact of incorporating Direct Broadcast on future missions.

3. BIOMASS REMOTE SENSING

The most common uses of radar in remote sensing is for measuring and monitoring geophysical parameters. However, there exists a large potential for radar in biological remote sensing that is virtually unexploited. Biological remote sensing promises in depth ecosystem monitoring that is currently very limited. Detecting ecosystem change, which is known to have a positive correlation to human health, provides ample opportunity for environmental monitoring. Active radar excites biological compounds in living matter, such as as florescence, and would therefore detect spectral signatures of biomass. To determine frequencies that excite biological factors, as opposed to geophysical, is a nascent field that can impact how remote sensing is used in environmental monitoring.

4. SOIL MOISTURE ACTIVE PASSIVE (SMAP)

SMAP will be launched in the near future and is headed by Jet Propulsion Laboratory (JPL) [6]. It will provide products for mapping soil moisture and freeze/thaw state. The satellite will utilize a combination of low and high-resolution active radar and passive microwave operating at L-band. The frequency (1.20-1.41 GHz) will be able to sense soil conditions through some vegetation as well as be relatively not susceptible to interference from clouds. The final soil moisture product (L3) has a projected latency of 12 to 24 hours. The satellite currently does not have the ability to send real-time feed. The data can be implemented for long-term uses, such as agricultural and climate mapping.

5. POTENTIAL REAL-TIME APPLICATIONS FOR SMAP

Direct Broadcast or access to real-time instrument data can be of the utmost importance from a local standpoint. The near-real-time processing of soil moisture product could be used for applications to determine potential for natural hazards including: landslides, flood and fire. Landslides are dependent on a variety of factors, but SMAP, which will be able to determine soil moisture of a region, may provided helpful indication of hazardous zones. Similarly, the soil moisture product could highlight preconditions for flooding. SMAP data exposing arid soil can be helpful to predict the likelihood of forest fires, or fuel loading. Each application will likely be generated from data SMAP will provide; yet without Direct Broadcast, timely action to save lives from hazardous environmental conditions will be limited.

6. DIRECT BROADCAST IMPORTANCE

Direct Broadcast (DB) [7] is the real-time or near real-time transmission and processing of satellite feed. Users must have necessary ground equipment to receive the feed and be in the direct line of sight. While the upcoming Earth Science missions are intended to provide helpful information for society, they have a difficult limitation, which is that they lack the ability to be useful in real-time. In a case of emergency, 12-hour product latency may prevent timely evacuation. The emerging emphasis on obtaining data to aid humankind will have a lasting impact on environmental remote sensing. The addition of Direct Broadcast on board the upcoming satellites will set a standard in Earth Science observations for the use of real-time data. While it may be generally accepted that real-time data can be useful, it is not used to its full potential, as evidenced by the decadal survey report in which none of the satellite specifications include Direct Broadcast. NASA, as a strong supporter of Direct Broadcast is analyzing key missions to include this capability.

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