MONITORING OF INUNDATED WETLAND ECOSYSTEMS WITH INTEGRATED SATELLITE REMOTE SENSING

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1. INTRODUCTION

Wetlands are common landscape features and exert major impacts on hydrologic processes, surface atmosphere carbon exchange and associated impacts on global climate. Their extent and seasonal, interannual, and decadal variation play key roles in ecosystem dynamics. Yet despite their importance in the global cycling of carbon and water and climate forecasting, they remain poorly characterized and modeled primarily because of the scarcity of suitable regional-to-global remote sensing data for characterizing wetlands distribution and dynamics. Spaceborne microwave remote sensing offers effective tools for characterizing wetlands since it is particularly sensitive to surface water and to vegetation structure, and it allows monitoring large inaccessible areas on a temporal basis regardless of atmospheric conditions or solar illumination. Integrating wetland-derived remote sensing products with methane models is an essential tool for observing wetlands and characterizing methane cycling, with useful predictions on the future climate.

In this study we employ multi-temporal 30 meter L-band SAR data from the Phase Array L-Band SAR (PALSAR) sensor mounted on the Advanced Land Observing Satellite (ALOS) and 100 meter SAR data from the Japanese Earth Resources (JERS-1) satellite to map and monitor wetlands and open water in the state of Alaska and across select basins within Eurasia. In concert, we derive coarse resolution (~25 km) inundation products using high temporal repeat observations from combined AMSR-E, MODIS-LAI, and QuikSCAT data sets. A multi-scale analysis is then performed to harmonize the information content between the high and low resolution products.

This work supports science application development for the upcoming NASA Soil Moisture Active Passive (SMAP) mission, which will provide combined L-band radar and radiometer coverage globally with 3-day revisit for characterization of soil moisture and saturation extent. Also, this research supports efforts that are part of a NASA MEaSUREs project, which is assembling a satellite-based global-scale Earth System Data Record (ESDR) of inundated wetlands to facilitate investigations of their role in ecosystem processes. Here, we present our efforts for characterization of inundated wetlands, including wetland classification, and mapping of inundation dynamics.

2. METHODOLOGY

We employ multi-temporal PALSAR (HH/HV polarizations and 30 meter resolution) data between 2006 and 2008 to generate classifications of wetland vegetation. To produce each classification map, supplementary data are employed, including Landsat images, a Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) [1] and derived surface slope. The classification scheme is based on a supervised decision-tree classifier known as Random Forests [2]. The classifier is trained using ground data. The classification algorithm functions by generating a large number of decision trees based upon the training data, implementing the decision trees, and classifying each pixel according to the class selected by the most decision trees. Results are validated using an independent set of training data.

An L-band JERS-1 mosaic of Alaska developed under the Global Boreal Forest Mapping Project

(GBFM) is used to generate the open water classification for Alaska. The mosaic was compiled from imagery acquired during the summer of 1998 and is at a 100 meter resolution. A similar decision tree based classification approach is applied. A USGS DEM and derived slope are used as supplementary layers in the classifier to prevent areas of steep topography, were shadowing is prevalent, as being classified as open water. The 100 meter open water classification is then compared to the coarser resolution products through a multi-scale analysis.

The coarser resolution wetland and open water products are generated by exploiting the temporal behavior of C-Band AMSR-E brightness temperature ratios to changes in surface water extent and vegetation cover. MODIS-LAI and QuickSCAT backscatter are employed to account for seasonal variation in vegetation structure and water content. The AMSR-E data are screened to remove Radio Frequency Interference (RFI) and to account for snow and frozen ground. Initial results demonstrate that this method can be applied without tuning of the input data.

3. PRELIMINARY RESULTS AND CONCLUSIONS

Preliminary results using the decision tree classifier show correlation between training data and the classification maps and the utility in using dual-polarization SAR data, optical data, and DEM and derived slope for classifying wetlands vegetation with accuracies exceeding 80%. Harmonization of the SAR-derived wetlands maps and coarse resolution inundation mappings at high temporal fidelity demonstrate the utility of the multiple satellite datasets for characterizing inundation dynamics. The combined high spatial resolution and high temporal fidelity data sets to be provided by SMAP will enable enhanced characterization of wetland dynamics for assessment of land-atmosphere carbon fluxes.

4. References

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