Feasibility of Estimating Relative Nutrient Contributions of Agriculture and Forests Using MODIS Time Series

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Abstract

Around the Gulf of Mexico, high-input crops in several regions make a significant contribution to nutrient loading of the coastal near-shore area. A project to explore the use of MODIS data to enhance the spatial and temporal resolution of near-coast nutrient information available to the coastal community. The purpose of this project is to demonstrate the viability of nutrient source information products applicable to small to medium watersheds surrounding the Gulf of Mexico. Elevation canopy products are intended to complement estuarine nutrient monitoring and to the near-shore Gulf. Some crops cultivated near the coast include sugarcane in Texas, rice in Texas and Louisiana, sugarcane in Florida and Louisiana, citrus orchards in Florida, pecan orchards in Mississippi and Alabama, and heavy soy and ornamental production around Mobile and Tampa Bay. In addition to crops, management of landfills to proximity to the coast also plays a role in nutrient loading. In the summer of 2008, a feasibility project is planned to explore the use of NASA data to enhance the spatial and temporal resolution of near-coast nutrient information available to the coastal community. The purpose of this project is to demonstrate the viability of nutrient source information products applicable to small to medium watersheds surrounding the Gulf of Mexico. Conceptually, these products are intended to complement estuarine nutrient monitoring.

Near-Coast Crops

Introduction

This project seeks to use NASA data to enhance the spatial and temporal resolution of near-coast cropping information available to the coastal community. In doing so, we hope to contribute to an improved understanding of nutrient loading and nutrient sources for sensitive water bodies around the Gulf of Mexico.

Remote sensing is effectively applied to determining the distribution of the crops. LULC (Land use/land cover) information is a well-established part of modeling nutrient flux at the watershed level. LULC is often produced through classification of multispectral remote sensing data, but this effort proposes to derive the land cover information for crops through time series analysis of multitemporal data sets of the MODIS (Moderate Resolution Imaging Spectroradiometer) sensor. Additionally, we hope to provide information relevant to intra-seasonal variations in nutrient flux, such as:

* The presence or absence of canopy to intercept precipitation, and
* The timing of fertilization based on ancillary information regarding the relationship of crop phenology and management practices.

After producing the crop information, we propose to demonstrate its usefulness by showing how the information might be input into one or more nutrient loading models.

Potential Products

* Provide near real-time Land Use/Land Cover Information
* Use phenology products to infer application dates for fertilizer
* Identify periods when phenological data is most likely useful when using phenology parameters to assess the presence/absence of vegetation

Proposed Flow from NASA Remote Sensing Observations to Watershed Model Input

Typical MODIS Input Datasets

- MOD02 Planetary Reflectance (Swath)
- MOD03-48-Bit Cloud Mask
- MOD05 Sensor Zenith Angle
- MOD06 Clouds and Cloud Shadows
- MOD11 Surface Reflectance (Tile)
- MOD12 Land Cover Products
- MOD15A2G MODIS Land Cover Map
- MOD13A2G MODIS Land Cover Map

Time Series Product Tool (TSPT)

TSPT Overview

The TSPT software was custom-designed for NASA to rapidly create and display single-band and band-combination time series, such as NDVI (Normalized Difference Vegetation Index), for visible-spectrum, forest health, disturbance detection, and other time-critical applications. The TSPT is used for this project. The TSPT has been used to generate MODIS time series to monitor crop phenology in California and Argentina and to monitor forest health at an area southwest of Mississippi following Hurricane Katrina.

TSPT Data Flow

1. Extract the TSPT-filtered time series data for each year
2. Identify growing seasons via sinusoidal curve fitting
3. Locate targeted data points within the growing season
4. Calculate the NDVI data value and day of year for each phenological parameter of interest
5. Compute cumulative integrals: 23 integral values accumulated over each 16-day period within the NDVI time series per year
6. Generate MODIS (Moderate Resolution Imaging Spectroradiometer) sensor data products

Targeted Phenological Data Points

Example Phenological Parameter: Start-of-Season for Mobile Bay Area for 2005 Season

Phenological Parameters Estimation Tool (PPET)

PPET Processing Overview

For each data set:
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