Introduction
Changes in vegetation phenology depict an integrated response to change in environmental factors and provide valuable information to global change research. Typically, remote sensing of vegetation phenology is based on the analysis of vegetation index temporal profiles, because of their simplicity, stability, and inherent resistant to noise. Most phenology estimates are, however, limited to using one sensor owing to the inter sensor continuity challenges.

Although, phenology is used for a variety of research and application topics, the central objective remains the study of vegetation dynamics change in response to change in climate and other factors. Consequently, the consistency and length of data records are key requirements.

With satellite missions lasting few years only, long term phenology measures will have to be based on a mixture of satellite data records.

Objectives
In this MEASURES’ project, our multi-institution team of investigators will generate a seamless and consistent sensor independent long term (30+ years) Earth Science Data Records (ESDRs) of land surface phenology parameters and vegetation index, by using measurements from different satellite missions and sensors. We’ll validate, characterize and establish the error and uncertainty of these products.

Project Overview
We’re using AVHRR, MODIS, VIIRS and VGT daily land surface reflectance and we’re designing a series of sensor independent algorithms to apply to these data.

Validation
In collaboration with the National Phenology Network (USA-NPN) we plan to correlate these remote sensing based ESDR estimates of VI and phenology with ground observations. We seek to evaluate their consistency and accuracy by comparing them with in situ growing season phenophases observations over different biomes, latitudinal and elevation gradients.

Applications & Distribution
Changes in phenology provide valuable information for global change research, land degradation studies, integrated pest and invasive species management, drought monitoring, wildfire risk assessment, and agricultural production.

This project is expected to generate, document, and deliver 30+ years of consistent and well characterized ESDR/CDR quality daily measurements of Vegetation Index and land surface phenology metrics. These ESDR products will be distributed through the LP-DAAC, and separately via a PI based interactive visualization and analysis system.

Phase I: Continuity – The Cluster method
The cluster method, assumes that phenology (i.e. vegetation dynamic) is controlled by factors that capture climate, soil, elevation gradient, sun shade exposure, and biophysical limitations. The concept of phenology cluster is similar to the biotic life zones used to classify ecosystems. In that regard, a phenology cluster is also a biotic zone, with similar plant species, at around the same elevation gradient, and governed by similar temperature, precipitation and radiation regimes.

For this initial continuity phase we constructed a global CMG resolution cluster map to drive the continuity work:

- Global DEM GTOP030 data
- FAO Global Average annual Temperature
- FAO Global Precipitation map
- USDA-NRCS Global soil
- MODIS CMG Land Cover

Conclusions
We’re currently building more complex cluster maps and we plan to generate separate continuity equations for each of these clusters. The goal is then to reconstruct a new VI record using these continuity equations. The phenology algorithm will be driven by this VI ESDR.

Issues with:
Sensor/Platforms:
- Bandpass
- Spatial resolution
- Orbital characteristics
- Sensor degradation

Algorithms/ReProcessing:
- Atmosphere correction
- Temporal compositing
- Spatial aggregation
- VI formula

We plan to monitor the growing season along elevational and biotic gradients. We will also leverage from ongoing national and international efforts, particularly the ones lead by the US-NPN.