INTRODUCTION & GEO-GLAM BACKGROUND

Why Agricultural Monitoring?
• Climate Change
• Extreme weather events
• Growing global population

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GEO-GLAM's Goals:
• To strengthen the international community's capacity to produce and disseminate timely and accurate forecasts of agricultural production at national, regional, and global scales through the use of Earth observations (EO).
• To build upon existing agricultural monitoring initiatives at national, regional, and global levels, enhancing and strengthening them through international networking and data and methods sharing.
• To mobilize calendar data, meteorological data, and ground-based agricultural observations, while advocating for full and open data sharing.

EARTH OBSERVATIONS FOR GLOBAL AGRICULTURE MONITORING

• EO are used for crop condition monitoring, yield forecasting, cropland area estimates, and crop type mapping, among other applications (Justice & Becker-Reshef, 2007).
• Remotely sensed data and information available throughout the growing season are regionally and temporally inconsistent, leaving knowledge gaps regarding crop distribution and condition in many agricultural areas of the world.

The Goal of this Research: To articulate fine-to-moderate (FTM; 1-100m) EO requirements for global agriculture monitoring as inputs into an operational image acquisition strategy (GEO-GLAM Component 4). To do this, the following must be addressed:

IMAGERY FOR AGRICULTURE MONITORING: WHERE & WHEN?

• Cloud cover limits optical acquisitions!
• Actual Temporal Resolution (ATR): The revisit time of an optical EO instrument.
• Effective Temporal Resolution (ETR): The number of days until a cloud-free clear view is achieved.

Data and Methods:
Ten years (2003-2010) of 8-day 250m MODIS Terra Surface Reflectance (MOD09Q1) with QA bits applied (Vermote & Kotchenova, 2008), converted to NDVI (Tucker, 1979.)
• Multiple strict cloud mask applied
• Resampled to 0.05°, processed for phenological transition dates (PTDs) using a combination of thresholds and inflection points.

Output: Growing Season Calendars
• Start of Season ➔ green-up of earliest cropping cycle;
• Peak Period ➔ ≥95% annual NDVI range; can help identify period for which more intense imaging is necessary for inputs to yield models (Becker-Reshef et al., 2010; Boken & Shaykewich, 2002).
• End of Season ➔ end of senescence of final cropping cycle; approximates harvest & marks the end of the agricultural growing season.
• Variability in SOS, peak, and end of season over 10 years

DISCUSSION & FUTURE RESEARCH

• Agricultural GSCs provide important information on key agricultural growing periods, including insight into recent interannual variability in growing season timing and duration, thereby facilitating EO coordination for agriculture monitoring.
• A similar method of phenological transition date detection is being used to generate global crop-specific calendars for wheat, maize, soy, and rice.
• Some areas are very cloud limited (e.g. S. Asia) and may be limited to active microwave remote sensing for agriculture monitoring applications.
• Information on landscape heterogeneity & spatial pattern could strengthen spatial resolution requirements.
• Once ATR requirements are fully articulated, it is crucial to investigate whether we presently have the observational capabilities to meet our EO-based agricultural monitoring needs at national, regional, and global scales.

IMAGERY FOR AGRICULTURE MONITORING: HOW FREQUENTLY & AT WHAT SPATIAL RESOLUTION?

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• Actual Temporal Resolution (ATR): The revisit time of an optical EO instrument.
• Effective Temporal Resolution (ETR): The number of days until a cloud-free clear view is achieved.

Data and Methods:
• Agricultural growing season calendars, resampled to 0.05°
• 12 years of daily AM (Terra) & 10 years of daily PM (Aqua) cloud masks (Vermote) ➔ ≥1 cloudy 1km pixel = cloudy 0.05° cell
• Calculate probability of cloud-free clear view for portions of the agricultural growing season (e.g. start-to-peak, peak period, peak-to-end)

Output: 1) Days until clear view ➔ what is the ETR for a given ATR? 2) Repeat time required ➔ what is the required ATR to achieve a given ETR?

• Field size is a major determinant of necessary spatial resolution: Smaller fields = finer resolution
• If you need one 10m cloud-free image per week during the early season (SOS to peak), and one 10m cloud-free image per month during the late season (peak to harvest), for small fields (f< 0.01 ha), what repeat time (ATR) would that require?

CITATIONS