Advances in remote sensing for vegetation dynamics and agricultural management

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Overview: Enhance the NASA-Foreign Agricultural Service’s Global Agricultural Monitoring System with Coincident NDVI, Soil Moisture, & Chlorophyll Fluorescence
GLAM OVERVIEW

- Second generation MODIS-based agricultural system to support FAS monitoring activities
- Successor to the Pekko system (@ UMD) – proof of concept ...
- Improvements – wall to wall global coverage, rapid query, & simplicity

Includes:
- NRT production - every 8-days – 2000-Present (TERRA), 2002-Present (AQUA)
- Two processing nodes set up (glam0 for USDA/FAS/IPAD, glam1 as fail-safe/other agency/public system).
- Data: provides Terra and Aqua data (NDVI + Anomalies, Color Composites).
- GUI Data query and plotting by Crop masks (10+), administrative regions (3) and LIS (0.25°)
- Capture AoI /current map view with visible crop and shape layers in PNG or JPEG formats.
- Keyboard shortcuts to improve data set navigation and querying
- Updated MODIS Collection 6 Near Real Time Time Products in progress…
- Soil Moisture data layer also in progress…
- Working toward possible chlorophyll fluorescence data layer
SYSTEM OVERVIEW

http://glam1.gsfc.nasa.gov/
Sample MODIS NDVI Output

Australia 35 S x 146 E
Sample MODIS NDVI Output

Australia 35 S x 146 E

NDVI

Date

NDVI Anomaly

Mean

NDVI
USDA/FAS NDVI Application

Conclusion: Drought During Pollination Reduced So. African Corn Yield

Jan 17-24, 2015

Feb 18-25, 2015

Crop conditions change from above-average to below-average during the critical pollination stage in early February.

Differences from 10-year MODIS NDVI Average (2003-13)

Source: USDA/NASA MODIS Global Agriculture Monitoring (GLAM) Project
http://glam1.gsfc.nasa.gov/
USDA/FAS NDVI-based Estimate for French Corn

2014 Record Corn Crop -- 17 M tons

2003-13 Mean

2014

Corn “Peak”

Aquitaine & Midi-Pyrenees Departments, France’s Primary Corn Region

MODIS Aqua NDVI 8-Day Anomaly; Corine Dryland Mask
Soil Moisture Objective

To enhance the USDA FAS global crop assessment decision support system via the integration of SMAP soil moisture products into the FAS 2 layer Palmer model. SMAP’s radar failed—SMOS radar data being used instead. Solar Induced fluorescence is also being investigated for an additional data layer.
PM-SMOS Soil Moisture, Methodology

Set up:

**Palmer Model**
- physically based model
- 2 layers, surface and subsurface
- 0.25°

**Forcing**
- former AFWA
  - Upcoming change: GPM
- Variables: Precipitation; Min and Max Temp.

**Satellite observations**
- SMOS ESA (SMOPS)
  - Upcoming change: SMAP and ASCAT (Passive and Active); Prototype developed (SMOS and ASCAT)

**Data Assimilation**
- EnKF
- 30 ensemble members
- Rescaling: Variance-based
- R: NDVI-based climatology
  - Upcoming change: Triple Collocation Analysis

**Diagram Notes**
- SMAP
- ASCAT
- TCA
- DA: EnKF
- 2-layer PM
- AFWA
- T \_\_min/max
- Variance-based rescaling
- Root-zone SM Analysis
- 2-layer PM
- PM – Palmer Model
- SM – Soil Moisture
- SMOS – Soil Moisture Ocean Salinity
- SMAP – Soil Moisture Active Passive
- ASCAT – Advanced Scatterometer
- GPM – Global Precipitation Measurement
- AFWA – U.S. Air Force Weather Agency
- NDVI – Normalized Difference Vegetation Index
- DA – Data Assimilation
- EnKF – Ensemble Kalman Filter
- TCA – Triple Collocation Analysis
PM-SMOS Soil Moisture, Products

- All data products
  - 3-days composites
  - Near-real time (max 5 days latency)
- Products
  - L03 – SMOS assimilated soil moisture [mm]
    - Surface layer ‘as1.grib’
    - Sub-surface layer ‘as2.grib’
  - L04 – profile soil moisture [%]
    - Profile ‘smp.grib’
  - L05 – anomaly soil moisture [-]
    - Surface layer ‘anom1.grib’
    - Sub-surface layer ‘anom2.grib’
India Rapeseed

• Planting Sept. mid-Nov. monsoon dependent
• ~70% irrigated after monsoon ends
• Lowest area planted in 5 years due to weak 2015 monsoon in Rajasthan
• SMOS soil moisture critical input

Bolten & Mladenova NASA/GSFC
Methodology: *Operational Implementation*


Model only

The benefit of assimilating satellite-based estimates.

11-20 April, 2014
Methodology: Operational Implementation
NDVI & Soil Moisture for the USDA/FAS

Soil Moisture by Bolton & Mladenova NASA/GSFC
• Solar-Induced Fluorescence (SIF) is currently produced using the Global Ozone Monitoring Experiment 2 (GOME-2) on the EUMETSAT MetOp-A platform.
• SIF has been shown to be useful for estimating crop yields (Guanter et al., 2014, PNAS; Guan et al., 2015, Glob. Change Biol., in press)
• SIF has been shown to follow the seasonal cycle of GPP derived from flux tower measurements (Joiner et al., 2014)
How do we retrieve fluorescence from GOME-2?

START
Radiance and irradiance data; Level 1B

[SZA < 70° and over land? yes]

Retrieve fluorescence, atmospheric absorption (coefficients of PCs), and surface reflectance using linear radiative transfer model with non-linear fitting

[Over cloudy ocean ($\rho_{670} > 0.7$) or over snow/ice or Sahara] and SZA < 75°? yes

Principal component analysis (generate PCs)

Quality assurance checks (residuals, cloud filter, etc.); Level 2

Gridded fluorescence data; Level 3

Data are publicly available (2007-present): http://avdc.gsfc.nasa.gov/
Monthly (level 3 gridded) data are produced shortly after the end of a month.
NDVI, Soil Moisture, & SIF

1 Stop Shopping: same grid & time step

SIF by Joiner & Yoshida NASA/GSFC
NASA NDVI, Soil Moisture, & SIF
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