Mapping Phenology, Water Use and Drought at Field Scales

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**TOOLS**

- **STARFM**: Multi-sensor data fusion
- **DMS**: Thermal image sharpening
- **ALEXI**: Multi-scale ET modeling

**APPLICATIONS**

*(daily/30 m)*

- Crop phenology metrics
- Crop water use (Evapotranspiration)
- Crop stress (drought early warning)

**ASSETS**

- **GEO**
  - Hourly: 5km/5km
- **MODIS**
  - Daily: 250m/1km
- **Landsat**
  - 16 day: 30m/100m
- **Lsat-like**
  - ~20-60m/ --
Spatial and Temporal Adaptive Reflectance Fusion Model

STARFM Algorithm

STARFM: Multi-sensor data fusion

Spatial and Temporal Adaptive Reflectance Fusion Model

Observed pairs

Reconstructed images

Landsat Science Team, Dec 2012
Data Mining Sharpener

DMS: Thermal image sharpening

COARSE IMAGE

SHARPENED IMAGE

REFERENCE IMAGE

TEXAS (960 to 60 m)  ALASKA (960 to 60 m)  IOWA (120 to 30 m)
Atmosphere Land Exchange Inverse Model

ALEXI: Multi-scale ET modeling

SURFACE TEMPERATURE

EVAPOTRANSPIRATION

DisALEXI (Landsat)
DisALEXI (USU aircraft)

ALEXI (ISCCP)

DisALEXI (MODIS)

AERONET

GEO

MODIS

Landsat

Temperature (C)

Latent Heat (Wm\(^{-2}\))

1 July 2002 – 10:30AM LST

100 200 300 400 500

GEO

MODIS

Landsat

Global

Continental

Regional

Basin

Watershed

Field scale

Hourly

Daily

Bi-weekly

corn

soy

DisALEXI (USU aircraft)
APPLICATIONS

... daily monitoring at 30 m
FIELD-SCALE PHENOLOGIC METRICS

SW reflectances

MODIS
Landsat
Lsat-like

STARFM

Daily EVI timeseries

TimeSat:
- start of season
- end of season
- peak greenness
- start of senescence
Simulated Landsat Time Series EVI
from 2009274 (Oct. 1, 2009) to 2010151 (May 31, 2010)
FIELD-SCALE
DAILY EVAPOTRANSPIRATION

SW/TIR

GEO
MODIS
Landsat

STARFM
DMS
ALEXI

Daily 30 m ET maps

Landsat Science Team, Dec 2012
Rainfed soybean – SMEX02 (Iowa)

Improvement over Landsat-only

Cumulative ET (mm)

Day of Year

Daily ET (mm per day)

Day of Year

Reference ET

Observed ET

Landsat retrievals

Landsat-only

Landsat-MODIS fusion

RAIN

Cumulative ET (mm)

Day of Year

Daily ET (mm per day)

Day of Year

RAIN

Reference ET

Observed ET

Landsat retrievals

Landsat-only

Landsat-MODIS fusion

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FIELD-SCALE DROUGHT IMPACTS

Daily ET maps

Crop phenology

Stress signals

Yield impacts (with NASS)

TASK 3: Drought/Crop Stress

GEO
MODIS
Landsat
Lsat-like

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GOES Evaporative Stress Index

JUNE 2002

hrsl.arsusda.gov/drought

TASK 3: Drought/Crop Stress

Standardized ET/PET anomalies

-2σ < -1σ  0  +1σ  > +2σ
GOES Evaporative Stress Index

JUNE 2002

MODIS (1 km)  Landsat (60 m)

MODIS (1 km)  Landsat (60 m)

TASK 3: Drought/Crop Stress

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**TOOLS**
- STARFM data fusion
- DMS TIR image sharpener
- ALEXI/DisALEXI ET modeling

**FIELD-SCALE APPLICATIONS**
- Crop phenology
- Daily ET
- Crop stress / drought early warning
APPLICATIONS FOR SATELLITE ET

... Food and Water Security
Daily Evapotranspiration
9 February 2008
2011 Famine in Somalia

Acute Food Insecurity Phase

FEWS NET Presence Countries:
1: None or Minimal
2: Stressed
3: Crisis
4: Emergency
5: Catastrophe/Famine

Non-Presence Countries:
1: None or Minimal
2: Stressed
3*: Crisis or higher

ESI
6 months
(July 2011)