Use of Land Surface Temperature Observations in a Two-Source Energy Balance Model Towards Improving Monitoring of Evapotranspiration and Drought

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MULTI-SCALE SATELLITE ET RETRIEVAL

... based on land surface temperature
Approaches to mapping ET

**PRECIPIRATION**

- Root uptake
- Infiltration
- Sfc moisture
- Soil moisture holding capacity
- Rootzone moisture
- Drainage

**SURFACE TEMPERATURE**

- Transpiration & evaporation
- Soil evaporation
- T_{soil} & T_{veg}
- Transpiration & evaporation

**WATER BALANCE APPROACH**

(prognostic modeling)

Given known radiative energy inputs, how much water loss is required to keep the soil and vegetation at the observed temperatures?

**ENERGY BALANCE APPROACH**

(diagnostic modeling)
DATA FUSION: daily ET at field scale

SURFACE TEMPERATURE
- GEO (ISCCP)
- Polar (MODIS)
- Polar (Landsat)
- Airborne (USU aircraft)

EVAPOTRANSPIRATION
- GEO (GOES Sounder)
- GEO (GOES Imager)
- Watershed (60m)
- Regional (5km)
- Continental (10km)
- Basin (1km)
- Field scale

Temperature (C)
- 1 July 2002 – 10:30AM LST
- 1 LS – 16 day
- 2 LS – 8 day
- Latent Heat (Wm^-2)

1 July 2002 – 10:30AM LST
Applications for Remotely Sensed ET

WATER MANAGEMENT

DROUGHT MONITORING

FOOD AND WATER SECURITY
MONITORING DROUGHT

... Crop stress and yield impacts
Satellite ET Drought Indicator

Atmosphere-Land Exchange Inverse Model (ALEXI)

(Anderson et al., 1997, 2007)
2012 FLASH Drought

Monthly changes

Figure 1. 2012 State Corn Yields as a Percent of Trend Yield.

Real-time Drought Monitoring
APPLICATIONS FOR SATELLITE ET

... Monitoring Food and Water Security
August-October composite of clear-sky midday latent heat flux for 2013 (10 km)
ANNUAL MUNICIPAL LEVEL SOYBEAN YIELD ANOMALIES
EXPANSION of IRRIGATION

Landsats 4, 5, 7

1987

1991

2000

2012

Visible, near IR bands: vegetation amount
Thermal band: water use

Wadi As-Sirhan Basin

http://earthobservatory.nasa.gov/IOTD/view.php?id=779600
Water use by irrigation

ALEXI ET - AL JOWF IRRIGATION SITE

AXL (mm/day) vs YEAR (2006-2014)

GROUNDWATER DEPLETION TRENDS

GRACE, mm/yr

MULTI-SCALE ET MAPPING (mm/day)

METEOSAT (3km)
MODIS (1km)
LANDSAT (30m)

Houborg et al., 4th International Symposium of RAQRS, Valencia, Spain, Sept. 2014
“Constraint is often high quality weather information at the village scale – satellite data are the key to scaling up”

**Figure 1. Summary of Data and Analysis for Index Insurance Project**
Yield estimation in Tunisia

2001 2002 2003 2004 2005 2006 2007

Wheat yield anomaly

2008 2009 2010 2011 2012 2013

ESI

Yield anomaly

ESI Legend

Yield anomaly

> 1.5
0.75 - 1.5
0.75 - 1.5
0 - 0.75
-0.75 - 0
-1.5 - 0.75
<- 0.75
No data
Global basin water accounting

Global ESI Pilot Study Regions for USDA FAS (Brazil, Ukraine, Kazakhstan; 2000-2013)
11 August 2010

Global ESI Pilot Study Regions for USDA FAS (Brazil, Ukraine, Kazakhstan; 2000-2013)
Questions?

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Daily Evapotranspiration – Orlando, FL, 2002

Spatial Temporal Adaptive Reflectance Fusion Model (STARFM) (Gao et al, 2006)
Irrigated vs. rainfed crop water use

Bushland, TX

Mead, NE