UNIVERSITY OF COPENHAGEN

Hydrologidag, 2014

Application of satellite data to estimate evapotranspiration over large areas.

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Introduction

1. What is remote sensing?
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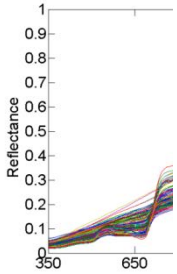
2. Typ...
   -



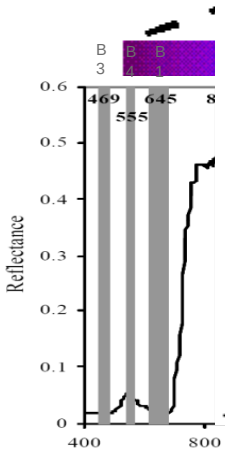
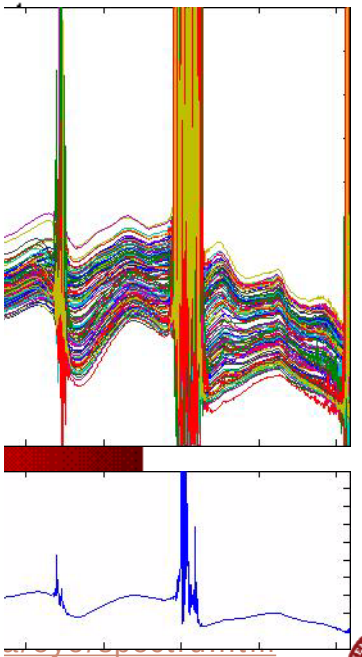


Table 1: List of indices calculated in this study using MODIS and the field spectra measurements.

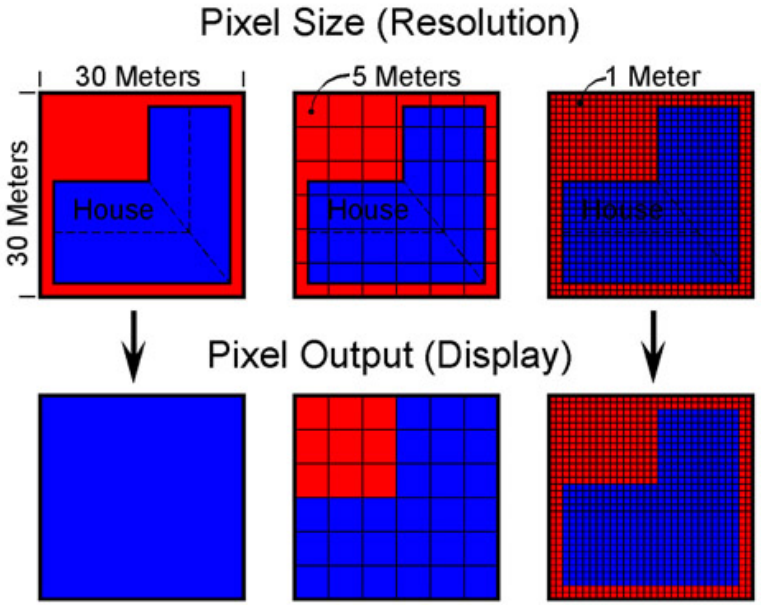
Index	Formula	Reference
Normalized difference vegetation index	$NDVI = \frac{B_2-B_1}{B_2+B_1}$	(Tucker, 1979)
Enhanced Vegetation Index	$EVI = 2.5 \cdot \left(\frac{B_2-B_1}{B_2+6 \cdot B_1-7.5 \cdot B_3}\right)$	(Huete et al., 2002)
Normalized Difference Water Index	$NDWI = \frac{B_2-B_5}{B_2+B_5}$	(Gao, 1996)
Short Infrared Water Stress Index	$SIWSI = \frac{B_6-B_2}{B_6+B_2}$	(Fensholt & Sandholt, 2003)
Normalized Difference Water Index	$NDVI = \frac{B_2-B_7}{B_2+B_7}$	(Rubio et al., 2006)
Normalized Difference Infrared Index	$NDII = \frac{B_2-B_6}{B_2+B_6}$	(Hardisky et al., 1983)
Simple Ratio Water Index	$SRWI = \frac{B_2}{B_5}$	(Zarco-Tejada et al., 2003)
Inverted Simple Ratio Water Index	$ISRWI = \frac{B_5}{B_4}$	(Trombetti et al., 2008)
Moisture Stress Index	$MSI = \frac{B_6}{B_2}$	(Jr. & Rock, 1989)
Moisture Stress Index 7	$MSI7 = \frac{B_7}{B_2}$	(Trombetti et al., 2008)
Inverted Moisture Stress Index	$IMSI = \frac{B_2}{B_6}$	This study
Inverted Moisture Stress Index 7	$IMS7 = \frac{B_2}{B_7}$	This study
Shortwave Infrared Ratio	$SRI = \frac{B_6}{B_7}$	(Trombetti et al., 2008)
Soil Adjusted Vegetation Index	$SAVI = \left(\frac{B_2-B_1}{B_2+B_1+L}\right) \cdot (1+L)$	(Huete, 1988)
Global Environment Monitoring Index	$GEMI = \eta \cdot (1-0.25\eta) - \frac{\rho_1-0.125}{1-\rho_1}$	
	where $\eta = \frac{2 \cdot (\rho_2^2-\rho_1^2)+1.5 \cdot \rho_2+0.5 \cdot \rho_2}{\rho_2+\rho_1+0.5}$	(Pinty & Verstraete, 1992)
Canopy Water Content	See Trombetti et al. 2008	(Trombetti et al., 2008)
Visible Atmospherically Resistant Index	$VARI = \frac{B_4-B_1}{B_4+B_1-B_3}$	(Gitelson et al., 2002a)
Global Vegetation Monitorin Index	$GVMI = \frac{(NIR_{REC}+0.1)-(SWIR_{REC}-0.02)}{(NIR_{REC}+0.1)+(SWIR_{REC}-0.02)}$	(Ceccato et al., 2002)
Normalized indices calculated in the study	$NormalizedIndex = \frac{B_x-B_y}{B_x+B_y}$	
	where B_x and B_y indicate one of the seven reflectance bands	
	available in the MOD09GA product	



...avelength

Introduction

1. What is remote sensing?
   - Observation and measurement of and object without touching it.
2. Types of resolution in remote sensing
   - Spatial Resolution



Source: http://www.satimagingcorp.com/services/resources/characterization-of-satellite-remote-sensing-systems/

Introduction

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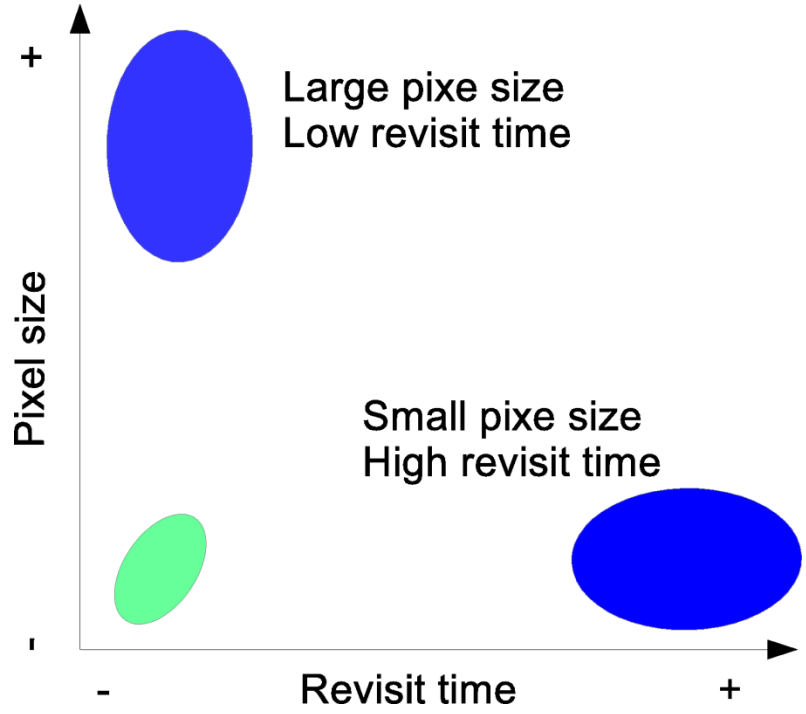
   - Temporal Resolution

     How often the data is collected



Introduction

- Sources of remote sensing data

UAV

- Small pixel size (cm)

- Difficulties to cover a large area
- Limited sensors can be mounted

Airborne

- Small pixel size (m)
- Hyperspectral sensors can be mounted

- Difficulties to cover a large area
- Expensive
- Require a lot of planification

Polar orbiting

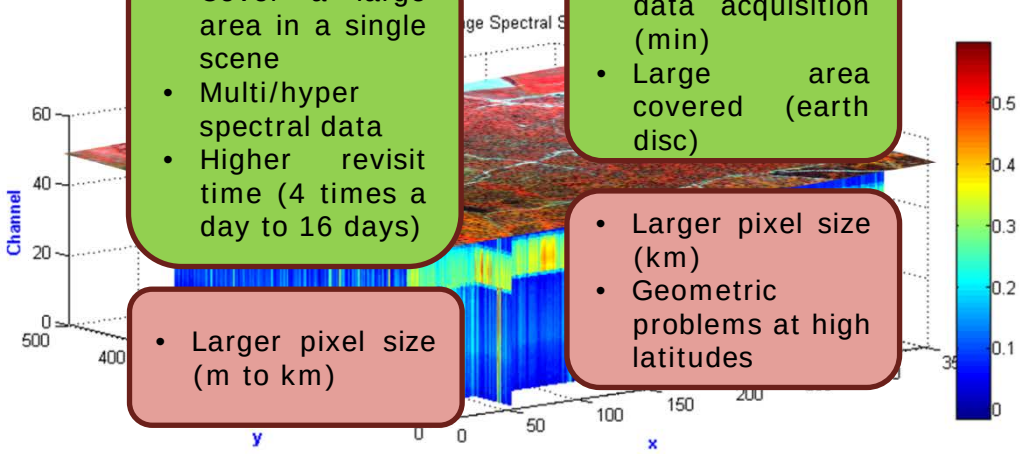
- Cover a large area in a single scene
- Multi/hyper spectral data
- Higher revisit time (4 times a day to 16 days)

- Larger pixel size (m to km)

Geostationary

- Very frequent data acquisition (min)
- Large area covered (earth disc)

- Larger pixel size (km)
- Geometric problems at high latitudes



How do we calculate Evapotranspiration (ET) using satellites?

- Empirical aproach
  - Vegetation index related with ET measurements
- Semi-empirical aproach
  - Triangle aproach relating temperature and vegetation indices
- Physical aproaches (Based on Land Surface Temperature (LST), Leaf Area Index and Albedo)
  - One source energy balance model (OSEB)
  - Two source energy balance model (TSEB)

    Dual-Temperature-Difference (DTD) adapted for polar orbiting satellites (Guzinski, 2013)

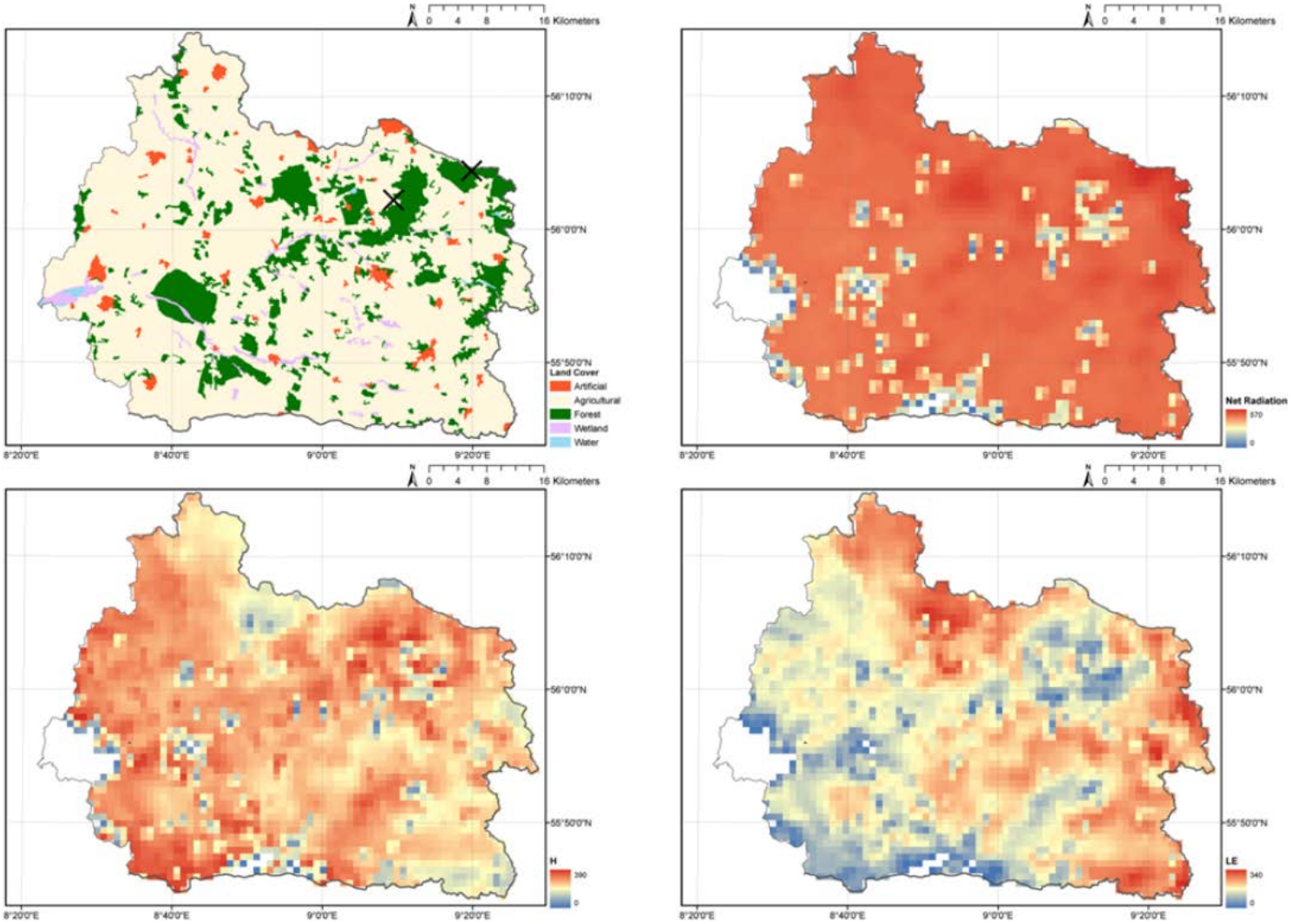
The DTD model

- Is based on the energy conservartion law

$$R_n = \mathrm{LE} + \mathrm{H} + \mathrm{G}$$

- Uses two observartions in time to minimize systematic errors in temperature estimation
- Requires LAI as input to split LST between soil and canopy
- Net radiation and ET for soil and canopy as outputs.

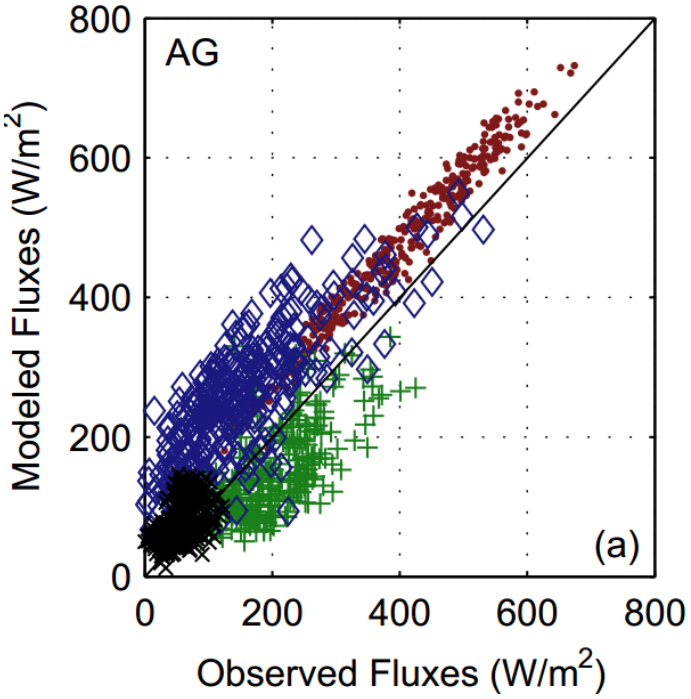
The DTD applied to Skern River catchment



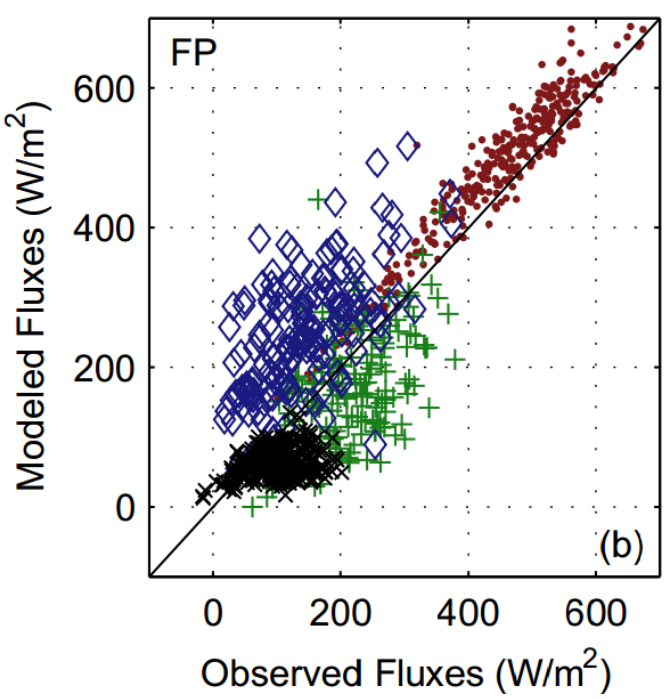
Guzinski et al. (2013)

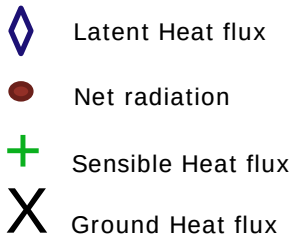
DTD performance

SEMI-ARID



TEMPERATE

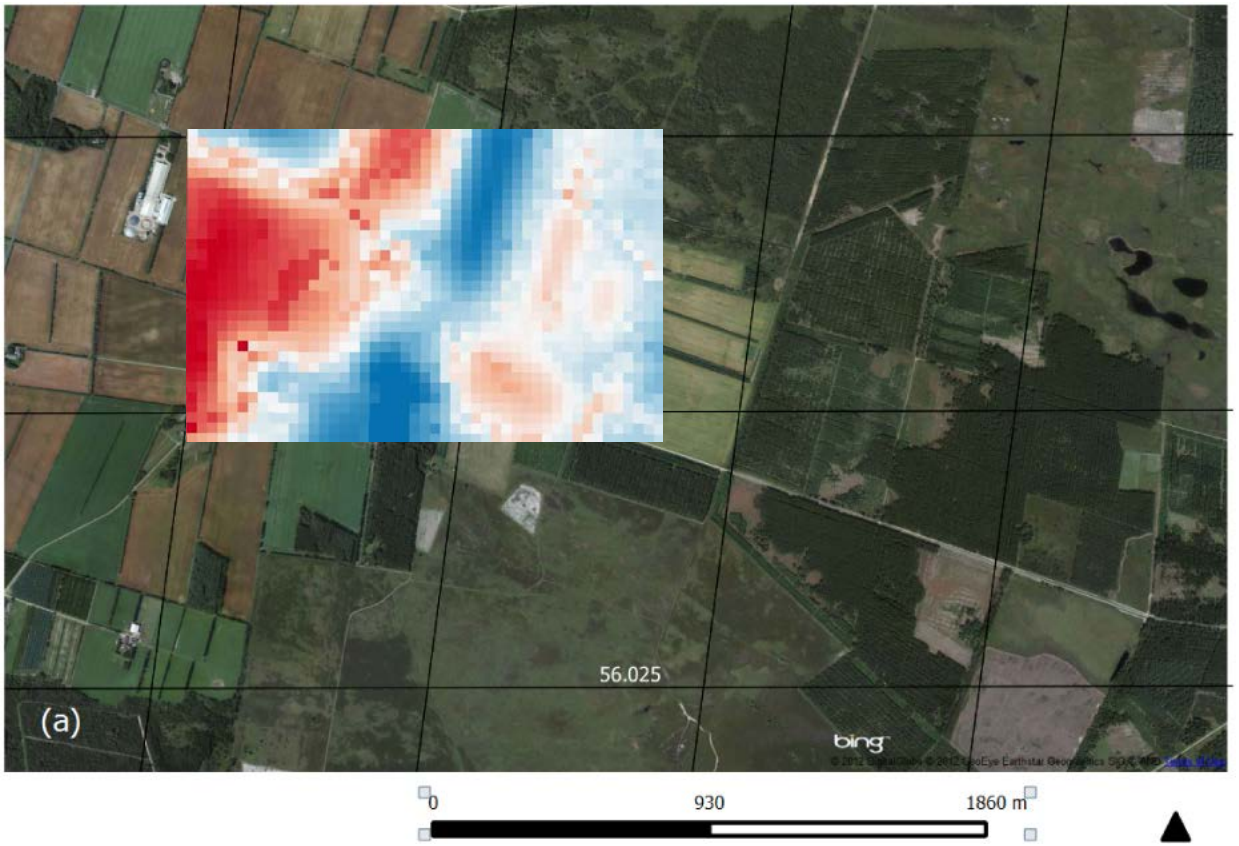




(Guzinski, 2013)

Scale issues

- Downscaling fluxes
  - Low resolution fluxes can be disagregated using higher spatial resolution images (Dis-ALEXI)



Summary and conclusions

- Remote sensing is a powerful tool to monitor hydrological processes
- ET was presented as an example. Spectral and thermal information can also be used to retrieve other biophysical properties of vegetation (LAI, Albedo) as well as other soil properties
- Combination of different sensors offers a wide range of possibilites, as very dynamic processes can be monitored with higher spatial resolution. Specially important when studying heterogenous areas.

Thanks for your attention!!!!

Any questions???