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Center for Earth Observation and Digital Earth  
Chinese Academy of Sciences

# *Development of land surface phenology monitoring with time series of remote sensing data*

Lin Lin Lu, Hua Dong Guo, Liang Yun  
Liu, Cui Zhen Wang

Center for Earth Observation and Digital Earth,  
Chinese Academy of Sciences



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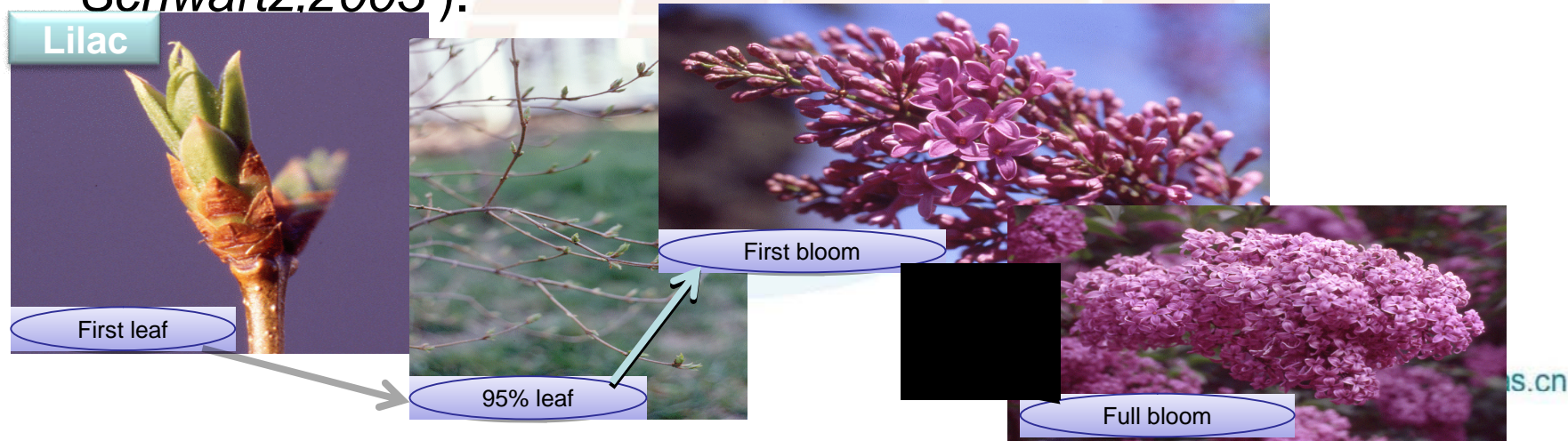


- Background
- Remote Sensing Data
- Methodologies
- Applications
  - climate change research
  - land cover and use classification
  - crop management
  - ecological environment assessment

# Background



- **Definition:** generally described as the art of observing life cycle phases or activities of plants and animals in their temporal occurrence throughout the year (Lieth, 1974).
- **Plant phenology:** annual calendars of leaf opening, flowering, fruiting, and leaf fall.
- **Importance:** global change has strong **interactions** with vegetation phenology( a bio-indicator for climate change; global change impacts on phenology; the integration of phenology in climate and vegetation models) (*Menzel,2002; Schwartz,2003* ).



# Background



## ◆ Phenology observation :

- observational networks, historical records, controlled experiments;
- intensive sites;
- bioclimatic modeling;
- space borne sensors and data assimilation;

## ◆ Different scales:

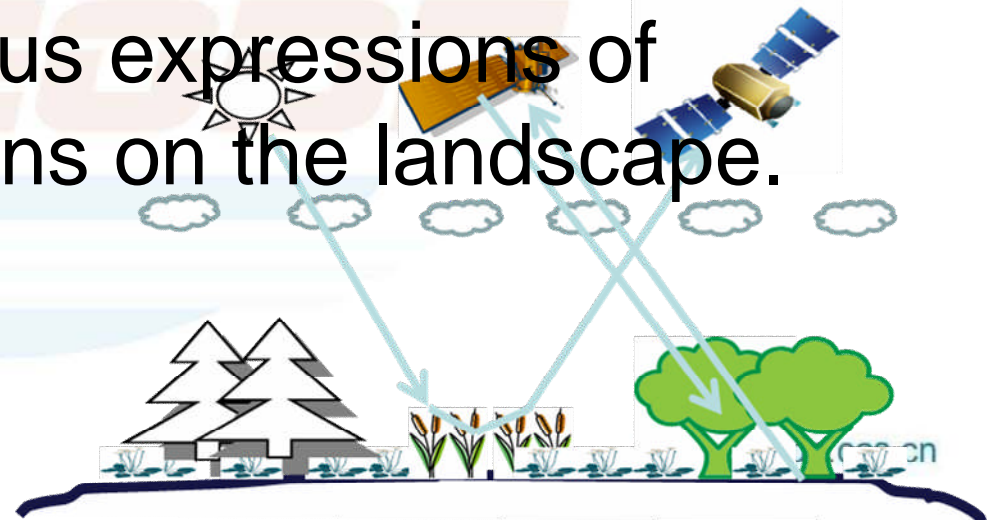
- plot:  $<10\text{km}^2$
- landscape:  $10\text{-}100\text{km}^2$
- regional:  $100\text{-}10^5\text{km}^2$
- continental:  $>10^5\text{km}^2$
- global



# Background



- ◆ **Land surface phenology:** the seasonal pattern of variation in vegetated land surfaces observed from **remote sensing** (Friedl, 2006 ; Henebry, 2005) .
- ◆ **Advantage:** provides the potential to move from plant specific observations to complete, continuous expressions of phenological patterns on the landscape.



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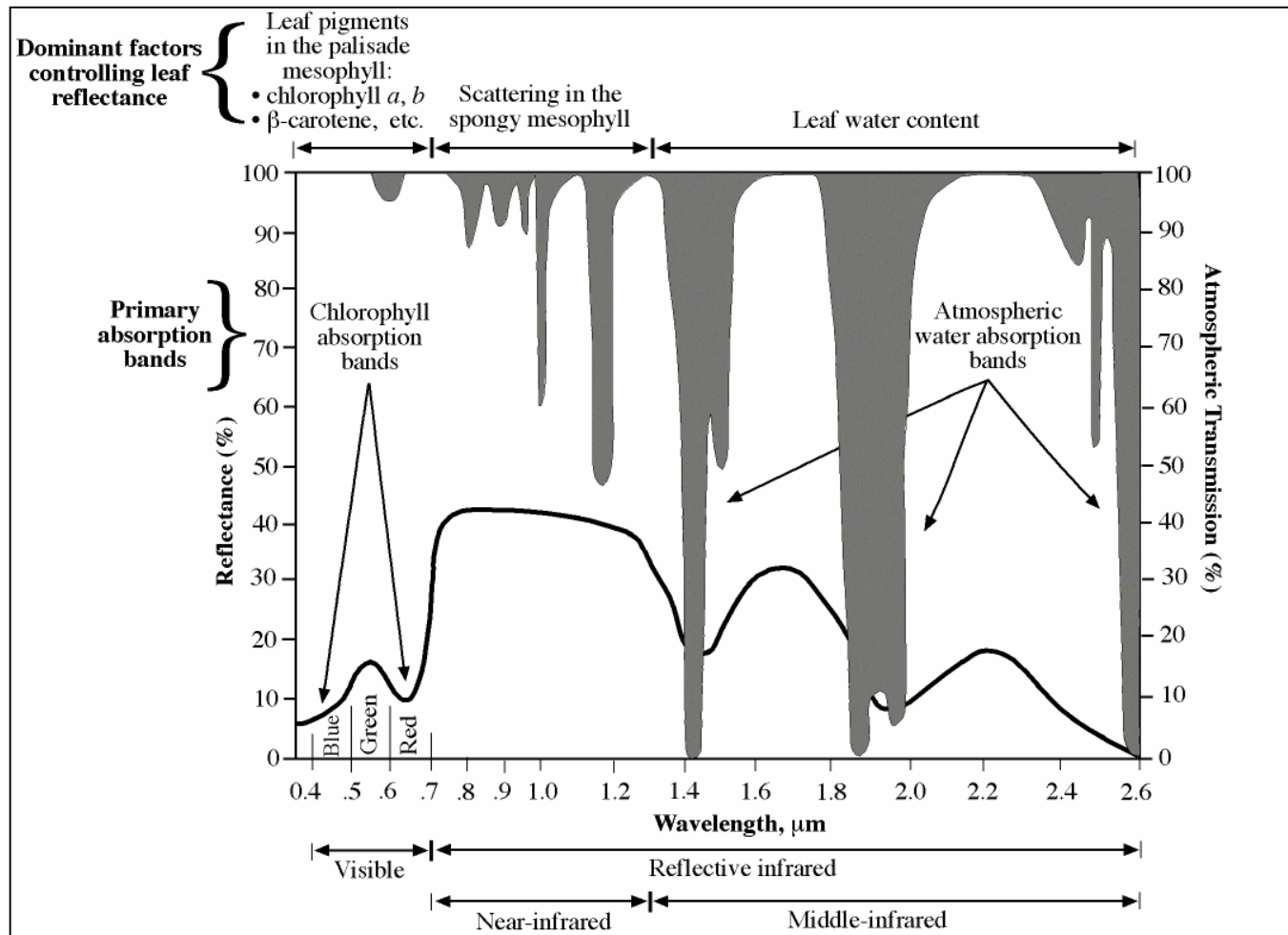


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# Remote sensing data



## Vegetation Spectra



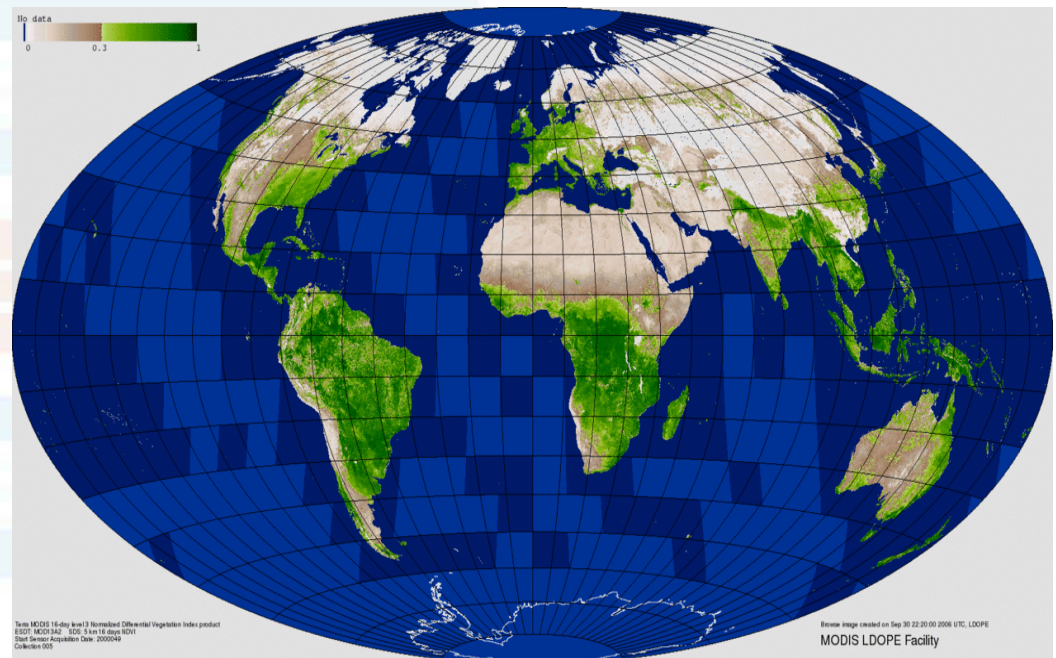
# Remote sensing data



- Vegetation Index: dimensionless, radiometric measures usually involving a ratio and/or linear combination of the red and near-infrared (NIR) portions of the spectrum. They serve as **indicators of relative growth and/or vigor of green vegetation**, and are **diagnostic of various biophysical vegetation parameters**". (Huete, 1994).

- VIs used:

- NDVI, EVI, LAI, MSAVI;
- LSWI;
- CI(Chlorophyll Index);
- FPAR;
- .....



**GIMMS AVHRR NDVI**



# Remote sensing data



**Satellite sensors and data sets utilized for land surface phenology studies:**

Satellite	Sensor	Operation	Resolution	Frequency
Landsat	MSS	1973–1985	79 m	18 days
Landsat	TM	1984-present	30m	16 days
Landsat	ETM+	1999–present	30 m	16 days
NOAA	AVHRR	1982-present	8km	twice monthly
NOAA	AVHRR	1989-present	1km	biweekly
Terra	MODIS	2000-present	250 m, 500m, 1km	1-2days
Aqua	MODIS	2002-present	250m,500m,1km	1-2 days
SPOT	Vegetation	1999-present	1km	1-2 days
Envisat	MERIS	2002-present	300m	1-3 days
Aqua	AMSR-E	2002-present	5km, 15km, 25km, 50km	1-2 days

# Remote sensing data



- LSP Products:
  - AVHRR: US Geological Survey  
(<http://edc2.usgs.gov/phenological>)
  - MODIS: NASA(<http://accweb.nascom.nasa.gov/data>)
  - MODIS: Boston University  
([https://lpdaac.usgs.gov/lpdaac/products/modis\\_product\\_table/land\\_cover/dynamics\\_yearly\\_l3\\_global\\_1km/v5/terra](https://lpdaac.usgs.gov/lpdaac/products/modis_product_table/land_cover/dynamics_yearly_l3_global_1km/v5/terra))

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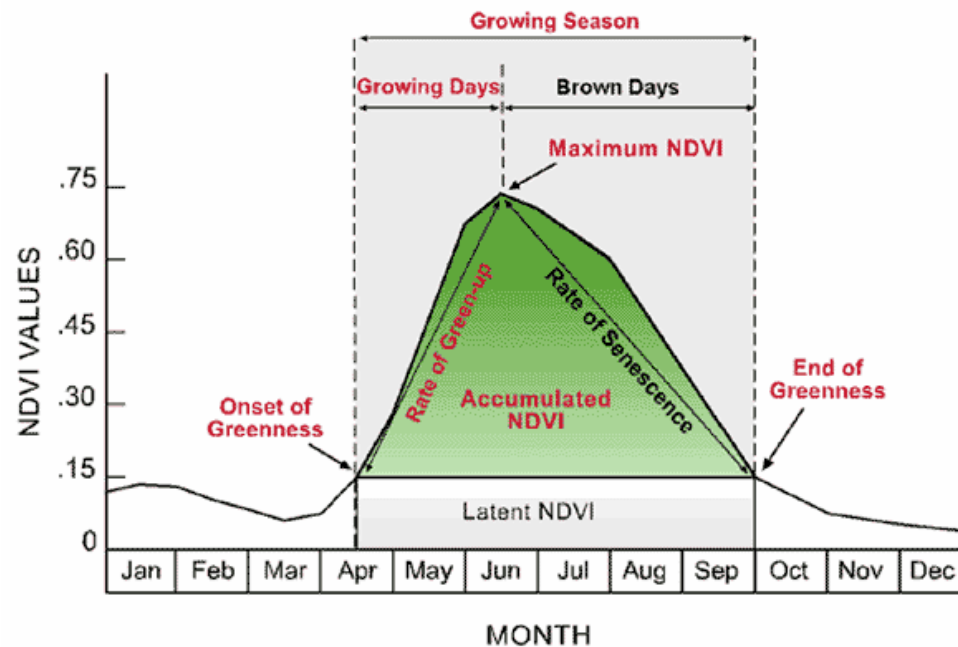


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# Methodologies



- **Aim:** use time series of vegetation indices to identify the timing of phenological transition dates such as the start and end of the growing season.



# Methodologies



- Different types of phenological metrics extraction methods:
  - ✓ threshold-based techniques (Jonsson & Eklundh, 2002; White et al., 1997);
  - ✓ methods based on moving average( Brown, 2002);
  - ✓ techniques based on first derivatives(Xin et al. 2002;Viña et al. 2004; Zhang et al., 2003).
  - ✓ techniques based on empirical equations(Koduk, 1996;Moulin, 1997)
  - ✓ .....

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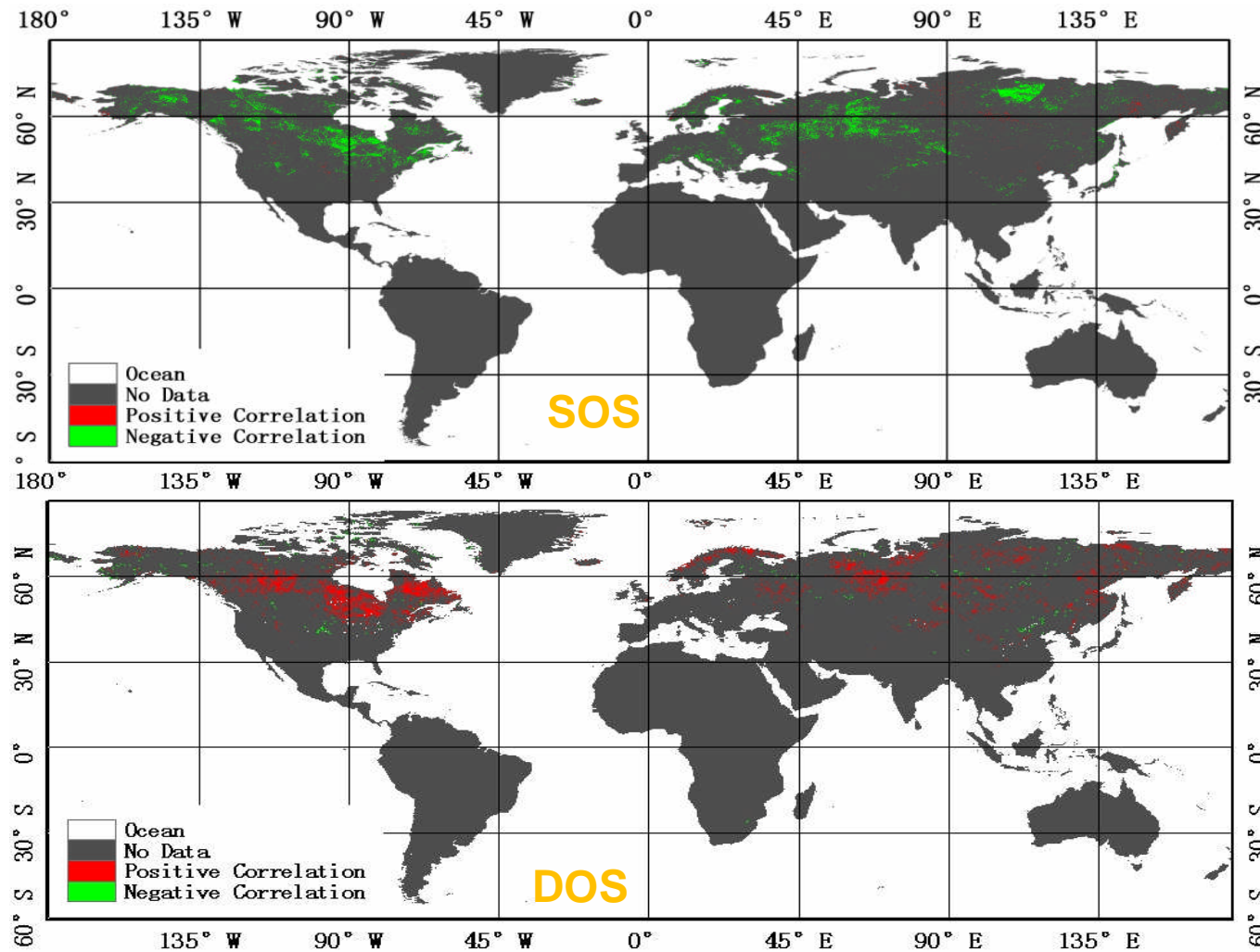


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# Applications: climate change



## Phenology's response to global warming

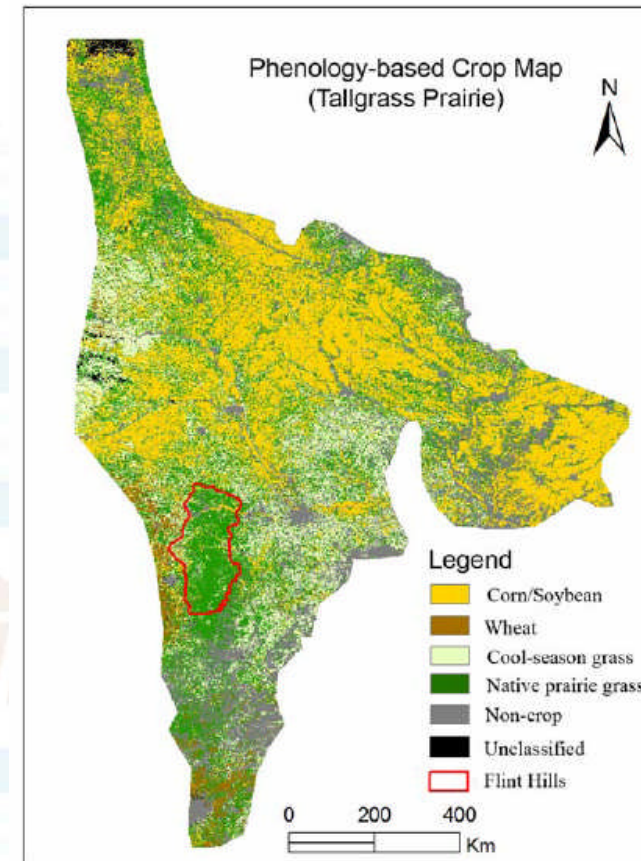
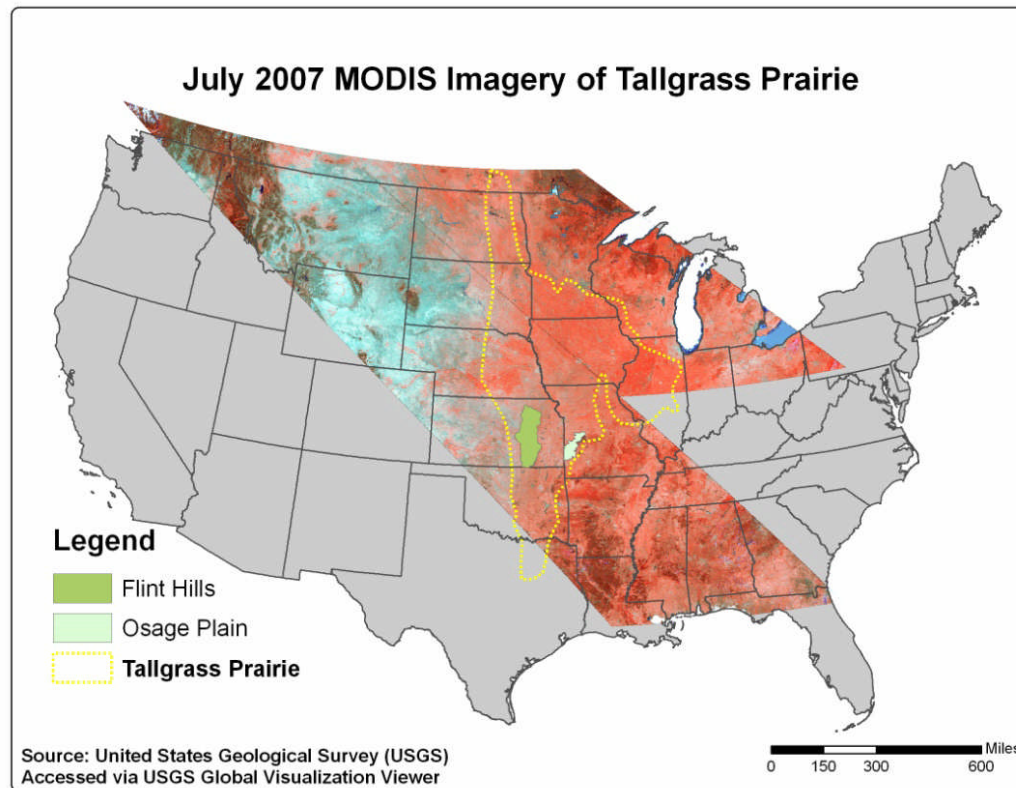


Relations between the year mean temperature and phenologies(Liu,2010)

# Applications: land cover and use



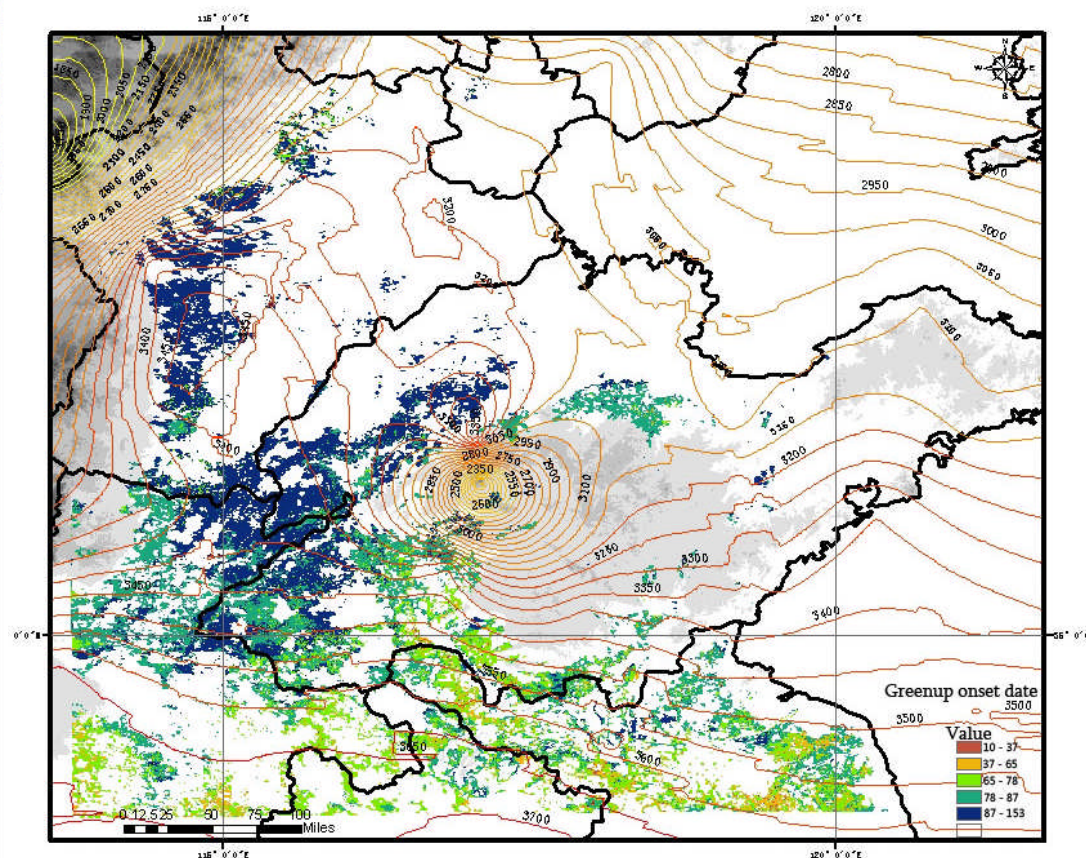
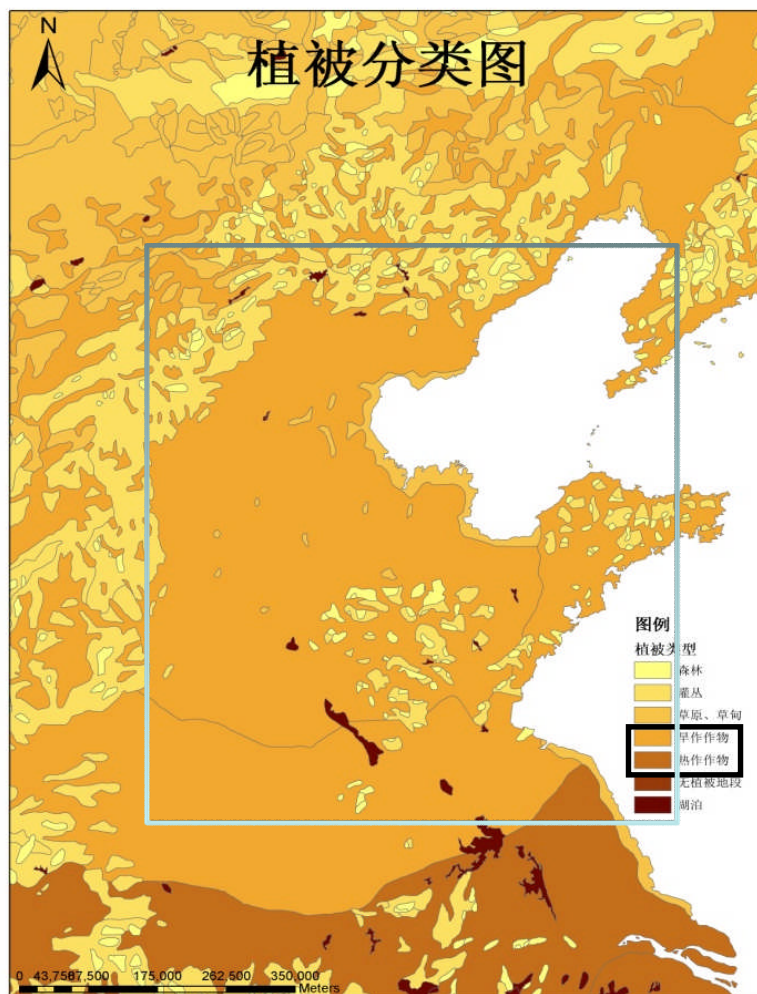
## Assessment of Perennial Energy Crops



2007 crop map of the Tallgrass Prairie extracted from time series of MODIS imagery. (Wang,2010)

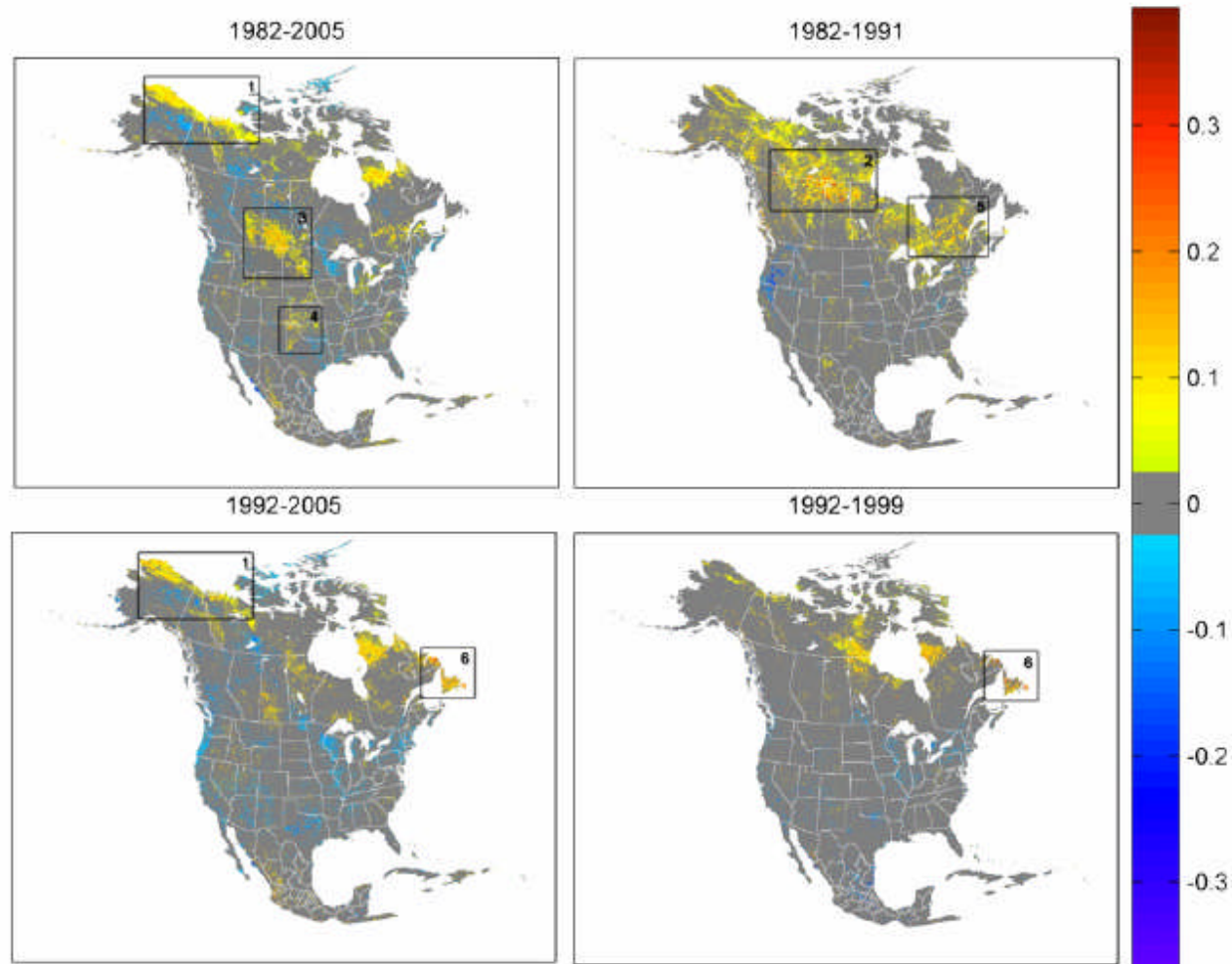


# Applications: crop management



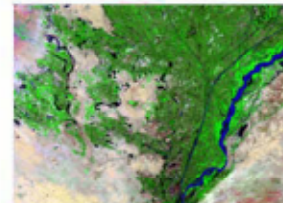
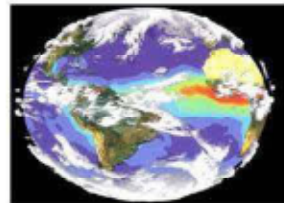
**Greenup onset date of winter wheat corresponds with cumulative temperature in the northern plain of China,2003(Lu, 2010).**

# Applications: ecological environment assessment



Annual AVHRR NDVI trends for selected periods between 1982 and 2005 in North America(Neigh,2008).

# Thanks !



Center for Earth Observation and Digital Earth  
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Add: No.9 Beiyitiao Road, Zhongguancun, Beijing China 100190

Tel: 86-10-58887301 Fax: 86-10-58887302

E-mail: [office@ceode.ac.cn](mailto:office@ceode.ac.cn)

Web: [www.ceode.cas.cn](http://www.ceode.cas.cn)