Shifting Trends in Phenology of the Temperate Deciduous Forest in the Midwest and Northeast of US

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Local observations of NEP and phenology

Morgan-Monroe State Forest (MMSF)
AmeriFlux Site

- Mixed deciduous forest
- 80 year old forest
- 27 m average canopy height
- Continuous measurements since 1989
Phenology at MMSF

Start of the season

End of the season

Length of the season

Dragoni et al. (2011), Global Change Biology
NEP at MMSF

Late-summer NEP
DOY 260-299
Mid-September – End of October

Annual NEP vs. Length of vegetative season

Dragonì et al. (2011), Global Change Biology
From local to continental scale

Normalized Difference Vegetation Index (NDVI) data from Advanced Very High Resolution Radiometer (AVHRR) satellite from the United States Geological Survey (USGS) at a 1-km resolution (http://phenology.cr.usgs.gov/ndvi_avhrr.php).

From 1989 to 2008
Start of the season – 1989-2008 trends

Negative trends = earlier green-up

SOS shows widespread negative trends north of 36-40°N

SOS shows no-trend or positive trends South of 36-40°N
End of the season – 1989-2008 trends

EOS shows widespread positive trends across the entire US Eastern deciduous forests

positive trends = later senescence
SOS and EOS time-series

Areas with negative SOS trends

Areas with positive SOS trends

Areas with positive EOS trends

Areas with either positive SOS (empty squares) or negative SOS (solid dots) and positive EOS trends
Change in annual NEP (gC m²)

Estimates obtained by

- Using the SOS and EOS linear trends from all the pixels in the map

- Assuming a change in annual NEP of 4 gC m² and 3 gC m² for each day of change in the SOS and EOS, respectively (Richardson et al., 2009 Dragoni et al., 2011)

- Assuming no indirect effects of phenology variability on annual NEP
Conclusions

• Spring phenology seems to show a slow-down in the green-up advancing in the ‘northern’ regions of US Eastern deciduous forests, and even a delay in the ‘southern’ regions

• Fall phenology shows a spatially and temporally consistent trend in senescence delay

• The contribution of fall phenology is becoming important in determining the short- and long-term variability of the length of vegetative season and potentially of (net) carbon uptake

• Questions on the drivers, mechanisms, and feedbacks for the observed trends
Acknowledgments

• The US-Department Of Energy (BER)

• NASA

• Indiana University

• Indiana Dept. of Natural Resources (Forest Service)