An Algorithm for Green Vegetation Fraction and Its Implication in WRF

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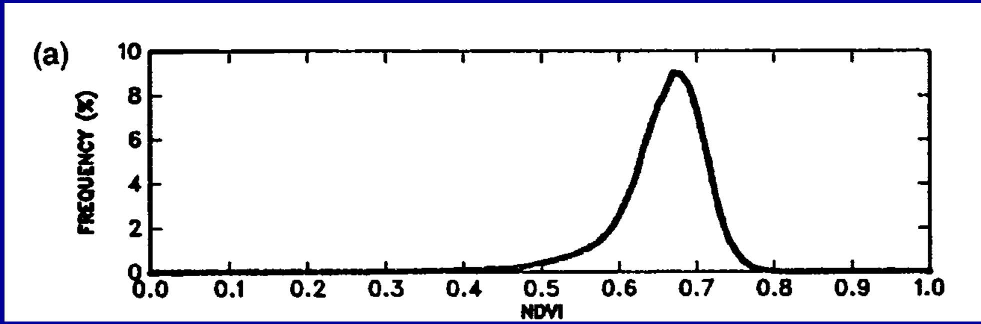
An Algorithm to Incorporate Real-time NDVI into the WRF Model

- Goal: develop a simple algorithm to determine high-resolution real-time surface properties for use with operational models
- Test AVHRR and MODIS NDVI data with global resolutions of 0.144º, 1’, and 1km
- Derive global green vegetation fraction(GVF)
- Compare with existing WRF/Noah GVF
- Must have at least one complete annual cycle
- Determine stability for multi-year data

GVF calculation

$$GVF = \frac{NDVI_{time} - NDVI_{soil}}{NDVI_{veg} - NDVI_{soil}}$$

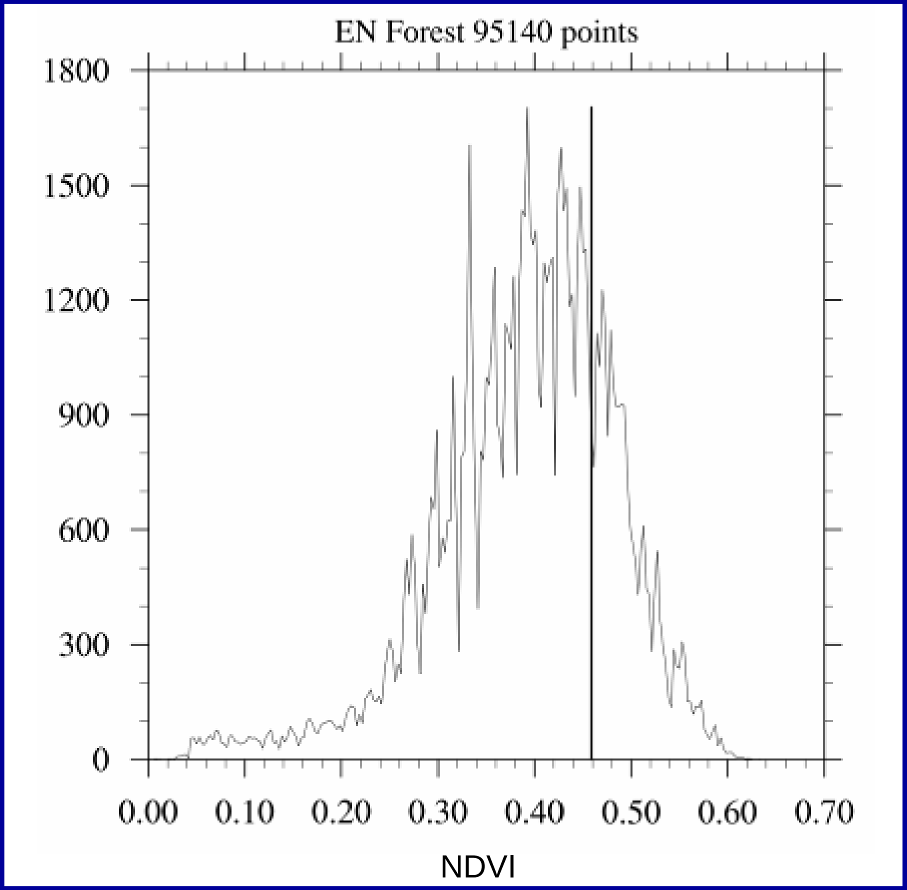
- To find $NDVI_{veg}$ and $NDVI_{soil}$, we introduce land type classifications
- For each land cover type, find histogram of annual maximum at each global land point
- $NDVI_{veg}$ and $NDVI_{soil}$ correspond to cumulative percentiles determined from aircraft and Landsat observations



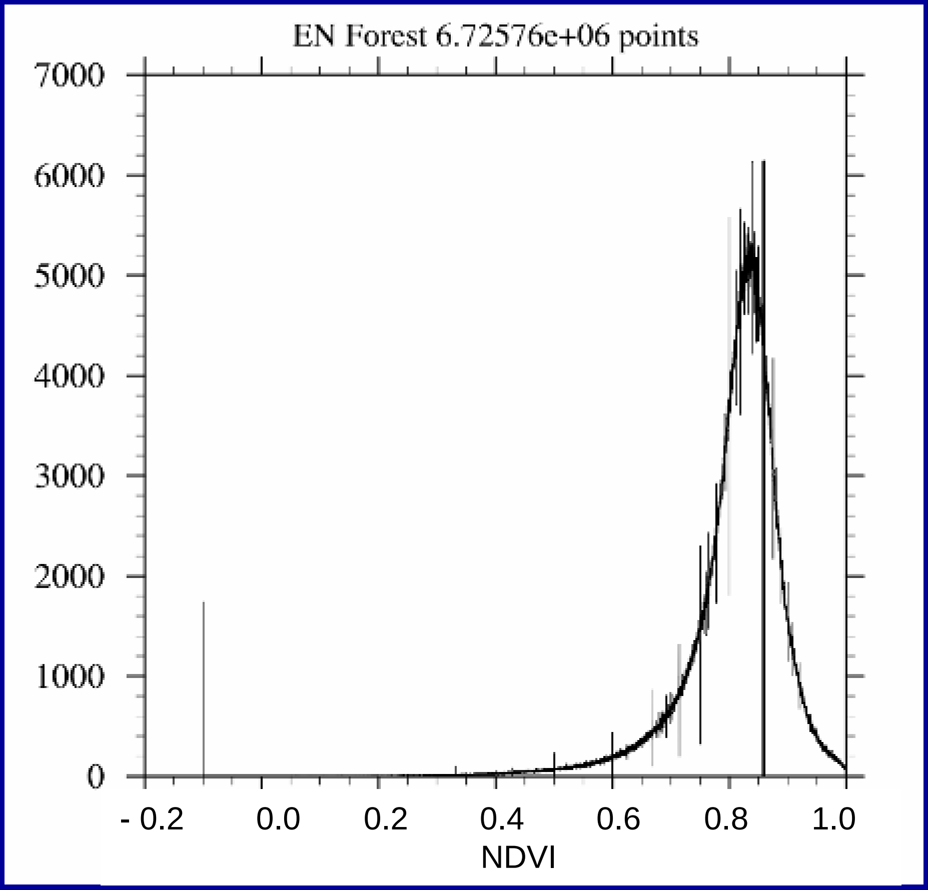
Histogram of evergreen broadleaf

$NDVI_{max}$ histograms

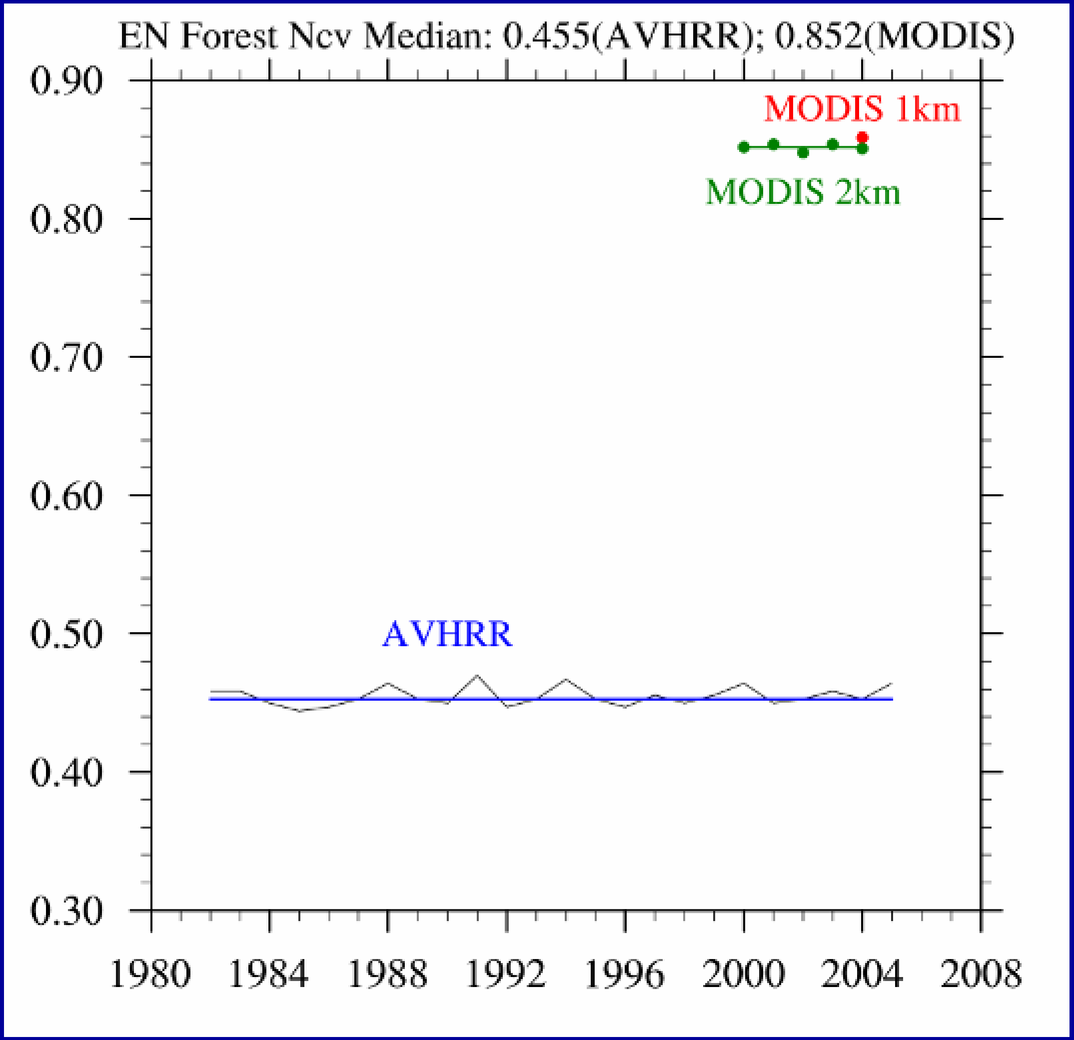
AVHRR



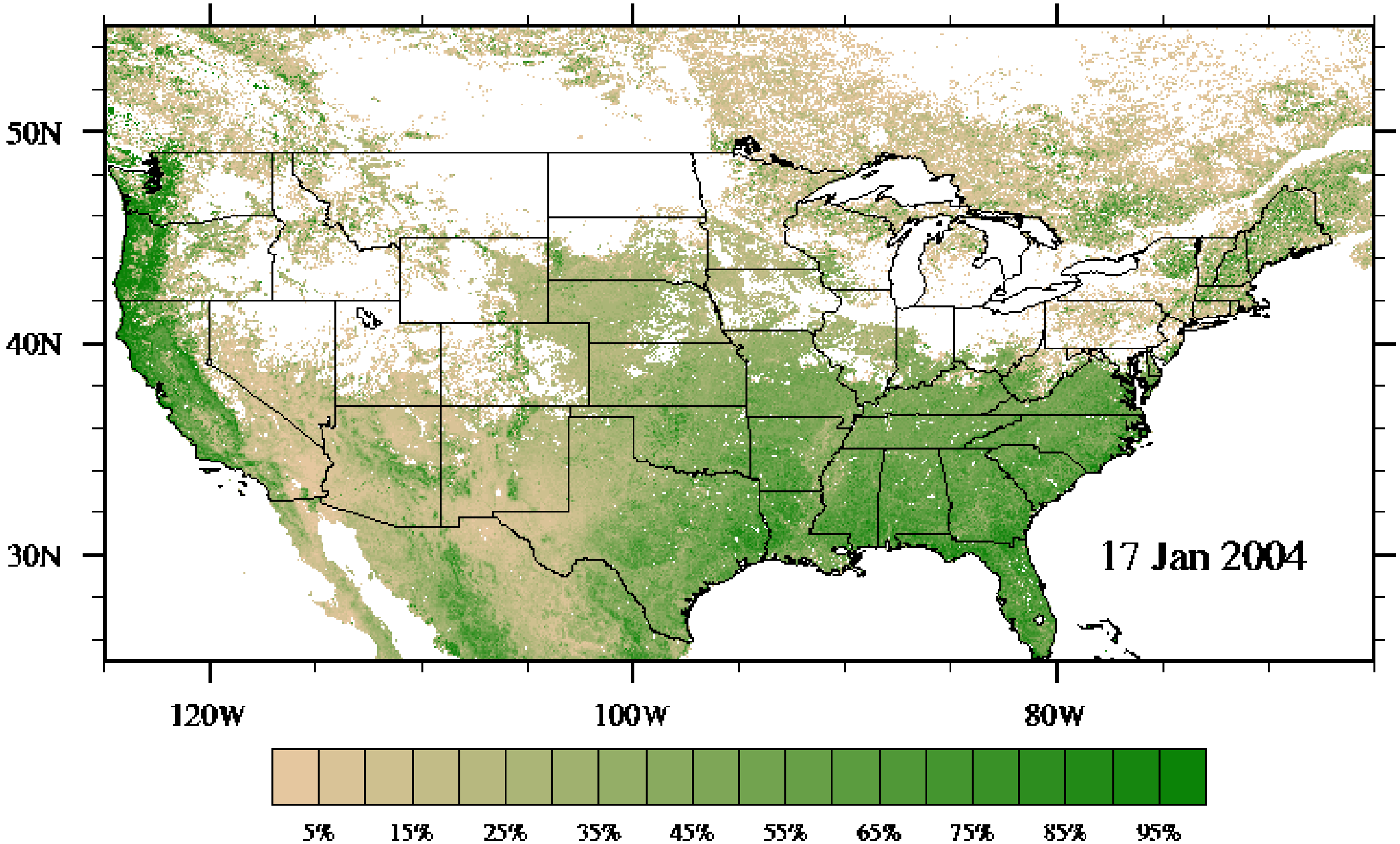
MODIS 1km



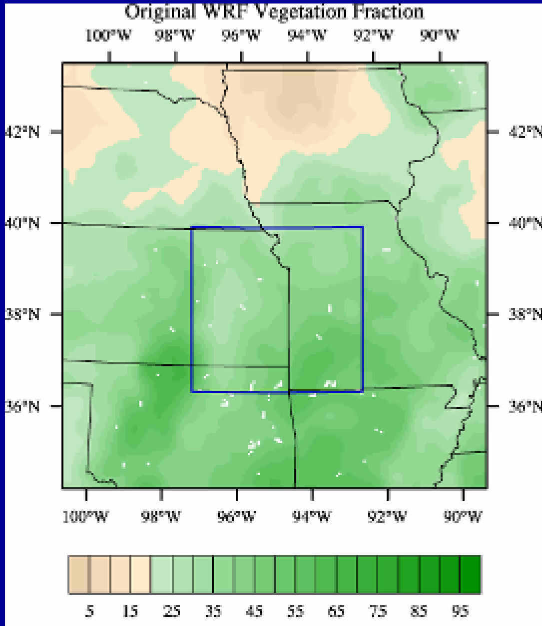
N_{veg} Inter-annual Variation

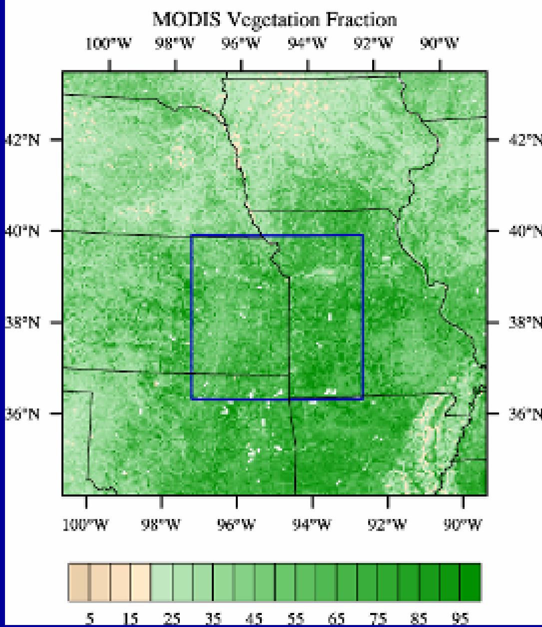


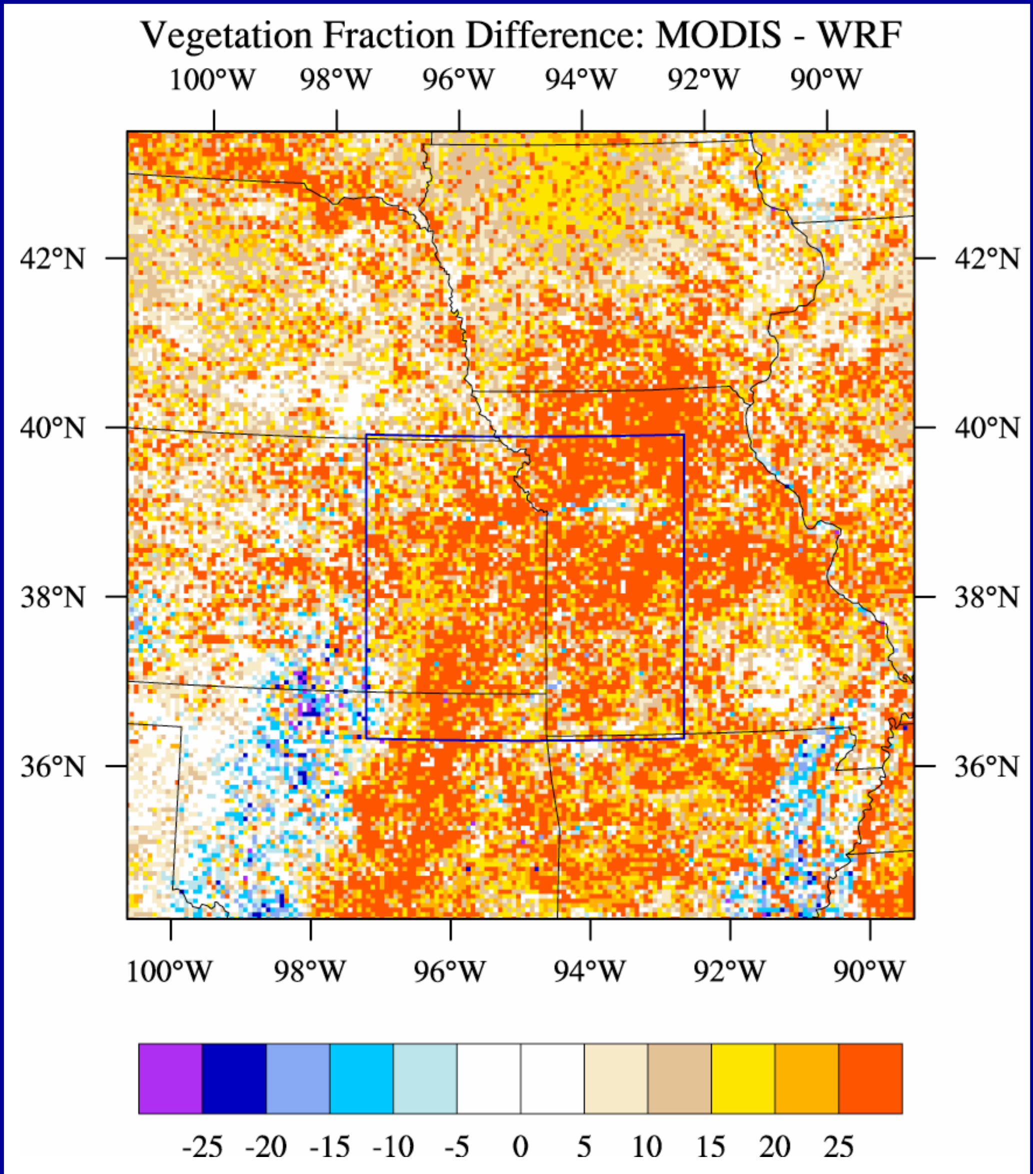
MODIS 1km Green Vegetation Fraction



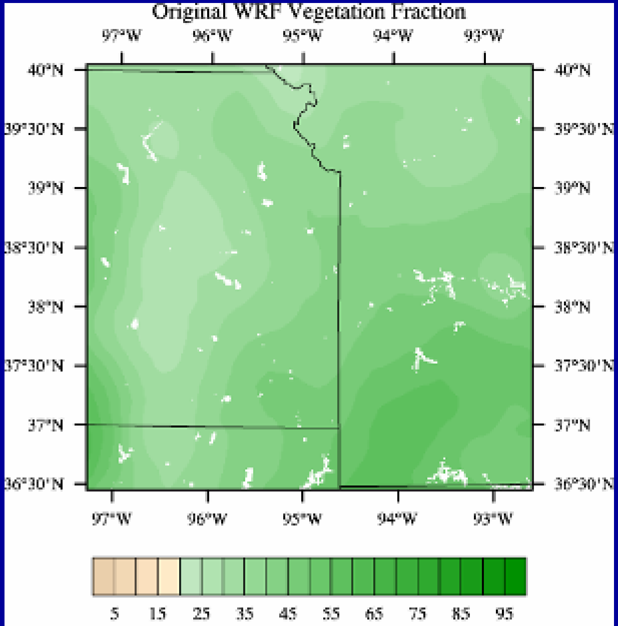
WRF Outer Domain(6km) Vegetation Fraction
April 2, 2006

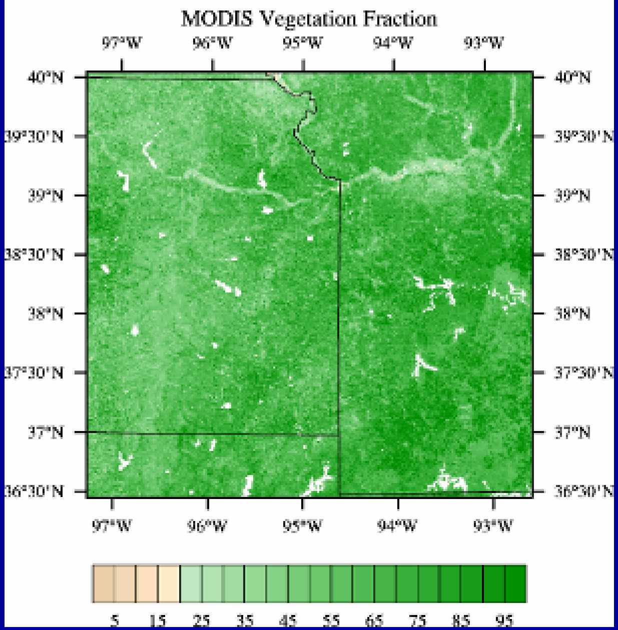


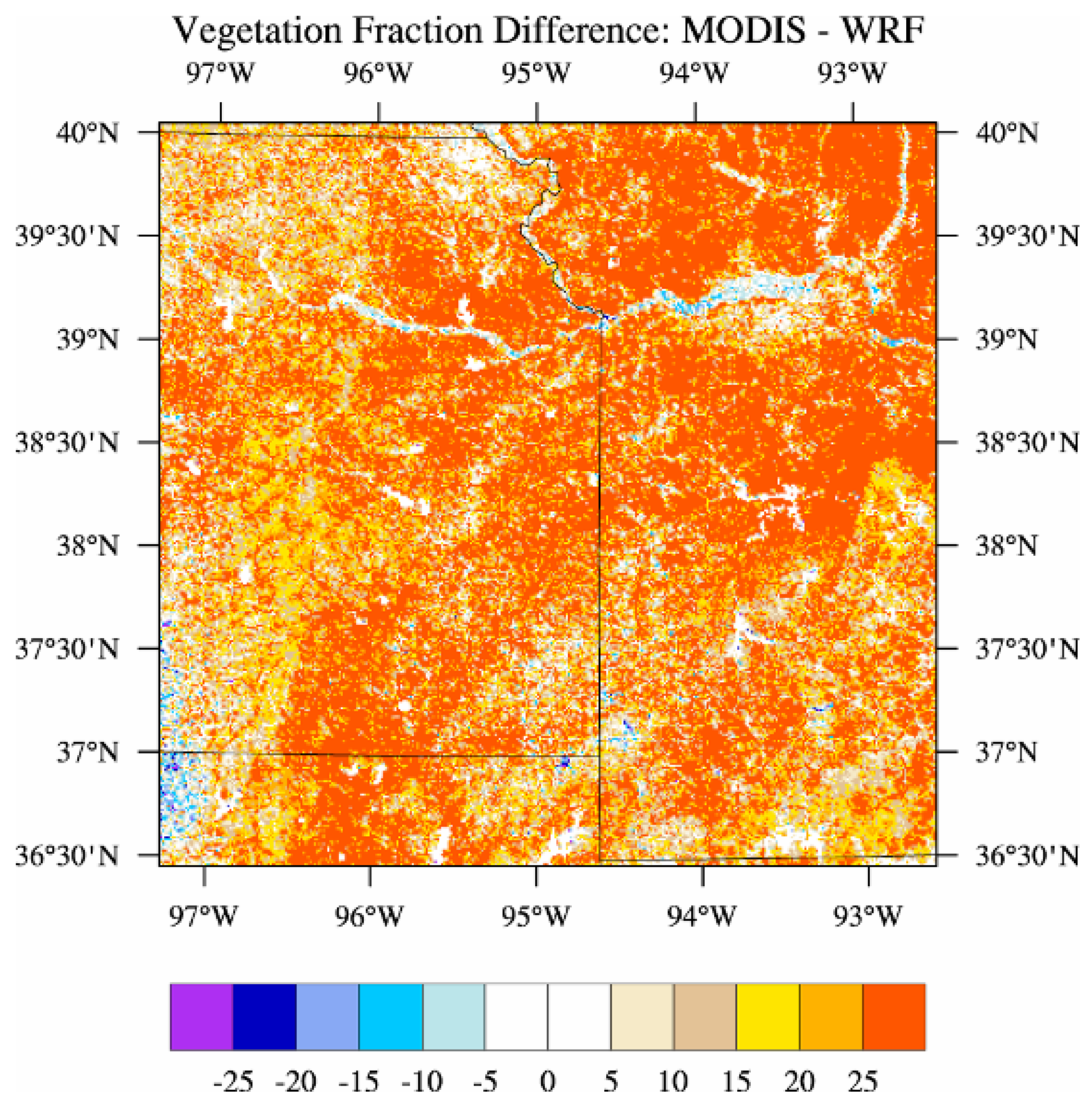




WRF Inner Domain(1.2km) Vegetation Fraction
April 2, 2006







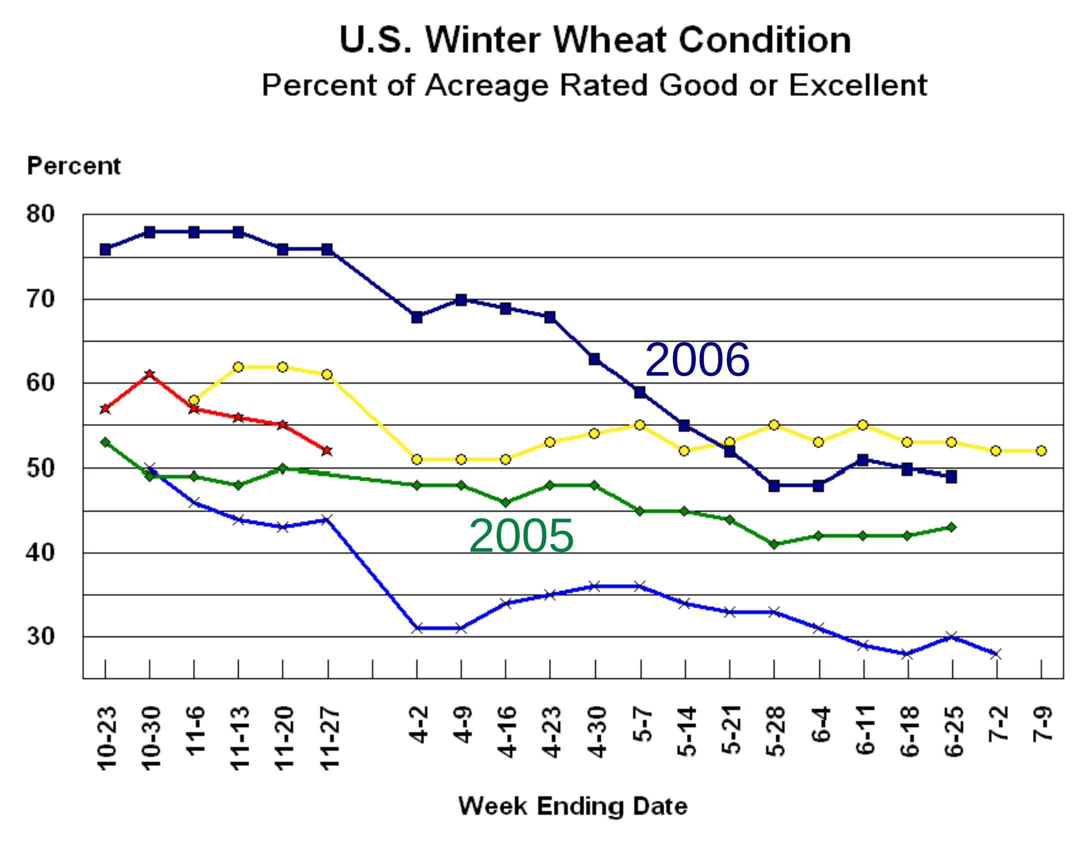
Winter Wheat Crop Growth

% of Missouri Winter Wheat Headed

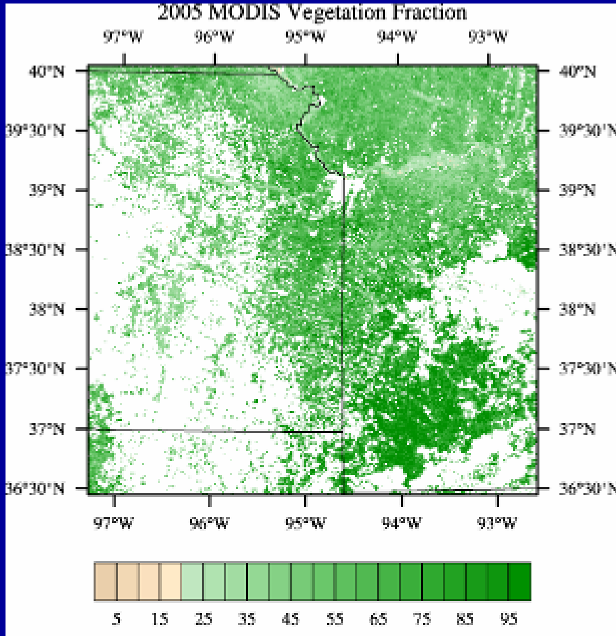
National Agriculture Statistics Service

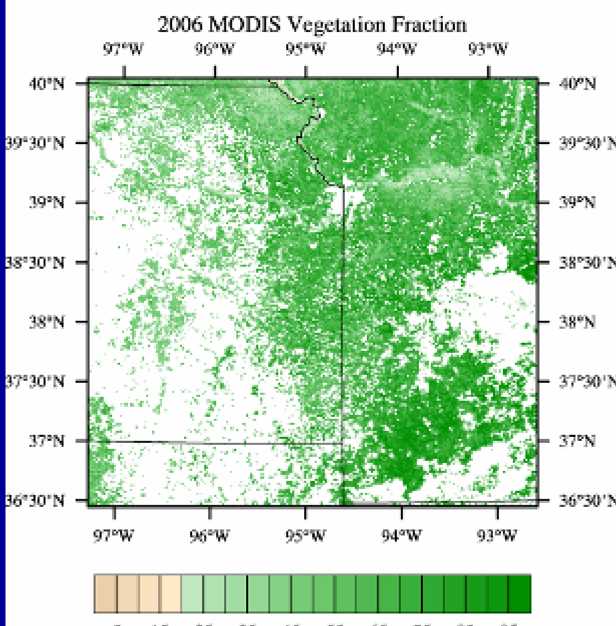
	2006	5-yr AVG
April 9	2%	1%
April 16	30%	6%
April 23	64%	22%

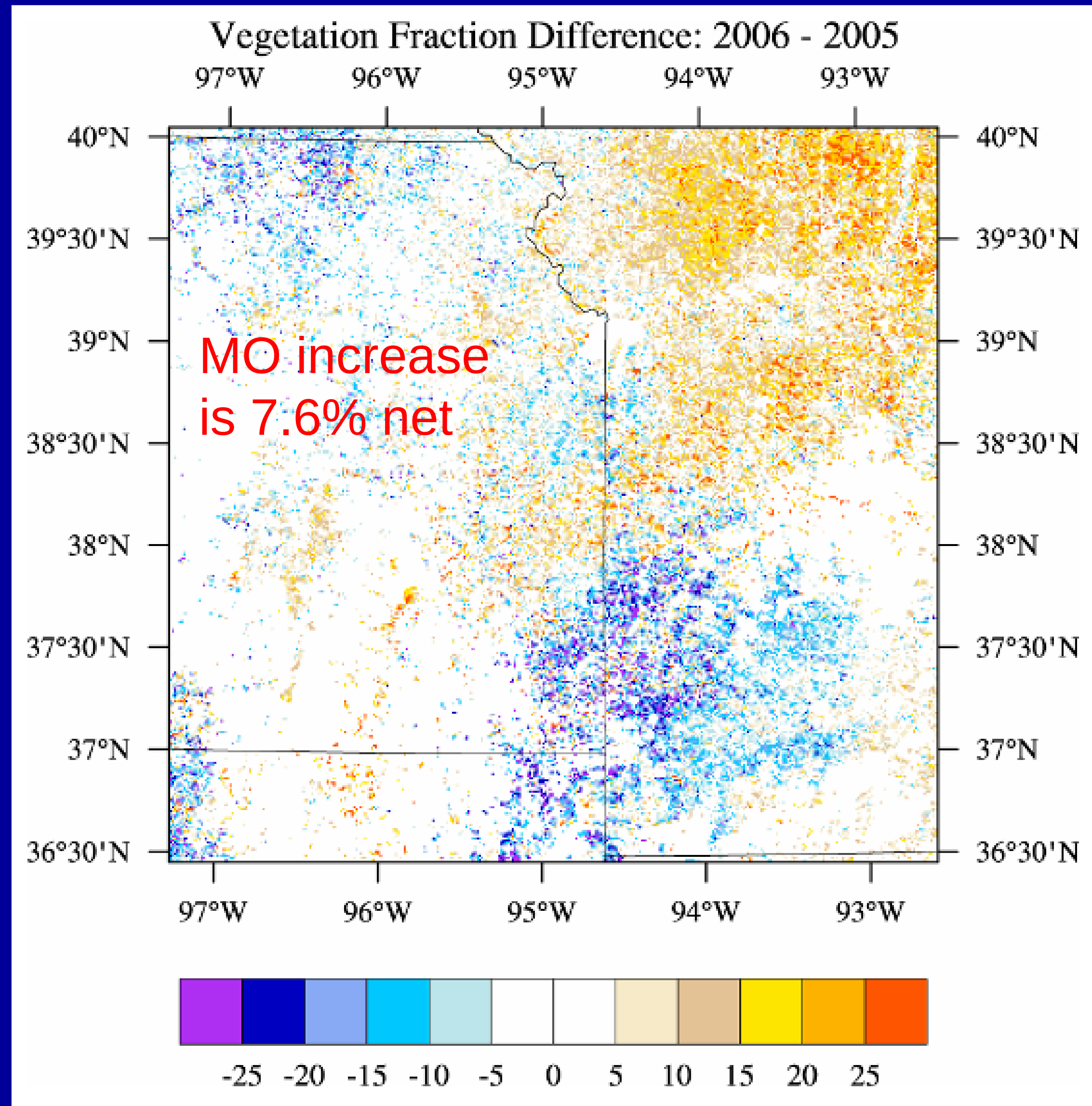
- Proxy for vegetation condition
- Winter wheat crop in 2006 was relatively better than 2005
- Missouri Winter Wheat crop about 1.5 weeks ahead of 5-year average



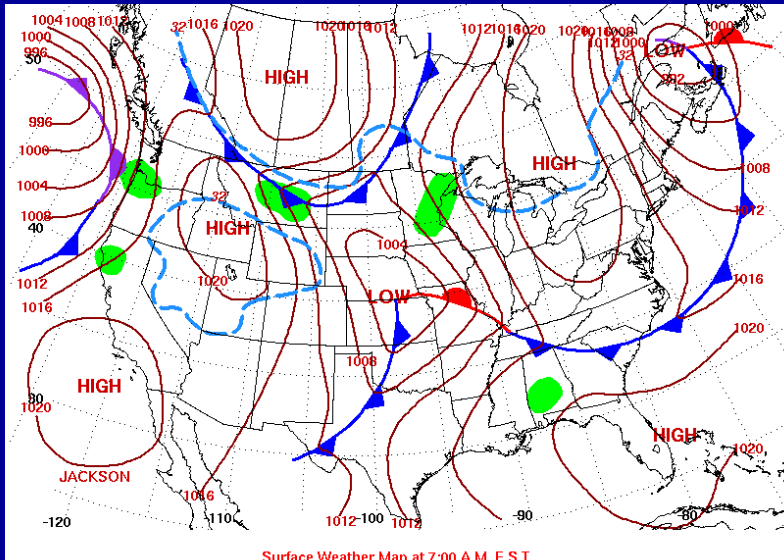
Inter-annual Vegetation Fraction Variation

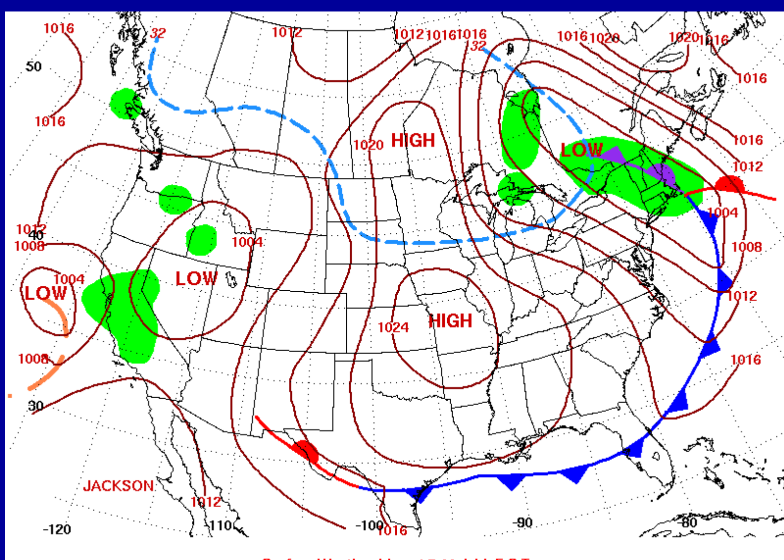




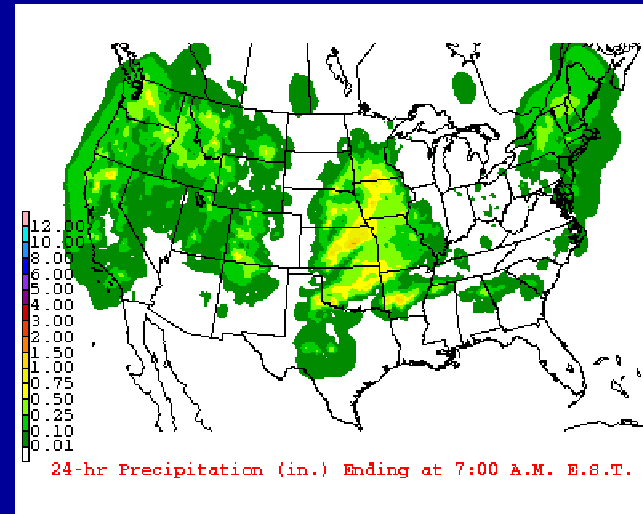


Daily Weather Maps

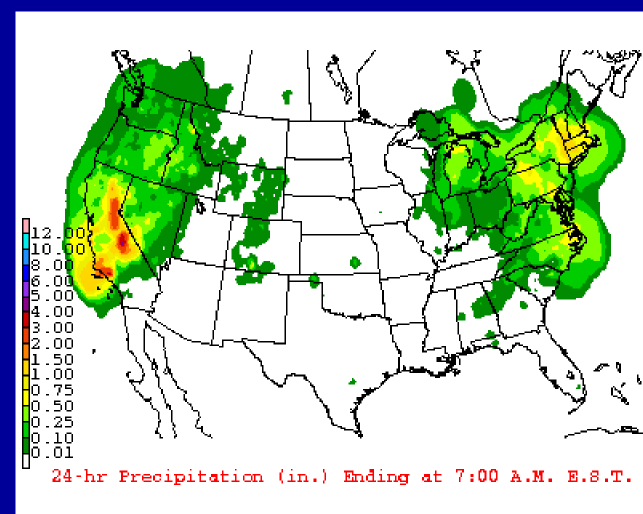




2 April 2006

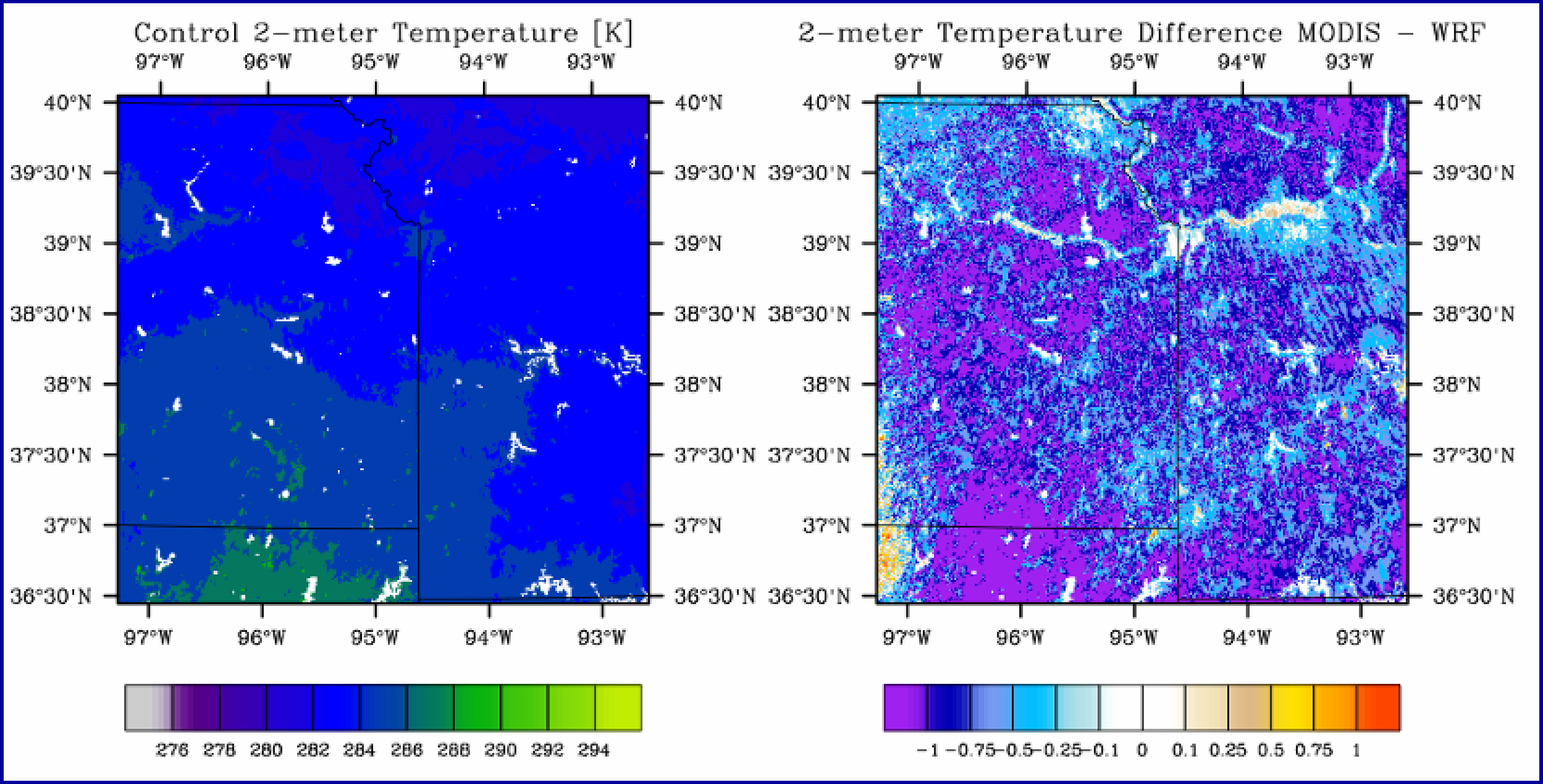


4 April 2006



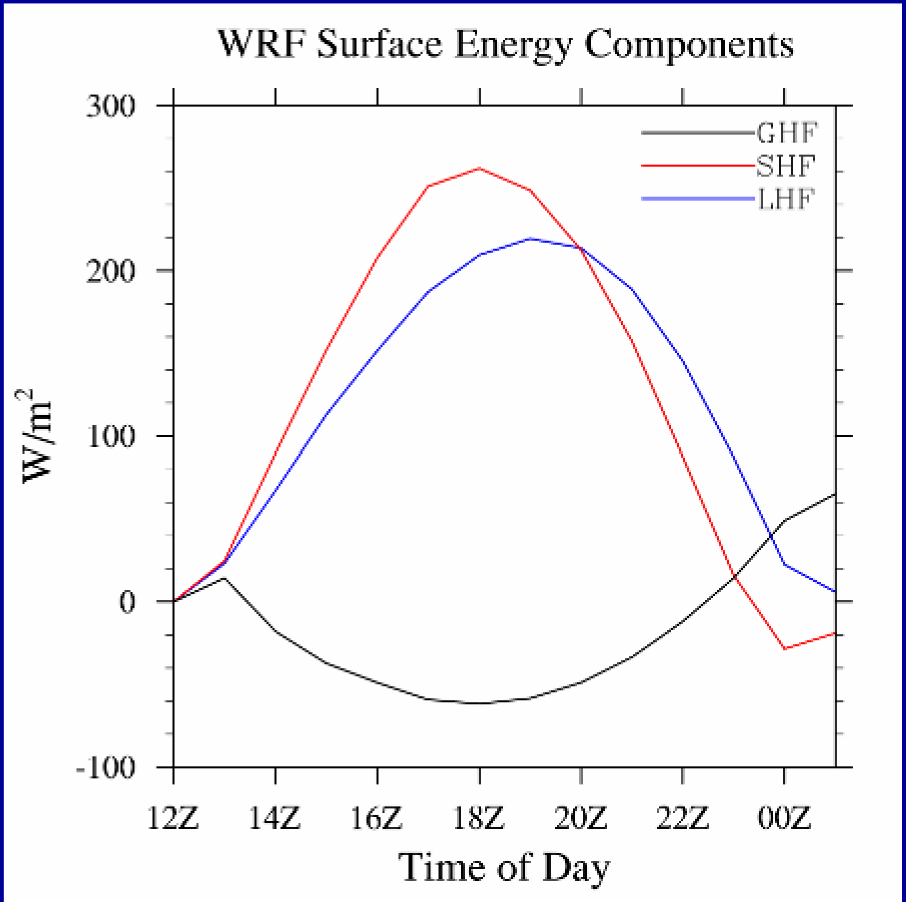
WRF Simulations: 00Z April 4

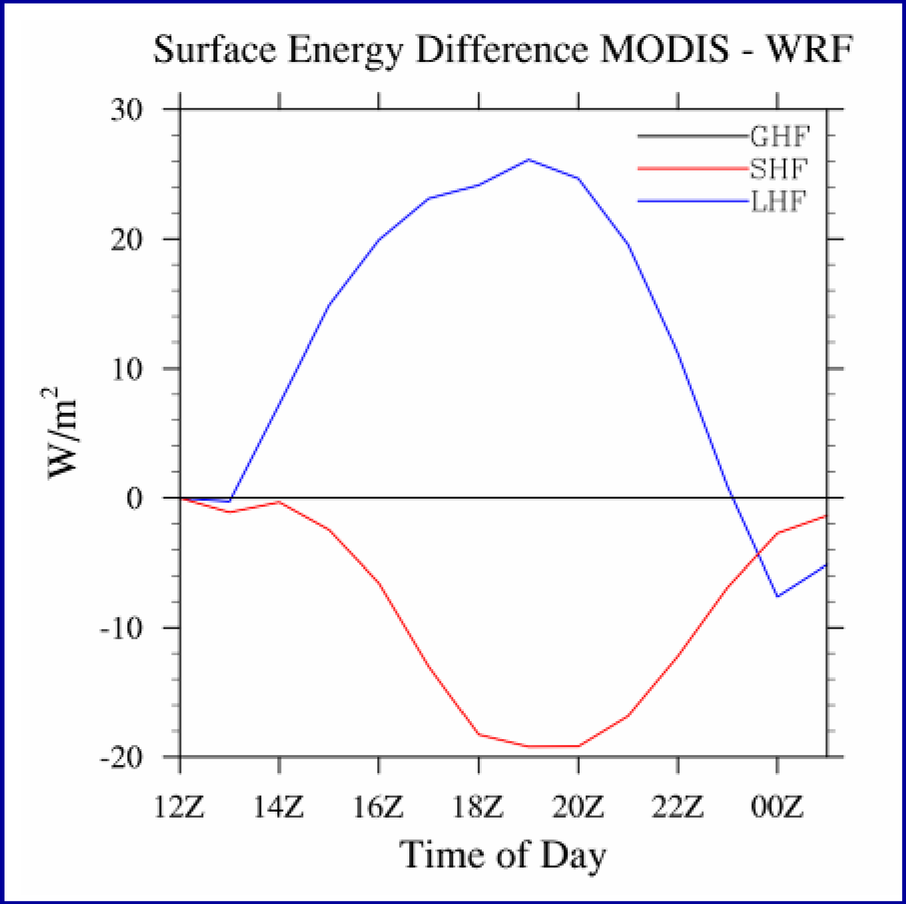
- 2-meter Temperature decreases over almost entire inner domain



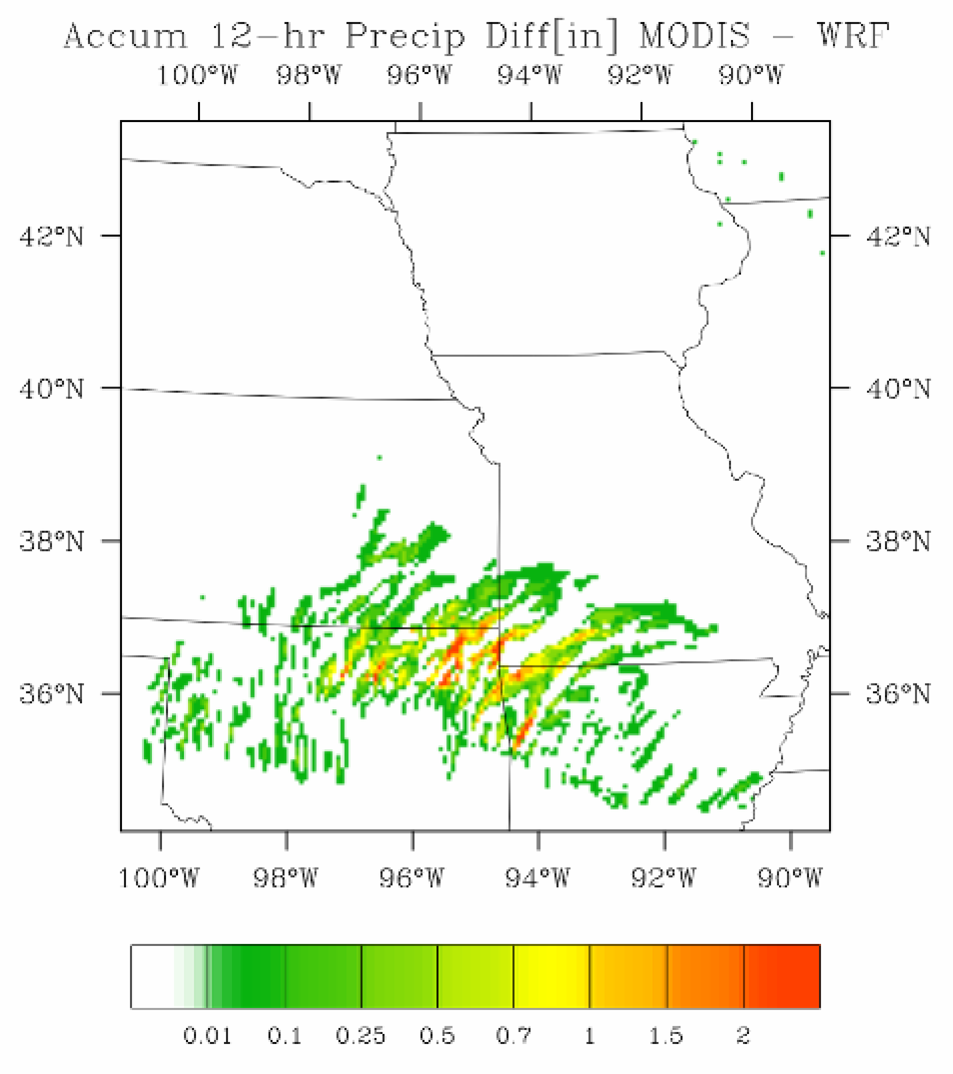
WRF Simulations: April 4

- Latent and sensible heat surface fluxes are of similar magnitude
- New vegetation cover increases LH(mostly TR), decreases SH
- Similar to results of Miller, et al.(2006) over entire U.S.





WRF Simulations: April 2



- GVF differences do produce large local increases in precipitation
- More simulations and ensembles are needed to provide statistical significance of results

Summary

- Developed a simple algorithm to determine high-resolution green vegetation fraction for use with operational models
- Algorithm parameters have little inter-annual variability and are therefore appropriate for real-time application
- Inclusion into 1.2km WRF simulation produces surface energy budget component changes of up to 25W/m^2 resulting in 2-meter T changes of 1^{o}C
- Much more testing is needed to determine consistency with current Noah parameters and validation with observations

Future Work

- Coupling of Noah and CRTM: LAI, canopy water
- A PhD student is already analyzing the respective code
- Addition of multi-layer snow model; thinner upper soil layer for T_{skin} assimilation; separate T_{skin} for canopy, soil, and snow; combined use of GVF/LAI; consistent snow fraction across Noah