TABLES & FIGURES

Table 1: Relative dominance of the most common vegetation per 2001 NLCD for Piedmont study sites

Site ID	Location ID	Deciduous	Evergreen	Mixed	Deciduous Wetland	Relative Total
1	Rural	13.62%	21.18%	6.33%	56.53%	97.66%
2	Rural	67.07%	2.86%	4.35%	0.00%	74.29%
3	Rural	66.21%	4.63%	5.31%	0.00%	76.16%
4	Rural	66.26%	3.93%	2.85%	0.00%	73.04%
5	Rural	74.62%	8.78%	1.23%	0.00%	84.64%
6	Urban	59.76%	3.52%	35.09%	0.00%	98.37%
7	Urban	41.63%	0.00%	2.99%	47.89%	92.52%
8	Urban	61.62%	18.65%	9.86%	0.00%	90.14%
9	Rural	93.35%	1.90%	1.36%	0.00%	96.61%
10	Rural	62.04%	11.84%	8.98%	2.31%	85.17%
11	Urban	10.30%	0.95%	1.49%	86.72%	99.46%
12	Urban	54.78%	17.35%	14.21%	0.00%	86.34%
13	Urban	53.86%	10.01%	3.25%	0.00%	67.12%
14	Urban	32.66%	5.56%	17.89%	43.50%	99.59%

Table 1: Relative dominance of vegetation type within 510m buffer of selected sites, based on 2001 NLCD cover types. Coastal Plain and Mountain sites were omitted due to the relative homogeneity (near 100% deciduous vegetation) and lack of fragmentation (relative lack of development) of these stands.

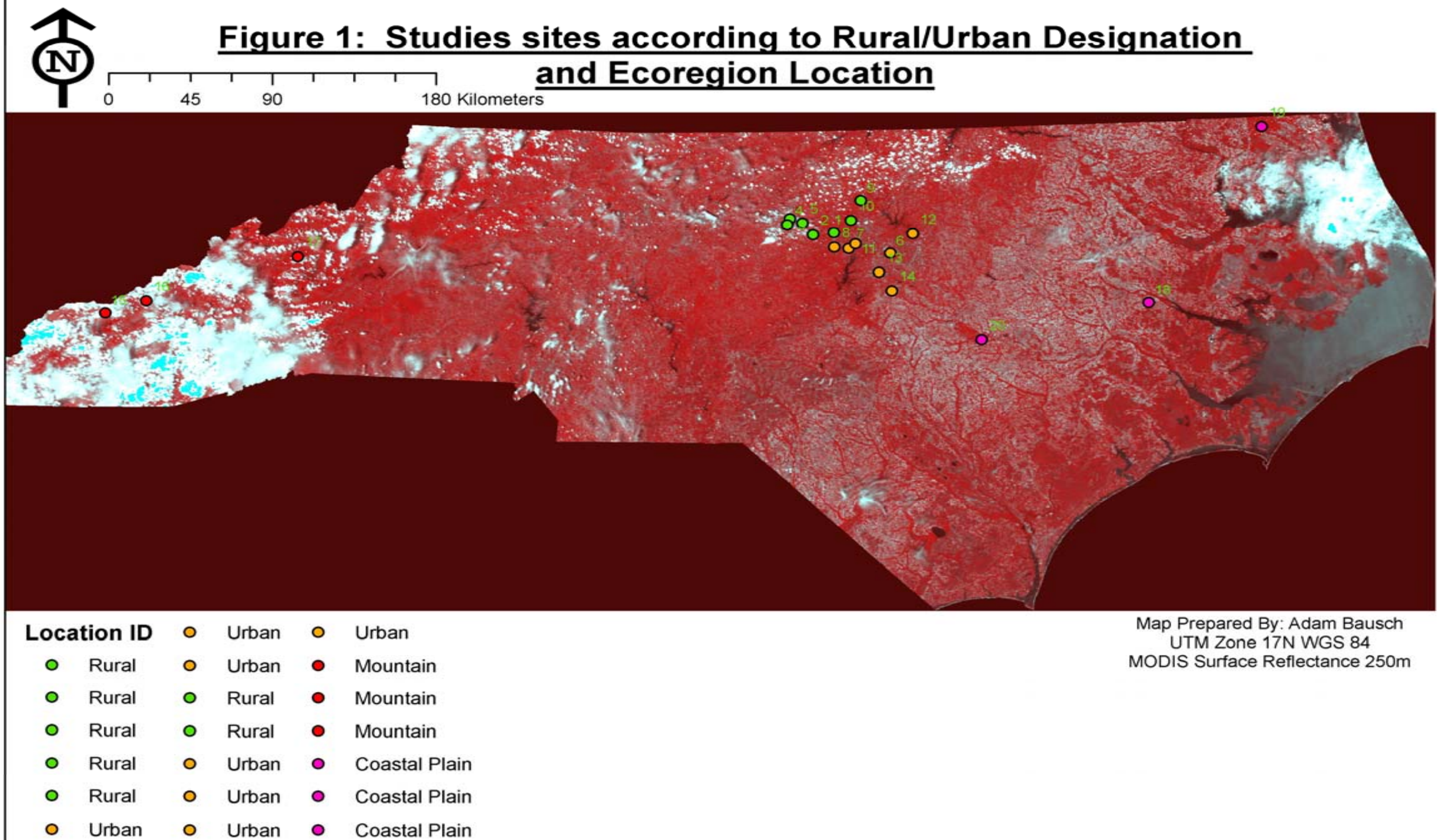


Figure 1: Geographic distribution of study sites in North Carolina according to ecoregion and/or urbanization degree on the piedmont.

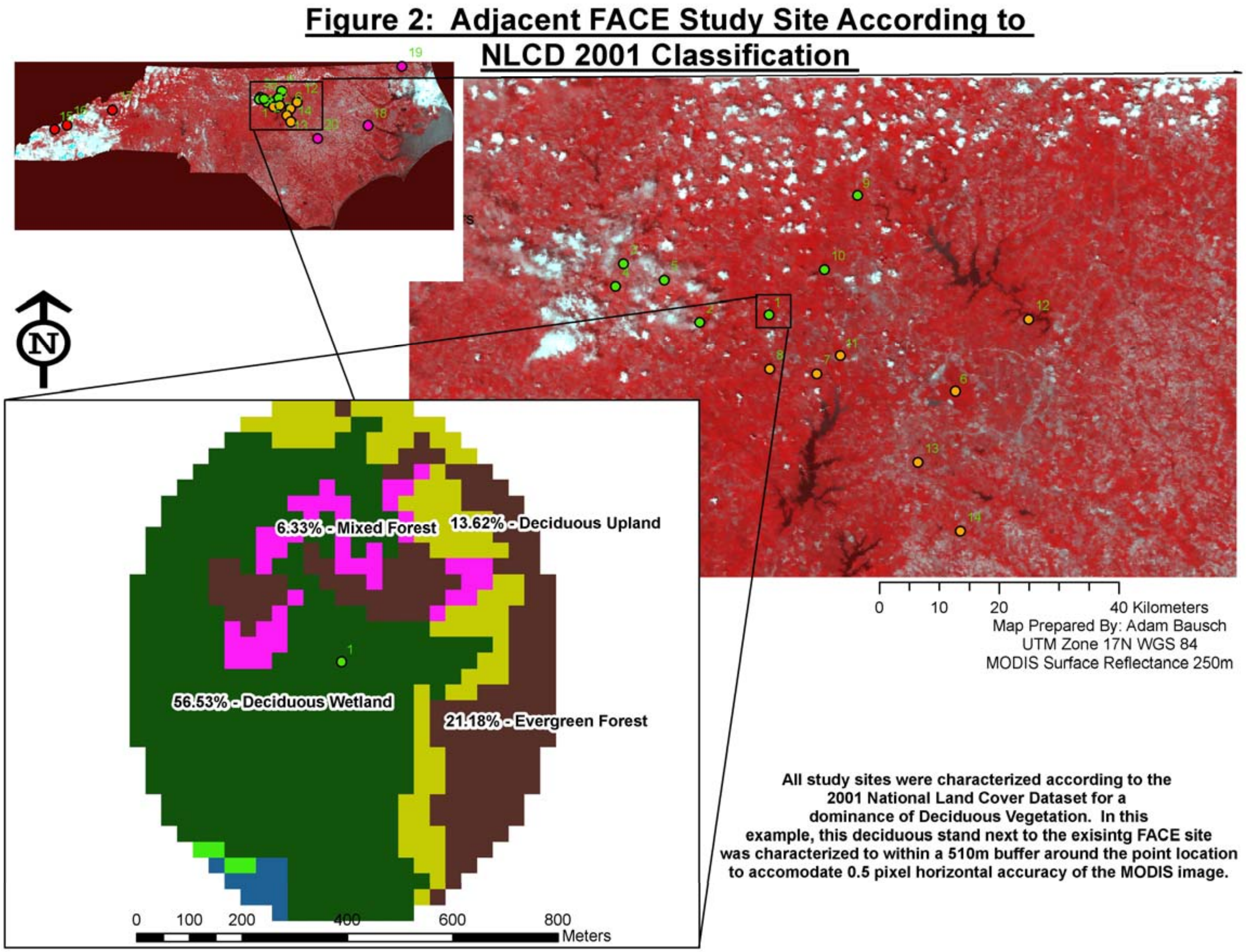


Figure 2: Example of the characterization performed for each site in Table 1, as performed at the deciduous stand adjacent to the FACE site.

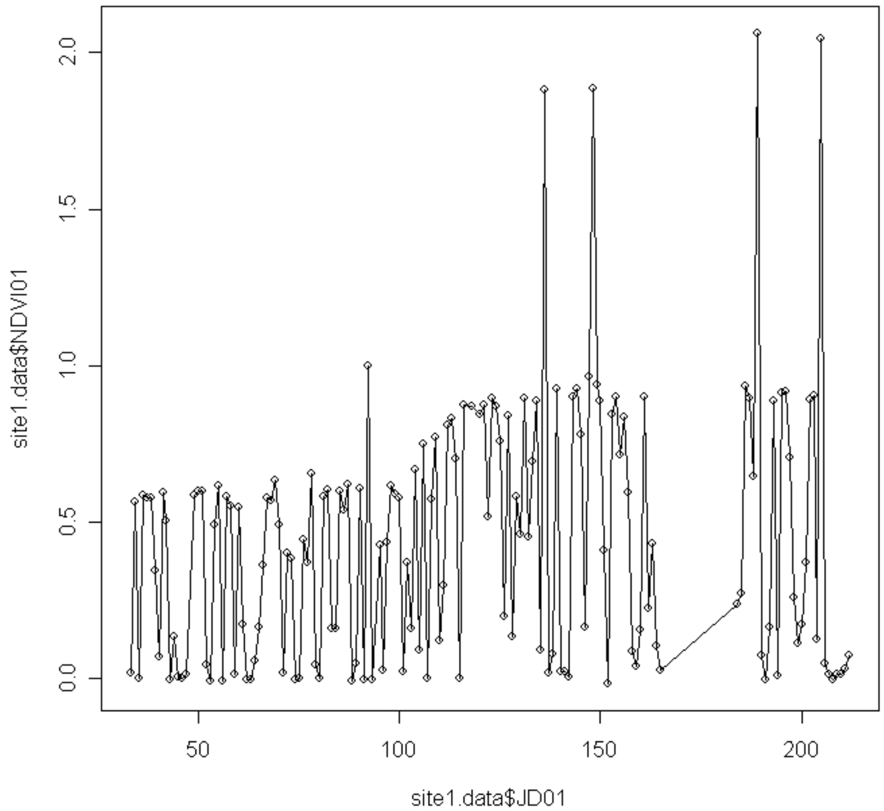


Figure 3: Example of raw NDVI values extracted from the adjacent FACE site; clouds and Atmospheric effects have not been filtered and results in a nearly indistinguishable signal of green-up. Extreme high and low values represent bad images or clouds and atmospheric effects respectively

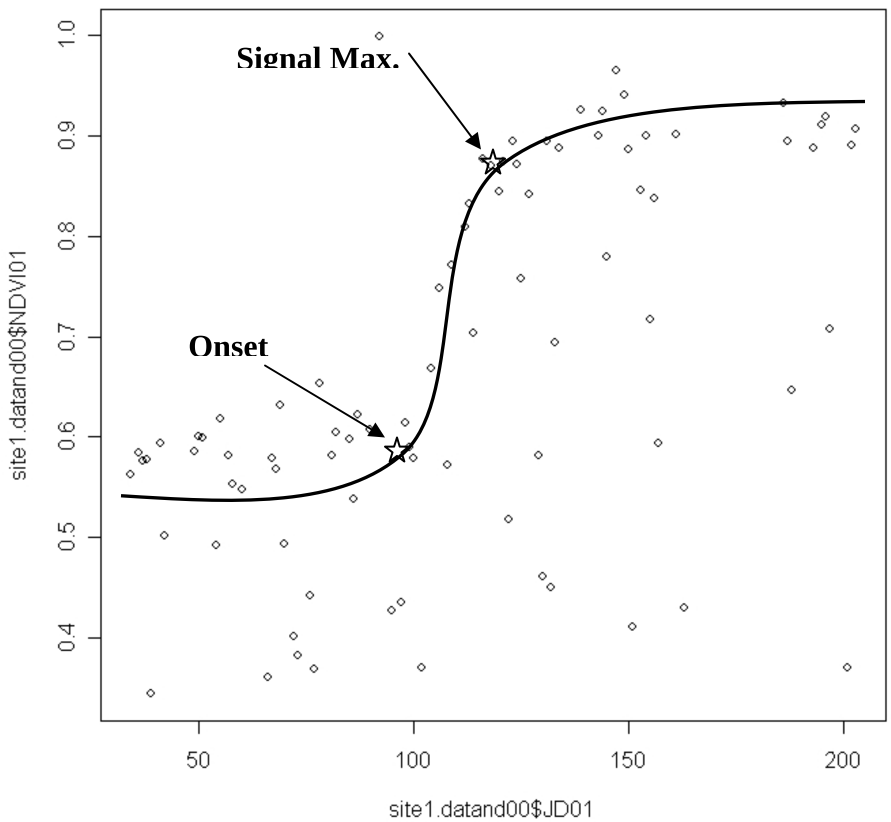
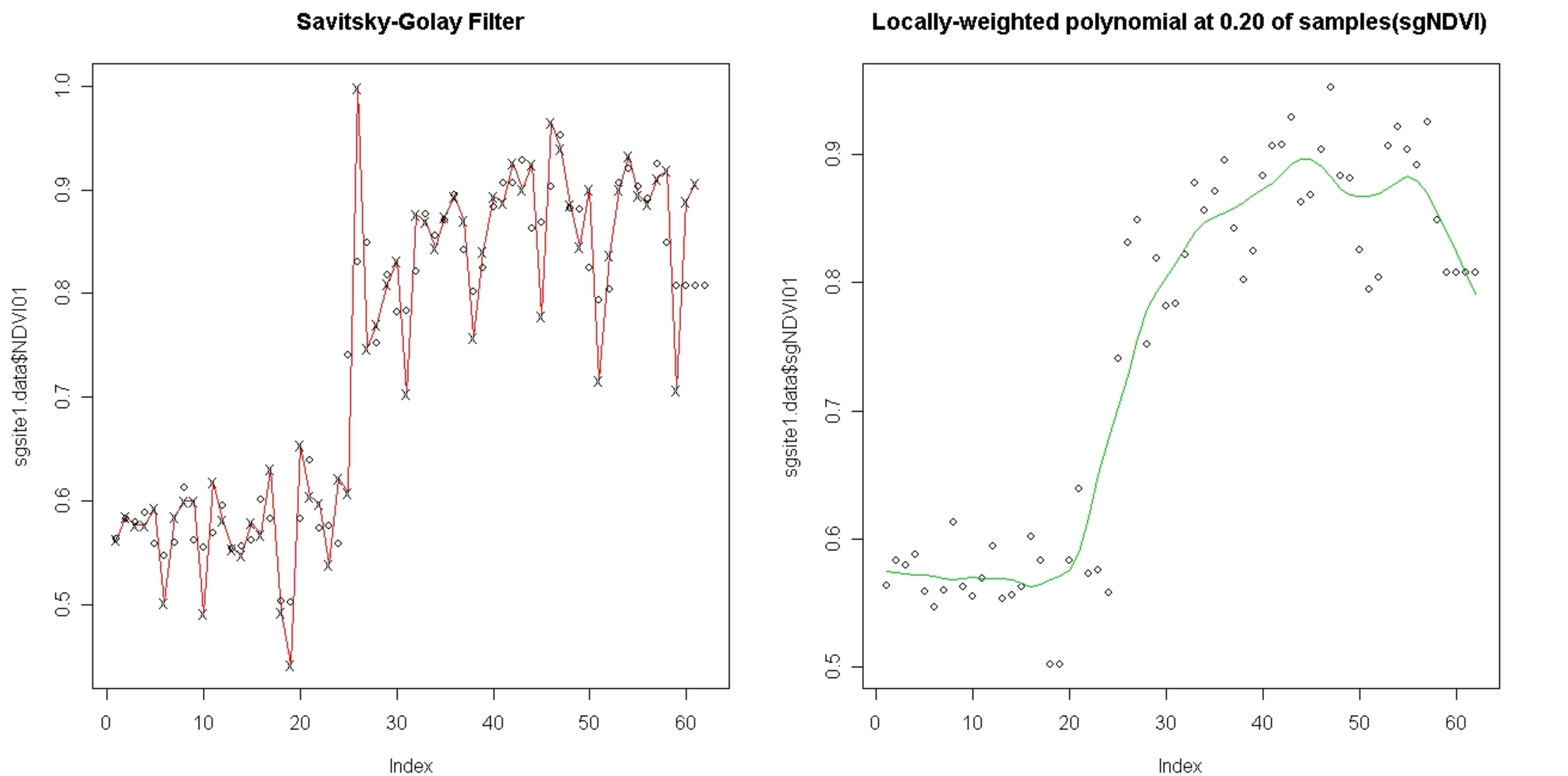


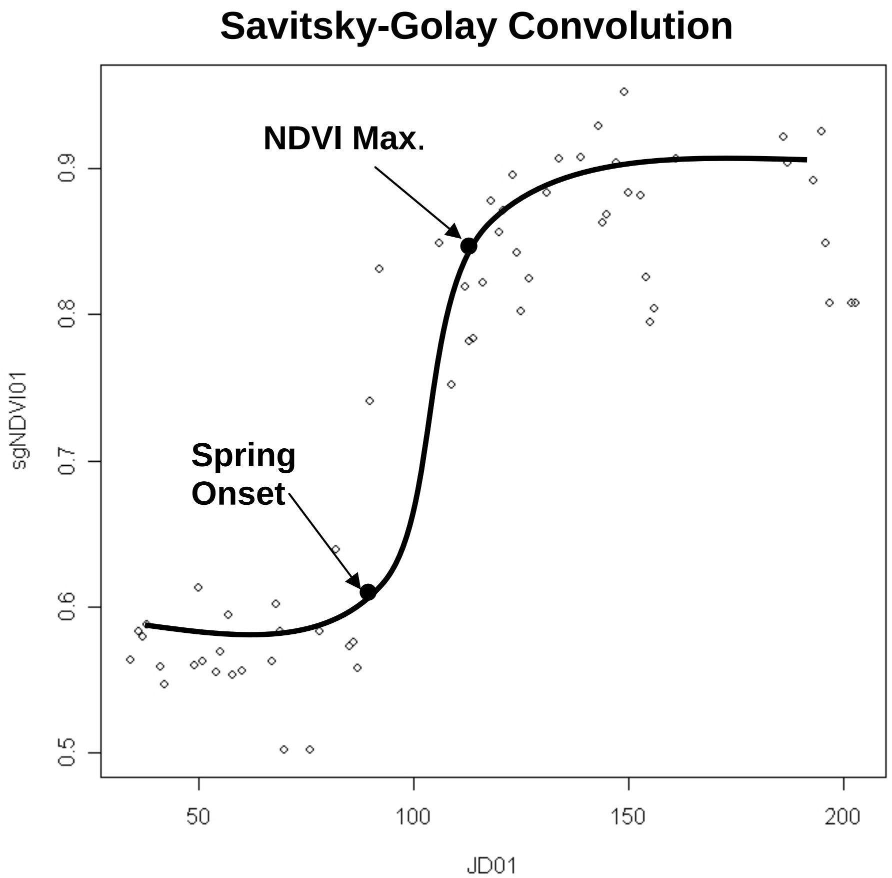
Figure 4: Raw data with the expected sigmoid function. This distribution could not Be accurately achieved without filtering extraneous values.

Samples	2000	2001	2002	2003	2007
Period of Sample	Feb. 24-July 31	Feb. 2-July 31	Feb. 1-July 31	Feb. 2-July 31	Jan. 1-July 28
Available Images	144	158	168	160	162
Post-Processed Images	62	61	94	63	99
Mean(Max.) Sampling Interval during Green-Up Period	2(7)	3(14)	2(17)	3(11)	2(6)
Mean(Max.) Sampling Interval over Whole Sampling Period	3(13)	3(25)	2(17)	3(23)	2(26)

Table 2: The composition of the MODIS dataset developed for the purposes of describing vegetation phenology. This illustrates the number of available images during the whole spring season and intervals Within periods of green-up.



<u>Figure 5</u>: Two Polynomial Lowpass filter techniques to remove systematic noise form the NDVI signal. On left (red) a combination of lower-bound thresholding and Savitsky-Golay filter were used. This technique computes cubic estimations of past and future values to compute the smoothed values. At right, the LOWESS technique (green) is a locally-weighted polynomial regression using a 0.20 window to compute the regression values.



<u>Figure 6:</u> Example of the S-G filtered estimates of NDVI for a given site in 2001. This convolution was performed for all study sites to remove atmospheric and deteriorated image effects.

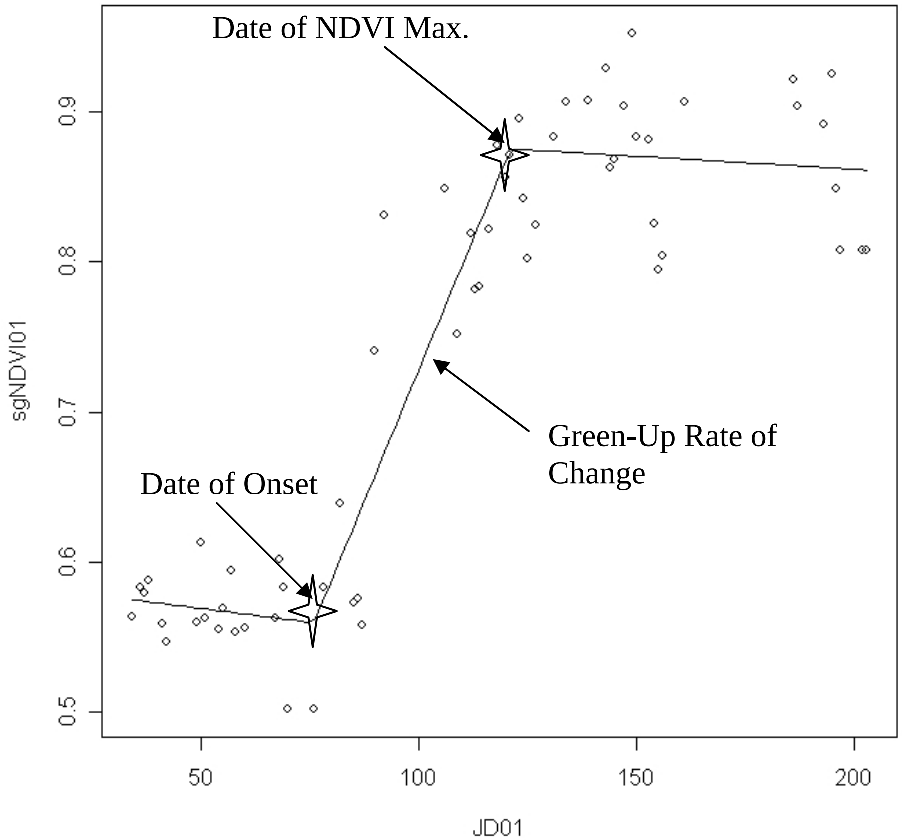


Figure 7: Once the S-G filter and thresholding were applied to remove systematic noise, a segmented linear model, that fits a regression model with segmented relationships between response and explanatory variables to estimate slope parameters and breakpoint coefficients or the rate of spring green-up and the date of onset and the date of maximum NDVI was fit for all sites over all years..

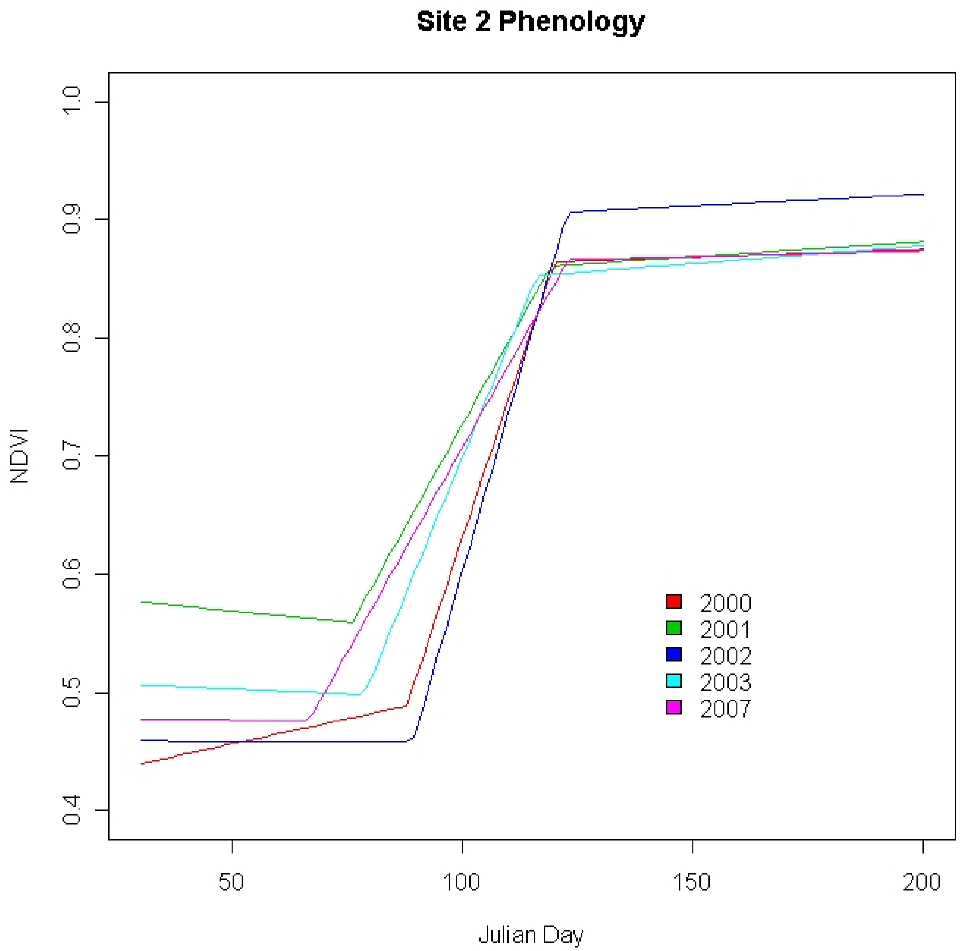
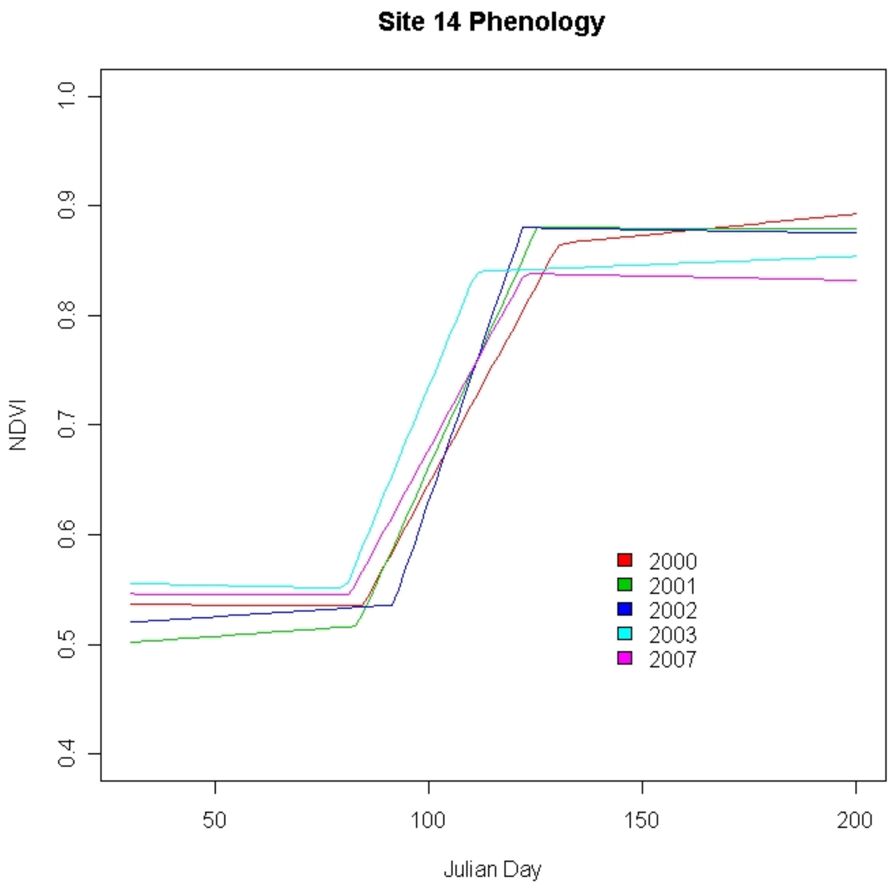


Figure 8: Example of the segmentation analysis over all study years for Site 2. This illustrates the high interannual variability in the onset of spring in some of the study sites.



<u>Figure 9</u>: Example of the segmentation analysis over all study years for Site 14. This illustrates the high overall variability in the onset of spring in some of the study sites.

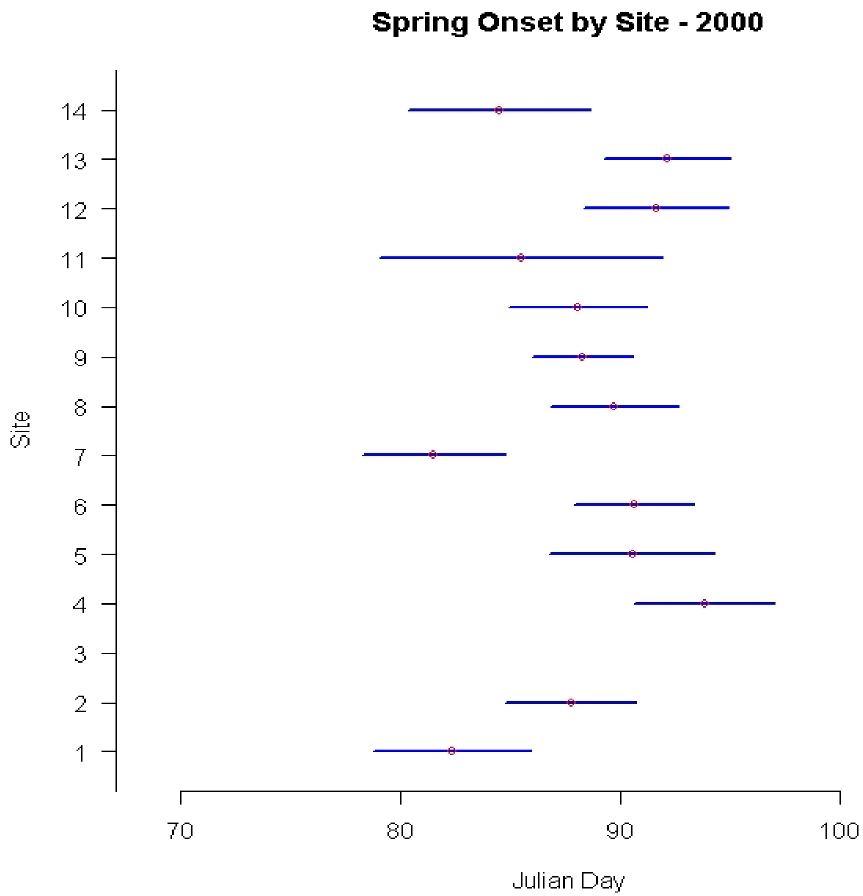
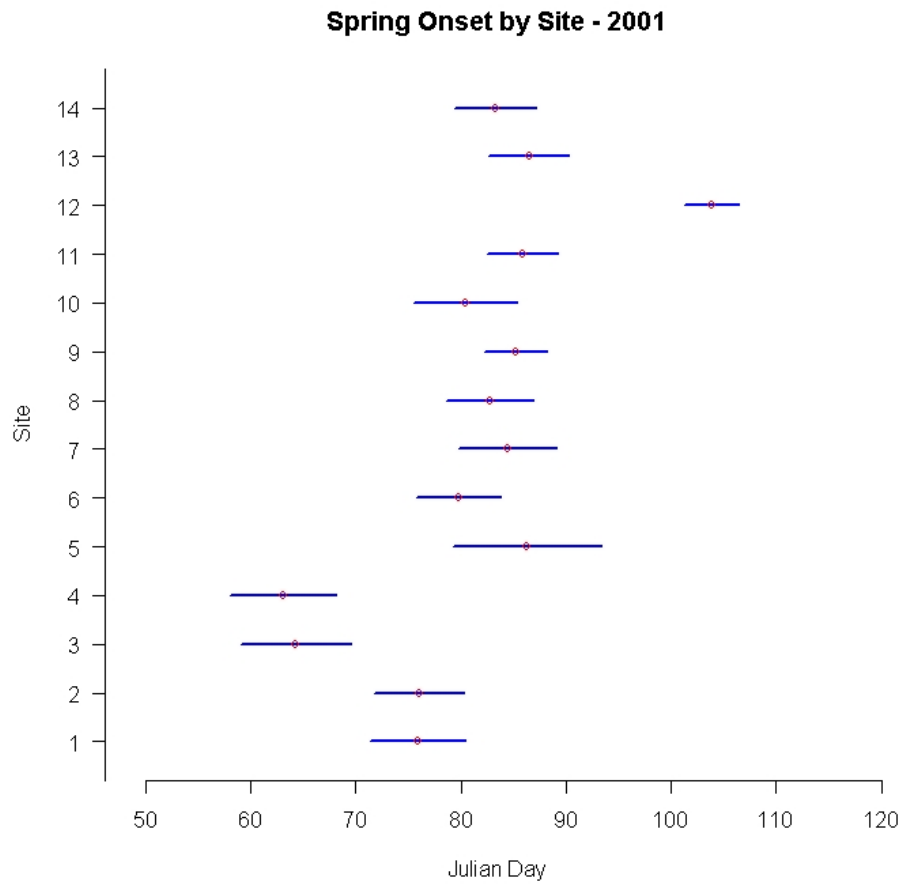


Figure 10: Julian Day of Spring Onset for 2000 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.



<u>Figure 11</u>: Julian Day of Spring Onset for 2001 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.

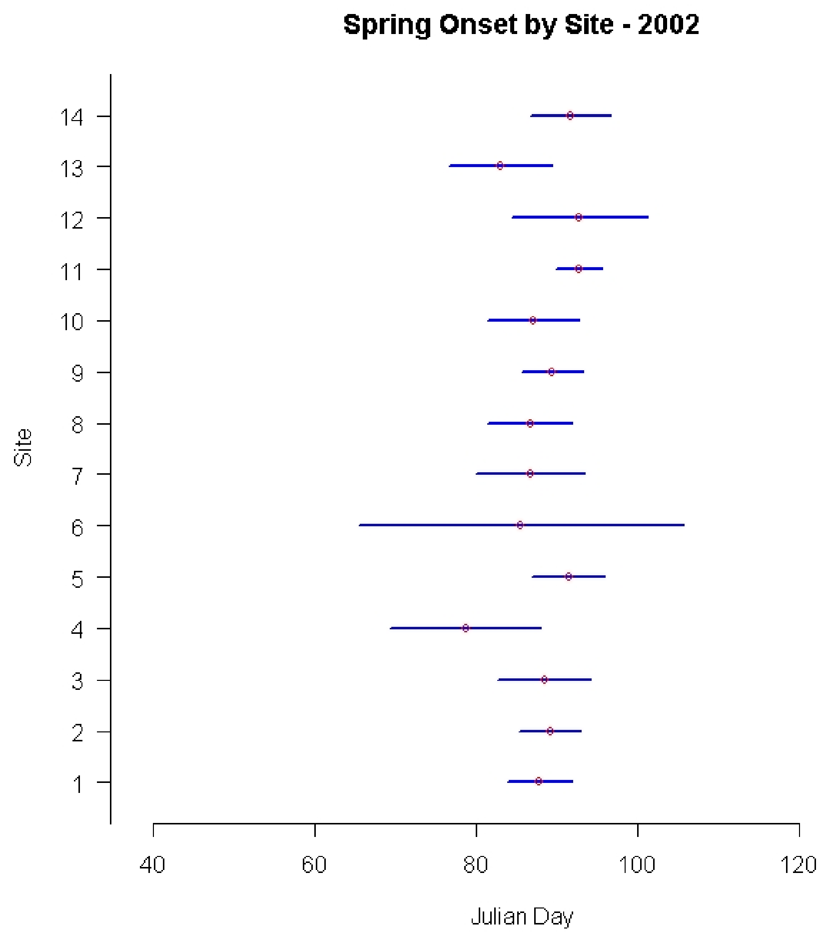
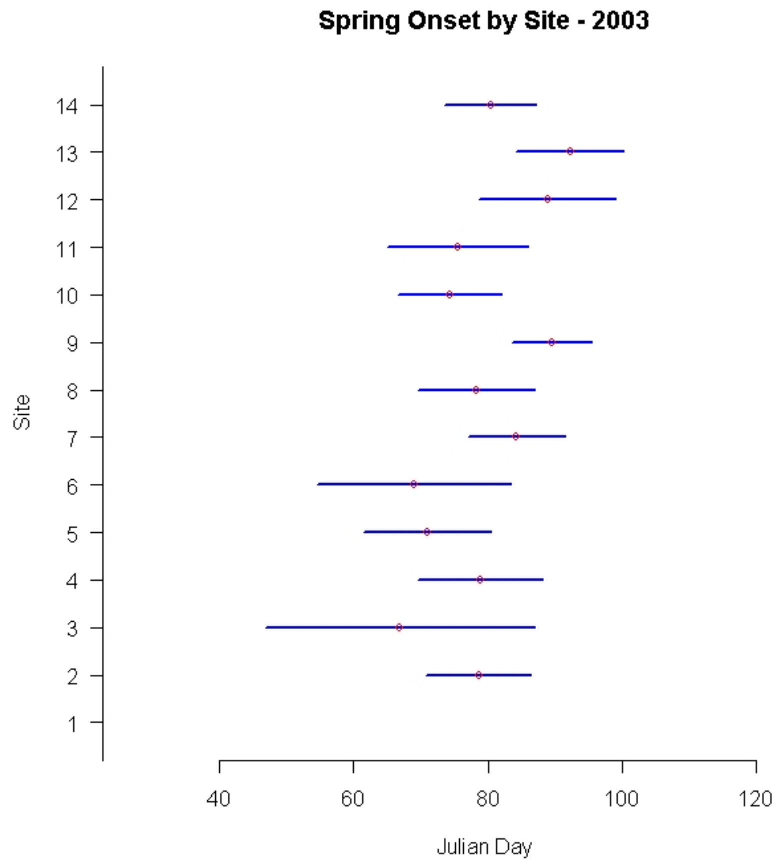


Figure 12: Julian Day of Spring Onset for 2002 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.



<u>Figure 13</u>: Julian Day of Spring Onset for 2003 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.

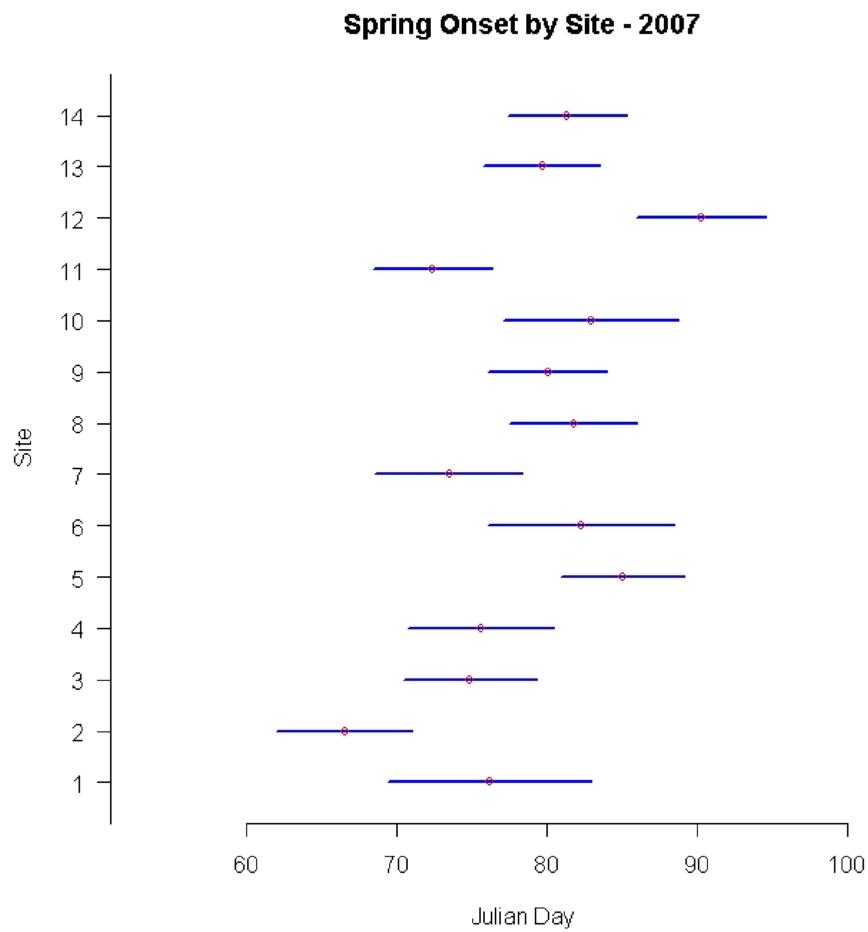
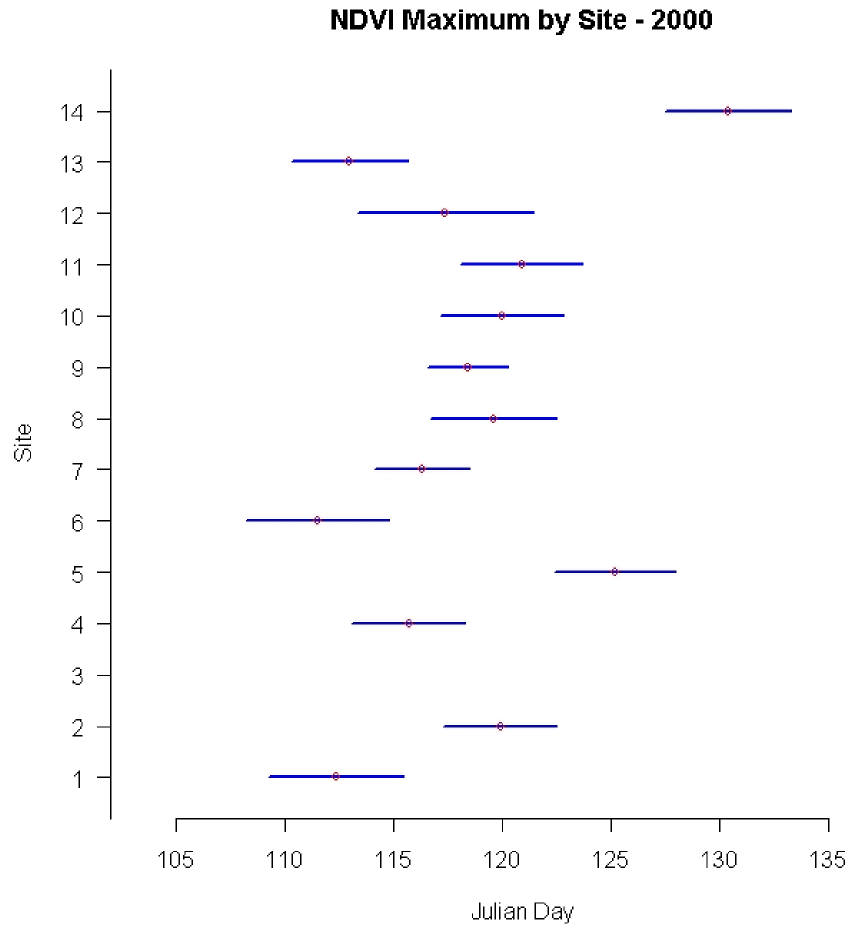


Figure 14: Julian Day of Spring Onset for 2007 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.



<u>Figure 15</u>: Julian Day of Maximum NDVI for 2000 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.

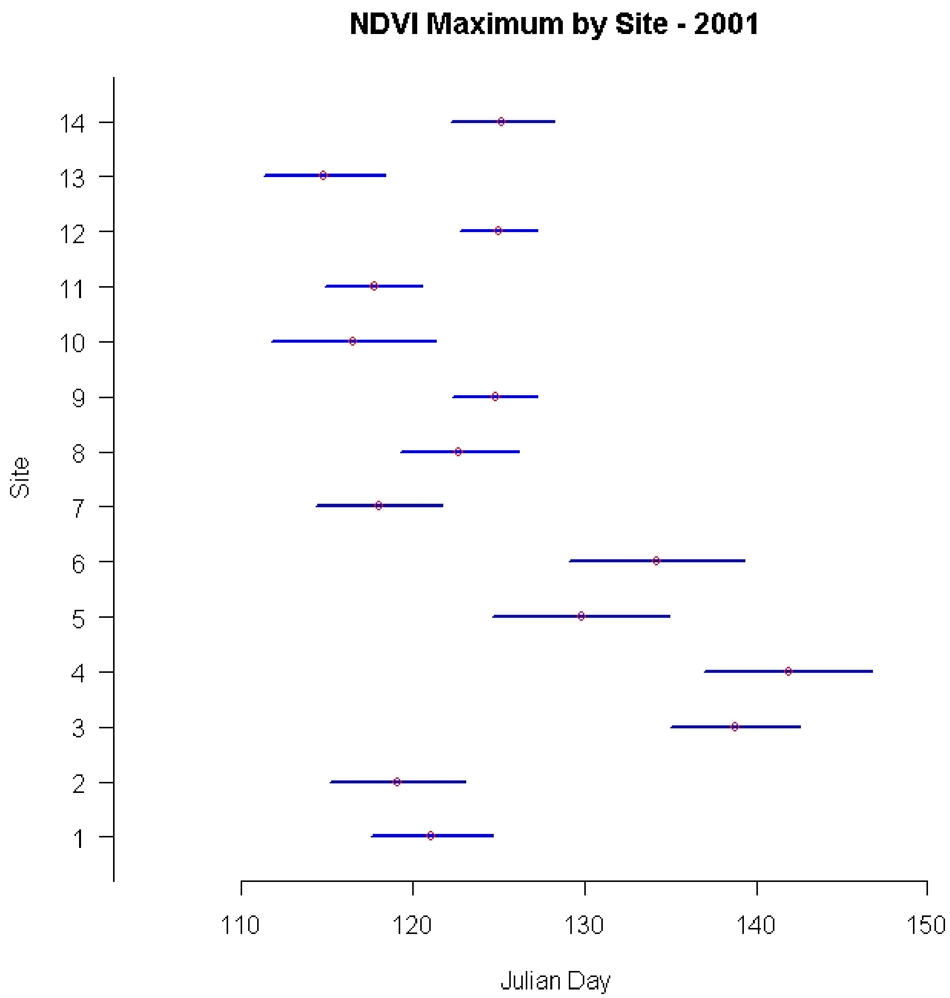


Figure 16: Julian Day of Maximum NDVI for 2001 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.

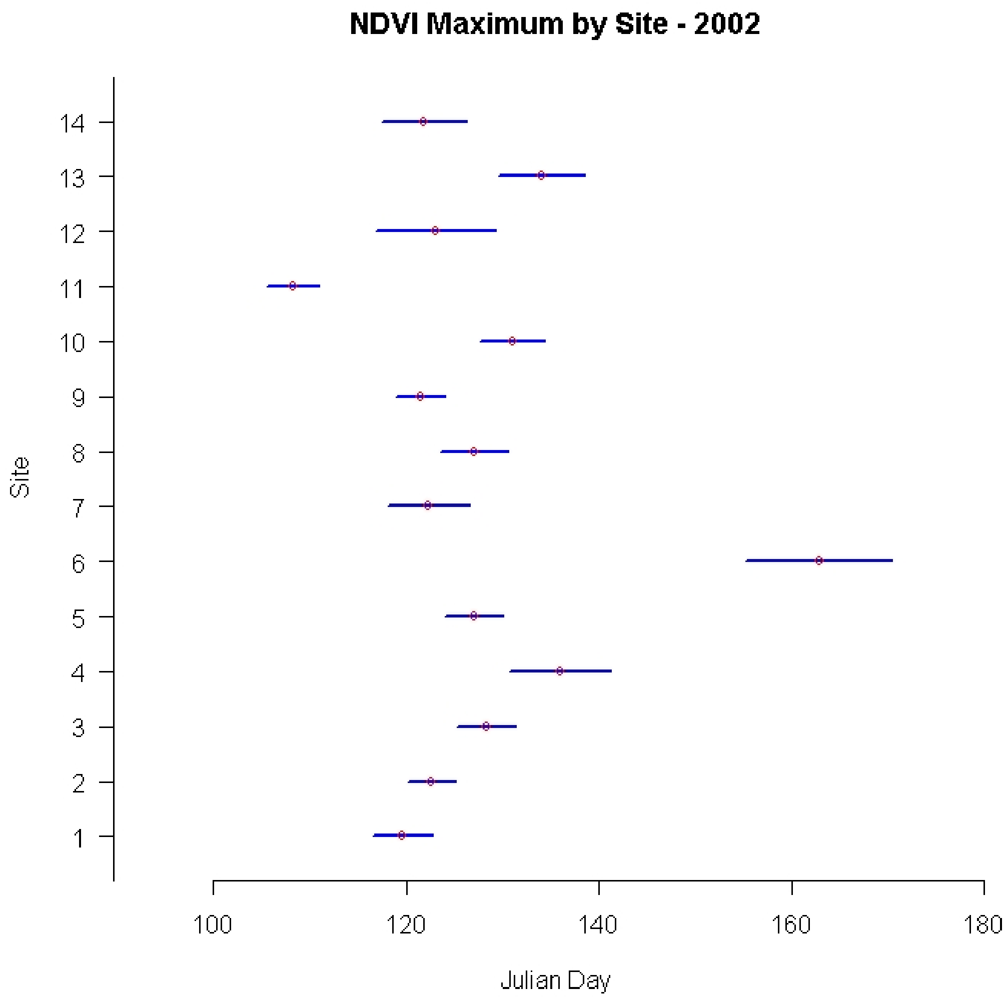
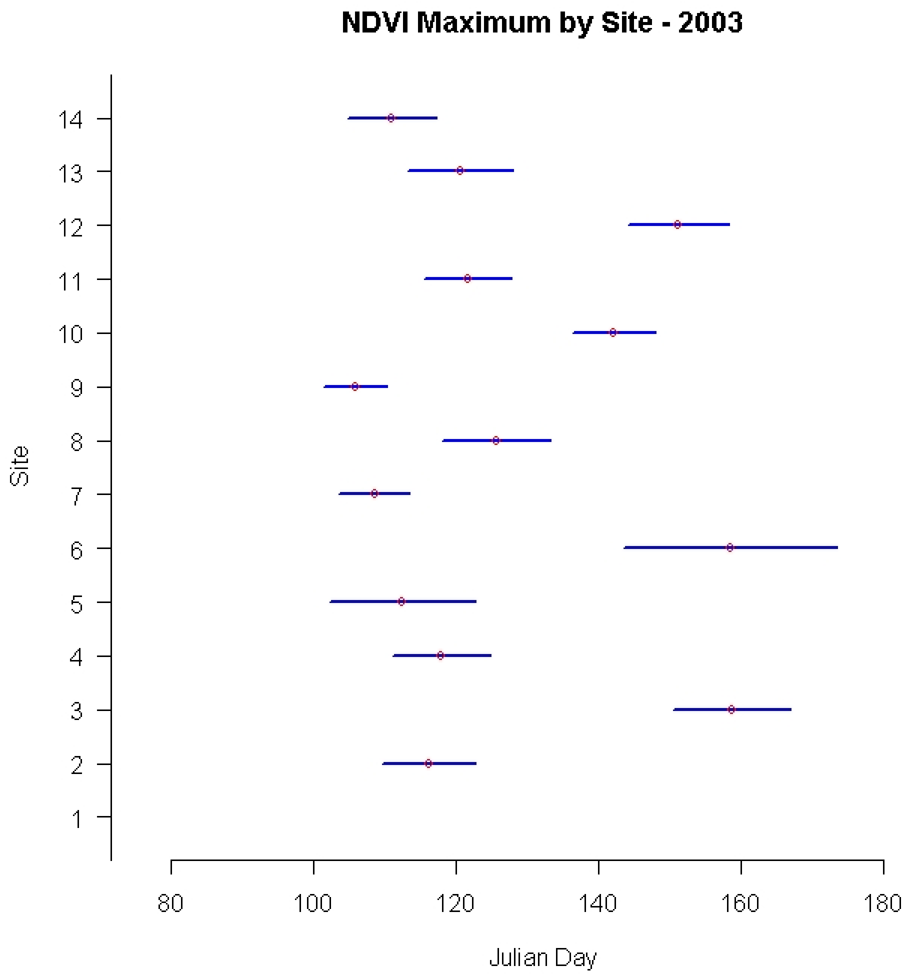


Figure 17: Julian Day of Maximum NDVI for 2002 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.



<u>Figure 18</u>: Julian Day of Maximum NDVI for 2003 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.

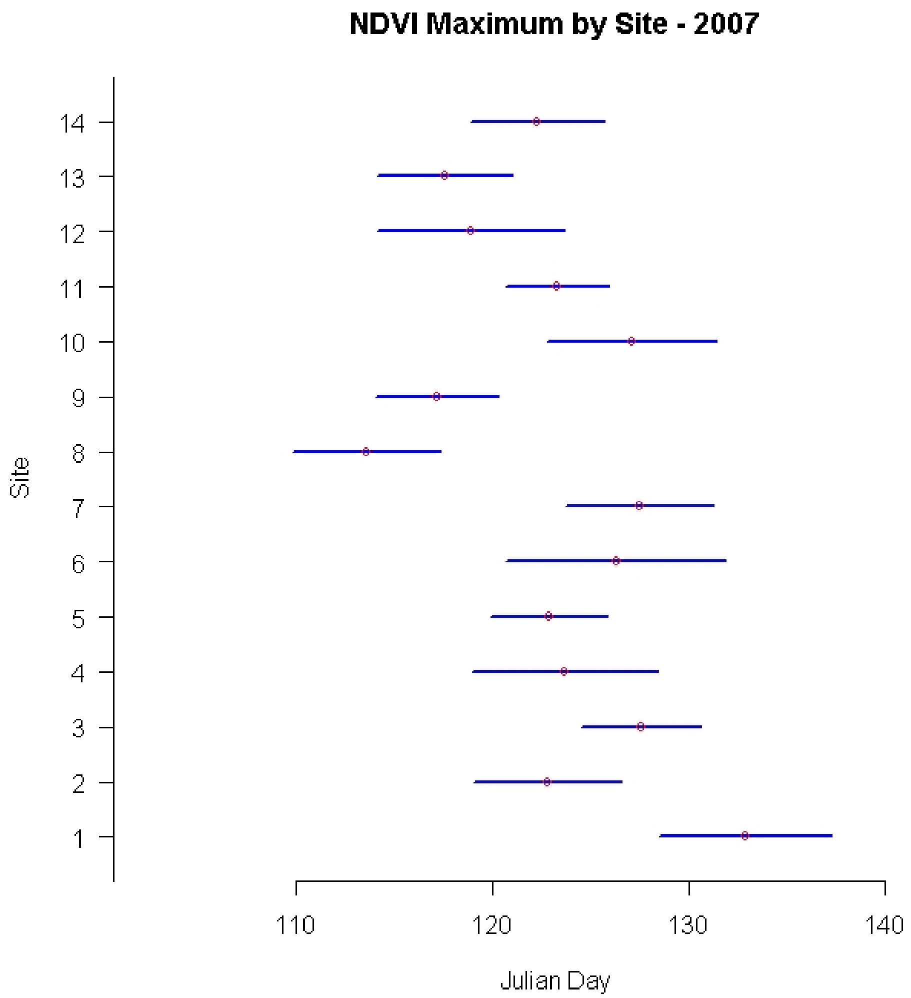


Figure 19: Julian Day of Maximum NDVI for 2007 as determined by the segmented linear model for Piedmont sites. Data points are shown with standard error terms determined from the model.

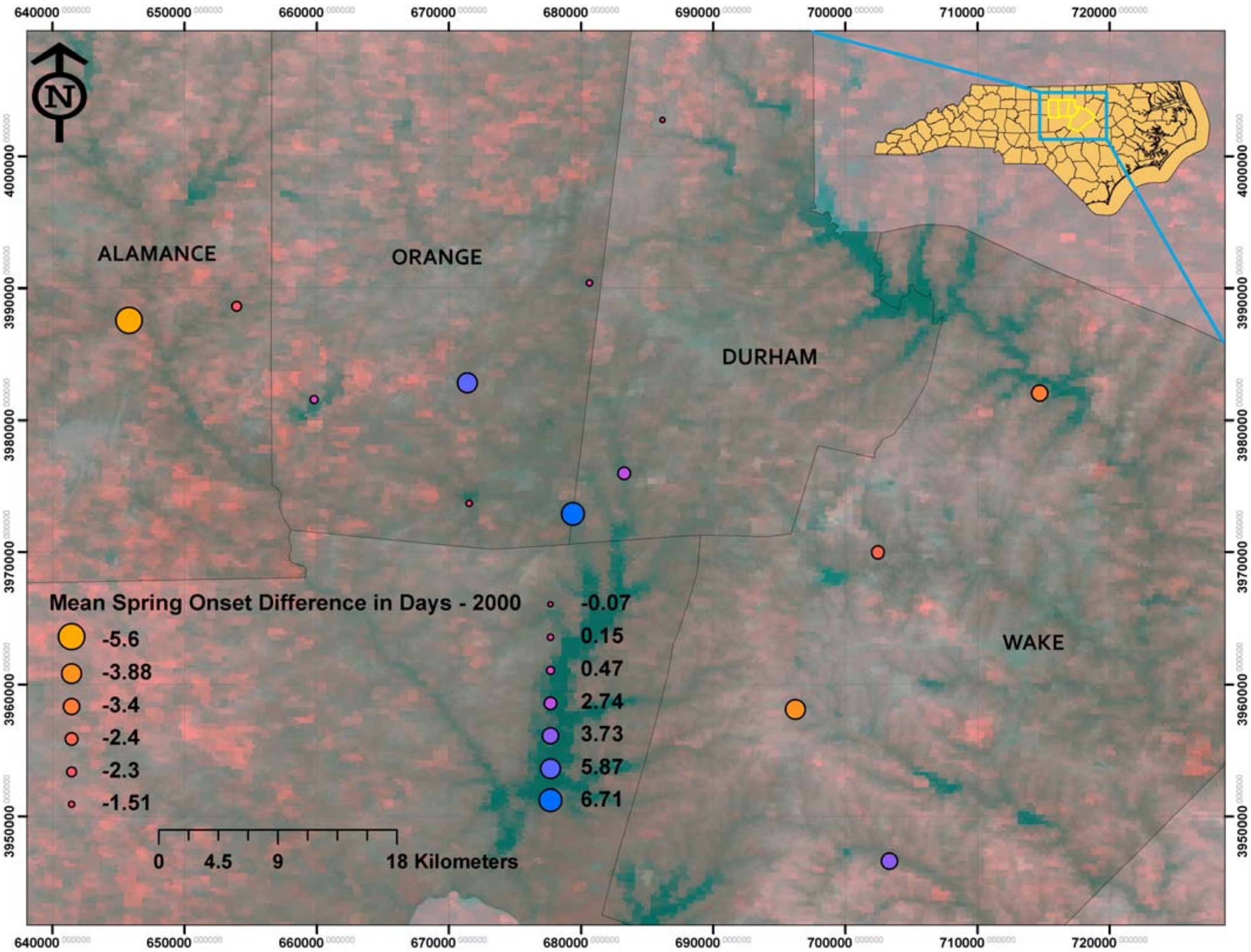


Figure 20: Geographic distribution of piedmont sites showing difference from mean spring onset values for 2000.

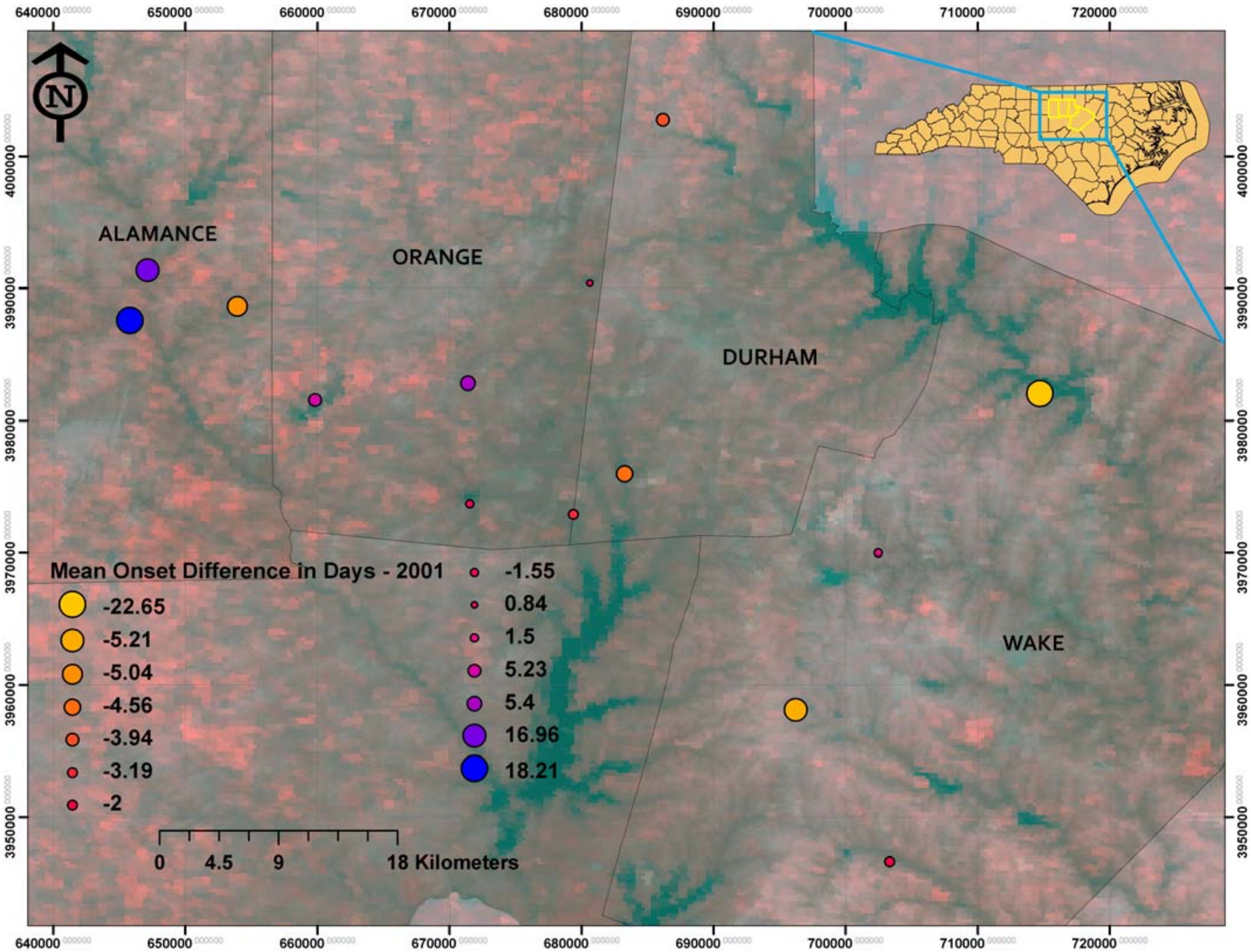


Figure 21: Geographic distribution of piedmont sites showing difference from mean spring onset values for 2001.

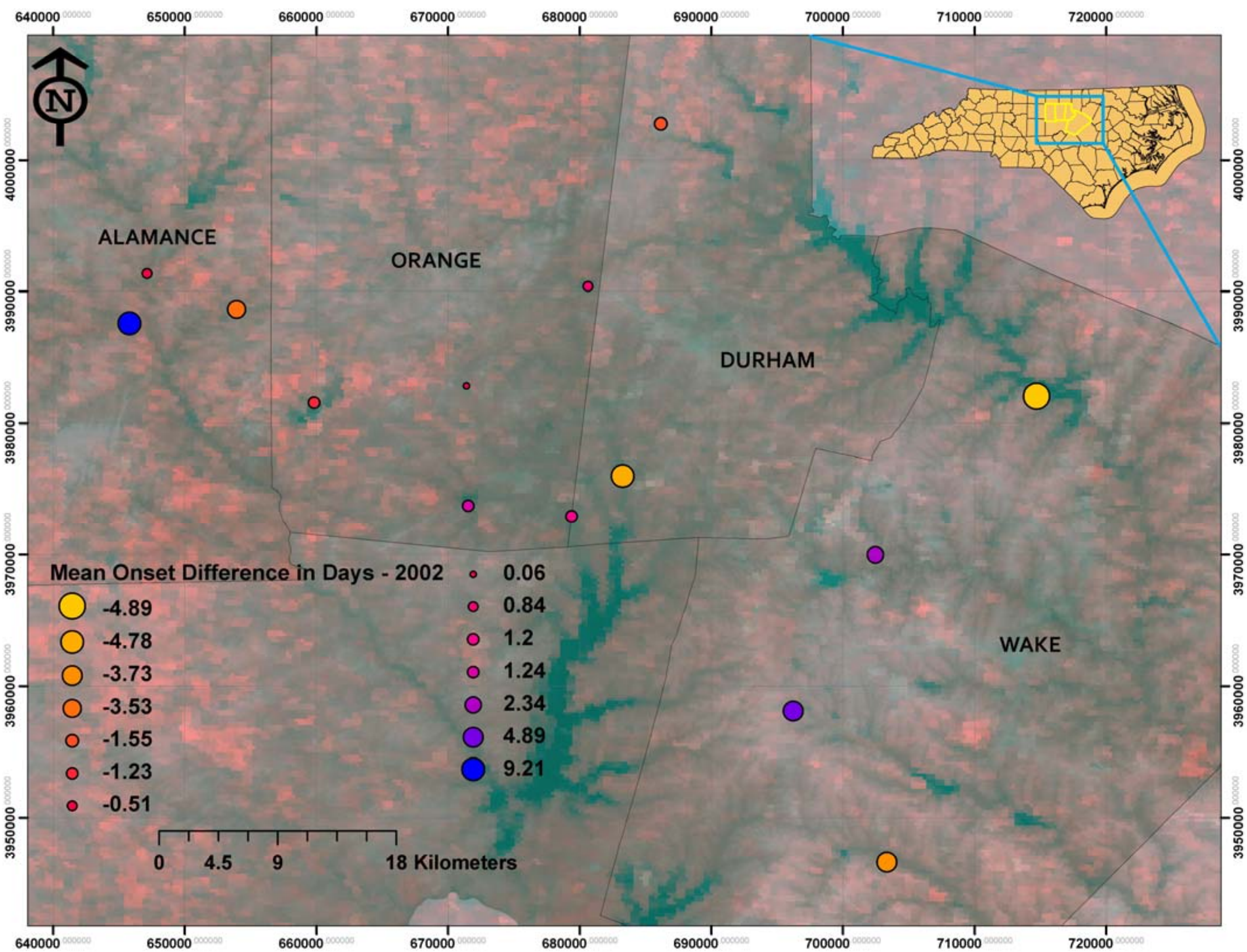


Figure 22: Geographic distribution of piedmont sites showing difference from mean spring onset values for 2002.

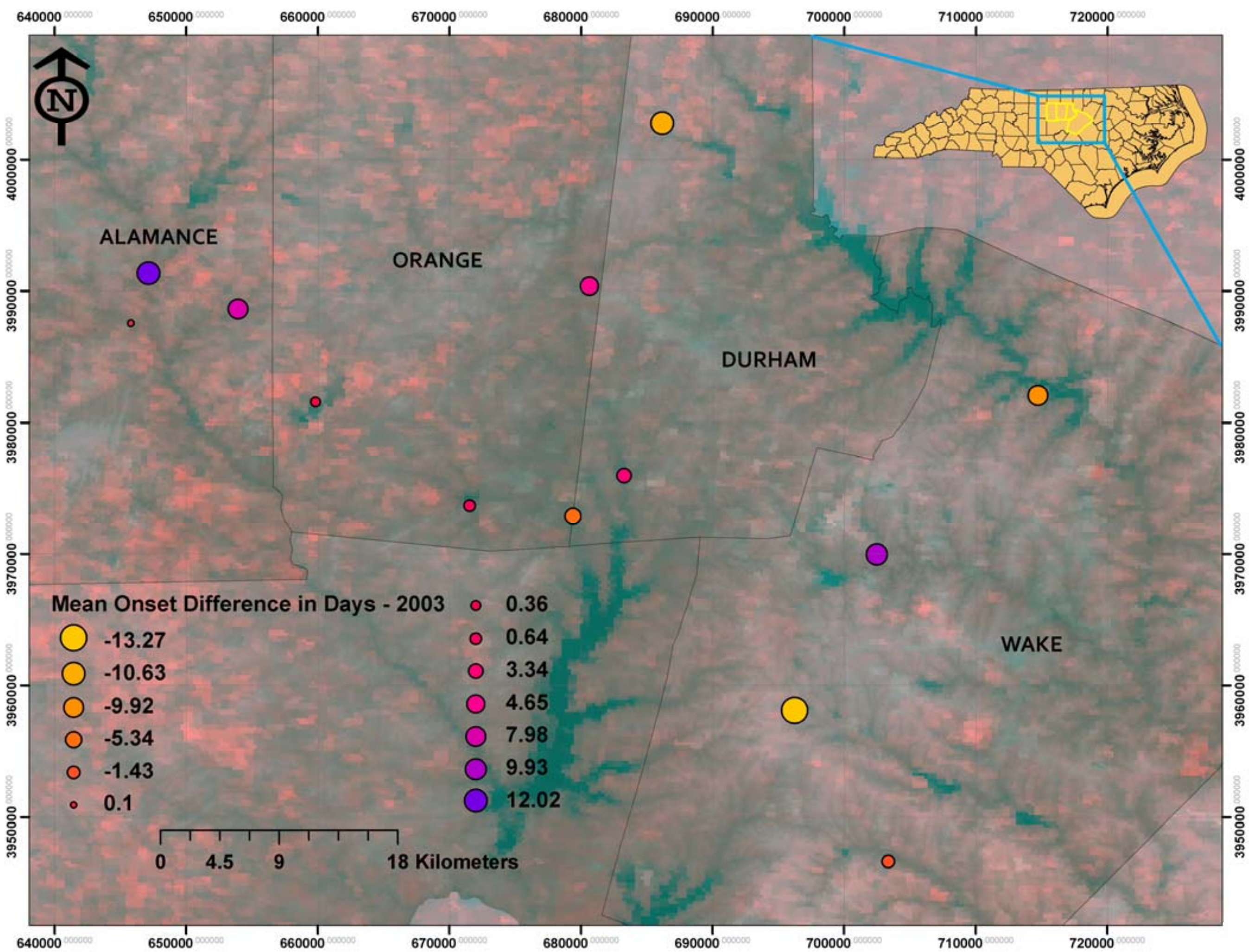


Figure 23: Geographic distribution of piedmont sites showing difference from mean spring onset values for 2003.

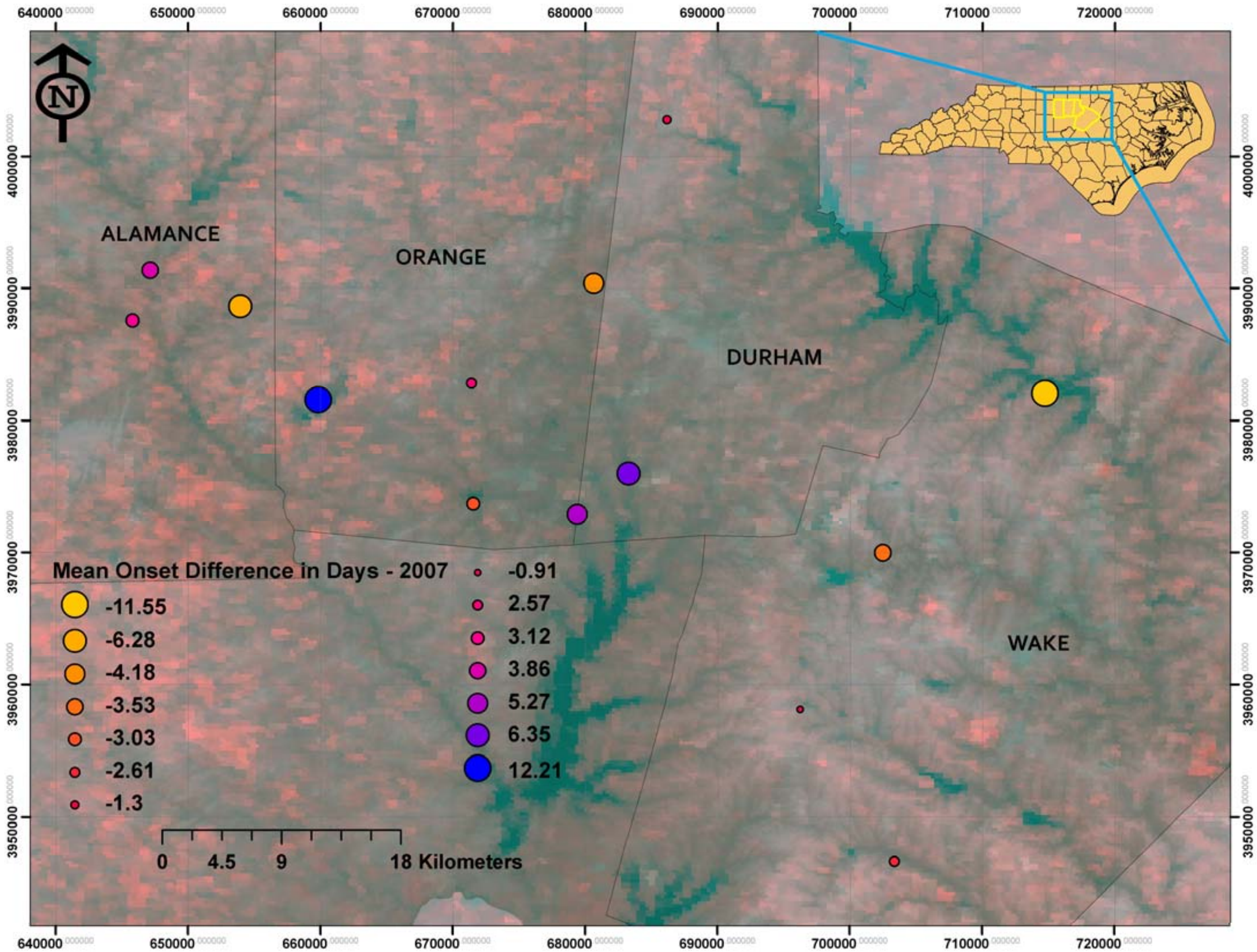


Figure 24: Geographic distribution of piedmont sites showing difference from mean spring onset values for 2007.

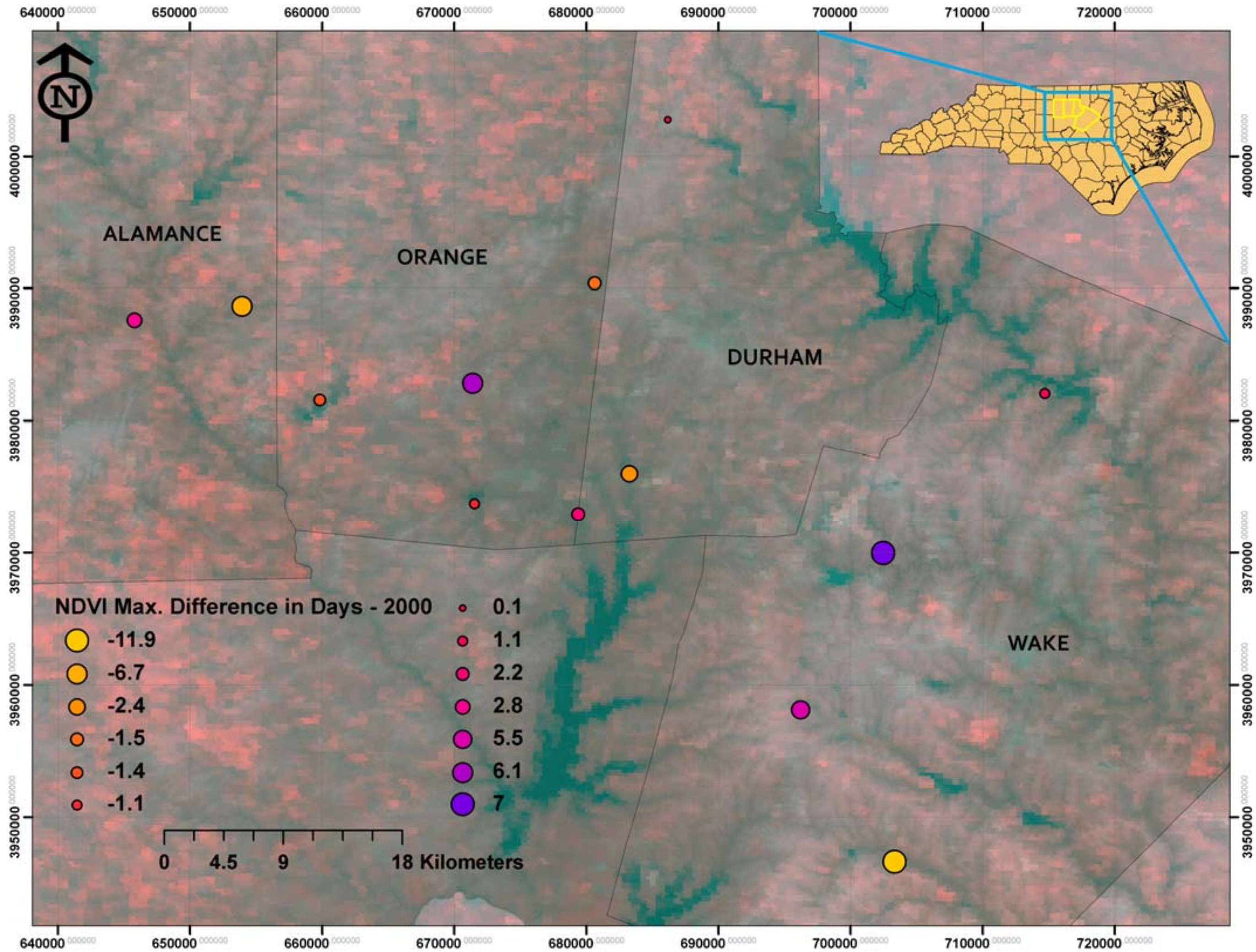


Figure 25: Geographic distribution of piedmont sites showing difference from mean maximum NDVI for 2000.

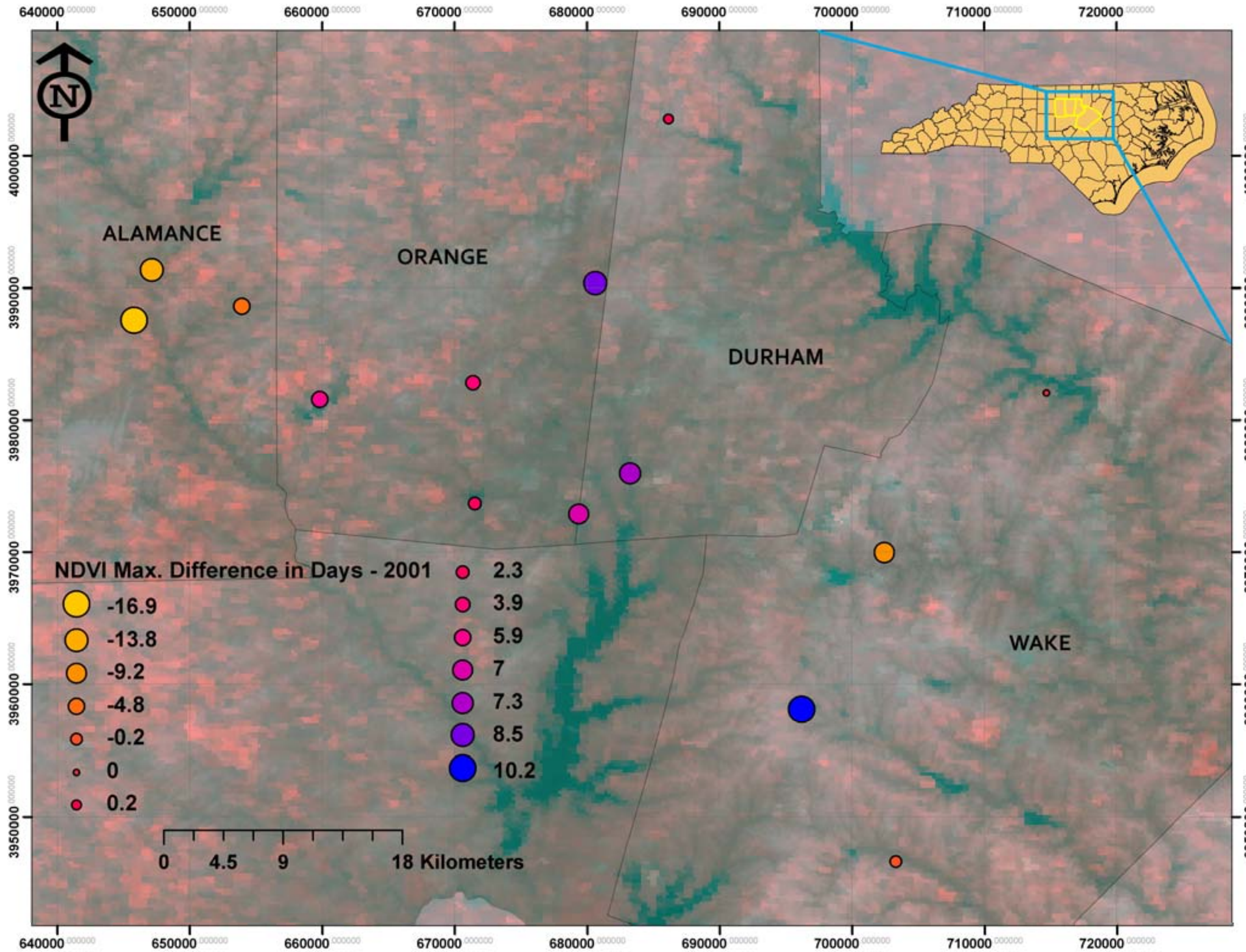


Figure 26: Geographic distribution of piedmont sites showing difference from mean maximum NDVI for 2001.

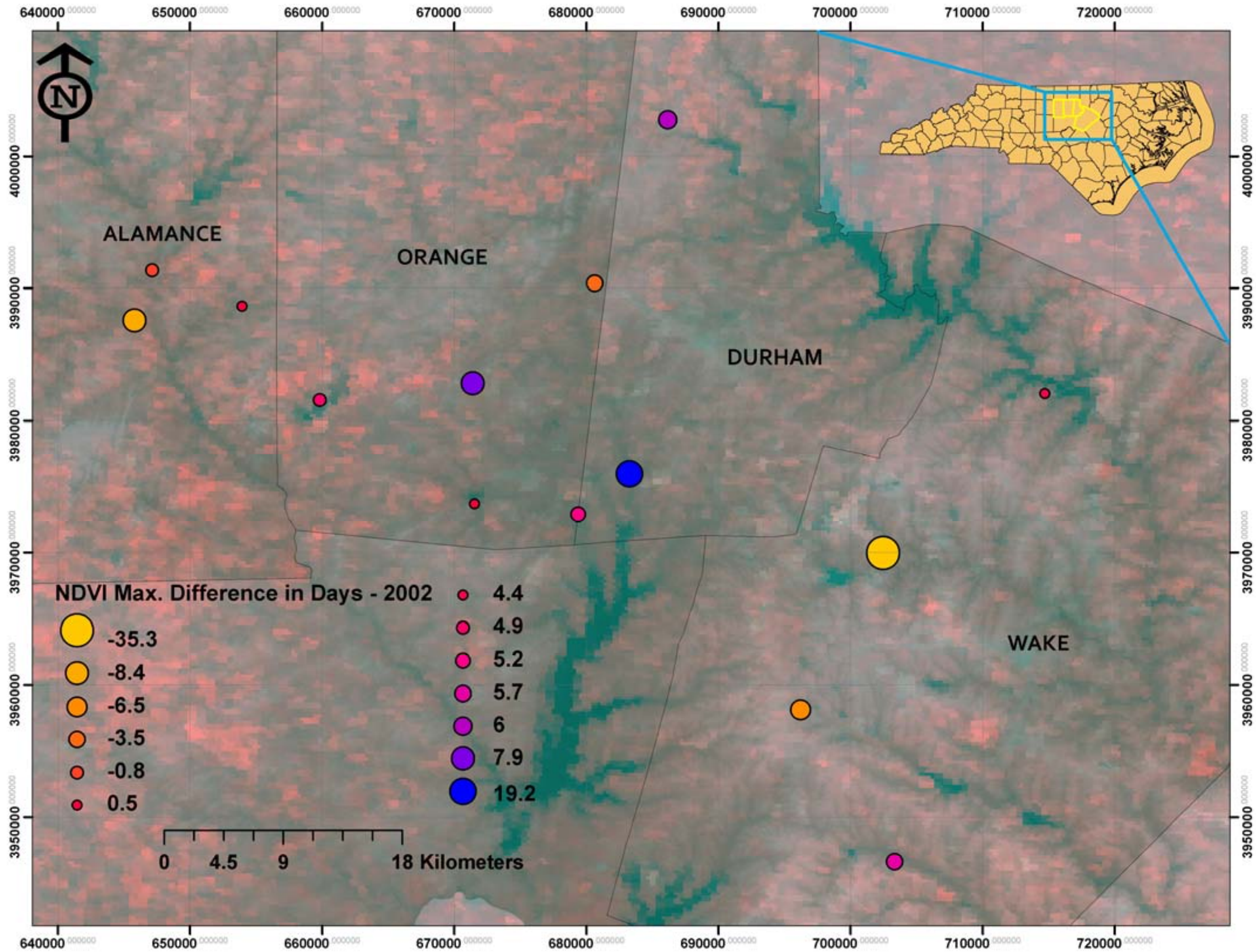


Figure 27: Geographic distribution of piedmont sites showing difference from mean maximum NDVI for 2002.

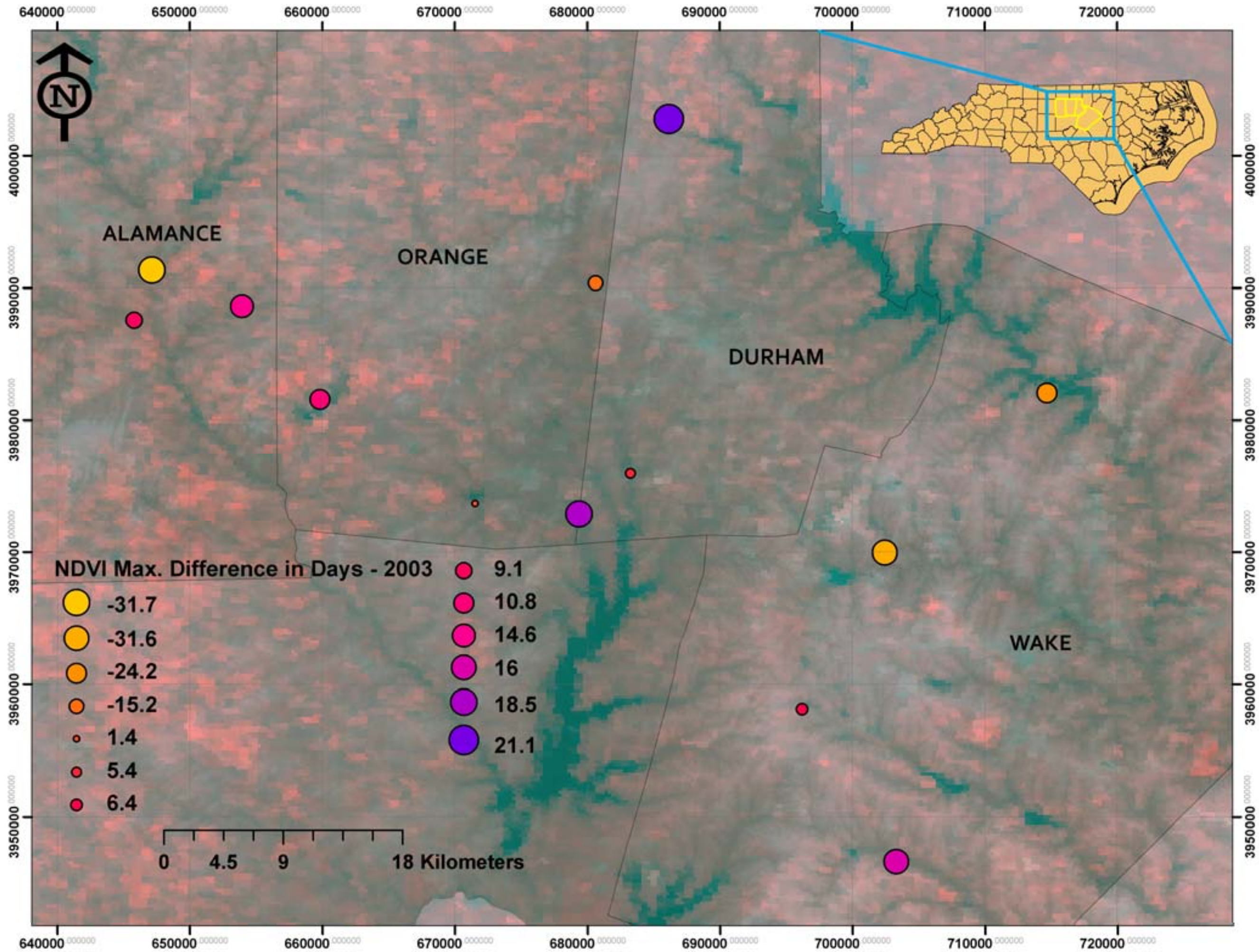


Figure 28: Geographic distribution of piedmont sites showing difference from mean maximum NDVI for 2003.

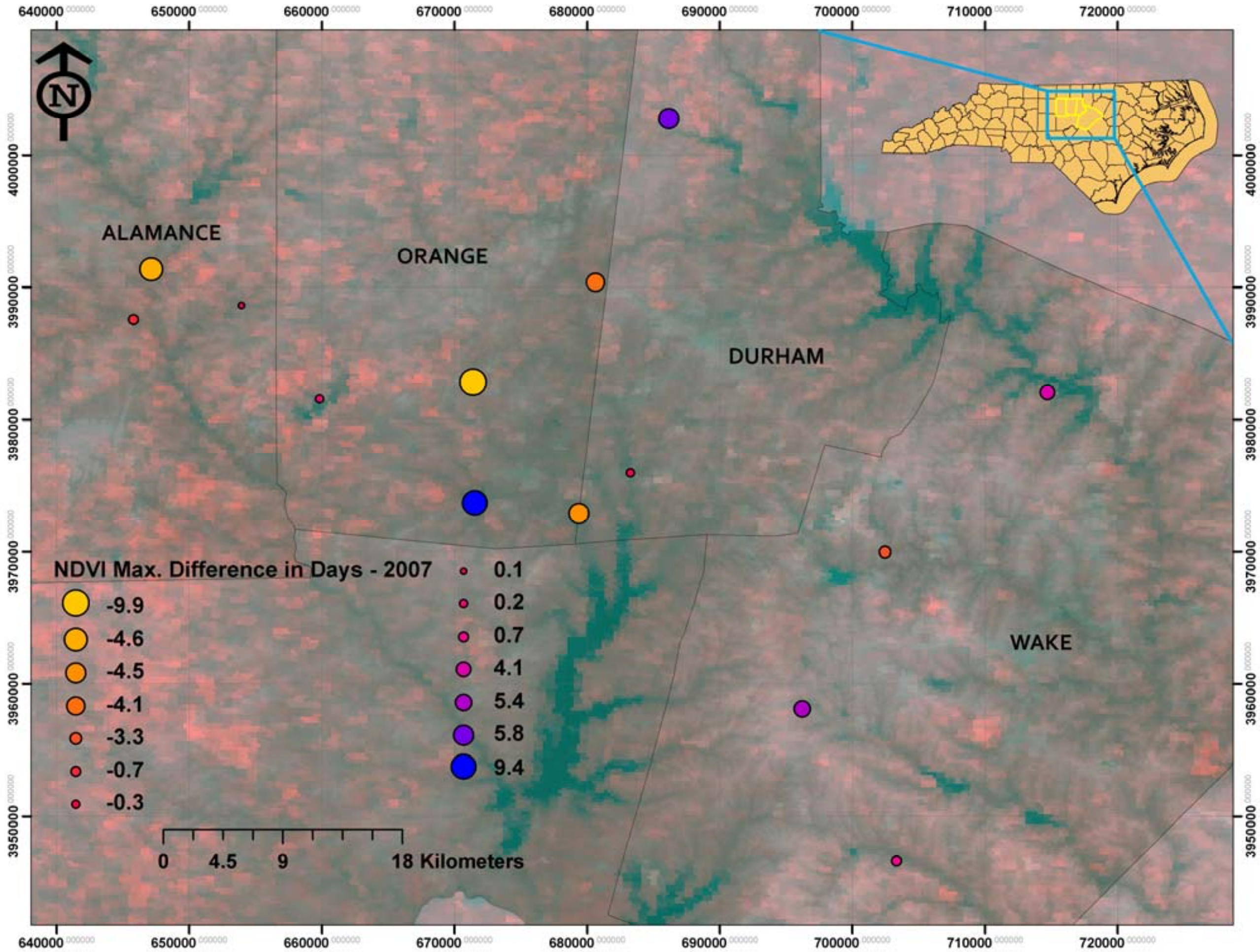


Figure 29: Geographic distribution of piedmont sites showing difference from mean maximum NDVI for 2007.

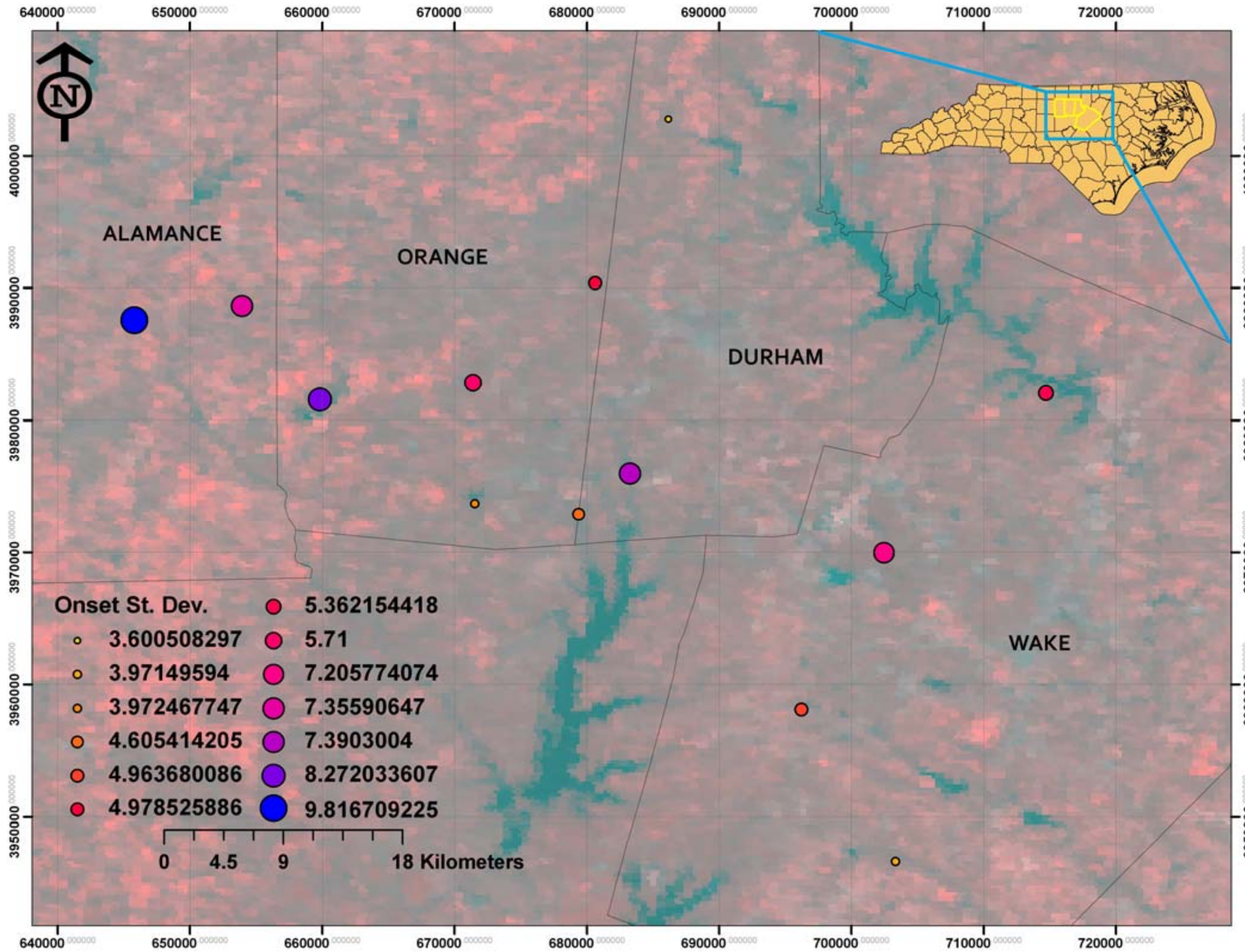


Figure 30: Geographic distribution of piedmont sites showing standard deviation of onset among all study years.

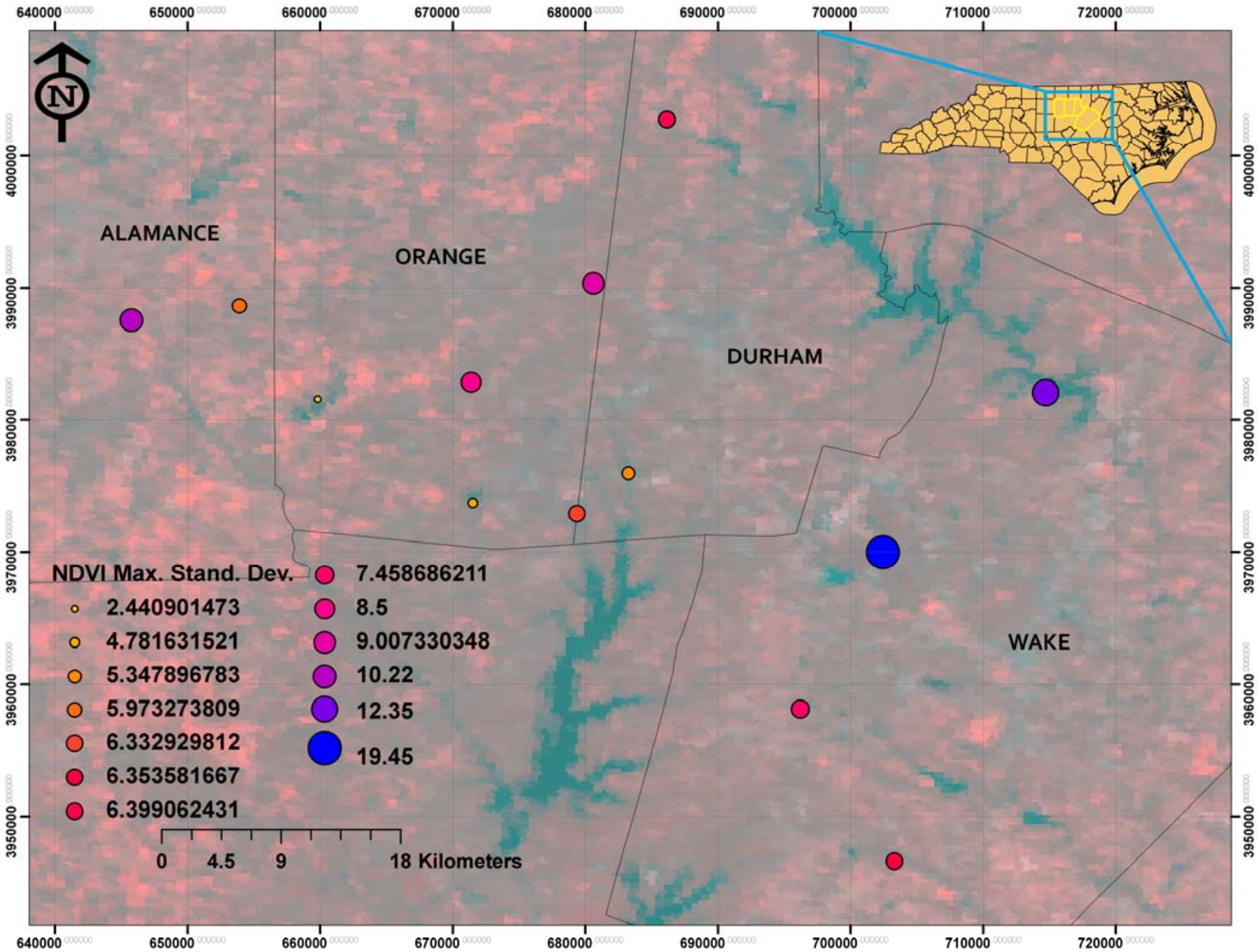


Figure 31: Geographic distribution of piedmont sites showing standard deviation of NDVI Maximum among all study years.

	Date of Onset					Date of NDVI Maximum					Number of Days in Greenup				
Site	2000	2001	2002	2003	2007	2000	2001	2002	2003	2007	2000	2001	2002	2003	2007
Site 1	82.38	75.85	87.84		76.18	112.4	121.1	119.6		132.9	30.02	45.25	31.76		56.72
Site 2	87.78	76.02	89.13	78.59	66.54	119.9	119.1	122.6	116.2	122.8	32.12	43.08	33.47	37.61	56.26
Site 3		64.29	88.41	66.93	74.89		138.8	128.3	158.7	127.6	0	74.51	39.89	91.77	52.71
Site 4	93.85	63.04	78.69	78.85	75.63	115.7	141.9	135.9	117.9	123.7	21.85	78.86	57.21	39.05	48.07
Site 5	90.55	86.29	91.43	70.97	85.03	125.2	129.8	127	112.4	122.9	34.65	43.51	35.57	41.43	37.87
Site 6	90.65	79.75	85.56	69.02	82.28	111.5	134.2	162.8	158.6	126.3	20.85	54.45	77.24	89.58	44.02
Site 7	81.54	84.44	86.7	84.29	73.48	116.3	118	122.3	108.5	127.5	34.76	33.56	35.6	24.21	54.02
Site 8	89.76	82.8	86.66	78.31	81.78	119.6	122.7	127	125.6	113.6	29.84	39.9	40.34	47.29	31.82
Site 9	88.32	85.19	89.45	89.58	80.05	118.4	124.8	121.5	105.9	117.2	30.08	39.61	32.05	16.32	37.15
Site 10	88.1	80.41	87.06	74.3	82.93	120	116.5	131	142.2	127.1	31.9	36.09	43.94	67.9	44.17
Site 11	85.51	85.81	92.68	75.61	72.4	120.9	117.7	108.3	121.6	123.3	35.39	31.89	15.62	45.99	50.9
Site 12	91.65	103.9	92.79	88.87	90.3	117.4	125	123.1	151.2	118.9	25.75	21.1	30.31	62.33	28.6
Site 13	92.13	86.46	83.01	92.22	79.66	113	114.8	134	120.6	117.6	20.87	28.34	50.99	28.38	37.94
Site 14	84.52	83.25	91.63	80.38	81.36	130.4	125.2	121.8	111	122.3	45.88	41.95	30.17	30.62	40.94
Site 15	118.6		99.77	108.7	118.7	136.8		139	125.1	134.3	18.2		39.23	16.4	15.6
Site 16	118.4		114.2	107.6	120.1	148		136.7	152.2	137.9	29.6		22.5	44.6	17.8
Site 17	88.92	126.9	112.3	96.67	120.8	158.6	134.1	141.2	175.3	128.7	69.68	7.2	28.9	78.63	7.9
Site 18	95.59	88.19	79.13	87.71	91.86	128.2	130.8	122.3	110.7	126.2	32.61	42.61	43.17	22.99	34.34
Site 19	61.46	78.9	75.97	79.39	87.32	120.3	123.5	152.6	99.58	137.2	58.84	44.6	76.63	20.19	49.88
Site 20	71.45	61.37	78.69	66.65	53.83	115.7	112	107.1	118.1	107.4	44.25	50.63	28.41	51.45	53.57

Blanks represent missing values from the segmentation analysis due to insufficient data points

Table 3: Breakpoint parameters obtained from the Segmented Linear Model for all sites over all years. Dates of Onset and Date of NDVI Maximum were the major breakpoints with the Number of Days in Green-Up as the difference.

Pearson's R-Value			
Potential Predictors	**2001**	**2002**	**2003**
Julian Day	0.803126	0.77963	0.64325
Mean Air Tempurature (Cel.)	0.807214	0.6951	0.470643
Soil Temperature @10cm (Cel.)	0.876737	0.77015	0.56601
Soil Temperature @25cm (Cel.)	0.876434	0.77069	0.585046
Precipitation (mm)	0.029371	0.1264	0.027968
Relative Humidity (%)	0.570232	53269	0.258273
Vapor Pressure Deficit (kPa)	0.583176	0.51464	0.298848
Soil Moisture @ 10cm (m3 m-3)	-0.52584	-0.80864	-0.52883
Soil Moisture @ 25cm (m3 m-3)	-0.60777	-0.81639	-0.54314
Ecosystem Respiration (umol/m2/s)	0.532328	0.45668	0.470376
Day of Last Freeze	0.610437	0.70318	0.593386
Growing Degree Days 10C	0.640326	0.6935	0.575802
Growing Degree Days Since Last Freeze	0.730941	0.721	0.5902

Table 4: Pearson's Correlation Coefficient as it relates to the linearized NDVI response for all potential predictor Variables used in the climate regressions for 2001-2003.

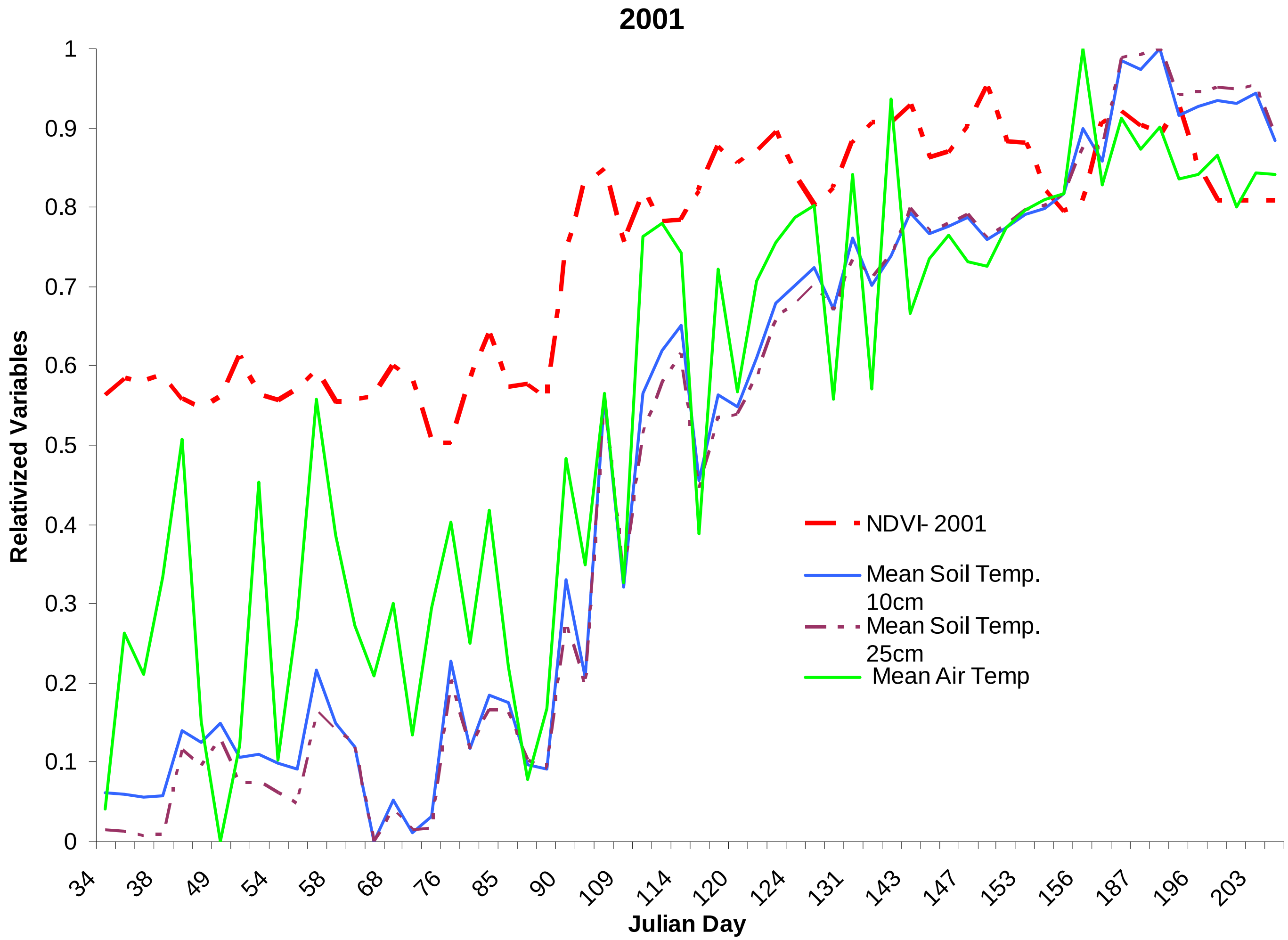


Figure 32: Most highly correlated variables in agreement with the NDVI response for the AmeriFLUX Climate regression in 2001.

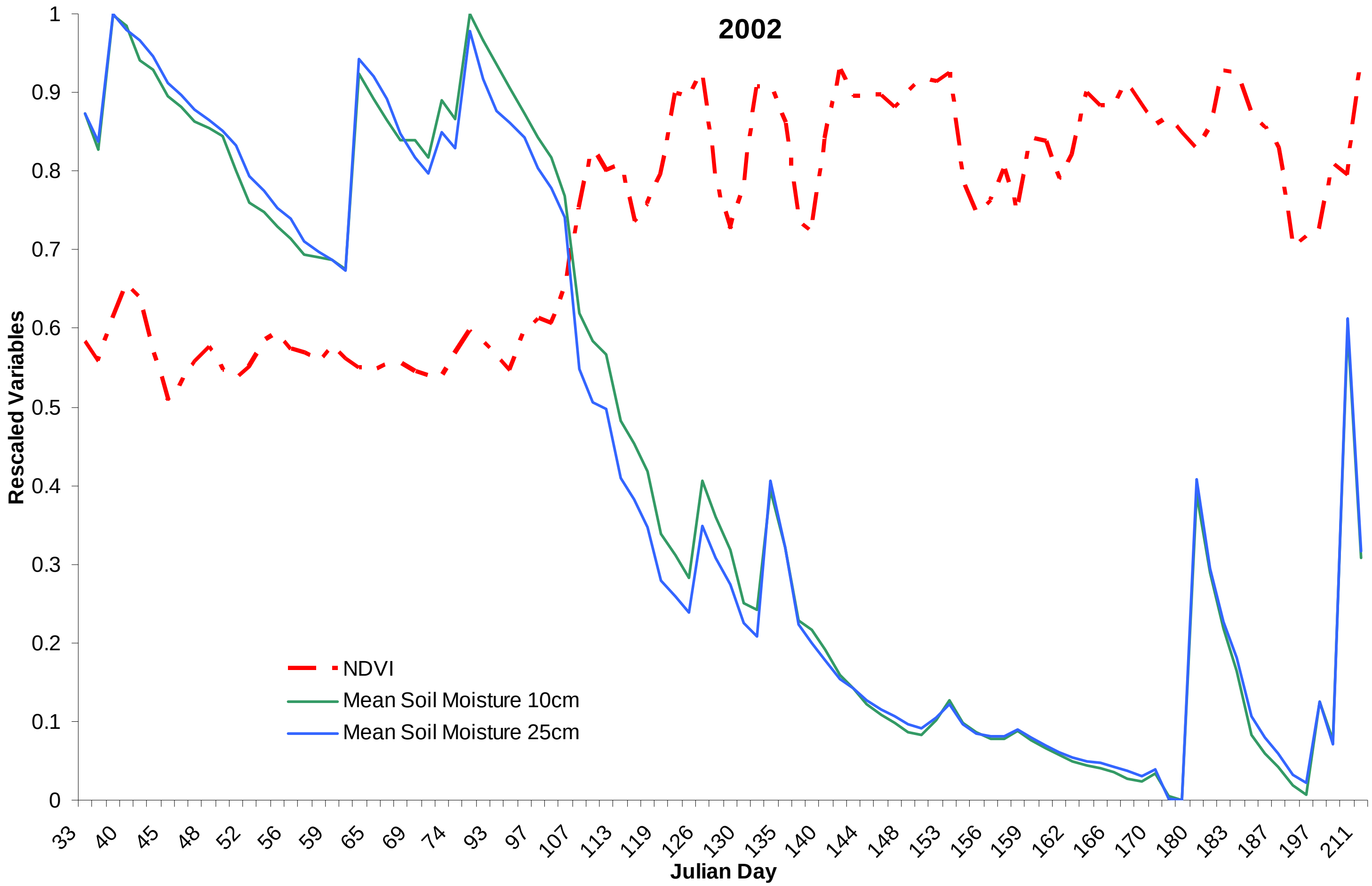


Figure 33: Most highly correlated variables in agreement with the NDVI response for the AmeriFLUX Climate regression in 2002.

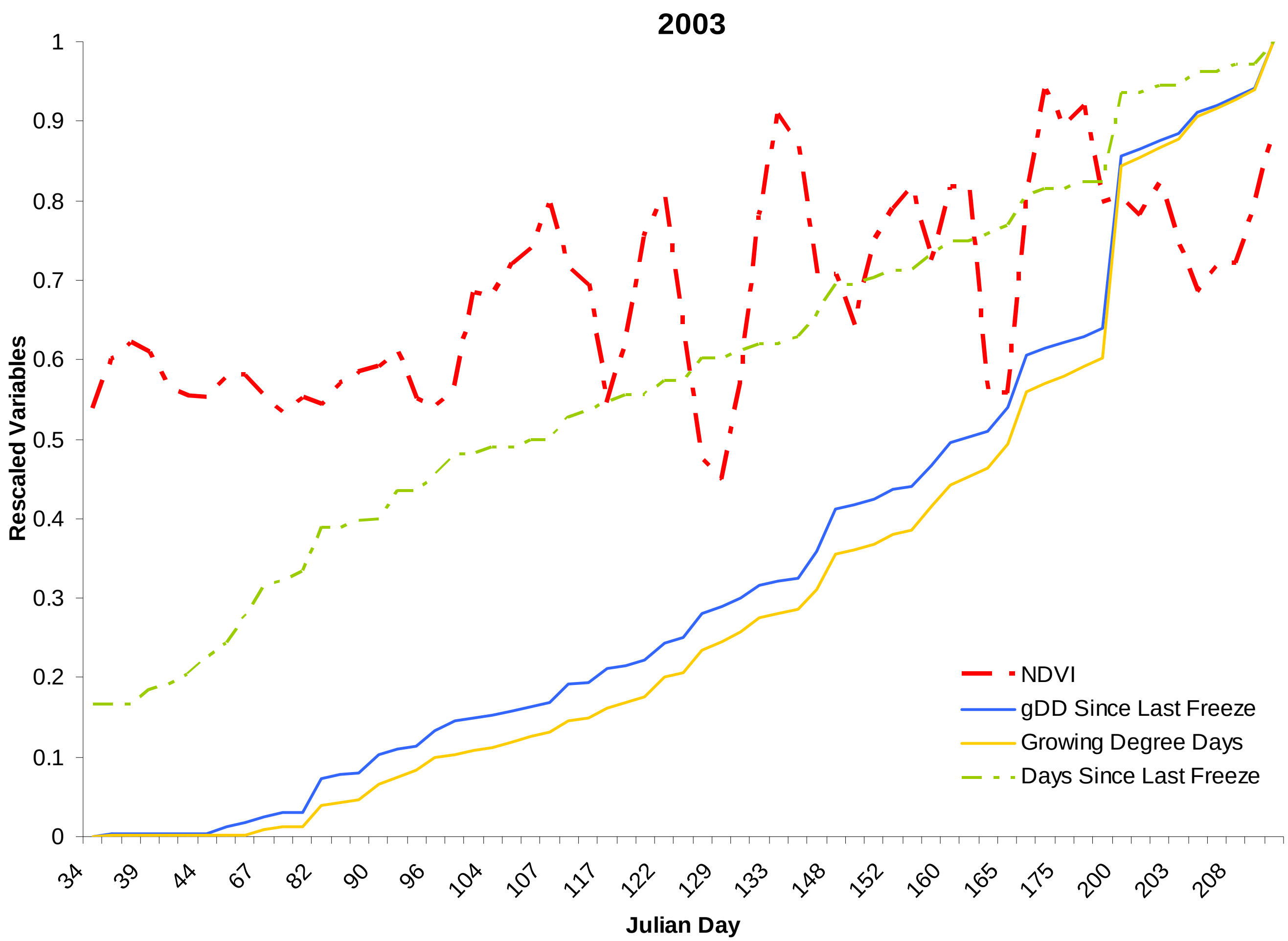


Figure 34: Most highly correlated variables in agreement with the NDVI response for the AmeriFLUX Climate regression in 2003.

Climate Regressions for 2001			
Predictor Variables	**p-value**	**Model R2**	**Model Rank**
Mean Soil Temperature @ 10cm	<2e-16	0.765	1
Mean Soil Temperature @ 25cm	<2e-16	0.764	2
Mean Air Temperature	2.30E-15	0.646	3
Julian Day	4.10E-15	0.639	4
Growing Deg. days Since Last Freeze	1.50E-11	0.527	5
Growing Degree Days	2.10E-08	0.4	6
Days since Last Freeze	1.40E-07	0.362	7
Mean Soil Moisture @ 25 cm	1.60E-07	0.359	8
Vapor Pressure Deficit	6.60E-07	0.329	9
Relative Humidity	1.30E-06	0.314	10
Ecosystem Respiration	8.50E-06	0.271	11
Mean Soil Moisture @ 10 cm	1.10E-05	0.264	12
Mean Daily Precipitation	0.82	-0.0158	13
Climate Regressions for 2002			
Predictor Variables	**p-value**	**Model R2**	**Model Rank**
Mean Soil Moisture @ 10 cm	<2e-16	0.663	1
Mean Soil Moisture @ 25 cm	<2e-16	0.65	2
Julian Day	<2e-16	0.604	3
Mean Soil Temperature @ 25cm	<2e-16	0.59	4
Mean Soil Temperature @ 10cm	<2e-16	0.589	5
Growing Deg. days Since Last Freeze	2.50E-16	0.515	6
Days since Last Freeze	2.80E-15	0.489	7
Mean Air Temperature	7.70E-15	0.478	8
Growing Degree Days	9.40E-15	0.475	9
Relative Humidity	3.30E-08	0.276	10
Vapor Pressure Deficit	1.10E-07	0.257	11
Ecosystem Respiration	3.70E-06	0.2	12
Mean Daily Precipitation	0.22	0.00528	13
Climate Regressions for 2003			
Predictor Variables	**p-value**	**Model R2**	**Model Rank**
Julian Day	8.50E-08	0.367	1
Days since Last Freeze	3.00E-07	0.341	2
Growing Deg. days Since Last Freeze	3.60E-07	0.338	3
Mean Soil Temperature @ 25cm	4.80E-07	0.331	4
Growing Degree Days	7.90E-07	0.321	5
Mean Soil Temperature @ 10cm	1.30E-06	0.309	6
Mean Soil Moisture @ 25 cm	4.20E-06	0.283	7
Mean Soil Moisture @ 10 cm	8.40E-06	0.268	8
Ecosystem Respiration	0.0001	0.208	9
Mean Air Temperature	1.00E-04	0.209	10
Vapor Pressure Deficit	0.017	0.0744	11
Relative Humidity	0.041	0.0541	12
Mean Daily Precipitation	0.83	0.0156	13

Table 5: Significance, agreement, and rank of individual predictor variables within the climate regressions for 2001-2003. Green variables represent relative contribution of soil characteristics; Yellow variables represent cumulative heat unit contribution to the agreement with NDVI.

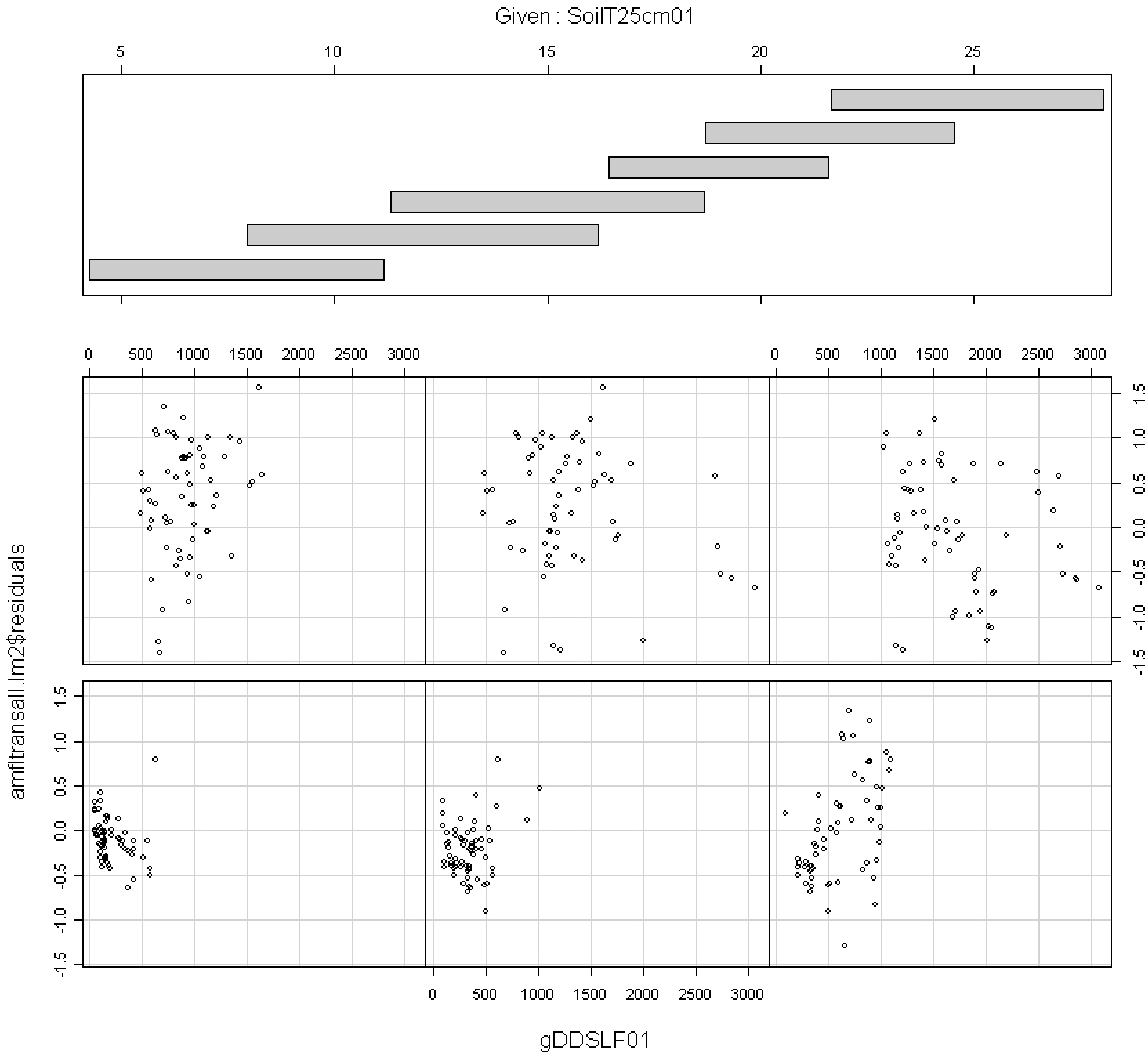


Figure 35: Conditional Plot showing the distribution of model residuals with Julian Day given a change in Soil Temperature at 25 cm (SoilT25cm01) with Growing degree days since last freeze (gDDSLF01) predicting the residuals.

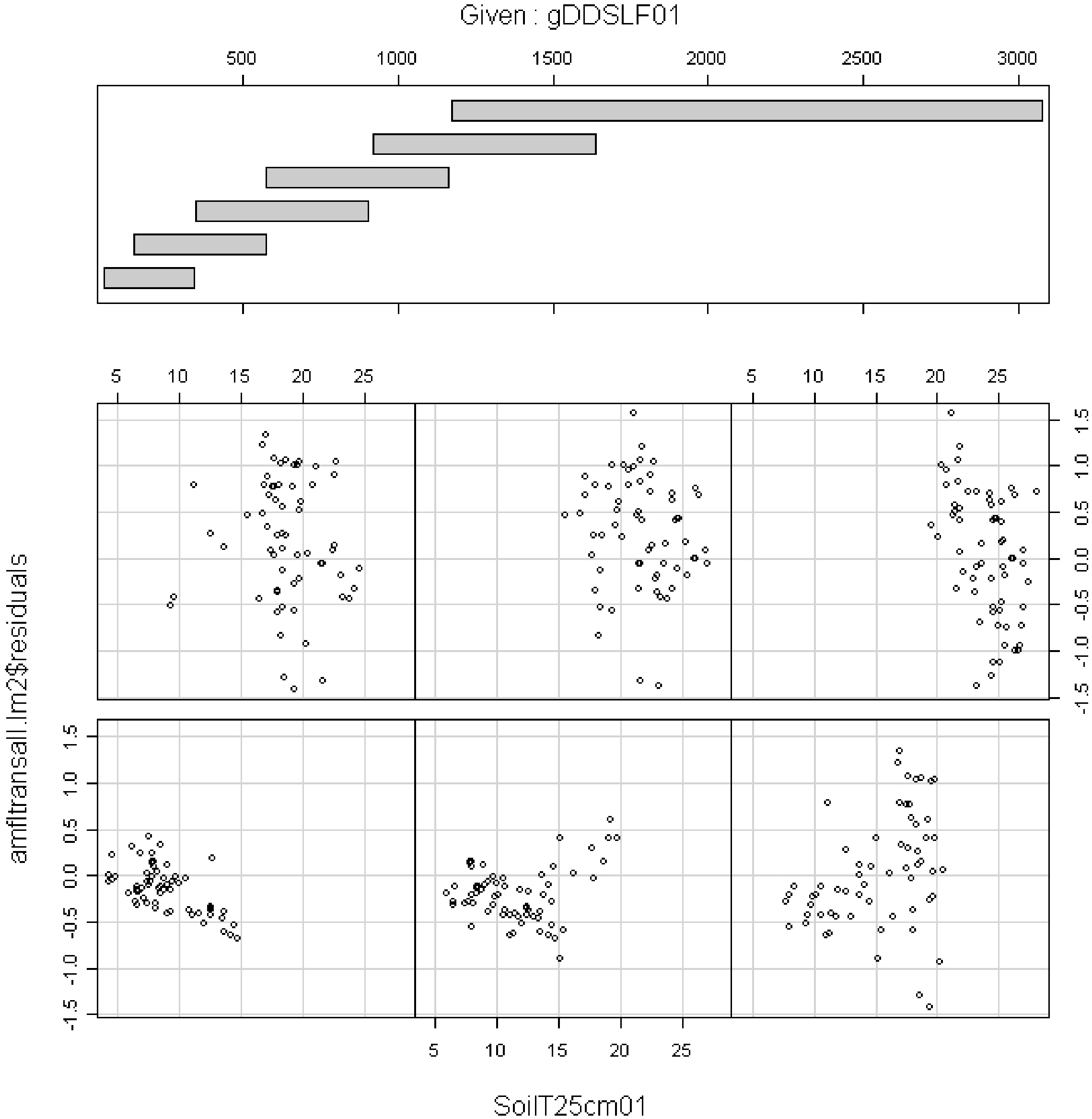


Figure 36: Conditional Plot showing the distribution of model residuals with Julian Day given a change in Growing degree days since last freeze (gDDSLF01) with Soil Temperature at 25 cm (SoilT25cm01) predicting the residuals

Figure 37: Pairs plots of the predictor variables relationship to each other and the NDVI response for the AmeriFLUX dataset in 2001. Notice the degree to which most of the variables co-vary.

Figure 38: Pairs plots of the predictor variable's relationship to each other and the NDVI response for the AmeriFLUX dataset in 2002. Notice the degree to which most of the variables co-vary.

Figure 39: Pairs plots of the predictor variable's relationship to each other and the NDVI response for the AmeriFLUX dataset in 2003. Notice the degree to which most of the variables co-vary.