Supporting Information

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SI Materials and Methods

The retrieved results for the start of the vegetation growing season (SOS) based on remote sensing datasets in this paper were validated by comparison with the in situ observed phenological data from 18 agro-meteorological stations in the Tibetan Plateau. The retrieved SOSs for the sites were averaged over a circle area with a 5-km radius centered each site. Fig. S6 shows the comparisons between the in situ observed results and our retrieved results using SPOT VEGETATION (SPOT-VGT) and Moderate Resolution Imaging Spectroradiometer (MODIS) data. For almost all sites there is a high consistency between the observed and retrieved SOSs in this study. The mean absolute error (MAE) between the MODIS-based SOSs and the observed SOSs was 9.9 d, and the root mean-square error (RMSE) between them was 12.5 d. The retrieved SOS result is reasonably good considering the temporal resolution (16 d) of MODIS data. SPOT-VGT–based results also have good consistency with the observed results (MAE = 9.9 d, RMSE = 12.6 d). On the whole, the consistency between the retrieved SOS results from SPOT-VGT and MODIS data and the in situ observed SOS results (Fig. S6) proved that our retrieved results are effective and reliable in the Tibetan Plateau and the SOS retrieval method is suitable for our targeted area.

The SOS trend in the entire Tibetan Plateau from 1982 to 2011 has also been validated by comparison with the previous studies in different segmental periods, as mentioned in the main text. Besides the evidences from those remote sensing-based studies, we also collected more evidences from in situ observation-based studies (1–5), which further verified the reliability of our conclusion about the SOS advancement in the Tibetan Plateau from 1982 to 2011.

1. Wang J (2011) The phenological variation of Elymus nutans during recent 20 years at the side slope conditions in the northeast region of Qinghai-Xizang Plateau—A case study of Hezuo. *Pratacultural Sci* 28(10):1851–1854.
2. Huang R, Zhou H, Liu Z, Xu W, Kui W (2012) Response of Kobresia pygmaea phenology and biomass to climate change in the Yangtze River headwaters region. *Acta Bot Boreal-Occident Sin* 32(05):1021–1026.
3. Wang Z (2011) The change in green-up dates of Elymus nutans in Gannan pasture in the past 30 years. *Gansu Agric* (1):25–26.
4. Guo L, Zhao N, Tian H (2011) Impacts of climatic warming on reproductive stages of forages growing in alpine grassland of the Three River Sources Areas. *Pratacultural Sci* 28(04):618–625.
5. Li H, Ma Y, Wang Y (2010) Influences of climate warming on plant phenology in Qinghai Plateau. *J Appl Meteorol Sci* 21(04):500–505.

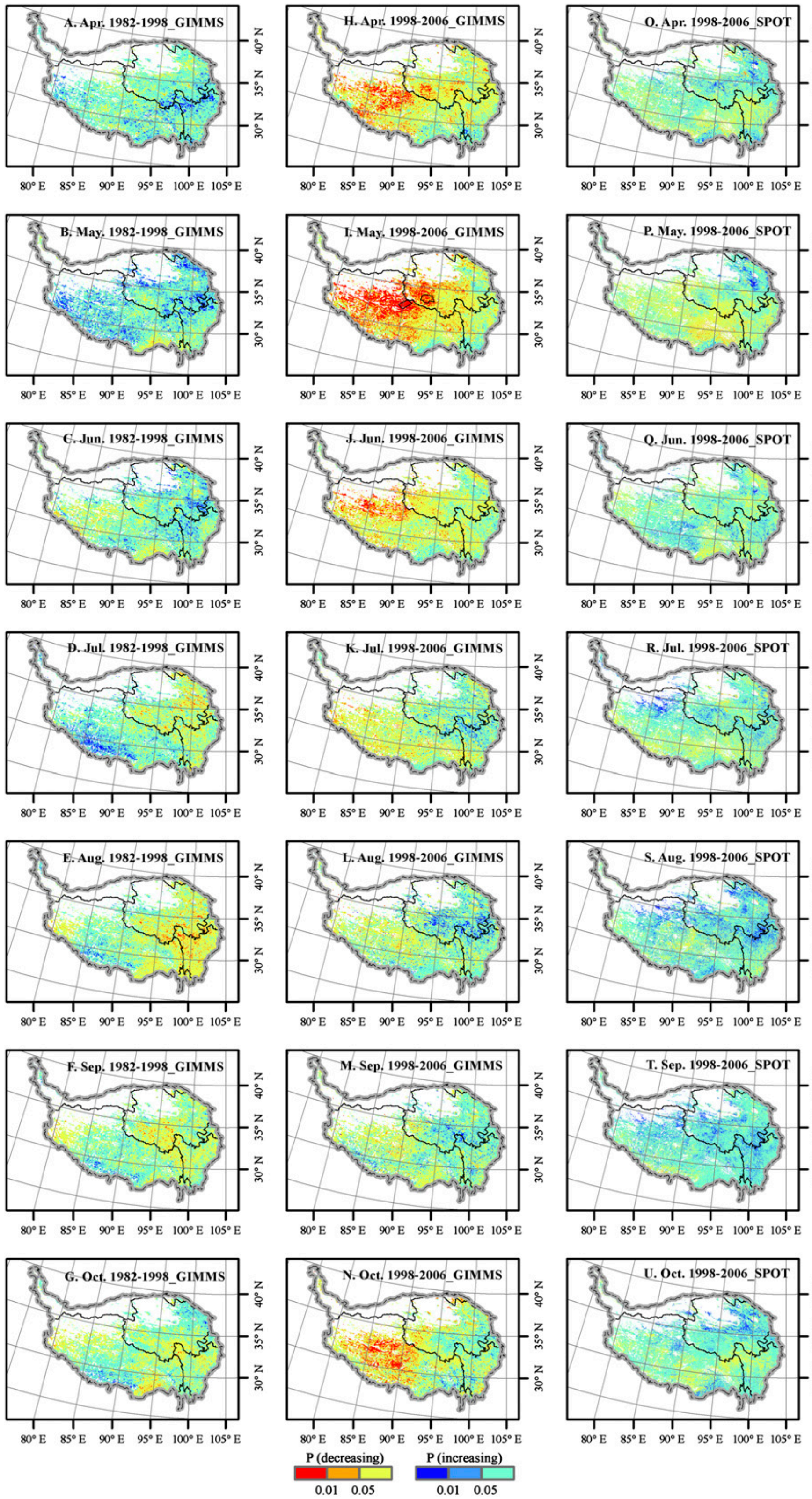

Fig. S1. Spatial distributions of significance levels of monthly NDVI (from April to October) change in the Tibetan Plateau from 1982 to 1998 (*A*–*G*) and 1998–2006 (*H*–*N*) based on GIMMS data and 1998–2006 (*O*–*U*) based on SPOT-VGT data. *P*(decreasing) and *P*(increasing): *P* values of decrease and increase in monthly NDVI, respectively, which are divided into three levels, including $P < 0.01$, $0.01 < P < 0.05$, and $P > 0.05$.

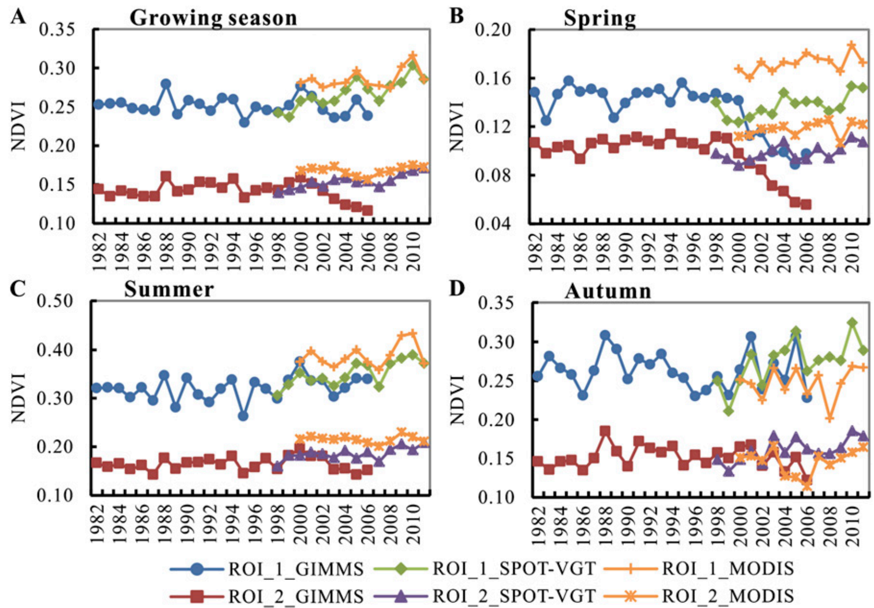

Fig. S2. Interannual variations in growing season (*A*), spring (*B*), summer (*C*), and autumn NDVI (*D*) of ROIs based on GIMMS (1982–2006), SPOT-VGT (1998–2011), and MODIS (2000–2011) datasets. The two ROIs are shown in Fig. S1*I*, the right polygon is the ROI_1 with alpine meadow, and the left one is the ROI_2 with alpine steppe. The discrepancy among the three NDVIs occurred from 2002 to 2006. GIMMS-based GSNDVI in ROIs decreased lineally since 2000, especially during spring, which fell apart from the NDVI trends based on SPOT-VGT and MODIS datasets.

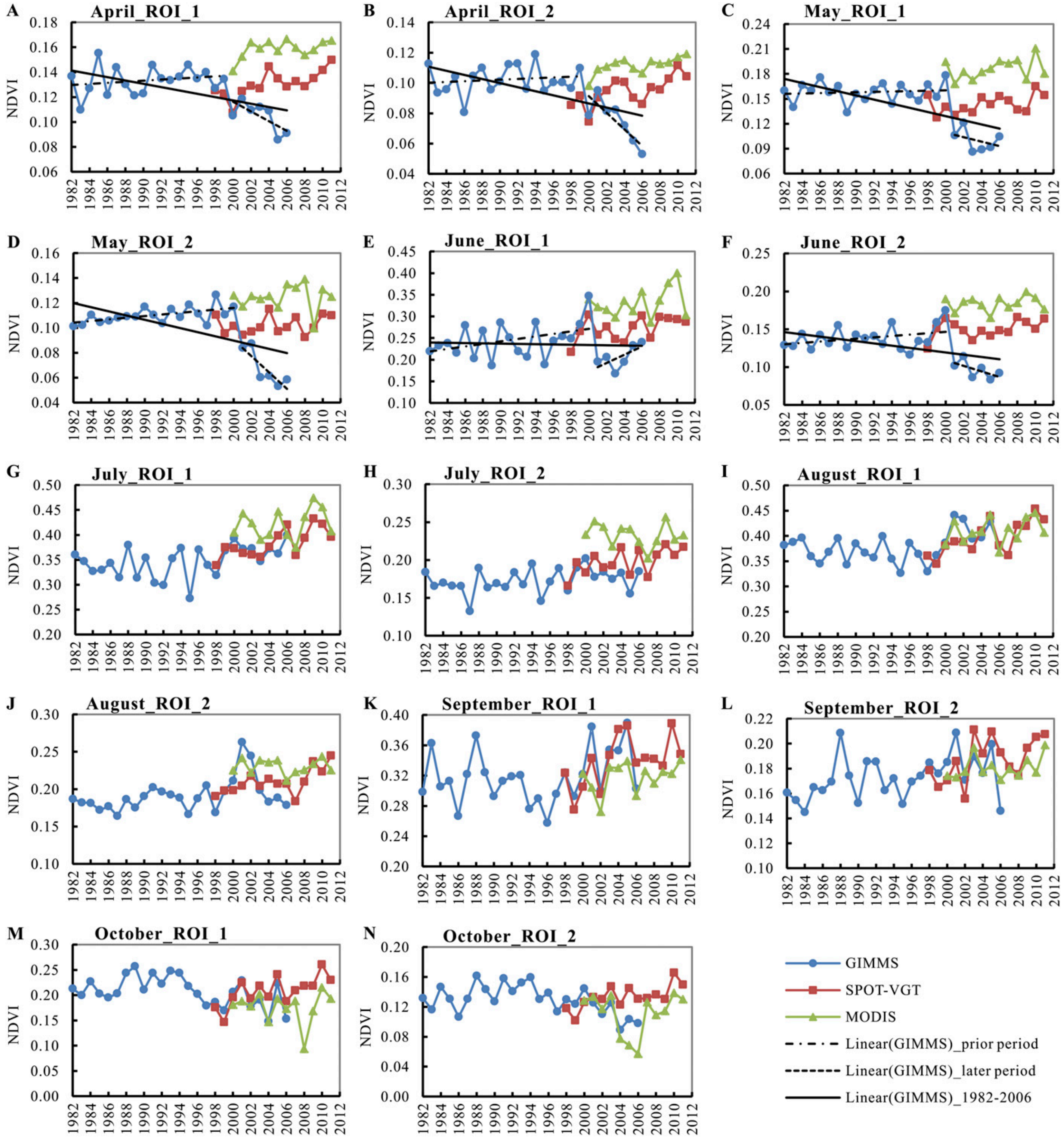

Fig. S3. Interannual variations in monthly NDVI (April–October) of the two ROIs based on the GIMMS (1982–2006), SPOT-VGT (1998–2011), and MODIS (2000–2011) datasets. The prior and later periods in the legend refer to the period before and after the turning point year, respectively. The GIMMS NDVI in April, May, and June had evident turning points during 1982–2006 based on the piecewise regression model. Compared with SPOT-VGT and MODIS NDVIs, the bias of GIMMS NDVI in April and May of ROIs occurred during 2002–2006 and those in June occurred during 2001–2006.

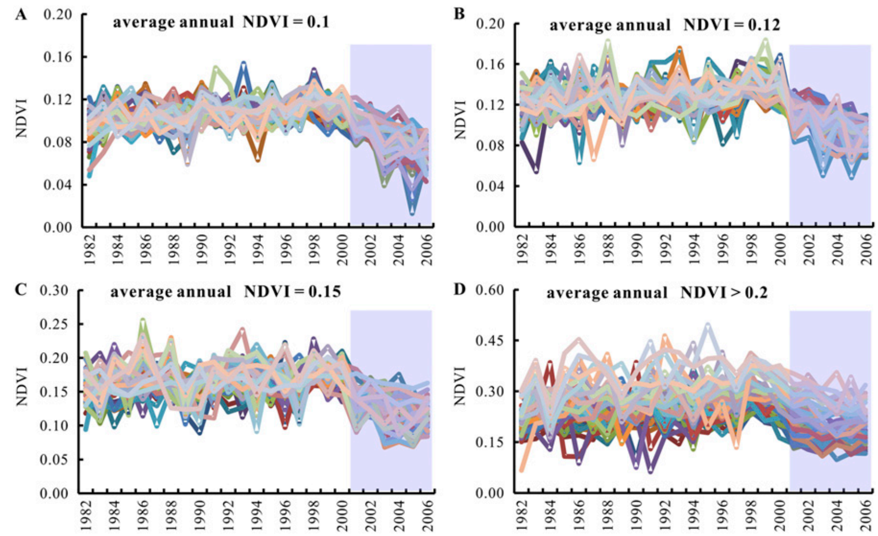

Fig. S4. Interannual variations in the May NDVIs of 200 randomly selected pixels from the regions with significant GIMMS NDVI decrease in May from 1998 to 2006 ($P < 0.05$). To highlight the features of NDVI abnormal drops, those samples are divided into four groups with average annual NDVI approximately equal to 0.10 (*A*), 0.12 (*B*), 0.15 (*C*), and >0.20 (*D*), respectively. GIMMS NDVI in May started to decrease continuously from around 2001–2006, and the variations in NDVI from 2001 to 2006 were abnormal compared with those from 1982 to 2000.

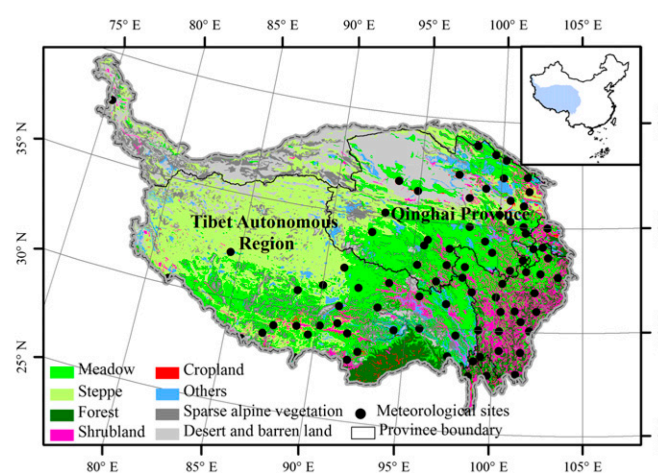

Fig. S5. Spatial distributions of vegetation types and 85 meteorological stations in the Tibetan Plateau.

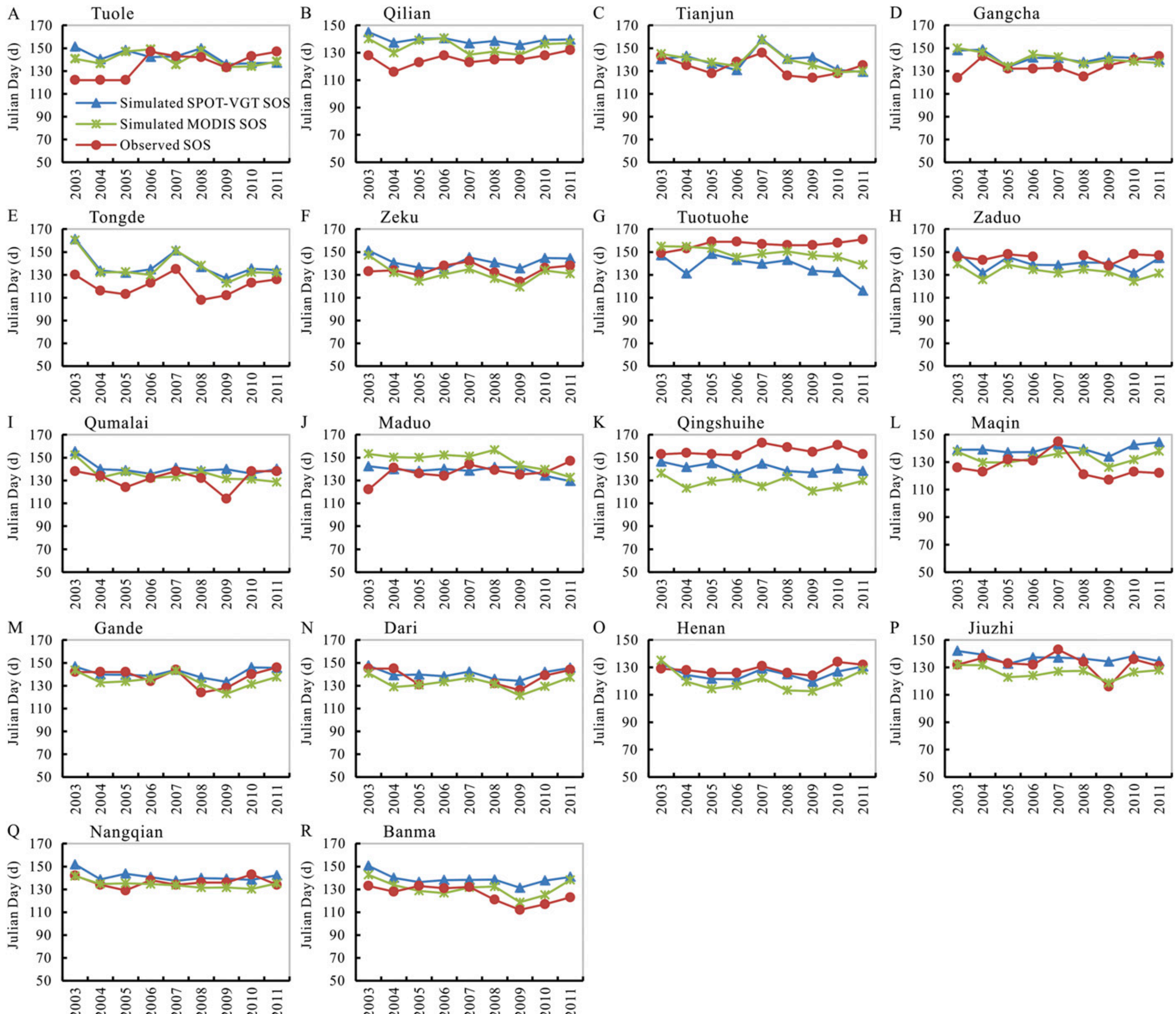

Fig. S6. A comparison between the remote sensing (SPOT-VGT and MODIS NDVI) retrieved results of the start of the vegetation growing season (SOS) and the observed results from 18 agro-meteorological stations in the Tibetan Plateau.

Table S1. Area percentages (%) of different significance levels of monthly NDVI (April–October) change in the Tibetan Plateau from 1982–1998 and 1998–2006 based on GIMMS data and 1998–2006 based on SPOT-VGT data

		P(decreasing)			*P*(increasing)				
Data	Month	<0.01	0.01–0.05	>0.05	>0.05	0.01–0.05	<0.01	Sum_de	Sum_in
GIMMS (1982–1998)	Apr.	0.03	0.14	18.62	70.01	8.19	3.02	18.78	81.22
	May	0.01	0.23	15.75	63.54	13.52	6.95	15.99	84.01
	Jun.	0.10	0.57	28.27	61.63	6.79	2.64	28.95	71.05
	Jul.	0.61	1.69	33.42	55.65	5.91	2.71	35.72	64.28
	Aug.	1.14	3.94	54.02	38.37	1.91	0.62	59.09	40.91
	Sep.	0.28	1.40	45.19	50.61	1.95	0.57	46.87	53.13
	Oct.	0.17	1.15	40.60	54.78	2.58	0.71	41.93	58.07
GIMMS (1998–2006)	Apr.	6.20	9.33	59.72	23.51	0.94	0.29	75.25	24.75
	May	**15.22**	**14.86**	50.90	18.43	0.49	0.10	80.98	19.02
	Jun.	3.49	7.00	60.01	28.84	0.56	0.09	70.51	29.49
	Jul.	0.76	3.16	47.98	43.03	3.87	1.19	51.91	48.09
	Aug.	0.32	1.30	36.32	52.52	6.37	3.17	37.94	62.06
	Sep.	0.33	1.35	37.18	54.28	5.13	1.73	38.86	61.14
	Oct.	5.09	7.96	50.55	33.94	1.85	0.60	63.61	36.39
SPOT-VGT (1998–2006)	Apr.	0.29	0.88	29.47	61.65	6.03	1.69	30.64	69.36
	May	**0.38**	**1.55**	44.90	48.23	3.62	1.33	46.82	53.18
	Jun.	0.08	0.37	26.55	64.87	6.14	1.99	27.00	73.00
	Jul.	0.13	0.51	26.22	62.53	7.48	3.13	26.87	73.13
	Aug.	0.08	0.28	15.12	65.50	13.11	5.91	15.48	84.52
	Sep.	0.05	0.15	7.95	74.79	13.15	3.91	8.14	91.86
	Oct.	0.03	0.19	21.15	68.42	7.58	2.63	21.37	78.63

P(decreasing) and *P*(increasing) represent *P* value of decrease and increase in monthly NDVI, respectively. Sum_de and Sum_in, represent the total area of decrease and increase in monthly NDVI, respectively. *P*(decreasing) and *P*(increasing) are divided into three levels, including $P < 0.01$, $0.01 < P < 0.05$, and $P > 0.05$. The comparison on areas with significant change ($P < 0.05$) is meaningful. See the data in bold for an example.