

Supporting Information

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SI Materials and Methods

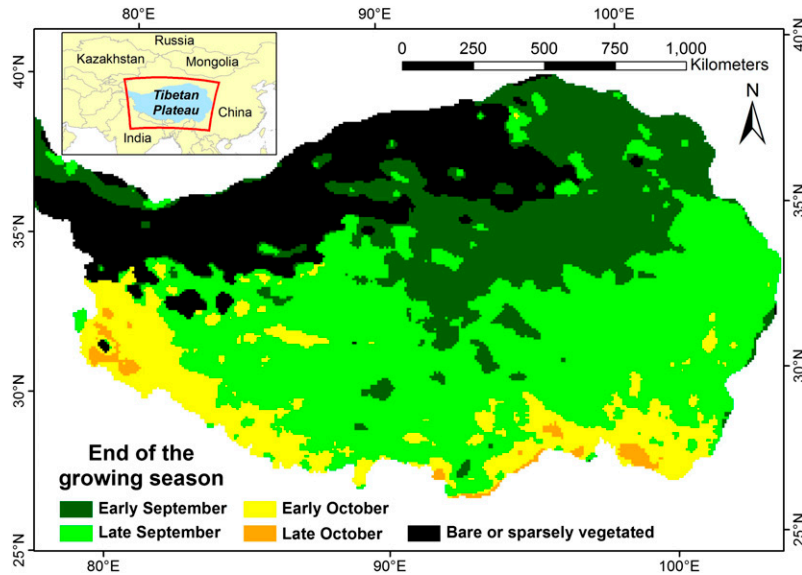


Fig. S1. Average timing of the end of the growing season (EGS) on the Tibetan Plateau between 1982 and 2006. EGS dates varied by up to one month between different parts of the Plateau.

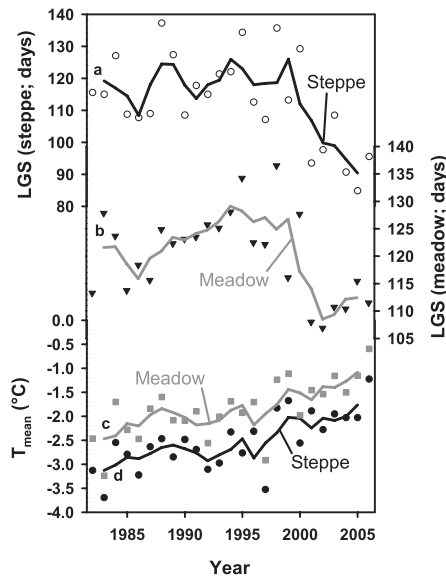


Fig. S2. Length of the growing season (LGS) for steppe (a) and meadow (b) vegetation on the Tibetan Plateau between 1982 and 2006 derived from 15-d Normalized Difference Vegetation Index composites obtained from the Advanced Very High Resolution Radiometer sensor. In response to a delayed beginning and (especially for steppe) an advancing end of the growing season, the length of the growing season declined for both steppe and meadow vegetation. Such a decline has not typically been associated with rising temperatures [which occurred in both steppe (d) and meadow (c)], which is generally expected to extend the period, during which vegetation is active. Lines in the graph represent 3-y running means.

Table S1. Mean monthly temperatures in the steppe region of the Tibetan Plateau between 1982 and 2006

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|----------------------------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|
| | °C | | | | | | | | | | | |
| 1982 | -13.6 | -13.1 | -8.0 | -3.3 | 0.8 | 5.2 | 8.2 | 8.0 | 3.9 | -2.9 | -9.4 | -13.6 |
| 1983 | -16.0 | -15.2 | -8.9 | -4.5 | 1.4 | 4.7 | 8.0 | 7.7 | 4.7 | -2.4 | -10.0 | -14.0 |
| 1984 | -15.2 | -11.6 | -6.1 | -1.9 | 3.0 | 6.9 | 7.2 | 7.0 | 3.5 | -1.7 | -10.0 | -11.6 |
| 1985 | -15.5 | -12.1 | -5.4 | -1.8 | 2.2 | 6.0 | 7.3 | 8.3 | 3.5 | -2.6 | -10.4 | -13.0 |
| 1986 | -15.0 | -12.4 | -8.2 | -3.2 | 1.0 | 6.6 | 8.3 | 7.5 | 3.3 | -3.9 | -8.8 | -13.7 |
| 1987 | -14.6 | -10.8 | -6.8 | -2.5 | 1.1 | 7.0 | 8.7 | 7.1 | 4.3 | -2.3 | -7.9 | -15.0 |
| 1988 | -14.9 | -10.8 | -8.2 | -2.2 | 3.0 | 6.6 | 8.9 | 7.7 | 4.4 | -2.2 | -9.5 | -12.4 |
| 1989 | -15.8 | -12.1 | -7.1 | -3.2 | 2.5 | 6.2 | 8.6 | 7.1 | 5.1 | -2.0 | -9.5 | -13.9 |
| 1990 | -11.5 | -11.4 | -8.4 | -3.5 | 2.3 | 7.2 | 8.0 | 7.3 | 4.1 | -2.8 | -8.5 | -12.6 |
| 1991 | -16.2 | -10.8 | -6.8 | -2.8 | 2.5 | 7.0 | 9.2 | 7.3 | 4.0 | -2.5 | -9.7 | -13.5 |
| 1992 | -14.3 | -14.2 | -6.4 | -1.7 | 1.2 | 5.6 | 7.0 | 7.7 | 4.7 | -3.0 | -9.8 | -14.1 |
| 1993 | -14.3 | -10.1 | -8.1 | -8.1 | 2.5 | 6.2 | 8.7 | 7.9 | 3.4 | -2.7 | -8.4 | -12.6 |
| 1994 | -13.0 | -12.5 | -7.3 | -2.8 | 2.6 | 6.9 | 9.0 | 8.2 | 5.5 | -2.8 | -9.1 | -12.6 |
| 1995 | -17.1 | -13.1 | -7.5 | -3.2 | 4.4 | 8.2 | 8.4 | 7.3 | 5.0 | -1.8 | -10.0 | -13.7 |
| 1996 | -14.5 | -11.6 | -6.4 | -2.1 | 2.7 | 6.2 | 8.8 | 8.2 | 4.0 | -2.2 | -8.1 | -12.8 |
| 1997 | -15.1 | -13.2 | -6.5 | -3.3 | 1.5 | 5.6 | 8.7 | 7.8 | 3.8 | -4.6 | -10.2 | -16.9 |
| 1998 | -15.4 | -11.3 | -8.0 | -1.2 | 3.8 | 8.5 | 9.1 | 8.3 | 5.7 | -0.8 | -7.7 | -13.0 |
| 1999 | -14.0 | -9.2 | -5.3 | -0.5 | 3.3 | 7.2 | 8.9 | 7.6 | 5.4 | -2.0 | -8.1 | -13.6 |
| 2000 | -14.2 | -14.0 | -8.7 | -2.2 | 3.7 | 7.4 | 9.2 | 7.5 | 4.1 | -1.8 | -8.3 | -13.5 |
| 2001 | -13.2 | -9.9 | -7.9 | -2.6 | 2.4 | 6.6 | 9.9 | 8.1 | 5.3 | -1.3 | -7.8 | -12.3 |
| 2002 | -15.9 | -10.9 | -7.2 | -1.1 | 2.1 | 7.1 | 9.6 | 8.2 | 3.7 | -2.7 | -8.6 | -11.8 |
| 2003 | -13.3 | -11.3 | -6.8 | -1.3 | 1.1 | 6.6 | 8.3 | 8.8 | 5.3 | -1.3 | -7.4 | -12.4 |
| 2004 | -13.7 | -10.9 | -5.8 | -2.3 | 1.7 | 6.9 | 9.1 | 8.5 | 5.6 | -2.0 | -8.4 | -13.0 |
| 2005 | -13.7 | -10.9 | -5.8 | -2.3 | 1.7 | 6.9 | 9.1 | 8.5 | 5.6 | -2.0 | -8.4 | -13.0 |
| 2006 | -10.5 | -7.8 | -7.0 | -2.5 | 3.5 | 7.4 | 10.0 | 8.4 | 5.1 | -1.8 | -7.8 | -11.8 |
| Mean | -14.4 | -11.6 | -7.1 | -2.6 | 2.3 | 6.7 | 8.7 | 7.8 | 4.5 | -2.3 | -8.9 | -13.2 |
| Trend (year⁻¹) | 0.08 | 0.10 | 0.04 | 0.06 | 0.04 | 0.06 | 0.07 | 0.04 | 0.06 | 0.04 | 0.08 | 0.03 |

All months showed temperature increases during this period.

Table S2. Mean monthly temperatures in the meadow region of the Tibetan Plateau between 1982 and 2006

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|----------------------------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|
| °C | | | | | | | | | | | | |
| 1982 | -12.0 | -11.5 | -6.0 | -2.7 | 1.7 | 5.1 | 7.5 | 7.1 | 4.2 | -1.7 | -8.2 | -13.1 |
| 1983 | -15.1 | -13.8 | -7.3 | -3.3 | 2.3 | 5.4 | 7.7 | 6.6 | 4.4 | -0.6 | -12.6 | -12.6 |
| 1984 | -13.5 | -8.4 | -4.8 | -0.7 | 2.6 | 6.4 | 7.1 | 6.0 | 3.5 | -0.4 | -8.4 | -9.9 |
| 1985 | -13.2 | -11.1 | -4.5 | -1.3 | 2.9 | 5.6 | 6.6 | 7.9 | 3.6 | -1.9 | -9.9 | -12.2 |
| 1986 | -13.8 | -11.0 | -6.7 | -2.3 | 2.4 | 6.6 | 7.7 | 6.7 | 2.9 | -3.0 | -7.7 | -11.6 |
| 1987 | -12.8 | -8.8 | -5.6 | -1.6 | 2.2 | 7.6 | 7.7 | 6.2 | 3.7 | -1.5 | -6.7 | -12.5 |
| 1988 | -12.2 | -8.5 | -6.7 | -1.6 | 2.6 | 6.5 | 8.1 | 7.3 | 4.0 | -0.1 | -7.8 | -10.9 |
| 1989 | -13.7 | -10.3 | -5.4 | -2.5 | 2.9 | 6.4 | 8.0 | 6.7 | 5.1 | -0.9 | -7.9 | -13.6 |
| 1990 | -10.9 | -9.8 | -7.0 | -2.6 | 1.7 | 5.9 | 7.6 | 6.8 | 3.6 | -1.9 | -7.1 | -11.4 |
| 1991 | -14.6 | -8.6 | -5.0 | -1.6 | 3.0 | 6.6 | 8.5 | 6.9 | 3.7 | -1.0 | -8.4 | -12.3 |
| 1992 | -13.7 | -12.7 | -5.2 | -0.9 | 2.1 | 5.8 | 6.5 | 7.0 | 4.7 | -2.3 | -8.9 | -13.2 |
| 1993 | -13.8 | -9.0 | -6.4 | -1.6 | 2.5 | 5.5 | 7.7 | 7.1 | 3.4 | -1.5 | -7.0 | -10.9 |
| 1994 | -11.1 | -10.5 | -6.5 | -1.5 | 3.0 | 6.2 | 7.7 | 7.8 | 5.8 | -1.6 | -7.9 | -11.7 |
| 1995 | -14.4 | -11.8 | -5.8 | -2.3 | 4.9 | 7.6 | 7.5 | 6.7 | 4.9 | -0.7 | -7.5 | -12.3 |
| 1996 | -13.4 | -9.8 | -4.7 | -1.0 | 3.0 | 5.6 | 8.0 | 7.9 | 3.7 | -1.0 | -7.1 | -11.7 |
| 1997 | -13.6 | -12.1 | -5.5 | -2.9 | 2.3 | 5.3 | 7.6 | 7.3 | 3.2 | -3.4 | -8.7 | -14.4 |
| 1998 | -13.2 | -10.0 | -6.2 | -0.5 | 4.3 | 7.8 | 8.2 | 7.4 | 5.1 | -0.1 | -6.2 | -11.5 |
| 1999 | -12.2 | -7.0 | -3.9 | 0.9 | 3.0 | 7.2 | 7.7 | 7.1 | 4.8 | -1.0 | -7.2 | -12.9 |
| 2000 | -12.9 | -11.7 | -7.0 | -2.0 | 3.1 | 7.0 | 8.7 | 6.8 | 3.7 | -0.8 | -7.0 | -11.8 |
| 2001 | -11.8 | -8.5 | -6.7 | -1.9 | 1.8 | 5.7 | 9.0 | 7.3 | 5.4 | -0.5 | -6.7 | -10.6 |
| 2002 | -13.3 | -8.5 | -5.8 | -0.1 | 2.0 | 6.9 | 8.8 | 7.3 | 4.4 | -2.2 | -7.6 | -10.3 |
| 2003 | -11.8 | -9.4 | -5.3 | -0.1 | 2.0 | 5.9 | 7.7 | 8.4 | 5.0 | 0.2 | -6.0 | -10.5 |
| 2004 | -12.3 | -10.3 | -3.5 | -0.6 | 3.2 | 5.8 | 7.3 | 7.9 | 5.0 | -1.6 | -8.5 | -10.3 |
| 2005 | -11.1 | -8.9 | -4.7 | -1.3 | 2.4 | 6.6 | 8.7 | 8.2 | 5.6 | -0.9 | -7.3 | -11.1 |
| 2006 | -8.2 | -6.5 | -5.6 | -1.6 | 3.0 | 7.2 | 9.8 | 8.6 | 5.3 | -1.2 | -7.0 | -10.8 |
| Mean | -12.7 | -9.9 | -5.7 | -1.5 | 2.7 | 6.3 | 7.9 | 7.2 | 4.4 | -1.3 | -7.8 | -11.8 |
| Trend (year⁻¹) | 0.09 | 0.09 | 0.04 | 0.06 | 0.02 | 0.03 | 0.06 | 0.06 | 0.06 | 0.02 | 0.09 | 0.05 |

All months showed temperature increases during this period.

Table S3. Monthly precipitation on the Tibetan Plateau between 1983 and 2006, averaged over the 25 weather stations shown in Fig. 1, as well as long-term precipitation trends for all months

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-----------------------------------|------------|------------|------------|------------|------------|-------------|-------------|------------|-------------|------------|------------|------------|
| | mm | | | | | | | | | | | |
| 1983 | 4 | 4 | 12 | 19 | 40 | 100 | 158 | 120 | 162 | 26 | 7 | 2 |
| 1984 | 4 | 2 | 6 | 14 | 49 | 116 | 201 | 103 | 117 | 49 | 1 | 2 |
| 1985 | 4 | 3 | 12 | 17 | 62 | 114 | 216 | 93 | 123 | 25 | 5 | 3 |
| 1986 | 1 | 3 | 6 | 26 | 49 | 97 | 148 | 168 | 158 | 24 | 4 | 3 |
| 1987 | 1 | 5 | 7 | 24 | 43 | 102 | 143 | 118 | 126 | 20 | 4 | 3 |
| 1988 | 3 | 7 | 14 | 20 | 54 | 81 | 162 | 139 | 115 | 14 | 3 | 4 |
| 1989 | 4 | 7 | 10 | 27 | 60 | 122 | 144 | 135 | 117 | 36 | 6 | 2 |
| 1990 | 2 | 8 | 10 | 24 | 51 | 78 | 153 | 162 | 131 | 34 | 8 | 4 |
| 1991 | 6 | 5 | 10 | 20 | 42 | 96 | 169 | 117 | 109 | 40 | 2 | 2 |
| 1992 | 2 | 6 | 11 | 12 | 50 | 100 | 156 | 135 | 97 | 21 | 6 | 5 |
| 1993 | 8 | 6 | 13 | 18 | 50 | 94 | 140 | 118 | 130 | 27 | 2 | 2 |
| 1994 | 8 | 5 | 12 | 25 | 48 | 103 | 173 | 168 | 88 | 25 | 2 | 2 |
| 1995 | 5 | 9 | 13 | 25 | 35 | 81 | 113 | 105 | 115 | 19 | 7 | 3 |
| 1996 | 5 | 7 | 11 | 17 | 56 | 87 | 150 | 175 | 97 | 31 | 9 | 5 |
| 1997 | 2 | 9 | 18 | 21 | 57 | 91 | 168 | 88 | 122 | 35 | 4 | 0 |
| 1998 | 2 | 6 | 16 | 21 | 57 | 83 | 132 | 111 | 101 | 29 | 7 | 5 |
| 1999 | 3 | 4 | 12 | 15 | 68 | 122 | 197 | 183 | 92 | 46 | 5 | 2 |
| 2000 | 3 | 6 | 11 | 25 | 53 | 110 | 180 | 146 | 80 | 58 | 5 | 1 |
| 2001 | 4 | 4 | 10 | 29 | 58 | 89 | 110 | 138 | 115 | 21 | 5 | 3 |
| 2002 | 5 | 3 | 8 | 16 | 60 | 104 | 134 | 135 | 123 | 27 | 5 | 3 |
| 2003 | 3 | 5 | 10 | 17 | 58 | 104 | 147 | 78 | 110 | 19 | 6 | 1 |
| 2004 | 5 | 3 | 7 | 21 | 59 | 108 | 168 | 202 | 122 | 33 | 3 | 3 |
| 2005 | 5 | 8 | 17 | 26 | 55 | 91 | 155 | 175 | 109 | 34 | 5 | 2 |
| 2006 | 1 | 6 | 13 | 19 | 50 | 94 | 201 | 162 | 156 | 44 | 4 | 1 |
| Mean | 4 | 5 | 11 | 21 | 53 | 99 | 159 | 136 | 117 | 31 | 5 | 3 |
| Trend (year⁻¹)* | 0.0 | 0.1 | 0.1 | 0.1 | 0.4 | -0.2 | -0.5 | 1.5 | -0.9 | 0.3 | 0.0 | 0.0 |

*None of the trends are significant at $P < 0.05$.