**Supplementary materials**

**Table S1.** Climate regions and locations used to compare the responses of plant species with differing spring phenology to climate warming.

| Climate region/location | Latitude and longitude | Annual mean temperature (°C) (1981 – 2010) |
|-------------------------|------------------------|------------------------------------------|
| **Boreal Canada**       |                        |                                          |
| St. John's, Baie-Comeau, Timmins, Kapuskasing, Sioux Lookout, Thompson, Fort McMurray, La Ronge, High level, Fort Nelson, Yellowknife, Whitehorse | 47°37′ – 62°28′N; 52°44′ – 135°04′W | -4.3 – 5.0 |
| **Temperate Canada**    |                        |                                          |
| London, Toronto, Montreal, Sherbrooke, Quebec City Ottawa, Sudbury, North Bay, Sault Ste. Marie | 43°01′ – 46°48′N; 71°23′ – 84°30′W | 4.0 – 7.9 |
| **Cold temperate China**|                        |                                          |
| Shenyang, Changchun, Tonghua, Baicheng, Xilingol, Shihezi, Jiamusi, Mudanjiang, Harbin, Yichun, Dedu, Nenjiang | 41°25′ – 49°06′N; 85°56′ – 130°11′E | 0.1 – 8.5 |
| **Warm temperate China**|                        |                                          |
| Baoji, Luoyang, Taian, Jinan, Xingtai, Dezhou, Minqin, Taiyuan, Tianjin, Yixian, Qinhuangdao, Beijing | 34°13′ – 39°31′N; 103°03′ – 119°37′E | 8.8 – 14.8 |
| **Temperate United Kingdom** |                        |                                          |
| Belfast, Harris, Thurso, Inverness, Aberdeen, Edinburgh, Sunderland, Chester, Norwich, Brighton, Plymouth, Pembroke | 50°49′ – 58°35′N; 0°08′ – 7°18′W | 7.8 – 11.2 |
Table S2. Phenological models for different species/specie groups listed by increasing forcing requirements (early to late season species) within each climate region.

| Species             | Model*         | Parameters (a, b, c, d) |
|---------------------|----------------|------------------------|
| **Boreal Canada**   |                |                        |
| *Pinus banksiana*   | 3-exponential  | 2013, 10993, 0.0049    |
| *Populus balsamifera* | 4-sigmoid   | 3266, 51776, 247, -107 |
| *Betula papyrifera* | 3-exponential  | 5819, 50394, 0.0054    |
| *Populus tremuloides* | 4-sigmoid   | 6217, 53076, 304, -115 |
| *Picea glauca*      | 3-exponential  | 6505, 21558, 0.0080    |
| *Picea mariana*     | 3-exponential  | 8768, 18145, 0.0118    |
| **Temperate Canada** |                |                        |
| *Pinus strobus*     | 4-sigmoid      | 1438, 29274, 429, -165 |
| *Larix laricina*    | 4-sigmoid      | 2769, 199142, -297, -248 |
| *Betula alleghaniensis* | 4-sigmoid   | 1311, 88151, 332, -263 |
| *Pinus resinosa*    | 4-sigmoid      | 5175, 113800, 17, -221 |
| *Thuja occidentalis* | 4-sigmoid   | 5742, 80365, 376, -124 |
| *Picea rubens*      | 4-sigmoid      | 10771, 59227, 430, -176 |
| **Cold temperate China** |            |                        |
| *Salix babylonica*  | 2-exponential  | 104.2, 0.0170          |
| *Salix matsudana*   | 2-exponential  | 117.4, 0.0266          |
| *Populus simonii*   | 2-exponential  | 127.8, 0.0139          |
| *Ulmus pumila*      | 2-exponential  | 86.5, 0.0080           |
| *Populus X canadensis* | 2-exponential | 375.1, 0.0090          |
| *Amorpha fruticosa* | 2-exponential  | 294.6, 0.0078          |
| *Koelreuteria paniculata* | 2-exponential | 175.7, 0.0110          |
| *Fraxinus chinensis* | 2-exponential | 136.1, 0.0048          |
| *Ailanthus altissima* | 2-exponential | 210.1, 0.0088          |
| *Ginkgo biloba*     | 2-exponential  | 256.8, 0.0156          |
| *Morus alba*        | 2-exponential  | 284.1, 0.0110          |
| *Sophora japonica*  | 2-exponential  | 115.6, 0.0083          |
| **Warm temperate China** |            |                        |
| *Prunus davidiana*  | 2-exponential  | 190.4, 0.0178          |
| *Platycladus orientalis* | 2-exponential | 385.6, 0.0150          |
| *Juglans regia*     | 2-exponential  | 263.7, 0.0183          |
| *Malus pumila*      | 2-exponential  | 305.1, 0.0071          |
| *Euonymus alatus*   | 2-exponential  | 61.2, 0.0457           |
| *Prunus kansuensis* | 2-exponential  | 182.5, 0.0107          |
| *Amygdalus persica* | 2-exponential  | 161.0, 0.0110          |
| *Robinia pseudoacacia* | 2-exponential | 162.1, 0.0065          |
| *Gleditsia sinensis* | 2-exponential | 177.1, 0.0099          |
| *Toona sinensis*    | 2-exponential  | 221.1, 0.0083          |
| *Ziziphus jujuba*   | 2-exponential  | 174.7, 0.0075          |
| **Pinus tabuliformis** | 2-exponential | 724.2, 0.0094 |
|-----------------------|---------------|---------------|
| **Temperate United Kingdom** |               |               |
| Group 1<sup>b</sup>  | 3-exponential | 41.4, 548, 0.0391 |
| Group 2               | 3-exponential | 35.3, 410, 0.0228 |
| Group 3               | 3-exponential | 34.8, 545, 0.0200 |
| Group 4               | 3-exponential | 19.1, 664, 0.0142 |
| Group 5               | 3-exponential | -15.1, 1143, 0.0139 |

<sup>a</sup>Three model types, 2-parameter exponential decay, y=a*exp(-bx) (Zhang et al., 2018), 3-parameter exponential decay, y=a + b*exp(-cx) (Murray et al., 1989; Man et al., 2017), and 4-parameter sigmoid curve, y=a +b*(1+ exp((x-c)/d) (Man et al., 2020).

<sup>b</sup>Group 1 – *Populus trichocarpa* and *Crataegus monogyna*; Group 2 – *Sambucus nigra*, *Rosa rugosa*, *Salix viminalis*, *Larix decidua*, and *Prunus avium*; Group 3 – *Rubus idaeus*, *Sorbus aucuparia*, *Betula pendula*, and *Corylus avellana*; Group 4 – *Robina pseudoacacia*, *Tsuga heterophylla*, and *Picea sitchensis*; and Group 5 – *Fagus sylvatica*. As the reported model parameters are not consistent with the model types presented, models were refitted with data extracted from the graphical presentations using the distance measuring tool in Adobe Acrobat Reader DC.