**Supplementary information**

**Table S1.** Detailed information of 16 alpine lakes in the eastern monsoonal region of China

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Code | | Lake | Latitude (°N) | Longitude (°E) | Altitude (m a.s.l.) | Bedrock | Water depth (m) | lake area (ha) | Category | Dominant  plants | Source |
| 1 | Xiaolongwan | | 42.30 | 126.36 | 655 | Basalt | 15.0 | 10 | North | Tree | [1] |
| 2 | Erlongwan | | 42.30 | 126.35 | 724 | Basalt | 36.0 | 30 | North | Tree | [2] |
| 3 | Gonghai | | 38.90 | 112.23 | 1840 | Carbonate | 10.0 | 36 | North | Shrub and meadow | [3] |
| 4 | Tianchi | | 35.26 | 106.31 | 2430 | Clastic | 8.2 | 2 | North | Shrub and meadow | [4] |
| 5 | Congping | | 31.40 | 110.06 | 2080 | Carbonate | 0.2 | 0.038 | South | Meadow | [5] |
| 6 | Mulong | | 31.40 | 110.06 | 2080 | Carbonate | 1.5 | 0.042 | South | Meadow | [5] |
| 7 | Tsuifong | | 24.50 | 121.60 | 1840 | Clastic | 4.5 | 10 | South | Tree | [6] |
| 8 | Shade Co | | 29.73 | 101.35 | 4442 | Slate | 8.7 | 7 | South | Shrub | [7] |
| 9 | Moon | | 31.48 | 102.33 | 4260 | Carbonate | 20.0 | 15 | South | Shrub | [7] |
| 10 | Jiren | | 29.72 | 100.80 | 4480 | Lamprophyre | 28.0 | 14 | South | Shrub and meadow | [8] |
| 11 | Cuoqia | | 27.40 | 99.77 | 3980 | Basalt | 26.8 | 7 | South | Tree | [8] |
| 12 | Heihai | | 27.35 | 100.07 | 4118 | Basalt | 42.2 | 18 | South | Shrub and meadow | [8] |
| 13 | Tiancai | | 26.63 | 99.72 | 3898 | Rhyolite | 7.0 | 2 | South | Tree | [8] |
| 14 | Taiji | | 26.63 | 99.71 | 3978 | Granite | 3.5 | 1.84 | South | Tree | [9] |
| 15 | Erye | | 33.95 | 107.76 | 3660 | Granite | 5.4 | 0.3 | Transitional | Meadow | This study |
| 16 | Sanye | | 33.95 | 107.77 | 3485 | Granite | 12.0 | 1 | Transitional | Lichen | This study |

**Table S2.** Geographic location of three stations for monitoring atmospheric deposition.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| City | Station | Site Classification | Latitude (N) | Longitude (E) | Altitude (m) |
| Chongqing | Jinyunshan | Rural | 29º49’ | 106º22’ | 800 |
| Xi’an | Jiwozi | Remote | 33º50’ | 108º48’ | 1800 |
| Xiamen | Xiaoping | Remote | 24º51’ | 118º2’ | 686 |

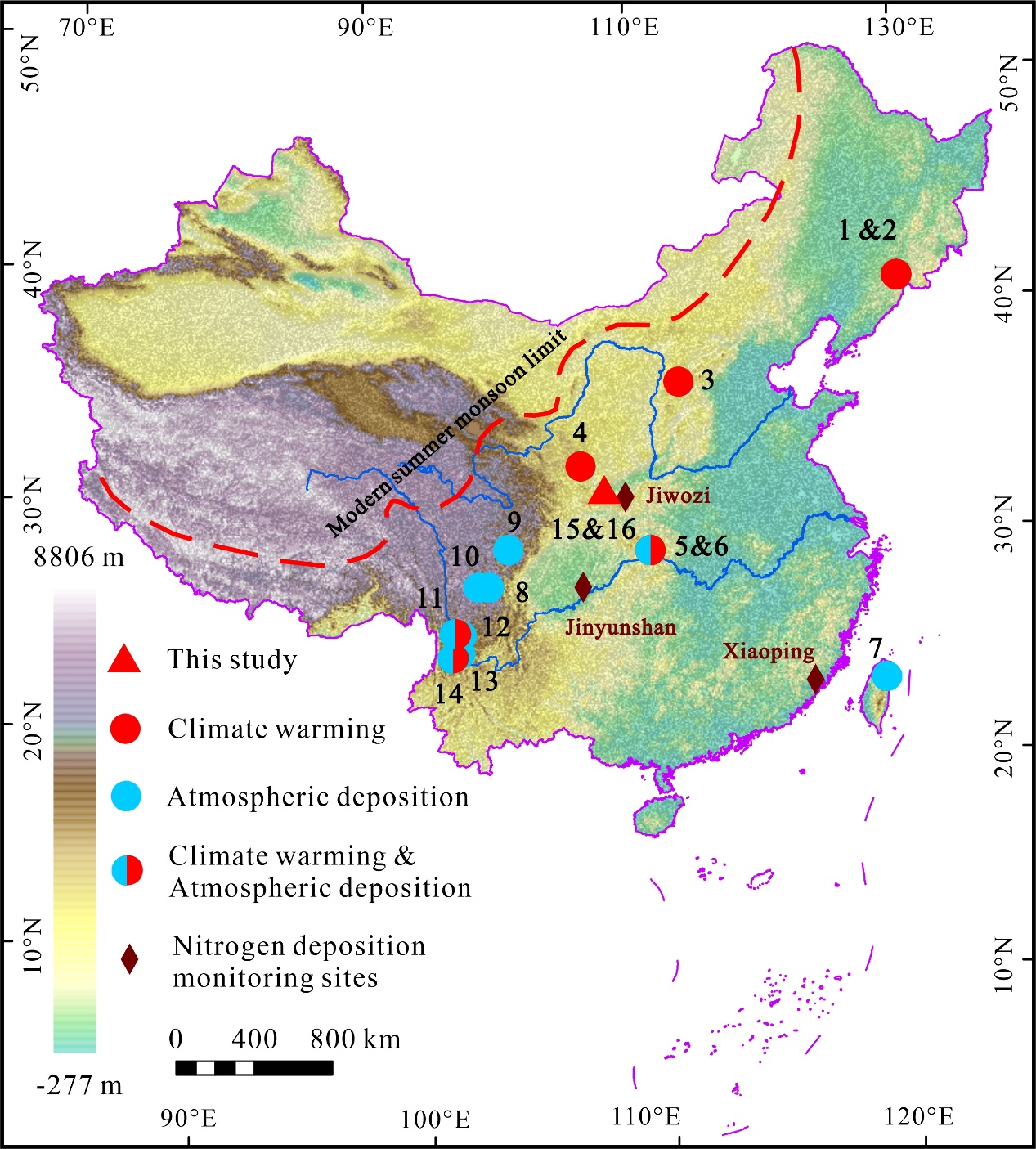


Figure S1. Location of sixteen alpine lakes in the eastern monsoonal region of China with main driving forces for diatom flora shifts shown. Red and blue filled circles represent climate warming and atmospheric deposition as the major driving force, respectively. Lake codes are labelled using Arabic numerals (see details in Table S1).

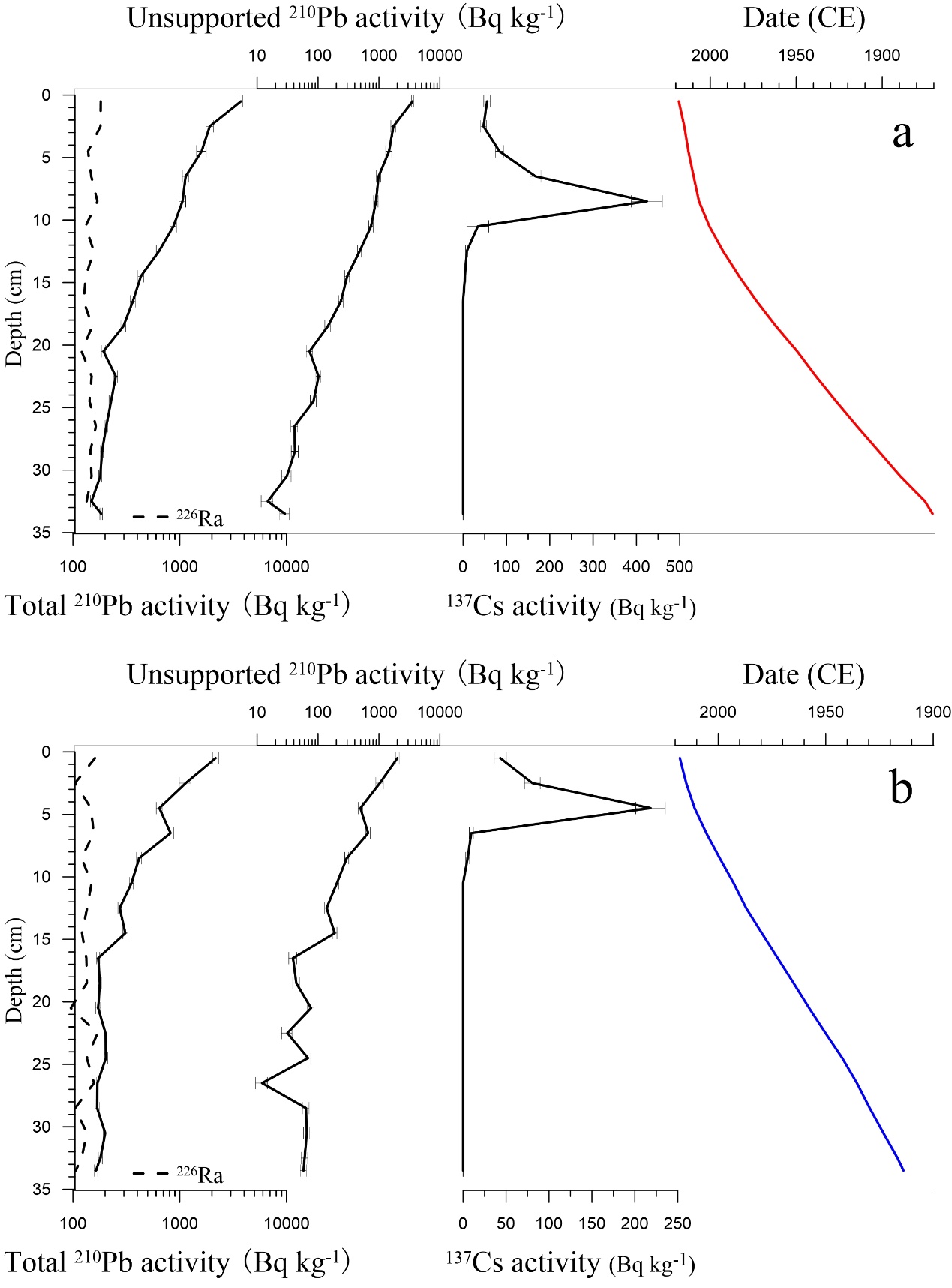


Figure S2. The chronologies of sediment cores collected from Erye Lake (a) and Sanye Lake (b). Original data are sourced from our previous study [10].

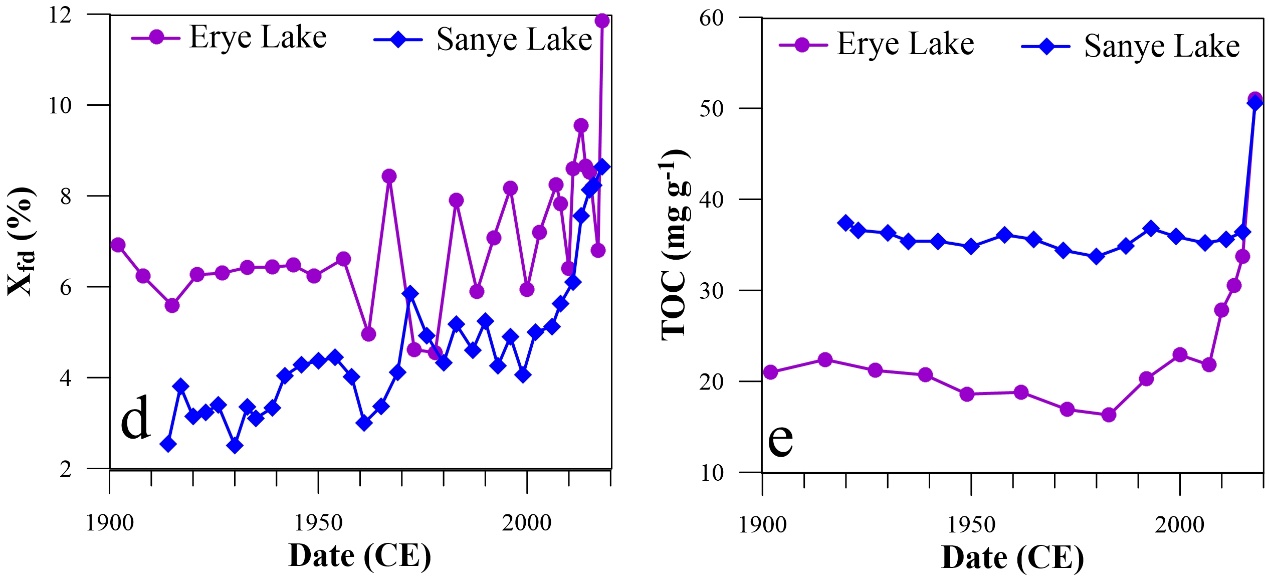


Figure S3. Temporal changes in Xfd and TOC in Erye and Sanye lakes. Original data are sourced from our previous study [10].

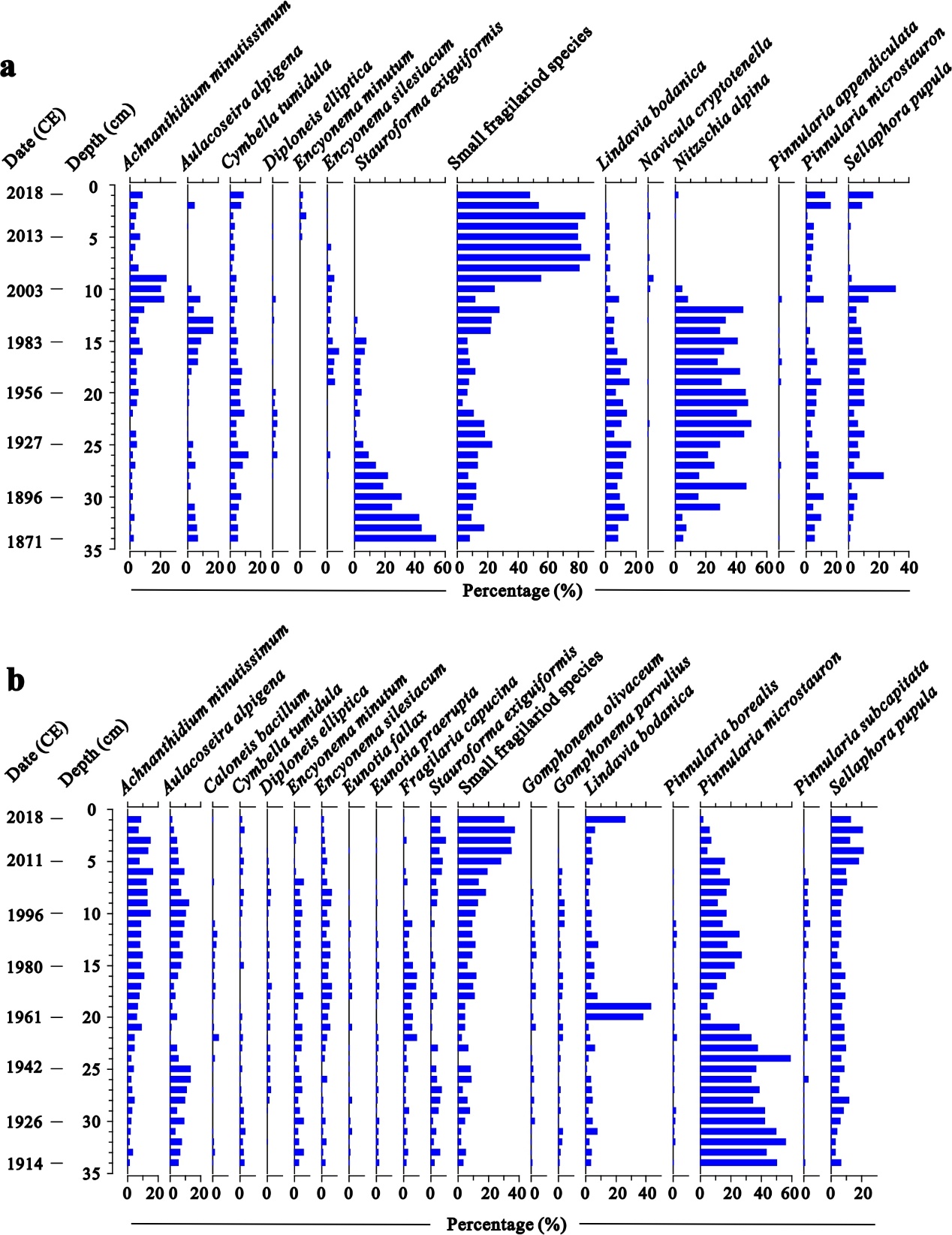


Figure S4. Diatom assemblages in Erye (a) and Sanye (b) lakes, with main diatom species (percentage > 2% in at least one sample) shown.

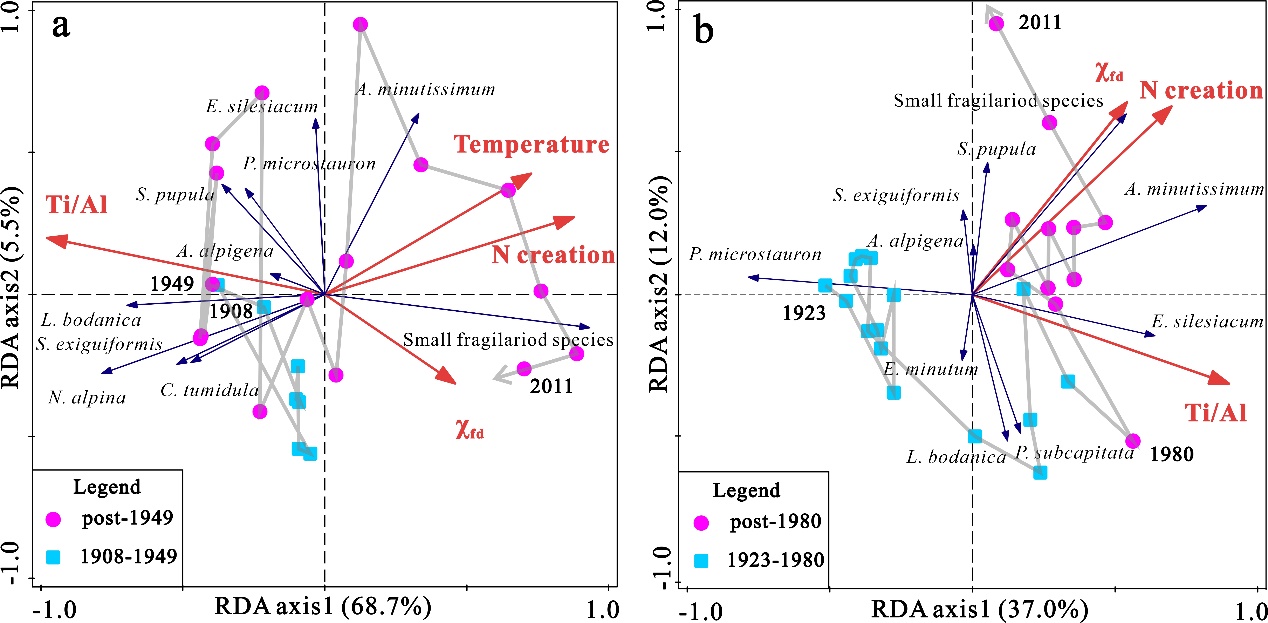


Figure S5. The ordination triplots showing main diatom taxa, samples and significant explanatory variables in Erye Lake (a) and Sanye Lake (b).

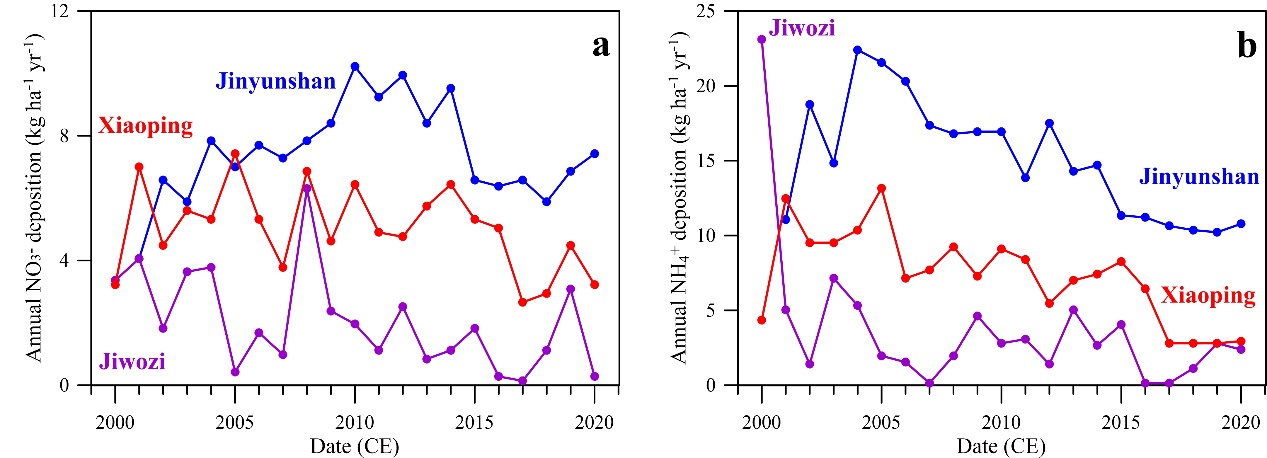


Figure S6. Atmospheric deposition of NO3- (a) and NH4+ (b) three monitoring sites between 2000 and 2020. Original data are gathered from https://www.eanet.asia/. Geographic location of monitoring sites are seen details in Table S2.

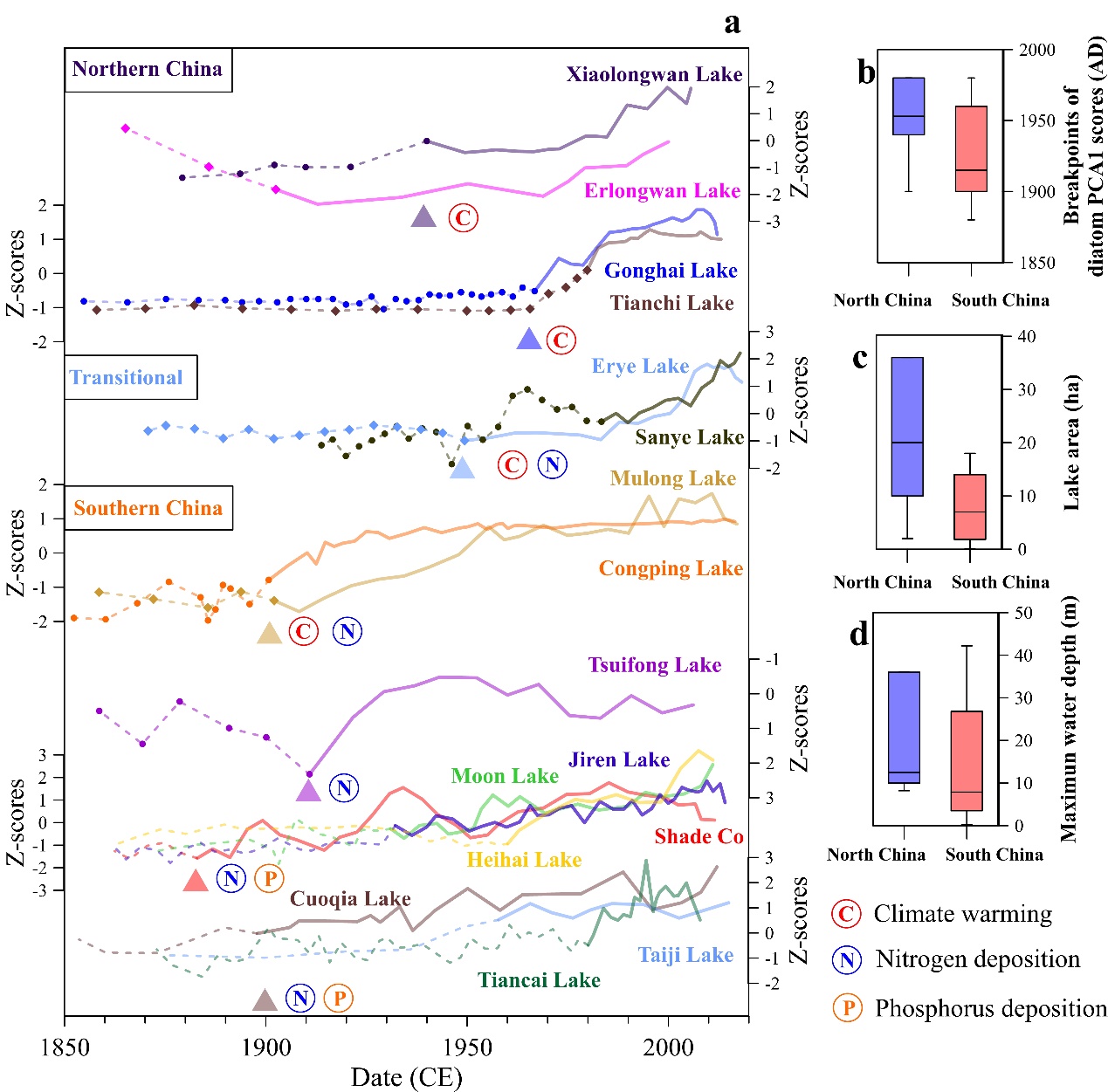


Figure S7. Comparison of diatom PCA1 scores (a) among the sixteen lakes (see details of each lake in Table 1), with main driving forces shown. Differences in breakpoints of diatom PCA1 scores (b), surface area (c), maximum water depth (d) in alpine lakes between northern and southern China.

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