Supplementary information for

Role of Pacific Ocean climate in regulating runoff in the source areas of water transfer projects on the Pacific Rim

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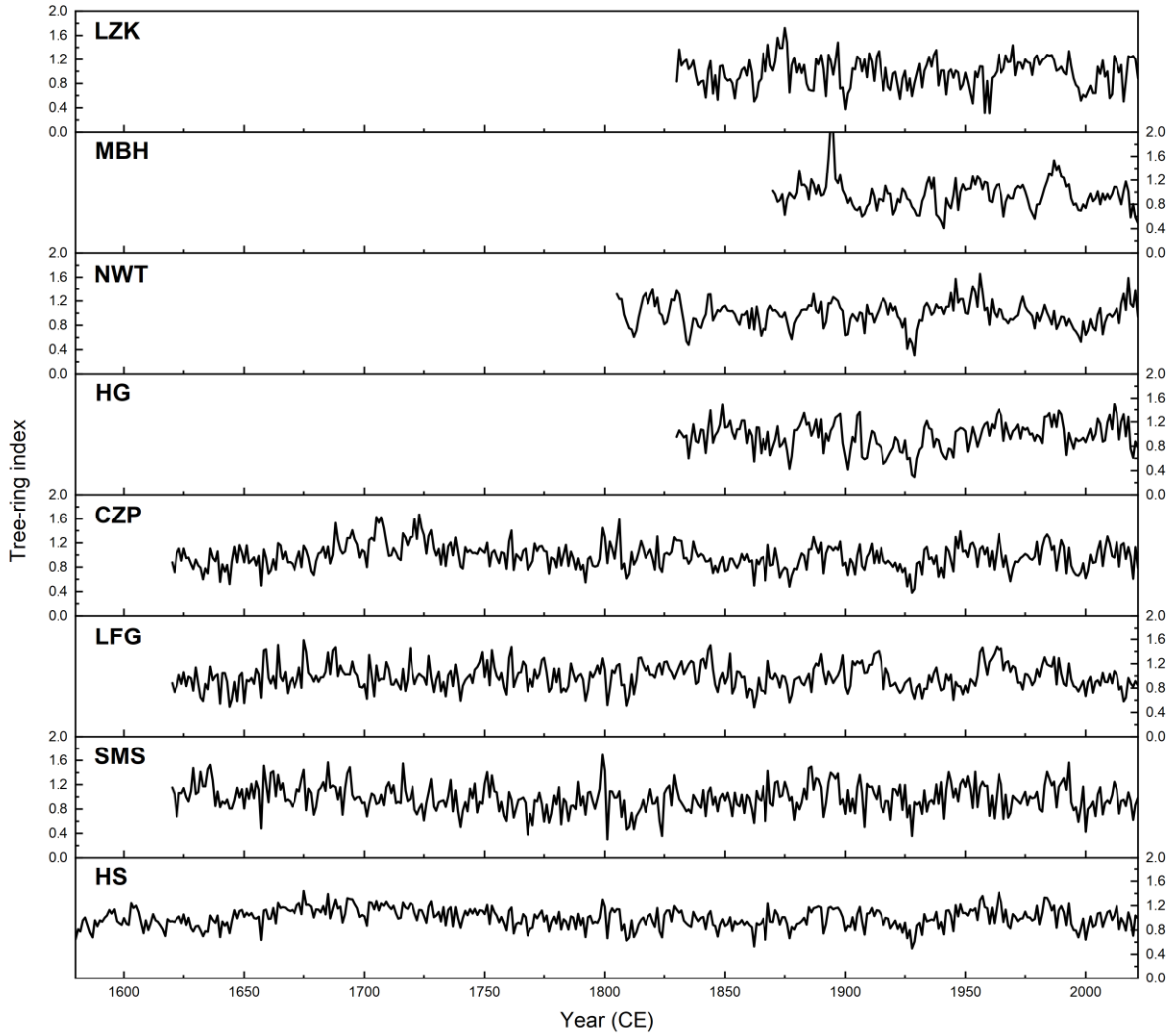
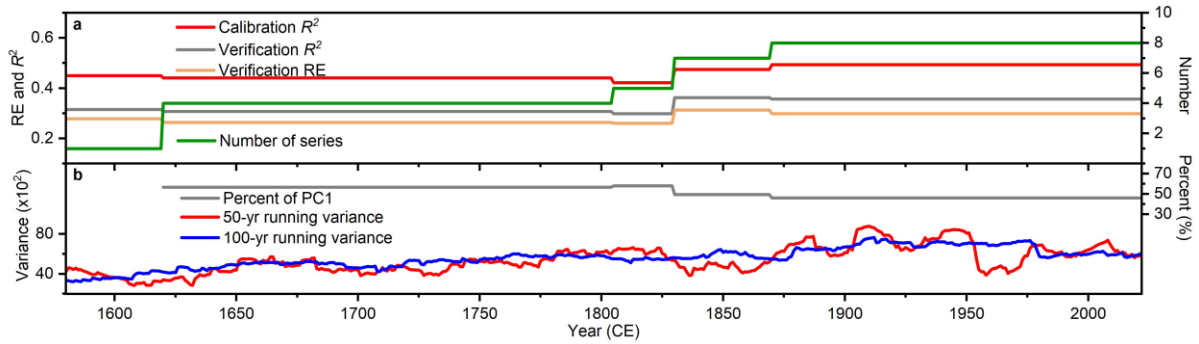
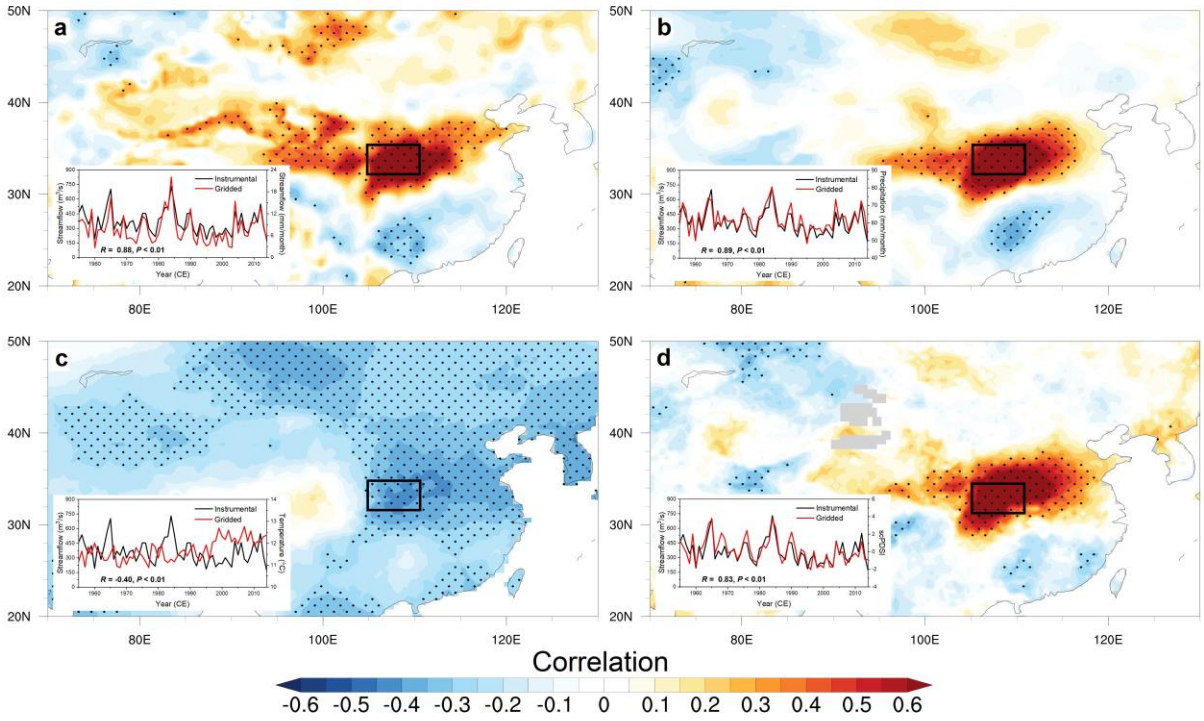


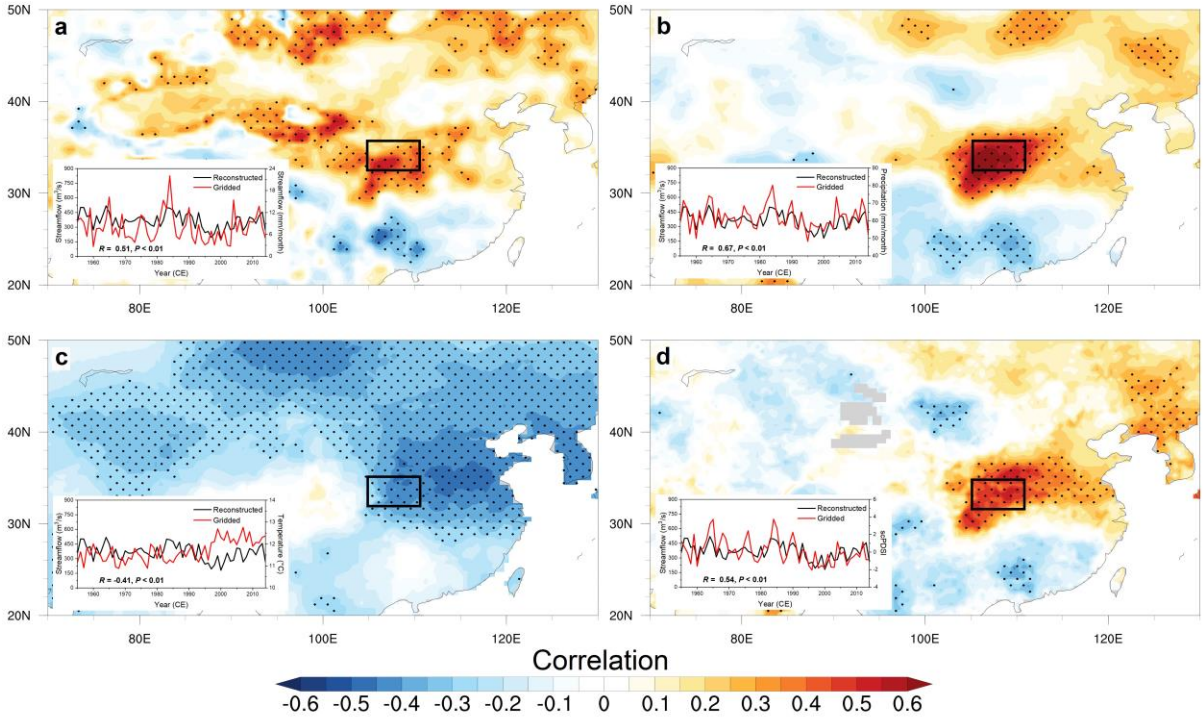
Supplementary Figure 1 The eight tree-ring width chronologies.



Supplementary Figure 2 (**a**) Explained variance (R^2), reduction of error (RE), and numbers of series for each segment. (**d**) 50- and 100-year running bi-weighted variance for the runoff reconstruction, and the percentage total variance of the first principal component of the tree-ring width chronologies.



Supplementary Figure 3 Spatial correlation patterns of instrumental runoff (August–July) with gridded runoff (**a**), precipitation (**b**), temperature (**c**), and scPDSI (**d**) from 1955 to 2014. Dots indicate values above the 95% confidence level. Insets show comparisons between instrumental runoff and the gridded climate and runoff data for the Hanjiang basin for 1955–2014 (averaged over 32 -35°N, 105-111°E).



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44 **Supplementary Figure 4** Spatial correlation patterns of the reconstructed runoff (August–July) with gridded
45 runoff (**a**), precipitation (**b**), temperature (**c**), and scPDSI (**d**) from 1955 to 2014. Dots indicate values above
46 the 95% confidence level. Insets show comparisons between reconstructed runoff and the gridded climate
47 and runoff data for the Hanjiang basin for 1955–2014 (averaged over 32–35° N, 105–111° E).

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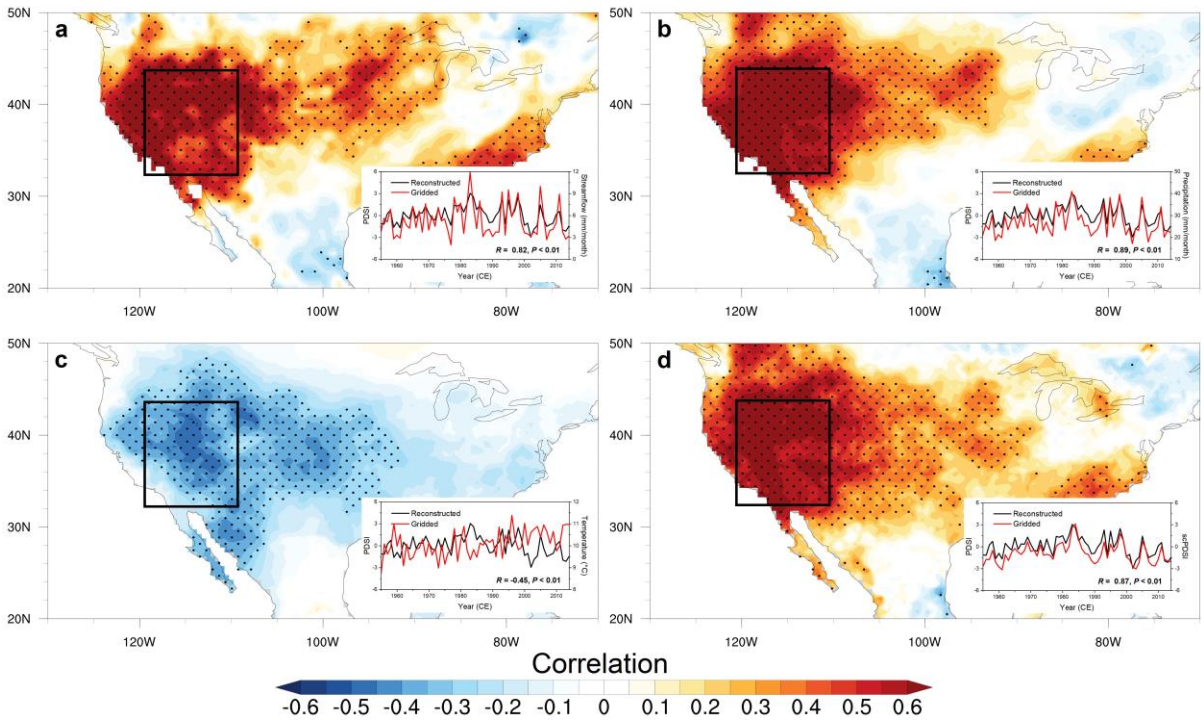
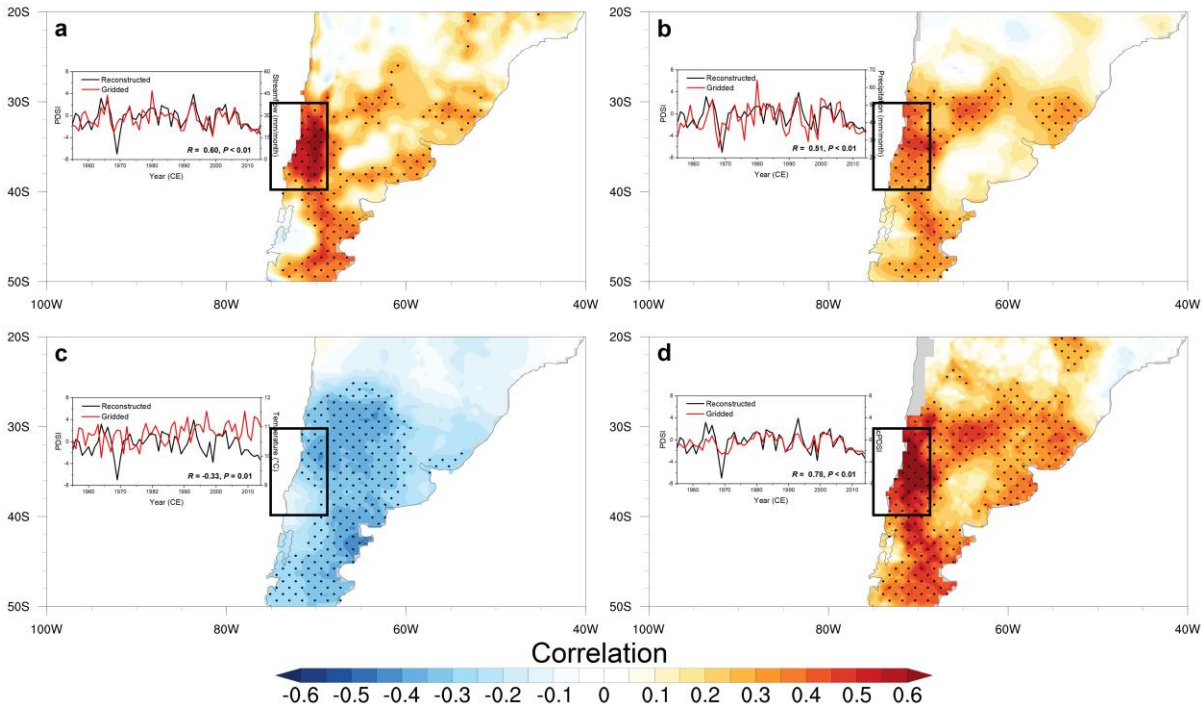
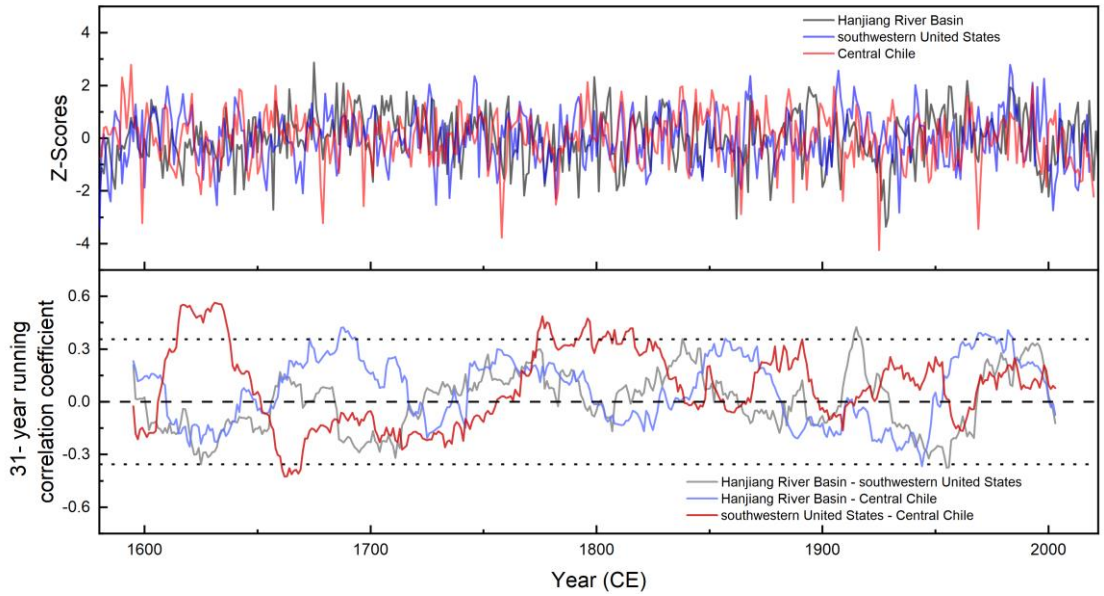


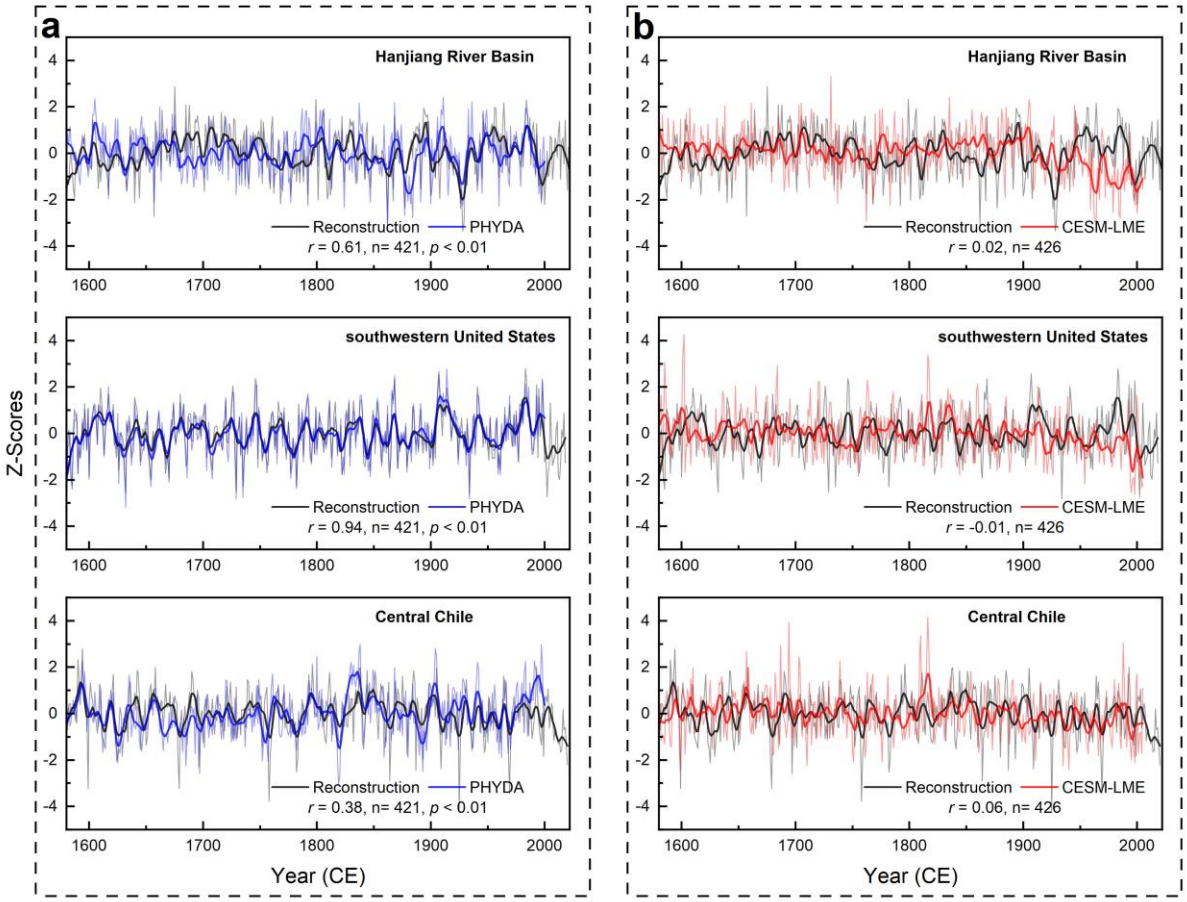
Supplementary Figure 5 Spatial correlation patterns of the summer soil moisture reconstruction for the southwestern USA with gridded runoff (**a**), precipitation (**b**), temperature (**c**), and scPDSI (**d**) from 1955 to 2014. Dots indicate values above the 95% confidence level. Insets show comparisons between reconstructed summer soil moisture and the gridded climate and runoff data for the southwestern USA for 1955–2014 (averaged over 34–44° N, 110–120° W).



Supplementary Figure 6 Spatial correlation patterns of the drought reconstruction for central Chile with gridded runoff (**a**), precipitation (**b**), temperature (**c**), and scPDSI (**d**) from 1955 to 2014. Dots indicate values above the 95% confidence level. Insets show comparisons between the drought reconstruction and the gridded climate and runoff data for central Chile for 1955–2014 (averaged over 30–40° S, 68–75° W).



Supplementary Figure 7 Comparison of reconstructions in the Han River Basin, the southwestern United States, and Central Chile along with 31-year running correlations with each other. Dotted lines indicate 95% significance level.



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68 **Supplementary Figure 8** (**a**) Comparison of reconstructions with PDSI from PHYDA, including 11-year
69 low-pass filtering (thick lines), for the Han River Basin, southwestern United States, and Central Chile. (**b**)
70 is the same as (**a**), but for reconstructions with runoff from the CESM-LME.
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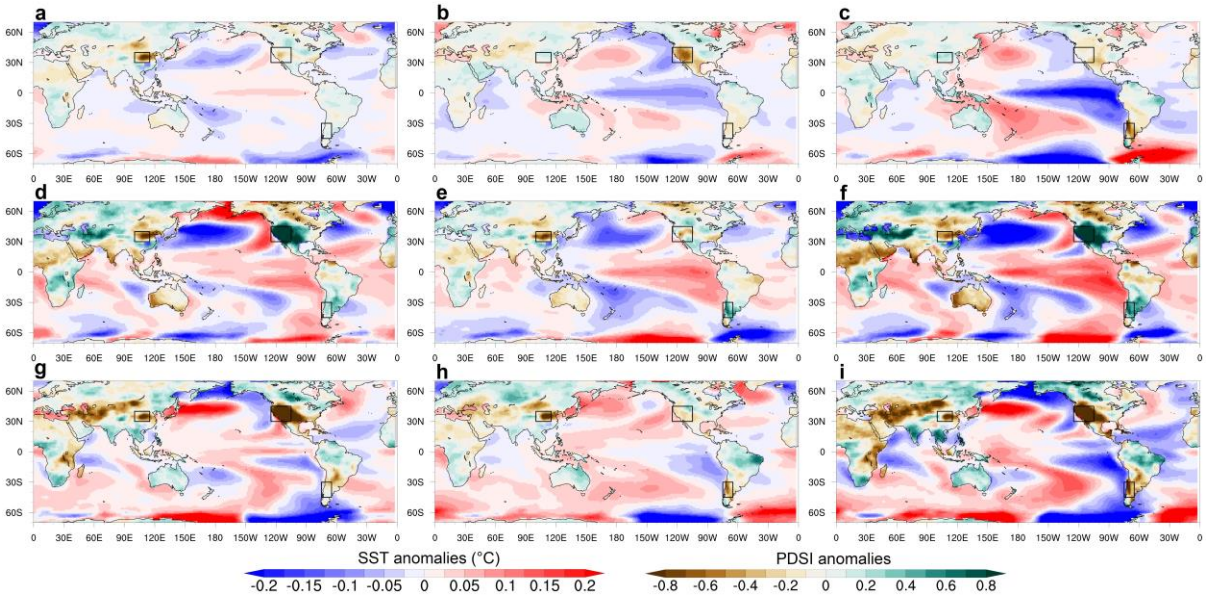
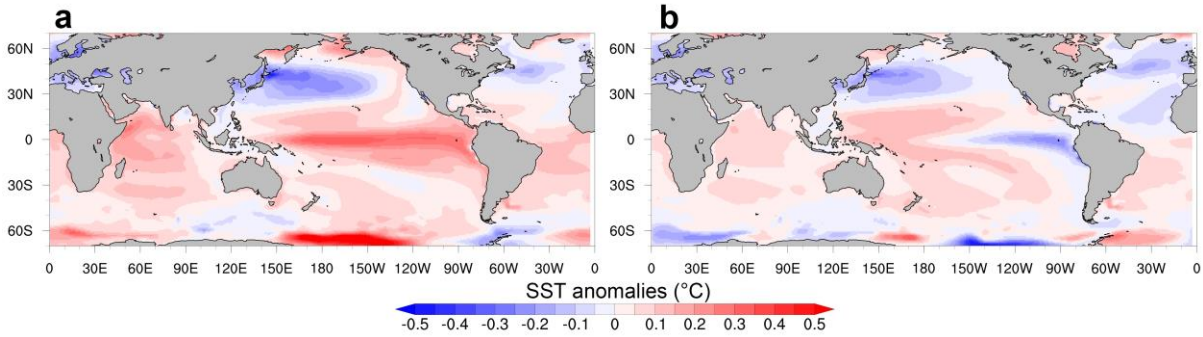


Supplementary Figure 9 Composite maps of SST and PDSI for the drought years for each region. (**a**) Composite for the drought years in Hanjiang River Basin. (**b**) Composite for drought years in the southwestern United States. **c**, Composite for drought years in Central Chile. (**d**) Composite for drought years in Hanjiang River Basin and wet conditions in the southwestern United States. (**e**) Composite for drought years in Hanjiang River Basin and wet conditions in Central Chile. (**f**) Composite for drought years in Hanjiang River Basin and wet conditions in the southwestern United States and Central Chile. (**g**) Composite for drought years in Hanjiang River Basin and the southwestern United States. (**h**) Composite for drought years in Hanjiang River Basin and Central Chile. (**i**) Composite for drought years in Hanjiang River Basin, the southwestern United States, and Central Chile. PDSI and SSTs data are anomalies with respect to the period of 1580–2000.



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85 **Supplementary Figure 10** Composite maps of SST in the CESM-LME for all years that correspond to the
86 medium ELI conditions (**a**), and the low ELI conditions (**b**). SST data are anomalies with respect to the
87 period of 1580–2005.

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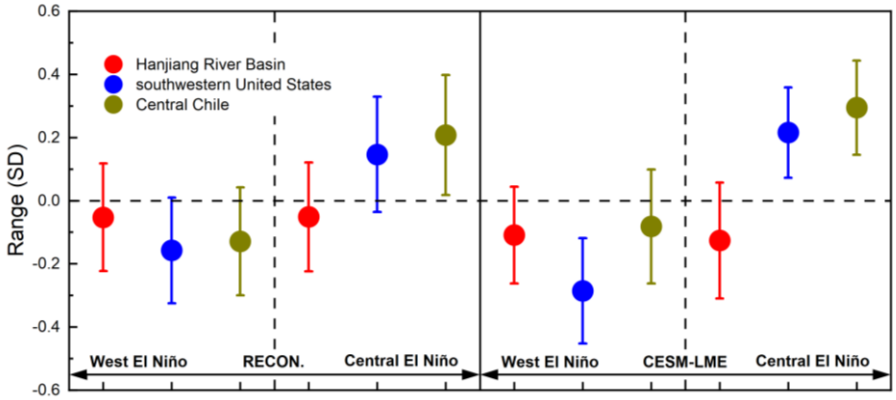
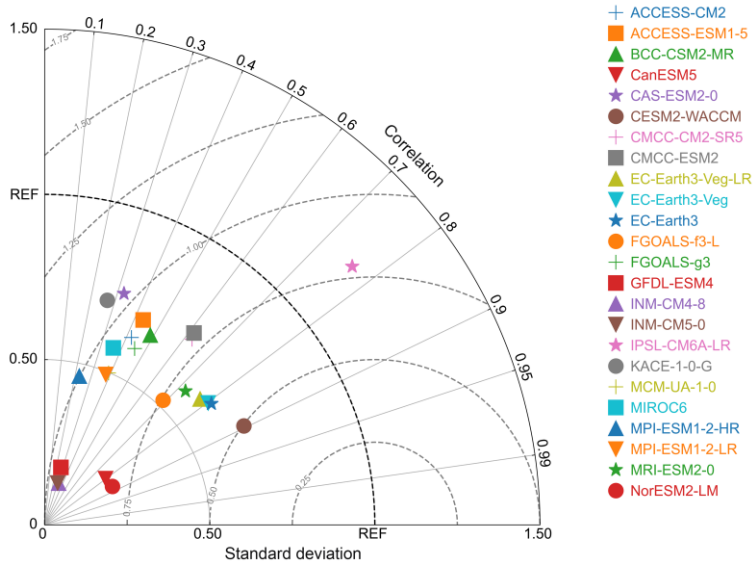
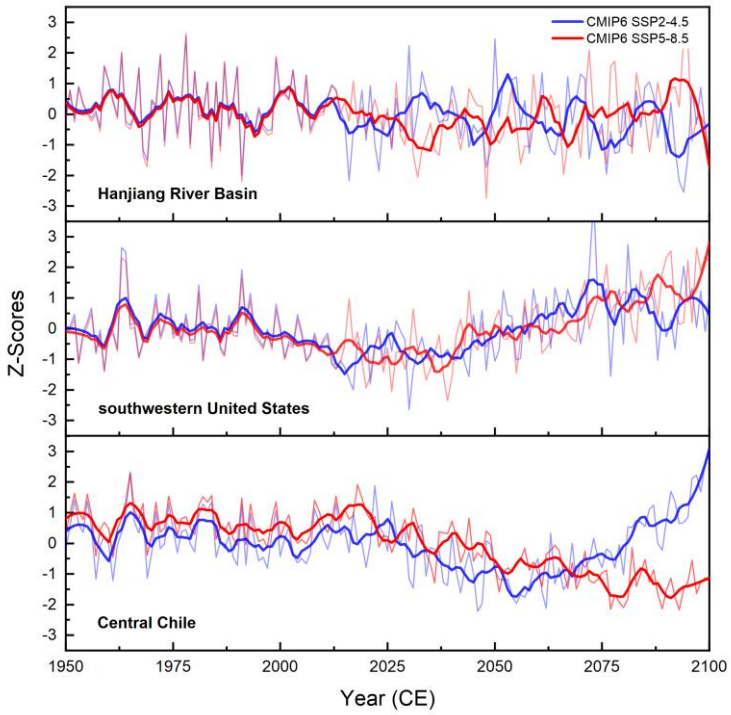


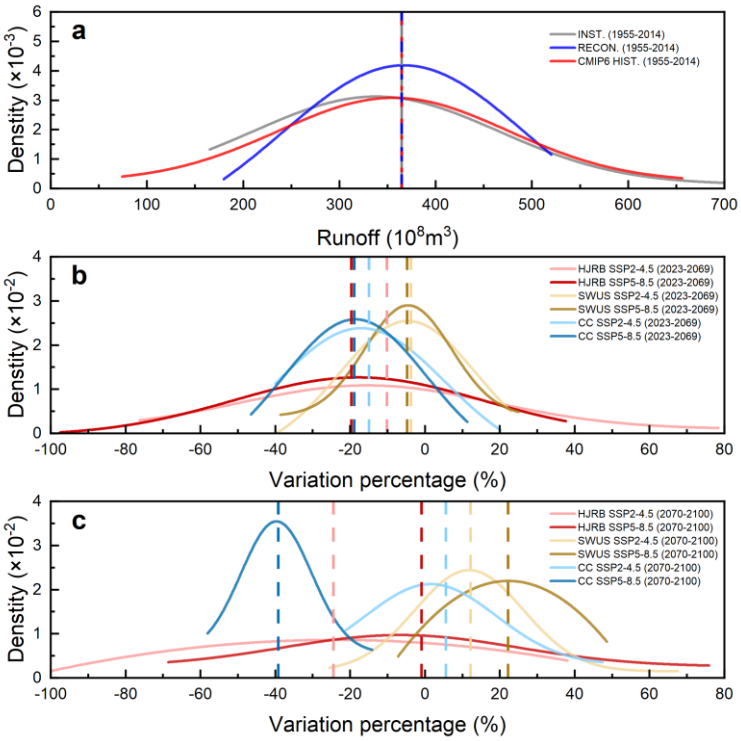
Supplementary Figure 11 Box-and-whisker plots of runoff changes in the Hanjiang River Basin, the southwestern United States, and Central Chile for low and medium ELI conditions in reconstruction and CESM-LME. Here, the box of the box-and-whisker plot indicates the mean, the whisker line indicates the 95% confidence interval (CI).



Supplementary Figure 12 Taylor diagram of global mean runoff from multi-model simulations versus the GRUN dataset for 1902-2014.



Supplementary Figure 13 The simulated runoff changes from 1950 to 2100 under SSP2-4.5 and SSP5-8.5 scenarios in the Hanjiang River Basin, the southwestern United States, and Central Chile, which are standardized. The thin line represents the original values, while the thick line represents the 11-year low-pass filted values.



Supplementary Figure 14 (**a**) Kernel density profiles of instrumental, reconstructed, and CMIP6 historical runoff in the Hanjiang River Basin from 1955 to 2014. (**b**) Future runoff variations of the Hanjiang River Basin (HJRB), southwestern United States (SWUS) and Central Chile (CC) during the period of 2023–2069 under SSP2-4.5 and SSP5-8.5 scenarios. (**c**) is the same as (**b**), but for the period of 2070-2100. The vertical dashed lines represent the respective mean values.

Supplementary Table 1 Information on tree-ring chronologies and hydrological stations. Statistics and location information are listed first for the eight tree-ring sites. The last four entries are locations of hydrologic stations, or stream gages. Locations of data points are shown on the map in Fig. 1.

Site	Lon. (E)	Lat. (N)	Elevation (m)	Species	Period (EPS ⩾ 0.85)
MBH	106 °25'41"	32 °40'38"	1139	*Pinus tabulaeformis*	1870-2022
LZK	103°52′36″	33°56′56″	2261	*Pinus tabulaeformis*	1830-2022
HG	108 °20'03"	33 °32'52"	1655	*Pinus tabulaeformis*	1830-2022
NWT	108°58′13″	33°59′35″	1380-1450	*Pinus tabulaeformis*	1805-2022
CZP	108°26′07″	33°50′50″	1324	*Pinus tabulaeformis*	1620-2022
LFG	106°39′07″	33°49′24″	1246	*Pinus bungeana*	1620-2022
SMS	106°08′35″	34°26′34″	2050-2100	*Pinus tabulaeformis*	1620-2022
HS	110°04′38″	34°28′55″	1950-2060	*Pinus tabulaeformis*	1580-2022
Danjiangkou	111°31′00″	32°31′00″			
Hankou	114°17′31″	30°33′56″			
Gaochang	104°25′00″	28°48′00″			
Tingzikou	105°49′13″	31°51′13″			

Supplementary Table 2 Statistics of the verification and calibration test results.

Period	Number	Percent (%)	R^2	Calibration R^2 (1955-1984)	Verification R^2 (1985-2014)	Verification RE (1985-2014)
1580-1619	1		0.426	0.450	0.315	0.278
1620-1804	4	56.7	0.413	0.441	0.308	0.264
1805-1829	5	58.0	0.407	0.422	0.299	0.260
1830-1869	7	49.4	0.448	0.475	0.362	0.313
1870-2022	8	46.3	0.445	0.494	0.357	0.298

Supplementary Table 3 Reconstructed runoff during dry and wet years obtained from the historical record.

Flood years	Mean (10^8 m^3)	Flood years	Mean (10^8 m^3)	Drought years	Mean (10^8 m^3)	Drought years	Mean (10^8 m^3)
1583	329.79	1882	376.51	1586	238.90	1814	344.81
1595	381.20	1883	392.15	1587	203.56	1834	305.77
1618	338.51	1886	399.53	1616	263.69	1862	115.75
1648	411.24	1887	432.65	1617	213.66	1867	192.89
1651	405.12	1888	436.02	1621	302.16	1876	303.17
1653	368.96	1889	427.44	1628	309.91	1877	172.73
1658	458.61	1890	455.55	1629	303.34	1878	248.44
1663	292.87	1894	504.51	1631	305.31	1879	303.52
1664	493.02	1895	485.61	1632	288.61	1891	234.89
1676	438.25	1896	471.09	1633	225.15	1900	207.66
1680	352.23	1897	473.51	1634	291.13	1901	226.13
1693	461.16	1898	430.73	1635	300.60	1904	267.82
1703	417.34	1903	346.16	1638	312.22	1907	278.57
1706	417.06	1906	425.83	1640	187.87	1908	199.95
1724	429.25	1910	376.51	1641	332.37	1919	304.46
1779	342.24	1911	423.32	1643	330.80	1920	298.40
1781	390.18	1921	339.40	1684	357.15	1922	282.26
1802	378.86	1933	408.47	1691	302.59	1923	289.77
1811	340.48	1934	384.02	1700	303.62	1924	252.28
1815	404.28	1935	379.05	1701	224.37	1925	329.71
1822	473.03	1938	386.23	1704	347.77	1928	93.87
1826	413.36	1943	392.69	1729	314.61	1929	122.62
1827	408.12	1944	370.17	1752	283.88	1930	261.74
1828	385.49	1946	489.32	1759	233.40	1931	302.45
1831	454.66	1947	375.39	1770	250.18	1932	243.23
1832	434.61	1949	425.33	1792	178.56	1939	279.87
1852	381.88			1801	195.76	1941	226.39
1868	475.95			1807	305.54	1945	267.52
1871	416.74			1813	261.97		

Supplementary Table 4 Years in which different drought combinations occurred in the reconstructions.

Types of dought	Years
Hanjiang River Basin (n=207)	1580, 1581, 1582, 1583, 1585 ,1586 ,1587 ,1588, 1589, 1590, 1591, 1592, 1597, 1598, 1599, 1600, 1601, 1602, 1607, 1608, 1609, 1610, 1611, 1613, 1614, 1615, 1616, 1617, 1618, 1619, 1620, 1621, 1622, 1624, 1626, 1627, 1628, 1629, 1630, 1631, 1632, 1633, 1634, 1635, 1638, 1640, 1641, 1642, 1643, 1644, 1645, 1647, 1650, 1652, 1654, 1657, 1660, 1661, 1663, 1668, 1669, 1670, 1671, 1674, 1679, 1686, 1691, 1698, 1699, 1700, 1701, 1704, 1714, 1715, 1722, 1726, 1729, 1730, 1732, 1734, 1737, 1739, 1740, 1741, 1752, 1756, 1758, 1759, 1762, 1763, 1764, 1765, 1768, 1769, 1770, 1772, 1775, 1777, 1778, 1779, 1780, 1782, 1783, 1784, 1785, 1788, 1790, 1791, 1792, 1793, 1795, 1796, 1797, 1801, 1807, 1808, 1809, 1810, 1811, 1812, 1813, 1814, 1821, 1823, 1824, 1833, 1834, 1835, 1836, 1839, 1842, 1845, 1846, 1847, 1848, 1850, 1851, 1853, 1854, 1855, 1856, 1859, 1860, 1861, 1862, 1863, 1864, 1865, 1866, 1867, 1869, 1870, 1873, 1876, 1877, 1878, 1879, 1880, 1884, 1891, 1892, 1899, 1900, 1901, 1902, 1903, 1904, 1907, 1908, 1909, 1916, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1939, 1940, 1941, 1945, 1960, 1962, 1966, 1968, 1969, 1978, 1979, 1981, 1988, 1992, 1994, 1995, 1996, 1997, 1998, 1999, 2000
southwestern United States (n=209)	1580, 1581, 1583, 1584, 1585, 1590, 1591, 1592, 1593, 1595, 1598, 1600, 1607, 1613, 1622, 1623, 1624, 1626, 1628, 1629, 1630, 1631, 1632, 1637, 1638, 1639, 1645, 1646, 1648, 1652, 1653, 1654, 1655, 1657, 1658, 1659, 1663, 1664, 1665, 1666, 1667, 1668, 1669, 1670, 1671, 1675, 1676, 1677, 1679, 1684, 1685, 1686, 1690, 1691, 1695, 1696, 1698, 1703, 1704, 1706, 1707, 1708, 1709, 1714, 1715, 1716, 1717, 1721, 1722, 1728, 1729, 1730, 1733, 1735, 1736, 1737, 1739, 1740, 1742, 1744, 1748, 1751, 1752, 1753, 1754, 1755, 1756, 1757, 1763, 1765, 1770, 1772, 1773, 1774, 1776, 1777, 1778, 1779, 1780, 1781, 1782, 1783, 1786, 1788, 1789, 1794, 1795, 1796, 1798, 1800, 1805, 1806, 1807, 1808, 1809, 1812, 1813, 1814, 1818, 1819, 1820, 1822, 1823, 1824, 1829, 1834, 1836, 1841, 1842, 1843, 1844, 1845, 1846, 1847, 1848, 1851, 1855, 1856, 1857, 1858, 1859, 1861, 1863, 1864, 1865, 1870, 1871, 1872, 1873, 1874, 1875, 1877, 1879, 1880, 1881, 1882, 1883, 1886, 1887, 1888, 1889, 1892, 1893, 1894, 1895, 1896, 1898, 1899, 1900, 1902, 1904, 1910, 1918, 1924, 1925, 1928, 1929, 1931, 1933, 1934, 1935, 1936, 1939, 1940, 1946, 1948, 1950, 1951, 1953, 1954, 1955, 1956, 1959, 1960, 1961, 1963, 1964, 1966, 1971, 1972, 1974, 1976, 1977, 1989, 1990, 1991, 1994, 1996, 2000

Central Chile (n=193)	1580, 1581, 1589, 1598, 1599, 1604, 1605, 1606, 1607, 1608, 1611, 1612, 1613, 1614, 1615, 1616, 1622, 1623, 1624, 1625, 1626, 1628, 1629, 1630, 1631, 1632, 1633, 1634, 1637, 1639, 1645, 1646, 1647, 1648, 1650, 1651, 1652, 1662, 1665, 1666, 1672, 1678, 1679, 1680, 1682, 1683, 1685, 1686, 1694, 1697, 1698, 1700, 1701, 1706, 1707, 1709, 1710, 1711, 1712, 1716, 1717, 1718, 1722, 1726, 1727, 1728, 1730, 1731, 1732, 1733, 1737, 1738, 1741, 1746, 1752, 1753, 1757, 1758, 1759, 1760, 1768, 1769, 1772, 1773, 1774, 1775, 1776, 1777, 1779, 1780, 1781, 1782, 1783, 1784, 1785, 1786, 1788, 1789, 1790, 1792, 1798, 1799, 1800, 1803, 1806, 1807, 1808, 1809, 1813, 1814, 1818, 1819, 1820, 1821, 1823, 1825, 1826, 1827, 1829, 1832, 1840, 1841, 1842, 1853, 1854, 1860, 1861, 1864, 1865, 1866, 1867, 1873, 1874, 1880, 1887, 1890, 1891, 1893, 1894, 1897, 1904, 1907, 1908, 1909, 1910, 1911, 1912, 1913, 1914, 1917, 1918, 1921, 1922, 1924, 1925, 1926, 1927, 1928, 1934, 1935, 1936, 1937, 1938, 1939, 1944, 1946, 1947, 1948, 1950, 1953, 1955, 1957, 1958, 1959, 1960, 1961, 1962, 1968, 1969, 1970, 1974, 1975, 1977, 1982, 1986, 1989, 1990, 1991, 1995, 1996, 1997, 1998, 1999
Hanjiang River Basin without southwestern United States (n=103)	1582, 1586, 1587, 1588, 1589, 1597, 1599, 1601, 1602, 1608, 1609, 1610, 1611, 1614, 1615, 1616, 1617, 1618, 1619, 1620, 1621, 1627, 1633, 1634, 1635, 1640, 1641, 1642, 1643, 1644, 1647, 1650, 1660, 1661, 1674, 1699, 1700, 1701, 1726, 1732, 1734, 1741, 1758, 1759, 1762, 1764, 1769, 1775, 1784, 1785, 1790, 1791, 1792, 1793, 1797, 1801, 1810, 1811, 1821, 1833, 1835, 1839, 1850, 1853, 1854, 1860, 1862, 1866, 1867, 1869, 1876, 1878, 1884, 1891, 1901, 1903, 1907, 1908, 1909, 1916, 1919, 1920, 1921, 1922, 1923, 1926, 1927, 1930, 1932, 1941, 1945, 1962, 1968, 1969, 1978, 1979, 1981, 1988, 1992, 1995, 1997, 1998, 1999
Hanjiang River Basin without Central Chile (n=111)	1582, 1583, 1585, 1586, 1587, 1588, 1590, 1591, 1592, 1597, 1600, 1601, 1602, 1609, 1610, 1617, 1618, 1619, 1620, 1621, 1627, 1635, 1638, 1640, 1641, 1642, 1643, 1644, 1654, 1657, 1660, 1661, 1663, 1668, 1669, 1670, 1671, 1674, 1691, 1699, 1704, 1714, 1715, 1729, 1734, 1739, 1740, 1756, 1762, 1763, 1764, 1765, 1770, 1778, 1791, 1793, 1795, 1796, 1797, 1801, 1810, 1811, 1812, 1824, 1833, 1834, 1835, 1836, 1839, 1845, 1846, 1847, 1848, 1850, 1851, 1855, 1856, 1862, 1863, 1869, 1870, 1876, 1877, 1878, 1879, 1884, 1892, 1899, 1900, 1901, 1902, 1903, 1916, 1919, 1920, 1923, 1929, 1930, 1931, 1932, 1940, 1941, 1945, 1966, 1978, 1979, 1981, 1988, 1992, 1994, 2000
Hanjiang River Basin without southwestern United States and Central Chile (n=58)	1582, 1586, 1587, 1588, 1597, 1601, 1602, 1609, 1610, 1617, 1618, 1619, 1620, 1621, 1627, 1635, 1640, 1641, 1642, 1643, 1644, 1660, 1661, 1674, 1699, 1734, 1762, 1764, 1791, 1793, 1797, 1801, 1810, 1811, 1833, 1835, 1839, 1850, 1862, 1869, 1876, 1878, 1884, 1901, 1903, 1916, 1919, 1920, 1923, 1930, 1932, 1941, 1945, 1978, 1979, 1981, 1988, 1992
Hanjiang River Basin with southwestern United States (n=103)	1580, 1581, 1583, 1585, 1590, 1591, 1592, 1598, 1600, 1607, 1613, 1622, 1624, 1626, 1628, 1629, 1630, 1631, 1632, 1638, 1645, 1652, 1654, 1657, 1663, 1668, 1669, 1670, 1671, 1679, 1686, 1691, 1698, 1704, 1714, 1715, 1722, 1729, 1730, 1737, 1739, 1740, 1752, 1756, 1763, 1765, 1770, 1772, 1777, 1778, 1779, 1780, 1782, 1783, 1788, 1795, 1796, 1807, 1808, 1809, 1812, 1813, 1814, 1823, 1824, 1834, 1836, 1842, 1845, 1846, 1847, 1848, 1851, 1855, 1856,

	1859, 1861, 1863, 1864, 1865, 1870, 1873, 1877, 1879, 1880, 1892, 1899, 1900, 1902, 1904, 1918, 1924, 1925, 1928, 1929, 1931, 1939, 1940, 1960, 1966, 1994, 1996, 2000
Hanjiang River Basin with Central Chile (n=95)	1580, 1581, 1589, 1598, 1599, 1607, 1608, 1611, 1613, 1614, 1615, 1616, 1622, 1624, 1626, 1628, 1629, 1630, 1631, 1632, 1633, 1634, 1645, 1647, 1650, 1652, 1679, 1686, 1698, 1700, 1701, 1722, 1726, 1730, 1732, 1737, 1741, 1752, 1758, 1759, 1768, 1769, 1772, 1775, 1777, 1779, 1780, 1782, 1783, 1784, 1785, 1788, 1790, 1792, 1807, 1808, 1809, 1813, 1814, 1821, 1823, 1842, 1853, 1854, 1860, 1861, 1864, 1865, 1866, 1867, 1873, 1880, 1891, 1904, 1907, 1908, 1909, 1918, 1921, 1922, 1924, 1925, 1926, 1927, 1928, 1939, 1960, 1962, 1968, 1969, 1995, 1996, 1997, 1998, 1999
Hanjiang River Basin with southwestern United States and Central Chile (n=47)	1580, 1581, 1598, 1607, 1613, 1622, 1624, 1626, 1628, 1629, 1630, 1631, 1632, 1645, 1652, 1679, 1686, 1698, 1722, 1737, 1752, 1772, 1777, 1779, 1780, 1782, 1783, 1788, 1807, 1808, 1809, 1813, 1814, 1823, 1842, 1861, 1864, 1865, 1873, 1904, 1918, 1924, 1925, 1928, 1939, 1960, 1996

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Supplementary Table 5 Information about the 24 GCM models provided by CMIP6.

Model	Source	Accuracy (Lat.×Lon.)	Model	Source	Accuracy (Lat.×Lon.)
ACCESS-CM2	Australia	144×192	GFDL-ESM4	America	180×288
ACCESS-ESM1-5	Australia	145×192	INM-CM4-8	Russia	120×180
BCC-CSM2-MR	China	160×320	INM-CM5-0	Russia	120×180
CanESM5	Canada	64×128	IPSL-CM6A-LR	Europe	143×144
CAS-ESM2-0	China	128×256	KACE-1-0-G	Korea	80×96
CESM2-WACCM	America	192×288	MCM-UA-1-0	America	144×192
CMCC-CM2-SR5	Italy	192×288	MIROC6	Japan	128×256
CMCC-ESM2	Italy	192×288	MPI-ESM1-2-HR	German	192×384
EC-Earth3	Europe	256×512	MPI-ESM1-2-LR	German	96×192
EC-Earth3-Veg	Europe	256×512	MRI-ESM2-0	Japan	160×320
EC-Earth3-Veg-LR	Europe	160×320	NorESM2-LM	Norway	96×144
FGOALS-f3-L	China	192×288			
FGOALS-g3	China	80×180			