# A Global Drought and Flood Catalogue from 1950 to 2016

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# Contents

## Inundation and discharge—The fluvial risk

In addition to the traditional flood risk analysis mostly based on streamflow, we use the Catchment-Based Macro-Scale Floodplain model (CaMa-Flood) to simulate floodplain dynamics at the global scale with a particular focus on flood inundation extent (see details in appendix A, "Enhanced routing model" section). We perform fluvial risk analysis to estimate inundation fraction and flood magnitude at different recurrence intervals (i.e., return period) based on fitted generalized extreme value (GEV) distributions globally for the annual maximum flooded area (Fig. S16) and daily streamflow (Fig. S17). Areas of high fractional coverage and flood peaks can be clearly detected from these fluvial (inundation and streamflow) risk maps, including the lower Mississippi River and the western United States, the Amazon and Parana catchments in South America, the Lake Chad, Congo and upper Niger River catchments in Africa, the Indus and Ganges–Brahmaputra–Meghna catchments on the Indian subcontinent, the Yellow, Yangtze, and Songhua River basins in China, the Chao Phraya and Mekong River in Southeast Asia, the Murray Darling, Lake Eyre basin, and Carpentaria Coast in Australia, and the Euphrates and Tigris River catchment in western Asia. As expected, the fraction of flooded area and the flood magnitude both increase with heightened return period. This is especially the case in Amazon, Indus, and Ganges–Brahmaputra–Meghna catchments, where more than 50% of the total 25 km × 25 km grid cell can be flooded. The spatial pattern of these inundation hazard maps (Fig. S16) is consistent with previous modeling studies, although these are based on shorter time periods (e.g., Pappenberger et al. 2012). Similar spatial patterns can be found in the estimated return levels for streamflow (Fig. S17), compared to recently developed operational flooding warning systems [e.g., Global Flood Awareness System (GloFAS); Alfieri et al. 2019]. These inundation hazard maps can be combined with demographic and economic data to study other components of flood risk, such as vulnerability and exposure for impact assessment (Winsemius et al. 2013), similar to the Dartmouth Flood Observatory (DFO), and explicitly include impact indicators, such as people affected and damage estimates.
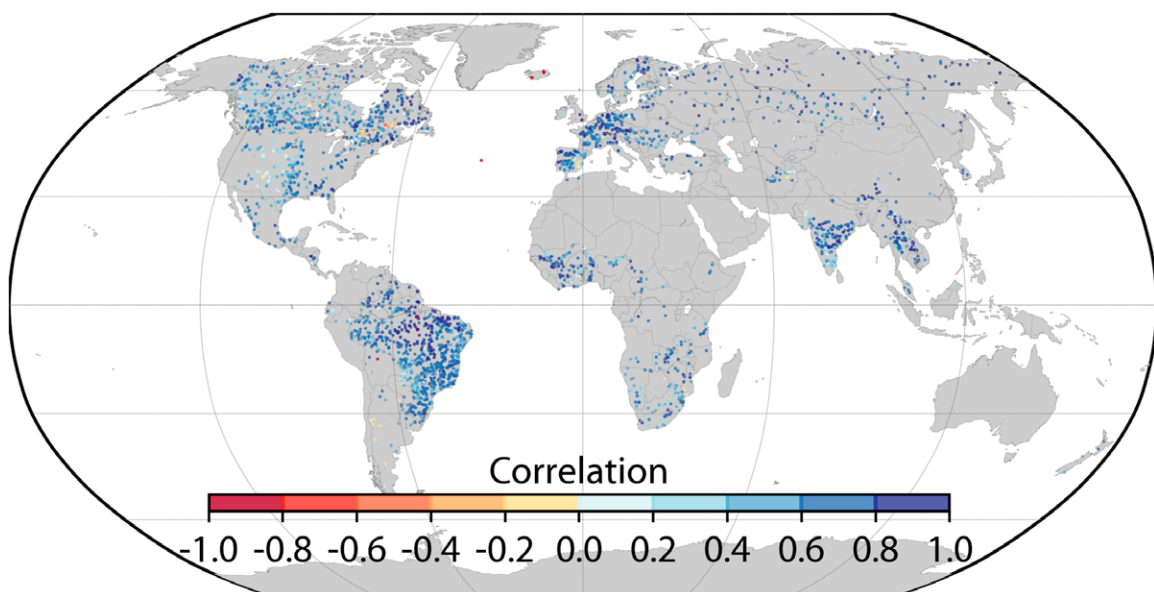


Fig. S1. Monthly streamflow validation results based on correlation coefficient. Only gauges with a drainage area larger than 5,000 km² are selected. Streamflow observations are obtained from the Global Streamflow Indices and Meta data archive (GSIM; Do et al. 2018; Gudmundsson et al. 2018).

**Fɪɢ. S2.** As in Fig. 3, but drought and pluvial events are detected using SPI3.



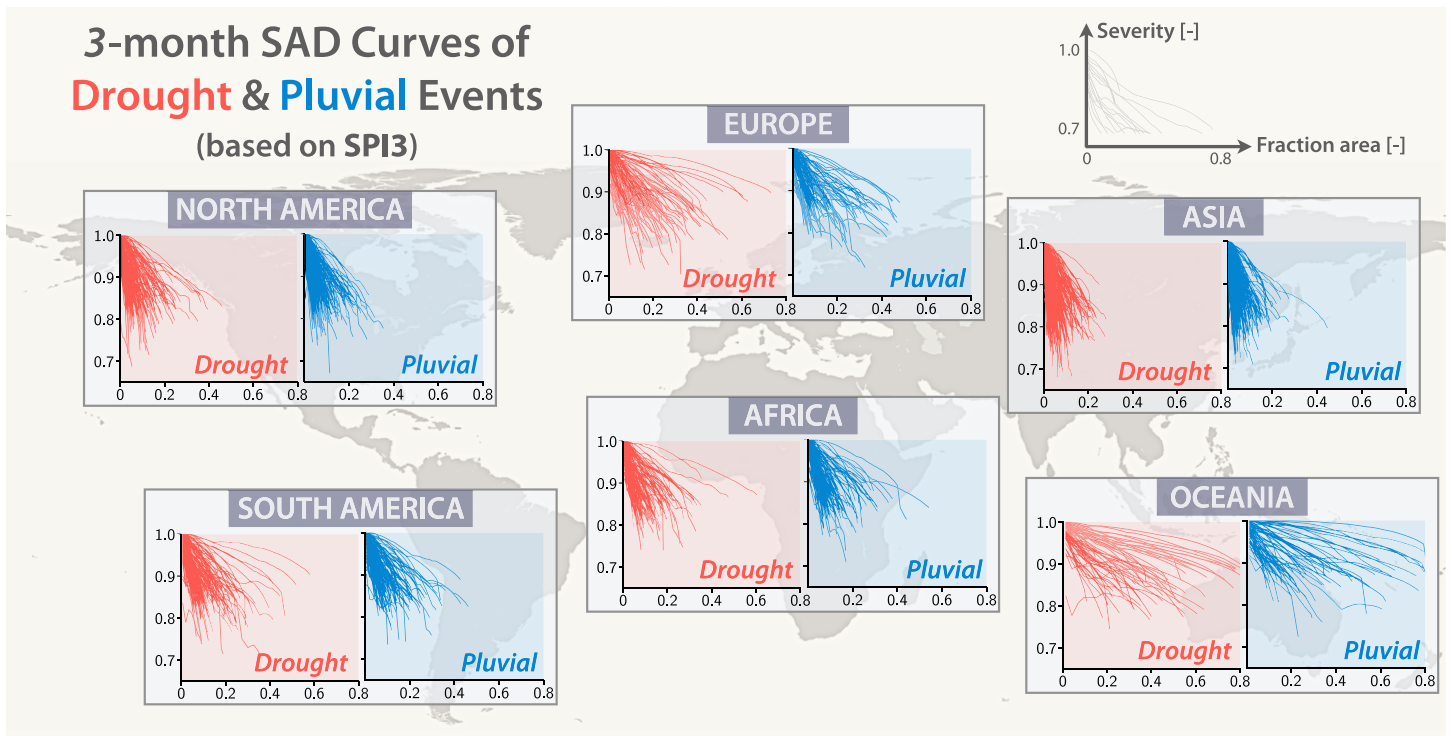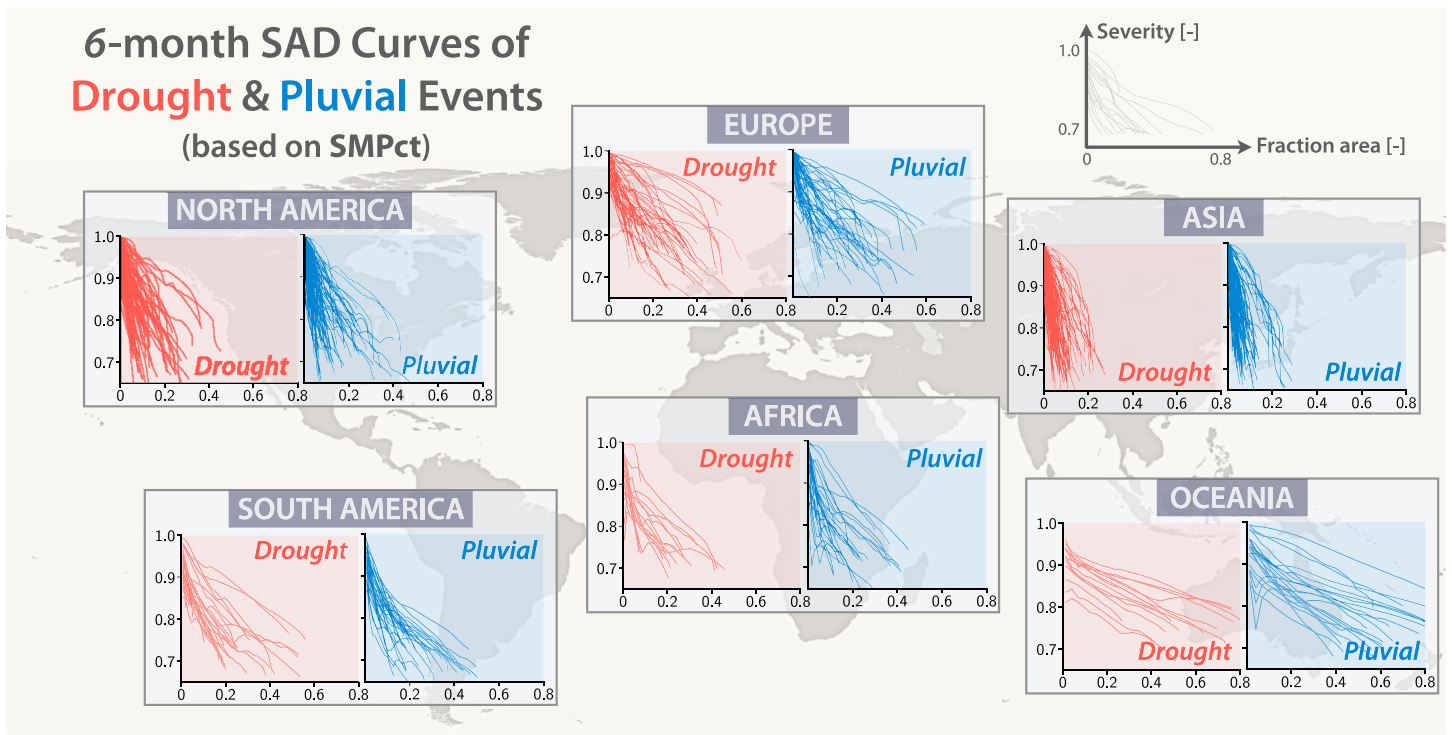**Fɪɢ. S3.** As in Fig. 3, but for 6-month drought and pluvial events.

FIG. S4. As in Fig. S3, but drought and pluvial events are detected using SPI3.



FIG. S5. As in Fig. 3, but for 9-month drought and pluvial events.

Fig. S6. As in Fig. S5, but drought and pluvial events are detected using SPI3.
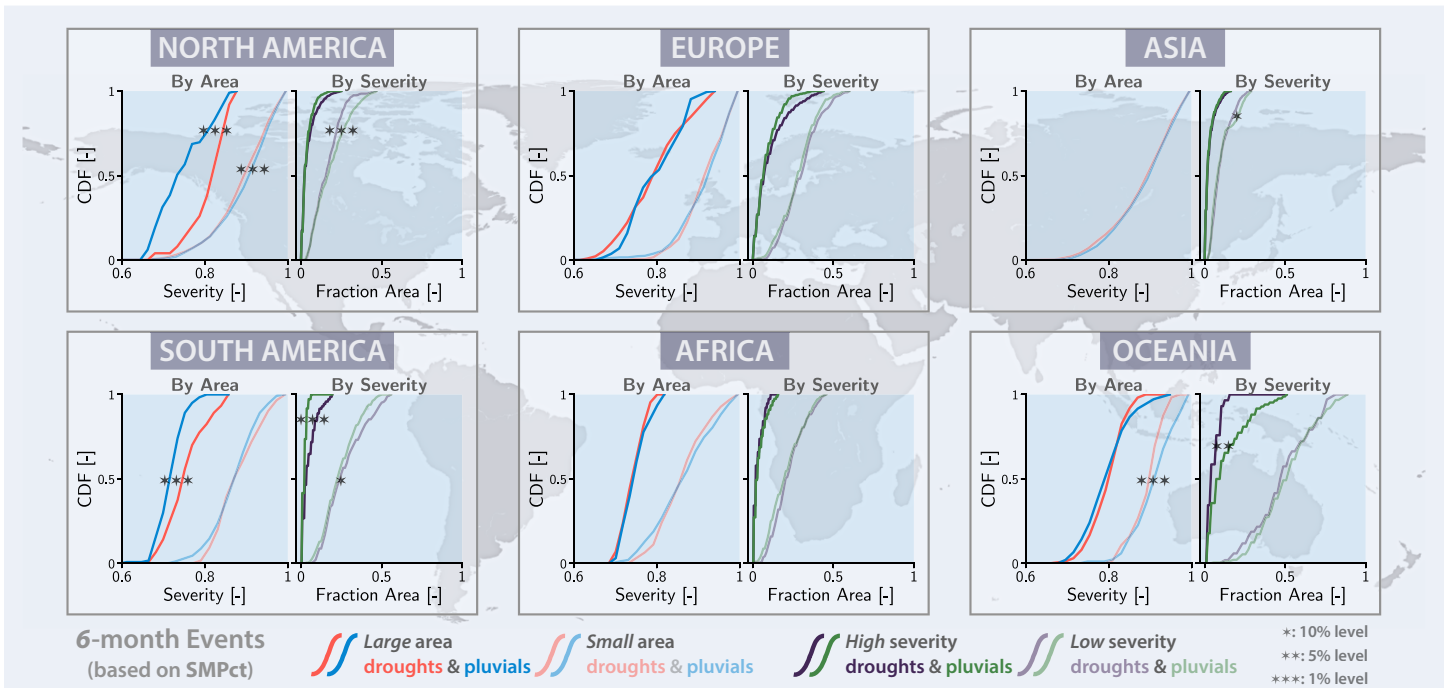


Fig. S7. As in Fig. 4, but for 6-month events.
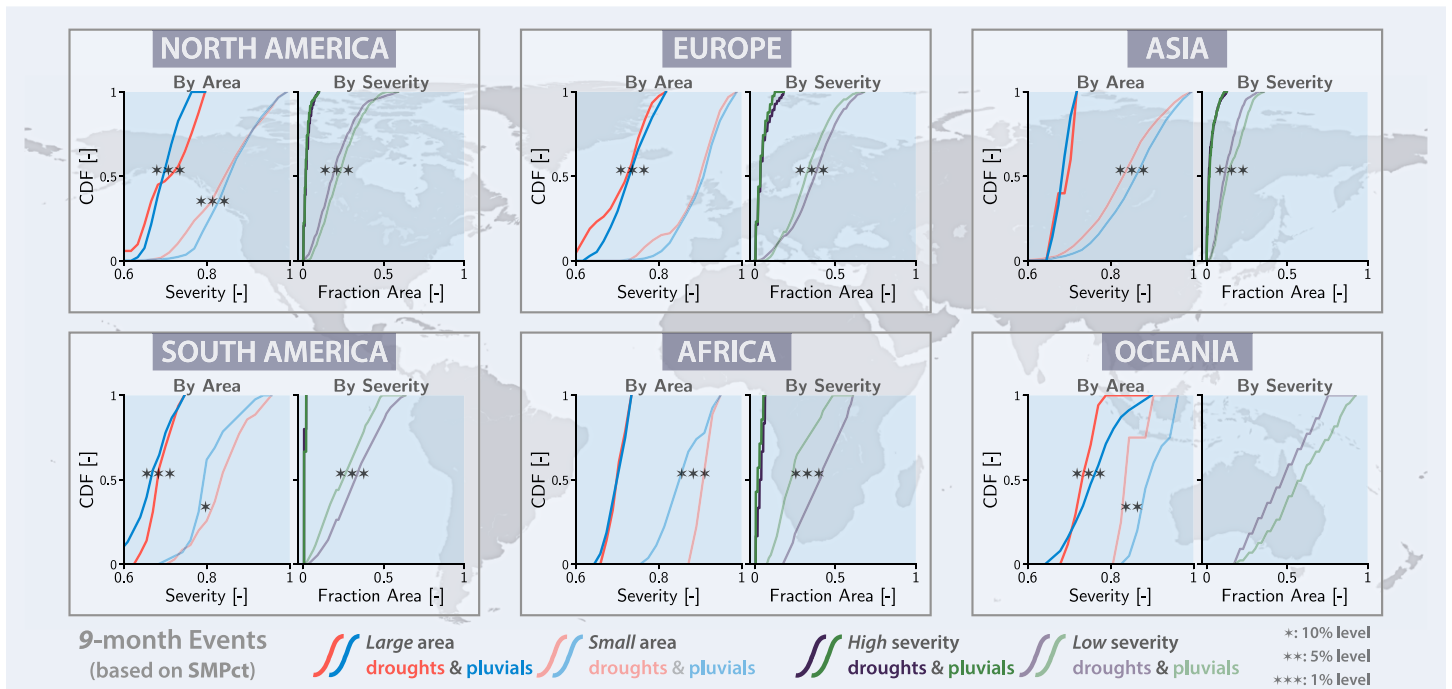
**Fig. S8.** As in Fig. 4, but for 9-month events.
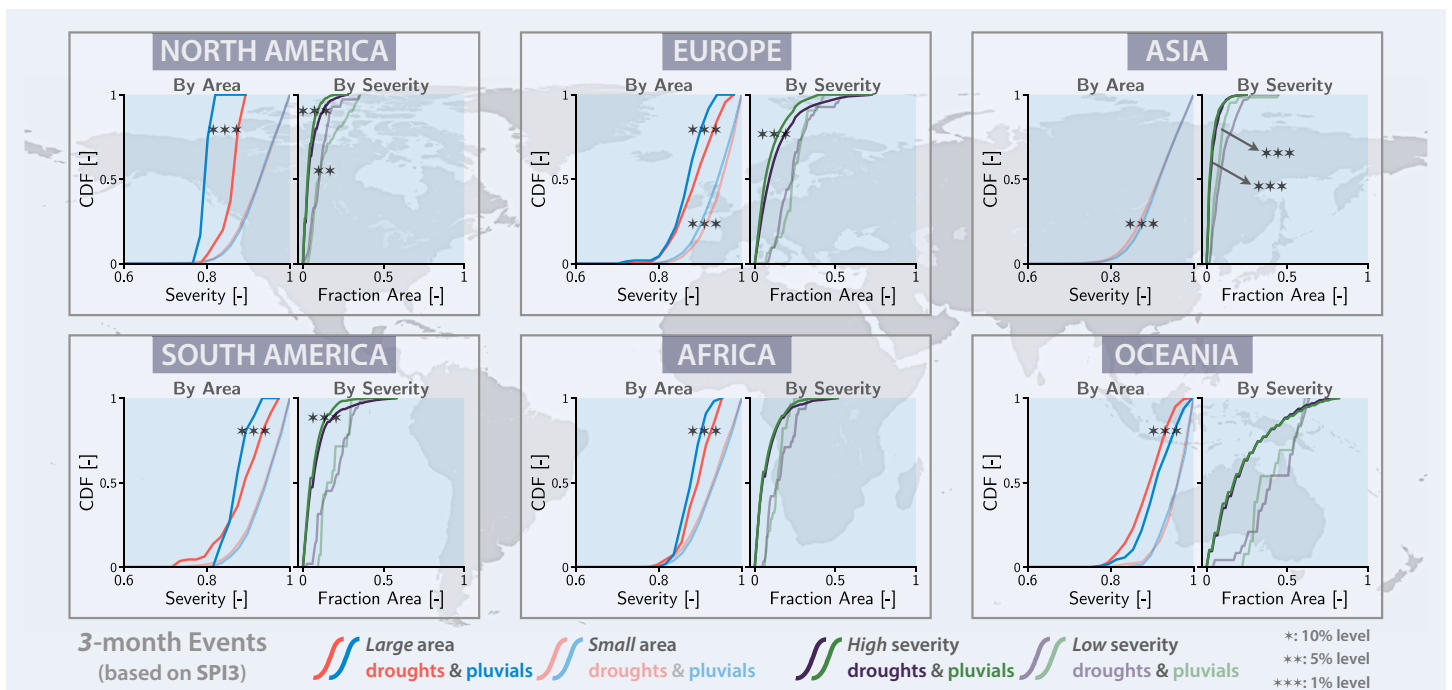


**Fig. S9.** As in Fig. 4, but drought and pluvial events are detected using SPI3.
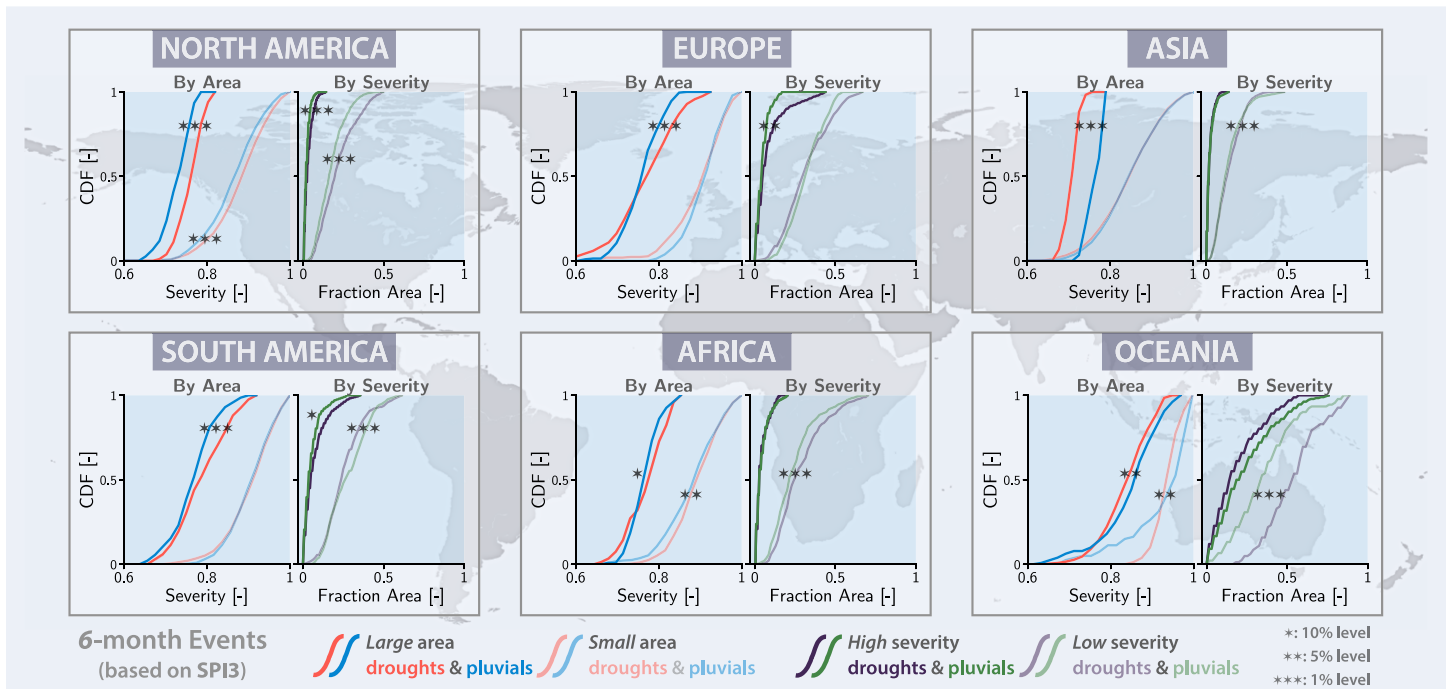
F<small>IG</small>. S10. As in Fig. S9, but for 6-month events.
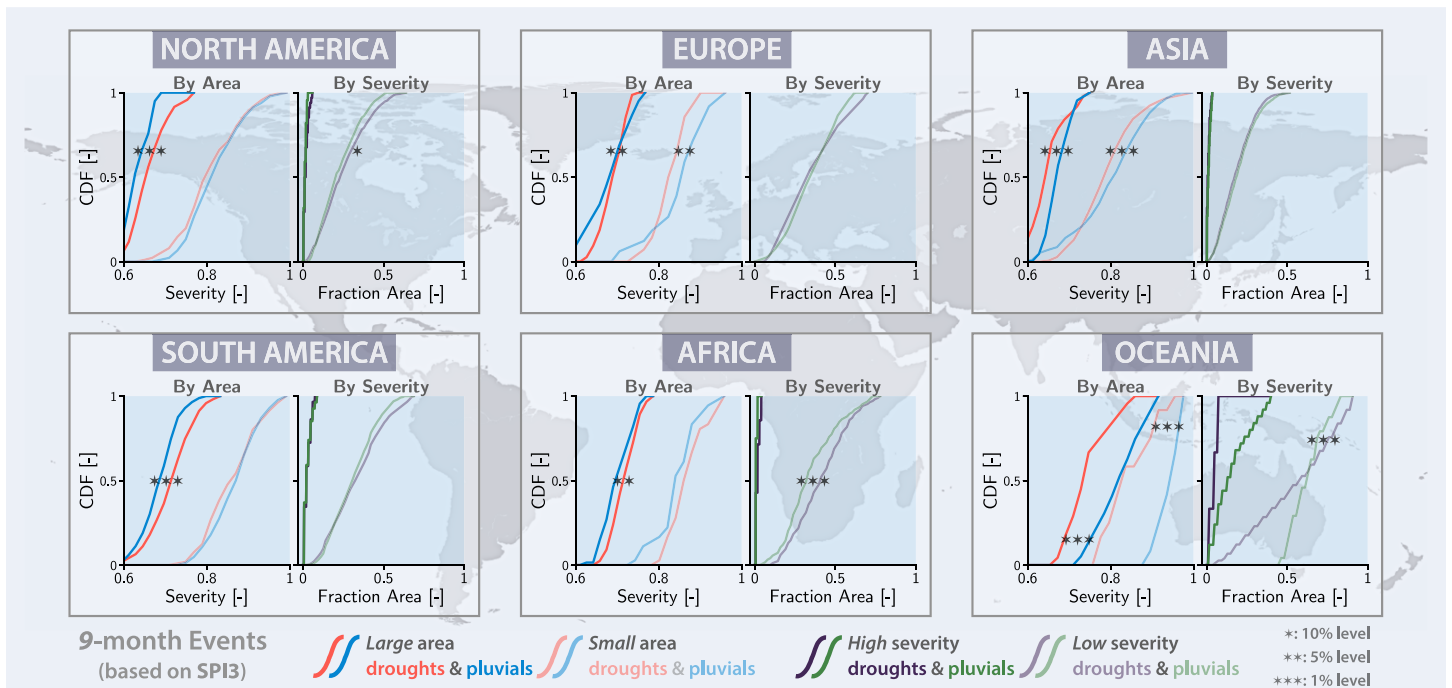


F<small>IG</small>. S11. As in Fig. S9, but for 9-month events.

## SAD Envelope Curves of Drought Events
### (based on SPI3)



**NORTH AMERICA**
05/1999-08/2000
10/1997-05/1999
08/1968-02/1970
09/2001-06/2003
07/1952-05/1955
06/1976-05/1977
06/1955-04/1958

**EUROPE**
03/1980-11/1980
08/1983-06/1984
02/1956-01/1957
07/1962-05/1964
03/1976-02/1977
10/1953-06/1954

**ASIA**
01/1950-06/1950
08/1981-09/1982
10/1950-06/1952
05/1978-01/1980
05/1986-05/1987
11/1983-03/1985
08/2000-11/2001
05/1975-12/1977

**SOUTH AMERICA**
08/1982-12/1983
04/1963-05/1964
01/1985-09/1985
08/1991-08/1992
07/2015-08/2016

**AFRICA**
09/1993-12/1994
06/1996-03/1997
01/2004-08/2004
10/1994-07/1995
10/1991-11/1992
12/1983-12/1984
01/1983-01/1984

**OCEANIA**
07/2004-07/2005
06/1982-03/1983
05/1994-12/1994
03/2002-02/2003
01/1965-08/1965

Severity [-]
● ● ● 3 month
■ ■ ■ 6 month
▲ ▲ ▲ 9 month
Fraction area [-]

FIG. S12. As in Fig. 7, but drought events are detected using SPI3.

## SAD Envelope Curves of Pluvial Events
### (based on SPI3)



**NORTH AMERICA**
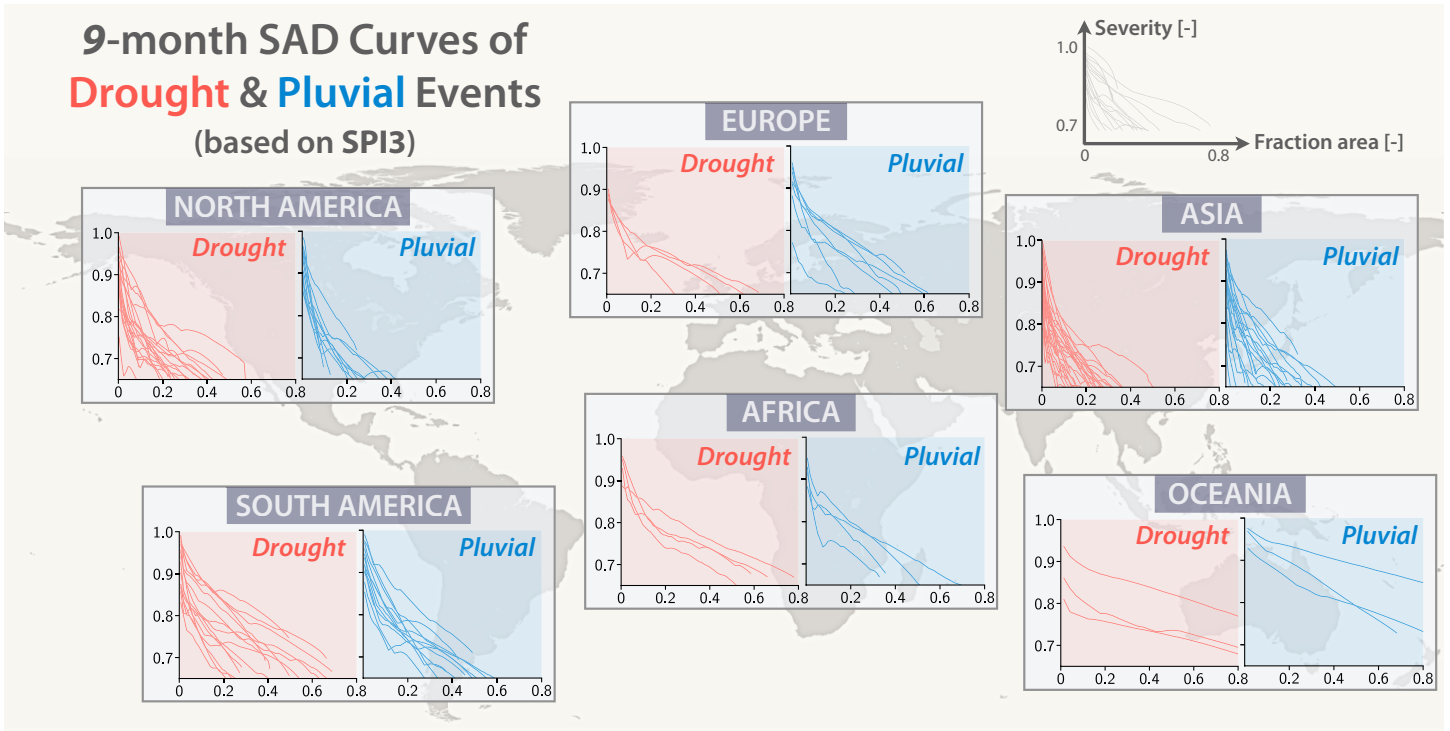11/1966-11/1967
11/1975-11/1976
12/1976-05/1978
09/2016-11/2016
12/1950-04/1952
10/1972-07/1973
09/1996-06/1997
05/1988-11/1988
04/1961-11/1962
08/1992-12/1993
06/1973-06/1974

**EUROPE**
06/2009-02/2011
08/1952-02/1953
09/1976-09/1977
03/1998-03/1999
06/1981-02/1982
11/2011-07/2013
08/1989-12/1990
12/2015-10/2016
12/1965-06/1966
10/2006-10/2007

**ASIA**
07/1958-04/1960
12/1968-01/1970
11/2006-05/2009
08/1965-05/1966
10/2000-12/2002
09/2012-12/2016
06/1966-07/1967

**AFRICA**
10/1973-09/1974
10/1951-03/1952
02/1967-07/1968
02/1961-09/1962

**SOUTH AMERICA**
01/2000-07/2000
05/2015-06/2016
02/1985-09/1985
11/2007-10/2008
06/2010-07/2011
11/1981-01/1984
05/1956-02/1957
02/1984-05/1985
04/1973-11/1975

**OCEANIA**
04/1968-09/1968
09/1975-05/1976
11/1999-07/2000
06/1973-07/1974

Severity [-]
● ● ● 3 month
■ ■ ■ 6 month
▲ ▲ ▲ 9 month
Fraction area [-]

FIG. S13. As in Fig. S12, but for pluvial events.

Fɪɢ. S14. As in Fig. 9, but droughts and pluvials are identified based on SPI3.



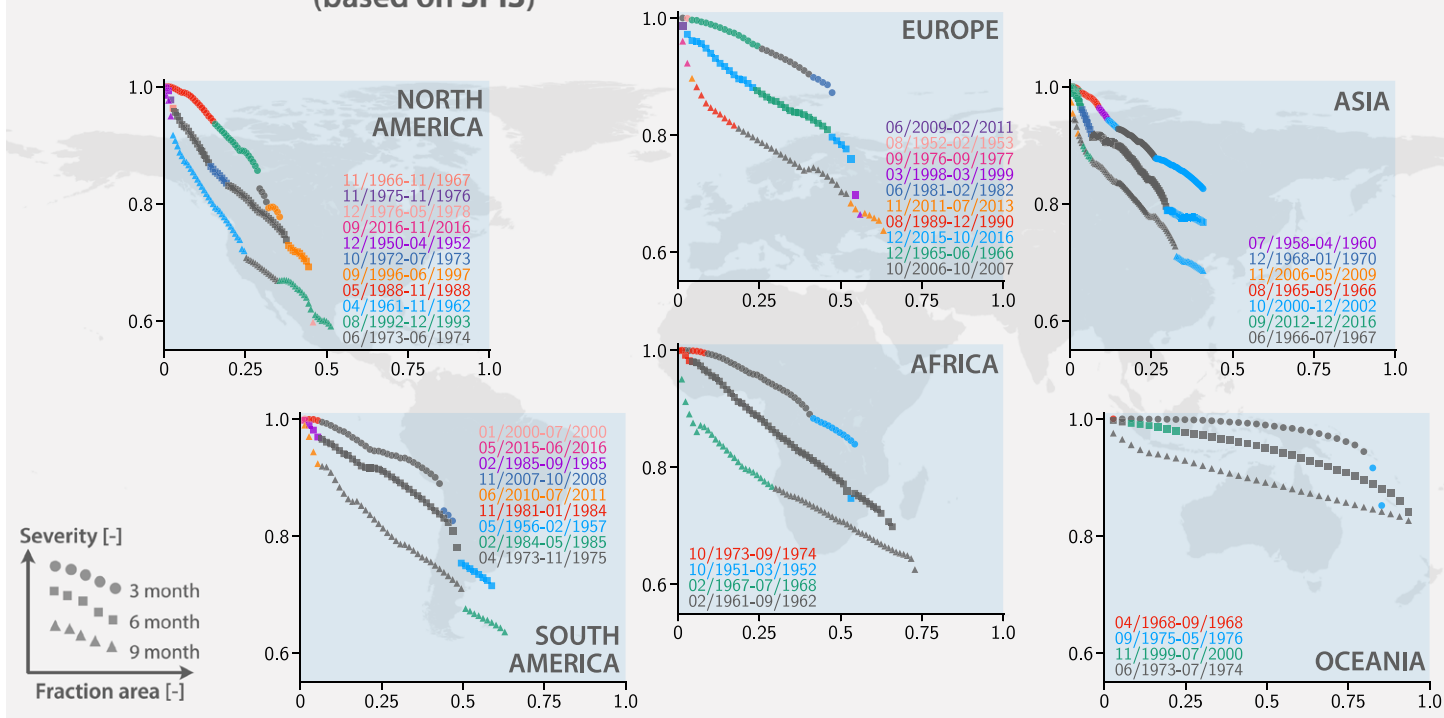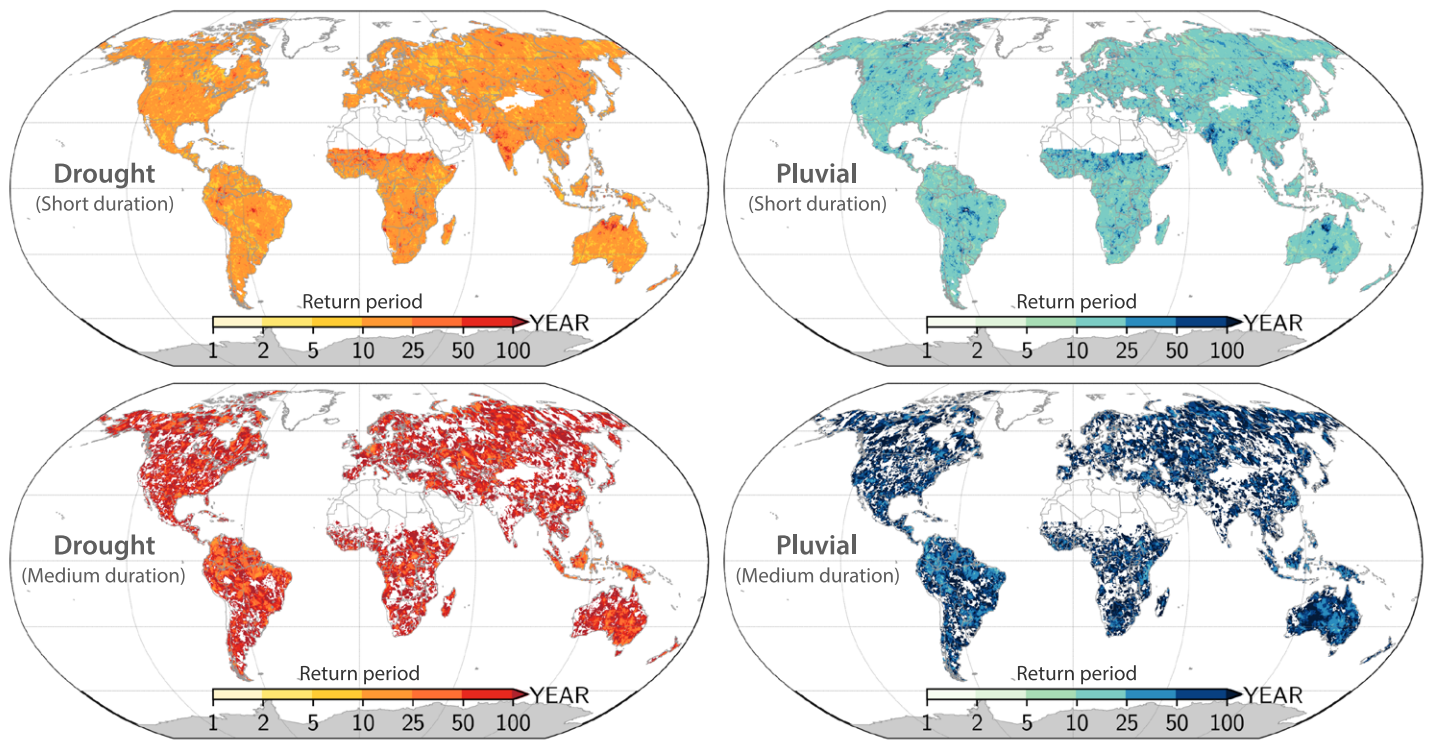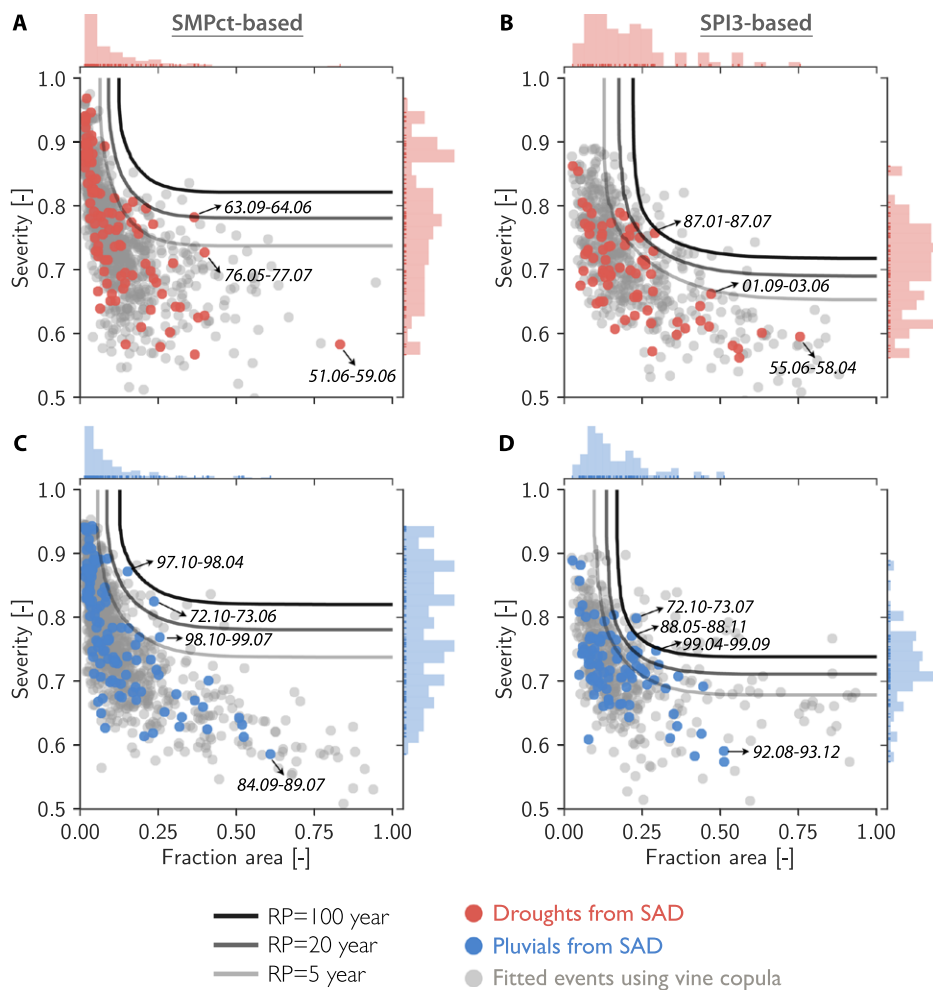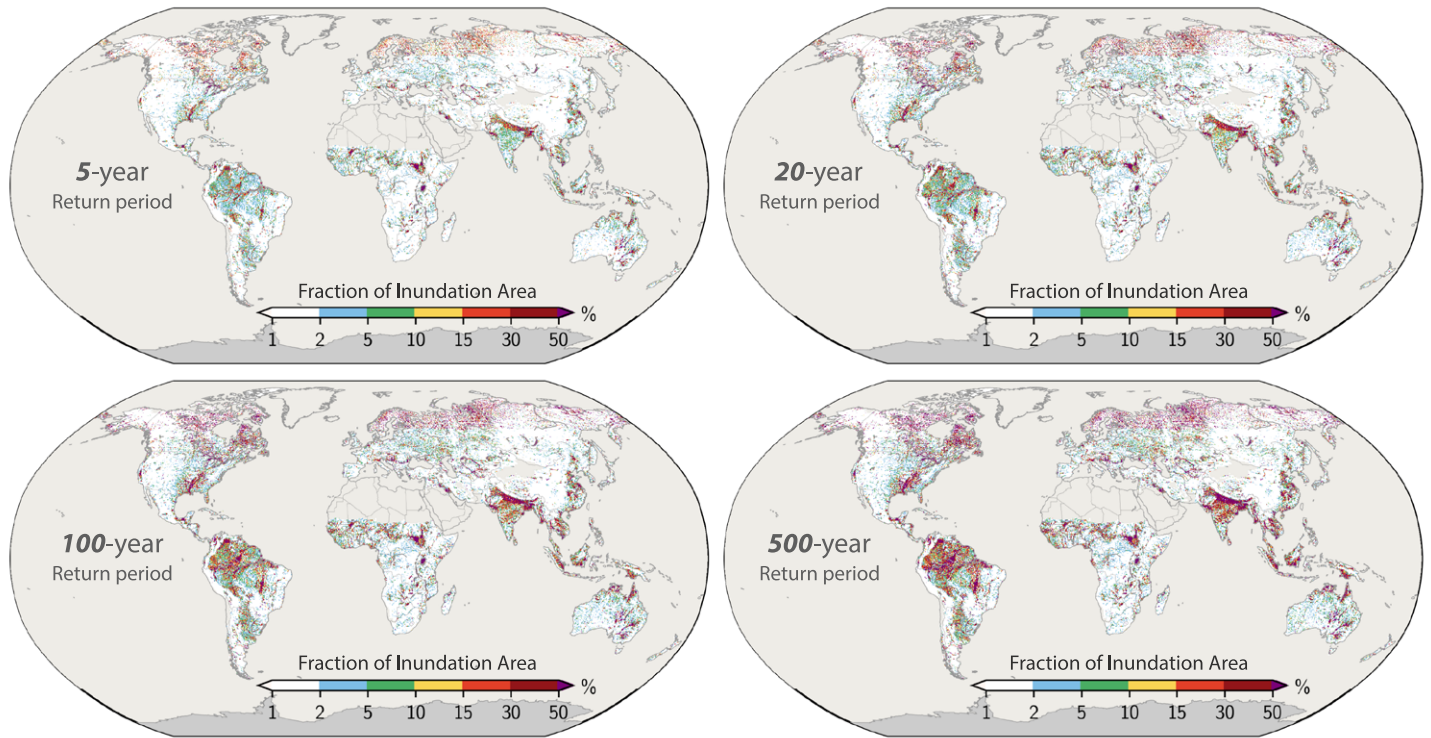Fɪɢ. S15. As in Fig. 10, but for North America.

FIG. S16. Annual maximum fractional flooded area for different return periods.
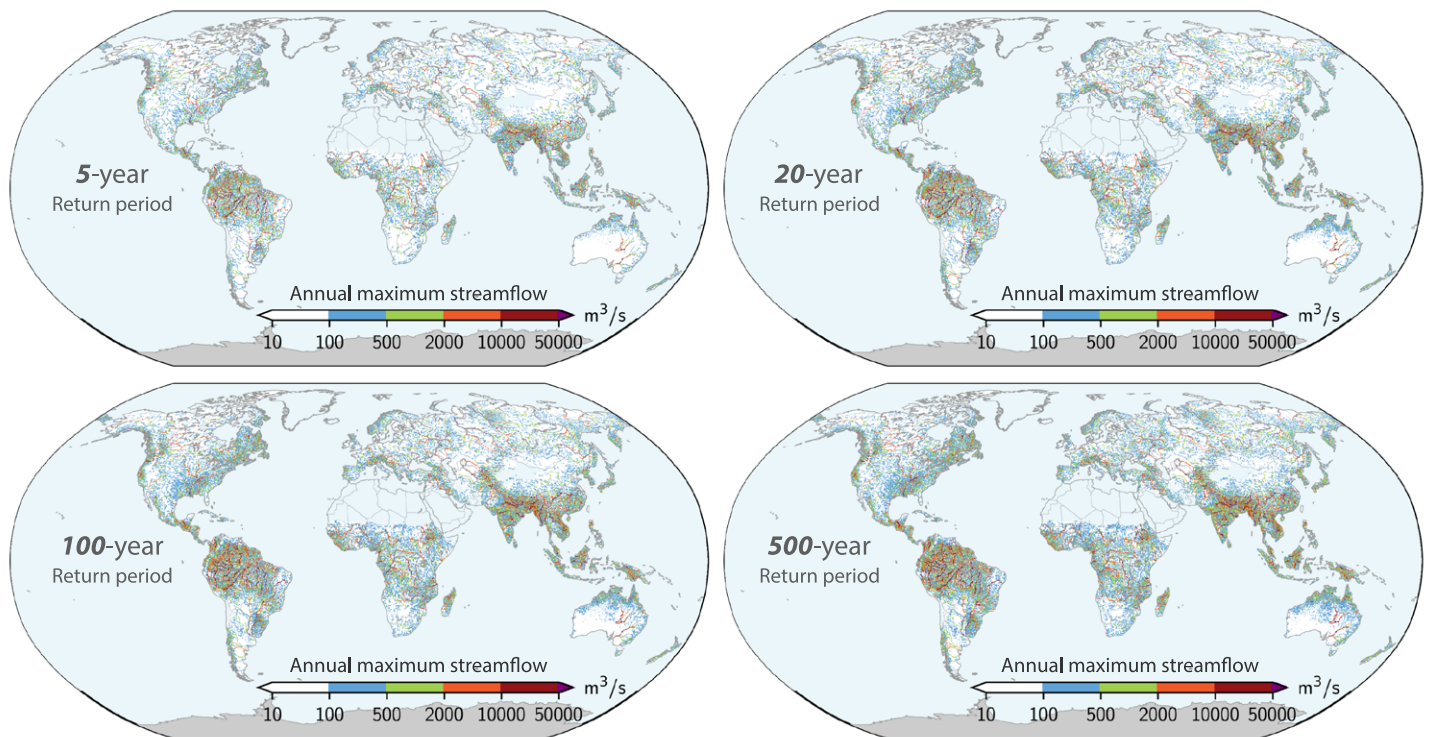


FIG. S17. As in Fig. S16, but for annual maximum daily streamflow.

**TABLE S1. List of top five drought and pluvial episodes ranked by duration and spatial extent using both SPI-based and SMPct-based event indices. The duration (months) and fraction area (percentage) under drought or pluvial are given in parentheses. The format for the period of each episode is YYYY.MM–YYYY.MM; for example, 1993.09–1994.12 indicates September 1993–December 1994.**

| Region | Duration (months) | | | | Spatial extent (fraction %) | | | |
|---|---|---|---|---|---|---|---|---|
| | SPI based | | SMPct based | | SPI based | | SMPct based | |
| | Drought | Pluvial | Drought | Pluvial | Drought | Pluvial | Drought | Pluvial |
| Africa | 1993.09–1994.12 (16) | 1961.02–1962.09 (20) | 1984.01–1985.06 (18) | 1967.01–1968.08 (20) | 1983.01–1984.01 (77.9) | 1961.02–1962.09 (73.0) | 1984.01–1985.06 (60.9) | 1967.01–1968.08 (47.5) |
| | 1991.10–1992.11 (14) | 1967.02–1968.07 (18) | 1991.09–1992.07 (11) | 1952.09–1953.09 (13) | 1983.12–1984.12 (65.9) | 1951.10–1952.03 (58.8) | 1982.12–1983.05 (45.6) | 1961.09–1962.06 (44.8) |
| | 1983.12–1984.12 (13) | 1954.03–1955.02 (12) | 1987.07–1988.05 (11) | 1956.08–1957.07 (12) | 1991.10–1992.11 (58.5) | 1967.02–1968.07 (52.0) | 1991.09–1992.07 (41.3) | 1961.01–1961.08 (40.7) |
| | 1983.01–1984.01 (13) | 1973.10–1974.09 (12) | 1996.08–1997.05 (10) | 1968.02–1968.12 (11) | 1993.09–1994.12 (52.9) | 1968.12–1969.06 (39.9) | 1983.08–1984.05 (33.1) | 1968.12–1969.05 (39.2) |
| | 2015.05–2016.03 (11) | 1965.10–1966.08 (11) | 1983.08–1984.05 (10) | 1961.09–1962.06 (10) | 1999.11–2000.08 (41.9) | 1962.11–1963.07 (38.7) | 1994.02–1994.07 (30.8) | 1977.10–1978.07 (36.8) |
| Asia | 1975.05–1977.12 (32) | 2012.09–2016.12 (52) | 1977.09–1984.04 (80) | 1965.09–1972.05 (81) | 1975.05–1977.12 (61.0) | 2012.09–2016.12 (65.4) | 1977.09–1984.04 (48.0) | 1987.09–1991.05 (47.6) |
| | 1971.07–1973.07 (25) | 2006.11–2009.05 (31) | 1983.09–1987.09 (49) | 1959.06–1964.06 (61) | 1981.08–1982.09 (41.9) | 2000.10–2002.12 (55.7) | 2001.08–2005.05 (43.8) | 1959.06–1964.06 (45.6) |
| | 1987.03–1988.12 (22) | 2000.10–2002.12 (27) | 1961.07–1965.07 (49) | 1972.02–1976.07 (54) | 2002.08–2004.02 (40.9) | 2006.11–2009.05 (45.2) | 2012.04–2015.06 (37.8) | 1965.09–1972.05 (39.8) |
| | 1978.05–1980.01 (21) | 1960.12–1962.09 (22) | 1958.10–1962.09 (48) | 1987.09–1991.05 (45) | 1996.12–1998.05 (39.5) | 1958.07–1960.04 (45.0) | 1961.07–1965.07 (34.7) | 1996.06–1999.04 (39.6) |
| | 1950.10–1952.06 (21) | 1958.07–1960.04 (22) | 2001.08–2005.05 (46) | 1950.01–1953.06 (42) | 1971.07–1973.07 (38.0) | 1960.12–1962.09 (35.1) | 1983.09–1987.09 (34.6) | 2006.07–2009.07 (37.9) |
| Europe | 1962.07–1964.05 (23) | 2011.11–2013.07 (21) | 1958.09–1961.05 (33) | 1999.10–2002.04 (31) | 1953.10–1954.06 (76.9) | 2011.11–2013.07 (62.7) | 1987.11–1989.09 (67.7) | 2012.05–2013.06 (64.2) |
| | 1956.02–1957.01 (12) | 2009.06–2011.02 (21) | 1975.09–1977.09 (25) | 1965.07–1967.06 (24) | 1962.07–1964.05 (70.1) | 1996.12–1997.12 (60.6) | 1975.09–1977.09 (65.7) | 1998.06–1999.07 (60.3) |
| | 1976.03–1977.02 (12) | 1989.08–1990.12 (17) | 2001.12–2003.11 (24) | 1957.07–1959.03 (21) | 1976.03–1977.02 (68.4) | 1998.03–1999.03 (60.5) | 2005.06–2006.11 (63.2) | 1952.08–1954.03 (58.1) |
| | 1951.08–1952.07 (12) | 2006.10–2007.10 (13) | 1955.06–1957.04 (23) | 1992.08–1994.04 (21) | 1995.12–1996.07 (66.8) | 2009.06–2011.02 (58.1) | 1971.07–1972.10 (62.3) | 1981.06–1982.07 (54.9) |
| | 1996.07–1997.05 (11) | 1998.03–1999.03 (13) | 1987.11–1989.09 (23) | 1982.09–1984.05 (21) | 1971.09–1972.05 (66.7) | 2015.12–2016.10 (53.5) | 2001.12–2003.11 (61.3) | 1955.01–1955.08 (54.0) |
| North America | 1952.07–1955.05 (35) | 1961.04–1962.11 (20) | 1951.06–1959.06 (97) | 1984.09–1989.07 (59) | 1955.06–1958.04 (75.5) | 1976.12–1978.05 (51.2) | 1951.06–1959.06 (83.2) | 1984.09–1989.07 (60.9) |
| | 1955.06–1958.04 (35) | 1976.12–1978.05 (18) | 1968.07–1971.07 (37) | 1981.10–1984.07 (34) | 1952.07–1955.05 (63.3) | 1992.08–1993.12 (51.1) | 1976.05–1977.07 (39.9) | 2008.07–2010.09 (52.4) |
| | 1960.09–1962.08 (24) | 2003.12–2005.04 (17) | 1961.07–1963.07 (25) | 2008.07–2010.09 (27) | 1999.05–2000.08 (56.0) | 1996.09–1997.06 (44.5) | 1999.05–2000.06 (39.9) | 1992.06–1994.03 (51.9) |
| | 2001.09–2003.06 (22) | 1992.08–1993.12 (17) | 1961.06–1963.06 (25) | 1961.06–1963.07 (26) | 1958.02–1959.03 (55.7) | 1973.06–1974.06 (43.9) | 2012.02–2013.04 (37.8) | 1981.10–1984.07 (50.9) |
| | 1967.03–1968.11 (21) | 1950.12–1952.04 (17) | 1965.07–1967.06 (24) | 1978.06–1980.05 (24) | 1980.10–1982.04 (53.9) | 1998.01–1999.03 (41.8) | 2005.11–2007.07 (36.7) | 1959.06–1960.07 (41.1) |

| Region | Duration (months) | | | | Spatial extent (fraction %) | | | |
|---|---|---|---|---|---|---|---|---|
| | SPI based | | SMPct based | | SPI based | | SMPct based | |
| | Drought | Pluvial | Drought | Pluvial | Drought | Pluvial | Drought | Pluvial |
| Oceania | 2004.07–2005.07 (13) | 1973.06–1974.07 (14) | 1961.02–1962.01 (12) | 1973.04–1974.11 (20) | 2004.07–2005.07 (90.7) | 1973.06–1974.07 (93.0) | 1965.01–1965.07 (80.7) | 1973.04–1974.11 (92.4) |
| | 1972.02–1973.01 (12) | 1998.07–1999.06 (12) | 1982.05–1983.02 (10) | 2010.01–2011.06 (18) | 2002.03–2003.02 (90.6) | 1975.09–1976.05 (89.9) | 1951.11–1952.06 (76.6) | 1975.04–1976.05 (88.7) |
| | 2002.03–2003.02 (12) | 1950.03–1951.02 (12) | 2002.04–2003.01 (10) | 1975.04–1976.05 (14) | 1972.02–1973.01 (90.4) | 2010.07–2011.05 (85.4) | 2002.04–2003.01 (75.9) | 2010.01–2011.06 (87.8) |
| | 1977.02–1977.12 (11) | 2010.07–2011.05 (11) | 1972.01–1972.09 (9) | 1950.02–1951.02 (13) | 1994.05–1994.12 (90.0) | 1955.04–1955.11 (83.9) | 1994.04–1994.12 (75.9) | 1998.07–1999.06 (82.2) |
| | 1982.06–1983.03 (10) | 1975.09–1976.05 (9) | 1967.04–1967.12 (9) | 1998.07–1999.06 (12) | 1951.11–1952.06 (80.8) | 1998.07–1999.06 (81.9) | 1961.02–1962.01 (74.5) | 1968.04–1968.09 (80.5) |
| South America | 1966.12–1968.09 (22) | 1973.04–1975.11 (32) | 1957.11–1959.05 (19) | 2008.12–2010.05 (18) | 1963.04–1964.05 (68.8) | 1984.02–1985.05 (62.4) | 1967.07–1968.10 (63.5) | 1956.09–1957.05 (50.1) |
| | 1961.12–1963.04 (17) | 1981.11–1984.01 (27) | 1982.06–1983.11 (18) | 1982.06–1983.08 (15) | 1966.12–1968.09 (66.7) | 2008.12–2010.03 (59.5) | 2015.05–2016.06 (59.7) | 2007.10–2008.05 (49.6) |
| | 1958.01–1959.05 (17) | 2008.12–2010.03 (16) | 1967.07–1968.10 (16) | 1973.04–1974.06 (15) | 1988.02–1989.04 (66.5) | 1956.05–1957.02 (58.9) | 1951.04–1952.03 (54.0) | 1975.04–1976.04 (48.8) |
| | 1982.08–1983.12 (17) | 1984.02–1985.05 (16) | 2015.05–2016.06 (14) | 1989.05–1990.05 (13) | 2015.07–2016.08 (66.4) | 1981.11–1984.01 (58.8) | 1988.01–1988.09 (53.5) | 1973.04–1974.06 (47.7) |
| | 1988.02–1989.04 (15) | 2015.05–2016.06 (14) | 1951.04–1952.03 (12) | 1975.04–1976.04 (13) | 1951.01–1952.03 (54.2) | 1973.04–1975.11 (55.9) | 1963.03–1963.12 (53.0) | 2008.12–2010.05 (47.6) |

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