Baldcypress false ring formation linked to summer hydroclimatic extremes in the southeastern United States

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Abstract

We describe the utility of false rings in Taxodium distichum (i.e. baldcypress) as a proxy for hydroclimatic extreme events in three different river basins (Pascagoula, Mobile, and Choctawhatchee) that discharge into the northern Gulf of Mexico. False rings occur as a result of a change in the environmental limiting resource for tree stem growth, and in T. distichum, false ring production is usually a result of increases in mid-growing season water availability. Our results show that false ring occurrence (from 1931 to 2018) is similar across sites but occur in different years, suggesting that false ring production is indicative of tree response to its local environment. False ring production in T. distichum has previously been correlated with summer streamflow, the season when tropical cyclone precipitation (TCP) is highest. To assess a stand-wide response, we define high false ring (HFR) years as all years when ≥20% of trees produced a false ring. We show total TCP in July is the best predictor for HFR years in T. distichum, and false ring production in smaller river basins captures local TCP better than larger river basins. Additionally, HFR years coincide with summers of anomalously high precipitation, anomalously low temperatures, and a positive phase of the North Atlantic Oscillation. 77% of HFR years occur in seasons when there is heavy tropical cyclone activity near sample sites, building a foundation to use false ring records as robust TCP proxies with hydroclimate reconstruction potential.

1. Introduction

Flooding, hurricanes, and severe weather have caused nearly 75% of all natural hazard monetary losses in the last half century (Gall et al 2011, Davenport et al 2021). Torrential flooding in the southeastern United States, particularly that delivered by tropical cyclones, has increased throughout the 20th century (Trepanier and Tucker 2018, Bishop et al 2019, Brown et al 2019). Tree-ring derived precipitation reconstructions of the region show that this increase in precipitation has occurred for the past 300 years along the U.S. Atlantic Coast with the largest increase in the last 60 years (Maxwell et al 2021). A high degree of uncertainty in spatial and temporal trends of precipitation exists along the U.S. Gulf of Mexico coast as instrumental records of precipitation are not long and cohesive enough to capture large-scale, long-term climatic changes (Marsooli et al 2019, Russell et al 2020). Climate proxies, such as tree-ring data, can be used to place modern instrumental records in a broader temporal context through climate reconstructions. However, tree-ring reconstructions are only as good as their climate-growth relationship, and newly-defined climate indices using updated data provide a regional and global context for local changes in tree growth. Tree-ring data are ideal for analyzing long-term extreme climate on annual scales because trees produce a growth ring each year, thus tracking year-to-year changes well. Newly collected and updated tree-ring chronologies provide greater spatial and temporal comparisons to modern climate records, and novel methods (e.g. wood anatomy, wood chemistry, powerful computing and image processing)
allow researchers to delve into multi-proxy climate-growth relationships more easily than ever before.

Tree growth recorded in mid-latitude locations corresponds directly with local environmental conditions, and this growth is recorded in the tree stem as ring widths with one year of growth recorded as one ring. The physical dimensions and chemical compositions of an annual ring can be used as a proxy for climate in the region, and long-lived tree species can provide climate reconstructions via growth rings prior to the instrumental period. Year-of-fluctuating environmental stressors prime trees to produce inter-annual density fluctuations in cambium cells called false rings (figure 1; Battipaglia et al 2016). Each tree ring is comprised of two main components: earlywood (i.e. less-dense, thin-walled tracheids that usually occur in the early part of the growing season after dormancy) and latewood (i.e. densely-packed tracheids with thick cell walls that usually occur in the later part of the growing season prior to dormancy; Fritts 1976). Latewood formation is often driven based on seasonal conditions that occur prior to the dormant season (e.g. cell-wall thickening to protect the wood from dangerous freezes; Schulman 1939). False ring formation appears when latewood cells occur within two bands of earlywood cells before true latewood growth occurs for that growth ring (De Micco et al 2016).

At many sites across the globe, xylogenesis (i.e. the formation of vascular tree tissue) is the result of normal growing conditions on the landscape, and false rings are present in the wettest years at those sites (Ren et al 2015, Ziaco et al 2016). In the arid southwestern U.S., Morino et al (2021) described the occurrence of false rings as a response to monsoonal rainfall in summer months (Larson 1962, Giddings 1965, Morino et al 2021). The formation of earlywood-like cells within latewood has also been linked to drastically wetter conditions in a semi-arid Mediterranean region (de Luis et al 2011). In the wetter eastern U.S., false ring production occurs in years with a late-season weather reversal, often the result of an early-fall cold front into the region (Edmondson 2010). Additionally, long-term chronologies of false ring production have proven useful in reconstructing regional hydroclimate (Wimmer et al 2000, Griffin et al 2011).

Ample moisture in the southeastern U.S. is conducive to tree growth but is also a source of environmental stress to trees growing in floodplains. Taxodium distichum (i.e. baldcypress) is one of the longest-lived tree species occurring in North America and records of the species’ tree-ring width can robustly reconstruct precipitation for thousands of years (Stahle et al 2012). This species is known to produce false rings in the presence of late-season flooding events (Therrell et al 2020). Young et al (1993) and Copenheaver et al (2017) report that inundation stress caused young T. distichum to produce false rings, while other studies indicate that streamflow variability drives tree-ring-width within the same species (Cleaveland 2000, Keim and Amos 2012, Palta et al 2012). Relatively high flow in the spring (March–May) prompts wood growth early in the year, and as those floods recede, T. distichum begin to enter dormancy and produce latewood cells. If high river flows caused by anomalously high precipitation occur in the later growing season (June–October),
earlywood production may begin again thus producing a false ring, similar to how North American monsoon rains in the southwestern US trigger renewed growth in *Pinus ponderosa* (Morino et al 2021). Therrell et al (2020) suggest that years with a stand-wide high production of false rings frequently occur as a result of tropical cyclone rainfall, and Mitchell et al (2019) demonstrated that *Pinus palustris* false rings occurred as a result of tropical cyclone occurrences from June–October as most Atlantic hurricane rainfall along the Gulf of Mexico coast occurs during June–September (Trepanier and Tucker 2018, Bregy et al 2020).

In this study, we explore our tree-ring record of false rings at three sites within floodplains of the northern Gulf of Mexico coastline and examine how this record relates to hydroclimate locally and beyond. We re-imagine regional and hemispheric-scale climatic conditions through the lens of false ring production, and we discuss the role of local geography in targeting potential false-ring records for hydroclimate reconstructions.

2. Materials and methods

2.1. Study areas

We analyzed tree-ring records from three previously-sampled sites, chosen for their proximity to the coast, location where tropical cyclones frequently impact, and length of the tree-ring chronologies (>100 years; figure 2). The climate of the northern Gulf of Mexico coast is humid subtropical with warm summer months (27°C average for July) and mild winter months (10°C average for January). Precipitation in the region averages >150 cm annually. Most precipitation during the growing-season (March–October) falls as a result of tropical disturbances and scattered thunderstorms (Keim 1996). The 20th century saw on average one tropical cyclone make landfall in this region every 3–4 years, and Category 1 hurricanes (winds 33–42 m s⁻¹) make landfall once every 6–10 years (Elsner and Kara 1997, Keim et al 2007).

The three study sites (from west to east) are located within their respective floodplains and named after their respective nearby river basins (figure 2): Pascagoula (30.65° N, 88.64° W), Mobile (30.96° N, 87.91° W), and Choctawhatchee (30.44° N, 85.91° W). These three rivers basins are 23 000 km², 114 000 km², and 13 500 km² in area respectively.

2.2. Tree-ring data

Sites were selected for this study based on previous research for their hydroclimate sensitivity (Stahle and Cleaveland 1994, Stahle et al 2006, Harley et al 2017, 2018, Therrell et al 2020, Vines et al 2021). Thirty trees at each site were each cored twice using a 5 mm Haglof increment borer above buttress height. *T. distichum* at these sites produced large buttresses at stem base as high as 3.0 m, and these growth aberrations near the ground can affect ring width. We used high-resolution scans (1200 DPI) of the cross-dated tree cores to identify false rings. We assessed the quality of our crossdating using the computer program COFECHA (Holmes 1983). We manually identified false rings as darker cells that fade on both sides of the growth fluctuation (figure 1). Some tree cores had locally absent false rings; however, we assumed the presence of a false ring if any core taken from the tree had a false ring.

2.3. High false ring (HFR) years

Following the methods of Therrell et al (2020), we calculated the proportion of all trees and represent them as a percentage of trees exhibiting false rings at each site. The proportion (F) of all trees exhibiting a false
Figure 3. Cumulative tropical cyclone precipitation (TCP) during the days 1 June–15 October (1948–2018) for Pascagoula (a), Mobile (b), and Choctawhatchee (c). Red circles indicate HFR years.

ring (N) compared to all trees analyzed at that site (n) for each year (1948–2014) as shown in equation (1)

\[ F = \frac{N}{n}. \]  

We categorize HFR years for analysis as years when \( \geq 20\% \) of the trees contain a false ring, as found in Therrell et al (2020). Appendix tables A1, A2 and A3 includes the highest false ring proportion years for this study. HFR years are used for correlation analysis with tropical cyclone precipitation (TCP) and for creating composite maps of climatological conditions.

2.4. Tropical cyclone rainfall maps

For initial examination, we collected Tropical Cyclone Rainfall Maps created by the National Oceanic and Atmospheric Administration (NOAA; www.wpc.ncep.noaa.gov/tropical/rain/tcrainfall.html; 1900–2021) for the HFR years. Tropical cyclone rainfall often occurs in unusual patterns, and these rainfall maps proved useful for initial identification of a potential late season TCP-false ring relationship. Although precipitation intensity maps are available for all U.S. landfalling tropical cyclones since 1956, the data set from 1900 to 1955 is incomplete and only contains maps for select tropical cyclones causing severe damage.

2.5. TCP

We used a gridded TCP data set derived from instrumental data \((0.25^\circ \times 0.25^\circ; \text{1948–2018})\) publicly-available at https://github.com/jbregy/TCPDat (Bregy et al 2020). The TCP data set combines gridded precipitation data from the Climate Prediction Center Unified Gauge-based Analysis of Daily Precipitation over CONUS (Higgins et al 2000) with the TC Best Track data from HURDAT2 (World Meteorological Organization’s International Best Track Archive for Climate Stewardship initiative version 4.0 Knapp et al 2010, Landsea and Franklin 2013). The data are available as precipitation amounts (mm) per day of the year.

We calculated annual total precipitation for each site within a maximum radius of 223 km. We chose this radius for our analysis of TCP because Matyas (2010) found that 223 km is the average rainfield size of hurricanes at the time of landfall. Although the Atlantic hurricane season officially lasts from 1 June–30 November, most northern Gulf of Mexico coastal trees do not grow during this entire period, thereby limiting their proxy potential temporally. As in Maxwell et al (2021), we limited our analysis to the period when tree growing season overlaps the Atlantic hurricane season (1 June–15 October; figure 3). We tested the relationship of false ring proportion to precipitation in different windows of time within this
period (i.e. 1 June–30 September, 1 July–30 September, and 1 July–31 August) to determine the season during which trees are most likely to produce false rings.

We performed superposed epoch analyses (SEA) between our HFR years and TCP to test the significance of the relationship between TCP events and false ring production. These analyses were limited to the common period of the TCP data (1948–2018) and tree ring data (1932–2014). Because the false ring data are not distributed normally and have numerous zero-values, we used SEA to test if there were significant differences in TCP events in the 2 years preceding and 4 years after HFR years (Haurwitz and Brier 1981). SEA is commonly used to test event-based analyses of tree growth and environmental factors (Swetnam and Baisan 2003, Harley et al 2014, Tucker et al 2018, Rao et al 2019).

SEA diagnoses temporal relationships between TCP values and HFR years by comparing statistical windows of past, present, and future TCP conditions on each HFR year individually. SEA uses 1000 bootstrapped Monte Carlo simulations to model the effects of TCP on HFR years to assess significance of the results. Thus, a simulation of 1 year of HFR is compared with 1 year of a TCP value, the results of that test are recorded, and the model is repeated with 1000 other random simulations. The mean and standard deviations of these simulations are calculated and compared with the uncertainty discovered by running multiple simulations. We set analysis windows as 2 years before and 4 years after the event year, though it should be noted that shifting this lag year did not change the statistical significance of our results. We performed these analyses in the burnr package version 0.6.1 in the computer program R as used in Rao et al (2019).

2.6. Composite maps
To determine the larger scale climate dynamics associated with HFR years, we averaged climate variables, including surface temperature, precipitation rates, and 500 mb geopotential height anomalies, from the 20th century reanalysis product for the HFR years (Compo et al 2011). In light of the results from our seasonal climate-sensitivity analysis, we show the composites for the summer (June–August) months (1948–2015).

3. Results
We examined 19 crossdated tree-ring series for Pascagoula (n = 19, r = 0.520), 17 for Mobile (n = 17; r = 0.475), and 14 for Choctawhatchee (n = 14; r = 0.602). Correlation coefficients reported represent the average correlation between one tree-ring series and the master of averaged tree-ring series at the site, and these values are acceptable for further analyses. Over the analysis period of 1932–2018, Choctawhatchee trees produced the highest average proportion of false rings through time (14.19%), Pascagoula the second-highest (11.14%), and Mobile the lowest (10.93%). Each of these sites received a different set of tropical cyclones, occasionally overlapping, thus false rings are locally-driven and not as affected by longer-term, larger-scale climate. The years for each individual site with the highest percentage of HFR years occurred in years with a high TCP event (1948–2013): 143 cm for Pascagoula in 1949 (50% of trees produced a false ring this year), 77 cm for Mobile in 1950 (35.71%), 93 cm for Choctawhatchee in 1994 (48.15%; figure 4).

Figure 4. Proportion of trees producing false rings in a given year for Pascagoula (a), Mobile (b), and Choctawhatchee (c).
much as 100 cm (approximately 70% of annual average) of rain fell on these sites from these five events alone.

3.1. Superposed epoch analysis
Results of SEA suggest that TCP values are related to HFR years. Analyses with statistically significant results at $p < 0.1$ are reported and discussed below. Though we tested TCP values of multiple periods within the year (i.e. 1 June–30 September, 1 July–30 September and 1 July–31 August), our results indicate that among all monthly time windows for TCP tested, only one produced significant results: 1 July–31 August. These results suggest that TCP falling outside of 1 July–31 August is less often related to HFR production.

Results of SEA show a positive relationship between HFR years (year 0) and TCP (figure 5). For all sites, years with high TCP are linked with HFR years, and at Pascagoula and Choctawhatchee (figures 5(a) and (b)), low TCP is related to years preceding HFR years, though this relationship is only significant at $p < 0.1$. High TCP 2 years prior to HFR years is also positively significant at $p < 0.1$. Results of TCP in years following HFR years are not significant; this is expected because tree growth is not physically a predictor of TCP.

3.2. Results from composite maps
Previous research on false rings strongly suggests that seasonal changes in local hydroclimate are responsible for a growth reversal in trees. All sites show a generally consistent pattern of climate in HFR years. The common pattern for composite maps was anomalously high precipitation (figures 6(b), 7(b) and 8(b)) and low temperatures (figures 6(c), 7(c) and 8(c)).
Figure 7. Spatial composite map of Mobile site for (a) 500 mb geopotential height anomaly, (b) precipitation anomaly, and (c) temperature anomaly in June, July, and August during HFR years.

Figure 8. Spatial composite map of Choctawhatchee site for (a) 500 mb geopotential height anomaly, (b) precipitation anomaly, and (c) temperature anomaly in June, July, and August during HFR years.

and 8(c)) in corresponding summer in the southeastern U.S. HFR years also commonly have a large low pressure system over northeastern Canada and high pressure system sweeping over the eastern Atlantic and western Europe during the summer (figures 6(a), 7(a) and 8(a)).

As with the SEA results, these results are strongest at Pascagoula and Choctawhatchee. Temperatures at Mobile in HFR years are not anomalously low like they are at the other two sites (figure 7(c)). Additionally, 500 mb geopotential heights and precipitation patterns are not as strongly represented at Mobile compared to Pascagoula and Choctawhatchee (figures 7(a) and (b)).

4. Discussion

4.1. Geographic differences among sites

In this study, false ring production in coastal *Taxodium distichum* is appears to be frequently linked to precipitation from tropical cyclone events. However, large-scale climate patterns are likely responsible for producing conditions conducive to extreme rainfall events and thus false ring production. Despite the
sites’ close proximity to each other and similar large-scale climate dynamics, the proportion of trees with false rings in any given year are not correlated among the three sites. Edmondson (2010) described that sites experienced different local rainfall rates and thus false ring production at different sites is not the same. Tropical cyclones produce rain locally (i.e. 223 km), and the three sites experience different weather events with varying amounts of precipitation. For example, TS Alberto (1994) produced rain directly over the Choctawhatchee River Basin, thus none of that water made it to the other two sites, and they did not produce false rings in 1994.

Results from the composite maps indicate that climate during HFR years for Pascagoula and Choctawhatchee is more anomalous than for Mobile. We can attribute this difference in sensitivity, in part, to river basin size. The Mobile River Basin is an order of magnitude larger than the Choctawhatchee and Pascagoula River Basins. Localized flooding can be muted in such a large river basin (O’Connor and Costa 2003), and similar rainfall rates would produce greater magnitude flows in Pascagoula and Choctawhatchee than in Mobile, thus reducing the potential for false ring production in larger river basins. River basin size should be considered when analyzing false ring production in other river basins, as our results suggest that smaller river basins ultimately require less rainfall for false ring production.

4.2. Large-scale climate
Mitchell et al (2019) suggest that false ring production in North Carolina longleaf pine is dependent on large scale climate patterns. Composite maps of climate during HFR years do show common, strong anomalies, suggesting that larger scale ocean-atmospheric patterns set the stage for weather phenomena conducive to false ring formation. Composite maps show that HFR years have, on average, higher summer precipitation rate and cooler-than-normal temperatures. High precipitation leads to increased cloud cover, and increased moisture at the surface likely produces cooler-than-normal temperatures. Additionally, these years are associated with anomalous high pressure systems over the northeast Atlantic and low pressure systems over northeastern North America. The North Atlantic Oscillation (NAO) generally describes the changing positions and strengths of the Icelandic Low and North Atlantic Subtropical High pressure systems at sea level (Hurrell and Deser 2010). During a positive phase wherein the Icelandic Low has lower than normal pressures and the North Atlantic Subtropical High has higher than normal pressures, the Atlantic jet stream moves northward allowing warm, moist air from the Caribbean to flow into the southeastern U.S. thus causing a wetter weather pattern in the region (Coleman and Budikova 2013). This southerly flow into the northern Gulf of Mexico can also drive tropical cyclone frequency in the region (Elser and Kocher 2000, McCloskey et al 2013). Ultimately, the climate of HFR years suggest that the larger scale ocean-atmospheric setting may prime the system for wetter conditions and tropical cyclone landfall in the northern Gulf of Mexico.

4.3. False rings and TCP
Most of the tropical cyclone events making landfall in the southeastern US do so in late summer, with most events occurring in July and September (appendix). Only TCP during the 1 July–31 August period correlates well with HFR years, whereas results from Mitchell et al (2019) show that false rings in Pinus palustris result from tropical cyclones occurring June–October. Our data suggest that the most likely relationship with false ring production is with TCP in July.

Our statistical analyses indicate that years with $\geq 20\%$ of trees producing false rings are correlated with TCP events (figure 5). Because they grow within the floodplain, T. distichum trees respond to typical early season (i.e. March–May) flow as a start to the year’s growth, and as those annual waters recede, the trees begin latewood formation (Stahle et al 2012). Summer flooding from TCP prompts T. distichum to transition from lateward to earlywood in the presence of increased water. The relationship between TCP and HFR years is statistically significant ($p < 0.05$) for the year of TCP occurrence (figure 5, year 0), with no significant lag impact. Drier conditions in prior years may prime trees for false ring production the following year, as we see a –1 lag negative relationship. However this relationship is not consistent among all three sites and not as strong as the year 0 relationship.

Though our results indicate that most false ring occurrences are a result of TCP, 23% of the non-TC HFR years could be the result of rainfall caused by weather other than tropical cyclones. For example, each site has an HFR year in 1958, but no measureable TCP exists for that year, and no tropical cyclones passed near the river basins discussed. Summer-season frontal systems are likely culprits for non-TC HFR years. Regardless, 77% of HFR years co-occur with TCP events, thus one may assume that 77% of all HFR years in the past are related to TCP events. Future studies developing on our understanding of TC-induced false rings should explore how other climate and extreme weather affects false ring production so that millennial-length T. distichum can be used to reconstruct TCP through time. This makes false ring chronologies useful for synchronous-event reconstructions, similar to previous research (e.g. Swetnam and Baisan 2003).

5. Conclusions
For this study, false ring proportion is similar across sites but occur in different years, suggesting that false
ring production responds to localized factors. False ring production in *T. distichum* has previously been correlated with streamflow in summer months, a period during which TCP is high. TCP in July is the best predictor for HFR years in *T. distichum*, and false ring production in smaller river basins captures TCP better than larger river basins. Additionally, HFR years occur during years of anomalously high precipitation, anomalously low temperatures, and years during a positive phase of the NAO. Ultimately, results of this study indicate that 77% of HFR years are related to tropical cyclone activity near individual sites, thus suggesting a potential for false-ring records to be used for future TCP reconstruction.

**Data availability statement**

The data generated and/or analysed during the current study are not publicly available for legal/ethical reasons but are available from the corresponding author on reasonable request.

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Appendix. Tropical cyclones during HFR years

Table A1. HFR years (≥20% of trees exhibiting a false ring) for Pascagoula. Nearby associated tropical cyclones (TC) and their rainfall dates are included (TD = tropical depression; TS = tropical storm; H = hurricane). *The 2005 hurricane season contained 5 tropical cyclones that likely impacted each site: TS Arlene (8–15 June), H Cindy (4–11 July), H Dennis (7–18 July), H Katrina (24 August–1 September), H Rita (20–25 September).

| Year | Associated TC | Rainfall dates |
|------|---------------|----------------|
| 1949 | TS 5          | 3–5 September  |
| 1952 |               |                |
| 1958 | H Carla       | 9–15 September |
| 1971 | H Fern/H Edith| 1–13 September |
| 1975 | TD 4/TD 12    | 27 July–31 August/15–20 October |
| 1979 | H Bob/H Frederic | 9–16 July/9–14 September |
| 1980 |               |                |
| 1982 | TS Chris      | 8–14 September |
| 1989 | TS Allison    | 23 June–7 July |
| 1993 | TS Arlene     | 18–23 June |
| 1997 | H Danny       | 17–26 July |
| 2003 | TS Bill       | 27 June–4 July |
| 2005 | *             |                |

Table A2. HFR years (≥20% of trees exhibiting a false ring) for Mobile. Nearby associated tropical cyclones (TC) and their rainfall dates are included (TD = tropical depression; TS = tropical storm; H = hurricane). *The 2005 hurricane season contained 5 tropical cyclones that likely impacted each site: TS Arlene (8–15 June), H Cindy (4–11 July), H Dennis (7–18 July), H Katrina (24 August–1 September), H Rita (20–25 September).

| Year | Associated TC | Rainfall dates |
|------|---------------|----------------|
| 1953 | TS Alice/H Florence | 30 May–9/24 June–28 September |
| 1955 | TS Brenda/TS 5 | 1–3 August/25–28 August |
| 1958 |               |                |
| 1961 |               |                |
| 1965 | TS 1          | 13–17 June |
| 1971 | TS 8/H Fern   | 11–20 August/1–13 September |
| 1975 | TD 4/H Eloise | 27 July–3 August/20–27 September |
| 1983 |               |                |
| 1987 | TS 2          | 8–17 August |
| 1989 | TS Allison    | 23 June–7 July |
| 1994 | TS Alberto    | 30 June–8 July |
| 2003 | TS Bill/TS Henri | 27–4 June/2 July–17 September |
| 2004 | H Ivan        | 13–26 September |
| 2005 | *             |                |
| 2013 | TS Karen      | 3–15 October |

Table A3. Years with HFR proportions (≥20% of trees exhibiting a false ring) for Choctawhatchee. Nearby associated tropical cyclones (TC) and their rainfall dates are included (TD = tropical depression; TS = tropical storm; H = hurricane). *The 2005 hurricane season contained 5 tropical cyclones that likely impacted each site: TS Arlene (8–15 June), H Cindy (4–11 July), H Dennis (7–18 July), H Katrina (24 August–1 September), H Rita (20–25 September).

| Year | Associated TC | Rainfall dates |
|------|---------------|----------------|
| 1953 |               |                |
| 1955 |               |                |
| 1958 |               |                |
| 1961 |               |                |
| 1965 |               |                |
| 1971 |               |                |
| 1975 |               |                |
| 1983 |               |                |
| 1987 |               |                |
| 1989 |               |                |
| 1994 |               |                |
| 1999 |               |                |
| 2003 |               |                |
| 2004 |               |                |
| 2005 |               |                |
| 2013 |               |                |

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