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Article

Vertical Differences in the Long-Term Trends and Breakpoints of NDVI and Climate Factors in Taiwan

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Academic Editor: name
Received: date; Accepted: date; Published: date

Supplementary Materials

S1 NDVI

Supplementary Figure S1 showed the regional BFAST results for NDVI at varied elevations. Again, clear variations can be observed. In the North region, an upward trend below 2000 meters altitude was observed. A downward trend was observed between 2000 and 3000 meters at the altitude, with one breakpoint detected in December 1984. The general upward trend and only one breakpoint detected in the North region except for 2000-3000 meters indicated that the North region's vegetation had grown steadily.

The Central region NDVI trend showed a downward tendency without breakpoint at low altitudes below 500 meters. Almost all breakpoints above 500 meters occurred in 1989-1990 and 1994. Among them, at the 500-2000 meters altitude, another breakpoint in 2000 was detected. The changing pattern was similar for the 500-1500 meters altitude, which was an upward trend followed by two gradual downward trends, increasing after 2000. However, 1500 to 2000 meters' altitude has shown a continuous downward tendency after an increasing trend before 1989. The trend of NDVI in the Central region above 2,000 meters is consistent. It increased before 1989, decreased significantly from 1989 to 1994, and decreased slowly after 1994. It shows that vegetation's growth status in the Central region has gradually deteriorated, with obvious deterioration between 1989 and 2000. Still, the growth status of vegetation has improved after 2000 at altitudes of 500-1500 meters.

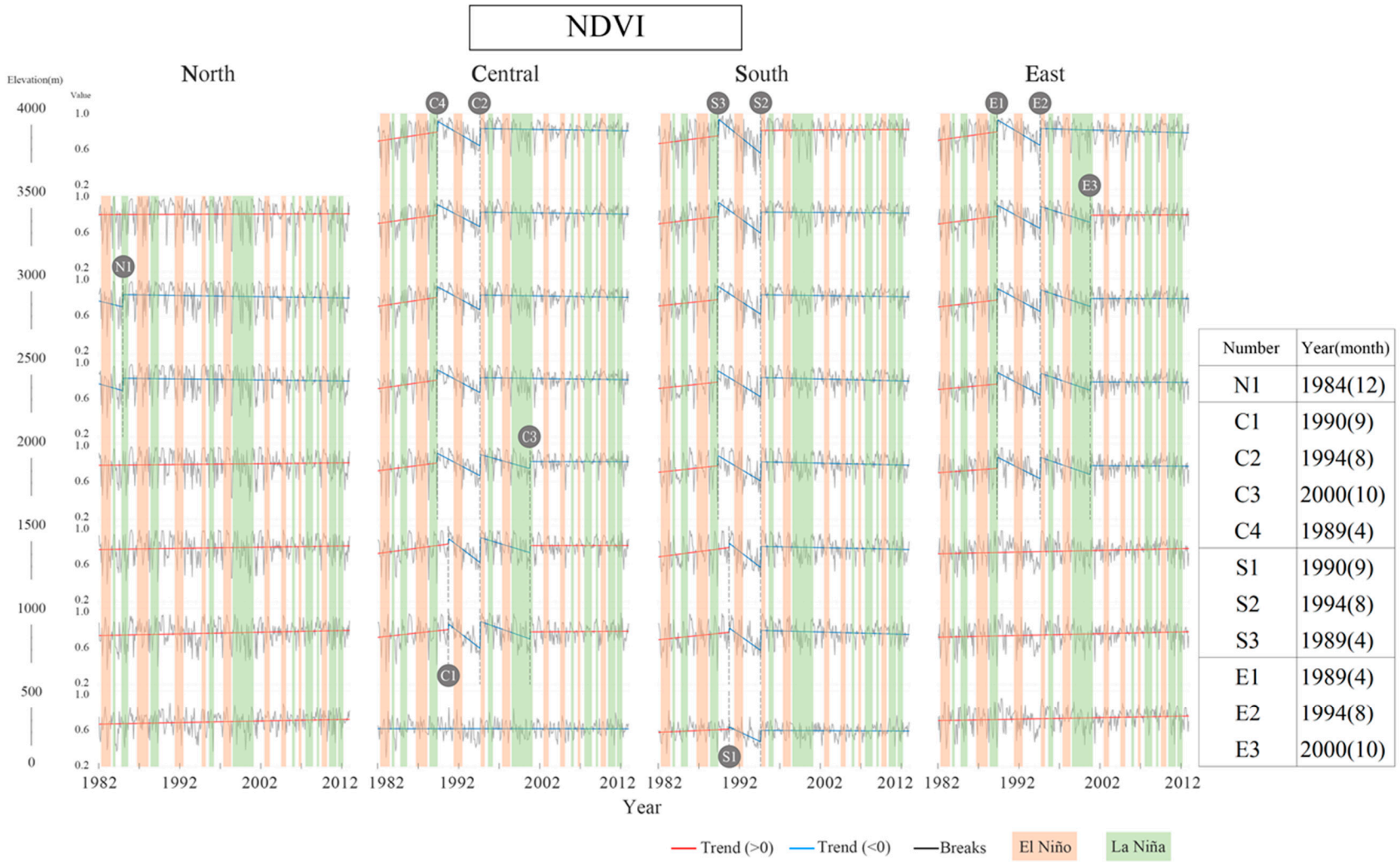
The vegetation trend in the South region is relatively consistent with breakpoints around 1989-1990 and 1994. However, it has begun from an upward trend to a significant deterioration from 1989 to 1994. Only the South region's highest altitude of 3500-4000 meters presented an improved vegetation growth status after 1994. On the other hand, the East region showed a greening tendency below 1500 meters altitude, similar to the North region. Additionally, as the East region covers a large area across various latitudes, the NDVI pattern of 1500 to 4000 meters has shown a good agreement with patterns found of the same altitude in Taiwan, reflecting the overall NDVI trend throughout Taiwan.

S2 Rainfall

The results of the regional BFAST analysis of rainfall at varied elevations are shown in Supplementary Figure S2. The results showed no breakpoints had been found in each altitude range for the whole island, and the trends are all positive. In short, the rainfall in Taiwan is gradually increasing islandwide.

S3 Temperature

The average temperature (Avg-Temp), the maximum temperature (Max-Temp), and the minimum temperature (Min-Temp) of the BFAST analysis results are shown in Supplementary Figures S3, 4, 5, respectively. Again, a complicated mixed situation was observed with various occurring times and numbers of breakpoints. The average temperature (Figure S3) seemed to be controlled by the maximum and the minimum temperatures. At low altitudes from 0 to 500 meters, except for the East region, the North, Central, and South regions show an increasing pattern. The urbanization level may contribute to the associated urban heat island effect across this low altitude range [52]. On the other hand, in terms of the maximum temperature (Figure S4), most regions showed a decreasing trend, whereas the minimum temperature (Figure S5) showed an increasing tendency. This opposite transition just explained the smaller temperature variations in Taiwan, implying a less pronounced seasonality nowadays.



Number	Year(month)
N1	1984(12)
C1	1990(9)
C2	1994(8)
C3	2000(10)
C4	1989(4)
S1	1990(9)
S2	1994(8)
S3	1989(4)
E1	1989(4)
E2	1994(8)
E3	2000(10)

Figure S1. Regional BFAST results for NDVI at varied elevations.

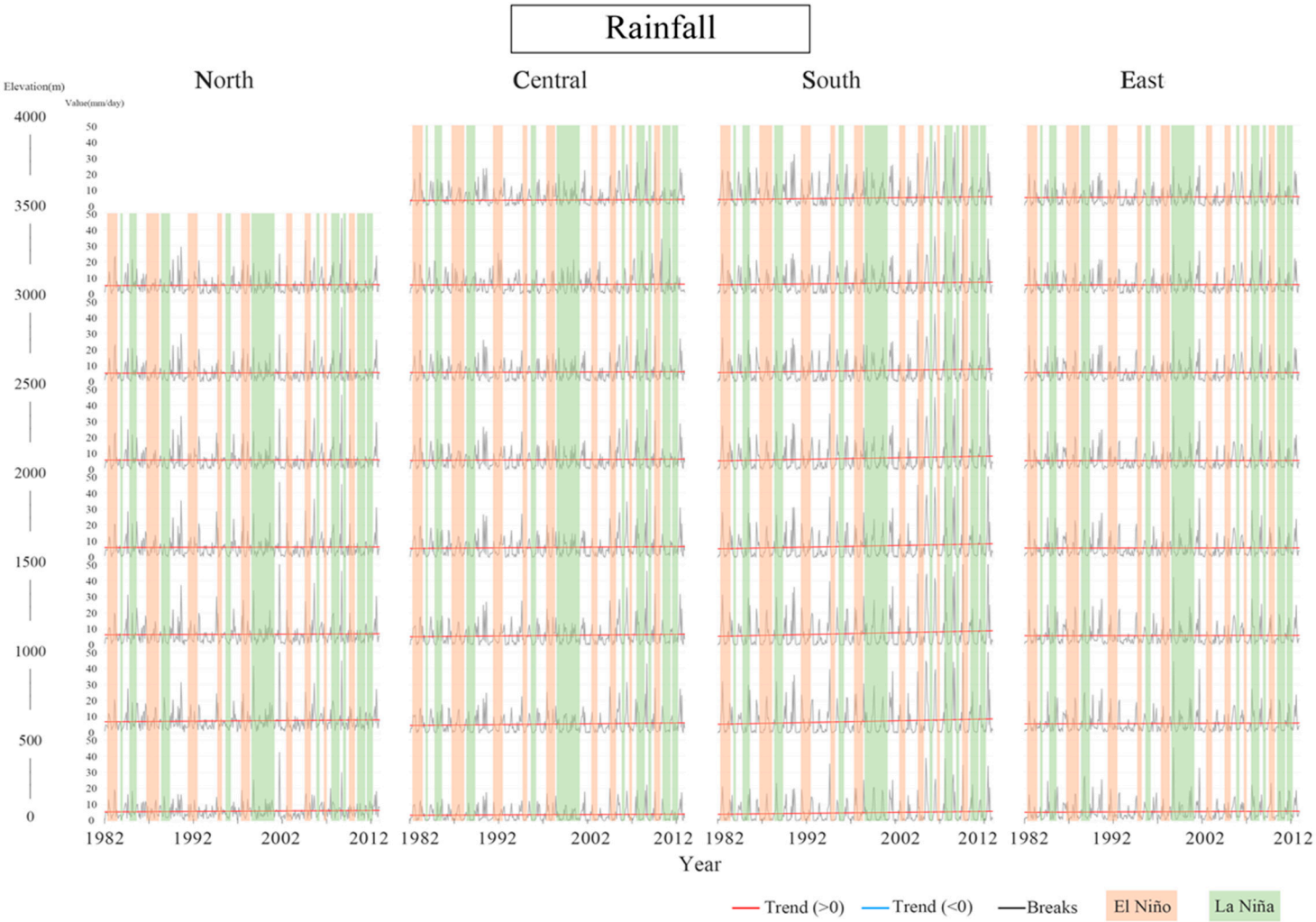
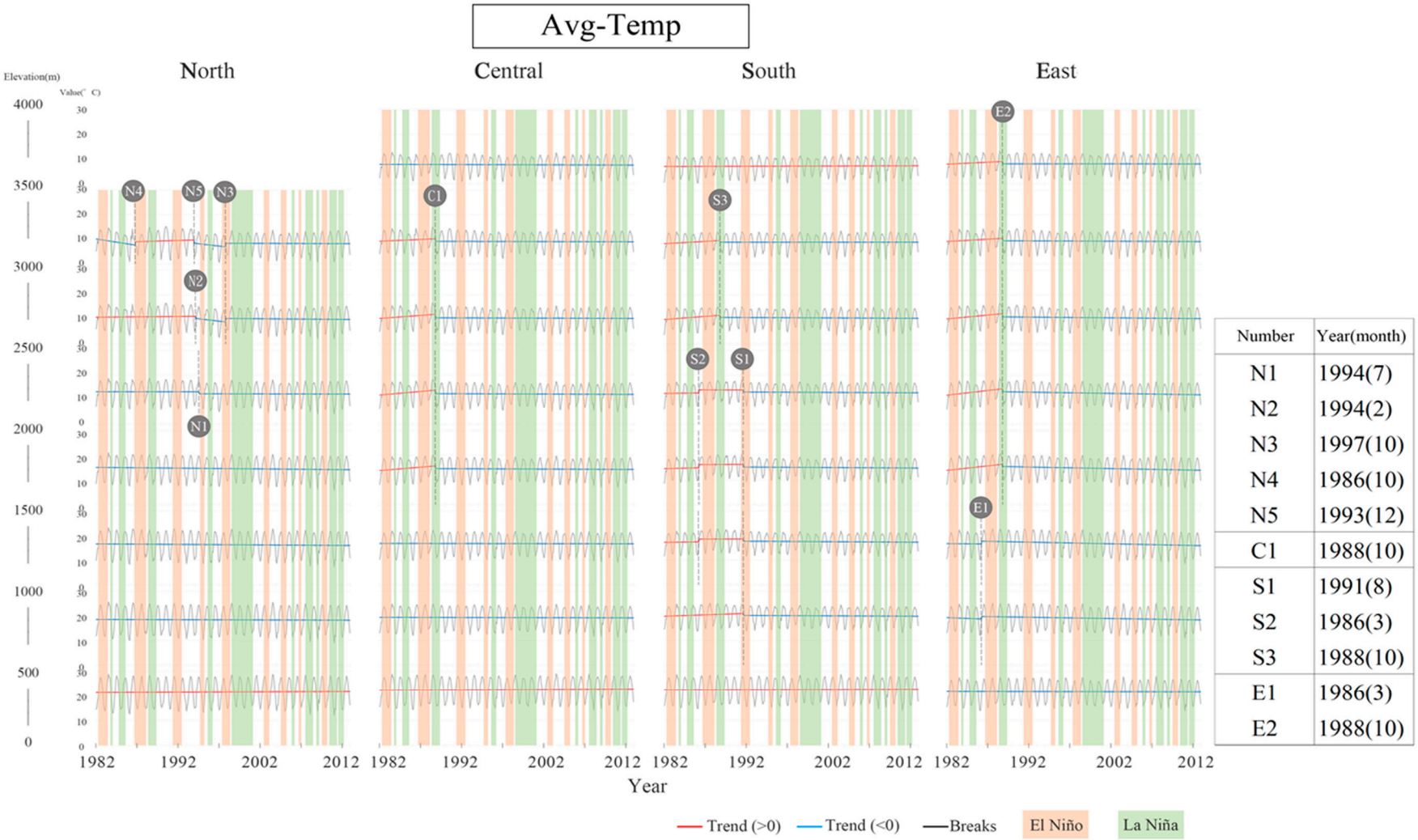
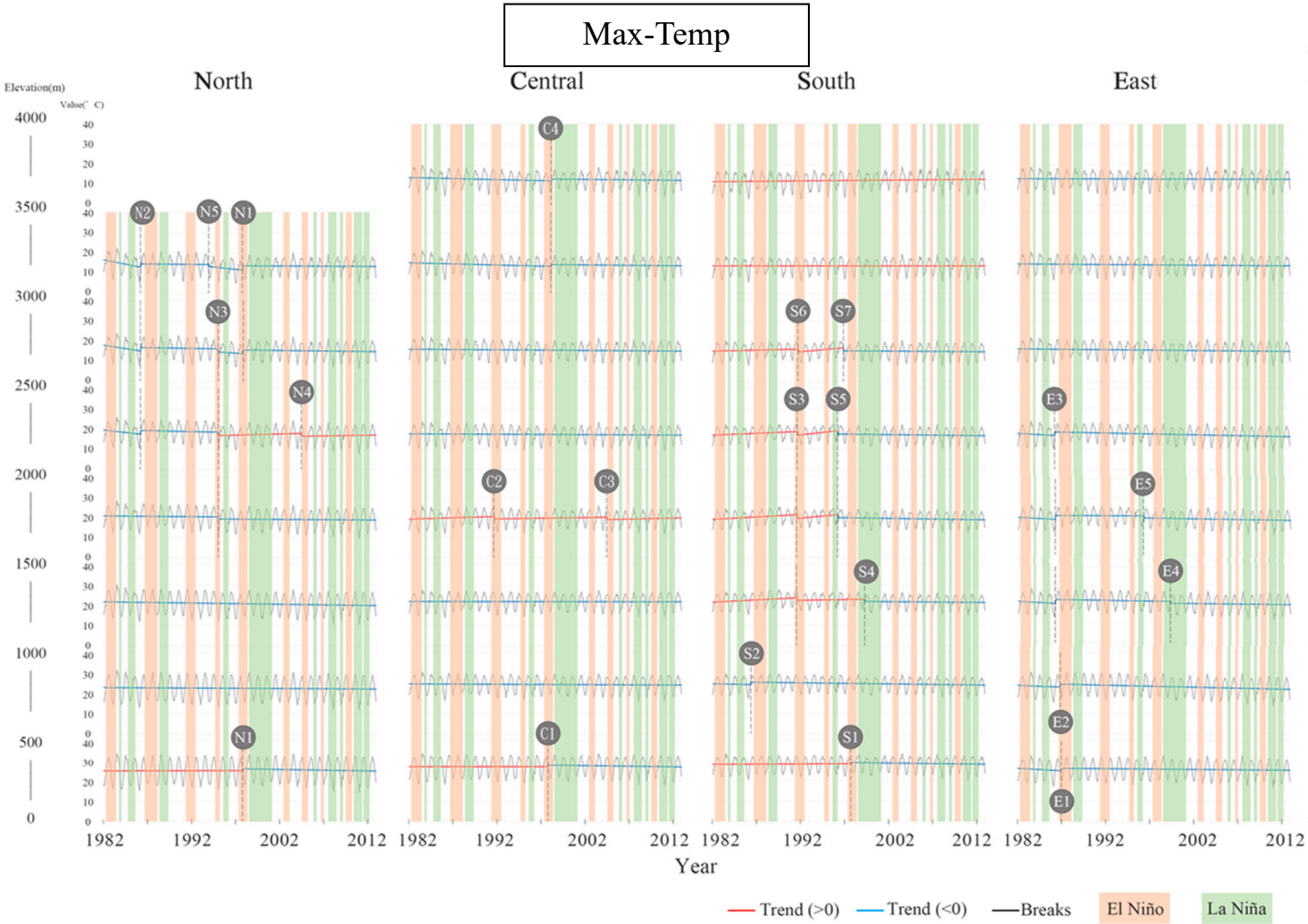


Figure S2. Regional BFAST results for rainfall at varied elevations.



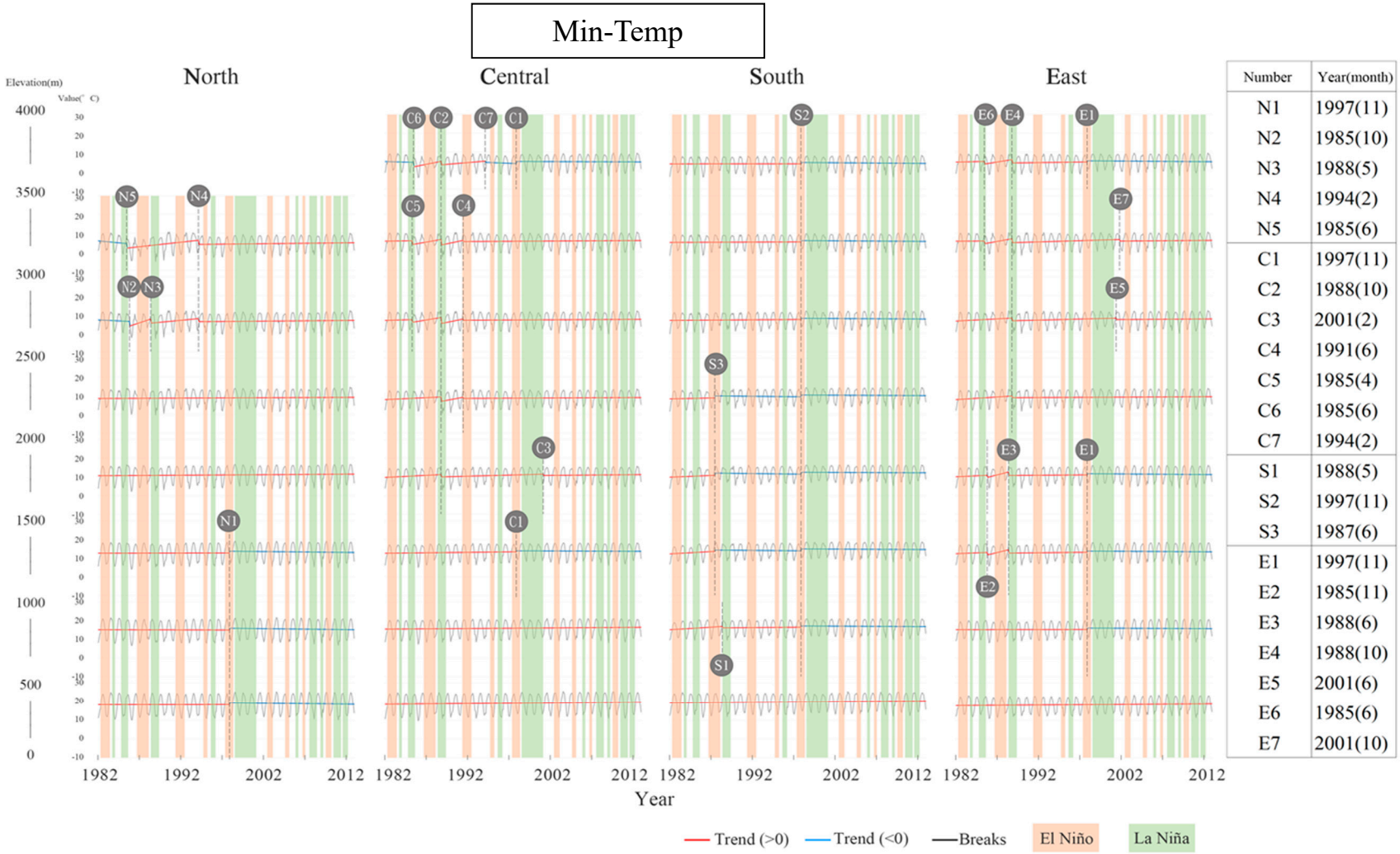
Number	Year(month)
N1	1994(7)
N2	1994(2)
N3	1997(10)
N4	1986(10)
N5	1993(12)
C1	1988(10)
S1	1991(8)
S2	1986(3)
S3	1988(10)
E1	1986(3)
E2	1988(10)

Figure S3. Regional BFAST results for the average temperature at varied elevations.



Number	Year(month)
N1	1997(10)
N2	1986(3)
N3	1995(1)
N4	2004(6)
N5	1994(1)
C1	1997(10)
C2	1991(8)
C3	2004(6)
C4	1998(2)
S1	1997(9)
S2	1986(6)
S3	1991(7)
S4	1999(4)
S5	1996(3)
S6	1991(9)
S7	1996(11)
E1	1986(12)
E2	1986(10)
E3	1986(3)
E4	1999(4)
E5	1996(3)

Figure S4. Regional BFAST results for the maximum temperature at varied elevations.



Number	Year(month)
N1	1997(11)
N2	1985(10)
N3	1988(5)
N4	1994(2)
N5	1985(6)
C1	1997(11)
C2	1988(10)
C3	2001(2)
C4	1991(6)
C5	1985(4)
C6	1985(6)
C7	1994(2)
S1	1988(5)
S2	1997(11)
S3	1987(6)
E1	1997(11)
E2	1985(11)
E3	1988(6)
E4	1988(10)
E5	2001(6)
E6	1985(6)
E7	2001(10)

Figure S5. Regional BFAST results for the minimum temperature at varied elevations.