

Supplementary Material

The combined QBO and ENSO influence on Tropical Cyclone Activity over the North Atlantic Ocean

Alejandro Jaramillo, Christian Dominguez*, Graciela Raga and Arturo I. Quintanar

Instituto de Ciencias de la Atmósfera y Cambio Climático, Universidad Nacional Autónoma de México, Mexico City, Mexico

* Correspondence: dosach@atmosfera.unam.mx

Table S1. Classification of the years from 1953 to 2020 by ENSO+QBO phases. The numbers in parenthesis corresponds respectively to the mean value of ONI and QBOI for the season JJASON.

El Niño + QBOW	El Niño + QBOE	La Niña + QBOW	La Niña + QBOE	Neutral + QBOW		Neutral + QBOE	
1953 (0.78, 0.54)	1965 (1.57, -1.37)	1955 (-1.06, 1.25)	1954 (-0.73, -0.55)	1959 (-0.1, 1.2)	2013 (-0.29, 1.07)	1956 (-0.49, -1.13)	1996 (-0.35, -1.52)
1957 (1.32, 1.15)	1968 (0.52, -1.27)	1964 (-0.7, 0.51)	1970 (-0.68, -1.39)	1961 (-0.08, 1.03)	2016 (-0.49, 1.05)	1958 (0.49, -1.17)	2001 (-0.19, -1.02)
1963 (1.07, 0.35)	1972 (1.49, -1.11)	1971 (-0.82, 1.14)	1974 (-0.57, -1.28)	1966 (0.04, 1.21)	2019 (0.32, 0.87)	1960 (0.16, -1.04)	2003 (0.17, -1.4)
1969 (0.63, 0.91)	1986 (0.57, -0.95)	1973 (-1.39, 0.84)	1988 (-1.36, -0.06)	1978 (-0.31, 0.75)		1962 (-0.16, -1.2)	2005 (-0.18, -1.42)
1977 (0.54, 0.1)	1991 (0.77, -0.94)	1975 (-1.28, 1.2)	1998 (-1.03, -1.15)	1980 (0.13, 1.09)		1967 (-0.19, -0.5)	2012 (0.22, -1.53)
1982 (1.38, 0.34)	1994 (0.6, -0.76)	1995 (-0.6, 0.53)	2000 (-0.6, -1.17)	1985 (-0.43, 0.88)		1976 (0.46, -0.88)	2014 (0.27, -1.35)
1987 (1.47, 0.43)	2009 (0.73, -0.83)	1999 (-1.19, 0.88)	2007 (-0.96, -1.42)	1990 (0.36, 1.04)		1979 (0.26, -1.18)	2017 (-0.25, -1.0)
1997 (1.93, 0.89)		2010 (-1.32, 0.46)		1992 (0.09, 0.32)		1981 (-0.21, -1.2)	2018 (0.41, -0.52)
2002 (0.97, 0.65)		2011 (-0.74, 0.15)		1993 (0.24, 0.02)		1983 (-0.22, -0.64)	
2004 (0.57, 0.78)		2020 (-0.77, 0.93)		2006 (0.44, 0.9)		1984 (-0.44, -1.23)	
2015 (1.95, 1.04)				2008 (-0.39, 0.96)		1989 (-0.27, -1.35)	

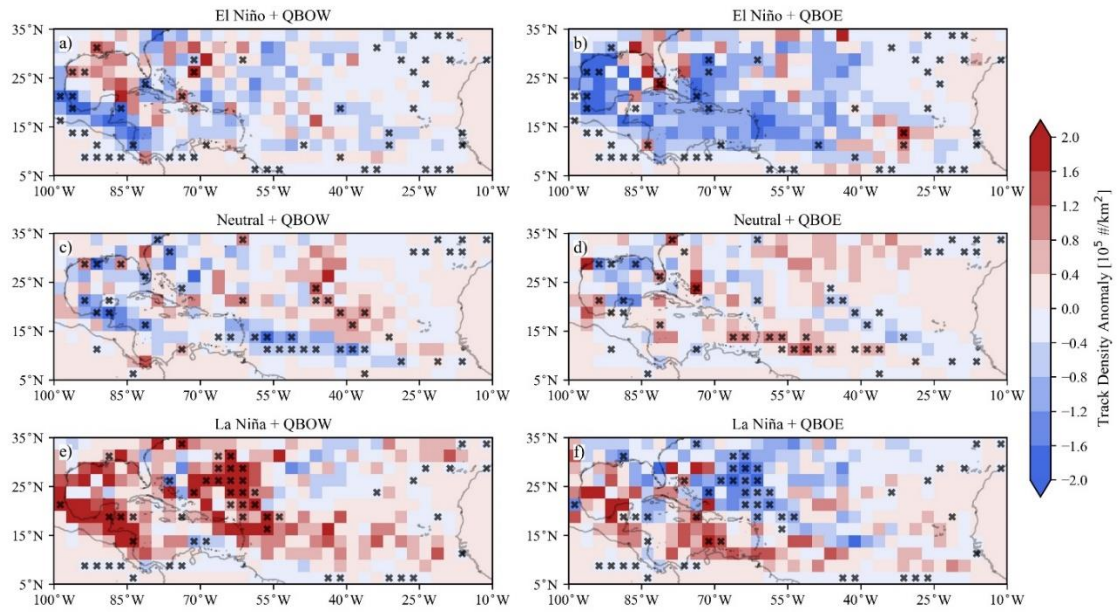


Figure S1. Mean TCs track density anomalies during the season JJASON for the years classified as ENSO and QBO phases: a) El Niño-QBOW, b) El Niño-QBOE, c) Neutral-QBOW, d) Neutral-QBOE, e) La Niña-QBOW, and f) La Niña-QBOE during the 1953-2020 period. The crosses show the regions where the p-value of a two-sided T-test is lower than 0.1.

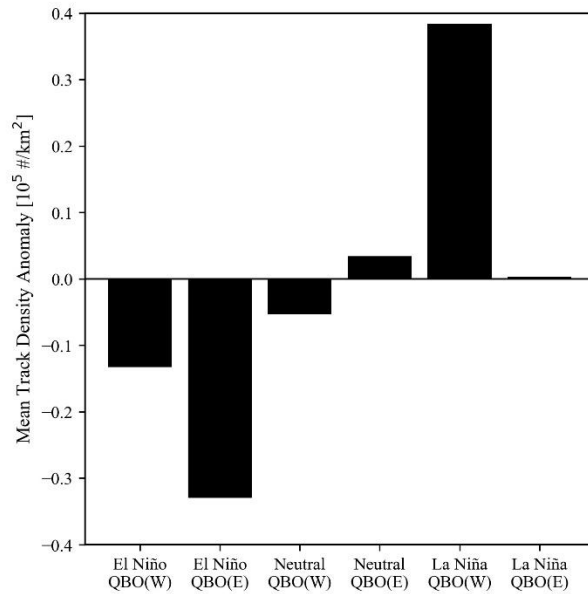


Figure S2. Mean TCs track density anomalies for the whole domain of North Atlantic for each ENSO-QBO phase combination during the 1953-2020 period.

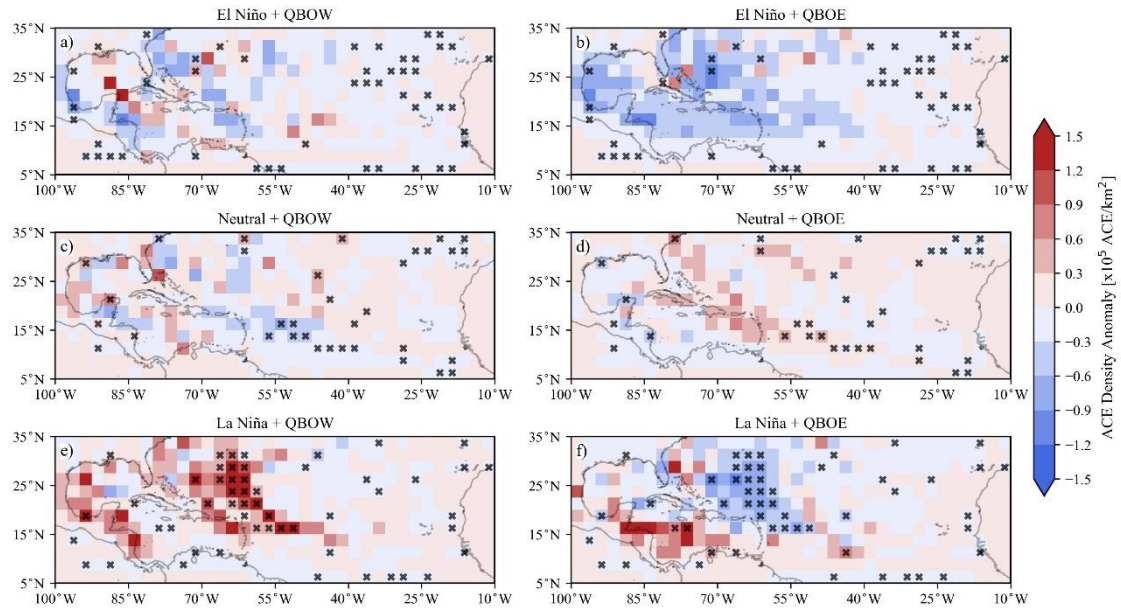


Figure S3. Same as Figure S1, but for the Mean ACE density anomalies during the season JJASON for the years classified as ENSO and QBO phases during 1953-2020 period. The crosses show the regions where the p-value of a two-sided T-test is lower than 0.1.

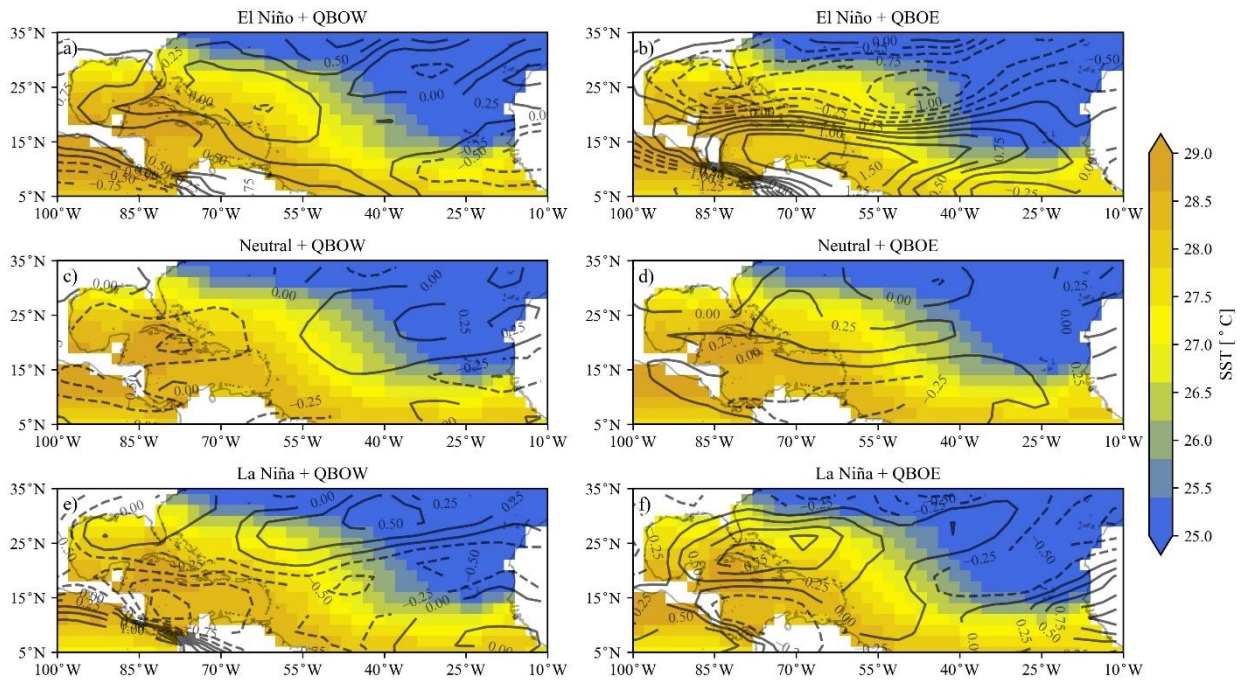


Figure S4. Mean SSTs and standardized anomalies of tropospheric vertical wind shear between 850 hPa and 200 hPa during the season JJASON for the years classified as ENSO and QBO phases during the 1953-2020 period.

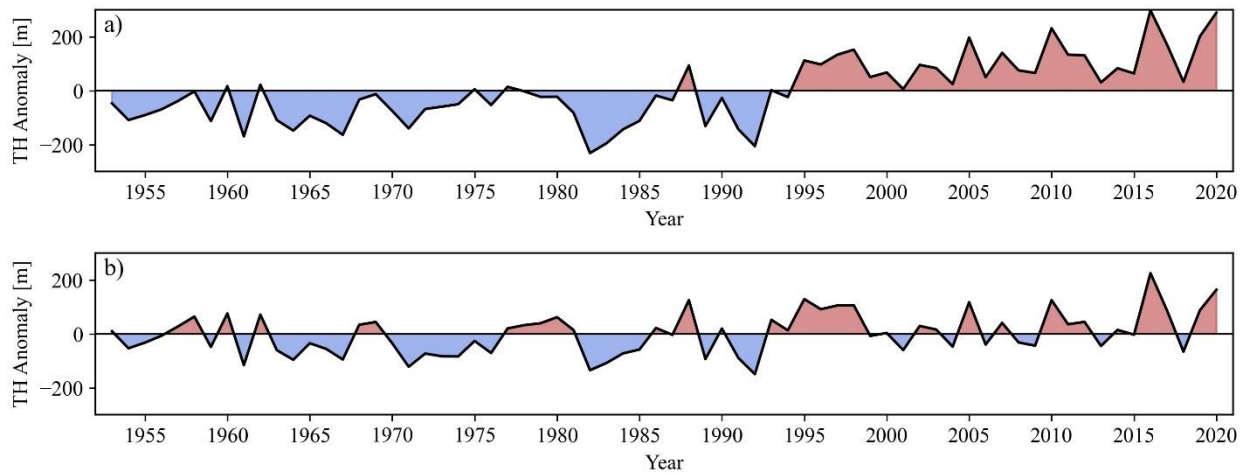


Figure S5. Time series of (a) the mean TH in the study region for the 1953-2020 period, and (b) filtered TH after removing multidecadal variability.

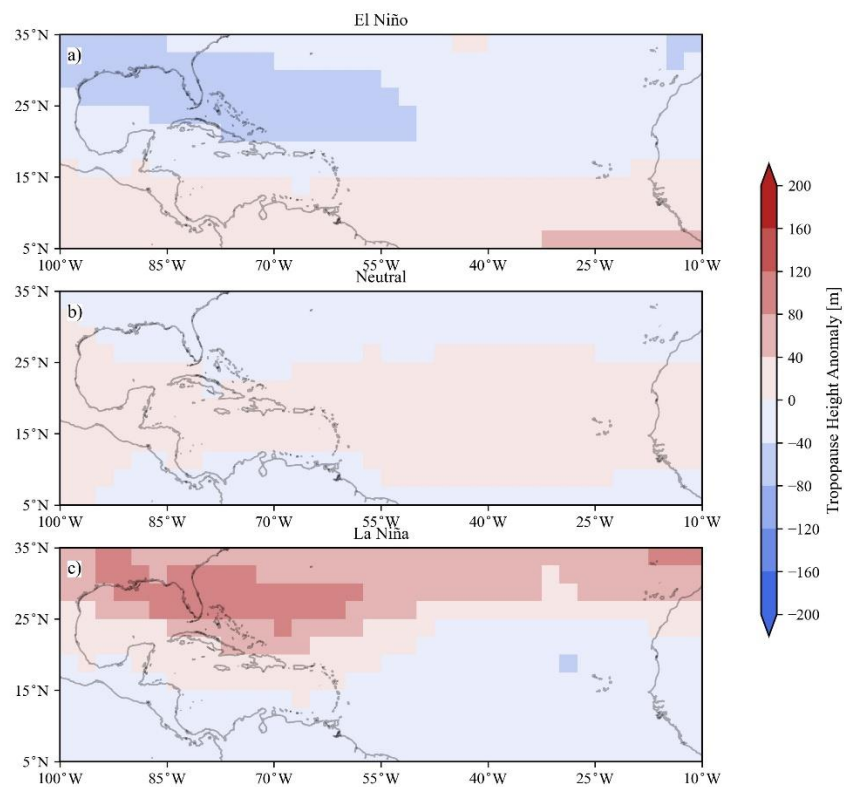


Figure S6. Mean tropopause height during the season JJASON for the years classified by ENSO phase: a) El Niño, b) Neutral, and c) La Niña during the 1953-2020 period.

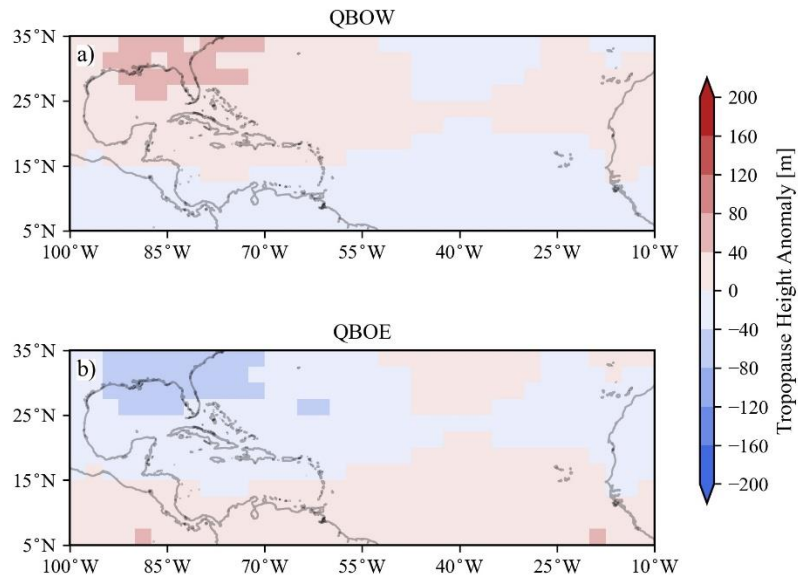


Figure S7. Mean tropopause height during the season JJASON for the years classified by QBO: a) QBO(W) and b) QBO(E) during the 1953-2020 period.

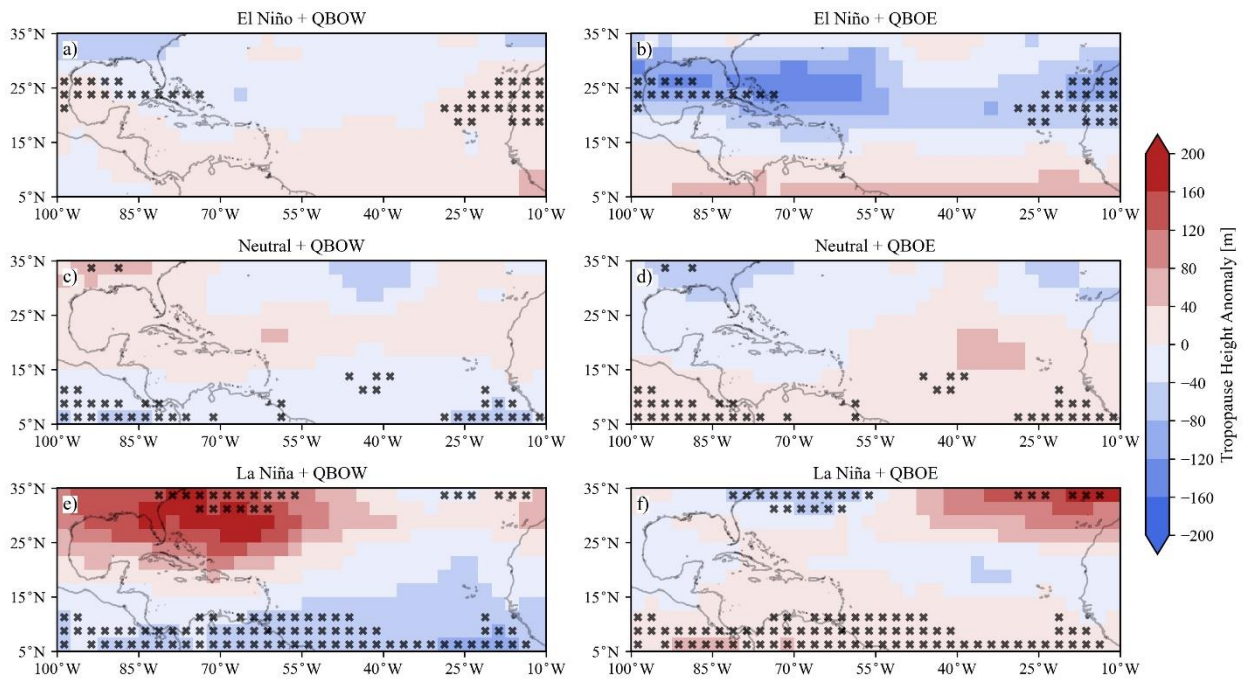


Figure S8. Same as Figure 6 for the NCEP-NCAR tropopause height anomalies for the season JJASON for the years classified by ENSO and QBO phases during the 1953-2020 period. The crosses show the regions where the p-value of a two-sided T-test is lower than 0.1.

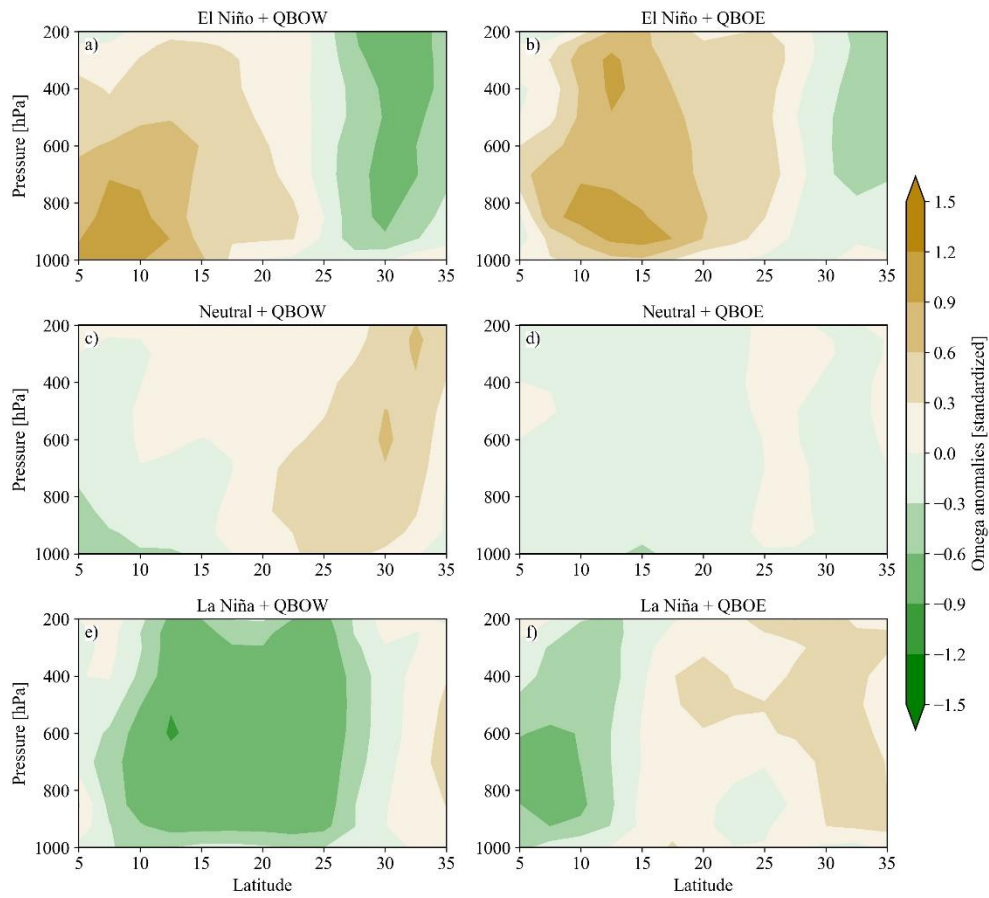


Figure S9. Cross-section standardized anomalies in Omega anomalies for the season JJASON for the years classified by ENSO and QBO phases during the 1953-2020 period.

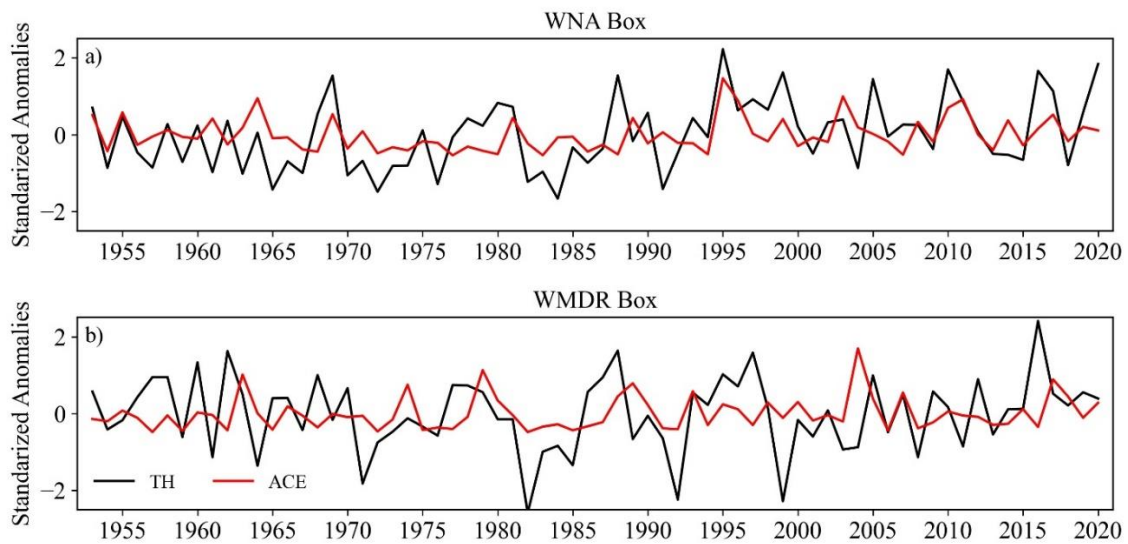


Figure S10. Time series of standardized anomalies for mean tropopause height (black) and ACE (red) for the boxes in a) the WNA and b) the WMDR during the 1953-2020 period.