

(39-220415-C) Forcing for Multidecadal Brightening and Dimming Trends over Northern Hemisphere Continents

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Multidecadal cycles of increasing and decreasing surface solar radiation, commonly known as brightening and dimming, have been well documented over the Northern Hemisphere (NH). Generally, dimming from the late 1950s to the mid-1980s, and brightening from the mid-to-late 1980s through the first decade of the 2000s has been observed over North America, Europe, and east Asia. The cause of these trends has been attributed to aerosols, clouds, or both. Although aerosols dominate in highly industrialized places like India and parts of China, cloud variability is the principal driver in North America and Europe. Recent dimming in the U.S. after 2012 has also been attributed to an increase in cloudiness. However, the meteorological forcing for decadal-scale cloud variability has not been identified. Here, the systematic variation of northern ocean sea surface temperatures (SSTs) is identified as the possible source. Dimming over the North America and east Asia is shown to be coincident with the transition of the Pacific Decadal Oscillation (PDO) from a cold to warm phase, and vice versa for brightening. Reanalysis is used to relate SST patterns to geopotential height patterns and their relation to brightening and dimming over the continents. Warm SST anomalies are associated with high mid-level geopotential height anomalies, and cold SSTs are associated with low mid-level height anomalies (see figure). Restrictions on the size of Rossby waves dynamically force height anomalies of the opposite sign on either side that could affect continental weather downstream. Sequential subperiods of the dimming and brightening eras are analyzed to show how changing SSTs relate to changing height patterns and how they affect long-term weather patterns over the continents.

1947 – 1956 Anomalies (Reference: 1953 – 2012)

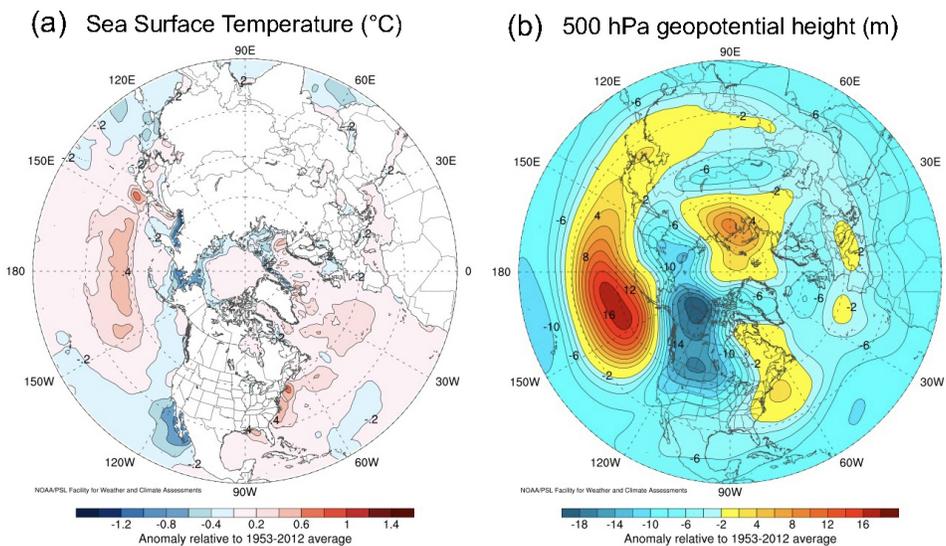


Figure 1. Figure (a) Northern Hemisphere SST anomalies (C) for the PDO cold phase period (1947 – 1956) relative to the base period (1953-2012). (b) Northern Hemisphere 500 hPa geopotential height anomalies (m) for that same period relative to the base period.