Mechanisms of monsoon variability across South Asia are of growing interest as the planet warms and changes. Monsoon rains provide fresh water for much of the population in this region, and is the dominant driver for primarily agrarian societies, meaning monsoon failures can lead to large scale drought, famine, and death for the inhabitants of this area. One proposed mechanism of monsoon variability is changes in the evaporation – precipitation budget for the North Arabic Sea stemming from increased solar variability. Recent studies examine this mechanism and its implications for the South Asian region in a warming climate.

Monsoon patterns create a distinct zonal precipitation gradient over the North Arabic Sea. By examining two sediment cores taken from geographically distinct regions, M5-422 from the Gulf of Oman and 63 KA from the formerly active Indus River delta, Staubwasser et. al. determined that a monsoon failure and subsequent extreme drought occurred approximately 4.2 ka. The δ18O record of 63 KA shows a positive shift towards heavier δ18O at 4.2 ka. The Gulf of Oman, which is unaffected by summer monsoon upwelling, shows opposing δ18O trends that are difficult to explain in terms of SST. Instead, increases in evaporation resulting in high saline environments are proposed to create the observed δ18O trends. At the time of the 4.2 ka drought, Staubwasser determined there to be an increase in dust flux and decrease in Indus river discharge, leading to the destabilization of Mesopotamian societies and decline of Harappan civilization.

Using δ18O as a temperature proxy, Thompson et al. examined cores from Dasuopu, Tibet, high on the Tibetan Plateau. These cores were of higher resolution than those used by Staubwasser et al. due to distinct seasonality of δ18O by enrichment and high aerosol concentrations in the winter, and δ18O depletion during the summer wet season. Layer counting for these cores was verified by location of a 1963 beta radioactivity horizon produced by the 1962 atmospheric thermonuclear tests in the Arctic, with resulting resolution to 1440 AD ± 3 years. This study revealed a negative relationship between precipitation and dustiness, as well as a high aerosol concentrations in the spring before the summer monsoon. Annually averaged δ18O, aerosol, and dust concentrations from core C3 have spikes as a result of long dry periods, similar to the 4.2 ka event discussed by Staubwasser et. al. Thompson et. al. mentions two large scale monsoon failure events, 1790-1796 and 1876-1877, the former being the most intense. This event is concurrent with the strong ENSO of 1790-1793, which lead to droughts across the globe as well. As core C3’s SO42- decreases with snow accumulation and summer monsoons, it suggests that snow accumulation is a measure of monsoon intensity. The 19th century sees a continual decrease in SO42-  leading to a proposed intensification of summer monsoon circulation. Building off of Staubwasser et. al., δ18O is a proxy for temperature, and this paired with its strong correlation to dust concentrations implies a direct link between warming and atmospheric dustiness. The δ18O record of Dasuopu suggests significant evidence of global warming, with the greatest rates at higher elevations.

Both of these studies suggest that solar variability is one mechanism for monsoon variability and that rising global temperatures are already affecting the Tibetan Plate region. With what we know of historic intense droughts in this area, human lives are at stake if current warming trends persist and monsoons fail, leading to increased aridity and decreased amounts of snowfall that is a main source for irrigation and drinking water in South Asia.