Accurate estimation of precipitation is critical for hydrology, study of the Earth system, and various water-related applications. This study investigates the performance of various precipitation products in two challenging areas. First, their performance in capturing Atmospheric rivers (ARs) precipitation and extreme events related to ARs and, second, precipitation estimation over cold surfaces with snow and ice on the surface. Atmospheric rivers are a part of a larger earth system that transports moisture from tropics toward the poles. They are usually associated with strong winds and heavy precipitation. However, lack of ARs could cause severe droughts as experienced over California in 2010. The first chapter of our study comprises investigation of AR-related precipitation using 18 years (2001–2018) of globally gridded AR locations. AR precipitation features are explored regionally and seasonally using remote sensing and reanalysis precipitation products. The second chapter includes assessment of IMERG’s various products (IMERG products include precipitation estimates from infrared (IR), combined PMW, and their combination) with respect to near-surface wet-bulb temperature (Tw), precipitation intensity, and surface type (i.e., with and without snow and ice on the surface) over the CONUS and using Stage-IV product as reference precipitation.