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On tracking moisture during heatwaves – a case of Europe.

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Moisture recycling capability of a region has been increasingly studied in terms of its persistence on climatological, yearly, and seasonal scales, rather than of their response to an extreme event. In Europe, heatwave is a phenomenon that will become more relevant in the future and understanding how moisture is transported during heatwaves might help alleviate some of the severe drought-related impacts. In this study, Northern, Western, and Southern Europe are looked into separately as moisture sink regions, given that an increase in heatwaves is likely to be experienced differently among them. The moisture recycling model Water Accounting Model (WAM-2layers) is used to backward track moisture that precipitates in these sink regions and a comparison on moisture source regions between climatological summer mean and heatwaves is done. As heatwaves can intensify upon dry soil, only heatwaves that occurred in relatively dry years between 1979 and 2017 are taken into account. A preliminary selection of heatwave events for the three regions is done using combined criteria of (1) lowest 50% of MJJA precipitation, (2) highest 25% of daily JJA maximum temperature for five consecutive days, and (3) highest 20% of daily JJA mean temperature for five consecutive days. This results in eight, five, and eight heatwave events for Northern, Western, and Southern Europe, respectively. A general finding in both climatological mean and heatwaves, is that most moisture in all three regions is supplied from the North Atlantic Ocean that extends down to the east of the United States. Tracking the precipitation in the sink regions during heatwaves uniformly suggests that the recycling of moisture within their own regions decreases. In contrast, it appears that the reliance on their immediate surrounding increases significantly for each sink region. During heatwaves, (1) Northern Europe receives more moisture from the Baltic Sea, Central Europe, and Eastern Europe, (2) Mediterranean Sea, North Sea, North Atlantic Ocean, and Eastern Europe play a more significant role as source regions for Western Europe, and lastly, (3) more moisture is supplied from the Mediterranean Sea and Africa to Southern Europe. With regards to the extent of moisture source regions, Northern and Southern Europe seem to be most affected by the heatwaves, while no significant change is observed for Western Europe. In addition, when heatwaves are analyzed individually, some years, such as 2002, 2003, 2005, 2006, and 2014, show a distinctive pattern in terms of moisture contribution from the North Atlantic Ocean, which might suggest a change in direction of the atmospheric flow during heatwaves. In conclusion, this study shows that (1) unlike previous studies suggesting that moisture recycling within a certain region would increase during generally dry years, moisture recycling ratio appears to decrease during heatwaves in dry years, (2) Northern, Western, and Southern Europe rely on moisture from the surrounding seas and oceans and to a lesser extent, from continental Europe, during heatwaves, and (3) diversion of moisture source regions from the North Atlantic Ocean to continental Europe seems to be the case for some specific years of heatwaves.