Causes and contributing factors of heat waves engineering essay

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Basically there are two types of heat waves. Dry heat waves often bring clear skies and large input of solar radiation, which usually occur in locations with a continental or Mediterranean climate. Moist heat waves have characteristically very warm humid conditions during day and night with a large amount of cloud coverage. These usually occur in mid-latitude temperate and maritime climates.

The main cause of heat waves are high pressure systems, located in the midlevel/higher troposphere, which remain over a location for a prolonged time. Under pressure the air subsides and sinks towards the surface, compressing the air at the surface causing the temperature to rise. This sinking creates a dome with winds blowing outward, trapping the heat inside and disallowing mixing with other weather potentially cooling the surface. When the air sinks from a high pressure system, heat is unable to rise and cumulus clouds cannot be formed. In this way the area will not be cooled by rain solar radiation directly hits the surface, resulting in a building temperature.

Another important factor in the formation of heat waves is the location of the jet streams. Jet streams are narrow, fast flowing air currents near the tropopause formed by the earth’s rotation and atmospheric heating. During a heat wave, a jet stream lies above an affected area disallowing transported polar air mass to cool the area.

Heat wave are also seasonally bound because of a slower, meandering jet stream during summertime. Jet streams are formed by change in temperature between colliding Arctic and tropical air masses, which are

weaker during summer causing it to slow down. A slower jet stream causes less change in weather patterns, therefore increasing stationary weather conditions explaining why heat waves occur during summer.

Furthermore, land-atmosphere coupling is found to increase mean, maximum as well the minimum temperatures averaged over warm summers. Research by Fischer et al (2007) indicates the very important role of dry soils in driving/enhancing heat wave episodes in 1976, 2003, and 2005. In addition, when vertical mixing of air is weak due to the sinking air, it produces strong stability and the continuance of humidity near the surface.

Landscapes with surfaces that hold heat can amplify the effect of a heat wave. The urban heat island effect is the phenomenon whereby urban regions experience warmer temperatures than their rural surroundings. The annual mean air temperature of a city with one million or more people can be 1 to 3°C warmer than its surroundings, and on a clear, calm night, this temperature difference can be as much as 12°C (Oke, T. R, 1997)

Based on the characteristics heat waves are more likely to occur in locations with high variable summer climate or clear hot seasons.

Climate change and heatwaves:

Some researchers link climate change to the increased frequency and intensity of meteorological event as wind storms, prolonged drought, cold spells and heat waves. Recent observational studies have demonstrated that the frequency of hot summer days and heat waves over Europe has increased in recent decades along with an enhanced variability of interannual and daily summer temperatures (Klein Tank et al. 2002).

Results demonstrate that the European summer climate might experience an increase in year-to-year variability in response to greenhouse-gas forcing. Such an increase in variability might be able to explain the unusual European summer 2003, and would strongly affect the incidence of heat waves and droughts in the future. According to research from CO2 doubling would lead to an increase by 10°C in average temperature in the a 1-in-20-yr heat wave event in the Great Lakes. This heat wave, lasting 5 days with intensity range of between 28° and 34°C under present day conditions, would become 38°C to 44°C when CO2 doubles. The research also shows similar changes due to CO2 doubling in the Czech Republic, Eastern China and South-West France (Clark et al in 2006).

Furthermore models indicate that there is a shift towards warmer and dryer climates with less soil moisture and could be connected to the increased amount of recent heat waves. The growing season is extended by warmer springs increasing the amount of soil water uptake by vegetation. (Seneviratne et al, 2006). In addition the physical processes that characterized the 2003 heat wave such as soil moisture depletion and the positive feedback on summer temperatures, and the lack of rainfall in many parts of the continent that generally occur from June – September, are projected to occur with greater frequency in the future.

Another consequence of climate change is the Arctic amplification, the faster rate at which the Arctic warms compared to the rest of the world. Also recent analysis of North American and North Atlantic atmospheric data from 1971-2010 found that this amplification makes the jet stream slower and wavier. As a result, blocking events become more likely. (Francis, Vivrus, 2012)

The numerous factors contributing to the formation and intensification of heat waves seem to increase in the future. IPCC states that for the next two decades, a warming of about 0. 2°C per decade is projected for a range of emission scenarios. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0. 1°C per decade would be expected. Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century. Lastly, anthropogenic warming and sea level rise would continue for centuries because of climate processes and feedbacks, even if greenhouse gas concentrations were stabilized. (IPCC, 2007)

The processes driving the variability changes are different for the three components but generally relate to enhanced land-atmosphere coupling and/or increased variability of surface net radiation, accompanied by a strong reduction of cloudiness, atmospheric circulation changes and a progressive depletion of soil moisture within the summer

season.

Warm climate.

Seasonal – Summer

Low latitude (but not necessarily)

High pressure systems, especially if relatively stationary

Little/no rain

Little/no cloud cover.

Dry land

Dark landscape with surfaces that hold heat – asphalt, rock, concrete.

There are generally four factors contributing to the formation of a heat wave. First the location of the jet stream, which should be above the affected area. Jet streams are narrow air currents flowing in the upper troposphere and tropopause. The northern and southern hemisphere both experience jet streams, and exist because of a combination of the earths rotation and a , which is a fast flowing stream of air currents near the tropopause, should be above the affected area, so polar air masses are not able to reach the region. Second, a high pressure system

The first involves the location of the jetstream. It should be above the affected area disallowing polar air masses to reach the region. Second, a high-pressure system may exist permitting the surface to be heated in the absence of moisture. A third related factor is a dry ground, which facilitates the heating of the surface. The fourth and final factor is the amount of vertical mixing of the air. Specifically, weak vertical mixing produces strong stability and the continuance of humidity near the surface.

The main cause is a high pressure area, located in the midlevel/higher troposphere, which strengthens and remains over a location for a prolonged time. This is common in summer in both the Northern and Southern Hemispheres because of the jet stream following the sun.

The jet stream

Summertime weather patterns are generally slower to change than in winter. As a result, this mid-level high pressure also moves slowly. Under high pressure, the air subsides (sinks) toward the surface. This sinking air acts as a dome capping the atmosphere.

Heat waves can be caused by various different weather conditions but the main cause is when an area of high pressure becomes stationary over a location. Due to the high pressure, other weather conditions cannot dissipate the heat and therefore the ground and the air become much hotter than would normally be recorded. The high pressure discourages cloud cover meaning the sun is constantly heating the location during the day and the pressure in the air stops wind currents moving the heat on.

The atmospheric pressure systems that control the local weather are made up of areas of high pressure and areas of low pressure. These move around and bring with them various weather conditions. In an area of high pressure, the air from the atmosphere is at a higher pressure than the air around that location. This causes drier air and blue skies. When this area of high pressure becomes stationary over a global position, that area experiences cloudless skies and rises in day time temperature. The longer the high pressure is stationary, the larger the rise in temperature as other weather conditions, such as rain or wind, are unable to enter the environment and cool these temperatures.

There are however other causes of heat waves, but the important point is that other weather conditions are unable to enter the location and cool the

temperature. Desert winds can cause heat waves as they naturally blow warm air into cooler areas. If this location, either due to seasonal or geographic reasons is unable to cool the temperature, the area will experience a heat wave.

There usually are four atmospheric conditions necessary in forming a heatwave, although they do not have to occur at the same time. At first, a

The first involves the location of the jetstream. It should be above the affected area disallowing polar air masses to reach the region. Second, a high-pressure system may exist generally to the east permitting the surface to be heated in the absence of moisture. A third related factor is a dry ground, which facilitates the heating of the surface. The fourth and final factor is the amount of vertical mixing of the air. Specifically, weak vertical mixing produces strong stability and the continuance of humidity near the surface.

Mainly because an area of high atmospheric pressure becomes stationary over a location. The high pressure prohib

A heat wave is in effect when a location has excessively high temperatures, compared to normal, for a prolonged period of time.

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Modeling Northern Hemisphere Summer Heat Extreme Changes and Their Uncertainties Using a Physics Ensemble of Climate Sensitivity Experiments)

ROBIN T. CLARK, SIMON J. BROWN, AND JAMES M. MURPHY

Severe and Hazardous Weather: An Introduction to High Impact Meteorology (Bob Rauber, John Walsh, Donna Charlevois

Seneviratne S, Lüthi D, Litschi M, Schär C. Land-atmosphere coupling and climate change in Europe. Nature [serial online]. September 14, 2006; 443(7108): 205-209.