Abstract

Hurricane Sea to Air Heat Transfer

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Warm sea water is the energy source for hurricanes. Interfacial sea-to-air heat fluxes calculated using the Dalton coefficient range from 100 W/m^2 in light wind to 1000 W/m^2 in hurricane force wind. The heat required to evaporate the precipitation produced in a hurricane is roughly equal to he heat removed from the sea and can be as high as 500 TW. A heat flow of 500 TW would require an eyewall heat flux of over 100,000 W/m^2 which is 2 orders of magnitude higher than the heat flux calculated using the Dalton coefficient.

Drops of spray cool to the wet bulb temperature of the air before falling back in the sea and can be 2 to 4 °C cooler than the drops leaving the sea thus transferring a large quantity of heat from sea to air. The heat of evaporation is taken from the sensible heat of the remainder of the drop. Evaporating 0.3% to 1% of a drop is sufficient to reduce its temperature to the wet bulb temperature of the air. Heat transfer from drops to air is much higher than from sea surface to air because drops have much higher surface to mass ratios. The cooling of small drops takes place in seconds because evaporation occurs quickly so long as the vapor pressure of the water in the drop is higher than the vapor pressure of the water vapor in the air.

Spray can produce very high heat fluxes; the heat which took months to be accumulated in the upper layer of the sea can be transferred to the atmosphere in a matter of hours. The sea cooling is concentrated to the right of the hurricane track. Wind is strongest on the right side of the storm. The spray is heaviest in the rear right quarter of the storm

where the wind is at its strongest and where in addition the wind direction has just reversed so that the top of well established waves is torn off by head wind. The cooled spray is prevented from falling directly back in the sea by upward velocity and is centrifuged out to the right of the storm track. Isenthalpic mixing of spray with air can explain high hurricane sea to air heat transfer. Cross correlation heat flux measurements could be underestimating hurricane heat fluxes. The observed hurricane sea cooling is due to heat removal from above and not to the mixing of cold water from below.