P1.8 CHANGES IN THE AIR-SEA TEMPERATURE DIFFERENCE OF THE NORTH ATLANTIC FOR THE PAST 50 YEARS

Henry F. Diaz, Jon K. Eischeid
NOAA/ESRL/PSD Climate Diagnostics Center, Boulder, Colorado
Richard J. Murnane
Risk Prediction Initiative, BBSR, Bermuda

1. INTRODUCTION

Changes in the difference between the air and sea surface temperatures are documented for much of the North Atlantic Ocean for the period 1960–2002, and possibly earlier. We have found a reduction in sea-air temperature gradient for the region of the subtropics (~20˚N–40˚N) that is likely a combination of an increase in wind speed and air near the ocean surface warming more than the sea surface. In the subpolar regions (~45˚N–60˚N) there has been an increase in the air-sea temperature difference over this time.

We examine the impact of these changes on the behavior of the sensible and latent heat fluxes, using surface marine observations from ICOADS (Worley et al., 2005) and from the NCEP-NCAR Reanalysis dat set (Kistler et al., 2001).

2. DATA AND METHODS

The ICOADS files, besides the SST and AT summaries, contain information that is proportional to the surface sensible and latent heat fluxes. The variables are:

$$SHF = W^*(SST - AT), \qquad LHF = W^*(Q_S - Q_a), \quad (1)$$

where, W is the wind speed, Q_s and Q_a are the saturation and air specific humidity, and SHF and LHF are the so-called 'pseudo' sensible and latent heat fluxes, respectively.

We calculated the changes in (SST-AT) and in SHF and LHF from ICOADS, and examined the NCEP/NCAR Reanalysis near surface (925-mb) wind fields for evidence of trends in these variables since 1960. We used the one-degree (which starts in 1960) and two-degree resolution data from ICOADS and computed linear trends using different thresholds for data availability in time. For example, we calculated the linear trend for the period 1960–2002 requiring that the grid boxes contain at least 30 years of data in that interval. The results were repeated with no restriction, and with the condition that at least 3 years of data had to be present in both the first half and the second half of the record. The results are largely insensitive to these data availability thresholds.

Our aim is to first document large-scale changes in the air-sea surface temperature gradient in the North Atlantic Ocean occurring over several decades, and second to ascertain whether such changes, if any, represent a real climate signal.

3. ANALYSIS

Changes in the difference between the air and sea surface temperatures for much of the North Atlantic Ocean for the period 1960–2002, and possibly earlier, exhibit a dipole pattern, partly correlated with the North Atlantic Oscillation, with the subpolar latitudes of the North Atlantic showing an increase in the air-sea temperature difference and 'pseudo' sensible heat fluxes (SHF), and the subtropical North Atlantic experiencing a decline in air-sea temperature difference and a decrease in SHF.

The decline in the SHF in the subtropical Atlantic occurs along with a strengthening of the subtropical atmospheric circulation during that time. Comparison of these results derived from ICOADS with the actual sensible heat flux field in the NCEP-NCAR Reanalysis data set results in good agreement both spatially and temporally. These results are illustrated in Figures 1–6.

Because the change in SHF is largely associated with a more rapid increase in air

* *Corresponding author address:* Henry F. Diaz, NOAA/ESRL/PSD-Climate Diagnostics Center, 325 Broadway, Boulder, CO 80305; email: henry.f.diaz@noaa.gov.

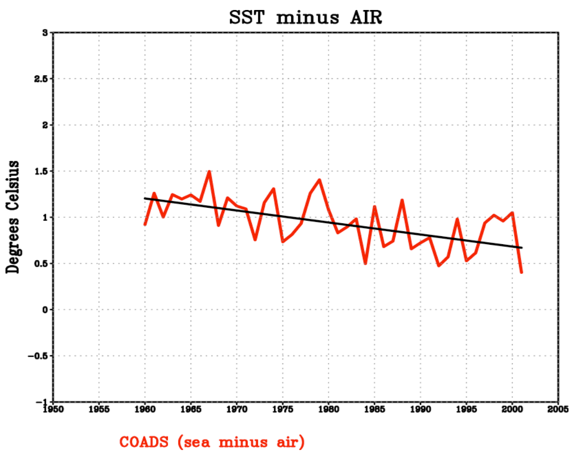

Figure 1. Annual mean values of the sea-minus-air surface temperature difference in the vicinity of Bermuda from ICOADS, 1960–2001.

temperature compared to the SST, we suggest that this may be a result of GHG forcing. The thinking is that while the oceans are sequestering some of the excess greenhouse warming below the surface, the lower atmosphere with its much lower heat capacity is heating up faster. We also examined the change in the 'pseudo' latent heat flux field in ICOADS and in the actual field using the NCEP Reanalysis data. Generally, the two change fields were not compatible, with only some regional agreement evident between the two data sets. We cannot say with certainty what the cause of the discrepancy is, but because the change occurs rather rapidly in the 1970s, perhaps a change in the input data for the Reanalysis (e.g., satellite retrievals) is a contributor.

4. CONCLUDING REMARKS

An analysis of *in-situ* surface temperature data in the vicinity of Bermuda (32˚N–33˚N, 64˚W–65˚W) as well as for the bulk of the North Atlantic Ocean (10˚N–60˚N, 0˚–90˚) show that the air-sea temperature difference has diminished since 1960, and possibly from as early as the 1920s in much of the subtropical region of the North Atlantic (~20˚N–40˚N). This decline is the SST-AT field is associated with a decline in one observational measure of the sensible heat flux field (the 'pseudo' sensible heat flux variable in ICOADS). The decline in SHF is also found in the actual sensible heat flux field from the NCEP Reanalysis, which also depicts a similar spatial pattern of change.

Because the change in SHF is largely associated with a more rapid increase in air temperature compared to the SST, we suggest that this may be a result of GHG forcing. The thinking is that while the oceans are sequestering some of the excess greenhouse warming below the surface, the lower atmosphere with its much lower heat capacity is heating up faster.

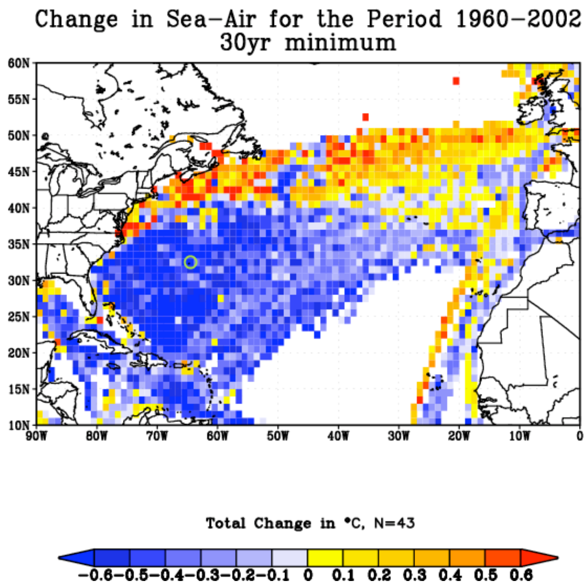

Figure 2. Change in sea-minus-air surface temperature, 1960–2002, using the one-degree resolution version of ICOADS. Values are the total linear trend with a minimum of 30 years of data required. The location of Bermuda is denoted by a circle near 32˚N, 65˚W.

5. REFERENCES

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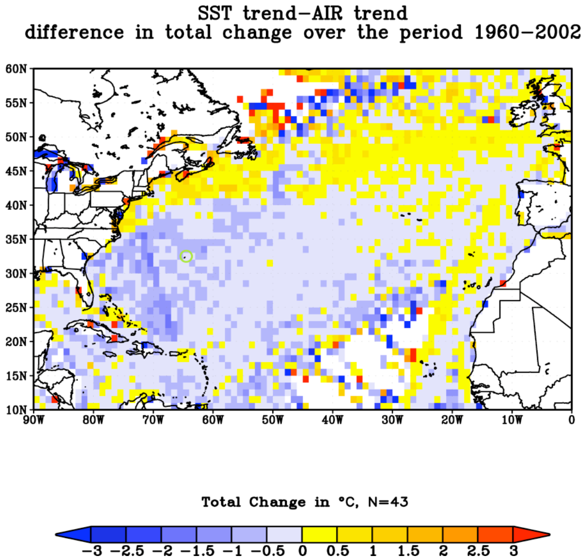

Figure 3. Difference in the computed total SST change (˚C) based on its linear trend minus the corresponding change in air temperature for the period 1960–2002. Data is from the one-degree resolution version of ICOADS. Trend is based on a minimum of six years, three in each half of the record.

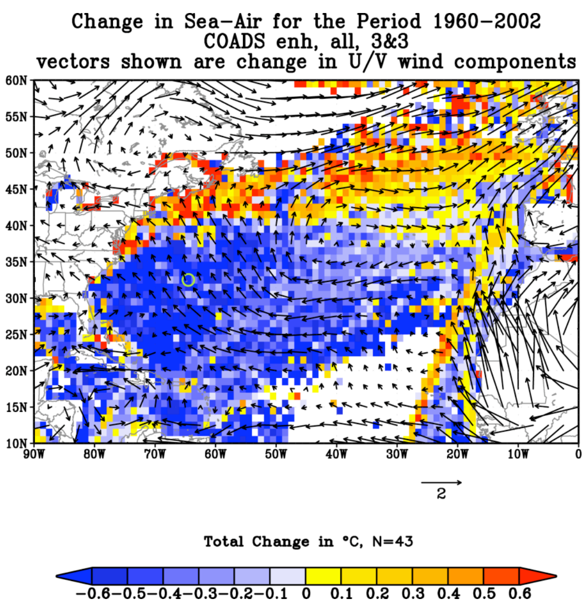

Figure 4. Trends in sea-minus-air temperature difference (blue shading indicating negative, red shading indicating positive trends) with superimposed trends in near-surface (925-mb) winds for the 43-year period 1960–2002.

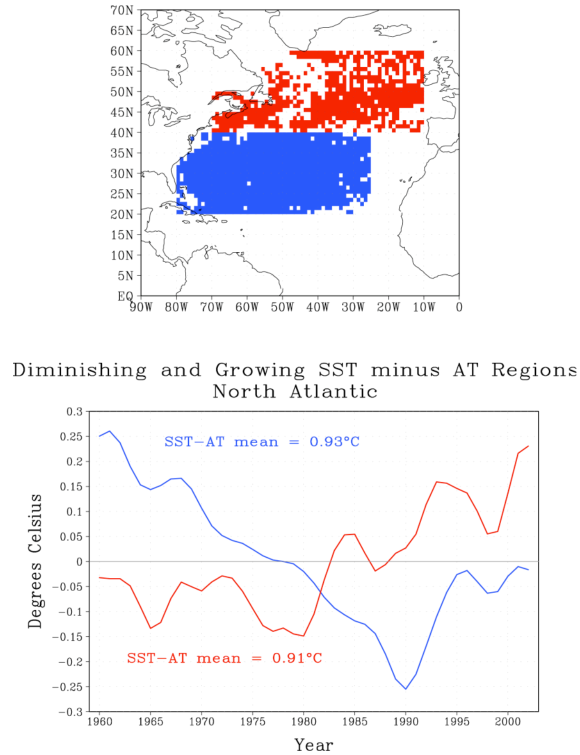

Figure 5. Time series of SST-AT computed over the two regions depicted in the top panel. The red curve in the lower panel is an average for the area in the top panel (referred to as the "subpolar" region) where the long-term trend is positive, indicating increasing air-sea temperature difference and hence a potential increase in the sensible heat flux other things being equal. Blue curve is for the corresponding blue area in the top panel, referred to as the "subtropical" region in the text, where this difference has diminished. Annual values were smoothed with a 1-2-1 running filter applied twice (a five-term Gaussian filter). The zero line corresponds to the respective mean value (denoted in the figure) of the SST-AT in each region.

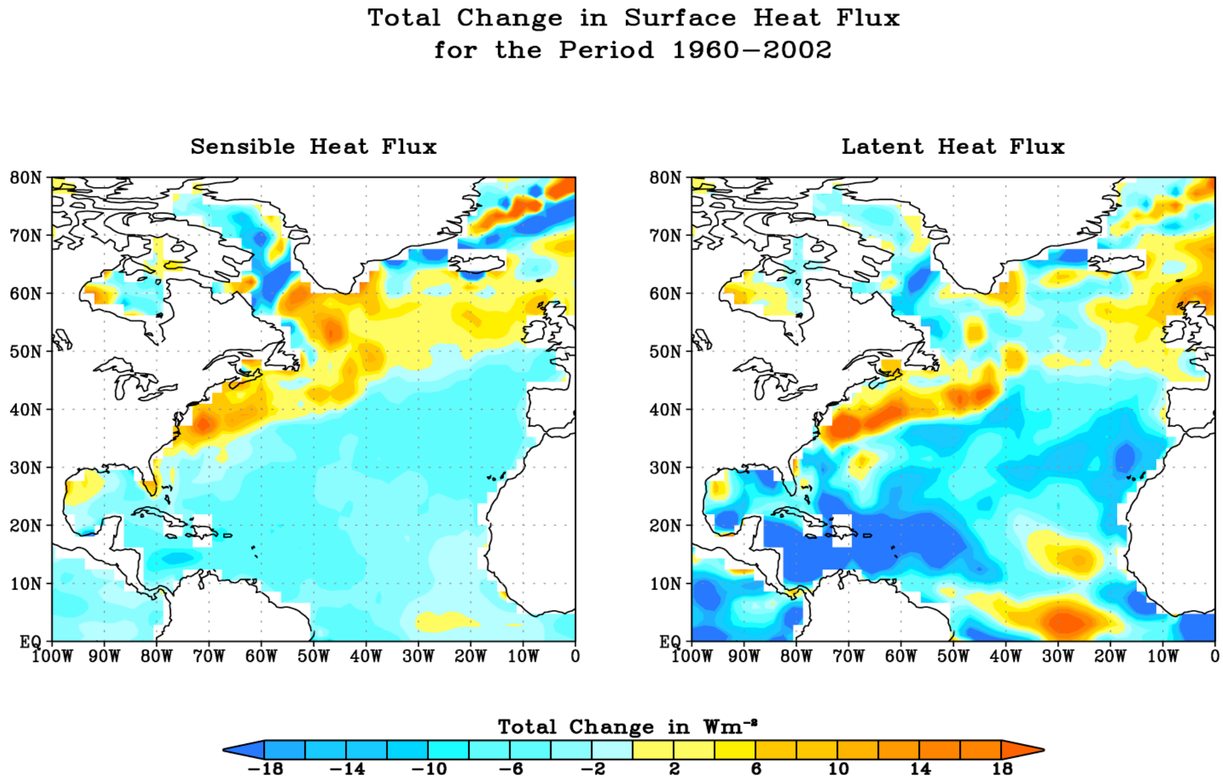

Figure 6. Total linear trend change (1960–2002) in sensible heat flux (left panel) and the latent heat flux (right panel) for the North Atlantic sector. Data is taken from NCEP-NCAR Reanalysis, units of W m^{-2}.