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Synoptic mechanism of the formation of extreme surface turbulent heat fluxes in North Atlantic

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Surface turbulent heat fluxes are responsible for variability of surface ocean heat budget on synoptic and interannual scales and also have strong impact on atmospheric heating. We analyze the origins of the variability of surface fluxes in the context of interaction of the North Atlantic extratropical cyclones with the ocean in winter. Our focus is on the atmospheric conditions triggering extreme air-sea turbulent fluxes. The main questions addressed in this study are (i) what are the large scale atmospheric conditions associated with extreme ocean surface fluxes and are they related to cyclones, (ii) what is the role of extreme surface fluxes in the variability of surface oceanic heat content, and (iii) which characteristics of atmospheric cyclones are sensitive to the surface ocean flux signals?

To answer these questions, we derive probability distributions of surface fluxes in the North Atlantic from NCEP-CFSR reanalysis 1979-onwards. We show that from 30 to 60% of the oceanic heat loss in winter are due to fluxes exceeding 90th percentile. From composite analysis we found that these extreme flux events are associated not with the cyclones per se, but with the cold air outbreaks in cyclone-anticyclone interaction zones.

Next, we put the analysis of synoptic air-sea interaction into the context of the cyclone characteristics derived from the numerical storm tracking of reanalysis SLP data. Over the North Atlantic, from 20 to 60% of cyclone occurrences associated with flux extremes exceeding 90th percentile, while 80% of cyclone tracks at least once during lifetime associated with flux extreme. We also show that over the Gulf Stream more than 60% of cyclogenesis were associated with extreme surface fluxes. Further we analyze the role of the Northern Hemisphere circulation modes (such as NAO and PNA) in the long-term variability of the cyclone controlled extreme air-sea exchanges.