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Interactive comment on "The open ocean sensible heat flux and its significance for Arctic boundary layer mixing during early fall" *by* Manisha Ganeshan and Dong L. Wu

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Specific Comments:

Comment 1: The method to estimate the cloud fractions should be describe clearly.

Response: In the current manuscript, we have replaced the term "boundary layer cloud fraction" with "boundary layer cloud thickness ratio" which is defined in Section 3.3, as the percentage ratio of cloud layer within the BL. The cloud-base is defined as the first layer above the surface where the relative humidity (RH) equals 90% or more (as in Sato et al. 2012), and the cloud layer is calculated as the vertical integral of all layers within the boundary layer that exceed 90% RH. As an example, for the profile shown in

Fig. 2 (inset) of the revised manuscript, the cloud-base and BL heights are calculated as 580 m and 1180 m respectively, and the BL cloud thickness ratio is estimated to be ∼50%.

Comment 2: The definition of cloud regimes were unclear.

Response: The clouds are categorized based on the BL cloud thickness ratio as explained in Section 4.2.1 (Pg. 6, Lines 16-18) of the revised manuscript. Three distinct BL cloud types emerge, with thickness ratios peaking at 5%, 65%, and 95% (Fig. 5 (a)). Consequently, three categories are identified consisting of low (<20%), medium (20-80%), and high (>80%) BL cloud thickness ratios, respectively. Each category corresponds to one (or two) of the four regimes described by Barton et al. (2012). The low BL cloud thickness category (<20% ratio) corresponds to the "uplift regime", the medium BL cloud thickness category (20-80% ratio) corresponds to the "stable" regime, and the high BL cloud thickness category (>80% ratio) corresponds to the "highly stable and very highly stable" regimes described by Barton et al. (2012). This is expressed in Table 1 of the revised manuscript.

Comment 3: The interpretation of the role of SLP on the surface sensible heat flux is questionable. Response: We would like to stress that, in our study, we do not explicitly state that the SLP influences the surface sensible heat flux (SSHF). The SSHF depends on the surface winds and the air-sea temperature gradients as indicated by Eq. 1 of the revised manuscript. However, the efficiency of turbulent mixing might be favored within an unstable boundary layer which often accompanies cyclones or storms. There is some evidence for increased surface turbulent heat transfer during cyclonic activity in the Arctic Ocean (Nilsson et al. 2001, Brummer et al. 1994). Moreover, in the revised manuscript, we discuss the thermodynamic equation for the Arctic BL (Eq. 2) in order to better understand the factors favouring turbulent mixing. It is possible that warm air advection (stratus regime) and low-pressure conditions (uplift regime) will favour rising motion/adiabatic cooling, which may lead to an unstable lapse-rate in the Arctic BL (term C in Eq. 2 of the revised manuscript). This may subsequently lead to a good correlation between the SSHF and BL height as turbulence is favoured in an unstable BL. Whereas high-pressure or cold air advection typically causes sinking motion in the BL, which may be responsible for the poor correlation between the SSHF and BL height during the stratocumulus regime. (The reader should be cautioned that this is purely speculative and we have not evaluated the relative contributions from thermal advection and compensatory adiabatic motions in the Arctic BL).

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