## *Reply to Review #1*

Thank you for your constructive comments, which are very helpful to improve the paper and clarify our points. Our point-by-point reply follows with the original comments quoted in `Courier` font.

1. `Title: Solar radiation is included in all of the analysis, so not sure why the authors have "longwave" in the title?`

   We removed "longwave" in the title.
2. `Figure 6c suggests that there is a lot of cloud water in the fog. Especially towards the end the cloud water content is constant at ~1 g/kg throughout the layer. I assume that at this high value, there is got to be some cloud water to rainwater conversion. Now if the rain is leaving the fog and falling into the sea surface, it will thin the fog layer and also affect the budget terms. Normally the surface rain flux is a heating and drying term in boundary layer budgets, see Caldwell and Bretherton (2005 JAS). Can you please expand on this a bit more? The cloud droplet number concentration is set constant in the simulations, but there is no mention of rain, so it is hard to tell what might cause this. Lack of rain might be the reason that the fog is persisting over a long time. I assume there are no aerosols in the model.`

We calculated the sedimentation ($F_p$) term from moisture budget. The precipitation term is calculated using the total water budget equation (Caldwell and Bretherton, 2005),

$$\frac{\partial \overline{q_t}}{\partial t} = -\frac{\partial \overline{w' q_t'}}{\partial z} + F_p \tag{1}$$

where $q_t$ is total water mixing ratio. The terms on the *RHS* describe the $q_t$ change from turbulent mixing effect and droplet sedimentation. The sedimentation term is provided as a source/sink term for $q_t$ budget. The advection and molecular diffusion terms are omitted as their magnitudes are much smaller than other terms in the equation. Total water ($q_t$) can be divided into water vapor ($q_v$) and liquid water ($q_l$), their budget equations are:

$$\frac{\partial \overline{q_v}}{\partial t} = -\frac{\partial \overline{w' q_v'}}{\partial z} + \frac{E}{\overline{\rho}} \tag{2}$$

$$\frac{\partial \overline{q_l}}{\partial t} = -\frac{\partial \overline{w' q_l'}}{\partial z} - \frac{E}{\overline{\rho}} + F_p \tag{3}$$

The $\overline{w' q_v'}$ and $\overline{w' q_l'}$ are turbulent water vapor flux and turbulent liquid water flux, respectively. The sedimentation effect on heat budget is calculated using the following quation,

$$\frac{\partial\bar{\theta}}{\partial t} = -\frac{\partial\overline{w'\theta'}}{\partial z} - \frac{L_v E}{\bar{\rho} C_p} - \frac{1}{\bar{\rho} C_p}\frac{\partial \bar{Q}}{\partial z} - \frac{L_v F_p}{C_p}, \quad (4)$$

where the last term is the sedimentation term.

The precipitation primarily contributes to the liquid water budget. The liquid water generation is most pronounced at the top of the fog, leading to a peak in liquid water content at the fog top. Large cloud water content converses into rainwater and descends, resulting in a secondary peak of liquid water near the surface at about 20 m (Fig. S5a). However, within the boundary layer and at surface, sedimentation has a drying effect. The impact of sedimentation for the heat budget is relatively small compared to turbulent mixing and LWC, both at surface and within the boundary layer (Fig. S5b). We added the related descriptions (lines 335-336, and 359-362).

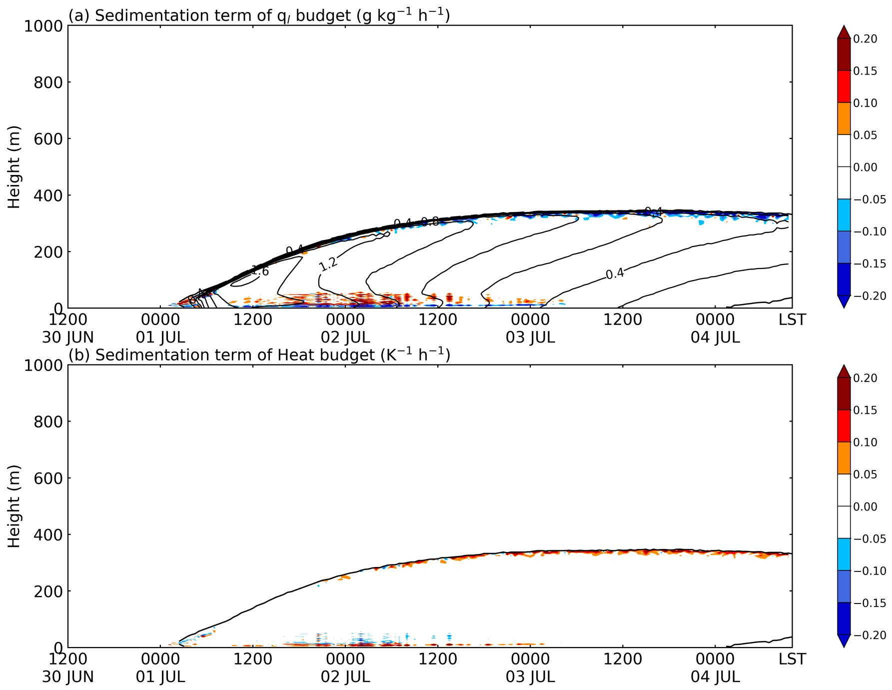


FIG. S5 Horizontal mean sedimentation term for (a) liquid water (g kg$^{-1}$ h$^{-1}$) and (b) heat (K h$^{-1}$) budget. Contours in (a) are liquid water mixing ratio (g kg$^{-1}$) and black lines in (b) indicates fog top and bottom.

We also calculated the sedimentation term for moisture and heat budget using turbulent liquid water flux (Caldwell and Bretherton, 2005):

$$\frac{\partial\bar{q_t}}{\partial t} = -\frac{\partial\overline{w'q_t'}}{\partial z} - \frac{\partial\overline{w'q_l'}}{\partial z} \quad (5)$$

$$\frac{\partial\bar{\theta}}{\partial t} = -\frac{\partial\overline{w'\theta'}}{\partial z} - \frac{L_v E}{\bar{\rho} C_p} - \frac{1}{\bar{\rho} C_p}\frac{\partial \bar{Q}}{\partial z} - \frac{1}{\bar{\rho} C_p}\frac{\partial\overline{w'q_l'}}{\partial z} \quad (6)$$

The results still show that the sedimentation term has a relatively small impact on the moisture and heat budget (Fig. S6).

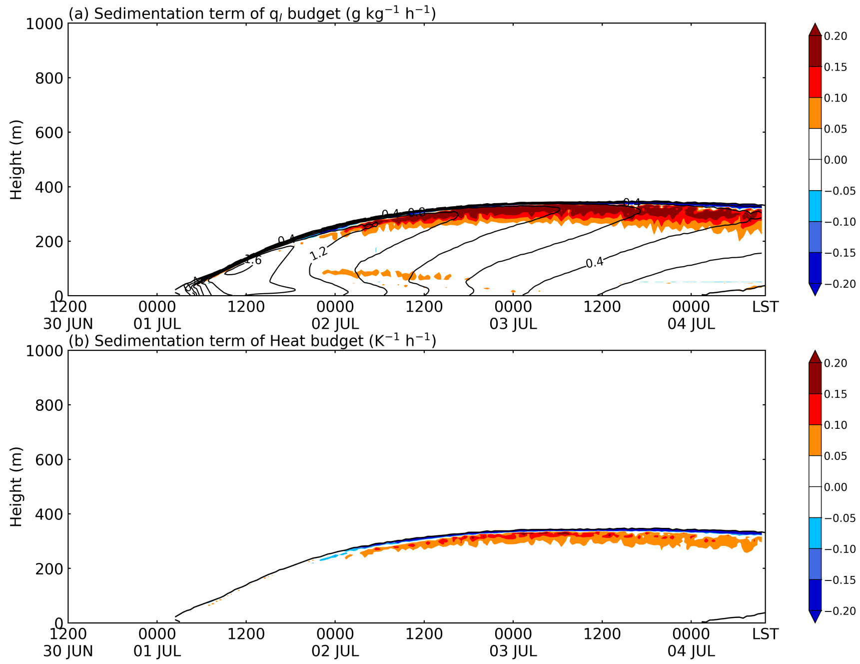


*FIG. S6 The same as Fig. S5 but the sedimentation rate is calculated using turbulent liquid water flux.*

3. `Section 2.2: please mention the vertical and horizontal resolution of the LES model.`

   We added resolution information in lines 148-150.

4. `Line 151-152: you mean "respectively"?`

   Revised (line 158).

5. `Line 169-170: How were the fog events tracked, was there a trajectory model used for this analysis?`

We tracked the fog observations by integrating ERA5 10-m winds and validated the obtained trajectory in Fig. 5 using the HYSPLIT (Draxler and Rolph, 2010). The trajectory in Fig. 4 is roughly consistent with the trajectory based on HYSPLIT (red line in Fig. S7). We added the related descriptions (lines 176, and 260-261).

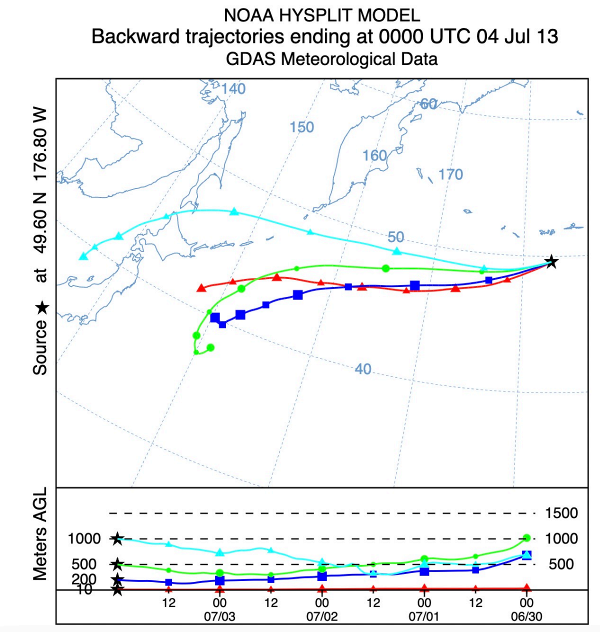


*FIG. S7 4-day backward trajectory from the ssH fog observation at 49.6°N 183.2°E reported at 1000 LST (0000 UTC) on 04 July. The tracked height for air parcels includes 10 m (red line), 200 m (blue line), 500 m (green line) and 1000 m (light blue line).*

6. Figure 1: Please show the scale of the wind barb and mention the contour levels. I understand that you have mentioned two SST contours in the legend shown in thick lines, but it will be good to show them in the figure.

   We added wind barb scale and contour levels onto Fig. 1.

7. Figure 4: A lot of work has gone into this figure. I think snapshots of visible satellite imagery will be hugely beneficial to the readers.

   We added satellite images and theirrelated descriptions (Fig. 3, lines 221-223, and 230).

8. Section 4.2 heading: "Heat and Moisture Budgets"

   Revised (line 346).

9. Figure 10b and Figure 12 are fascinating. Compared to those in the constant solar radiation simulations, the fog layer bottom and top undulate a lot during the diurnal cycle simulations. Can you please elaborate causes of this? Thank you.

During the night, the strengthening of the fog-top LWC enhances thermal turbulence and the entrainment (Fig. S8), thereby bringing in more air into the fog layer and causing an increase in the fog top height. Conversely, during the day, the weakened the fog-top LWC reduces entrainment (Fig. S8), leading to a decrease in the fog top height. With the continued drying effect of entrainment, the liquid water content in the fog layer decreases. The cooling effect of the LWC gradually becomes weaker than the drying effect of entrainment, ultimately causing the transition into stratus. The cloud base height rapidly rises and decreases during night due to the absence of the solar radiation. We added the related descriptions (lines 455-460).

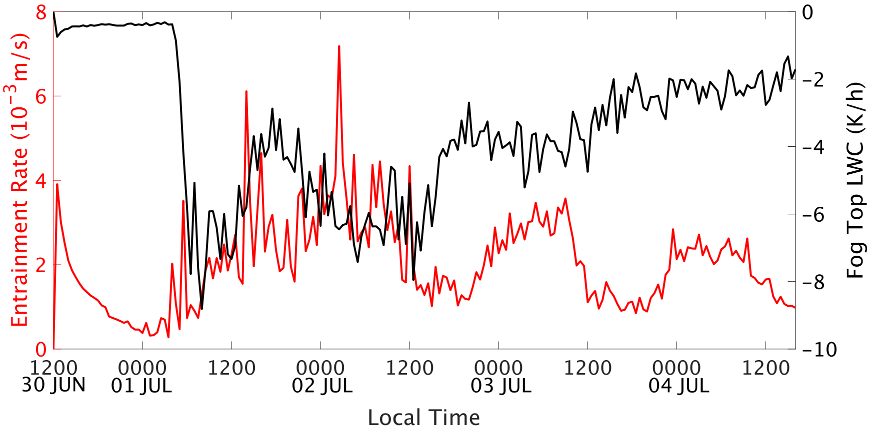


*FIG. S8 Time series of entrainment rate (red line) and LWC (black line) at the fog top for the simulation with diurnal cycle radiation.*