Review of "Effects of longwave radiative cooling on advection fog over the Northwest Pacific Ocean: Observations and Large Eddy Simulations"

Summary

This work studies advection fog events over the Northwest Pacific Ocean by including both observations and LES runs. First, they report that the frequency of SAT-SST events has diurnal variations based on observation statistics. Then, an observation derived case is simulated in a Lagrangian setup with two radiation configurations: constant mean solar irradiance and a realistic diurnal solar irradiance. The constant case is discussed thoroughly while the diurnal case is briefly described, with both analyses contributing to explain the mechanisms behind the diurnal SAT-SST variations, where the role of longwave cooling is central. Their work is interesting, the modeling approach is well thought, and their results contribute to better understand diurnal processes. Below are some minor comments aimed at a better understanding of their setup and some details on their boundary layer discussion. Adding more comparisons to other previous works in the results and discussion would strengthen the paper, and personally I think that the diurnal results could be explored more deeply or at least raise more future questions. Thus, I recommend a minor revision.

Minor comments

- 2.2. How are surface fluxes prescribed / computed?
- Fig. 1. Is there any difference, in terms of detection, between fog and advection fog? The caption says fog but the section equates it to advection fog. Only in L219 there is a mention of a combined criterion for advection fog
- L240 Here it seems like there is enough information to make a timeseries of the observational SAT-SST. Would that be possible to add in order to compare the model results?
- 4. More details about the LES configuration are needed. It references Yang et al. (2021) but the manuscript should be self contained. How are the initial profiles determined, is there any modification from the ERA5 vertical profiles? Is the initial profile cloudy or clear? Does the referenced paper work with the same case? I'm understanding that SST(t) is prescribed, are winds nudged?
- L244 Any reason to choose that value of divergence? I assume it can definitely affect the results by modifying the BL top height and LW cooling
- L255 Is this quick growth realistic when compared to observations?
- L256 Does the inversion strength grow due to BL cooling or to changes above the BL?
- L272 The four phases could be shown in the figures: Fig 5,7,10 as different shaded areas, and in Fig 6 as the labels (instead of times)
- L278 Would a shorter averaging time window give sharper vertical profiles?
- L309 Do you mean that LW cooling is directly related to a colder SST?

- L336 Here I got a bit confused, so 'SH' is just the sensible heat flux and 'Ent' is $\overline{w'\theta'_t(z_i)}$? By integral do you mean across the BL?
- Fig. 10. Why include the diurnal case here? It has not been done for the previous figures
- L371 I don't follow this argument, is it related to LW cooling attenuation for having more water content above?
- L377 I'm not familiar with the interpretation of the thermal turbulence interface, what does it add to the discussion?
- 5. I wonder if this section can bring more questions, such as the effect of dynamical changes on the evolution of the fog layer. In the end, for fog lifetime, does it matter if it's modeled with constant solar irradiance? When the sun goes down, how long does it take the layer to react? Does the stronger solar irradiance accelerate BL processes? How do these results compare to the observations?
- 6. In this section, many quantitative results for the constant solar irradiance are summarized, but not for the observational nor the varying solar case. It would be better to discuss the three if possible. How does this study relate to other modeling works other than Yang et al. (2021)? Is there anything novel in that regard to report? It would be good to not only include discussion with other works here but also in section 5, in order to support the description and explanations given. How do you propose that the modeling gap in larger models could benefit from this knowledge, in a practical sense?
- L453 I'm not sure where that comparison is

Writing comments / suggestions

In general, the manuscript is well written. Out of personal style, I'd recommend checking thoroughly the use of the article "the" over the document

- L21 maybe it's better to say the difference, not sure if SAT-SST will be understood
- L26 "arrives at"
- L28 "well simulates" means that it matches the observations, right?
- (1) what is E?
- L52 It is unusual to start a sentence with a symbol, though this could be a matter of style, I'd suggest to use commas an evaluate the use of more "the" in this paragraph
- L132 Turbulent fluxes are not part of the prognostic variables, right?
- L160 "moisture variations"
- (3) Shouldn't the buoyant term only have u_3?
- L170 "wind fields from ERA5"
- L173 "(ssC, when SAT-SST>0)"
- L190 "are positive" instead of "exceed 0^{o}C"
- L306 "budget terms"
- Fig 8 "heat and moisture"
- L330 "weakens and the turbulent mixing cooling dominates"
- L432 "analyzed in the detail"
- L439 "column"