COAMPS™ FOG FORECAST DURING 2003 CBLAST-LOW

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1. INTRODUCTION

The objective of Coupled Boundary Layer Air/Sea Transfer (CBLAST) at low wind speed is to understand the physical processes that strongly affect the air-sea interaction in both the oceanic and atmospheric boundary layers. Fog is a very important phenomena which may significantly affect the turbulent mixing in the marine boundary layer through its impact on radiation and thermodynamic structure. Accurate visibility forecast is, of course, vital for air traffic safety and operation efficiency.

The prediction of fog presents a particular challenge to the mesoscale community since its formation and dissipation are complex processes closely related to the large-scale weather pattern, local scale turbulence mixing, cloud microphysics and the radiation. This work focuses on fog episodes observed during CBLAST-Low field experiment in Summer of 2003, during which the NRL COAMPS™ has been used to provide real-time forecast. Our objective for this work is to evaluate the fog forecast of COAMPS™ and understand the interaction among the different physical processes.

2. OVERALL FOG CONDITIONS IN CBLAST

The NRL COAMPS™ is a nonhydrostatic modeling system (Hodur, 1997) with a full suite of physical parameterizations. Particularly, the surface flux parameterization is modified to fit the COARE2.6 results as described in Wang *et al*. (2002). This improvement is important as our focus is on the air-sea interaction in low winds. A 60-hour forecast was performed twice daily using nested grids with horizontal grid increments of 3 km, 9 km, and 27 km, respectively and 30 vertical levels. Fig. 1 shows part of the inner domain.

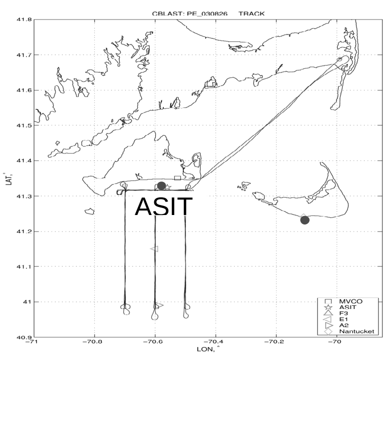

Fig.1 CBLAST-Low field experiment area. ASIT is the site of air-sea interaction tower.

Although comprehensive measurements of the mean and turbulence were made near surfaces on both sides of the air-sea interface, there were no cloud microphysics observations available during CBLAST-Low field experiments. Therefore, we heavily rely on the observer's reports in the field and regular weather reports regarding the presence and intensity of the fog. By definition, the term fog is used when visibility reduces to less than 1 km due to saturation of water vapor. Whereas mist is reported when visibility exceeds 1 km. Because there were often no rigorous observations of visibility and liquid water content in CBLAST, the fog situations in our discussions of observations may well fall in the category of mist.

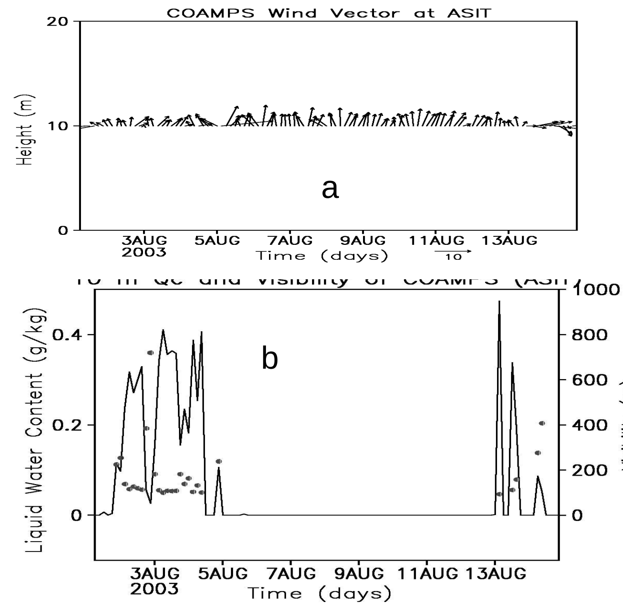

Fig. 2. Predicted wind vectors at 10 m (a) and the liquid water content (solid lines in b) and the computed visibility (dots in b) based on Eq. (1) .

In the first 13 days, there were constant southwestern flow which brought warm and moist air to the observation area as shown in Fig 2a. Fog often occurred and were recorded in the field log and reported in the airport weather report in both Martha Vineyard and Nantucket Islands. For this period, COAMPS predicted frequent fog occurrence as shown in Fig. 2b where the calculated visibility is well below 1 km. After 14 August, there was no liquid water predicted at 10 m level by COAMPS, even though the field records at ASIT site reported either fog or mist conditions on 22-23 of August.

2. FOG DURING 22-23 AUGUST

The SST used in COAMPS (Fig. 3a) clearly lacks diurnal variability compared with the ASIT observations. It is probably partly due to the high SST, the relative humidity at 10 m is lower than

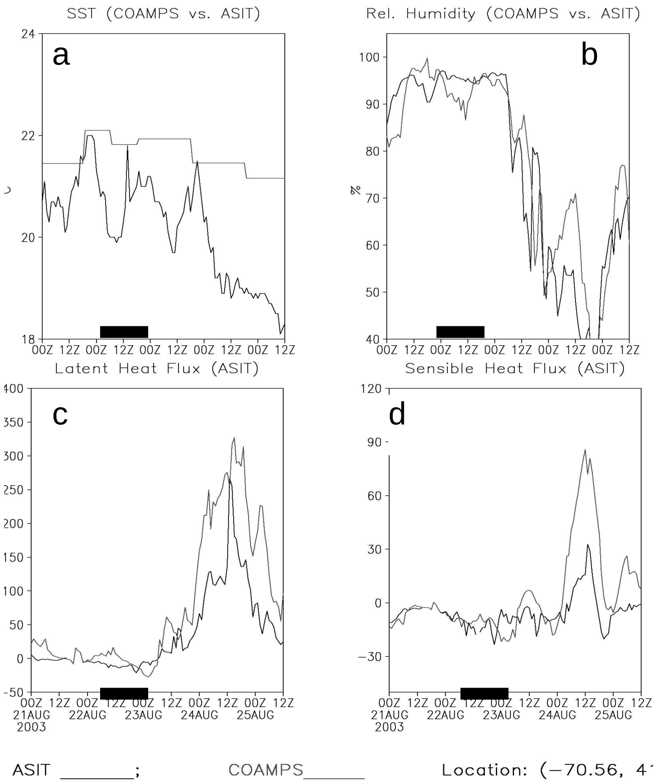

Fig. 3: Comparison between ASIT measurements and COAMPS results. a: SST; b: Relative humidity; c: Latent heat flux and d: sensible heat flux. The heavy horizontal bar denote the fog period in the discussion.

the observed. The differences in the latent and sensible heat fluxes are also in part due to the SST difference as discussed in Wang *et al*. (2004, this conference). It is also interesting to notice that the observation derived latent heat flux is negative being consistent with the sign of the sensible flux due to the saturation condition in the stable surface layer.

Our immediate questions are how the heat and moisture are balanced and what the controlling factors are for the fog formation. To answer these questions, we first evaluate the contributions from the large-scale advection and local turbulence mixing. There is a clear tendency that the two processes tend to balance each other, particularly for the moisture. For temperature, the radiative long-wave cooling (not included here) may play major role in

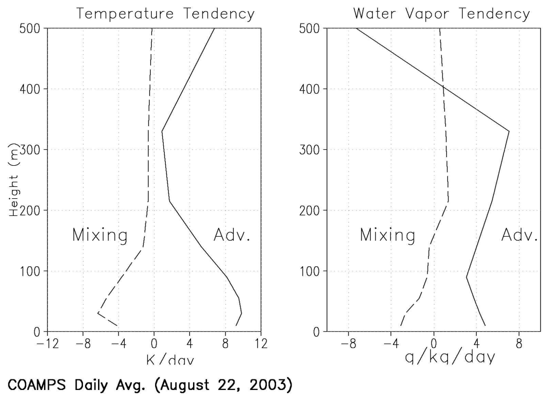

Fig. 4: Averaged tendencies of the turbulence mixing and large-scale advection for potential temperature and water vapor mixing ratio.

the heat balance. It is noticed that the tendencies are maximized at the lower lowest levels, suggesting that the warm advection is essential in maintaining the stable surface layer.

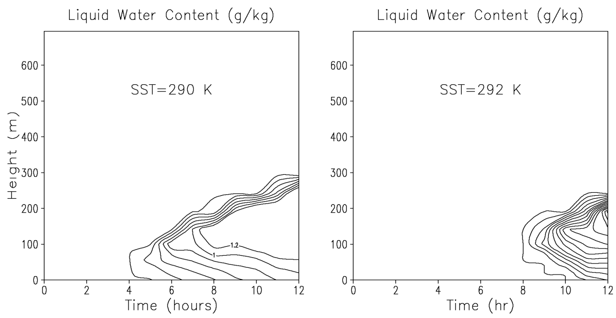

Fig. 5. Sensitivity of fog formation to different SST.

To asses the sensitivity of fog to the SST difference as shown in Fig. 3a, we also integrate COAMPS single column model with the observed sounding and different SSTs (294, 292, 290 K). There is no fog formation for SST of 294, while significant difference of the fog onset time for SSTs of 290 and 292 K. Therefore, the cooling introduced by low SST is essential for the fog initiation.

Currently we continue to study the roles of radiation and the ways to improve COAMPS fog forecast capability.

References

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Wang *et. al*. 2004: Evaluation of COAMPS^{TM} Real Time Forecast for CBLAST-Low Summer Experiments 2002/2003. 16th Symposium on Boundary Layers and Turbulence. Portland, ME.