Study on turbulent exchange in offshore oceanic atmospheric boundary layer

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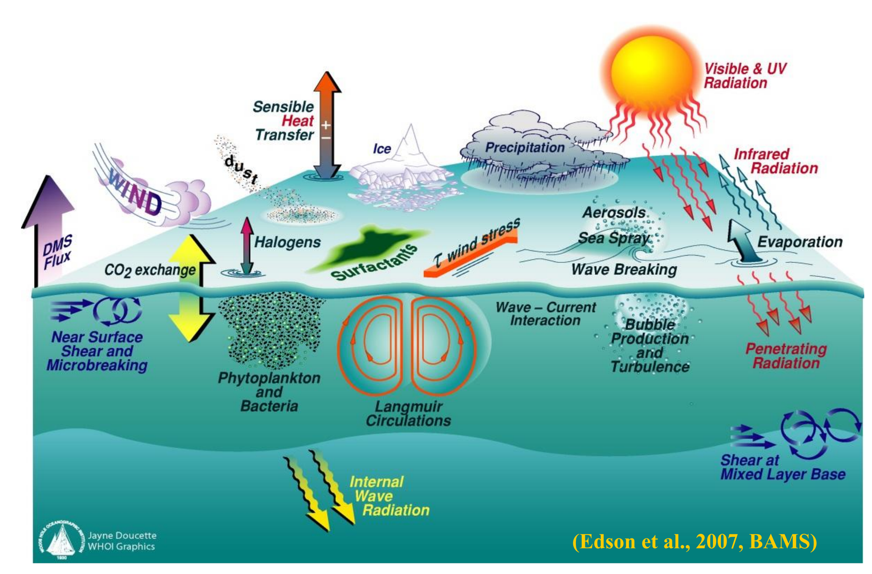
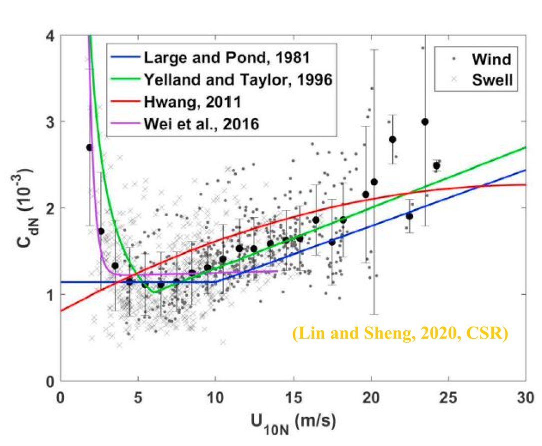
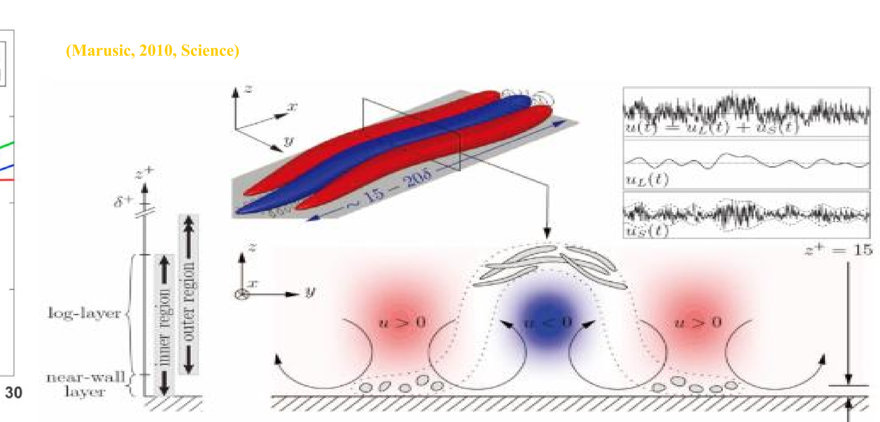
Introduction

- Ocean-atmospheric interactions are the central part of climate change problems, and climate change and their predictions on timescales from several years to decades can only be resolved on a full understanding of the coupling effects of the atmosphere and the ocean.
- Based on the observations of Coupled Ocean-Atmosphere Response Experiment (COARE), the various physical processes relating near-surface atmospheric and oceanographic bulk variables and their expression in a bulk flux algorithm were built.



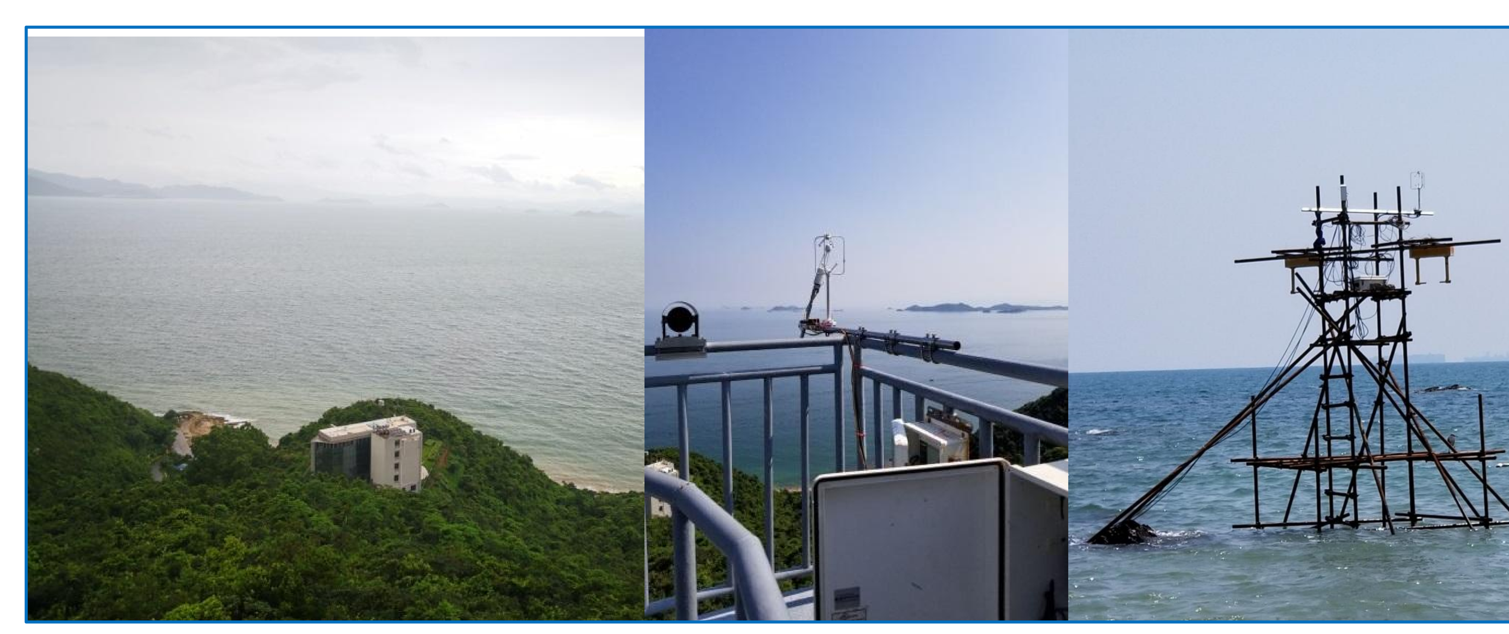
- There are many studies on turbulent exchange coefficient, and people found it has relationship with wind velocity. It was found when wind speed is very large, the coefficient does not change. There are different explanation. More and more people believe the coherent structure has very important effect on turbulent exchange.



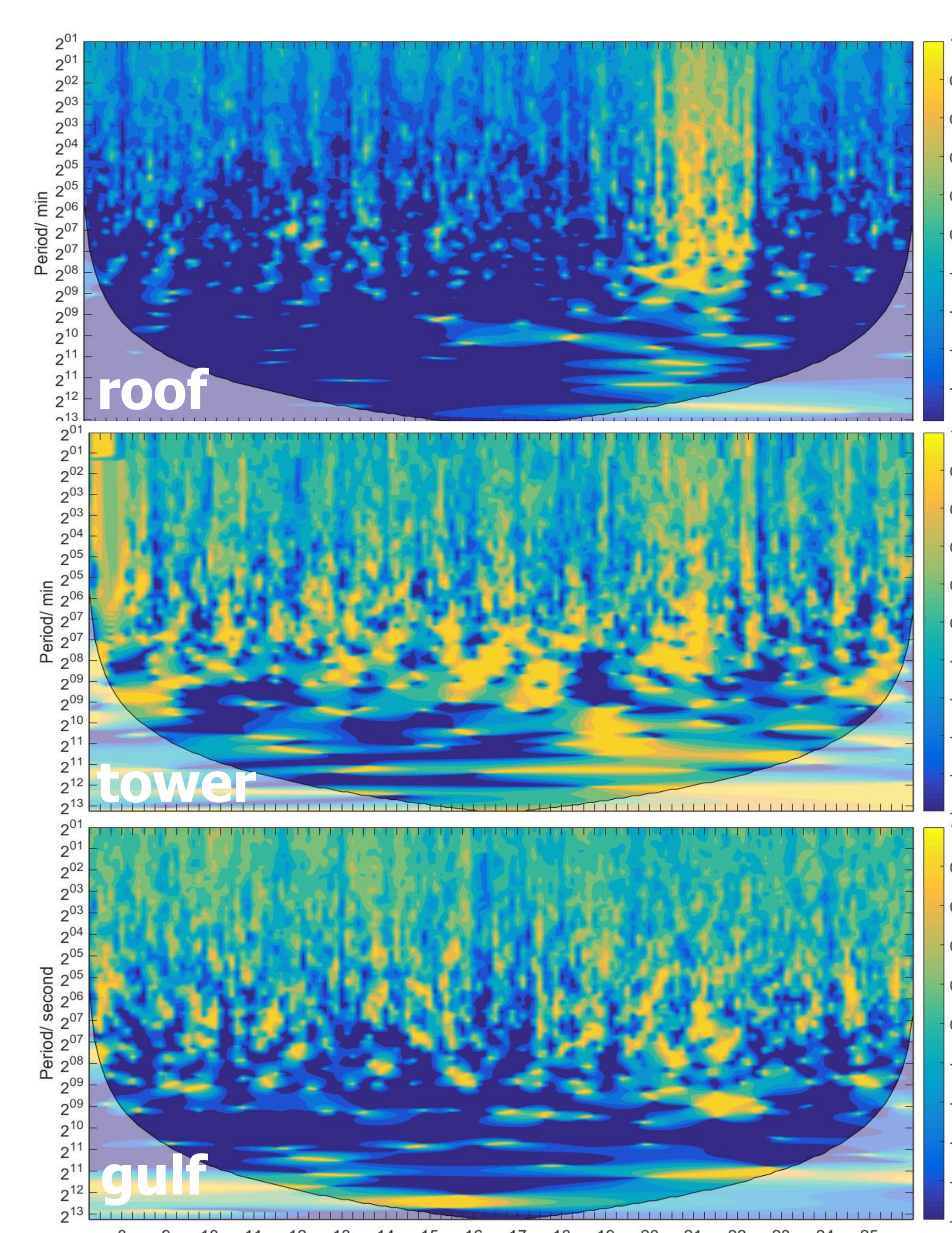


Effect of the multi-scale structure on turbulent exchange

- In September 2019, a comprehensive observation experiment on the offshore atmospheric boundary layer was carried out at the Yangmeikeng Ecological Monitoring Station and Sai Chung Gulf.
- The instrument was set up at these sites for the detection of turbulent fine structures in the non-uniform atmospheric boundary layer in coastal areas, and to observe the gradient of turbulent flux from **gulf** near the sea surface (8 m) to the **roof** of the monitoring station (70 m), and on the **tower** at top of mountain on which the monitoring station is situated, which is 130 m from the sea surface.



- Multi-scale flow structures are obvious phenomena in atmospheric turbulence. The characteristic form of the fluctuation (at a spatial scale from tens of metres to several hundred) has geometric and dynamic properties. The Wavelet Coherent Coefficients (WCCs) of the horizontal and vertical wind speed of the structures with scale between 1 min and 5 d.
- From the WCCs, we can see that the large-scale vortex had strong negative coherence at the roof, but positive coherence at the tower and gulf.
- The flux is decomposed into the contributions of different-scale vortices by scale decomposition and divided into three main parts: the flux of turbulence of less than 1 min; the flux of gusts of between 1 and 30 min; and vertical advection transport by large-scale structures of over 30 min.
- The contribution of larger-scale structures (30 min to 3 h) to friction velocity is significant because of the mountainous topography. The sea surface of the Gulf is flat and the friction velocity due to turbulence of less than 1 min is dominant.



Conclusion

- It is shown that the turbulent motion in the atmospheric boundary layer in the coastal area is affected by the underlying surface, such as that of the coastal land or the sea–land boundary.
- Different scales all make contributions to momentum flux. The complex terrain can lead to a strong, negative coherence structure, and yields interaction between large- and small-scale structures. On flat surfaces such as the beach, although there are multi-scale structures, turbulence makes greater contributions to flux than other scale structures.