# 運用黏性流理論對都卜勒雷達資料分析
# Doppler Lidar Data Analysis with a Viscous Flow Theory

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## 摘　要

2025年2月於台中梧棲港進行的都卜勒雷達測量發現，當強烈的東北季風盛行時，大氣邊界層可視為一個厚度達1公里時間平均下的二維邊界層，且其自由來流上方存在著熱逆溫層。此觀測結果，讓位於港口外之離岸海氣象塔所測得的風場及波浪資料，所進行之海面上方大氣邊界層分析，提供了物理依據。在假設邊界層表面因海面波浪造成完全粗糙的情況下，利用對數速度剖面(Log velocity profile)(Clauser 1956；Schlichting 1968)推導出特徵粗糙度高度。根據黏性流理論(White 1975)，在海洋表面上之黏性力與壓力梯度達到平衡，且此壓力梯度是自自由來流就被決定了。在本研究中，利用近壁速度剖面(Spalding 1962)成功估算了動量方程中的黏性力項，並接著針對自由流中的流動進行了動量收支分析。結果顯示，壓力梯度的影響相較於科氏力更加顯著。

關鍵字：都卜勒雷達、東北季風、大氣邊界層

## Abstract

Doppler lidar measurements made at Taichung Harbor in February 2025 unveiled that when strong north-east wind prevailed the atmospheric boundary layer can be treated as a time-averaged two-dimensional boundary layer with a thickness up to 1 km, capped by a thermal inversion layer of 0.5 km in thickness. This observation provides a physical ground for an analysis on the atmospheric boundary layer over the ocean surface offshore Taichung Harbor. The analysis was enabled with the wind and wave data obtained from an offshore met tower near the harbor. By assuming that the boundary layer is fully roughened by waves on the ocean surface, the characteristic roughness height was reduced from a log velocity profile (Clauser 1956; Schlichting 1968). Since at the ocean surface the viscous force is balanced by the pressure gradient (White 1975), the pressure gradient term was successfully evaluated with a near-wall velocity profile by adopting an expression inspired by Spalding (1962). Subsequently, a momentum budget analysis for flow in the freestream was carried out, in which two forcing terms of the pressure gradient and the Coriolis force are included (Pedlosky 1979). As a result, it is found that the pressure gradient effect is predominant over the Coriolis force effect in this case.

Key words: Doppler Lidar, Northeast Monsoon, atmospheric boundary layer

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