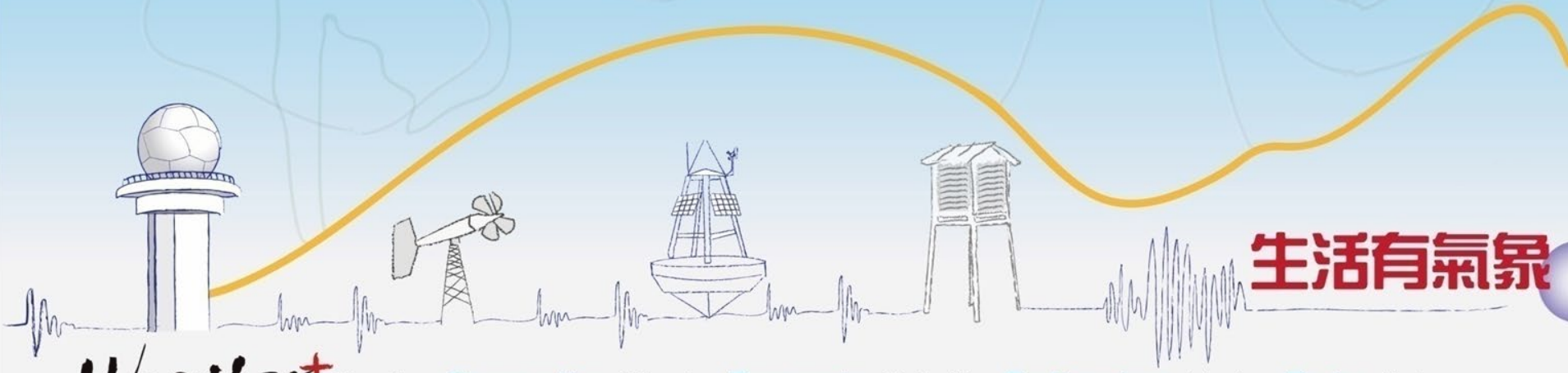
蘭嶼亂流分析

中央氣象局 科技中心
陳建蒲 鄧仁星



內容大綱

(一)前言

(二)研究資料與方法

(三)分析結果

(四)結論

(一)前言

離島的重症醫療不足

黑鷹接蘭嶼病患 起飛3分鐘失聯

華視 2018年2月6日 下午1:35 留言

台東縣 / 陳君毅 報導

黑鷹直升機驚傳失聯，有六人生死未卜！空勤總隊一架編號NA-706的黑鷹直昇機，昨天晚上11點多從蘭嶼執行醫療後送，協助肺炎病患回到台灣本島就醫，但沒想到直升機起飛不久，機身就左傾歪斜然後消失在雷達上，機上六人包含正副駕駛和機工長，病患以及家屬和護理師，生死不明，目前還在搜救中。

搜救人員在附近海域，出動直升機、巡防艇，以及漁民主動幫忙，漏夜搜尋，目前尚未找到機上六人。

空勤總隊，出動直升機出海搜救，熱心漁民趁天光亮起，開船到蘭嶼外海，全力幫忙仍無所獲，從台東豐年機場飛抵蘭嶼，11點48分再從蘭嶼起飛飛回台東，機上有三名機組人員，載著肺炎病患和家屬及護士，沒想到起飛三分鐘後，雷達光點消失，無線電失聯，六人通通下落不明。

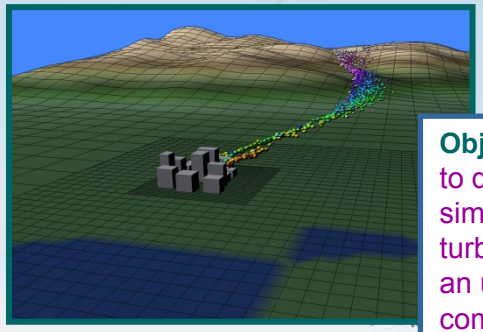
- 遭遇低空亂流
- 人為操控不當

參考來源:
https://tw.news.yahoo.com/%E9%BB%91%E9%B7%B9%E6%8E%A5%E8%98%AD%E5%B6%BC%E7%97%85%E6%82%A3-%E8%B5%B7%E9%A3%9B3%E5%88%86%E9%90%98%E5%A4%B1%E8%81%AF-052501173.html

(二)研究資料與方法

模式介紹

- **HOTMAC** is a three dimensional, primitive equation model to predict airflows over complex terrain and around buildings. Governing equations are conservation equations for momentum (U,V, and W), internal energy (potential temperature), mixing ratio of water vapor and turbulence.
- **Second-moment turbulence closure model** (Mellor and Yamada Level 2.5) was used. Prognostic equations are for the turbulence kinetic energy and a length scale.
- **Non-hydrostatic pressure** was computed based on the HSMAC pressure-velocity correction method (Hirt and Cox, 1972, J. of Computational Phys.,324-340)



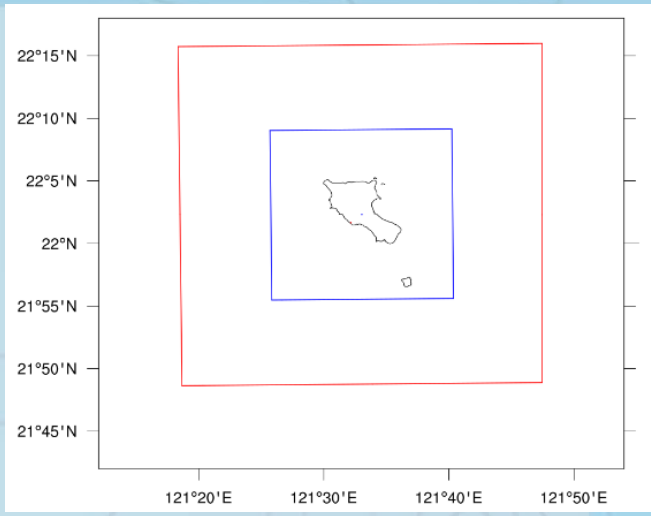
Objective:
to develop a model to simulate air flows and turbulence in and around an urban area located in complex terrain.

(二)研究資料與方法

模式設計

- 巢狀網格設計

紅線範圍為第一層之網格解析度為1公里；藍線範圍為第二層之網格解析度為250公尺



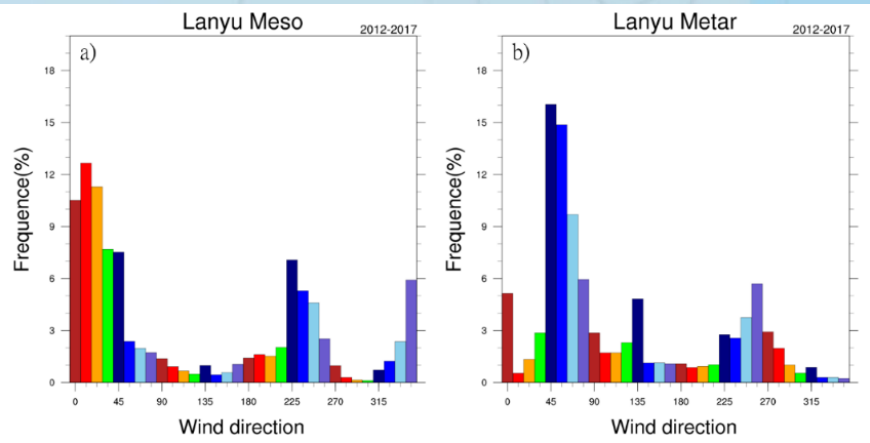
- 穩定度設定

➢ 0.65°C/100m， 相當於穩定度分類中的D級

➢ -0.35°C/100m， 相當於穩定度分類中的E級

- 初始風向風速

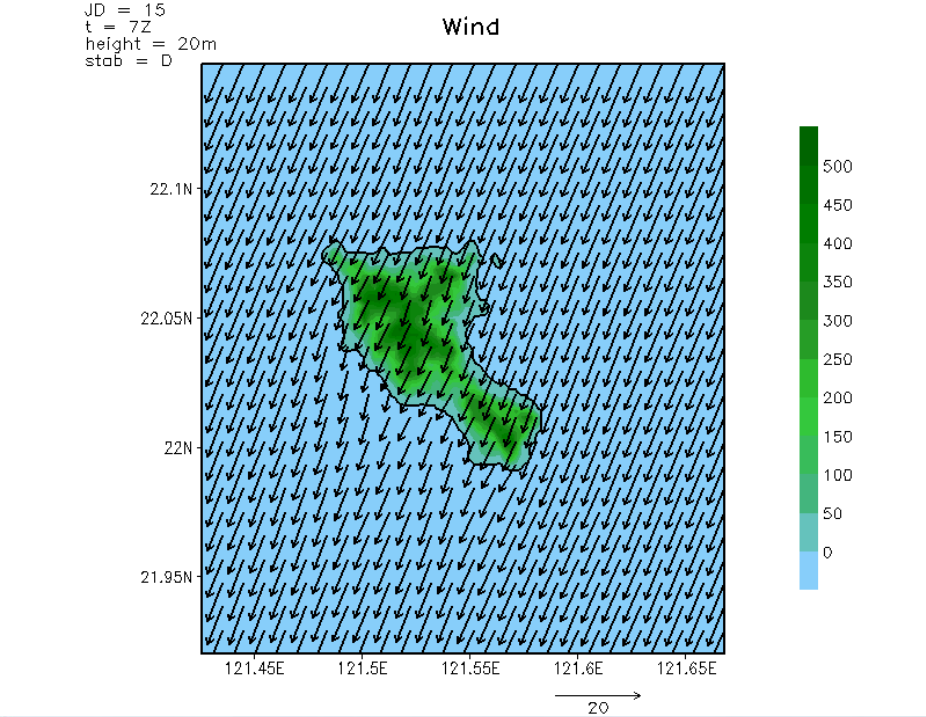
8個風向的分類，模擬的初始風速分別設為10m/s、15m/s和20m/s



(二)研究資料與方法

模式設計

- 春季和秋季的初始模擬時間為22LST，夏季的初始模擬時間為02LST，冬季的初始模擬時間為20LST，每個模擬皆模擬36個小時，時間間隔1小時。



模擬設定:

- 冬季
- 風向22.5。
- 風速20m/s
- 穩定度D

(二)研究資料與方法

亂流強度指數

- **渦流消散率**

  為在一特定大氣條件中，以能量消散的速率估算亂流的強度。

$$\epsilon = \frac{e^{\frac{3}{2}}}{Le}$$

e為亂流動能，Le為亂流長度尺度。

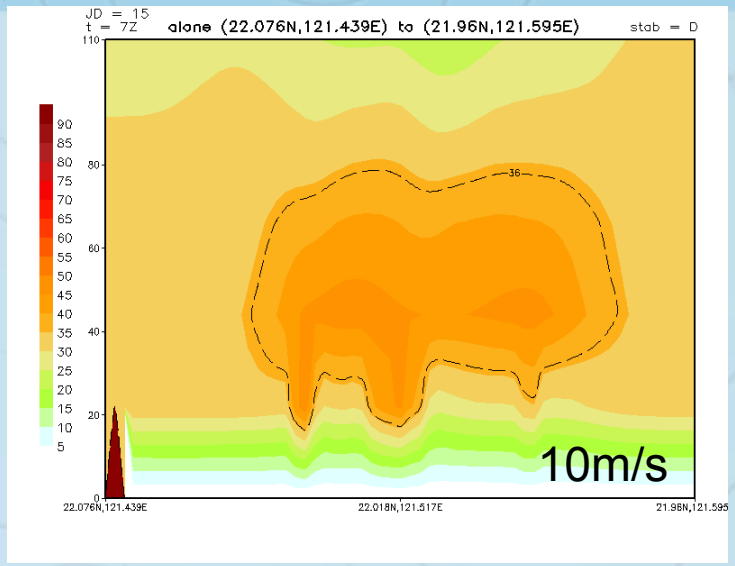
- **依照航空器重量分類**

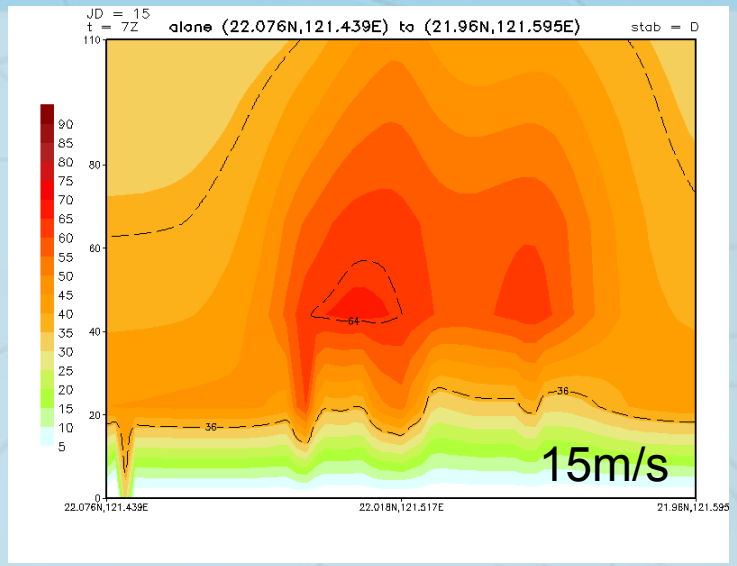
AC weight class	Estimated EDR Threshold * 100			
	Light	Moderate	Severe	Extreme
Light	13	16	36	64
Medium (Large)	15	20	44	79
Heavy	17	24	54	96

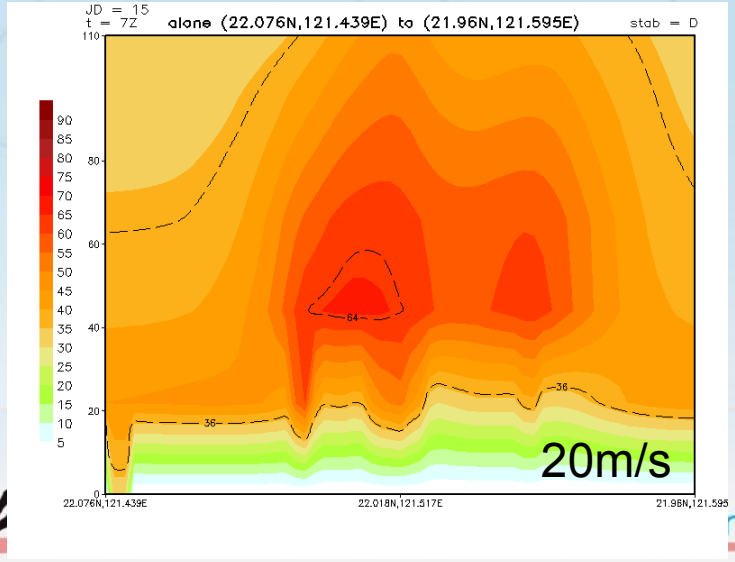
參考來源：https://www.aviationweather.gov/turbulence/help?page=plot

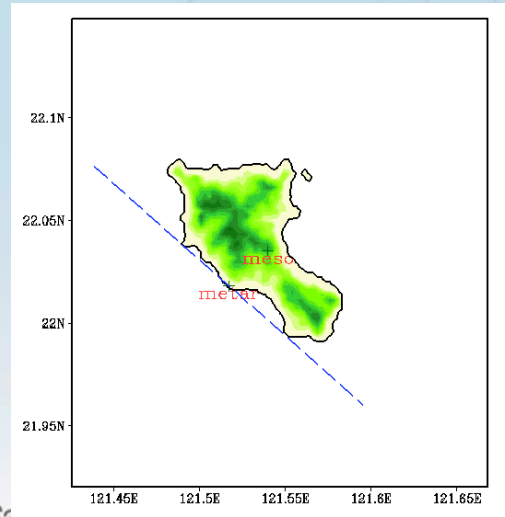
(三)分析結果 初始風速差異

冬季 風向11.25° 穩定度D



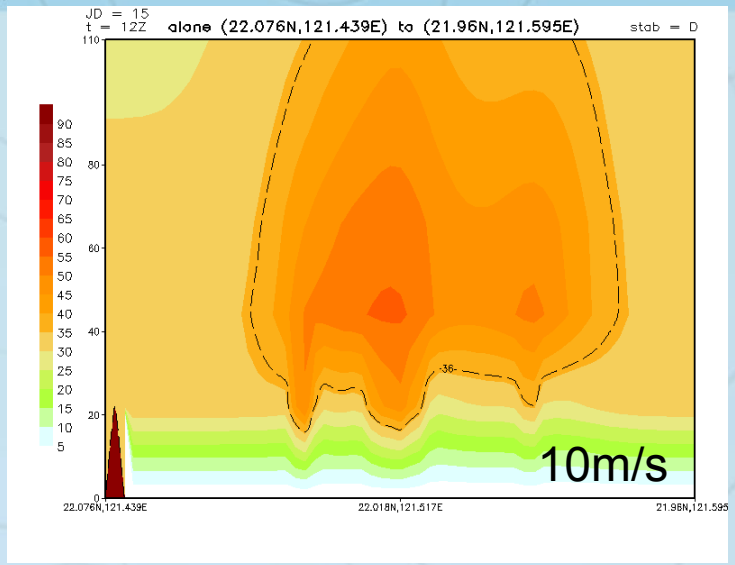


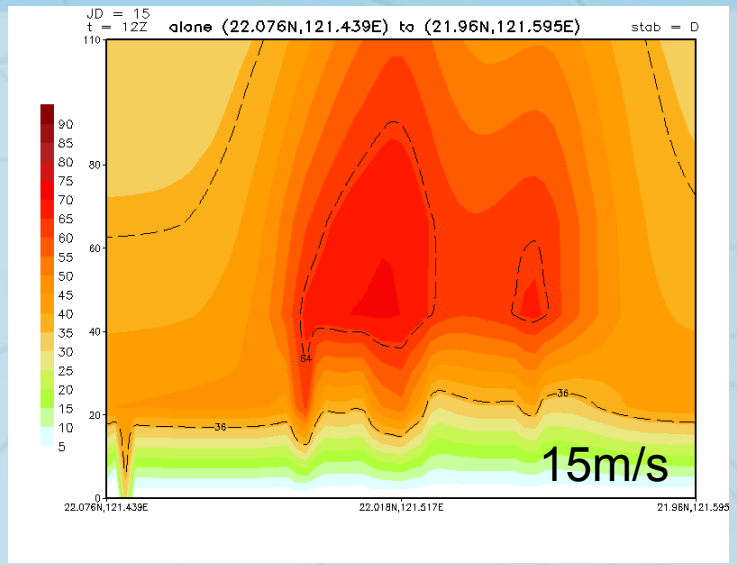


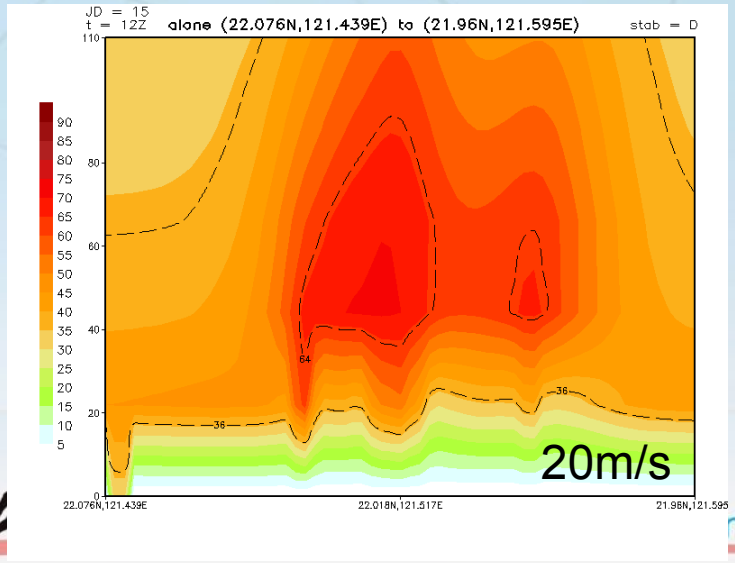


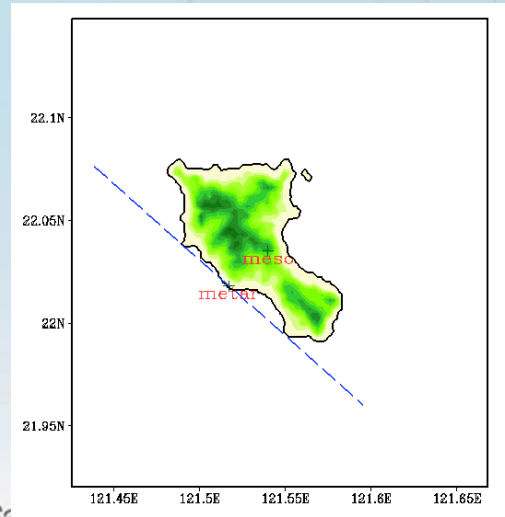
(三)分析結果 初始風速差異

冬季 風向11.25° 穩定度D 12Z



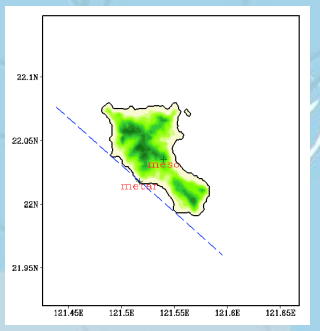


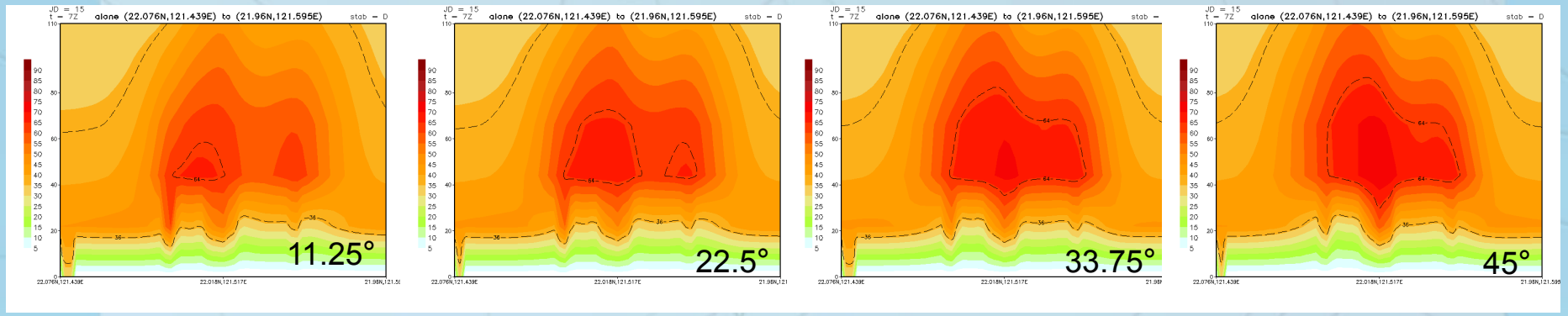


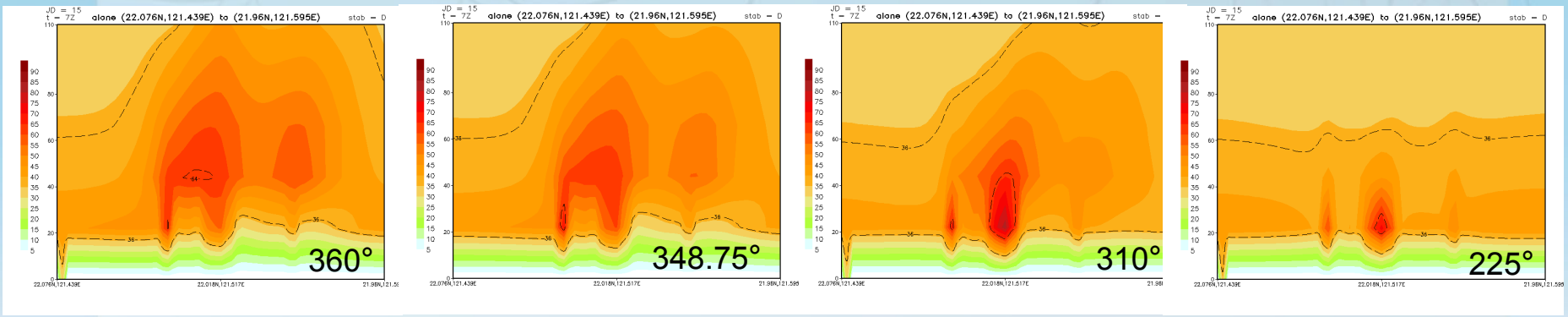


(三)分析結果 風向差異

冬季 風速20m/s 穩定度D

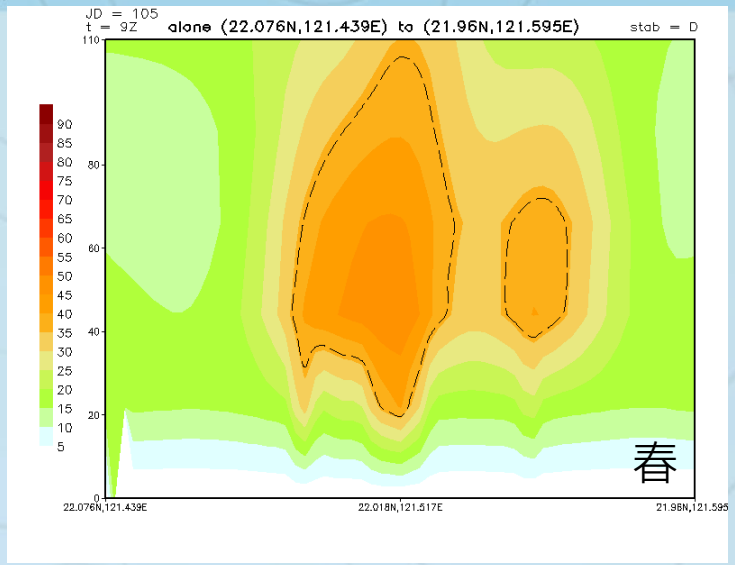


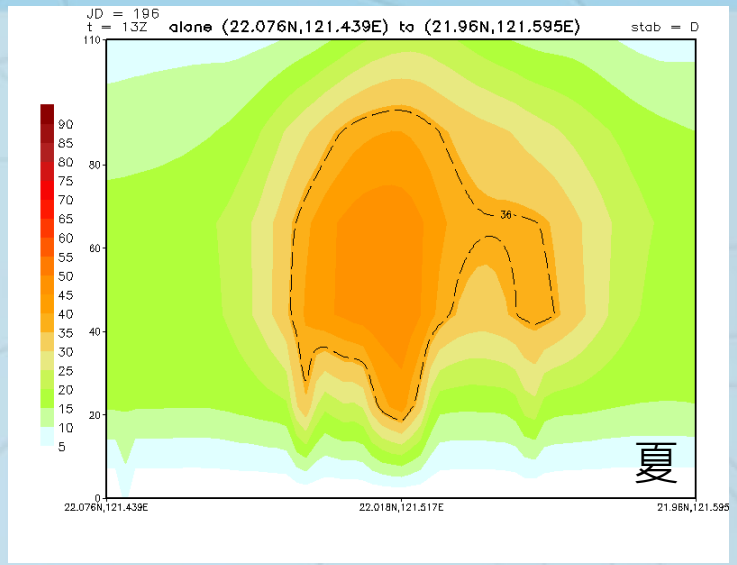


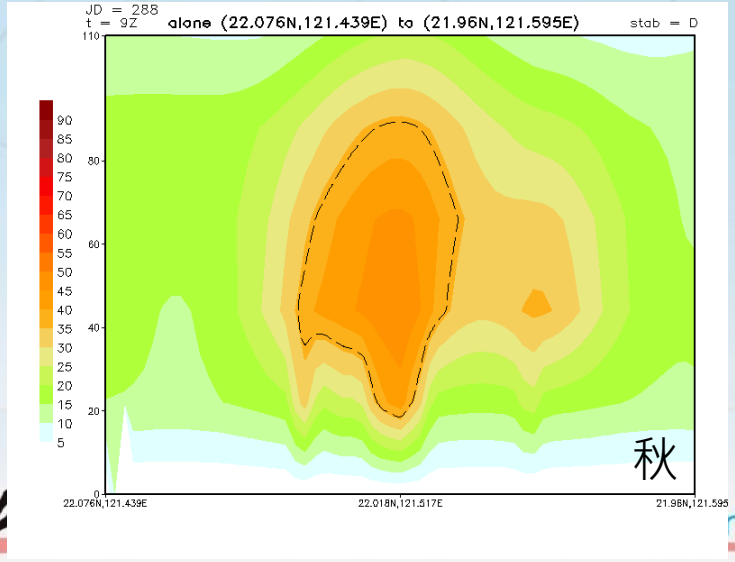


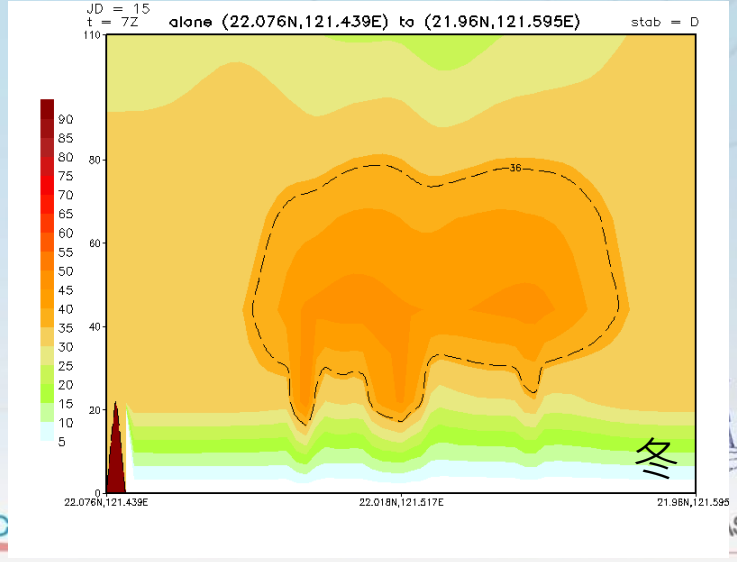
(三)分析結果 季節差異

風速10m/s 風向11.25° 穩定度D



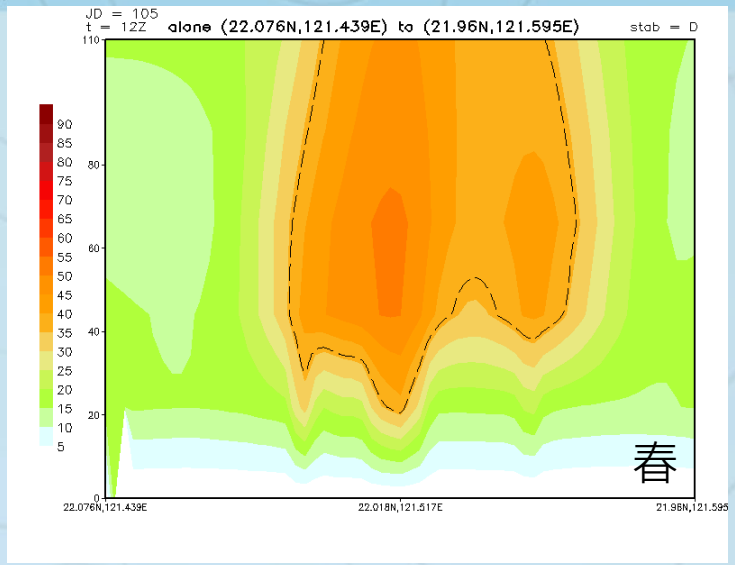


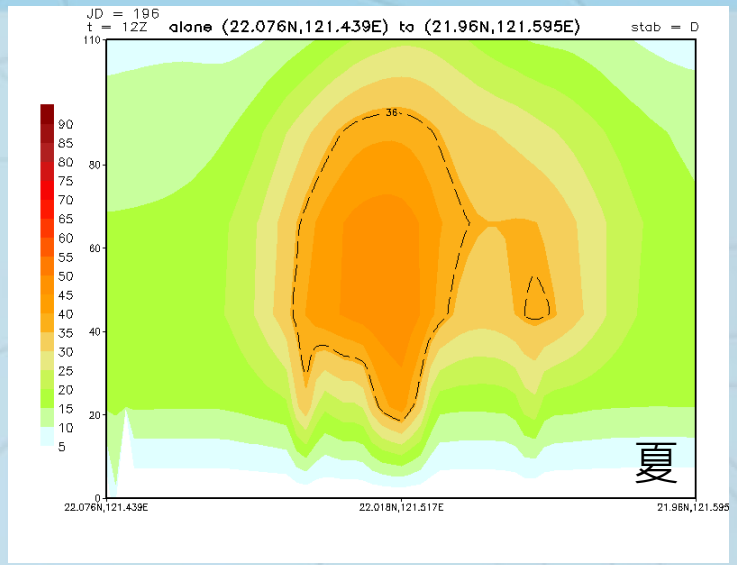


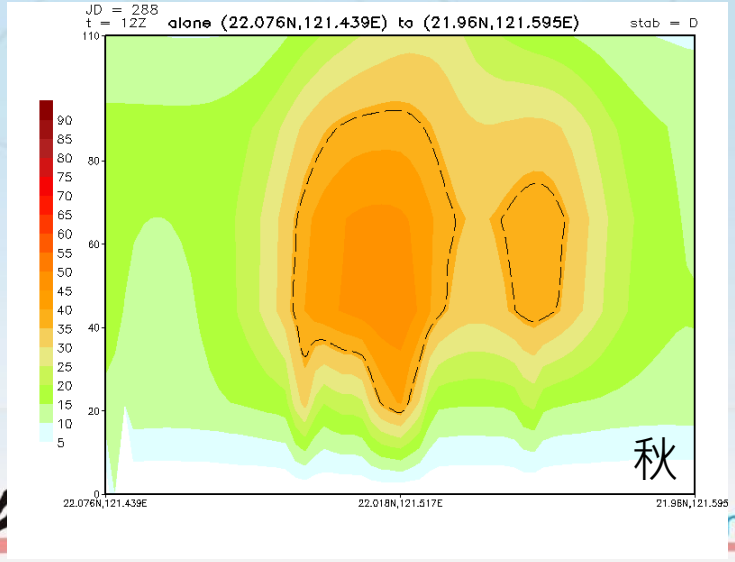


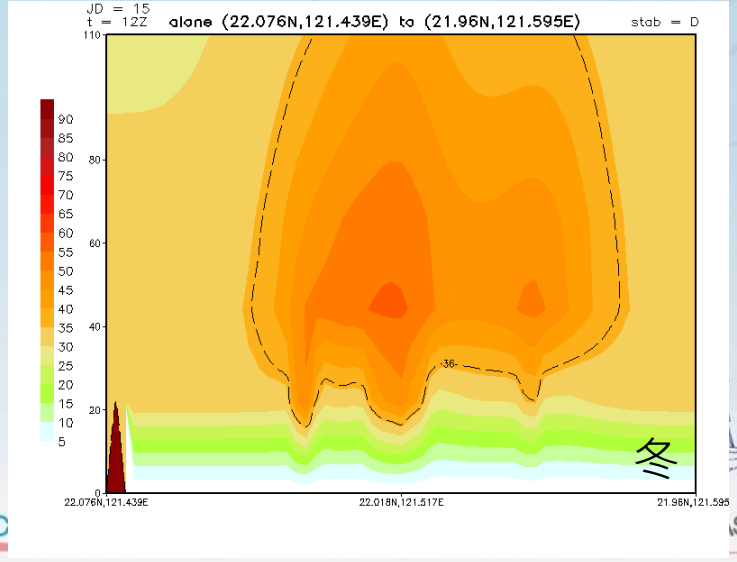
(三)分析結果 季節差異

風速10m/s 風向11.25° 穩定度D 12Z



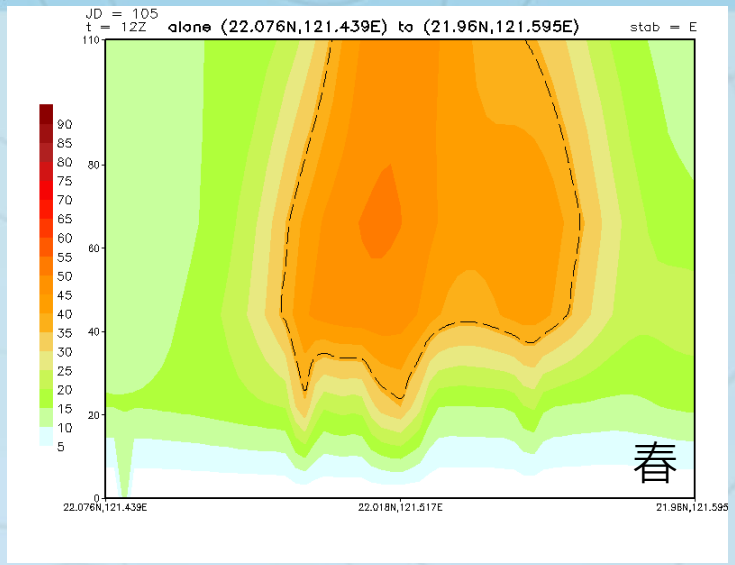


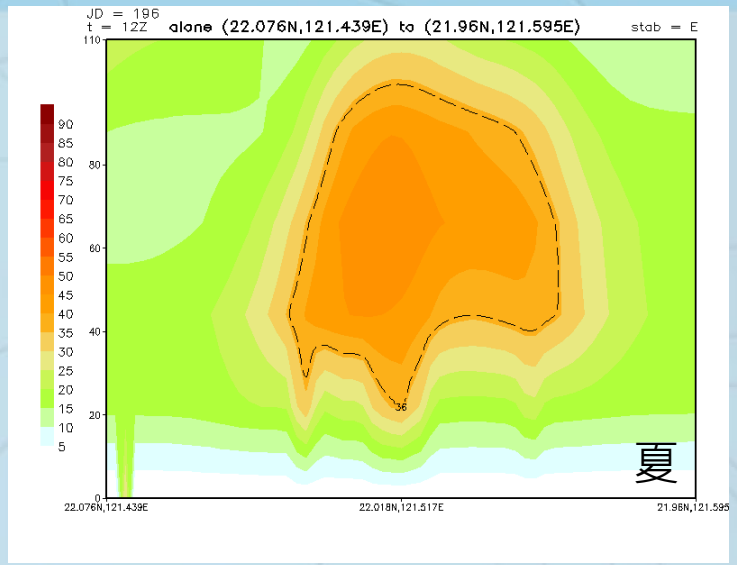


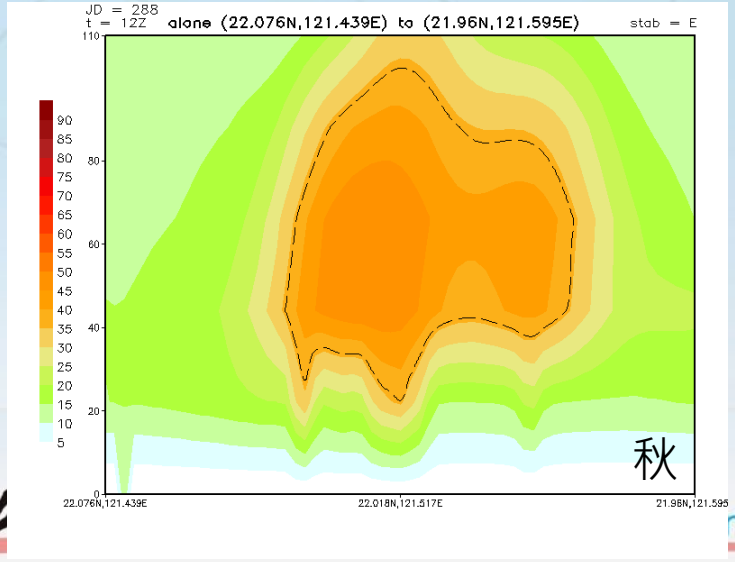


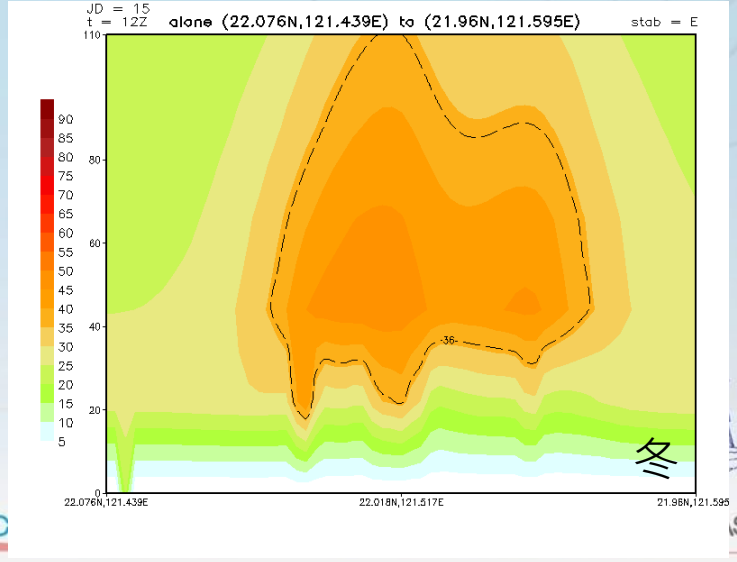
(三)分析結果 季節差異

風速10m/s 風向11.25° 穩定度E 12Z



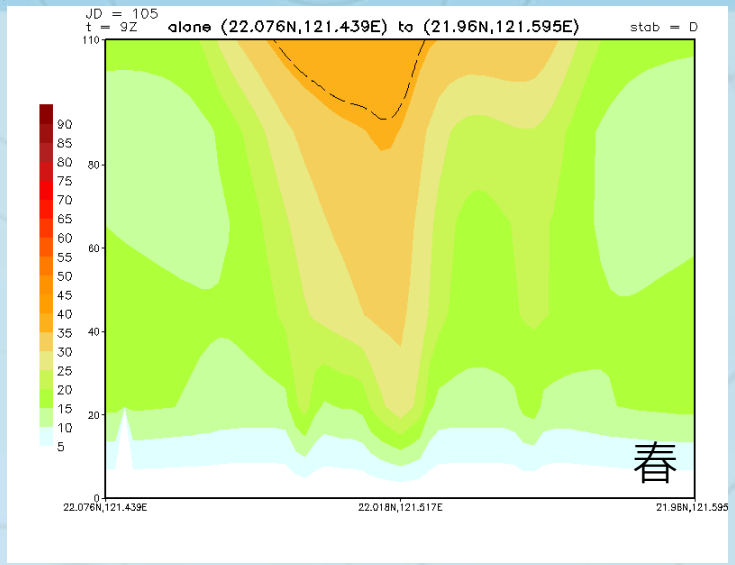


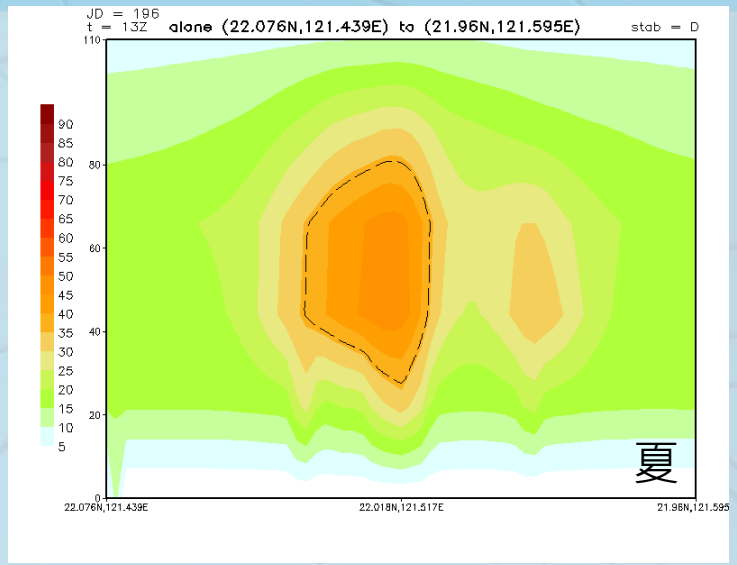


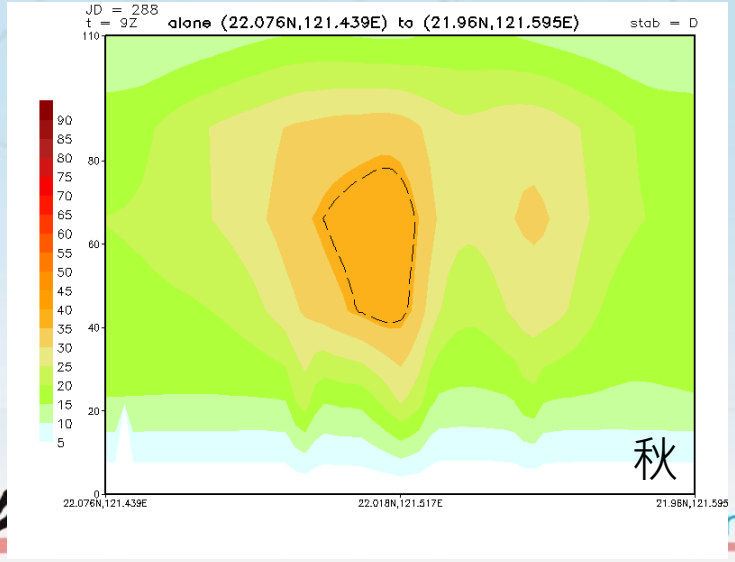


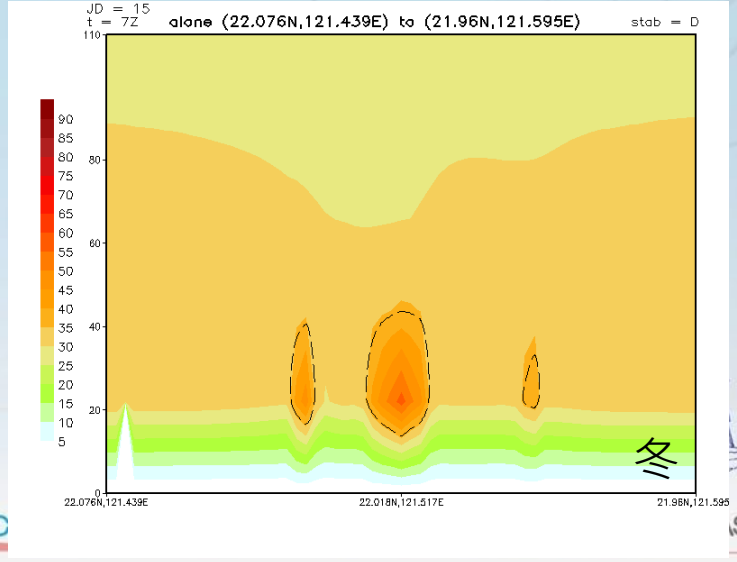
(三)分析結果 季節差異

風速10m/s 風向225° 穩定度D



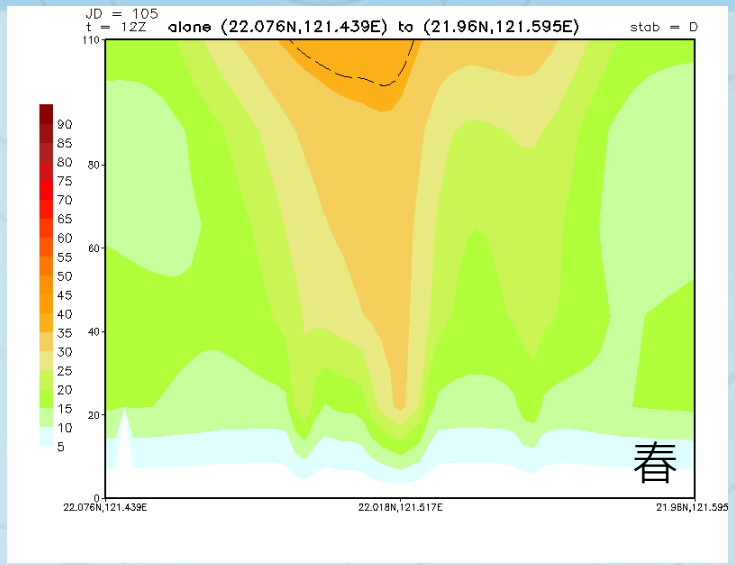


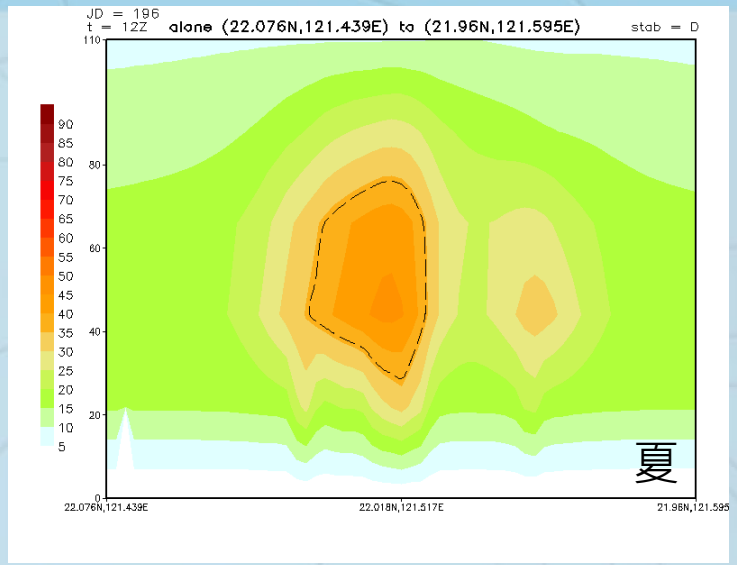


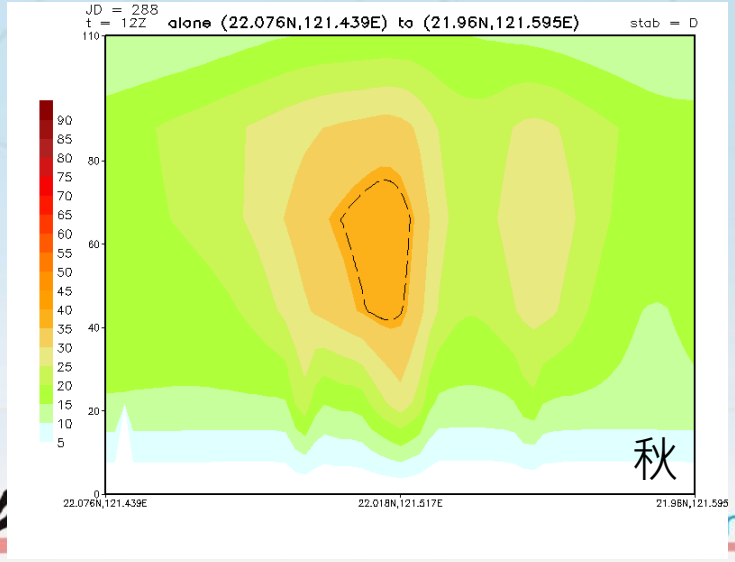


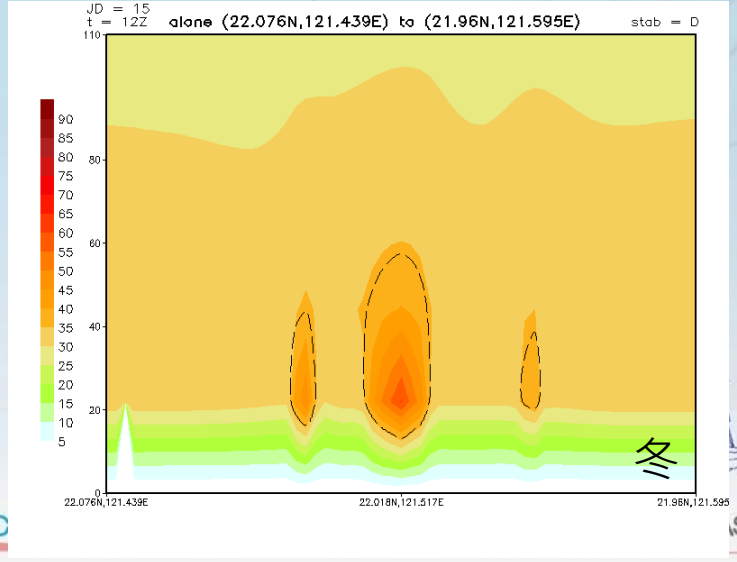
(三)分析結果 季節差異

風速10m/s 風向225° 穩定度D 12Z



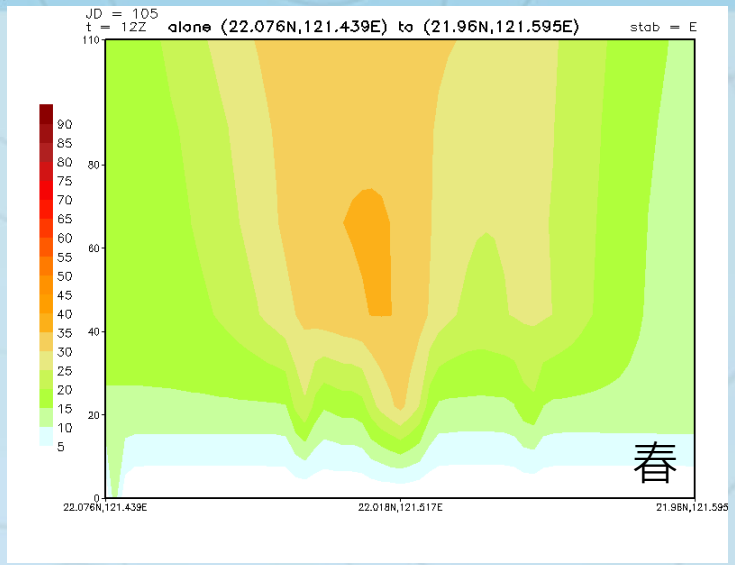


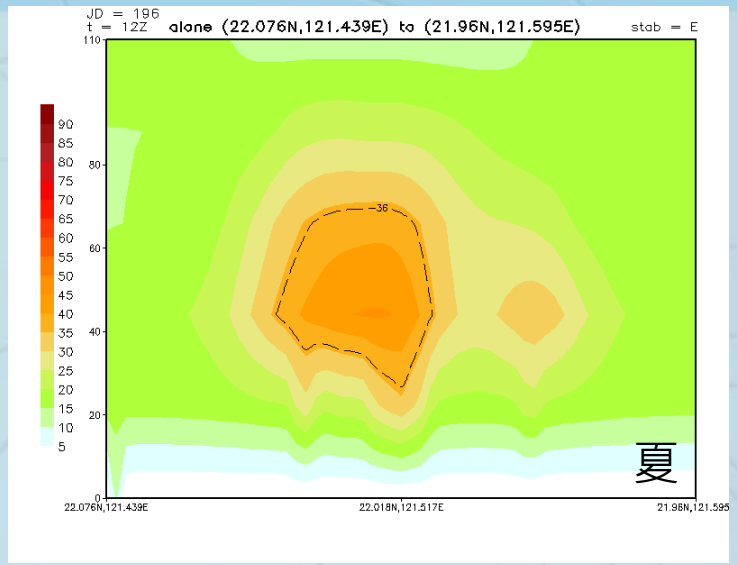


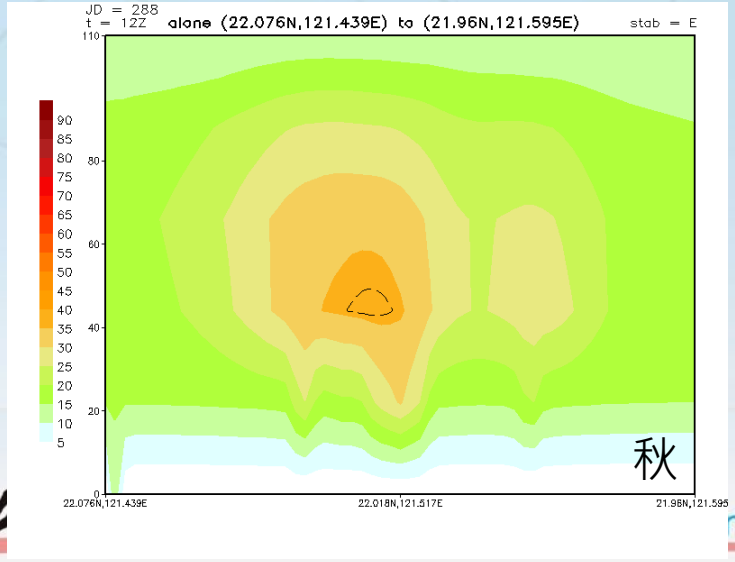


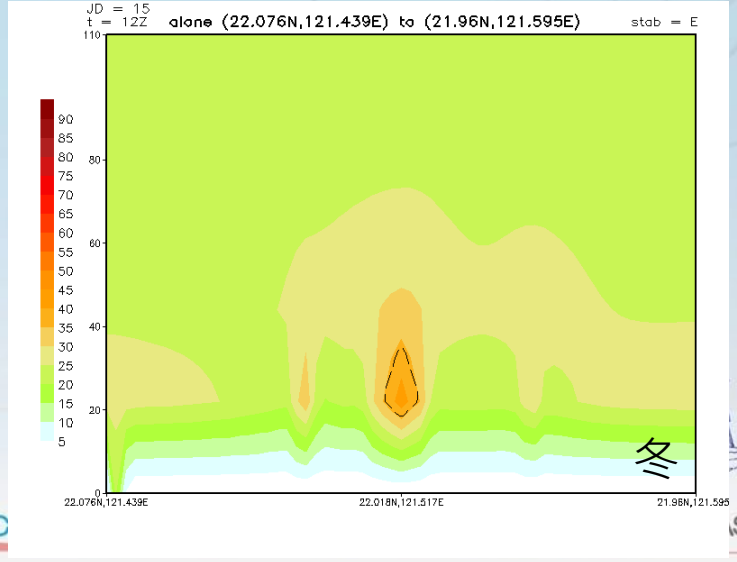
(三)分析結果 季節差異

風速10m/s 風向225° 穩定度E 12Z









(四)結論

- 風速15m/s與20m/s對於蘭嶼航空站上空亂流危險等級分布差異不大
- 在冬季且風向為東北風亂流危險等級多分布在40-60左右
- 當風向為225°(SW)時，春季亂流影響分布較高，冬季則分布較低層
- 當大氣穩定度D時亂流指數大於穩定度E
- 依照剖面圖在冬季時的亂流影響飛安分布較廣

報告完畢
敬請指導