

# WRF模式GODDARD與WSM6 微物理參數法之評估

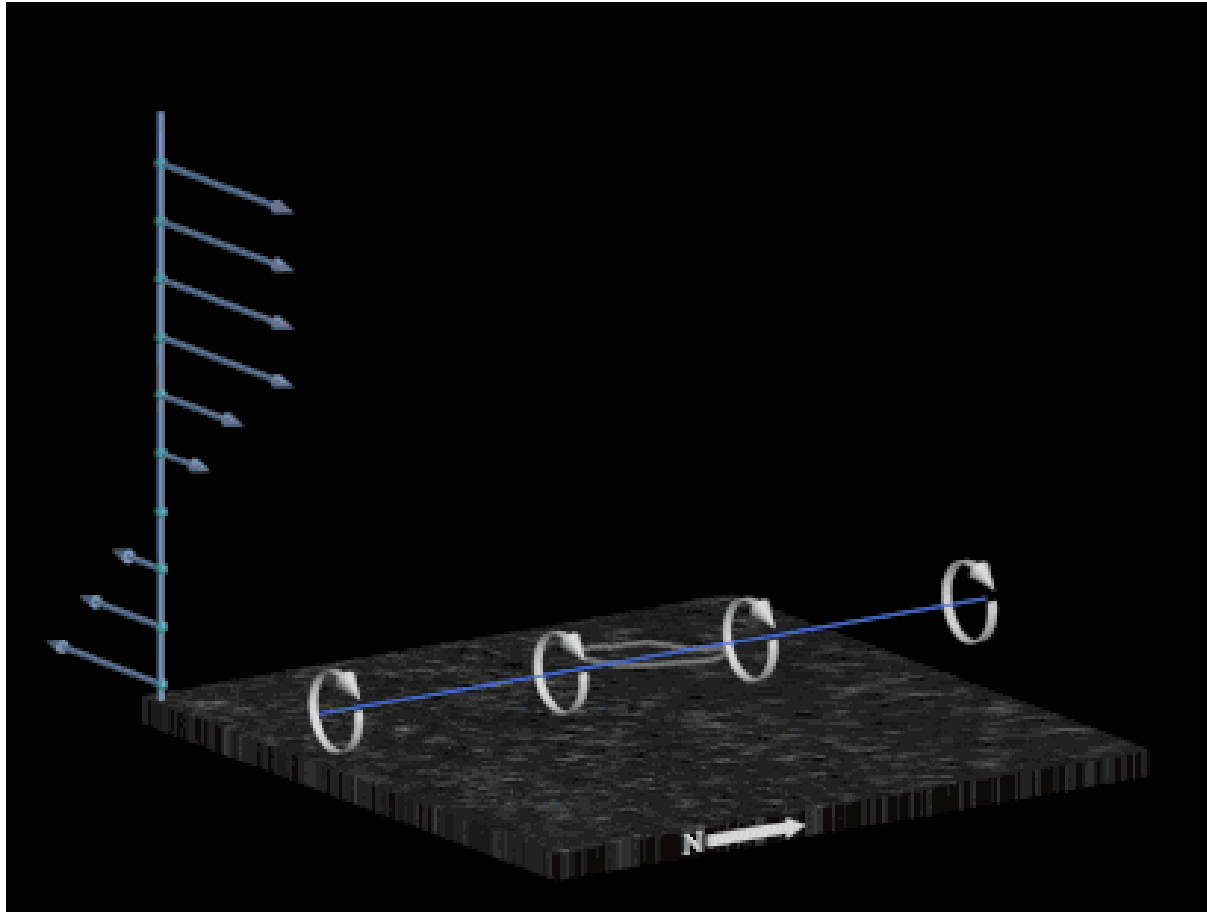
戴俐卉、洪景山、馮欽賜

# WRF模式GODDARD與WSM6 微物理參數法之評估

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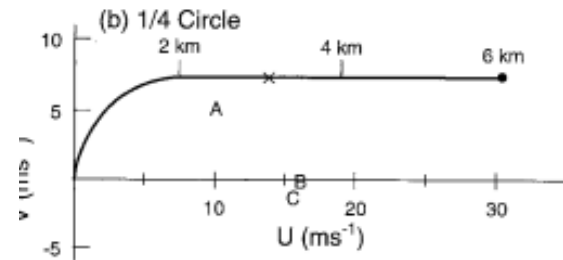
- 介紹三度空間理想化超大胞
- GODDARD vs. WSM6 差異
- 敏感度測試
- 結論

# Splitting Process



# Model configuration

- 使用Weisman and Klemp(1982)探空(with CAPE of 2200  $\text{J kg}^{-1}$ )
- 垂直風切使用一個製造典型超大胞常用的1/4圓風徑分布(Weisman and Rotunno, 2000)



- 3°K bubble centered in the domain with the temperature perturbation
- 忽略地表通量、摩擦效應、輻射、積雲等各項物理參數法，僅使用微物理參數法
- Resolution 2kmx500m (Domain 100km x 100km)  
tau=120mins

# WSM6 vs. GODDARD

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- 同樣基於 Rutledge and Hobbs(1984) & Lin et al. (1983) Bulk microphysics scheme
- 同樣具有 5 hydrometeor types ( $Q_c$ 、 $Q_i$ 、 $Q_r$ 、 $Q_s$ 、 $Q_g$ )
- 同樣為 One-Moment MP scheme
- **GODD**:傳統飽和調整的基礎下加入多項修正方案 (G) (W)
- **GODD**:McCumber et al. (1991) (G)
- **WSM6**: 以Purdue-Lin基準加入修正的冰態微物理過程 (W) – (1)假設冰核數濃度為溫度的函數；(2)假設冰晶濃度是冰量的函數；(3)雲冰沉降處理。
- **WSM6**: 飽和調整基於Tao et al. (2003)，但分開處理冰及水的飽和過程。

# WSM6@750m pressure 、 potential temperature

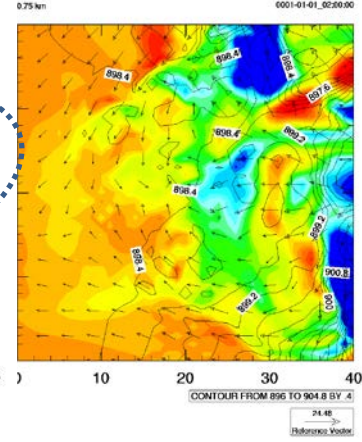
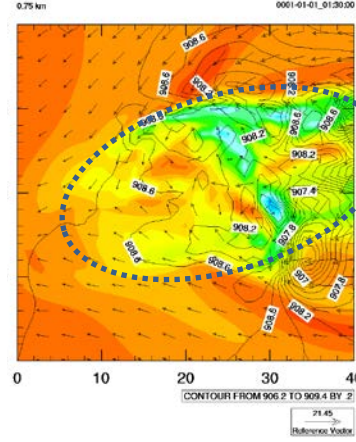
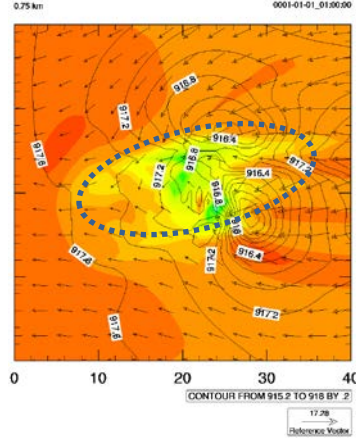
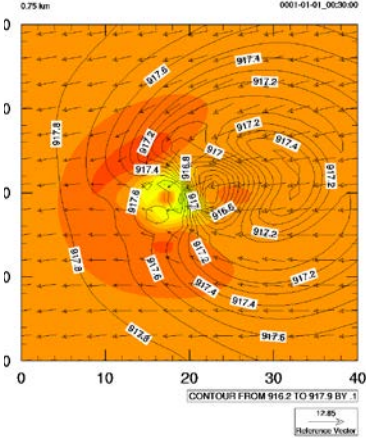
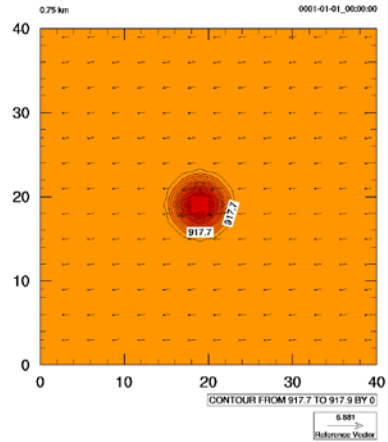
pressure (mb, lines),  $\theta$  (theta, color) and winds (m/s)

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pressure (mb, lines),  $\theta$  (theta, color) and winds (m/s)



Tau = 0

Tau = 30m

Tau = 60m

Tau = 90m

Tau = 120m

# GODDARD@750m

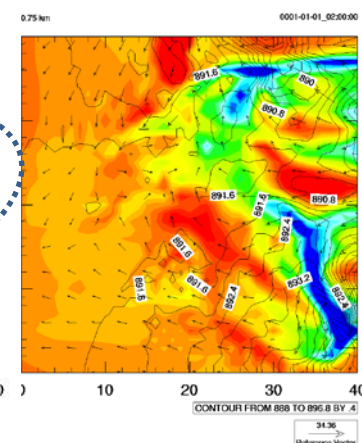
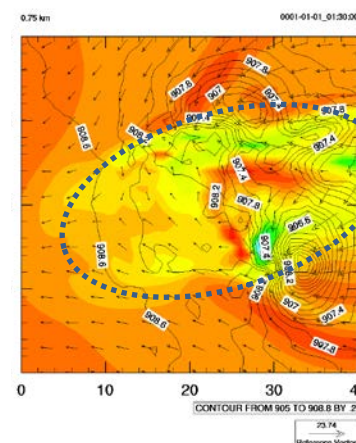
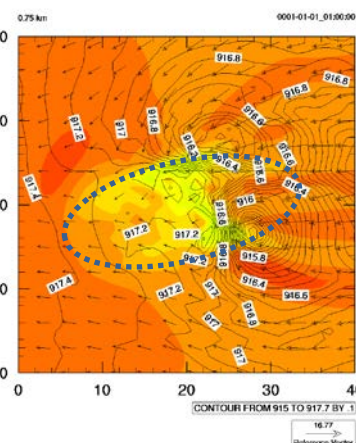
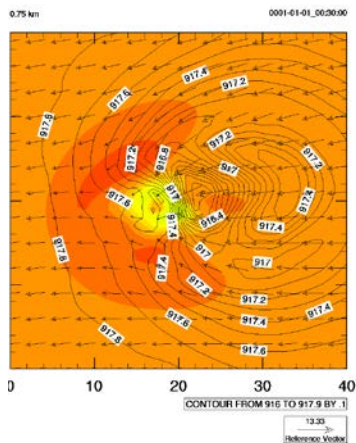
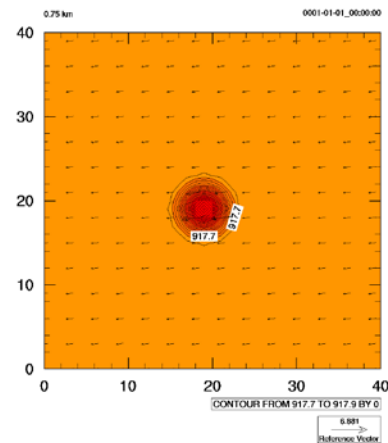
pressure (mb, lines),  $\theta$  (theta, color) and winds (m/s)

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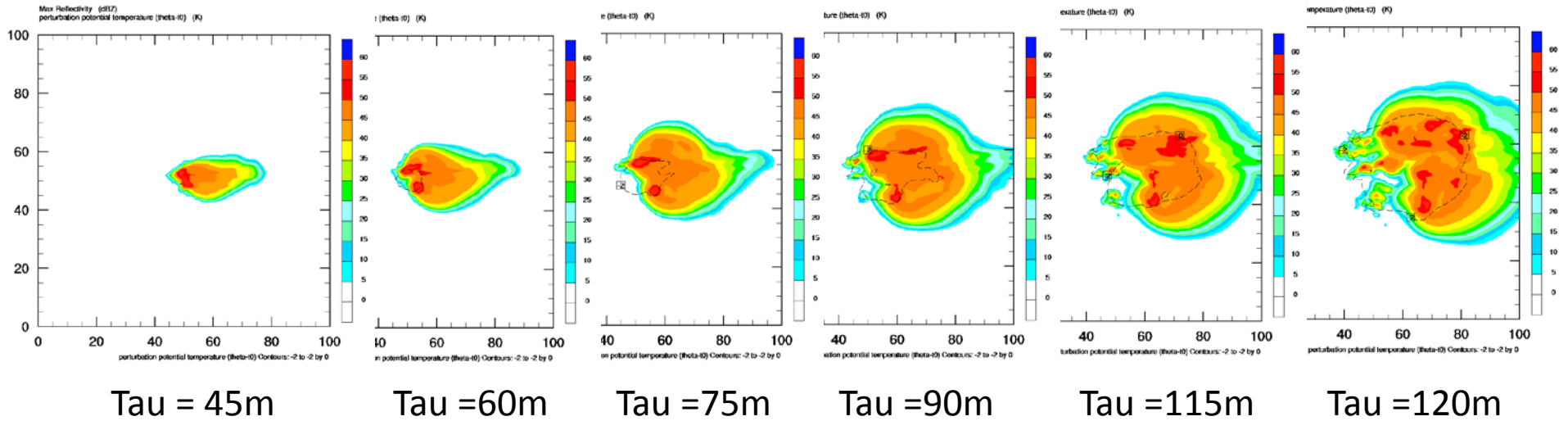
pressure (mb, lines),  $\theta$  (theta, color) and winds (m/s)

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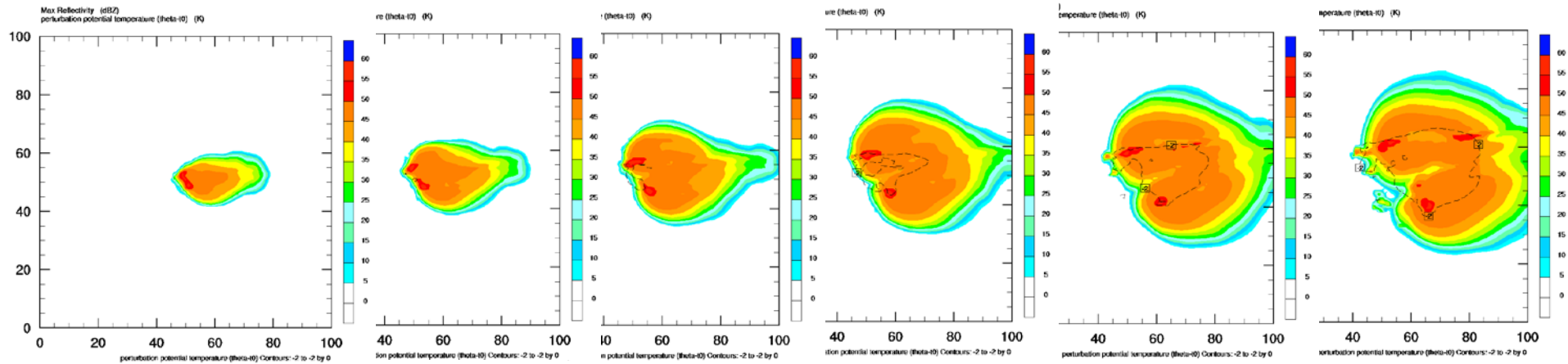
pressure (mb, lines),  $\theta$  (theta, color) and winds (m/s)



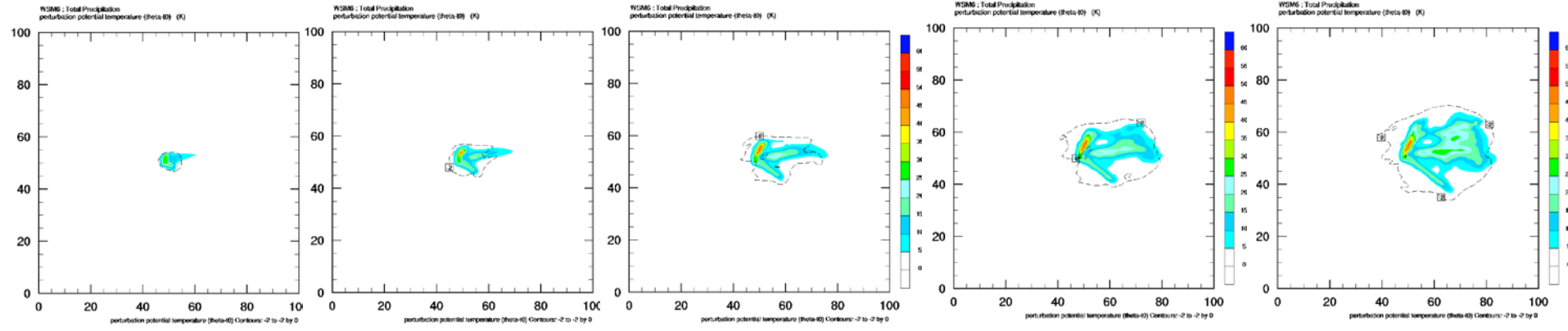
# WSM6@mdbz and perturbation potential temperature



# Goddard@mdbz and pp



# WSM6@PP and pp



Tau = 60m

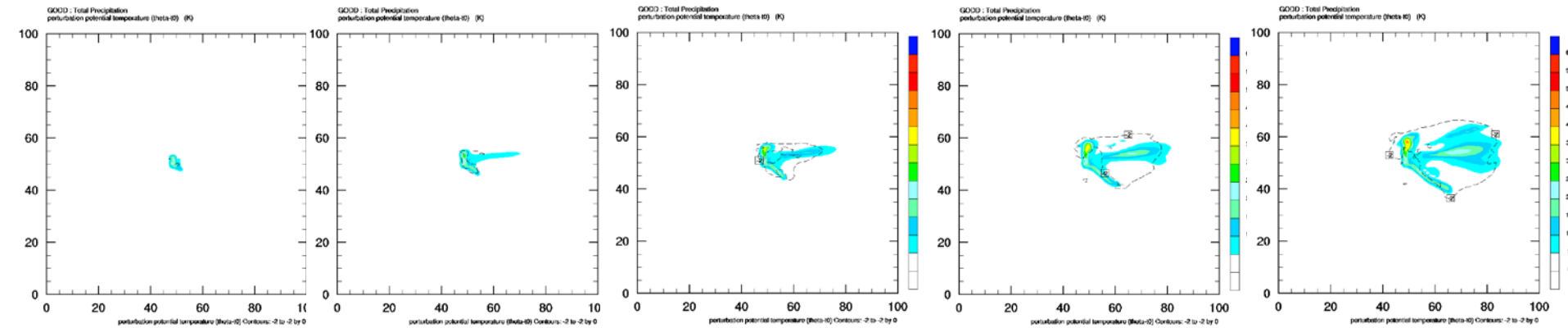
Tau = 75m

Tau = 90m

Tau = 115m

Tau = 120m

# Goddard@PP and pp

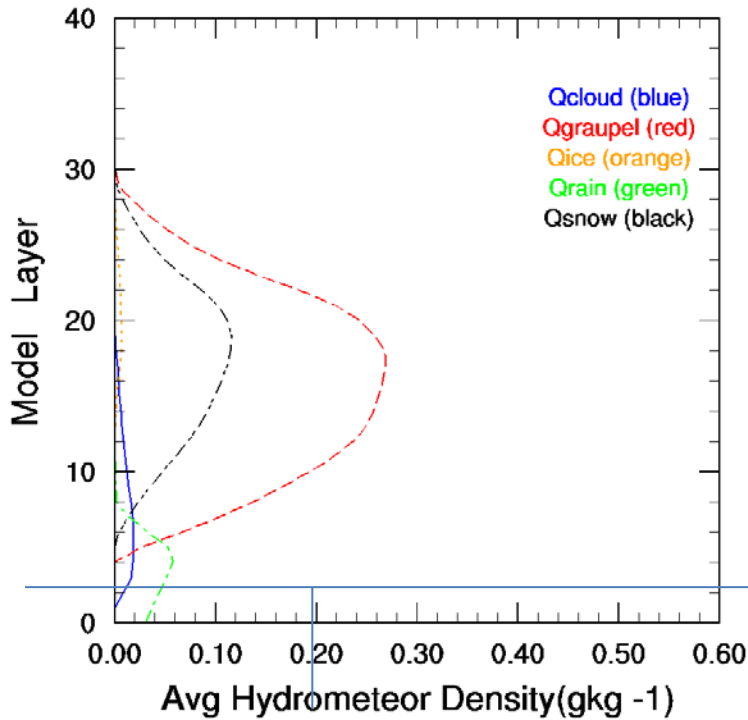




# Goddard v. WSM6

WRF IDEAL CASE: QUARTER SUPERCELL

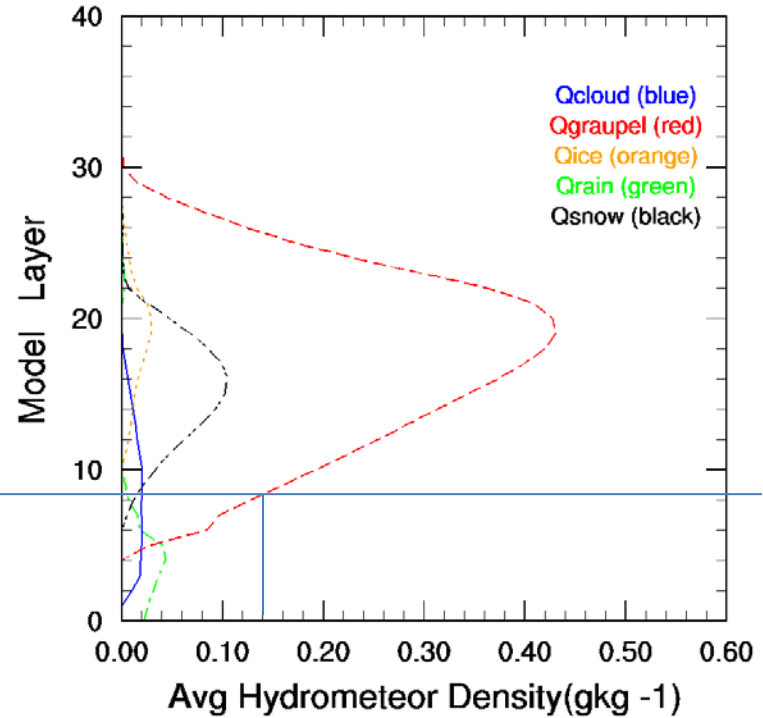
MP: WSM6



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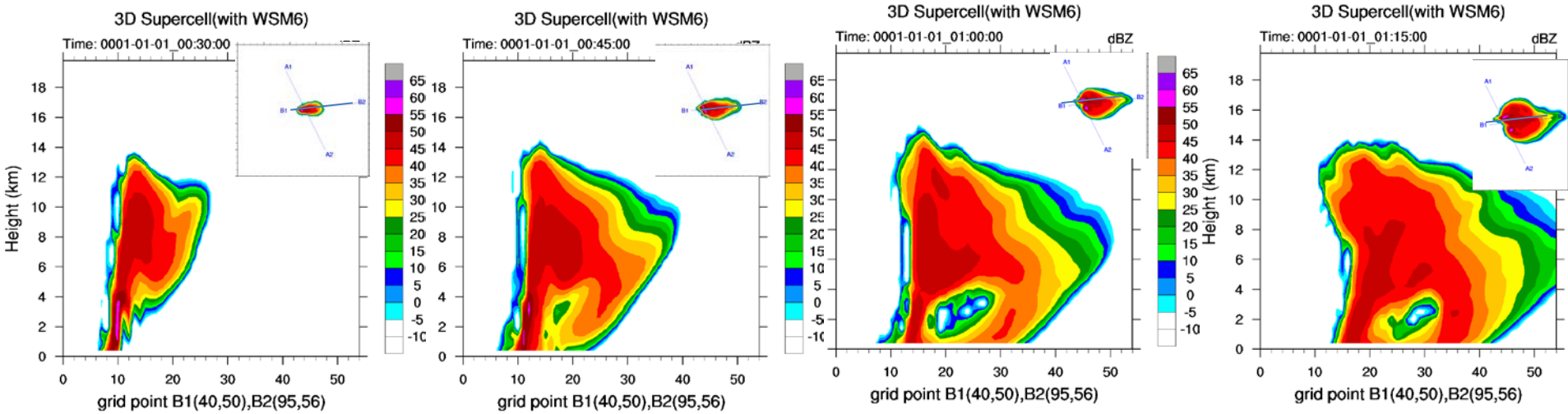
WRF IDEAL CASE: QUARTER SUPERCELL

MP: Goddard with graupel

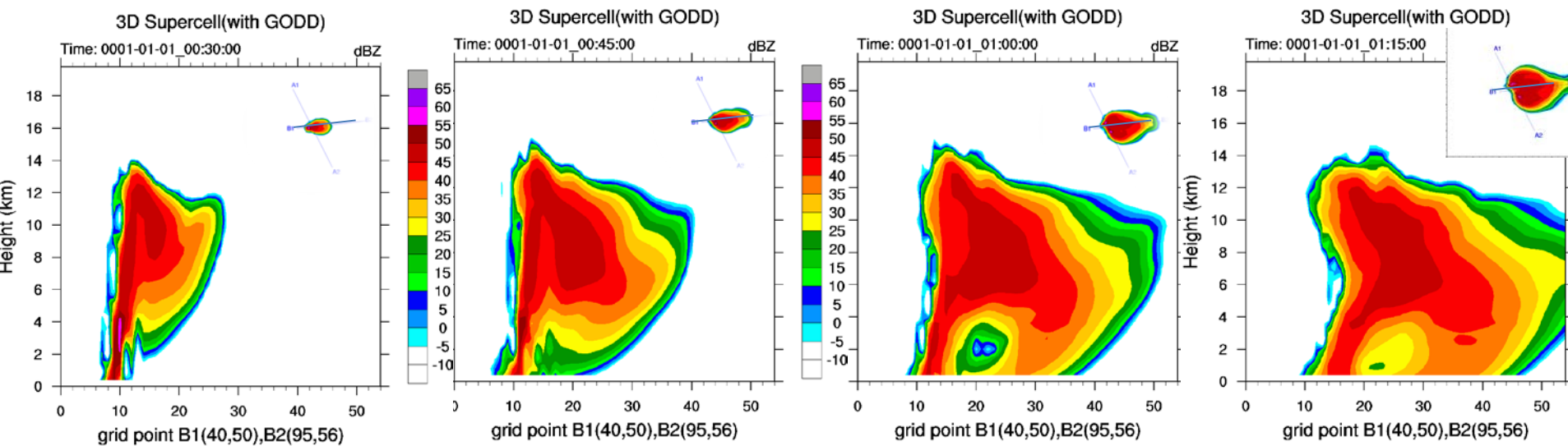


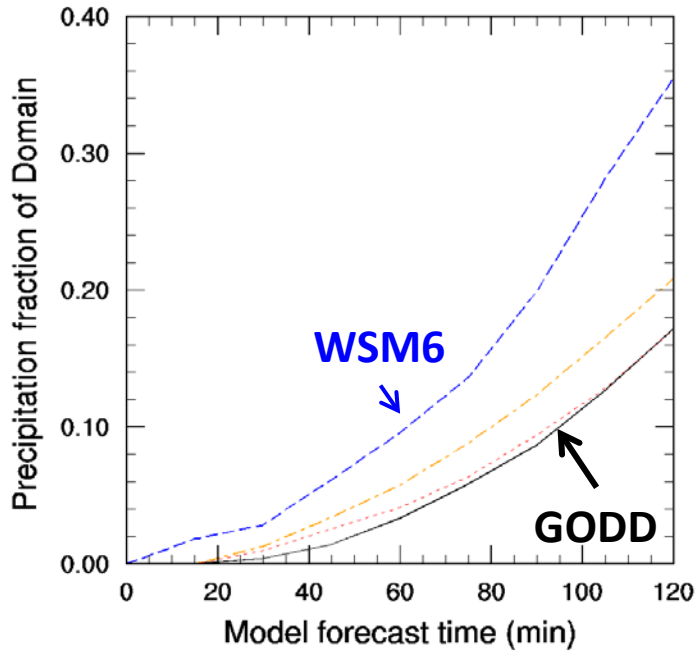
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# WSM6

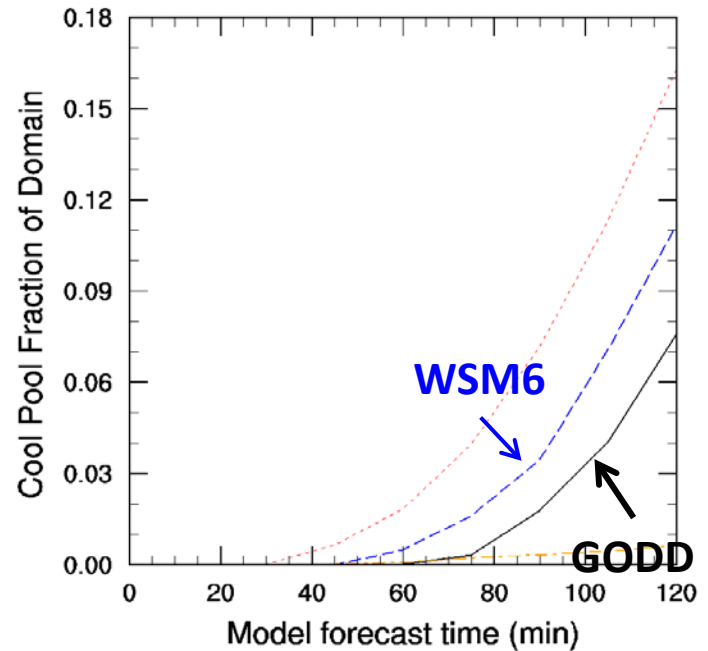


# GODD

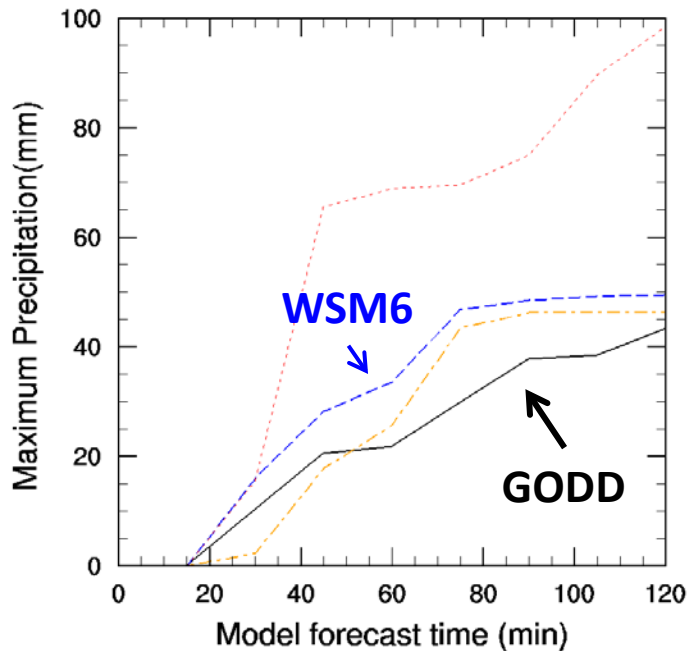




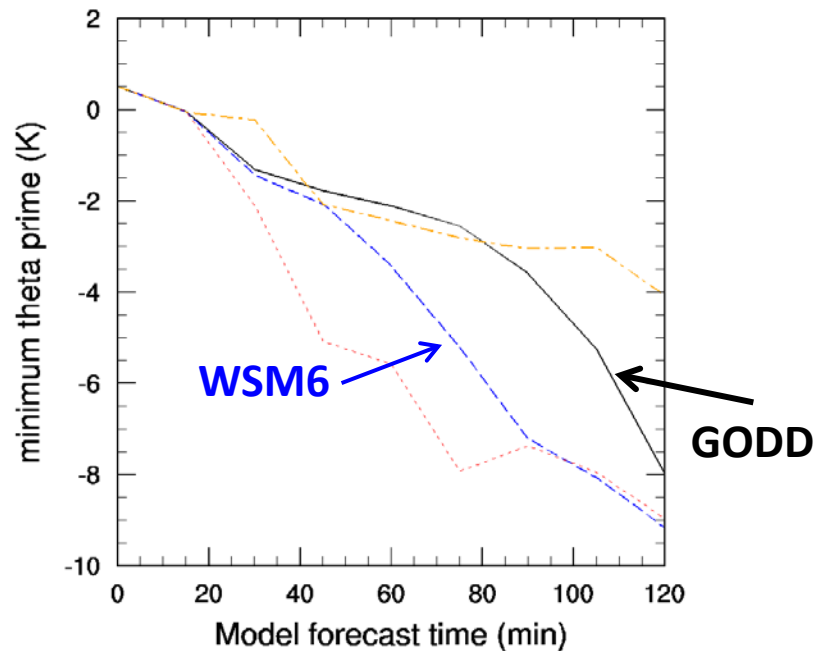
Godd(black) .vs. WSM6(blue) .vs. hail(red) .vs. Mor(orange)



Godd(black) .vs. WSM6(blue) .vs. hail(red) .vs. Mor(orange)



Godd(black) .vs. WSM6(blue) .vs. hail(red) .vs. Mor(orange)



Godd(black) .vs. WSM6(blue) .vs. hail(red) .vs. Mor(orange)

# 敏感度測試 1

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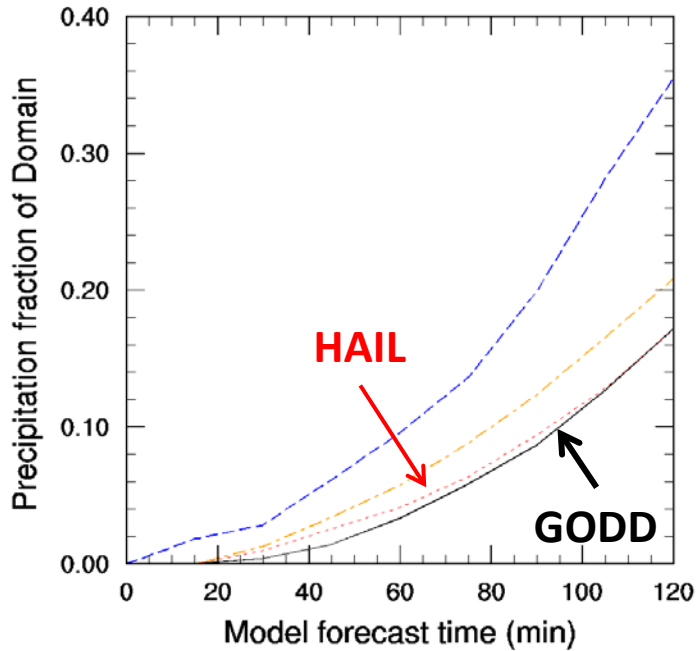
- Goddard GCE scheme :

gsfcgce\_hail = 1

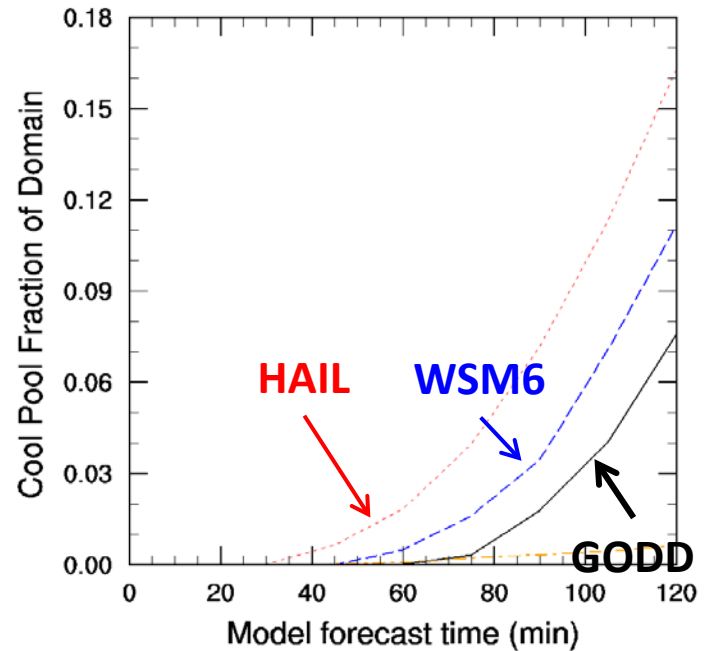
將GODDARD中第五種hydrometeor type  
由原來的 graupel置換成hail



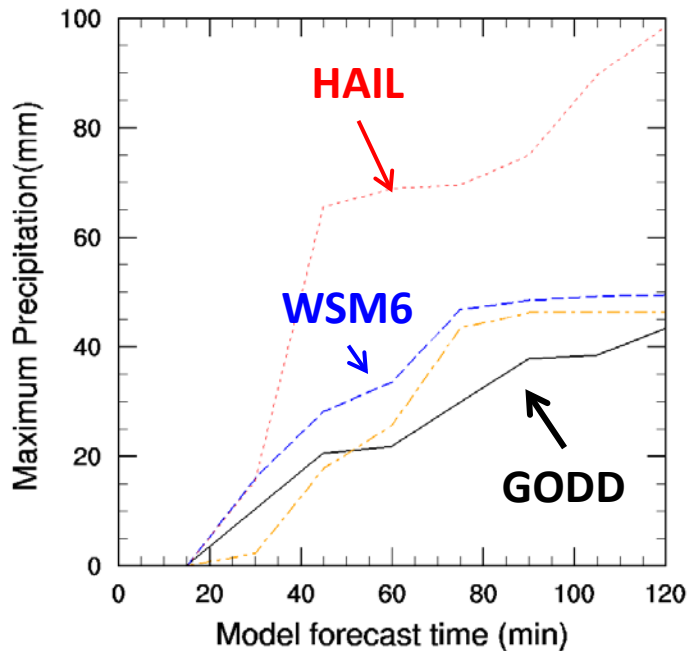




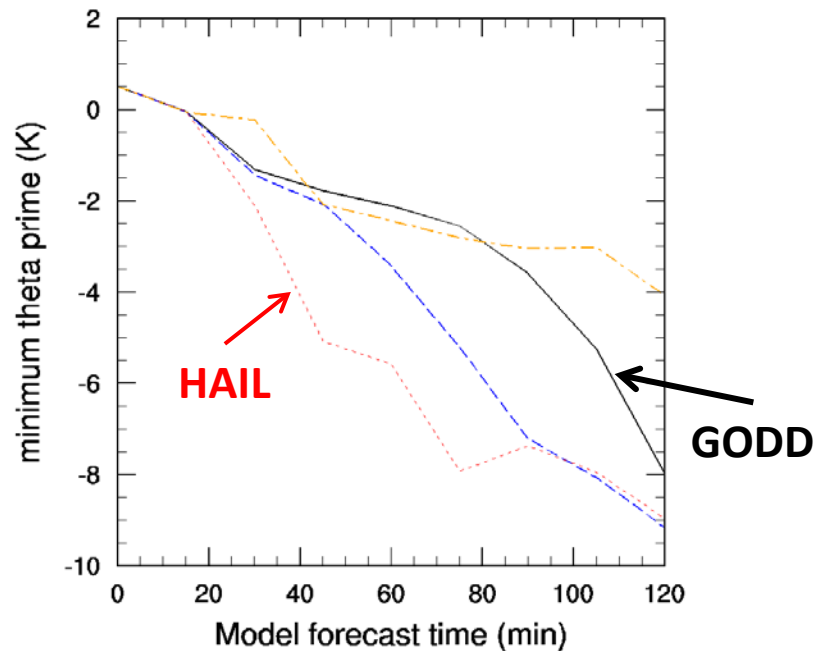
Godd(black) .vs. WSM6(blue) .vs. hail(red) .vs. Mor(orange)



Godd(black) .vs. WSM6(blue) .vs. hail(red) .vs. Mor(orange)



Godd(black) .vs. WSM6(blue) .vs. hail(red) .vs. Mor(orange)

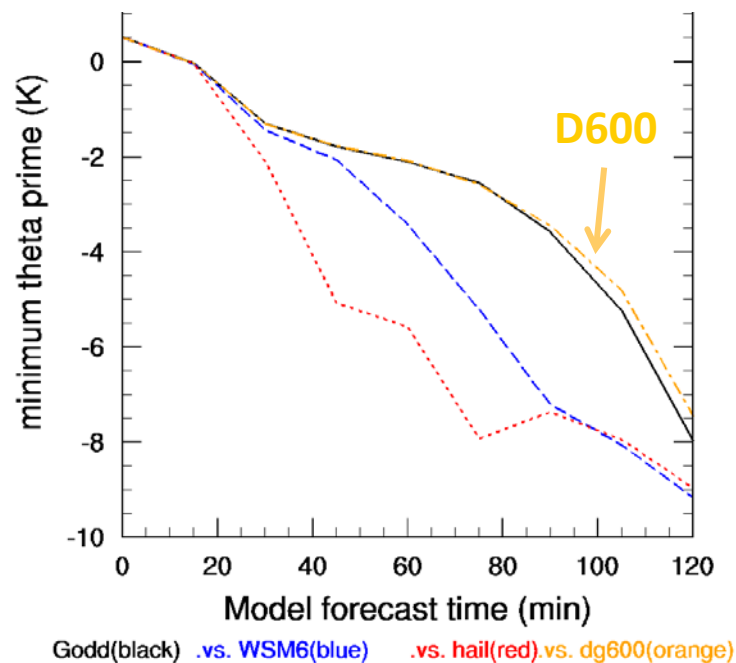
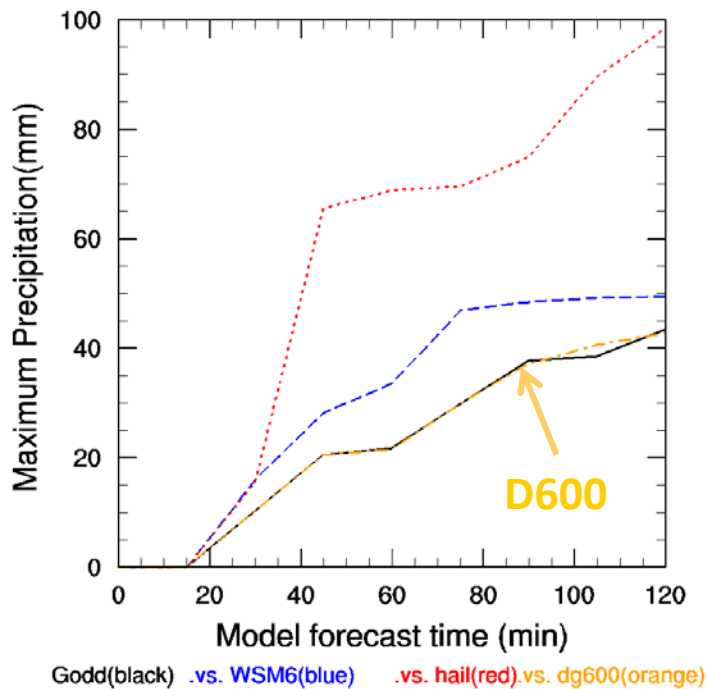
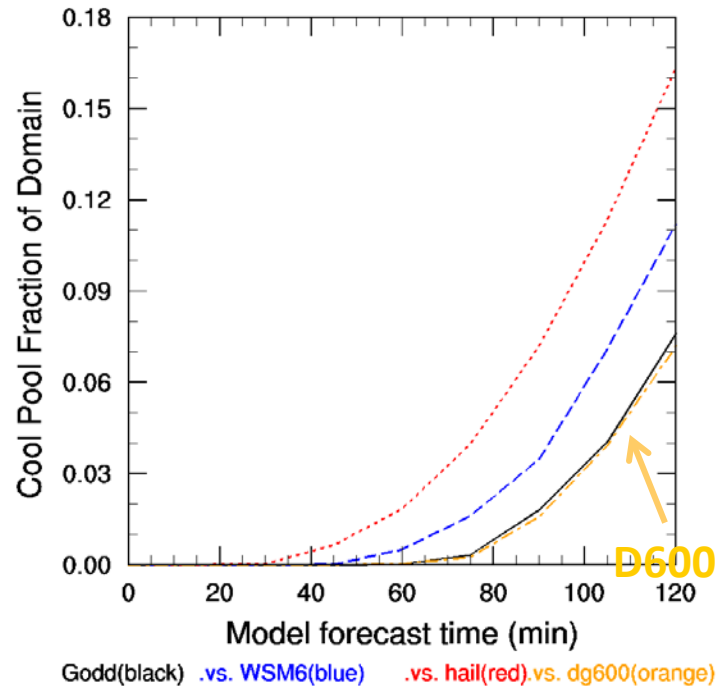
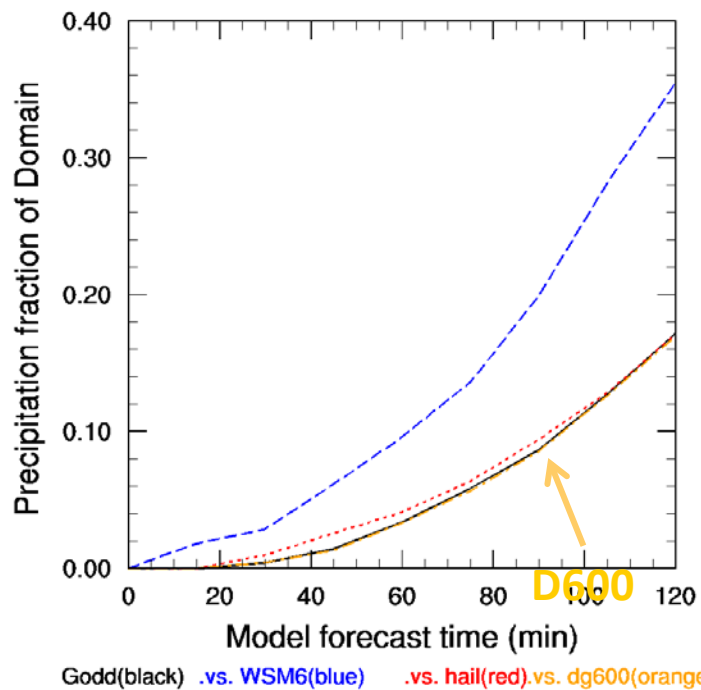


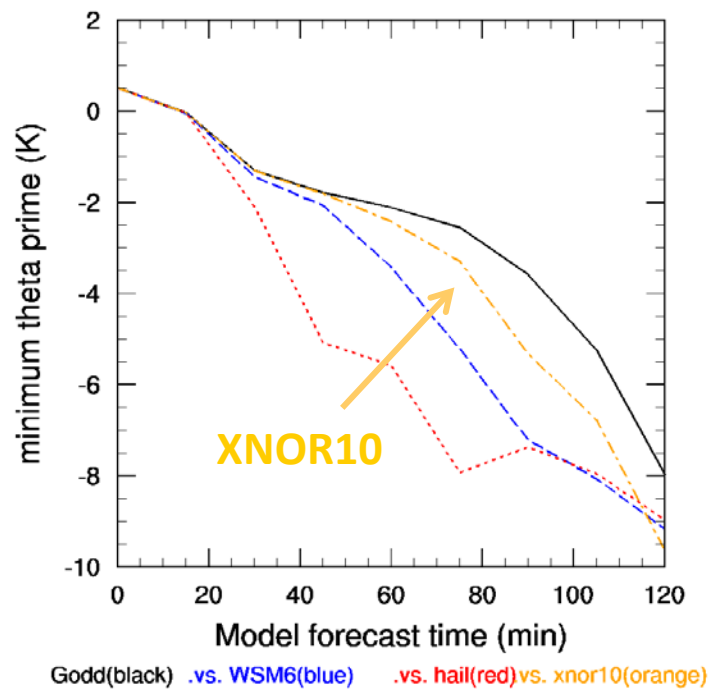
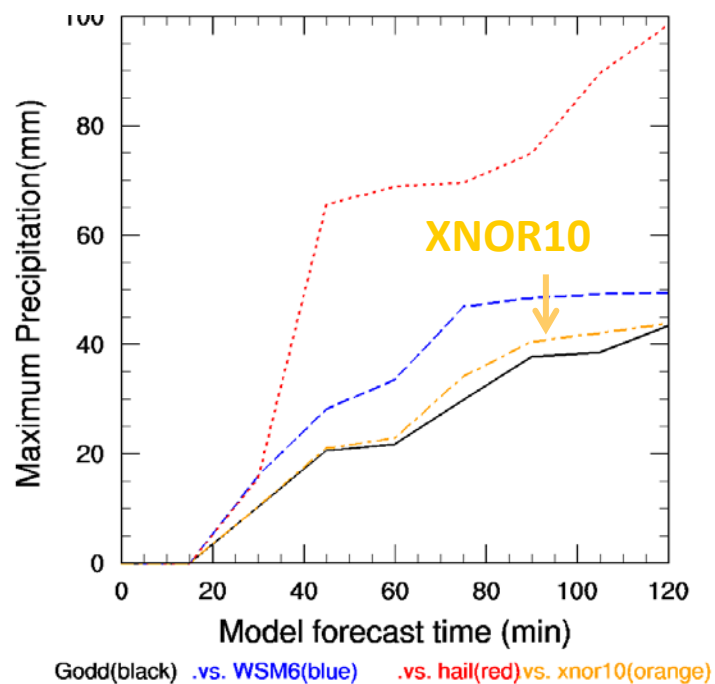
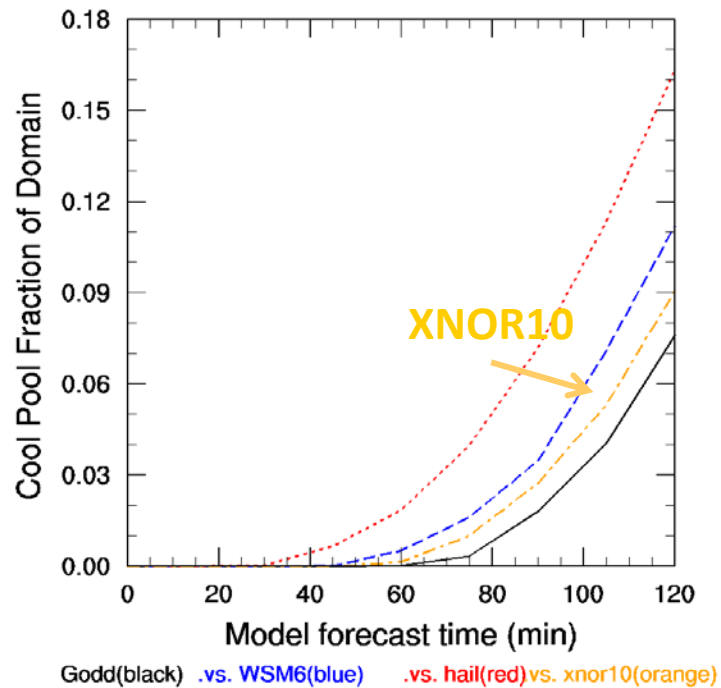
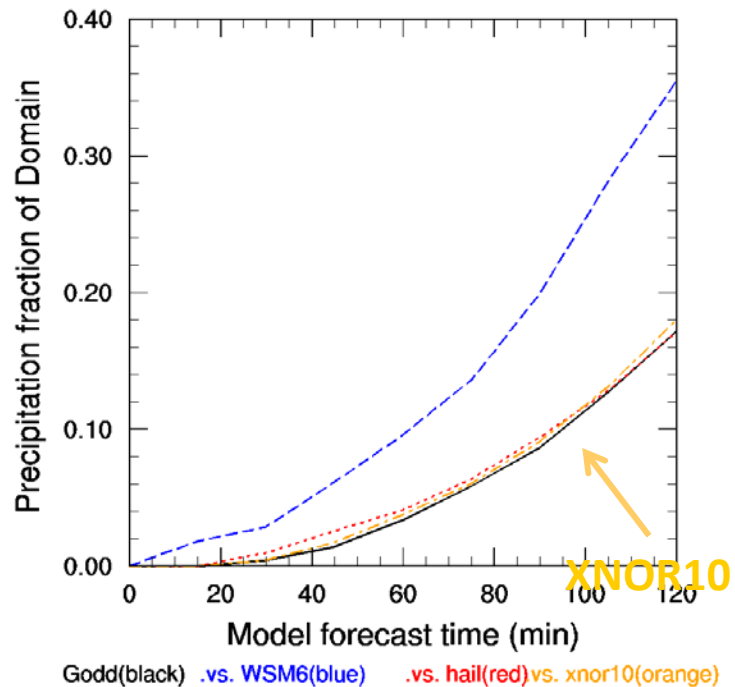
Godd(black) .vs. WSM6(blue) .vs. hail(red) .vs. Mor(orange)

# 敏感度測試 2( graupel deng)

- Gilmore et al. (2004) and Van Weverberg et al.(2010) showed large sensitivity of simulated supercell storm dynamics and precipitation to changes in the assumed **bulk density** and **fixed intercept parameter** of the graupel/hail category.
- GODD參數法中，GRAUPEL den =  $0.4\text{gcm}^{-3}$  ;
- (1) GRAUPEL density由 0.4改為0.6
- (2) intercept parameter 由 $4.0\text{e}^6$ 改為 $4.0\text{e}^5$







# 敏感度測試 3( modified GODD)

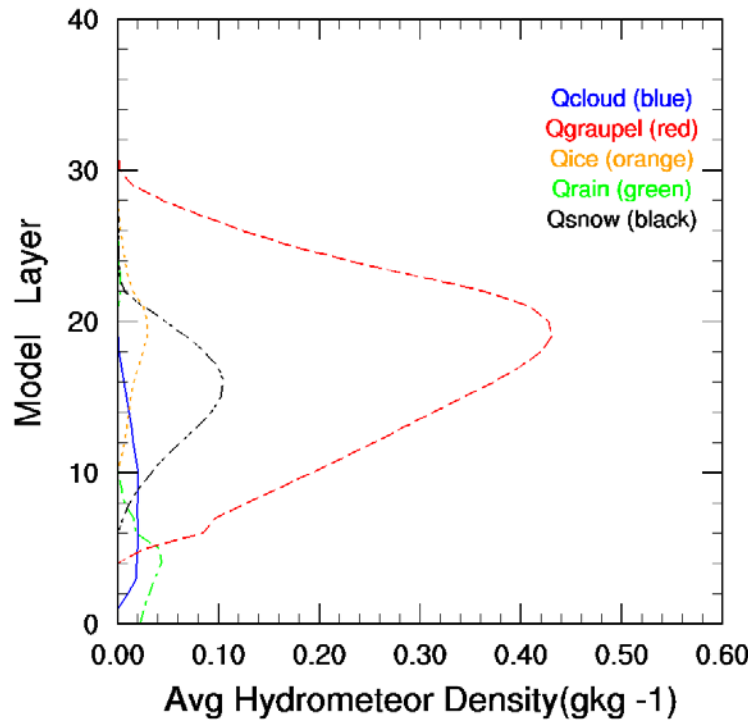
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- Modified Goddard (2012.03)
  - 減少雨之蒸發過程 (bulk vs. spectral bin)--- 使用 Li et al., 2009的方法來減少雨水蒸發過程之過度計算
  - Reduce 40dBz at high altitude---藉由減少 riming efficiency、riming threshold from snow to graupel...

# Goddard v. modGodd

WRF IDEAL CASE: QUARTER SUPERCELL

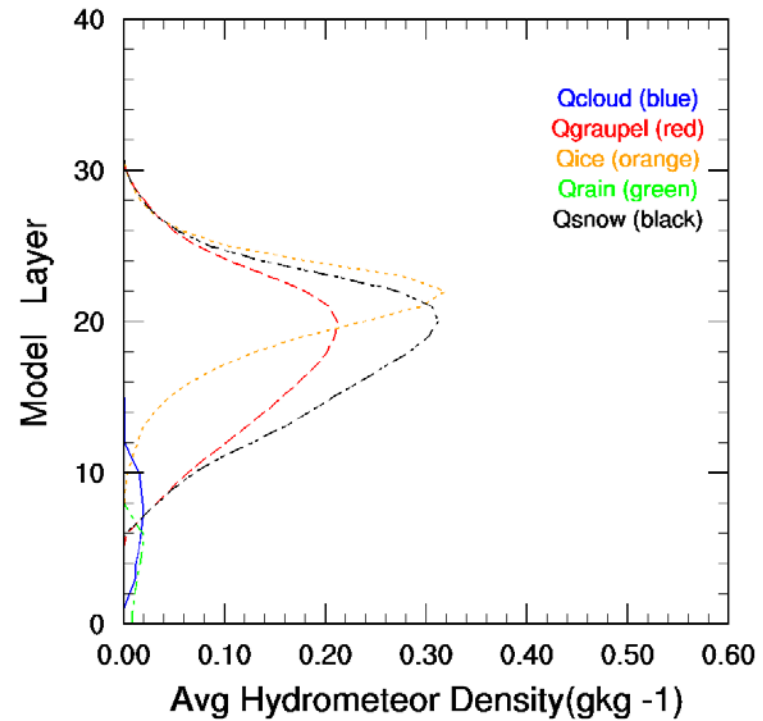
MP: Goddard with graupel



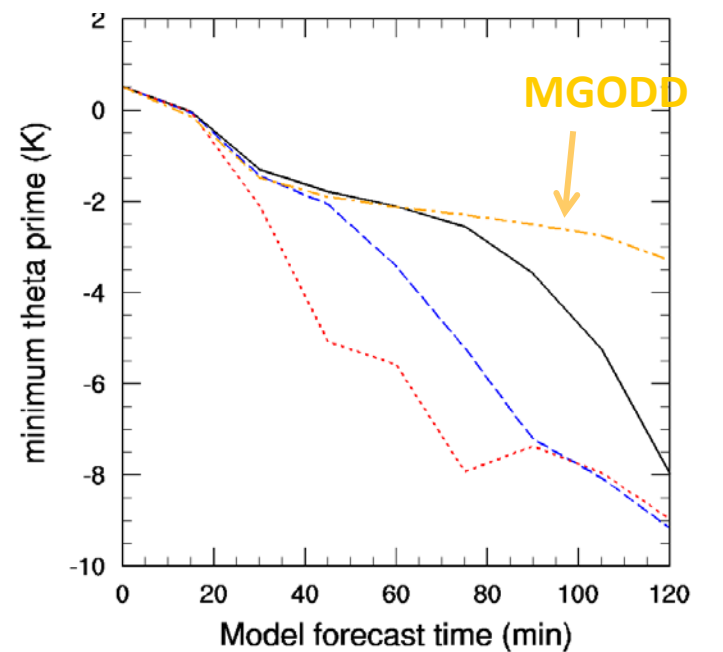
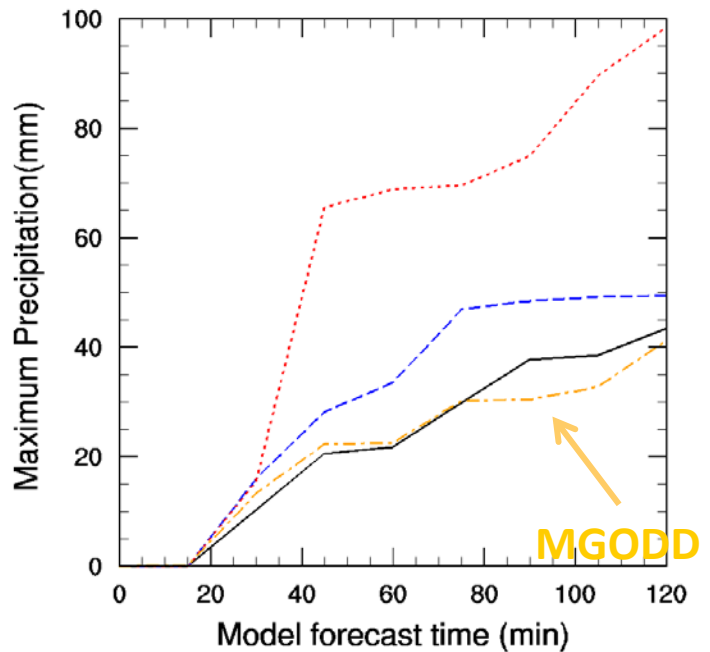
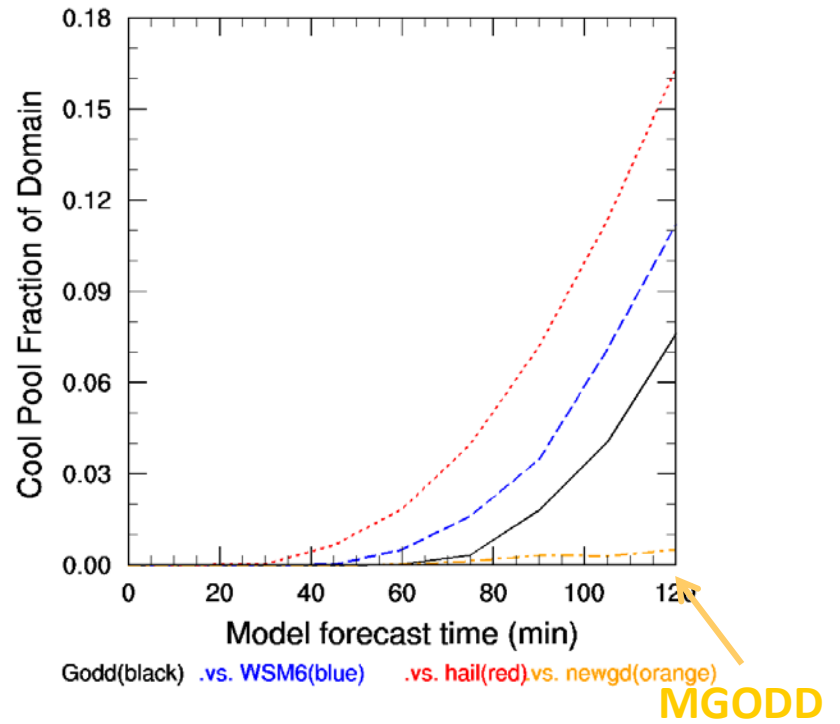
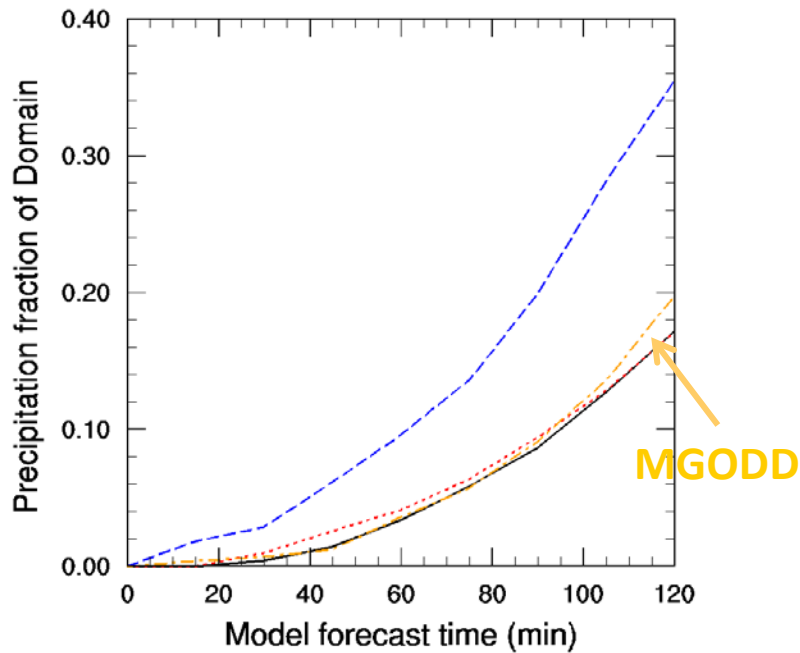
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WRF IDEAL CASE: QUARTER SUPERCELL

MP: NEW GODD



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# 結 論

- 本研究利用WRFv331模式中的理想化個案:3度空間超大胞之模擬，來檢視兩個微物理參數法(WSM6，GODDARD)差異特性與敏感度測試。
- 由5個種類冰水粒子在空間中的分布可以發現GODDARD在高空有較多的graupel粒子，WSM6則有較多graupel與snow粒子降至溶解層下，導致較多的雨水粒子以及因溶解及蒸發作用所致較為廣泛且強烈的冷池分布。
- 兩個參數法在模擬超大胞個案時，於前30分鐘主要受到相同環境探空、風切及初始溫度差異所主導，兩者差異甚微。其差異隨時間愈見明顯。
- WSM6相較GODDARD，有較大的降水以及較強的冷池發展。GODDARD在高空有較多的軟雹，導致其高空一直存在有明顯的強回波(>40dBz)分布。
- 將GODDARD微物理參數法中的graupel置換成hail時，其冷池的強度與範圍都明顯增大，降雨變強，且雨區集中在冷池前緣。置換Hail的差異明顯大於WSM6與GODD。
- Graupel的密度改變在GODD參數法中並不具有明顯的敏感度，而其intercept value的改變則具有較明顯的變化。

報告完畢，敬請指教

謝謝大家