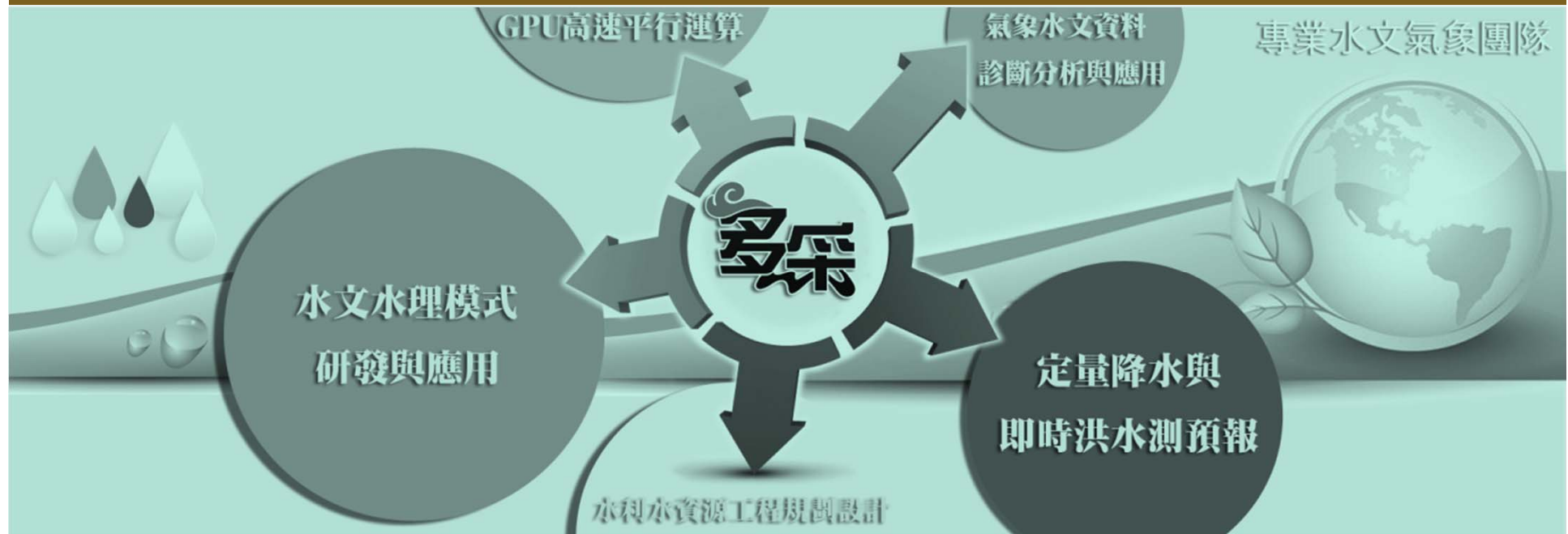


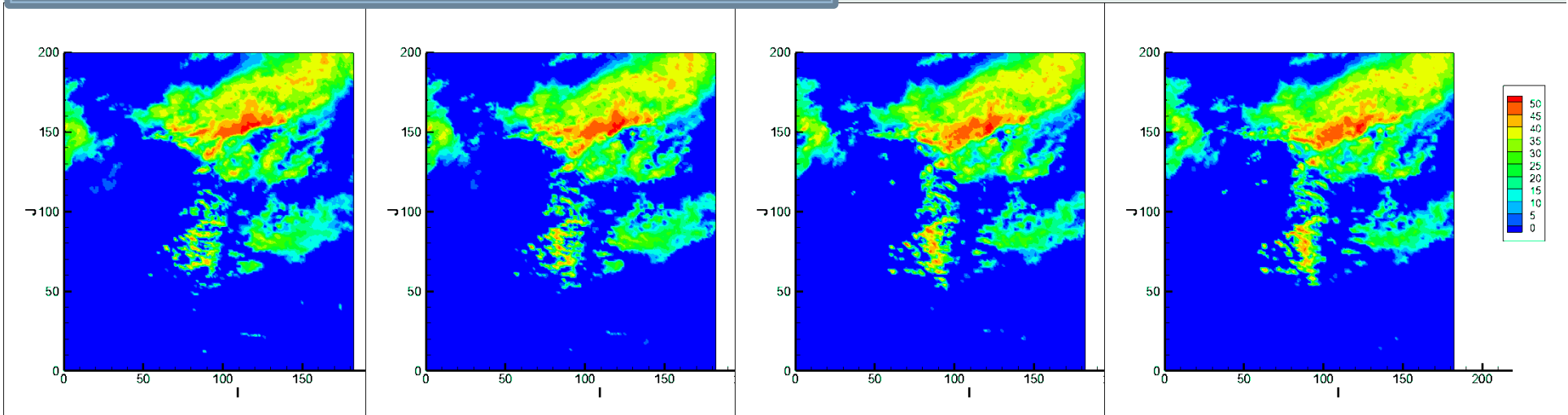
# 以改良式ABLER法應用於台灣地區降雨系統移速場外延估計

洪國展、李天浩、馮智勇、黃椿喜、丘君翹、林彥廷

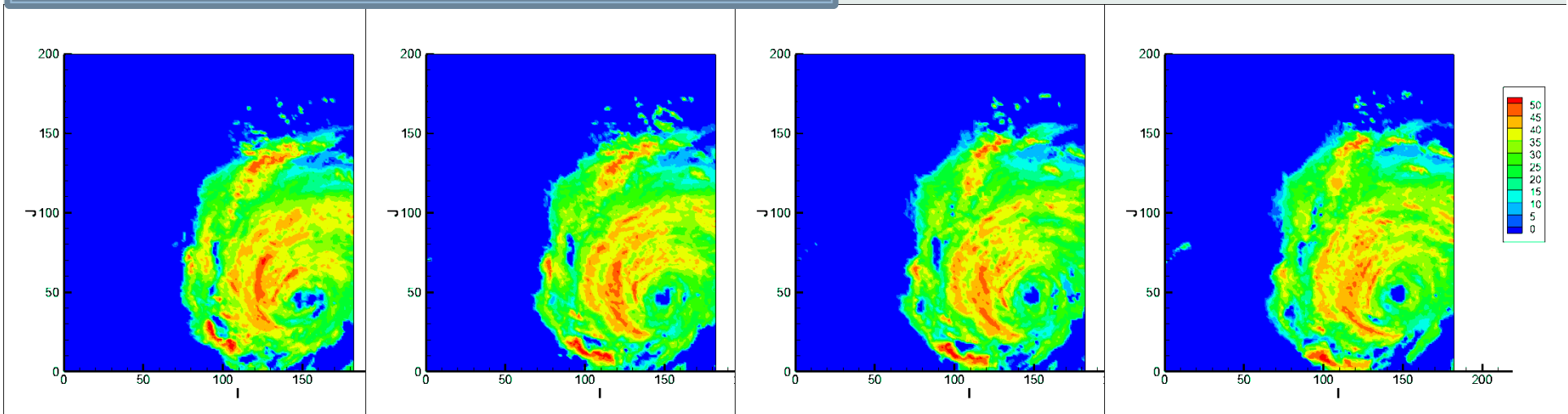
多采科技有限公司 Manysplendid Infotech, Ltd.



2012.0611.1440-2012.0611.1510



2014.0722.0700-2014.0722.0730



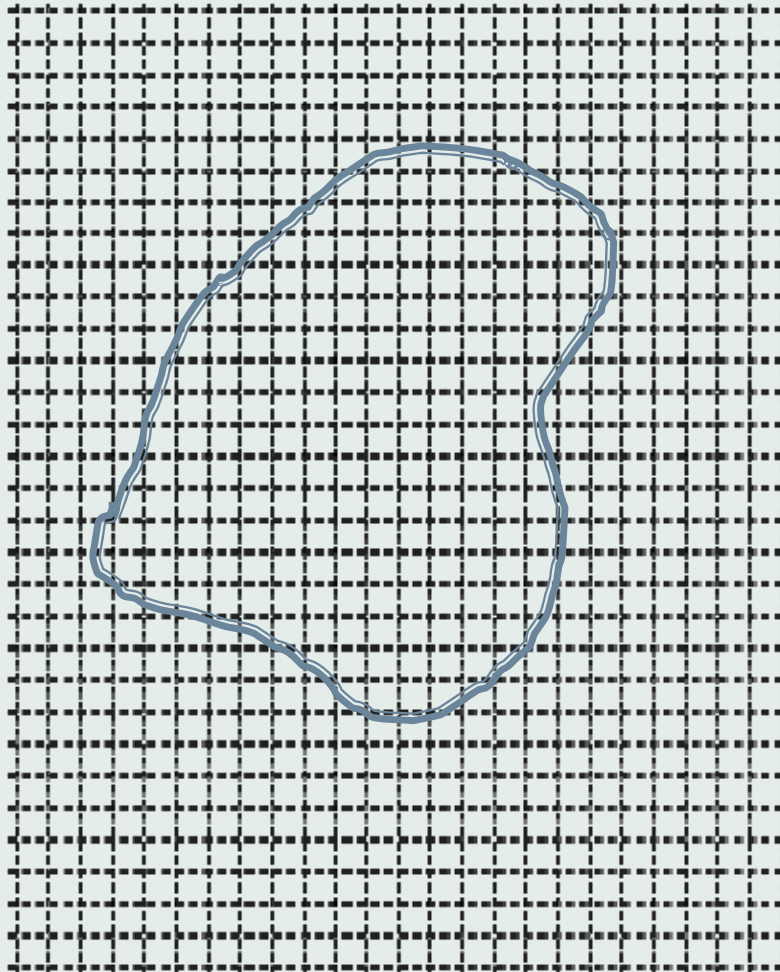
# Outline

- ▶ **ABLER演算法介紹**
  - Shiiba算則
  - **ABLER**
  - 改良式**ABLER**
  - **DEWMA**移速場外延
- ▶ 移速場外延結果
- ▶ 後續方向

# ABLER演算法<sup>1</sup> – Introduction

- ▶ **Advection–Based Lagrangian Eulerian Regression**
- ▶ 利用回歸方式，取得連續兩張影像之間的最佳空間關係
- ▶ **Shiiba**算則搭配**Lagrangian**平移處理，使原本方法能延伸至一個網格點外的位置，解決天氣系統移動可能超過單位網格範圍的問題

# ABLER演算法<sup>2</sup>-Shiiba算則



$$\frac{\partial z}{\partial t} + u\left(\frac{\partial z}{\partial x}\right) + v\left(\frac{\partial z}{\partial y}\right) = w$$

$$u = c_1x + c_2y + c_3$$

$$v = c_4x + c_5y + c_6$$

$$w = c_7x + c_8y + c_9$$

$$z_t = z_{t-1} - dt(c_1x + c_2y + c_3)\frac{\partial z}{\partial x}\Big|_{t-1} - dt(c_4x + c_5y + c_6)\frac{\partial z}{\partial y}\Big|_{t-1}$$

可計算t時刻觀測值與估計值之間的相關係數

$$\begin{matrix} \hat{z}_t \\ \vdots \end{matrix} \begin{matrix} \cdot \\ \cdot \\ \cdot \end{matrix} \begin{matrix} \hat{c}_1 \\ \vdots \\ \hat{c}_n \end{matrix} \begin{matrix} \left[ \begin{matrix} d_1 \\ \vdots \\ d_n \end{matrix} \right] \end{matrix}$$

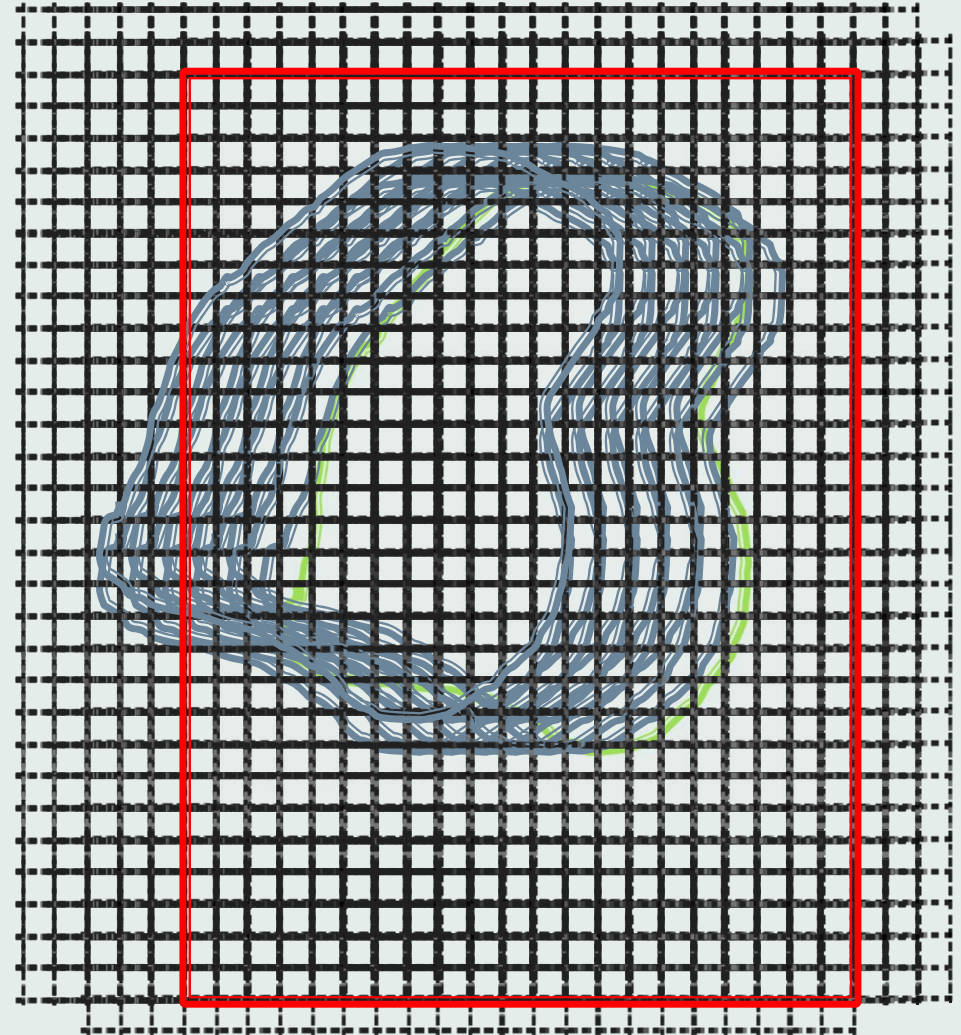
$$\hat{z}_t = z_{t-1} - dt(\hat{c}_1x + \hat{c}_2y + \hat{c}_3)\frac{\partial z}{\partial x}\Big|_{t-1} - dt(\hat{c}_4x + \hat{c}_5y + \hat{c}_6)\frac{\partial z}{\partial y}\Big|_{t-1}$$

# ABLER演算法<sup>3</sup>-原理<sup>1</sup>

$$z_t = z_{t-1} - dt(c_1x + c_2y + c_3)\partial z/\partial x|_{t-1} - dt(c_4x + c_5y + c_6)\partial z/\partial y|_{t-1}$$

此平移方式，具有最大相關係數

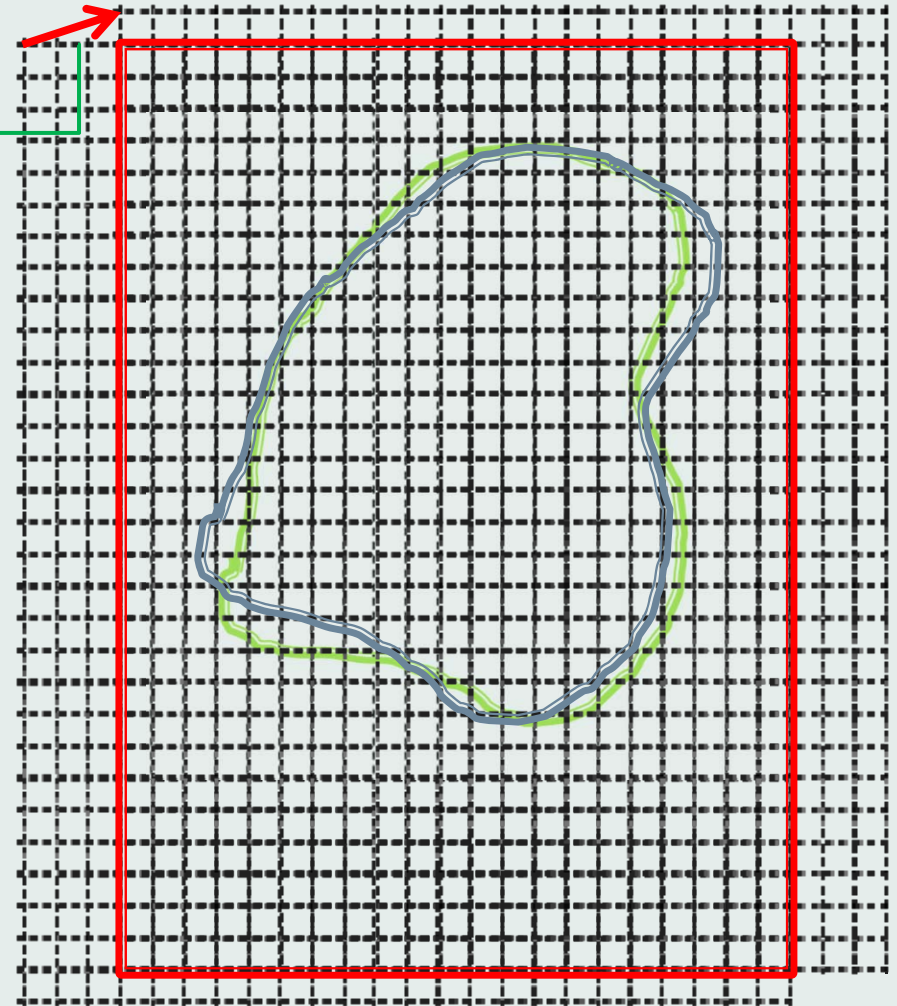
$$\hat{z}_t = z_{t-1} - dt(\hat{c}_1x + \hat{c}_2y + \hat{c}_3)\partial z/\partial x|_{t-1} - dt(\hat{c}_4x + \hat{c}_5y + \hat{c}_6)\partial z/\partial y|_{t-1}$$



# ABLER演算法<sup>4</sup>-原理<sup>2</sup>

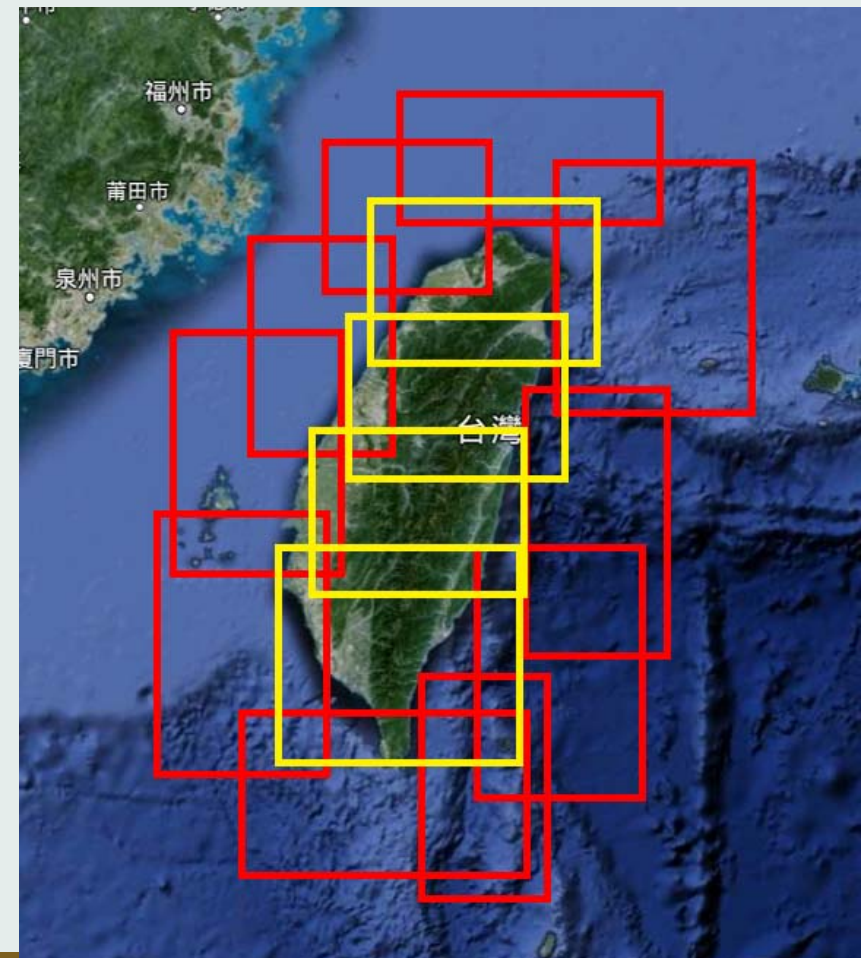
$$u_{t-1 \rightarrow t} = c_1 x + c_2 y + c_3 \equiv u_t^E + u_t^L$$
$$v_{t-1 \rightarrow t} = c_4 x + c_5 y + c_6 \equiv v_t^E + v_t^L$$

$$\hat{z}_t = z_{t-1} - dt(\hat{c}_1 x + \hat{c}_2 y + \hat{c}_3) \partial z / \partial x \Big|_{t-1}$$
$$- dt(\hat{c}_4 x + \hat{c}_5 y + \hat{c}_6) \partial z / \partial y \Big|_{t-1}$$



# ABLER演算法<sup>5</sup>-改良

- ▶ **回波資料門檻值設定**
  - 低回波降雨情況可能不明顯
  - 透過分析門檻值設定，可針對強回波的網格進行分析
- ▶ **分析範圍主觀劃分**
  - 雷達回波受地形影響大
  - 迎風面系統可能停滯、背風面系統可能加速
- ▶ **移速場合併**
  - 重疊區域加權合併
  - 高斯平滑化





# ABLER演算法<sup>6</sup>–移速外延DEWMA<sup>1</sup>

- ▶ Double Exponential Weight Moving Average
- ▶ 透過記憶的方式延續變數變化趨勢的特性

$$s_t = \alpha x_t + (1 - \alpha)(s_{t-1} + b_{t-1}) \quad t \geq 2, \quad 0 \leq \alpha \leq 1$$

$$b_t = \gamma(s_t - s_{t-1}) + (1 - \gamma)b_{t-1} \quad t \geq 2, \quad 0 \leq \gamma \leq 1$$

- $x_t$  為目標變數的時間序列
- $s_t$  為目標變數的平滑化數值
- $b_1$  為初始趨勢

$$b_1 = x_2 - x_1 \quad b_1 = \frac{1}{2}(x_3 - x_1) \quad b_1 = \frac{1}{3}(x_4 - x_1) \quad b_1 = \frac{1}{n-1}(x_n - x_1)$$

- $\alpha$ 、 $\gamma$  為平滑化參數

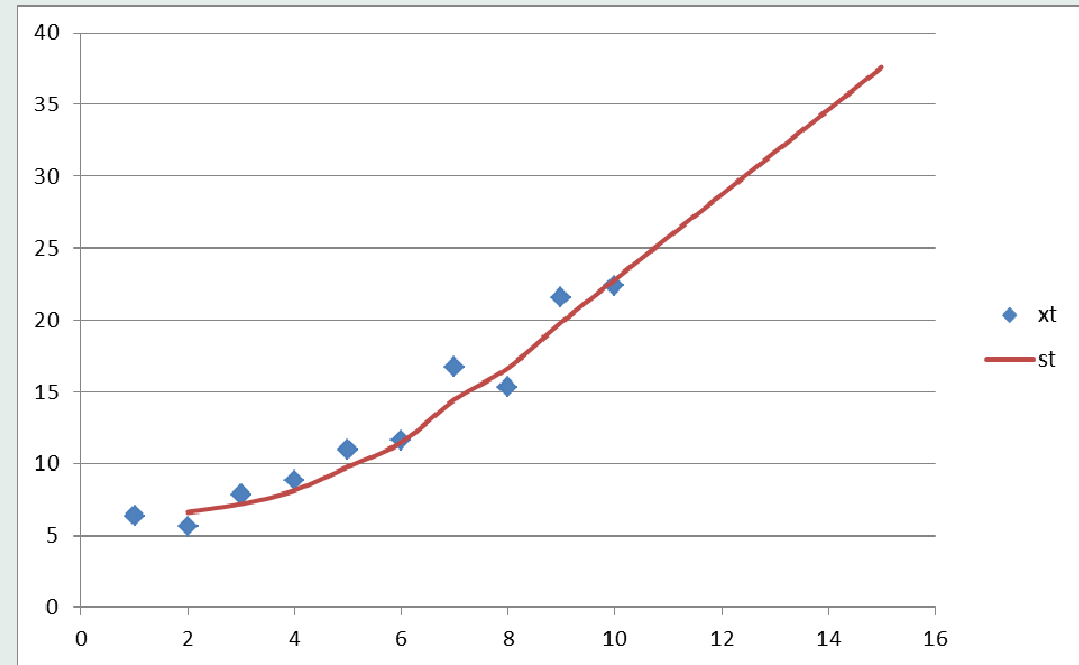
- ▶ 預報方程式

$$F_{t+m} = s_t + mb_t \quad m \geq 1$$

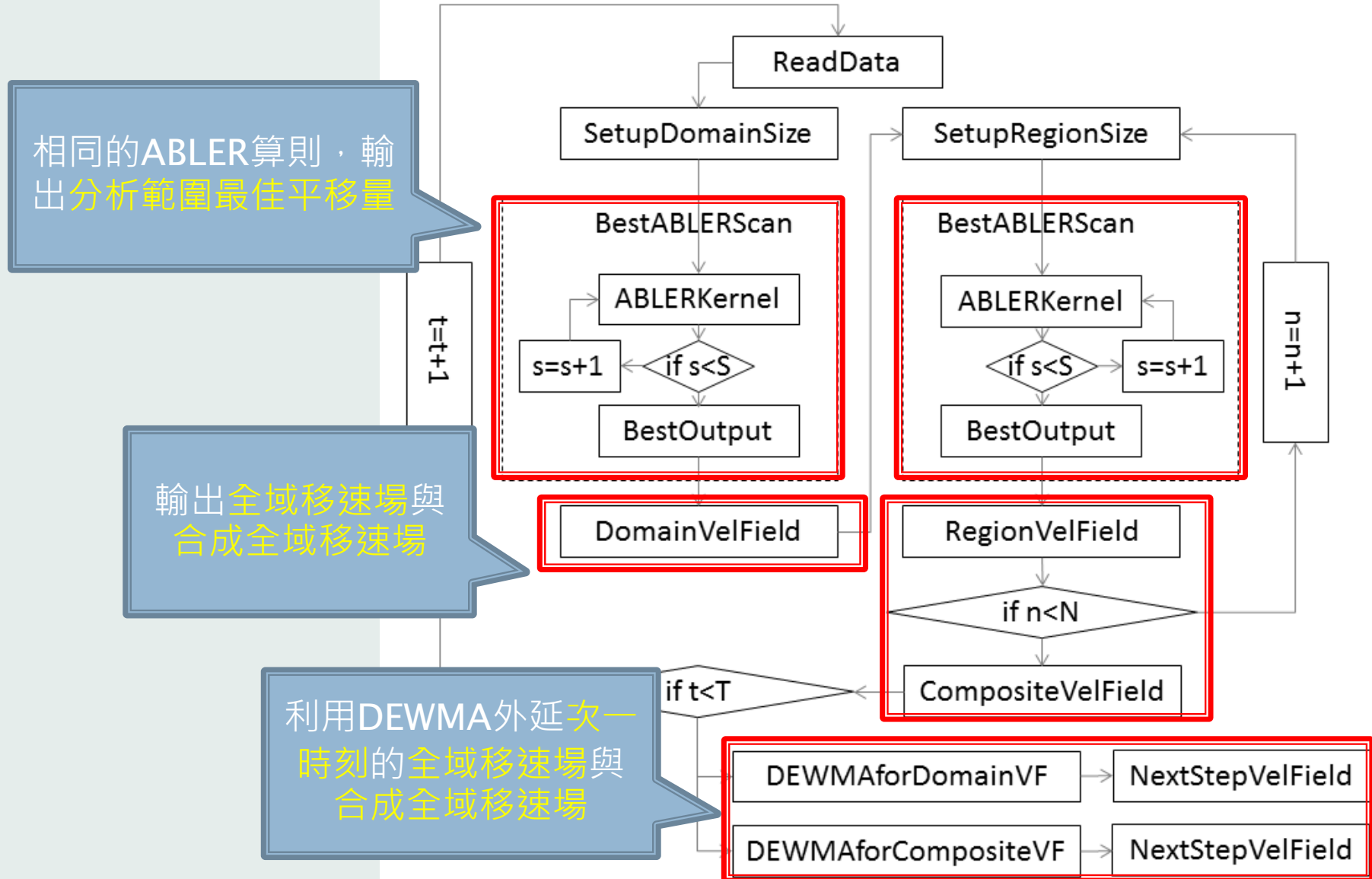
# ABLER演算法<sup>7</sup> - 移速外延DEWMA<sup>2</sup>

$$b_1 = \frac{1}{3}(x_4 - x_1) \quad \alpha = 0.3623 \quad \gamma = 1$$

1	6.4	
2	5.6	6.6
3	7.8	7.2
4	8.8	8.1
5	11	9.8
6	11.6	11.5
7	16.7	14.5
8	15.3	16.7
9	21.6	19.9
10	22.4	22.8
11		25.8
12		28.7
13		31.7
14		34.6
15		37.6

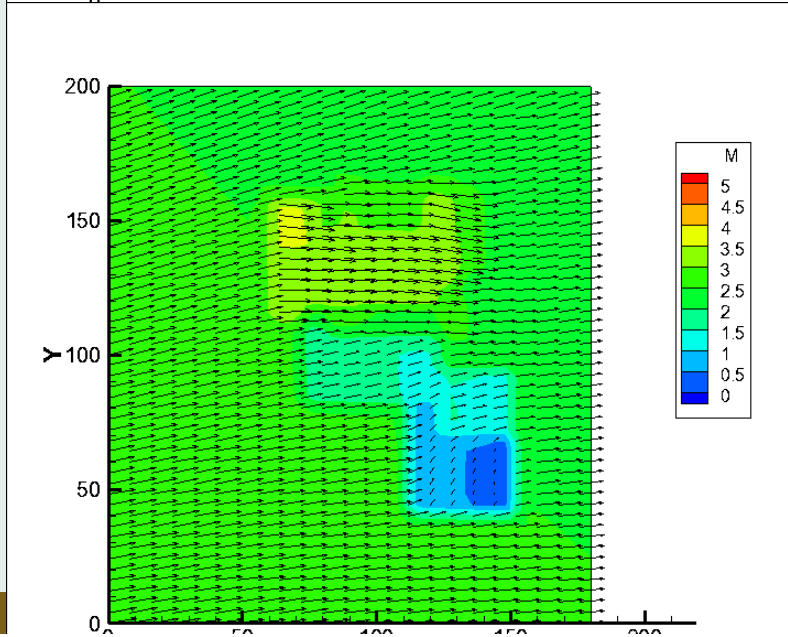
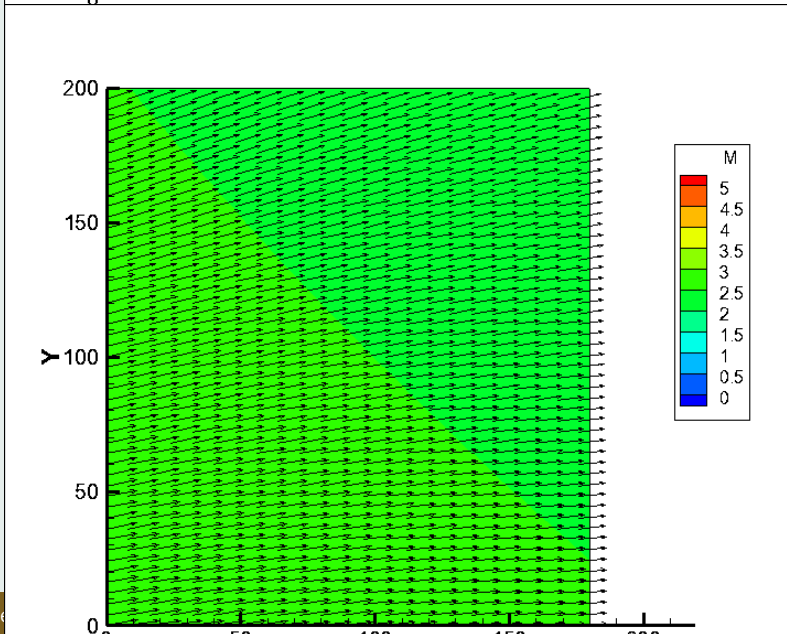
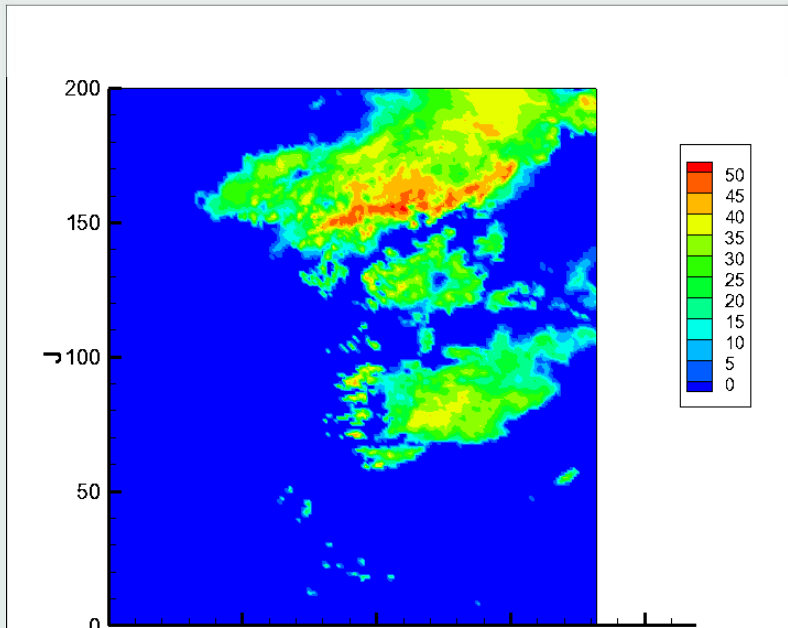
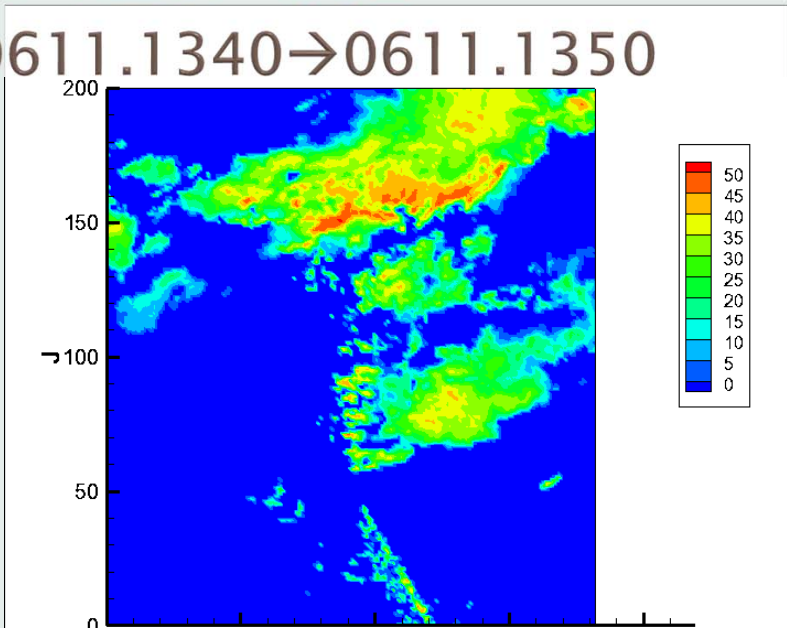


# ABLER演算法<sup>8</sup>–演算流程



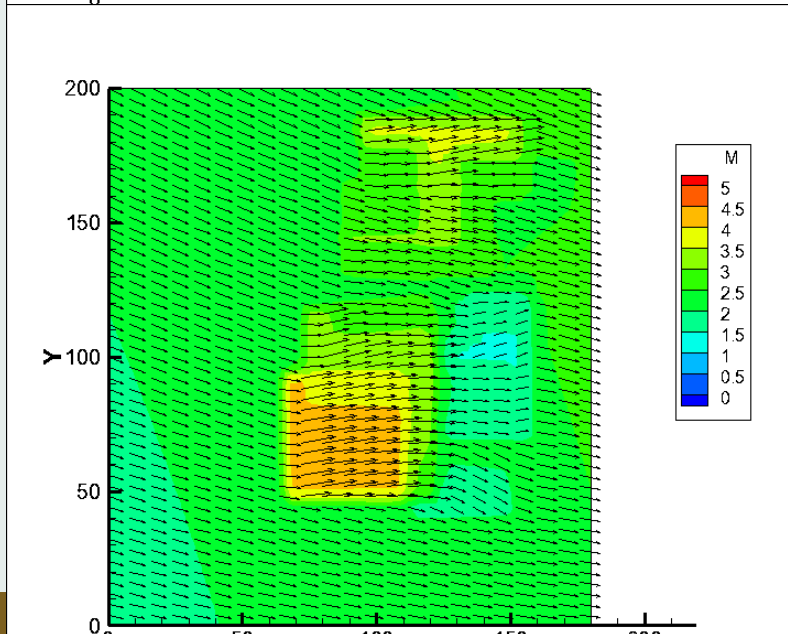
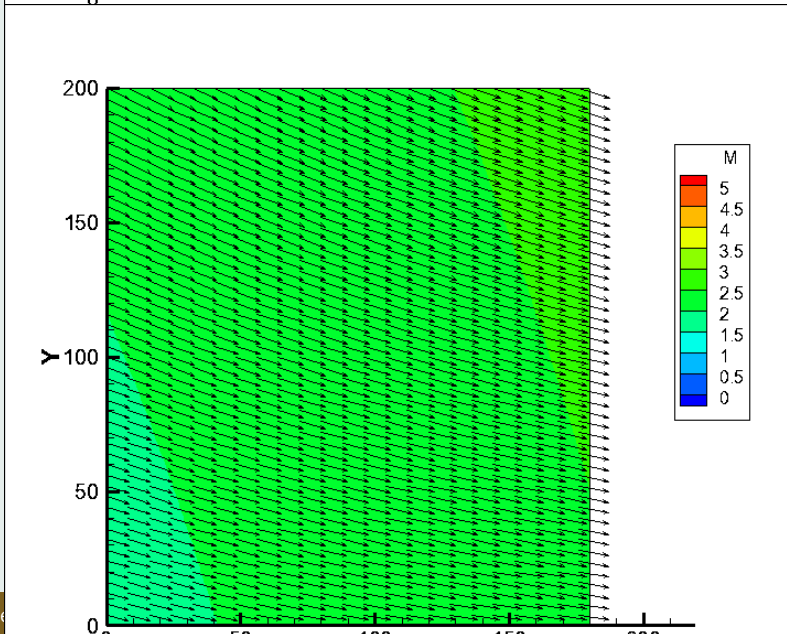
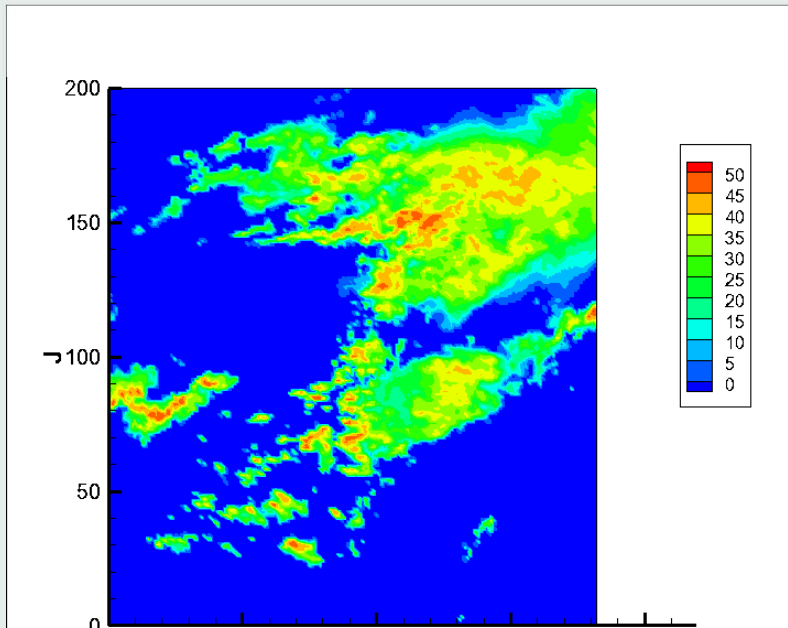
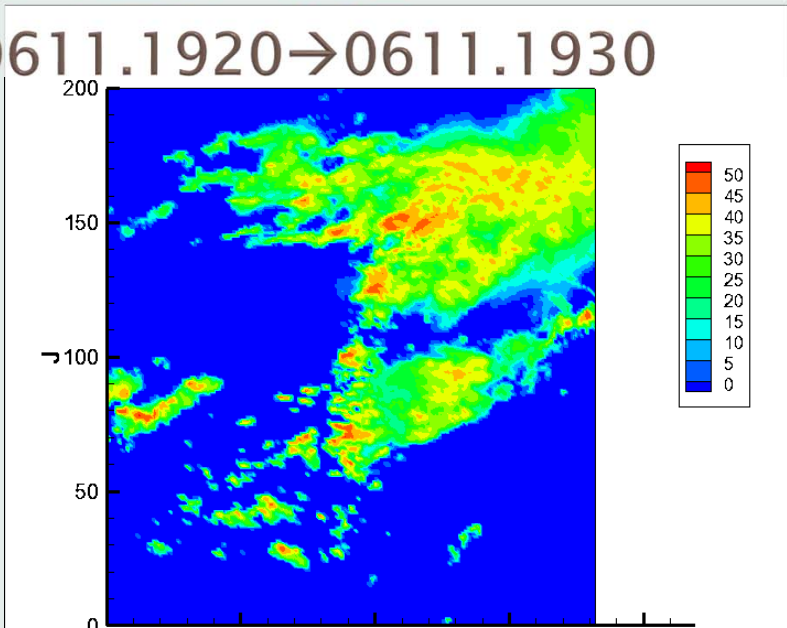
# 移速推估\_COMPREF.20120611.1200.data.10min

0611.1340→0611.1350



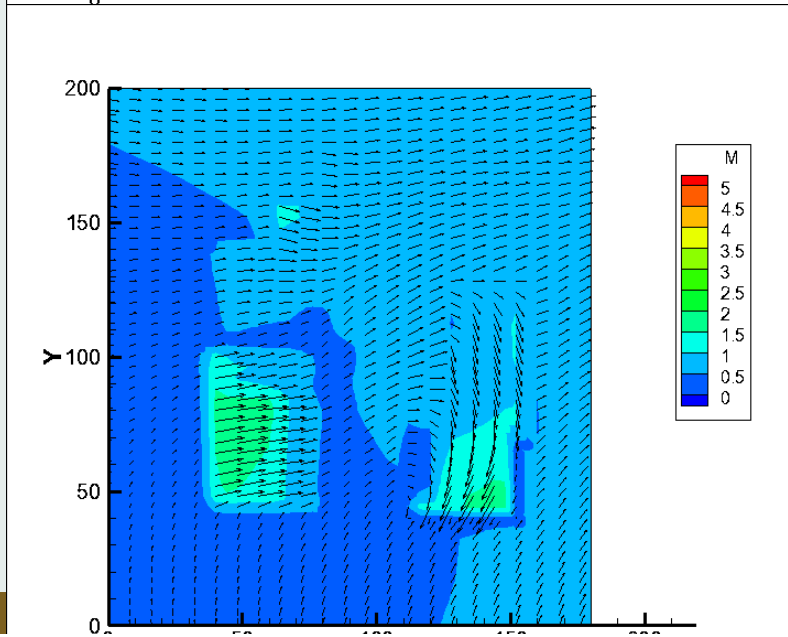
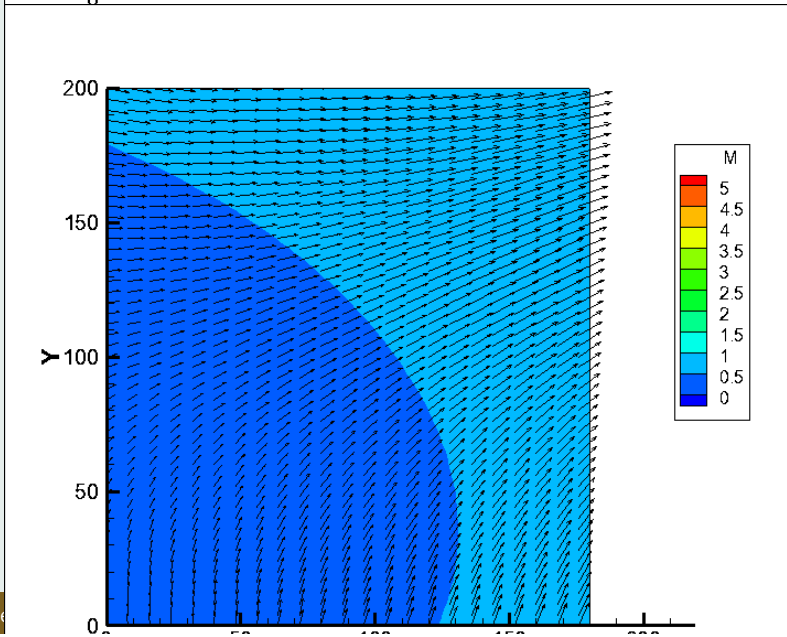
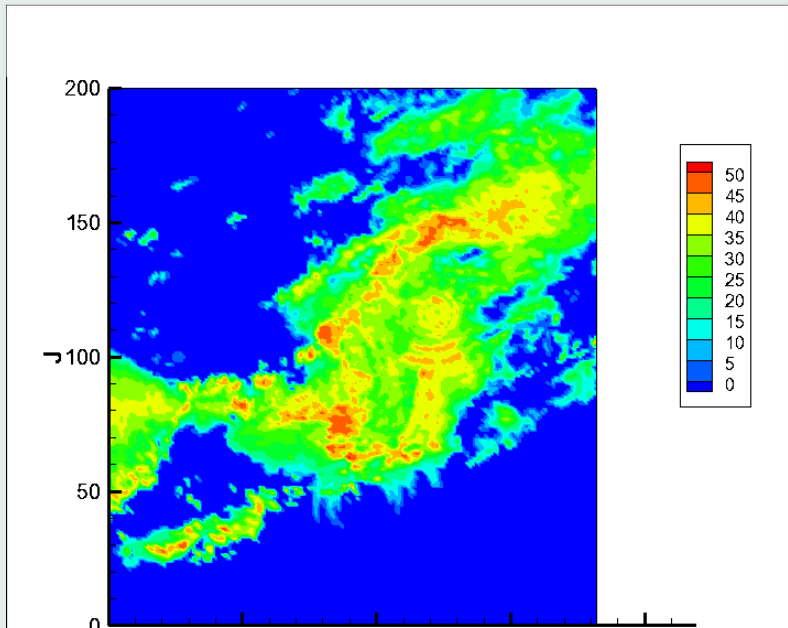
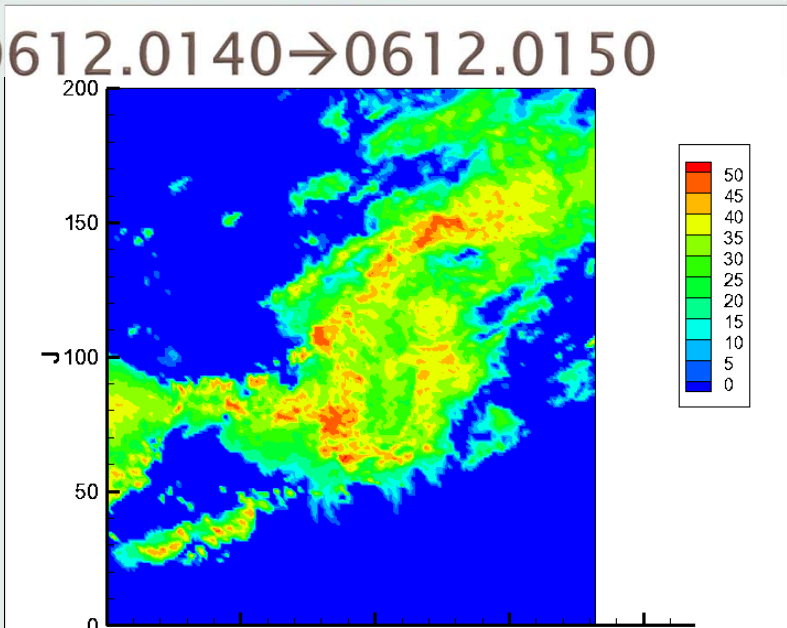
# 移速推估\_COMPREF.20120611.1200.data.10min

0611.1920→0611.1930



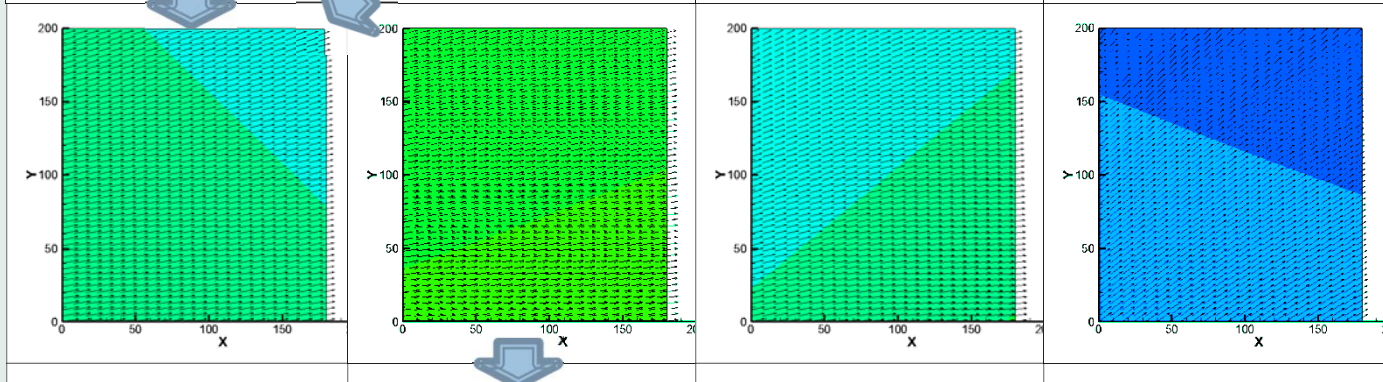
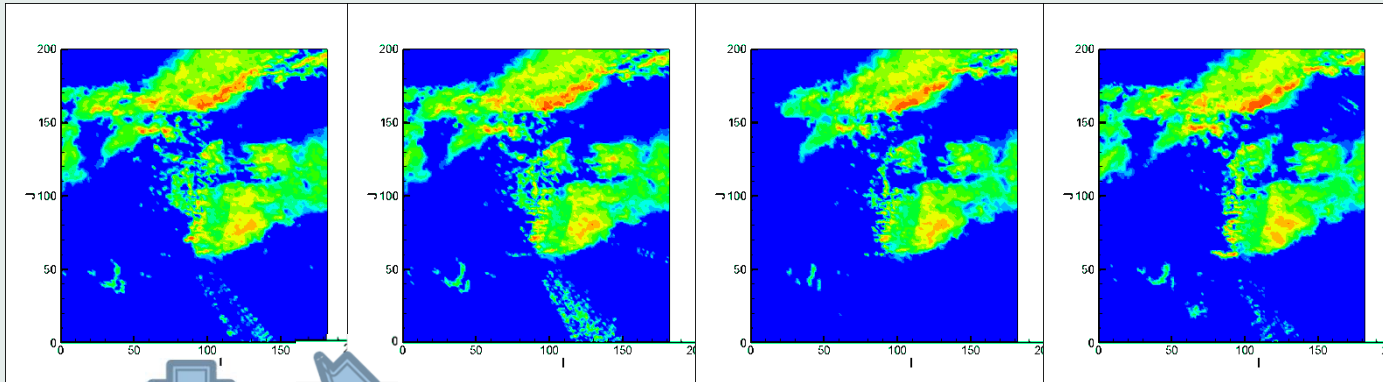
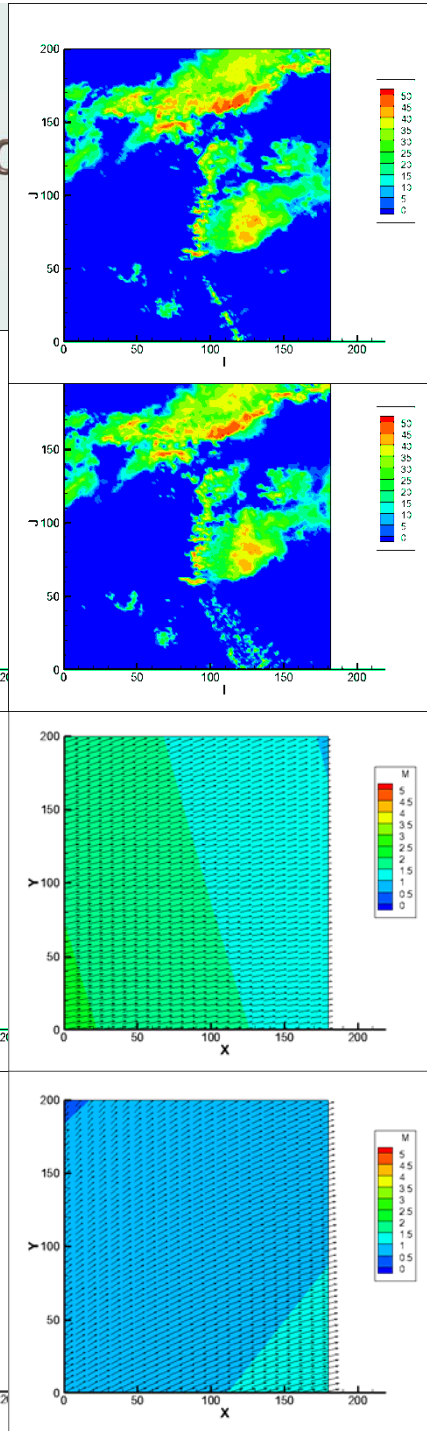
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0612.0140→0612.0150



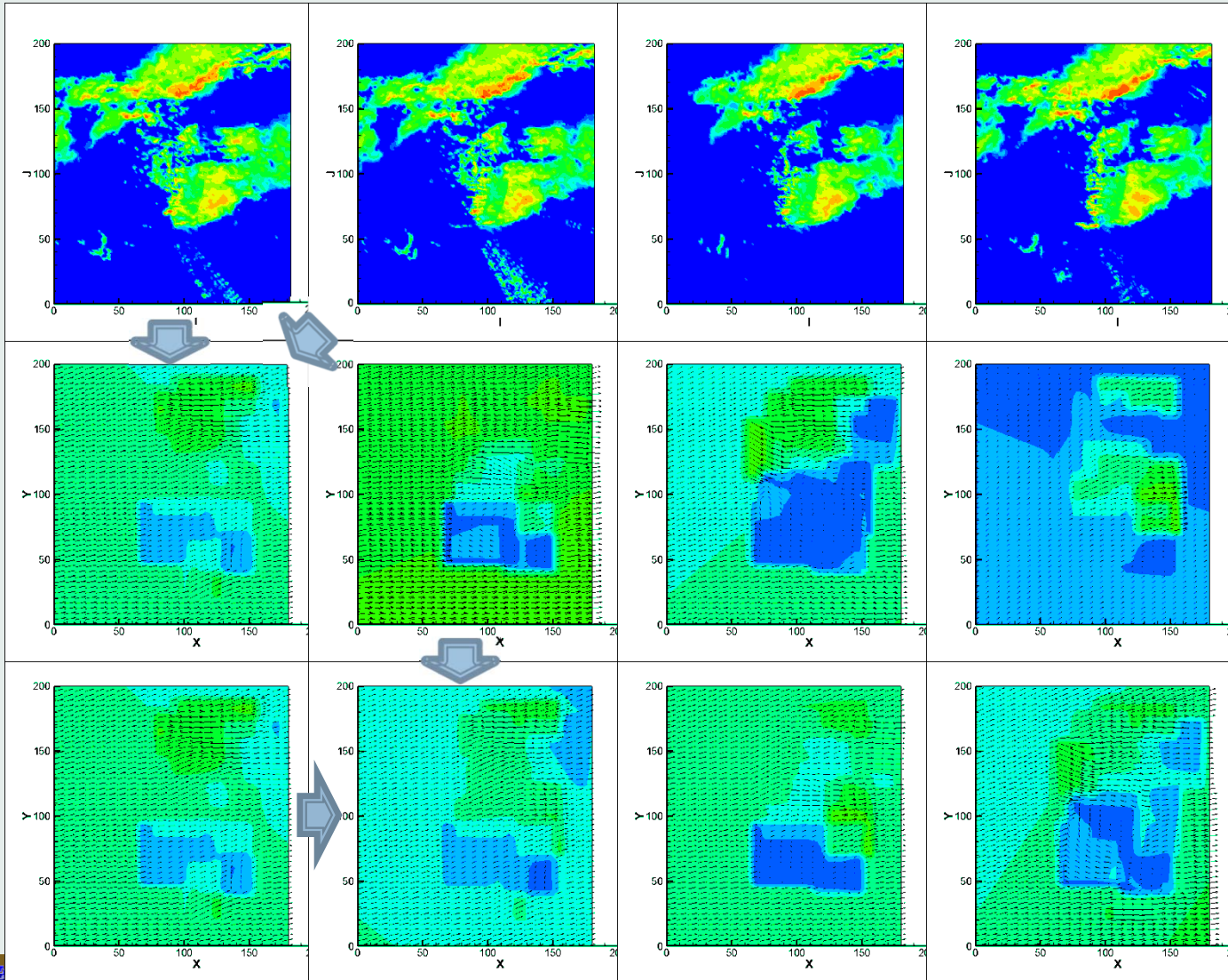
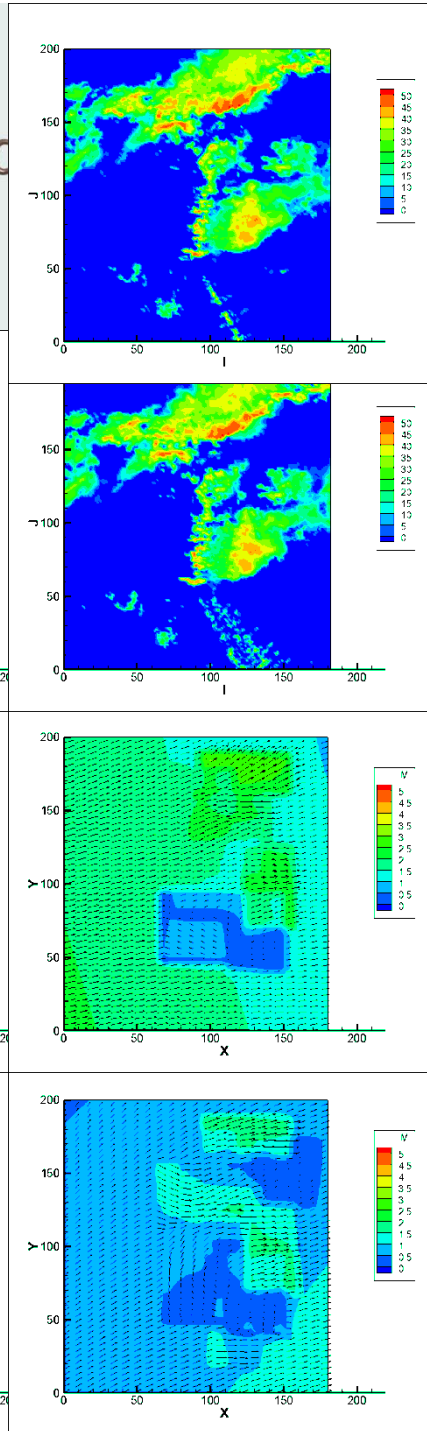
# 移速外延\_COMPREF.20120611.1200.c

## DomainVelocity0611.1200→0611.1250



# 移速外延\_COMPREF.20120611.1200.c

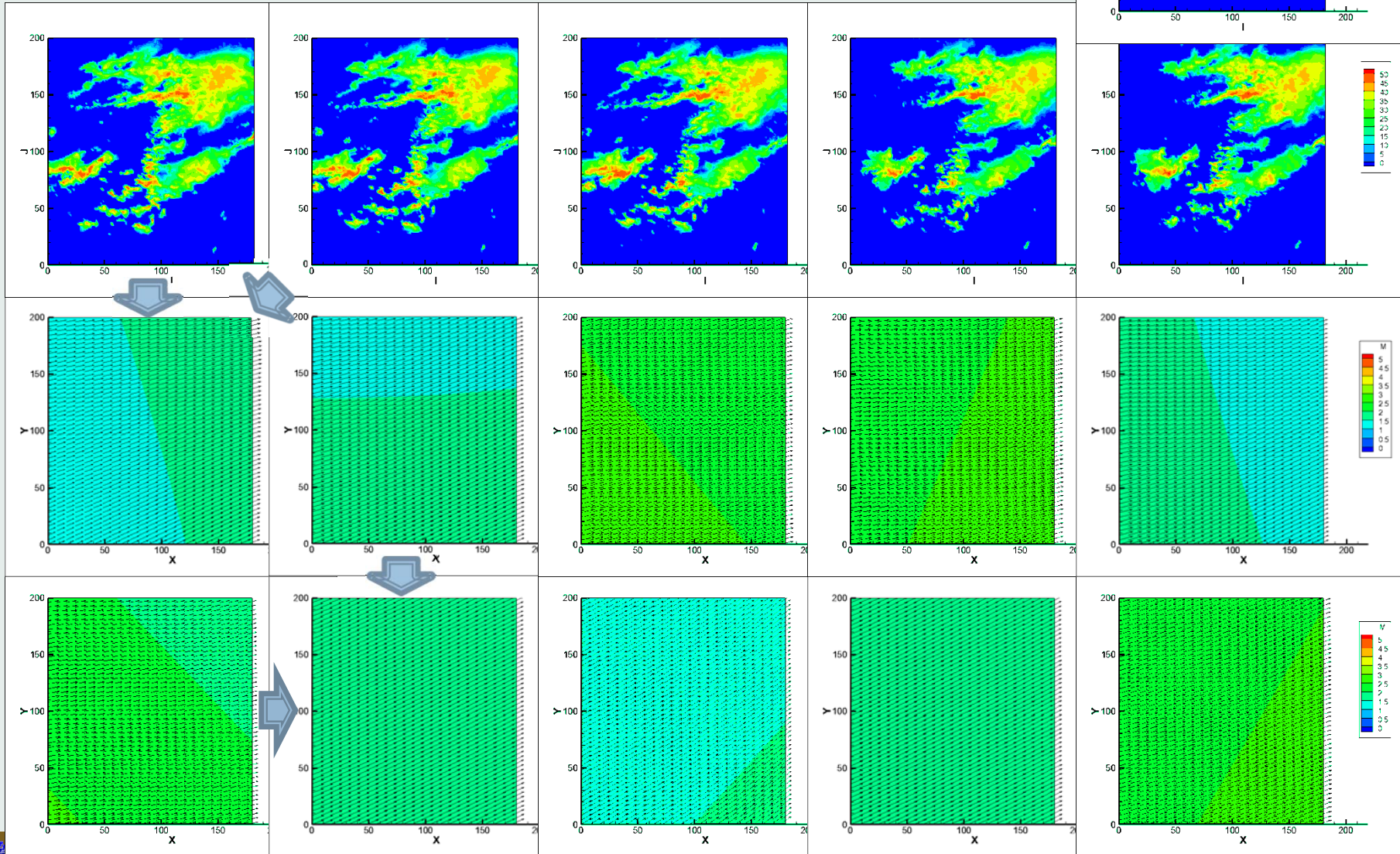
## CompositeVelocity0611.1200→0611.1250





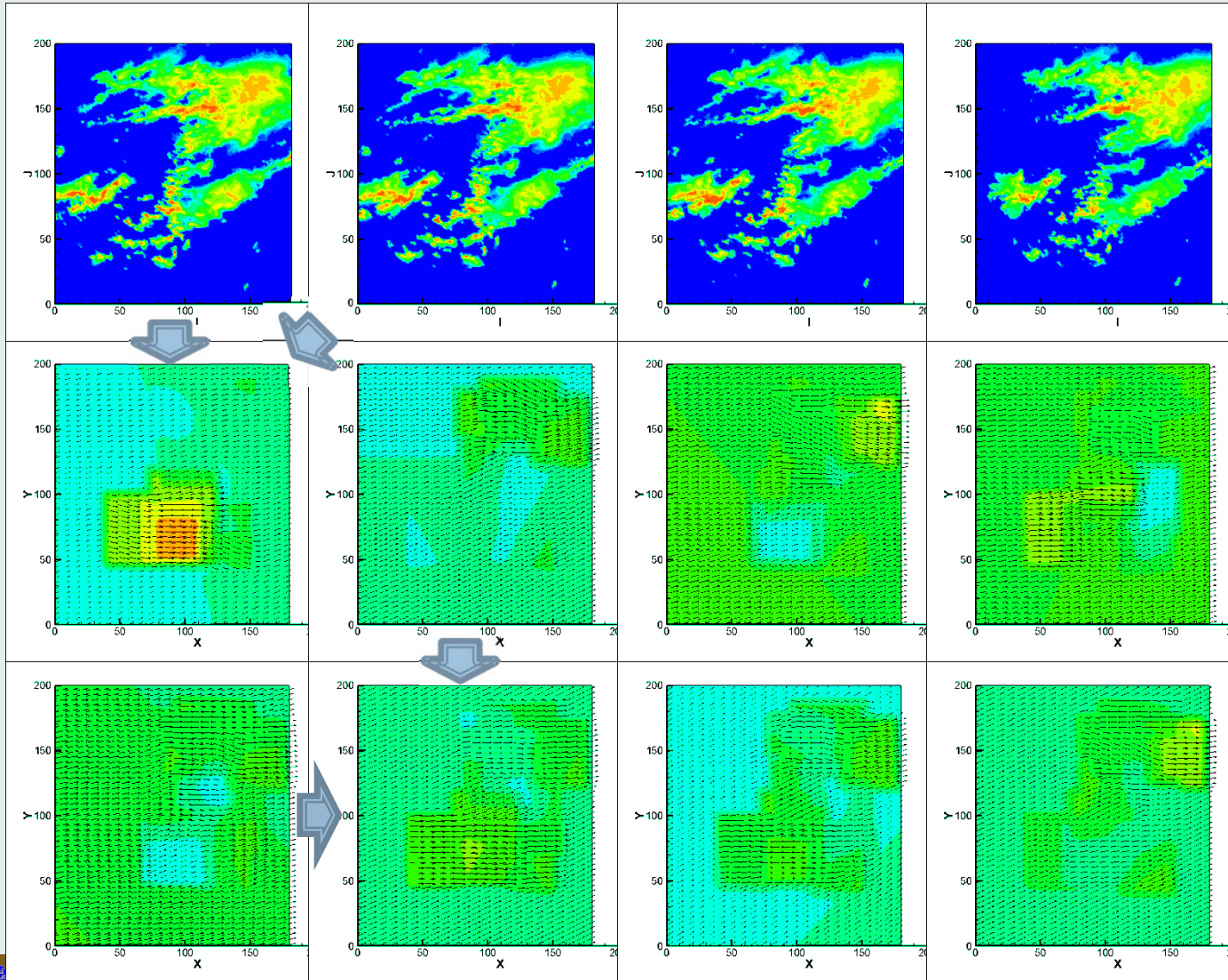
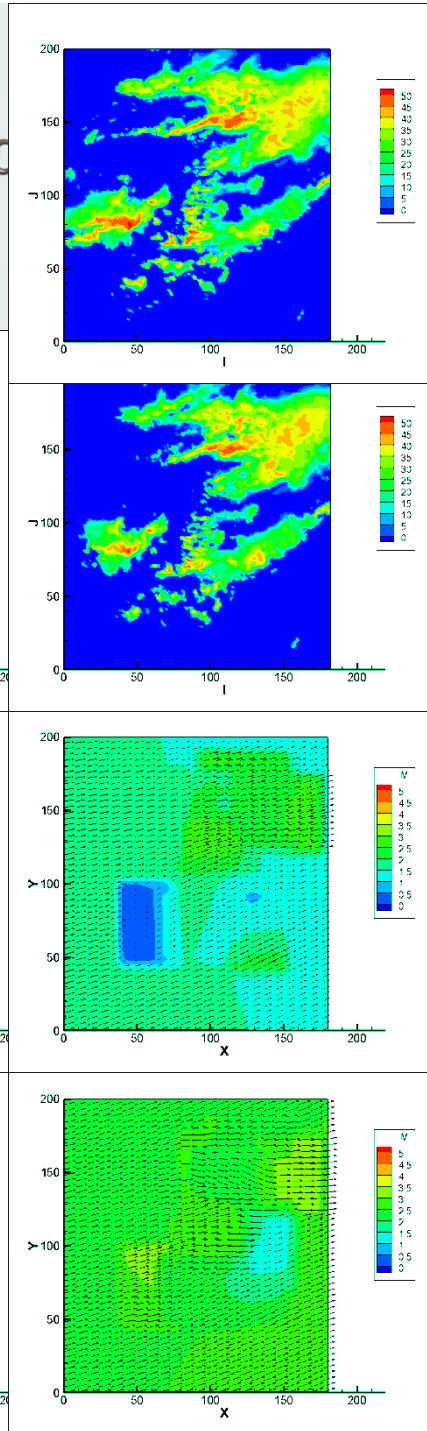
# 移速外延\_COMPREF.20120611.1200.c

## DomainVelocity0611.2020→0611.2110



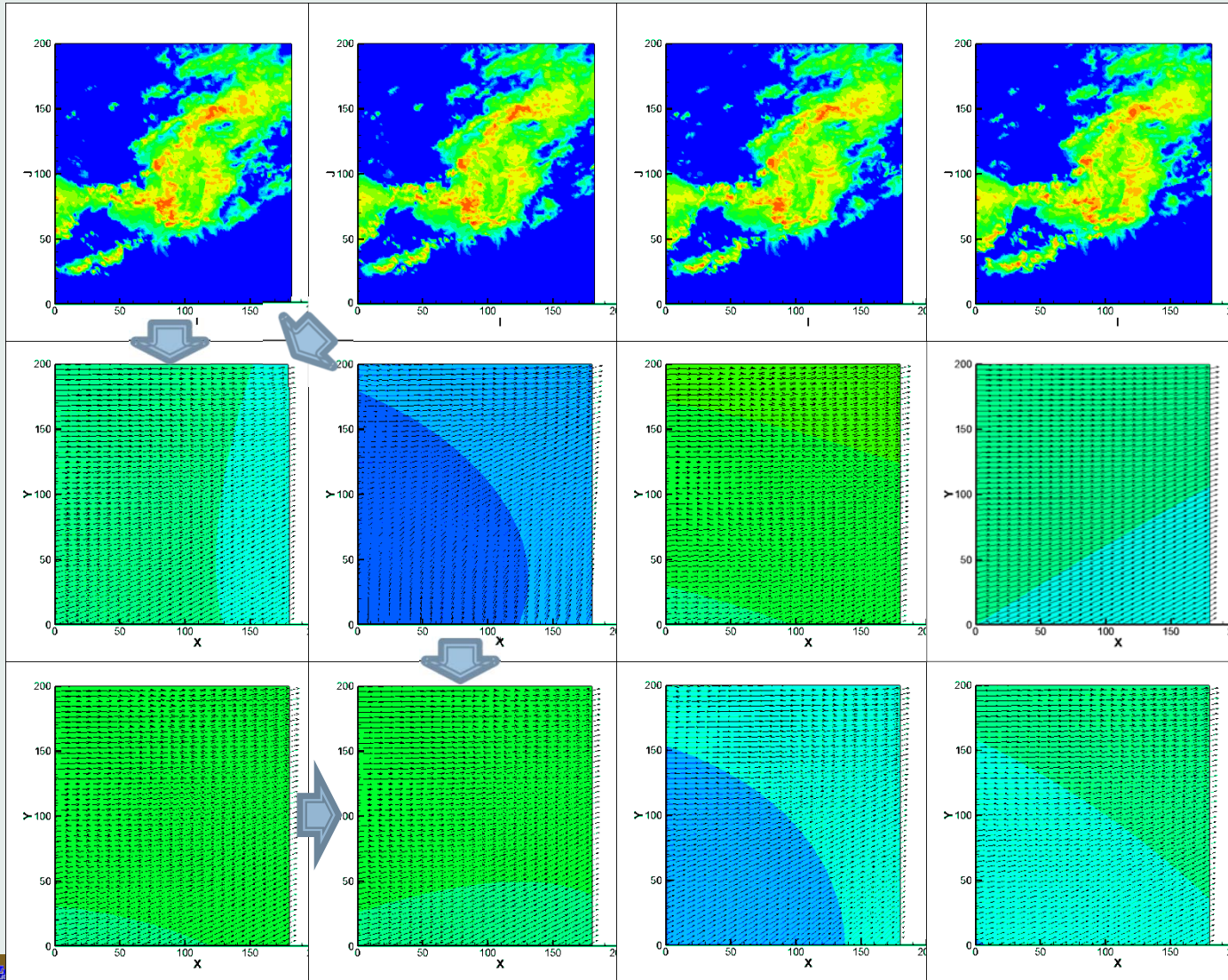
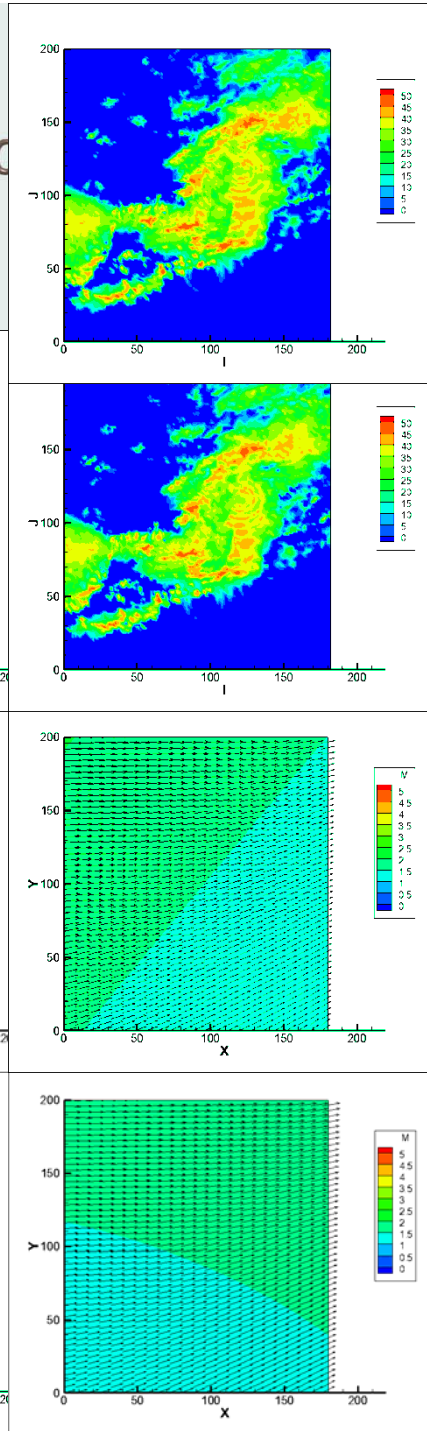
# 移速外延\_COMPREF.20120611.1200.c

## CompositeVelocity0611.2020→0611.2110



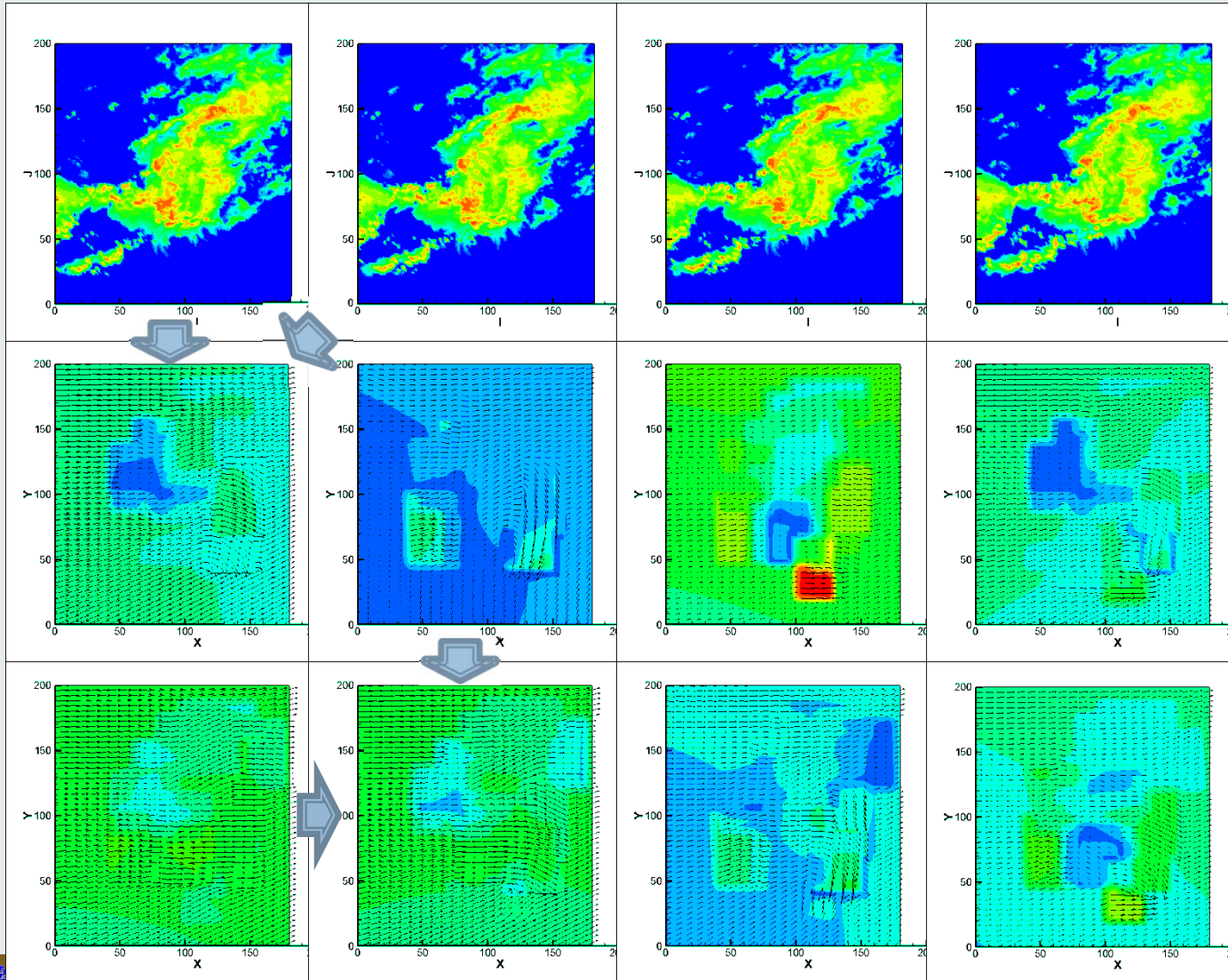
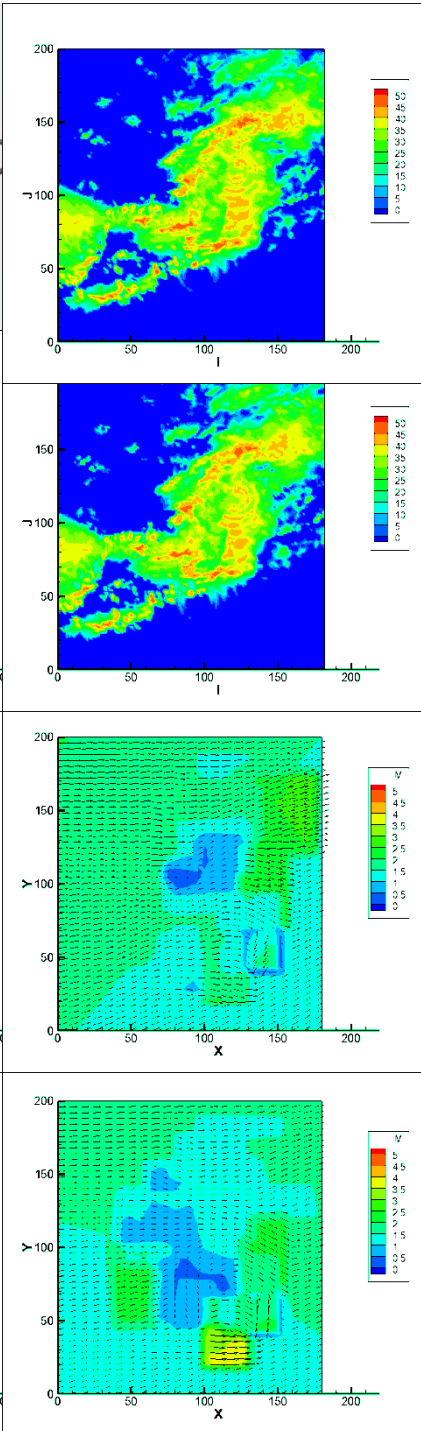
# 移速外延\_COMPREF.20120611.1200.c

## DomainVelocity0612.0130→0612.0220



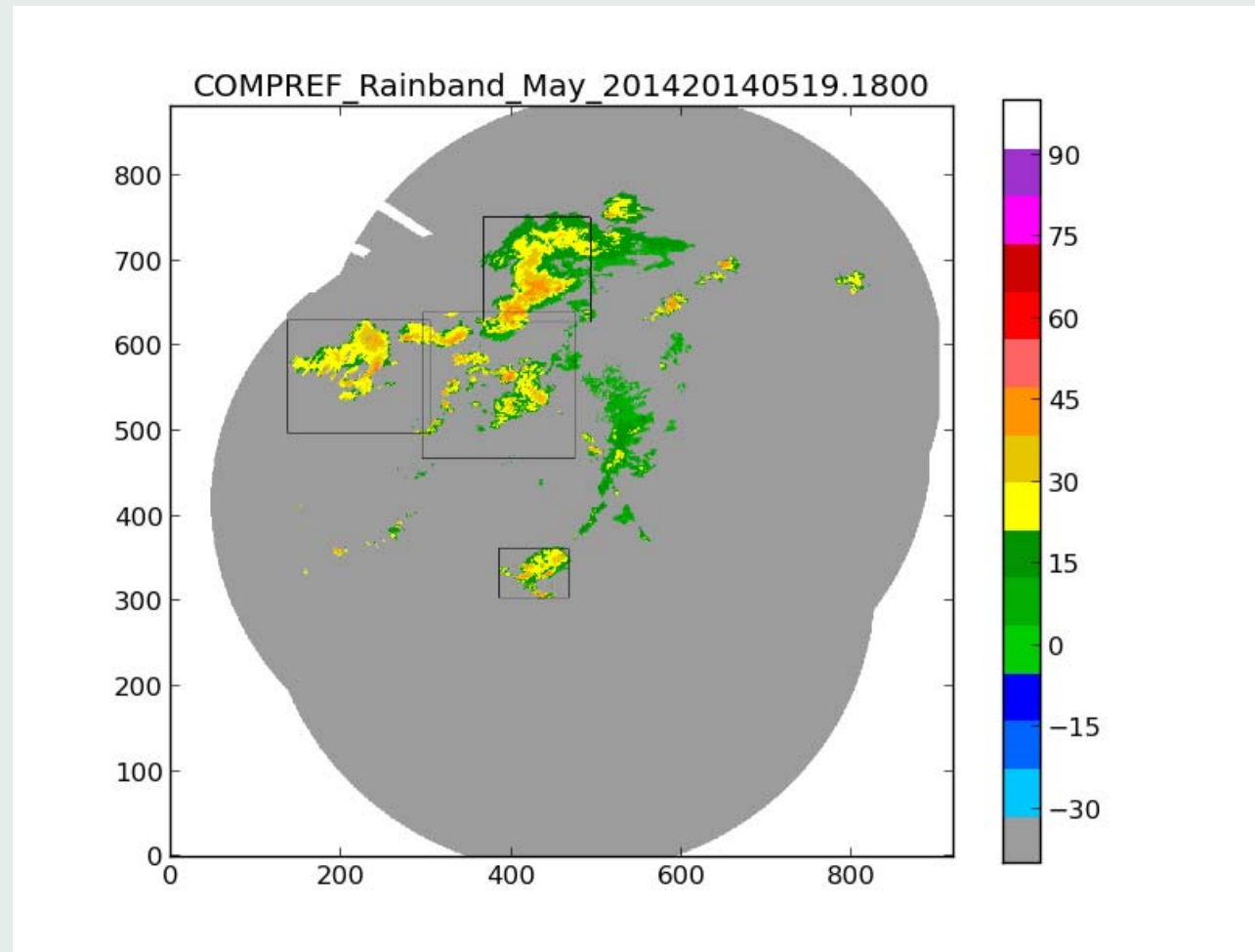
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## CompositeVelocity0612.0130→0612.0220



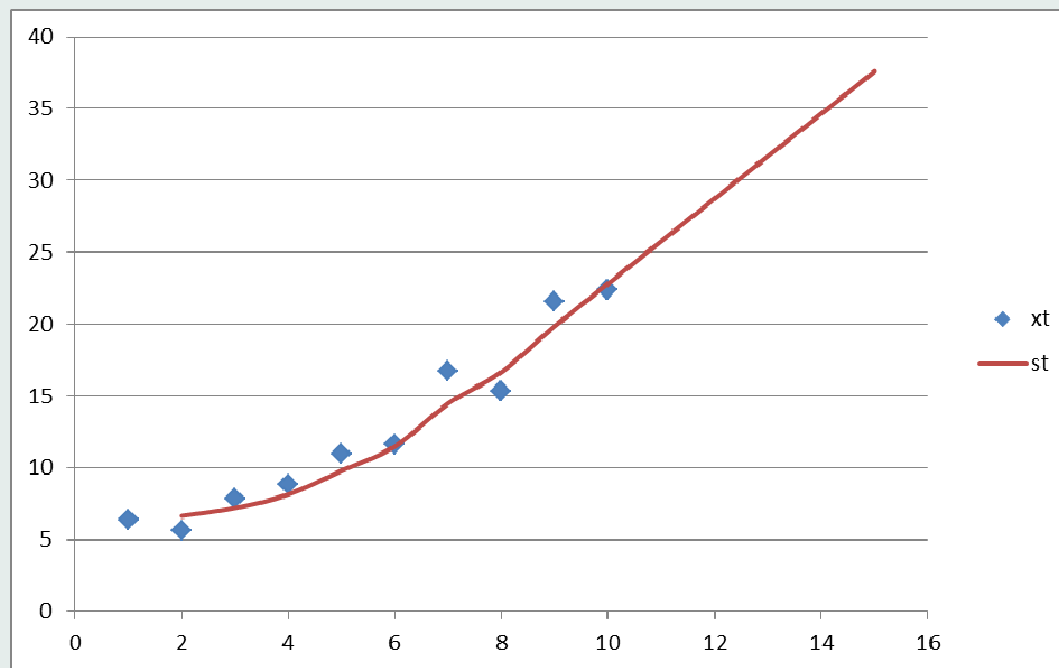
# 後續方向<sup>1</sup>

- ▶ 利用影像辨識技術，依回波分佈進行客觀分區



# 後續方向<sup>2</sup>

- ▶  $\alpha$ 、 $\gamma$  平滑化參數的最佳推估
  - 逐像元
- ▶ 回波場外延推估
  - 逐像元
  - Semi-Lagrangian
- ▶ GPU技術使用



# 敬請指教

多采科技有限公司 Manysplendid Infotech, Ltd.

