應用WRF FDDA同化衛星風以改善數值模式颱風預報之研究

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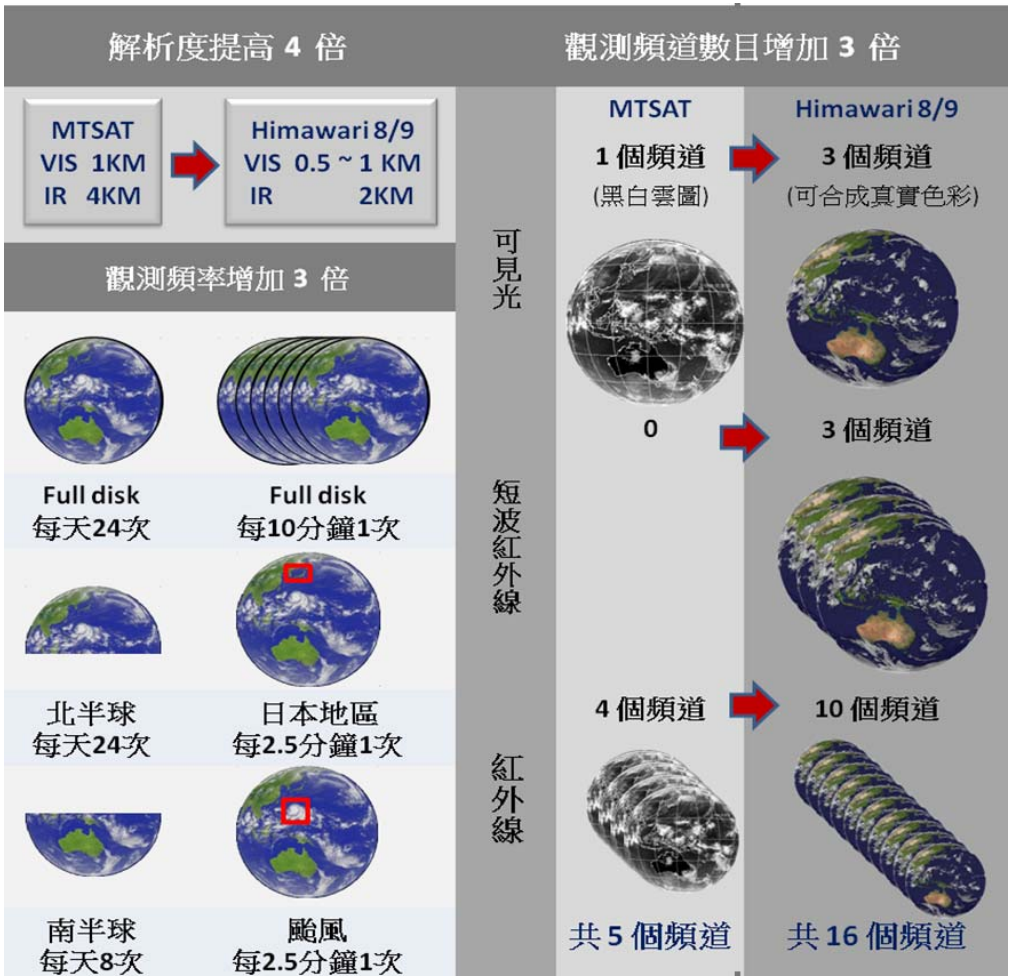
Himawari-8與MTSAT的差異

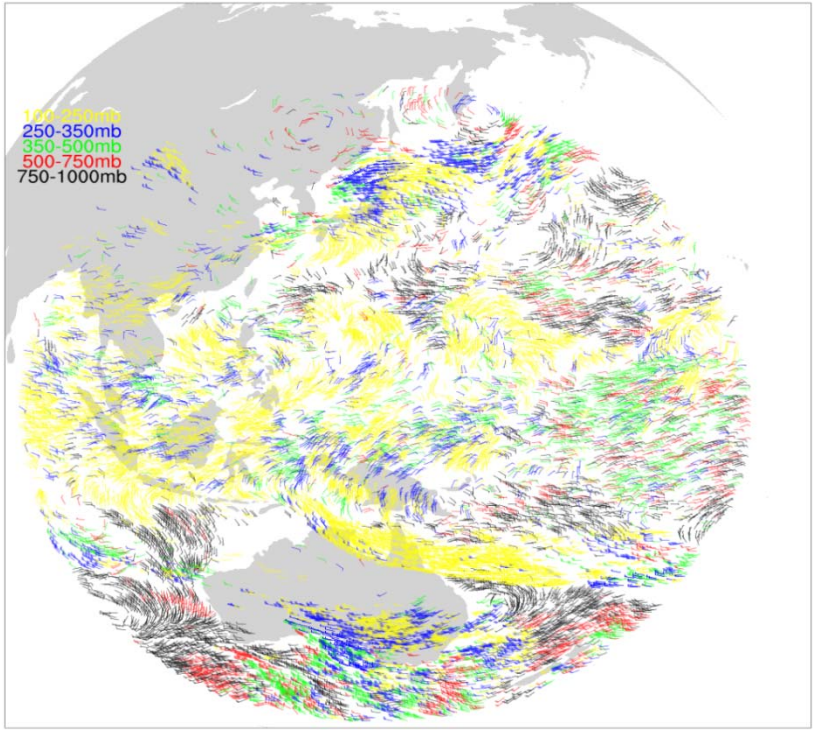


HIMAWARI-8與MTSAT-2的頻道比較			
	MTSAT-2 波長範圍	HIMAWARI-8 波長範圍	
可見光	0.55-0.80	1	0.45-0.49
		2	0.50-0.53
		3	0.63-0.67
近紅外		4	0.85-0.87
		5	1.60-1.62
		6	2.25-2.27
短波紅外	3.5-4.0	7	3.79-4.01
紅外	6.5-7.0 (水氣頻道)	8	6.0-6.37
		9	6.89-7.01
		10	7.32-7.49
長波紅外		11	8.34-8.66
		12	9.52-9.70
	10.3-11.3 11.5-12.5 (紅外窗區)	13	10.2-10.5
		14	11.1-11.3
		15	12.2-12.5
		16	13.2-13.4

圖片來源：向日葵八號衛星頻道基本資訊與應用_衛星中心_劉郁青

About AMVs(Atmospheric motion vectors)

- 使用H8衛星風資料，接收自JWA(日本氣象協會)，再經解碼而得
- 由多個不同頻道的圖像，估算風向量的高度，並決定風向量
- 來自紅外線及水氣頻道、以及少量來自可見光頻道



About AMVs

- 分布以高層最多，中低層較少

170911	12	13	14	16	17	18
100-250	6867	6901	7470	6704	6527	6653
250-350	3002	3134	3432	3272	3250	3378
350-500	2337	2401	2263	2419	2355	2306
500-750	1588	1621	1357	1721	1684	1733
750-1000	3586	3598	1872	3621	3825	4198

WRF FDDA (WRF four-dimensional data assimilation)

- Method of nudging model towards observations or analysis
- Don't need Error covariance, it's cheap.
- Be used for Dynamical initialization (pre-forecast period)

Observation Model

$$\frac{\partial q\mu}{\partial t}(x,y,z,t) = F_q(x,y,z,t)$$

Tendency term

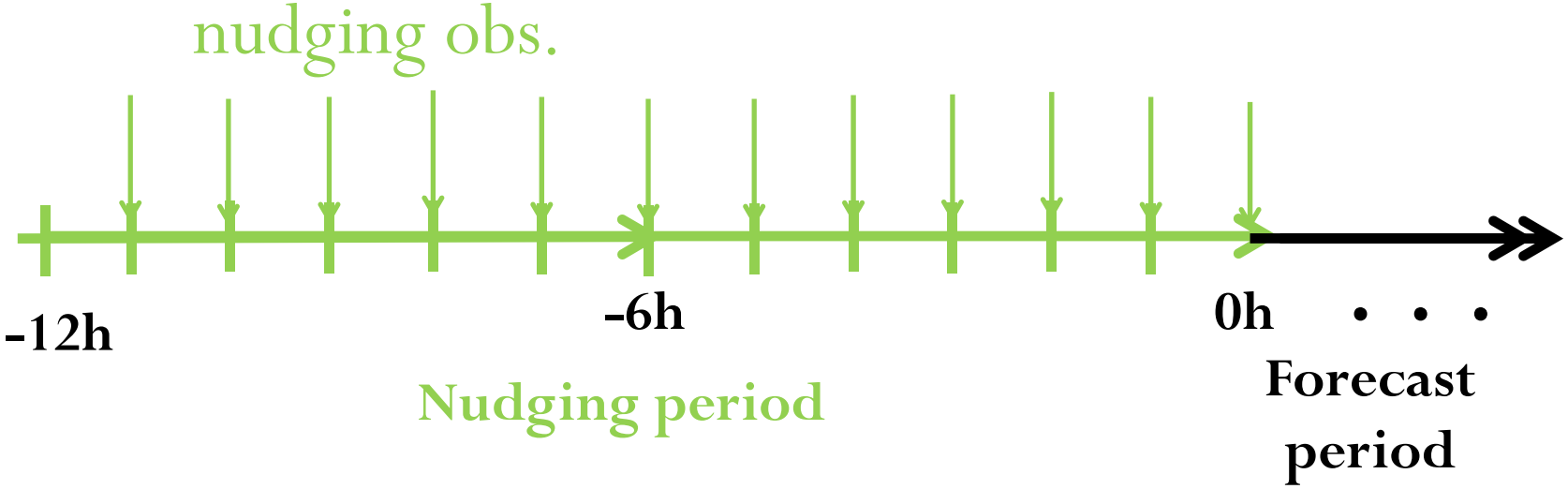
Forcing term

Nudging strength

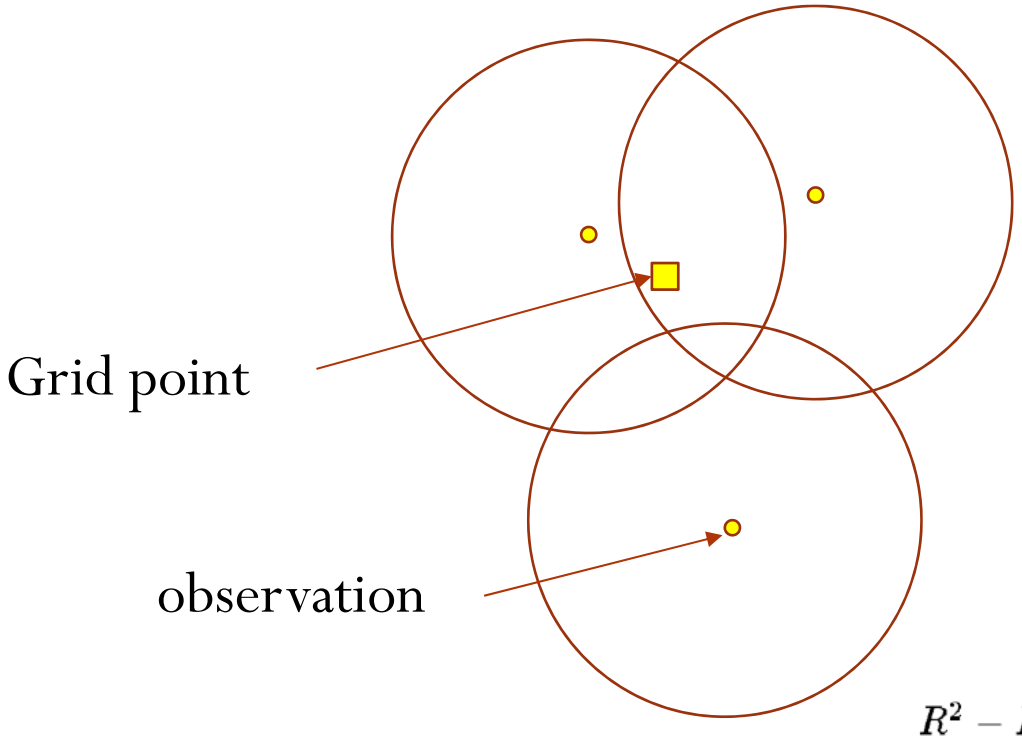
Weighting

WRF FDDA

- Model domains are nudged towards observation every hour in a pre-forecast period of 12 hours
- This has benefit of smooth start up at forecast time zero



WRF FDDA

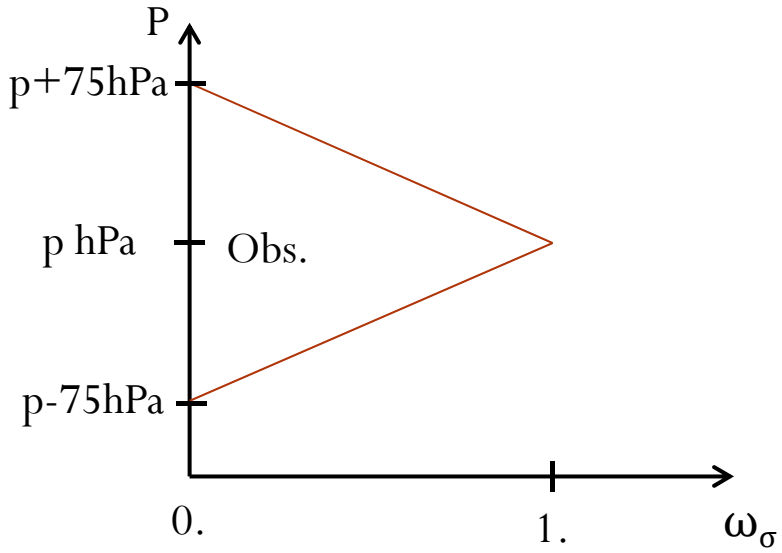


$$w_{xy} = \frac{R^2 - D^2}{R^2 + D^2} \qquad 0 \le D \le R$$

$$w_{xy} = 0 \qquad D > R,$$

WRF FDDA

- ω_σ is the vertical weighting
  - The vertical weighting function linearly decreases with pressure from one at the pressure of the observation to zero **75 hPa** above or below the observation

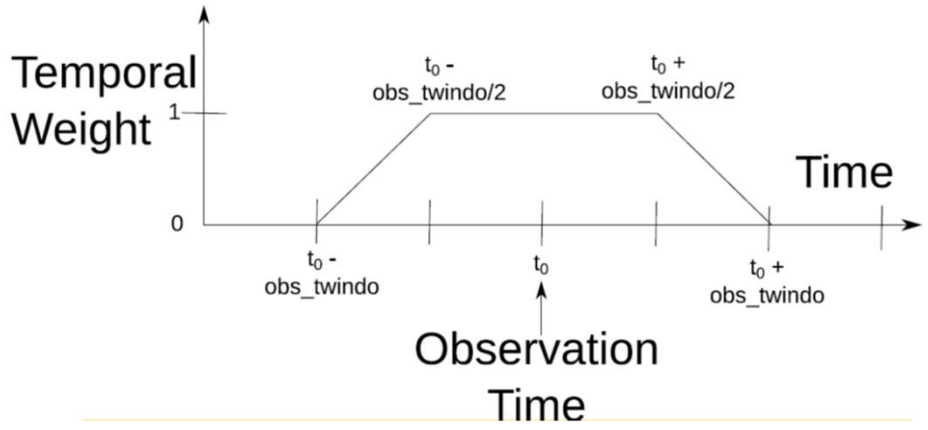


WRF FDDA

- τ is the specified time window for the obs

$$w_t = 1 \qquad |t - t_0| < \tau/2$$

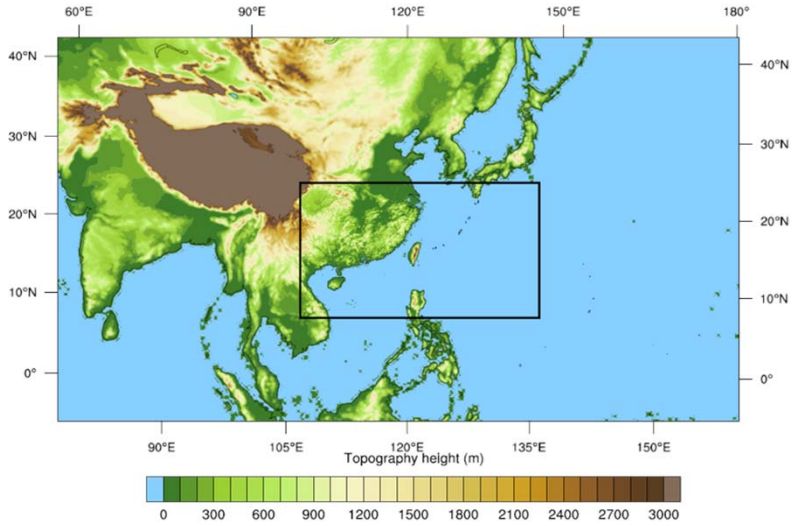
$$w_t = \frac{\tau - |t - t_0|}{\tau/2} \qquad \tau/2 \leq |t - t_0| \leq \tau$$



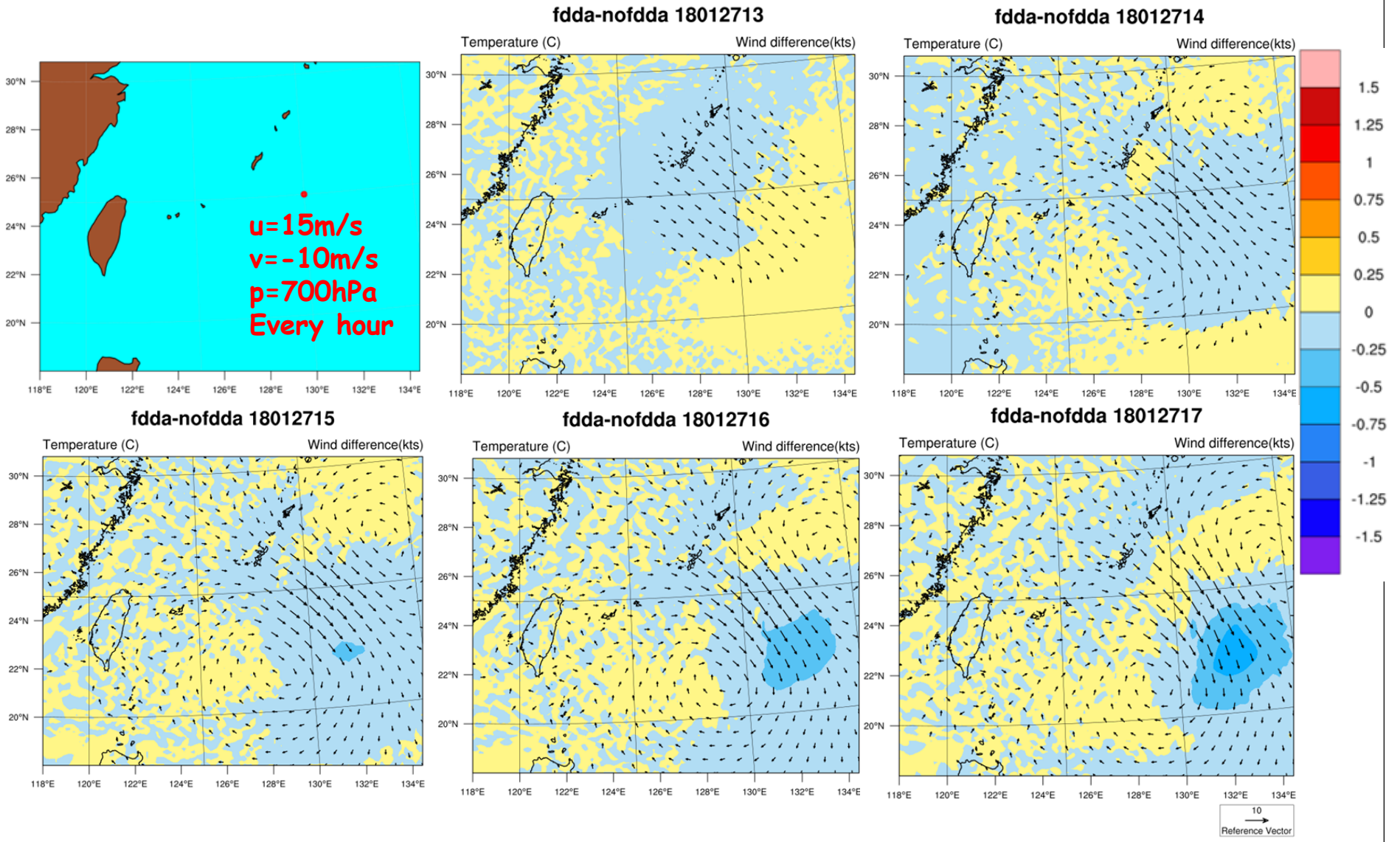
WRF FDDA

- Evalute the impact of FDDA
  --- single obs. test
  --- real case (Himawari 8 AMVs)

- TWRF (15/3 km)



Single observation test (25N,130E)



Single observation test (25N,130E)

u風速 (716hPa)	Fdda	No fdda	v風速 (716hPa)	Fdda	No fdda
1200	10.7346m/s	10.7346m/s	1200	-6.77772m/s	-6.77769m/s
1300	11.7062m/s	10.2663m/s	1300	-7.52101m/s	-6.5586m/s
1400	13.5637m/s	9.81963m/s	1400	-9.31248m/s	-6.23865m/s
1500	14.0523m/s	9.79587m/s	1500	-9.55678m/s	-5.99846m/s
1600	14.1502m/s	9.79568m/s	1600	-9.23695m/s	-5.31761m/s
1700	**14.6973m/s**	10.5945m/s	1700	**-9.33467m/s**	-5.33614m/s

- 使用WRF FDDA之積分結果可以向觀測資料逼近

U=15m/s
V=-10m/s
P=700hPa
Every hour

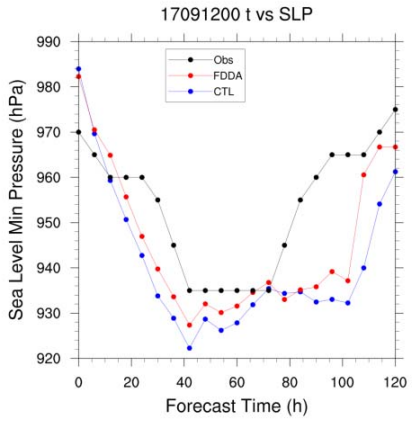
Real case

- TALIM (2017/09)
- TWRF(15/3km)
- Partial cycle with FDDA to assimilate Himawari 8 AMVs
- Forecast for 120hr
- 預報起始時間：17090912~17091300

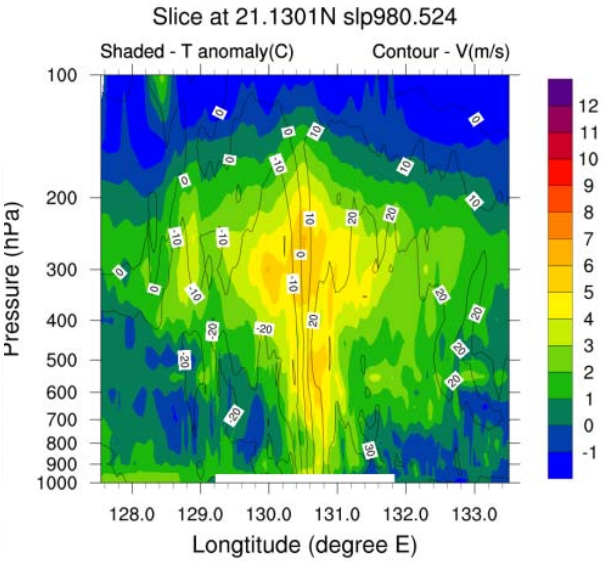
分析比較

FDDA後結構變好，中心氣壓更接近best track ↓

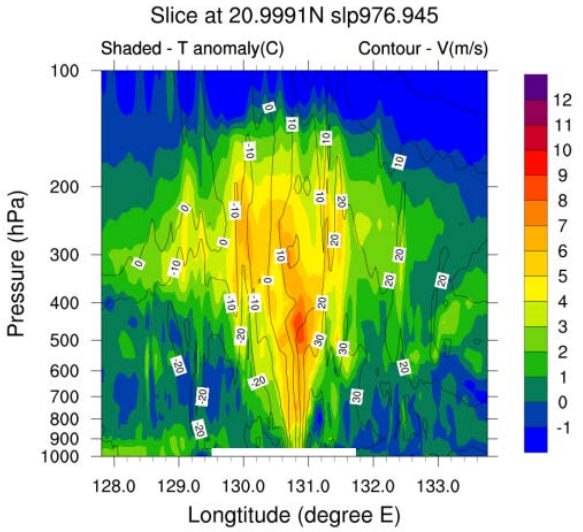
17091200



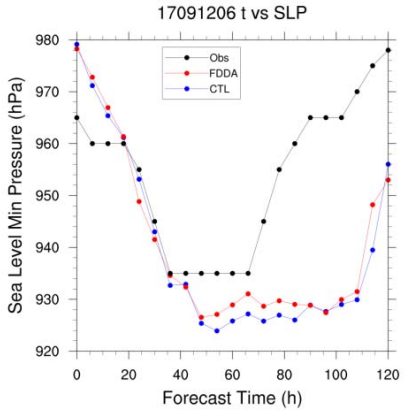
No FDDA

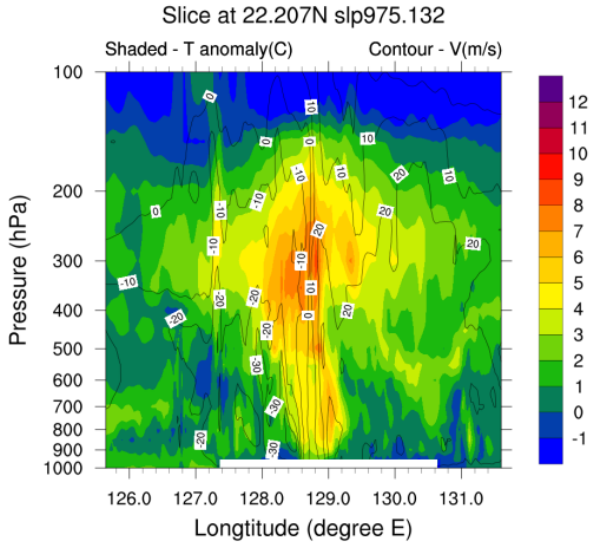


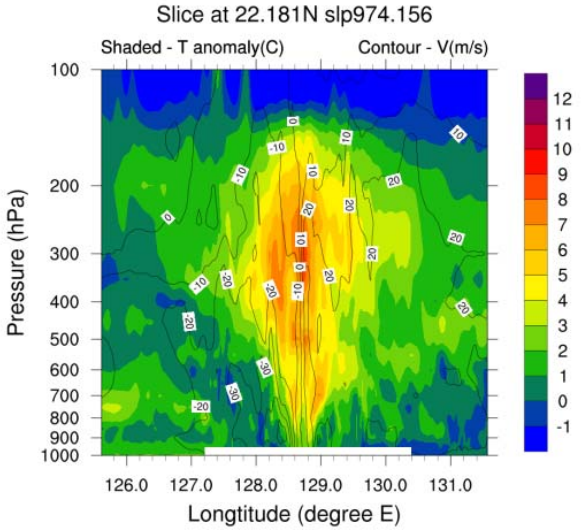
FDDA



17091206

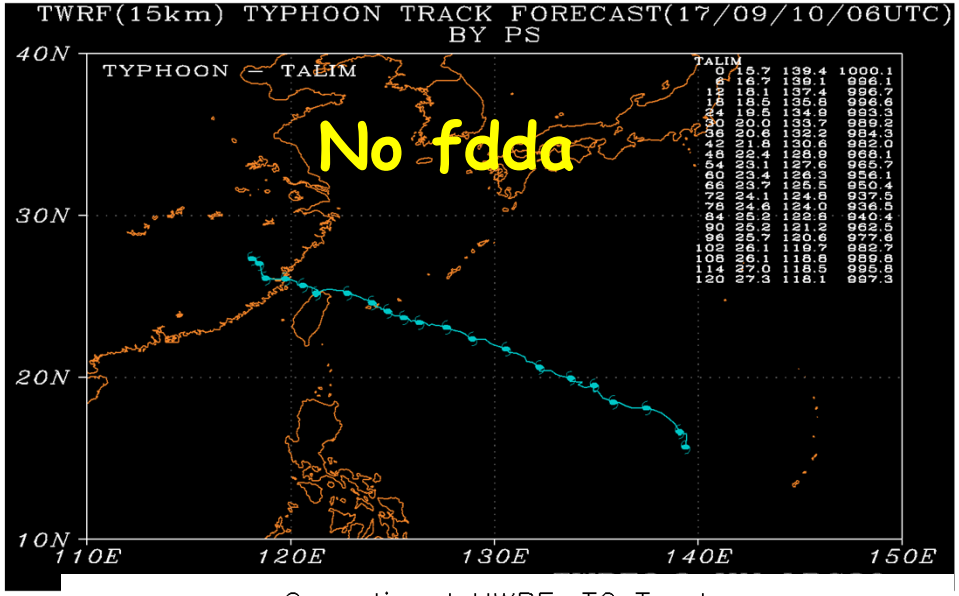


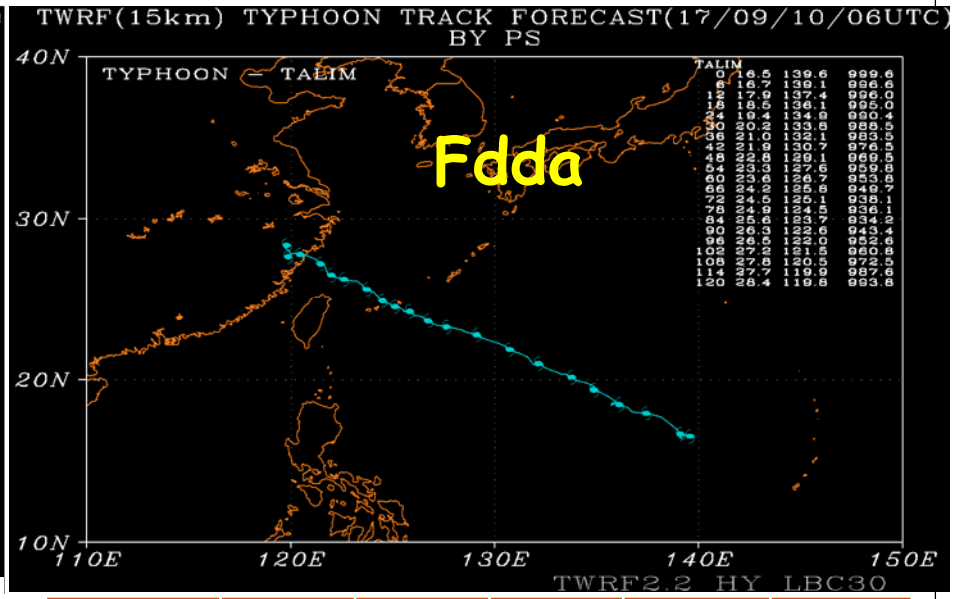


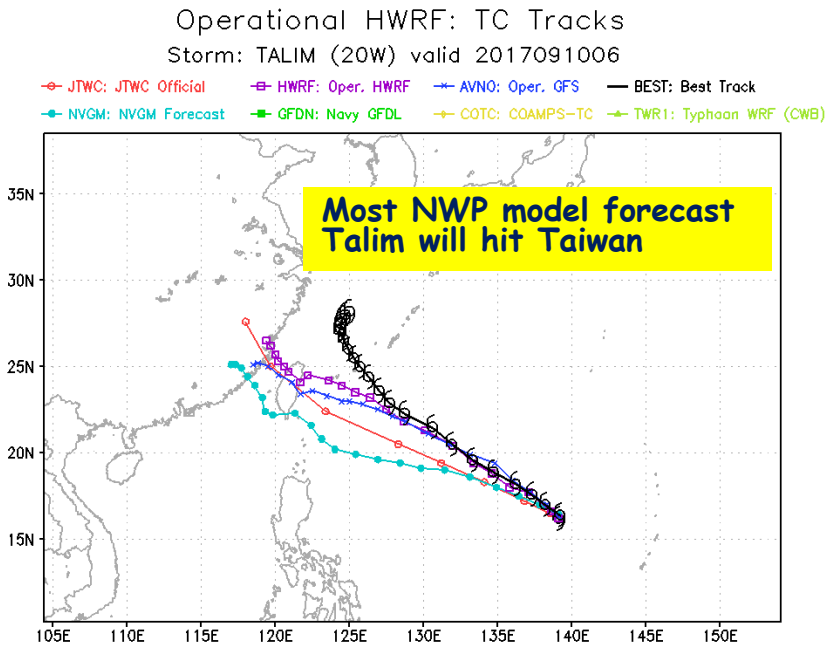


分析比較

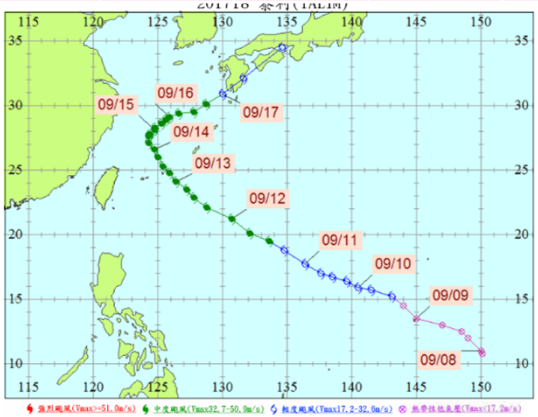
Case: 17091006 TALIM







	24h	48h	72h	96h	120h
nofdda	78.	34.	140.	401.	668.
fdda	63.	82.	85.	238.	489.



Summary

- 向日葵8號衛星的衛星風資料(AMVs)在高層較密集，中低層較稀疏 --- 可助於解析颱風上層**outflow**
- FDDA能使初始場趨近觀測值
- FDDA僅增加極有限之電腦資源

	FDDA	NOFDDA
17091112	1080.7s	1016.8s
17091118	1094.2s	1106.8s

- FDDA可優化TWRF初始颱風結構 進而改善颱風預報
- 未來將發展資料品質控制(QC)技術

Thanks for your attention!