衛星影像處理技術在颱風強度估算之應用研究

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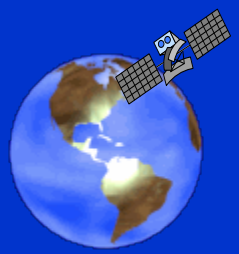
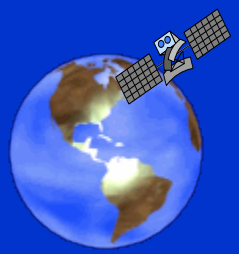
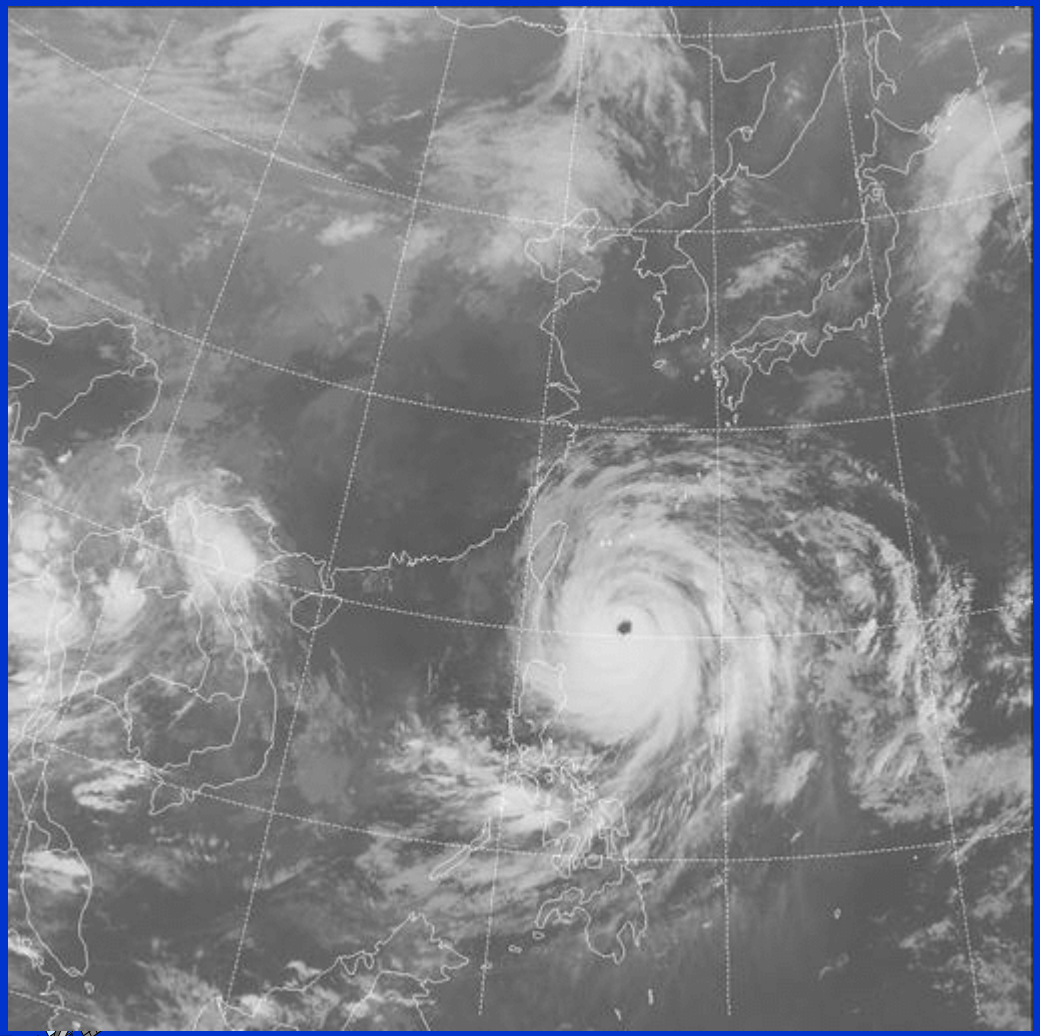


Outline

- ✓ Motive and Purpose
- ✓ Methodology
- ✓ Data
- ✓ Results
- ✓ Conclusion

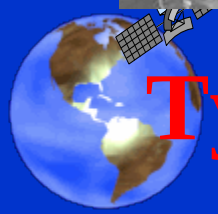


2007 Typhoon Krosa 10/1 00UTC ~ 10/5 00UTC



- 10/1 06UTC Mild
- 10/3 06UTC Moderate
- 10/4 12UTC Severe

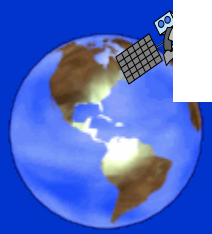
- Ocean!
- Direct observation?
- Typhoon intensity?
- Objective measurement!



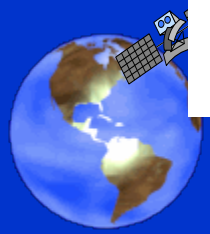
Typhoon intensity vs Cloud pattern?

Motive and Purpose

- In the past, a few techniques were developed to estimate the intensity of tropical cyclones through satellite data.
- Microwave imagers such as AMSU, SSM/I, TMI.
- Most microwave instruments are placed on board polar-orbiting satellites, it is difficult to obtain hourly data on the tropical cyclone intensity changes.



- Geostationary meteorological satellite are considered a more suitable data source in characterizing the hourly intensity variations.
- Dvorak Technique was proposed in determining the intensity of tropical cyclones based on subjective cloud pattern recognition.
- The technique has been employed worldwide by tropical forecast centers for over 30 years

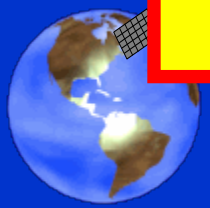


- To eliminate the subjective manual process in the original Dvorak method, an objective and advanced Dvorak technique was developed (Velden et al 1998; Olander and Velden 1999; 2007).

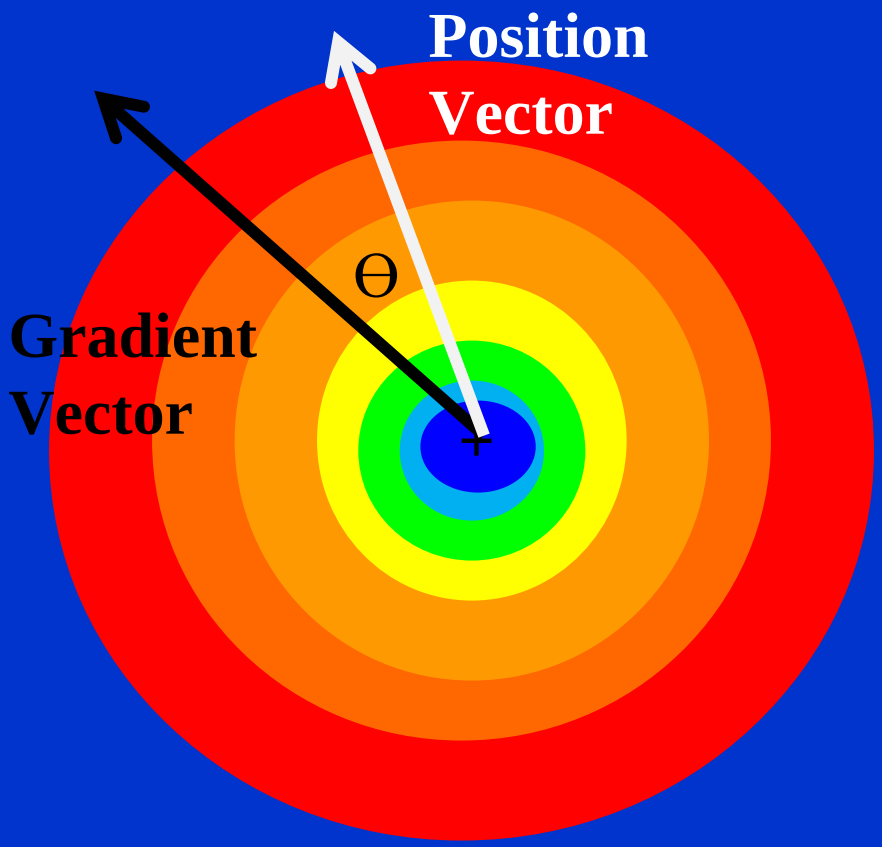
- More studies on delineating the tropical cyclone intensity have been made via optical channels of geostationary satellites (Mueller et al., 2006; Kossin et al., 2007).

- Pineros et al. (2008, 2011) described an algorithm to quantify the axis-symmetry of a tropical cyclone by using satellite infrared imagery, and proposed an objective technique to estimate the intensity of tropical cyclones from satellite infrared data in the North Atlantic basin.

•The present research is to develop a non-dimensional typhoon intensity index for the *Northwest Pacific Ocean.*



Methodology



Ideal distribution of TB

Θ➔0

➔stronger typhoon

Assumption:

➔a stronger typhoon has an axis-symmetric pattern

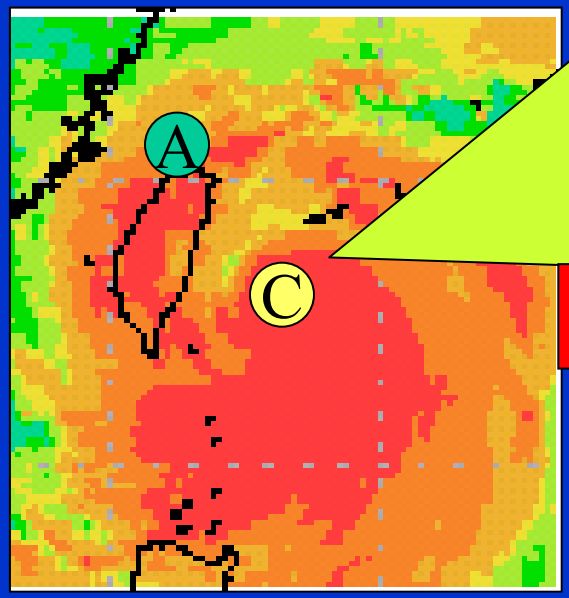
Definition:

➔Variation Angle (Θ)

➔ Typhoon, the stronger the smaller the angle Θ

Variation Angle

Θ at point A ?



Position vector $(\vec{V})$

Gradient vector $(\vec{G})$

θ 3

2

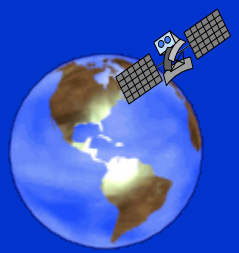
A

1

C

Typhoon Center

$$\text{Variation angle } \theta = \cos^{-1}\left(\frac{\vec{V}\cdot\vec{G}}{|\vec{V}||\vec{G}|}\right)$$



Data

MTSAT IR1, 1996~2011, 12 typhoon cases

8 for Training; 4 for Valuation

Typhoon	Tropical Depression ≦ 17.1 m/s	Mild 17.2 m/s ~ 32.6 m/s	Moderate 32.7 m/s ~ 50.9 m/s	Severe ≧ 51.0 m/s
1996 Herb	7/23 06:00 ~ 7/24 09:00	7/24 10:00 ~ 7/25 13:00	7/25 14:00 ~ 7/26 21:00	7/26 22:00 ~ 7/30 18:00
1996 Violet	9/11 18:00 ~ 9/12 16:00	9/12 17:00 ~ 9/13 07:00	9/13 08:00 ~ 9/15 00:00	9/15 01:00 ~ 9/16 16:00
1997 Ivan	10/1 06:00 ~ 10:1 13:00	10/1 14:00 ~ 10/1 03:00	10/1 04:00 ~ 10/1 13:00	10/1 14:00 ~ 10/1 16:00
1998 Zeb	10/9 18:00 ~ 10/1 09:00	10/1 10:00 ~ 10/1 19:00	10/1 20:00 ~ 10/1 18:00	10/1 19:00 ~ 10/1 00:00
2005 Haitang	7/11 12:00 ~ 7/11 17:00	7/11 18:00 ~ 7/13 23:00	7/14 00:00 ~ 7/15 03:00	7/15 04:00 ~ 7/17 00:00
2005 Talim	8/26 09:00 ~ 8/27 02:00	8/27 03:00 ~ 8/28 06:00	8/28 07:00 ~ 8/29 06:00	8/29 07:00 ~ 8/30 12:00
2005 Longwang	9/25 22:00 ~ 9/26 02:00	9/26 03:00 ~ 9/26 20:00	9/26 21:00 ~ 9/27 18:00	9/27 19:00 ~ 9/30 00:00
2007 Krosa	10/1 12:00 ~ 10/1 16:00	10/1 17:00 ~ 10/2 15:00	10/2 16:00 ~ 10/3 17:00	10/3 18:00 ~ 10/4 23:00
2008 Sinlaku	9/8 00:00 ~ 9/8 11:00	9/8 12:00 ~ 9/9 08:00	9/9 09:00 ~ 9/10 02:00	9/10 03:00 ~ 9/11 05:00
2008 Jangmi	-	9/24 00:00 ~ 9/25 11:00	9/25 12:00 ~ 9/26 08:00	9/26 09:00 ~ 9/27 13:00
2011 Songda	5/20 06:00 ~ 5/21 11:00	5/21 12:00 ~ 5/24 08:00	5/24 09:00 ~ 5/25 10:00	5/25 11:00 ~ 5/26 13:00
2011 Nanmodol	-	8/22 18:00 ~ 8/23 03:00	8/23 04:00 ~ 8/24 01:00	8/24 02:00 ~ 8/26 12:00

Traning typhoon cases

Testing typhoon cases

IR1 cloud pattern vs Variation angle

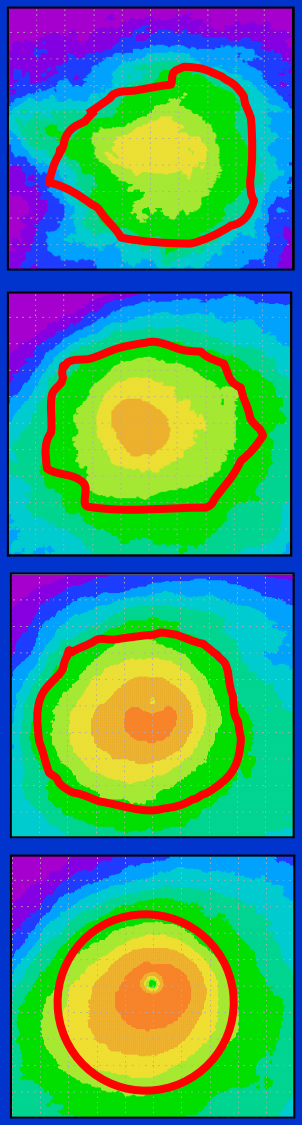
Stronger

Tropical Depression

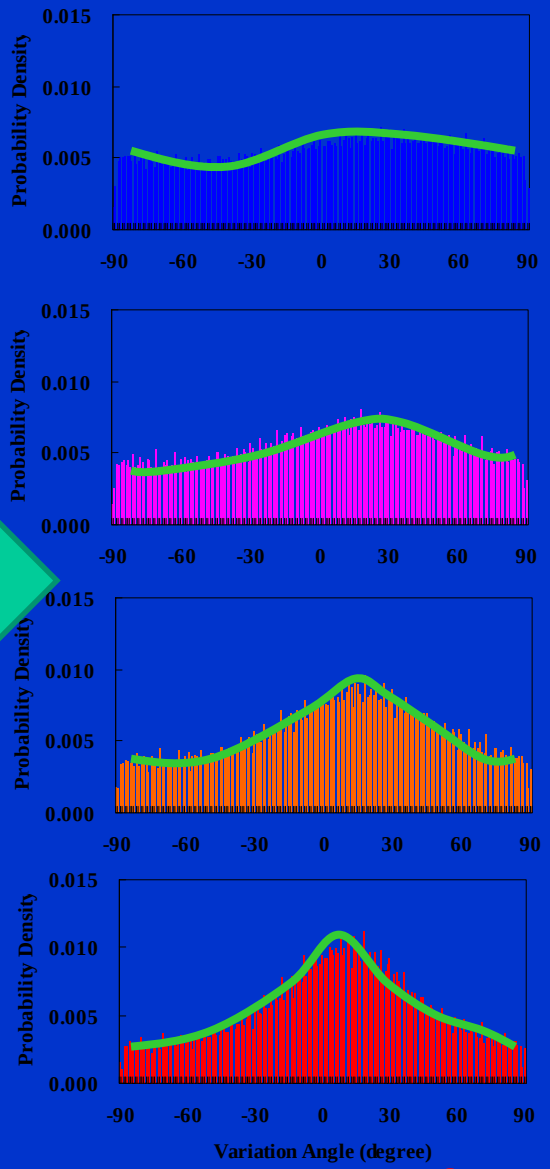
Mild

Moderate

Severe



<200km

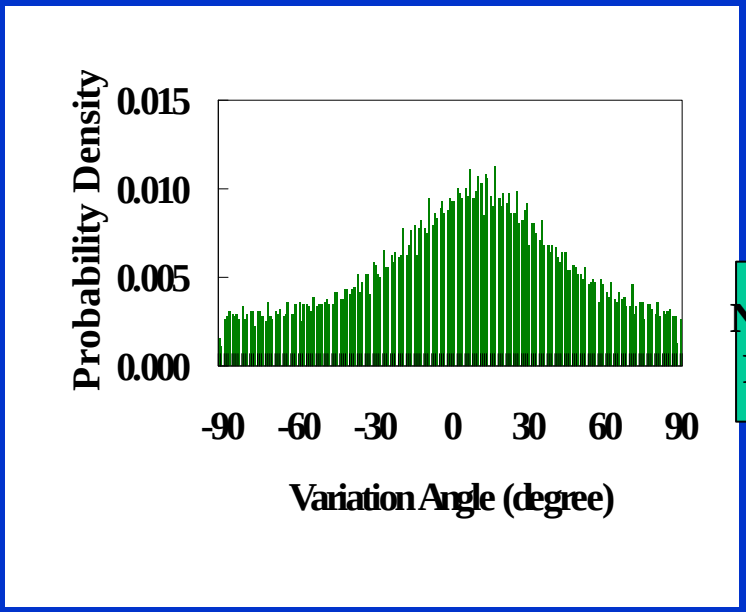


Eight Traing typhoons

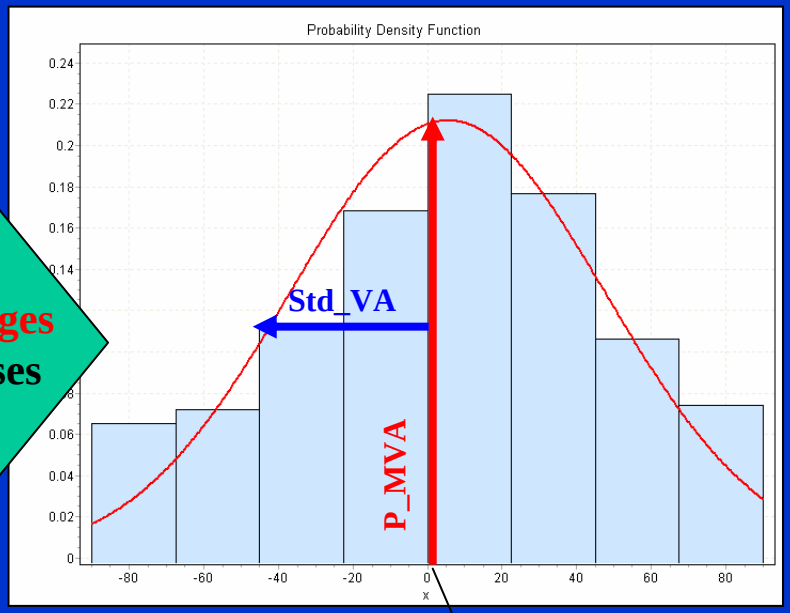
Mean 400 by 400 km IR image for the center of typhoon

Mean distribution of probability density of variation angle

The establishment of the TI Index



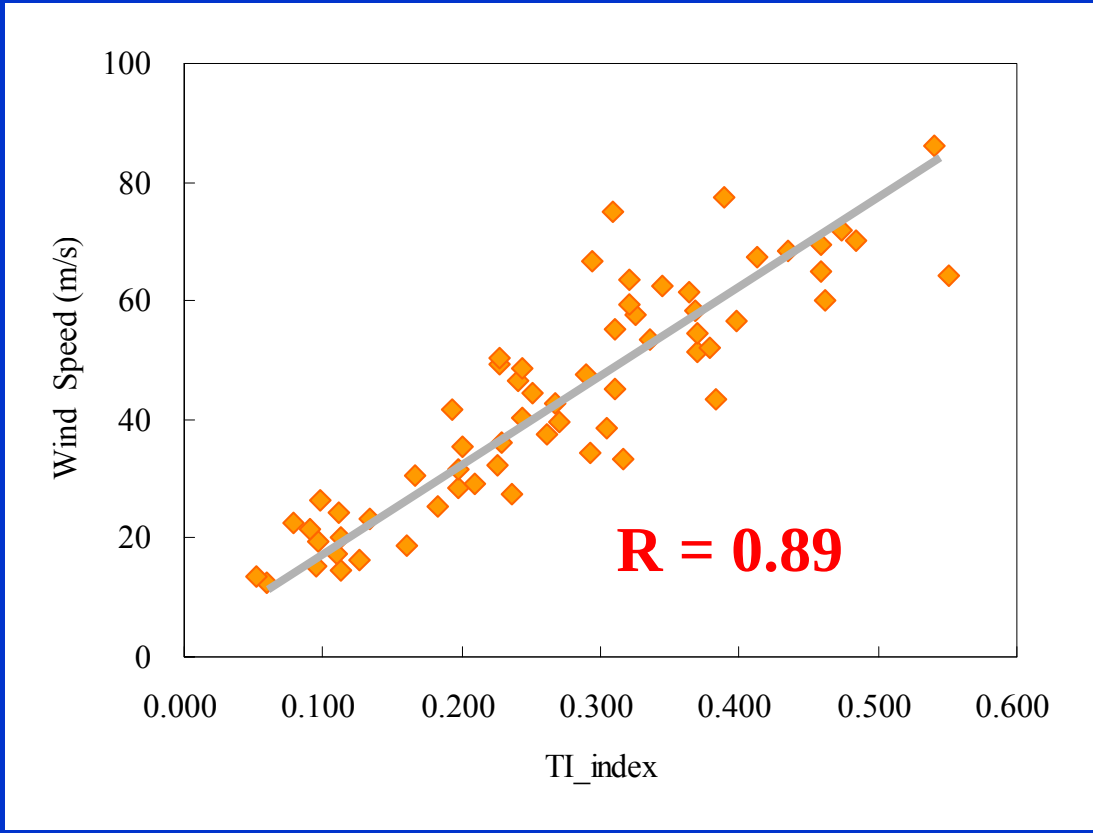
Normal Fit for 4 stages
From 8 training cases



Stronger typhoon➔Larger P_MVA
➔Smaller Std_VA

$$\text{TI index} = \left(\frac{\text{P\_MVA} - \text{P\_MVA\_min}}{\text{P\_MVA\_max} - \text{P\_MVA\_min}}\right) \times \left(\frac{\text{Std\_VA\_max} - \text{Std\_VA}}{\text{Std\_VA\_max} - \text{Std\_VA\_min}}\right)$$

The relationship of TI index and wind speed



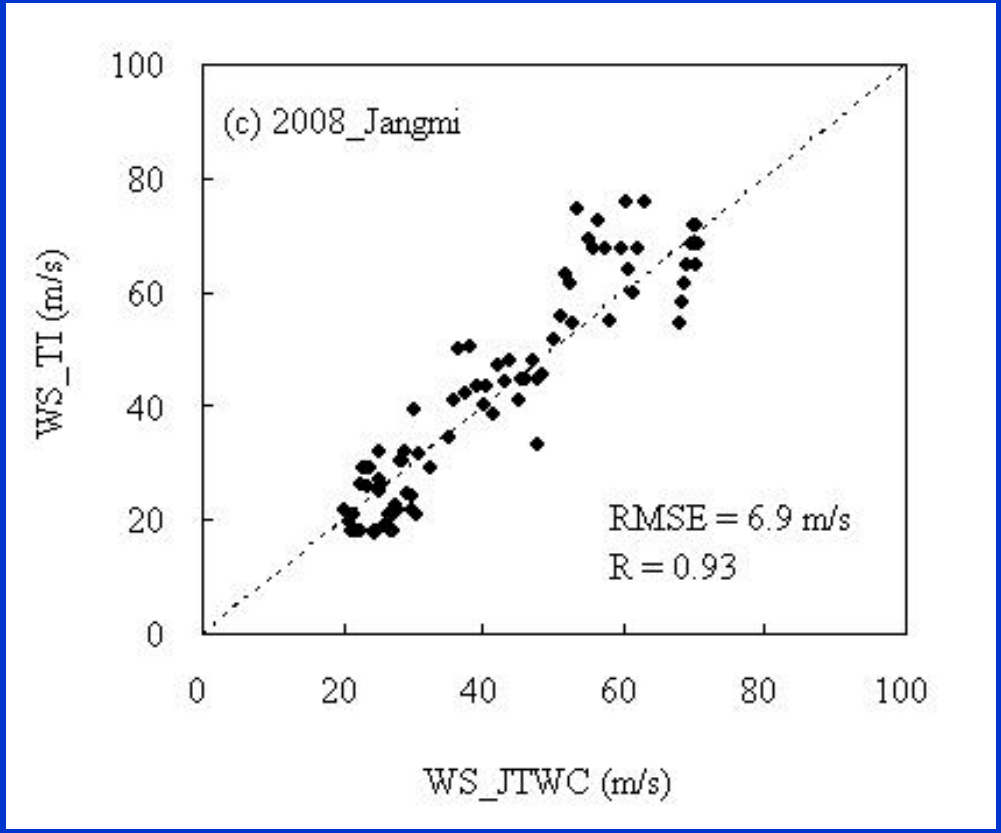
Eight Traing typhoons

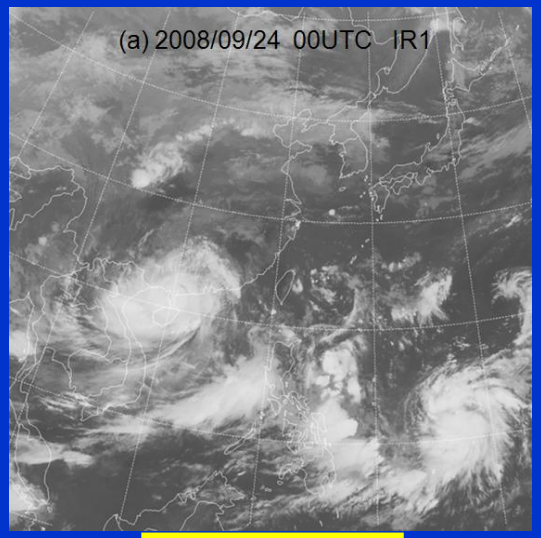
$$WS = 135.0 \times TI + 7.0$$

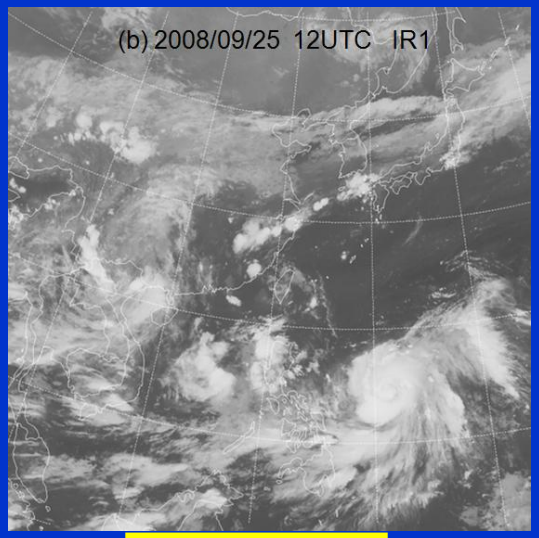
Valuation

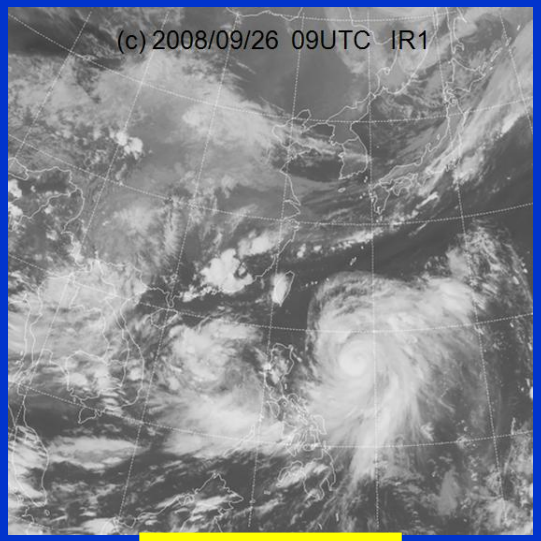
Four valuating typhoon cases

- 1996_Violet
- 2005_Talim
- 2008_Jangmi
- 2011_Songda





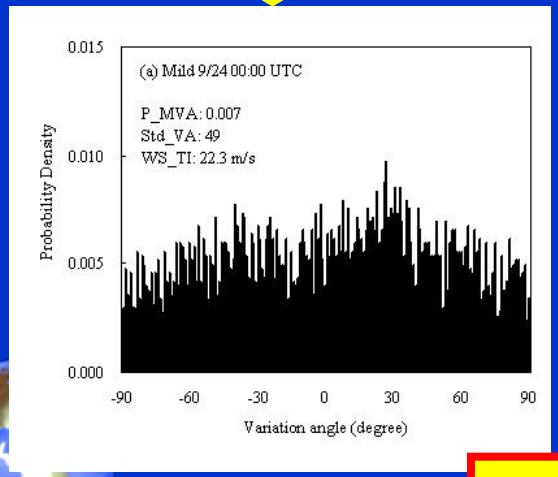


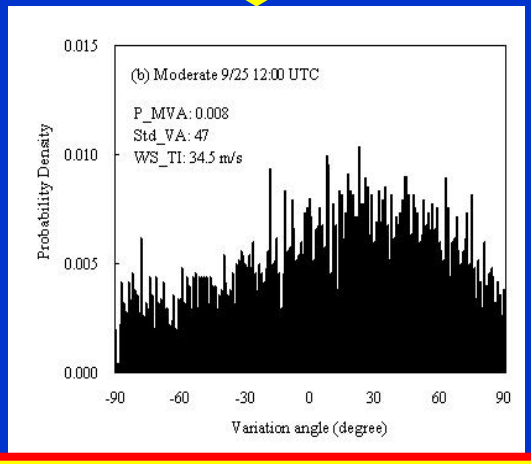


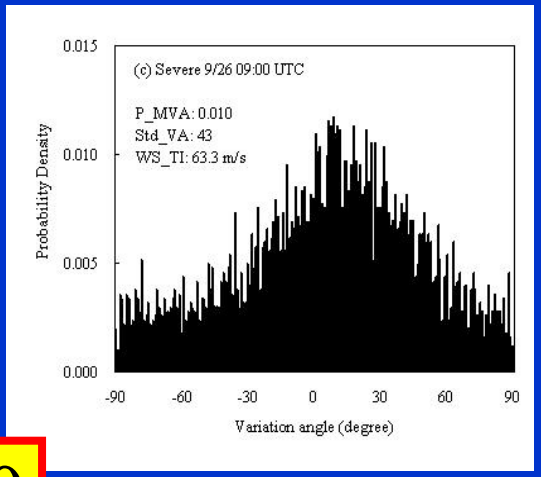
Mild
P_MVA=0.007
Std_VA=49
WS_TI=23.3m/s

Moderate
P_MVA=0.008
Std_VA=47
WS_TI=34.5m/s

Severe
P_MVA=0.01
Std_VA=43
WS_TI=63.3m/s



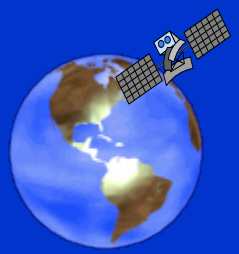




$$WS = 135.0 \times TI + 7.0$$

Conclusion

- 本研究利用地球同步衛星紅外線數據資料，發展一個可以用來描述颱風雲系結構及颱風強度的客觀參考指標(TI)。
- 研究結果顯示：TI所估算的颱風風速和JTWC最大風速值具有不錯的相關性。
- TI可以由計算機產出，具有客觀性。
- 當颱風還在海面上發展且一般傳統觀測資料不足時，可以做為研判颱風強度的參考。



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