利用高頻測流雷達觀測颱風期間海表面流場變化—以蘇力颱風為例

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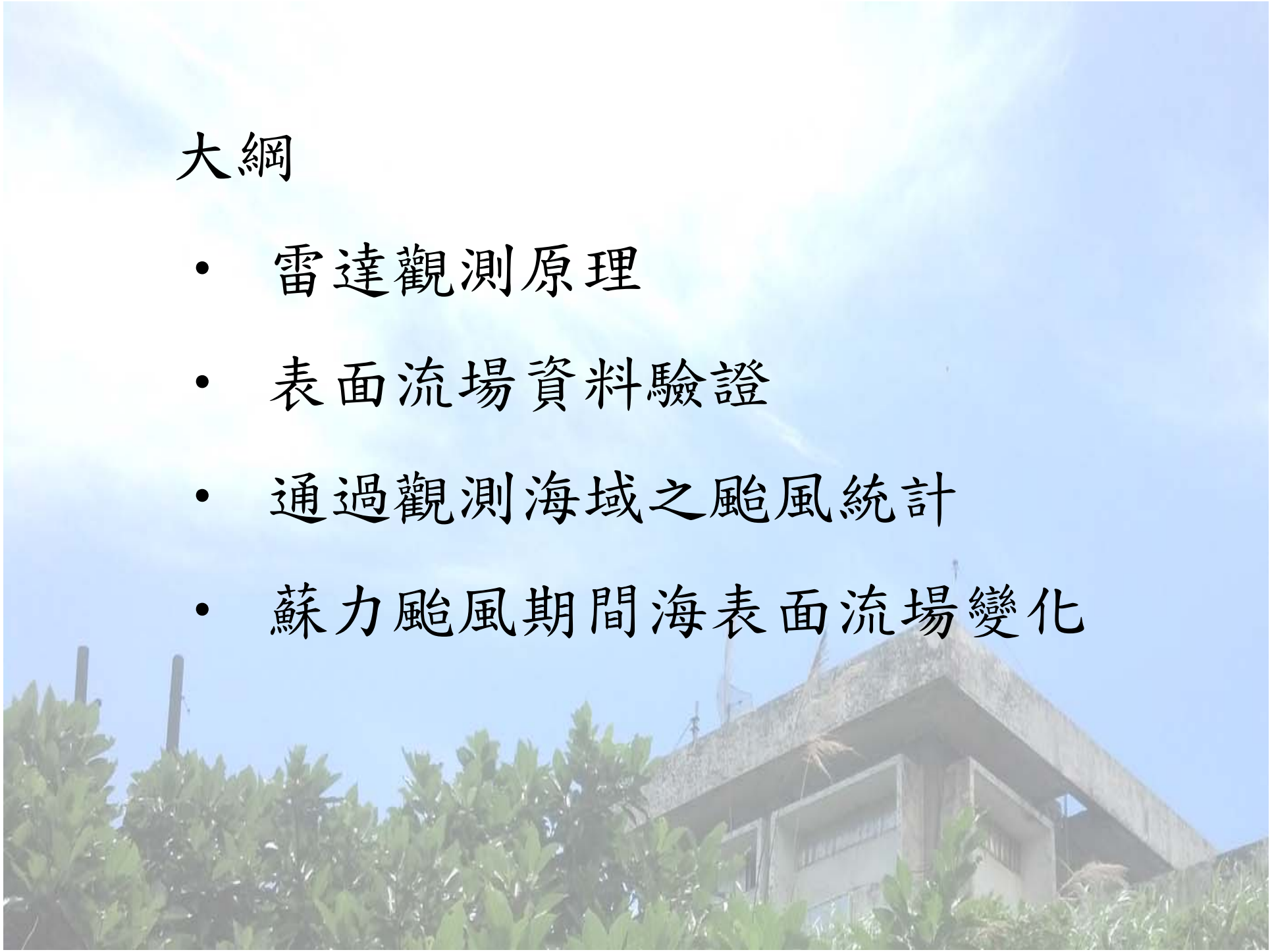
國立臺灣大學海洋研究所



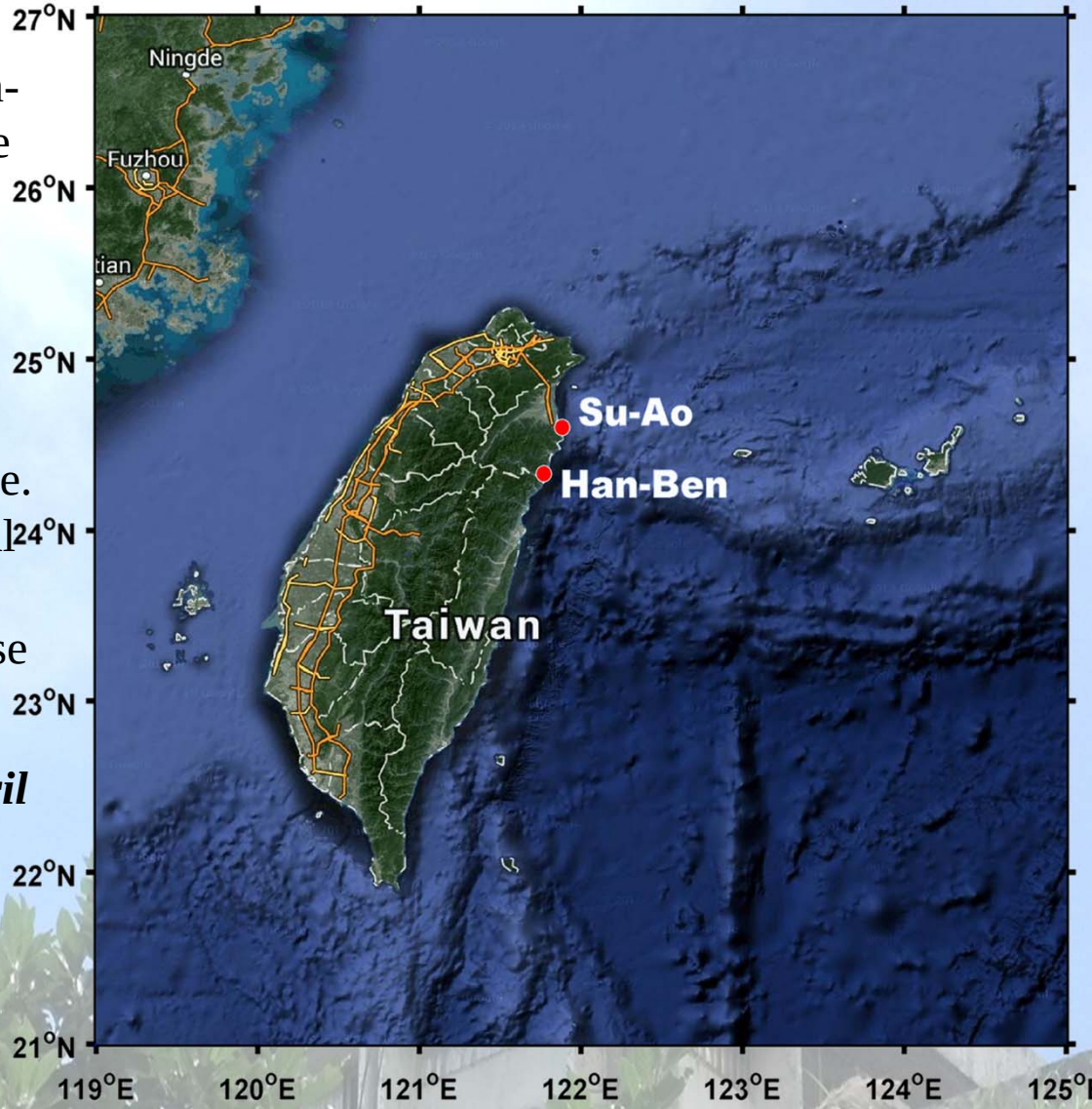
大綱

- 雷達觀測原理
- 表面流場資料驗證
- 通過觀測海域之颱風統計
- 蘇力颱風期間海表面流場變化

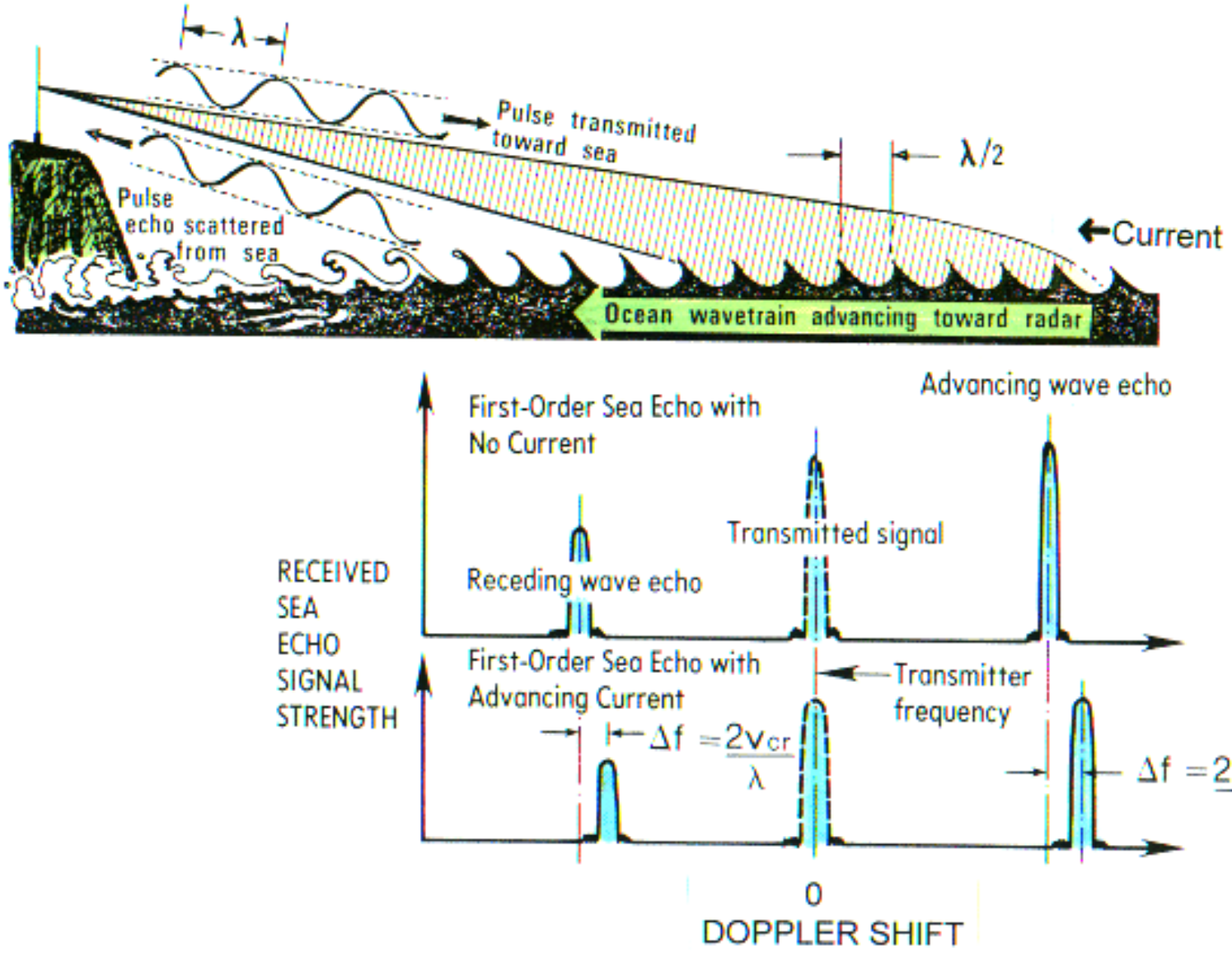
Origin

2011/3 – present

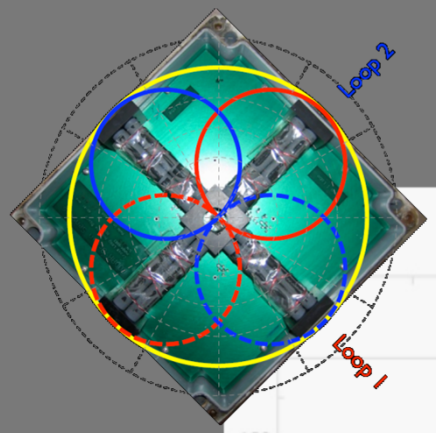
- Two long-range CODAR were established in 2010 at Suao and Han-Ben to remotely measure sea surface currents off northeast of Taiwan.
- The first year of observation was dedicated to the improvement of the data quality. (Fang et al., 2011)
- Series of adjustments are being made. For example, averaging time interval is changed to 4 hours to further reduce the effect of background noise and the disturbance of ionosphere.
- ***Become fully operational since April 2011, and have been collecting sea surface current data around northeast of Taiwan since then.***

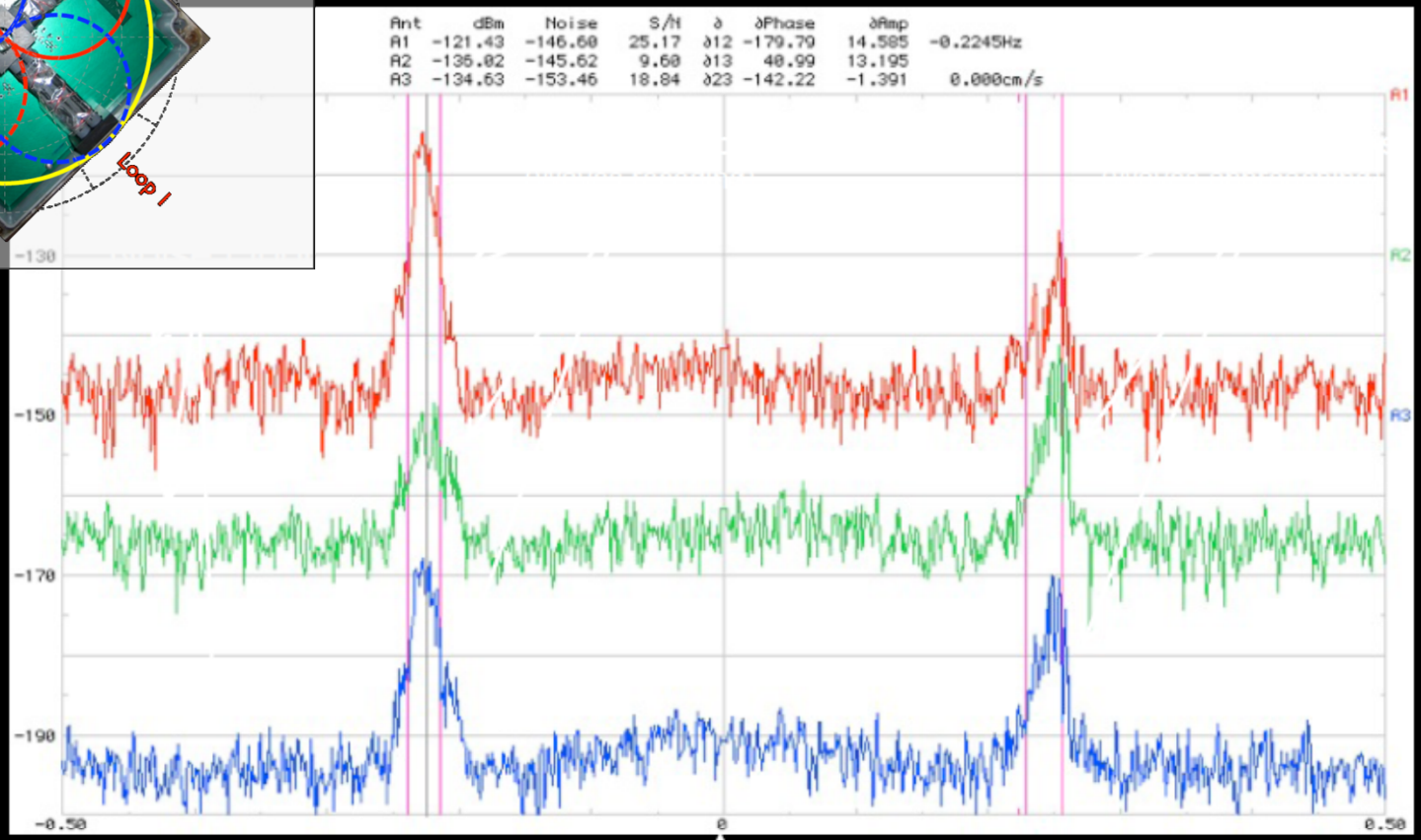


How HF Radar Measures Ocean Currents



The Doppler Spectrum





Loop 1 (A1)

Loop 2 (A2)

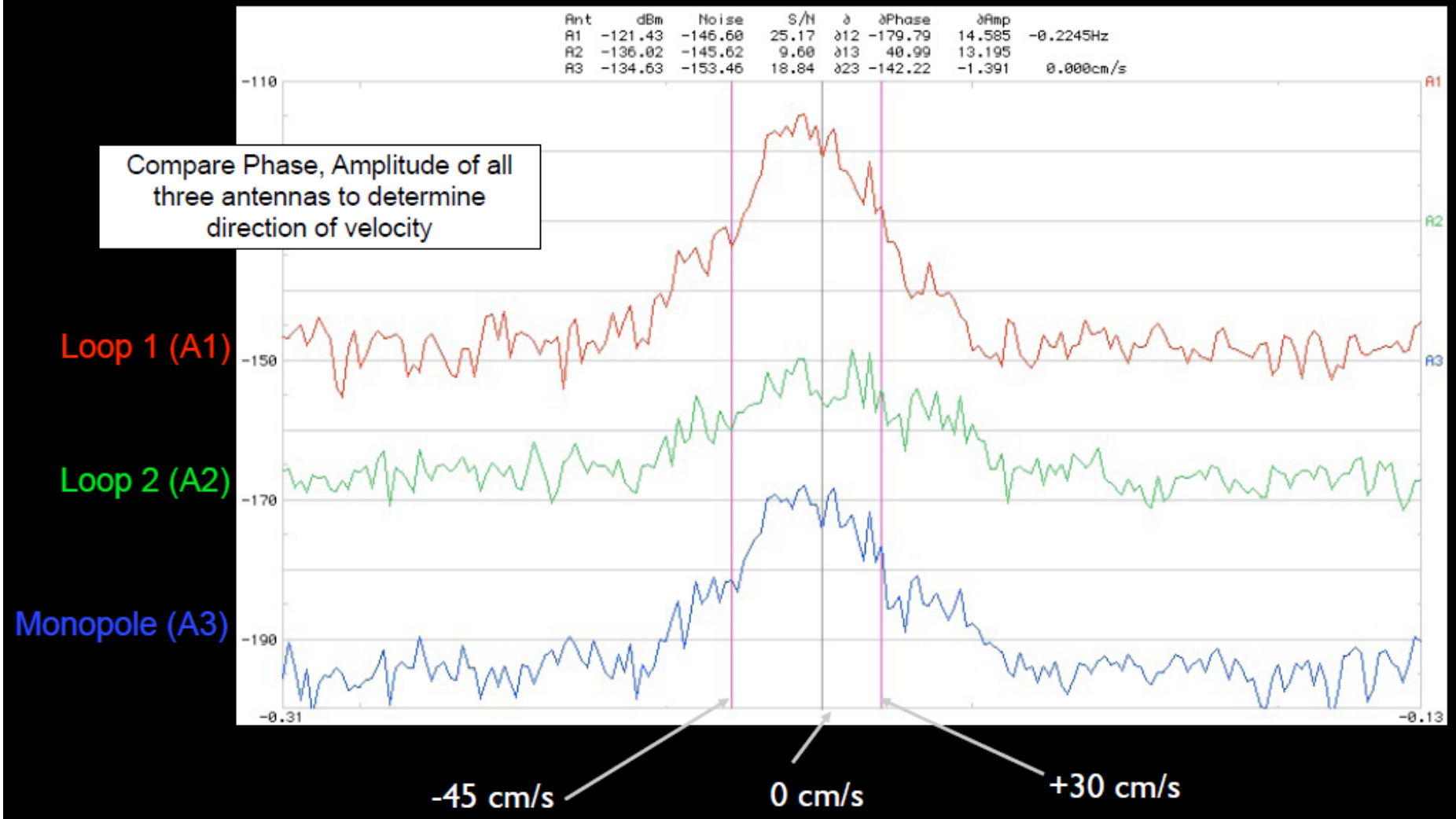
Monopole (A3)

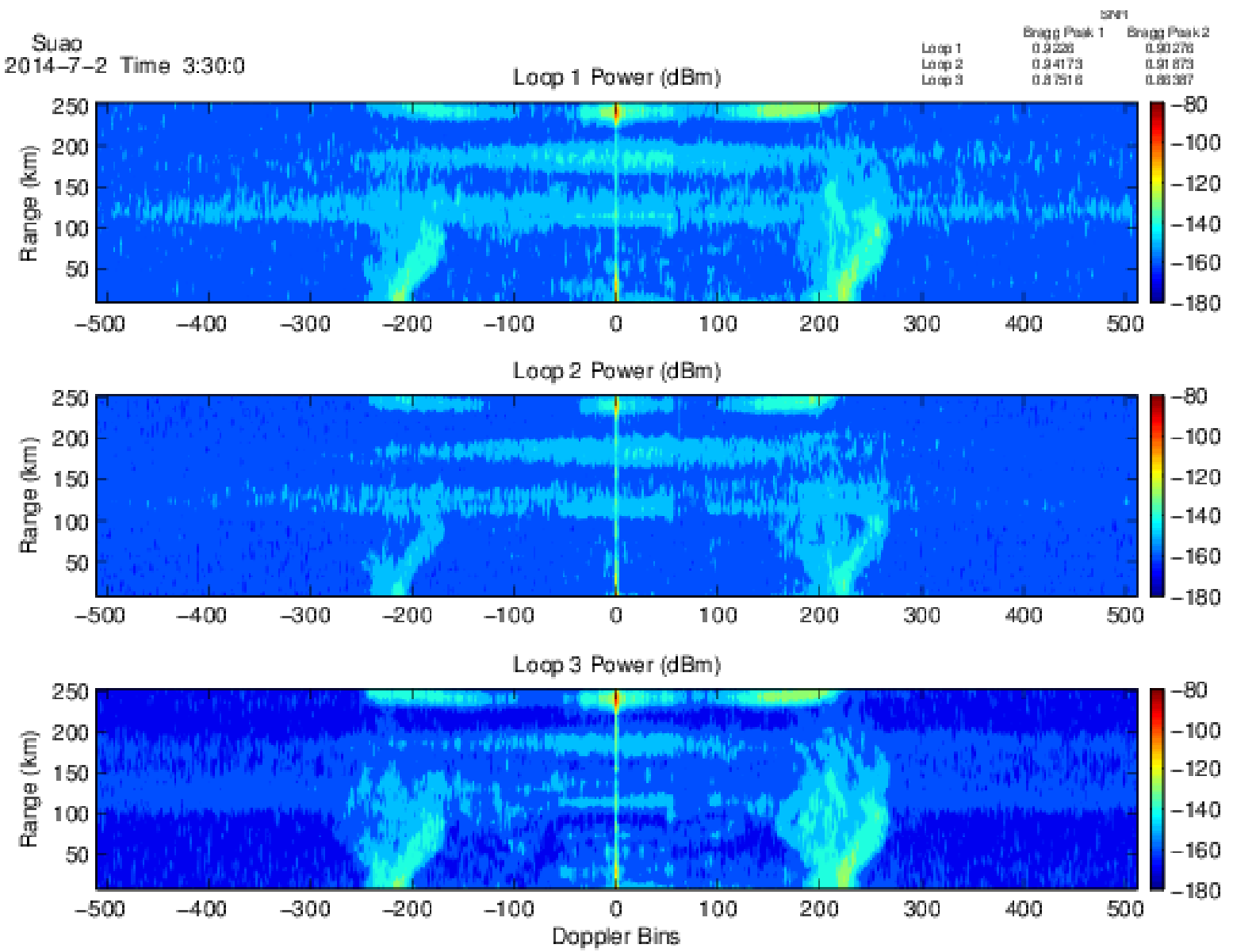
Negative Doppler:
Targets moving
away from Antennas

0 Hz
Doppler Offset
a.k.a. “DC”

Positive Doppler:
Targets moving
towards Antennas

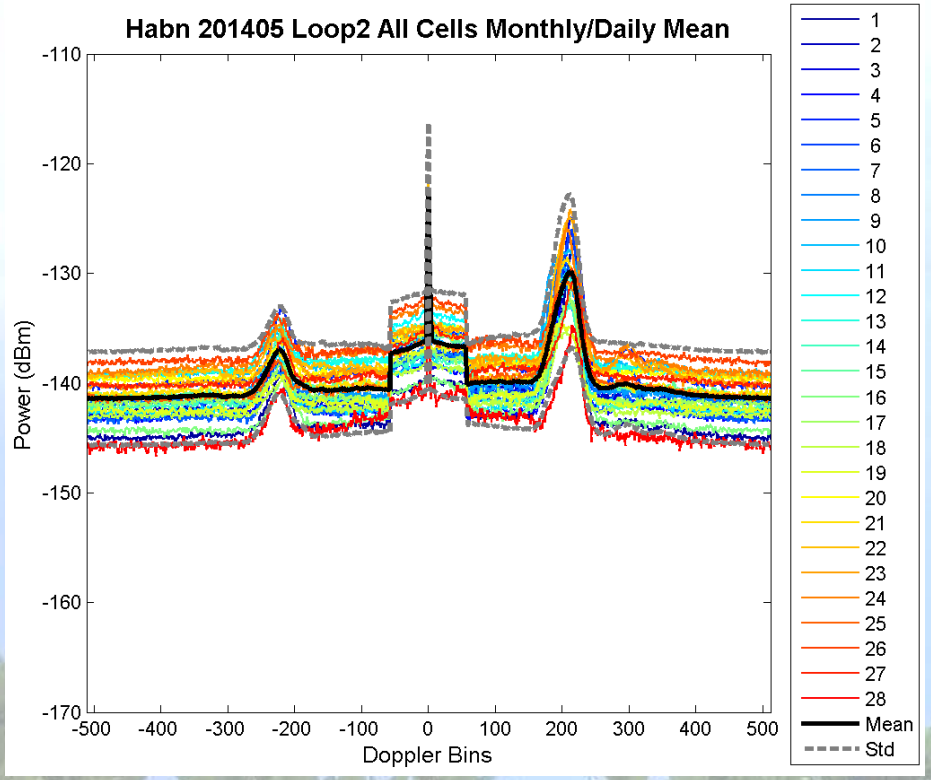
使用MUSIC算式, 根據三支天線所收到之回波訊號以估算信號來向



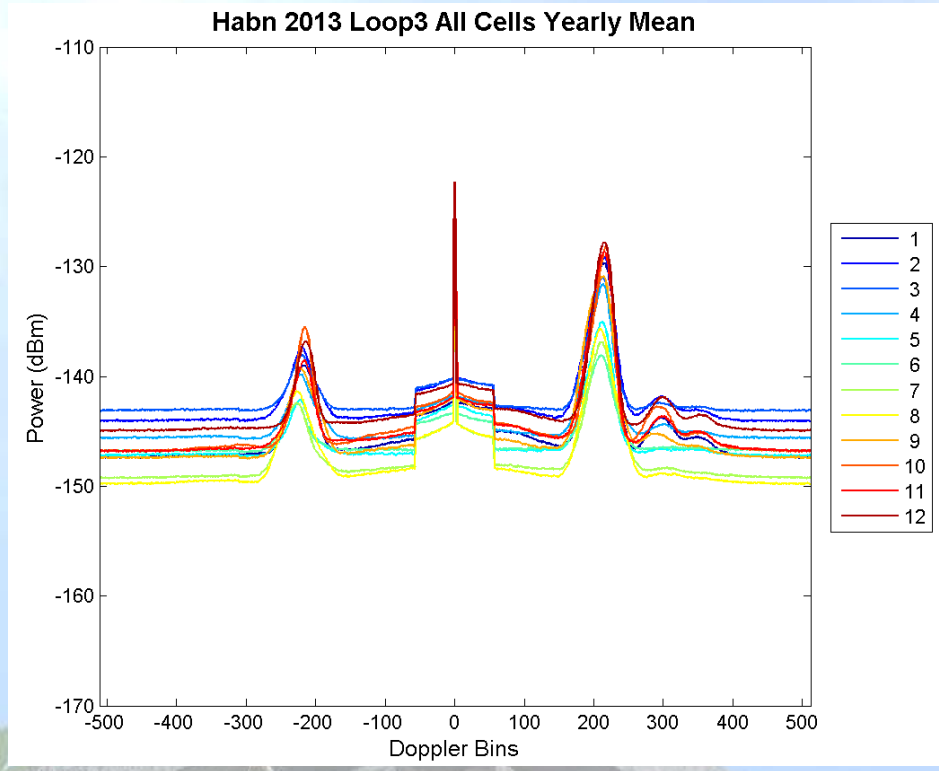

Suao
2014–7–2 Time 3:30:0
SNR
Bragg Peak 1
Bragg Peak 2
Loop 1
Loop 2
Loop 3
0.9228
0.94173
0.87516
0.90276
0.91873
0.88397
Loop 1 Power (dBm)
Loop 2 Power (dBm)
Loop 3 Power (dBm)
Range (km)
250
200
150
100
50
−500
−400
−300
−200
−100
0
100
200
300
400
500
−80
−100
−120
−140
−160
−180
Doppler Bins

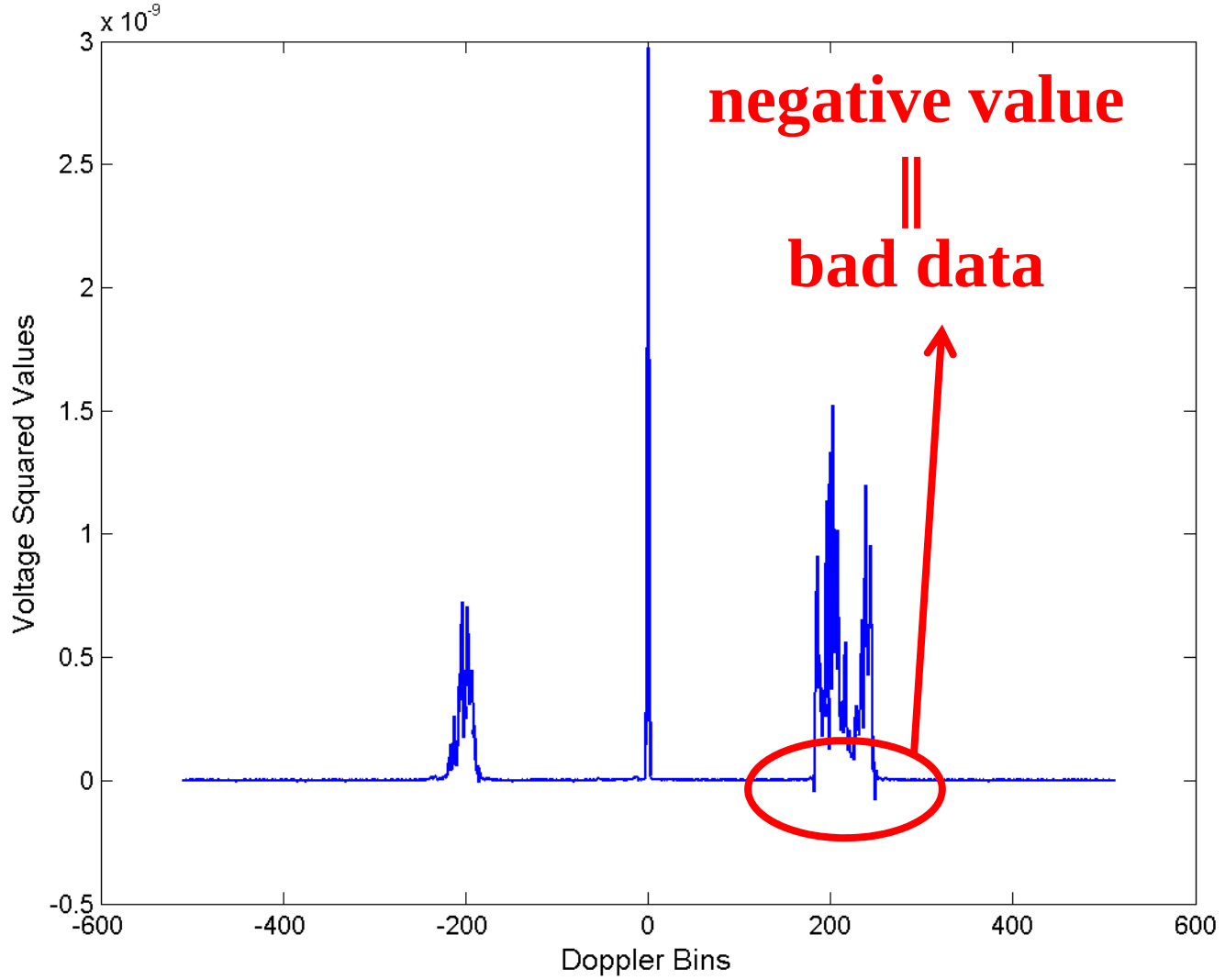
Data quality analysis – Power variation

daily



monthly





藉由統計First Order區域內負值出現次數，作為評估該Range Cell受干擾的程度。

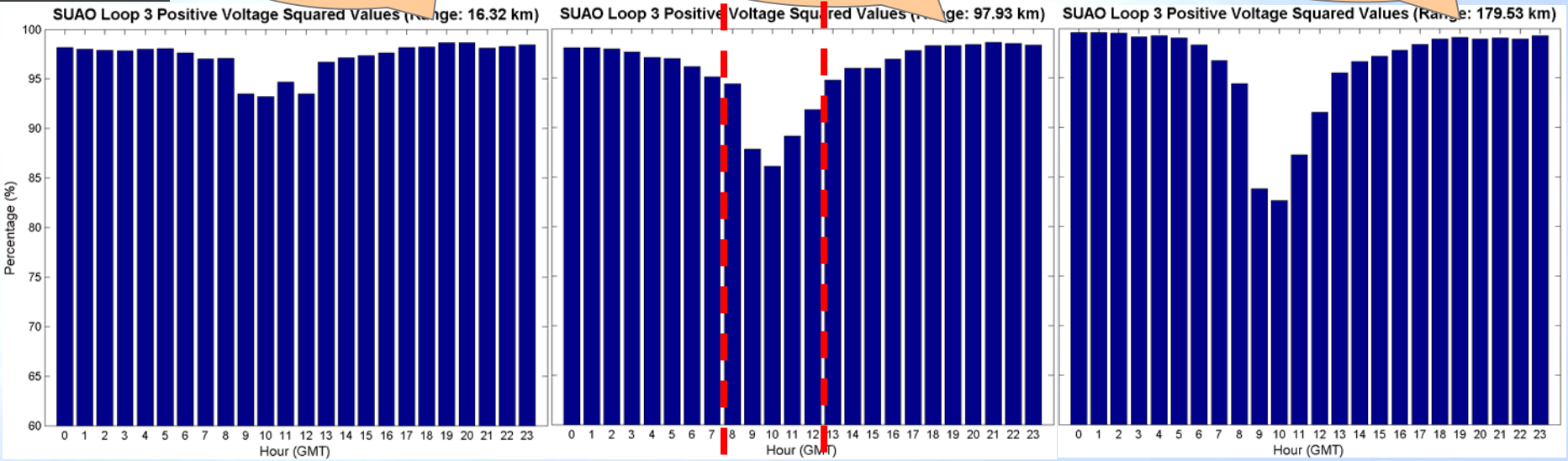
Data quality analysis – Daily variation with range

SUAO

~ 20 km

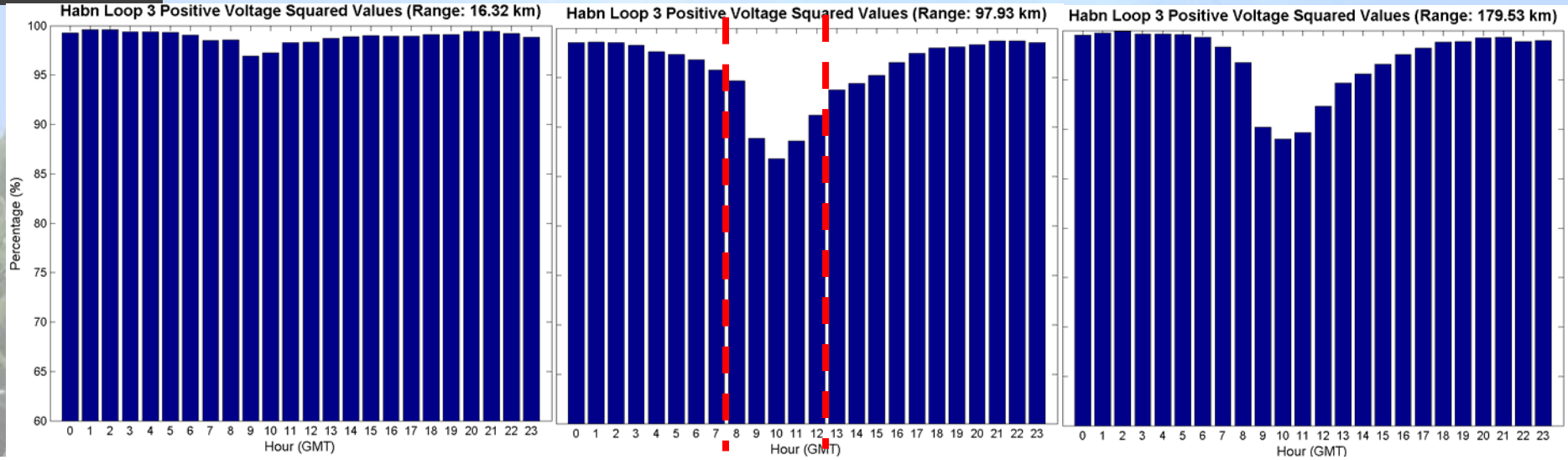
~ 100 km

~ 180 km



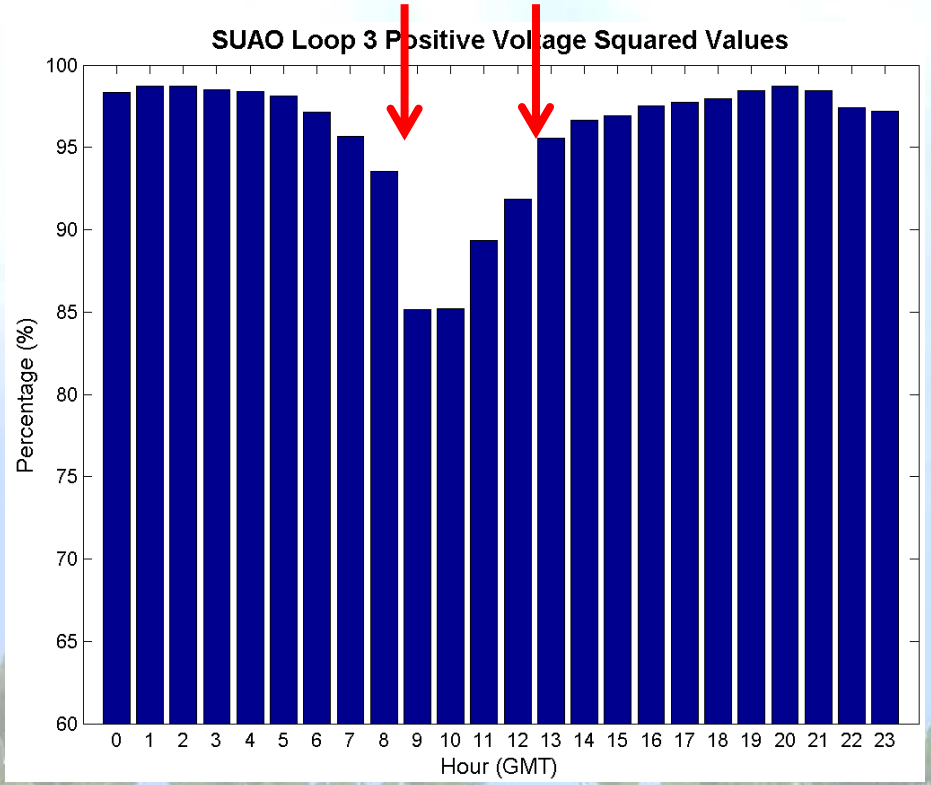
Habn

~ 4-5 hr

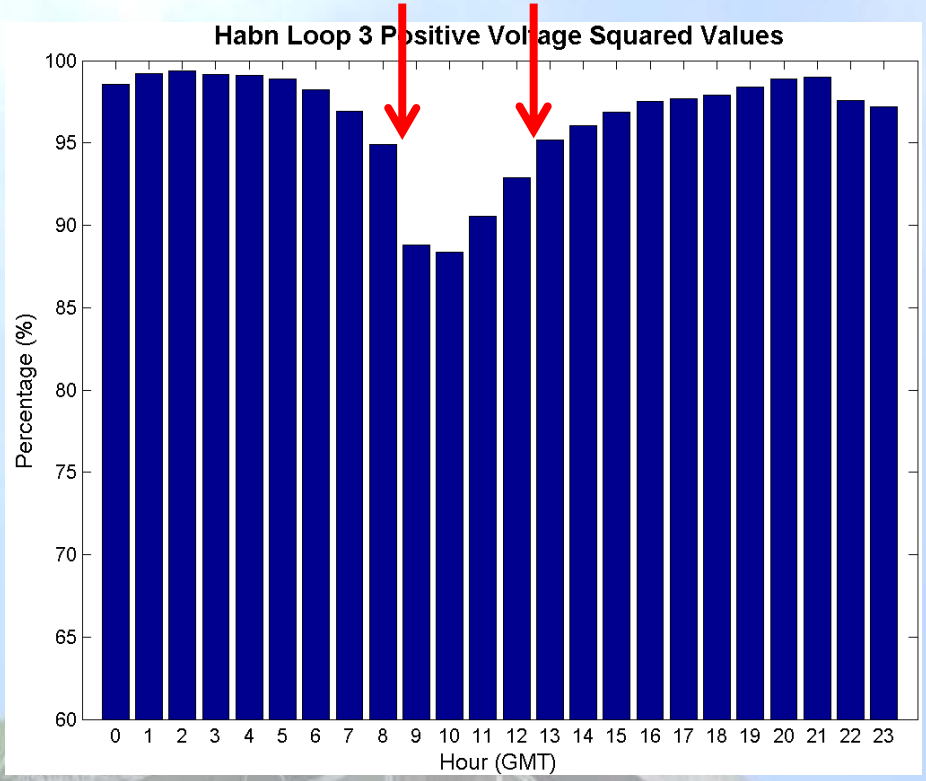


Data quality analysis – Daily variation

about 17:00~20:00 (Local time)



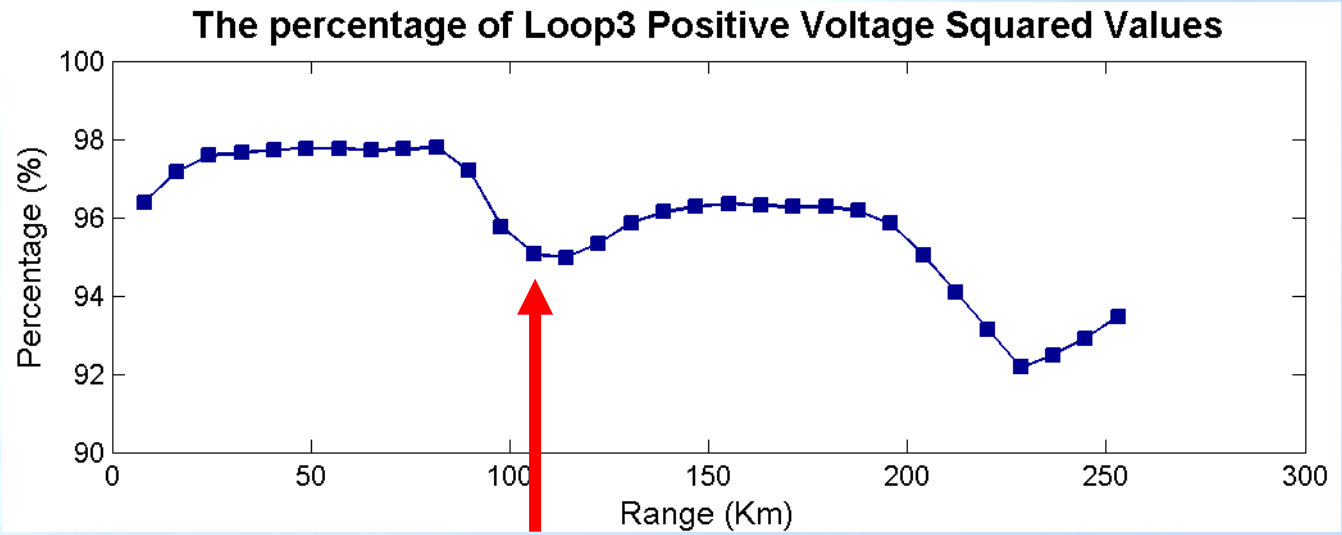
SUAO



Habn

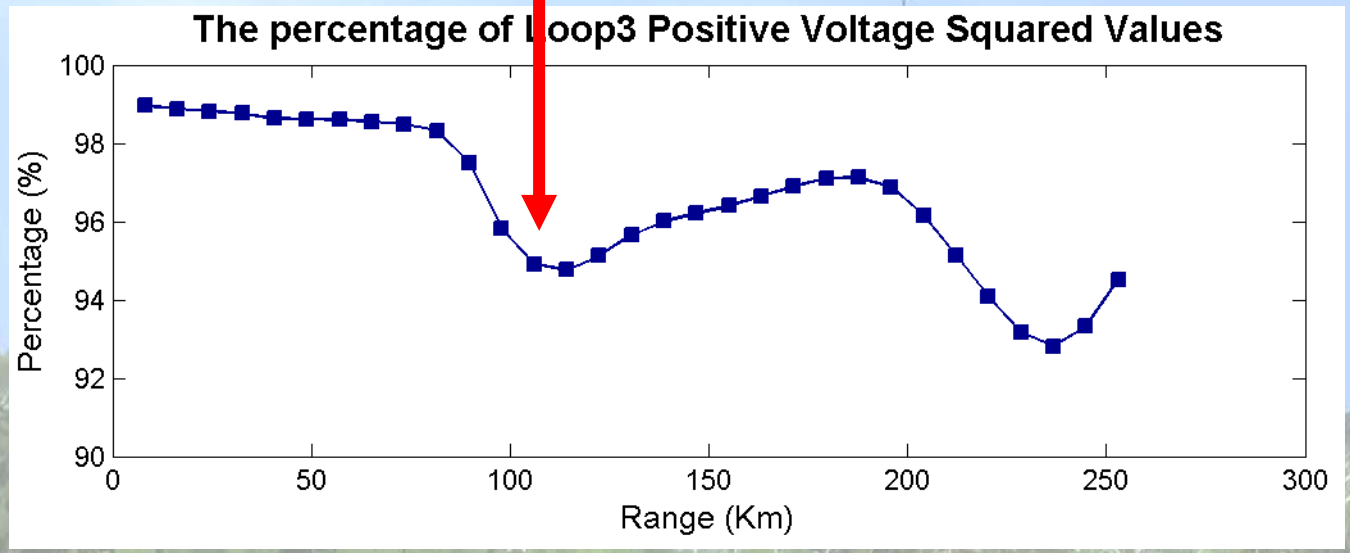
Data quality analysis – Spatial

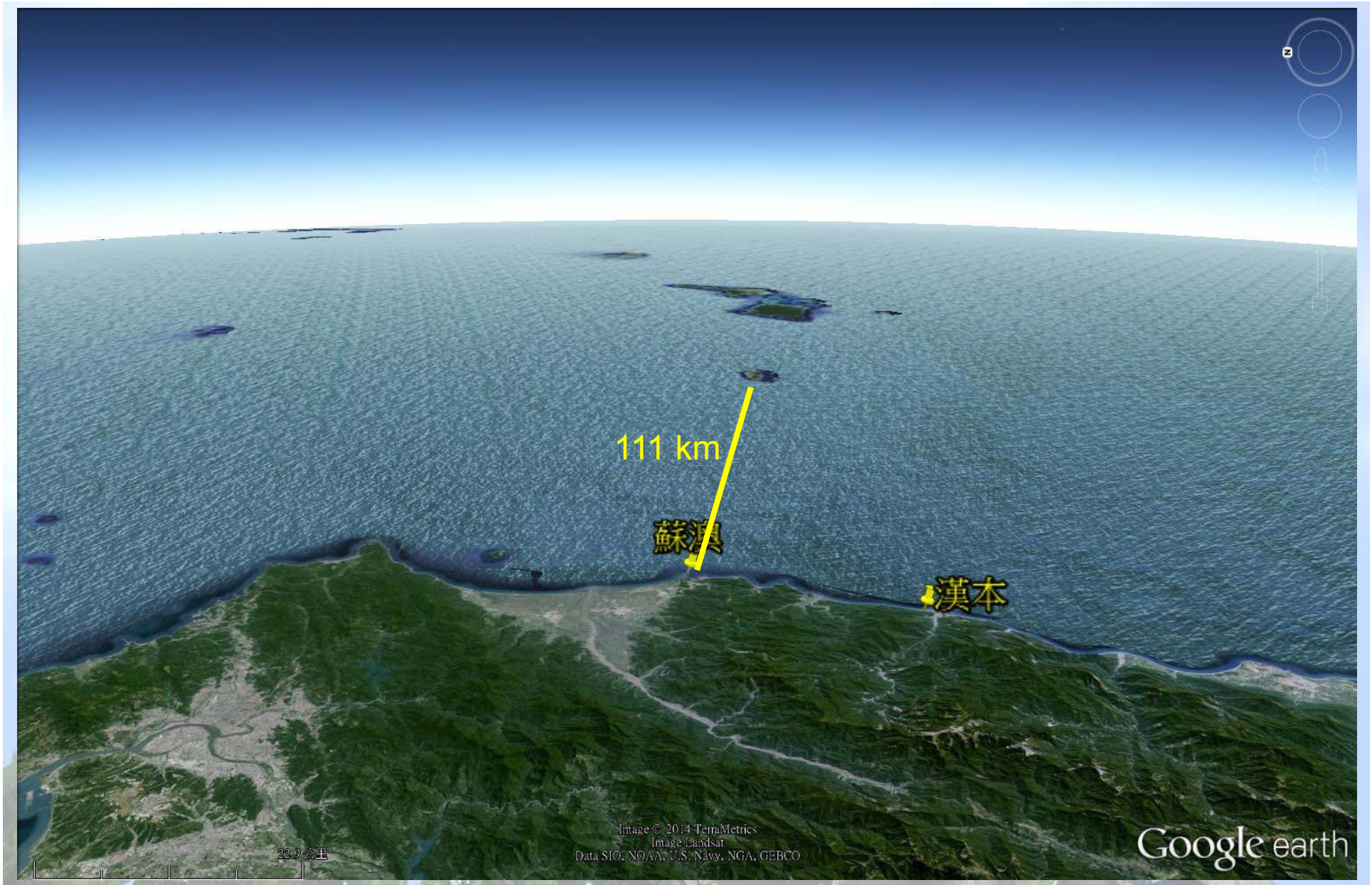
SUAO



~110 km

Habn

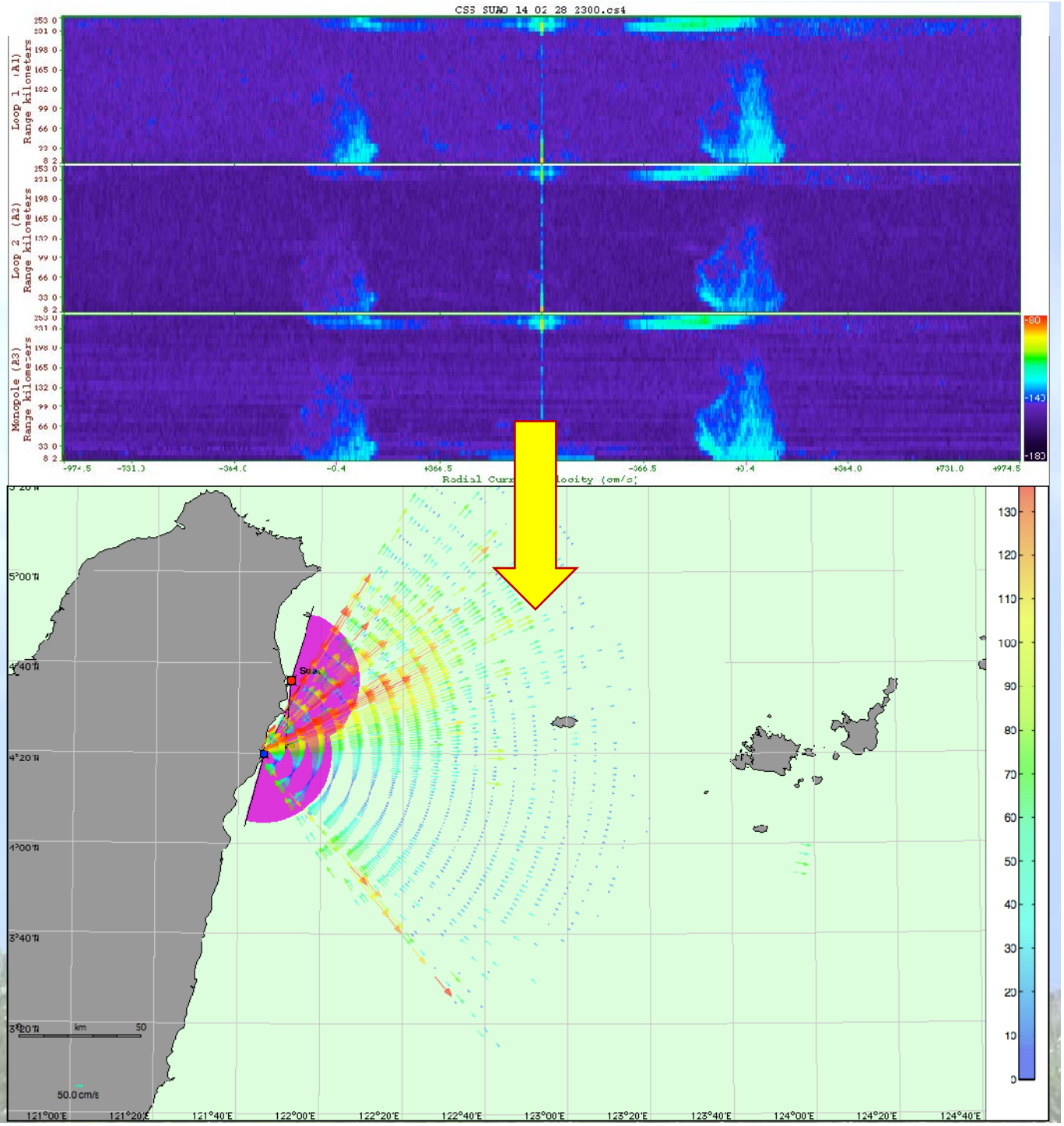




“非” 島嶼活動 (2014 ORCA，Barrick個人訪談)

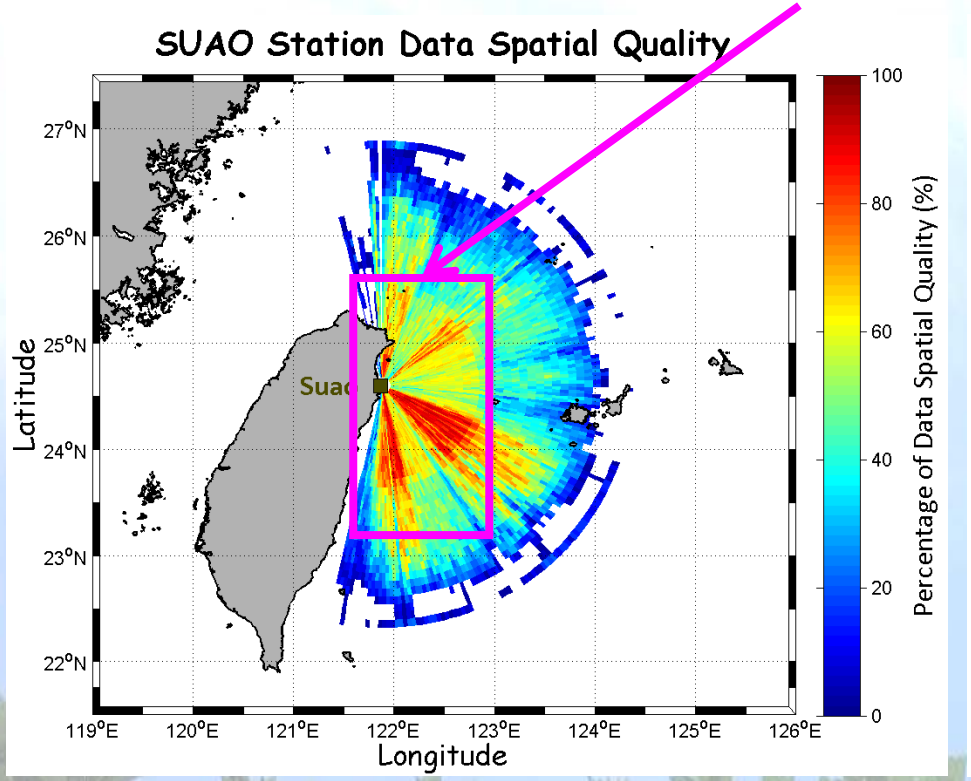
CSS

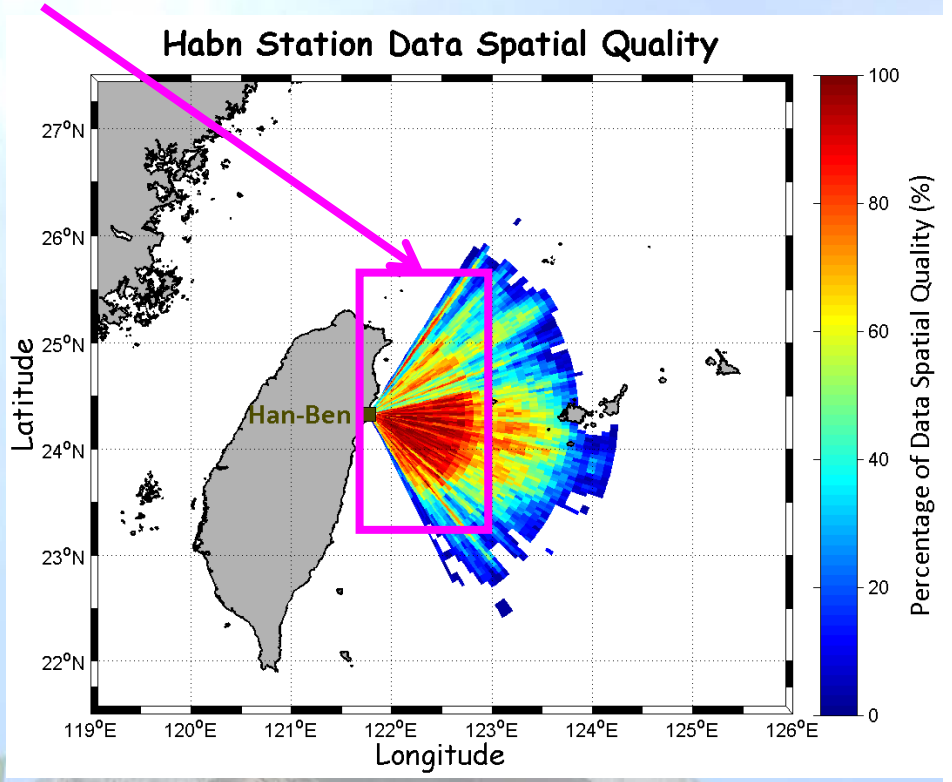
RUV


CSS SUAO 14 02 28 2300.cs4
Loop 1 (A1) Range kilometers
Loop 2 (A2) Range kilometers
Monopole (A3) Range kilometers
Radial Current Velocity (cm/s)
5°00'N
4°40'N
4°20'N
4°00'N
3°40'N
3°20'N
km
50
50.0 cm/s
121°00'E
121°20'E
121°40'E
122°00'E
122°20'E
122°40'E
123°00'E
123°20'E
123°40'E
124°00'E
124°20'E
124°40'E

Data quality analysis – Radial direction

~110 km

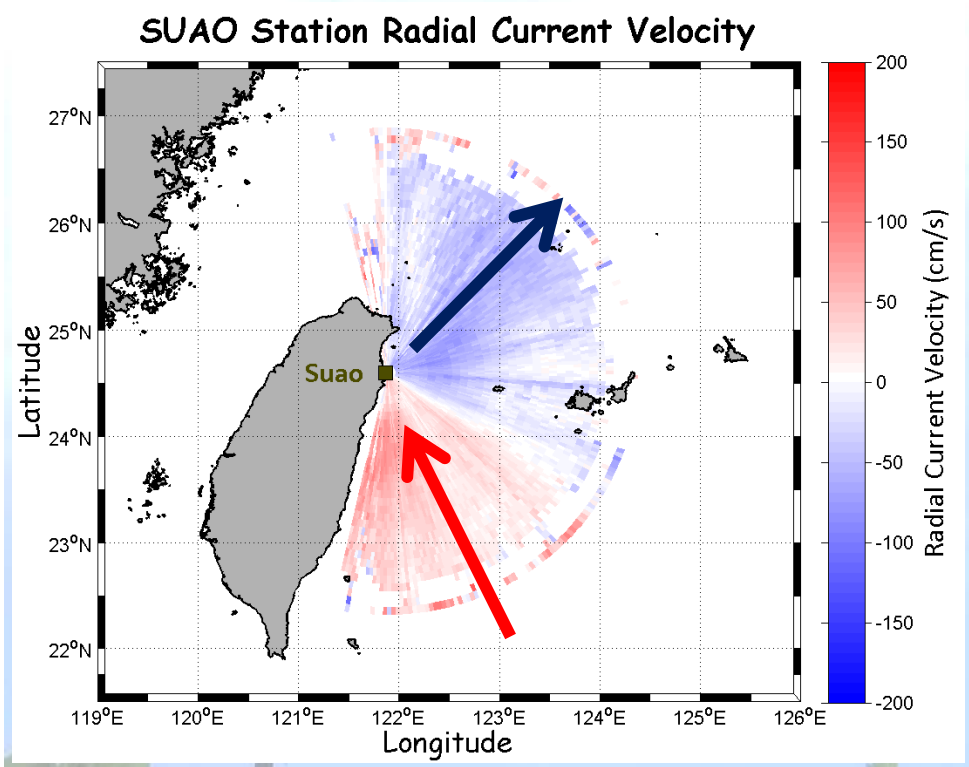


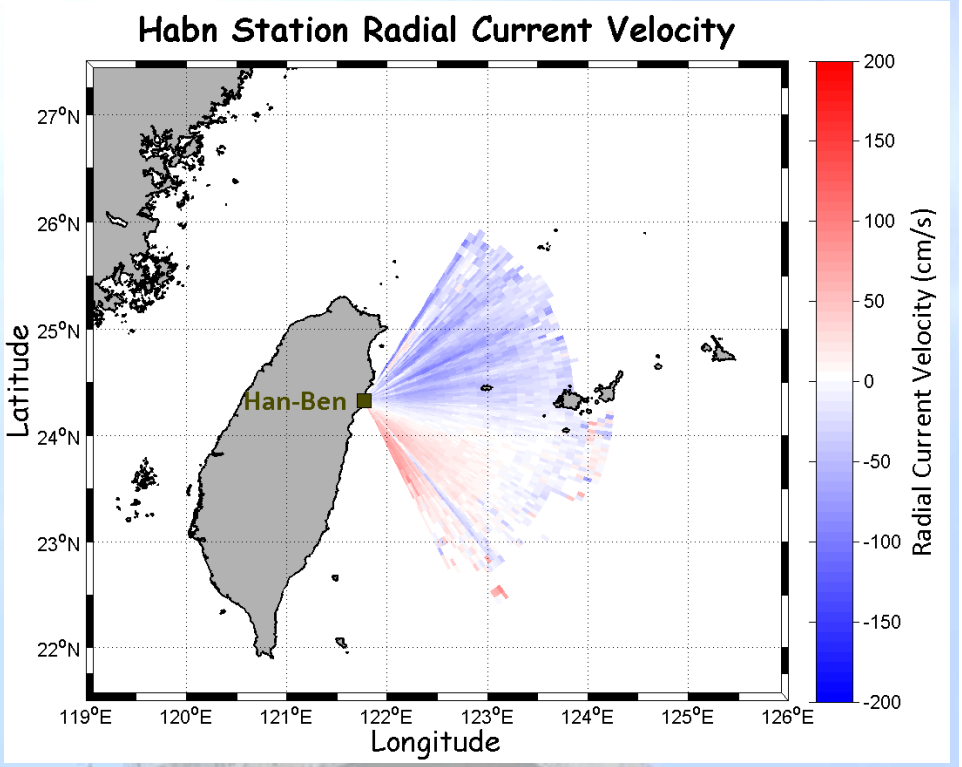


SUAO

Habn

Data analysis – Radial velocity

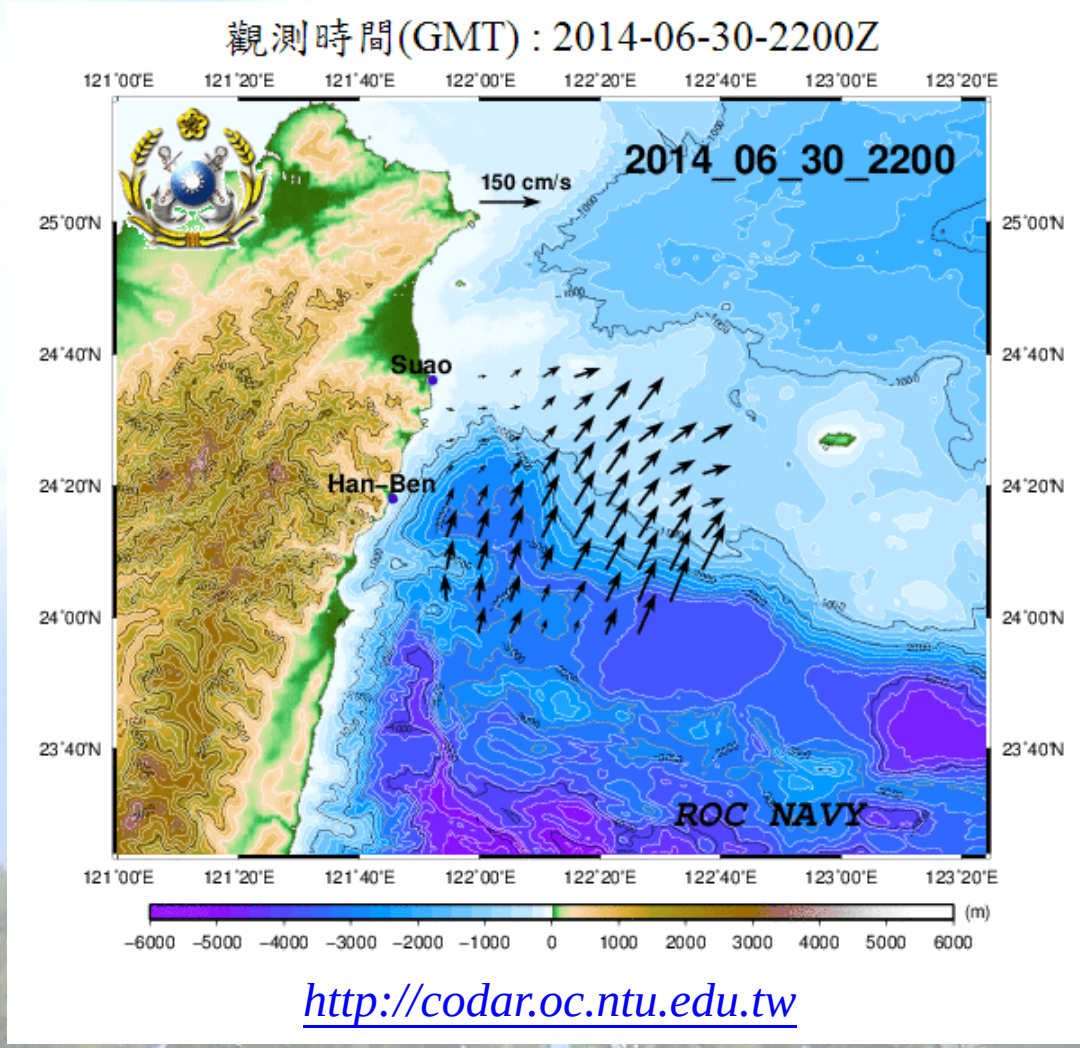


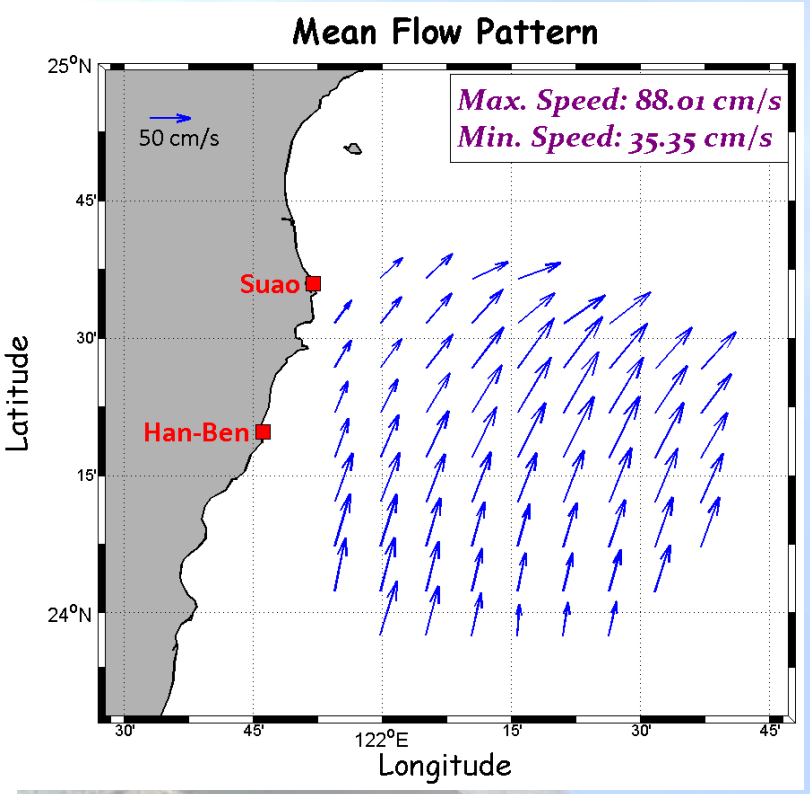


SUAO

Habn

TUV Data





http://codar.oc.ntu.edu.tw

2011/4 – present

http://codar.oc.ntu.edu.tw/

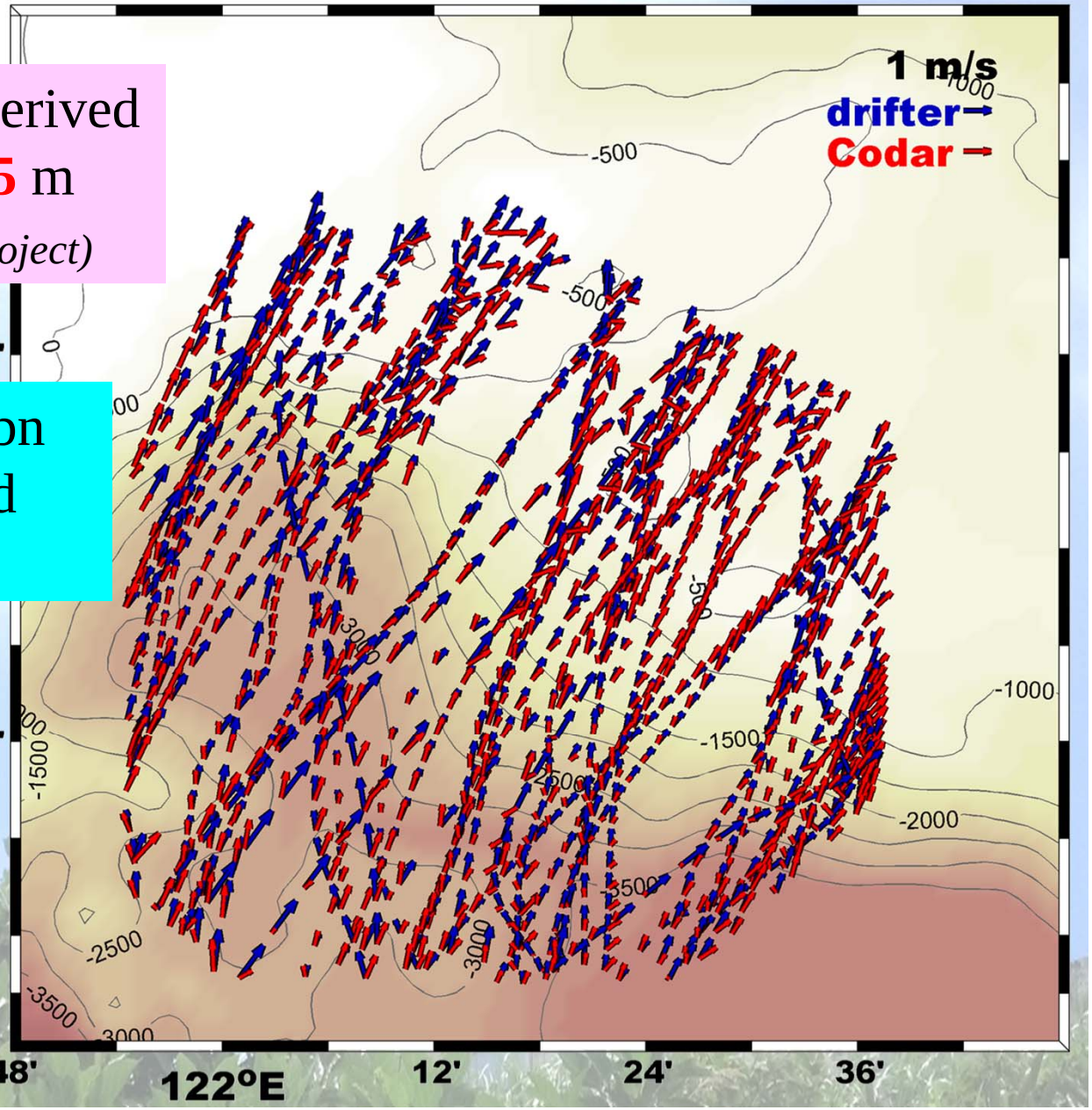
CODAR vs. SVP drifter

***64** sets of*

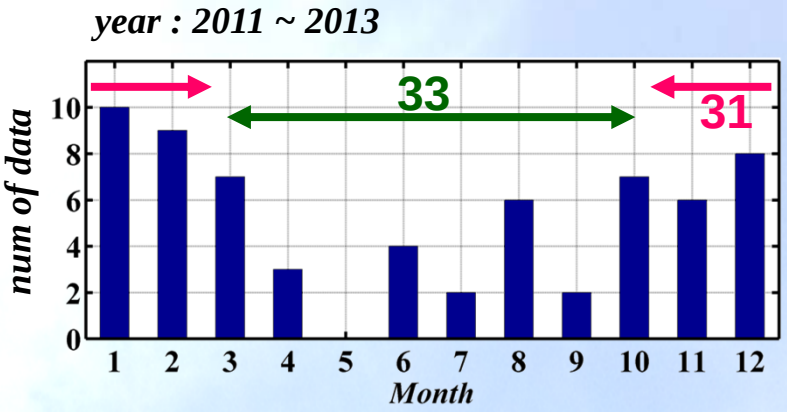
SVP drifter trajectory derived current velocity at **15** m (*GDP Program, Coriolis Project)*

VS.

Real-time Suao & Habn CODAR measured ***surface*** currents

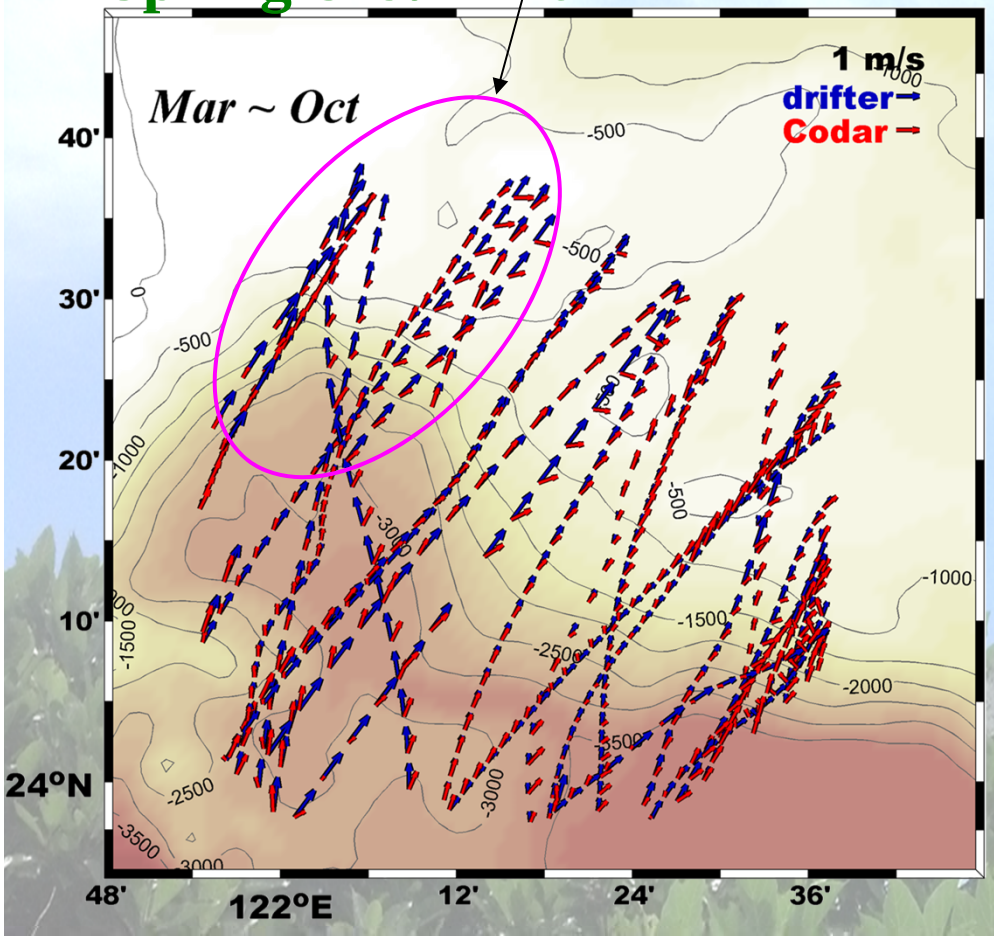


Seasonal discrepancy

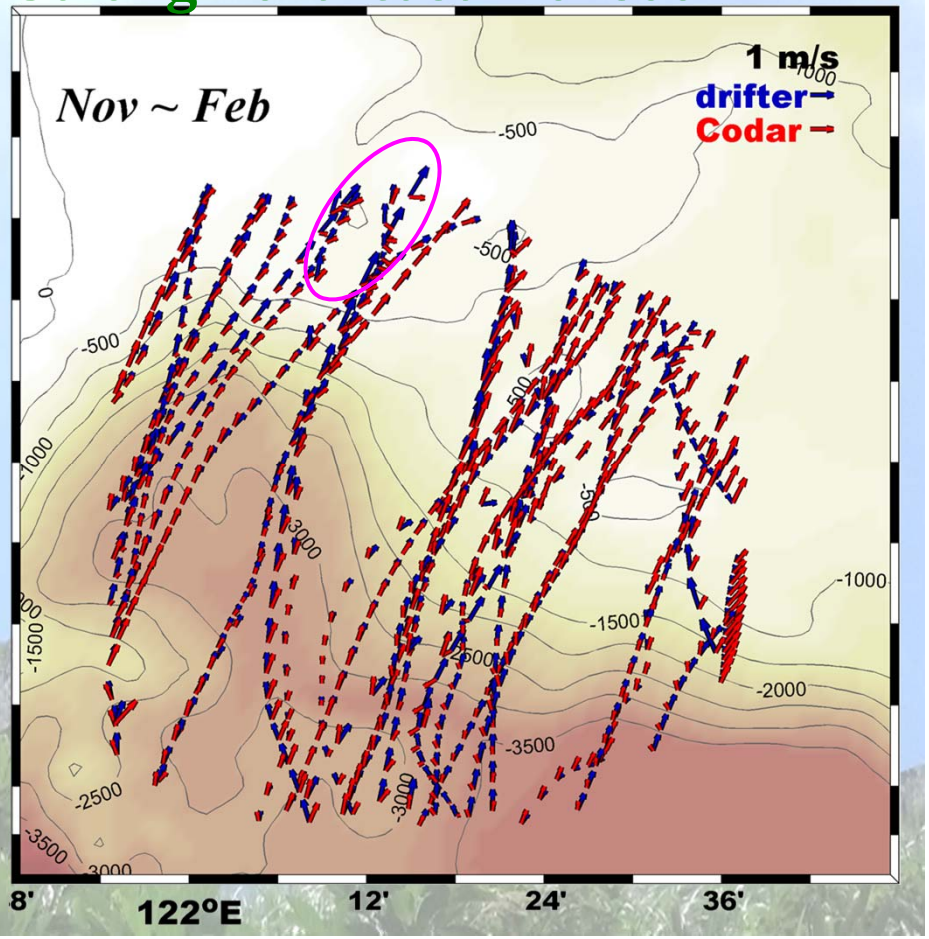


NOT Ekman spiral.

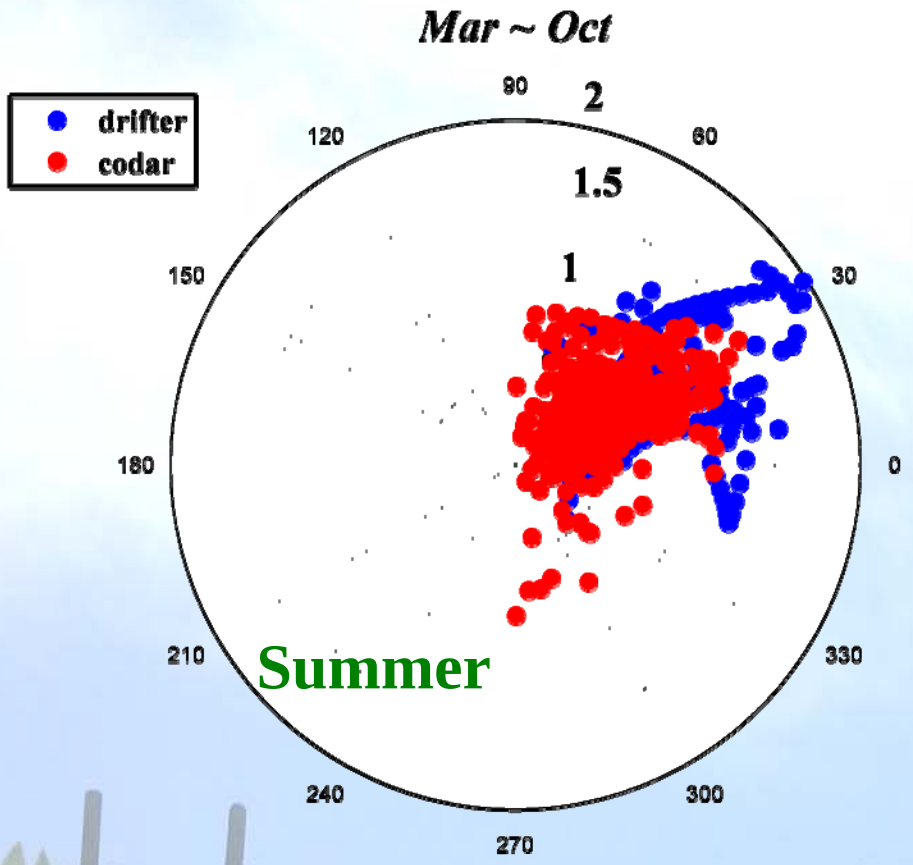
Spring & summer

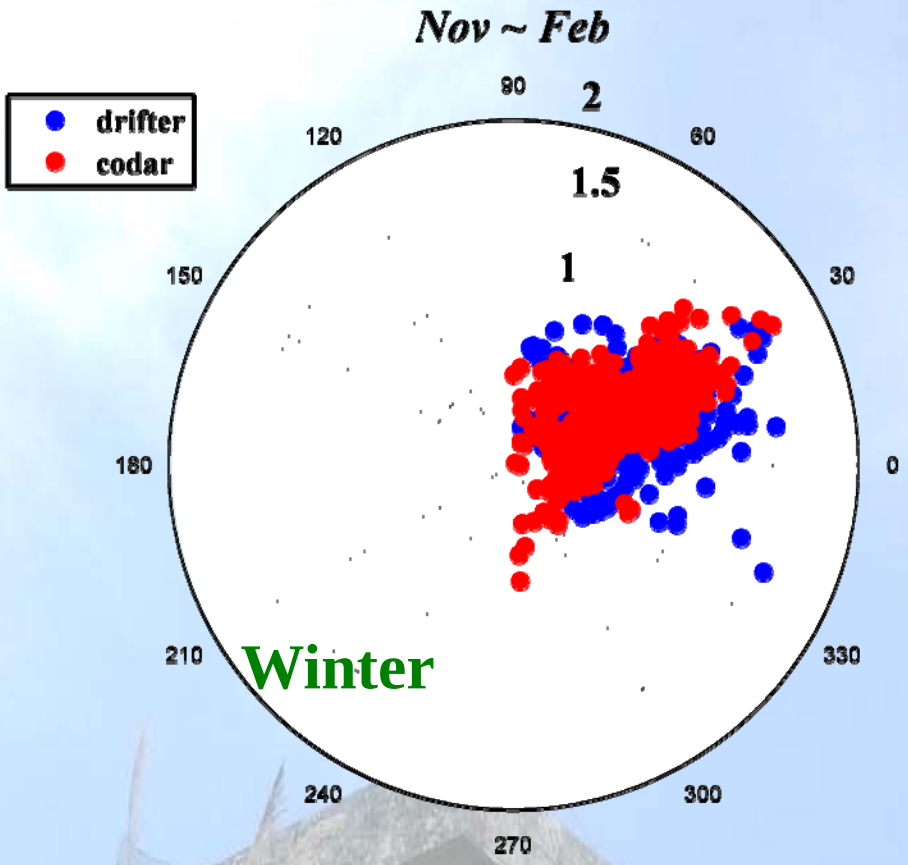


Strong northeast monsoon



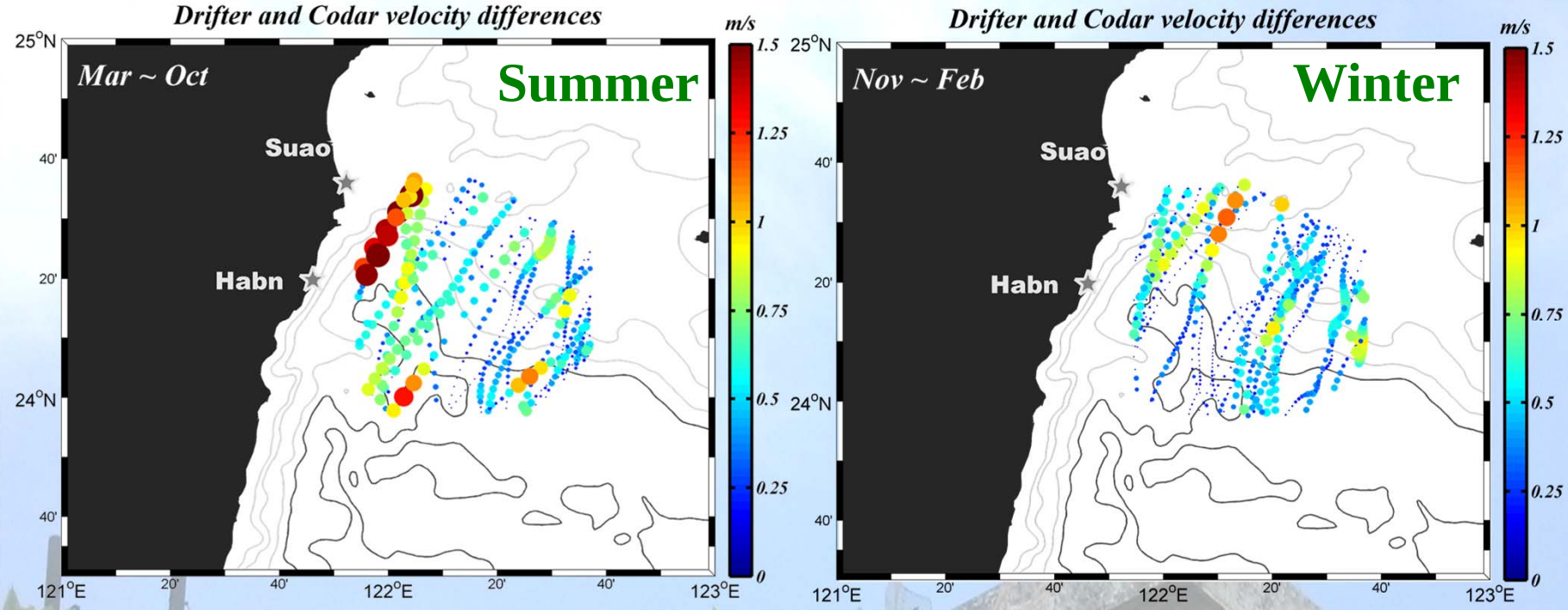
Speed & Direction





Spatial distribution

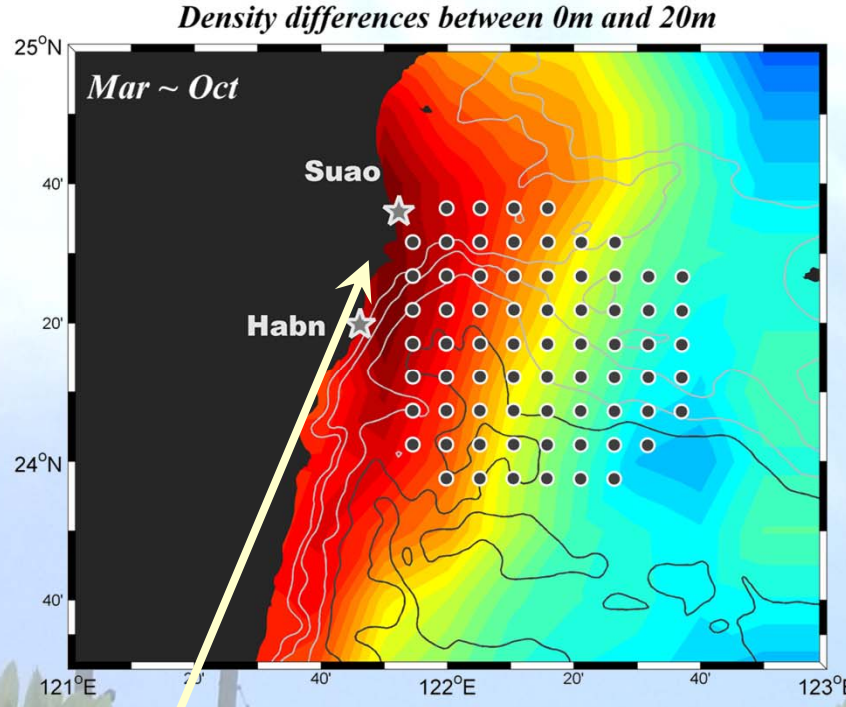
$$\left| Velocity_{CODAR} - Velocity_{drifter} \right|$$



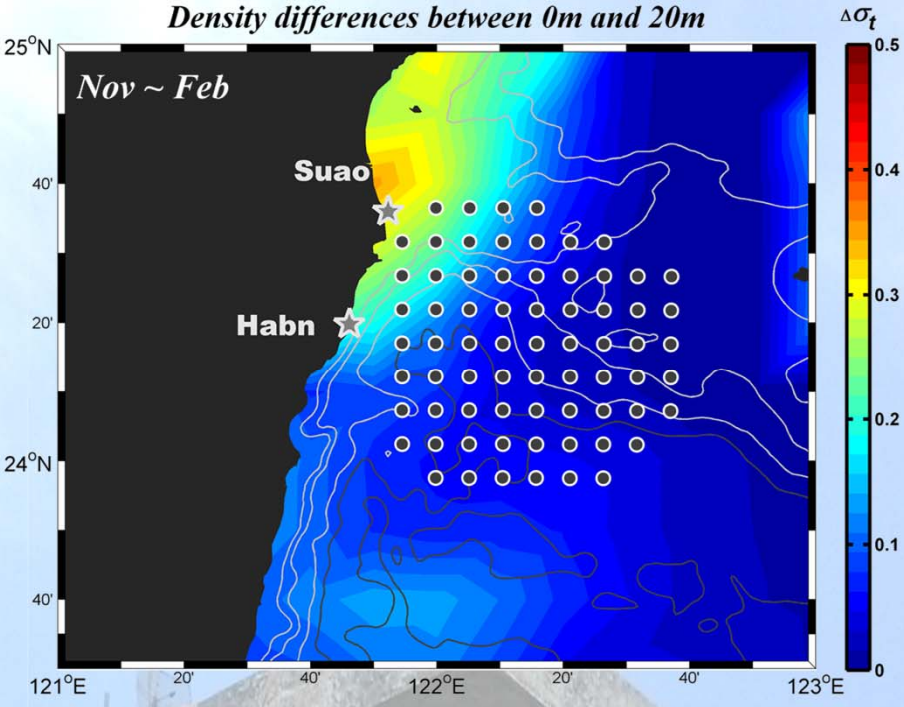
Density difference between *Surface & 20 m*

$$\frac{\partial \rho}{\partial z}$$

Summer



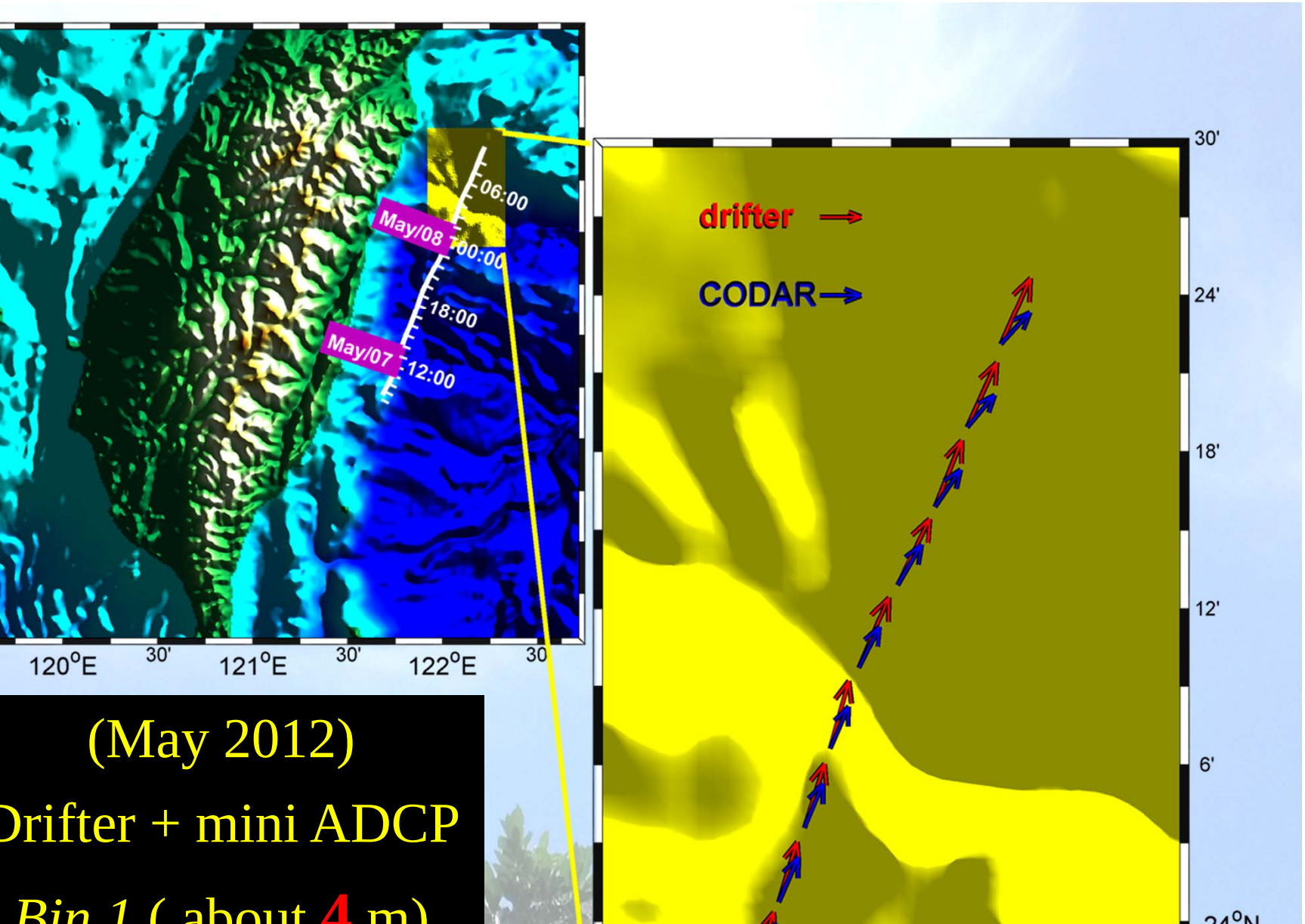
Winter



$\frac{\partial \rho}{\partial z}$ **> 0.65 kg/m^3**

Buoyancy frequency (N) **> 0.018 s^{-1}**

25-year-long averaged CTD data : NSC Ocean Data Bank



(May 2012)

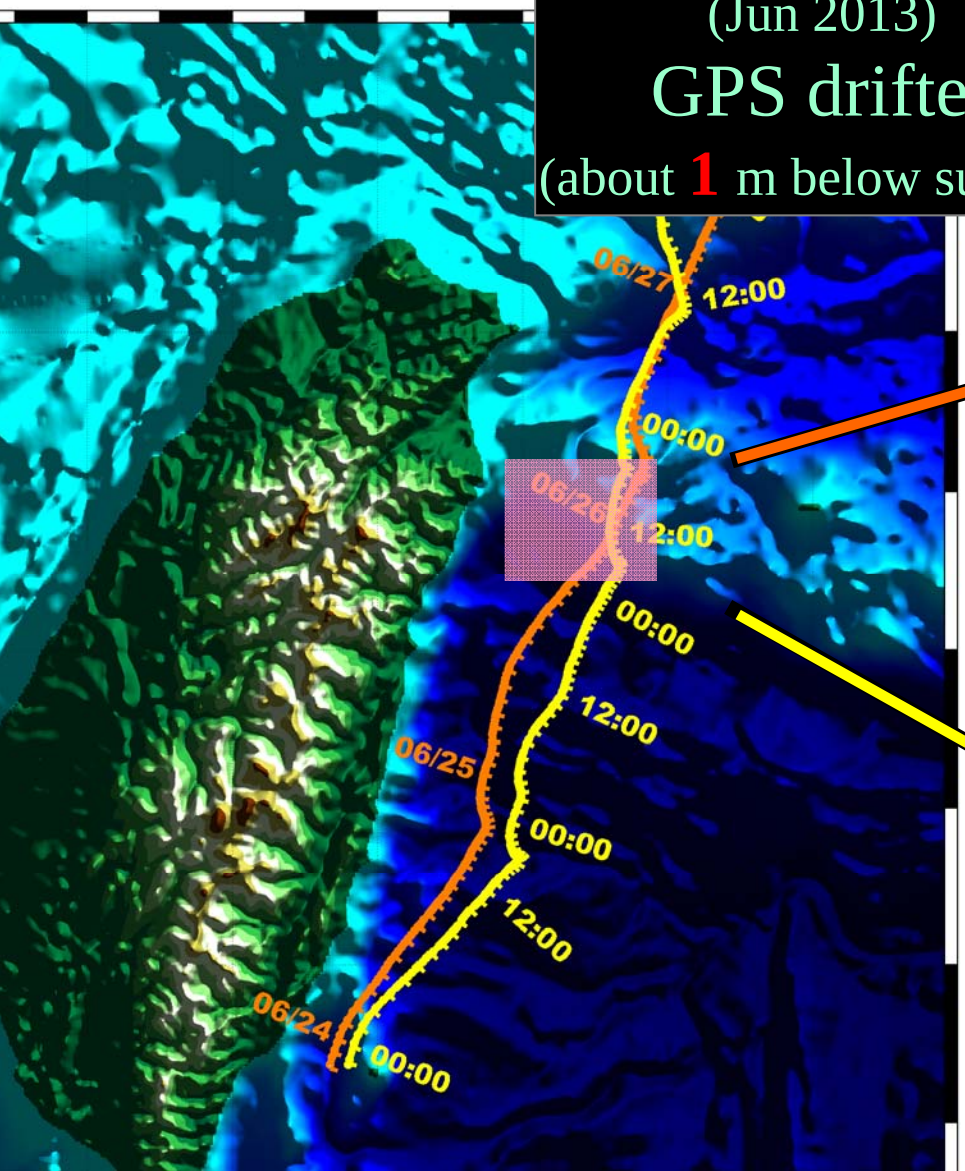
Drifter + mini ADCP

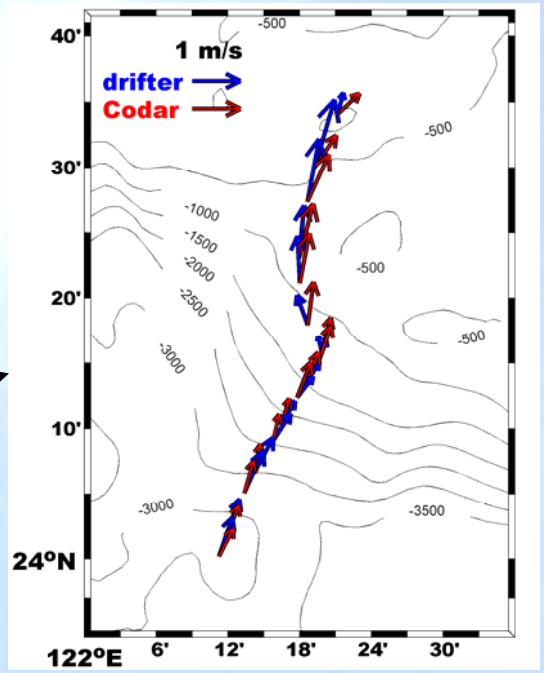
Bin 1 (about 4 m)

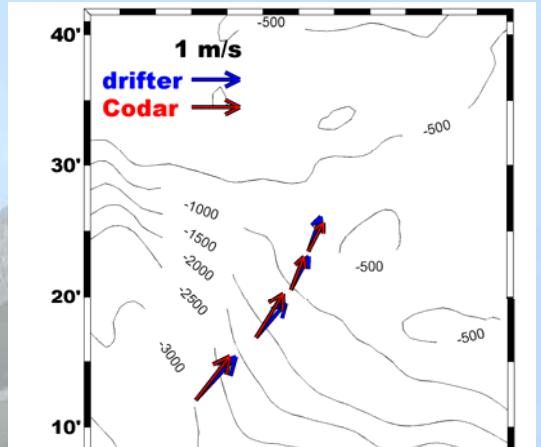
(Jun 2013)

GPS drifter

(about 1 m below surface)







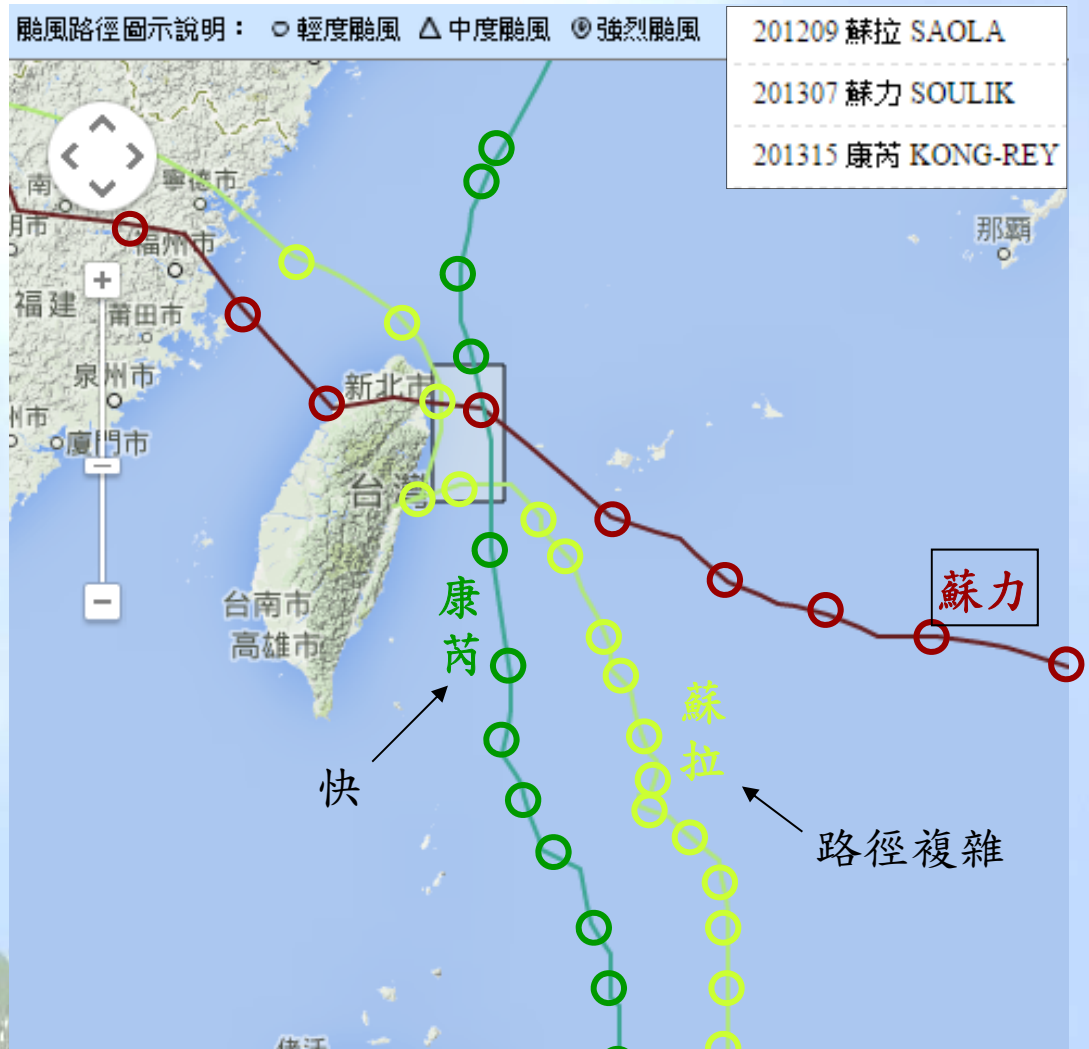
1/03 ~ 2014/09 中心通過CODAR觀測海域颱風統計

過CODAR觀測海域時間：

08/01 12:00 ~ 08/02 06:00

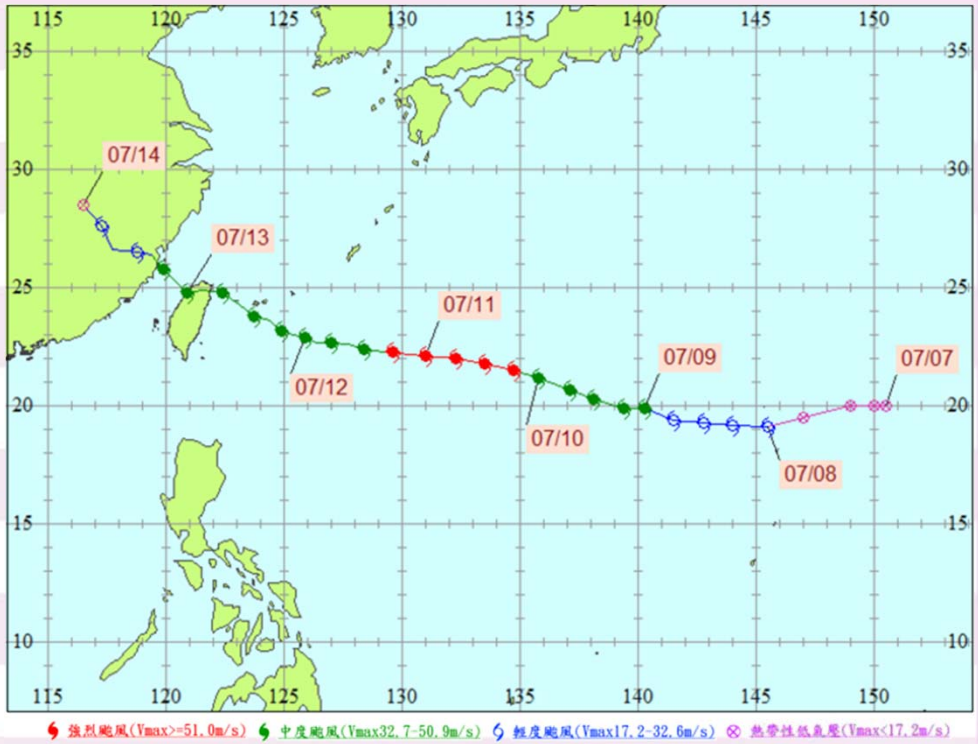
07/12 12:00 ~ 07/12 21:00

08/28 18:00 ~ 08/28 21:00



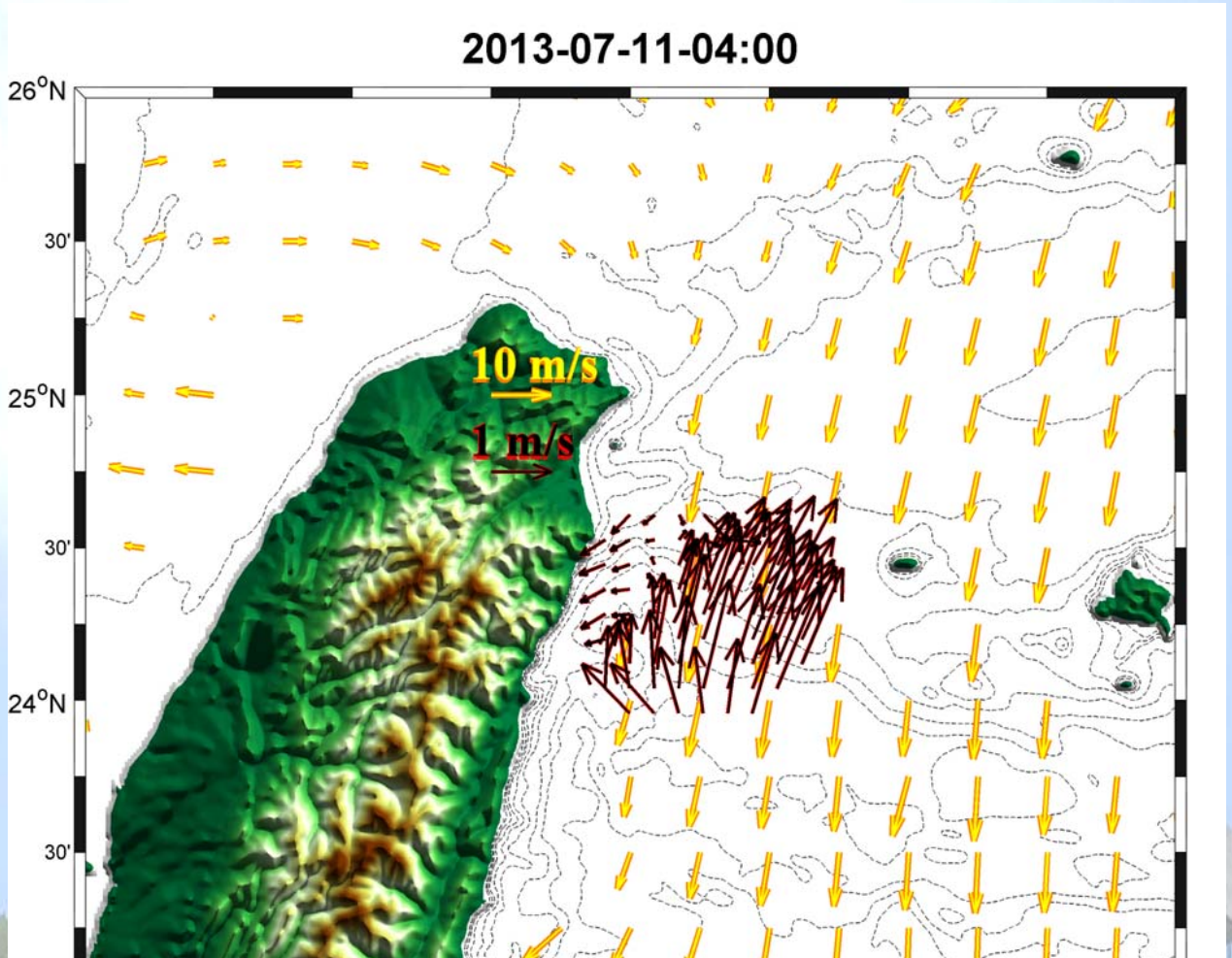
中央氣象局颱風警報發布概況表

	蘇力 (SOULIK)
	201307
點	關島北方海面
臺日期	2013年 07月 13日
間	海上 2013-07-11 08:30 陸上 2013-07-11 20:30
間	陸上 2013-07-13 23:30 海上 2013-07-13 23:30
數	22
度	強烈
最大風速	51 (公尺/秒)
徑分類	2
段	新北市與宜蘭縣交界處
	生成後向西北西方向移動，11日20時由強烈颱風減弱為中度颱風，接近臺灣東北部海面時略為向西北移動，13日3時於新北市與宜蘭縣交界處登陸，8時左右於新竹附近出海，16時前後由福建進入大陸。
	受颱風影響，全臺出現強風豪雨，造成多處地區淹水、道路坍方交通中斷。計有3人死亡，農損約新臺幣14.8億元。
害專區網頁連結	災害連結

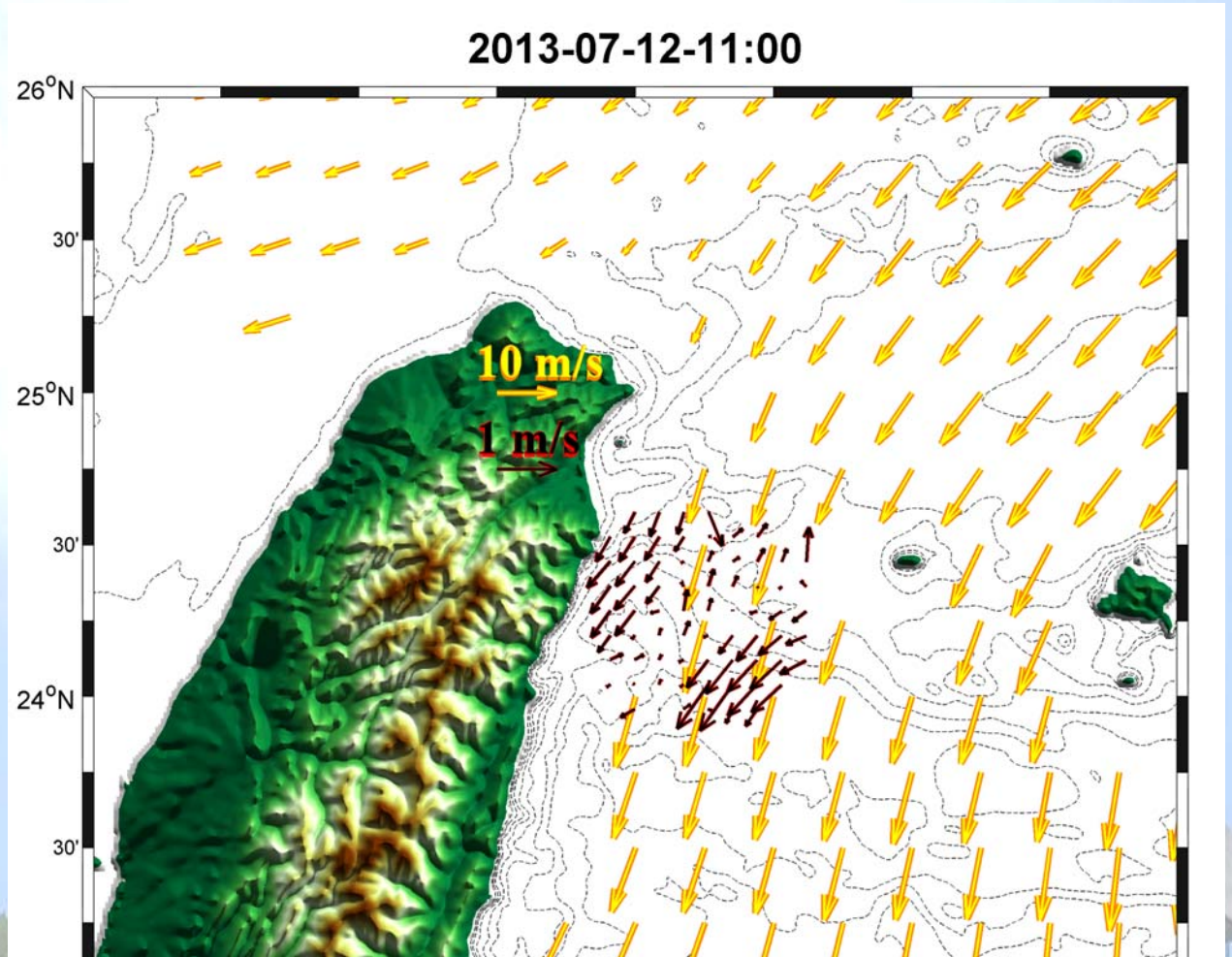


資料範圍取自警報發布至警報解除。

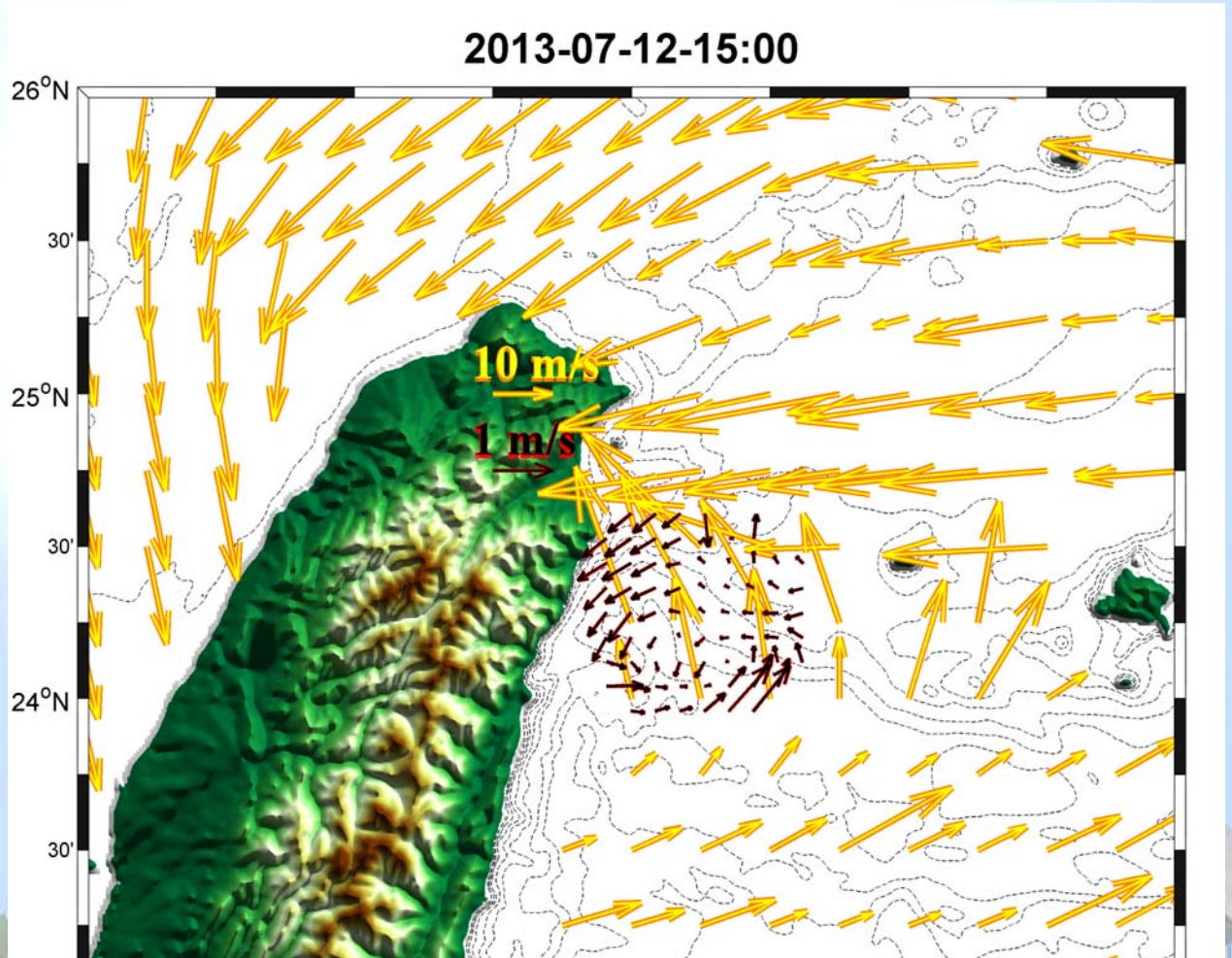
尚未接近(觀測海域東方900 km)



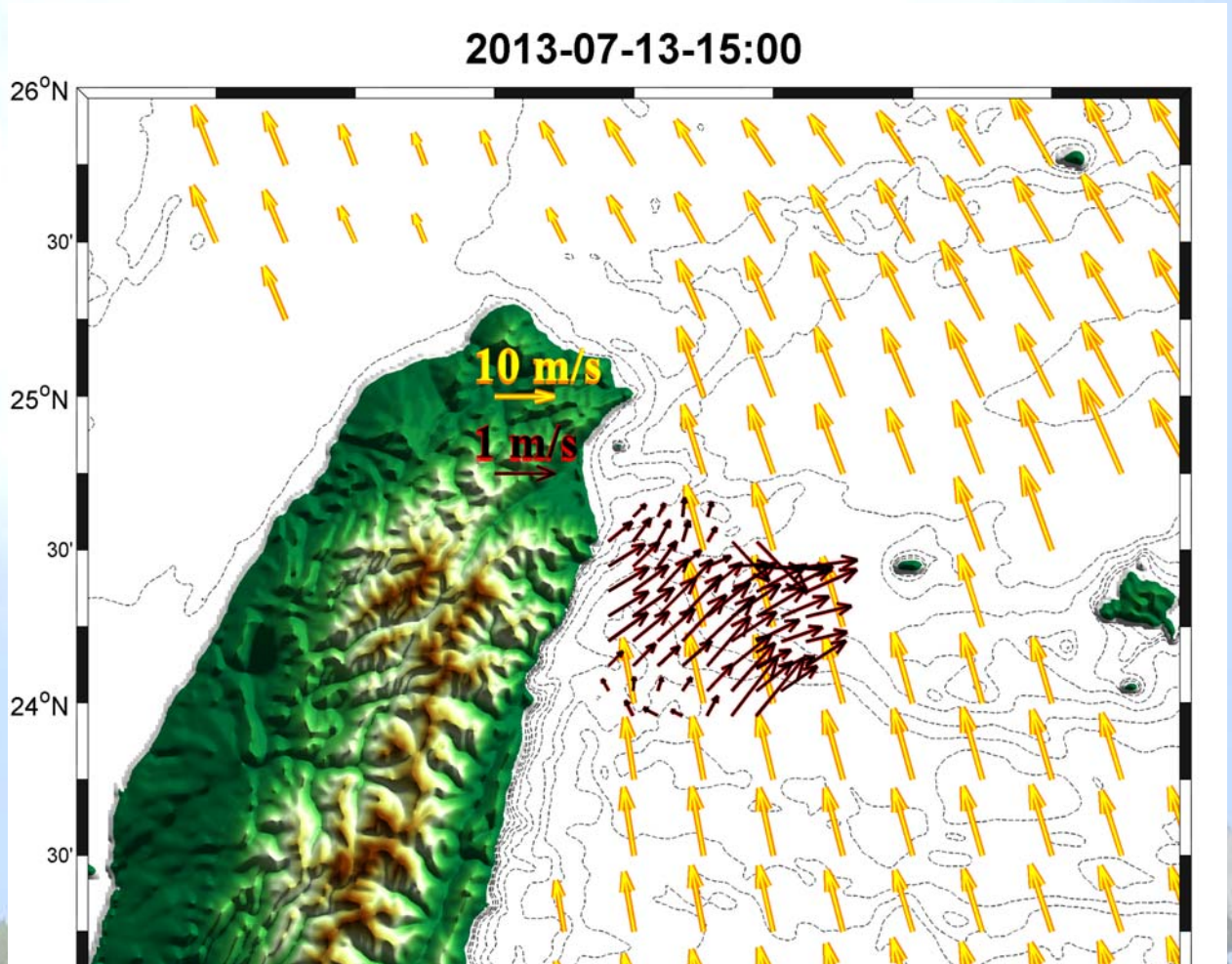
中心接近觀測海域、移動速度減慢、吹風時間長
海流呈西南向、最大流速達 -1 m/s



登陸，最大風速達48 m/s、加速轉向西北移動
海流呈逆時針渦旋狀

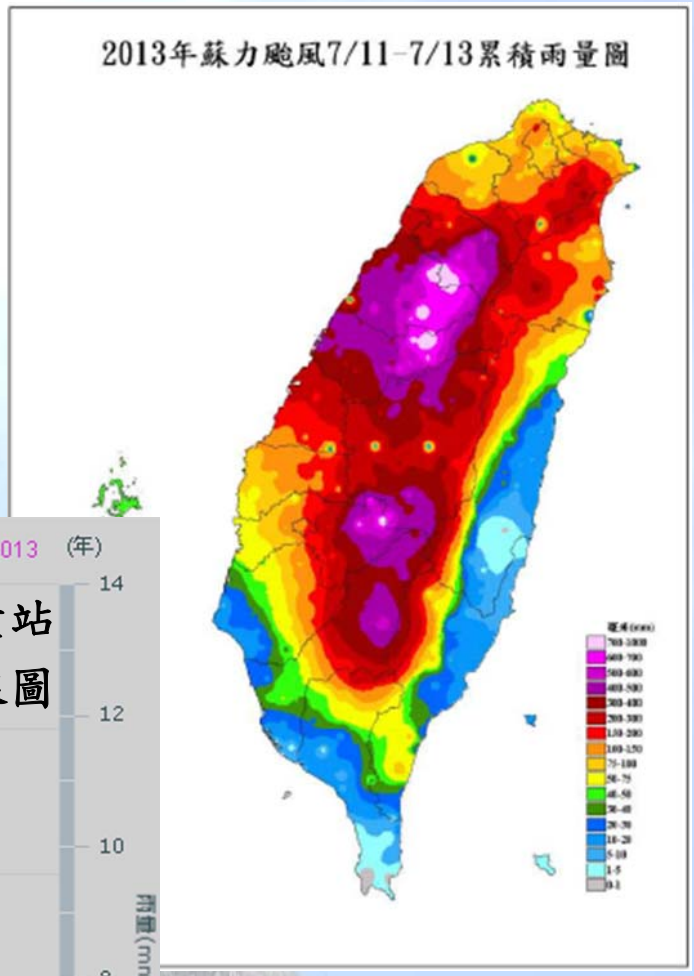


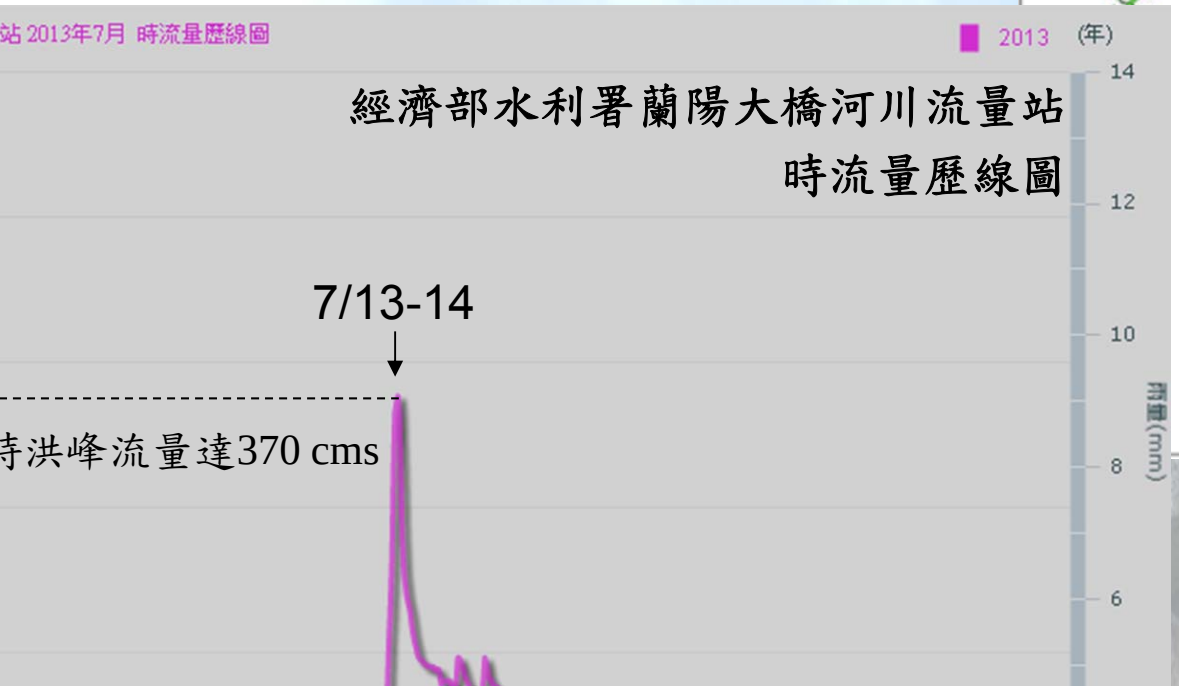
逐漸遠離、表面海流尚未調回北向流的平均狀態，
出現較強的東西向流速由陸地離岸向海



推測可能原因之一或許與蘇
風帶來的強降雨有關 ⟶

低鹽分淡水沖入海中，因密
而浮在表面 ↴





結

由於颱風期間無法從事海上觀測作業，藉由遙測海流資料，可以有效觀察上層海洋對於風場變化之反應。未來期可收集更多不同種類的遙測與浮標資料，比較其中差異與相關性，彌補單一觀測之不足，以進一步更深入的討論相關動力。


Thank you