從高頻雷達陣列天線訊號解算流場之研究

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守護海上交通安全

交通部中央氣象局新聞稿

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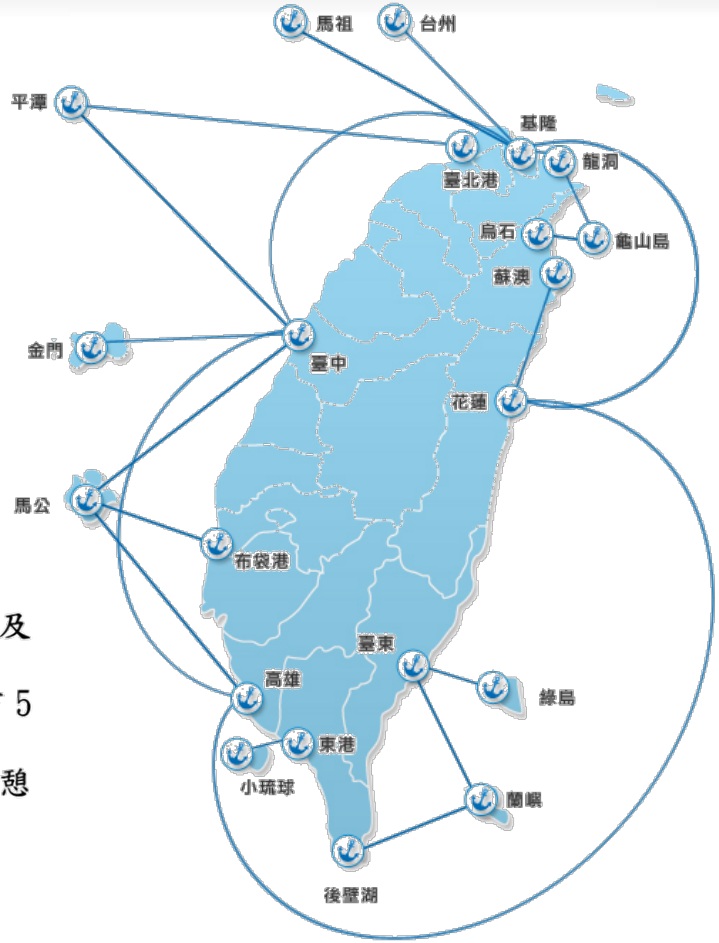
藍色公路海況預報

中央氣象局表示，為增進本島離島間海上航線航行的安全以及提升海上活動海氣象資訊服務的品質，該局由100年2月1日起發布5條藍公路未來24小時之海況預報資料，供航行船隻及民眾於海上遊憩參考。



圖片來源：中央氣象局網頁

觀測與預測技術之整合

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doi:10.5194/nhess-14-73-2014

Natural Hazards and Earth System Sciences
Open Access

Assimilation of decomposed in situ directional wave spectra into a numerical wave model of typhoon waves

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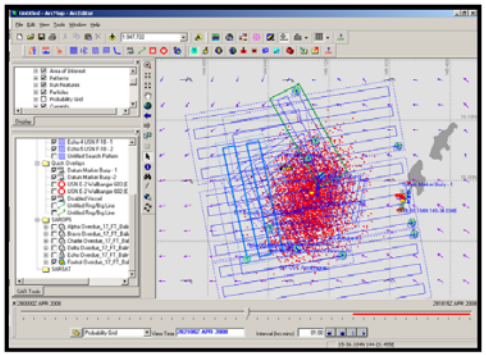
Search and Rescue Optimal Planning System (SAROPS)



SAROPS is the software used by the U.S. Coast Guard for Maritime Search Planning. SAROPS is a Monte Carlo based system that uses thousands of simulated particles generated by user inputs in a wizard based Graphical User Interface. SAROPS has the ability to handle multiple scenarios and search object types; model pre-distress motion and hazards; and account for the affects of previous searches.

SAROPS is written as a series of extensions to ESRI's ArcGIS 9.2 (COTS, not part of the SAROPS distribution). SAROPS makes requests to and receives from an Environmental Data Sever (EDS) real-time gridded environmental products. SAROPS also allows manual inputs of winds and currents input via a 'sketch' tool using objective analysis techniques. SAROPS uses the latest drift algorithms to project the drift of the survivors and craft.

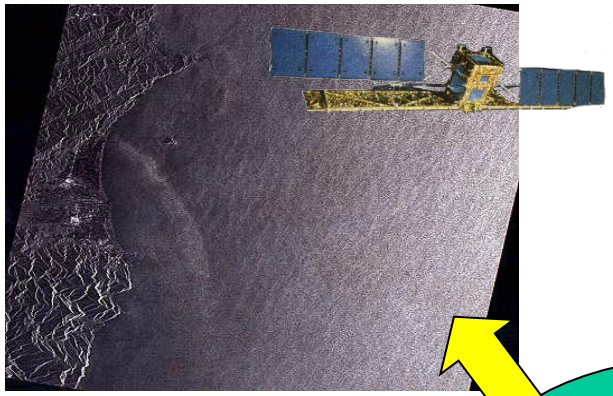
Search Rescue Unit (SRU) allocation is automated in SAROPS by maximizing Probability of Success (POS). Each SRU gets a recommended search pattern that accounts for the relative motion between the SRU and the drifting particles. This is done by using the Probability of Detection as function Lateral Range to update the probability of detection for each particle.

Search pattern summaries are available in several formats. Search effectiveness reports are also generated. There are capabilities for exporting and importing SAROPS case files

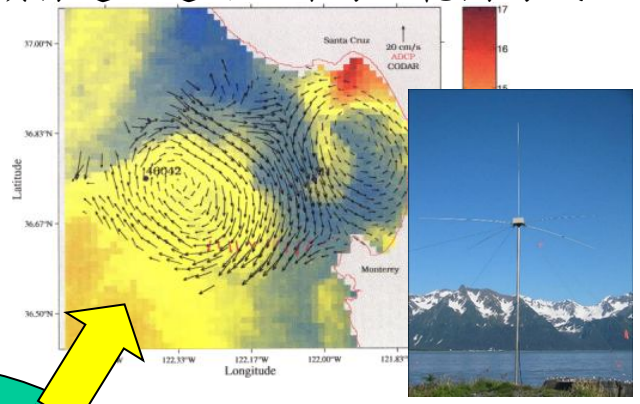
- 將觀測資料輸入至模式後，可有效改善預測結果。

非接觸式遙測技術發展現況

衛星：適用於外海極大範圍海域



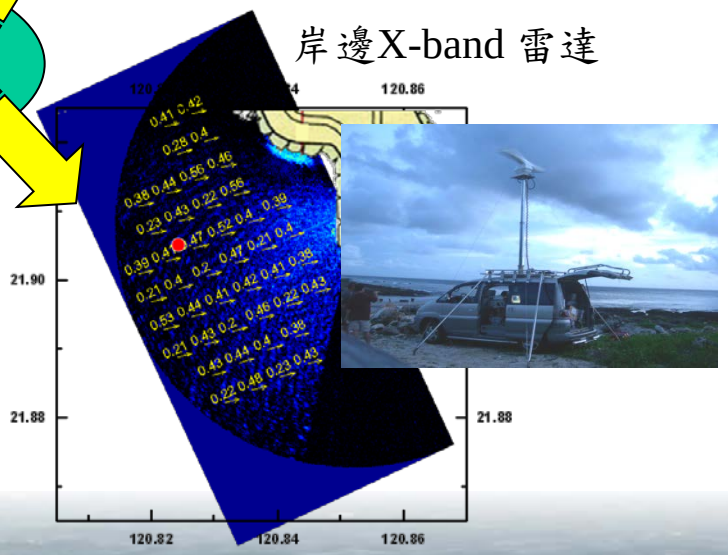
高頻雷達：適用於外海大範圍海域



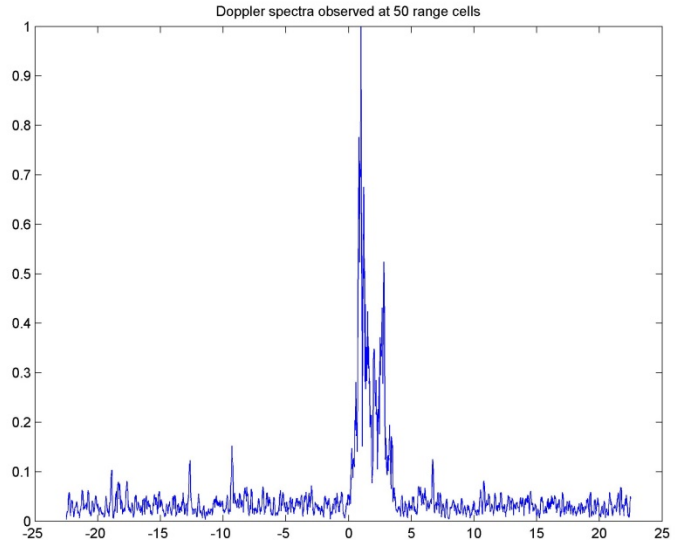
非接觸式遙測

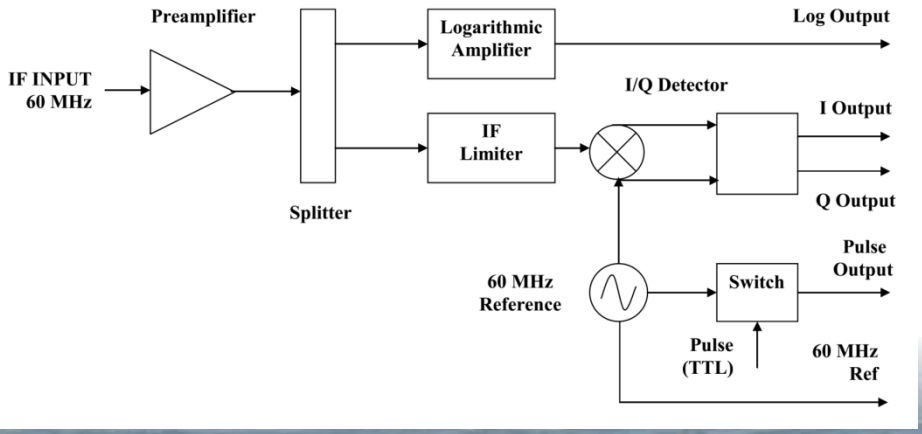
光學攝影機：適用於能見度佳之近岸環境

岸邊X-band 雷達

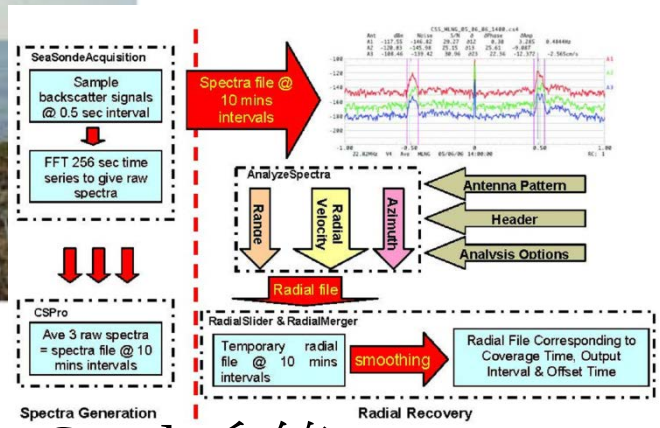


X-band同調雷達觀測技術

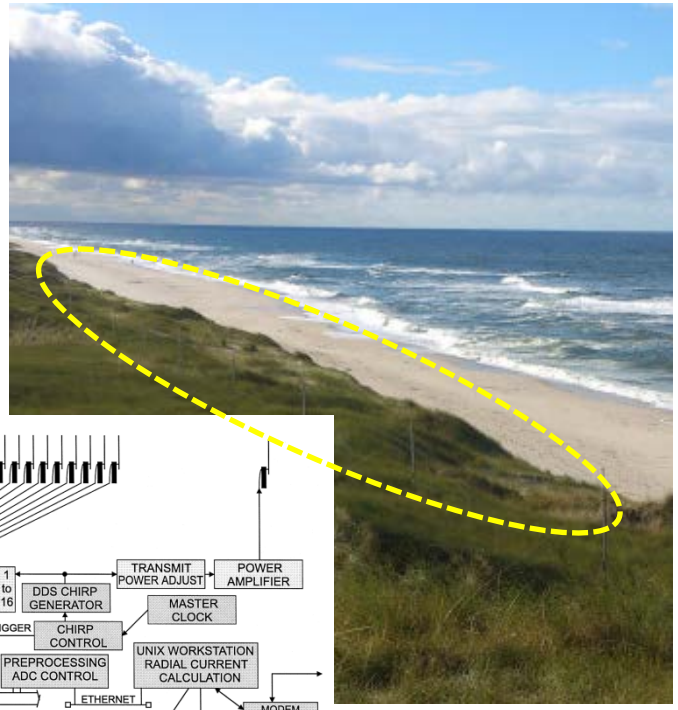




高頻雷達觀測技術現況



SeaSonde系統



WERA系統

Toh, K.W.D. (2005) " Evaluation of surface current mapping performance by SeaSonde high frequency radar through simulations "
Gurgel, K.W. (1999) "Wellen Radar (WERA): a new ground-wave HF radar for ocean remote sensing."

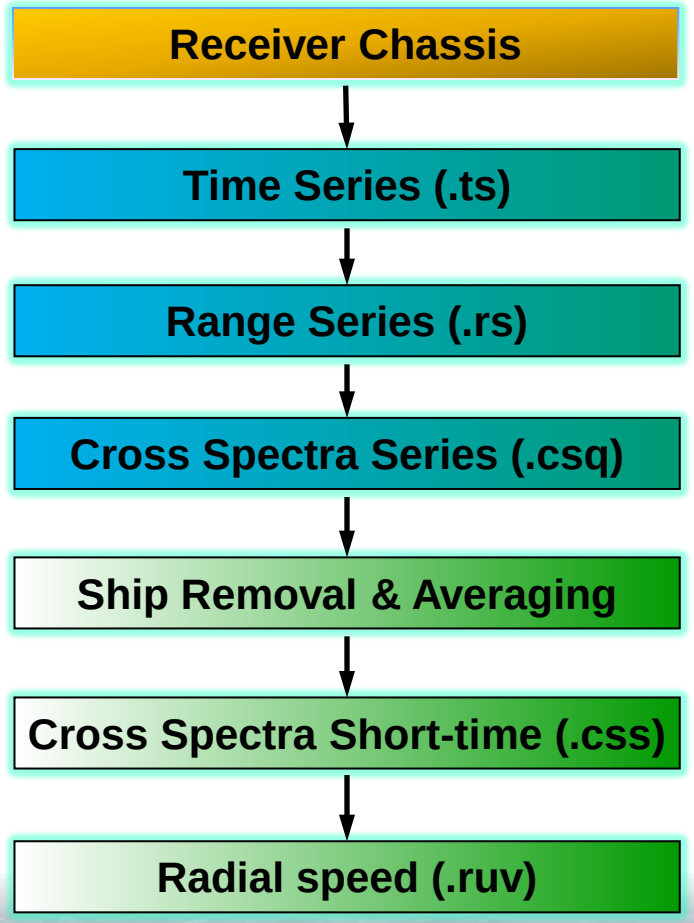
台灣海域高頻雷達觀測現況

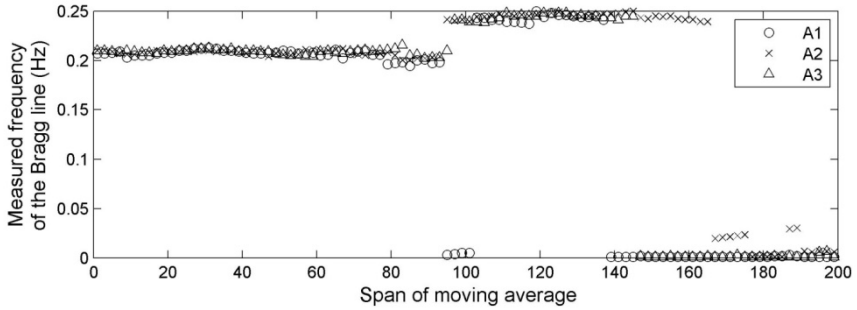
- 國家實驗研究院台灣海洋科技研究中心
- 海軍軍官學校與臺灣大學海洋研究所

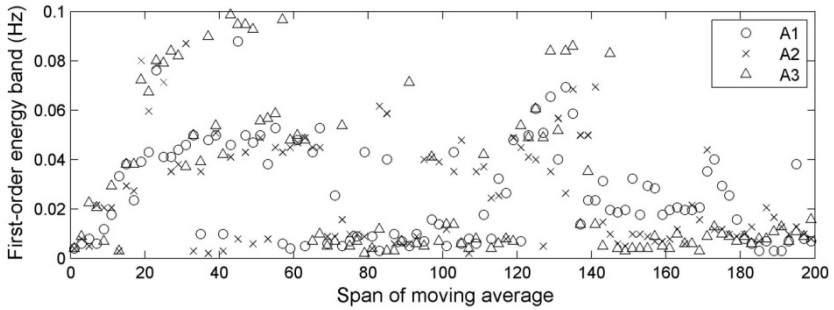
→ SeaSonde系統

- 交通部運輸研究所 → WERA系統

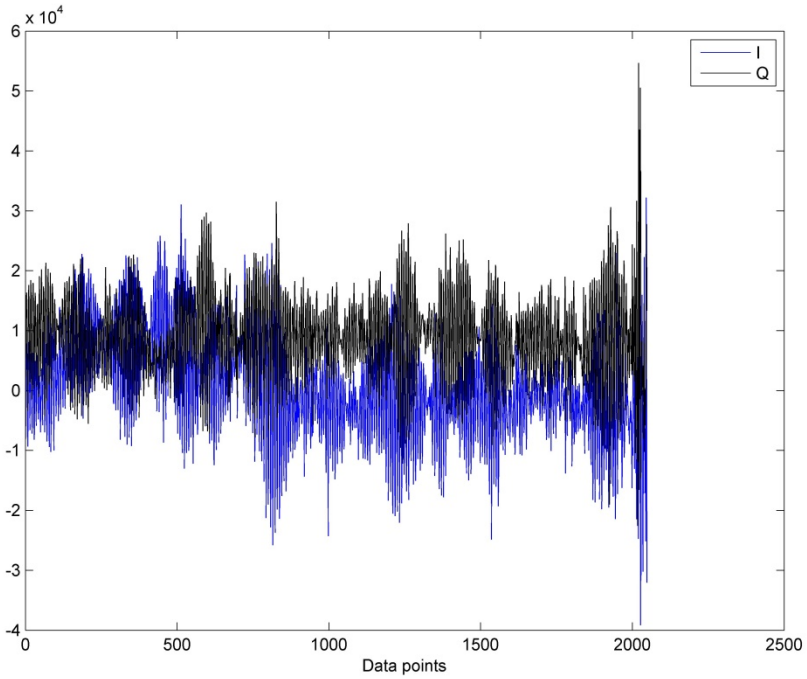
SeaSonde資料自主分析技術之研究



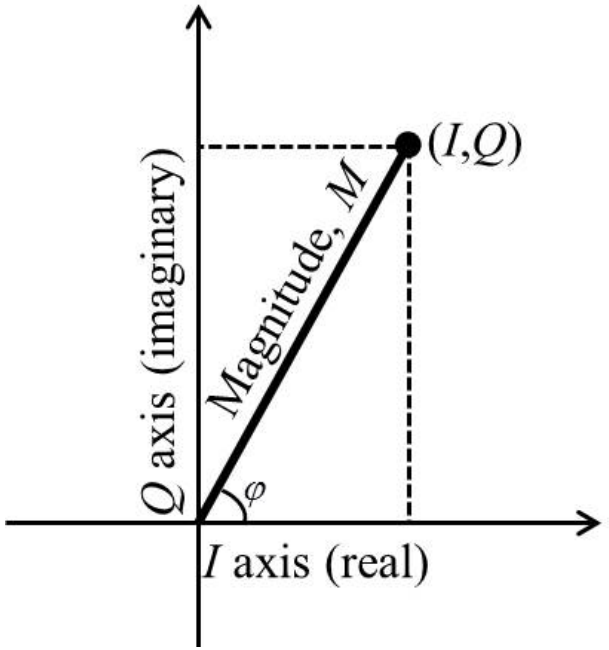




WERA雷達資料分析及探討

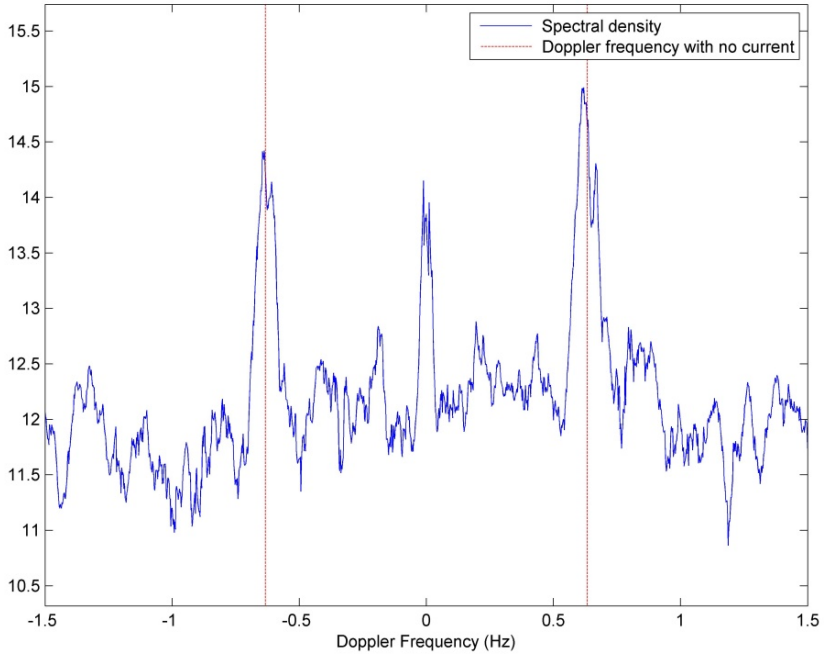


解算出WERA雷達回波原始資料時序列

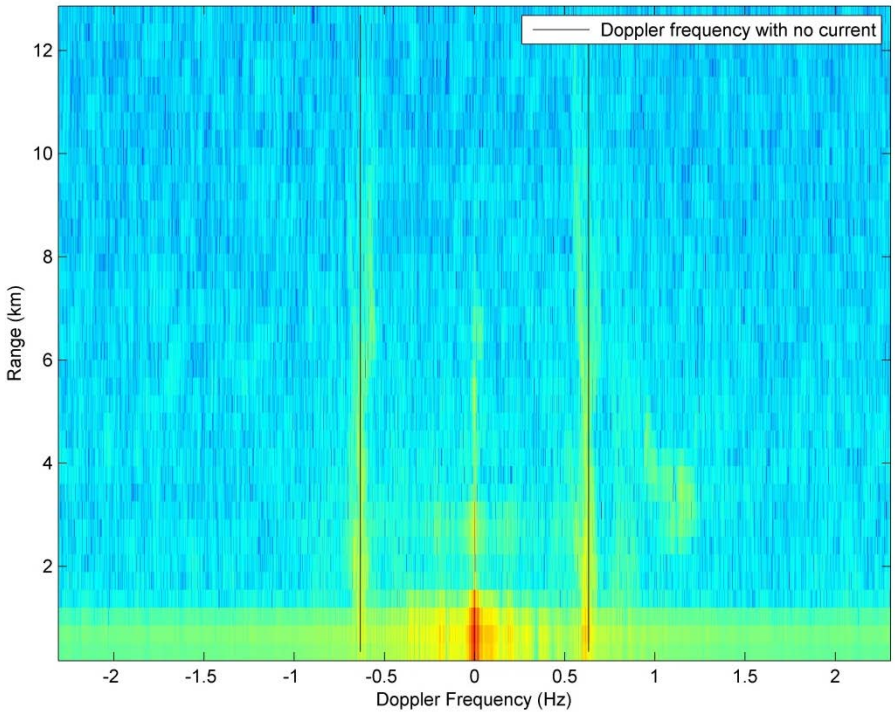


I/Q 時序列

WERA雷達資料分析及探討

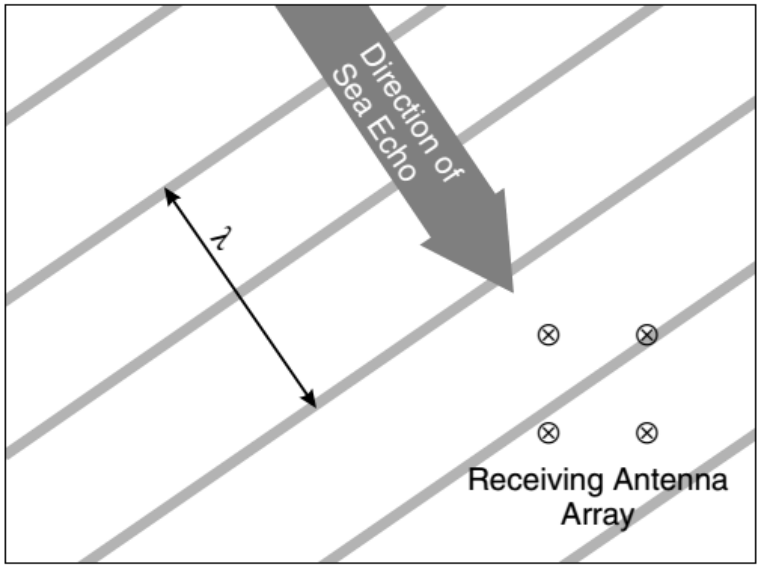


單一距離單元之雷達回波都卜勒能譜

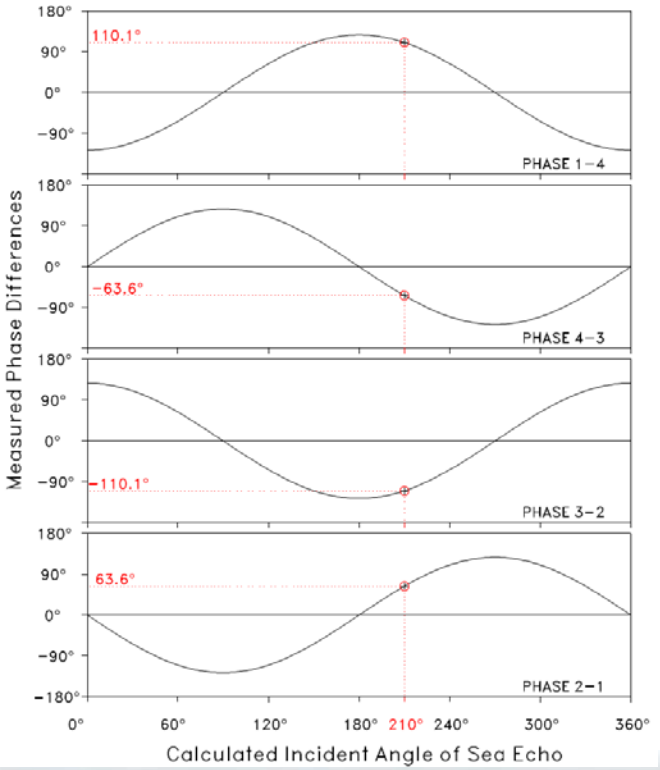


不同距離單元之雷達回波都卜勒能譜

陣列天線辨識訊號方位之基本原理



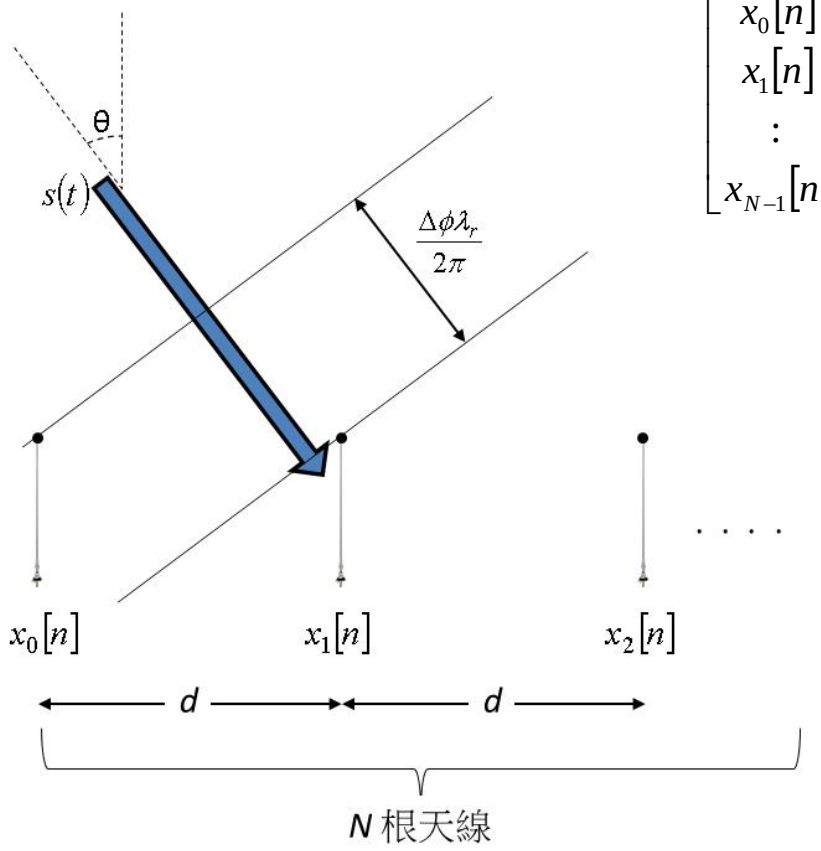
$$\theta = sin^{-1}(\frac{\Delta\phi \cdot \lambda}{2\pi d})$$



$$\varepsilon(\Theta) = \sum_{i=1}^{4}(\min(|\,\varphi_i^{\star} - \varphi_i(\Theta)\,|\,, 360 - |\,\varphi_i^{\star} - \varphi_i(\Theta)\,|))^2$$

$$\varepsilon(\Theta) \Longrightarrow Minimum$$

陣列天線辨識訊號方位之解算



$$\begin{bmatrix} x_0[n] \\ x_1[n] \\ \vdots \\ x_{N-1}[n] \end{bmatrix} = \left\{ \begin{bmatrix} a_0(\theta_0) & a_0(\theta_1) & .. & a_0(\theta_{r-1}) \\ a_1(\theta_0) & a_1(\theta_1) & .. & a_1(\theta_{r-1}) \\ \vdots & \vdots & .. & \vdots \\ a_{N-1}(\theta_0) & a_{N-1}(\theta_1) & .. & a_{N-1}(\theta_{r-1}) \end{bmatrix} \begin{bmatrix} s_0[n] \\ s_1[n] \\ \vdots \\ s_{N-1}[n] \end{bmatrix} \right\} + \begin{bmatrix} v_0[n] \\ v_1[n] \\ \vdots \\ v_{N-1}[n] \end{bmatrix}$$

$$a(\theta) = \begin{bmatrix} 1 & e^{-i\omega} & e^{-i2\omega} & .. & e^{-i(N-1)\omega} \end{bmatrix}^T$$

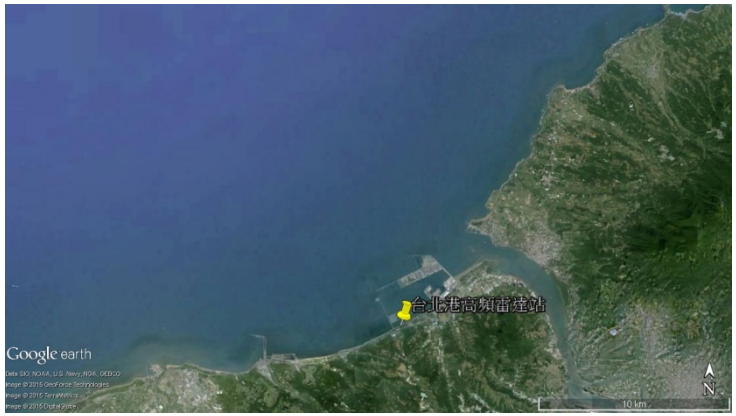
$$y[n] = \sum_{k=0}^{N-1} w_k x_k[n]$$

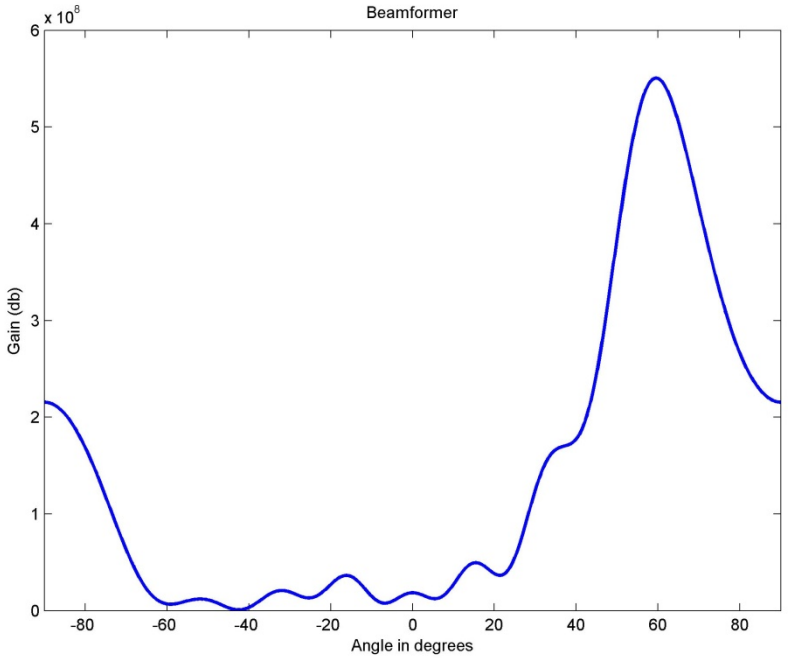
$$\mathrm{P}(\theta) = \mathrm{E}\left[y[n]^{\mathrm{H}} y[n] \right] = \mathrm{E}\left| \left[w[n]^{\mathrm{H}} x[n] \right] \right|^2$$

$$= \mathrm{E}\left| \left[a(\theta)^{\mathrm{H}} x[n] \right] \right|^2 = a(\theta)^{\mathrm{H}} R_{xx} a(\theta)$$

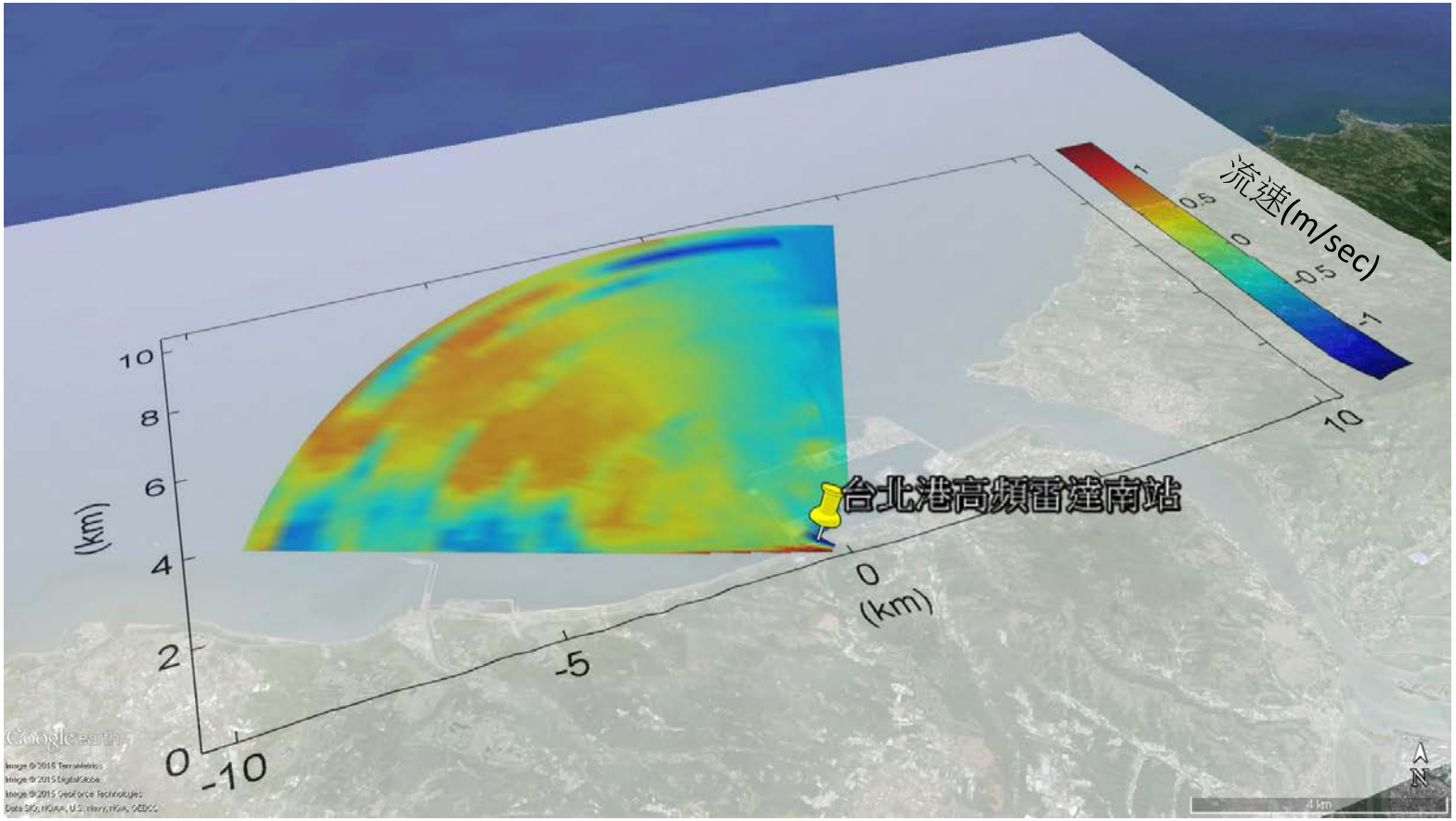
$$R_{xx} = \frac{1}{K} \sum_{i=0}^{K-1} x[n] x[n]^H$$

陣列天線訊號解算結果討論





陣列天線訊號解算結果討論



小結

- 本研究自行解算陣列雷達訊號，從中求取都卜勒能譜，並透過陣列天線搭配Beam Forming演算法，解算出雷達回波訊號中來自不同方向之成分。
- 分析結果確認了演算過程的可行性。本研究後續將進行兩站所測得徑向流之合成，藉以求取海面之流場向量資訊。

後續研究-Radio Frequency Interference

Re: The issue on the WERA data analysis - Taiwan

收件匣 x

Thomas Helzel <helzel@helzel.com> 7月21日

寄給 jack18、 Birgit、 Long-Lih、 Ole

Dear Jack,

Thank you for your mail. Yes we have some data about day/night range variations due to external noise effects.

The interesting thing is that above about 10 MHz the noise is dominated by man-made sources near to the radar installation. The effect is that during day-time the noise is higher and thus the range is reduced.

Thank you