Broadband matched-field source localization in the East China Sea*

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Outline

- Introduction
- Experiment description
- Environment of ocean
- Matched field processing
- Sound propagation model
- MFP source localization results
- Conclusion

Introduction

- ASIAEx2001was performed in the East China Sea.
- The environment is some complicated
- The effects of water depth mismatch on MFP source localization are investigated experimentally.
- The effects of simplified SVPs on MFP source localization are investigated also.

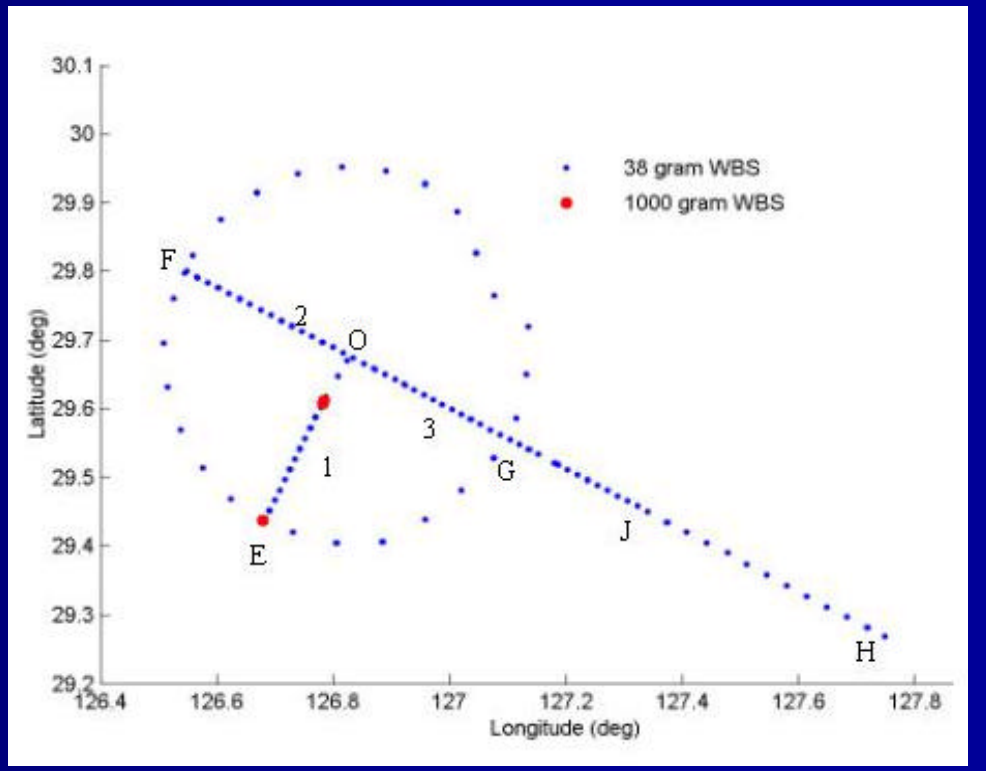
Experiment description

The actual WBS drop locations

O: the site of Shiyan3

Direction O-E: From center(O) to Southwest (E)

Direction F-O-G-J : From Northwest to Southeast

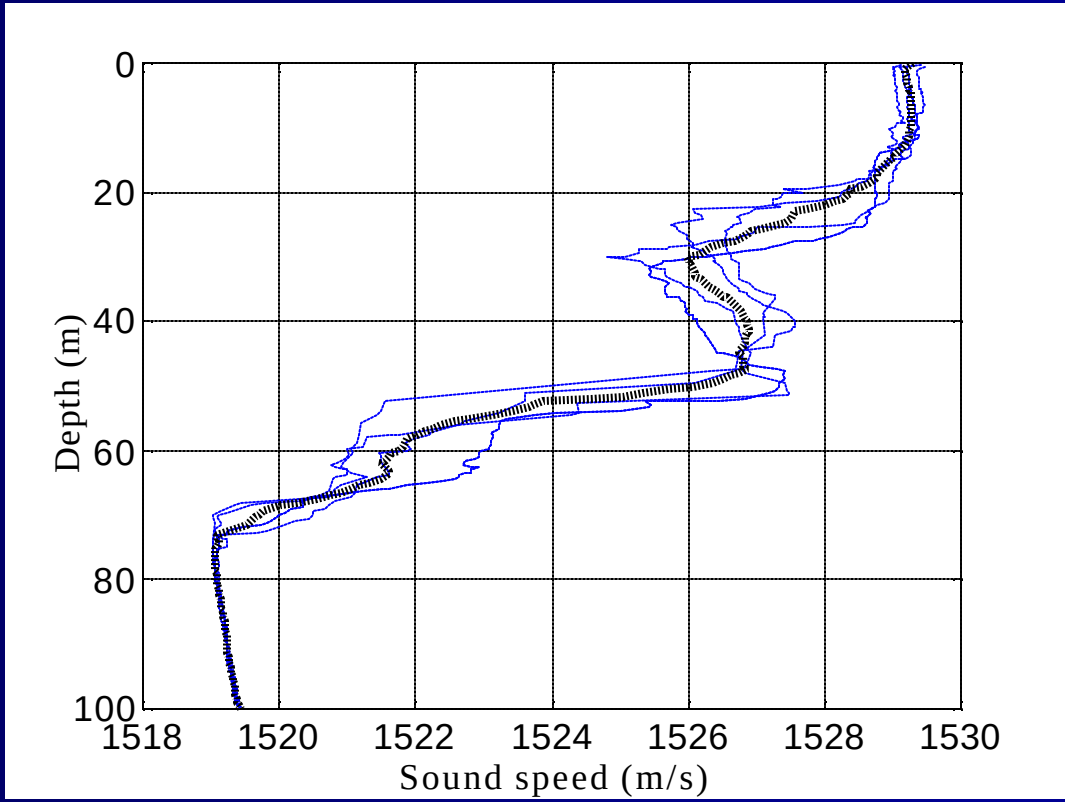


Given by Jim Miller

The Ocean Environment

- Experiment site is a continental slope environment. the sea depth vary from 96m to 150m in 80km range.
- The temperature of sea water has some fluctuation from sea surface to 70m depth.

SVP of sea water used in MFP source localization



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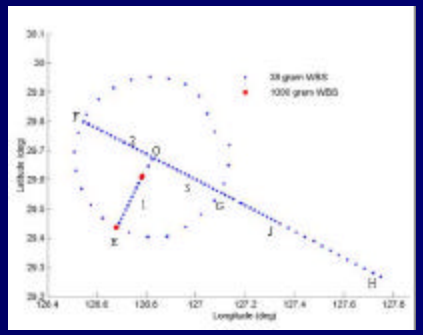
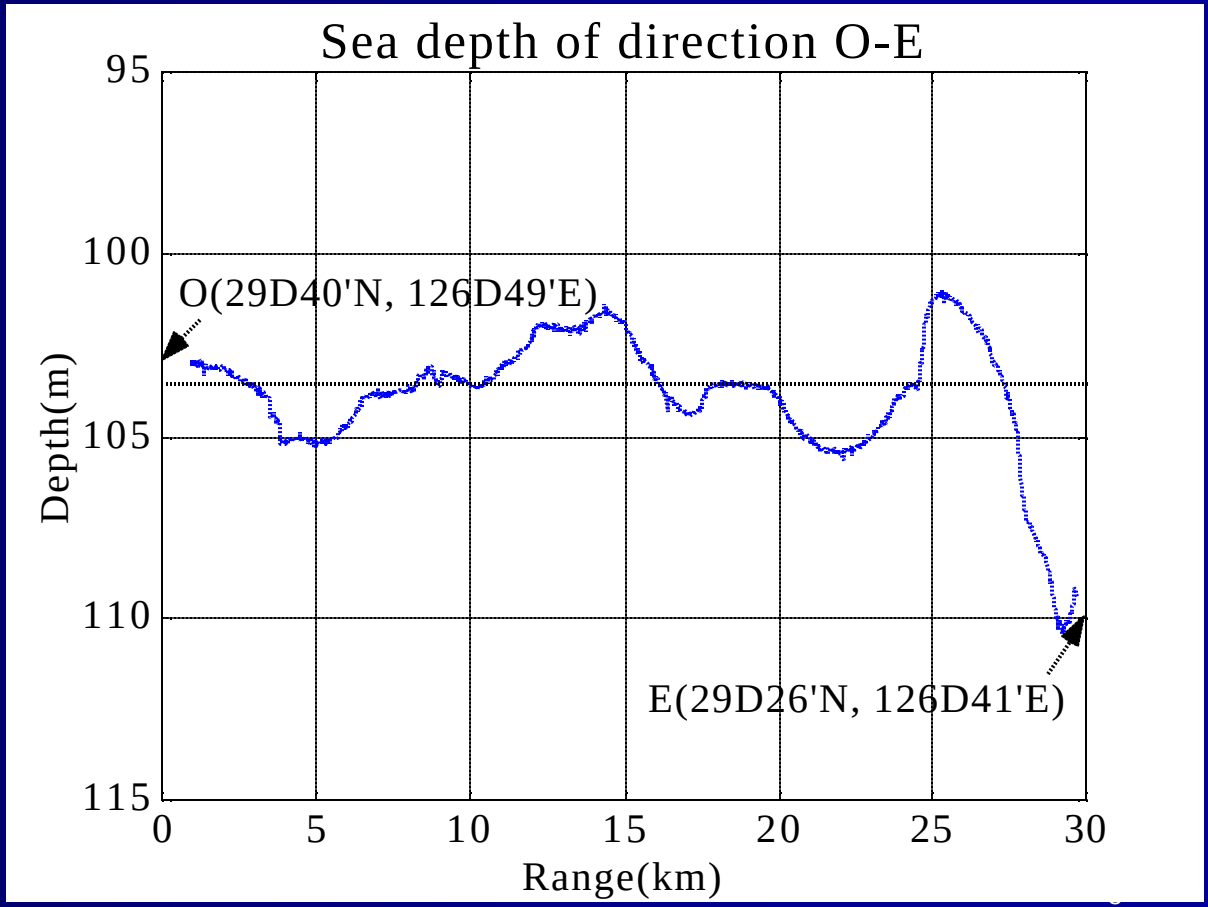
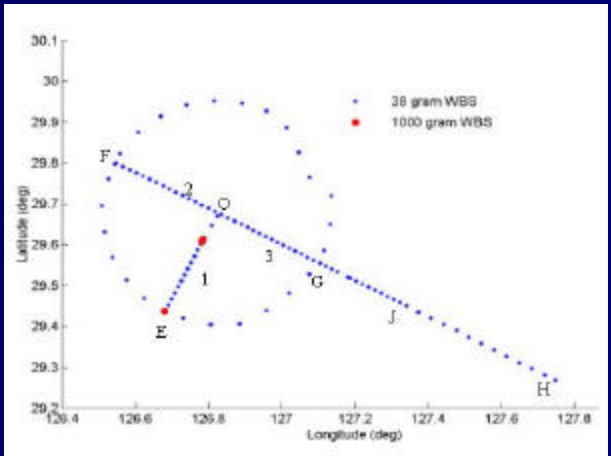
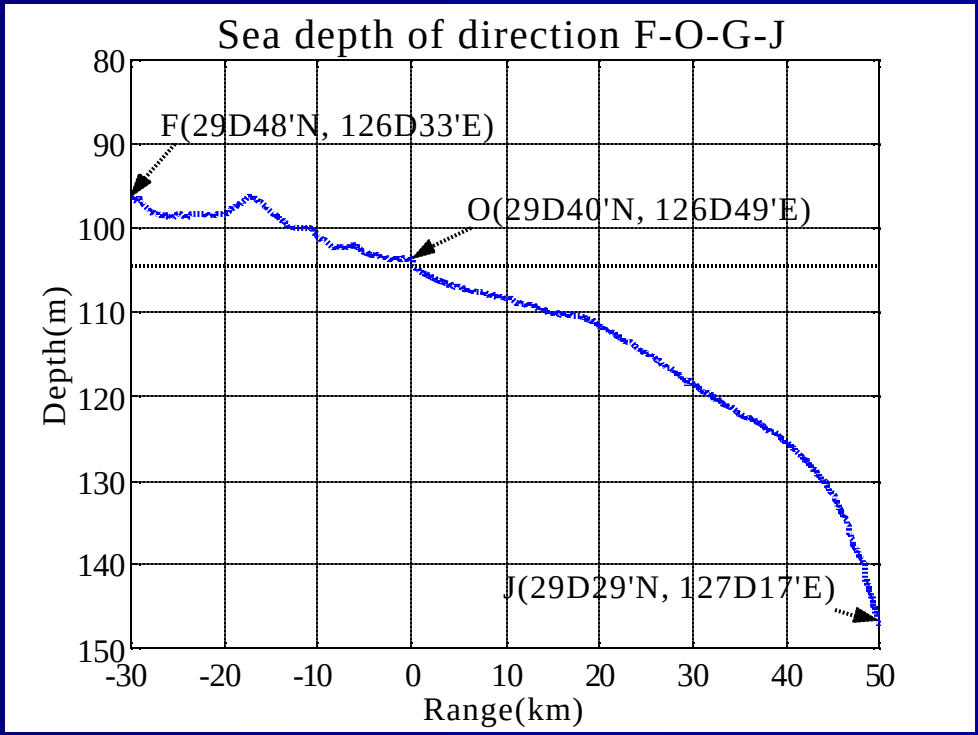
Sea-water depth from center(O) to southwest (E)





Sea-water depth from northwest (Site F) to southeast (Site J)





Matched field processor

1 Single frequency linear Bartlett MFP

$$B_{MF}(r, z, f_j) = \frac{\left| \sum_{i=1}^{N} p_i^e(f_j)^* \, p_i^c(f_j) \right|}{\sqrt{\left[\sum_{i=1}^{N} \left| p_i^e(f_j) \right|^2 \right] \left[\sum_{i=1}^{N} \left| p_i^c(f_j) \right|^2 \right]}}$$

2 Broadband MFP

$$\overline{B}_{MF}(r, z) = \frac{1}{M_f} \sum_{j=1}^{M_f} B_{MF}(r, z, f_j)$$

Sound propagation model

- **The coupling normal mode-parabolic equation theory based on the WKBZ approximation**

$$p^c(r,z,f) = r^{-\frac{1}{2}} \sum_{n=1}^{\infty} [k_n(r,f)]^{-\frac{1}{2}} u_n(r,f) f_n(z;r,f)$$

k_n **is the eigenvalue at local range** r

$f_n(z,r,f)$ **is the eigenfunction**

} **Solved by WKBZ**

u_n is the normal mode coefficient, and satisfies

$$\frac{\partial \vec{u}}{\partial r} = -A_r \vec{u} + iK\vec{u}$$

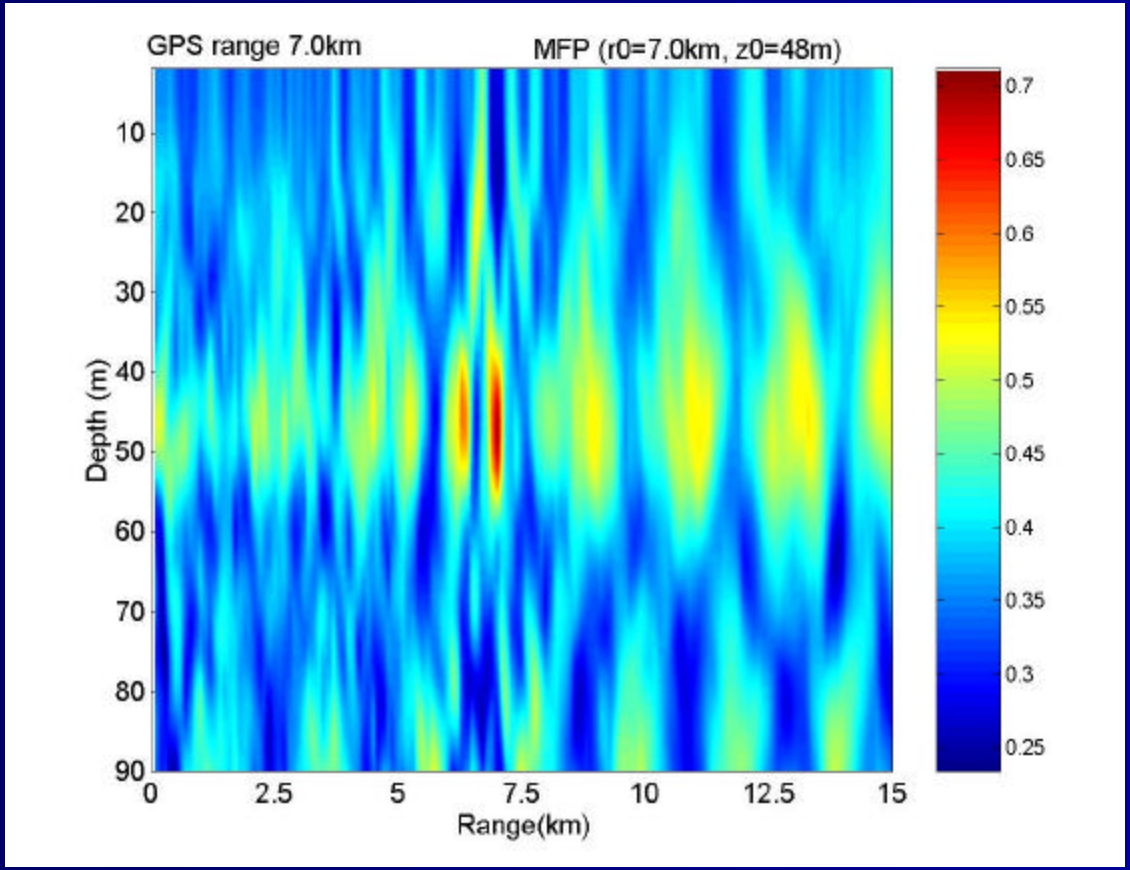
← **solved by split step PE method**

The geo-acoustic parameters of sea bottom

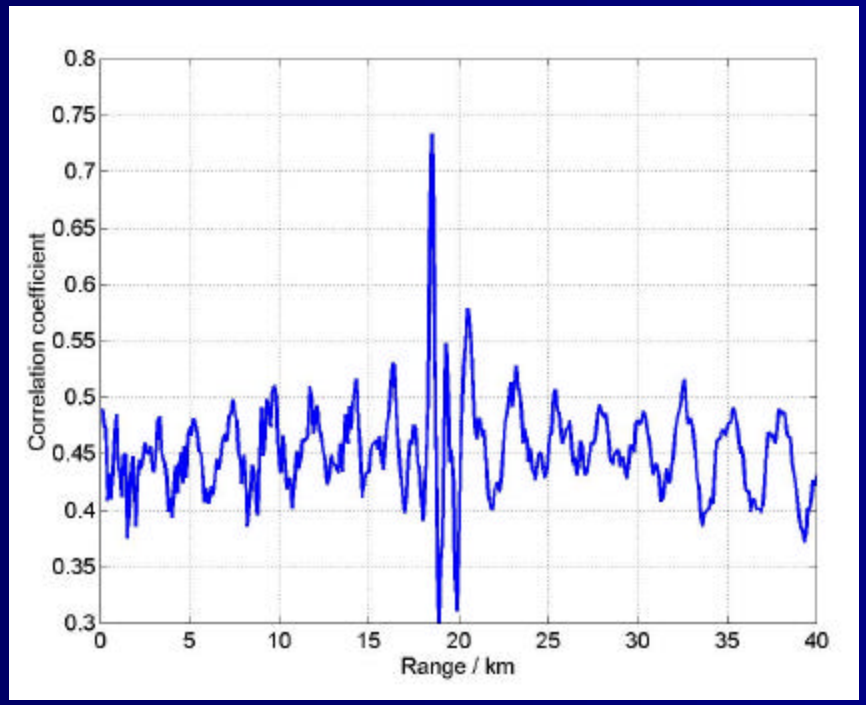
- Sound speed 1610.8m/s
- Density 1.86g/cm^3
- Attenuation 0.1dB/wavelength

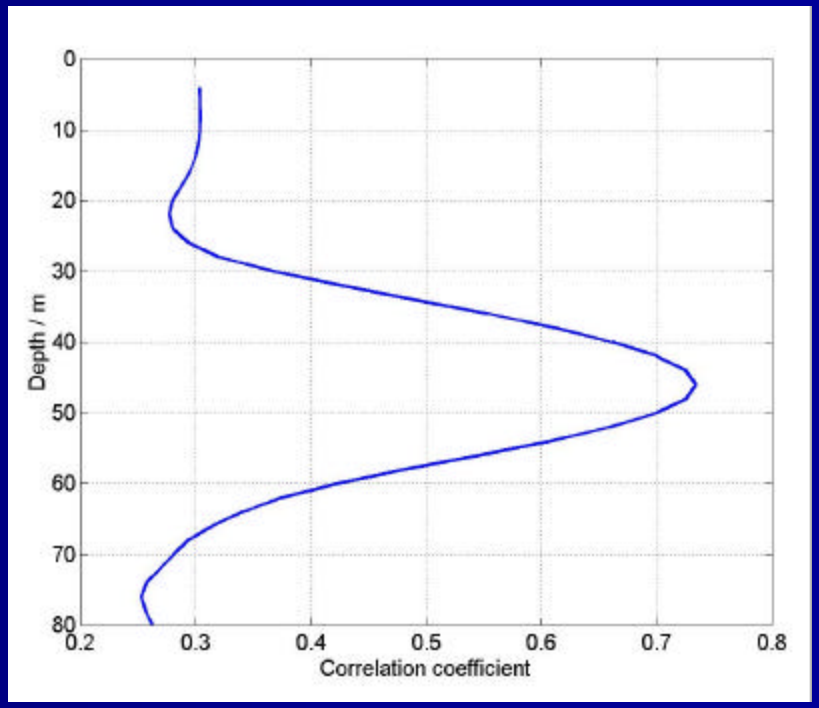
- Replica fields calculation parameters
  - **Range step: 100m**
  - **Depth step: 2m**
  - **Frequency band : 100Hz - 200Hz.**

The range-depth ambiguous function of a WBS at range 7.0km



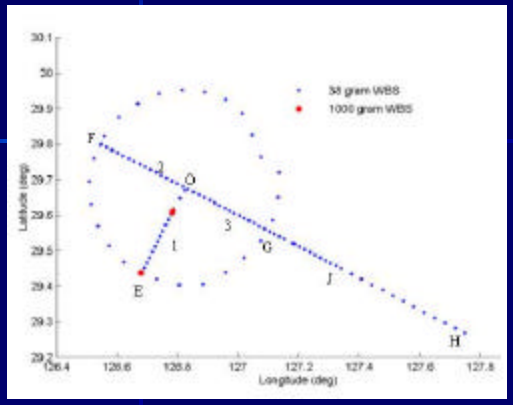
The range-depth ambiguous function of a WBS at range 18.9 km

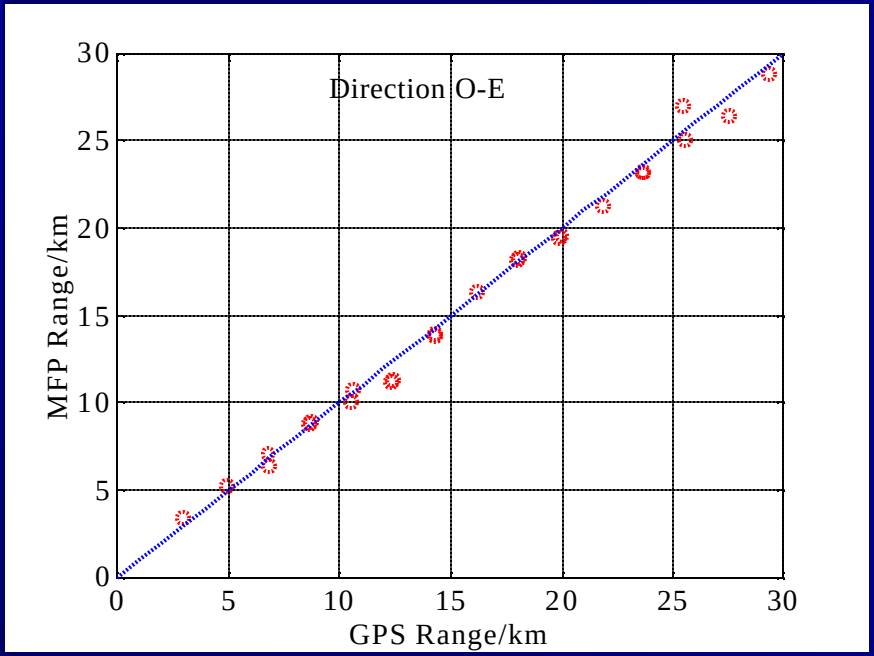


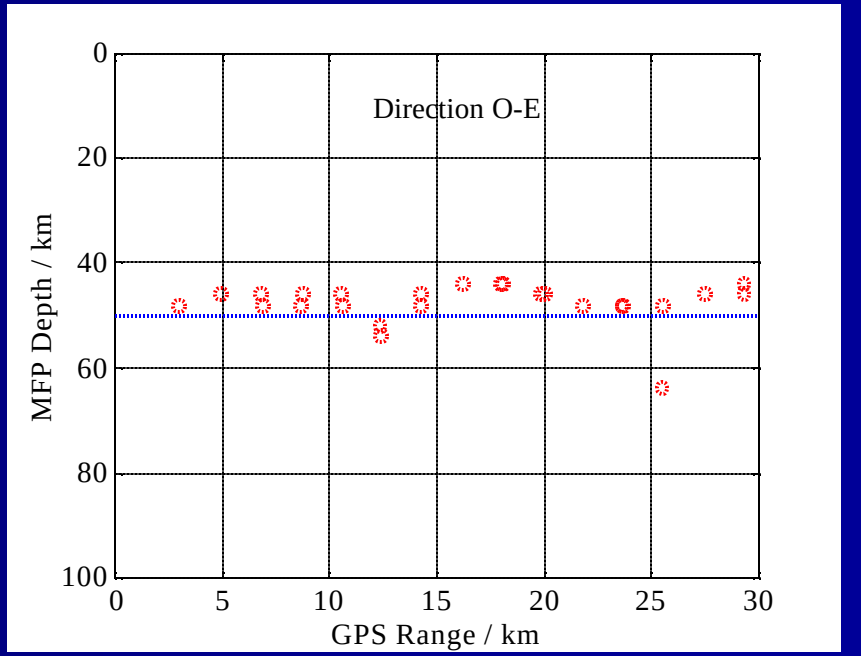


MFP range 18.5km and depth 46m

MFP results from center(Site O) to southwest(Site E) with a flat bottom



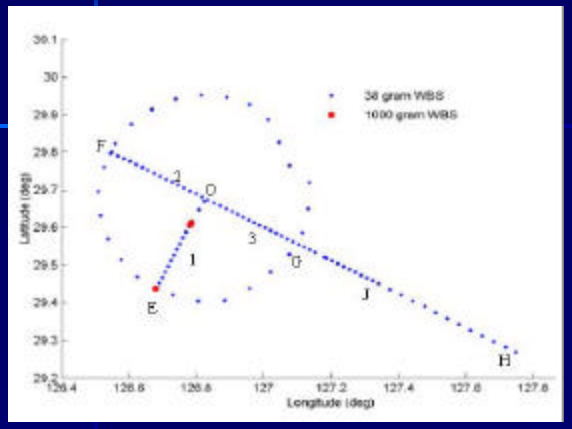


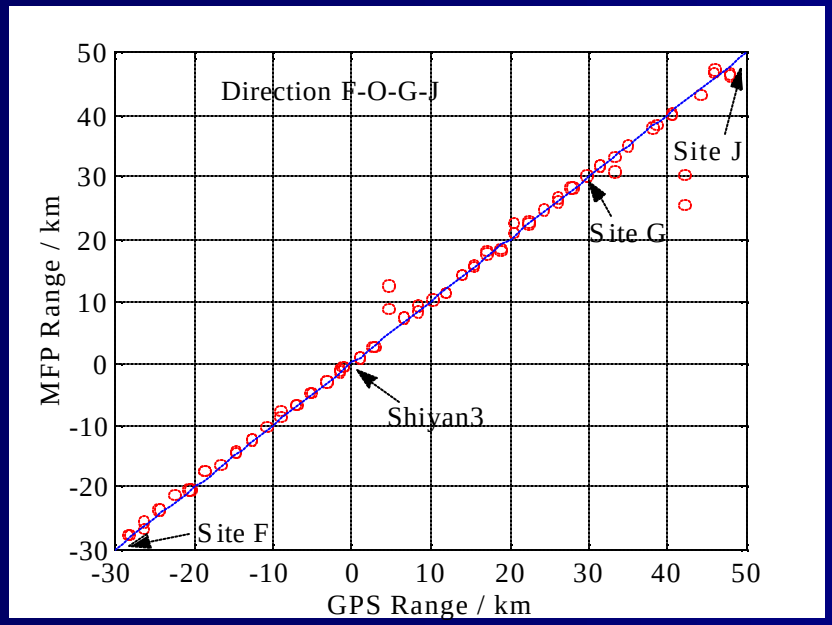


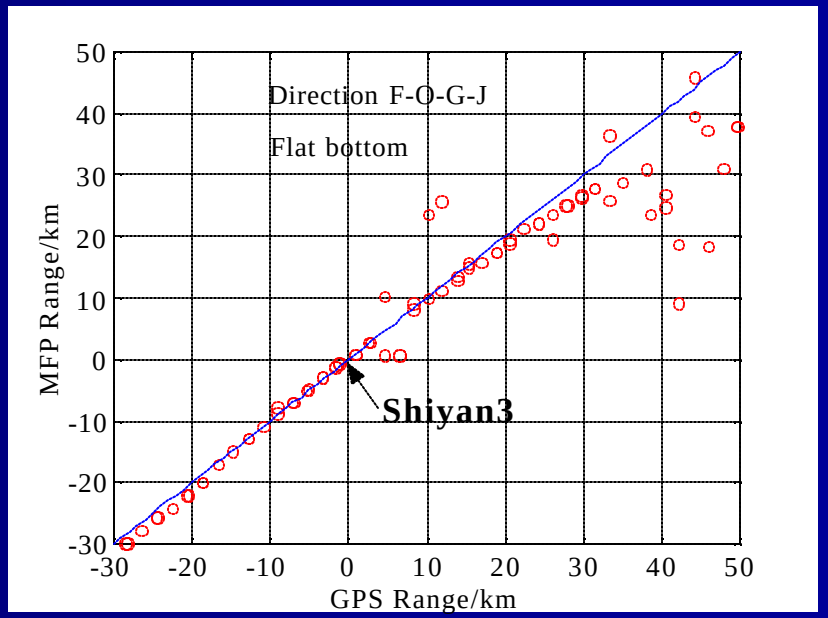
MFP range results

MFP depth results

MFP range results from northwest(F) to southeast(J)



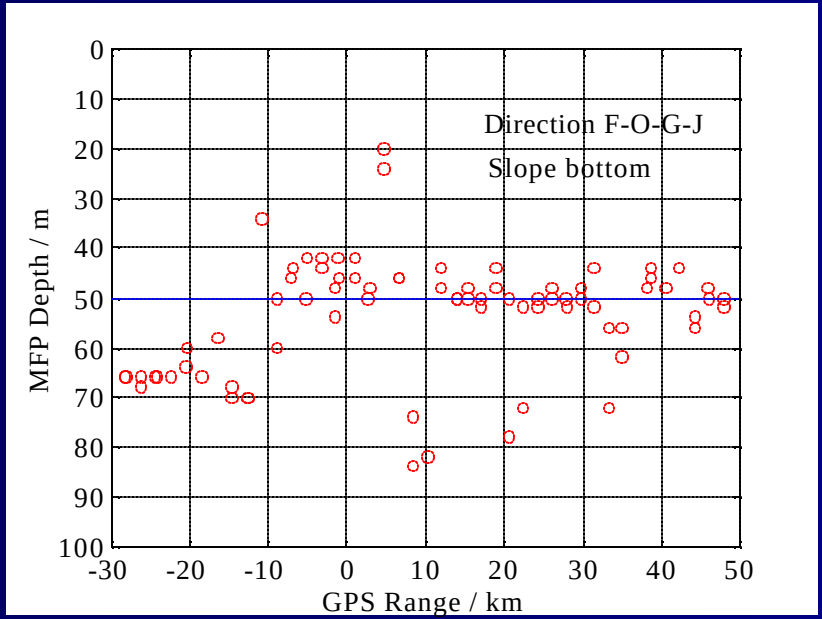


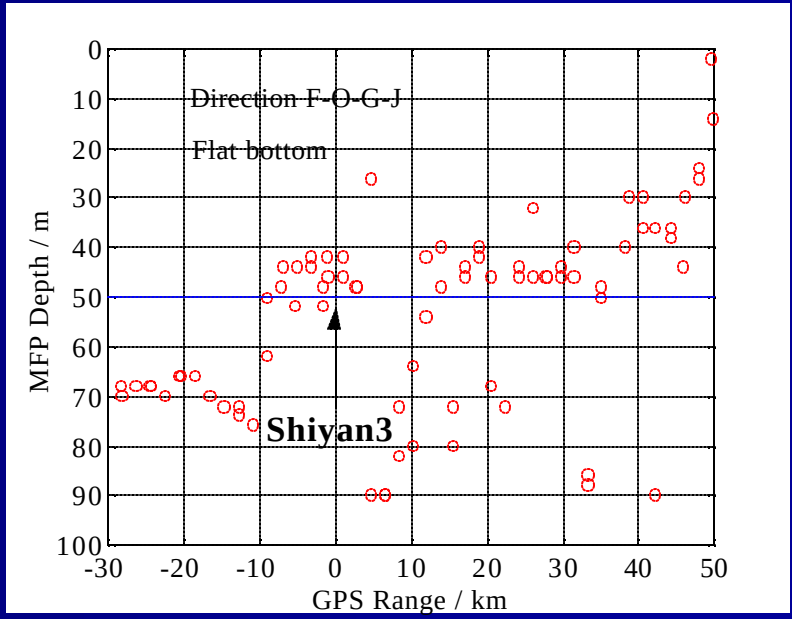


Slope bottom model

Flat bottom model

MFP depth results from northwest (Site F) to southeast(Site J)

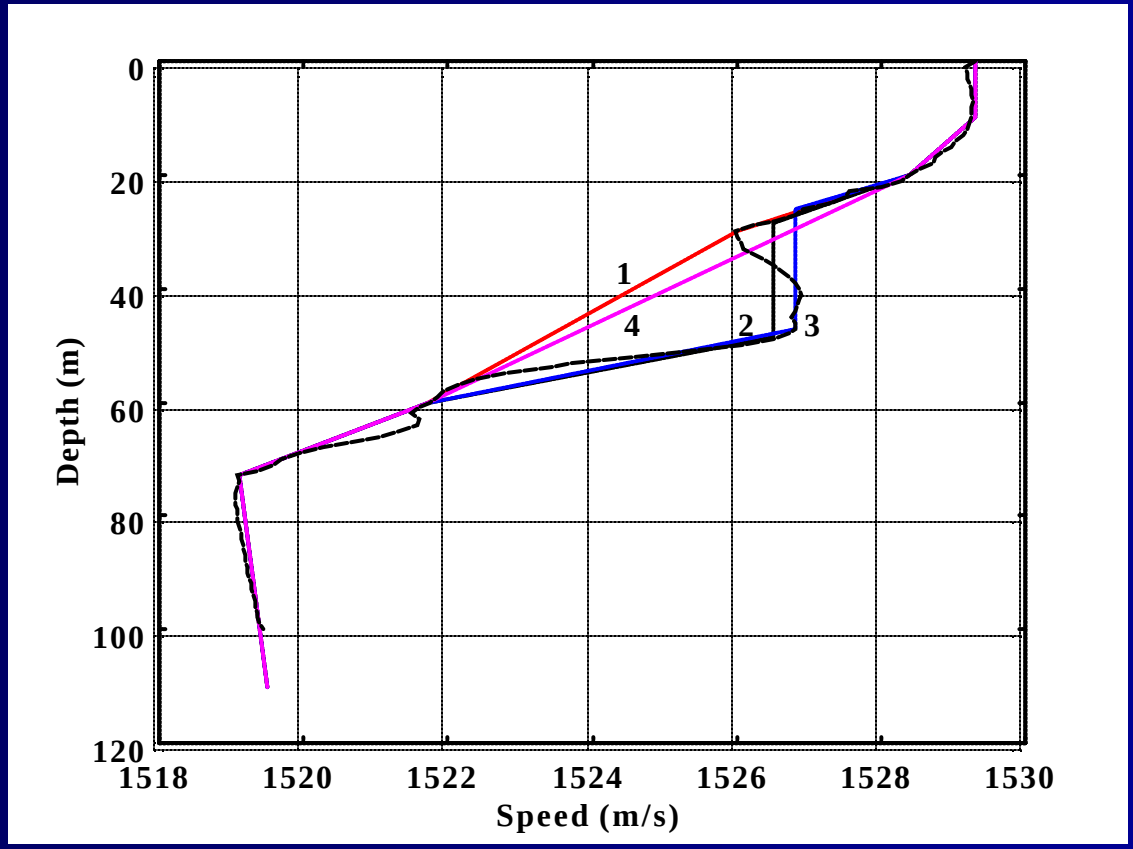




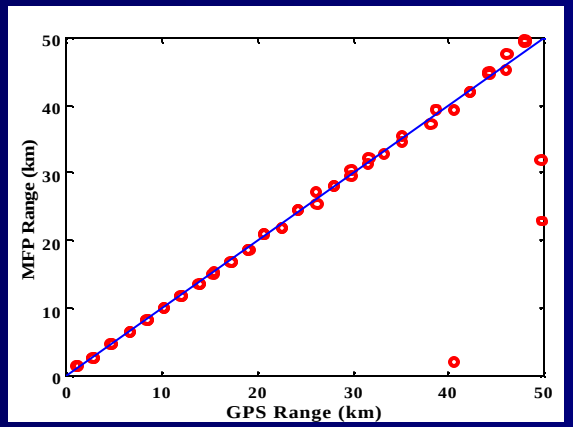
Slope bottom model

Flat bottom model

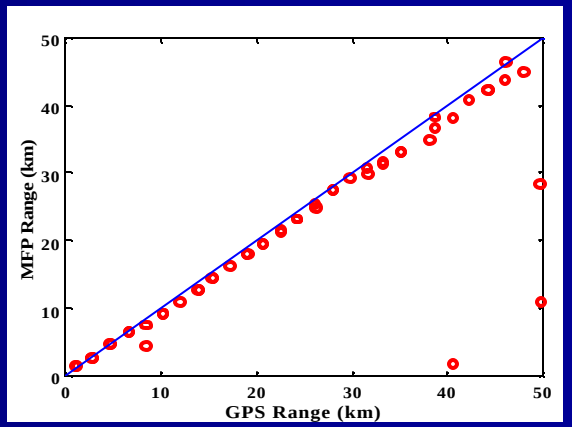
Simplification of the mean sound speed profile



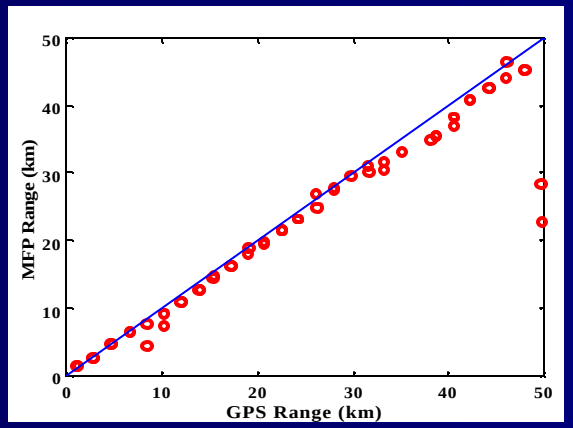
MFP range results from Site O to Site J with the simplified profiles



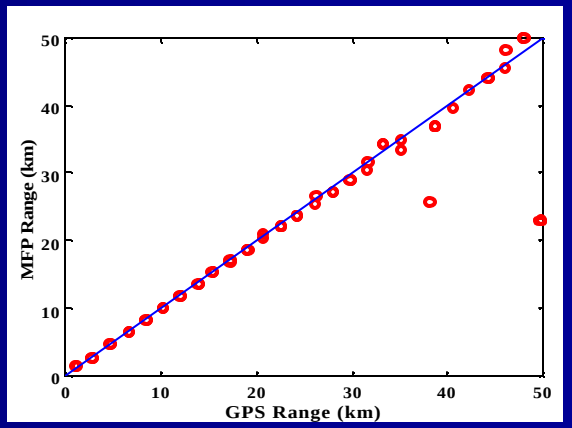
SVP1



SVP2



SVP3



SVP4

Summaries

- Broadband matched-field source localization is applied to the VLA signals received in the jointed ASIAEX 2001
- For the slope bottom ocean environment, if we calculate the replica fields using the flat bottom model, significant errors can be introduced into the range and depth localization predictions. If the depth mismatch is too large, it can not localize the source properly.

Summaries

- The accuracy of the source localization is largely improved with the consideration of the slope of the bottom. The range estimates of the most signals by MFP in the range from -30.0km to 50.0km are consistent with the GPS measured ones well.
- The effects of water sound speed profile on the matched field source localization are also studied in the paper. For the four types of simplifications, MFP processor could still give stable and reliable estimation of source location.

Thanks !