Methods for Delineating Saturated Response Areas in AGC Data

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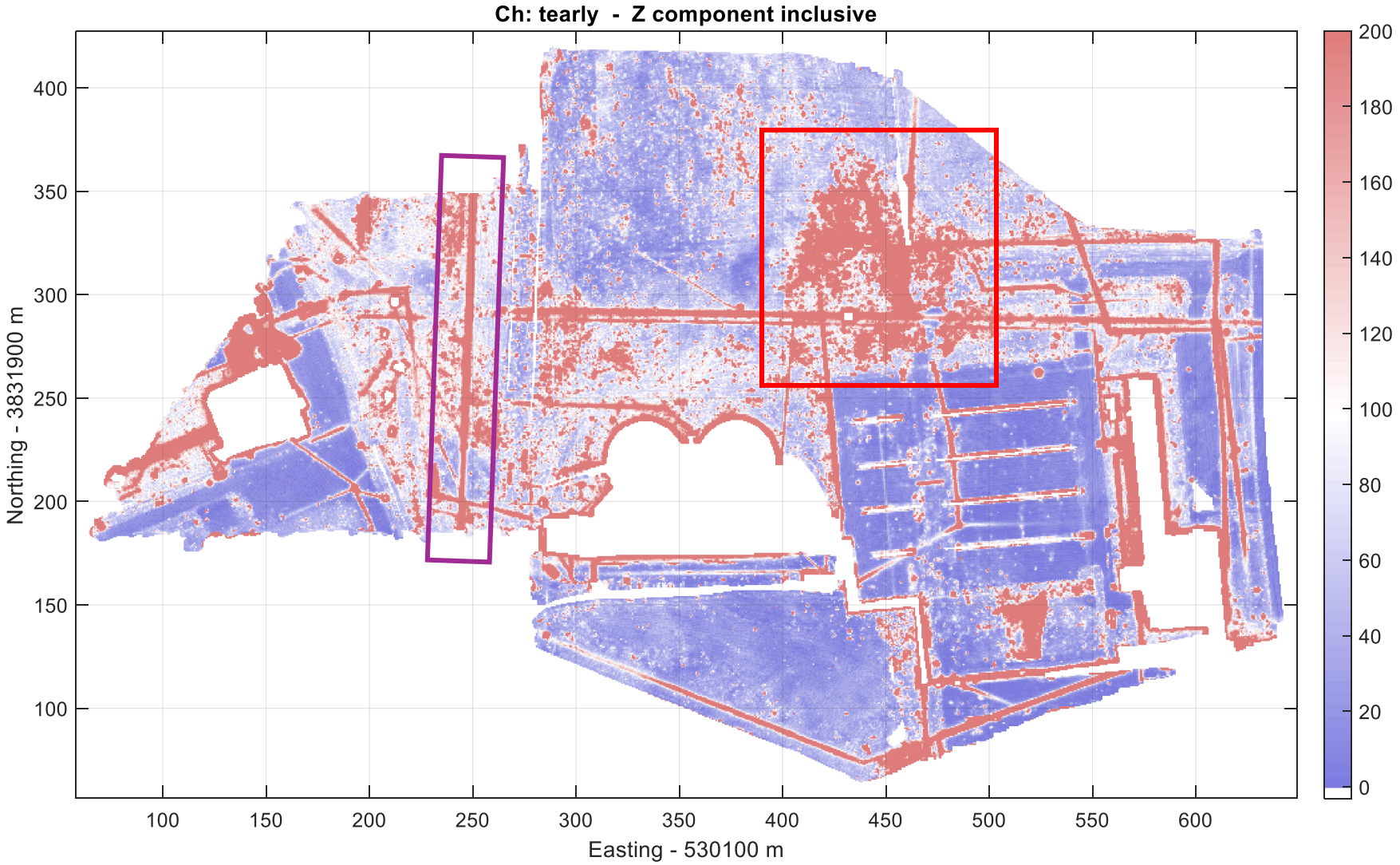
Black Tusk
GEOPHYSICS

Where can we apply AGC?



Redstone Arsenal, data shared with permission from USACE.

Outline

- Forthcoming ESTCP SRAs project
- What's an SRA and why can't we classify in SRAs?
- Methods and decision points for delineating SRAs
- Model-based SRA delineation:
  - Source density threshold
  - Procedure

ESTCP SRA Project

- **MR25-AZ-8796** Demonstration of Physics-based and Machine Learning Tools for Delineation of Saturated Response Areas.

- DOD QSR v2.0: “For the purposes of this document, a standard method is one that a) **has been successfully demonstrated during an ESTCP demonstration** and b) is capable of meeting all minimum recommended specifications contained in Appendix A. Any other method is considered to be a non-standard method. The use of any non-standard methods shall be approved by the DoD EDQW.”

Definition

Saturated Response Areas (SRAs) are regions where Advanced Geophysical Classification (AGC) cannot reliably identify targets of interest in the ground due to **spatially extended**, elevated signal that precludes estimation of dipole parameters required for classification.

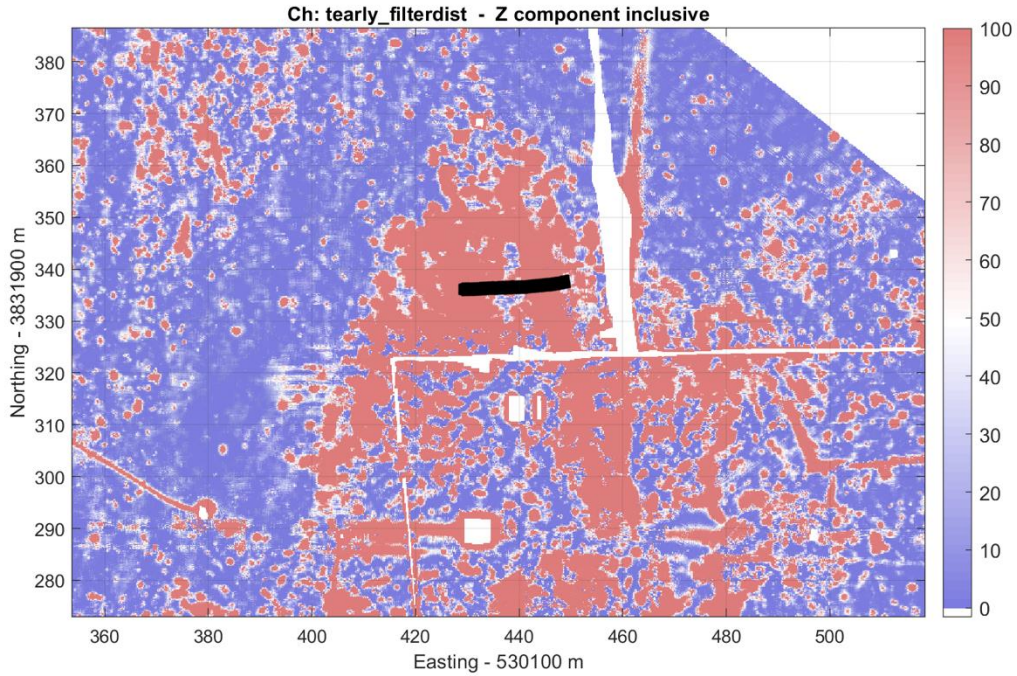
Elevated response can be due to:

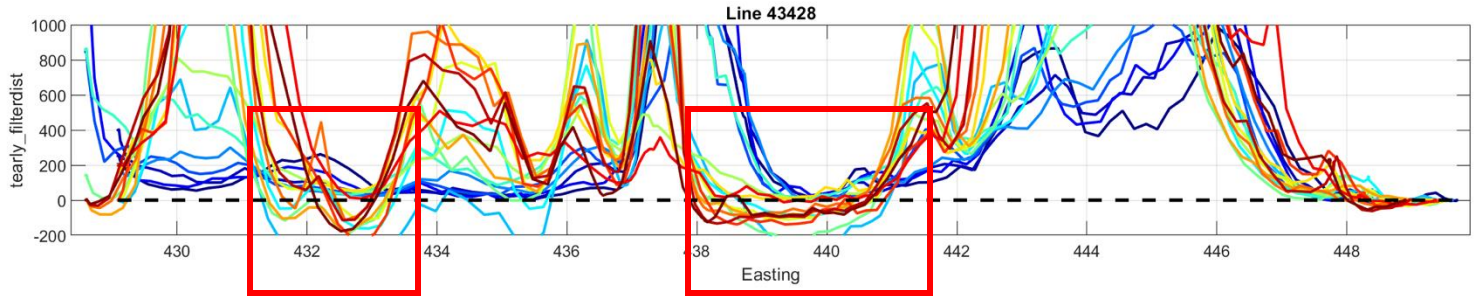
- High anomaly density
- Infrastructure
- Magnetic soils

What is the root cause of our inability to classify in spatially extended SRAs?

Extended signal affects:

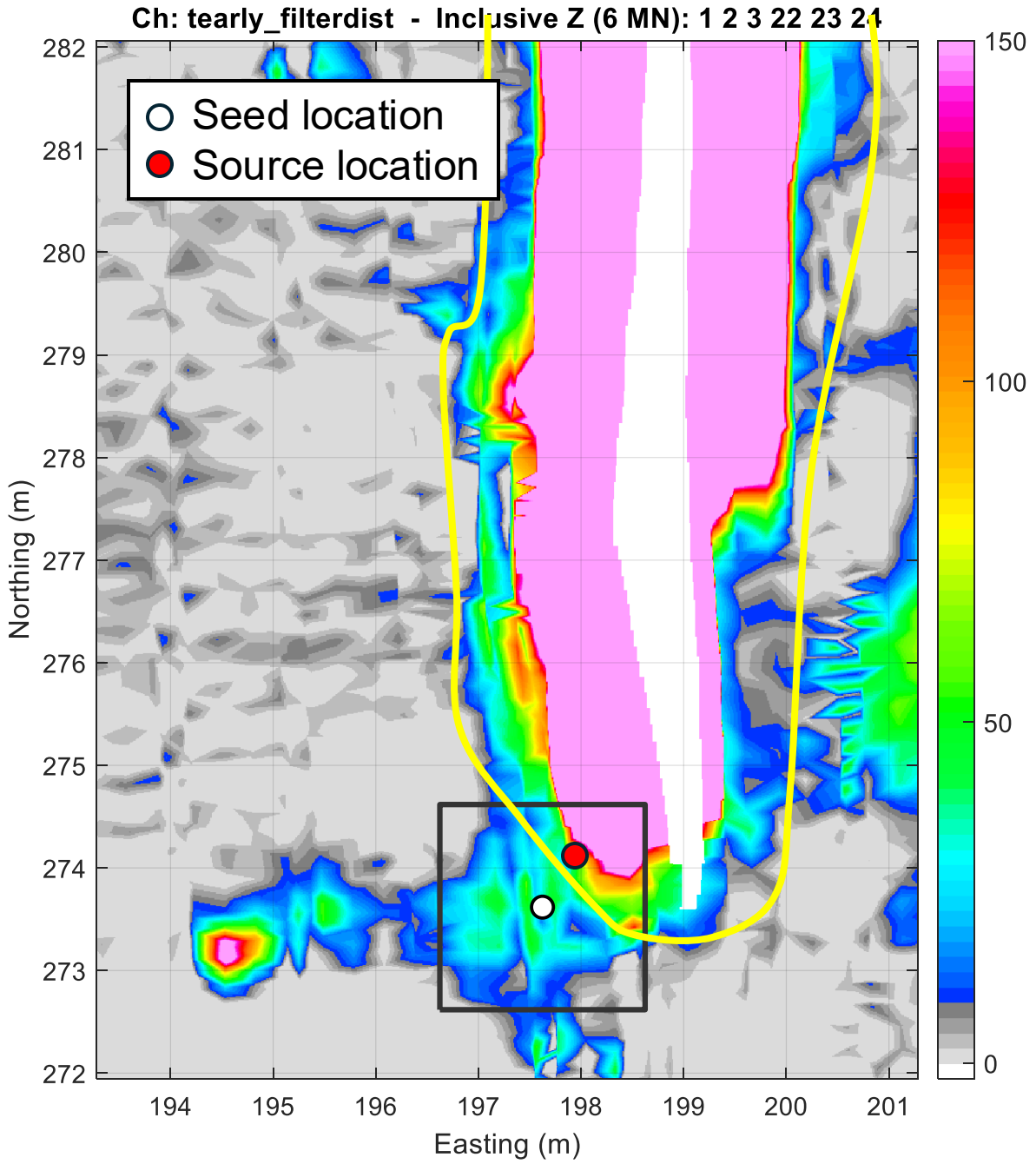
- filtering
- inversion



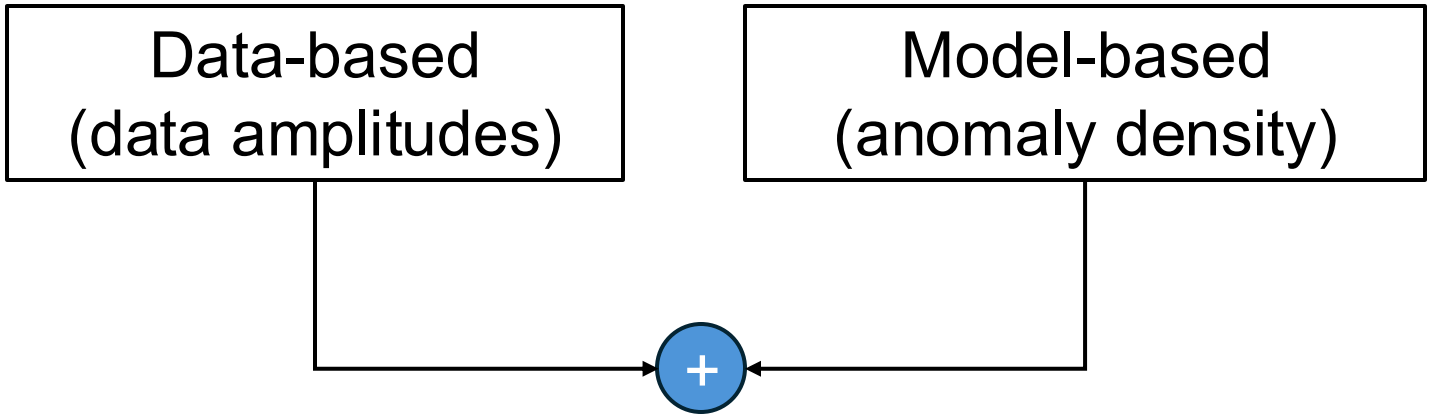


Effect of saturation on inversion

- Saturated signal pulls models to SRA if not properly masked



Delineating SRAs

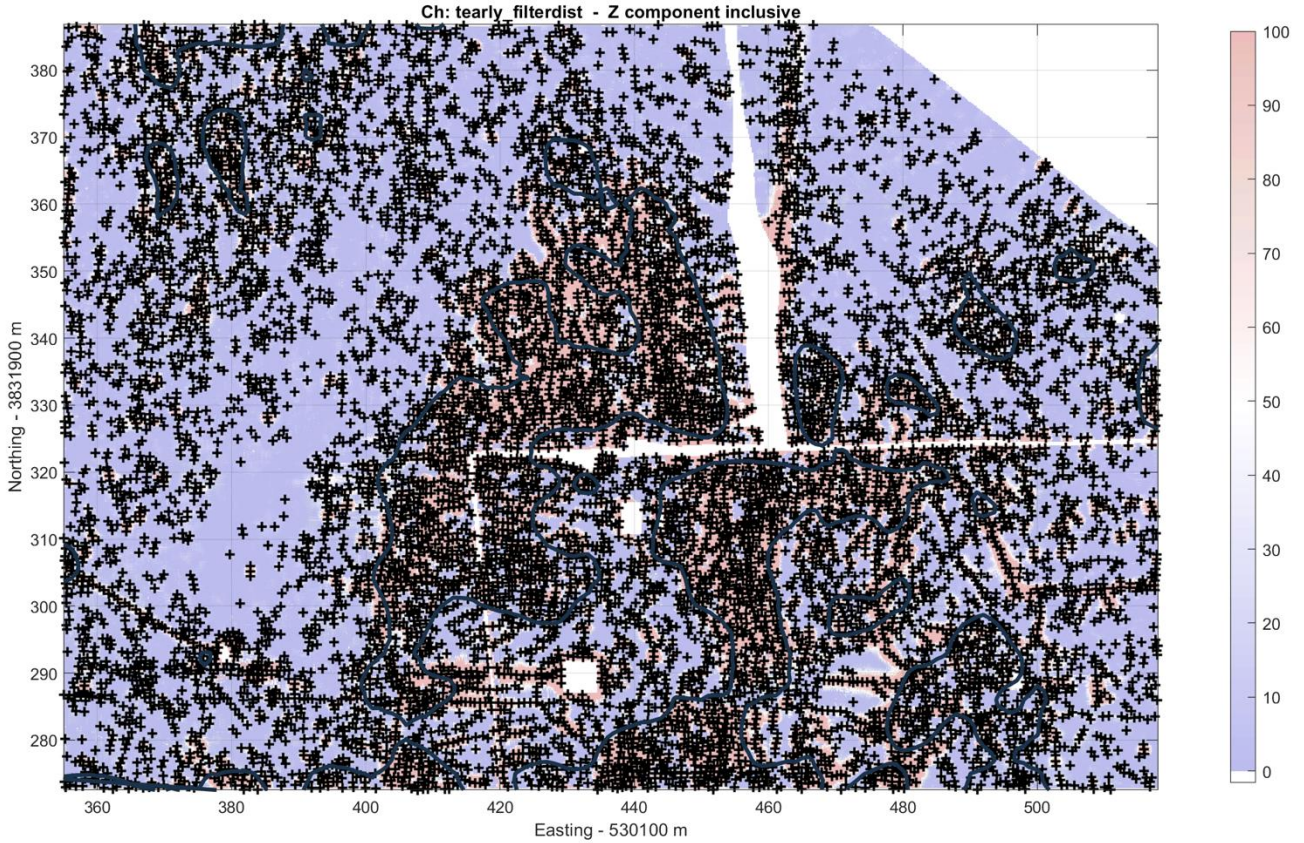


How should objective decision points be selected and verified for SRA delineation methods?

Model-based SRA delineation

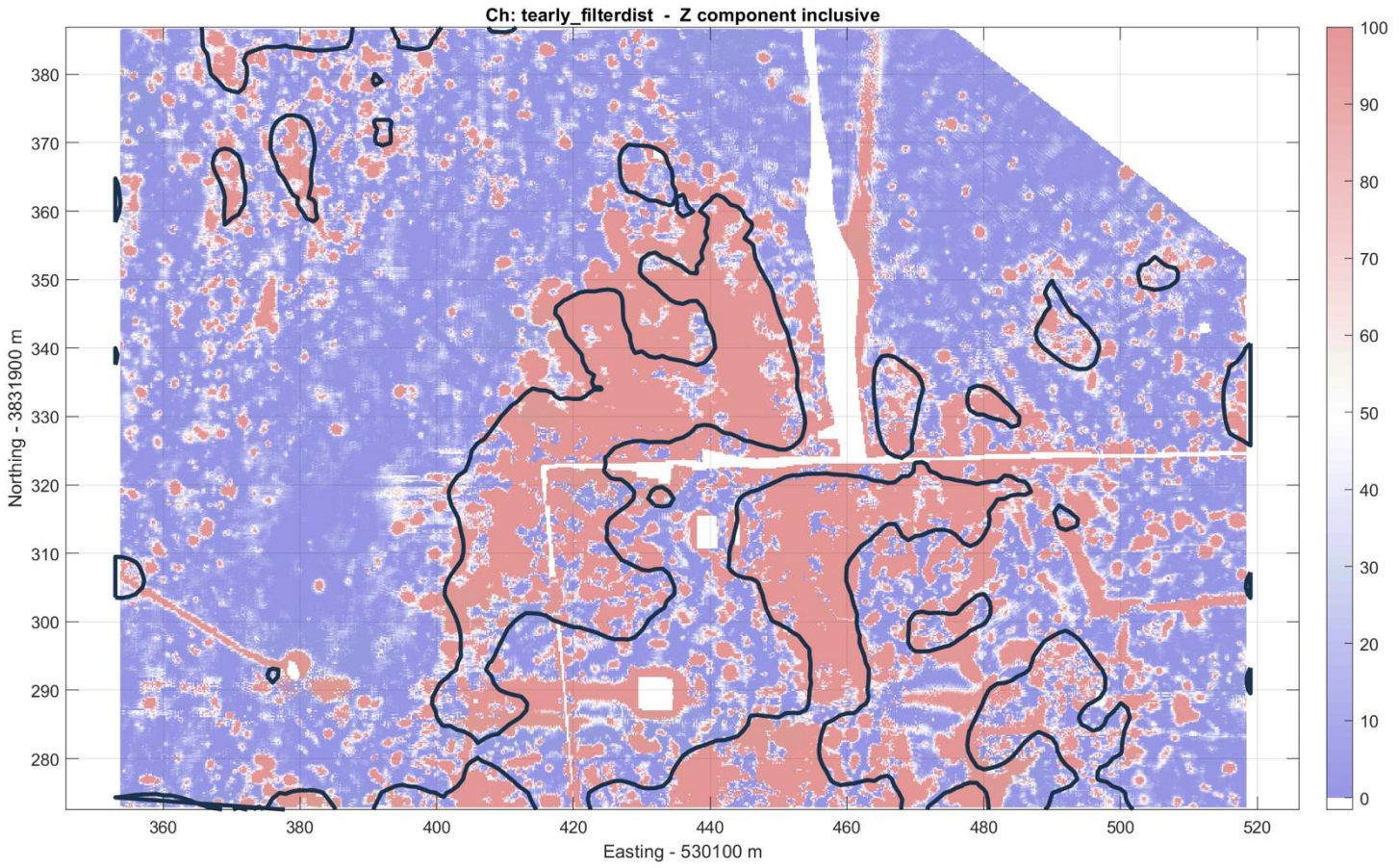
What anomaly (source) density threshold should be used?

MR-QAPP v2 recommends **3500 anomalies/acre**.

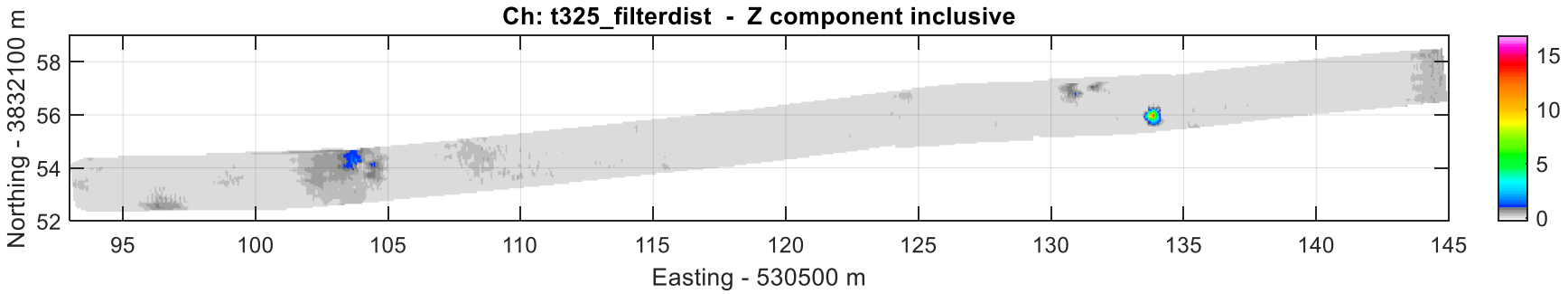


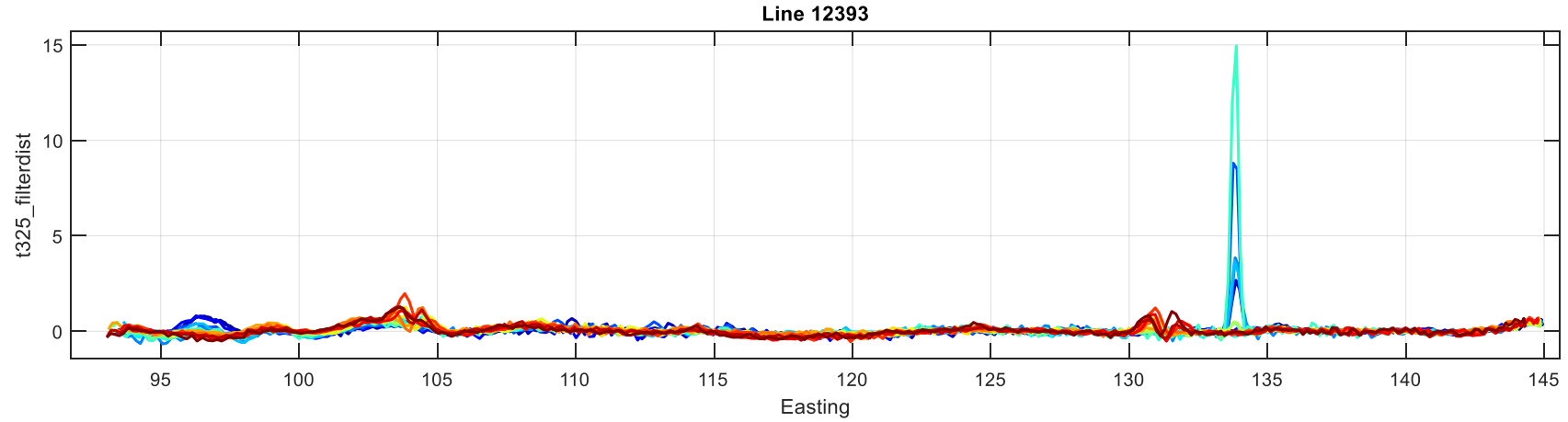
Model-based SRA delineation

- Anomaly density is a low resolution map that does not always conform with saturation in the data.



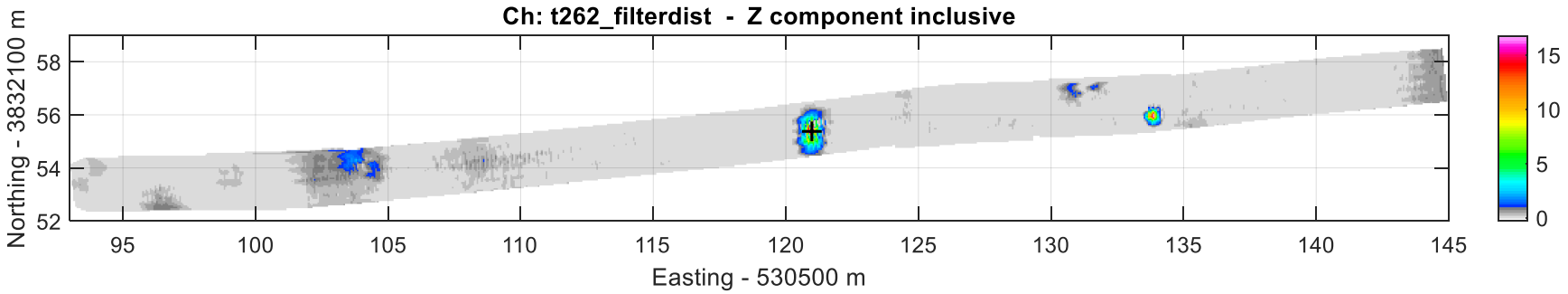
Synthetic seeding example

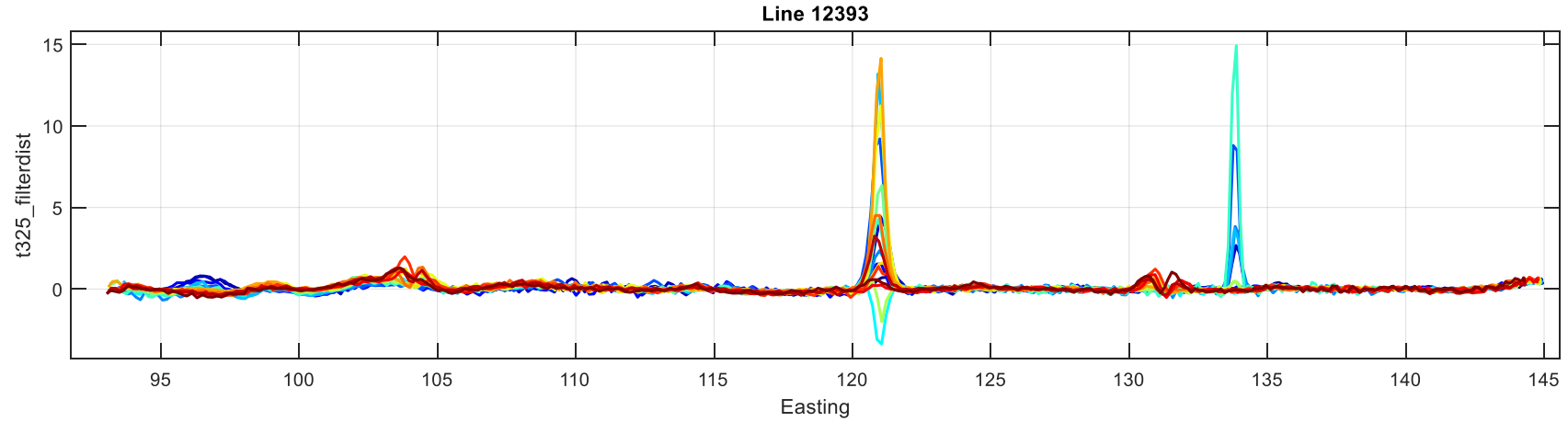




Synthetic seeding example

Seed a small ISO at 15 cm



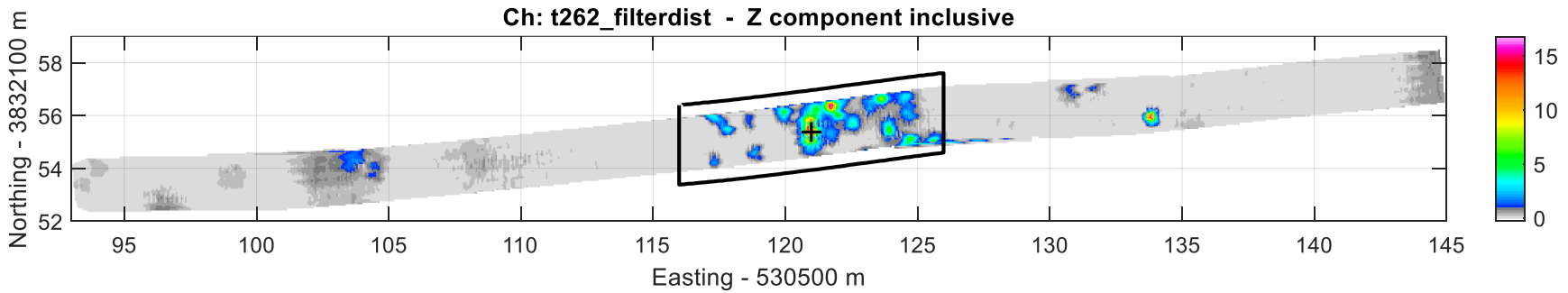


Synthetic seeding example

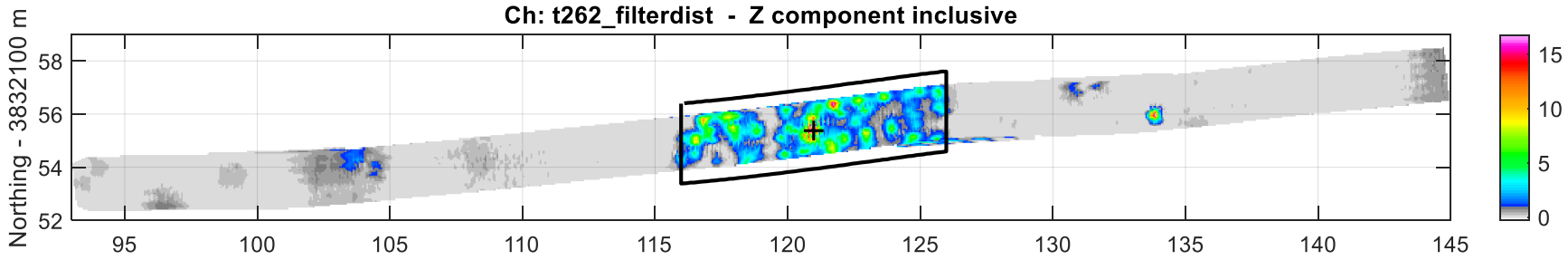
Seed clutter in increasing densities

- Random depths 5-15 cm
- Minimum 25 cm separation between sources

3500 anomalies/acre (26 sources)

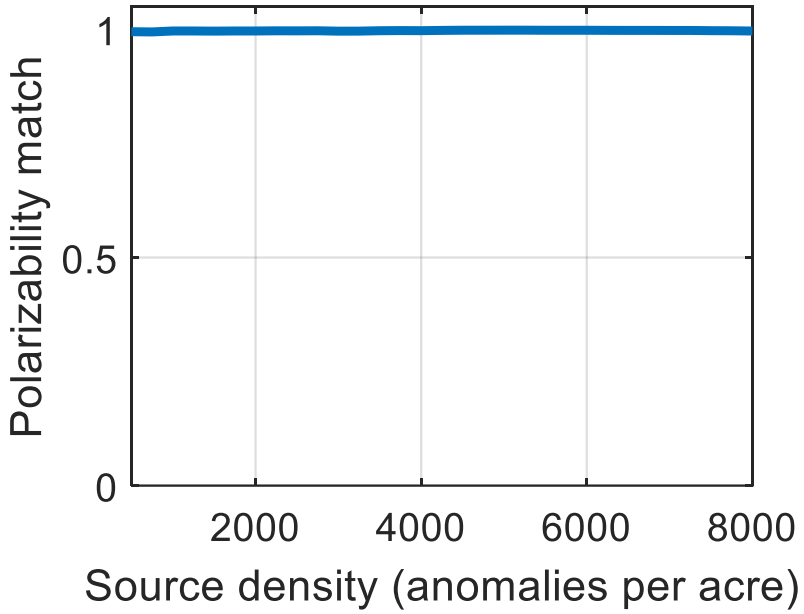


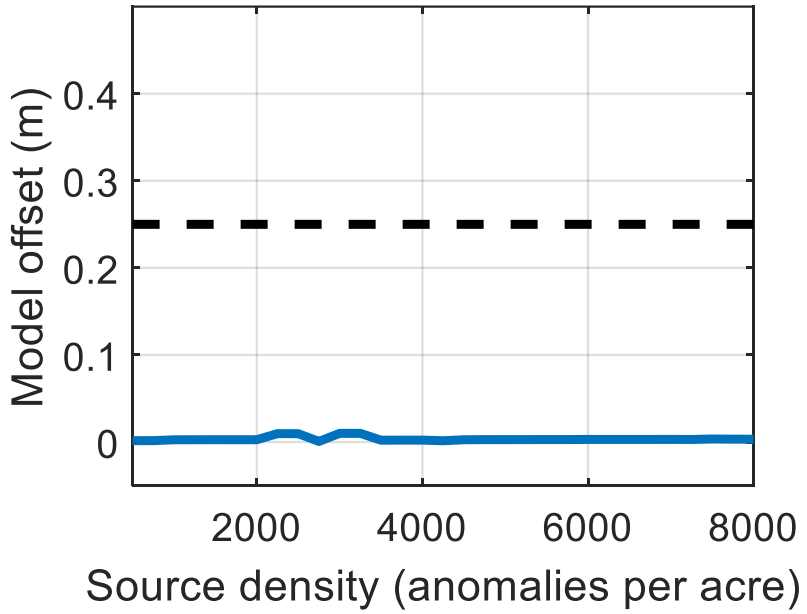
8000 anomalies/acre (59 sources)



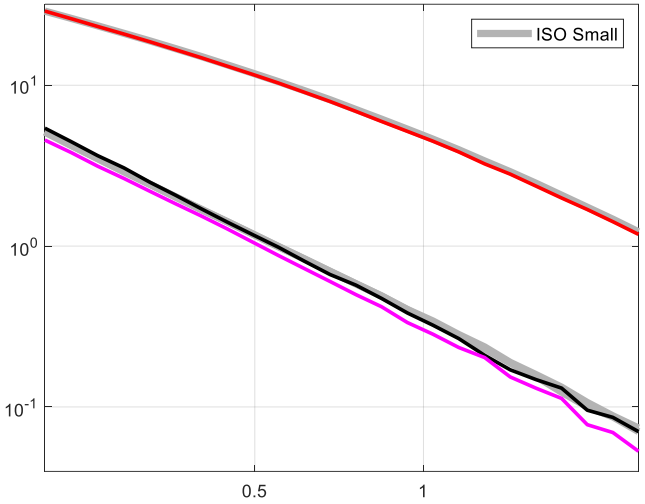
Effect of source density on inversion accuracy

Clutter: fuzes





Small ISO polarizabilities
at 8000/acre



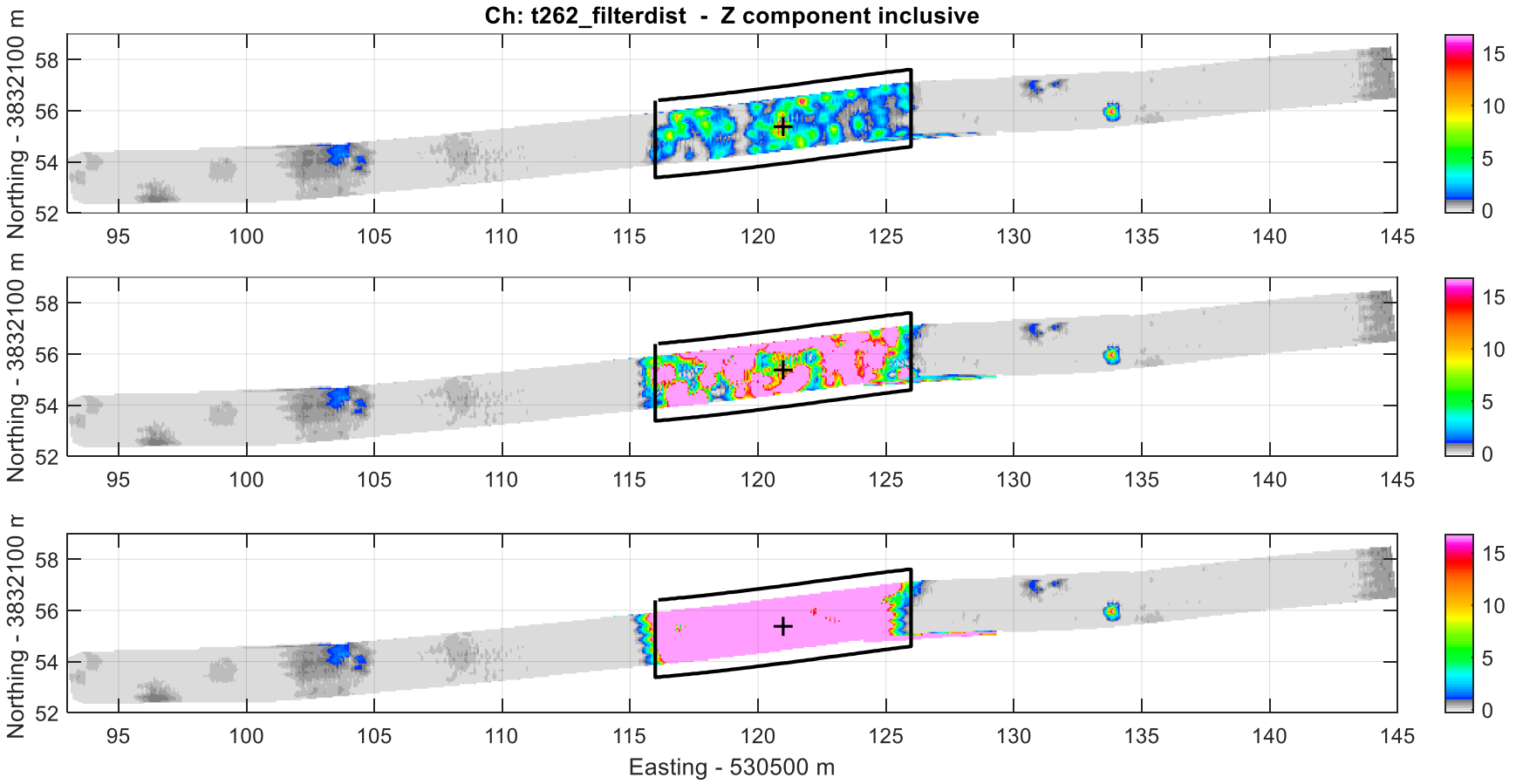
Synthetic seeding example

8000 anomalies/acre

Fuzes

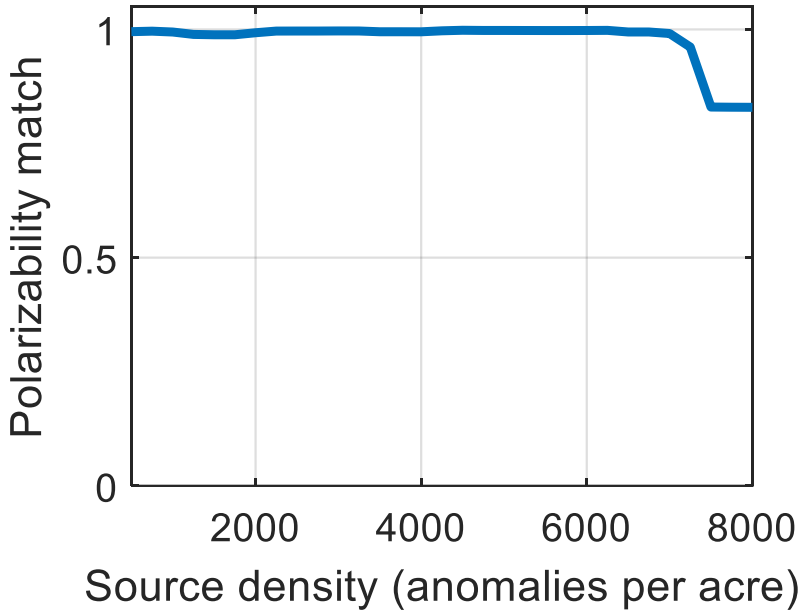
Small ISOs

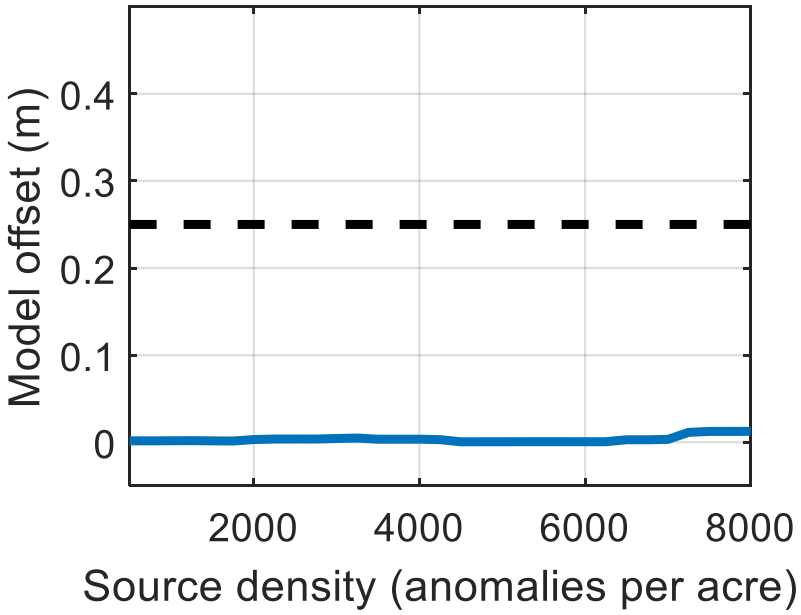
Medium ISOs



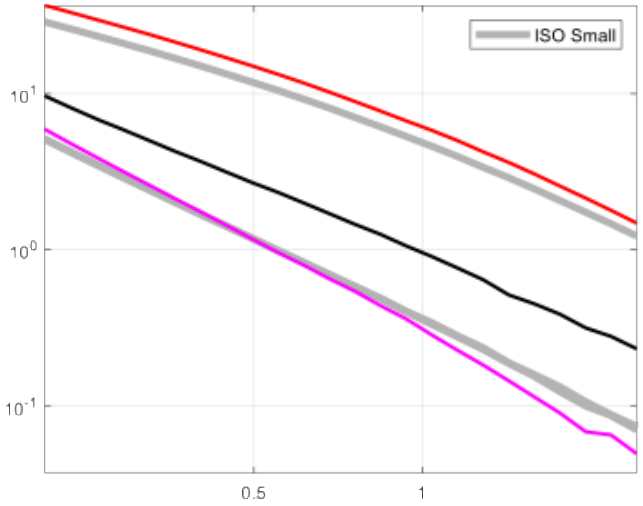
Effect of source density on inversion accuracy

Clutter: small ISOs



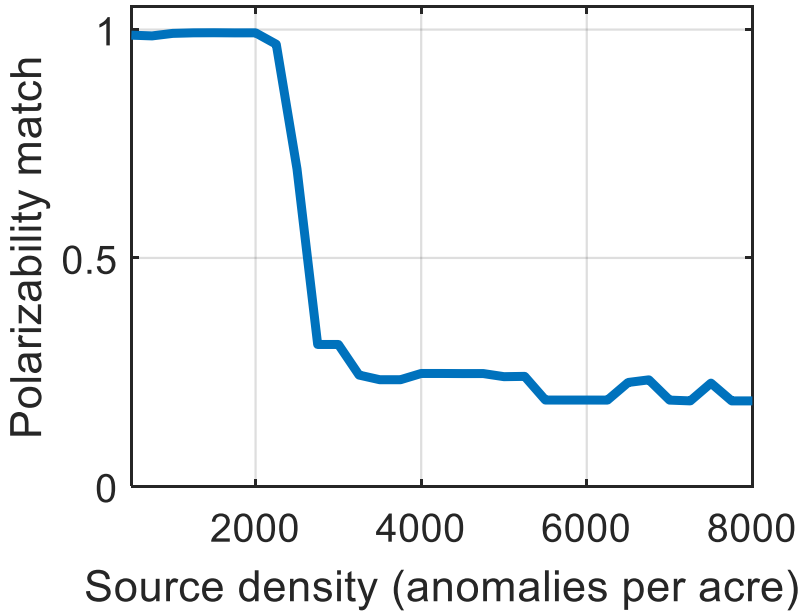


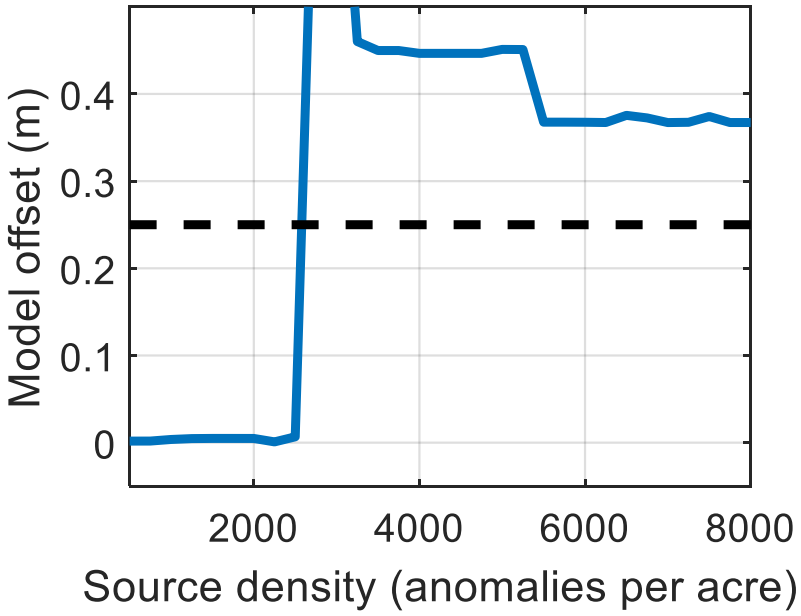
Small ISO polarizabilities
at 8000/acre



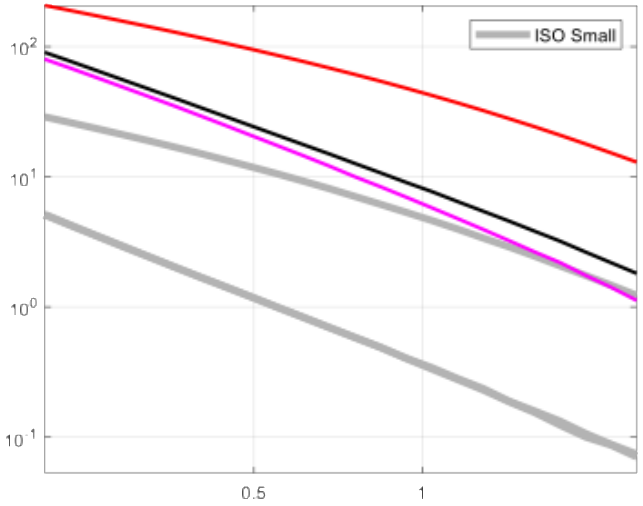
Effect of source density on inversion accuracy

Clutter: medium ISOs





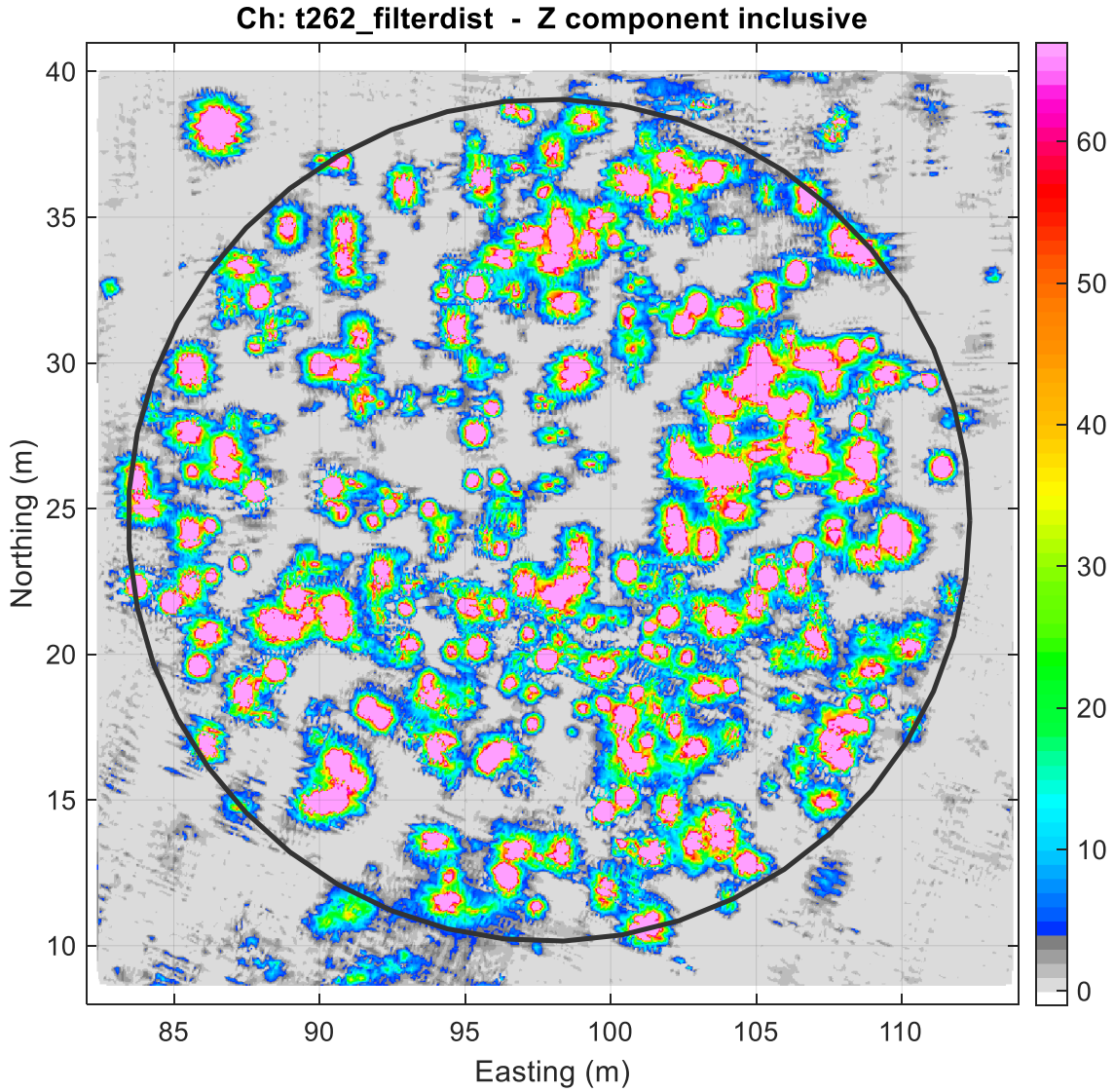
Small ISO polarizabilities at 8000/acre



Conclusion: source density of large sources producing significant signal in the data (relative to TOI) limits AGC in high density areas

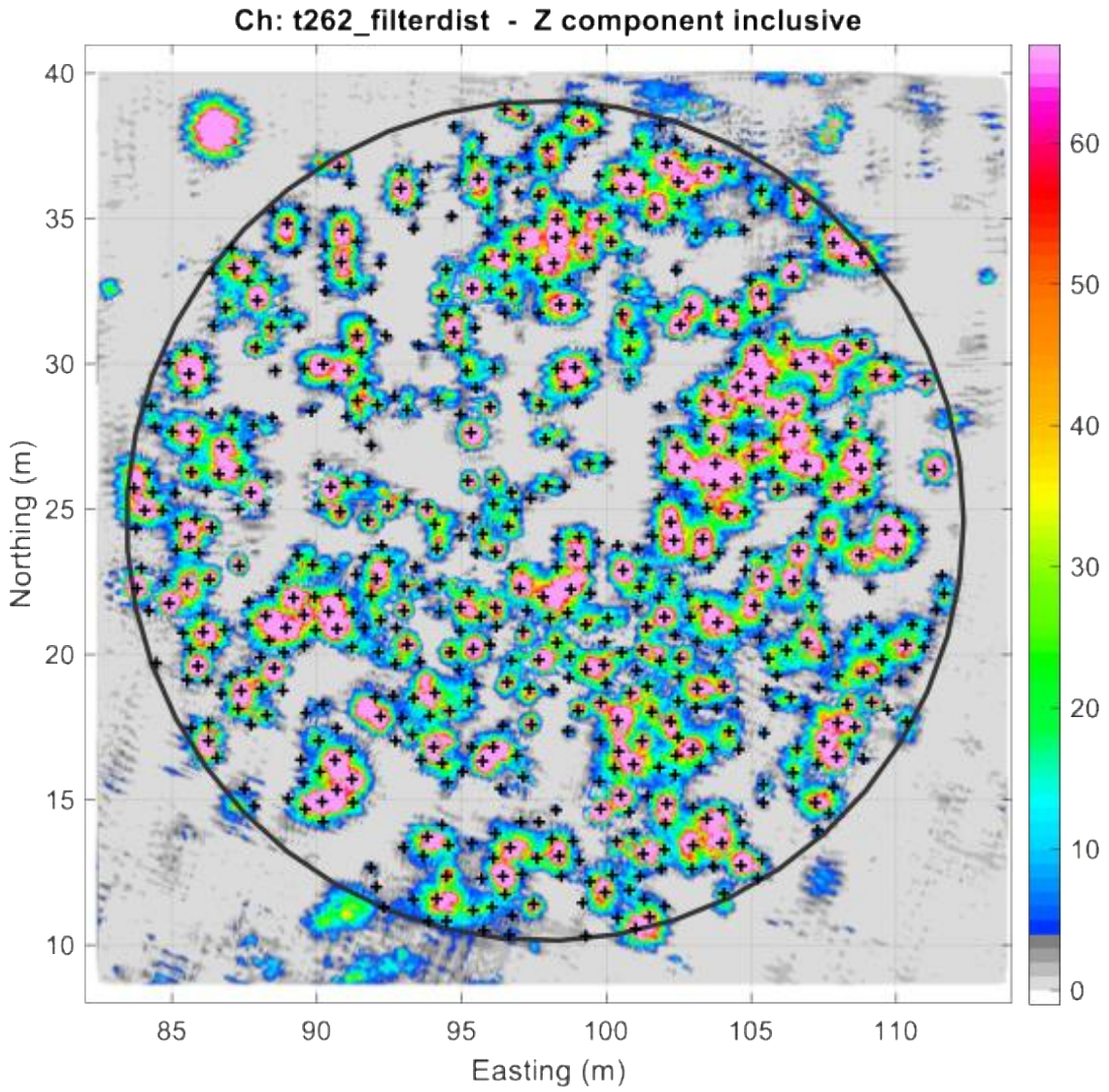
Model-based SRA process

Synthetic bombing target,
3500 sources per acre



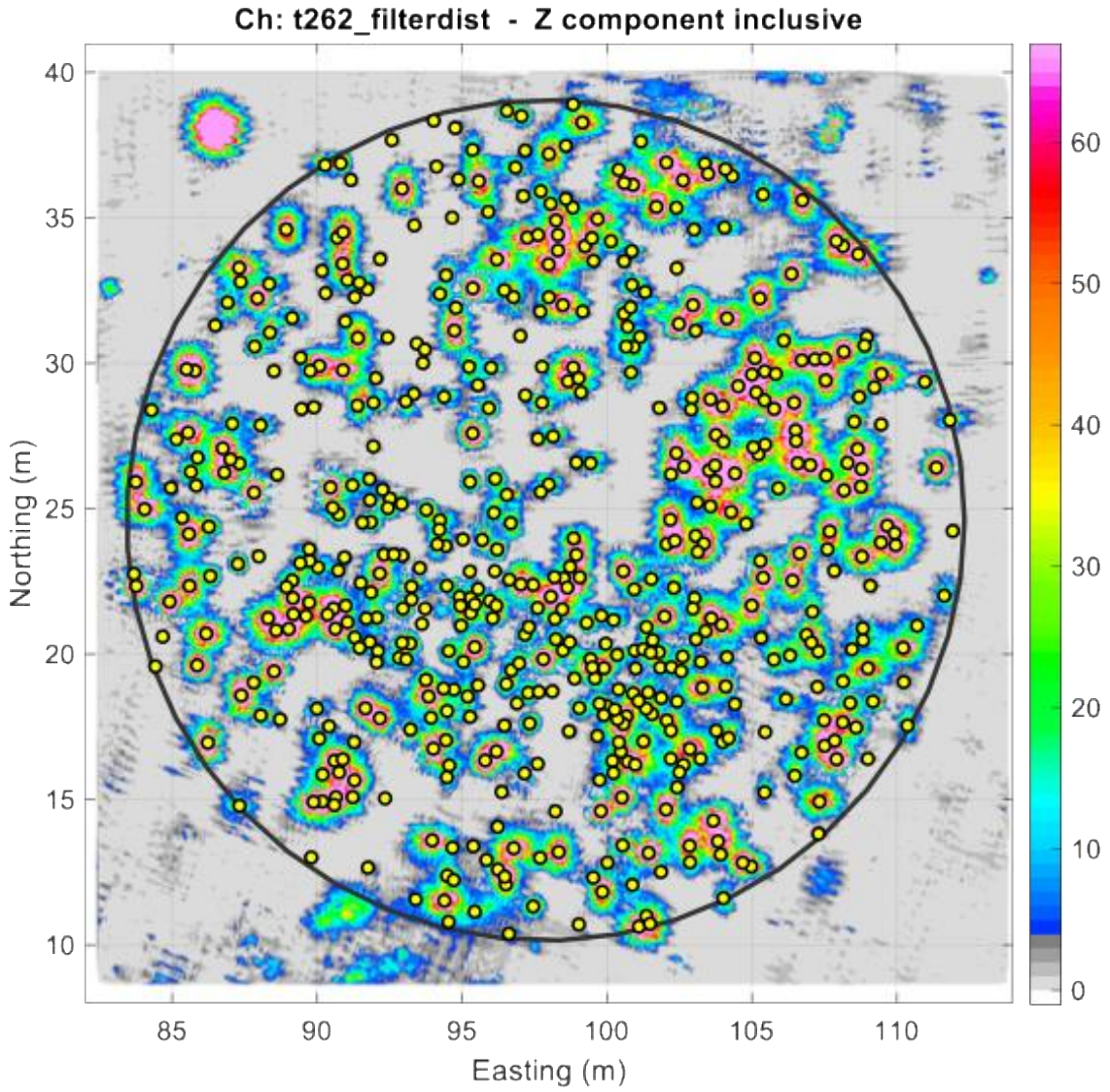
Model-based SRA process: target selection

4350 targets/acre



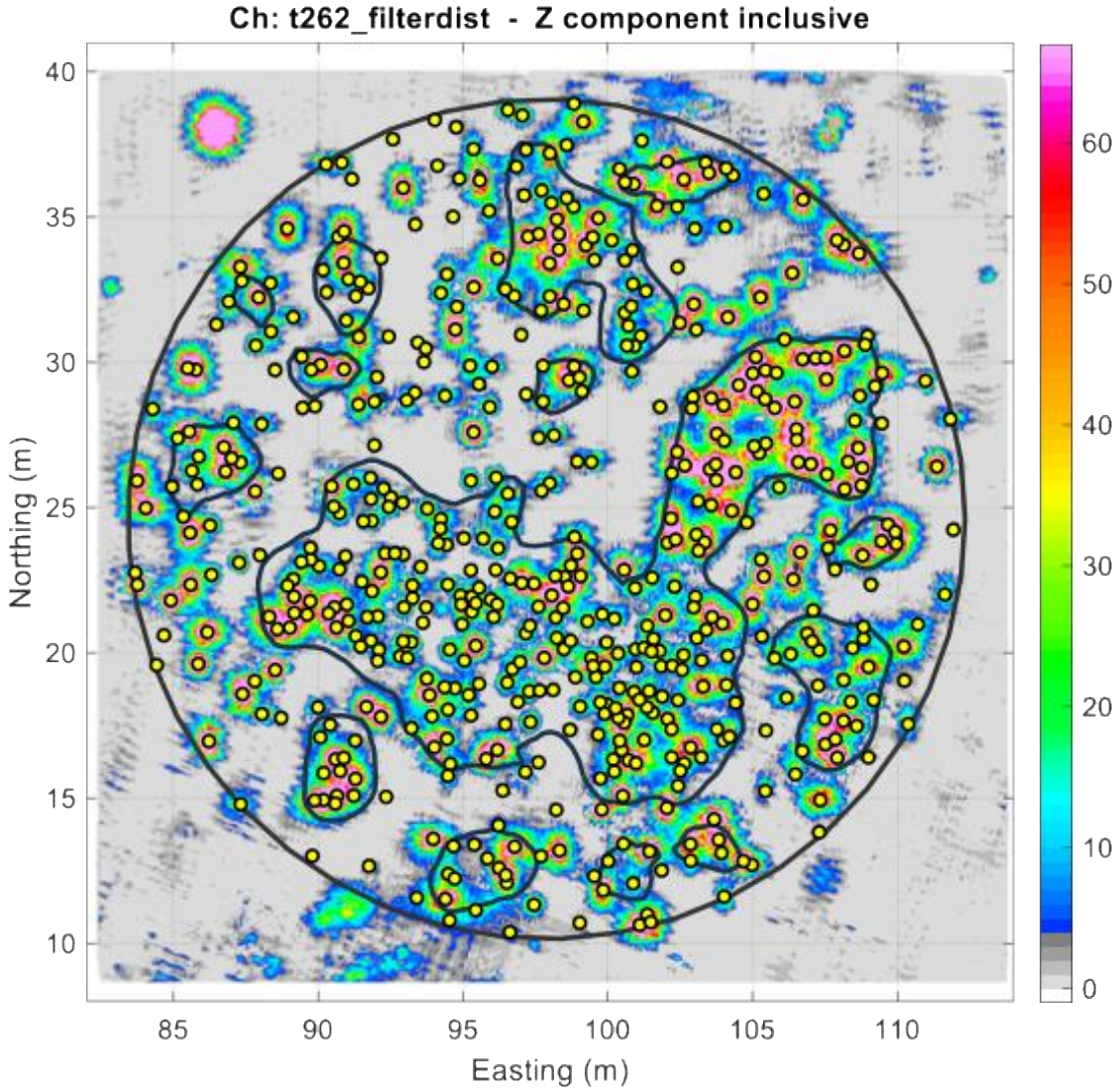
Model-based SRA process: source estimation and informed source selection

3500 sources/acre



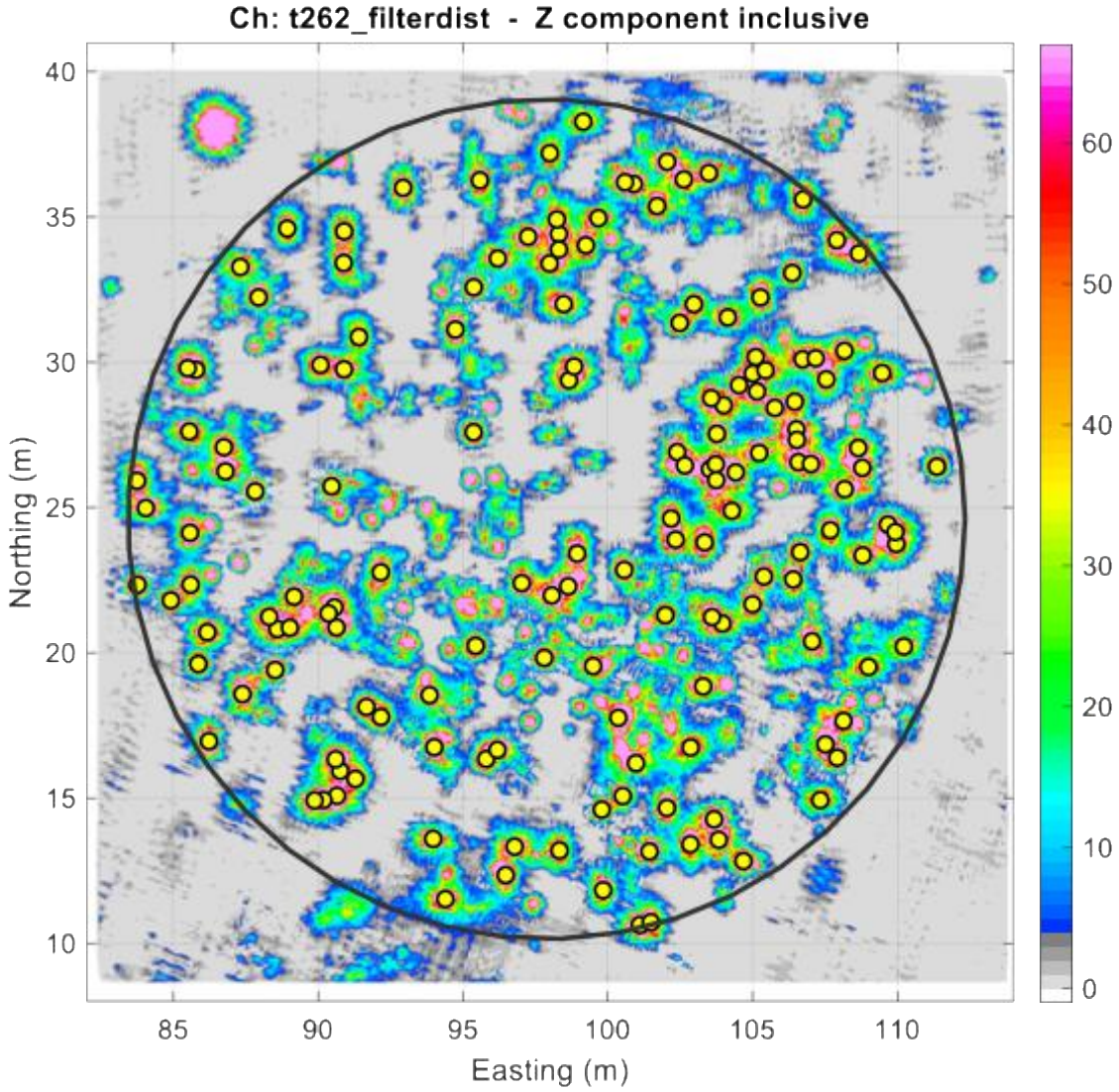
Model-based SRA process: screening

Threshold at 3500 sources/acre

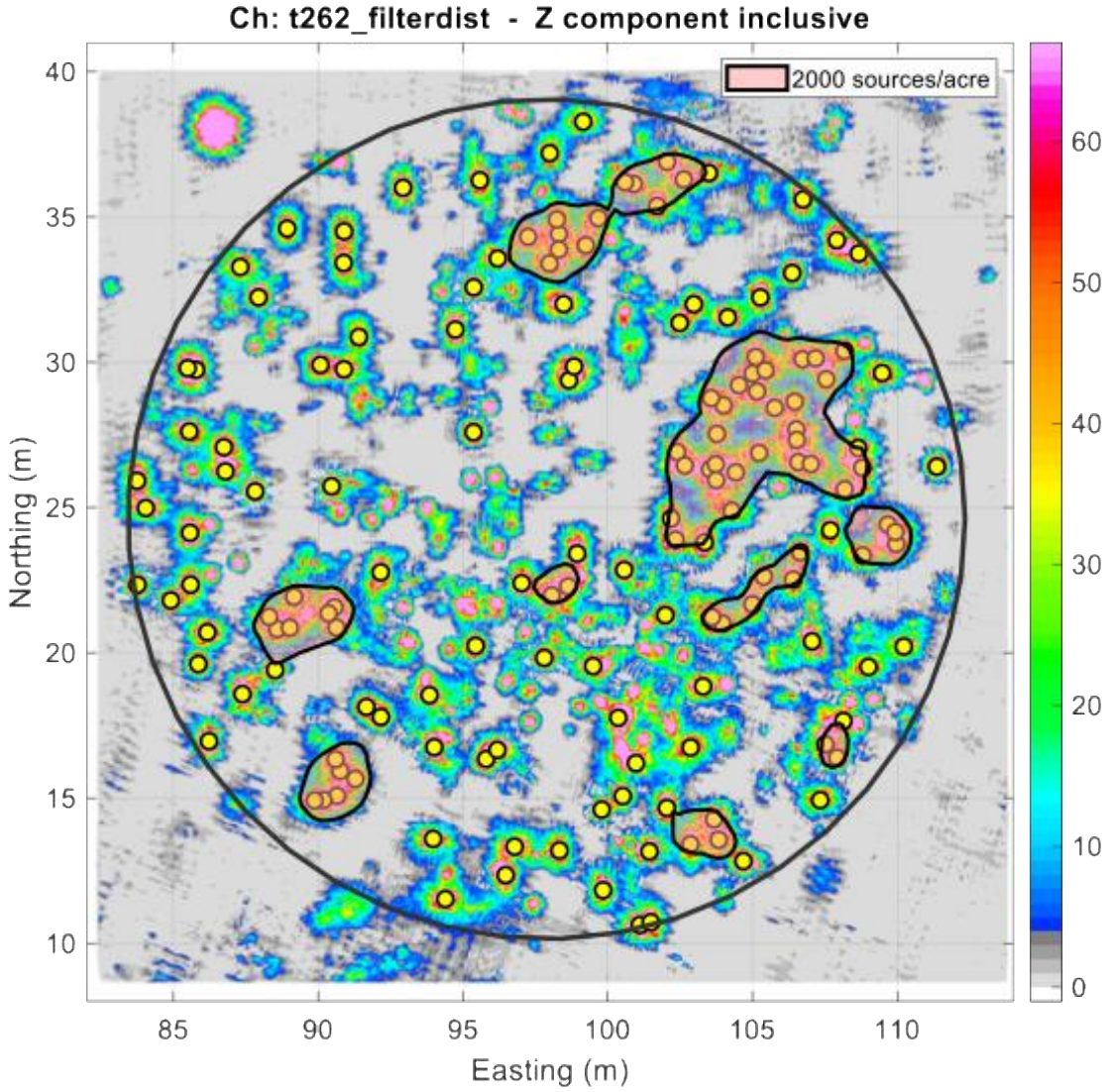


Model-based SRA process: screening

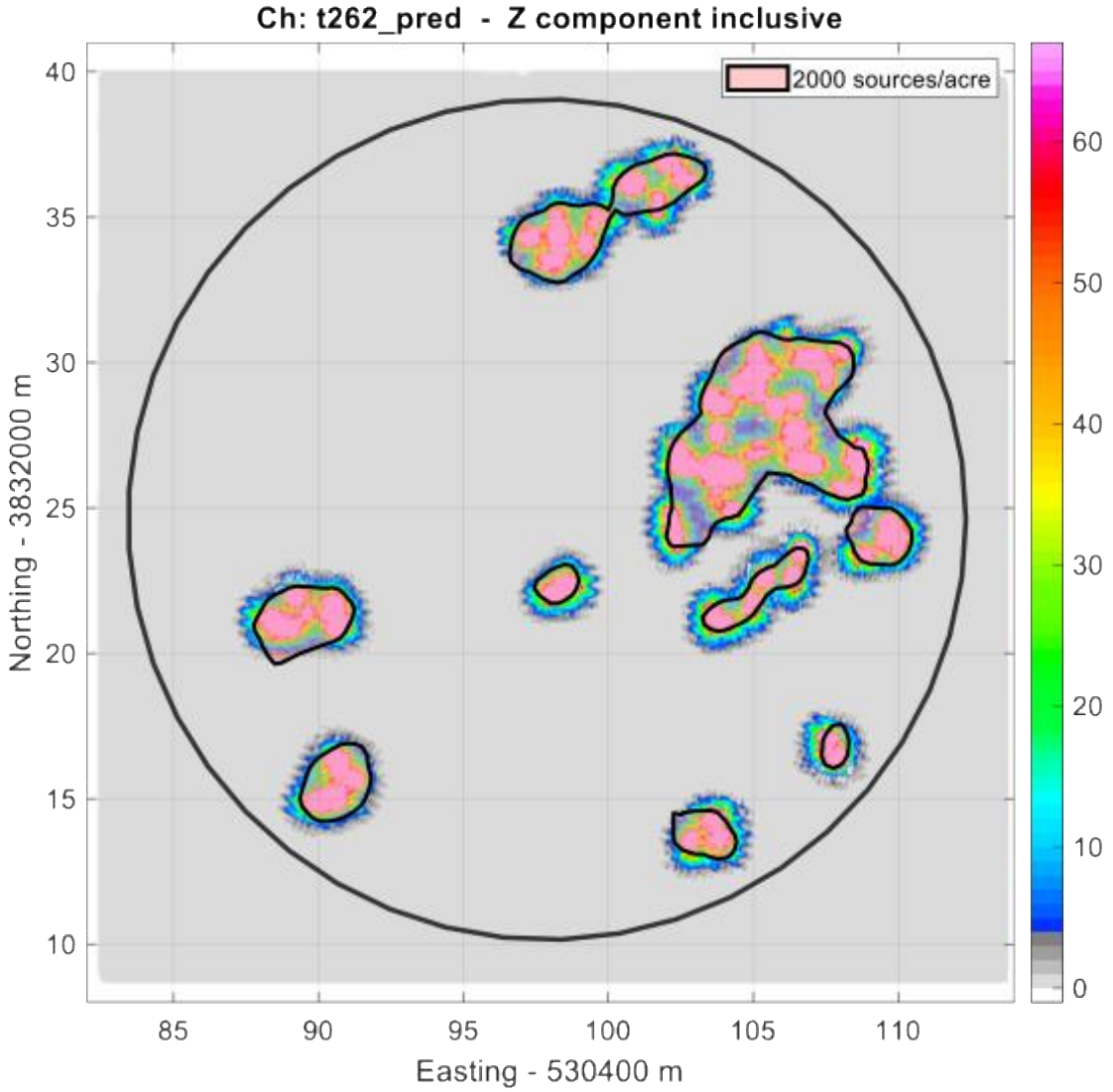
Select large sources that may prevent classification of small TOI



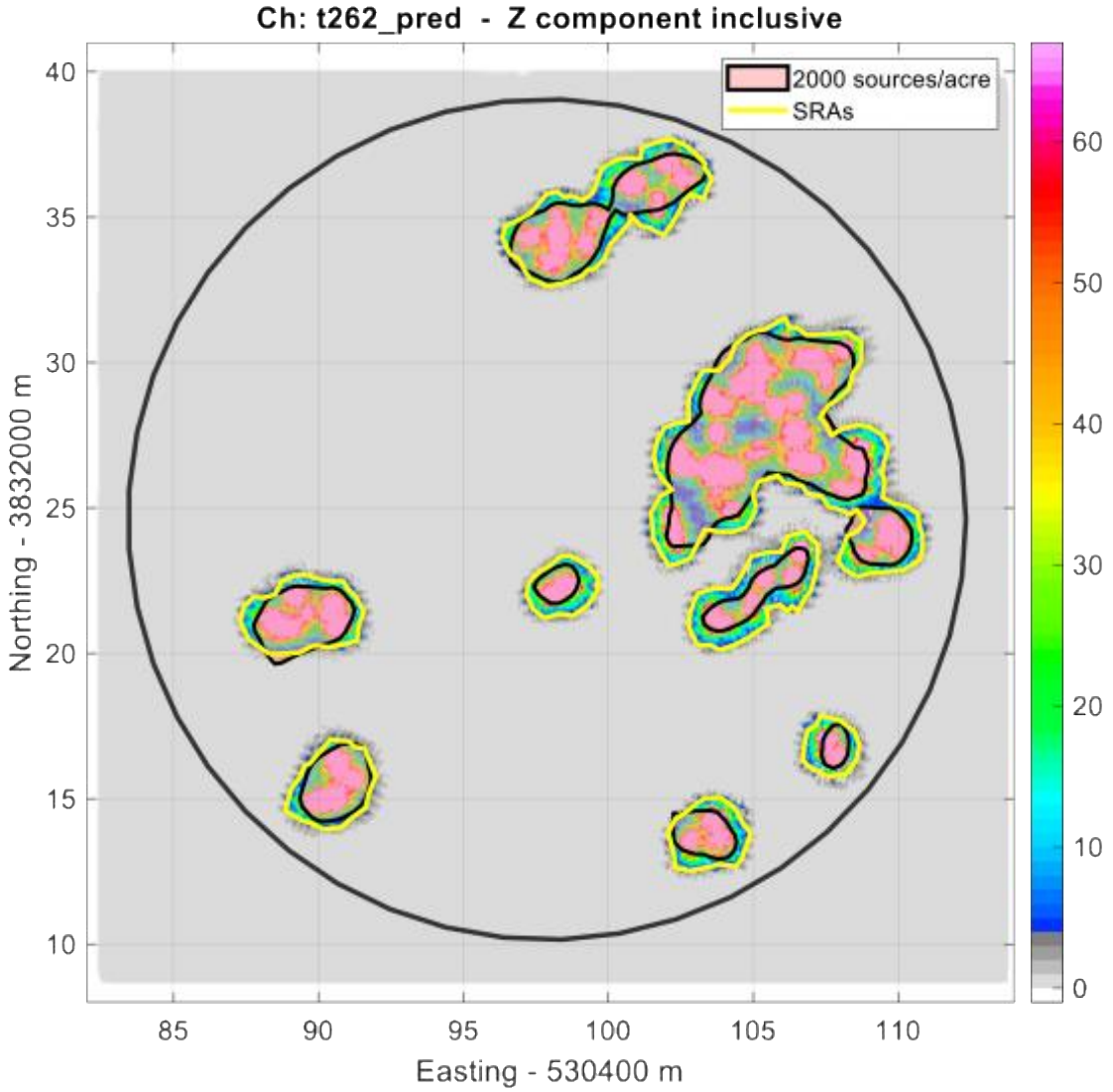
Model-based SRA process: density estimation



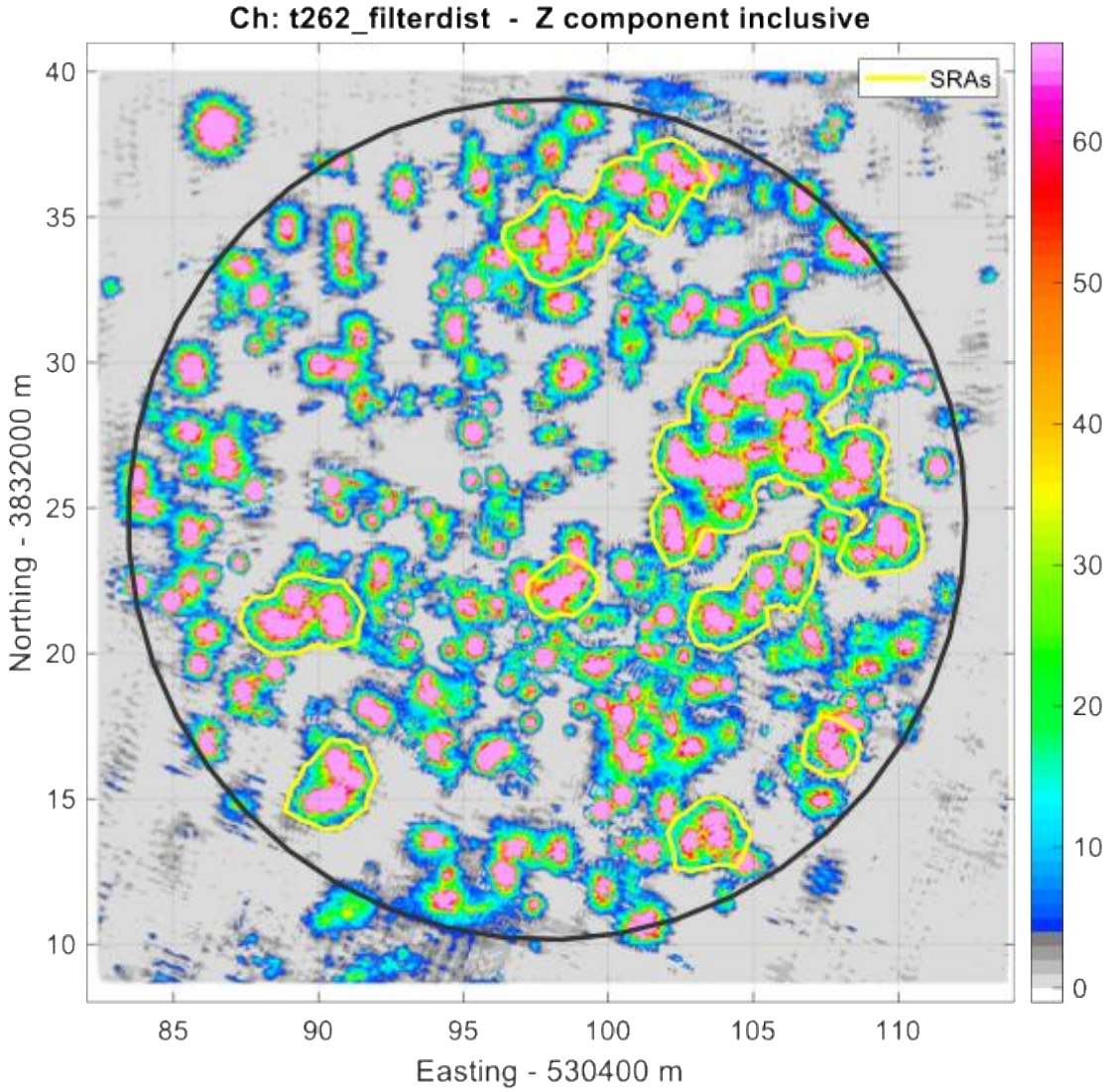
Model-based SRA process: refine boundaries



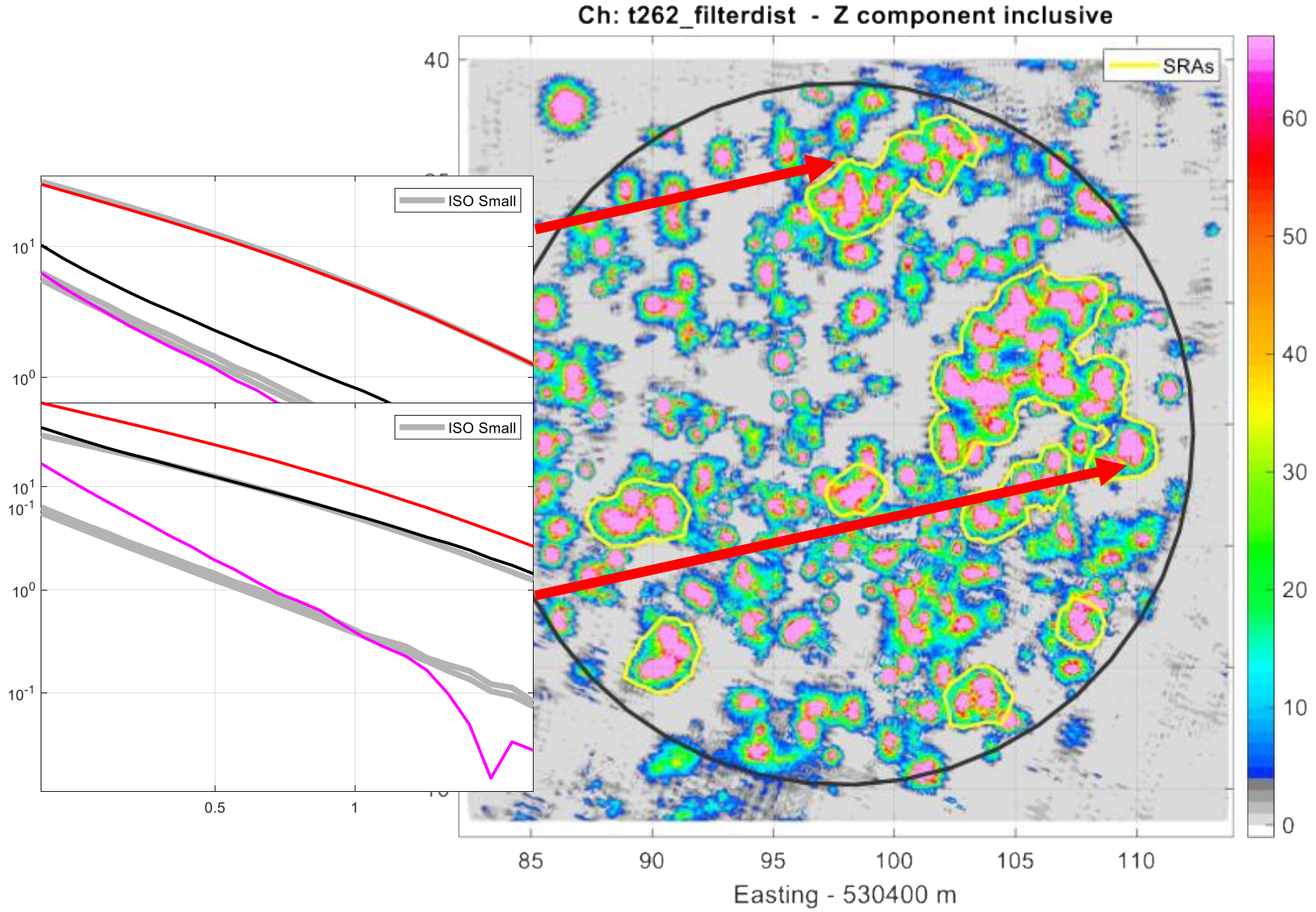
Model-based SRA process: refine boundaries



Model-based SRA process



Model-based SRA process: verification with synthetic seeds



Conclusion

- Model-based SRA delineation:
  - More work and more decision points
  - SRAs focused on sources which will preclude classification of small TOI.
  - Forward modelled data can be used to refine boundaries.

- More to follow with ESTCP SRA project
  - Suggestions welcomed!
  - Postdoctoral position!

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