

Cross Borehole Change Detection

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Geophysics Department

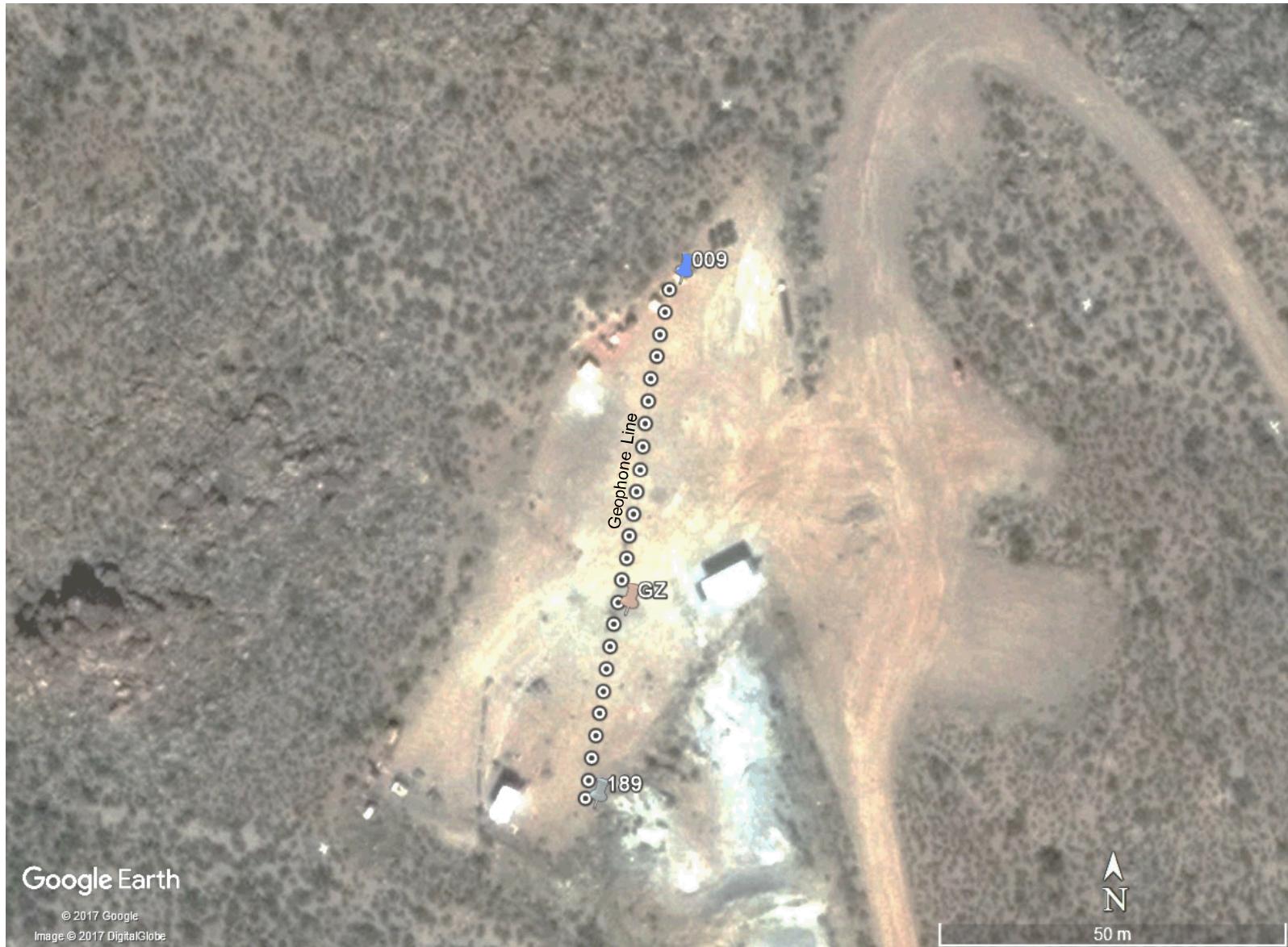


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Acknowledgements

- NSTec: Bob White, Kale McLin, Ryan Emmit, Maggie Townsend, Curtis Obi
- SNL: Nedra Bonal, Fred Helsel, Rebekah Lee, Liam Toney, Matt Geuss, Josh Feldman

Site Map



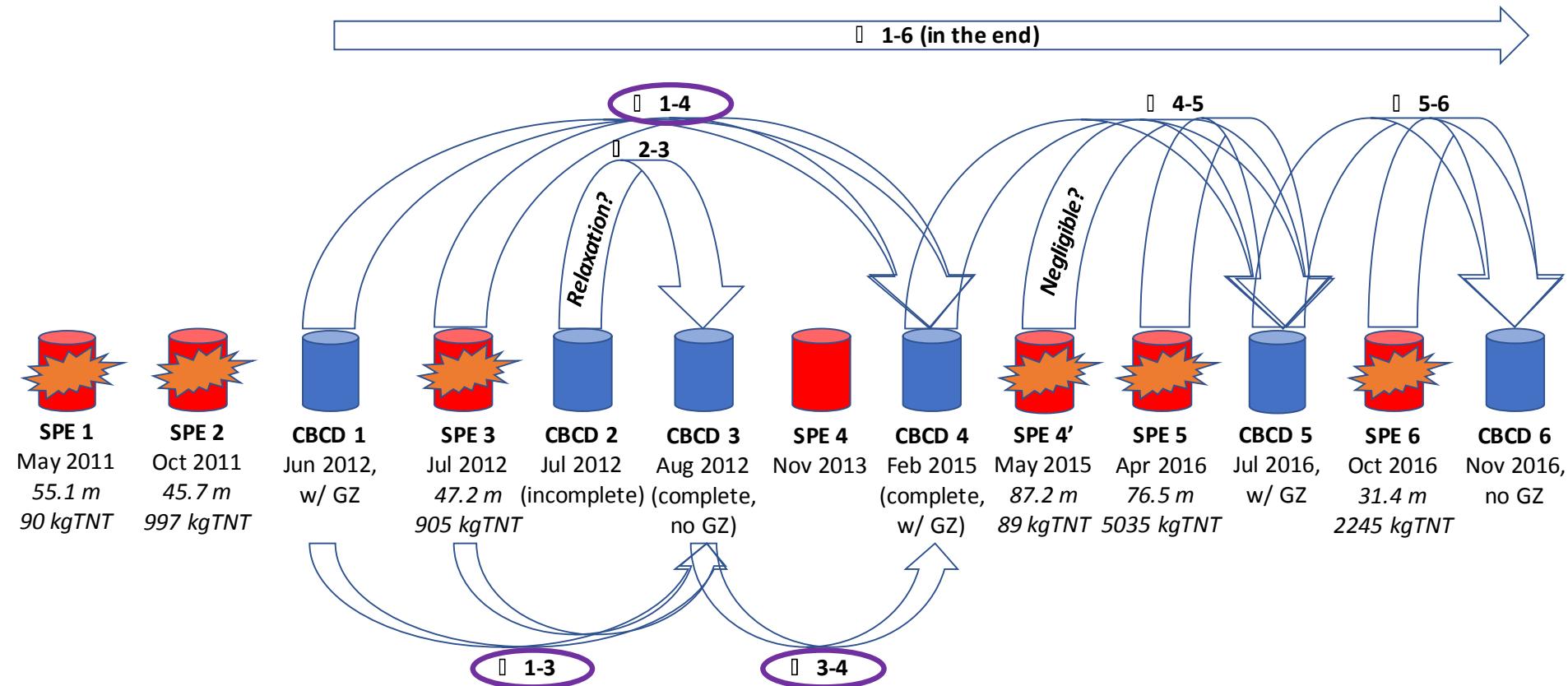
Google Earth

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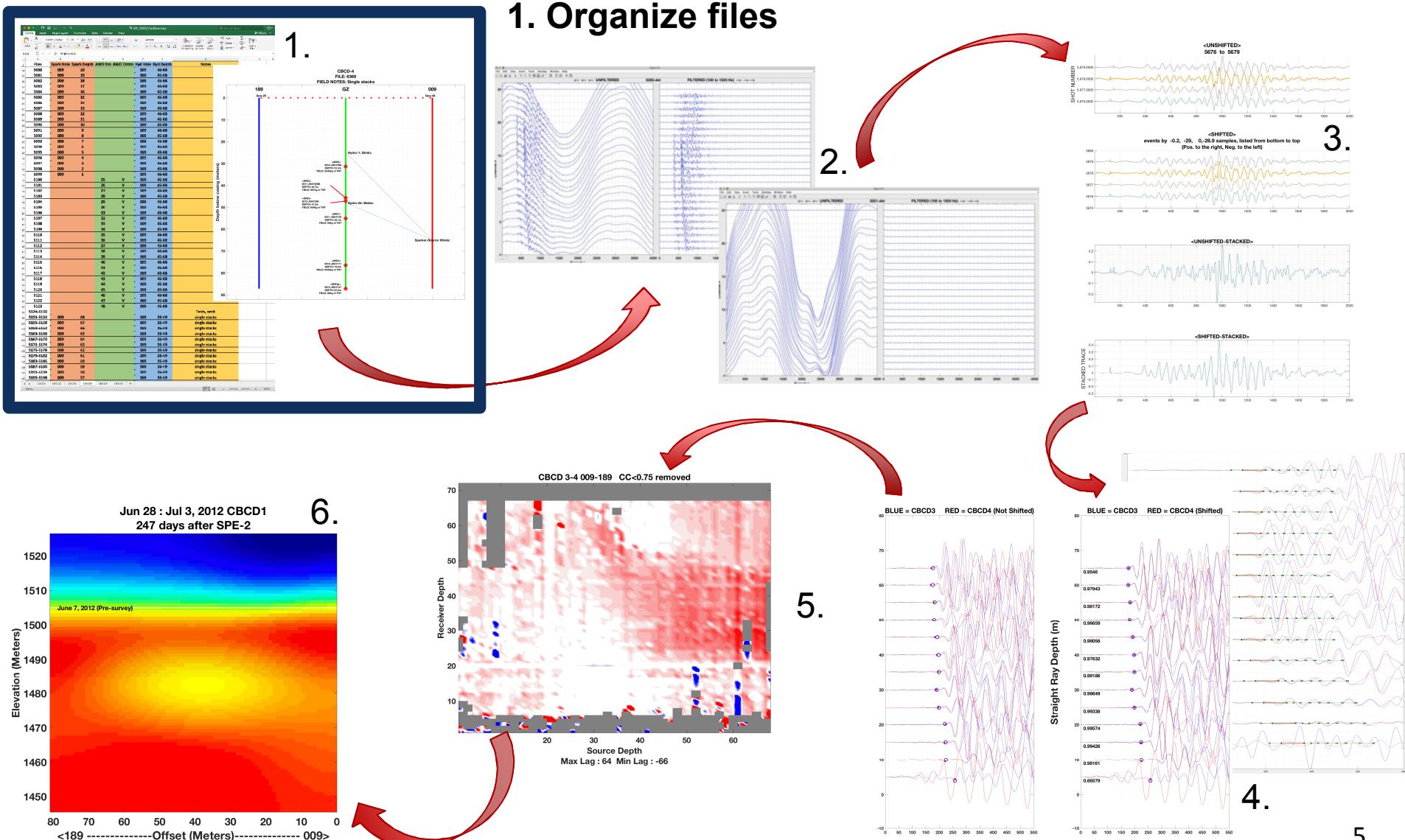
N

50 m

SPE/CBCD Phase Timeline



Change Detection Flow

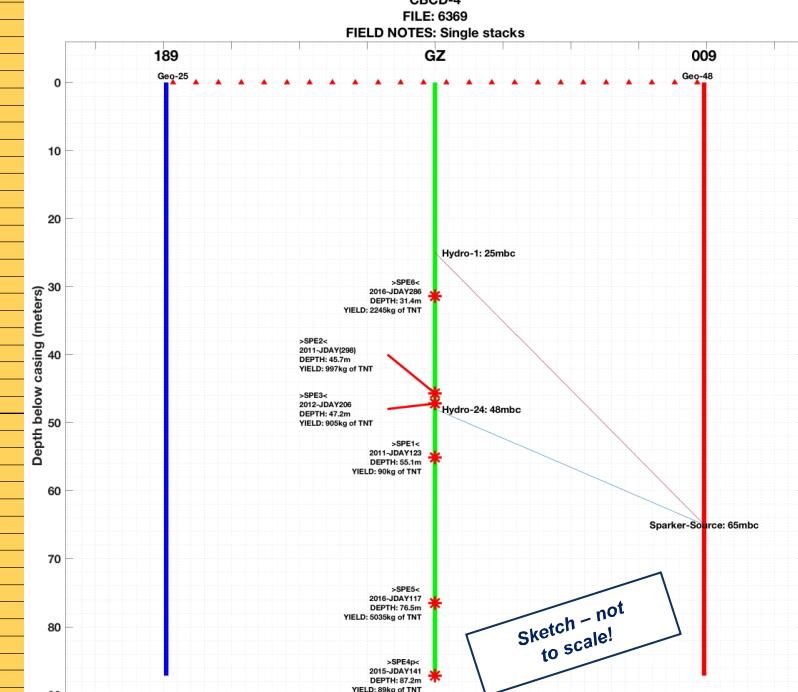


File Structure & Geometry

- Organize file, shot, receiver metadata
- Illustrate geometries to verify coverage, examine anomalies

Excel screenshot showing a table titled "SPE_CB4D_FieldSummary" with data organized by shot number (Files) and receiver number (Spark Hole, Spark Depth, AWD Stn, AWD Orntn, Hyd Hole, Hyd Depth). The "Notes" column contains the text "Tests, omit single stacks". The table has 110 rows, starting from row 1 and ending at row 110. The columns are A through K.

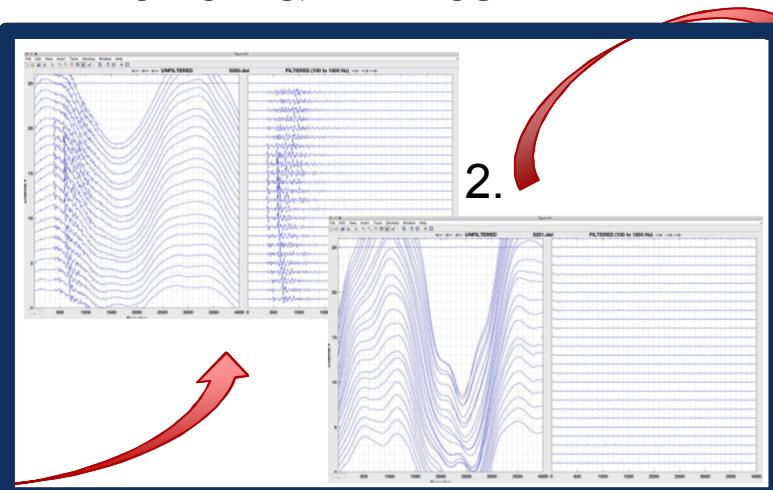
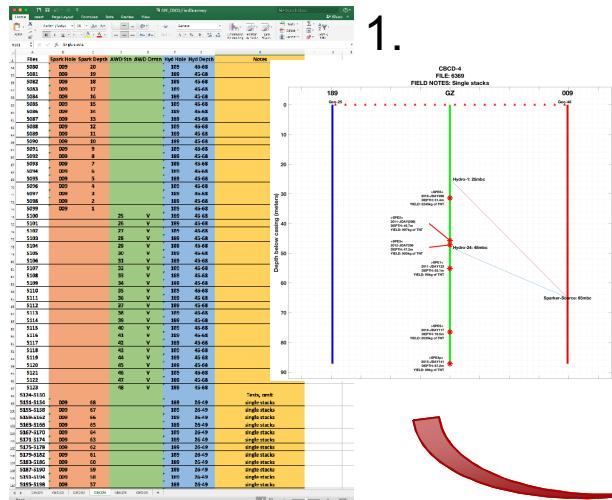
Files	Spark Hole	Spark Depth	AWD Stn	AWD Orntn	Hyd Hole	Hyd Depth	Notes
5080	009	20			189	45-68	
5081	009	19			189	45-68	
5082	009	18			189	45-68	
5083	009	17			189	45-68	
5084	009	16			189	45-68	
5085	009	15			189	45-68	
5086	009	14			189	45-68	
5087	009	13			189	45-68	
5088	009	12			189	45-68	
5089	009	11			189	45-68	
5090	009	10			189	45-68	
5091	009	9			189	45-68	
5092	009	8			189	45-68	
5093	009	7			189	45-68	
5094	009	6			189	45-68	
5095	009	5			189	45-68	
5096	009	4			189	45-68	
5097	009	3			189	45-68	
5098	009	2			189	45-68	
5099	009	1			189	45-68	
5100			25	V	189	45-68	
5101			26	V	189	45-68	
5102			27	V	189	45-68	
5103			28	V	189	45-68	
5104			29	V	189	45-68	
5105			30	V	189	45-68	
5106			31	V	189	45-68	
5107			32	V	189	45-68	
5108			33	V	189	45-68	
5109			34	V	189	45-68	
5110			35	V	189	45-68	
5111			36	V	189	45-68	
5112			37	V	189	45-68	
5113			38	V	189	45-68	
5114			39	V	189	45-68	
5115			40	V	189	45-68	
5116			41	V	189	45-68	
5117			42	V	189	45-68	
5118			43	V	189	45-68	
5119			44	V	189	45-68	
5120			45	V	189	45-68	
5121			46	V	189	45-68	
5122			47	V	189	45-68	
5123			48	V	189	45-68	
5124-5150							Tests, omit single stacks
5151-5154	009	68			189	26-49	single stacks
5155-5158	009	67			189	26-49	single stacks
5159-5162	009	66			189	26-49	single stacks
5163-5166	009	65			189	26-49	single stacks
5167-5170	009	64			189	26-49	single stacks
5171-5174	009	63			189	26-49	single stacks
5175-5178	009	62			189	26-49	single stacks
5179-5182	009	61			189	26-49	single stacks
5183-5186	009	60			189	26-49	single stacks
5187-5190	009	59			189	26-49	single stacks
5191-5194	009	58			189	26-49	single stacks
5195-5198	009	57			189	26-49	single stacks



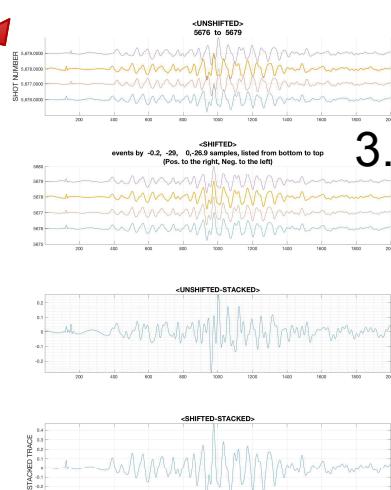
Change Detection Flow

2. Review & kill files

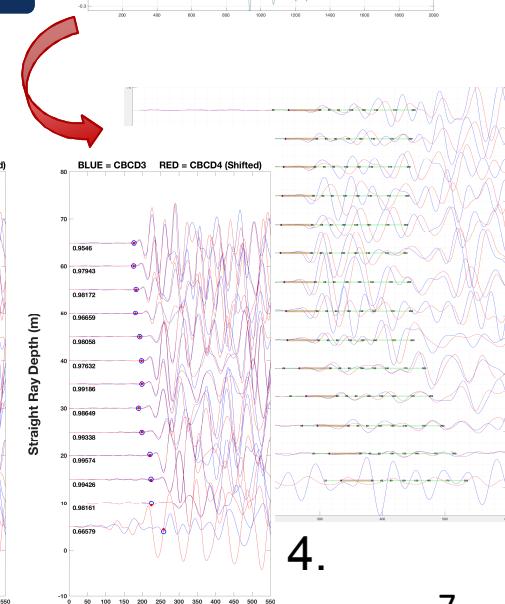
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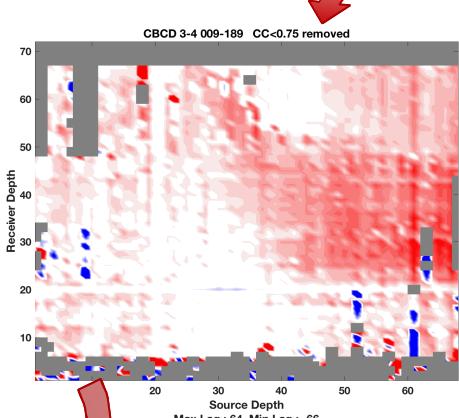
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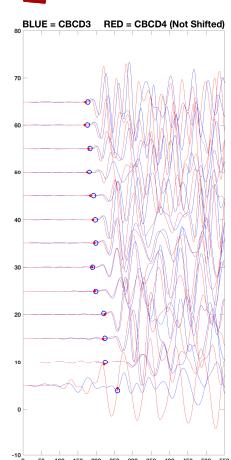
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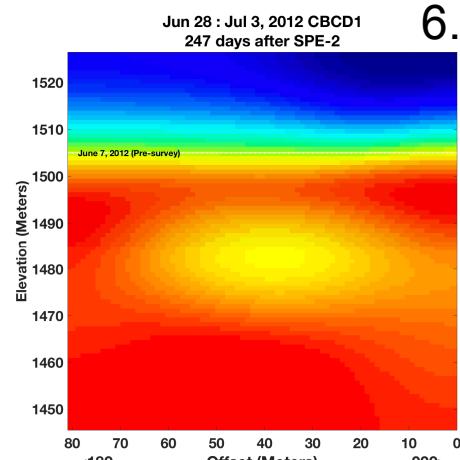
4.



5.



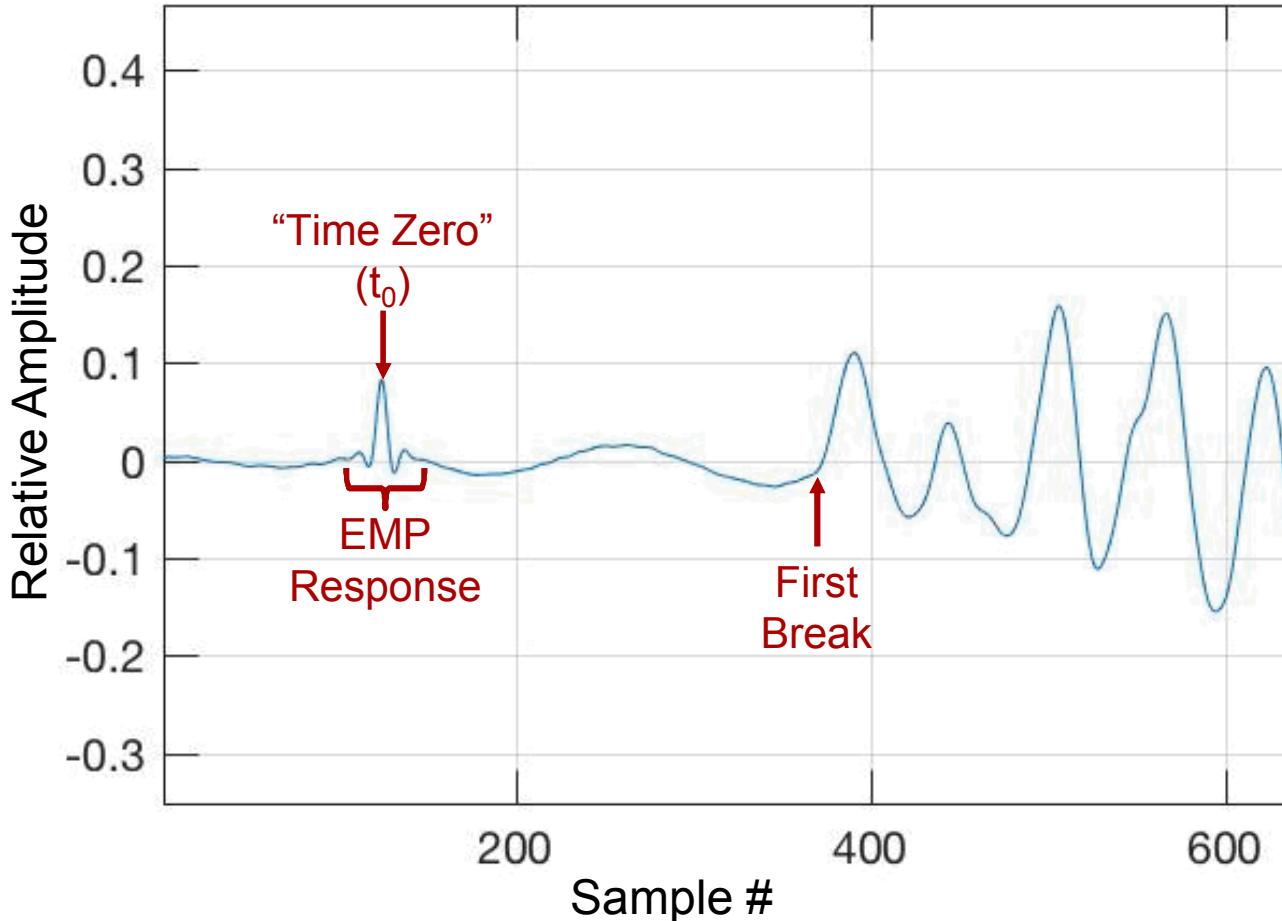
Jun 28 : Jul 3, 2012 CBCD1
247 days after SPE-2



6.

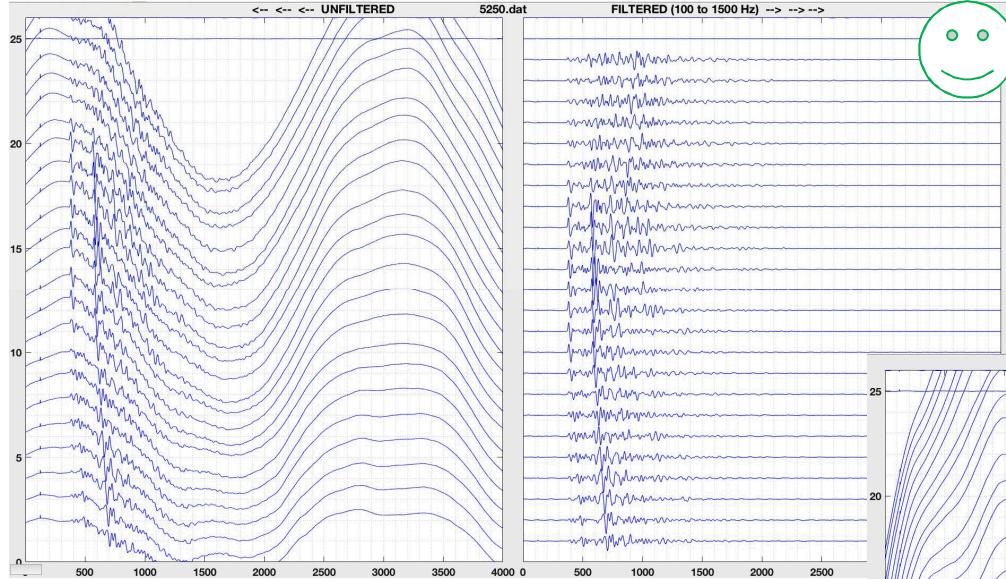
7

A “Typical” Trace

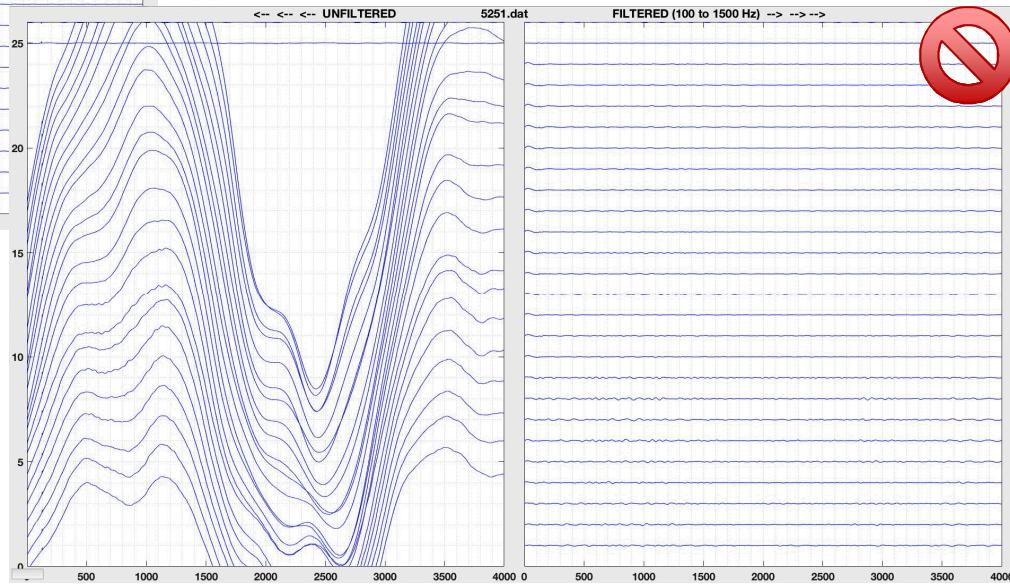


- Ideally, EMP response appears at 160 samples (t_0)...
- BUT that's not always the case!

CBCD 4 File Kills



- 24 hydrophone channels

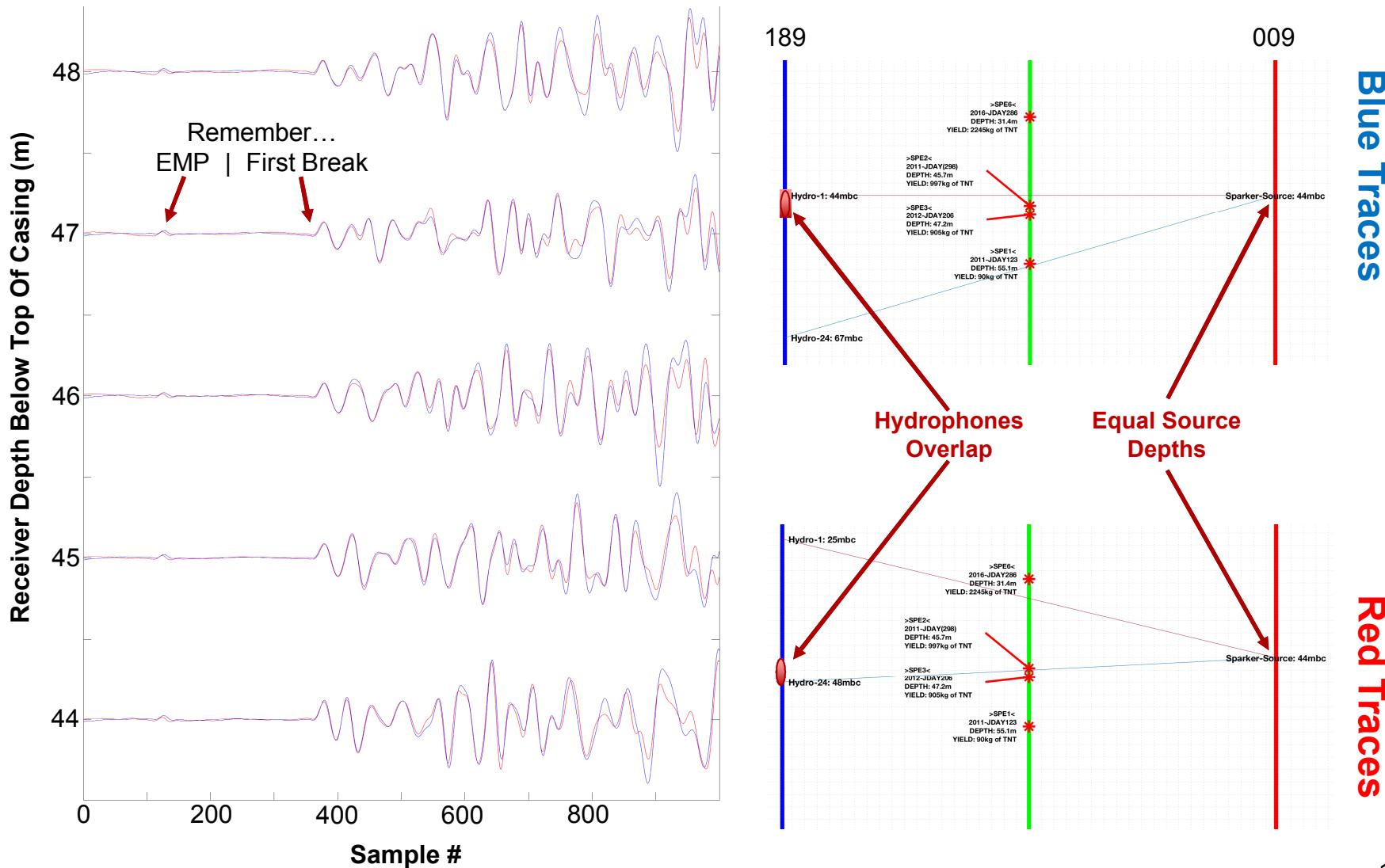


- Time (horizontal) axis shown in units of 'samples'
 - 16,000 samples/sec, or 62.5 μ s sample interval
- Depth (vertical) axis shown in units of 'meters below top of casing'

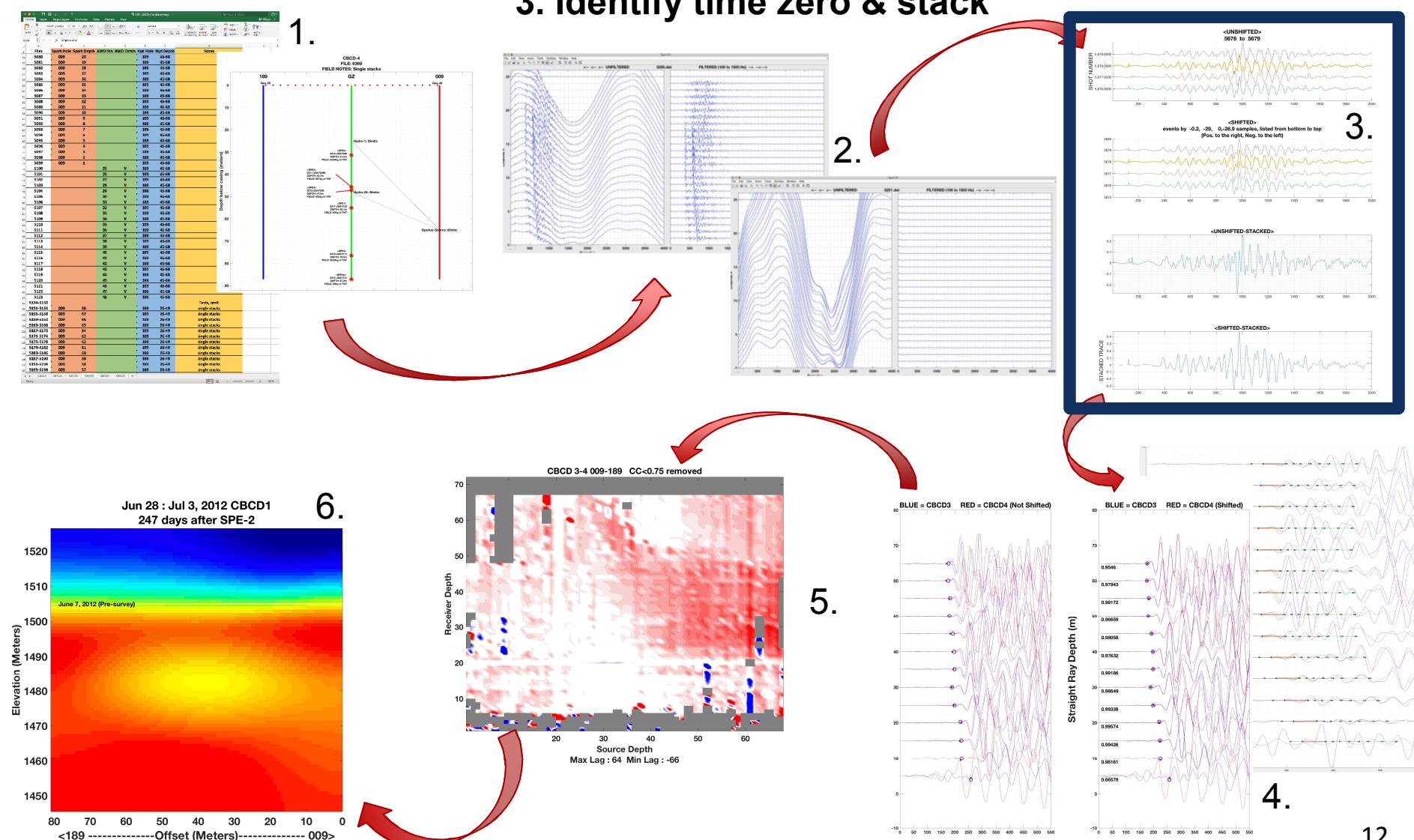
CBCD4 Kill File Statistics

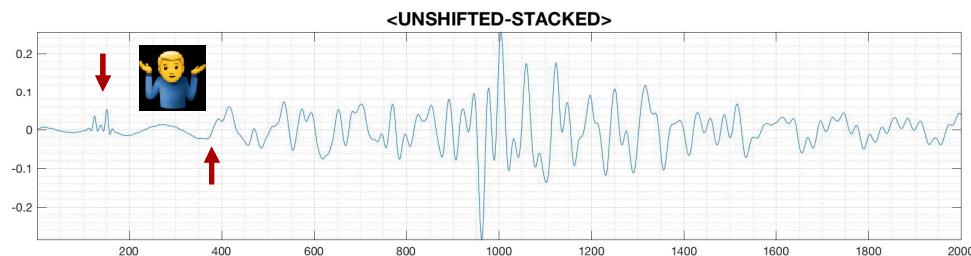
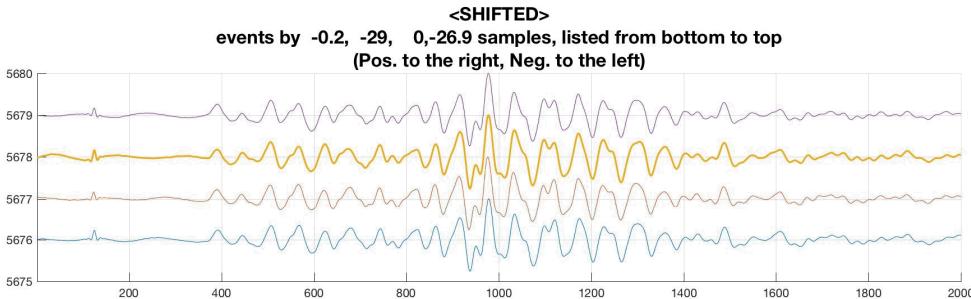
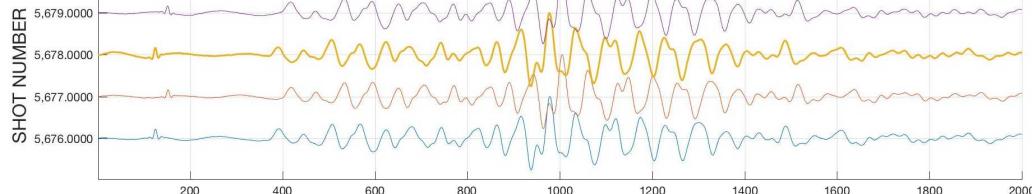
<u>CBCD4</u>	<u>Kills</u>	<u>Totals</u>	<u>% Killed</u>	<u>Notes</u>
009-189	7	70	10.0%	<i>Pre-stacked; KILLED = LOST SHOTS</i>
009-189	43	638	6.7%	Single-stack files; NO LOST SHOTS
009-GZ	16	551	2.9%	Single-stack files; NO LOST SHOTS
189-GZ	7	275	2.5%	Single-stack files; NO LOST SHOTS
CBCD4 Total	66	1464	4.5%	Single-stack files only

CBCD4 – Repeated Source Locations at Reoccupied Receivers (Shot Gather)

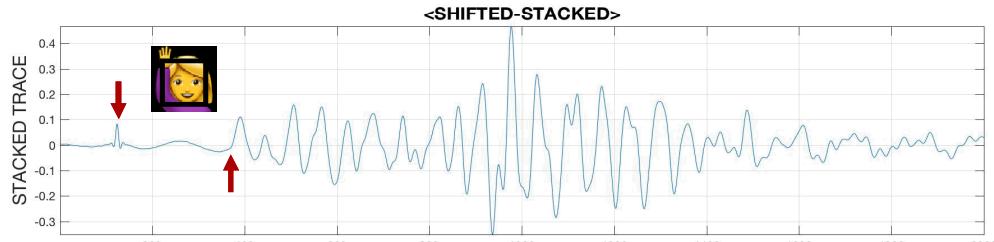


Change Detection Flow





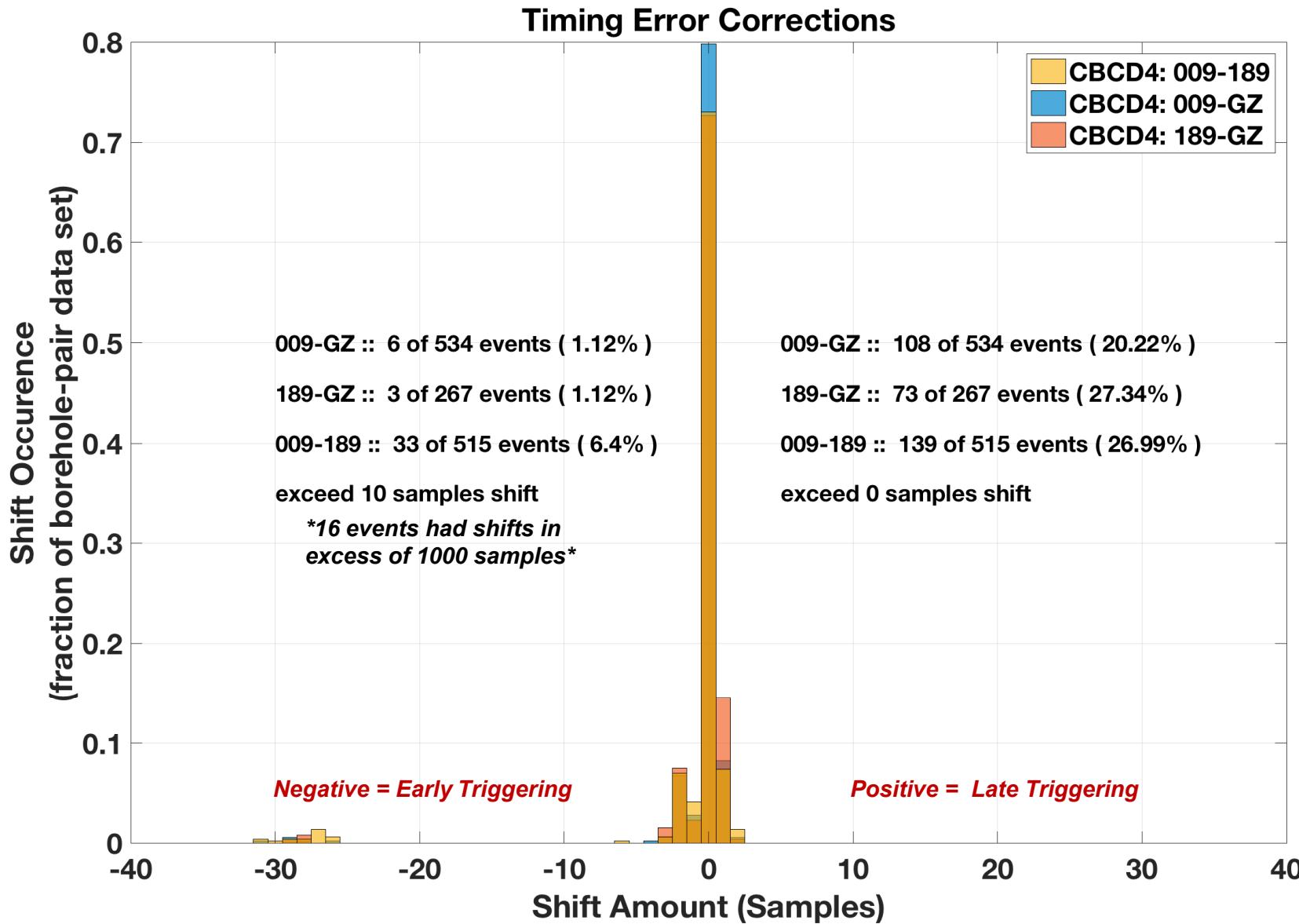
"Who can pick t_0 & first break?"



Shift & Stack

- CBCD4 files
- Use EMP response to align traces – t_0
- Note signal enhancement!

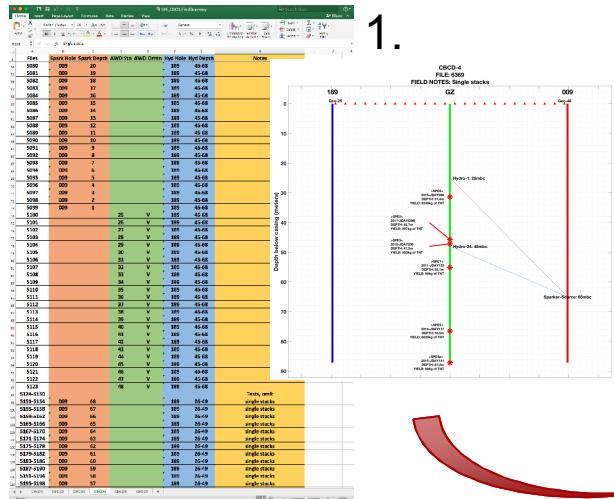
CBCD4 Timing Statistics



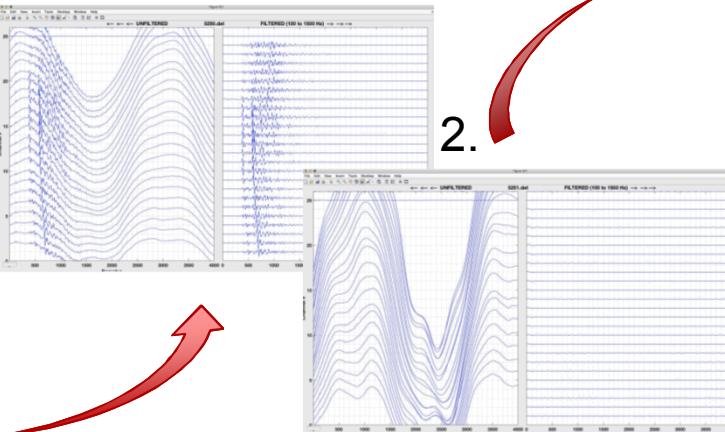
Change Detection Flow

4. Cross correlate

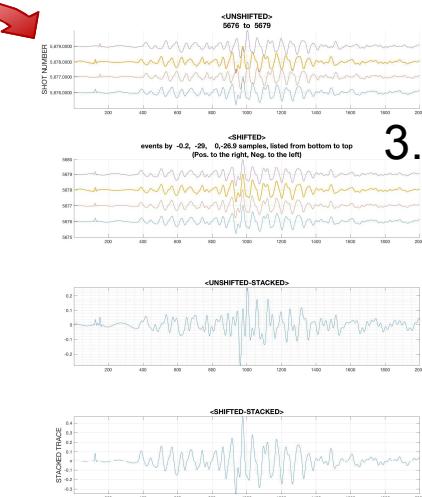
1.



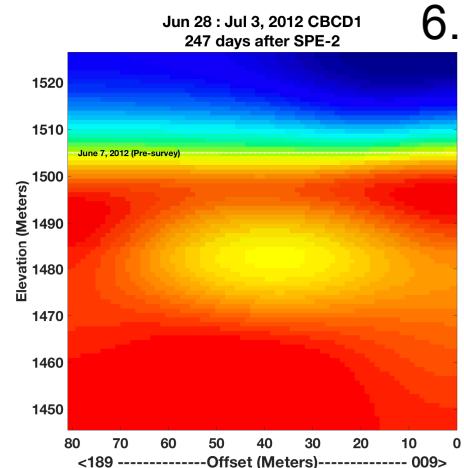
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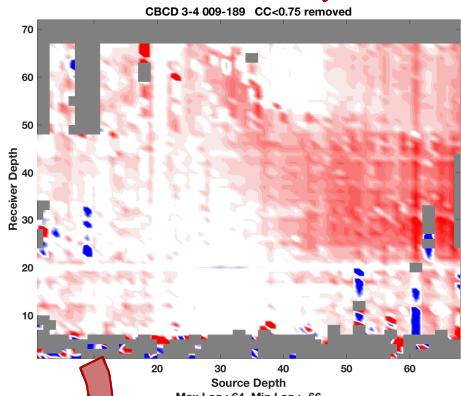
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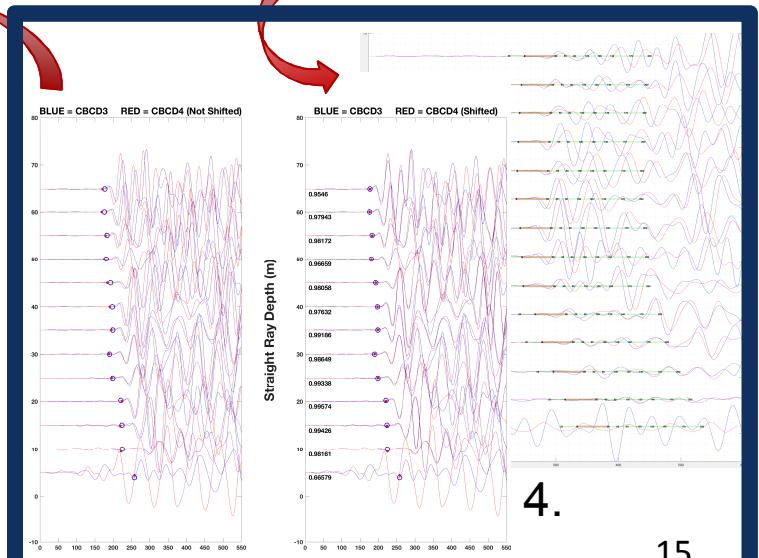
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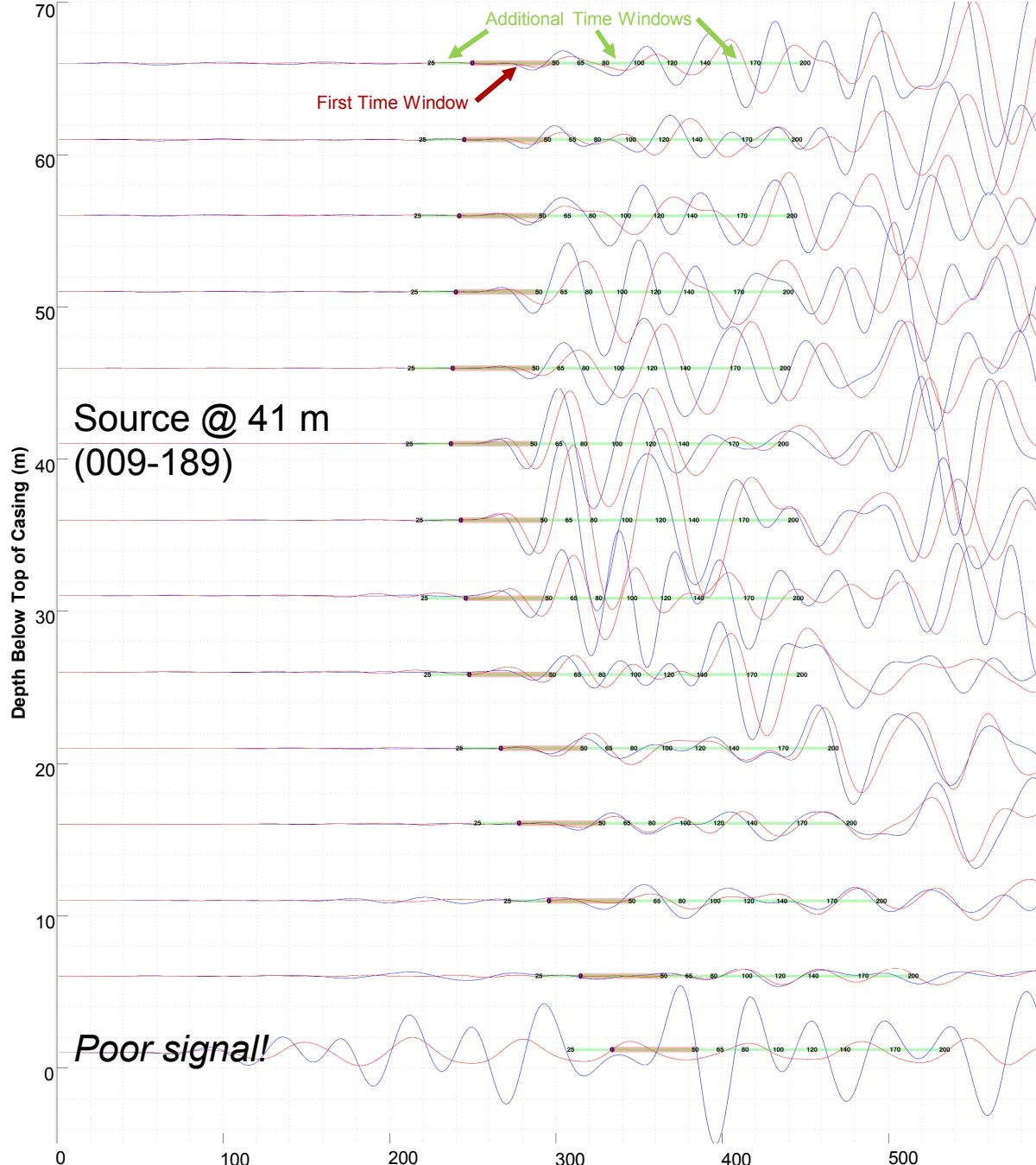


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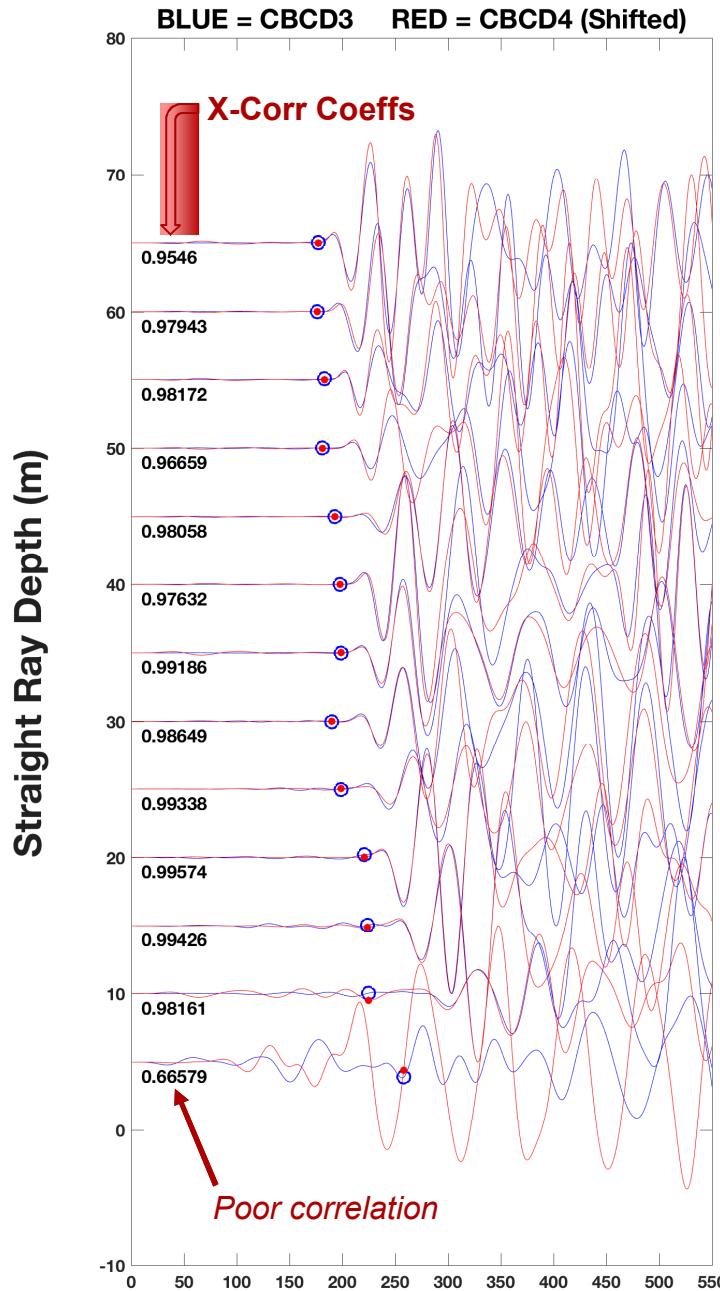
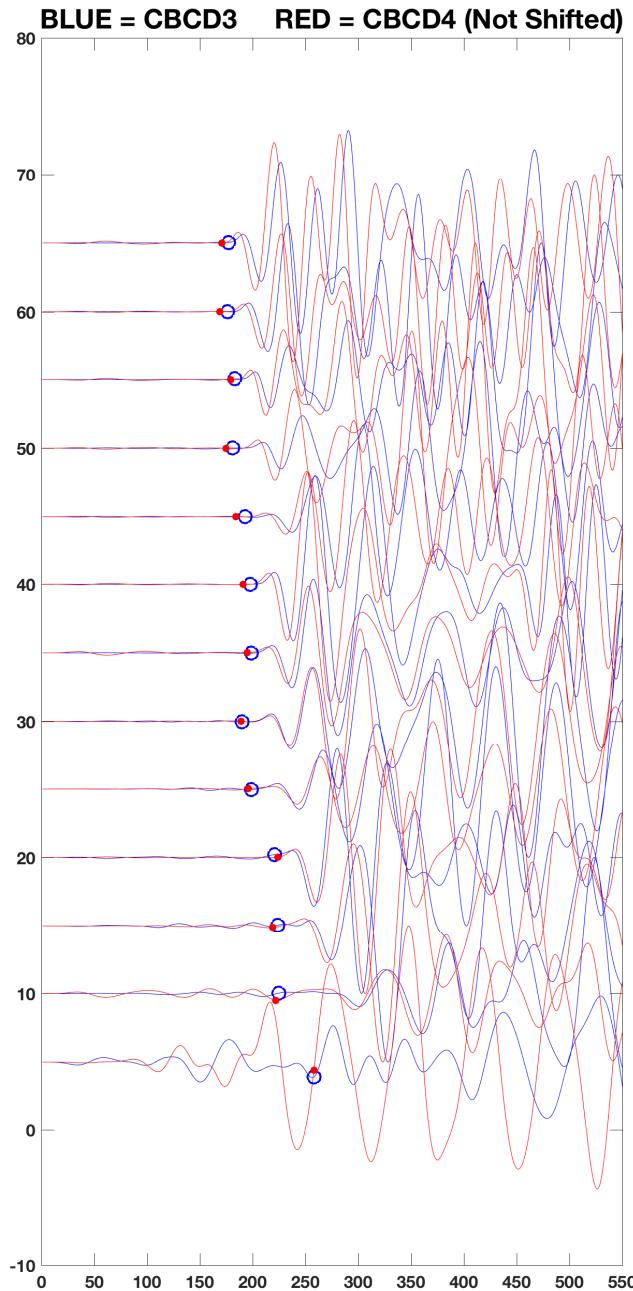
4.





First Breaks

- Shot Gather
- Use previous first breaks (e.g., CBCD3 – black dot & blue traces) as reference for cross-correlation windows (e.g., CBCD4 – red traces)
- Note shift to t_0 (EMP @ 0)!

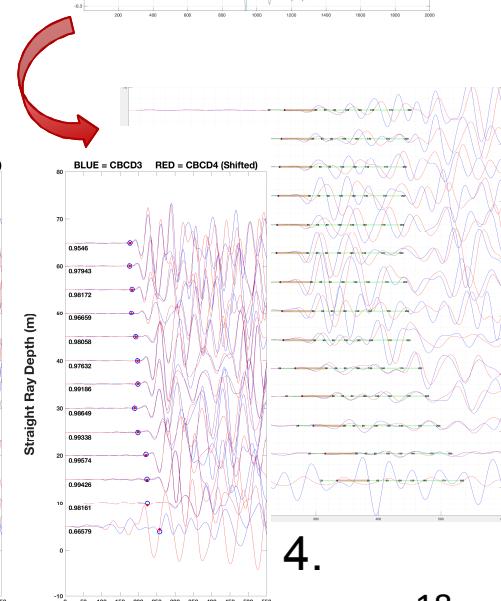
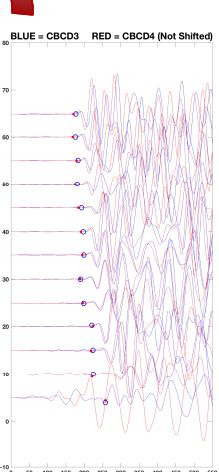
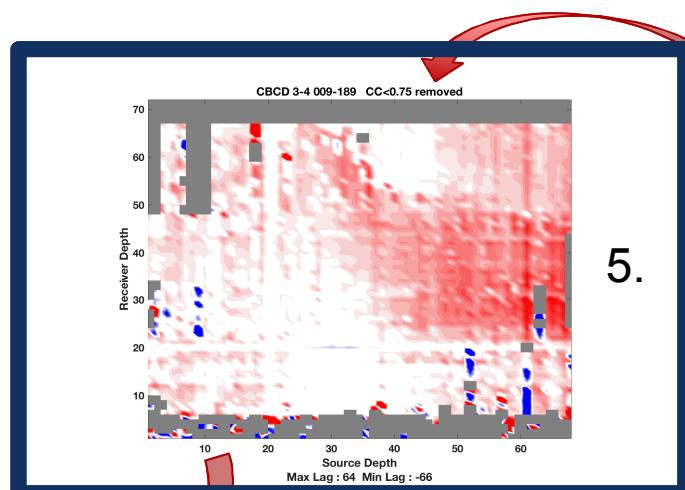
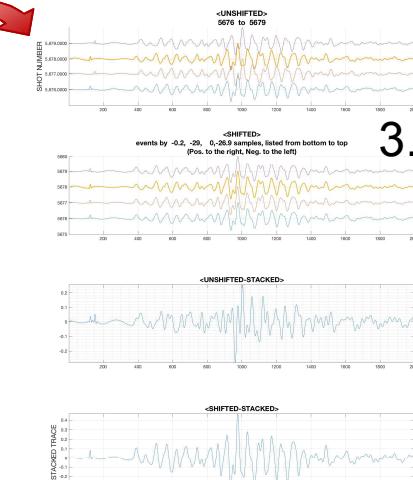
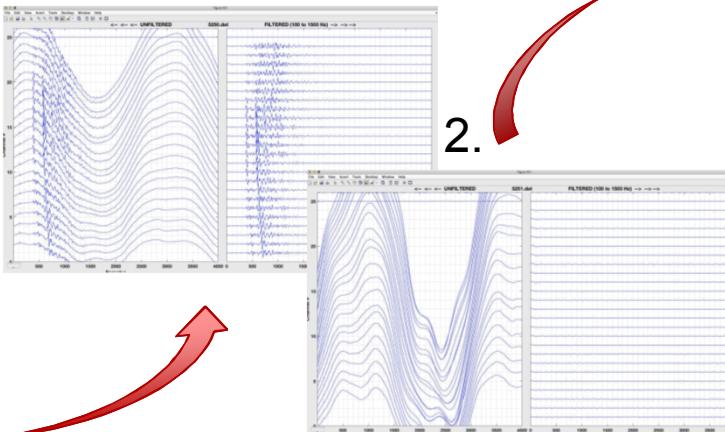
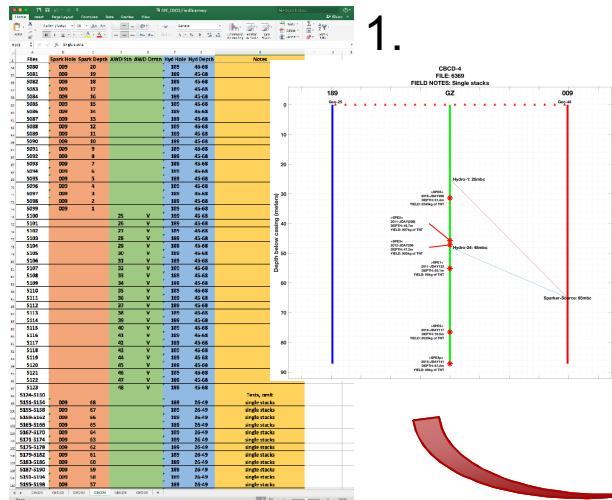


Cross Correlation

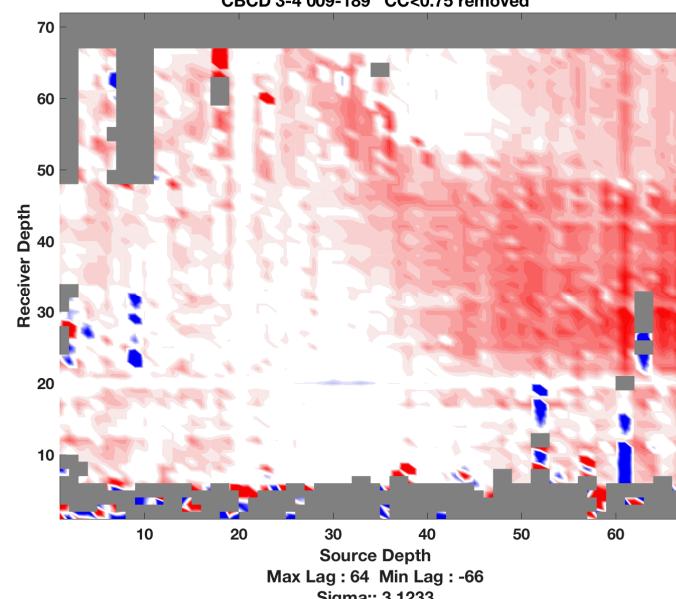
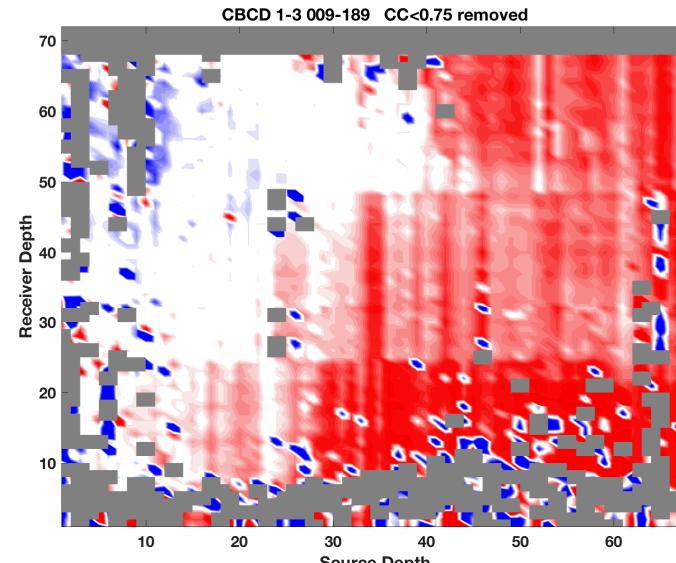
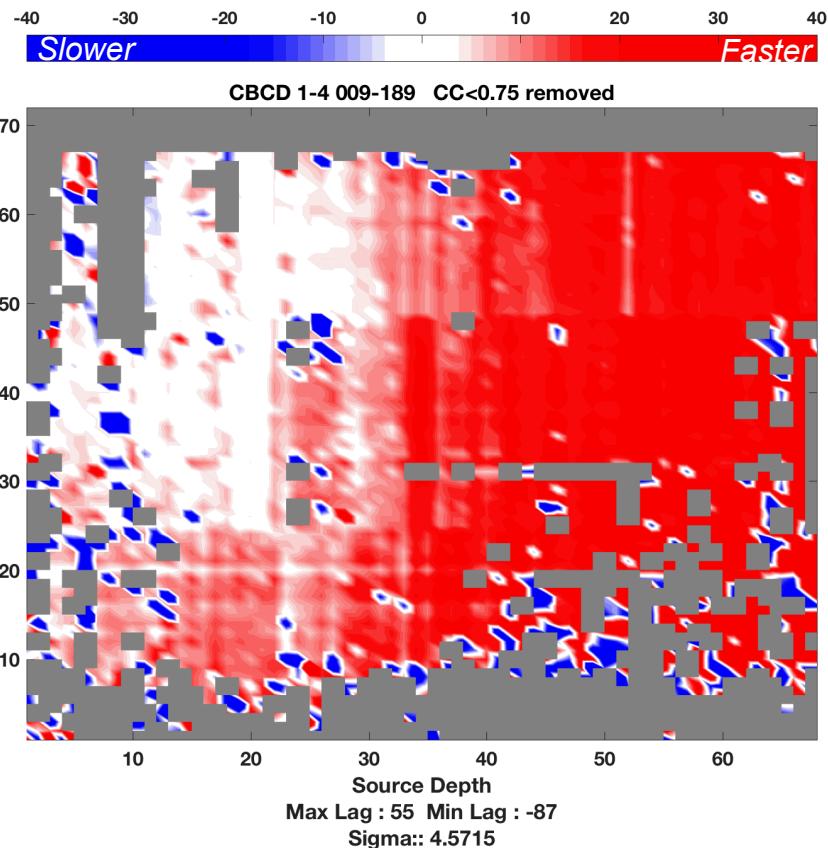
- 1D profile
- Identify maximum cross-correlation coefficient for each trace & 'shift' trace by associated time
 - Red first break 'identified' by cross-correlation, using blue first break time basis

Change Detection Flow

5. Perform change detection



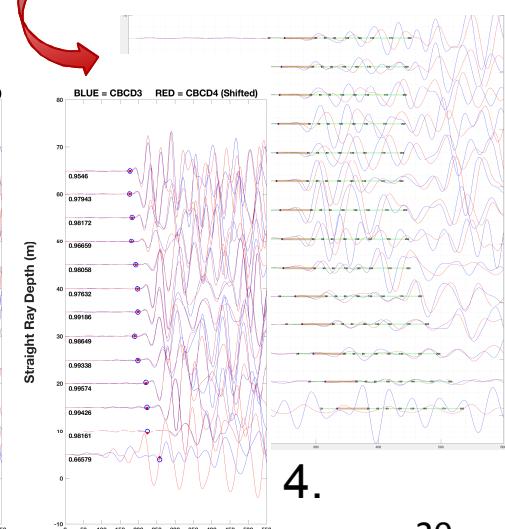
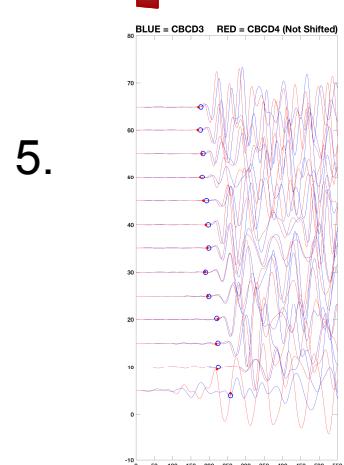
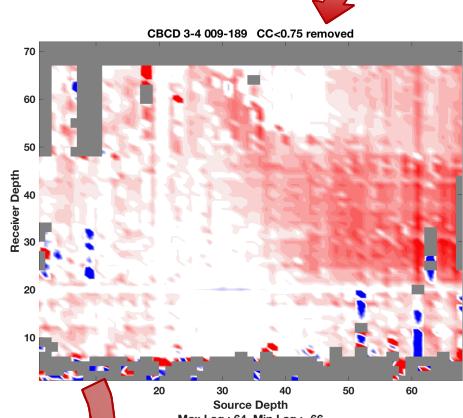
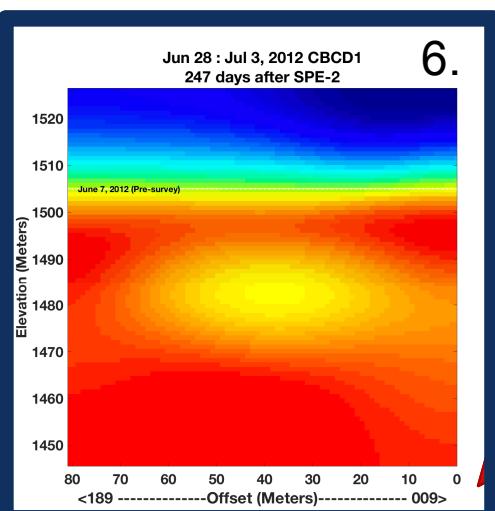
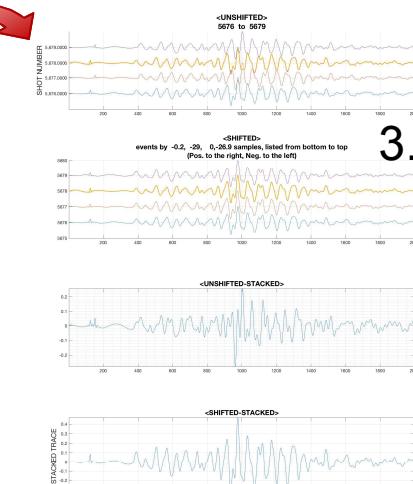
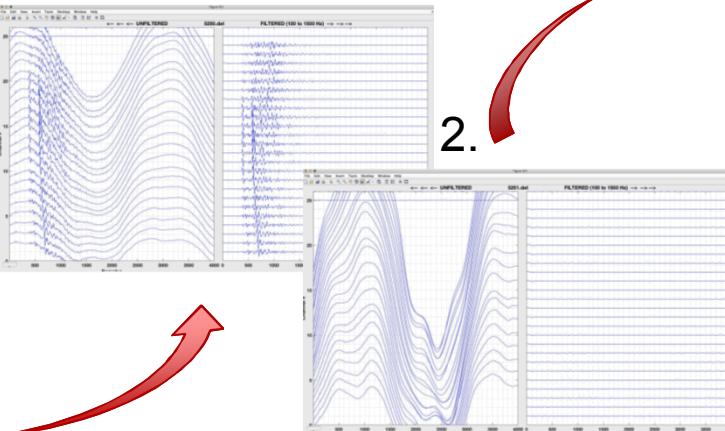
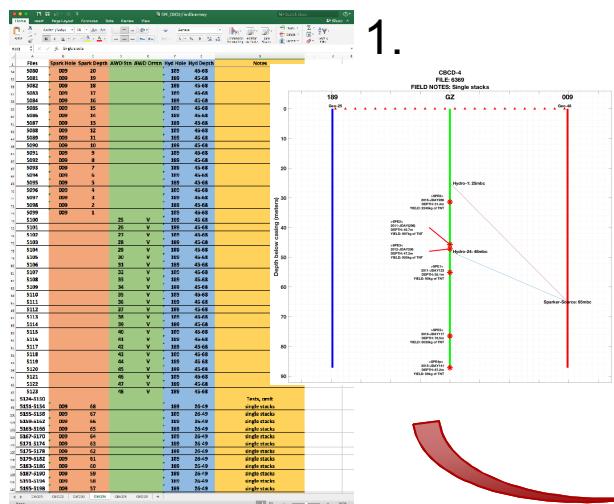
Change Detection



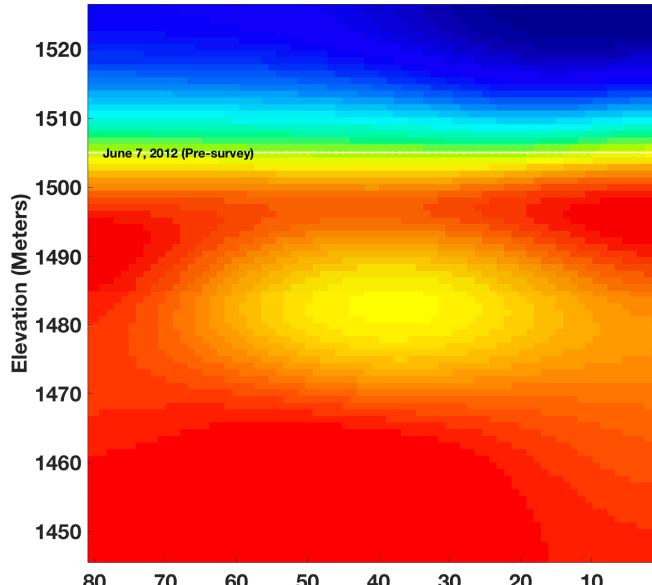
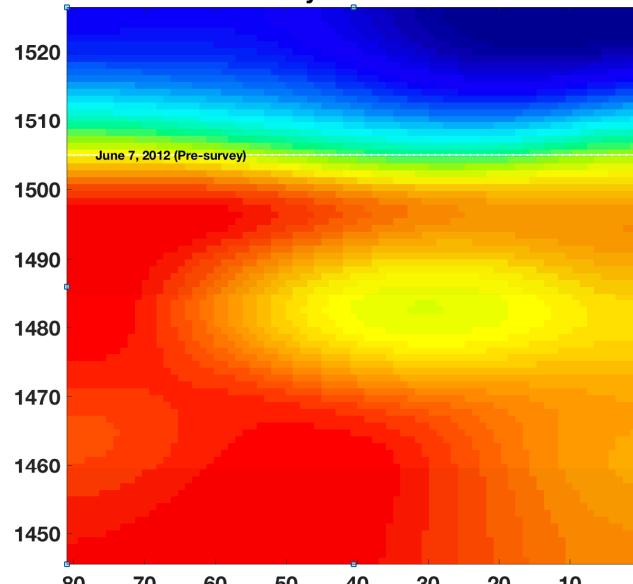
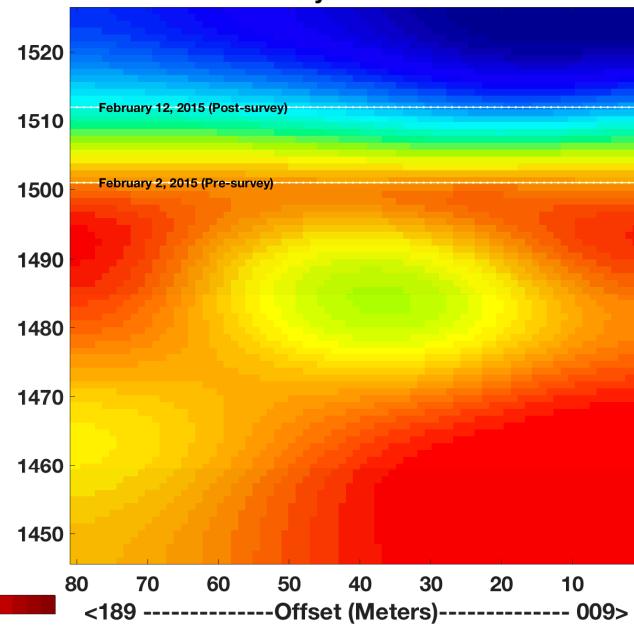
- Color scale indicates amount of sample shift (lag) based on cross-correlation
- Grey = no data

Change Detection Flow

6. Invert and analyze



Preliminary Inversions

 Jun 28 : Jul 3, 2012 CBCD1
 247 days after SPE-2

 Aug 27 : Aug 29, 2012 CBCD3
 33 days after SPE-3

 Feb 9 : Feb 13, 2015 CBCD4
 930 days after SPE-3


To Do

- Inversion refinement
- CBCD5
- CBCD6
- Incorporate further groundwater monitoring measurements
- Geologic interpretations – What does this all mean?
- Incorporation into near field models

Questions?

