COHERENT NOISE SUPPRESSION WORKFLOW – PROGRAM coh_noise_suppression_workflow

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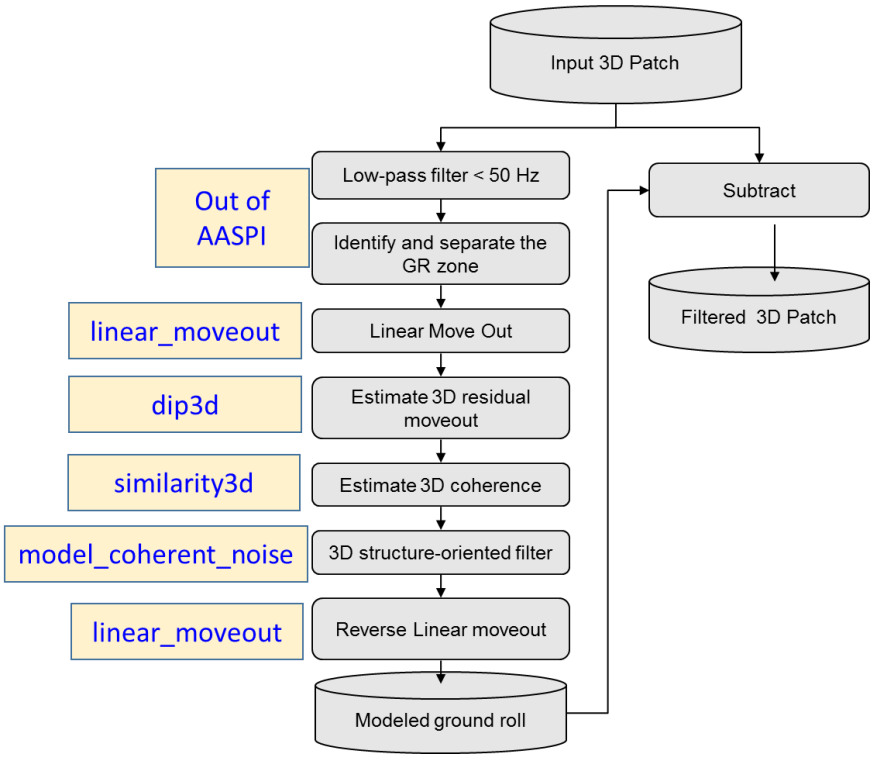
Computation flowchart



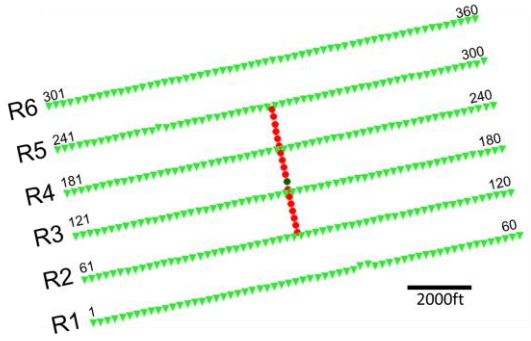
This flowchart is based on Verma et al. 2015.

Approach

The seismic data includes geological reflections of all frequency ranges (e.g. 12-85 Hz). The first step is to apply a low pass filter, $f < 50$ Hz (10-15-35-45Hz) that removes the signal in the higher frequency range ($40 < f < 85$ Hz). The second step is to window the groundroll contaminated zone, based on an average group velocity of 1000 m/s. In this manner, subsequent filters will not impact reflection events outside the groundroll window. In the third step, apply a linear move out (**liner_moveout** utility) correction using groundroll phase velocity $v = 1500$ m/s (5000 ft/s), thereby approximately flattening the shingled groundroll events and misaligning the higher apparent velocity geological reflections of interest. At this point, we have created a patch of data that is amenable to 3D edge preserving structure-oriented filtering (Marfurt, 2006).

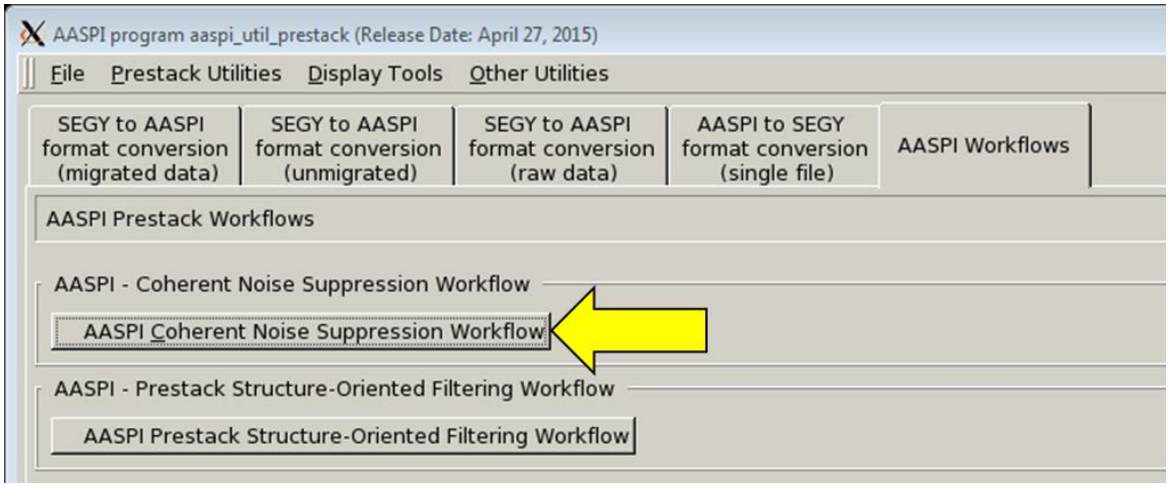
We compute the residual inline and crossline (with **dip3d** utility) components of linear moveout as well as coherence (with **similarity3d** utility) within each and every 3 channel by 3 shot by 0.020 s analysis window. Each sample forms part of 9 spatial by 21 vertical (or 189) windows. The most coherent Kuwahara (1976) window (i.e. the one that best represents moderately dipping coherent groundroll) is used for subsequent analysis. If the window is sufficiently coherent ($c > 0.7$) we apply a Karhunen–Loève (KL) filter (with **model_coh_noi_workflow** utility) to model the strongest event (the moveout-corrected groundroll) at the current sample of interest. If the window is incoherent ($c < 0.6$), only misaligned signal (or random noise) exists, and no filter is applied. We blend the modeled noise and signal for value of $0.6 < c < 0.7$.

We apply an inverse linear moveout after the KL filter to obtain the modeled groundroll (**Error! Reference source not found.**a). Finally we subtract the modeled groundroll from the o riginal data. A major advantage of KL filtering is that the scale of the seismic amplitude does not change. A simple subtraction therefore is effective and sufficient. In this workflow, the most important parameters are the high cut frequency, linear moveout velocity, window size, and the threshold values of coherence. We obtain the high cut frequency by simply applying bandpass filters to the gather to determine at which frequency band the groundroll is sufficiently low in amplitude. Since we know our data is dispersive and will need to search for residual linear moveout we only need an approximate phase velocity of groundroll. The size of vertical analysis window used in the KL filter should be smaller than the dominant groundroll period to avoid vertical mixing of events. If the window is too large, vertical samples that correspond to different groundroll phase velocities will be smeared, reducing the amount of noise that can be modeled. When using a nine-trace (three shots into three channels) window, we find that the first two eigenvectors (rather than simply the first eigenvector) better estimate the groundroll.

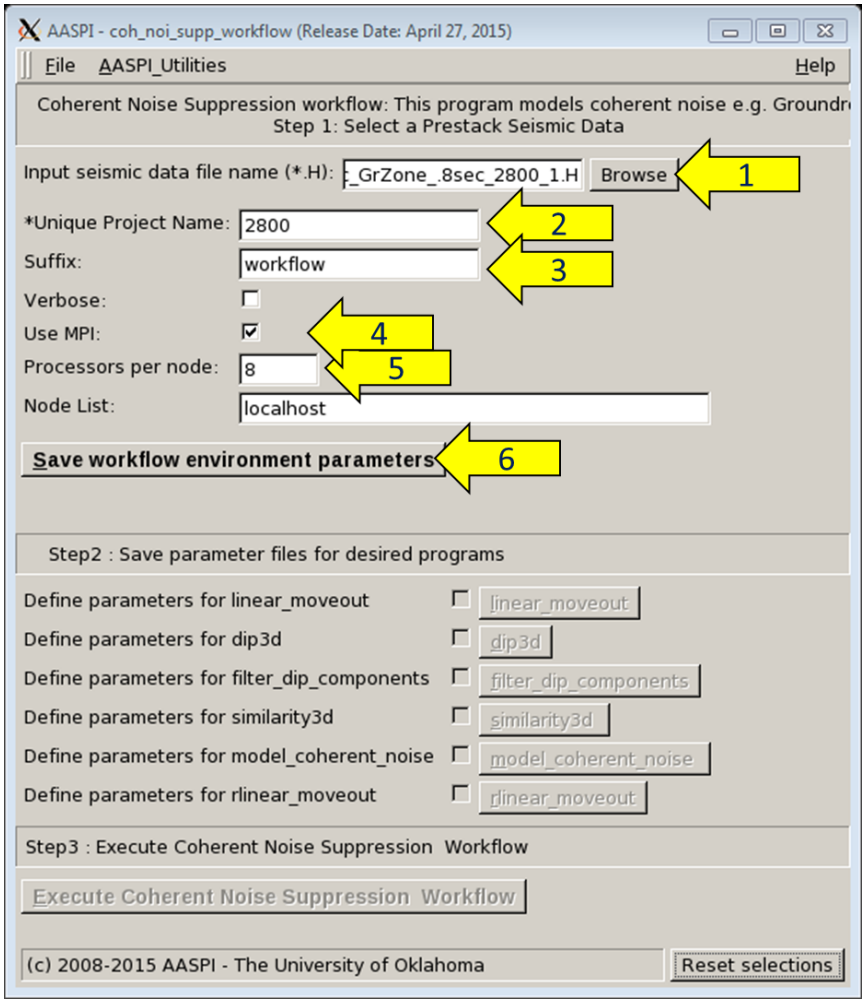


Please note that this method works the best if your data is acquired as piecewise 3D (or in patches).
Like in this figure if any shot point in (red point) is active then the whole receiver patch (R1-R6) is active.

You can initiate the workflow utility either by typing **aaspi_coh_noi_supp_workflow** or by clicking on **AASPI Coherent Noise Suppression Workflow** from the AASPI prestack utility under ASSPI Workflows.



The following window will pop-up (see next page).



Here, choose (1) Input seismic file, which is recommended to be 3D, with Shotline as Inline and Channel number as X line (please see the section below to get the details of the format), (2) unique project name. Choose the number of processors (5); all of the utilities under this workflow are on MPI except linear move out. Once you click (6) Save workflow parameter, a parameter file will be created as well as the linear moveout tab will be active.

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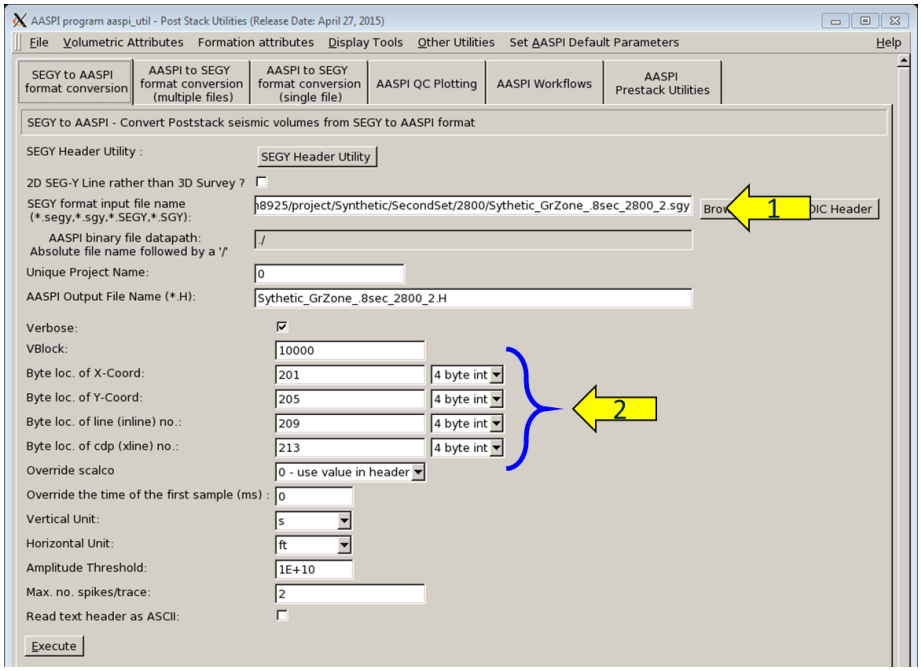
Input file format:

Before you import the input file, in order to make the process smooth, you can create the following header

X= Shot no *110 Y=Channel No*110.

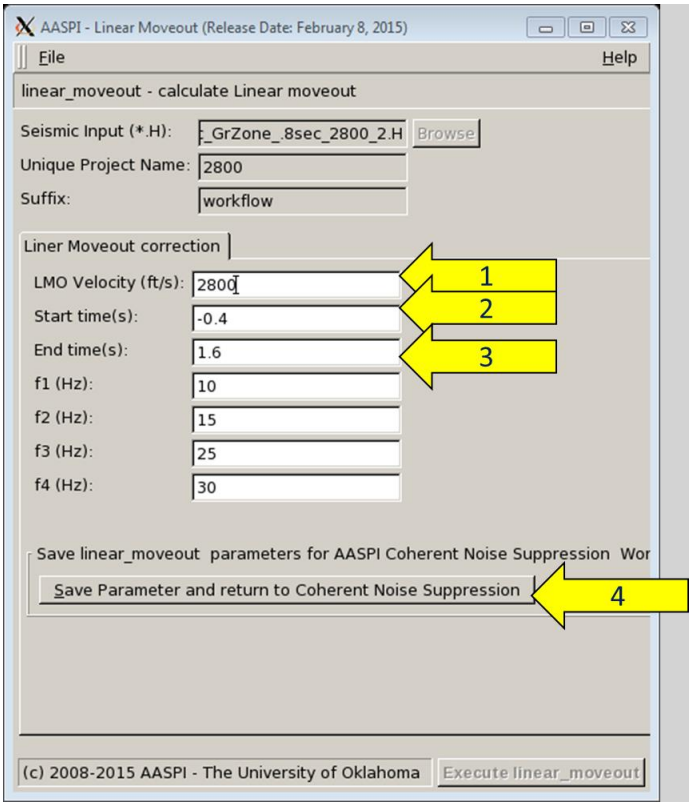
If your data has the same number of channels for all the shots, you may not require to change X and Y.

Choose the shot point no. byte location as inline no and channel no. byte location as cross line byte location.



Linear moveout

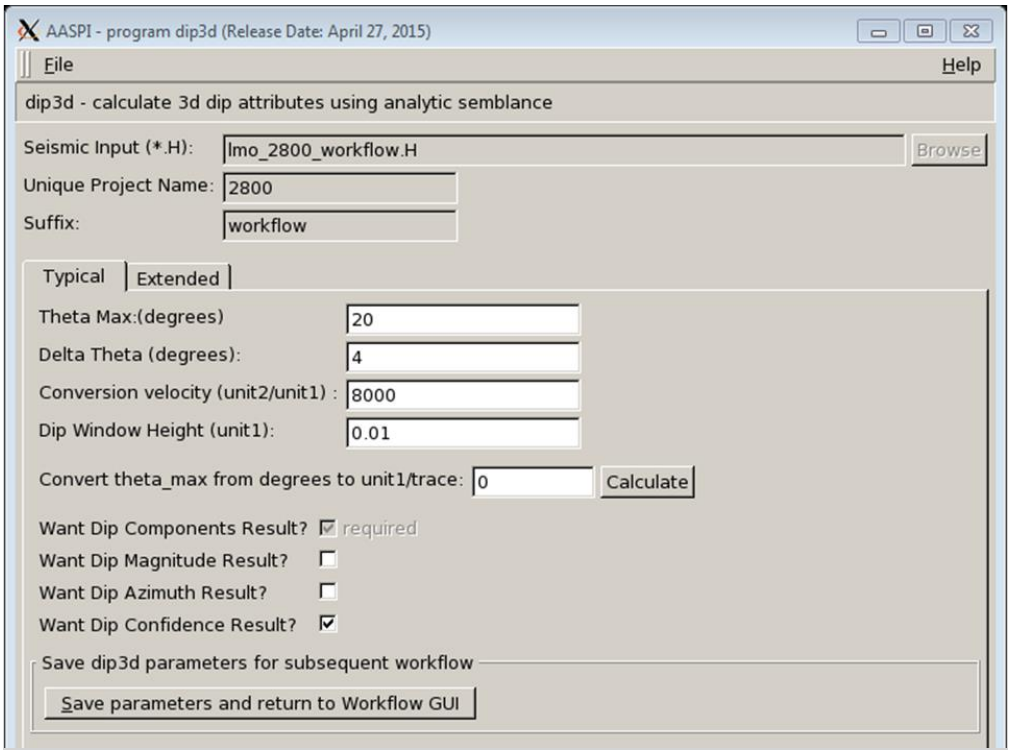
After you save the parameters on the workflow utility, the linear moveout utility will become active. If you click on **liner_moveout** the following window will display:



Here, the input file is taken from the input seismic file provided to the **coh_noi_supp_workflow** main utility and it will be greyed out. Choose (1) velocity for linear moveout - for ground roll suppression you can choose most common phase velocity of ground roll here. Choose (2) a start time of less than 0, as the high velocity events can be over corrected and may have negative time, choose (3) an end time. As you click on (4) save parameter, a linear moveout parameter file will be created and the linear moveout utility will close. The dip 3d tab should be active now.

dip3d

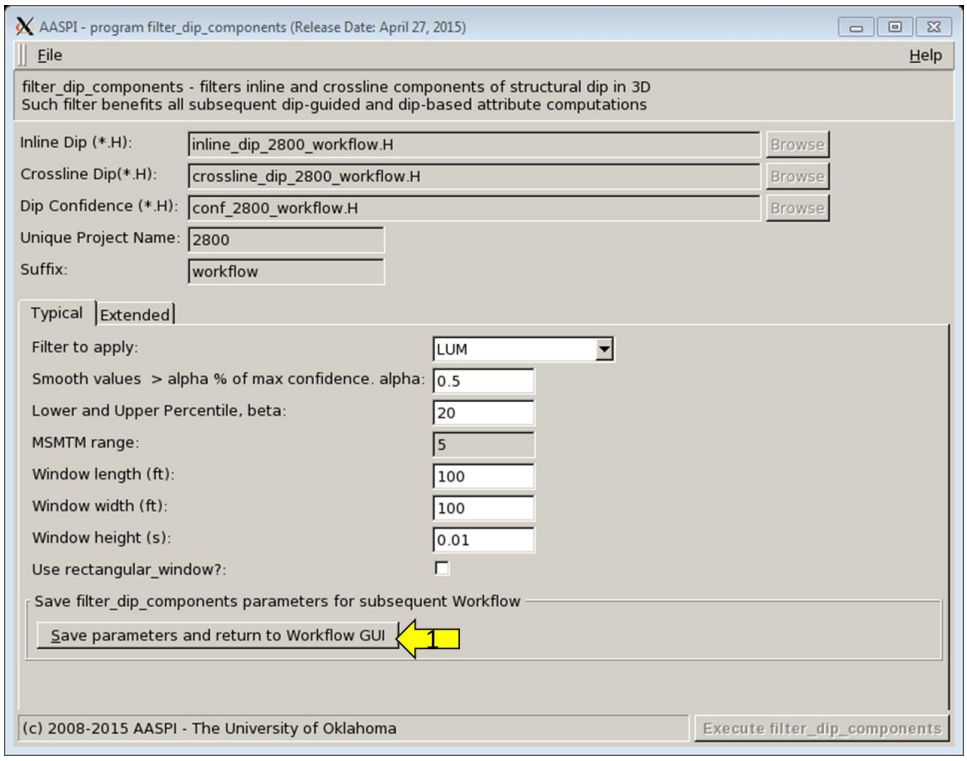
As you click on the **dip3d** tab, a dip3d window will pop-up , here you can choose the parameter you wish . You can also see **dip3d** documentation for details. Input file for this utility is automatically provided and is the output of linear moveout utility.



Here, I prefer to keep the default parameters. As, I click (3) save parameter a **dip3d** parameter file is created and, filter dip components tab becomes active.

filter dip components

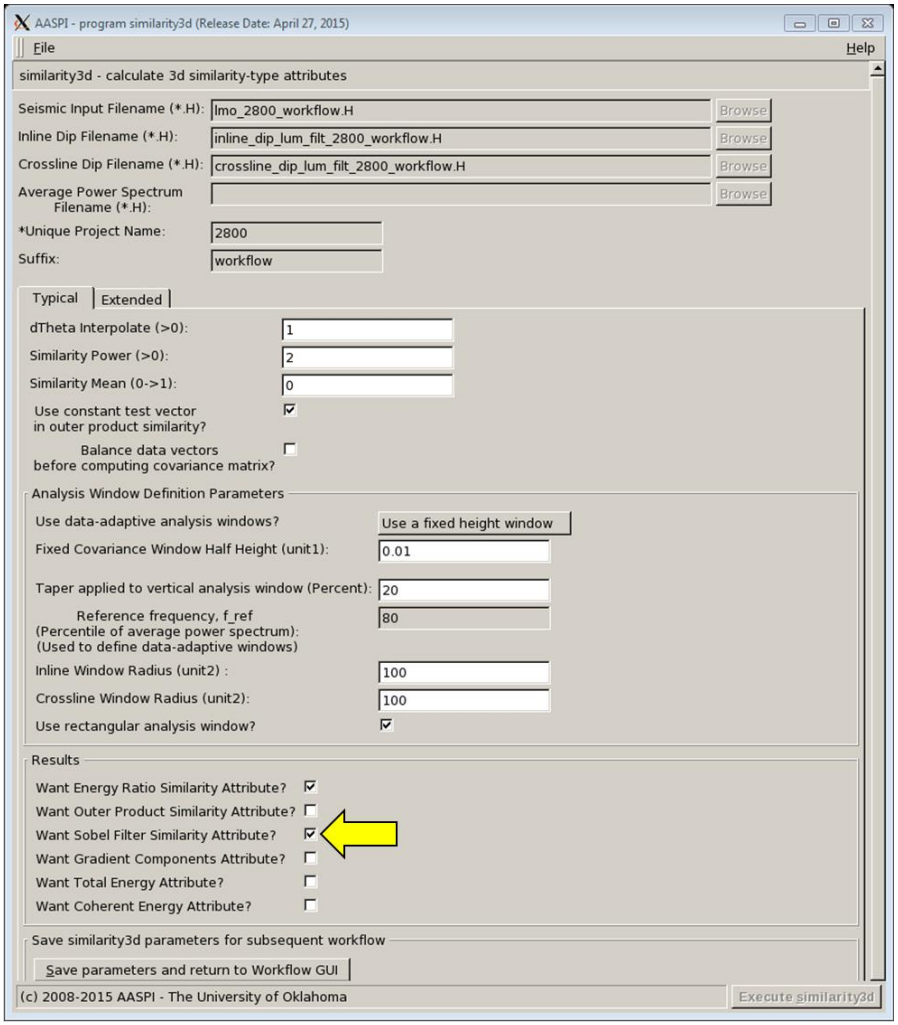
As you click on the filter dip components tab, a **filter_dip_components** window will pop-up , here you can choose the parameter you wish . You can also see **filter_dip_components** documentation for details. Input files for this utility are automatically provided and are output files of **dip3d** utility.



Here, I prefer to keep the default parameters. As, I click (1) save parameter, a **filter_dip_components** parameter file is created and, **similarity3d** tab becomes active.

similarity3d

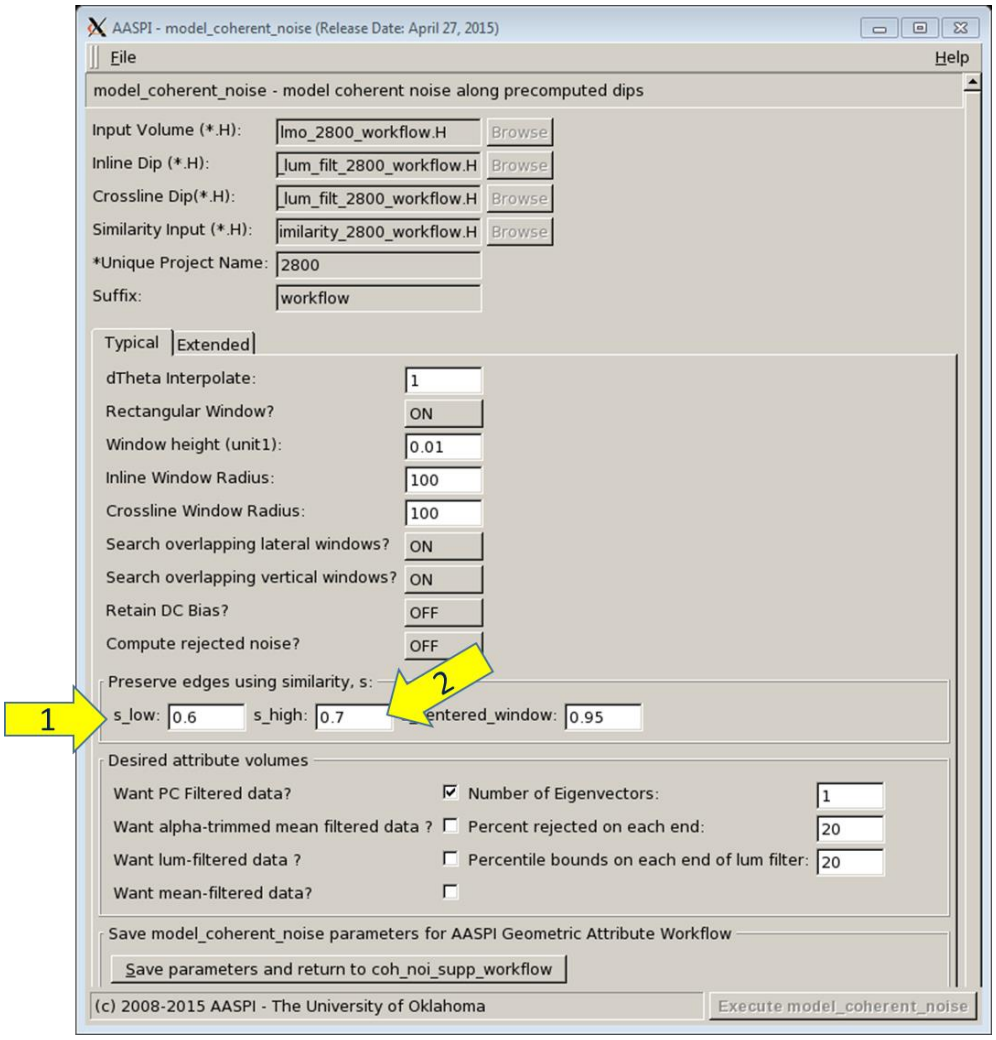
As you click on the **similarity3d** tab, a **similarity3d** window will display; here you can choose the parameter you wish. You can also see **similarity3d** documentation for details. Input files for this utility are automatically provided and are output files of **dip3d** and linear moveout utilities.



Here, it is prefered to not generate only sobel filter similarity or energy ratio similarity, so unclick the gradient component and outer product similarity and keep the other parameters at default. Click save parameter, and a **similarity3d** parameter file is created, and model coherent noise tab becomes active.

Model Coherent Noise

As you click on the model coherent noise tab, a **model_coherent_noise** window will be displayed. Here you can choose the parameter you wish. This utility is modified from **sof3d**. Input files for this utility are automatically provided and are output files of linear moveout, **dip3d** and **similarity3d** utilities.

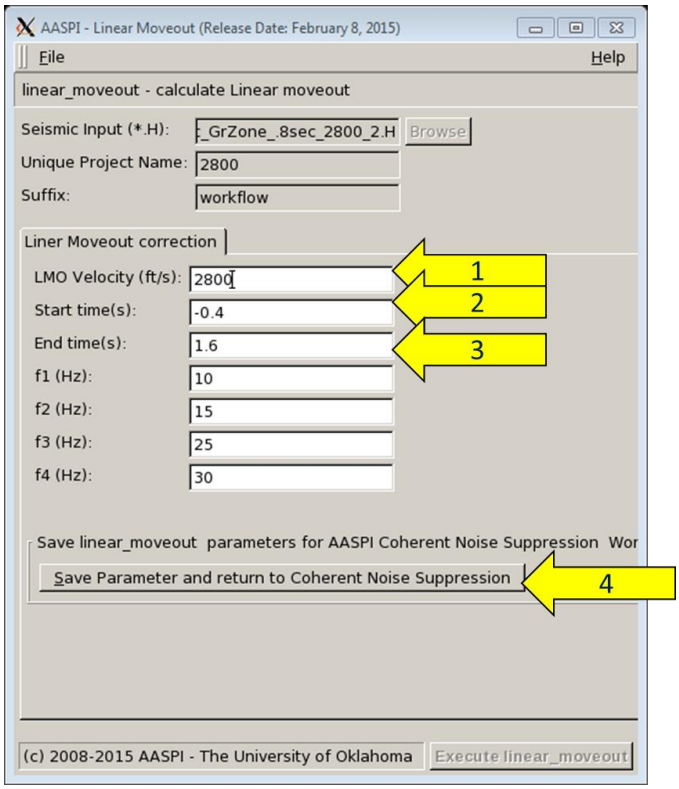


Here, (1) for c < s_low, only misaligned signal (or random noise) exists, and no filter is applied. Choose (2) s_high, keeping in mind that for *c* > s_high the window is sufficiently coherent and a Karhunen–Loève (KL) filter is applied. For the values between (0.6 < *c* < 0.7), it blends the modeled noise and signal.

Click save parameter, and a **similarity3d** parameter file is created and, rlinear moveout tab becomes active.

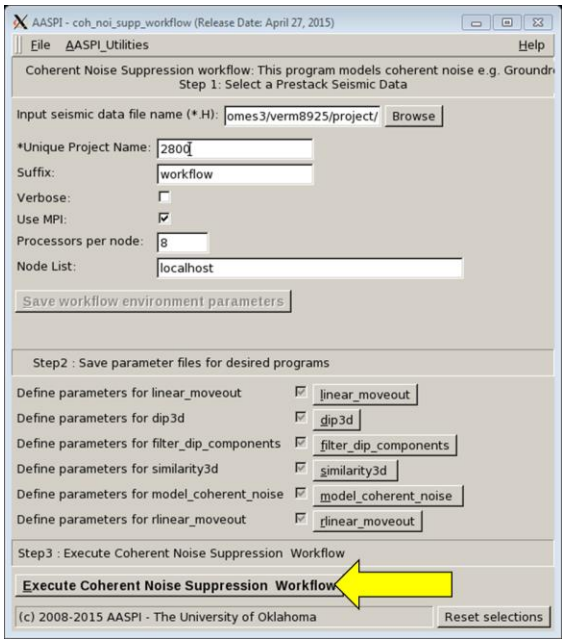
Reverse linear moveout

As you click on the **rlinear_moveout** tab, **linear_moveout** window will pop-up. Input files for this utility are automatically provided and output a file of **model_coherent_noise** utility.

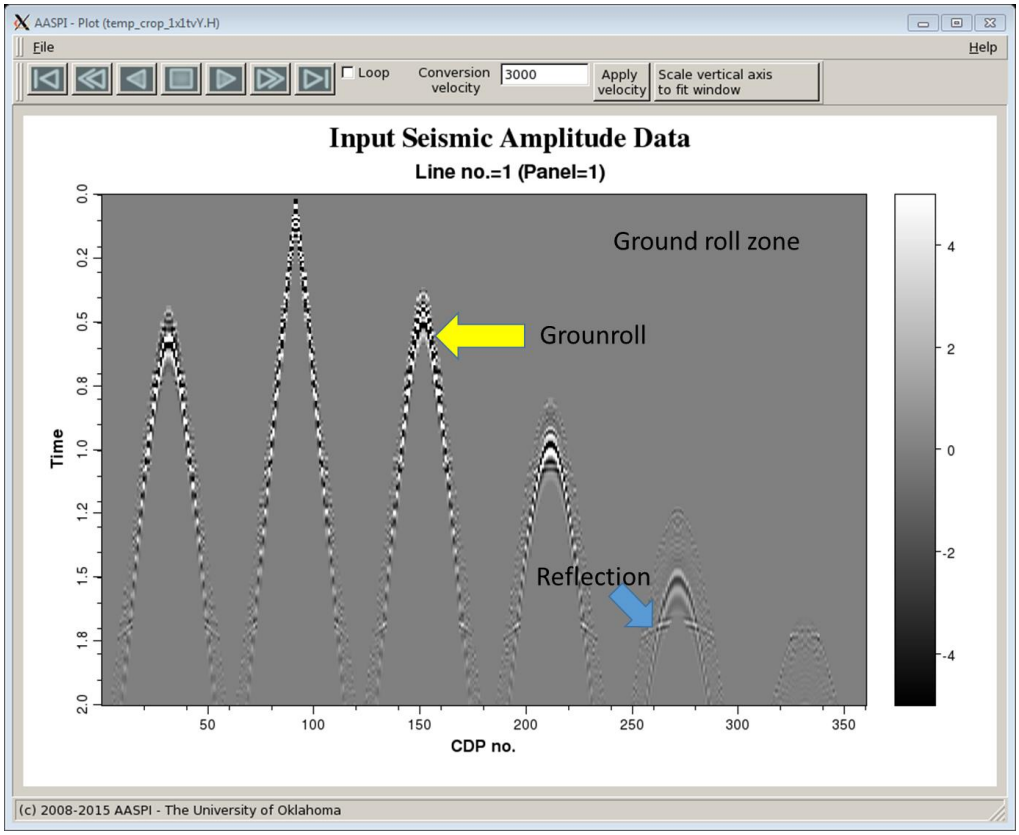


Choose (1) velocity for linear moveout. Please put a negative velocity with the same absolute value as you choose for linear moveout. Choose (2) start time as the original file start time, and (3) an end time as original file end time. As you click on (4) save parameter, a linear moveout parameter file will be created and rlinear moveout utility will close.

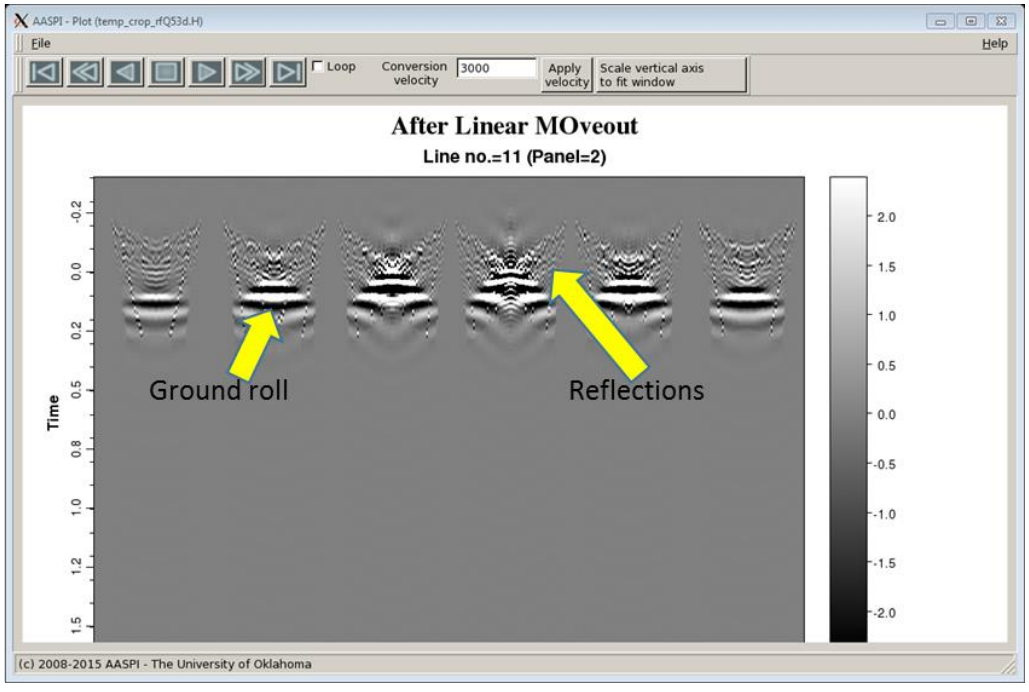
Now, you can press execute button on the main utility window.



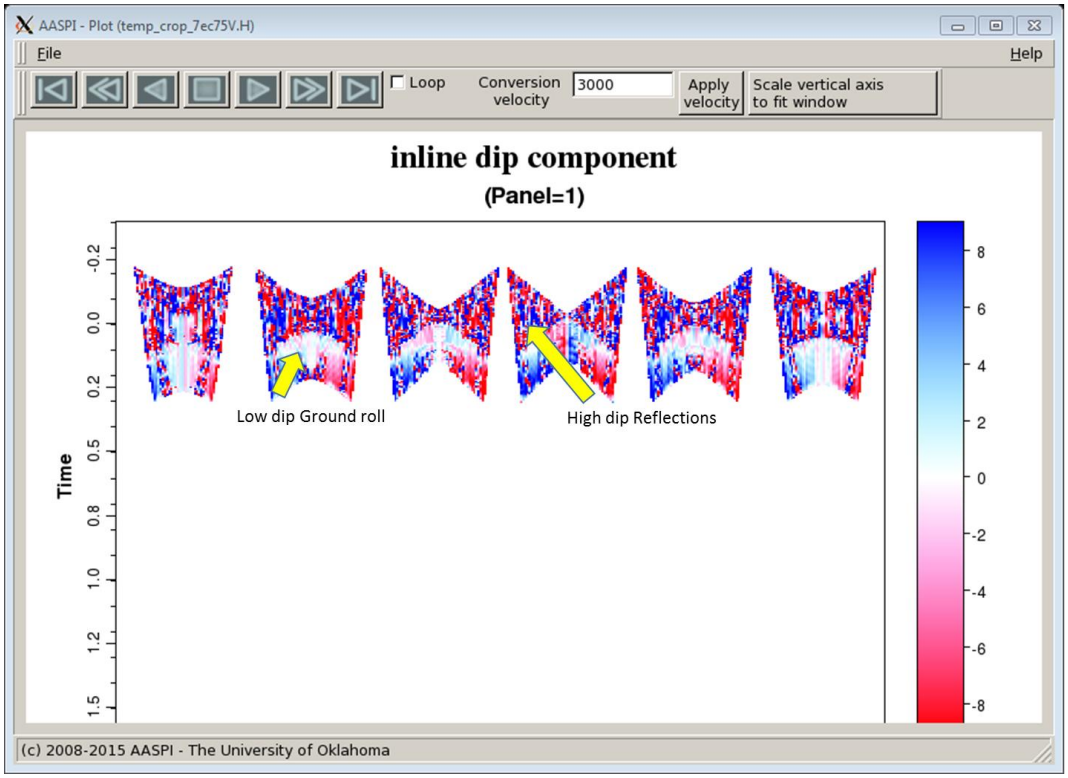
Input ground roll zone:



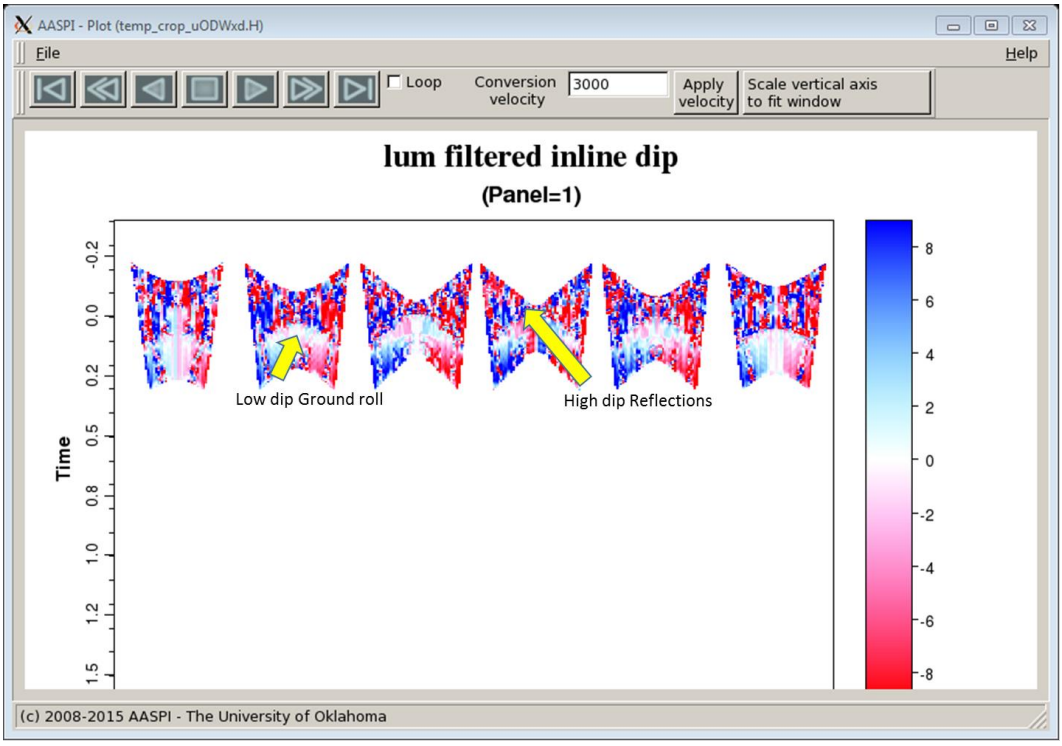
Outputs: Output of linear moveout.

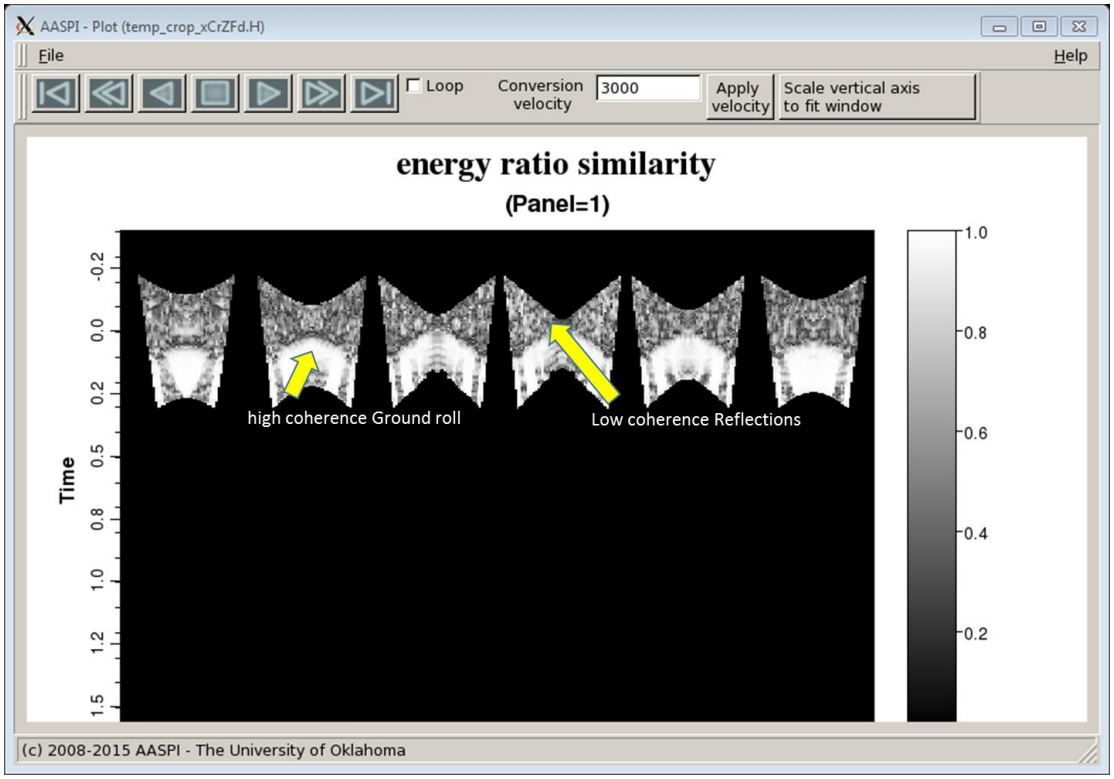


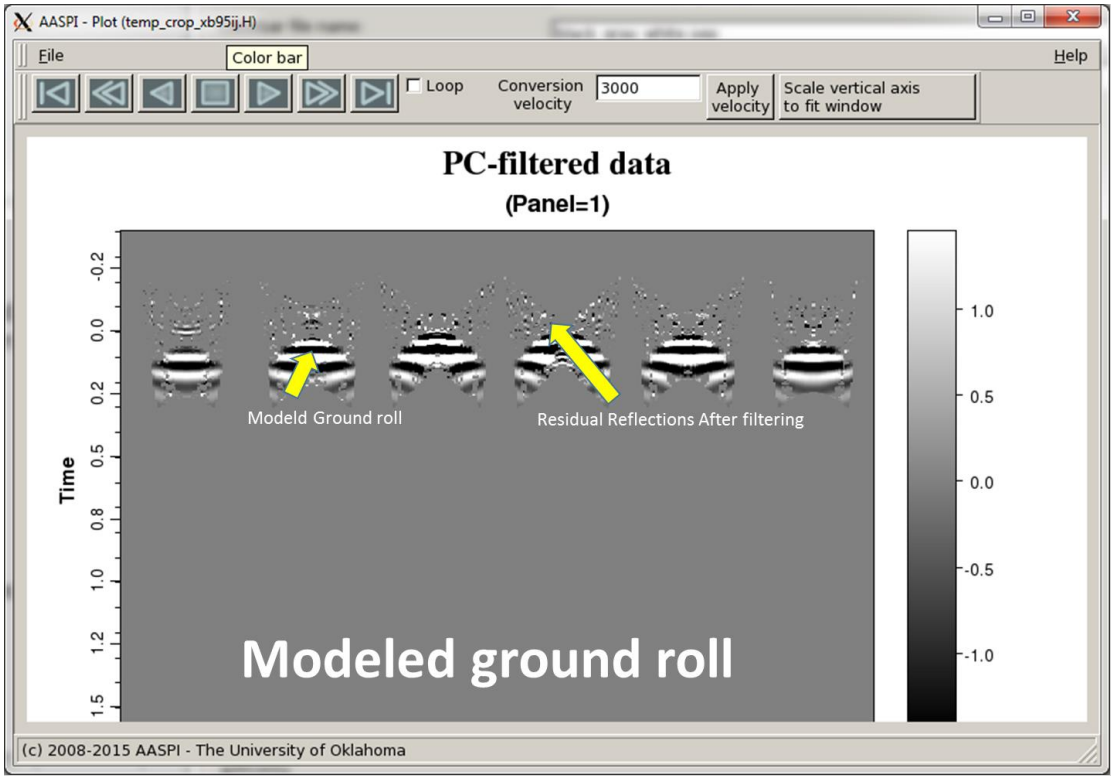
Output of **dip3d**, this is in shot line direction.



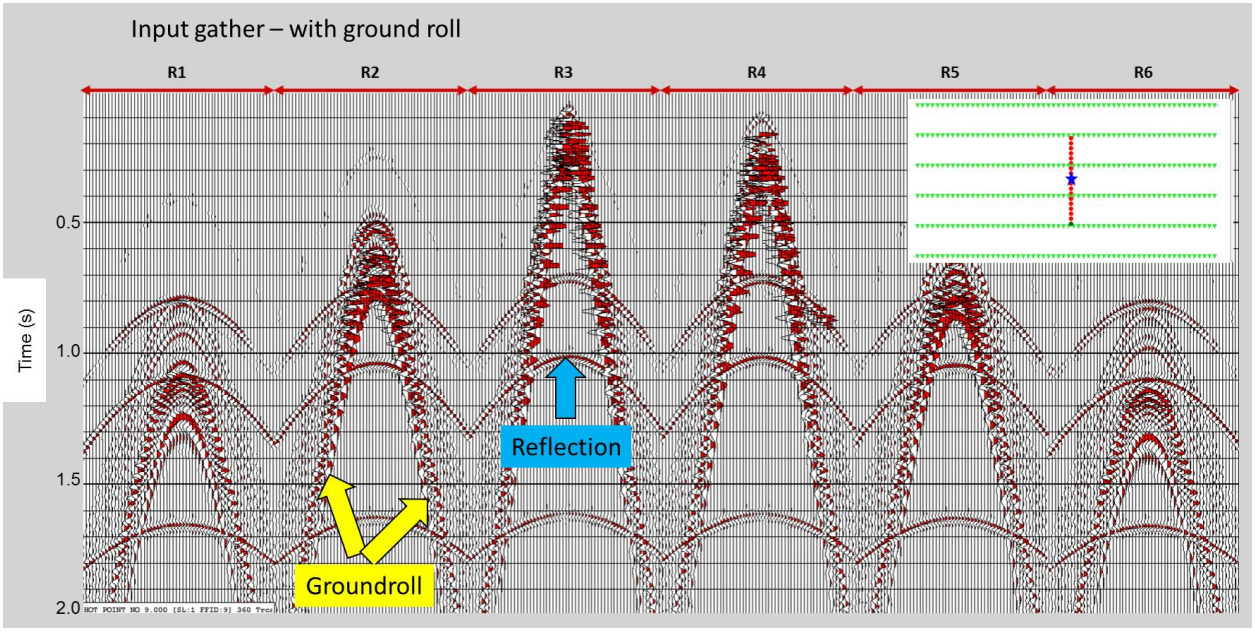
Output of **filter_dip_components**, this is in shot line direction.

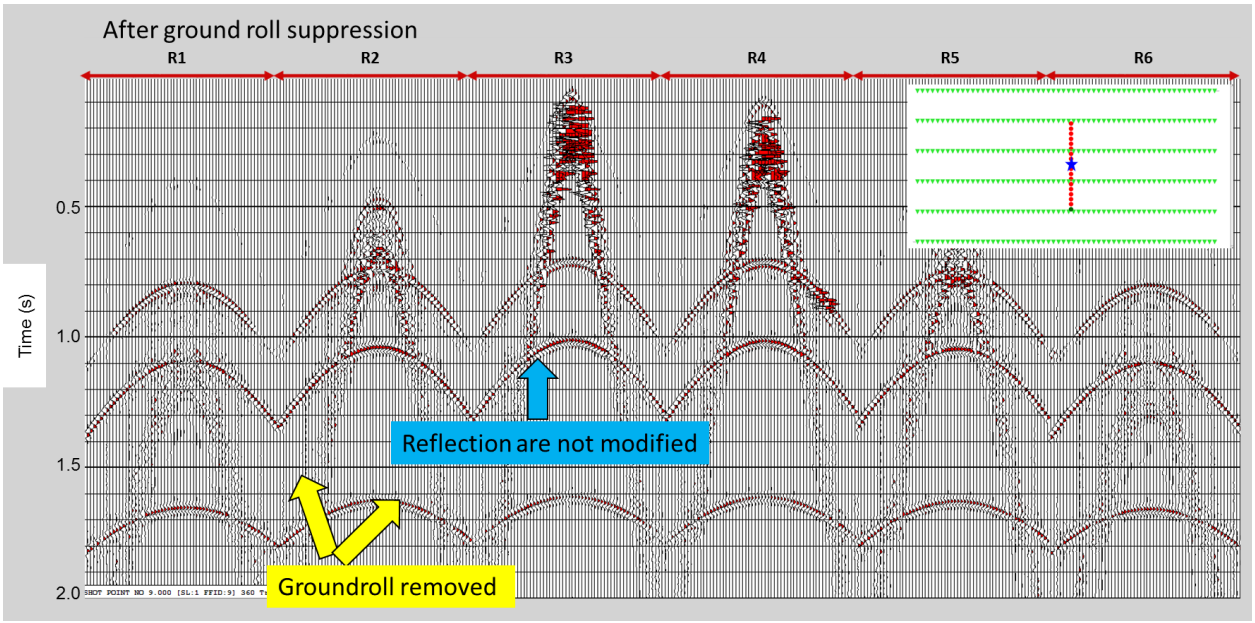



AASPI - Plot (temp_crop_xCrZFd.H)
File
Help
Loop
Conversion velocity
3000
Apply velocity
Scale vertical axis to fit window
energy ratio similarity
(Panel=1)
high coherence Ground roll
Low coherence Reflections
Time
-0.2
0.0
0.2
0.5
0.8
1.0
1.2
1.5
1.0
0.8
0.6
0.4
0.2
(c) 2008-2015 AASPI - The University of Oklahoma


AASPI - Plot (temp_crop_xb95ij.H)
File
Color bar
Help
Loop
Conversion velocity
3000
Apply velocity
Scale vertical axis to fit window
PC-filtered data
(Panel=1)
Modeld Ground roll
Residual Reflections After filtering
Time
-0.2
0.0
0.2
0.5
0.8
1.0
1.2
1.5
1.0
0.5
0.0
-0.5
-1.0
Modeled ground roll
(c) 2008-2015 AASPI - The University of Oklahoma

The complete gather:





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