

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.

Eile Prestack Utiliti	es <u>D</u> isplay Tools	Other Utilities		
SEGY to AASPI				
format conversion f (migrated data)	SEGY to AASPI format conversion (unmigrated)	SEGY to AASPI format conversion (raw data)	AASPI to SEGY format conversion (single file)	AASPI Workflows
AASPI Prestack Work	flows			
AASPI - Coherent No	ise Suppression W	orkflow		
AASPI <u>C</u> oherent N	Voise Suppression V	Workflow		
AACDI Desete du Che	waterna Onianta d Fil			
AASPI - Prestack Str	ucture-Oriented Fill	tering worknow —		
AASPI Prestack S	tructure-Oriented F	iltering Workflow		

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

	27. 2015)
AASPI - con_noi_supp_workflow (Release Date: April	
j <u>E</u> ile <u>A</u> ASPI_Utilities	Help
Coherent Noise Suppression workflow: This Step 1: Select a Pr	orogram models coherent noise e.g. Groundri estack Seismic Data
Input seismic data file name (*.H):GrZone	8sec_2800_1.H Browse
*Unique Project Name: 2800	
Suffix: workflow	
Verbose:	
Use MPI: 🔽 🧹 📕	
Processors per node: 8 5	
Node List: localhost	
Save workflow environment narameters	
Save worknow environment parameters	
Step2 : Save parameter files for desired pro	ograms
Define parameters for linear_moveout	Iinear_moveout
Define parameters for dip3d	□ dip3d
Define parameters for filter_dip_components	filter_dip_components
Define parameters for similarity3d	□ <u>s</u> imilarity3d
Define parameters for model_coherent_noise	<u>m</u> odel_coherent_noise
Define parameters for rlinear_moveout	□
Step3 : Execute Coherent Noise Suppression	Workflow
Execute Coherent Noise Suppression W	orkflow

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.

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.

🗙 AASPI program aaspi_util - Post Stack Utilities (R	elease Date: April 27, 2015)
<u>File</u> <u>Volumetric</u> Attributes Formation	attributes _Display Tools _Other Utilities Set AASPI Default ParametersHe
SEGY to AASPI format conversion (multiple files)	AASPI to SEGY format conversion (single file) AASPI QC Plotting AASPI Workflows Prestack Utilities
SEGY to AASPI - Convert Poststack seism	ic volumes from SEGY to AASPI format
SEGY Header Utility :	SEGY Header Utility
2D SEG-Y Line rather than 3D Survey ?	-
SEGY format input file name (*.segy,*.sgy,*.SEGY,*.SGY):	8925/project/Synthetic/SecondSet/2800/Sythetic_GrZone_8sec_2800_2.sgy Broc 1 DIC Header
AASPI binary file datapath: Absolute file name followed by a '/'	
Unique Project Name:	0
AASPI Output File Name (*.H):	Sythetic_GrZone8sec_2800_2.H
Verbose:	
VBlock:	10000
Byte loc. of X-Coord:	201 4 byte int 💌
Byte loc. of Y-Coord:	205 4 byte int 🗸
Byte loc. of line (inline) no.:	209 4 byte int 🚽
Byte loc. of cdp (xline) no.:	213 4 byte int 💌
Override scalco	0 - use value in header 💌
Override the time of the first sample (ms) : 0
Vertical Unit:	s 🔻
Horizontal Unit:	ft 🔻
Amplitude Threshold:	1E+10
Max. no. spikes/trace:	2
Read text header as ASCII:	
Execute	

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:

<u>F</u> ile		<u>H</u> elp
linear_moveout - ca	alculate Linear moveout	
Seismic Input (*.H)	_GrZone8sec_2800_2.H Bro	wse
Unique Project Nan	ne: 2800	
Suffix:	workflow	
Liner Moveout corr	ection	
LMO Velocity (ft/s): [280q]	1
Start time(s):	-0.4	2
End time(s):	1.6	3
f1 (Hz):	10	
f2 (Hz):	15	
f3 (Hz):	25	
f4 (Hz):	30	
Save linear_move	out parameters for AASPI Cohere	nt Noise Suppression Wor
Save Paramete	r and return to Coherent Noise Su	ppression

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.

🗙 AASPI - program dip3d (Release Date: April 27, 2015)	
]] <u>F</u> ile	<u>H</u> elp
dip3d - calculate 3d dip attributes using analytic semblance	
Seismic Input (*.H): Imo_2800_workflow.H	Browse
Unique Project Name: 2800	
Suffix: workflow	
Typical Extended	
Theta Max:(degrees) 20	
Delta Theta (degrees): 4	
Conversion velocity (unit2/unit1) : 8000	
Dip Window Height (unit1): 0.01	
Convert theta_max from degrees to unit1/trace: 0 Calculate	
Want Dip Components Result? 🔽 required	
Want Dip Magnitude Result?	
Want Dip Azimuth Result?	
Want Dip Confidence Result?	
Save dip3d parameters for subsequent workflow	
Save parameters and return to Workflow GUI	

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.

X AASPI - program filter_o	dip_components (Release Date: April	27, 2015)	Help
filter_dip_components Such filter benefits all	- filters inline and crossline co subsequent dip-guided and di	mponents of structural dip in 3D p-based attribute computations	
Inline Dip (*.H):	inline_dip_2800_workflow.H		Browse
Crossline Dip(*.H):	crossline_dip_2800_workflow.	н	Browse
Dip Confidence (*.H):	conf_2800_workflow.H		Browse
Unique Project Name:	2800		
Suffix:	workflow		
Typical Extended			
Filter to apply:		LUM	
Smooth values > alp	oha % of max confidence. alph	a: 0.5	
Lower and Upper Per	rcentile, beta:	20	
MSMTM range:		5	
Window length (ft):		100	
Window width (ft):		100	
Window height (s):		0.01	
Use rectangular_wine	dow?:	Γ	
Save filter_dip_comp	onents parameters for subseq	uent Workflow	
Save parameters	and return to Workflow GUI 🎸	1	
(c) 2008-2015 AASPI -	The University of Oklahoma		Execute filter_dip_components

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.

🗙 AASPI - program similarity3d (R	telease Date: April 27, 2015)		
similarity3d - calculate 3d sin	nilarity-type attributes		<u>Teib</u>
Soismic Input Filonomo (* H):	Ima 2000 workflow U		Trenural
Inline Din Eilename (* H).	inting_2800_worknow.H		Browse
Crossline Din Filename (* H):	Inline_dip_tum_tit_2800_	workflow.H	Browse
Average Power Spectrum	[crossine_aip_ium_iiic_28	oo_worknow.H	Browse
Filename (*.H):	1		biowse
*Unique Project Name:	2800		
Suffix:	workflow		
Typical Extended			
dTheta Interpolate (>0):	1		
Similarity Power (>0):	2		
Similarity Mean (0->1):	0		
Use constant test vector in outer product similarity?	N		
Balance data vecto before computing covariar	nce matrix?		
Analysis Window Definition	Parameters		
Use data-adaptive analysi	s windows?	Use a fixed height window	
Fixed Covariance Window	Half Height (unit1):	0.01	
Taper applied to vertical a	nalysis window (Percent)	20	
Reference frequenc (Percentile of average pov (Used to define data-adap	:y, f_ref wer spectrum): otive windows)	80	
Inline Window Radius (unit	:2) :	100	
Crossline Window Radius	(unit2):	100	
Use rectangular analysis v	vindow?	<u>ज</u>	
Results			
Want Energy Ratio Similari Want Outer Product Simila Want Sobel Filter Similarity Want Gradient Componen Want Total Energy Attribut Want Coherent Energy Att	ty Attribute? rity Attribute? (Attribute? ts Attribute? te? ribute? T		
Save similarity3d paramete	ers for subsequent workflo	w	
Save parameters and re	turn to Workflow GUI		
(c) 2008-2015 AASPI - The U	Iniversity of Oklahoma		Execute similarity3d

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.

AASPI - model_conerent	t_noise (Release Date: Apri	11 27, 2015)	
<u> </u>			Help
model_coherent_noise	- model coherent nois	se along precomputed dips	
Input Volume (*.H):	Imo_2800_workflow.	.H Browse	
Inline Dip (*.H):	_lum_filt_2800_workf	flow.H Browse	
Crossline Dip(*.H):	_lum_filt_2800_workf	flow.H Browse	
Similarity Input (*.H):	imilarity_2800_workf	flow.H Browse	
*Unique Project Name:	2800		
Suffix:	workflow		
Typical Extended			
dTheta Interpolate:	1		
Rectangular Windowi	? ON		
Window height (unit1	.):	01	
Inline Window Radius	100	0	
Crossline Window Ra	dius: 100	0	
Search overlapping la	ateral windows? ON		
Search overlapping v	ertical windows? ON		
Retain DC Bias?	OFF	F	
Compute rejected no	ise? OFF	F	
Preserve edges using	g similarity, s: 📈	2	
s_low: 0.6 s_	high: 0.7	entered_window: 0.95	
Desired attribute volu	limes		
Want PC Filtered dat	ta?	Vumber of Figenvectors	1
Want alpha-trimmed	mean filtered data ?	Percent rejected on each end	20
Want lum-filtered da	ata ?	Percentile bounds on each en	d of lum filter: 20
Want mean-filtered	data?	Г	120
Cause model, asheren	•	an AACDI Coomotrio Attributo World	flaur
Save model_coheren	ic_noise parameters ic	or AASPI Geometric Attribute work	now
Save narameters a	and return to coh noi	supp workflow 1	

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.

🗙 AASPI - Linear Moveout (Release Date: February 8, 2015) 🛛 🗖 🖾 🔀
Eile Help
linear_moveout - calculate Linear moveout
Seismic Input (*.H): GrZone8sec_2800_2.H Browse
Unique Project Name: 2800
Suffix: workflow
Liner Moveout correction
LMO Velocity (ft/s): 2800
Start time(s): -0.4
End time(s): 1.6 3
f1 (Hz): 10
f2 (Hz): 15
f3 (Hz): 25
f4 (Hz): 30
Save linear_moveout parameters for AASPI Coherent Noise Suppression Wor
Save Parameter and return to Coherent Noise Suppression
(c) 2008-2015 AASPI - The University of Oklahoma Execute linear_moveout

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.

Coherent Noise Supp	ression workflow: This Step 1: Select a Pr	orogram models col estack Seismic Data	erent noise e.g. Groun a
Input seismic data file	name (*.H): omes3/ver	m8925/project/ Br	owse
*Unique Project Name:	2800	_	
Suffix:	workflow	_	
Verbose:	Γ		
Use MPI:	N		
Processors per node:	8		
and the state of t			
Node LIST: Save workflow envi	llocalhost ronment parameters]	
Node List: Save workflow envir Step2 : Save parame	liocalhost ronment parameters eter files for desired pr	ograms	
Node List: Save workflow envi Step2 : Save param Define parameters for	localhost ronment parameters eter files for desired pro linear_moveout	ograms ☞linear_moveou	t
Node List: Save workflow envi Step2 : Save param Define parameters for Define parameters for	localhost ronment parameters eter files for desired pr linear_moveout dip3d	ograms F jinear_moveou F gip3d	<u>t</u>
Note List: Save workflow envi Step2 : Save param Define parameters for Define parameters for Define parameters for	localhost ronment parameters eter files for desired pr linear_moveout dip3d filter_dip_components	ograms F jinear_moveou F gip3d F filter_dip_com	t
Node List: Step2 : Save param Define parameters for Define parameters for Define parameters for Define parameters for	localhost ronment parameters eter files for desired pr linear_moveout dip3d filter_dip_components similarity3d	ograms Filinear_moveou filinear_moveou	t j
Save workflow envir Step2 : Save param Define parameters for Define parameters for Define parameters for Define parameters for Define parameters for	llocalhost ronment parameters eter files for desired pr linear_moveout dip3d filter_dip_components similarity3d model_coherent_noise	ograms F linear_moveou Gip3d F filter_dip_com Similarity3d F model_cohere	t ponents
Save workflow envir Step2 : Save param Define parameters for Define parameters for Define parameters for Define parameters for Define parameters for	llocalhost ronment parameters eter files for desired pr linear_moveout dip3d filter_dip_components similarity3d model_coherent_noise rlinear_moveout	ograms F linear_moveou dip3d F filter_dip_com gimilarity3d F model_cohere F dinear_moveou	t ponents nt_noise

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.









The complete gather:



References

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