#### Improving Dip Estimates – Program filter\_dip\_components

#### **Computation flow chart**

The input to program **filter\_dip\_components** includes estimates of the inline and crossline dip components as well as the confidence of these estimates. The initial input to program **filter\_dip\_components** is the output of program **dip3d**. The confidence computed in program **dip3d** is simply the semblance along dip of the analytic traces that fall within the (potentially uncentered) Kuwahara window used in the computation. Program **filter\_dip\_components** can be run iteratively, whereby the output can be used as input for the next iteration.

AASPI



#### Computing mean, median, and other filtered dip volumes

Return to the **aaspi\_util** menu and now choose program **filter\_dip\_components**.

🔳 aaspi	_util GUI - Post Stac	k Utilities	(Release [	Date: Septemb	er 30, 2015)						x
] <u>F</u> ile	Volumetric Attribu	ites Hori	zon-based	d Classification	Volumetric C	lassificati	ion Image Proc	essing	Display Too	s Other Utilities	Set <u>A</u> /
SEGY	dip3d		AA	SPI to SEGY							-
format	similarity3d	apply filte	on form	tor din lile)	AASPI QC Plot	tting A	ASPI Workflows	Prest	tack Utilities		
SEGY	sof3d		eismic vo	olumes from SE	GY to AASPI for	mat		-			
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The following window appears:

aaspi_filter_dip_cor	nponents GUI (Release Date: Sej	ptember 30, 2015)		- • • <b>- ×</b>
<u>F</u> ile				Help
filter_dip_component Such filter benefits all	s - filters inline and crossline con subsequent dip-guided and dip-	nponents of structural dip in 3D -based attribute computations		
Inline Dip (".H):	E:\test_data\boonsville\inline_	dip_boonsville_0.H	Browse	
Crossline Dip(*.H):	E:\test_data\boonsville\crosslin	ne_dip_boonsville_0.H	Browse	
Dip Confidence (*.H):	E:\test_data\boonsville\conf_b	ooonsville_0.H	Browse	
Unique Project Name				
Suffic	0			
Verbose:	Г			
Primary parameter	s Parallelization parameters			
Filter to apply:		LUM		
Smooth values > al	pha % of max confidence. alpha:	0.5		
Lower and Upper Pe	rcentile, beta:	20		
MSMTM range:		5		
Window length (ft):		110.015		
Window width (ft):		109.998		
Window height (s):	4	0.02		
Use rectangular_win	dow::	n Workflow		
Save mer_up_com	ponents parameters for subseque	Ent worknow		
2ave parameters	ind return to worknow GUI			
(c) 2008-2015 AASPI -	The University of Oklahoma			Execute filter_dip_components

**filter\_dip\_components** has three input files: (1) inline and (2) crossline components of dip and the (3) confidence (analytic semblance) of the estimate. There will be two output files – the filtered inline and crossline components of dip. Since June 2010, the algorithm runs under MPI. I've set the *Suffix* to be '1' indicating that this is the first pass of filtering. The possible filters at present include LUM (lower-upper-middle), MSMTM (multistage median-based modified trimmed mean), *median* and *mean* filters. Dossary and Marfurt (2007) show the applicability of LUM and MSMTM filters.

Among the parameters, (7) the confidence, *alpha*, is active for all the filters in the list; *alpha* does not work on the values of dip as in an alpha-trimmed mean filter, but rather on the confidence estimate. For the default value of *alpha=0.5*, the values that fall within the analysis window are sorted according to their confidence. If the confidence falls below *alpha=0.5* of the most confident estimate of dip, we reject it. For those values for

which we are quite confident, we take the selected filtered value as our output. The default window size consists of the neighboring traces and samples, in this case +/-25m and +/-0.02 s.

If you have selected the LUM filter, then the (8) *beta* value becomes active. If we set *beta* to be 50%, the result will be the same as using the median filter, where as if we set it to 0%, the result will be as if we had not filtered the data. If we set *beta* to be between 0 - 50%, for example, 20%, then values which fall between 20 - 80% of the confidence estimate will be kept. Values that fall below 20% of the confidence estimate will be set to the lower threshold 20% confidence value, and values that fall above 80% of the confidence value. Values that fall below our lower threshold and above our upper threshold will be clipped.

The MSMTM (Multistage median-based modified trimmed mean) filter is able to preserve detail, meaning it acts as an edge preserving filter, a lineament preserving filter and can smooth noise. The MSMTM is a modified trimmed mean (MTM) filter that implements a multistage median filter (MSM). A data sample's value is kept if it lies in the range of [m - q, m + q], where *m* is calculated using a MSM filter and *q* is a user defined range. Larger values of *q* result in some smearing of lineaments through higher amplitude "noise" areas, while smaller values of *q* better preserve narrow lineaments. For further discussion, please refer to Dossary and Marfurt (2007).

The *Parallelization parameters* panel only asks for the list of nodes and the number of processors per node:

aaspi_filter_dip_com	ponents GUI (Release Date: September 30, 2015)								
]] <u>F</u> ile		Help							
filter_dip_components - filters inline and crossline components of structural dip in 3D Such filter benefits all subsequent dip-guided and dip-based attribute computations									
Inline Dip (*.H):	E:\test_data\boonsville\inline_dip_boonsville_0.H Browse								
Crossline Dip(*.H):	E:\test_data\boonsville\crossline_dip_boonsville_0.H Browse								
Dip Confidence (*.H):	E:\test_data\boonsville\conf_boonsville_0.H Browse								
Unique Project Name:									
Suffix:	0								
Verbose:									
Primary parameters	Parallelization parameters								
Use MPI: 🔽									
Processors per node:	24 Determine Maximum Processors on localhost								
Node list (separated b	y blanks): localhost								
Build an LSF Script?	Do Not Run Under LSF								
Build a PBS Script?	Do Not Run Under PBS								
Maximum LSF run tin	ne (hrs): 10								
Available batch proce	ssors: 0								
Determine Optimum Number of Batch Processors LSF Batch Queue:									
(c) 2008-2015 AASPI - 1	The University of Oklahoma	Execute filter_dip_components							

Like all AASPI codes, click *Execute* and intermediate information will be printed in the xterm from which aaspi\_util was launched:

8:data ;	preloaded					
7:data	preloaded					
0: first	line.current line.last line.ETA	105	110	201	0.003	h
0: first	line.current line.last line.ETA	105	120	201	0.003	h
0: first	line, current line, last line, ETA	105	130	201	0.002	h
0: first	line,current line,last line,ETA	105	140	201	0.002	h
0: first	line,current line,last line,ETA	105	150	201	0.002	h
0: first	line,current line,last line,ETA	105	160	201	0.001	h
0: first	line,current line,last line,ETA	105	170	201	0.001	h
0: first	line,current_line,last_line,ETA	105	180	201	0.001	h
0: first	line,current_line,last_line,ETA	105	190	201	0.000	h
0: first	line,current_line,last_line,ETA	105	200	201	0.000	h
	1 :end loop over lines					
	1 number of traces processed:	1649				
process	ta	sk	time (hr	:) time/	'trace	(3)
1:	read data		0.000		0.000	
1:	send data via MPI		0.000		0.000	
1:	receive data via MPI		0.000		0.000	
1:	send results via MPI		0.000		0.000	
1:	receive results via MPI		0.000		0.000	
1:	calculate attributes		0.000		0.000	
1:	write results to disk		0.000		0.000	
1:	total time		0.004		0.008	
	1 : memory residing only on slaves a	eallocate	ea			
	1 : attempt to deallocate g_out					
	1 : attempt to deallocate q_out					
	1 : attempt to deallocate line index					
line inde	x deallocated					
in memory	deallocated					
lag inter	p deallocated					
t lag int	erp deallocated					
t lag int	erp,start cdp,end cdp deallocated					
	1 : shared arrays residing on both m	aster and	i slave d	leallocat	ed	
	8 :end loop over lines					
	8 number of traces processed:	1552				
process	ta	sk	time (hr	) time/	'trace	(3)
8:	read data		0.000		0.000	
8:	send data via MPI		0.000		0.000	
8:	receive data via MPI		0.000		0.001	

Once the job is completed, typing ls - ltr at the terminal prompt shows that the following files were created:

-rw-rr	1	kmarfurt	aaspi	31	Aug	З	16:10	live_processor_list	
-rw-rr	1	kmarfurt	aaspi	1921	Aug	З	16:10	inline_dip_median_filt_boonsville_1.H00	
-rw-rr	1	kmarfurt	aaspi	2987	Aug	3	16:10	inline dip median filt boonsville 1.H	
-rw-rr	1	kmarfurt	aaspi	1927	Aug	З	16:10	dip_magnitude_median_filt_boonsville_1.H00	
-rw-rr	1	kmarfurt	aaspi	3023	Aug	З	16:10	dip_magnitude_median_filt_boonsville_1.H	
-rw-rr	1	kmarfurt	aaspi	1925	Aug	3	16:10	dip azimuth median filt boonsville 1.H00	
-rw-rr	1	kmarfurt	aaspi	3040	Aug	з	16:10	dip_azimuth_median_filt_boonsville_1.H	τ
-rw-rr	1	kmarfurt	aaspi	1927	Aug	з	16:10	crossline dip median filt boonsville 1.H00	Т
-rw-rr	1	kmarfurt	aaspi	3005	Aug	3	16:10	crossline dip median filt boonsville 1.H	
-rw-rr	1	kmarfurt	aaspi	1909	Aug	з	16:10	conf median filt boonsville 1.H00	
-rw-rr	1	kmarfurt	aaspi	2776	Aug	з	16:10	conf_median_filt_boonsville_1.H	
-rw-rr	1	kmarfurt	aaspi	22535	Aug	з	16:11	image filt3d boonsville 1.out	
[kmarfurt@oj	pa.	l boonsvil	lle]\$						

Note that we have created filtered versions of the inline dip and crossline dip components. The part of the name *median\_filt* denotes the kind of filter that was applied. Had we applied a LUM filter, we would see *lum\_filt* instead. Program **filter\_dip\_components** also generates new versions of dip magnitude and dip azimuth computed from the filtered dip component volumes.



The results of the median filter look like this (time slice, t = 1.1 sec):

Here we see what the result of the LUM filter looks like (time slice, t = 1.1 sec):



And here is the result of the MSMTM filter with q = 4 (time slice, t = 1.1 sec)



We note that the median filtered image is overall is less noisy, smoother, with a little less N-S acquisition footprint. However, it also has somewhat lower resolution than the input image shown previously. In comparison to the median filter, the LUM filtered image shows more acquisition footprint, but it has enhanced the collapse features too. The MSMTM filter improves in regards to the footprint and shows better details near the collapse features.

Let's now plot the filtered dip magnitude. Return to the main *AASPI\_UTIL* GUI and select the tab titled *'AASPI QC Plotting'*:

	aaspi_util GUI - Post Stack Utilities (Rele	rase Date: September 30, 2015)	
	Eile Volumetric Attributes Horizon-	based Classification Volumetric Classification Image Processing Display Tools Other Utilities Set 🗚 SPI Default	t Parameters <u>H</u> elp
	SEGY to AASPI format conversion (multiple files)	AASPI to SEGY format conversion (single file) AASPI QC Plotting AASPI Workflows Prestack Utilities	<u> </u>
	AASPI QC Plotting - A quick tool to disp	lay AASPI-fromat attribute volumes	
$\rightarrow$	AASPI format input file name (*.H):	E:\test_data\boonsville\lum_filtered_inline_dip_boonsville_0_0.H Browse	
<u> </u>	Colorbar file name:	C:\Program Files\AASPI\sep_colors\white_gray_black.sep Browse	
	Enter plot title:		
	Minimum Time (s):	1.1	
	Maximum Time (s):	1.1	
	Increment Time (s):	0.002	
	Minimum CDP no.:	74	
	Maximum CDP no.:	206	
	Increment CDP no.:	1	
	Minimum Line no.:	105	
	Maximum Line no.:	201	
	Increment Line no.:	1	
	Desired output axis 1:	Line no.	
	Desired output axis 2:	CDP no.	
	Desired output axis 3:	Time (s)	
	Reverse x-axis?	n	
	Reverse y-axis? (Default is positive down)	auto	
	Display color bar?	<u>y</u>	
	Auto - Scaling?	Fixed-Scale	
	Min Amplitude :	0	
	Max Amplitude :	5	
	Percent Histogram Clip :	98	
<b></b>	All positive?	y	
	Execute		-

First select the file *dip\_magnitude\_median\_filt\_boonsville\_1.H* to plot. Dip magnitude will be strictly positive, so we will want to (2) set the *All positive?* option to *y*. Finally (3) we will want to plot dip magnitude against a white-gray-black colorbar so that flat dips appear as white. The resulting image looks like this:



The very steep dip (black areas) corresponds to collapse features. Let's now plot the dip azimuth. Our *AASPI QC Plotting* GUI looks like this

Ele	Volumetric Attributes Horizon-b	ased Classification	Volumetric Classifi	ation Image P	rocessing	Display Tools	Other Utilities	Set AASPI Default Parameters	Help	
SEGY t	to AASPI conversion (multiple files)	AASPI to SEGY format conversion (single file)	AASPI QC Plotting	AASPI Workflow	vs Presta	ASPI ock Utilities			-	
AASPI	QC Plotting - A quick tool to displ	ey AASPI-fromat attr	ibute volumes							
AASPI	format input file name (*.H):	E:\test_data\boons	ville\lum_filtered_d_	mig_boonsville_n	nedian.H	Browse				
Colorb	ar file name:	CAProgram Eiles AASPRisen colors curie sen								
Enter p	lot title:	F				-				
cinci p		1								
Minim	um Time (s):	11	_							
Maxim	um Time (s):	11	_							
Increm	ent Time (s):	0.002	_							
Minim	um CDP no.:	74	_							
Maxim	um CDP no.:	206	_							
Increm	ent CDP no.:	1	_							
Minima	um Line no.:	105	_							
Maxim	um Line no.:	201	_							
Increm	ent Line no.:	1								
Desired	I output axis 1:	Line no.								
Desired	l output axis 2:	CDP no.	-							
Desired	I output axis 3:	Time (s)	•							
Reverse	e x-axis?	n								
Reverse	e y-axis? (Default is positive down)	auto								
Display	color bar?	<u>y</u>								
Auto -	Scaling?	Fixed-Scale								
Min An	nplitude :	180	_							
Max An	mplitude :	-180	_							
Percent	t Histogram Clip :	98								
All posi	itive?	у —								
Executi	e									

Enter the (1) file name *dip\_azimuth\_median\_filt\_boonsville\_1.H* as the *AASPI Input*. Then (2) choose the cyclic.sep color bar so that  $-180^{\circ}$  will plot up with the same color as  $+180^{\circ}$  (yellow for this colorbar). (3) Turn the *Auto Scale* to be *Off* to turn off the histogram scaling and instead use explicit clipping. The ranges of these attributes are (4)  $-180^{\circ}$  to  $+180^{\circ}$ .The result will look like this



A drawback of dip azimuth is that it is meaningless when the dip magnitude is very close to 0.0 (the white areas in the dip magnitude image). We can better visualize these areas by using transparency and blending the two images:



However, this image is somewhat disappointing in that the areas of greater dip where the dip azimuth estimates are accurate are now blackened out. We can ameliorate this problem by plotting the dip magnitude against a black-gray-white color bar, thereby rendering the strong dip-magnitude areas more pastel:



However, the image is still less than ideal.

#### **References:**

- al-Dossary, S., and K. J. Marfurt, 2007, Lineament-preserving filtering: Geophysics, **72**, P1-P8.
- Corrao, A., M. Fervari, and M. Galbiati, 2011, Hewett Plattendolomite: Reservoir Characterization by Resolution Enhanced Seismic data: GCSSEPM 31st Annual Bob. F. Perkins Research Conference on Seismic attributes – New views on seismic imaging: Their use in exploration and production, 66-99.