



DepSim/PROMISE+AVO/4D

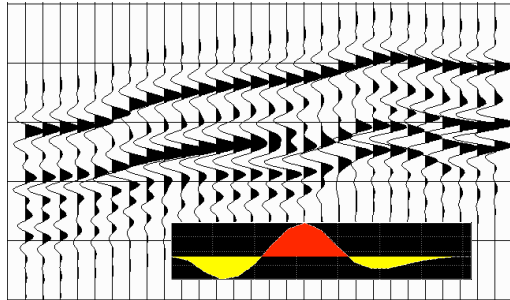
Michael Glinsky
Shell E&P Technology Co.

Jaap Leguijt
SIEP-RTS

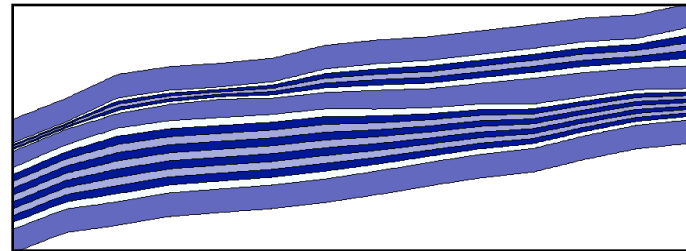
Inputs to inversion



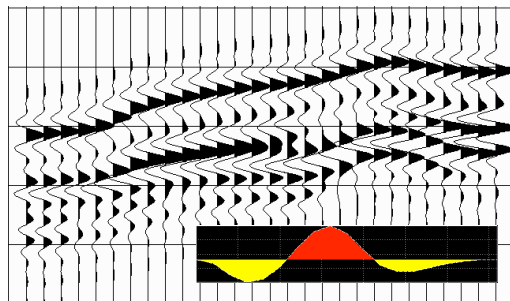
near stack and wavelet



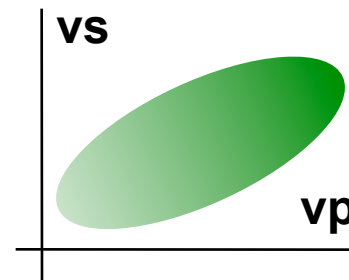
initial DepSim model



far stack and wavelet



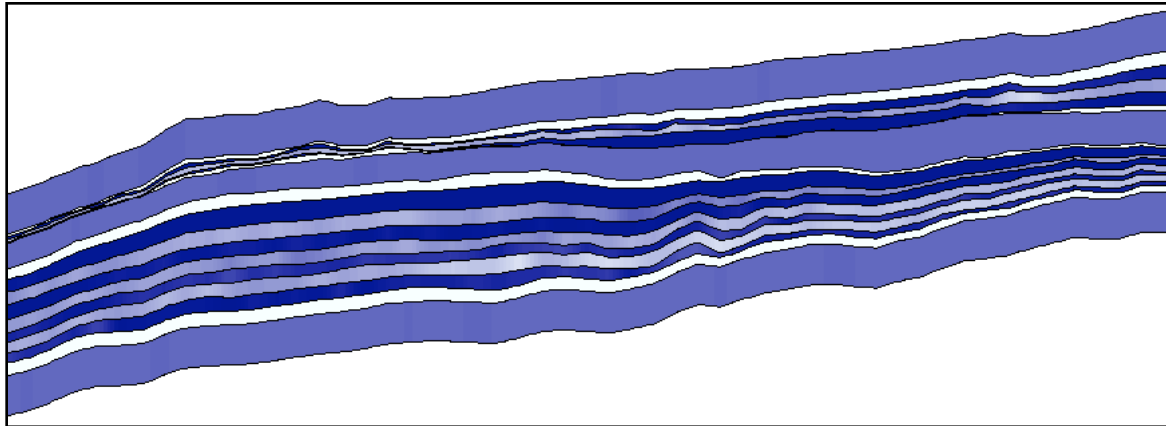
rock properties



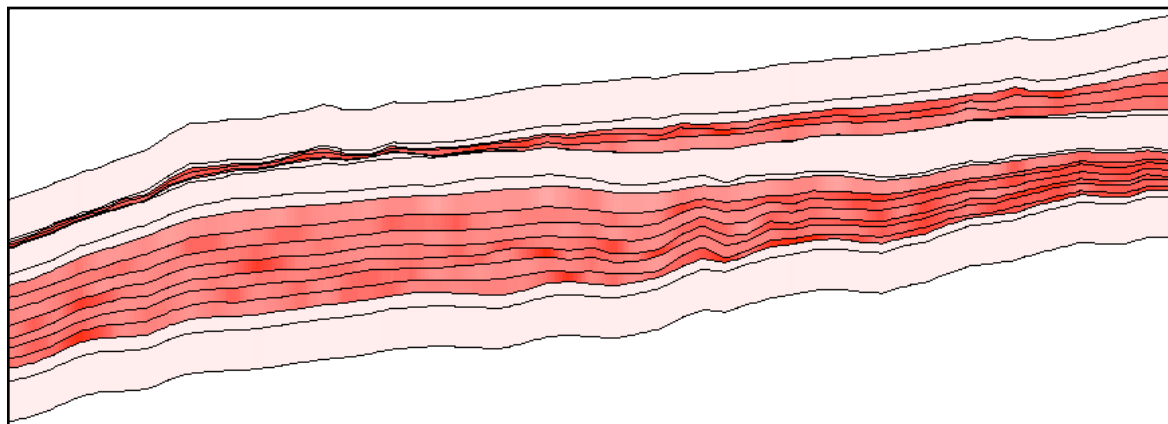
Output of inversion



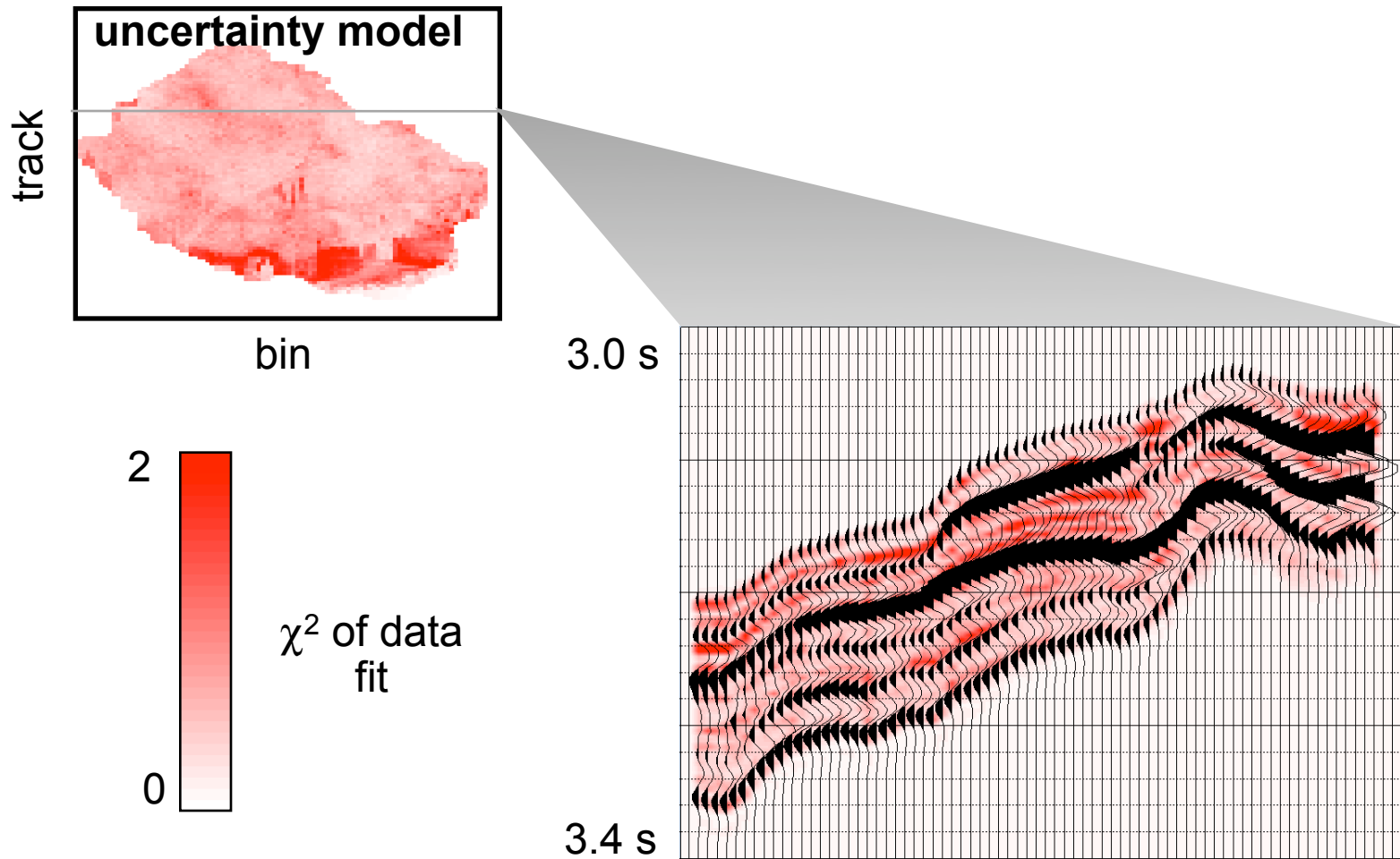
updated DepSim model



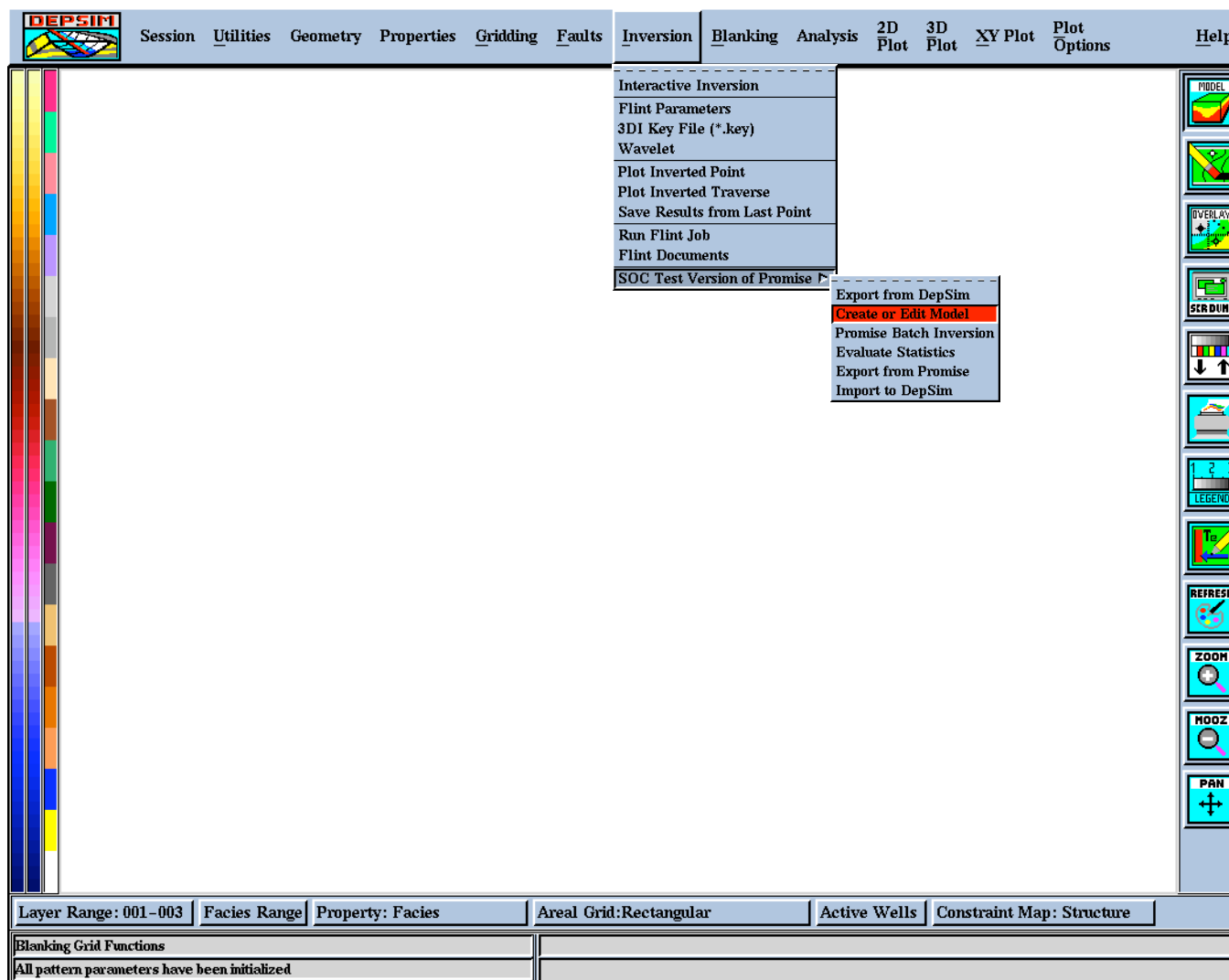
uncertainty in DepSim model



Error output



DepSim/PROMISE integration



D2P menus



main_popup

**DepSim to PROMISE+AVO/4D
(SOC test version)**

DepSim Jaap grid file name:

depsim.jgrd

PROMISE model file name:

model.mod

read/create PROMISE model

edit PROMISE model

write PROMISE model

Reset

EXIT

layerEdit_popup

Edit PROMISE model

Number of stacks: 1

Layer: 004: lower sand

Litho: 012: SDDI_lam_sand

Fluid: 004: LIPOS_fluid

Error in thickness:
(in m or ft) 100.0

Horizon time (layer top):
(layer 1 can not be constrained)
(one layer must be constrained)

☒ constrained

☐ free

Error in horizon time:
(in ms) 100.0

COPY LAYER

PASTE LAYER

EDIT LAYER

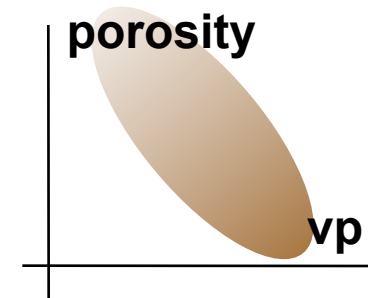
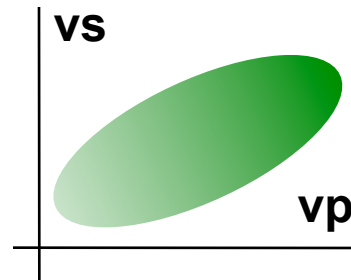
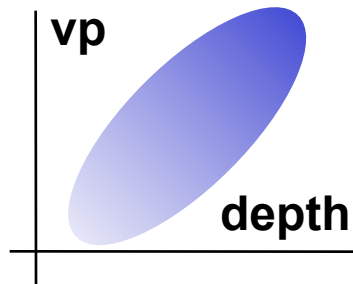
EDIT STACKS (AVO,4D)

DONE

GOM petrophysical end member trends used in prior probability

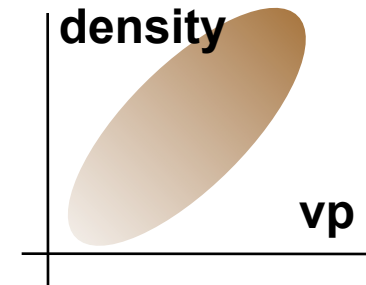
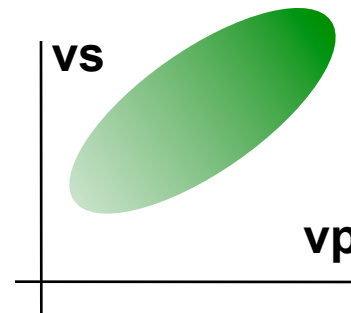
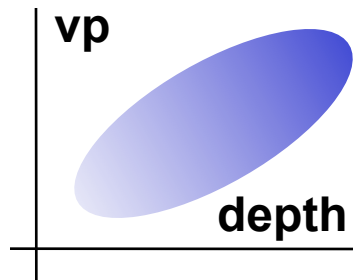


wet
sand



mix with net/gross $\pm \sigma$

mud-
stone



note: separate trend for each layer

SDDI_lam_sand menu



litho_popup

Edit lithology

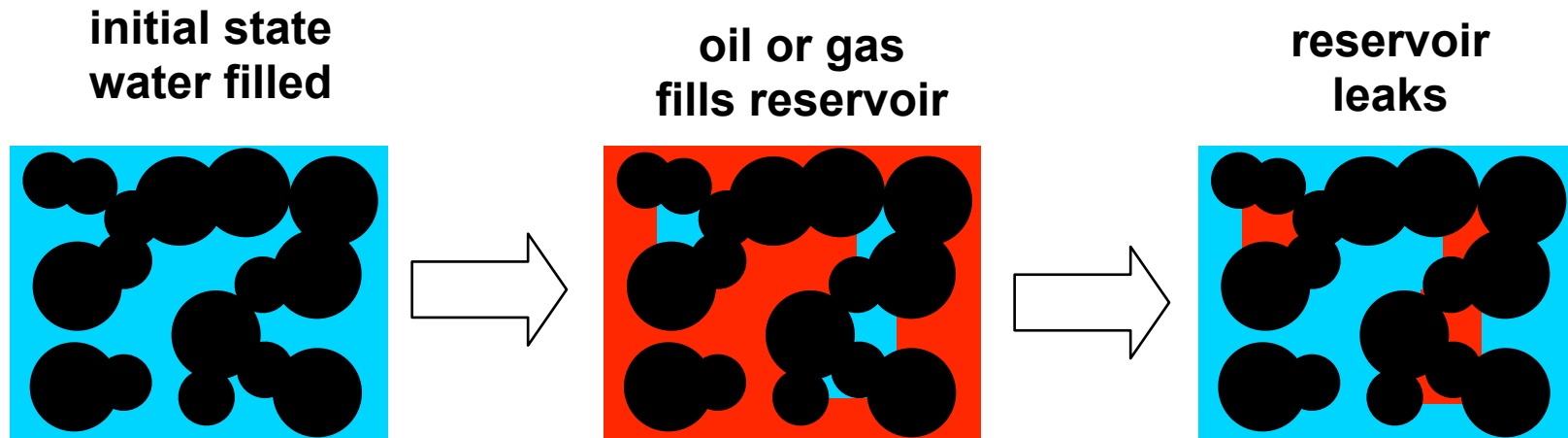
002: Top_F_Mudstone
012: SDDI_lam_sand

Statistical parameters:		Fixed parameters:	
ntg_avg **** FROM DEPSIM ****	0.5	vp_mud_devia	536.0
ntg_devia	0.2	vs_mud_zero	-3373.0
vp_sand_zero	4988.0	vs_mud_slope	0.801
vp_sand_slope	0.3572	vs_mud_devia	206.0
vp_sand_devia	457.0	density_mud_factor	0.0977
vs_sand_zero	-3996.0	density_mud_exp	0.3467
vs_sand_slope	0.894	density_mud_devia	0.041
vs_sand_devia	226.0		
porosity_zero	0.579		
porosity_slope	-3e-05		
porosity_devia	0.0137		
vp_mud_zero	6162.0		
vp_mud_slope	0.2828		

COPY PASTE

Ok Reset Cancel

Discrete cases of fluid fill are used



- **prior probability of each fluid fill case**
 - neural network fluid prediction
 - regional information (trap probability, leak probability, etc.)
- **posterior probability of each fluid fill case**
 - adds seismic AVO information

LIPOS_2_fluid menu



fluid_popup

Edit fluid

002: Top_F_Mudstone
005: LIPOS_2_fluid

Statistical parameters:		Fixed parameters:	
oil_prior	▼ 0.09 ▲	oil_density	▼ 0.7 ▲
gas_prior	▼ 0.03 ▲	brine_density	▼ 0.95 ▲
residual_oil_prior	▼ 0.03 ▲	gas_density	▼ 0.3 ▲
residual_gas_prior	▼ 0.01 ▲	oil_vp	▼ 4000.0 ▲
lowsat_gas_prior	▼ 0.02 ▲	brine_vp	▼ 5000.0 ▲
oil_prior2	▼ 0.09 ▲	gas_vp	▼ 3000.0 ▲
gas_prior2	▼ 0.03 ▲	oil_fraction	▼ 0.85 ▲
residual_oil_prior2	▼ 0.03 ▲	gas_fraction	▼ 0.85 ▲
residual_gas_prior2	▼ 0.01 ▲	residual_oil_fraction	▼ 0.15 ▲
lowsat_gas_prior2	▼ 0.02 ▲	residual_gas_fraction	▼ 0.15 ▲
		lowsat_gas_fraction	▼ 0.05 ▲

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Ok Reset Cancel

Edit stacks menu



stack_popup

Edit stacks

Veff:	▼ 7000.0 ▲	L factor: (dB)	▼ 0.0 ▲
Dip: (ms/kft or km)	▼ 0.0 ▲	L error: (dB)	▼ 1.5 ▲
Time: (ms)	▼ 3000.0 ▲	M factor: (dB)	▼ 0.0 ▲
		M error: (dB)	▼ 0.5 ▲

stack: 001:

Time of stack: ☒ base survey ☐ monitor survey

Signap file name: data.sip Wavelet file name: wavelet.wav

x_min:	▼ 0.0 ▲	x_mute_start_1:	▼ 0.0 ▲
x_max:	▼ 0.0 ▲	x_mute_start_2:	▼ 0.0 ▲
t_mute_1: (ms)	▼ 0.0 ▲	x_mute_end_1:	▼ 1.0 ▲
t_mute_2: (ms)	▼ 0.0 ▲	x_mute_end_2:	▼ 1.0 ▲

Noise:

snr: (dB)	▼ 10.0 ▲	f_low: (Hz)	▼ 1.0 ▲
refl_coeff:	▼ 0.0376 ▲	f_high: (Hz)	▼ 1000.0 ▲

Ok

PROMISE, EVALUATE and P2D menus



main_popup

**PROMISE+AVO/4D
(SOC test version)**

Input PROMISE parameter deck:

model.deck

Ok Reset EXIT

main_popup

**EVALUATE
(SOC test version)**

Input PROMISE diag file:

model.diag

Input statistic requisition file:

model.prq

Output PROMISE eval file:

model.eval

Output model variables to ascii file: yes

Output ascii file:

model.txt

Ok Reset EXIT

main_popup

**PROMISE to DepSim
(SOC test version)**

Input PROMISE model file:

model.mod

Input PROMISE eval file:

model.eval

Input DepSim Jaap grid file:

depsim.jgrd

Output PROMISE Jaap grid file:

promise.jgrd

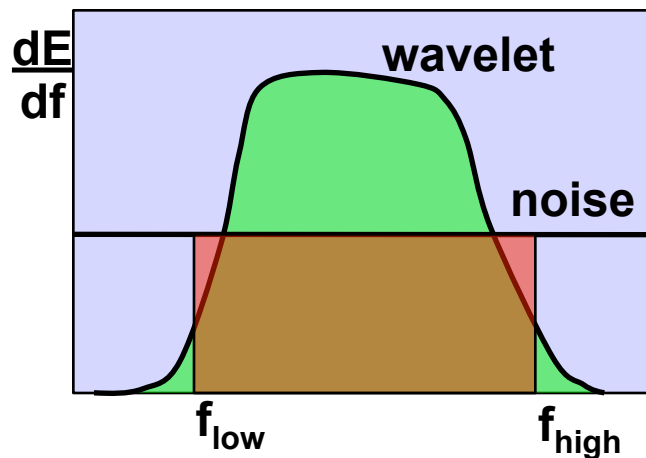
Output non-layer quantities: yes

Ok Apply Reset EXIT

White noise specification



- **seismic wavelet**
- **bandwidth of information content of seismic wavelet**
 - f_{low} and f_{high} (Hz)
- **average reflection coefficient**
- **SNR (dB)**
 - parameter to vary (others set initial scale, use 10 dB)

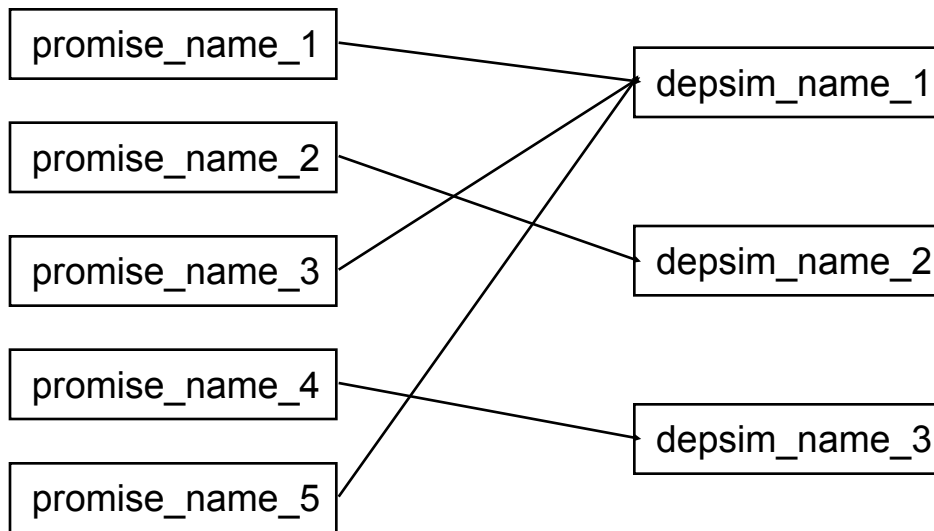


SNR = green / red

PROMISE to DepSim translator



- **finds DepSim equivalent of PROMISE parameters**
 - import to PROMISE
 - export from PROMISE
- **uses ASCII file dictionary (depsim_promise_dictionary)**
- **default is no translation**



A time migration approximation is used to model AVO



expansion in $(X / V T)$ and $(V dT/dx) \ll 1$

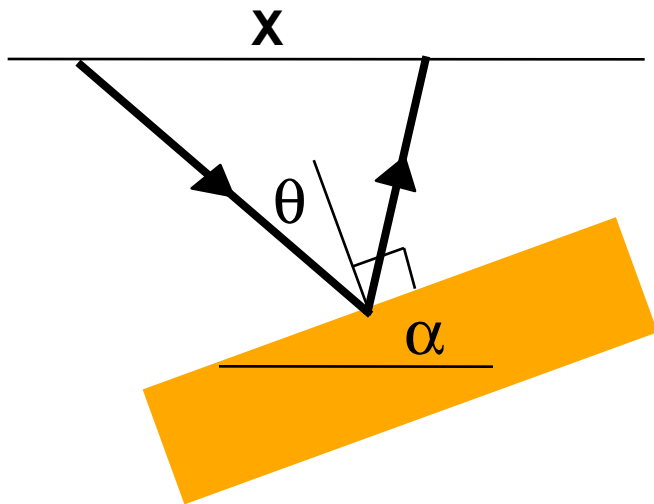
where, X = offset

V = migration velocity

T = migrated time of reflector

x = migrated subpoint

v = interval velocity



$$\theta = (v/V) (X / V T) + \text{3rd order}$$

$$\alpha = 0.5 (V dT/dx) + \text{3rd order}$$

Equations that are used to model AVO



reflection coefficient

$$R(X) = A L + B M \overbrace{(v/V)^2 (X / V T)^2}^{\sin^2 \theta} + 4\text{th order}$$

wavelet stretch

$$S(X) = 1 + \overbrace{0.5 (X / V T)^2}^{\text{NMO}} + \overbrace{0.125 (V dT/dx)^2}^{\text{dip}} + 4\text{th order}$$

offset average wavelet & reflection coefficient

$$\text{wavelet} = W(X, t) = W_0(t / S(X))$$

$$\langle R W \rangle_x = \langle R \rangle_x \langle W \rangle_x + 4\text{th order}$$