DECOMPOSITION THEOREMS

[S]

COHERENT DECOMPOSITION

E. KROGAGER (1990)

W.L. CAMERON (1990)

[K]

TARGET DICHOTOMY

J.R. HUYNEN (1970)

R.M. BARNES (1988)

[T] [C]

AZIMUTHAL SYMMETRY

EIGENVECTORS BASED DECOMPOSITION

MODEL BASED DECOMPOSITION

S.R. CLOUDE (1985)

W.A. HOLM (1988)

A.J. FREEMAN (1992)

EIGENVECTORS / EIGENVALUES ANALYSIS & MODEL BASED DECOMPOSITION

J.J. VAN ZYL (1992)

EIGENVECTORS / EIGENVALUES ANALYSIS ENTROPY / ANISOTROPY

S.R. CLOUDE - E. POTTIER (1996-1997)

MODEL BASED DECOMPOSITION

ANTHONY FREEMAN

(1992)

MODEL BASED DECOMPOSITION

3 COMPONENTS SCATTERING MECHANISM MODEL

$$\langle [C] \rangle = f_S [C_S] + f_D [C_D] + f_V [C_V]$$

$$\langle [T] \rangle = f_S [T_S] + f_D [T_D] + f_V [T_V]$$

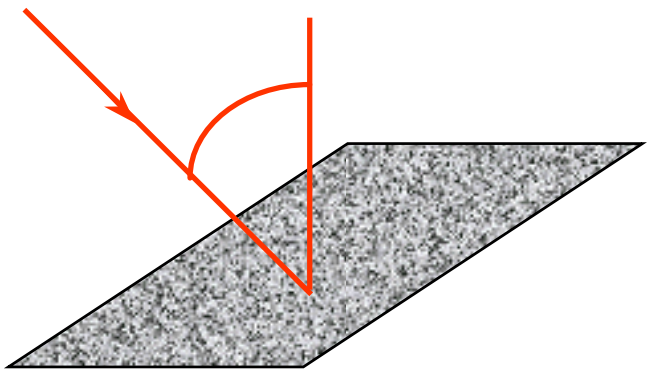
SINGLE SCATTERING

DOUBLE SCATTERING

VOLUME SCATTERING

MODEL BASED DECOMPOSITION

SINGLE SCATTERING
(ROUGH SURFACE)



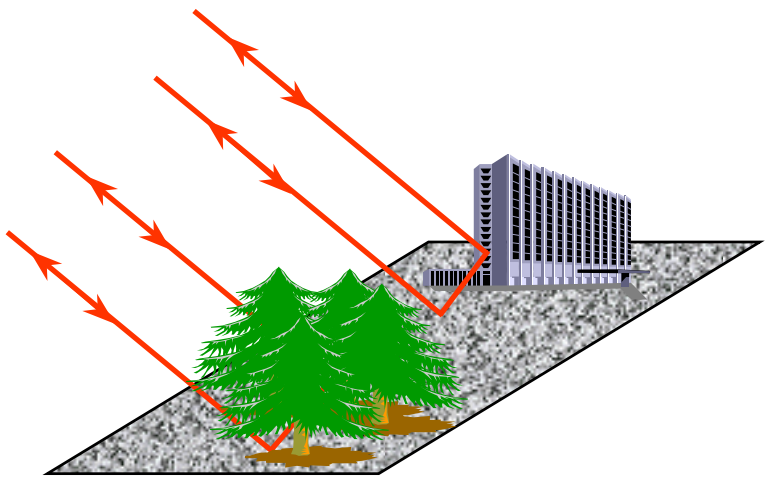
MECHANISM

$$[S_S]=\begin{bmatrix} R_H & 0 \\ 0 & R_V \end{bmatrix} \Rightarrow \underline{\Omega}_S=\begin{bmatrix} R_H \\ 0 \\ R_V \end{bmatrix}$$

COVARIANCE MATRIX

$$[C_S]=f_S\begin{bmatrix} \beta^2 & 0 & \beta \\ 0 & 0 & 0 \\ \beta & 0 & 1 \end{bmatrix} \qquad f_S=|R_V|^2 \qquad \beta=\frac{R_H}{R_V}$$

DOUBLE SCATTERING



MECHANISM

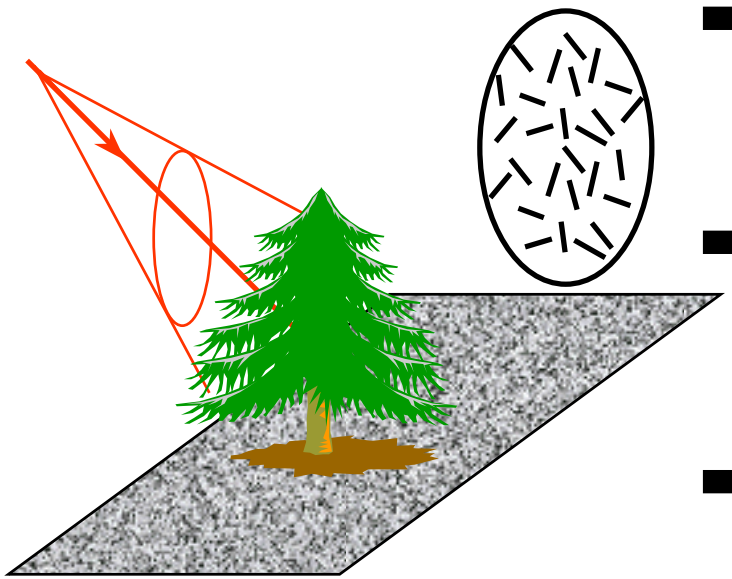
$$[S_D]=\begin{bmatrix} R_{GH}R_{TH} & 0 \\ 0 & -R_{GV}R_{TV} \end{bmatrix} \Rightarrow \underline{\Omega}_D=\begin{bmatrix} R_{GH}R_{TH} \\ 0 \\ -R_{GV}R_{TV} \end{bmatrix}$$

COVARIANCE MATRIX

$$[C_D]=f_D\begin{bmatrix} \alpha^2 & 0 & -\alpha \\ 0 & 0 & 0 \\ -\alpha & 0 & 1 \end{bmatrix} \qquad f_D=|R_{GV}R_{TV}|^2 \qquad \alpha=\frac{R_{GH}R_{TH}}{R_{GV}R_{TV}}$$

MODEL BASED DECOMPOSITION

VOLUME SCATTERING
(RANDOMLY ORIENTED VERY THIN CYLINDER-LIKE SCATTERERS)



MECHANISM
(CYLINDER)

$$[S]=\begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$$

ORIENTED MECHANISM

$$[S_\theta]=[U_2(\theta)]^T[S][U_2(\theta)]$$

UNIFORM ORIENTATION

$$P(\theta)=\frac{1}{2\pi}$$

SECOND-ORDER STATISTICS

$$[C_V]=\langle[C_\theta]\rangle=\int_0^{2\pi}[C_V]P(\theta)d\theta$$

COVARIANCE MATRIX

(THIN CYLINDERS)

$$a \mapsto 1 \quad b \mapsto 0$$

$$[C_V]=f_V\begin{bmatrix} 1 & 0 & \frac{1}{3} \\ 0 & \frac{2}{3} & 0 \\ \frac{1}{3} & 0 & 1 \end{bmatrix}$$

MODEL BASED DECOMPOSITION

3 COMPONENTS SCATTERING MECHANISM MODEL

$$\langle [C] \rangle = \begin{bmatrix} f_S\beta^2 + f_D\alpha^2 + f_V & 0 & f_S\beta - f_D\alpha + \frac{f_V}{3} \\ 0 & \frac{2f_V}{3} & 0 \\ f_S\beta - f_D\alpha + \frac{f_V}{3} & 0 & f_S + f_D + f_V \end{bmatrix}$$

→ 5 UNKNOWN REAL COEFFICIENTS

→ 4 OBSERVED EQUATIONS

MODEL BASED DECOMPOSITION

$$if\ \Re\left(\left\langle S_{XX}S_{YY}^{*}\right\rangle - \frac{f_V}{3}\right) \geq 0 \quad \Rightarrow \quad \alpha = +1$$

$$if\ \Re\left(\left\langle S_{XX}S_{YY}^{*}\right\rangle - \frac{f_V}{3}\right) \leq 0 \quad \Rightarrow \quad \beta = +1$$

$$\downarrow$$

$$\left\{f_S, \beta, f_D, |\alpha|, f_V\right\}$$

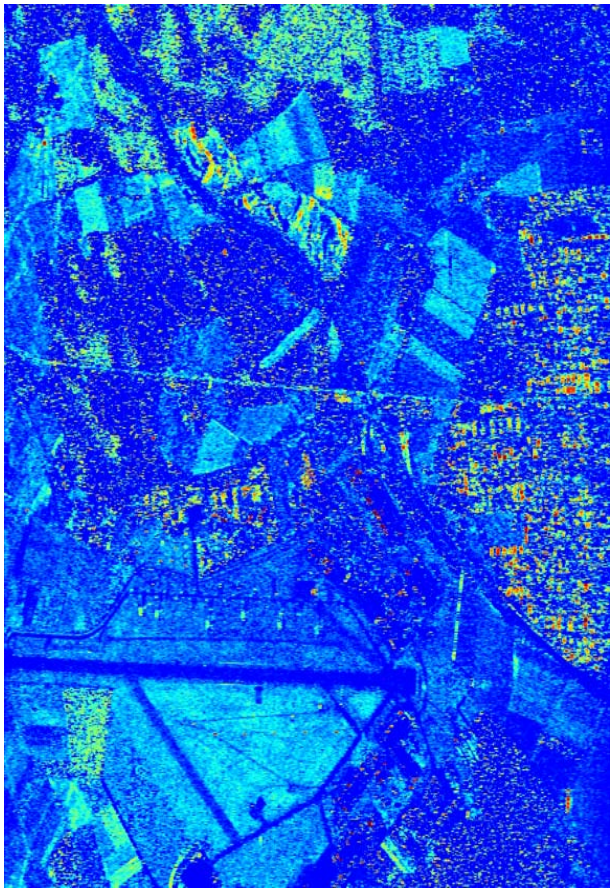
3 COMPONENTS SCATTERING MECHANISM MODEL

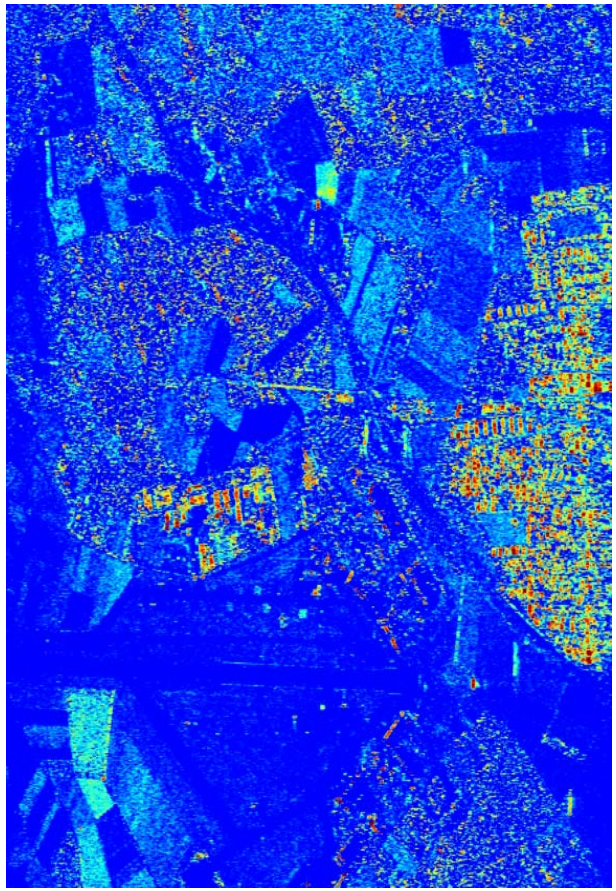
$$span = \left\langle C_{11}\right\rangle + \left\langle C_{22}\right\rangle + \left\langle C_{33}\right\rangle = f_S\left(1+\beta^2\right) + f_D\left(1+|\alpha|^2\right) + \frac{8}{3}f_V$$

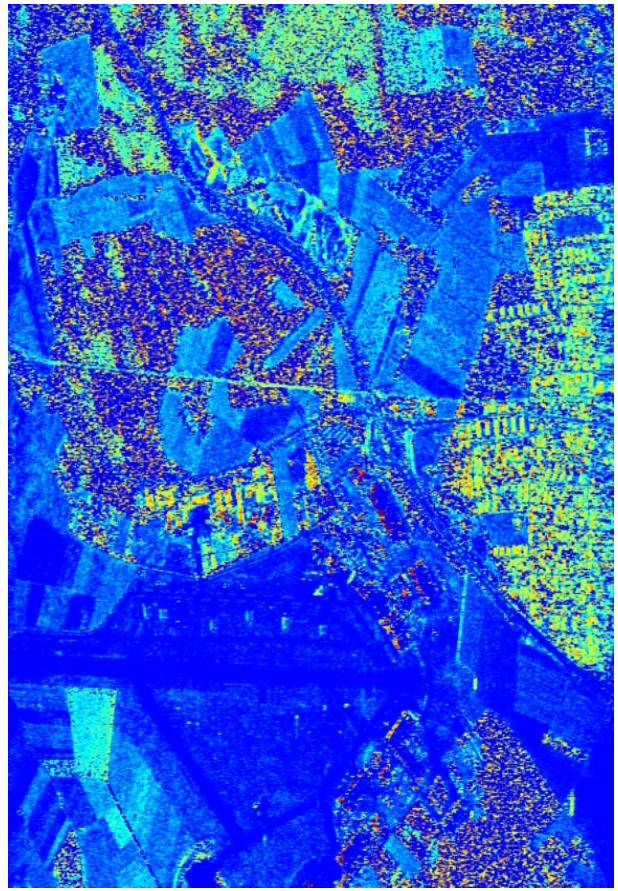
$$\downarrow \qquad \downarrow \qquad \downarrow$$

SINGLE BOUNCE SCATTERING (ODD) | **DOUBLE DOUBLE SCATTERING (DBL)** | **VOLUME SCATTERING (VOL)**

MODEL BASED DECOMPOSITION





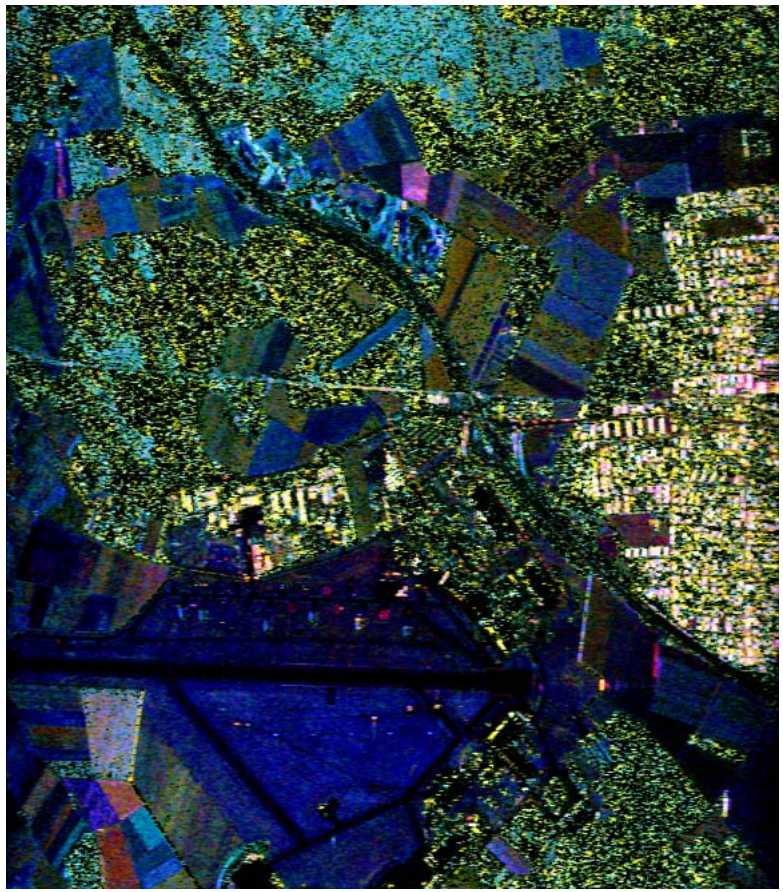


$$ODD = f_S\left(1+\beta^2\right)$$

$$DBL = f_D\left(1+\alpha^2\right)$$

$$VOL = \frac{8 f_V}{3}$$

MODEL BASED DECOMPOSITION



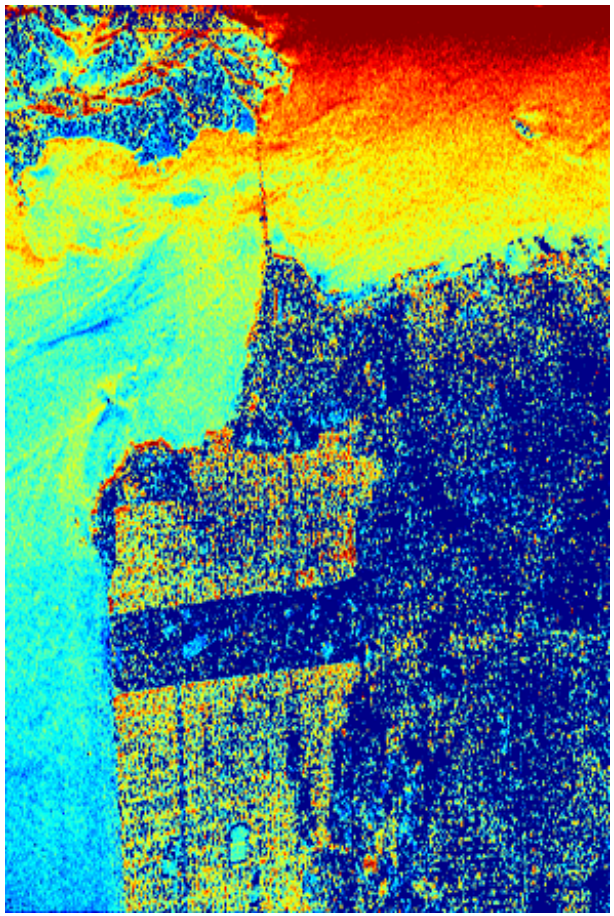
$2A_0$ $B_0 + B$ $B_0 - B$

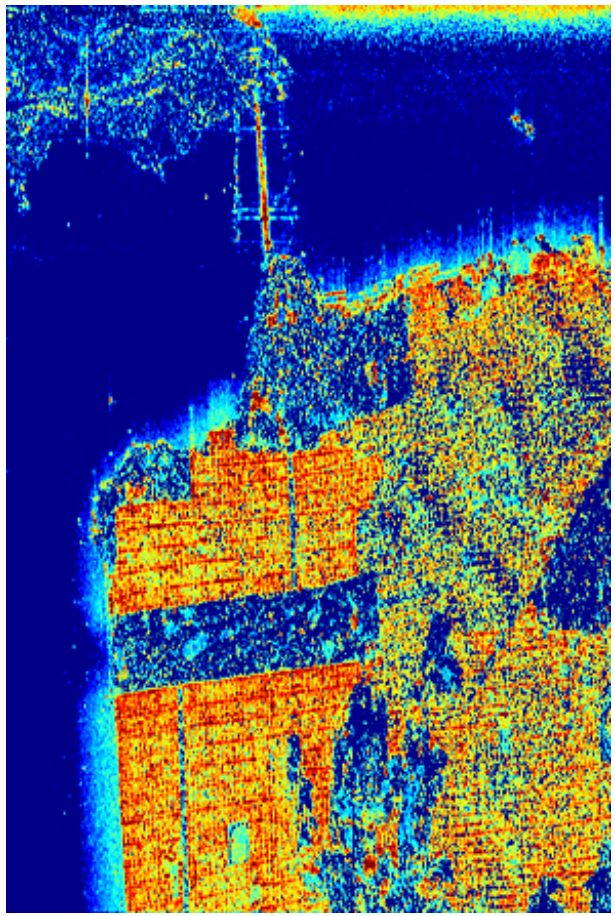
$$ODD = f_S\left(1+\beta^2\right)$$

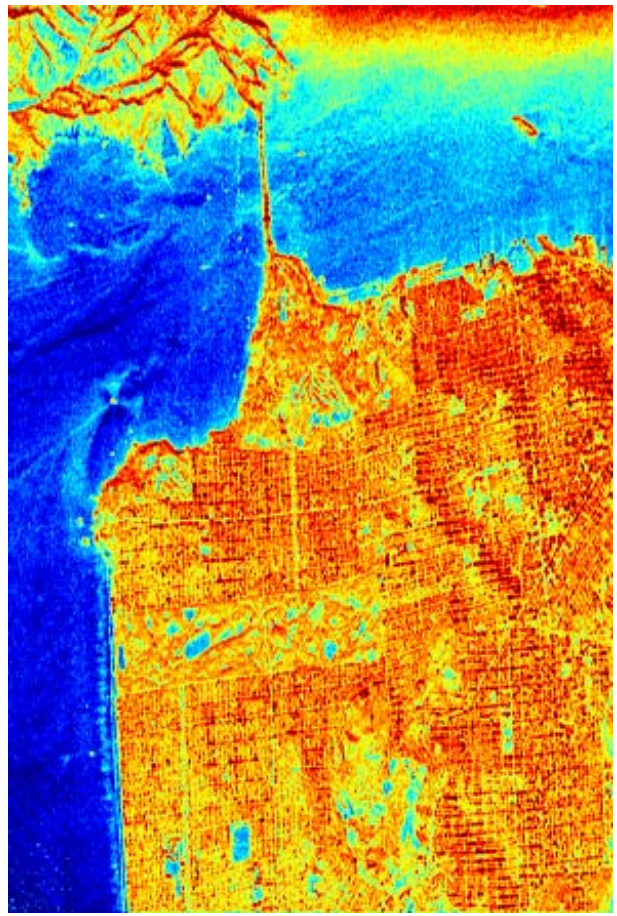
$$DBL = f_D\left(1+\alpha^2\right)$$

$$VOL = \frac{8 f_V}{3}$$

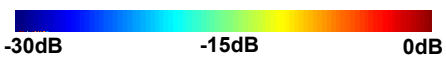
MODEL BASED DECOMPOSITION







$$ODD = f_S\left(1+\beta^2\right) \qquad DBL = f_D\left(1+\alpha^2\right) \qquad VOL = \frac{8 f_V}{3}$$



MODEL BASED DECOMPOSITION

$2A_0$ $B_0 + B$ $B_0 - B$

$$ODD = f_S\left(1+\beta^2\right)$$

$$DBL = f_D\left(1+\alpha^2\right)$$

$$VOL = \frac{8 f_V}{3}$$