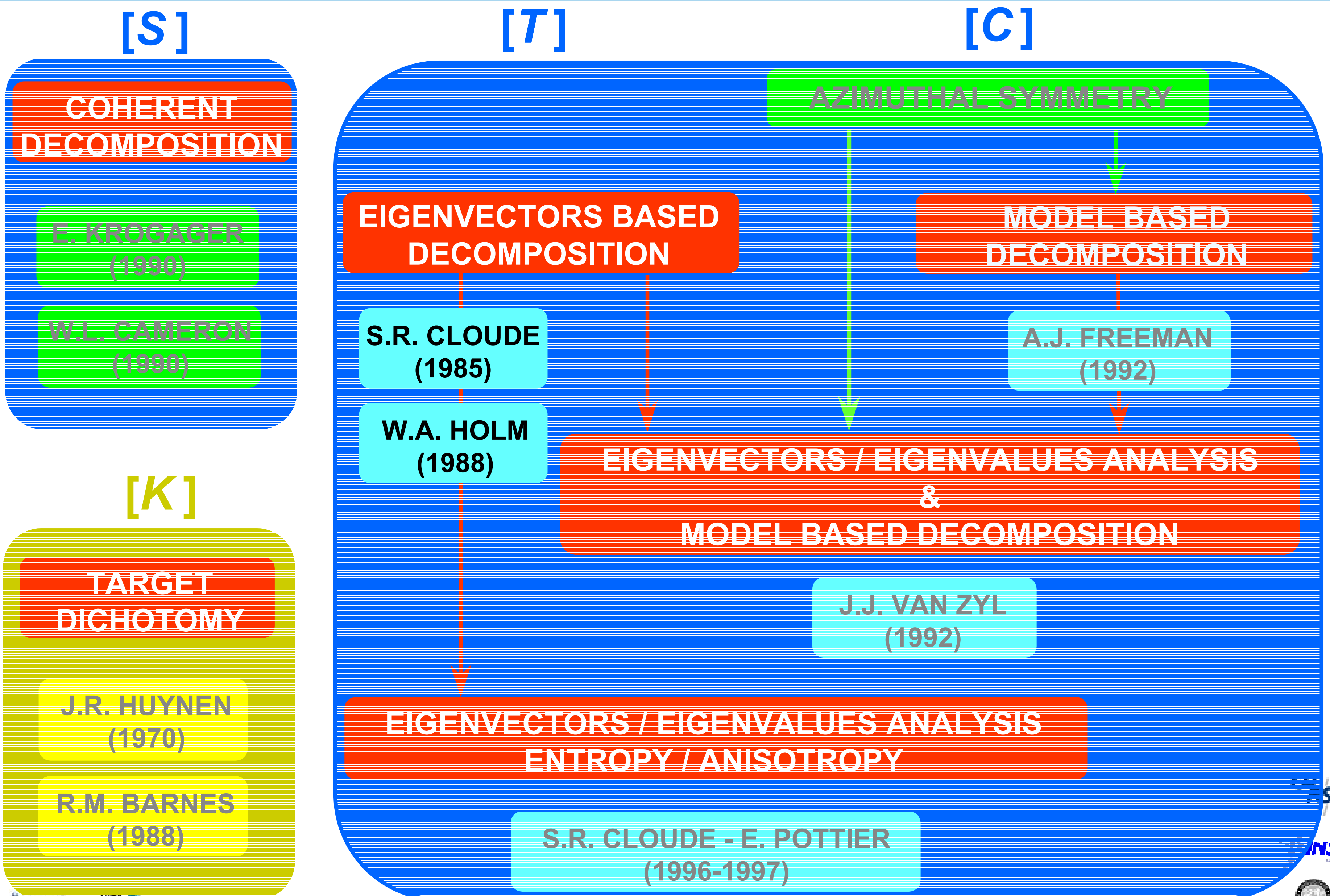
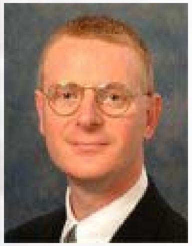
DECOMPOSITION THEOREMS



EIGENVECTOR BASED DECOMPOSITION

SHANE R. CLOUDE

(1985-1992)



WILLIAM A. HOLM

(1988)

EIGENVECTOR-BASED DECOMPOSITION

PROPRIETY

EIGENVALUE PROBLEM IS AUTOMATICALLY

BASIS INVARIANT

- GENERATE A DIAGONAL FORM OF THE COHERENCY MATRIX
- PHYSICALLY INTERPRETATION AS STATISTICAL INDEPENDENCE BETWEEN A SET OF VECTORS
- GENERAL DECOMPOSITION INTO INDEPENDENT SCATTERING PROCESSES

EIGENVECTOR-BASED DECOMPOSITION

COHERENCY MATRIX $\langle[T]\rangle = [T_1] + [T_2] + [T_3]$

KENNAUGH MATRIX $\langle[K]\rangle = [K_1] + [K_2] + [K_3]$

SINCLAIR MATRIX $[S_1] \quad [S_2] \quad [S_3]$

STATISTICAL INDEPENDENCE BETWEEN THE TARGETS

EIGENVECTOR-BASED DECOMPOSITION

COHERENCY MATRIX

$$\langle [T] \rangle = \begin{bmatrix} \langle 2A_0 \rangle & \langle C \rangle - j\langle D \rangle & \langle H \rangle + j\langle G \rangle \\ \langle C \rangle + j\langle D \rangle & \langle B_0 \rangle + \langle B \rangle & \langle E \rangle + j\langle F \rangle \\ \langle H \rangle - j\langle G \rangle & \langle E \rangle - j\langle F \rangle & \langle B_0 \rangle - \langle B \rangle \end{bmatrix}$$

$$\langle [T] \rangle = [U_3][\Sigma][U_3]^{-1}$$

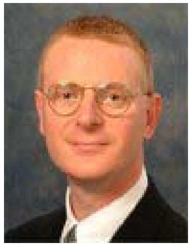
$$[\Sigma] = \begin{bmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{bmatrix}_{\lambda_1 \geq \lambda_2 \geq \lambda_3}$$

3x3 DIAGONAL MATRIX OF EIGENVALUES

$$[U_3] = [\underline{u}_1, \underline{u}_2, \underline{u}_3]$$

SU(3) UNITARY MATRIX (EIGENVECTORS)

SHANE R. CLOUDE



(1985-1992)

DECOMPOSITION

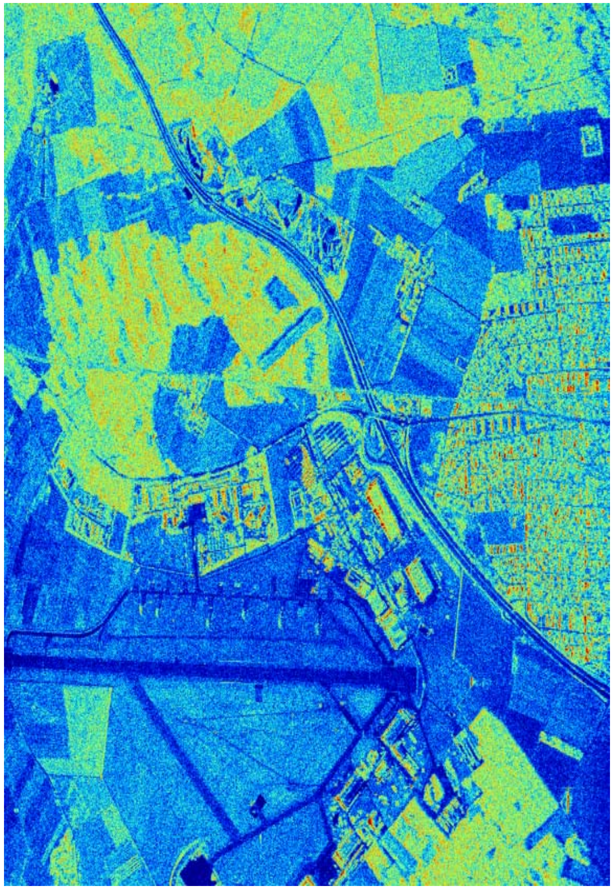
IDENTIFICATION OF THE DOMINANT SCATTERING MECHANISM

VIA THE

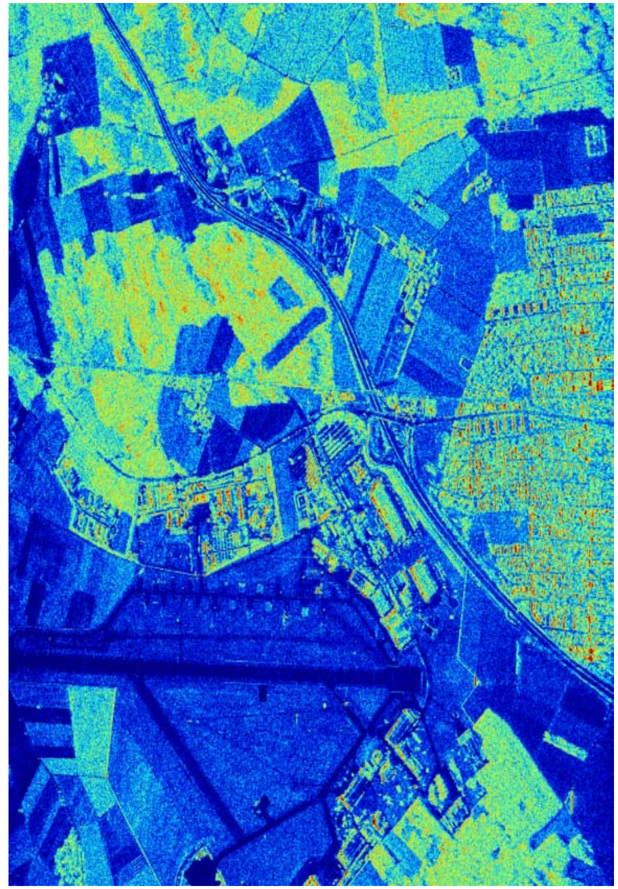
EXTRACTION OF THE LARGEST EIGENVALUE

$$\langle [T] \rangle = [U_3][\Sigma][U_3]^{-1} \quad \Rightarrow \quad [T_1] = \lambda_1 \underline{u}_1 \underline{u}_1^{T*} = \underline{k}_1 \underline{k}_1^{T*}$$

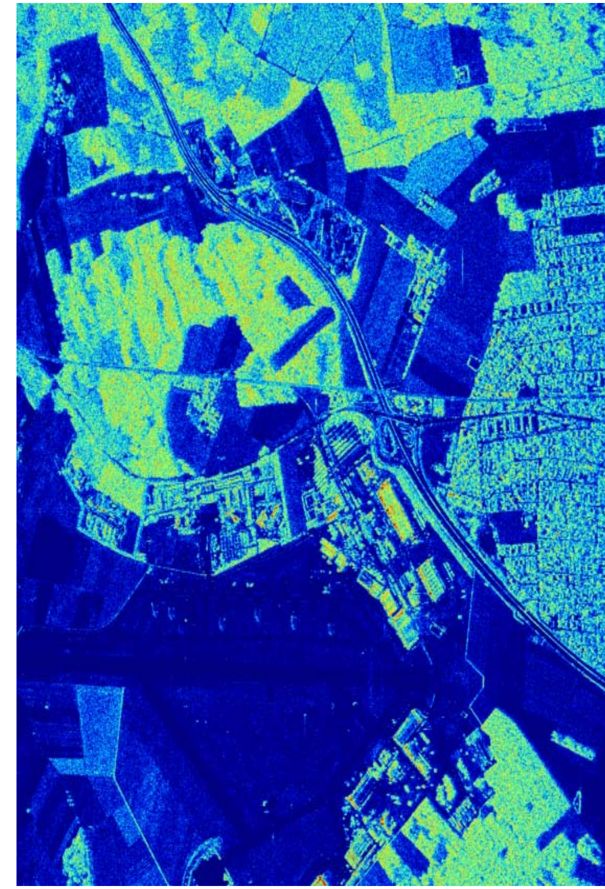
S.R. CLOUDE DECOMPOSITION



$$(2A_0)_{dB}$$



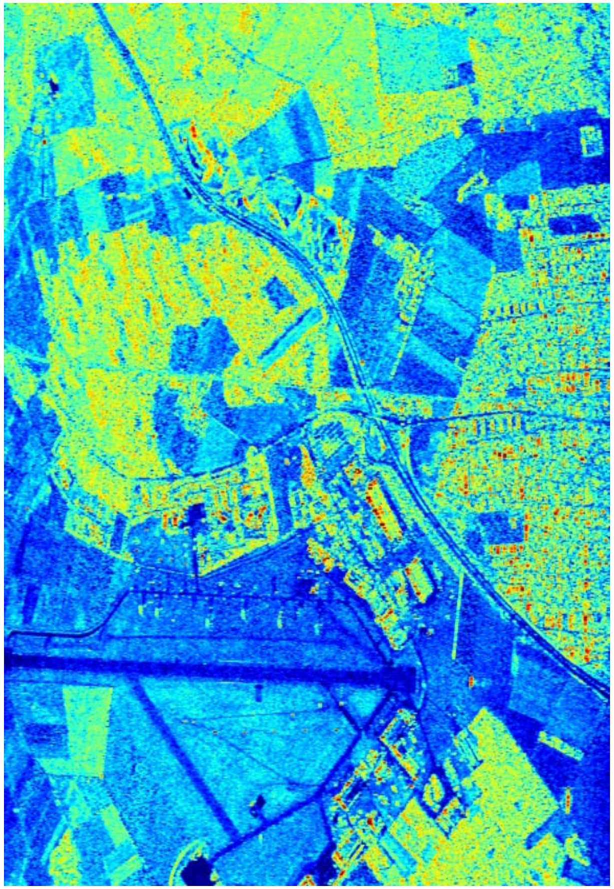
$$(B_0 + B)_{dB}$$



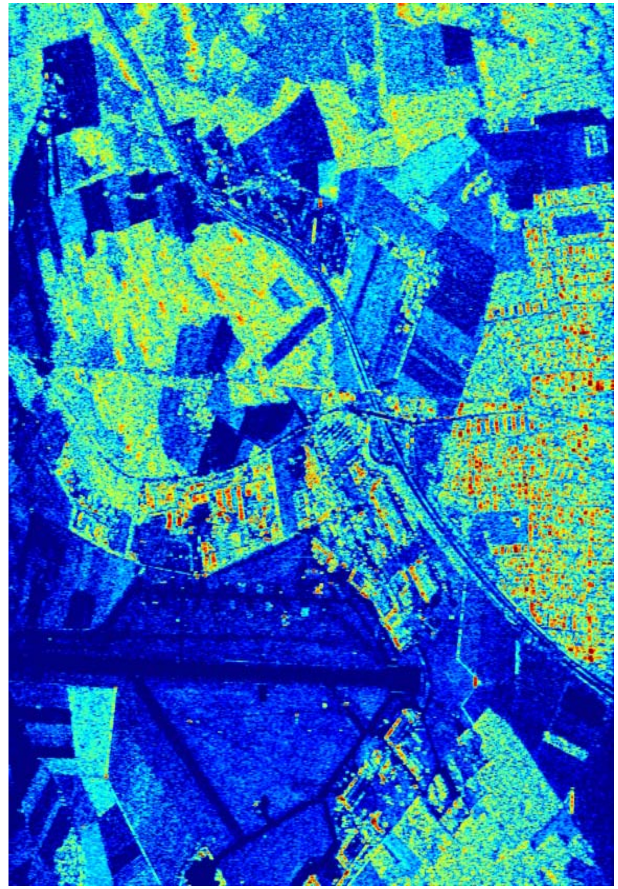
$$(B_0 - B)_{dB}$$

0dB 20dB 40dB

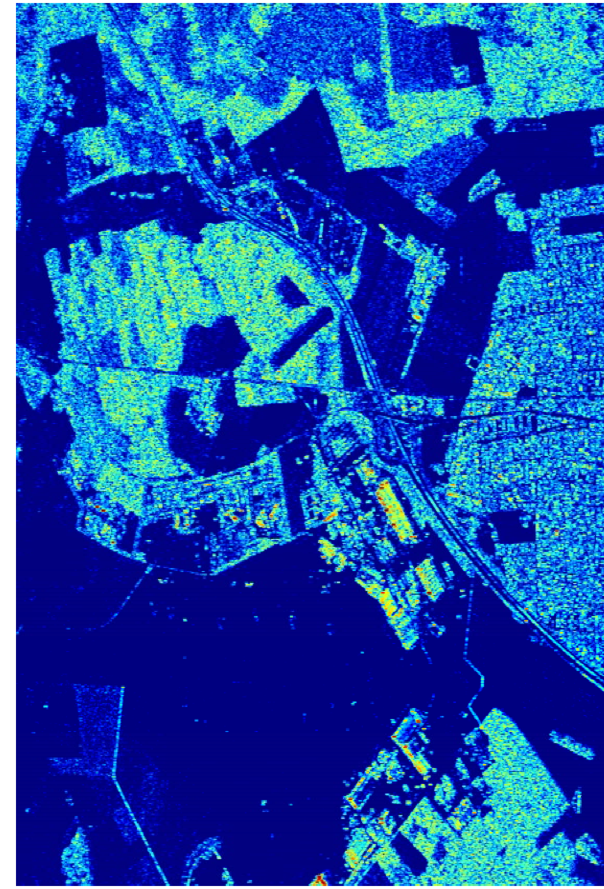
S.R. CLOUDE DECOMPOSITION



$$\sqrt{\lambda_1}\,|u_{13}|$$



$$\sqrt{\lambda_1}\,|u_{12}|$$

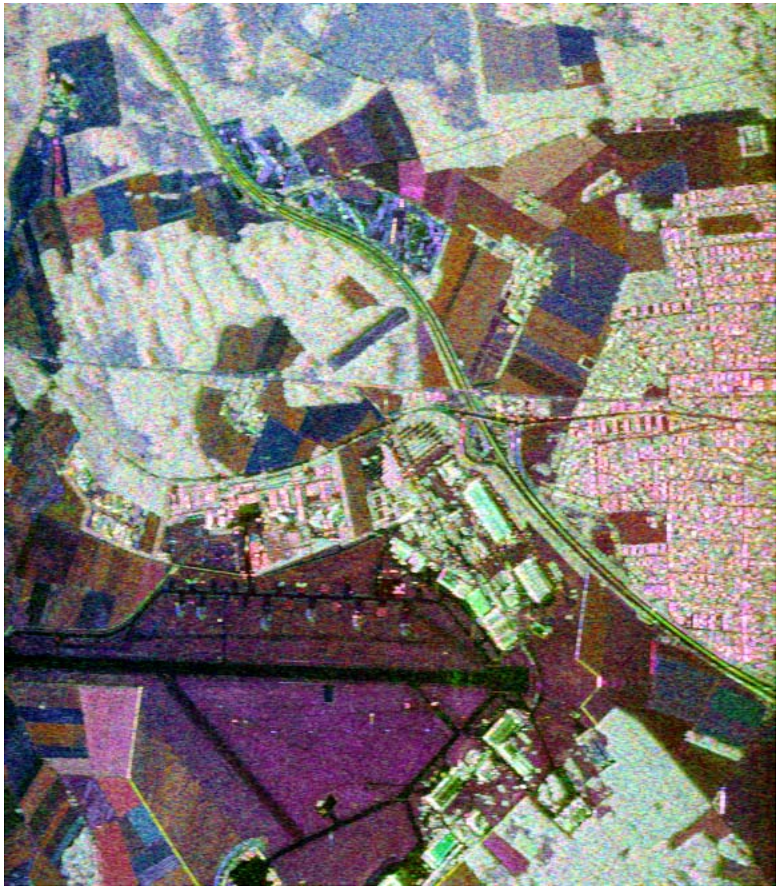


$$\sqrt{\lambda_1}\,|u_{11}|$$

0dB 20dB 40dB

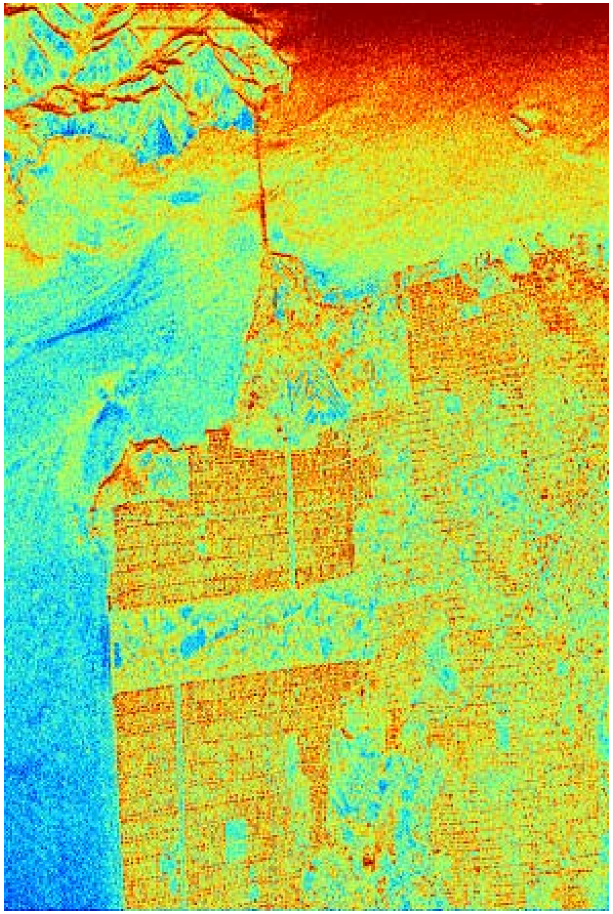
S.R. CLOUDE DECOMPOSITION

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

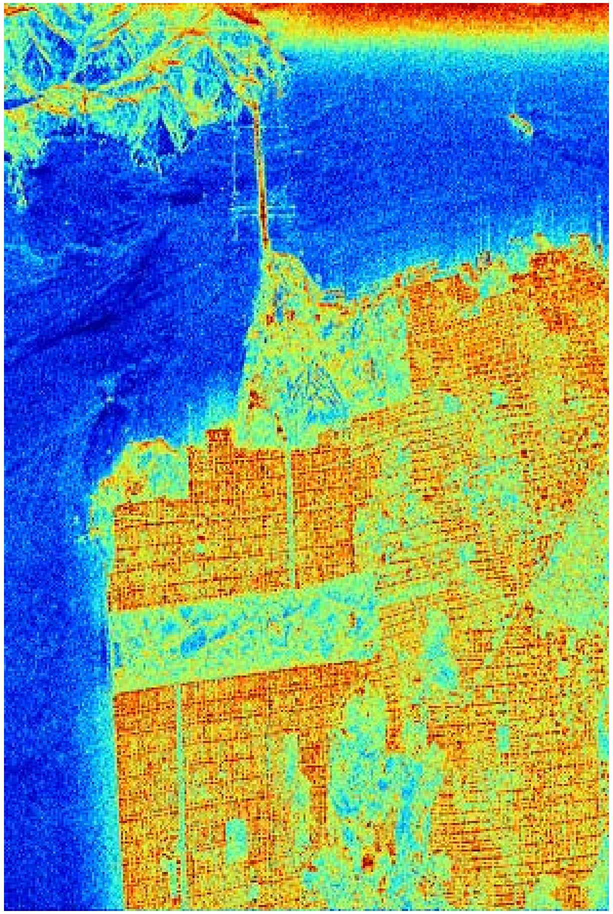


$\sqrt{\lambda_1}\,|u_{11}|$ $\sqrt{\lambda_1}\,|u_{12}|$ $\sqrt{\lambda_1}\,|u_{13}|$

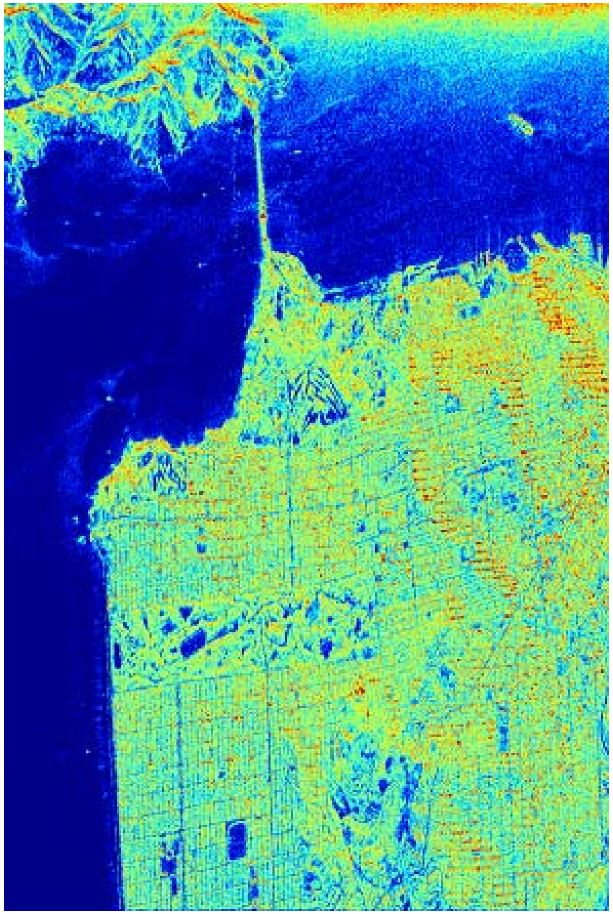
S.R. CLOUDE DECOMPOSITION



$(2A_0)_{dB}$



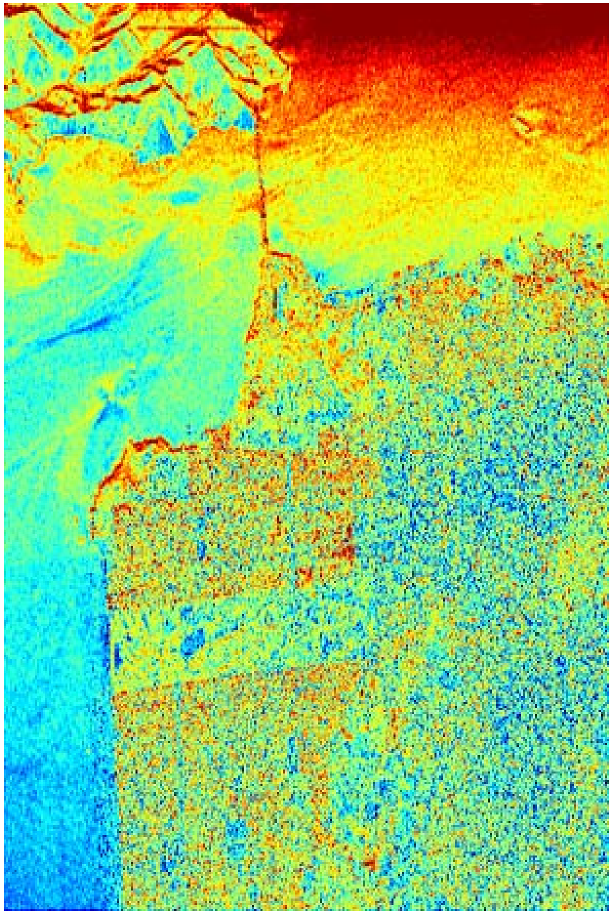
$(B_0 + B)_{dB}$



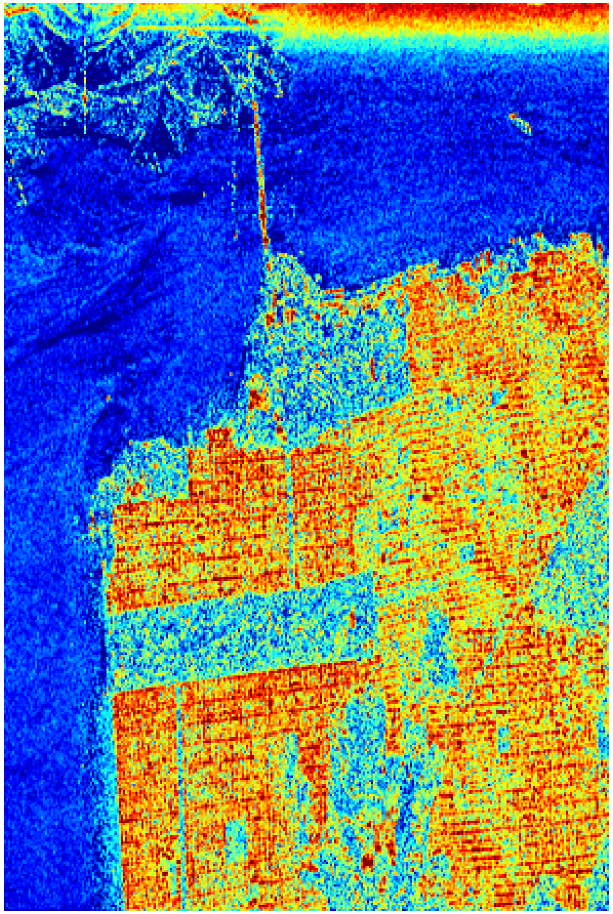
$(B_0 - B)_{dB}$

-30dB -15dB 0dB

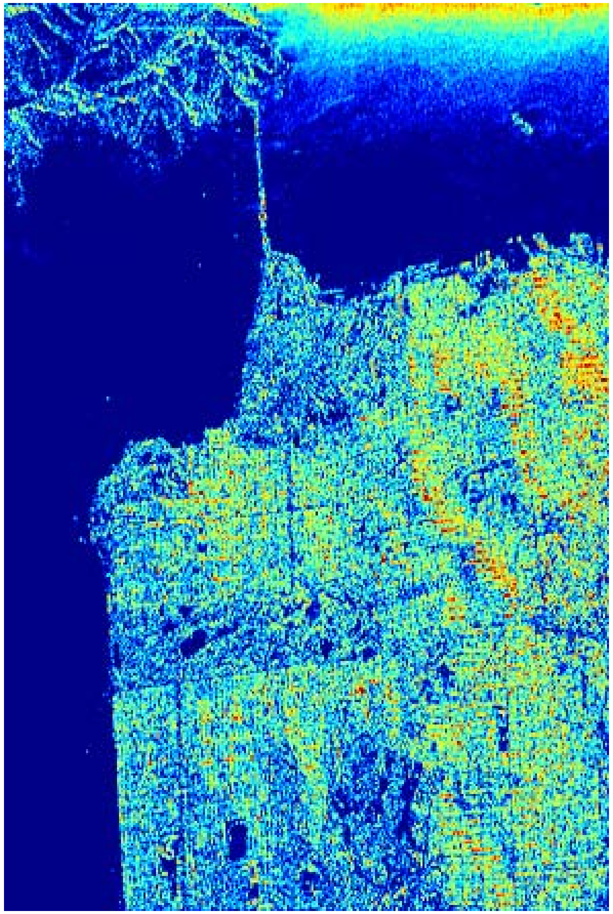
S.R. CLOUDE DECOMPOSITION



$\sqrt{\lambda_1}\,|u_{13}|$



$\sqrt{\lambda_1}\,|u_{12}|$



$\sqrt{\lambda_1}\,|u_{11}|$

-30dB -15dB 0dB

S.R. CLOUDE DECOMPOSITION

$2A_0 \qquad B_0 + B \qquad B_0 - B$

$\sqrt{\lambda_1}\,|u_{11}| \qquad \sqrt{\lambda_1}\,|u_{12}| \qquad \sqrt{\lambda_1}\,|u_{13}|$

WILLIAM A. HOLM

(1988)

DECOMPOSITION

ALTERNATIVE PHYSICAL INTERPRETATION

OF THE EIGENVALUES SPECTRUM

$$[\Sigma]=\begin{bmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{bmatrix}$$

$$\Downarrow$$

$$[\Sigma]=\begin{bmatrix} \lambda_1-\lambda_2 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}+\begin{bmatrix} \lambda_2-\lambda_3 & 0 & 0 \\ 0 & \lambda_2-\lambda_3 & 0 \\ 0 & 0 & 0 \end{bmatrix}+\begin{bmatrix} \lambda_3 & 0 & 0 \\ 0 & \lambda_3 & 0 \\ 0 & 0 & \lambda_3 \end{bmatrix}$$

W.A HOLM DECOMPOSITION

$$\langle [T] \rangle = \lambda_1 \underline{u}_1 \underline{u}_1^{T*} + \lambda_2 \underline{u}_2 \underline{u}_2^{T*} + \lambda_3 \underline{u}_3 \underline{u}_3^{T*}$$

↓

$$\langle [T] \rangle = (\lambda_1 - \lambda_2) \underline{u}_1 \underline{u}_1^{T*} + (\lambda_2 - \lambda_3)\left(\underline{u}_1 \underline{u}_1^{T*} + \underline{u}_2 \underline{u}_2^{T*}\right) + \lambda_3 [I_{3D}]$$

PURE TARGET (AVERAGE)

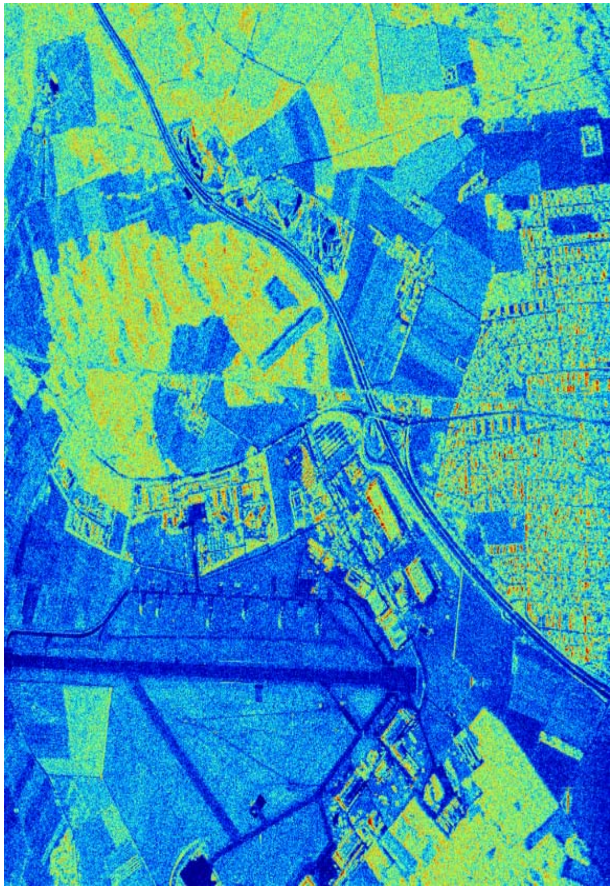
MIXED TARGET (VARIANCE)

NOISE (UNPOLARIZED)

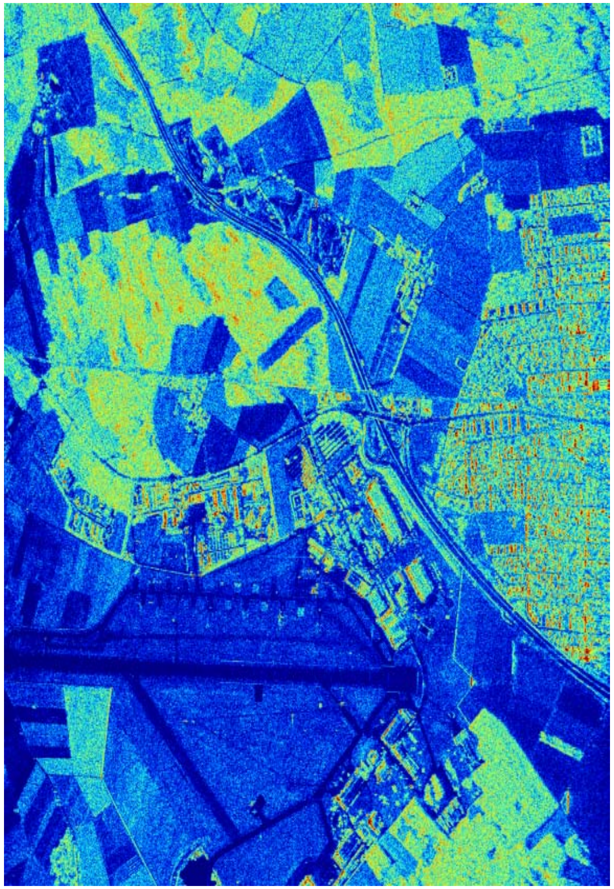
CONCEPT OF : **TARGET** PLUS **NOISE**

HYBRID APPROACH OF THE HUYNEN MODEL

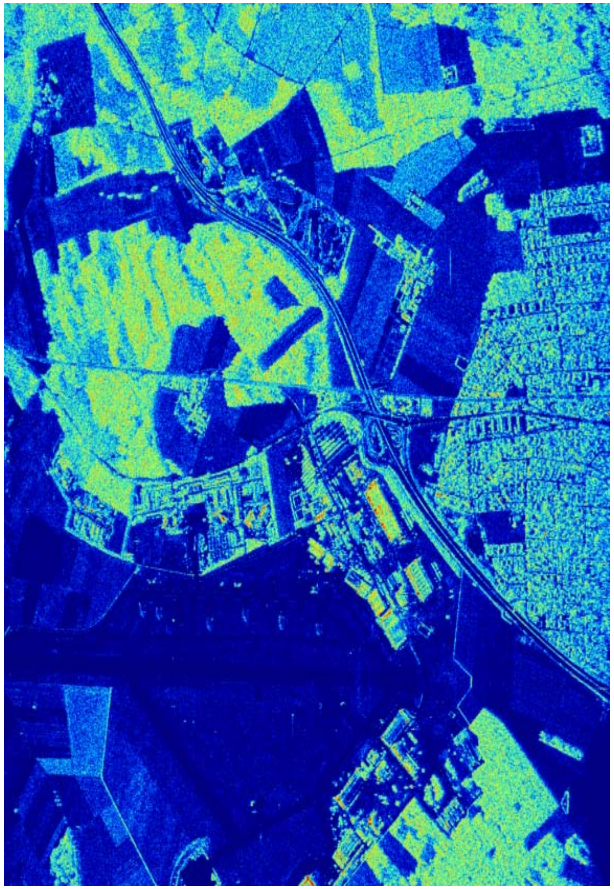
W.A HOLM DECOMPOSITION



$(2A_0)_{dB}$

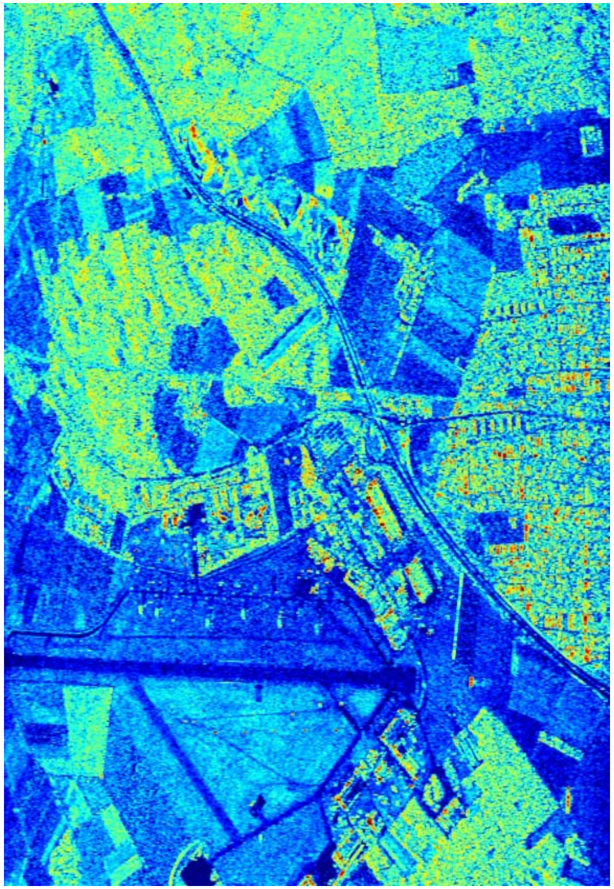


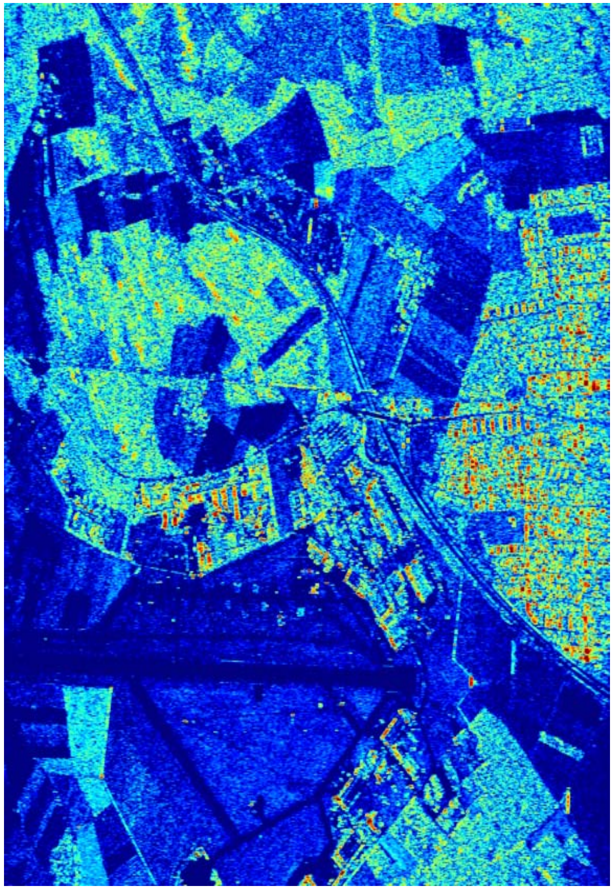
$(B_0 + B)_{dB}$

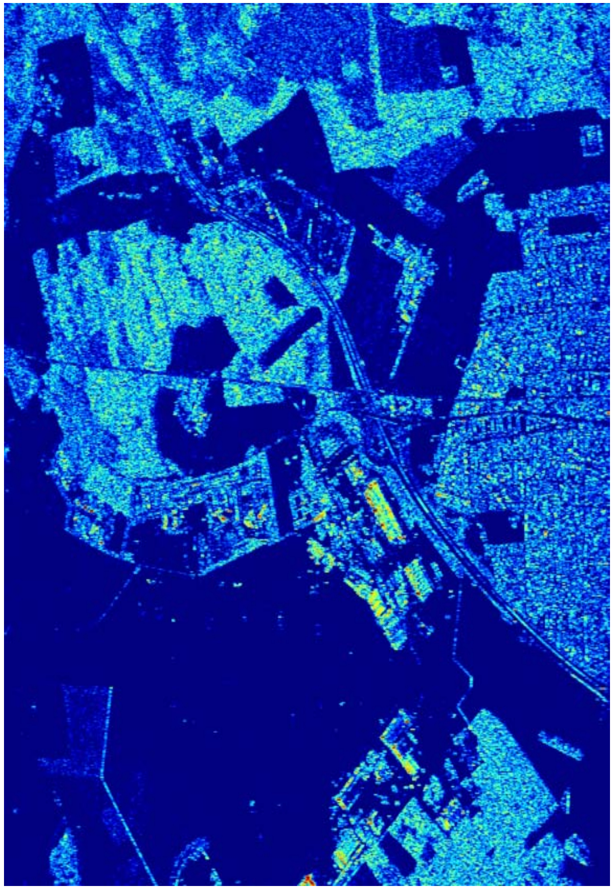


$(B_0 - B)_{dB}$

W.A HOLM DECOMPOSITION



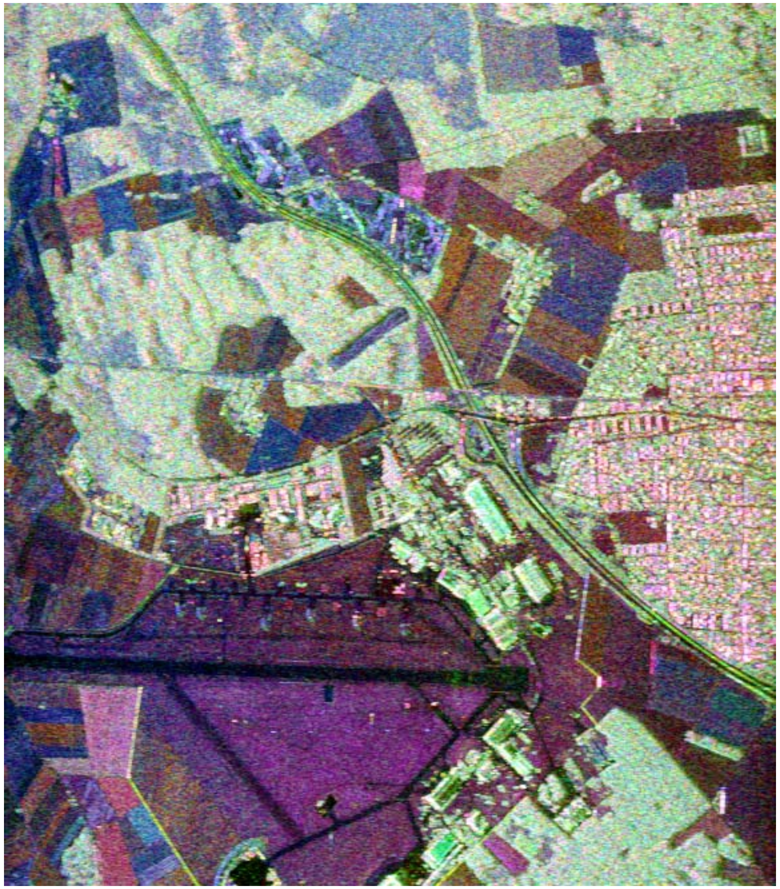




$\sqrt{\lambda_1 - \lambda_2}\,|u_{13}|$ $\sqrt{\lambda_1 - \lambda_2}\,|u_{12}|$ $\sqrt{\lambda_1 - \lambda_2}\,|u_{11}|$

W.A HOLM DECOMPOSITION

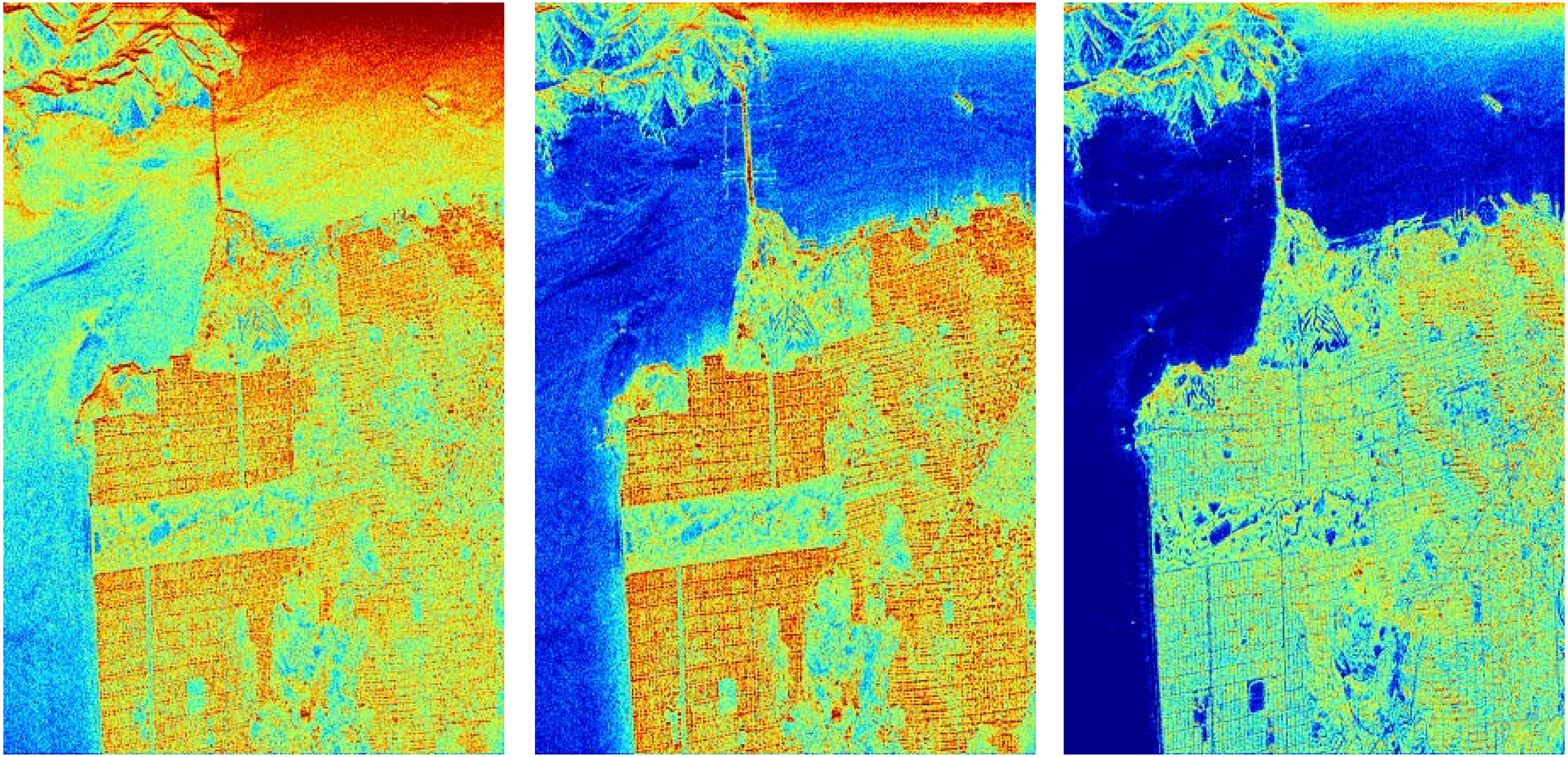
$2A_0$ $B_0 + B$ $B_0 - B$



$\sqrt{\lambda_1 - \lambda_2}\,|u_{11}|$ $\sqrt{\lambda_1 - \lambda_2}\,|u_{12}|$

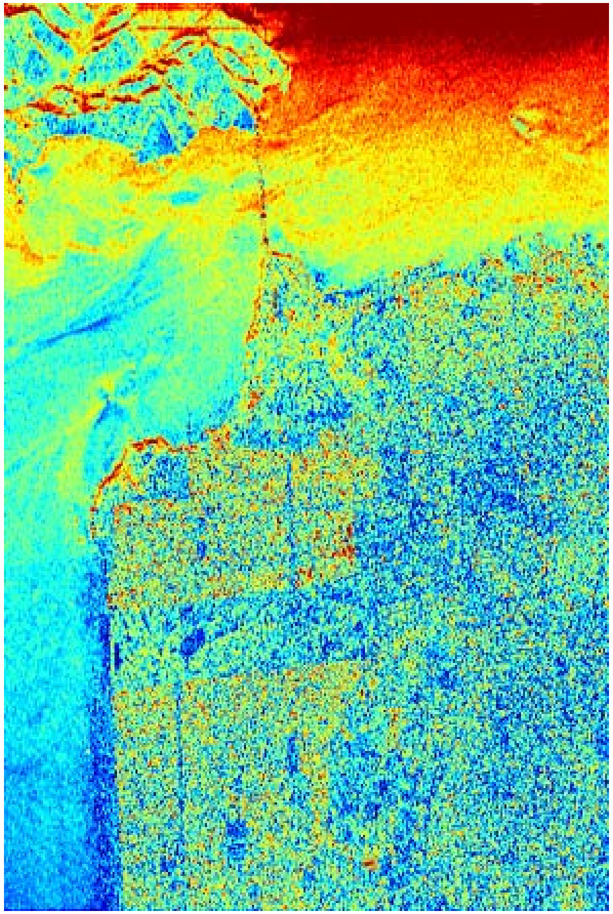
$\sqrt{\lambda_1 - \lambda_2}\,|u_{13}|$

W.A HOLM DECOMPOSITION

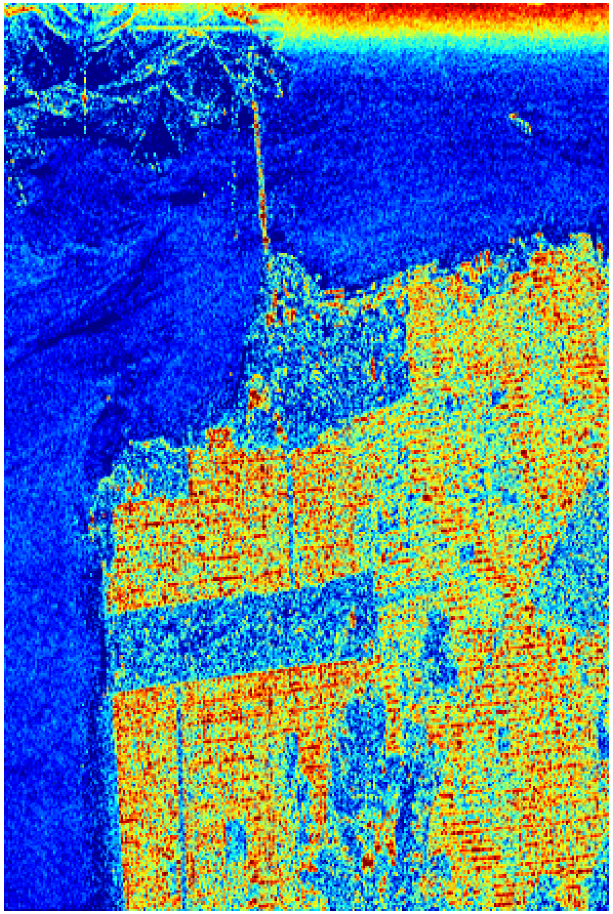


$(2A_0)_{dB}$ $(B_0+B)_{dB}$ $(B_0-B)_{dB}$

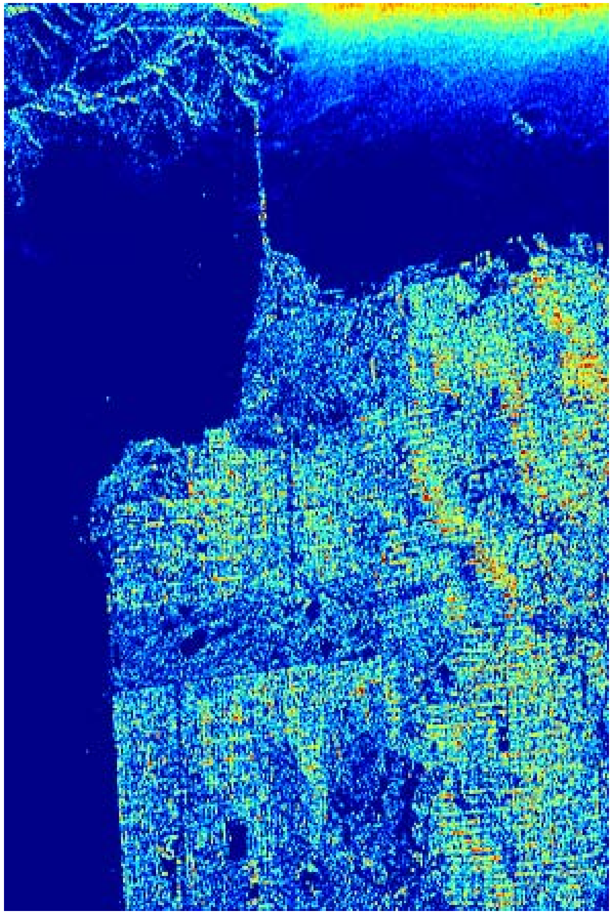
W.A HOLM DECOMPOSITION



$$\sqrt{\lambda_1 - \lambda_2}\,|u_{13}|$$



$$\sqrt{\lambda_1 - \lambda_2}\,|u_{12}|$$



$$\sqrt{\lambda_1 - \lambda_2}\,|u_{11}|$$

W.A HOLM DECOMPOSITION

$2A_0$ $\quad B_0 + B$ $\quad B_0 - B$

$\sqrt{\lambda_1 - \lambda_2}\,|u_{11}|$ $\quad \sqrt{\lambda_1 - \lambda_2}\,|u_{12}|$

$\sqrt{\lambda_1 - \lambda_2}\,|u_{13}|$