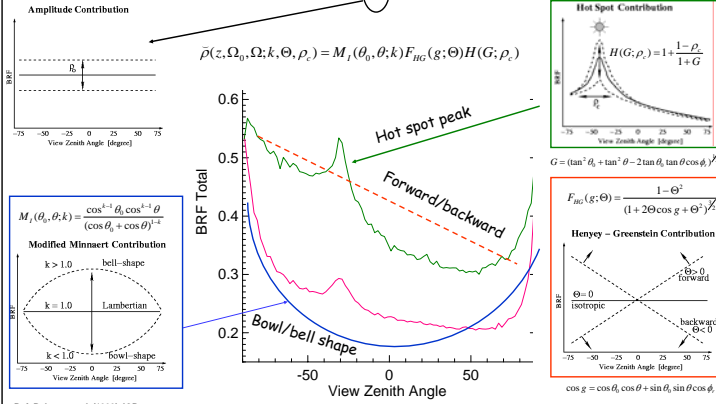


The RPV Model

The RPV formulation splits a Bidirectional Reflectance Factor (BRF) of a surface into a scalar amplitude component and the associated angular field describing the anisotropy of the surface

$$BRF(z, \Omega_0, \Omega; \rho_0, k, \Theta, \rho_c) = \rho_0 \tilde{\rho}(z, \Omega_0, \Omega; k, \Theta, \rho_c)$$

$$\tilde{\rho}(z, \Omega_0, \Omega; k, \Theta, \rho_c) = M_1(\theta_0, \theta; k) F_{HO}(g; \Theta) H(G; \rho_c)$$



Overview of the Inversion Methodology

Estimate the *a posteriori* (noted 'post') probability distribution $P(m)$ of model parameter m given *a priori* (noted 'pr') knowledge on model parameters and measurements d (assuming Gaussian distributions)

Optimal parameter m_{post} at minimum of misfit function J :

$$J(m) = \frac{1}{2} [(m - m_{pr})^T C_{pr}^{-1} (m - m_{pr}) + (M(m) - d)^T C_d^{-1} (M(m) - d)]$$

a priori covariance matrix of parameter uncertainty

covariance of uncertainty in measurements + model

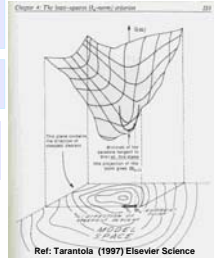
Optimization performed with a gradient algorithm minimizing the misfit function. This gradient is provided by the adjoint code generated by automatic differentiation of J .

Second Derivative (Hessian) of $J(m)$: $\partial^2 J(m) / \partial m^2$ at m_{post} yields curvature of J and provides estimated uncertainty in m_{post}

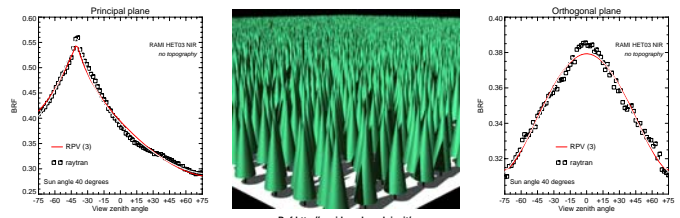
Uncertainty for m_{post} is quantified by the covariance matrix C_{post} approximated by the inverse of the Hessian of J when evaluated at $m = m_{post}$: $C_{post}^{-1} \sim \partial^2 J(m) / \partial m^2 |_{m=m_{post}}$

$$P(m) \sim \exp[\frac{1}{2} (m - m_{post})^T C_{post}^{-1} (m - m_{post})]$$

Ref: Giering and Kaminski (1998) ACM, Trans. Math. Soft.



Performances on Model-based Simulations

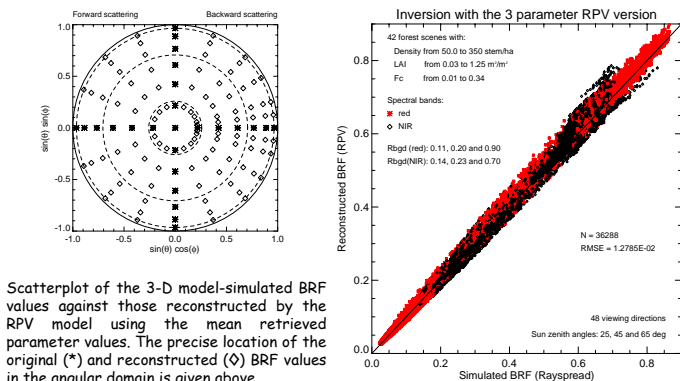


Mean and standard deviations of the RPV parameter values as retrieved by inversion.

Viewing conditions	Moment	ρ_0	k	Θ
Principal plane with 3 parameters	Mean	0.239	0.993	-0.091
	Standard deviation	$0.54 \cdot 10^{-2}$	$2.26 \cdot 10^{-2}$	$0.85 \cdot 10^{-2}$
Orthogonal plane with 3 parameters	Mean	0.199	0.831	-0.112
	Standard deviation	$2.92 \cdot 10^{-2}$	$12.13 \cdot 10^{-2}$	$9.08 \cdot 10^{-2}$

Table 2: Correlation of a posteriori uncertainties of the retrieved RPV parameter values. Values obtained in the principal (orthogonal) plane are reported in the upper (italicized) in the lower (td) corner, respectively.

Parameters	ρ_0	k	Θ
ρ_0	1.000	0.999	0.932
k	0.999	1.000	0.222
Θ	0.932	0.222	1.000



Application on MISR Land Surface BRFs

