4.1 SAOCOM Hybrid CL-Pol Mode

- Same as F-Pol mode
- Additional parameters: elevation, incidence
- Assumptions:
  - Ground topographic phase and volume phase from PolSAR data
  - Ground height from elevation
- Advantages:
  - Parallel processing of F-POL and CL-POL data

1.2 Random Volume over Ground Model

Two-layer model:
- Ground + impenetrable scattering surface
- Vegetation + homogeneous layer of randomly oriented scatterers characterized by:
  - height
  - constant extinction coefficient
- Ground-to-volume ratio
- Ground-to-volume ratio dependent on polarization
- Bottom of canopy + ground surface:
- Top of canopy: $z_0 = z_g + z_v$
- Phase from ground (azimuthal) + topographic phase $a_2$

1.3 RVoG Model Inversion

- Ground-to-volume ratio
- Vegetation height
- Compensation for height underestimation
- PolInSAR tool tailored to SAOCOM and SARAT specificities allowing these estimates to be made.
- Theoretical and practical expertise in canopy height extraction using advanced PolInSAR techniques.

2. Polarimetric Interferometry + RVoG Model

- Complex interferometric coherences for various polarizations from PolSAR data
- Model parameters:
  - Ground topographic phase
  - Vegetation height
  - Ex-itation coefficient
  - Ground-to-volume amplitude ratio
- RVoG model inversion
- Ground phase retrieval
- Vegetation height evaluation

According to RVoG model: Complex coherence follows a straight-line segment in complex plane with respect to the transmitted and received polarization choice.

2 Assumptions:
- Ground topographic phase $a_0$ on fig.
- Phase center of pure volume coherence $m = m_g$ is assumed to be located exactly at top of vegetation.

3. RVoG Model Inversion

- Best fit line through observed coherence values.
- Better conditioning when using full-pol interferometric optimised coherences.
- Working also with dual-pol interferometric coherences.
- Intersection point nearest to highest coherence $m_g$ for $f_m = f_m(m)$ closer to the ground.

4. Compact Polarimetric SAR

- Circular polarization at emission and reception
- Advantages:
  - Improved efficiency as compared to other C-POL or CL-POL modules
  - Compensation for height underestimation

4.1 SAOCOM Hybrid CL-Pol Mode

- CL-POL mode: F-POL + CL-POL
- Evaluation of $m$ for CL-POL coherence
  - using data acquired on bare surfaces
  - from calibration of F-POL also available afterward

4.2 Faraday Rotation in CL-POL mode

- Using full-pol interferometric optimised coherences
- Ground phase retrieval: intersection point nearest to highest coherence $m_g$ for $f_m = f_m(m)$ closer to the ground.

4.3 Extension of CL-POL to PolInSAR Processing ad RVoG Model Inversion

Compact Polarity: less information as compared to F-POL (2 measurements instead of 4)
- For dense forest: lack of information can be compensated by symmetry properties
- Asymmetrical symmetry scatterers
- Full-POL information $+\text{reconstr. of full-pol information}$
- Applicable when volume scattering dominates
- Dense forests, negligible underlying ground contribution
- Compensation for height underestimation

5. Results - Conclusion

- Full-PolInSAR technique + RVoG model inversion
- Retrieval ground topographic phase and forest height
- RVoG model inversion adapted to Dual-Pol mode
- CL-Pol mode available on SAOCOM
- Calibration guidelines
- Applicability & Usefulness of PolInSAR/RVoG model inversion for canopy height retrieval

**References**

- Granier, P., et al., 2006. Interferometric polarimetric SAR of tall forest in the boreal area of Canada, Théorie et Applications de l’Interférométrie Polarisée à la Caractérisation de la Forêt. Théorie et Applications de l’Interférométrie Polarisée à la Caractérisation de la Forêt. Thèse de Doctorat, Université de Bordeaux 1, France.