

→ POLINSAR 2013

The 6th International Workshop on Science and Applications of SAR Polarimetry and Polarimetric Interferometry

Applications of SAR Polarimetry on Land: Soil Moisture and Wetlands

Session Summary and Recommendations

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Session Summary



- **T. Jagdhuber et. Al.: Polarimetric Decompositions for Soil Moisture Retrieval from Vegetated Soils in TERENO Observatories**
 - The presentation showed the existence of new extensive quadpol data sets and supporting ground data in Europe collected by DLR's novel F-SAR for surface parameter studies. Demonstrated an approach using ICTD to estimate sub-canopy moisture. Current results show good trends with season and location but some variance in estimates. Future work will involve using improved volume scattering models to improve accuracy of estimates.
- **F. Charbonneau et. Al.: RCM Compact Polarimetry Applied to Watershed Study**
 - This paper contained two key ideas. The first for bare surfaces a reworking of the IEM scattering model for compact products to ensure estimation of surface parameters from compact mode. Secondly use of InSAR coherence and phase for vegetation structure estimation. Currently using Radarsat-2, 24 day repeat so coherences are low but 4 day repeat of RCM anticipated better discrimination. Demonstrated polarization synthesis for compact mode to estimate signatures in scatter and coherence

- **Natale et al., Soil moisture retrieval via a polarimetric two-scale and two-component scattering model**
 - This paper presented a two scale fully polarimetric (T3) surface scattering model for moisture estimation of bare surfaces. Here extended to include a simple random volume component. Showed both good results and bad results when the volume model causes a bias in the retrieved parameters.
- **Paillou et al., The chott El Jerid, Tunisia: Observation and interpretation of a SAR phase signature over evaporitic soils**
 - A series of polarimetric Radarsat2 acquisitions was used to demonstrate the importance of the HH-VV phase information for monitoring arid environments, particularly those associated with evaporative salt plains. Clear information was shown in HH-VV phase and a tentative suggested explanation by physical modeling was presented .

- **Touzi R. et al.: Polarimetric L-band ALOS PALSAR for subarctic Peatland Characterization and monitoring**
 - In this study, the potential of polarimetric L-band ALOS for peatland subsurface water monitoring is demonstrated. The Touzi decomposition is applied on a series of ALOS acquisitions collected over the Wapusk National Park, and the potential of the scattering type $\phi_{\alpha S}$ is demonstrated for peatland subsurface water flow monitoring. While $\phi_{\alpha S}$ provides information on peatland subsurface water flow, the conventional radiometric information provided by HH, HV, VV, as well as the Freeman decomposition parameters, and the Cloude-Pottier alpha-H cannot detect peatland subsurface water variations. Such potential is very promising for low cost and operational monitoring of subarctic bog-fen transformations related to climate change.

Seed Questions



- *Can we say that all the polarimetric SAR information is fully exploited by the most popular (model based) incoherent target decomposition (ICTD)?*
- *We have seen some interesting results for using polarimetric phase information in wetlands but as yet not with widespread confirmation by the community. What barriers are there to progress on this issue?*
- Can quadpol decomposition be used for robust sub-canopy moisture estimation? If not, what problems remain...are existing vegetation models used in quadpol decomposition adequate for the task?
- Is compact mode the best dual-pol option for surface moisture/parameter estimation? What are calibration requirements on RCH-RCV for surface parameters? Are they primarily noise or polarimetric limited?
- Does the quality of polarimetric space-borne SAR data from recent missions meet the needs for accurate estimation of moisture and wetland classification & monitoring?
- PolinSAR 11: The **operational** use of polarimetric SAR is not demonstrated yet it is just at study levels. Any progress Today?

- *Can we say that all the polarimetric SAR information is fully exploited by the most popular (model based) incoherent target decomposition (ICTD)?*
 - The most popular ICTD are the model-based Cloude-Pottier, Freeman, and Yamagushi Decompositions. They lead to coarse resolution target scattering classification in terms of *surface scattering, double bounce and volume scattering (+ Helix Yamagushi)*
 - Even though these Decompositions provide excellent results, It is to be recommended that for surface moisture and wetland studies a wide range of polarization analysis techniques (such as coherent decompositions, signature analysis and optimization approaches) should be considered by the community rather than just few ICTD techniques which may not be best suited to some applications.
 - It was noted that such wide diversity of tools does already exist in software such as Polsarpro but the applications community should be encouraged to make much wider use of them

- ***We have seen some interesting results for using polarimetric phase information in wetlands but as yet not with widespread confirmation by the community. What barriers are there to progress on this issue?***
 - The target scattering type $\phi_{\alpha S}$ (generated by the Touzi decomposition) is shown to be sensitive to peatland subsurface water flow, and as a result, the phase information looks to be very promising for monitoring subarctic peatland (bog-fen) transformation related to climate change.
 - Paillou has demonstrated how useful the HH-VV phase can be for monitoring arid environments, particularly those associated with evaporative salt plains.
- Recommendation:
 - such approaches require both full quadpol data and low noise floor (HV of low S/N) and hence impact on system requirements for future SAR systems.
 - There is also a strong seasonal (spring to fall under no snow conditions) coverage requirement which may not be met by future satellite missions
 - It is strongly requested to allow adaptation of quadpol mode availability to suit seasonal requirements for subarctic and boreal wetland monitoring.
 - It is strongly wished that L-band ALOS-2 planned mode coverage would permit polarimetric acquisitions over subarctic and boreal region from the spring run off (June-July) to the fall (October) for the operational monitoring of subarctic and Boreal peatland transformation.

- Can quadpol decomposition be used for robust sub-canopy moisture estimation? If not, what problems remain...are existing vegetation models used in quadpol decomposition adequate for the task?
 - We saw here some evidence that the volume models available are not yet robust enough for operational applications and more research is required to find better improved models for use in decompositions. However it was noted that more complex models will increase the number of parameters which may take inversion outside of polarimetry alone. One possibility is to include POLInSAR in surface studies but so far suitable data is limited.

- **Is compact mode the best dual-pol option for surface moisture/parameter estimation? What are calibration requirements on RCH-RCV for surface parameters? Are they primarily noise or polarimetric limited?**
 - While it has been shown that the Compact can be efficient for bare soil moisture estimation (HV of insignificant return), further R&D is required to see if the dual-receive polarization measurements completed with one transmitted polarization (CP) can generate like HV accurate soil moisture estimation under vegetation cover.
 - Among the RH, RV, RR, and RL, RL looks to be the most promising for soil moisture estimation. Others validations are needed in preparation of the upcoming Canadian constellation (RCM) that will include 3 satellite equipped with scanSAR compact.
 - Cal-Val requirement on the Compact: RH-RV: **0.5 dB in radiometry and phase within 10°**
 - Received polarization synthesis and accurate generation of the RR-RL from RH-RV
 - **Non circularity** of the transmitted CP has to be calibrated for.
 - The Compact will become operational with the upcoming Canadian constellation the RCM. The wide swath mode (up to 350km) should lead to the operational use of polarization information for optimum soil moisture mentoring.
 - Potential barrier : NESZ=-17 dB

- *Is the quality of polarimetric space-borne SAR data from recent missions sufficient for quantitative geo- & bio-physical parameter retrieval?*
 - *ALOS and Radarsat2 excellent: antenna isolation (better than -35 dB) + low noise floor (NESZ about -34 dB).*
 - *TerraSAR: Experimental Polarimetric Modes*
 - *HH and VV well calibrated (in radiometry and phase).*
 - *HV needs to be calibrated (-25dB contamination by HH and VV)*
 - *Calibrated HV information should be used with care (high NESZ).*
 - *Recommend the design of the new mission with low noise floor (-34 dB) and high antenna isolation (-30 dB) for accurate single, dual (HH-HV, VV-VH & Compact) and quad-pol polarization information extraction*

- PolinSAR 11: The **operational** use of polarimetric SAR is not demonstrated yet it is just at study levels. Any progress Today?
- Operationalization of polarimetry for wetland monitoring require larger global and temporal coverage. We can accommodate the problem of dual- vs full-polarimetric using the temporal dimension. Large cover monitoring can be provided by dual-pol while polarimetry can be used for temporal monitoring 50x50km (Radarsat2, AOS and ALOS2) sample that are very representative of typical wetland /environment classes. Polarimetric indicator measurements completed within a sample area can then be transferred to global coverage. Eventough the 50 km swath of Radarsat2 and AOS
- Many thanks to ESA, CSA, JAXA and DLR for the effort they are making to make available full-polarimetric Radarsat-2, ALOS and TerraSAR data.
- The larger availability of (low cost) polarimetric Radarsat2, ALOS, and TerraSAR data should widen the polarimetric R&D community and will permit the demonstration of key applications that promote and address the need for operational use of SAR polarimetric and POI-InSAR information in key international issue such as wetland protection and monitoring of the climate change on ecosystem and forests .
- Strong recommandation for X, C, L, and P Missions with Digital antenna beaming for Larger swath (such as the DLR L-band TDX mission with DBA => 500km swath quad-pol