Critical Assessment of diverse Polarimetric SAR Systems – pros and cons

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Considerable advances have been made during the past decades in polarimetric SAR systems leading to increased ability for recovering inherent polarization information conveyed by vector-electromagnetic wave backscatter. This paper compares the benefits offered by the major types of systems in relation to their application, as a function of their polarimetric architecture. POL-SAR system characterization includes the radar sensor, processing to transform the received data to polarimetric products, and calibration. More complex scattering scenarios require more capable polarimetric data collection and analysis. The system types considered are: *Mono-Pol* (single polarization, amplitude-only); *Dual-Pol* (traditional amplitude-only configuration, including HH+VH, VV+HV); *Compact-Pol* (transmit one polarization in base AB, and coherently receive two orthogonal polarizations in orthogonal base CD, which retain the relative phase between the received polarizations); and *Full-Pol* (coherent HH, HV, VH and VV). Under the simplifying assumption of scattering symmetry in monostatic configurations implying HV=VH, the *Full-Pol data* reduce to the familiar *Quad-Pol products* (coherent HH, HV and VV). Compact-Pol architectures include: *Coherent Linear LH-Pol* (HH+HV, or VV+VH, or HH+VV, coherently in each case); *Coherent Diagonal/Linear DL-Pol* (transmit linear polarization at a diagonal angle of 45* with respect to horizontal, and receive coherently the conventional linear H and V, thus DH+DV); *Coherent Circular LR-Pol* (coherent RR+RL or LL+LR); *Coherent Hybrid Circular/Linear CL-Pol* (RH+RV or LH+LV). The amount of acquired data (and of all data-dependent subsystems such as storage and transfer), processing and calibration increases, for greater polarimetric sophistication; and so do mass and volume with greater polarimetric capability. The various architectures have different implications on data rate, swath-width and resolution issues that apply to any multi-channel radar whether polarimetric, interferometric or for multiple frequencies. Given this multi-dimensional possibility space, the paper attempts to identify the benefits of each type of system as a function of implementation, also addressing the forthcoming demands of space-borne *POLin SAR* and *RP (Diff) POLinSAR* deployments. Since *SEASAT* (Mono-Pol HH, L-band), space-based SAR systems are gradually becoming polarimetrically more capable, including *ENVISAT* (Dual-Pol, C-band), *ALOS-PALSAR* (Full-Pol or Quad-Pol, depending on processing algorithm, L-band), *TerraSAR-X* (Full-Pol or Quad-Pol, X-band), and *RADARSAT-2* (Full-Pol or

Quad-Pol, C-band). Planetary examples include *Magellan* (Venus: HH, S-band), *Cassini* (Saturn: Mono-Pol – amplitude-only, Ku-band), two *Mini-SARs* (Moon: CL-Pol, S-band or S- and X-band), for which mass and data rate (or data volume) are critical parameters. Polarimetric diversity implies additional costs and impacts the mission operation scenario defined by user requirements and/or technological constraints. The paper hazards recommendations for the polarimetric architecture of future space-based SAR Systems; and it is concluded that any so-called cost-saving measures are ill-conceived and that we need to focus fully on the advancement of fully polarimetric SAR systems technology and stop all of the regressive approaches which will only take us back to the child stage of SAR concept initiation..

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