Canadian Perspective on Analysis Ready SAR Data (ARD)

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Maximize Potential / Value of SAR

- + 35 year investment in SAR
- Important operational data set for the GoC
- More potential if ARD staged within a digital cube

1995 to 2013

2018 Launch
✓ More frequent coverage
✓ Largely open data
RCM and Value Added Products

- In preparation of RCM, two online/on-demand processing tools are under development.
- Users will be able to select Level 1 frames and request a certain level of processing to jumpstart their analysis.

1. **Value Added Products (VAP)**
   - LUT $\beta^0, \sigma^0, \gamma^0$
   - Base $[S], [C], [T], [K]$
   - Limited $\Delta\tau$ tools
   - Pol. Decomp
   - Other algos

2. **InSAR**
   - Co-registration
   - Spectral band filter
   - Coherence & interferograms
   - MSBAS

This is not ARD
GEODE Initiative

- The development of a Geoanalytics Earth Observation Data Environment (GEODE) is presently under consideration.
- GEODE will make available decades of analysis ready optical and SAR data.
- This initiative is supported by CSA.
- SAR ARD component: Still at brainstorming stage.
Value of Analysis Ready SAR Data

- Value in pre-processing RADARSAT data on a large scale to ARD and making them available within an HPC environ.

- Bring more users to the dataset

- Facilitate **time series** analysis and other analytics

- The co-location of **optical** and **radar** data will promote/ease **fusion** of the datasets.

Do RADARSAT Archives are valuable for ARD?  
- Temporal & Spatial coverage  
- What are the challenge?
Evaluate R1 & R2 potential for ARD

- **R1 Stripmap**
  - Land is covered with 50 – 100 scenes in 18 years
  - Will be difficult to auto-orthorectify due to OSV

- **R2 Stripmap**
  - Limited time serie potential at Northern latitude
  - Recent frequent coverage over agriculture areas (W2)
RADARSAT Data Presents Some Challenges

- Most of R-1, R-2 data not collected systematically in time and space
- Driven by users and R&D projects

R2 Scenes over AOI from 2008 to 2016

- 1788 acquisitions
- 12 different beam modes (Spotlight to ScanSAR)
- 48 different incident angles (swath positions)
- Ascending - Descending passes
- 4 different polarization configurations
- Different LUT
- Different product format (SLC, SGX, SGF,...)
RCM Standard coverage

- Large majority of RCM data will be collected in standard coverages
- Nevertheless, mode and polarization diversity will persist.
- Hopefully may be under CP configuration

Water extend

Agriculture
Sentinel-1

- Sentinel-1 is very valuable for increasing the temporal coverage and filling the gaps
- Interoperability between ARD cubes is important
ARD Challenges

- Which steps can be pre-process?
  - Without losing too much info
  - Satisfying max number of users
  - Reducing the overall CPU time
  - Process an acquisition once
Intensity

- 16 bits data scaled back to 32 bits $\sigma^0$ (not in dB)
  - Most preprocess require linear scale as input

- $\sigma^0$ corrected for local incident angle (require DEM)
  - Prefer $\sigma^0$ to $\gamma^0$ for modeling

- ARD should not aim to only “good looking” mosaic
  - $\gamma^0$ is good for flattening but not common for modeling

- If community prefer $\gamma^0$, then GEODE will follow ... may be
Keep Polarization Information

- R1-R2-RCM polarization diversity
- Need to preserve relative polarimetric phase through Kennaugh or covariance matrix representation
- RCM – Compact pol is useless without phase. Better with linear dual pol

Ground-space method impact on polarimetric info

Speckle Filter

- Sigma Lee
  - 7x7 window & target 3x3
  - Weighting coefficients issue with multi-temporal analysis

- Other options
  - Multi-temporal filter
    - Difficult to implement without reprocesssing each time

- Wavelet, curvelet, ....
Geocorrection / Orthorectification

- Ability to automatically geocorrect /orthorectify data is a requirement

- Precision of RADARSAT GCPs will present a challenge
  - R1 200-300 m
  - R-2/RCM 0.5 - 1 res. cell

- Will require additional GCP generation and co-registration refinement with seasonal basemaps
Grid Sample Spacing

- Current CCMEO’s **optical** mini-cubes are under **LCC projection**
- Sample spacing is function of data source
- Variable grid size is suitable to the RADARSAT family since its extensive range of modes
- Might limit interoperability with other SAR ARD cubes

Other approach would be

<table>
<thead>
<tr>
<th>\Grid Missions \</th>
<th><strong>Ultra-Fine 2 m</strong></th>
<th><strong>Fine 10 m</strong></th>
<th><strong>Standard 20 m</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td></td>
<td>F</td>
<td>S, EH, EL, W</td>
</tr>
<tr>
<td>R2</td>
<td>SLA, UF, UW, XF</td>
<td>F, MF, MFW, FQ, FQW</td>
<td>S, W, EH, EL, SQ, SQW</td>
</tr>
<tr>
<td>RCM</td>
<td>FSL, 3M, 5M</td>
<td>16M</td>
<td>SC30M</td>
</tr>
</tbody>
</table>
Data compression

- TBD
- This is a costing issue
  - Data volume storage vs CPU time
Metadata

- Local incident angle (needed for modeling)

- RMS error on geolocation
  - Point vs extended targets

- Relative State vector to a reference

- Layer flag (8bit)
  - No data & shadow
  - Layover
  - Saturation (LUT issue)
  - < NESZ (LUT issue)
What about InSAR?

- Different scenarios are possible
  1. Preserve ground projected InSAR filtered phase relatively to a master orbit reference with topo phase removed;
     - Won’t satisfy InSAR users
     - No speckle filter
     - Potential issue over high relief area
  2. Build sequential InSAR differential stack as ARD layers
     - As some limited potential
     - Could be enough for change detection
  3. A link to the RCM InSAR on-demand tool, then importation to ARD.
     - Break the ARD concept but might be the only robust way to gradually incorporate InSAR to an ARD structure.
Next Steps

- Investigate pre-processing options through development of prototype *mini-cubes*
- Finalize definition of ARD specification for RADARSAT data
- Survey analytical tools that should be provided to users to make best use of the cube
Merci / Thank You