Cultural effects on the Urban detection based on SAR polarimetric characteristics

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Introduction

Full polarisation data is able to distinguish between the different scattering phenomena, which are normally linked to different types of objects:

- Single bounce
- Double bounce
- Volume scattering
But, what happens if things could be different than expected? Even more, if humans are changing the expected behaviour of the backscatter?

In this work, we have analysed four cities from different continents to evaluate which is the predominant backscatter mechanism for the different urban areas.
How?

Dataset:
- Full polarimetric ALOS PALSAR [2006-2009]
- Landsat 7 ETM+ [2006-2009]

Cities:
- San Francisco
- Greater Cairo
- Beijing
- Milan
PolSARpro
• T3 matrix
• Yamaguchi 4 decomposition
• Wishart H/A/α classification

Google Earth Engine
• Supervised classification using full year Landsat data matching SAR datasets

How?
How?

Odd

Double

Volume
Cairo

Pauli  Odd  Double  Volume  Wishart H/alpha
Milan

Pauli  Odd  Double  Volume  Wishart H/alpha
Classification based on Entropy/Alpha for the different cities
San Francisco
Cairo and "Garbage City" Manshiyat Naser
Land Cover vs Backscatter predominance: San Francisco

- Bare soil
- Water
- Field
- Urban

Hlx
Vol
Db1
Odd
None
Land Cover vs Backscatter predominance: Cairo

Bare soil

Water

Field

Urban

Hlx

Vol

Dbl

Odd

None
Land Cover vs Backscatter predominance: Beijing

- Bare soil
- Water
- Field
- Urban

- HLx
- Vol
- Dbl
- Odd
- None
Land Cover vs Backscatter predominance: Milan

- Bare soil
- Water
- Field
- Urban

Hlx
Vol
Dbl
Odd
None
### Backscatter predominance

<table>
<thead>
<tr>
<th>City</th>
<th>Single Bounce</th>
<th>Double Bounce</th>
<th>Volume/Random Scattering</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>33.04 %</td>
<td>13.96 %</td>
<td>53.00 %</td>
</tr>
<tr>
<td>Greater Cairo</td>
<td>95.77 %</td>
<td>0.10 %</td>
<td>4.13 %</td>
</tr>
<tr>
<td>Beijing</td>
<td>51.15 %</td>
<td>23.61 %</td>
<td>25.23 %</td>
</tr>
<tr>
<td>Milan</td>
<td>48.55 %</td>
<td>21.26 %</td>
<td>29.93 %</td>
</tr>
</tbody>
</table>
Conclusions

We have analyzed the predominant behavior of the SAR signal over different cities and:

• New methods are needed to properly identify buildings which are not aligned with LOS of the SAR sensors.
• Humans artificially alter the expected behavior of SAR signal, making more difficult to blindly trust satellite measurements.
• In situ data is needed to understand what we see in SAR images.
• Expected double bounce backscatter from buildings is not always reflected with medium resolution full polarization data (residential area, old city center, ...)
• Open data policies and online platforms help us to quickly analyze large series of satellite data, which was not possible one decade ago.

Authors acknowledge the use of the satellite data employed in this study, i.e ALOS PALSAR (Copyright JAXA, METI [2006-2009] and ESA/JAXA [2006-2009])