ScanSAR Interferometry with PALSAR

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Data: ALOS PALSAR - JAXA EORC and ASF

Outline of Talk

- use standard strip-processing software (Balmer and Eidner, 2002)
- desire mixed-mode interferograms: WB1-FBD, WB1-FBS, WB1-WB1 (Ortiz and Zebker, 2007)
- zero-pad with integer # of lines, 6 bursts per patch
- focus and position accuracy of corner reflectors
- InSAR correlation vs. mode combination
- InSAR correlation vs. burst overlap
- Wenchuan earthquake example, seamless interferogram
Los Angeles - ScanSAR and FBD
- SW4 look angle matches FBS/FBD 34.3°
- SW4 PRF matches FBS/FBD 34.3°
- of course ScanSAR and StripSAR will have 100% burst overlap
- Pinon corner reflectors appear in SW2
raw WB1 data
raw SW4 data

6 bursts per patch
zoom on SW4 data

first 12 lines are bad

355 lines in SW4
Pinon Flat Geodetic Observatory - Radar reflectors
2.4 m corner reflectors
D1, D2 installed 1996
A1 installed Nov, 2005
Precise orbit for image focussing and geolocation

Phase history of point reflector

\[ C(s) = \exp \left\{ i \frac{4\pi}{\lambda} \left[ R(s) \right]\right\} \]

Parabolic approximation to range history

\[ R(s) = R_o + \dot{R}_o (s - s_o) + \frac{\ddot{R}_o}{2} (s - s_o)^2 + \ldots \]

Least-squares fit of range history for each point in DEM provides both the accurate position in range azimuth \([R_o, s_o]\) space and the Doppler centroid and rate parameters needed to focus the image. This analysis only needs to be applied to the master image.
Precise orbit for image focussing and geolocation

<table>
<thead>
<tr>
<th></th>
<th>FBS</th>
<th>FBD</th>
<th>WB1</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>13</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>ground-range</td>
<td>-11.5±5.5 m</td>
<td>-14.9±5.8 m</td>
<td>-5.6±8.4 m</td>
</tr>
<tr>
<td>azimuth</td>
<td>1.3±3.7 m</td>
<td>2.4±4.2 m</td>
<td>-9.55±18.3 m</td>
</tr>
</tbody>
</table>
Los Angeles

PALSAR

FBD-FBD

$\Delta T = 46 \text{ days}$

JUL 3, 2007

AUG 18, 2007

$B_{\text{perp}} = 10 \text{ m}$

(topophase not removed)

mean coherence

$= 0.67$
Los Angeles
PALSAR
FBD-ScanSAR

$\Delta T = 184$ days
DEC 31, 2006
JUL 3, 2007

$B_{perp} = 121$ m
(topophase not removed)

mean coherence
$= 0.48$
Los Angeles
PALSAR
FBD-ScanSAR

$\Delta T = 184$ days
DEC 31, 2006
JUL 3, 2007

$B_{\text{perp}} = 121$ m
(topophase not removed)

mean coherence
$= 0.24$

Note that the FBD raw data is not zeroed in the zero areas of the ScanSAR
Los Angeles
PALSAR
ScanSAR-ScanSAR

$\Delta T = 92$ days
DEC 31, 2006
APR 1, 2007

$B_{\text{perp}} = 445$ m
(topophase not removed)

Burst alignment decreases because the reference and repeat images have different PRF.
Need > 0.2 burst overlap to recover phase form ScanSAR to ScanSAR interferometry.
Wenchuan Earthquake, M7.9, May 12, 2008,

Scan-Scan, $B_{\text{perp}} = 850$ m

JAXA controlled burst overlap in this case. Thank You!

(Tong et al., JGR in review, 2009)
seamless abutment of 10 swaths processes independently with **no adjustments**
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ALOS_preproc

ALOS_pre_process

ALOS_pre_process_SS

ALOS_merge

ALOS_fbd2fbs

ALOS_Ilt2rat
ALOS_pre_proc_SS


creates data.raw and writes out parameters (PRM format) to stdout

imagefile     ALOS Level 1.0 complex file (CEOS format):
LEDfile       ALOS Level 1.0 LED file (CEOS leaderfile format):

options:
-near near_range       specify the near_range (m)
-radius RE                   specify the local earth radius (m)
-swath                          specify swath number 1-5 [default 4]
-burst_skip                   number of burst to skip before starting output (1559 lines/burst)
-num_burst                  number of burst to process [default all]
                          there are 72 bursts in a WB1 frame
-swap                           do byte-swap (should be automatic)
-fd1 [DOPP]                sets doppler centroid [fd1] to DOPP
-V                                 verbose write information
-debug                         write even more information
-quiet                           don't write any information

Example: ALOS_pre_process_SS IMG-HH-ALPSRS049842950-W1.0__D LED-ALPSRS049842950-W1.0__D -near 847916 -radius 6371668.872945 -burst_skip 5 -num_burst 36

burst #   look_angle   #lines_burst
 1   20.1      247
 2   26.1      356
 3   30.6      274
 4   34.1      355
 5   36.5      327
ALOS_llt2rat

Usage: ALOS_llt2rat master.PRM [-bo[s|d]] < inputfile > outputfile

master.PRM   - parameter file for master image and points to LED orbit file
inputfile    - lon, lat, elevation [ASCII]
outputfile   - range, azimuth, lon, lat, elevation [ASCII default]
-bos or -bod - binary single or double precision output

Example: ALOS_llt2rat master.PRM < topo.llt > topo.ratll
Wenchuan Eq.
ScanSAR-ScanSAR

Processed using ALOS_preproc and GAMMA software by Manabu Hashimoto, Kyoto Univ.
Conclusions

- ALOS ScanSAR data can be processed with strip-mode software
- good focus and accurate corner reflector location provided by precise orbit
- corner reflector geolocation accuracy (~5 m) is limited by image resolution and not orbital accuracy
- FBD-ScanSAR_SW4 provides coherence similar to FBD-FBD
- ScanSAR to ScanSAR is possible when burst overlap > 0.2
- Wenchuan earthquake example provides seamless interferogram
- ALOS preprocessor including the ScanSAR module is freely available [http://www-rohan.scsu.edu/~rmellors/ALOS_preproc.tar.gz](http://www-rohan.scsu.edu/~rmellors/ALOS_preproc.tar.gz)