Processing of Bistatic TanDEM-X Data

Remote Sensing Technology Institute, German Aerospace Center DLR
Outline

- Overview of the Integrated TanDEM-X Processor (ITP) functionalities
- Test of ITP functionalities during the “drift-phase” of the TDX-satellite
- First results of the Pursuit Monostatic commissioning phase
The *Integrated TanDEM-X Processor* (ITP):
*From Instrument Raw Data to Raw DEMs*

- **data take screening** at receiving stations
- **mono- and bistatic SAR focussing**
  - including instrument synchronization, timing and drift corrections and combined antenna pattern compensations
- **interferometric processing**
  - with spectral filtering and *precise co-registration*
- **single- and multi-baseline phase unwrapping** (PU)
  - in different mission phases
- **geocoding to Raw DEMs** and generation of quality files for *DEM mosaicking and calibration processor (MCP)*
- generation of **experimental TanDEM-X standard products** (as CoSSCs), higher resolution DEMs and specific baseline cal. data
TanDEM-X Interferometric Acquisition
Downlink of TSX Data and Screening at Receiving Station

Integrated TanDEM-X Processor ITP:
Screening at Receiving Station:
Cal-Pulse Analysis, Sync-Pulse Analysis, Timing Analysis, Raw Data Statistics, Doppler Centroid Estimation
Downlink of TSX Data and Screening at Receiving Station
Interferometric Quality Pre-Check

Integrated TanDEM-X Processor (ITP):
Interferometric Quality Pre-Check

- Common Coverage
- Differential Oscillator Drift
- Received Signal Gain
- Orbit
- Attitude

Screening Report #1
TanDEM-X PGS Oberpfaffenhofen
Fast feedback for operator & arching → acquisition (re-) planning

IQPC automatic quality analysis

<table>
<thead>
<tr>
<th>Overall</th>
<th>APPROVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>99.9968%</td>
</tr>
<tr>
<td>Doppler</td>
<td>97.7487%</td>
</tr>
<tr>
<td>Range coverage</td>
<td>100%</td>
</tr>
<tr>
<td>Doppler bandwidth</td>
<td>99.994%</td>
</tr>
<tr>
<td>Illuminated coverage</td>
<td>65.3662%</td>
</tr>
<tr>
<td>Midrange doppler shift</td>
<td>4.51828e-05...9.40519 Hz</td>
</tr>
<tr>
<td>Illuminated range coverage</td>
<td>65.3899%</td>
</tr>
<tr>
<td>Common coverage area</td>
<td>99.9638%</td>
</tr>
<tr>
<td>Doppler shift violations</td>
<td>0</td>
</tr>
<tr>
<td>Sync evaluation (total sat/sat2)</td>
<td>100%</td>
</tr>
</tbody>
</table>

(common & InSAR suitable) coverage polygons for catalogue, production monitoring & instrument operations
Shipment of tapes containing the SAR instrument source packets
RawDEM Generation

Integrated TanDEM-X Processor (ITP):

- RawDEM Generation
- CoSSCs
- RawDEMs

- Baseline
- Attitude

Instrument Source Packet Tapes

TanDEM-X PGS Oberpfaffenhofen
ITP Processing Capabilities

Integrated TanDEM-X Processor (ITP):
- Stripmap and Spotlight Data
- Repeat Pass Mode
- Pursuit Monostatic Mode
- Bistatic & Alternate Bistatic Mode

RawDEM Generation

CoSSCs

RawDEMs

Operational DEM Acquisition
ITP: RawDEM Generation Workflow

see also, today:
Poster Session:
THP2.PJ, 14:55 – 16:00, Poster Area J
“Interferometric Processing Algorithms of TanDEM-X”

and tomorrow:
FR3.L09, 14:55 – 15:15, Coral 1
“Mutlibaseline Gradient Ambiguity Resolution To Support Minimum Cost Flow Phase Unwrapping”
TanDEM-X Commissioning Phase

- Drift Phase (started after launch)
- Pursuit Monostatic Phase (20 km along track distance & nominal baselines, starting last week July 22)
- Bistatic Phase (October 2010)

During the drift phase TSX and TDX acquired an unique set of SAR data characterized by a varying temporal separation and large baselines.
ScanSAR acquisitions separated in time by 110 seconds
ScanSAR acquisitions separated in time by 110 seconds

- Scene heading angle difference of 0.4 deg
  - Azimuth Spectra shifted by ~3300 Hz
  - ScanSAR azimuth bandwidth ~500 Hz
  => No spectral overlap, no coherence

- But, robustness test of coregistration (incoherent cross correlation modul)
Color coded overlay of enhanced ellipsoid corrected intensity images
Motion of sea ice estimated by incoherent cross-correlation

Correlation Coefficient

processing & visualization by W. Abdel Jaber
First Joint Interferometric Acquisition: October Revolution Island

- Experiment planned by G. Krieger, DLR-IHR:
  - Antenna steering to compensate heading angle difference of 0.2 deg

- 2010-07-16T00:42:00.05 & 00:42:48

- Effective baseline of 2636 m => height of ambiguity: -3.91 m / cycle

- Test of the “ITP Spectral Filtering Modul”:
  - Estimation of “fringe frequency” in range and azimuth
Spectral Filtering Results:

**Near range : Range Spectrum**

- Reference master range spectrum (*1.0*)
- Reference slave range spectrum (*1.0*)
- Filtered master range spectrum (*0.5*)
- Filtered slave range spectrum (*0.5*)

**Near range : Azimuth Spectrum**

- Reference master azimuth spectrum (*1.0*)
- Reference slave azimuth spectrum (*1.0*)
- Filtered master azimuth spectrum (*0.5*)
- Filtered slave azimuth spectrum (*0.5*)
Potential of Large Baseline Interferometry

Processing of Bistatic TanDEM-X Data

IGARSS 2010
Experimental TanDEM-X Spotlight Mode

- Two harbor cities at the Pacific Ocean
  - Honolulu
  - Sydney
Processing of Bistatic TanDEM-X Data
IGARSS 2010
TanDEM-X Spotlight Interferometry
Sydney: High Resolution Spotlight 300 MHz, HoA: 51m
Urban Areas in Stripmap Mode: Las Vegas, 151m baseline -> 50 m HoA
First Pursuit Monostatic Volcano DEMs

Hawai’i:

- Mauna Loa & Mauna Kea,
- 33.8 deg incidence angle,
- 132 m effective baseline,
- 51 m height of ambiguity.
Processing of Bistatic TanDEM-X Data

Detail of Mauna Kea
First Pursuit Monostatic Volcano DEMs

- Hawai’i:
  Mauna Loa & Mauna Kea,
  132 m effective baseline, 51 m height of ambiguity.

- Spain, Tenerife:
  Pico de Teide,
  102 m effective baseline, 67 m height of ambiguity.
First Pursuit Monostatic Volcano DEMs

- Hawai’i:
  Mauna Loa & Mauna Kea

- Spain, Tenerife:
  Teide

- U.S.:
  St. Mt. Helens
Processing of Bistatic TanDEM-X Data

IGARSS 2010
Conclusions & Outlook

- Overview of the interferometric processing concept has been presented

- TDX drift phase provided a unique data set. Varying temporal and large spatial baselines enable new SAR applications

- First checkout of the TanDEM-X processor in the Pursuit Monostatic commissioning phase and processing of the first TanDEM-X DEMs.

- The challenges of bistatic processing will be encountered in October
Thank you for your attention!