DORIS NETWORK STATUS REPORT
IDS Workshop, Ponta Delgada, Azores
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THE NETWORK SERVING THE SPACE ALTIMETRY MISSIONS FOR MORE THAN 25 YEARS

Overall performance review
NETWORK INFRASTRUCTURE: 25Y OF SERVICE (1/4)

Very homogeneous geographical distribution
Coverage of about 90% for LEO satellites (when all DORIS stations are operating)
More than half of the network located on islands or coastal areas (38 stations)

Nearly sixty stations over the past fifteen years
This number of stations allows to maintain a sufficient supply of operational services

Fully meets the orbit determination requirements for satellite altimetry
Coverage gaps can be awkward for the orbit determination (especially for near-real time orbit)
Continuing effort to co-locate DORIS with others techniques

Improving the geodetic reference systems for the space oceanography
NETWORK INFRASTRUCTURE: 25Y OF SERVICE (3/4)

- GNSS (IGS)
- SLR
- VLBI
- No active co-location < 1 km

today: 47 co-locations out of 59 DORIS sites

This map was created by IGN-France

IGN DORIS Network

IDS Workshop 2018
NETWORK INFRASTRUCTURE: 25Y OF SERVICE (4/4)

Co-location with tide gauge

- Distance < 1000 m
- 1 km < Dist. < 3 km
- 3 km < Dist. < 10 km
- No co-location

half of the network is co-located
3 generations of beacons have been developed

Improving reliability, robustness and performance (Auriol & Tourain, 2010)

The third-generation beacon is implemented everywhere since 2010

With the capacity to shift the frequencies to eliminate the risk of jamming between neighboring stations

Development of antennae to improve measurements accuracy

Gradual replacement of Alcatel antennae with Starec antennae from 1992 to 2006 (Fagard, 2006)

Continual improvement in manufacturing processes of the Starec antennae to improve the repeatability

Key development: Starec C type from Sept. 2014: standard uncertainty of the 2GHz phase center in the vertical direction was reduced to 1 mm from 5 mm (Saunier & Tourain, 2016)
Standardization of the network monumentation

Specifying 3 standard monuments compliant with the DORIS system requirements in 2009
Today 3/4 of the network monuments are compliant with standards

Monument stability steadily improved

Progressive renovation of the network monuments started in 2000 (Fagard, 2006)
The 3 standard monuments are compliant with the GGOS stability goal of 0.1 mm/y (Saunier, 2016)

Antenna monuments distribution

- Steel tower on concrete block anchored into the ground: type 3
- Tripod on concrete pillar anchored into the ground: type 2
- Steel tower on load-bearing wall of building: type 1
- Substandard
NETWORK RELIABILITY: 25Y OF SERVICE

Long-term life and stability

Several time series extremely long and most of them longer than 22 years
Very few changes of antennas or sites

Standardizing installations (since 2007)

System requirements for a DORIS station to ensure smooth operation and good performance

Integrity monitoring system (since 2010)

Immediate detection of a faulty beacon; checking of the signal quality and reliability for each station (Jayles et al. 2016)
THE CURRENT STATUS OF THE NETWORK

Recent events and evolution and outlook for the coming years

San Juan
OPERATIONAL STATUS

60 permanent stations of which: 11 beacons are out of order (3 decommissioned)

Decommissioned (pending replacement):
- Yuzhno-Sakhalinsk (11/2005)
- Port-Moresby (06/2013)
- Easter (08/2015)
12 maintenance operations (equipment replacement) in 2017-2018
Network availability maintained over 85% of operating stations from 2012
Highly satisfactory overall performance thanks to the combined effort of all maintenance teams at CNES, IGN and all Host Agencies.
<table>
<thead>
<tr>
<th>2017</th>
<th>Station</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb.</td>
<td>PAUB</td>
<td>Papeete Local tie survey</td>
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<tr>
<td>Mar.</td>
<td>SOFC</td>
<td>Socorro Restarting: equipment replacement (antenna + beacon)</td>
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<td></td>
<td>RIMB</td>
<td>Rikitea Beacon replacement</td>
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<td></td>
<td>-</td>
<td>Papenoo Reconnaissance and RF compatibility tests</td>
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<tr>
<td>Apr.</td>
<td>MIAB</td>
<td>Miami Service interruption: power supply outage (18/04 – 05/05)</td>
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<tr>
<td>Aug.</td>
<td>TRJB</td>
<td>Tristan DC Beacon replacement</td>
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<td>Nov.</td>
<td>CRQB</td>
<td>Crozet Beacon replacement</td>
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<tr>
<td></td>
<td>SARC</td>
<td>Sal Antenna verticality adjustment</td>
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<td></td>
<td>GR4B</td>
<td>Grasse Part of the Permanent Network</td>
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<tr>
<td>Dec.</td>
<td>ARFB</td>
<td>Arequipa Beacon replacement</td>
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<tr>
<td></td>
<td>CIDB</td>
<td>Cibinong Beacon replacement</td>
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</tbody>
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*In bold: main events*
*In normal font: on-site operations carried out by IGN*
*In italics: operational maintenance (equipment replacement) managed by CNES with the participation of Host Agencies*
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<tr>
<td>Feb.</td>
<td>ROXC</td>
<td>Rothera Station relocation and local tie survey</td>
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<tr>
<td></td>
<td>BADB</td>
<td>Badary Shutdown for indefinite period</td>
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<tr>
<td></td>
<td>KRBB</td>
<td>Krasnoyarsk Shutdown for indefinite period</td>
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<tr>
<td>Apr.</td>
<td>WEUC</td>
<td>Wettzell Beacon replacement</td>
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<tr>
<td></td>
<td>MLAC</td>
<td>Mangilao Station installation and local tie survey</td>
</tr>
<tr>
<td>Jun.</td>
<td>CRQB</td>
<td>Crozet Service disruption from 19 June</td>
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<tr>
<td>Aug.</td>
<td>RIRB</td>
<td>Rio Grande Restarting after a two-years outage (equipment replacement)</td>
</tr>
<tr>
<td>Sep.</td>
<td>SJUC</td>
<td>San Juan Station installation and local tie survey</td>
</tr>
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NETWORK FUTURE PROSPECTS

Restarting in:
Santa-Cruz, Ecuador: new tripartite agreement recently signed; full replacement of the equipment
Badary, Russia: negotiating with local authorities to restart transmission
Krasnoyarsk, Russia: negotiating with local authorities to restart transmission + possible relocation

Relocation in:
Ny-Alesund, Norway (co-location GNSS + SLR + VLBI): planned in October 2018
Easter island, Chile following site closure in 2015: reconnaissance planned at the end of 2018
Reykjavik, Iceland (co-location GNSS) to get better performance: reconnaissance planned mid 2019

New sites in:
Changchun, China (co-location GNSS + SLR): awaiting for government agreement
Katherine, Australia (co-location GNSS + VLBI): awaiting for the VLBI upgrade
Papenoo, French Polynesia (co-location GNSS + SLR + VLBI):

4th generation beacon deployment from early spring 2019
Improving the network robustness and performance
Opportunity to relocate antennas to get better visibility (cable length 50 m compared with 15 m before)
NETWORK MAIN CHALLENGES

Continuous operation of the stations: reliable service
Facing local difficulties: withdrawal, site refurbishment; frequency clearance…
Equipment failures: ageing network

DORIS / VLBI RF compatibility (at GGOS core sites)
3 RF compatibility tests performed at: Greenbelt (2014); Wettzell (2015-16); Papenoo (2017)
Requirements for the installation at co-located sites were set

Monument stability monitoring
GGOS goal: 0.1mm/year
Equipping sites with control points and targets to carry out stability monitoring surveys
Installing devices such as tiltmeter or Geocube (small GPS receiver)
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