



DORIS in Latin America: more sun, more warmth, and more rhythm

By Jérôme Saunier (IGN),

France and the French people have always had a very close and special relationship with Latin America where Romance (Latin) languages are spoken because of their similar culture, history and language.

Thus, DORIS as French system forged strong links with its Latin partners who host nine stations of the current ground network: at Socorro (Mexico) with INEGI and the help of the Secretariat of the Navy (SEMAR), Managua (Nicaragua) with INETER, Le Lamentin (West Indies) with Météo-France, Kourou (French Guyana) with CSG, Santa Cruz (Ecuador) with FCD, Arequipa (Peru) with UNSA, Cachoeira-Paulista (Brazil) with INPE, San Juan (Argentina) with UNSJ, and Rio Grande (Argentina) with UNLP.



DORIS STATIONS HOSTED BY COUNTRIES OF LATIN AMERICA.

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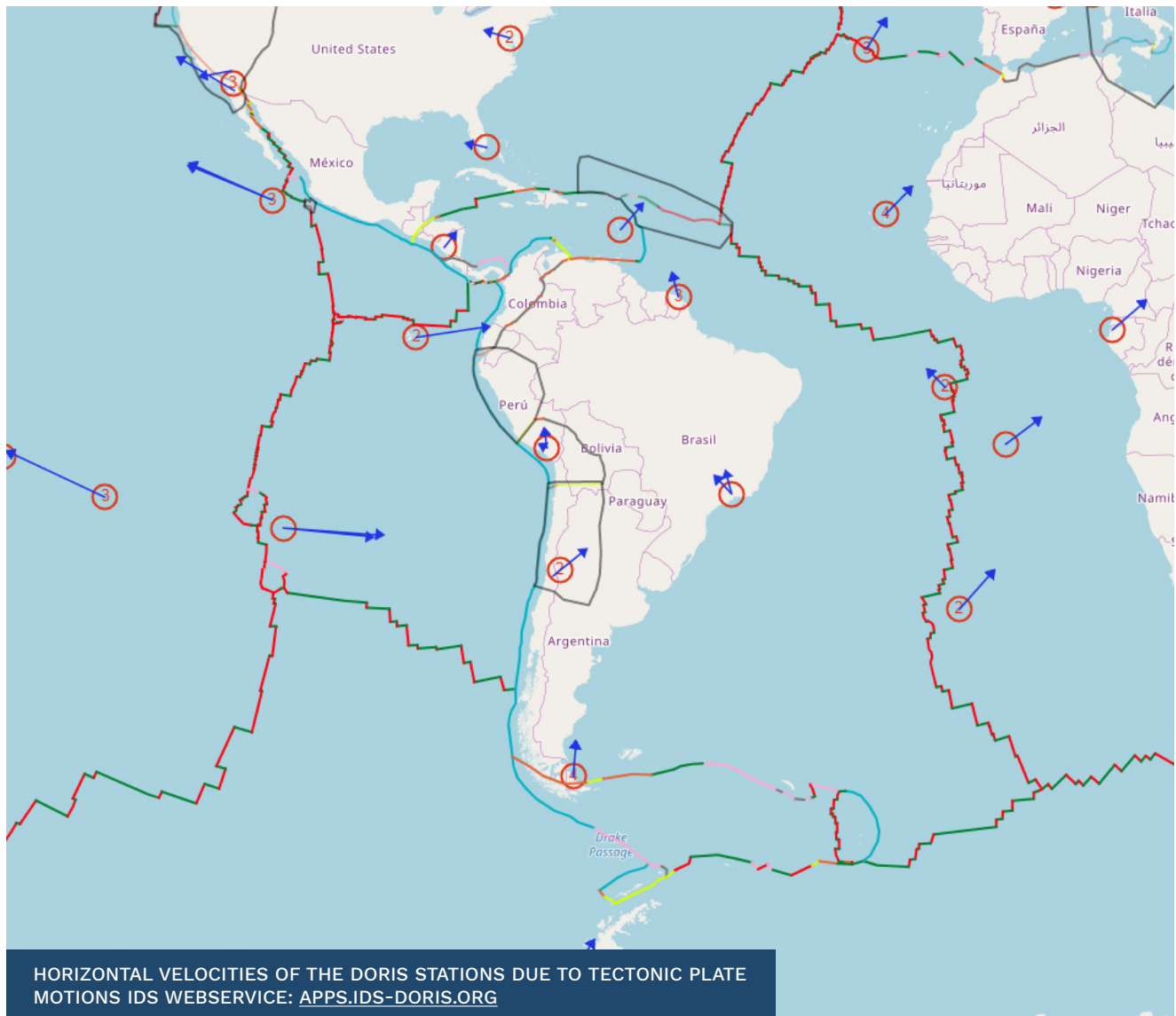
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LAS ESTACIONES DORIS EN LATINA AMÉRICA

The Latin American DORIS stations are located on coastal regions and islands so as to provide a good coverage of the oceans. Some have been part of the permanent network since the start of DORIS in the early 90's years (Socorro, Arequipa, Cachoeira-Paulista, Rio Grande, Kourou), while the others were established more recently (Santa Cruz, 2005, Le Lamentin, 2013, Managua, 2016, San Juan, 2018). The long-standing stations contributed to the study of crustal deformations and plates motion especially in active deformation zones such as the south-western America coast, and also to the modeling of the South Atlantic Anomaly (SAA) for Low Earth Orbit (LEO) satellites. The best example of DORIS contri-

tribution to geophysics in this area is the observation and measurement of local deformation from the time series analysis of the DORIS station, following submarine eruption close to Socorro Island. Socorro DORIS station, co-located with tide gauge, allowed observing displacements due to the subsidence of the volcano after eruption and, at another time, the arrival of lava in a secondary duct (Briole et al., 2009). The old-established stations located further to the south (Kourou, Arequipa, Cachoeira-Paulista) have been extensively studied to explain from the 2000s satellite-specific problems and errors in the stations positioning. Actually, the magnetic field that is much weaker over this region affects the behavior of satellites equipment, in particular

on-board clocks, causing erroneous results in the stations position/velocity estimation. Since then, the modeling of the SAA effect has been continuously improved and evaluated through the DORIS data of these South American stations. In addition, the DORIS station at Kourou plays an important role as one of the four master beacons of the network that are connected to atomic clocks and to the control center in order to send essential information to satellites, like the time reference for the system. More recent DORIS stations in Latin America are also very interesting for geodesy and geophysics. Le Lamentin in Martinique Island (French West Indies) and Managua in Nicaragua are both located on the Caribbean plate and thus will provide valuable

information on the plate motion in this geologically complex area. In addition, these DORIS stations are both co-located with GNSS stations, which will allow comparisons to enhance geodynamical models. Finally, stations in Chile and Argentina are essential for the coverage of the southern part of Latin America. If we count the DORIS station at Belgrano, the scientific base of the Instituto Antártico Argentino, Argentina currently hosts three DORIS stations: Belgrano, Rio Grande and the latest San Juan replacing the Chilean former station at Peldehue, Santiago. In Chile, Easter Island is a key location for the Pacific coverage and there is an ongoing project with the University of Chile for a new DORIS site on the island.

The recent workshop “Implementation of the Global Geodetic Reference Frame in Latin America” held in Buenos Aires last September was an opportunity to strengthen the links with these countries and reinforce how the DORIS presence is important in Latin America for the terrestrial reference frame realization.

We will now focus on the two main recent DORIS ground network events: installations in San Juan, Argentina, and Santa Cruz, Galapagos Islands.

DORIS EN EL OBSERVATORIO ASTRONÓMICO FÉLIX AGUILAR, SAN JUAN, ARGENTINA

The DORIS station in San Juan was installed on October 21th, 2018 at the astronomical observatory Felix Aguilar (OFA) that is managed by the National University of San Juan (UNSJ) (see insert on page 6). San Juan is located 300 km northeast of Santiago, Chile on the other side of the border formed by the Andean Mountains. Settled in the Tulúm Valley, the astronomical observatory benefits from an exceptional climate (the sunniest place of South America) and one of the purest skies in the world for astronomical observation. After the reconnaissance

DORIS site	Host agency
Arequipa PERU <i>since Dec 1988</i>	Instituto Astronómico y Aeroespacial P. Paulet Universidad Nacional de San Agustín (UNSA)
Cachoeira Paulista BRAZIL <i>since Aug 1992</i>	Instituto Nacional de Pesquisas Espaciais (INPE)
Kourou French Guyana, FRANCE <i>since Dec 1986</i>	Centre Spatial Guyanais (CSG)
Le Lamentin Martinique, FRANCE <i>since June 2013</i>	Météo-France
Managua NICARAGUA <i>since April 2016</i>	Instituto Nicaragüense de Estudios Territoriales (INETER)
Rio Grande ARGENTINA <i>since Dec 1987</i>	Estación Astronómica de Rio Grande (EARG), Universidad Nacional de la Plata (UNLP)
San Juan ARGENTINA <i>since Oct 2018</i>	Observatorio Astronómico Félix Aguilar Universidad Nacional de San Juan (UNSJ)
Santa Cruz Galápagos, ECUADOR <i>since April 2005</i>	Fundación Charles Darwin (FCD)
Socorro MEXICO <i>since Feb 1991</i>	Instituto Nacional de Estadística y Geografía (INEGI) Secretaría de Marina (SEMAR)
Belgrano ARGENTINA base <i>since Feb 2004</i>	Instituto Antártico Argentino (IAA)

THE DORIS ANTENNA “SJUC” OF SAN JUAN, CO-LOCATED WITH SLR AND GNSS





AERIAL VIEW OF Oafa OBSERVATORY WITH THE PART OF THE LAND DEDICATED TO GEODESY (CIRCLE)

in 2014 for a new DORIS site in the area, including several options in Chile, the choice was made for the San Juan observatory. This site offers good environment for the DORIS antenna broadcasting and co-location with other space geodetic techniques: the Satellite Laser Ranging (SLR) station set up by the Chinese Academy of Sciences in 2005 and the permanent GNSS station of the national network RAMSAC (Red Argentina de Monitoreo Satelital Continuo) in operation since 2012. This instrument co-location is of high interest for geodesy and geophysics. With three of the four geodetic techniques contributing to the International Terrestrial Reference Frame (ITRF) realization, San Juan observatory is a core site for the combination of the reference frames of the different techniques into a unique reference frame by introducing terrestrial measurements (tie vectors between co-located instruments). In addition, using the measured station velocities from three different techniques, this co-location will provide essential information for the study of this

deformation zone where global plate models are not applicable.

The three geodetic instruments are gathered together in the middle of the observatory in a 50 m radius area that offers a clear view of the sky. After the installation, IGN carried out a local tie survey to determine with high precision the relative position of the reference points of the three instruments: DORIS, GNSS and SLR. As the GNSS data observations from the Oafa station should be included in the IGS data reprocessing that will be used as input data for the next ITRF realization, these tie vectors will be very useful.

The commissioning of the DORIS station has come as a great relief after lot of paperwork and lengthy delays for shipping and customs clearance of the equipment. Patience and perseverance are needed with such obscure administrative processes.

We hope long and continuous operation for this major station of the DORIS network that will play an essential role in the Global Geodetic Observing System (GGOS).

DORIS EN LA ESTACIÓN CIENTÍFICA CHARLES DARWIN, ISLA SANTA CRUZ, GALÁPAGOS, ECUADOR

DORIS has been present in the Galapagos Islands since 1991. The station was first located in San Cristobal Island at the Instituto Oceanográfico de la Armada (INOCAR). The station was then moved in 2005 in Santa Cruz Island in order to improve its operating conditions and environment. After very good results in the four early years, the equipment unfortunately broke down. And all that went with it got worse: loss of the spare equipment, a fruitless search, and loss of time, loss of motivation, loss of contact...

We had to start all over again from scratch: new people, new agreement, new equipment and new confidence in the future!

The DORIS station were reinstalled in September 2019 thanks to the efficient cooperation of the local staff of the Fundación Charles Darwin (FCD) that hosts the equipment. The

FCD scientific station is located in a quiet place south of Puerto Ayora where iguanas and tortoises are living peacefully for millions of years. A permanent GNSS from the IGS network took up residence in the parcel in 2003 and must fight against the hardy vegetation on ground. The DORIS antenna was set-up on the terrace roof of the directing staff assuring an undisturbed environment. Galapagos archipelago is located 1000 km away from the West coast of South America. Thus, the DORIS station in Santa Cruz is essential for providing tracking coverage for DORIS satellites over the Pacific Ocean. It is also a key location for the Nazca plate motion monitoring, one of the fastest moving plates.



©GoogleMap

THE DORIS ANTENNA « SCRC » OF SANTA CRUZ



LOCATION AND VISIBILITY CIRCLE OF THE DORIS STATION IN SANTA CRUZ, GALÁPAGOS, ECUADOR

FCD activities (see insert on p. 6) are far away from geodesy or geophysics but the FCD found a common cause to work together because the DORIS system contributes through Earth observation satellites to the study of climate change and they are particularly interested in satellite imagery that constitute essential material for their work of research. With the Santa Cruz DORIS station back to operation, the orbit determination and thus the height measurements from the altimetry satellites will be improved in this area and the co-location with the GNSS station will provide meaningful data to contribute toward the understanding of the complex structure of this area known as hot spot in geological terms. We wish a long and successful life to this station!

LOS COLORES DE LAS ESTACIONES DORIS LATINOAMERICANAS

When you look at a Latin America DORIS station, there is no apparent difference compared to the others. But yet you see more sun in the picture, you feel the heat. If you think about the people taking care of the equipment, you remember their warm welcome the first time you met them. You notice their unique generous support to deal with difficulties greater than elsewhere. The station history has a different flavor imbued with the local situation and hampered by administrative barriers. But your friends there make it fun and always look on the bright side. Don't you hear the Latin sounds in the South American DORIS stations transmissions? /

THE HOST AGENCIES IN SHORT

SAN JUAN

By Dr. Ricardo C. Podestá,
OAFA Director, San Juan National University, Argentina



The Observatorio Astronómico Félix Aguilar (OAFA) was founded on September 28, 1953 and belongs to the National University of San Juan. The OAFA was firstly dedicated to astrometric observations through scientific projects that led to outstanding discoveries of asteroids, comets, other celestial bodies and contributions to stellar catalogs. It is now playing an important role in space geodesy, in the maintenance of the International Terrestrial Reference Frame and Solar Physics. OAFA research areas are Dynamic Astronomy, Astrophysics, Astronomy of Position and Geodesy, Technological Development, Divulcation and Astronomical Tourism. Historically, the institute's research projects have been conducted with the help of other countries. The first international agreement concluded with a foreign entity was with the Universities of Yale and Columbia for the operation of the Double Astrograph telescope. Then, over the years, more agreements were added with countries such as China through the National Astronomical Observatories of China (NAOC) of the Chinese Academy of Sciences (CAS), the Royal Institute and Observatory of the Spanish Navy, the Max Planck MPS and MPE institutes in Germany, the Mackenzie Presbyterian University of Brazil, the Moscow State University in Russia and the National Centre for Space Studies (CNES) and the National Geographic Institute of France (IGN). The OAFA has two astronomical observatories. One hand, the OAFA Headquarters, located 15 km west of the city of San Juan. It includes the offices of the researchers and the administration. SLR and GNSS space geodetic techniques were installed on this site through an agreement with the Chinese Academy of Sciences, and recently, a DORIS station was added through an agreement with CNES and IGN. On the other hand, Carlos U. Cesco Station, located 250 km away from San Juan in the location of Calingasta in the Andes mountain range, was founded on March 31, 1965 through an agreement between San Juan National University and the Universities of Yale and Columbia, where mainly astrometric, solar physics and astrophysical observational activities are developed.

Observatorio Astronómico Félix Aguilar (OAFA) Website
www.cielodesanjuan.com

SANTA CRUZ

By Johanna Carrión,
Executive Coordinator and Interinstitutional Affairs,
Charles Darwin Foundation, Galápagos Ecuador



The Charles Darwin Foundation for the Galapagos Islands (CDF) is an international non-profit organization dedicated to scientific research. CDF has carried out its mission in the Galapagos since 1959, thanks to an agreement with the Government of Ecuador and with the mandate to pursue and maintain collaborations with government agencies by providing scientific knowledge and technical assistance to promote and secure conservation of Galapagos. The Charles Darwin Foundation puts a high priority on collaborative conservation. In addition to working with individual researchers through our Visiting and Adjunct Scientist program, the Foundation also enters into inter institutional agreements with other organizations. These Agreements promote the causes of joint research projects, knowledge transfer, data management, volunteer support and training, facilitation of research, and many others. Our current collaborators include governmental institutes, national and international universities, and private organizations. For the CDF it is important to be part of the DORIS project since this contributes to generating knowledge and sharing information for science purposes around the world.

IDS LIFE

JASON-2 (2008-2019)



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DORIS will turn 30 in 2020.

The first DORIS measurement was received by the first DORIS receiver embarked on SPOT-2 on Feb. 3rd 1990.

Bye bye Jason-2

After more than 11 years in orbit, the ocean-observing altimetry satellite Jason-2 ended its mission on October 10th, 2019.



DGFI-TUM is the 4th Associated Analysis Center

The application of the DGFI-TUM (Munich, Germany) to become an Associate Analysis Center was approved by the IDS Governing Board at its meeting on October 1st, 2019. In addition to the six regular Analysis Centers, four Associate Analysis Centers now contribute to the IDS analysis activities.

IDS Strategic Plan

After the IDS Retreat held in June 2018, the IDS GB worked on the development of a strategic plan for the IDS. In the coming years, IDS will focus on growing the community, extending the DORIS applications, and improving the technology, the infrastructure and the processing.

DORIS RINEX and DIODE orbit soon available in NRT

Following a request from the Working Group "NRT DORIS data" chaired by D. Dettmering, Jason-2/3: DORIS RINEX and DIODE orbit may be soon available in NRT.

Creation of an IDS Working Group on Geocenter

A new IDS Working Group on the observation of geocenter motion was proposed. DORIS can play a role because the tracking network is stable and well distributed.

IDS AT GGRF WORKSHOP



VIRGINIA MACKERN (UNIVERSIDAD NACIONAL DE CUYO AND UNIVERSIDAD JUAN AGUSTÍN MAZA, MENDOZA, ARGENTINA; VICE-PRESIDENT OF SIRGAS) AND FRANK LEMOINE (NASA/GSFC; CHAIRMAN OF THE IDS GB)

Frank Lemoine and Laurent Soudarin attended the International Workshop for the Implementation of the Global Geodetic Reference Frame in Latin America held in Buenos Aires, Argentina, from Sep 16 to 20, 2019. It was the opportunity to meet the friendly colleagues from the agencies hosting DORIS stations in this part of the world.

www.sirgas.org

EVENTS

DORIS day 2020

A « DORIS day » will be organized on May 2 at the Vienna University of Technology prior to EGU 2020 to promote the use of the IDS products. More information soon on the IDS website.

IDS Analysis Working Group, Spring 2020

Date and location are still to be defined.

IDS Workshop 2020

The next IDS Workshop will be held on October 19-21, 2020, in Venice, Italy, in conjunction with the Ocean Surface Topography Science Team meeting.

IDS & DORIS QUICK REFERENCE LIST

1. IDS website

<https://ids-doris.org/>

2. Contacts

Central Bureau

ids.central.bureau@ids-doris.org

Governing Board

ids.governing.board@ids-doris.org

3. Data Centers

CDDIS: <ftp://cddis.gsfc.nasa.gov/doris/>

IGN: <ftp://doris.ign.fr>

and <ftp://doris.ensg.eu>

4. Tables of Data and Products

<https://ids-doris.org/ids/data-products/tables-of-data-products.html>

5. IDS web service

<https://ids-doris.org/web-service>

DOR-O-T for DORIS Online Tools

(pronounced in French like the

given name Dorothee) is the IDS

web service developed to promote

the use of the DORIS products. The

current version of the service pro-

vides tools to browse time series in

an interactive and intuitive way, and a

network viewer.

6. Citation

The following article is suggested for citation in papers and presentations that rely on DORIS data and results:

Willis, P.; Lemoine, F.G.; Moreaux,

G.; Soudarin, L.; Ferrage, P.; Ries,

J.; Otten, M.; Saunier, J.; Noll,

C.; Biancale, R.; Luzum, B., 2016.

The International DORIS Service

(IDS), recent develop-ments in

preparation for ITRF2013, IAG

SYMPOSIA SERIES, 143, 631-639, DOI:

10.1007/1345_2015_164

7. DORISmail

The DORIS mail service is used to

send information of general interest

to the DORIS community. To send a

DORISmail, use the following address:

dorismail@ids-doris.org

8. List of the documentation

It gives a table compiling links to the

various pages providing documents,

grouped in four categories: DORIS

system components; IDS information

system; Publications, presentations;

Documents

[https://ids-doris.org/ids/reports-](https://ids-doris.org/ids/reports-mails/documentation.html)

[mails/documentation.html](https://ids-doris.org/ids/reports-mails/documentation.html)

9. List of presentations given at DORIS or IDS meetings

Full list of presentations given at

DORIS or IDS meetings with the

corresponding access links

[https://ids-doris.org/ids/reports-](https://ids-doris.org/ids/reports-mails/meeting-presentations.html)

[mails/meeting-presentations.html](https://ids-doris.org/ids/reports-mails/meeting-presentations.html)

10. List of documents and links to discover the DORIS system

[https://ids-doris.org/analysis-](https://ids-doris.org/analysis-coordination/documents-related-to-data-analysis.html)

[coordination/documents-related-to-](https://ids-doris.org/analysis-coordination/documents-related-to-data-analysis.html)

[data-analysis.html](https://ids-doris.org/analysis-coordination/documents-related-to-data-analysis.html)

11. List of DORIS publications in international peerreviewed journals

[https://ids-doris.org/ids/reports-](https://ids-doris.org/ids/reports-mails/doris-bibliography/peer-reviewed-journals.html)

[mails/doris-bibliography/peer-](https://ids-doris.org/ids/reports-mails/doris-bibliography/peer-reviewed-journals.html)

[reviewed-journals.html](https://ids-doris.org/ids/reports-mails/doris-bibliography/peer-reviewed-journals.html)

12. Overview of the DORIS system

[https://www.aviso.altimetry.fr/en/](https://www.aviso.altimetry.fr/en/techniques/doris.html)

[techniques/doris.html](https://www.aviso.altimetry.fr/en/techniques/doris.html)

13. Overview of the DORIS satellite constellation

[https://ids-doris.org/doris-system/](https://ids-doris.org/doris-system/satellites.html)

[satellites.html](https://ids-doris.org/doris-system/satellites.html)

14. Site logs

DORIS stations description forms and

pictures from the DORIS installation

and maintenance department:

[https://ids-doris.org/doris-system/](https://ids-doris.org/doris-system/tracking-network/site-logs.html)

[tracking-network/site-logs.html](https://ids-doris.org/doris-system/tracking-network/site-logs.html)

15. Virtual tour of the DORIS network with Google Earth

Download the file and visit the DORIS

sites all around the world.

[https://ids-doris.org/doris-system/](https://ids-doris.org/doris-system/tracking-network/network-on-google-earth.html)

[tracking-network/network-on-](https://ids-doris.org/doris-system/tracking-network/network-on-google-earth.html)

[google-earth.html](https://ids-doris.org/doris-system/tracking-network/network-on-google-earth.html)

16. IDS video channel

Videos of the DORIS-equipped

satellites in orbit

[https://www.youtube.com/channel/](https://www.youtube.com/channel/UCiz6QkabRioCP6uEjkkTKKg)

[UCiz6QkabRioCP6uEjkkTKKg](https://www.youtube.com/channel/UCiz6QkabRioCP6uEjkkTKKg)

17. IDS Newsletters

Find all the issues published in color

with live links on the IDS website

[https://ids-doris.org/ids/reports-](https://ids-doris.org/ids/reports-mails/newsletter.html)

[mails/newsletter.html](https://ids-doris.org/ids/reports-mails/newsletter.html)

18. Photo Gallery

<https://ids-doris.org/ids/gallery.html>

PUBLICATION DIRECTOR:

P. FERRAGE

EDITOR-IN-CHIEF: L. SOUDARIN

CONTRIBUTORS TO THIS ISSUE:

J. CARRIÓN, R. C. PODESTÁ,

J. SAUNIER, L. SOUDARIN

DESIGN: STUDIO OGHAM

IDS

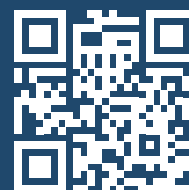
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PARC TECHNOLOGIQUE DU CANAL

31520 RAMONVILLE

SAINT-AGNE,

FRANCE



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