

IDS NEWSLETTER

Newsletter of the International DORIS Service



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On a mission from DORIS in the Himalayas

By **Jérôme Saunier** (IGN, France)

Some stations of the DORIS network are located in very remote areas of the world. The station we are going to talk about is not located in the middle of the ocean, nor in the polar zone, but at 5,000 m altitude in the Himalayas, near the Everest base camp! Story of my trip in fall of 2024.

Reaching this altitude is not without risk: lack of oxygen can cause acute mountain sickness, which can lead to cerebral or pulmonary oedema in a matter of hours. That is why you need to climb in increments of 400 m per day from an altitude of 3,000 m, to acclimatize your body to the high altitude. To reach the DORIS station, it takes a six day's walk from Lukla (elevation: 2,860 m), respecting the acclimatization stages.

Lukla is the gateway to Khumbu, the region of Nepal that attracts thousands of trekkers and mountaineers every year. One gets there by helicopter or small propeller plane landing on an impressive cliffside runway. I was dropped off here with my 250 kg of luggage: the new DORIS station equipment to be installed and the surveying equipment (tachymeter, prisms, tripods, GNSS receivers and antennas, etc.).

The equipment was loaded onto a helicopter and taken to the station. I began my slow ascent on foot with Bijaya, my guide-carrier.

An entirely different world begins here: there are no roads, only people on foot and animals at the service of human beings: mules, cows and yaks. The trails are marked by cairns and numerous religious signs: stupas, prayer wheels, prayer flags, rock paintings... The Khumbu is a land of Sherpas, the Tibetan ethnic group who settled here in the mid-16th century. Since then, the Himalayan mountains are dotted with the symbols of Tibetan Buddhism. This immersion in nature, with its grandiose high mountain landscapes, invites you to meditate.

Has DORIS climbed so high to monitor the oceans?



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The DORIS “Everest” station was installed in 1992, at a time when the summits of Everest in Nepal and K2 in Pakistan were vying for the status of roof of the world. The installation of the first permanent space geodesy station in the area, recording observation data continuously, contributed to the precise determination of the altitude of the summit of Mount Everest.

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At the time, it was more of an experimental station, and CNES did not know how long it would live (or survive) at this altitude. In the end, the station has accumulated over 26 years of data (despite some service interruptions) and is now one of the most prestigious stations of the DORIS network! We had not been back to our highest station since it was installed in 1992. The ongoing deployment of the 4th generation DORIS beacon was an opportunity to organize a new expedition to completely renovate the station.

First visit 32 years after the installation

I was treading in the footsteps of my former IGN colleague, Michel Lansman, who had come here to install the station 32 years ago (1). I was going to have the same adventure. The mountain has not changed. It is just as demanding as ever, and we still marvel at it. The two-day hike to Namche Bazaar (3,440 m), the hub of trekkers in the Khumbu region, is a perfect introduction.



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Namche Bazaar

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The trail leads up the valley of Dudh Kosi, literally the river of milk because of its white color. The path crosses the adjacent torrents that feed this enormous river, one after the other, via long, impressive footbridges. The weather is misty, intensifying the impression of entering another world. On the way, we pass long convoys of mules or cows going up and down to supply Namche.

Namche Bazaar is the last city offering some comfort and services before the high Himalayas. Before reaching Namche, we enter Sagarmatha National Park through a natural gateway between two large rocks. An entrance fee is required. This park includes Mount Everest, all the surrounding famous peaks and the DORIS station!

A day of acclimatization in Namche is recommended, but with some exercise: a 10 km loop on foot to the Khumjung high plateau (3,800 m). It's the first sunny day, and we're delighted to be able to see the peaks of Everest and Ama Dablam in the distance.



The next day the weather is less pleasant. A few squalls of rain at the start meant we had to protect our bags. Fortunately, the sun returns in the afternoon as we cross the Dudh River for the last time. Then, it is a long climb up the Amji Khola valley to reach the Tengboche monastery, the end of our stage. The night is cool.

What a joy it is to start the day in this beautiful and peaceful place. How lucky I am to be here! Well, I experience these moments as the culmination of a long process of preparation and organization. It was not all so simple: 850 emails in three years; major difficulties with Nepalese customs; trip postponed four times; expired airline tickets; equipment lost... but today I am here, on the way to renovate the DORIS Everest station!

This day's walk to Pheriche (4,370 m) is the most beautiful for its sumptuous scenery. The fairly easy trail up the colorful Amji Khola valley allows one to fully appreciate the grandiose scenery that follows, with the majestic Ama Dablam (6,812 m) and Lhose (8,516 m) peaks always in the background.

(1) Read Michel Lansman's article in DORIS Newsletter #4 (1993)
<https://ids-doris.org/documents/1993-DORISnewsletter-4.pdf#page=11>

Our breath is short now that we are over 4,000 m altitude. On my arrival in Pheriche, I meet for the first time my colleague Gian Pietro Verza, technical director of the Ev-K2-CNR Pyramid where the DORIS station is located. Pheriche is a day's walk from the Pyramid. What a pleasure to meet in person someone we've been working with for so long!

Peter (as we use to call him) was already here when my colleague Michel came to install the station in 1992! After long moments chatting together, he recommends that I stay an extra night in Pheriche to acclimatize better. Time to discuss the objectives and program of my week's stay at Ev-K2-CNR Pyramid.

Ev-K2-CNR Italian Committee (see the article presenting the host agency) which promotes scientific and technological research in high mountain areas, is our partner for 32 years. They built the Pyramid in 1990. The DORIS antenna was installed some ten meters north of the Pyramid because we were limited by cable length.



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With a base of 15x15 m and a height of over eight meters, the Pyramid obstructs the DORIS signal to the south, and its reflective surface can cause multipath propagation, which alters measurements. This is one of the objectives of the trip: to find a better environment for the antenna. But I will have to do it without building materials or concrete, looking for a rock that is stable enough to anchor the antenna support. The second objective is to keep the station operating smoothly for many years to come by installing the latest generation of antenna and beacon. Finally, the time series of the station's position must be continued by performing a local tie survey between the station's old and new reference points after its relocation.

The last stage

During the last stage to reach the DORIS station, the landscape becomes more and more mineral, the vegetation becomes scarce, several peaks over 6,000 m high are really close: Ama Dablam, Tabuche, Cholatse.

Halfway through the day, the difficulty that lies ahead is the ascent to the Thukla pass (4,830 m), where the huge Khumbu glacier tongue ends. This place is known for its Everest Memorial for the great climbers and sherpas who have lost their lives attempting to reach the roof of the world. Stones with photos and texts have been erected here to honor them. There is a chill in the air just to remind us how dangerous the mountains can be. Lobuche and the Pyramid are not far away now, and I am getting more and more excited at the prospect of discovering the highest station of the DORIS network! A few snowflakes fall as we reach the fork where a signpost points to the **“Pyramid International Laboratory-Observatory, only 5 minutes away”**.

We are at 5,000 m altitude, I can not go faster, but I can not wait to get there! Here it is, around a bend in the path, the Pyramid is nestled here in a peaceful spot. DORIS antenna is just behind...

I run without saying hello to anyone, embracing the antenna with joy! I come down from my emotions to meet the local team and present the objectives of the mission. From there, a week's work begins: site survey, inventory of equipment on site, choice of a new antenna location, installation of a new antenna monument, installation of all the new DORIS equipment, adjustment, surveying measurements, functional tests in coordination with CNES, photographs, documentation, dismantling of the old station, debriefing, etc.



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Time for renovation

The antenna was moved about 20 meters and raised by about 5 meters, on a large rock located a little higher up to the northeast. By moving away from the Pyramid, which was obstructing the propagation of the DORIS signal and causing multipath interference, measurements should improve. The installation also better complies with DORIS system requirements: standard monumentation, monument stability, cable routing, antenna verticality, and latest-generation equipment.

Working in a remote location requires careful preparation, as any missing parts or tools cannot be found on site and could cause the mission to fail. One should also allow extra time in case of bad

weather conditions. Finally, for this very special location, the very specific working conditions due to the high altitude must be considered: one is short of breath, one's physical abilities are diminished, one often has headaches, and it is very difficult to sleep. Another problem that I had not anticipated and that scared me was the loss of visual acuity due to altitude and the dilation of the blood vessels in the retina.

I could not take my measurements with the theodolite on the first day because my vision was blurred. Fortunately, everything returned to normal the next day!

Overall, everything went very smoothly thanks to the invaluable help of the local

people and my guide-carrier, who was always ready to run and fetch things I had left behind in the Pyramid or carry equipment.

The working days outside were short because it was cold in the morning until 10 a.m. and again from 4 p.m. onwards in the afternoon. But the conditions were very good all week, which allowed me to finish the installation earlier than planned. After commissioning, we had to wait for the DORIS control center in France to verify that the signal was being received correctly by the satellites and that the measurements were of good quality. This usually takes at least 24 hours, which gave me time to take a short trip to see Mount Everest up close.



Let's go higher

It is quite frustrating to work only a dozen kilometers away from Mount Everest without being able to see it. The Pyramid site is in a basin from which it is impossible to see the roof of the world.

The best spot nearby to see Mount Everest is the summit of Kala Patthar (5,644 m), accessible in a two-and-a-half-hour walk from the Pyramid. I decide to go there accompanied by a guide on a beautiful sunny day after verifying that the DORIS station was still transmitting.

The hike consists of first climbing above the Pyramid and walking along the enormous Khumbu Glacier to cross the Lobuche Pass and reach the village of Gorkashep (5,140 m). Gorkashep is truly a village at the end of the world, the last supply point before Everest base camp. The environment is very rocky, with no vegetation. From here, it's a long climb with a 500 m elevation gain.

The peaks gradually rise up against the sky, but one must wait until the final section to

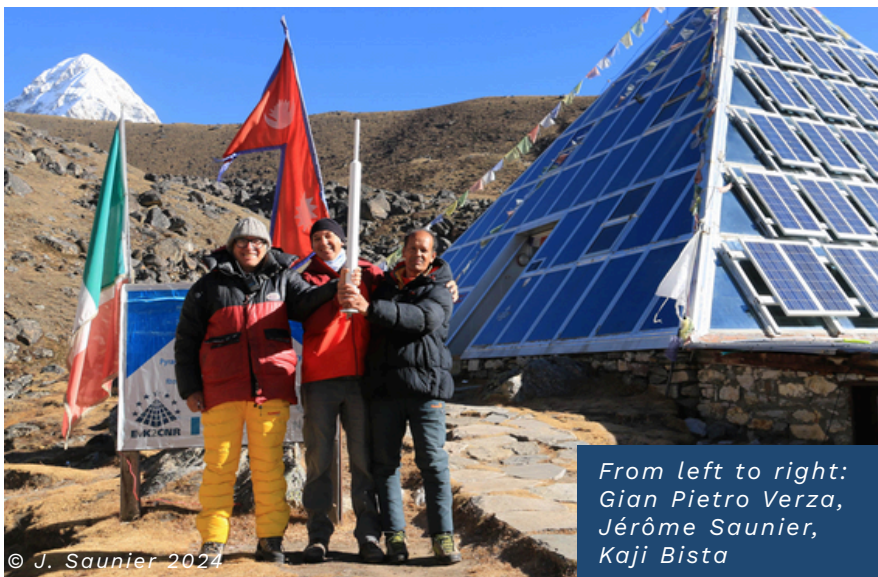
catch one's first glimpse of Mount Everest, which until then has been hidden by the imposing Lhotse mountain. This final section is very rocky, which is where a guide comes in handy. One needs to use one's hands a little to climb the last few meters. Only when one reaches the summit can one look around and see the roof of the world just a few wing beats away. The 360° view is breathtaking. I stay there for at least half an hour. **That is definitively my most beautiful mission!**

The next day, good news arrived from CNES: the station was working perfectly again. All that remained was to do a few last tasks on the station installation, tidy everything up, prepare to return the surveying equipment, and debrief with the team on site before taking a few photos. The return to Lukla can be done much more quickly because there is no longer the constraint of having to

respect altitude stages for acclimatization. And what a joy it is to be able to sleep through the night again! It will take me three days to reach Lukla, from where I can reach Kathmandu by plane or helicopter.

These three days of hiking were wonderful again, with splendid weather and sumptuous landscapes that seemed almost new to me since I was walking in the other direction!

I would like to thank Agostino da Polenza, president of the Ev-K2-CNR association, for his help in organizing the mission, Gian Pietro Verza, technical director of the Ev-K2-CNR Pyramid, for his on-site assistance, and Kaji Bista, local manager of the Pyramid, for his logistical support throughout the mission. J.S.



From left to right:
Gian Pietro Verza,
Jérôme Saunier,
Kaji Bista

The host agency in short / EVEREST

By **Francesca Steffanoni**
(EvK2CNR, Italy)

Founded in 1989, EvK2CNR is a recognized association dedicated to scientific and technological research at high and extreme altitudes, with a focus on the areas belonging to the so-called Third Pole of the Earth (Himalayas and Karakorum). Over the years, EvK2CNR has redefined the world of mountain research through its constant presence in the mountainous regions of the Hindu Kush, Karakorum, Himalayas, in Nepal, Pakistan, Tibet, as well as in Africa, South America, and the Alps. The crown jewel of our activities is the Pyramid International Laboratory-Observatory, located at 5,050 meters on the Nepalese side of Mount Everest. This unique facility is far more than a research station; it is a strategic sentinel for climate change and a benchmark for high-altitude science. Its continuous operation for over three decades provides an irreplaceable long-term dataset that is crucial for understanding global environmental processes.

It is in this context of scientific excellence that we have hosted the DORIS station since 1992.

The presence of DORIS at the Pyramid is of paramount importance. Positioned in a region of intense tectonic activity and serving as the highest ground-based reference point for satellite orbit determination and precise geodetic measurements, its data is invaluable. The station has been instrumental not only in monitoring crustal dynamics of the Himalayan range but also in contributing to the definitive measurement of Mount Everest's height, in synergy with GNSS systems. The data from our site helps to calibrate and validate satellite altimetry missions globally, making a direct contribution to the International DORIS Service and to our understanding of sea-level rise and the Earth's changing shape.

The interdisciplinary research conducted from the Pyramid has led to groundbreaking discoveries in earth sciences, environmental sciences, medicine and physiology, anthropological sciences, and eco-efficient technologies. This work provides crucial data and insights to address the increasingly evident climate crisis and has been recognized in over 600 international scientific publications, including Nature. Furthermore, EvK2CNR undertakes numerous projects in ecology and international cooperation, in collaboration with the Italian Ministry of Foreign Affairs and the Italian Development Agency, UNDP, many Italian and international Universities and local stakeholders and institutions to protect ecosystems, preserve biodiversity, and promote sustainable development for local populations.



<https://www.evk2cnr.org>

Sentinel-6B: DORIS is on

By **Cécile Manfredi** (CNES, France)

Sentinel-6B (COPERNICUS – ESA/EUMETSAT/NOAA/NASA/CNES), the second of the two-satellites Sentinel-6 series was launched by a Falcon-9 rocket from Vandenberg Air Force Base, California, on November 17th, 2025. And DORIS is onboard.

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Almost five years to the day after the launch of Sentinel-6A, its twin Sentinel-6B joined it in orbit at an altitude of 1,336 km. Thanks to its payload comprised of four conventional instruments – the Poseidon-4 altimeter, a radiometer, GNSS and DORIS satellite positioning systems and a laser reflectometer – Sentinel-6B will measure sea level rise and atmospheric temperature, which are essential indicators for monitoring climate change.

It will reach its nominal orbit on December 18th, 2025, and will remain 30 seconds ahead of Sentinel-6A until the end of the commissioning phase, scheduled for November 17th, 2026. At that point, Sentinel-6B will become the reference mission for monitoring sea surface height and will ensure continuity of measurements until 2030.

On this mission the DORIS instrument is combined with GNSS to provide long-term measurement stability and also will reduce the uncertainty of sea level measurements (between 0.1 and 0.3 mm/year over 10 years). In addition, the DORIS-integrated DIODE navigator provides the satellite with a priori knowledge of its location: this information is then cross-referenced with a Digital Terrain Model loaded on board, enabling the altimeter to know when it can expect to receive the return signal that it wants to measure. This improves measurements in areas where the topography varies rapidly, such as coastal areas or areas of continental ice. This expertise is provided to the program by CNES.

“Once again, the ‘Switch on and forget it’ start-up of the DORIS instrument has been demonstrated.”

Switched on at 09:41 UTC on November 21th, 2025, the DORIS instrument convergence was achieved 1 hour 30 minutes later. This remarkable performance was made possible by an excellent configuration of master beacons: Master Beacon 1 Toulouse, Master Beacon 2 Papeete, followed by fine synchronisation at Kourou. Once again, the ‘Switch on and forget it’ start-up of the DORIS instrument has been demonstrated.

With this new mission, the DORIS constellation now comprises 10 satellites, and is set to increase to 12 in 2026 with the launches of Sentinel-3C and HY2-E and the extensions of the Cryosat-2, SARAL and Jason-3 missions. This is the largest ever number of active DORIS receivers that have been on orbit!



IDS was in Athens

By **Laurent Soudarin** (CLS, France)

In early November 2025, the IDS organized the DORIS Days and the meeting of the Analysis Working Group. Both events were hosted by the National Technical University of Athens (NTUA) in Greece.

DORIS Days 2025

Second edition of courses on DORIS and its applications organised by the IDS



The International DORIS Service organized a new edition of the DORIS Days, held for the first time in a hybrid format on November 3 and 5, 2025.

This year's program was designed to provide both a foundational overview and a hands-on experience with DORIS and the IDS community, tailored especially for early-career researchers and students. Courses could be attended remotely and in person at NTUA's School of Rural Surveying & Geoinformatics Engineering.

More than 70 participants from 25 countries joined the event, either in person or online, demonstrating the growing interest in the DORIS system and its applications.

A large proportion of participants were students, teachers and researchers. This training course was also attended by members of organisations hosting DORIS stations and stakeholders in the future Genesis mission.

All presentations, recordings and materials from the practical sessions are available on the IDS website.



Hands-on session in a classroom at the School

Program Highlights

November 3: A global introduction to the DORIS technique, system, and scientific applications.

November 5: A full-day hybrid workshop combining theoretical lectures with guided exercises using Jupyter Notebooks, offering participants practical insights into DORIS data processing.

Organizing Committee

Maria Tsakiri, Karine Le Bail, Xanthos Papanikolaou, Guilhem Moreaux, Laurent Soudarin.



Students, teachers and IDS members at Zografos Campus

IDS AWG Meeting

Exchange between experts from the DORIS community

Following the DORIS Days, the IDS Analysis Working Group (AWG) meeting brought together representatives from DORIS Analysis Centers and associated groups.

Sessions were hosted at the Dionysos Satellite Observatory (Nov. 6) and the NTUA Patission Complex (Nov. 7).

The visit to Dionysos Satellite Observatory, home to one of Greece's two DORIS stations, was a highlight for the participants.



Group photo in Patission Complex



◀ Attentive audience under the dome of the University

At the foot of the antenna of the DORIS station at Dionysos Satellite Observatory ▶



The IDS extends its warmest thanks to Maria Tsakiri and her team at NTUA for their outstanding organization, and to all speakers and attendees for making these events a success.

IDS LIFE

Mark your calendars for the next IDS workshop in 2026

The IDS workshop will be held in Wiesbaden, Germany, in conjunction with the Ocean Surface Topography Science Team (OSTST) meeting 2026, during the week of June 22-26. More information to come in early 2026.

Using NRT DORIS data for validation of existing GNSS-based ionosphere models

Since August 2025, NRT DORIS data from Jason-3 have been routinely used by the IGS Real-Time Service to monitor the accuracy of different RT-GIM products with a latency of about 24 hours. See <https://igs.org/rts/monitoring/>.

Involvement in ESA Genesis project

IDS fully supports this project and together with CNES experts, is involved in the Genesis Science Exploitation Team. Several IDS members are part of the Working Group DORIS (WG 4) chaired by Guilhem Moreaux.

IDS website gets a makeover

A new version of the website was launched in May 2025. The aim is to make the website clearer for users. This site version offers some new features and headings. See what has changed under <https://ids-doris.org/documents/2025-IDSwebsiteV3.pdf>.

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