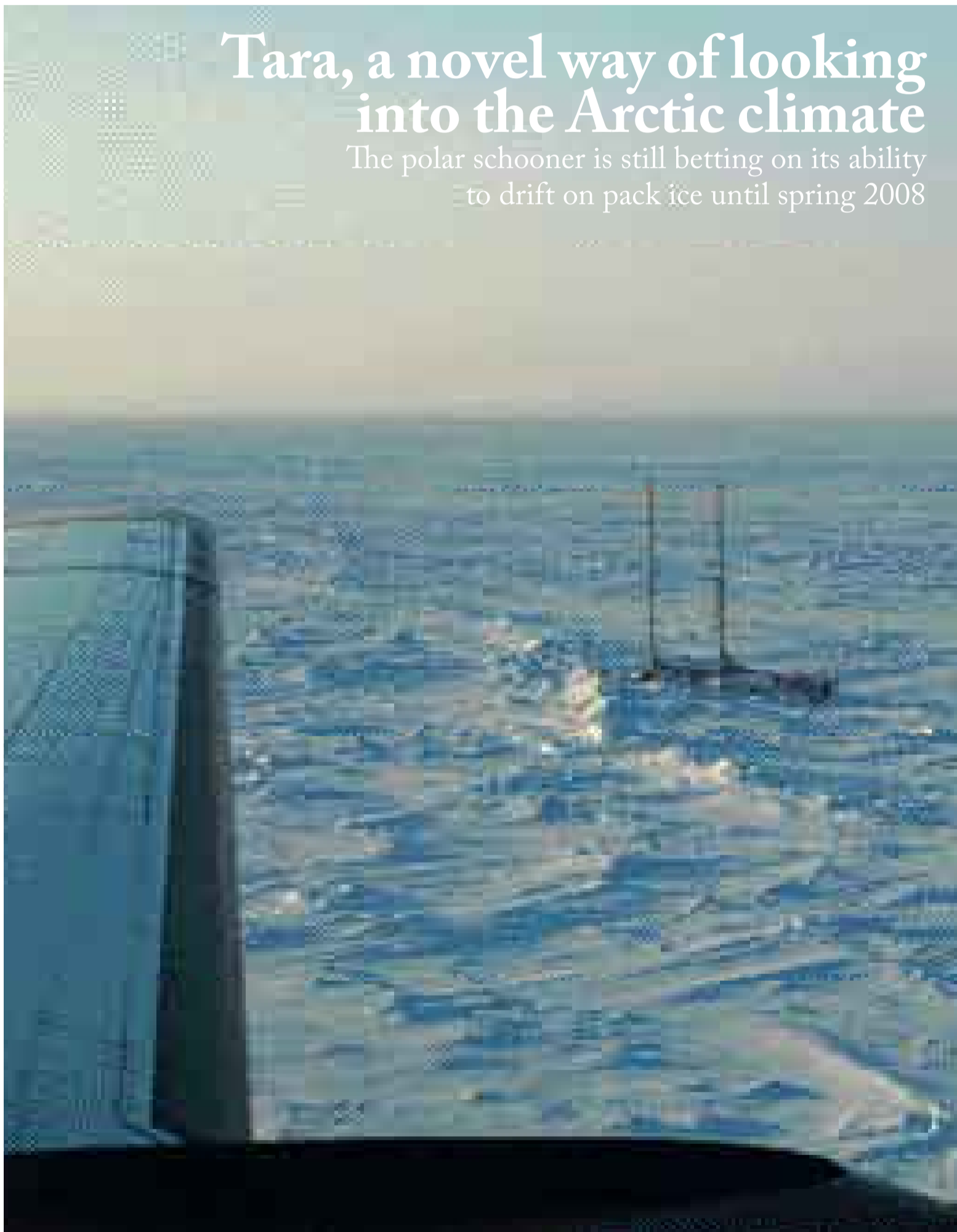


## Tara, a novel way of looking into the Arctic climate

The polar schooner is still betting on its ability to drift on pack ice until spring 2008



First flight over Tara in April 2007, first visual contact after seven months of isolation on the pack ice. © François Bernard

BY SYLVESTRE HUET\*

### Can the Arctic Ocean ice disappear?

During the summer, at the very least. The question has arisen since the climatologists have sounded the alarm. The global warming caused by greenhouse gas emissions could upset the high northern latitudes. To what extent? All the digital simulations of the future climate predict the complete disappearance of the sea ice during the Arctic summer.

It remains difficult to predict the pace of this transformation. As soon as 2030? Not before 2080? One thing is certain; the pack ice disappearance would cause a real upheaval. According to Jean-Claude Gascard (CNRS, Pierre-et-Marie-Curie Paris-VI University) «the sea ice plays a decisive part in the climate by isolating the ocean surface from the atmosphere and by reflecting solar energy. Its disappearance would lead to important feedbacks on the climate. These could accelerate the melting of the Canadian and Siberian permafrost and, on a longer time scale, of the Greenland icecap. Enough to raise the level of the oceans by six meters!»

### The aim is to study the effects of climate warming

To solve the unknown factors regarding the extent and the rhythm of this transformation is thus a major issue. The latest scientific publications indicate that the disappearance of the summer pack ice could happen faster than what has been predicted.<sup>(1)</sup>

One of the keys to this problem is to watch this ice in order to register its evolution in real time. Yet how? In the Arctic, a hostile environment, instruments are rare. The satellites do measure the ice surface—in 2003, the NASA published 24 years of satellite observations that showed that the summer pack ice had diminished by 20% —, but they say nearly nothing about its thickness. Cryosat, the first satellite capable of measuring it will only be launched in 2009 by the European Spatial Agency. Its data will have to be validated by actual field measures, as always in remote sensing.

Former measures provided by American submarines suggest that the average thickness of the ice has gone from measuring more than three meters to less than two meters in thirty years. Yet are they representative of the pack ice as a whole? To find out, scientists need a perennial observation device of the ice but also of the sub-ice ocean (temperature, salinity, currents), of the atmosphere, of the energy flux between the air, the ice and the water. This is the aim of the Damocles programme of which Jean-Claude Gascard is the scientific coordinator. Half funded by the European Union (16 million euros), it gathers more than 100 scientists specialized in the Arctic Ocean. Onboard Tara, these scientists accomplish measures in the ocean, the ice and the atmosphere and test prototypes, able to transmit their data on surface, but also under the ice.

The next years' stakes is to monitor the Arctic in order to provide climate digital simulations with reliable data and on a long term basis. Then, the scientists will be able to solve the uncertainty that still remains on the pace of the changes that one should expect but also to specify the extent of the latter regarding the greenhouse gas emission scenarios. Hoping that this information will prompt mankind to limit the disorder that it is inflicting to the planet climate. ■

(1) Stroeve, J., M. M. Holland, W. Meier, T. Scambos, and M. Serreze (2007), Arctic sea ice decline: Faster than forecast, *Geophys. Res. Letter* of 1<sup>st</sup> of May.  
\* Sylvestre Huet is a journalist at *Liberation*.

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### A night unlike others

After an eventful night that lasted for 147 days, the wintering crew relives its adventure. Story.

page 3

### Twenty four hours on a base

The April crew has arrived despite the air-drop delay. Everybody is getting organised. Report.

page 8

### A drift faster than anticipated

The first results by J.-C. Gascard, scientific coordinator of Damocles. Overview.

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### The project manager assesses the situation

Etienne Bourgois, expedition director, goes back over the first months. Interview.

# “A beautiful and long night of 147 days”



The winter crew: Bruno Vienne, Hervé Bourmaud, Denys Bourget, Matthieu Weber, Nicolas Quentin, Grant Redvers, Gamet Agarmirzaev and Viktor Karasev. © François Bernard

BY DINO DIMEO\*

**Another adventure started when night befell. It lasted for 147 days. It is a wonder how the body can live that long without light.**

Upon their return to civilization in April 2007, Hervé Bourmaud, Bruno Vienne as well as Denys Bourget, Nicolas Quentin, Matthieu Weber and the two Russians, Gamet Agarmirzaev and Viktor Karasev, relive the incredible experience of their seven months drift on Tara. The first, Hervé Bourmaud, is a trained fisherman and a captain. He allowed himself a two week break to see his wife and little boy. The second was the onboard cameraman. He has definitely left the expedition. Denys was the onboard physician, Nicolas, the chief mechanic in charge of energy. Finally, Matthieu was the onboard scientist, assigned by the oceanography laboratory of the University of Jussieu. The young engineer is still filled with wonder by this extraordinary journey and speaks of an incredible feeling of freedom. “Paradoxically, this adventure could appear sometimes like a prison, without bars and walls”, he says. Nowhere to go, a vision limited by the darkness of the polar night, hostile surroundings and devoid of any life where no physical contact with another human being is possible. Inexhaustible, they share their memories of a rough night, highlight of an adventure that began in September 2006.

## Like a shattered mirror

“I nearly thought that we would have to cancel the expedition even though we had just arrived into the zone, recalls Bruno, still shaken. We arrived with an arrogant attitude, a whole fleet, with an icebreaker... We said good-bye to everyone. Everything was ok then four days later, the pack ice mirror shattered. As if this strong sanctuary was testing us before welcoming us.” Even though he is more used to the marine environment, Hervé, like Bruno, also remembers this major episode when the boat was put in the ice. “A big storm made the pack ice smash up. It shattered in thousands of pieces with a strong swell. We had already settled part of our equipment on it. We had to recover 8 tons of kerosene and to hoist them onboard. We operated the boat to approach to these floating ice sheets as near as possible. We were totally desillusioned”. The adventure really began at that moment.

The crew then waited for the famous polar night. And when darkness settled in, another adventure began, just as tricky and extreme as Denys Bourget the onboard physician confirms it “In this very hostile environment, the least

technical fault can make one switch from peaceful navigation to survival” A very special and surreal atmosphere. The crew had to learn how to discover the phenomena that inhabit these latitudes.

“Even so, with all the setting of the scientific material, the night did not appear to me as long” acknowledges Hervé. “Moreover, the darkness bound the team once again the tea”. During a month, nothing or nearly nothing happened. Until the pack ice woke up everyone. “As soon as we did something, a pressure ridge would come to destroy everything and we had to start off all over again”, adds Hervé. “We realized later that the ascending full moon and the wind played an important part in the movements of the ice. Depressions over the Atlantic also. Three to four days later, the ice would crack. But it is like a game of poker. Nothing is reliable.” One day, the pack ice would swallow the shroud of the weather mast that then needed to be dismant-

led and brought back on the schooner. Another time, the hole used for the toilets disappeared. There is a lot of movement and it can become dangerous. One wonders if the boat is going to hold up, adds Bruno. The two Russians, Victor and Gamet knew we were in the presence of a living organism” An organism that we listen to, in the dark.”

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At the beginning of the night, the ship's bottom rose which created a list of eight degrees to which we also had to adapt to. Upon his return on land, Bruno realized that his internal ear had remained accustomed to it. “When we arrived in Longyearbyen (Spitzberg), I was under the impression that all the houses were tilted”. Yet on board, one gets used to it and one forgets quickly even if it is difficult to join our feet standing up with eight degrees. “I was very much helped by the presence of the moon, the stars and the aurora borealis” admits Bruno. “In fact the moon cycle had replaced the sun cycle for me. The moon turned around the boat. Like a reference.”

The crew tries to sleep whole nights every two days and strives to maintain their Sunday rest “at least in the afternoon to preserve our biological equilibrium”. But in the darkness of the night, if a clock is unnecessary, it was not easy to choose the time zone that would also suit Paris headquarters. “there were great discussions onboard. We finally decided to follow

Longyearbyen time” says Hervé. The scientific work rhythm finally put an end to our arguments and life on Tara organized itself little by little. It is crucial to have one's own place of refuge for in the darkness we re-built our own little world.

Lost in polar isolation, the non-sailors took a bit of time to understand why it was important to take night watches. “The greatest danger on a boat, is a fire onboard, says Hervé. With these temperatures, nearly everything that could be used to put out a fire is frozen. One must remain vigilant. Hence, two hour watches are organized. During the ‘day’, teams are organised by pairs to accomplish the different ‘chores’. “For the household chores, we changed every week, specifies Hervé. Fresh supplies had been eaten. We ate dehydrated food. We restricted ourselves to have meat and fish just once a week. Otherwise we had quiches, pizzas and a lot of bread”. The crew consumed about 200 litres of

water a day. “This is the equivalent of two pulkas (sleighs) filled with ice each day. Our new unit of measurement” jokes Hervé. Others were in charge of the scientific holes maintenance that could take about two hours each day. The trash, was compacted and piled up on the deck. “we shattered the glass and compacted the rest. It produced a big bundle each month. Everything was brought back by the DC3 in April.” He adds.

Breakfast toward eight o'clock, lunch at 12h30, dinner at 7h30 and in bed around midnight. One feels tired with temperatures below 40. The body spends much more energy “We have less feeling in the fingers and the eyes suffer.” Adds the captain.

Yet for eight persons to live together in an enclosed environment is not an easy feat. The crew did experience a few shouting spells but nothing exceptional. Parties were more than welcome. “It enabled us to unwind. We had the opportunity to celebrate six birthdays out of eight. But we would also gather each time the schooner reached a latitude degree adds Hervé. All occasions were welcome. For Christmas, for instance, we even disguised as the three Wise men” Grant Redvers, the chief of expedition, a New-Zealander even organised a haka on the pack ice for his birthday.

Bruno experienced this relative solitude very much inside. “One cannot escape oneself” he

says “we enter in the depths of our self. We carry out an introspection. To keep in contact, we must recreate our own world, have markers. With our pictures, our music, our books.... Because we spend after all seven months without any money, without a car. Yet the absence of any feminine environment is what I missed the most”.

The expedition cameraman was nicknamed named “the big eye”. One day, he came back to the boat and made the mistake of saying that the frames he had just shot were nothing too spectacular. “I shocked them all. I then put down my camera for a certain length of time so that they would stop thinking of me as the peeping tom of the expedition and accept me as one of them.”

Hervé was in a hurry to go back to Tara. “I will find a new team” he said And I shall see the two dogs again”. Hervé is also the master of dogs for the expedition. There is Zagrey, the biggest and oldest one who is on guard around the ship. He is the one who detects the polar bears when he can smell them. And then there is Tiksy, much younger, who remains mostly on the boat. He is used to tow the pulka. Hervé finds him in the cockpit when he goes there to have a smoke quietly. “By minus forty, one smokes less” he admits. The dogs are accustomed to sleep covered in snow”

## The fear of bears

This unique animal presence was crucial for Bruno. The dogs also give the alert when the pack ice begins to move. “One day with Matthieu who was in charge of the scientific equipment, the ice opened up” tells Bruno. Tiksy found herself on the other side. Matthieu went to retrieve her but then the river widened even more. We had to cover two kilometres to find a pressure ridge that enabled them to come back on the right side. Yet we had to rope ourselves because it was out of the question to set foot in the water as it would have frozen immediately.” Same thing for noses and ears. “We examine each other”, he says “If we see that a bit of nose is freezing, we ask its owner to get back immediately into the boat”.

Nicolas Quentin who is in charge of onboard energies will never forget the flow of happiness that he felt when he took breaks on the pack ice. “What a pleasure to walk on the pack ice and to see the lights of Tara from afar, the only sign of life in the midst of this huge white desert.” Except when a polar bear comes a little too close to the schooner. Denys recalls this very well; “We had gotten used to not seeing them anymore”, he says “Then at the end of January, I noticed one who was ten meters from the front of the boat, standing on a pressure ridge. Impressive”; the dogs had not smelt him. “From our memory, fear was revived” continues Denys. When we left the boat, even to go to the toilet, we would take guns and VHF”.

One night, the faint light on the horizon became a bit more intense. “We were impatient to see this red ball again” says Hervé. We could finally appreciate distances with a vision that was no longer restricted to 200 meters.”

“When the sun came back, I was out of my mind with joy. It is completely irrational” claims Bruno who came home disoriented by this experience. “It is very hard physically, biologically and mentally” he says Yet, I came back full of treasures. I shall strive to take them in little by little. “Upon our arrival, people looked at us as if we were aliens.”

Bruno especially learnt to respect time “It is a luxury of which I had forgotten the flavour. For me it was a gift from the pack ice”. On the return flight, another gift was awaiting the cameraman “I was offered an orange and I wept. I stared at it like our planet” he confides, convinced more than ever that one must preserve at all cost this magical place from now on. ■

\* Dino DiMeo is journalist at *Liberation*.



# Twenty four hours in the life of a base



The tethered balloon can rise up to 2000 meters high to study the atmosphere  
© François Bernard

BY ERIC BIEGALA

**The 2007 spring field work was shortened but practically all the planned experiments and measures were accomplished... at a sustained pace.**

Nothing indicates that it is early morning. With each hour going by, light inundates the Tara galley. Daylight is permanent at this season and if the French time zone has been chosen onboard, it is only for convenience purposes to be phased in with the Paris headquarter. The sun revolves permanently around the schooner. One hardly notices whether it is going above or below the horizon.

It might well be the silence that signals that it is the beginning of the day. Timo Palo has just finished his watch and is dozing off on his notebook, leaning his elbows on the main table of the galley. The young meteorologist has decided to write each evening in his diary... The tables are still empty but in the kitchen one can hear H el ene Santener in charge of stewardship humming... breakfast is on its way. It must be around seven thirty.

Bread, tea, muesli, jams, coffee, in the schooner's galley as under the mess tent established on the ice, scientific staff, logistic team or pilots are going to follow one another to regain their strength. It will be a long day. The Russian quibblings, preventing for two weeks the air-drop of equipment necessary for the base, have indeed considerably shortened the time presence of the scientific teams on Tara. One has to accomplish within three times shorter what was planned for the spring campaign, even it means to sleep less. If some persons arrive late to the table-that is around nine o'clock-, it is because they went to bed at around five o'clock...

After finishing breakfast and putting on their down jackets and boots, the forty persons here present get down to work. Here, one has to set up the new weather mast to replace the old one that held up during the wintertime but that is now tilting dangerously. Then the tethered balloon will be released. Timo Palo will hoist it nearly every day except when the wind is blowing too hard to measure the different atmospheric layers up to 2000 meters high.

A little farther away, the ice is being drilled to the water, once, twice, thrice... Four hundred times in all and covering 2 km. A fastidious but necessary task: it will enable to check on the thickness estimates given by the measurement instruments that are airborne, reason why it has been sponsored by the Danish Space Center.

On their knees with a wind of 15 knots that increases the sensation of cold well beyond the minus 18 that one can read on the thermometer, Suzanne Hanson and Henriette Skourup handle drills and metres as fast as possible. One has to drill and measure quickly before the ice forms again.

Further yet, the Twin Otter, small bi-motor plane, that can go everywhere on the pack ice like a four wheel drive, has just taken off with Micha el Offermann onboard and his "beacons". The scientist from the University of Hamburg must air-drop 16 weather beacons over very precise spots over a square measuring 500 km per side of which Tara is at the centre. Long flight day ahead!

H el ene Santener and Marion Lauters have been very busy all morning to make up a menu to recharge the batteries of forty people. Forty place settings: the equivalent of a small restaurant but without the appropriate room, nor the cutlery for everyone, nor even the saucepans. One has to organise three sittings for the lunch break...and be careful with the water. Dishwashing water is made from sea ice picked by the logistics team (the teams work in shifts water, dishwashing or waitering) and can contain a bit of leftover salt. Fresh water on the other hand is picked in the snow layer, stemming from the snow falls, and is heated on board.

Back to the pack ice after doing the dishes: the scientists set up or activate their machines while the logistics team is busy maintaining the base, and especially the landing runway. It is the Russian brigade of Bernard Buigues, co-initiator of the Tara Arctic expedition, made of Anatoly, Gamet and Andrey that manage the required hundreds of meters. The way has to be marked out, and cleared of the possible snowdrifts that form themselves as soon as the wind blows... and find a place that can be used as an emergency runway.

The second break for dinner is longer for everyone: again three sittings and twice a week, a few bottles are retrieved from the reserve...

For the scientists of which the programme has not been irreparably cramped as for those in charge of logistics, time has come to unwind before joining ones bunk in a dark cabin or a camp bed in the darkness of a tent. For those who are less lucky, it is time to go back on the pack ice to work for a couple of hours while the camp dozes off. ■

## Tara, a strong vessel to resist the ice

### First technical assessment of the schooner

BY ERIC BIEGALA

**Tara is a funny boat as much at her ease in the water as in the pack ice.**

« Although she had been designed to resist to the ice, Tara had never been tested! ». For Grant Redvers, the expedition chief, this was the unknown factor. Even though the schooner had been very well prepared in Lorient, was she really going to resist to the assaults of the pack ice? After eight months of drift, one has to admit that Tara has held up, "during the pressure episodes, one could feel the strength of the ice as it was pressuring the boat and making her vibrate with each assault... We regularly inspected the plating of the boat and the solders, inside and outside. Nothing indicates that the hull was split or had a hole"

In fact, the ice did imprint its mark on the metal... Etienne Bourgois, director of Tara-Arctic and owner of the boat, scrupulously examined the ship during his visit in April. On the portside, at the bow, he noticed a slight indent "like a bump on a saucepan... The hull has a one meter long indent of one centimetre deep" It is most likely a deformation that is not serious and without any consequences.

Since she has been caught in the ice, Tara is not quite like a boat... "In any case, she is not a navigating boat, remarks Etienne Bourgois." "The navigation organs have not been tested yet but will be so very soon." And this as soon as the ice will have melted.

Then, before the final exit that should take place before April 2008, everything will be checked over, from the winches to the rudder blades without forgetting the fire hose. The only time to do this will be during the Arctic summer when the snow has melted on deck and the boat is floating once again. ■



Above, the polar night and the return of daylight.  
© Bruno Vienne et Denys Bourget



The Fram of Fridtjof Nansen, first ship to drift on the Arctic ice took more than three years (1894-1897) to be delivered from the pack ice. 113 years later, Tara has already covered three times the distance covered by the Fram in the past nine months.



# At the end of the night: a runway as flat as a billiard table

## Grant Redvers two years onboard!



The DC3 can only remain twenty minutes because of the ice's dynamism. © Francis Latreille

BY DINO DIMEO

**To carry out the April 2007 campaign and organise seven flight rotations on the Tara base, a runway was necessary. Directions to reach one of the most isolated places in the world.**

To mark out a runway at the far end of the Arctic Sea is not an easy feat. The expedition team of Tara Arctic found this out at its own expense. Responsible for the polar expedition logistics, Romain Troublé was entrusted with the task of organising the April flight rotations as well as the camp preparation so the scientists and the new crew could reach the ship anchored on the pack ice and carry out their mission. The task was very tricky. On the one hand, the Tara drift went so fast that the logistics that had been planned previously via Siberia had to be

reorganised to go from Spitzberg. In April, Tara was closer to the latter yet still 4h30 away by plane. On the other hand, the ice being a dynamic matter, one never knows when it is going to break. This makes the building of a runway for a DC3 turbo, even equipped with skis, a colossal undertaking.

Romain is a specialist: "the runway must measure about 1000 meters, have a width of 30 meters and its surface has to be relatively flat. In order to hold, the ice's thickness must exceed one meter twenty." But without the air-drop that was supposed to bring a bulldozer to the base, essential to prepare the runway, the Tara crew members had to busy themselves with this task. They even had to break the pressure ridges with pickaxes, ice picks and shovels as the small mechanical shovel embarked in September had given up the ghost. The schooner was then 1

400 kilometers away from Spitzberg.

"We were then compelled to take significant risks, explains Romain. Indeed, the Ken Borek DC3-T was supposed to cross a point of no return. The evolution of the conditions was under close scrutiny before each take-off. The final decision to continue toward Tara had to be taken at the end of three hours of flight just before the point of no return. "The plane did contain one hour of reserve fuel in case it ran into a problem and had to join a Russian temporary base. Rather perilous when one knows that the weather and the pack ice can change at any minute." adds Romain.

Then the whole enterprise was delayed. The air-drop was supposed to depart from Russia, with the big bulldozer and kerosene as well as all the necessary equipment for the continuation of the expedition. The Russian customs created quite some difficulties to the point of obliging Etienne Bourgois, director of the expedition, to request the intervention of French diplomacy.

This delay that simply threatened to jeopardize the continuation of the mission also detained 35 people in Longyearbyen. Scientists and journalists, were at a standstill during 18 days in the small Norwegian town, waiting for favourable conditions. In the end, eight of them had to give up the journey and return to the south.

But the end of the April campaign also caused one to have a cold sweat. One evening, the two runways split in the middle making it impossible for the DC3-T to come over. The Twin Otter, a smaller plane had to be requisitioned. After a four-hour flight and as it was about to come back empty handed, the Twin finally spotted a lead that had just frozen up (a stretch of sea that had solidified two months previously) like a sort of natural billiard table located only two kilometres away from Tara. At last, the team's lucky break had arrived. The two "shuttles" needed to bring back some twenty people could now be organised at the given dates. ■



A New-Zealander in the North Pole. © Francis Latreille

BY ERIC BIEGALA

**As far as he can remember, Grant Redvers has always dreamt of following Scott and Amundsen. At 33 years old, he is following in their footsteps. Expedition chief of Tara Arctic, the second polar drift ever attempted, he has gone for two years, following the whim of the slow transpolar current.**

From his childhood, Grant has kept his fine features and a smile full of curiosity. A state of mind also: calm, a great sense of moderation to the point of appearing shy at first. But one just needs to talk with him, particularly in French, to dissipate this faulty impression. The New-Zealander skipper and diver has learnt how to speak the language of Molière on boats and essentially on Tara. As precise and as polished as the one used by sailors. Grant likes to address

**"when I leave the boat with the dogs, I feel as though I was taking a walk in my garden."**

the summits of the world whether the pole or world leaders, in a simple and direct fashion. His Serene Highness Albert of Monaco who was calling the boat by satellite to find out how things were going heard the chief of expedition to whom he had not been formally introduced answer "you know, right now, it is a bit of a bloody mess!"

To drift during two years? Quite an unusual undertaking for a sailor "It is quite strange" answers Grant, "Yet it is what is required to appreciate this place... At first one does not see anything: the pack ice is a desert, a dead space. Yet there are subtleties that one can notice only by spending some time there. The storms like the aurora borealis are all different from one another and the light never touches the snow in the same way..."

Used to long missions- Grant has already spent three seasons on the New-Zeland base Scott in Antarctica- the chief of expedition has been confronted here to the elements: "On the pack ice, I really became aware of nature's power. If one does not respect it, one cannot survive... in particular during the polar night. Little by little, one finds ones bearings, one gets used to the wind and the ice... Presently, when I leave the boat with the dogs, I feel as though I was taking a walk in my garden."

A garden of 14 million square kilometres, big like a continent, yet a garden living on borrowed time. Beyond his wish still intact to accomplish an expedition, Grant wishes to sound the alarms "My goal is especially to continue scientific expeditions. One has to take the time to examine, to explain the importance and fragility of the environment, to raise the public's awareness to what is happening around us." If he has the impression of being insignificant in regards to the arctic world, Grant knows that it is but a barometer of more profound changes. "Without research, without science, one would never be able to tell that this world seemingly so powerful is also very much vulnerable." ■



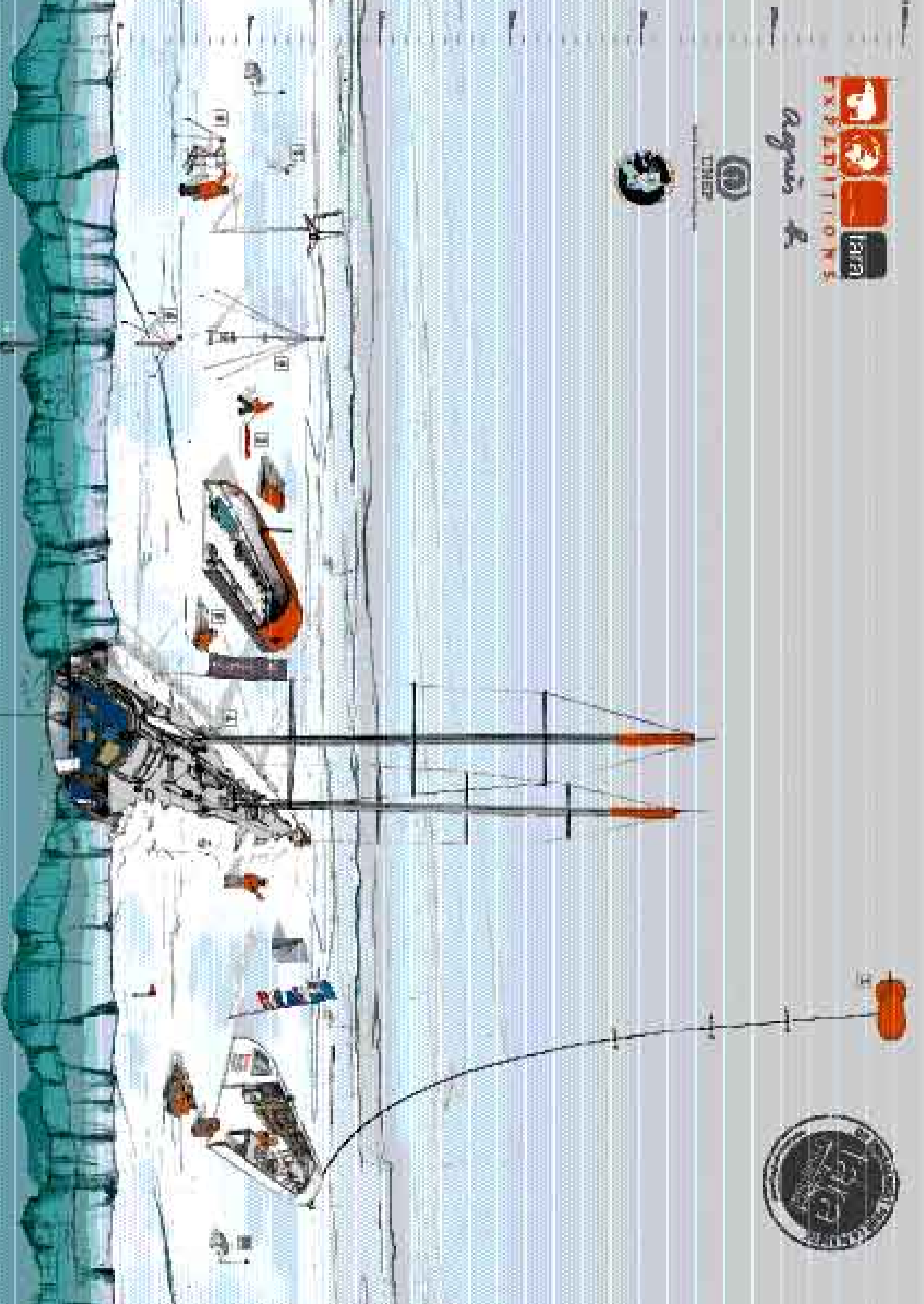
While the DC3 attempts to land without any visibility, the Twin Otter is ready to take off if necessary to guide it to another runway. © Denys Bourget







*Agustin R.*





# A drift faster than anticipated

*Since September 2006, Tara has covered 1000 km in a straight line.  
First scientific assessment*

BY JEAN-CLAUDE GASCARD\*

**Caught in the ice of the Arctic transpolar drift, Tara has covered more than 1000 km in a straight line within nine months since September 2006 when she started off from the Laptev sea.**

This drift in the ice is twice as fast than what was imagined and Tara has practically covered half of the way that leads her to the Fram Strait, that is her exit from the Arctic Ocean. Positioned towards the geographic North Pole, this drift enables Tara to be the vessel imprisoned by the ice having reached the most northern latitude. A historical record.

All this information can be explained for several reasons. The present Arctic climate system is characterized by a weak extension of the anticyclonic circulation in the Beaufort Sea (Canadian basin), a mean atmospheric pressure field weakened in the centre of the Arctic, air temperatures above the seasonal average as well as a quantity of sea ice, exported from the Arctic Ocean towards the Atlantic Ocean greater than the norm.

During the first eight months of the drift, several important mechanisms that characterise the ocean circulation and the formation of sea ice were identified. These concern mainly the inertial oscillations that were observed since the beginning of the drift in September and in October 2006. They are linked on the one hand to the wind stress acting on the ocean mixed layer 20 to 30 meters thick under the surface and on the Coriolis force linked to the Earth's rotation on the other hand. When the wind ceases, the water mass moved previously by the wind, adjusts itself to the Coriolis effect by inertial (centrifugal force). These inertial oscillations as quasi circular movements of the Tara drift are

easily identifiable thanks to her frequent and precise positioning by GPS.

The radius of curvature of the inertial circles is directly a function of the speed induced by the wind on the water mass divided by the inertial frequency. The inertial period being of about 12 hours at this latitude, each circle is described in 12 hours. The inertial circles radius being about 2 km, this corresponds to a drift speed of 30cm/s. These inertial

oscillations trigger a very efficient mixing process within 20 to 30 meters of the Ocean under the surface called the Ocean mixed layer.

A second identified mechanism concerns the sea ice formation at about twenty to thirty meters underneath the surface, which is located at the base of the ocean mixed layer. At that depth, the mixed water mass and super cooled by the atmosphere is maintained in a liquid state by the effect of pressure. If the pressure diminishes under the effect of internal waves for instance ice crystals that are called frazil, can appear at depth. They surface rapidly thanks to the buoyancy they have acquired when changing from a liquid state to a solid state (ice).

The making of frazil ice phenomenon arose with strength to the point of scrambling the bathymetry readings of the ocean bottom by acoustic survey that were accomplished from Tara, as well as the salinity and water masses temperature measurements. This phenomenon was considered of marginal importance to ex-

plain sea ice formation in the Arctic. Observations accomplished on Tara during the course of the winter 2006-2007 oblige us to change our point of view on this subject. This might explain why we have discovered in April 2007, one hundred miles south of Tara very thick new winter ice (over two meters) and not deformed.

Generally speaking, it seems as though the Arctic sea ice has a tendency to behave more

**This might lead to a total disappearance of the summer sea ice and more ice formed in the winter for the coming decades.**

and more like the Antarctic sea ice. In the coming decades, it would mean a complete disappearance of the Arctic sea ice in summer and of the formation of new ice in winter.

It would change drastically the radiation planet assessment with 80% of the incident solar energy that would be absorbed by the Arctic Ocean, free of ice in the summer instead of being reflected back into space from an ice surface of 7 million km<sup>2</sup> (equivalent to Europe's surface area). Paradoxically more ice would form in the winter but this ice would disappear during the summer thawing.

Is the perennial Arctic ice in the process of disappearing and why? The European integrated Damocles project is precisely addressing these two questions and trying to answer them. This project concerns 48 institutions from more than ten European countries. Fifteen scientists of seven different nationalities came to participate in the crew change of eight persons who have spent winter onboard of Tara since the month of September 2006. Ten

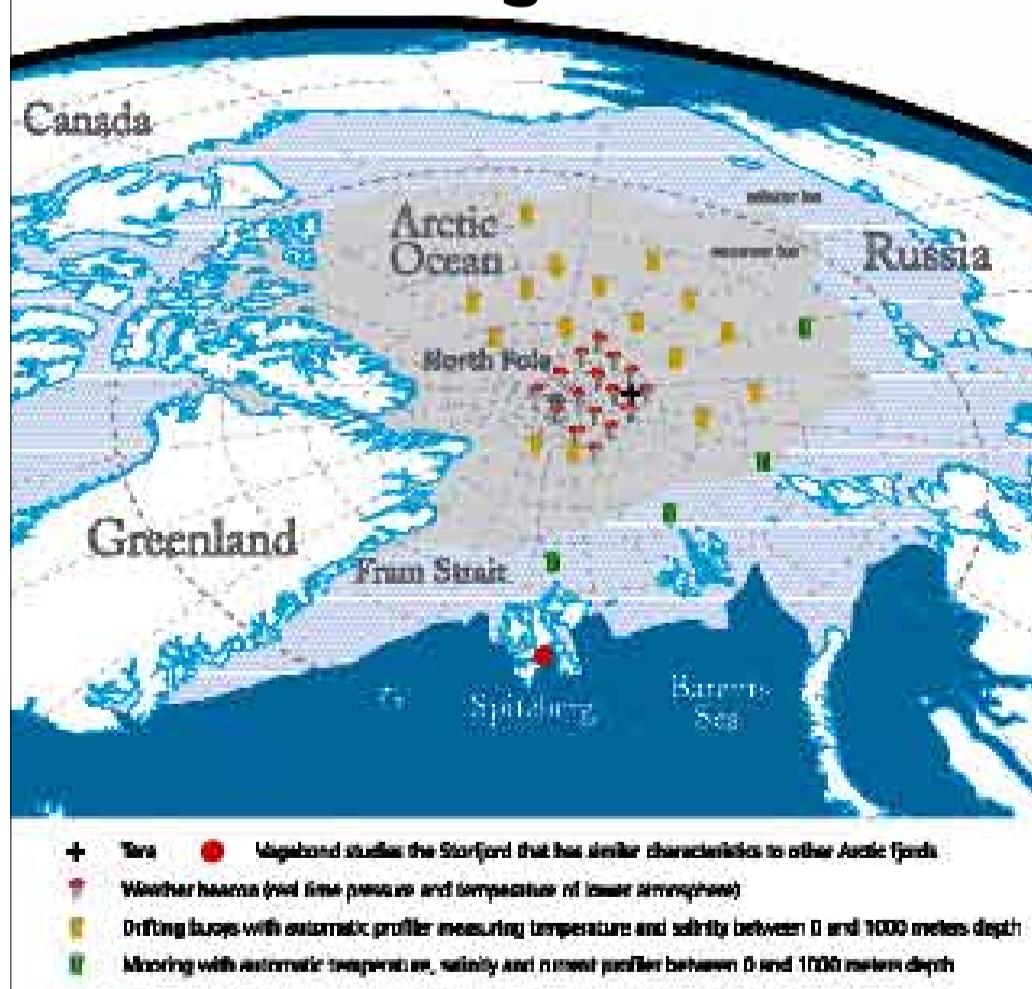
persons in charge of routine measurements have taken their turn.

The onboard scientific programme has now fully started with observations that are simultaneously carried out in the atmosphere up to 1500 meters high, in the ocean down to 4000 meters depth and through the few meters of ice that separate them. It is essentially a matter of measuring the air, water temperature and the pressure according to altitude and/or depth. The humidity of the air and the salinity of the sea water are observed as well as the intensity and the wind direction and currents. Ultra violet, infra red and visible radiations are analyzed permanently thanks to radiometers oriented toward the zenith and the nadir. A web of 16 weather beacons has been set up within a square with sides measuring 500 km of which Tara is at the centre. By the end of the summer, a web of 20 oceanographic beacons will be installed in the heart of the Arctic Ocean. At that time, Tara will already be located at the front of this web and in the process of exiting the Arctic Sea Ocean planned before spring 2008.

The data collected by these automatic networks of platforms as well as observations collected at Tara and from the drifting Russian station NP35 that will be deployed in September 2007, should enable us to establish more reliable predictions concerning the current evolution of the Arctic in the context of global warming. ■

\*By Jean Claude Gascard, CNRS Research Director  
Coordinator of the European project Damocles at the University Pierre et Marie Curie in Paris.

## Damocles: a sophisticated observing network



The Damocles programme during the summer 2007



The snow's thermal conductivity is measured thanks to a heated needle. © Francis Latreille





15 April 2007, a violent wind gale over Tara, the gusts reached 55 knots. © Francis Latreille

## An Arctic summer team

BY ERIC BIEGALA

**With the return of permanent daylight, the summer crew has taken over. The pack ice being more fragile, gathering scientific data could well be more perilous.**

“Summering” will be much richer than wintering, at least, in terms of crew numbers. From a winter crew of eight living in seclusion, Tara has now a crew of ten, of which Marion Lauters in charge of stewardship and of a biology programme with the Marseille Oceanology Centre. Regarding supplies, there is a risk with warming temperatures. Indeed, the temperature should rise above zero for a few weeks and the conservation of fresh supplies will not be possible outside of the two freezers located in the front store-rooms.

The more senior members, Grant Redvers the

Regarding ice and snow, the two scientists are assisted by Samuel Audrain, the second mechanic and by Audun Tholfsen, the Norwegian crew member of Tara, a trained chemist who is familiar with polar climates.

Charles Terrin, the Monegasque officer of the deck watch who materializes the partnership with the Yacht Club of Monaco and Minh Ly Pham-Minh, second woman of the crew and onboard physician (former physician and chief of station of the Antarctic base Concordia) lend a helping hand; They are supported off course by the indispensable schooner mechanic, Guillaume Boehler.

Some procedures that seem easy can prove to be particularly arduous such as gathering measures of ice fragility, recorded by the seismometers. One has to read them on a simple

Grant Redvers, the chief of expedition and Hervé Bourmaud, the captain are the only ones to go beyond the first seven months drift and to continue the adventure ...

chief of expedition and Hervé Bourmaud, the captain are the only ones to remain beyond the first seven months of the drift and to continue the adventure.

Among new arrivals, two scientists represent Damocles onboard: Timo Palo of the University of Tartu in Estonia and Jean Festy of the oceanographic laboratory of Paris VI Jussieu. They are in charge of the experiments and the measurements follow-through.

Indeed, it is a matter of “reading meters” of different sensors and probes installed in April and that record the main data of the water, the ice and the atmosphere. Timo Palo is in charge of the atmosphere whilst Jean Festy collects oceanographic data, their respective specialties.

computer. However, the stations are far from Tara and in the summer, the snow melts on the surface, creating large pools of water that are one meter deep. It can sometimes take several hours just to reach each station and come back. The respect of safety rules in these circumstances is crucial, especially since the pack ice is more fragile, instable and dynamic at this time of the year. In fact, in April, one of the seismometers found itself separated from the others, drifting on a piece of ice. In this case, one has to contemplate going in the water to recover the data, literally in a survival outfit.

Waterproof clothes have been provided. They might be necessary beyond emergency situations. ■



The day after a storm as viewed from the top of the 26 meter mast. Tara has been buried in just three days.

© François Bernard



The sensors tied at different levels of the tethered balloon string give the wind direction and strength and the air temperature and pressure in real time. © Francis Latreille



© Nomura

## agnès b. the gentle touch

BY DINO DIMEO

Agnès b's name has not landed randomly on the deck of this schooner caught for two years in the pack ice. The label that this great lady of fashion has sewn on "Tara" demonstrates her strong desire to be part of an adventure of which her son Etienne is the number one architect. And if Agnès Troublé has put her signature, it is because she is very much preoccupied by the planet's destiny. "I have personally committed myself to this project that might have appeared completely utopian at the beginning" she says "In the end, it is a wonderful

"Tara refers to *Gone with the wind*. When I was a little girl, my father had already christened his first boat that way."

story to which we have joined in as a family. And the name of Tara itself encompasses all of this". But why was Jean-Louis Etienne's and sir Peter Blake's boat rechristened Tara? Agnès tells the story her eyes filled with happiness.

"Tara refers to the plantation in Margaret Mitchell's novel 'Gone with the wind' she explains "When I was a little girl, my father had already christened his first boat that way and those that followed. When we were in our family home in Antibes, we would often say 'I want to go back to Tara' as in the American saga.

Through her son's eyes, Agnès has become aware that from the environmental cause stems another fight, the humanitarian one. A cause she has espoused a long ago. Led by her overflowing generosity, agnès b involves herself on another field ground that is just as hostile. "I have fallen in love with this boat" she says "I kissed her before her departure in Lorient. I like her grey mat colour. To me it is what makes her strong. I just wanted to add a touch of orange".

This expedition carries her in the Jules Verne novels, the same that adorned the library of the Antibes house. For an adventure that is according to Agnès, completely linked to our times. "With Etienne, we have found each other in this commitment; she says "we especially wanted to share this fabulous destiny with the general public".

This polar expedition has also triggered in her the desire to pursue the extraordinary career of this ship supported par the United Nations Environment Program in an accolade to Africa, a project to create a dialogue all around the African continent. "We have so much to learn from them" she confides, aware to have fully entered in the century of sharing. ■



Tiksi, the youngest of the two dogs. © Francis Latreille

## Attending polar school

BY BRIGITTE SABARD

The great Tara Arctic 2007-2008 polar adventure offers an unusual opportunity to raise the awareness and open the minds of young generations to the 21st century issues.

Since September 2006, a very special device is being enriched regularly on the pedagogical website created specially by the Regional Center for Pedagogical Documentation (CRDP) of Paris. It enables any interested person to use the Tara-Damocles data in a pedagogical fashion. Its content and activities have been elaborated by about ten teachers from six disciplines, supported by the Tara team and by Jean-Claude Gascard, coordinator of the European scientific programme Damocles.

The Foundation for Environmental Education in Europe (FEEE), on the other hand, answers to the requests of the educational community (advice, guidance, information) and coordinates the projects call that is launched for the new school year in September 2007 in the Paris region thanks to the support of the

Regional Council. For this occasion, it will organise a poster contest and scientific activities with the association Planète Sciences and with the University Pierre et Marie Curie.

Finally, the ADEME (French Environment and Energy Management Agency) is committing itself at Tara's side to reinforce the education steps on environmental and eco-responsibility questions linked to life onboard the ship. To implement this latter project, Marion Lauters has joined Tara in April 2007. As of September, she will be in charge of conceiving the resource files on the environment linking life onboard Tara, science and sustainable growth (waste, energy, water, man living in extreme conditions, food, hygiene and onboard safety). These files will put on line on the website of the Paris CRDP. ■

**For additional information :**

Contact : 01 45 49 07 09 – education@taraexpeditions.org

The pedagogical website conceived in partnership with the Paris CRDP

<http://crdp.ac-paris.fr/tara/index.php>

## "Explorations", a non profit association to support Tara in its future development

BY FRANÇOIS SICARD

The non profit association "Explorations" aims to raise the public's awareness on the major environmental issues of our planet, sustainable growth and renewable energies.

"Explorations" has struck a partnership with Tara on the occasion of the Nautical Fair 2006. Thanks to this special relationship, the

association contributes to events (conferences, exhibitions, etc...) organised around Tara and to studies relative to her future after the end of the Tara Arctic expedition.

If you wish to support Tara or to participate in the studies of "Explorations", you can apply for membership by paying a subscription fee of 30 euros. The payment should be made by check to the order of "Explorations". You

will then become member of the Association "Explorations". You can consult the Associations' statutes on the website [www.taraexpeditions.org](http://www.taraexpeditions.org). ■

**Contact :**

"Explorations" Association

8 rue de la Paix

75002 Paris - France



# A filmed journey into the heart of the climate machine

## Tara at the Palais de la Découverte

BY MICHAEL PITIOT

The movie production company MC4 and Tara Expéditions are co-producing a 90 minute movie on the Tara Damocles expedition. This feature length documentary aims to lead the audience through a scientific odyssey in order to discover "the climate machine". The first broadcast is planned in prime time on Arte in 2008.

Shot in high definition, the movie is directed by Emmanuel Roblin. At 40 years old, with more than 38 documentaries to his credit, he is making what he considers to be "a true feature length documentary" that shows the wealth of events and the unexpected that make up such an expedition through the Arctic. The director who specialises in major environmental movies, has chosen to show science on the move, "that does not lapse into conveying gloom and doom but that brings a positive and documented vision". He argues that the audience has the right to understand what is happening in the Arctic and more widely in matters of planet climate. Emmanuel Roblin adds however that "individual destinies and human adventure" remains at the heart of this movie targeted for the general public.

The shootings began before the departure from Lorient and continued in September 2006 with the beginning of the drift with the cameras of Bruno Vienne, chief operator. Embarked during the six month polar night, he had to compromise with the cold, the permanent night and the men. "I was an outside observer and at the same time a member of the crew" recalls Bruno Vienne who acknowledges having to put down the camera to give time to the mission. Despite all of this, he has come back with novel frames such as when the pack ice shatters in pieces or when Tara is subject to the pressure ridge assaults. "The Arctic gave us an incredible sight that was even more impressive under the polar night" specifies the cameraman who shot under all weather conditions and sometimes in total darkness. He acknowledges also that a lot of tact was necessary to film the intimacy of a team isolated from the world and striving to carry out its scientific missions. Bruno Vienne was replaced by a new team at the beginning of the month of April. A day team. "In the Arctic, when there is a white-out, one no longer distinguishes the contrasts but on the contrary, in April, with clear skies the sun offers golden lights during twenty-four hours" says Philippe Moreau enthusiastically. The new cameraman has covered a programme in April rich with scientific sequences including the implementation of new experiments. With permanent daylight, researchers and crew team would leave to work on the pack ice at all hours. "We would not even unload the cameras from the pulkas" specifies Philippe Moreau who reminds us that



It is difficult to focus. Even by -30°C, one has to remove one's gloves. © François Bernard

"to film in this region, one must remember to take a radio and a gun because of the bears."

Borrowing from movie techniques: crane, travelling and other aerial shots as well as 3D computer-generated images, the making of this movie in the heart of the Arctic Ocean is a challenge that is human as well as technological and logistical. Yet, beyond the technical feat, to turn the scientists into modern heroes without distorting their word remains without a doubt the biggest challenge of this journey into the heart of the climate. It is also the bet of Tara Expéditions and Damocles as well as the associate producer MC4. ■

BY ERIC BIEGALA

The Tara exhibition space opened in March 2007 at the Palais de la Découverte in Paris at the same time as the International Polar Year. The Tara space welcomes the general public and in particular school children until November 2007.

A scale model of the biggest centerboarder in the world and of its surrounding polar base of which she is the center, explanatory posters of the scientific missions undertaken onboard or from Tara, the space also welcomes a real polar tent under which are shown pictures of the expedition and of the Arctic pack ice. In order to make the reconstruction as realistic as possible, a mannequin is dressed in a polar outfit. A sign lists the different equipment that he needs to withstand the winds and the different temperature swings. The exhibition displays high up the replica of a helium balloon that measures the atmosphere above Tara. There are also Nansen bottles used to take samples of the sea water as well as buoys to study acoustical frequencies under the ice. On the floor, a map of the Arctic Ocean is displayed. The itinerary of Tara's drift is drawn since she was caught in the ice and can be followed by foot.

Finally, a photo exhibition of the Tara Arctic expedition will be shown from the 17th of September until the 8th of October in the context of the event "Adventure to the poles" organised by the Palais de la Découverte. ■

### Contact:

**Palais de la Découverte**  
Avenue Franklin-D-Roosevelt 75008 Paris  
Open from Tuesday to Saturday  
from 9.30 am until 6.00 pm  
Sundays and holidays  
from 10.00 am until 7.00 pm

## The summer 2007 crew



© Grant Redvers

### 1. Grant Redvers

33 years old, New Zealander - chief of expedition  
Training: Masters of Environmental Science, Skipper diploma, Dive master  
Experience: three seasons at Scott Base, a New-Zealand scientific base located in the Antarctic as a scientific technician.

### 2. Hervé Bourmaud

35 years old - French - Captain  
Training: Skipper Certificate, General Machine Operation Certificate, Aptitude Certificate for life-saving appliances (BAEERS)  
Hervé teaches at the professional maritime high school of St Malo.  
Hervé is in charge of the oceanographic winch and is also the dogs master.

### 3. Guillaume Boehler

31 years old- French- Chief Mechanic  
Training: Chief mechanic for all ships- Second captain for all ships University degree in merchant navy.

### 4. Minh-Ly Pham-Minh

39 years old- French - Doctor  
Training: specialty in emergency and sinister medicine, General practitioner and tropical medicine.  
Experience: Doctor and station chief of the Franco Italian Antarctica base Concordia for more than a year. Chief physician of the Amsterdam island, French territory of the Antarctic and austral land for more than a year.

### 5. Timo Palo

27 years old- Estonian-Engineer.  
Training: University of Tartu in Estonia.  
In charge of weather mast and tethered balloon to sound the atmosphere. He represents the Damocles programme on board. He will remain on board Tara until fall.

### 6. Jean Festy

25 years old- French- engineer in computer science and electronics.  
He represents the Damocles programme on board.  
Training: National Engineering School of Brest- Masters in computer science.  
Experience: He has worked since the beginning of the expedition on the lab data in Paris.

### 7. Marion Lauters

23 years old- French- Masters student- In charge of a biology programme with the Centre d'Océanologie in Marseille and responsible of the of food supplies and cooking on board.  
Training: Master II Environment and Ecology, bachelor of science of biology.  
Experience: She helped prepare Tara in September 2005 and was the cook for the conveyance of the ship to Siberia during the summer of 2006.

### 8. Audun Tholfsen

34 years old, Norwegian. Crew member.  
Training: Bachelor degree in chemistry and business. Carpenter.  
Experience: rafting guide, snowmobiles and polar dogs. He has spent three winter seasons as a guide in Spitzberg.

### 9. Charles Terrin

23 years old-French- Port officer. Training: BSC (Honors) Merchant Ship Operations, Southampton Institute (Great Britain) Certificate of officer of the deck watch (STCW95) Maritime & Coastguard Agency (GB)

### 10. Samuel Audrain

28 year old-French-Second mechanic  
Training : captain 200 UMS (sailing) Mechanic 750 Kw. Sailing instructor.  
Diver: level 4/class 2B-Certificate of Para motor pilot.





© Paolo Verzone for Style Magazine Corriere della Serra.

# Etienne Bourgois: expedition conductor

BY DINO DIMEO

**Etienne Bourgois, General Manager of agnès b. and director of this polar expedition, goes back over the first winter on Tara, the April 2007 scientific programme and his role in Tara Expéditions.**

*Organising the first flights on Tara this spring was not that easy...*

What happened in April reminds one that managing logistics on a boat, especially in a latitude never reached before, represents a tremendous enterprise. An enterprise all the more difficult if it is hampered by administrative problems. Thank goodness, this is all behind us, now.

*Your arrival on Tara was very much expected...*

After seven months, the crew was expecting me, especially Grant, the chief base. We actually spent half a day to examine all the difficulties, misunderstandings and winter specific problems. It enabled us to start afresh. At one point, there were 43 persons on the pack ice representing 13 different nationalities. Despite all the complications that we faced since its beginning, the April campaign was a success. The scientists from the Damocles programme accomplished a fantastic achievement.

*In what state did you find the boat after her long winter night?*

Upon my arrival, Tara seemed like a ship wrecked in the ice. It was impressive. The deck was covered with snow. The front had been caught in a pressure ridge during the winter and the stem was slightly deformed. Nothing too

remain very calm and then become dynamic very fast. A sheet of ice can move 30 meters forward very quickly. I like to compare the pack ice to an egg shell that floats above three to four thousand meters of water. It seems sturdy but it is extremely fragile. This means that one must always leave the ship as a team for safety reasons.

My commitment does not consist in solely signing a check. Tara Expéditions is a programme that represents for me a real personal involvement, exciting but very much time consuming.

serious like an indent on a saucepan. We shall know whether there are cracks when the ice has melted and we can dive under the boat. Should there be cracks, we do have some cement on-board. But everybody was surprised by the sturdiness of the boat, conceived nearly twenty years ago by Michel Franco and the architects Luc Bouvet and Olivier Petit for Jean-Louis Etienne. For that matter, I take my hat off to Grant and to the first team, the wintering team that had to live through this polar night.

*Did the team get used to these hostile elements?*

One doesn't get used to them. The pack ice can

*Is the new crew well prepared for the challenges awaiting it?*

Except for Grant and Hervé who will accomplish the mission up to the end, all the other crew members have been replaced. There are eight sturdy young men who are now on board. Some tasks are very tiring under these temperatures. But I am not worried about their physical condition. Two women have also joined the crew, I am very happy even if we have not yet reached equal representation. However, we must not lose sight that summer will be as hard as winter. The pack ice is very fickle. There will also be a lot of water and more scientific equipment to operate and maintain.

*The end of the Nansen drift had been epic. How is it going to happen for Tara next year?*

This risks being a critical stage. All the ice sheets will converge toward the Fram Strait. We are expecting an increase of the pressure phenomenon. It will be like going through a funnel. We also have to be on the watch: bears will be more numerous as we shall be closer to land.

*Which message does Tara want to convey?*

Planet Earth will always pull through. Now, we have to see how we, humans, will survive this climate change. Our objective with the Tara Expéditions programme that has existed for more than three years, is to raise the awareness of people on the dangers that threaten our planet. Each person, each company, each leader must act with his or her own means. It is a more positive way to see things. To invest in this programme has more meaning to me than investing in the cup of America for instance. Even if the latter is more fashionable...

*It is thus a very personal commitment ...*

As general manager of agnès b., my commitment does not consist solely in signing a check. Tara Expéditions is a programme that represents for me a real personal involvement, exciting but extremely time consuming. This programme is the fruit of my commitment and that of a team. I want to mention the work accomplished by my partners Bernard Buigues, and Philippe Clais, of Romain Troublé, Jean Collet and of our éminence grise in the matter of poles, Christian de Marliave. And all the others...

*What are your projects for the after-drift?*

This expedition will be a very enriching experience for us. And the experience of the winter crew already testifies to that. Today, they are the living proof of an extraordinary adventure. They are proving it in all the conferences in which they are participating. Presently, we are looking into several projects for the after-drift. The first step will surely be to create a foundation. Will it be centred on polar issues? We do not know yet. On the other hand, we know that it will be related to the environment. But let's first concentrate on bringing back the boat to dock. ■



After this storm, it took three days for the crew to clear Tara's snow cover away. © Tara Arctic

agnès b.



United Nations Environment Programme

