CNES MAG

SPACE ● INNOVATION ● SOCIETY

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SPACE CLIMATE OBSERVATORY (SCO)

DATA SERVING TERRITORIES

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INSIDE

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CNESMAG
SPECIAL ISSUE

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EDITORIAL

Jean-Yves Le Gall

CNES PRESIDENT

Alongside the international mobilization to rise to the challenge of climate change, which led in 2015 to the adoption of the Paris Agreement, are the less well-known efforts being pursued to achieve climate resilience. This is no small matter, for the inertia of the climate system is such that it will be impossible to halt the trend of global warming before 2050, meaning that territories are going to have to learn to live with higher temperatures, rising sea level and possibly the spread of exotic diseases to temperate regions. Some regions seem more vulnerable than others, like for example Equatorial Africa, Indonesia and the many island nations around the globe. While France would appear less exposed, it will nonetheless have to cope with the gradual depletion of its groundwater resources, more-intense urban heat islands and recurring floods. It is to address local needs that CNES launched the Space Climate Observatory (SCO) initiative, which was subsequently selected by President Emmanuel Macron at the One Planet Summit in December 2017. The SCO combines the expertise of the world's space agencies to supply satellite data that will serve to model the impacts of climate change on specific territories. Europe, with its data infrastructures like Data Terra and its Copernicus satellite programme, is a key asset in this respect for the SCO, which will also be supporting official development assistance projects. France is the first country to have set up its own national SCO, with 18 organizations partnering CNES to contribute their research infrastructures, subject matter expertise and databases to help our territories in metropolitan France and overseas to gear up and ready themselves to tackle climate change, the main challenge facing us in the 21st century.

SCO

A PLANET-WIDE RESPONSE TO A GLOBAL EMERGENCY

The ambition of the Space Climate Observatory (SCO) is to use satellite data to better gauge the impacts of climate change so that decision-makers can devise coping strategies. CNESmag looks at the challenges facing this unique initiative.

1

Climate ALERT

For more than 30 years now, successive reports from the International Panel on Climate Change (IPCC) have been regularly reviewing the state of scientific knowledge on climate change and detailing its causes and impacts. With desertification, severe weather events, acidification of the oceans and other effects making themselves felt around the globe, the verdict is clear: climate change is picking up pace and bearing down on an increasing number of human populations and ecosystems. The latest IPCC special report on oceans and the cryosphere released in September is no exception, revealing for example that as a result of accelerating ice melt, sea level rise is faster than predicted and could reach up to 1.10 metres by 2100.

2

TIME **FOR** action

Given the extent of the phenomenon, alerting public opinion and policymakers is no longer enough. We now need to ready ourselves for the inevitable local consequences of climate change, which will likely include increasing coastal erosion, hotter urban heat islands and more-intense severe weather events to name a few. To guide public investment, land-planning decisions and information campaigns for citizens, policymakers need to know just how vulnerable territories are and determine their capacity to adapt on the basis of the main scenarios the IPCC has established. And that means they need relevant, up-to-date and reliable data to prioritize their actions.

3

Space technologies
TO THE **RESCUE**

Part of the solution will come from space. Satellites enable us to observe the planet repetitively and acquire data so that scientists can understand and predict climate phenomena and how ecosystems are going to evolve. Out of the 54 essential climate variables identified to check the pulse of our planet, 26 can only be measured from space. Tracking them over time is therefore a priority for the international scientific community. But besides these climate variables, satellite observations can also be combined with multisource in-situ data and local socio-economic data on populations, urban spread, protected areas, infrastructures and so on to help decision-makers to better protect coasts, encourage sustainable farming practices and monitor forests, for example.

4

FEDERATING efforts

What makes the SCO so unique is that it is operating both on a global scale to share best practices and pool data from international programmes and agencies like Copernicus, NOAA[1] and Eumetsat[2], and at local scales to devise operational responses tailored to individual nations and territories. This is the rationale that motivated the choice of an architecture combining an international observatory and national observatories, the latter working closely with scientists, subject matter experts, local authorities and innovators. With CNES in the driving seat, France is the first to have rolled out its national SCO.

1. National Oceanic and Atmospheric Administration (USA)
2. EUropean organization for the exploitation of METeorological SATellites

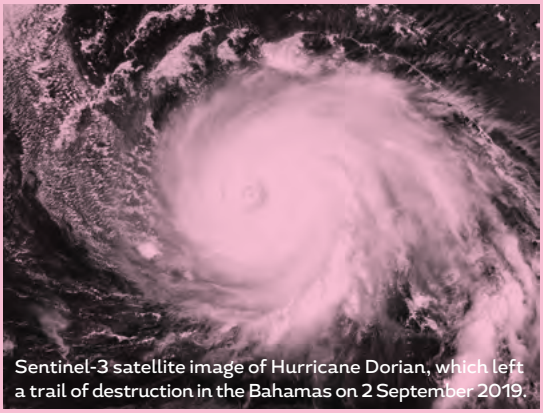
26

FOUNDING PARTNERS SIGNED UP TO THE INTERNATIONAL SCO

comprising the space agencies of 24 nations—Europe, China, India, Israel, Russia, Mexico, Morocco and the United Arab Emirates—and two UN agencies, UNOOSA (United Nations Office for Outer Space Affairs) and UNDP (United Nations Development Programme).

SCO CHARTER

To formally enshrine the commitment of all international SCO stakeholders to a set of shared values, an international charter is planned in two years' time. Along the same lines as the International Charter on Space and Major Disasters, it will organize international cooperation in support of efforts to adapt to climate change. The aim is to obtain a founding document laying down the main guiding principles of the observatory.



Sentinel-3 satellite image of Hurricane Dorian, which left a trail of destruction in the Bahamas on 2 September 2019.

DATA CENTRES

MISSION AFTER MISSION, THE RECORD OF SATELLITE DATA IS BUILDING UP.

To enable wide access to satellite data and services, CNES and its scientific partners have set up the DataTerra infrastructure, which encompasses four dedicated data centres: AERIS for atmosphere, ForM@Ter for solid Earth, ODATIS for oceans and THEIA for land surfaces. Europe has also created major data centres for its Copernicus programme, for example offering free access to the Copernicus Climate Data Service. SCO projects will be able to work with these well-structured data centres.

MODELS

Satellite observations are crucial for modelling,

whether immediate, seasonal or climatic, sustaining a constant stream of data for both forecasting and validation. Modelling of climate change impacts aims to gauge the effect of local actions, land-planning decisions, changing lifestyles, energy consumption, mobility requirements and more besides.
Many useful variables fed into models are measured from space, such as land use and land cover, man-made surfaces, croplands and forests, and snow cover.

LABEL

The idea of awarding a specific label to projects backed by the SCO is currently under consideration. Such a label would give the projects more international visibility and a better chance of securing funding.

Satellite view of Palavas-les-Flots from the Pleiades Earth-observation satellite.

COASTS
MONITORING FROM SPACE: A PILOT METHOD

At Palavas-les-Flots, on France's Mediterranean coast, coping with climate change will mean managing flood risks compounded by rising sea level and increasingly frequent severe weather events. A demonstrator now ready for export has successfully employed space technologies, validated by field data, to measure this risk.

The pilot project in question pre-dates the SCO, otherwise it could have come under the observatory's wing. In 2017, the LEGOS[1] space geophysics and oceanography research laboratory chose the Mediterranean seaside resort of Palavas-les-Flots to demonstrate how space tools could locally model coastal flood risks fuelled by rising sea level. The choice was motivated by available local lidar[2] and levelling data. "*These field data alone enabled a very good assessment of the risk*," explains Benoit Meyssignac, a climatologist and geodesist at LEGOS. "*Our aim was to prove that just as good results could be obtained with satellite data.*" Indeed, the cheaper satellite-based method makes sense for nations with seaboards but without the resources to conduct costly lidar surveys, like for example Italy, Greece or Spain.

Model makes the grade

The shoreline at Palavas-les-Flots was successfully modelled by combining observations with geodetic and satellite altimetry data. This model was then used to simulate the impact of a rise in sea level of one metre. In particular, it showed that a very strong storm surge like the one that hit Palavas-les-Flots in 1983 would completely submerge the currently urbanized sandbank. "*The method is now ready to be transposed abroad to other coastal regions without sufficient field survey data to gauge flood risks*," concludes Benoit Meyssignac. The town could soon be in the spotlight again with a new study envisioned in 2020, this time under the SCO banner. The aim is to go one step further and cross-reference the models developed with precise socio-economic data supplied by the local council, with a view to resolving some of the real-world issues it has identified.

1. Laboratoire d'Etudes en Géophysique et Océanographie Spatiales.
2. Light detection and ranging, a survey technique for measuring distances by analysing the properties of a beam of light—usually from a laser—reflected by a target.

BRINGING THE SCO TO LIFE

BERTRAND FROT

Chief of Portfolio Management for the United Nations Development Programme (UNDP)

UNDP is the main United Nations agency implementing climate projects in 140 countries. It's also working closely with nations to help them raise their climate action ambitions in line with the Paris Agreement. UNDP has in-depth knowledge of the local impacts of climate change and a comprehensive record of field data. For example, in Uganda we're working on wetland areas that provide subsistence to four million people. We're closely monitoring water pollution, farming practices and yields, as well as populations' standard of living. By combining this information with precise satellite data, we'll be able to more effectively support efforts to change practices and achieve the necessary logistic and administrative reorganization. With the database and reliable scientific models the SCO is going to provide, we'll also be able to extrapolate our analyses. In other words, what we learn about shoreline erosion in Senegal will directly benefit populations living on the coasts of Vietnam or Mozambique. This role in ramping up the response to climate change globally is crucial, as time is running out.

JEAN-FRANÇOIS DESBOUIS

Head of the Aude territorial and maritime directorate (DDTM) (Occitanie, Southwest France)

The SCO offers a great opportunity to combine human and artificial intelligence to make territories more resilient. At DDTM, managing hazards and informing citizens are part of our core missions, and space provides some fantastic tools for these tasks. After the floods of October 2018 around Carcassonne and Trèbes, we set up an observatory with CNES to keep track of affected areas. Satellite data and artificial intelligence developed with our field data served to closely monitor vineyard damage and better locate logjams along the 150 kilometres of rivers where the flooding left a trail of destruction. That made the task of relief teams much easier while enabling speedier and more-resilient reconstruction. In August this summer, after the major fire in the area of Montirat, we called on CNES again to determine whether smoke from the fire would affect vinification. We didn't think it possible at first, but a cartographic analysis of the potential impacts was accomplished. The prospects offered by space are huge. At DDTM, we're very proud to be helping to pioneer such revolutionary tools.

JEAN-NOËL THÉPAUT

Director of Copernicus Services at the European Centre for Medium-range Weather Forecasts (ECMWF)

Europe's Copernicus Earth-observation programme is built around satellite data, in-situ data and freely available thematic services. The mission of its Climate Change Service (C3S) is to provide climate products covering the past (long time-series of data for gauging climate trends like temperature or sea level, for example), the present (near-real-time climate monitoring) and the future (seasonal forecasts and climate projections). To make all of these products more easily available, a Climate Data Store has been created with access to a wealth of data and a toolbox to help users—notably in the energy and tourism sectors—to extract the information they need. Our mandate is to make it easier to generate end-products from our climate data; the SCO could thus become a major downstream user of C3S, covering more specific local and regional needs. We currently envision case studies with the SCO to validate this complementarity and the value chain between C3S and the SCO.

ANNE DEBAR

Deputy CEO, Meteo-France

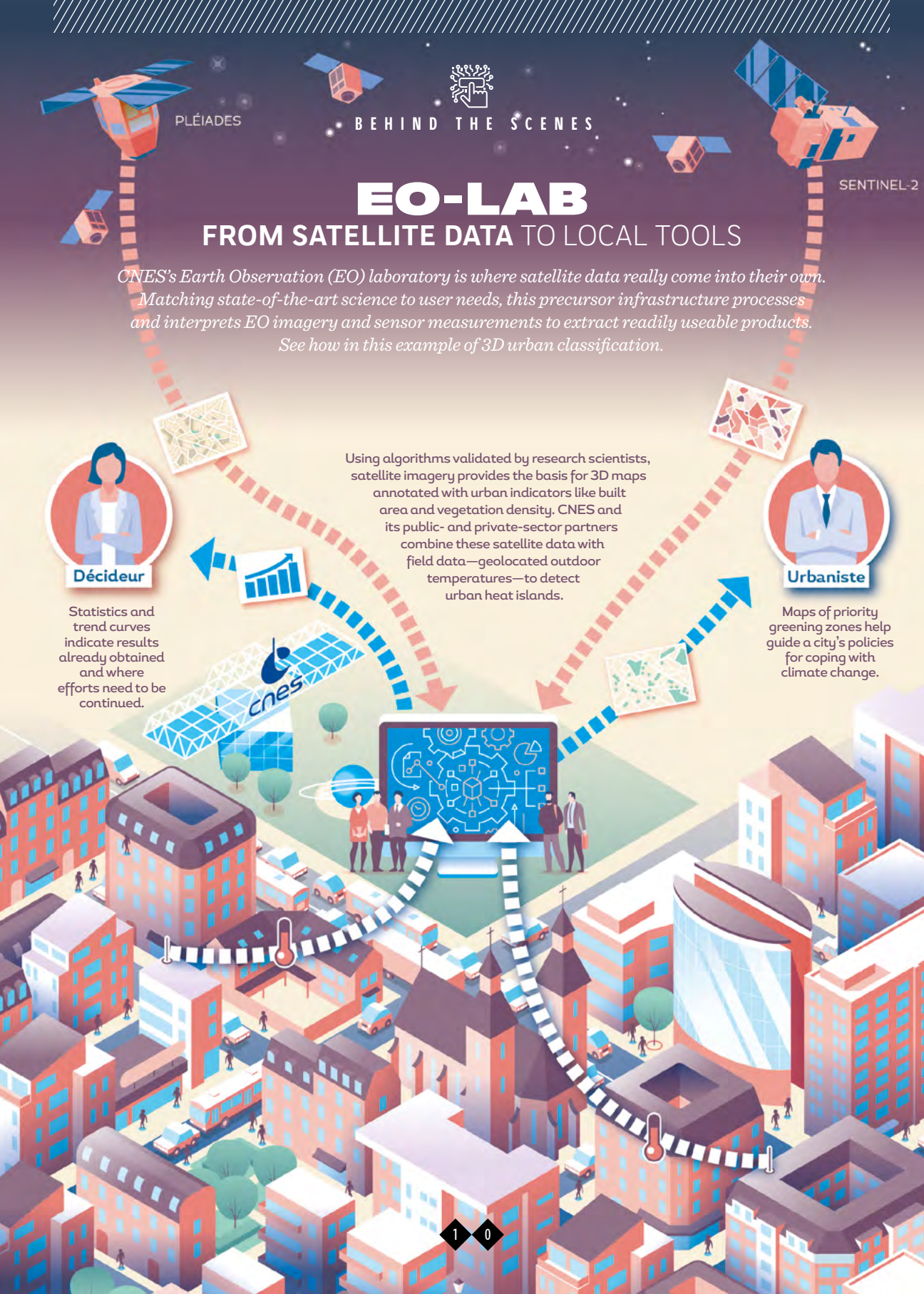
One of our missions at Meteo-France, the French national weather service, is to preserve the climate record. Readings from our weather stations have been feeding into our databases for more than a century. Moreover, our research centre regularly produces climate simulations for the IPCC reports. We're now starting to complement these global models with regional simulations. For example, with our Aladin high-resolution (12 km) climate model, we're now able to provide detailed data over Europe and overseas territories to represent smaller-scale phenomena like intense rainfall in the Mediterranean and cyclones overseas. Meteo-France also has a long legacy of developing climate services, through freely accessible platforms such as Climat d'Hier et de Demain [Climate of Yesteryear and Tomorrow] and DRIAS. We're also contributing to Copernicus services. We'll be bringing this broad spectrum of experience to the SCO, spanning research activities and operational services. Lastly, we're following with interest the SCO initiative to federate international efforts. Clouds don't stop at borders and national weather services everywhere know how far international cooperation can help them to improve.

SCO France ready to move

CNES has so far been joined by Ifremer, the Ministry for the Ecological and Inclusive Transition, ONERC, CEA, IGN, the Ministry for Higher Education, Research and Innovation, IRD, AFB, SHOM, Cerema, INERIS, IRSTEA, INRA, BRGM, ADEME, Meteo-France, IDDRI and CNRS.

EO-LAB
FROM SATELLITE DATA TO LOCAL TOOLS

CNES's Earth Observation (EO) laboratory is where satellite data really come into their own. Matching state-of-the-art science to user needs, this precursor infrastructure processes and interprets EO imagery and sensor measurements to extract readily useable products. See how in this example of 3D urban classification.



FROM DATA TO DECISION-MAKERS: THE MISSING LINK

LAURENCE MONNOYER-SMITH

Climate and Environment Adviser to the CNES President

"The SCO could make all the difference in aiding territories to cope with the effects of climate change"

What needs is an initiative like SCO seeking to meet?

Laurence Monnoyer-Smith: For years now, we've been generating an unbelievable amount of Earth-observation data—notably through the European Copernicus programme—for mainly scientific purposes. We haven't sufficiently developed our ability to get actionable data to local decision-makers, yet we know how to create algorithms that combine satellite and in-situ data to produce spectacular results. Experiments currently underway show that we're already able to precisely monitor the kinds of damage caused by floods, forecast snow cover on a mountain peak and even gauge the amount of available water in a river, for example. But getting these data to decision-makers in a form they can use demands the kind of work that's rarely being done right now: by that, I mean analysing local needs, translating them into databases that need to talk to one another and devising operational responses. It's that gap in our capabilities that the SCO aims to fill.

What are the priorities to get this initiative on the rails?

L. M.-S.: Local decision-makers are relatively unaware of the potential that data have to meet their needs. To fulfil its vocation, the SCO will therefore have to start by developing effective demonstrators to prove their potential as a decision-support tool. And teasing out territories' needs and then translating them in precise enough terms to propose concrete solutions is a long and difficult process. So canvassing local needs is also a priority.

What is the SCO's vocation in terms of boosting capabilities?

L. M.-S.: The nations hardest hit by climate change are also those least able to cope with its effects. They most often don't have their own space agency and are dependent on official development assistance (ODA). The idea of the SCO is therefore to get data useful to advancing knowledge of the impacts of climate change working for ODA and to better target aid to nations that need it.

The idea of this observatory came from CNES. What role is it going to play in the SCO?

L. M.-S.: Space agencies are working intently alongside research scientists to monitor climate change. It's worth reminding ourselves that about half of the variables we need to measure to keep track of climate change can only be measured from space. The community of research scientists active in the field of Earth observation is extremely well structured, which explains why CNES and its scientific partners are behind this initiative. Like the other founder members, CNES is a key link in the chain of the International SCO, and at national level its role is to co-lead the SCO community. So it will continue to play that role—nothing more, nothing less.

THE ROAD AHEAD

GEARING UP THE SCO TO GO LIVE

Since its official launch in June this year at the Paris Air Show, the outlines of the SCO are gradually coming into sharper focus. 2020 will be devoted to structuring the observatory and identifying pilot projects. We review some of the likely developments.

While the SCO's vocation is clear, the work of defining its governance, operation and methodologies now has to be done. Next year will therefore be devoted to structuring the observatory. International events throughout the year, like the forthcoming Abu Dhabi Sustainability Week in January, will offer the opportunity for the International SCO's founders to meet again and chart the course for the months ahead.

Defining form and function for SCO France

In France, 2020 will also mark the start of pilot projects. A number of demonstrators will need to prove SCO France's ability to develop solutions and determine the exact vulnerabilities of specific territories according to different climate scenarios. The underlying objective here is to not only identify existing projects that could serve as a foundation for the SCO and fuel the global momentum, but also to achieve tangible results sufficient to convince local decision-makers of its potential.

Alongside this effort, new projects will have to be spawned. To this end, CNES will continue to canvass the needs of territories through its partnership with regional councils. Work has already begun this year with the Nouvelle-Aquitaine regional council and others are set to follow suit throughout 2020. Inter-regional seminars will also be held with SCO France partner organizations with a view to sharing expertise.

Another matter expected to reach its conclusion within the next two years is the formalization of the SCO's role in strengthening the resilience of nations eligible for official development assistance. A partnership between the United Nations Development Programme (UNDP), the French development agency AFD and CNES should enable the most vulnerable nations—like for example Uganda, which suffers from severe droughts—to call on SCO France to meet a specific one-off need.

2022

The date the SCO has set itself to establish an international charter that any nation vulnerable to climate change could call upon when in need of terrain modelling.

Water stress in the Ugandan savanna.

1 2