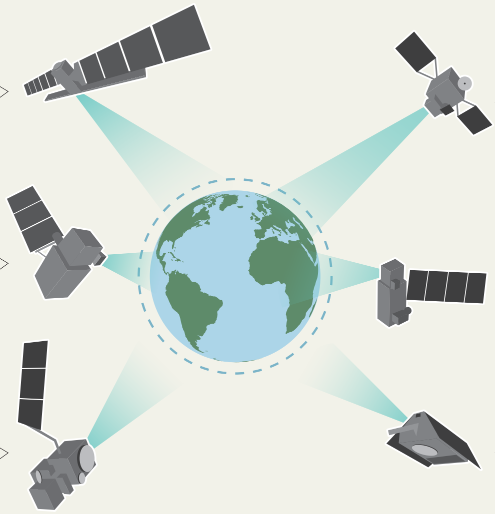
WATCHERS IN THE SKIES

Once its Sentinel satellites are fully operational, Copernicus will probably be the world's most comprehensive Earth-observation programme. In addition to Sentinels 1 to 6, a Sentinel 5 Precursor satellite will be launched in 2016 to minimize the gap in atmospheric data following the expiration of Envisat in 2012.

SENTINEL-1
Launch date: 1A: Launched; 1B: 2015
Payload: All-weather radar
Revisit time: 1–3 days
Applications: Monitoring sea ice and the Arctic, land surface motion risks, disaster response

SENTINEL-2
- 2A: 2015; 2B: 2016–17
- Optical sensors with 13 bands
- 2–5 days
- Monitoring land-use changes, agriculture and ecosystems, volcanoes and landslides

SENTINEL-3
- 3A: 2015, 3B; 2016–17
- Sea/land temperature radiometer, sea/land colour instrument
- 1–2 days
- Sea-surface and land-ice topography, sea and land surface temperatures and colours



SENTINEL-4
- Near end of this decade
- Ultraviolet/visible/near-infrared spectrometer
- Geostationary. Hourly coverage of Europe/North Africa
- Monitoring of air pollution, stratospheric ozone, solar radiation

SENTINEL-5
- Near end of this decade
- Ultraviolet/visible/near-infrared/shortwave spectrometer
- 17 days
- Monitoring of air pollution, stratospheric ozone, solar radiation and climate

SENTINEL-6
- Mission still under discussion
- Radar altimeter
- Under discussion
- Measure global sea-surface height for oceanography and climate studies

SOURCE: COPERNICUS/ESA

SPACE

Earth observation enters next phase

Expectations high as first European Sentinel satellite launches.

BY DECLAN BUTLER

Europe has launched the first satellite of what is heralded as one of the most ambitious Earth-observation programmes ever. On 3 April, a Soyuz rocket dispatched into orbit the Sentinel-1A probe, the first craft of a planned constellation of six Sentinel families set to be launched by the end of the decade. Together, the satellites will offer unprecedented long-term monitoring of the planet's land, water and atmosphere.

The Sentinels will be the core of the €8.4-billion (US$11.5-billion) Copernicus programme, which is managed by the European Commission. Copernicus will also draw in data from about 30 other satellites, and from ocean buoys, weather stations and air-quality monitoring networks.

"The Sentinels and Copernicus have the potential to become the world's most comprehensive Earth-monitoring system," says Zbynek Malenovsky, who studies vegetation using remote sensing at the University of Wollongong in Australia.

Copernicus was designed by the European Union (EU) and the European Space Agency (ESA) to help the European Commission and EU member states to develop environmental policies and monitor the results. Its data will be used to create services for myriad practical applications, including ice mapping, agriculture management, climate-change forecasting and disaster response. The idea is to produce images, maps and models in near real time, much as is done with weather monitoring, but for many more variables.

Unlike most previous Earth-observation missions, the Sentinels will be replaced regularly as they age. This will help to generate long-term cross-calibrated data sets of a variety of imagery and measurements, says Cathy Clerbaux, an atmospheric scientist at the LATMOS atmosphere and astrophysics research institute in Paris. "It's not easy to connect data series such as measurements of pollutants, ozone or greenhouse gases when you have different instruments, and gaps between missions," she says.

The data will be free for anyone to access and use. But researchers will enjoy formal user status alongside public authorities, and will thus have privileged access, including dedicated help desks and support. "Scientists are now much more integrated into the user community, and not neglected as they have been in the past, when the focus was more on the operational side," says Josef Aschbacher, head of ESA's Copernicus office. "I expect scientists to be the number-one user group."

Sentinel-1A is the first of two identical satellites; 1B is set to be launched in the next 18 months. Both contain a radar system that can see in darkness and through clouds, unlike the optical instruments on many satellites. This will allow them to continuously image cloudy areas such as tropical forests. They will operate in tandem, cutting down the time between flyovers of the same point on Earth (known as revisit time), and enabling quick-succession imaging to measure, for example, ground deformation from earthquakes.

Sentinels 2 to 5 will have different goals. Between them, they will use optical sensors, radiometers and spectrometers to measure everything from sea temperatures to air pollution. In addition, a Sentinel-5 Precursor satellite will be launched in 2016 to minimize the shortfall in atmospheric data-gathering following the 2012 loss of the European Envisat satellite. A sixth Sentinel, a radar altimeter that will measure sea-surface heights, is also under discussion (see 'Watchers in the skies').

These diverse measurements of the major components of Earth systems will make the Sentinels very valuable, says Richard Anthes, emeritus president of the University Corporation for Atmospheric Research in Boulder, Colorado. "A balanced suite of Earth observations is required for observing and understanding Earth as an interconnected system," he says.

Sentinel-4, for example, will be one of the first satellites to monitor atmospheric pollutants from a geostationary orbit, notes Clerbaux — and the first to provide hourly measurements over a single area, in this case most of Europe and North Africa.

Sentinel-2, a pair of high-resolution imaging devices, is also causing excitement. The satellites' specifications are superior to those of Landsat-8, the flagship US Earth-observation satellite, with a spatial resolution down to 10 metres — three times finer than Landsat-8 — and shorter revisit times of just 2–3 days at mid-latitudes. This opens up research into areas that update every few days, such as crop changes.

"Sentinel-2 should really change the face of Earth observing," says Gregory Asner, an Earth scientist at the Carnegie Institution for Science in Stanford, California. "This is the satellite that could revolutionize land-cover and land-use change monitoring and analysis."

Scientists from Sentinel-2 and Landsat-8 have been working together to make their data compatible and to develop joint archives. It is a test of the concept of a virtual satellite constellation, says Mike Wulder, a scientist at the Canadian Forest Service in Victoria and a member of the Landsat science team. "Satellite data products could be significantly improved if these were not limited to individual sensors but would combine complementary platforms across space agencies and sensor types."

Compatibility, says Malenovsky, will be a key factor within the Sentinel fleet. The fleet's scientific value, he says, will be maximized if data from various crafts can be combined to create virtual, as well as practical, constellations. ■ SEE EDITORIAL P.149

POLICY

Funders punish open-access dodgers

Agencies withhold grant money from researchers who do not make publications openly available.

BY RICHARD VAN NOORDEN

For years, two of the world's largest research funders — the US National Institutes of Health (NIH) and the Wellcome Trust in the United Kingdom — have issued a steady stream of incentives to coax academics to abide by their open-access policies.

Now they are done with just dangling carrots. Both institutions are bringing out the sticks: cautiously and discreetly cracking down on researchers who do not make their papers publicly available.

Neither agency would name those who have been sanctioned. But the London-based Wellcome Trust says that it has withheld grant payments on 63 occasions in the past year because papers resulting from the funding were not open access. And the NIH, in Bethesda, Maryland, says that it has delayed some continuing grant awards since July 2013 because of non-compliance with open-access policies, although the agency does not know the exact numbers.

The result, say officials, has been a noticeable jump in researchers following the rules. The NIH's compliance rate — the percentage of papers placed in the PubMed Central database for public access no later than a year after publication — now stands at 82% (see 'Opening up'). It had flatlined at around 75% for two years, says Neil Thakur, who oversees policy for the NIH's Office of Extramural Research. The Wellcome Trust's compliance rate is 69%, up from 55% in March 2012, says Robert Kiley, head of the trust's digital services.

The stricter enforcement by the Wellcome Trust began in June 2012, when its then-head Mark Walport (now the UK government's chief science adviser) said that it was "simply unacceptable" that almost half of publications resulting from the trust's funding remained behind paywalls. The trust had mandated since 2006 that the results of work it funded should be made public, yet it had never enforced the policy. In November 2012, the NIH announced a similarly tough line on its own public-access policy; that, too, had never been enforced, despite being a legal requirement since 2008.

The NIH and the Wellcome Trust are the only funders in the world to withhold grants for open-access violations so far. Funders in other nations that have open-access policies — such as Germany, France and Australia — do not generally track their compliance rates. These other agencies may start to mimic the tougher stances of the Wellcome and the NIH, says Peter Suber, director of the Harvard Open Access Project in Cambridge, Massachusetts.

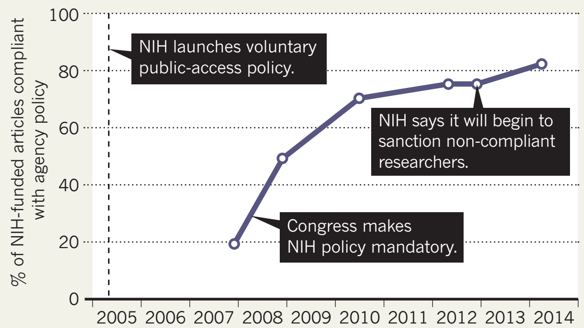
Withholding grants is not the only enforcement tool available to funders. On 31 March, four UK higher-education funders announced that from 2016, only open-access papers posted to online institutional archives will be considered in the Research Excellence Framework — the periodic research audit that grades academic work and guides the distribution of money to UK universities. Because the audit has become an academic obsession (see *Nature* **502,** 288–290; 2013), the policy will be "a game-changer", says Paul Ayris, director of library services at University College London.

Research institutions can also help with bottom-up policy enforcement, says Bernard Rentier, rector of the University of Liège in Belgium. At Liège, only articles placed in a local repository count towards internal evaluations such as pay rises and promotions. Rentier says that almost 50% of Liège's publications are now accessible. By contrast, at the Massachusetts Institute of Technology in Cambridge, which has an open-access policy it does not enforce, just 37% of papers published since 2009 are openly available from the local repository.

Without the buy-in of researchers, funding agencies know that no amount of whip-cracking will be enough, says Kiley. Some scientists are not even aware that they could be penalized. *Nature*'s news team contacted Sheila MacNeil, a tissue engineer at the University of Sheffield, UK, who has published hundreds of articles, including a March 2013 paper on making stem-cell lattices for corneal repair that was funded by the Wellcome Trust (I. Ortega *et al. Acta Biomater*. **9,** 5511–5520; 2013). *Nature* pointed out that the article should be open access but is not. "This is new to me," responds MacNeil, who plans to make the paper available. "Agreeing with open access is easy — making it happen, less so," she says. ■ SEE GO.NATURE.COM/SSKWDW FOR A Q&A WITH ROBERT KILEY.

OPENING UP

More researchers are abiding by the open-access policy of the US National Institutes of Health (NIH) since enforcement was stepped up. It requires articles to be publicly available in PubMed Central within a year of publication.



SOURCE: NIH