



# SWIMMING AGAINST THE TIDE

*The rising stars on Japan's research landscape include traditional big-hitters and newer institutions selected for initiatives to boost their global standing and promote autonomy.*

BY MARK ZASTROW

Institutions both public and private are counted among Japan's rising stars — those that have gained the most in the Nature Index since 2012 in terms of the absolute or relative increase in their weighted fractional count (WFC).

Four of the index's top 10 institutions are part of the country's flagship national university system, including three of the top four. The rest are split between governmental or semi-governmental research institutions, and fully private universities.

Many of the institutions have been selected for various government programmes intended to boost their global standing and internationalize their faculty. The top two, the Tokyo Institute of Technology (Tokyo Tech) and Okayama University, are members of the Top Global University Project, often referred to as the Super Global Universities programme, which started in 2014. And Doshisha University, a private institution in Kyoto, was also one of the beneficiaries of that programme's forerunner, the Global 30.

Tokyo Tech also hosts the Earth-Life Science Institute, which focuses on fundamental research on the origins of life on Earth and is one of nine high-profile centres funded by the government's World Premier International Research Center (WPI) Initiative.

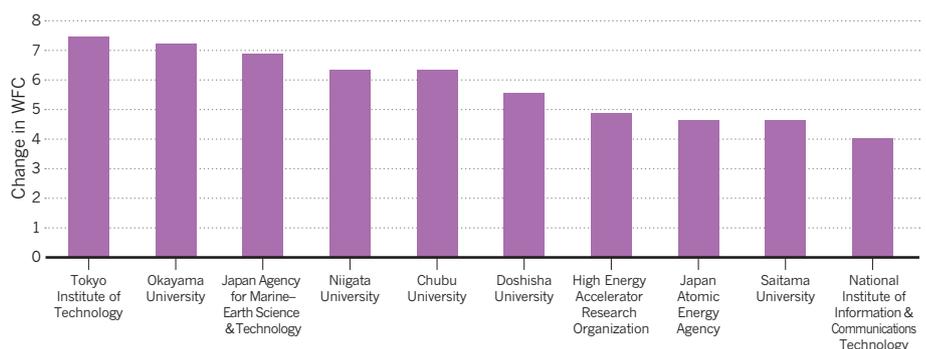
These initiatives can be seen as part of the Japanese government policy that holds that

“universities and institutes should have their own individuality,” says Kumi Okuwada, a senior fellow at the National Institute of Science and Technology Policy (NISTEP). However, the rise of these institutions takes place against a backdrop of concern that the nation's research funding and output is stagnating.

Nevertheless, government-backed institutions

## TOP 10 RISERS

These 10 institutions have shown the largest increase in WFC in the Nature Index from 2012 to 2015.





**JAMSTEC'S *Chikyu*, a giant of deep-sea drilling, was at the forefront of investigations into the fault that caused the 2011 Tohoku earthquake.**

JAMSTEC

are well-represented among those which have an increasing high-quality research output. One such organization is the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). With headquarters in Yokosuka, south of Yokohama, it maintains offices on both sides of the Pacific and operates more than a dozen research ships and remotely operated vehicles. That includes the drilling vessel *Chikyu*. In 2012 it set a then-world record for the deepest hole in deep-sea drilling and, in the aftermath of the 2011 Tohoku earthquake and tsunami, investigated the fault that caused it.

Another government organization rising in the rankings is the Japan Atomic Energy Agency, the nation's nuclear R&D organization. Based in Tokai, north of Tokyo, it operates more than a dozen research institutes, employing a staff of more than 4,000. In addition to its ongoing nuclear power research (including participation in the international ITER fusion reactor), it has devoted resources in recent years to the containment and clean-up of the Fukushima Daiichi reactor following the 2011 quake.

The other government research institute in the top ten — the High Energy Accelerator Research Organization (KEK)—can count a Nobel Laureate among its recent faculty: Makoto Kobayashi received the physics prize in 2008 for his work on symmetry violation in particle physics. Only one other private university made the list—Chubu University near Nagoya, which has colleges in biotechnology, health sciences, and engineering.

### TOKYO INSTITUTE OF TECHNOLOGY

2015 WFC: 120 2015 AC: 365

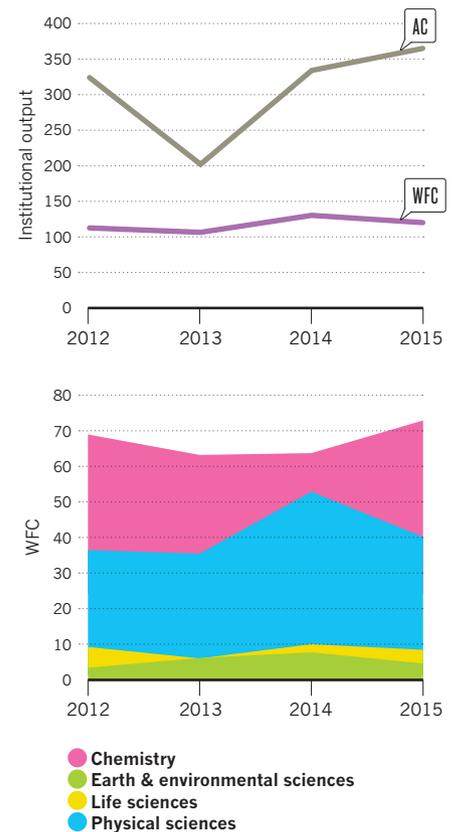
Japan's fastest-growing research institute in the Nature Index is also the largest technical university: the Tokyo Institute of Technology. Its WFC increased from 112 in 2012 to 120 in 2015. More than 40% of its revenue comes from public funds, and it has a research budget for commissioned projects in 2015–16 of 13.8 billion yen (US\$123 million).

Tokyo Tech's executive vice president of research, Makoto Ando, credits the university's comprehensive range of research interests as key to its rise in the Nature Index, citing research in materials science, cell biology, and fibre optic communication — as well as the Tsubame supercomputer, which the university owns and operates. Tsubame is the world's second-most energy efficient supercomputer, one of the fastest owned by a university, and has powered compelling research ranging from measuring blood flow in drug simulations, to modelling seismic activity of the volatile Nankai Trough off the island of Honshu.

The university operates 16 research institutes, laboratories across its three campuses situated in the capital city and surrounds. Ando says reforms from April 2016 will include a focus on globalization: the university has nearly 200 visiting international researchers, 10% of its students come from outside Japan, and it hopes to further boost those numbers.

### PHYSICAL STRENGTH

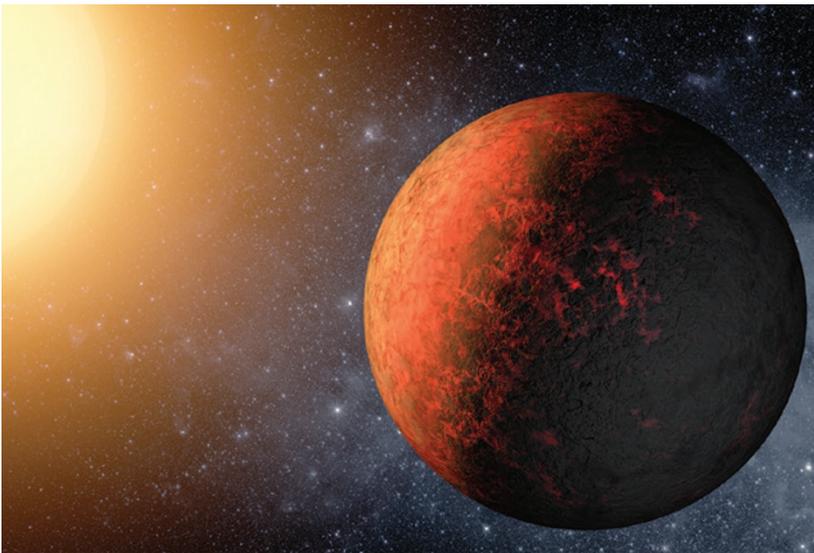
The line graph shows overall trends for both WFC and article count (AC) since 2012. The area plot highlights which subject has contributed most to the increase in WFC.



TOKYO TECH



NASA/AMES/JPL-CALTECH



JTB PHOTO/UG/GETTY IMAGES



**Top:** The Tsubame supercomputer at Tokyo Tech has powered research ranging from blood flow in drug simulations to modelling seismic activity.  
**Middle:** An impression of the exoplanet Kepler-20e. These molten-covered planets are the subject of work by geophysicists at Okayama University.  
**Bottom:** Sado, off the coast of Honshu is the site of Niigata University's marine biology station.

**OKAYAMA UNIVERSITY**

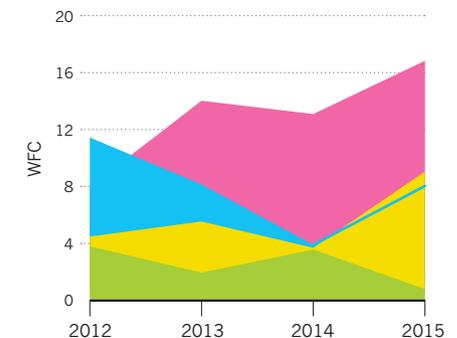
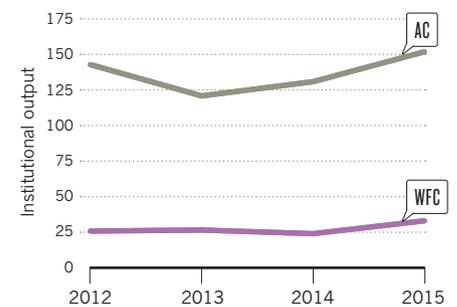
2015 WFC: 33 2015 AC: 152

Okayama University's rise in the Nature Index is the second-largest in Japan, making it also the overall second-most prolific institute on the list. Its vice president of research, Shinichi Yamamoto, credits this to a focused effort to selectively fund distinctive research projects, helped by funding from the nation's science ministry, which allowed it to create an organization for interdisciplinary studies.

One of Okayama's strengths is in physics, from high-energy physics to its geophysical research institute. The latter's expertise is also being applied to the study of other worlds. For example, a recent study in *The Astrophysical Journal* coauthored by Okayama's George Hashimoto proposed a new target for astronomers hunting for exoplanets: planets with an entirely molten surface, covered with magma oceans. Scientists expect that most rocky planets, including Earth-like ones, go through this phase early in their evolution. The team's models showed that they cool significantly after a million years or less, rendering their heat signatures practically invisible. However, the steam rising from the still-warm magma would be highly reflective, making them promising targets for the upcoming generation of telescopes.

Okayama's other major research centre focuses on plant science and photosynthesis. Yamamoto says the university has plans to increase its efforts in medical research, cybersecurity and big data.

**CHEMISTRY CHAMPS**



**JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY**

2015 WFC: 22 2015 AC: 84

Below the abyss, there is the hadal, as in Hades of the Greek underworld. This is the realm of the deepest sea trenches. “It is the least explored biosphere on Earth,” says environmental microbiologist, Takuro Nunoura, of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC).

In the ocean’s deep abyssal zone, food is scarce, and microbes eke out what energy they can mostly from rocks. The hadal is even less surveyed, and previous work had been conducted like classical species hunting. But in a 2015 study published in the *US Proceedings of the National Academy of Sciences*, Nunoura and colleagues brought to bear the techniques of modern environmental microbiology.

To his surprise, they found a thriving ecosystem of microbes living off organic matter at the bottom of the Mariana Trench. He suspects that organic matter collected on the trench’s slopes gets churned into the water during underwater earthquakes, nourishing this unique ecosystem.

JAMSTEC, which has been the nation’s premiere oceanographic institute since its founding in 1971, rose in the index by 47% between 2012 and 2015. Nunoura says this coincides with the retirement of the institute’s first generation of scientists, and the rise of younger scientists to leadership positions.

**NIIGATA UNIVERSITY**

2015 WFC: 13 2015 AC: 53

The port of Niigata is the largest city on the Sea of Japan — the more sparsely populated of the nation’s coasts—and Niigata University is one of the coast’s largest national universities with more than 10,000 undergraduates and 2,200 graduate students.

Not surprisingly, much of its research reflects regional interests or challenges. It operates a marine biological station on Sado Island, 50-km offshore.

One of its major research centres, the Research Institute for Natural Hazards and Disaster Recovery, plays a key role in assessing earthquake and tsunami risk and preparations along the Sea of Japan coast and in the mountains just inland. It studied and responded to big quakes in the region in 2004 and 2006, but its work extends to many mountainous regions at high risk of natural disasters, including in Nepal in the aftermath of its 2015 quake.

But Niigata has global ambitions as well, including in its other major centre, the Brain Research Institute. Founded in 1967, it remains the only neuroscience research institute at a Japanese national university.

Its agriculture department also maintains a collaboration with Thailand to study and develop specialized varieties of rice, including low-protein rice intended to benefit those with kidney disease.

**CHUBU UNIVERSITY**

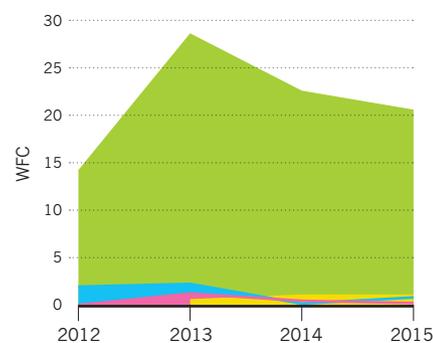
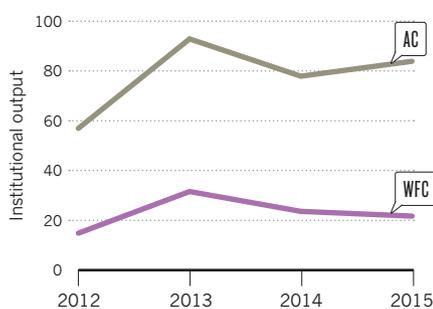
2015 WFC: 7 2015 AC: 19

Located in Kasugai, a suburb northeast of Nagoya, Chubu University was founded in 1938 as a technical and engineering university. In 2001 it opened a college of biotechnology and five years later added another for life and health sciences in 2006. Today it has more than 10,000 undergraduate students and 250 graduate students. The university’s WFC increased from a low base, one, in 2012 to 7.4 by 2015.

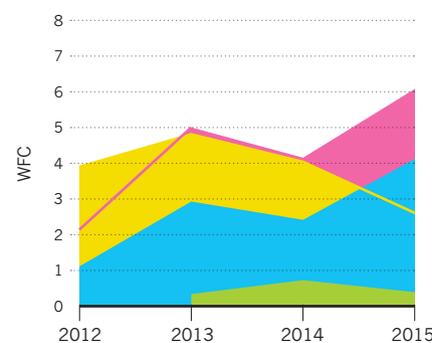
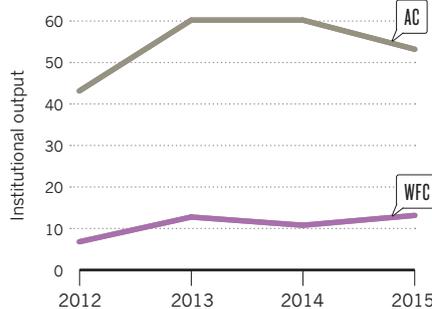
In recent years, the university has focused on recruiting top researchers including chemist Hisashi Yamamoto, who is known for his work in synthesizing organic compounds and moved from the University of Chicago to head Chubu’s Molecular Catalyst Research Center.

One of the biggest projects on campus is Satoru Yamaguchi’s work on superconducting power lines, which could deliver electricity through underground pipelines much more efficiently than overhead power lines. He is currently collaborating with two Japanese power companies and an internet cloud provider on a test site on the northern island of Hokkaido, a haven for wind and solar power. In 2015, they powered a data centre from solar power using a 500-m superconducting cable, one of the world’s longest tests yet. By 2018, they hope to test a 2-km line that can connect to the commercial power grid. ■

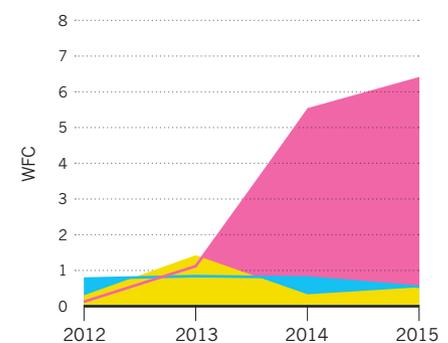
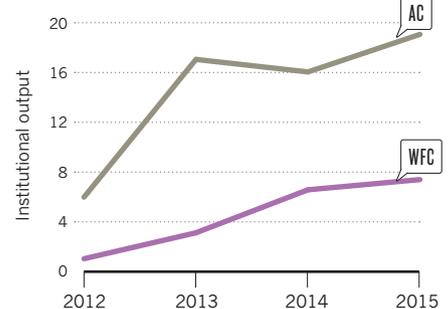
**SPOTLIGHT ON LIFE SCIENCES**



**WELL MIXED**



**GROWTH SPURT**



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