Research

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As Oceans Rise, Scientists Work Toward Consensus

Behind the scenes of the U.N.'s latest climate-change report

The Asahi Shimbun via Getty Images

A melting glacier near Qaanaaq, Greenland

By Paul Voosen

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As a glaciologist, Peter U. Clark has seen his fair share of icy cliffs plunging into the abyss. But four years ago, Mr. Clark, a geoscience professor at Oregon State University, went over a ledge like he'd never seen before: He agreed to help lead the next report from the United Nation's Intergovernmental Panel on Climate Change.

The group, known for issuing a definitive take on the science of global warming every six or seven years, had a dire need for Mr. Clark. The public had, for the most part, lauded the panel's fourth assessment; in 2007 its contributors won the Nobel Peace Prize. But other scientists had one complaint. The report's projection of how much sea level would rise was incomplete, they said. It didn't account for the melting they saw in Greenland and Antarctica.

Soon enough, Mr. Clark, known for his expertise on ancient sea-level rise, got the call. He had never contributed to the panel, and it could use his outside eyes.

"It wasn't something I actively sought," Mr. Clark said in a phone call this year. "It was something I was asked to do."

Enlarge Image

Jorie Clark

Peter Clark, shown here while doing fieldwork in Ireland, is a geoscience

He would find that there's nothing in academic life quite like the U.N. panel. It's the jury duty of climate science, pulling researcher after researcher into its evaluations. Media spectacle follows its every step. Governments bend policies, and energy systems, to its guidance. It has a culture of consensus-building all its own. And its time

professor at Oregon State U. who served as a coordinating lead author of the IPCC report. As part of the job, he had to assess 500 climate studies.

demands are insatiable, especially on the authors who are asked, unpaid, to shepherd through each of its many chapters over four years of creation.

The result of Mr. Clark's labors, along with those of 258 other authors, finally began to be released late last month, in Stockholm. The 2,216-page report's message is familiar: Humanity is profoundly influencing the climate. Temperatures are rising; each recent decade has been the hottest in modern records. Arctic ice is in retreat. The oceans are acidifying. The seas are swelling.

Getting to the final report wasn't easy. Mr. Clark was joined by John A. Church, an oceanographer at the Centre for Australian Weather and Climate Research and a veteran of the third assessment. Together they would serve as "coordinating lead authors," guiding a team of 12 scientists in reading hundreds of new studies to prepare a chapter on sea-level rise.

"I found this time around much tougher than the third assessment," Mr. Church said. There was so much to cover; so many details to check. "And much greater pressure to get it right."

Criticisms of the fourth report's incomplete sea-level predictions haunted them, said R. Steven Nerem, a professor of aerospace engineering at the University of Colorado at Boulder and an author of the chapter.

"From the get-go, we all knew we were going to be under the magnifying glass," he said.

If they got sea level wrong a second time, the climate world would be ready to pounce. If they underplayed their projections, they could reinforce the panel's reputation for conservatism, its reluctance to adopt recently unearthed evidence. If they went with bleeding-edge estimates, they might get ahead of accepted science and undermine their credibility with world governments. Dikes might be built too tall, or they might not be built where needed. And either way, groups on both sides of the climate debate would likely be dissatisfied with their results.

Some of the authors had dreaded committing their time to the project, but came out of duty. Others had previously applied to serve and been passed over. They had all heard the stories.

"I told Peter that whatever they told him about the effort involved, he should double it," said Richard B. Alley, a climate scientist at Pennsylvania State University and a lead author of the panel's fourth report. "And then consider that to be a lowball estimate."

Mr. Clark is not, by nature, a man who makes predictions.

His expertise lies in pulling cores from ice sheets, searching for the cause of ancient, rapid phases of melting. He keeps abreast of wider debates, of course, and so a decade ago he knew that the panel's fourth assessment was struggling with sea-level rise. A few years earlier, the ice sheets on Greenland and Antarctica, which scientists thought stable, had begun to show signs of melt. They were centuries ahead of schedule.

The melting prompted a flurry of work, but not soon enough to meet the fourth report's deadlines. The panel does not conduct new research; each conclusion must stem from an existing study. Its authors could project how much sea-level rise would come from melting glaciers or heat-driven ocean expansion, but they could not get at these new, complex dynamics. So they punted, projecting the rise in a table noting the panel's own inability to grapple with "future rapid dynamic changes in ice flow."

Mr. Alley didn't expect that anyone would look at that caveat and then assume the numbers represented the full sea-level rise. "But," he said, "some people seem to have done that."

Critics like Michael Oppenheimer, a professor of geoscience and international affairs at Princeton University, published papers calling the panel out. He said there were other ways, beyond the models, to get at the full range of factors that could contribute to sea-level rise in the future.

"The models are like a millstone, in a way, when they're not working right," Mr. Oppenheimer said. This was constructive criticism. He had come out of the fourth assessment thinking there was a hole, he said, "and it has to be filled."

Early on, in a workshop for the fifth report, Mr. Clark learned to describe uncertainties in the probabilistic language favored by the climate panel. Take one of the panel's recent top conclusions: "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century." In panel argot, "extremely likely" means that the authors gave the

statement a 95- to 100-percent chance of being true. "Unlikely"? That's a zero to 33-percent chance.

Those written determinations depend on no greater science than the authors' collective best judgment of the research literature. They had to assess existing studies, and they had to do it as one.

That's where Mr. Clark came in.

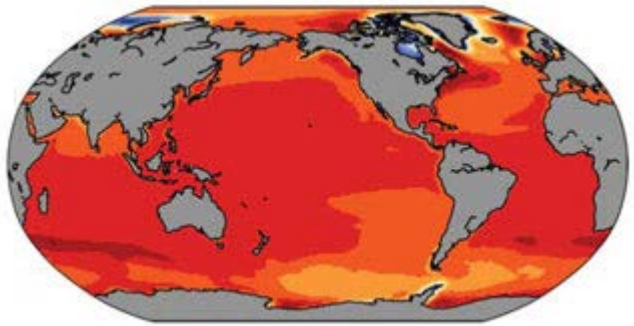
The group first met in Kunming, China, in November 2010. There would be four meetings like this around the world, the authors packed together in small rooms for six hours a day, a week straight. The coordinating authors fell into an easy dynamic, with a dash of good cop, bad cop.

"I was a bit more confrontational," Mr. Church said. "Peter was more laid back in trying to drive consensus." With the outsider perspective of someone studying ancient climates, Mr. Clark could bore down to the crux of an issue. "He's also a very good listener," Mr. Church added. "Probably better than I am."

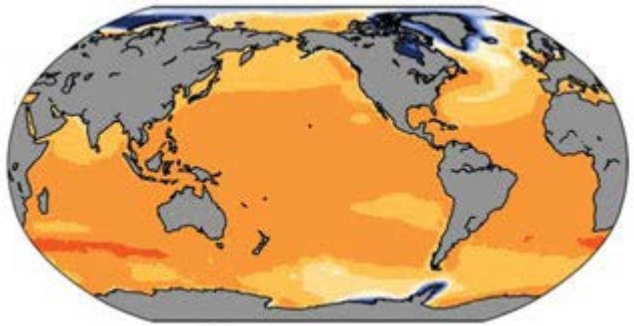
The Future Ocean, Rising Unevenly but Steadily

The IPCC's best prediction, below, sees rising sea levels by century's end even with action on carbon emissions:

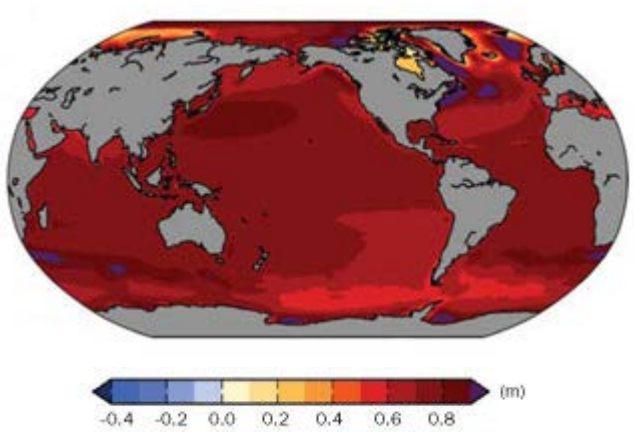
Since 2007, some landmark results were obvious. Scientists had "closed" the sea-level budget, as witnessed by satellites. Meaning, they could say with certainty that seas are rising about 3.2



Derived from 21 models, each IPCC projection carries uncertainty; below, the same prediction's best-case scenario:



The projection's worst-case scenario; in a world without carbon limits, these predictions grow even higher:



Source: Intergovernmental Panel on Climate Change

millimeters a year today, and could account for that gain, calculating with precision how much was due to thermally expanding water, retreating glaciers, and melting ice sheets, among other factors. And the models could now reproduce that observed sea-level rise down to its components.

Knowledge of regional sea levels had also improved. The oceans are not a big bathtub; nowhere on the planet do they sit at "global sea level." Every coast is influenced by its context. Wind currents push water up against the East Coast. Northern lands that hosted ice-age glaciers are

rising, buoyed by expanding rock now free of its icy load; sea level in Stockholm, for example, is falling. And the ice sheets even exert their own gravitational pull, drawing the ocean up toward them. Even as Greenland melts, the waters around it will fall, the ocean bereft of its upward tug.

But the unpredictable ice sheets would remain an issue. The scientists knew that a new branch of sea-level projection, called semi-empirical modeling, had arisen to solve the problem. Traditional models tried to simulate every part of an ice sheet. The semi-empirical methods were simpler, taking the uncertain records of energy's entering and leaving the planet over the past few decades and comparing them with sea-level rise over that time. The scientists then used those data to guide their future projections. Several authors, like Svetlana Jevrejeva, a researcher at Britain's National Oceanography Centre, believed deeply in the new models.

Others, like Anders Levermann, a physicist at Potsdam University, were dubious. These new models were built off historical data of questionable accuracy. They might recreate sea-level rise, but that could simply be luck. There was no indication they had the fundamentals right.

"I think that these methods are not valid," Mr. Levermann said, "because they might give the right numbers for the wrong reason."

Drafting the chapter was mostly a remote collaboration. Mr. Church would hassle authors to finish their sections. Mr. Clark kept the chapter lined up with parallel efforts in, say, the cryosphere, ocean-observation, or paleoclimate

groups. Everything needed to agree.

Mr. Clark would retreat to his cabin in Montana, near Yellowstone, to work. He worried about his outside research. He had received free time from his university equal to teaching one course, but he was using much more than that. By the last year, he had spent six months on the effort. He had read 500 studies.

It was also straining for W. Tad Pfeffer, a glaciologist at the University of Colorado at Boulder. Money for investigating his research specialty, mountaintop glaciers, had dried up. He was grant-poor, and the panel took time away from his efforts to win new financing. Contributing governments might cover some travel expenses of the panel, but additional costs had to come out of his own pocket.

"I was doing things like paying airfare for other people to go to the meetings," Mr. Pfeffer says.

Work on the ice sheets was coming along. The modelers had recovered from their original sin of pretending that sheets were unreactive white mountains. Circulation. Tides. Hidden troughs. It was all in the models now.

True to Mr. Oppenheimer's word, his lab had also developed a framework for calculating future sea-level rise from Antarctica that included the physical models, then added ties to several estimation methods and observed melting from the ice sheets. It allowed the panel, at last, to include a full range of uncertainty.

"Their sea-level-rise numbers are much more credible than last time," Mr. Oppenheimer said. "They did take up more work, so of course I'm happier."

The semi-empirical models were still a problem. What to do with those numbers? Team members heard that the chapter authors looking at future warming would cite similar models to slightly increase the uncertainty on future temperature rise. Should they follow that lead?

Mr. Levermann also had a few growing doubts about how they would present their projections. He imagined coastal planners reading the report. They would have a single question in mind: How high should they build their sea defenses?

"You don't want to build a dike," he said, "and realize, after 50 years, that the West Antarctic Ice Sheet has collapsed, I have to rebuild it."

The report didn't answer that question. Could it?

When the leak came, Mr. Clark was at the end of the world.

It was December 2012, and he was in the McMurdo Dry Valleys, a boulder-strewn land between Antarctica's western and eastern ice sheets, collecting rocks to test for cosmic-ray exposure. Returning from one field trip, he got word: Someone had given a second draft to climate contrarians, who then selectively cited the report to support their biases, with claims like, "Predictions of planetary warming have been overstated" and "Game-changing admission of enhanced solar forcing."

In the United States, the mainstream press largely ignored the leak. In Europe, however, it was major news. German media, for example, trumpeted the leak

while ignoring the report's contents.

"It was just, 'Climate scientists are hiding something,'" said Mr. Levermann.

The leak raised questions of transparency. Did their drafting have to be so opaque? Mr. Levermann wondered. There were so many studies coming out right before the deadlines, as researchers rushed to get their work considered; the panel's assessment was bound to shift. Would everyone jump to conspiracy theories?

"I worry about people not understanding why things change from the draft to the final version," said Colorado's Mr. Nerem.

The sea-level-team members had resolved one longstanding issue: They wouldn't use the semi-empirical models for the top-line estimates, but they would write about them extensively. It was clever, responsible work, but they just couldn't judge its uncertainties. It could lead to some awkward conversations, added Mr. Levermann—he's close with the researcher, Stefan Rahmstorf, who pioneered the models. They practically sit next to each other at Potsdam.

It's to the credit of Mr. Church and Mr. Clark that the debate didn't get acrimonious, said Mr. Pfeffer. "There's nothing intrinsic about the process or material we're dealing with that makes it collegial automatically."

Their last test would hinge on Mr. Levermann's idea of providing a number for the worst-case scenario, the maximum possible sea-level rise the world could see in

this century. Mr. Pfeffer and Mr. Nerem liked the idea. Others resisted. No study had nailed that number; the chapter would be moving toward risk assessment if it included such a maximum. The issue seemed unresolvable.

"That's probably where we struggled the most," Mr. Church said.

The upper-boundary debate would not end until after the team's last meeting, this past January in Hobart, Australia, as they wrote the final draft. They couldn't lose sight of their duty to assess. Their figures had to connect back to the literature. And no one could say what the error margin would be if they gave an estimate of maximum sea-level rise for the century. They couldn't say it was "very likely," or even "about as likely as not."

The team cut Mr. Levermann's number.

"We could have made the statement that it is very likely that sea-level rise in the 21st century will not exceed 1.5 meters," Mr. Levermann insisted. But he could understand the others' thinking, too. "I fully support the report as it is. It's just missing one piece."

Without that piece, Mr. Clark and Mr. Church traveled to Stockholm last month for the report's debut. It was an eye-reddening week, as scientists and wonks swarmed a brick brewery-turned-convention-center on the city's retreating harbor. In the main hall, each paragraph in the final summary appeared on a screen for debate by U.N. delegates. Authors sat to the side, waiting for their sections to come up. Off and on, they talked about the future of the panel.

Many scientists question the utility of the process. "The big reports are too big and too frequent," Mr. Oppenheimer said. They could be svelte, taking on select issues when rapid shifts in understanding occur. There's a lot of support for that approach, Mr. Alley added, as long as researchers continue their valuable modeling work. It's become common to hear that the fifth assessment could be the last report of its kind.

The final push in Stockholm lasted 24 consecutive hours. Mr. Clark tried to stay alert. Finally, the sea-level section came up. On the screen, their most important conclusion appeared: Under pessimistic estimates and with no climate action, sea levels will rise between 1.7 and 3.2 feet by the last two decades of this century; with robust, global action, in a lucky world, they would still rise—but by only 0.8 to 1.8 feet.

Then came the section they added to mollify Mr. Levermann:

"Based on current understanding, only the collapse of marine-based sectors of the Antarctic ice sheet, if initiated, could cause global mean sea level to rise substantially above the likely range during the 21st century," it read. "However, there is medium confidence that this additional contribution would not exceed several tenths of a meter of sea level rise during the 21st century."

Through such unlovely paragraphs is consensus forged.

The summary had a hundred more such points, each its own story of discussion, dispute, resolution. It was good to see it all finally unfold. For many scientists, it

would be the most important work they'd ever do. But Mr. Church was still prepared for criticism.

"I daresay we will be attacked by both sides," he said, "for having too high numbers and having too low numbers."

Sitting in that former brewery, they found it impossible to say what their legacy would be. Would the public even pay attention? Reports of an opening with Iran and a possible government shutdown dominated the U.S. news media. Would the panel's authors still be seen as too conservative? It was impossible to say.

Really, they only knew one thing for sure: The water was rising.

The Chronicle Review

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