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# 1.0 OPENING

## 1.1 Opening Remarks and Administrative Arrangements *Sicre, Urban*

### 1.1.1 Memorials for Scientists Involved With SCOR *Sicre*

**Wallace Broecker**
Full Member of SCOR WG 20 on Radiocarbon Estimation of Primary Production and SCOR WG 44 on Ocean-Atmosphere Materials Exchange

From https://blogs.ei.columbia.edu/2019/02/19/wallace-broecker-early-prophet-of-climate-change/:
"Wallace Broecker, a geochemist who initiated key research into the history of the earth's climate and humans' influence upon it, died Feb. 18 in New York. He was 87. The cause was congestive heart failure, said his family. His death was confirmed by Columbia University's Lamont-Doherty Earth Observatory, where he spent a career that spanned nearly 67 years.

One of the first scientists to predict an imminent rise in the earth's temperature due to human output of carbon dioxide, Broecker was credited with introducing the phrase "global warming" into the scientific lexicon in the 1970s. Much of his work focused on the oceans. Among other things, his studies of marine chemistry helped lay out the map of global ocean circulation, and its powerful effects on climate. His studies also helped lay the basis for many other scientists' work in a variety of fields. Not content to just do research, he made friends with and extended his influence to powerful figures in government and business.

Broecker—universally known as Wally—at first made an unlikely scientist. Born Nov. 29, 1931, the second of five children, he grew up in the Chicago suburb of Oak Park, Illinois. His father, also named Wallace, ran a gas station. His mother was the former Edith Smith. Both parents were evangelical Christians who rejected modern geologic theory for the literal Biblical interpretation that the earth is just a few thousand years old. They also forbade drinking, dancing and movies. Broecker attended Illinois' fundamentalist Christian Wheaton College, where daily chapel attendance was required; it was at the time the recent alma mater of preacher Billy Graham. While still a student, he married the former Grace Carder, and spoke of becoming an insurance actuary.

While at Wheaton, Broecker decided one day that Christianity was not for him, and abandoned it "cold turkey," in his own words. He got sidetracked on the career idea as well after an older Wheaton student helped him arrange a summer 1952 lab internship at what was then called Lamont Geological Observatory, in Palisades, N.Y. The student was Paul Gast, who later went on to head NASA's moon-rock program. At Lamont, Broecker worked with J. Laurence Kulp, a geochemist doing pioneering work on radiocarbon dating, a then revolutionary new method that allowed researchers to tell the ages of materials as far back as 40,000 years.

By his own account, Broecker had fun tinkering with the lab equipment, and he was excited by the newly wide-open chance to make discoveries about nature using carbon dating. He transferred to Columbia that fall and kept working with Kulp. Some other students made fun of

his background, calling him a “theo-chemist.” And, while other students were sent on exotic ocean research cruises, he was left off the list for his first eight years. Nevertheless, he earned a PhD. in geology in 1958 and stayed around, gradually rising to the first rank of prominence. In a 2016 memoir he said that Lamont became “my Garden of Eden.”

“My great joy in life comes in figuring something out,” he told The New York Times in 1998. “I figure something out about every six months or so, and I write about it and encourage research on it, and that’s the joy of my life.”

One of Broecker’s first achievements was a series of papers demolishing the stock idea that it took tens of thousands of years for water to circulate between shallow and deep regions of the world’s oceans. His analyses of carbon isotopes collected by Lamont ships from around the world showed that water could make the switch in just centuries—a discovery showed that the oceans are far more dynamic than previously thought. This in turn implied that the oceans could potentially affect the composition of the atmosphere, or vice-versa.

Starting in 1960, Broecker sailed on many of the world’s oceans and seas. In addition to sampling water, he maintained instruments, helped winch seafloor sediment cores to the surface, and threw dynamite overboard to produce explosions whose echoes were read to chart the bottom. In the 1970s, he co-led a global program funded by the U.S. government to use a wide variety of trace metals, nutrients and isotopes of radioactive elements to map the circulation of the deep ocean, the exchange of gases with the atmosphere, and other marine processes. This collective work provided the underpinnings for virtually all later studies of marine chemistry, and the oceans’ relationship to climate. It was Broecker who provided a running commentary for a documentary film on the project while on a cruise from Tahiti to San Diego. He used related geochemical methods to study lake waters, sediments and rocks in Canada and the American West for clues about climates of the past, with a special interest in the comings and goings of ice ages.

Early on, Broecker became interested in how the oceans absorb carbon dioxide from the air, and what effects this might have on climate. The history and behavior of atmospheric carbon dioxide were poorly known when he started out, but by the early 1970s, other researchers had analyzed ice cores from the Greenland ice and shown that they could track levels of atmospheric $CO_2$ through the distant past. Work by others suggested that higher $CO_2$ levels could be correlated with periods of warming. And scientists had speculated since the 19$^{th}$ century that rising output of human-produced $CO_2$ could potentially warm the planet; some of Broecker’s contemporaries, including Charles Keeling of the Scripps Institution of Oceanography, were already tracking $CO_2$ levels in real time and considering the effects.

In August 1975, Broecker synthesized his and others’ related research in the journal *Science* in a piece called “Climatic Change: Are We on the Brink of a Pronounced Global Warming?” It was later said to be the first time the phrase was used in a scientific paper. In it, he argued that humans were changing the climate by emitting $CO_2$; it just wasn’t evident yet, because the world was experiencing what he believed was a natural 40-year cooling cycle that was masking the effects. He predicted that the cycle would soon reverse, and then the manmade warming on top of that would become dramatically visible. It later turned out that he had misinterpreted some of

the ice-core data, but had the overall picture right. Right on cue in 1976, temperatures started ascending, and have continued since then pretty much along the trajectory Broecker laid out.

“Global warming” was quickly adopted by the science world, including in the first large-scale report on the subject, published in 1979 by the U.S. National Academy of Sciences. Decades later, when some credited Broecker with coining the phrase, he shrugged it off as “dumb luck.” He warned that he would turn over in his grave if someone put “global warming” on his tombstone. He once offered $200 to any student who could find an earlier citation for the phrase. (One postgrad did find it in a 1958 editorial in the Hammond Times of Indiana. It apparently didn’t catch on at that time.)

Broecker and a handful of other scientists began briefing government leaders on climate change in the 1980s. He testified at the first congressional hearings dealing with the subject, led in 1984 by then Tennessee Representative Al Gore. Over succeeding years, as the science advanced, Gore and other politicians repeatedly met with and consulted Broecker to have him explain.

In the mid-1980s Broecker synthesized a grand picture of world ocean circulation, based on his and others’ studies. He dubbed it “The Great Ocean Conveyor.” In simplest terms, it is a vast river of warm, shallow water flowing from the south Pacific into the Indian Ocean, rounding Africa and then heading north through the Atlantic. Once it hits cold water from the Arctic, the water then cools and sinks near northern Europe. From there, it loops through the abyss back to the Pacific to warm, rise and begin the cycle again. The flow is so huge, Broecker asserted, that it must help regulate global climate by moving around vast amounts of heat from one place to another. This idea soon became general consensus.

Broecker then put forth the idea that the conveyor could suddenly switch on and off, leading to drastic climate shifts–not over millennia, as many had come to think, but perhaps just decades. He pointed to an apparently rapid cooling some 12,000 years ago that threw Europe and other regions into a temporary deep freeze. Paradoxically, he argued, the cause might have been a then-warming climate and the collapse of northern ice sheets, which introduced a pulse of freshwater that pushed back on the conveyor. He warned that “the uncontrolled experiment” of modern human-induced warming might bring similar rapid changes. He was fond of saying, “The climate system is an angry beast, and we are poking it with sticks.”

Climatologists are still debating whether and how rapid climate swings might take place today. That notwithstanding, Broecker’s ideas were taken up and wildly exaggerated in the 2004 movie The Day After Tomorrow, which featured a climate-change-powered tsunami engulfing Manhattan and then freezing into an ice sheet–all in the same day. They were more credibly explained in possibly the only pop song about physical oceanography, “Uncle Wally’s Tale,” by the singer Tom Chapin. (Chapin was Broecker’s brother-in-law, married to Broecker’s younger sister, Bonnie.)

In the 1990s, Broecker served as chief scientific advisor for Biosphere 2, an experimental glassed-in environment in the Arizona desert meant to mimic the workings of land, oceans and air on a small scale. Columbia had just taken over scientific management, and the business side was temporarily handed over to a consultant named Steve Bannon—later chief advisor to U.S.

president Donald Trump, and potent enemy of U.S. efforts to fight climate change. “An intense guy. I actually kinda liked him,” Broecker told the New Republic in 2017. After the 2016 election, Broecker was alarmed that maybe Bannon had forgotten or did not understand the science, and tried contacting him to set him straight. He never heard back.

Broecker authored or coauthored close to 500 research papers, and at least 17 books. Many of the books were self-published spiral-bound affairs, passed out free to anyone interested. More commercial ones included the 2008 Fixing Climate (with science journalist Rob Kunzig), an autobiographical look at the development of modern climate science. He also collaborated with Harvard scientist Charles Langmuir on How to Build a Habitable Planet, a widely used text on Earth’s origin and evolution first published in 1984 and expanded in a 2012 edition. Broecker mentored about 50 Lamont grad students, many of whom went on to prominent careers.

There is no Nobel Prize in earth sciences, but Broecker received honors and millions of dollars in awards from foundations, governments and scientific societies. He received honorary degrees from Harvard, Cambridge and other universities. He was elected to London’s Royal Society and the U.S. National Academy of Sciences. In 1996, he received the National Medal of Science from U.S. President Bill Clinton. He plowed most of cash awards back into research.

In summer 2001, billionaire Gary Comer, founder of the Lands’ End clothing company, managed to sail his large yacht clear through Canada’s Northwest Passage —long impassable because of ice, but now suddenly open because of warming climate. Comer was intrigued by his own feat and sought out Broecker to learn more. The two became fast friends. Broecker, then entering his 70s, credited the businessman with “adopting” him and reviving his career at a time when he was considering retirement. Using Comer’s yacht and private aircraft, they carried out multiple expeditions to the far north together. Under Broecker’s influence, Comer gave some $25 million to fund climate researchers across the world, and to build a new geochemistry building at Lamont.

Broecker, who suffered from dyslexia, never got around to learning how to type or use a personal computer. He wrote with a pencil and notepad, and had staffers retype manuscripts and emails. He was known for his friendly demeanor, but also for his bluntness and volcanic temper; he publicly skewered grad students and senior scientists alike for sloppy work. “He has singlehandedly pushed more understanding than probably anybody in our field,” said Richard Alley, a leading climatologist at Pennsylvania State University. “He is intellectually so huge in how the earth system works and what its history is, that all of us are following Wally in one way or other.”

In recent years, Broecker increasingly spoke out about the dangers of climate change, but averred that much remained unknown. “It humbles you to study the earth system, because you realize nature is really complicated,” he told CBC television. He advocated for the eventual abandonment of fossil fuels, but saw little hope it would happen soon. “I don’t think we can destine the poor people on the planet to remain poor, just so we can not have $CO_2$ build up in the atmosphere,” he said. “Coal is going to get burned and there is not anything we can do about it. [H]ow are you going to stop people from using it?”

As a stopgap, in his later years Broecker became an advocate of nascent technologies to suck $CO_2$ from the air and store it back underground. Toward the end, though in failing health, he continued discussing the latest research, and pressed colleagues to consider the radical and highly controversial idea of engineering the planet itself to cut down warming, possibly by injecting vast amounts of sulfur dioxide into the upper atmosphere to repel solar energy. To this end, he helped organize a symposium at Arizona State University that brought together many of the world's top climate scientists to debate the topic. The meeting was held on Feb. 11, 2019. By then too ill to attend, he addressed the participants via a livestream on a big-screen TV. "If we are going to prevent the planet from warming up another couple of degrees, we are going to have to go to geoengineering," he told them. Otherwise, he said, there could be "many more surprises in the greenhouse." He was using a wheelchair and breathing through an oxygen tube, but assured the attendees, "My mind is running pretty smoothly." Almost exactly seven days later, he passed away.

**Keith Hunter**

Full Member of SCOR WG 80 on Role of Phase Transfer Processes in the Cycling of Trace Metals in Estuaries and Co-chair of SCOR WG 109 on Biogeochemistry of Iron in Seawater

From: https://www.pressreader.com/new-zealand/otago-daily-times/20181222/282415580394219

"Respected Academic and Climate Change Researcher

He will be remembered as a pioneer in the field of climate change research, but climate, freshwater and marine scientist Prof Keith Hunter was known for his warm and affable nature as well as his academic brilliance.

The University of Otago lecturer and former head of the department of chemistry and pro-vice chancellor of the sciences division of the university died at his Dunedin him on Octover 24, aged 66, and is mourned by his family, friends, colleagues and former students.

A leader in the marine science field, Prof Hunter was awarded both the Prime Minister's Science Prize and the Marsden Medal, was a Fellow of the Royal Society of New Zealand, and a fellow of the New Zealand Institute of Chemistry, as well as New Zealand delegate to the UN Scientific Committee on Oceanic Research, a member of the American Geophysical Union, and the American Society of Limnology and Oceanography.

He specialized in trace metals in natural water, and chemical equilibrium in marine and freshwater systems, and helped establish the joint Niwa/University of Otago Centre of Excellence for Physical and Chemical Oceanography, not the Joint Institute for Oceanography. Prof Hunter supervised more than 100 graduate students during his academic career. He was born on November 24, 1951 to Othle May Hunter (nee Brenton) and Nevin Lindsay Hunter, and grew up in Auckland.

“As a child, Keith was reported by his parents to always be asking ‘why’ questions, and wanting to find the reasons for things,” a family spokeswoman said.

“It was his curiosity that naturally lent itself to science.  Keith had always had a fascination for how life evolved in the oceans.”

At Prof Hunter’s request, he did not have a funeral, but did have a family farewell on November 17 – followed by a gathering of staff and friends at the University of Otago staff club on November 29.

A common thread in the tributes paid to Prof Hunter at the gathering and at the staff club was his "sense of humour, his affable nature, and the fact that he always made time to stop, chat and connect with everyone", she said.

Prof Hunter's younger brother, Ian, said when they were children, he and his older sibling built a hut which was used for experiments.

"I thought it would be a great secret hut for our friends but Keith had other plans."
Keith was "always building stuff " and built a radio, a miniature cannon, skateboards and trolleys, as well as fireworks and gunpowder, nearly burning the hut down twice.

He funded his early experiments by delivering newspapers and working in a grocer's shop. After he left Auckland Grammar School, he opted to study chemistry at the University of Auckland - and after completing his master's degree, he became the first recipient of the Rutherford Scholarship, allowing him to study towards a PhD anywhere in the Commonwealth.

He chose to study marine chemistry at the University of East Anglia, and was to say later that the best part of marine chemistry was that it was "a relatively small field".

Knowing most of the main players personally gave a "strong sense of community", he said.
After completing his PhD, Prof Hunter went on a year's exchange to the French Atomic Energy Commission, returning to New Zealand in 1979, to take up a position at the University of Otago.
He began to focus on metals in seawater, and his research led to the realisation that in major parts of the ocean, the productivity of phytoplankton was limited by the low availability of iron.
A tribute written by former student Dr Luke Moseley, now a senior research fellow at the University of Adelaide, spoke of Prof Hunter's patience, his "sharp mind" and his passion and knowledge of the effects of climate change.

"I feel privileged to have studied under him. The training and experience we received was truly world class.

"One major gift he gave me was when he shared his passion and knowledge of climate change effects on the ocean in his lectures and informal talks, I feel it is incumbent on us to now carry the knowledge Keith enabled in us forward, training the next generation of scientists, doing science and fighting for action on climate change.

"I will be forever grateful to have studied and worked under Keith and he will be remembered." Prof Hunter was a strong supporter of the university's HandsOn Science programme for secondary school pupils (now known as "HandsOn At Otago' '), and he often attended events during the programme in January each year.

A statement from Niwa said Prof Hunter's research into marine trace metals and the carbonate system "paved the way for the high profile research fields of ocean fertilisation and acidification. In his spare time, Prof Hunter loved music and spent many hours playing the electric guitars he enjoyed collecting.

From the early 2000s, he and his wife, Wynsome, lived outside Dunedin. Prof Hunter spent a lot of time growing vegetables, including some giant ones his family said he was "extremely proud of.""

**Angus McEwan**
Member of SCOR/IOC Committee on Climate Change and the Ocean and Nominated Member from Australia

From election to Australian Academy of Sciences in 1982:

"Originally an engineer and aerodynamicist, McEwan was invited by Sir Geoffrey Taylor to collaborate in pioneering studies in electrohydrodynamics and in viscous free surface phenomena. Fundamental work on rotating fluids turned his interest towards geophysical problems. He has devised and conducted laboratory experiments on processes of the atmosphere and ocean as diverse as fronts, waves, convection, stratified and rotating flows, and the quasi-biennial oscillation. His special ability has been to produce simple abstractions of complex real-world situations, capable of innovative experimental and mathematical investigation. Both of these have been pursued at high scientific level, revealing new phenomena and providing new understanding of the complex geophysical dynamics. His work is characterised by an interactive blend of mathematical and physical insights which give his investigations a totality and scientific unity very rarely achieved by one individual."

**Walter Munk**
Full Member of SCOR WG 96 on Acoustic Monitoring of the World Ocean

Extracted from press release from Scripps Institution of Oceanography:

Walter Munk, who gave the Allies a strategic edge in World War II, helped nurture a university into existence, and became a living synonym for oceanography, died February 8 at his home in La Jolla, Calif. He was 101.

As a geophysicist at Scripps Institution of Oceanography at the University of California San Diego, Munk made groundbreaking observations of waves, ocean temperature, tidal energy in the deep ocean, ocean acoustics and the rotation of the earth. As an advocate of science and broader scholarship, Munk served as an advisor to presidents and the Pentagon and conferred

with public figures including the Dalai Lama and Pope Francis. His convictions led him to refuse to sign a loyalty oath required by the University of California during the peak of anti-communist fervor in the early 1950s and his passion helped create the architecture that would become the defining style of the Scripps Oceanography campus.

Munk's contributions to science throughout the latter half of the 20th Century and into the present century were measured not only in terms of the new knowledge his research yielded, but in the quality and diversity of the questions he considered. An ethos he expressed throughout his career was for scientists to take risks, pursue new directions, and embrace the educational value of failure.

"Walter Munk has been a world treasure for ocean science and geophysics," said Scripps Oceanography Director Margaret Leinen. "He has been a guiding force, a stimulating force, a provocative force in science for 80 years. While one of the most distinguished and honored scientists in the world, Walter never rested on his accomplishments. He was always interested in sparking a discussion about what's coming next. Ideas were important to him, and the future of geoscience and oceanography was so important to him that he pushed all of us to be audacious, to take action, and to focus on the big ideas that could transform our world."

"During my career I have worked on rather too many topics to have done a thorough job on any one of them," Munk himself wrote in a 1980 autobiographical essay. "But 'definitive papers' are usually written when a subject is no longer interesting. If one wishes to have a maximum impact on the rate of learning, then one needs to stick out one's neck at an earlier time."

However inconclusive Munk might have left some questions before turning to others, his work on nearly all he considered informs ocean and earth science to this day – in some cases, decades after he first posed them.

"From World War II through the 1990s, the U.S. Navy poured financial and logistical support into American oceanography, for its importance in anti-submarine warfare, national defense, and climate change," said Naomi Oreskes, professor of the history of science at Harvard University. "Walter Munk was one of the leaders of the generation of men and women who used this support to revolutionize our understanding of the oceans, particularly the physical phenomena of waves, tides and currents, and the relationship of these phenomena to basic geophysical processes. In his long life, he inspired scores of younger scientists to take on the challenges of understanding the geophysics of the Earth."

Rebellion and romance played a role in Munk's journey to a science career at Scripps. He was born on Oct. 19, 1917, in Vienna, Austria, to a cosmopolitan banking family. In 1932, when he was 14, his family sent him to New York for school with the expectation that his time in the financial capital would prepare him for his own career in banking. After spending a few years working at the firm of a family friend, Munk decided he had no fondness for banking and instead applied to and was accepted at the California Institute of Technology. There he received a bachelor's degree in physics in 1939 and a master's degree in geophysics in 1940.

In pursuit of a romantic interest who vacationed in La Jolla, Munk applied for a summer job at Scripps in 1939. The infatuation with the young woman passed, but Munk acquired a new love for San Diego. After receiving his master's, he returned to Scripps and was admitted as a PhD candidate.

Then-Director Harald Sverdrup would become a lifelong friend and mentor to Munk, who also became fast friends upon joining Scripps with Roger Revelle, a research oceanographer who had just received his doctorate.

Munk became an American citizen in 1939 and when war with Germany seemed imminent, he joined the U.S. Army, serving in the 146th Field Artillery, 41st Division at Fort Lewis, Wash. Sverdrup, however, requested his recall in 1941 and Munk returned to Scripps to begin work at the new U.S. Navy Radio and Sound Laboratory in the San Diego neighborhood of Point Loma. A week after his release, the Japanese attacked Pearl Harbor.

Munk and Sverdrup were soon tasked with aiding Allied amphibious landings off the coast of Africa. During Munk's time as an Army private, he had observed that amphibious landing exercises off the coast of South Carolina would have to be cancelled when waves were high enough to breach landing craft. His mission with Sverdrup was to predict days when wave conditions would be most suitable to enable landing craft to get close to the beach.

After the two worked out a scheme that yielded reliable predictions, they began training Navy and Air Force weather officers and their principles were applied to landings in the Pacific and Atlantic theaters of war. The meteorologists they trained correctly predicted that the waves troops would face taking the beach in Normandy would be high but manageable.

After the war, Munk returned to the dissertation he had set aside. He received a PhD in oceanography from the University of California Los Angeles, with which Scripps was affiliated at the time, in 1947.

In the 1950s, Munk explored topics such as the wobble of Earth and wind-driven ocean gyres as oceanography transitioned from a wartime emphasis on defense to a focus on basic science questions supported by entities such as the National Science Foundation. He took part in iconic seagoing expeditions including the Capricorn Expedition in 1952 and 1953. For this expedition, Munk, Revelle and dozens of other scientists were dispatched to the Marshall Islands in the Pacific Ocean in the prelude to the testing of a nuclear bomb at Bikini Atoll. Munk's concern for the potential that the detonation would trigger a tsunami led to his development of early warning methods incorporated into modern warning networks. During Capricorn, Munk was also among scientists who participated in a first: using scuba diving equipment to conduct underwater research.

Munk watched with some dismay as space science eclipsed ocean and earth science in the popular imagination and in research funding during the decade. His desire to create an equally exciting rival project was the genesis of Project MOHOLE, a quest to drill to the earth's mantle. The project would eventually be scuttled, but an initial test run of a drilling vessel in 1961 did yield the important finding that acoustic signals from the seafloor could be used to guide

dynamic positioning of platforms floating at the surface. That could enable them to remain at a fixed point in the ocean without drifting away from their drilling target. The failed MOHOLE project succeeded in creating a permanent international collaboration to drill for ocean sediments at locations around the world. The International Ocean Discovery Program continues to this day as a legacy of MOHOLE.

Munk was the first director of IGPP's La Jolla campus, a process set in motion when he began considering leaving Scripps in 1959. To counter the overtures being made to Munk by other research centers around the country, Revelle, by this time the director of Scripps, persuaded Munk to establish a geophysics research group. Revelle's enticements helped Munk raise money for the new center, which completed its first buildings that same year.

At the same time, Revelle was lobbying the University of California to build a new campus in San Diego and Munk joined his friend in the effort, which encountered considerable opposition from UCLA. (Watch Munk's recollection of the debate here.) Munk's home, known as Seiche after a variety of the waves he studied, became an incubator of ideas for the new campus.

Munk chaired the faculty senate at UC San Diego through a tumultuous period as the Vietnam War raged. In that role, he conferred with both counterculture icons like Black Panther Eldridge Cleaver and then-California Gov. Ronald Reagan. He served on the search committee for UC San Diego's chancellor in 1964 and chaired the committees that produced the hirings of William Nierenberg and Ed Frieman as directors of Scripps in 1965 and 1986, respectively.

"Walter was the most brilliant scientist I have ever known," said UC San Diego Chancellor Pradeep K. Khosla. "He was a great inspiration to many generations of students at UC San Diego and to every chancellor the campus has seen. I stand in awe at the impact Walter Munk had on UC San Diego, from his countless discoveries that put the university on the map as a great research institution, to his global leadership on the great scientific issues of our time. As a campus, we mourn the loss of a legend."

Munk's relationship with the U.S. Navy and other military branches remained a constant throughout his career. He joined JASON, a select group of scientists that advised the Pentagon. Additionally, he served on several panels of the President's Science Advisory Committee and held the title of Secretary of the Navy Chair in Oceanography until his death.

One task assigned to JASON scientists regarding anti-submarine warfare led to Munk turning his attention to marine acoustics. This brought on another era of profound advances in the understanding of the oceans as his work led to the creation of ocean acoustic tomography and thermometry through which acoustic data became a vehicle for understanding currents, circulation, and heat content.

The most famous example of this work might have been a Munk-led experiment to see whether acoustics could be used as a way to estimate ocean temperatures on a global scale and thus, the effects of global warming. In 1991, at a remote location near Heard Island in the southern Indian Ocean, Munk's team transmitted low-frequency underwater acoustic signals. The location had been chosen because the sound waves could travel on direct paths to listening stations in both the

Pacific and Atlantic oceans. The premise was validated as stations from Bermuda to New Zealand to the United States West Coast all received the signal. The time the signal took to travel was a function of the temperature of the water it traveled through. (View an Emmy-winning 1994 University of California profile of Walter Munk here.)

After being widowed by wife Judith in 2006, Munk found love again. In 2009, he met Mary Coakley, chair of the Friends of La Jolla Shores organization, and the two were married in 2011. Together, they were immersed in the La Jolla community and became involved in numerous projects, including planning efforts for a 2,400 square-foot mosaic of marine life to be installed at La Jolla Shores in 2019.

Throughout his career, Munk acquired a resume of accolades almost as impressive as the work that inspired them. Munk was elected to the National Academy of Sciences in 1956 and to the Royal Society of London in 1976. He was a Guggenheim Fellow three times.

In 1983, Munk was honored with the President's National Medal of Science, the nation's highest award for lifetime achievement in scientific research. In 1999, Munk was awarded the Kyoto Prize in Basic Sciences for his fundamental contributions to the field of oceanography, the first time the prize was awarded to an oceanographer. In 2001, he was the inaugural recipient of the Prince Albert I Medal in the physical sciences of the oceans, which Prince Rainier of Monaco created in cooperation with the International Association for the Physical Sciences of the Oceans. Among Munk's favorite honors was the 2014 awarding of the Explorer's Medal from the Explorer's Club, an organization founded in 1904 that includes some of the last century's most famous names in science and exploration among its members.

More recently, in 2018, Munk received the French Legion of Honor with the rank of Chevalier (Knight) in Paris for his exceptional contributions to oceanography. The Legion of Honor is the highest French decoration recognizing military and civilian merit.

Munk has two marine species named in his honor: Mobula munkiana or Munk's devil ray—a "flying" pygmy devil ray known for its ability to leap out of the water at great heights—and Sirsoe munki, a deep-sea worm. The 2017 documentary Spirit of Discovery follows Munk as he goes on an expedition to Cabo Pulmo in Baja California, Mexico, in search of the mysterious devil rays named after him.

Munk's habit of everyday scholarship never stopped. He remained active in his advisory work with JASON in recent years and he was working on research papers when Scripps was joined by national political and science leaders in celebrating his 100th birthday in 2017. In the past decade, he had continued outreach, conferring with Pope Francis and the Dalai Lama on the threat of climate change.

At a civic event in October 2017 that was part of a series of celebrations for his 100th birthday, an array of elected officials came to La Jolla to fete Munk when the boardwalk on La Jolla Shores was renamed in his honor and would become Walter Munk Way. With his thanks, Munk left the crowd with an observation to ponder.

“The $CO_2$ we are putting into the atmosphere now is producing a rate of sea-level rise so that the Walter Munk Way is not going to enjoy another 100 years,” he said.

At the event, City of San Diego officials issued a Proclamation that Oct. 19, 2017, would officially be known as “Walter Munk Day.”

**Rengaswamy Ramesh**
Full Member of SCOR WG 117 on Synthesis of Decadal to Millennial Climate Records of the Past 80ky

From https://en.wikipedia.org/wiki/Rengaswamy_Ramesh

“Prof. Rengaswamy Ramesh (1956–2018) was an Indian climatologist, oceanographer, a former Prof. Satish Dhawan Professor at the Physical Research Laboratory and a senior professor at the National Institute of Science Education and Research, Bhubaneswar. He was known for paleoclimatic and paleo-oceanographic studies and was an elected fellow of all the three major Indian science academies viz. Indian National Science Academy, Indian Academy of Sciences, and the National Academy of Sciences, India as well as of The World Academy of Sciences. The Council of Scientific and Industrial Research, the apex agency of the Government of India for scientific research, awarded him the Shanti Swarup Bhatnagar Prize for Science and Technology, one of the highest Indian science awards for his contributions to Earth, Atmosphere, Ocean and Planetary Sciences in 1998.

R. Ramesh, born on 2 June 1956 in the south Indian state of Tamil Nadu, did his graduate studies in physics (1976) at the University of Madras and completed his master's degree at the same university in 1978. Enrolling for his doctoral studies under the supervision of Kunchithapadam Gopalan of Physical Research Laboratory (PRL), he secured a PhD from Gujarat University in 1984 and did his postdoctoral studies at his mentor's laboratory during 1985–86. He joined the Planetary and Geosciences Division of PRL as a research associate in 1987 and has served the institution in such various capacities as a Scientist-Grade D (1987–94), Reader (1994–98), Associate Professor (1999–2001), Professor (2002–07) and Senior Professor (since 2008) and holds the position of a Foundation for GLocal Science Initiatives (FGSI) Outstanding Scientist. In between, he had a short stint at Scripps Institution of Oceanography during 1992–93 as a visiting research associate, working under the guidance of Devendra Lal. He died on 2 April 2018, at the age of 61.

Ramesh is known to have contributed to the reconstruction studies of paleoclimatic and paleo-oceanographic conditions of the Indian Ocean. He is credited, along with S. K. Bhattacharya and Kunchithapadam Gopalan, with the establishment of a Stable Isotope laboratory for the first time in India. At the laboratory, he applied stable isotope methodology to study tree-rings, corals, peat deposits, speleothems, lake sediments and marine sediments and his studies assisted in widening the knowledge of the monsoons for the past 35 kiloannum. He developed equations for the calculation of past temperatures and rainfall using stable isotope ratios and prepared high resolution documentation of the monsoon changes during the Holocene epoch. His studies have been detailed in several peer-reviewed articles; ResearchGate and Google Scholar, two online

repositories of scientific articles, have listed 208 and 267 of them respectively. He was one of the lead authors of the book, Climate Change 2013: The Physical Science Basis, a 1552-page compilation of reports of the Working Group I of the Intergovernmental Panel on Climate Change, published by Cambridge University Press in 2014. He has mentored 15 scholars in their doctoral studies who were also trained by him in stable isotope methodology. He is the project director of the National Program on Palaeoclimate studies of the ISRO-Geosphere-Biosphere Programme (GBP) and sits in the Research Council of the National Geophysical Research Institute as an external member."

**Bert Semtner**
Full Member of SCOR WG 107 on Improved Global Bathymetry

From: https://www.legacy.com/obituaries/montereyherald/obituary.aspx?n=albert-julius-semtner-bert&pid=191107210&fhid=32277

Albert "Bert" Julius Semtner, Jr. passed away in Carmel, California on December 15, 2018 at the age of 77. Bert was born on May 25, 1941 in Oklahoma City, OK to Albert J. Semtner and Dorothy K. Erler. He graduated from Jesuit High School in Dallas, Texas as Class Valedictorian in 1959. He went on to earn a bachelor's degree in mathematics from the California Institute of Technology in 1963, a master's degree in mathematics from the University of California, Los Angeles in 1968 and a Ph.D. in Geophysical Fluid Dynamics from Princeton University in 1973. He also served in the NOAA Commissioned Officer Corps, attaining the rank of Lt. Commander. Dr. Semtner had a distinguished academic and scientific research career, first as a faculty member in the Department of Meteorology at UCLA, then as a research oceanographer at the National Center for Atmospheric Research in Boulder, Colorado starting in 1976, and finally as Professor of Oceanography at the Naval Postgraduate School in Monterey, California from 1986 until his retirement in 2005. He held the title of Professor Emeritus through the remainder of his life. Bert was a pioneer in the utilization of state of the art computing systems coupled with his keen physical insight to advance our understanding of the role of the world's oceans in both maintaining and perturbing the earth's climate system. He regularly made himself available as a mentor to several generations of students and young scientists. He also was constantly pursued to serve on a variety of review and advisory panels. His leadership and accomplishments were acknowledged by an impressive array of awards and honors, including the Smithsonian Leadership Award in Breakthrough Computational Science in 1993, which he won in collaboration with his great friend Bob Chervin. Bert had an impact on many and will be forgotten by few. When not working, Bert enjoyed traveling and being outdoors, especially hiking, mountaineering and finding his way to ocean vistas. He was very proud of his children Eric and Katy and loved to talk about their accomplishments. During his retirement years, he enjoyed spending time with his wife Jolene and their ever-growing collection of dogs and cats. They loved to travel and hike together and participated in canine search and rescue work on the beautiful Monterey Peninsula. They also spent time in Winner, South Dakota where they maintained their second home.

**1.2 Approval of the Agenda (see Tab 0)** ***Sicre***

The agenda can be rearranged at the meeting to accommodate the schedules of presenters and to add items to it.

**1.3 Report of the SCOR President** ***Sicre***

The SCOR President will present a report at the meeting that describes her activities on behalf of SCOR since the 2018 SCOR Annual Meeting in Plymouth, UK.

**1.4 Report of SCOR Executive Director** ***Urban***

The ongoing work through SCOR-supported projects and working groups has continued as usual this year, thanks to the many dedicated scientists and project staff. My main jobs have been to manage funds for SCOR and its activities, and to provide staff support for the SCOR Executive Committee, SCOR Committee on Capacity Building, the International Quiet Ocean Experiment, and GlobalHAB project.

**Finances**—Dues income is on track for this time of year. Income from dues is important for funding the central administration of SCOR, namely the costs of the Secretariat and the annual SCOR meetings. Dues also fund some costs of working groups and other SCOR activities that are not funded from grants. SCOR depends on grant funding for large-scale research projects, ocean carbon activities, and some working groups. SCOR is currently in the second year of a three-year grant from NSF to funding of international large-scale research projects and infrastructural activities, working groups, and other activities.

**National Members—**The number of countries involved in SCOR has been stable for the past year. The SCOR Executive Committee and Executive Director are continually seeking to add new national SCOR committees. There was some rotation of Nominated Members (see Tab 8).

**Publications and Outreach**—The SCOR Web site is the major vehicle for providing up-to-date information about SCOR to the international ocean science community and I make changes to the site several times each week, as I receive new information. The site is checked for “dead links” monthly. The re-designed SCOR Website has been working well and seems to be appreciated by the SCOR community.

SCOR activities yielded several publications in the peer-reviewed literature and other venues this year, as noted in Tab 8. Because SCOR’s reputation is largely affected by the quality of documents resulting from SCOR activities, I spend a significant amount of my time writing, reviewing, and/or editing publications.

SCOR will have a booth again at the Ocean Sciences meeting in San Diego in February 2020. The booth provides an opportunity for SCOR-sponsored projects to gain visibility and for SCOR projects to distribute information and to meet with people who drop by the booth. Several SCOR working groups are planning to meet in conjunction with the Ocean Sciences meeting.

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The SCOR Twitter account has 570 followers (as of 13 August 2019), up from 414 followers in July 2018. I tweet news items that I think would interest the broader community. There is almost no overlap between SCOR's Twitter followers and people on the SCOR email list. I generally post the same items on the SCOR Facebook page as items tweeted. The SCOR email list current has 1,311 subscribers and the SCOR Facebook group has 74 members.

**Meetings**—In the 12 months between the 2018 and 2019 SCOR annual meetings, 7 SCOR working groups will have met (WGs 147, 149, 152, 153, 154, 156, 157). The Scientific Steering Committees of GEOTRACES, GlobalHAB, IIOE-2, IMBER, IOCCP, IQOE, and SOOS also met.

**Outreach to Scientists from Developing Nations and Capacity-Building Activities**—SCOR continues to invest funding and effort in expanding its capacity-building activities. SCOR approved six SCOR Visiting Scholars in 2019. The sixth annual Research Camp was held at the University of Namibia (UNAM) campus in Henties Bay this year. This concept grew out of Kurt Hanselmann's two visits to UNAM as a SCOR Visiting Scholar and subsequent grants from the Agouron Institute and Simons Foundation to SCOR for this activity.

**Service to International Ocean Research Projects—**SCOR helps SCOR-sponsored research projects in many different ways, including providing funds from the U.S. National Science Foundation, the U.S. National Aeronautics and Space Administration, and other sources, providing travel support for developing country scientists and scientists from countries with economies in transition to special events of the projects, providing IPO-type support until an IPO can be funded, providing access to the Conference Manager software for management of open science meetings, and leasing the GoToMeeting audio conferencing system for the projects.

**Support of Project Offices—**SCOR currently provides partial support for three project offices, as subawards to one of SCOR's grants from NSF:

- International Ocean Carbon Coordination Project (IOCCP)—This office is located in Sopot, Poland, at the Institute of Oceanology of the Polish Academy of Sciences. SCOR pays the salary and benefits for the project director, Dr. Maciej Telszewski, as well as activity funding. IOC helps support the cost of the office and provides activity funding for IOCCP, and the host institution provides in-kind support.
- GEOTRACES Data Assembly Centre—This office is located at the British Oceanographic Data Centre. SCOR pays for salary support and other expenses related to the office, for the GEOTRACES Data Manager. The office receives occasional support from other countries whose scientists are involved in GEOTRACES.
- GEOTRACES International Project Office—This office is located in Toulouse, France at the Université Toulouse III - Paul Sabatier, SCOR support pays for about half of the office cost, including some salary support for the GEOTRACES Executive Officer, Ms. Elena Masferrer-Dodas. SCOR funds are supplemented by funds from other countries whose scientists are involved in GEOTRACES.

**Partnerships With Other Organizations**—Maintaining existing partnerships and developing new ones depends on SCOR having the ability to commit funding to joint activities and to send representatives to partners' meetings. We have strong partnerships with Future Earth, IOC,

PICES, POGO, and SCAR. This year, Marie-Alexandrine Sicre and I represented SCOR at the IOC General Assembly in June.

**Staffing—**Currently, I am working full-time for SCOR and Elizabeth Gross is working about one-third time as a contractor to handle many financial duties. I handle the regular duties related to the SCOR Secretariat each year, but this year I also did the following:

- Served as the project coordinator for the International Quiet Ocean Experiment (IQOE), which included planning and management of the first meeting of the IQOE WG on Arctic Acoustic Environments in January 2019. I have been helping the WG on Acoustic Measurement of Ocean Biodiversity Hotspots with a review paper. I am also serving as the first author of a poster on IQOE at OceanObs'19 and on an introductory article about IQOE in a special issue of *ECO Magazine* (see https://scor-int.org/IQOE/IOOE_Article_ECO_Magazine.pdf).
- Continued to work on implementing recommendations from the ICSU review of SCOR.
- Produced three *SCOR Newsletters*.
- Worked with the SCOR Committee on Capacity Building to manage approval of requests for travel support for developing country scientists to attend ocean science meetings, and the process to select new SCOR Visiting Scholars. Provided feedback on SCOR capacity-development activities for *Scientia* magazine (see https://www.scientia.global/from-coast-to-coast-building-capacity-in-ocean-science/).
- Served as staff for the IOCCP and GEOTRACES review panels.

I am working on several other publications as time allows, on the following topics:

- outcomes of the U.S. Program in Biology of the first International Indian Ocean Expedition,
- outcomes of the Visiting Scholar/Professor programs of SCOR and POGO (with Sophie Seeyave of POGO),
- survey of SCOR's role in the science of the ocean iron cycle (with Andy Bowie, Philip Boyd, Kristen Buck, Maeve Lohan, Sylvia Sander, Reiner Schlitzer, Alessandro Tagliabue, and David Turner),
- history of the development of the SCOR working group process, and
- development of SCOR-UNESCO Reference Stations as part of the first International Indian Ocean Expedition.

I continue to manage all SCOR Secretariat activities and oversee the finances of SCOR activities, pursue new funding for SCOR activities, represent SCOR at various meetings, help edit various publications, and work on the SCOR Web site and *Newsletter*.

As this is my final SCOR Annual Meeting as SCOR Executive Director, I would like to express my thanks to the ocean scientists involved in SCOR from around the world. It has been a pleasure to serve you for the past 19 years (as of 16 October 2019), building on the strong foundation established by Elizabeth Gross and George Hemmen, my predecessors. I have offered

to continue to help SCOR in various ways after my retirement and I hope to see many in the SCOR community in the years to come.

### 1.5 Appointment of an *ad hoc* Finance Committee *Sicre*

The Executive Committee appointed the 2019 Ad Hoc SCOR Finance Committee before the meeting, so the committee members can receive and review SCOR financial information in advance. Participation on the Finance Committee is limited to Nominated Members who are attending the meeting, but who are not members of the SCOR Executive Committee. This ensures that a group independent from the Executive Committee and SCOR Secretariat staff can make recommendations to the Executive Committee about SCOR finances. The members of this year's Finance Committee are Riitta Autio (Finland), Peter Croot (Ireland), Ilka Peeken (Germany), and Song Sun (China-Beijing).

### 1.6 2020 Elections for SCOR Officers *Burkill*

The election process for 2020 SCOR officers should begin after the SCOR meeting in Toyama, led by the SCOR Past President, Peter Burkill.