February Events:

6th February: *Climate Change in Australia & Demystifying the IPCC*

13th February: *The State Control Centre: Forecasting Victoria's Extreme Weather*

27th February: *Diamonds: An Implant's Best Friend*

March Advance Notice:

12th March: *Towards a Sustainable Energy Future*

26th March: *AQFx – A New Quantitative Smoke & Air Quality Forecasting System*

February 2020 Newsletter

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Climate Change in Australia & Demystifying the IPCC

The Penelope Whetton Memorial Lecture

Thursday, 6ᵗʰ February at 7:00pm

Climate change is literally the hot topic of our era – more than ever before, we are all seeing its impacts globally, with this summer's vigorous bushfire season in Australia driving calls for action by industries, governments and policy makers. In a time when science has become a critical aspect of our public lives, and the impacts of climate change are sweeping across our continent, it is now critical that we all understand the basic aspects of this area of scientific research.

Colleagues in the Earth sciences have been diligently working to quantify and project the impacts of human activities on the global climate for decades, developing predictive models that inform the official report from the UN Intergovernmental Panel of Climate Change (IPCC), which directs international policy. The IPCC Report is rapidly becoming one of the most impactful contemporary scientific publications. It is also often treated with skepticism by policy makers and the public.

Join us to learn more about the science of climate projections, the implications for our continent, and to demystify the process that takes us from scientific results to the publication of IPCC reports.

About the speakers:

Dr James Driscoll is an assistant lecturer at Monash University's School of Earth, Atmosphere and Environment. He works in geoscience education to help educators and researchers to communicate the complexities and nuances of climate science to their learning communities and the broader public. Jim is an active and much valued member of the RSV, convening the science community in and around the City of Monash to celebrate science and scientific work with a broad community of interest under the Inspiring Victoria program, including National Science Week.

Dr Chloe Mackallah received their PhD in Physics from Monash in 2018 working on stellar atmospheres. After graduating they felt compelled to change the course of their career to work in the subject of climate change. They now work at CSIRO in the Climate Model Development division. Their team works to improve simulations of important climate processes in the Australasian region, focusing on rainfall and weather extremes, as well as climate variability and change. This will allow for multi-year to multi-decadal projections, as well as enabling better forecasting on daily through to seasonal time scales. Chloe is also a recent addition to the organizing committee for Queers In Science.

This lecture is presented in collaboration with QueersInScience to commemorate the legacy of Dr Penny Whetton (1958 – 2019), a senior climatologist and expert in regional climate change projections due to global warming. Penny contributed as a Lead Author to the Fourth Assessment Report of the IPCC, which was awarded the Nobel Peace Prize in 2007. Penny was a valued member of the Royal Society of Victoria and a trans woman who underwent gender affirmation in 2003.

Places limited, bookings essential! *Formal function to follow from 7:30pm.* **Register online** now at https://rsv.org.au/events/climate-change-ipcc/, call or email the RSV office to secure your place: 9663 5259, rsv@rsv.org.au. Fully subscribed **RSV Members** can access discounted tickets by registering via their online profile, or entering their **promotional code** in the online ticketing window.

Weather Intelligence: Supporting Victoria's State Control Centre

Thursday, 13th February at 7:00pm
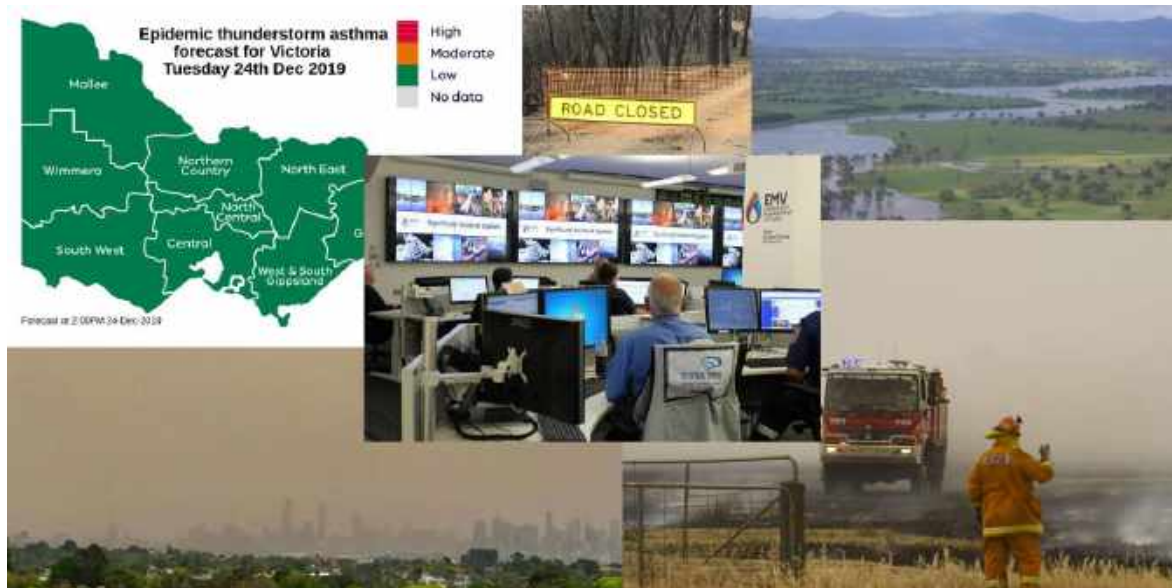
Emergency management organisations rely on the latest weather intelligence for preparedness and making decisions in an emergency. For the last ten years, a Bureau of Meteorology meteorologist has been embedded in Victoria's Emergency Centre, (known as the State Control Centre) to provide weather briefing services to emergency managers, operational practitioners and emergency personnel working at an incident.

Join Kevin Parkyn, who will share his journey in communicating weather intelligence leading up to and during high impact weather events to the emergency management sector. Kevin will also describe how advances in numerical weather modelling is changing the role of operational meteorologist through reference to several significant weather events that have impacted Victorian communities over the last 30 years.

About the speaker:

Kevin Parkyn is a senior meteorologist with the Bureau of Meteorology, having worked in severe weather and fire weather operations since the early 1990s. Since 2009, Kevin has been the embedded meteorologist at Victoria's State Control Centre, responsible for evolving the preparation and delivery of weather intelligence to emergency services. With an explosion of weather information from multiple platforms and providers in our modern age, Kevin is driven by the need to communicate targeted weather information, packaged with associated risk and confidence so that timely informed decisions by emergency managers are made.

Places limited, bookings essential! *Formal function to follow from 7:30pm.* **Register online** now at https://rsv.org.au/events/weather-intelligence/, call or email the RSV office to secure your place: 9663 5259, rsv@rsv.org.au. Fully subscribed **RSV Members** can access discounted tickets by registering via their online profile, or entering their **promotional code** in the online ticketing window.

Diamonds: an Implant's Best Friend

Thursday, 27th February at 7:00pm
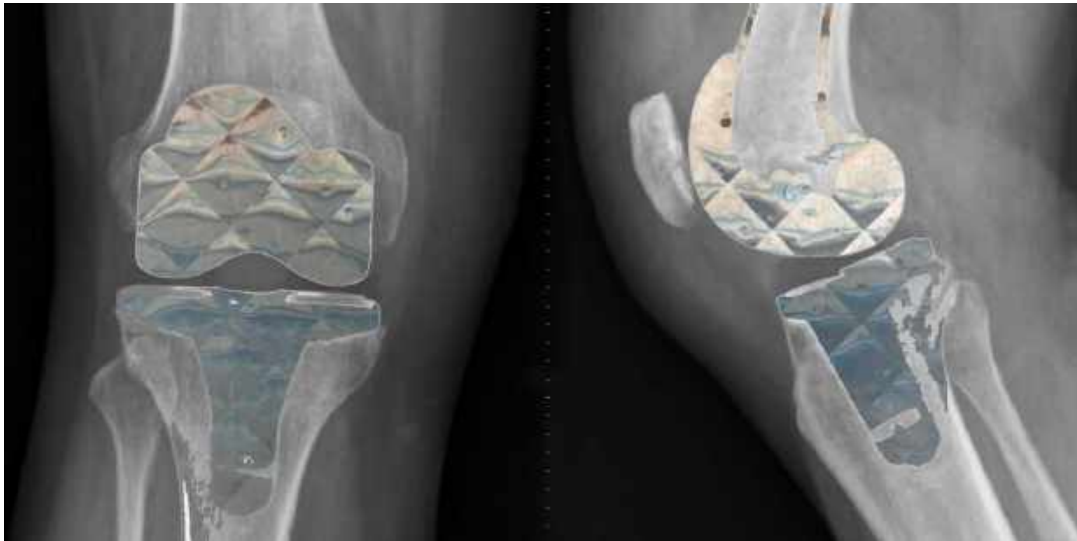
3D printing is fast transforming medicine, providing an avenue for personalised implant technology. As "just in time" implant technology progresses, where a patient-specific implant can be produced during treatment of bone tumours, more avenues for application are appearing. With improvements to the technology, new materials are being investigated for medical implants.

Diamond, while not the most obvious material for this purpose, is showing considerable progress as a novel and interesting option. Diamond exhibits exceptional chemical, physical and biological properties unlike conventional counterparts such as titanium. Join biomedical engineer **A/Professor Kate Fox** to chart diamond's progress from providing a coating surface for heart valves to application as a conductive material for retinal implants, all the way to its latest application as a 3D printable implant surface.

About the speaker:

Kate Fox is an Associate Professor in the **School of Electrical and Biomedical Engineering** at **RMIT University.** Her research is focused on developing diamond as an orthopaedic biomaterial. Kate is a biomedical engineer with significant experience and expertise in hydroxyapatite coatings and implant design for orthopaedic applications. She has experience in hybrid material design, surface science characterisation techniques and implants. Prior to joining RMIT, she was part of the Bionic Eye Project, working to develop a high acuity diamond electrode capable of electrically stimulating retinal tissue. With prior experience as a patent attorney, Kate is experienced in working in highly complex, transdisciplinary projects, coordinating research teams and providing the surgical integration necessary to transition an engineered product into a surgically feasible product. Kate is one of Science & Technology Australia's Superstars of STEM, a program equipping high-achieving female scientists and technologists with advanced communication skills in the media, on the stage and in speaking with decision makers.

Places limited, bookings essential! Register online now at https://rsv.org.au/events/diamond-implants/, call or email the RSV office to secure your place: 9663 5259, rsv@rsv.org.au. Fully subscribed **RSV Members** can access discounted tickets by registering via their online profile, or entering their **promotional code** in the online ticketing window.

Nominations for RSV Membership

Nominations for membership of the Society have been received on behalf of:

Dr Philip **HEGARTY**, General Practitioner, Parkville Medical Centre

Professor David **GRAYDEN**, Biomedical Engineer, The University of Melbourne

Professor Andrew **PITMAN** AO, Director, ARC Centre of Excellence for Climate Extremes

Mr Alex **O'BRIEN**, Student, Koonung Secondary College

Mr Paritosh **SHARMA**, Management Consultant, KPMG Australia

Unless Members request a ballot, these will be considered for election by Council and if elected, will be announced at the Ordinary Meeting of the Royal Society of Victoria to be held on 12th March 2020. Recently elected members who have not yet signed the Society's membership book are warmly invited to attend the 13th February meeting to be formally welcomed as members. **Please inform the office if you plan to attend, so we can prepare your membership certificate and welcome pack for collection.**

From the President

A great start to 2020 for RSV Members

I would like to thank the RSV Members who offered to help fellow Members in response to my message in early January regarding people affected by the ongoing bushfires in Victoria. Your support is much appreciated. It showed me that our Members, like so many in the Victorian community, are very generous in their support of those facing difficulty. Thank you to all.

I was delighted to welcome about 70 guests and members who attended our first of three lectures as part of the QueersinScience Lecture Series timed to coincide with this year's Midsumma Festival. By the time you read this the second lecture has been held and we look forward to seeing you at the third - details are earlier in this newsletter.

As you read about other February events and activities in this newsletter, please think about your friends, family members and colleagues who might like to attend our presentations with
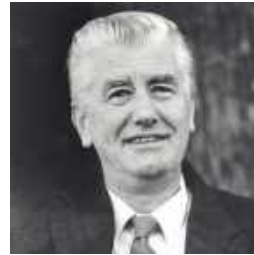
you. I look forward to catching up with as many members and guests as possible.

If you wish to contact me about any RSV matter, please email me at president@rsv.org.au or call me on 0418 346 999.

- **David Zerman**
  President

Vale

Dr David Maughan Churchill, 1933 -2019

RSV Trustee,RSV President, 1983-84

The Council of the Royal Society of Victoria records with sadness the passing of Dr David Maughan Churchill on Monday, 16 December 2019.

His contribution to the life and leadership of our Society has been significant, not just as one of our four Trustees, but also as our President from 1983 to 1984. David's election was a meaningful moment in our long succession of science community leaders, as his corresponding tenure as the Government Botanist of Victoria and Director of the Royal Botanic Gardens (RBG) recalled the role and contribution of our first (Royal) President, Baron Sir Ferdinand von Mueller, in 1859, and perpetuated the long relationship between the RBG's scientific leadership and the RSV.

In recent years, David's enduring dedication to our mission to promote science in Victoria was capably demonstrated through occasional yet sustained attendance at our public lectures, particularly those concerned with the environmental sciences, despite the challenge of travel from Apollo Bay to Melbourne. Acting as one of our four Trustees for decades, David governed the terms of the Crown Grant that enables our headquarters in the Melbourne CBD to be used for the purposes of promoting the progress and utility of science in Victoria.

For his gracious and incisive leadership, we remain most grateful to David and his legacy, and convey our sad condolences to Sylvia and family.

Please Renew Your Membership

As a membership organisation we rely on your active subscription to maintain our programs and govern our Society. Please ensure you are a financial member.

Prompts will have recently been emailed to all members due for subscription renewal; you can call the RSV office on 9663 5259 to renew over the phone, or log on to your membership profile at https://www.joinit.org/o/rsv/members to renew online.

2020 RSV Council Elections

Thanks to all members who have agreed to be nominated as candidates for ordinary member positions on Council for the 2020 to 2022 period.

As we have received five excellent nominations for the five available positions for ordinary members of Council, **an election will not need to be held.** Please congratulate the following RSV members on their two-year appointment to Council from the forthcoming Annual General Meeting:

Dr Kevin Orrman-Rossiter MRSV

OneCRM Research & Enterprise Domain Lead, University of Melbourne

Dr Kevin Orrman-Rossiter has a passion for science and its positive impact in society. Kevin sees the Royal Society of Victoria as the active hub of science activity and promotion in Victoria, and influential across Australia. With that intention, Kevin has been an active councillor for the past four years - since 2017 Chairing the Science & Awards Committee - who put together the bi-monthly science presentations and coordinate the RSVs Young Scientist Award and the Philip Law Postdoctoral Award.

Kevin has worked in the Research, Innovation and Commercialisation group at the University of Melbourne since 2013. He originally trained as a physicist at RMIT, moved to Manchester to work on the surface science of semiconductor materials on MoD and SERC research projects whilst earning a PhD from the University of Salford. After postdoctoral work in the UK he returned to Australia in 1990 as an ARC Queen Elizabeth II Fellow.

Kevin then left academia and joined Amcor as a Principal Research Scientist. His commercial career evolved into marketing and strategy for the NAB, Australian Unity and private consulting before moving to the University of Melbourne.

Dr Sophia Frentz MRSV

Graduate Consultant, Technology, Strategy & Architecture, Deloitte

During my four years of time on the Royal Society of Victoria's council, I have had the pleasure of engaging in both the ongoing operations of the Society through my role as a co-chair of the Memberships and Mentoring Committee and membership of the Outreach Committee, but also through facilitating the workshops and planning going towards the future of the Royal Society of Victoria.

My core passions for the future of the Society are sustainability, accessibility, and inclusion, and I aim to support the RSV surviving and thriving for another 160 years.

Dr Jane Canestra MRSV

Medical Practitioner and Emergency Physician (retired)

I have had a life-long passion for science, particularly science education. With a career in emergency medicine, public health and emergency management, I see effective science communication and evidence-based public policy as crucial to community well-being.

I have expertise in risk management; executive experience in hospital management; considerable experience in state, national and international liaison representing government agencies; and I am a member of the Radiation Health and Safety Advisory Council of the Australian Radiation Protection and Nuclear Safety Agency.

I can contribute to the fundamental role of the Royal Society of Victoria in the promotion of science, science education and raising public

awareness of the contribution of science to daily life and future development of community welfare. I believe the Royal Society should be a key influencer in the promotion of evidence-based understanding of science in public policy.

The Society faces some challenging circumstances and I am prepared to invest my time and energy to the resolution of these matters.

Dr Catherine de Burgh-Day MRSV

Research Scientist, Bureau of Meteorology

I'm an early career researcher who has worked in multiple fields including astrophysics, economics, oceanography, and software engineering. I have a PhD in astrophysics from the University of Melbourne, and now work in Seasonal Prediction at the Bureau of Meteorology.

I've been a member of the Society since jointly winning the Young Scientist Research Prize in 2015 and have had the honour of serving on the Council since 2017.

I'm passionate about enabling the Victorian community to connect with science and scientists. I believe the Royal Society of Victoria is uniquely positioned to do this through our public lectures, the Inspiring Victoria program, and more. I believe we also provide great value to the Victorian scientific community through the forums and workshops we facilitate.

I will be doing everything I can to help the Society grow and to best serve Victorian science and science communication. I bring experience with numerous governance groups, including the Australian Astronomical Observatory User's Committee, the Harley Wood Winter School Local and Science Organizing Committees, and as Executive Officer of the *Journal of Southern Hemisphere Earth System Science*.

I'm excited to continue serving the members of the Society as we move towards a promising future!

Dr Gavin Smith MRSV

MICA Paramedic (Clinical Instructor, Single Responder)

Having engaged in academia as Chair of Paramedicine at Victoria University for the previous five years, I have returned to serve the Victorian community as a MICA Paramedic with Ambulance Victoria (AV), a position I have now held for 28 years. My work has resulted in development of evidence-based prehospital Clinical Practice Guidelines across Victoria and Tasmania, changing paramedic management of patients in these States. Previous appointments include membership of the AV Medical Standards Committee, Monash University Prehospital and Emergency Medicine Trauma Group, and as Associate Editor of the *Australasian Journal of Paramedicine*. These positions have further enhanced my skills in research, management, mentorship, and editorial roles.

I will continue to further the principles and goals of the Royal Society of Victoria in promoting science to the Victorian community, specifically through the Membership and Mentoring Committee, pursuing innovative and inclusive measures to grow our cohort. I will continue to be a proactive and constructive member of Council, engaging and involving paramedicine and the wider Victorian community in understanding and promoting science. I look forward to the opportunity to continue engaging with RSV members and will always represent the interests of the Society and its membership.

Australia Day Honours 2020

Congratulations to the following RSV members acknowledged with an honour within the Order of Australia on Australia Day:

Dr Peter George Thorne AM

For significant service to computer science education, and to history.

Professor Rachel Lindsey Webster AO

For distinguished service to education in the field of astrophysics, to astronomical research, and to young women scientists.

Problems and Problem-Solving Around Epilepsy

by Catriona Nguyen-Robertson MRSV

Image: Frank Dicksee, The crisis (detail), 1891, oil on canvas,122.4 × 158.1 cm, National Gallery of Victoria, Melbourne

This article follows a presentation to the Royal Society of Victoria on 28 of November titled "Epilepsy, Algorithms and AI: Personalised Seizure Forecasting" by Professor David Grayden.

"Epilepsy is a big problem," according to **Professor David Grayden**, a biomedical engineer at the University of Melbourne. It affects 1% of the world's population.

Among epileptic patients, 70% are effectively treated with drugs and live a generally normal life, but the other 30% are resistant to these drugs. Some can get around this by having invasive surgical procedures. Yet despite progress of the last 30 years to improve epilepsy treatment, the percentage of patients who cannot be treated remains at 30%.
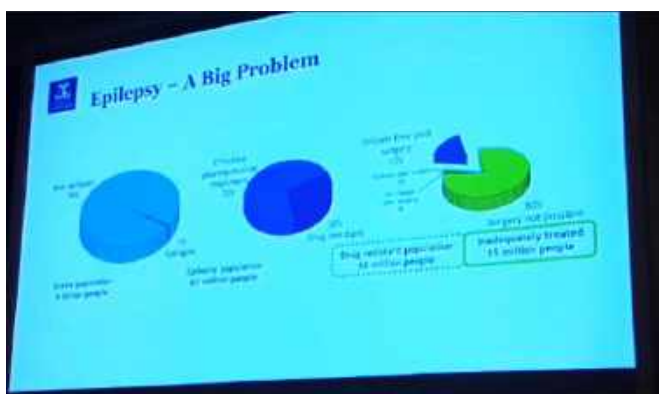
Of the 30% of epilepsy sufferers resistant to pharmaceutical treatment, only 17% can resolve their seizures through surgery.

Seizures – whether big or small – can make it dangerous for people going about their everyday lives. If you do not know when a seizure is coming, it limits the amount of control you feel you have over your body. For those patients who cannot control their seizures with drugs, swimming, bathing, driving, and certain jobs become too dangerous. If they lose their job, this leads to stigma and social isolation. But above all, the most pressing reasons advance epilepsy treatment is the prevention of sudden death due to seizure.

One of the most debilitating aspects of epilepsy is the uncertainty of when a seizure will occur – even if they are as infrequent as two a year. If you don't know when the seizures will come, you cannot know when you are safe.

Professor Grayden wants to remove this unpredictability in a person's life. The ability to predict the onset of seizures would change the lives of over 15 million people.

The Melbourne NeuroVista Seizure Prediction Trial was launched in 2009 as a collaboration between multiple institutions, including the Graeme Clark Institute. In the trial, 16 electrodes were implanted in the brain to measure brain activity, which communicated with an external seizure warning device. A total of 15 patients with drug-resistant epilepsy were enrolled in the study and monitored continuously for up to three years – the first time a study like this had ever been done.

An algorithm was trained using data from each patient's electroencephalogram (EEG) (their electrical brain activity), and for most patients, was able to indicate low, moderate or high probability of seizure occurrence with a series of coloured light indicators. A red light indicated high probability of seizure – and seizures did often occur at times that the light was red. This demonstrated that seizure prediction was indeed possible, but the red

light seemed to be on for most of the time, which was not ideal.

It is difficult to train algorithms on few seizures, so the team needed to apply more sophisticated artificial intelligence (AI) approaches. In partnership with IBM Research, they generated a deep learning neural network, the "TrueNorth chip", a cognitive computer that combines AI and machine-learning algorithms to mimic the behaviour of the human brain. Team input previously recorded intercranial EEG recordings from the original Neurovista study participants for the deep learning system to develop a new warning model. The deep learning systems continually adjusted itself as it made mistakes (much like humans do). Its caveat, however, was that it relied on pre-existing training data. An even better algorithm was needed so that each individual could have a personalised warning system.
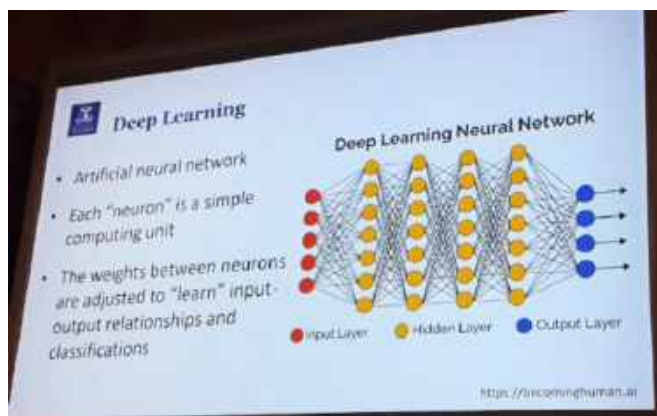
Data scientists around the world were invited to develop an algorithm for the team's data and over 10,000 were submitted that aimed to improve the sensitivity of the epilepsy monitor – making sure that the device gets its warnings right without having the red light constantly on. The team selected the top several algorithms that had the best balance between the two – the next problem was that most of the algorithms required a super-computer to run.

The solution was to consider the brain's capacity to rapidly change state. Prior to a seizure, brain signals can exhibit a *critical slowing*, which indicates that the brain is wobbling between normal and seizure states. The team analysed EEG recordings to find key signatures of critical slowing prior to seizures, which turned out to be the most reliable

indicator for their seizure forecasting algorithms.

Citizen science: Professor Grayden's team crowd-sourced global data expertise through Kaggle and the resources of strategic partnerships.

Seizure diaries can also be used to forecast seizures so long as patients accurately monitor their own seizures. The team observed cycles in which people tended to have seizures at particular times of the day, or week, or month (e.g. if a person has a seizure once a week, it tends to be on a weekend). Tracking these cycles could hence help determine times a person is most at risk or not at risk at all.

Professor David Grayden (centre) with Councillor Professor David Walker MRSV (left, vote of thanks) and Vice-President Mrs Nicola Williams MRSV (right, Chair).

Engineering, biology, bioinformatics, and data science have converged to make it possible to forecast seizures. Professor Grayden and colleagues are working to ensure that each person will be at low risk more than 50% of the time so that they can go about their everyday lives without the worry and stigma associated with unpredictable seizures.

Blue Haze

by Priya Mohandoss MRSV

While travelling through the Yarra Ranges, be it the winding road from St Andrews to Kinglake or a stretch of the Melba Highway, you are most likely to notice a bluish haze resonating from the mountains above. This phenomenon happens as a result of the emission of biogenic volatile organic compounds (BVOCs) that are released from the abundance of eucalyptus in these areas. When the oils from this genus combine with dust particles and water vapour, and then react with sunlight, a scattering of short wavelengths are produced, causing a blue colour to appear in the surrounding atmosphere.

The "Blue Dandenongs"

The BVOC that is the source of this reaction is called isoprene and it is a major chemical in trees. Globally, trees and shrubs are able to release over 500 million tonnes of isoprene per year and in Australia, eucalypts emit one of the highest levels of this chemical into the surrounding air. It is biogenic in character as it is made due to the fact that it comes from living organisms or formed through biological processes.

Apart from being a natural air pollutant and the main component in the composition of photochemical smog, isoprene also acts as a defence mechanism in plants. As a result, it is capable of deterring insects and also shields plants from other hazards such as overheating, which can disrupt the process of photosynthesis.

In general, BVOCs vary in their method of emission. Some of the chemicals are found inside the tissues of plants that are kept insulated from the atmosphere and are only released when there is some form of tissue damage. Other compounds are regularly transmitted into the open air. In addition to this, some BVOCs spread presently after being made instead of being stored. This reaction happens to counteract stress, including during crisis events such as bushfires.

While we are fortunate enough to witness the beauty of this blue haze, we also must acknowledge its perils and predicament too.

My thanks to Priya for this fascinating piece! Interesting to note from further reading the prospect of certain species of trees emitting higher levels of BVOCs with a warming global climate, which can result in the formation of harmful, ground-level ozone. Plainly this risk should further inform careful species selection in planning for urban forests in particular. - Mike

A Warming Climate's Extremes

by Catriona Nguyen-Robertson MRSV

This article follows a presentation to the Royal Society of Victoria on 12 of December titled "Climate Extremes: Present and Future" by the 2019 Research Medallist, Professor Andrew Pitman.

It is all very well to present facts.

It is a fact that levels of greenhouse gases are increasing in the atmosphere. It is also a fact that we are experiencing global patterns of accelerated warming.

Professor Andrew Pitman, Director of the Australian Research Council (ARC) Centre of Excellence for Climate Extremes, presented the Royal Society of Victoria with many alarming facts. As the recipient of the RSV

Research Medal in its 60th year, he delivered a seminar explaining why we should care about these climate science facts.

Since our earliest records, an extra 2 Watts has been added to Earth's energy balance per square metre. According to the laws of physics, this energy has to do work - and so it does: it heats our planet. The global average temperature has increased by 1.1∘C. We are losing 127 gigatonnes of Antarctic ice per year while sea levels rise 3.3 mm per year. These changes are directly attributable to greater carbon dioxide levels. But what does this mean for us and our everyday lives?
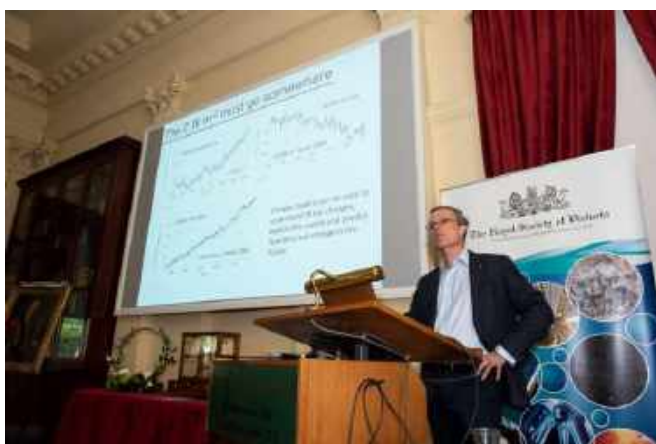
Heatwaves are becoming longer, hotter, and more frequent. Professor Pitman recalled the heatwave of January 2009, when it reached 47∘C, leading to over 200 premature deaths, buckling train lines, and a loss of approximately $800 billion. We are also in the midst of a national bushfire crisis, severely affecting multiple communities, Australian biodiversity, air quality, the loss of homes and life, and calling on a massive number of volunteers to aid however they can.

It does not help that Australia has experienced a drying trend. "Drought is becoming the default position," says Professor Pitman. And whatever rain we have left has intensified into short, extreme rainfall events. This affects the agricultural industry, bushfire season, and our personal lives as we avoid floods and hail.

Professor Pitman is concerned that climate scientists are underestimating how quickly situations can change. Current climate models cannot capture the persistence of drought and length of heatwaves, and they struggle to

simulate future rainfall extremes, sometimes because they offer conflicting results.

Climate prediction and greenhouse gas emission models are not just in the hands of climate scientists. They have to take the human population into account – demography, economics, technology, and our actions. The modelling of future carbon dioxide emissions provides multiple possible futures depending on these. Professor Pitman asks "what do you want for your future? Which do you think we can achieve?"

Global warming is not merely a problem of the environmental sciences. Social scientists, business leaders and economists have to consider how our society will influence our future, and how the environment will influence our society. For example, studies have revealed a correlation between rising temperatures and reduced work productivity in Oceania (and increased productivity in Europe).

Professor Pitman is not interested so much in what the global temperature will be, but rather in determining how this will be expressed in weather and temperatures that we feel. Will our roads become liquified due to heat? Will

we have drought or floods? Will our houses be hit by large hail stones?

Led by Professor Pitman, the ARC Centre of Excellence for Climate Extremes uses its researchers, data, modelling, and collaboration to advance Australia's capacity to predict climate extremes and minimise the risks of extreme weather phenomenon to our environment, society and economy.

Questions from the floor: Rob Gell MRSV

Professor Todd Lane and **Dr Claire Vincent** at the University of Melbourne study atmospheric processes. They have developed high-resolution cloud and weather prediction models to determine the processes controlling rainfall extremes and better predict them.

Professor Andy Hogg and **Dr Andrew Kiss** at the Australian National University, in collaboration with the Bureau of Meteorology and CSIRO, study ocean-atmosphere interactions and can simulate the intricacies of the flow of the Southern Ocean. They are close to achieving the highest resolution in the world for ocean-climate system models.

The RSV's first Research Medallist (1959, Dr George Baker MRSV, also an Earth Scientist (geology).

Climate science needs computation, data scientists, scientists and technical people to work together. Currently the best computing power is only a tenth of what is needed. Professor Pitman encourages interdisciplinary science moving into the future, so that we can best prepare ourselves with the best climate prediction models.

Climate change affects everyone and is a battle we need to fight together. Professor Pitman was presented the RSV Research Medal for his outstanding leadership, research, and innovative thinking by **Dr Gillian Sparkes**, Victoria's Commissioner for Environmental Sustainability. Climate change is not just a science problem, which is why he calls for leaders in all fields to come into the conversation too. The more we know about the future, the better prepared we will be, and perhaps we can even change it.

Professor Andrew Pitman is presented with the 2019 RSV Medal for Excellence in Scientific Research by Dr Gillian Sparkes MRSV, Victoria's Commissioner for Environmental Sustainability.

Photo highlights from the 160th Anniversary Function:

RSV colleagues spontaneously form a "Coriolis of Climate Scientists" with Professor Pitman.

The RSV Functions Team! From left, Cassandra Ferry, Samuel Smale, RSV Events Manager Malourie Crawford and Nikki Wood.

Kate Barnard from Scienceworks (Museums Victoria) and Deputy Chair of the Science Week Coordinating Committee talks partnerships and National Science Week – again, with a continued, close alignment with the RSV in 2020.

Anne Sarr MRSV, RSV Trustee James Warren MRSV, RSV Secretary Peter Baines MRSV, RSV CEO Mike Flattley, Norman Taralrud-Bay MRSV, Monica Parravicini and Manju Mohandoss MRSV.

Paula Kelly Paull from the Hobson's Bay City Council, Public Libraries Victoria and the Inspiring Victoria Board talks about the involvement of public libraries in lifelong learning in the sciences - Libraries Change Lives!

Andres Lomp from the Parliament of Victoria talks partnerships and National Science Week – including the exciting prospect of a return to Parliament House in 2020!

Acknowledging the 2016 Medallist in the Earth Sciences category, climate scientist Professor David Karoly MRSV, with RSV Councillor Pam Borger MRSV, Immediate Past President Bill Birch MRSV, Andrea Smith, Sharon Orrman-Rossiter, and RSV Councillors Gavin Smith MRSV and Kevin Orrman-Rossiter MRSV.

Our Caretakers: RSV Business and Membership Manager James McArthur with Amanda McArthur.

Sue Humphries MRSV and Tessa Barrett MRSV.

Rupert Dalley MRSV, Tom Beer MRSV, Peter Thorne MRSV and Jim Warren MRSV.

Shining a Light on Patients

by Catriona Nguyen-Robertson MRSV
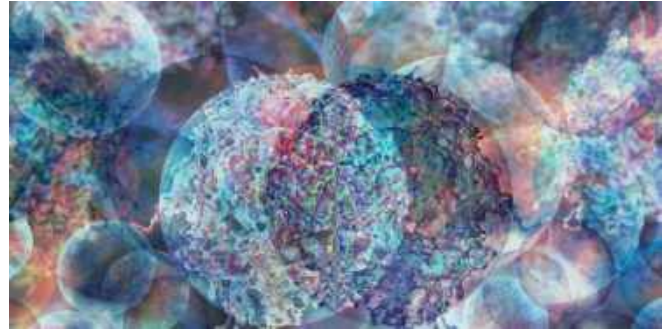
This article follows a presentation to the Royal Society of Victoria on 24 of October, 2019 titled "Nanomaterials: Exploiting Colour and Light" by Dr Rajesh Ramanathan.

'For most of the problems we try to solve, nature has already done it for us' – Dr Rajesh Ramanathan.

Winner of the 2019 Phillip Law Postdoctoral Award for Physical Sciences, **Dr Rajesh Ramanathan** shared his journey to incorporate elements of nature into the design of nanoparticles for a wide range of biomedical applications. By shining a light on patients and nanoparticles, he can reveal their glucose levels, repair their wounds, and image their tumours.

Dr Rajesh Ramanathan with RSV President David Zerman.

Whenever Ramanathan was sick as a child, he was interested in why. He constantly engaged with doctors to ask what was going on in his body and how his treatments worked. He also enjoyed reading *Prey* by Michael Crichton, a novel in which nanotechnology seemed merely science-fiction. Little did he know that

he would one day be pioneering new nanotechnology in biomedicine.

In an eco-friendly production method, Ramanathan makes use of bacteria to manufacture nanoparticles as "nanofactories." Bacteria are currently widely used in biotechnology as factories to produce large numbers of proteins and DNA for clinical and research purposes, so he was able to manipulate them to instead churn out nanoparticles, the production of which is naturally a part of certain bacteria species' mechanism for surviving high metal ion concentrations in their environment.

Ramanathan links his past research in sensing technologies as a postdoctoral fellow at the University of Massachusetts with his current research to develop nano-sensors. He is developing a non-invasive, sensitive glucose sensor for diabetics so that they no longer have to monitor their blood. The foundation of current glucose sensors are two chemical reactions testing for blood glucose levels: glucose is oxidised, producing hydrogen peroxide, which is then broken down into water by peroxidase, causing a visible colour change measured by the sensor. To avoid using blood and to combat the rapid degradation of peroxidase, Ramanathan mimicked its activity with a nanozyme (nano-enzyme) and found that it can detect glucose with a similar reaction using urine. He first used silver-based nanoparticles but these were saturated very quickly high glucose concentrations in urine in that they could not distinguish between medium and high glucose levels. To overcome this, he used copper instead of silver, which was sensitive enough but also oxidises easily, interfering with the glucose oxidation result. By dipping the copper nanoparticles in gold, silver

and platinum, this overcame all hurdles to allow for a detectable colour change in the presence of glucose that can be easily measured by patients themselves.

Ramanathan and his team also designed nanoparticles that use small, engineered single strands of DNA (ssDNA aptamers) to bind specific DNA targets from bacteria. The ssDNA aptamers are linked to nanozymes so that they undergo a reaction when the aptamer finds its target DNA that is visible as a colour change.

In face of the alarming rise of superbugs that are resistant to many antibiotics, we need better methods of detecting superbug infections and identifying ways to treat infection. One of the most common superbugs is *Staphalococcus aureus* (golden staph), which is usually harmless, but if it picks up genetic elements that confer antibiotic resistance and get inside the blood, it can cause severe infection. Similar to our ability to detect distinct smells by recognising combinations of odour molecules, Ramanathan created a 'chemical nose' for detecting these superbugs. He generated a unique colourmetric fingerprint for the DNA of each strain of *S.aureus* as well as different genetic elements that encode antibiotic resistance. The ssDNA-nanozyme

nanoparticles can detect the presence of a particular bacterial strain in an infection and determine which antibiotics can be used to treat it based on the combinations of DNA sequences it has.

Wound management

Using light to kill bacteria and heal wounds

- Chronic wound management 'new global epidemic'
- 400K people affected in Australia alone ($3 billion per year – 2% of total national healthcare expenditure) *Australian Centre for Health Services Innovation (2017)*
- Electrical stimulation therapy (very effective but has its limitations)
- Most commercial products typically control bacterial growth
- Our textile shows outstanding ability to control bacterial growth and promote wound healing when you shine IR light on them

Another application for Ramanathan's nanotechnology is in wound management. He designed nanozymes that break down hydrogen peroxide into hydroxyl radicals in the presence of light. Hydroxyl radicals are produced by the immune system in response to bacteria, and therefore this is another example of mimicking nature. The nanoparticles also deliver pain-free electric stimulation to accelerate wound healing, which has been used previously by sticking electrodes in the wound in a painful process that could occasionally do more harm than good. By embedding these nanoparticles into fabric, Ramanathan designed a bandage that acts both as an antibiotic and promoter of healing when activated by infrared light.
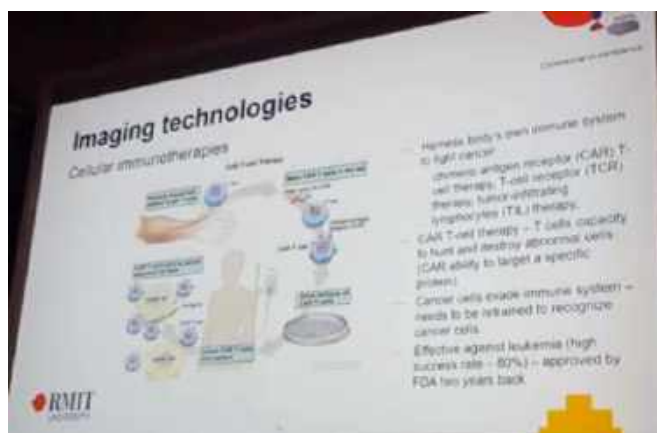
Lastly, in a project that has been in the making since 2012, Ramanathan has designed nanoparticles that can be combined with cancer immunotherapies to image tumours. An exciting cancer immunotherapy, for which

Australia is at the forefront of developing and using in clinics, is CAR-T cell therapy. Specialised immune cells called T cells are taken from the patient and manipulated so that they can efficiently target and kill tumour cells when re-delivered to the patient. Ramanathan linked radioactive tracers to the CAR-T cells so that when they migrate to the site of the tumour 24-48 hours after delivery, they can be used to image the tumour with a combination of MRI and PET scanning techniques. This will be an available product within the next month, so stayed tuned to see it in the clinic.

Dr Ramanathan is presented with the 2019 Phillip Law Postdoctoral Award for the Physical Sciences by RSV President David Zerman.

Ramanathan combines nanoparticles with light to achieve a wide range of biomedical applications. From sensing chemicals and bacteria, to healing wounds and imaging patients, his nanotechnology is at the forefront of biomedical science and its potential is endless.

RSV Councillor Dr Kevin Orrman-Rossiter MRSV (vote of thanks), Dr Rajesh Ramanathan, RSV President David Zerman MRSV (Chair), Ms Deepa Subramanian.

Videos of RSV Lectures and Events

Recent Transactions as of February 2020

*Livestream video recordings of our lectures and presentations are streamed live via the RSV's **Facebook** site and archived in our "videos" section on conclusion. A selection of playlists are displayed below – these and others can be accessed from* https://www.facebook.com/pg/royalsocietyvictoria/videos/ .

2019 RSV Lectures

30 videos · Updated 3 seconds ago

Archived livestream video presentations at the Royal Society of Victoria.

1:13:57	1:02:17	58:25
Climate Extremes: Present and Future	Epilepsy, Algorithms and AI: Personalised Seizure Forecasting	Pyrodiversity: Fire and Wildlife in the Anthropocene
632 views · 12 December 2019	187 views · 28 November 2019	717 views · 26 September 2019

National Science Week

4 videos · Updated 3 seconds ago

Highlights from events during National Science Week

3:53	9:38	1:05:21
Extrasensory - see, feel, hear, touch, taste, more!	Science at the Extreme - National Science Week Launch 2019	National Science Week Community Briefing - underway
432 views · 30 September 2019	222 views · 6 December 2019	386 views · 18 March 2019

The Science of the Regional Forest Agreements

11 videos · Updated 14 seconds ago

The Royal Society of Victoria and the Department of Environment, Land, Water & Planning are partnering to deliver this series of talks concerning the... See more

1:20:52	42:54	1:17:32
First session: the Contribution of Forests to Global Carbon Cycles. ...	Second session: the Contribution of Forests to Global Carbon Cycles. ...	The Conservation of Water & Soil Resources: Rne Van der Sant,...
1.3K views · 24 September 2019	273 views · 24 September 2019	139 views · 25 July 2019

YouTube Channel

High quality digests and long-form videos of recent RSV lectures are available from our YouTube channel - http://tiny.cc/kx5q7y will take you to the list below.

The Royal Society of Victoria
90 subscribers

Darkness Visible Down Under (Short)

Mind Over Faecal Matter: Gut Biome & Mental Health (Short)

Social Work - Collaborative Human-Robot Interaction (Short)

Modernisation of the Regional Forest Agreements

The Royal Society of Victoria and the Department of Environment, Land, Water & Planning (DELWP) are partnering to deliver this series of talks concerning the science underpinning the modernisation of Victoria's Regional Forest Agreements, addressing each of the criteria listed in the latest State of the Forests report, released in 2019 by the Commissioner for Environmental Sustainability (https://www.ces.vic.gov.au/articles/scientific-report-card-victoria%E2%80%99s-forests). High quality video of proceedings has been produced by DELWP and are available from their Future Forests site at https://www2.delwp.vic.gov.au/futureforests/forest-values-assessment/public-lecture-series - footage currently online incorporates four of the five public lectures convened thus far.

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