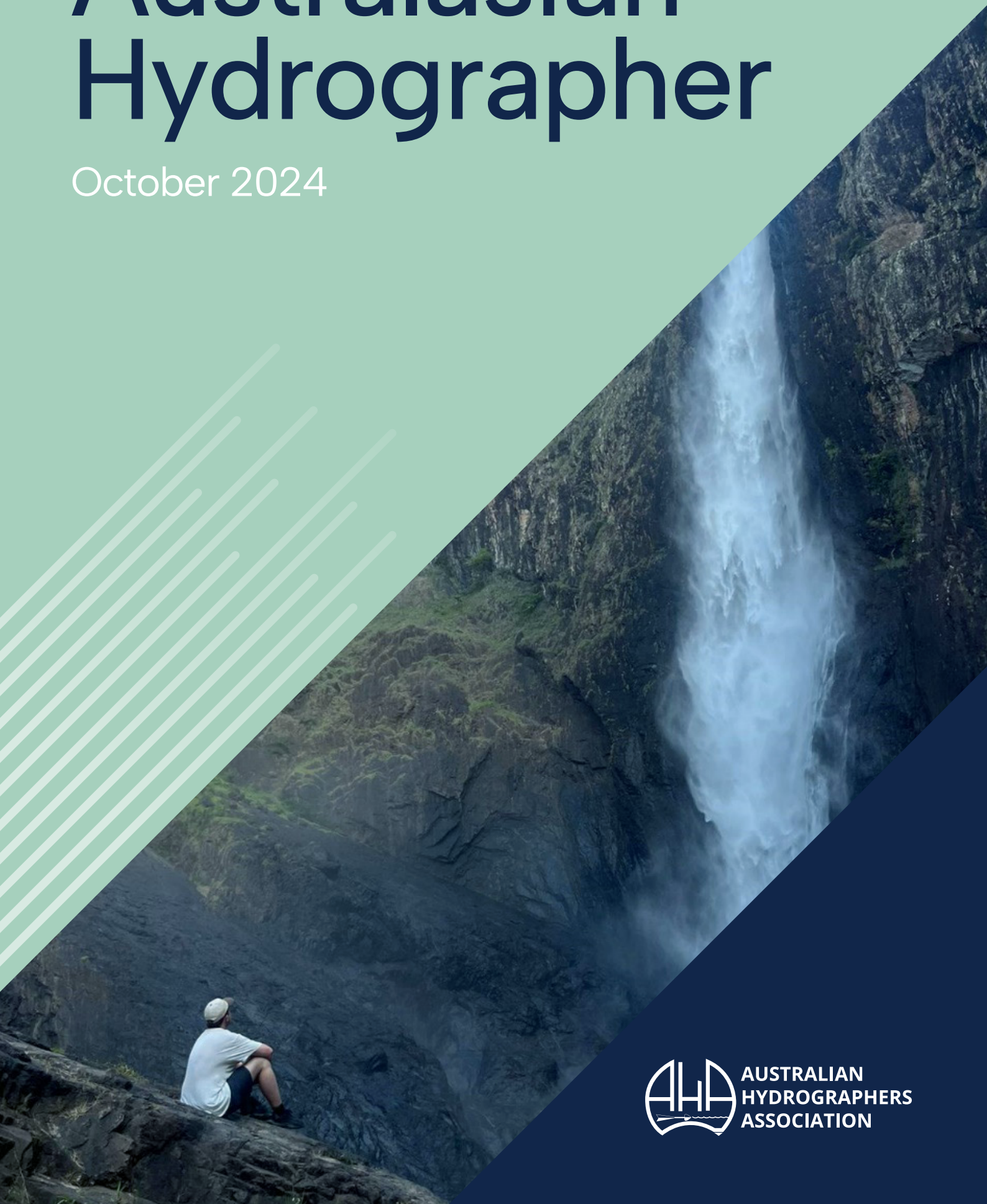
Australasian Hydrographer

October 2024



AUSTRALIAN HYDROGRAPHERS ASSOCIATION

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Wallaman Falls – Wallaman, Queensland

Acknowledgement of Country

The AHA acknowledges the Australian Aboriginal and Torres Strait Islander peoples of this nation. We acknowledge the traditional custodians of the lands on which our association is located and where we conduct our business. We pay our respects to ancestors and Elders past, present and emerging. The AHA is committed to honouring Australian Aboriginal and Torres Strait Islander peoples' unique cultural and spiritual relationships to the land, waters and seas and their rich contribution to society.

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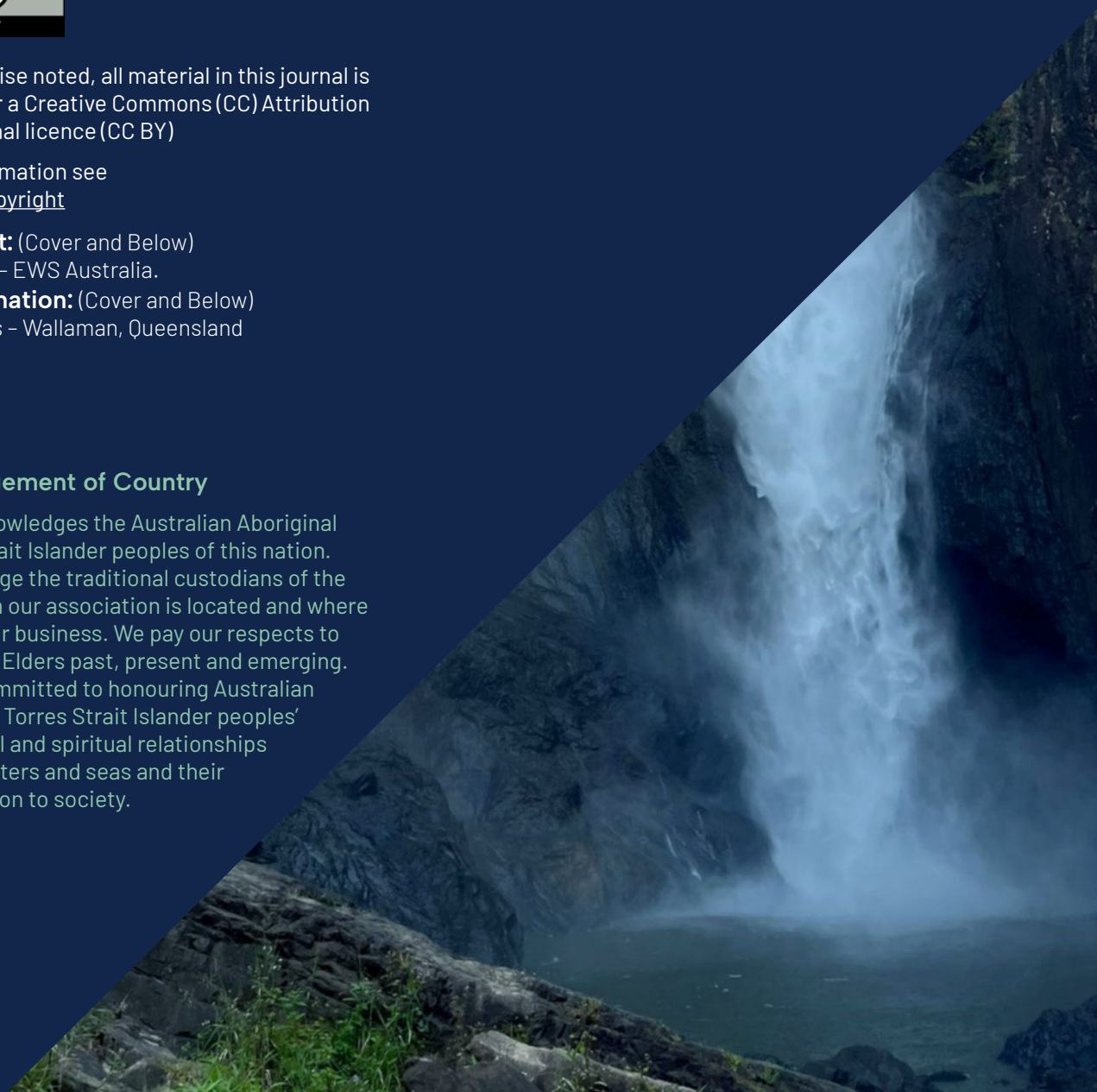


From the Editor-In-Chief

Zac Ward

As we edge closer & closer to the end of 2024 it's awesome to see the wider cohort of Australian Hydrographer's out there training, networking and collecting those precious CPD points for ongoing AHA Certifications.

A great example of this is contained in this edition with the inaugural Technical Water Monitoring Training held in Darwin by the AHA & associated sponsors. More info and no doubt more training events to come so please keep your ears and eyes peeled for any upcoming workshops in your area. Some truly invaluable, hands-on training from some of the industry's best and most well-travelled (I mean that in a nice way). thanks to everyone who helped contribute and assist in pulling this all together. No doubt there will be more from Arran below who was front & centre for all the week long event.

There will be more AHA Training Events moving forward through the remainder of 2024 & 2025 with the next one scheduled for Perth (WA) in November which colleagues of mine will be attending. I also eagerly await any further article write-up's from such event's so we can spread the good word of how beneficial these workshops are amongst the water industry and peers.

So, whether you're approaching the sticky & sultry Wet Season up north or potentially another sweltering hot Summer (and holidays like myself) please stay keen, stay safe and stay curious in the hydrometric learning space.

As always please reach out for article/photo submission for any future publications:

publication.thinktank@aha.net.au
Zachariah.Ward@ewsaustralia.com

Cheers,

Zac Ward CPH

From the President

Arran Corbett

As we head toward the end of 2024, our attention turns to what promises to be another busy wet season across Australia. According to the Bureau of Meteorology's long-range forecast, we are likely to experience above-average rainfall in several regions, reinforcing the essential role that hydrographers play in water management and planning. In times like these, communication becomes crucial—not only in the field but also within our organisation—as we continue to support one another and share vital knowledge.

Our Annual General Meeting (AGM) in Melbourne is fast approaching. Scheduled to take place in November, it presents an excellent opportunity for members to come together, discuss recent developments, and look ahead to the future of our organisation. I encourage everyone to attend and participate in the conversation, as this meeting will help shape the direction of the AHA in the year to come. A significant milestone for us this year is the soft release of our new AHA website and member portal. This project represents a major advancement for the Association, providing a user-friendly platform for members to access resources, connect with peers, and stay informed on upcoming events and initiatives. The website will serve as an important communication tool, ensuring that members stay connected and have the latest information at their fingertips. I extend my gratitude to the dedicated subcommittee that has been tirelessly working on this launch—it is exciting to see our efforts come to life.

Reflecting on this past September, I am pleased to highlight the success of our inaugural AHA Technical Workshop in Darwin. This event saw an impressive turnout and featured a fantastic field day at Berry Springs National Park, allowing participants to explore real-world hydrographic applications and engage in hands-on learning. Events like this strengthen our community and reinforce the commitment of hydrographers across Australia to continuous learning and skill development. The enthusiasm and feedback from attendees underscore the value of these practical, field-based gatherings.

Looking ahead, we are thrilled to announce that a date has been set for our 2025 AHA Conference, to be held from the 12th-15th of May at the Country Club in Launceston, Tasmania. The theme, "Exploring Water's Depth - Unveiling the Evolution & Future of Surface Water, Groundwater, and Water Quality Monitoring," promises an engaging lineup of discussions and presentations. I encourage you all to mark your calendars and start planning for what will undoubtedly be an insightful and impactful event. I would also like to acknowledge the efforts of our various subcommittees, whose hard work is crucial to the smooth functioning and progress of our Association. From the team working on the website launch to the Water Quality Community of Practice and the Conference Organising Committee, your dedication is invaluable, and I thank each of you for your commitment.

As we approach the holiday season, I wish all our members a safe, enjoyable, and restful Xmas break. Let's take the time to recharge and prepare for what lies ahead. Thank you for your ongoing support, and I look forward to another year of collaboration, growth, and shared successes within the AHA.

Best regards,

Arran

*(*AHA President, Arran Corbett, is an employee of Ninox)*

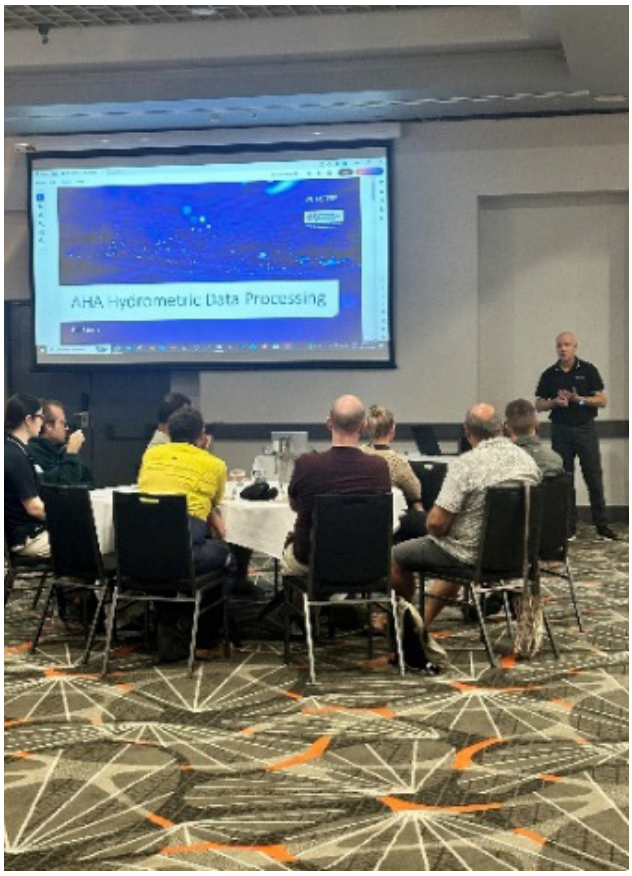
Inaugural Australian Hydrographers Association Technical Workshop: September 16–19, Darwin (NT)

Article submitted by Tara Matthews (Water Quality Community of Practice and AHA contributor)

This year the Australian Hydrographers Association was excited to introduce our Technical Water Monitoring Workshop in Darwin. The aim of this event which we plan to continue is to expand our presence across Australia and to introduce industry training into regional areas. We wanted to provide this opportunity for staff and for our members that don't always get to make it every 2 years to the East Coast of Australia for the AHA conference to connect with the industry and participate in AHA training streams, which students were also awarded CPD points upon completion of a training stream.

This year, we ran 3 concurrent streams including:

- Introduction to Hydrometric Monitoring, presented by Mike Lysaght
- Introduction to Real-Time Water Quality Monitoring presented by Paul Webb from Water Obs and Ben Ferguson **Department of Environment Science and Innovation**, facilitated by Tara Matthews from **Thermo Fisher Scientific**
- Introduction to Groundwater Monitoring, presented by Richard Campbell and Ture Carson from **Hydroterra**.



The event kicked off on Monday with a Welcome Reception for all students and an AHA Presidential welcome from Arran Corbett.

It was great to see everyone from different organisations from around Australia come together and network over a few drinks.

A big thank you to our Drinks Sponsor **Ninox Monitoring** for supporting this event.

The group came back together on Tuesday for an Introduction into each training stream and an overview of Hydrometric Data Processing with specific examples from Hydstra. This session was presented by Industry Expert Anthony Skinner and provided students with an overview of data management and key elements of establishing a good hydrometric data management system.

Tara Matthews alongside Ben Ferguson also provided an overview of the AHA Community of Practice in Water Quality, with the first virtual event scheduled for November. Stay tuned for further information on this event.

After this session, the 3 streams broke out to start the specific training subjects and class continued the following day.

On the final day we all headed out to Berry Springs Nature Reserve, where there were 3 different sites set up in a surface water, water quality monitoring and groundwater monitoring configuration. The students spent the first couple of hours in their chosen stream, and then there was an opportunity to rotate to the other sites for a well-rounded field experience.

As the weather heated up, students and sponsors alike were able to have a dip between sessions to cool off in 'safe waters' as the day started to heat up. Thank you to **Kisters** for sponsoring our field day.

Water Quality Monitoring Field Site

Groundwater Site Marquee

Observed During Site Assessment

Quick Dip Between Sessions

Local Resident During Training

Surface Water Gauging Site

The workshop organisers would like to extend a heartfelt thanks to the following people for bringing this event to life.

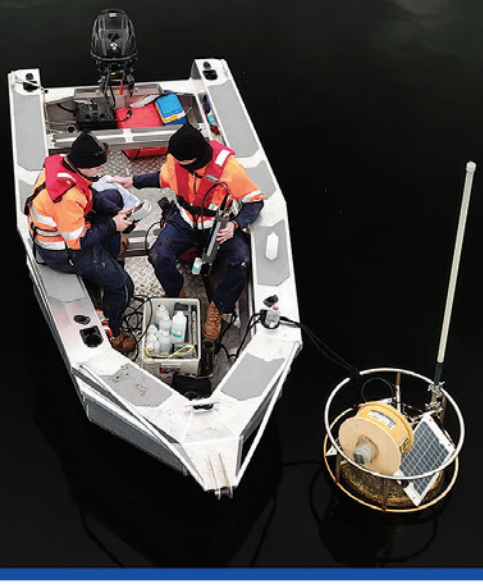
- **Agnes Zalan**, who is such a guiding force for us all in executing these events
- A big thank you to **Mike Lysaght** for facilitating the Introduction to Hydrometric Monitoring stream and running the surface water site.
- **Richard Campbell** and **Ture Carson** for running the Introduction to Groundwater Monitoring stream and for running the groundwater site.
- **Paul Webb, Ben Ferguson** and **Tara Matthews** for running the Real Time Water Quality stream and for running the Water Quality site.

We also want to extend our thanks to **Sean Lawrie, Robert Chaffer** and **Trevelyan Edwards** from the Territory Government for their help and site access and for demonstrating their sampling procedure using their submersible pumping rig.

We also appreciated the download from the level data from the logger deployed in the demo bore and the demonstration of the seasonal fluctuation of the local groundwater.

Lastly, we want to thank our sponsors for their time and for access to their instrumentation during the field day. It was great to see such collaboration in the industry.

A big thank you to **Kisters, Thermo Fisher Scientific, Xylem, Ninox, Aqualab Scientific** and **Hydroterra.**



right solutions.
right partner.

Hydrographic Careers at ALS

ALS has the biggest contingent of Hydrographers in Australia. We operate many long-term contracts for major Water Authorities as well as a diverse list of Government and private sector clients. If you're after a career in Hydrography while working with a dynamic team, ALS is your destination.

What ALS offers

- A safety-first approach
- The largest employer of Hydrographers in Australia offering room for advancement in varied career paths across the following groups: field hydrology, international projects, data management, instrumentation, and systems in 16 office locations across Australia allowing for voluntary relocation and Management opportunities
- Industry approved Enterprise Agreement with guaranteed annual salary increments and above market pay rates
- Sponsored certification and membership of the Australian Hydrographic Association and free enrolment for the AHA Diploma Water Industry Operations (Hydrometric Monitoring)
- Strong R&D Focus allowing for exposure to technological advancements including Photogrammetry/STIV, remote control boats, acoustic dopplers, iPhone app and sonar
- Field work encompassing working above the snow line, 4WD'ing in isolated areas, kayaking on rivers, hiking, working from boats, and operating drones
- Providing awareness in the education system through work experience placements and internships

If you are keen for a challenge while working alongside the best staff in the industry in a very dynamic company, contact us via email **hydrographics@alsglobal.com**

Importance of Hydrological Data

A presentation from the AHA Conference 2023.
Andy Pitman – Director of the ARC Centre of Excellence for Climate Extremes

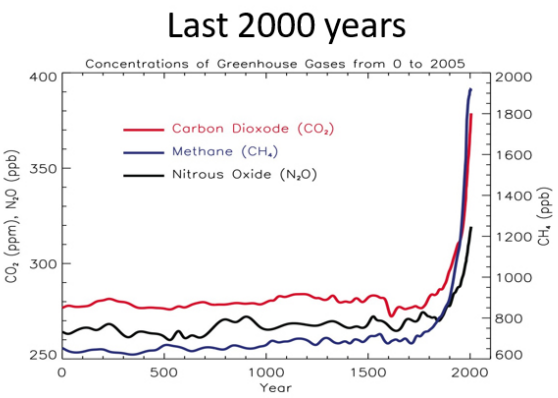
Outline

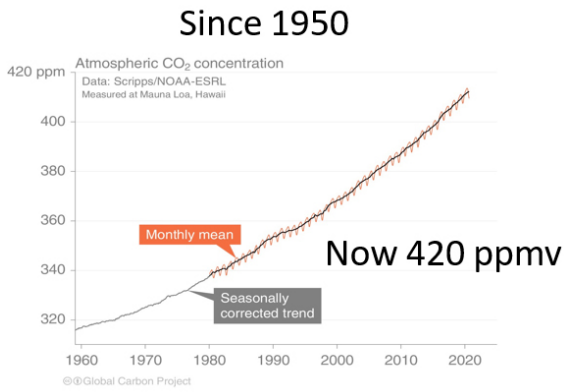
- What we know about climate change
- Limits to our knowledge
- Why we cannot be more definitive in links between climate change and extreme events

The Current State of Climate Science

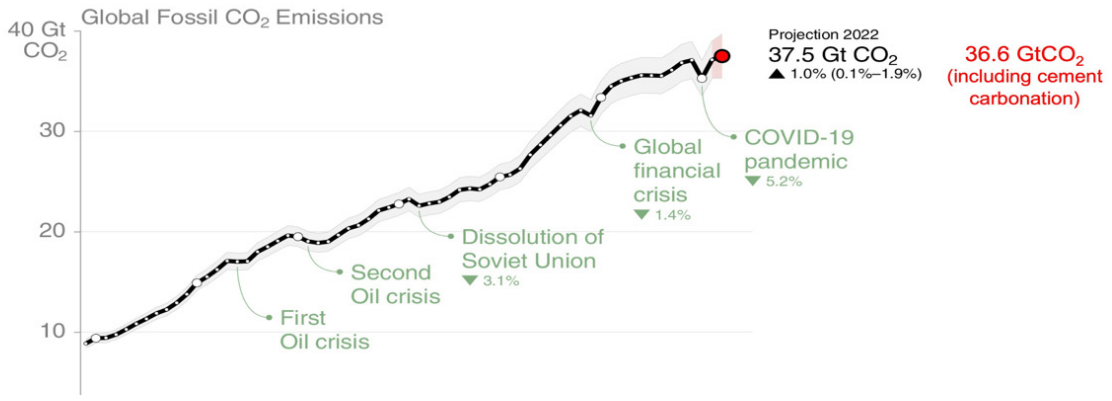
Greenhouse gases are increasing due to burning of fossil fuels, agriculture, land clearing, industrial activity

These increases add ~2 W m-2 to the Earth's energy balance or ~1,250,000,000 Joules per square meter over 20 years



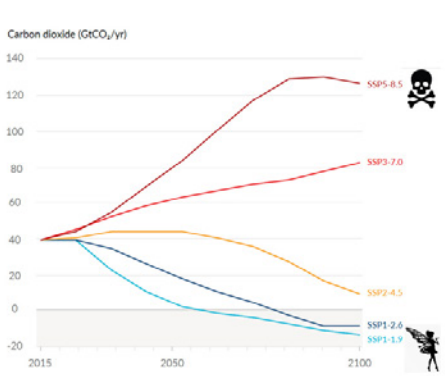


Increasing due to Human Emissions

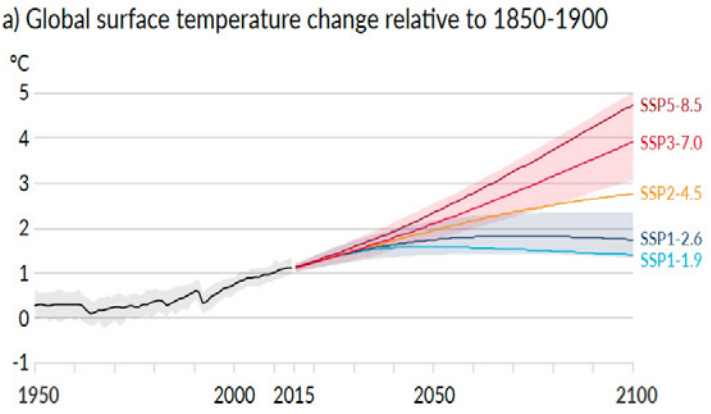


Global carbon project, 2023

Future Warming Depends on the Emission Scenario

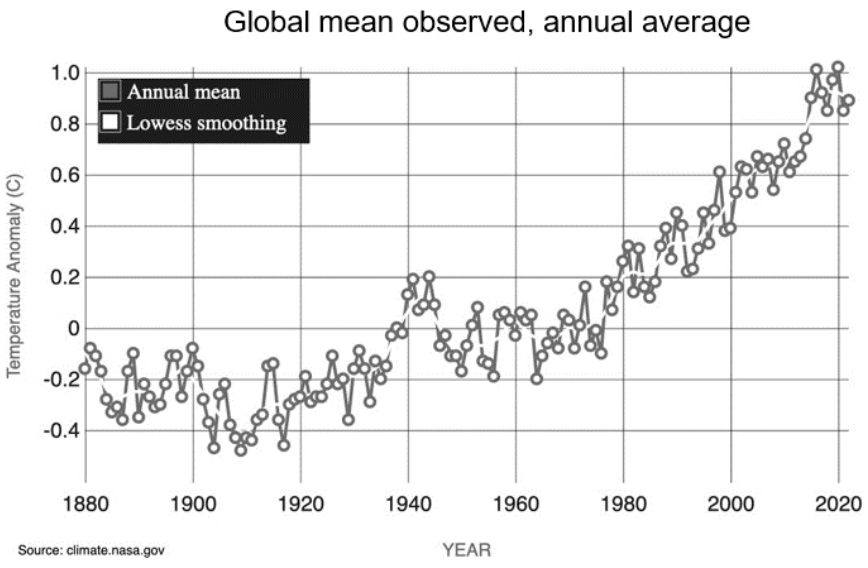


IPCC used 5 emission scenarios



All feasible scenarios lead to further warming

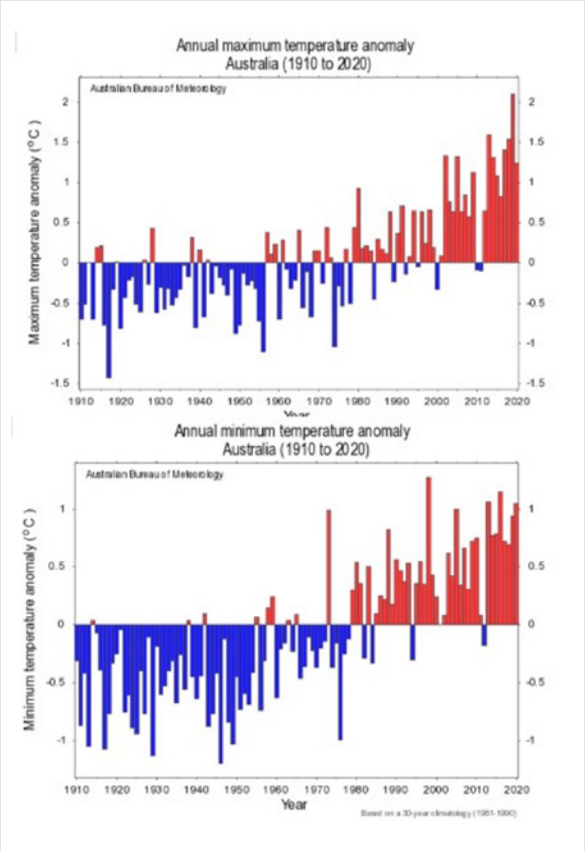
The ~1,250,000,000 J m–2 must go somewhere



… and so the Earth is warming

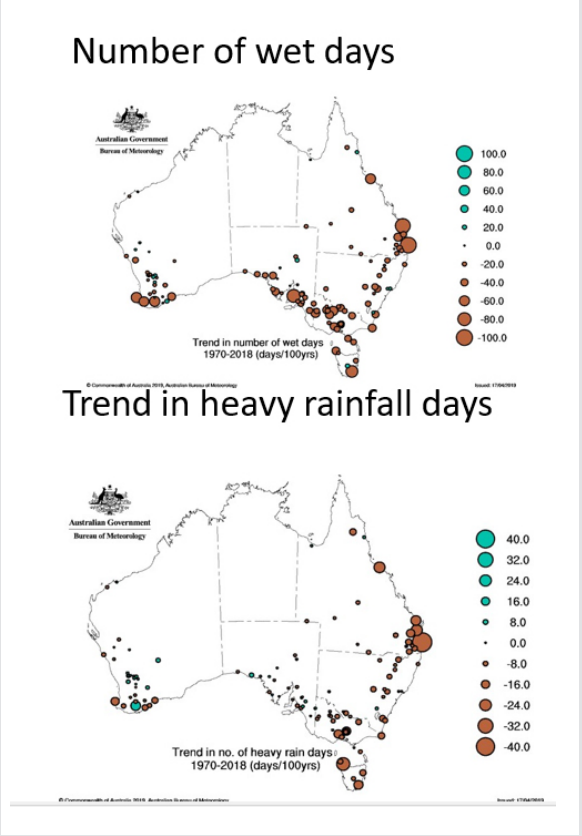
Global average air temperature has increase by ~1°C since the start of the 20th century

Over Just Australia: We Are Warming



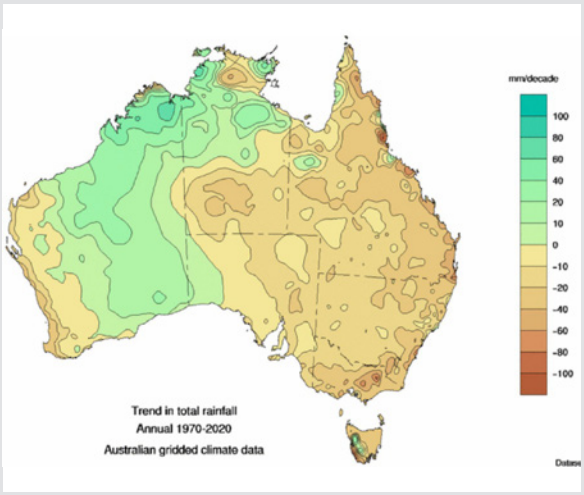
- Average temperature is rising
- Maximum temperature is rising
- Minimum temperature is rising
- Heatwaves are getting:
  - Hotter
  - Longer
  - More frequent
  - Directly attributable to increasing CO_2

Over Just Australia: Rainfall Complicated

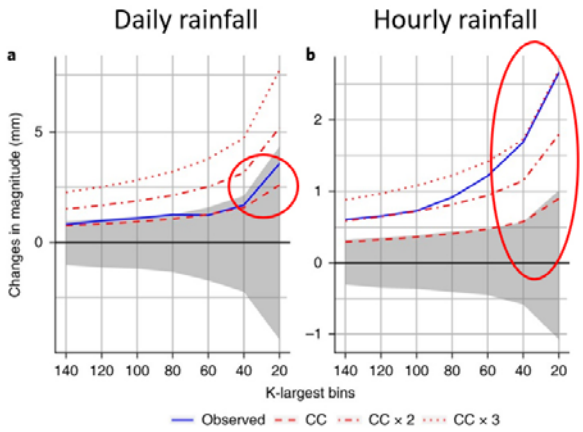


Rainfall is getting rarer. Little evidence of higher intensities in multi-day, weekly, monthly rainfall

Links to increasing CO_2 not direct like temperature (harder to attribute)



But Australian Short-Duration Rainfall is Intensifying



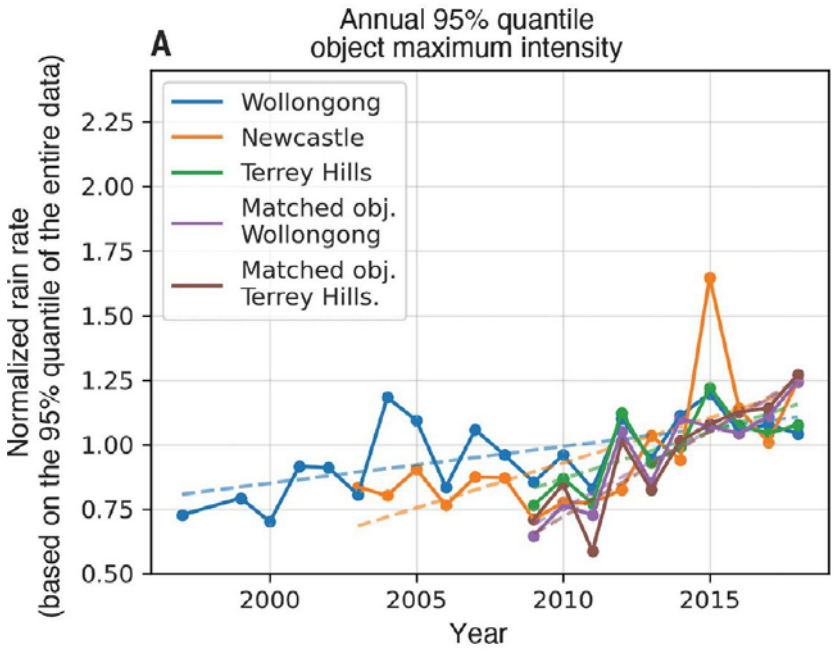
Suggests most extreme rainfall is intensifying a lot

Based on direct observations

This does not explain Lismore / Western Sydney flooding

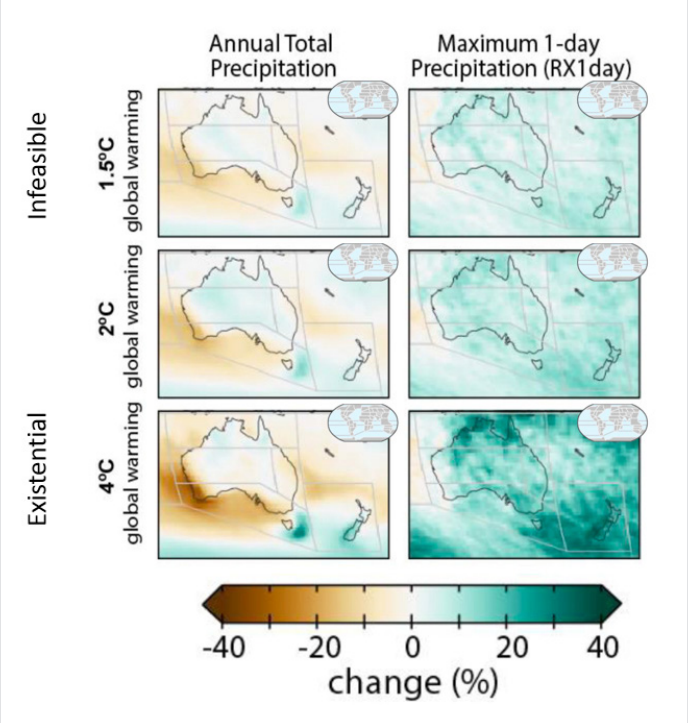
- Evidence of most extreme rainfall intensifying (by more than theory predicts) – should scale by Clausius–Clapeyron = ~6.5% $^{o}C^{-1}$

Westra et al., Nature CC, 2018



- Sydney Basin short duration rainfall
- Increasing by 20% per decade in sub-hourly
- No trends in daily amounts
- Again, short duration increasing by much more than ~6.5% $^{o}C^{-1}$

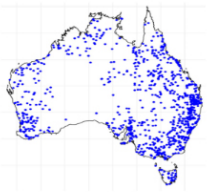
Changes in Rainfall will Occur in the Future



- Changes in annual rainfall not clear over most of Australia
- Drying over southern regions projected due to southward move of storm tracks
- Daily rainfall will intensify, on average, in the future
- The evidence that systems are "stalling" is deeply worrisome

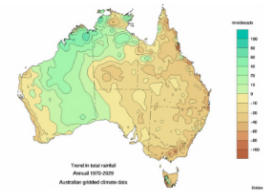
Summary for the First Part

Earth's climate is changing – we can detect changes, and attribute them to human emissions



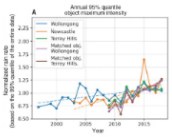
A small trend in any variable measured hourly or daily over this many locations over 50-100 years can be detected

Rainfall amounts are declining in many areas, and frequency of events is declining in many areas



Small changes in amounts or patterns of any variable measured hourly or daily over this many locations over 50-100 years can be detected

Rainfall intensity is increasing on sub hourly, hourly and less than daily timescales



Reasonable trends in any variable measured hourly or daily over several nearby locations over 50-100 years can be detected

About 205,000,000 results (0.52 seconds)

Scholarly articles for detection and attribution research

Detection and **attribution** of climate change: a regional … - Stott - Cited by 418

… of models in **detection** and **attribution** of climate change - Hegerl - Cited by 300

The **detection** and **attribution** of human influence on … - Stone - Cited by 92

And now, Floods

A Single Event is not the Same as a Statistically Large Set of Events

Standard detection and attribution methods require "big data" while a flood is an event

Determining if a single event is caused by / influenced by global warming is known as "event attribution"

Climate Change and the Recent Floods

- Press around the event varied in their description of the climate change effect on the heavy rain
- Climate change is not "the story". It's much more complicated than that
- To explain why we can know the 6.5% $^{o}C^{-1}$, and know rainfall is intensifying, but not know if a major flood is caused by climate change requires some detail

NEWS / CLIMATE IMPACTS / CLIMATE POLITICS /

CLIMATE COUNCIL STATEMENT ON THE FLOODS

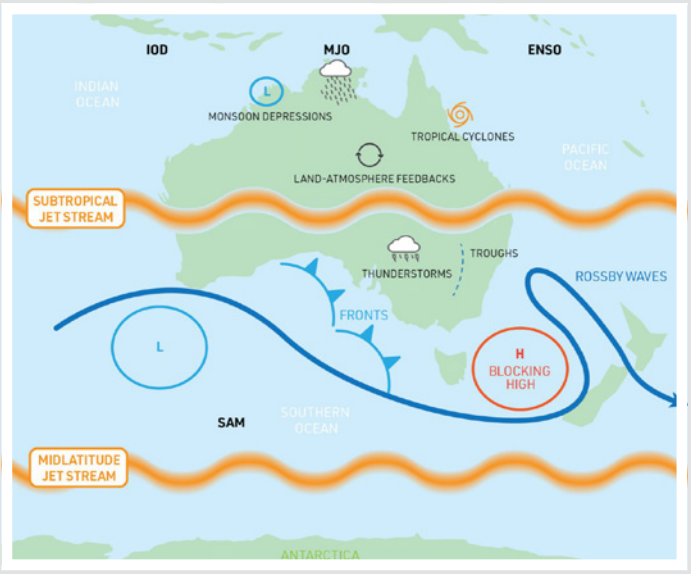
292 Shares Share Tweet Share Email Share

This is climate change. Now is the time for leadership.

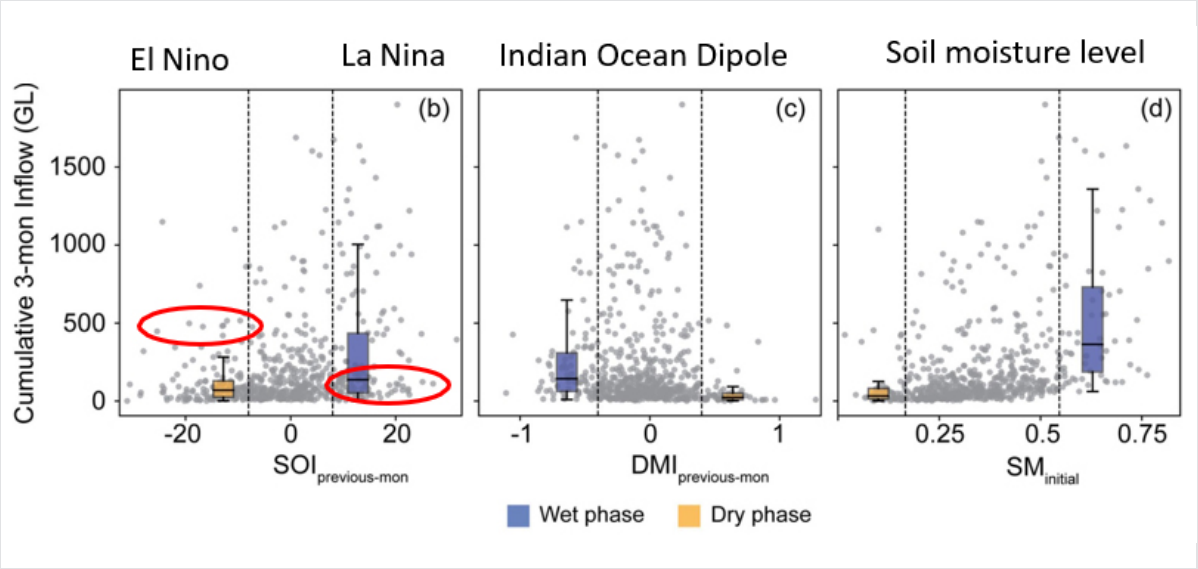
Climate change isn't a footnote to the story of these floods. It is the story.

Australia's record-breaking floods can be traced back to one thing, experts say

Floods (well, actually Rainfall)



- Rainfall variability in Australia is associated with many modes of variability
- These can act to confuse a signal, or amplify a signal, or "driver" of rainfall
- ENSO explains ~30% of the variance of rainfall over SE Australia
- Alignment between La Nina and the IOD can be informative



- Rainfall variability in Australia is associated with many modes of variability
- These can act to confuse a signal, or amplify a signal, or "driver" of rainfall
- However, modes of variability are one chapter in the book that explains what is being observed
- These show the variation in cumulative 3-month reservoir inflow into Warragamba (in GL) with ENSO, IOD and soil moisture Clearly, the likelihood of large flows are related to these modes, but they are not individually strong predictors

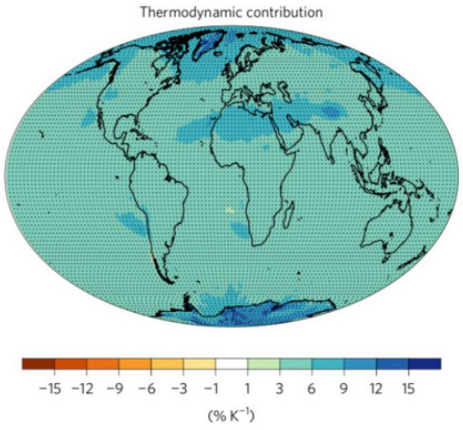
However, modes of variability are one chapter in the book that explains what is being observed

To understand rainfall in the context of climate change we need to talk about two mechanisms:

- The thermodynamic process
- The dynamic process

Rain should increase under global warming by ~6.5% oC–1 according to Clausius– Clapeyron because warmer air can hold more water

Known as the thermodynamic response



Note, its pretty well ~6.5% per degree everywhere.

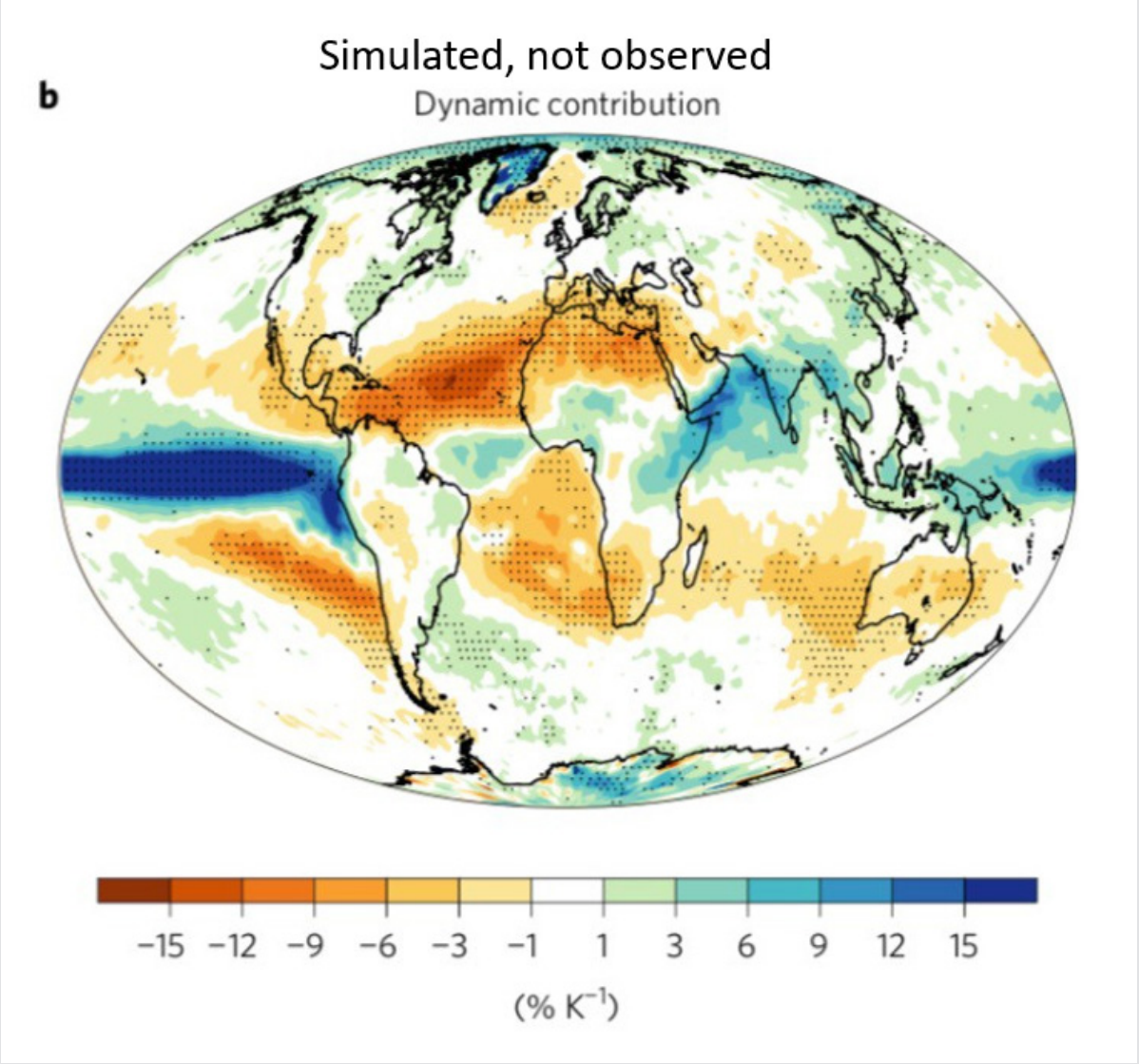
Always positive

Its pretty straightforward (here I am grossly glossing over lots of complexity)

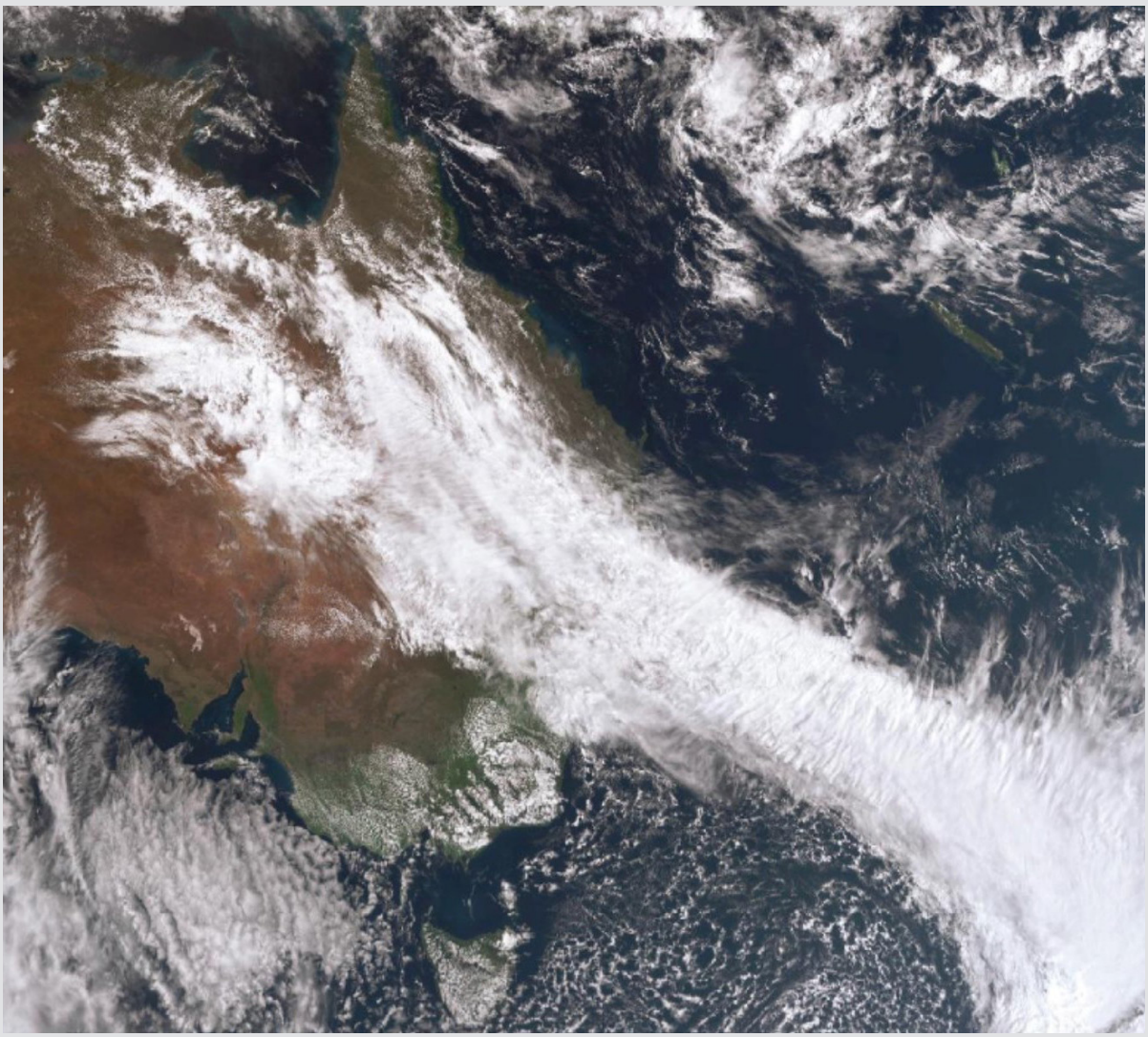
https://en.wikipedia.org/wiki/Clausius–Clapeyron_relation

Paul O'Gorman

The Dynamic Response to Global Warming

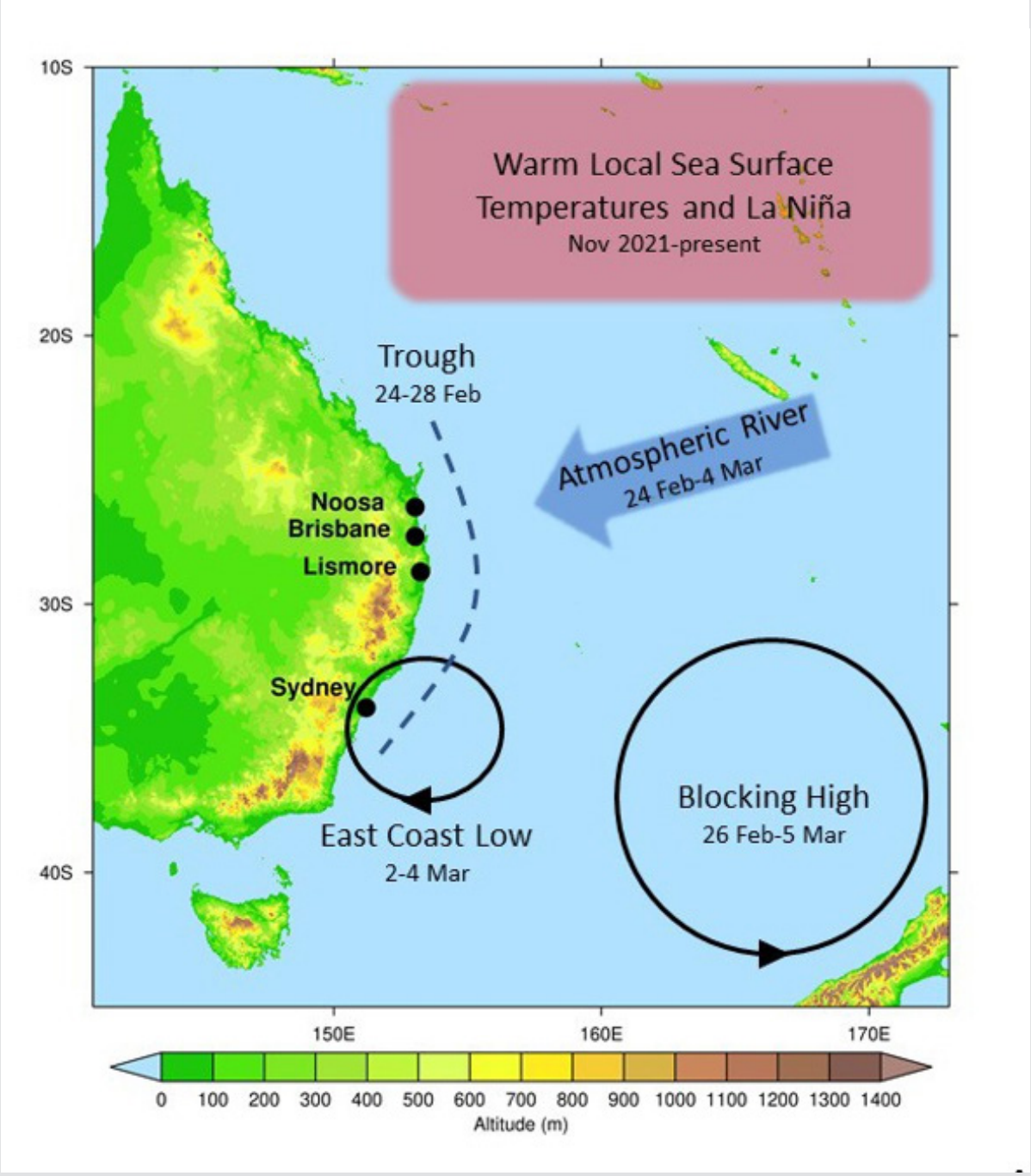


- The dynamic response to global warming is frightfully complicated
- It can dramatically increase, or dramatically decrease, the amount of rain available at a specific location
- It can decelerate systems (e.g. stalling)
- It can trigger multiple discrete events impacting a location
- It can change seasonality, or compress rainfall into a few days, or give consistent drizzle even when it does not change the amount of rain.
- 1200 mm / year all falling in a month is catastrophic even if annual average rainfall does not change



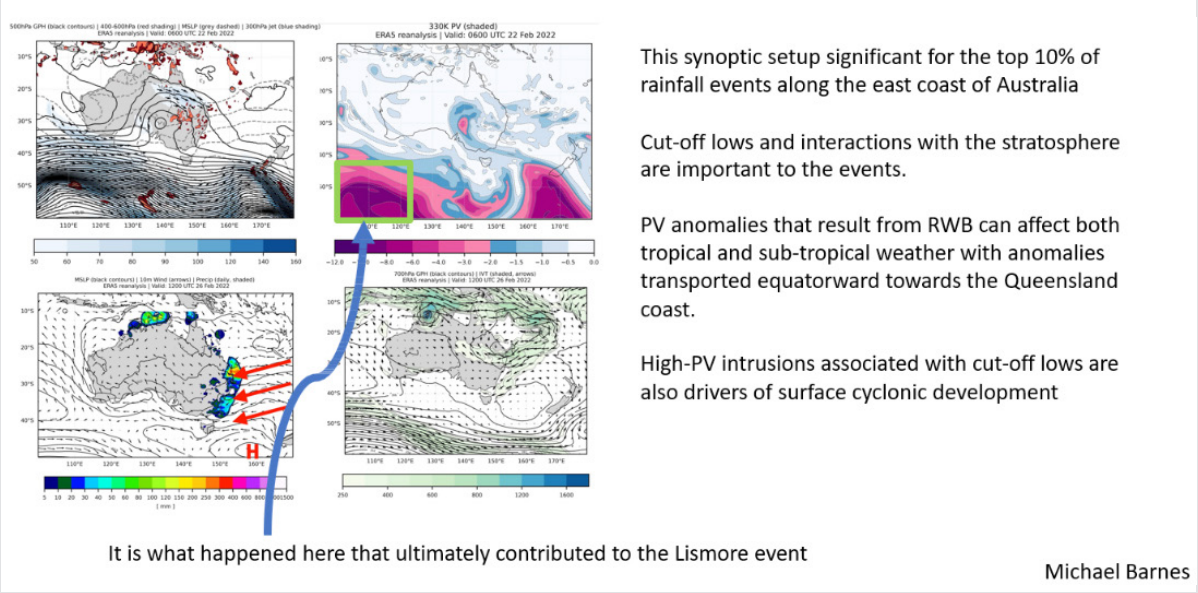
- Atmospheric rivers are regions of strong atmospheric moisture transport in the lower atmosphere
- contribute 20-35% of southeast Australia's annual rainfall
- Are factors in roughly 50% of extreme rainfall events over NSW
- Can concentrate very heavy rainfall (e.g. February-March 2022 in Eastern Australia)
- Evidence of increasing frequency and intensity (~40%) over our region later this century, due to climate change

Climate Change and the 2021–22 Floods



- Multiple severe multi-day events
- Different causation, lots of different interacting factors that evolved over time
- The weather circulation processes (dynamics) and thermodynamics were important.
- But this is not the whole story...

Lets Get Dynamical



- But we do not really understand the balance of all these mechanisms
- We do not know if there are situations that concentrate the outcomes to specific regions
- We do not know how climate change is affecting these mechanisms
- We do not know the degree to which climate projections capture these mechanisms
- And therefore we do not know how climate change might affect the sorts of events we saw at Lismore.

So Were the Floods Linked with Climate Change?

The La Nina definitely contributed to antecedent conditions.

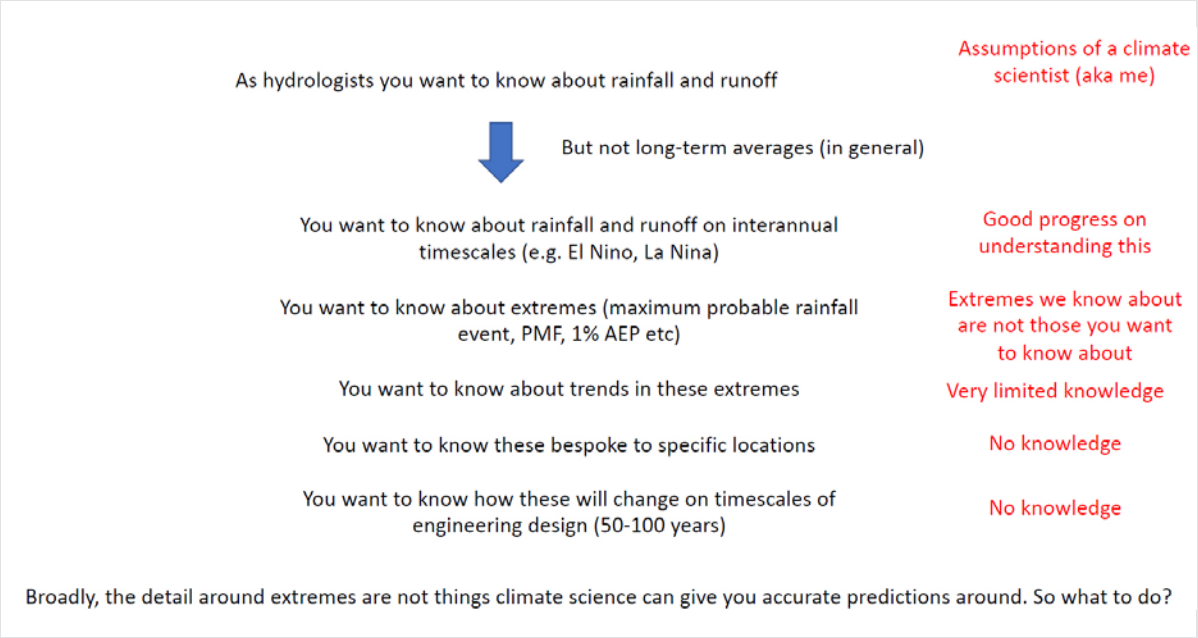
Thermodynamic response increased the rainfall intensity Local dynamic response can be explained naturally, but

- The ocean temperatures were very warm
- This could have intensified the moisture flow on-shore

Remote dynamic response can be explained naturally, but

- The location and frequency of the Rossby Wave breaking and
- The trajectories of the PV anomalies
- The formation of surface low, and crucially
- If systems stalled
- Might have been perturbed by global warming

In Short, Rainfall is Complicated



Climate Change – Key Issues for Hydrologists

Stationarity is dead. But using historical data from the last 20 years for the next 20 years might be ok with care.

Accuracy and precision are different. Our models are very precise but not necessarily accurate. Don't be fooled by quantification.

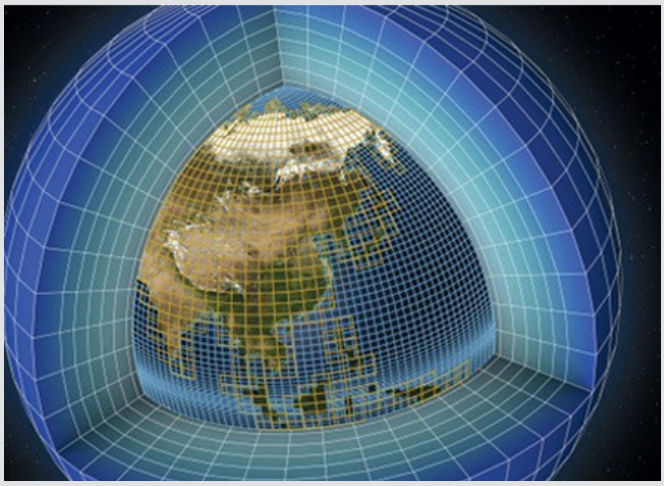
- We know the direction of change for temperature
- We do not know the direction of change for most impactful extremes – these are weather events, not climate statistics

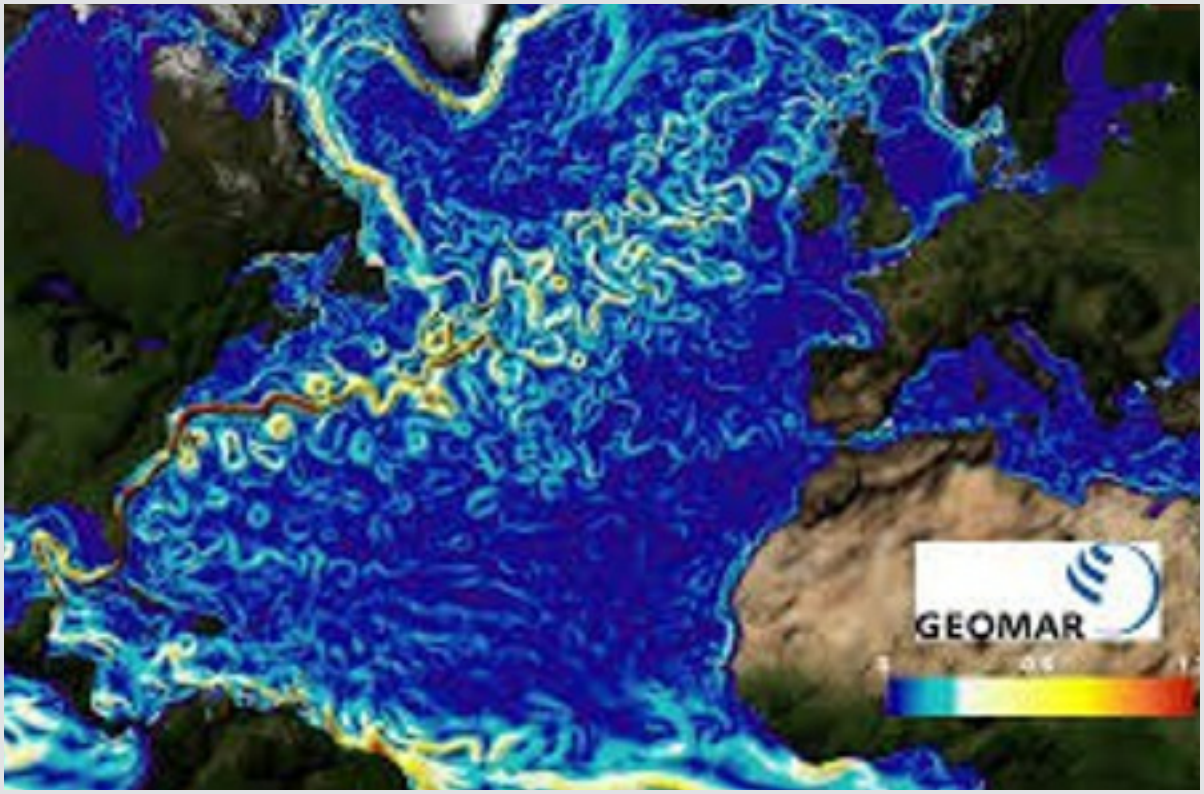
Talk to card-carrying climate scientists. Learn your predictions from your projections. Understand the ecosystem. If someone offers you a short-cut, would thorough methods change the decision.

Embrace uncertainty. You lot do math and stats, so question products, methods etc and insist on full uncertainty estimates.

Climate Change – Key Issues for Climate Scientists

- There are no substitutes for observations
- Climate projections utilize global climate models
- These require hydrology to be described without knowledge of every basin. The modelling is physically based, not regression based
- Our global models are increasing in spatial detail – and are now closing on 20 x 20 km
- This requires basin scale hydrology, and formal connection of energy, water and carbon at the catchment scale, to be explicitly resolved
- Very few hydrologists work in this area – an opportunity therefore exists moving forwards





Optical Flow Proves Crucial in High Water Flow – Prado Dam

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Introduction

The monitoring of accurate and reliable flow data can be particularly challenging in certain site and hydraulic conditions when using traditional measurement methods. Many natural and man-made waterways, such as rivers, streams, and canals, often exhibit complex flow patterns and hydraulic characteristics that can make it difficult to obtain precise, representative flow data using standard techniques. Take, for example, the U.S. Geological Survey (USGS) gage located just below Prado Dam in Southern California shown in Figure 1. (https://waterdata.usgs.gov/monitoring-location/11074000/#parameterCode=00060&period=P7D&showMedian=false).

Figure 1: USGS gaging station 1107400, Santa Ana R BL Prado Dam, CA

The site plays a key role, as it monitors flow releases from the dam, which directly impact the water supply needed for two vital purposes: ensuring proper discharge into Orange County Water District's (OCWD) groundwater recharge basins and maintaining sufficient water levels to support bird habitats. The reliability of the flow data is essential for managing water resources effectively.

The site is located 2,500 feet downstream of Prado Dam, a flood control structure on the Santa Ana River near Corona, California. Flow monitoring takes place within a concrete channel, which consists of a two-stage compound trapezoidal section (Figure 2), with the low stage centrally nested at 37 feet wide and 2.8 feet deep. The high stage of the compound section is 213 feet wide and 20 feet deep, designed to accommodate higher flow volumes.

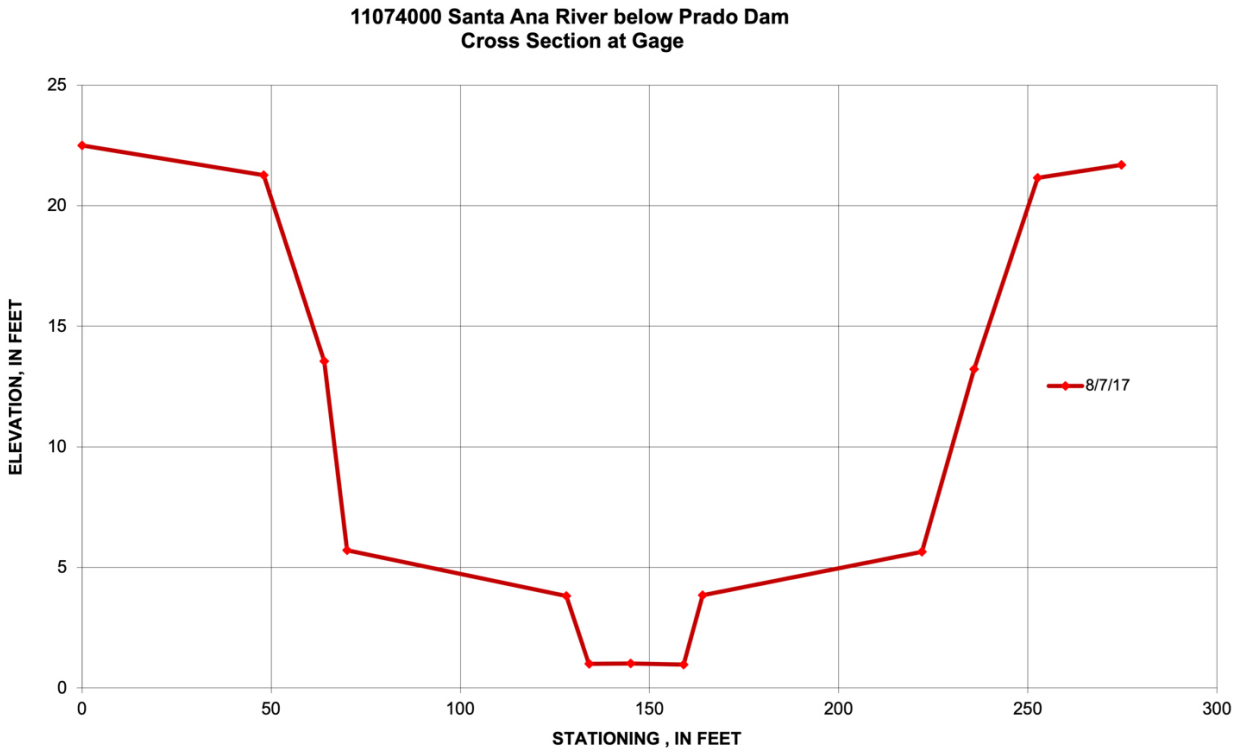

Figure 2: Two-stage compound trapezoidal section profile

Accurate flow measurements, particularly in the range of 250 to 1,000 cubic feet per second (cfs), are crucial for the OCWD groundwater recharge basins located downstream of the dam. Flows up to 1,000 cfs can be captured for groundwater recharge, while higher flows must be diverted downstream, where the Santa Ana River discharges into the Pacific Ocean.

The flow range, between 250 and 1,000 cfs, aligns with the transition section (see Figure 2) from low-stage to high-stage within the compound trapezoidal channel. Measuring flow during this transition is especially challenging. Conventional methods like wading measurements using the SonTek FlowTracker2 are impractical due to the water depth and velocity, while acoustic Doppler current profilers (ADCPs) such as the SonTek-M9 or -RS5 operation is impacted by the shallow water conditions within the transitioning section. This makes precise flow measurement exceedingly difficult under these conditions.

Historical Issues

Historically, the USGS has made efforts to develop an accurate discharge rating curve at the site, but they have faced significant challenges in establishing a reliable relationship across the full range of flow conditions. To further improve the accuracy of the flow data reported, an upward-looking Acoustic Doppler Velocity Meter (ADVM) was installed with the development of an index velocity (IV) rating. Unfortunately, the development of the IV rating has not been successful at the USGS gage due to the extreme flow conditions. The turbulent flow conditions and high sediment transport made it challenging to measure accurate and reliable flow data with an ADVM instrument.

In August 2022, the University of California San Diego (UCSD) Center for Western Water and Weather Extremes (CW3E), as part of work funded by FIRO (https://cw3e.ucsd.edu/firo_prado_dam/), installed a cutting-edge Computer Vision Stream Gauging (CVSG) system at the site shown in Figure 3.

The CVSG system makes use of stereo cameras for remote sensing of surface velocities and water level to develop an adaptive learning discharge rating curve for flow calculations. The real-time monitoring of surface velocity changes within a channel reach allows the CVSG system to develop an accurate stage-discharge relationship in an exceptionally short timeframe. The CVSG rating is continuously assessed from instantaneous discharge, surface velocity and water level measurements by the system over consecutive flow events to provide an accurate flow record within the flow monitoring site and hydraulic conditions.

The process works by remotely capturing surface velocity using stereo video footage, which is then analyzed with the Farneback algorithm to determine the water's speed. Once the surface velocity is known, it is converted into discharge by calculating the mean velocity (following Hauet et al. 2018) and multiplying it by the cross-sectional area of the channel. This area is determined using water level data and a cross-section survey, allowing for an accurate calculation of volumetric flow.

Figure 3: CVSG system installed at USGS gaging station 1107400, Santa Ana R BL Prado Dam, CA.

The appeal of the new and innovative CVSG system is that it can remotely measure the water surface velocity over a wide range of flow conditions and then develop an adaptive learning discharge rating curve without relying on manual streamflow measurements. Additionally, this method does not require a minimum depth or ground control points to measure velocity. Conditions that are typically challenging or impossible using wading methods or ADCPs can be ideal for CVSG. If the section is visible and there is consistent water surface texture, the system can measure surface velocity, compute discharge, and refine its rating through a wide variety of flow conditions.

The CVSG system was installed at the site specifically so that its adaptive learning discharge rating curve could be compared against the USGS rating for this site and the Prado Dam releases upstream. As mentioned, the USGS rating has not captured the entire range of flow accurately, according to cross-referenced dam releases and flow measurements downstream of the USGS gage, though all three references agree at the lower and higher end of the flow range.

Flow range in the channel varies considerably from low flow during the summer and fall, with flows averaging around 80 cfs and peak water velocity of about 3 ft/s. During the flood season flows as high as 7,000+ cfs and peak water velocity reaching 11 ft/s can be expected.

Outcomes

In February 2024, following an exceptionally wet flood season, the U.S. Army Corps of Engineers (USACE) made record releases from Prado Dam, exceeding 7,000 cubic feet per second (cfs). During this time, teams from the USGS, CW3E, and SonTek made multiple attempts to capture accurate flow measurements using ADCPs (Figure 4), with both moving boat and stationary methods. After performing a series of streamflow gauging's with different ADCP instruments, the SonTek-RS5 equipped with RTK provided the most consistent flow results.

Figure 4: ADCP Streamflow gauging's with RiverSurveyor M9 and RS5. High flow conditions left, low flow conditions right.

The data collected with the SonTek-RS5 was used to further develop the USGS rating. The adaptive learning discharge rating curve developed by the CVSG system aligns closely with the ADCP measurements, the USGS rating, and Prado Dam gated outlet release rating shown in Figure 5.

The CVSG system developed rating curve independent of streamflow gauging's performed during flow releases, demonstrating that the CVSG is a matured flow monitoring solution that performs just as well as traditional methods at this challenging sites.

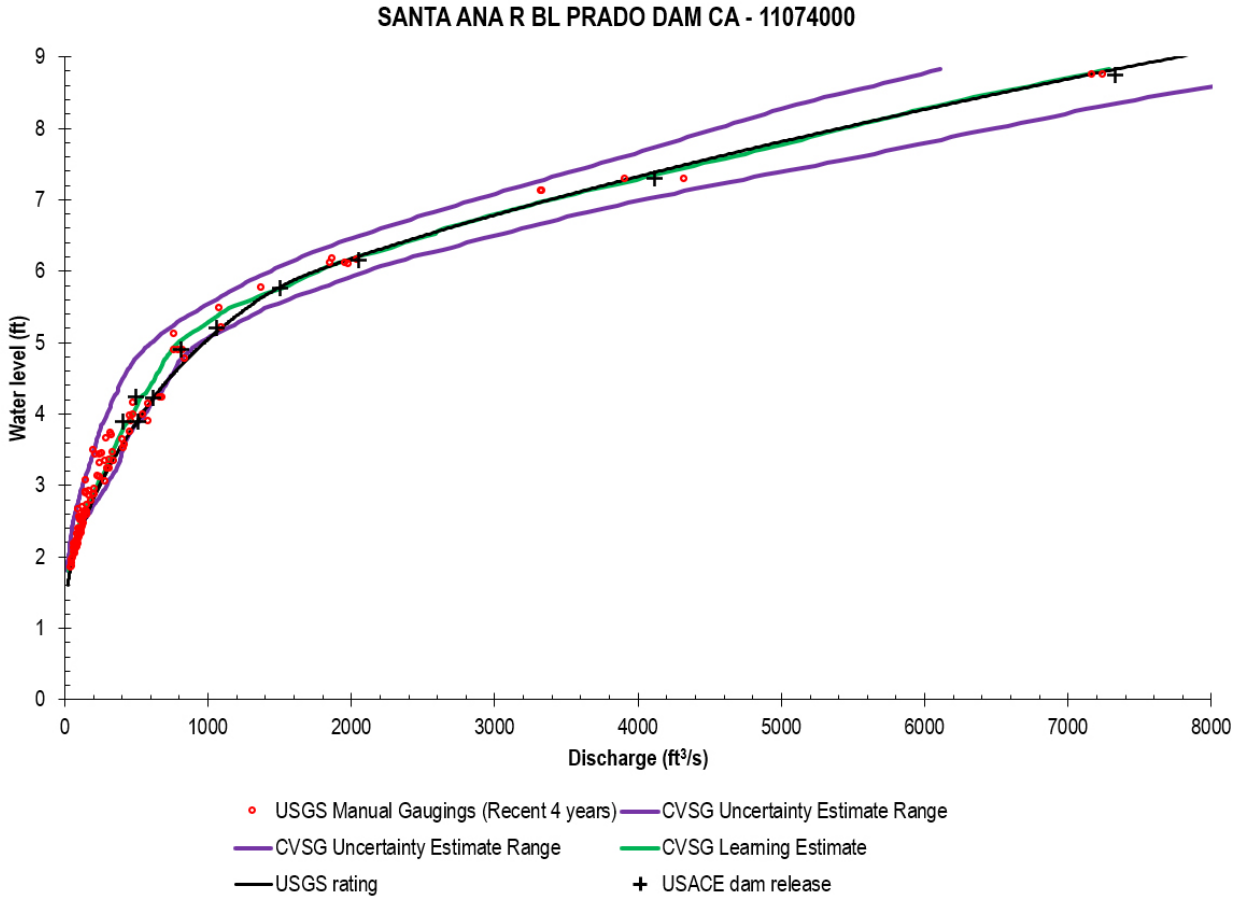

Figure 5: Comparison of USGS wading and ADCP discharge measurements, USGS rating, CVSG Learning estimate (rating), USACE Prado Dam release data, with CVSG rating uncertainty estimates.

This result is an exciting breakthrough for CW3E and their collaborators as they explore new, adaptable methods to accurately measure flow at challenging sites where traditional approaches fall short. At Prado Dam, their specific goal is to retain more water during the flood season, allowing for a more consistent release during the dry season to maximize groundwater recharge. This is crucial for the Orange County Water District; especially as imported water becomes more expensive and less reliable.

The CVSG system delivered reliable data even in extremely high-flow conditions at this difficult site and developed a rating curve in a much faster timeframe than traditional methods would allow.

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