
# OzFlux 2021
# Scientific program and schedule
# 1-2 November 2021

*Online and free via Zoom webinar*

OzFlux Australian and New Zealand Flux Research and Monitoring

tern Ecosystem Research Infrastructure

NCRIS National Research Infrastructure for Australia
An Australian Government Initiative

THE UNIVERSITY OF MELBOURNE

# OzFlux 2021

**The ecosystem processes conference in Australia and Aotearoa - New Zealand**

***1-2 November 2021 all online & free***

The conference will showcase research investigating ecosystem processes in agricultural and natural ecosystems in Australia and New Zealand. It offers a forum for microclimatologists, ecosystem modellers, ecologists, ecophysiologists and social scientists from across the region to share their latest research. OzFlux is an ecosystem research network that provides the global ecosystem research community with standardised observations of energy, carbon and water exchange between the atmosphere and key terrestrial ecosystems. This knowledge is critical to inform decision making and risk assessment relating to land use and climate change impacts on ecosystems. OzFlux 2021 features a wide range of themes from the latest developments in instrumentation and software to spatial scaling and modelling, greenhouse gas emissions, drivers of carbon sequestration and food security.

**Format**
OzFlux 2021 will be an entirely online conference via Zoom webinar.
Presentations will be either live or pre-recorded. After each talk there will be time for questions. Questions will have to be posted via the Zoom Q&A function.

**Registration:**
Registration is a Zoom webinar registration, there is no cost.
https://unimelb.zoom.us/webinar/register/WN_Jhu4K-IzQE6-rNXLHjw2iQ

**Conference webpage:**
https://www.tern.org.au/ozflux-conference-2021

**Conference organising committee**
Stefan Arndt – The University of Melbourne
Alison Bennett – The University of Melbourne
Jason Beringer – University of Western Australia
Jamie Cleverly – James Cook University
Cacilia Ewenz - TERN
Nina Hinko-Najera – The University of Melbourne
Peter Isaac – TERN
Ian McHugh – The University of Melbourne
Caitlin Moore – University of Western Australia

*We are grateful for the assistance of Mark Grant (TERN) and Mark Kitchen (CSIRO) in the organisation and promotion of OzFlux 2021*

***We acknowledge and celebrate the First Nations people on whose traditional lands we meet and work, and whose cultures are among the oldest in human history.***

# Scientific program

Times in the program are all AEDT (VIC/NSW/TAS) time

| NZ | **VIC/NSW/TAS** | SA | QLD | NT | WA | California |
|---|---|---|---|---|---|---|
| 13.00 | **11.00** | 10.30 | 10.00 | 9.30 | 8.00 | 17.00 |
| 16.00 | **14.00** | 13.30 | 13.00 | 12.30 | 11.00 | 20.00 |
| 18.00 | **16.00** | 15.30 | 15.00 | 14.30 | 13.00 | 22.00 |

# Monday 1 November

10.45-11.00 Welcome to OzFlux 2021

**Session 1**

*Chair – Stefan Arndt*

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|---|---|---|
| 11.00-12.00 | **KEYNOTE**<br>**Belinda Medlyn** | Modelling Australia's dynamic vegetation |

**Ecosystem processes - ecosystems and flux studies**

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|---|---|---|
| *Chair* | *Jamie Cleverly* | |
| 12.00-12.15 | Jason Beringer | Trends and Interannual variability of ecosystem processes along a rainfall gradient (NATT) |
| 12.15-12.30 | Rodrigo Pires | Adaptive hydraulic traits and vulnerability to drought and heat stress in a mixed Banksia-eucalypt woodland |
| 12.30-12.45 | Anne Griebel | The trade-offs when living with a parasite in a warmer, drier and more flammable world. |
| 12.45-13.00 | Caitlin Moore | Ecosystems living on the edge in Australia's wild west |
| 13.00-13.15 | Jordan Goodrich | Exploring the drought resilience of New Zealand's peatland carbon sink |
| 13.15-13.30 | Miko Kirschbaum | CarbonWatch NZ. Modelled carbon exchange of forests ranging from long-term averages to sub-diurnal fluxes |
| 13.30-13.40 | Robert Ward<br>*Speedtalk* | Carbon fluxes from wine grapes in the Hawke's Bay, New Zealand |

**Break 13.40 – 14.00**

**Session 2**

*Chair – Cacilia Ewenz*

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|---|---|---|
| 14.00-15.00 | **KEYNOTE**<br>**Nina Hinko-Najera**<br>**Lauren Bennett** | Forest carbon dynamics – research in the Wombat Forest |

***Remote, terrestrial and novel sensing***

*Chair – Nina Hinko-Najera*

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|---|---|---|
| 15.00-15.15 | Michael Forster | Resolving the heat velocity measurement range limitation of sap flow methods |
| 15.15-15.30 | Thang Ha | Seagrass resource inventory from space: A case study in Tauranga Harbor (New Zealand) using radar imagery and machine learning |

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|---|---|---|
| 15.30-15.45 | Tiet-Dat Pham | Improving estimates of agricultural soil organic carbon using Sentinel-2 MSI and Sentinel-1 SAR data combined with active and ensemble learning in Western Australia |
| 15.45-16.00 | Ashvath Kunadi | Variation in Zero Plane Displacement Length and Roughness Length Revisited |
| 16.00-16.15 | Tommaso Julitta | Field spectrometers for continuous proximal sensing monitoring |
| 16.15-16.30 | Jo Owens | Linking long-term grazing trials and modelling with the new flux towers in Queensland |

# Tuesday 2 November

10.45-11.00 Welcome to Day 2

**Session 3**

*Chair – Peter Isaac*

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|---|---|---|
| 11.00-12.00 | **KEYNOTE**<br>**Trevor Keenan** | Fluxnet 2.0: OzFlux and the FLUXNET coordination project |

***Sites, ecosystems and methods***

*Chair – Alison Bennett*

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|---|---|---|
| 12.00-12.15 | Will Woodgate | The road to recovery: the Tumbarumba site post major fire disturbance in 2020 |
| 12.15-12.30 | Jamie Cleverly | Evapotranspiration, soil water content and precipitation pulses in a water-limited ecosystem |
| 12.30-12.45 | Richard Silberstein | Two eddy covariance systems on the same tower, looking for the constant flux layer |
| 12.45-12.55 | Markus Löw<br>*Speedtalk* | Comparison between three mobile eddy covariance systems located in close proximity of each other |
| 12.55-13.10 | Johannes Laubach | Nitrous oxide and carbon exchange of mixed-species pasture: win-win or trade-off? |
| 13.10-13.25 | Ryan Burrows | Methanotroph community structure and processes in an inland river affected by natural gas macro-seeps |

**Break 13.25-14.00**

**Session 4**

*Chair – Jason Beringer*

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| 14.00-15.00 | **KEYNOTE**<br>**Pep Canadell** | Ecosystem collapse dynamics under the rapid emergence of climate change |

***Ecosystem processes - seasonal dynamics & temperature responses***

*Chair – Caitlin Moore*

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|---|---|---|
| 15.00-15.15 | Alexandre Renchon | Inter-annual and seasonal interactions of canopy dynamics, carbon and water fluxes in a temperate evergreen angiosperm forest: a data-model comparison |
| 15.15-15.30 | Tim Wardlaw | A direct response to supra-optimal temperatures for reduced GPP during the 2017 warm spell at Warra |

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|---|---|---|
| 15.30-15.45 | Alison Bennett | Thermal optima of Gross Primary Productivity and air temperature closely align: A synthesis of OzFlux's wooded ecosystems. |
| 15.45-16.00 | Sami Rifai | Continuous subseasonal temperature acclimation of solar induced fluorescence in forest ecosystems |
| 16.00-16.15 | Nurit Agam | Water where there is no water - Atmospheric water captured by world deserts |
| 16.15-16.30 | Samantha Grover | A tale of two peatlands; fluxes from Australian alpine and Indonesian tropical peatlands |

## Abstracts

***Jason Beringer, Lindsay Hutley, Simone Fatichi and Jamie Cleverly***
The University of Western Australia
*Trends and Interannual variability of ecosystem processes along a rainfall gradient (NATT)*
Abstract: The northern half of Australia has a diverse climate and vegetation with mesic topical savannas to the north and arid Mulga woodlands toward inland Australia. A strong rainfall gradient is present that forms the basis of a vegetation transect called the North Australian Tropical Transect (NATT). Due to the long term investment of TERN in these sites we now have 20 years of record at Howard Springs and 10 years at 4 other sites along the NATT and we now have an opportunity to examine how the ecosystem processes at these sites along the transect have changed over time and what the drivers may be. We use the long term observations and a sophisticated land surface model (Tethys-Chloris (T&C)) to simulate the trends and IAV of ecosystem processes at each site. Results show significant increasing trends in productivity at the mesic sites and a flat and more variable trend at the arid sites including Alice Springs Mulga. Trends in evapotranspiration were more variable but also indicated increasing trend at the mesic sites that drove increasing water use efficiency at most sites. We found that the T&C model performed extremely well in simulating not only mean quantities but also functional behavior and IAV along the transect. Such assurance in our models now enables us to further attribute changes in ecosystem processes to drivers through model experiments.

***Rodrigo Neto Pires, Paul Drake, Pieter Poot, Erik Veneklaas***
The University of Western Australia
*Adaptive hydraulic traits and vulnerability to drought and heat stress in a mixed Banksia-eucalypt woodland*
Abstract: Drought-related mortality events have increased globally, and climate change models predict drier and warmer climate further threatening plant communities. Evergreen woody species from seasonally dry ecosystems are of particular concern as plant communities in the region already experience marked dry and hot seasons. Stomatal regulation plays a central role in reducing the risk of physiological failure, as operating beyond water potential thresholds can lead to tissue desiccation and mortality. Co-occurring tree species with contrasting hydraulic strategies provide an opportunity to evaluate if a given behaviour is more likely to enhance survival under future climate scenarios. In this study, we carried out a range of eco-physiological measurements (water potentials, photosynthesis, transpiration, stomatal conductance, sap-flow, vulnerability and pressure-volume curves) during a transition from the wet winter to the dry summer to determine: (i) key diurnal and seasonal water use-related responses and (ii) the role of stomatal regulation of plant water status. Results show that the stomatal control strategies were clearly separated into species that strongly regulate leaf water potentials (‚Äòisohydric‚Äô) versus species that allow leaf water potential to fall below apparently critical thresholds (‚Äòanisohydric‚Äô). We

discuss the implications of the different hydraulic strategies considering reports of tree mortality events and changes in vegetation composition in the region.

***Anne Griebel, Daniel Metzen, Jennifer Peters, Matthias Boer, Brendan Choat, Craig Barton, Chelsea Maier, Alexandre Renchon, Rachael Nolan, Hamish Clarke, Elise Pendall***
Hawkesbury Institute for the Environment, Western Sydney University
*The trade-offs when living with a parasite in a warmer, drier and more flammable world.*
Abstract: Mistletoes are emerging as important co-contributors to tree mortality, particularly when infected trees are stressed by water limitations during drought. In Australia, mistletoe distributions are expanding in temperate woodlands, while their hosts experienced unprecedented heat and drought stress in recent years. To investigate whether the excessive water use of mistletoes increased the risk of premature host mortality at the Cumberland Plain Ecosystem Processes site, we monitored transpiration of infected and uninfected branches from two eucalypt species and used hydraulic vulnerability curves to estimate percent loss in xylem conductivity for each species. We show that daily transpiration of infected branches increased up to 4-fold during heatwaves, which contributed to a 30% increase in xylem dysfunction of infected hosts. We further coupled mistletoe population dynamics with measurements of host tree stem growth, canopy turnover and stand structure to demonstrate that severe mistletoe infection reduced live standing biomass and canopy volume, and to establish a threshold beyond which mistletoe infection halts tree growth. Yet, subsequent increases in basal area and the thickening of canopy volume after the three-year drought indicate that host trees could recover rapidly once the compounded drought and heat stress nearly extinguished the mistletoe population.

***Moore Caitlin, Norton Alexander, Beringer Jason, Silberstein Richard, Prober Suzanne, Macfarlane Craig, Lardner Tim***
The University of Western Australia
*Ecosystems living on the edge in Australia's wild west*
Abstract: Australia's terrestrial ecosystem observation capacity supported by TERN provides critical measurements of ecosystem health, and how ecosystems respond to climate variability and change. However, monitoring gaps exist within TERN,Äôs SuperSite framework and work is underway to address them in Western Australia (WA), facilitated through a co-investment in TERN from the WA state government. New instrumentation has been installed at WA's three TERN SuperSites' a Wandoo woodland at Boyagin Reserve, the Salmon gums of the Great Western Woodlands, and the coastal banksia heath of Gingin. These ecosystems are unique to WA and are identified as sentinel systems for environmental change, occurring along a temperature/rainfall gradient in the southwest region of the state. Given the good temporal coverage of flux data from these three sites, we explored how productivity at each site has varied in response to meteorological variability with the aim to determine whether these ecosystems are already living on the edge in terms of their annual net carbon uptake (NEE) and water use (ET). Initial findings suggest this is already true for the Great Western Woodlands, which has an annual cumulative NEE close to zero and ET almost equal to precipitation. How these ecosystems will fare in a part of Australia trending towards a hotter and drier climate in the future remains a crucial question. Improvements to ecosystem monitoring will help to identify ecosystem changes sooner, rather than later.

***Jordan Goodrich, Dave Campbell***
University of Waikato, New Zealand
*Exploring the drought resilience of New Zealand's peatland carbon sink*
Abstract: Peatlands have accumulated carbon throughout the Holocene, with a net cooling effect on global climate. With increasing inter-annual variability of precipitation, and consistent

warming caused by climate change, the stability of this sink is uncertain. However, New Zealand peatlands are uniquely equipped to maintain large rates of annual carbon uptake, even during extreme drought years. The net carbon balance of Kopuatai Bog, an undisturbed New Zealand peatland, is roughly 130 gC m-2 yr-1 during dry years, which is larger than the maximum rates published for most Northern Hemisphere peatlands. This resilience is partly enabled by dual-phase energy balance partitioning of the main peat forming vegetation, Empodisma robustum, constraining evaporation rates, and contributing to maintaining high water tables during dry summers. Kopuatai water table rarely drops more than 30 cm below the surface even during the most extreme seasonal droughts. This allows respiration rates to remain fairly constrained, albeit somewhat elevated during dry conditions. Here we expand on our previous work in this area by analysing a longer (~10 years) continuous record of CO2 and H2O fluxes, capturing a greater range of hydrologic variation, with an eye toward using this system as a benchmark for future peatland restoration efforts.

***Miko U.F. Kirschbaum, Donna L. Giltrap, Lìyǐn L. Liáng***
Manaaki Whenua - Landcare Research, New Zealand
CarbonWatch NZ. Modelled carbon exchange of forests ranging from long-term averages to sub-diurnal fluxes
Abstract: CarbonWatch NZ tried to infer surface gas exchange from atmospheric CO2 concentrations. This was combined with prior surface gas exchange estimates from applicable models. Our contribution to the overall project was the modelling of gas exchange estimates from forests, categorised as exotic (pine) forests, low-stature shrubby forests (manuka-kanuka stands and old-growth indigenous forests.
Here we presented the modelling results to date, consisting of comparison of long-term growth data compared with plot surveys and with short-term gas exchange observations from eddy-covariance sites. The model was also constrained by available ecophysiological understanding of plant and ecosystem responses to the environment.
The model was then run over 10 years with daily weather data at 0.05 degree resolution for all of New Zealand. Daily fluxes were further down-scaled to hourly fluxes. This was combined with a land-cover data base of the proportion of each 0.05 degree cell covered by respective vegetation types. That made it possible to derive the estimated hourly gas exchange flux emanating from each forest type over the whole of New Zealand.

***Robert Ward, Roberta Gentile***
Plant and Food Research, New Zealand
*Carbon fluxes from wine grapes in the Hawke's Bay, New Zealand*
Abstract: We have been operating two EC towers on a commercial vineyard in the Hawke's Bay of New Zealand since May 2019, with the aim of quantifying the seasonal and annual patterns of carbon fluxes in grape vines. One tower is observing a mature Merlot block and we present results from May 2020 to January 2021. Over the winter of 2020 it was a consistent carbon source, and over the subsequent growing season it was a consistent carbon sink. The other tower is observing a mature Sauvignon blanc block, which was converted into Pinot gris in the summer of 2019-2020. We present results from May 2019 to December 2020 and we see a much more complicated pattern of fluxes due to the change of varietal. Over the 2019-2020 growing season we estimate the block to be a small net carbon sink, with periods of net carbon emission attributed to removing old grape vines and other management practices. Over the 2020-2021 growing season, up to December 2020, the Pinot gris block is a consistent carbon sink, displaying similar patterns to the Merlot block but at a smaller magnitude. Over the course of the observations, significant technical difficulties were encountered resulting in somewhat limited flux data.

***Michael A. Forster***
Edaphic Scientific Pty Ltd, Cities Research Institute, Griffith University, Australia
Resolving the heat velocity measurement range limitation of sap flow methods
Abstract: Sap flow is related to the water flux between soils and atmosphere via plants and is a critical component of the hydrologic cycle. Sap flow is difficult to measure directly and is instead estimated from heat velocity (Vh) measurements via thermometric sensors. In turn, Vh is derived from several empirical or theoretical methods with an observed measurement range between ~ -20 cm hr-1 ('reverse flow') to >250 cm hr-1 ('positive flow'). Yet, it is well known that existing methods cannot resolve the entire observed Vh measurement range. Consequently, there are significant errors and uncertainties in the estimation of sap flow. A new method, the Dual Method Approach (DMA), resolves the issue by combining reverse/slow flow methods with fast flow methods via a theoretical transition derived from of the thermal conduction/convection equation. A linear regression of estimated sap flux density against gravimetric sap flux density for 15 woody species found an r2 of 0.541 for the reverse/slow method, 0.879 for the fast method, and 0.940 for DMA. Additional datasets from field grown trees further demonstrate the measurement range resolution of the DMA. Adoption of the DMA will improve sap flow measurements and accurate estimates of water flux between soils, plants and atmosphere.

***Nam-Thang Ha, Merilyn-Manley Harris, Tien-Dat Pham, Ian Hawes***
Faculty of Fisheries, University of Agriculture and Forestry (Hue University), Vietnam
*Seagrass resource inventory from space: A case study in Tauranga Harbor (New Zealand) using radar imagery and machine learning*
Abstract: Seagrass provides important ecosystem services across climatic regions. However, this resource is in decline globally and accurate mapping of extant meadows is in high demanding to support sustainable seagrass blue carbon conservation. This study develops a novel method for seagrass inventory using a suite of state-of-the-art machine learning (ML) and synthetic aperture radar (SAR) Sentinel ,Äì 1 remote sensing data. Our results indicate a promising application of Sentinel ,Äì 1 data for a binary mapping of extant seagrass meadows in Tauranga Harbor (New Zealand). The machine learning extreme gradient boost (XGB) model deliver the most accuracy mapping with scores of precision (P) = 0.82, recall (R) = 0.90, and F1 = 0.86). Of the orginal and transformed input bands, the VH and the first band of a principle component analysis (PCA) contribute approximately 79% to the success of model performance. Our findings contribute novel and advanced methods for seagrass detection, which are simple and reliable, use open source data and software and should be easily applicable to intertidal zones across many regions of the world.

***Tien Dat Pham, Thu Thuy Nguyen, Jacob Delfos, Robert Archibald, Huu Hao Ngo, and Julian Kruger***
Department of Earth and Environmental Sciences, Macquarie University, Sydney, Australia
*Improving estimates of agricultural soil organic carbon using Sentinel-2 MSI and Sentinel-1 SAR data combined with active and ensemble learning in Western Australia*
Abstract: This work developed a novel framework using Sentinel-2 (S2) multispectral data and Sentinel-1 (S1) C-band dual polarimetric synthetic aperture radar (SAR) combined with an integration of active learning for land-use mapping and advanced Extreme Gradient Boosting (XGBoost) for robustness of the soil organic carbon (SOC) estimates in Western Australia. We compared the effectiveness of the proposed machine learning model with the two well-known algorithms such as Random Forests (RF) and Support Vector Machine (SVM) to estimate agricultural SOC. Our results show that an integration of S1 and S2 sensors into the p roposed XGBoost model with optimal features could effectively predict SOC in farming areas with a satisfactory accuracy (R2 = 0.870; RMSE= 1.818 ton C/ha). Our innovative method using multi-

sensor data fusion combined with the XGBoost provides the best prediction results for mapping agricultural SOC at 10 m spatial resolution. The novel intelligence approach developed here could contribute significantly to various agricultural SOC retrievals globally. What makes this possible is its superior prediction performance at 10 m spatial resolution and cost-effectiveness using reliable free-of-charge space-borne optical and SAR data acquired from Copernicus Open Access Hub.

***Kunadi Ashvath Singh, Silberstein Richard, and Thompson Sally***
The University of Western Australia, Australia
*Variation in Zero Plane Displacement Length and Roughness Length Revisited*
Abstract: Zero plane displacement length d0 and roughness length for momentum z0m are the aerodynamic parameters that govern the fluxes of momentum, energy, and mass to and from a surface. Usually, d0 and z0m are assumed to be constants that can be estimated using the physical characteristics of the surface such as, the height of the canopy (Hc) and leaf area index. However, there is evidence that d0 and z0m vary for a physically unchanging surface. This variation has conventionally been tested as the linear functions of wind and friction velocity. We match the velocity at Hc as estimated by 4 analytical canopy wind velocity models to the log profile above the canopy to explain the variation. The wind velocity profile above Hc is used at 7 flux sites to get empirical estimates of d0 and z0m. At 6 sites where variations were observed, the conventional and the canopy velocity matching methods were calibrated and validated to predict the variation in the aerodynamic parameters at each site. The calibration shows that the canopy velocity matching method gives estimates of the momentum absorption capacity of the surface that vary with phenological changes, while the parameters generated by the conventional methods that have no physical meaning nor predictable change with phenology. The validation results show that the canopy velocity matching method recreates the distribution better than the conventional methods. A measurement of velocity at Hc makes this method reproducible at flux sites.

***Tommaso Julitta, George Burba, Roberto Colombo, Alexander Damm, Frank Griessbaum, Paul Naethe, Mirco Migliavacca, Uwe Rascher, Mike Delaney, Andreas Burkart***
JB Hyperspectral Devices, Germany
*Field spectrometers for continuous proximal sensing monitoring*
Abstract: Well-established carbon flux monitoring networks (e.g. TERN, ICOS, NEON) are recognized worldwide in terms of providing high-quality standardized data. Proximal sensing techniques such as field spectroscopy provide a link between these fluxes and remote sensing, enabling local information to be scaled up to global information.
JB Hyperspectral Devices, with the support of the scientific community, has developed autonomous instruments, capable of operating continuously in the field in a wide range of harsh climatic conditions. These instruments acquire punctual, high-temporal-resolution hyperspectral data. Thanks to a robust, open-source and standardized data processing chain, they return time series of radiometric parameters as well as optical properties (e.g. solar-induced chlorophyll fluorescence (SIF), reflectance and various spectral indices).
To further utilize the data collected with these devices, JB is currently in the process of making these instruments compatible with the latest flux data collection and processing systems running typical flux stations (e.g. SmartFlux from LI-COR) and a collaboration with existing consolidated flux networks (e.g. FluxNet and ICOS) is ongoing to explore better coupling between flux, optical, and remote sensing measurements. The possibility to integrate JB devices into flux networks, via a standardized procedures of configuration, set up, data processing, and different data product levels are currently being evaluated.

***Jo Owens, Jamie Cleverly, Peter O'Reagain and Greg McKeon***

University of Southern Queensland, Australia
*Linking long-term grazing trials and modelling with the new flux towers in Queensland*
Abstract: The Wambiana grazing trial is regarded as one of the most important field experiments in grazing science because it addresses the major issue of long-term livestock grazing of Queensland's native pastures in a highly variable climate. The trial provides an excellent opportunity to evaluate the effects of climatic (i.e. multi-year wet and dry periods) and grazing management (i.e. fire and stocking rate) on pasture production and resource degradation for a savanna ecosystem (open woodland with perennial native pastures) using the GRASP pasture model. The grazing trial is located close the Fletcherview research station, where Queensland's newest flux tower is being installed. This talk is about how we aim to link the findings and knowledge gained from long-term trials to data collected from Ozflux sites with biophysical modelling. This study is important for the grazing industry and policy as it impacts on calculations of long-term carrying capacities, pasture biomass and ground cover for sustainable grazing. This study contributes to current applications of the GRASP model used operationally in Queensland to address long-term carrying capacity in areas with woody vegetation.

***Will Woodgate, Jacqui Stol, Mark Kitchen, Tim Devereux, Stuart Phinn***
The University of Queensland, Australia
*The road to recovery: the Tumbarumba site post major fire disturbance in 2020*
Abstract: This talk presents details of the road to recovery of the Tumbarumba TERN/OzFlux site post a major fire disturbance as part of Australia's 2019/20 Black Summer. On New Year's Eve 2019 a major fire swept through the Tumbarumba site burning 90% of the Bago State Forest (50 000 ha of native forest in NSW, Aus). All ground-based infrastructure was lost, with the saving grace being the tower still standing with instrumentation at the top of the 70m tower largely unaffected. Since then, the road to recovery has been severely hampered by Covid-19, with bare bones data continuity resuming in late 2020. Specific aspects of the talk will focus on the bushfire extent and fire severity, recovery through the lens of optical satellites providing data continuity, ground-based inventory, and preliminary post-fire flux data analysis.

***Cleverly Jamie, Owens Jo***
Terrestrial Ecosystem Research Network, College of Science and Engineering, James Cook University, Australia
*Evapotranspiration, soil water content and precipitation pulses in a water-limited ecosystem*
Abstract: Water is the focus of Australia's burgeoning critical zone observatory network, in a land where fluctuations in precipitation strongly drive ecosystem function. In this presentation, we will explore the exponential decline in evapotranspiration and soil water content following precipitation pulses in central Australia, across extremes of wet and dry conditions. We will then apply these lessons as hypotheses for what is to come at the new Fletcherview Tropical Rangeland SuperSite and Critical Zone Observatory.

***Richard Silberstein, Ashvath Kunadi, Tim Lardner***
Edith Cowan University, Australia
*Two eddy covariance systems on the same tower, looking for the constant flux layer*
Abstract: Eddy covariance systems are collecting data from a surface assuming that their measurements are representative of uniform fetch conditions in all directions and usually these conditions are sufficiently satisfied to provide confidence that our data and analyses are valid. The second most important assumption, inherent in all installations, is that we place our in struments above the roughness sublayer, within the constant flux layer. We usually base the positioning on standard ,'rules of thumb' that our instruments should be at least twice the vegetation height. However, this 'rule' is based on a uniform, dense canopy which is often not the case in natural

vegetation systems, especially woodlands. The Banksia woodland of the Swan Coastal Plain near Perth is a typically sparse woodland, with inter-tree spacing approximately the average tree height (~5m). We took the opportunity provided by an instrumentation upgrade to firstly, run two eddy covariance systems side by side on top of our tower (at 15m) for 3 months to compare the measurements and check that they gave the same fluxes. We then moved one to 7m to test whether this height was within the constant flux layer. It is intended to move this up and down to further explore the structure of the near near boundary layer. We present preliminary data from these explorations.

***Markus Löw, Mark Adams***
Swinburne University of Technology, Australia
*Comparison between three mobile eddy covariance systems located in close proximity of each other*
Abstract: Eddy covariance systems can be used to compare fluxes between the atmosphere and different land use types. Variation in fluxes due to land use becomes significant when the latter vary strongly (e.g. forest/grassland/cropland) within relatively small geographic areas, as is found in large areas of temperate and coastal Australia. Prior to making such comparisons, an essential step is evaluation of differences due to specific sensors and their calibrations (e.g. IRGAs, anemometers, net radiometers, etc), such that any bias can be avoided or removed during data evaluation. Furthermore, and as is widely known, sensor drift can be significant over moderate periods time. We evaluated sensor stability (e.g. drift) and between-sensor differences using three, trailer-based eddy covariance sensor systems equipped with telescopic masts that allow sampling between 5 and 20 m above ground. Here we report a comparison of the three EC systems in a grassland site outside of Daylesford, Victoria, Australia. Each system was deployed for between one and six months, within 100 m of each other, using a 10 m sampling height. We found little bias between instruments of the same type and generation (e.g three Licor EC150 IRGAson) and little drift. There were larger differences among radiometers of different age (e.g. CNR1 and CNR4).

***Laubach Johannes, Hunt John, Graham Scott, Rogers Graeme, Mudge Paul, Whitehead David***
Manaaki Whenua, Landcare Research, New Zealand
*Nitrous oxide and carbon exchange of mixed-species pasture: win-win or trade-off?*
Abstract: On grazed pasture, reducing nitrous oxide (N2O) emissions and maintaining or increasing soil carbon stocks are critical to contribute to mitigating New Zealand's greenhouse gas (GHG) emissions. Our team is investigating the potential to mitigate GHG emissions and identify trade-off effects from an irrigated, mixed-species grassland that includes plantain, in comparison with an adjacent conventional ryegrass-clover grassland using continuous measurements of net exchanges of N2O and CO2. Both swards were established in April 2020 with previous identical management. We use the eddy covariance method with a multi-gas analyser, installed near the boundary of the two sites, and employ a split-footprint analysis to determine the gas exchange budgets for both. During the first grazing season (September to March) N2O emissions from the mixed-species pasture were just over half those from the ryegrass-clover pasture, while during the conversion period before and during a cow-free period after the grazing season the two pastures emitted similar amounts of N2O. Overall, the net carbon gain for the mixed-species pasture was smaller than that for the ryegrass-clover pasture, which appeared to be due to the very heavy first grazing event. Measurements are continuing to determine whether the second (current) grazing season will show similar or different findings.

***Ryan M. Burrows, Jodie van de Kamp, Levente Bodrossy, Michael Venarsky, Jack Coates-Marnane, Gavin Rees, Paavo Jumppanen, Mark J. Kennard***
Waterway Ecosystem Research Group, School of Ecosystem & Forest Sciences, University of Melbourne

*Methanotroph community structure and processes in an inland river affected by natural gas macro-seeps*

Abstract: Methane availability in freshwaters is usually associated with spatial-temporal variation in methanogenesis. Unusually, however, natural gas macro-seeps occur along the Condamine River in eastern Australia which elevate ambient water-column methane concentrations more than 3,000 times. We quantified the spatial-temporal variation in methane oxidation rates and the total microbial and methanotroph community composition (through the amplification and sequencing of 16S rRNA and particulate methane monooxygenase (pmoA) genes), and the factors mediating this variation, in reaches with and without macro-seeps. Sediment methane oxidation rates were, on average, 29 times greater, and the abundance of methanotrophs significantly higher, in the vicinity of methane macro-seeps compared to non-seep sites. Methylocystis was the most abundant methanotroph group at all sites, but type Ib methanotrophs showed the steepest increase in abundance at seep sites. pmoA gene analysis identified these as clade 501, while 16S rRNA gene analysis identified these as the closely related genus Methylocaldum. Sediment methane oxidation rates and the relative abundance and composition of benthic microbial communities were primarily influenced by methane availability which was in turn related to variation in river discharge. Methane-derived carbon may be an important energy source for the aquatic food webs in reaches affected by natural gas macro-seeps.

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*Inter-annual and seasonal interactions of canopy dynamics, carbon and water fluxes in a temperate evergreen angiosperm forest: a data-model comparison*

Abstract: Forest-atmosphere exchange of carbon and water is regulated by canopy structure as well as meteorological conditions. Canopy structure can vary seasonally and inter-annually in both deciduous and evergreen forests, but the influence of these variations on carbon and water fluxes for the latter is poorly understood. We study how variation of leaf area index (LAI, m2 m-2) and meteorological conditions interact to regulate carbon and water fluxes in a temperate evergreen angiosperm eucalypt forest near Sydney, Australia. We used eddy-covariance measurements (years 2014-2017) and applied the Community Atmosphere Biosphere Land Exchange (CABLE-POP (r5046)) model to explore the importance of variable LAI for ecosystem carbon and water fluxes. Our results showed that the peak of LAI occurred in late summer-early autumn, with a higher peak occurring earlier in years when summer rainfall was greater. The allocation of carbon to leaf growth was dynamic seasonally (contrasting with the model assuming constant allocation), ranging from 0 % in winter to a peak of 59 % in summer. Change in LAI was not sufficient to capture change in photosynthetic capacity and surface conductance, we suggested that leaf efficiency, varying with age, could be another driver of these variables. These results highlight areas needing further research to improve ecological understanding and land surface models of temperate evergreen angiosperm forest.

***Tim Wardlaw***

University of Tasmania, Australia

*A direct response to supra-optimal temperatures for reduced GPP during the 2017 warmspell at Warra*

Abstract: Daytime temperatures were above the optimum for gross primary productivity (GPP) in the E. obliqua tall forest at Warra for 75% of the time during a prolonged warm spell between 10-30th November 2017. Ecosystem respiration increased by 26% and GPP decreased by 39%, compared with the same period in the previous two years. Multiple lines of evidence suggest reductions in GPP were in direct response to supra-optimal temperatures rather than via stomatal

regulation to limit water loss. They include measured energy fluxes, vapor pressure deficits and soil moisture, as well as historical data of stomatal conductance measurements in 70-y.o. E. obliqua forest during a period of record high temperatures. The presentation will detail the evidence leading to the conclusion of direct temperature effects causing the reduction in GPP.

***Bennett, Alison C; Arndt, Stefan K; Bennett, Lauren T; Knauer, Jürgen; Beringer, Jason; Griebel, Anne; Hinko-Najera, Nina; Liddell, Michael; Metzen, Daniel; Pendall, Elise; Silberstein, Richard; Wardlaw, Timothy; Woodgate, William; Haverd, Vanessa.***
The University of Melbourne, Australia
*Thermal optima of Gross Primary Productivity and air temperature closely align: A synthesis of OzFlux's wooded ecosystems.*
Abstract: Synthesis of eddy covariance data from the OzFlux network can reveal broadscale patterns of ecosystem functioning. We examined the relationship between gross primary productivity (GPP) and air temperature (Ta) across 17 of OzFlux's wooded ecosystems from five ecoregions. We used boundary line analysis to derive the GPP-Ta relationship and the thermal optima of GPP (Topt) including seasonal (wet vs dry season) analysis in tropical savannas. We demonstrated that the GPP-Ta relationship is a convex parabola with narrow curves in tropical forests, tropical savannas (wet season), and temperate forests and broader curves in temperate woodlands, Mediterranean woodlands, and tropical savannas (wet-season). We also examined the relationship between Topt and the mean daytime air temperature (MDTa), discovering a strong positive linear relationship between Topt and MDTa (adjusted R2: 0.81; Slope: 1.08). Our synthesis revealed that among these wooded ecosystems a) the shape of the GPP-Ta relationship is a convex parabola that is largely defined by the daytime temperature range, MDTa, and maximum GPP; b) Topt of GPP has adjusted (acclimation plus adaptation) to the local temperature regime. Our analysis suggests that GPP in the majority of these ecosystems is buffered against small temperature increases and that Australian wooded ecosystems possess a common capacity to adjust Topt of GPP to local air temperatures.

***Sami W. Rifai, Martin G. De Kauwe***
ARC Centre for Climate Extremes, University of New South Wales, Australia
*Continuous subseasonal temperature acclimation of solar induced fluorescence in forest ecosystems*
Abstract: Ecosystem models increasingly integrate temperature acclimation processes for modeling photosynthesis. Field measurements of the optimum temperature of photosynthesis (Topt) have repeatedly shown Topt capacity for acclimation, however there are practical limits of field measurement for understanding the limits of Topt acclimation responses across ecosystems and environmental gradients. In contrast, solar induced fluorescence (SIF) can be measured by remote sensing and has been shown to be an effective proxy of gross primary productivity (GPP) when compared with flux site measurements. Here, we ask (1) if the Topt of SIF is analogous to the Topt of eddy flux derived GPP, (2) how rapidly can Topt respond to changes in air or surface temperature, and (3) how does drought stress influence the Topt acclimation response? Using a new high-resolution SIF dataset from Sentinel-5p's TROPOMI sensor, we fit pixel-level models of Topt across forests in the continental United States, where the SIF data product is currently limited to. We found both flux site GPP and SIF derived Topt acclimated to monthly temperature variation, and that the responses of Topt to monthly temperature shifts were near identical between flux site GPP and SIF. The drought effect on Topt was negligible, in part because the drought effect already elevates (surface) temperature. We argue this approach may be suitable to constrain Topt acclimation processes in ecosystem models.

***Nurit Agam & Dilia Kool***
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*Water where there is no water - Atmospheric water captured by world deserts*
Abstract: Atmospheric water, or non-rainfall water inputs (NRWIs) are an important source of water in arid areas. Considering the large surface area of arid and extremely arid regions, NRWIs are a critical, albeit largely overlooked, component of the global hydrological cycle. Water vapor adsorption is not only the least studied form of NRWI but likely the most common one in arid areas. The amount of water vapor adsorption mainly depends on the gradient between water vapor pressure between the air (ea) and the soil (es). Sea breeze, which carries moist air from t he sea landward, can result in a significant daily increase in ea in desert areas.
We have examined the diurnal cycle of soil water content derived by water vapor adsorption and evaporation in two very different deserts: the Negev (loess soil, ~100 mm/y) and the Namib (sand dunes, ~20 mm/y). Water vapor adsorption into the Negev's loess soil has been established as the dominant NRWI (with 0.3-0.5 mm/night). Even in the Namib, which is known as a fog desert, even on nights with fog, at least half of the water accumulation occurred via water vapor adsorption, before the onset of fog (0.1-0.2 mm/night).

***Samantha Grover & students***
RMIT University
*A tale of two peatlands; fluxes from Australian alpine and Indonesian tropical peatlands*
Abstract: no abstract submitted