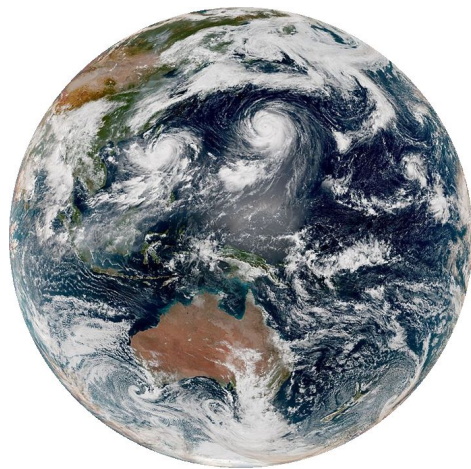


Using Himawari-8 observations to develop a proxy for convective rainfall



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OzEWEX 2020 Australian Climate and Water Summer Institute

Motivation

Can we identify regions of (severe) convection using Himawari-8 satellite products?

What is the climatology and seasonality of convective rainfall in Australia?

How to identify convective regions?

- Derive a metric of convective cloud using (multiple bands of) the Himawari-8 satellite

How to verify convective regions?

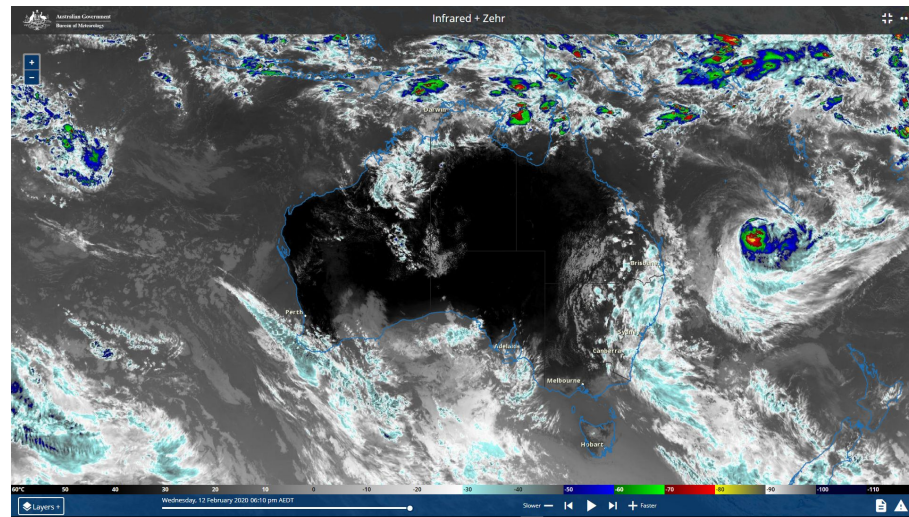
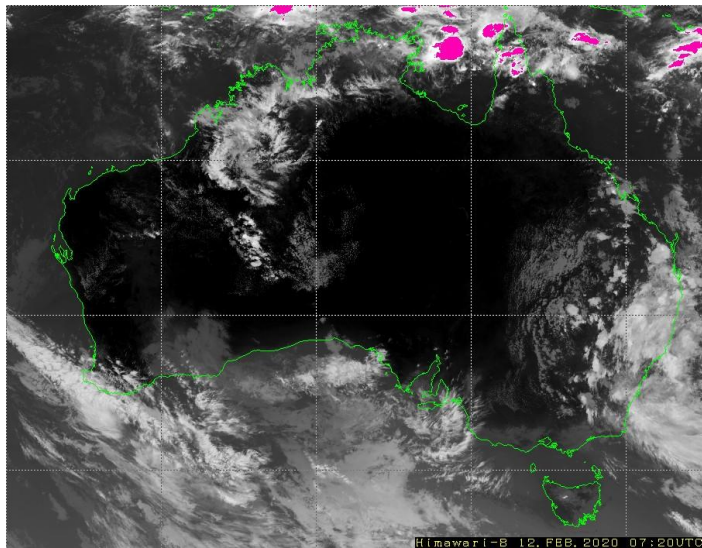
- Compare rainfall in areas under convectively active regions with regions outside

Some early ideas

Bureau of Meteorology Satellite Viewer – Zehr Colouration

<http://satview.bom.gov.au/>

- Areas below a threshold temperature?



JMA (Japanese Meteorological Agency)
Imagery with Heavy Rainfall Potential Areas
http://www.data.jma.go.jp/mscweb/data/himawari/Users_Guide.pdf

- Mask region using a combination of several IR bands?

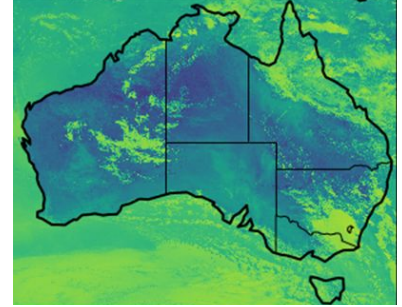
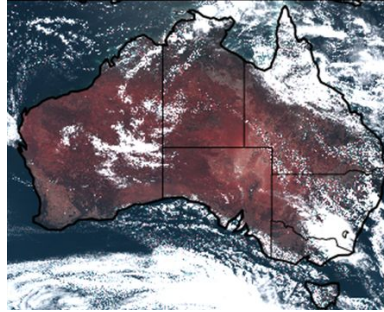
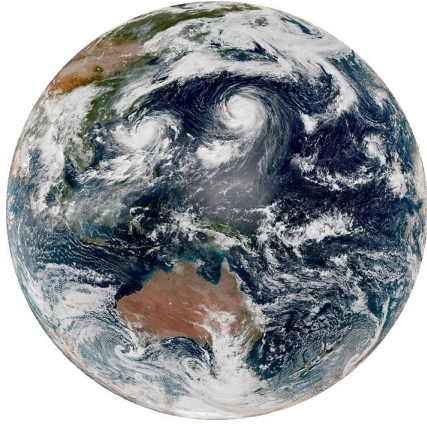
Indices to diagnose convective initiation



- CI is characterised by the rapid variation of temperature and the increase of cloud tops.
- CI nowcasting algorithms developed by determining thresholds for specific channels and the spectral / temporal differences between channels.

Can these indices be used to detect convective vs non-convective rainfall?

Workflow

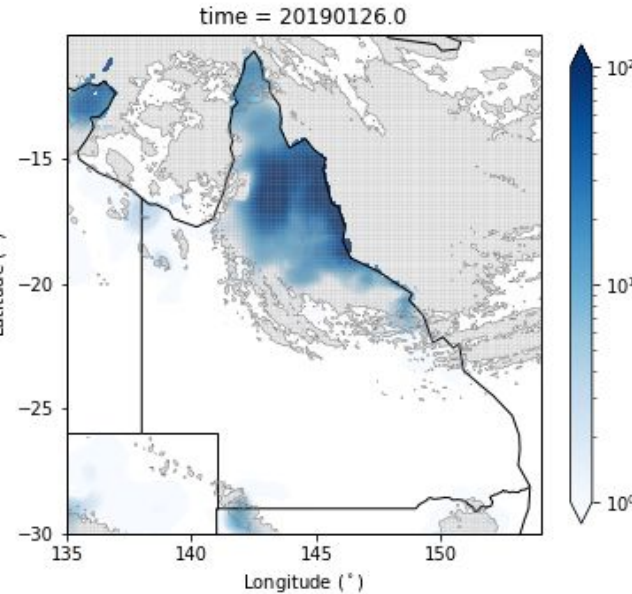
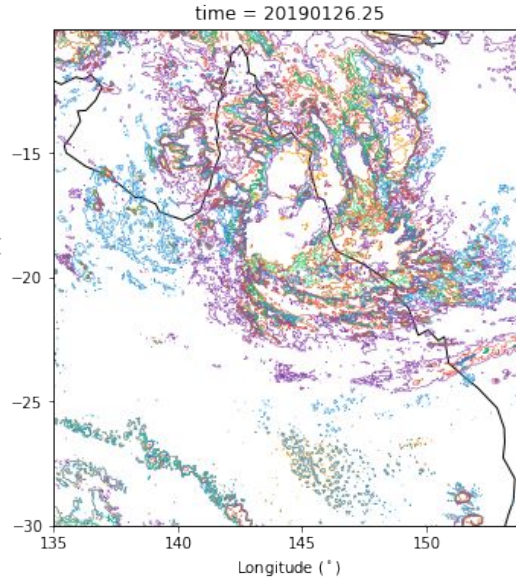
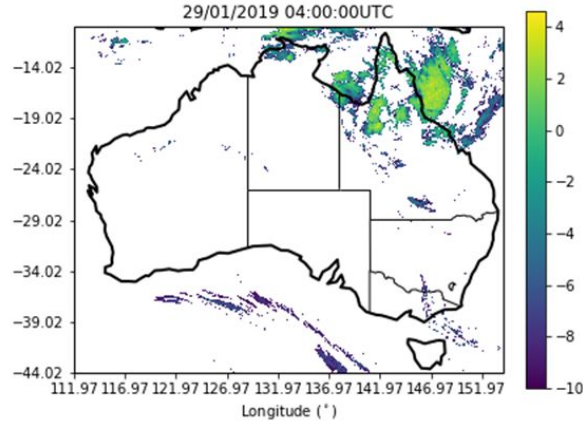


Data wrangling to re-project Himawari

- Regrid using gdal
- Extract required visible and IR for indices

This took many hours!

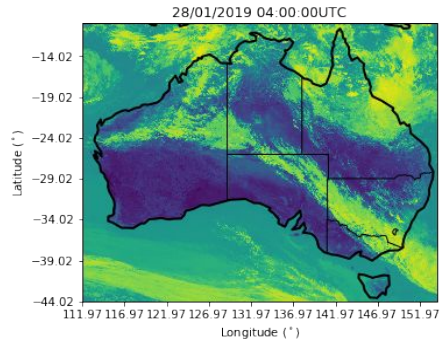
Workflow



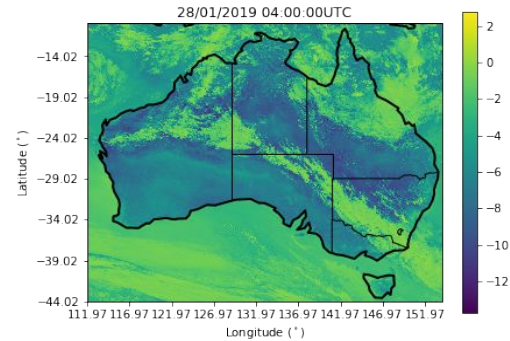
- Derived “convective initiation” indices (Lee et al., 2017 and JMA)
- Used multiple indices to derive a mask (matching AWAP resolution) estimating spatial extent of convection on a given day
 - Required agreement of 5 out of 6 indices
- Plotted mask over gridded rainfall data (AWAP / AGCD)
- Attribution of convective and non-convective rain

Convective Initiation Indices

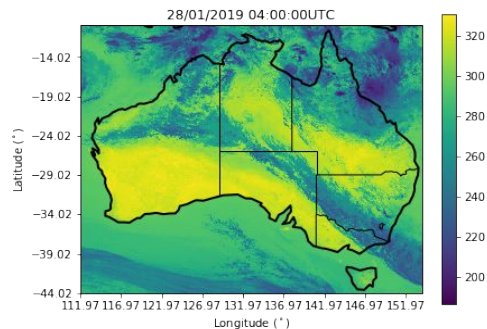
6 indices to measure 4 fields of interest:



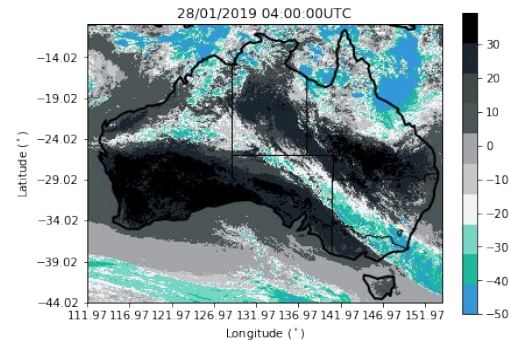
Cloud top-height relative to tropopause



Cloud top-temperature assessment



Cloud top-glaciation

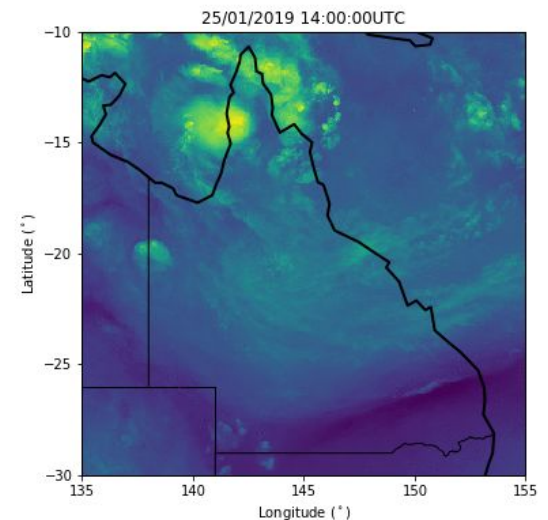
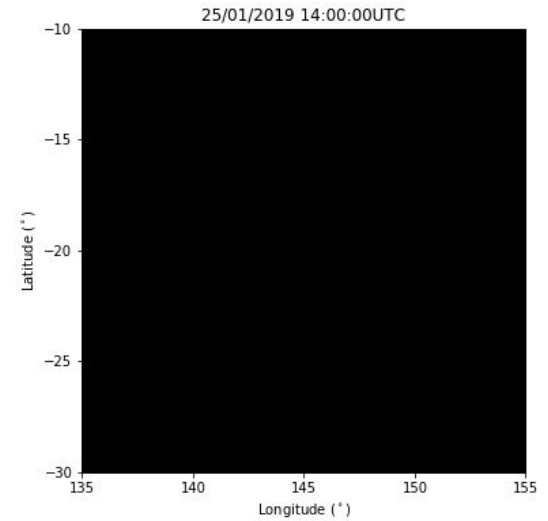


Areas of potential heavy rainfall “JMA-lite”

Case Study 1

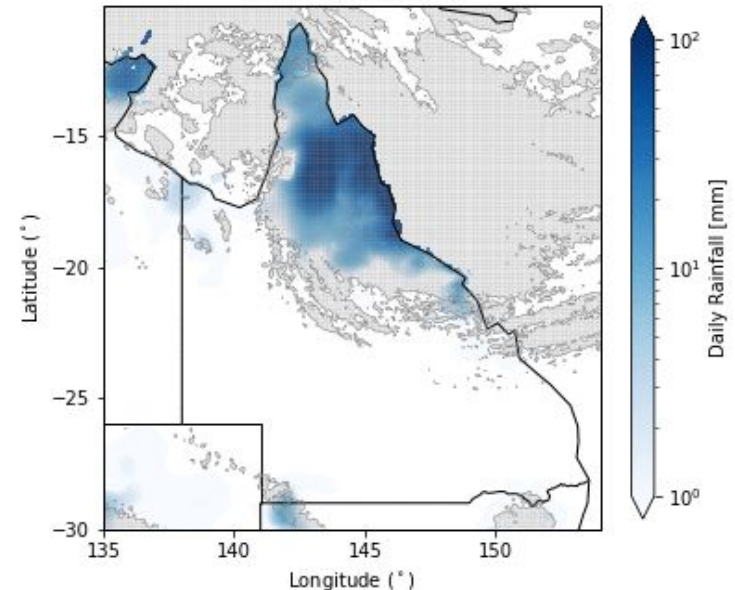
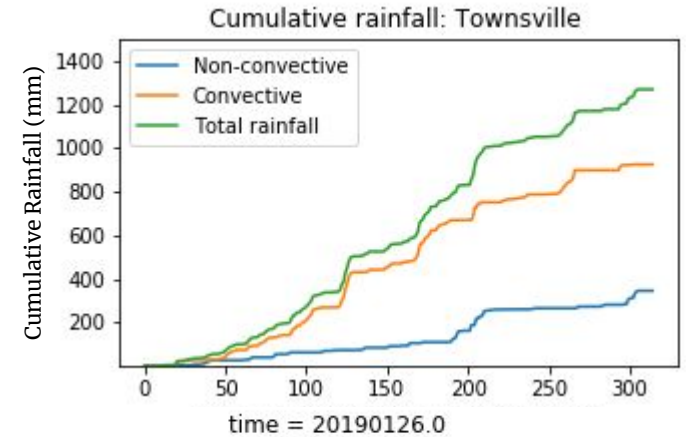
North Queensland flooding Jan-Feb 2019

- Large-scale areas of monsoonal convection
- Record rainfall in Townsville:
~1260 mm in 10 days
- Widespread flooding: 5 lives lost
- Huge numbers - several hundred thousand head of livestock lost in Gulf country



North Queensland Floods

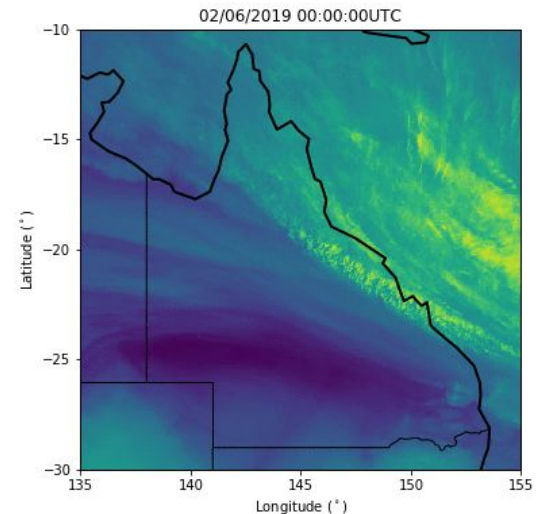
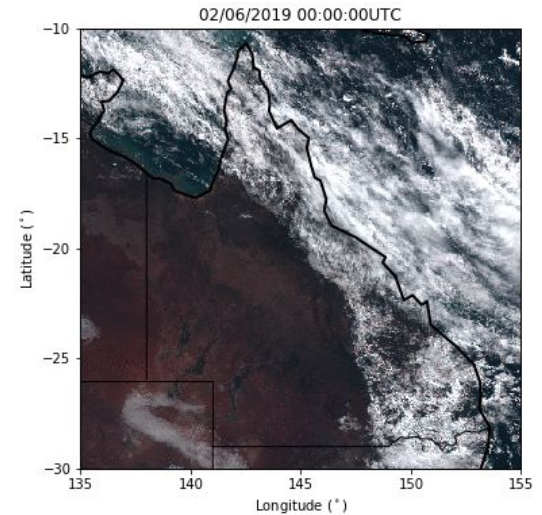
- Strong agreement during the most intense rainfall days:
Heaviest rainfall totals align well with convection mask
- Less agreement as the storm decays into early February
- Not all places under the mask receive large rainfall totals
- Majority of the event's rainfall is convective (according to the mask)



Case Study 2

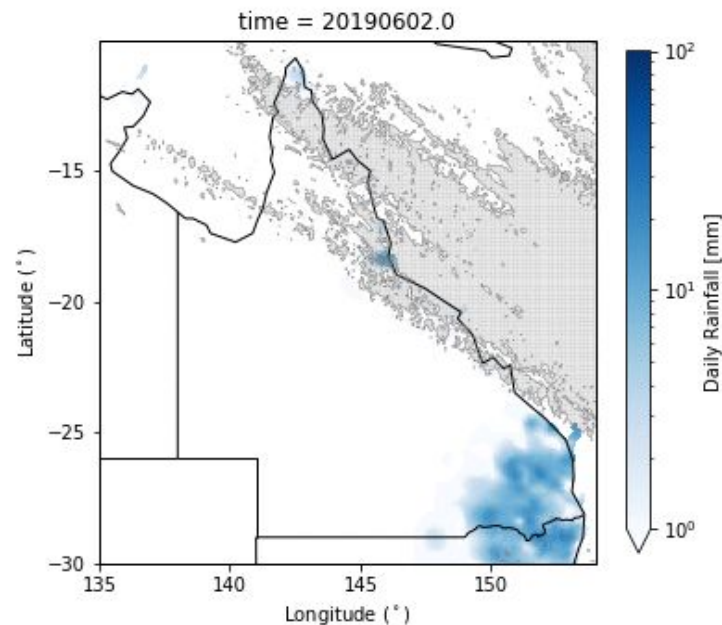
Southern Queensland snow, June 2019

- Complex low pressure system and cold front travelled north from Tasmania
- Storms hit large parts of the East coast
- Snowfall reached southern parts of QLD Darling Downs
- One of few significant precip. events in winter 2019
- Temperatures below freezing and light precipitation



Southern Queensland Snow

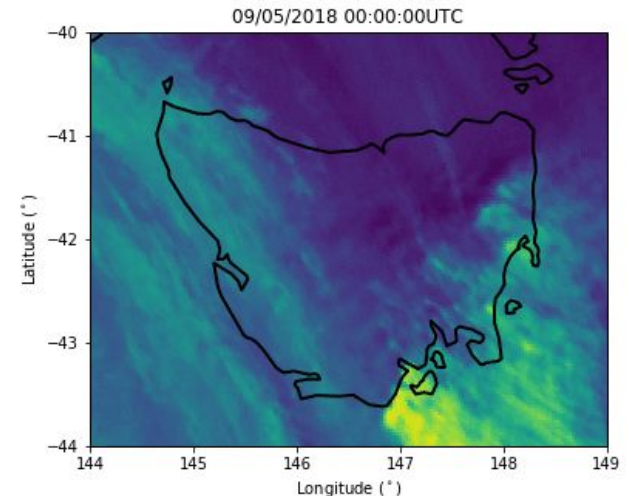
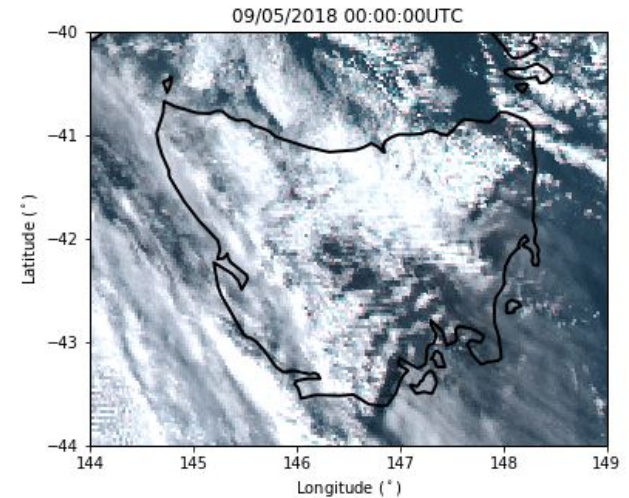
- Good agreement between convection mask and areas of high rainfall
- However convection mask also present during low / no rainfall days
- Perhaps our indices were not strict enough in discerning cloud types



Case Study 3

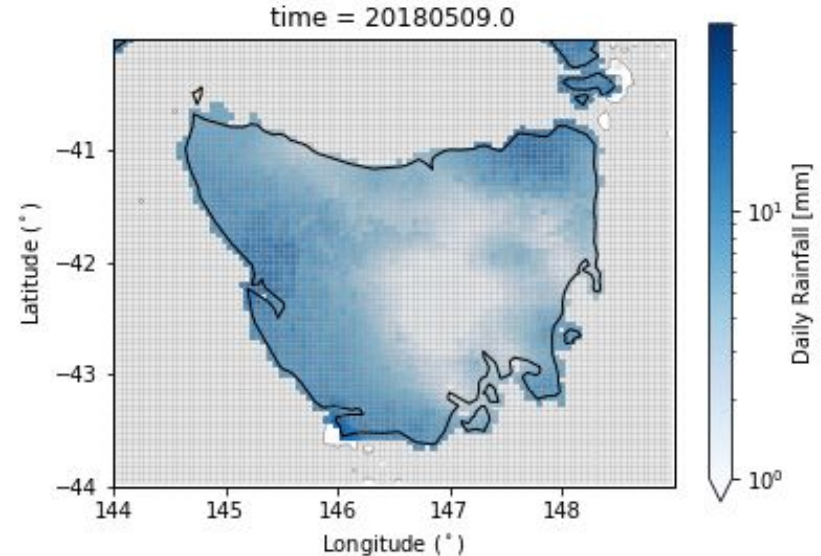
Hobart Flash Flooding, May 2018

- Complex low pressure system crossed Tasmania on the 10/5/18
- Unusual direction of airflow with embedded storms led to large rainfall amounts on upslope of Mount Wellington / Kunanyi
- Hobart city recorded ~129 mm on the 10th-11th, doubling previous May record



Hobart Floods

- Good agreement between the location of CI and heavy rainfall
- Large scale coverage could suggest over-identification of convection
 - Are we identifying all types of clouds?
- Room to further improve detection technique for more localised convection in extra-tropics



Climatology of convective rainfall

Q: What proportion of rainfall can we attribute to convection?

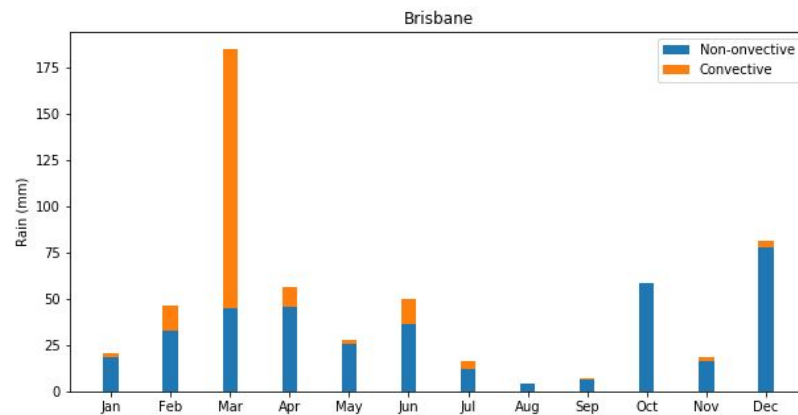
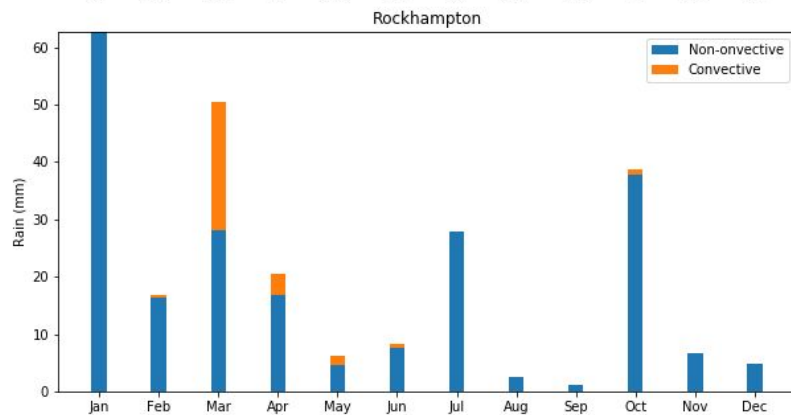
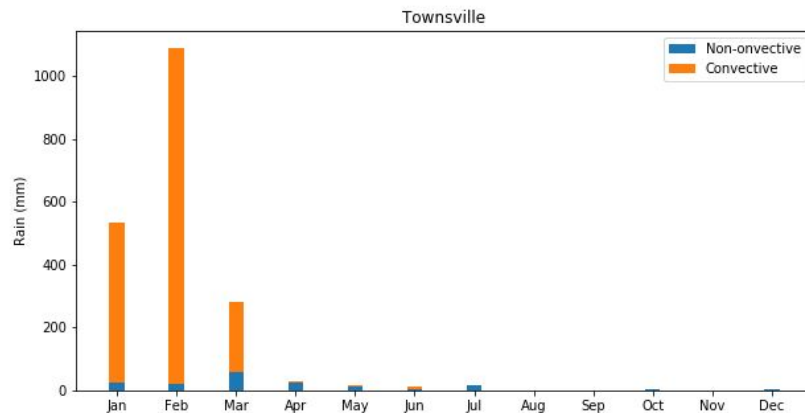
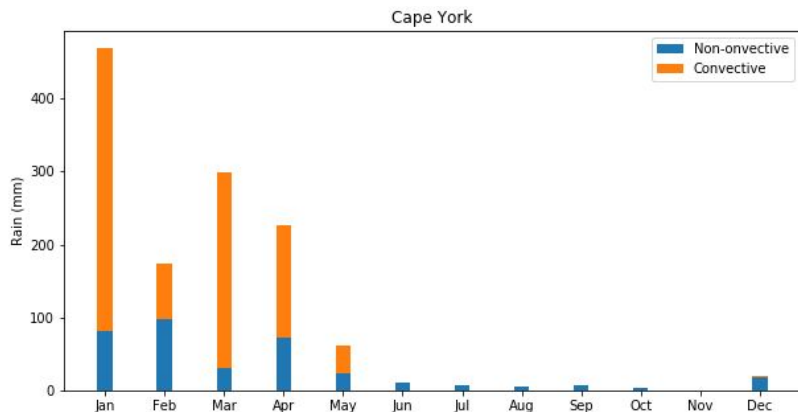
Convective indices developed / calibrated in tropical environments (e.g. JMA Areas of Potential High Rainfall)

Queensland case studies showed promise...

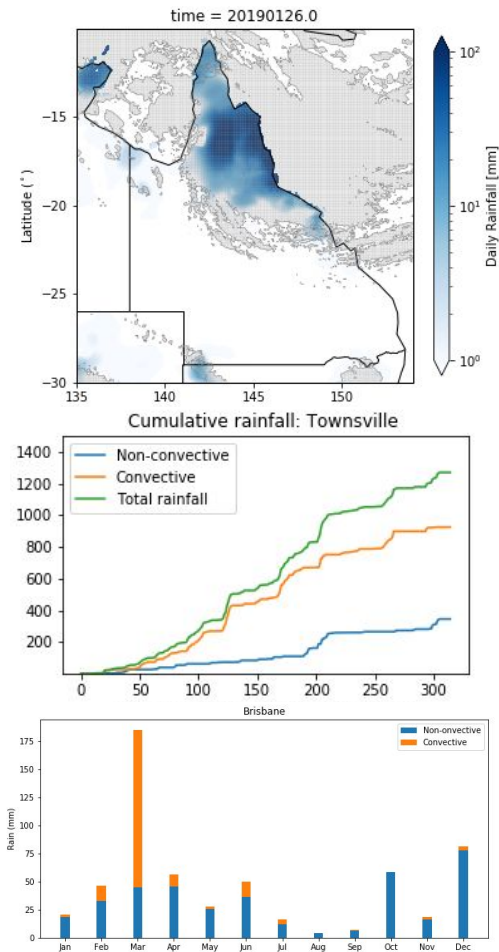
Use our convective mask to discriminate between AWAP rainfall on convective days vs non-convective days

Queensland climatology

Monthly rainfall stratified by storm mechanism (ignore December!)



Summary



- Convective clouds were classified using several indices based on Himawari-8 satellite bands
- Indices were combined to create daily masks of areas with potential convection
- Masks overlaid on daily AWAP rainfall
 - And pluviograph data for Townsville
- Convection masks successfully overlaid regions of large rainfall totals in case studies over Queensland
- Perhaps we have over-captured cloud?
 - e.g. Tasmanian case study masked more areas than those receiving heavy rainfall
- Partitioned rainfall over Queensland for a full year based on convection masks
 - extracted stats for several key locations

If we had more time....

- Fix our mistakes!
- Be more strategic in choosing Himawari bands
- More objective means of identifying convection and testing our mask algorithm
- Assess localised convective thunderstorms as well as large convective events
- Consider using information from other data products (NWP? Regional climate models?)
- Derive volume of water produced on convective rainfall days
- More nifty data visualisation

Acknowledgements

Luigi Renzullo – suggestions for techniques, satellite bands

Pablo Larraondo – python help

Conrad Wasko – pluviograph data

Bureau of Meteorology and Japanese Meteorological Agency

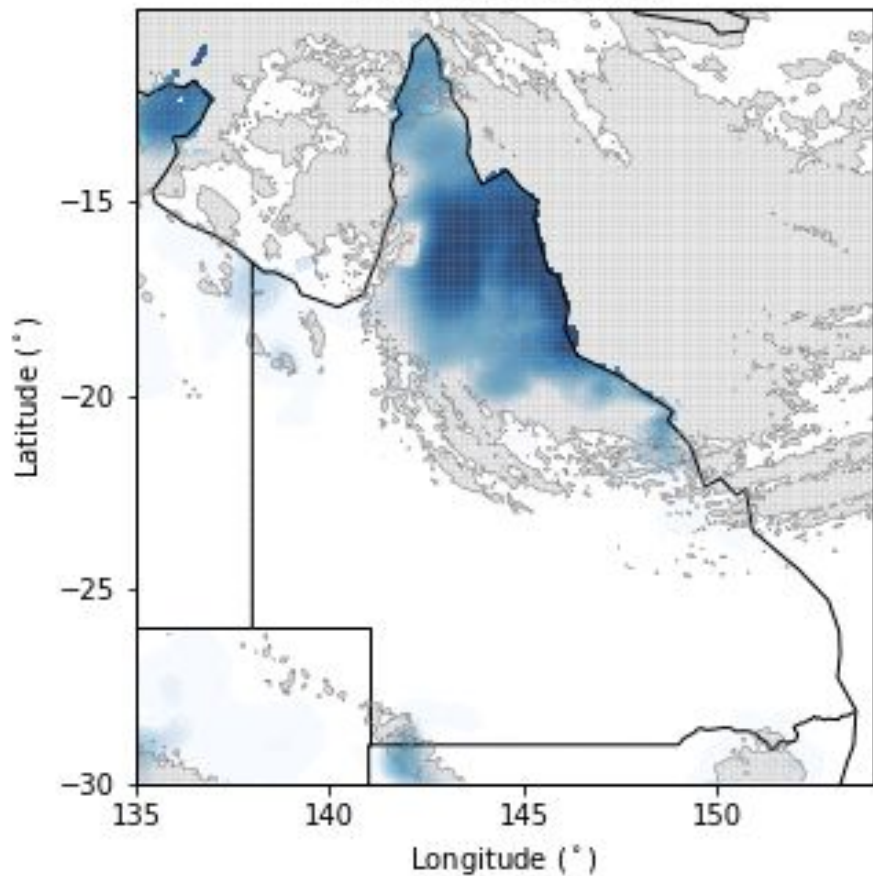
OzEWEX and ANU

NCI, GA, BoM, MDBA and CSIRO

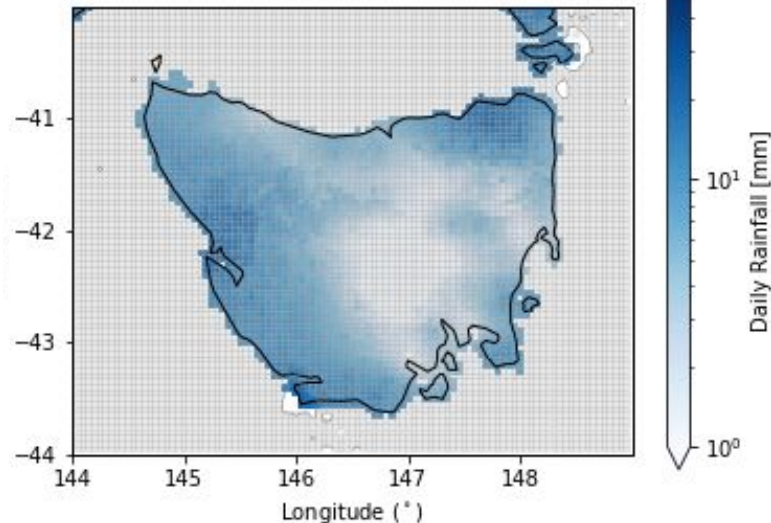
Our respective organisations for allowing us to be here!

Highlights (GIF City)

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