A comprehensive, nationally consistent climatology of fire weather parameters

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AFAC Conference Science Day

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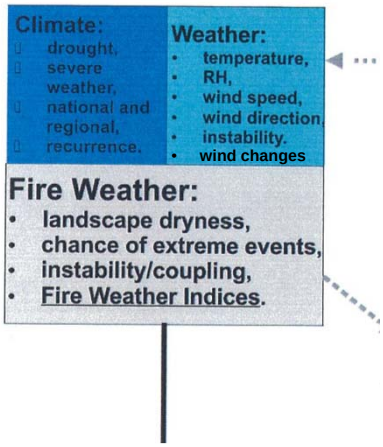
Modular FDR System: The Meteorology



- Some aspects of fire weather are not fully considered in current indices
  - Wind changes
  - Stability (partly)
  - Inversions
  - Sudden surface dryings / dry slots
  - Instability
  - Preceding heatwaves
- Aim for ~3 component FWIs
  - e.g. (i) hot/dry/windy, (ii) 3D weather, (iii) wind change
- Plus one master FWI that combines all factors.

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Climatology Project

- "This project will assess the climatology of extreme fire events to provide a better understanding of the weather conditions that lead to severe fire behaviour and to inform the future development of future indices of fire weather."

- Nationally consistent climatology of existing indices (FFDI, GFDI, C-Haines).
- Include important matters that existing indices omit (e.g. wind changes, dry slots).
- Underpin future development of new and/or improved fire weather indices.

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Milestone 1

- Determine meteorological structures to be studied.

DRAFT FOR COMMENT

Report on Meteorological Structures to be Analysed for the Fire Danger Rating Project

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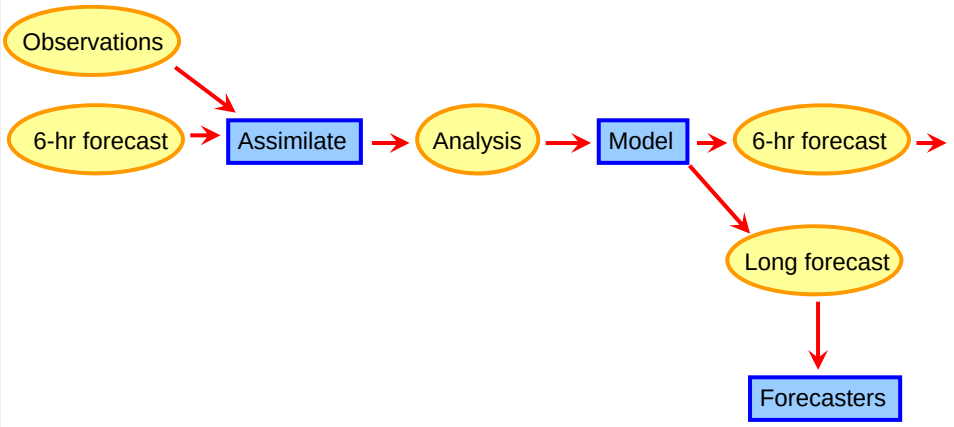
Parameters to be calculated

- **Existing fire indices**
  - FFDI Mark V, GFDI Mark IV, Canadian FWI
- **Atmospheric parameters**
  - Atmospheric stability (continuous Haines, vertical velocity at 850 hPa).
  - Boundary Layer depth.
  - Temperature at screen level.
  - Humidity at screen level.
  - Wind speed and direction at 10 m.
  - Mixed-layer mean wind.
  - Wind change strength, time permitting.
  - 1000-500 thickness gradient vector.
  - An index of dry lightning favourability.
  - An index of dry slots, to be devised.
  - An index of plume behaviour, if a suitable measure exists.

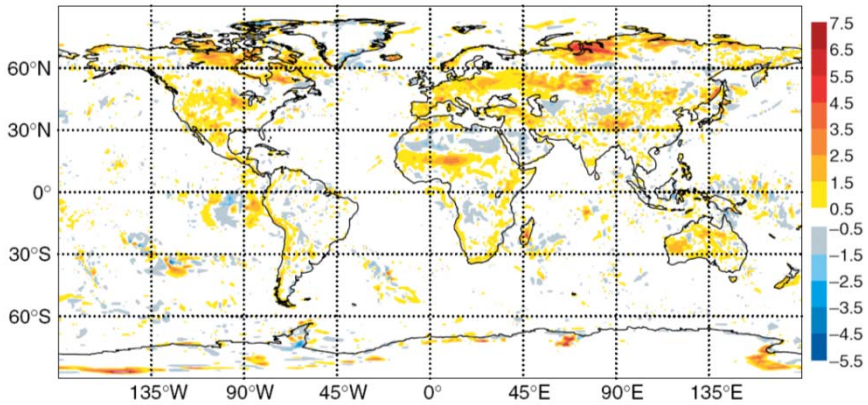
The dataset

- Reanalysis applies current numerical weather analysis and prediction techniques to historical data.
  - Better science than was available at the time.
  - Bigger computers than were available at the time.
  - “Benefit of hindsight” correction of some observational issues.
  - Big effort to collect all the data.
- European Centre for Medium-Range Weather Forecasts (ECMWF) have the best weather modelling and analysis system in the world.
- ECMWF are also world leaders in reanalysis.
- The ECMWF Interim Reanalysis ERA-I is their latest effort.
  - Originally 1989 – 2008, later extended back to 1979 and forward to present.
  - Uses more up-to-date model and analysis than their previous efforts.
  - Higher resolution (75 km horizontal).
  - Cleans up many of the details of their previous efforts.

Numerical Weather Analysis and Prediction

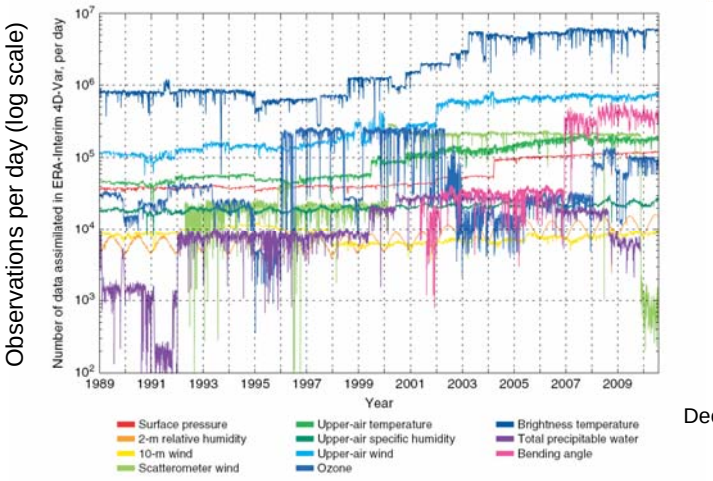


Example improvement: better surface winds



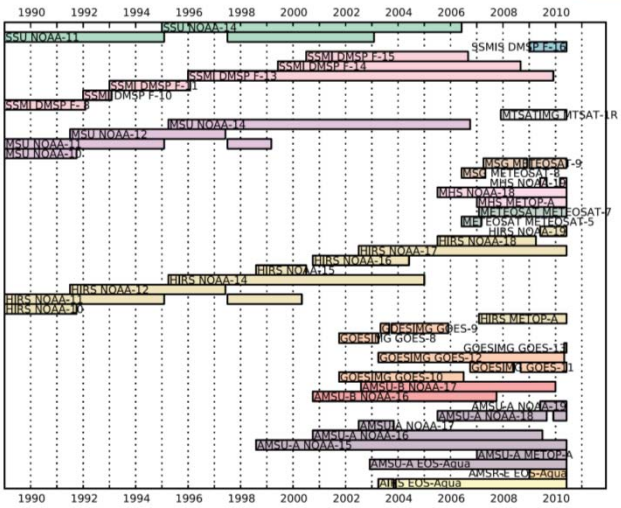
- Mean difference between “old” and “new” wind speeds for a single month.
  - Dee et al. 2011.

Observation Usage

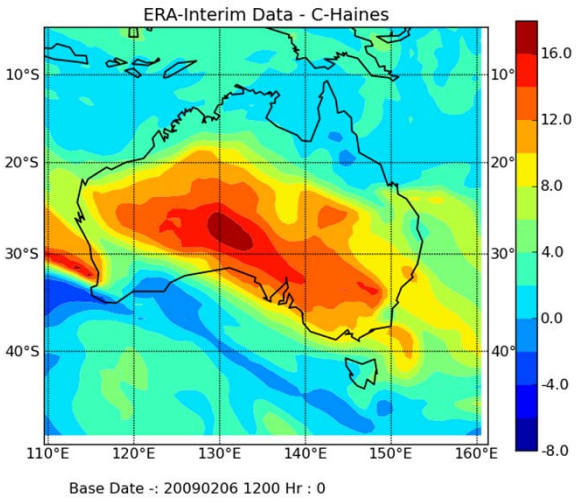


Dee et al. 2011

Satellite data usage



C-Haines on Black Saturday



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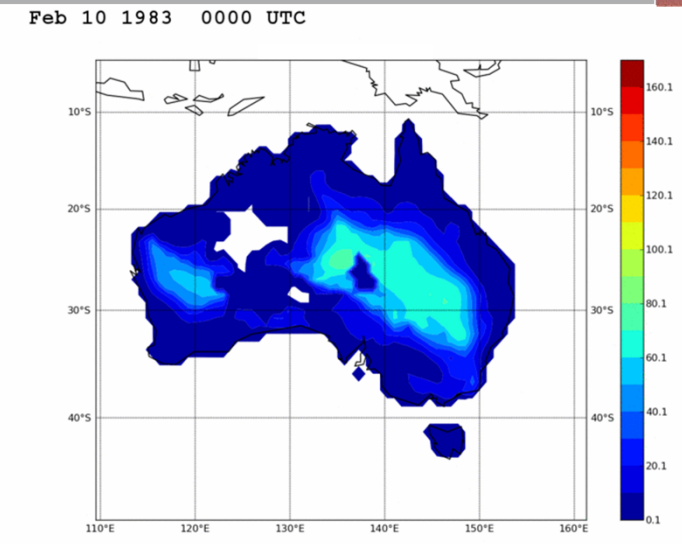
FFDI leading up to Ash Wednesday



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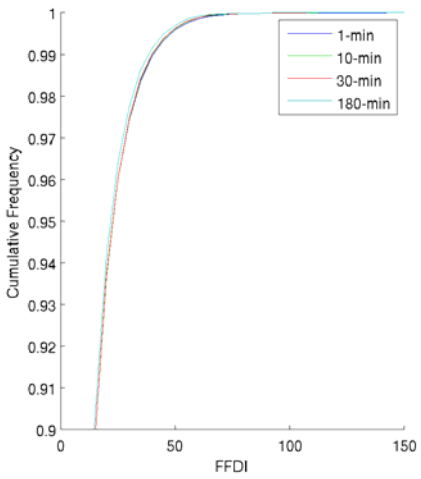
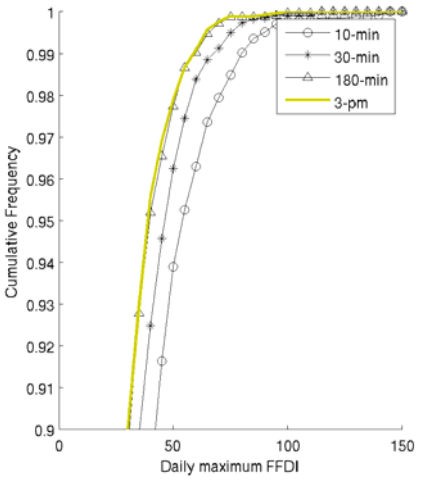
Some Limitations: Temporal sampling



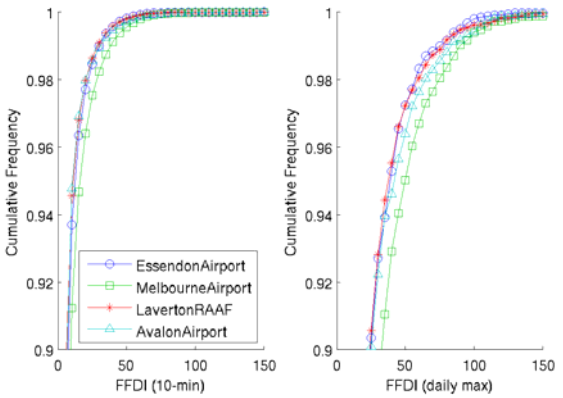
- How well can 3-hourly data represent the true probability density function?
- Fig shows FFDI calculated from 1-min, 10-min, 30-min, 3-hr AWS data at Yarrawonga.
- More frequent sampling leads to slightly higher FFDI climate

Some Limitations: Temporal sampling 2



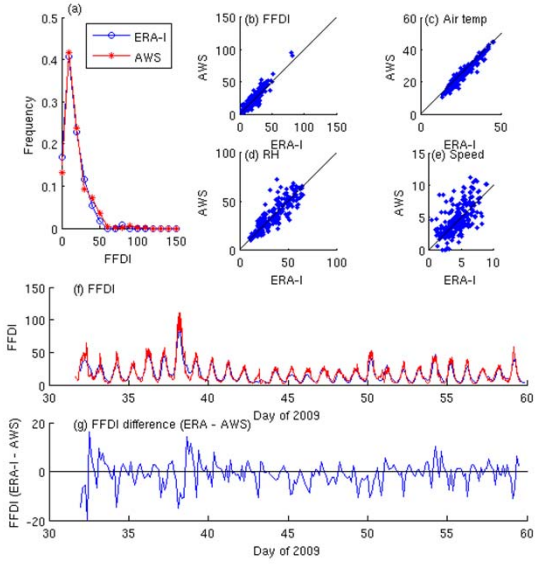
- How well can 3-hourly data represent the true probability density function **of the daily maximum**?
- Fig shows **daily maximum** FFDI calculated from 10-min, 30-min, 3-hr AWS data at Yarrawonga, plus the 3 pm value.
- More frequent sampling leads to significantly higher FFDI climate (15 – 20 units).
- The chances of catching a short-term extreme excursion are increased.
- c.f. Fox-Hughes, MWR 2011.

Some limitations: Spatial sampling



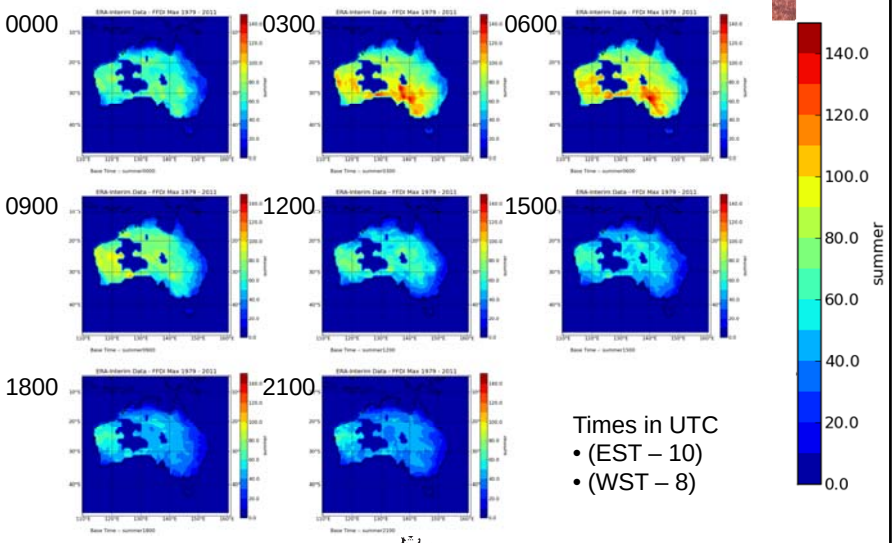
- Cumulative density functions of FFDI at four nearby AWS.
- Climatological extreme is 5 – 15 units higher at inland site, depending what parameter you use.
- All these sites are within 50 km of each other (compared to ERA-I resolution of 75 km).

Verification: Yarrawonga on Black Saturday



- Agreement of FFDI and its ingredients is very good.
  - Wind speed has some scatter, temperature very little.
  - Diurnal cycle is excellent.
  - Peak errors in FFDI so far tend to be on the "shoulders" of the diurnal cycle.

Maximum summertime FFDI, 1979 - 2011



Times in UTC
- (EST – 10)
- (WST – 8)

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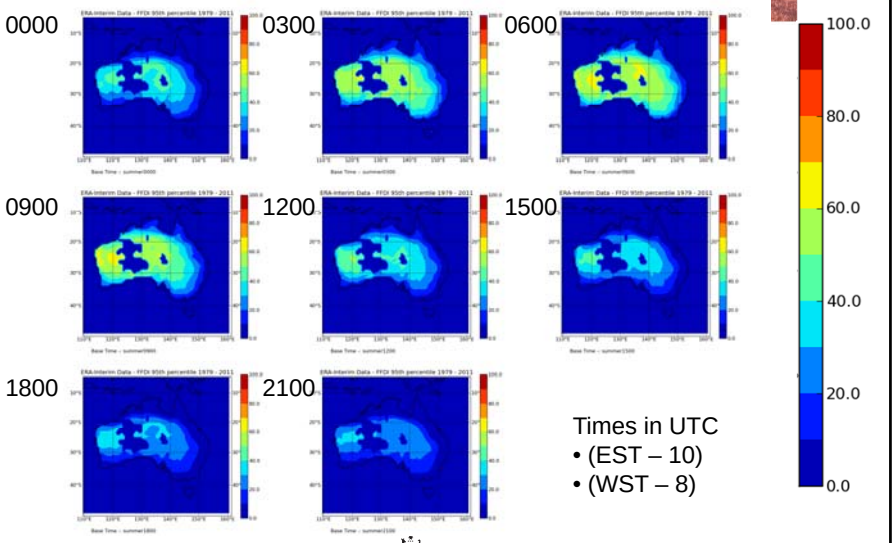
95th percentile summertime FFDI



Times in UTC
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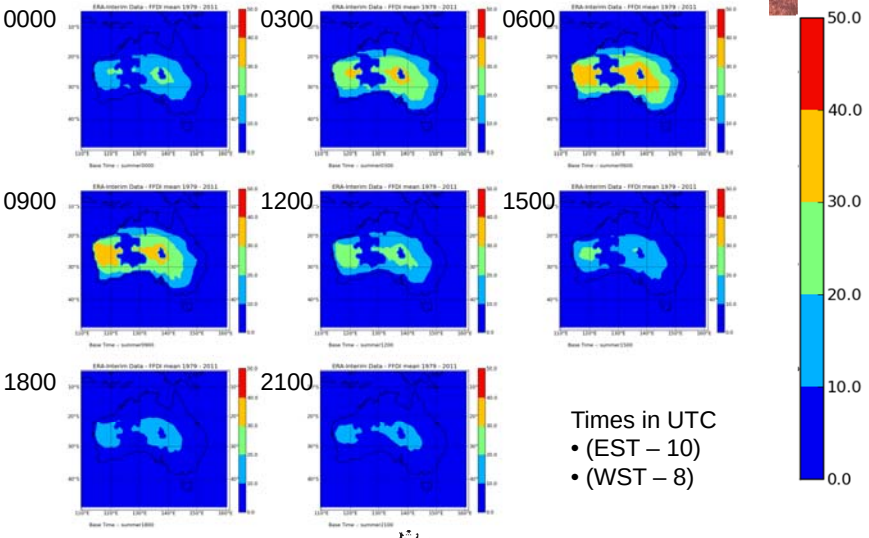
Mean summertime FFDI



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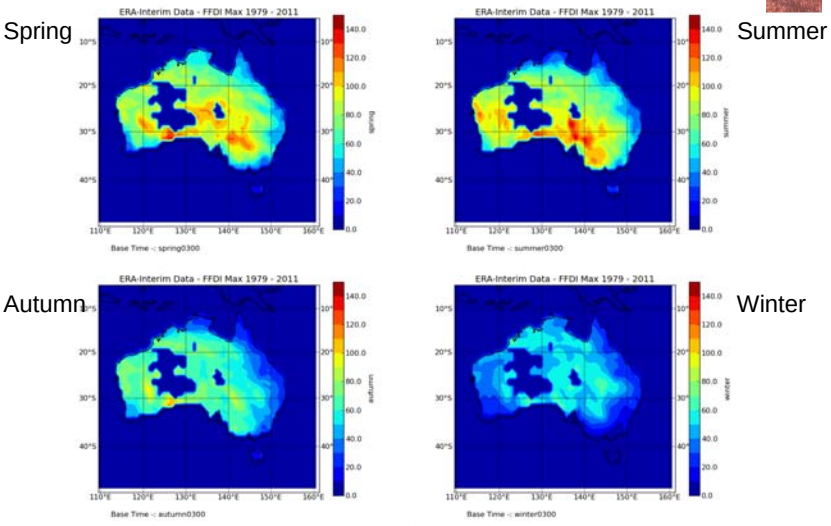
Maximum 0300* UTC FFDI by season

*1 pm EST
*11 am WST



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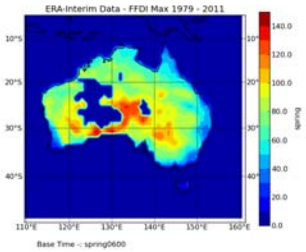
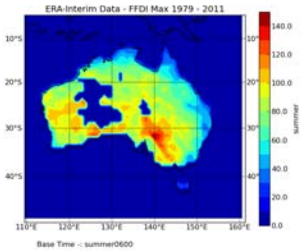
Maximum 0600* UTC FFDI by season

*4 pm EST
*2 pm WST

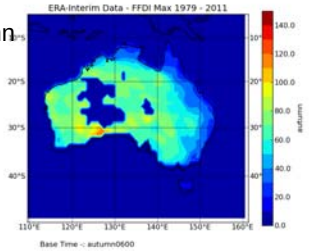
Spring



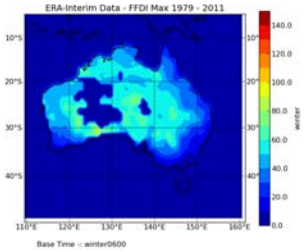
Summer



Autumn



Winter



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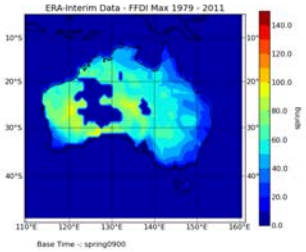
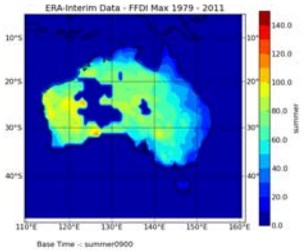
Maximum 0900* UTC FFDI by season

*7 pm EST
*5 pm WST

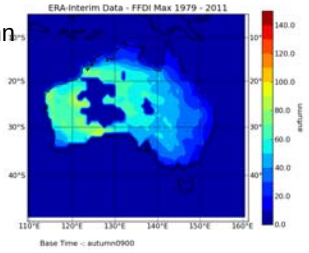
Spring



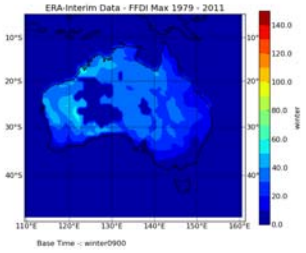
Summer



Autumn



Winter



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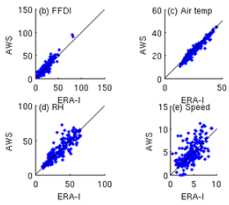
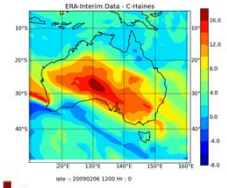
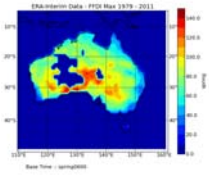
Summary

- ERA-Interim reanalysis at full resolution allows a high-quality, nation-wide analysis of fire weather risk.
- Comparison to AWS is ongoing, but suggest small bias.
- Temporal sampling reduces daily extrema, relative to 1-min sampling.
- Spatial averaging may affect results in regions of strong gradients.
- Data captures significant events.
- Climatology of FFDI shows some clear regional differences.
- Data and software infrastructure will be a valuable resource for Fire Danger Rating project.







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