Monitoring Australia's Climate: Current Practices and Some Thoughts on Future Directions

Bureau of Meteorology

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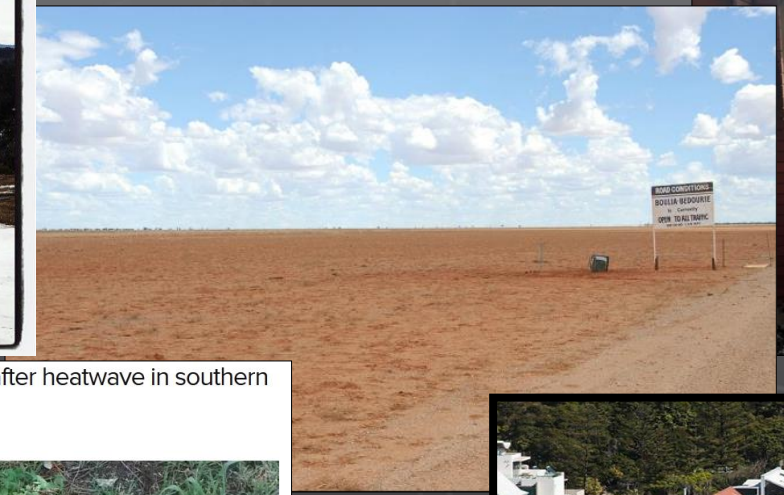
Australian Government
Bureau of Meteorology

Overview

- What outcome are we seeking through our analysis of climate (climate monitoring)
- Current Bureau practices
  - all stations analyses
  - high-quality subsampled (homogenised) networks
- How are networks changing through time
- Some thoughts on future directions and opportunities from emerging observations

Climate *monitoring* to improve decisions




About 100,000 bats dead after heatwave in southern Queensland

By Josh Bavas

Updated Wed 8 Jan 2014, 8:55pm AEDT

Rising stench as heatwave kills 100,000 bats

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VIDEO: Rising stench as heatwave kills 100,000 bats (7pm TV News QLD)

About 100,000 bats may have died as a result of last weekend's heatwave in southern Queensland, the RSPCA says.

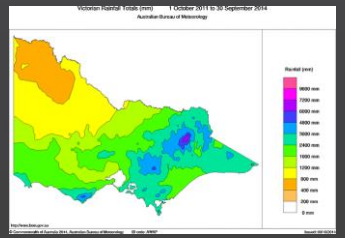
PHOTO: A pile of dead bats at the foot of a tree in Boonah west of Brisbane. (ABC News: Josh Bavas)

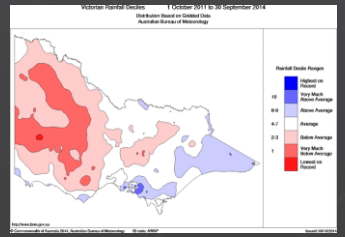
RELATED STORY: Brisbane temperature rising with 41C high

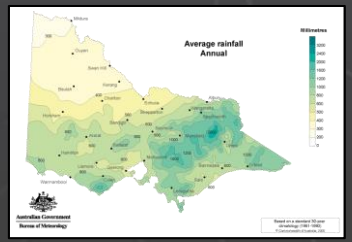
What questions are we looking to inform

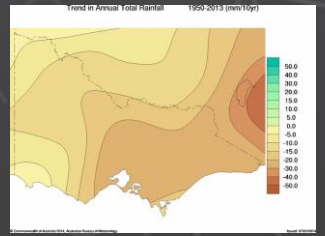
(Using Rain as an example)

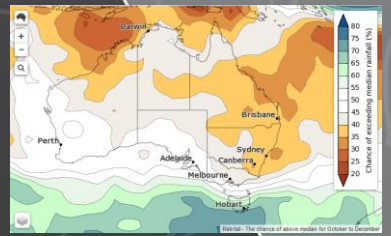
- How much rain has fallen?
- How does this compare to *my* normal rainfall?
- What is *my* normal rainfall?
- Is *my* rainfall changing through time, and is the past a guide to the future?
- What is *my* rainfall forecast?











Current climate monitoring practices

Largely use the *in situ* station data

- Whole network analyses (stations) providing gridded AWAP outputs
  - Spatial and temporal consistency achieved through spatial analysis ("gridding")
- Homogenised datasets (subset of networks) – The Australian Climate Observations Reference Networks (ACORNS)
  - Spatial and temporal consistency by subsampling the network to yield *stable* network coverage
    - Surface air temperature
    - Rainfall
    - Evaporation
    - Cloudiness
    - Upper air temperature and humidity
    - Humidity

Approach to (AWP) spatial analysis

The spatial analysis of *in situ* meteorological data using a topography resolving anomaly approach

Analyses averages [T_i] using 3-dimensional (x,y,z) Laplacian Smoothing Spline – ANUSPLIN

Analyses anomalies T'_i using 2-dimensional (x,y) optimised Barnes analysis scheme

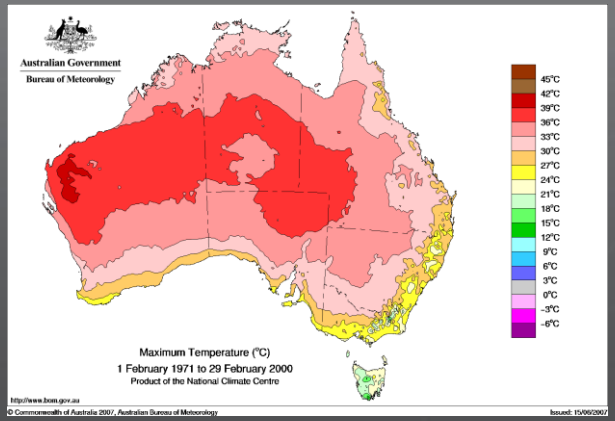
$$T(x,y) = [T(x,y,z)] + T'(x,y)$$

For example, for months between 1971 and 2000

$[T(x,y,z)]$ *is the 1971-2000 average*

$T'(x,y)$ is the anomaly for the 1971-200 average

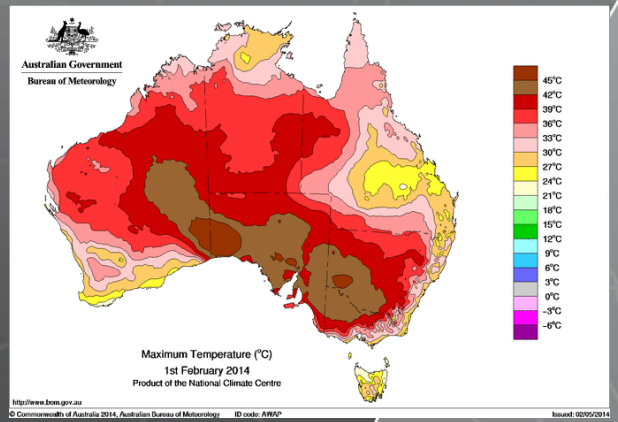
Visualising current practice

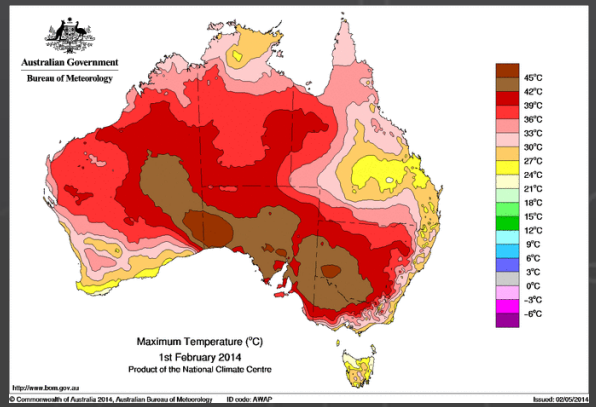


Climate Average

$$[T_i] + T_i'$$

Anomaly Analysis

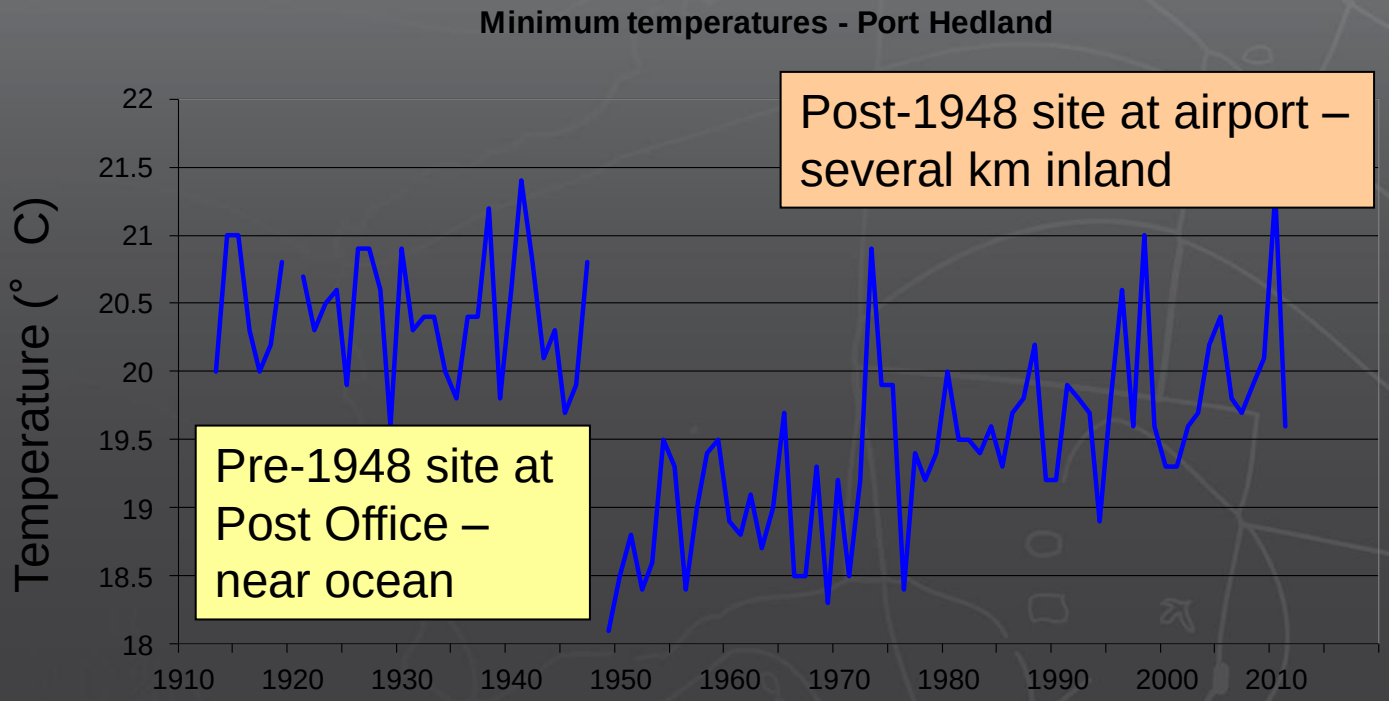




High quality climate data as an *alternative*

- Subsample network to gain maximum spatial and temporal consistency and data fidelity
- Climate data considered homogeneous if variations in the data are result of variations in weather and climate; data need to be collected in an identical way (spatially and temporarily)
- Inhomogeneities in the data series result from changes in (1) instruments and their exposure, (2) observation sites and their environment, or (3) observation practices.
- For detection and monitoring of long-term climate trends, BoM maintains Australian Climate Observations Reference Network (ACORN) which are expected to be more stable through time

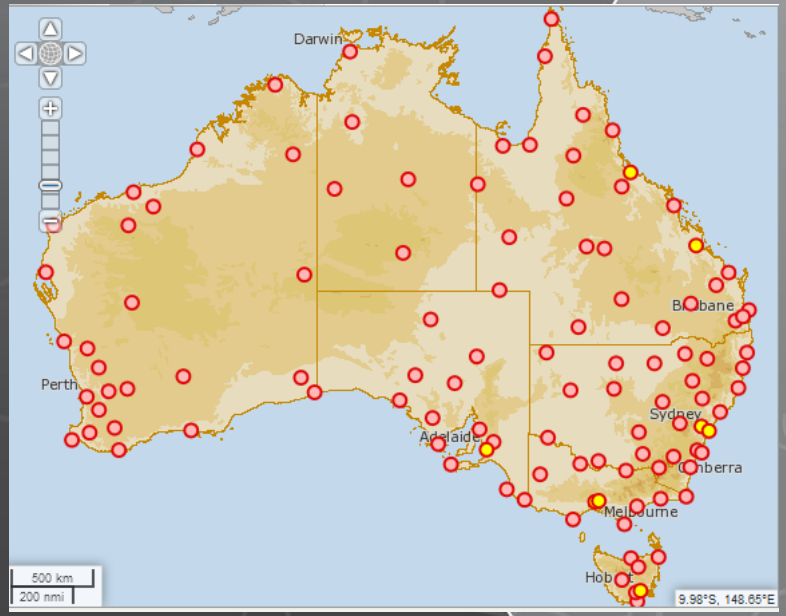
An example of change in a site location



Homogeneous data give us confidence that changes in the observations reflect real changes in the climate

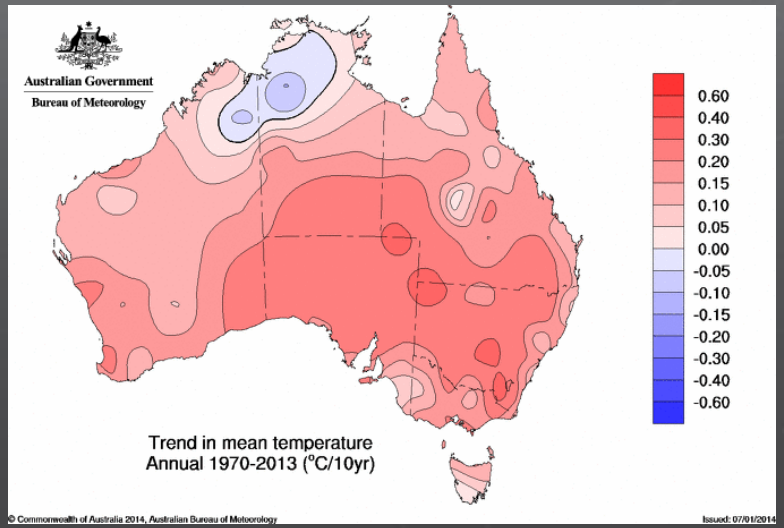
The ACORN-SAT station network

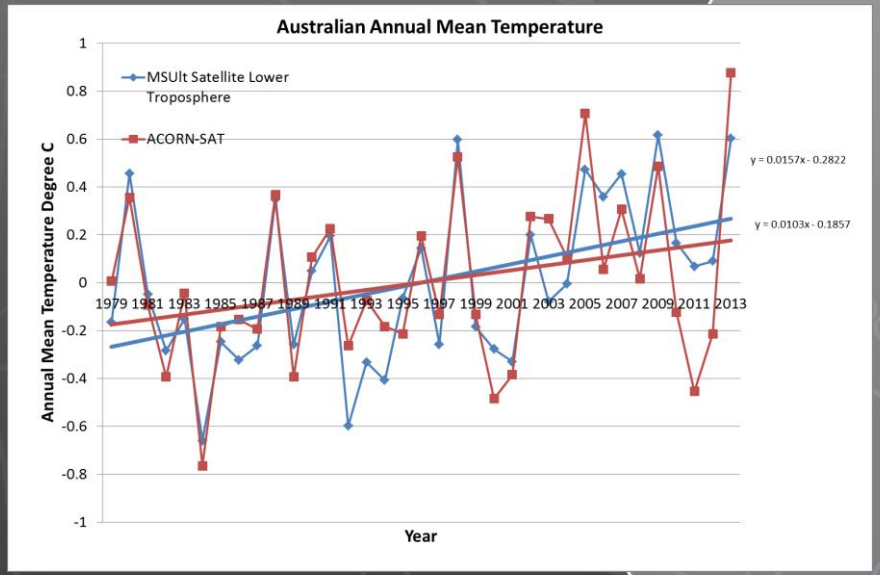
- 112 stations (Tmax, Tmin and Tmean)
- Contains daily Tmax, Tmin and Tmean for the 1910-present period
- Supersedes two previous datasets: Annual (starting 1910 – Torok and Nicholls) and daily (starting 1957 - Trewin)
- First continent-wide daily temperature dataset in existence
- Allows century-scale analyses of temperature extremes as well as more general climate



Red non-urban ACORN stations
Yellow some urban influence

Temperature trends - Australia





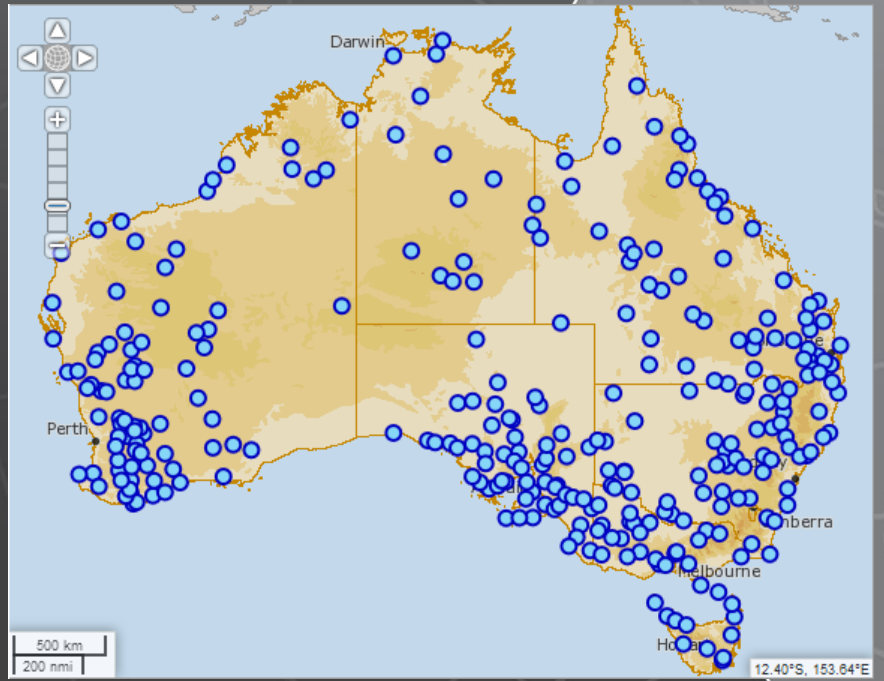
- Australia has warmed by nearly a degree C since 1910
- Need for a (close to) frozen reference network to be sure that network changes are not influencing the results

Australian rainfall – what do we currently have?

- Gridded daily and monthly data sets (the AWAP data set)
- Station-based monthly and daily sets – last significant update early 2010s
- ACORN-RAIN: under development

  this data set to become available in 2015 and will replace the existing dataset
- Early attempts underway to prepare data incorporating remote sampling

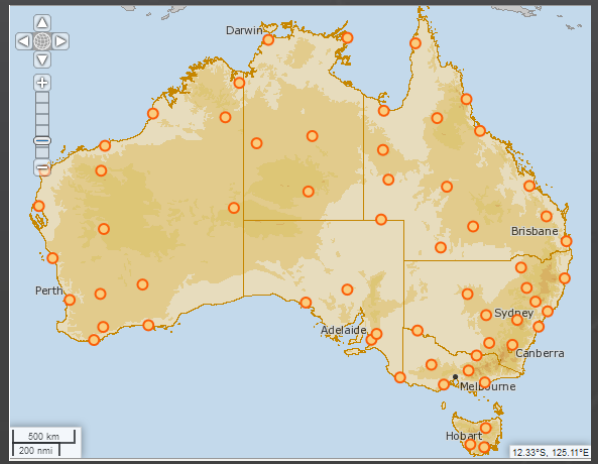
The current HQ network

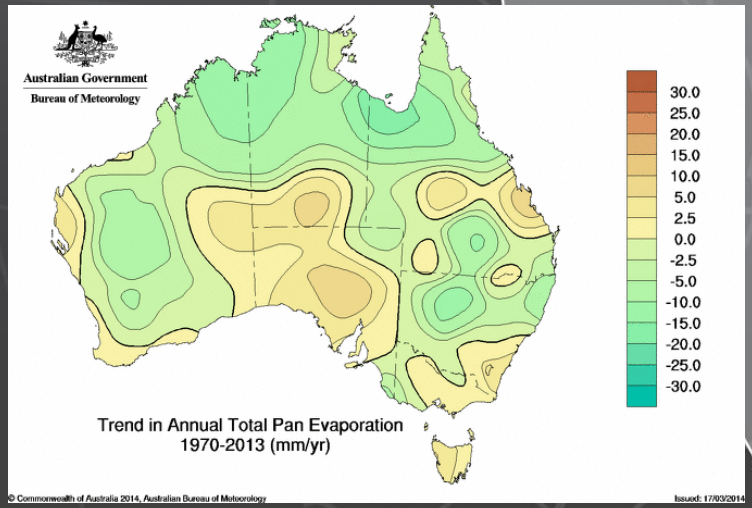


Pan-evaporation - reference network

- Class A evaporation pans
- 60 stations with long enough record (see disclaimer below)
- Observations at 9am LST
- Dataset from 1970
- Requires manned stations, with automation not viable at this point

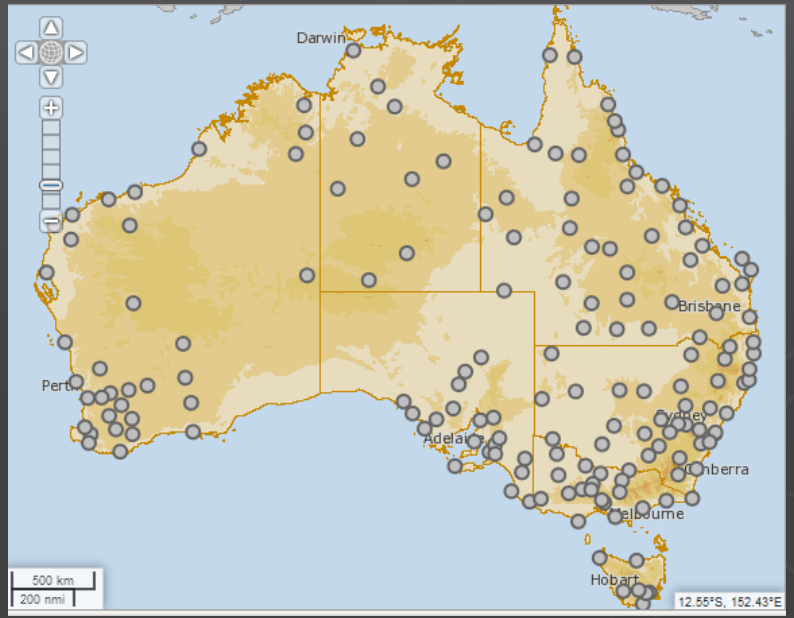
Class A Evaporation Pan

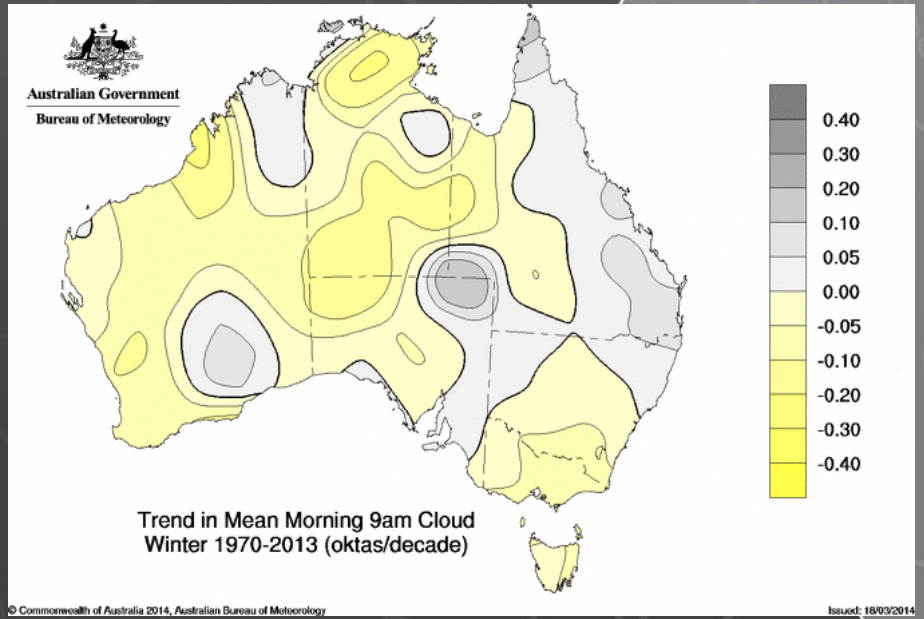




Total cloud amount– reference network

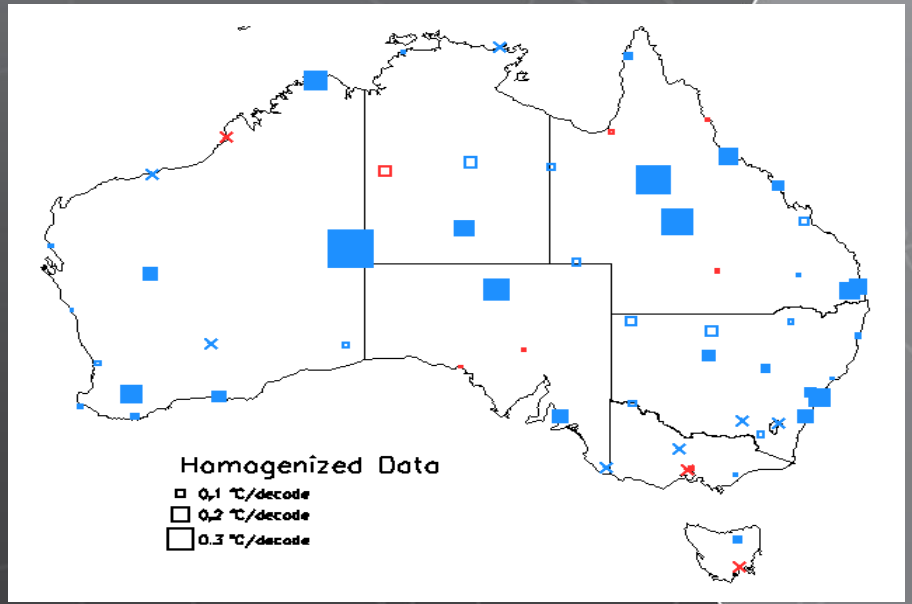
- 165 locations; monthly mean 9am and 3pm TCA
- BoM stations: 42 Co-operative stations: 123
- Most digital records start around 1957





Surface humidity – reference network

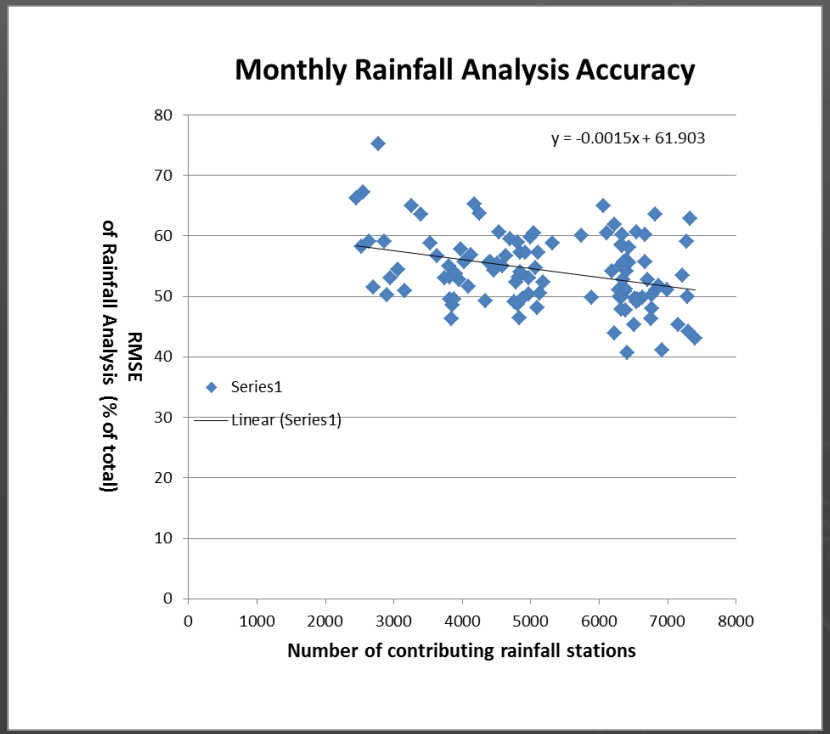
- 58 stations in the current set
- monthly mean 9am surface humidity (dew point temperature)
- Start year 1957

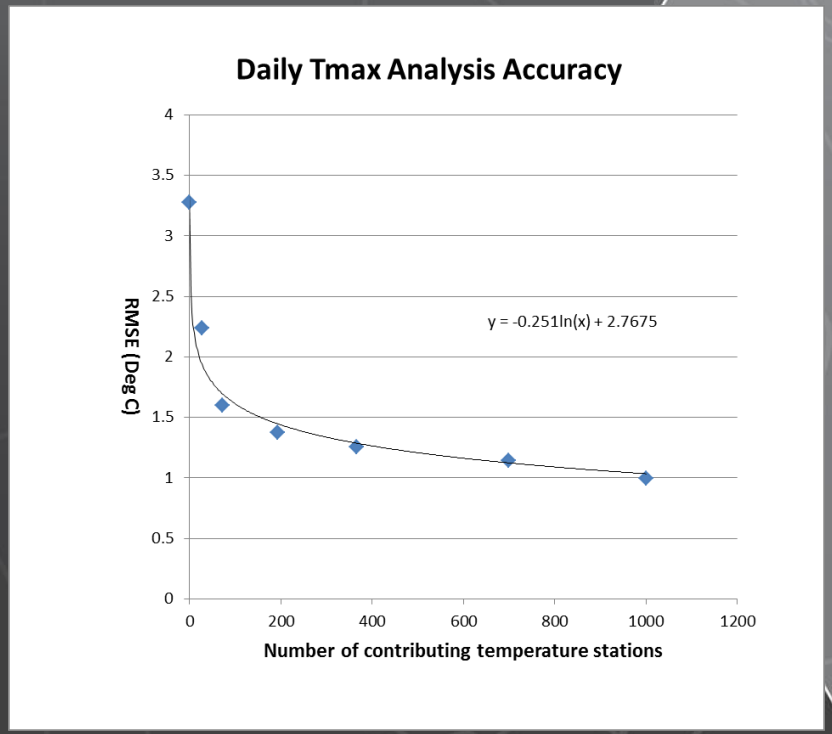


Trend in station dewpoint

What future for *in situ* observation and univariate analysis?

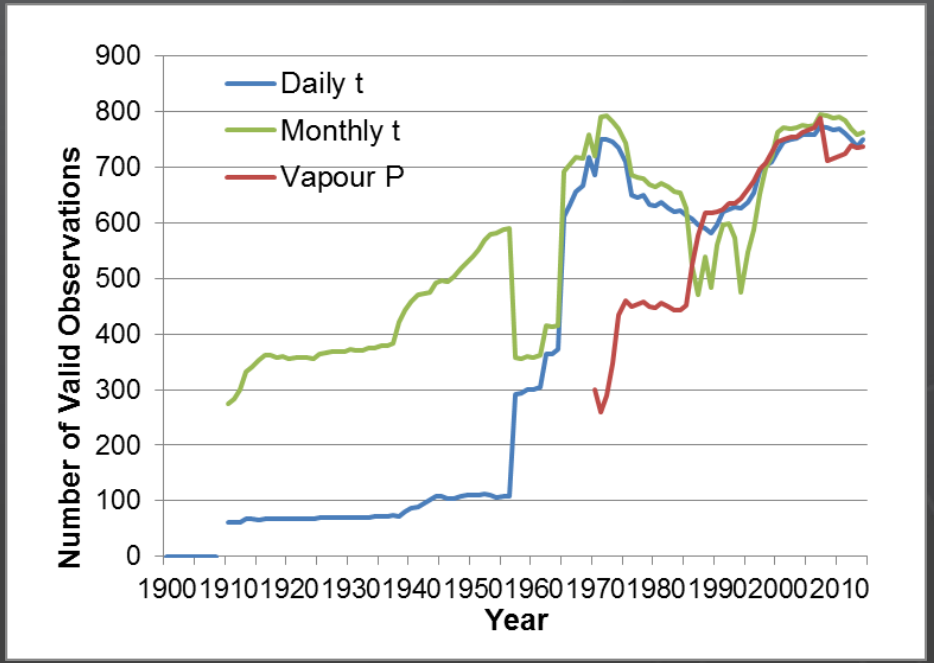
- Are out analyses sensitive to changes in the network?
- Can we improve our analyses through expanded networks?

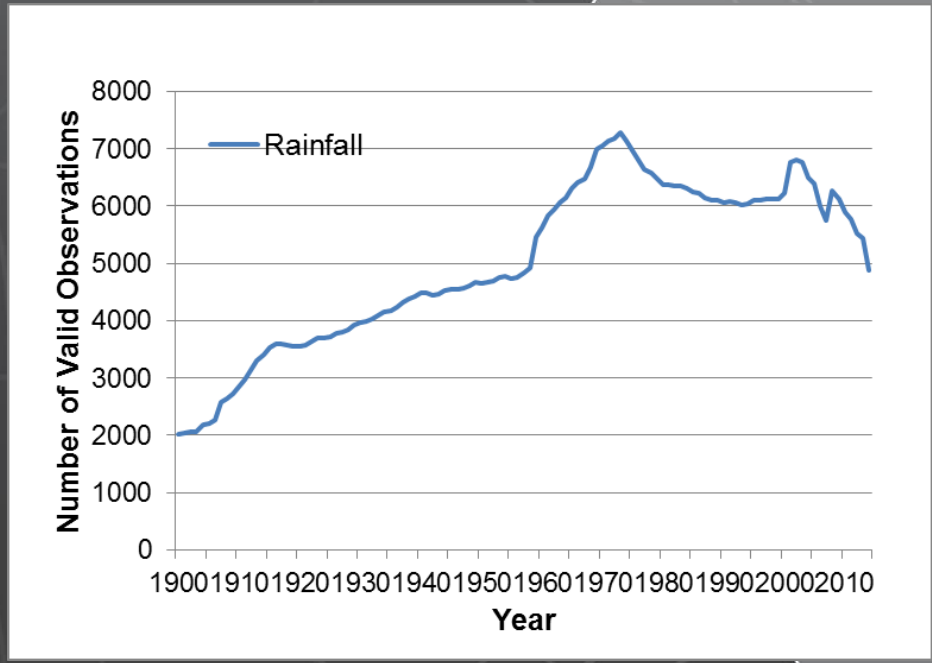




How stable are our networks?

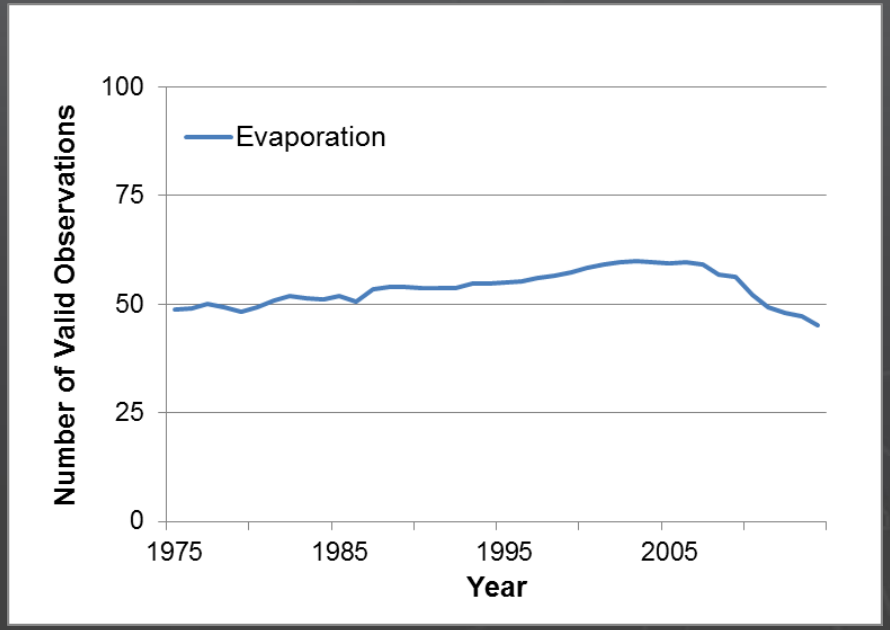
- A story of two halves….
- Observations able to be automated are relatively stable, while volanteer networks are in decline

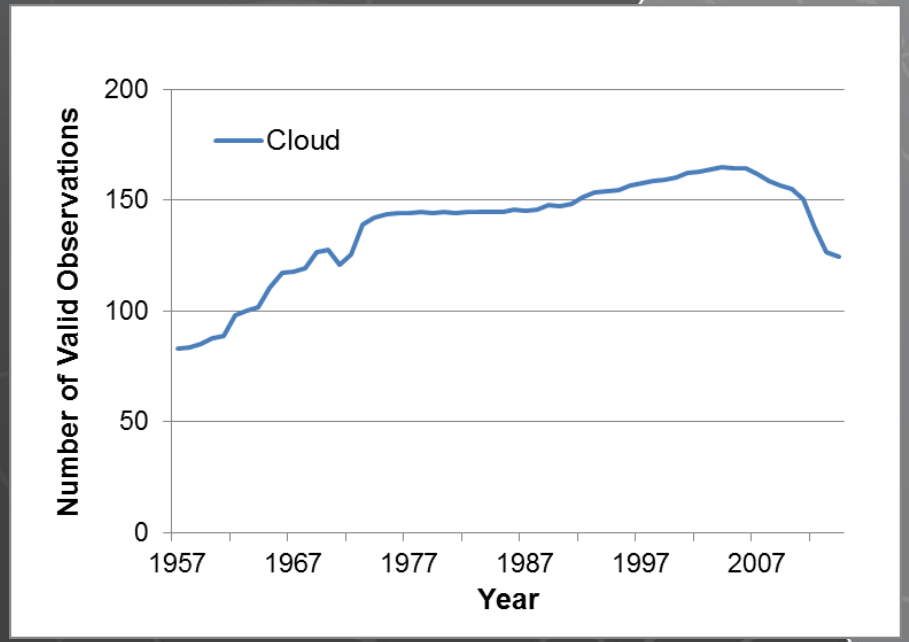




How stable are our (HQ) networks?

- Manual based observations are in rapid decline
- Urgent need to consider alternatives to using the *in situ* data for monitoring climate variability and change

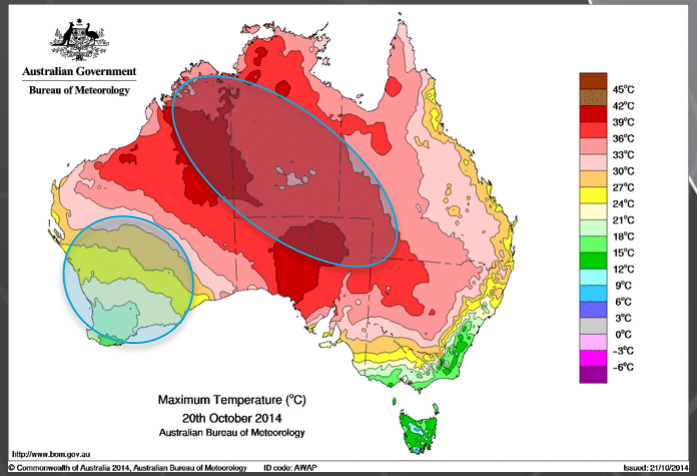




Where next for the Bureau's climate analyses

Implementing the next version of AWAP (version 2)

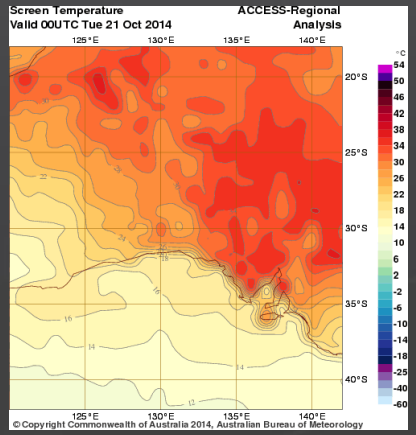
- Incorporation of directional weighting function (potential to synoptically type)
- Better representation of station covariances
- Improved representation of the historical climatology
- Health of network monitoring



Where next for the Bureau's climate analyses

AWAP3 (The Australian Gridded Climate Dataset, AGCD)

- Move to an optimal interpolation technique
- Incorporation of an improved first guess field – a step towards a comprehensive reanalysis
- Likely to have two versions – one including Numerical Weather Prediction and one without



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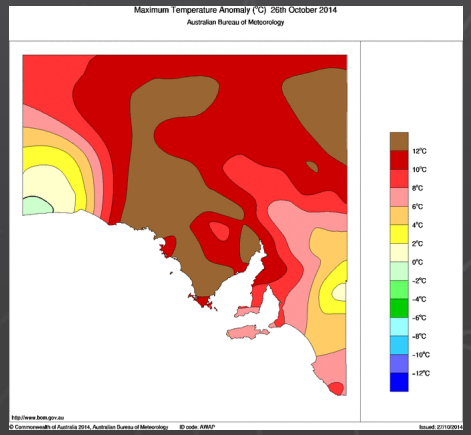

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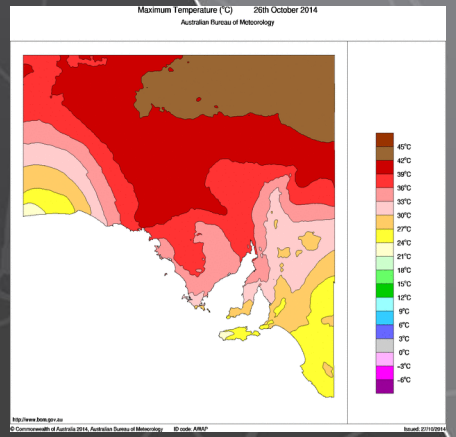
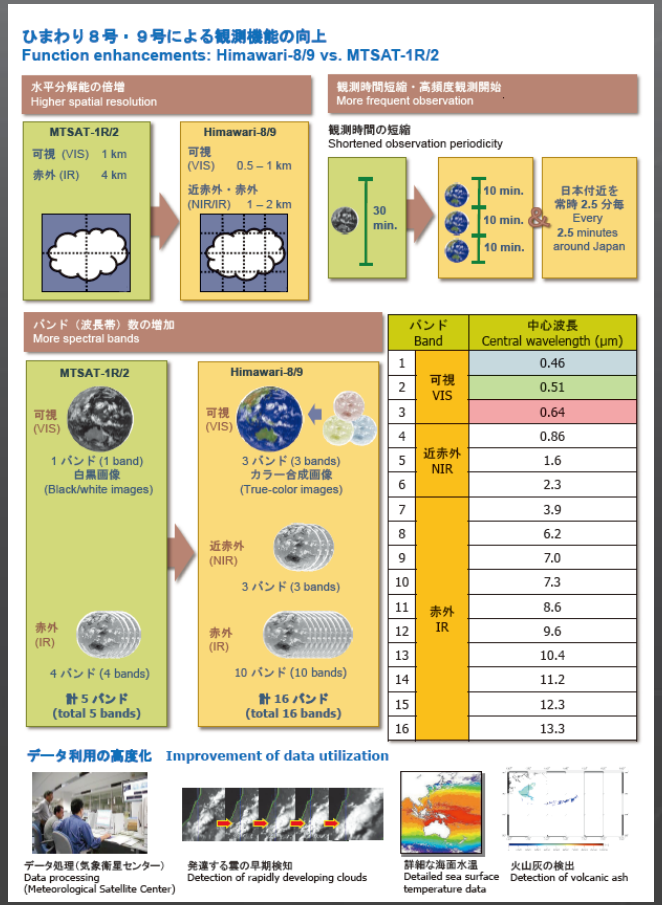
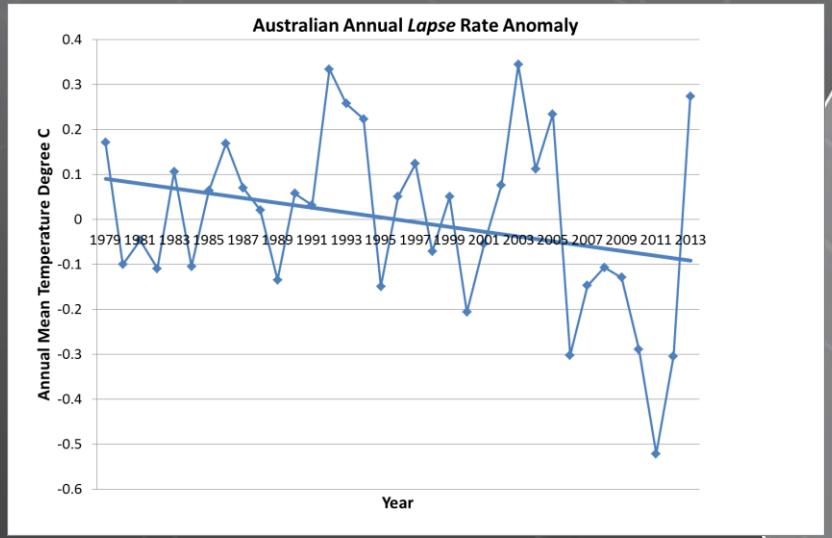


Flood of new remotely sensed data





But need to be cognisant of the differences between data (e.g., MSU lower troposphere versus surface temperature)

Reanalysis (NWP) approach is preferred but cost beyond BoM/Community currently

Questions?

Thank You