NIWA
Taihoro Nukurangi

# Drought Monitoring in New Zealand

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National Institute of Water & Atmospheric Research Ltd (NIWA), New Zealand

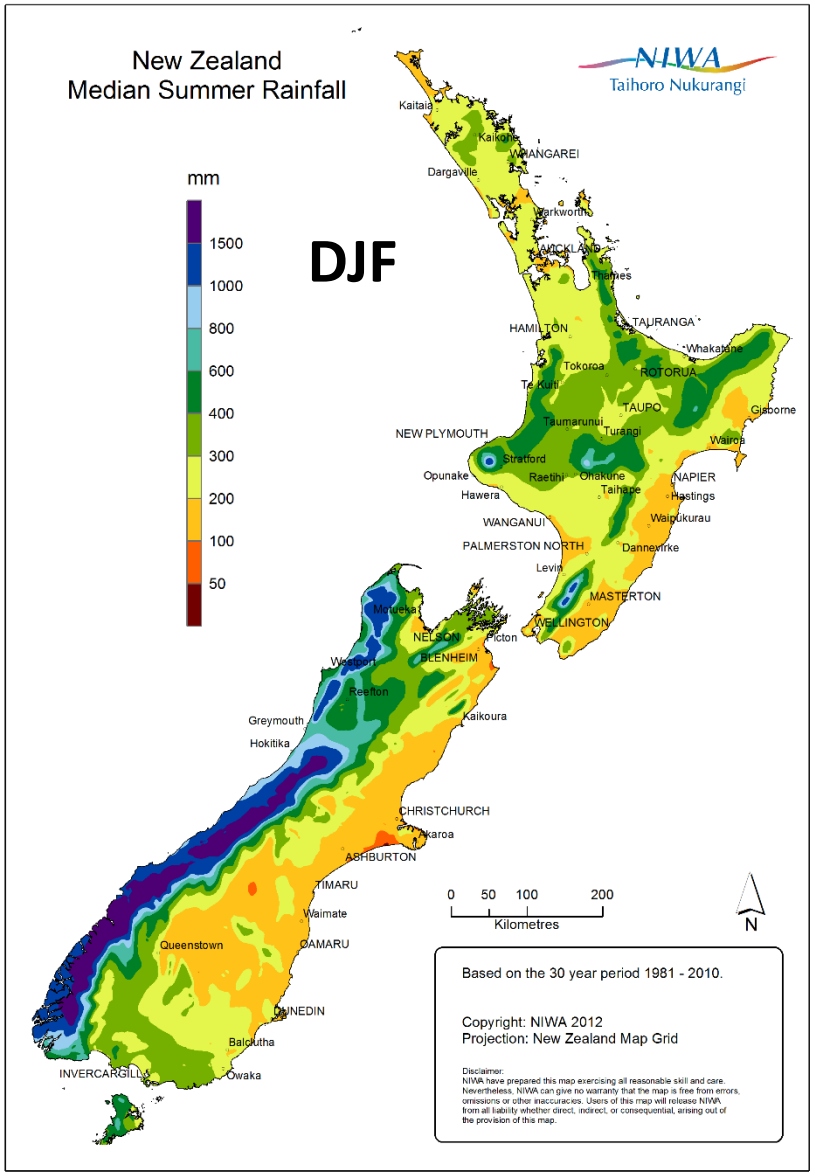
APEC Climate Symposium 2013, Jakarta, Indonesia, November 11-13, 2013

# Outline

- Brief primer on NZ climate & drought
- Development of the 2012-13 drought

  & NIWA's role
- Historical assessment of the 2012-13 drought
- Causes of this drought
- Climate change & NZ droughts

# Seasonality of Rainfall

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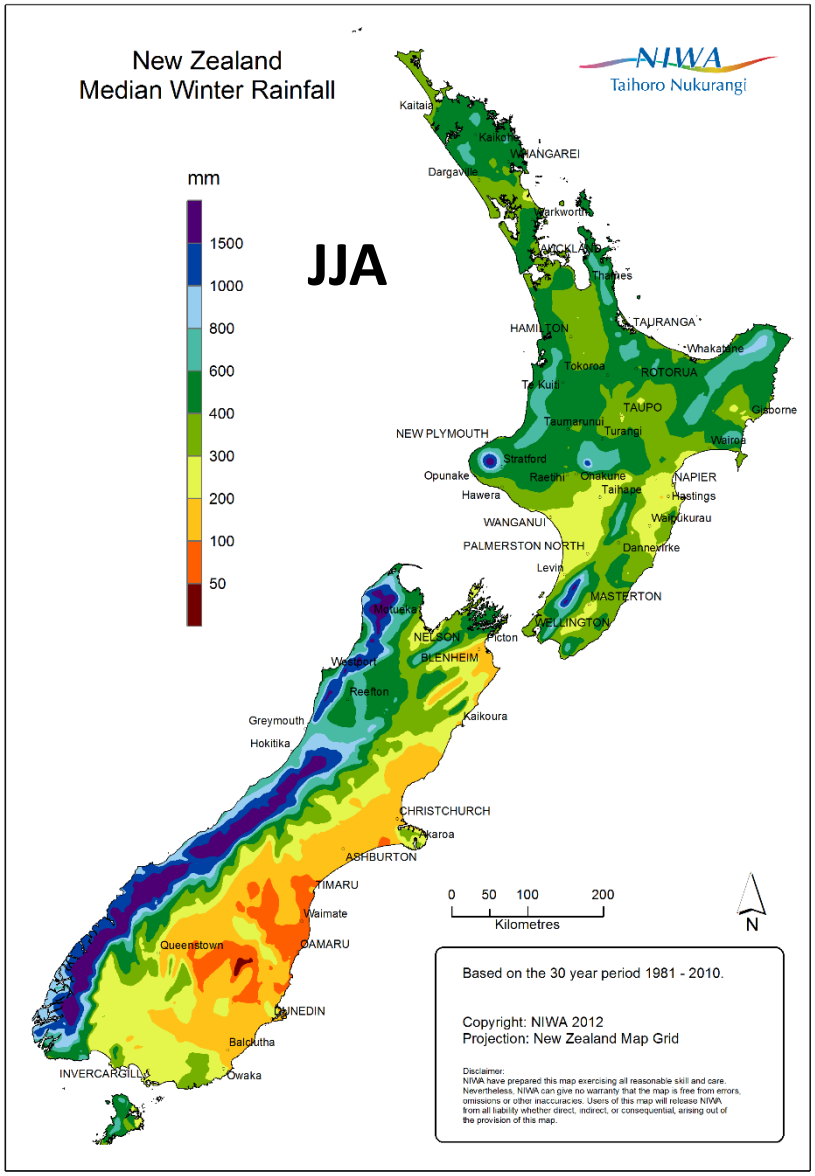
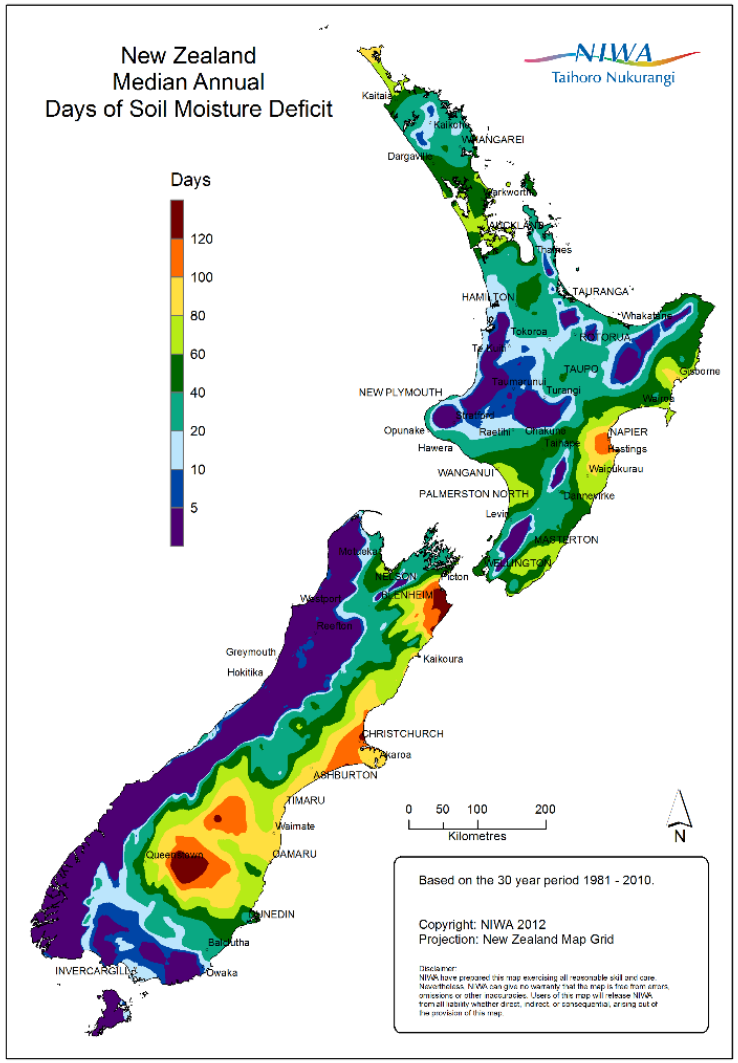
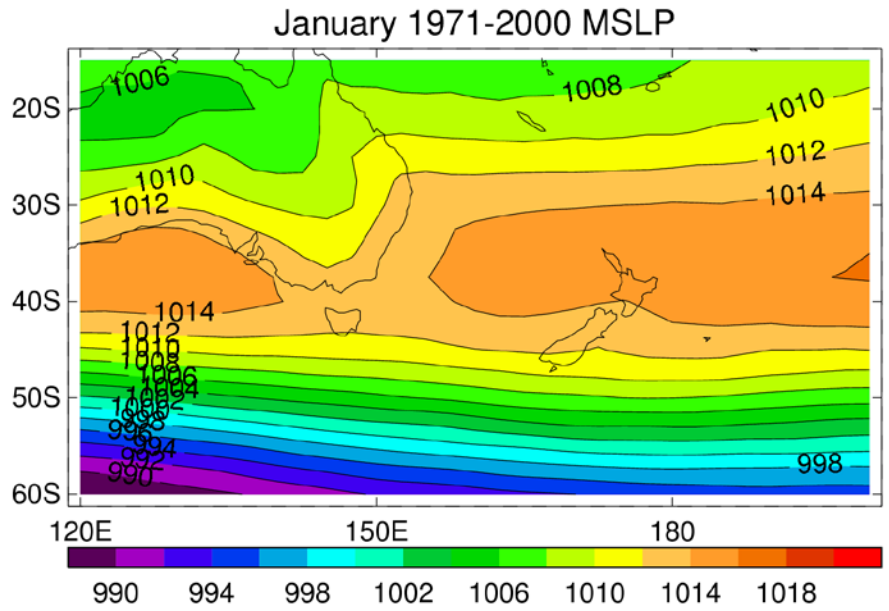
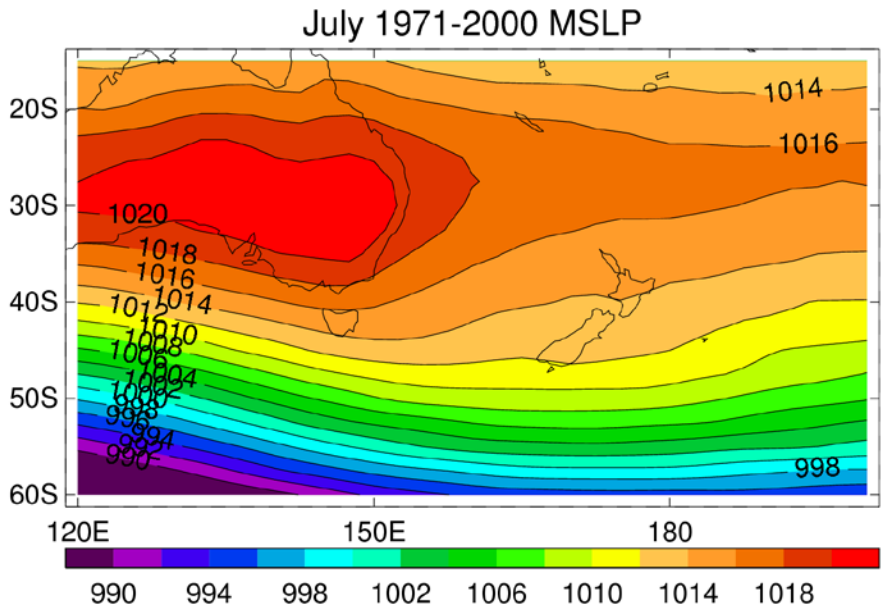


# Climatology – SMD & MSLP

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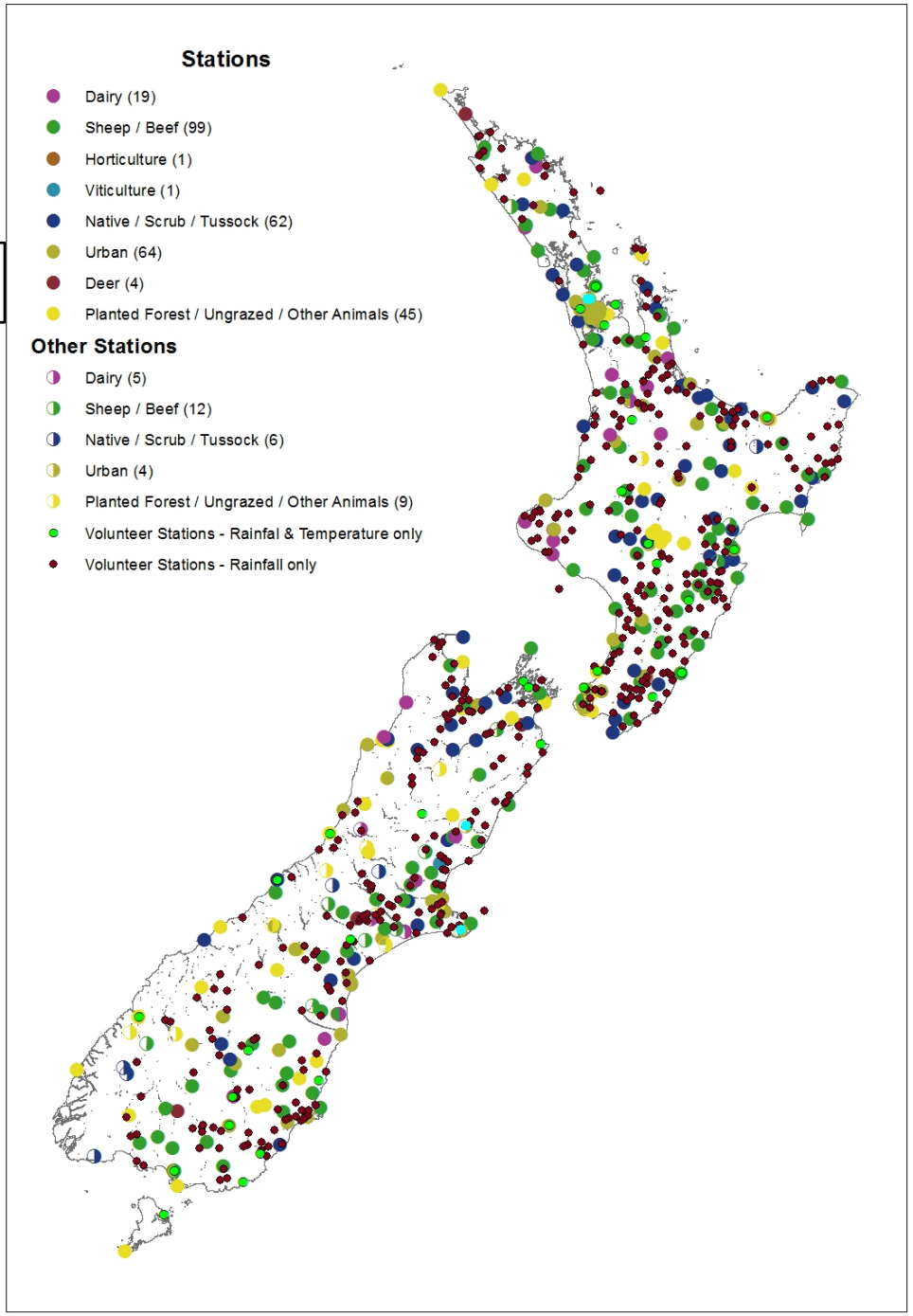
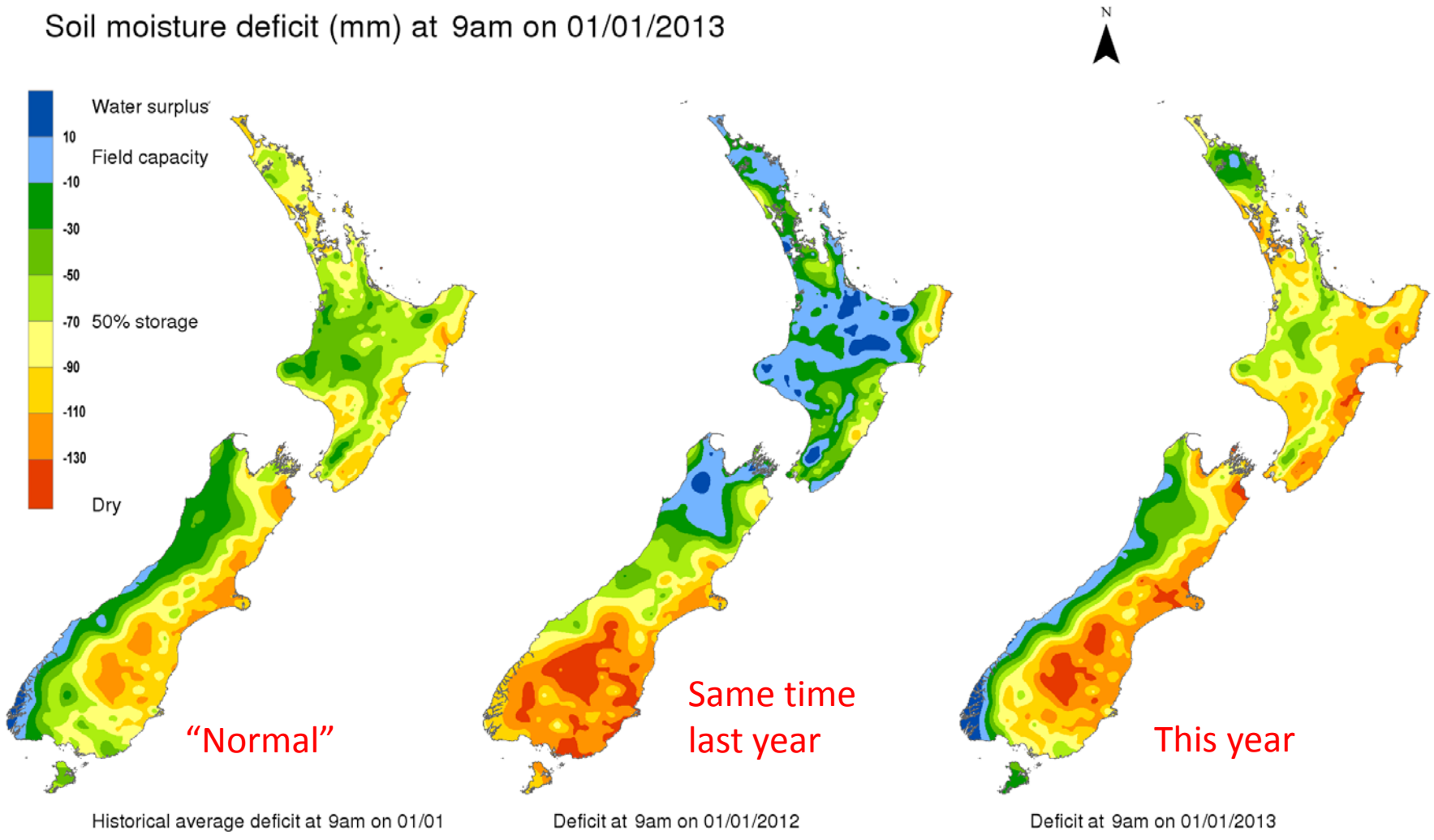
# Data network

Measured (~300 + rainfall-only)

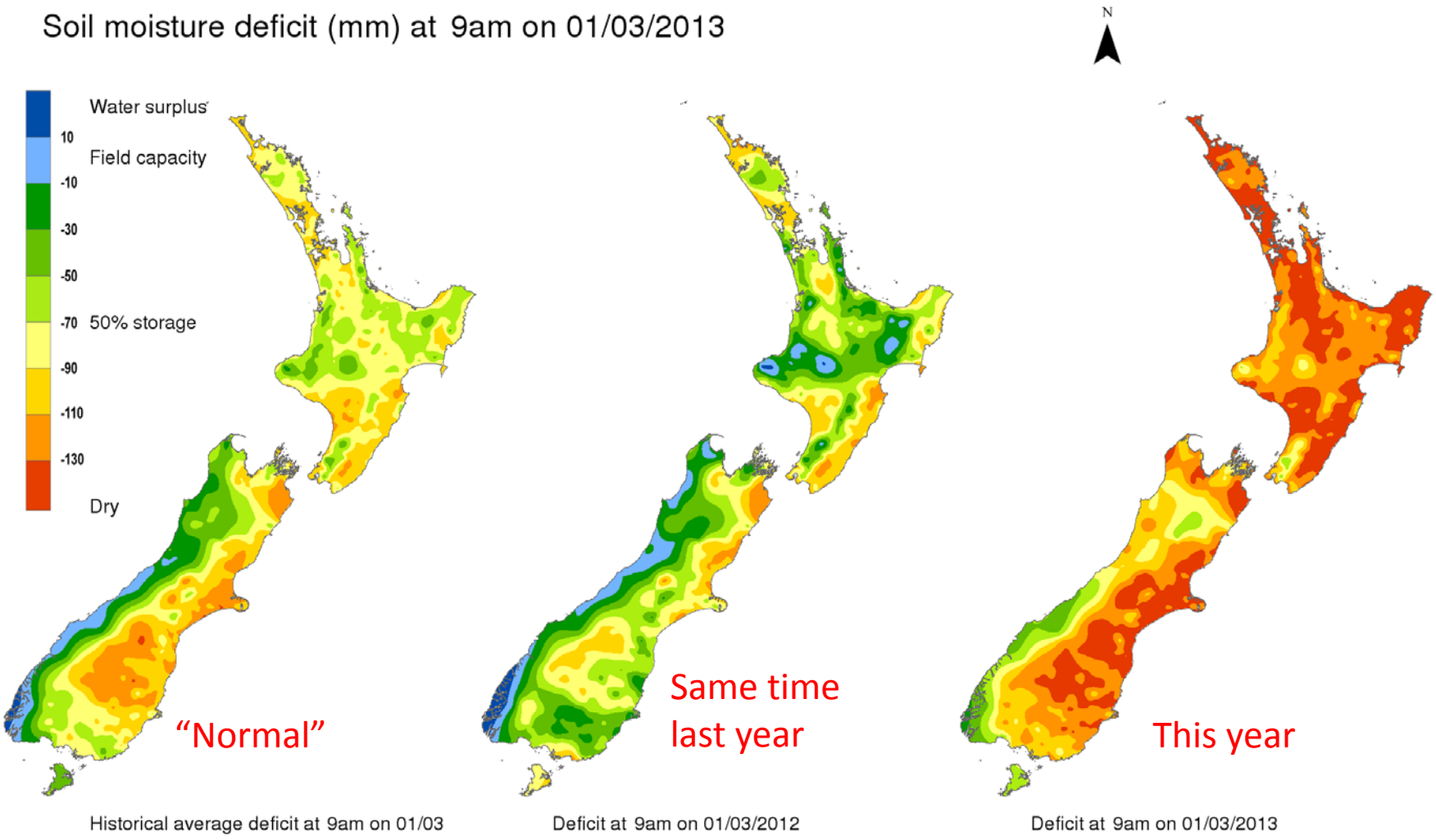
Interpolated (11,491 total): **VCSN**

# Beginning of January soil moisture status

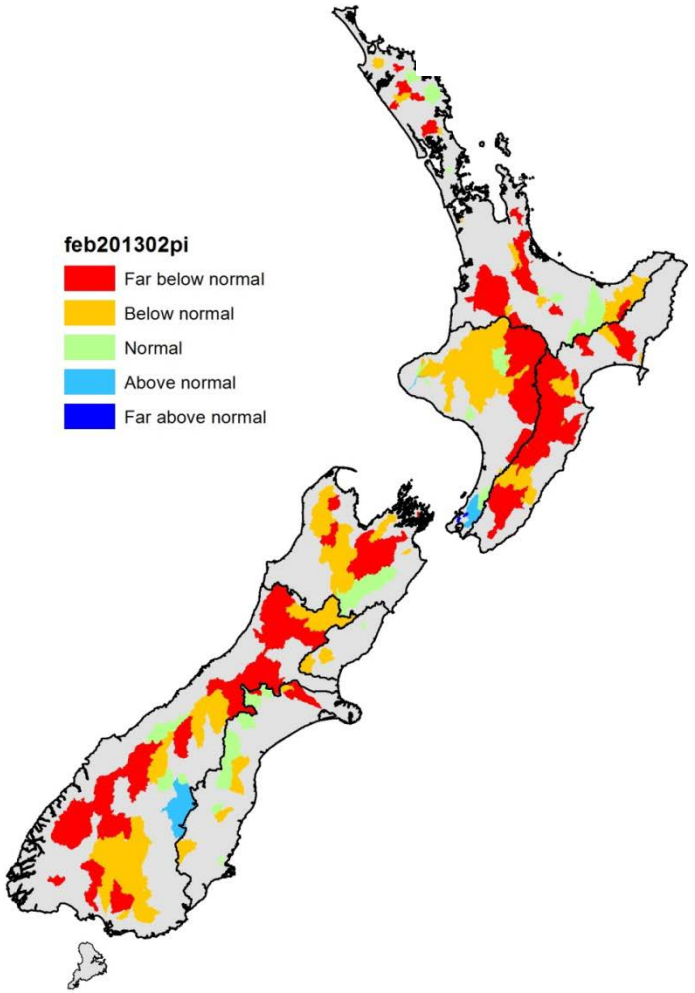


# Beginning of March soil moisture status



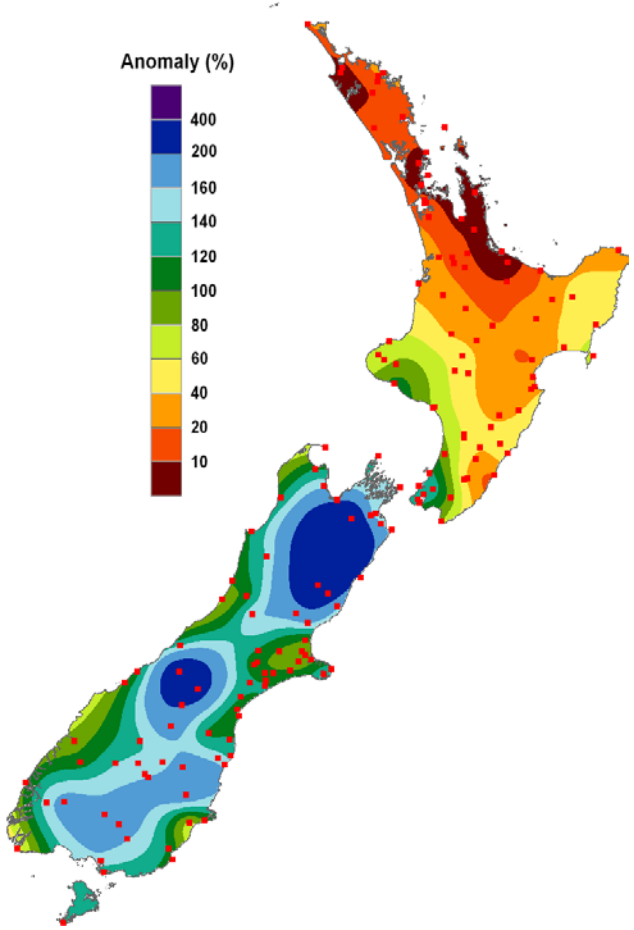
# February 2013 river flows

- Map shows river flows across New Zealand for February, related to previous Februaries.
- Much of the country has flows that are in the lowest 10% of recorded values for that month (red).
- Nearly all the country has flows in the lowest third (red and orange).
- Data from NIWA, Regional Councils, power companies and NZX.

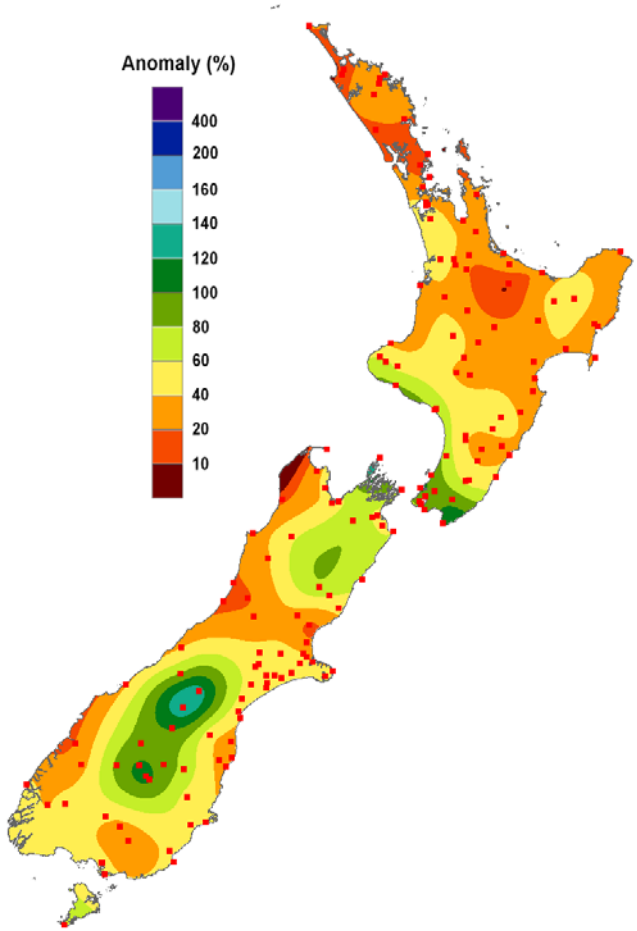


# Rainfall (% normal) early 2013

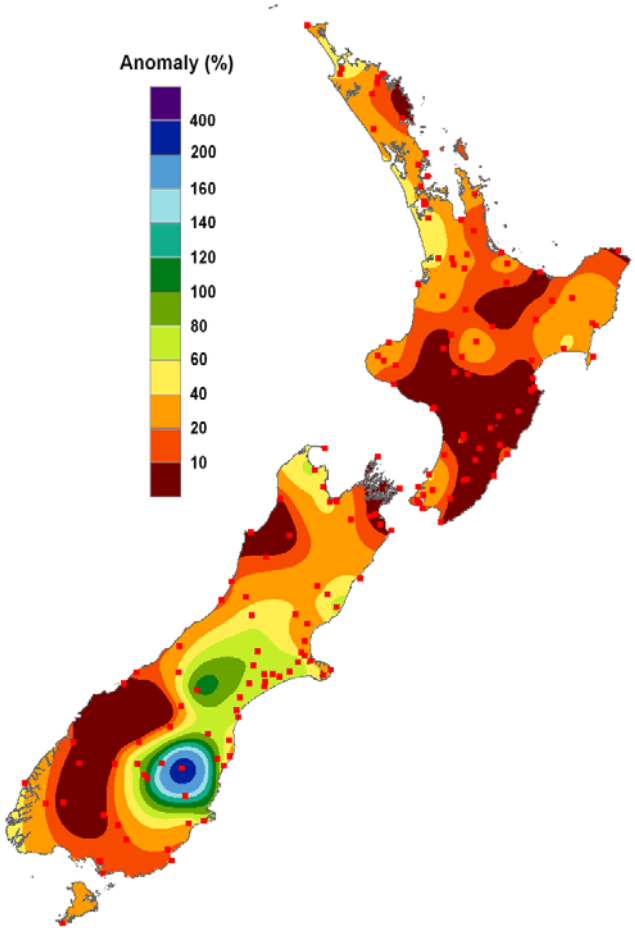
Jan



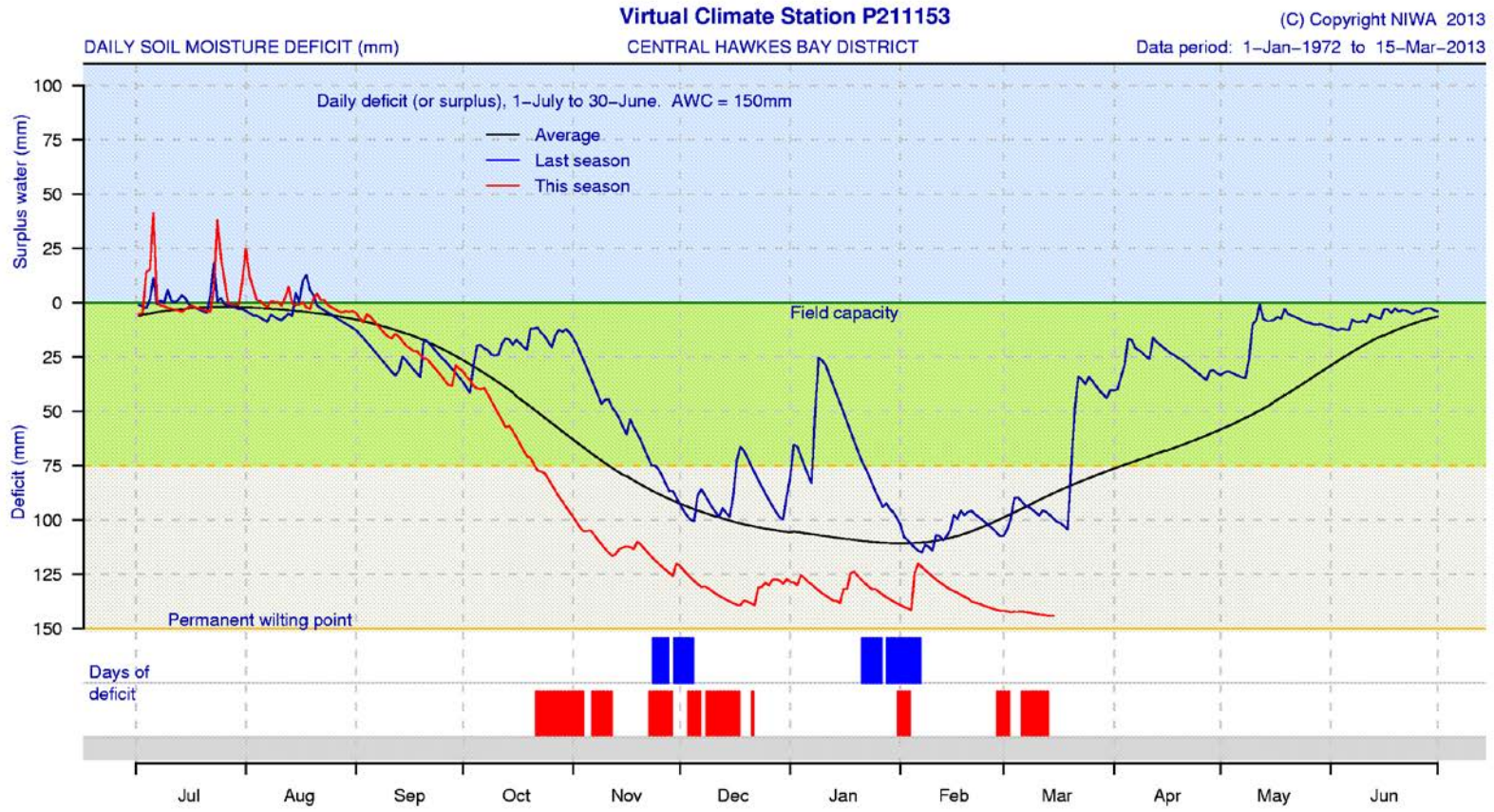

Feb




Mar 1st – 17th



# Mid-March 2013 soil moisture status



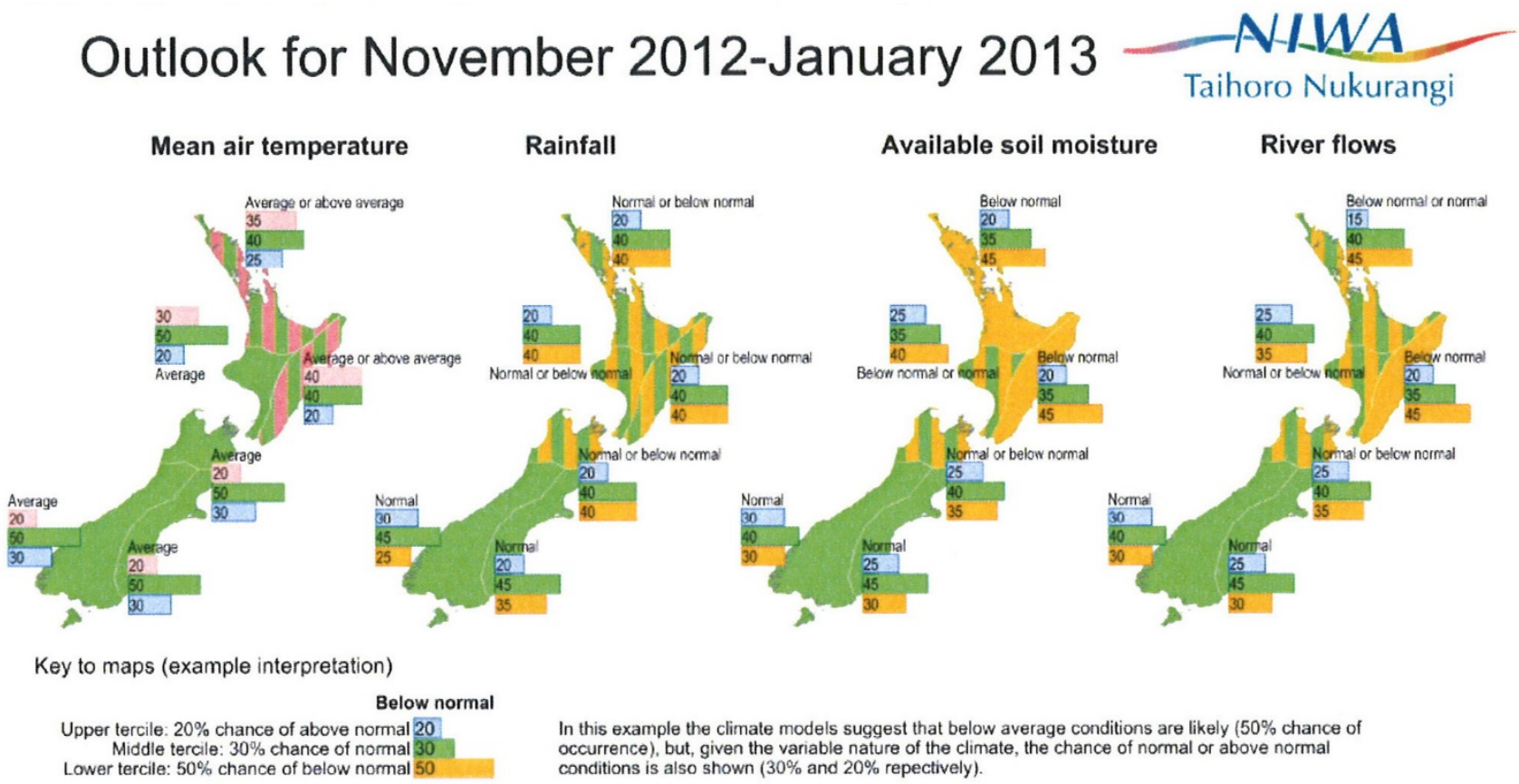
# Briefings on drought status

- Regular updates (~4 weeks) to MPI (Ministry for Primary Industries) National Adverse Events Committee
- Report to MPI – on extent and historical context of 2012-13 drought

Ministry for Primary Industries
Manatū Ahu Matua

- Reponses to individual enquiries from journalists
- Media Centre of Royal Society of NZ

# Seasonal Outlook before drought developed



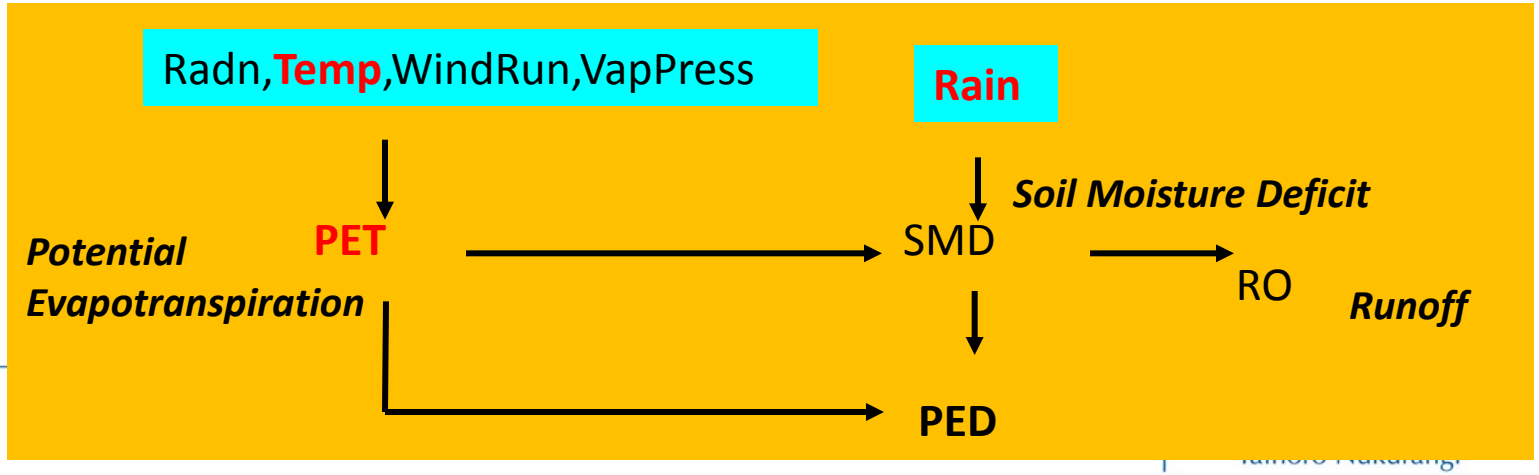
# Drought Index: Potential Evapotranspiration Deficit (PED)

Run a daily soil moisture (S) balance on daily potential evapotranspiration (PET) & precipitation (P), using 0.05° gridded data, 1972-2003

$$S_d = S_{d-1} + P_d - ET_d - RO_d - D_d$$

- Rainfall in excess of field capacity is lost as runoff + drainage *(RO+D)*
- If $S_d$>½(AWC) then $ET_d = PET_d$ *(Available Water Capacity, AWC = 150mm)*
  If $S_d$<½(AWC) then $ET_d = 0$
- Accumulate PED on a daily basis, beginning July 1: $PED_d = PED_{d-1} + (PET_d - ET_d)$

Accumulated PED is essentially the amount of water that would need to be added to a crop over a year to prevent loss of production due to water shortage



# Water Balance & Spline Interpolation

PED calculation applied to:

Climate Database record (sites), or

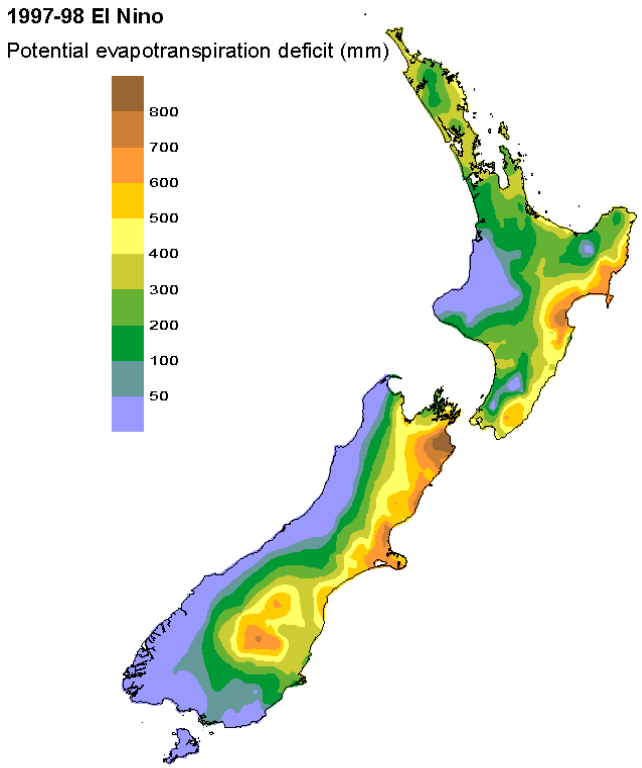
5km gridded data

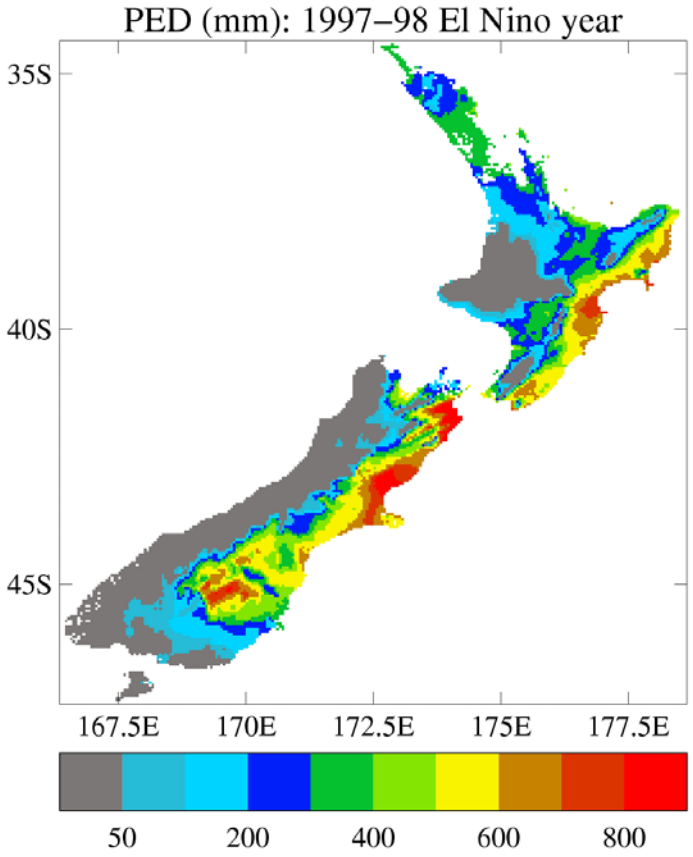
References:

Porteous, AS; Basher, RE; Salinger MJ (1994). Calibration and performance of the single-layer soil water balance model for pasture sites. *New Zealand Journal of Agricultural Research*, **37**, 107-118.

Tait, AB; Woods, R (2009). Spatial interpolation of daily potential evapotranspiration for New Zealand using a spline model. *Journal of Hydrometeorology*, **8**, 430-438.

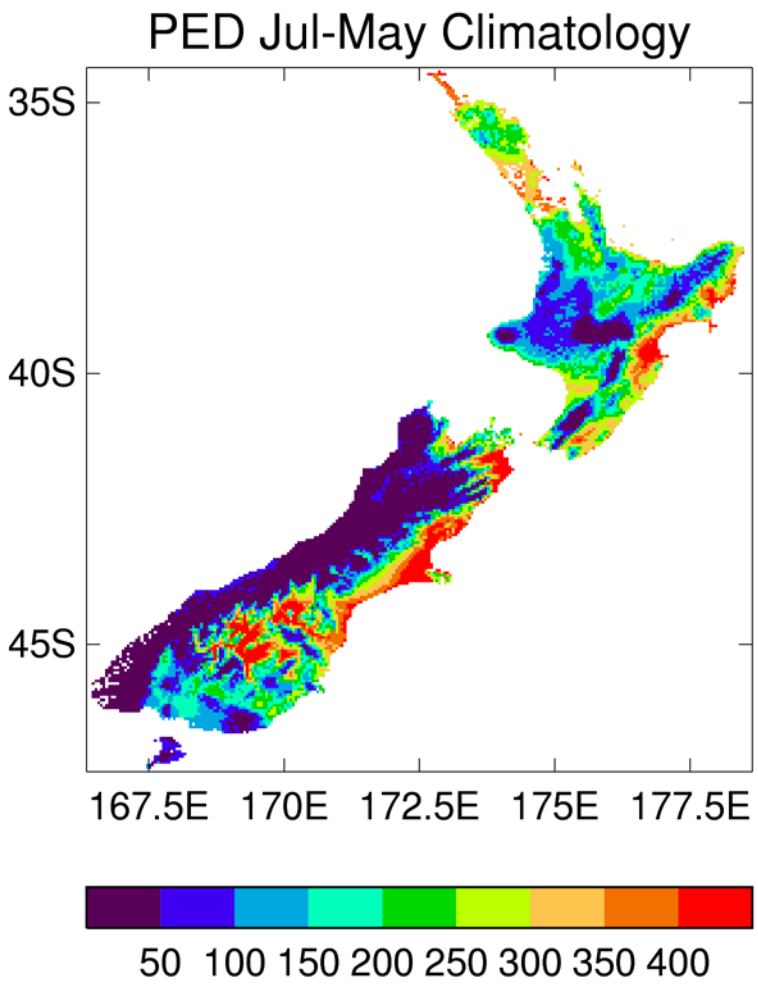
# Water Balance & Spline Interpolation

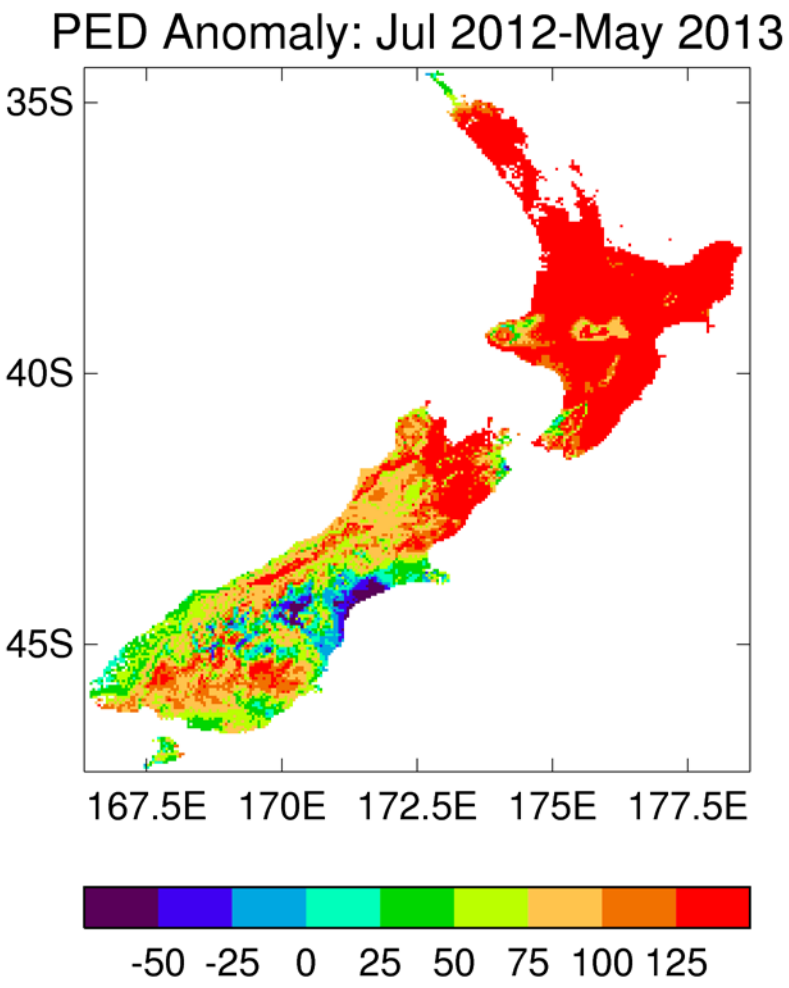


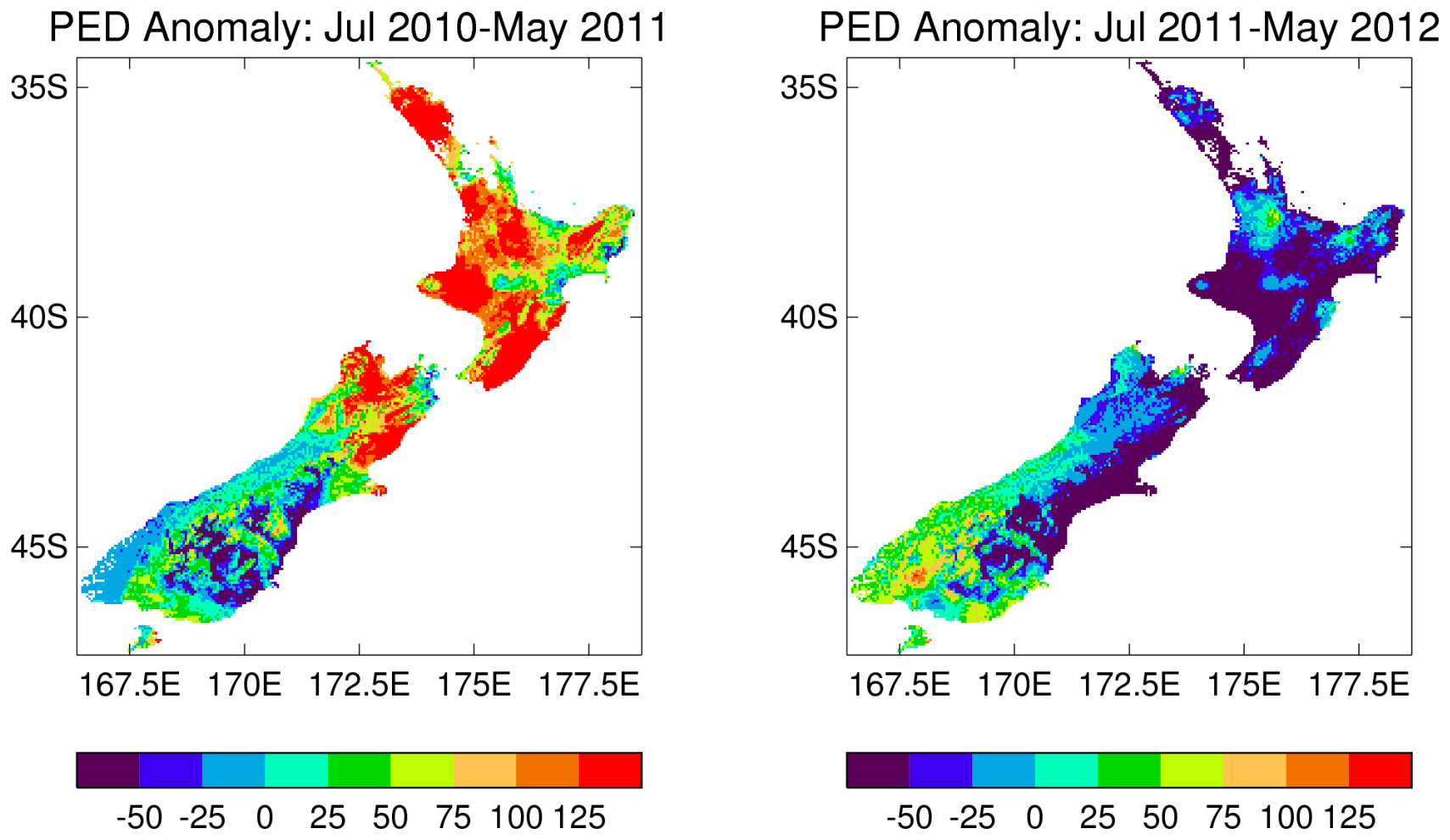

**Total potential evapotranspiration deficit (mm), July 1997 to June 1998**

# Cumulative Potential Evapotranspiration Deficit

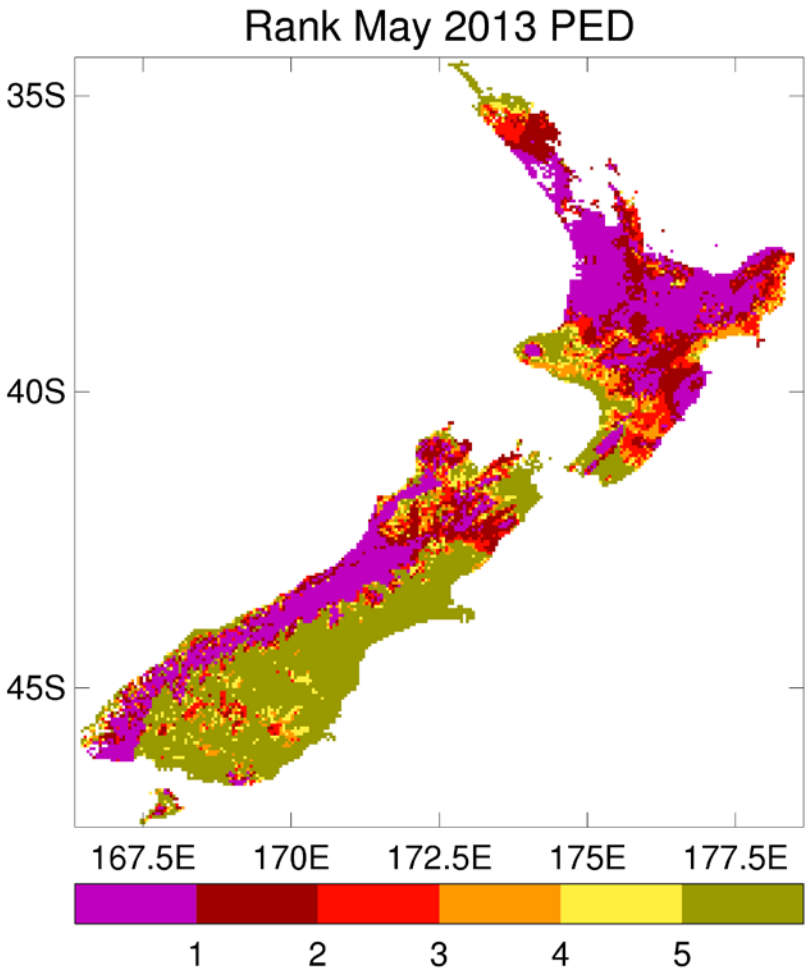


# Cumulative Potential Evapotranspiration Deficit



# 2012-13 Drought – Spatial Extent



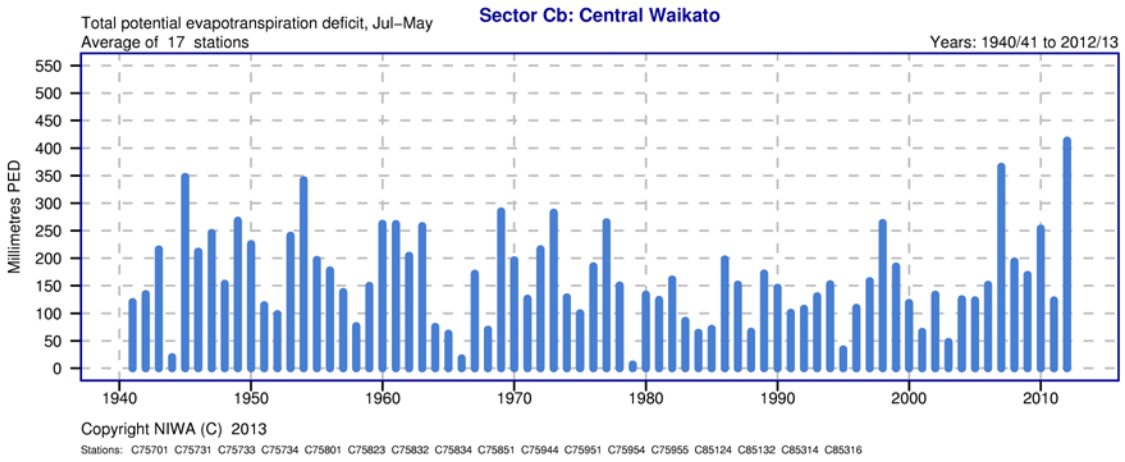

Purple shading = Rank 1 = Highest PED

- Dry conditions unusually widespread across North Island, & also affected West Coast of South Island
- Highest PED (in 41 years of VCSN data) much of: southern Northland, Auckland, Waikato, Bay of Plenty, Gisborne, Hawkes Bay, Westland
- Largest July-May PED accumulation in 41 years (VCSN data) over 34% of North Island (purple shading)
- 2nd largest PED at 22% of North Island
- 

| Rank | North Island | South Island |
|---|---|---|
| 1 | 2012-13 | 1972-73 |
| 2 | 1997-98 | 1997-98 |
| 3 | 2009-10 | 1988-89 |

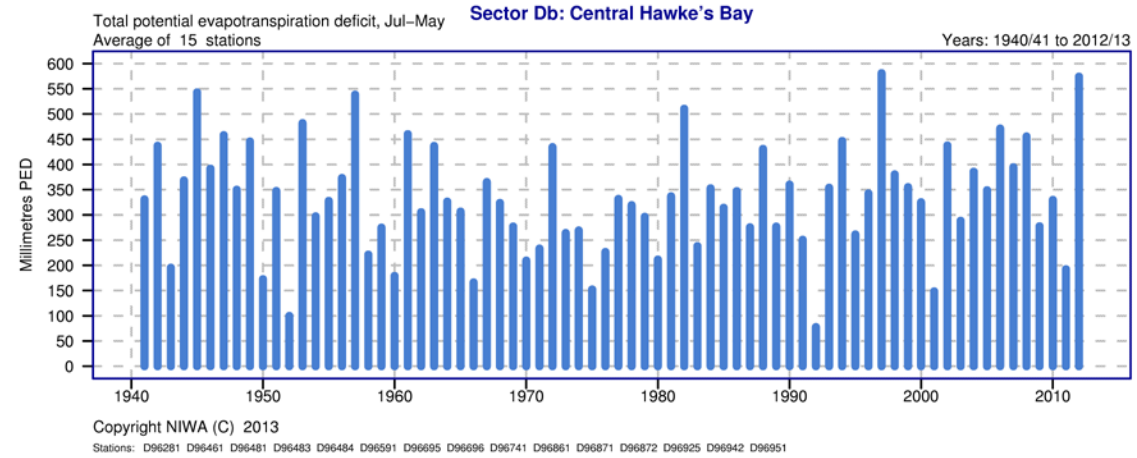
PED = Accumulated Potential Evapotranspiration Deficit over July-May agricultural year

# 2012-13 Drought – How does it compare?




Waikato: (West of North Island)

- 2012-13 drought probably worst in over 70 years for Waikato
- Other severe drought years: 1945-46, 1954-55, 2007-08




Hawke's Bay: (East of North Island)

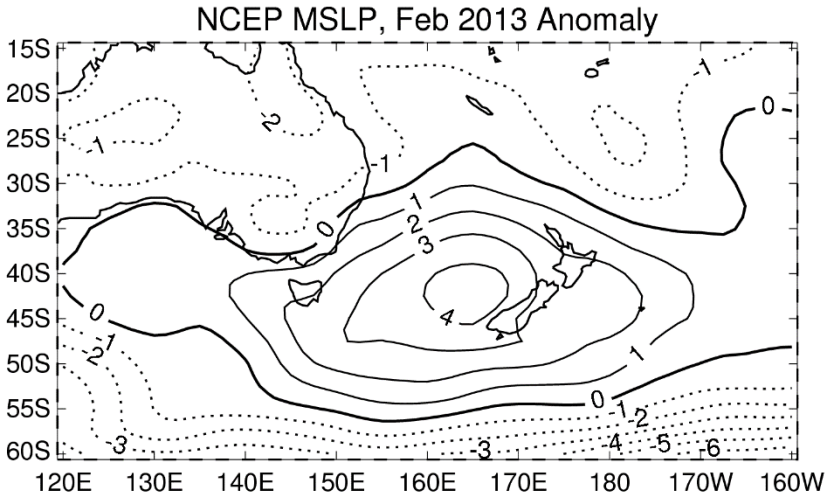
- 2012-13 drought probably 2nd worst in over 70 years for Hawkes Bay
- Other severe drought years: 1945-46, 1957-58*, 1997-98* (worst)

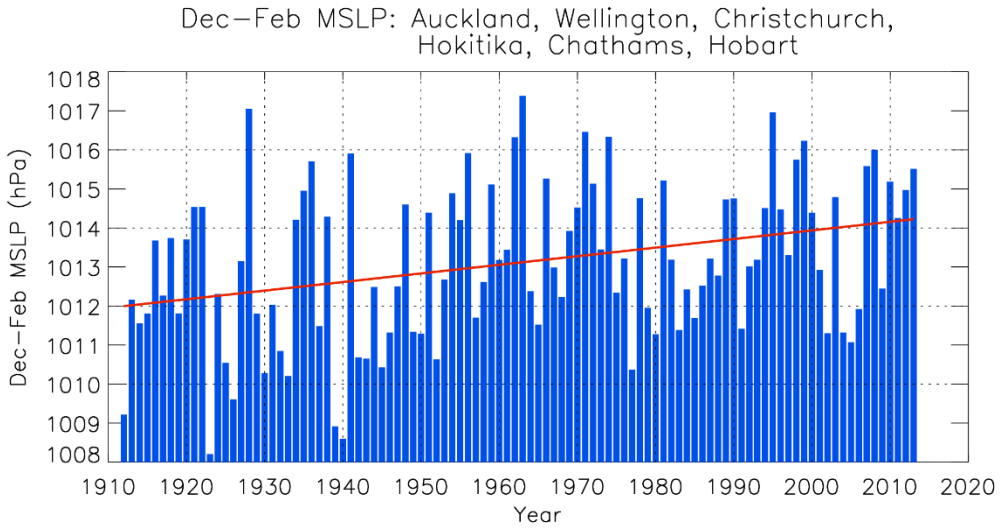
PED time series from NIWA CliDB records: central Waikato & central Hawke's Bay



*El Niño years

# Immediate Cause of 2012-13 drought – high pressures



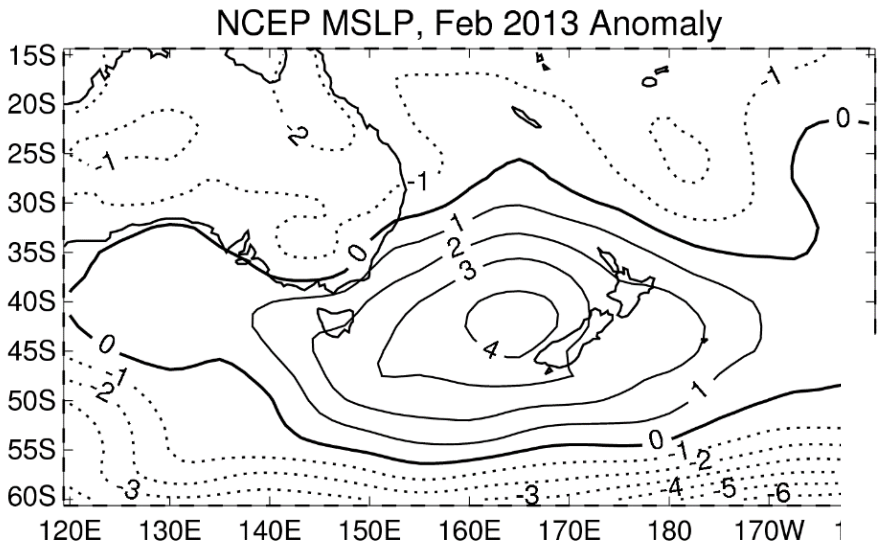




- High pressure centres unusually persistent in Tasman Sea and over NZ during early months of 2013
- Very low rainfalls; also very sunny and warm

- Summer High Pressure Index (averaged over 6 sites: Auckland, Wellington, Hokitika, Christchurch, Chathams, Hobart)
- Index shows very significant increase since 1911/12 summer
- However, high pressures don't always lead to drought conditions; e.g., 1962-63, 1995-96

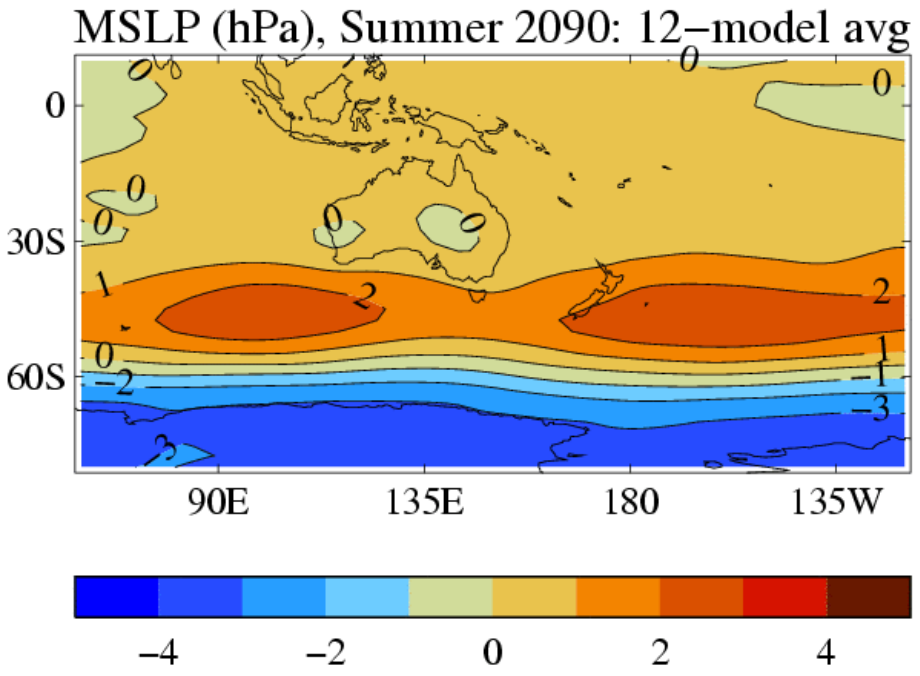
Related to SAM trend

# Any relation to Climate change?




Observed MSLP anomaly, Feb 2013

Projected MSLP change, summer 1990-2090, from 12 AR4 global models



# Cause: Enhanced Convection & Rossby Wavetrains?



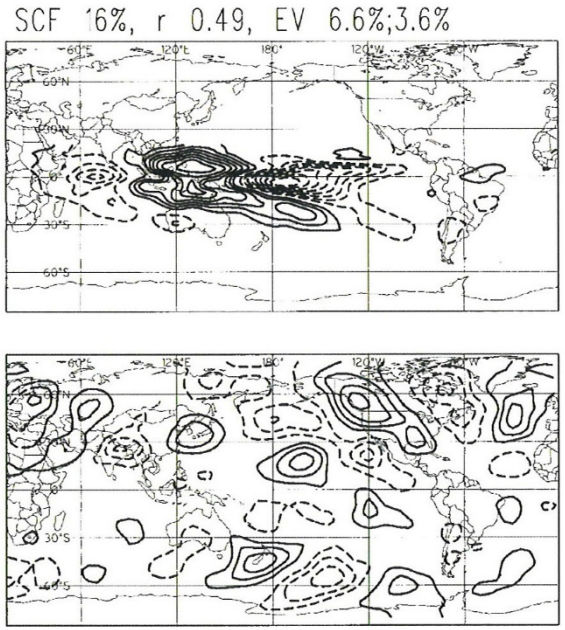
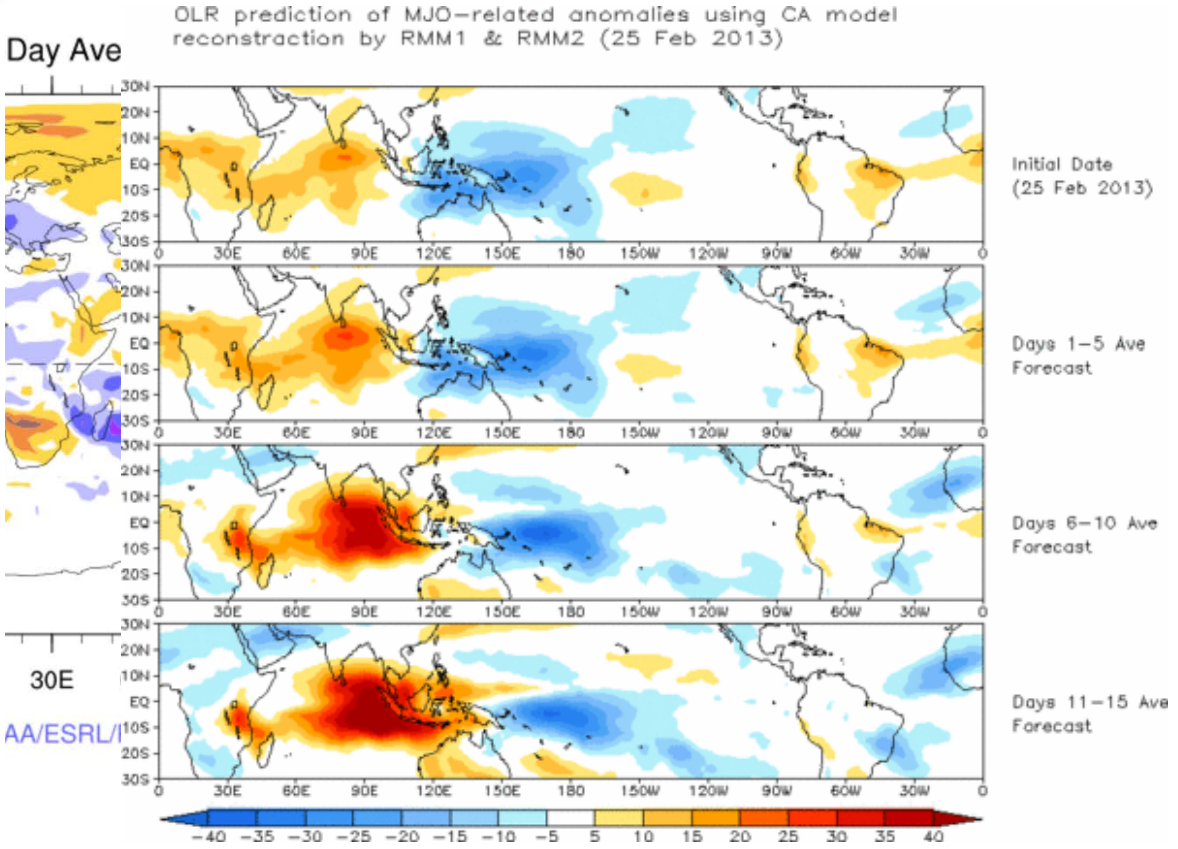



FIG. 8. Covariance maps (OLR homogeneous, V300 heterogeneous) representing the first mode of a two-pentad (10 day) lagged SVDA between pentad-mean OLR anomalies over the tropical Pacific Ocean and V300 over the globe, two pentads later, during SONDJF. The contour interval in the top panel (OLR) is 2.5 W $m^{-2}$ and is 0.5 m $s^{-1}$ in the bottom panel (V300). In both panels, negative contours are dashed and the zero contour has been omitted. Statistics printed are the squared covariance fraction, temporal correlation between the expansion coefficient time series, and respective explained variance.




Renwick & Revell, 1999. MWR, 127: 2233

NCEP prediction of MJO

# Climate Change & Drought

Clark, A; Mullan, B; Porteous, A. (2011).

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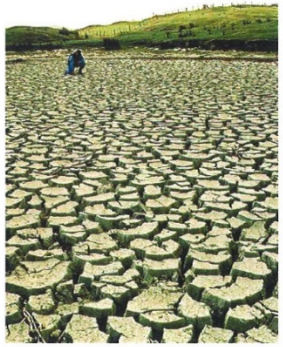
Scenarios of Regional Drought under Climate Change

Prepared for Ministry of Agriculture and Forestry

June 2011



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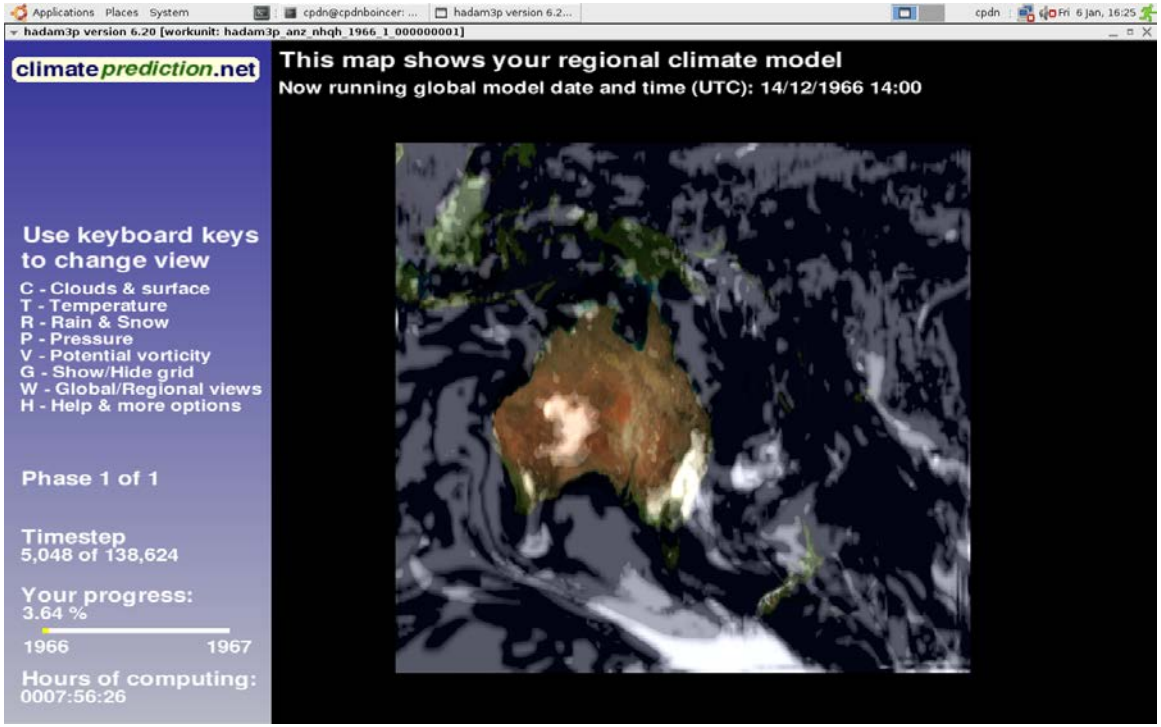
# Study underway to examine climate change & drought

http://www.climateprediction.net

## ‘**weatherathome**’ Australia/New Zealand

Global volunteer computing enables huge ensembles to be performed

UK (Oxford)
Australia
(Univ Melbourne)
NZ (NIWA)



# Summary

- New Zealand experiences droughts which impact on the economy
- The 2012-13 drought the most widespread on record, costing > $2 billion
- Monitoring drought development ✓
- Forecasting drought development ?x
- No clear trend in drought severity, in spite of trend towards higher pressures along 40-45S.