

# ACRE Antarctica: Data rescue to improve understanding of The Deep South weather & climate

Andrew LORREY<sup>1</sup>, Petra PEARCE<sup>1</sup>, Nicolas FAUCHEREAU<sup>1</sup>

Clive WILKINSON<sup>2</sup>, Ursula RACK<sup>3</sup>,

Rob ALLAN<sup>4</sup>, Philip BROHAN<sup>4</sup>, Gil COMPO<sup>5</sup>,

<sup>1</sup> National Institute of Water and Atmospheric Research, Auckland, New Zealand

<sup>2</sup> RECLAIM, University of East Anglia, United Kingdom

<sup>3</sup> Gateway Antarctica and University of Canterbury, Christchurch, New Zealand

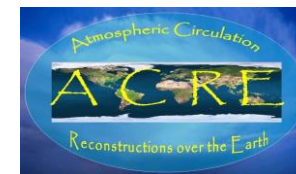
<sup>4</sup> UK Met Office, Exeter, United Kingdom

<sup>5</sup> NOAA-CIRES, University of Boulder, Colorado, United States



**NOAA**

NATIONAL OCEANIC AND  
ATMOSPHERIC ADMINISTRATION  
UNITED STATES DEPARTMENT OF COMMERCE



National  
**Science**  
Challenges

THE DEEP SOUTH

Te Kōmata o  
Te Tonga



**MINISTRY OF BUSINESS,  
INNOVATION & EMPLOYMENT**  
HĪKINA WHAKATUTUKI

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# Background

A NZ Earth Systems Model (NZESM) is being constructed as part of the DSNSC.



The NZESM is expected to help NZ better prepare for the impacts associated with climate variability and change - including droughts, storms and floods.

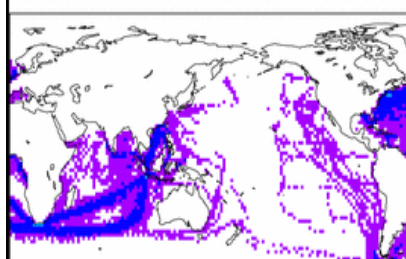
Testing the NZESM requires detailed observations that link NZ weather and climate to local outcomes, with an integrated link to Southern Hemisphere processes. Key regional elements to understand include the Southern Ocean, the Southern Westerly Winds and Antarctica.

At present, the depiction of the Deep South's historic climate and weather from extended reanalyses are poor for the NZ and high latitudes.

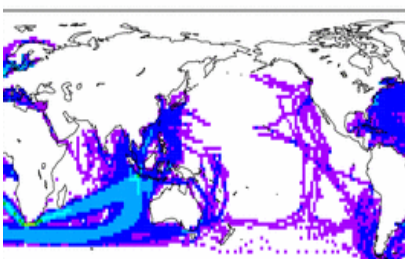
# Problem: Data sparseness

Evidence from ICOADS for Southern Hemisphere high latitude SLP coverage.

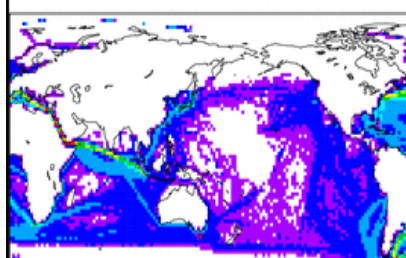
Release 2.5 1840–1849



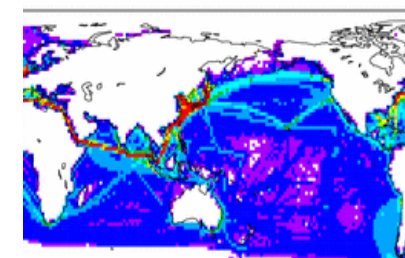
Release 2.5 1860–1869



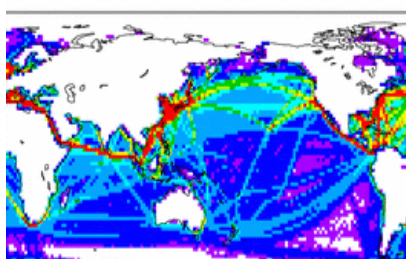
Release 2.5 1890–1899



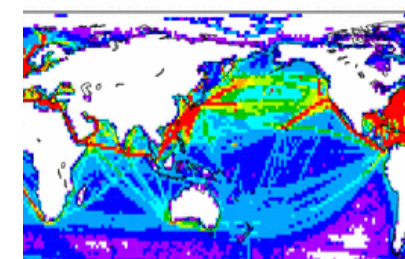
Release 2.5 1910–1919



Release 2.5 1930–1939



Release 2.5 1950–1959



**Number of Observations per decade**



1-10



11-120



121-600



601-1200



1201-1800



1801-2400



2401-3000



3001-3600



>3600

# Opportunity

DSNSC has provided \$385K NZD to support ACRE Antarctica through mid 2019

ACRE Antarctica will contribute to validation of the NZESM using historic and observational data.

Interrogating iterations of the extended RA products will let us assess how new surface data improve our depiction of NZ past weather and climate.

There are several climate drivers that we will help to improve, and interrogate by decomposing weather pattern archetypes and mapping their occurrence onto key climate modes (see table below from Yuan et al., 2004).

**Table 1.** Major Climate Modes in Mid-High Latitudes of the Southern Hemisphere

|                                   | Pacific South American Pattern (PSA)  | Stationary Wave-3 Pattern (wave-3)  | Southern Annular Mode (SAM)  | Semi-Annual Oscillation (SAO)   |
|-----------------------------------|---|---|--|---|
| Surface fields that modes present | SLP   | sea ice, SLP, winds   | SLP, winds   | Meridional gradients of SAT and SLP   |
| Characteristics                   | Three alternating pressure anomaly centers in south Pacific, southeast Pacific polar seas and South America | Quasi-stationary waves 3 around the global at midlatitudes; strong in winter, swinging east-westward over an annual cycle | Annular shaped, out-of-phase pressure anomalies in polar and midlatitude regions | Enhanced meridional temperature pressure gradients (south of 50°S) in spring and autumn |
| Dynamical or physical causality   | Rossby wave train [Karoly, 1989]  | Midlatitude land-ocean distribution [van Loon and Jenne, 1972]  | Eddies and mean flow interaction [Lorenz and Hartmann, 2001]                     | Differential solar heating at mid and high latitudes [van Loon, 1967]                   |

# NZ snow and ice

New Zealand is rich when it comes to water resources. But will it remain so?

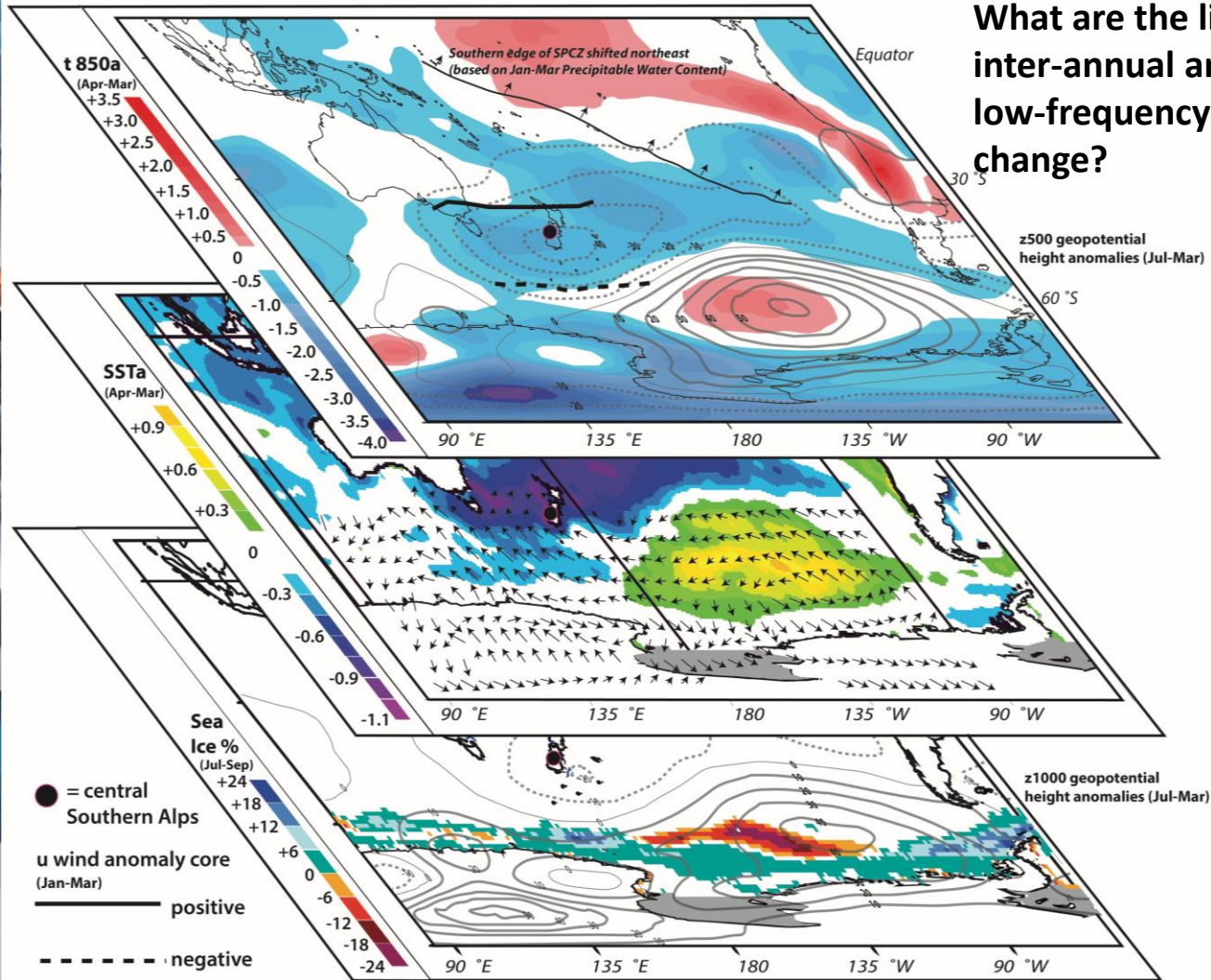


How will high latitude processes and change impact the NZ cryosphere?

Strong connections exist between NZ surface climate anomalies and high latitude modes (PSA, ZW3, SAM) via teleconnections  
*(from Mackintosh et al., 2016, Nature Communications, in revision)*

# Reanalysis fields link NZ to the Deep South

**What are the links between inter-annual anomalies and low-frequency variability & change?**



*Advancing glaciers = cool surface temperatures during most of glacier hydrology year*

*Cool central Tasman SST during glacier hydrology year; advection onto land via prevailing flow*

*Anomalous sea ice and surface pressure patterns; several drivers working in unison – NOT just ENSO*

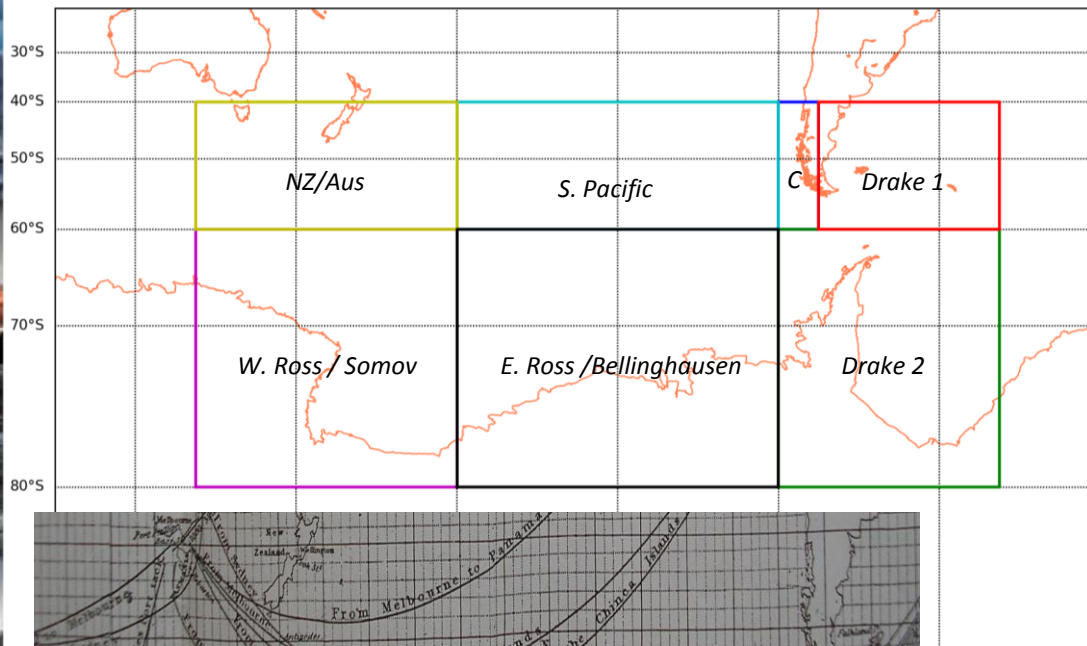
# ACRE Antarctica data rescue plan



## Objectives of ACRE Antarctica:

- **Identify, prioritize, and rescue meteorological records to upgrade the ER for climate/weather research**, inclusive of the region extending from New Zealand south to Antarctica and laterally from the Drake Passage/Bellinghousen Sea sector west to the South Indian Ocean sector of the Southern Ocean.
- Scan and digitally archive 'high value' paper observations documenting past weather and climate observations in a series of strategic data rescue pushes. **Prioritise recovery of surface pressure, sea ice and temperature (sea surface and ambient) quantitative measurements and qualitative observations.**
- **Data entry, quality control & vetting of surface pressure data to the International Surface Pressure Databank (ISPD)** to upgrade the ER spatial and temporal Coverage.
- **Analyse and establish past climate driver activity (including indices) and deduce their links to NZ using the improved ER and new visualisation tools.**
- **Promote significant findings and opportunities to utilise, apply, and transfer knowledge** to government agencies & stakeholders.

# AA domain selection and approach

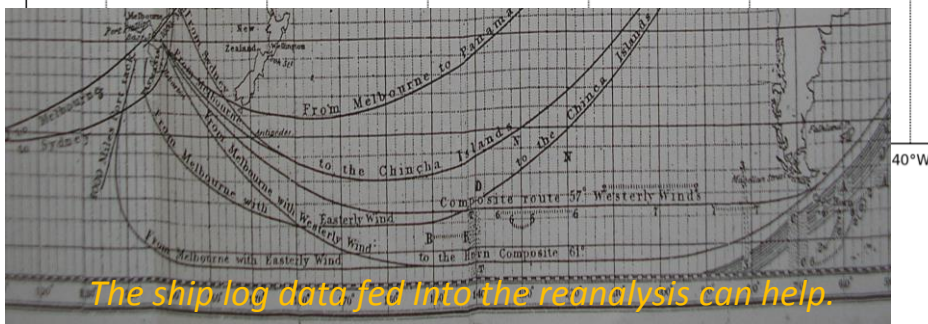


Domain selection: core action centres of drivers

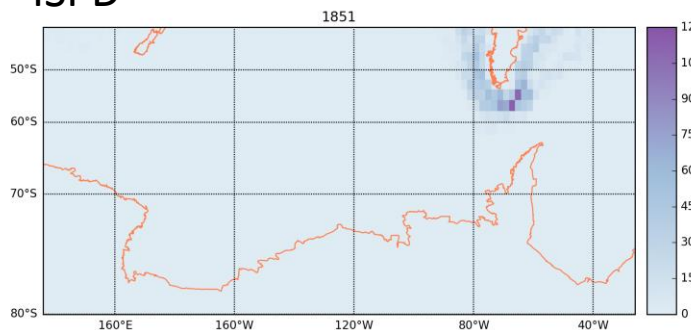
Subdomains (7): track data input relevant to reconstructing driver spatial patterns, continual reassessment, targeting, & spatiotemporal improvements (and share)

Goal: at least 6 daily data points added to the whole domain and build from there

Initial benchmarking: ISPD vs. actual data assimilated



ISPD



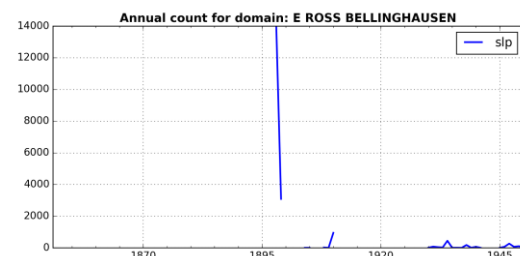
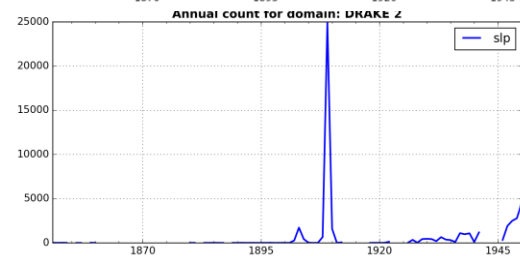
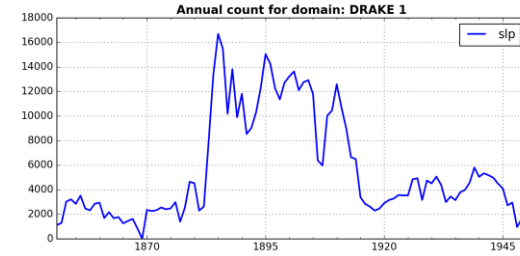
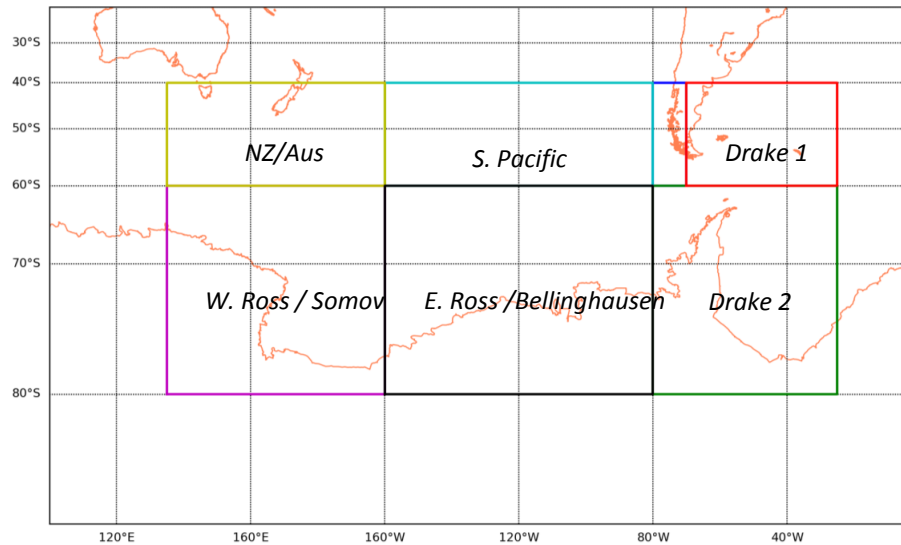
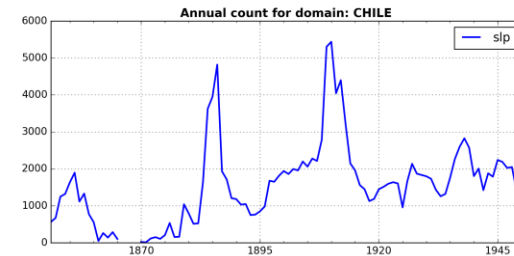
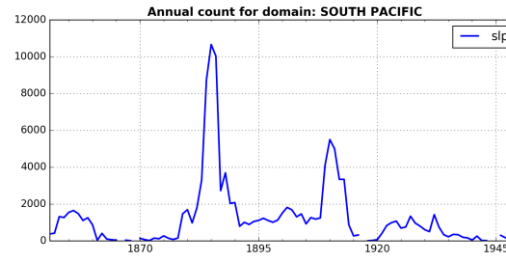
Assimilated





# What we have done so far...

- Evaluated temporal coverage in subdomains



- Established baseline for daily observation counts
- Evaluated 1 TB of images provided by SEARCH project
- Evaluated NIWA's library with first issue printing from late 19<sup>th</sup> / early 20<sup>th</sup> C scientific voyages



# ACRE Antarctica science plan

- Engage with researchers who can assist in contributing to data rescue from a national and international perspective for ACRE
- Help other 'overlap' regions for ACRE (Chile & Argentina) by identifying data sources
- Recover data with the aim of improving understanding of high-latitude climate driver impacts (eg. SAM, PSA, WP3) on NZ climate
- Assessment of climate variability and atmospheric processes on multidecadal scales, identify and attribute drought and deluge in New Zealand that have polar climate linkages

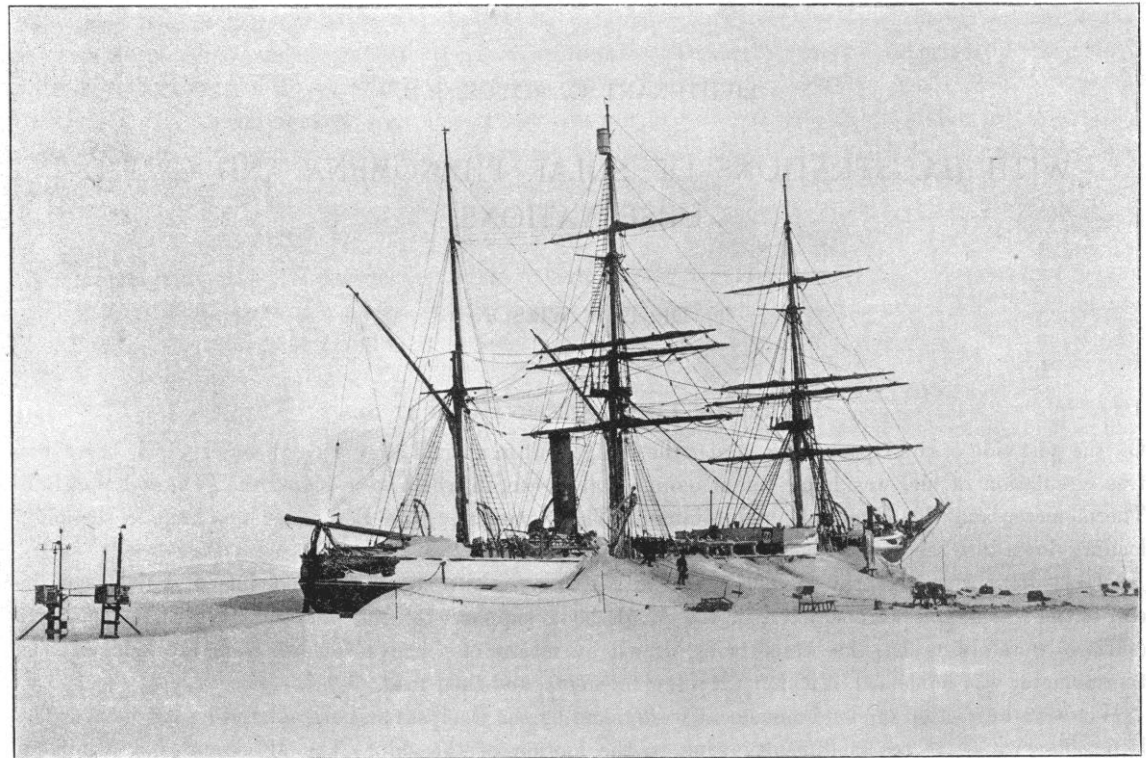


Fig. 1. "Discovery" in Winter Quarters, looking South.

<https://www.niwa.co.nz/climate/research-projects/climate-present-and-past>

# ACRE Antarctica science plan

- Improve sea ice observations and examine their relationships to surface pressure anomalies and New Zealand regional climate
- Improve historic sub polar cyclogenesis patterns and examine their relationships to sea ice & planetary wave activity
- Assess impacts and risks to NZ associated with formation/interaction of subpolar synoptic systems
- Examine changes in the SAM through time and linkages to long-term changes in SH/mid-latitude blocking and drought
- Explore ocean-atmosphere climate and weather connections for the Southern Ocean and Tasman Sea

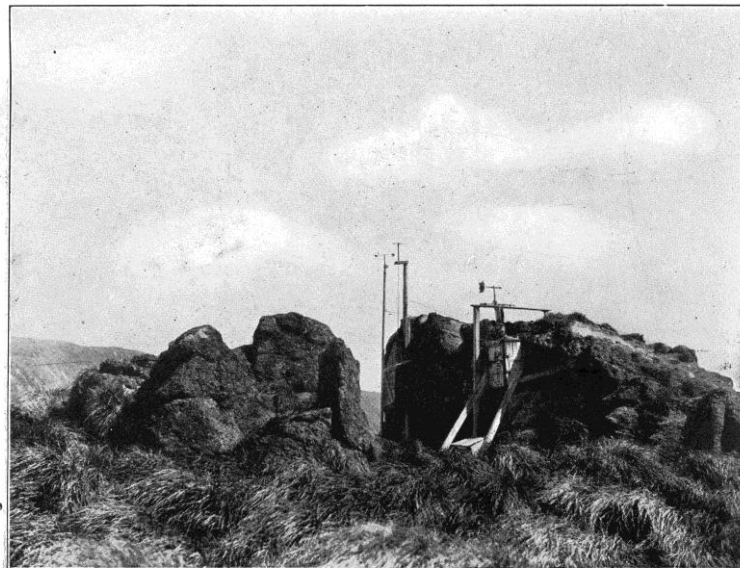
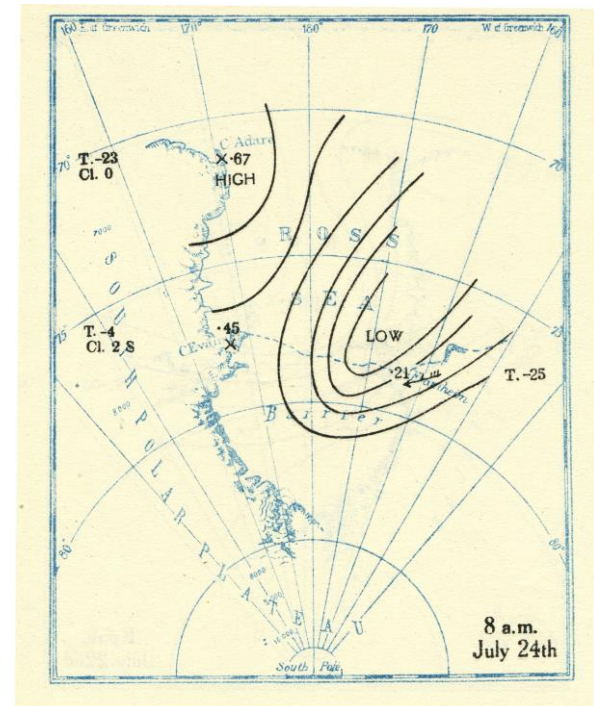
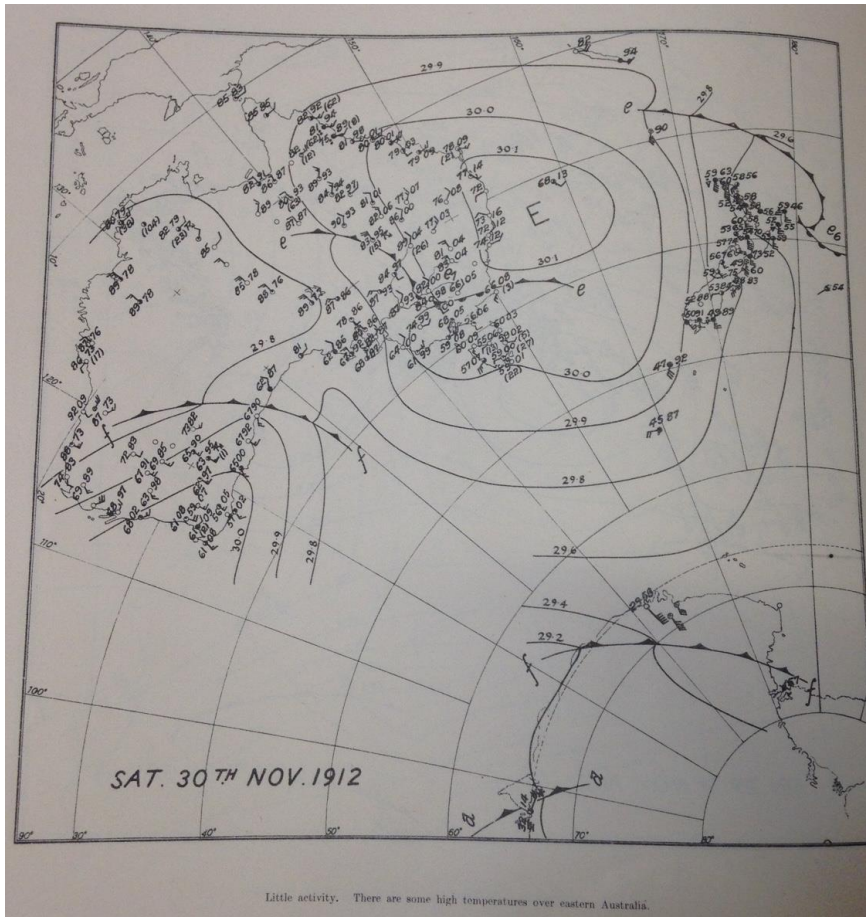


Fig. 1.—The Wind-recording Instruments at Macquarie Island.



# ACRE Antarctica science plan



*Hand-drawn synoptic map by E. Kidson (1919)*

- Extend knowledge of NZ's synoptic weather patterns; application of K-means clustering to define a joint Ross Sea-NZ synoptic type classification; improve definition of the role high-latitude drivers play in mid-latitude variability and related climate and weather extremes
- Assess improvements to ER depiction over NZ and the subantarctic sector of NZ using successive scout runs
- Historic analog-based modeling of New Zealand daily weather and seasonal climate patterns using the NIWA-based Past Interpretation of Climate Tool (PICT), palaeoproxies, in situ observations and the ER (enabled via augmentation from subantarctic and Antarctic observations).
- produce daily gridded data for 13 variables (with uncertainty estimates) for all of the country resolved at 5x5km resolution using the VCSN

Please direct questions to me via email. Thank you!



# Auckland 2017 for the next ACRE workshop!

