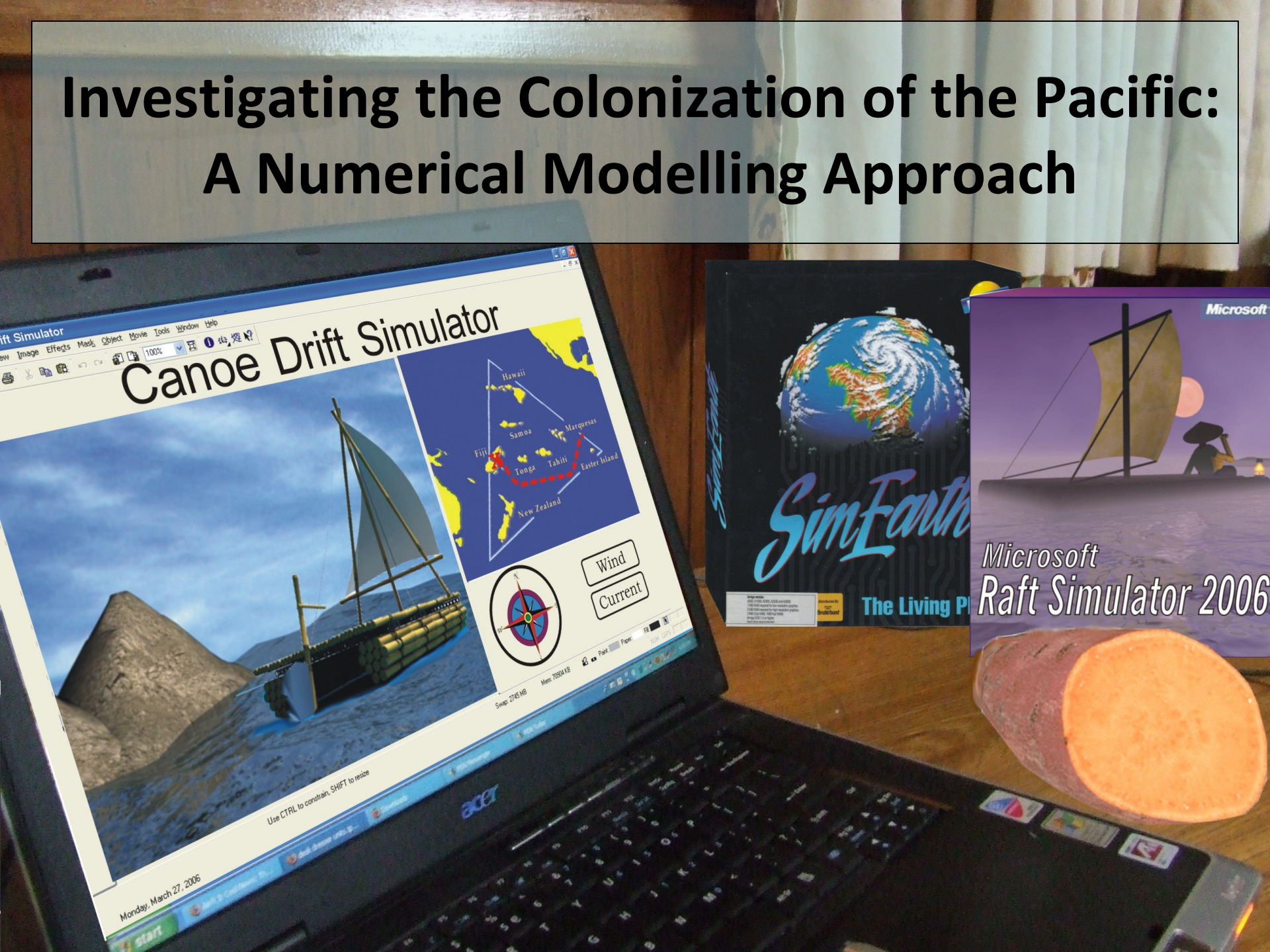
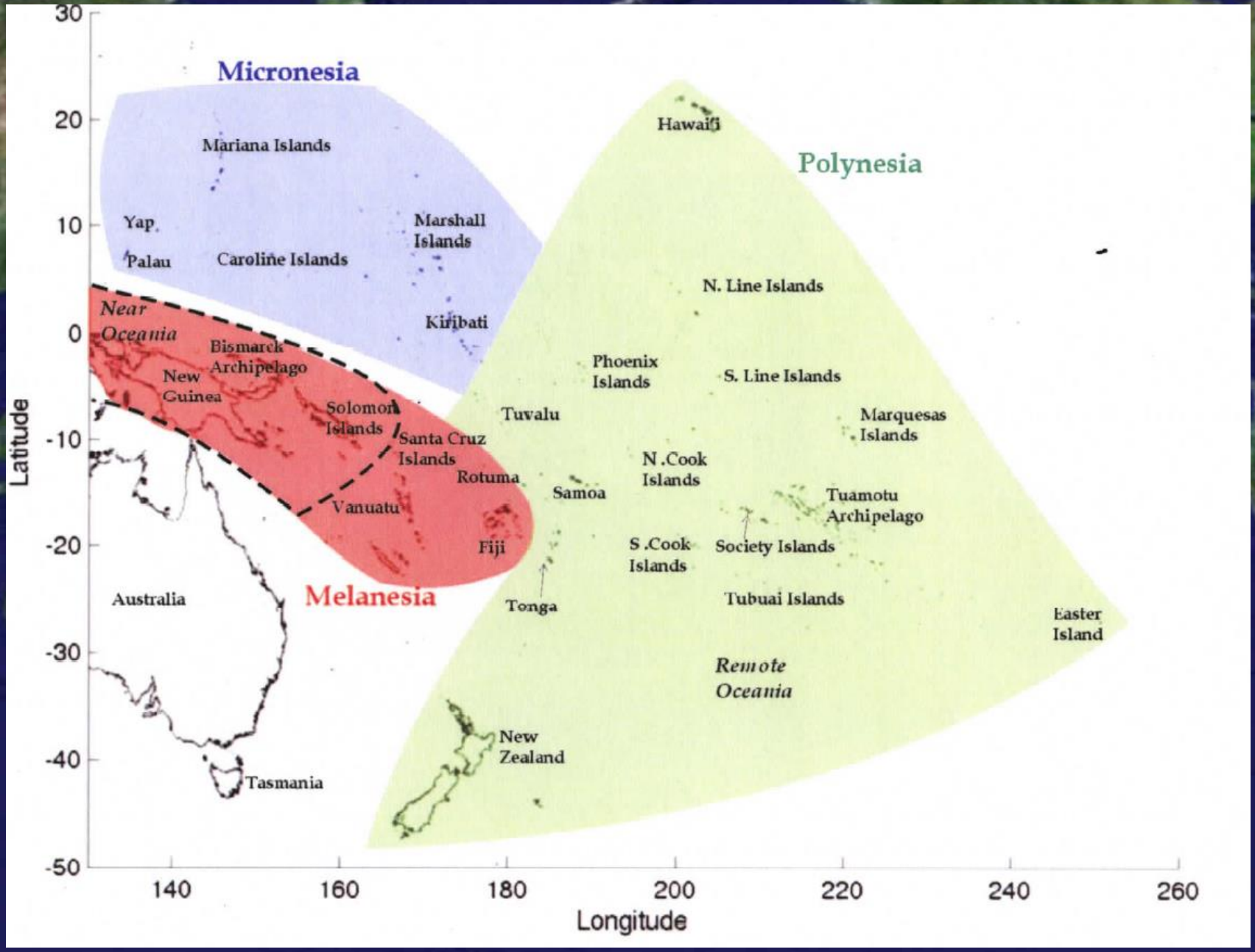
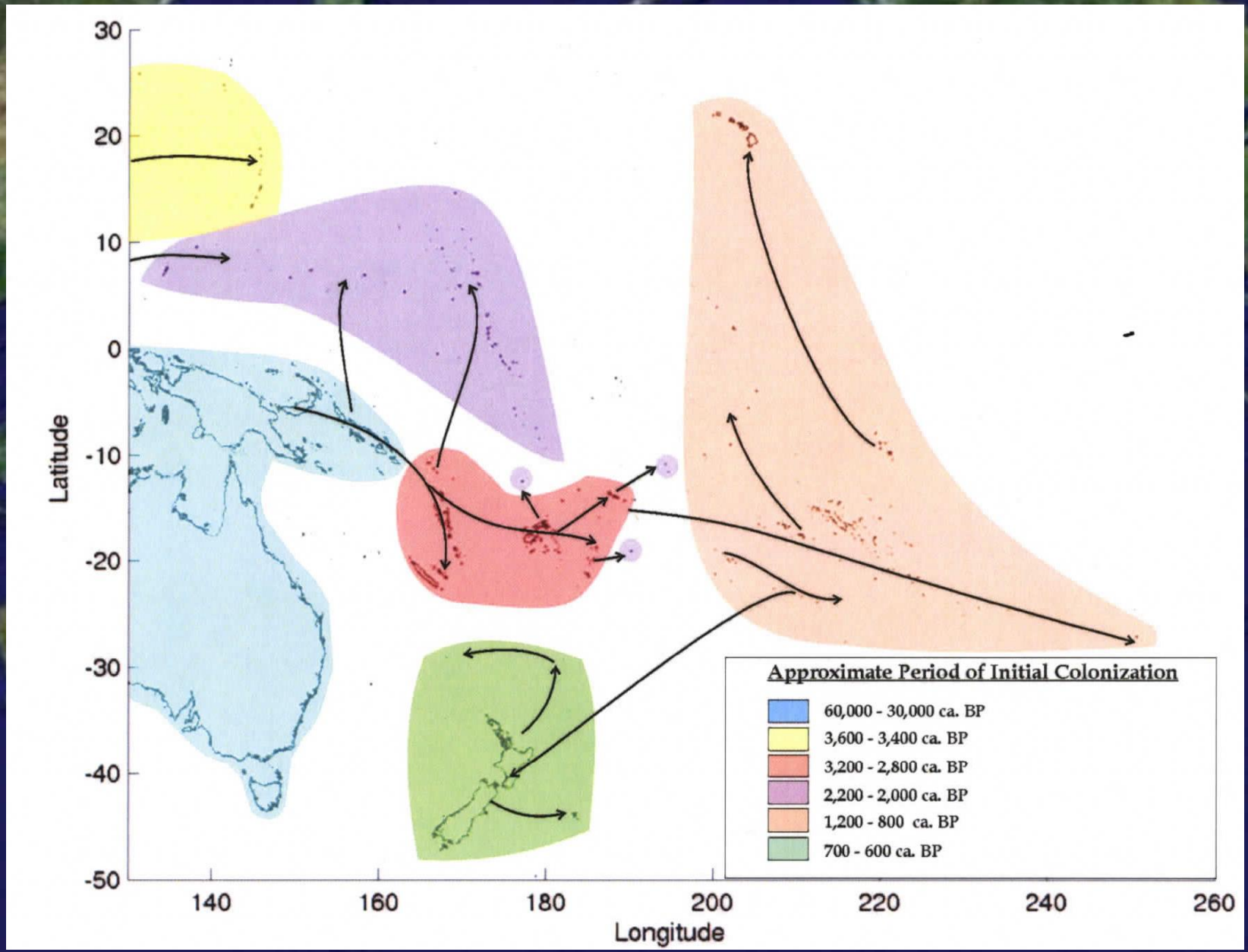
Investigating the Colonization of the Pacific: A Numerical Modelling Approach



The Colonization of Oceania

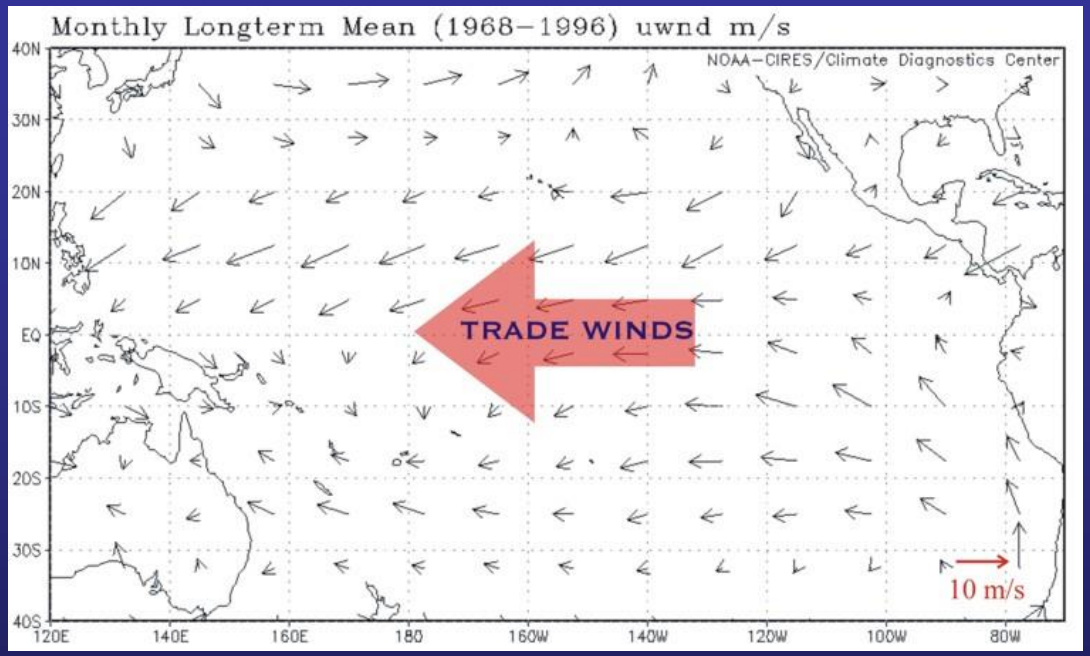


The Colonization of Oceania

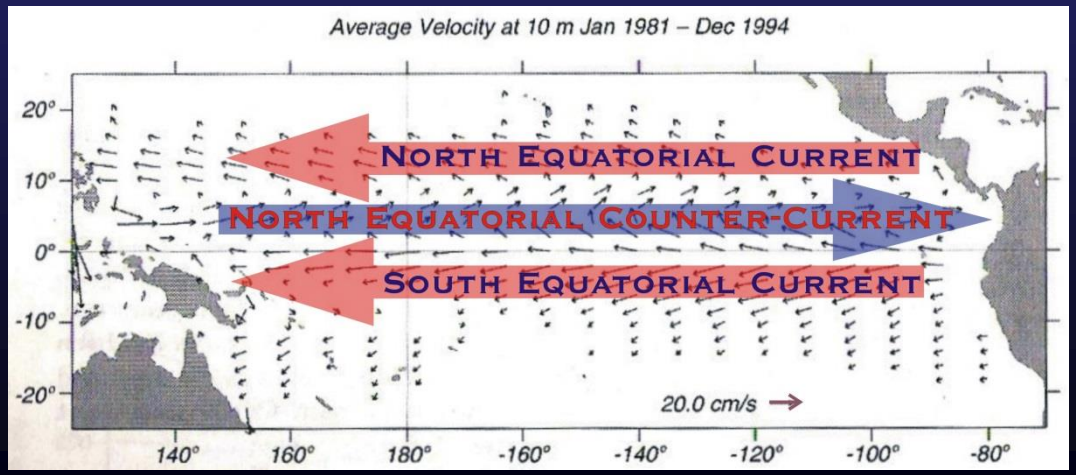


Climate Background

The Climate in the Equatorial Pacific

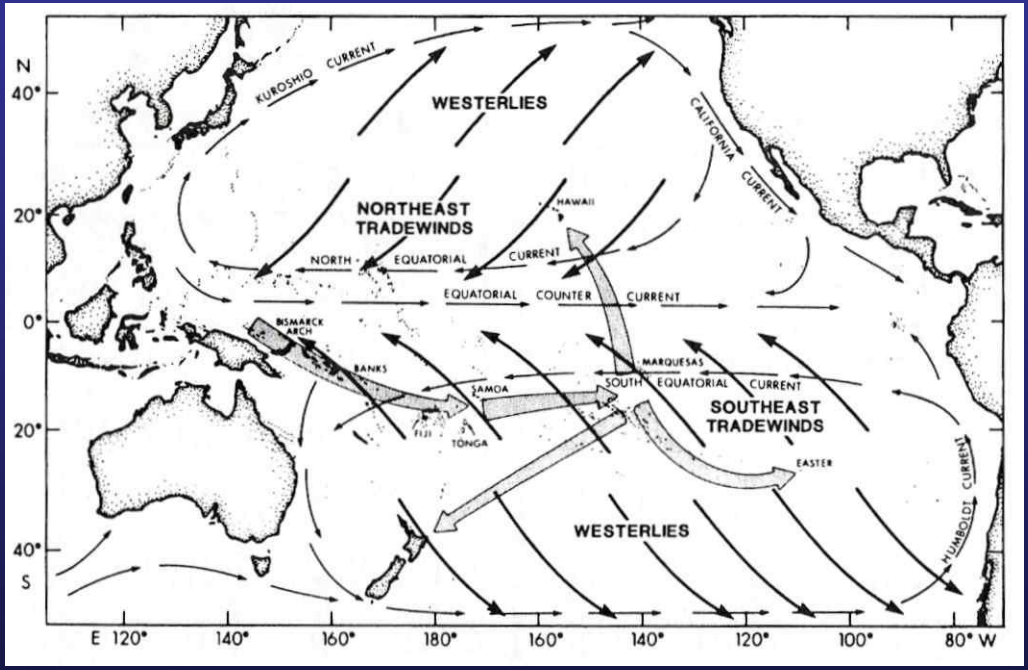


Winds…



Currents...

How did they do it?



Simulation Setup

Discovery Hypotheses

- Nothing definite known about maritime technology or navigation at the time of settlement

- One-way voyaging (*Sharp, 1956*): Drift, or one-way exploration.

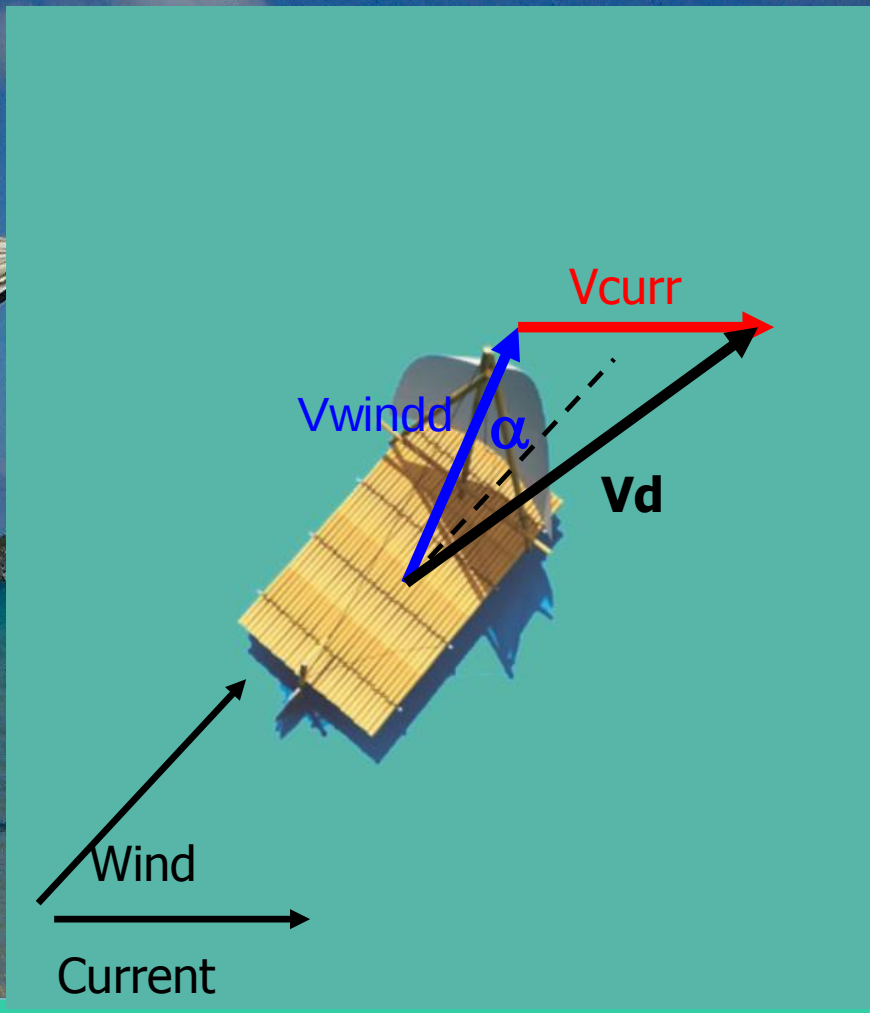
- Systematic, two-way exploration (*Irwin, 1992*) Cautious exploration “against, across and down” the *prevailing* winds.

Simple Discovery Models

- Drift voyages: No attempt to sail or orient the vessel in a chosen direction.
- Modelled using US Coast Guard (USCG) drift parameters

- Downwind Sailing: Mariners choose to sail in the direction of the wind.
- Modelled using the parameters of *Levison et. al*.

Modelling the Influence of Winds and Currents

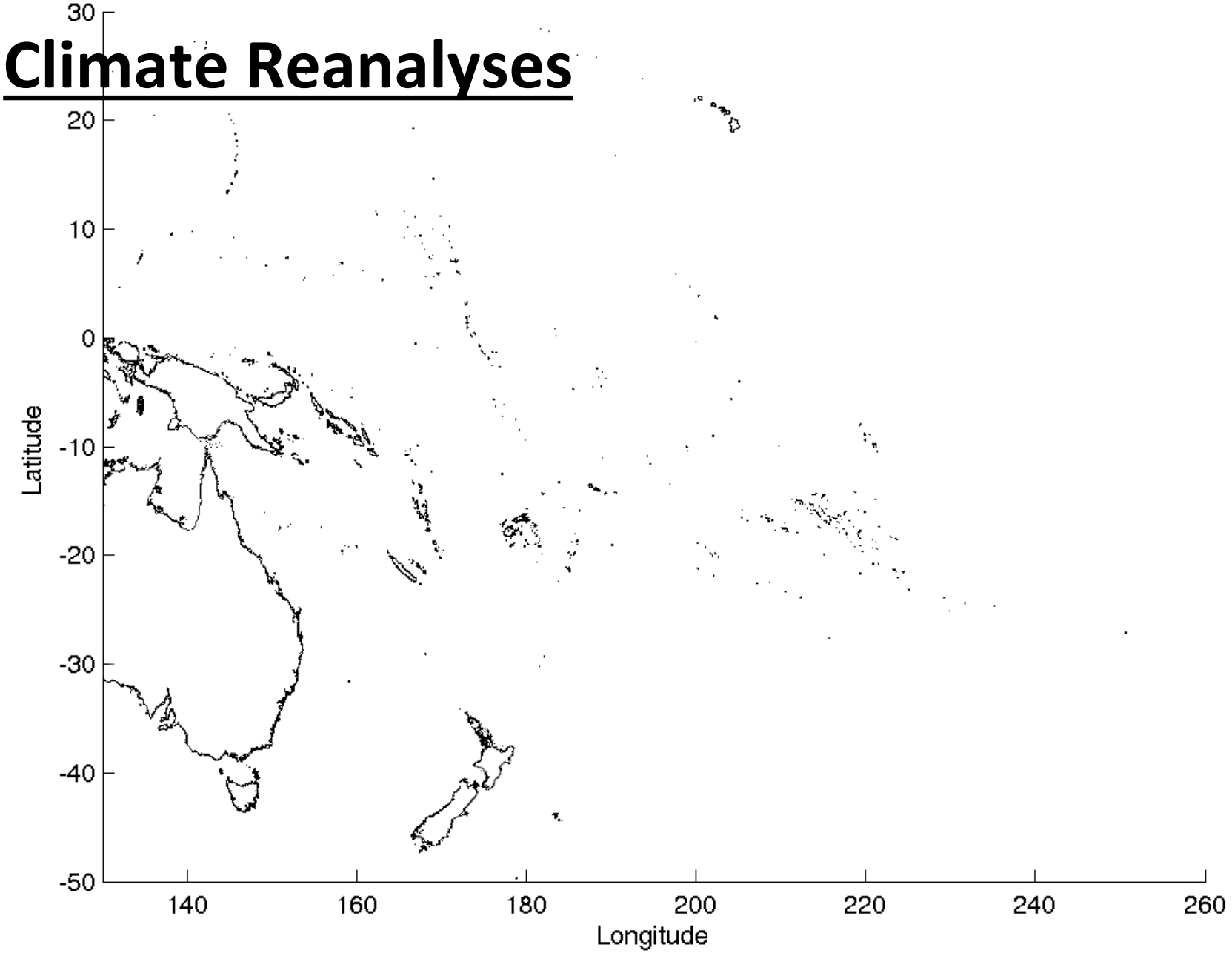


$$V_d = V_{curr} + V_{windd}$$

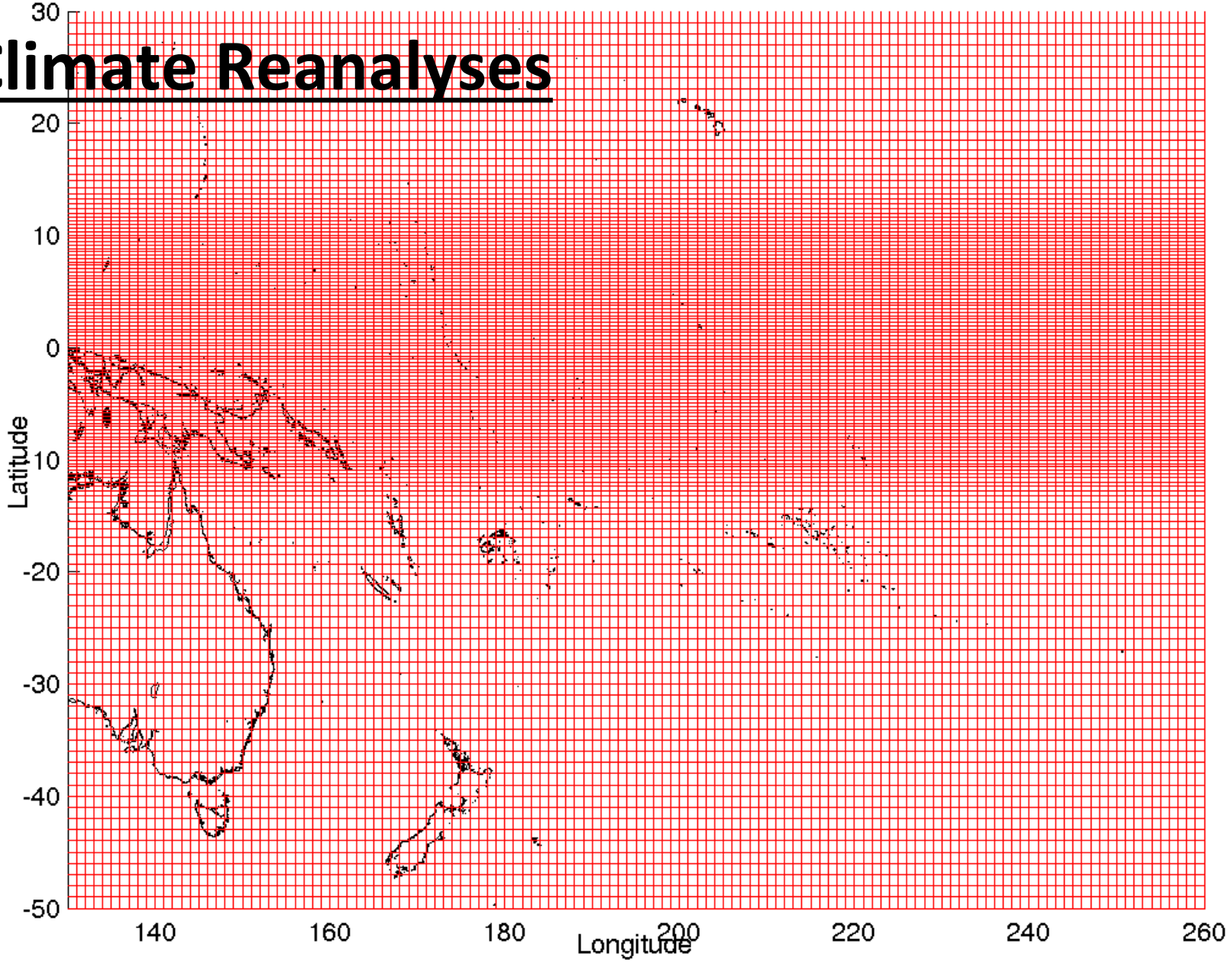
Climate Data

- Present-day atmospheric/oceanic circulation across the Pacific established 8,000 years ago.
- El Niño began to behave as it does in the present climate at least 5,000 years ago.
- Use high resolution present-day climate and ocean data to drive simulations from reanalysis products

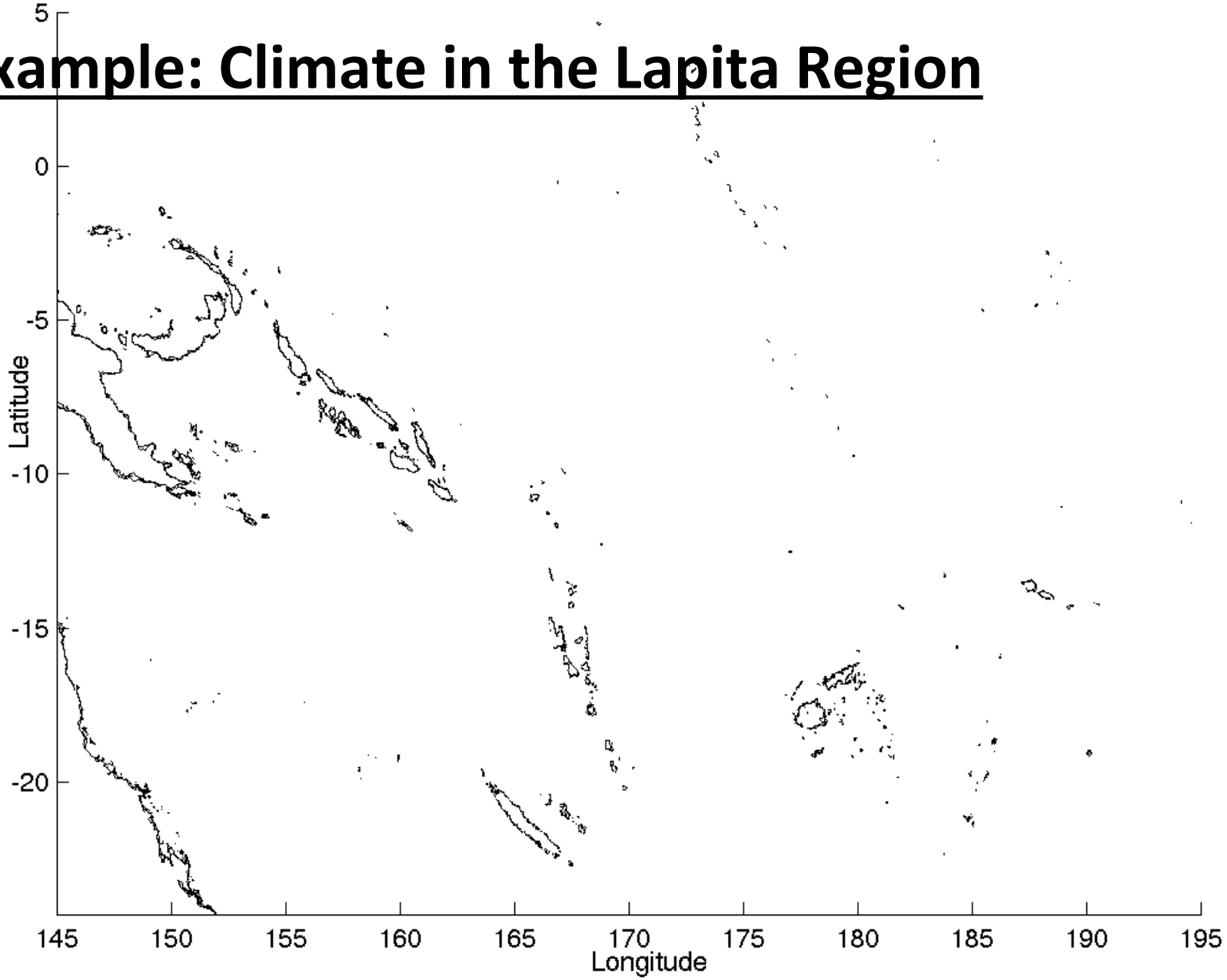
Climate Reanalyses

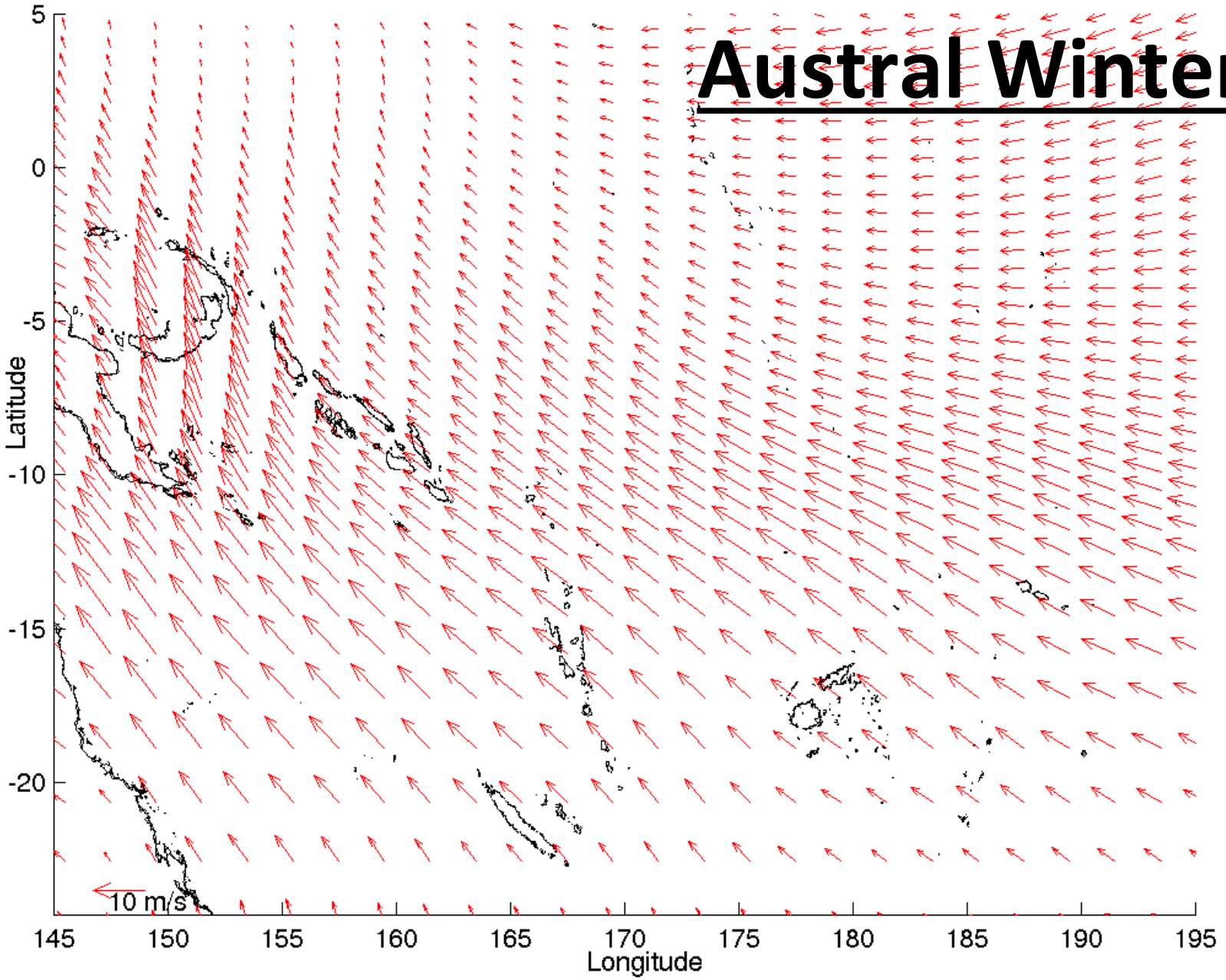


Climate Reanalyses

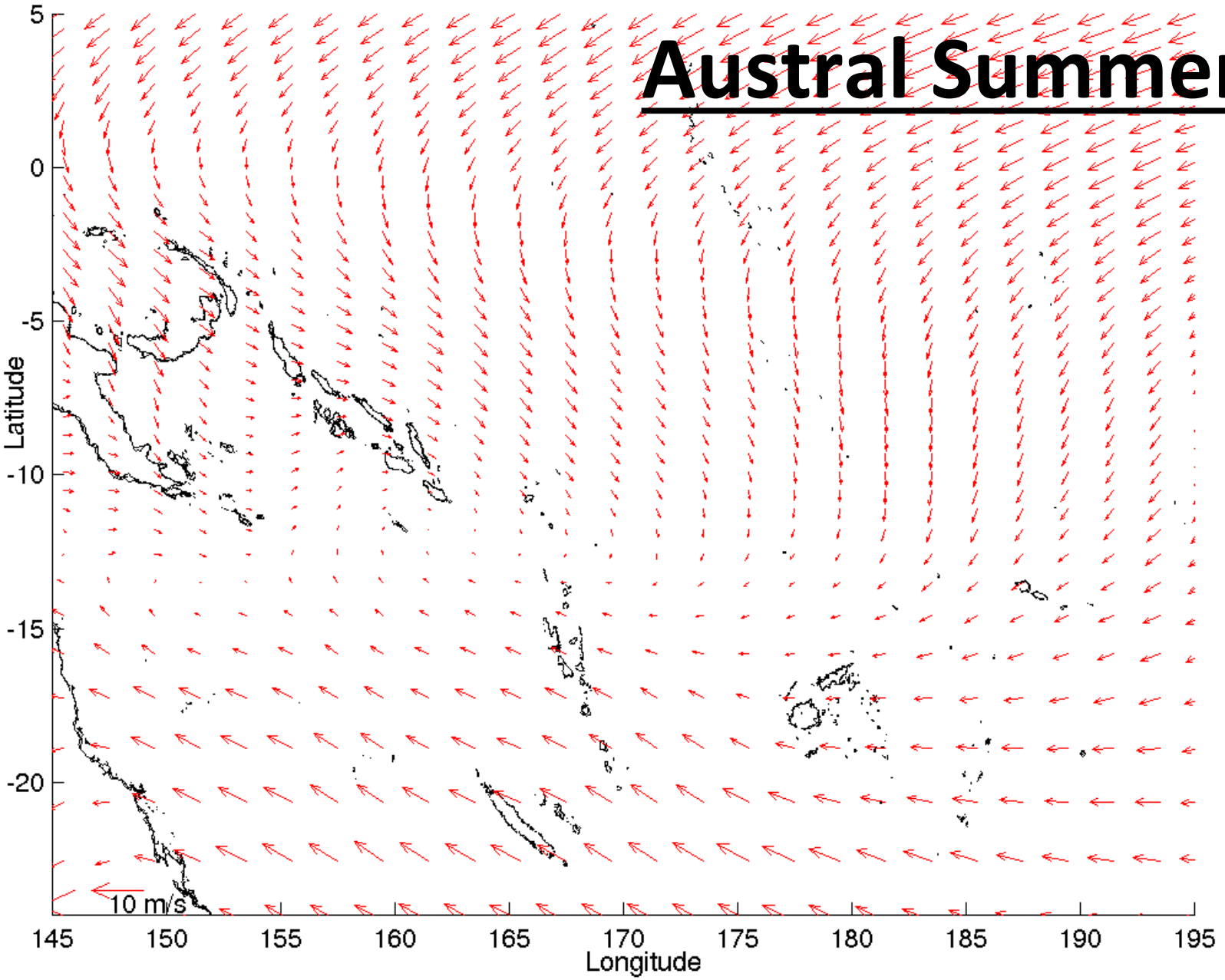


Example: Climate in the Lapita Region




Austral Winter
5
0
-5
-10
-15
-20
Latitude
10 m/s
145
150
155
160
165
170
175
180
185
190
195
Longitude

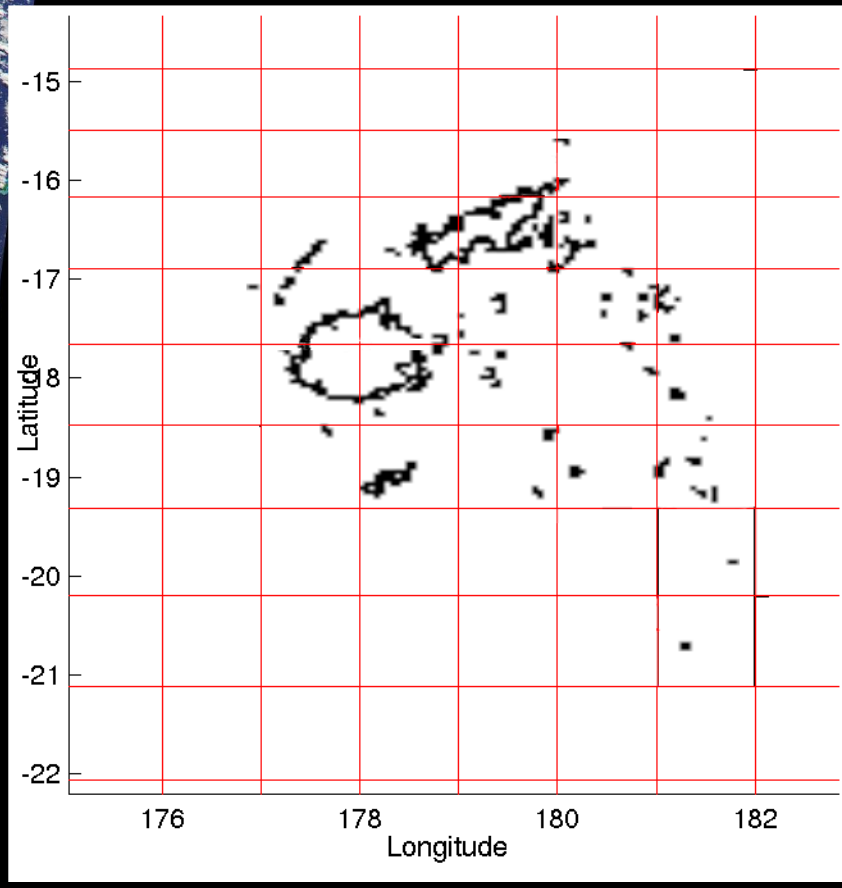
Austral Summer



Modelling Island Groups

- Estimate: Oceanic mariners could read signs of land from 30 nautical miles out.
- Overlapping *sighting circles* result in extensive islands screens
- Use islands screens & data grid to identify grid cells to serve as launching points & target boxes for drift voyages.

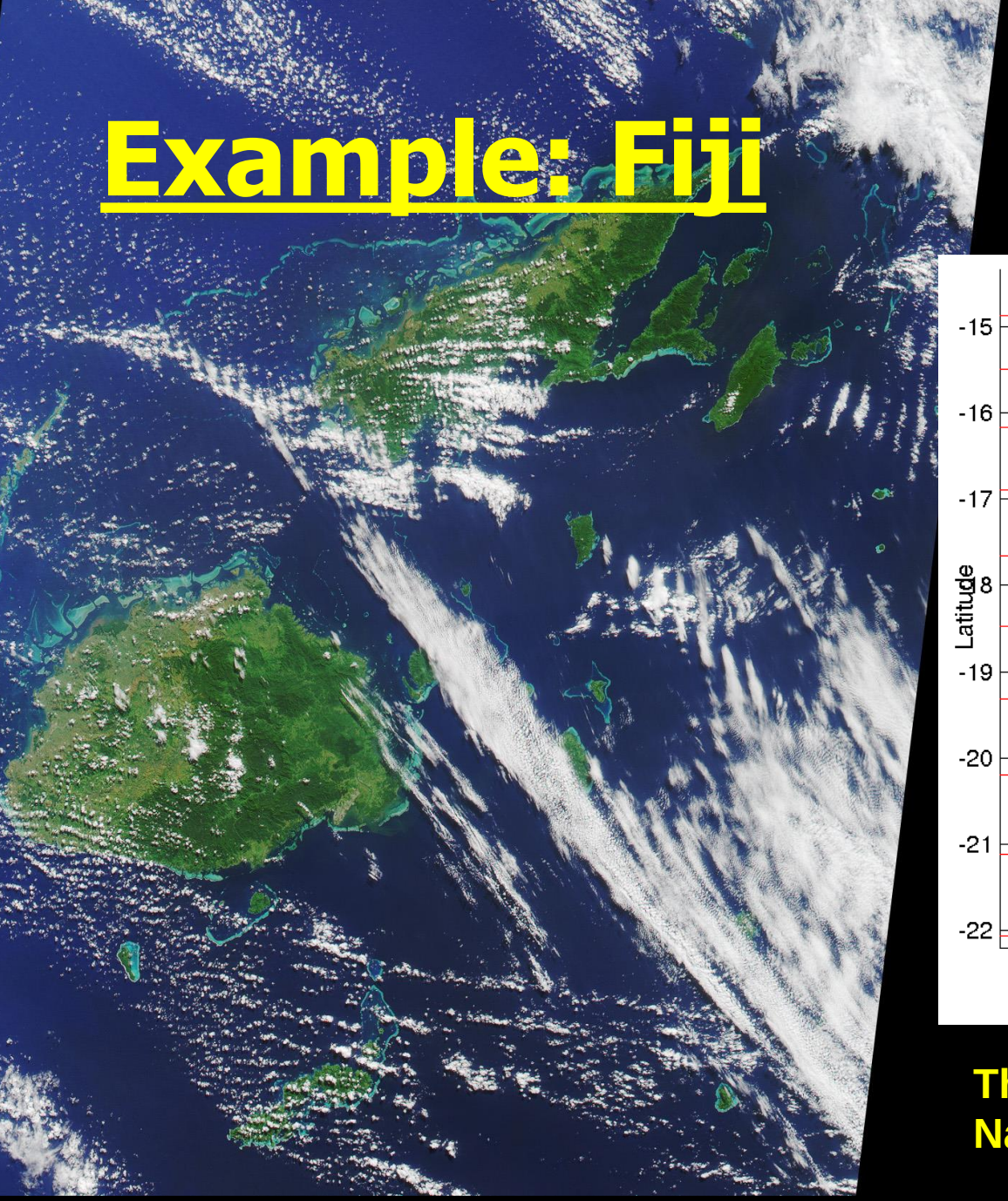
Example: Fiji

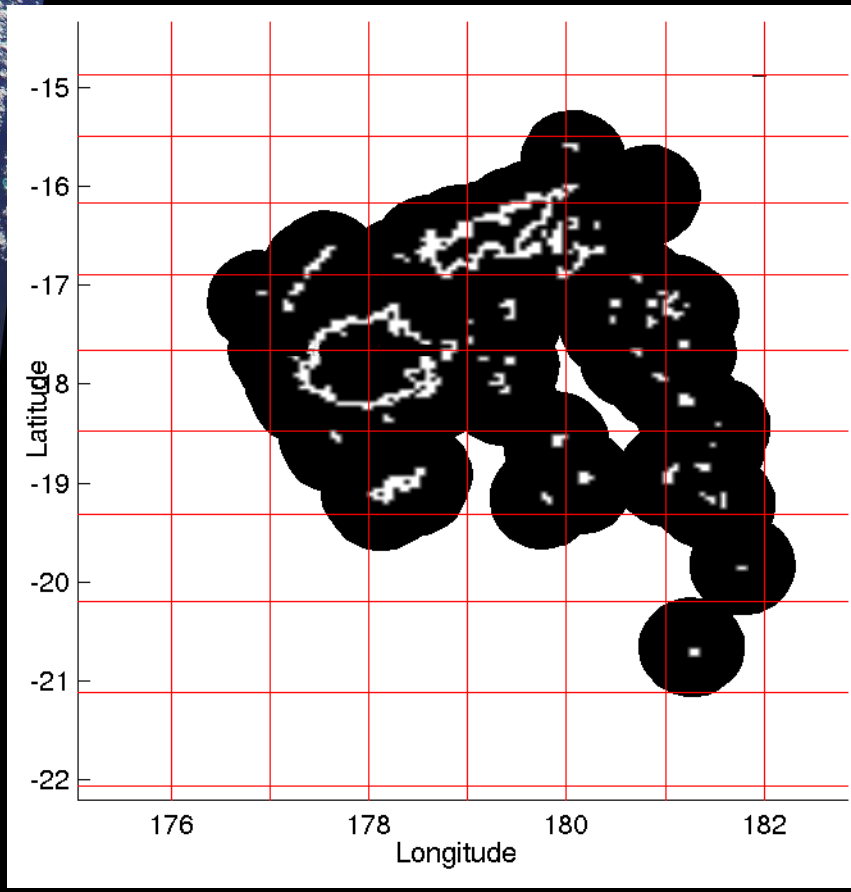


Fiji's Coastline as Determined by GLOBE 30" DEM

Source: NASA's the Visible Earth

Example: Fiji

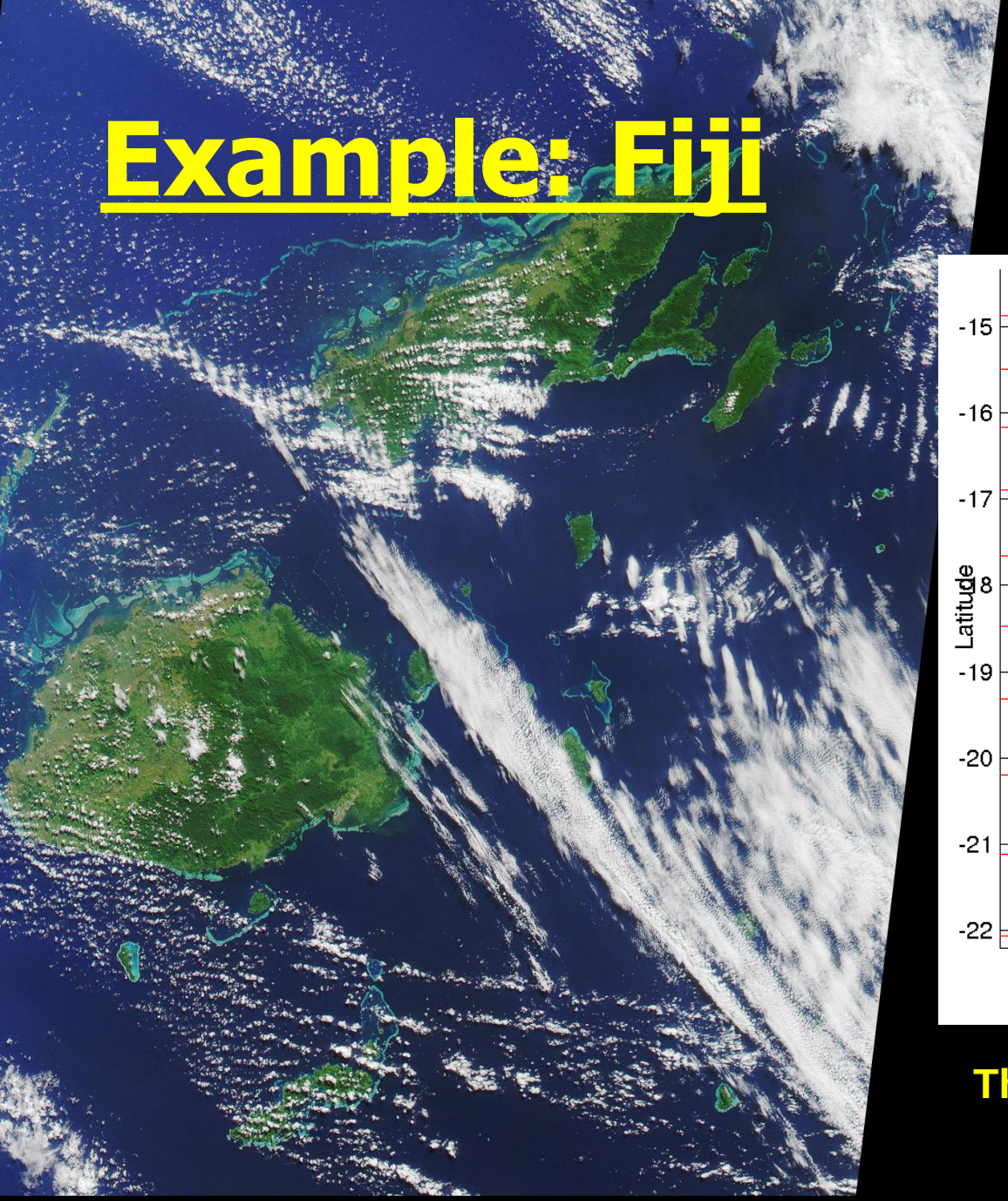


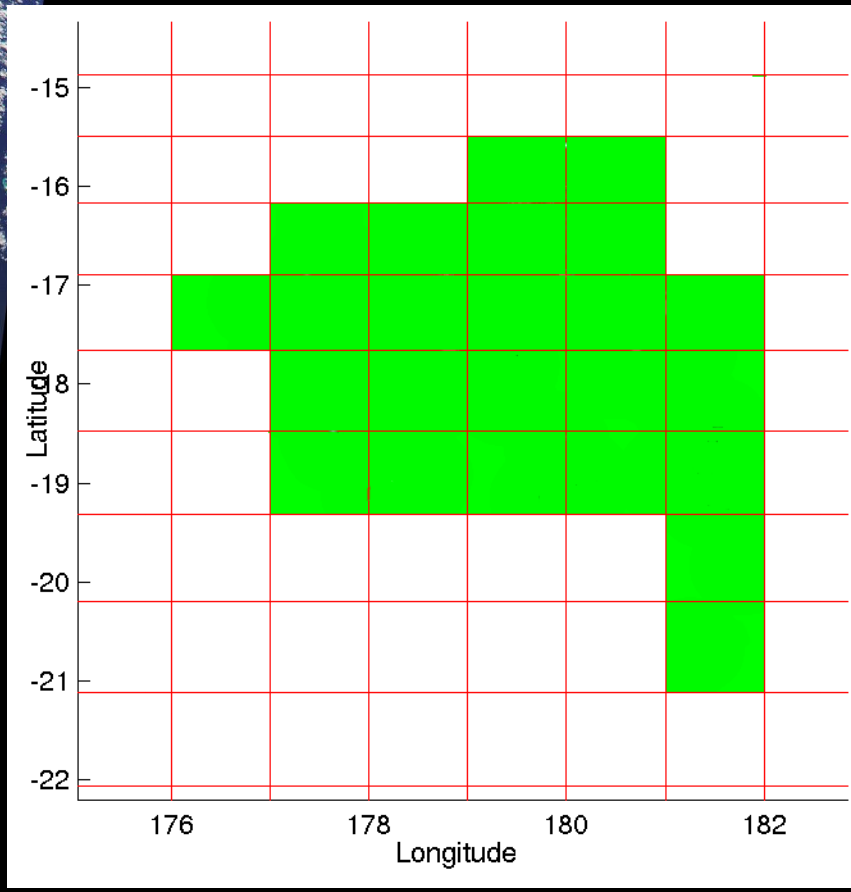


The Coastline Surrounded by 30 Nautical Mile Sighting Circles

Source: NASA's the Visible Earth

Example: Fiji





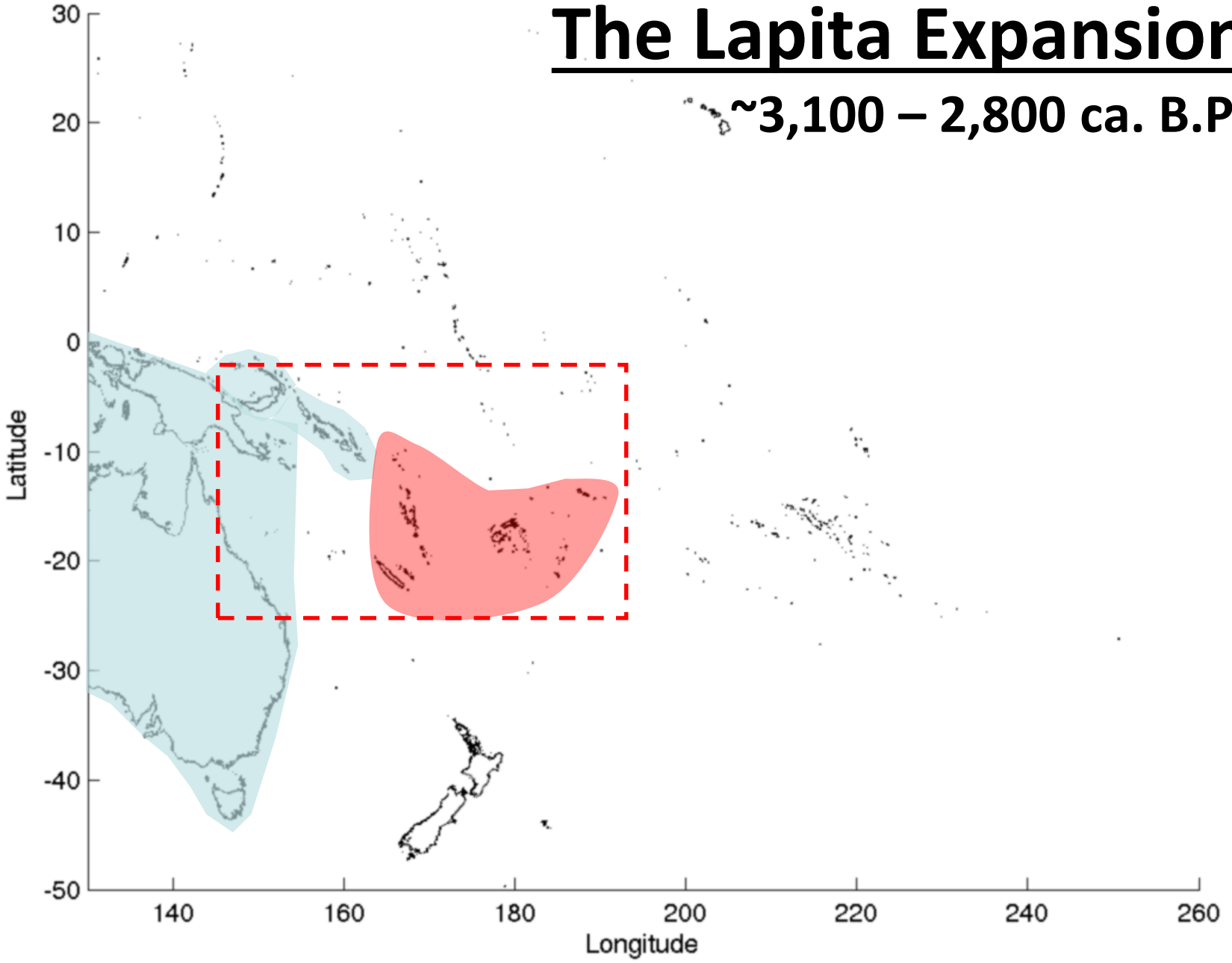
The Selected Grid Cells

Source: NASA's the Visible Earth

Specific Focus:
The Lapita Expansion

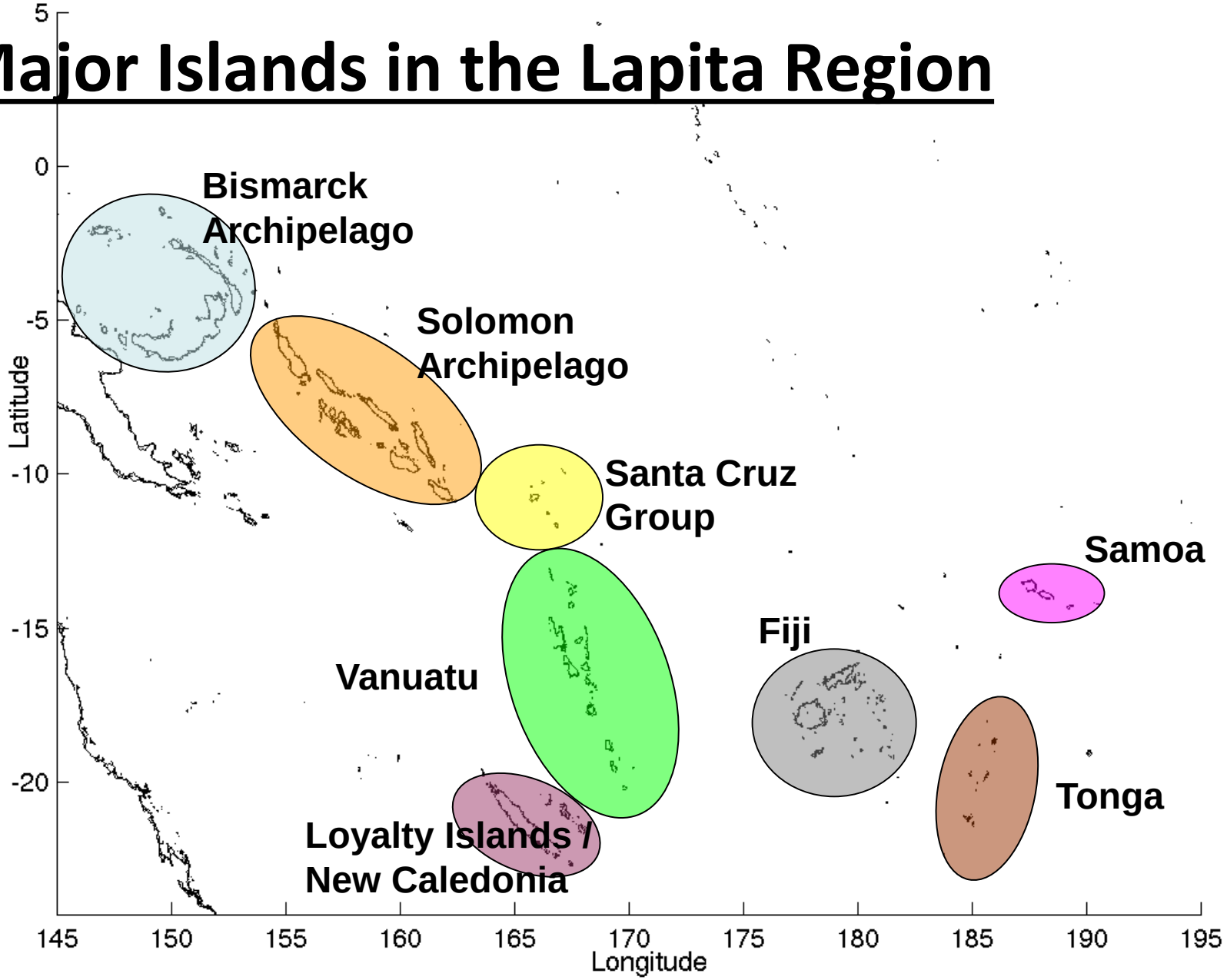
The Lapita Expansion

~3,100 – 2,800 ca. B.P.

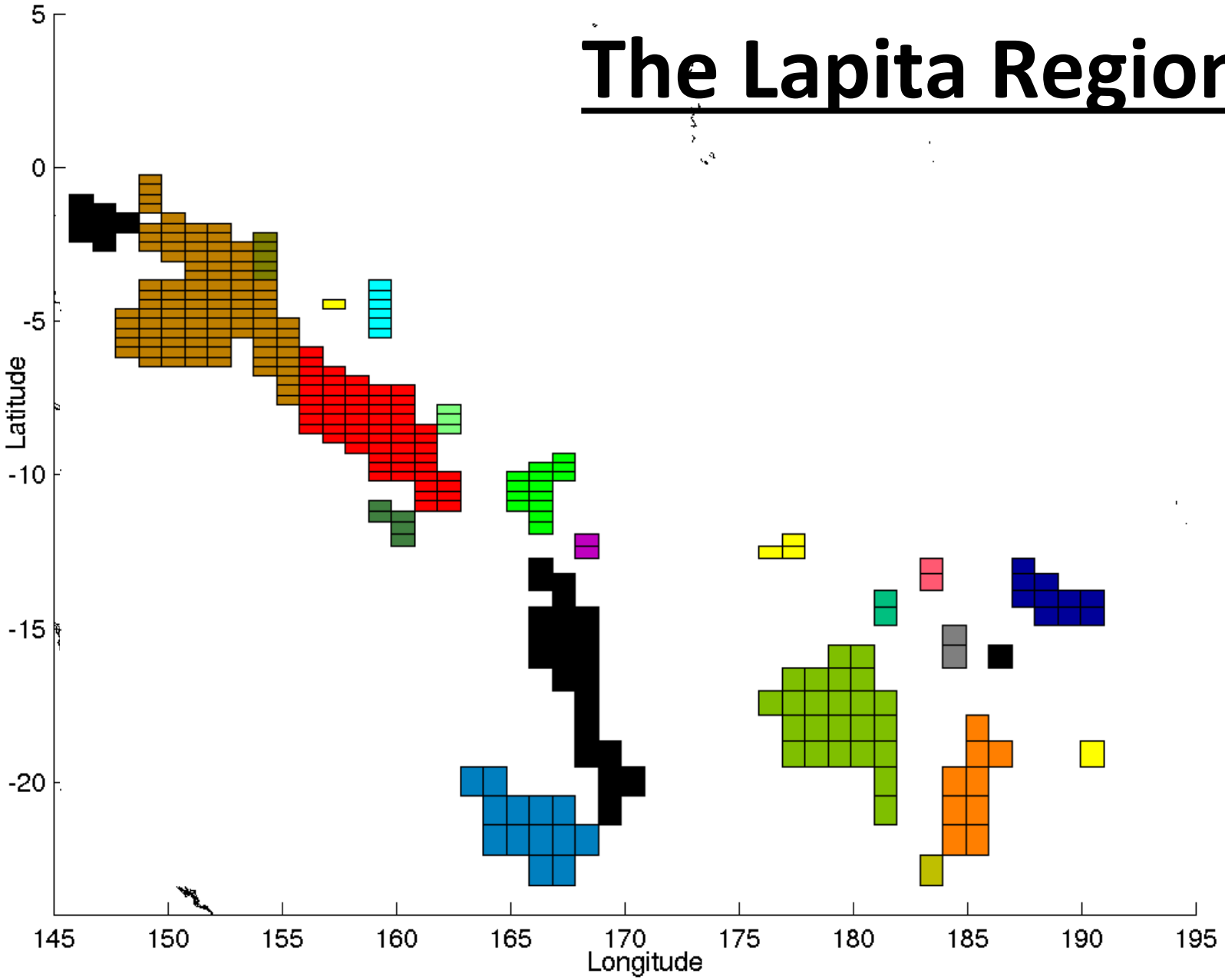


Map generated with Globe 30 “ DEM

Major Islands in the Lapita Region



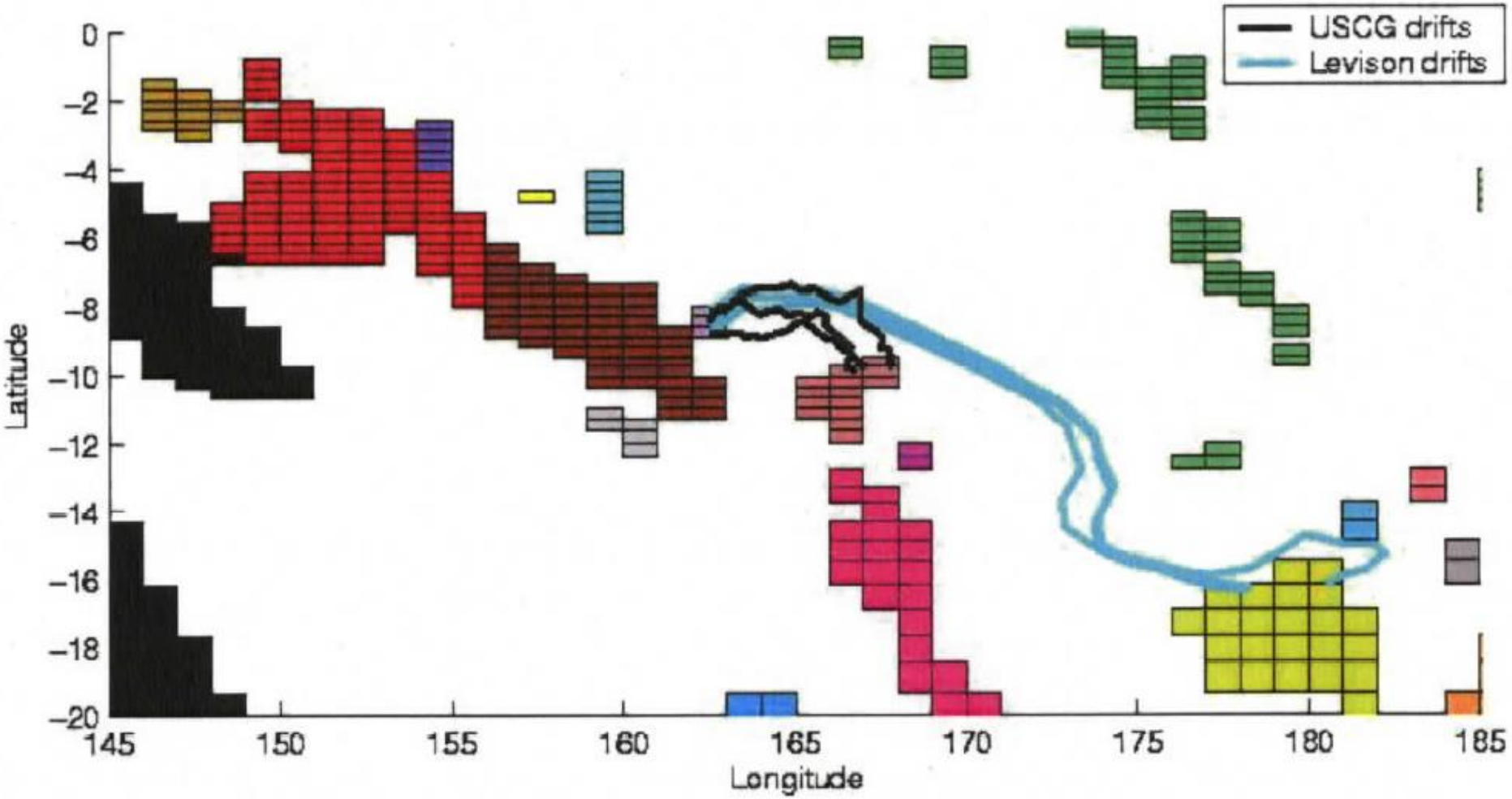
The Lapita Region



Simulation Conditions

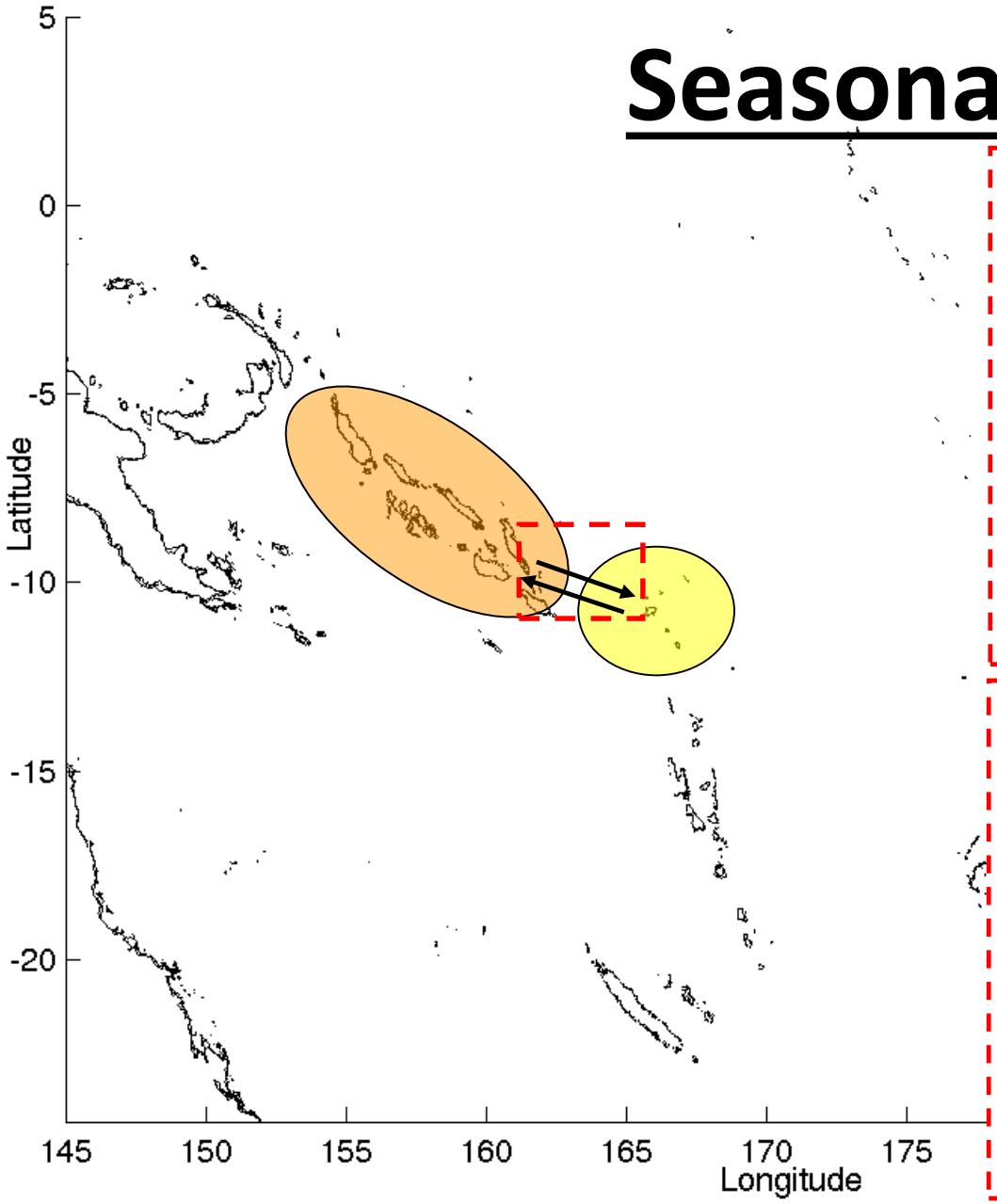
- Drifters / sailors start every 7 days for 12 years using data from 1993-2005.
- Voyages *stop* when vessels encounter land and otherwise last for up to 90 days.
- Take 5 % probability as threshold condition for probable crossings.

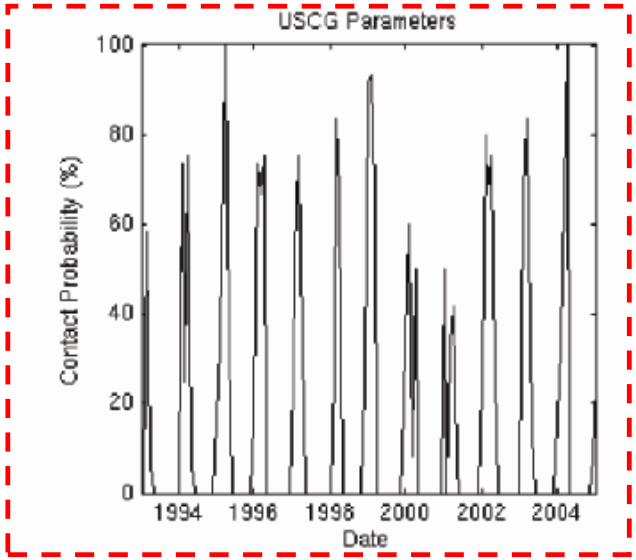
Sample Drifts

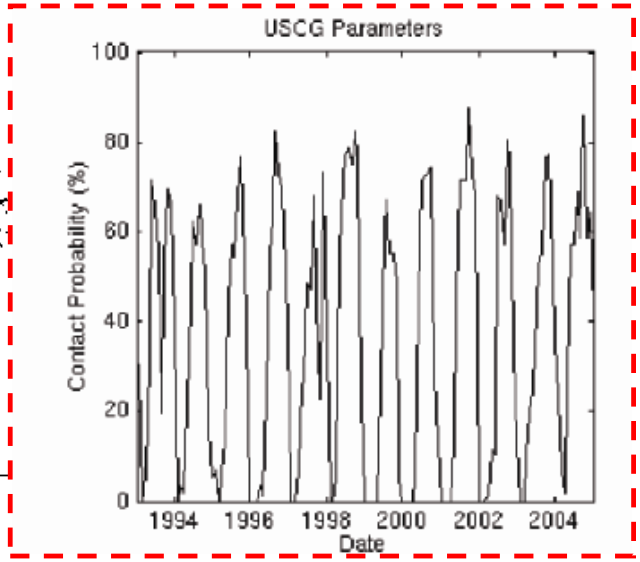


Results: Lapita Expansion

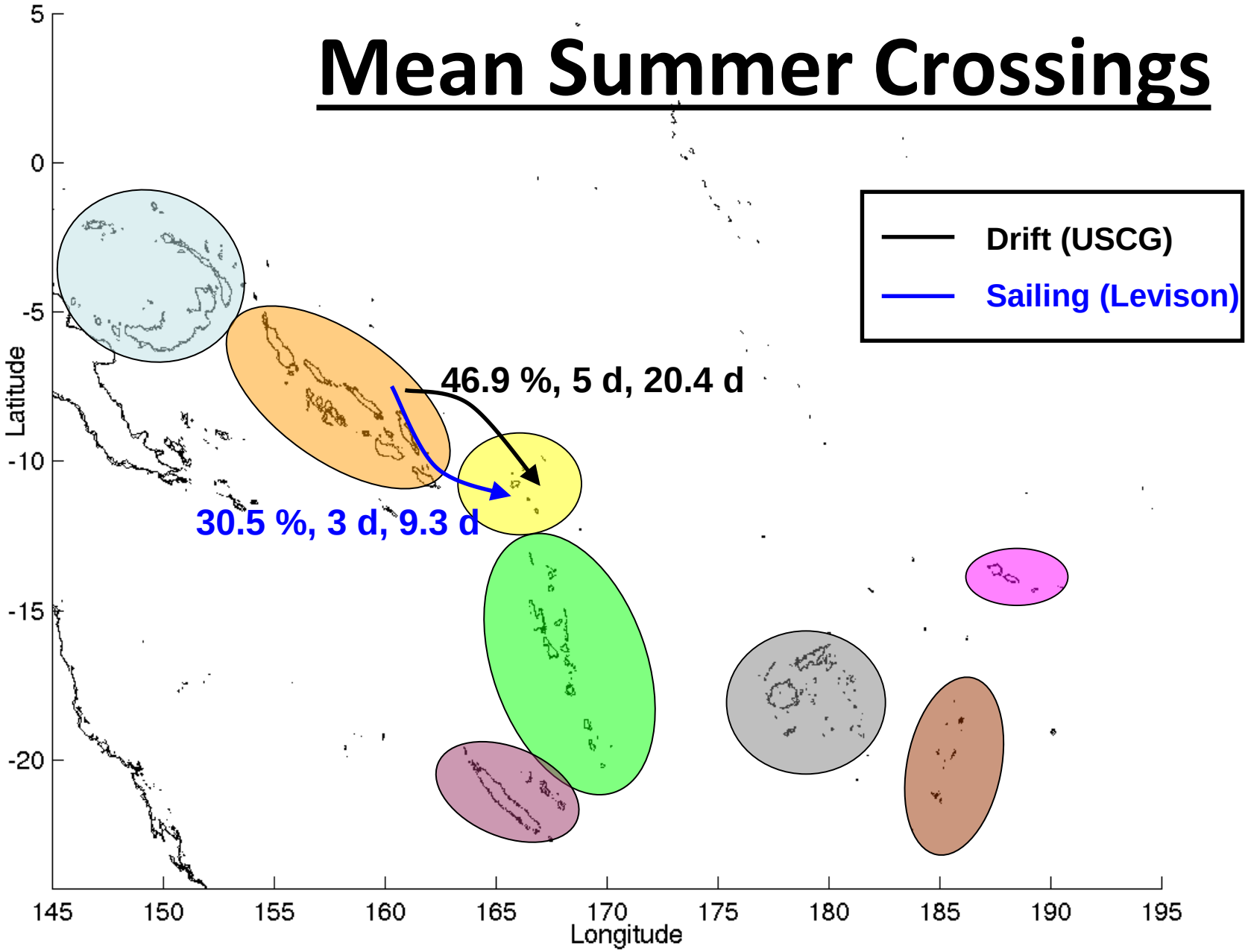
Seasonal Variability



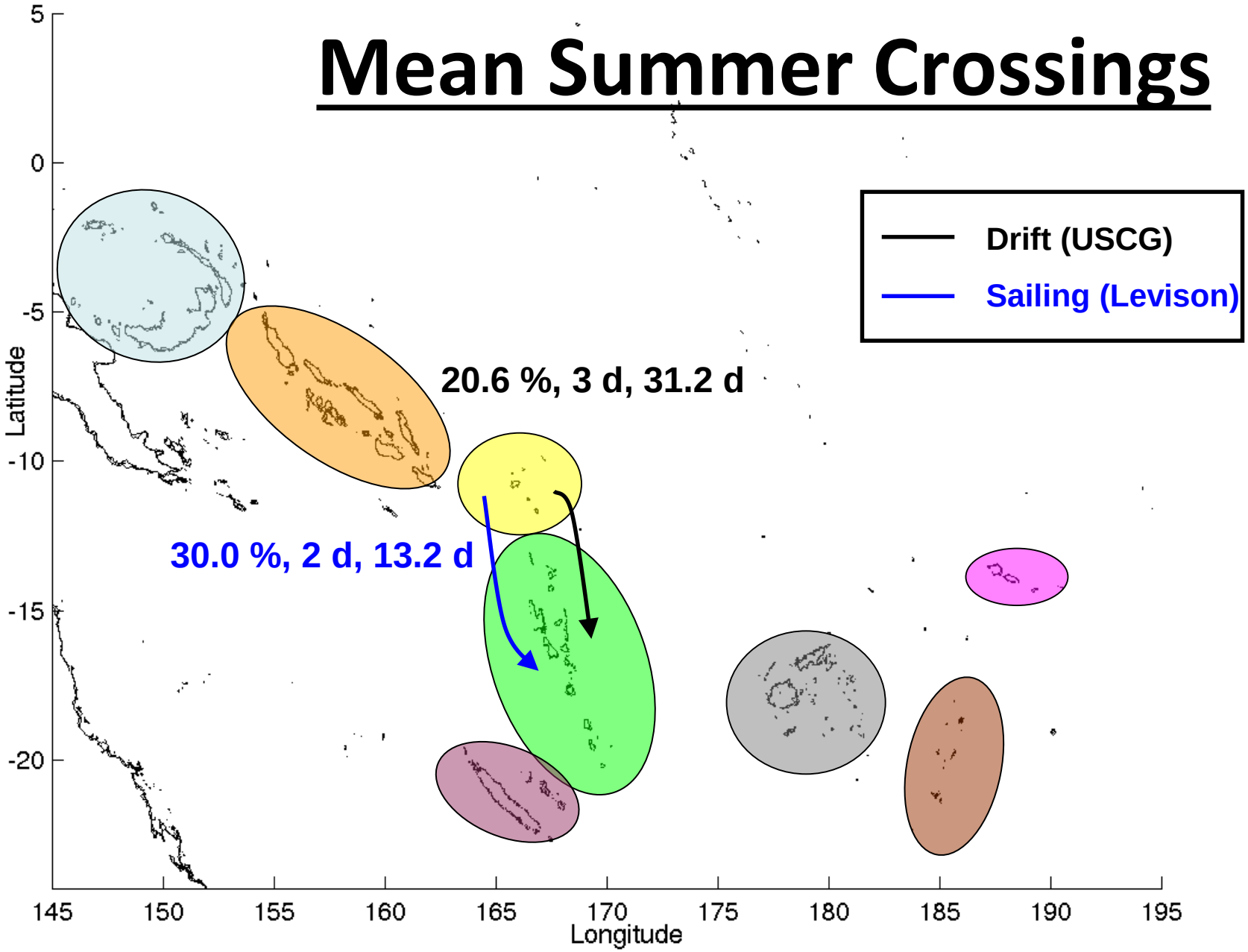




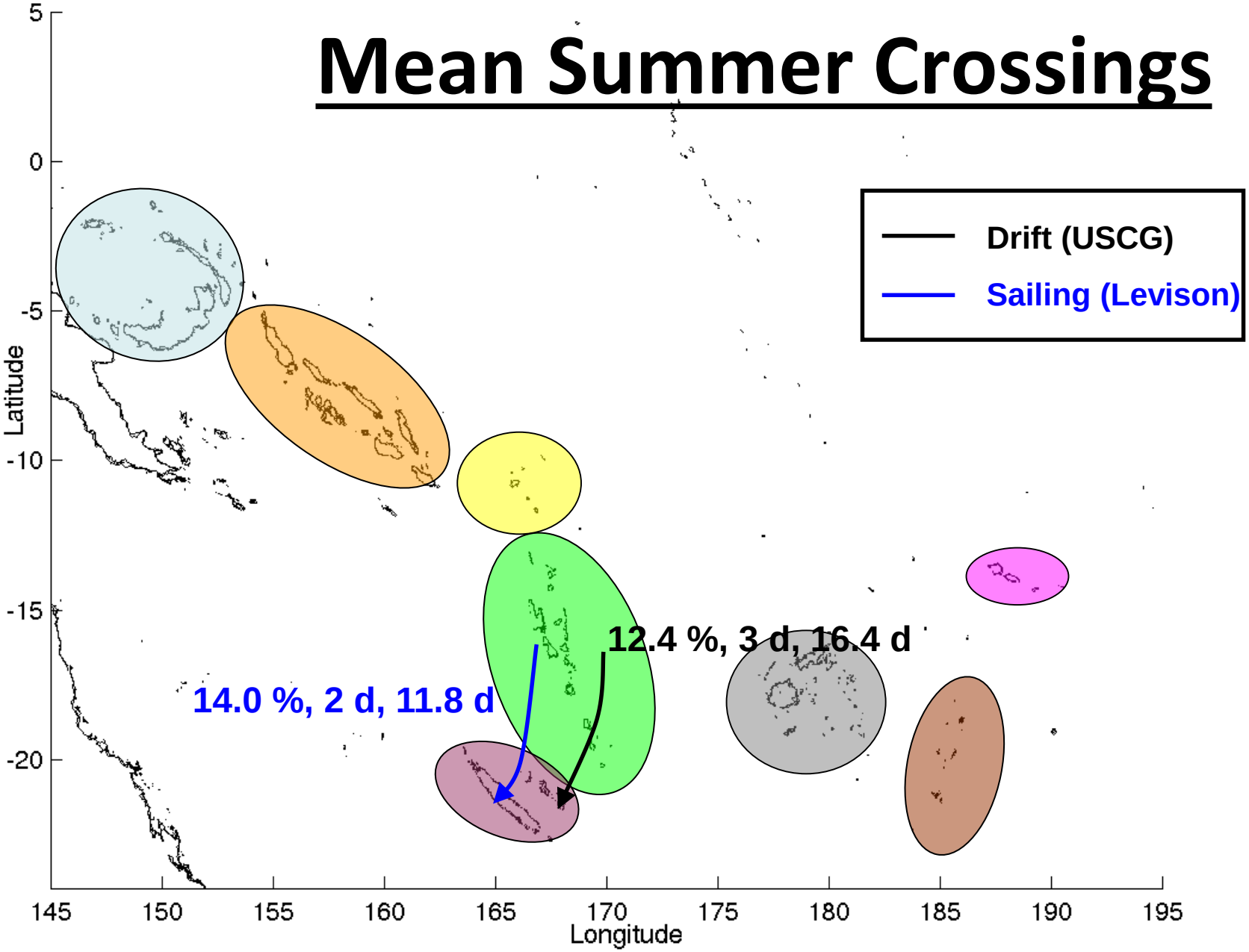
Mean Summer Crossings



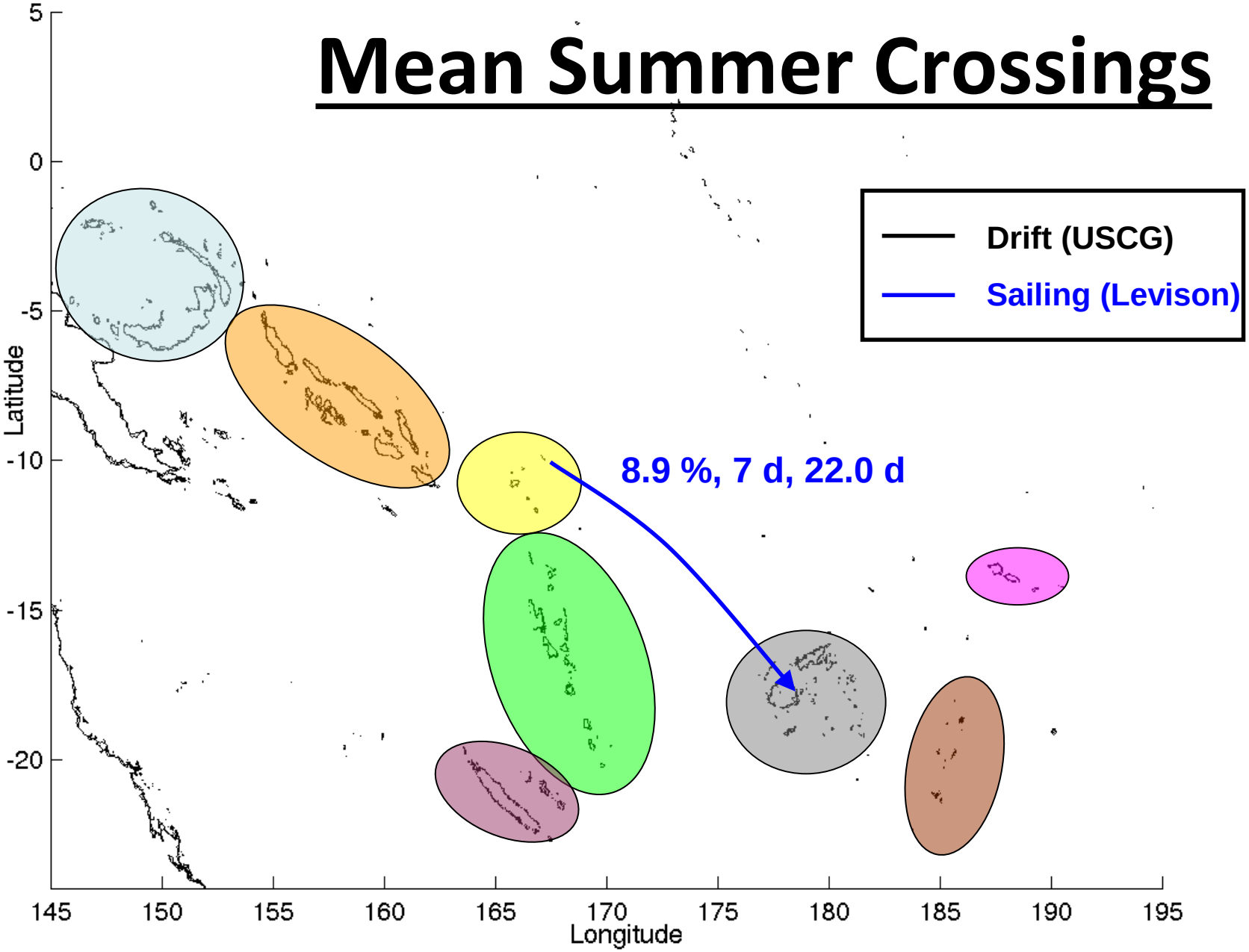
Mean Summer Crossings



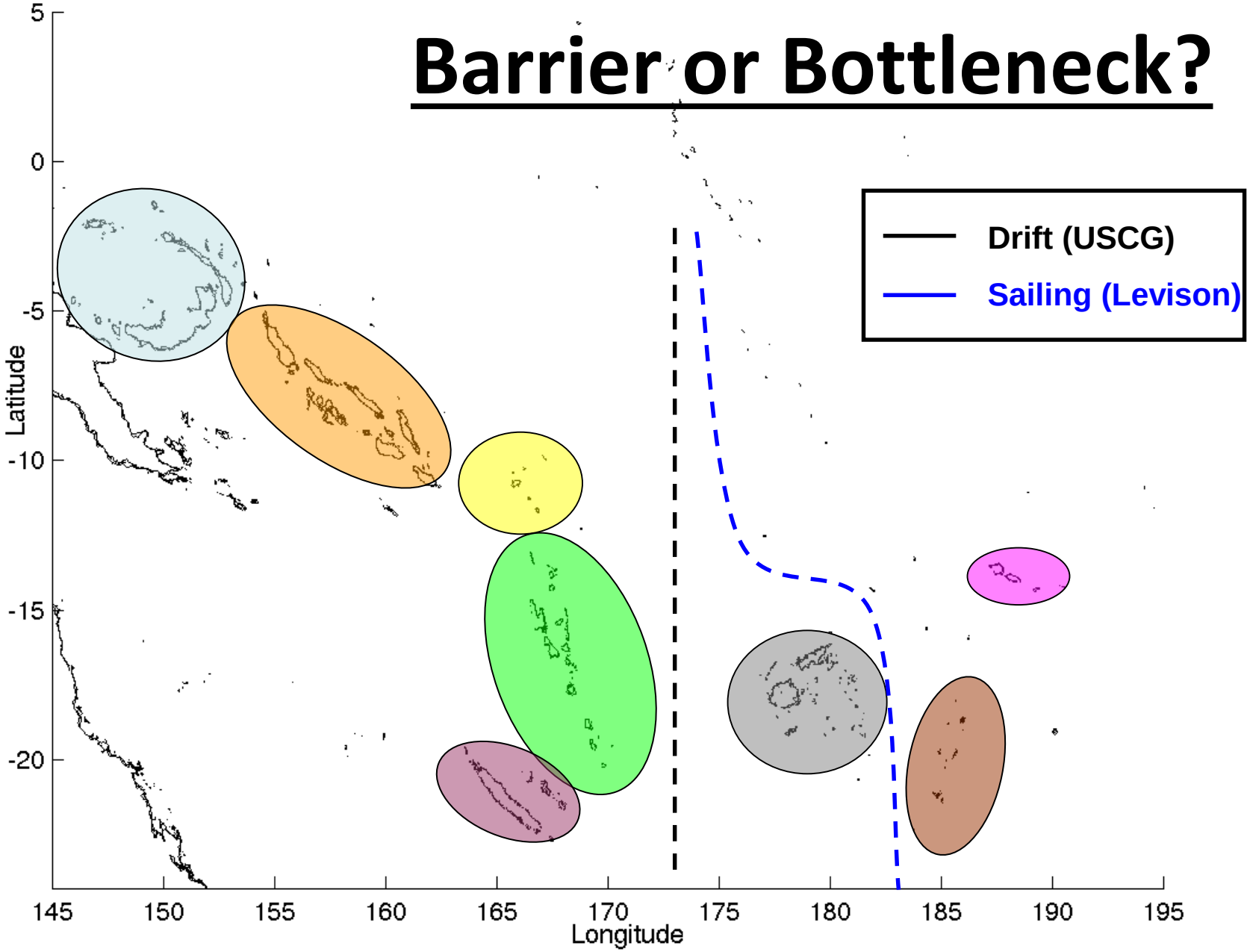
Mean Summer Crossings



Mean Summer Crossings

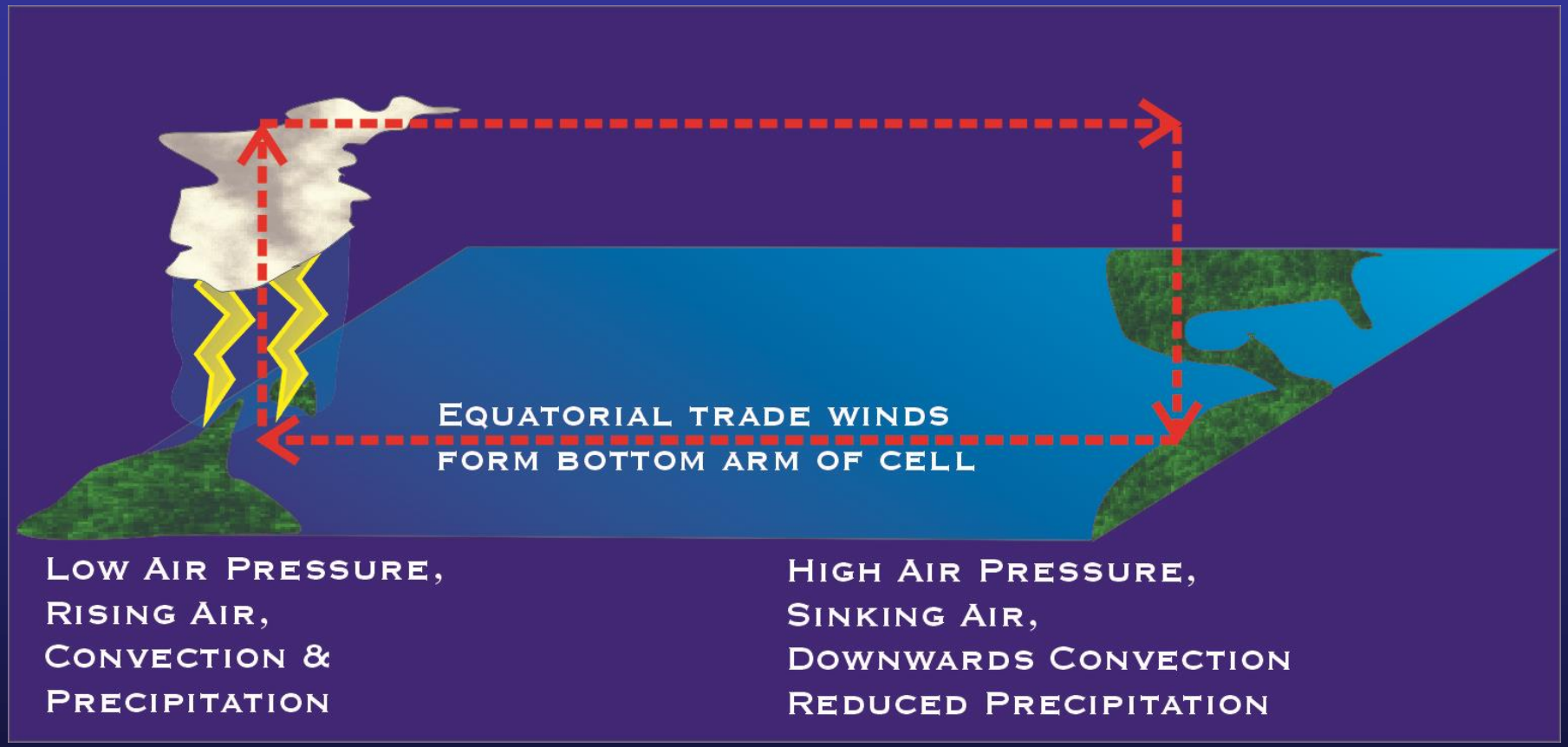


Barrier or Bottleneck?



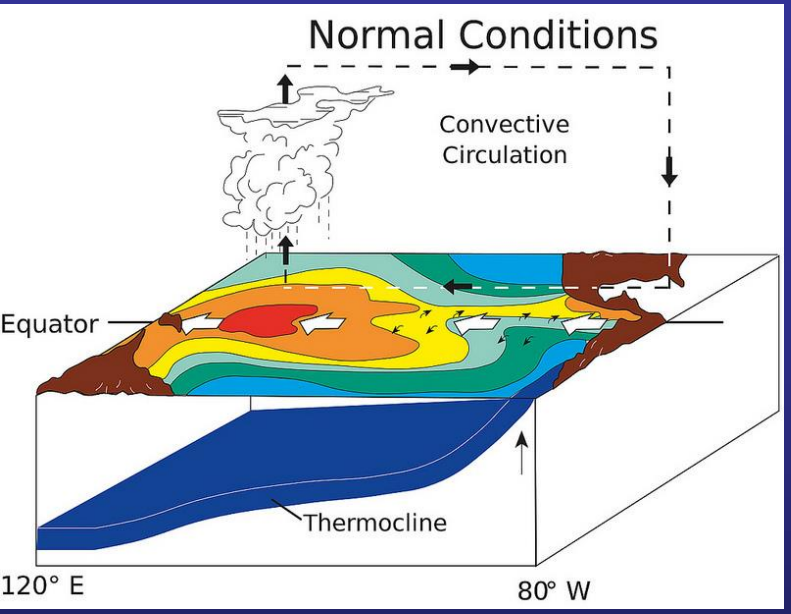
El Nino Years

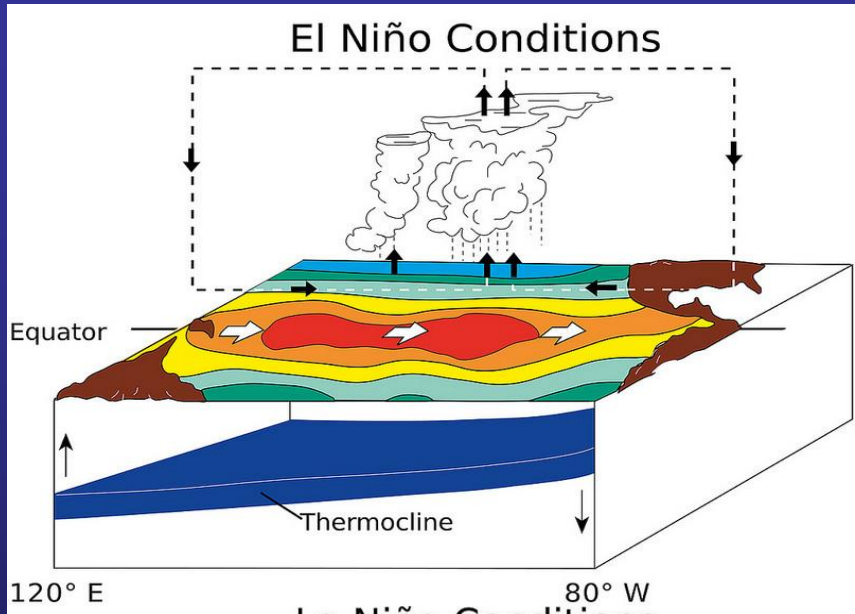
El Niño: Interannual Variability



The Walker Circulation: 'Normal Conditions'

El Nino and La Nina



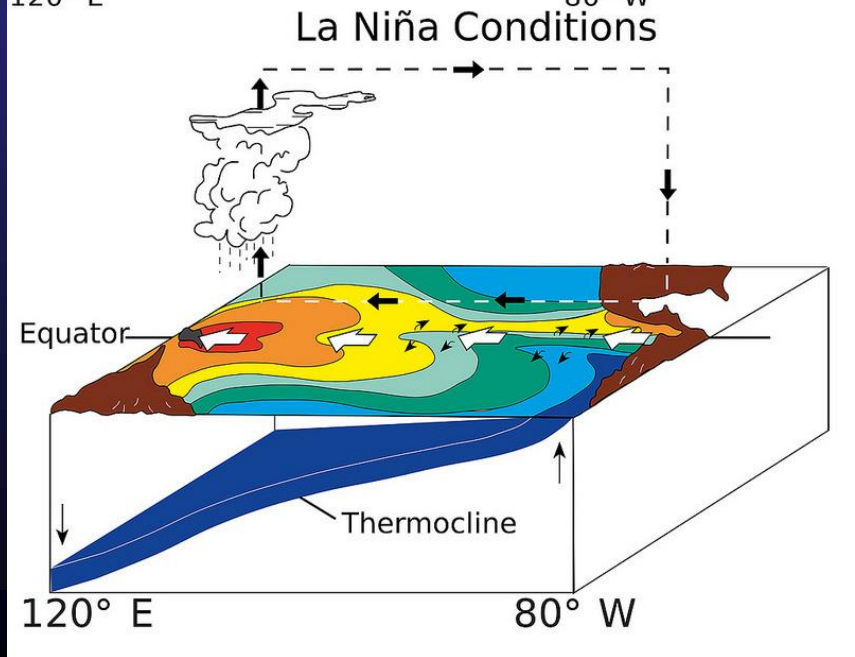


El Niño: Floods, Heavy Rains, huge effect on anchovy fishery in E. Pac.

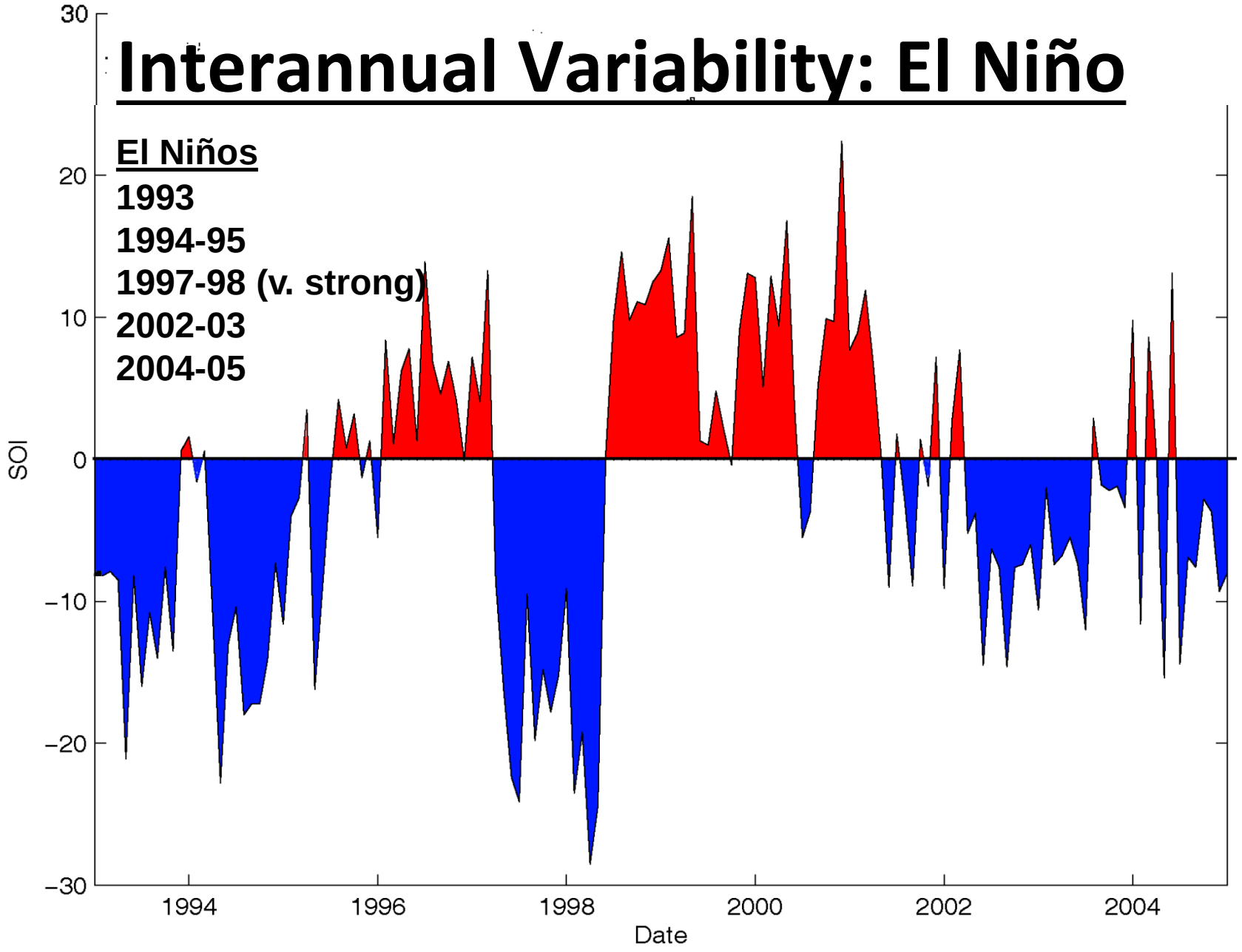
Severe droughts, wild fires, monsoons affected in W. Pac.

Reverse effects during La Niña events

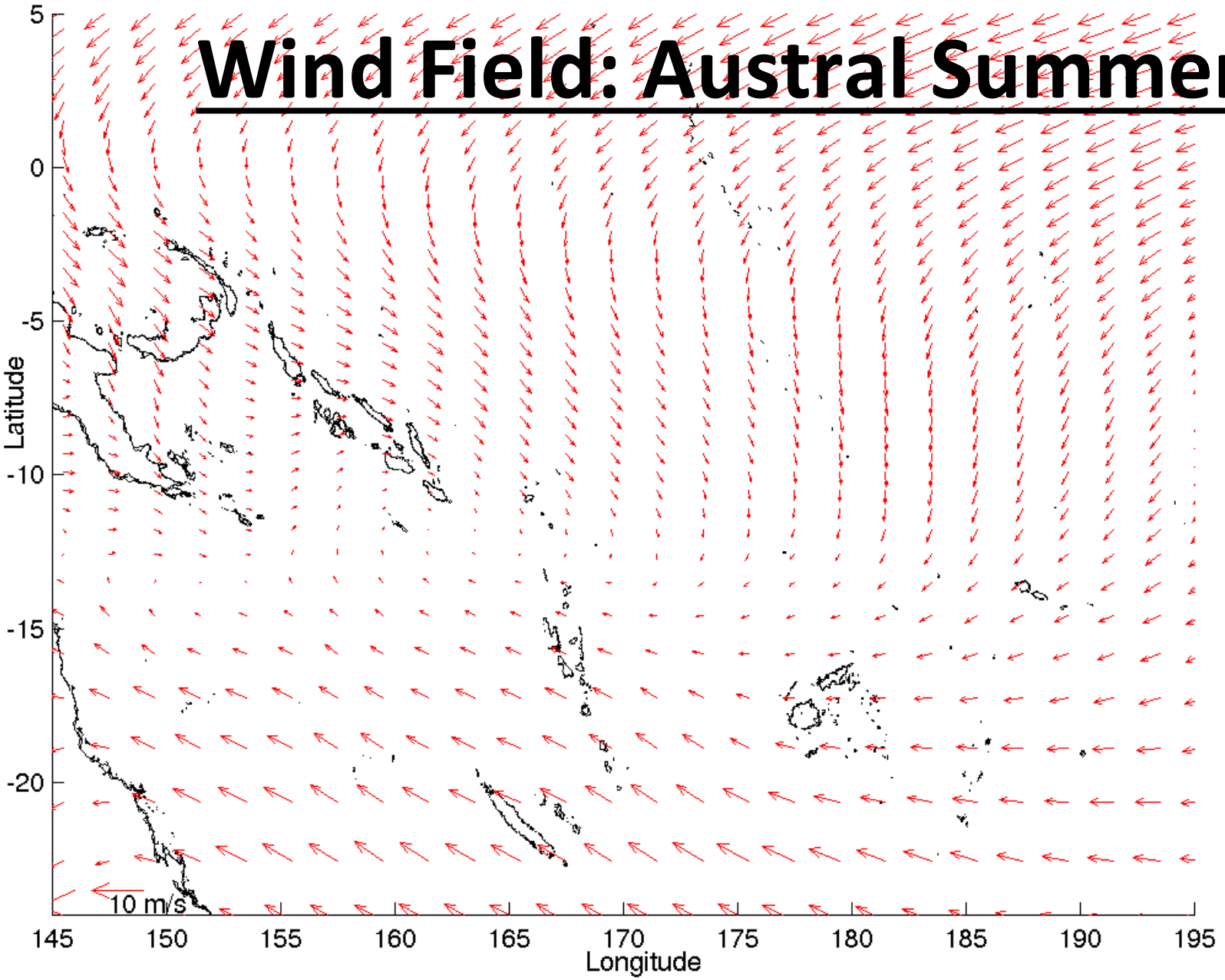
- **Conditions around the world may also be affected via *teleconnections***



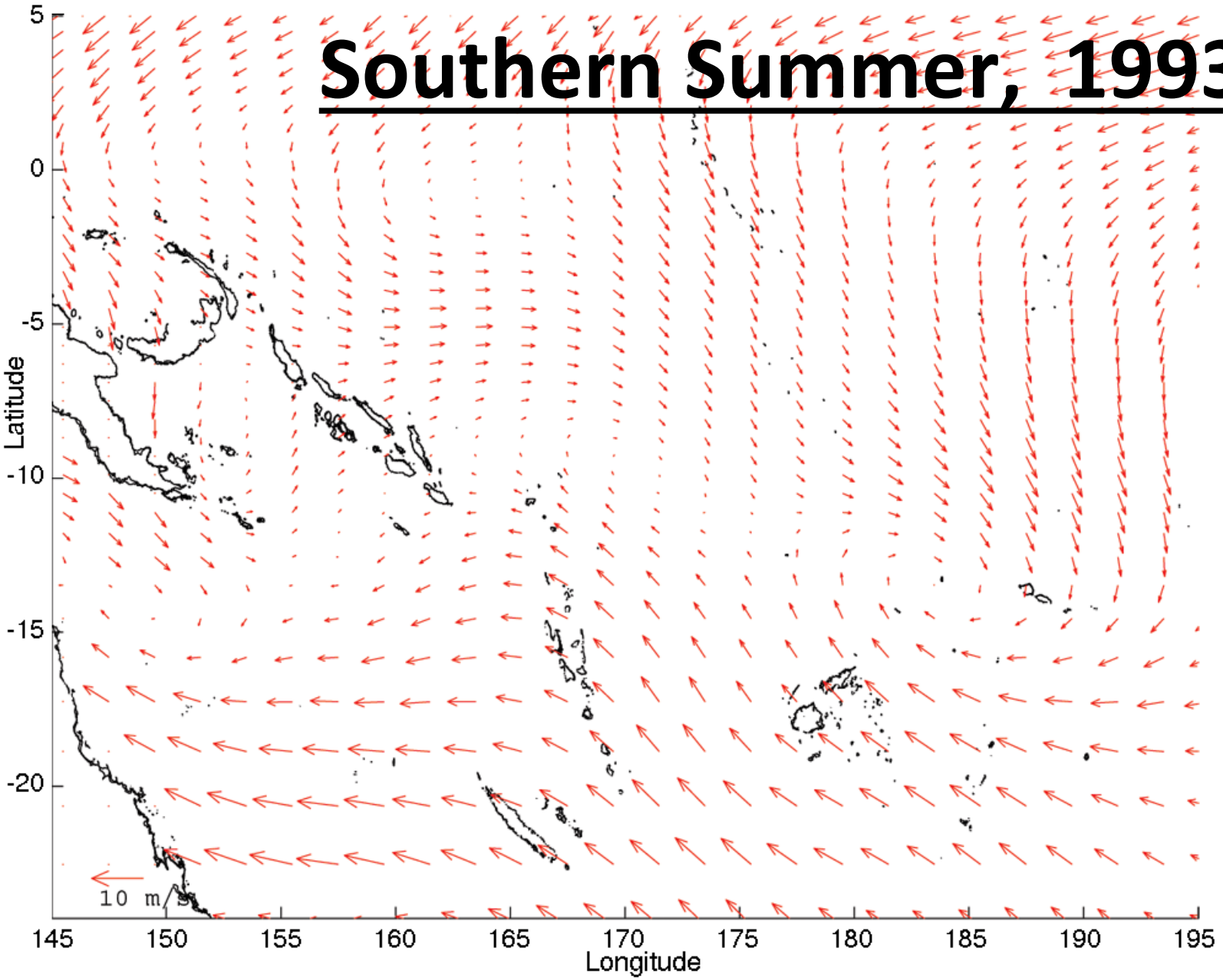
Interannual Variability: El Niño



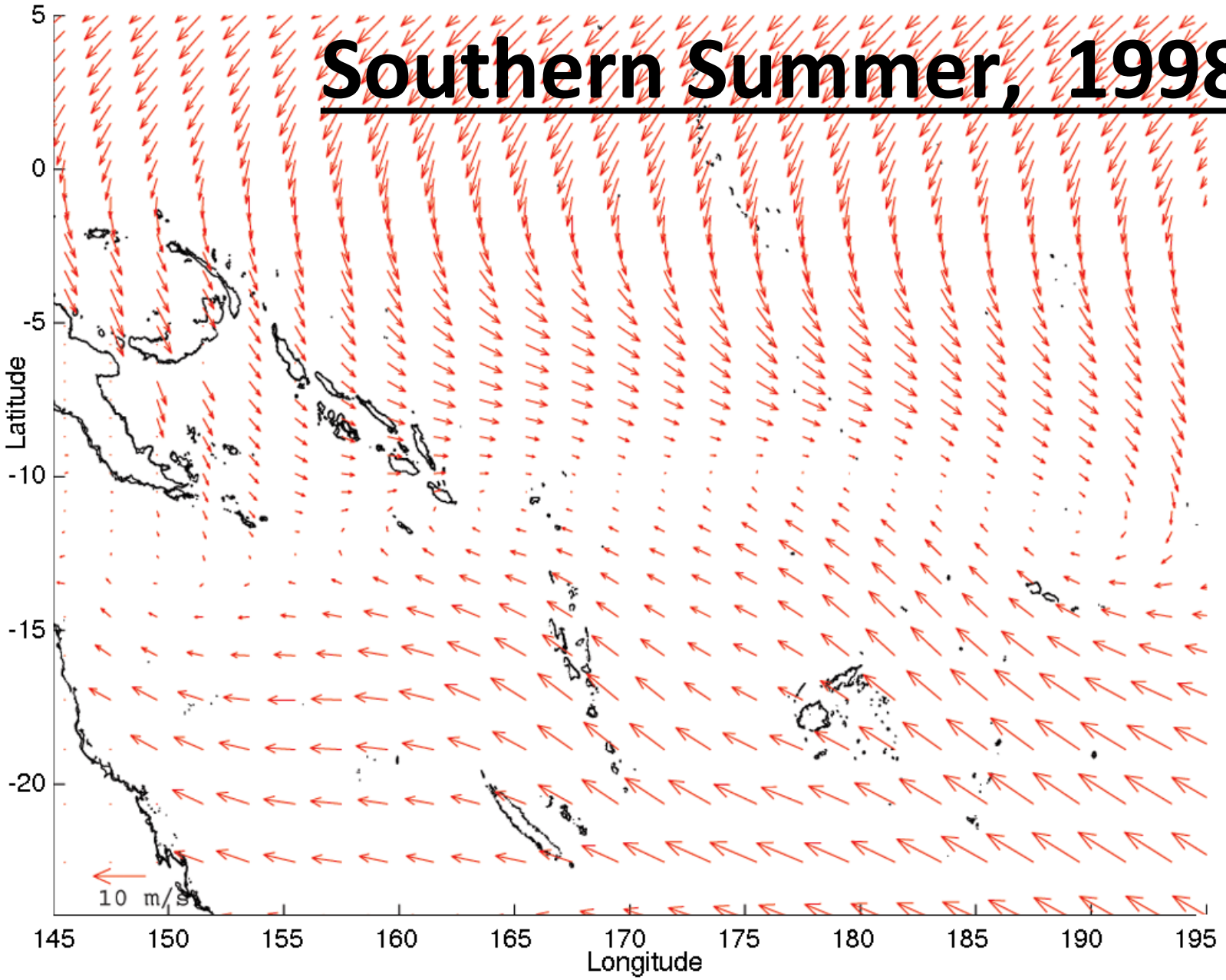
Wind Field: Austral Summer



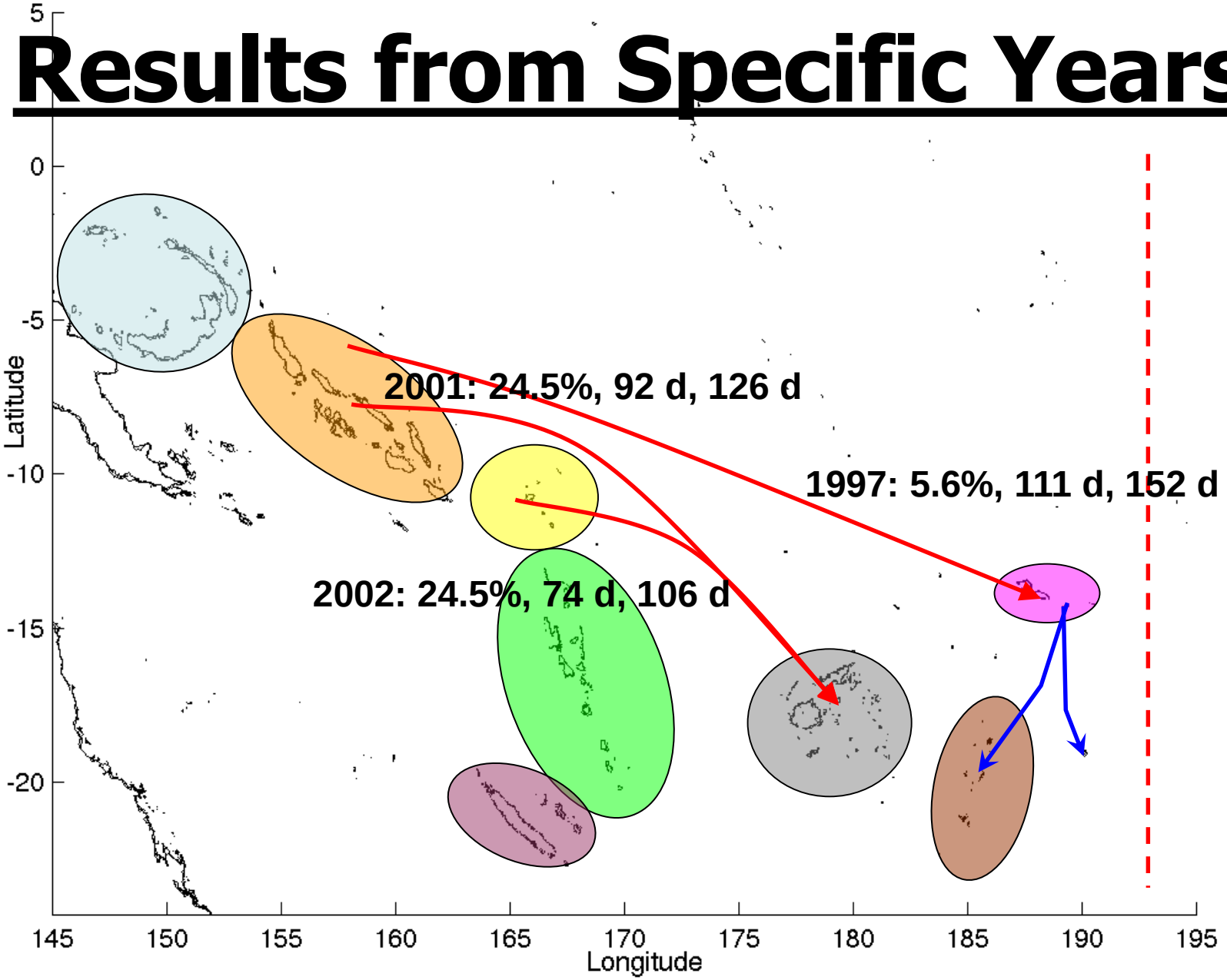
Southern Summer, 1993



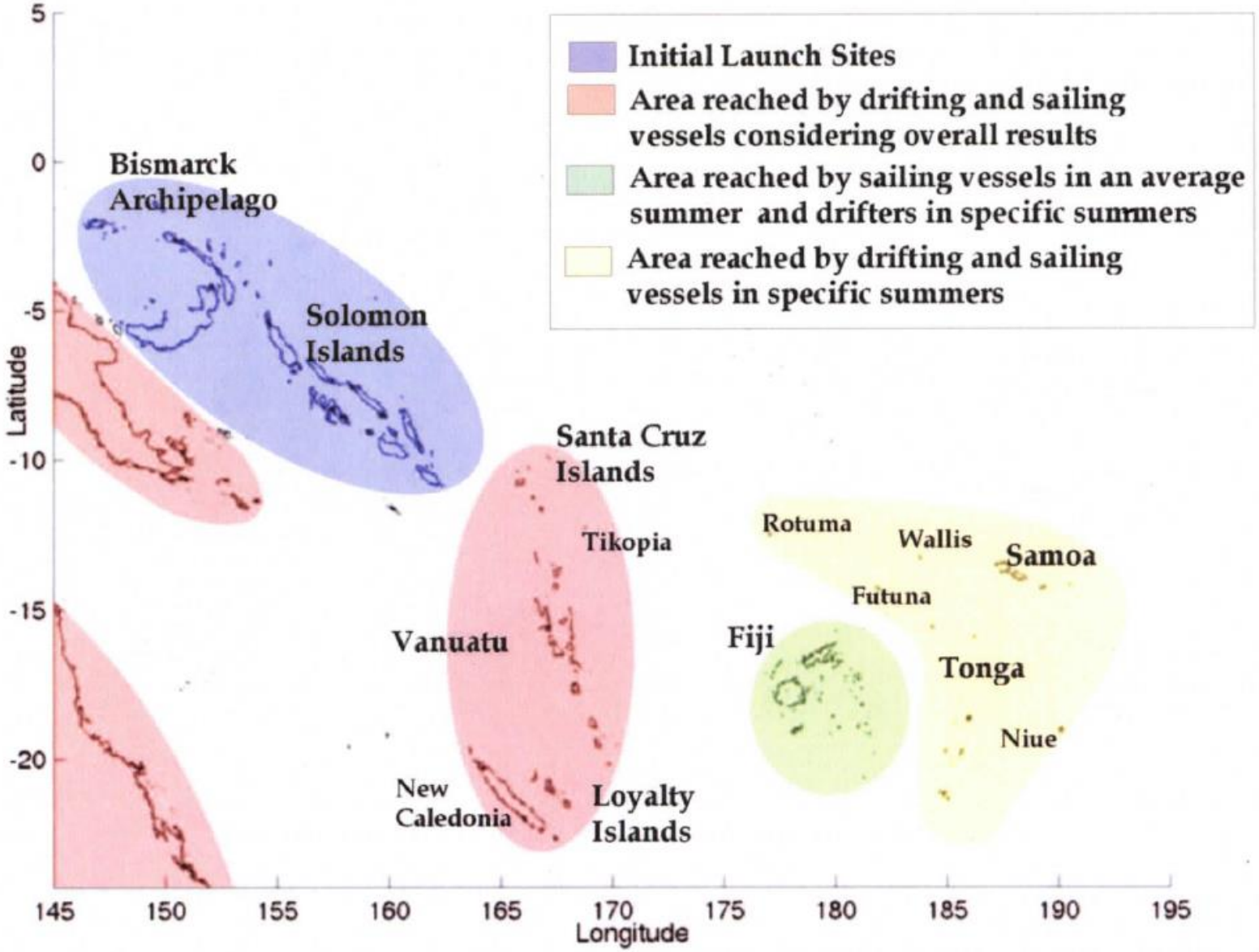
Southern Summer, 1998



Results from Specific Years



Summary


Initial Launch Sites
Area reached by drifting and sailing vessels considering overall results
Area reached by sailing vessels in an average summer and drifters in specific summers
Area reached by drifting and sailing vessels in specific summers
Bismarck Archipelago
Solomon Islands
Santa Cruz Islands
Tikopia
Vanuatu
New Caledonia
Loyalty Islands
Rotuma
Wallis
Samoa
Futuna
Fiji
Tonga
Niue
Latitude
Longitude
5
0
-5
-10
-15
-20
145
150
155
160
165
170
175
180
185
190
195

Significance?

- Interannual variability important in facilitating key crossings
- Major portion of the important variability associated with El Niño
- No advanced sailing strategies needed to account for discovery of islands in Lapita region
- A possible explanation for the long pause in eastward expansion?
- El Nino events are highly variable…

Prehistoric maritime migration in the Pacific islands: an hypothesis of ENSO forcing.

(Anderson et. al, 2006)

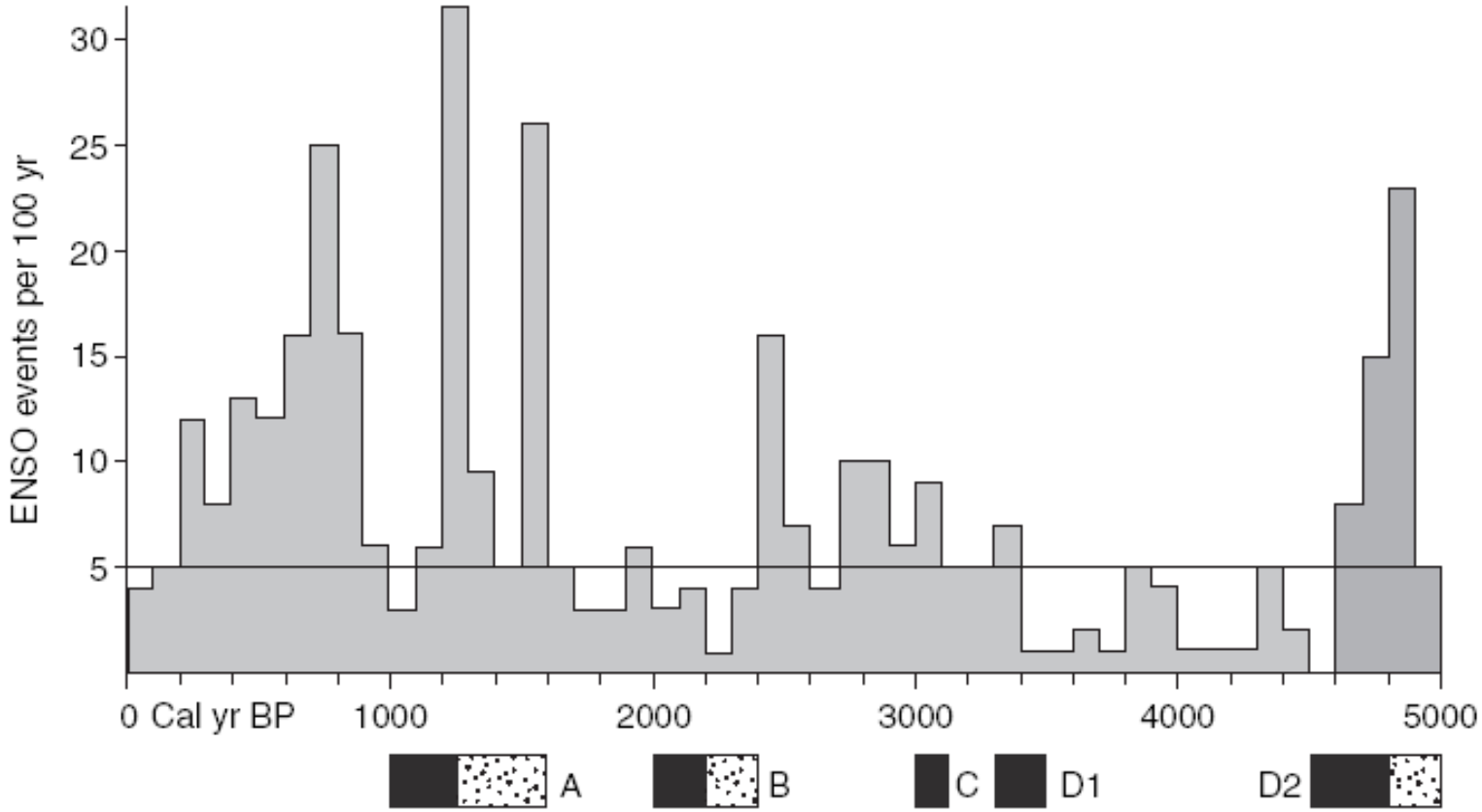


Figure 3 Late Holocene human migration and ENSO frequency. The solid line at 5 indicates threshold frequency to produce ENSO-band variance (data: NOAA/NGDC Paleoclimatology Program web site: http://www.ngdc.noaa.gov/paleo/pubs/moy2002, last accessed 19 October 2005). Migration phases: A, East Polynesia; B, Central Micronesia and marginal West Polynesia; C, Remote Oceanic Lapita; D1 and D2, West Micronesia by archaeological and palaeoenvironmental data, respectively. Migration phase bars show the range of early radiocarbon date medians as solid shading and the possible earlier range of migration (stippled) in the phase if ENSO activity was a major factor