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  `https://github.com/julianmak/academic-notes`

  The repository principally contains the compiled products rather than the source for size reasons.
- Associated Python code (as Jupyter notebooks mostly) will be held on the same repository. The source data however might be big, so I am going to be naughty and possibly just refer you to where you might get the data if that is the case (e.g. JRA-55 data). I know I should make properly reproducible binders etc., but I didn't...
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OCES 3301 :

basic Data Analysis in ocean sciences

Session 2: basic manipulations and statistics

Outline

(Just overview here; for actual content see Jupyter notebooks)

- basic stats with basic example
- El Nino 3.4 SST data

  $\rightarrow$ demonstration of data

  $\rightarrow$ overview

  $\rightarrow$ some plotting + exercises

Basic stats

Suppose I have some data samples as the following:

$$x_i = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

- **sample size** N, the number of samples
- **range**, largest minus smallest of sample
  $\rightarrow$ crude measure of spread

averages (but actually three of these):

1. **mode**, most frequent occurrence
2. **median**, rank these, and find the middle one
3. **mean**, THE average

Basic stats

$$x_i = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

- **lower/upper (25/75 percent) quartile**, rank data, value at which 25/75 percent of data lie below
- **inter-quartile range**, the different between upper and lower quartile

  $\rightarrow$ measures spread

Basic stats

Summary as a box-and-whisker plot

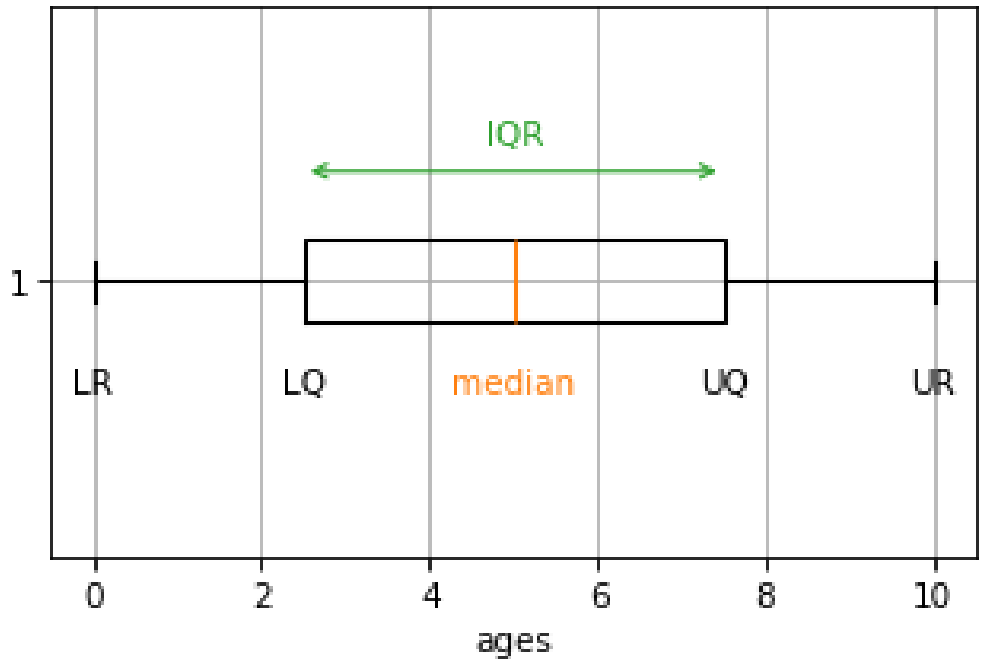


Figure: Nobel prize winning box plot.

Basic stats

$$x_i = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

- **mean**, THE average

$$\overline{x} = \frac{x_1 + x_2 + \ldots + x_N}{N} = \frac{1}{N} \sum_{i=1}^{N} x_i$$

$\rightarrow$ sum up, divide by number going into sum

Basic stats

$$x_i = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

- (unadjusted) **variance**

$$s^2 = \frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \ldots + (x_N - \bar{x})^2}{N} = \frac{1}{N} \sum_{i=1}^{N} (x_i - \bar{x})^2,$$

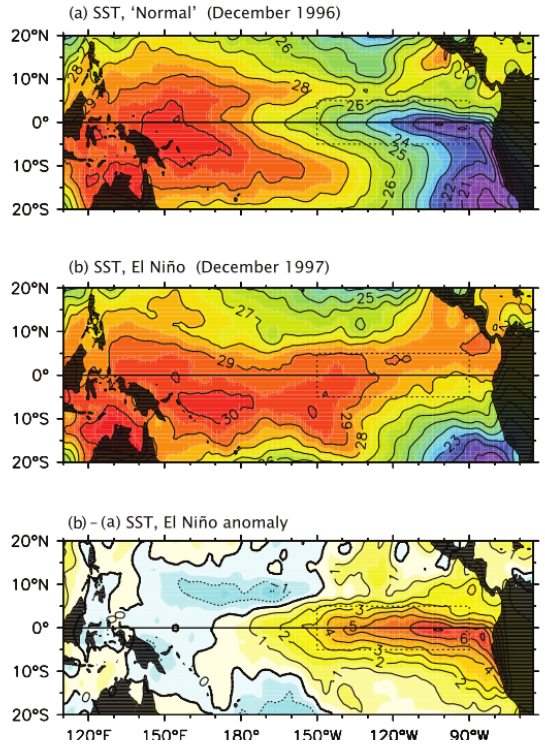
$\rightarrow$ take mean off sample, square each result, sum, divide by number going into sum

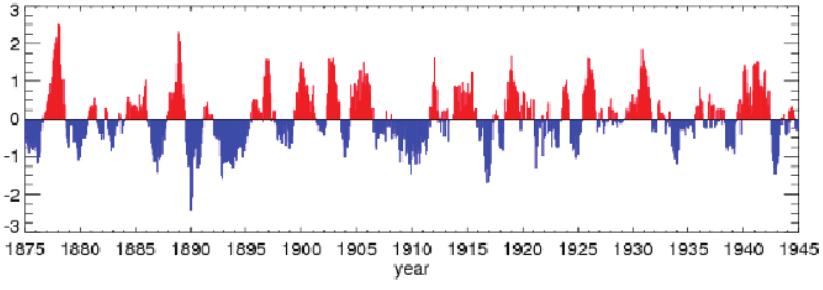
$\rightarrow$ square-root of variance is the **standard deviation** (**s.t.d.**)

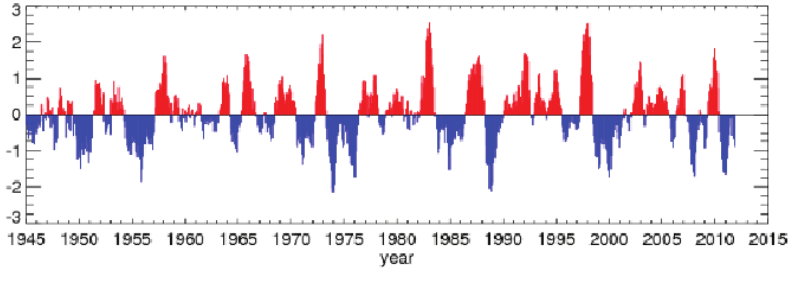
El-Niño (see also ENVS 3004; probably see also OCES 4001)

- "the little boy", known to fisherman in South America for a long time
- generally starts around Christmas time
- warming in Eastern equatorial Pacific ocean
- signal in SST in modern day

  → proxy data from **corals**







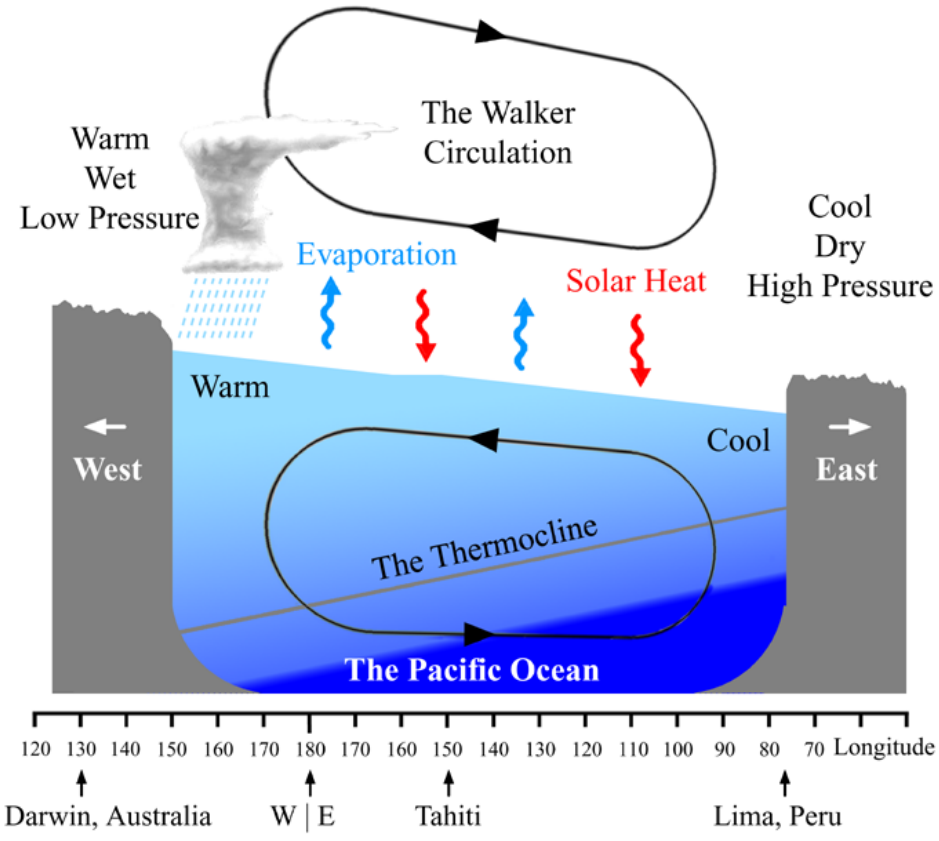
Southern Oscillation

- discovered by Gilbert Walker (1868–1958)

  → correlation with monsoon and thus famine and drought in India

  → Companion of the Order of the Star of India in 1911
- winds change directions periodically

  → Walker circulation changes (E-W, part of N-S Hadley circulation)



(Ocean heat source moving affects atmospheric circulation)

“Normal” + El-Niño event

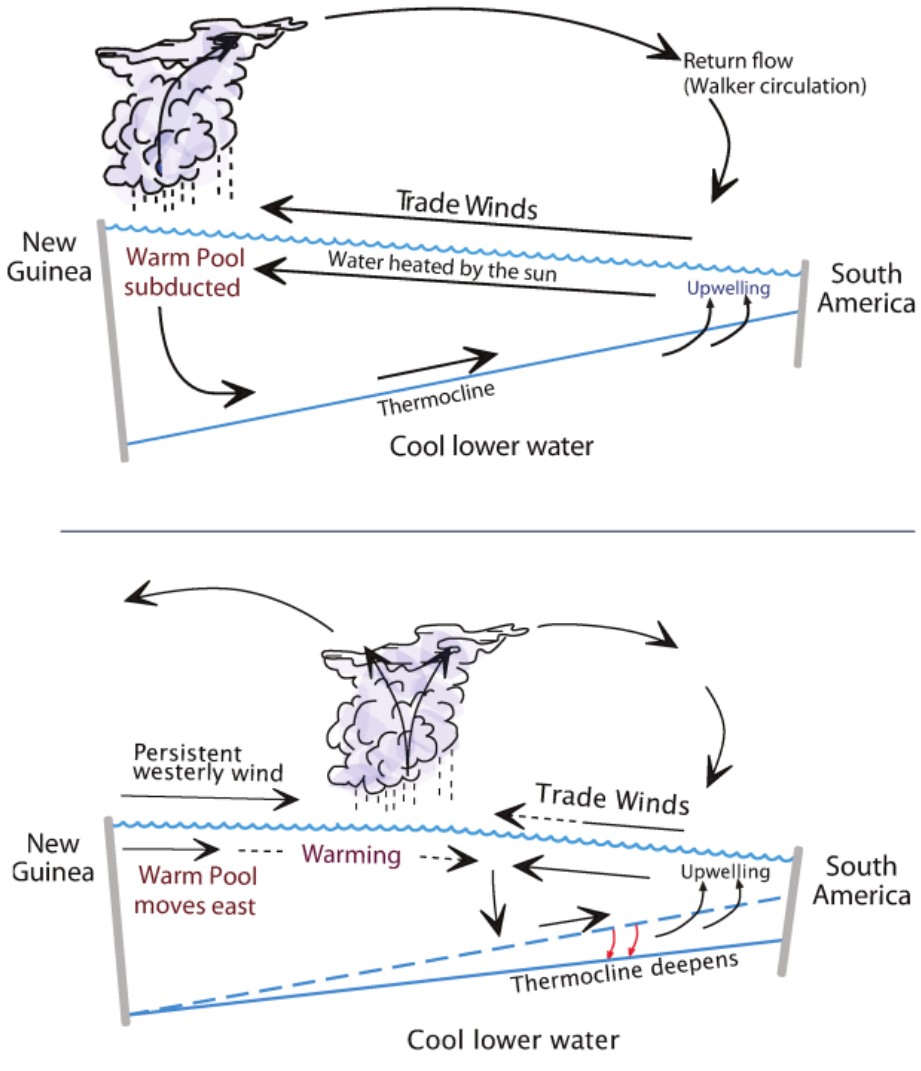


Figure: Schematic of ENSO, from Vallis (2019).

El-Niño 3.4 region

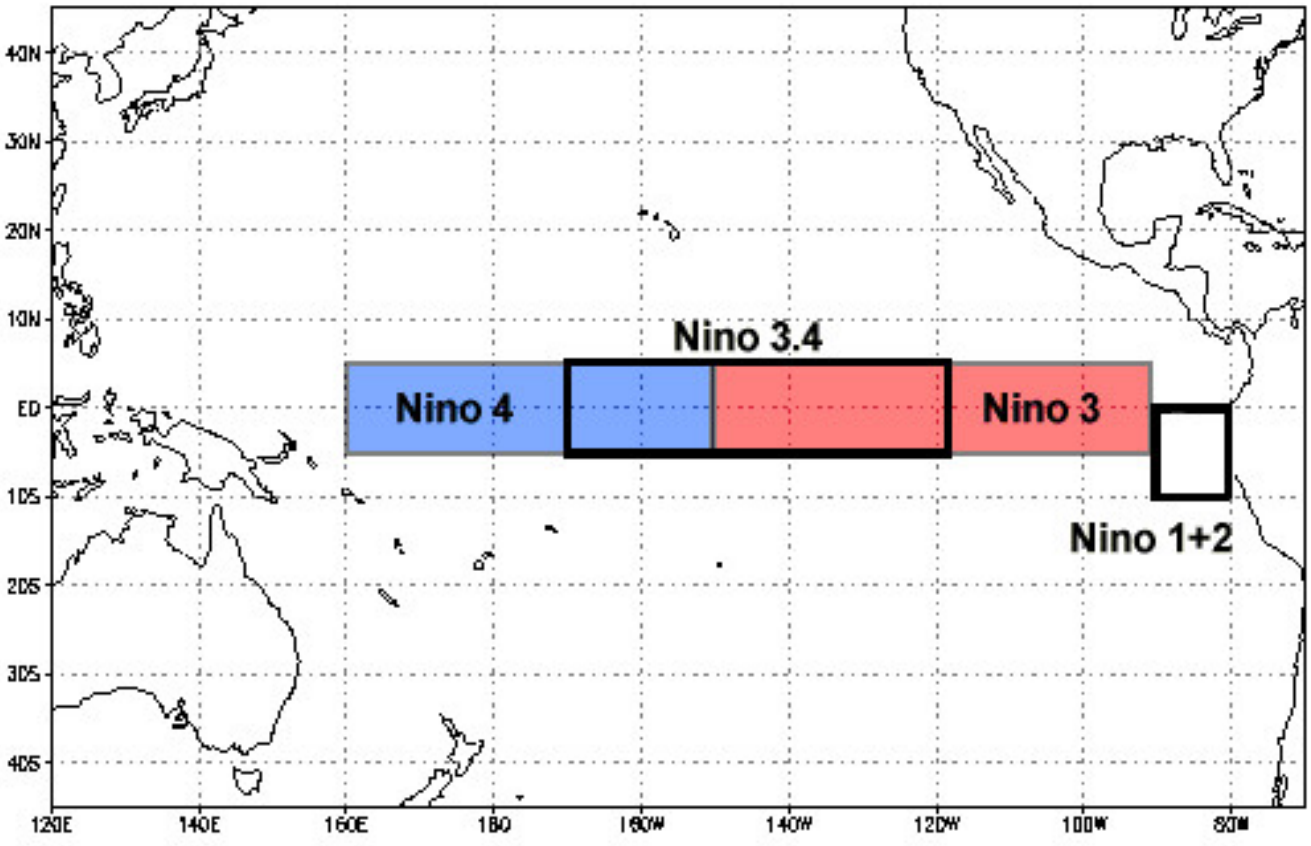


Figure: Pre-defined regions related to El-Niño indices. Picture probably (?) from NOAA.

El-Niño 3.4 SST

Example of time-series data (see S07 and S08 also)

1		1948		2019									
2	1948	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
3	1949	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
4	1950	24.55	25.06	25.87	26.28	26.18	26.46	26.29	25.88	25.74	25.69	25.47	25.29
5	1951	25.24	25.71	26.90	27.58	27.92	27.73	27.60	27.02	27.23	27.20	27.25	26.91
6	1952	26.67	26.74	27.17	27.80	27.79	27.18	26.53	26.30	26.36	26.26	25.92	26.21
7	1953	26.74	27.00	27.57	28.04	28.28	28.12	27.43	26.94	27.01	26.87	26.88	27.00
8	1954	26.98	27.03	26.90	26.64	27.12	26.80	26.11	25.43	25.12	25.23	25.57	25.26
9	1955	25.61	25.81	26.22	26.60	26.66	26.55	26.15	25.51	25.28	24.41	24.25	24.57
10	1956	25.34	25.76	26.46	26.85	27.13	26.81	26.23	25.68	25.73	25.75	25.56	25.71
11	1957	26.04	26.54	27.46	28.23	28.55	28.36	28.17	27.69	27.44	27.42	27.62	27.90
12	1958	28.33	28.24	28.27	28.27	28.31	27.99	27.32	26.85	26.40	26.45	26.75	26.62
13	1959	27.07	27.18	27.47	27.88	27.70	27.37	26.44	26.09	25.92	26.24	26.04	26.18
14	1960	26.27	26.29	26.98	27.49	27.68	27.24	26.88	26.70	26.44	26.22	26.26	26.22
15	1961	26.23	26.56	26.94	27.36	27.75	27.67	26.89	26.19	25.78	25.71	26.07	25.97
16	1962	25.96	26.19	26.80	27.13	27.05	27.08	26.76	26.33	25.94	25.97	25.75	25.67
17	1963	25.77	26.22	27.18	27.78	27.63	27.62	27.78	27.48	27.40	27.36	27.47	27.62
18	1964	27.34	27.13	27.02	26.95	26.82	26.59	26.33	25.60	25.32	25.37	25.26	25.23
19	1965	25.66	26.19	26.94	27.38	27.99	28.09	27.90	27.97	28.01	28.17	28.12	27.96
20	1966	27.67	27.55	28.21	28.16	27.55	27.64	27.33	26.48	26.27	26.22	26.23	26.03
21	1967	25.88	26.11	26.50	26.74	27.35	27.47	26.97	26.44	25.86	25.97	26.08	25.95
22	1968	25.69	25.68	26.33	27.10	27.19	27.88	27.58	27.01	26.72	26.75	27.20	27.27
23	1969	27.50	27.86	27.82	28.13	28.29	27.69	27.08	27.02	27.15	27.34	27.10	26.98

Figure: Sample content of `elnino34_sst.data`.

Palmer Penguin data

Example of categorical + numerical data (multivariate), in `penguins.csv`

Figure: Cursed penguins.

See `https://allisonhorst.github.io/palmerpenguins/articles/intro.html`

Jupyter notebook

Go to 02 Jupyter notebook to play around with these datasets in Python