Climate and Oceans Support
Program in the Pacific

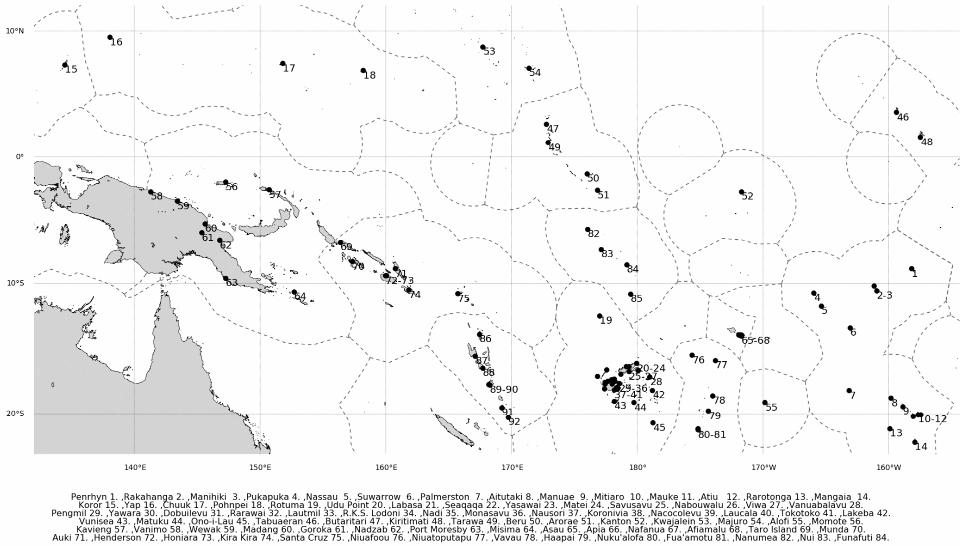
Module 4: Satellite rainfall monitoring and MSWEP

Zhi-Weng Chua

Introduction – Existing monitoring

Climate and Oceans Support Program in the Pacific

- Rainfall data from stations, rainfall values converted to percentiles/SPI, which are then converted to a drought status



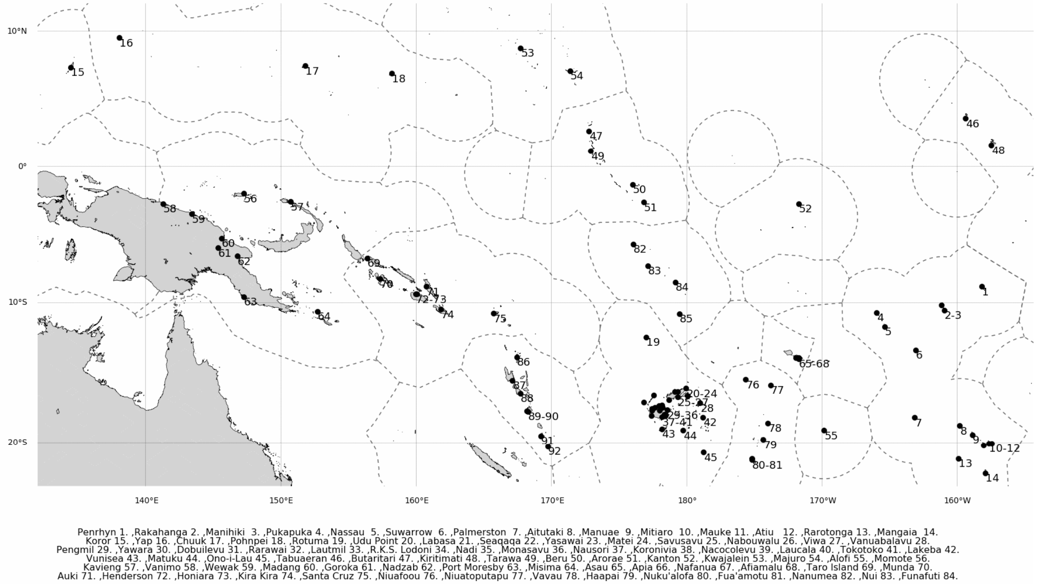
"Drought" series for 3mth Percentile Drought method
Coloured by 3 Phase SOI Values & Rank by Integral(*)

	Date	SOI 3-mnth mean	NINO 3.4 SSTA	Funafuti Mar 1933 to Jul 2022 n=1073 3mth Per...	Nanumea Mar 1941 to Jul 2022 n=977 3mth Per...	Niulakita Mar 1953 to Jul 2022 n=833 3mth Per...	Nui Mar 1946 to Jul 2022 n=917 3mth Per...
1042	Dec 2019	-6.8		50.00	49.37	44.62	47.95
1043	Jan 2020	-4.5		81.82	51.90	90.62	63.01
1044	Feb 2020	-2.1		93.18	97.47	93.94	91.78
1045	Mar 2020	-2.0		85.39	97.47	88.24	76.32
1046	Apr 2020	-2.6		66.29	97.47	62.32	72.37
1047	May 2020	-1.0		29.21	59.49	7.35	34.21
1048	Jun 2020	-2.4		51.69	35.00	55.88	35.53
1049	Jul 2020	-0.9		53.93	35.00	85.29	71.05
1050	Aug 2020			60.23	36.71	92.65	81.33
1051	Sep 2020			69.32	44.30	94.12	78.67
1052	Oct 2020			69.32	31.65	61.76	40.00
1053	Nov 2020			32.95	20.25	62.12	20.00
1054	Dec 2020			15.91	5.06	58.46	27.40
1055	Jan 2021			2.27	0.00	70.31	23.29
1056	Feb 2021			43.18	11.39	96.97	34.25
1057	Mar 2021			33.71	11.39	86.76	19.74
1058	Apr 2021			83.15	35.44	92.75	39.47
1059	May 2021			31.46	26.58	16.18	32.89
1060	Jun 2021			38.20	26.25	67.65	40.79
1061	Jul 2021			23.60	23.75	45.59	19.74
1062	Aug 2021			67.05	30.38	82.35	25.33
1063	Sep 2021			78.41	36.71	72.06	26.67
1064	Oct 2021			88.64	32.91	58.82	36.00
1065	Nov 2021			72.73	25.32	51.52	36.00
1066	Dec 2021			92.05	16.46	35.38	26.03
1067	Jan 2022			89.77	30.38	62.50	17.81
1068	Feb 2022			86.36	24.05	37.88	10.96
1069	Mar 2022			74.16	22.78	50.00	18.42
1070	Apr 2022			15.73	1.27	21.74	14.47
1071	May 2022			46.07	1.27	35.29	31.58
1072	Jun 2022			10.11	1.25	10.29	17.11
1073	Jul 2022			16.85	0.00	10.29	9.21

La Nina | El Nino | Neutral | Watch | Warning | Drought

Stations

- Directly measures rainfall through what is collected
- In most circumstances, it is the most reliable
- Greatest limitation is coverage



Other ways of estimating rainfall

Gauge

Satellite

Model Reanalysis

Remote sensing through satellites

- Satellites can produce a gridded dataset on close to a global domain.
- Detect changes in scattering and emission of microwaves and convert this to a rain rate.

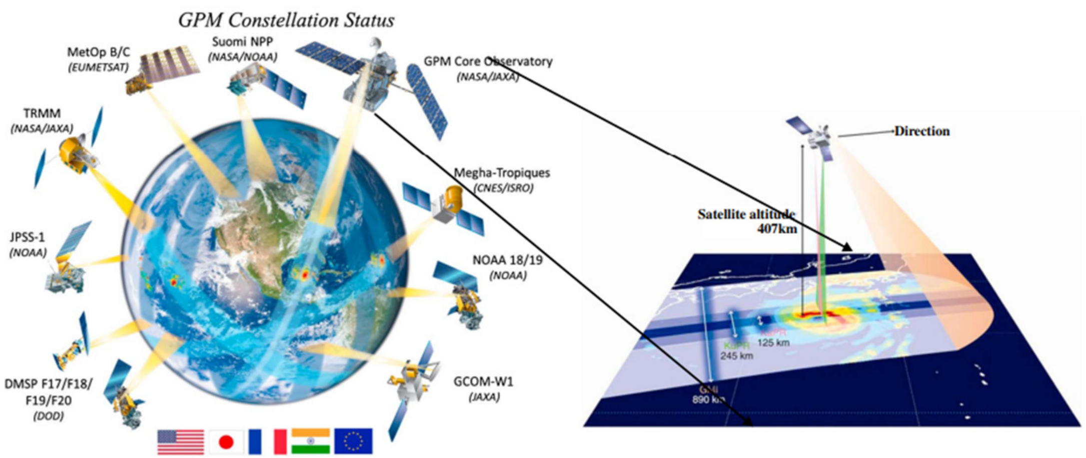
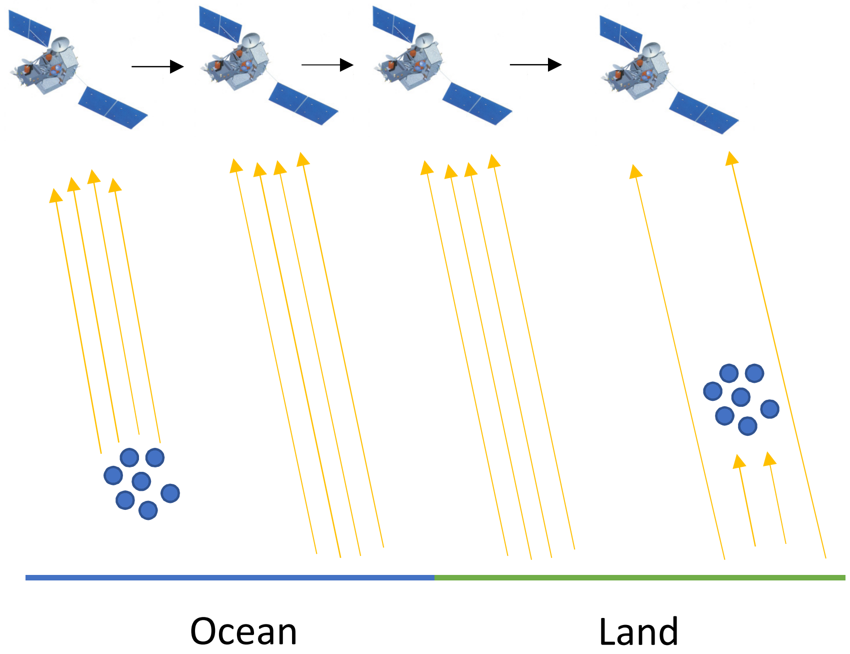
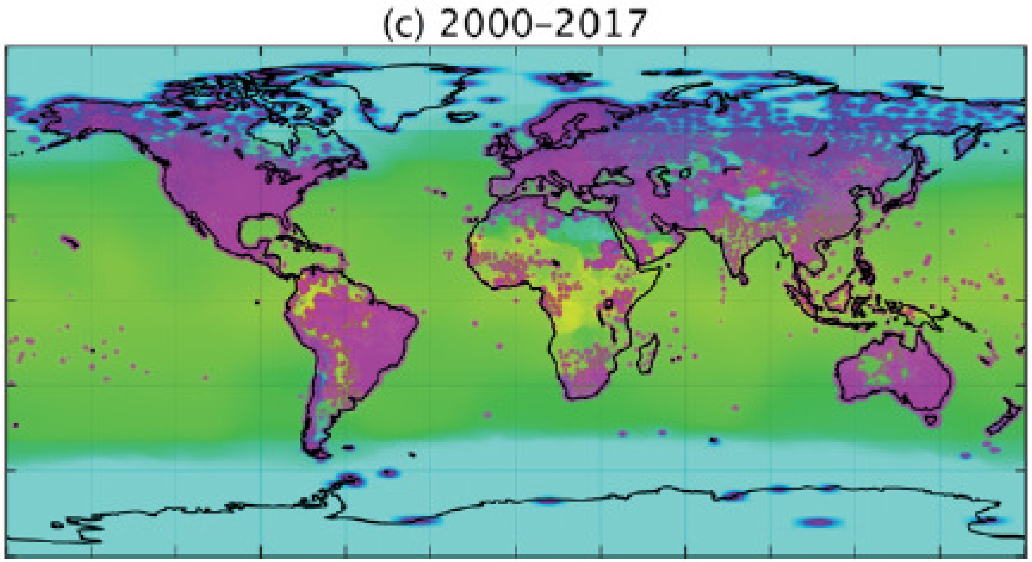


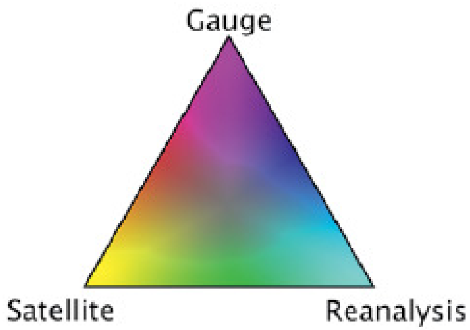
Figure 3. Conceptualization of precipitation observations from the GPM core satellite. Figure adapted from Hou et al. (2014) and GPM/DPR special site (http://global.jaxa.jp/countdown/f23/overview/gpm_e.html).



Multi Source Weighted Ensemble Precipitation (MSWEP)

- Blend of gauge, satellite and model reanalysis data, weighted by their accuracy to gauges.
- Stations from GHCN-D database (Menne et al. 2012), the GSOD database, the Latin American Climate Assessment and Dataset (LACA&D) database, the Chile Climate Data Library, and national databases for Mexico, Brazil, Peru, and Iran are used.





Left to right: Relative accuracy of rainfall estimates as indicated by their weight into the Multi-Source Weighted Ensemble Precipitation (MSWEP) dataset (Beck et al., 2019)

Climate and Oceans Support Program in the Pacific

Validation and why MSWEP?

- Studies have shown it to be one of the best performing datasets available (Beck et al. 2017; Beck et al. 2019)
- Did our own validation study comparing station data, MSWEP, ERA5 and GSMaP covering:
  - Solomon Islands
  - PNG
  - Kiribati
  - Tuvalu
  - Marshall Islands
  - Cook Islands
  - Fiji
- MSWEP performed the best, ERA5 was a close second.
- GSMaP performance is not bad, but shorter record is an obstacle.

Basic validation of data against stations

- Compared gridded data from 2001 to 2020 to 14 stations over Fiji.
- R = Linear correlation (closer to 1 is better) – when station values are large, are values from the gridded dataset also large?
- MAE = Mean Absolute Error (based on average error).

Dataset	R	MAE (mm/month)
GSMaP	0.78	95.49
ERA5	0.77	82.58
MSWEP	0.85	64.27

Basic validation of data against stations

- Compared gridded data from 2001 to 2020 to 32 stations over the Pacific.
- R = Linear correlation (closer to 1 is better) – when station values are large, are values from the gridded dataset also large?
- MAE = Mean Absolute Error (based on average error).

Dataset	R	MAE (mm/month)
GSMaP	0.70	104.05
ERA5	0.69	91.36
MSWEP	0.76	75.53

Advantages and limitations for gridded maps

Advantages

- Provides estimate of rainfall where stations cannot.
- Consistent over space and time.
- Data updated relatively quickly.

Limitations

- Greater uncertainty than station data.
- Record only extends back to 1980.

Station and remote sensing data are complementary. Gridded maps used in EAR WATCH but station data is still useful for verification and ground-truthing.

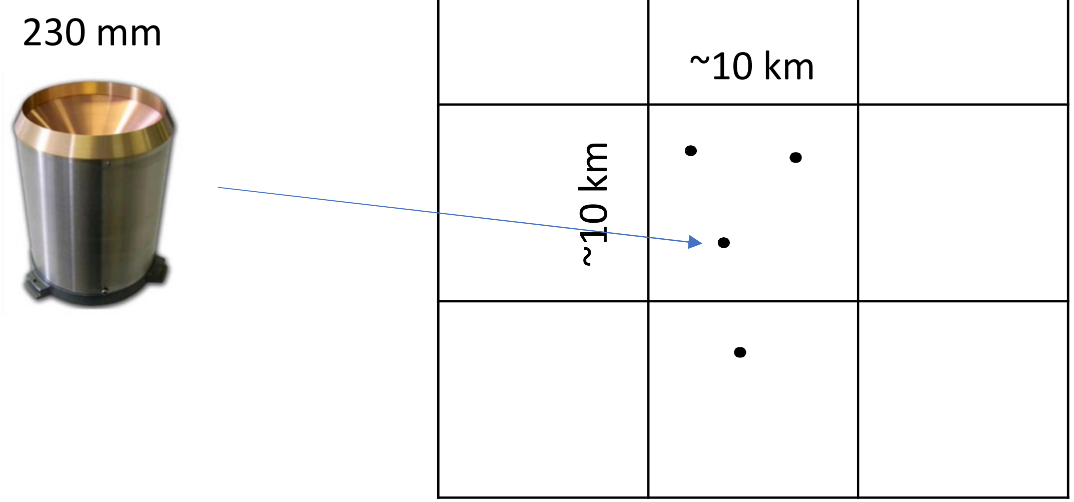
Why are there differences?

Stations

- Direct measurement.
- Rainfall value at a point.

Remote-sensing

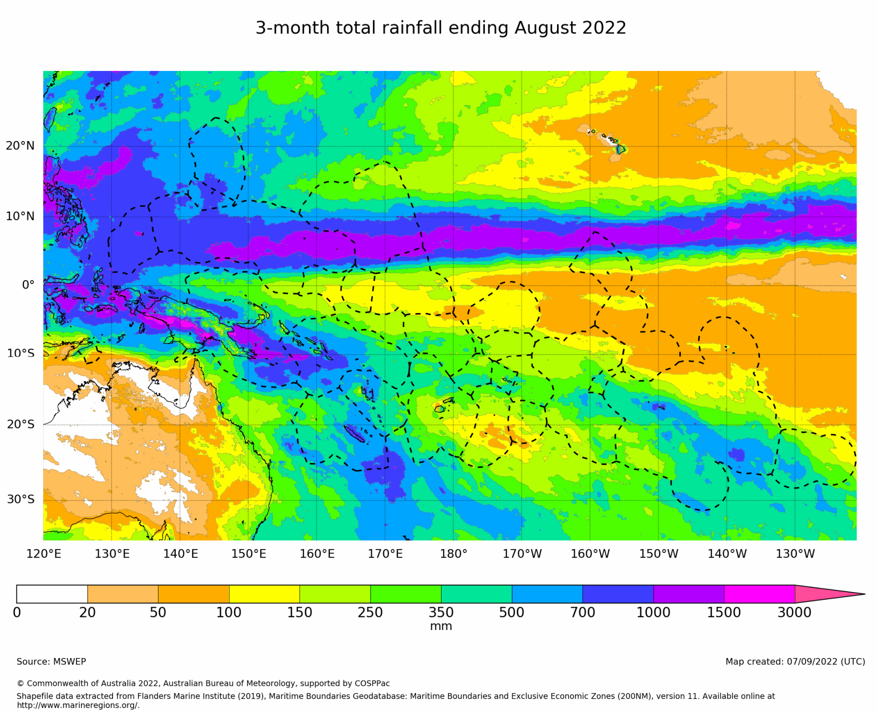
- Indirect estimation
- Value averaged over a grid square
- Does not include all stations



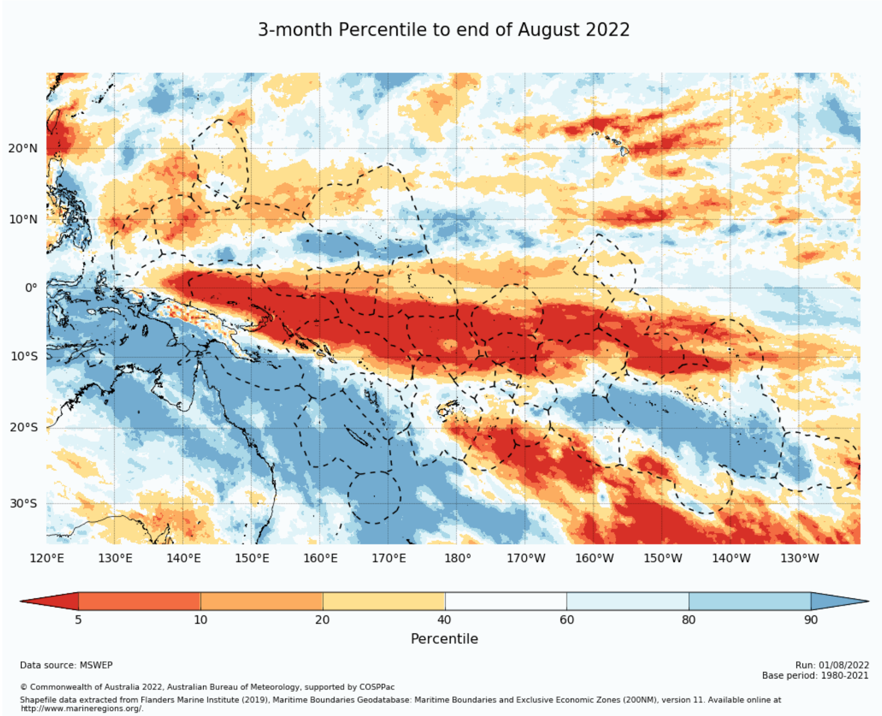
Percentile maps

Climate and Oceans Support Program in the Pacific

- At each grid point, use rainfall values from MSWEP to calculate percentile.
- Use the climatology of MSWEP; record goes back to 1980.



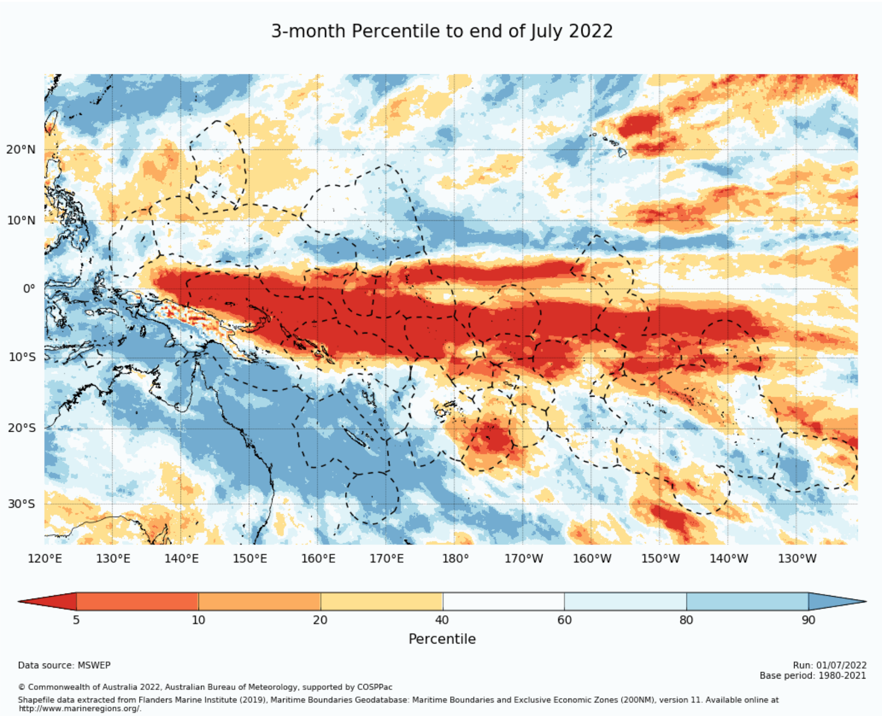
Convert to percentiles



Drought status maps

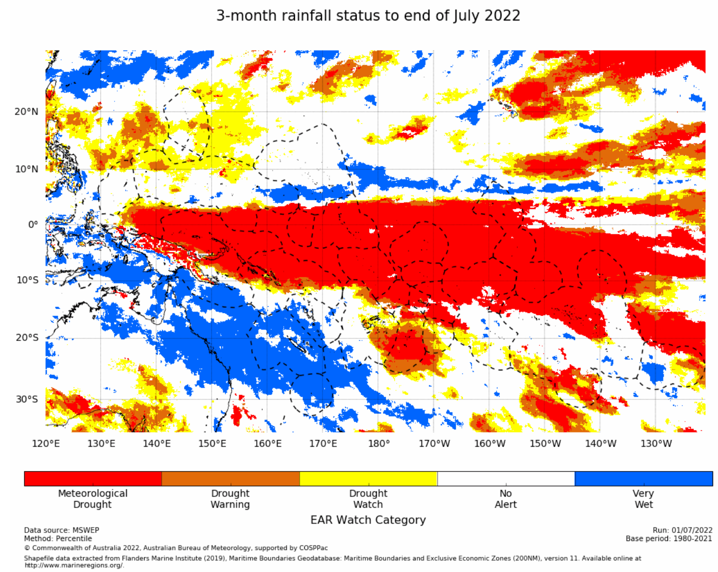
Climate and Oceans Support Program in the Pacific

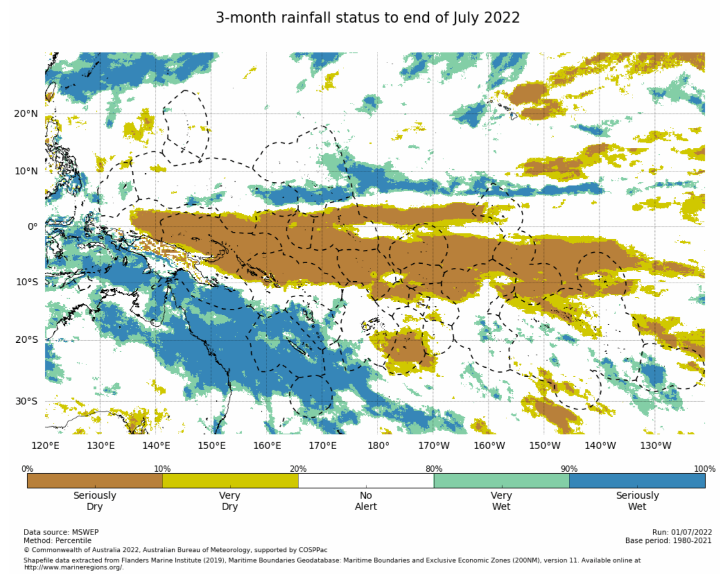
Percentiles



Convert percentile to a status

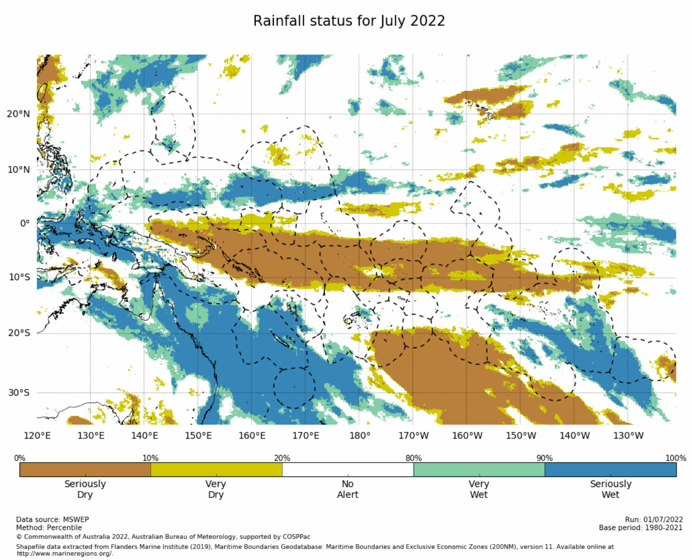
Rainfall status

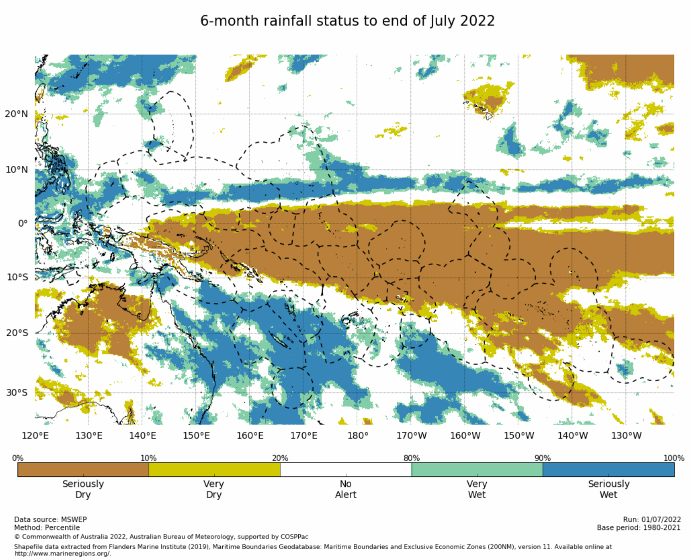


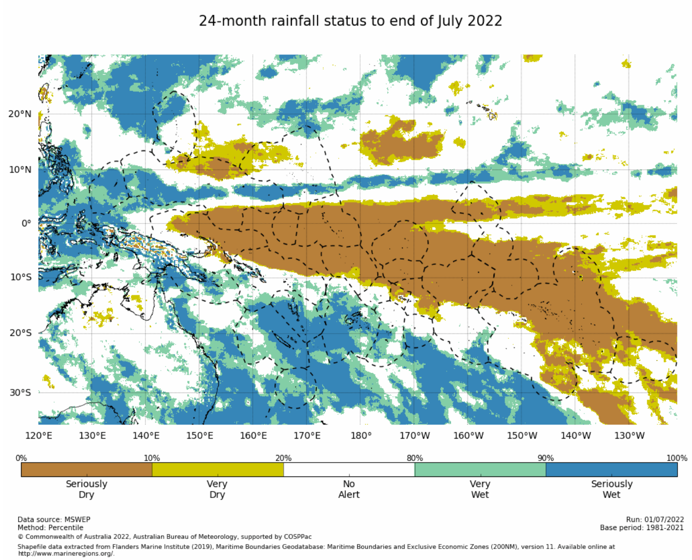


Drought status for multiple timescales

1-month 3-month 6-month 12-month 24-month







Closing remarks

Thank you!

Products available at: http://www.bom.gov.au/climate/pacific/outlooks/