Australian Government
Bureau of Meteorology

COSPPac Ocean Portal
About: Seasonal Sea Level Anomaly Forecasts

In Brief

Seasonal Sea Level Anomaly Forecasts *on monthly timescales are available up to six months ahead.*

Seasonal forecasts differ from a short-term forecast in that, instead of predicting individual events, they show the average sea level anomalies (values higher or lower than the long-term average) usually due to large scale climate drivers.

Introduction

Periods of higher or lower than normal sea level can persist for several weeks or months, with such fluctuations modifying the normal daily tides. In the Pacific, higher or lower than normal sea levels, otherwise known as sea level anomalies, are usually a result of La Niña or El Niño events when they persist for a month or longer.

When significant sea level anomalies occur at the same time as extreme sea level events from spring tides and/or storm surges, an already serious situation can become even more problematic. The impacts of extreme sea levels include: the loss of amenities; the inhibition of primary production processes; loss of property; loss of cultural resources and values; loss of tourism, recreation and transportation functionality; and increased risk of loss of life (Miles et al., 2014).

Seasonal sea level anomaly forecasts for upcoming months are currently being produced using the Australian Bureau of Meteorology's ocean-atmosphere forecast model, ACCESS-S[1] (Hudson et al., 2017). At any point in the ocean, ACCESS-S calculates the surface height (sea level) due to the combined effects of temperature, salinity and wind on the water column.

Sea level variations from ACCESS-S are primarily used to monitor seasonal cycles. It does not account for atmospheric pressure, astronomical tides, surface waves, land water storage, self-attraction and loading, tectonic uplift, inter-decadal Pacific Oscillation, glacial isotactic adjustment.

Figure 1. Lagoon side inundation at Majuro, Marshall Islands. p*hoto: Nover Juria, Marshall Islands National Weather Service*

Figure 2. Exposed coral in Guam in 2016. Sea level standings this low only occur during El Niño events. p*hoto: Laurie Raymond, University of Guam*

[1] ACCESS-S: Australian Community Climate Earth-System Simulator - Seasonal

Skill of Forecast

The accuracy of the seasonal forecast is dependent on location and how far into the future the forecast is targeting, known as the lead-time. To determine model skill, the model is run retrospectively (in the past) and compared to satellite observations of sea level during that time. A lead time of 0 corresponds to the month following model initialisation, and a lead time of 1 is the next month after that, and so on.

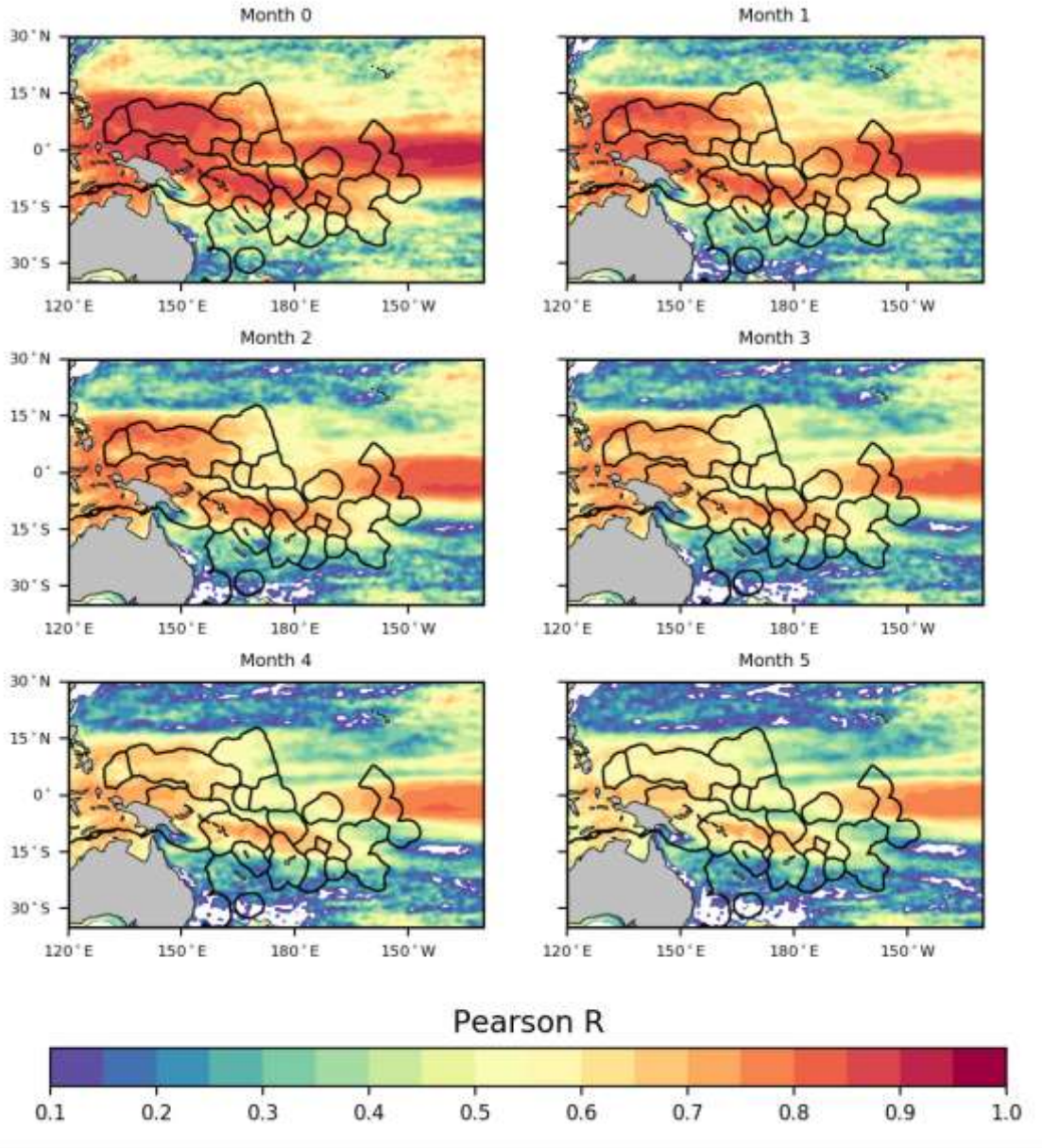
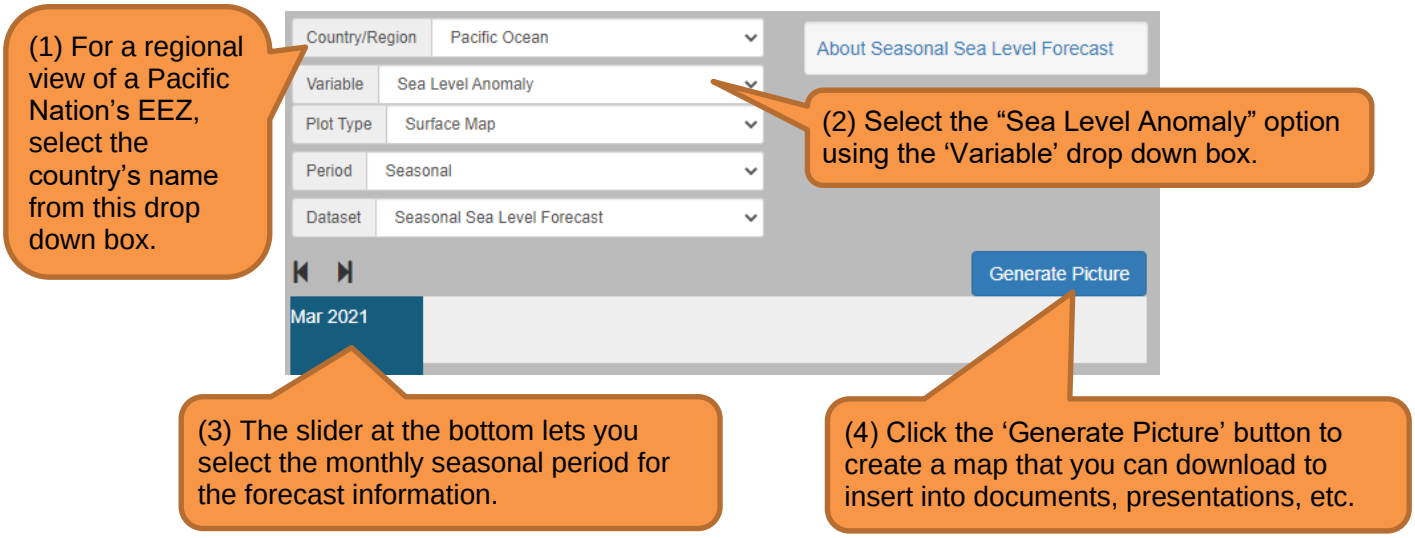


Figure 3. Skill of ACCESS-S Sea Level Forecast compiling forecasts representative of all times of the year, using retrospective forecasts from 1993 to 2018. Observations for comparison were from AVISO satellite monthly sea level product.

Model skill is acceptable where the Pearson correlation Coefficient is statistically significant, in this case being the value of 0.1 or greater. The area of highest skill for the sea level anomalies is in the tropical Pacific, most likely due to skill related to capturing the El Niño Southern Oscillation (ENSO) signal (Figure 3). The skill reduces for longer forecasts, however there is statistically significant skill for most equatorial, western, and southwest Pacific Island countries out to six months in the future (Long et al., 2021).

Using the Portal



Description of Parameters

Sea Level Anomaly (SLA):

A seasonal SLA forecast shows how the sea level is different from the long-term average. The map shows locations of both higher and lower water levels, indicated by positive and negative numbers. Units for SLA are in metres. The seasonal SLA forecasts are created by calculating the difference between the model predictions of sea level in the coming months to the model hindcast period 1981-2018. The anomaly also has the global mean subtracted from the data to present an anomaly that is relative to itself, and therefore does not include any long-term trends from climate change.

Examples of Applications

- **Management of Extreme Sea Level Events:** Stakeholders can use forecasts of extreme sea level to make decisions aimed at the protection of communities and infrastructure (Miles et al., 2013).
- **Monitoring ENSO Impacts:** Sea level varies during El Niño Southern Oscillation events, resulting in significantly high or low levels for many months. This was the cause of much coral die-off in Samoa during the 1997-1998 El Niño event, when sea level dropped in the western Pacific by up to 30 cm, exposing shallow reefs. Samoans refer to this sea level event as "taimasa" - shown in Figure 4 (Widlansky et al., 2014).

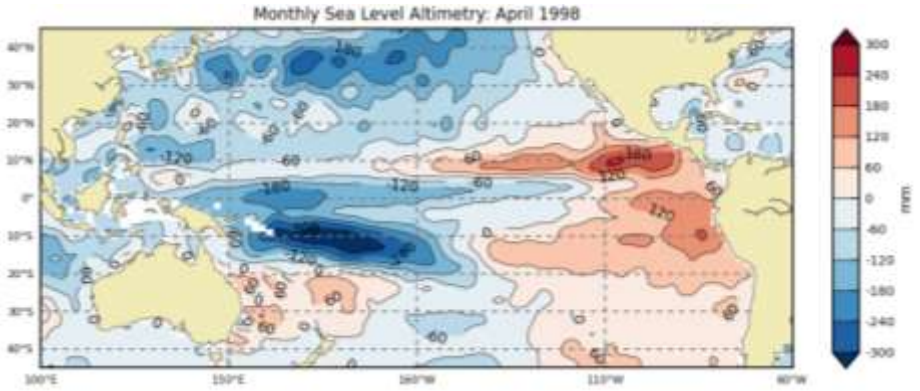


Figure 4. Altimetry data showing 'taimasa' which is the low sea level event occurring during certain El Niño events (dark blue region).

Data Source

The forecasts are generated using the Australian Bureau of Meteorology's seasonal model ACCESS-S. It is a state-of-the-art dynamical (physics-based) forecast modelling system, which uses ocean, atmosphere, ice and land observations to initiate outlooks for the season ahead. The ACCESS–S climate model is a collaboration between the Bureau of Meteorology and the UK Meteorological Office (UKMO).

The ocean model component of ACCESS–S operates at an approximate resolution of 25 km in the Pacific region. At this resolution, the model can resolve small-scale currents and eddies. ACCESS-S outlooks are based on a 99-member ensemble. This is a common climate forecasting technique where the model is run 99 times with slightly different initial conditions to capture a range of likely future scenarios.

ACCESS-S replaced POAMA in August 2018. POAMA, also a dynamical climate model, was used for official Bureau climate outlooks from May 2013 until ACCESS–S was brought into operation.

Links

Further information about the Bureau of Meteorology Seasonal Model ACCESS-S

http://www.bom.gov.au/climate/ahead/about/model/access.shtml

University of Hawaii Sea Level Center Forecasts (CFSv2)
https://uhslc.soest.hawaii.edu/sea-level-forecasts/

Disclaimer

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