Seasonal Outlooks for Coastal Sea Level and High Tide Flooding around Australia

R. Holmes, O. Richet, B. Hague, G. Smith and C. Spillman, Bureau of Meteorology

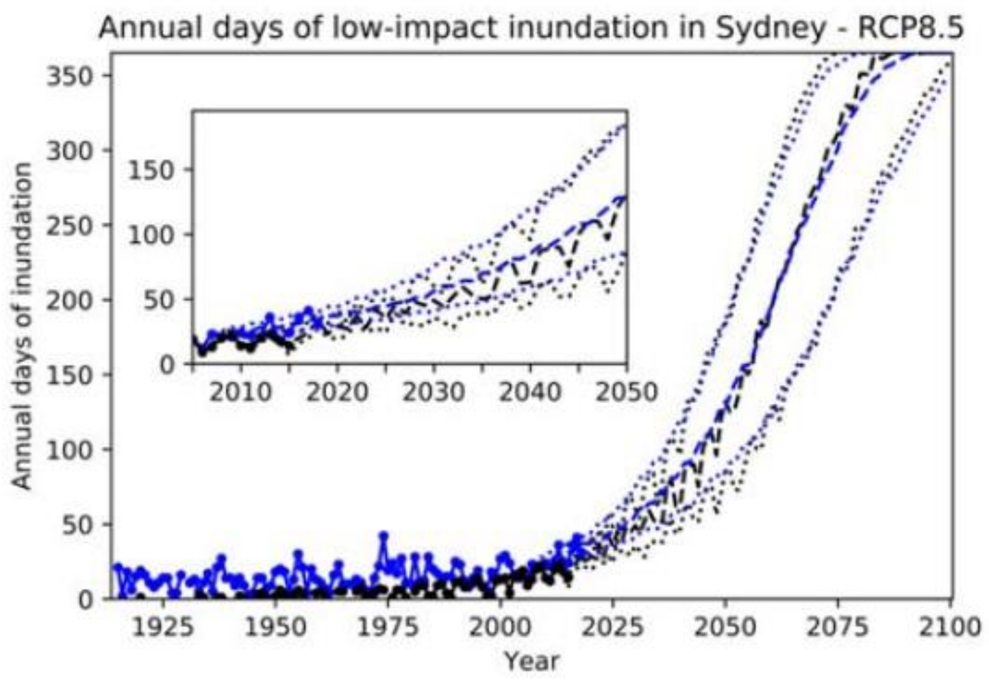
Coastal high tide flooding – a growing problem around Australia

The flooding of low-lying areas on high tides (known as high tide or "sunny day" flooding) is projected to increase with sea level rise, and with it comes rising social, environmental and economic impacts.

High tide flooding is driven by a combination of:

1. **Tides,**
2. **Sea level rise,**
3. **Weather variability (storm surge),**
4. **Subseasonal-to-seasonal variability (e.g. El Niño, MJO)**

The Bureau of Meteorology and the Australian Climate Service are developing ***seasonal sea level forecasts*** to help coastal managers prepare for the impacts of high tide flooding

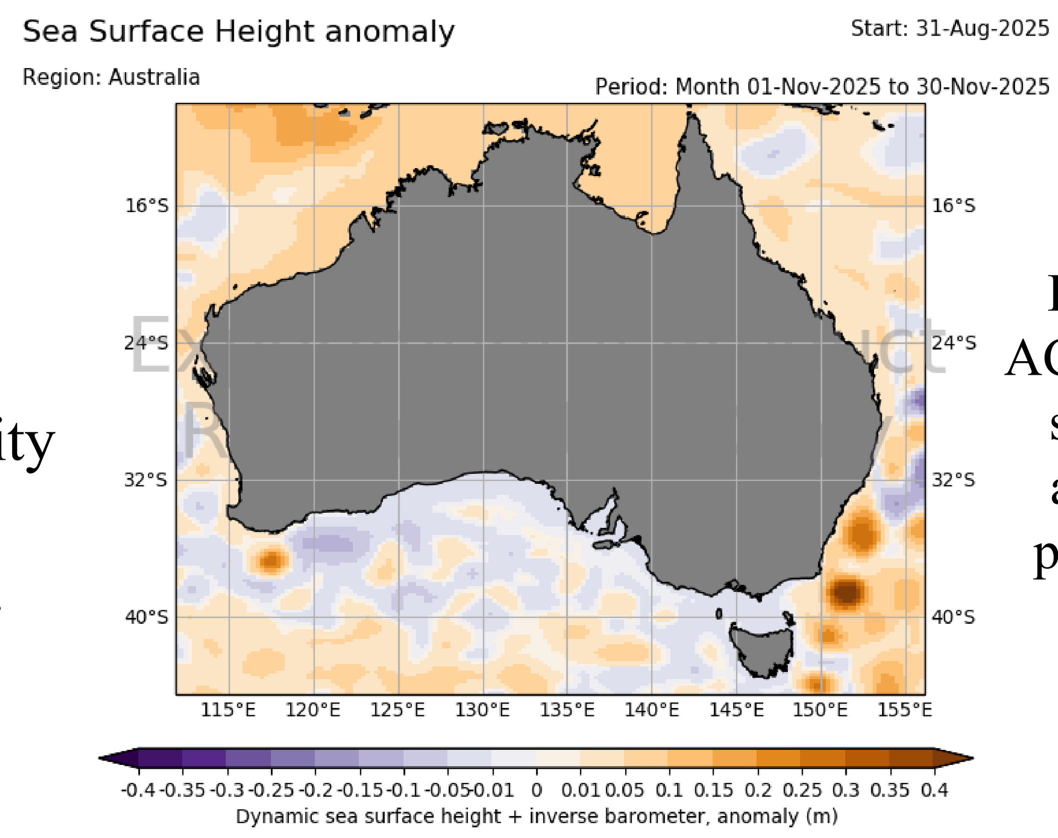


(top) High tide flooding in Sydney, (left) projections for the number of days of high tide flooding in Sydney under RCP8.5 emissions scenario (Hague et al. 2020, https://doi.org/10.1029/2020EF001607)

Subseasonal-to-seasonal forecasts from ACCESS-S2

ACCESS-S2 is the Bureau's operational seasonal ensemble prediction system. It includes a 25km-resolution ocean component that provides 99-member ensemble forecasts of non-tidal dynamic sea level anomalies at daily resolution out to 6 months into the future.

The forecasts include the "inverse barometer" effect of atmospheric sea level pressure variability (added during post-processing). The forecasts are skillful particularly on the north, west and south coasts where seasonal sea level variability is largest (reaching ±20cm in the northwest). Reference: Holmes et al. 2025b, https://www.publish.csiro.au/ES/ES24047

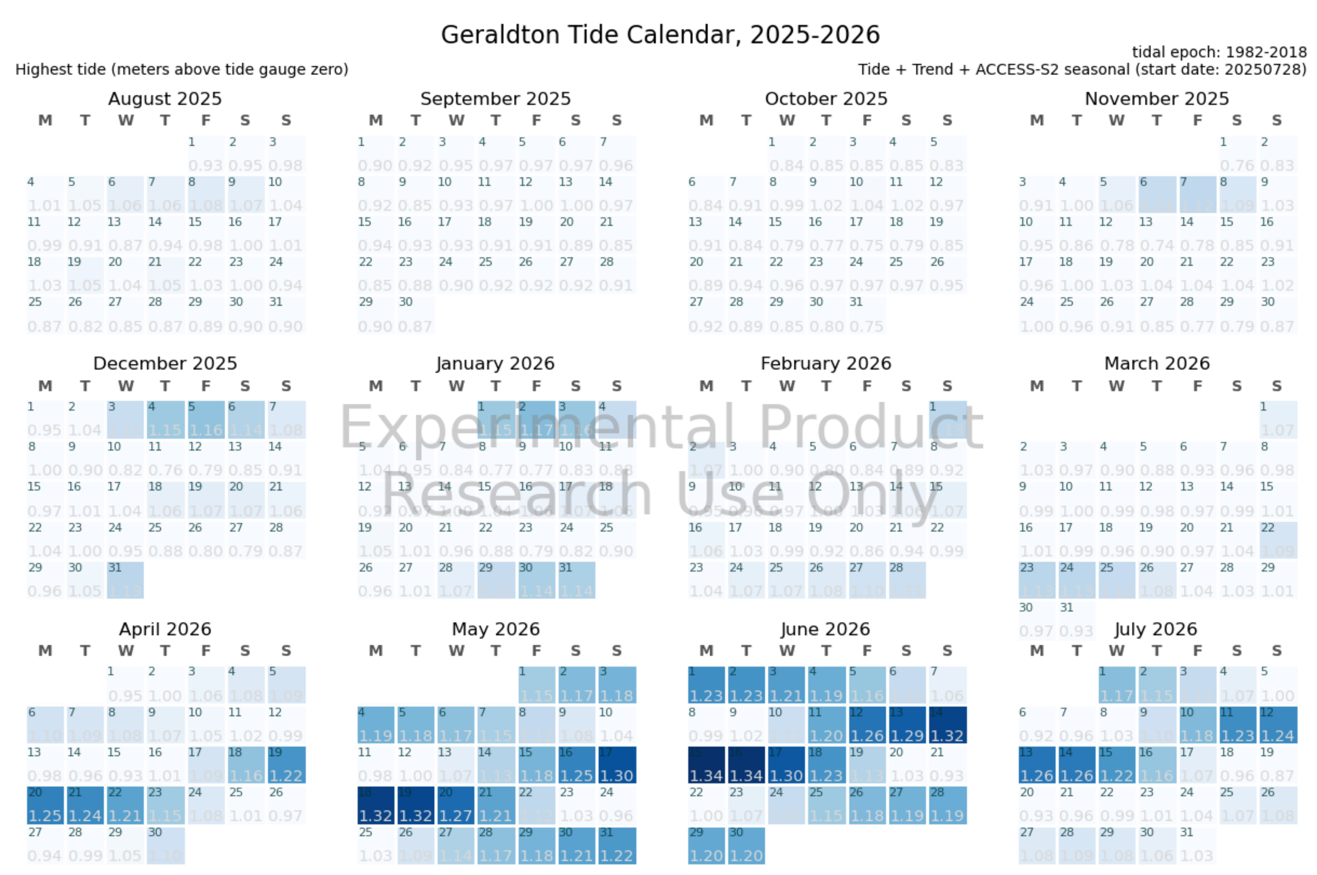


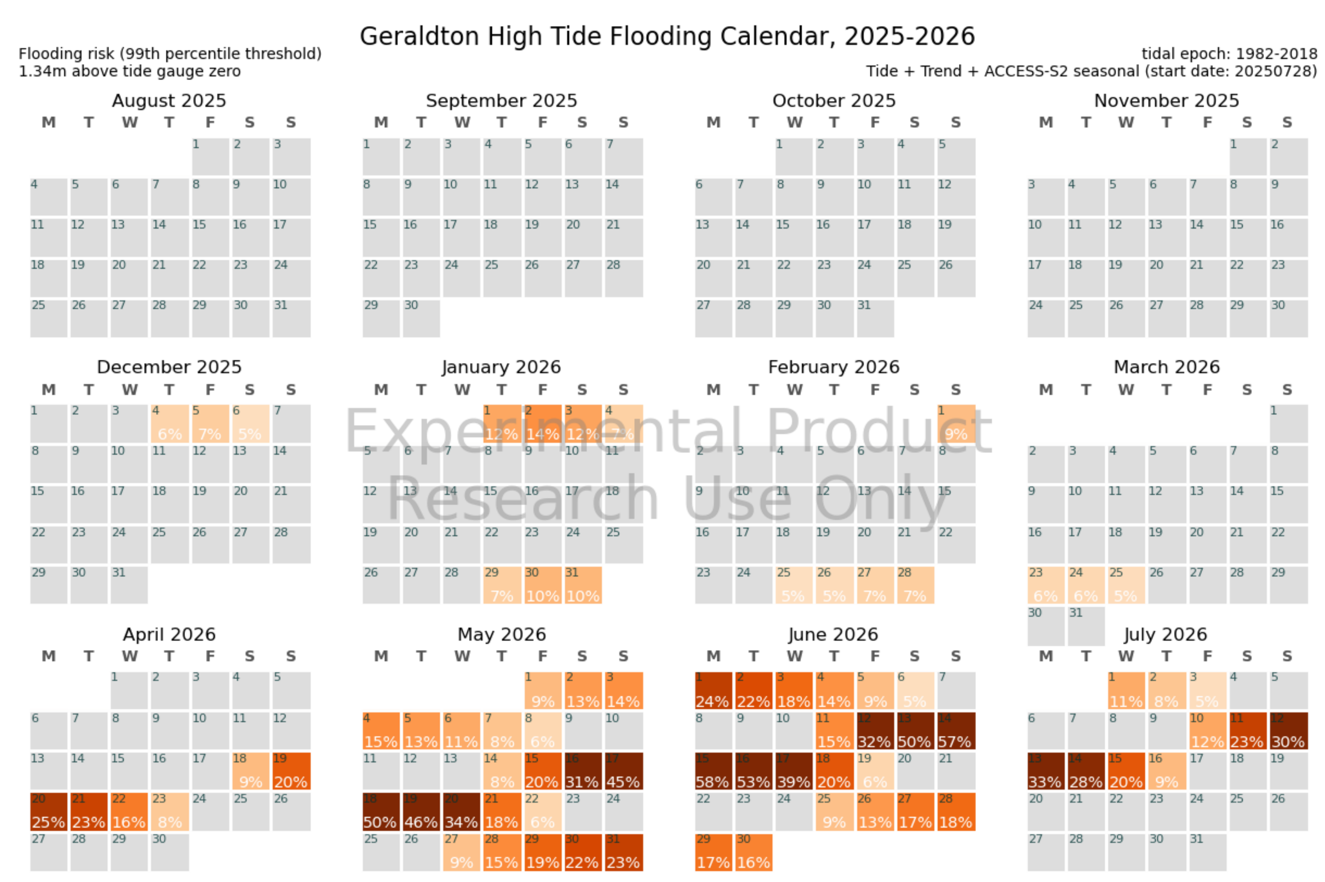
Example ACCESS-S2 sea level anomaly prediction

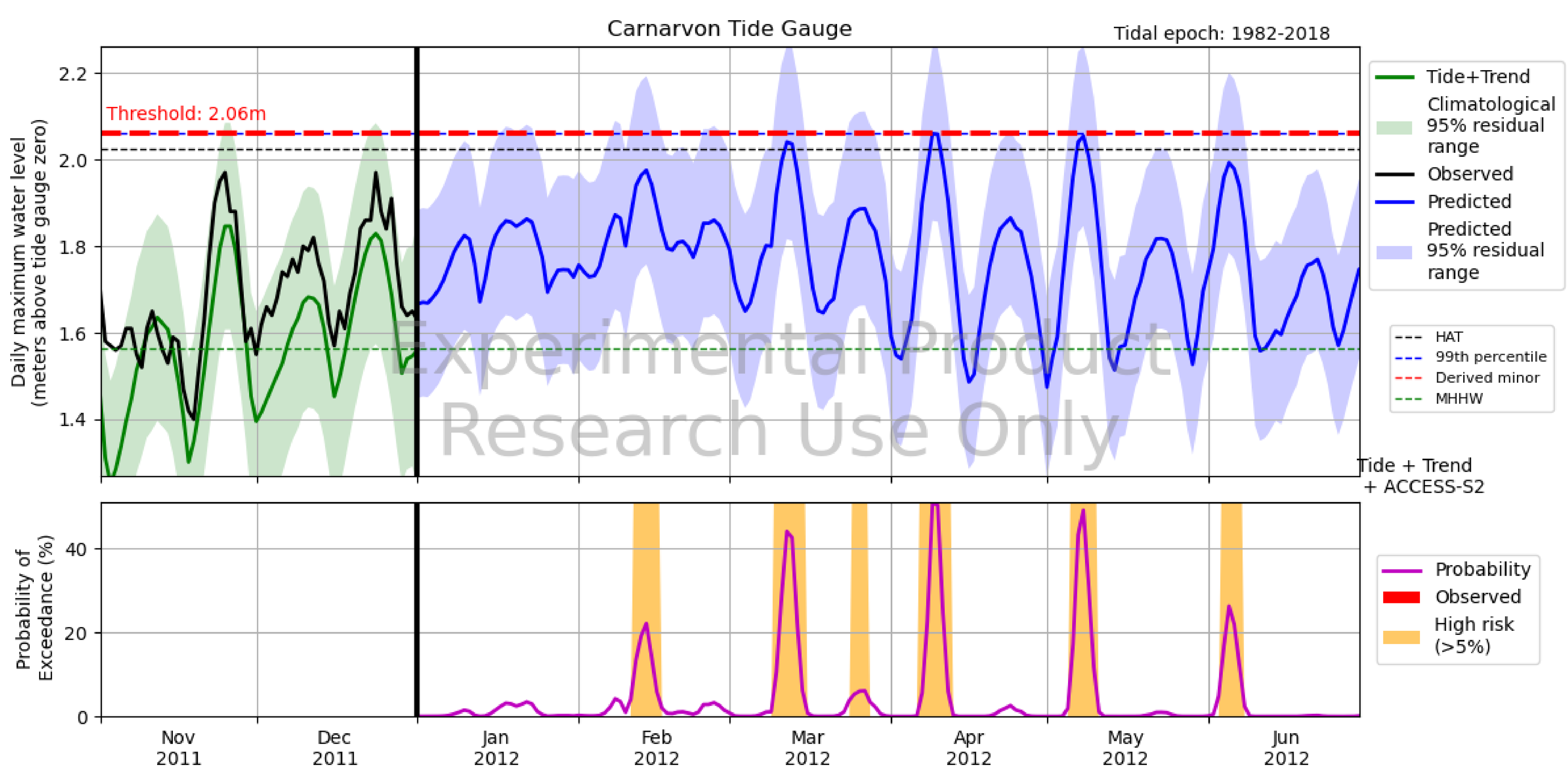
Seasonal outlooks for high tide flooding (SOHTF)

The SOHTF system combines ACCESS-S2 sea level predictions with tide predictions, sea level rise estimates and storm surge climatologies at tide gauges around Australia. SOHTF provides:

1. Probabilistic forecasts for daily maximum/minimum sea level from 2 weeks to 12 months into the future.
2. Calibrated daily probabilities of exceeding pre-defined flooding thresholds (e.g. minor flooding).







Example SOHTF products (above) SOHTF prediction for daily maximum sea level at Carnarvon for the first six months of 2012 and flooding probability (99th percentile threshold)
(left) SOHTF high tide flooding calendars for Geraldton in 2025-2026. The first calendar shows the predicted maximum daily sea level and the second shows the flooding risk

Reference: Holmes et al. 2025a, https://doi.org/10.1007/s11069-025-07548-x

Users and use cases

- Meteorological agencies (rostering for high-risk seasons)
- Councils and utilities (planning maintenance and response)
- Environmental planning (salt-water intrusions)
- Ports and shipping (low-water risk)

Australian Government

Australian Climate Service

Australian Government
Bureau of Meteorology

This research has been undertaken with the support of the Australian Climate Service. The Australian Climate Service is a partnership made up of the Bureau of Meteorology, CSIRO, the Australian Bureau of Statistics and Geoscience Australia.

Ryan Holmes
ryan.holmes@bom.gov.au
Sydney Bureau Office