Weekly Report: Nowcasts and forecasts for measles in South Africa, 2023

For Public Release

SACEMA's Modelling and Analytics Response Team

2023-03-29

Overview

This report provides transmission estimates, nowcasts, and short-term forecasts for measles cases, in order to improve situational awareness and inform resource planning. The report is intended for use by national and provincial departments of health, the National Institute for Communicable Diseases (NICD), and district-level managers.

This report is based on line list data with sample collection dates through 2023-03-15. The data are provided by NICD for the purpose of these analyses and are the same data used in the NICD Situation Report dated 2023-03-24 (https://www.nicd.ac.za/south-african-measles-outbreak-update-2023-24-march).

The time-varying reproduction number is a metric that indicates whether infections are increasing ($R > 1$), decreasing ($R < 1$), or stable ($R = 1$).

Highlights

- Nationally, the reproduction number as of 2023-03-15 was estimated to be 0.74 (0.32 – 1.4), suggesting that infection incidence is likely decreasing. There is a 80% chance that the reproduction number was below 1 as of 2023-03-15.
- At the provincial level, the reproduction number as of 2023-03-15 was estimated to be 1.2 (0.85 – 1.5) in Limpopo and 1.1 (0.74 – 1.5) in Gauteng, suggesting that infection incidence is likely increasing. In contrast, the reproduction number as of 2023-03-15 was estimated to be 0.72 (0.47 – 1.1) in Mpumalanga and 0.84 (0.58 – 1.1) in North West, suggesting that infection incidence is likely decreasing.

SACEMA
DSI-NRF Centre of Excellence in Epidemiological Modelling and Analysis

NATIONAL INSTITUTE FOR COMMUNICABLE DISEASES
Division of the National Health Laboratory Service

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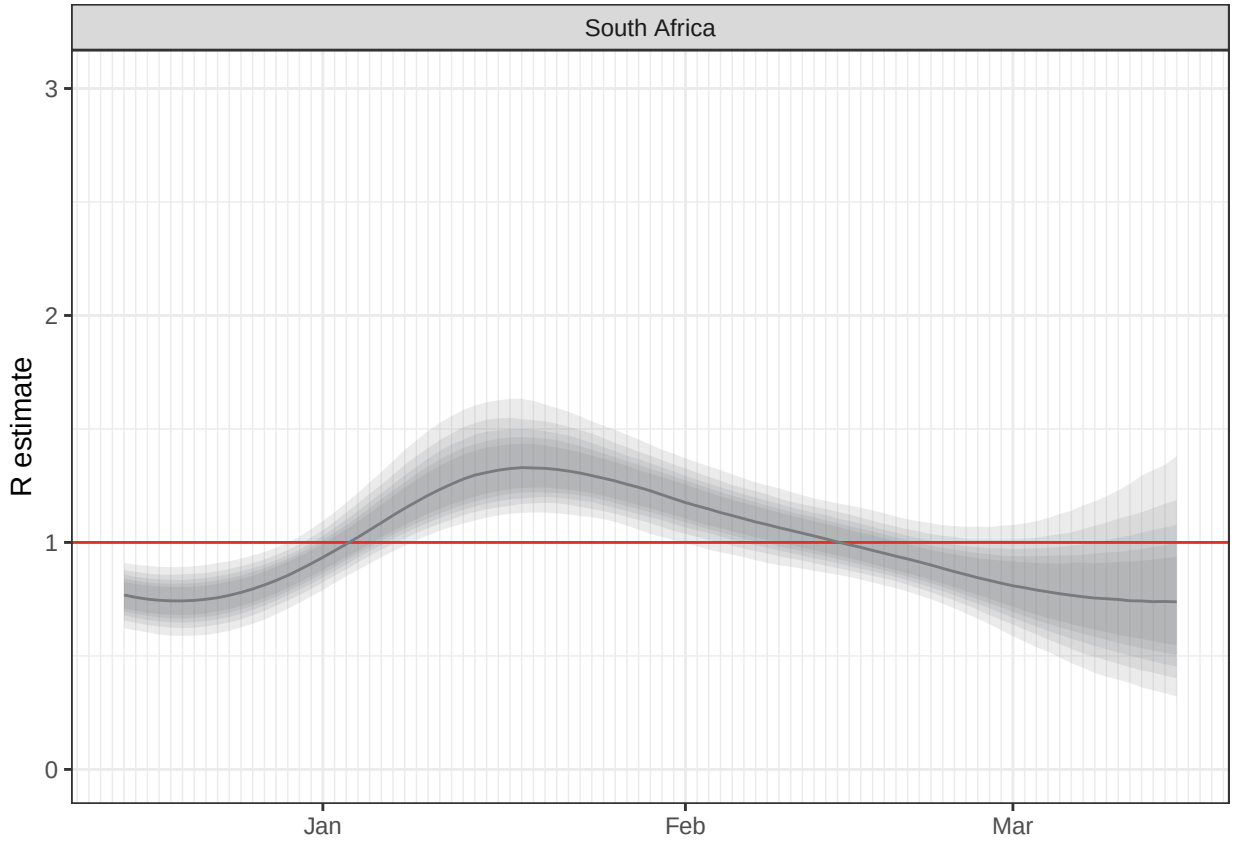
Reproduction number

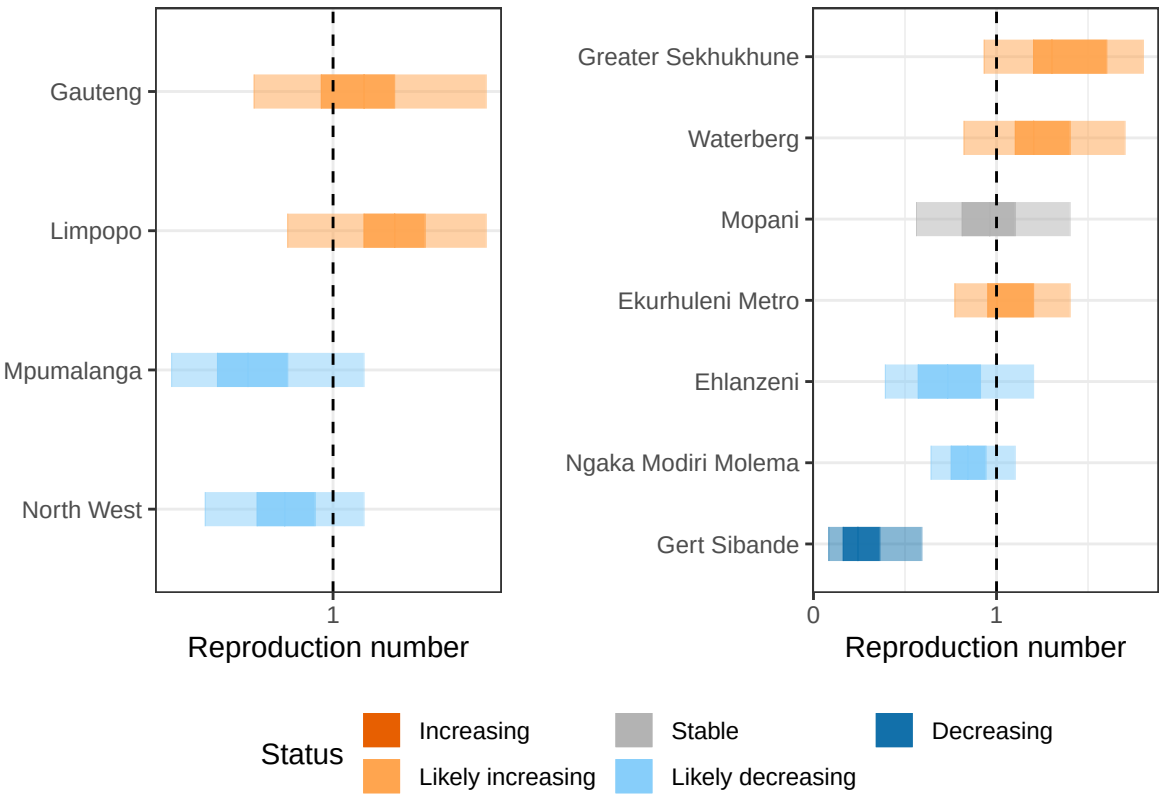
The figure below shows the national time-varying reproduction number over the past 90 days. The estimated reproduction number dipped below 1 from early December to early January, coinciding with the school holidays, then increased, reaching a peak of approximately 1.3 in mid-January. The reproduction has since declined, crossing the threshold value of 1 in mid-February, and has remained steady at around 0.75 since early March.

Nationally, the reproduction number as of 2023-03-15 was estimated to be 0.74 (0.32 – 1.4), suggesting that infection incidence is likely decreasing.



Latest estimates

The figures below show the latest reproduction number estimates at the province and district levels, for regions with a minimum of 40 detected cases since week 40 of 2022.



Probability that incidence was declining on 2023-03-15

The table below summarizes how likely it is that the reproduction number was below 1 on the given date, by region.

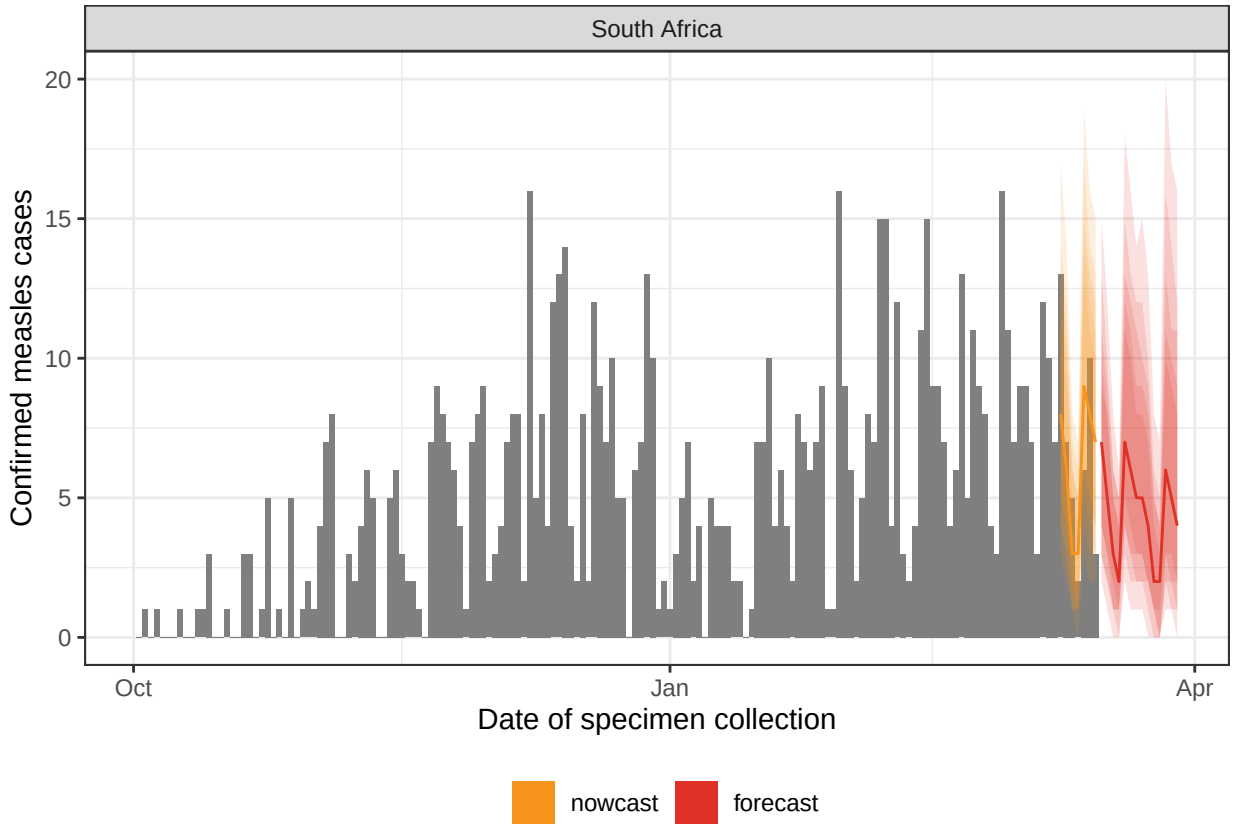
Region	Probability
South Africa	0.80
Limpopo	0.16
Gauteng	0.33
North West	0.87
Mpumalanga	0.92
Greater Sekhukhune	0.09
Waterberg	0.18
Ekurhuleni Metro	0.38
Mopani	0.56

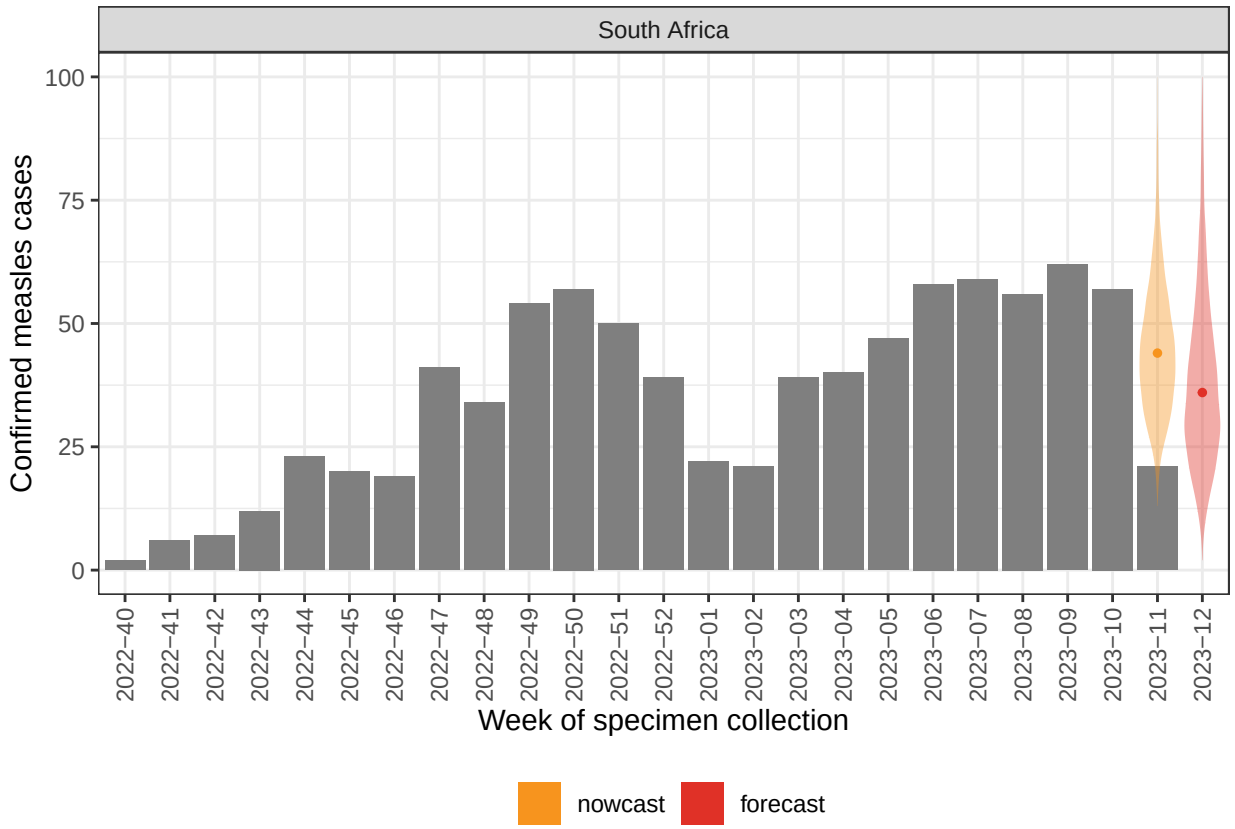
Region	Probability
Ngaka Modiri Molema	0.85
Ehlanzeni	0.84
Gert Sibande	1.00

Nowcasts and Forecasts

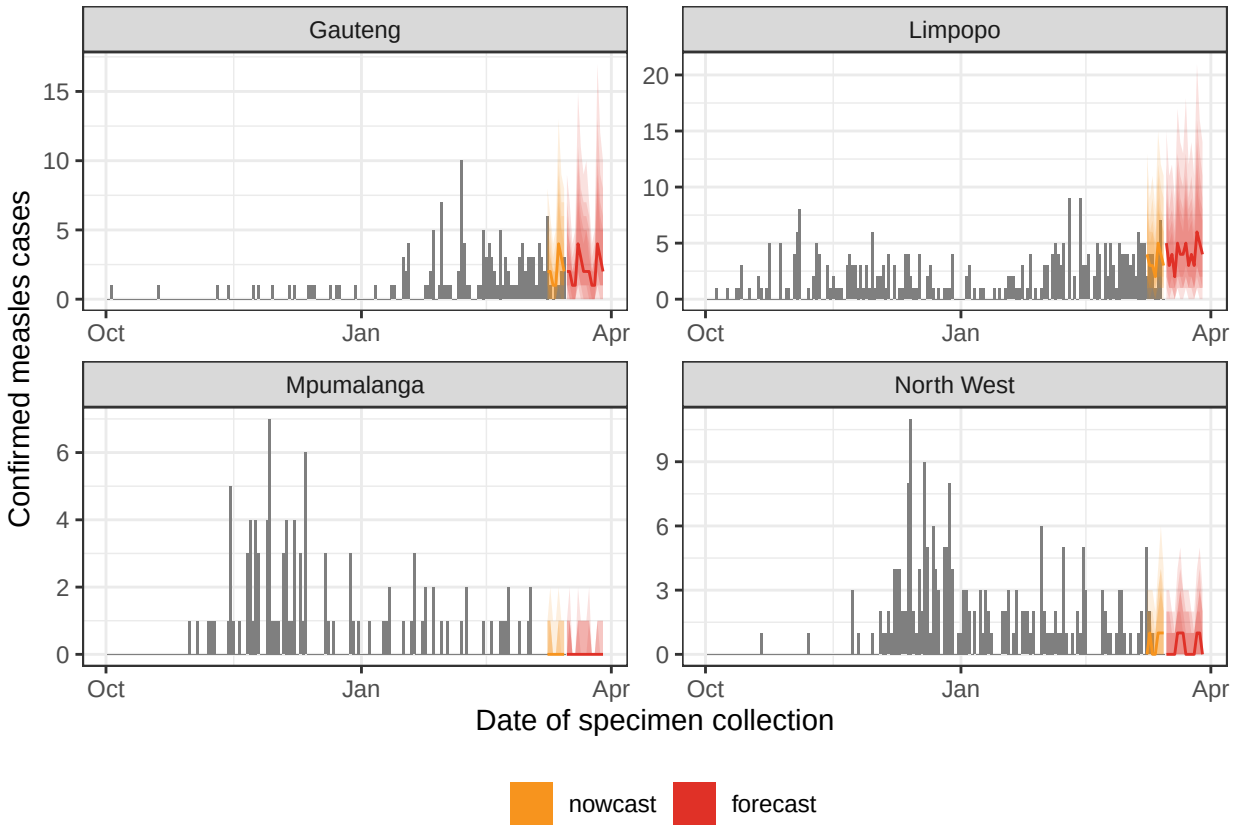
The following plots present nowcasts and forecasts for each region that has a minimum of 40 detected cases since week 40 of 2022. Nowcasts are estimates of the number of cases that will be detected in a time period for which reporting may be incomplete, accounting for reporting delays. Forecasts are projections of the epidemic trajectory that take into account uncertainty in the reproduction number and relevant delays. See the Methods section for additional details.

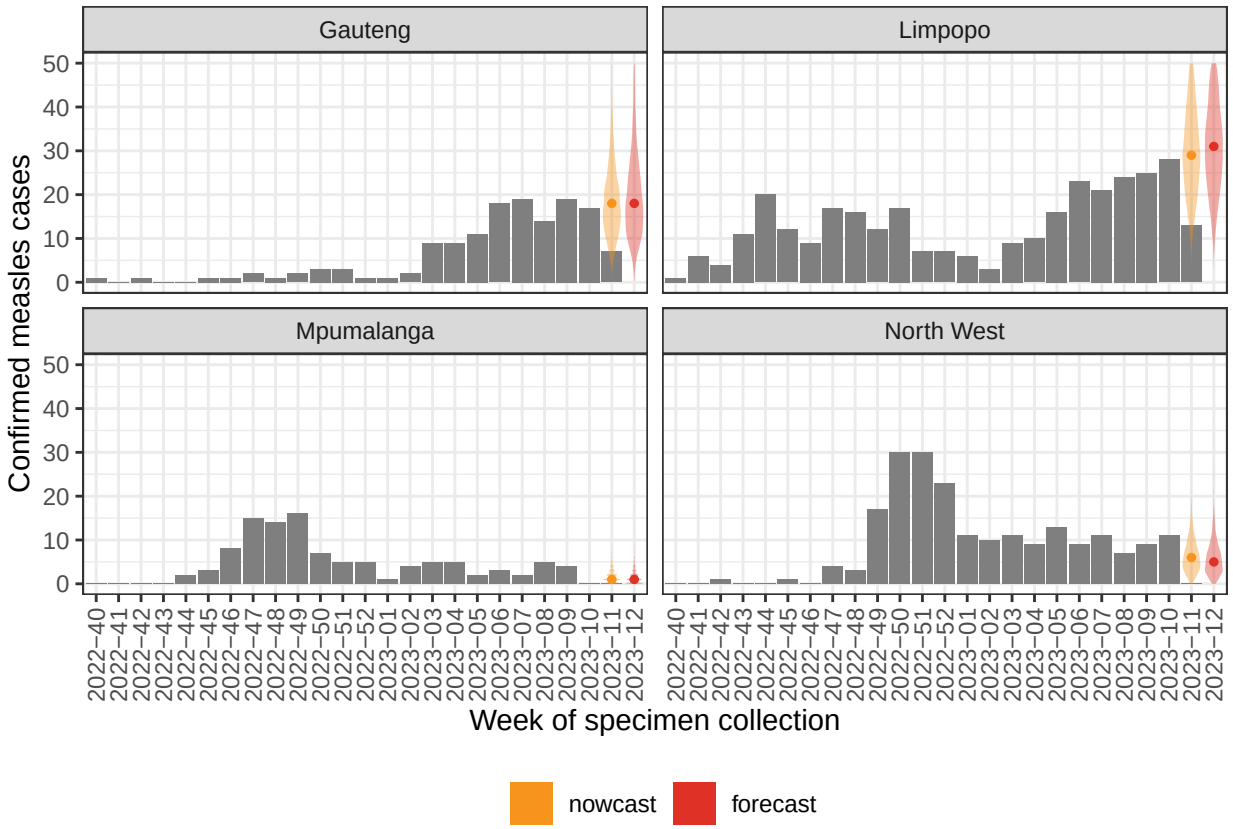
National level



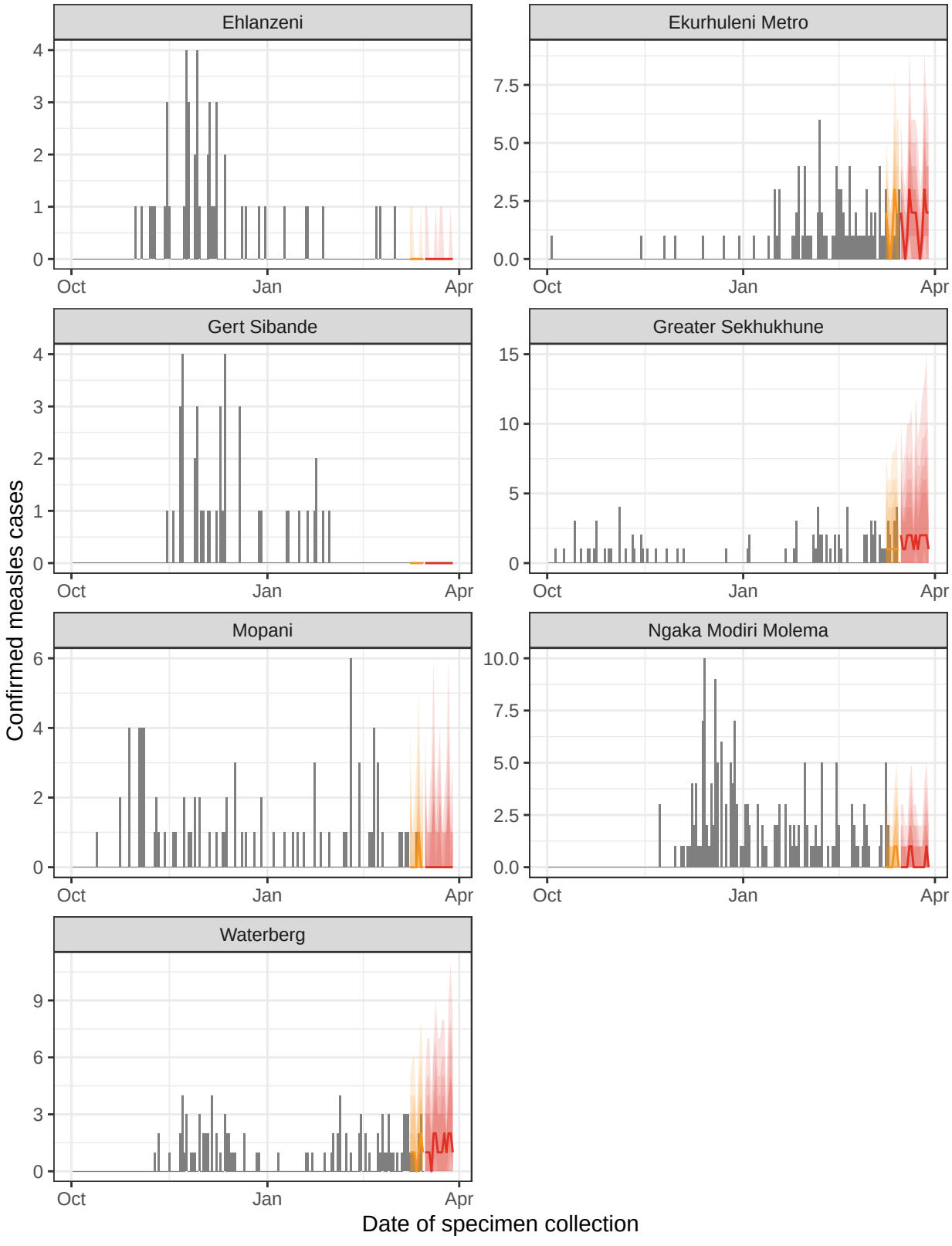

South Africa
Confirmed measles cases
100
75
50
25
0
2022−40
2022−41
2022−42
2022−43
2022−44
2022−45
2022−46
2022−47
2022−48
2022−49
2022−50
2022−51
2022−52
2023−01
2023−02
2023−03
2023−04
2023−05
2023−06
2023−07
2023−08
2023−09
2023−10
2023−11
2023−12
Week of specimen collection
nowcast
forecast

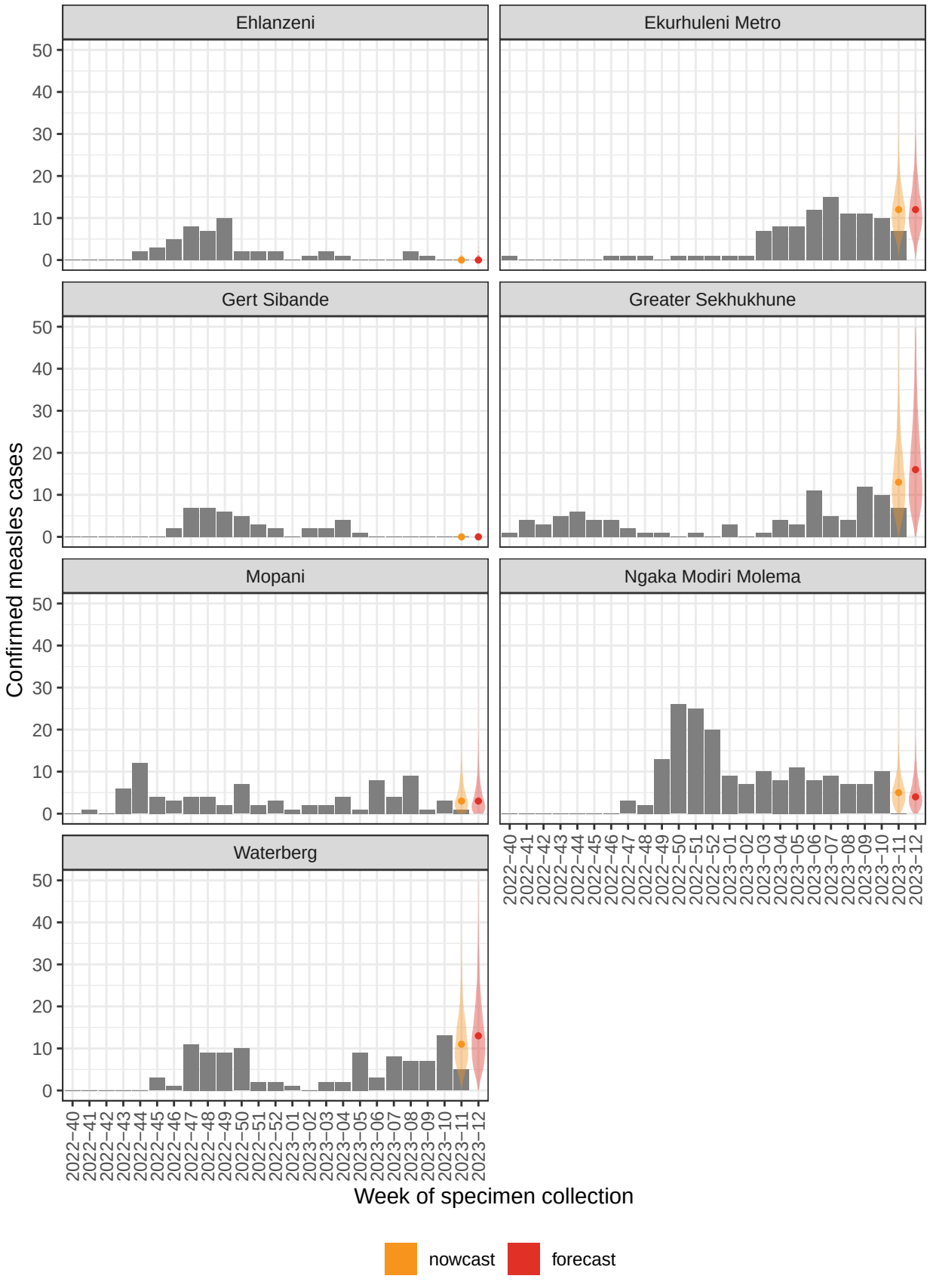
Province level




Gauteng
Limpopo
Mpumalanga
North West
Confirmed measles cases
0
10
20
30
40
50
2022–40
2022–41
2022–42
2022–43
2022–44
2022–45
2022–46
2022–47
2022–48
2022–49
2022–50
2022–51
2022–52
2023–01
2023–02
2023–03
2023–04
2023–05
2023–06
2023–07
2023–08
2023–09
2023–10
2023–11
2023–12
Week of specimen collection
nowcast
forecast

District level




Ehlanzeni
Ekurhuleni Metro
Gert Sibande
Greater Sekhukhune
Mopani
Ngaka Modiri Molema
Waterberg
Confirmed measles cases
0
10
20
30
40
50
2022–40
2022–41
2022–42
2022–43
2022–44
2022–45
2022–46
2022–47
2022–48
2022–49
2022–50
2022–51
2022–52
2023–01
2023–02
2023–03
2023–04
2023–05
2023–06
2023–07
2023–08
2023–09
2023–10
2023–11
2023–12
Week of specimen collection
nowcast
forecast

Methods

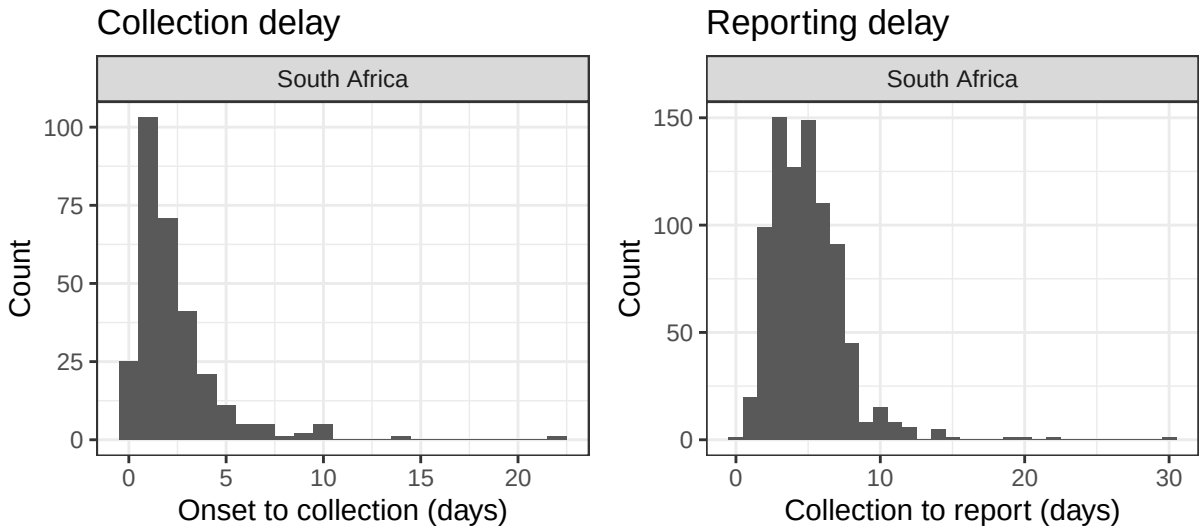
Estimation procedure

Case forecasts are simulated using the `EpiNow2` package in the R statistical programming language, as described in Abbott *et al*. (2020). Briefly, the method estimates an instantaneous time-varying reproduction number (R_t) based on the reported case time series, a specified generation interval distribution, and specified reporting delays and then simulates infection trajectories based on 4,000 draws from the posterior distribution of R_t. Simulated case trajectories are then generated based on these infection trajectories and the specified delay distributions.

Each simulated case trajectory can be analyzed in the same manner as actual reported case data. This allows us to, for example, examine weekly aggregates of simulated cases.

Delay distributions

The nowcasts and forecasts presented here are produced using generation interval and incubation period distributions estimated by Klinkenberg *et al*. (2011). The delays from onset to specimen collection and from specimen collection to report are estimated directly from line list data using the `bootstrapped_dist_fit` function in `EpiNow2`. The delay distributions are estimated at the national level and used for nowcasts and forecasts at all scales.



Limitations

The main limitation of the approach used is that case forecasts can substantially overshoot when close to the epidemic peak.

A further limitation is that the reporting date used for the estimation of the delay from specimen collection to report is the date on which the district was notified of the lab result, which may occur substantially before the case is added to the national line list. As a result of this limitation, reproduction number estimates, nowcasts, and forecasts may all be biased downward. This approach is taken because the date a case is added to the line list is not currently recorded.

References

Abbott *et al*. (2020) Estimating the time-varying reproduction number of SARS-CoV-2 using national and subnational case counts [version 2]. *Wellcome Open Research* 5: 112. https://doi.org/10.12688/wellcomeopenres.16006.2

Klinkenberg and Nishiura. (2011) The correlation between infectivity and incubation period of measles, estimated from households with two cases. *Journal of Theoretical Biology* 248(1): 52-60. https://www.sciencedirect.com/science/article/pii/S0022519311003146

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About SACEMA

The South African Centre for Epidemiological Modelling and Analysis (SACEMA, www.sacema.org) is a national DSI-NRF Centre of Excellence founded in 2006 and hosted at Stellenbosch University. SACEMA aims to improve health in South Africa, and across the continent, through modelling and analysis.

About SMART

SACEMA's Modelling and Analytics Response Team (SMART) provides training in outbreak response analytics and tackles real-world outbreak response projects as they arise. Current SMART members include: Jeremy Bingham (convener), Lauren Brown, Zinhle Mthombothi, Prof Juliet Pulliam, Tumelo Sereo, and Dr Cari van Schalkwyk.

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