Note added for release (1)

Pilot short-term forecasts from SPI-M-O. This was considered at SAGE 24 on 9 April 2020.

These short-term forecasts are pilots for England only, and as such the metrics and geographies considered in this slidepack are not consistent with those from later meetings.

It should be viewed in context: these short-term forecasts represent SPI-M-O's best predictions based on the data and evidence available at the time of writing. Therefore, some of the information in this paper may have been superseded and the author's opinion or conclusion may since have developed.

Separate forecasts are produced using different models and approaches by the modelling groups represented at SPI-M-O. These individual forecasts are then combined to form a consensus forecast which is subsequently shared with the Scientific Advisory Group for Emergencies (SAGE).

The short-term forecasts are produced by transmission models of the epidemic process. These models are fit to trends in the past data, and therefore do not predict the impact changes to social distancing measures will have on the number of COVID-19 deaths or hospitalisations - unless the impact of any changes have already started to be reflected in the data by the time the forecasts were produced.

It isn't possible to produce accurate forecasts when case numbers fall to very low levels. Furthermore, where data series are inconsistent, for example if ICU bed occupancy is decreasing much faster than general bed occupancy, the models may not always fit well to the data. If case numbers drop to very low levels in a region or the forecasts do not fit well to the data, then these forecasts are excluded from the slides circulated to SAGE.

Data limitations mean some of the forecasts aren't informed by past data. Where this is the case these forecasts need to be treated with caution and represent SPI-M-O's best assessment using the available data from other parts of the UK.

These documents are released as pre-print publications that have provided the government with rapid evidence during an emergency. These documents have not been peer-reviewed and there is no restriction on authors submitting and publishing this evidence in peer-reviewed journals.

Note added for release (2)

The metrics used in these slides are for England only and cover:

1. ICU bed occupancy: Number of confirmed COVID-19 patients in HDU/ITU at 0800
   Please note that this relates to HDU/ITU, and not mechanical ventilation (MV).
2. Hospital bed occupancy: Total number of beds occupied with confirmed COVID patients at 08:00
3. Hospital deaths by date of report
4. Hospital and community deaths by date of death
5. New and newly confirmed patients/cases in hospital: Number of patients admitted with COVID-19 and inpatients diagnosed with COVID-19 in last 24 hours

Forecasts by NHSE region are also included for metric 4.

Note that there are two measures of deaths forecast in these slides, and for those released under SAGE 23 and 25:

- Hospital deaths by date of report
- Hospital and community deaths by date of death

Please note that the former was discontinued as a forecast metric after SAGE 25. From SAGE 27 onwards, the main measure of deaths used in the forecasts is "hospital and community deaths by date of death"; no short-term forecasts were tabled at SAGE 26.

Not all of the models produce forecasts each week or for every metric.

A description of the metrics used in the short-term forecasts between SAGE 22 and 25 are listed overleaf, together with caveats for each measure and source. These are additional to the existing caveats on the individual forecast slides, and should be taken into account. Please note that the coverage and definitions of these data streams have changed over time, reflecting improved understanding of the disease and epidemic.

Note added for release (3)

Nation	Metric	Definition and additional caveats
England	**ICU bed occupancy** (SAGE 22-46)	NHS England Sitrep, field "Number of HDU/ITU beds, as at 08:00 (occupied with confirmed COVID patients)". Please note that this relates to HDU/ITU, and not mechnical ventilation (MV). This is management information, collected on a daily basis with a tight turnaround time. No revisions are made to the dataset; where known errors have come to light trusts have made the appropriate correction in the following day's data. As of the 24 April, the forecast metric used covers all NHS trusts other than mental health and community trusts.
	Hospital bed occupancy (including ICU beds) (SAGE 22-46)	NHS England Sitrep (all NHS trusts), field "Total number of beds occupied with confirmed COVID patients at 08:00 (Total)" Please note that this is management information, collected on a daily basis with a tight turnaround time. No revisions are made to the dataset; where known errors have come to light trusts have made the appropriate correction in the following day's data. As of the 24 April, the forecast metric used covers all NHS trusts other than mental health and community trusts.
	Hospital deaths by date of death (SAGE 22-25)	Deaths of people in hospitals with laboratory-confirmed COVID-19 . This corresponds to the daily COVID-19 deaths in England reported as part of the daily 10 Downing Street press conferences before 29 April 2020 (SAGE 29 and earlier). It is important to note that these figures are subject to reporting practices and working patterns.
	Hospital and community deaths by date of death (SAGE 23-51)	PHE line list of deaths, by date of death Deaths of people with laboratory-confirmed COVID-19. This does not include deaths of people where COVID-19 is suspected, but not laboratory confirmed - but is a more timely measure. Please note that this data was prior to the change in definition on 12 August, and this measure relates to deaths of people with laboratory-confirmed COVID-19 with no time restriction imposed. Recent data points at the time of forecast will be more uncertain due to reporting delays. More information on this change can be found in the PHE data series on deaths in people with COVID-19: technical summary: https://www.gov.uk/government/publications/phe-data-series-on-deaths-in-people-with-covid-19-technical-summary
	New and newly confirmed cases in hospital (SAGE 22-41)	NHS England Sitrep, sum of fields "Number of inpatients diagnosed with COVID-19 in last 24 hours (Total)" and "Number of patients admitted with COVID-19 in last 24 hours (Total)". Please note that this is management information, collected on a daily basis with a tight turnaround time. No revisions are made to the dataset; where known errors have come to light trusts have made the appropriate correction in the following day's data. As of the 24 April, the forecast metric used covers all NHS trusts other than mental health and community trusts.

Short-term forecasts

As of 7 April 2020

Pilot

Models:

- *Imperial*: micro simulation based fitted to multiple data streams
- *LSHTM:* branching process fitted to new cases in hospital; combined with a time series model to forecast trends in transmission
- *Manch/Oxf*: deterministic SEIR model via MLE fitted to new cases in hospital
- *PHE*: deterministic transmission model combined with a disease reporting model, fitted to deaths by date
- *Warwick*: age-structured SEIR model fitted to multiple data streams

Forecasts: 2 weeks ahead

- *ICU beds occupied*: number of patients with COVID-19 in HDU/ITU at any time
- *Total beds occupied*: number of patients with COVID-19 in any bed (including HDU/ITU) at any time
- *Hospital deaths (by date of report)*: number of deaths due to COVID-19 as per PHE dashboard, recording hospital deaths only by date of registration
- *All deaths (by date of death)*: number of deaths due to COVID-19 as per PHE deaths line list
- *New and newly confirmed patients in hospital:* new admissions of patients previously tested positive for COVID-19 and new positive test results of inpatients

General notes:

Forecasts are shown by individual models and aggregated. Models are aggregated by fitting a normal distribution to each individual predictive distribution and combining them in a normal mixture distribution with equal weights.

Two measures of deaths are presented:

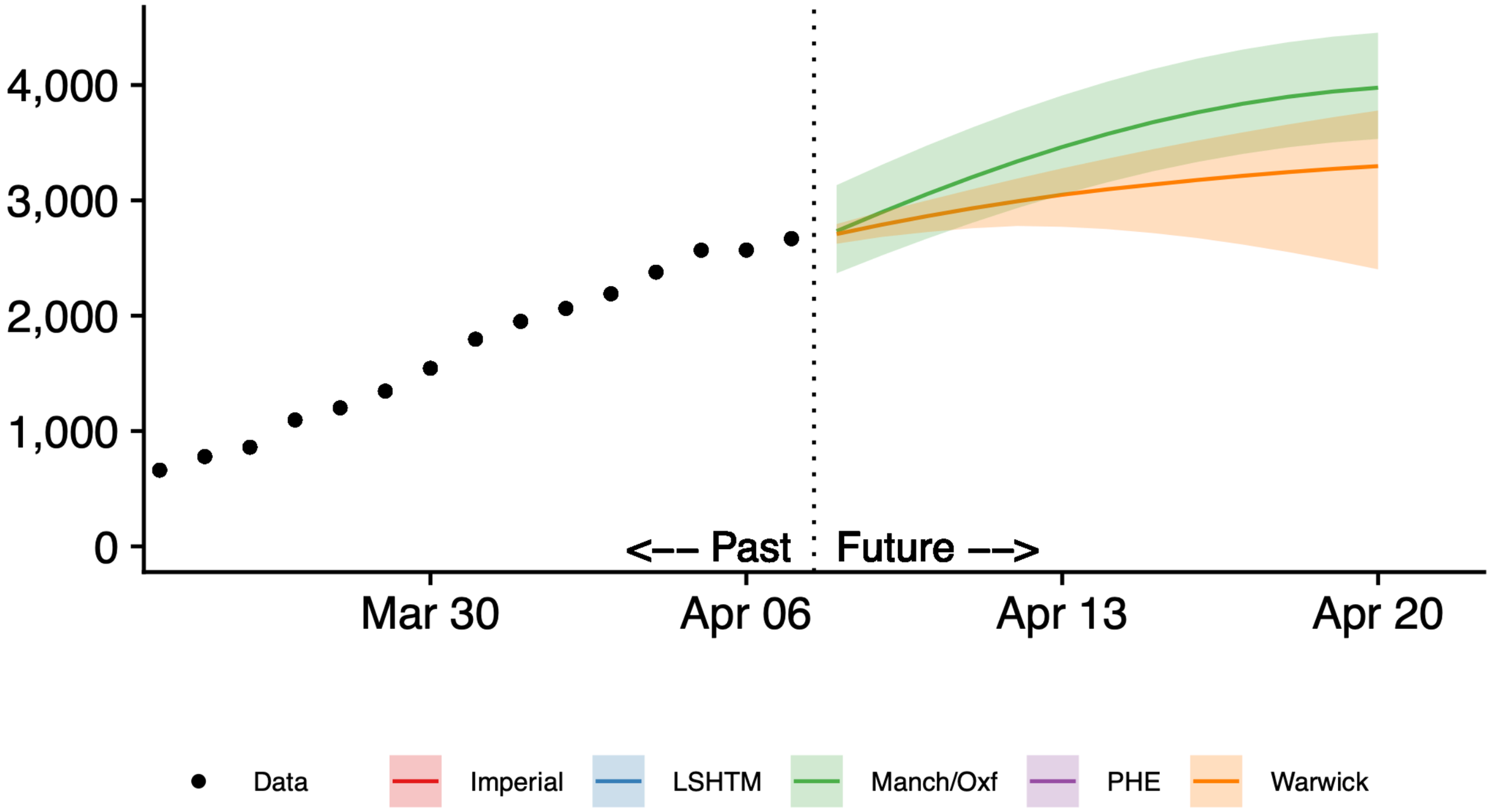
1. All deaths by death of death; this is subject to right truncation because of delays in reporting. The four most recent data points are coloured in grey.
2. Hospital deaths by date of report; this corresponds to the daily headline figure reported by DHSC.

Only 2 weeks of data are shown, but data going back longer are used to inform the models.

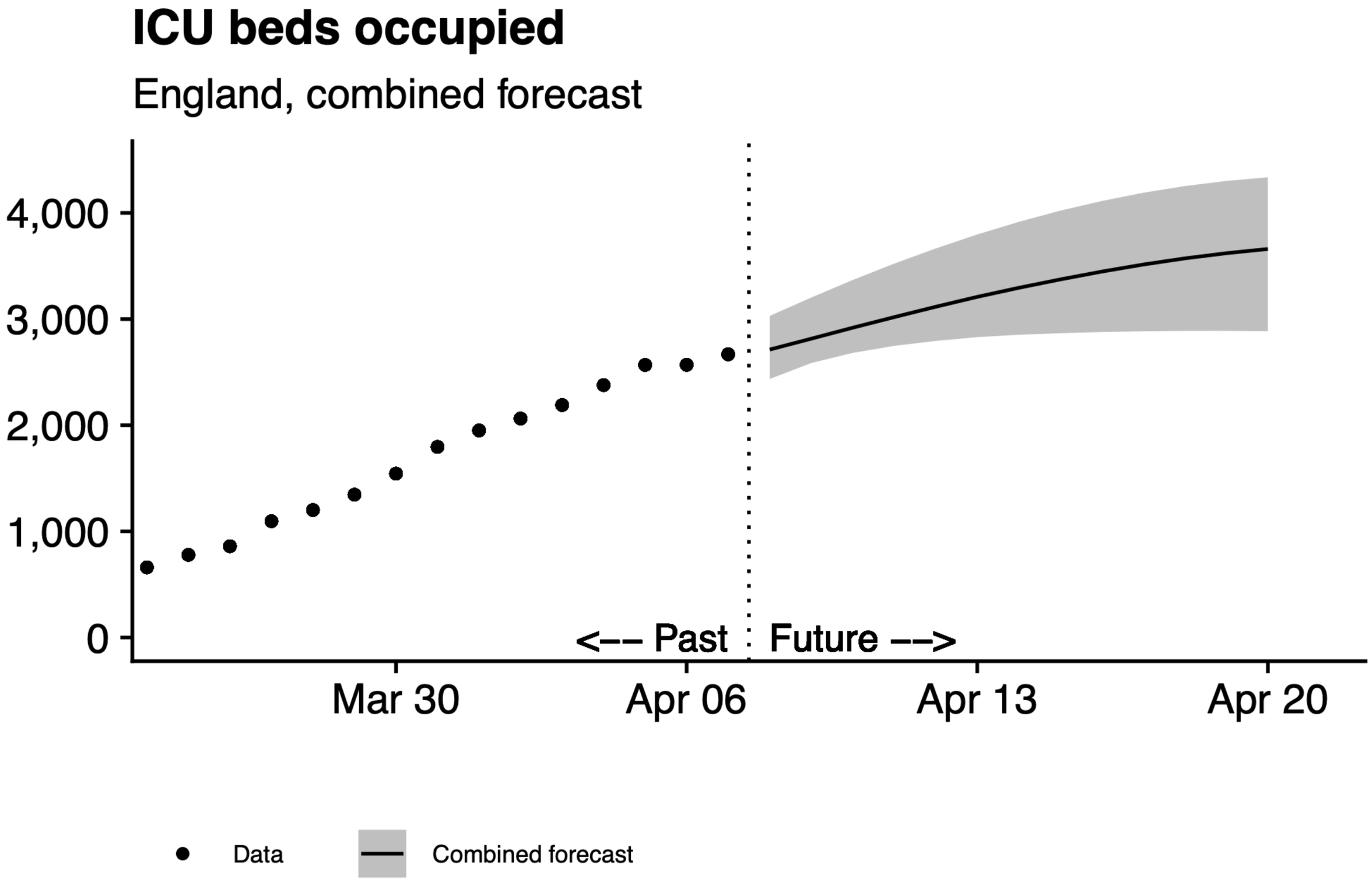
Not all models currently make all forecasts for all geographies. Only forecasts and geographies with more than two models producing forecasts are shown. Other geographies (Wales/Scotland/Northern Ireland) and forecasts (total number of infections) are being produced but are not shown because they are each currently only included in a single model. More teams are beginning to make forecasts from these, and they will be included in these plots in the future.

ICU beds occupied

England, individual forecasts.



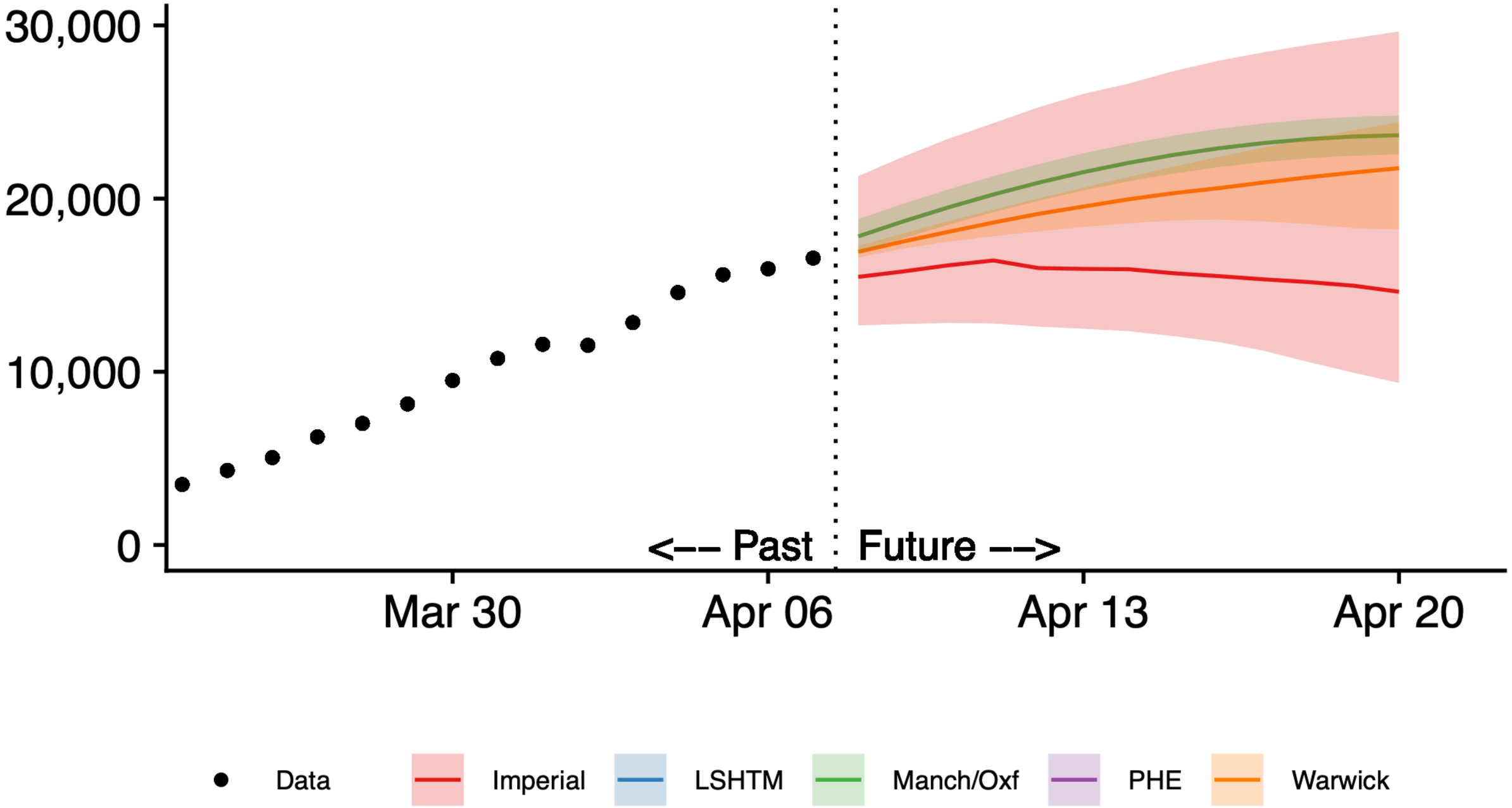
Note: Total number of ICU beds occupied on any given day. This depends on the distribution of lengths of stay, which is estimated separately for the different models from different data sources. We will work with NHS England to evolve this understanding.
Data: NHSE SitReps. Shaded area: 90% confidence.



Note: Total number of ICU beds occupied on any given day. This depends on the distribution of lengths of stay, which is estimated separately for the different models from different data sources. We will work with NHS England to evolve this understanding.
Data: NHSE SitReps. Shaded area: 90% confidence.

Total beds occupied

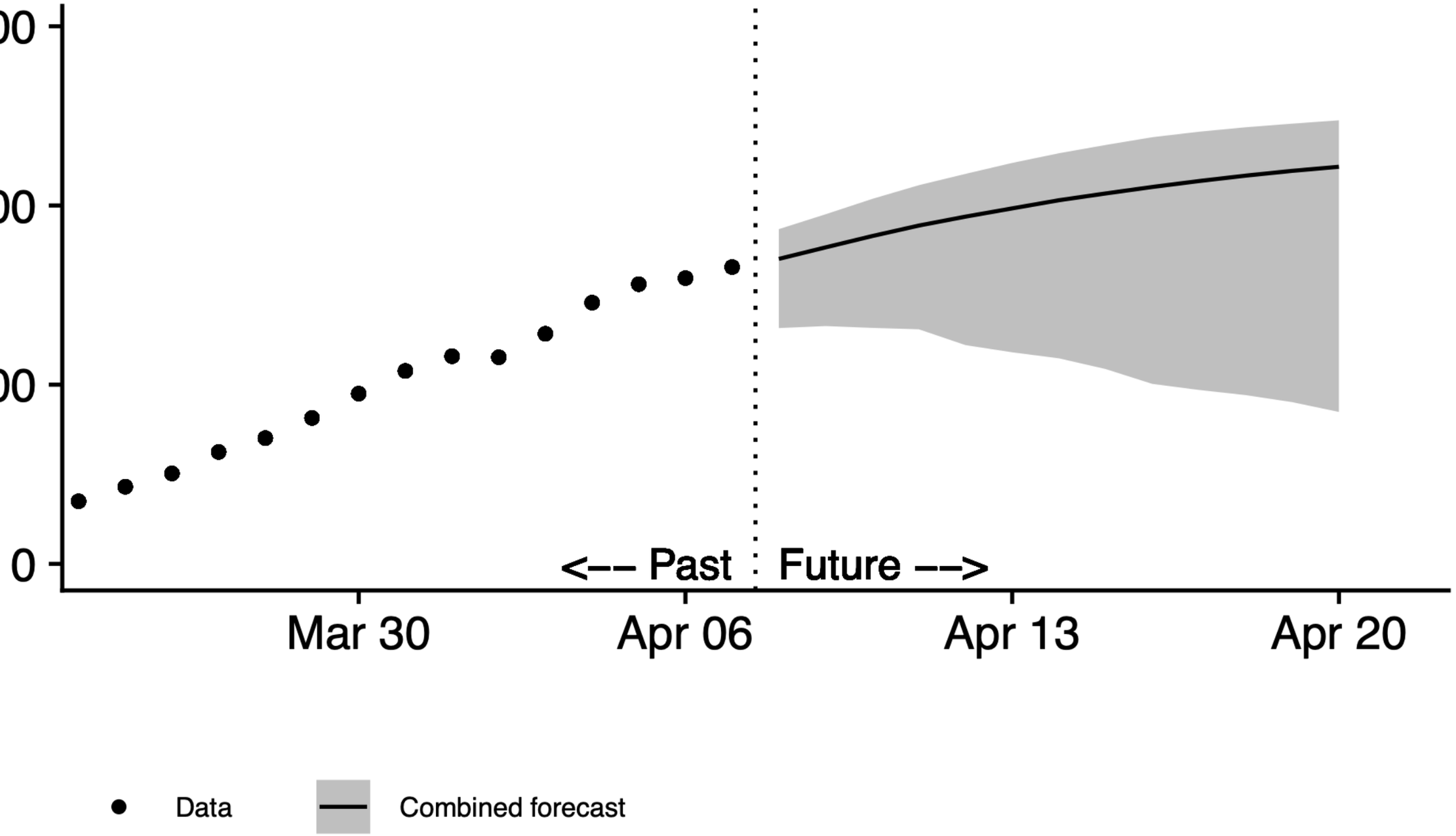
England, individual forecasts



Note: Total number of beds (including ICU) occupied on any given day. This depends on the distribution of lengths of stay, which is estimated separately for the different models from different data sources. We will work with NHS England to evolve this understanding. Data: NHSE SitReps. Shaded area: 90% confidence.

Total beds occupied

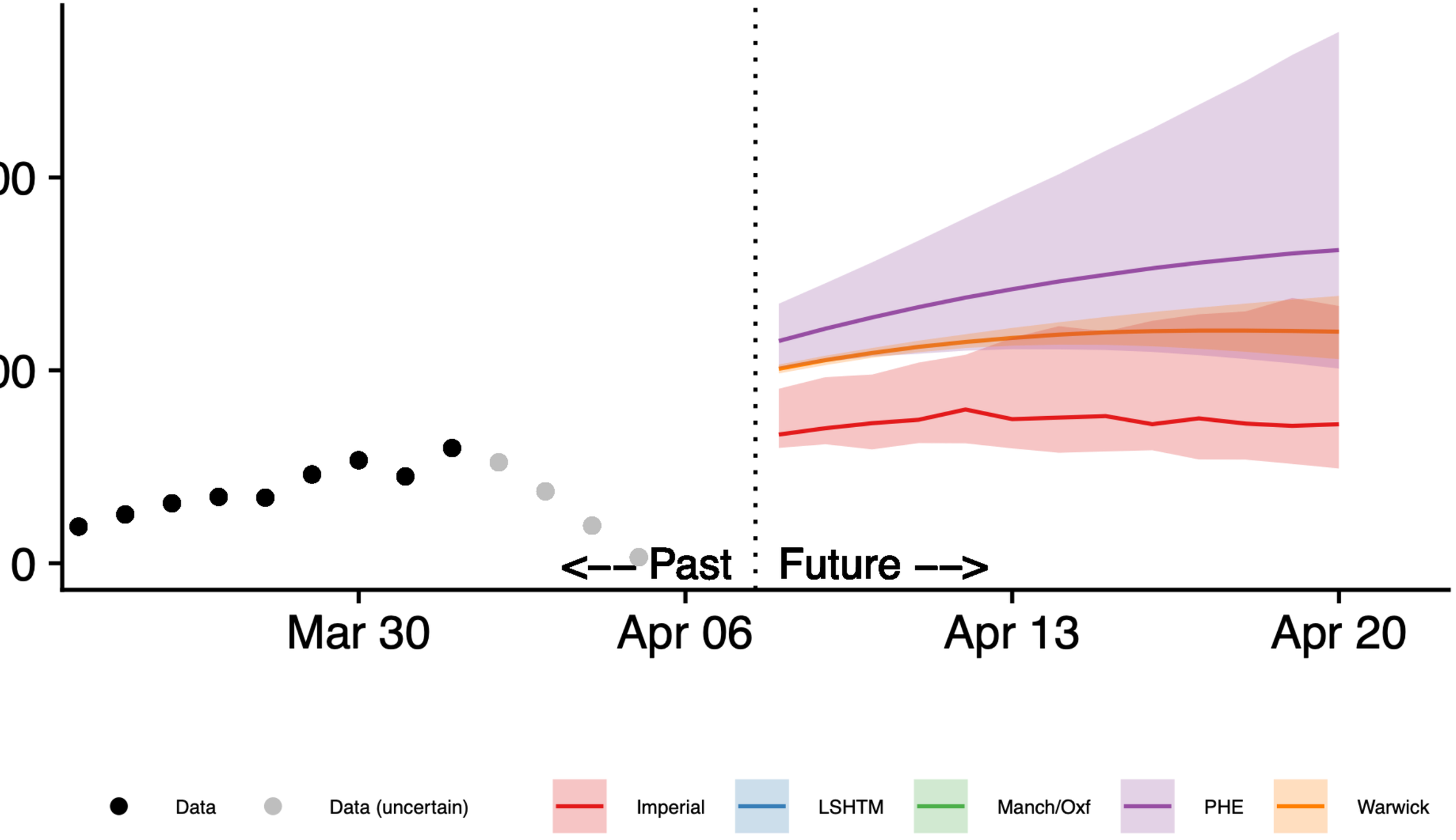
England, combined forecast



Note: Total number of beds (including ICU) occupied on any given day. This depends on the distribution of lengths of stay, which is estimated separately for the different models from different data sources. We will work with NHS England to evolve this understanding. Data: NHSE SitReps. Shaded area: 90% confidence.

All deaths (by date of death)

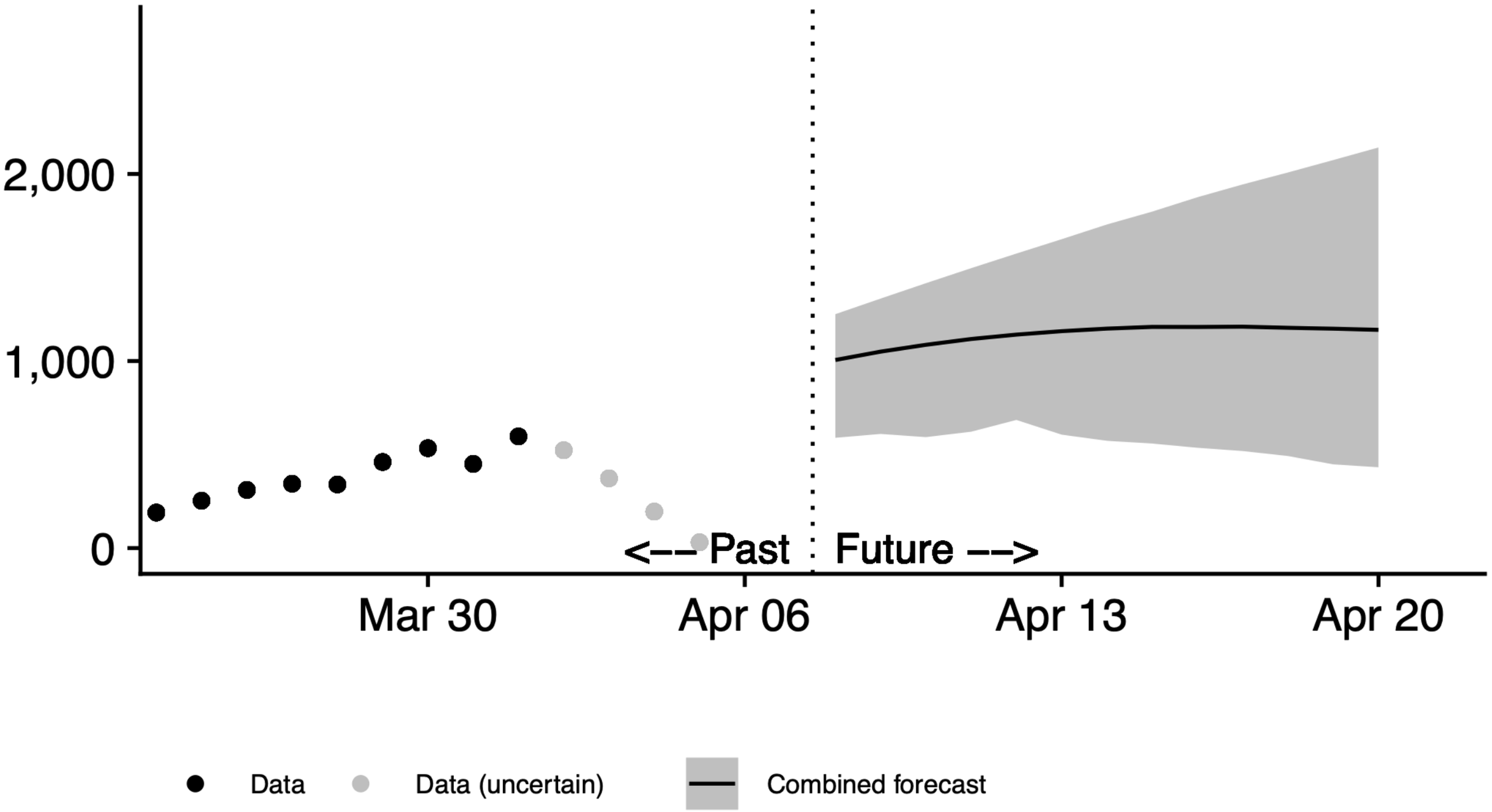
England, individual forecasts



Note: Subject to uncertainty as recent deaths may not have entered the data base yet.
Data: PHE line list of deaths. Shaded area: 90% confidence.

All deaths (by date of death)

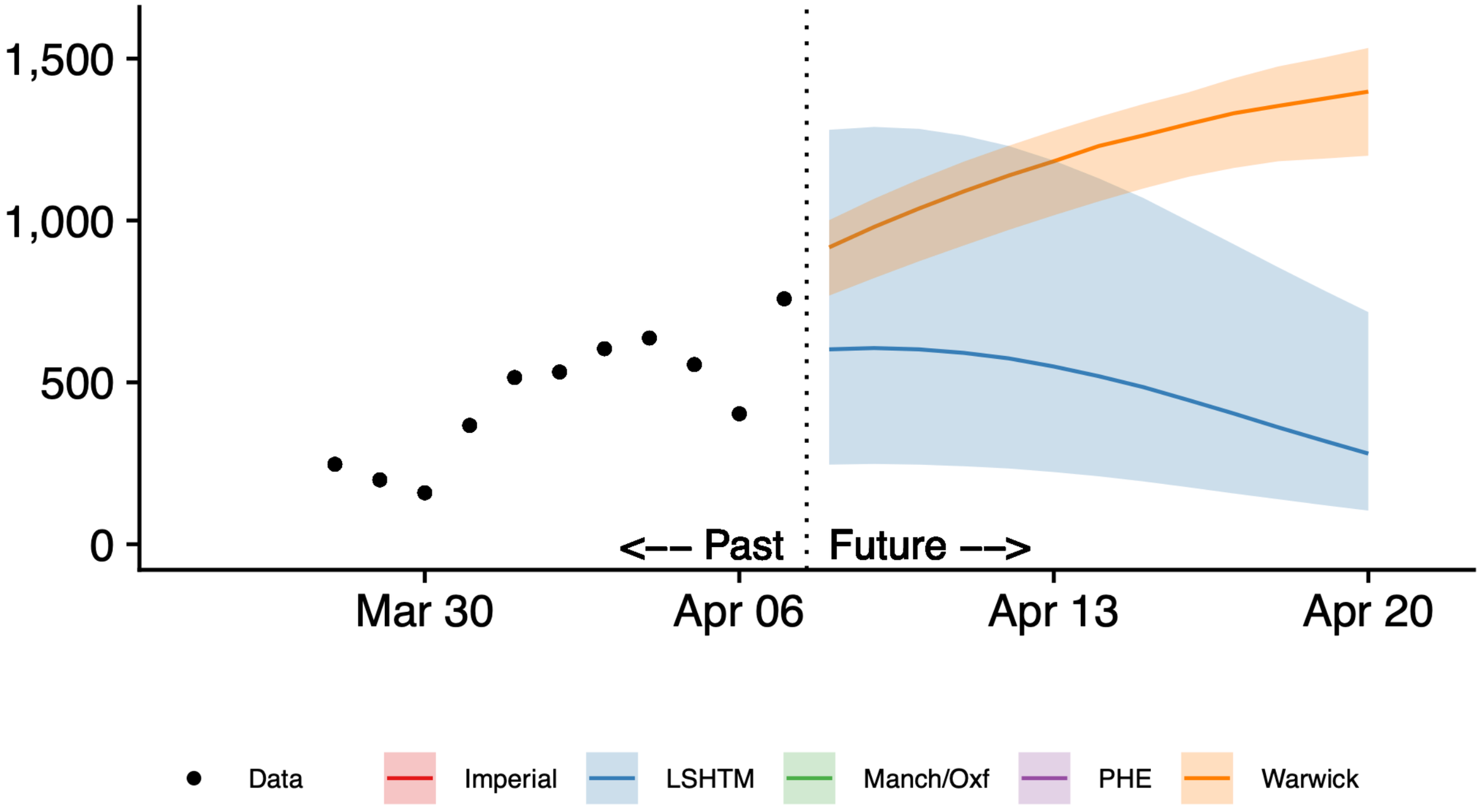
England, combined forecast



Note: Subject to uncertainty as recent deaths may not have entered the data base yet.
Data: PHE line list of deaths. Shaded area: 90% confidence.

Hospital deaths (by date of report)

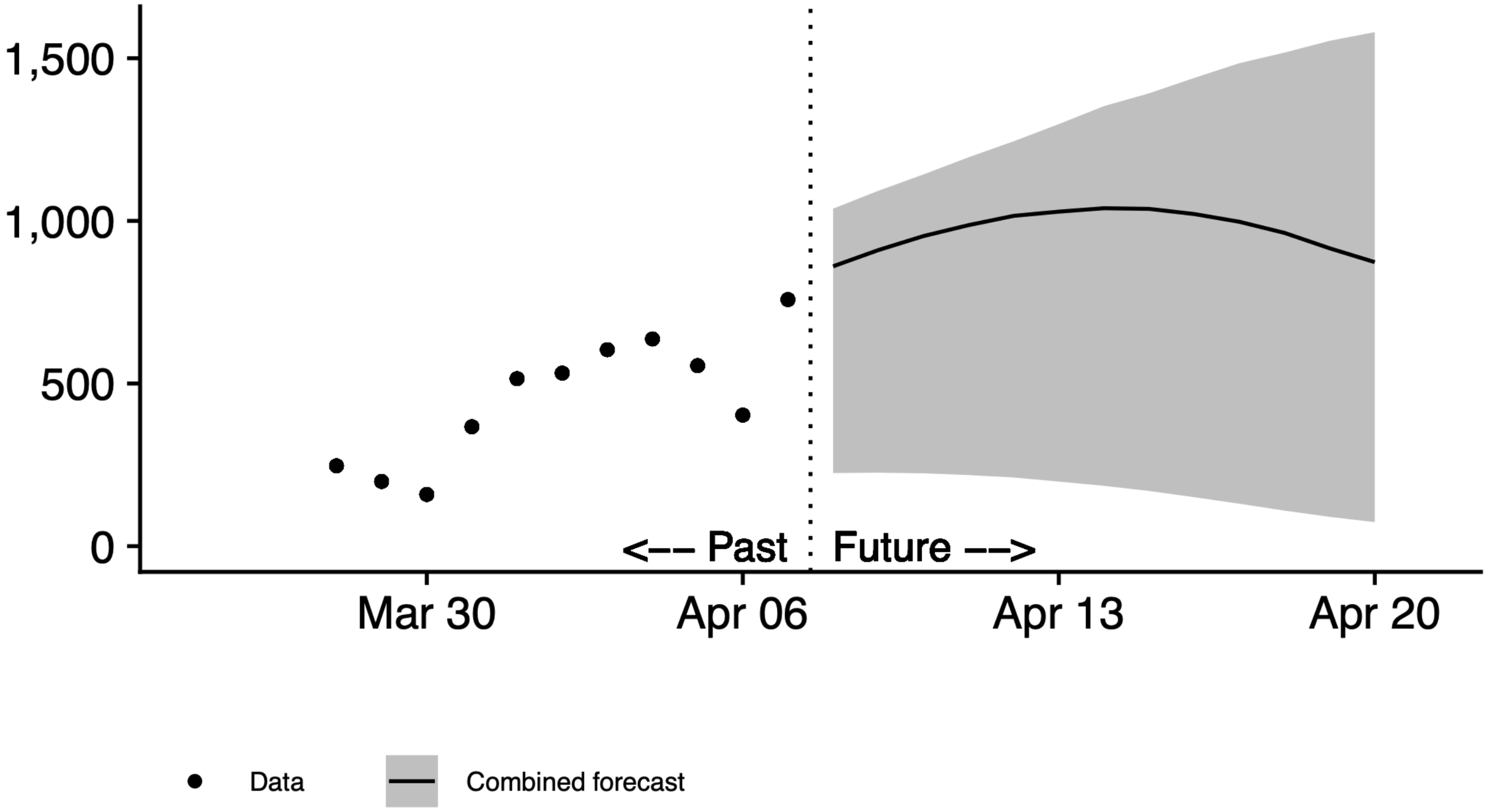
England, individual forecasts



Note: Number of reported deaths in hospital corresponding to the daily report by DHSC. Data: PHE dashboard. Shaded area: 90% confidence.

Hospital deaths (by date of report)

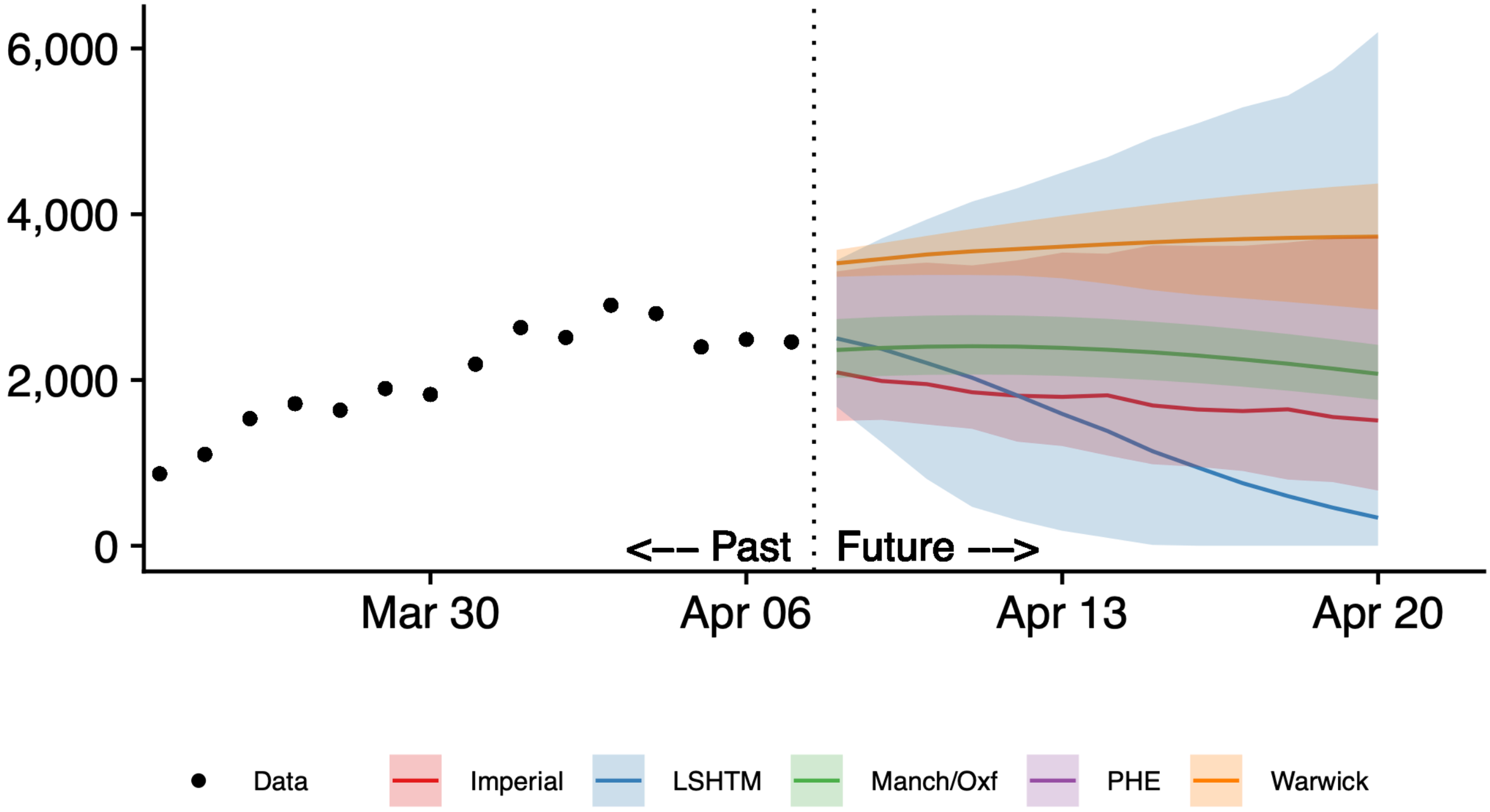
England, combined forecast



Note: Number of reported deaths in hospital corresponding to the daily report by DHSC. Data: PHE dashboard. Shaded area: 90% confidence.

New and newly confirmed patients in hospital

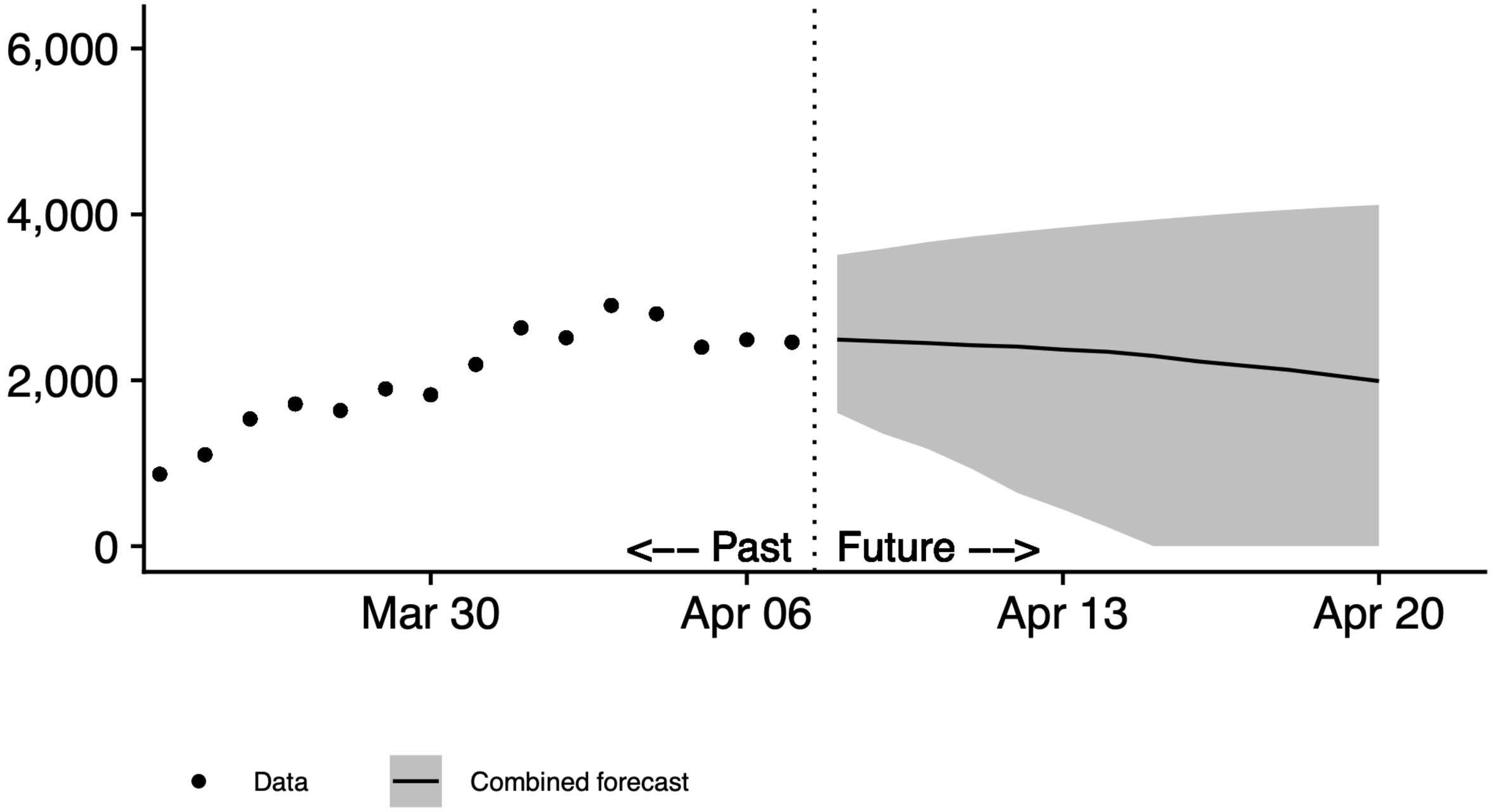
England, individual forecasts.



Note: Includes new admissions that tested positive, new admissions that were tested positive prior to admission, and existing patients that tested positive.
Data: NHSE SitReps. Shaded area: 90% confidence.

New and newly confirmed patients in hospital

England, combined forecast



Note: Includes new admissions that tested positive, new admissions that were tested positive prior to admission, and existing patients that tested positive.
Data: NHSE SitReps. Shaded area: 90% confidence.