

› **COVID-19 SEIR-MODEL TNO : UPDATE APRIL 9 2020**
JAN-DIEDERIK VAN WEES

› **CONTENT**

COVID-19 EFFICIENT SEIR-MODEL TNO: UPDATE APRIL 9 2020

01. MODEL INTRODUCTION

02. DATA 9 APRIL, MODEL UPDATE

03. RESULTS

04. DISCUSSION AND CONCLUSION

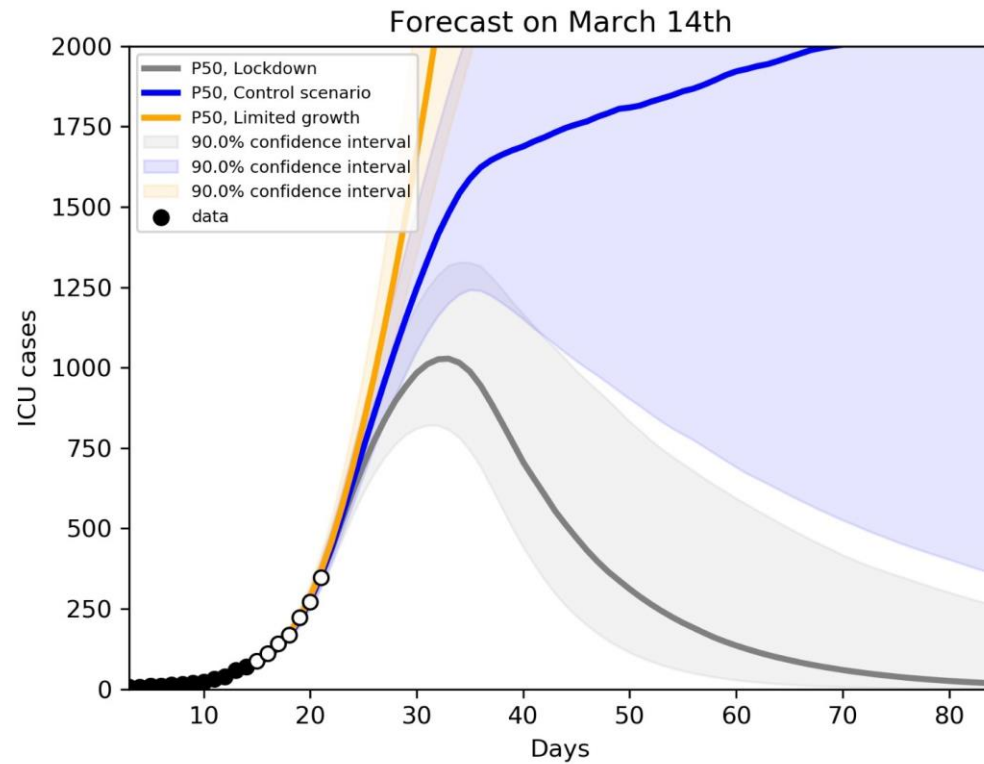
› MODEL

TNO COVID-SEIR MODEL

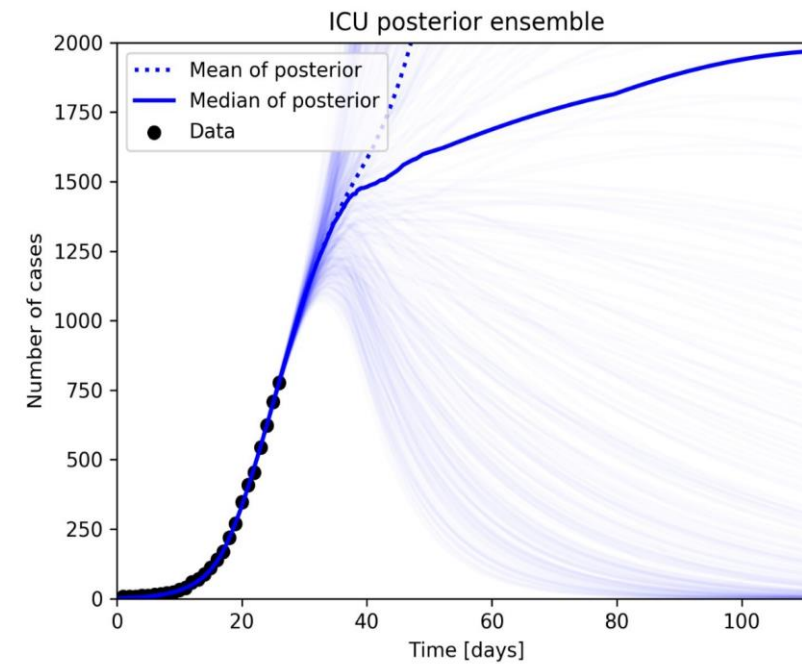
- › Developed jointly with MD of Amsterdam UMC, publication submitted to WHO bulletin
 - › Publication https://www.who.int/bulletin/online_first/covid-19/en/ <http://dx.doi.org/10.2471/BLT.20.256743>
 - › Open access github <https://github.com/TNO/Covid-SEIR>
- › status
 - › Ensemble based & data calibration (log likelihood and Ensemble Smoother): calibration for R_0^A and social distancing through time (reduction of R_0^A by $(1-\alpha)$)
 - › aggregated $R_0^A \sim 3.4$ (Netherlands)
 - › Calibration on hospital patients (but can also be on mortalities or ICU)
 - › Fastly running, <1 minute on laptop, postprocessing with confidence plots
- › For the Netherlands very good results for the period 14-27 of march (see next slide)

MODEL

PREDICTIONS MARCH 14, 26 ICU



Forecast March 26-control scenario

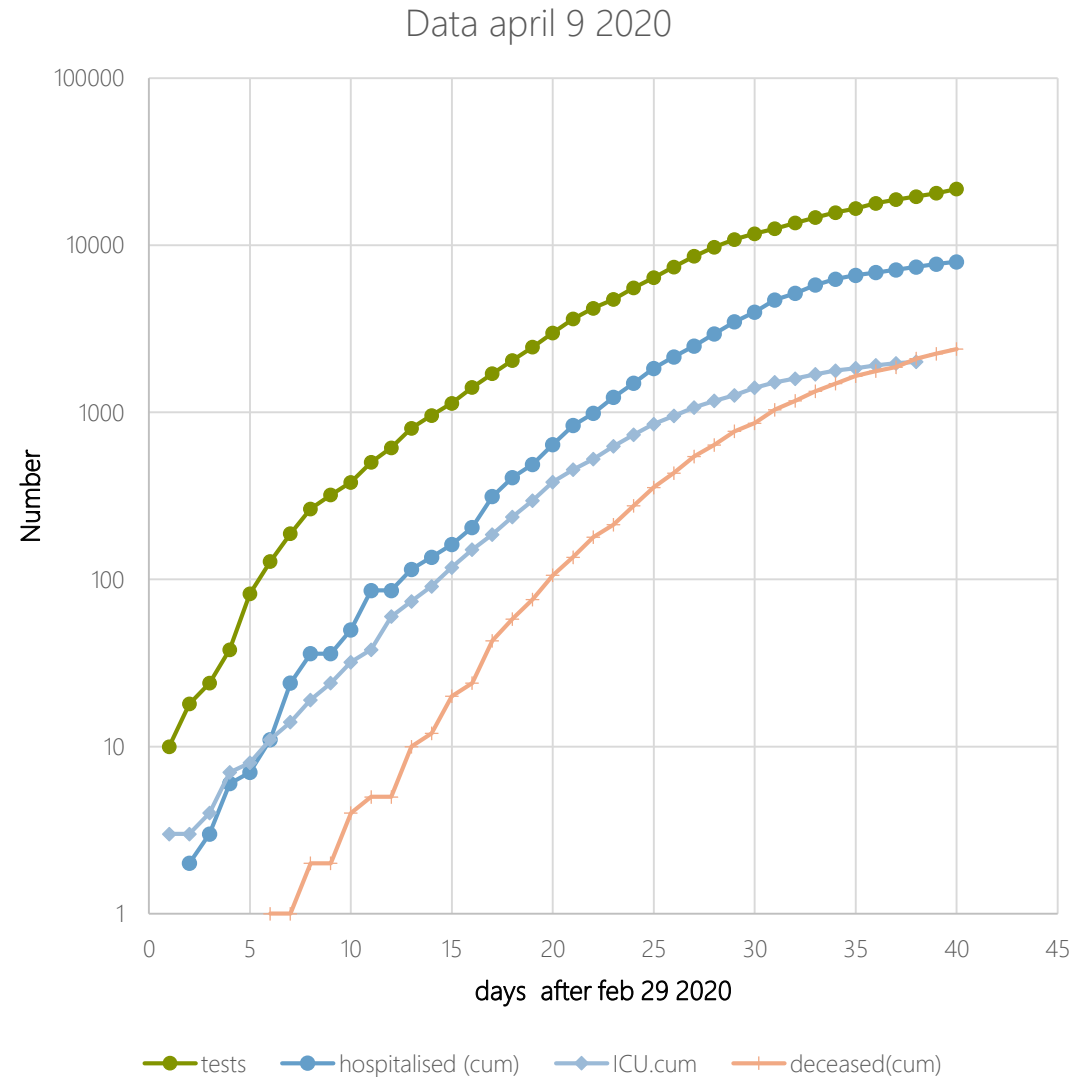


https://www.who.int/bulletin/online_first/covid-19/en/ <http://dx.doi.org/10.2471/BLT.20.256743>

› ACTUAL DATA TESTS, PATIENTS, MORTALITIES, ICU

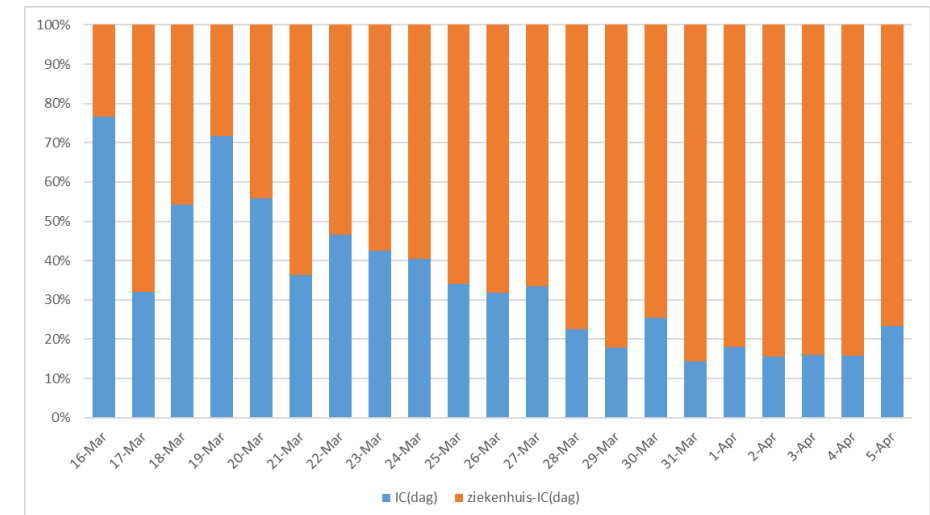
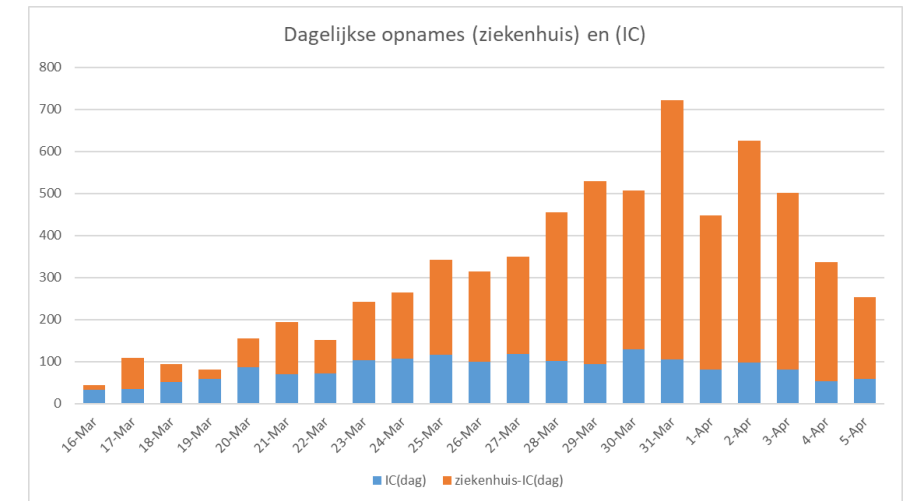
- › Positive tests keep increasing
- › Reduced intake hospital
- › ICU progressively lags behind patients
 - › Initially high, more than 50% to ICU
 - › Since march 28 less than 20%
- › mortalities
 - › Follows hospitalized
 - › CFR hospitalized > 20%

Sources: RIVM, stichting NICE, NOS



› RELATIONSHIP HOSPITALIZATION AND ICU RATES

- › Hospitalization rates (source RIVM)
- › ICU rates (source stichting Nice)
- › IC fraction lower through time
- › In the model we therefore assume that ratio of hospitalized patients flowing to ICU varies through time
- › From April 4 we take 17%, as data is not complete on ICU



› ANALYSIS OF TRANSIT TIMES IN ICU OF COVID-19 PATIENTS FROM DATA NICE (APRIL 7)

› Best fit (delay and Gaussian smoothing)

› Mortality 8 days, stddev 5 days

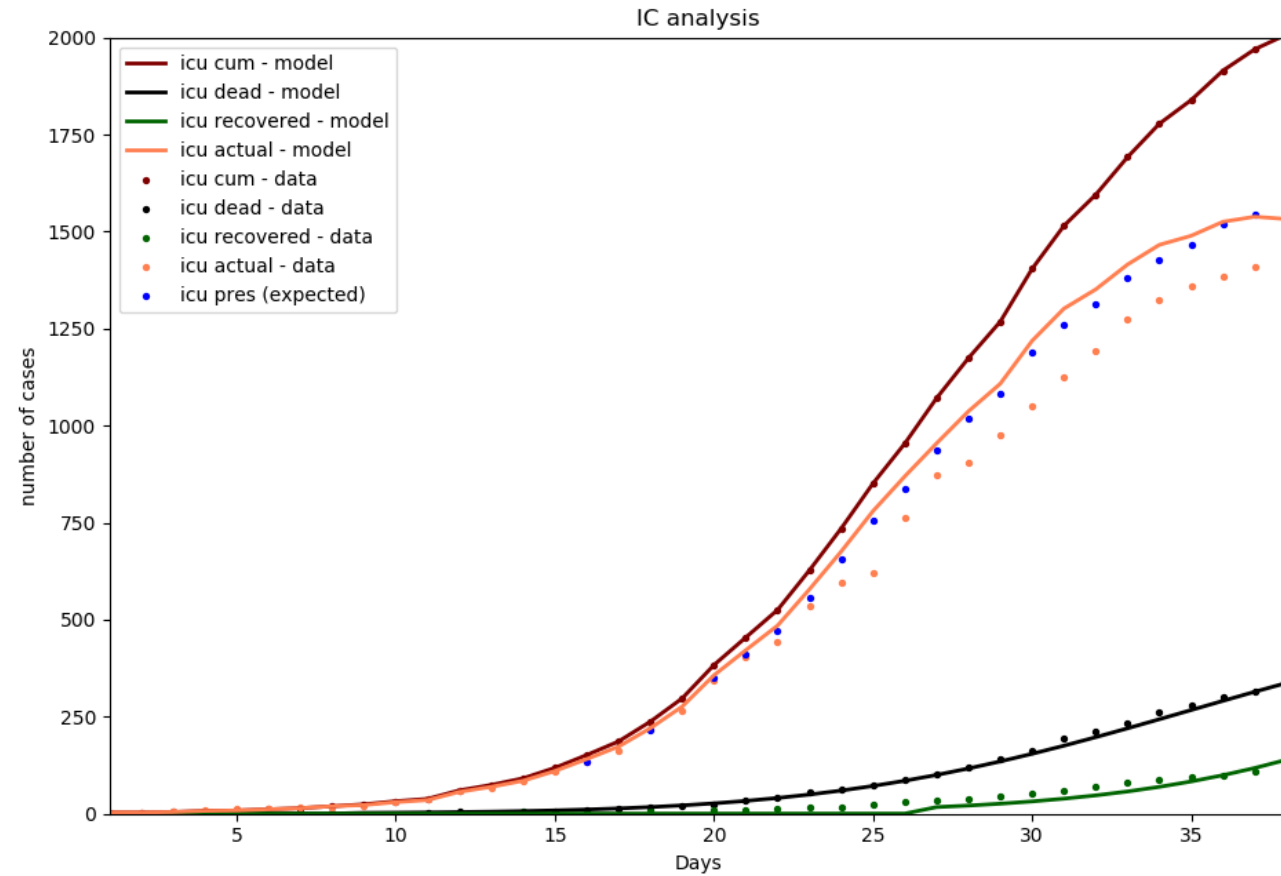
› CFR (25%)

› Recovery 26 days, stddev 8 days

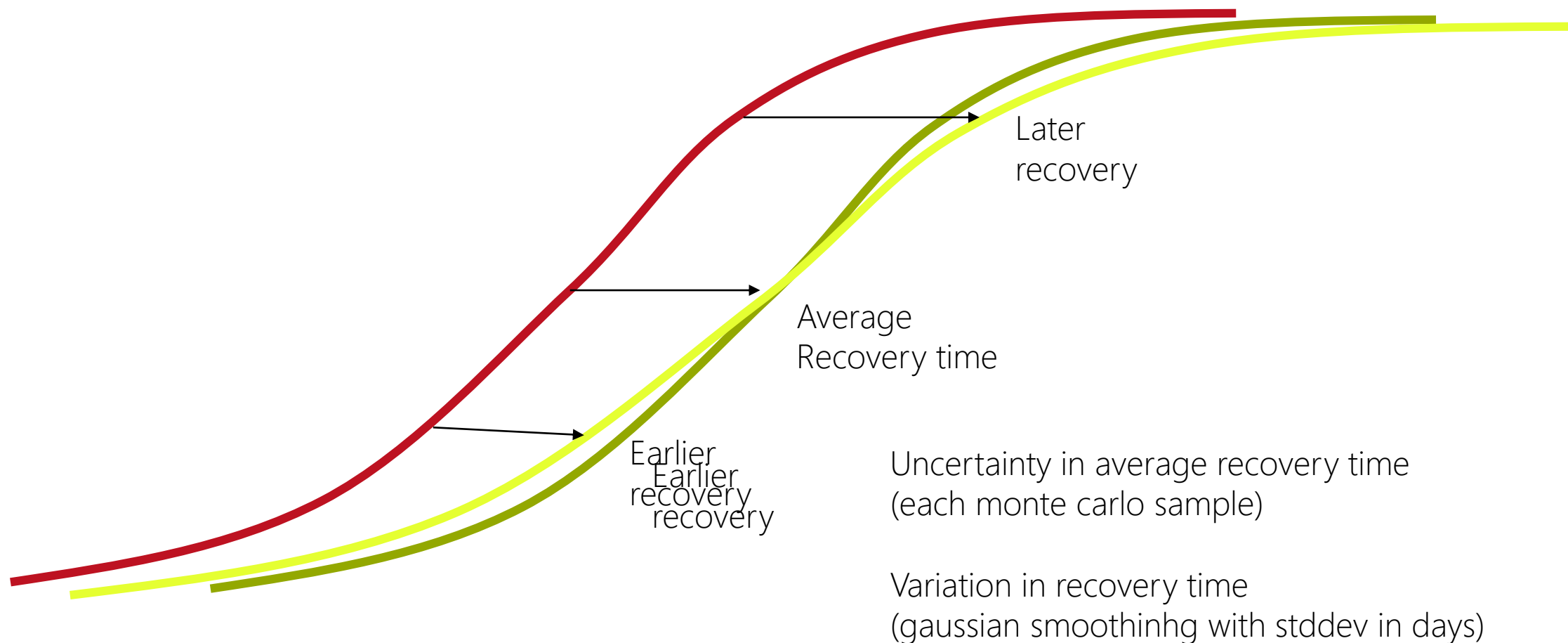
› $\text{Icu-actual} \neq \text{Icu cum} - \text{Icu dead} - \text{Icu recovered}$

› $\text{Icu-pres (expected)} = \text{Icu cum} - \text{Icu dead} - \text{Icu recovered}$

April 7: D. Gommers: ICU CFR ca 30%

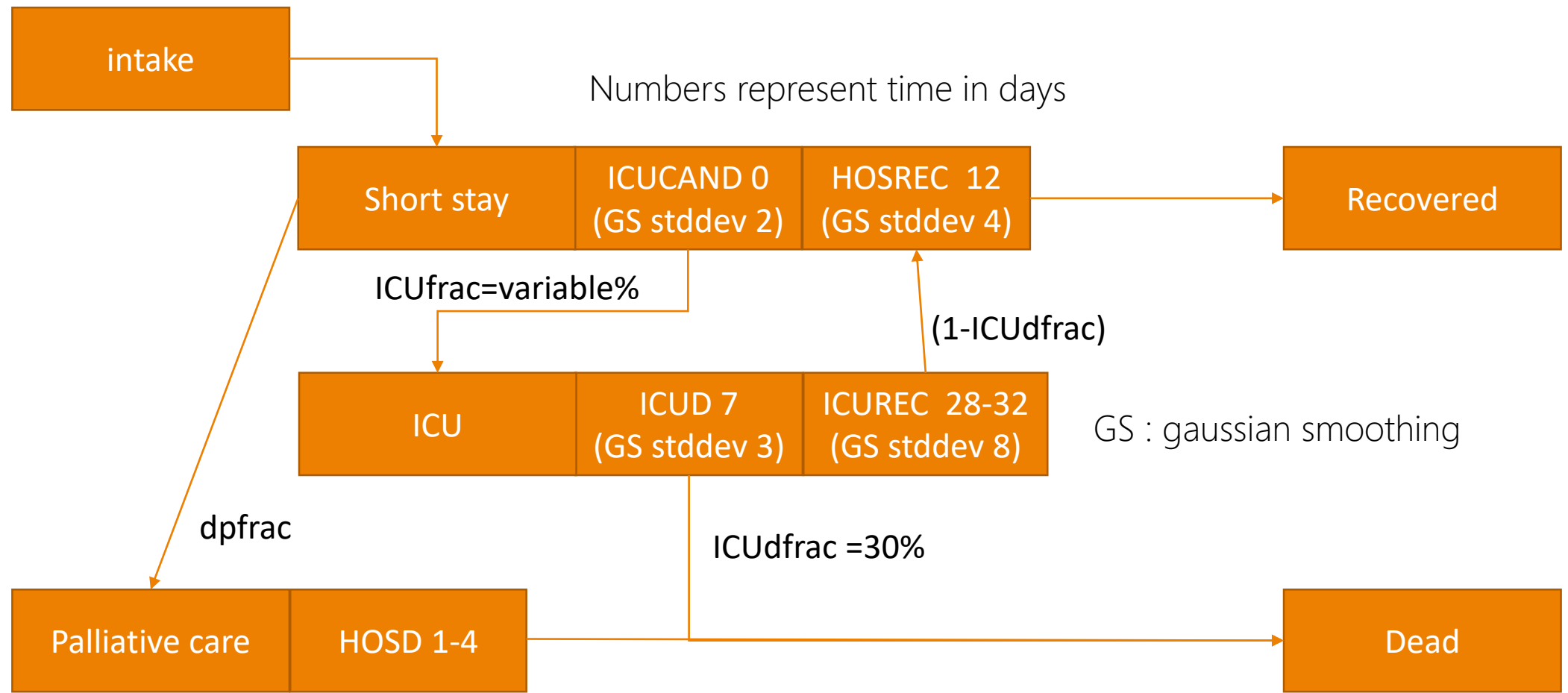


GAUSSIAN SMOOTHING TO TAKE INTO ACCOUNT SPREAD IN FLOW IN HOSPITAL



ASSUMPTIONS FOR FLOW OF HOSPITALIZED PATIENTS AND ICU

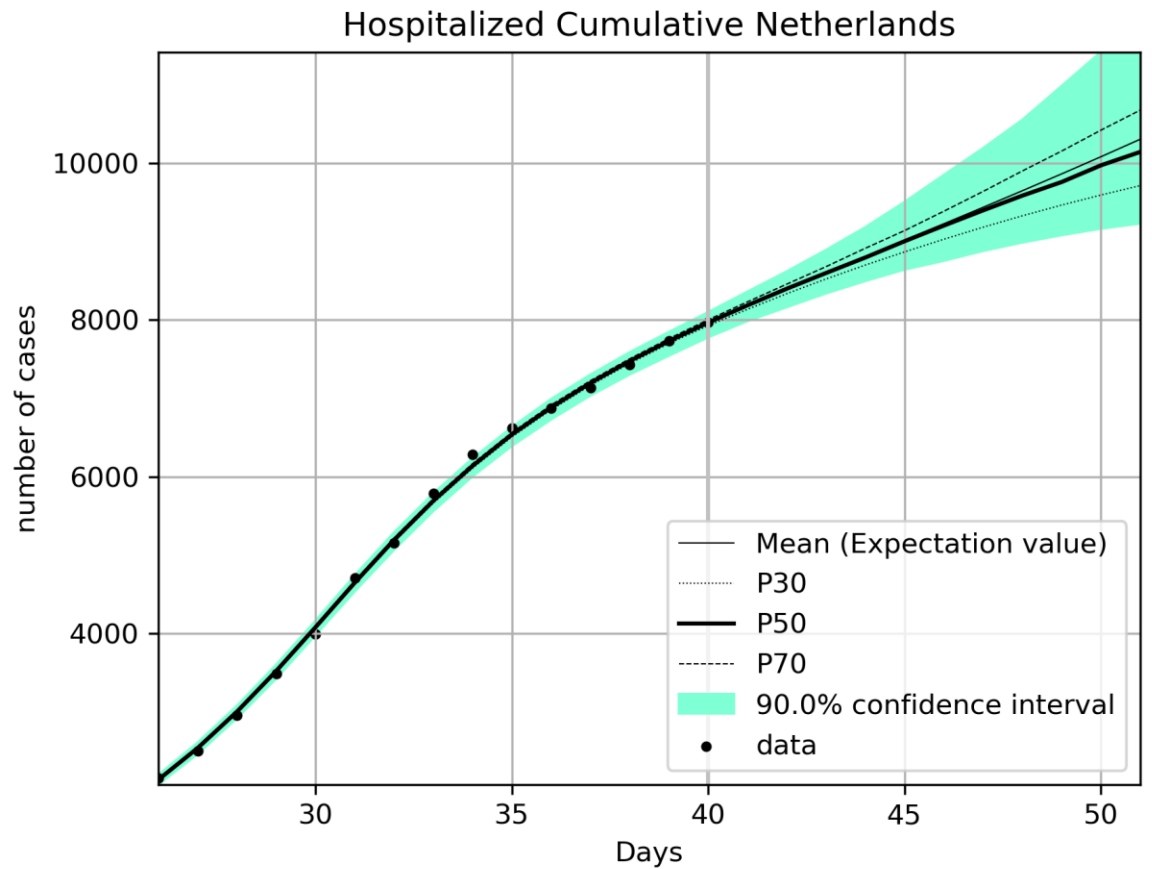
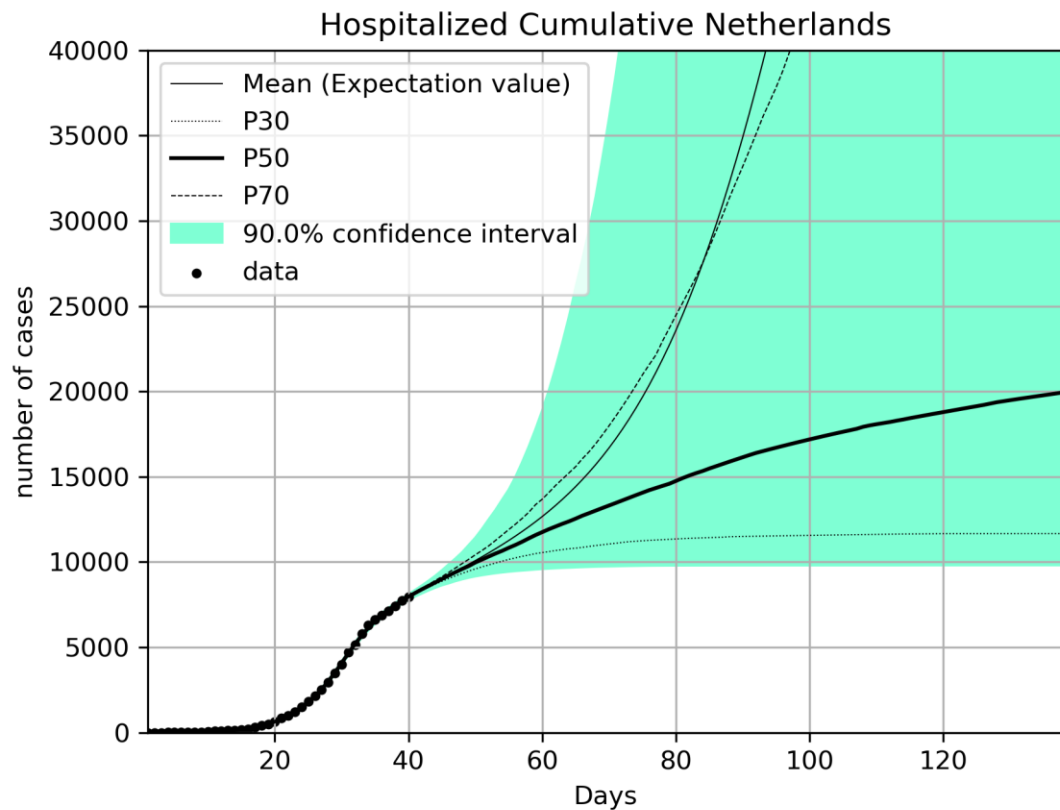
11 days between infection and hospitalization (may be as low as 7 days, longer assumed including registration delays)



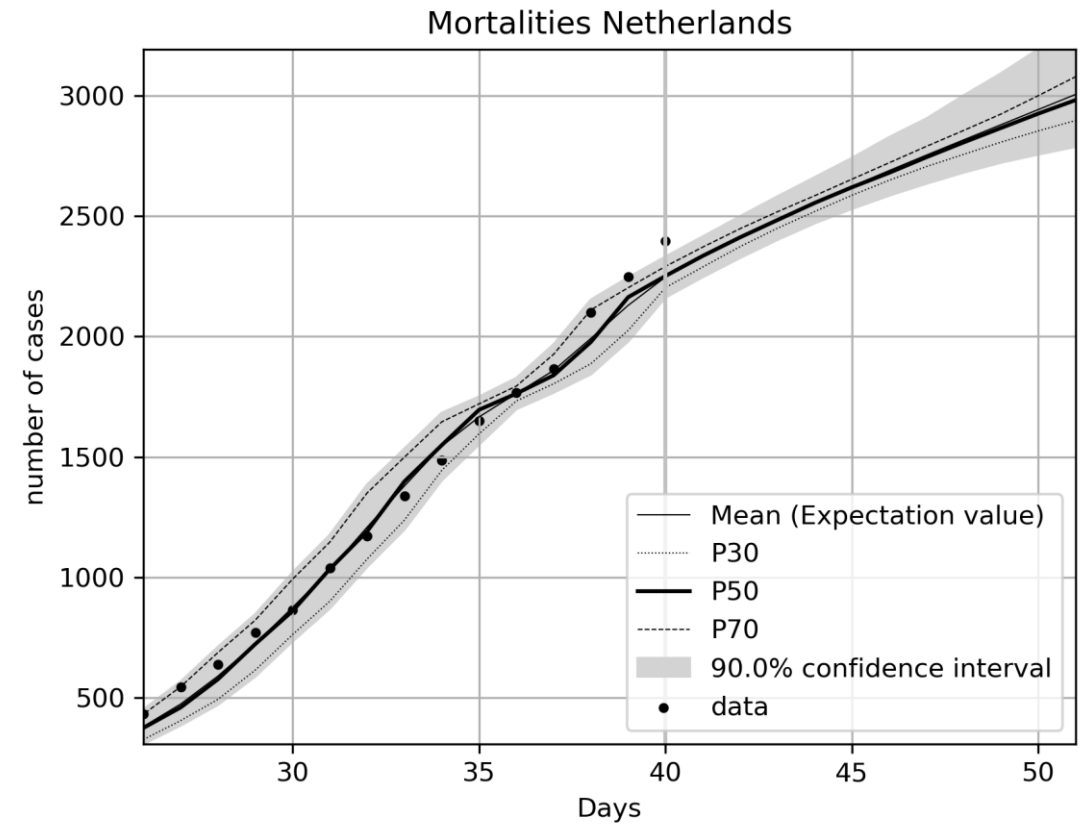
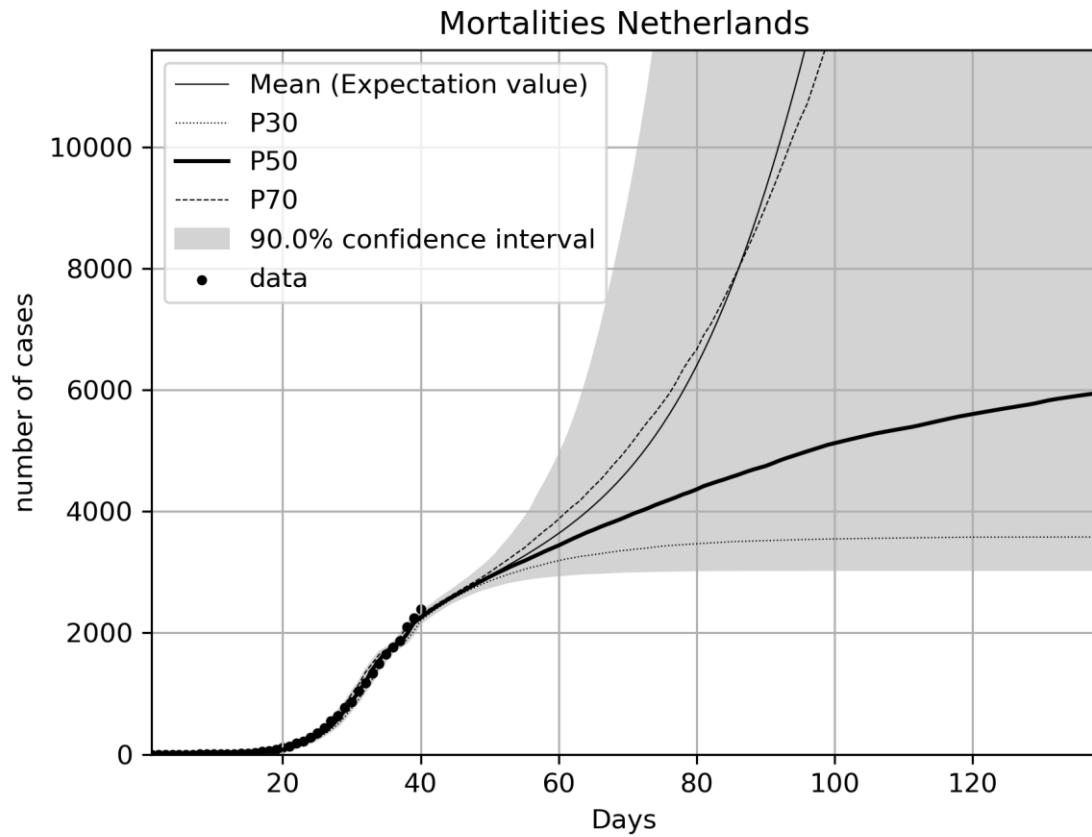
CFR (hospitalized) = dfrac = 29%

$$dpfrac = (dfrac - ICUfrac * ICUdfrac) / (1 - ICUfrac)$$

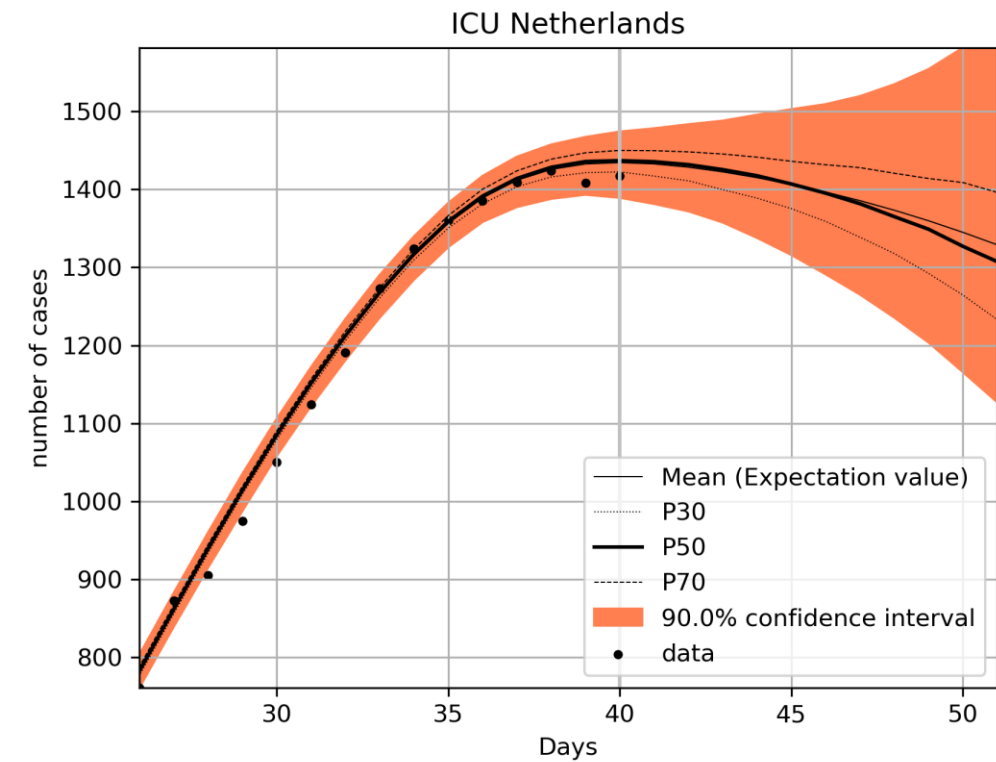
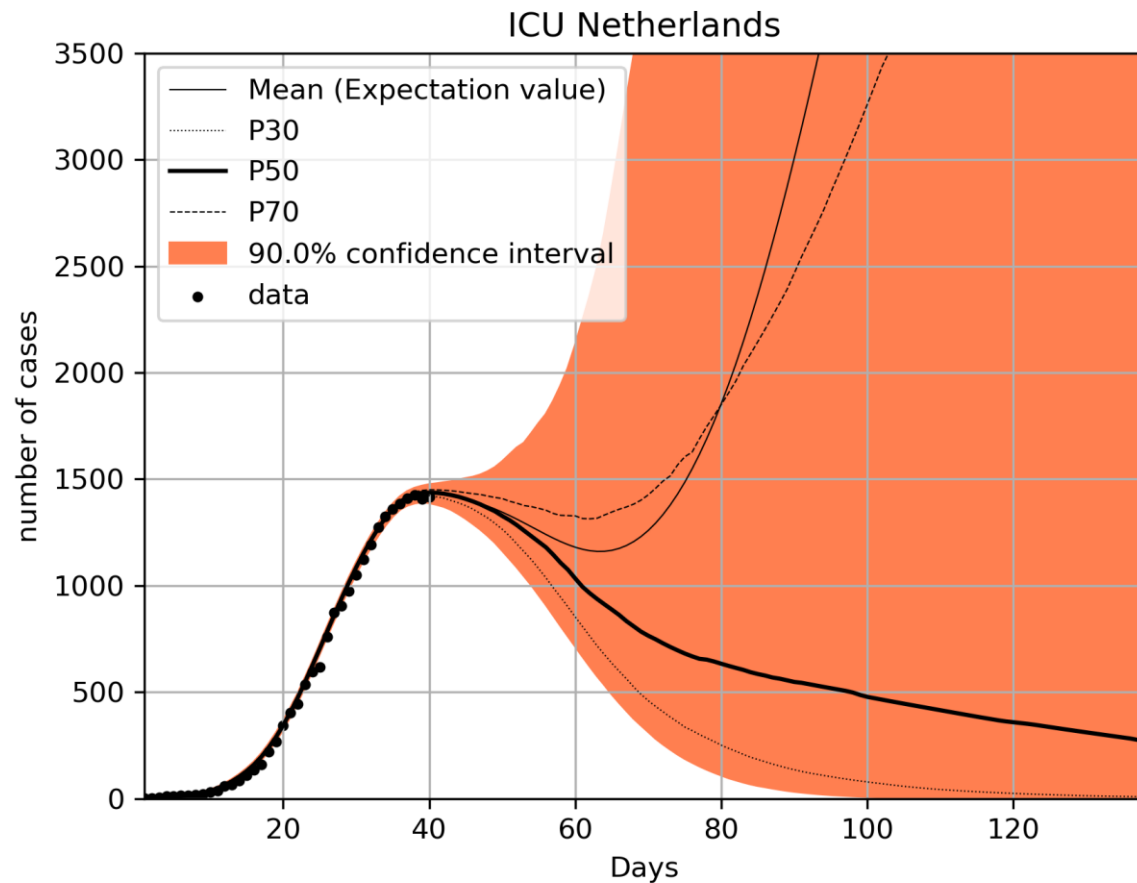
› RESULTS –ENSEMBLE SMOOTHER (ESMDA) ON HOSPITALIZATION



› RESULTS – MORTALITIES

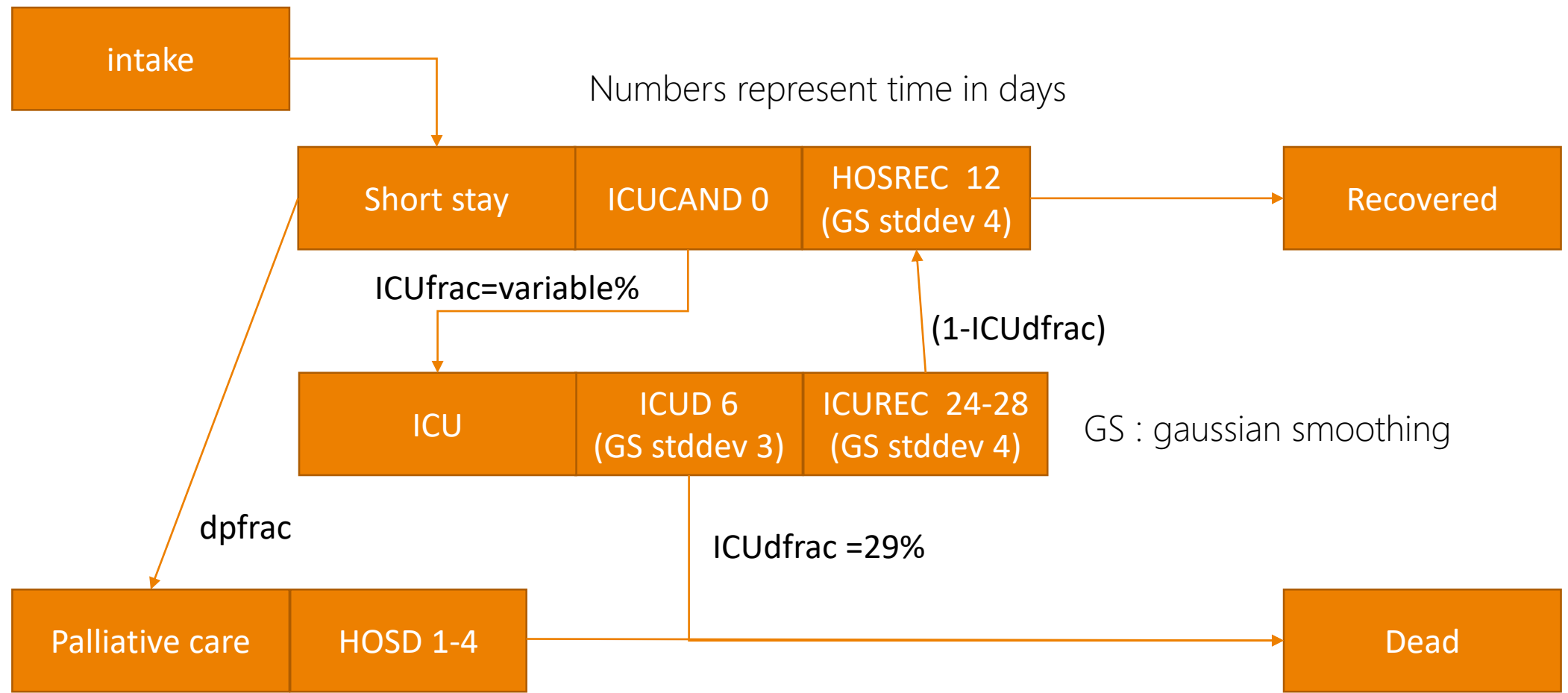


RESULTS – ICU DATA DAY 33-40 SOURCE NOS, ICU RATES 17% FROM DAY 40



› ALTERNATIVE MODEL WITH LOWER PEAK

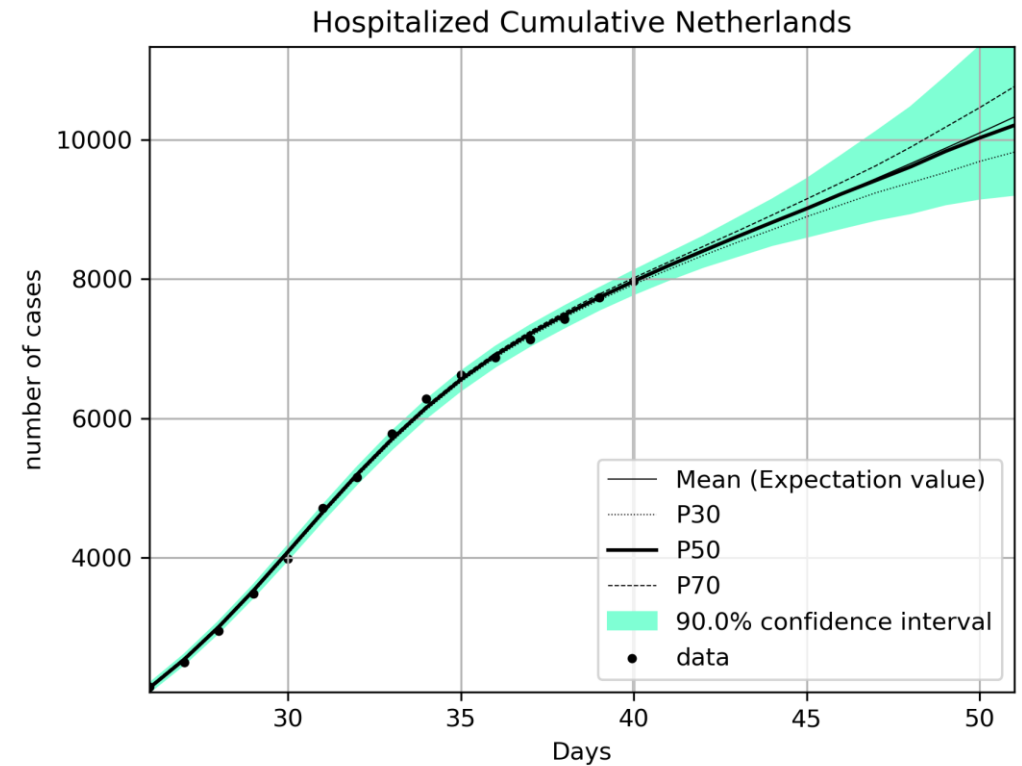
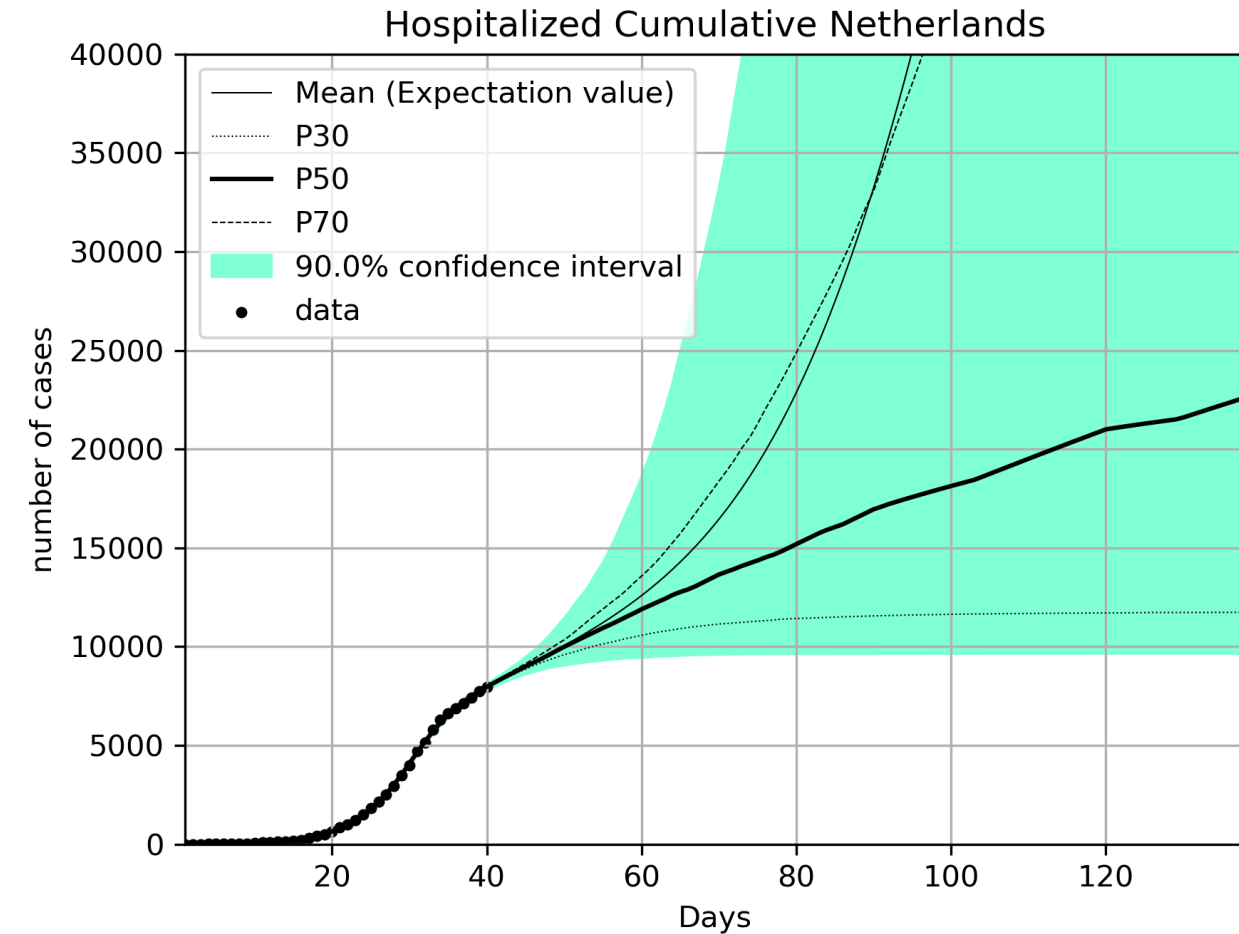
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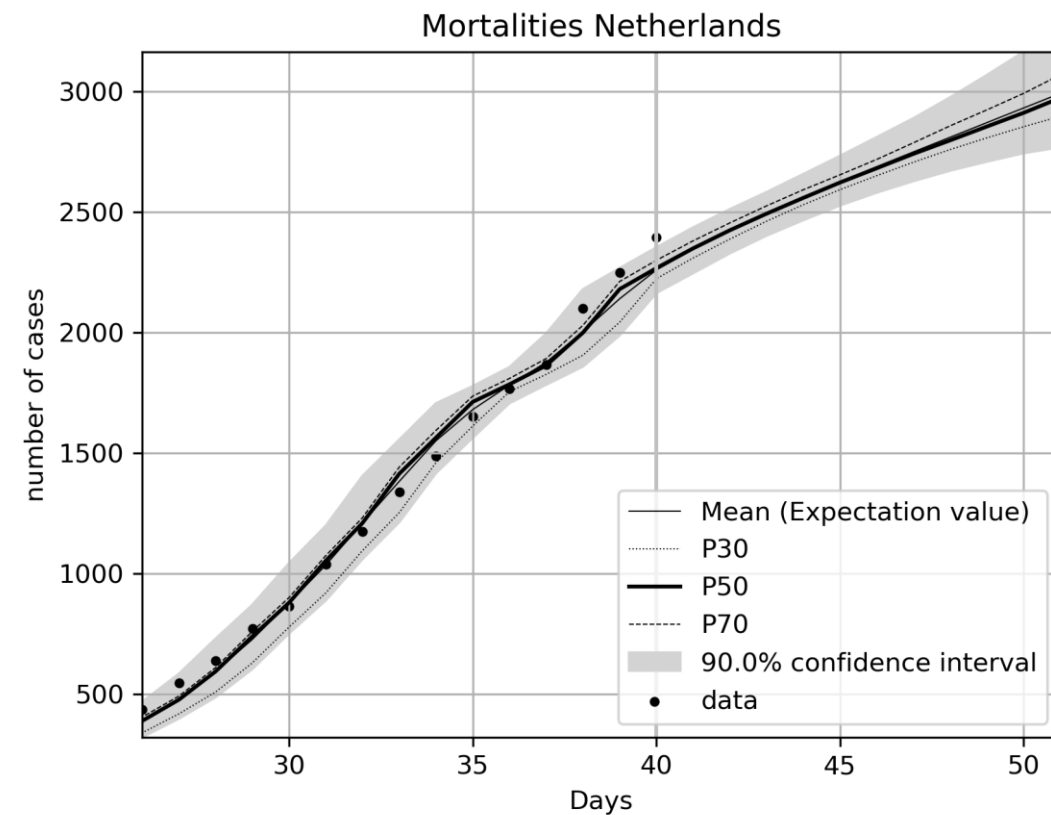
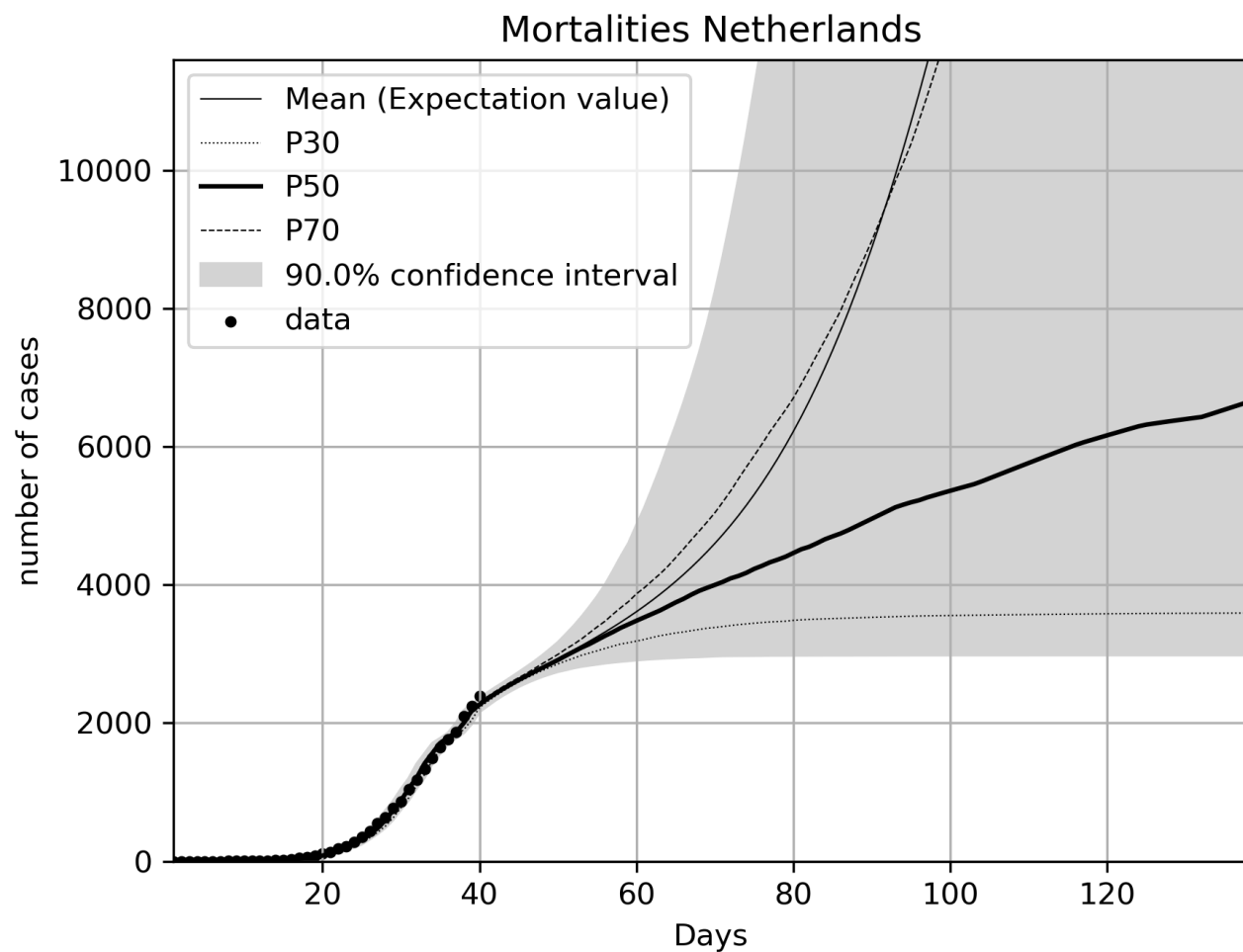
CFR (hospitalized) = dfrac = 29%

$$dpfrac = (dfrac - ICUfrac * ICUdfrac) / (1 - ICUfrac)$$

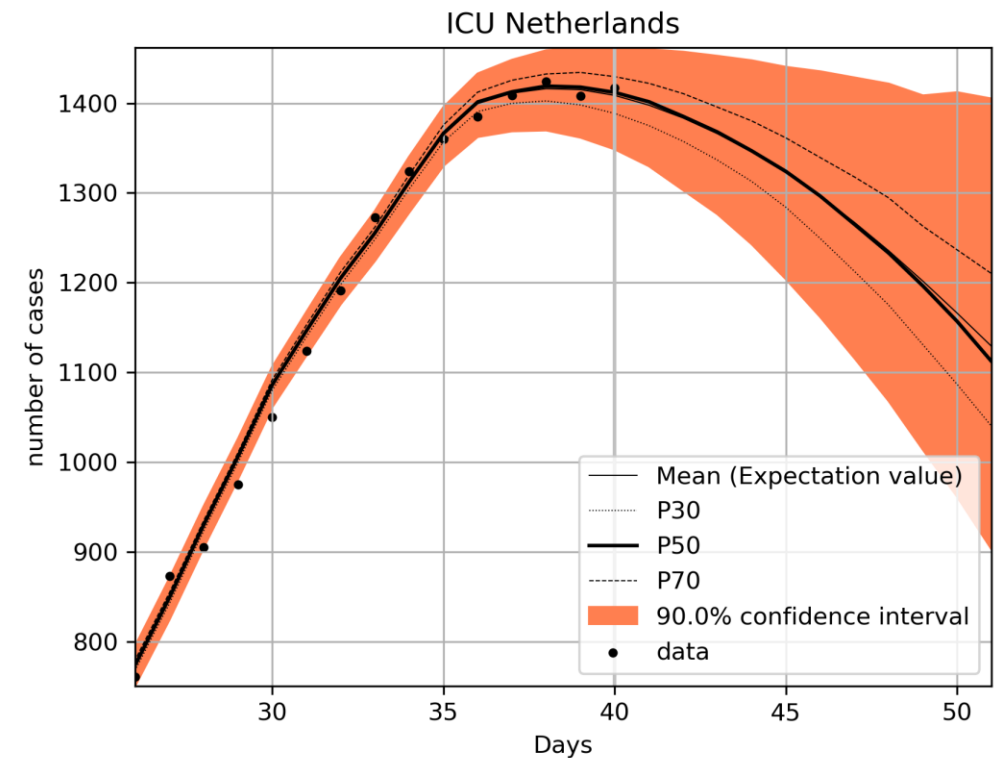
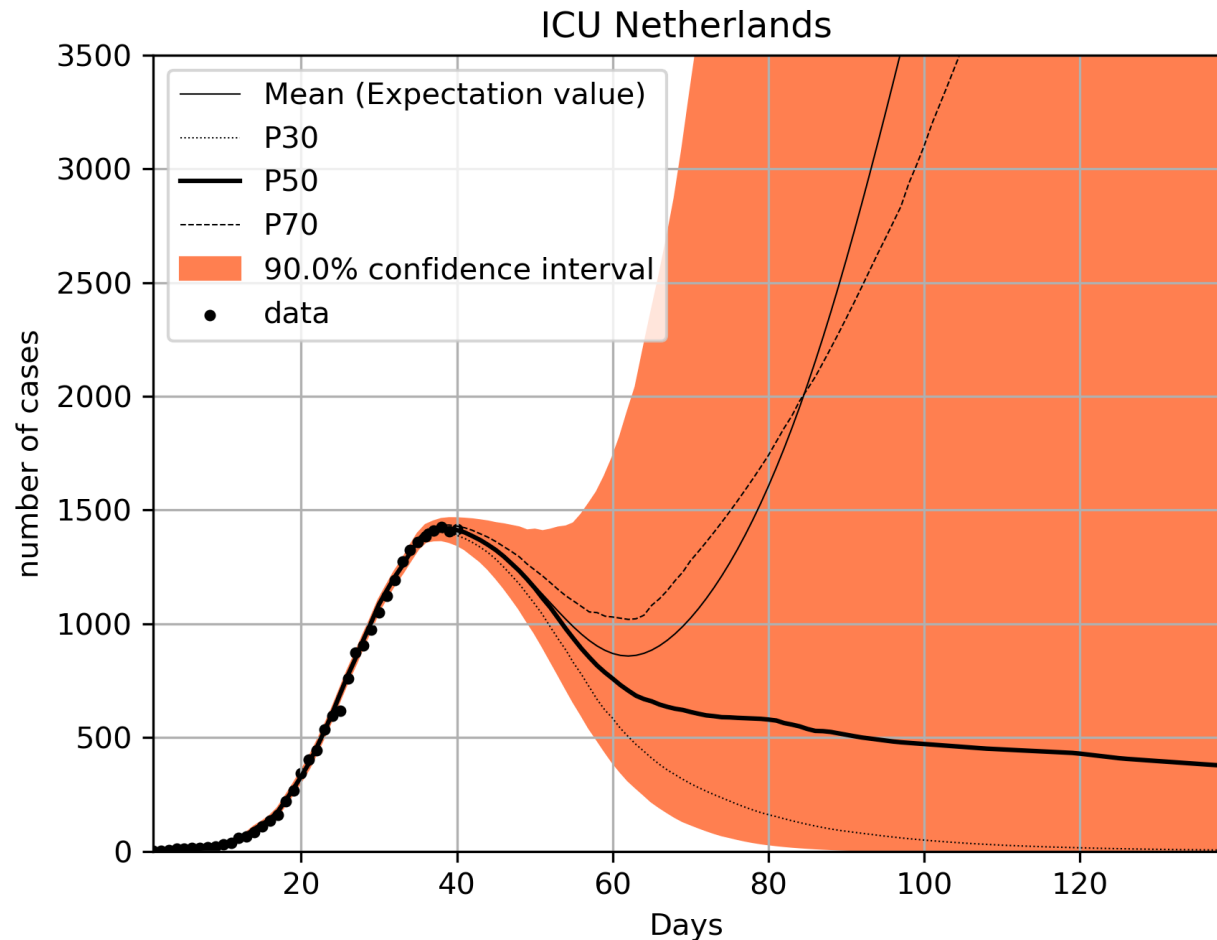
› RESULTATS –ENSEMBLE SMOOTHER (ESMDA) ON HOSPITALIZATION



› RESULTS – MORTALITIES



RESULTS – ICU DATA DAY 33-40 SOURCE NOS, ICU RATES 17% FROM DAY 40



› CONCLUSIONS AND DISCUSSION

- › The previous prediction of Sunday April 5 proved correct that peak would be reached in 5-10 days
 - › Fit on hospitalized, in agreement with ICU data, and minor deviation in latest reported death rates
 - › ICU inflow: very low rates in terms of hospitalized patients (less than 20% last week, now estimated 17%)
 - › ICU outflow mortalities: assumed ca 30% based on information D. Gommers, and in line with data of Nice (25%)
 - › ICU outflow mortalities: after 6 or more days
- › Discussion
 - › Mortalities: may be lower in hospital as numbers include deaths outside hospital, this may explain high CFR for patients (29%)
 - › Mortalities: are above expected trend, this can suggest relatively more deaths outside hospital compared to earlier (could be consistent with very low ICU inflow)
 - › The ICU peak may rise and last longer if inflow rates get on the rise (from 17% to higher values), and/or subject to other model parameters
 - › The peak can be shorter if assumptions on average and gaussian spreading in stay in ICU are overestimated (and inflow rates further reduce)

An aerial photograph of a coastal landscape. The image shows a mix of dark blue water, light brown sandbars, and patches of green vegetation. The perspective is from a high angle, looking down on the terrain. The text 'THANK YOU FOR YOUR ATTENTION' is overlaid in white, with a small blue arrow pointing to the left.

› **THANK YOU**
FOR YOUR ATTENTION

TNO innovation
for life