Artificial Intelligence (AI) ToOLs for Outbreak Detection and response: a transnational platform for surveillance, monitoring and decision support

Génin M[1], Botz J[2], Coudeville L[3], Eisenlauer M[4], Fauvel T[1], Huschka F[4], Lambert N[1], Wang D[2], Bosch Castells V[3], Commaille-Chapus C[5], Frandji B[6], Haberstroh M[4], Robin JY[5], Roehn P[7], Sippel H[4], Thiele P[7], Thommes E[8], Weber C[4], Amzal B[1], Fröhlich H[2], Kannt A[9], Mahé C[3]

[1] Quinten Health, Paris, France, [2]Fraunhofer SCAI, Sankt Augustin, Germany, [3]Sanofi, Lyon, France, [4]umlaut consulting GmbH part of Accenture, Aachen, Germany, [5]Impact Healthcare, Paris, France, [6]CompuGroup Medical, Nanterre, France, [7]Docmetric GmbH, Koblenz, Germany, [8]Sanofi Vaccines, Toronto, ON, Canada, [9]Fraunhofer ITMP, Frankfurt, Germany

OBJECTIVE

Numerous digital surveillance tools were developed during the COVID-19 pandemic to support public health decisions. Yet, those ad-hoc tools were essentially for short-term insights, more reactive than predictive, and not generalisable to be used to predict hospital capacities or shortages of medical supplies in real-time[1]. To overcome these limitations, we developed, under a public-private consortium, a transnational predictive platform to detect the first signs of respiratory epidemics, monitor progression, and assist in defining and evaluating appropriate measures: AIOLOS (**A**rtificial **I**ntelligence To**OL**s for **O**utbreak Detection and respon**S**e).

AIOLOS aims at supporting decision making by integrating and combining information from various sources and using advanced AI analytical methods to detect early signs of an epidemic related to respiratory pathogens, monitor their spread, derive appropriate response measures and assess their impact.

METHOD

The approach is structured around three dimensions:

- **ALERT**: detection of unforeseen epidemic trends;
- **MONITOR**: real-time tracking of epidemic spread and intervention effectiveness, evaluation of the impact on healthcare services and the global economy;
- **DECIDE**: provide information on appropriate response measures.

The first year was dedicated to working on the design and development of an MVP (Minimum Viable Product). The MVP is the very first version of the target solution, relying on historical Covid-19 data to train and test the models. The MVP consists of:

- A first set of data sources including respiratory virus surveillance data from France and Germany, as well as diagnostic and prescription data from physician software (Germany at this stage), pharmacy sales data (Germany at this stage), data resulting from wastewater analysis (France at this stage), data resulting from social media analysis, and mobility data (see figure 2);
- A first set of alert, prediction, and scenario planning models (see figure 3);
- A first version of the AIOLOS dashboard offering a series of visualizations of the results (see figure 1).

The MVP is intended to be enriched throughout the second year through a series of modular improvements. This will include:

- Expanding the scope of considered data by integrating new data providers;
- Transitioning from a retrospective approach (historical data) to a prospective approach based on real-time data;
- Fine-tuning and adjusting the models and analytical approach;
- Expanding the scope of considered pathogens, beyond just SARS-CoV2, particularly including influenza and RSV (respiratory syncytial virus)[2].
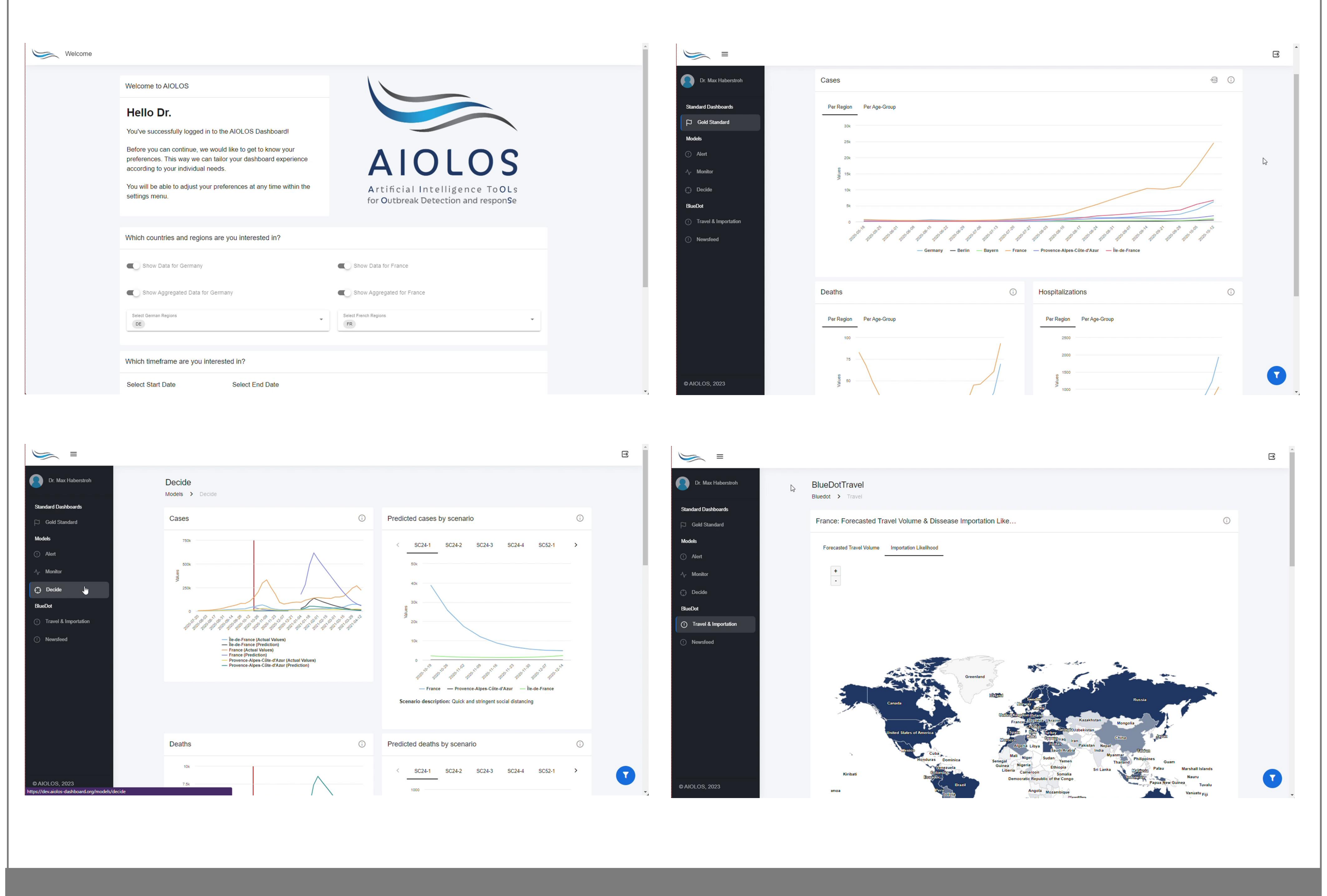
Figure 1: First version of the tool
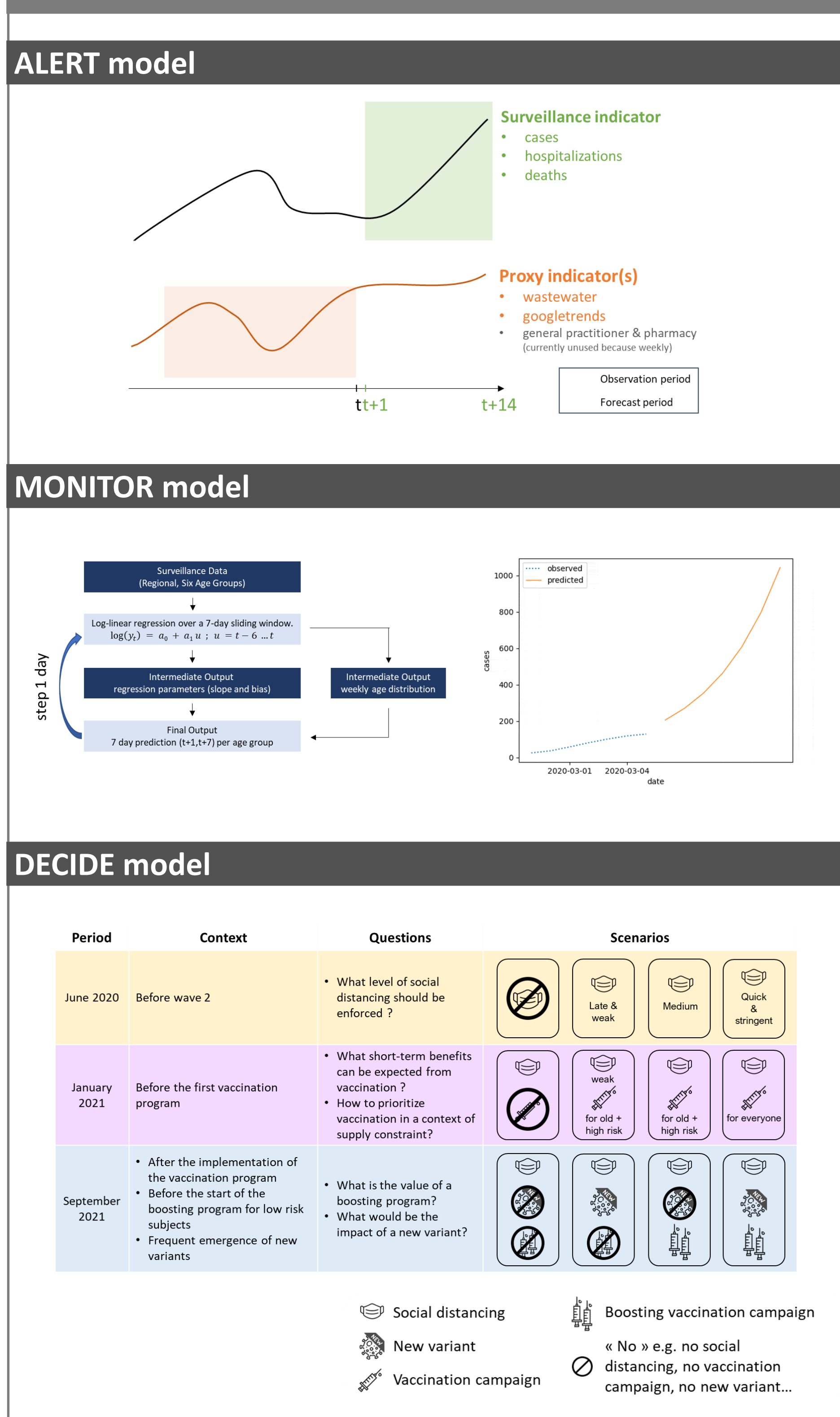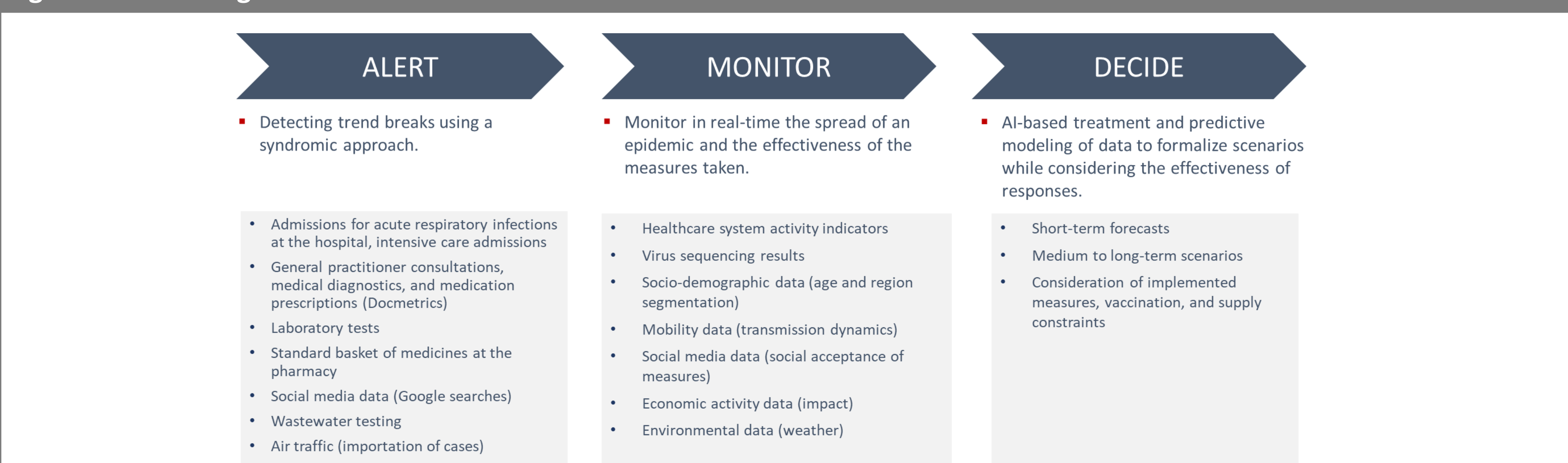

Figure 3: Calibration of the models

ALERT model

MONITOR model

DECIDE model

RESULTS

The first project year was dedicated to data mobilization and harmonization and to the development, testing and calibration of models while engaging and aligning across partners and stakeholders. A first version of the tool was developed and dashboarded with visuals, delivering promising preliminary results , e.g. highlighting and quantifying the value of wastewater data in predicting pandemic waves, and the impact of social distancing and vaccination on epidemics.

DISCUSSION

At the end of the 2-year project, AIOLOS plans to deliver a Proof of Concept (POC) consisting of three components that can be utilized post-project:

- A fully operational dashboard serving as a pre-industrial solution, tailored to the needs of various public and private stakeholders (health, economy).
- A data infrastructure integrating a wide variety of data types and capable of scalability.
- An agile artificial intelligence and predictive modeling engine.

The solution will focus on France and Germany. An evaluation of expanding the tool to other European geographies, each with its own data structure, will be conducted at the conclusion of the project.

CONCLUSIONS

Improvements will be made in the coming year e.g. by integrating new data sources and partners, accounting for more pathogens and respiratory viruses and enabling real-time prediction updates. AIOLOS stands as a serious candidate to become an EU-wide public health decision support tool.

Figure 2: Data integrated in the tool

ALERT
- Detecting trend breaks using a syndromic approach.
  - Admissions for acute respiratory infections at the hospital, intensive care admissions
  - General practitioner consultations, medical diagnostics, and medication prescriptions (Docmetrics)
  - Laboratory tests
  - Standard basket of medicines at the pharmacy
  - Social media data (Google searches)
  - Wastewater testing
  - Air traffic (importation of cases)

MONITOR
- Monitor in real-time the spread of an epidemic and the effectiveness of the measures taken.
  - Healthcare system activity indicators
  - Virus sequencing results
  - Socio-demographic data (age and region segmentation)
  - Mobility data (transmission dynamics)
  - Social media data (social acceptance of measures)
  - Economic activity data (impact)
  - Environmental data (weather)

DECIDE
- AI-based treatment and predictive modeling of data to formalize scenarios while considering the effectiveness of responses.
  - Short-term forecasts
  - Medium to long-term scenarios
  - Consideration of implemented measures, vaccination, and supply constraints

REFERENCES
1. https://www.europarl.europa.eu/thinktank/en/document37
2. Gomez et al. [2021] Uncertain evolution of influenza and other respiratory viruses post SARS-CoV-2 reinforces the need for expanded global surveillance. Science