CITIZENS IN ACTION: INCREASING CAPACITIES WITH LOCALIZED AIR POLLUTION FORECASTS

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Citizen Science

The Sentinel Citizen pilot project (ended December 2020) has **demonstrated a model of citizen science action**, where citizens do not only volunteer their labour for top-down scientific research but are engaged because they understand that **scientifically grounded societal actions are crucial for their quality of life**.

In this **societal and policy-oriented pilot action** citizen scientists together with experts and stakeholders established **atmospheric commons** as the mutual ground for shareholders to collaborate.

Background

The Sentinel Citizen pilot project provides the communities of Nord-Holland **EO enhanced, localized air pollution forecasts** with which they can influence policymakers **to regulate local and regional polluters and alert citizens accordingly**.

- Citizen Science Data: **Making Sense framework for citizen sensing**, using **HoLu sensor-kits** (http://hollandseluchten.waag.org).
- Regional air pollution forecasts: **CAMS ensemble forecasts** (Copernicus; CAMS: http://atmosphere.copernicus.eu)
- Localized air pollution forecasts: Statistical forecast using **MOS** (**M**odel **O**utput **S**tatistics = multivariate linear regression model; https://sentinelcitizen.waag.org/local-air-pollution-forecast-model)

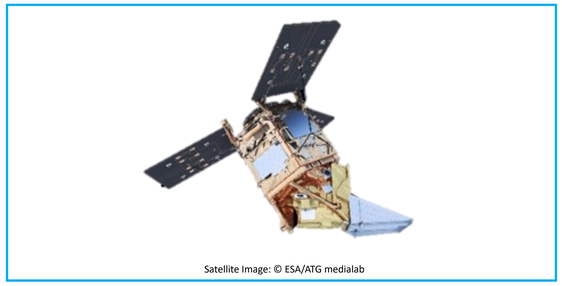
Main Achievements

- **Create awareness of our common good -** respect the atmosphere as our common good
- **Establish atmospheric commons** - establish a common ground between involved stakeholders and engaged citizens (see blue box)
- **Overview of existing CS and EO capacities -** establish a technical foundation of atmospheric commons (more info: link/QR code)
- **Enable science driven societal actions -** societal actions performed by citizens by using localized air pollution forecasts

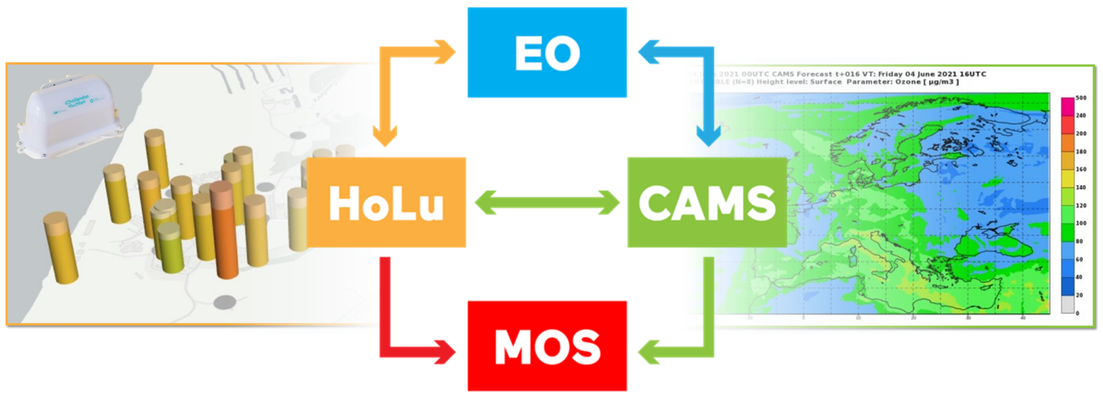
Localized Air Pollution Forecasts

The procedure is illustrated schematically in the middle of the poster.

- Method: **MOS** (Model Output Statistics, e.g. R.A. Verzijlbergh et al., Improved model output statistics of numerical weather prediction based irradiance forecasts for solar power applications, Solar Energy, 2015)
- Data: **CAMS** (regional air pollution forecasts); Citizen Science **HoLu** data (local observations); **EO** (Earth Observation, to build clusters)
- Procedure: To forecast localized air pollution: apply MOS using CAMS forecasts and clustered HoLu observations (see Fig. 1 and 3)
- HoLu Clusters: Using Ward-like hierarchical clustering with distance weighting, including PM2.5 concentration feature space (see Fig. 2)
- Results: Y = *local*/f.c. air pollution; MOS "localizes" regional CAMS forecasts (used as predictors X_i): $Y = A_0 + A_1X_1 + A_2X_2 + A_3X_3 + \ldots$ A_i = regression coefficients (see Fig. 1 and 3)



Satellite Image: © ESA/ATG medialab



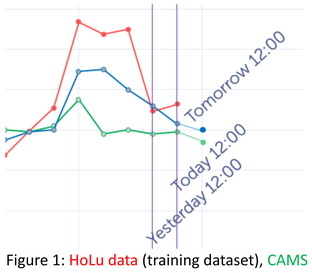


Figure 1: HoLu data (training dataset), CAMS forecast, MOS forecast (in forecast mode)

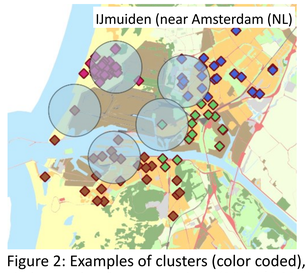


Figure 2: Examples of clusters (color coded), circles mark reference stations (RIVM/GGD)

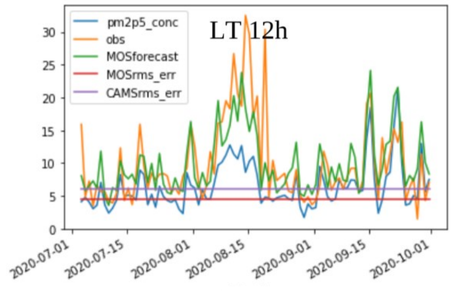


Figure 3: MOS forecasts for test period Jul-Aug-Sep 2020 (training period: January - September 2020). Legend:

- obs: HoLu (clustered) observations
- pm2p5_conc: regional CAMS forecasts for PM2.5 for cluster area
- MOSforecast: MOS-based forecast for PM2.5 (lead time LT: 12h)
- MOSrms_err: Root-mean-squared error (MOS forecasts)
- CAMSrms_err: Root-mean-squared error (CAMS forecasts)

RMSE of MOS forecast is systematically lower than RMSE of CAMS forecast (for all lead times: 3, 6, 9, 12, 15, 18 and 21h)

Discussion (air pollution forecasts)

+ CAMS: High-quality, reliable air pollution forecasts (regional)
+ MOS: conceptually simple method (applicable by citizens)
+ Results: MOS forecast closer to HoLu data as with CAMS forecast only
- Data gaps and data quality issues of Citizen Science (HoLu) data
- Large difference in scale between EO and local HoLu data

ATMOSPHERIC COMMONS - a set of recommendations

Recommendations are formulated in a way that proposes very concrete actions to each identified stakeholder. These recommendations are:

COMMON RESOURCE - All stakeholders should recognise air and atmosphere as a common resource.

KNOWLEDGE SOCIETY - Policymakers should support open and collaborative research and innovation practices, engaging citizens alongside academia and industry.

SCIENCE LITERACY - Policymakers and academia should support citizens in developing scientific literacy to understand urgencies and express their concerns.

CITIZEN ENGAGEMENT - Citizens should be supported to organise themselves around pressing environmental matters.

SITUATED DATA - Citizens should play an active role in data production. In this way citizens can make sense of their surrounding environment.

CITIZEN-DRIVEN INNOVATION - Polluting industry should involve citizens in understanding their technological challenges, so citizens can influence policymakers in prioritising research and innovation investments.

GOVERNANCE - Atmospheric commons should be governed by knowledge society.

sentinelcitizen.waag.org

QR code

sentinel citizen