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Smart Urban Solutions on Air Quality (including health aspects) - *what is there and where do we want to be in 5 years from now?*

Jay G. Slowik, Pavel Kupr,
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Horizon 2020
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Context and motivation

- Over half of the world's population lives in urban areas,
- Although in most EU cities AQ has improved over the past decades for some pollutants, air pollution is still a concern
- City administrations must find appropriate measures against air pollution
- This requires appropriate information e.g. on spatial distribution and source contribution of air pollution
- Smart technologies offer exciting possibilities

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Scientific issues

Need to know what pollutants are and where they come from

EXAMPLE: AEROSOL PARTICLES





Emissions Sources

Primary Aerosol

Removed!

Case study: automobile with filter

Gases

Atmospheric Reactions

Secondary Aerosol

Unaffected!

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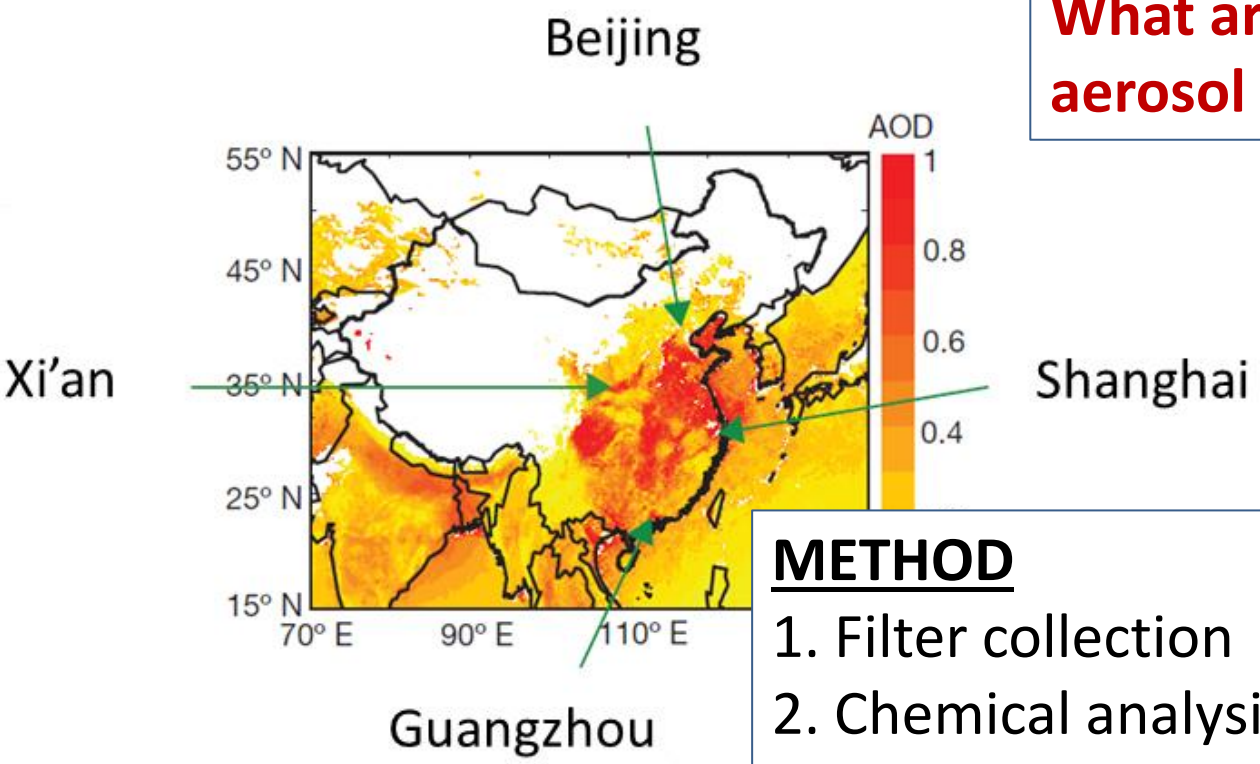
Extreme haze in China

Winter 2013: Satellite measurements show extreme haze affecting much of eastern China

What are the dominant aerosol sources?



METHOD

1. Filter collection
2. Chemical analysis - offline vs. online
3. Source apportionment (SoFi)
4. Policy response

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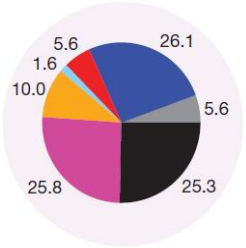
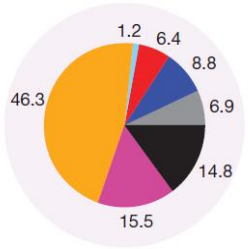
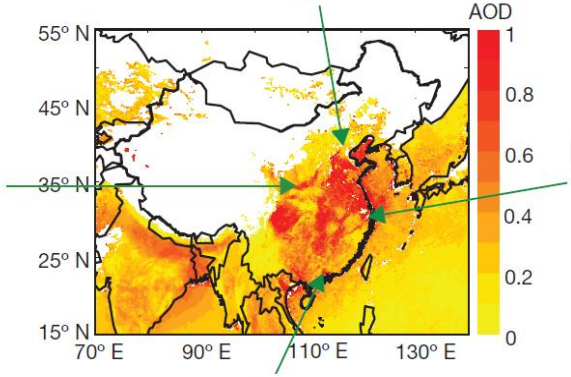
Extreme haze in China

Beijing

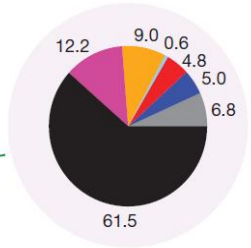


Xi'an

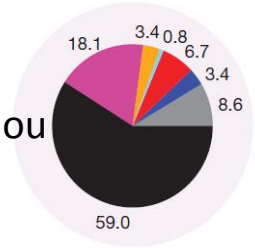




Shanghai



Guangzhou



Sources/factors (%)

- Traffic
- Coal burning
- Biomass burning
- Cooking
- Dust related
- Secondary organic-rich
- Secondary inorganic-rich

Extreme pollution events dominated by secondary aerosol

New control strategies shift focus to domestic heating

Huang et al., Nature, 2014

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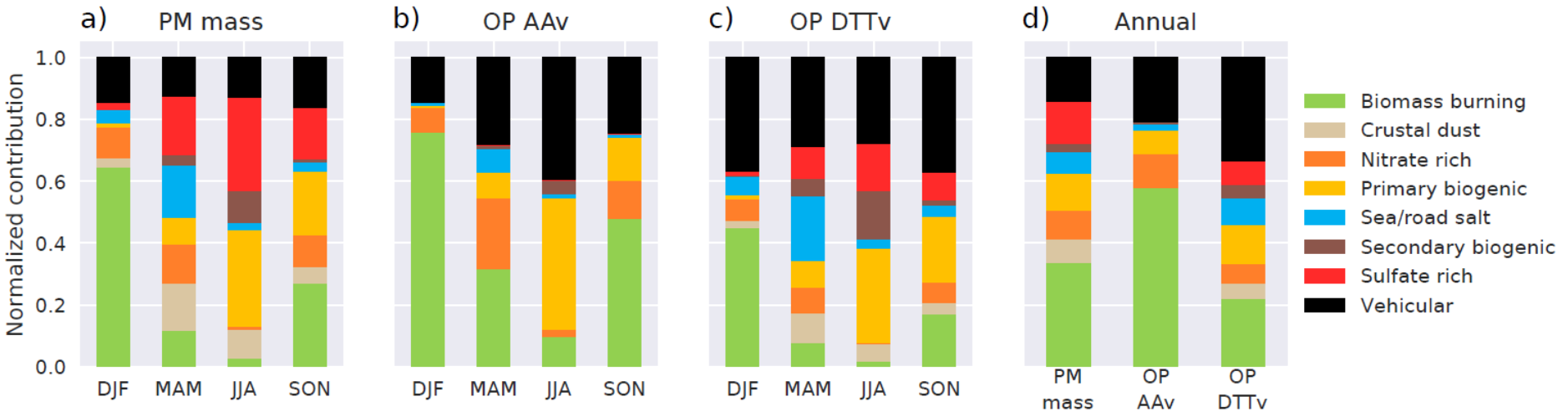
Aerosols and health

Oxidative potential (OP) as surrogate measurement for toxicity

Chamonix-Mont Blanc, France



Sources weighted towards adverse health effects

Samuel et al., ACPD, 2017

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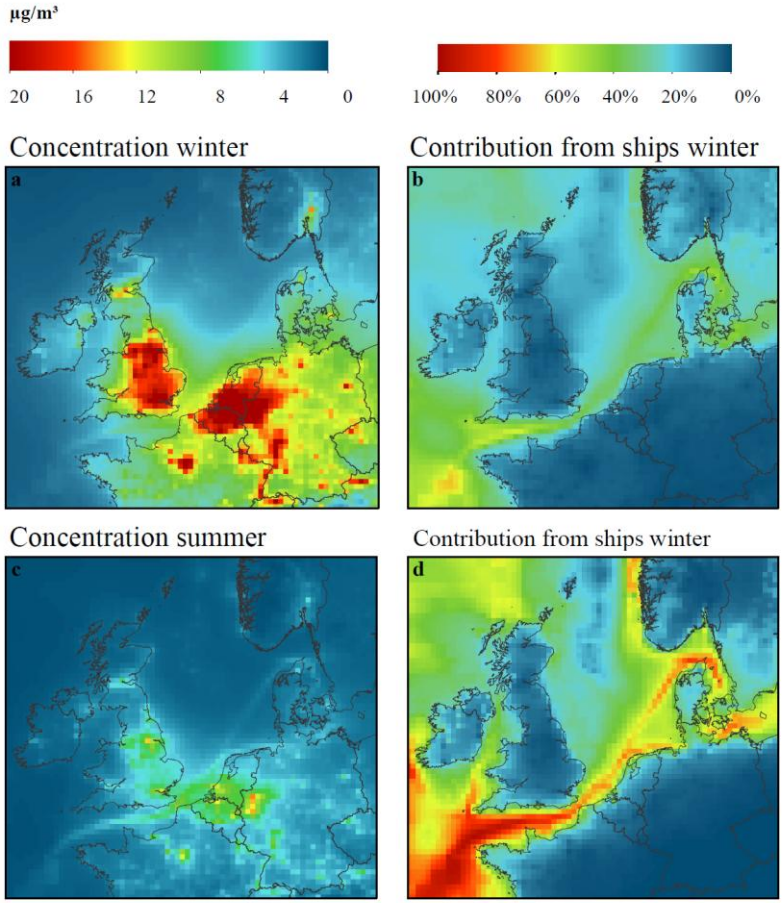
Modeling and policy

CURRENT Shipping emissions in North and Baltic Seas

- Example: NO_2
- Left: Modelled average NO_2 concentration in winter and summer
- Right: Contribution of shipping to the average NO_2 concentration in %



www.shipemissions.eu

Aulinger at al., ACP, 2016

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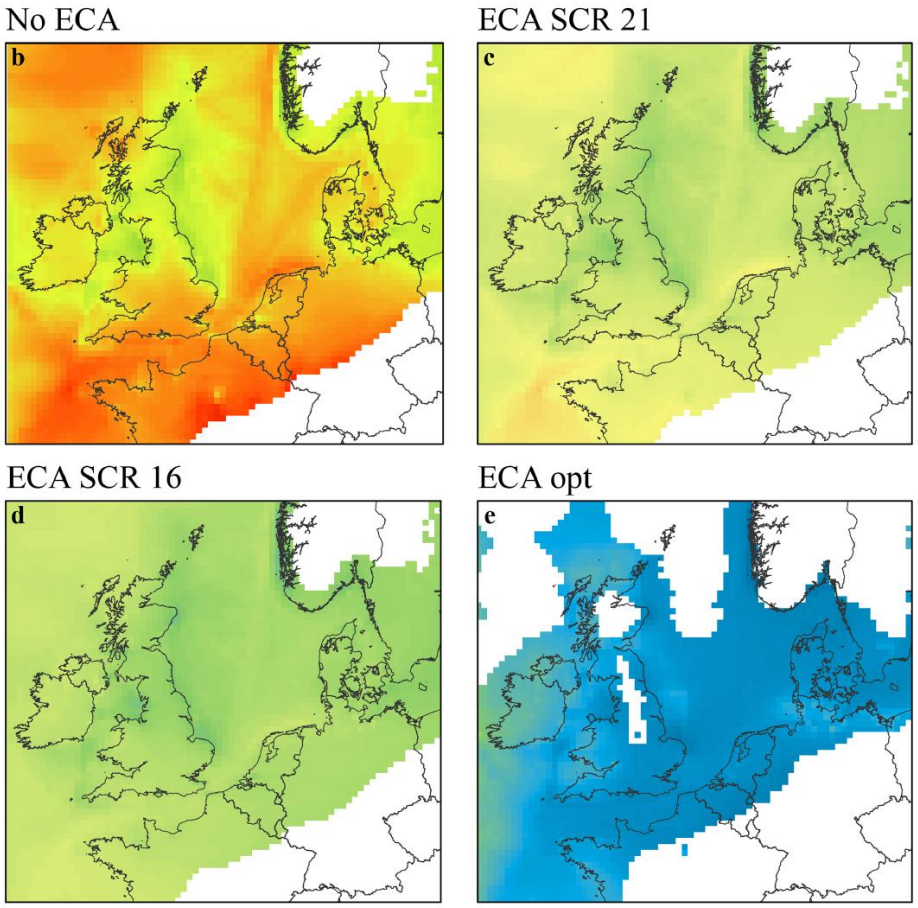
Modeling & policy

PROJECTED effects of proposed emissions controls



Change in NO_2 concentration from ships, summer 2030

100% 60% 20% -20% -60% -100%

From 2021:
Implementation of NECA in North and Baltic Seas

www.shipemissions.eu
Aulinger at al., ACP, 2016

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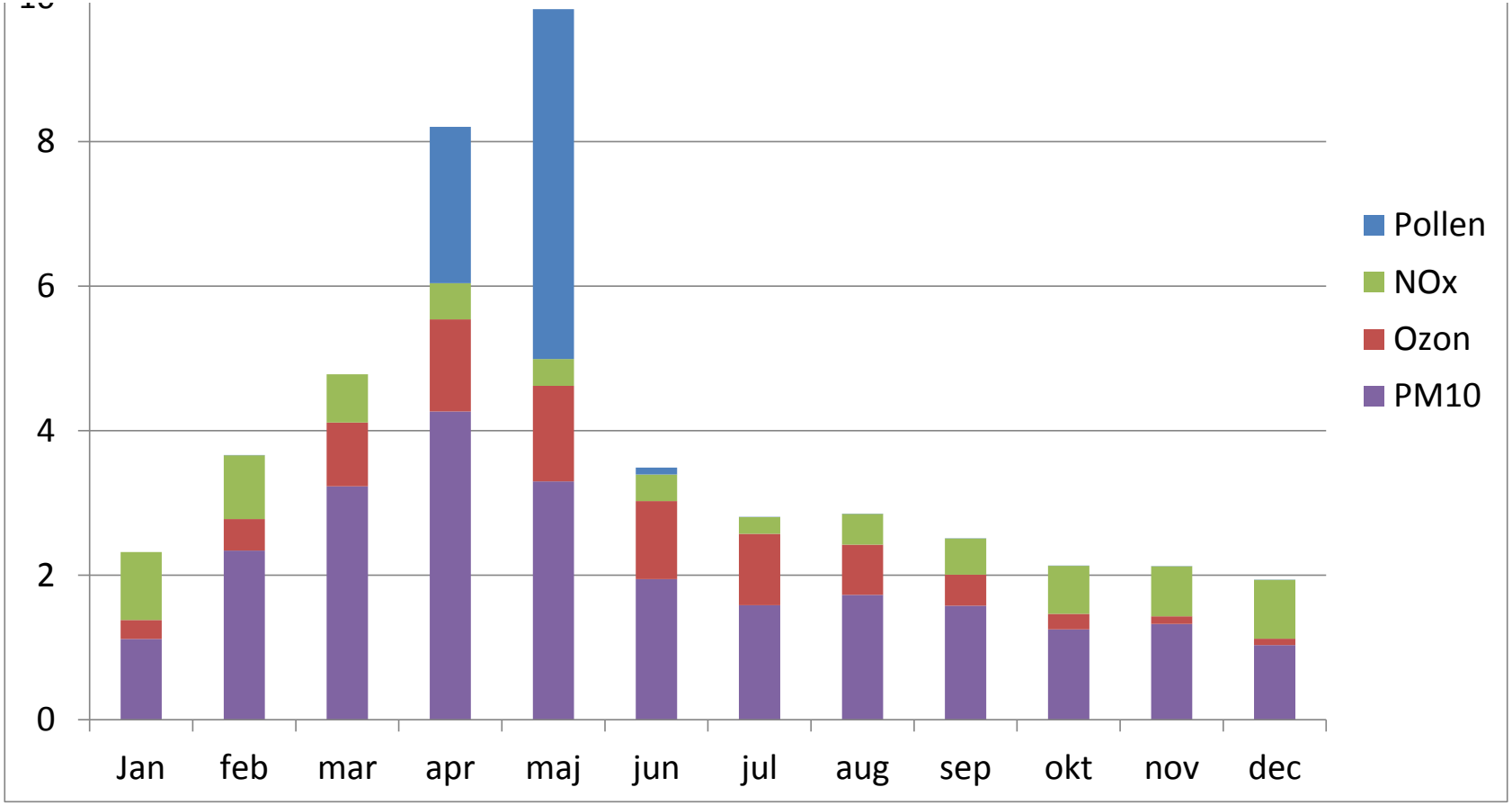
Links to health outcomes

Pollutant contribution to hospital admissions (2006-2011)



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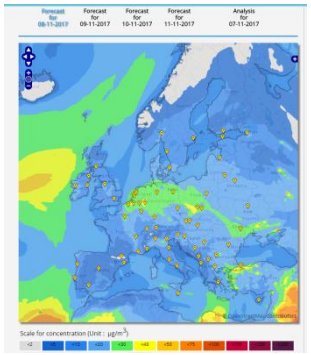
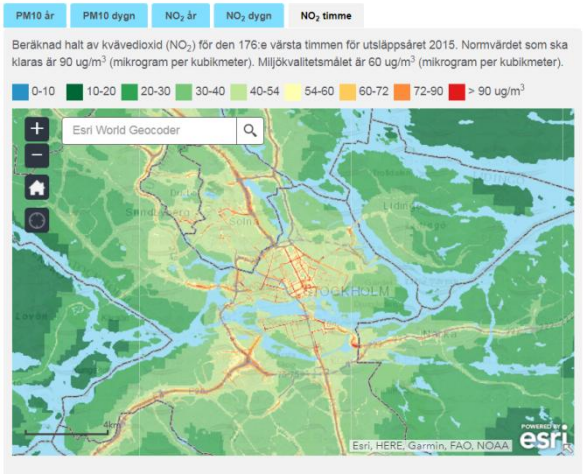
Towards a smart city

Local prognoses (hourly)

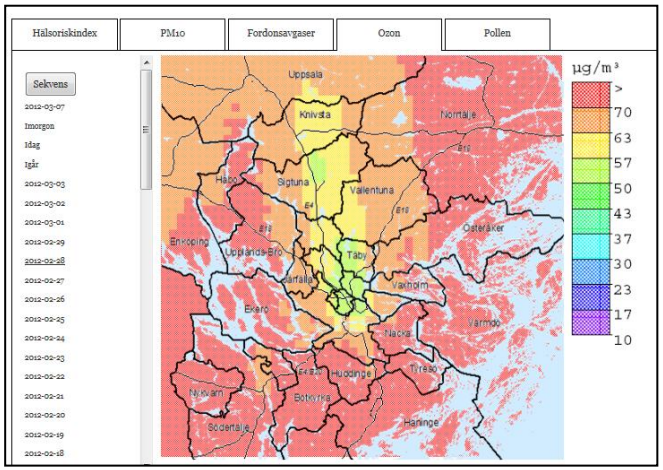


CAMS prognoses
(Ensemble of 7 air quality models)
www.regional.atmosphere.copernicus.eu



Averaging and health risk calculations

Web-presentation
App-presentation



Validation and adjustment with on-site measurements

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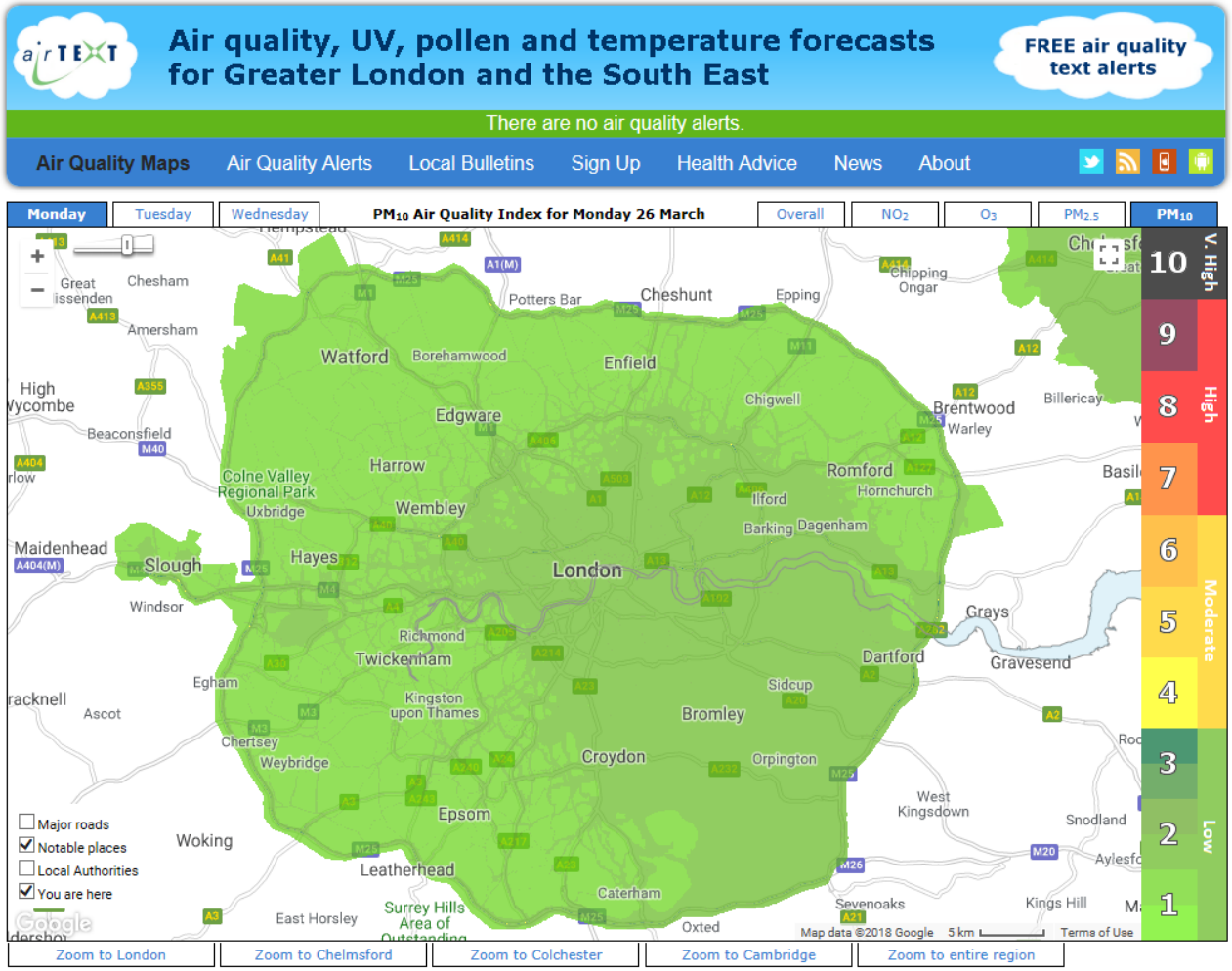
Example: London

airTEXT: online map projections of air quality

Four pollutants (NO_2, O_3, $PM_{2.5}$, PM_{10} + overall index)

www.airtext.info



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Validation

Pollutant	Number of monitoring stations	Statistic	Number of valid data points		
			Day 0	*Day 1*	*Day 2*
NO_2	70	Daily maximum	22486	22486	22486
O_3	20	Daily maximum of 8-hour rolling mean	5992	5992	5992
PM_{10}	62	Daily mean	18828	18828	18828
$PM_{2.5}$	22	Daily mean	6486	6486	6486

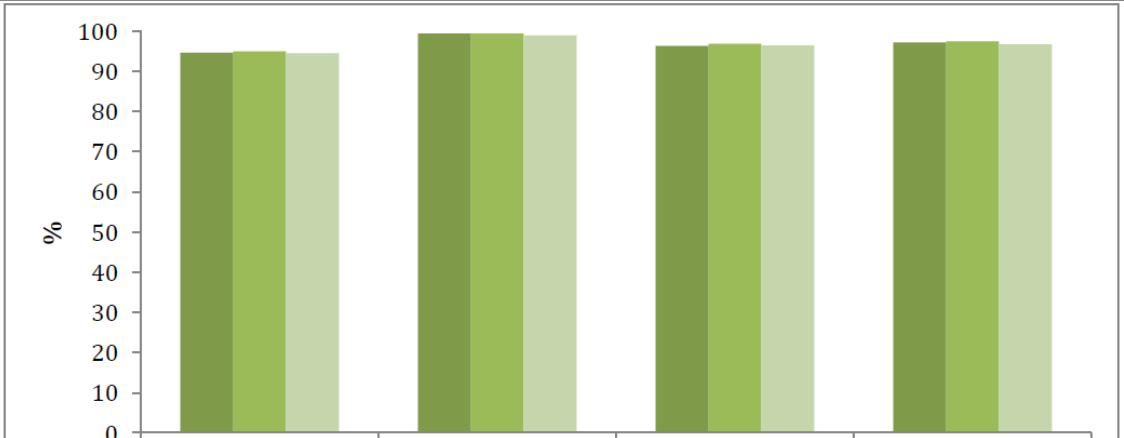
Spatially dense monitoring network

Confidence metrics for public & decision-makers

Built-in model/measurement feedback

www.airtext.info

Percentage of *air*TEXT forecast indices within one band of the corresponding observed indices



	NO2	O3	PM10	PM2.5
Day 0	94.60	99.43	96.34	97.16
Day 1	95.01	99.35	96.85	97.47
Day 2	94.49	98.97	96.48	96.75

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Conclusions

- Many tools to address urban AQ
  - Direct measurements, modeling, remote sensing
- What variables are most relevant?
  - Regulatory (current & suggested), decision-oriented
- Optimization & integration
  - Spatial & temporal scales
  - Infrastrucutre, expertise, cost
  - Data availability and timeliness
- Tailoring & locating AQ data within decision-making process

THANKS FOR YOUR ATTENTION!

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