FAIRMODE

The combined use of models and monitoring for applications related to the European air quality Directive: SG1-WG2 FAIRMODE

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- Representativeness
- Work plan

Terms of reference

- To provide a **permanent European forum** for AQ modellers and model users
- To produce **guidance** on the use of air quality models for the purposes of implementation of the AQ Directive and in preparation for its revision
- To study and set-up a system (protocols and tools) for **quality assurance** and continuous improvements of AQ models
- To make **recommendations** and promote further research in the field of AQ modelling

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Aims of SG1

- To promote ‘good practice’ for combining models and monitoring (Directive related)
- To provide a forum for modellers and users interested in applying these methodologies
- To develop and apply quality assurance practices when combining models and monitoring
- To provide guidance on station representativeness and station selection

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Some concepts

- ’Combination’ used as a general term
- Data integration
  - Refers to any ‘bringing together’ of relevant and useful information for AQ modelling in one system (e.g. emissions/ meteorology/ satellite/ landuse/ population/ etc.)
- Data fusion
  - The combination of separate data sources to form a new and optimal dataset (e.g. models/monitoring/satellite/land use/etc.). Statistically optimal but does not necessarily preserve the physical characteristics
- Data assimilation
  - The active, during model integration, assimilation of observational data (e.g. monitoring/satellite). Physical laws are obeyed

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Some concepts

- Geometrical methods
  - Methods for interpolation or ‘combination’ that are based on geometrical arguments. E.g. Inverse distance weighting, bilinear interpolation, as an interpolation method. Simple combinations of data, some GIS based methods.
- Non spatio-temporal statistical methods
  - Covers methods such as regression and bias corrections that do not take into account the spatial or temporal correlation of the data.
- Spatio-temporal statistical methods
  - Covers a wide range of methods e.g. 2-4 D variational methods, kriging methods, optimal interpolation. Based on Bayesian concepts. Minimalisation of some specified error.

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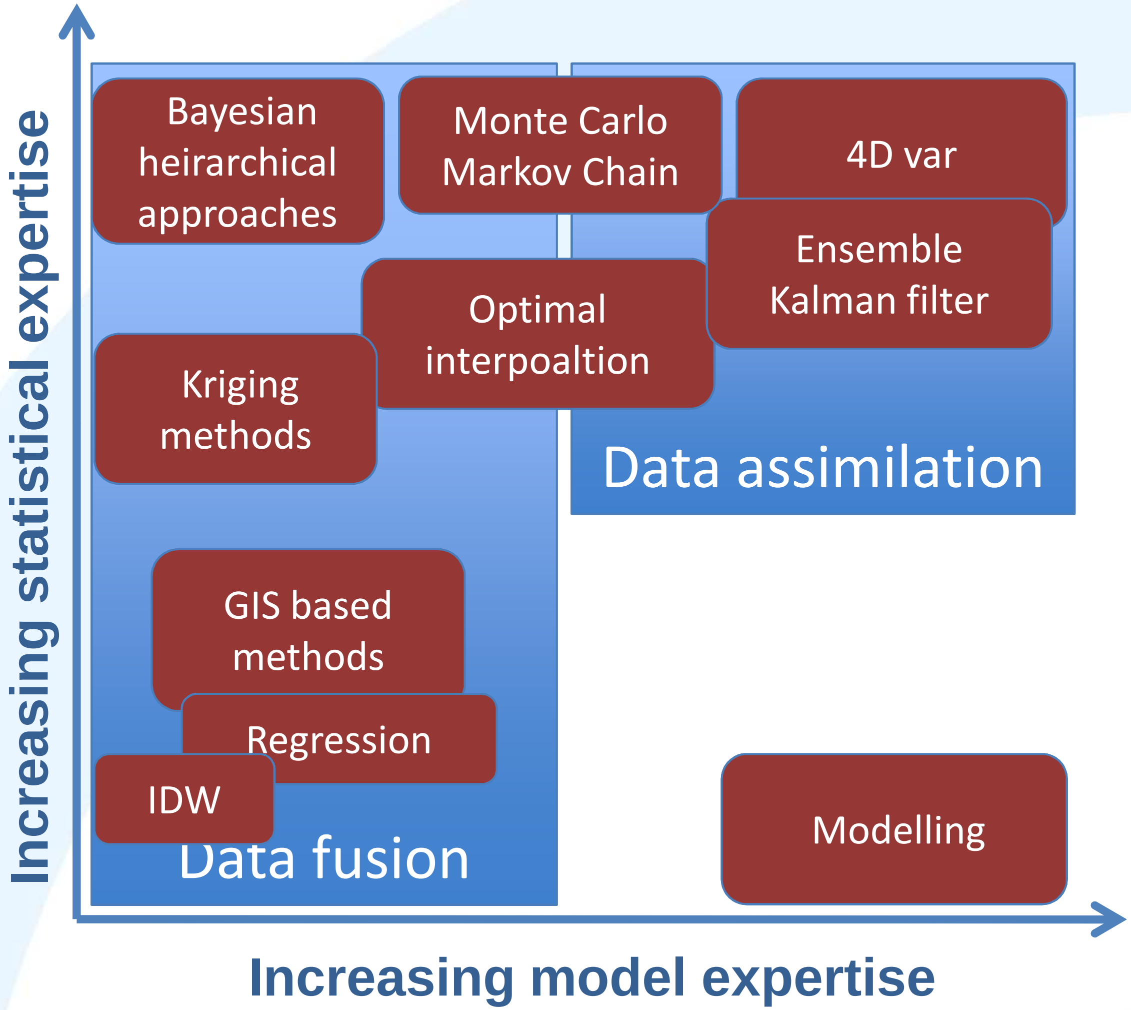
Expertise required for methods



Users and developers (DA)

Person	Institute/project	Contact	Model	Method	Application (resolution)
Hendrik Elbern	**RIU**/MACC/PASA DOBLE	he@eurad.Uni-Koeln.DE	EURAD-IM	3-4D var	European forecasts (45 – 1 km)
Martijn Schaap	**TNO**/MACC	martijn.schaap@tno.nl	LOTOS_EUROS	Ensemble Kalman filter	European assessments and forecasting (25km)
L. Menut	**INERIS**/MACC	menut@lmd.polytechnique.fr	CHIMERE	Optimal interpolation , residual kriging and EnKF (in development)	European and Urban scale forecasts and assessments (25 km)
Hilde Fagerli	**Met.no**/MACC	hilde.fagerli@met.no	EMEP	3 – 4D var (in development)	European scale forecasts and assessment (25km)
Valentin Foltescu	**SMHI**/MACC	Valentin.Foltescu@smhi.se	MATCH	2 – 4D var (in development)	European to Urban scale (25 - ? km)
Sébastien Massart	**CERFACS**/MACC	massart@cerfacs.fr	MOCAGE/PALM	3 -4D var	Global to European
Bruno Sportisse	**INRIA,CEREA**	Bruno.Sportisse@inria.fr	Polyphemus	3 -4D var, OI, EnKF	European

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Users and developers (DF:1)

Person	Institute/project	Contact	Model	Method	Application (resolution)
John Stedman	**AEAT**	John.stedman@aeat.co.uk	ADMS	Statistical interpolation, residual kriging	UK wide assessment of air quality
Bruce Denby	**NILU**/ETC-ACC	bde@nilu.no	EMEP, LOTOS-EUROS	Statistical interpolation, residual kriging	European wide assessments at 10 km
Jan Horálek	**CHMI**/ETC	horalek@chmi.cz	EMEP	Statistical interpolation, residual kriging	European wide assessments at 10 km
Dennis Sarigiannis	**JRC Ispra**	Dimosthenis.SARIGIANNIS@ec.europa.eu	CTDM+ (model not important, platform more relevant) ICAROS NET	Data fusion (unknown methodology)	Urban scale
Marta Garcia Vivanco Palomino Marquez Inmaculada Fernando Martín	**CIEMAT**	m.garcia@ciemat.es inma.palomino@ciemat.es fernando.martin@ciemat.es	MELPUFF CHIMERE	Anisotropic inverse distance weighting Regression and residual kriging.	Assessment Spain

Users and developers (DF:2)

Person	Institute/project	Contact	Model	Method	Application (resolution)
Clemens Mensink Stijn Janssen	**VITO**	stijn.janssen@vito.be Clemens.mensink@vito.be	RIO and BelEUROS	Detrended kriging. Land use regression model used for downscaling CTM	Belgium (3km)
J.A. van Jaarsveld	**RIVM**	hans.van.jaarsveld@rivm.nl	OPS	Kriging with external drift	Nederland (5km)
Florian Pfäfflin (Goetz Wiegand Volker Diegmann)	**IVU Umwelt GmbH**	fpf@ivu-umwelt.de	FLADIS/ IMMISnet/ EURAD	Optimal interpolation	Ruhr, Germany (5km)
Arno Graff	**Umwelt Bundes Amt, UBA II**	arno.graff@uba.de	REM-CALGRID	Optimal interpolation	Germany
Wolfgang Spangl	**Umweltbundesamt**	Wolfgang.spangl@umweltbundesamt.at		Representativeness of monitoring data	
Sverre Solberg	**NILU**/EMEP	sso@nilu.no	EMEP	Representativeness of monitoring data	EMEP monitoring network

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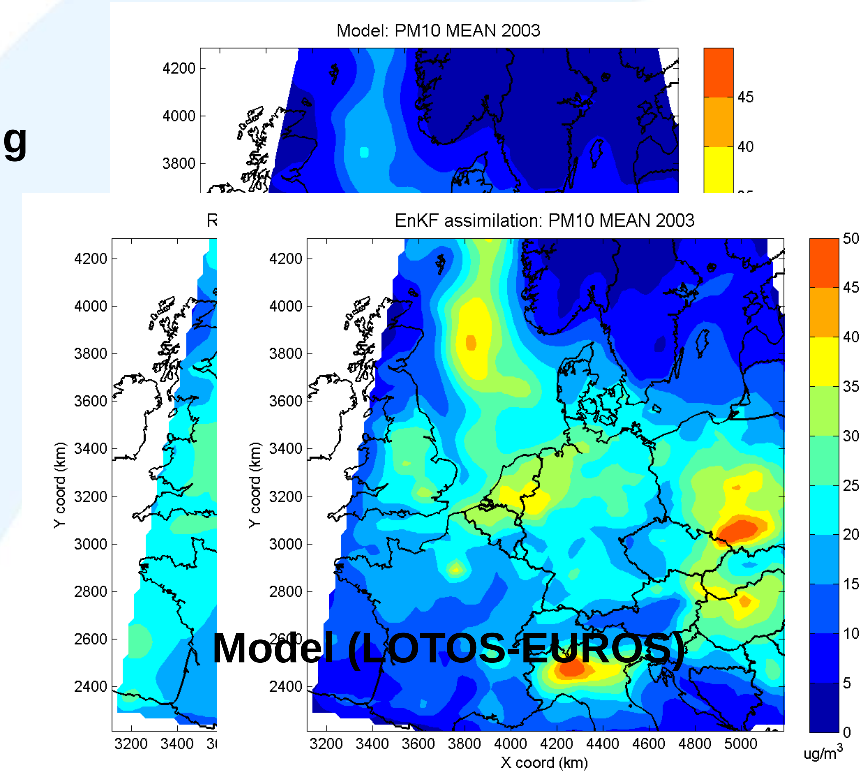
Examples: Regional scale

Comparison of Residual kriging and Ensemble Kalman Filter for assessment of regional PM_{10} in Europe

Residual kriging

EnKF



Model (LOTOS-EUROS)

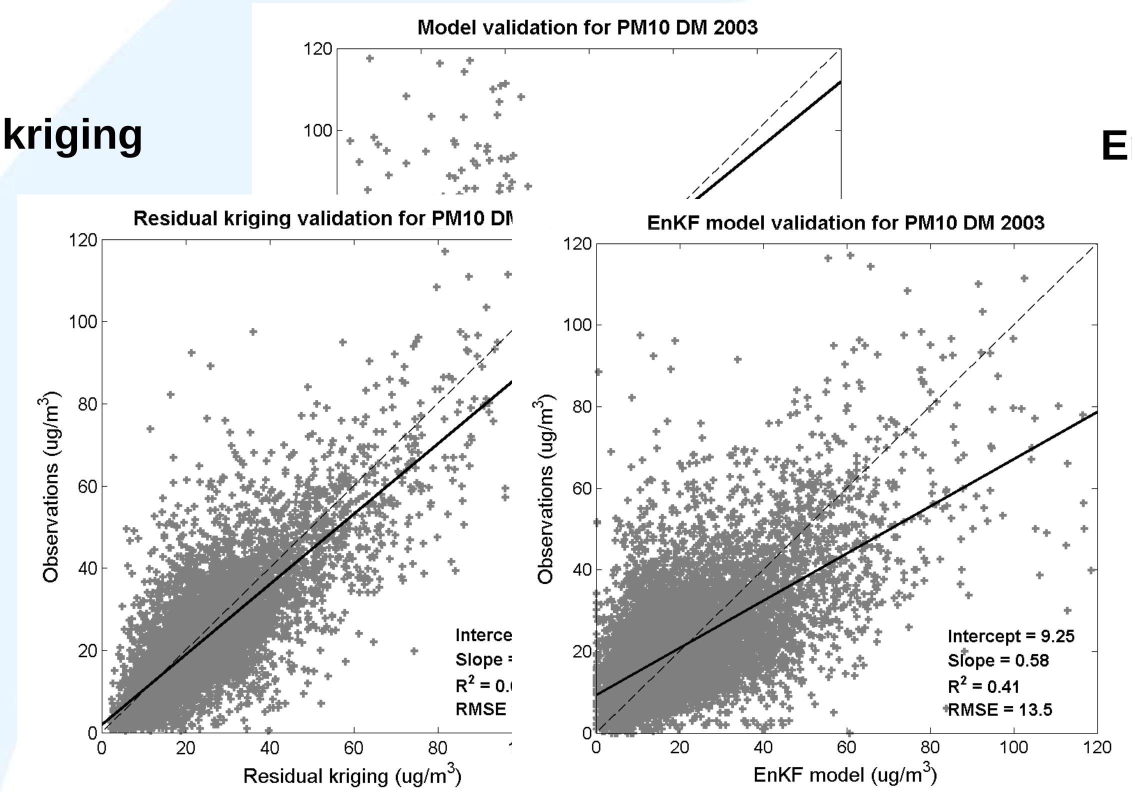
Denby B., M. Schaap, A. Segers, P. Builtjes and J. Horálek (2008). Comparison of two data assimilation methods for assessing PM10 exceedances on the European scale. Atmos. Environ. 42, 7122-7134.

Examples: Regional scale

Comparison of Residual kriging and Ensemble Kalman Filter for assessment of regional PM_{10} in Europe

Residual kriging

EnKF



Denby B., M. Schaap, A. Segers, P. Builtjes and J. Horálek (2008). Comparison of two data assimilation methods for assessing PM10 exceedances on the European scale. Atmos. Environ. 42, 7122-7134.

Examples: Regional scale

MACC ensemble forecast system

Model	Assimilation method	Implementation
CHIMERE	Innovative kriging, Ensemble Kalman filter	Not implemented in operational forecasts
EMEP	Intermittent 3d-var	In development
EURAD	Intermittent 3d-var	Implemented in forecast, using ground based observations and satellite derived NO_2
LOTOS-EUROS	Ensemble Kalman filter	Not implemented in operational forecasts
MATCH	Ensemble Kalman filter	In development
MOCAGE	3d-FGAT and incremental 4d-VAR	Not implemented in operational forecasts
SILAM	Intermittent 4d-var	Not implemented in operational forecasts

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http://www.gmes-atmosphere.eu/.

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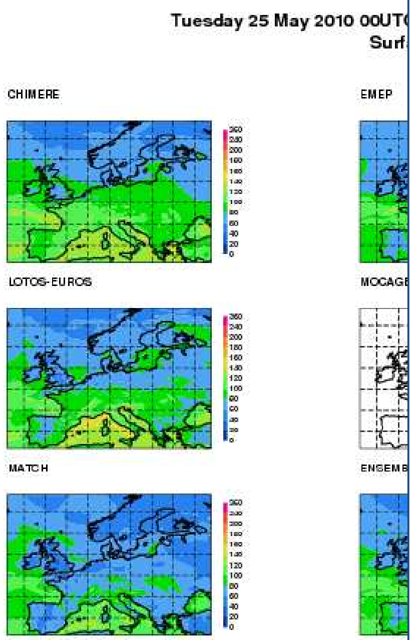
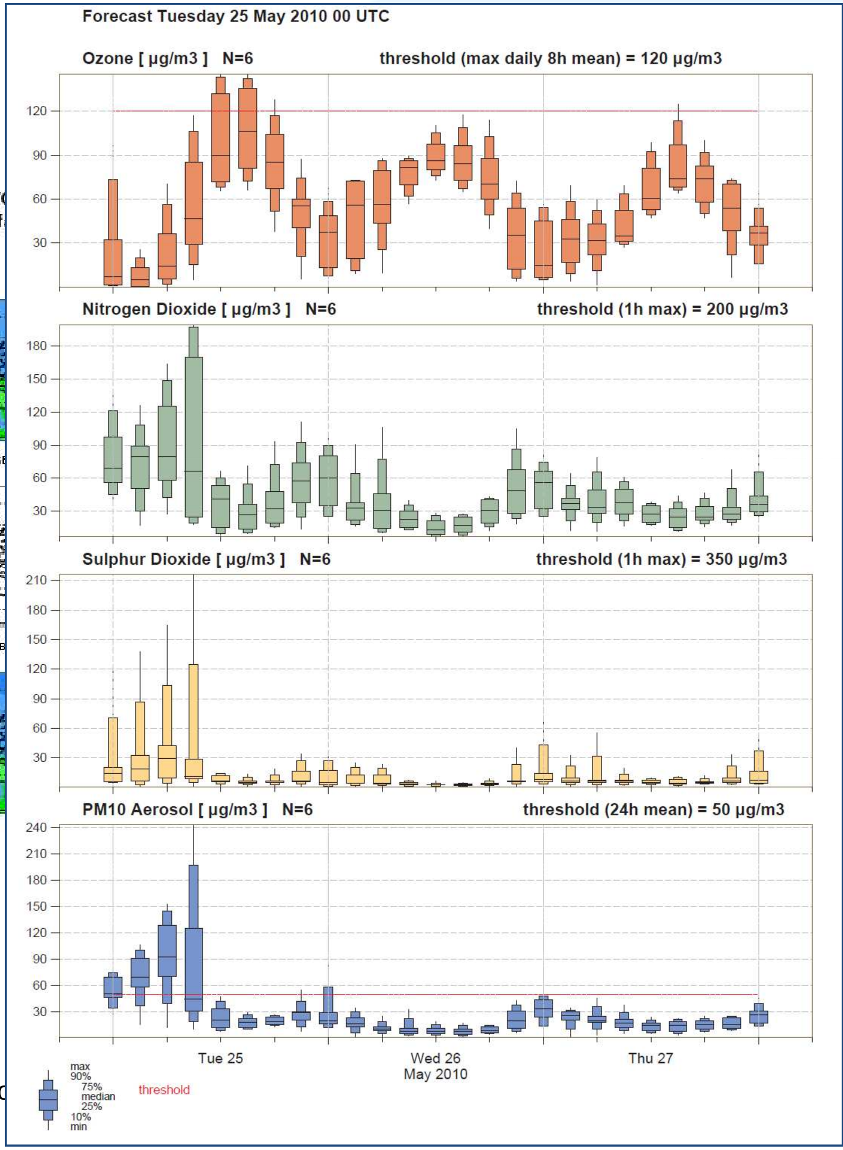
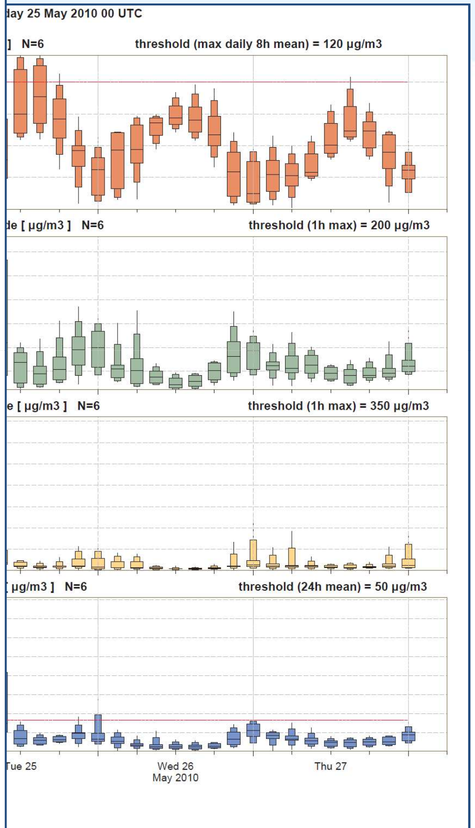
Examples: Regional scale

MACC ense







EPS Graph

http://www.gmes-atmo

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Examples: Local and urban

- Few examples of data fusion/assimilation on the local and urban scale
  - Spatial representativeness of monitoring sites is very limited (10 – 1000 m)
  - Often the number of sites is limited (compared to their spatial representativeness)
  - Monitoring contains little information for initialising forecasts
- Application for assessment is possible
  - E.g. regression, optimal interpolation

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Representativeness

- Two types of representativeness:
  - spatial and temporal (physical)
  - similarity (categorisation)

- Knowledge of this is important for:
  - validation of models
  - data fusion/assimilation

Representativeness

- For modelling applications the representativeness of monitoring data should be reflected in the uncertainty of that data
  - NB: Not just the measurement uncertainty
- This is reflected in the AQ Directive (Annex I)

  "The fixed measurements that have to be selected for comparison with modelling results shall be representative of the scale covered by the model"
- Representativeness will be pollutant and indicator dependent

Representativeness and the AQD

- For monitoring the AQ Directive states:
  - For **industrial** areas concentrations should be representative of a 250 x 250 m area
  - for **traffic** emissions the assessment should be representative for a 100 m street segment
  - **Urban** background concentrations should be representative of several square kilometres
  - For **rural** stations (ecosystem assessment) the area for which the calculated concentrations are valid is 1000 km^2 (30 x 30 km)
- These monitoring requirements also set limits on model resolution

Defining spatial representativeness

- The degree of spatial variability within a specified area
  - e.g. within a 10 x 10 km region surrounding a station the variability is ± 30%
  - *Useful for validation and for data assimilation*

- The size of the area with a specified spatial variability
  - e.g. < 20% of spatial mean (EUROAIRNET) or < 10% of observed concentration range in Europe (Spangl, 2007)
  - *Useful for determining the spatial representativeness of a site*

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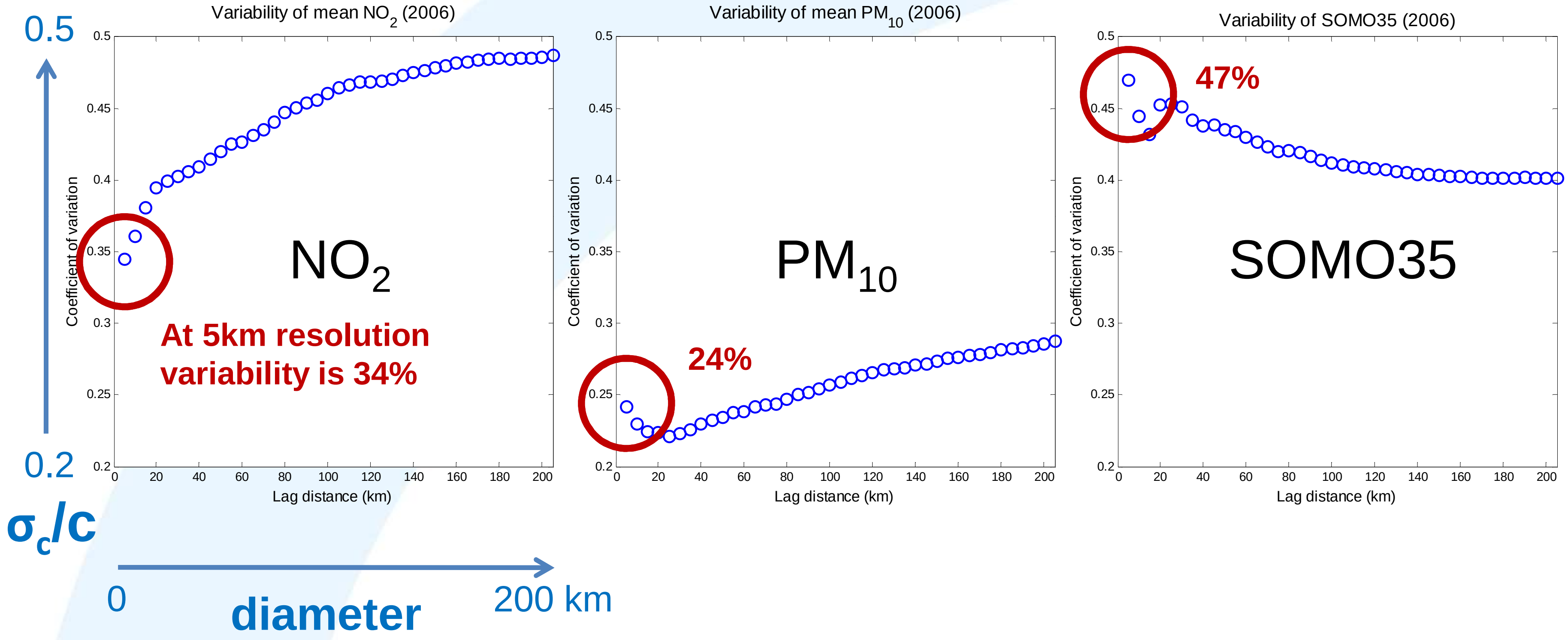
Observed spatial variability

Coefficient of variation σ_c/c for annual indicators as a function of area (diameter) for all stations (Airbase)



A random sampling within a 5km grid in an average European city will give this variability

Future progress in SG1-WG2

- Complete a review/list of activities and institutes carrying out DA and DF
- Provide an accessible review of these methods
- Recommend methods for quality assurance (→ SG4 'Bench marking')
- Develop a consensual understanding of representativeness (→ SG4 'Bench marking')
- Further develop the network and funding

For information and contributions contact

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and register interest on the website

http://fairmode.ew.eea.europa.eu/

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