Air quality modelling system SILAM: moving towards finer resolution

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What is SILAM?

- Lagrangian particle model for atmospheric transport/dispersion calculations (FMI: Sofiev, Atm. Environ, 40, 2006).

- **Forward formulation**: emission sources & meteorological fields in → concentrations & deposition fluxes out

- **Inverse formulation**: concentration measurements & meteorological fields in → probability distribution for sources out.

- I.e. **carbage in** → **carbage out**.

- How to avoid garbage? (answer later)

How it works?

- **Forward formalism:** $\dfrac{\partial \varphi}{\partial t} + \dfrac{\partial \varphi}{\partial x_i} u_i - \dfrac{\partial}{\partial x_i} \mu_{ii} \dfrac{\partial \varphi}{\partial x_i} + \xi\varphi = E$

φ – concentration;

μ_{ii} – durbulent diffusivities;

ξ – all sinks, E – all sources.

- **Inverse formalism:** $\dfrac{\partial \varphi^*}{\partial t} + \dfrac{\partial \varphi^*}{\partial x_i} u_i - \dfrac{\partial}{\partial x_i} \mu_{ii} \dfrac{\partial \varphi^*}{\partial x_i} + \xi\varphi^* = S$
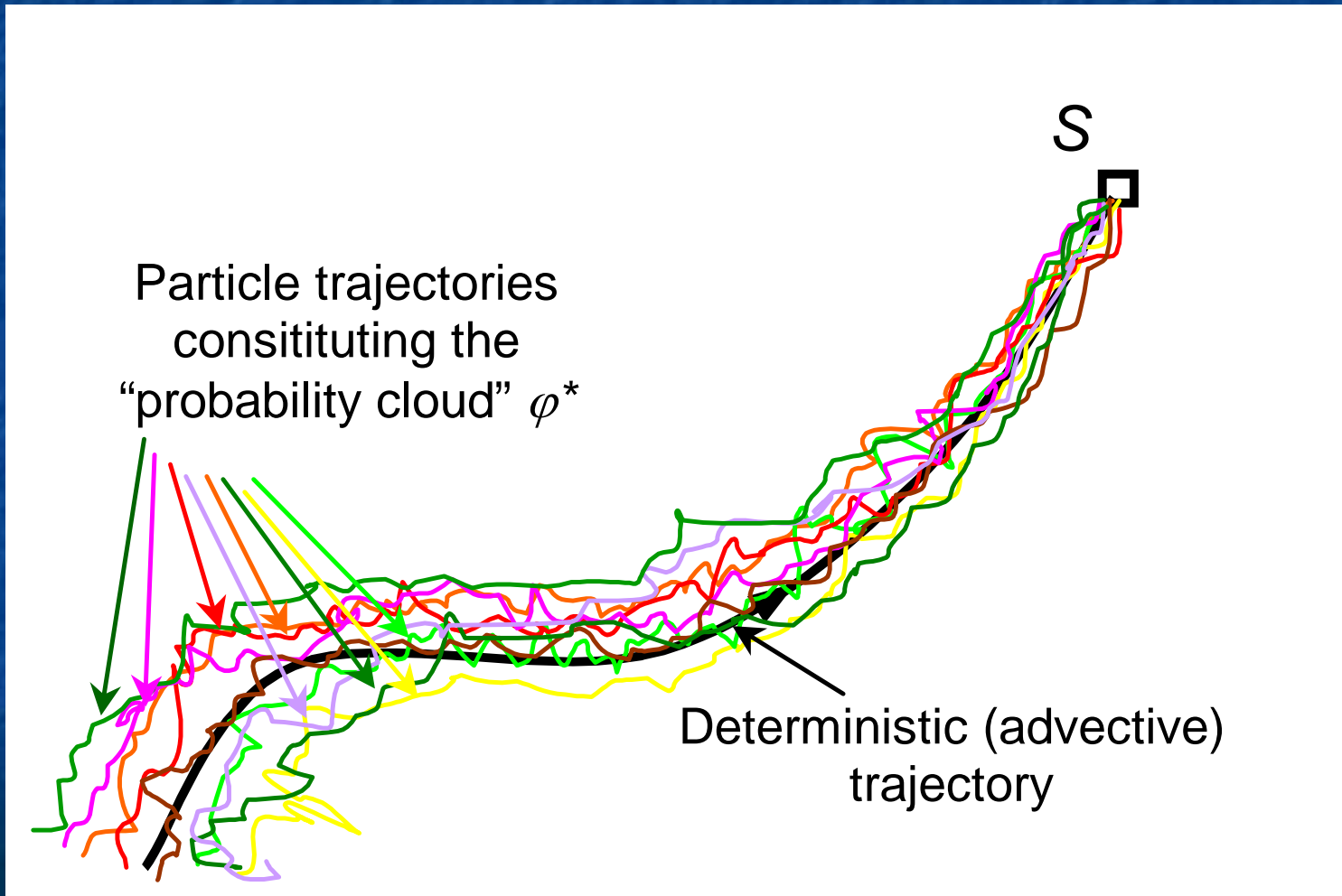
φ^* – sensitivity distribution;

μ_{ii} – turbulent diffusivities;
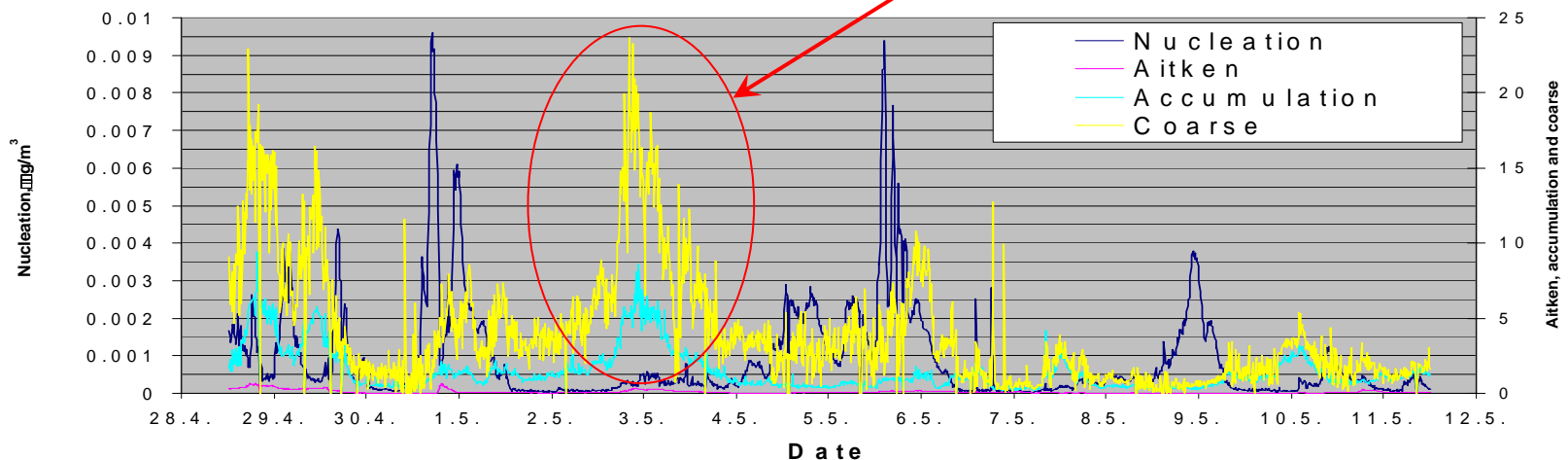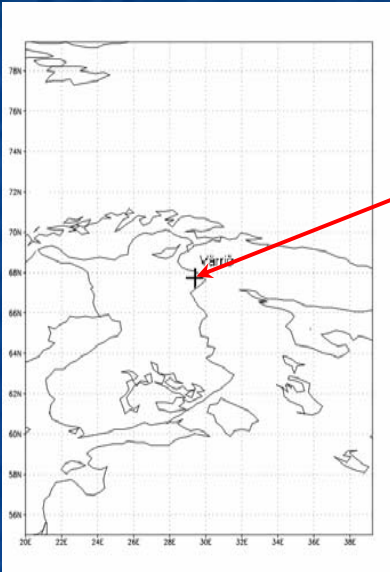
ξ – all sinks,

S – sensitivity source function.

Inverse (adjoint) run:

S

Particle trajectories
constituting the
"probability cloud" φ^*

Deterministic (advective)
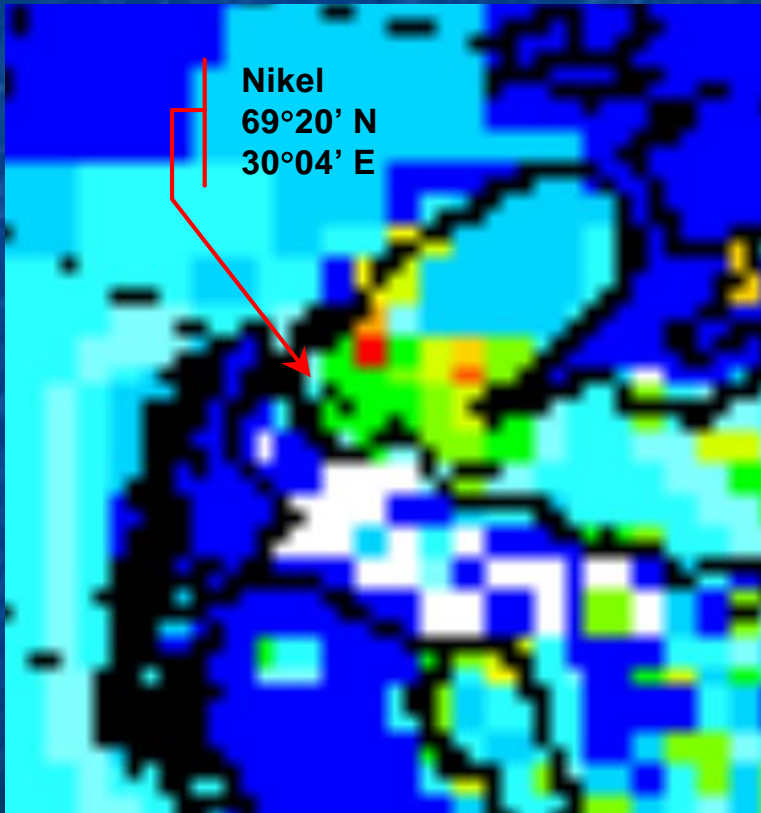trajectory

An example

- Värriö aerosol campaign, aprill – mai, 2003

- Peak of coarse aerosol, May 2 – 3.

Modelling for Värriö:

- Sources ($SO_2 \rightarrow SO_4$, PM10, PM2.5) – EMEP;

- Meteorological fields – HIRLAM (FMI);

- Horisontal resolution – 20 km.

- Vertical resolution – 5 layers through lower 2500 m.

An error found in EMEP database:

Nikel
69°20' N
30°04' E

Why we need finer resolution?

"Urbanising" the SILAM model: underlying surface properties, heat island effects.

Experiments near Narva power plants (Estonia) with **5 km** SILAM resolution and **22 km** HIRLAM fields showed a lot of "carbage":

- improper vertical dispersion,
- doubtful wind directions,
- coastline effects not resolved.

Non-hydrostatic future?

Apply meteorological fields of non-hydrostatic "Tartu" HIRLAM:

- Horisontal resolution 3.3 km, hopefully finer in near future.

- Enough aerosol mesurement campaigns for model validation.