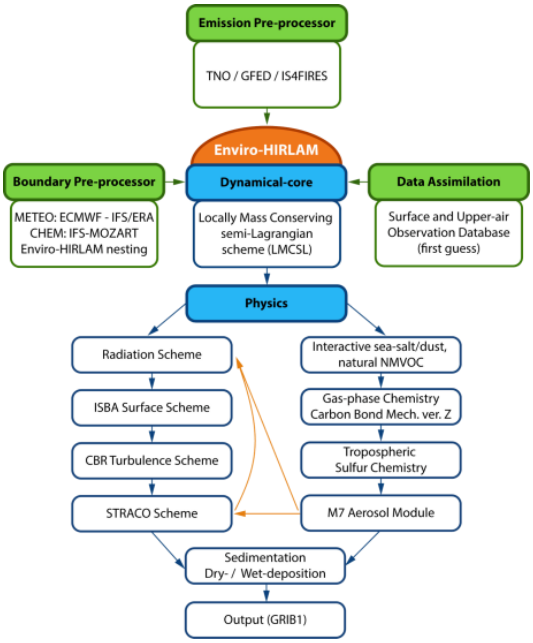
Enviro-HIRLAM: Environment – HIgh Resolution Limited Area Model



The Enviro-HIRLAM is a fully online-coupled ACT-NWP (Atmospheric Chemistry Transport – Numerical Weather Prediction) modeling system for regional-, meso- and urban scale different environmental applications. The NWP part developed by HIRLAM consortium (*Unden et al, 2002*) is used for operational weather forecasting. The Enviro-components (see Figure) were mainly developed by DMI and NBI/UoC with partners from European countries (*Korsholm, et al., 2008; Baklanov, et al., 2008).* It consists of gas-phase chemistry CBMZ (*Zaveri & Peters, 1999*) and aerosol microphysics M7 (*Vignati et al., 2004*), which includes sulfate, mineral dust, sea-salt, black and organic carbon (*Nuterman et al. 2013*). There are modules of urbanization for land surface scheme, natural and anthropogenic emissions, nucleation, coagulation, condensation, dry and wet deposition, and sedimentation of aerosols. The Savijarvi radiation scheme (*Savijaervi, 1990*) has been improved to account explicitly for aerosol radiation interactions for 10 aerosol subtypes. The aerosol activation scheme (*Abdul-Razzak & Ghan, 2000*) was also implemented in STRACO condensation-convection scheme. The nucleation is dependent on aerosol properties and the ice-phase processes are reformulated in terms of classical nucleation theory.

Model Setup includes:

period to be studied; boundaries of modeling domain; selected projection; horizontal & vertical resolutions; chemical & meteorological initial & boundary conditions; emissions (anthropogenic, biogenic, natural); chemical & aerosol modules.

Emission Inventories:

Anthropogenic: TNO-MACC for year 2009 (species: SO_2, PM; Temporal profile: hour-of-day, day-of-week and day-of-year (depends on country time zone/shift); Vertical profile: according to TNO; PM emissions scaling following TNO)

Biomass burning: IS4FIRES by FMI (species: SO_2 and TPM split into $PM_{2.5}$ and PM_{10}; vertical profile is as follows (approx. recommendation of emitting 50% in lowest 200 m and 50% between 200 and 1000 m):

Natural: Interactive sea-salt (*Zakey et al., 2008*) and mineral dust (*Zakey et al., 2006*) emission modules.

Boundary (BC) and Initial (IC) Conditions:

Meteorological IC/BC: data are taken from operational ECMWF IFS model at N-hr temporal & N ^{o} x N ^{o} horizontal resolutions for domain specified in geographical coordinates and N-vertical levels; parameters need to be retrieved from ECMWF to force model are: 2D surface fields: soil moisture, snow depth, surface pressure & roughness, geopotential, land-cover/use classes, albedo, vegetation & soil types; and 3D fields: specific humidity, temperature, winds.

Chemical IC/BC: data are taken from IFS-MOZART output. The two mineral dust size bins of IFS-MOZART are treated. The aerosol number concentration is computed from the aerosol masses according to the Hatch-Choate conversion equations. The following variables of IFS-MOZART are used in Enviro-HIRLAM: O_3, NO, NO_2, HNO_3, H_2O_2, SO_2, OH, SO_4, dust, black and organic carbon.

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