PALM - Using Non-Cyclic Boundary Conditions

PALM group

Institute of Meteorology and Climatology, Leibniz Universität Hannover

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  - At the outflow, a boundary condition is required which allows the eddies to freely leave the domain.

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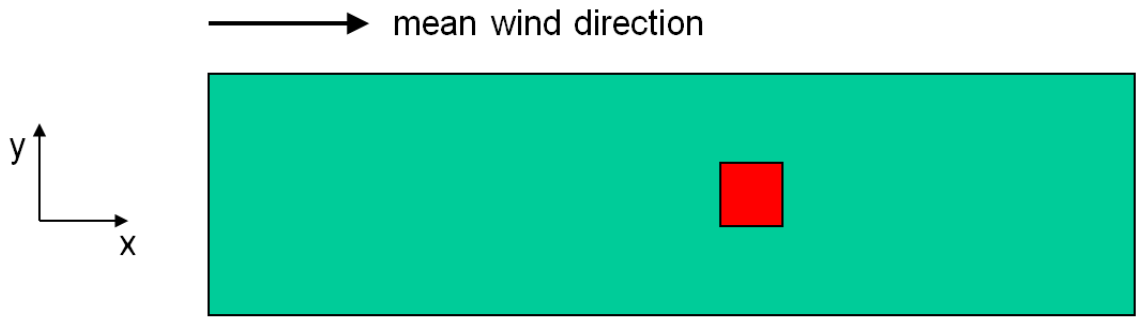

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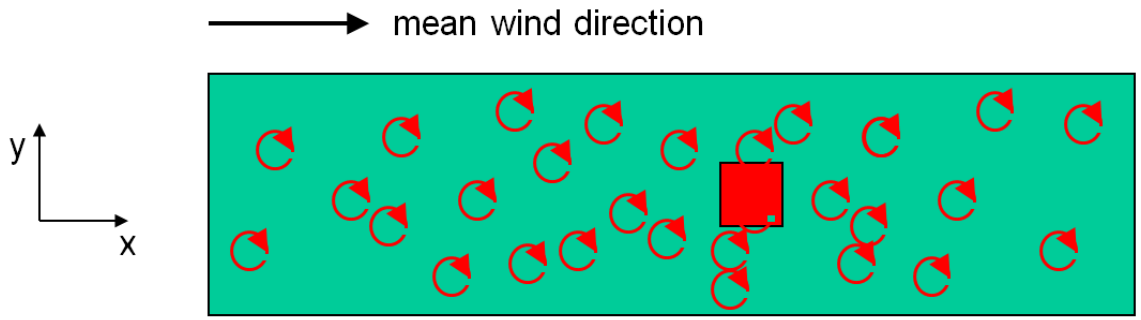

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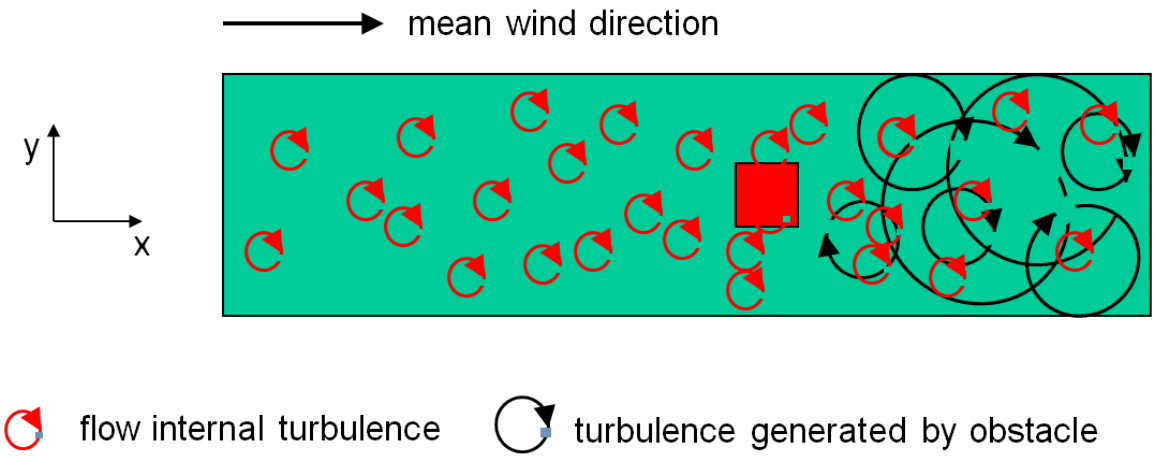

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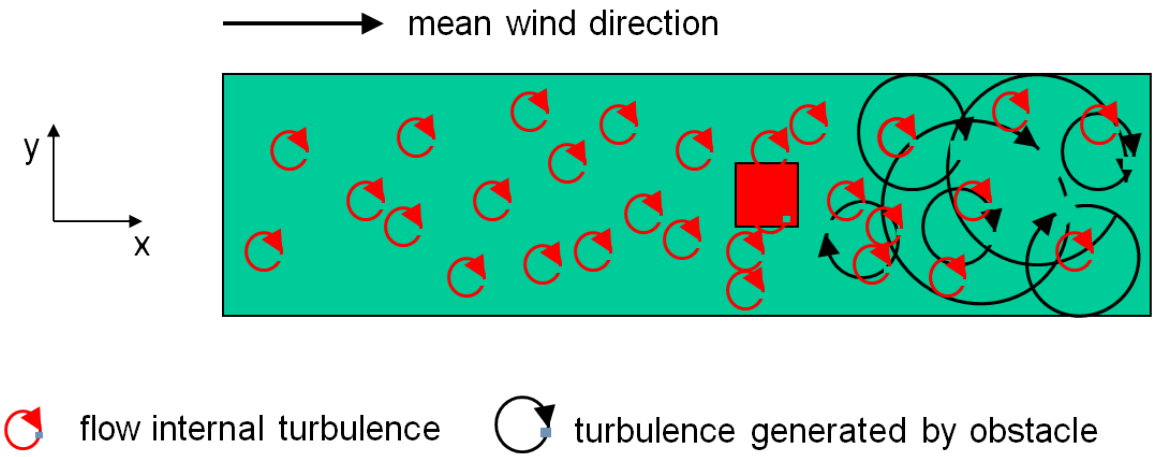

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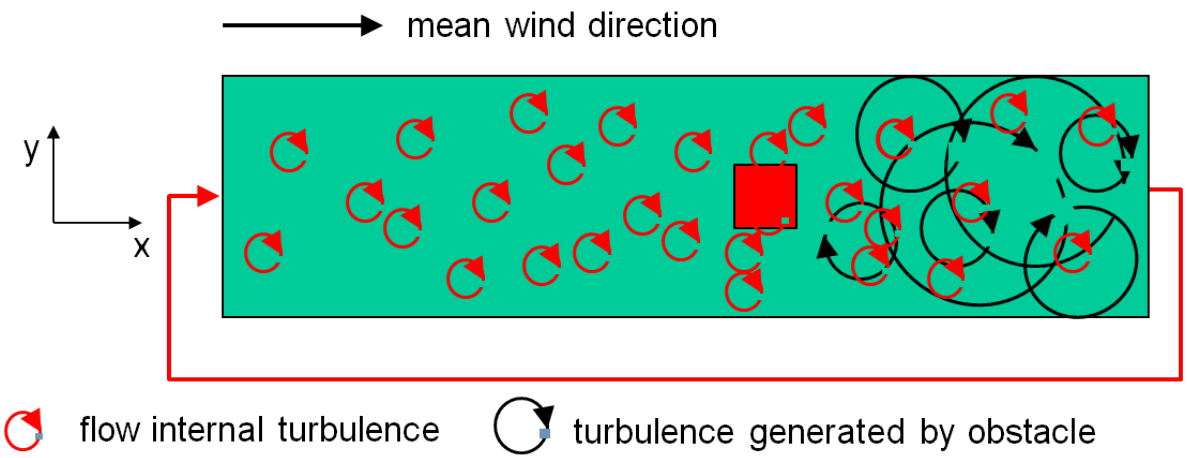

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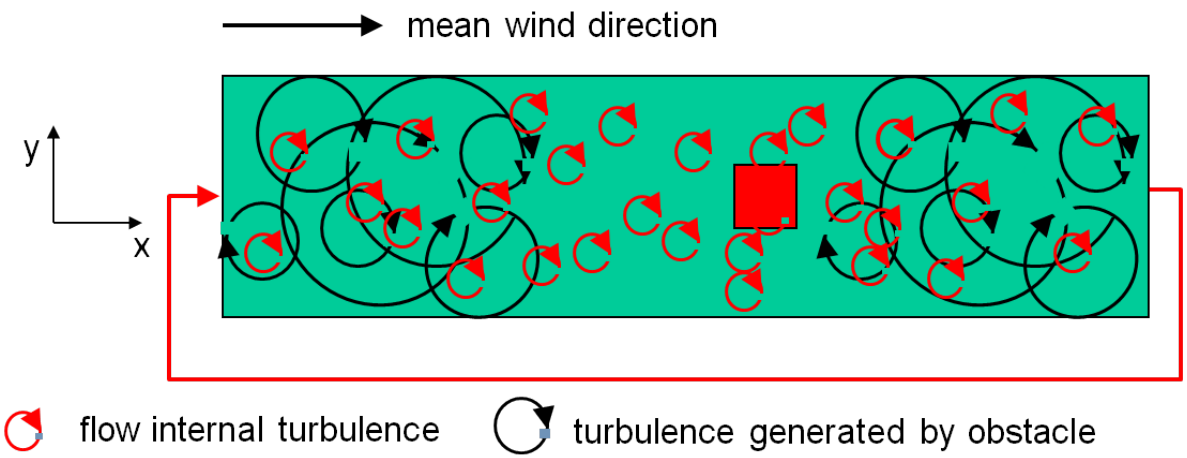

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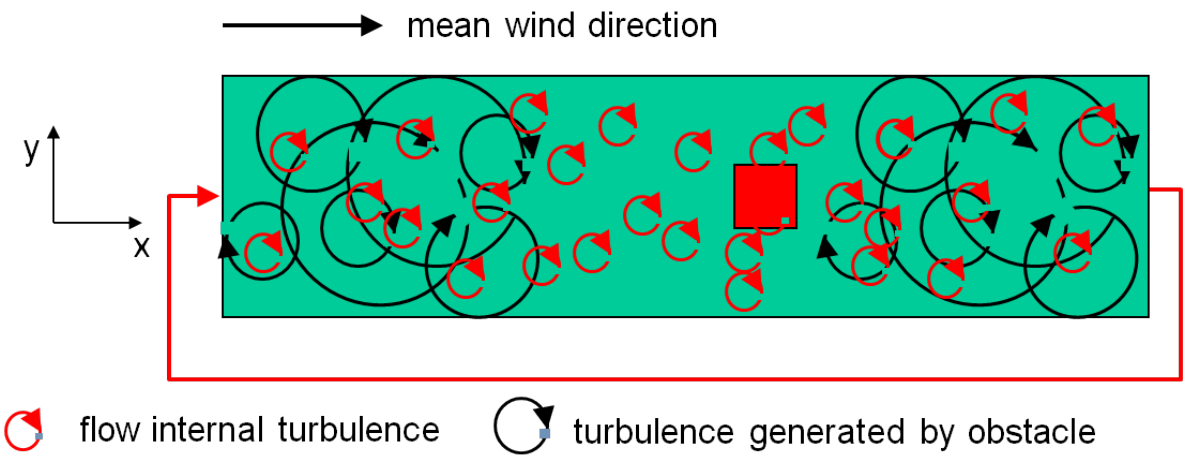
This wouldn't be a simulation of a single building, but of an infinite row of buildings!



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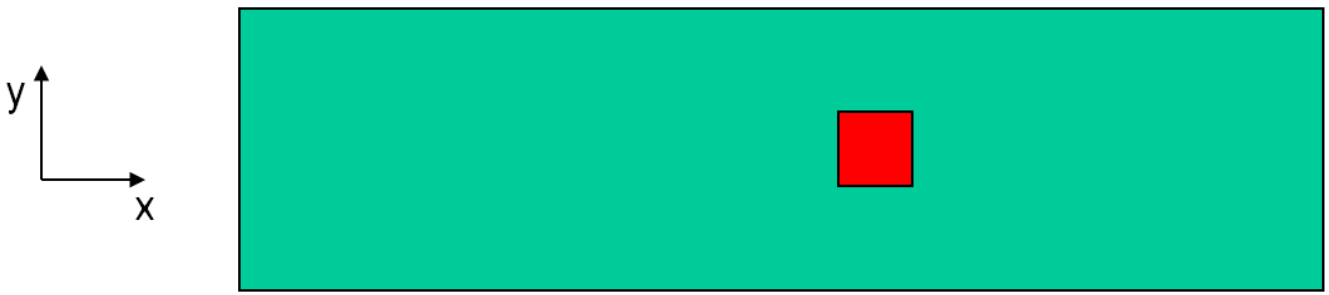

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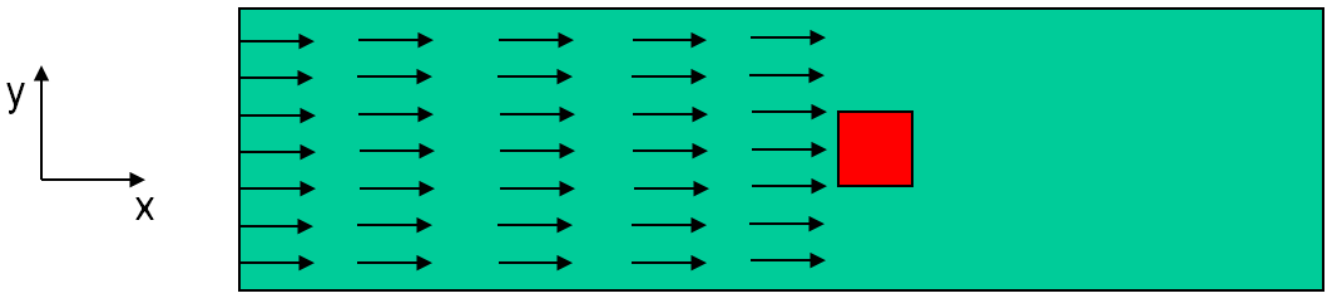

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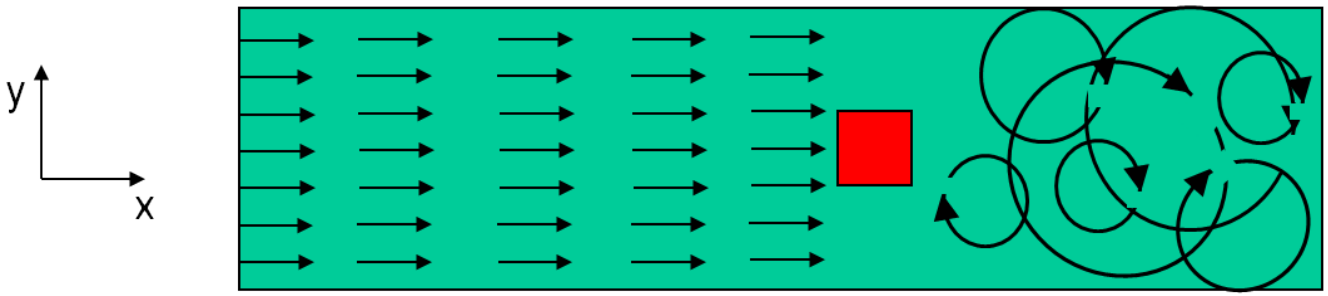

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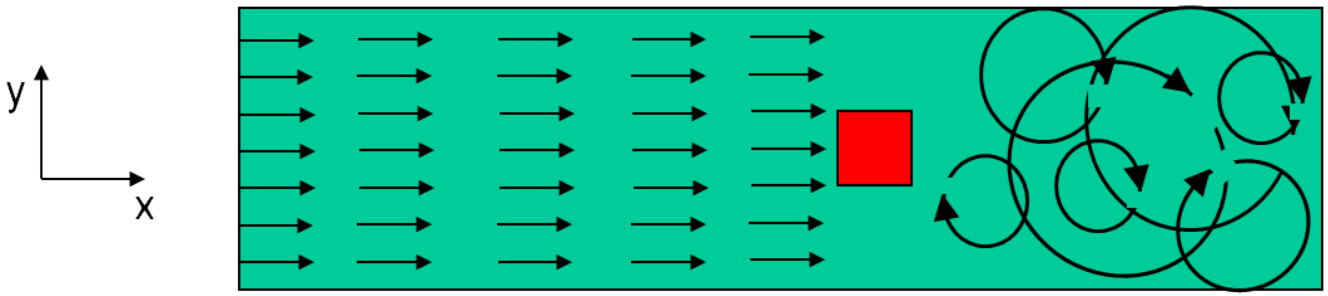

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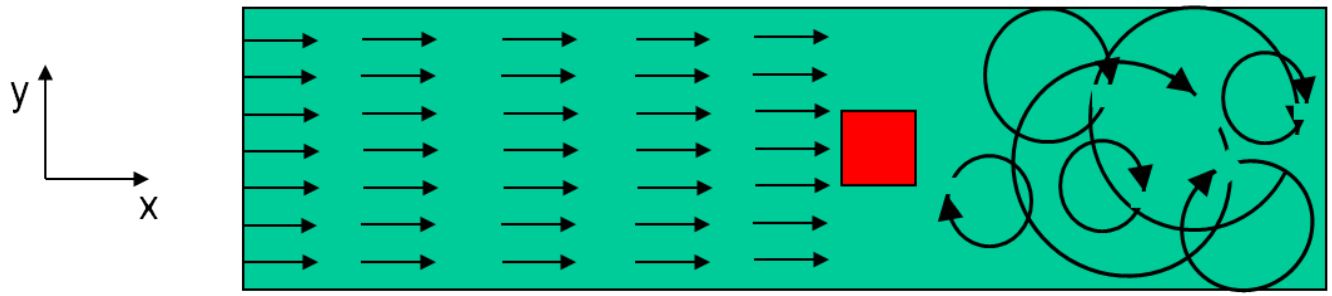

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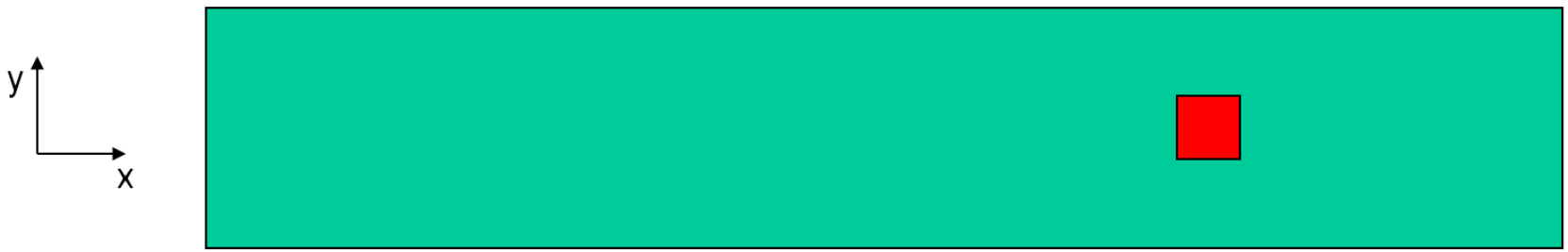

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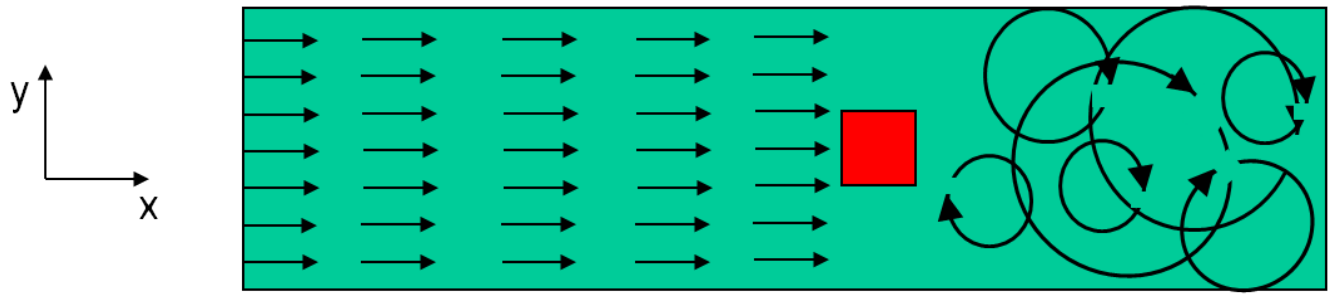

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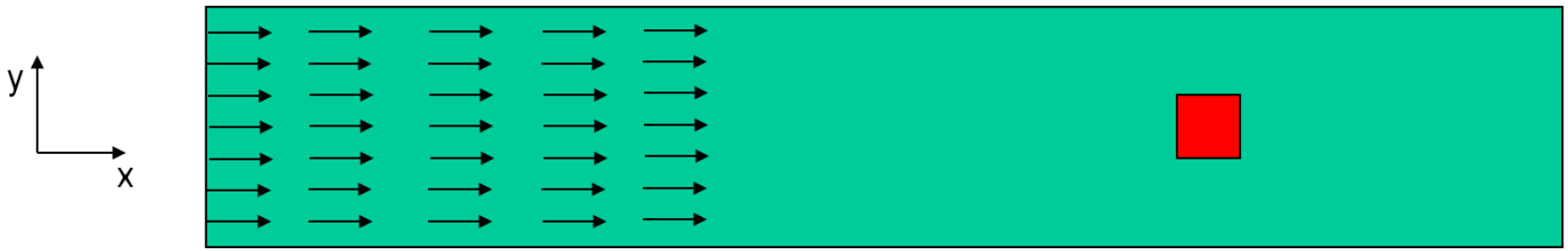

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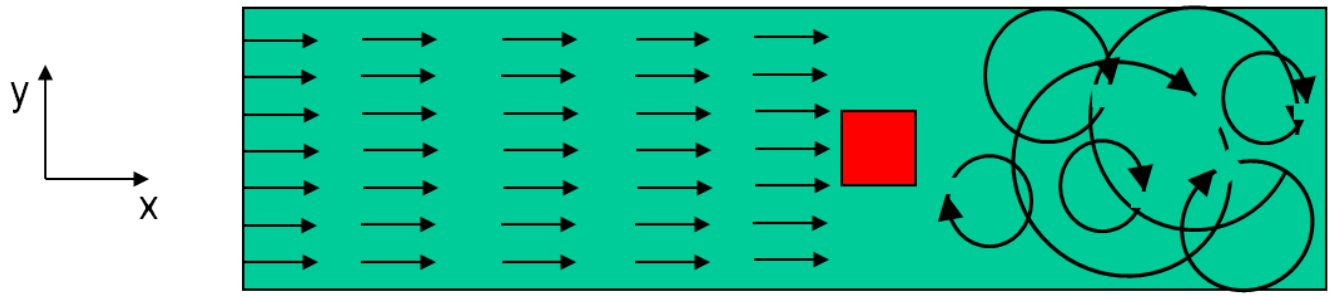

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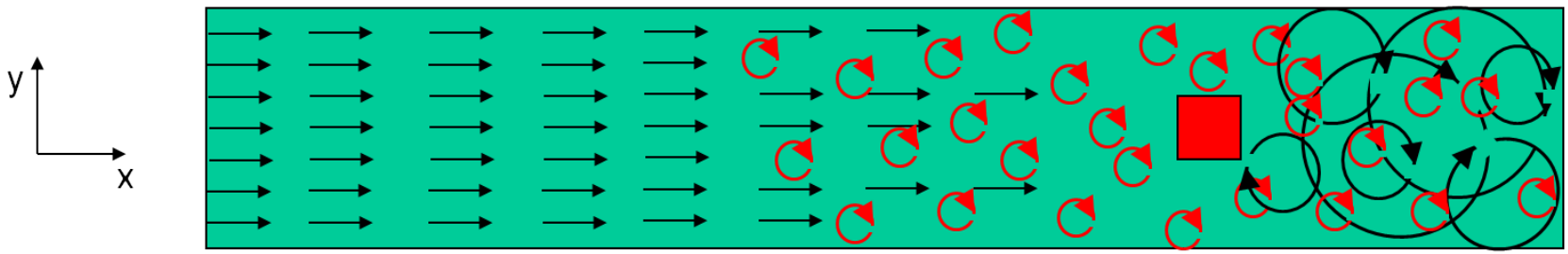

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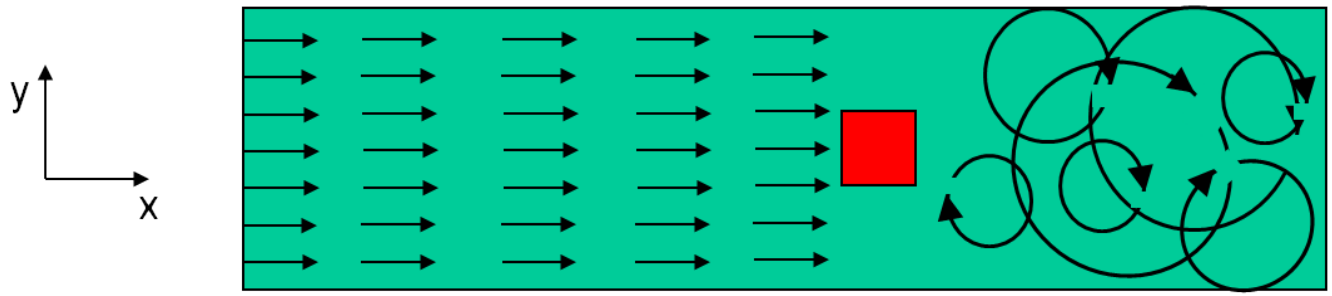

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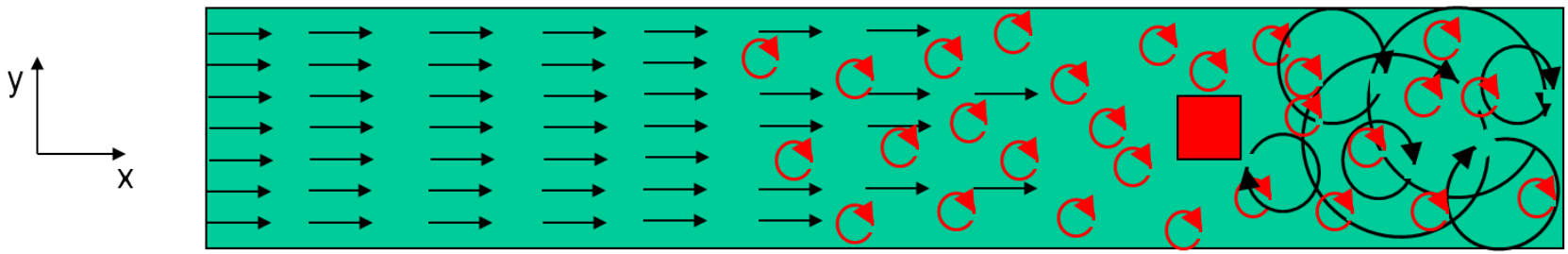

There is a need to supply turbulence information at the inflow.

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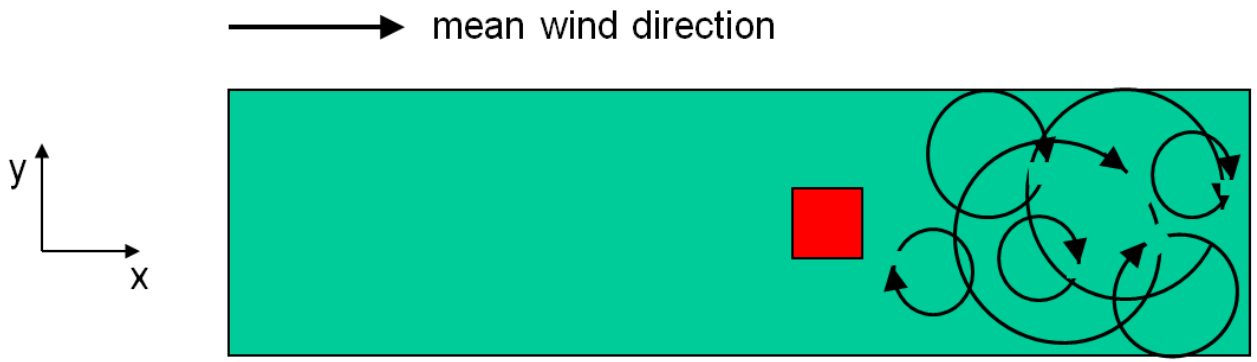

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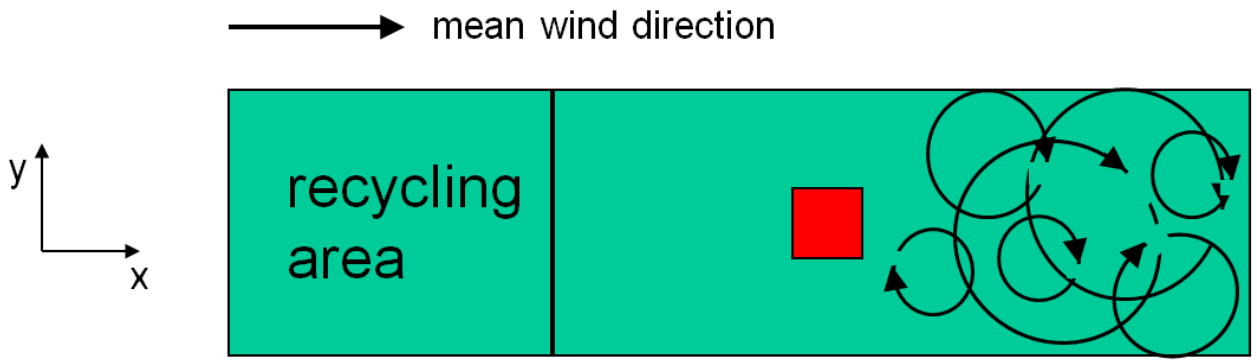

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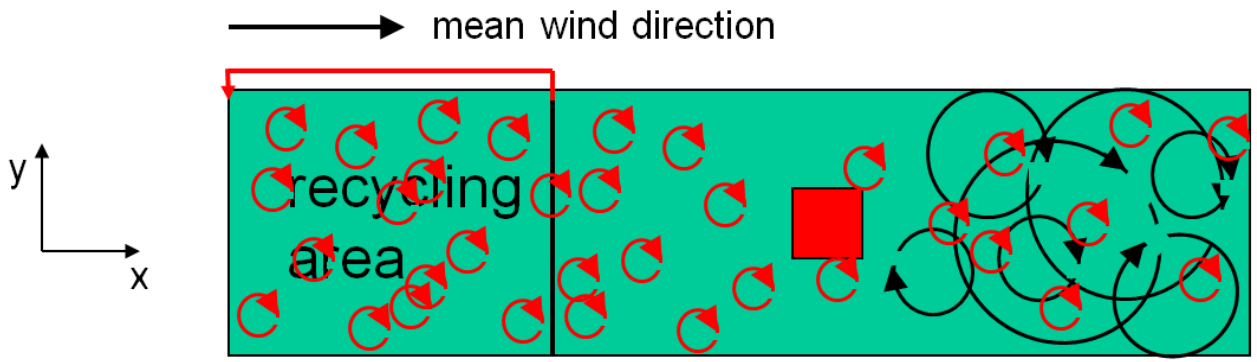

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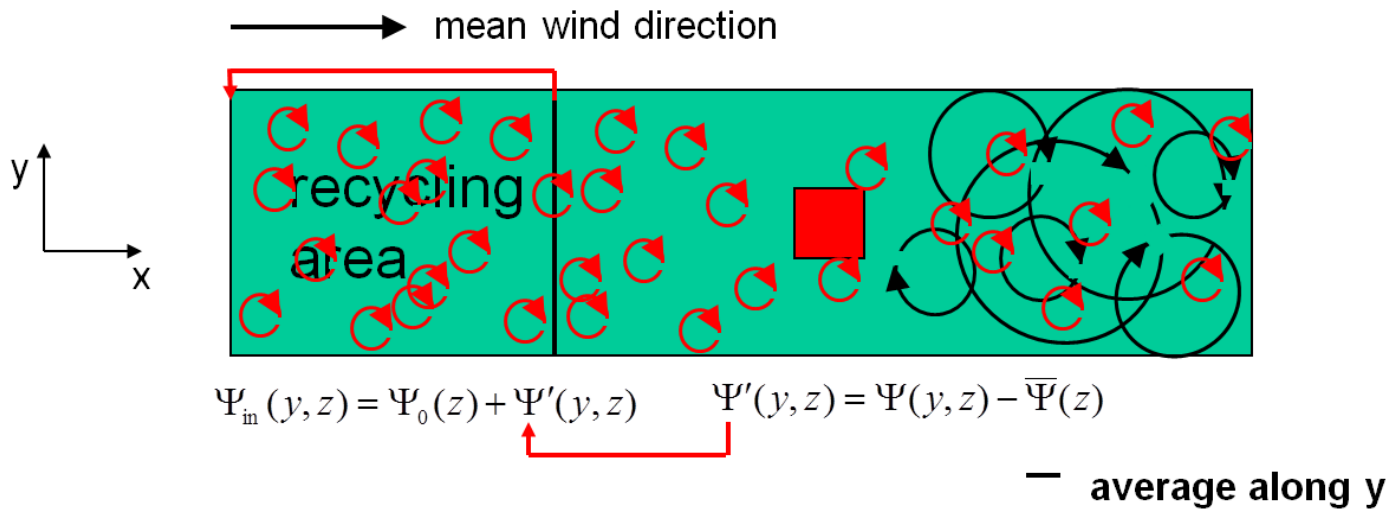

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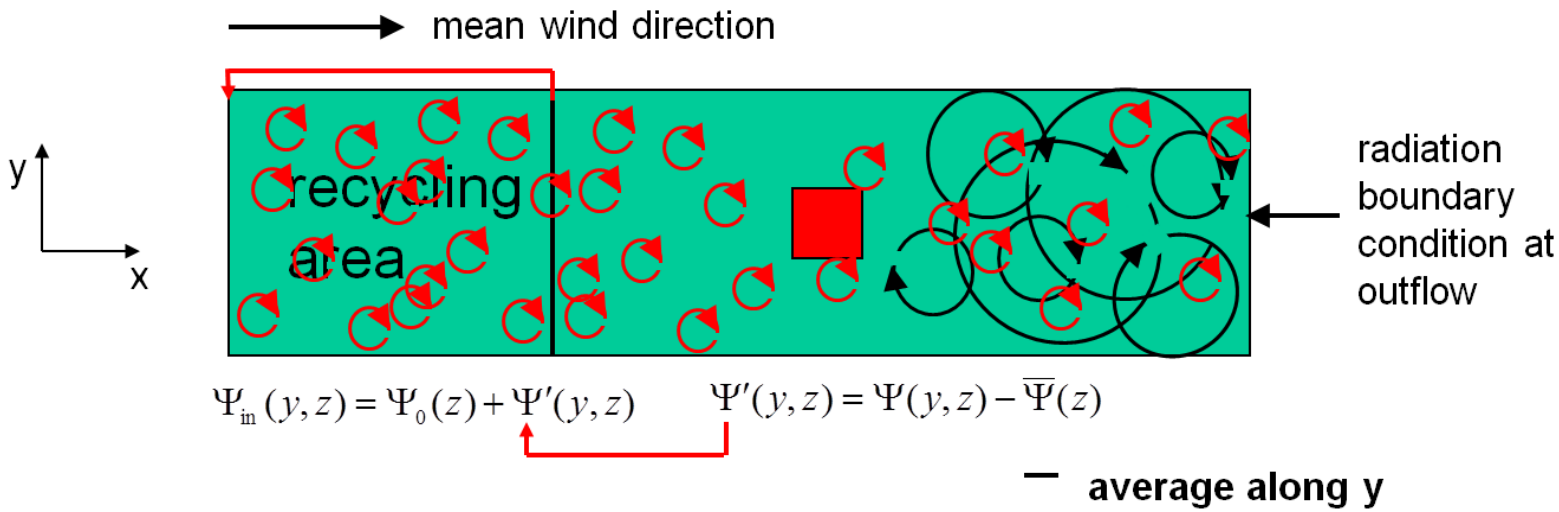

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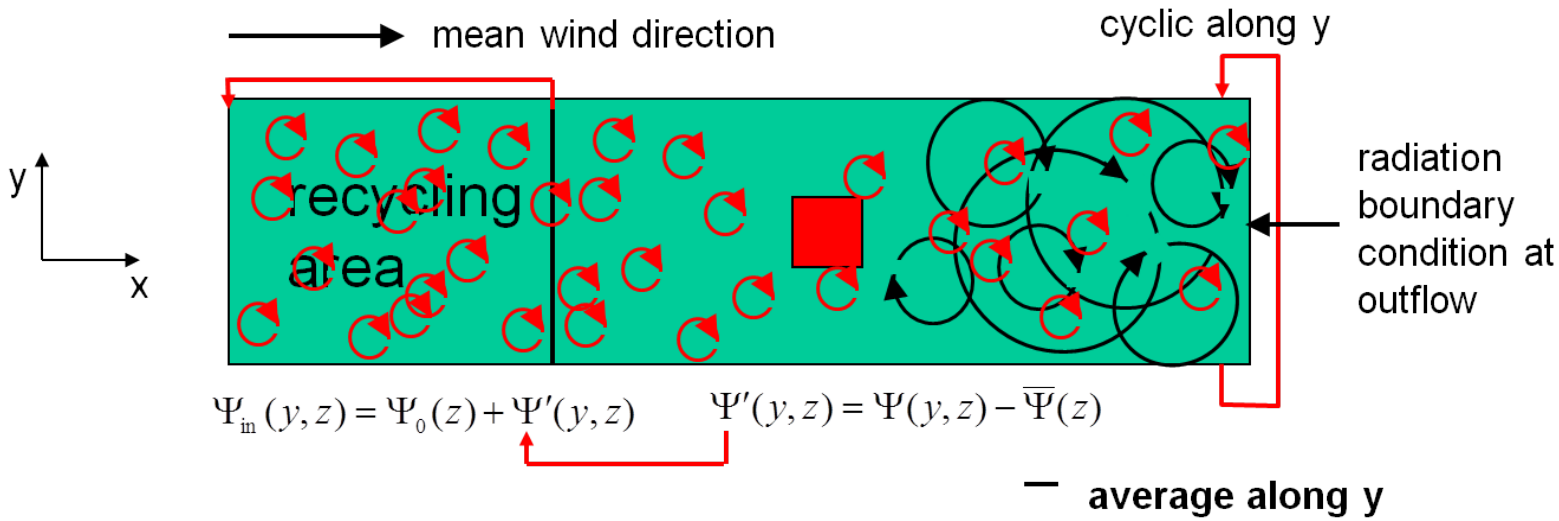

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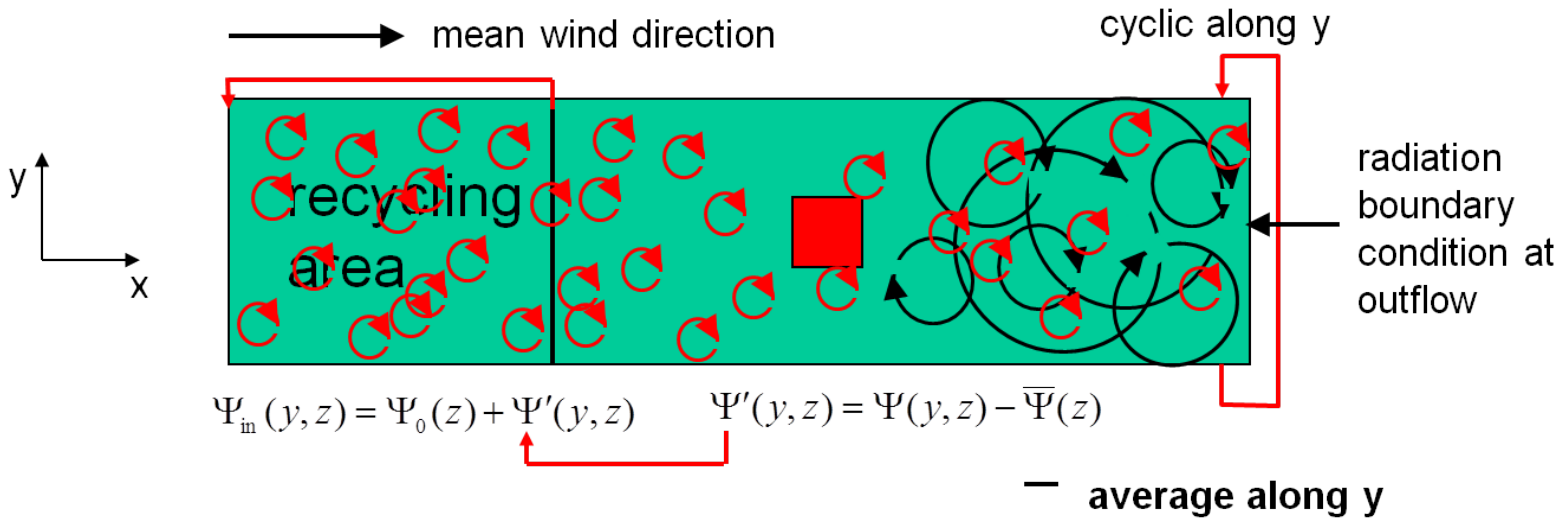

How do we get the initial turbulence in the recycle area?
If there is no turbulence, there is nothing to recycle!

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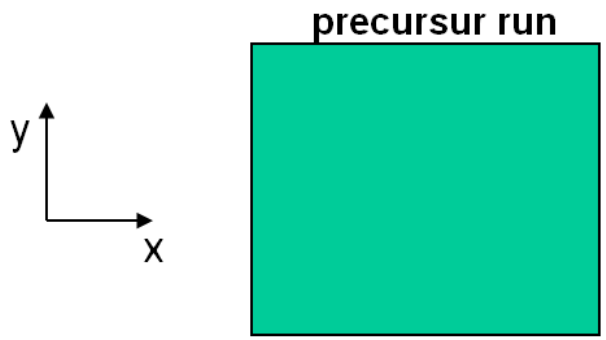

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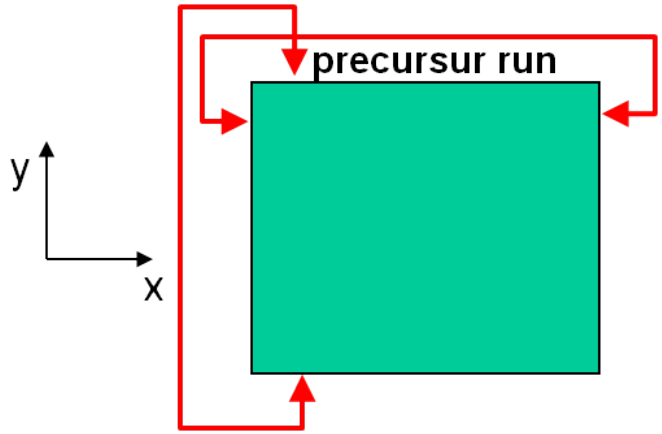

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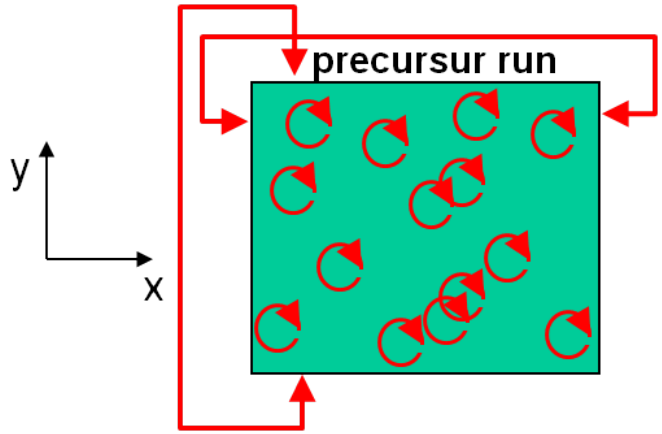

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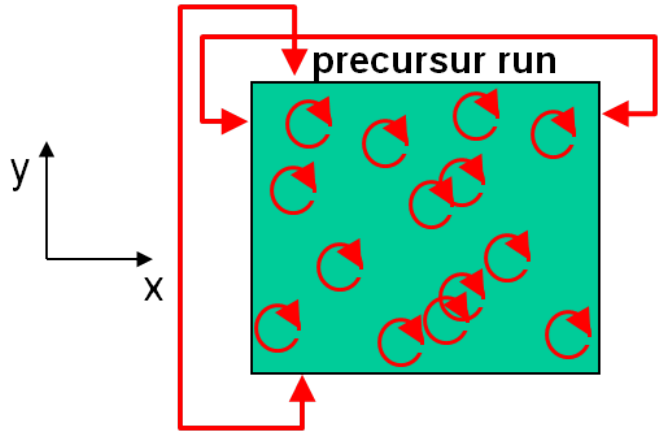

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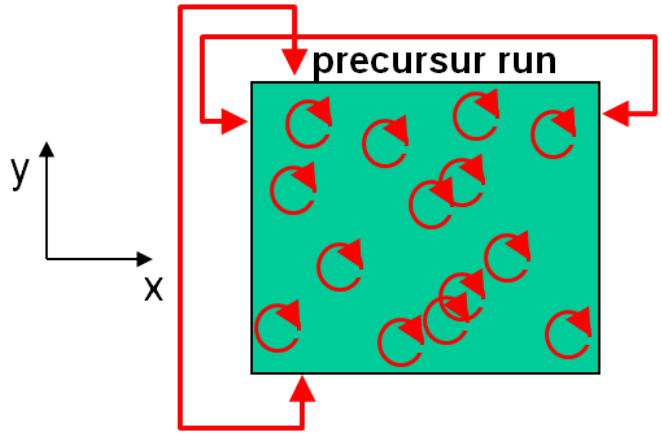

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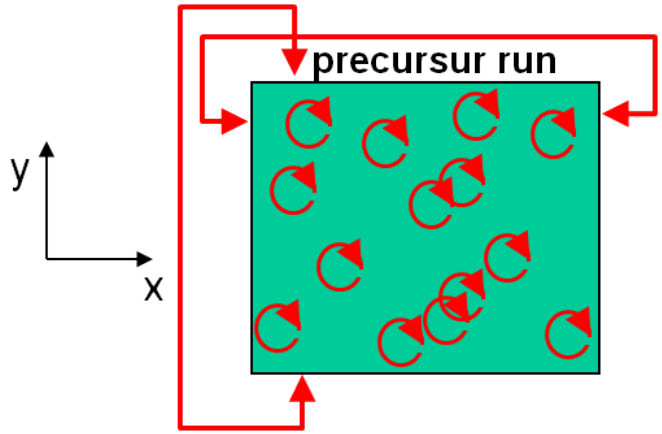

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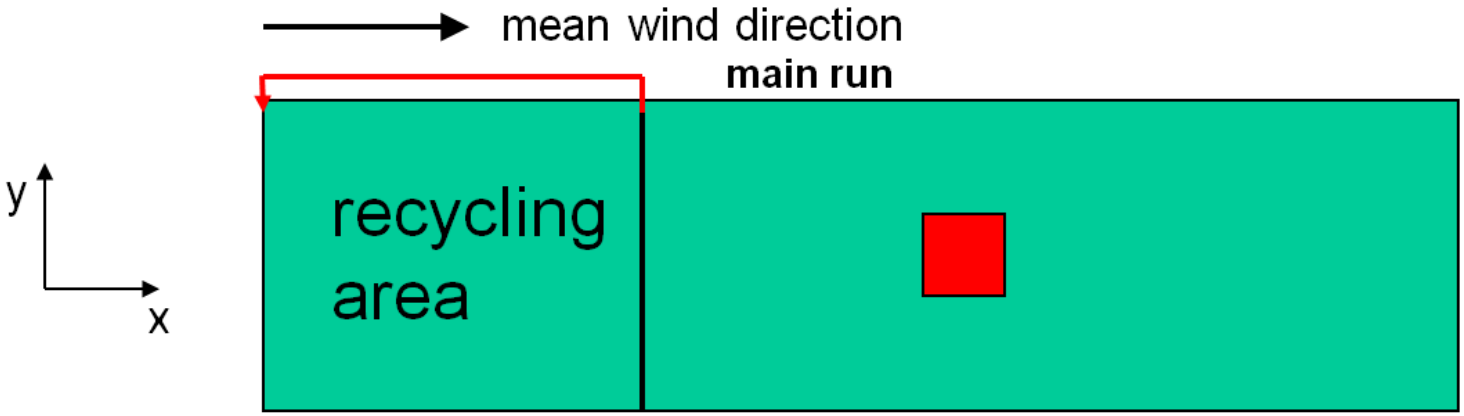

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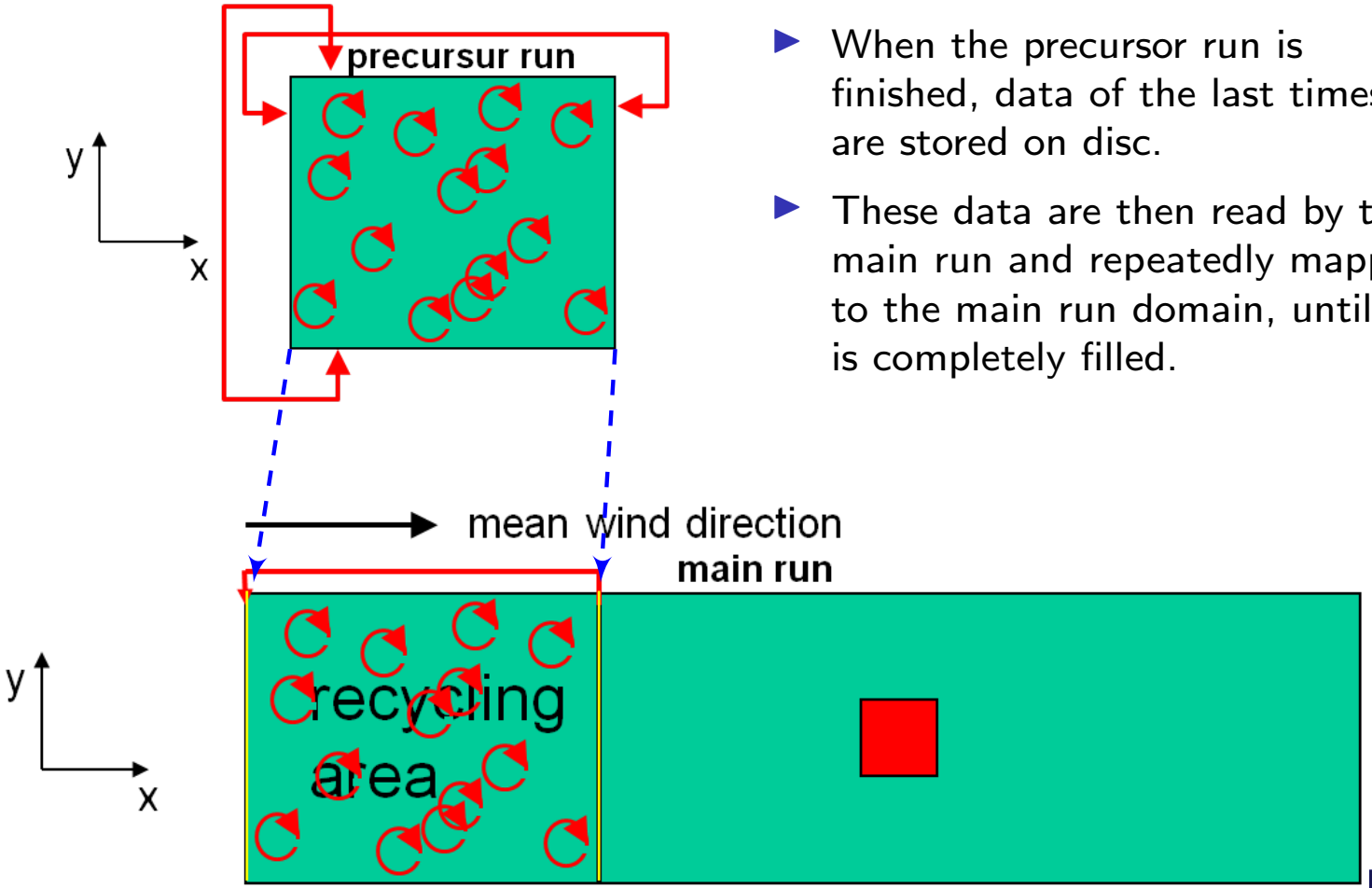

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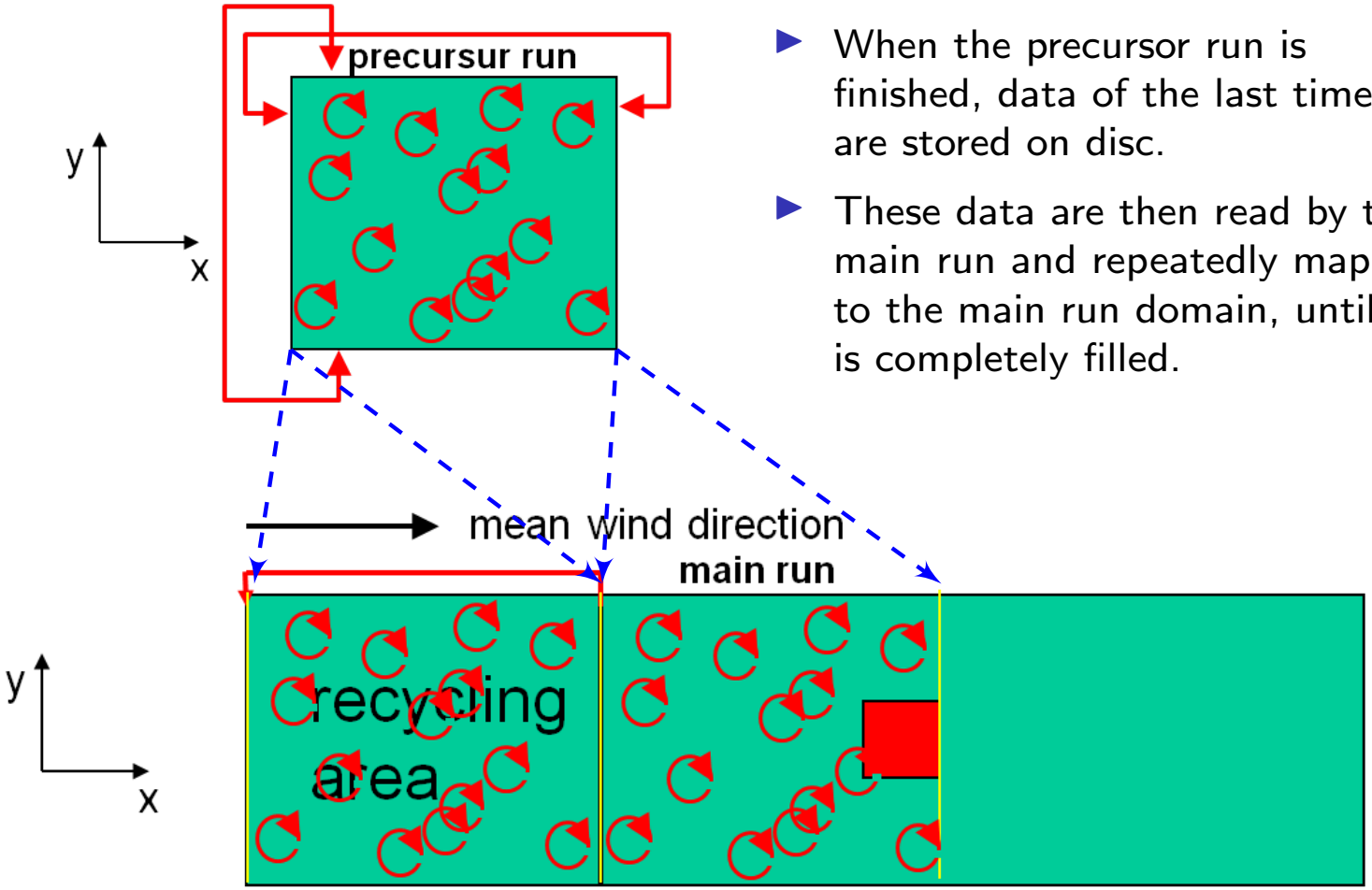

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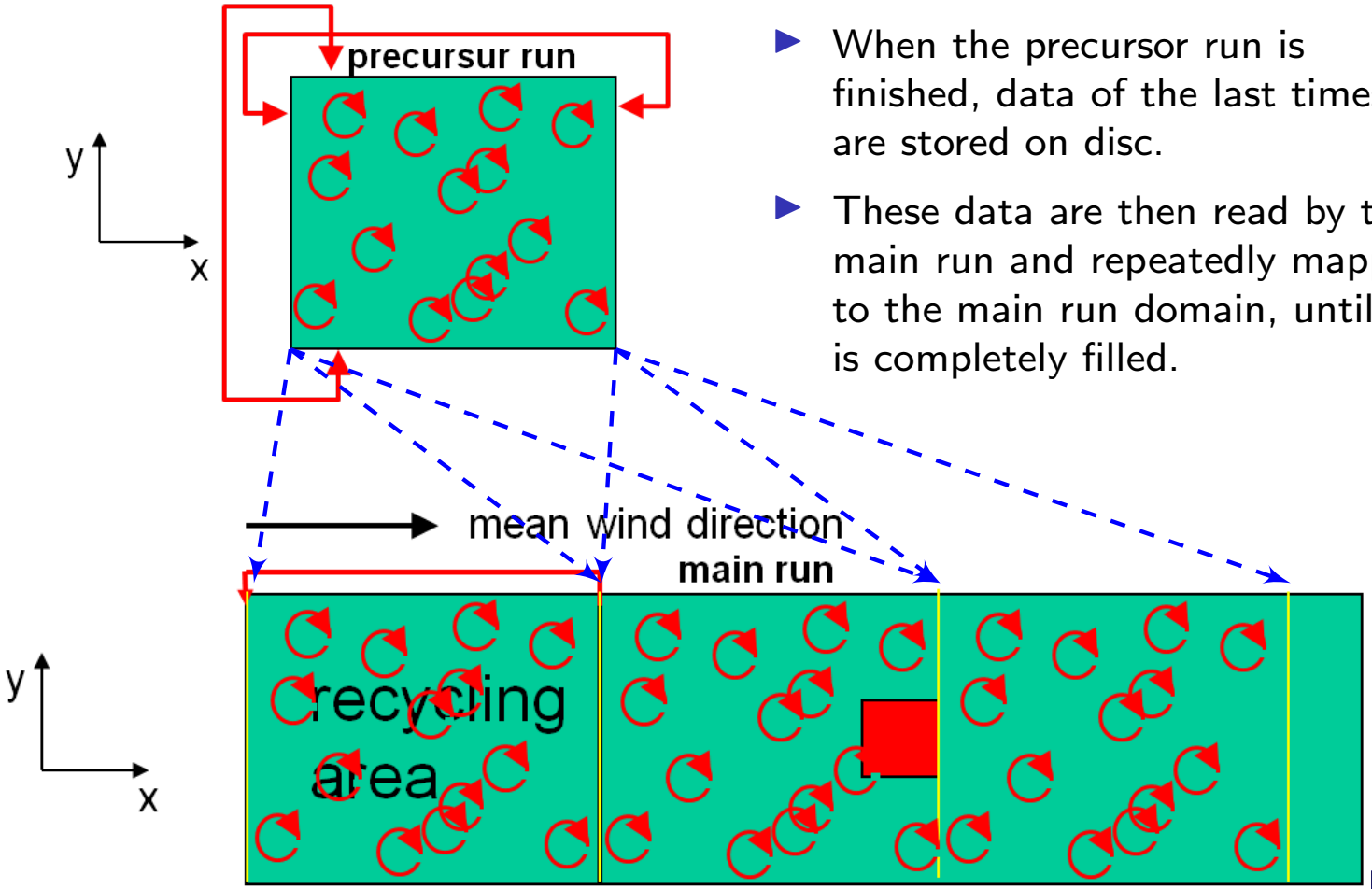

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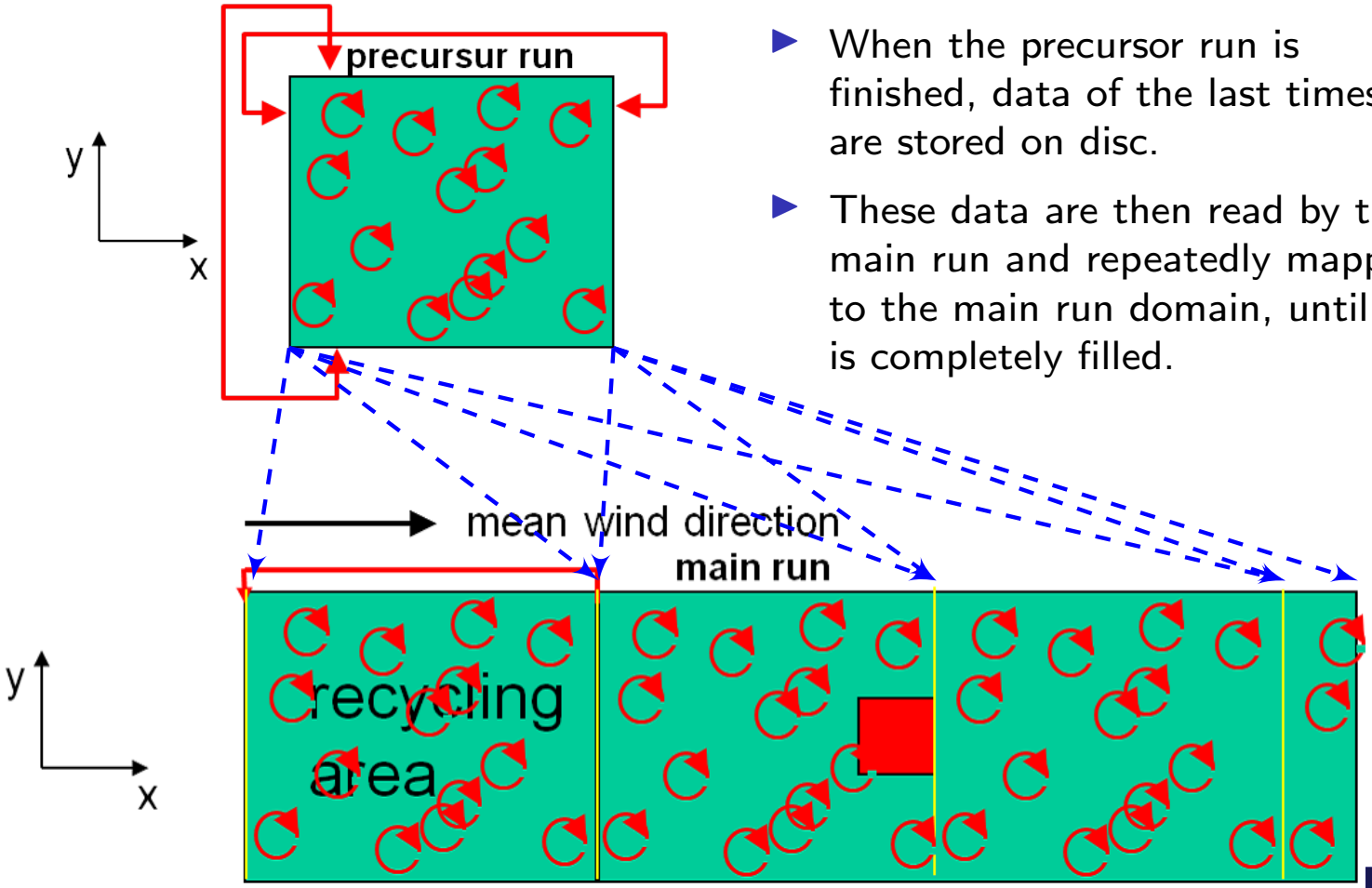

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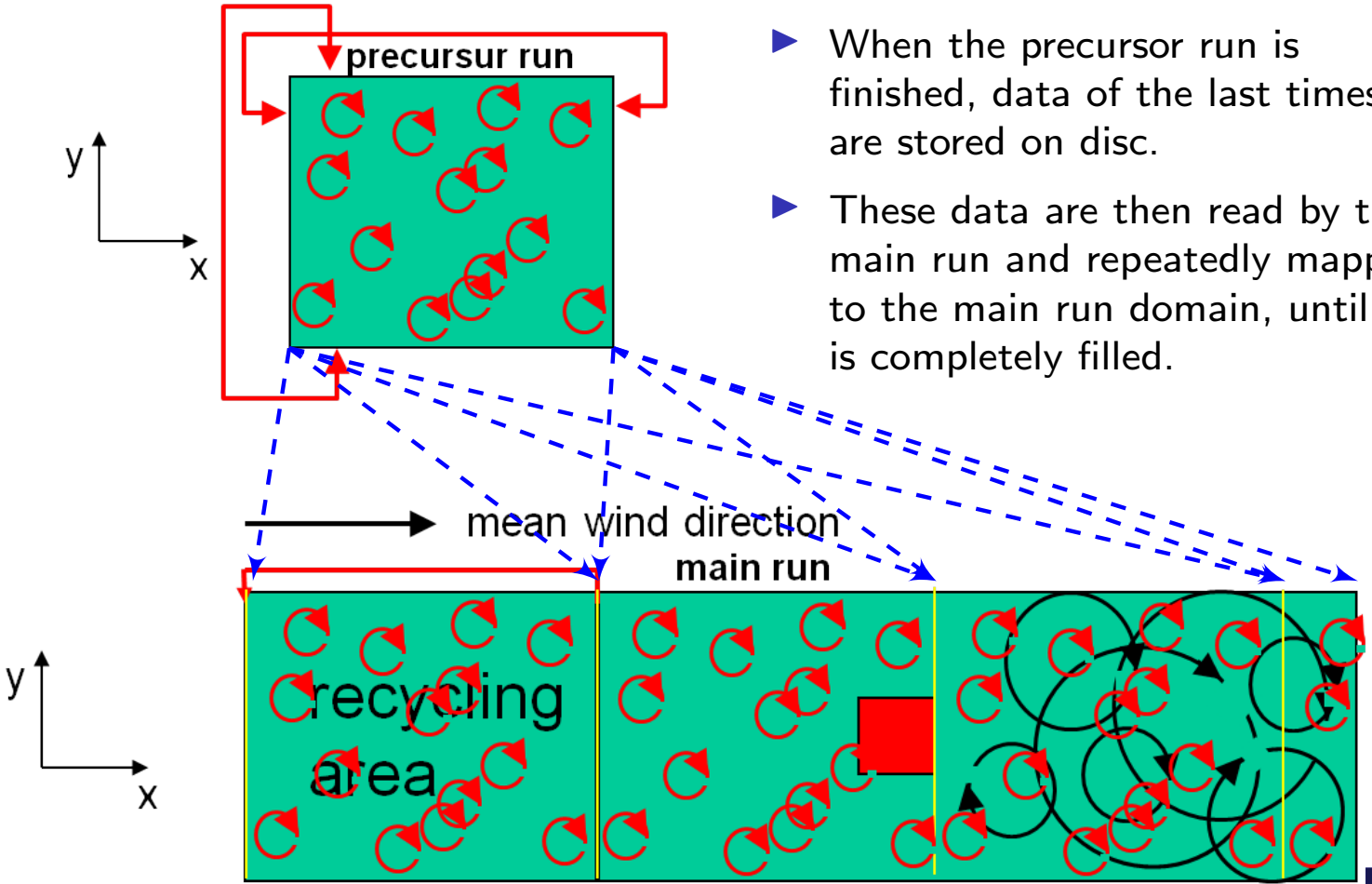

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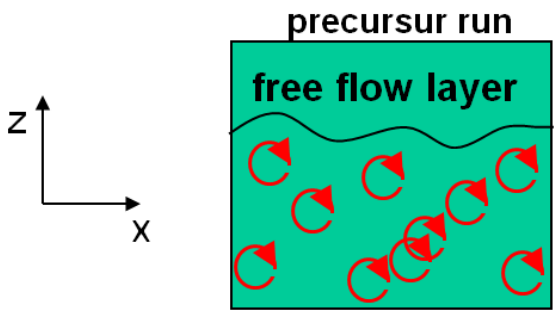

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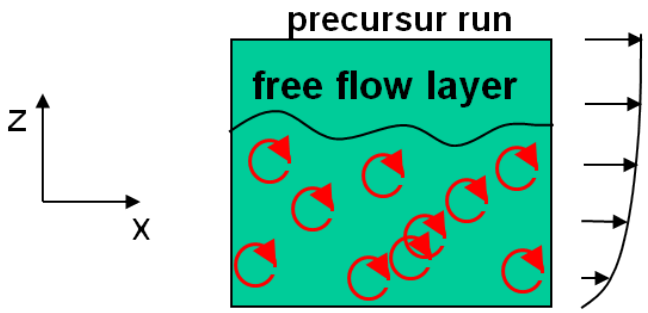

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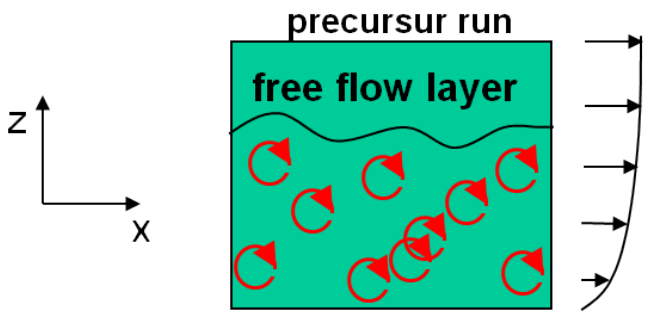

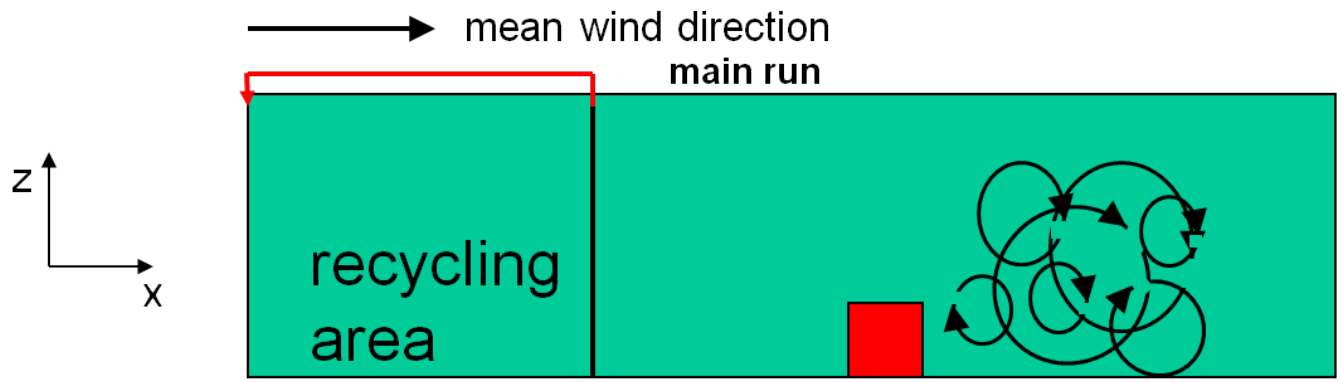

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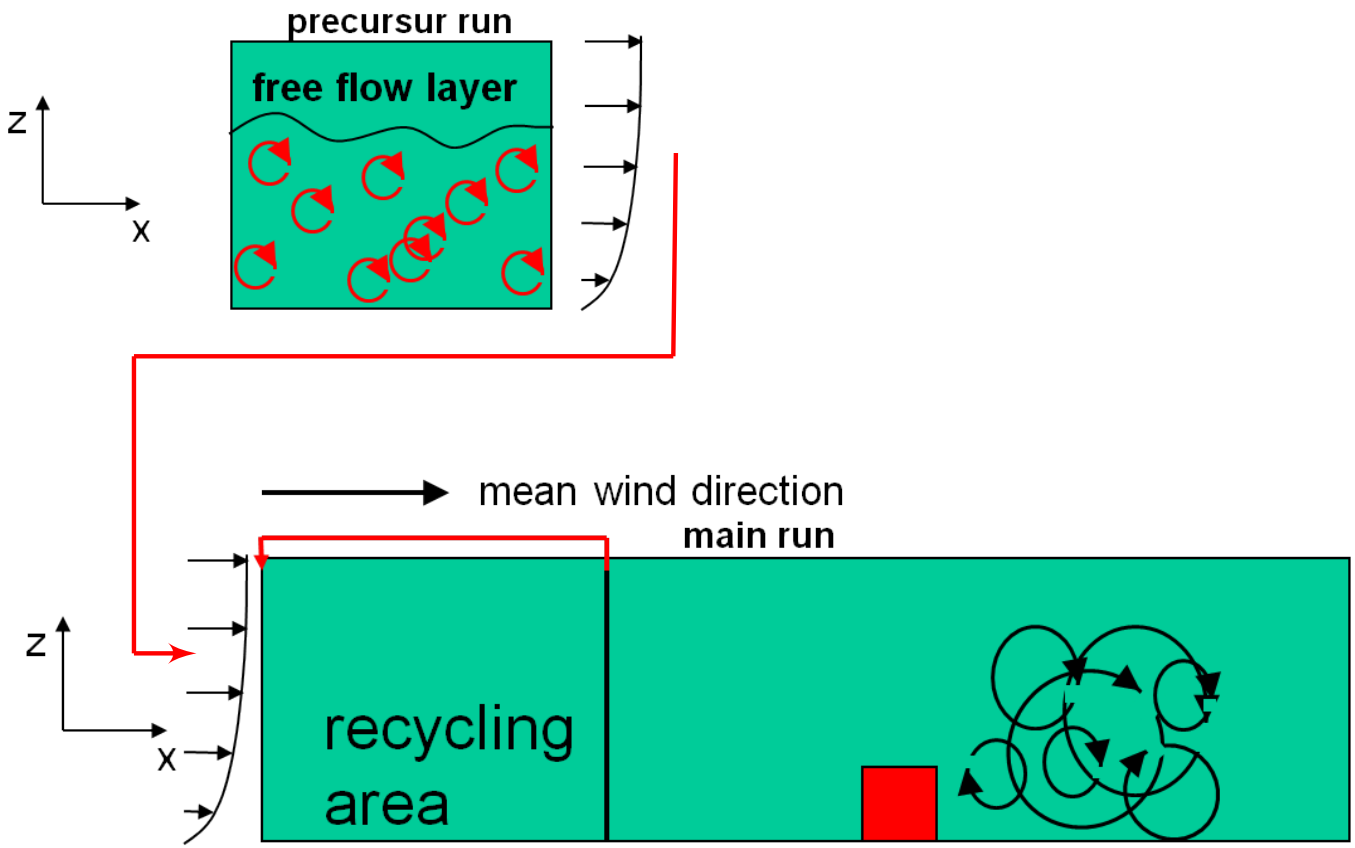

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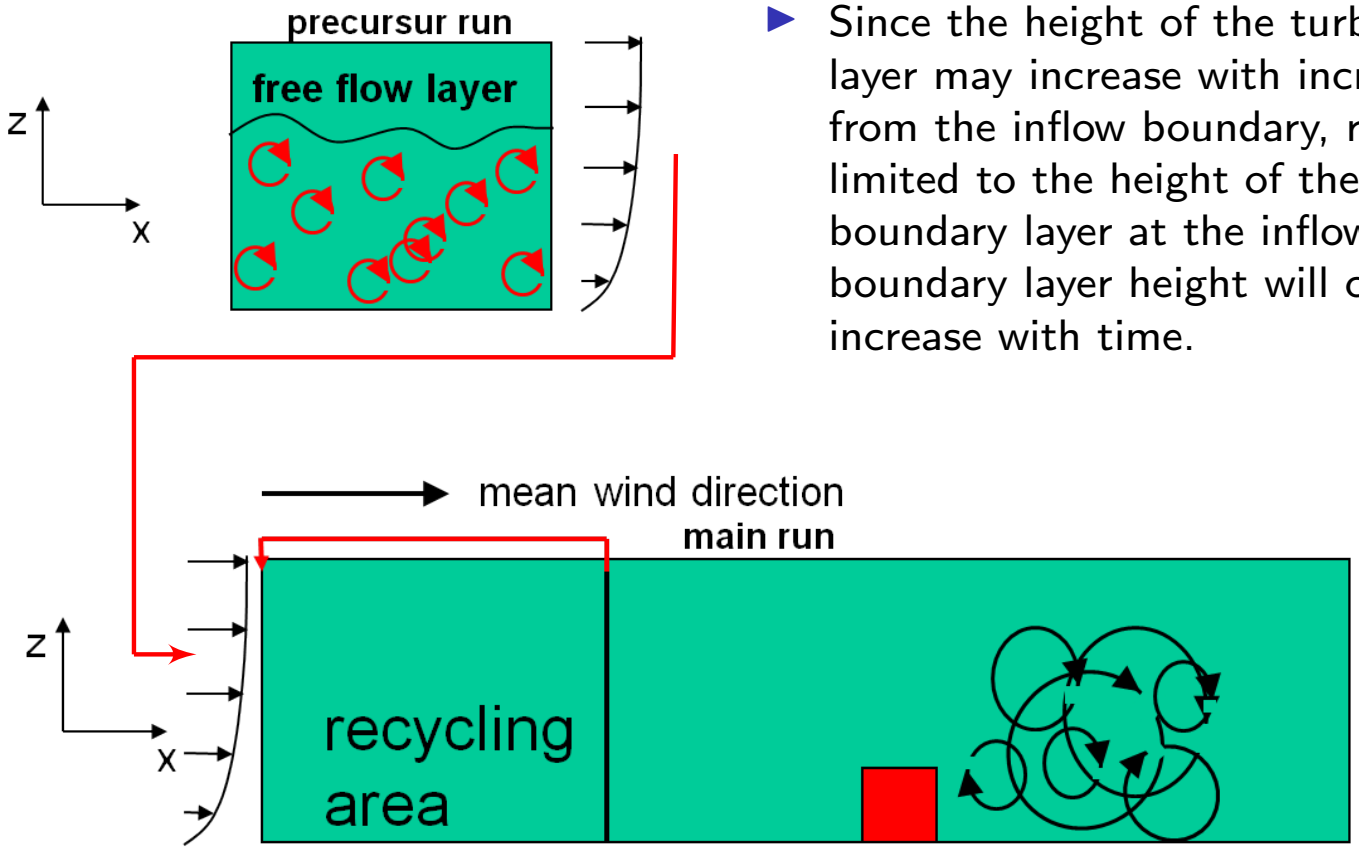

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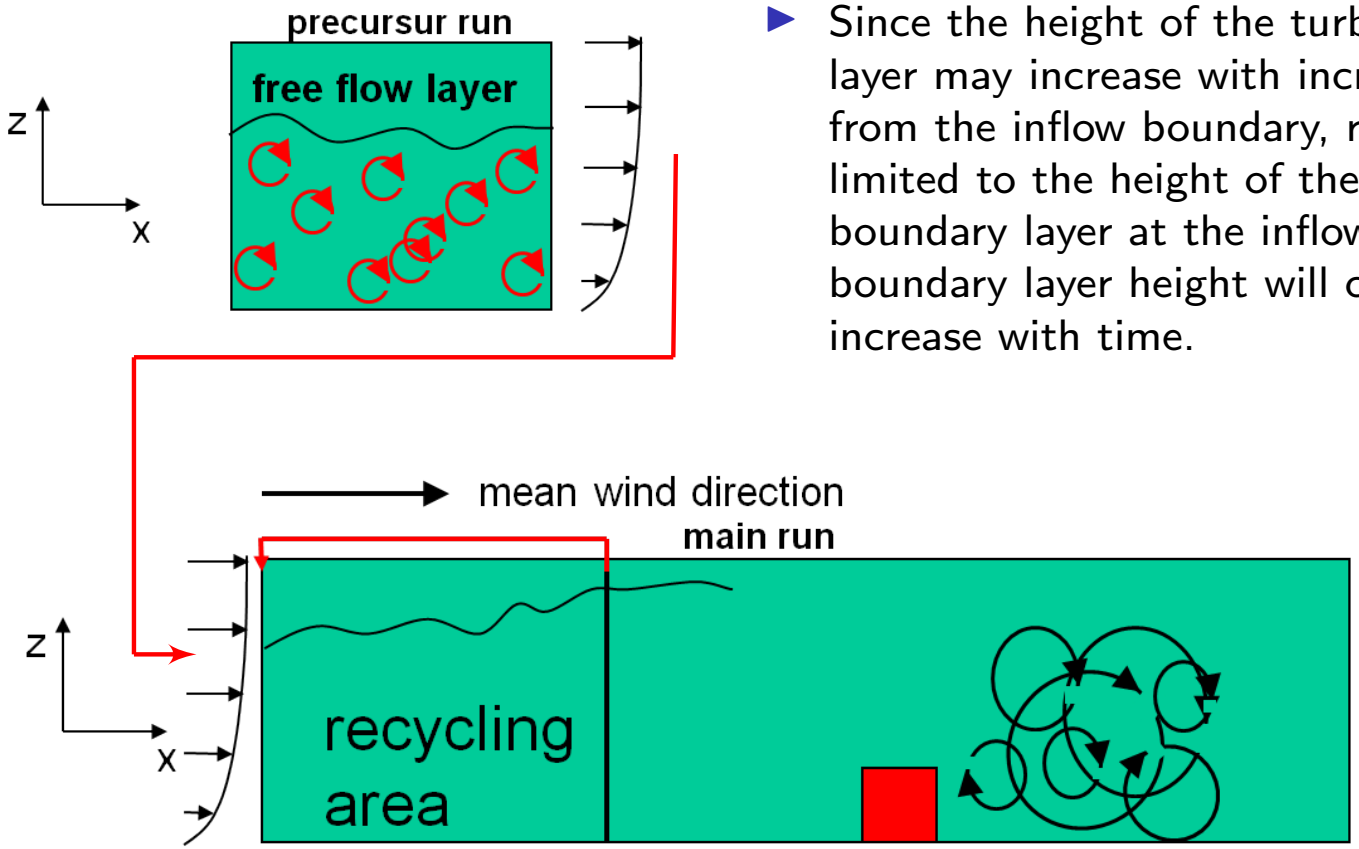

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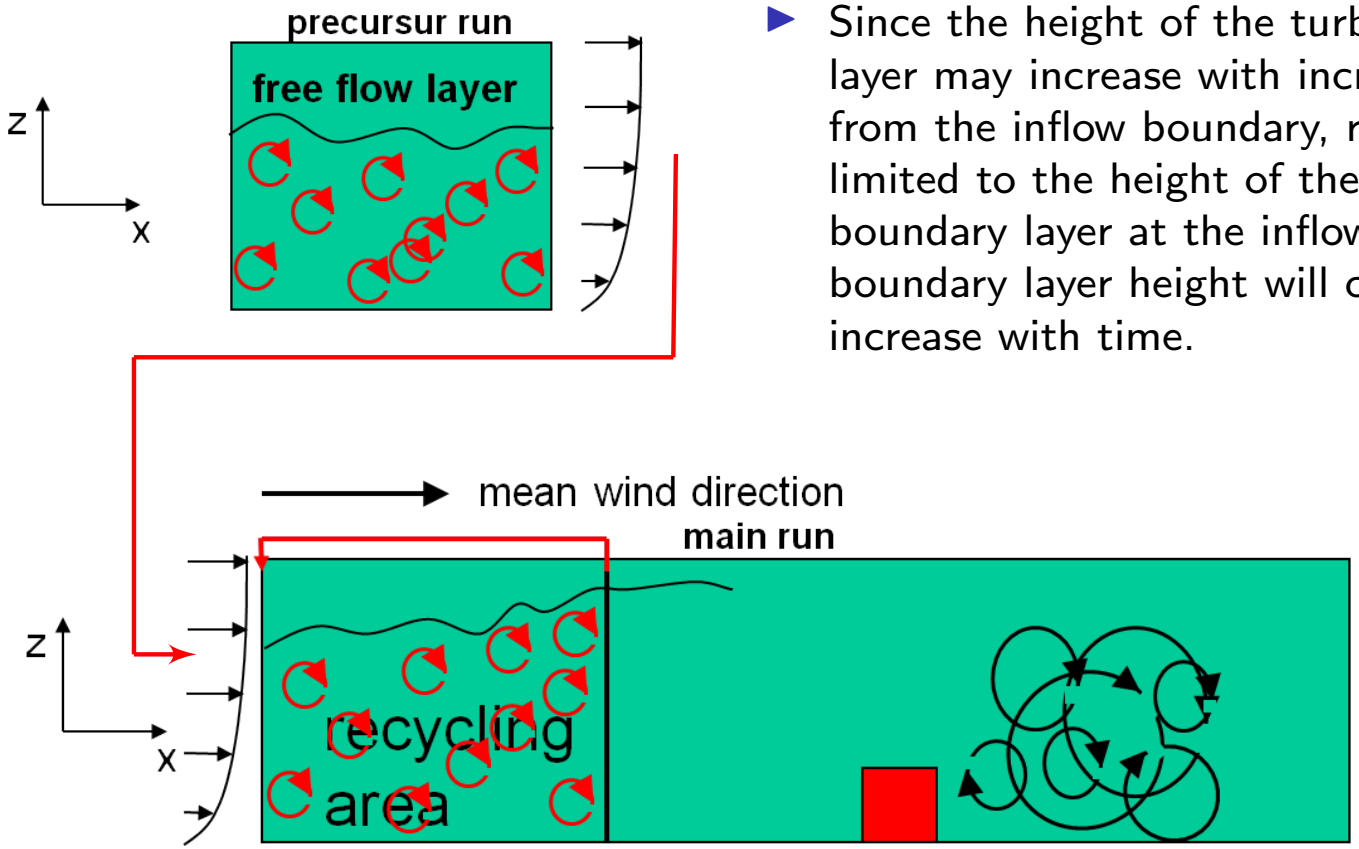

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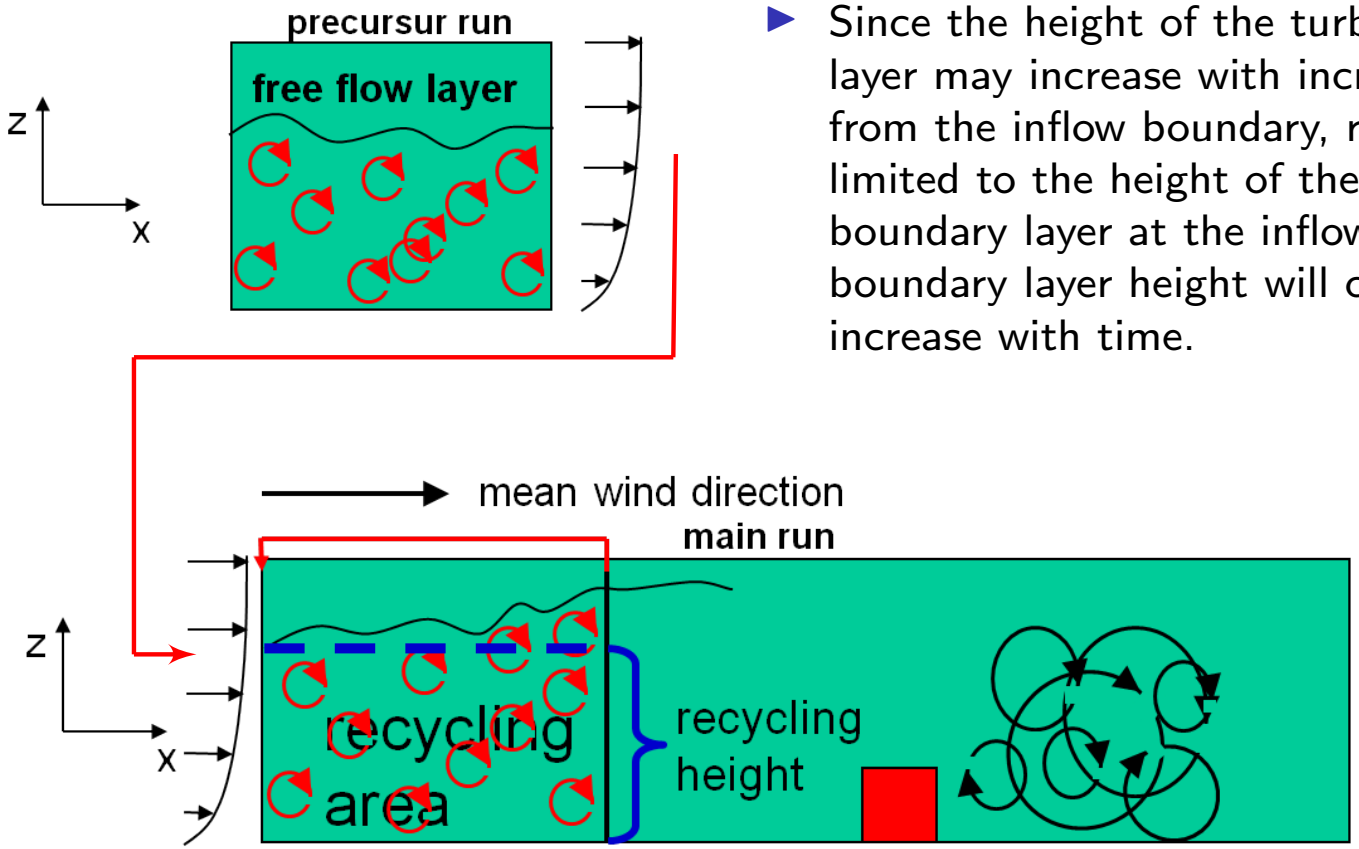

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- Turbulence recycling method for inflow **from left**.

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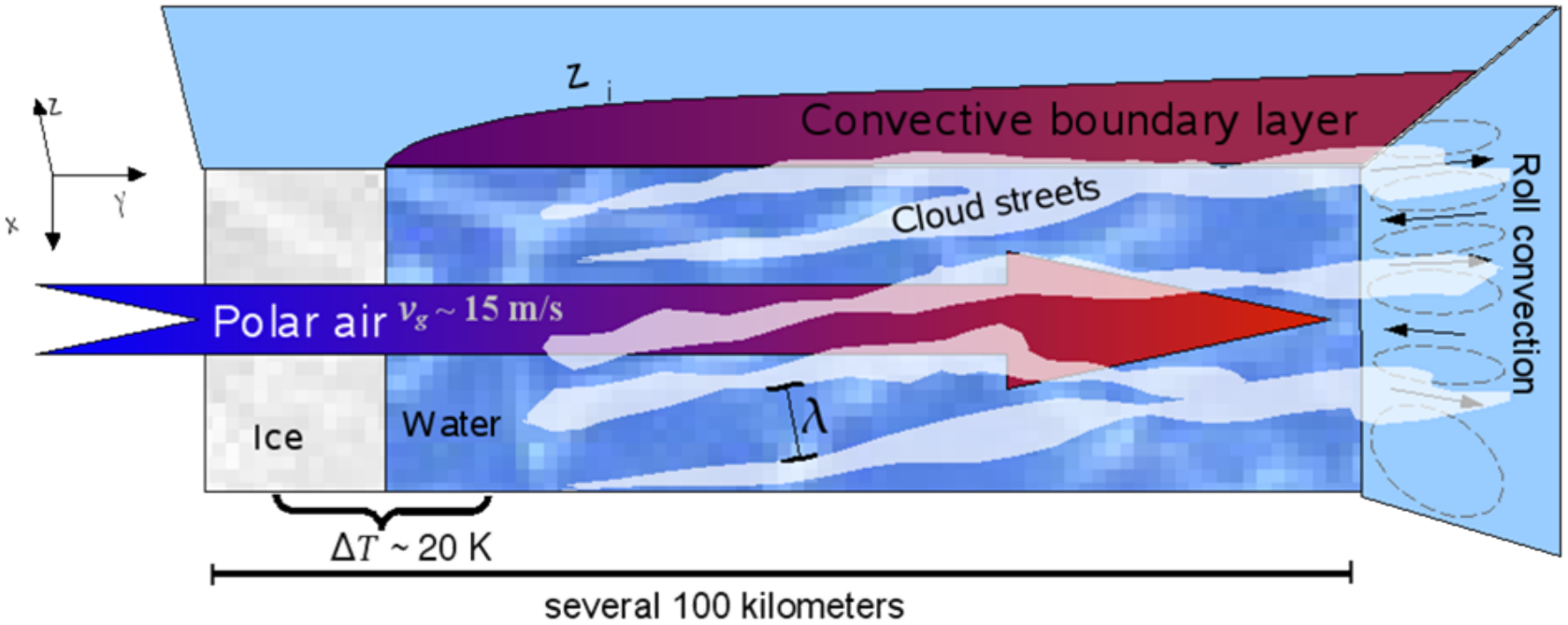
- **Volume flow conservation** may have to be activated, because flow acceleration or deceleration may appear along the non-cyclic direction. The resulting horizontal divergence creates a mean vertical velocity.
- If turbulence recycling is not used, it may be neccessary to **continuously impose perturbations** on the horizontal velocity field in the vicinity of the inflow throughout the whole run, in order to maintain a turbulent state of the flow.

Current Applications of Non-Cyclic BCs (I)

Cold air outbreaks



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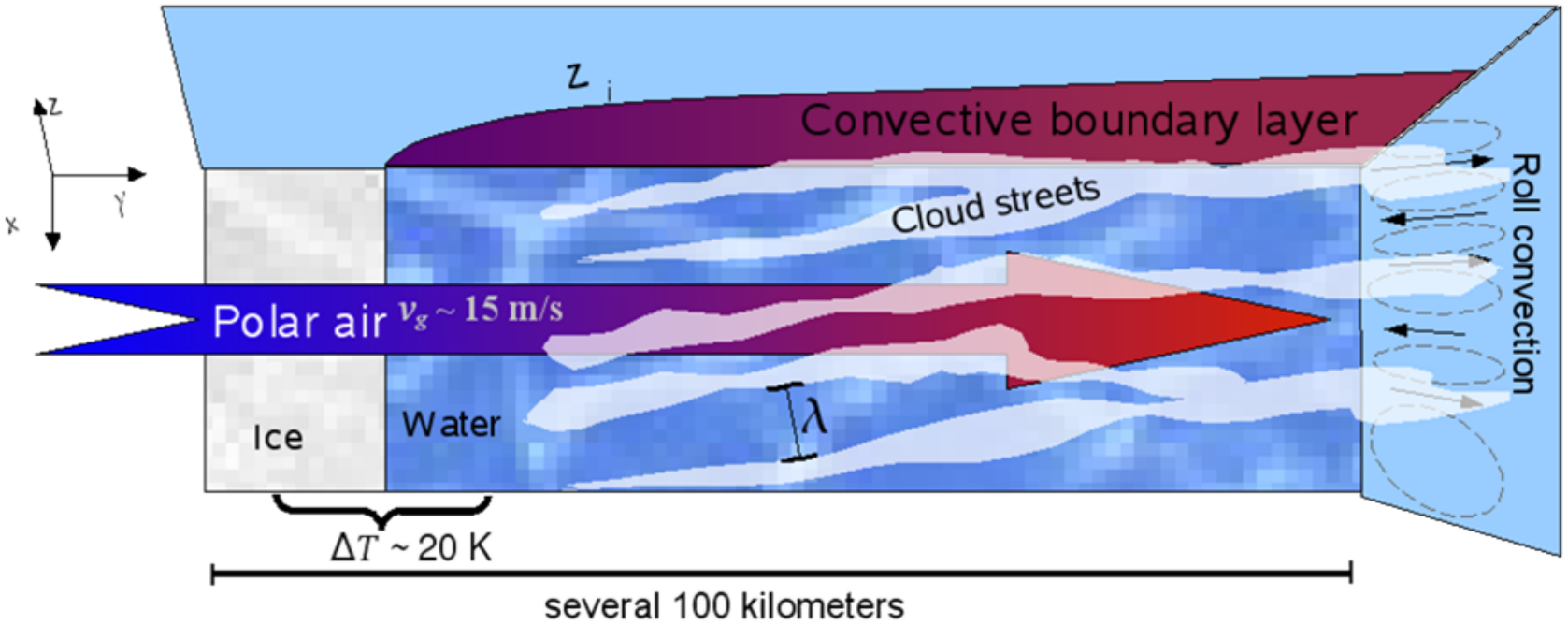

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Turbulence recycling has not been used!

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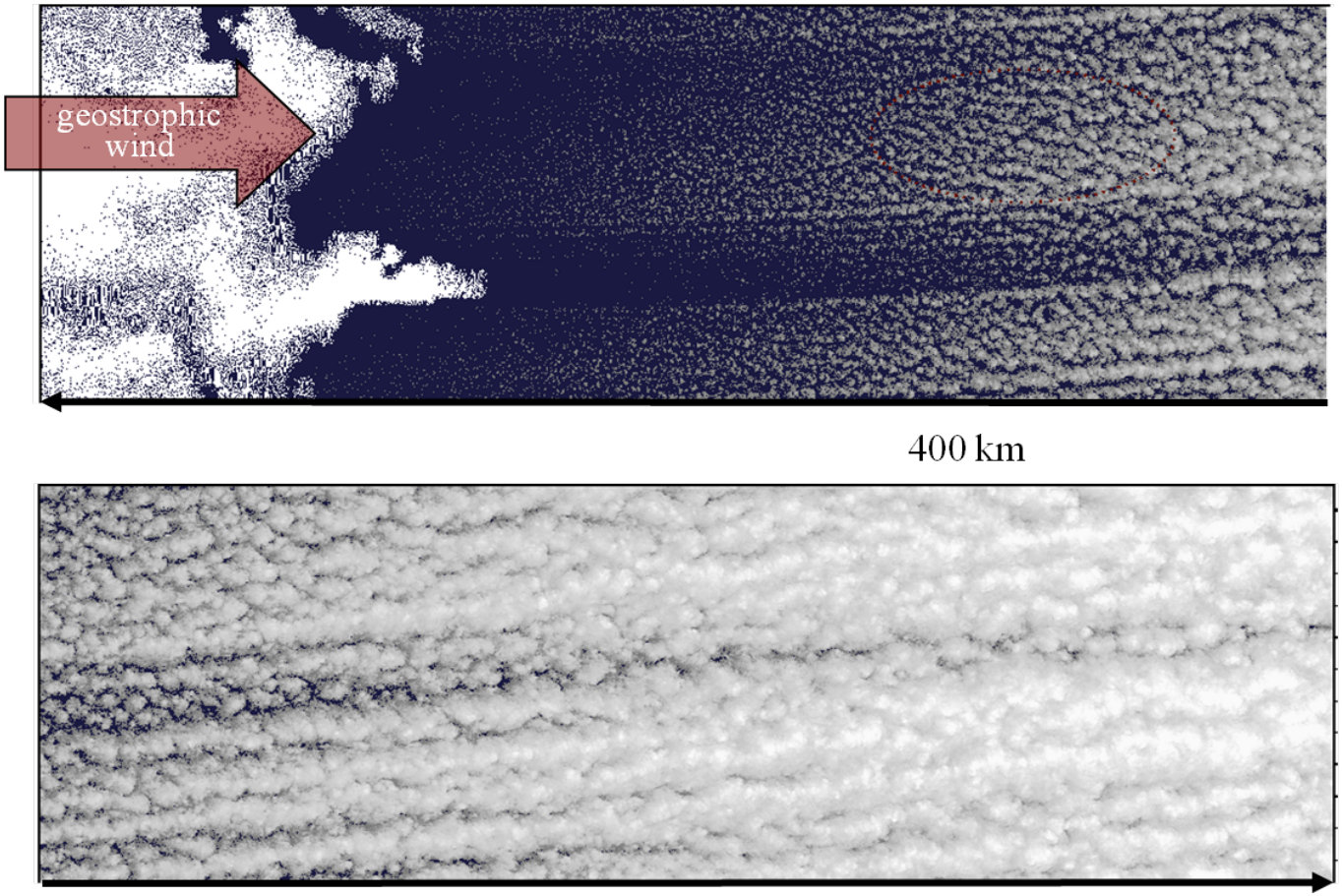

liquid water content (vertically intgrated)

How to set up non-cyclic runs with PALM

- **required** / recommended parameter settings:

```
&inipar .....

        bc_lr = 'dirichlet/radiation', (bc_ns = 'dirichlet/radiation',)
        psolver = 'multigrid',

        initializing_actions = 'set_1d-model_profiles',
        conserve_volume_flow = .T.,

        ..... /
```

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&d3par end_time = 3600.0,
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- Restart data has to be output and output of instantaneous, horizontally averaged profiles has to be switched on and performed at the end of the run. This enables writing of profiles to the restart file, which can then be used by the main run.
- Instead of using averaged profiles from the prerun, inflow profiles for the main run can also be prescribed using parameters `u_profile`, `v_profile`, and `uv_heights`.

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- The main run has to read the data from the precursor run (however, it is not a restart run!). This requires an extra activating string (e.g. turrec) in the file connection statement for restart data.

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#------------------------------------------------------------------------------
# List of input-files
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BININ        in:loc:flpe    d3f:turrec    $base_data/$fname/RESTART   _d3d
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```

- The mrun-command to start the main run then has to look like

```
mrun ...  -r "d3# turrec"
```

The main run is allowed to use a different number of processors and a different domain decomposition than the precursor run!

How to set up turbulence recycling with PALM (III)

- **required** / recommended parameter settings for the main run:

```
&inipar .....

        turbulent_inflow = .TRUE.,
        bc_lr = 'dirichlet/radiation',
        psolver = 'multigrid',
        initializing_actions = 'cyclic_fill',
        recycling_width = ...,
        inflow_damping_height = ...,
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Horizontal width of the recycling domain.

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recycling_width: Horizontal width of the recycling domain.

inflow_damping_height: Vertical extent of the recycling domain. If the precursor run simulated a convective boundary layer, information is automatically taken from the precursor data.

Final remarks

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- So far, these methods have been applied only to a few special cases (cold air outbreaks, urban canopy layer for neutral stratification). Other setups may require modifications.
- Biggest problems are caused by gravity waves in capping inversions. Simulations with pure neutral stratification cause less problems.
- A synthetic turbulence generator will be available around mid 2015 as an additional option for creating inflow turbulence