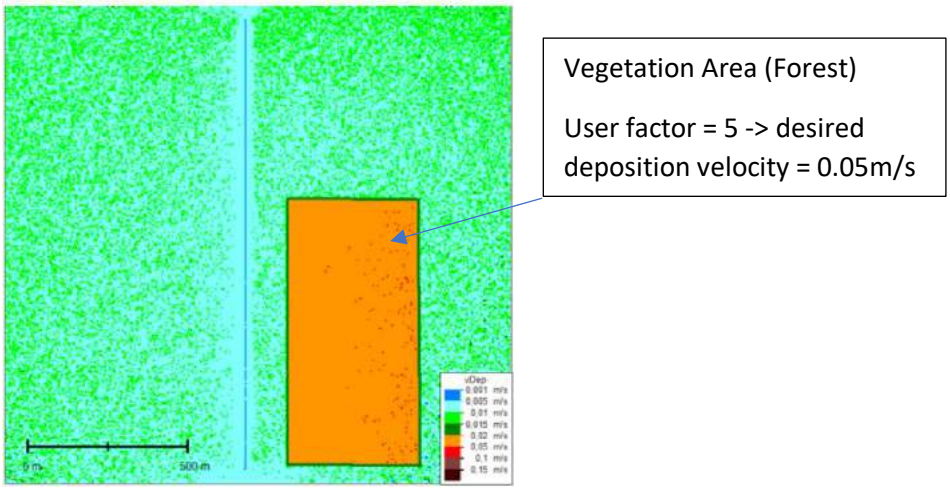
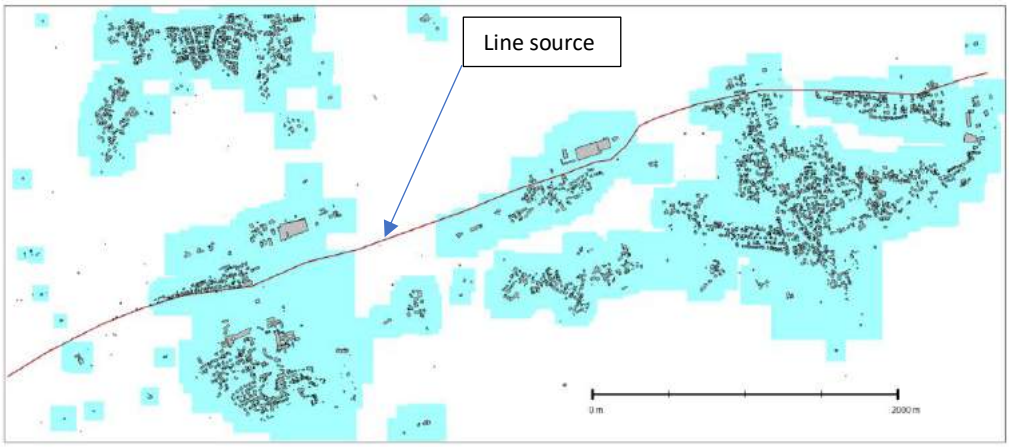
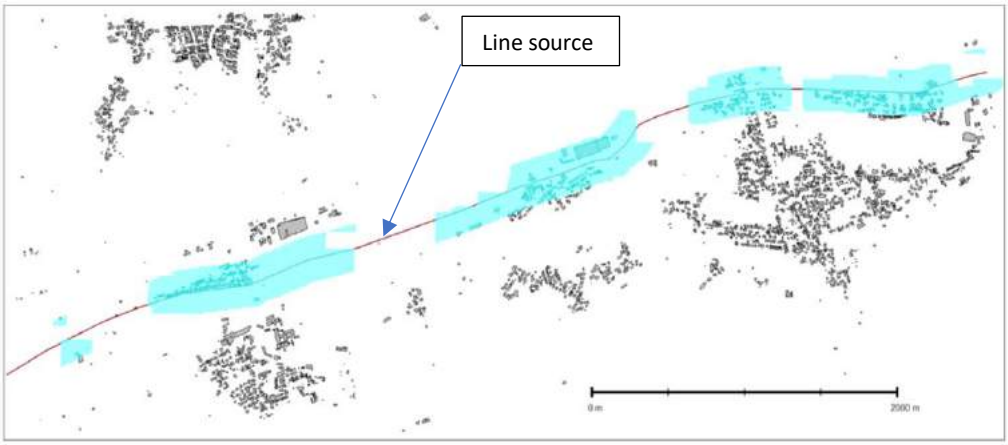
GRAL V21.09 compared to V20.09

#	Bug fixes
1	Fixed the rasterization of the vegetation mesh
2	A slight overestimation (about 20 %) of the deposition rate has been fixed

#	GRAL Improvements
3	Optimized computational accuracy for the prognostic flow field calculation
4	Reduced memory requirement
5	Optional deactivation of the online output (reduction of file accesses during the calculation)
6	Deposition within vegetation areas: by default, GRAL increases the deposition velocity within vegetation areas by a factor of “1.5 * Coverage” for gases and the particle classes PM2.5 and PM10 and by a factor of “3 * Coverage” for particles PM30 and larger. Coverage is a value that can be entered for each vegetation area. Now it is possible to replace these fixed factors 1.5 and 3 with your own factors. Thus, in combination with the coverage value, a spatial varying deposition velocity can be set. If you want to specify your own factors, you must create a file named “VegetationDepoFactor.txt” in the Computation folder. The first line specifies the factor for gases, PM2.5 and PM10, the second line the factor for PM30 and larger. The user defined deposition velocity for each source is subsequently increased by the value “Factor * Coverage” within vegetation zones. If GRAL can read these user settings, you will find the imported values in the terminal output and in the file "Logfile_GRALCore.txt". Here you can see an example for the computed deposition velocities for a roughness length of z_0 = 0.2m – 1.0 m (option “Adaptive Roughness”) within a vegetation area (green rectangle in the lower left panel, Coverage = 100 %) and a very high user defined scaling factor of 5. The line source has a deposition velocity of 0.01 m/s. Note: there will be an underestimation of the deposition velocity in the forest without the Adaptive Roughness Option. 

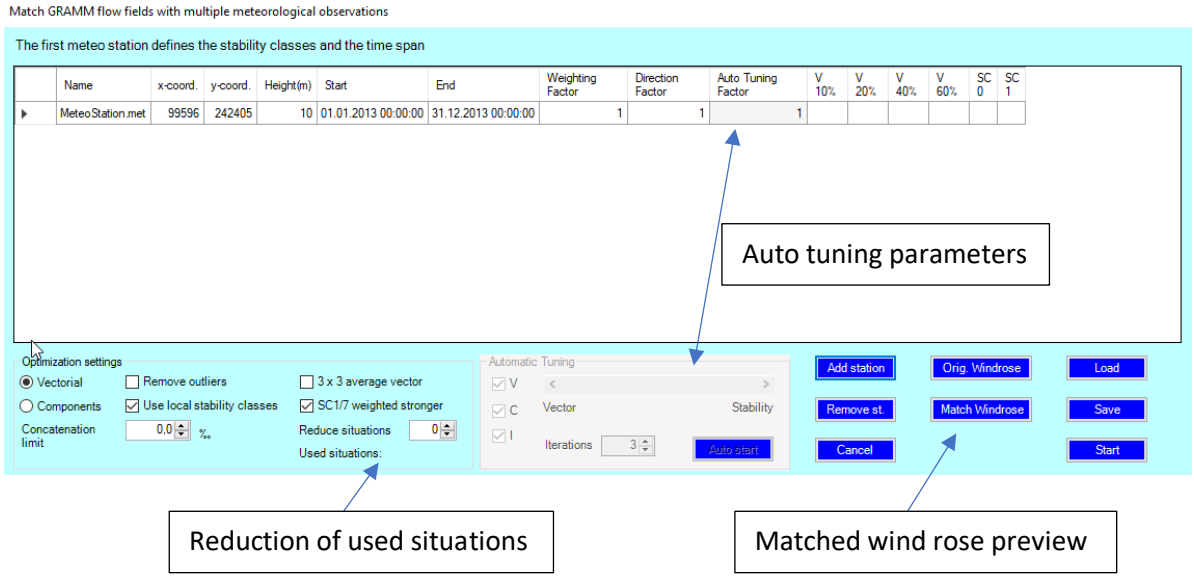
#	GRAL Improvements
7	Output of a file "PrognosticSubDomainAreas.txt" containing the prognostic sub-domains areas. This file is created when building_heights.txt is also written.
8	Optional reduction of prognostic sub-domains depending on the distance to sources by default the prognostic sub-domains are created around buildings using the building height multiplied with the sub-domain factor. You can check the prognostic sub domain size using the new output file "PrognosticSubDomainAreas.txt" (see Figure 1). If the new option is used, prognostic subdomains are created around sources at a defined distance only. An example is shown in Figure 2. With reduced sub-domains, memory requirements and computation time are reduced. If large contiguous prognostic wind fields are required, as in urban areas, this option should not be used. This option can be set in the GUI under Special Options (Wrench Button).  Figure 1: default prognostic sub domains  Figure 2: reduced prognostic sub domains 150 m around sources
9	Several performance improvements by using the latest .NET5 high performance instruction sets: https://devblogs.microsoft.com/dotnet/performance-improvements-in-net-5/

#	GRAL and GRAMM
10	Linux: compiled for .NET5 as single file applications. Start GRAL or GRAMM using ./GRAL or ./GRAMM or using the Linux GUI. The .NetCore or .Net5 Framework no longer needs to be installed for Linux when using the self-extracting executables. It is still possible to use the operating system independent *.dll files if the .NetCore Framework is installed
11	GRAMM: use the correct sign for the wind vectors, if an overflow occurs while writing the wind field vectors. Catch an overflow, which could occur when writing the stability class files

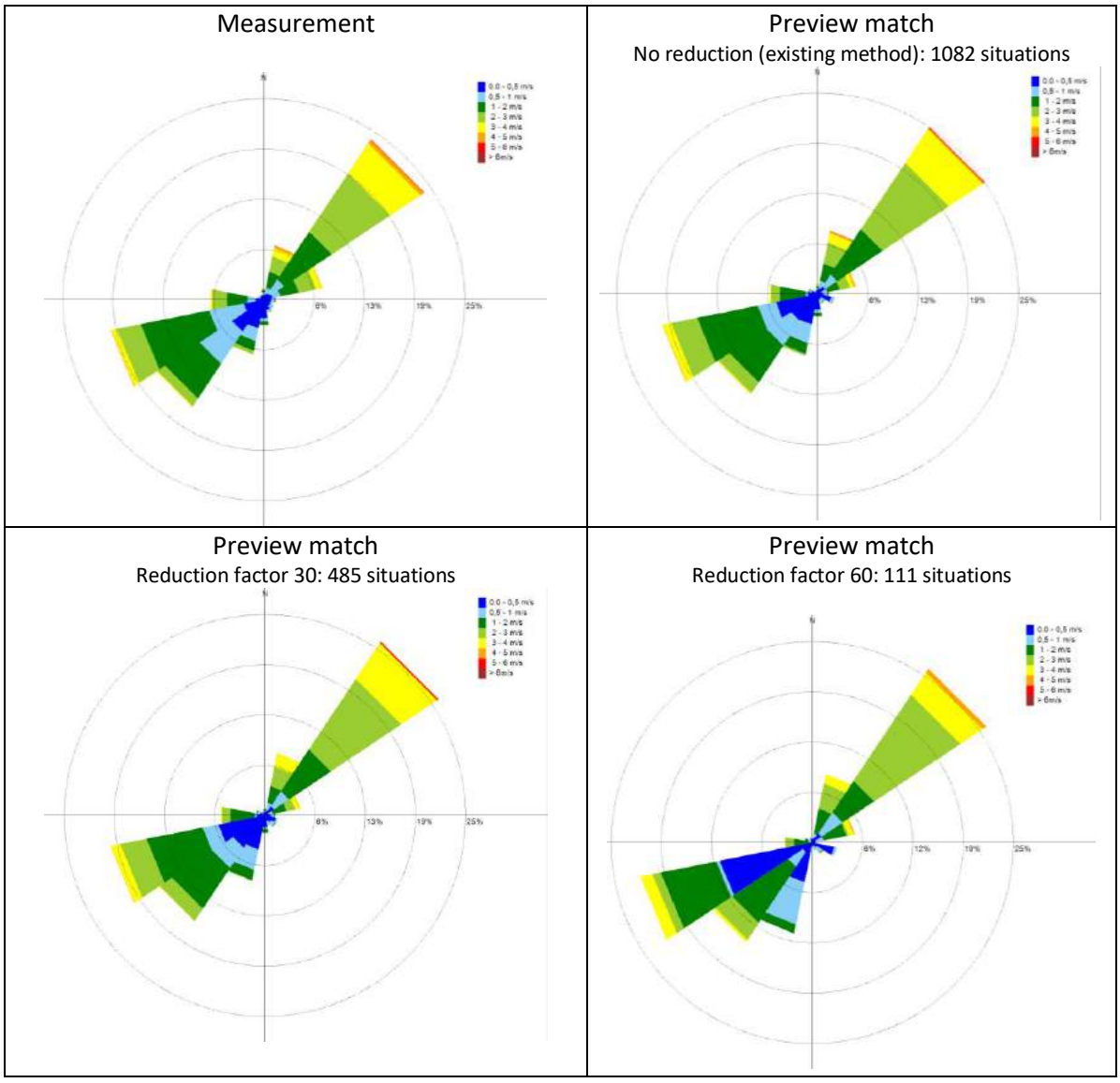
GUI V21.09 compared to V20.09

#	GUI Improvements
12	Creation of concentration time series for arbitrary raster cells as post processing based on the *.grz files (Menu bar “Analyze results” – “Generate time series for several evaluation points”) enabled
13	Creation of GRAL wind “Time-series” for arbitrary raster cells based on the *.gff files (Windfield analysis – Windrose button or menu bar “Windfield analysis” – “Wind statistics at a point”) enabled
14	Item dialogs are no longer TopMost windows but child forms of the Domain window. This means that these dialogs do not lose their focus when the mouse pointer leaves the dialog. In addition, the dialog will be minimized with the domain window. Furthermore, the dialogs are clipped to the Domain window. Each item dialog got an additional cancel button to avoid unintentional modifications. The question whether a new shape of a source should be applied is no longer asked for new sources, where no shape is available yet.
15	Better performance for the high percentiles calculation
16	An optional evaluation of GRAMM wind vectors at a height above sea (absolute height) is enabled
17	New option for displaying GRAL wind vectors in a relative height above terrain or in an absolute height
18	The GRAMM grid heights are displayed either for each cell (as used up to V 20.09) or per corner point (as used in GRAMM) using the new menu entry “View –> Show cell heights for -> “
19	Progress bars showing the real progress and additional cancel buttons for further long taking operations
20	GUI settings: enable/disable automatic scaling when loading/drawing vector maps
21	GUI settings: it is possible either loading the entire wind file (default) or discard lines with wind speed 0 and wind direction 0 or shuffle the wind direction for lines with wind speed 0.
22	GUI settings: You can now select whether GRAL concentration files and GRAMM wind fields should be deleted or moved to the recycle bin when they are deleted. Deleting is faster, moving to the recycle bin is safer. The option “move to the recycle bin” is enabled by default!
23	Use the unit kg/h as optional input for the emission rates of line sources in the user dialog. The emission rates are still saved as kg/h/km and converted within the dialog using the total length of the line source.
24	Support for various wind rose sector widths in the wind rose view
25	Further improvement of the 2 screen usability
26	Support for the new GRAL options (deactivation of GRAL Online and Prognostic Sub Domain reduction)
27	You can write meteorological files *.met from the GUI. Therefore, for example, an imported *.akt or *.akterm file can be saved as a *.met file or an imported subset of a large *.met file (e.g. one or more months or days) can be saved as new *.met file.

New features for the “Match to Observation” function



#	GUI Improvements
28	Preview the matched wind roses for the used meteorological stations during the match process (before you finish the match process). This makes it possible to improve the adjustment of the match parameters, because the results at the meteorological stations can be visualized in advance while tuning the parameters.
29	Reduce the number of matched weather situations. You can set a value (0 to 90) to apply a bonus value to the calculated vectorial error for already used weather situations at the match tuning process. A value of 0 means no bonus (default behavior), 90 applies the maximum bonus (90 %) for the wind vector of already used situations. How to use this option? Define a value and press the “Repeat” or the auto tuning “Start” button. The number of used situations (the concatenation option is not considered here) will be displayed in the dialog. The preview for the matched situations shows the resulting wind rose for the selected meteorological station. Here you see an example. Whether and how much the number of situations can be reduced depends on the specific issue. In the case of odor dispersion, a reduction is not advisable; in the case of large-scale infrastructure projects, a reduction can certainly make sense (the fewer situations, the faster the calculation). The results of the reduction can be visualized in advance by using the above new wind rose preview.



Example: reduction function

#	GUI Improvements
30	**Breaking changes** The new Auto Tuning Factor affects the match tuning in such a way that stations with an Auto Tuning Factor of 0 are no longer considered in the tuning process. This makes it possible to include additional stations in the match to observation process and deactivate/activate them during the match process. However, you can use the preview of the wind rose at all stations (also those with an Auto Tuning Factor of 0) in the match process. New created match settings files *.mmo are updated to include the new Automatic Match to Observation tuning options and therefore loading these files is not possible with GUI versions prior to 21.09.

31	**New option** *Automatic Match to Observation tuning function* Choosing match parameters is a challenge for many users. Especially with many meteorological stations, even for power users this is not an easy task. After the GRAMM wind fields have been read and a first match tuning with the standard parameters has been processed, the auto tuning can be started. **Settings** *Slider*: you can use the slider to select whether you want to represent the wind vectors or the stability classes more accurately. *Checkboxes*: use the checkboxes to select the optimization method: V for the vectorial and C for the component method. The cycles for the iteration can be selected using the numeric up-down item. *Auto Tuning Factors*: a new column in the DataGridView enables the setting for a weighting factor for the automatic tuning process. This factor is applied to find the best weighting (and direction) factor for the automatic tuning process. A value of 0 means, the station is not used for the auto tuning optimization. The higher the factor, the stronger the weighting for the meteorological station. Once the auto-match is finished, you can check the percentile results V10% to V60% and SC0/SC1 (if you like, you can also use the preview of the matched wind roses), change some parameters (weighting factor or direction factor, the latter is not active in the vectorial mode) and then start either a default match ("Repeat" button) or a new auto-match (when changing the Auto Tuning factor or if you like to apply additional iterations). The matching optimizer is now partially parallelized but is still quite time consuming, especially when several stations are considered.

#	GUI V21.09 Bug fixes
32	Fix the reuse of shape objects (problem, when using shape files with multiple parts)
33	Reset the cell heights view when creating a new GRAL domain area
34	Fix a bug for walls having only 2 edge points (such walls were ignored when reloading the project)
35	Correction of the cell index calculation (elimination of rounding errors from double to int)
36	Fix invalid reset cancellation tokens (avoid NullReferenceException)
37	Fix a bug in the GRAMM terrain mesh generation (one offset error); use a new terrain interpolation for the GRAMM terrain mesh, fix incorrect NoData handling
38	Disable controls in the "Special Settings" dialog if a project is locked
39	Fix a bug if no item is selected in the most recent files dialog
40	Fix the display of the adaptive roughness settings when loading a project
41	Improved Linux compatibility

42	Fixed a rare error when reading the *.scl files or writing *.wnd files for the GRAMM export function
43	Fix unit of odor sources at the item info form (MOU/h instead of OU/h)
44	Reset the new option for the conversion from kg/h to kg/h/km when selecting a new line source using the slider
45	Disable the selection of source groups for the receptor evaluation, because the evaluation delivers incorrect results when some source groups are not included
46	A possible division by 0 has been fixed in the emission modulation preview window
48	It is possible that an area source is not included in the file cadestre.dat if too large grids are set for area sources or the area sources are strongly divided. To avoid this problem, the raster size is decreased during rasterization until at least two subareas are generated per area source.
49	Fix an incorrectly displayed sum emission in the deposition dialog
50	Enable to close the Select Item dialog with a double click on the selected item
51	Enable all supported separator characters when showing the file emissions_timeseries.txt or when summing up the total emissions

	Bug fixes compared to V21.09RC2
52	Fix wrong dates (year) in created GRAMM meteorological time series files
53	Fixed incorrect values on the GRAL progress bar
54	Fixed an error message during the Match-to-Observation process when the user closes all message windows during the process
55	Correct initialization the display settings for the GRAL roughness lengths file
56	The forms for meteorological data are no longer opened right above the main window, to prevent the main window from being closed unintentionally

Concluding remarks

Version 21.09 is a continuous development of the previous version 20.09. The numerous changes are evident in the following statistics from the GitHub repository:

GUI: 235 changed files with about 27000 additions and 13000 deletions.

GRAL: 56 changed files with 2930 additions and 2096 deletions.

GRAMM: 16 changed files with 60 additions and 61 deletions.