ZeFir : an Igor Tool for Geographical Origins

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Why?

If answering « what are the sources? » is crucial, answering « where do they come from? » is just as much important !

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receptor approaches : **Wind** or **Backtrajectories**

Wind analyses are best for sources within a relatively short geographical range. As wind measured at the receptor site is not necessarily representative of the global origin of the air mass, it is not very precise for long-range advected pollution.

Trajectory analyses are best for long-range pollution. They conceptually fail to provide meaningful information for local sources.

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TrajStat : user-friendly soft for trajectory analyses only

Openair: can do both, but not user-friendly

→ need of a user-friendly soft to do both

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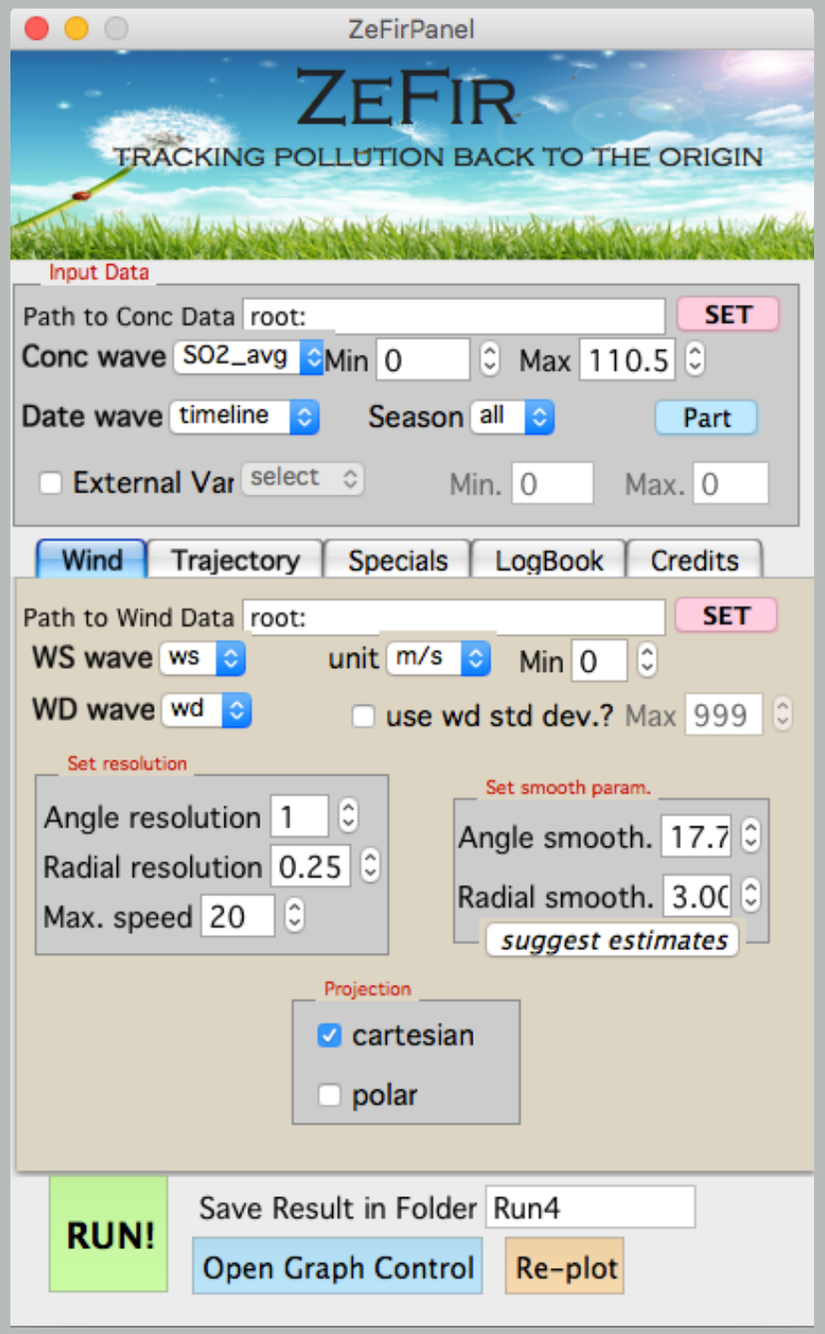

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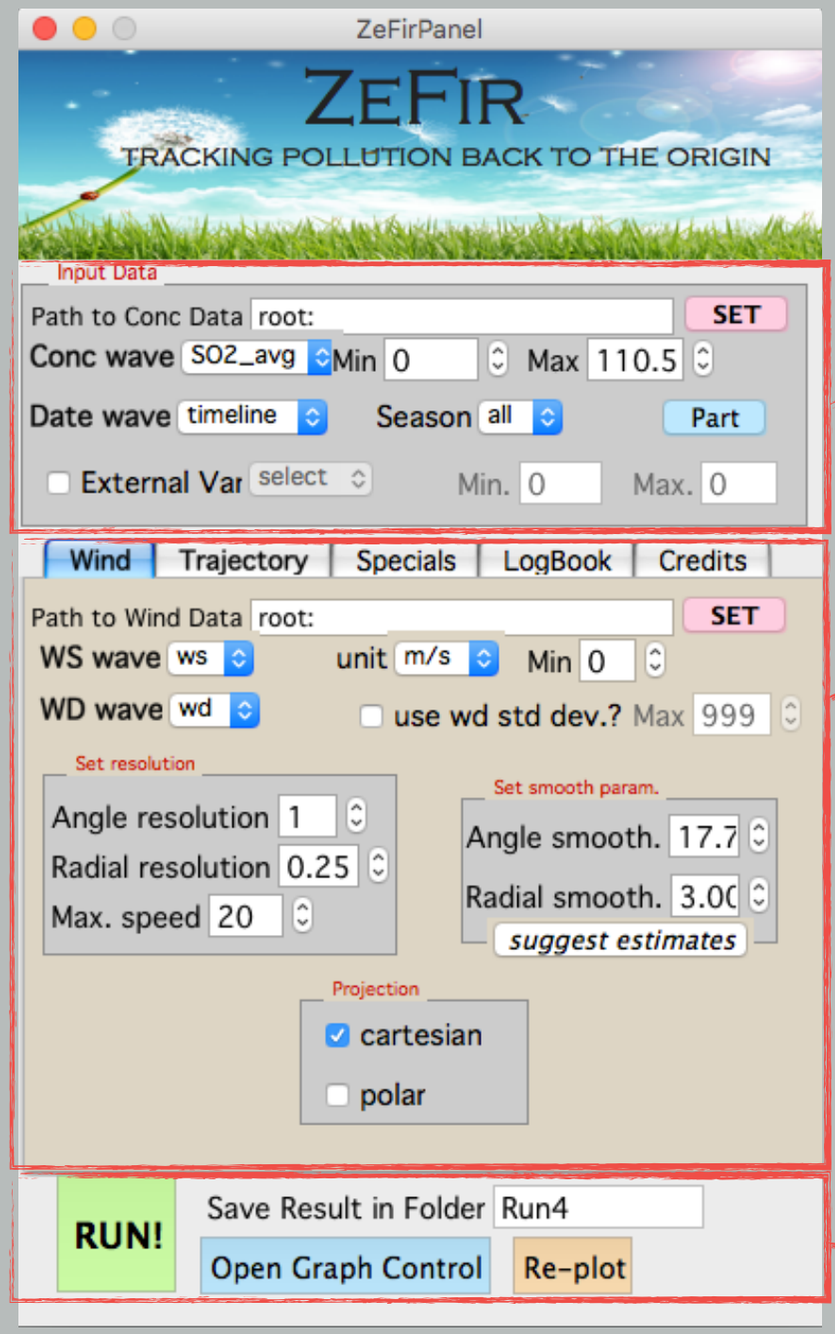

1- Input Data

2- Wind / Traj Analysis
+ Special runs

3- Run & options

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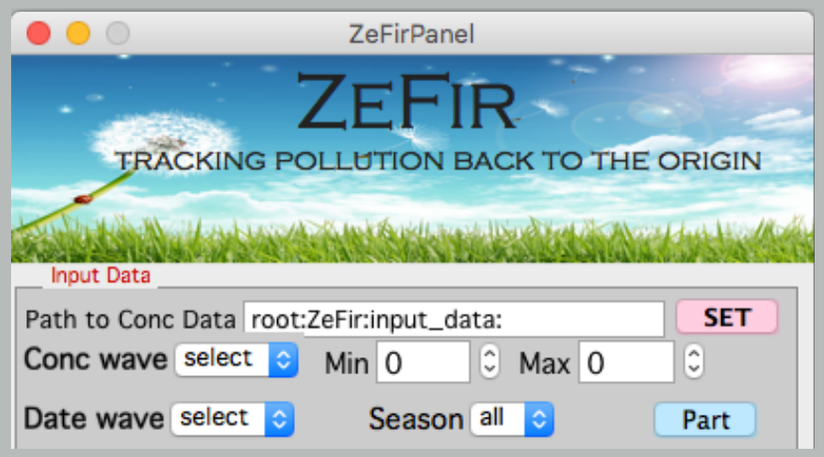
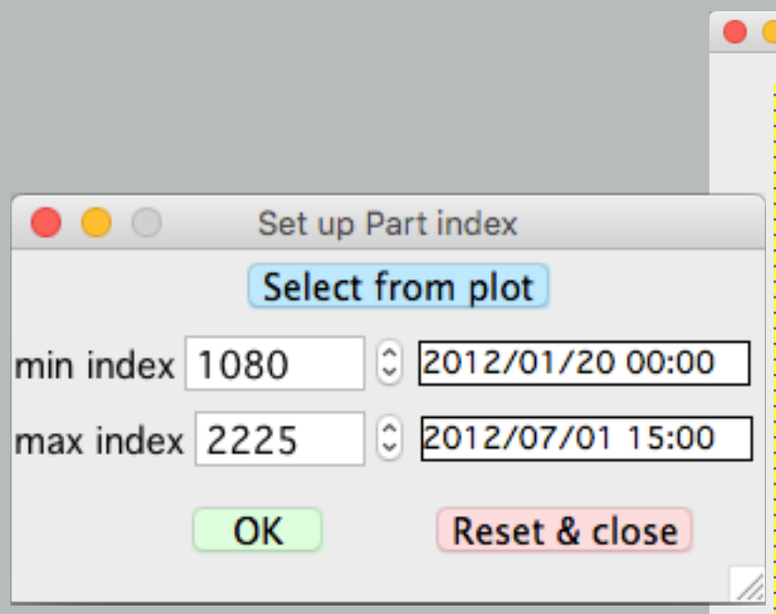
Input Data

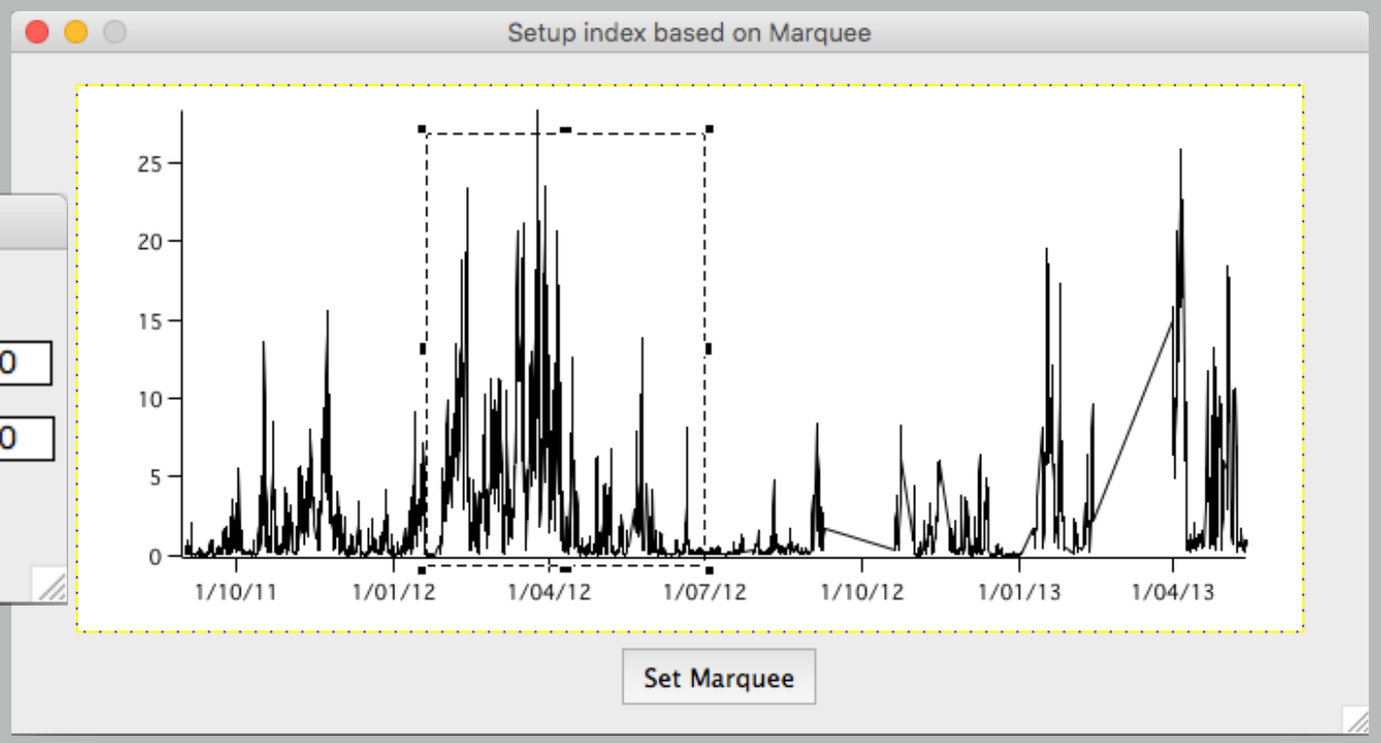
what you need: **concentration & date/time**



Filtering input data by:

- concentration (min/max)
- seasons (all / DJF / MAM / JJA / SON)
- customized temporal window





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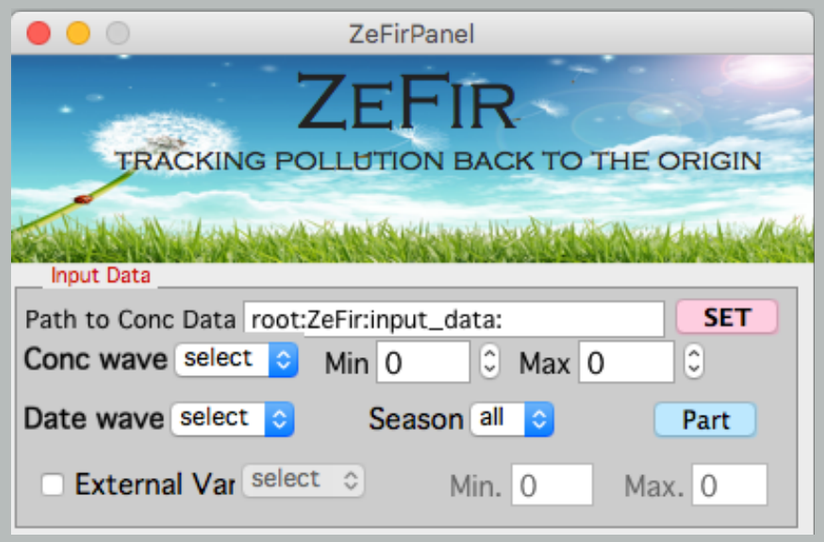
Input Data

what you need: **concentration & date/time**



Filtering input data by:

- concentration (min/max)
- seasons (all / DJF / MAM / JJA / SON)
- customized temporal window
- external variable (min/max)

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Wind Analysis

performed by 2-D Non-Parametric Wind Regression (Henry et al., 2009)

$$E(\theta,u)=\frac{\sum_{i}^{N} K_1\left(\frac{\theta\text{-}W_i}{\sigma}\right)\cdot K_2\left(\frac{u\text{-}Y_i}{h}\right)\cdot C_i}{\sum_{i}^{N} K_1\left(\frac{\theta\text{-}W_i}{\sigma}\right)\cdot K_2\left(\frac{u\text{-}Y_i}{h}\right)}$$

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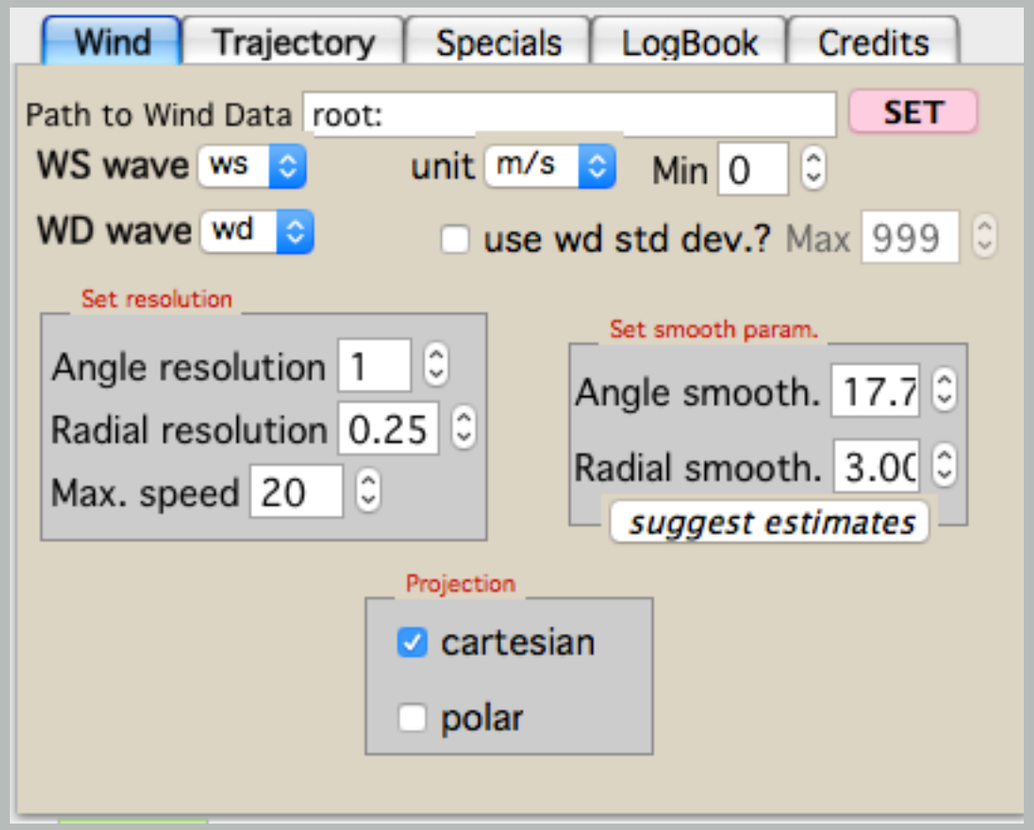

what you need: **wind direction and speed**

additional filtering by

- wind speed values (min)
- wind direction standard deviation (max)

suggest estimates provides an estimation of theoretical smoothing parameters

cartesian or polar projections to display the results

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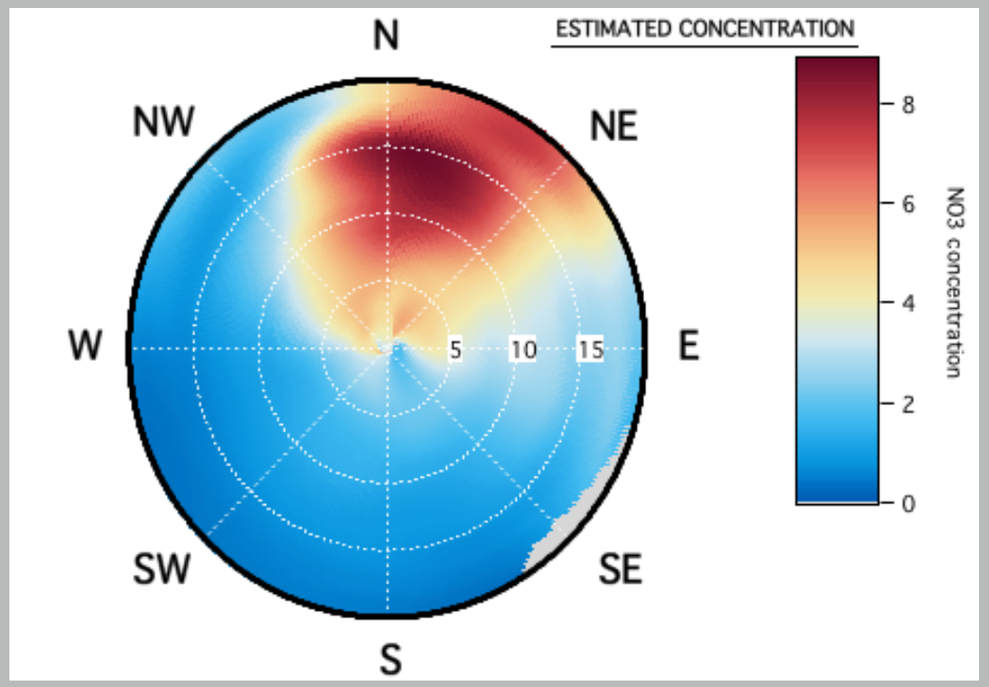
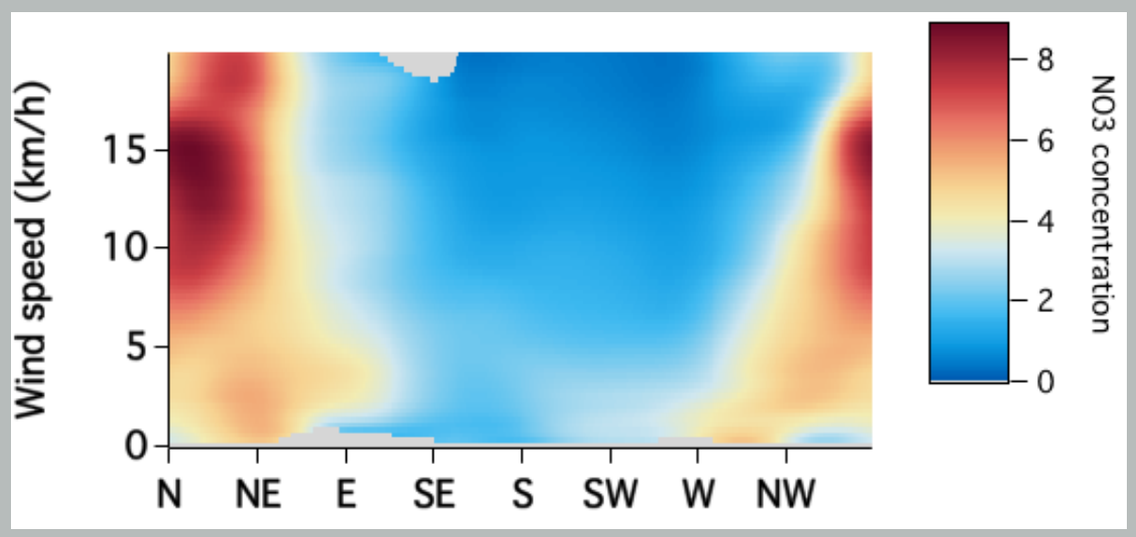
Wind Analysis

Estimated Concentration

POLAR

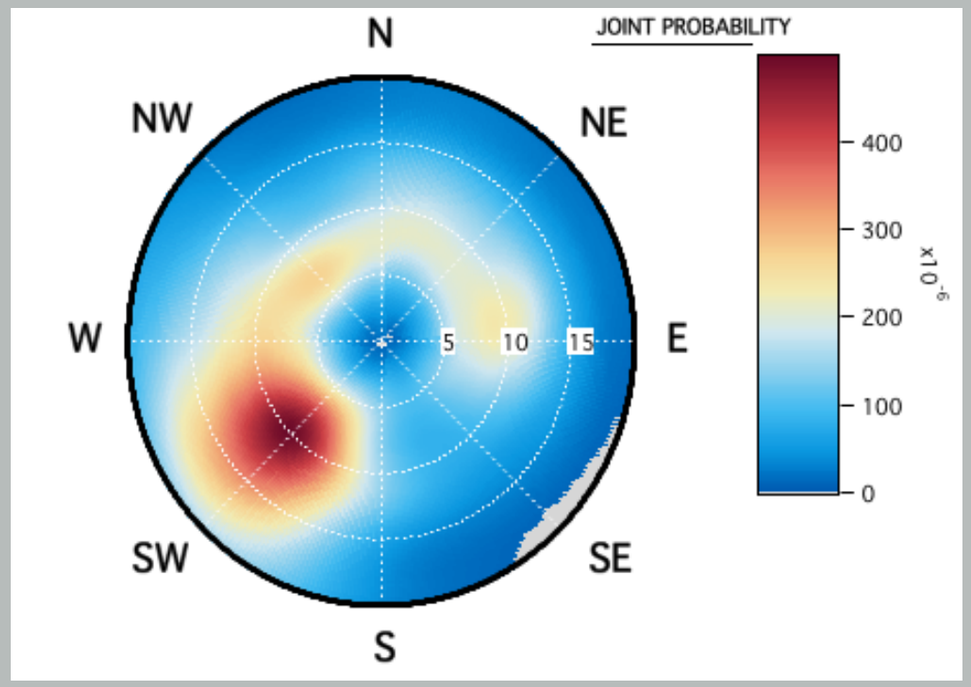


CARTESIAN



Joint Probability ≡ Wind Rose

POLAR



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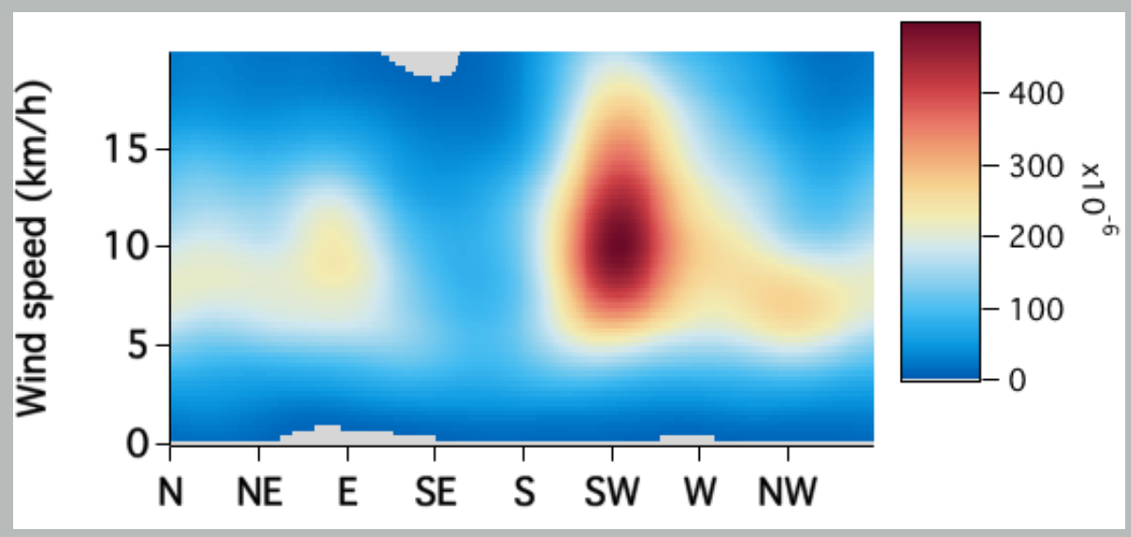

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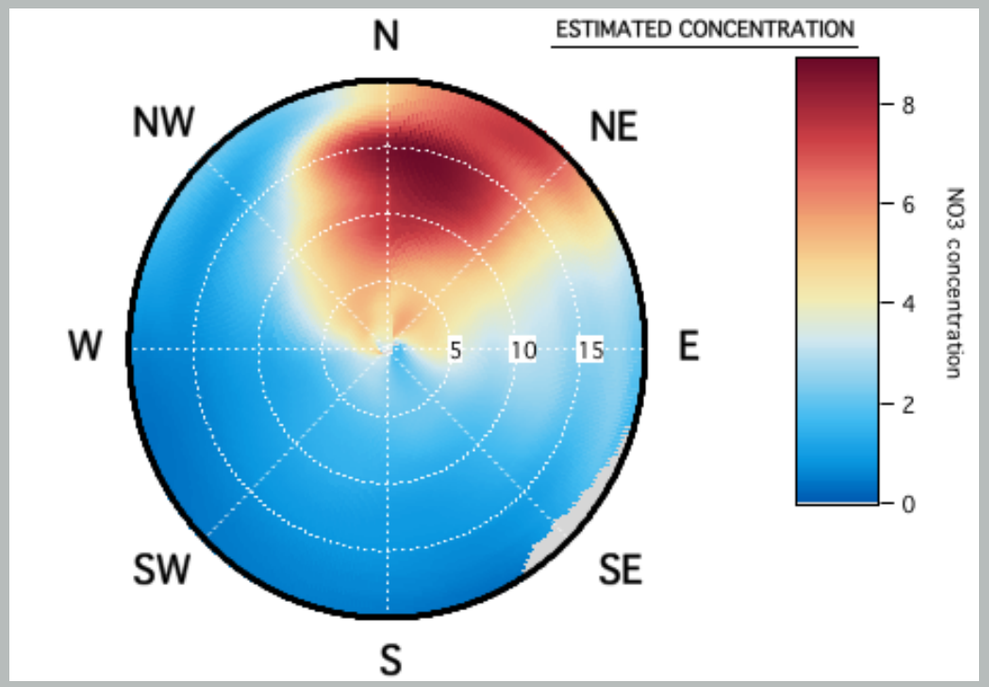
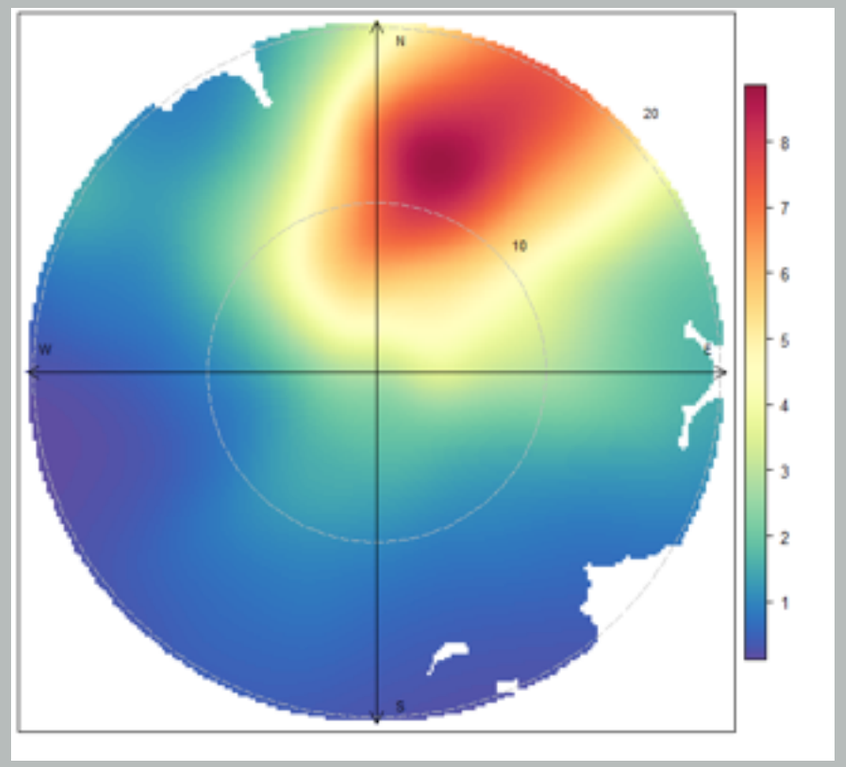
Wind Analysis

Comparison with Openair

ZeFir



OpenAir



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Trajectory Analysis

performed by PSCF / CWT / CF

$$M_{ij} = \frac{m_{ij}}{n_{ij}}$$

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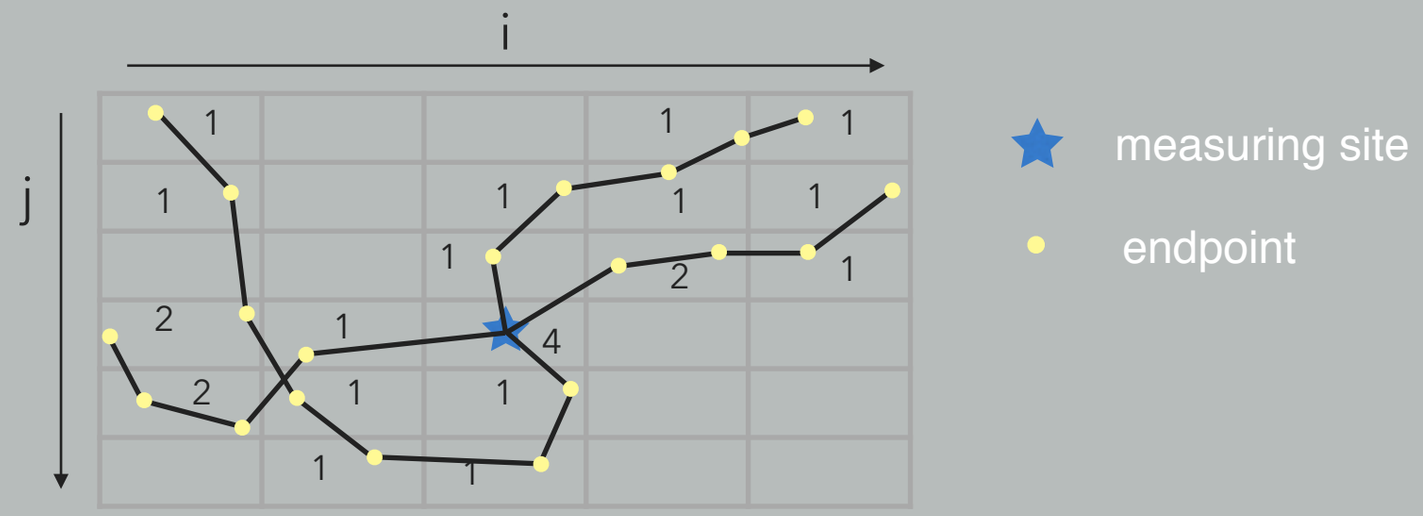
$$M_{ij} = \frac{m_{ij}}{n_{ij}}$$

n_{ij} :

1 in cell where endpoint falls



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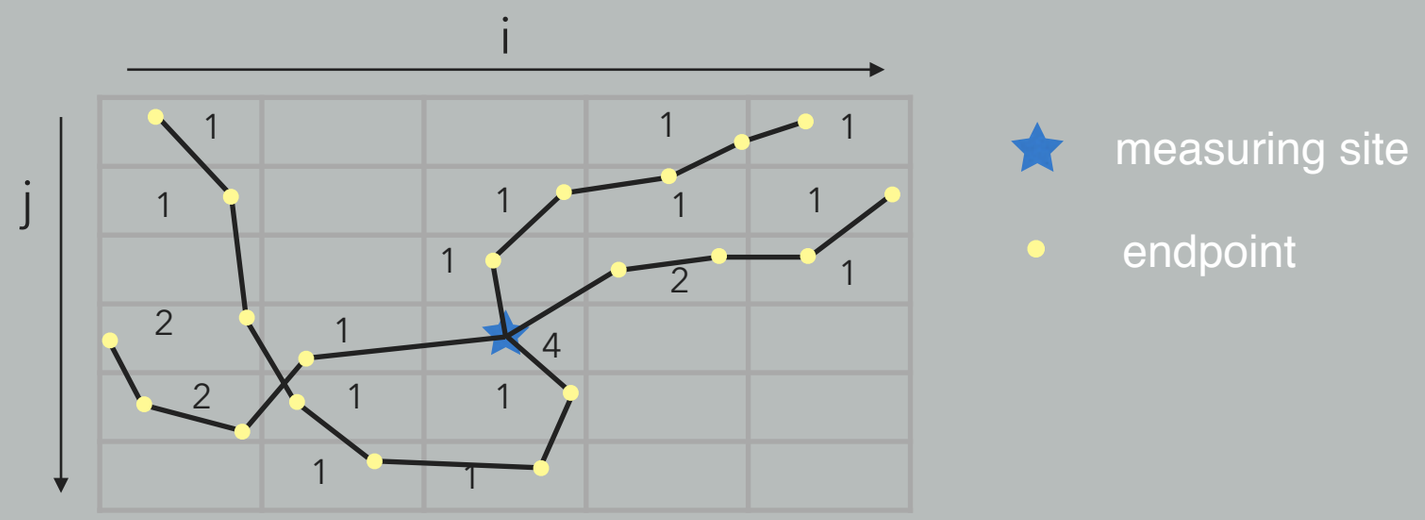
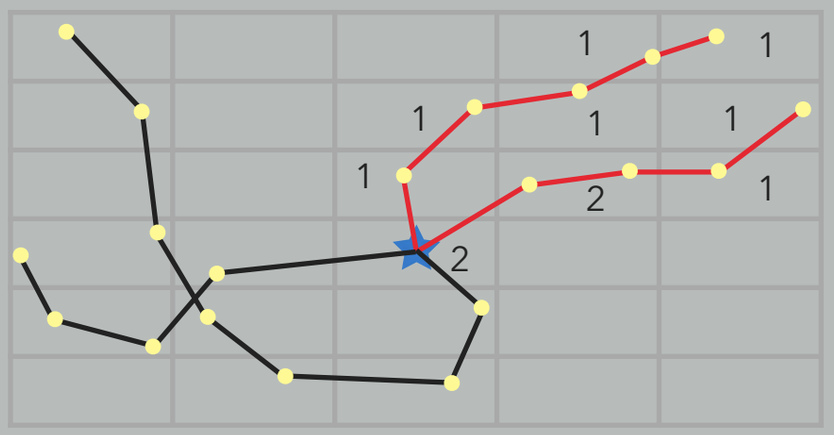


n_{ij} :

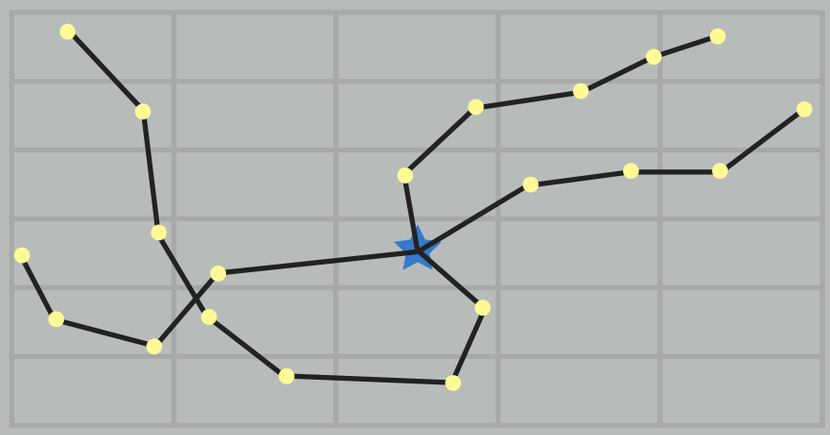
1 in cell where endpoint falls

m_{ij} :

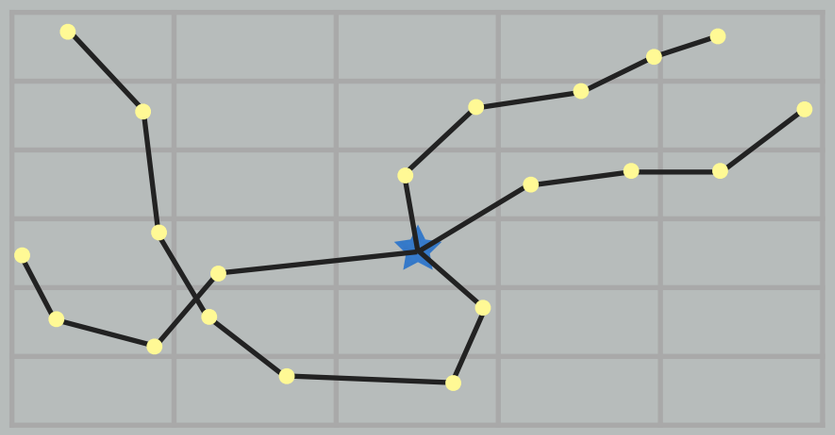
PSCF : 1 in cells if $C_l > C_{crit}$



CWT : C_l in cells at each endpoint



CF : $\log(C_l)$ in cells



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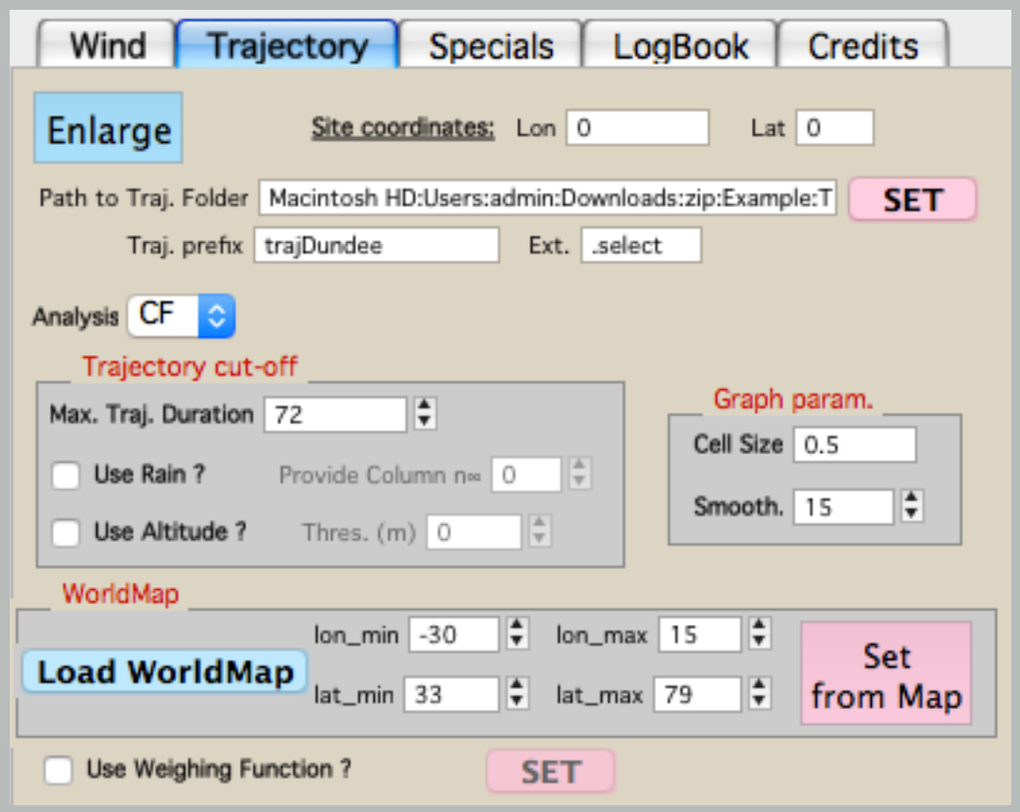
Trajectory Analysis

performed by PSCF / CWT / CF

what you need: **trajectory files from Hysplit**



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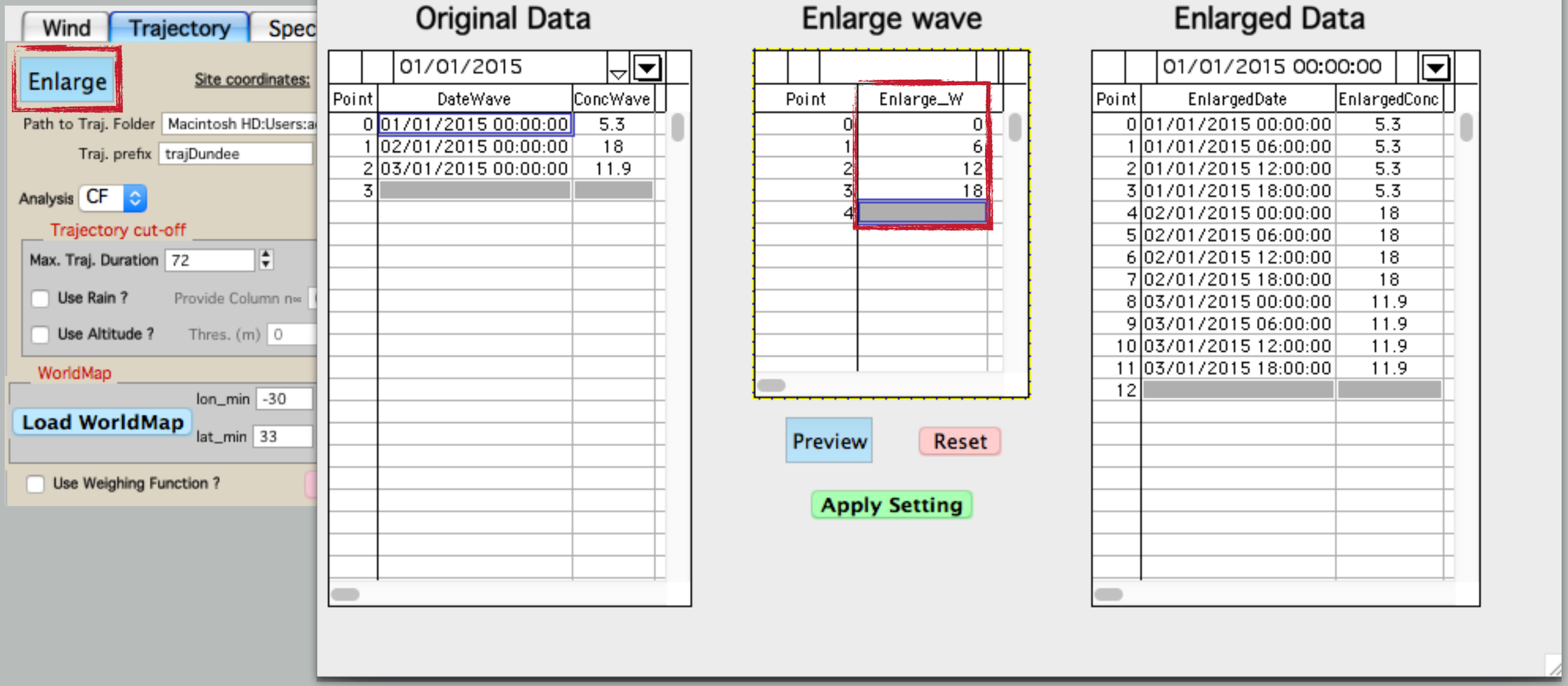
Trajectory Analysis

performed by PSCF / CWT / CF

Enlarge dataset



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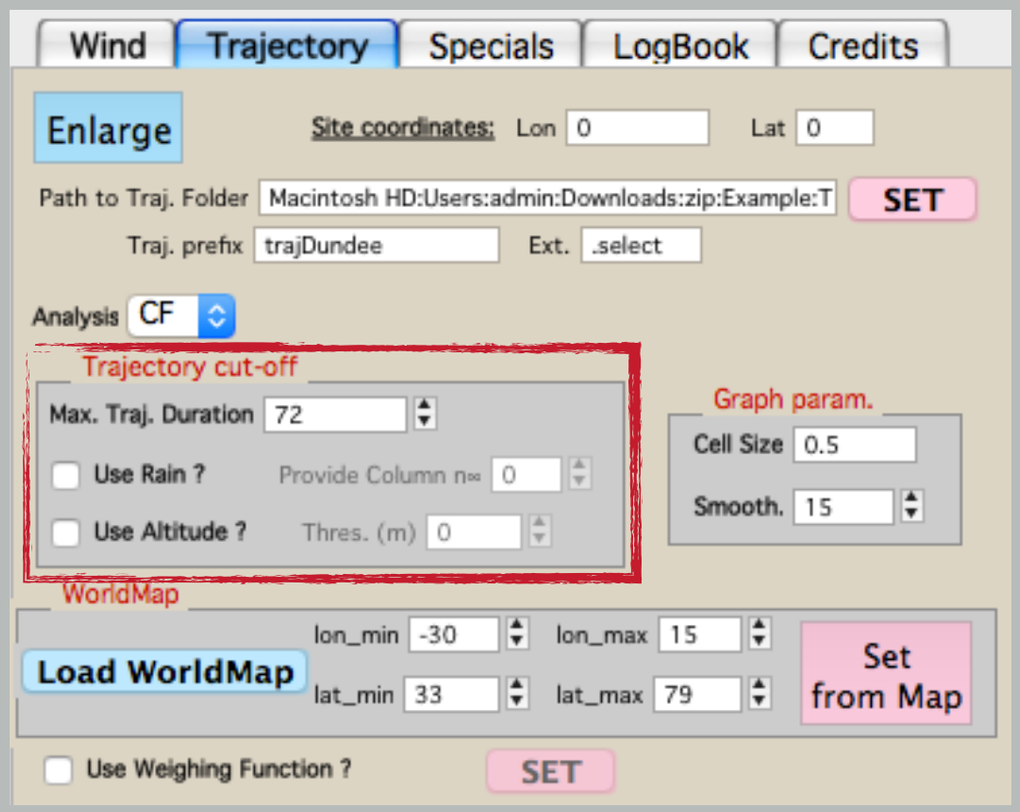
Trajectory Analysis

performed by PSCF / CWT / CF

Trajectory cut-off



- max. traj. duration (in hours)
- precipitation data along traj.
- altitude (in meters)

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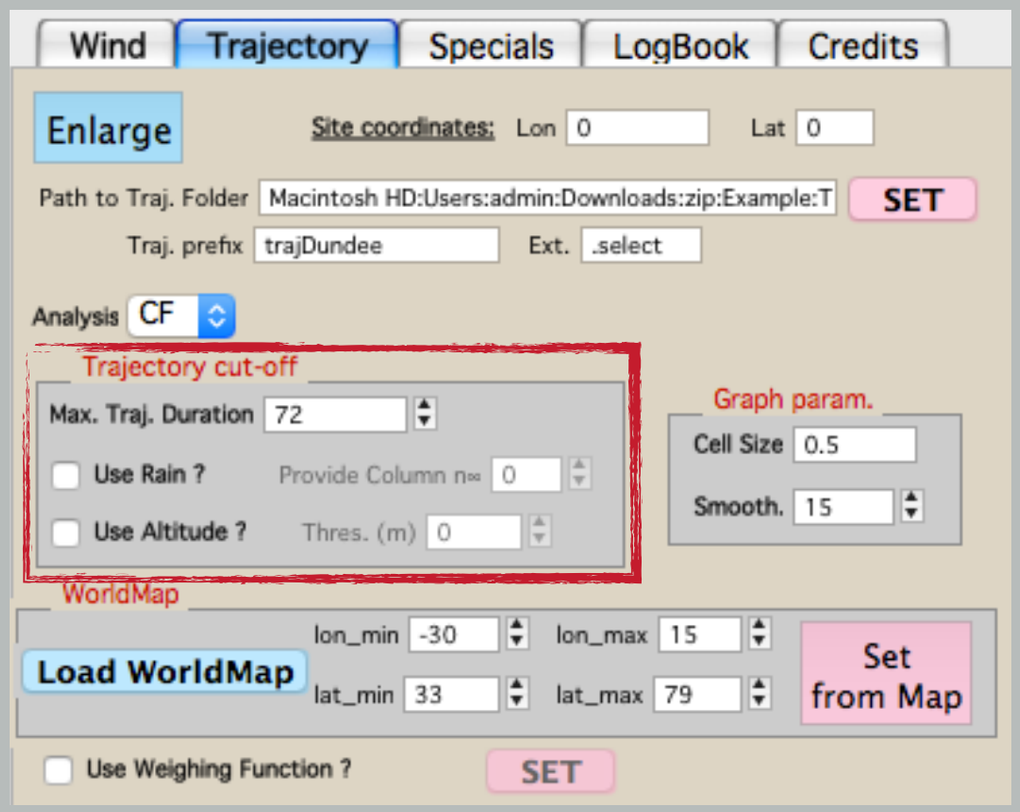

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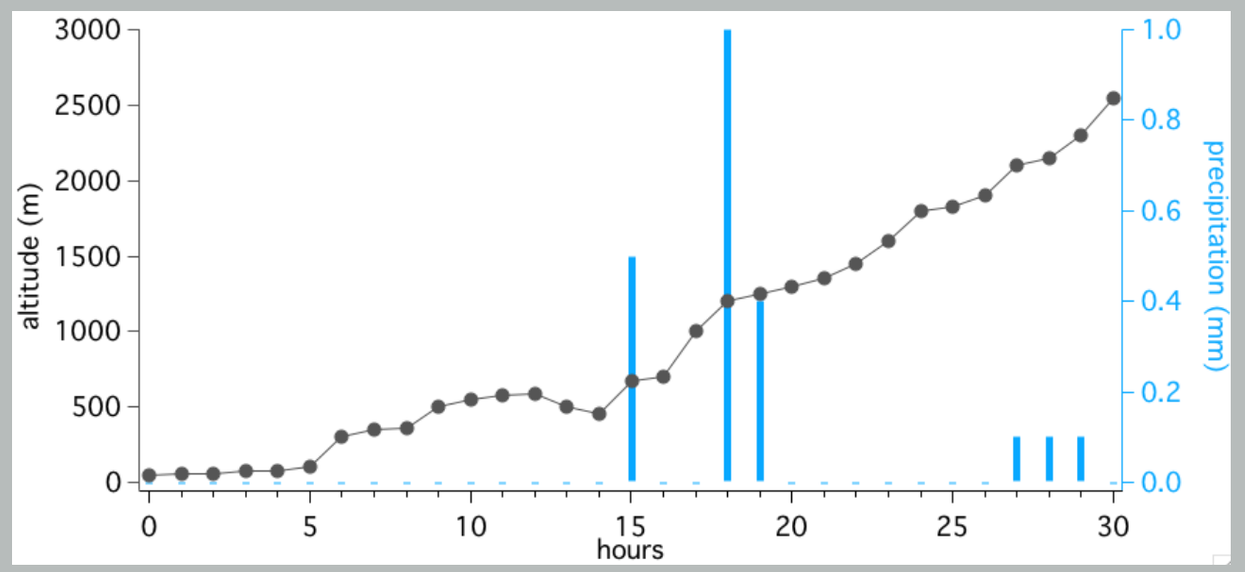

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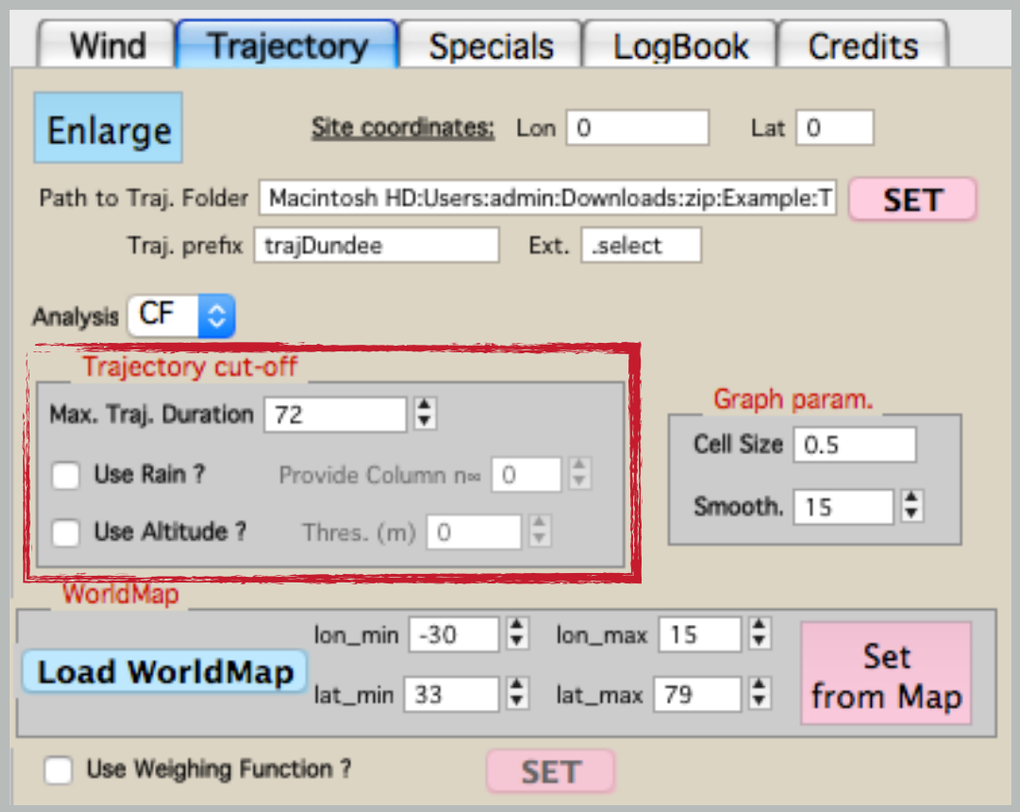

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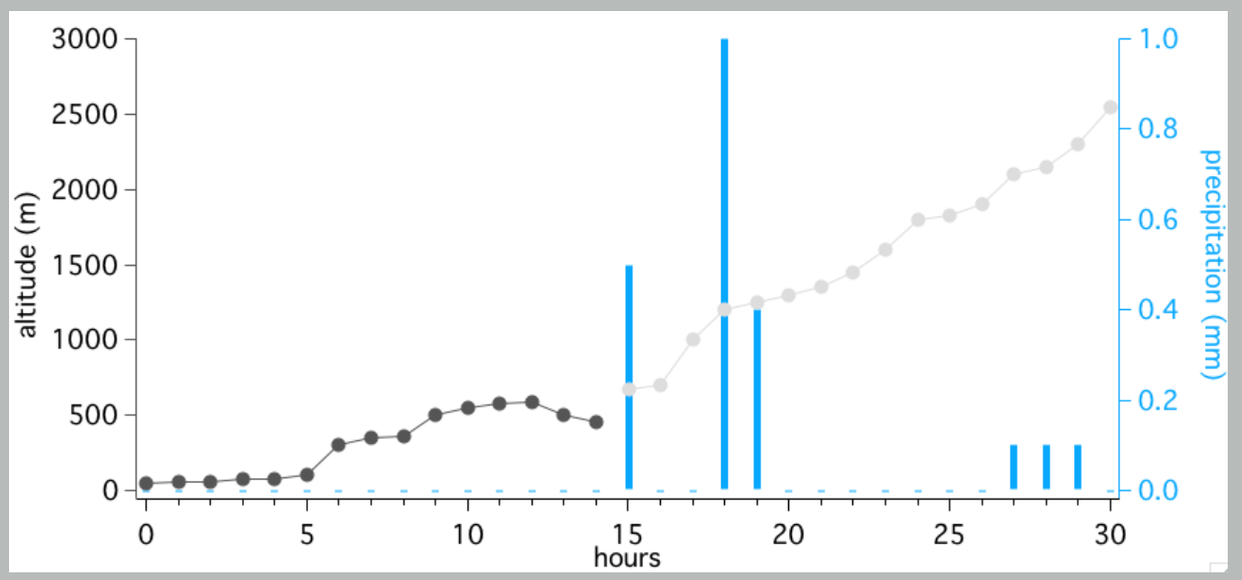

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Trajectory Analysis

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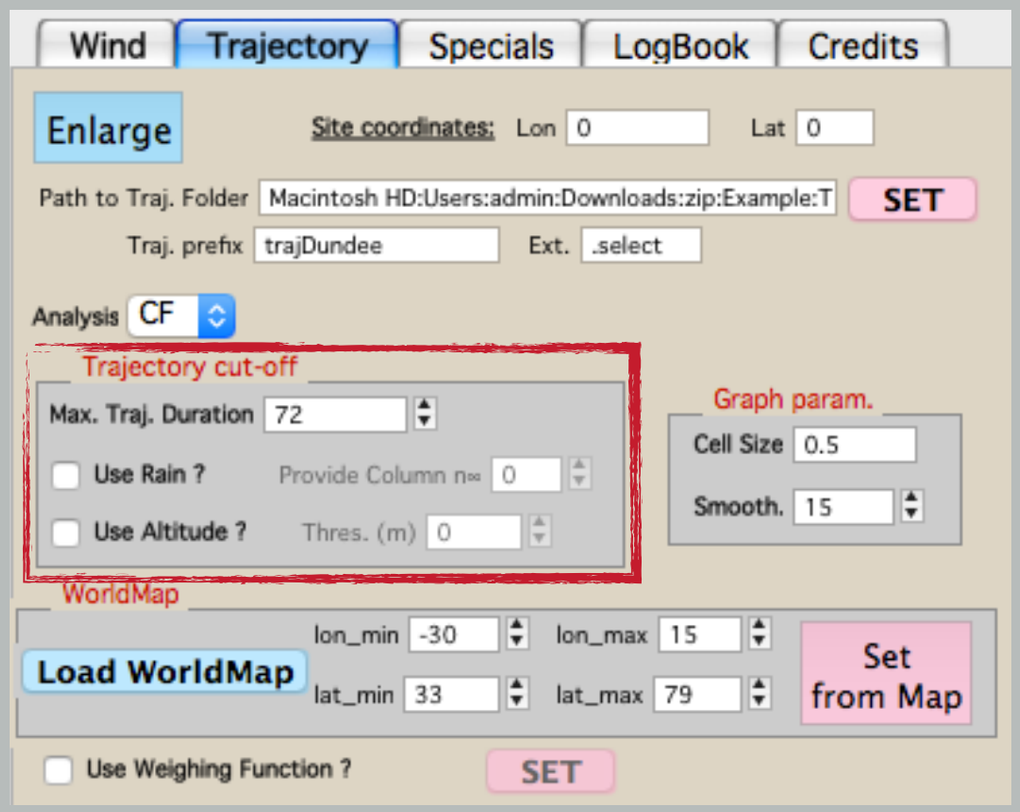

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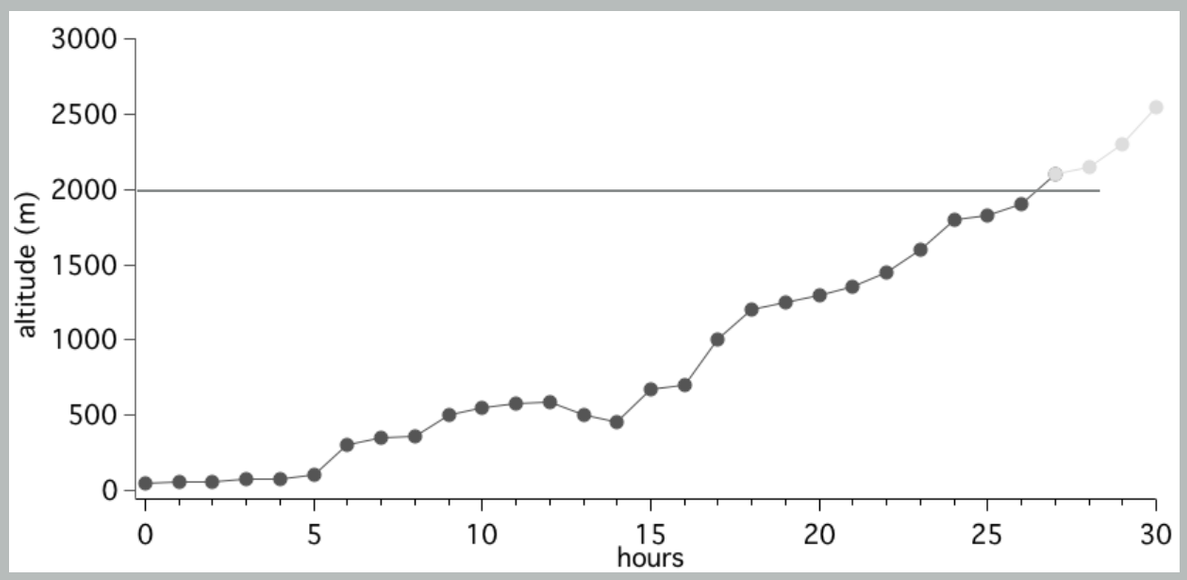

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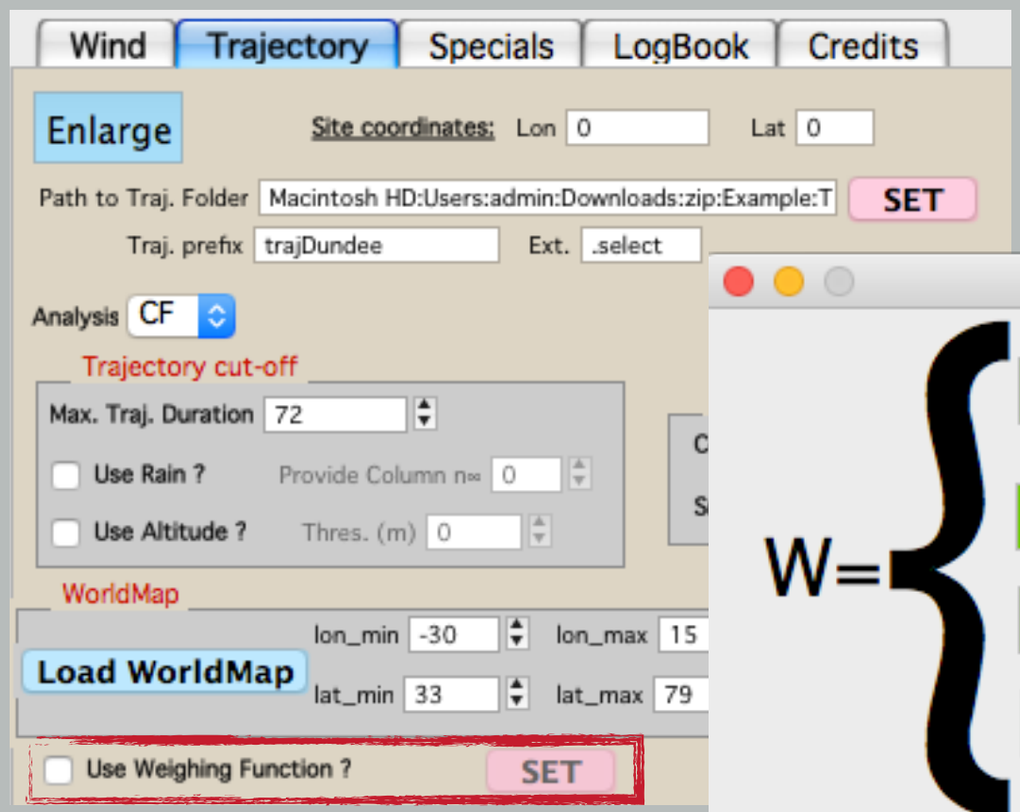
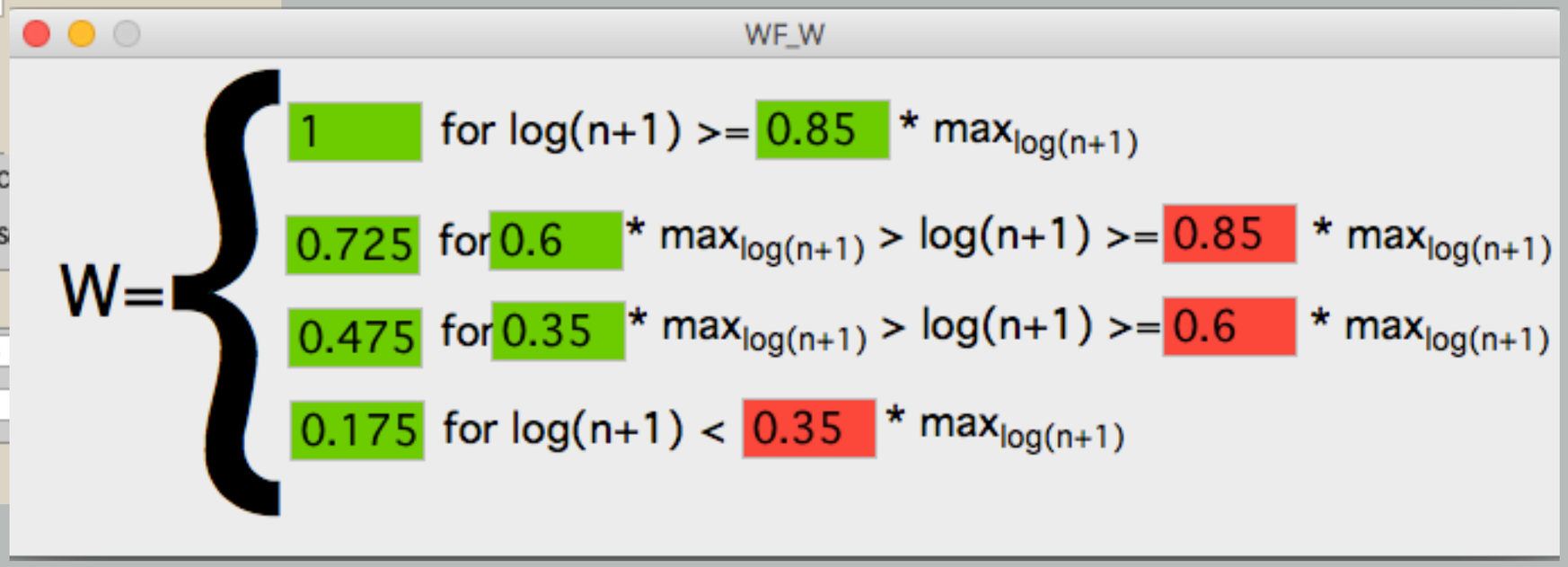
Trajectory Analysis

performed by PSCF / CWT / CF

Weighing Function



Weighing function is important to downweight cells associated with low n_{ij}.



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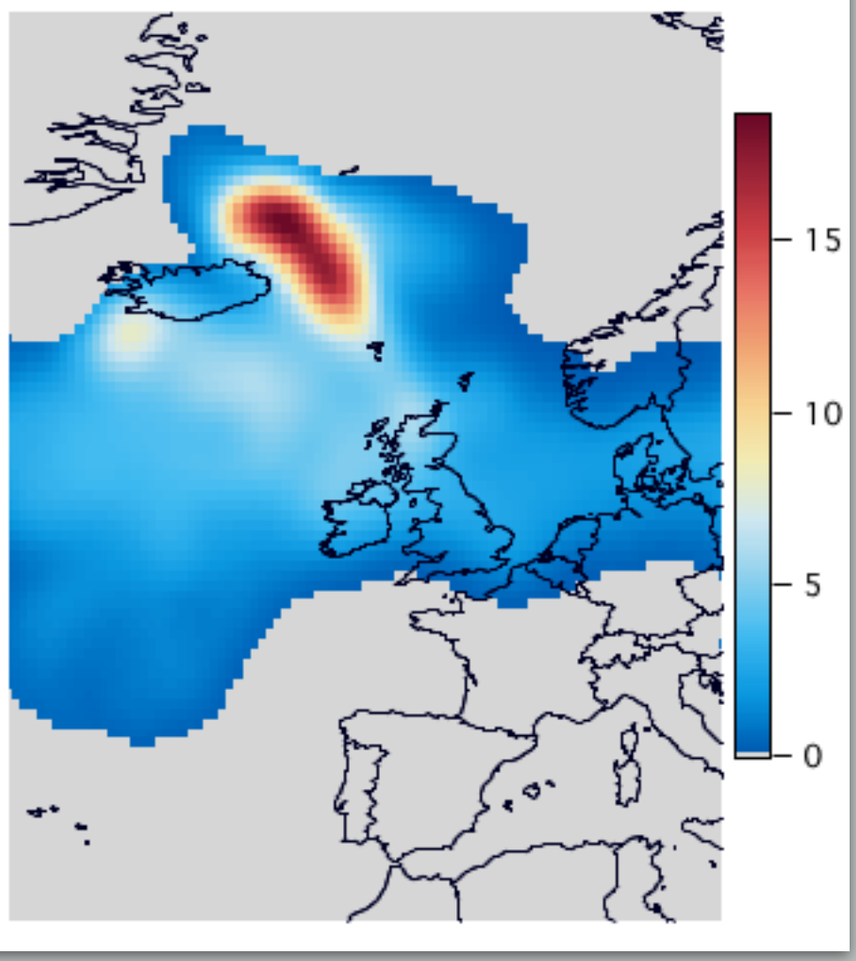
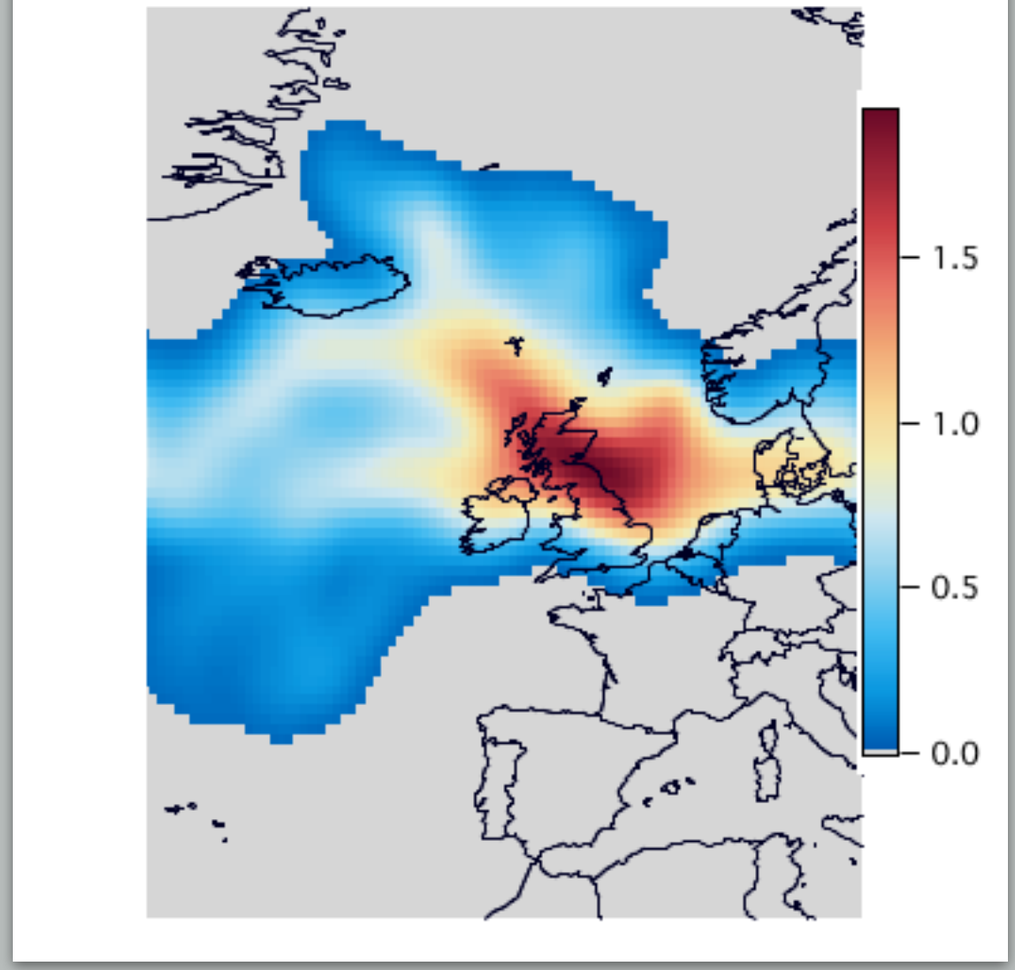
Trajectory Analysis

example SO_2 in Dundee (Scotland) during 09/2014 with hourly traj. CF method

Estimated Concentration



Trajectory Density



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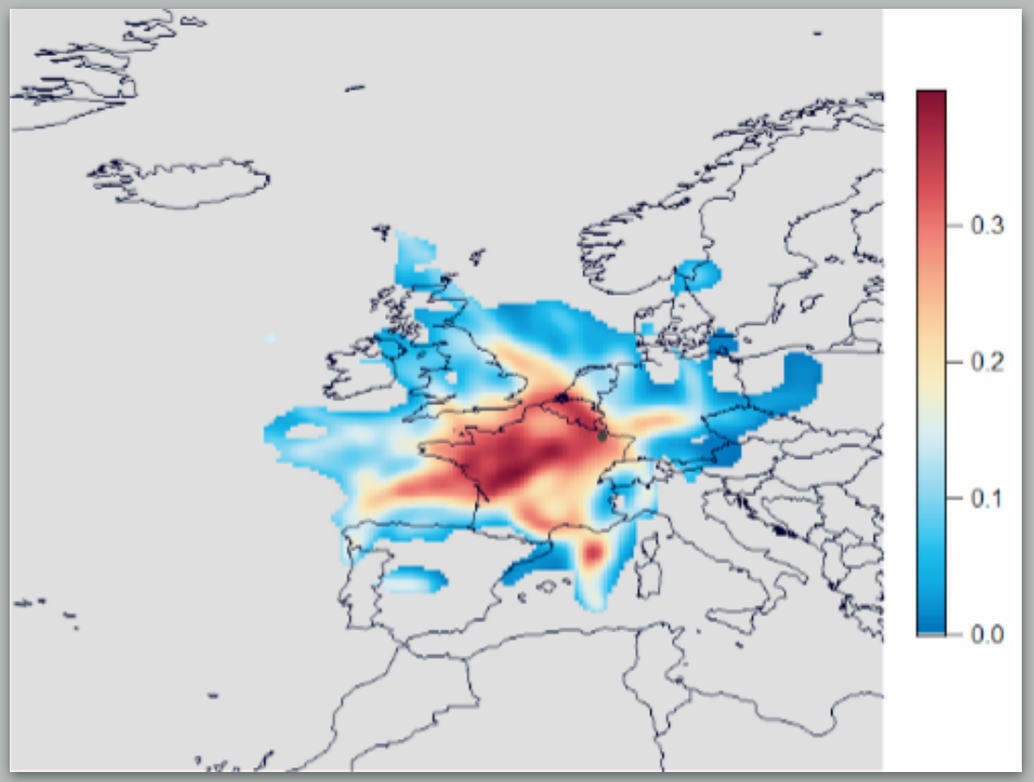
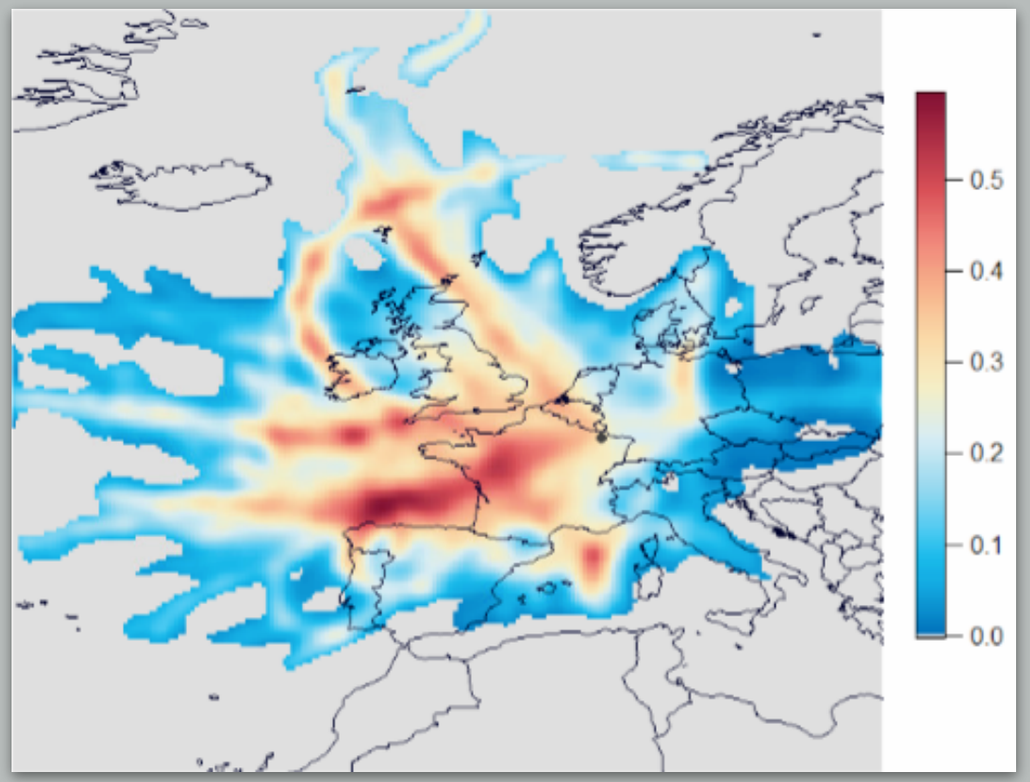
Trajectory Analysis

example Na^+ in Metz (East of France) between 04/2015 and 03/2016
daily filter sampling 1day/3
CWT method

Without data enlargement



With data enlargement



added traj at +3h, +6h, +9h, +12h, +15h, +18h & +21h

multiplied size of dataset by 8 !

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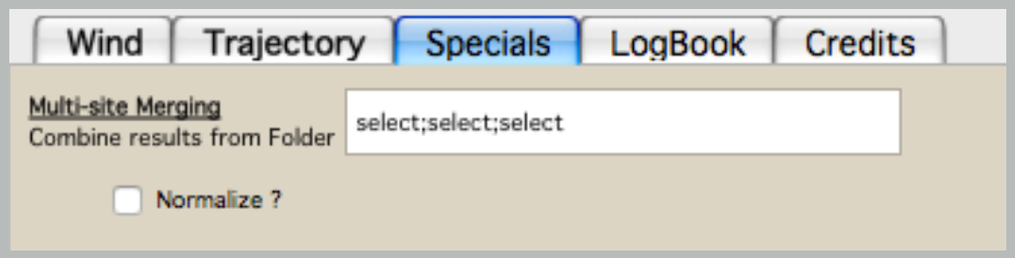
Special Runs

Multisite Merging



Combines N trajectory analyses : $$M_{ij} = \frac{\sum_{k=1}^{N} m_{ij}}{\sum_{k=1}^{N} n_{ij}}$$

Geographical origin phenomenology from Michael's ACSM dataset?

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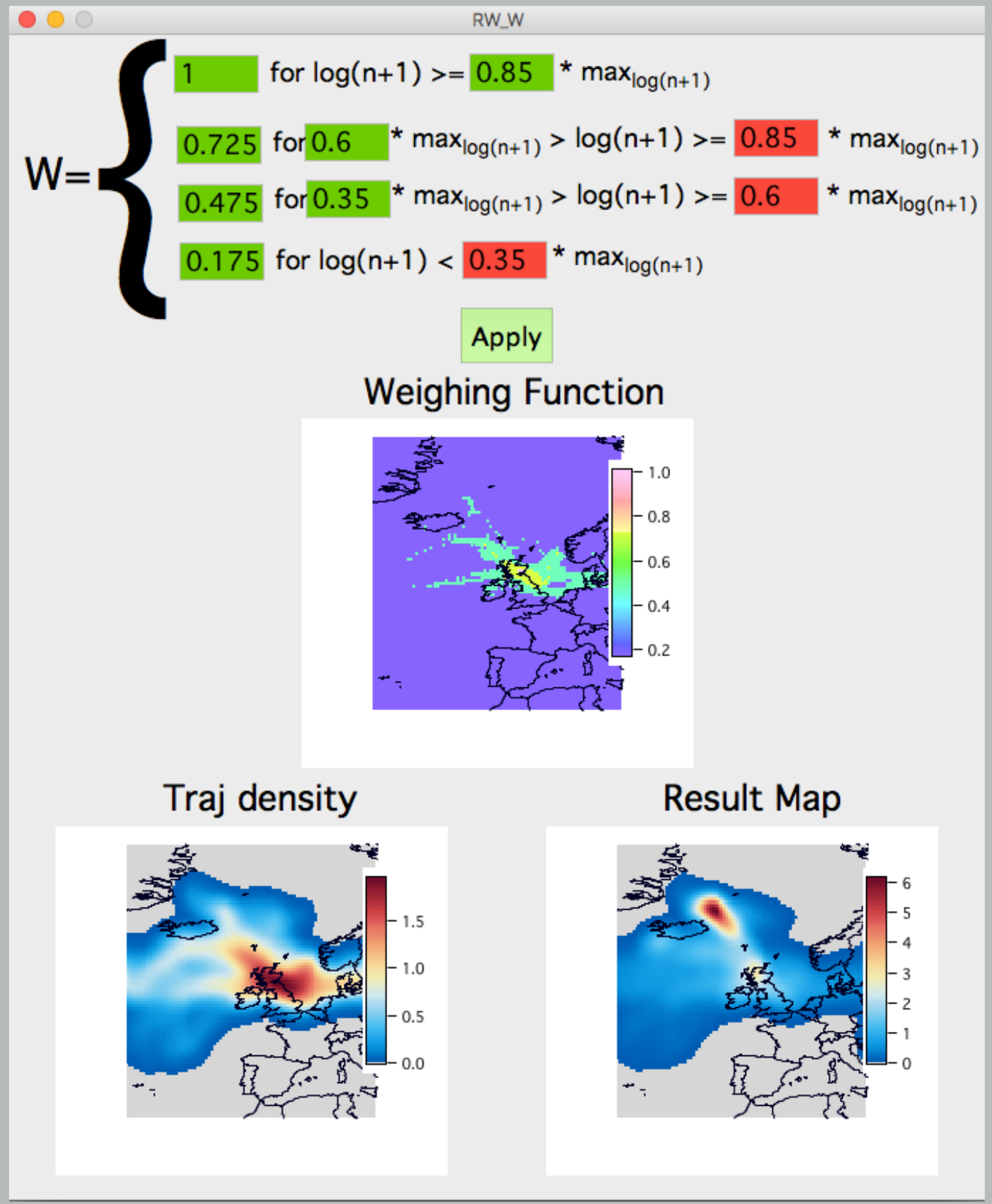
Special Runs

Weighing Function

As for now, its empirical determination was performed by running as analyses as necessary.

With ZeFir, you only need **one single run**, and **interactively** adjust the weighing function



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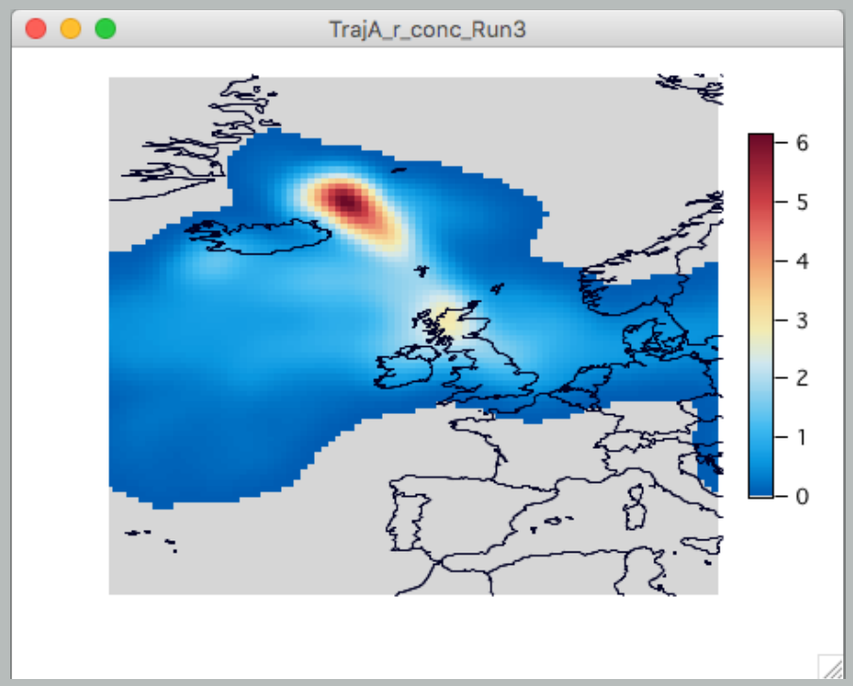
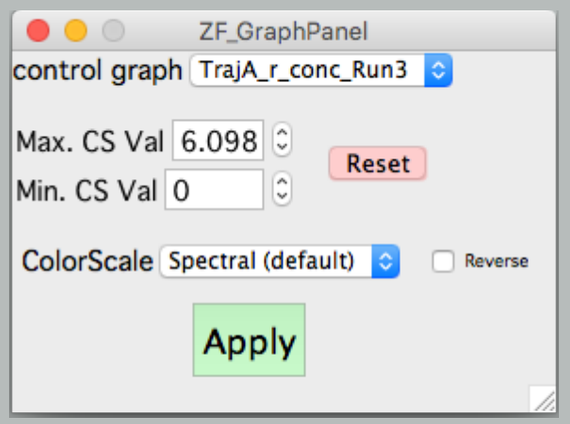
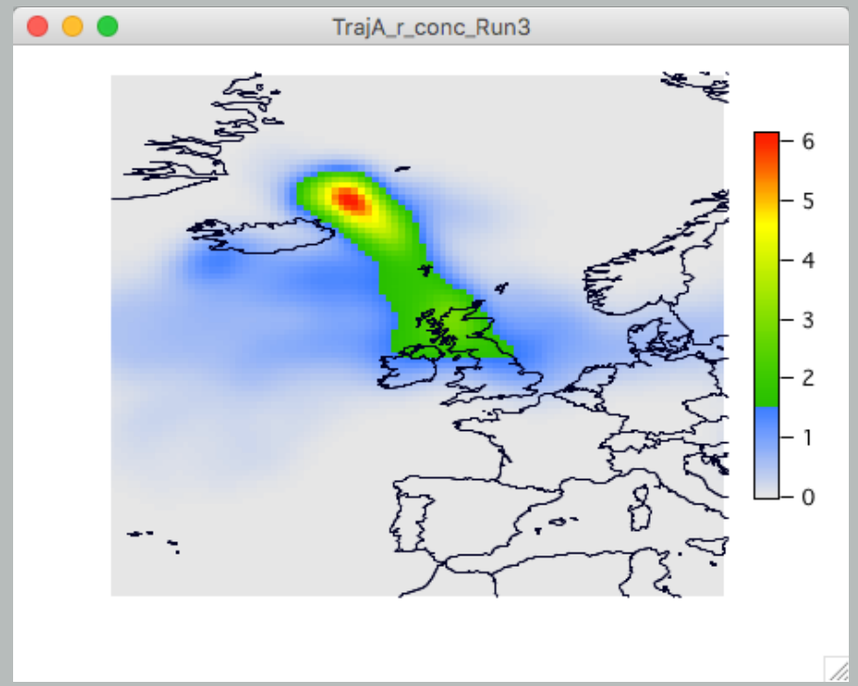
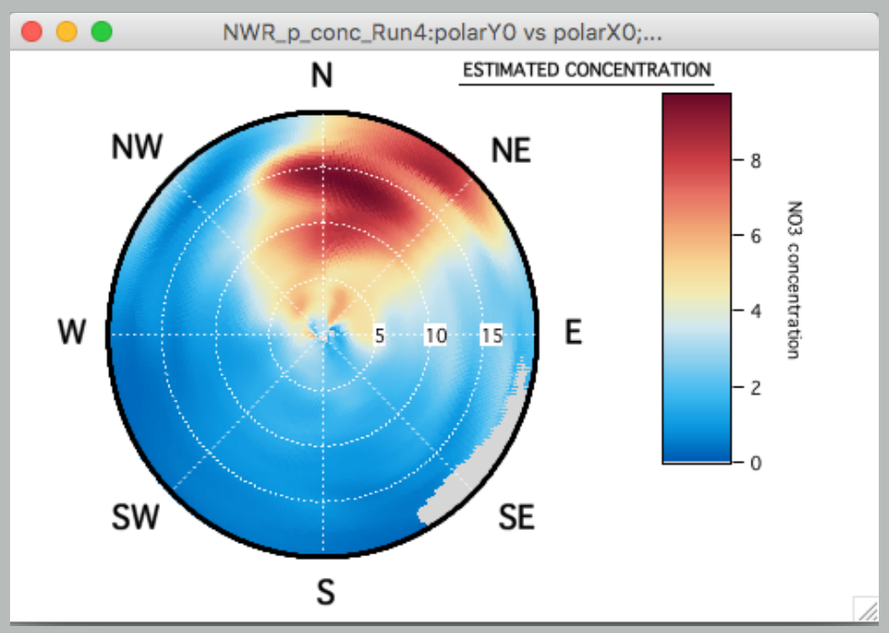
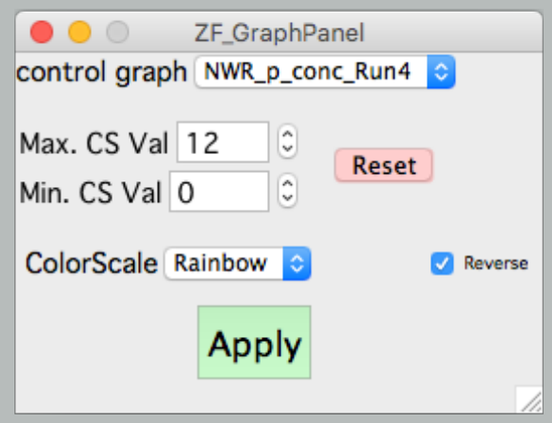
Graph_Control

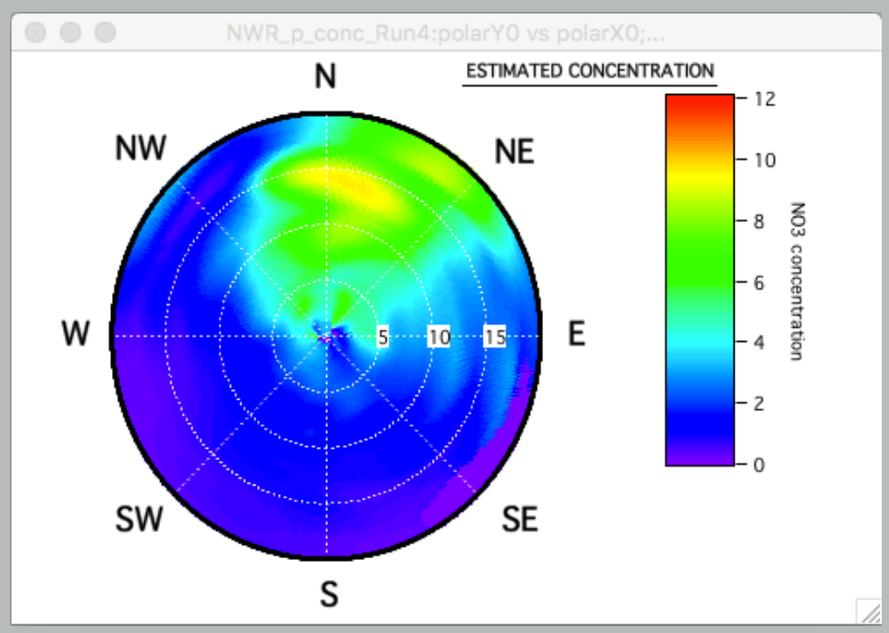












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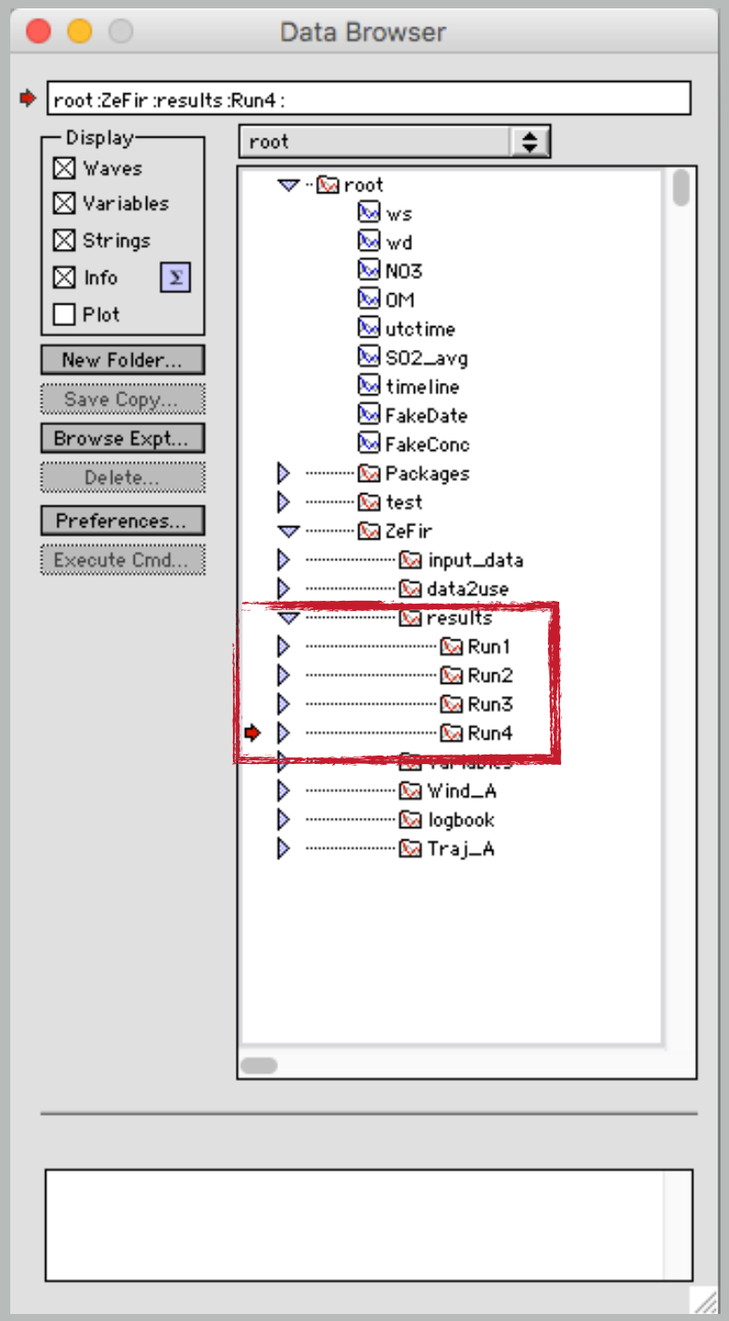
Re-Plot

Make the red arrow points towards the result folder of interest, and press re-plot results will be automatically re-displayed



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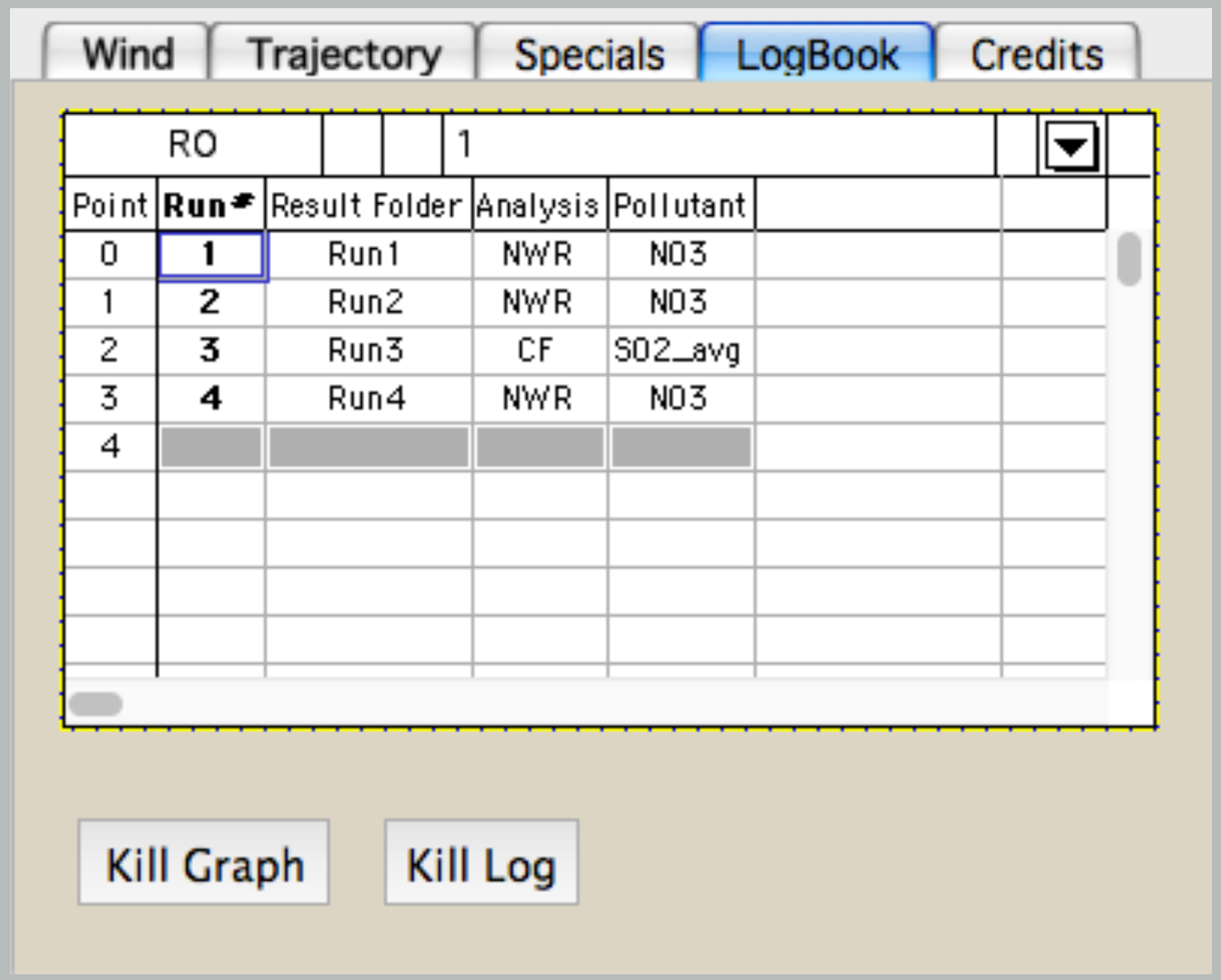
Logbook



ZeFir: an Igor Tool for Geographical Origins

Paper submitted on Environmental Modeling and Software (under review).

Petit, J.-E., Favez, O., Albinet, A., Canonaco, F.: **An Igor-based tool for comprehensive evaluation of the geographical origins of atmospheric pollution: wind and trajectory analyses**. Environmental Modelling and Software, submitted.

Procedure available on :

- **http://www.air-lorraine.org/zefir**
- **zefir.contact@gmail.com**
- **je.petit@air-lorraine.org**

Package (~5 Mb) contains: .ipf procedure, manual, worldmap, example data for wind analysis and trajectory analysis