Latest in Flux Data Analysis Software: from Quality Control & Gap Filling to Flux & Footprint Partitioning

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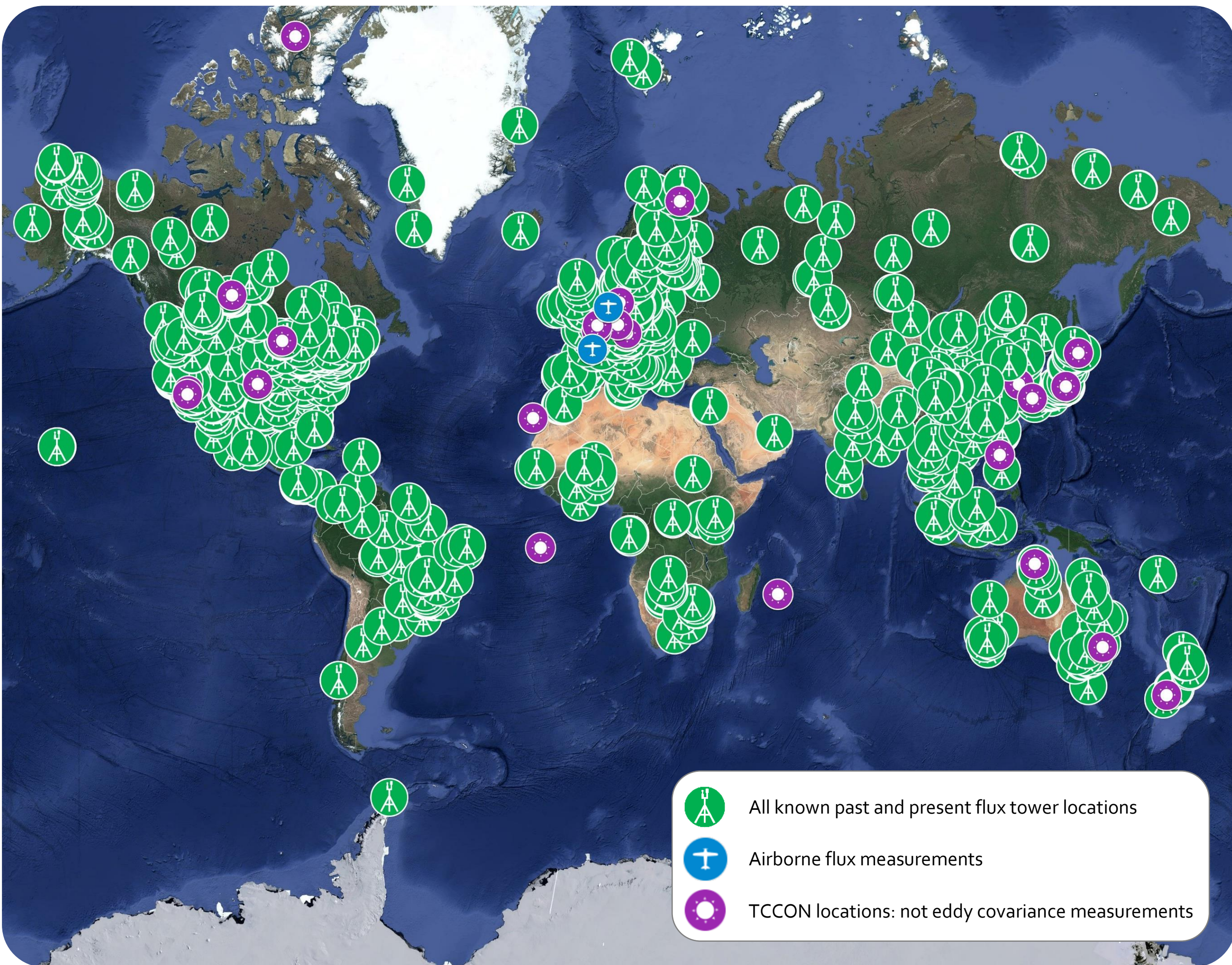
DATA ANALYSIS PLATFORM

- Driven and guided by the Research Community; developed, implemented & supported by LI-COR
- Research Community provides scientific competence, methods and codes, and outlines the needed tools
- LI-COR provides software engineering, solid implementation, easy-to-use GUI, documentation, trainings, support, and continuous development: www.tovi.io

HOW DOES IT WORK?

- Scientifically sound and programmatically robust software allows seamless data retrieval, quality control, analysis, and workflow documentation.
- Shareable, traceable, and reproducible workflow uses methods available from the research community.
- Greatly enhances standardization and comparability among sites and users, and makes results defensible.
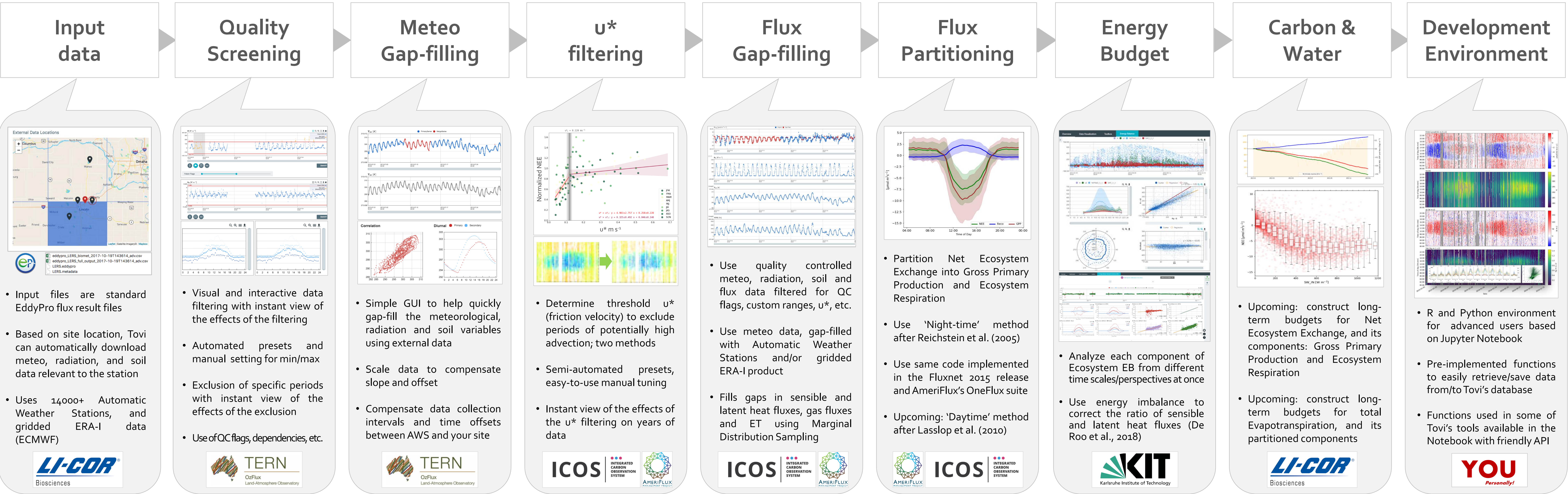
WHAT CAN IT DO?

- Automates multiple time-intensive procedures and handles large datasets
- Automated search of 14000+ weather stations for gap-filling, reproducible workflows and lists of references, easy use of proven analytical tools and easy cross-domain collaborations
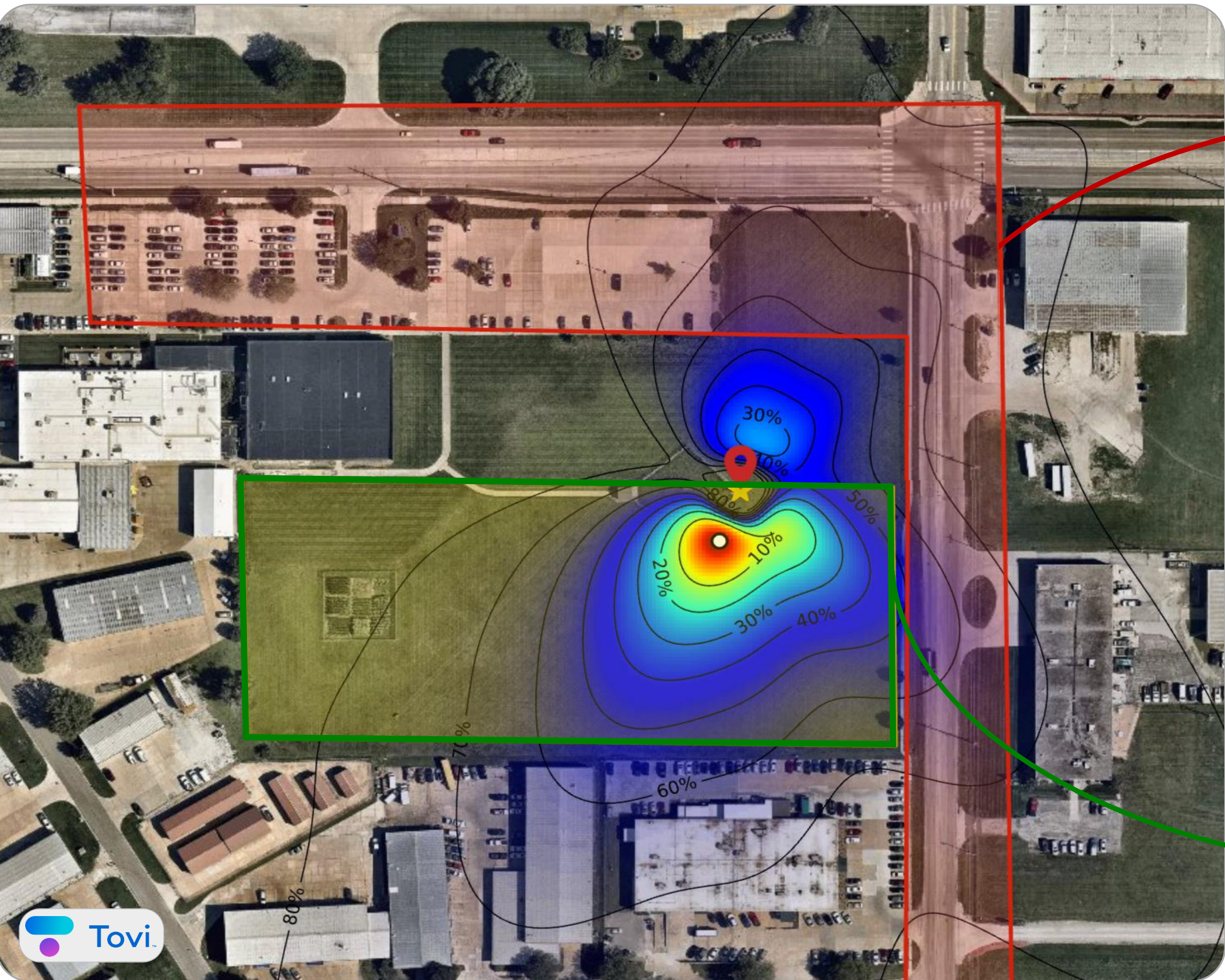

All known past and present flux tower locations
Airborne flux measurements
TCCON locations: not eddy covariance measurements

Data from over 2100 past and present EC locations can be analyzed and reanalyzed

EXAMPLE OF ONE OF MANY POSSIBLE WORKFLOWS

| Input data | Quality Screening | Meteo Gap-filling | u* filtering | Flux Gap-filling | Flux Partitioning | Energy Budget | Carbon & Water | Development Environment |

Input data
- Input files are standard EddyPro flux result files
- Based on site location, Tovi can automatically download meteo, radiation, and soil data relevant to the station
- Uses 14000+ Automatic Weather Stations, and gridded ERA-I data

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Quality Screening
- Visual and interactive data filtering with instant view of the effects of the filtering
- Automated presets and manual setting for min/max
- Exclusion of specific periods with instant view of the effects of the exclusion
- Use of QC flags, dependencies, etc.

TERN OzFlux

Meteo Gap-filling
- Simple GUI to help quickly gap-fill the meteorological, radiation and soil variables using external data
- Scale data to compensate slope and offset
- Compensate data collection intervals and time offsets between AWS and your site

TERN OzFlux Land-Atmosphere Observatory

u* filtering
- Determine threshold u* (friction velocity) to exclude periods of potentially high advection; two methods
- Semi-automated presets, easy-to-use manual tuning
- Instant view of the effects of the u* filtering on years of data

ICOS / AmeriFlux

Flux Gap-filling
- Use quality controlled meteo, radiation, and flux data filtered for QC flags, custom ranges, u*, etc.
- Use meteo data, gap-filled with Automatic Weather Stations and/or gridded ERA-I product
- Fills gaps in sensible and latent heat fluxes, gas fluxes and ET using Marginal Distribution Sampling

ICOS / AmeriFlux

Flux Partitioning
- Partition Net Ecosystem Exchange into Gross Primary Production and Ecosystem Respiration
- Use 'Night-time' method after Reichstein et al. (2005)
- Use same code implemented in the Fluxnet 2015 release and AmeriFlux's OneFlux suite
- Upcoming: 'Daytime' method after Lasslop et al. (2010)

AmeriFlux / ICOS

Energy Budget
- Analyze each component of Ecosystem EB from different time scales/perspectives at once
- Use energy imbalance to correct the ratio of sensible and latent heat fluxes (De Roo et al., 2018)

KIT Karlsruhe Institute of Technology

Carbon & Water
- Upcoming: construct long-term budgets for Net Ecosystem Exchange, and its components: Gross Primary Production and Ecosystem Respiration
- Upcoming: construct long-term budgets for total Evapotranspiration, and its partitioned components

LI-COR Biosciences

Development Environment
- R and Python environment for advanced users based on Jupyter Notebook
- Pre-implemented functions to easily retrieve/save data from/to Tovi's database
- Functions used in some of Tovi's tools available in the Notebook with friendly API

YOU Personally!

EXAMPLE OF ONE OF MANY AVAILABLE TOOLS

Select perimeter around roads

Select perimeter around lawn

1) Select the data from your own or another site
2) Select two or more perimeters of interest
3) Run the footprint tool for your site
4) Try different percentage of flux footprint coming from each of the perimeters, including multiple dis-contiguous perimeters, to tease out the unique data

Morning traffic peak
Evening traffic peak
Roads and parking
Entire footprint
Traffic count
Green grass

NEE, umol CO_2 m^{-2} s^{-1}
US DOT traffic count: % of hourly to daily
Time of Day
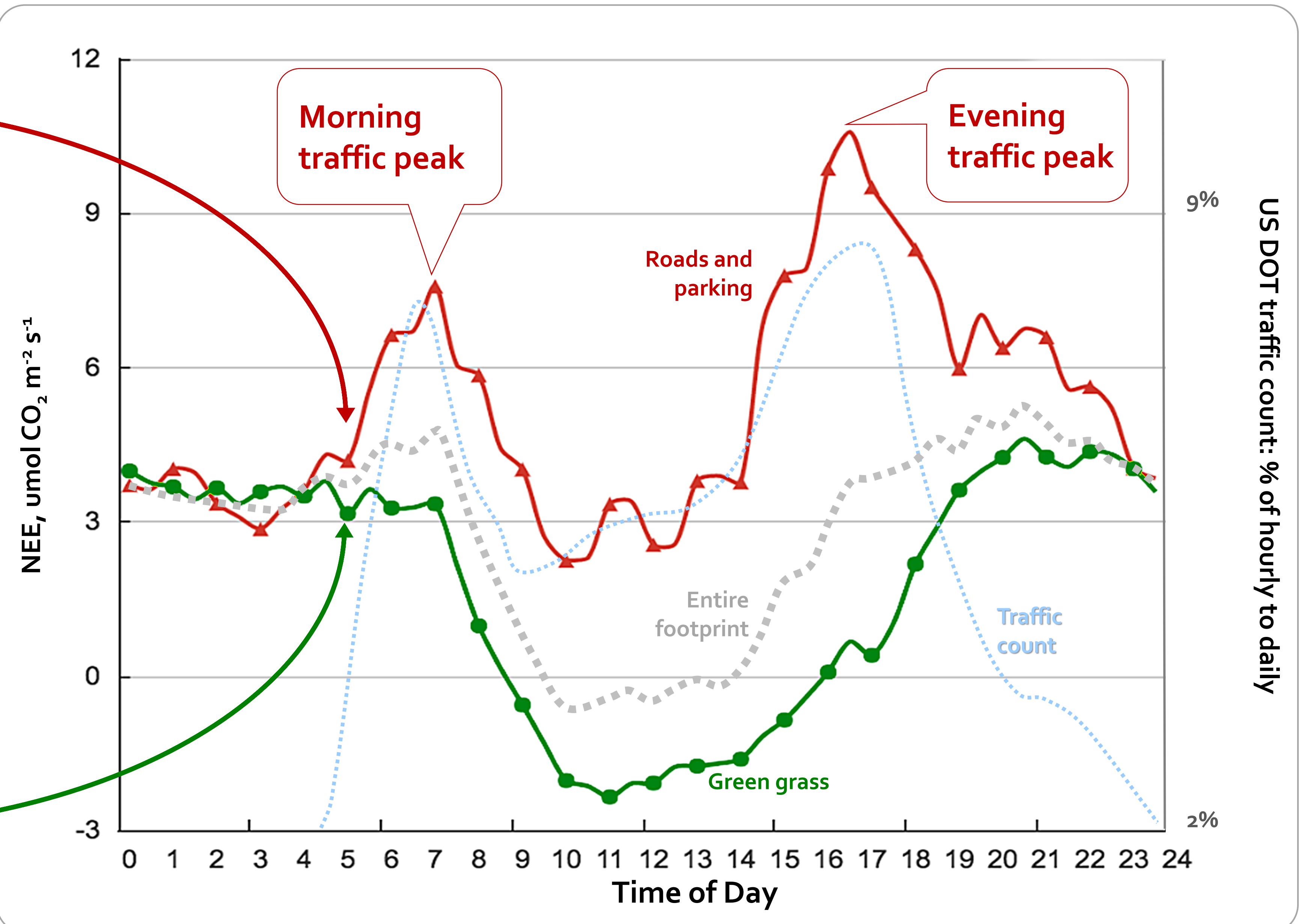
Select multiple dis-contiguous perimeters to apportion flux, discover unique patterns, create new scientific products much faster

Identify source area of measured fluxes, sort out different dynamics in mixed ecosystems, collaborate with remote sensing/modelling communities