

Visualization, Selection, and Analysis of Traffic Flows

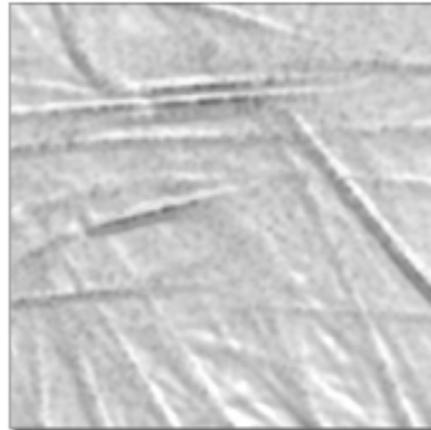
Roeland Scheepens, Christophe Hurter, Huub van de Wetering, and
Jarke J. van Wijk

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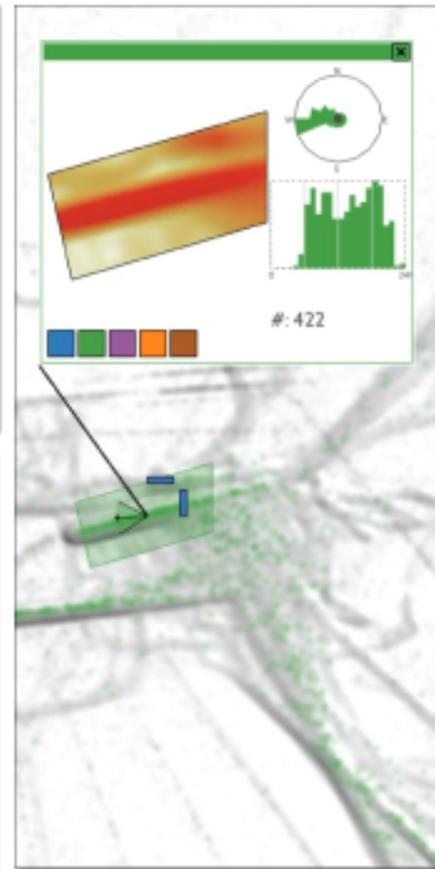
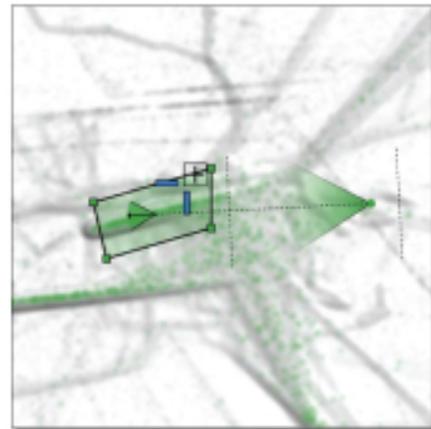
Presentation by Alistair Wick

Overview

Visualize
Traffic flows



Select
Traffic flows



Analyze
Dynamics

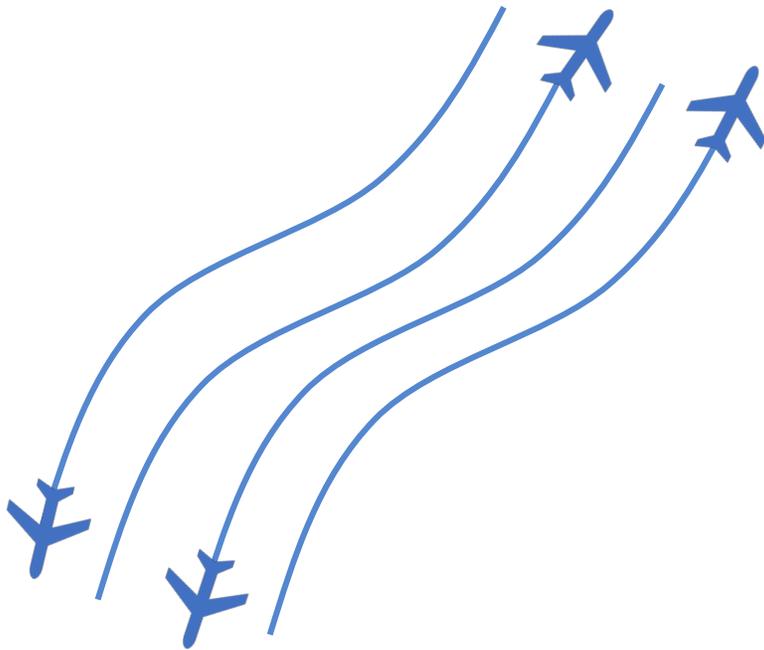
Motivation

- Individuals move, but groups make *traffic*
- Traffic is unpredictable, but not random – it forms patterns
- These patterns are important, but difficult to analyse

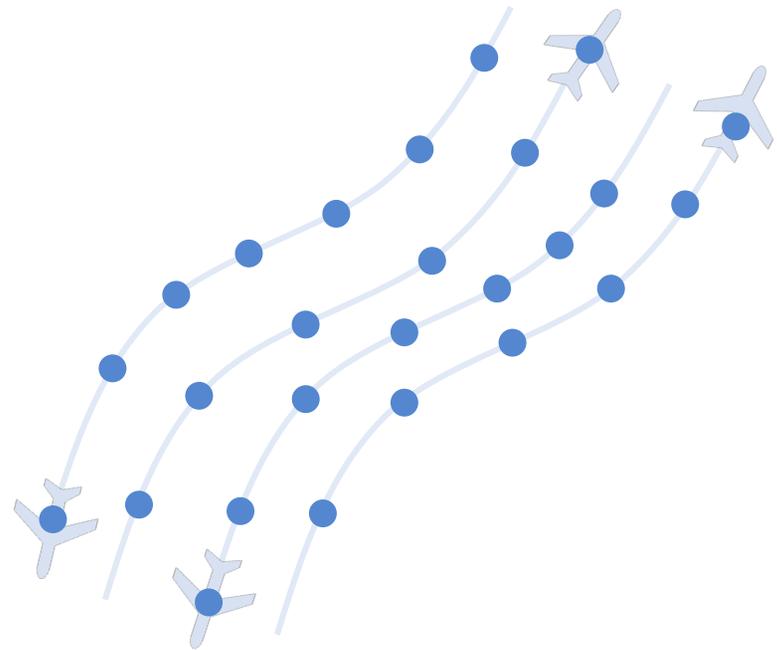
- This tool helps us examine these patterns, and how they change
- Takes a novel approach, using animation as a key visual channel

Data

- Trajectories over time



10s of thousands of journeys

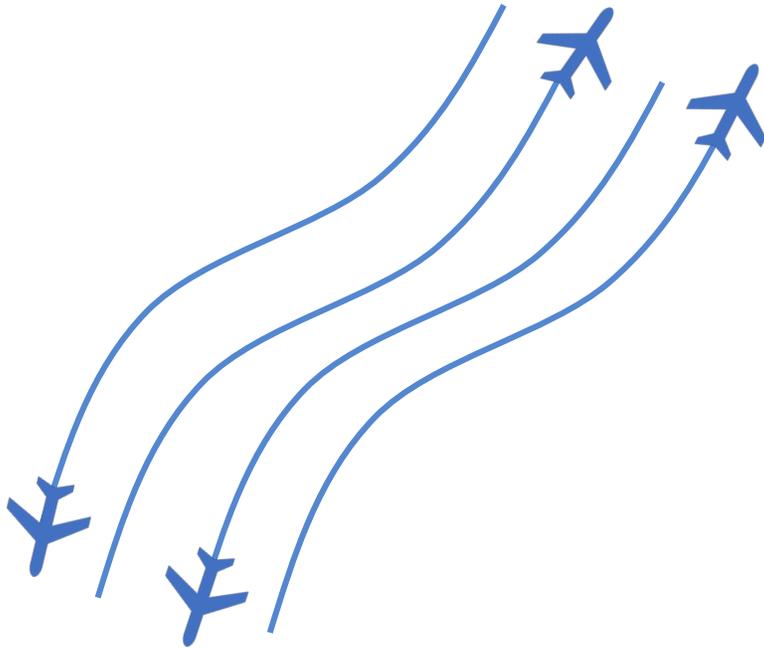


100s of thousands of sample points

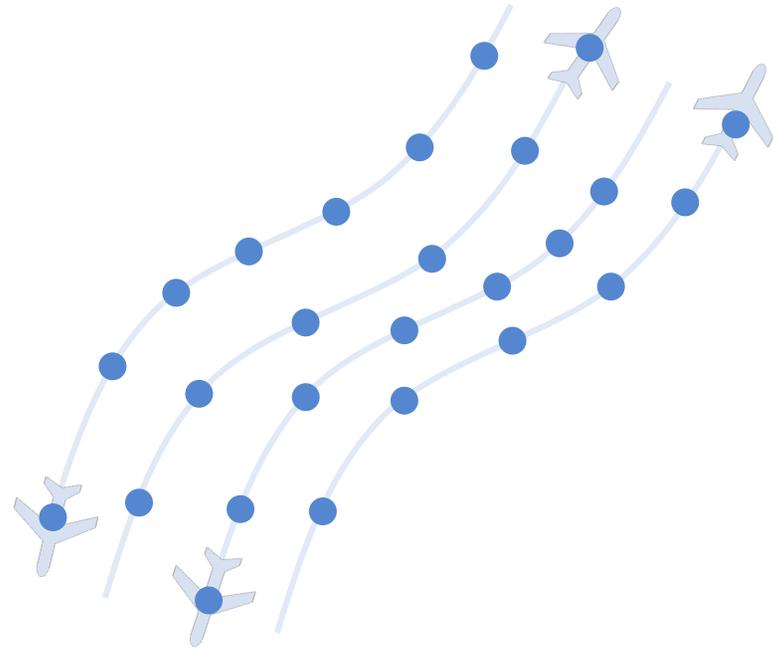
Data

Case Studies

- One day over Paris: 17,841 flights, 424,546 samples
- Vessel data near Dutch coast: 16,421 vessels, 420,335 samples



10s of thousands of journeys



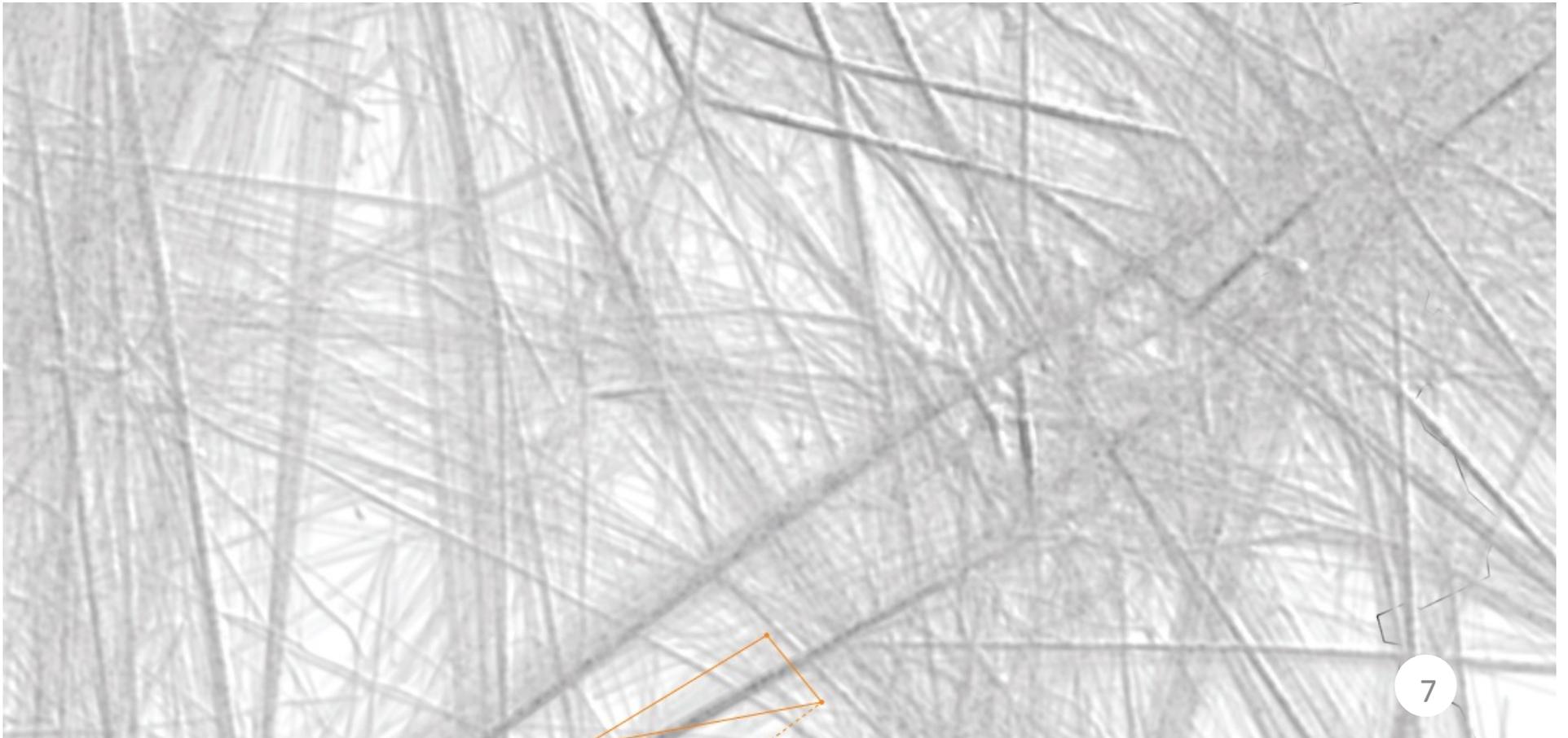
100s of thousands of sample points

Data

- Large numbers of overlapping trajectories
- High density variation
- At a minimum, data includes:
 - Position
 - Heading
 - Velocity
- May also include:
 - Vehicle type
 - Altitude for aircraft
- Approach is designed for ordered traffic, *not* random movements!

Approach

- Density map shows *where* the trajectories lie
 - Like a high-resolution heatmap, simple lightness encoding
 - High-level overview of the paths taken



Approach

- Animated particle flow shows direction
 - Low clutter (unlike glyphs, arrows)
 - Leaves a wide range of visual channels for other uses

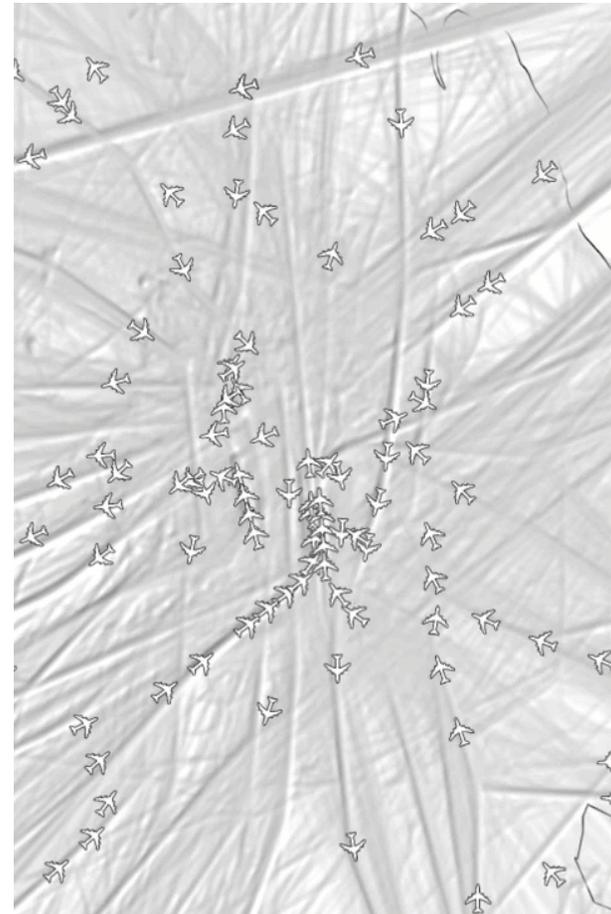
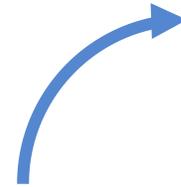
Approach

- Important to realise the particles are *not* marking individual vehicles
- They are a visual aid to show direction of flow
- Not part of the data: vis layer added by the application
- Uses some form of edge bundling (may be optional) on trajectories



Alternatives

- Animated textures
 - Doesn't work for thin trajectories
- Color maps
 - Low resolution, can't overlap
- Arrows/Glyphs
 - Cluttered; obscure the view
- Could just show the vehicle locations?
 - Terrible for identifying distinct trajectories



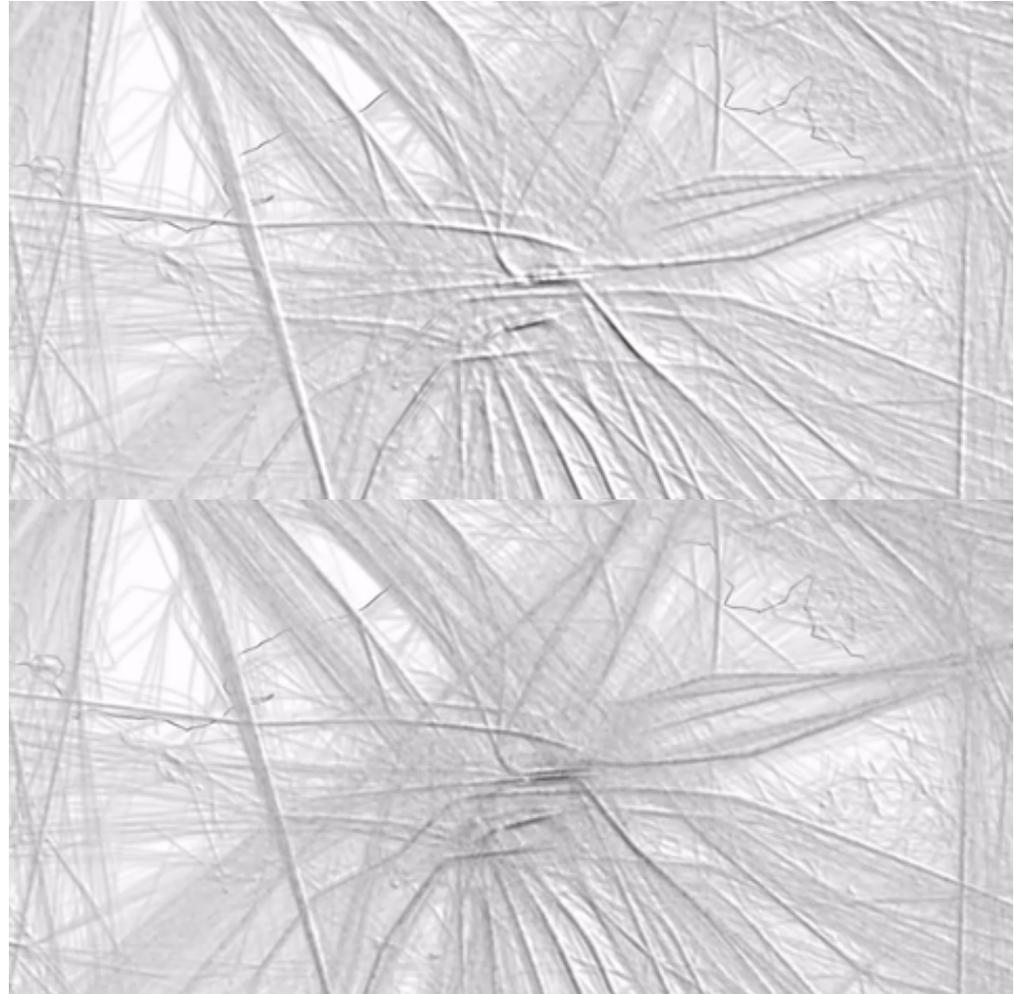
Particle Display Method

Incorporated to density map

- Hard to combine with color
- Imprecise

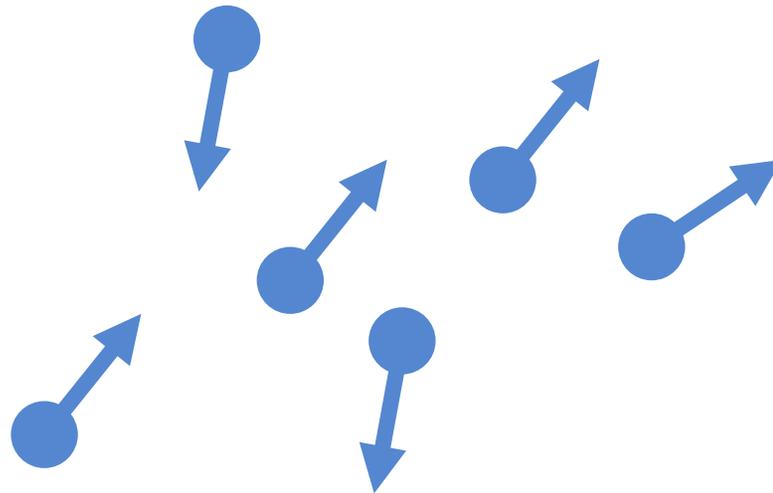
Gaussian Bells

- Alpha-blended on top of map
- Easy to color
- High visibility



Particle Flow - Pros

- Can resolve opposing directions
- Low clutter
- Intuitive; motion encodes motion
- Low-priority channel – color channels remain free



Particle Flow - Cons

- (Very) high overhead
- Requires guaranteed performance
- Real-time rendering at high resolution and framerate
- Thousands or millions of particles with constant turnover

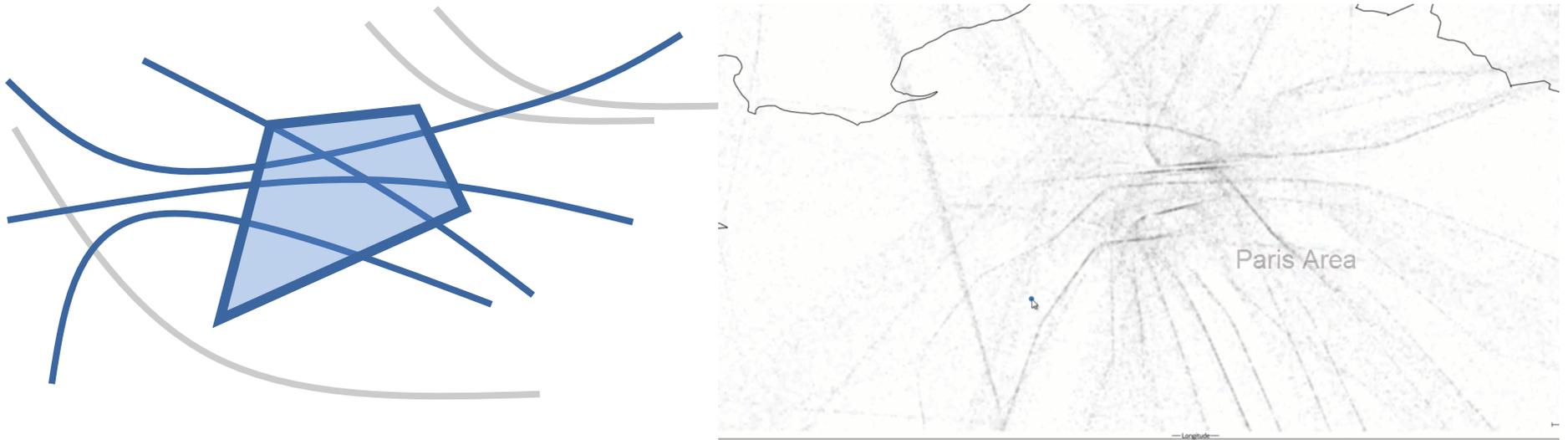
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*Challenging – but not intractable

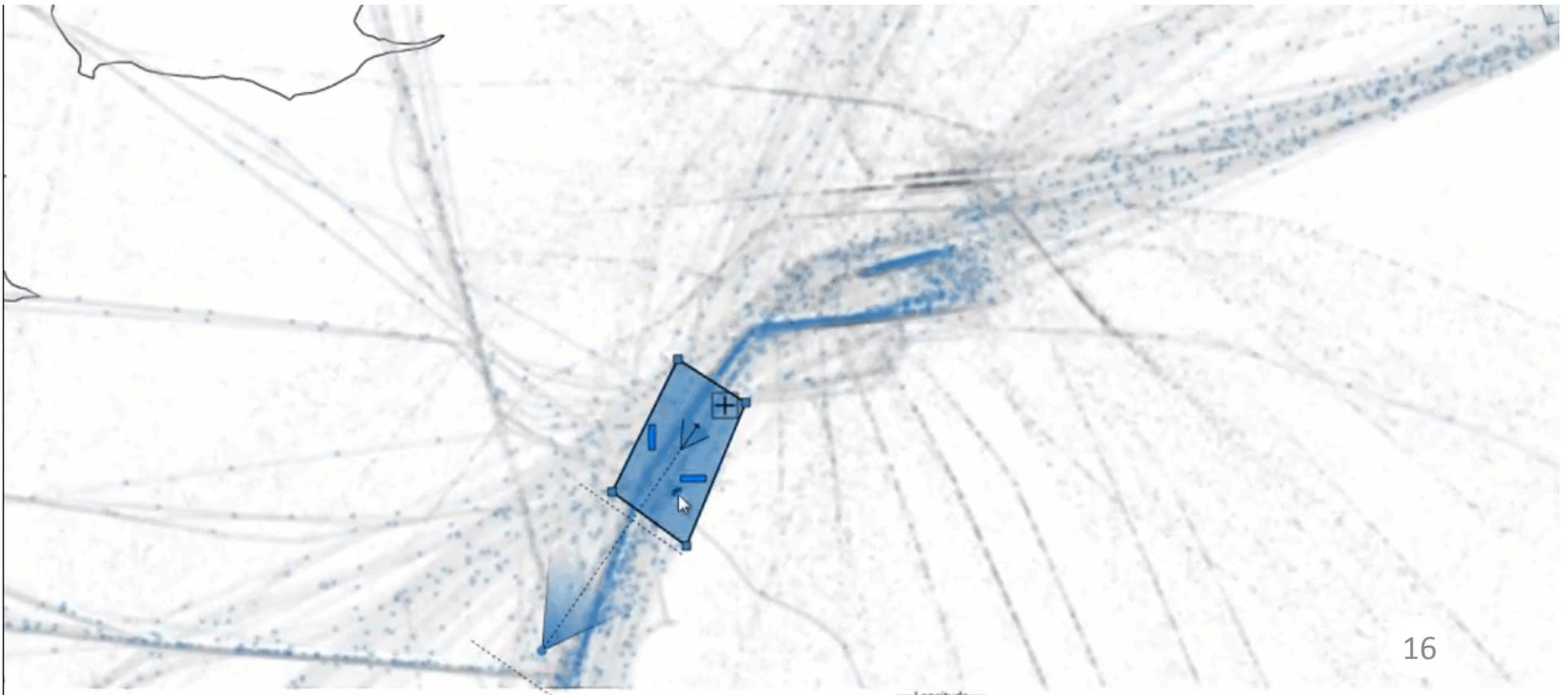
Selection/Filtering

- Both representations respond to selection
- This is how the user explores the data
- Selections are localized and filter all paths passing through them:



Selection/Filtering

- Selections are also *directional*
- The user picks a direction range to filter – paths which match the range within the selection area are selected



- Selections can be refined in other dimensions
- Here, the user filters by altitude:



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Selection/Filtering

- Different modes of selection can be combined
- Compound selections use set-like logic:

$$S = \oplus S_i \setminus UR_i$$

- Where \oplus can be either \cup or \cap (union or intersection), and \setminus is set subtraction
- Extremely powerful
- User can add, intersect, and subtract (inverse) selections

Selection/Filtering

Summary:

- Polygonal selection areas
 - Selects trajectories passing through area
- Select for heading/altitude ranges
 - Custom selection widget
- Powerful compound selections
- User can enable/disable specific selections
- Can hide the unselected trajectories
- Parametric – selections can be modified at any time

Examination

- Detail windows can be displayed on-demand for any selection

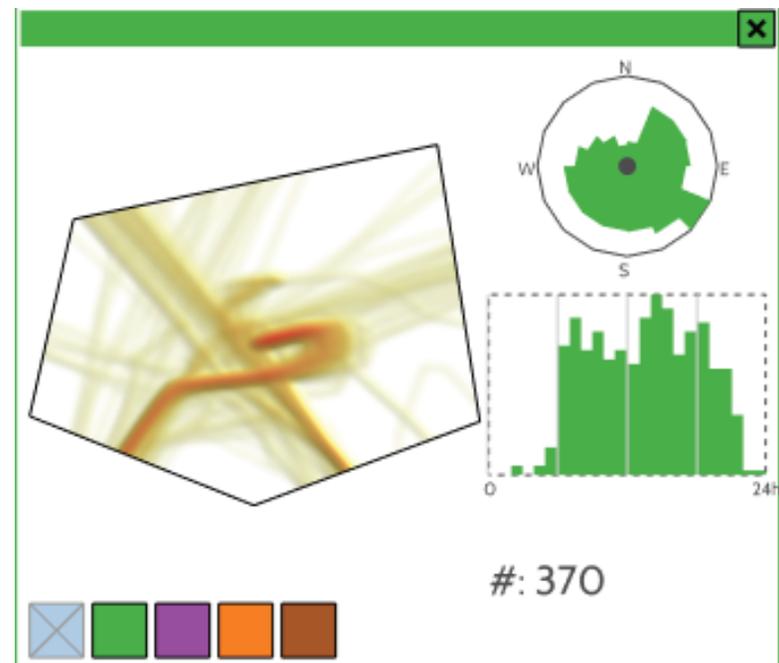
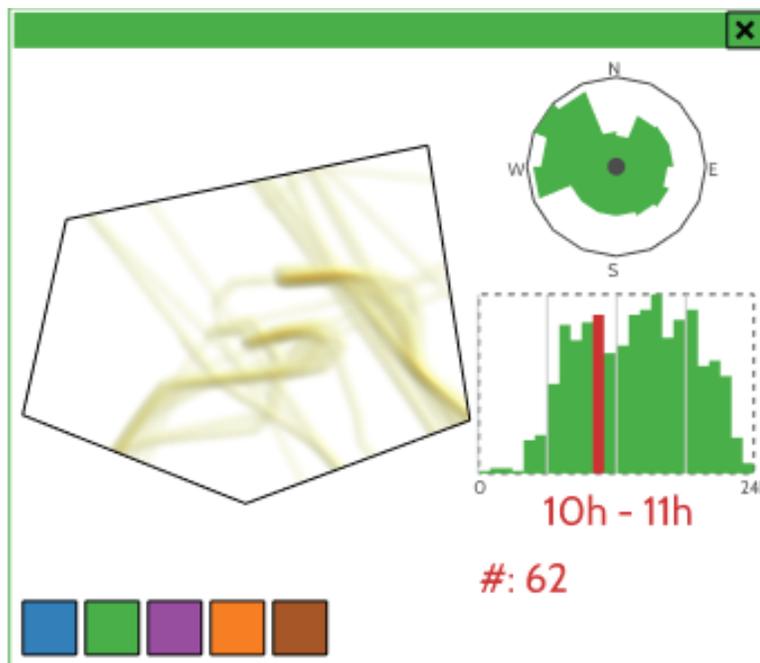
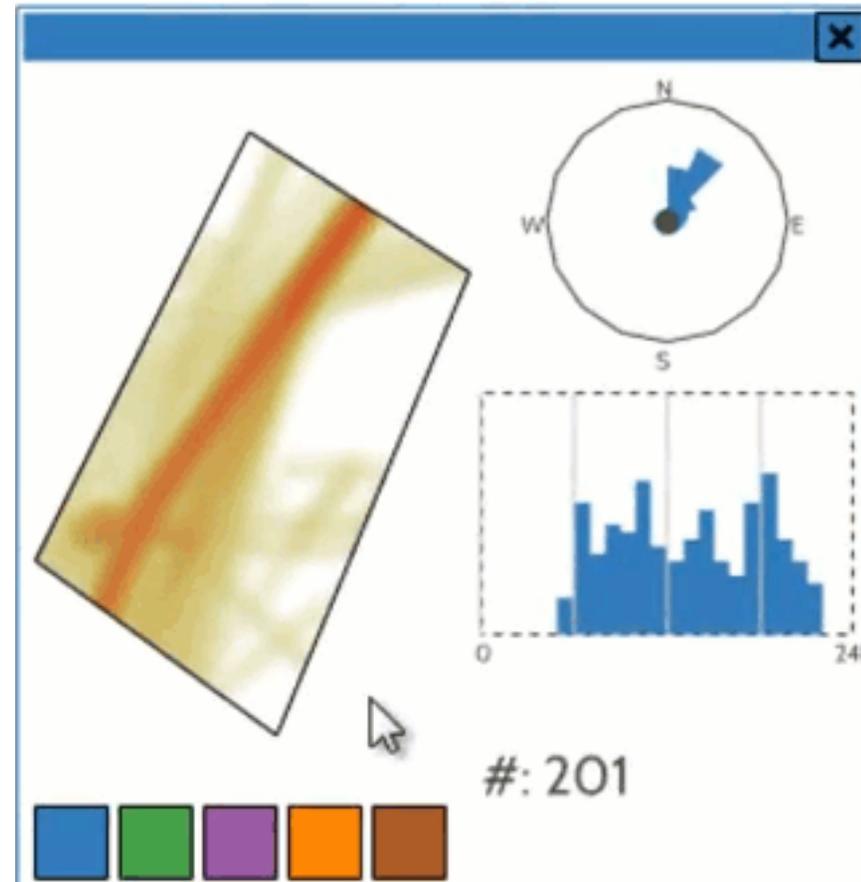


Fig. 6 (page 6)

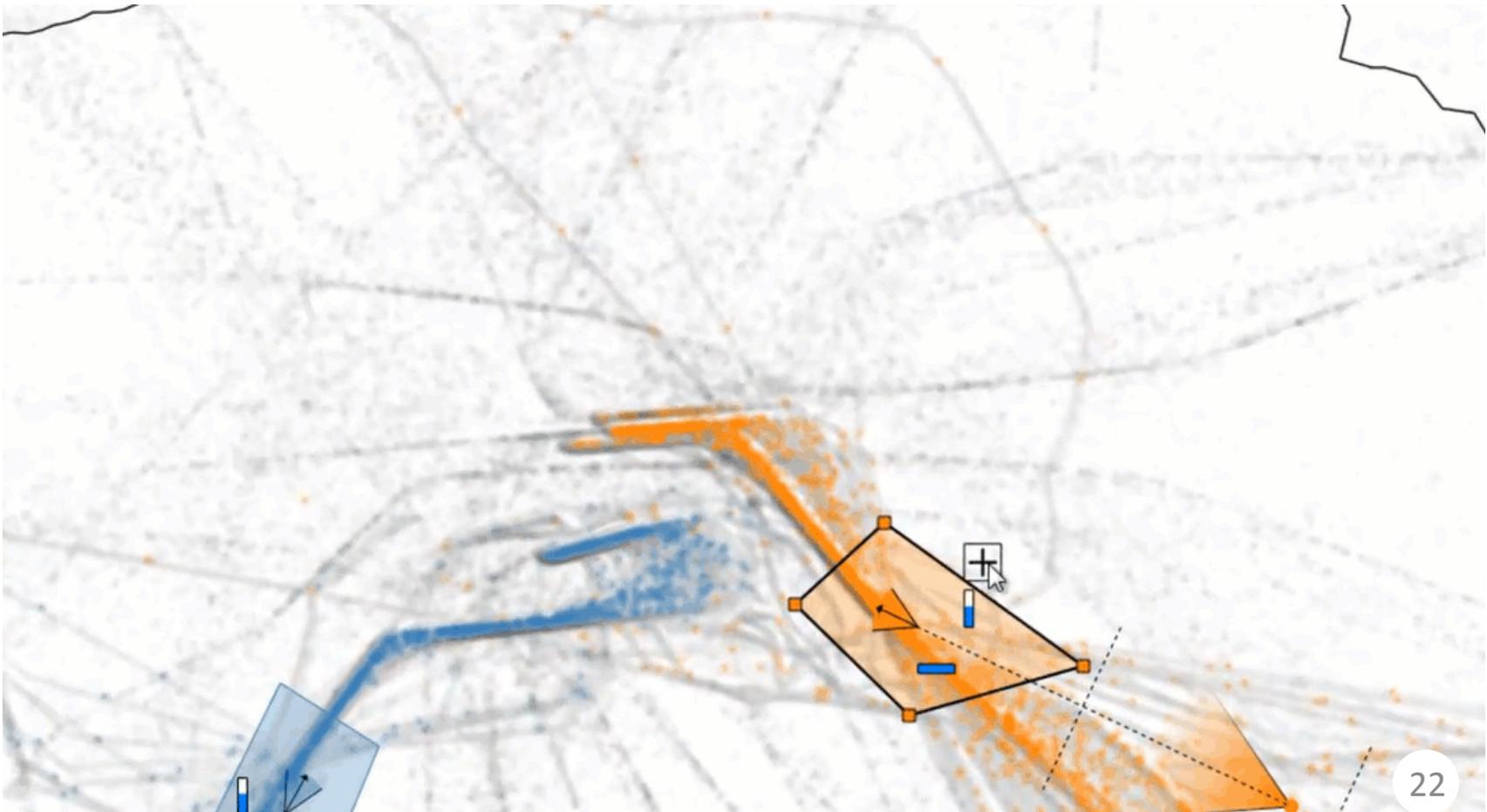
Examination

- Zoomed view of selection area
- Histogram of trajectories over time
- Polar area histogram of directions
- All sub-plots are linked
- Pickable selection color



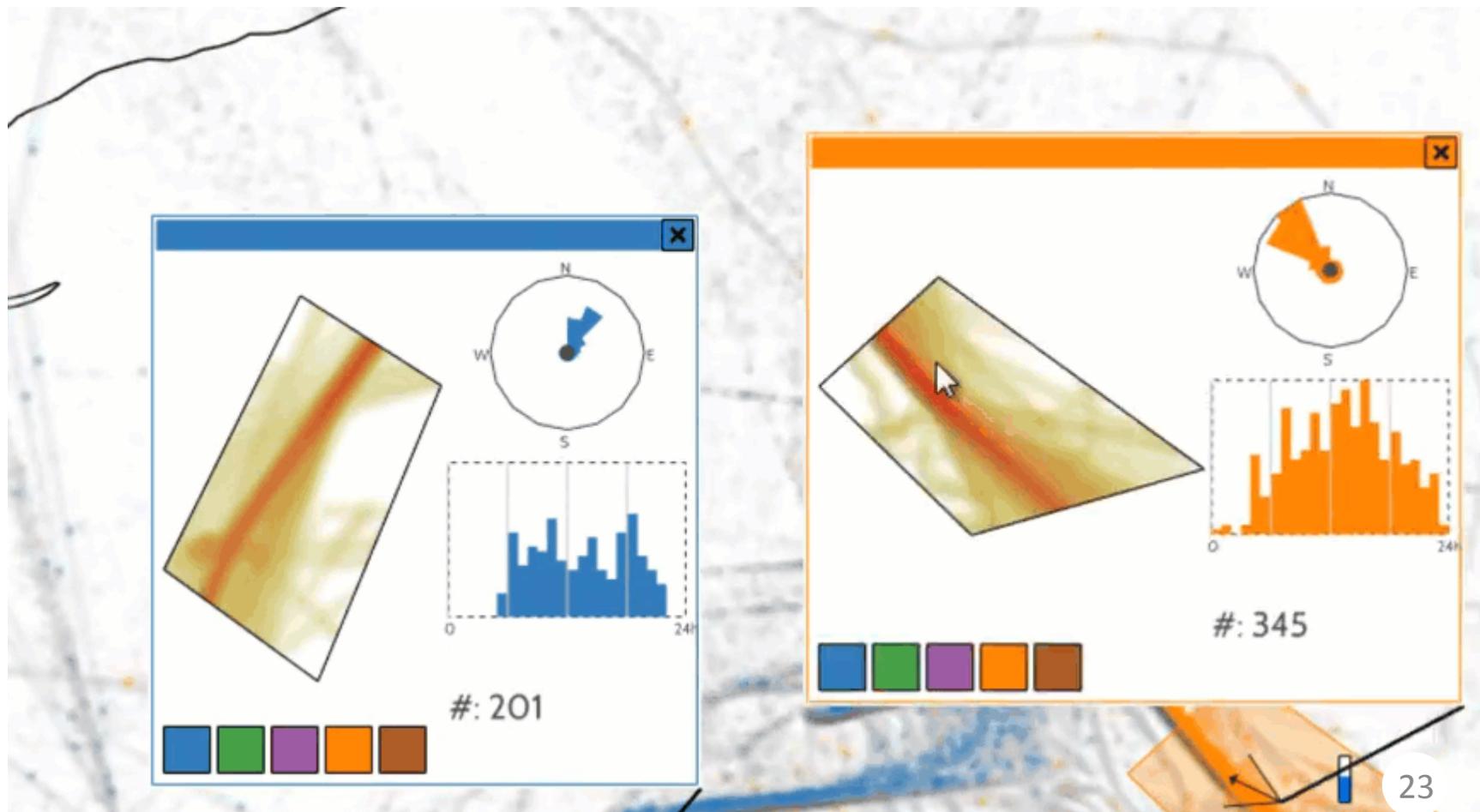
Comparison

- Different windows are also linked



Comparison

- Windows can be combined for more direct comparison



Use-Case: Infographics

- Multiple selections create a faceted view suitable for infographics
- Here a static view contains all the information needed

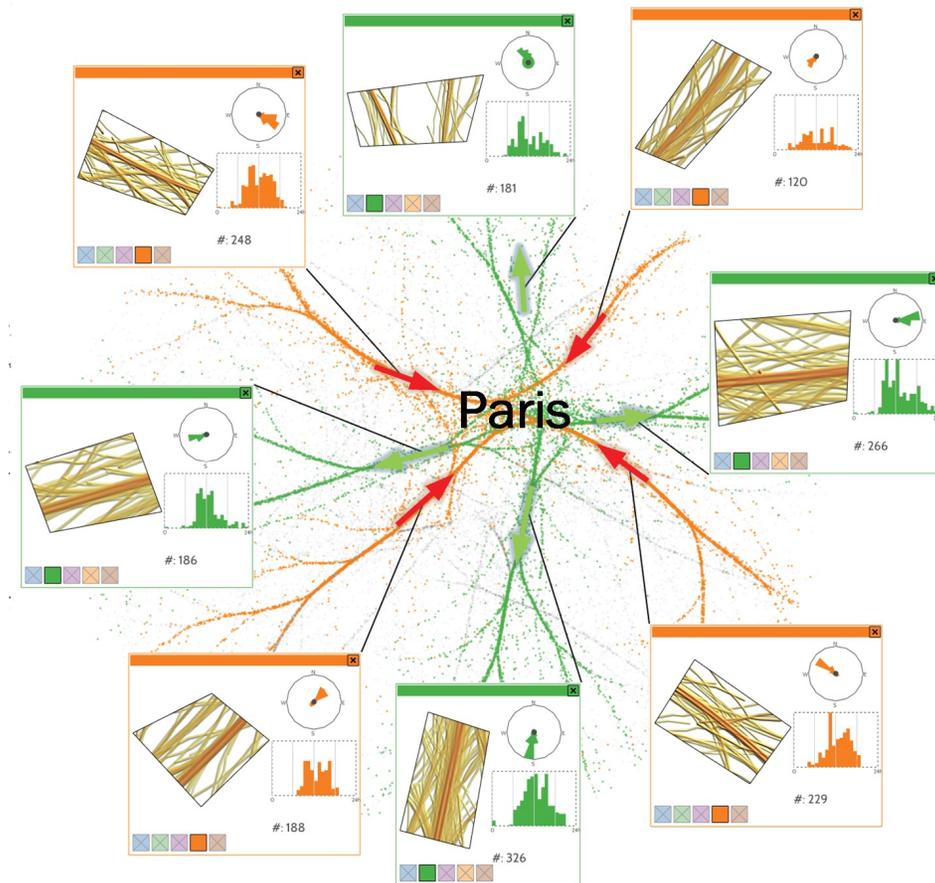


Fig. 10 (page 8)

Use-Case: Infographics

- Boat traffic on the Dutch coast
- Antwerp (bottom) histogram shows wave pattern – tides coming in and out!

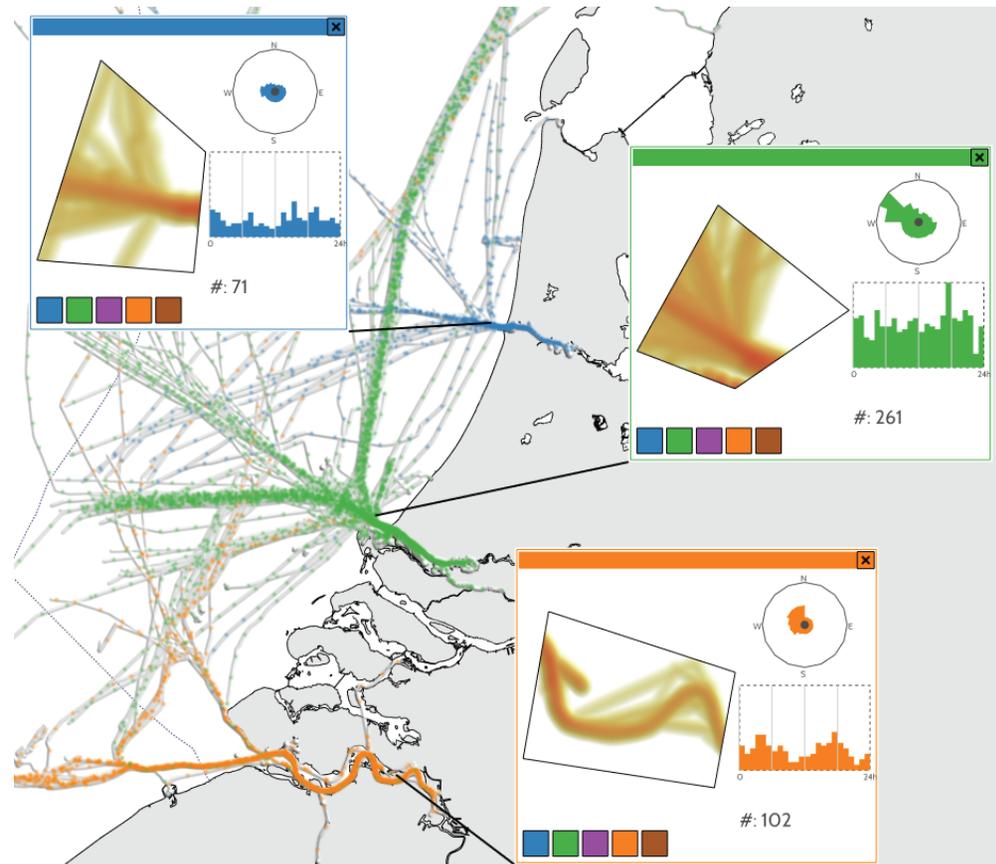


Fig. 11 (page 9)

Use-Case: Air Traffic

- Flights in and out of Charles de Gaulle airport
- Take-off in blue
- Landing in green
- Part of evaluation with 2 professional flight controllers

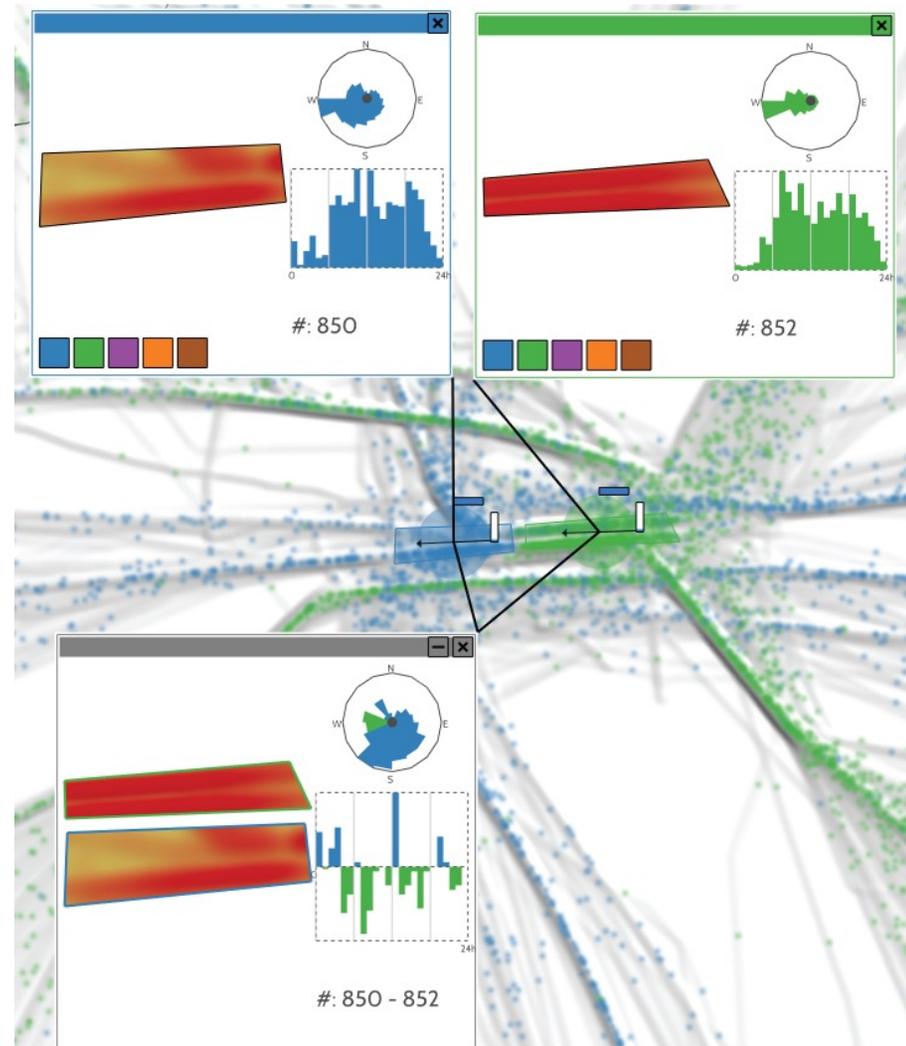
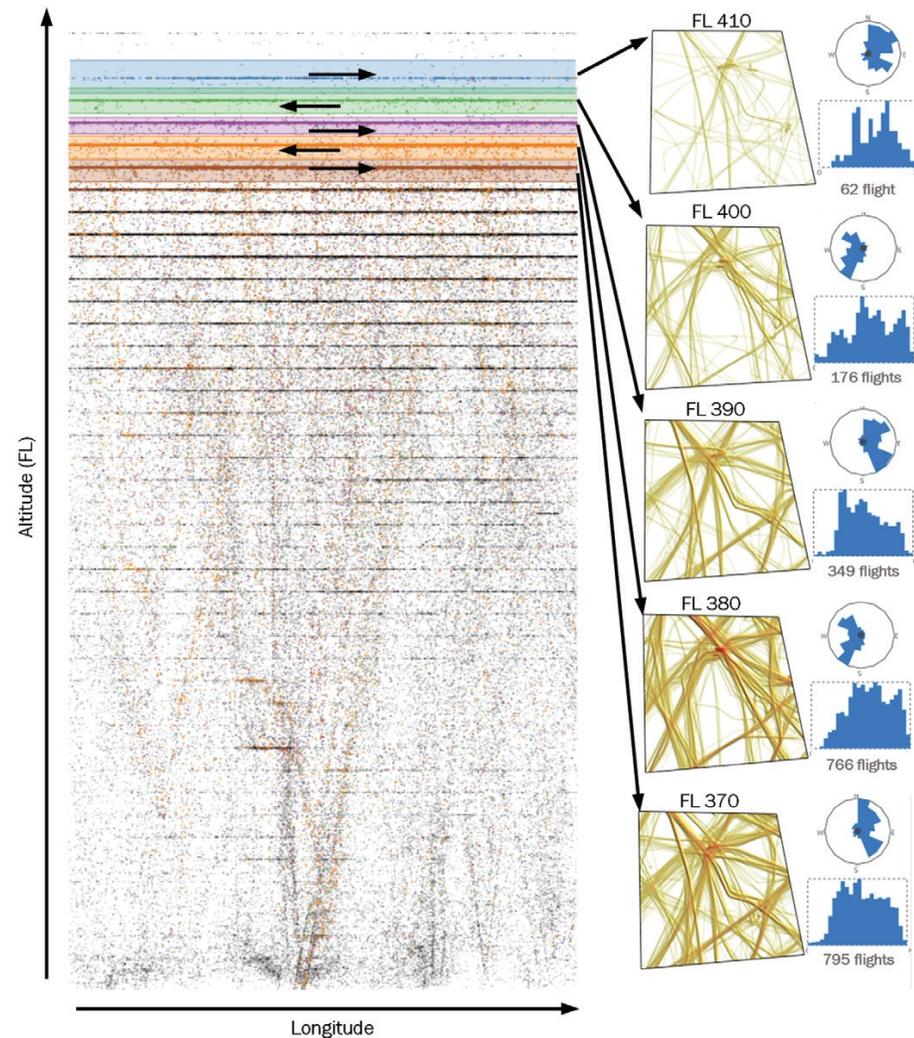


Fig. 9 (page 8)

Use-Case: Air Traffic

- Same view rotated to show altitude
- Alternating incoming/outgoing flows
- Different flows can be selected and compared

Fig. 9 (page 8)



Thanks!
Questions?