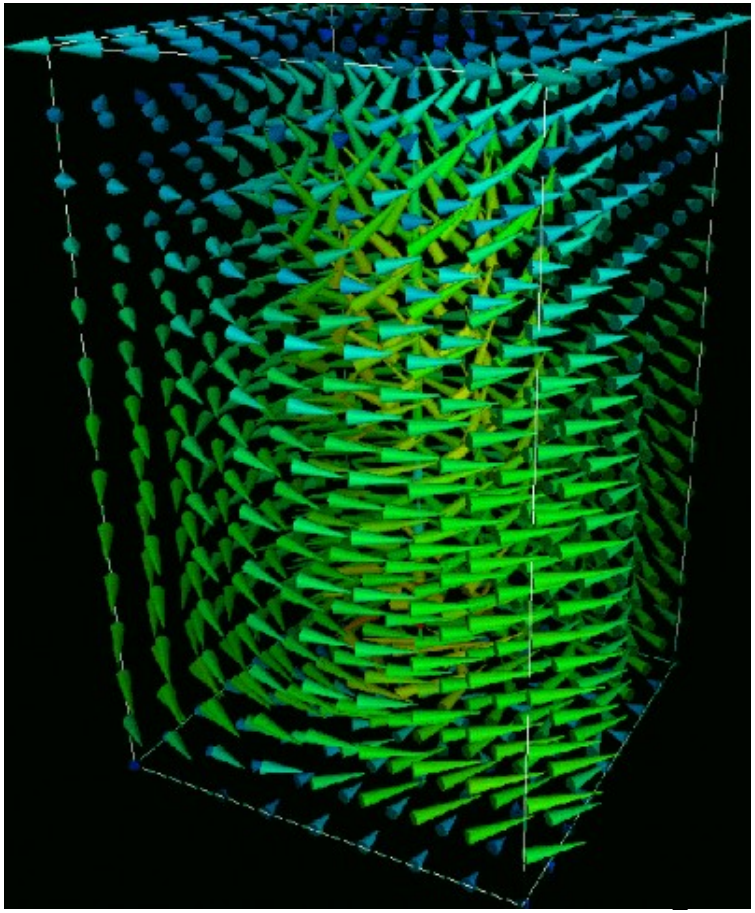
Glyphs and arrows

Thomas Torsney-Weir

What is direct flow visualization?

Direct flow visualization : encode the flow information at each voxel

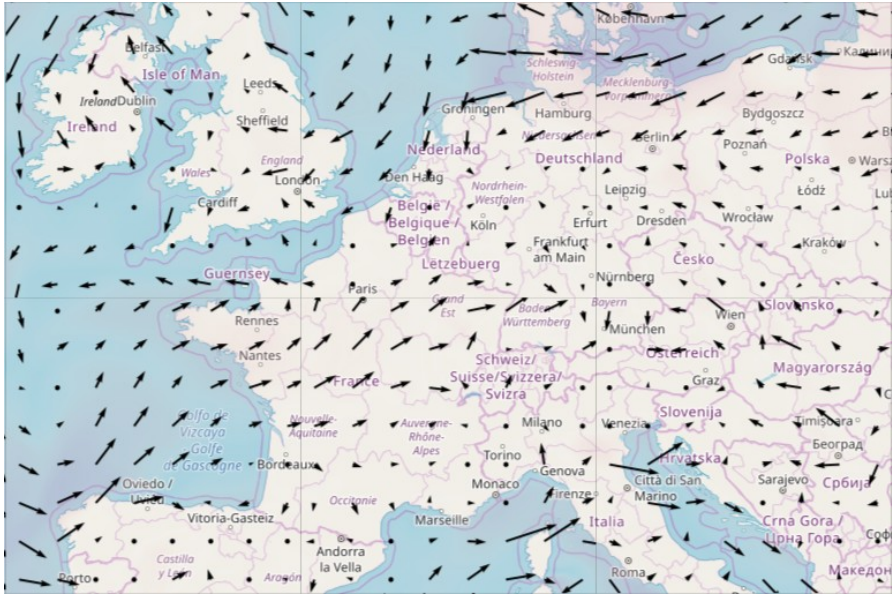
- Techniques: Arrows and glyphs
- Mentally integrate arrows to see flow
- Human as feature detector
- Frequently used



Tasks

Visualizing *local* features of dataset

- Vector itself
- Vorticity
- Addl data: temperature, pressure, etc.



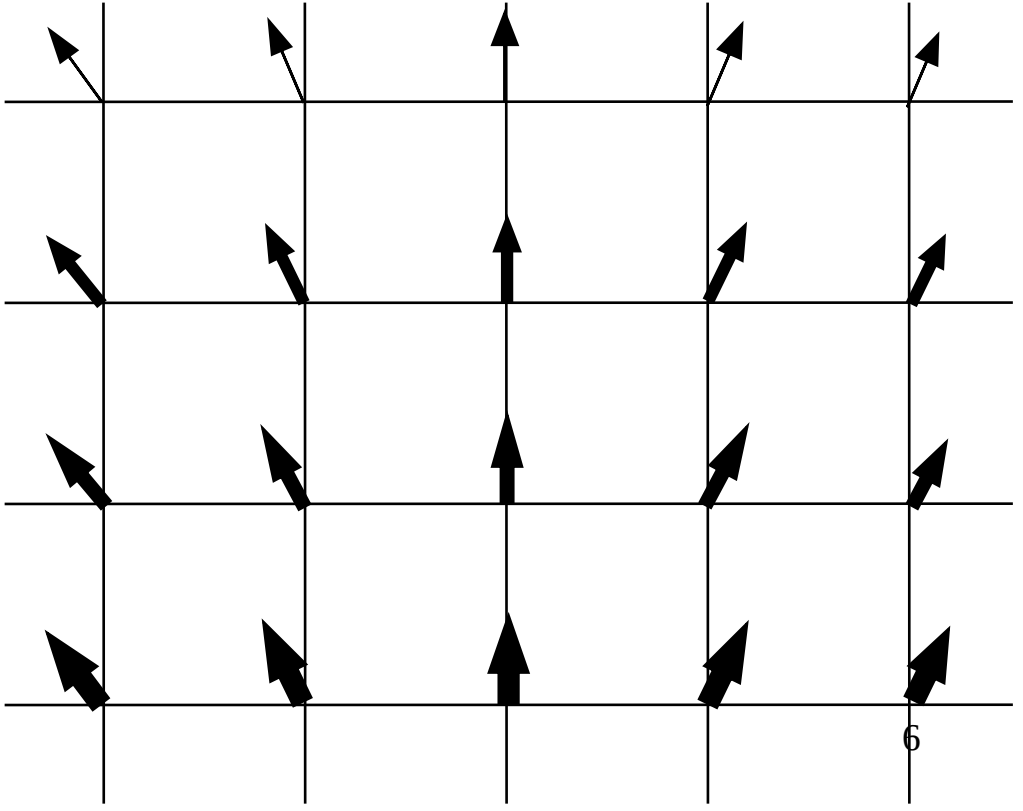
Technique: Arrows

Arrows

- Easy to understand encoding
- 2D: works well
- 3D: numerous issues
- Poor result if magnitude or velocity changes rapidly
- Time component missing

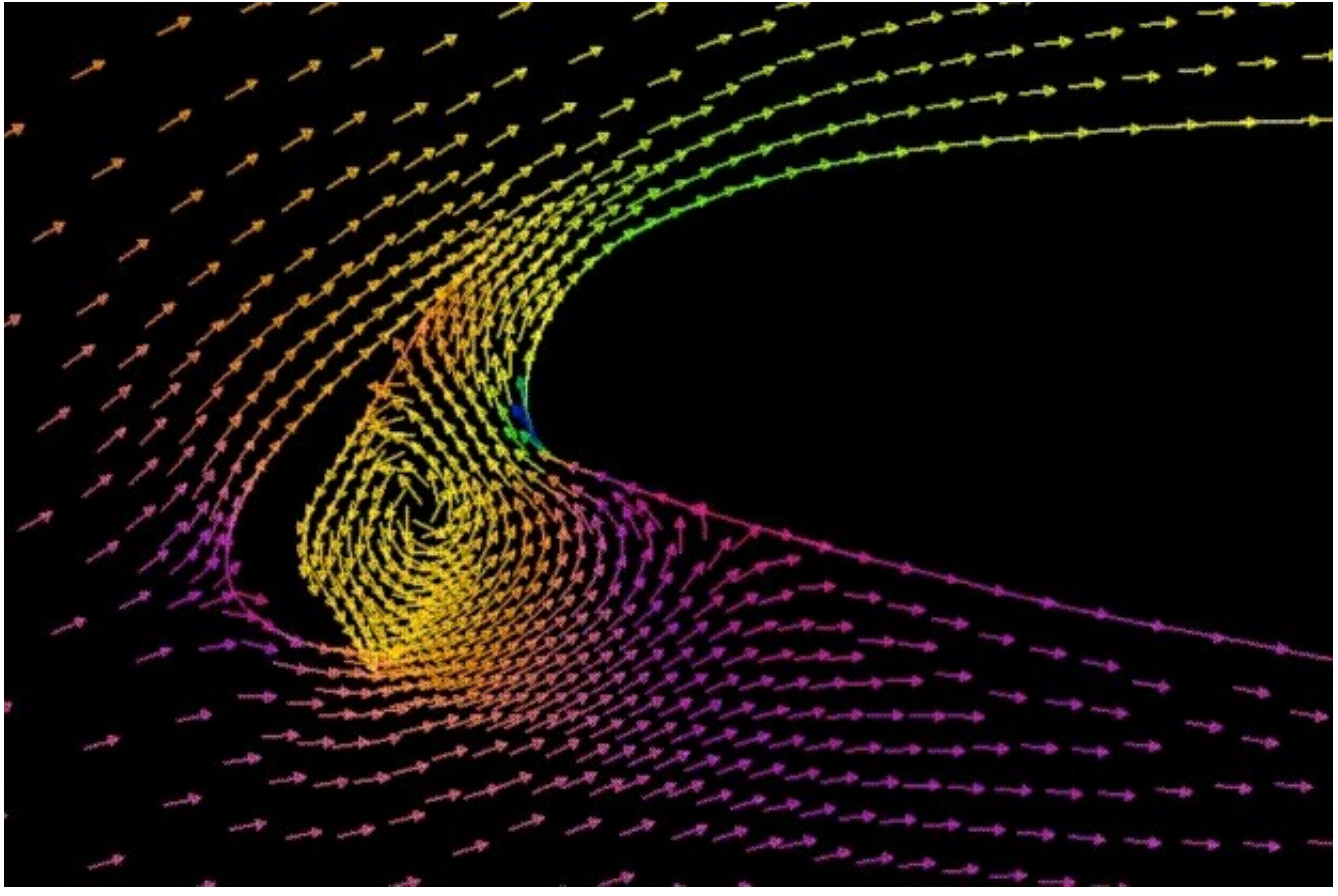
Arrows in 2D

- Very commonly used
- Angle = direction
- Magnitude: length vs color

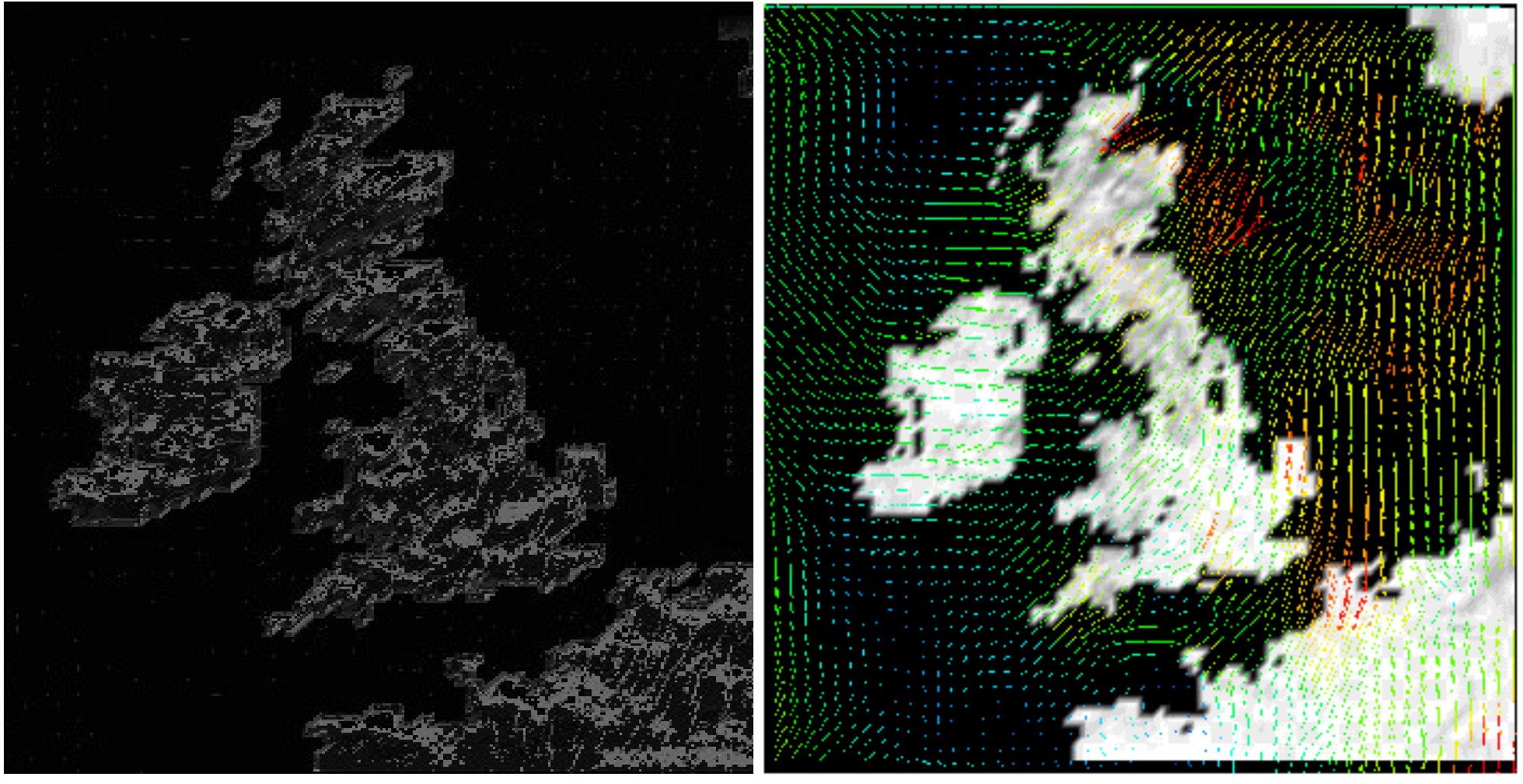


Length occlusion

Arrows can interfere with each other

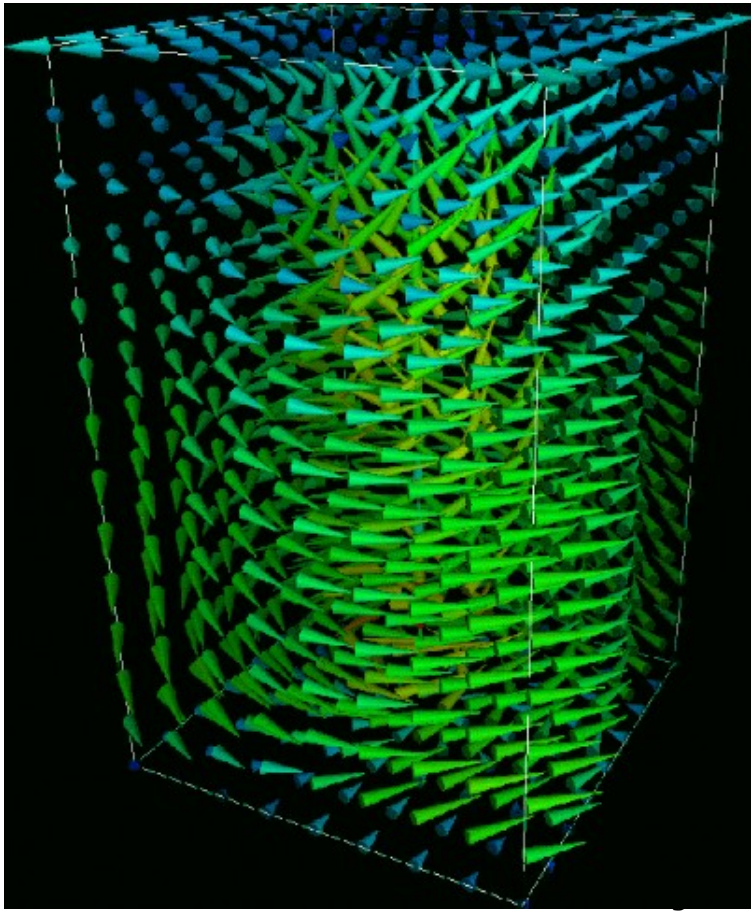


Scaled vs color coded



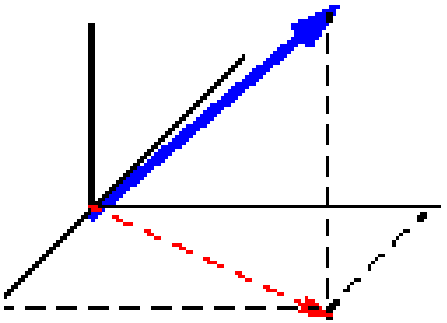
Arrows in 3D

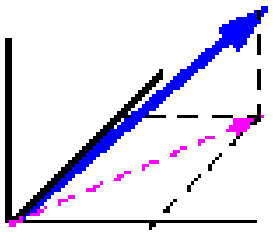
- Issues:
  - Occlusion
  - Perspecive ambiguity
- Solution: show subset

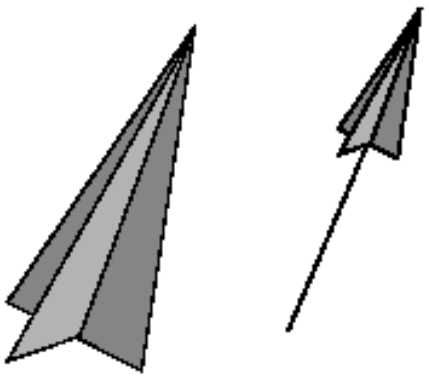


Perspective ambiguity

- Perspective shortening
- 1D objects generally difficult to grasp in 3D
- 3D arrows help slightly

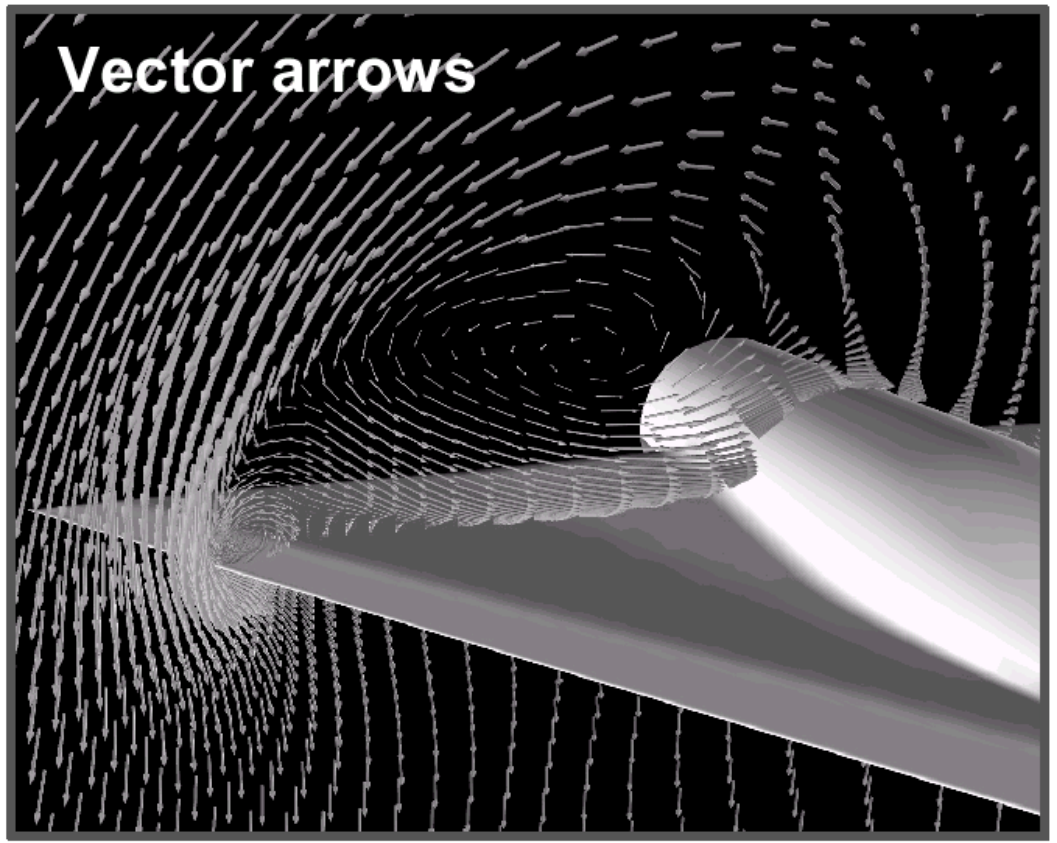


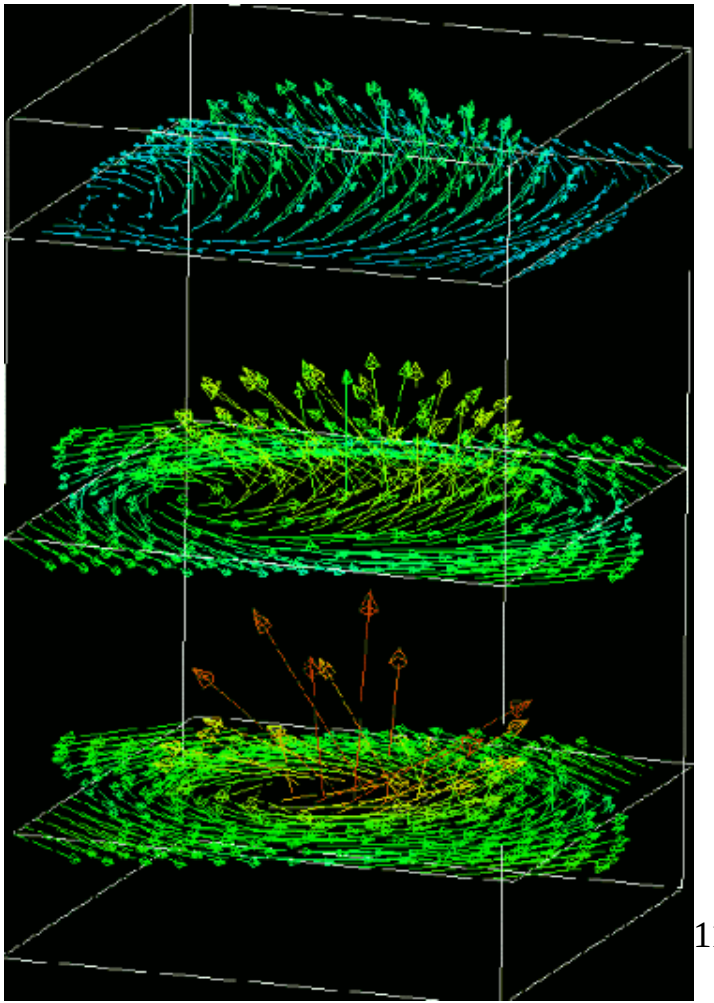




Addressing clutter

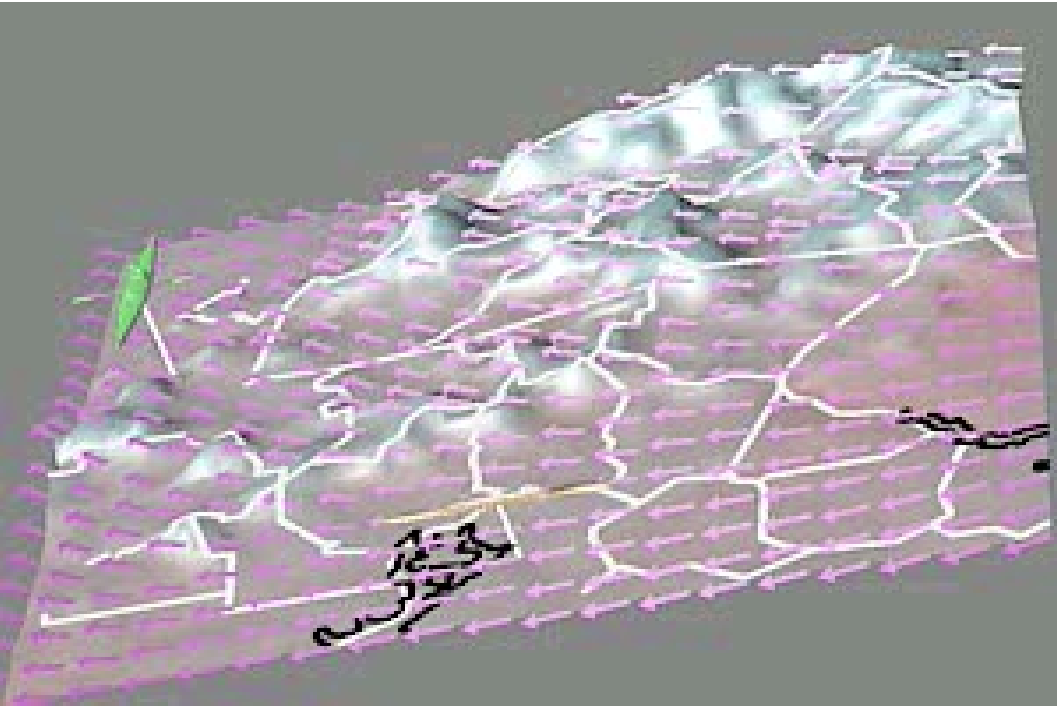
Arrows in layers

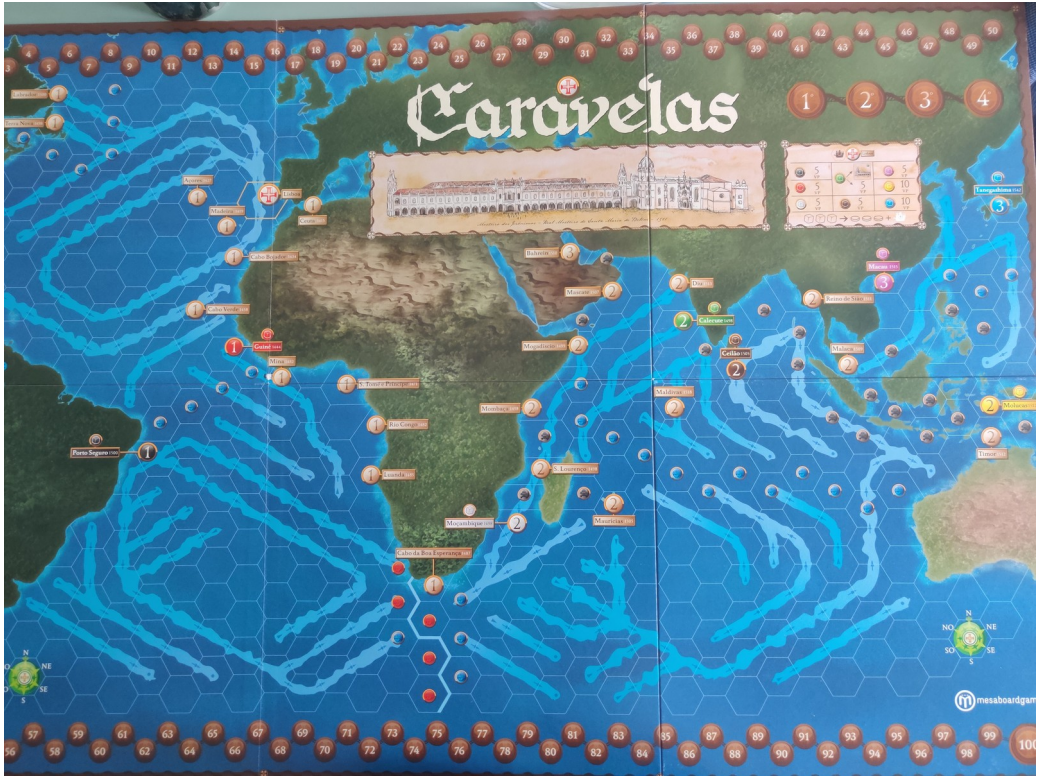




Addressing clutter

Combine with other techniques

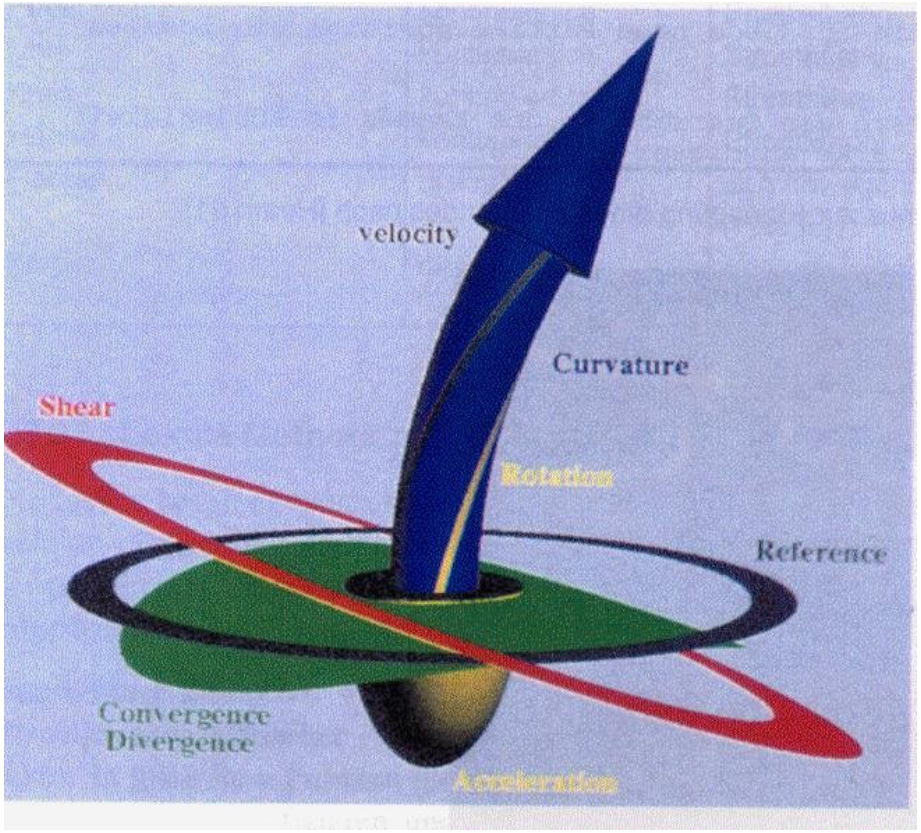




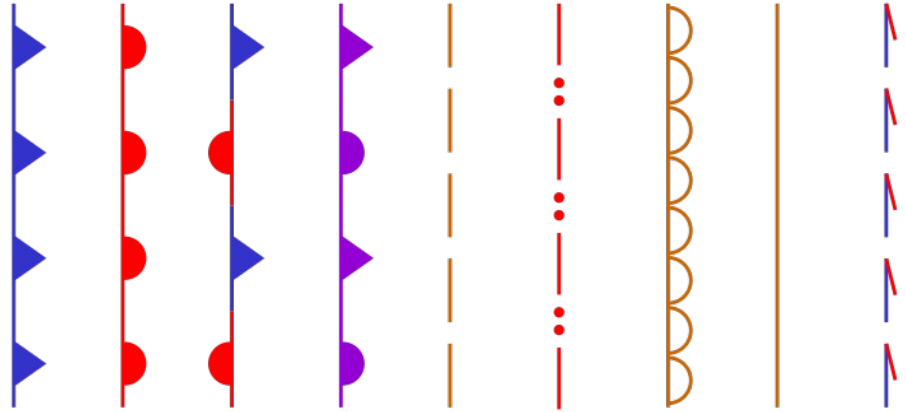
Technique: glyphs

Glyphs

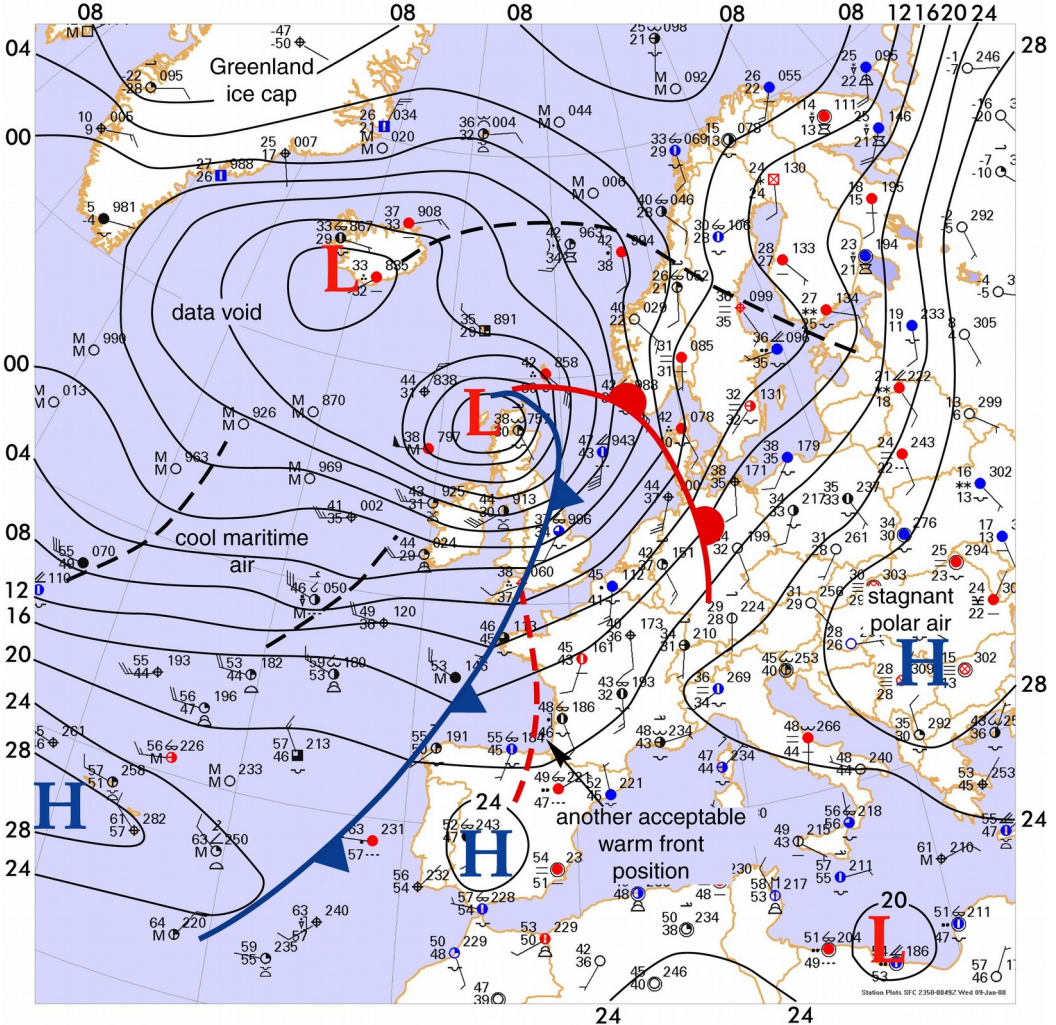
- More information per voxel
- Often modifications of familiar arrow shape
- Addl features:
  - Curvature
  - Rotation
  - Shear
  - Divergence
  - Acceleration
  - etc



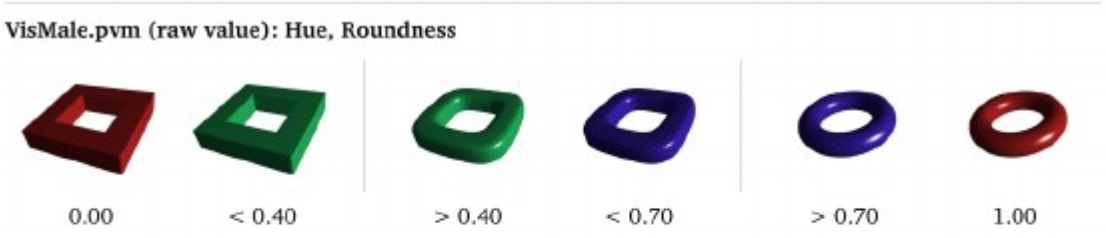
Weather maps

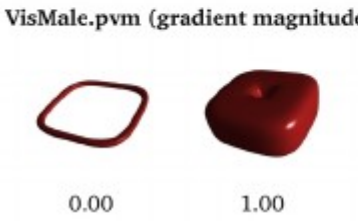


1) cold front
2) warm front
3) stationary front
4) occluded front
5) surface trough
6) squall line
7) dry line
8) tropical wave
9) trowal



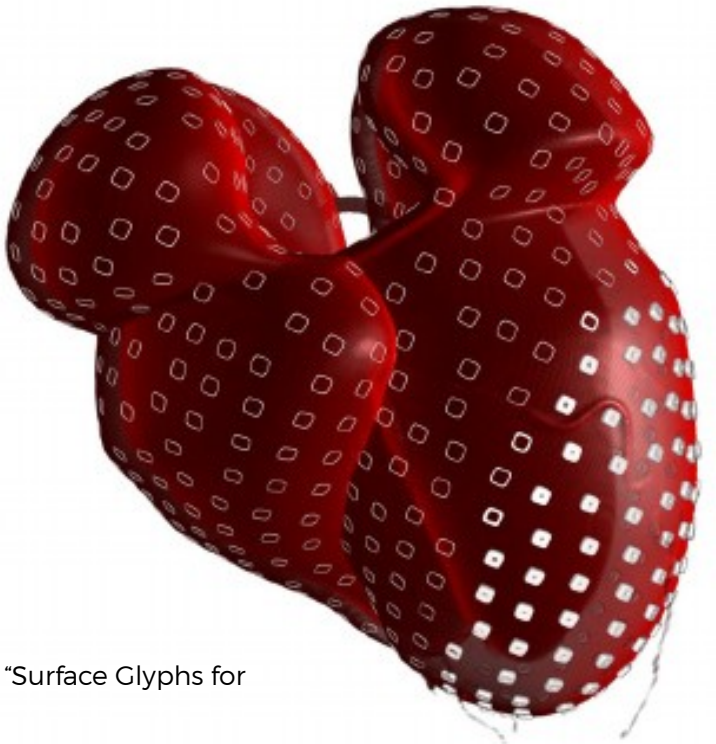
Medical applications





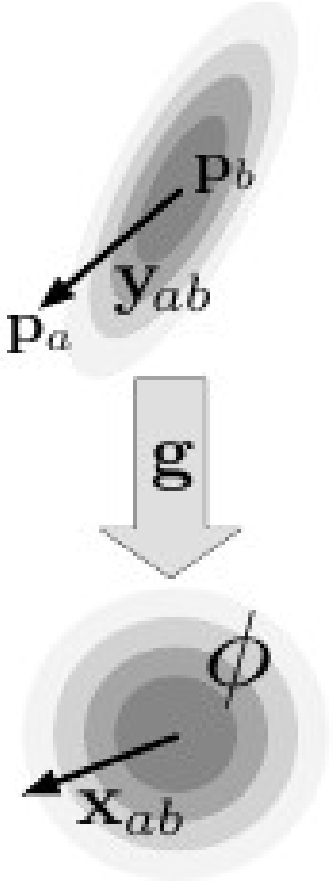
Thickness = gradient magnitude

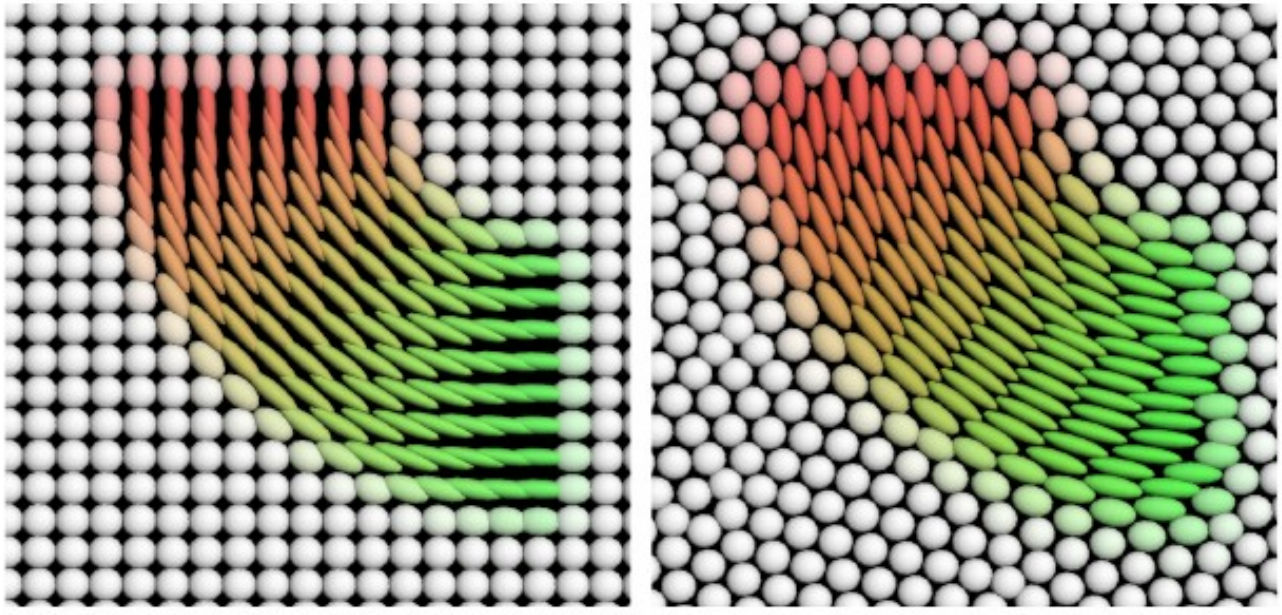
Hue = value



Ropinski, Timo, Michael Specht, Jennis Meyer-Spradow, Klaus Hinrichs, and Bernhard Preim. “Surface Glyphs for Visualizing Multimodal Volume Data,” 3--12, 2007.

Physics

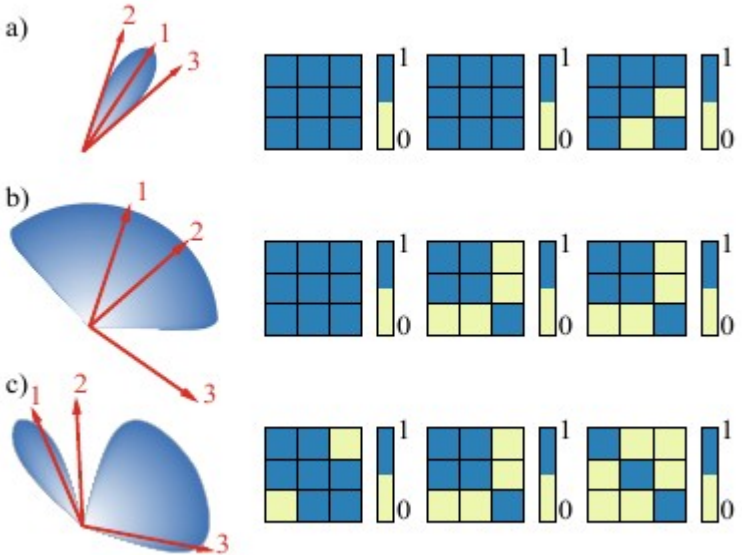




(a) Regular Grid (b) Glyph Packing

Kindlmann, Gordon, and Carl-fredrik Westin. “Diffusion Tensor Visualization with Glyph Packing.” IEEE Transactions on Visualization and Computer Graphics 12, no. 5 (September 2006): 1329–36. https://doi.org/10.1109/TVCG.2006.134.

Flow ensembles



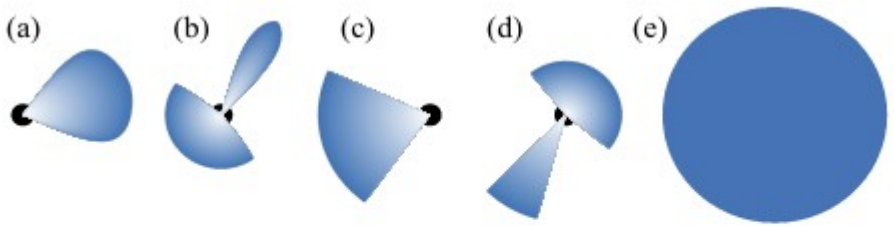
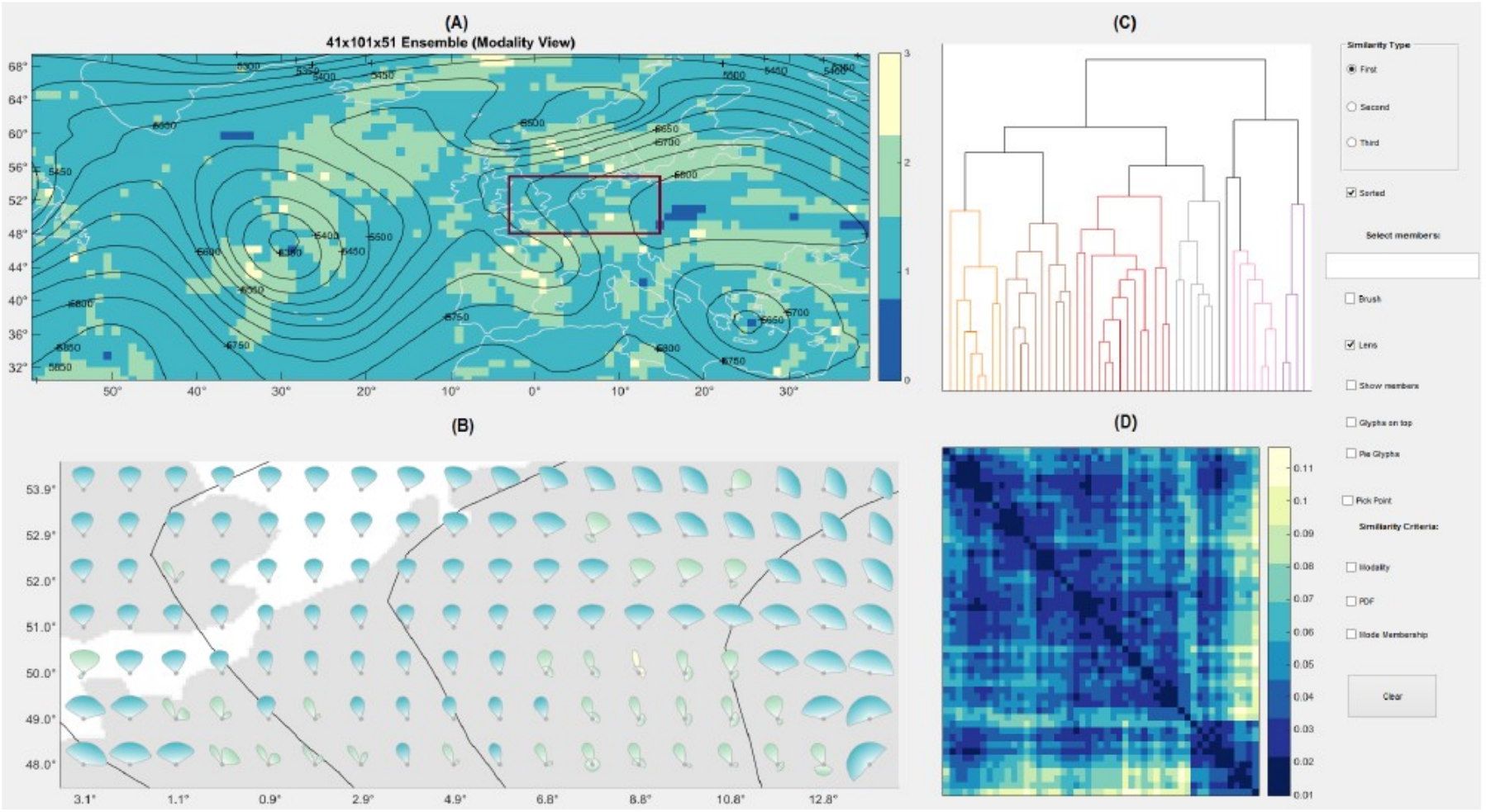


Figure 3: Glyphs for various directional distributions: lobular glyphs showing (a) unimodal pdf, medium variation and (b) bimodal pdf, main mode (low variation), second mode (high variation), and (c)-(d) corresponding pie glyphs; (e) uniform pdf.

Jarema, Mihaela, Ismail Demir, Johannes Kehrer, and Rüdiger Westermann. "Comparative Visual Analysis of Vector Field Ensembles." In 2015 IEEE Conference on Visual Analytics Science and Technology (VAST), 81–88, 2015. https://doi.org/10.1109/VAST.2015.7347634.

Flow ensembles



Conclusion

Summary

- **Direct flow visualization** : encode the flow information at each voxel
- Arrows in 2D: simple and effective
- Arrows in 3D: need to handle occulsion
- Glyphs:

Acknowledgements

- Robert S. Laramee
- Torsten Möller
- Bruno Jobard
- Malte Zöckler
- Georg Fischel
- Frits H. Post
- Roger Crawfis
- Helwig Hauser

Additional reading

- B. Jobard & W. Lefer: “Creating Evenly-Spaced Streamlines of Arbitrary Density” in Proceedings of 8th Eurographics Workshop on Visualization in Scientific Computing, April 1997, pp. 45-55
- Data Visualization: Principles and Practice, Chapter 6: Vector Visualization by A. Telea, AK Peters 2008
- Ropinski, Timo, Michael Specht, Jennis Meyer-Spradow, Klaus Hinrichs, and Bernhard Preim. “Surface Glyphs for Visualizing Multimodal Volume Data,” 3--12, 2007.
- Kindlmann, Gordon, and Carl-fredrik Westin. “Diffusion Tensor Visualization with Glyph Packing.” IEEE Transactions on Visualization and Computer Graphics 12, no. 5 (September 2006): 1329–36. https://doi.org/10.1109/TVCG.2006.134.
- Jarema, Mihaela, Ismail Demir, Johannes Kehrer, and Rüdiger Westermann. “Comparative Visual Analysis of Vector Field Ensembles.” In 2015 IEEE Conference on Visual Analytics Science and Technology (VAST), 81–88, 2015. https://doi.org/10.1109/VAST.2015.7347634.