Techniques for analyzing model output

Topics

- Graphical display and interpretation
- Calculation of derived variables
- Mathematical processing

- This subject is important because it is only through effective analysis of the model output data that a practical benefit can result – and you can get publications.

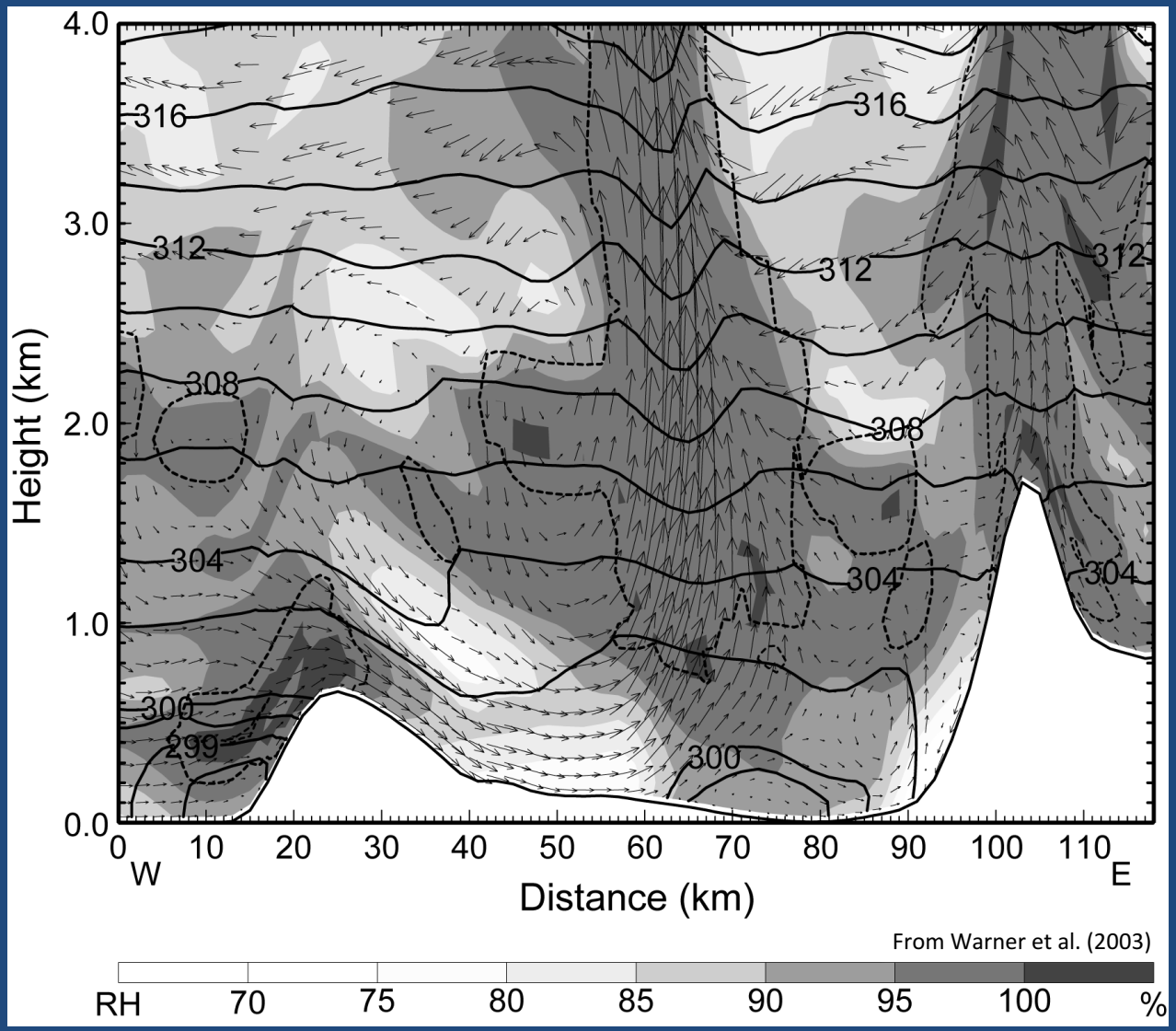
The Eulerian Framework – analysis of grid-point data

- Plan-view maps
- Vertical profiles (soundings)
- Vertical cross-sections
- Meteograms
- Time-height sections
- Hovmöller diagrams

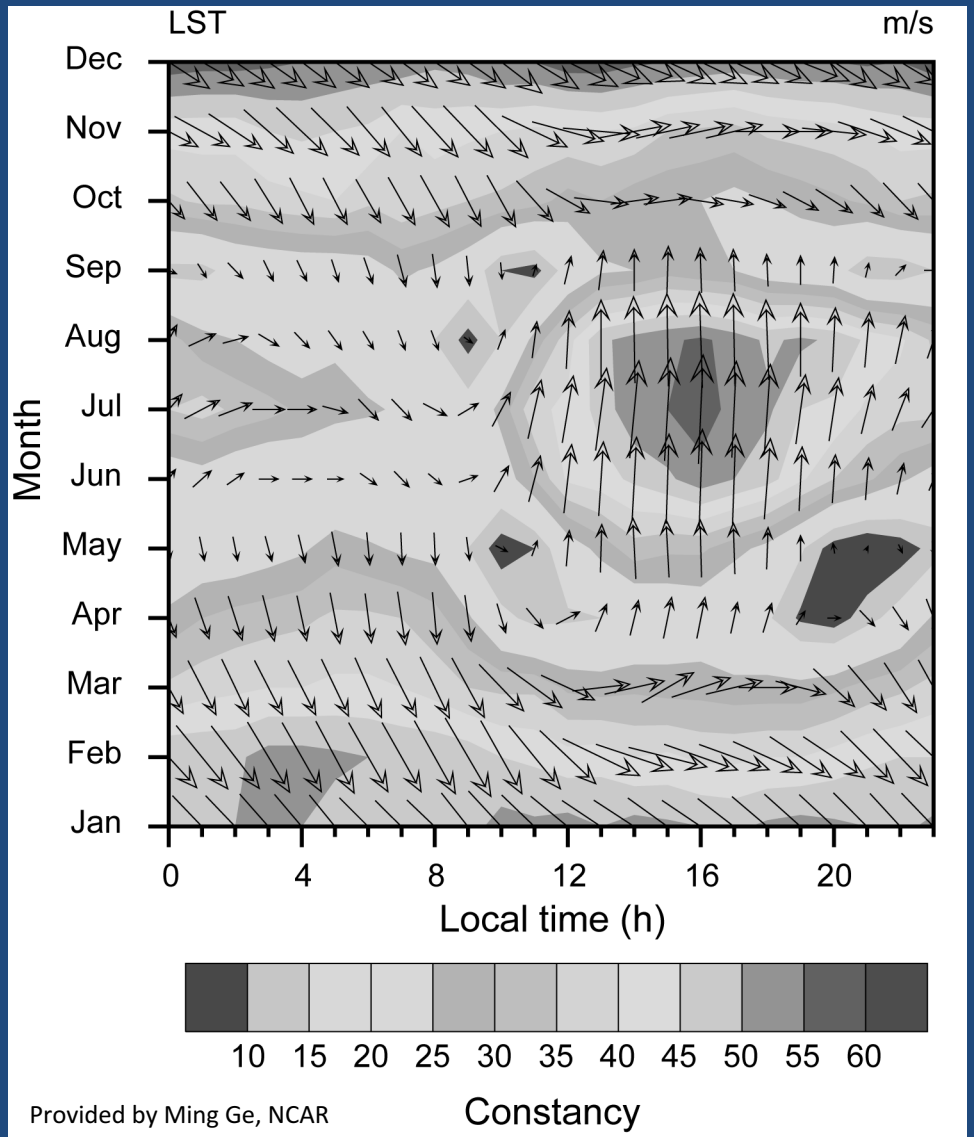
Plan-view maps

- Isobaric maps (constant p)
- Constant-height maps (ASL)
- Constant height maps (AGL)
- Isentropic-surface maps

Example of a cross section (x-z)

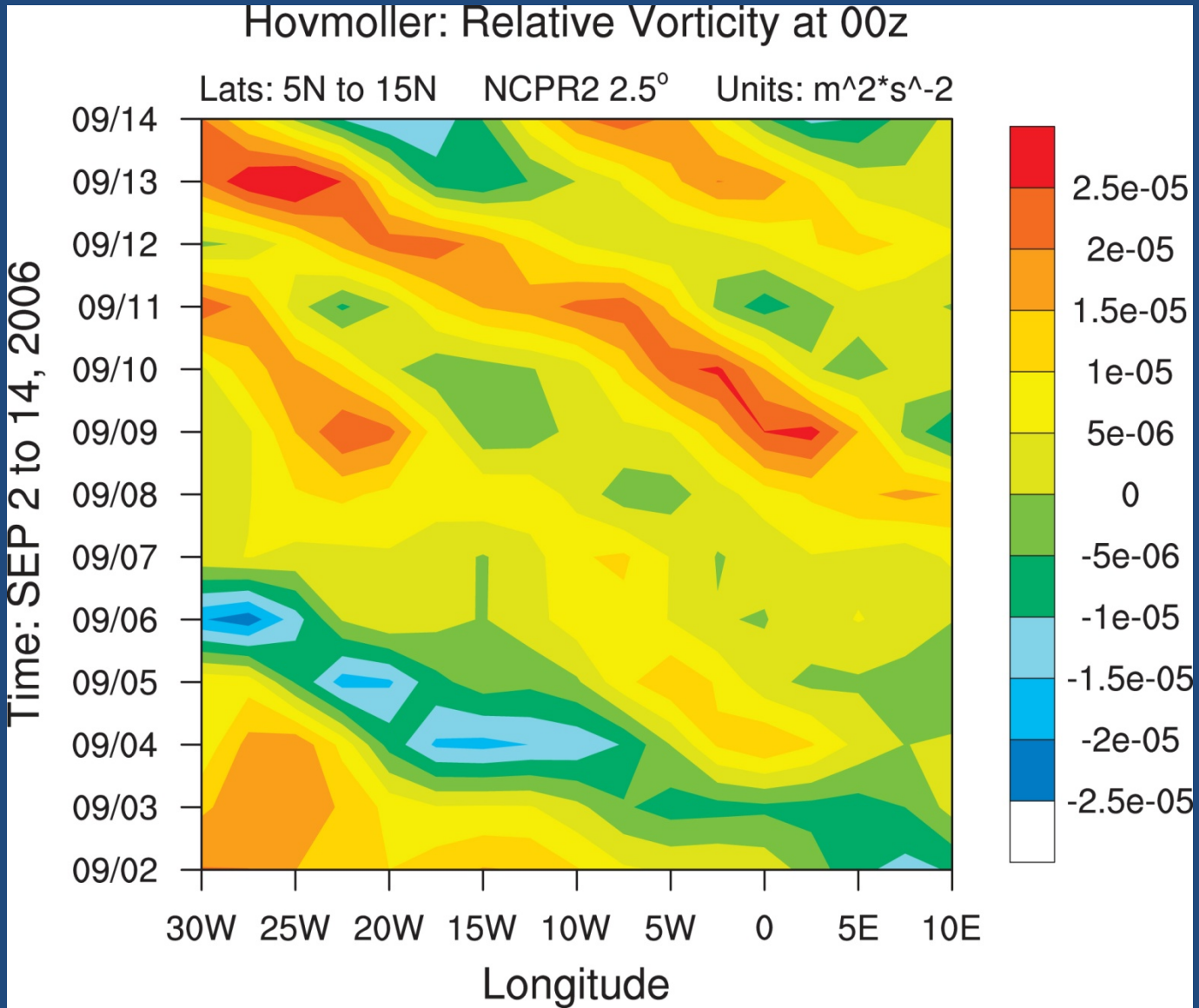


Value of a variable at a point as a function of time of day and time of year



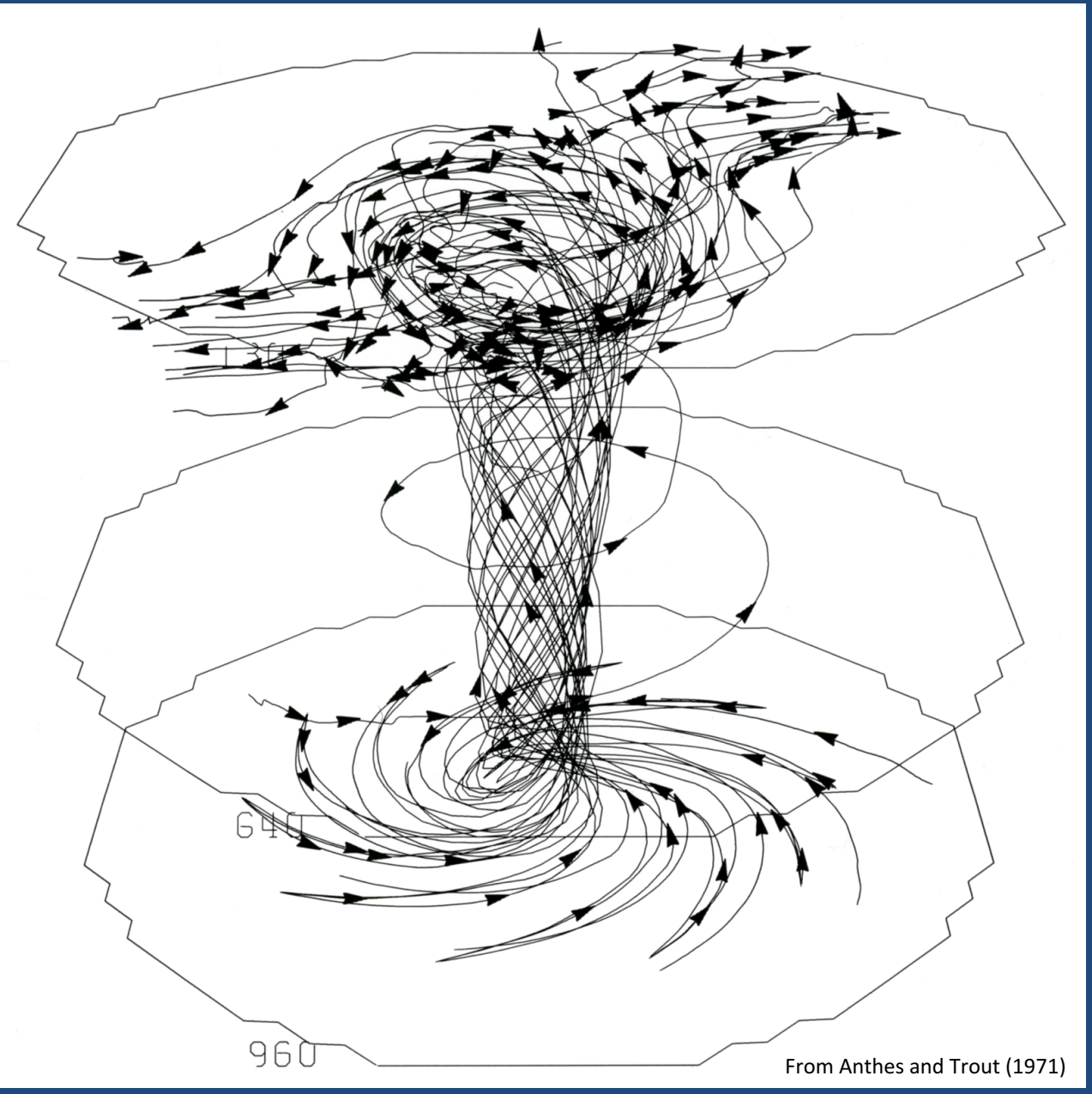
Winds at JFK Airport, NYC

Hovmöller plot



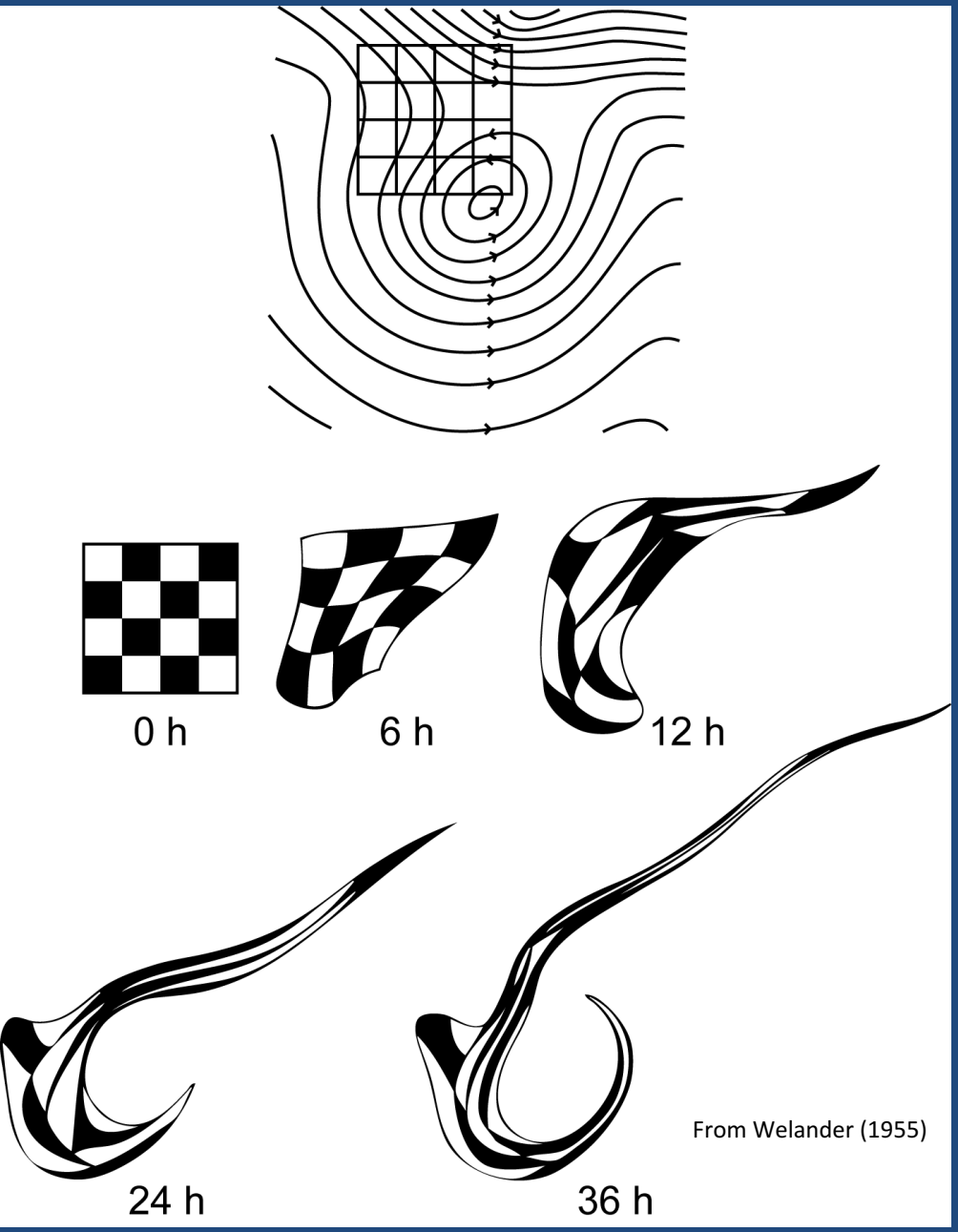
The Lagrangian framework

- Trajectories
- Streamlines
- Isochrones



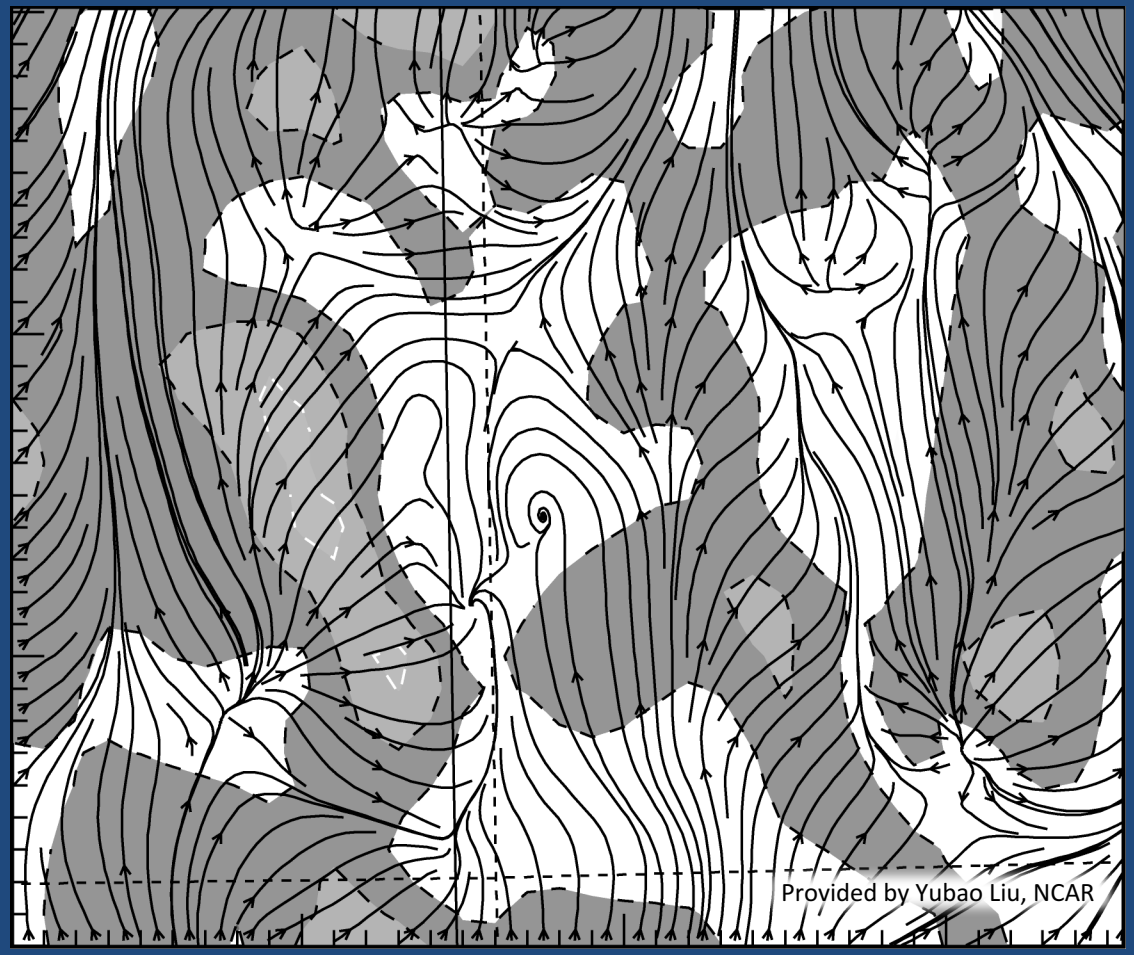
From Anthes and Trout (1971)

Trajectory analysis

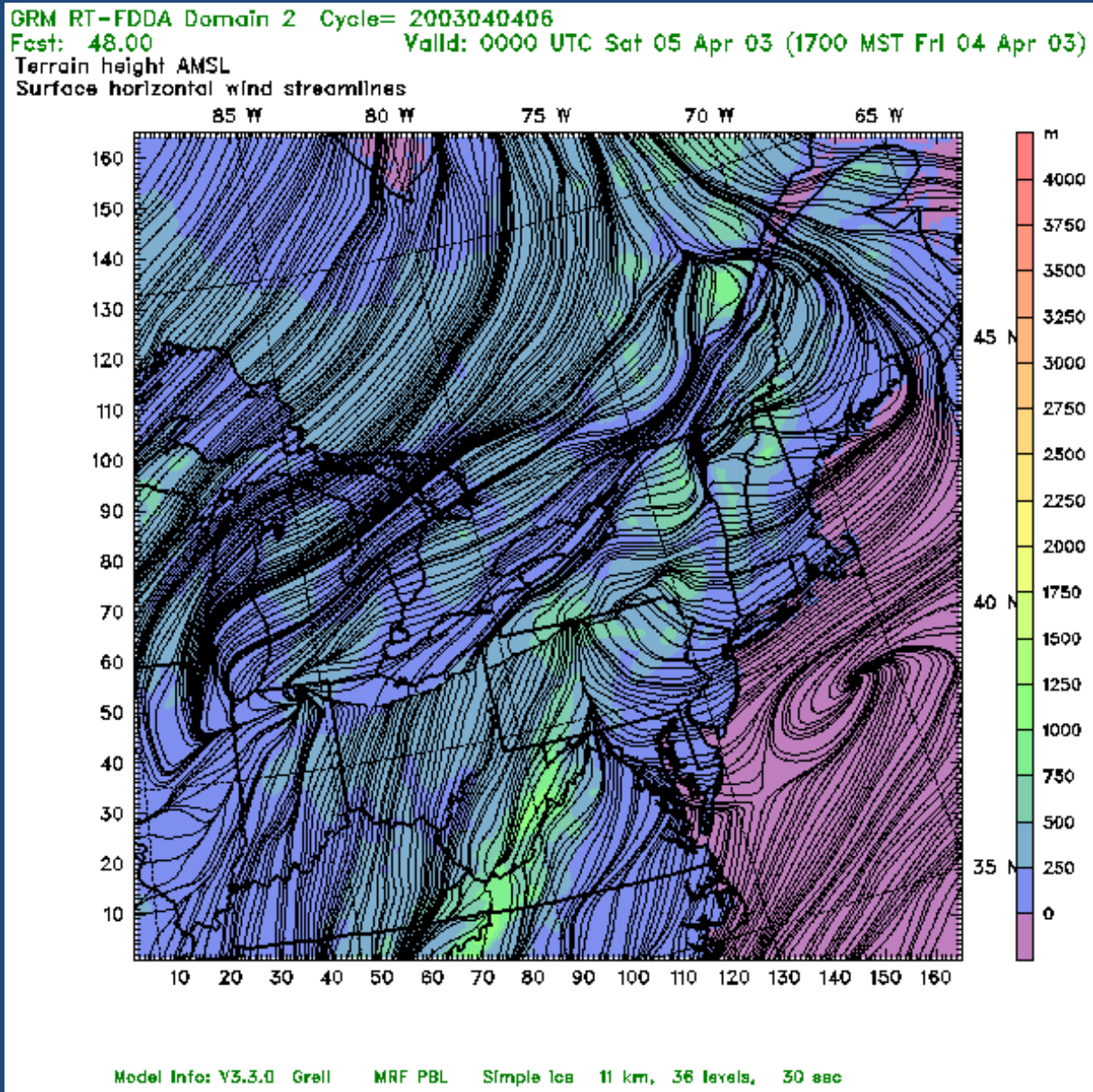


Visualizing complex spatial deformations

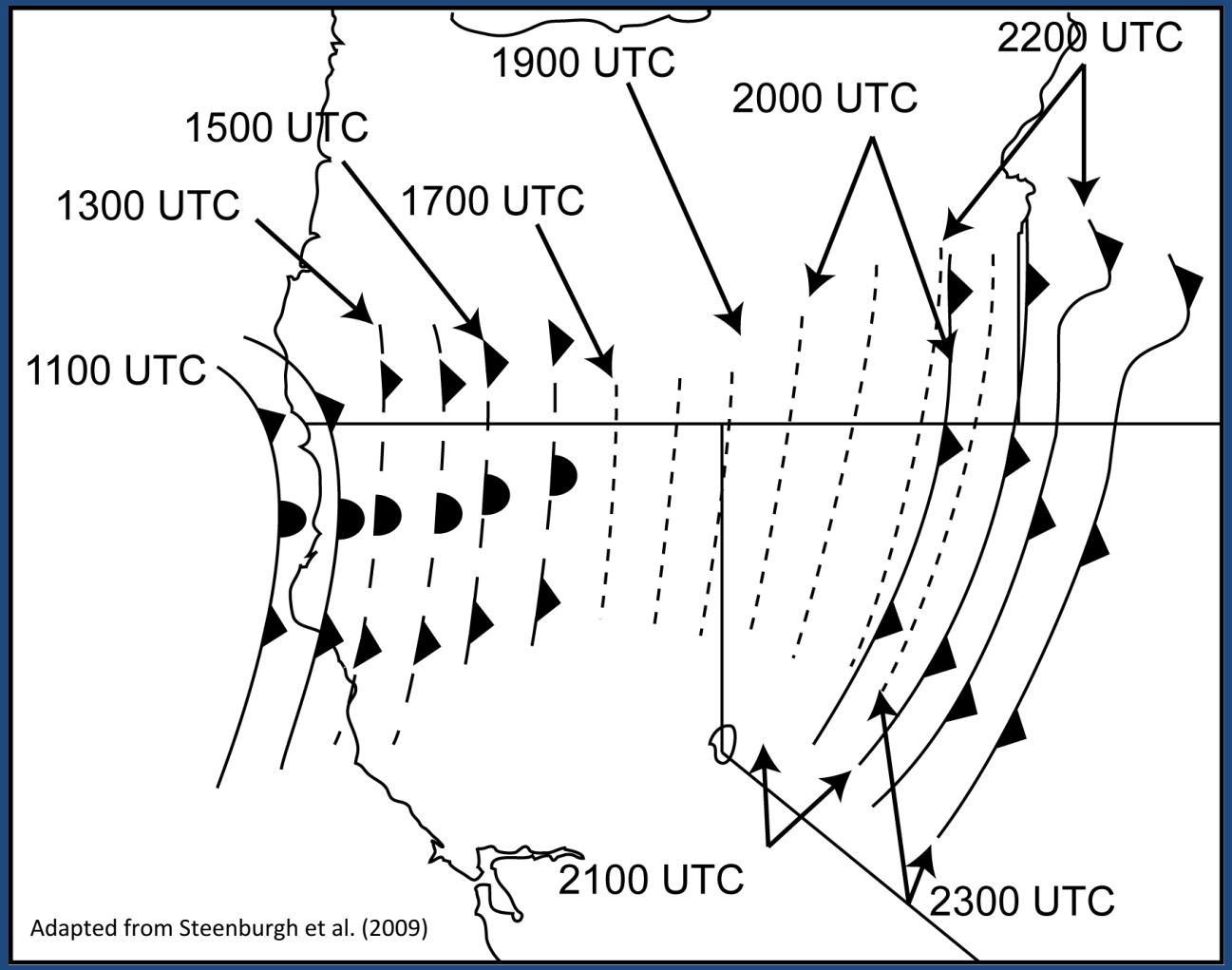
A streamline analysis



Another example



Isochrones of a front



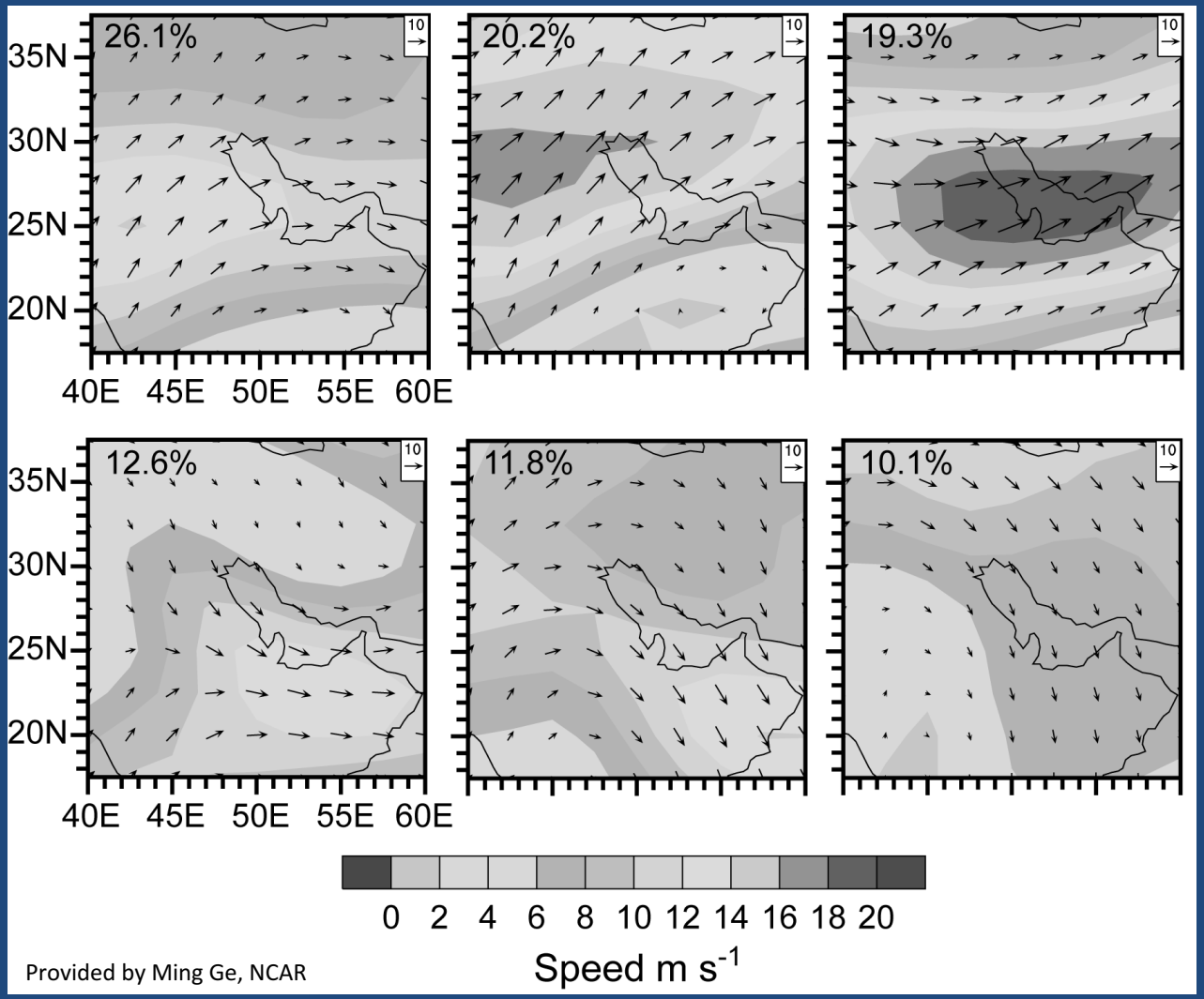
Pattern analysis, or cluster analysis

- Automated equivalent of sorting through weather maps and putting them in different piles according to the weather pattern.
- Many applications:
  - Summarize the climatology of the region in terms the variable being analyzed. Maps of prevailing patterns and their frequency of occurrence.
  - Weather-regime sequences/transitions in nature can be compared with those from the model.

- Verification statistics can be computed for the different regimes – remember the figure for the verification of forecasts for Athens – the strong Etesian regime and the sea-breeze regime.

- Challenges
  - No dynamic constraints are used in the sorting, so different processes will be “mixed” together in one category.
  - The field analyzed (mean) patterns (e.g., wind) are not dynamically consistent with any other variables, so sometimes a “typical day” is chosen.
  - The number of groups is chosen arbitrarily by the analyst.

SOMs analysis, using a small number of categories – 0000 UTC 700-hPa winds



Derived variables

- Horizontal vorticity
- Horizontal divergence
- Deformation (2 types)
- Latent-heating rates
- Vertical fluxes
  - Heat
  - Moisture (latent heat)
  - Momentum
- Frontogenesis
- Geostropic wind
- Ageostrophic wind
- Thermal wind
- Wind shear

Analysis of energetics

- Components
  - Potential, internal, kinetic
  - Kinetic – mean-flow and perturbation
  - Potential – available and unavailable, in terms of whether it can be converted to KE
- Two approaches
  - Grid-average values of conversions among different energy components.
  - Maps of the different components defined at grid points.