Three-dimensional visualization of atmospheric fronts

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We construct atmospheric fronts (AF) – thin surfaces separating generally homogeneous SYNOPTIC air masses using a set of meteorological fields: geopotential, temperature and wind. It can be useful for synoptic 3D analysis of the Earth atmosphere. The analysis can be organized on-line, e.g. during an aircraft's flight.

Firstly we construct lines of atmospheric fronts (AF) at isobaric (*p*=const) levels, see [1, 3]. In order to do this, we use differential geometry invariants, such as the Gaussian principal curvature of isotherms and the vector analogue of this invariant for horizontal wind. Basing on the initial meteorological fields (geopotential, temperature and wind), we firstly evaluate independent predictors, and then their linear combination – the field of the final predictor. The weights in this combination are being matched through numerical optimization. The corresponding quality criterion is the maximum difference between temperature correlation function for pairs of geographical points separated by AF and pairs lying at a given isobaric level in common synoptic mass.

At the second step, we connect closely lying lines at adjacent isobaric levels and construct 3D AF surfaces, see Figure 1. These surfaces have a complex geometric and topological structure and change quickly over time.

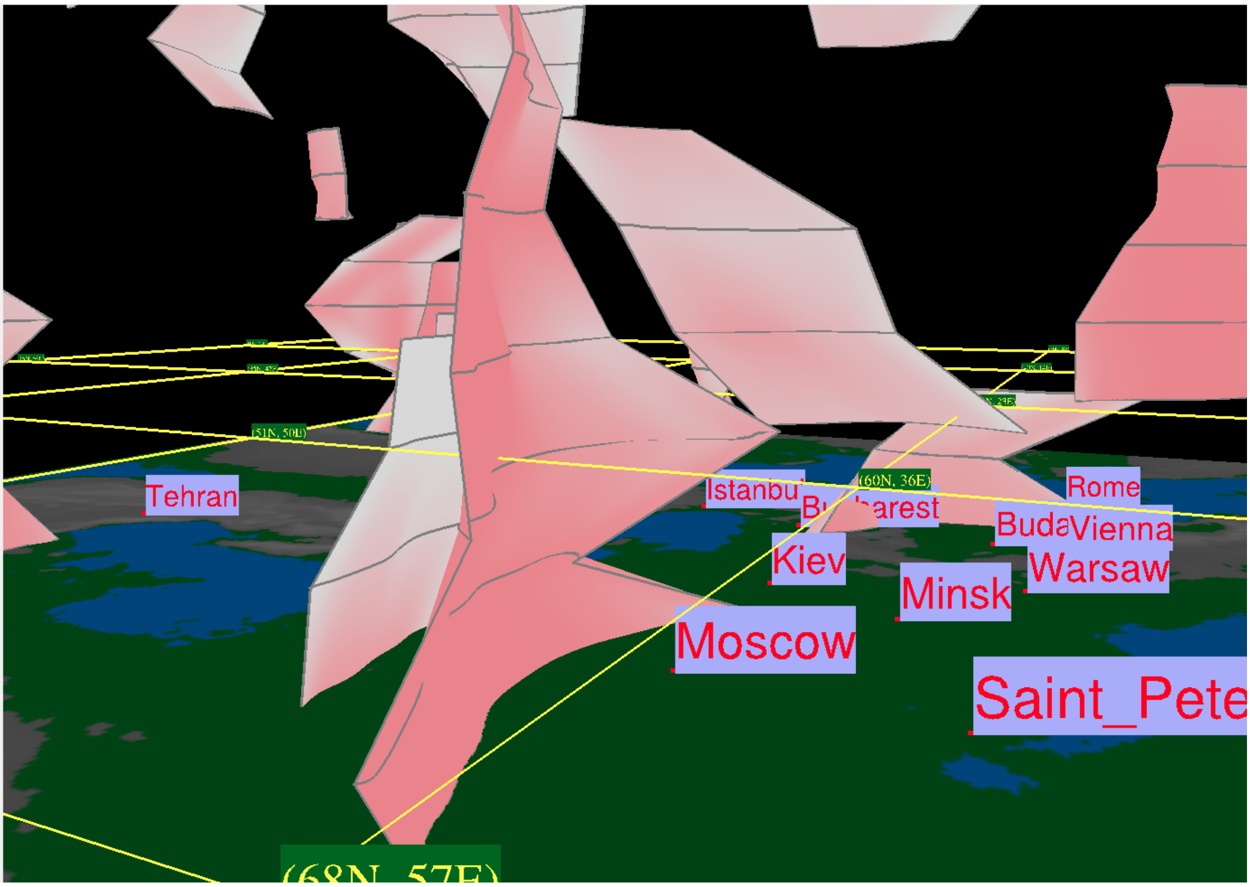

Figure 1. *View of the field of fronts over the European region. Date & Time: 6 March 2019, 12:00 GMT.*

Visualization of the AF surface improves understanding of the specific SYNOPTIC situation and accelerates understanding of the meteorological situation during an aircraft's flight. The AF geometry can influence precipitation [4].

Methodology

The AF curves obtained as the output of the algorithm described in [1, 3] are presented not in analytical form, but as some sets of points.

We approximate the curves using the Bezier approximation [5] and represent them as sets of N=200 points uniformly distributed along the length of the curve.

We have developed a measure of the "affinity" for a pair of curves, located at adjacent isobaric levels, reflecting the intuitive geometric continuity.

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