



Accurate measurements of upper-troposphere winds by watching contrails

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Contrails (short word for "condensation trails") are linear clouds that sometimes form behind aircraft. Their formation is triggered when the hot and humid air in the exhaust of aircraft engines mixes with sufficiently cold air in the upper atmosphere. Depending on the temperature and humidity at the flight altitude, contrails may not form at all, form and evaporate within a few seconds or minutes, or persist for a longer time, possibly spreading into cirrus clouds. We rely on a surface-based hemispheric sky camera and a flight radar to detect fresh contrails in an automated way.

The displacement of contrails on the sky images can be used to retrieve atmospheric motion vectors (AMV), either on a single image by comparing the flight trajectory to the contrail position, or on two successive images if the contrail lives long enough. We roughly estimate that the uncertainty on the AMV is less than 1.5 m s^{-1} for zenith measurements and less than 3 m s^{-1} for measurements at 60° solar zenith angle, which is within the required accuracy stated by GCOS (2007) and comparable to the uncertainty of satellite AMVs. However we will show on some examples that we may expect an even better accuracy.

The advantage of this method is twofold: first it provides data in clear sky conditions, hence it is complementary to satellite retrievals that track cloudy features, and second, unlike satellite AMVs from LEO and GEO satellites, it provides the exact altitude of the AMV. Such a dataset can therefore be used for validation of NWP forecasts and/or satellite wind measurements.