

Microphysical Dissolution and ERA5 Thermodynamic Bias in Prompt Generation

While disabling the Schmidt–Appleman Criterion (SAC) and initial-persistence filters in CoCiP is a sensible first step to prevent hard pre-filtering, it does not actually stop CoCiP from truncating prompt trajectories when ERA5 humidity is low.

CoCiP's underlying engine in `pycontrails` still evaluates wake vortex descent dynamics and ice microphysics. Specifically:

- During the wake vortex phase, the survival fraction f_{surv} drops to zero if ambient relative humidity over ice (RH_i) is below saturation.
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- Even if f_{surv} is manually bypassed, ice crystals will completely sublime during the very first microphysics integration timestep ($\Delta t = 30 \text{ s}$) under dry ERA5 conditions.
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In both cases, CoCiP marks the contrail segment as dissipated and stops tracking its spatial bounds. As a result, no spatial prompt raster is generated for SAM2 to evaluate. The prompt generation mechanism therefore remains heavily biased by ERA5 thermodynamic fields (temperature and humidity profiles) despite the intent to bypass meteorological filtering.

Why This Imposes a Major Limitation

Ground-based camera pipelines are most valuable when serving as independent observational benchmarks to validate contrail lifecycle models and numerical weather prediction (NWP) forecasts (e.g., evaluating how well Cocip using ERA5 predicts contrail formation, or to test whether aircraft performance models have an impact on the actual skill of a contrail prediction method).

If the observational detection pipeline inherits thermodynamic survival decisions from ERA5 microphysics:

1. **Circular Dependency:** The vision model is never prompted to look for contrails in regions where ERA5 incorrectly predicts dry air, creating systematic false negatives that mirror ERA5's own forecast errors.
2. **Unsuitability for Model Intercomparison:** The resulting observational dataset becomes intrinsically tied to ERA5's thermodynamic biases, rendering it unfit as an unbiased truth dataset for validating or comparing different atmospheric models.

Recommendation for Authors

To decouple prompt generation from thermodynamic reanalysis biases:

- **Switch to Kinematic Dry Advection:** Replace the full CoCiP lifecycle model with a purely kinematic 3D wind advection pipeline (using the dry advection module in [pycontrails](#)). This advects ADS-B flight segments using ERA5 3D wind vectors while completely ignoring temperature, humidity, and ice microphysics.
- **Implement Parameterized Shape Estimation:** Rather than relying on CoCiP's microphysics to scale plume dimensions, construct a parameterized contrail shape model (e.g., standard shear-driven lateral spreading and parameterized vertical extent), following a similar design pattern to the parameterized fall/sedimentation speed estimation already available in [pycontrails](#)' dry advection module.

This modification ensures that spatial prompts depend solely on aircraft geometry and wind transport, allowing SAM2 to act as a truly independent arbiter of contrail existence regardless of ERA5 humidity errors.

This modification is really important before people can use this pipeline for contrail studies.