Probing atmospheric convection in a local valley system

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A data-driven approach to characterise convection combining Eulerian and Lagrangian observations from paraglider, sailplanes, and LIDAR.

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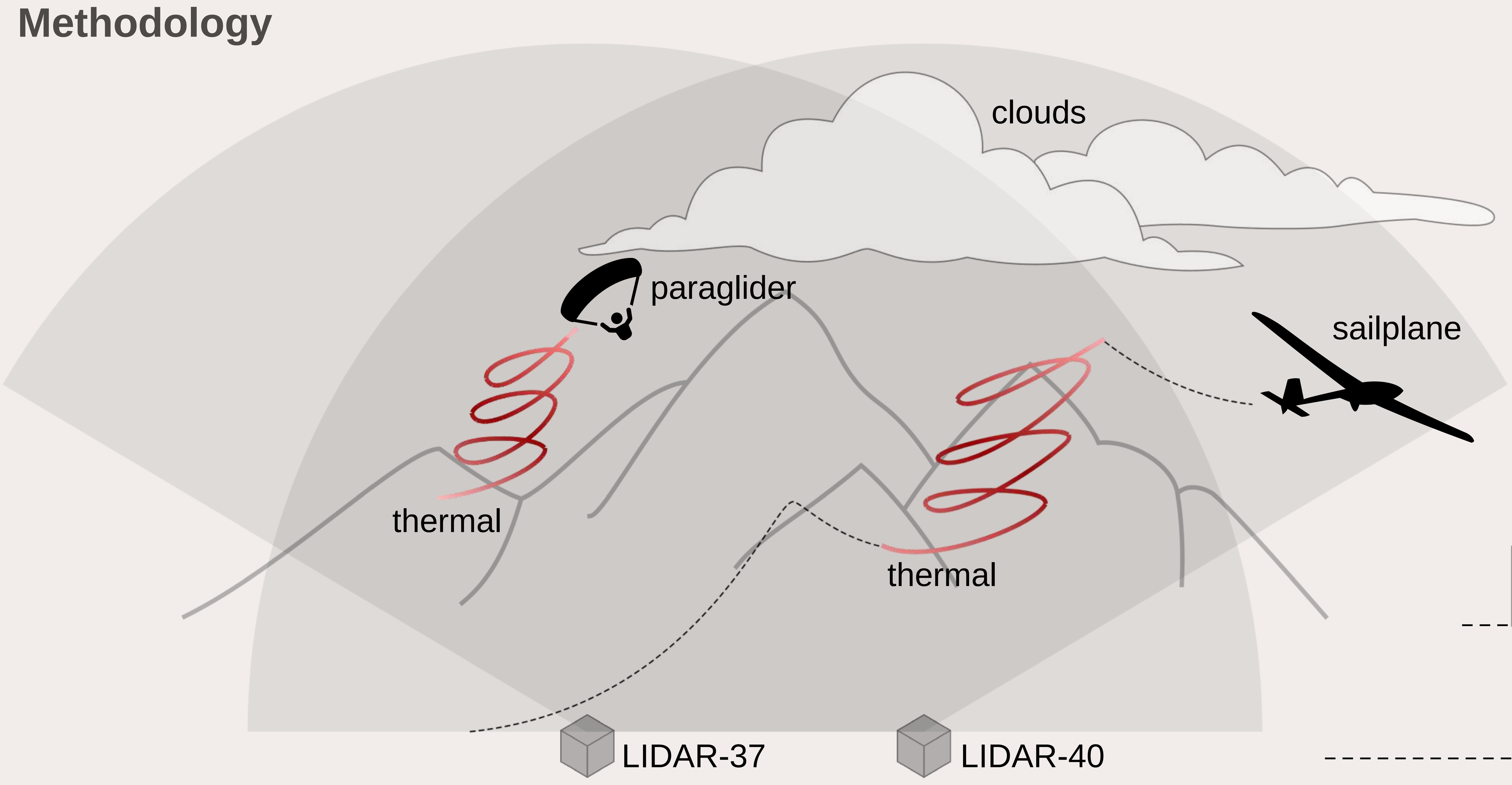
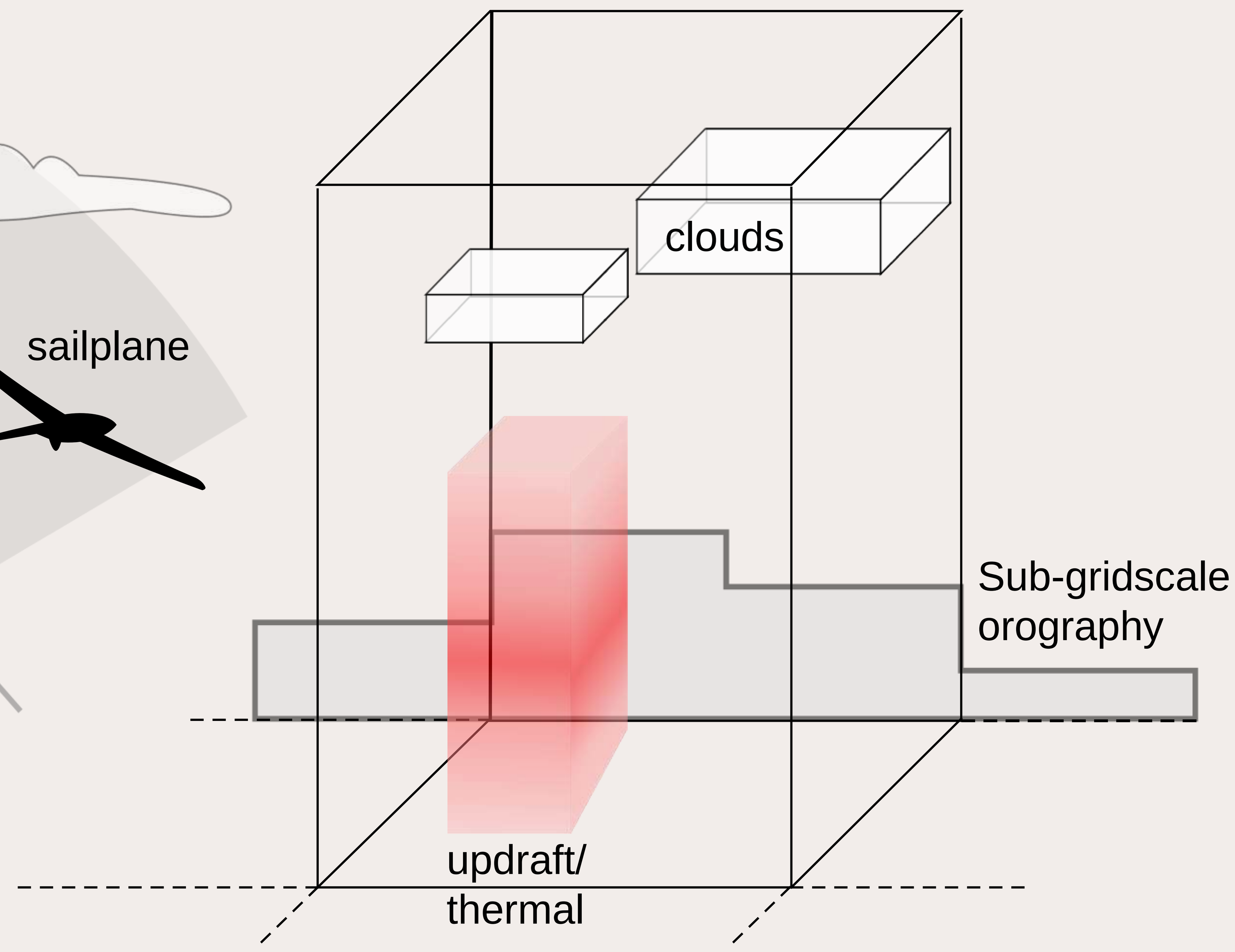
Background

Atmospheric convection describes the process of warm air rising due to density differences. It is responsible for moisture and energy transport in the lower atmosphere and cloud formation. Due to the small-scale characteristics of the process, the treatment of atmospheric convection in state-of-the-art simulations has to rely on simplified equations called parameterisations. The parameterisation schemes are a key source of uncertainty in weather prediction and climate modelling.

In this project we characterise and describe the atmospheric convection process using a data-driven approach, combining laser light detection and ranging (LIDAR) systems, together with tracks of sailplane flights. The observations are conducted at Vaksinen airport in Os near Bergen, Norway. We use this unique insight into convection to compare it to the parameterisation scheme in the HARMONIE-AROME numerical weather prediction model, in operational use at the Norwegian Meteorological Institute.

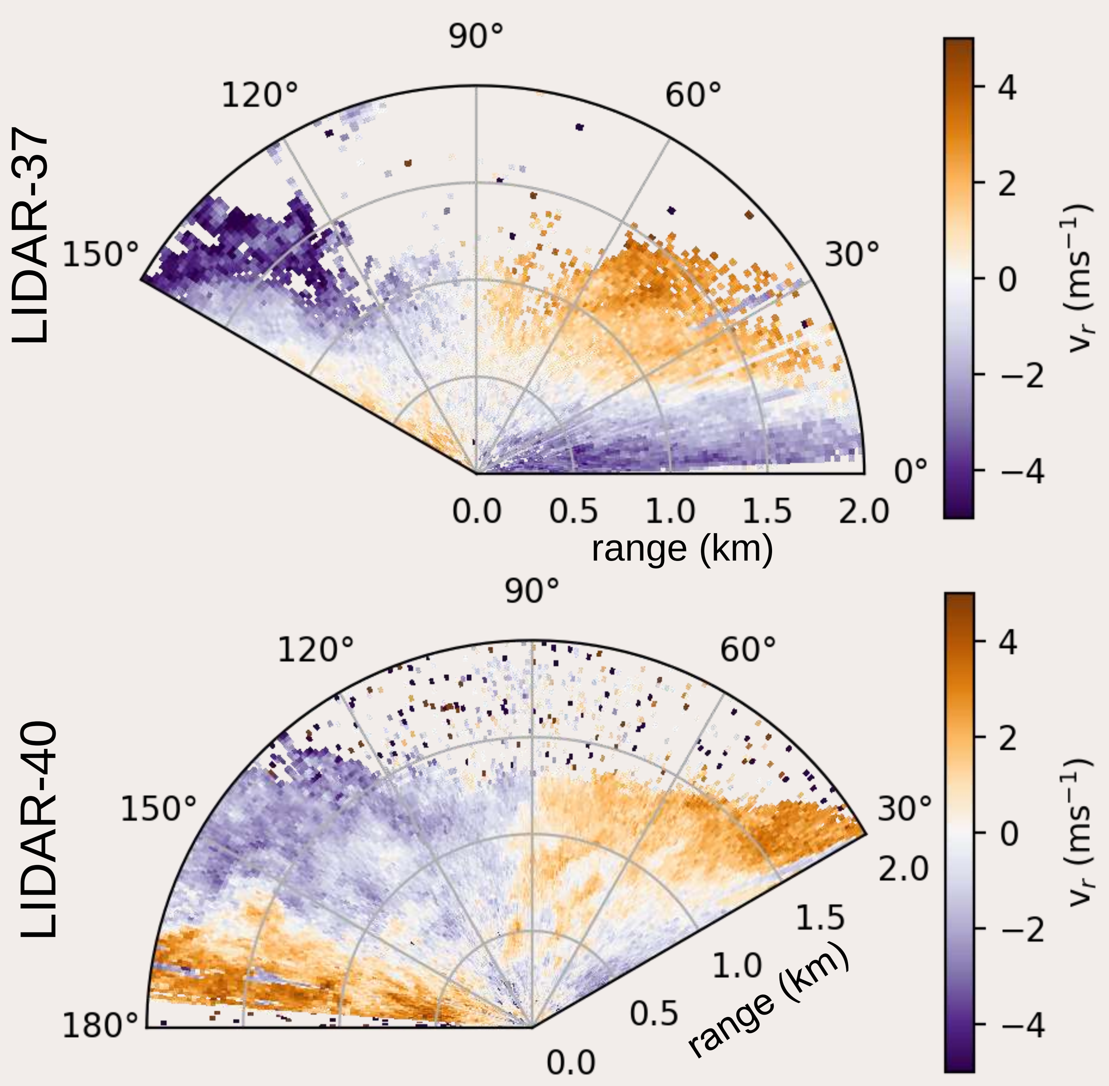
Methodology

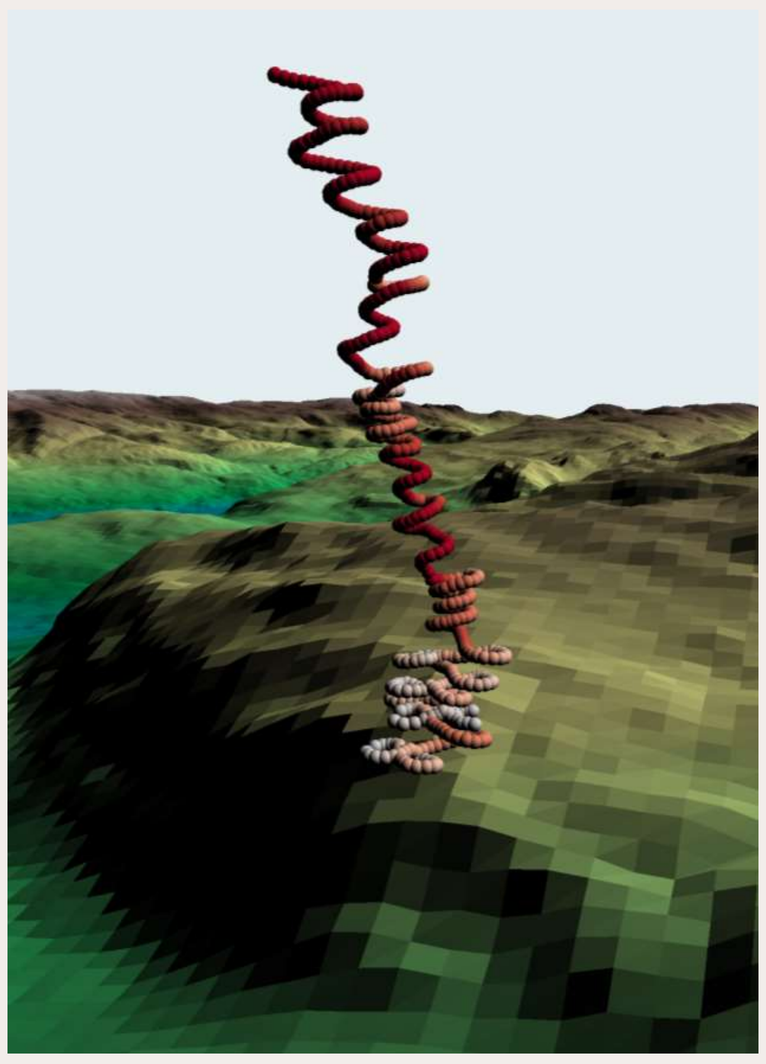




LIDAR

We installed two LIDARs (Wincube100S-37 and 40) at Ulven airport (12.05.21 - present). The LIDARs, each send out a laser beam, which interacts with the aerosol particles in the air, which are moved by the wind. From the doppler shift of the back-scattered beam, we obtain the line-of-sight or "radial" velocity, v_r, of the wind at several range gates along the laser beam. From vertical slices (see below example from 17.05.21 10:15 UTC), we retrieve the horizontal and vertical wind.



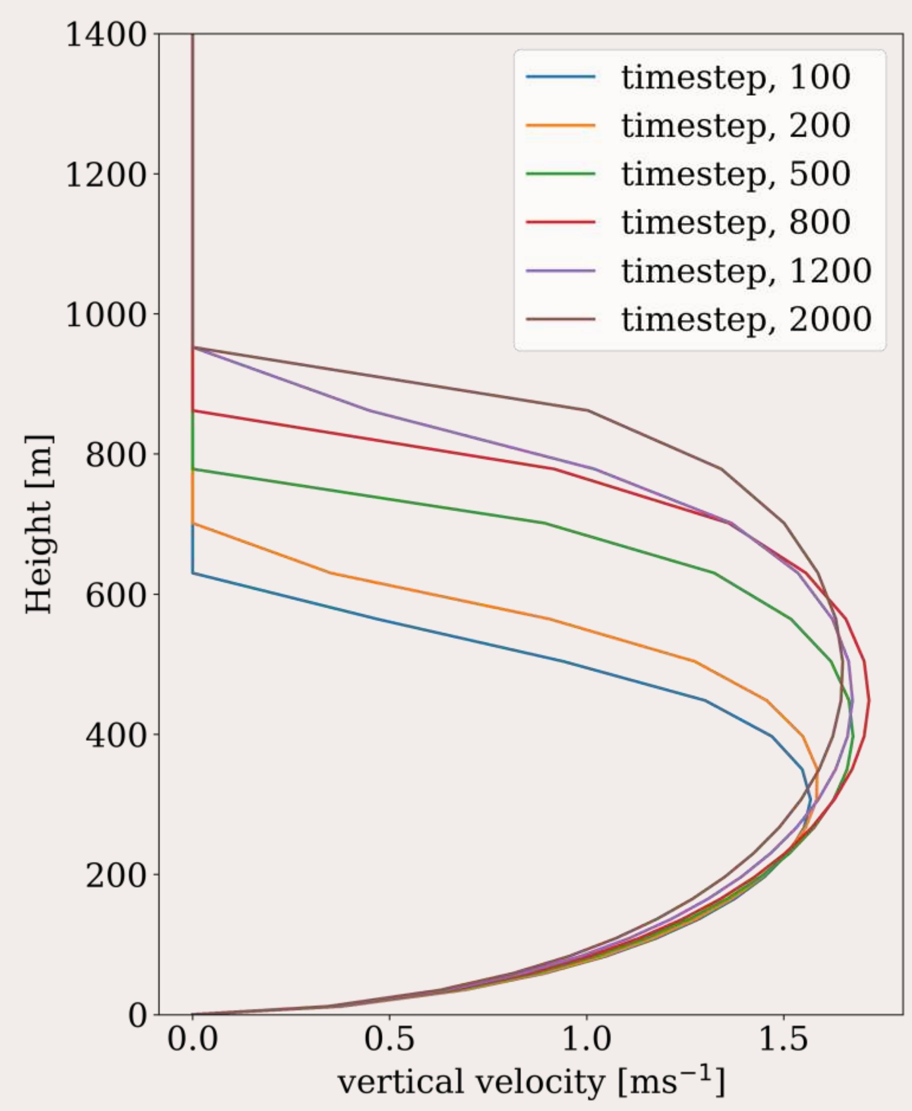


Paraglider & Sailplane*

Paragliders and sailplanes utilise the updraft velocity in convective thermals to gain altitude. Both systems use a GPS to track their location during the flight. From the evolution of the the GPS location in time, we retrieve the vertical velocity of the thermal. The figure above shows an example of the track of a paraglider within a convective thermal.

MUSC

We employ MUSC (Modèle Unifié Simple Colonne), which is the single column model (SCM) of the HARMONIE-AROME model. A SCM separates a vertical column from the full, 3D model, but retains all of the science and algorithms. One of these algorithms is the shallow-convection scheme, responsible for calculating the ensemble of updrafts (thermals) occurring within a model grid-box. The figure below shows the evolution of vertical velocity, calculated by the scheme.



ACKNOWLEDGEMENTS

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* For further work on vertical velocity estimates from paraglider and sailplane tracks and their incorporation in a theoretical convection model see Pálenik et al. (Poster 13)

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