An on-line glider pilot self-briefing system

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Background

My colleagues Drs. Olivier Liechti (Analysen und Konzepte of Winterthur CH) and Ralf Thehos of the German Weather Service (DWD) have developed a glider pilot self-briefing system for Europe. The system resides at www.flugwetter.de. Using the system, a pilot is able to 'fly' a planned task through a numerical weather prediction (NWP) to determine the task's feasibility. After the flight, the forecast can be checked using the resulting flight-recorder file.

During the 2009 soaring season, as an experiment, we operated the system for the East Coast USA and Colorado. We validated the East Coast system using data from glider contests and, with a few qualifications, found it successful (no contests occurred in Colorado).

I will explain and demonstrate this revolutionary system.

The system in Europe

As shown in Fig. 1, the system consists of 'nested' NWP models of the DWD, (Thehos's expertise) and Liechti's TOPTHERM convection model. The global model (GME) with coarse 40 km grid-point spacing initializes the higher resolution 7 km grid-point spacing regional model (COSMO-EU) and the TOPTHERM convection model initializes from the regional model. The TOPTHERM predicts the local weather in so-called forecast regions; regions of relatively uniform topography and ground cover. The different colors of the regions denote the potential flight distance (PFD, distance a Standard Class glider can fly from the first-to-last randomly-spaced thermal) where yellow represents 50 km and purple represents 700 km. So on this day (2 June 2009), the best flying using thermals was predicted to be in the eastern Pyrenees Mountains.

The system for the East Coast USA

The DWD global model, by its name, extends to the eastern USA (in Fig. 2, please imagine the GME globe rotated so the East Coast USA is in the box.). However, the DWD regional model, as you might guess, does not cover the eastern USA. So, TOPTHERM was predicting with 'one hand tied behind its back'.

The following scientific question, then, was explored. Can a high-resolution atmospheric model (e. g. the COSMOS-EU) be replaced with a coarser global model (e.g. the GME) and still allow TOPTHERM to produce soaring forecasts of a quality useful for glider pilot self-briefing? Liechti's flight planning algorithm, called Java TopTask (jTT), was connected to TOPTHERM. As we reported earlier, the answer is 'yes' for the northeast USA but with qualifications.

Some additional comments on what you are viewing in Fig. 2. The grey regions in the north mean the PFD values are near zero due to the over 30 knot predicted winds in the convective boundary layer (CBL). The thick wind 'strings' upwind of the Fairfield PA contest site (red circle) indicate the possibility of convective lift aligned with the wind.

The TOPTHERM forecast for 13 October 2009

Random convective lift

The atmospheric soundings predicted by the GME model at 60-minute intervals for each forecast region are utilized by the TOPTHERM atmospheric model to predict the daily evolution of the CBL (an atmospheric sounding is the vertical distribution of temperature, moisture and winds). The TOPTHERM predictions are displayed as a map of PFDs (Fig. 3, left panel) and as a barogram showing the CBL evolution (Fig. 3, right panel). These predictions are for the forecast region surrounding Fairfield PA (red dot) for 13 October 2009.

The map shows Fairfield was at the northern end of the soarable weather. The barogram shows the CBL was predicted to be about 1.4km MSL by 1500EST. The strong afternoon winds were predicted to align the convection (shown in the barogram by the fat, long wind strings and the row of cumulus icons above the surface T and Td values). Notice the strongest lift (blue) was early and weakened (yellow) as the winds strengthened.

For this day, a PFD of 54 km was predicted for a dry, Standard Class glider using randomly-spaced convection.

Aligned convective and ridge lift

Also, predictions are made for aligned convection, ridge and wave lift. So, if the pilot were to use aligned lift, the PFD would increase from 54 to 147 km (Fig. 4, left panel); the orange line represents the PFD (Fig. 4, right panel). As can be seen, distance beyond 147 km would be at ridge-level in 15 knot northwesterly winds.

Flight plan for 13 October 2009 for aligned convective and ridge lift

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By inspecting the TOPTHERM forecasts, our experienced local pilot knows that aligned lift will be required to fly any distance on 13 October 2009. Further, our pilot knows the task should head west from Fairfield using cloud streets to cross the Chambersburg Valley and run the first ridge. Then, a return to the windward ridges on the east side of the valley will complete the task.

Using the point-and-click feature of jTT, a 339 km task is entered (Fig. 5 left panel) and the 'optimum' start-time and 'aligned' lift boxes are checked (Fig. 5, right panel). It is seen, the task should start at 1400EST and be completed by 1809EST with a speed of 82 kph.

Analysis of the 13 October 2009 flight

After the flight, the recorder trace was analyzed by jTT (Fig. 6). The jTT analyzed the recorded flight and determined the flight distance (588km) and the flight speed (154kph) (Fig. 6, upper-left). The pilot, Baude Litt, is the only person I know who can fly faster than God! Notice the initial climb in convection, the dive onto the upwind ridges and the final climb in convection prior to final glide. Also, notice in the barogram the unusual uniformity of his flight speed (the red line superimposed over the straight, black diagonal line (distance/time)).

Validation of the TOPTHERM forecast

The jTT uses the recorded flight trace to 'fly' the glider through the predicted weather. If the flight had relied solely on random convective lift, a landout was predicted: the flight trace in the map loses color and wind strings at the point of the landout and no speed is displayed in the barogram (Fig. 7). If the pilot used aligned lift, once again a landout was predicted after 1800 EST (Fig. 8, barogram). The jTT 'pilot' was unable to return across the valley (Fig. 8, map). So, Baude flew much better than predicted.

Forecasts validated using data from 2009 East Coast USA contests

The GME-TOPTHERM-Java TopTask system was evaluated for the northeast USA using meteorological and flight recorder data collected from glider contests held in the spring, summer and fall of 2009 in the following states: New York (Sports Class), Pennsylvania (R2, R4N) and Virginia (R2S). The system made useful predictions of the convective boundary layer (CBL) depth, the flight speed and the Potential Flight Distance (PFD) with the following qualifications:

- The CBLs developed more slowly and lasted longer than the actual CBLs.
- More accurate surface T and T_d predictions would improve the CBL predictions.
- For flights in random convection, CBL depths were under-predicted by 75 m, flight speeds were under-predicted by 7 kph and PFDs were twice the actual flight distances.
- The Java TopTask successfully predicted flights that utilized a mixture of aligned convective and ridge lift, the longer the task the better the prediction. The actual threshold for weak aligned lift seems to be somewhat lower than the threshold assumed in Java TopTask.

Future

These findings are encouraging for setting up the system anywhere on the globe. Due to the coarse global model, limitations exist for convective lift in extremely complex terrain (e.g. Alps, Himalayas, ...), whereas wind generated aligned lift (ridge, wave) may be predicted anywhere. Minor improvements in T and T_d values can be expected by adjusting the surface sensible heat and latent heat fluxes. This will improve the growth of the CBL and the predicted base of cumulus clouds. Additionally, the assimilation of surface measurements of temperature and dew-point should further improve the prediction of cumulus (onset, base and depth) as is known from current German Weather Service operational runs.

The system is ready to be evaluated by USA glider pilots flying in the mid-Atlantic and northeast States and Colorado (Fig. 9). To encourage pilot participation, the system on www.flugwetter.de will available, free-of-charge, for the 2010 soaring season (1 March to 1 November). If you fly in the regions depicted in Figs. 2 and 9, and wish to evaluate the system, contact pcmet@dwd.de and identify yourself as a USA glider pilot desiring to participate in the DWD-AuK-CCNY experiment. Please e-mail me with the results of your evaluation.

If the experimental system is accepted and wanted by the pilots for the 2011 season, the system will be made operational. But, a fee will be required to access the system. The fee structure, necessary to cover the operational costs, has yet to be determined.

About the author: Dr. Ward Hindman is professor emeritus at The City College of New York, New York, NY USA, owner of a HP-14T with which he's earned two diamonds (missing altitude), Fellow of the American Meteorological Society, SSA Tuntland Award (2003) and OSTIV Diploma (2006). Currently he is editor of *Technical Soaring*.

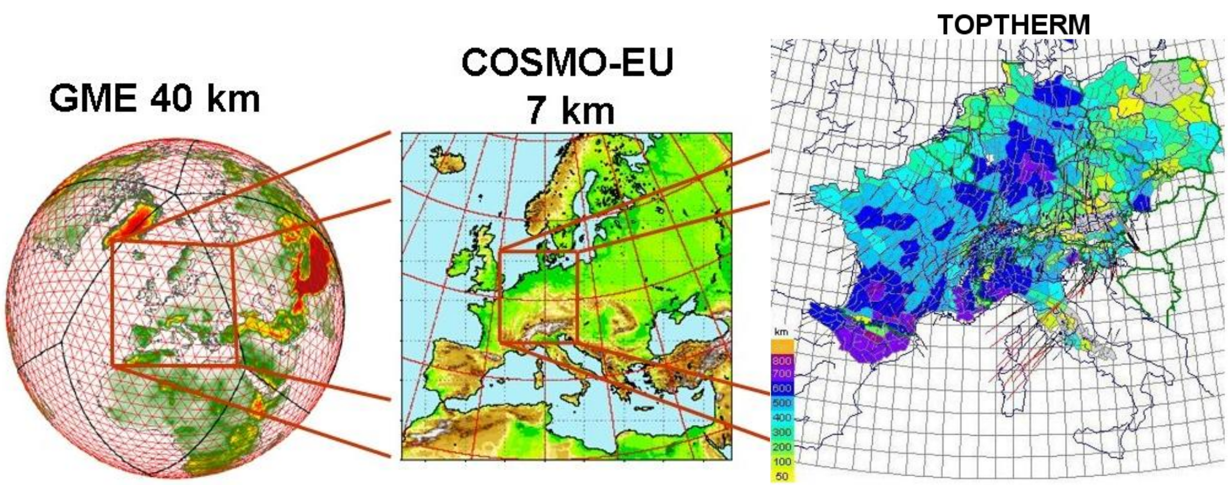

Figure 1 The 'nested' numerical weather prediction models.

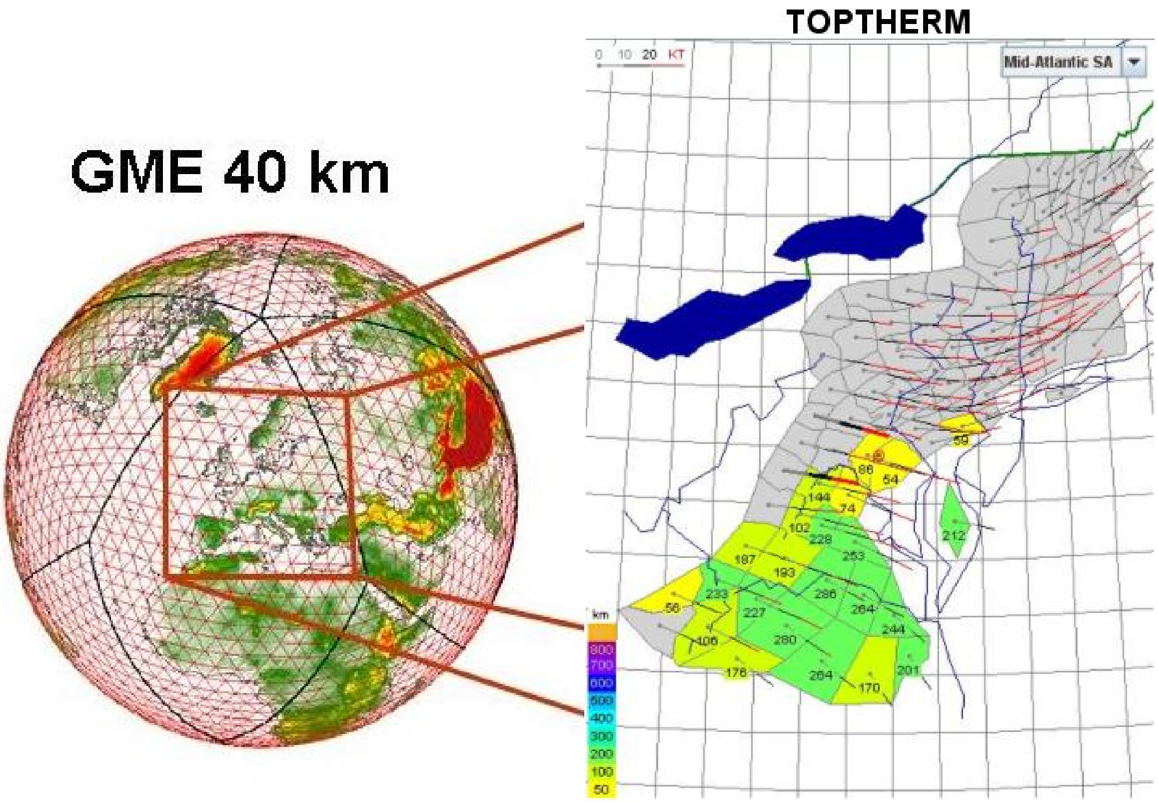

Figure **2** The system for the NE USA (please imagine the globe rotated so the NE USA is under the box).

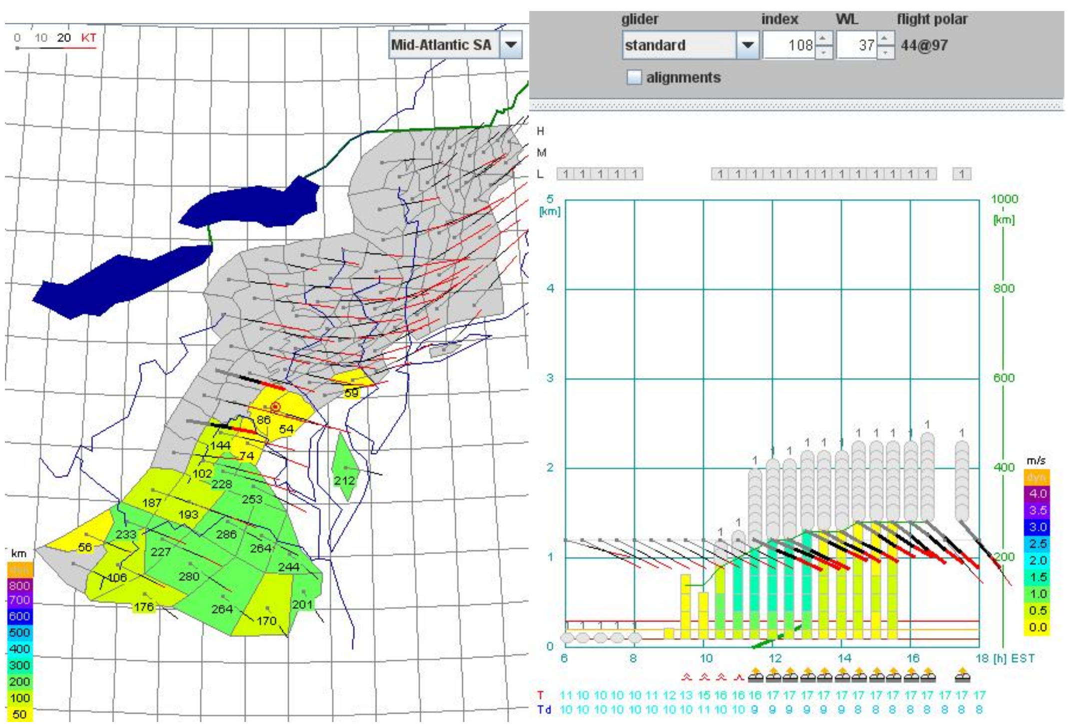

Figure 3 The TOPTHERM forecast for 13 October 2009 for random convective lift.

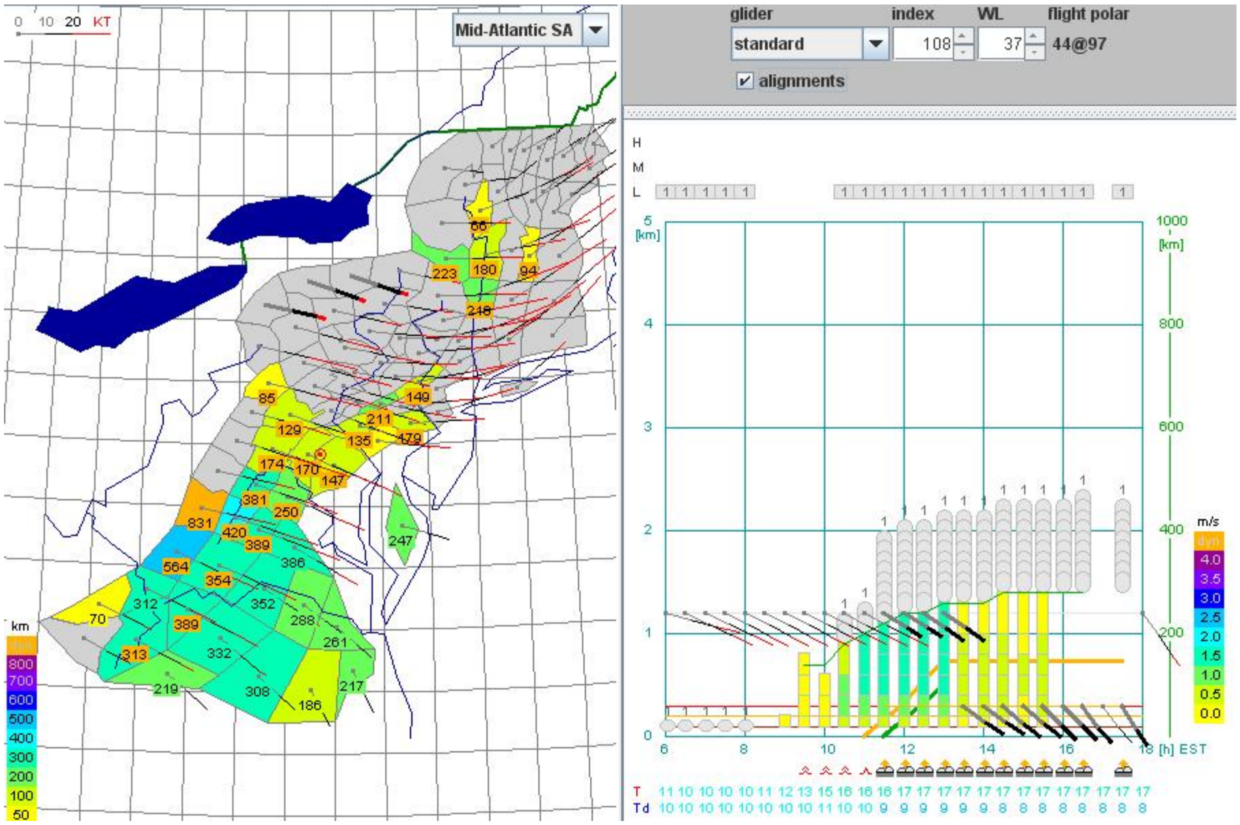

Figure 4 The TOPTHERM forecast for 13 October 2009 for aligned convective and ridge lift.

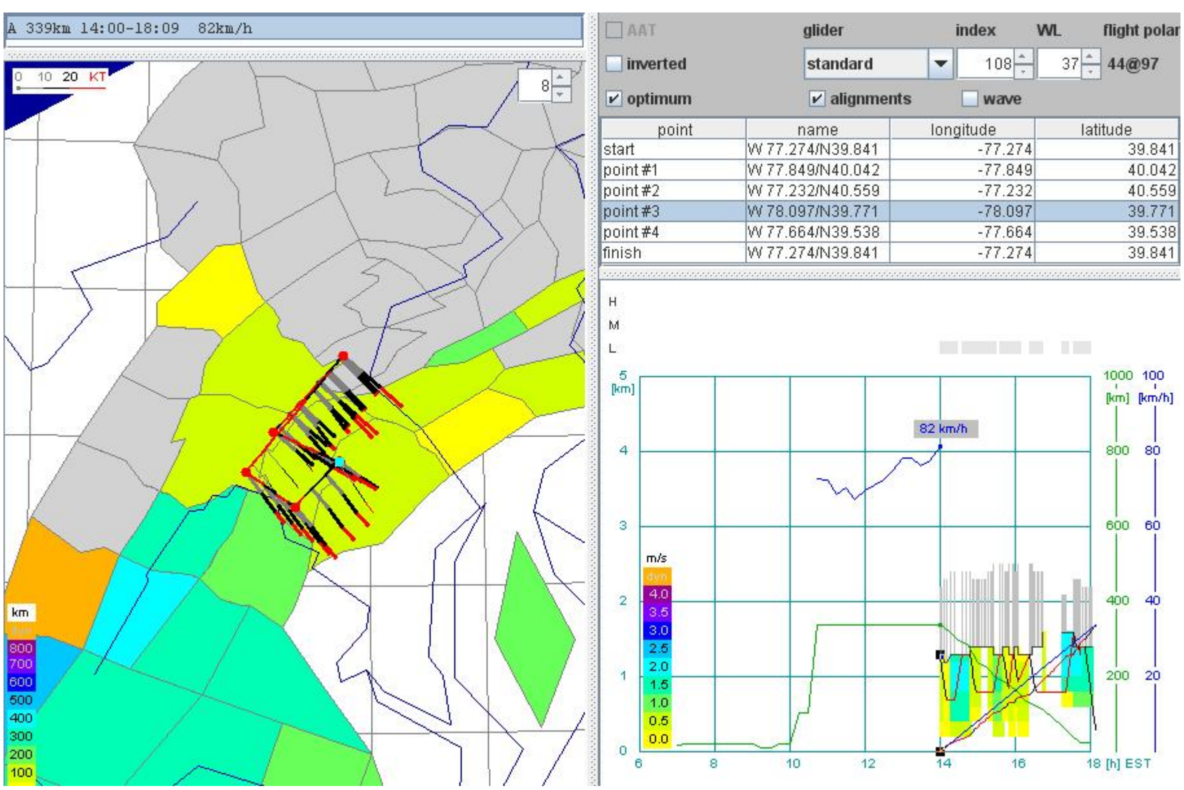

Figure 5 Flight plan for 13 October 2009 for aligned convective and ridge lift.

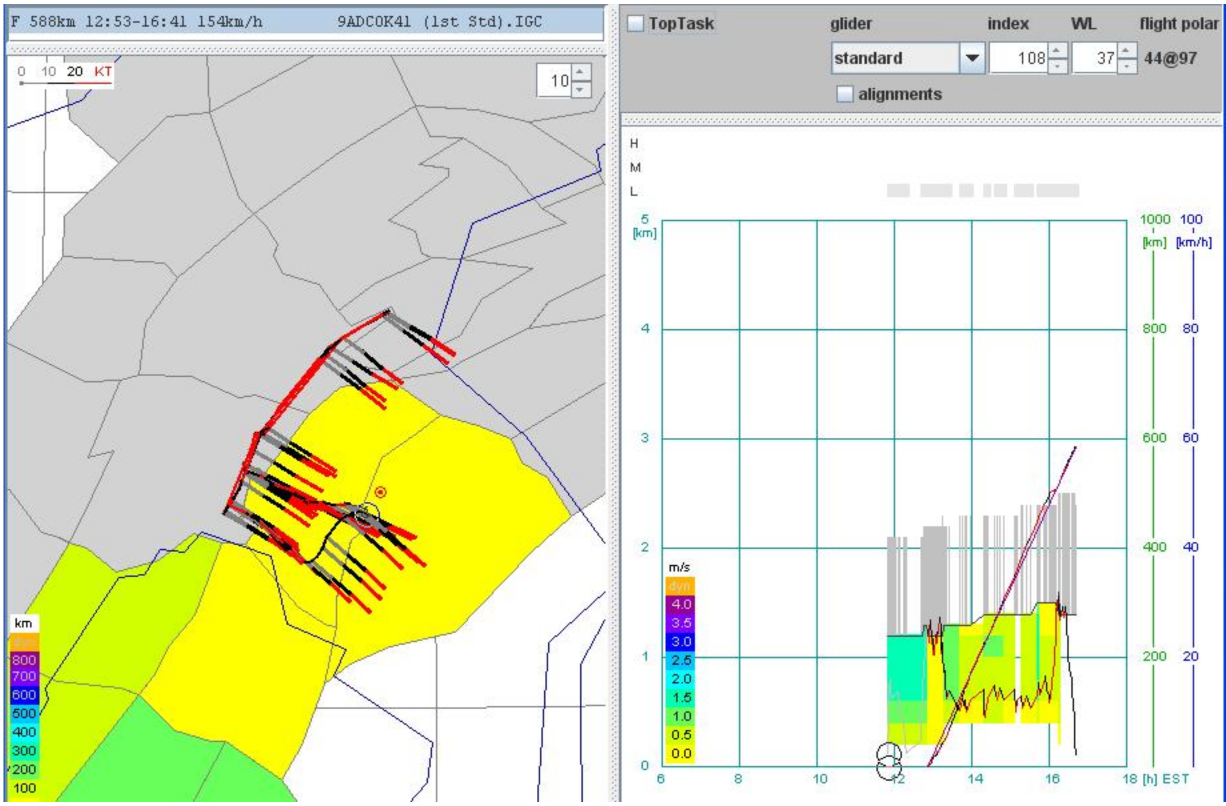

Figure 6 Analysis of the 13 October 2009 flight.

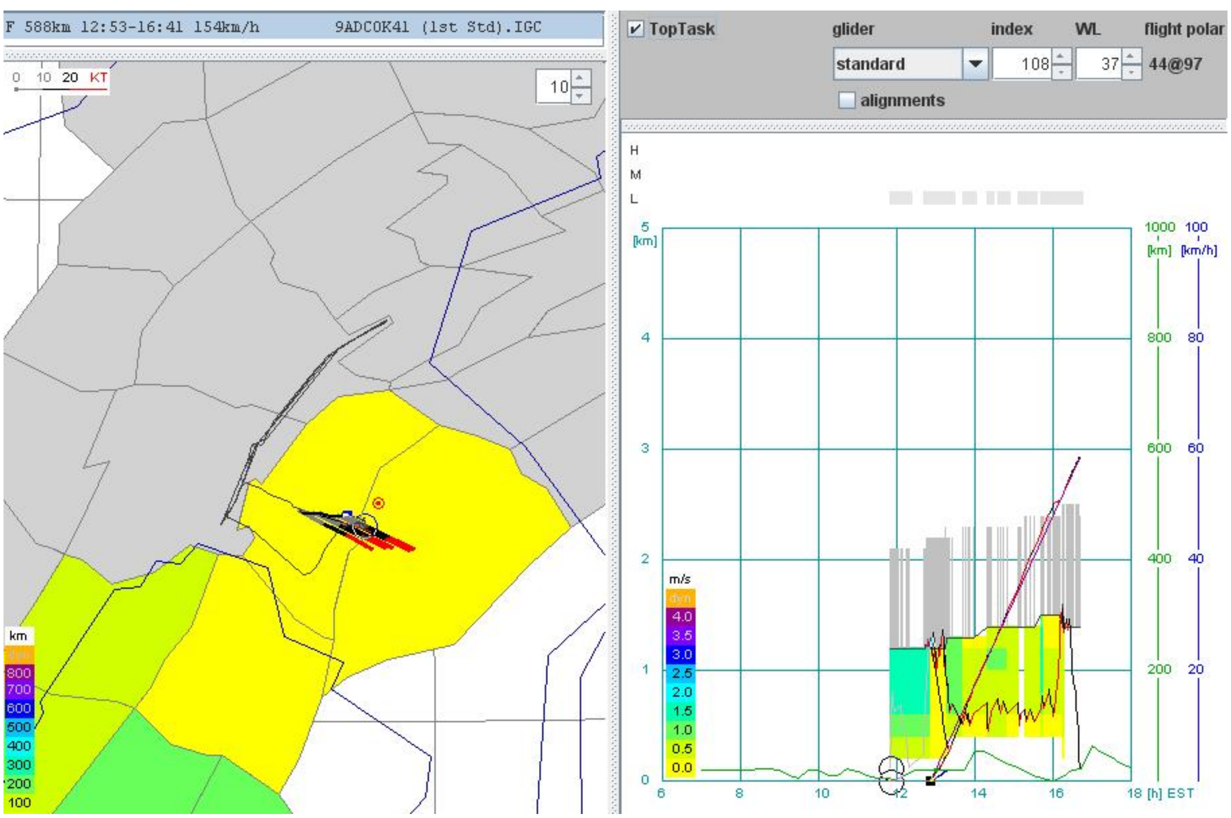

Figure 7 Validation of the TOPTHERM forecast for random convective lift**.**

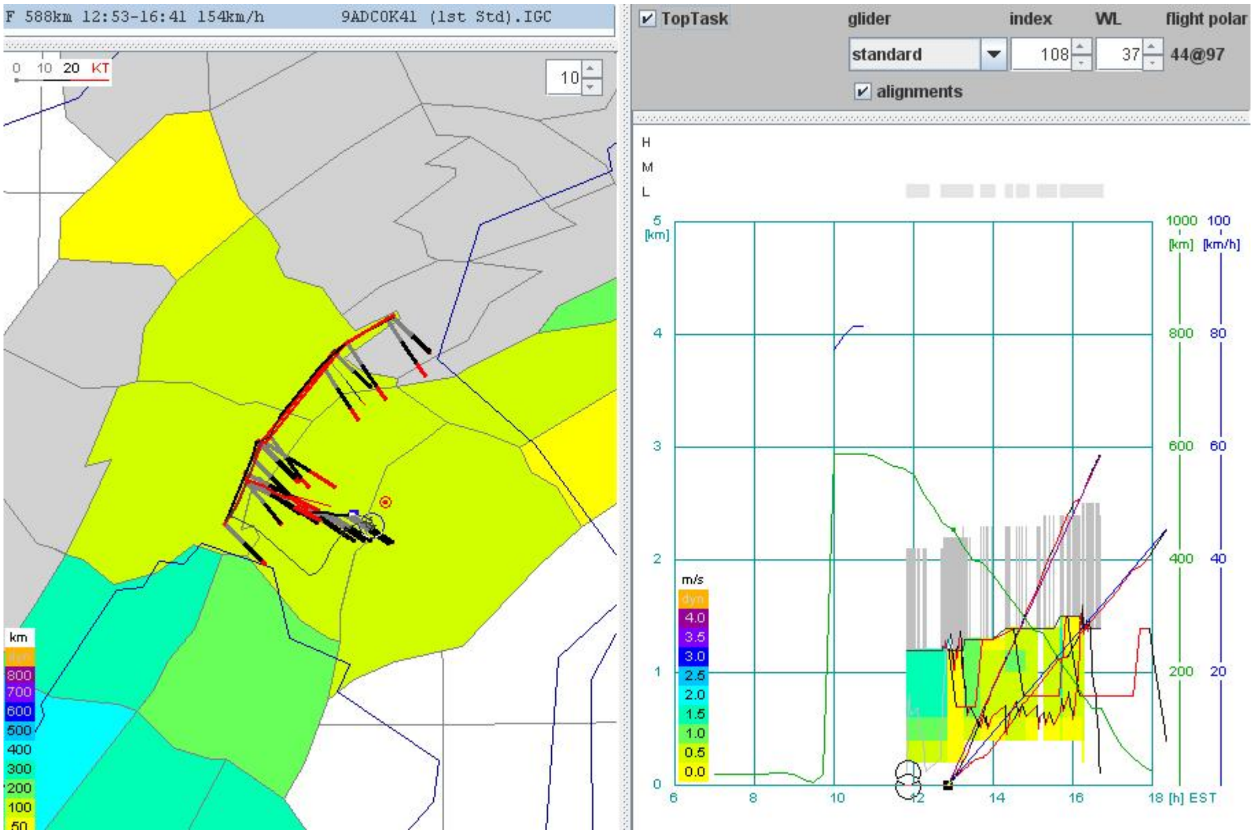

Figure 8 Validation of the TOPTHERM forecast for aligned lift.

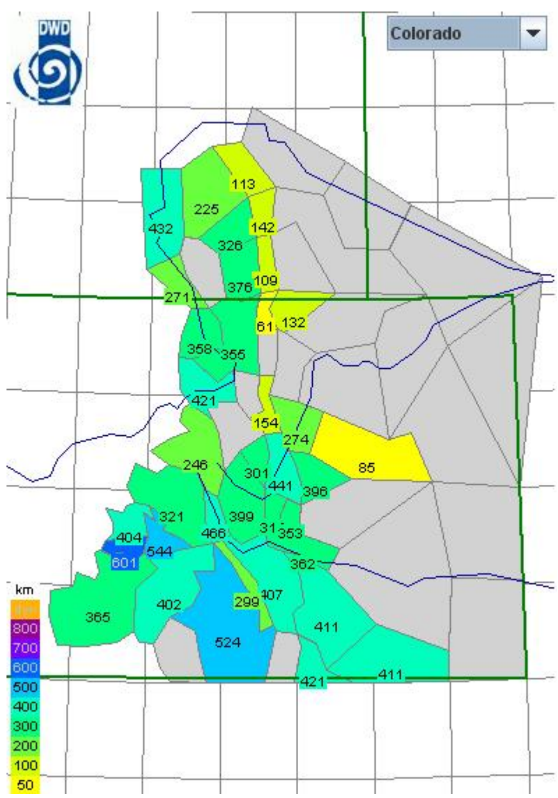

Figure 9 TOPTHERM forecast for 13 October 2009 for Colorado