Improving atmospheric numerical models using meteorological and glider flight recorded data

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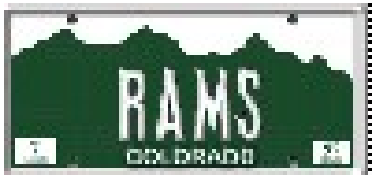

OSTIV Meteorological Panel
Saturday, 26 September 2009, (Happy Birthday, Ward!)
Hotel Garni an der Weinstrasse, Pfaffstaetten, Austria

Summary

For the past four-years, we have been working to bring the European TopTask to USA glider pilots. The TopTask 'flies' the pilot's glider through a numerical weather prediction to determine the feasibility of a proposed task. The initial step coupled the RAMS and TopTask in Colorado and had success in planning long-distance flights. Currently, the RAMS-TopTask system is being refined in the northeast USA using meteorological and glider flight recorder data primarily from glider contests. As a result, fundamental problems with predicting surface temperatures and dew points were discovered and minimized by improving the Solar-radiation model and the surface-flux model. Recently, RAMS and TOPTHERM predictions for the northeast USA were found comparable; the TOPTHERM is the atmospheric numerical model coupled to TopTask in Europe. Thus, the current TOPTHERM-Java TopTask system of the German Weather Service (DWD) can make useful predictions for northeast USA glider flights. But, predictions of surface dew points from both models need to be improved.

Background: In the beginning…..

2003: German Weather Service on-line, glider-pilot self-briefing system (in pc_met) was presented at the OSTIV Congress

TopTask
Meteorological Flight Planning for Soaring

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Analysen & Konzepte, Switzerland
Erland Lorenzen
Deutscher Wetterdienst, Germany

XXVII OSTIV Congress, Leszno, Poland, 2003

TECHNICAL SOARING **28**(4)

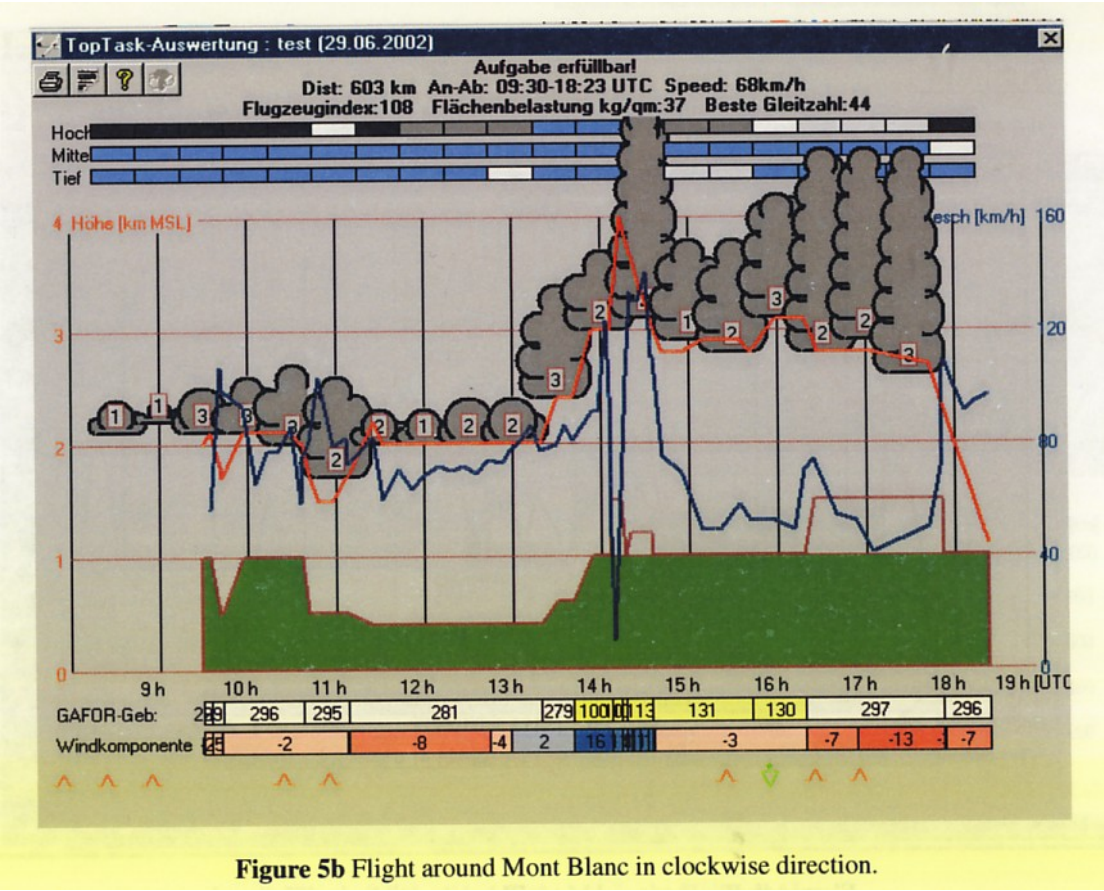

Figure 5b Flight around Mont Blanc in clockwise direction.

Background: Initial USA system

2005-06: The RAMS was successfully coupled to the TTC algorithm and produced useful predictions for Colorado

A Meteorological System for Planning and Analyzing Soaring Flights in Colorado USA

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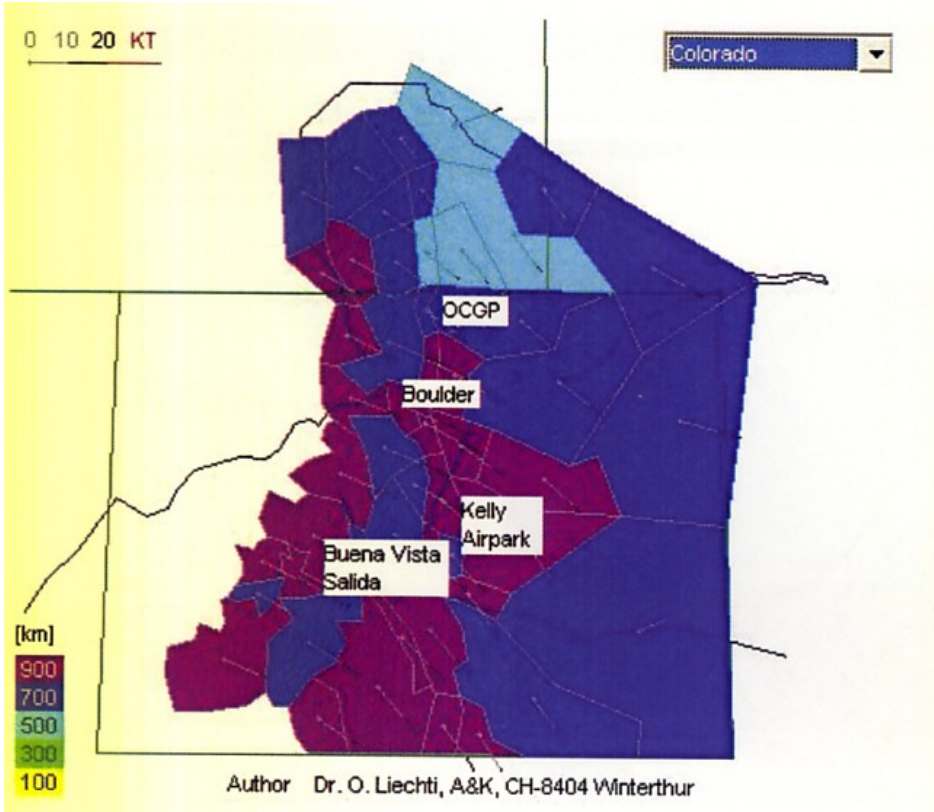
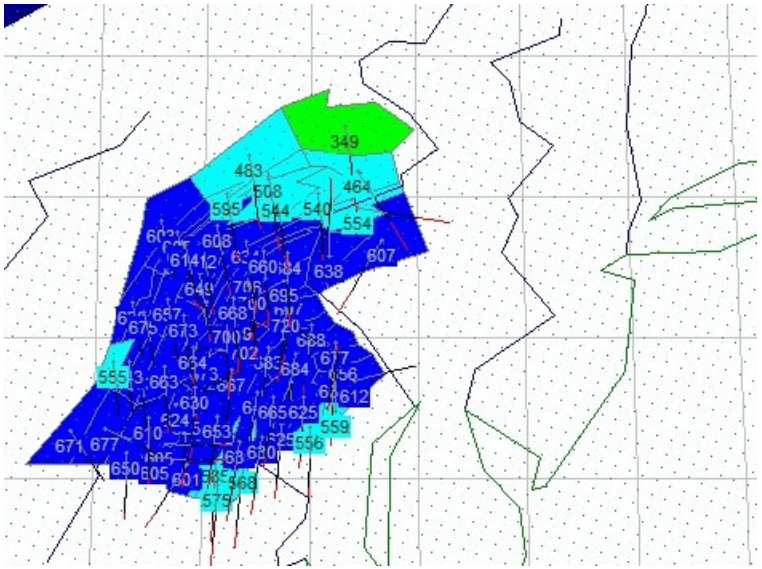
Presented at the XXVIII OSTIV Congress, Eskilstuna, Sweden, 8-15 June 2006

TECHNICAL SOARING **31**(3)



Background: Expansion to northeast USA

Fall 2006 and Spring 2007: the RAMS-TopTask system was adapted for the region surrounding Fairfield PA, the site of the fall Region 4 North contest and the region surrounding Reedsville PA, the site of the spring 15m and 18m Nationals.

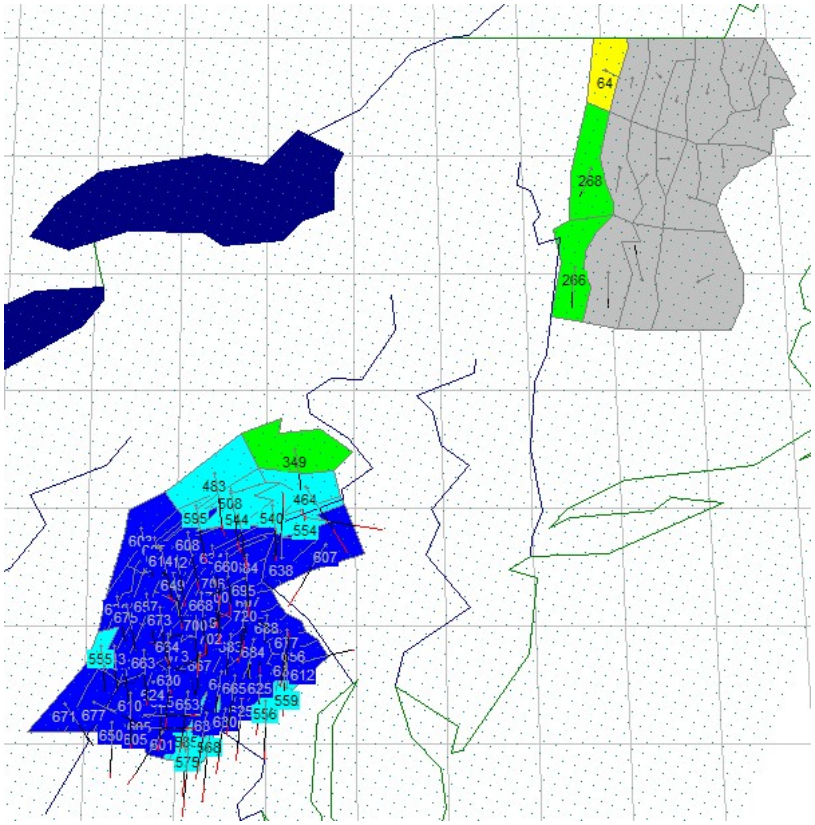


The results were accurate for contest days with winds < 20 knots (convective lift >> ridge lift) and for days with accurately predicted surface temperatures (T) and dew-points (T_d)

(ams.confex.com/ams/88Annual/techprogram/paper_133956.htm).

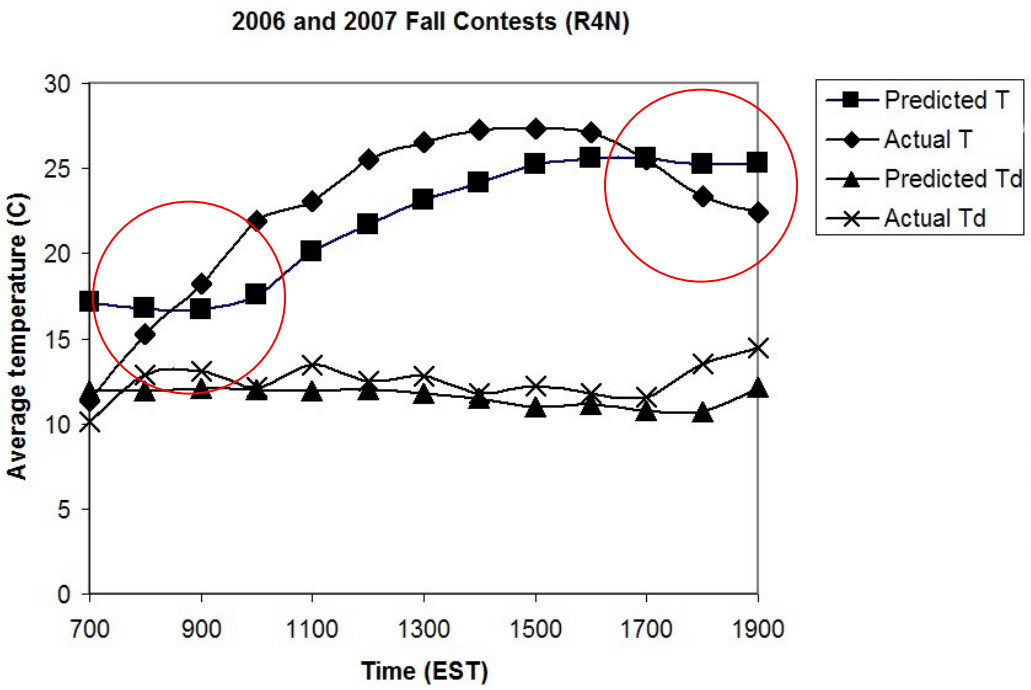
Background: Problems identified

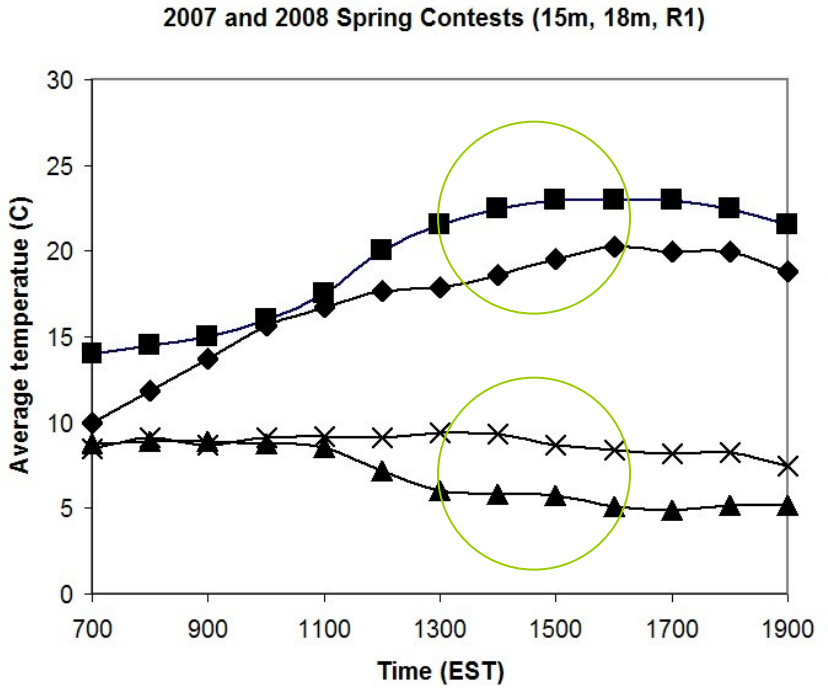
Spring and Summer 2008: The system was expanded to cover the region surrounding Warren VT, the site of the Region 1 contest. At the 2008 OSTIV Congress we reported the RAMS required fundamental work to correct systematic inaccurate T and T_d values.



Background

Too-late fall T predictions (red circle) and
too warm T and too dry spring T_d predictions (green circles)





Background

The difference between surface T and T_d values is directly related to the convective boundary layer (CBL) depth:

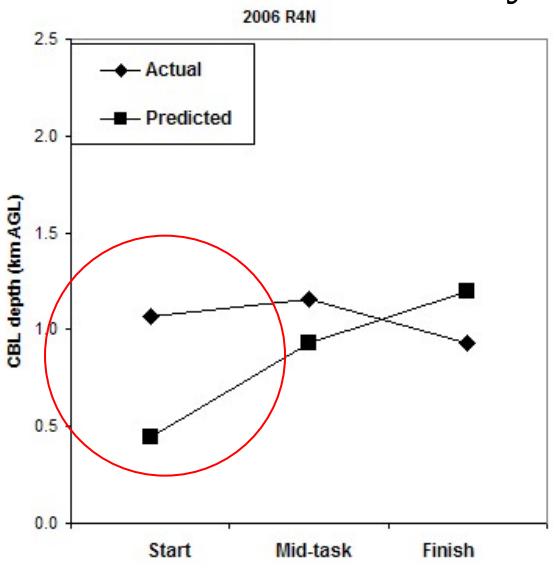
$$\text{CBL depth (m)} = ((T - T_d)/2.44°C)) \times 210.4$$

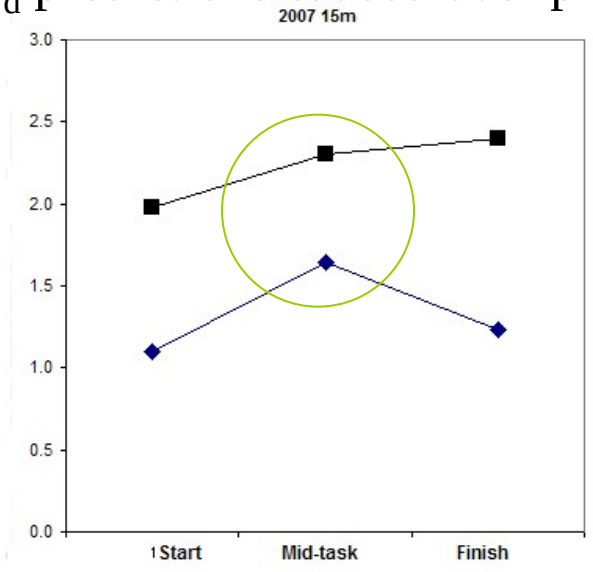
So, accurate surface temperature predictions are crucial to successful convective boundary layer predictions.

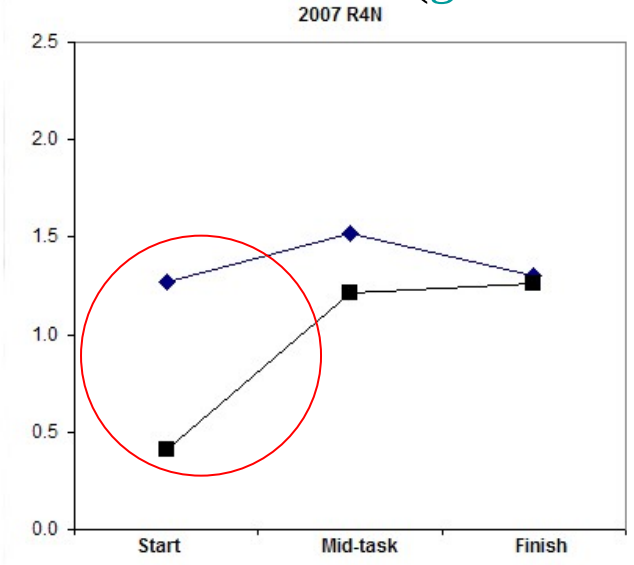
Background

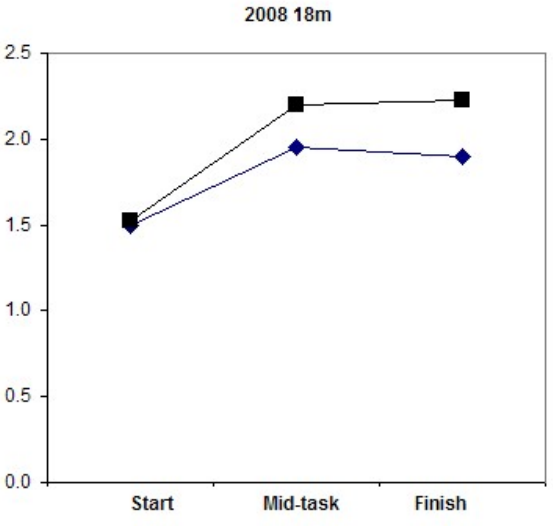
Early morning lag in T predictions caused CBL development too late (red circles)

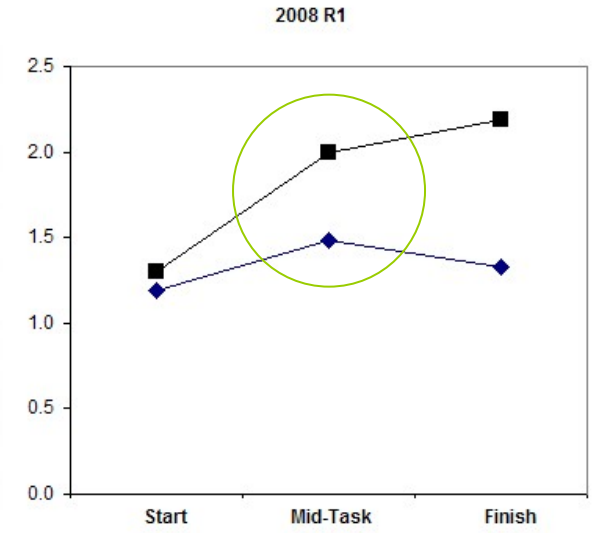
Too-warm T and too-dry T_d predictions caused over prediction of the CBL (green circles)

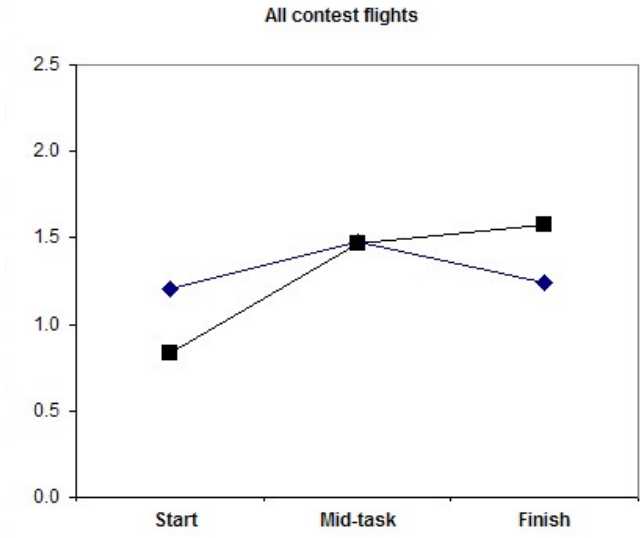












Objectives of study

The corrections suggested at the 2008 OSTIV Congress were implemented during the Spring and Summer of 2009 and the improved results are reported here.

The improved RAMS predictions were compared with TOPTHERM predictions. As a result, using the TOPTHERM-Java TopTask system in the northeast USA appears feasible.

Procedures: Fix inaccurate fall T predictions

The RAMS solar radiation predictions were compared with fall solar radiation measurements made at CSU. It was found that the RAMS solar radiation predictions were lagging about 30-40 minutes behind the measurements. Improved equations for computing the Sun angles were obtained and, near sunrise and sunset, the radiation model was run much more frequently than during the day or night. With these two fixes, the modeled shortwave radiation matched nearly exactly the measurements.

Additionally, the minimum wind speed that factors into computations of ground heat and moisture fluxes was adjusted and the temperature predictions improved dramatically.

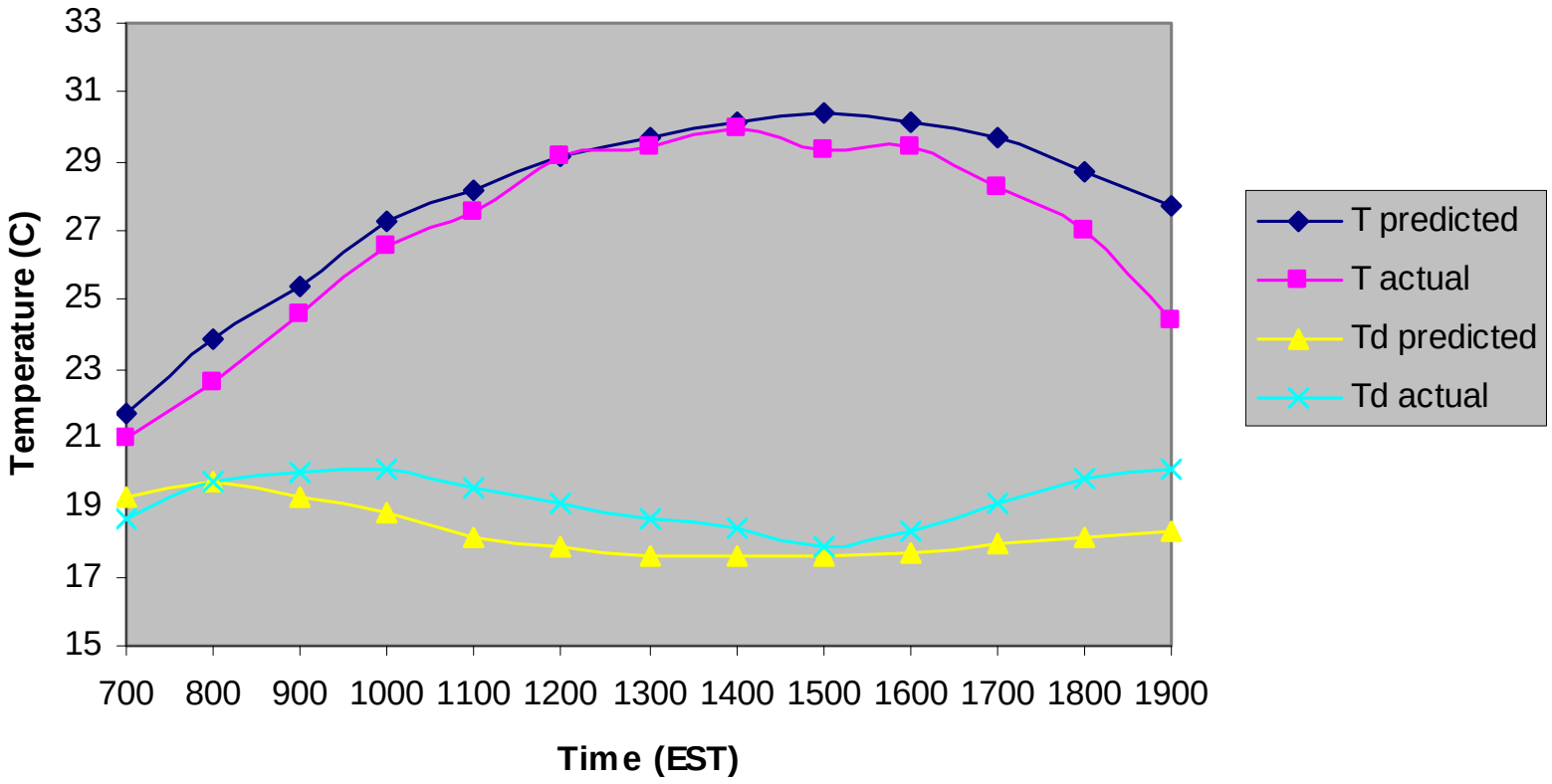
Procedures: Fix too-warm T and too-dry T_d predictions in spring

Two major changes were made in Spring 2009:

First, the ‘cold’ start procedure (initializing the model with only external initial conditions and daily restarting the model which ‘shocks’ the system) was replaced with the ‘warm’ start procedure (initializing the model with a mixture of ‘yesterdays’ predictions plus external conditions and continuously running the model which does not ‘shock’ the system).

Second, the constant and homogeneous soil moisture in the RAMS was replaced with the USA National Centers for Environmental Prediction’s NAM model soil moisture values. The synoptic-scale NAM initializes the meso-scale RAMS. This change allowed more realistic soil moisture initial values.

Results: Fixed fall T predictions



Results: Fixed too warm T and too dry T_d predictions

RAMS boundary layer configuration	Date	Maximum altitude (m ASL)	Corresponding predicted CBL depth (m ASL)	Predicted T C	Actual T C	Predicted Td C	Actual Td C
100% of NAM soil moisture, 'cold' start	15-23 May 09						
	Average	2147	1653				
	Std error	169	53				
30% of NAM soil moisture, 'warm' start	24 May - 7 July 09						
	Average	1916	1313	23	24	14	9
	Std error	68	120	1	1	1	1
Increased the imposed turbulence parameter	8-14 July 09						
and reduced the soil moisture flux term to 25%	Average	1833	2506	26	24	7	11
of computed amount based on soil to canopy	Std error	62	82	1	0	1	1
moisture gradient.							
Increased soil moisture flux term to	14 July - 13 Sep 09						
greater than 25% but less than 30% of NAM	Average	1724	2155	26	25	10	12
soil moisture.	Std error	39	66	0	0	0	0

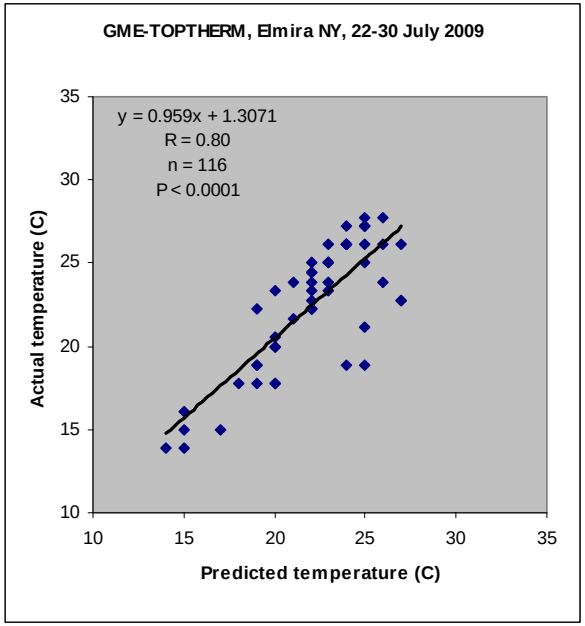
Results: RAMS-TOPTHERM comparison

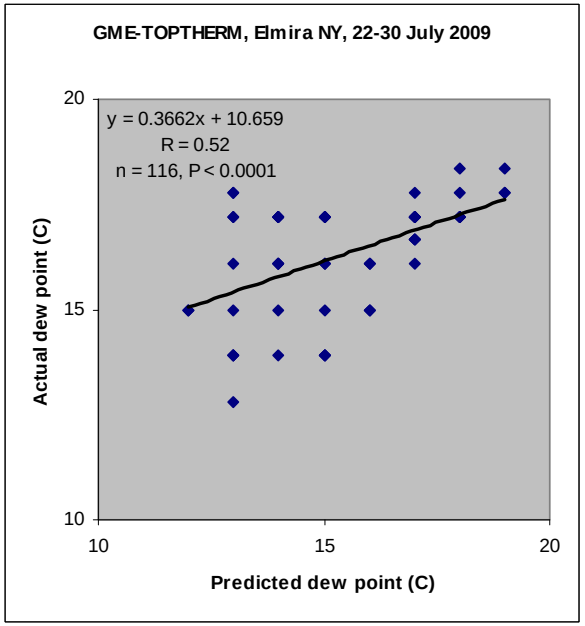
The TOPTHERM-Java TopTask system is imbedded in the DWD's pc_met where the DWD regional model (7 km) initializes TOPTHERM. To make the system operate for the northeast USA, the TOPTHERM was initialized by the DWD global model (40 km). So, TOPTHERM was predicting with 'one hand tied behind its back'. Further, the RAMS and TOPTHERM have different constructions.

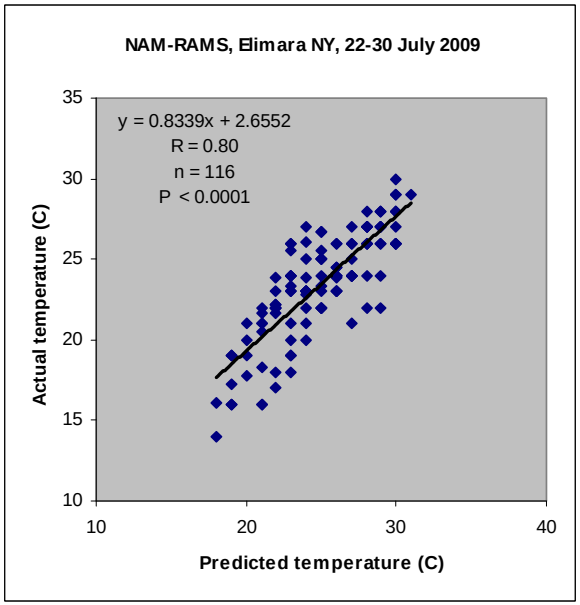
The RAMS and TOPTHERM predictions for the USA Sports Class Nationals, 22-30 July 2009, at the famous USA glider-town of Elmira NY

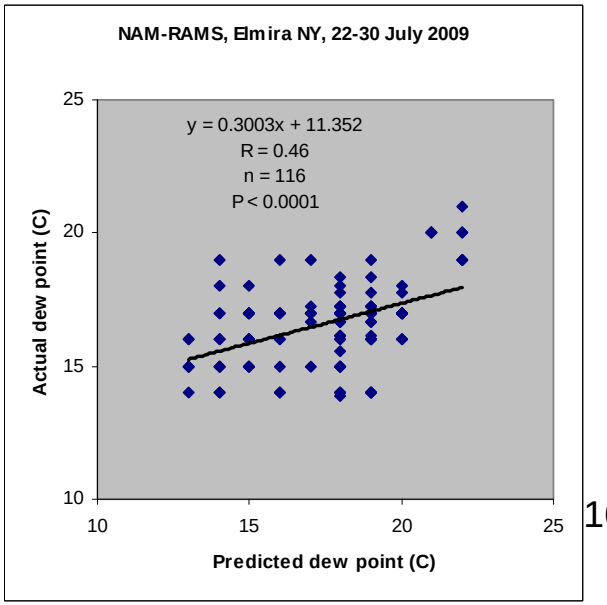
Atmospheric model		Maximum altitude (m MSL)	Predicted CBL-top (m MSL)	Predicted T C	Actual T C	Predicted T_d C	Actual T_d C	Actual speed (kph)	Predicted speed (kph)	Distance flown (km)	PFD (km)
RAMS	Avg	1722	2000	27	27	16	15	85	90	198	272
	StdError	28	133	1	0	1	0	2	5	12	42
TOPTHERM	Avg	1728	1894	25	27	13	15	84	94	197	504
	StdError	29	59	0	0	0	0	2	5	11	52

Results: RAMS-TOPTHERM challenge









Summary

The campaign continues to make available to USA glider pilots the European TopTask glider flight planning and analysis algorithm. The initial USA study coupled the Regional Atmospheric Modeling System (RAMS) and the TopTask in Colorado with success in planning long-distance flights. Currently the system is being refined in the northeast USA using meteorological and glider flight recorder data primarily from glider contests. As a result, fundamental problems with predicting surface temperatures and dew points have been discovered and minimized by improving the solar radiation model and the surface-flux model. Recent RAMS and TOPTHERM predictions for the northeast USA were shown to be comparable. Thus, the current TOPTHERM-Java TopTask system of the German Weather Service can make useful predictions for northeast USA glider flights. But, in both models, predictions of surface dew points need to be improved.

You are invited to submit your papers from this OSTIV Meteorological Panel meeting to the OSTIV International Journal *Technical Soaring*

journals.sfu.ca/ts/

XXX OSTIV-Congress 2010 Szeged, Hungary
21 - 28 July 2010

Call for Papers

The Congress will be held at the site of the 31th World Gliding Championships in the Open-, 18m- and 15m Class. The Congress addresses all scientific and technical aspects of soaring flight including motorgliding, hanggliding, paragliding, ultralight sailplanes and aeromodeling.

Please send titles and abstracts to l.m.m.boermans@tudelft.nl
by 1 May 2010