Creating and Using Lapse Rate Forecasts to Predict Soaring Conditions

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What we are going to discuss.

- What is a lapse rate forecast and how can we use it to predict soaring conditions?

- How to combine lapse rate forecasts with other information to choose where to fly and when.

- By knowing what made the forecast, and seeing how it turned out in reality, you can fine tune future forecasts for your flying area.

- The data is available at no cost from the government and is easy to get and interpret.

What is a lapse rate forecast?

- It is a prediction of the atmosphere from the ground to the stratosphere. You pick the location by airport ID or lat/long.

- It is based on balloons launched twice a day by the government at 92 sites, carrying radio transmitters that report data as the balloon goes up to the top of the stratosphere.

- The balloon data is combined with lots of other data to generate forecasts that you can custom-design for your soaring site or area and for the time of day you choose.

- Important for glider pilots – you can see how the strength and height of the lift will change as the surface temperature changes during the day.

- You can see whether cumulus clouds will form.

How to get the forecast and what does it look like?

- NOAA generates it.

- You can get it here: https://rucsoundings.noaa.gov/

- We are going to walk through how to get the sounding and how to use it for soaring forecasting – both in advance of the day of your flight and on that day.

- Several forecast models are only available for the current day and the next day.

- Others are available up for five days into the future.

This is what you see when you go the website:

Generate soundings from [Rapid Refresh (RAP)](#), [GFS, NAM](#), and other Model Analyses and Forecasts, [RAOBS](#), or [Aircraft (restricted)](#)

This site is not supported 24/7, and may be subject to outages.

Latest version: 23-Feb-2021. See change details for more information.

For up-to-date information about RAP runs, see the [RUC/RAP forum](#).
(You can subscribe to this forum to get email copies of new posts.) Please also see the **[RAP FAQ](#)**.

For up-to-date status of RAP/RR model Runs, see [RAP status (Bak40,and Bak20)](#).

[Instructions](#) | Latest **Op40** analysis is valid at **19:00 UTC** | Latest **Bak40** analysis is valid at **20:00 UTC**

Initial data source:	○ **Op40** (to 18h, NCEP 13km RAP on **CONUS** 40km grid, hourly) or ○ **Bak40** (to 24h, GSL 13km RAP on **CONUS** 40km grid, hourly, formerly "MAPS") or ○ **NAM** (to 15h, 3-hourly) or ○ **GFS** (Global, 0.5° grid, 3 and 6 hourly) or ○ **RAOBs** or ○ **Aircraft** (restricted) or --- **slower-to-load, high-server-load**, or special purpose soundings below --- ○ RETRO (special restores) or ○ CIMSS (special RAOBs)
Start Valid Time:	☑ Latest, or [2022 ▾] [Apr ▾] [9 ▾] - [20 ▾] : [0 ▾] UTC
Number of hours:	[1.0] Desired forecast projection [shortest ▾]
Name(s), "lat,lon", or RAOB-WMO-ID(s):	Site(s): Site info: METARs, Airports, [_____] RAOB locations, latest RAOB times.

[Interactive plot] [Ascii text (GSL format)] ([Explanation of GSL format](#) | [parameters for text requests](#),)

OLD java plots, soon to be unsupported: [SIMPLE java plot] [Java plot] [UNSIGNED plot]

This is a forecast for April 11, 2022 at KJOT at 18Z or 1 pm.

Zoom in to set a predicted surface temperature. Here 56 F. Prediction: Cus may form at 7,000. 3-Degree Spread at 4,800. West winds aloft at 25K.

GFS 54h Forecast, valid 11-Apr-2022 18:00:00 (8.1nm/98° from JOT)

CAPE 0
CIn 0
PW 11
TT 37
KI -14
LI 11
SI 11
SW 116
LCL 899
LFC 6
iCAPE 107465
iCIn -100116
iLCL 796
iLFC 5

wind (kts)

Pressure (mb)

700
800
900
1000
1050

1000mb T: 2 (36F)
269 ft   θ: -1.7   4.3 (5:
-946 ft.
1048.4mb

13.6 (56 F)   258°/12

GFS JOT(F54) 18Z 11Apr22

SkewT-log P

NOAA / ESRL / GSD

Press Alt. (Kft.)

kts

0   50   100

And there are likely to be high clouds at 30,000' and maybe another layer at 8,000'

Here are the steps to generate the chart:

- 1.   Select the forecast model to use from the options listed.
- 2   Set the date and time. (Not all models will generate hourly forecasts. GFS goes out five days and gives a good idea of future conditions. Op40 only works one day in advance, but provides hourly data.)
- 3.   Define the location. In our example, Joliet, Illinois (KJOT)
- 4.   Define the output format. We want an interactive chart.
- 5.   Get it by clicking the box marked "interactive plot".
- 6.   Expand the chart to focus on the boundary layer – where we fly.
- 7.   Add the temperature at the surface. Draw the DALR line – which is the lapse rate at 5.5 degrees F/1000'
- 8.   Analyze the chart that results.

What is the DALR – Dry Adiabatic Lapse Rate?

From the York Canada

Soaring Club:

https://yorksoaring.com/
wp-content/
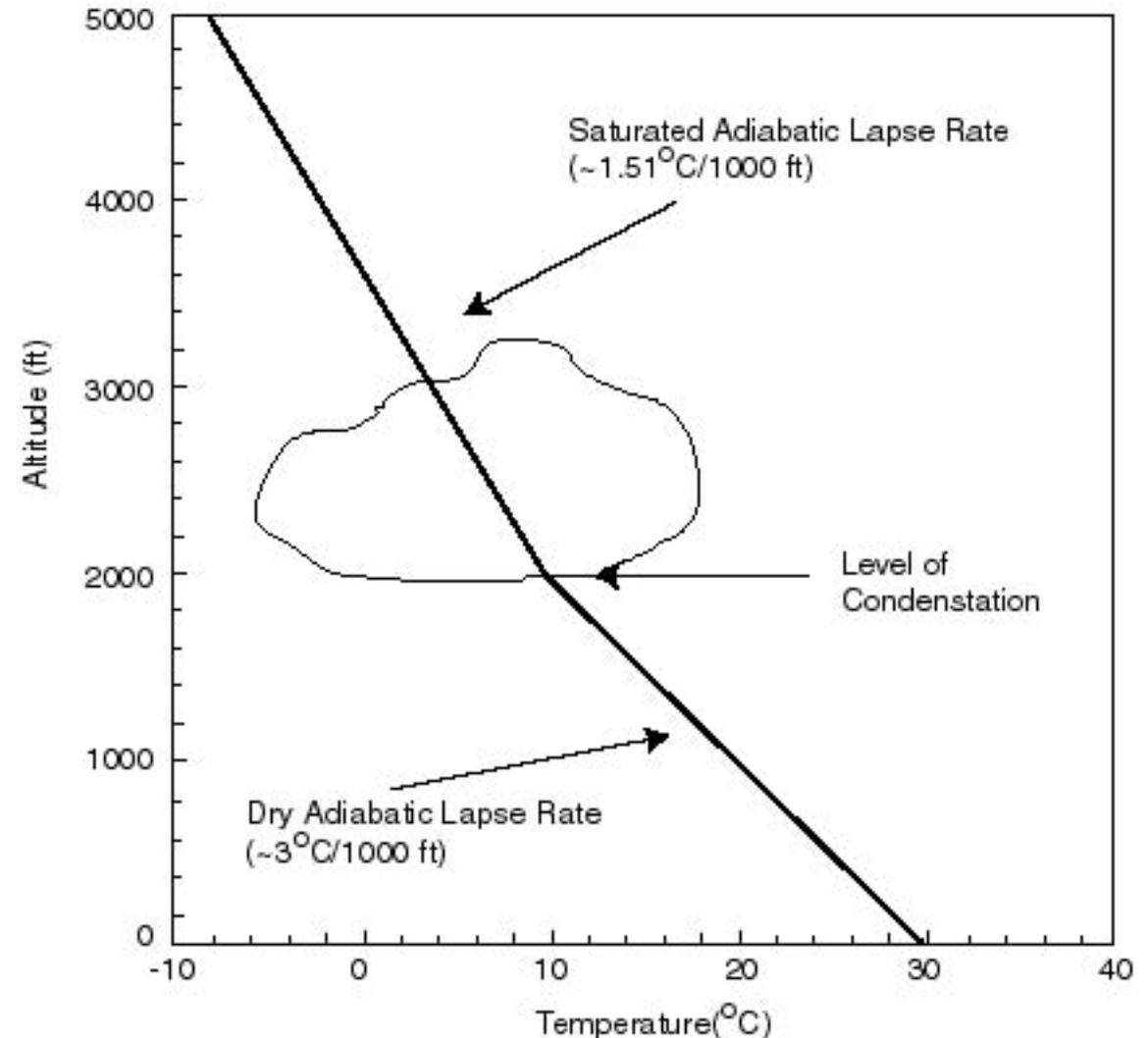
Why do we care about the DALR?

- "The actual lapse rate varies considerably, and depends somewhat upon the moisture content of the air and other factors." DALR is an approximation.

- "Pilots generally want two pieces of information, the actual change in temperature with height, and the conditions of air at the surface. If the air at the surface is warmer than the [surrounding air], a parcel of air will begin to rise . . . [*In other words – that's a thermal.*]

- "This rising air will cool off primarily by expansion at a rate known as the dry adiabatic lapse rate. When this parcel of air reaches its dewpoint however, the rate of cooling will decrease due to the heat released when water vapor condenses to a liquid. This is known as the saturated adiabatic lapse rate.

- "The height where the parcel of air becomes saturated also is the height at which cloud starts to form. [*Cloud base.*] When the parcel of air can rise no higher" or has released all of its moisture, the top of the cloud is reached." [From York Soaring.]

Back to the NOAA website: Here is the input box with data entered for April 11 at KJOT:

Clicking "interactive plot" creates the skew-t plot for our selected time and place:

What is a skew-t chart?

- "This diagram's name stems from the fact that lines of equal temperature are skewed at a 45 degree angle along the horizontal axis and pressure in millibars is plotted on a logarithmic scale along the vertical axis. . . .

- "[M]eteorologists overlay temperatures, dewpoints, and wind barbs on this diagram to make thermodynamic calculations easier.

- "Temperature, dewpoint, and wind information [is shown] on a Skew-T Log-P . . .)" [**This is why its really useful. It predicts soaring conditions.**]

- *Air Facts Journal: https://airfactsjournal.com/2018/08/how-to-use-a-skew-t-log-p-diagram/*

Back to the NOAA website: We want to look at the altitudes where gliders fly. So zoom in on the boundary layer: Hold the left mouse button and drag to create a rectangle that looks like this:
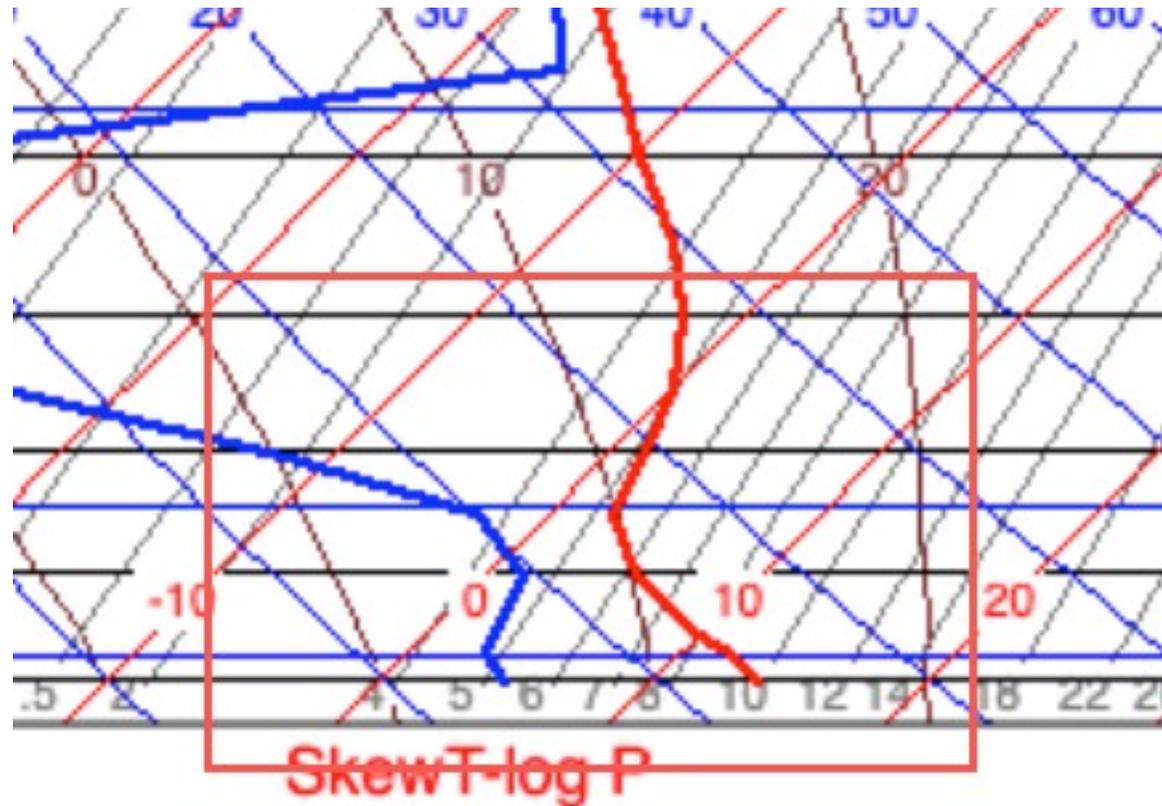
Now add the surface temperature.

- Do this by moving the mouse to the right to the desired temperature at the surface. Then click the left mouse button. It will draw a purple DALR line up and to the left:
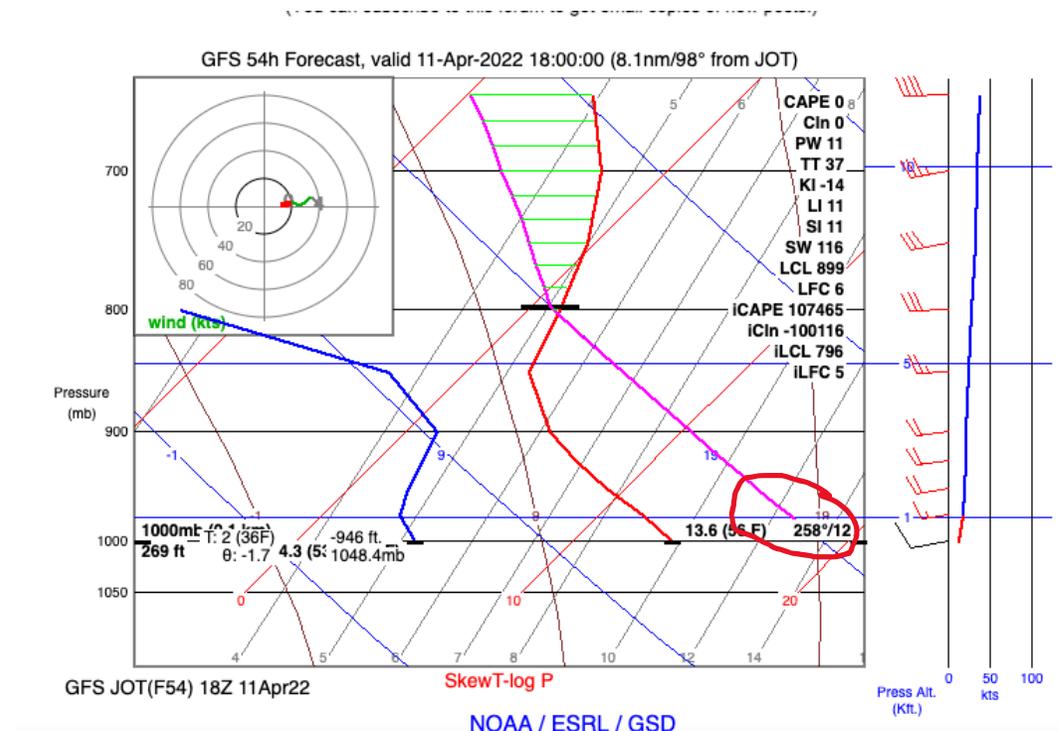
What do we get by drawing the DALR line?
A lot!

- It predicts whether there will be cumulus clouds and at what altitude.
- It provides the altitude of the 3-Degree Spread (normally the altitude the glider can reach).
- It shows winds aloft at each altitude.
- It shows whether there will be an inversion aloft.
- It can display all this over time to see how the soaring day will change.
- If you are unsure of the surface high temperature, you can use several to see how they differences will effect the soaring conditions.

To extract information from the skew-t chart we need to know about three colored lines: Red, Blue & Purple.

- The red line predicts the temperature of the atmosphere from the ground to the stratosphere, based on the radiosonde balloon data and the computer models.

- The blue line predicts the dewpoint – the temperatures and altitudes at which the air is fully saturated with moisture. I.e., clouds.

- The purple line predicts what will happen to a parcel of heated air rising from the surface – in other words, a thermal. That air has its own dew point. As it rises, it cools. If it reaches its dew point, a cumulus cloud forms.

- Let's look at the skew-t chart and these three colored lines.

The three lines give us important information:
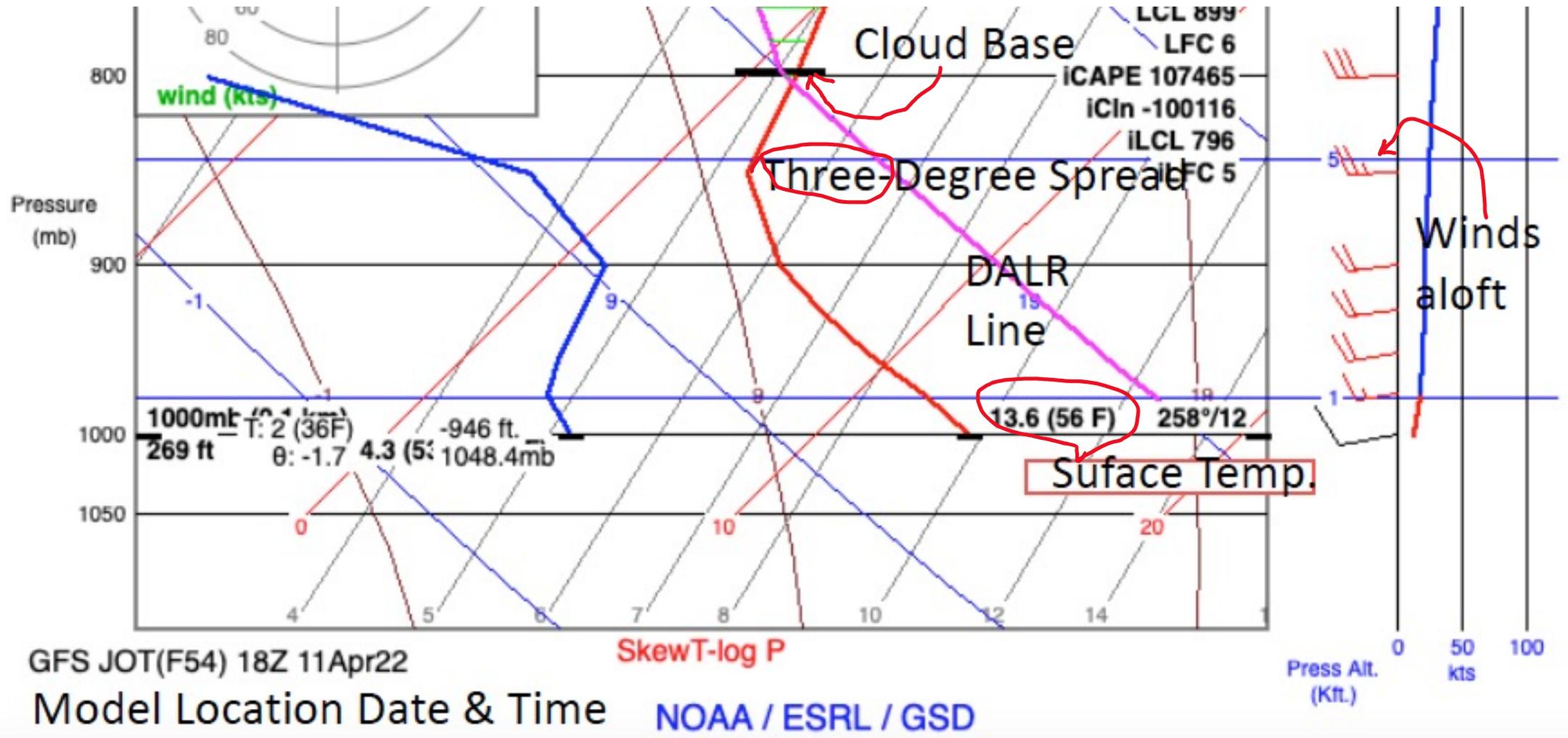
Want to try a different data model, date or time? Try April 10 from noon to 4 pm.

- Click the box on the chart that says "Load Sounding" to do so. Four hours were
- chosen
- starting at
- 17Z or noon.
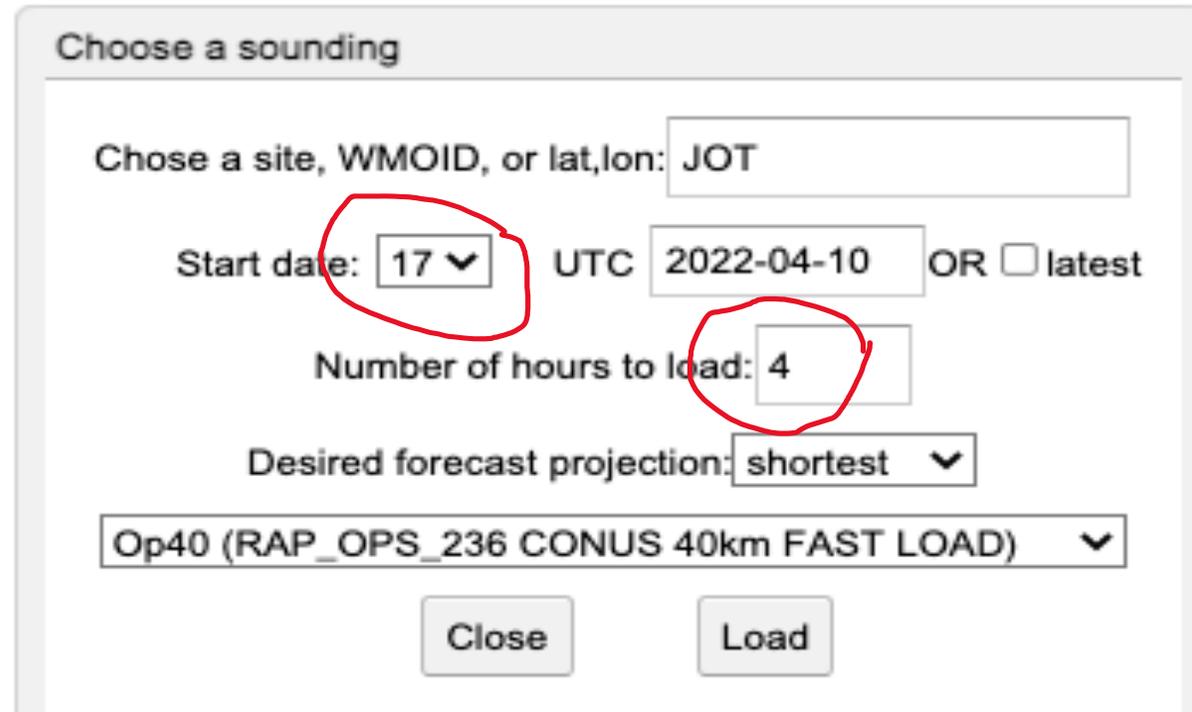
You can compare four hourly charts for April 10.

Op40 23h Forecast, valid 10-Apr-2022 20:00:00 (10.1nm/59° from JOT)

CAPE 0
Cln 0
TT 41
KI 10
LI 11
SI 7
SW 272
LCL 838

wind (kts)

Op40 JOT(F23) 20Z 10Apr22

SkewT-log P

NOAA / ESRL / GSD

Press Alt.
(Kft.)   kts

| Load Soundings | Get text | 0.5 mb scale | SkewT/Tephi. | Wind scale: 40/100 | Simple plot |
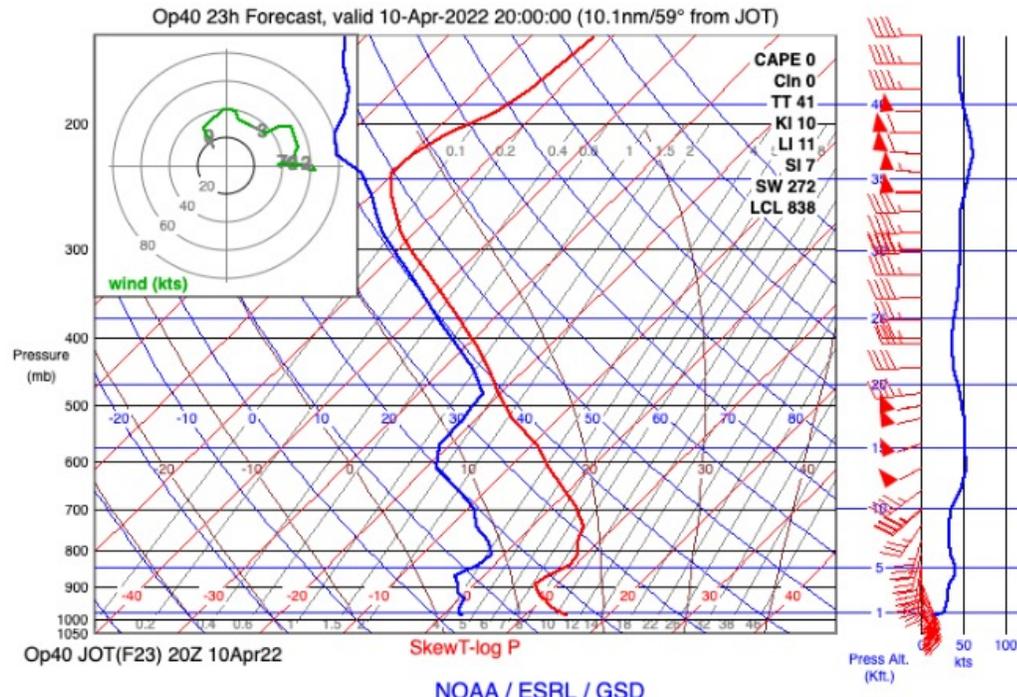
JOT(F23) 20Z 10Apr22	JOT(F22) 19Z 10Apr22	JOT(F21) 18Z 10Apr22	JOT(F20) 17Z 10Apr22
JOT(F48) 18Z 11Apr22			

• Click on the time boxes at the bottom to move to other chart times. This is the 20Z chart.

• See how the winds aloft change over the afternoon.

• See if the high clouds change.

• See if the inversion changes as the day advances.

# Want to learn more about the lapse rate?

- The NOAA website discussed in this presentation suggests several sources, including one from an SSA Annual meeting presentation: "Practical Use of Meteorological Models and Visulization Tools for Soaring Forecasters" A presentation by Walt Rogers at the 2016 Soaring Society of American National Convention (Greenville NC).

- For a less-soaring focused discussion see Tim Vasquez "Return of the Skew-T" in the January 2022 issue of IFR Magazine.

- Also useful is Scott Dimmish, How to use a Skew-T Log-P diagram, from Air Facts of Aug. 2018. https://airfactsjournal.com/2018/08/how-to-use-a-skew-t-log-p-diagram/

Lapse rate forecasts need to be used with other weather information

- Temperature forecasts – since the purple DALR line is based on an assumed surface temperature.

- The big-picture of fronts, their movement and precipitation.

- Soil moisture content is very important. Solar energy in wet soil makes dry soil, not thermals.

- Also important are local variables that can have an impact on surface temperature and soil moisture.

- If you make it a practice to look at all these sources, and relate them to the information generated by the lapse rate charts, you will become accurate in predicting when soaring will begin, when it will end, whether there will be cus and at what altitude.

Let's look at some relevant influence

- Temperature: You can get a forecast high and the rate of change over the course of the day from the local forecast office:

- Click "Hourly Weather Forecast" on the National Weather Service website for Joliet, Illinois and you will see this:

- As you gain experience you may want to add or subtract from the predicted numbers. I find the NWS 1-2 degrees over most days.
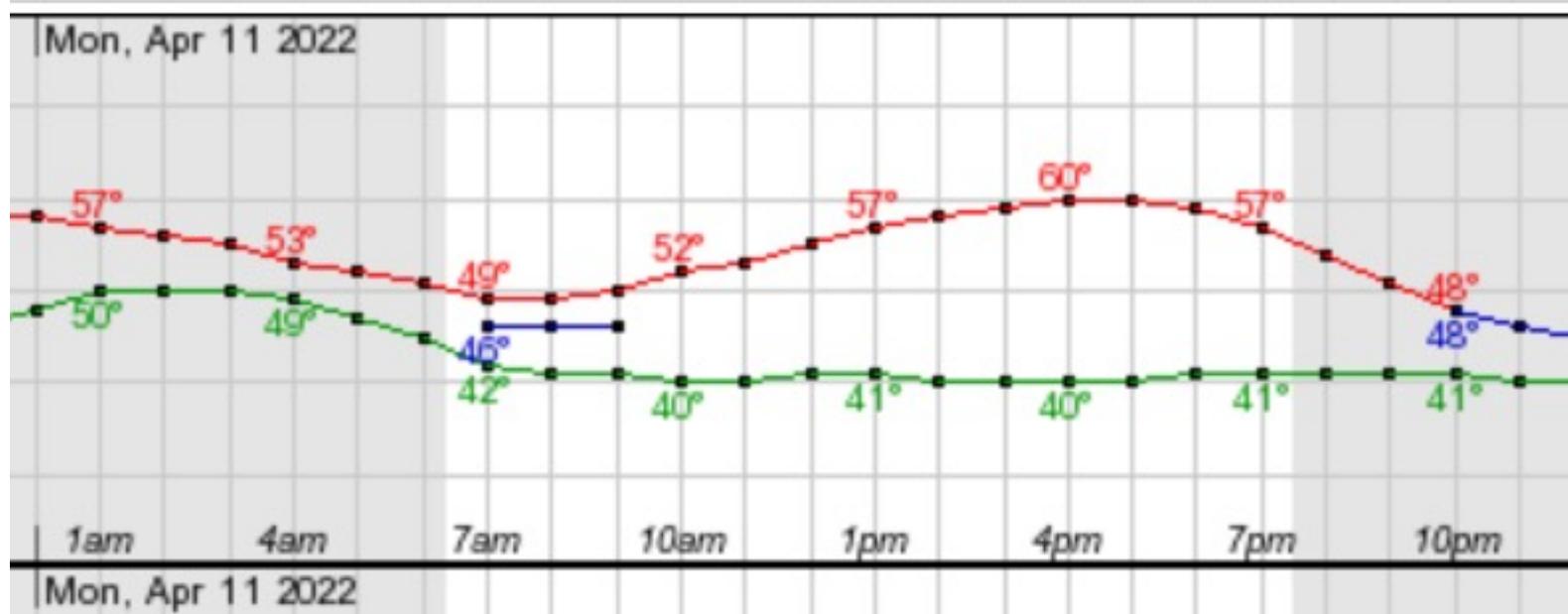
# Factor in the influences of the big picture – fronts and rain.

- Will a front pass on the day you choose, and how fast it is forecast to move.

- Is the front likely to bring rain or be dry?

- Wet means the soil will be wet and that solar heating may be used in drying the land, not generating thermals.

- The National Weather Service provides prog charts and soil moisture data.

- Let's look at those for April 11, as viewed on the evening of April 10.

The big picture from the prog charts: the front is relatively slow and wet.
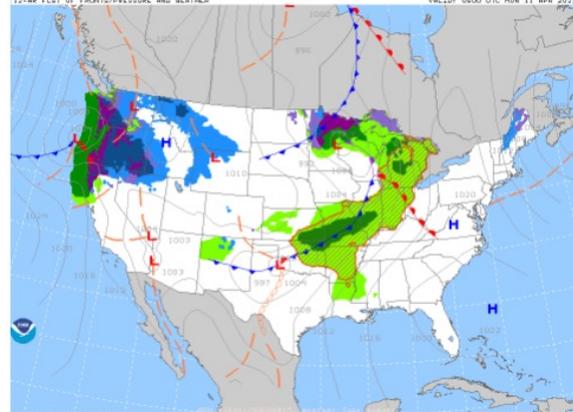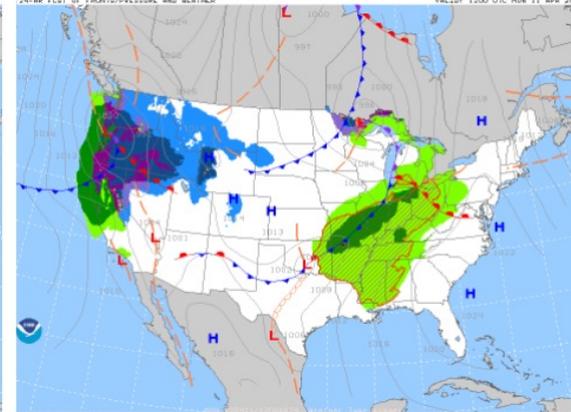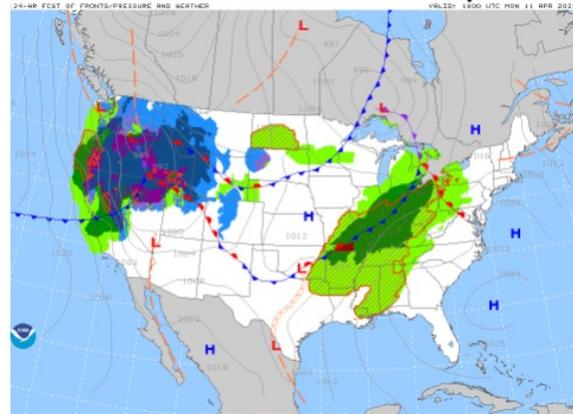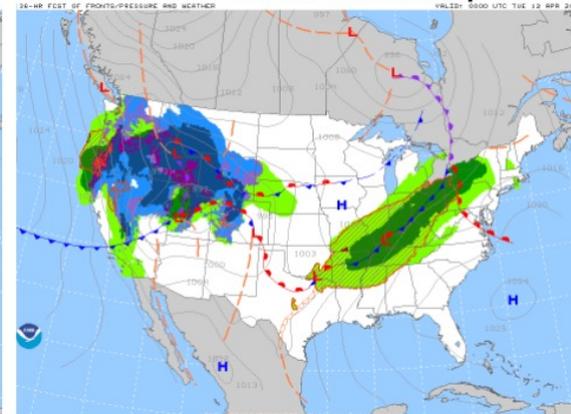
Has it been raining in the last week? Where and how much?

- Check the local NWS web page "Current Conditions/Observed Precipitation." Click "last seven days." This is what you would have seen on the evening of April 10:
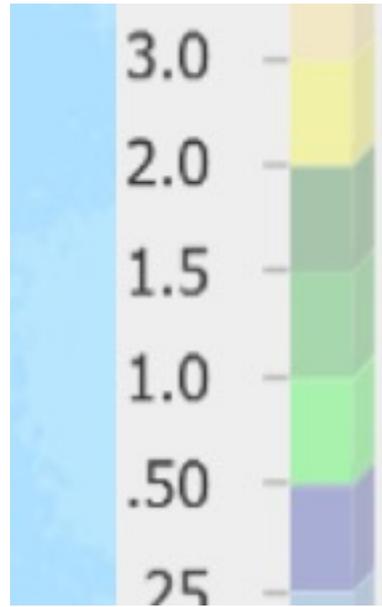

The Joliet area had between 1 and 1. 5 inches of rain in prior seven days.

That is likely to be relevant based on local soaring experience with conditions following a week of moderate rain.

Factor in your experience with the terrain

- Are you flying over farm land, fields, urban areas, factories, refineries, shopping centers – or some of each. Is there a river running through the area?

- In the Joliet area we have all of the above, as the next slide shows.

# The chart indicates the variety of features.
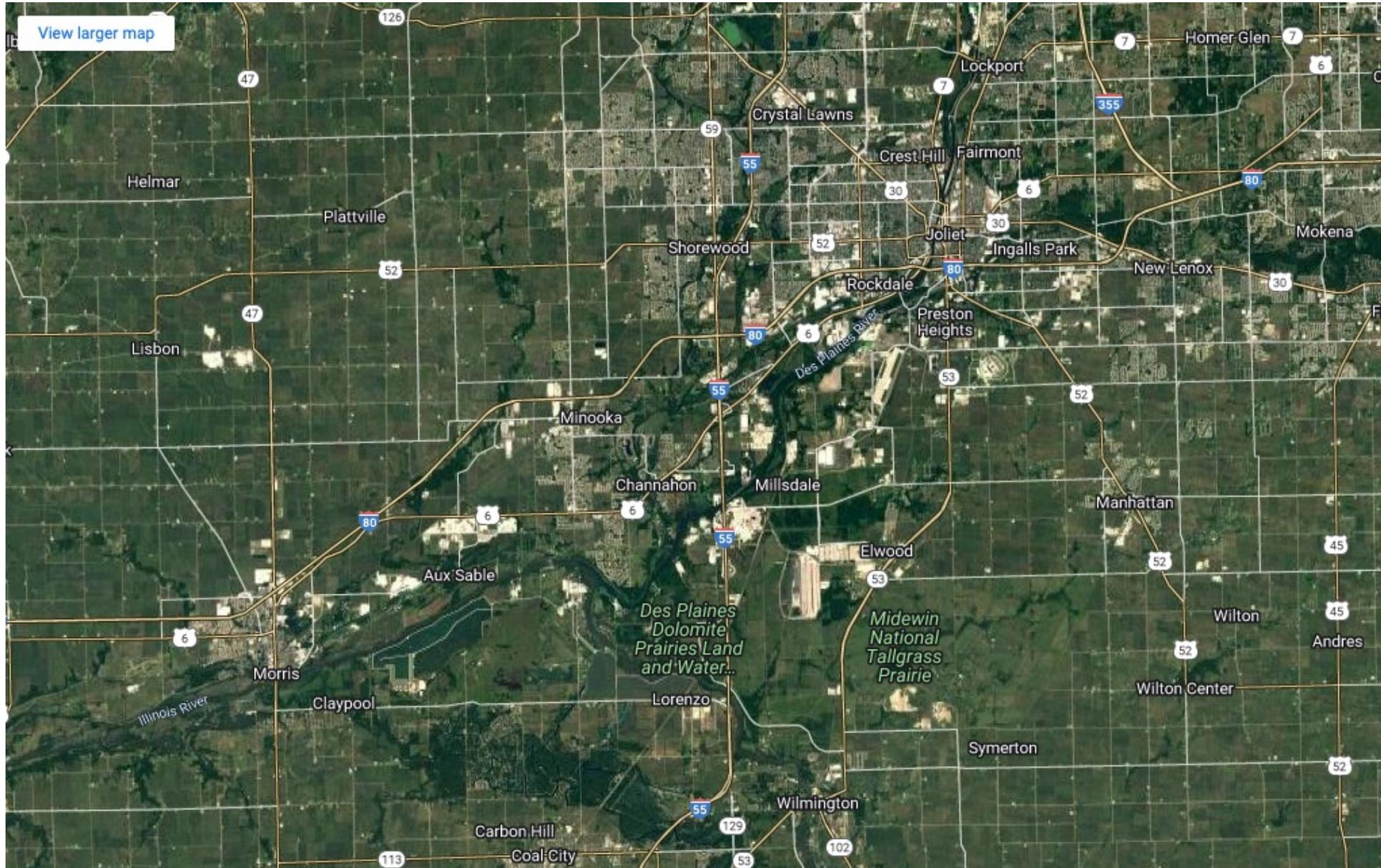
Cities and towns.

Warehouses & refineries

Major roadways.

Farm land.

Rivers and low areas.

What happens on a day when the lift is strong is some areas and weak in others?
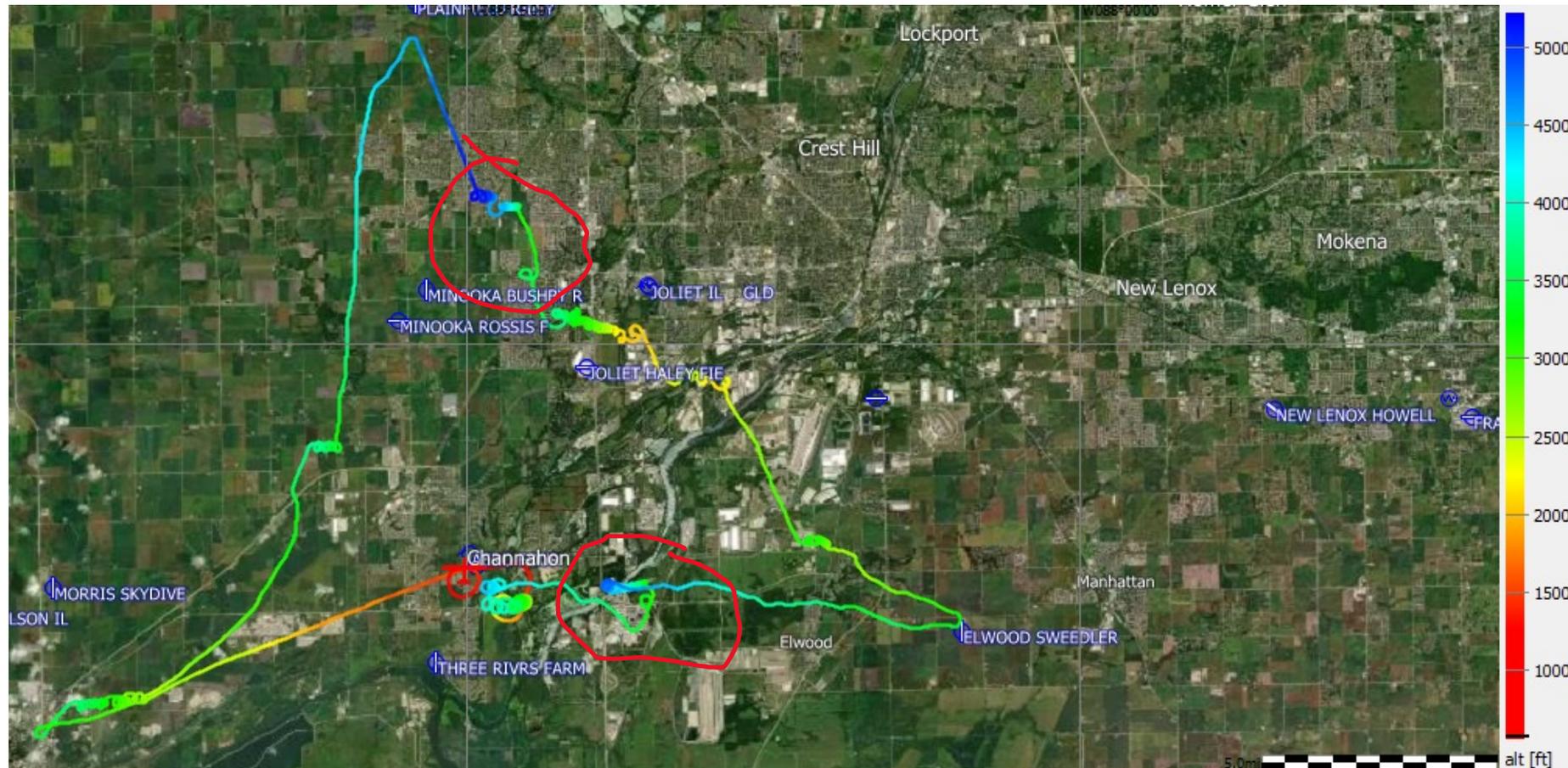
Strong lift at a refinery and Downwind of a suburban housing development.

The vertical view. Note refinery and housing development thermals.

To sum up:

- The information needed to prepare accurate forecasts of soaring conditions are available, at no cost, on the internet from the government.
- Try the lapse rate site at http://rucsoundings.noaa.gov/. It is intuitive to use, and will forecast soaring conditions for the next day, or even five days in the future. Experiment with the models offered.
- Develop a feel for local conditions including the accuracy of forecast temperatures from the local NWS office.
- Pay attention to fronts and recent rainfall in your area, and relate them to the lapse rate forecasts.
- Take account of what is on the ground. Conditions can change in a few miles depending on whether you are flying over farms, towns or industrial areas.
- Have fun being your own weather forecaster. Your forecasts will often be very accurate.