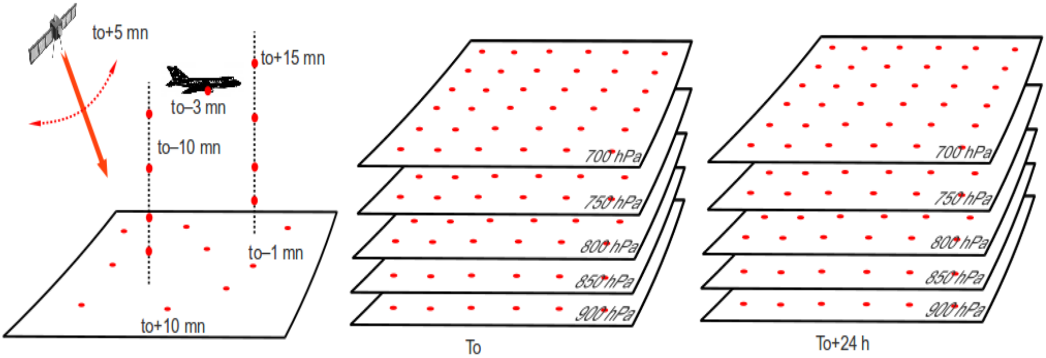
The GFS weather model

The Global Forecast System (GFS) is a numerical weather model of the National Weather Service and the National Oceanic and Atmospheric Administration (NOAA), USA. A numerical weather model is a very complex software that operates as follows : Measured weather data (stations, radiosondes, satellites), non-homogeneous in time and space, are assimilated by complex calculations on a regular 3D virtual grid of initialization at a specific time, also called analysis. Start weather data thus become homogeneous in time and space. GFS grid covers the entire Earth. Analyses are performed 4 times daily at 00Z, 06Z, 12Z and 18Z. Z = UTC = universal time hours = about the TZ of United Kingdom. Then GFS computes (i.e. simulates and predicts) the weather data evolution every 3 hours during the next 7 days at each grid point. The GFS model has a horizontal resolution of 0.5 ° between grid points (i.e approx. 30-50 km) and a vertical resolution of 64 levels.



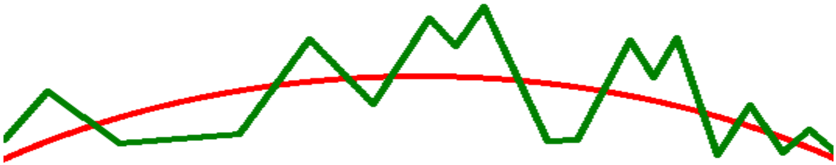
Observations and measurements are space-time heterogeneous.

Analysis (initialisation), on the left, at To and forecast (simulation), on the right, at Tx are space-time homogeneous.

GFS is the only global (or macroscale or synoptic, i.e. for the world) model whose digital outputs are freely and fully available in real time. Every one can legally take the daily coded files, freely available in the NOAA's servers.

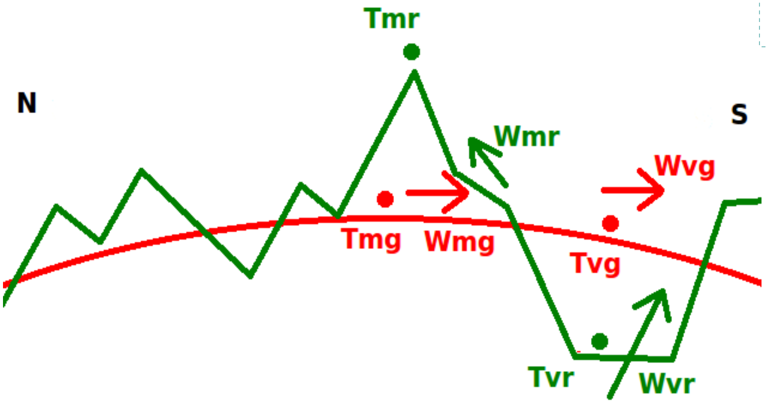
Interpretation of the model outputs

GFS 0.5 ° is a synoptic model with wide mesh. The topography is extremely simplified. For example, for the Alps, GFS "sees" no valley. It "guesses" just the Swiss Plateau between the Jura and the Alps. With GFS, the Alps thus seems like a huge smooth arc-shaped mountain.



The profile of the Alps in GFS appearance (red cross-sectional profile) and in green "real" appearance (in fact, also very simplified here).

This difference between microscale reality and simplified synoptic GFS appearance is therefore valid for the weather parameters as well:

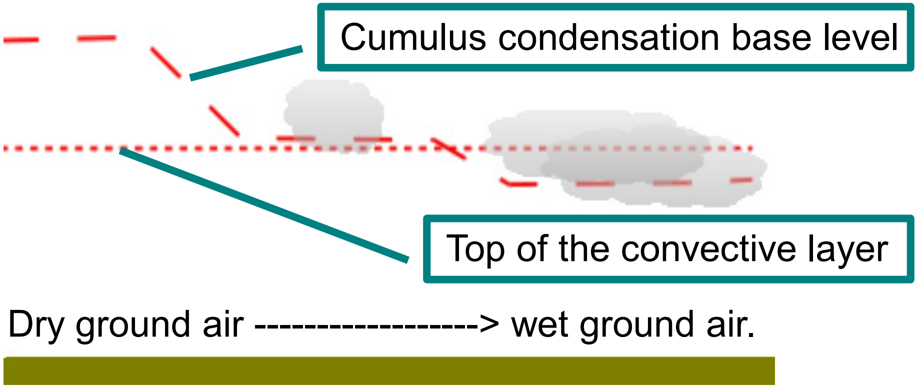


Terrain, wind W and the air temperature T are represented in green for the "reality" and red for GFS. The GFS forecast air temperature Tmg = 12 °C at a peak not visible at macroscale, while the actual real temperature **Tmr** = 0 °C at the top of the peak. Conversely, Tvg = 13 °C at the bottom of the broad and deep (i.e. with low background altitude) valley not seen by GFS, while the actual real air temperature **Tvr** = 27 °C.

The reasoning is also valid with the wind W. Let's imagine a little north GFS synoptic wind at the mountain peak location : Wmg. In reality, on the south side of the peak exposed to the sun, there will be a small south rising local thermal wind **Wmr** along the slope. In the valley, instead of the GFS weak north wind Wvg, there will be a local perpendicular moderate valley wind **Wvr**.

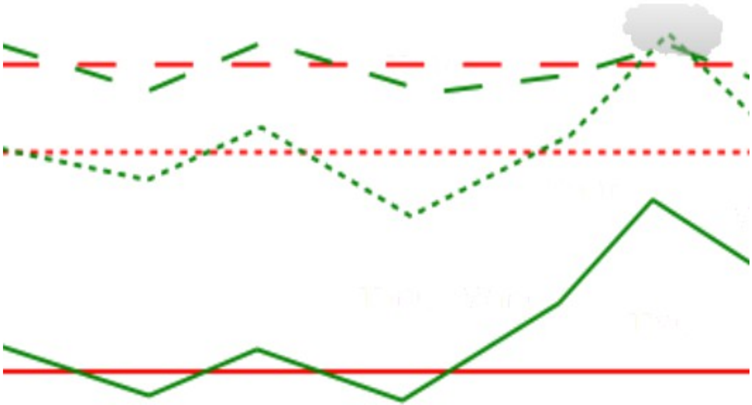
Finally here is another example of interpretation between the synoptic scale and the reality scale with the top of the convective layer and the cumulus condensation level (cloud base).

Reminder : the potential altitude of the cumulus base i.e. the cloud condensation level of the convective layer depends on the degree of air humidity near the ground. Wetter is, less high the cumulus base and inversely :



If the condensation level is higher than the top of the convective layer (on the left), thermals will fail to reach this level. Cumulus can not be formed. If the level of condensation is lower (on the right), there will be cloudy over-development.

In the next figure, red lines = GFS model. Green = the "reality". Solid lines = topography. Dotted lines = top of the convective layer. Dashed lines = level of vapour condensation = base height of cumulus :



The synoptic GFS condensation level is well above the top of the convective layer. In fact, over a relief "not seen" by GFS, the convective layer top can reach the condensation level. Cumulus clouds can therefore form on this relief while GFS has not forecast cumulus at this location !

Final remark about the accuracy of the GFS model :

The forecast takes place for the 7 following days. Obviously, from the third and fourth day, the model accuracy decreases. You may be often disappointed in the last days forecast. Empirically however I noticed a small tip. If on Monday, for example, you want to evaluate the flight conditions for the following weekend. You notice a sunny weekend with little wind. If such similar weather conditions are predicted without significant change in the next Tuesday and Wednesday for that same weekend, then the probability of reliable forecasts increases significantly! Conversely, if forecast change greatly from day to day, the forecast for the weekend are very random.