PV MODIFICATION: A TOOL ALLOWING THE FORECASTER TO IMPROVE THE MODEL INITIAL STATE

Bernard Roulet, Meteo France

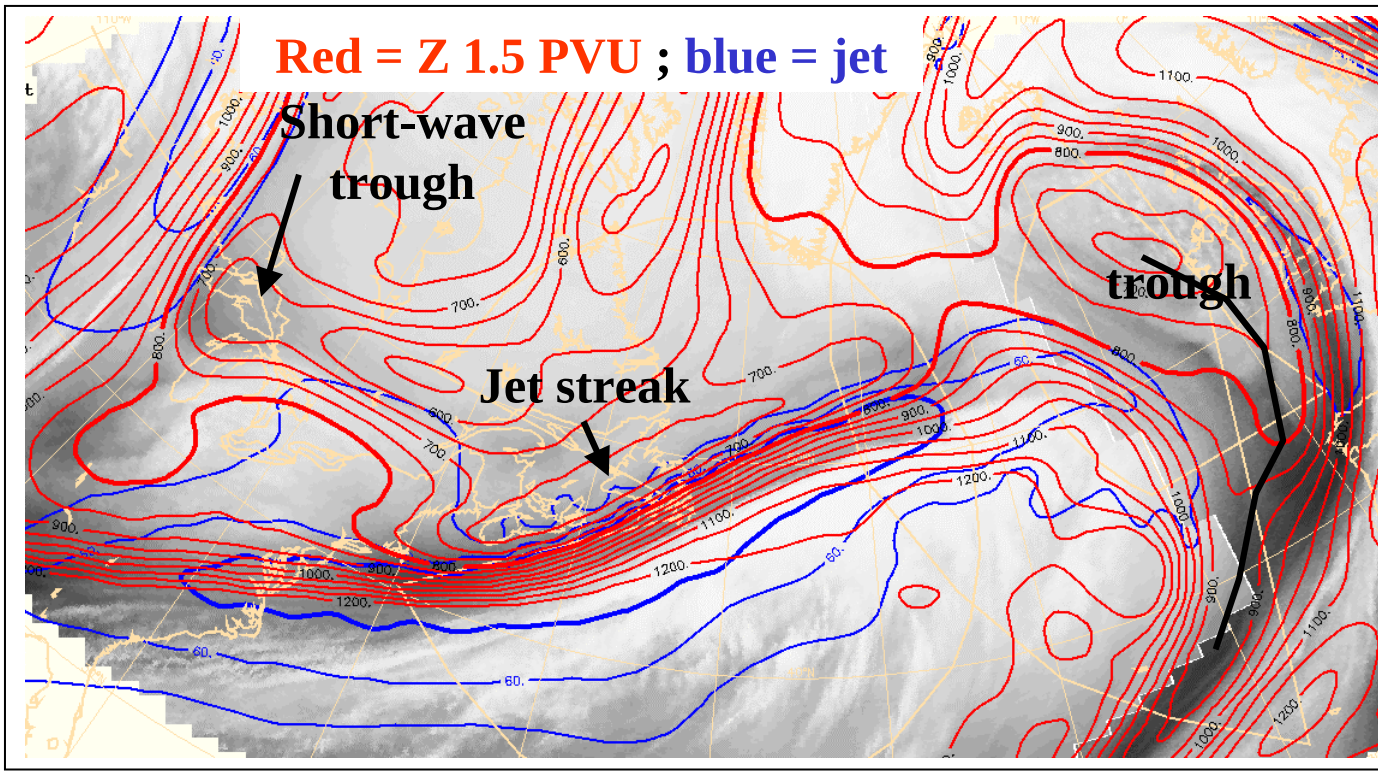
I. Introduction

Everyone agrees on the importance of obtaining the best numerical forecast guidance. Many numerical forecast errors are due to deficiencies in the initial state so if the initial state could be improved, a better forecast could be expected. The chief forecasters of Meteo France participated in an initial state modification experiment during winter 2001-spring 2002 with the use of Potential Vorticity (PV) fields. Some results of this experiment are shown in this article.

II. Water-vapour image/PV fields relationship

There is a close relationship between the WV image and tropopause height at mid-latitudes. A low tropopause has a dark signature on WV imagery and it also corresponds to an upper level PV anomaly. The animation of WV images gives an indication about synoptic vertical motion and this vertical motion is related to upper level dynamics. The different features of the flow such as tropopause folding, stratospheric intrusions, jet-streak axes and short wave troughs generally have a clear signature on WV imagery. Much use can be made of the good correlation between the WV image and 1.5 PVU height (dynamic tropopause).

III. Example of WV- PV correlation



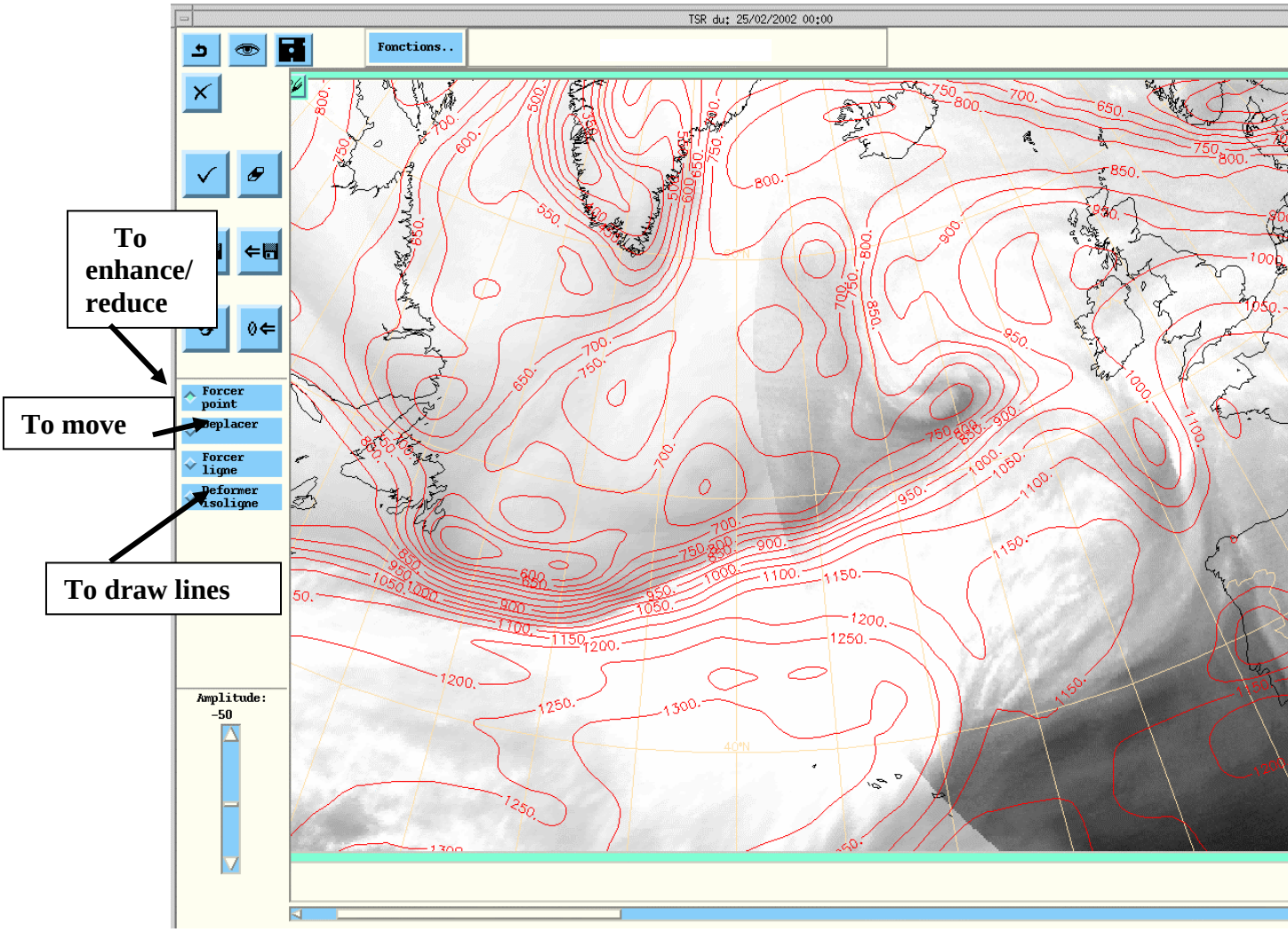
The signature of a jet is an elongated dark area with a sharp edge on its cyclonic side. The signature of a short wave trough is a more rounded dark area.

IV. Intervention by the forecaster

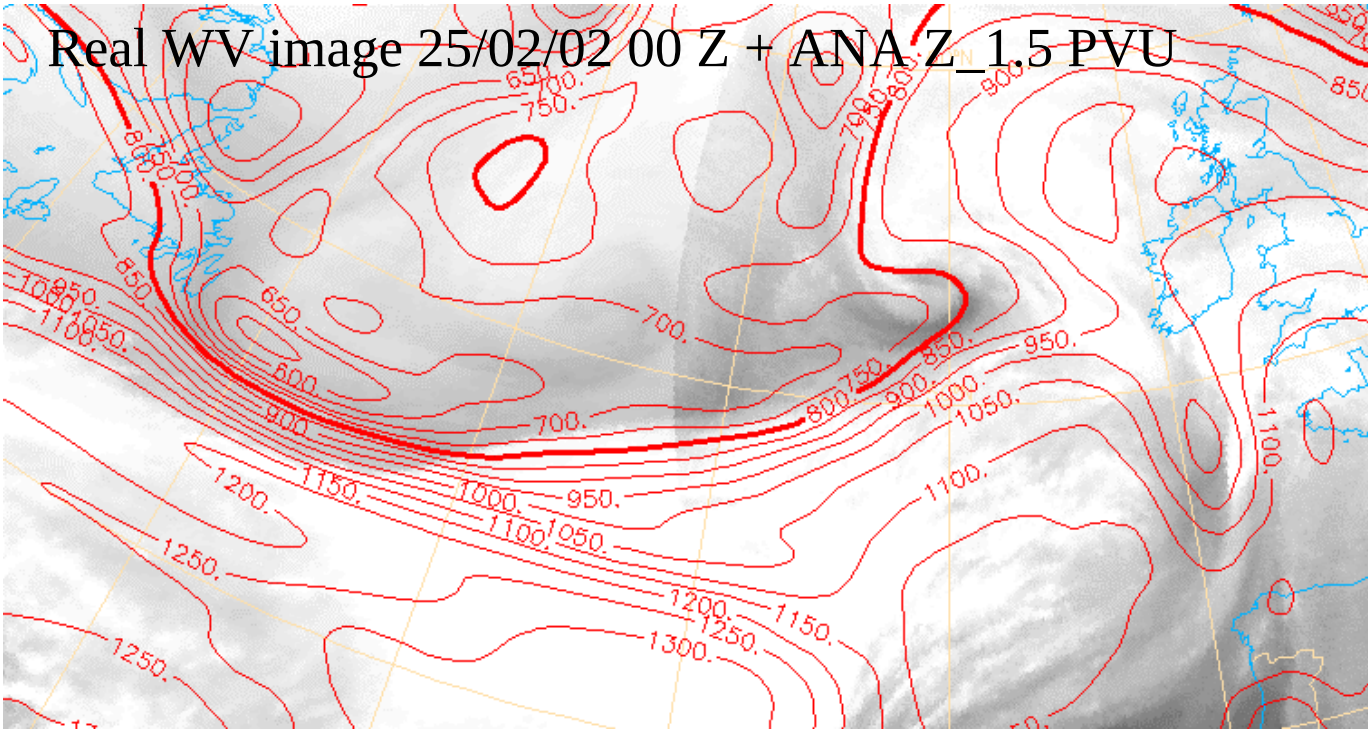
The forecaster compares the model output and imagery by superimposition of 1.5 PVU height (a model diagnostic) on WV imagery. Another useful tool is a pseudo-WV image calculated by the model. A comparison between this pseudo-WV image and the real WV image is useful in detecting possible errors in the initial state and identifying possible ambiguous structures. If the forecaster detects mismatches between the WV image and pseudo-WV/PV fields, he/she can modify the analysis of 1.5 PVU geopotential height to obtain a better fit with the WV image. It is also possible to modify the low-level temperature and height at 850 hPa. Then by PV inversion, a new initial state is rebuilt and the model is re-run.

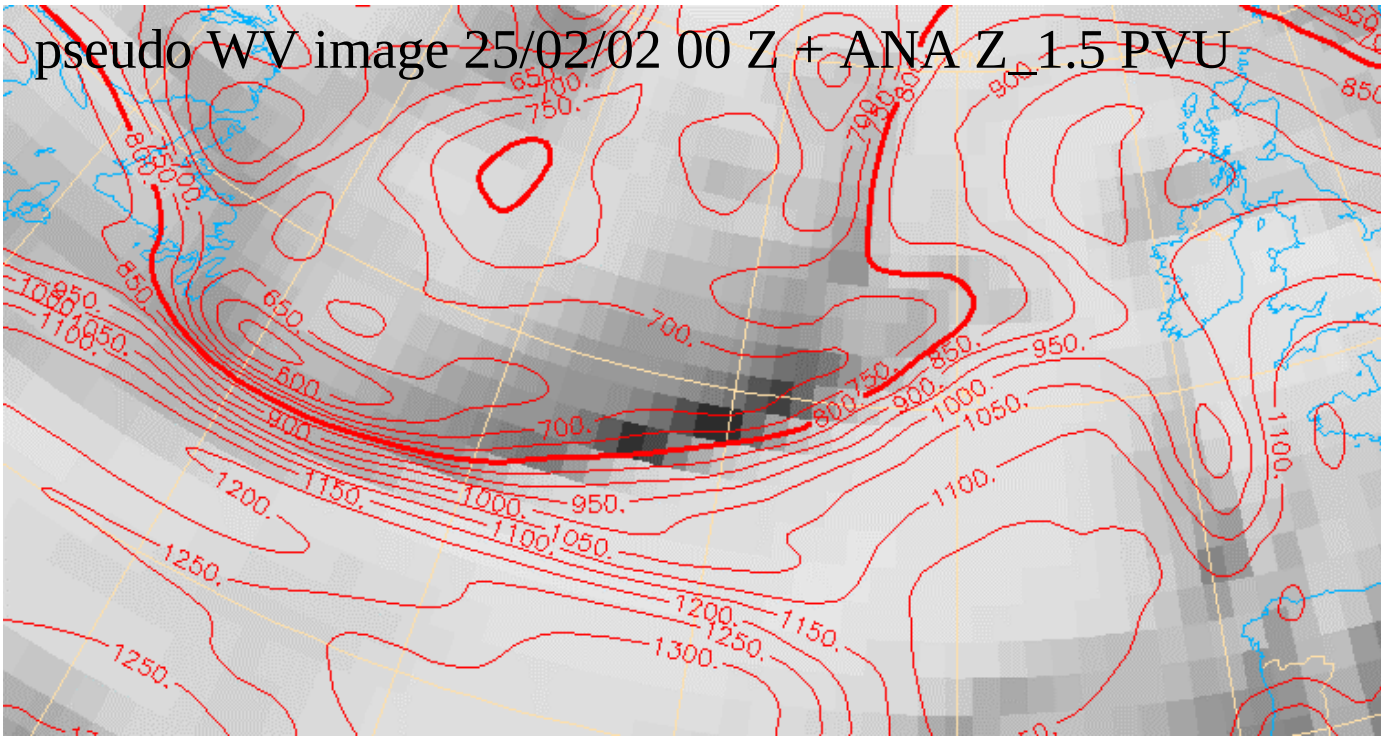
V. The modification interface

The modification interface is run on a Synergie workstation which allows the superimposition of model fields and satellite imagery. The 1.5 PVU height can be modified using several methods. PV anomalies can be enhanced/reduced or moved and isopleths can be drawn.



VI. Example: a cyclogenesis case

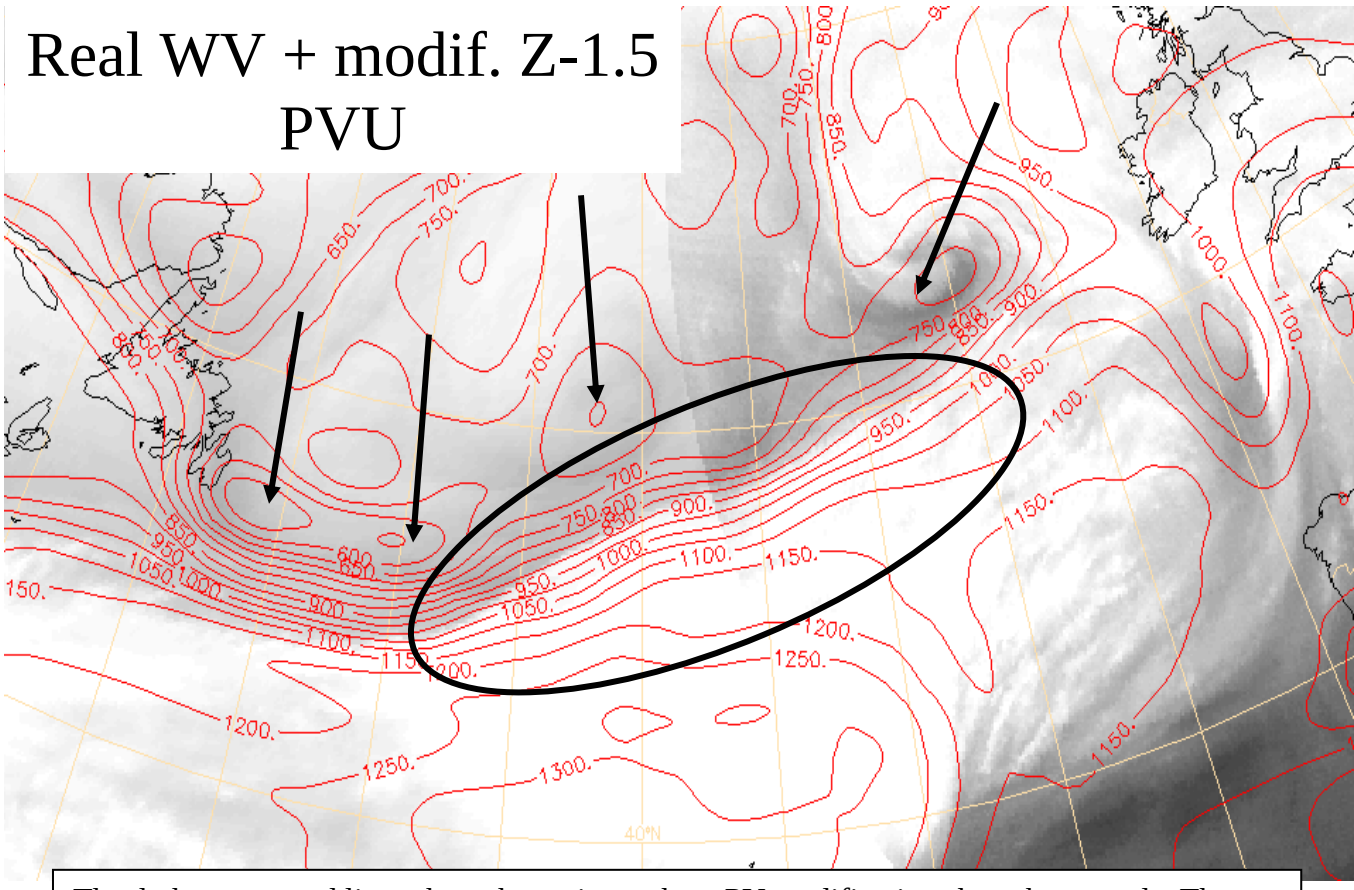




As expected, the 1.5 PVU height fits the pseudo-WV image (since these are model diagnostics) but there are differences when compared to the real WV image. The pseudo-WV image confirms mismatches between the real WV image and model

analysis: the PV anomaly to the west of Ireland is underestimated and the PV anomaly to the east of Newfoundland is too far north. Also, the isopleths of 1.5 PVU height over the central Atlantic are cyclonically curved, whereas imagery shows a slight anticyclonic curvature which suggests the beginning of a baroclinic interaction and cyclogenesis process.

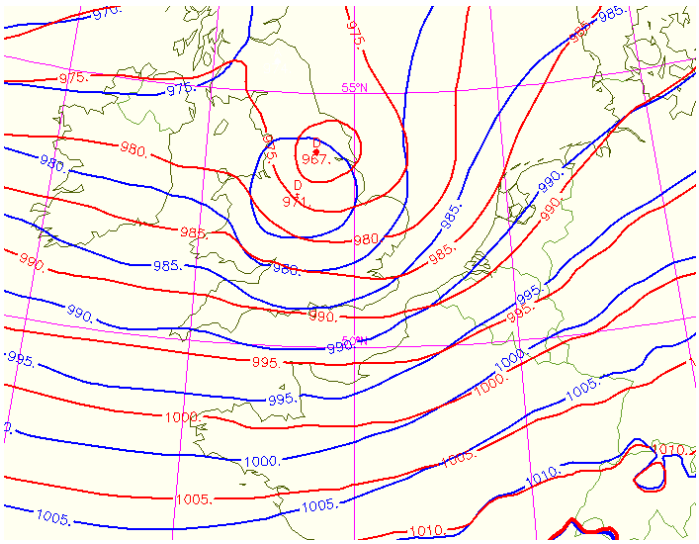
Real WV + modif. Z-1.5 PVU

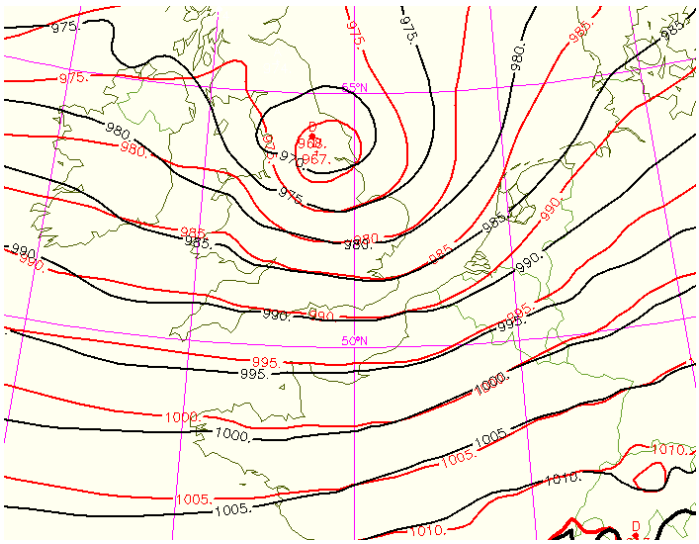


The dark arrows and lines show the regions where PV modifications have been made. The most important ones relate to the southward movement of the anomaly just east of Newfoundland and the anticyclonic curvature of the isopleths of 1.5 PVU height over the central Atlantic. The 850 hPa temperature field has also been changed to the east of Newfoundland to fit better with the observations (not shown here).

RESULTS: MSLP 30 h FORECAST

Blue=oper. run **Red=new run** **Black=analysis 26/02/02 06 Z**





The new run (with the modified analysis) produces a deeper low over northern England which is much closer to the verifying analysis.

VII. Conclusion

A successful example of PV modification has been presented. However during the trial, there were some cases where the forecast couldn't be improved and further experiments are required before this tool becomes operational. Nevertheless, it provides a promising method to modify model behaviour. The combined use of PV concepts, pseudo-WV and real WV imagery allows the correction of the initial state in order to re-run the model and obtain better forecast guidance.