P3.20 COMPARISON OF MAP-SOP OBSERVATIONS WITH MODEL ANALYSIS AND FORECASTS OF GRAVITY WAVE BREAKING.

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1. INTRODUCTION

During the MAP Special Observing Period (Bougeault et al., 2000), high resolution models operationally produced analysis and forecasts of index R_i (the Richardson Number, Bedard et al., 1986), that helped planning flights for in situ special observations. On the other hand, an enhanced upper air sounding network provided observational data with an unprecedented high spatial and temporal frequency, allowing a verification of model outputs for Gravity Wave Breaking (GWB).

Availability of high resolution data obliged to restrict this preliminary analysis to wave breaking mainly south of the Alps, where a maximum of 6 radio soundings and some wind profilers were normally available during Intensive Observation Periods (IOPs: Kuettner and Meitìn, 2000), integrated by instrumented flights data. Unfortunately, northerly flow was relatively less frequent than the climatological mean, and the few selected favourable cases proved to have been not very intense. Nevertheless, it has been possible to study some of these events, and to compare with model forecasts analysis results exclusively based on observational data.

2. SINGLE PROFILE DATA ANALYSIS

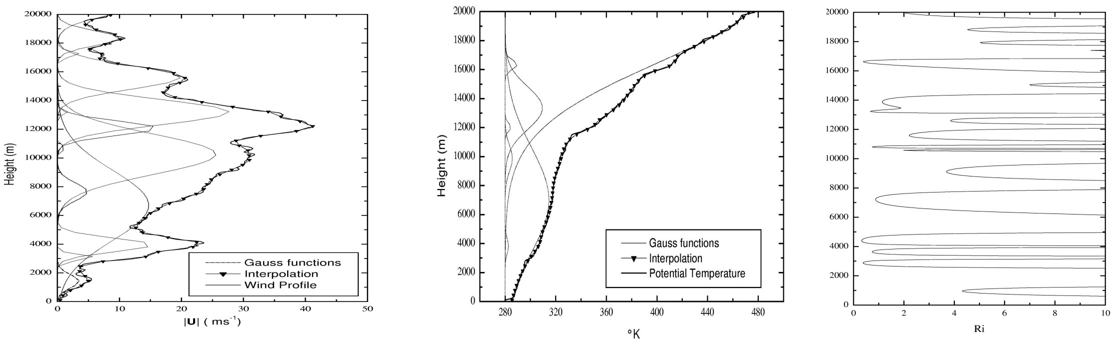
The observational data set has been first of all used for detailed, single profile analysis of radio sounding derived quantities. Considering the sensitivity of the Richardson Number:

$$R_i = \frac{g\partial\Theta}{\Theta\partial z} \Bigg/ \left(\frac{\partial V}{\partial z}\right)^2$$

specially on vertical wind shear, but also on temperature profile, an interpolation method has been developed to use a maximum of information from the high resolution data and to minimise numerical difficulties with R_i .

Making use of a maximum of 16 Gauss functions and conveniently selecting wind maxima, an analytical interpolation of T and / v / profiles allowed an accurate calculation of R_i (fig. 1), and other indexes on several tropospheric and lower stratospheric layers. This was performed for almost all the Map radio sounding stations, where high resolution data was available. After verification, wind direction has not been considered important, the upper winds being always almost exactly from the same direction in the selected cases.

A layer mean value of R_i has then been compared with forecasts by both the operational Swiss Limited Area Model (SM), and the experimental MC2 (Benoit, 1999): some results, which are not very sensitive to differences in the adopted layer thickness (chosen between 20 and 100 hPa), are



a) b) c)

Fig. 1: High resolution sounding data, Gauss functions and interpolated profiles of a) wind, b) potential temperature at 06 utc, 8 Nov. 1999, for Milan (WMO 16080) radio sounding. In c) the computed Richardson Number R_i.

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given for example in the contingency table for MC2. In general, low values of the R_i arising from the above depicted calculations are well reproduced in model analysis and forecasts only in the lower troposphere. A possible explanation could be the relative low resolution of models at mid tropospheric heights.

TABLE

Contingency Table		***R_i from MC2 (500 hPa)***				
		0-0,25	*0,25-1*	*1-4*	*4-10*	*>10*
R_i from Soundings	*0-0,25*	**0**	2	0	0	0
	0,25-1	0	**3**	12	6	11
	1-4	0	0	**12**	17	36
	4-10	0	1	9	**19**	24
	>10	0	3	10	11	**35**

Contingency table for computed layer mean (100 hPa) and MC2 forecast R_i values (69 cases).

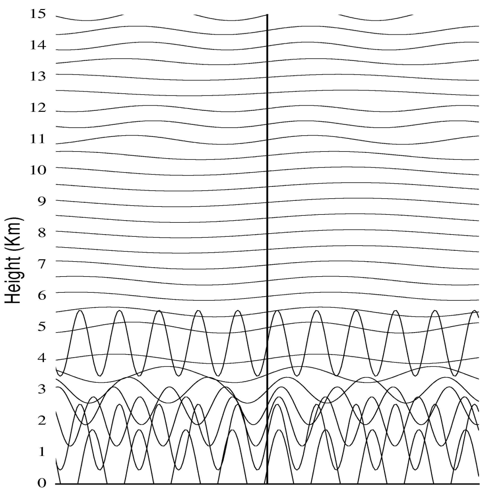

Fig. 2: Amplitudes and wavelengths as a function of height for Milan (WMO 16080) at 06 utc, 8 Nov. 1999.

Furthermore, gravity wave amplitudes and wavelengths were computed from the Scorer index at a number of levels (fig. 2), using the same analytical interpolation: wave breaking was again found in good agreement with model forecasts at lower levels only.

3. HORIZONTAL ANALYSIS

Investigating not only point values, but also the horizontal distribution of possible GWB, the enhanced radio sounding density appeared to be too low, even in the most favourable IOPs. To obtain a higher horizontal resolution of GWB indexes, wind profiler data can be used with an interpolated temperature profile. Obviously, this could be done only at lower levels, because of the limited vertical range of wind profilers. Again, a relatively good general agreement was found between observations and model forecasts, but resolution definitely proved to be insufficient for an effective validation of the much more detailed model outputs (fig. 3). Also, time resolution (soundings are available at most every 3 h, normally during IOPs every 6 h) is still not well suited for model validation.

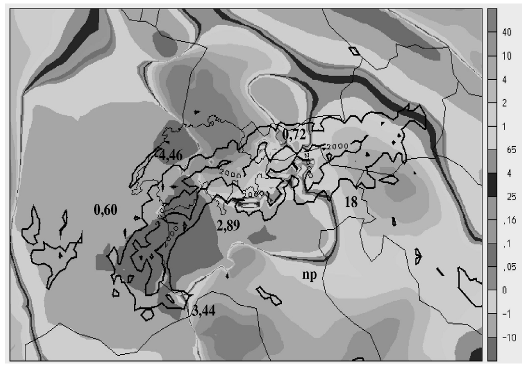

Fig. 3: Comparison of SM analysis and computed values of R_i (300 hPa for 00 utc, 21 Oct. 1999).

4. CONCLUSIONS

Direct comparison with the available models of single profile values, and of their evolution in space and time, shows that:

- the deployed upper air network is not tailored for a complete validation of model GWB analysis and forecasts;
- nevertheless, even high resolution LAMs seem to have limits in exactly predicting location and timing of GWB at upper levels.

Anyway, the described method provides indications for a possible operational use of real time observations in diagnosing GWB, at the advantage of aviation safety.

5. REFERENCES

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