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DEEP MOIST CONVECTION AT UPPER TROPOSPHERIC MOISTURE GRADIENTS – A POSSIBLE INVOLVEMENT OF MOIST SYMMETRIC INSTABILITIES

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I. INTRODUCTION

During days with no significant advection of moisture or heat, also devoid of frontal systems, forecasting convective storms in the Alpine region is limited to the declaration that throughout the day convective cells will form, initiating preferably over mountainous regions.

As comprehensive observations with the METEOSAT 7 WV – channel and MSG WV – channels 6.2µ and 7.3µ showed, Deep Moist Convection (DMC) developing from this shallow convection preferably appears first at the transition zones between areas with dark/dry and bright/humid pixels (so-called WV – Boundaries, Krennert and Zwatz – Meise, 2003).

A further investigation has been undertaken showing that WV gradients do not trigger DMC per se, but dynamics adherent to the WV gradients are capable of modifying or additionally supporting the onset of DMC.

Thus, in a fair weather situation with weak or moderate low level moisture supply (compared to other typical synoptic situations prone to DMC) a lifted air parcel hardly reaches its level of free convection (LFC), despite increased potential instability below WV dark zones and widespread conditional instability.

Also effects like differential diabatic heating at the surface and upper level entrainment in connection to moisture gradients have to be considered. But so far, measurements of i.e. the potential temperature at ground fail to give any indication for differential diabatic heating.

However, all investigated cases with a WV boundary zone have shown the existence of negative equivalent potential vorticity (EPV) in low and mid levels of the troposphere within the immediate vicinity of the WV gradients. As discussed in Schultz and Schumacher (1999) this is an indication of the existence of symmetric instability. Areas favourable for Moist Symmetric Instability (MSI) may be juxtaposed with areas favourable for gravitational convection such that convection can possess characteristics of both types of instability.

The coexistence of moist symmetric instability and conditional instability, as well as adequate moisture and lift, may result in a mixture of moist gravitational and moist slantwise convection associated with the release of convective–symmetric instability.

In connection to WV Boundaries, slantwise convection may contribute to further lifting of the parcel, making it more probable to reach its LFC and lead to further thunderstorm development, even hail.

Xu (1986) and Jascourt et al. (1988) suggest that the nature and organization of initially small-scale moist gravitational convection can be modulated due to the release of symmetric instability, most likely occurring outside of frontal regions, where small-scale moist gravitational convection is organized in the absence of synoptic-scale air mass boundaries.

II. PRESENTATION OF RESEARCH

If a saturated and still buoyant air parcel is reaching such a zone of distinct negative EPV, MSI might be released leading to additional lifting of the air parcel. This seems to be the reason why a majority of growing convective cells appears more likely at the boundary zone in the WV image.

So, if gravitational convection is weak, moisture supply is inefficient, entrainment causes negative buoyancy or the rising parcel has to surmount a capping inversion, then the release of MSI might be sufficient to accelerate the parcel towards its LFC.

Areas within the immediate vicinity of the WV boundaries seem to fulfil all necessary restrictions for the release of CSI:

- The WV boundaries indicate zones with distinct vertical wind shear but little directional shear
- Weak gravitational stability
- Local deformation at the boundary zone promotes EPV becoming smaller or negative
- A thermal gradient is induced by the dry and cold intrusion along with the WV dark zone.

Different parameters indicating preferred regions for the onset of DMC at upper tropospheric moisture gradients will be introduced and discussed in the presentation.

III. REFERENCES

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