Cyclogenesis in the Western Mediterranean causing Heavy-Rain Events (NEPTUN)

A Proposal for a coordinated Demomission of the HALO research aircraft in the field

“Transport processes and atmospheric dynamics”

Ch. Kottmeier, U. Corsmeier, N. Kalthoff, S. Jones (1)
Volker Wulfmeyer, Andreas Behrend (2)
Andreas Dörnbrack, Gerhard Ehret, U. Schumann (3)

(1) Institut für Meteorologie und Klimaforschung, Universität Karlsruhe/Forschungszentrum Karlsruhe
(2) Universität Hohenheim, Institut für Physik und Meteorologie
(3) Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre
Häufigkeit der Cyclogenese im Mittelmeer
(nach Reiter 1975)
Jeder Punkt entspricht einem an diesem Ort entstandenen Tief.
Beobachtungszeitraum: 1 Jahr

Fundstelle: http://www.inm.es/ww1/palma/JANSA/JANSA1.HTM
Objectives

The development of cyclones over the western Mediterranean especially in late autumn is often associated with heavy-rain events in southeastern France and northern Italy.

Large scale lifting combined with embedded convection and intensified by the orography of the western Alps and the Apennines may cause flash floods in the narrow mountain valleys due to rainfall of more than 300 mm m\(^{-2}\) per 24 hours.

The heavy-rain events are the results of combined advective and convective water vapour transport, both of which have to be measured or calculated.

THORPEX-related: It is the objective of the proposal to study the impact of additional airborne measurements on the prediction of cyclones by improved nowcasting techniques and targeted observations.
Severe cases of mesoscale cyclogenesis associated with heavy flash floods

<table>
<thead>
<tr>
<th>Episode</th>
<th>Country</th>
<th>Date</th>
<th>Max. precipitation in 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaison-la-Romaine</td>
<td>France</td>
<td>22.-23. 09. 92</td>
<td>300 mm at selected sites</td>
</tr>
<tr>
<td>Brig</td>
<td>Switzerland</td>
<td>23.-25. 09. 93</td>
<td>120 mm (23.09), 220 mm (24.09.)</td>
</tr>
<tr>
<td>Piedmont</td>
<td>Italy</td>
<td>04.-06. 11. 94</td>
<td>314 mm, 250 at several sites</td>
</tr>
<tr>
<td>Ticino</td>
<td>Italy</td>
<td>12.-13. 09. 95</td>
<td>186 mm in 12 h, 327 mm in 36 h</td>
</tr>
<tr>
<td>Friuli</td>
<td>Italy</td>
<td>19. 09. 95</td>
<td>180 mm</td>
</tr>
<tr>
<td>Friuli</td>
<td>Italy</td>
<td>05.-07. 10. 98</td>
<td>~250 mm in 48 h</td>
</tr>
<tr>
<td>Thyrrenian Sea</td>
<td></td>
<td>26.-27. 03. 99</td>
<td></td>
</tr>
</tbody>
</table>
Specific problems

Many authors state that simulation of the large scale features of the cyclogenesis and the amount of precipitation connected with accompanied lifting is quite satisfying, while

the prediction of rainfall caused by embedded pre-frontal rain bands and convective cells triggered by the orography shows often insufficient results.

The reasons mentioned therefore are

1. missing highly resolved data of the structure of the 3-dimensional humidity distribution,
2. missing information about the sea and land surface fluxes of latent and sensible heat and
3. little information about the flow modification caused by the orography.
Scientific Plan
(to be coordinated with MEDEX 2009/2010
and other international plans)

1. Measurement activities:

*Airborne measurements will* provide data for the analysis of the multiscale processes governing the development of a Mediterranean cyclogenesis with embedded convective rain bands. Flight schedules will address the synoptic scale baroclinicity, convergence, and trough lines. The upper tropospheric horizontal wind, the vertical structure of temperature, humidity and wind as well as the sea and land surface fluxes of latent and sensible heat and the modification of the near surface wind field by the orography are to be defined from measurements (HALO, radiosonde network, ground stations).

*Aircraft: HALO, + 1 smaller aircraft*
Proposed measurement area

The flights will be performed over south-western Europe and the Mediterranean Sea.

Mediterranean cyclone causing the Brig flash flood in Switzerland, September 23 to September 24, 1993.

Surface pressure (white isolines) and height of the 500 hPa topography (colour code) are shown.
Operation of HALO in the upper troposphere and simultaneously the DO-128 turboprop aircraft in the lower troposphere, especially very close to the sea and land surface in the pre-frontal areas of convective activity.
Originality

The mission proposed acquires its singularity from
(i) the area under investigation as the Mediterranean is a sensitive region for high impact weather affecting central Europe,
(ii) the combination of in-situ and remote sensing meteorological measurements made on board of several aircraft,
(iii) the possibility for weather prediction improvement by additional data (nowcasting) as well as by model improvement (convection scheme).

Participation in large international projects

It is planned to link the HALO demo mission to other Mediterranean experiments funded presumably by the EU.

→ NEPTUN can serve as a pre-campaign of MEDEX for testing flight strategies and measuring techniques
→ NEPTUN can identify the most important target regions in the Mediterranean for the development of high impact weather
→ combination with the HGF initiative TRACKS (Transport and Chemical Conversion in Convective Systems) will be aspired as TRACKS plans airborne field campaigns in the mid-latitudes and the tropics to quantify vertical transport of water vapour and trace gases in convective systems of different extent
Key instruments

- *Turbulence probing system at nose boom*
- *Vaisala dropsonde system*
- *DLR 2\(\mu\)m scanning wind LIDAR*
- *DLR water vapour DIAL*
- *Scanning rotational Raman LIDAR for temperature measurements*

This instrument is under development. First measurements are planned in summer 2006 within the Helmholtz virtual institute COSI_TRACKS. This system can be combined with the DLR DIAL laser transmitter (Behrendt et al., 2005).