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Editorial: "MAP Findings"

Inspection of a huge banana-shaped rock submerged slightly beneath the surface of a fast-flowing mountain stream would reveal a thin layer of water accelerating over the rock's rim, particularly through narrow clefts, with major height variations in the water surface to the lee, vigorous eddies on the rock's flanks and further downstream, and complex trajectories of suspended particles within the stream itself. Inspection of the cloud systems present over the European Alpine massif using time-lapse imagery from a geostationary satellite would likewise reveal equally if not more complex and dramatic flow phenomena. Close inspection of the imagery would provide hints of their structure and an indication of their evolution and linkage to one another. For example quasi-steady and quasi-stationary thin elongated cloud bands aligned east–west along the main Alpine ridge are often accompanied by thin rope-like cloud streets extending north–south downstream from the major Alpine passes, and these phenomena often presage the rapid development of a cloud complex forming within a moist southerly or southwesterly airstream and moving towards the main Alpine range.

The foregoing and other related phenomena were the subjects of interest of the Mesoscale Alpine Programme (MAP; 1995–2005). The programme itself focussed on eight interrelated themes: (P1) Orographic precipitation mechanisms; (P2) Incident upper-tropospheric anomalies; (P3) Hydrological measurements for flood forecasting; (P4) Dynamics of gap flow; (P5) Non-stationary aspects of föhn in the Rhine Valley; (P6) Three-dimensional gravity waves; (P7) Potential-vorticity banners; and (P8) Structure of the planetary boundary layer over steep orography. The international MAP initiative involved groups drawn from university institutes, research laboratories and meteorological services, and a central aspect of the programme was the conduct of a field campaign termed the special observing period (SOP) from 7 September to 15 November 1999.

In 2003 a special issue of the Quarterly Journal (no. 588, January Part B, 2003) assembled twenty-five research articles based upon SOP observations for all eight MAP projects. In this issue the consolidated findings of the MAP are documented in the form of nine review articles.

Rotunno and Houze collect the lessons learnt in the field of orographic precipitation. In particular, they demonstrate and emphasize the way in which subtle interplays of different (micro)physical mechanisms can determine whether or not episodes of heavy precipitation will occur. Richard, Buzzi and Zängl undertake a careful examination of the challenge posed for numerical weather prediction (NWP) by the presence of a major mesoscale mountain range. The prospects for the next generation of regional NWP models are demonstrated with MAP SOP cases and research needs are identified concerning data assimilation and predictability in mesoscale applications. Hoinka and Davies overview the triggering effect that a specific upper-tropospheric flow feature (the PV streamer) can exert upon the generation of Alpine heavy precipitation events. This includes establishing a climatology of the streamers and the ability of novel airborne instrumentation to establish their detailed spatial structure. The bridge to hydrological applications is made by Ranzi, Zappa and Bacchi, who document successful applications of coupled atmospheric–hydrological simulations, both in research mode and in near-real time. It is noted that it is difficult to reliably determine soil moisture in mountainous areas, but in many cases it is found that this shortcoming is of lesser importance for useful simulations than the estimate of prior river runoff.

A broad synthesis of gap flows through narrow constrictions carries over to 'dry MAP' studies, for which moisture effects are considered to be of only smaller importance. Mayr, Armi *et al.* summarize measurements and a hierarchy of simulation experiments, which take the Brenner Pass and the adjacent Wipp Valley as a prototype for a deep mountain gap. Drobinski, Steinacker *et al.* review the concerted observation and simulation efforts regarding föhn episodes in the Rhine Valley, where size and complex geometry call for a truly multi-scale approach. The crucial importance of the delicate interplay between föhn flows and pre-existing cold pools becomes evident. Smith, Doyle *et al.* examine the setting when mountain gravity waves can attain large amplitude and brake, causing severe turbulence and a redistribution of momentum. MAP observations from multi-aircraft missions and accompanying simulation experiments demonstrate the important role, not only of the underlying terrain, but also of the boundary layers within the valleys. The MAP results are juxtaposed with findings from other research initiatives around the globe. (Note in passing that a synthesis of the PV banner studies may appear in a future issue.) Finally Rotach and Zardi review the beneficial effects which the combination of high-density measurements in a steep Alpine valley and realistic large-eddy-type simulations can have for a revised description of boundary-layer profiles over complex topography. By also recalling the relevance of such findings for hydrological applications, they close the loop back to the 'wet MAP' studies at the outset of the collection.

In a *postscriptum*, Volkert and Gutermann view MAP from the perspective of other large atmospheric research programmes that have been centred around a field campaign. They use cooperation between such domains as nations, institutions, and generations as structuring elements and also provide accounting material to assess the overall financial input, and peer-reviewed publications and completed PhD theses for output.

Transforming the concept of a series of detailed MAP reviews to a high-quality special issue of a scientific journal requires both trust and cooperation. In addition to our appreciation of the co-authoring teams, it is a pleasure to thank (i) all reviewers for the investment of time and thought when providing constructive criticism, (ii) both editors Peter Read and Ian Roulstone for their general support and much practical assistance, (iii) Huw Davies for profound advice and brilliant polish, (iv) Jack Hopkins for speedy technical editing during the final phase, (v) Michelle Ames of Wiley for providing a realistic final time frame, and (vi) above all Alison Hunter for her untiring efforts to keep track of all the manuscripts in their various stages and to keep the timing as tight as possible to the pre-specified plan as the lead authors would allow.

The MAP logo shown below brings us back to the associative chain linking a rock in a stream with an entire mountain complex viewed from space. It was designed like a postage stamp in 1994 and depicts three schematic airstreams over and around a three-layer Alpine model orography with a mesh size of 25 kilometres placed on an idealized level plane. The articles in the remainder of this issue, which is outside the MAP review exercise, provide a fitting framework for judging the relevance of mountain meteorology for the advance of regional NWP in Europe and beyond, as well as for atmospheric research in general. We wish them all a broad and interested readership.

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