Nat. Hazards Earth Syst. Sci. Discuss., 2, C92–C96, 2014
www.nat-hazards-earth-syst-sci-discuss.net/2/C92/2014/

Natural Hazards and Earth System Sciences
Open Access
Discussions

Interactive comment on "Atmospheric processes triggering the Central European floods in June 2013" *by* C. M. Grams et al.

C. M. Grams

christian.grams@env.ethz.ch

Received and published: 24 February 2014

We thank the referee for the thorough review of our manuscript and are happy to adress the minor issues raised, as outlined below.

Referee 2 Summary The paper discusses the June 2013 flood event in Central Europe in terms of large- scale diagnostics based on the concepts of Rossby wave breaking, potential vorticity anomalies, and warm conveyor belts. The diagnostic results, such as the identification of continental moisture sources upstream of the affected area, are informative and they are convincingly presented. My recommendation is to accept the paper, taking into account some minor comments below.

Referee 2 Minor comments

Referee 2 Comment 1: Page 429, lines 22-24: The flood in 2002 consisted of two distinct events, separated by a 1-2 day break period. The first part of the event was associated with a small-scale cyclone which was not of classical Vb type since it did not originate south of the Alps and did not follow the typical Vb track.

Answer 1) We agree that the first part of the 2002 flood event was not linked to a Vb-type cyclone. As during the second part a Vb-type cyclone was crucial we think the summarizing statement that the events listed INVOLVED Vb-type cyclones is justified. The careful wording emphasises, that other cyclones and processes may also have played a role and that not only Vb-type cyclones were important.

Referee 2 Comment 2: Page 441, line 2: The authors stress the importance of their finding that 'upside down' warm conveyor belts (WCBs) are essential for heavy precipitation events. I wonder whether the notion of 'upside down' warm conveyor belts (WCBs) is scientifically useful. WCBs naturally vary in their orientation depending on the orientation of the associated baroclinicity. It seems to me that the specific WCB which occurred during this event is different by degree but not in principle. Where would the boundary between 'upside down' and 'normal' WCBs be? At an east-westerly orientation?

Answer 2) We will avoid the terminology "upside-down" WCB in a revised version of this manuscript. We agree that WCBs have a natural variation of their orientation, although early studies partly defined them as pole- and eastward ascending air streams (e.g. Eckhardt, 2004). Here we want to make the point that also WCBs with different and unusual orientation can lead to heavy precipitation events. Because "upside-down" could also be understood in vertical direction we will rephrase to "equatorward ascending" WCB to emphasise the special category of WCB. We do not claim that these WCB are more or less relevant for high impact weather than others.

Referee 2 Comment 3: Page 456, Figure 6b: The WCB trajectories starting 31/12Z have attained a height of about 500 hpa when they reach the northern Alpine areas *where the heaviest precipitation occurred. Since the bulk of precipitable water originates in the lower half of the troposphere, I wonder how relevant these trajectories are in explaining the large precipitation amounts observed there. Did you do a similar trajectory computation for, say, air parcels which have reached a height of 700-800 hPa at the northern side of the Alps, to determine their origin and humidity source region?*

Answer 3) The example trajectories started at 31/12Z (Figure 6b) have indeed their strongest ascent and associated precipitation over the Czech Republic rather than over the Alps. We also agree that the bulk of precipitable water is located in the lower half of the troposphere. However, the objective WCB precipitation diagnostics (green contours Figure 5 right; Pfahl et al., 2014) shows that large parts of the region that experienced most precipitation was affected by WCB during the entire period. The diagnostic uses a fixed threshold for specific humidity decrease of at least 1 g kg^{-1} (6h)$^{-1}$ along the WCB trajectories which would be rather high for air parcels above 500 hPa. This supports the assumption that WCBs also reside in the lower half of the troposphere. The WCB related precipitation over the Alps only ceased to the end of the event (Figure 5h). Moreover, the trajectories shown in Figure 6b only depict a snapshot of air-parcels located over the Alps during the next two days. Trajectories started earlier and later show air-parcels below 500hPa, which is in line with the objective WCB precipitation diagnostic. Also, the selection criterion (ascent $>$ 600 hPa (48h)$^{-1}$) focuses on the core of the WCB, that experiences the strongest ascent. A weaker criterion (500hPa/(48h)) shows more trajectories and air-parcels residing in the lower half of the troposphere over the Alps at that time (see supplemental material Figure 1). Also the cross-section in Figure 6d (including all trajectory calculations available at that time) shows some trajectory intersection points in the (Pre-)Alpine region below 500hPa.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 427, 2014.

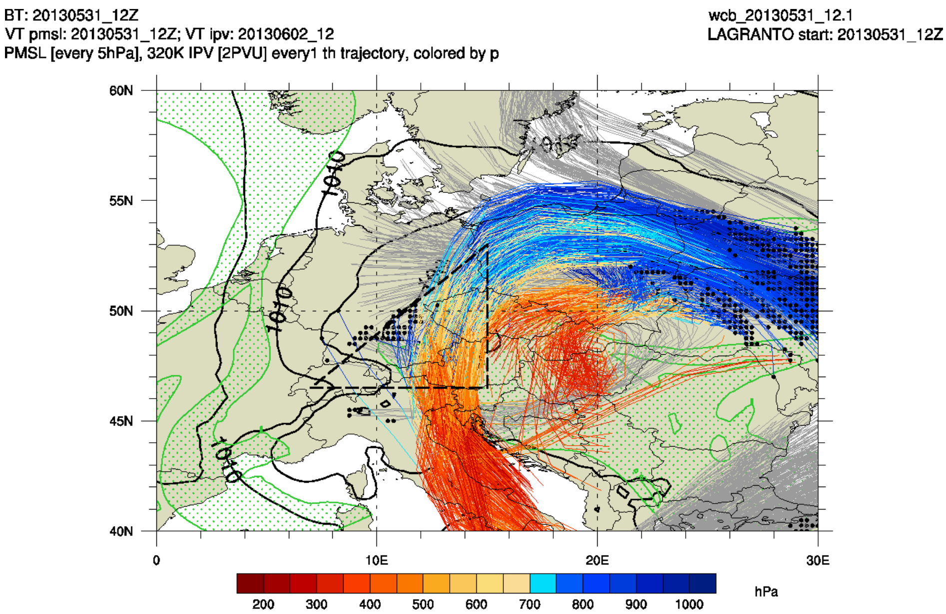

Fig. 1. As Figure 6b BUT with a weaker ascent criterion of 500hPa (48h)$^{-1}$, and trajectories plotted only with six-hourly position output.

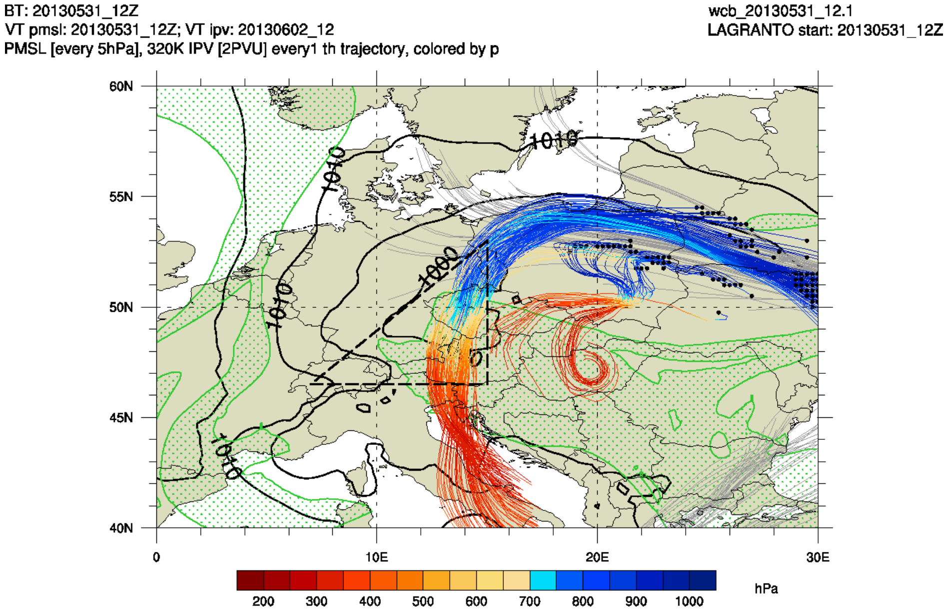

Fig. 2. Original Figure 6b with ascent criterion 600hPa (48h)$ˆ{-1}$, and trajectories plotted with one-hourly position output.