Evolution and structure of two severe Bora events: Contrast between the northern and southern Adriatic

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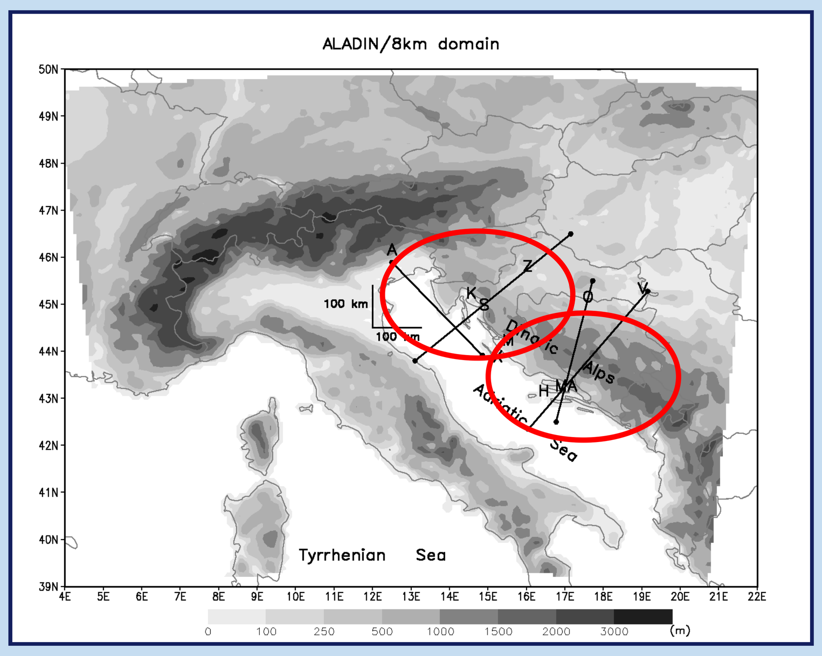
Introduction

While statistical analyses and observations show that severe Bora with maximum gusts exceeding 40 ms^{-1} can occur in all parts of the Adriatic, the Bora research to date has been mainly focused on the dynamics and structure of severe Bora in the northern Adriatic.

Examined to a significantly lesser degree is a less predictable counterpart in the southern Adriatic, where the Dinaric Alps are higher, broader, and steeper, and where the upwind Bora layer is generally less well defined. A comparative analysis of the evolution and structure of two typical severe Bora events, one "northern" (07-08 Nov 1999, the "NAB" case) and one "southern" (06-07 May 2005, the "SAB" case) is performed utilizing airborne, radiosonde, and ground-based observations, as well as the hydrostatic ALADIN/HR mesoscale model simulations.



BORA WINDSTORMS !

i) RAPID ONSET& HURRICANE FORCE GUSTS (70 ms^{-1})

ii) HIGH FREQUENCY

iii) NONLIN. FLOW REGIME (Fr<1)

iv) GUSTS OFTEN MORE THEN TWICE GREATER THAN WIND SPEED

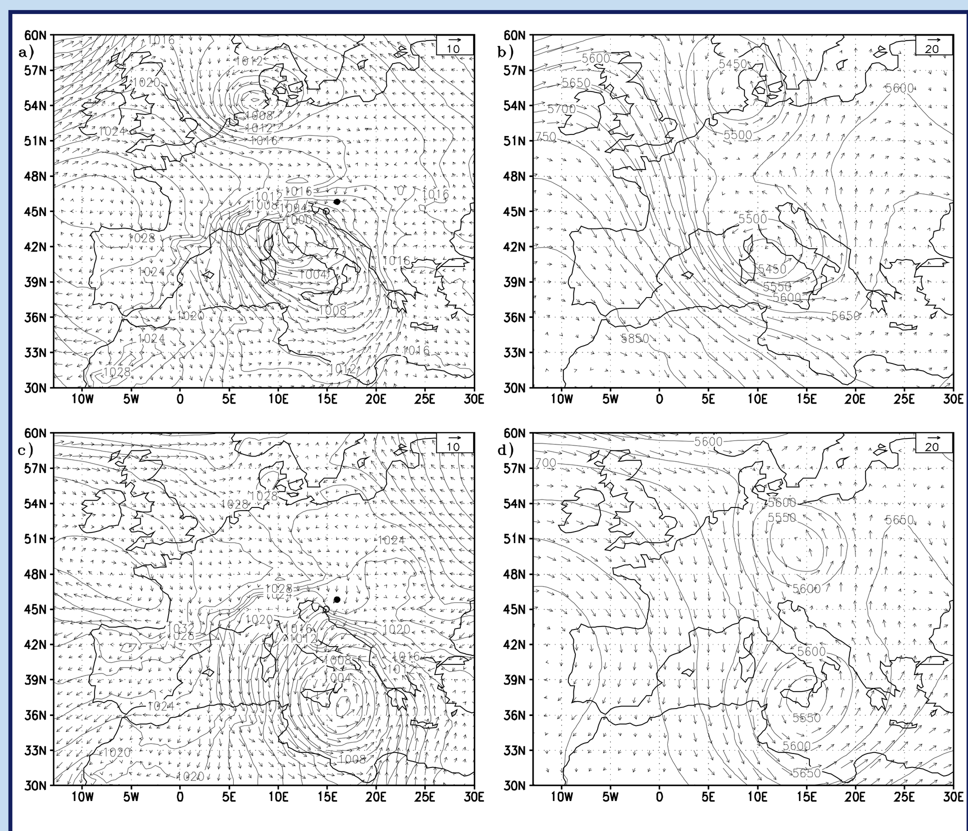
v) 2 GUST REGIMES

Figure 1: Domain of ALADIN/HR model setup with flight track (AX) and cross-mountain sections of the analysis. The "northern" and "southern" areas are denoted by ellipses.

Synoptic overview

Northern case: MAP IOP 15 Genoa lee cyclogenesis 07-09 Nov 1999 (Fig. 02)

Southern case: Mediterranean cyclone 06-07 May 2005 (Fig. 03)



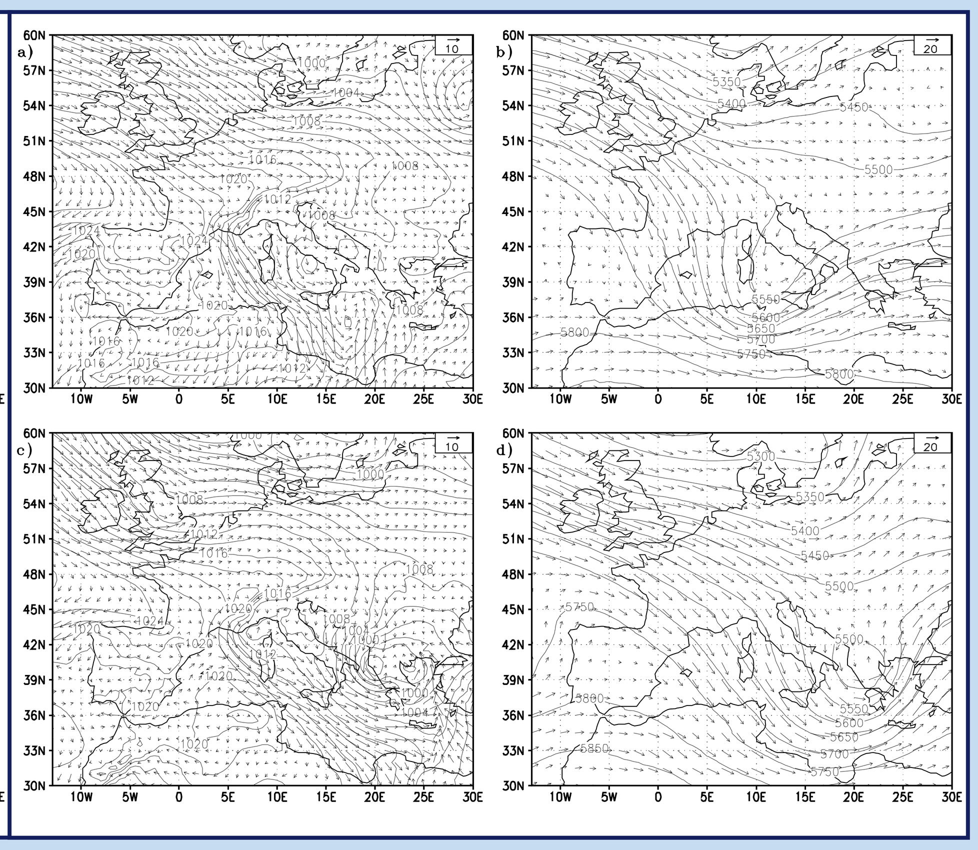


Figure 2: Surface (a,c) and 500 hPa (b,d) synoptic setting for the "northern" Bora.

Figure 3: Surface (a,c) and 500 hPa (b,d) synoptic setting for the "southern" Bora.

Methods & Models

Model characteristics: Operational ALADIN/HR, hydrostatic, full-physics, Louis (1979) turbulence scheme at 8 km grid resolution and 37 hybrid vertical levels, single nesting (Fig. 1).

Initial and boundary conditions: ECMWF T511 data

References

Horvath, K., S. Ivatek-Sahdan, B. Ivancan-Picek, and V. Grubisic, 2009: Evolution and structure of two severe cyclonic Bora events : contrast between the northern and southern Adriatic. *Wea. Forecasting*, In Press.

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Results

1. Environmental layering (as indicated by Scorer parameter)**:**

The "northern Bora case" (NAB):

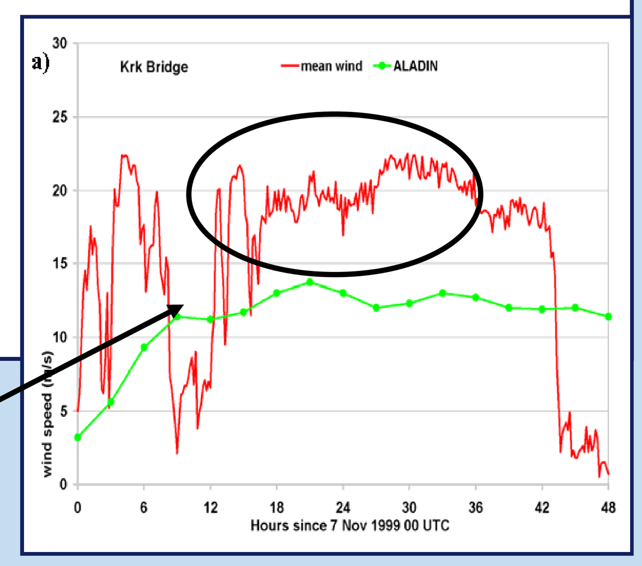
i) Time series of vertical profiles of Scorer parameter and surface measurements indicate two phases of the northern Adriatic Bora related with upstream layering (Fig. 4) – transitions within one Bora episode.

ii) Peak in Scorer parameter at 3-4 km

iii) No such transitions in southern background flow

The "southern" Bora case (SAB):

i) Weaker layering, deeper Bora layer



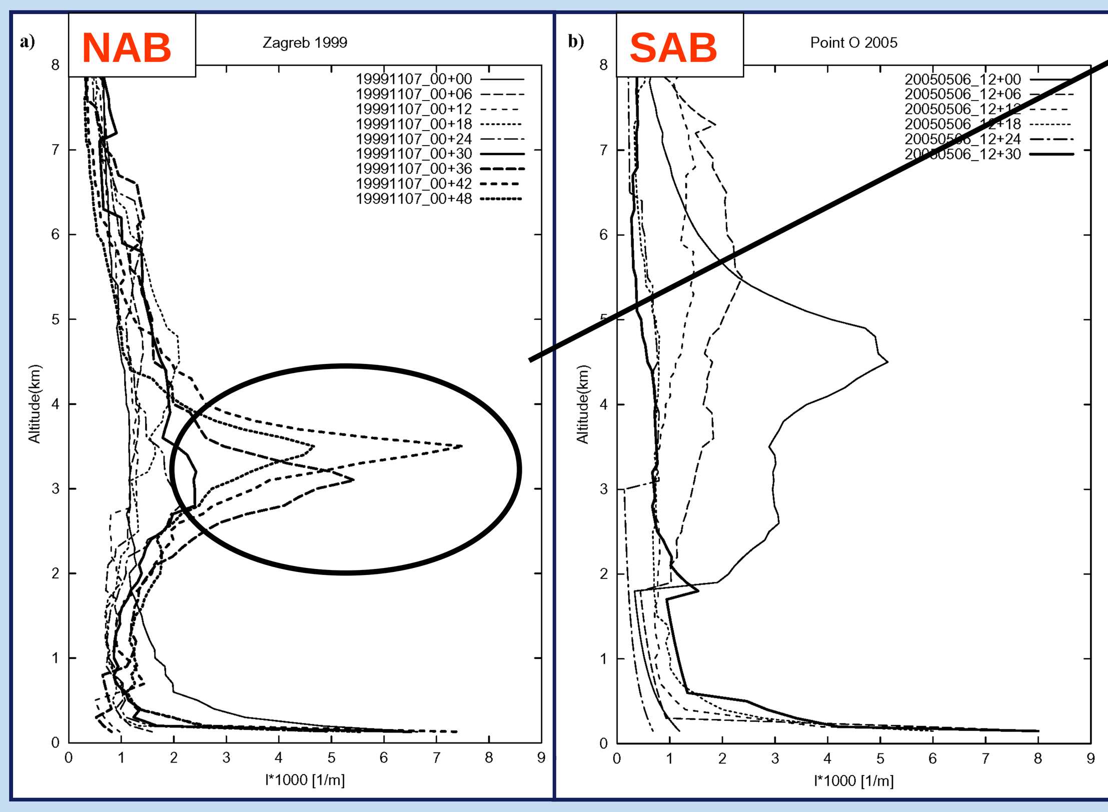


Figure 4 (left): Time series of vertical profiles of environmental Scorer parameter for NAB and SAB background flow.

Figure 5 (top): Surface wind measurements in the N. Adriatic.

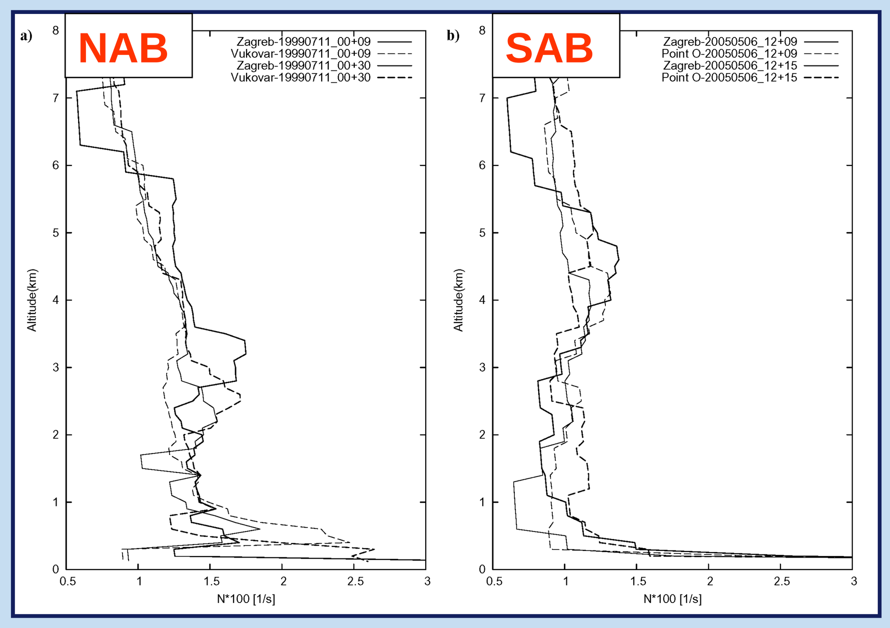
Figure 6 (down): Time series of buoyancy frequency for NAB and SAB background flow.

2. Stability (Fig. 6) stronger in NAB, due to frontal passage and season + **inversion** at ~ 3 km ASL during NAB

3. Vert. cross-sections (Fig. 7) – NAB:

-strong NAB backgr. flow layering, with inversion & environmental critical layer

-blocking on the s. Din. Alps = no SAB



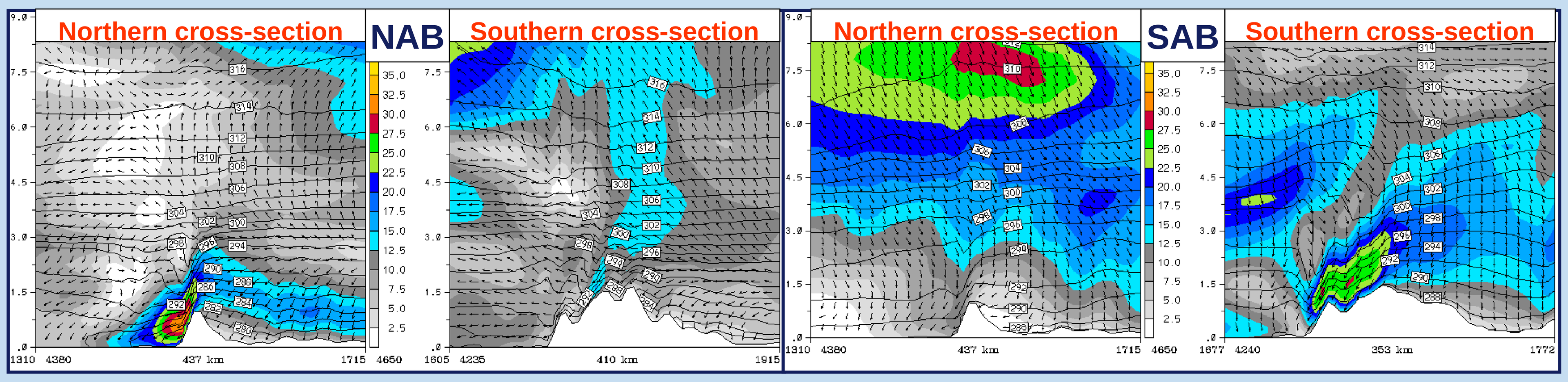


Figure 7: Vertical cross-sections during NAB (left) and NAB (right) for both the northern and southern Adriatic.

On the other hand – SAB:

-Deeper Bora layer, strongly steered in direction over the s. Dinaric Alps

-Upper-level jet (mountain-parallel) appears to impede severe NAB

Conclusions

SAB, compared to NAB: (a) Deeper bora layer, able to overcome the blocking potential of the southern Adriatic Dinaric Alps; (b) less pronounced layering; and (c) Curved flow over the southern Dinaric Alps

Character of env. critical level strongly modulates Bora behaviour (transitions within a single episode)

Mountain-parallel ULJ appears to impede severe Bora development

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