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Zagreb, Croatia

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Outline

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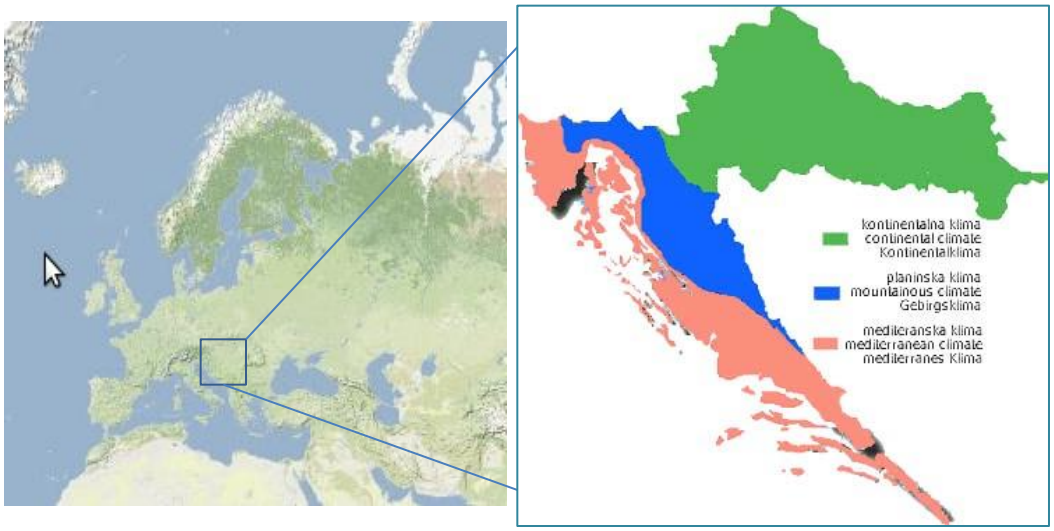
Introduction



- 56,542km^2
- 4,5 million inhabitants

Meteorological and Hydrological Service (DHMZ)
is a governmental institution established by the Government as the central state institution for the fields of meteorology, hydrology, climatology and air quality providing expert services for state administration bodies and public, as described in the Law on DHMZ services in Croatia

Introduction

- My position: Head of R&D

RESEARCH AND DEVELOPMENT DIVISION (35 employees)

- **Research and modelling of atmospheric processes department**
- **Climatological research department**
- **Agrometeorological department**

The official duties of R & D include:

- carry out research and development in support of the Service operational functions to ensure the highest possible standards
- study the national climatological conditions and produce climatological reports
- research and development of meteorological products and services for the public, governmental bodies and specific users
- participate in international meteorological co-operation
- make available the results of our work

Research interests

Mesoscale Dynamics and Modelling

Focus on:

✓Cyclonic activity in the Adriatic – trigger mechanism for a range of extreme weather phenomena

✓Classification of Adriatic cyclones

✓Severe winds:

Bora

Scirocco-like wind called Jugo

✓Heavy precipitation

✓orographic influence on the atmosphere

Main projects

- 2015 – 2018: DHMZ coordinator for the activity of **EU-CIRCLE** project “A panEuropean framework for strengthenining Critical Infrastructure resilience to climate change” (HORIZON 2020)

- 2002 – 2011: project leader “**Storms and natural disasters in Croatia**”, Ministry of Science and Education

- 2016 - : **PannEx** – RHP project over the Pannonian basin

- 2010 – 2020: **HyMeX** – HYdrological cycle in Mediterranean Experiment – member of ISSC

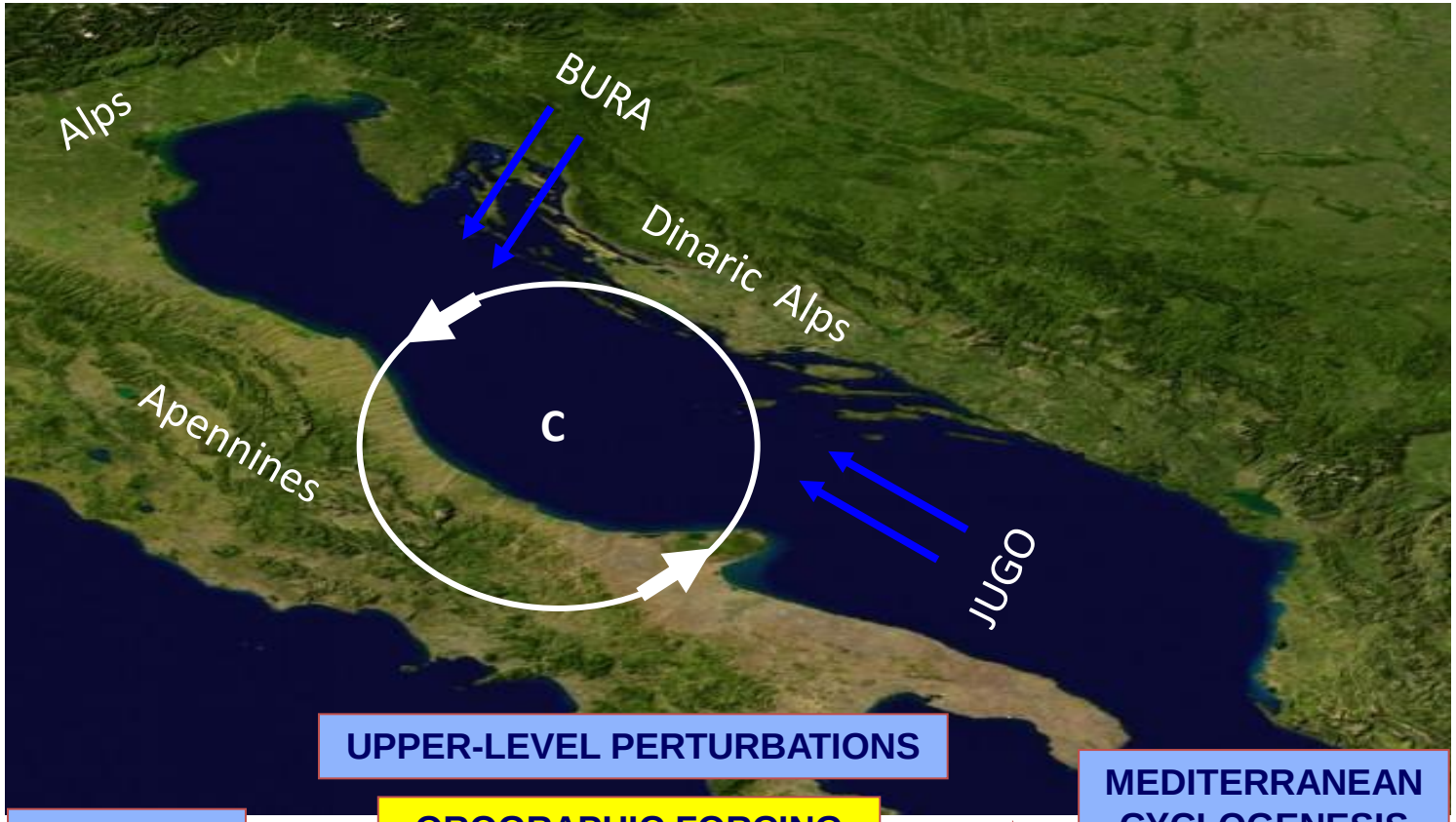
- 2000 – 2010: **WMO-MEDEX** (Cyclones that produce high impact weather in the Mediterranean) - member of ISSC

- 1998 – 1999: **MAP** (Mesoscale Alpine Programme) – coordination of Croatian participation

Main results

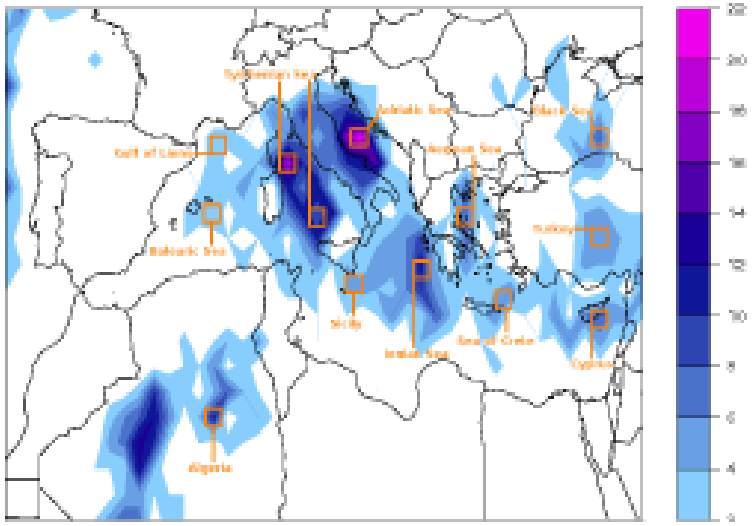
Cyclonic activity in the Adriatic

Ivancan-Picek, 1998: Mesoscale atmospheric vortex generation over the Adriatic Sea



Main results

- Severe weather forecasting over Adriatic region is closely related to the forecast of the position and intensity of the lee cyclogenesis
- Classification of different types of cyclogenesis in the area is fundamental and help the understanding and prediction of the relevant weather phenomena
- Cyclone activity in the Adriatic has to include meso-β scales (20-200 km)
- Horvath et al. 2008, based on the analysis of the 4-yr (2002-05) operational ECMWF T511 dataset, various types of cyclone tracks are classified and the mesocyclogenesis areas in the vicinity of the Adriatic are isolated



Number of mature intense cyclones (1.125°x1.125°) from ERA-40. The labels indicate the location of the 13 selected regional cyclone classes. (Garcies and Homar, 2010)

Horvath, Kristian; Lin, Yuh-Lang; Ivančan-Picek, Branka.
Classification of Cyclone Tracks over Apennines and the Adriatic Sea.
Monthly Weather Review. **136** (2008)

Main results

Severe wind - Bora

- Gusty NE downslope windstorm that blows at the eastern Adriatic coast
- Adriatic cyclogenesis is often a precursor of severe Bora
- Major advances in the understanding of Bora flows – ALPEX, MAP
- Change of concept – from a basic katabatic-type perspective to a hydraulic-like flow, often containing the orographic wave breaking as the main generating mechanism

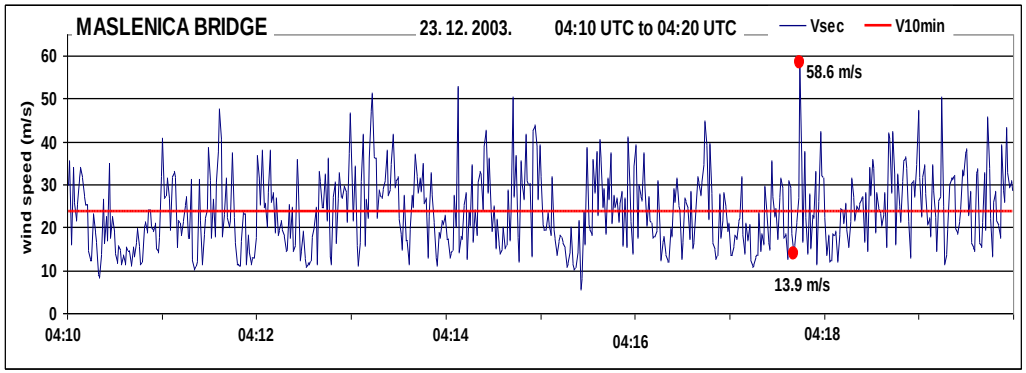
Jurčec (1981), Smith (1985), Bajić (1991), Ivančan-Picek&Tutiš (1995, 1996), Brzović (1999), Grubišić (2004), Belušić&Klaić (2006), Gohm et al. (2008), Grisogono & Belušić (2008), Horvath, Ivančan-Picek et al. (2009), Stiperski, Ivančan-Picek et al. (2012)

..... and many others

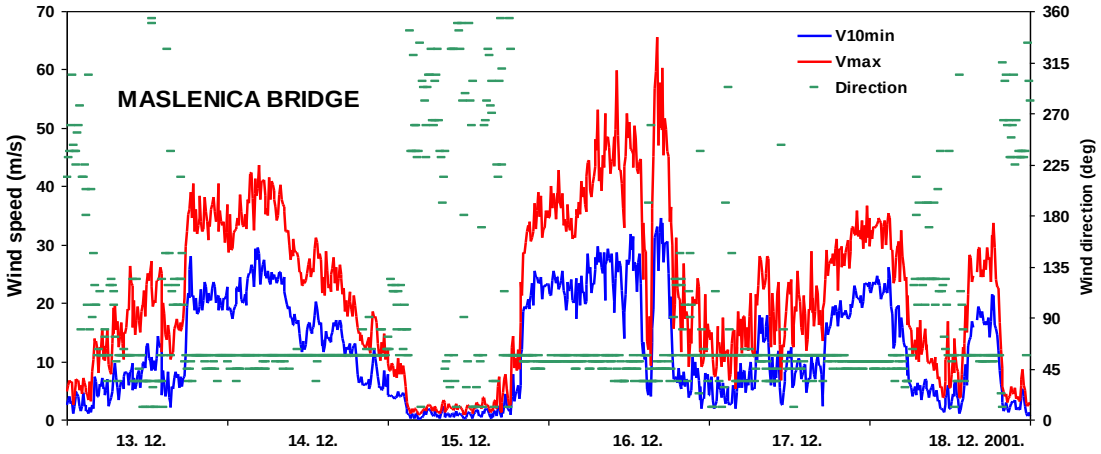
Main results

Severe wind - Bora

- huge Bora variability



- maximum Bora speed - 69 m/s



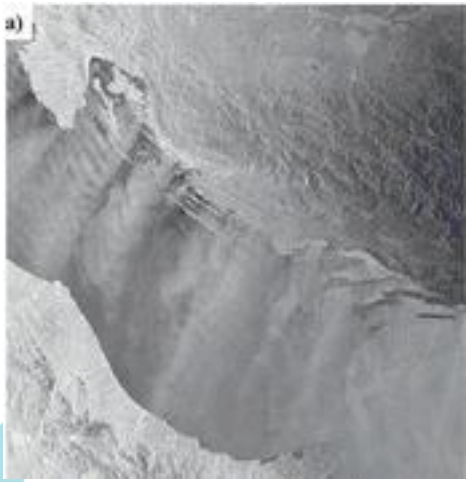
Essence of Bora

- existence of the upstream low-level critical level which enables wave breaking
- existence of the near – mountain – top temperature inversion

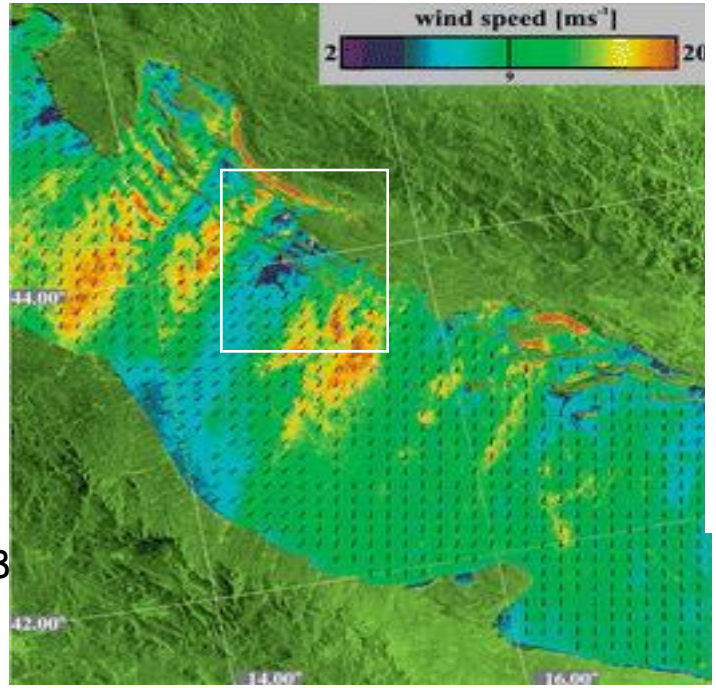
Most of fine mesoscale models simulate the basic Bora structures reliably – breaking gravity waves, hydraulic jumps, rotors, gap jets, boundary-layer separation flow, flow splitting

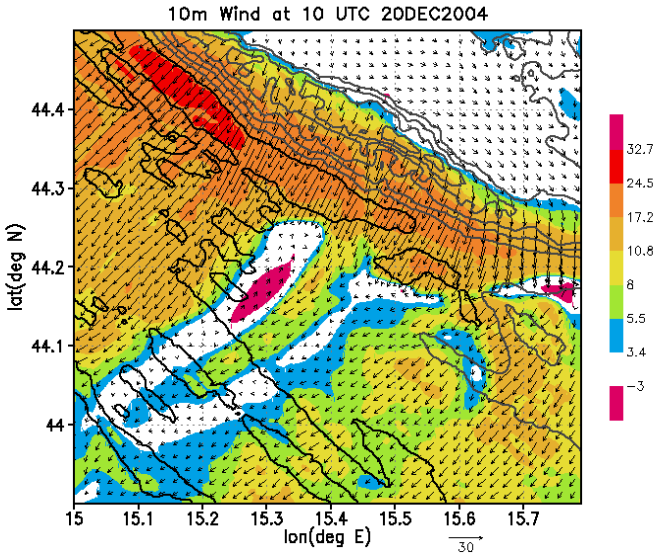
Main results

Complex Bora flow



Envisat ASAR & WiSAR
Bora 0908 UTC 23 Jan 2008
Alpers et al. (2009) MWR





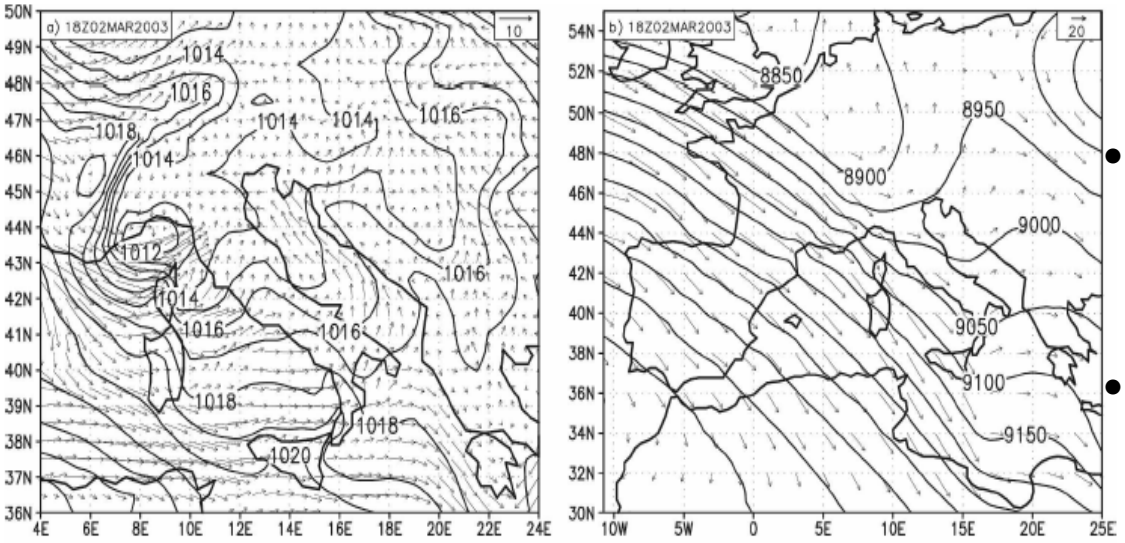
Focus on the less explored Southern Adriatic Bora

Horvath et al. (2009) Weather and Forecasting, 24, 946–964.
Stiperski, Ivančan-Picek et al., (2012) QJRMS, 138, 1490-1506.

Main results

Severe Jugo (Scirocco) wind

- **less known warm and humid S-SE Jugo wind**
- **belongs to the family of SE winds in the Mediterranean, generaly known under a common name Scirocco**
  (“jug” means “south” in Croatian)
- **Jugo blows prior to intense cyclogenesis**

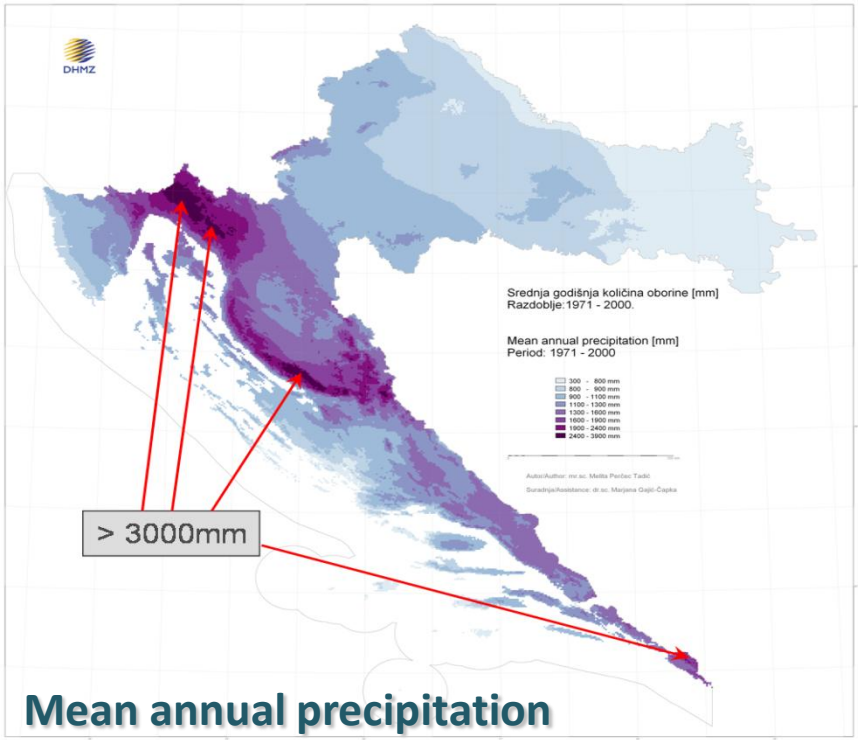


- **Jugo increases in strength gradually – maximal gusts reaching locally over 40 m/s**
- **great variability in space and time along the Adriatic coast and islands**
- **Heavy precipitation and high tides in the Adriatic**

Jurčec, Vesna; Ivančan-Picek, Branka; Tutiš, Vlasta; Vukičević, Vlatko. Severe Adriatic jugo wind. *Meteorologische Zeitschrift* (1996)

Main results

Heavy precipitation



Mean annual precipitation 1971 - 2000

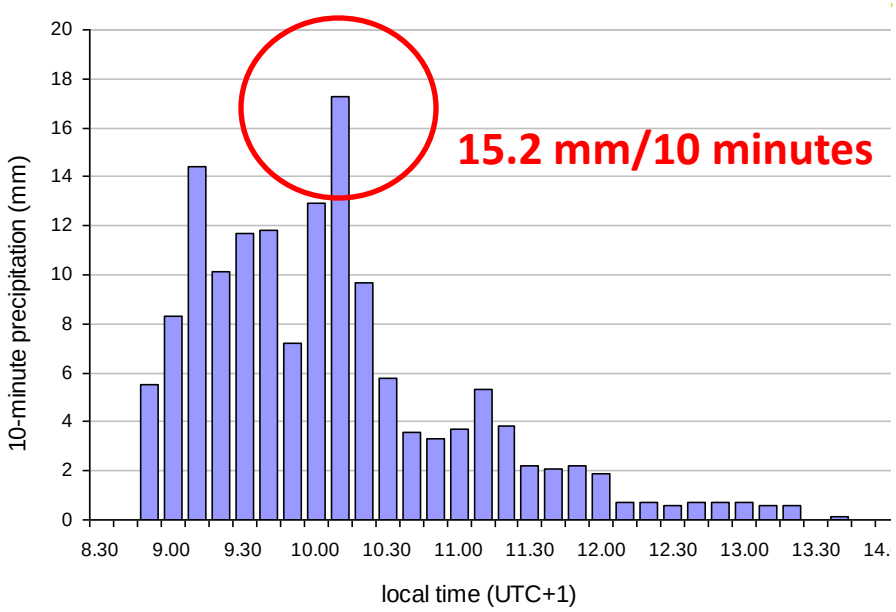
The goal of research:

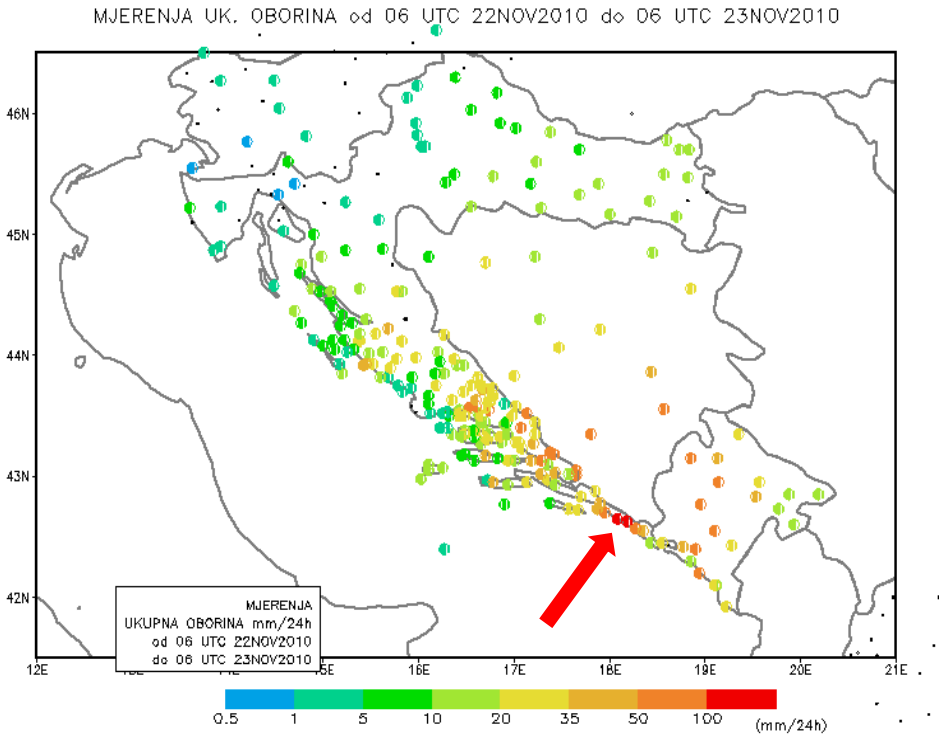
identify the main features and mechanisms responsible for the extreme precipitation events, as a contribution to understanding the factors which cause that climatic maximums of the annual precipitation are located over this region

Ivančan-Picek et al., 2014: Forcing mechanisms of a heavy precipitation event in the southern Adriatic area. *Natural hazards*

Ivančan-Picek et al., 2016: Overview of the first HyMeX special observation period over Croatia. Nat.Hazards Earth Syst.Sci.

Case: 22 November 2010



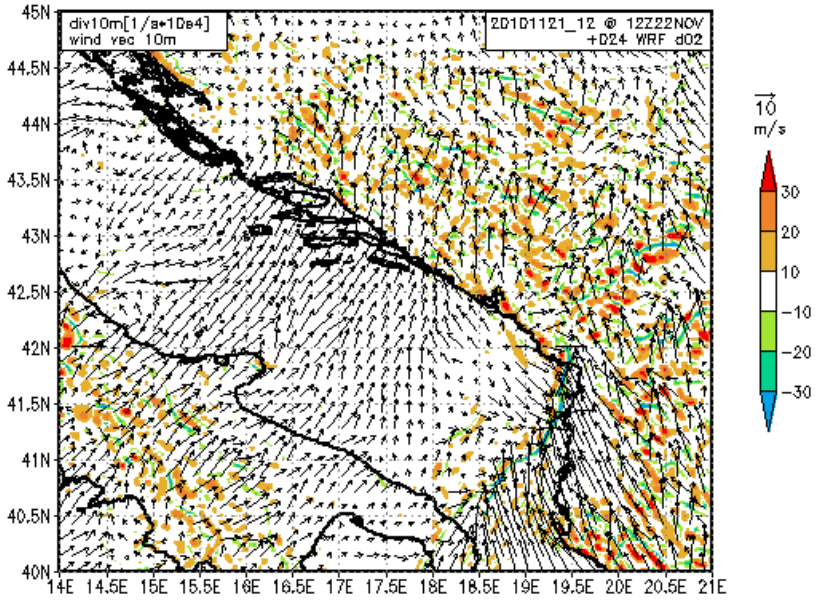


Total precipitation 22-23 Nov, 06 UTC

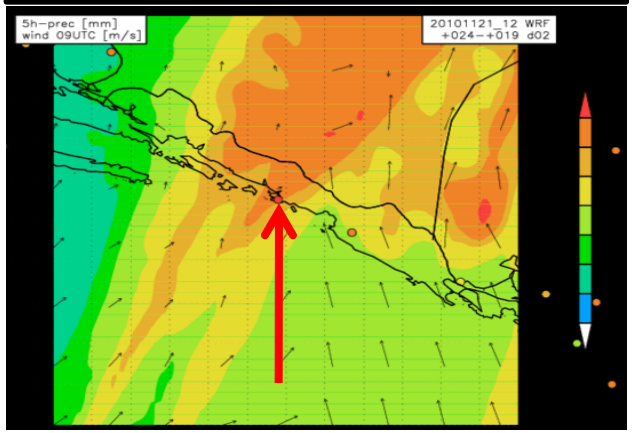
- Rain gauge measurements in Dubrovnik >160 mm/5 h
- Peak intensities: 71.5 mm/h (return period 25 years)

Mesoscale features:

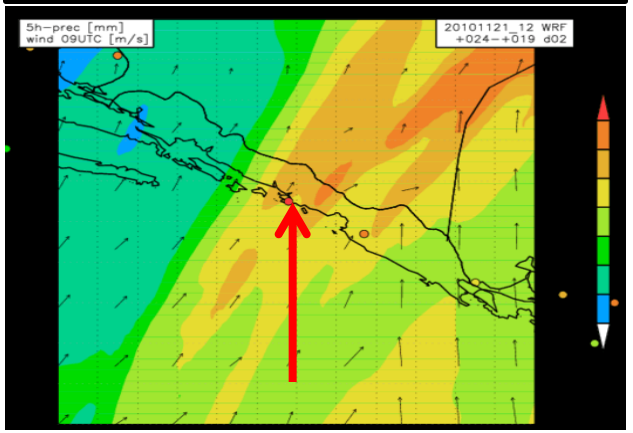
- strong upward motion in mid- and upper levels as a result of warm advection combined with large positive change in cyclonic (positive) vorticity advection
- strong surface convergence
- additional forcing provided by orographic lifting upslope the Dinaric Alps
- heaviest precipitation along the coast and over the mountainous hinterland



control run - WITH OROGRAPHY



NO OROGRAPHY



Questions and challenges

- Better understand and predict precipitation variability - future research adressing mesoscale phenomenon should deploy more remote sensing instruments (HyMeX, PANNEX ?); there is a demand of high-resolution real-time data, particularly radar data for operational data assimilation; improvements in data exchange policies
- Air-sea-land interaction (trigerring of convection over the sea; role of SST and need for coupled ocean-atmosphere modeling .....)
- Better understanding and future projection of extremes

Thank You