Numerical study of the November 2004 deep Mediterranean cyclone

Students: *Kristian Horvath, DHMZ, CRO*
Lluis Fita, UIB, SP
Ivana Stiperski, DHMZ, CRO

Supervisors: *Prof. Romualdo Romero, UIB, SP*
Dr. Branka Ivancan-Picek, DHMZ, CRO

Overview

- Introduction
- Synoptic overview
- Numerical experiments
  - cyclogenesis in the lee of Atlas
  - deepening over the Mediterranean Sea and resulting Bura wind analysis
- Conclusions

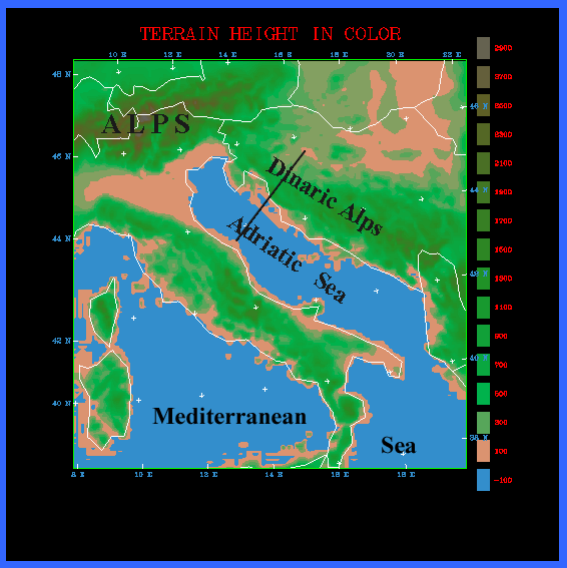
Introduction

- 12-15 November 2004 - MEDEX selected case
- deep and severe impact Mediterranean cyclone
- strong winds and floods-causing heavy precipitation exceeding 200 mm/24h in South Italy
- Bura wind gusts reaching 60 m/s along the Eastern Adriatic Coast in Croatia

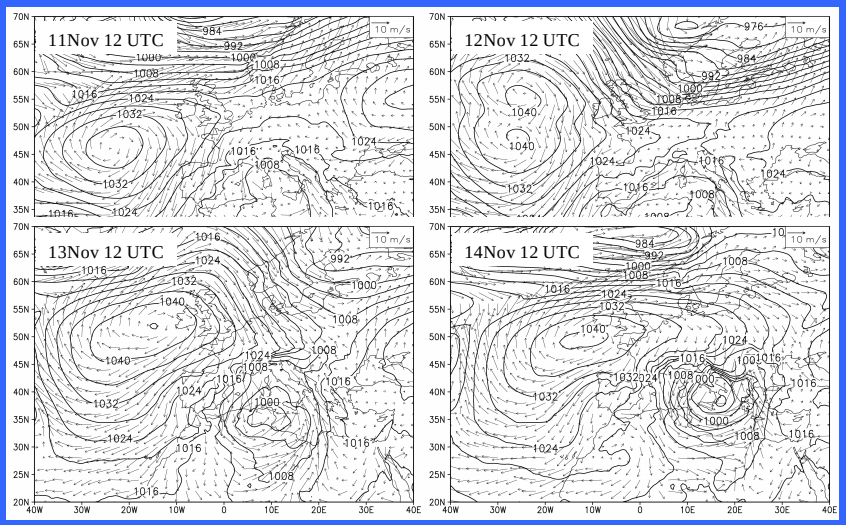
Numerical study: model description

- PSU/NCAR mesoscale model (MM5)
- initial and boundary conditions provided from NCEP Final Analysis
- mesoscale data assimilation
- two two-way nested domains at
  - 21 km (cyclogenesis in the lee of Atlas Mountains)
  - 7 km resolution (Bura wind)

Numerical study: model domains

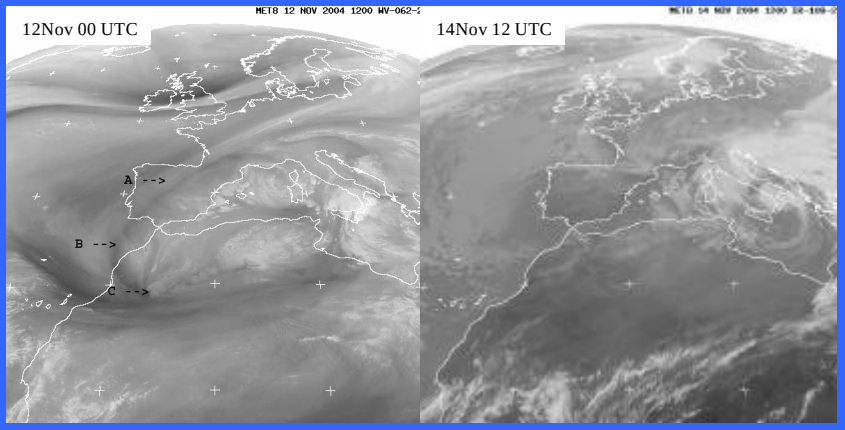


Synoptic overview: Observational data - surface



Synoptic overview: Observational data - upper-levels

- VW imagery IR imagery

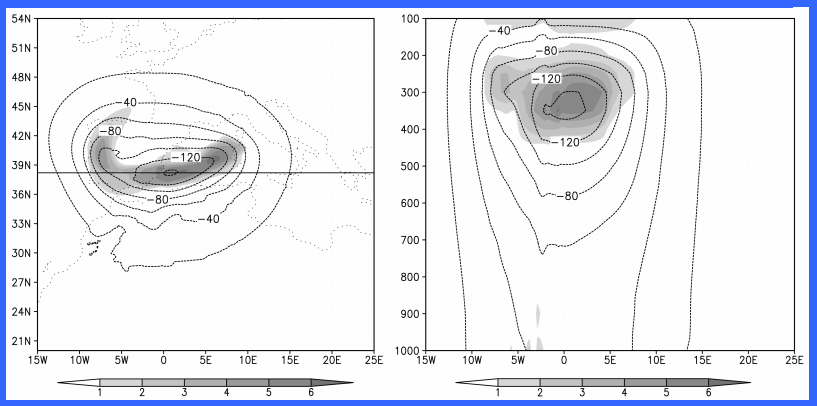


Cyclogenesis in the lee of Atlas: METHOD

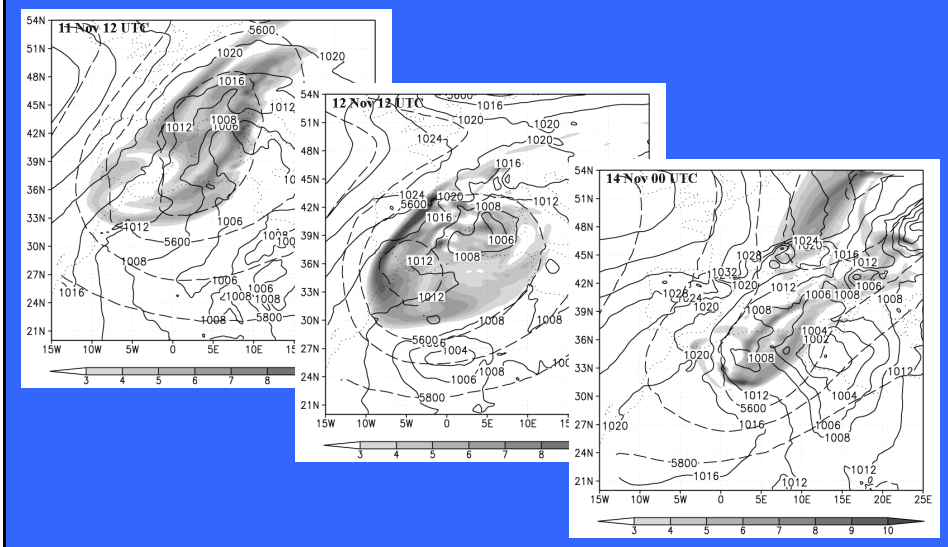
- Factor Separation method (Stein and Alpert, 1993)
  - $F_i = f_i - f_0$ (1)
  - $F_{ij} = f_{ij} - (f_i + f_j) + f_0$ (2)
  - $F_{ijk} = f_{ijk} - (f_{ij} + f_{ik} + f_{jk}) + (f_i + f_j + f_k) - f_0$ (3)
- chosen factors:
  - Atlas orography
  - surface sensible heat flux
  - upper-level dynamical factors

Cyclogenesis in the lee of Atlas: METHOD

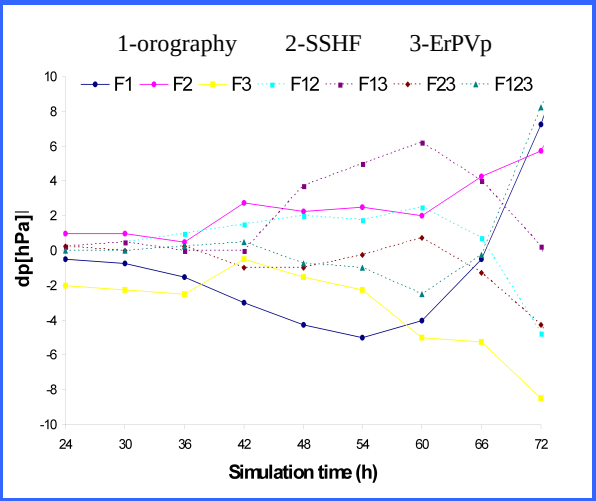
- ErPV perturbation



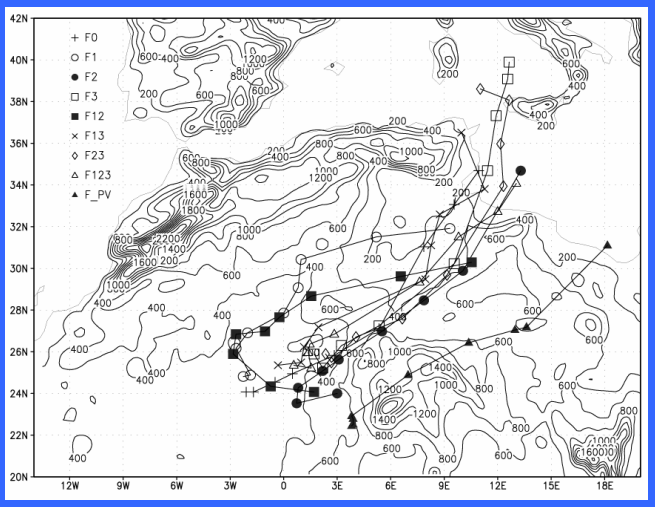
Control run



Cyclogenesis in the lee of Atlas: RESULTS
Factor Separation



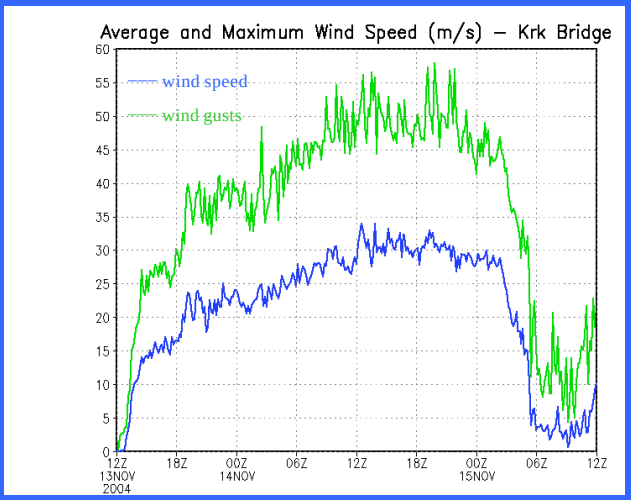
Cyclogenesis in the lee of Atlas: RESULTS
Simulation paths

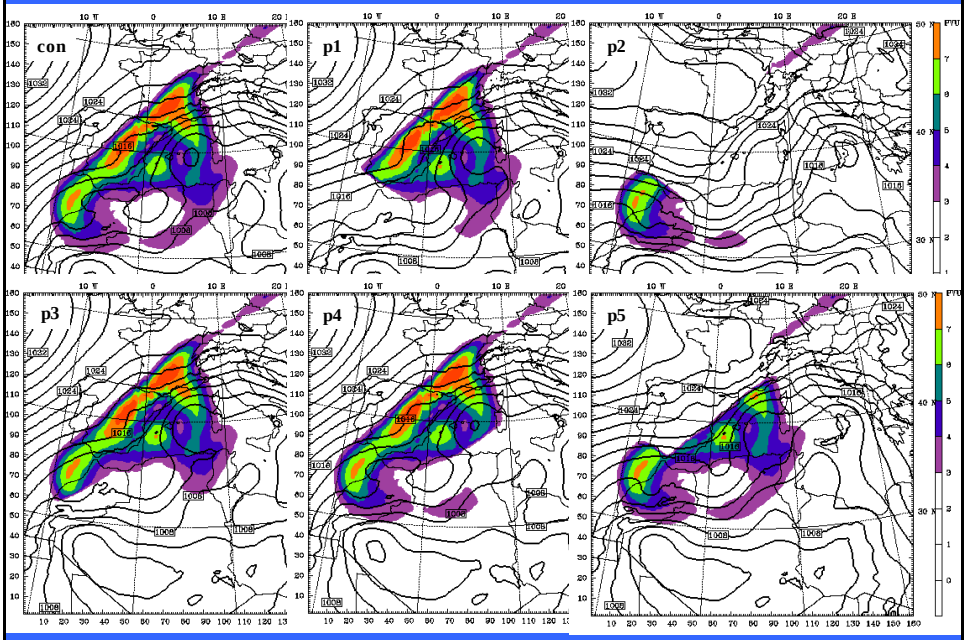


Phase 2: Cyclone deepening and Bura wind

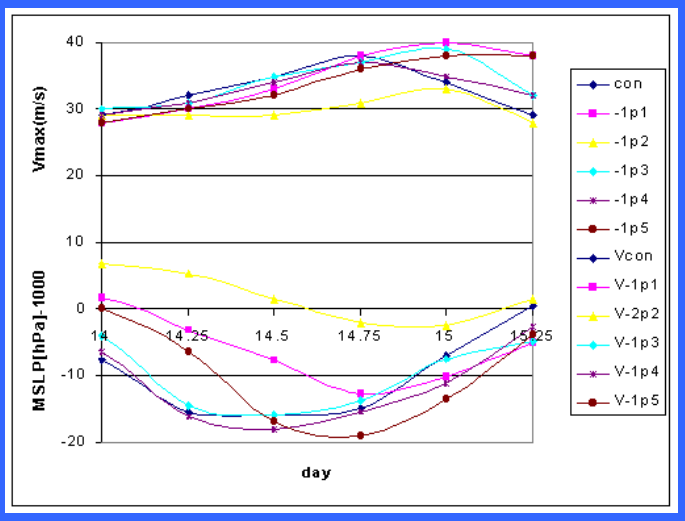
- what is the sensitivity of Bura wind to cyclone intensity and pressure distribution (large-scale pressure pattern)?

Measurements

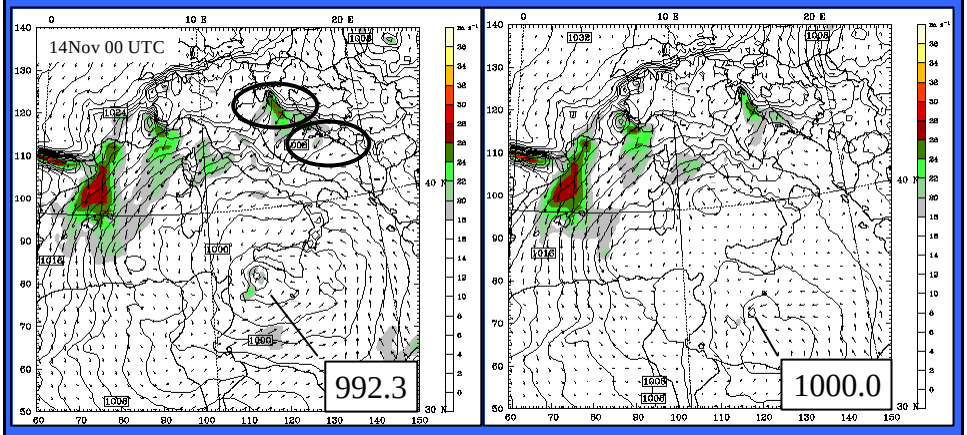




Numerical study: sensitivity to a cyclone intensity and pressure distribution



Sensitivity to a cyclone intensity and pressure distribution



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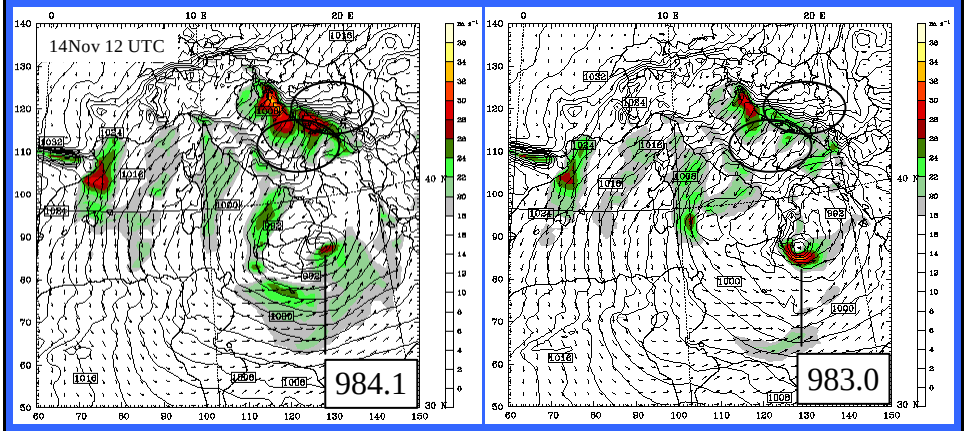
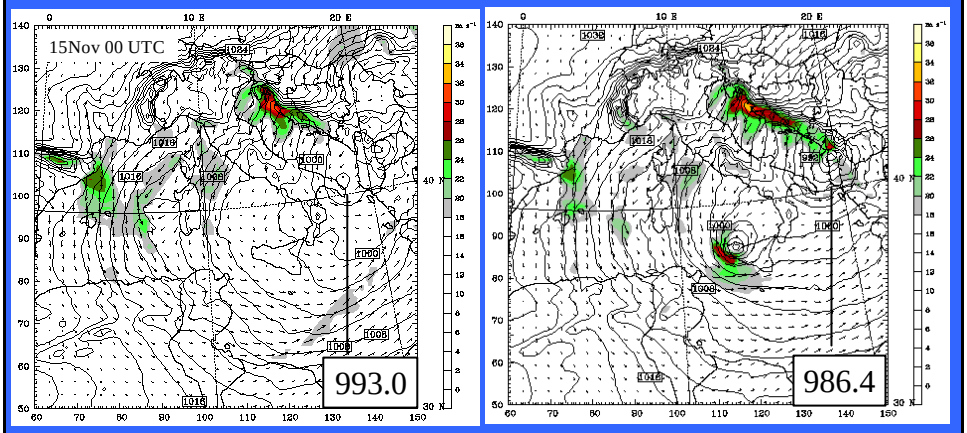


Sensitivity to a cyclone intensity and pressure distribution



Conclusions: Atlas lee cyclogenesis

- Upper-level dynamical factors and orography play the crutial cyclogenetic role
- Surface sensible heat flux has a cyclolytic afternoon contribution
- Can the two-phase lee cyclone development theory be applied to Atlas lee cyclogenesis?

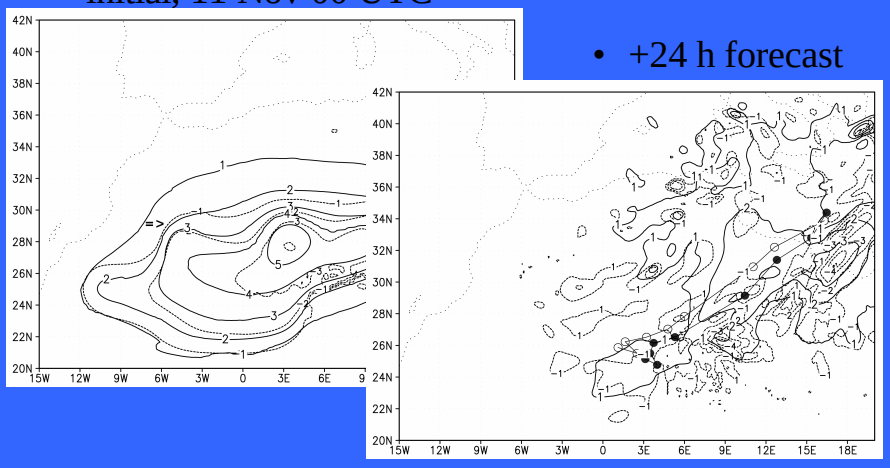
Conclusions: Bura analysis

- Bura along the Northern Adriatic coast is primarily dominated by the upstream conditions
- The existence of a a downstream low pressure system in the vicinity of Adriatic Sea is crutial for onset of Bura in Southern Adriatic

- Does Southern Adriatic Bura follow the hydraulic theory?

Cyclogenesis in the lee of Atlas: thermal anomaly sensitivity experiment

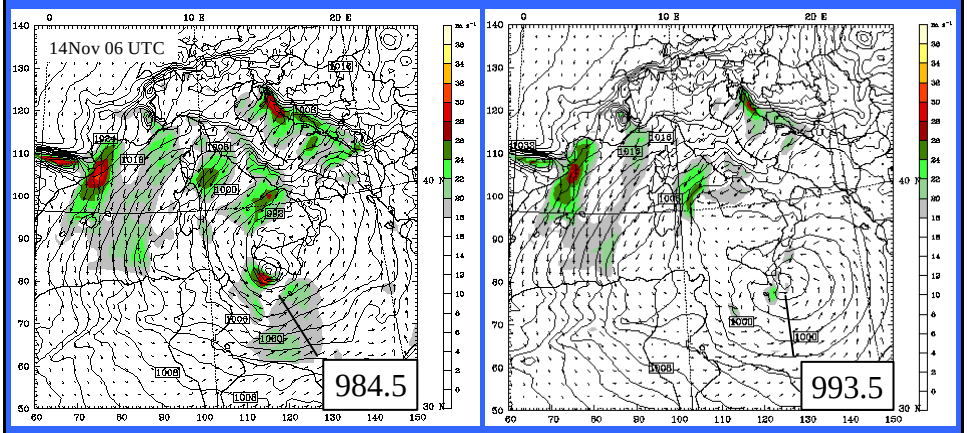
- initial, 11 Nov 00 UTC
- +24 h forecast



Bura

- Bura (bora) is gusty downslope wind occurring along the Eastern Adriatic coast
- develops when strong pressure gradients build up over the coastal mountain range
- qualitatively similar to hydraulic flow
- what is the sensitivity of the Bura response to macro-*?* (meso-*?*) scale pressure intensity and distribution?

Sensitivity to pressure intensity and distribution



Sensitivity to a cyclone intensity and pressure distribution