Evolution of the forecast error at various parameterization schemes in the MM5 model

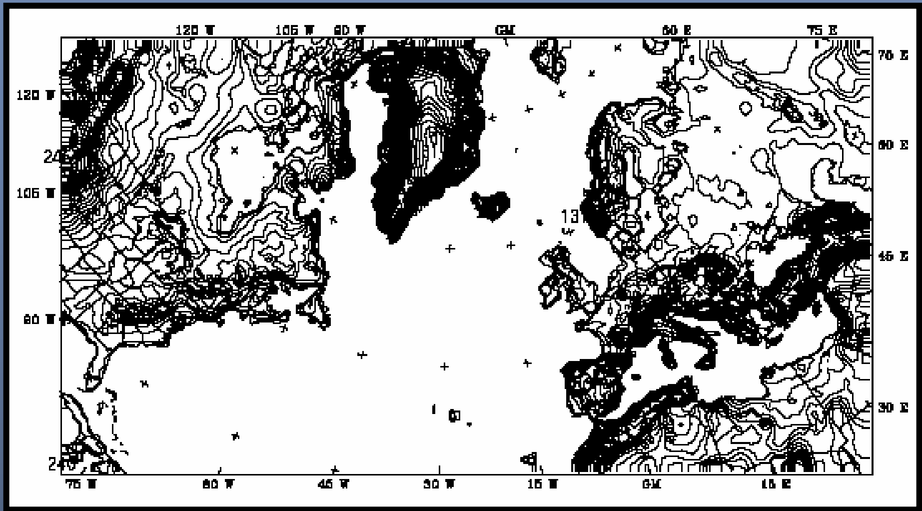
Iuliia Palamarchuk
Serge Ivanov

Odessa State Environmental University, Ukraine

Objective

To focus on capabilities of various parameterization schemes in the MM5 model to simulate basic meteorological parameters and system interactions and feedbacks in nesting domains.

Areas of interests



- North Atlantic + Europe region
- Large-scale winter atmospheric flow (neither meso-scale summer convection not spring-autumn sharper transition regimes)
- Resolution simulations

  (φ x λ)

  D1 - 75 x 139 (81 km)

  D2 - 124 x 145 (27 km)

- ERA40 reanalysis resolutions

(2,50 Lat-Lon, N80 Gaussian grid)

Systematic model error:

- Spatial distribution
- Vertical profiles
- Variability

Parameterization schemes

- Microphysics: Reisner (5), Schultz (8)
- Cumulus: Anthes-Kuo (2), Grell (3),
  Arakawa-Schubert (4), Kain-Fritsch (6)
- PBL: Eta (4), MRF (5)
- Radiation: CCM2 (3), RRTM (4)

Diagnostics

simple difference

$$\text{dif} = \Sigma_l \, (x_l^m - x_l^r) \, / \, L \; (\text{or } T)$$

x_l^m – model state vector
x_l^r - reanalysis state vector
L – domain
T – simulation period

absolute value of difference

$$\text{std} = \Sigma_l \, (|x_l^m - x_l^r|) \, / \, L \; (\text{or } T)$$

spectrum

dif *(++)* **std** *(+-)*

dif *(--)* **std** *(+-)*

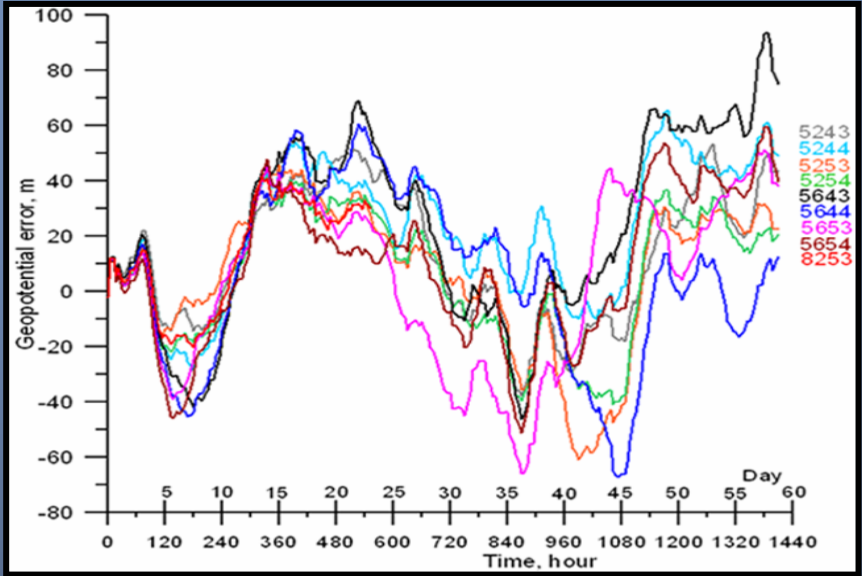
Results

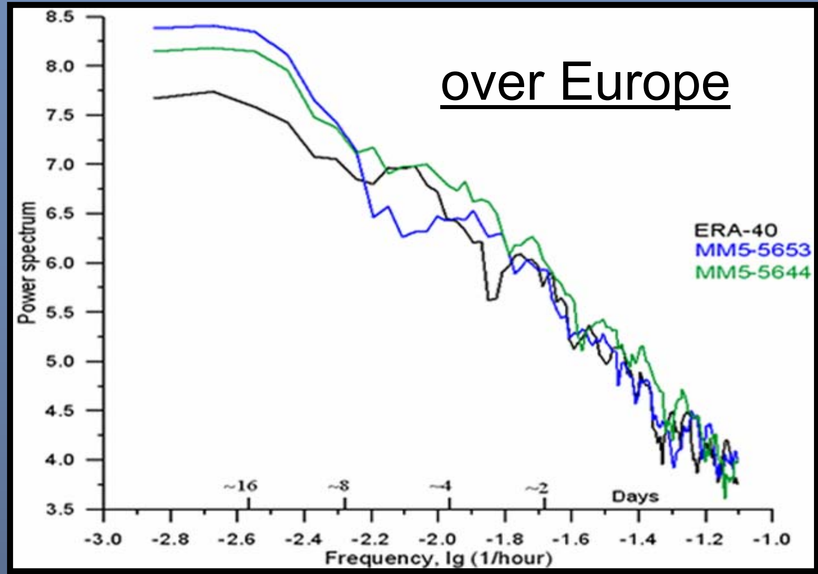
briefly

Evolution of model error

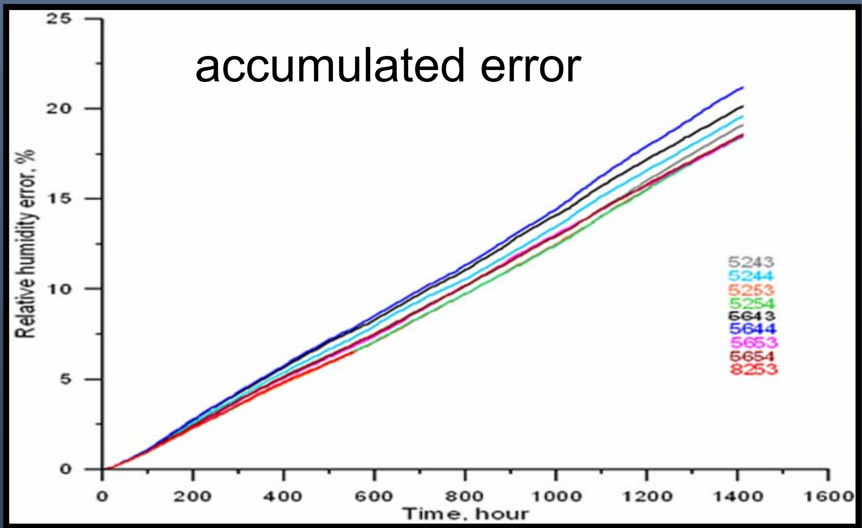
Geopotential (dif) 500 hPa

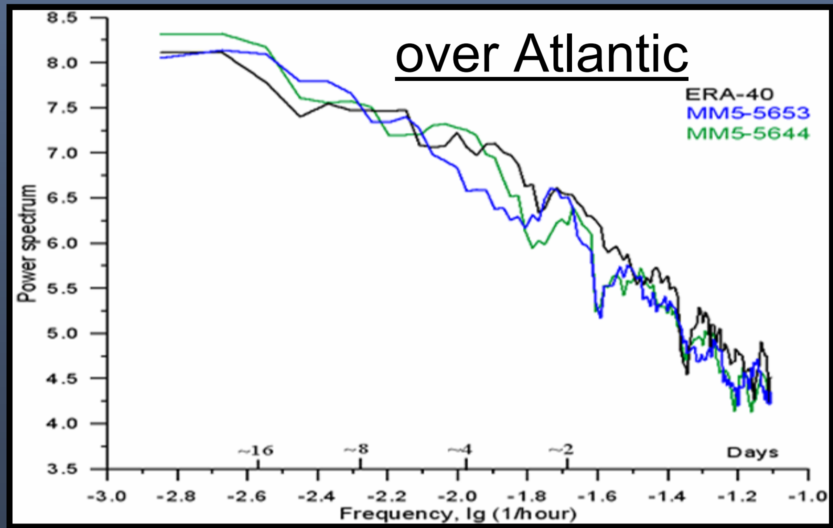
Power spectra





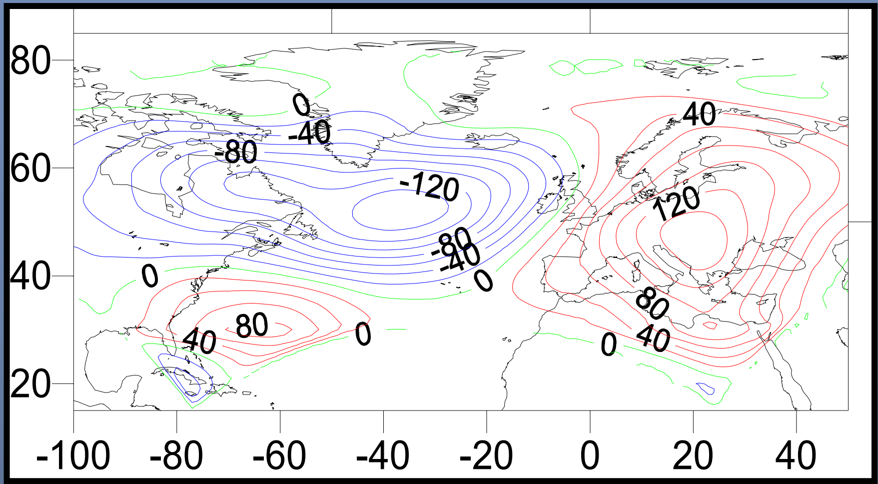
Relative humidity (std) 700 hPa



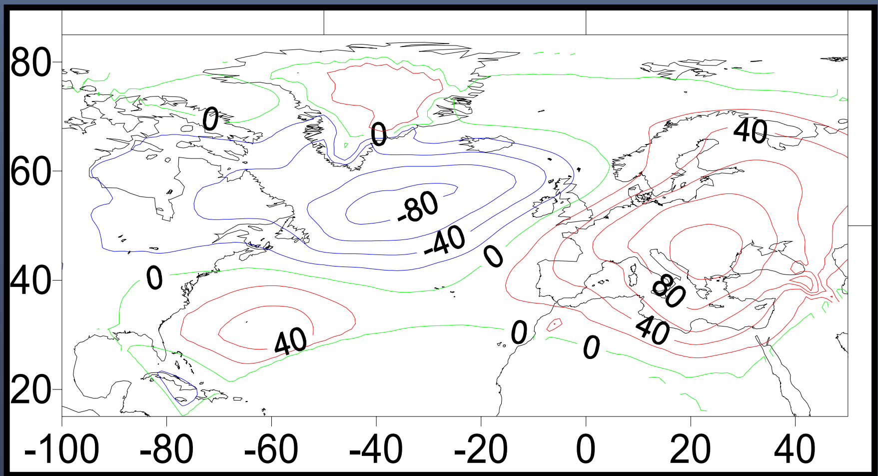


Spatial structure systematic error in the model

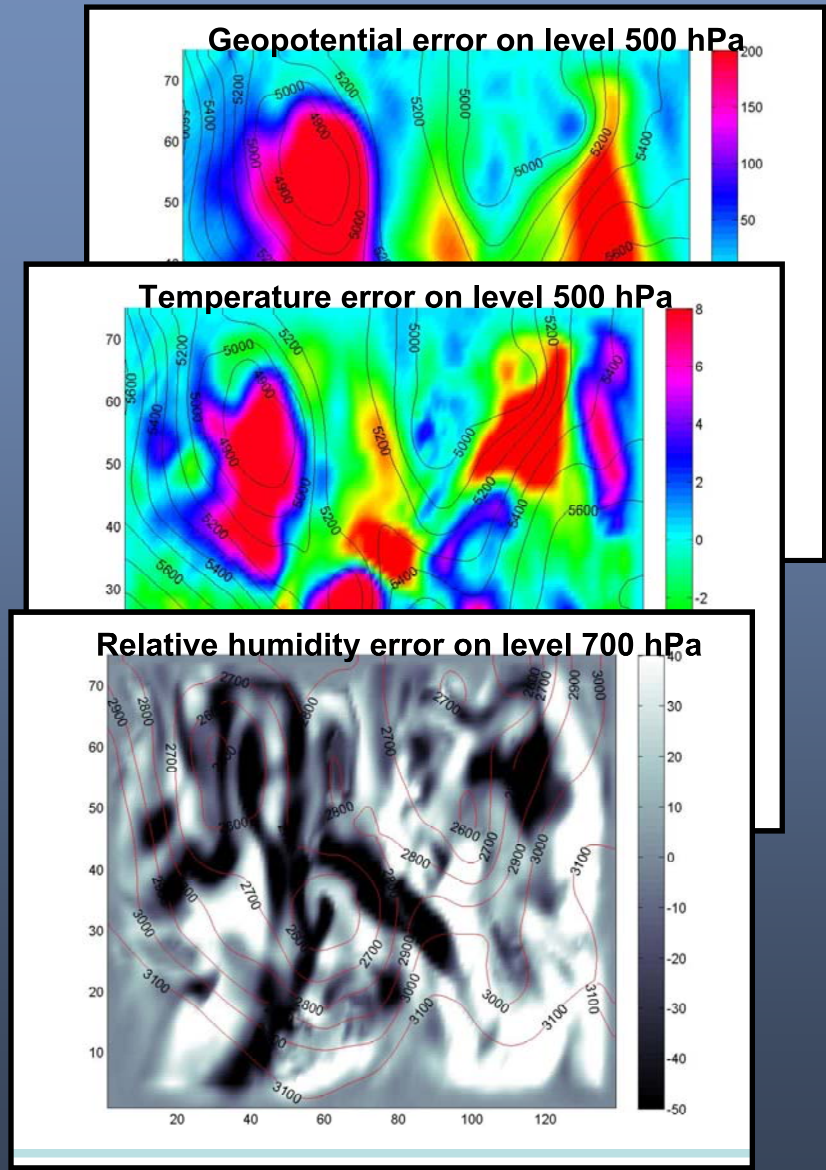
Geopotential error
500 hPa



MM5 – ERA40 > 0
MM5 – ERA40 < 0



850 hPa



Optimal sets of parameterization schemes MCBR →

- Microphysics
- Cumulus
- Boundary layer
- Radiation

5653 D1

5 – mixed phase Reisner;

6 – Kain-Fritch;

5 – MRF by Hong-Pan;

3 – CCM2.

5324 D2

5 – mixed phase Reisner;

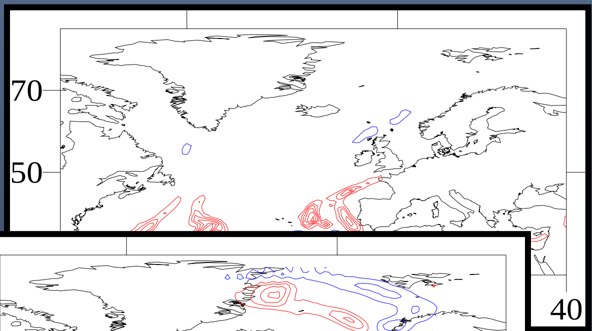
3 – Grell;

2 – hight-resolution Blackadar;

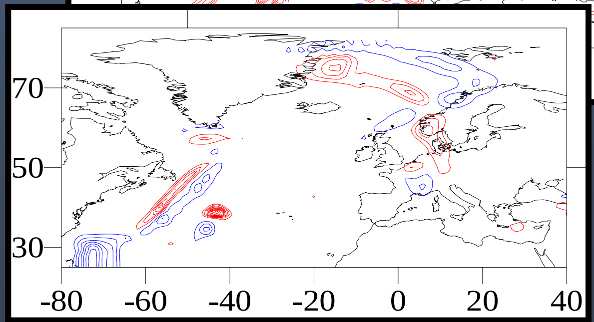
4 – RRTM.

Precipitation differences MM5 {5653} – ERA40

Convective

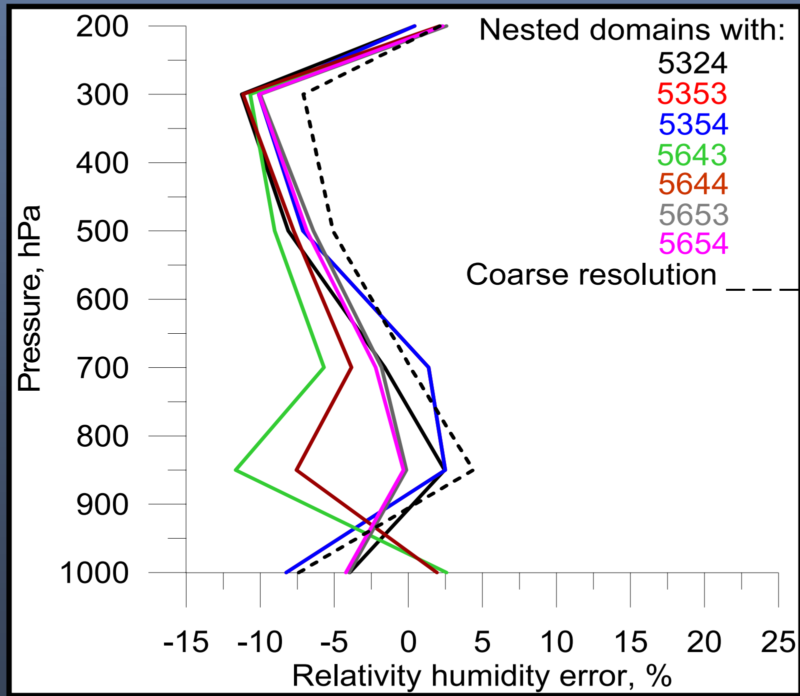


Large scale



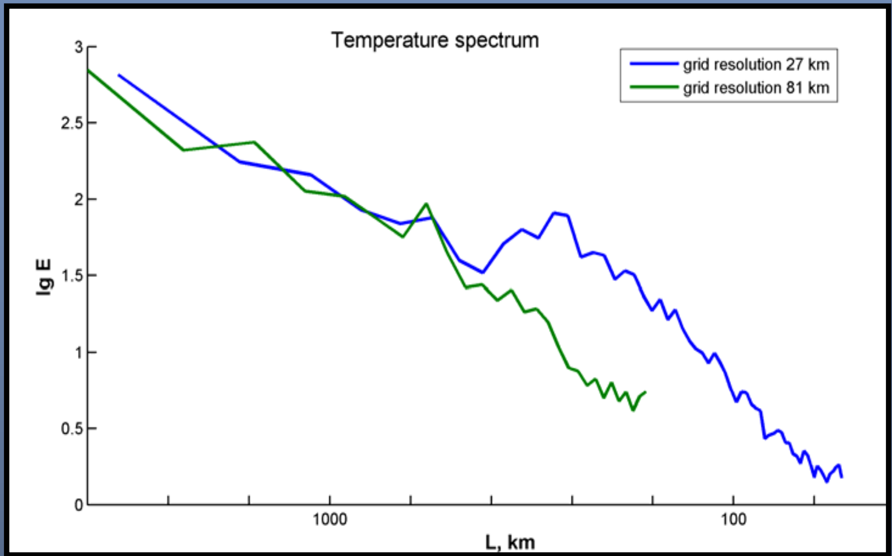
Vertical profiles of systematic error

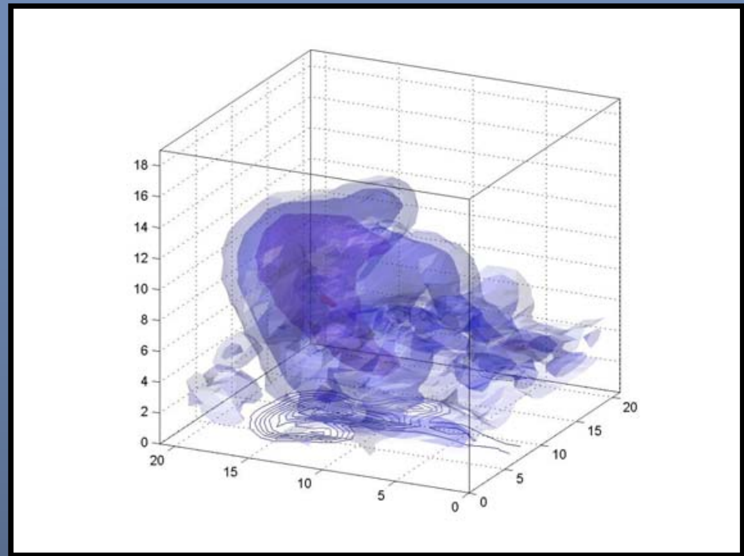
Relative humidity (DIF)



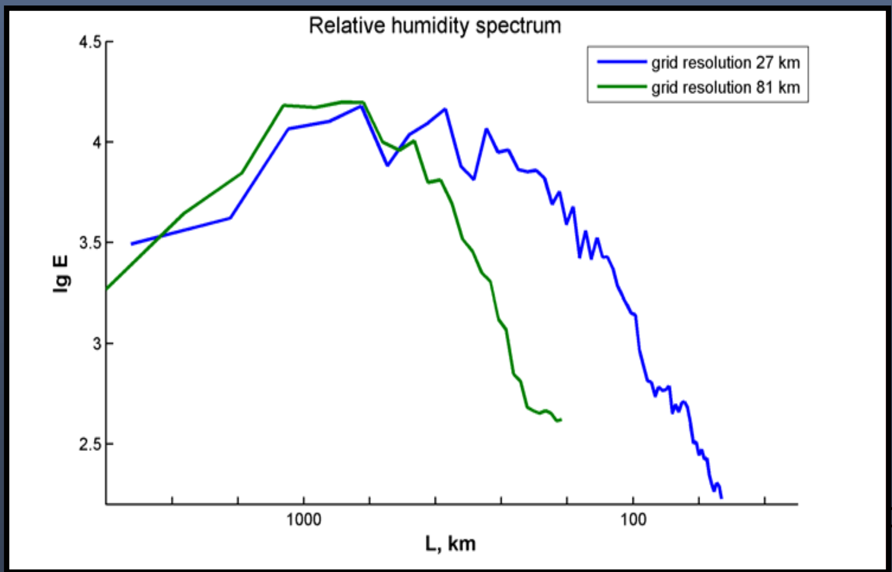
Fine-scale processes simulated on the different grids

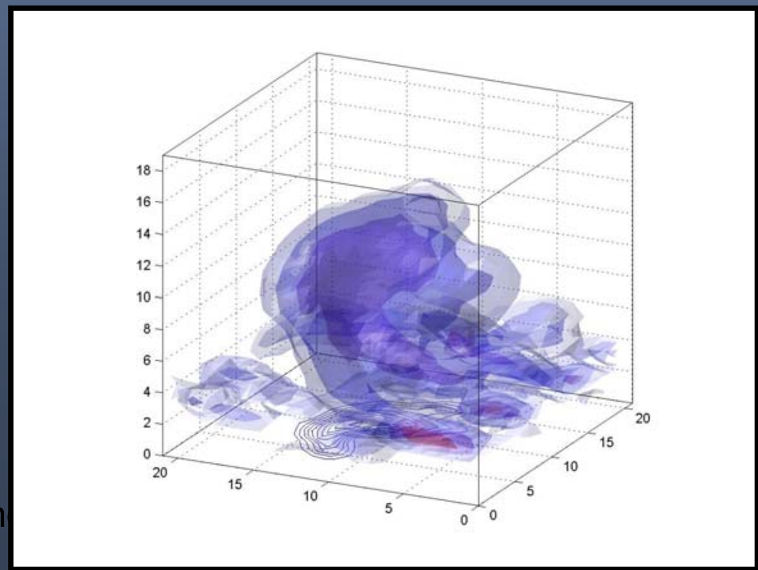
3D Cloud water in the model





5324





5643

of m

Conclusions

The most optimal for large scale simulations, in general, can be considered the set 5653 including the mixed phase by Reisner for microphysics, Kain-Fritsch for cumulus, MRF by Hang and Pan for PBL and CCM2 for radiation

In the model, humidity is redistributed from the middle and upper atmosphere downward to the low atmosphere. This provokes overestimation of convective precipitation, especially over warm regions and, in particularly, in the East Mediterranean.

For large scale precipitation, the systematic model error is mainly related to intensive synoptical patterns and manifests in the form of the phase error. This means that the magnitude of precipitation form is reproduced well enough but is placed in wrong position.

Feedbacks from finer to larger scales usually lead to better behavior in the simulated state. this is mainly true for the atmospheric properties characterized by smooth patterns with large scale structure functions, such as geopotential and temperature. Contrary, the humidity model error in the nesting mode is sensitive to the choice of a parameterisation scheme.

Smooth large-scale structures are associated with the geopotential field. Thus, it is not sensitive to a choice of the resolution within the fine-scale band.

Counterwise, simulation of the temperature and relative humidity fields becomes to be sensitive when resolution approches to smaller scales.

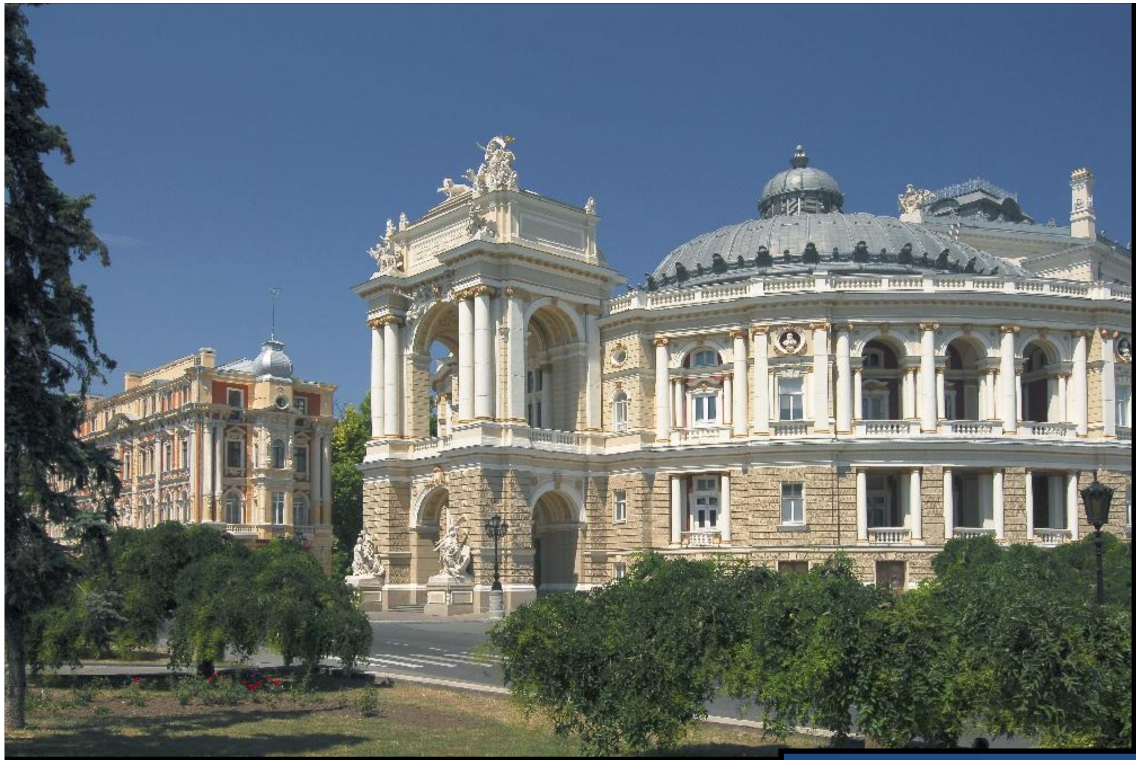
The model overestimates temperature in the pressure trough area throughout the whole atmosphere column. This leads to underestimation of geopotential height, in particular in the pressure ridge of the upper troposphere.

The warm sector of a cyclone is oversaturated near the surface, while negative model errors of relative humidity are related with the high pressure ridge in the upper troposphere and cold air in the cyclone near the surface.

Intensification of synoptic patterns speeds up the model error growth.

Some more details ?...............................

.... Welcome to poster !



Thanks for your attention

and
sorry for my English