Mechanisms of the polar low development

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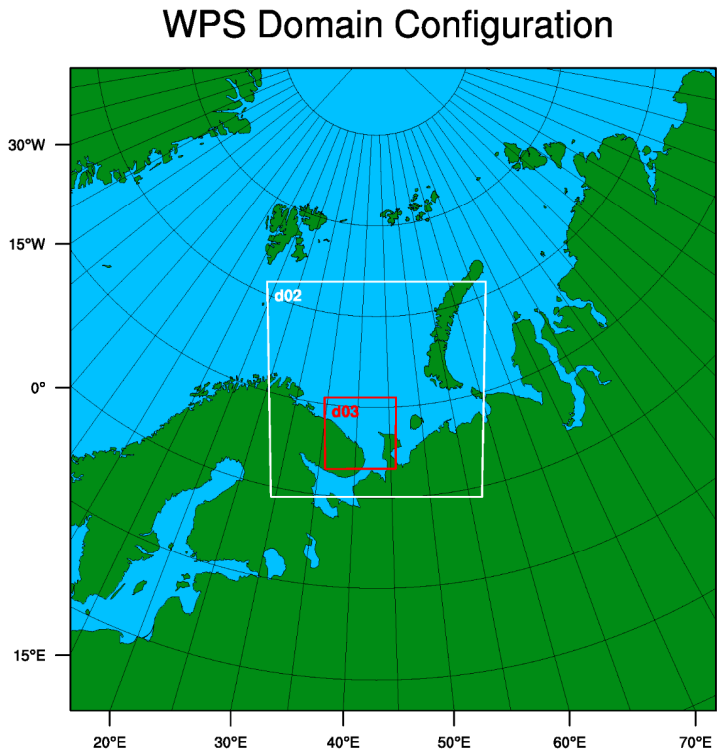
Different attitude at the dominant role in the mechanisms of the PL development

- In the recent researches, the disagreement on the issue of the mechanisms of the polar low development is observed.
- the dominant role:
- of baroclinic instability during the development of polar low at the initial stage of atmospheric vortex formation, but then the polar low was maintained due to the sensible heat flux from the surface;
- of condensational heating with a minor role of sensible and latent heat fluxes on the ocean surface;
- sensible and latent heat fluxes between the ocean and the atmosphere both at the stage of baroclinic intensification of the polar low and at the stage of its maintenance.

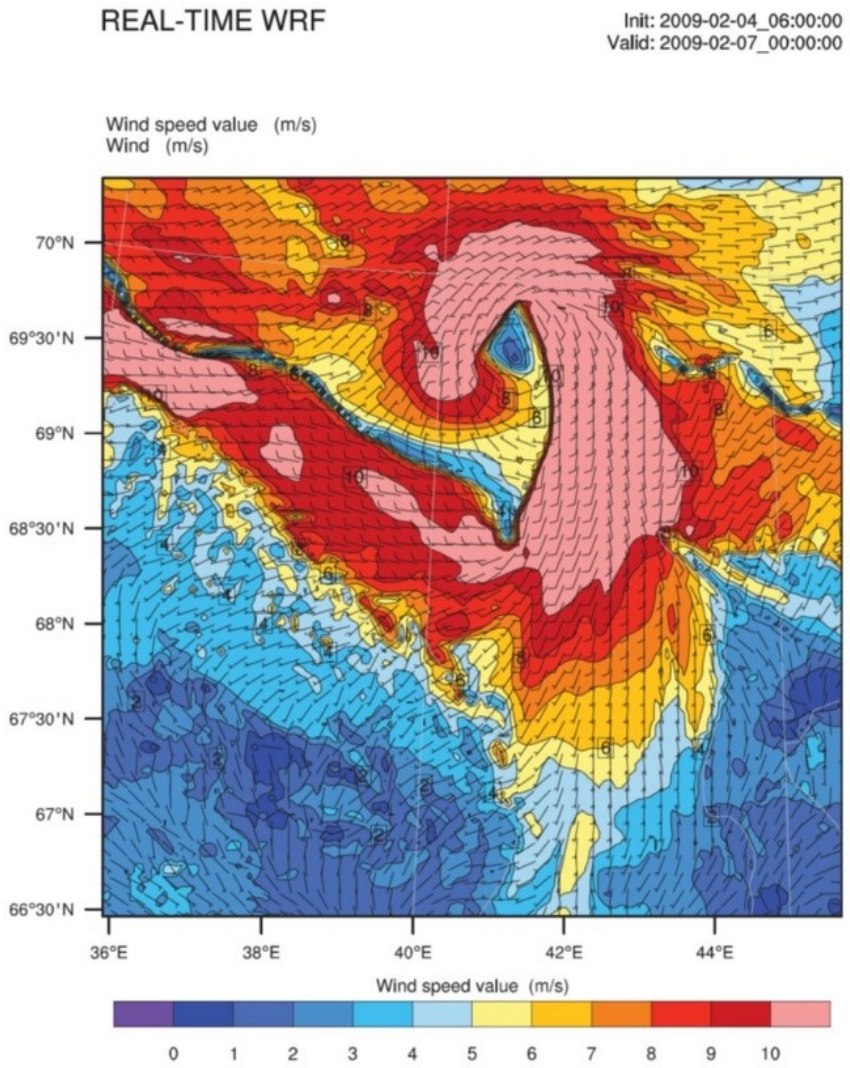
Polar low modeling



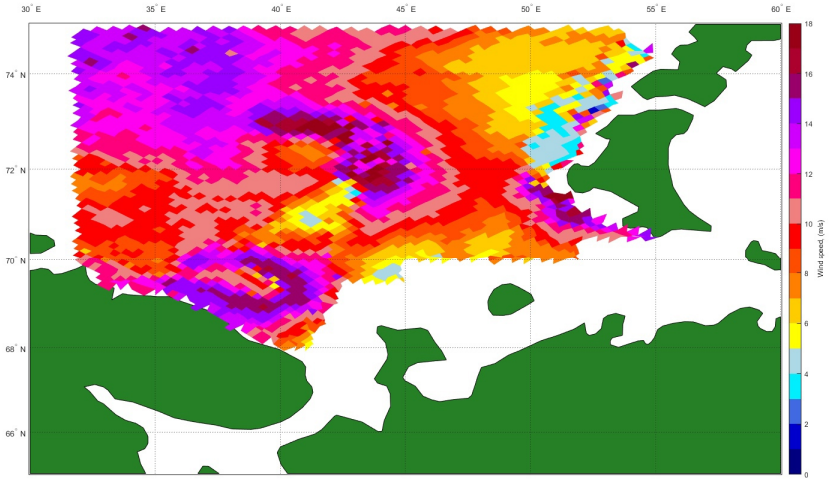
- To simulate wind waves under conditions of polar depression, the Barents Sea was selected
- The PL took place 5.02.2009 (69 N, 40 E)
- The simulations to elucidate the mechanisms of the development of polar low were carried out within the framework of the WRF atmosphere model.
- 3 considered domains are shown at the picture

WRF configurations

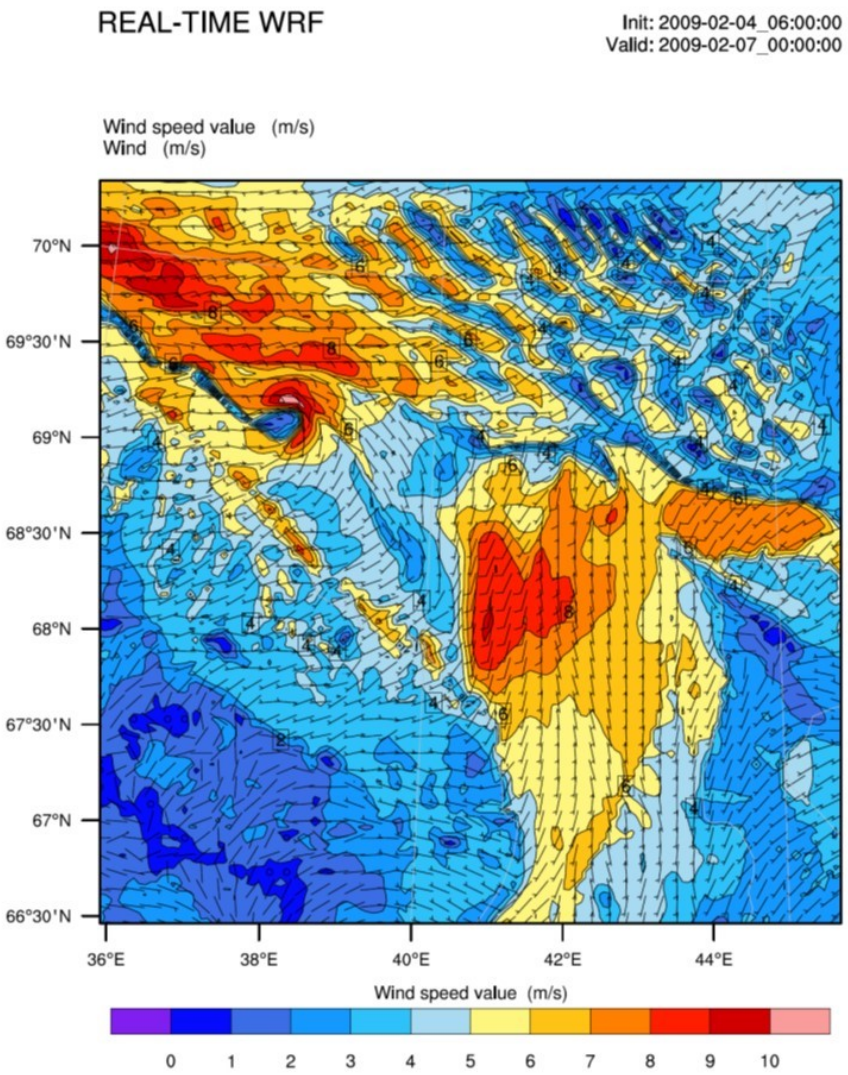
Option	WRF (control experiment)	WRF Polar
Number of domains	3	3
geographical data	MODIS LAKES (30s)	MODIS LAKES (30s)
initial and boundary conditions	NCEP Climate Forecast System Version 2 (CFSR) 6-hourly Products	NCEP Climate Forecast System Version 2 (CFSR) 6-hourly Products
micro physics	Thompson Scheme	**Thompson Scheme**
land surface	5–layer Thermal Diffusion Scheme	5–layer Thermal Diffusion Scheme
PBL	Yonsei University Scheme + LES (3d domain)	**MYNN Scheme Level 2.5**
cumulus parameterization	Betts–Miller–Janjic Scheme	Betts–Miller–Janjic Scheme
shortwave and longwave radiation	New Goddard Shortwave and Longwave Schemes	New Goddard Shortwave and Longwave Schemes
surface layer	Revised MM5 Scheme	MYNN Scheme

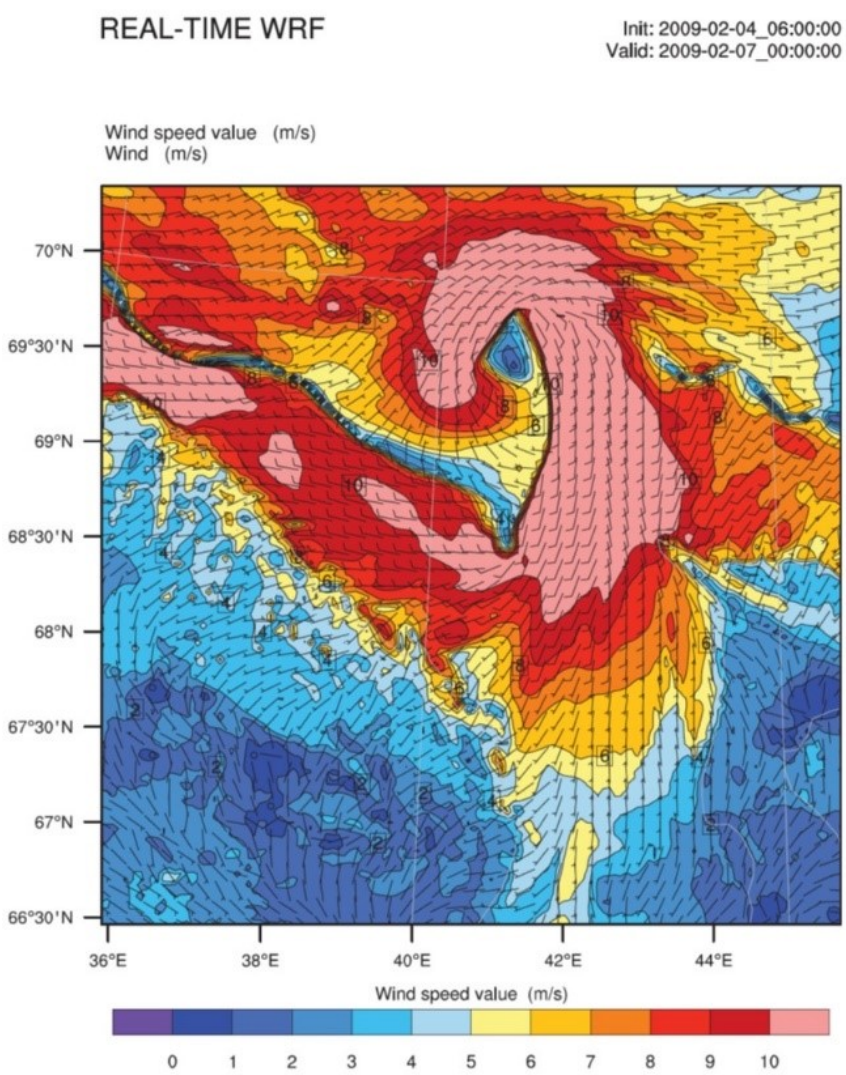


WRF modeling (control experiment)



QuickSCAT scatterometer

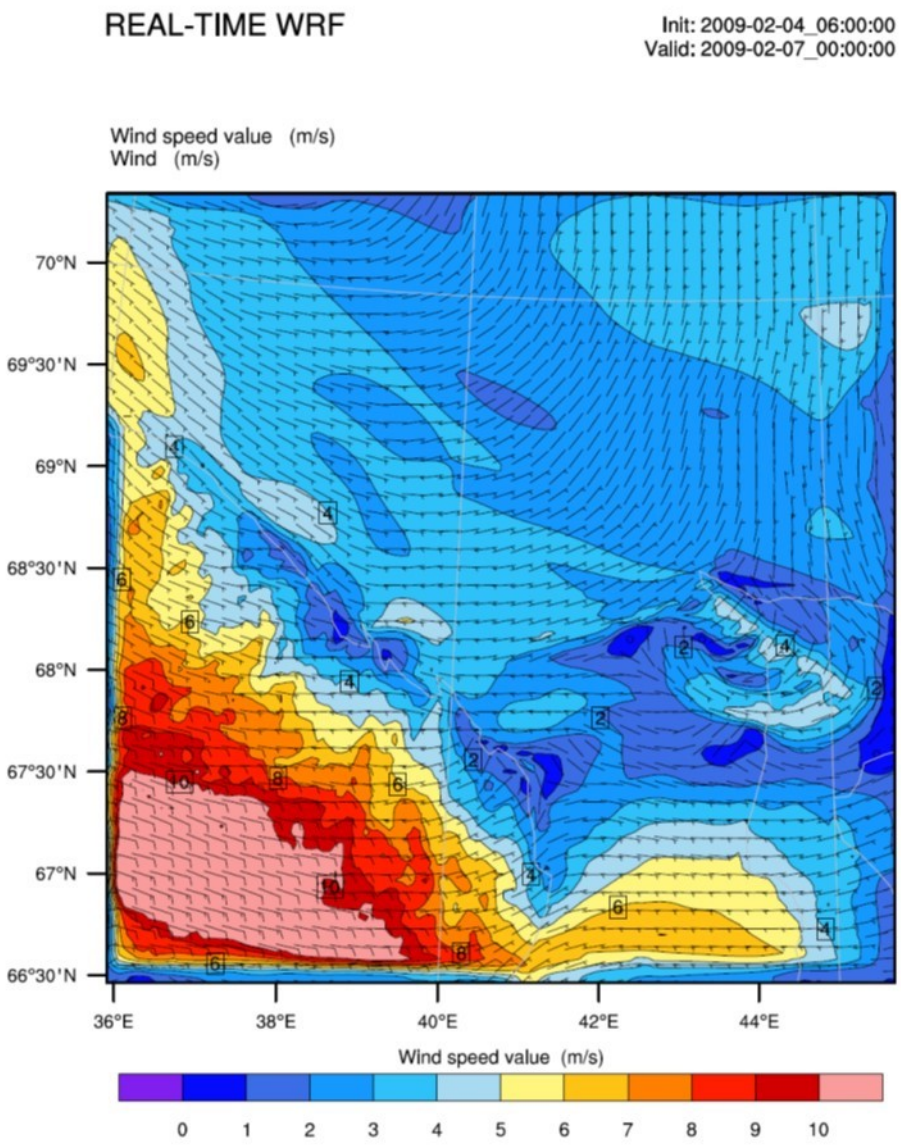




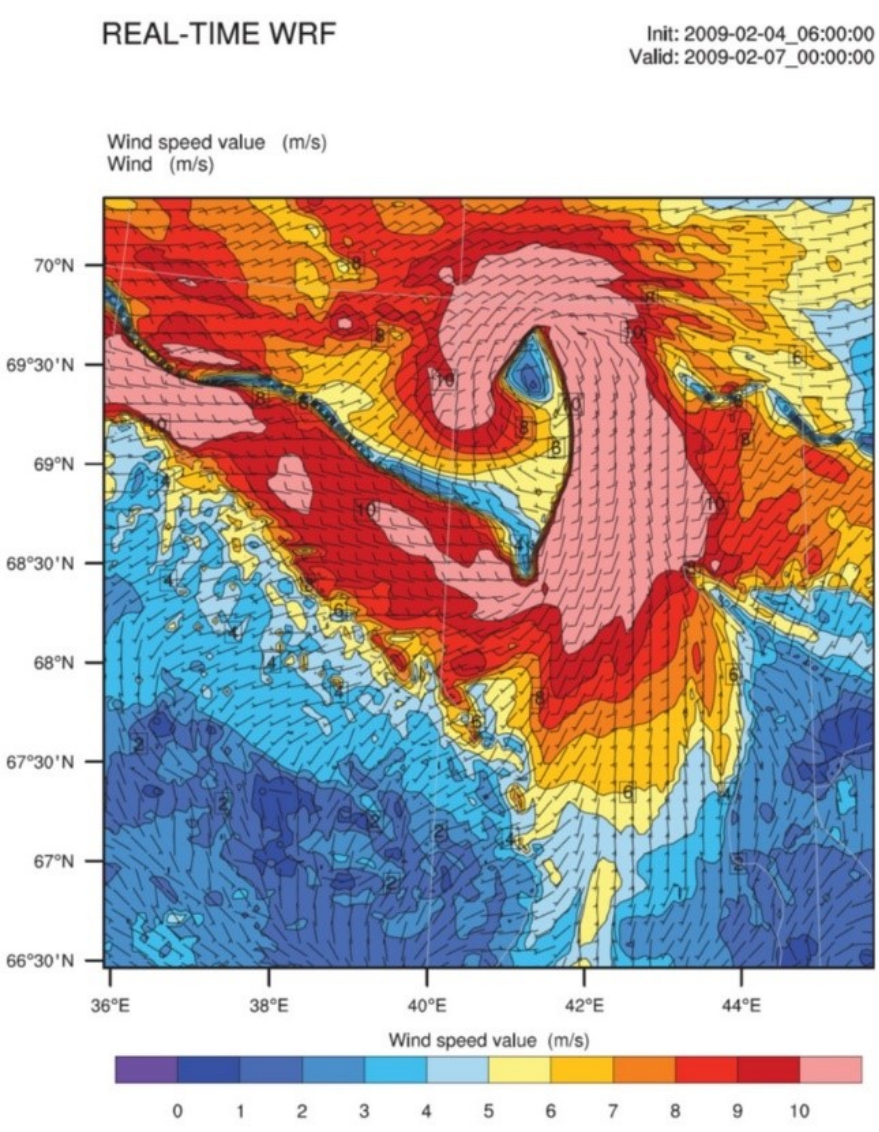
WRF modeling

no latent heat during condensation

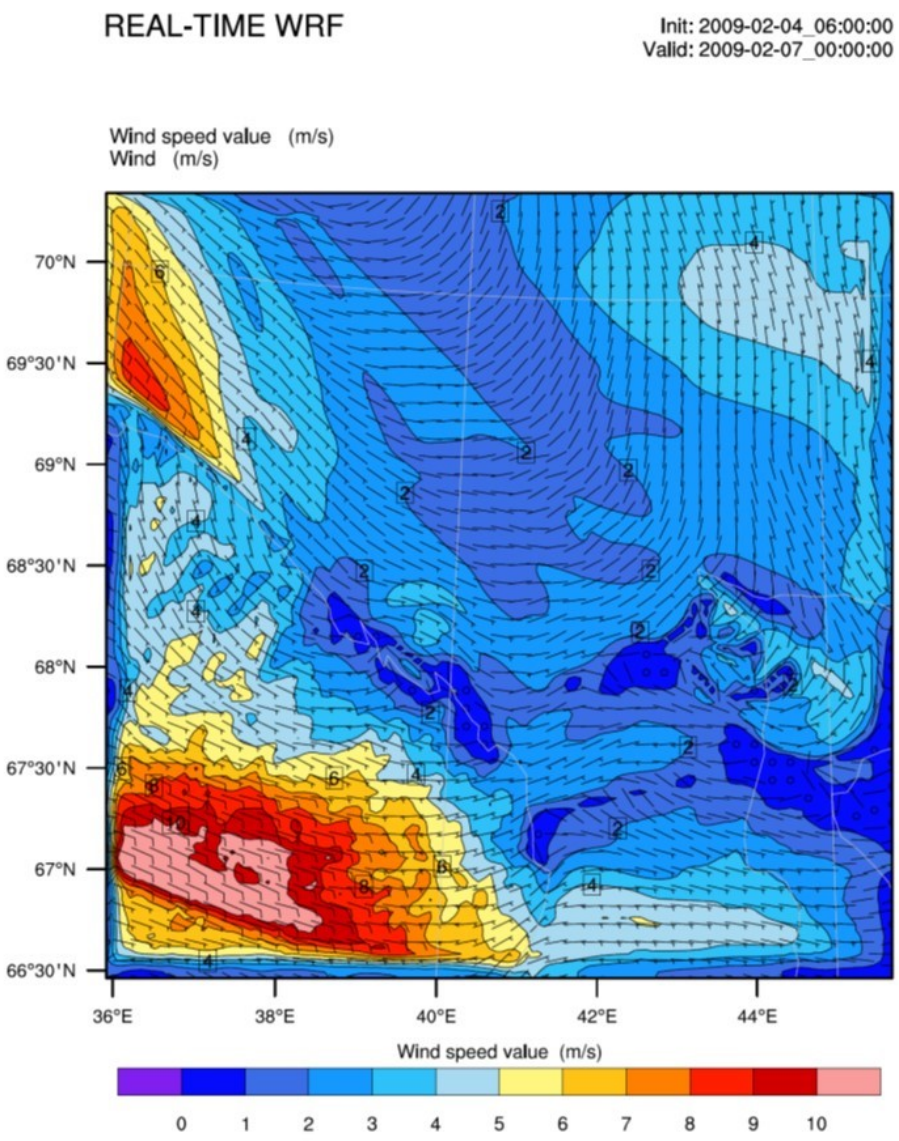
control experiment



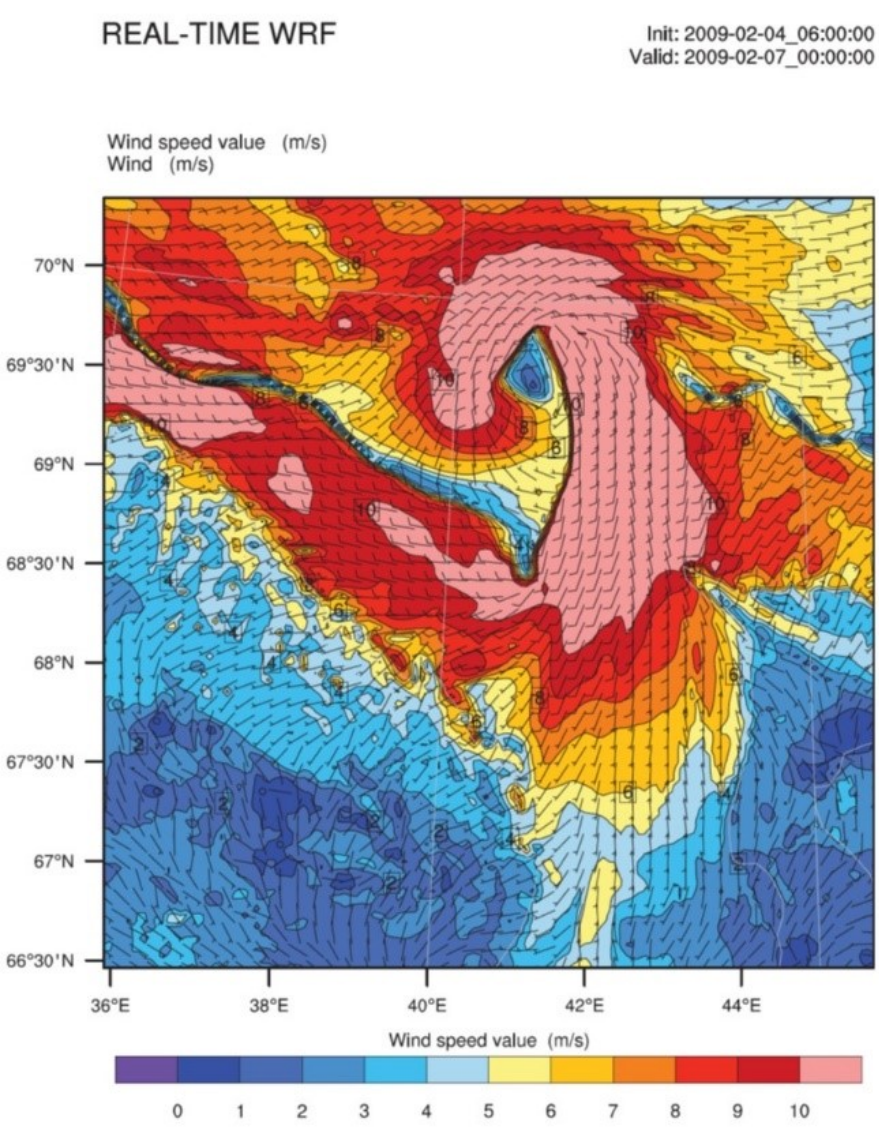
no heat fluxes on the surface



control experiment



no heat fluxes on the surface
no latent heat during condensation



control experiment

Conclusions

When parameterizations of all physical processes described in the WRF model are used, a vortex with high wind speeds and a pronounced “eye” of a polar hurricane is formed.

When the heat released during condensation is turned off, the vortex is not formed, however, high wind speeds are located in the area where the vortex should form.

When the heat fluxes are turned off on the surface, the vortex is also not formed and high values of the wind speed are shifted to the side, which does not correspond to the real picture of the polar depression obtained in the control experiment.

At the same time, the role of the baroclinic shear does not seem to be decisive: in the case of assessing the sensitivity to this process, the eddy is also not formed, however, the wind distribution is such that in the area where the eddy is formed in the control experiment, the wind speed “spins” a little.

Thus the role of energy fluxes on the ocean surface during the development of the polar low was demonstrated.

Thanks!

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