Implementation of an Improved Mellor-Yamada Level 2.5 and Level-3 Turbulence Closures in WRF

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During summer 2008, the improved Mellor--Yamada closure after Nakanishi and Niino (2000, 2001, 2004, 2006) was implemented in WRF. This closure imposes additional restrictions on original MY closure parameters to assure its realizability and numerical stability. It treats consistently condensation physics in the boundary layer by considering liquid-water potential temperature and total water content and allows for partial condensation in a model grid to assure proper interaction with microphysics and radiation. The scheme positively evaluated against LES and was successfully used in modeling of radiation fog. We believe that WRF will benefit from this enhancement especially in conditions when phase changes in the boundary layer occur. The scheme is available as a Level-3 scheme and Level-2.5. The choice of the level of the scheme can be decided in the namelist depending on available computer resources and user needs.

Initial experimentation was performed using a 1-D model described by Pagowski et al. (2004, 2005, 2006). This model's structure is identical to WRF but has increased flexibility with respect to ingesting observations. To assure that the scheme was correctly implemented one-dimensional experiments were compared with results obtained by Niino and Nakanishi (2006). Positive results of the comparison proved that one-dimensional implementation was bug-free. Subsequently, three-dimensional version of the scheme was implemented in the full-physics WRF (called MYNN PBL scheme). To model the surface layer a modified version of Blackadar scheme is used. Further details are given in Pagowski (2008).

Since we obtained one-month funding (against original two-month request) we were not able to extensively evaluate the scheme in the full-physics WRF. Recently, the scheme has been evaluated in simulations of barrier jet in Alaska by Olson (2008) and showed some advantages over the MYJ scheme (Fig. 1, from Olson 2008). A student visiting ESRL is currently performing simulations of marine fog with the scheme. It is probable that the scheme will be included in Rapid Refresh WRF forecasts issued at ESRL. If these ongoing projects materialize and evaluation is favorable the MYNN scheme could be released with the incoming version of WRF in December 2008.

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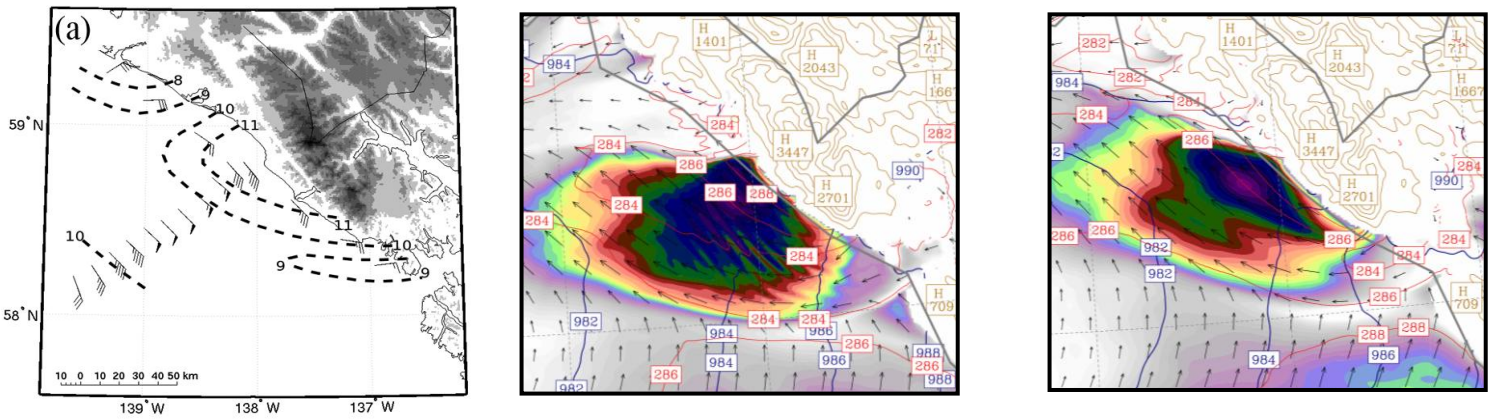

Fig.1 Observed and modeled velocity in barrier jet at 150 m AGL from IOP7 during SARJET field experiment. MYJ on the left, MYNN on the right. From Olson (2008).