COSMO for ICE-POP2018: status, verification results and plans

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ICE-POP2018 is an International Collaborative Experiments for Pyeongchang 2018 Olympic & Paralympic winter games.

ICE-POP2018 Field campaign

Observation platforms:

- **18 Supersites for cloud and precipitation microphysics (MRR-1, Marsivel, POSS, Pluvio 200/400, 2DVD, PIP, VertiX, Wind Profiler, Doppler Lider, D3R, MXPol, T-Rex)**
- **Sea surface condition & ASAP from ship**
- **Satellites (COMS, NOAA19)**
- **Aircraft (25 scientific instruments - dropsonde AVAPS-II, PIP, CCP, temperature sensor, dew point hygrometer etc.)**

Data:

- **Main meteorological parameters (air temperature and humidity, wind speed and direction, visibility etc.), Air-sea flux, Reflectivity, LWC, Precipitation rate and type, CCN, Fall velocity, DSD of cloud and precipitation particles**

Data availability from different type of instruments made possible observations cross-validation, e.g. POSS vs 2DWD, PARSIVEL vs 2DWD.

Precipitation forecast

COSMO MODEL CONFIGURATION FOR ICE-POP2018

COSMO-ICE02: domain 400x400 g.p., 60 levels, grid spacing 2.2 km, IC&BC – COSMO-ICE06, 1h update

COSMO-ICE005: domain 300x400 g.p., 80 levels, grid spacing 550 m, IC&BC – COSMO-ICE02, 15 min update

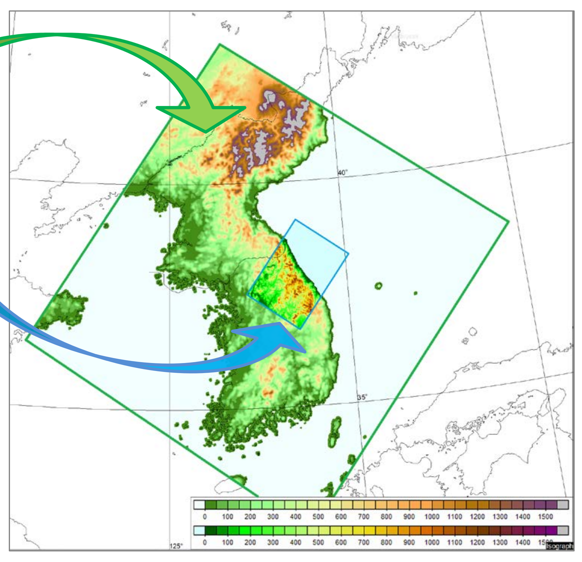

Fig. 1. COSMO-ICE domains and model orography

EXPERIMENTS SETUP

New cloud-aerosol-radiation scheme was developed within the COSMO PP T2(RC)2 framework. This scheme based on Segal-Khain parameterization taking into account aerosol influence on cloud nuclei number was implemented in COSMO-model.

Changes in cloud-aerosol-radiation scheme revealed primarily in precipitation forecasts: in precipitation localization and as a consequence in its amount, and also in rain/snow ratio.

Surface radiation fluxes, temperature, and wind speed will be subjected to change too, since the influence of liquid and solid cloud particles is considered in cloud optical parameters. Main effect was found for maximum T2m values (1-2° rise).

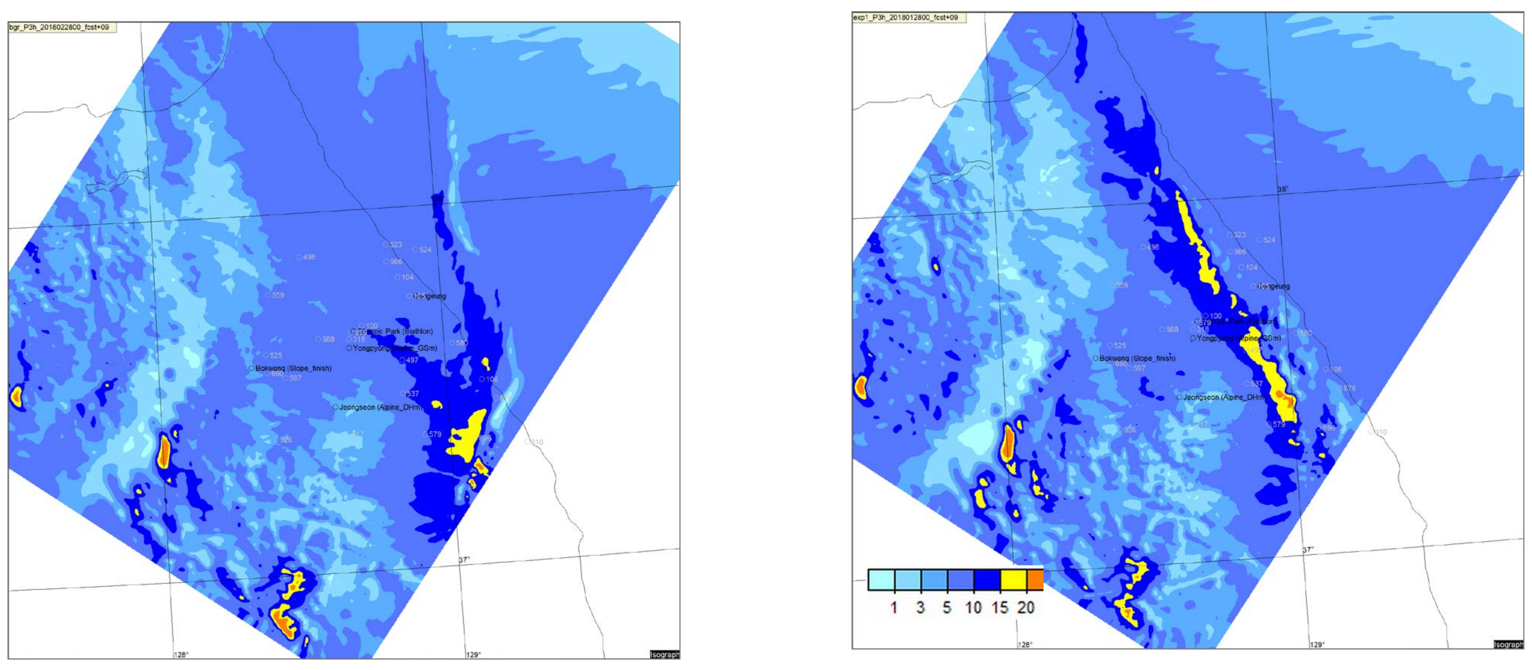

Fig. 2. Accumulated precipitation (mm/3h) in ctrl (left) and experimental (right) COSMO-ICE005 runs. Forecast from 2018022800, fcst+09

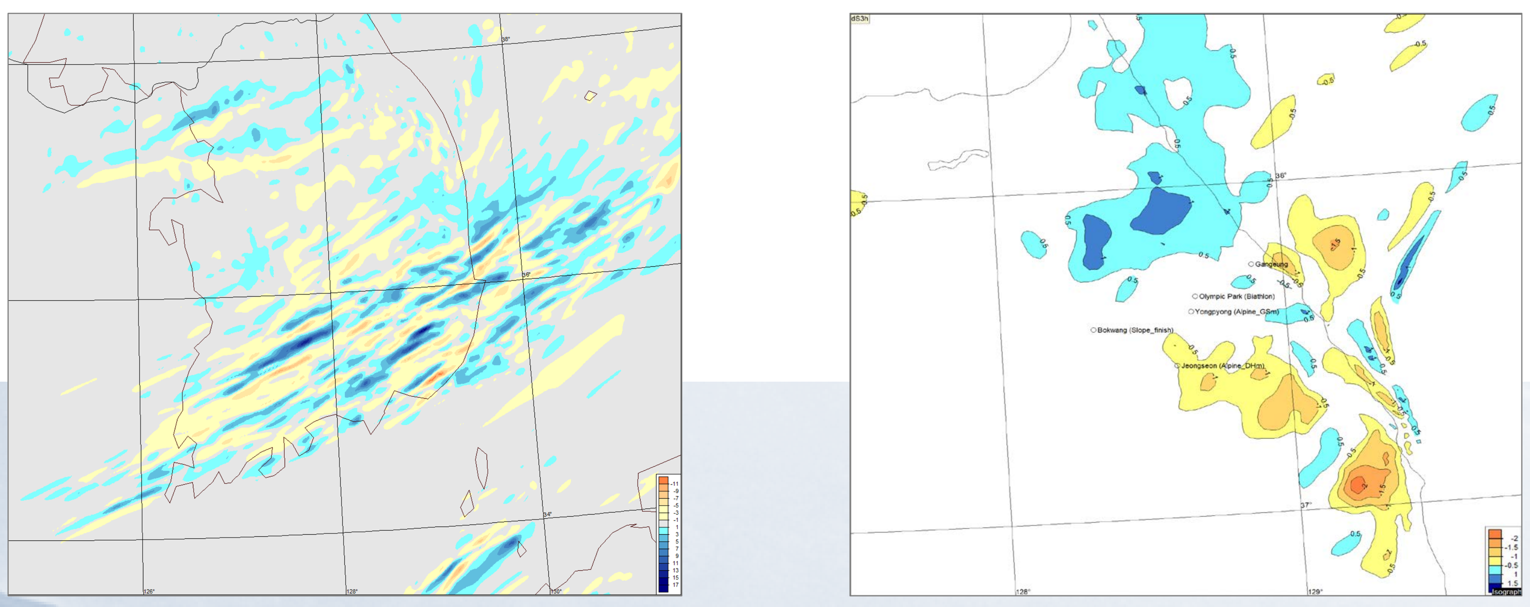

Fig. 3. Difference between experimental and ctrl COSMO-ICE02 runs: 3h accumulated precipitation (left); 3h accumulated snow in Pyeongchang area (right). Forecast from 2018030400, fcst+18.

Forecast verification

VERIFICATION SETUP

- **COSMO-ICE02 and COSMO-ICE005 model versions**
- **1h precipitation accumulations**
- **Korean radar composite as reference data interpolated on model grid**
- **Free R SpatialVx package (by E.Gilleland, NCAR) is used for applying spatial methods**
- **Neighborhood and object-based (Not considered here) approaches are applied**

NEIGHBORHOOD METHODS

Relax the requirement for an exact match by evaluating forecasts in the local neighborhood of the point of interest.

Fractions Skill Score, FSS (Roberts and Lean, 2008):

$$FSS = 1 - \frac{\frac{1}{N}\sum_N \left(P_f - P_o\right)^2}{\frac{1}{N}\left[\sum_N P_f^2 + \sum_N P_o^2\right]}$$

Ideal forecast FSS = 1;
Worst forecast FSS = 0.
***P* is a fraction of grid cells with an event in the neighborhood**
Worst forecast in denominator: there are no events forecast and some occur, or some occur and none are forecast.

$FSS_{uniform}$= 0.5+f_o/2, where f_o is the base rate, that is, halfway between random forecast skill and perfect skill.

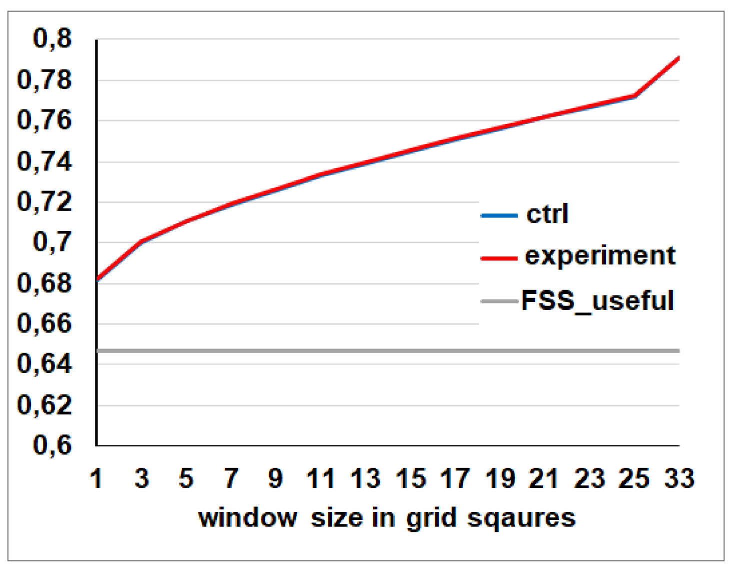

Fig. 4. FSS of ctrl and experimental COSMO-ICE02 runs, precipitation threshold 0.1 mm/h. Forecast from 2018030412, fcst+04.

For COSMO-ICE02 the new scheme in most cases produces similar patterns as the ctrl run. The FSS score is slightly better of low precipitation thresholds, but the difference is not significant (fig.4, fig.6). The error in most intense precipitation localization is not corrected in the new scheme run for 2.2 km version.

Experimental COSMO-ICE005 version produced better precipitation overall compared to COSMO-ICE02 and COSMO-ICE005 initial version (fig. 5).

COSMO-ICE02 forecasts were interpolated on COSMO-ICE005 grid as well as the Radar data in order to compare version and grid-spacing effect.

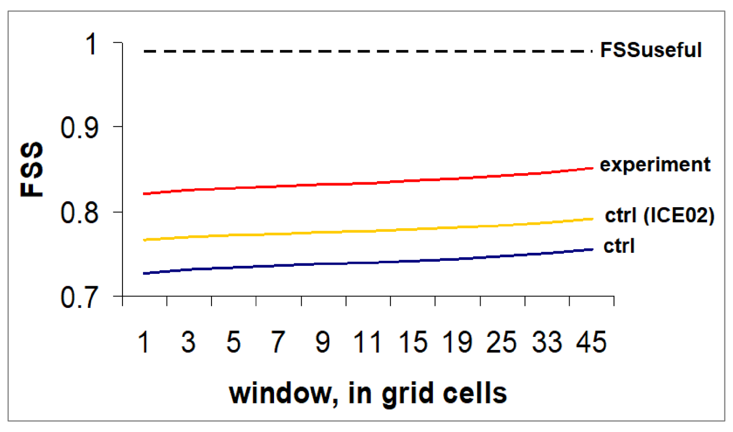

Fig. 5. FSS of ctrl and experimental runs, precipitation threshold 0.1 mm/h. Forecast from 2018022800, fcst+06.

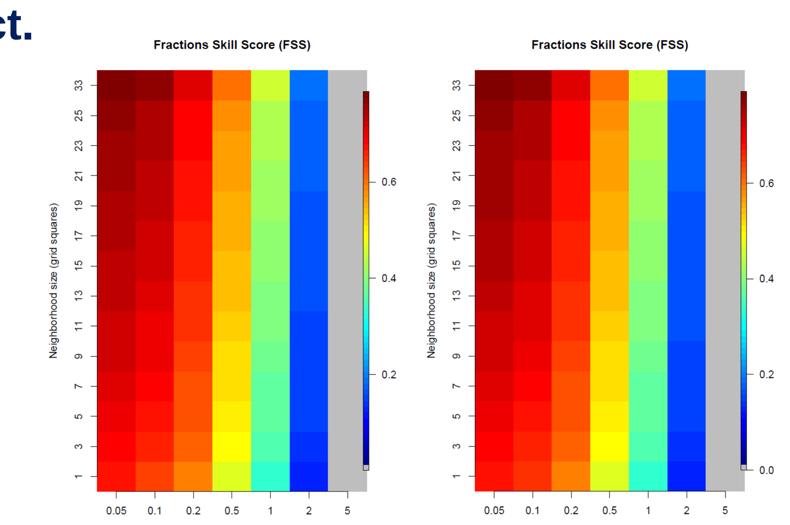

Fig. 6. FSS of ctrl (left) and experimental (right) runs for the different precipitation thresholds. Forecast from 2018030400, fcst+18.

Conclusions & Outlook

- **Winter precipitation events were simulated by COSMO-model with new cloud-aerosol-radiation scheme with grid step 2.2 and 0.55 km. .**
- **New scheme provides reduction in precipitation amount and significant changers in rain/snow ratio.**
- **Application of spatial methods to COSMO-ICE total precipitation forecasts was tested on different test cases of 2017-2018. The FSS and object-based approach give reasonable results compared to human assessment.**
- **The precipitation improvement is more evident in the model experiment with the new cloud-aerosol-radiation scheme in 0.55 km grid step version.**
- **The COSMO-ICE005 domain should be larger in order for the spatial methods to be more informative. The trade-off is needed between the grid-mesh size and domain size.**

Next steps:

- **Detailed comparison of cloud microphysics parameters with observations.**
- **Aggregate FSS over the cases by lead times.**
- **Try other displacement metrics for verification.**

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On the background Pyeongchang area skyline