VERY HIGH RESOLUTION WEATHER FORECASTING BY COSMO SYSTEM FOR PYEONGCHANG 2018

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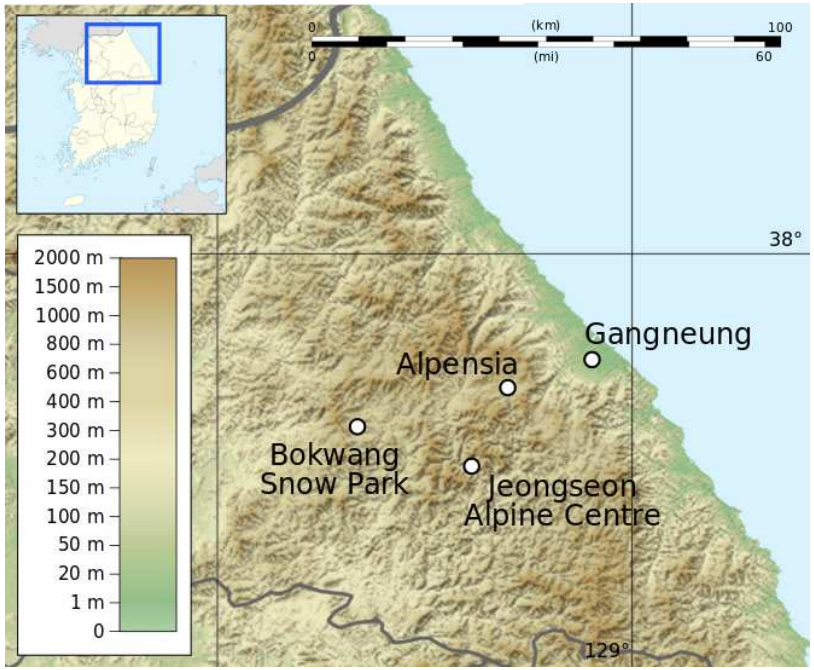
OUTLINE

- **ICE-POP 2018 project overview**
  - Goal and scientific challenge
  - Observations
- **Organizing NWP system for PyeongChang 2018**
- **Experiment results for snow event on January 29-30, 2016**
  - COSMO-ICE forecasts for different grid spacing
  - Precipitation forecast assessment
  - Shallow convection parameterization: switch ON vs switch OFF
- **COSMO-Ru for PyeongChang 2018: possibilities and perspectives**
- **Outlook**

ICE-POP2018 overview

International
Collaborative
Experiments for
Pyeongchang 2018
Olympic &
Paralympic winter games



Participants from 11 countries (Australia, Austria, Canada, China, Finland, Russia, Korea, Spain, Switzerland, UK, USA) take part in the project.

Experts from 20 organizations will provide:

- **instrumentation (radar, lider, MRR, 2DVD, etc.);**
- **nowcasting system forecasts;**
- **very-short range forecasts;**
- **forecast verification.**

ICE-POP2018: Goal and scientific challenge

The goal of the ICE-POP 2018 is advancing **seamless prediction from nowcasting to short-range forecast** for winter weathers over complex terrains **based on an intensive observation campaign**.

The scientific challenges related to the goal are:

1) to understand orographic effects in complex terrain considering small scales wind flow and its interaction with a large scale flow, vertical structure specifically at a lower level where ***snows forms and phased changes*** related to the wind flow and vertical structures;

2) to study ***the ocean-air interaction*** in the east bound of the PyeongChang such as moisture and heat flow, and low level rolling cloud formation process depending on the flow pattern and air-sea temperature difference;

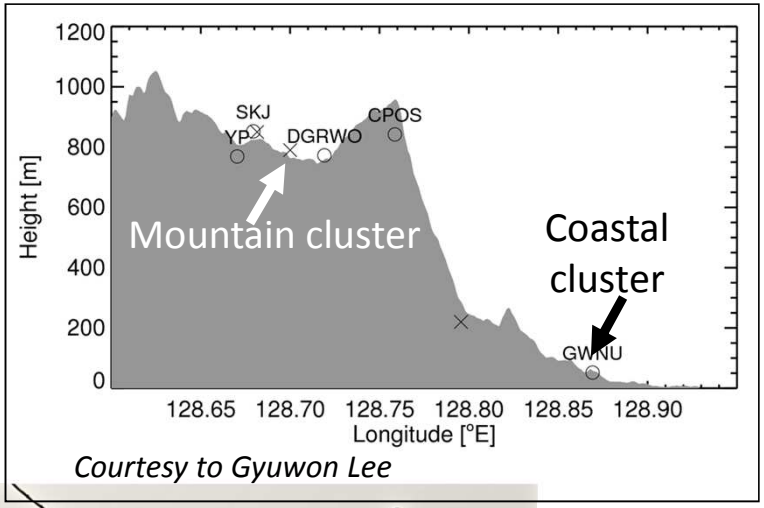
3) to improve the prediction of ***low level wind, poor visibility and precipitation amount and type*** through improved understanding in physical processes over the region and demonstrating the usefulness of the observations.

From the project web-page

ICE-POP2018: Goal and scientific challenge

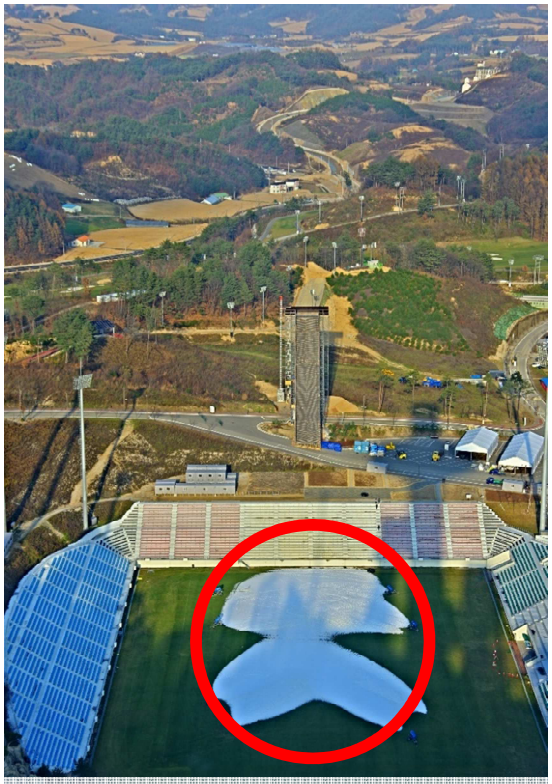
- Venues are located within a small area with complex terrain (sub km scale)
- Steep terrain in the coastal region
- Presence of artificial snow

Mountain cluster view from ski jump tower



Courtesy to Gyuwon Lee

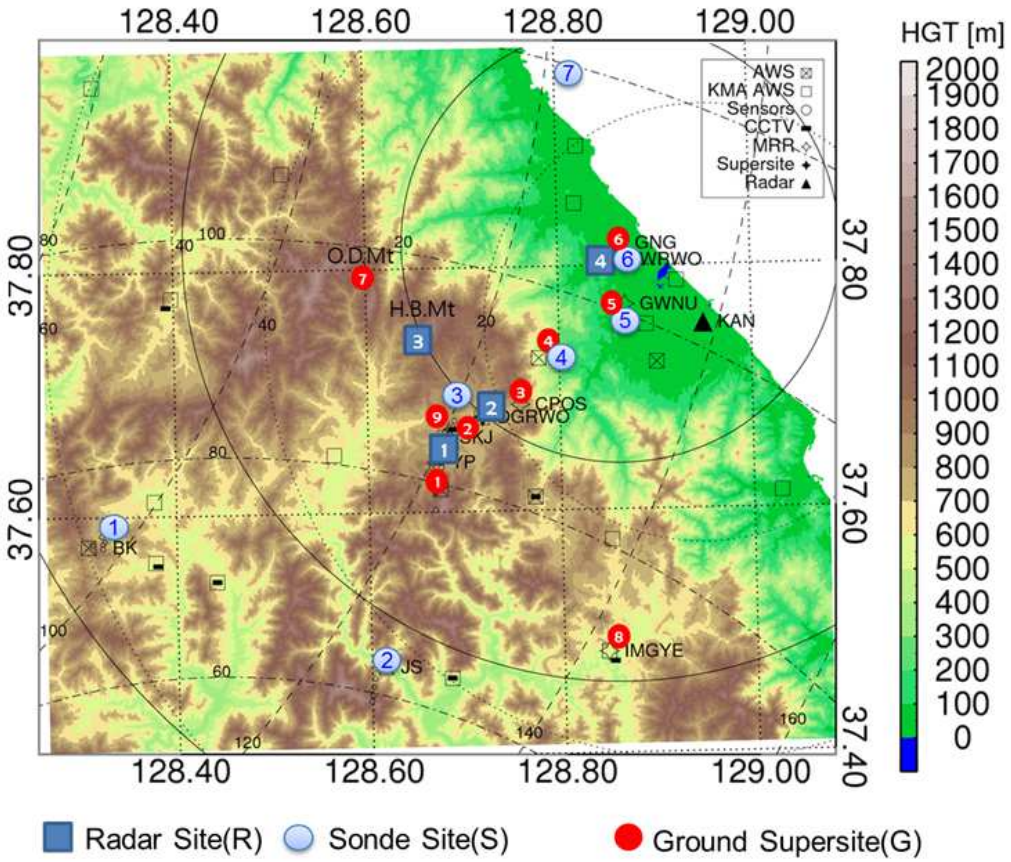
Skyline with ski jump tower



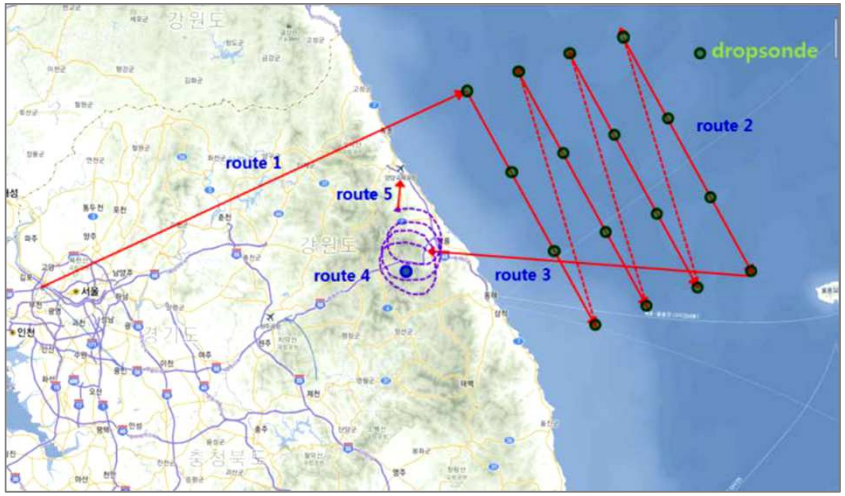
Artificial snow at ski jump outrun

ICE-POP2018: Observations

Observation network over the complex terrain



Observation network over the ocean



- **Aircraft measurements (CCNC200, CCP, SEA WCM2000, 16 dropsonds per flight)**
- **Sea surface condition & ASAP from ship**
- **Radar scan from the coast (S-band, C-band)**
- **Air-sea flux from satellite (COMS, HIMARWARI8)**

National Institute of Meteorological Sciences

From presentations Sangwon Joo et al. Progress and Plan of the ICE-POP2018; Introduction to the ICE-POP2018

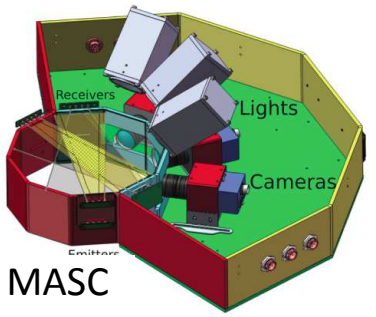
Korea Meteorological Administration

ICE-POP2018: Observations

Supersite instruments

- **Cloud radar (W-band)**
- **MRR** (*Micro Rain Radar* / **reflectivity, fall velocity, spectrum width**)
- **VertiX** (*Vertical pointing X band radar* / **reflectivity**)
- **2DVD** (*2 Dimensional Video Distrometer* / **precipitation rate, LWC, particle diameter**)
- **MASC** (*multi-angle snowflake camera* / **high-resolution photographs of snow and ice particles, fall speed**)
- **POSS** (*Precipitation Occurrence Sensor System* / **precipitation rate, precipitation type, particle diameter, temperature**)
- **Parsivel** (*Particle Size and Velocity* / **precipitation rate, precipitation type, particle diameter**)


Cloud radar



MASC

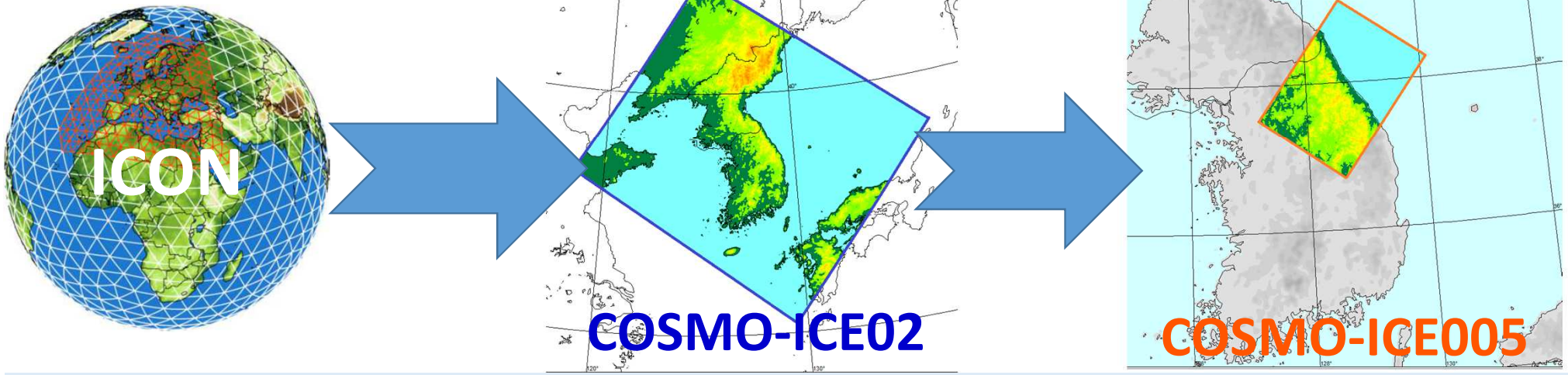

Parsivel

ICE-POP2018: Observation to run NWP model

		station number	obs frequency
DOMAIN		KOREA	
SURFACE	SYNOP	95	1 hour
	AWS	496	1 minute
	IAWS (PC)	29	1 minute
	METAR	13	1 hour
	BUOY	17	30 minutes
	SHIP	1	1 hour
	Visibility	278	1 minute
UPPER	TEMP	8	6/12 hours
	Windprofiler	12	10 minutes
RADAR	RADAR	11	10 minutes

"… ***ICE-POP 2018 participating organizations may release their own data to whomever they wish.*** *They may not release the data of other organizations (investigators) without consent…*
… The KMA Archive for the ICE-POP 2018 Project, and the archives of individual organizations, will be made publicly available after 3 years from conclusion of the observational part of the project... "
(from the draft of "Data Sharing and scientific publication agreement within the WMO ICE POP 2018 Science Project")

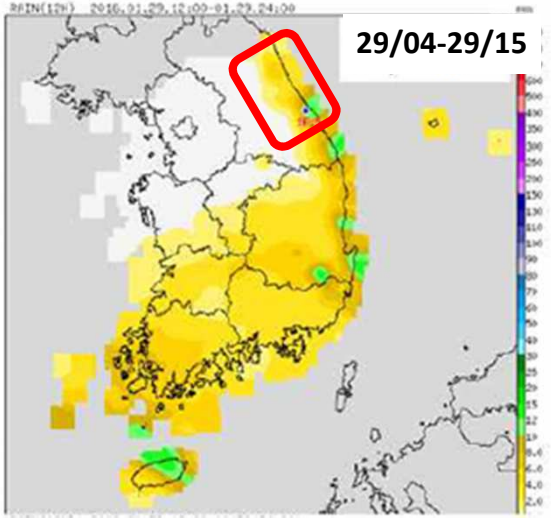
Organizing NWP system for PyeongChang 2018

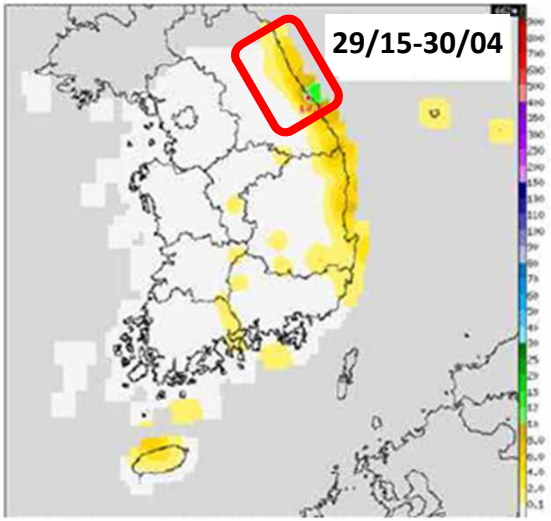


Domain	**1320 x 1100 km 600 x 500 grid points**	**150 x 200 km 300 x 400 grid points**
Grid spacing	**2.2 km**	**0.550 km**
Number of vertical levels	**50**	**60(?)**
Time step	**20 s**	**6 s**
Forecast lead time	**24 h**	**24 h**
Driven model	**ICON**	**COSMO-ICE02**
Boundary conditions update	**3h**	**15 min**

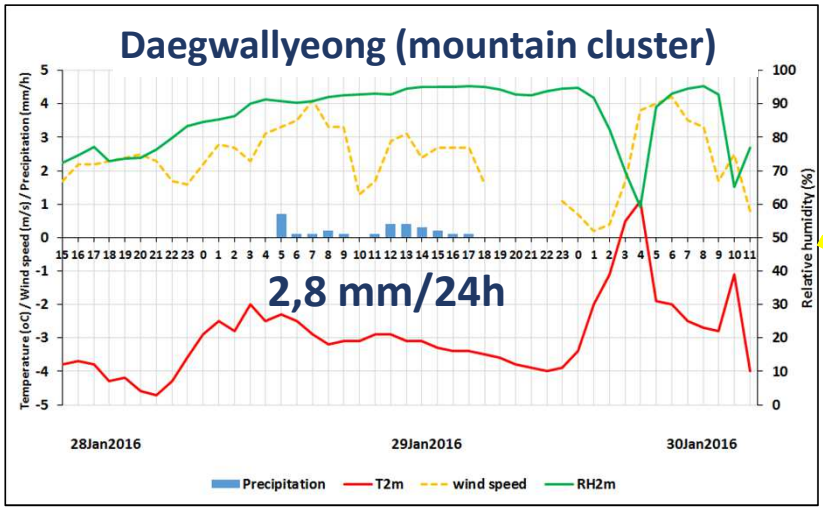
Case study: Snow event on January 29-30, 2016

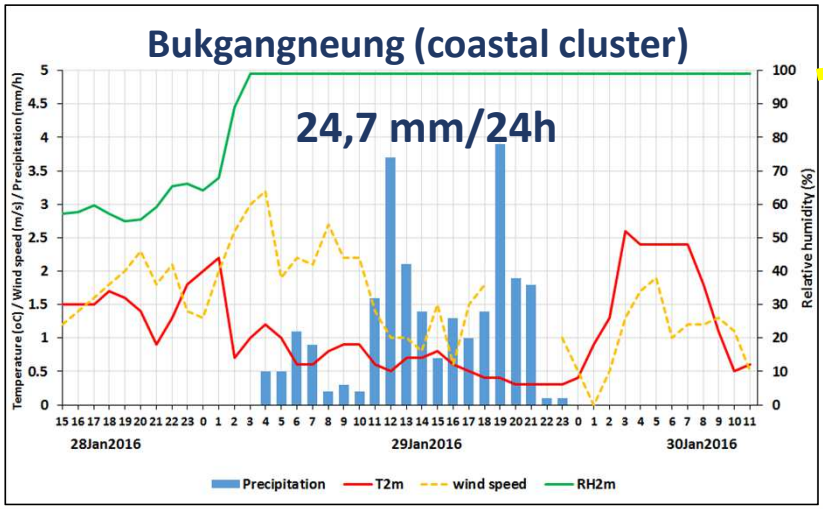
12H ACCUMULATED PRECIPITATION



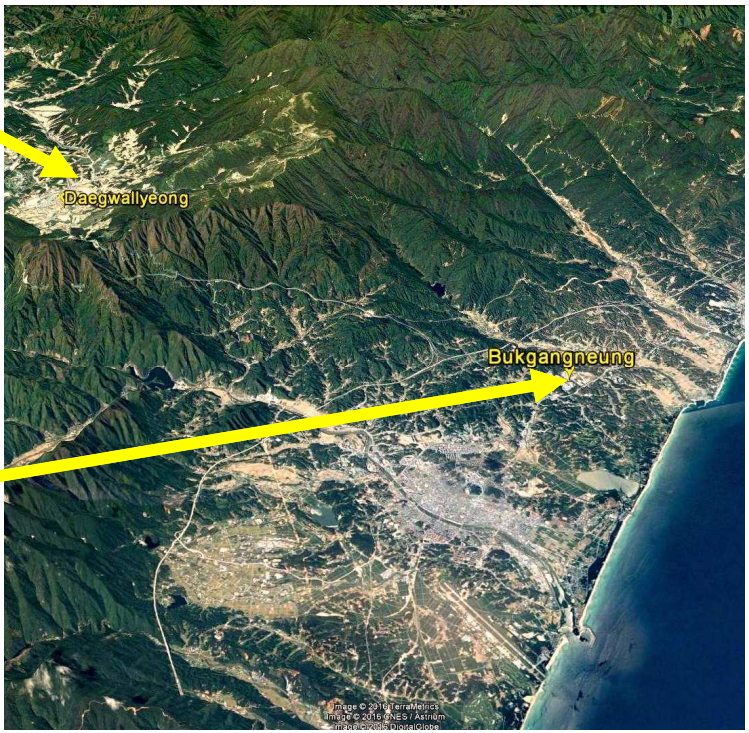


SURFACE VARIABLES TIME SERIES



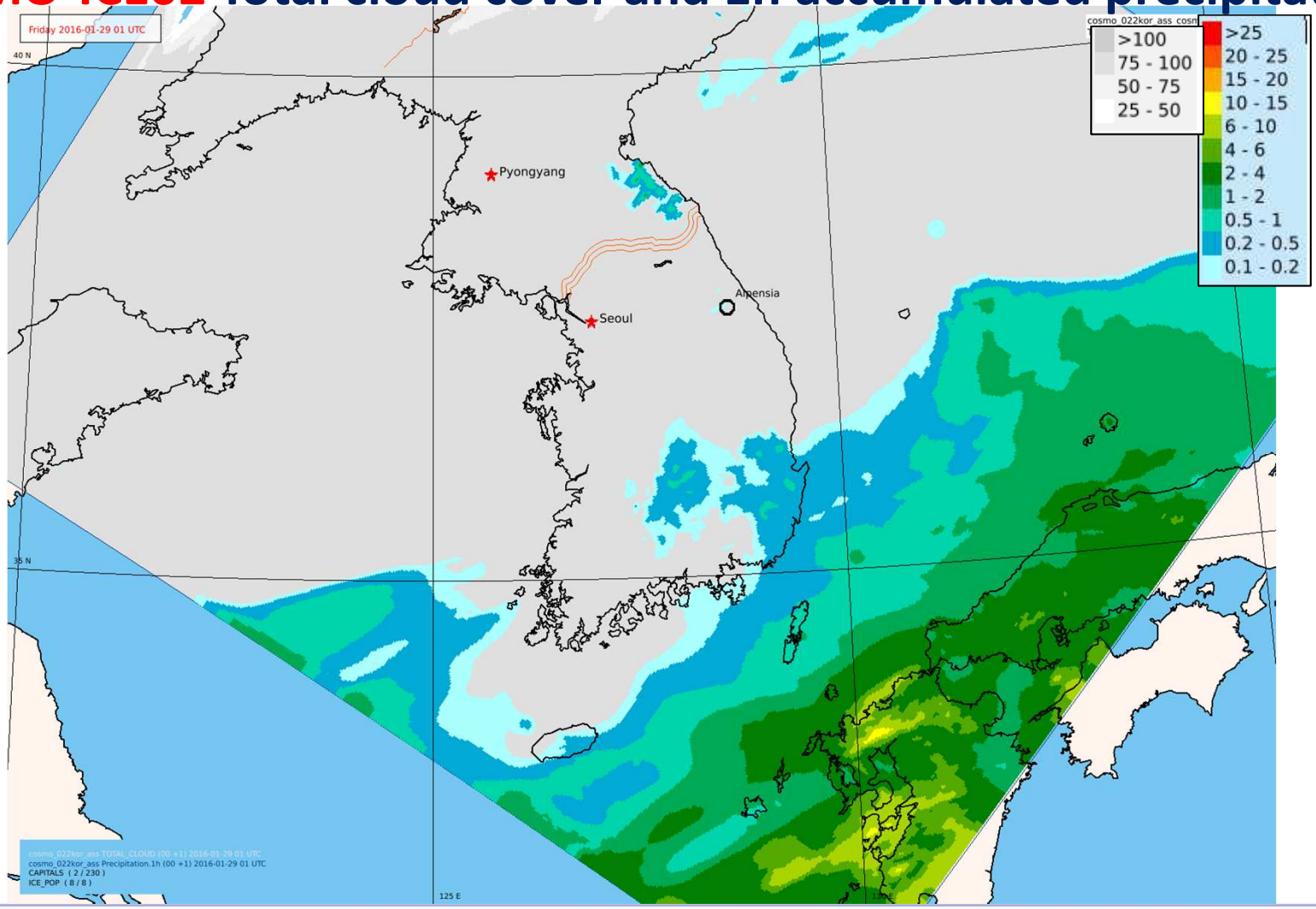


Distance between stations is ~20 km, Height difference is 690 m



Case study: Snow event on January 29-30, 2016

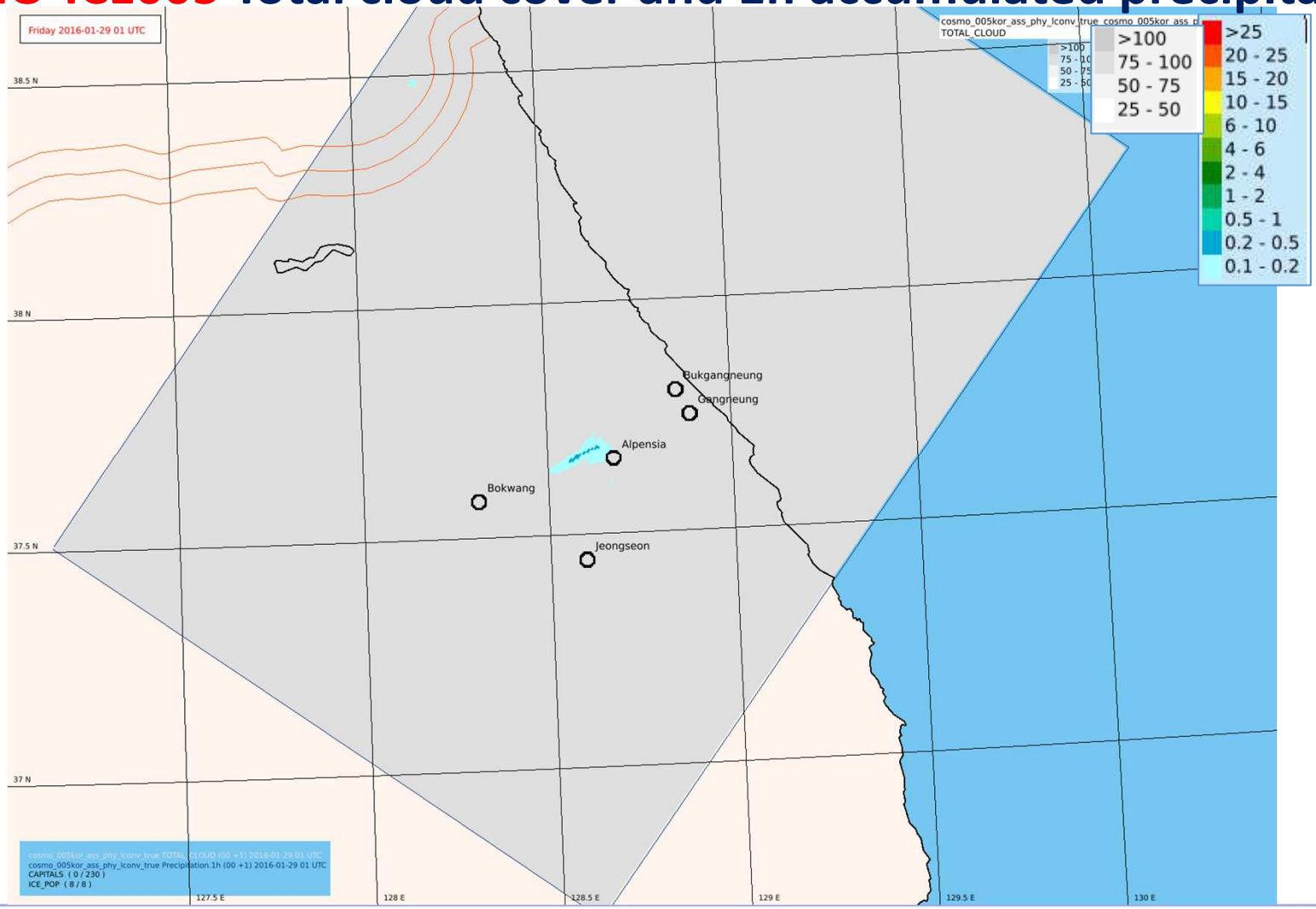
COSMO-ICE02 Total cloud cover and 1h accumulated precipitation



forecast from 29.01.2016, 00 UTC + 24 h

Case study: Snow event on January 29-30, 2016

COSMO-ICE005 Total cloud cover and 1h accumulated precipitation

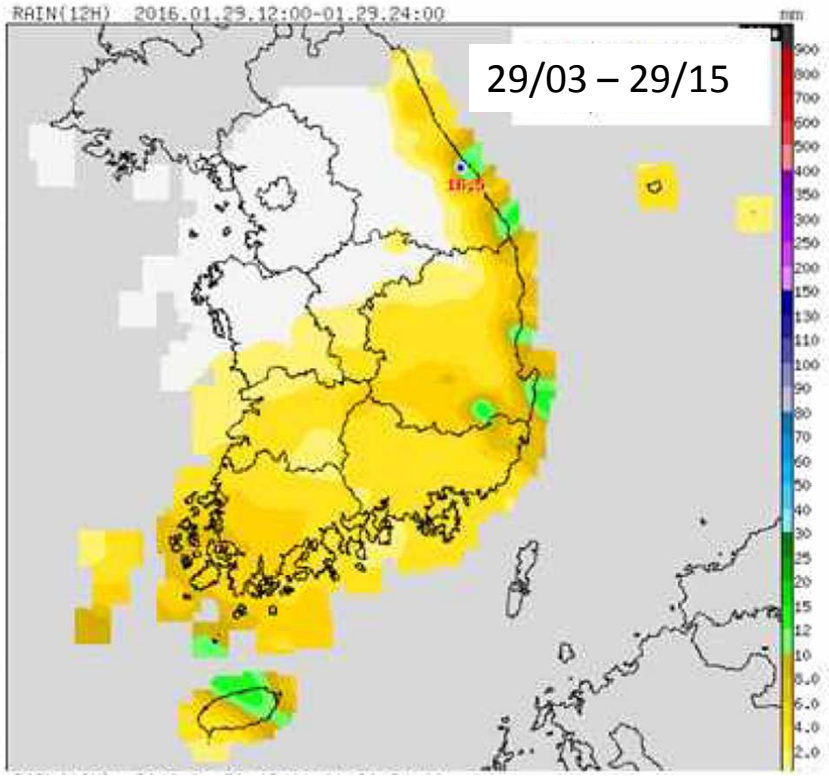


forecast from 29.01.2016, 00 UTC + 24 h

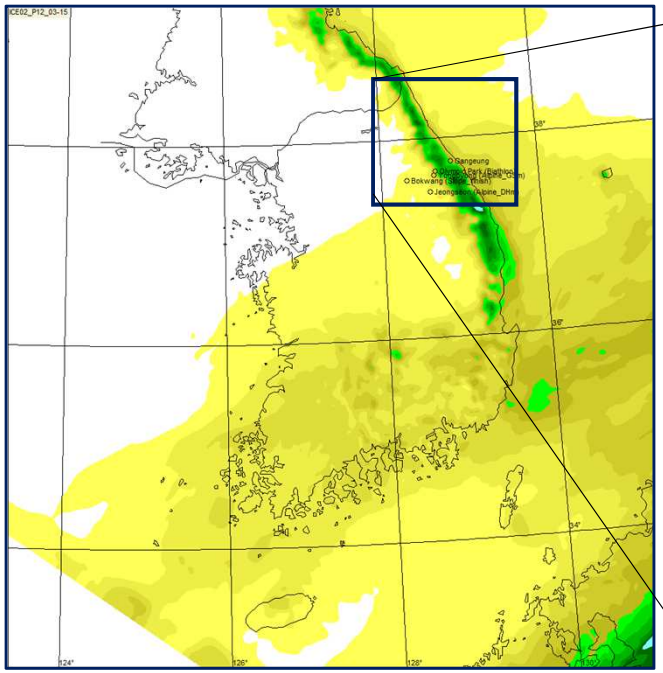
Snow event on January 29-30, 2016

12h accumulated precipitation (2016-01-29, 03-15 UTC)

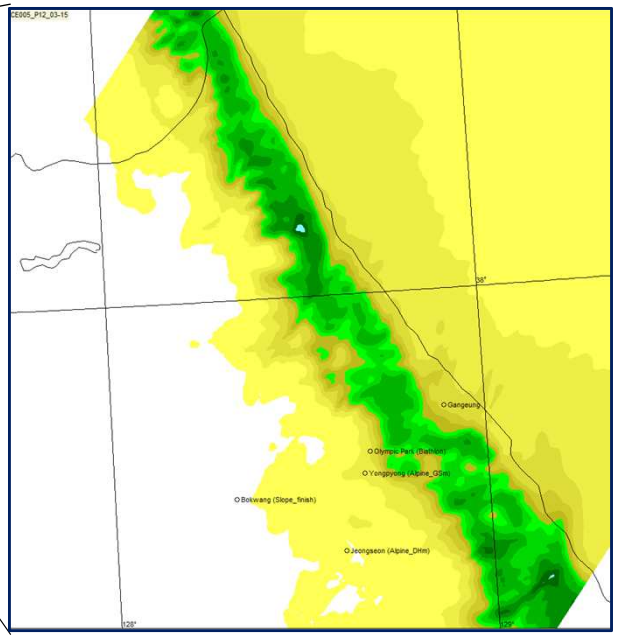
Observations



COSMO-ICE02 forecast



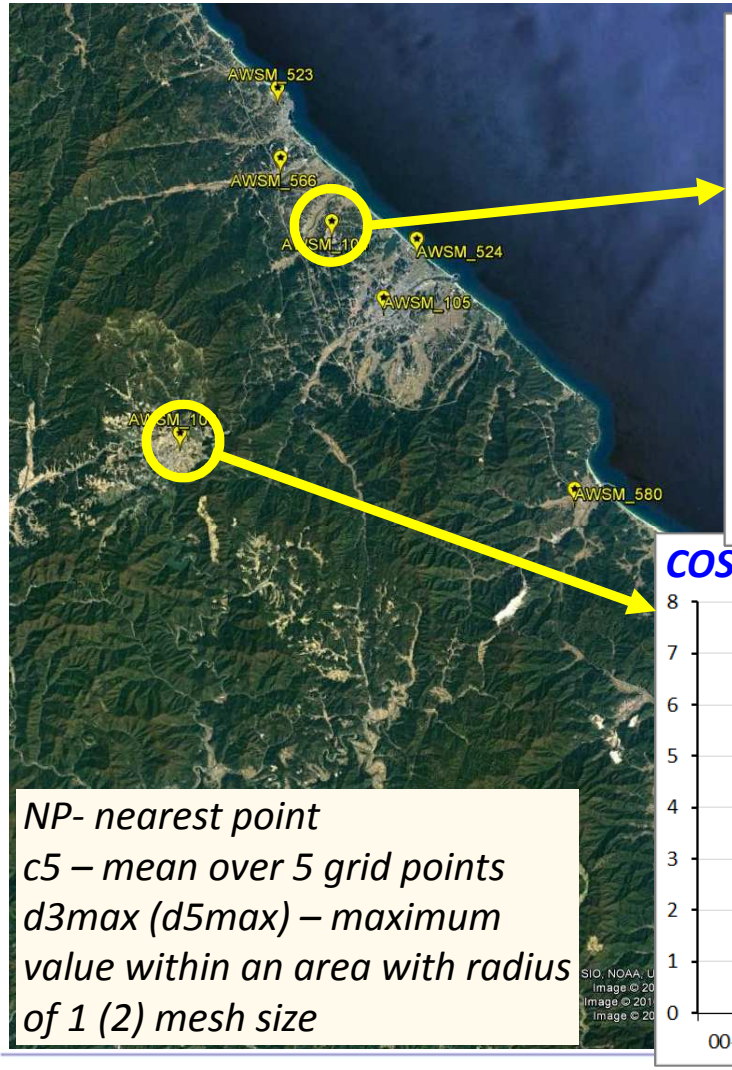
COSMO-ICE005 forecast



forecasts from 2016-01-29, 00 UTC

Snow event on January 29-30, 2016

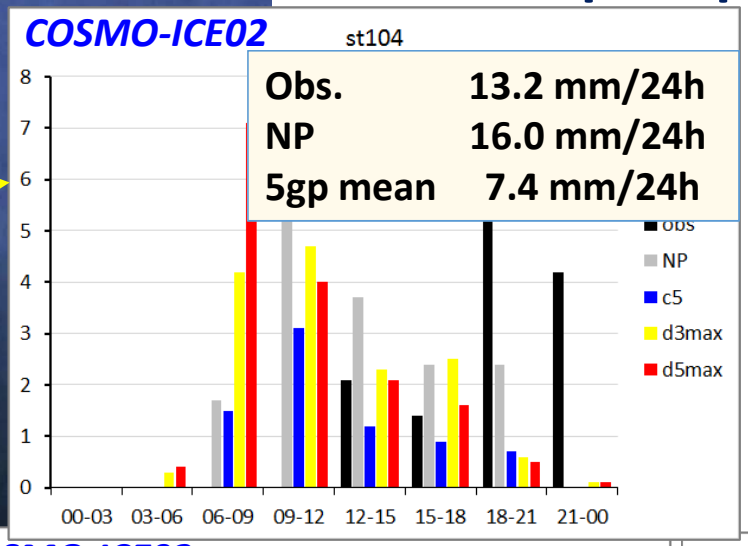
3h and 24 h accumulated precipitation



NP- nearest point
c5 – mean over 5 grid points
d3max (d5max) – maximum value within an area with radius of 1 (2) mesh size

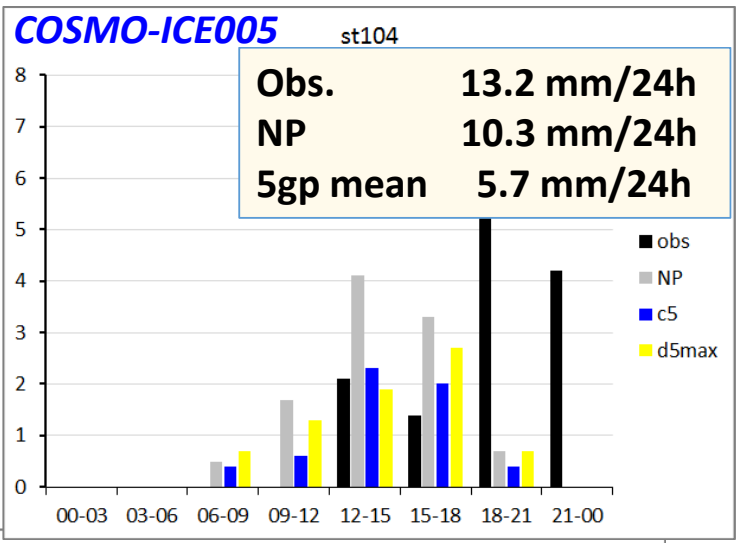
COSMO-ICE02 st104

Obs.	13.2 mm/24h
NP	16.0 mm/24h
5gp mean	7.4 mm/24h



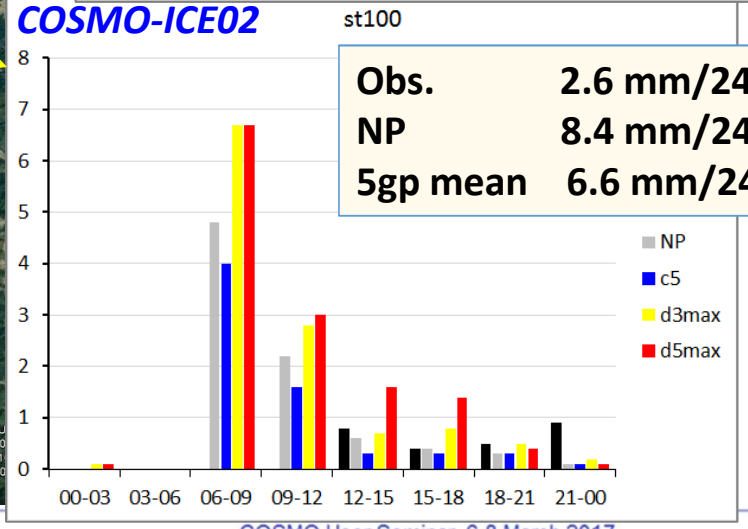
COSMO-ICE005 st104

Obs.	13.2 mm/24h
NP	10.3 mm/24h
5gp mean	5.7 mm/24h



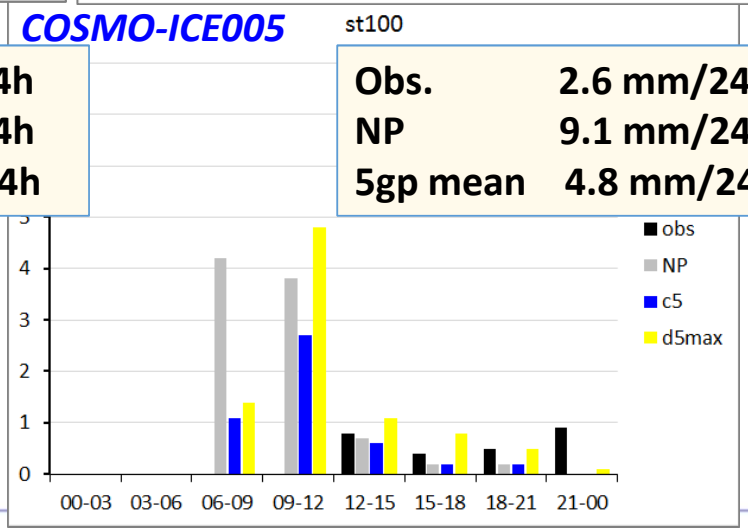
COSMO-ICE02 st100

Obs.	2.6 mm/24h
NP	8.4 mm/24h
5gp mean	6.6 mm/24h



COSMO-ICE005 st100

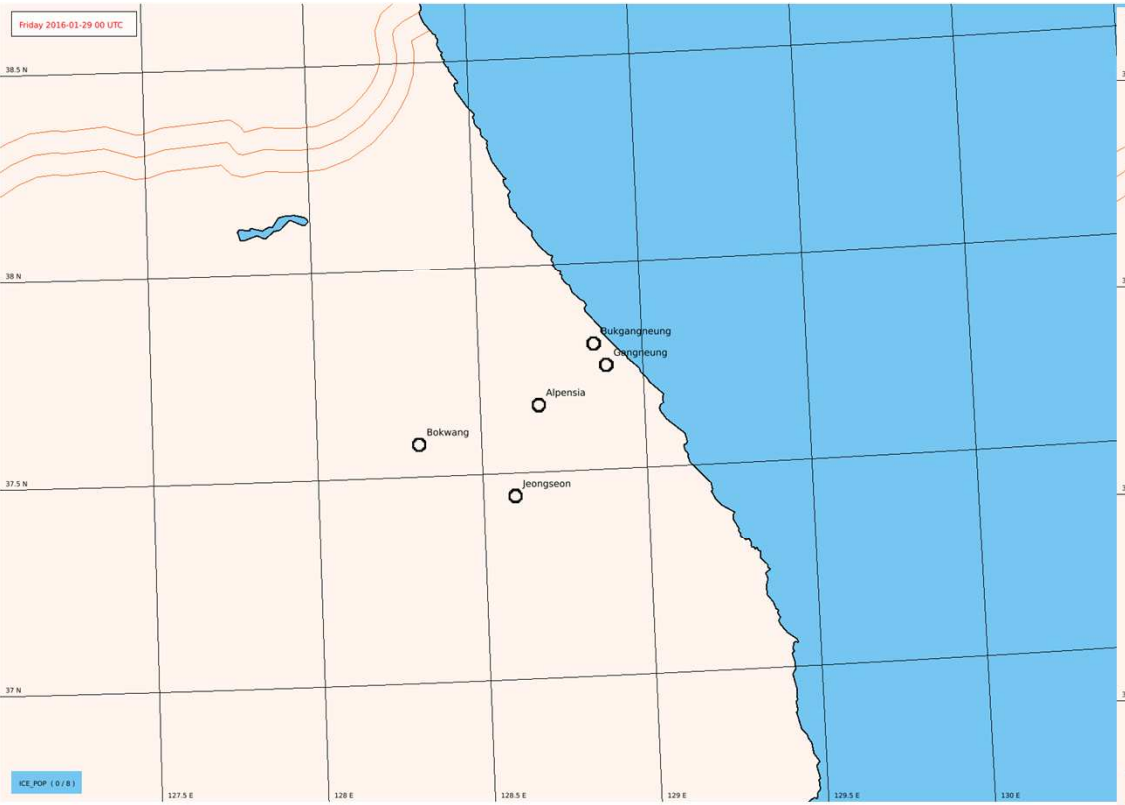
Obs.	2.6 mm/24h
NP	9.1 mm/24h
5gp mean	4.8 mm/24h



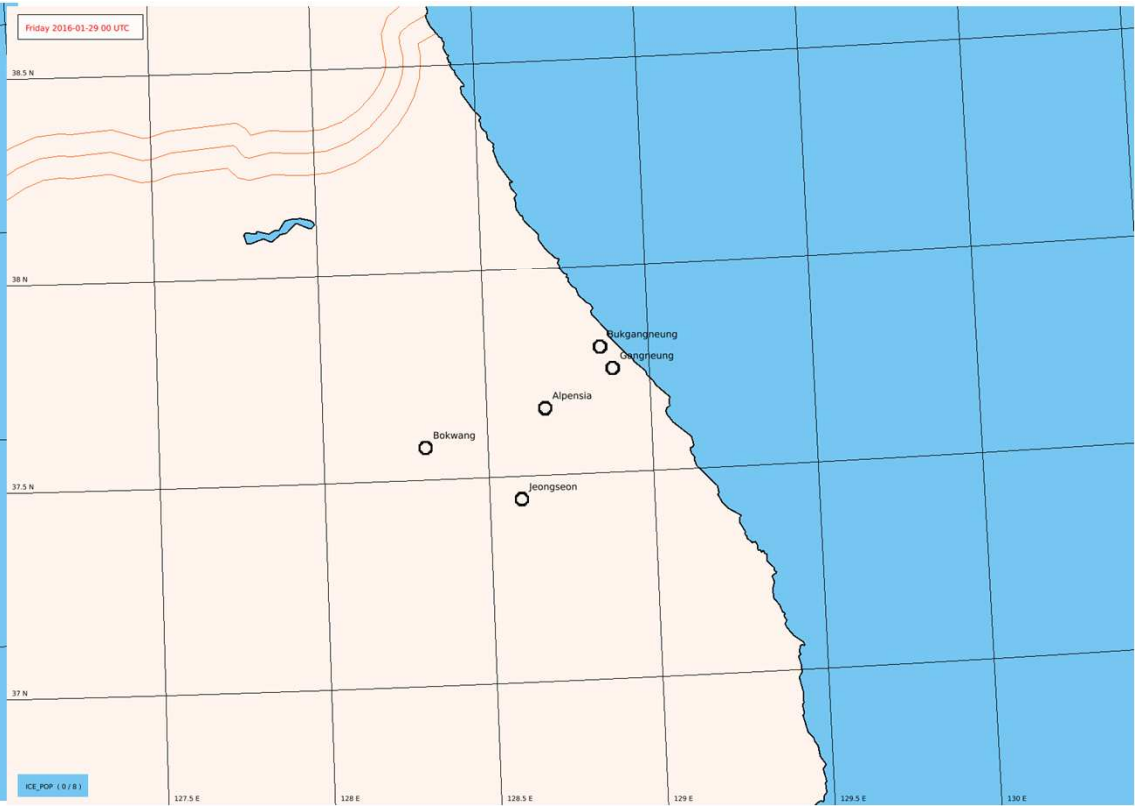
Snow event on January 29-30, 2016

COSMO-ICE005 1h accumulated precipitation

Ctrl (*lconv=.T., itype_turb=3*)



Exp (*lconv=.F., itype_turb=7*)

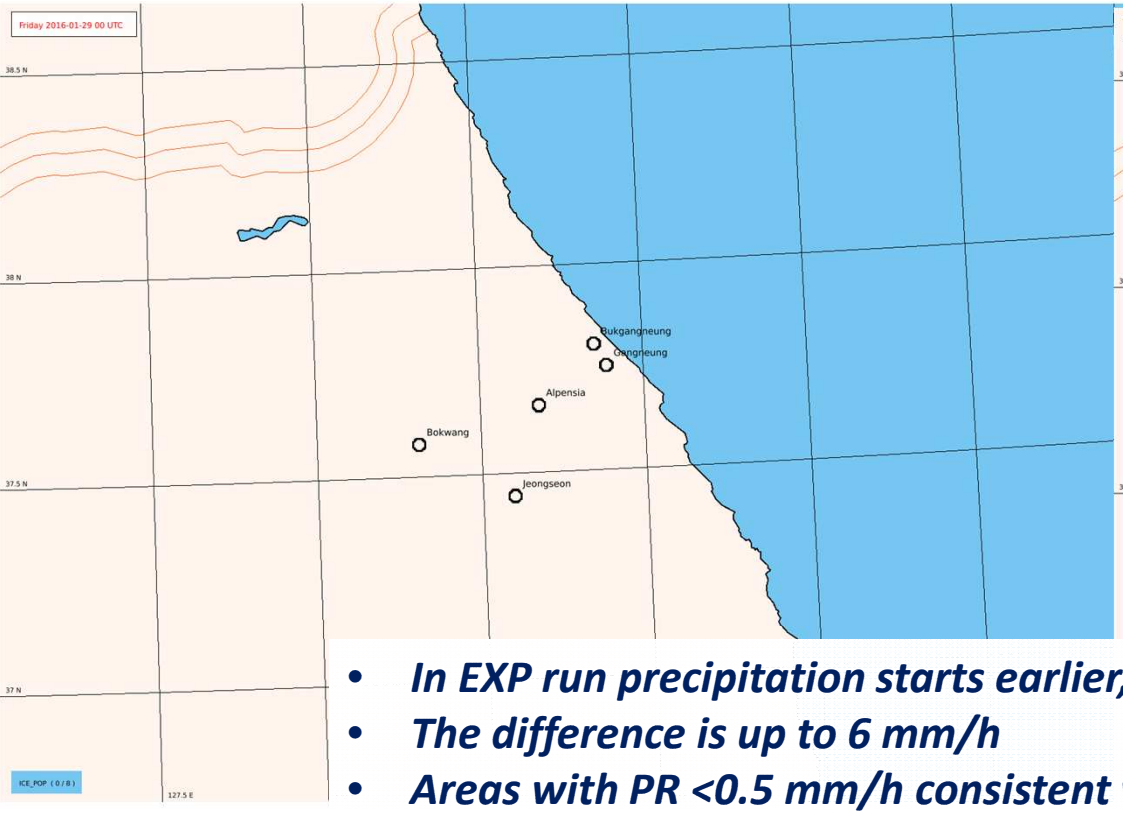


Snow event on January 29-30, 2016

COSMO-ICE005 1h accumulated precipitation

Ctrl *(isoline)* **& Exp***(filled)*

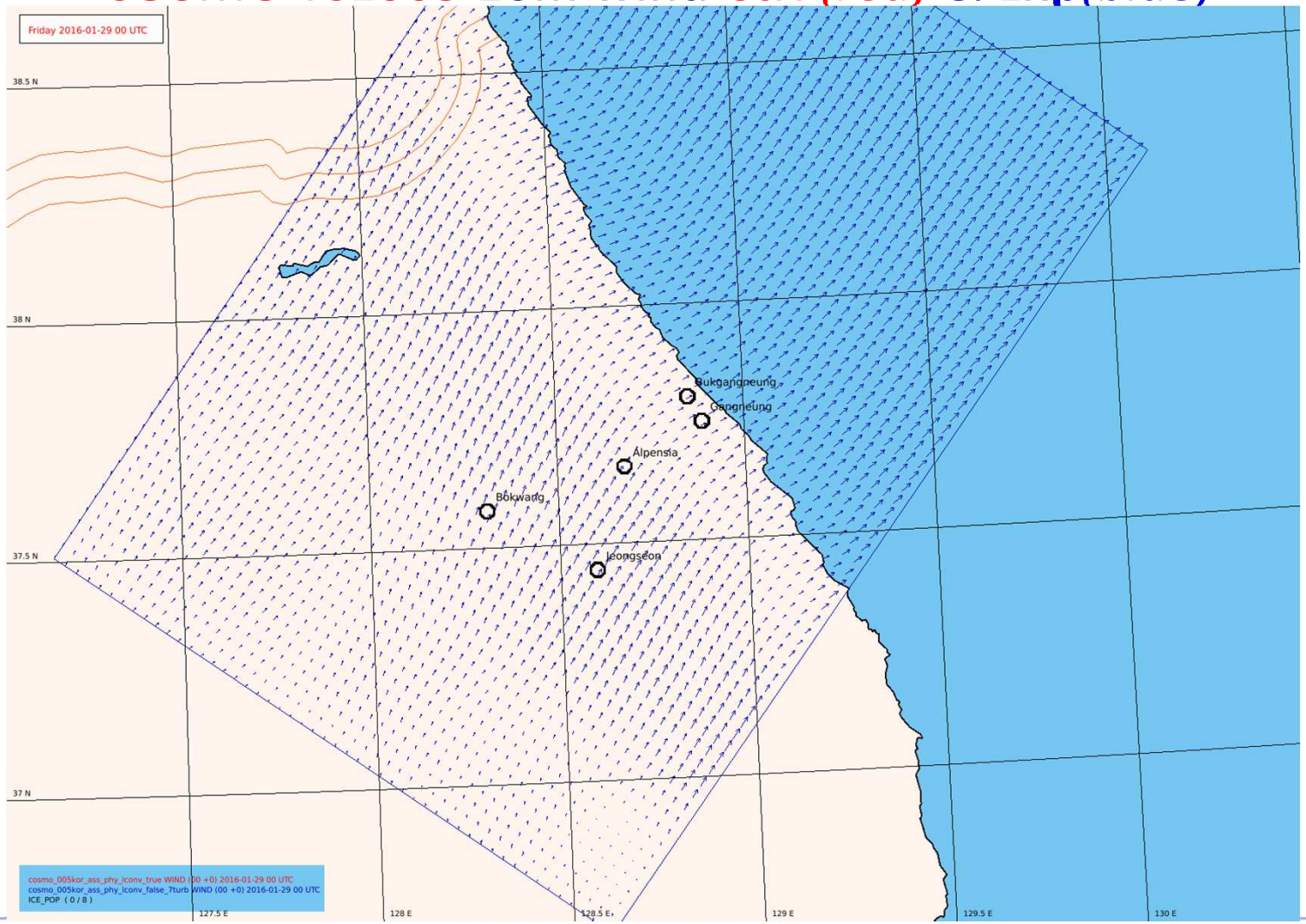
Exp-Ctrl



- ***In EXP run precipitation starts earlier, take up more space and has greater values.***
- ***The difference is up to 6 mm/h***
- ***Areas with PR <0.5 mm/h consistent with each other in both run over land, but over ocean area is greater in Ctrl run***

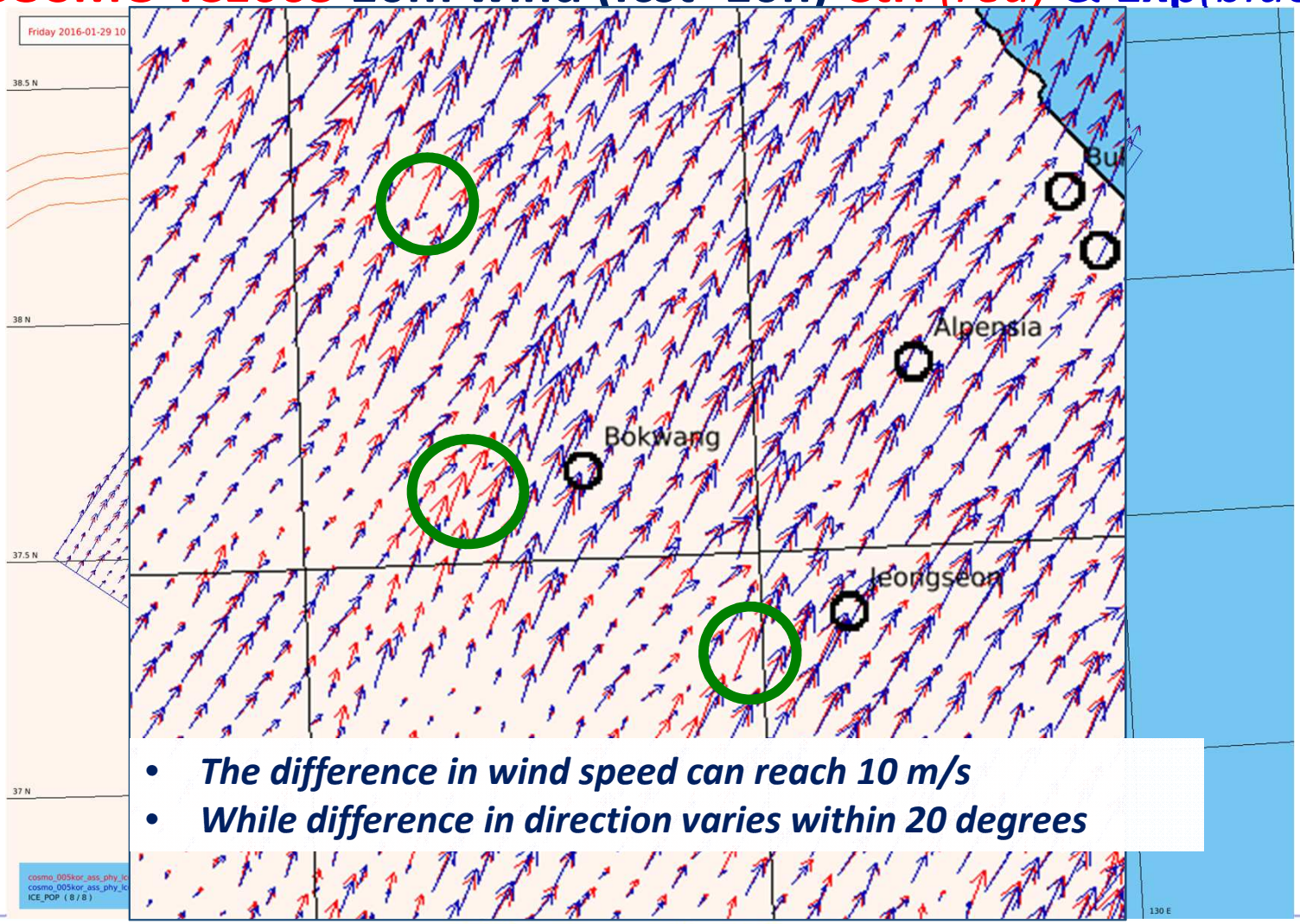
Snow event on January 29-30, 2016

COSMO-ICE005 10m wind Ctrl *(red)* & Exp*(blue)*



Snow event on January 29-30, 2016

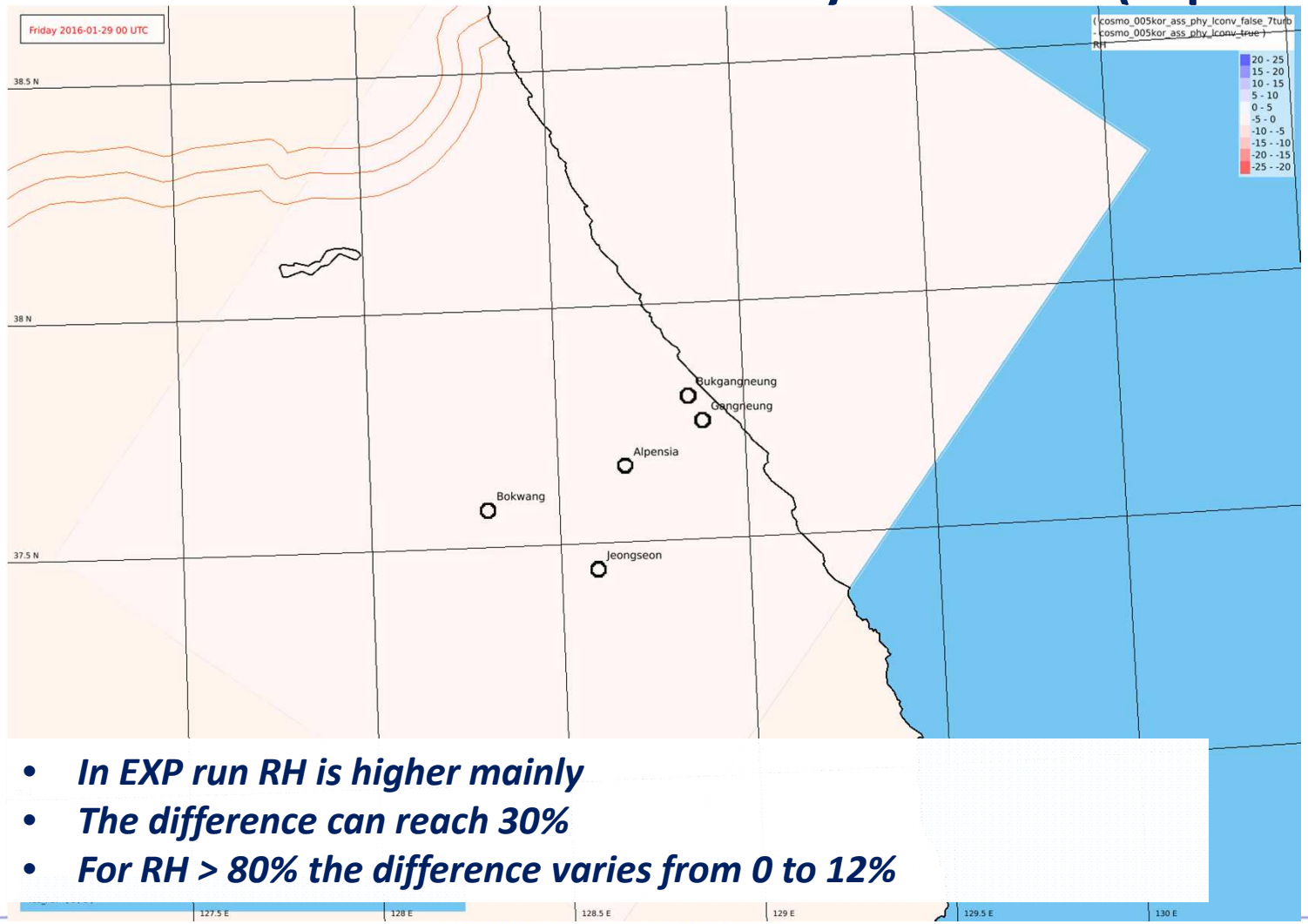
COSMO-ICE005 10m wind (fcst+10h) Ctrl *(red)* & Exp*(blue)*



- *The difference in wind speed can reach 10 m/s*
- *While difference in direction varies within 20 degrees*

Snow event on January 29-30, 2016

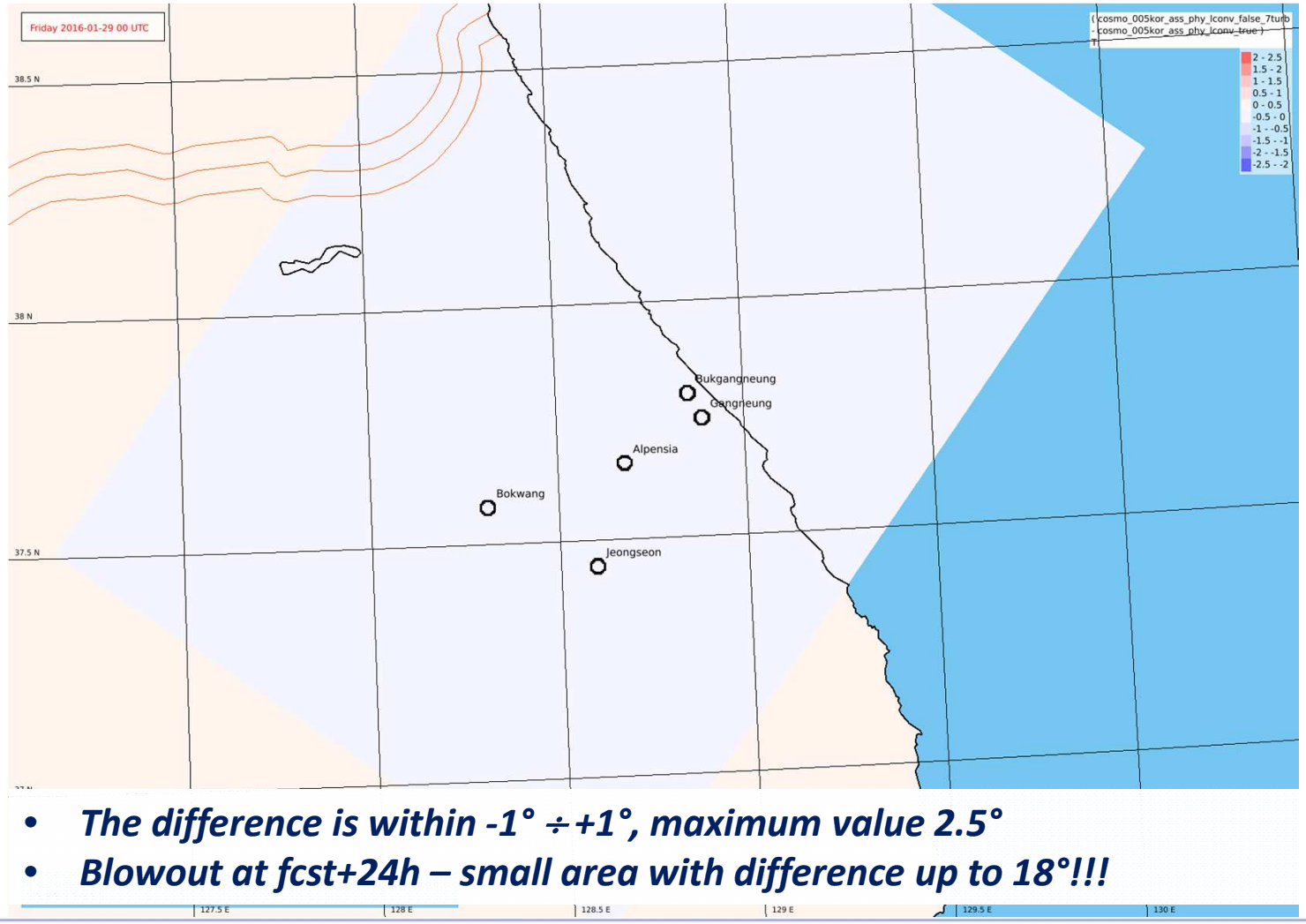
COSMO-ICE005 2m relative humidity difference (exp-ctrl)



- *In EXP run RH is higher mainly*
- *The difference can reach 30%*
- *For RH > 80% the difference varies from 0 to 12%*

Snow event on January 29-30, 2016

COSMO-ICE005 2m temperature difference (exp-ctrl)



- *The difference is within -1° ÷+1°, maximum value 2.5°*
- *Blowout at fcst+24h – small area with difference up to 18°!!!*

COSMO-Ru for PyeongChang 2018: possibilities and perspectives

- COSMO-based NWP system was adapted for the PyeongChang 2018 area
- COSMO-ICE model can provide forecast with spatial resolution 2.2 km and 550 m
- Case study showed:
  - satisfactory agreement between forecast and observations
  - a double penalty for precipitation forecast for high resolution models ?! – new verification methods are needed
  - necessity to make carefully physical parameterization setting for very-high resolution model

COSMO-Ru for PyeongChang 2018: possibilities and perspectives

- **High spatial and temporal resolution data availability is a good opportunity to test new verification methods (spatial methods)**
- **Presence of the additional observations on precipitation and cloud microphysics is a chance to test and (*maybe*) improve cloud processes parameterization**

OUTLOOK

❖ **Work with COSMO-ICE**

- **Data Assimilation (LHN…)**
- **Model run for test period (winter 2016-2017) and verification**
- **Model physics setting – experiments for better understanding model behavior at resolution less than 0,5 km**

❖ **ICON-LAM ?**

Acknowledgements

Uli Blahak and Uli Schattler for help and advices ☺

Thank you for your attention!