2c) Development and basic research for the ultrahigh precision regional models

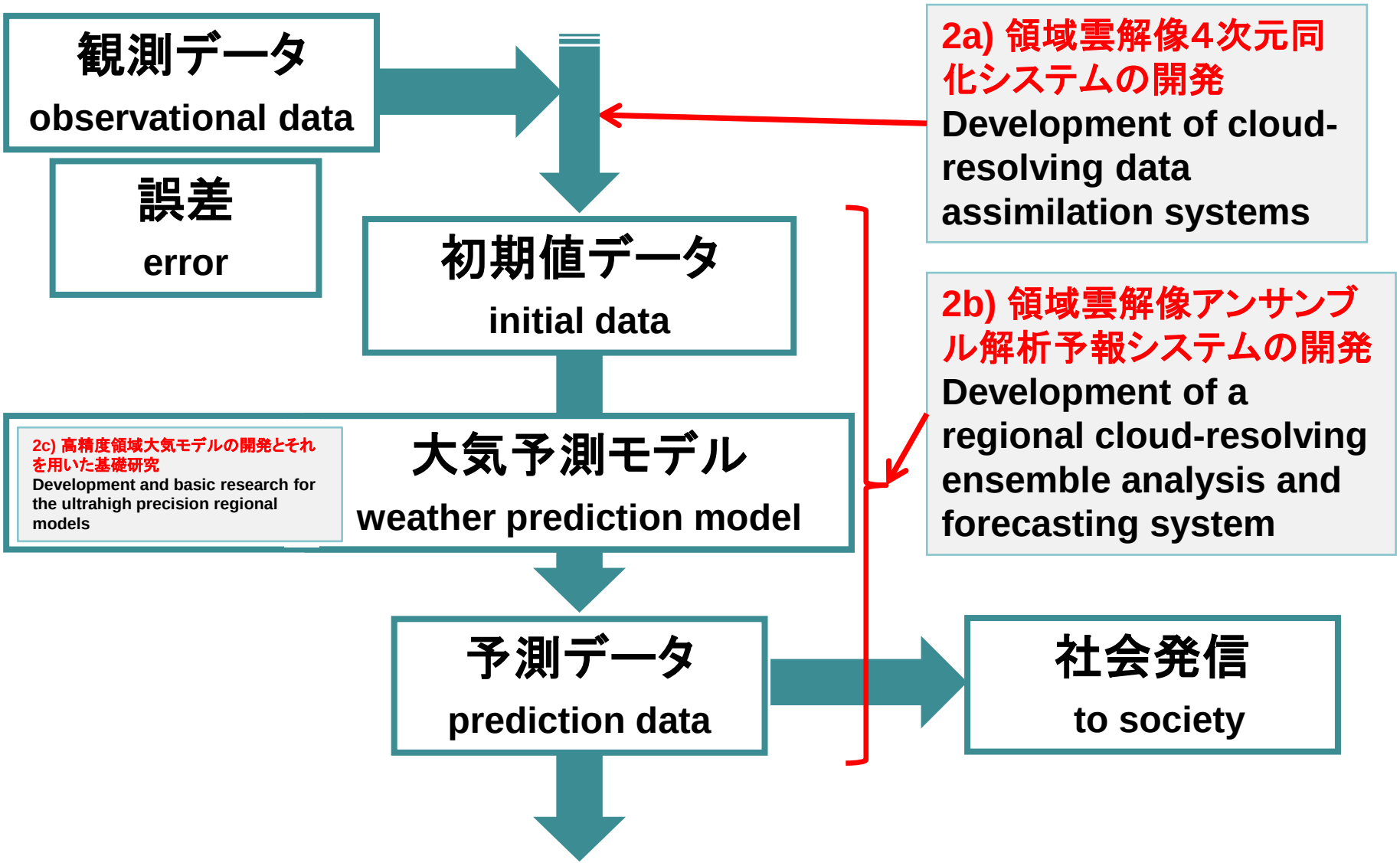
高精度領域大気モデルの開発とそれを用いた基礎研究

Development and basic research for the ultrahigh precision regional models

Kozo Nakamura, JAMSTEC

2) 超高精度メソスケール気象予測の実証

Super high accuracy mesoscale weather prediction



2c) 高精度領域大気モデルの開発とそれを用いた基礎研究
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大気予測モデル weather prediction model

B) B-1 model-development and/or B-2 simulation (K, others) ⇒ understanding mechanism and/or estimating uncertainty		A. what resolution ?	
		1. 空間 horizontal	2. 雲微物理 water drop size
解像度 resolution	内部モデル inner model	small motion	drop growth
粗 coarse	複雑 complicated	積雲対流para Cu. para.	bulk
蜜 fine	単純 simple	積雲対流解像 Cu. resolving	bin

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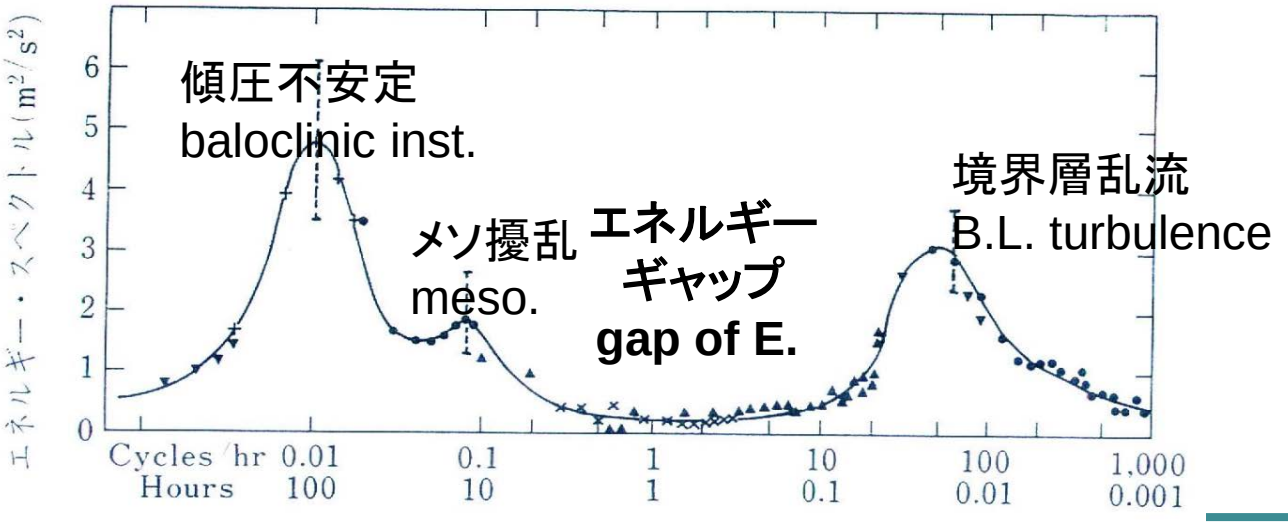
大気予測モデル　　weather prediction model

1：空間解像度、
horizontal resolution

2：雲微物理粒径分布解像度
water drop size distribution

Regional Model 領域モデル Cu. Conv., B.L. もっと怪しい more uncertain	CRM 雲解像モデル eddy vis. 怪しい uncertain	LES 大渦解像モデル turb. model 少し怪しい a little uncertain	DNS 直接積分 mol. vis. よく理解された物理を使う。 based on well known physics



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Regional Climate Model (Kawase, Nosaka)

Hiroshima heavy rain (Kato)

Eyewall Replacement (Tsujino)

tornado outbreak (Tochimoto)

Dev. and Organization of Cu (Takemi)

Gray zone (Sugi)

Tornado structure (Mashiko)

Typhoon B.L. (Ito)

B.L.Turbulence
Terra Incognita

High resolution
High accuracy
New information
New model

大気予測モデル　weather prediction model

1：空間解像度、horizontal resolution

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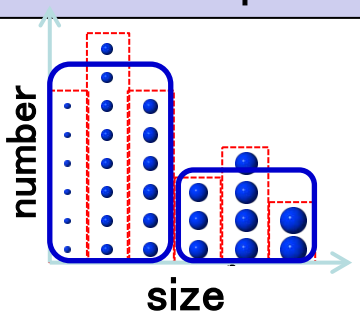
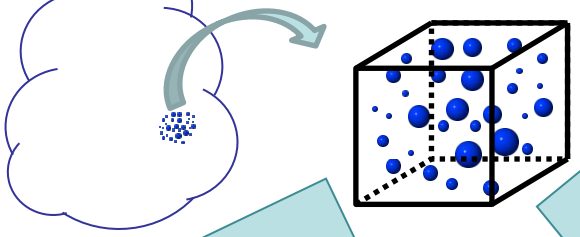
バルクモデル Bulk model

classified into two groups. cloud droplets and rain drops

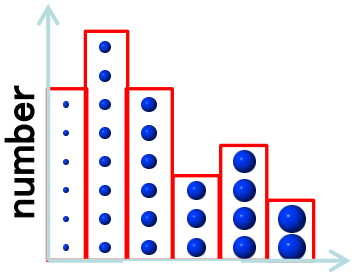


cloud includes many kinds of drops



ビンモデル Bin model

classified into several bins



$10^3=2^{10}$ times

bins of every twice mass→about 30 bins

Warm rain

only liquid water→one dimension

Cold rain

many properties→multi-dimension

大気予測モデル　weather prediction model

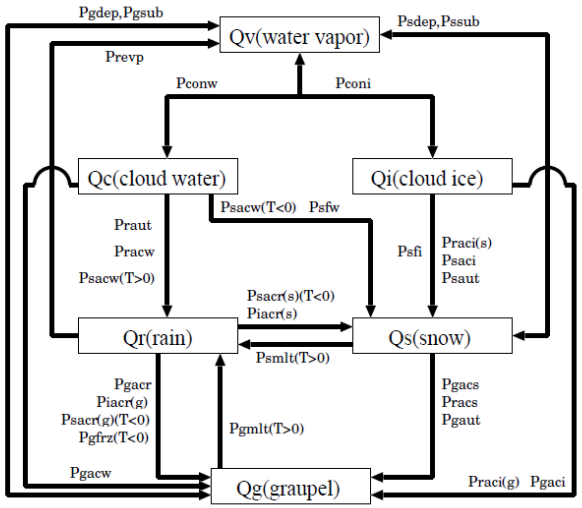
1：空間解像度、horizontal resolution

2：雲微物理粒径分布解像度 water drop size distribution

バルクモデル Bulk model

formulation of conversion between species

uncertainties：large



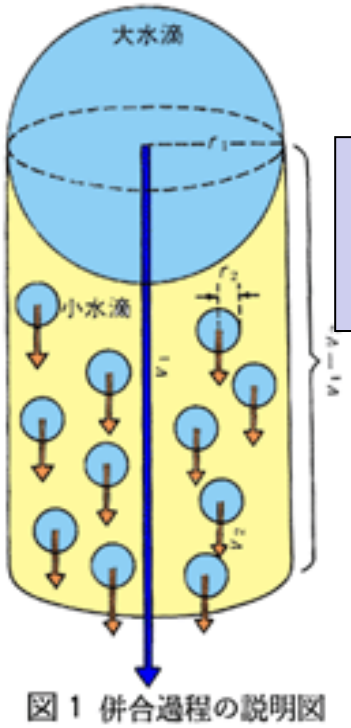


図 1 併合過程の説明図

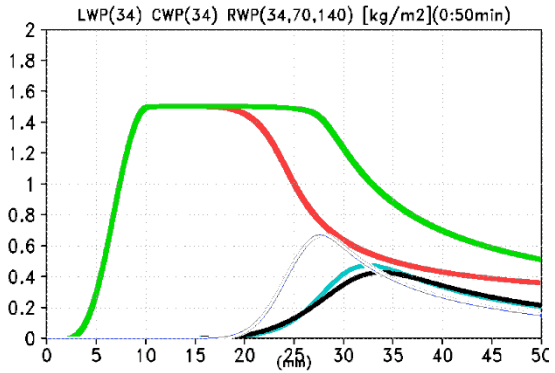
ビンモデル Bin model

←as collection (shown in the fig.)

formulation by well-known physics

uncertainties：small

dependence of LWP on the number of bins.
積分雨水量の時間変化
緑：液水(34bin)、赤：雲水(34)
青(34)、水(70)、黒(140)：雨水



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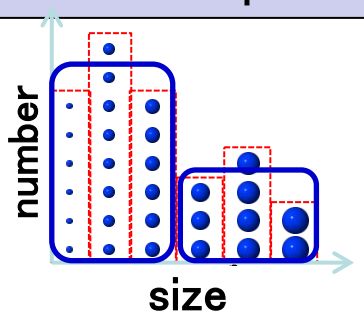
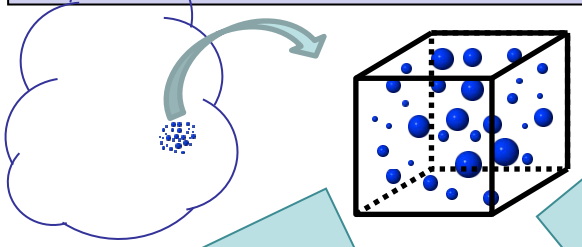


○ calculation time

×accuracy

used in many models

cloud includes many kinds of drops



Warm rain

only liquid water→one dimension

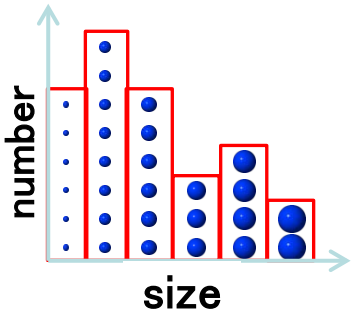
Cold rain

many properties→multi-dimension

Multi-dimensional bin (Hashimoto)

ビンモデル Bin model

classified into several bins



× calculation time

○ accuracy

activation of nucleus (Nakamura)

2C Development and basic research for the ultrahigh precision regional models
高精度領域大気モデルの開発とそれを用いた基礎研究

Dependency of horizontal resolution on structure changes of atmospheric stratification in the 2015 Hiroshima heavy rainfall Teruyuki Kato (MRI)

Super high-resolution simulation of the 6 May 2012 Tsukuba supercell tornado: Near-surface structure and dynamics Wataru Mashiko (MRI)

High-resolved NHRCM simulations of mountainous snow and comparisons with on-site observations Hiroaki Kawase (MRI)

Bias correction of wind direction (NHRCM) Shinya Nosaka (MRI)

BREAK

Various analyses on results of entire tropical cyclone LES Junshi Ito (MRI)

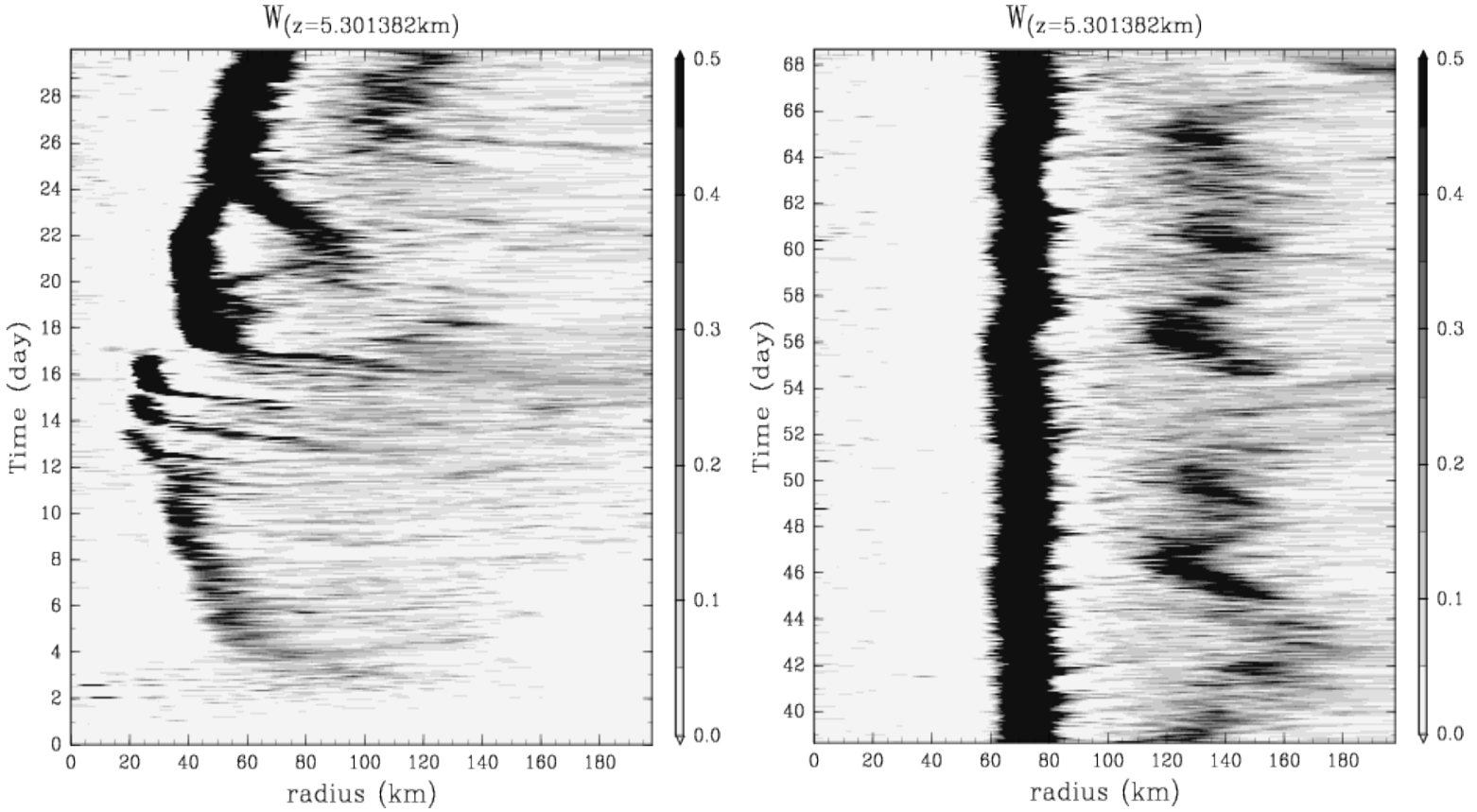
Cumulus convection scheme for gray zone Masato Sugi (MRI)

Influences of environmental moisture on the development and organization of cumulus convection (CRM) Tetsuya Takemi (DPRI, Kyoto Univ.)

Simulation of ice particle growth in multi-dimensional bin microphysics model Akihiro Hashimoto (MRI)

Numerical simulation of cumulus boundary layer: activation process of cloud condensation nuclei (bin) Kozo Nakamura (JAMSTEC)

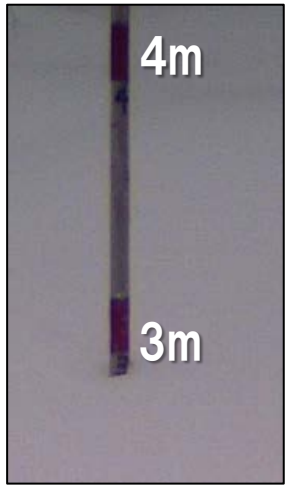
Eyewall Replacement of Tropical cyclone simulation (Tsujino)



Time-radius change of w averaged azimuthally at z=5.3km. Eyewall replacement (ER) occurs in the earlier period, and does not occur in the later period. The occurrence of ER depends on the environmental atmospheric structure, which can be changed by TC.

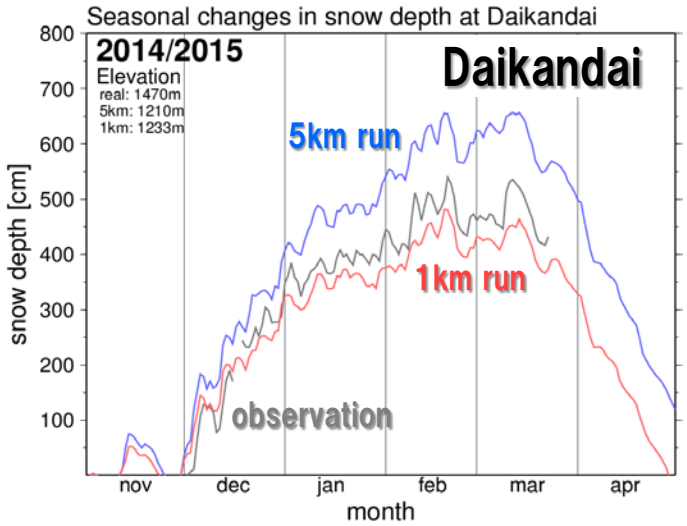
High-resolved NHRCM simulations of mountainous snow and comparisons with on-site observations

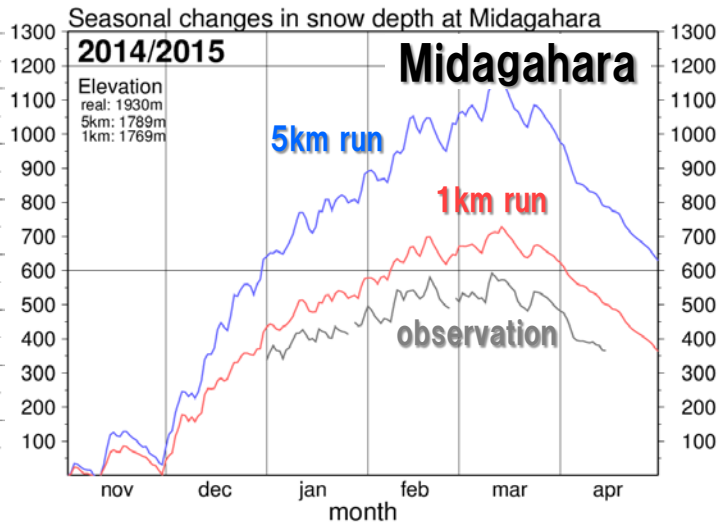
Hiroaki Kawase et al. (Meteorological Research Institute)



[*Kakenhi. 26750111 (JSPS)*]

■ Time series of snow depth simulated by NHRCM



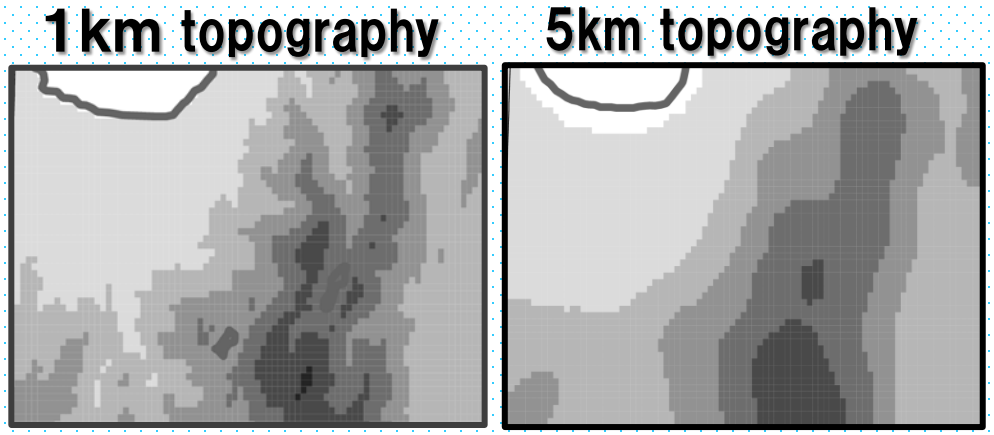


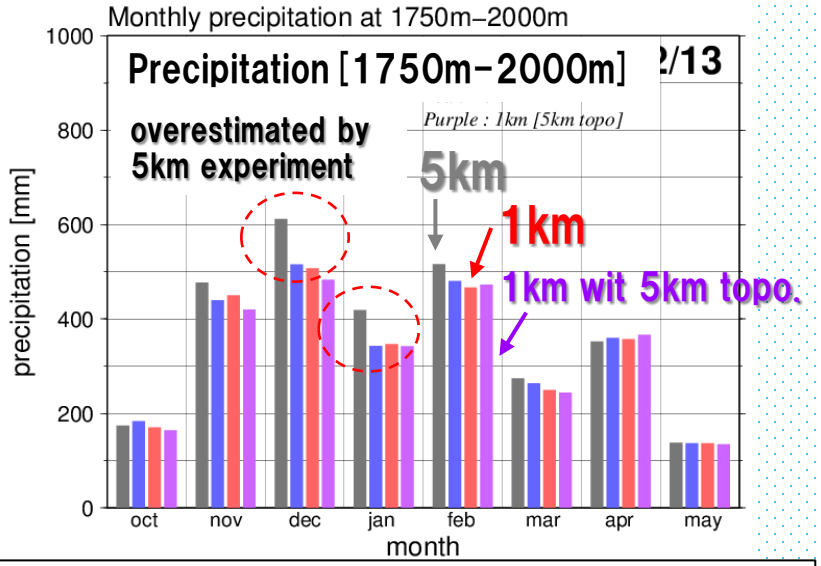
- Mountainous snow depth is well simulated by 1km grid-spacing experiment rather than 5 km experiment.

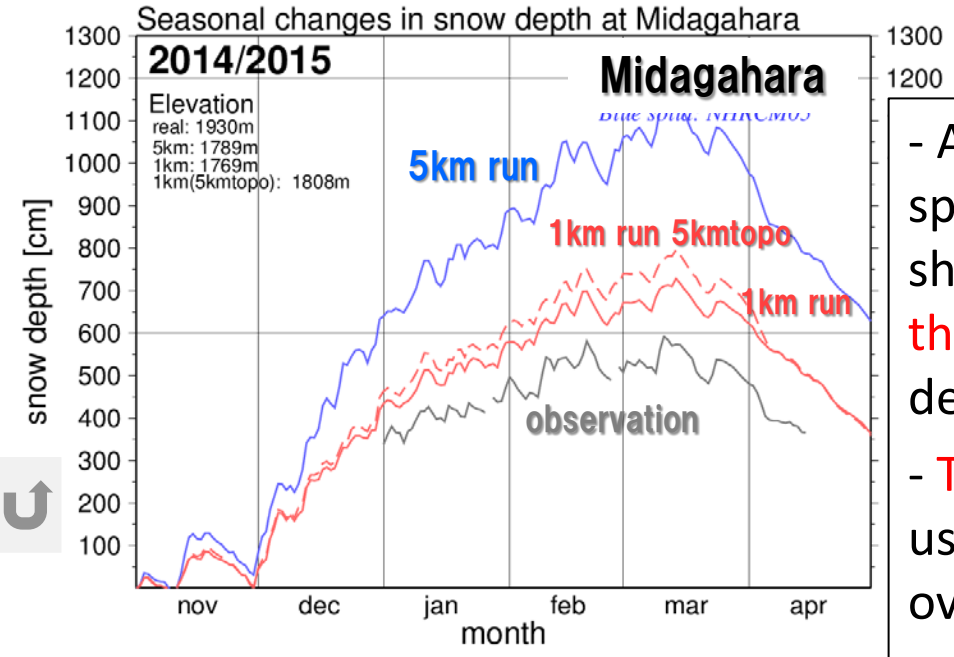
- Snow depth is over-estimated in 5km experiment.

High-resolved NHRCM simulations of mountainous snow and comparisons with on-site observations

■ 1km sensitivity experiments using coarse topography.







- A sensitivity experiment using 1 km grid-spacing with 5km (smoothed) topography show that high-resolved topography is not the main factor of overestimation of snow depth.
- The cumulus convective parameterization used in 5km experiment seems to cause overestimation of snow depth.