8th EGU LEONARDO CONFERENCE

A STUDY ON THE APPLICABILITY OF ATMOSPHERIC-HYDROLOGICAL COUPLED MODEL FOR FLASH FLOOD FORECASTS

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INTRODUCTION

- The flash flood, the rapid flooding cased by a short period of severe rain storm, that the Korean peninsula has had experiences almost every year.
- The needs of high resolution of hydrometeorological information such as runoff, soil mositure, evapotranspiration, etc. is growing for flash flood forecasts, however, relatively low resolution has been used as input data in hydrological model.
- Currently, atmosphere-hydrology coupled models have been developed and its application to generate hydrometeorological components with high resolution that is provided atmospheric input forcing from atmospheric model to hydrological model.
- This study attempts to apply a coupled atmospheric-hydrological model, WRF/WRF-Hydro, which included extention procedure of the flow routing to flash flood forecasts in Korea.

INTRODUCTION

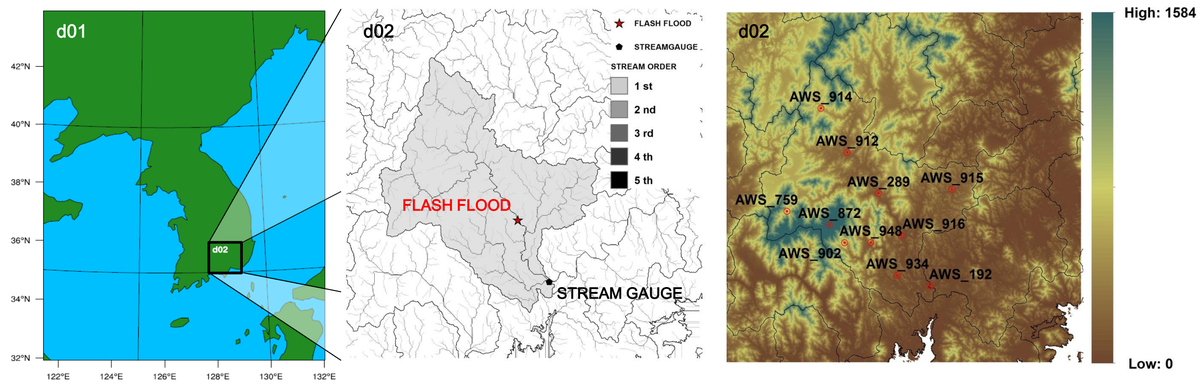
■ WRF/WRF-Hydro Model

- WRF-Hydro hydrological modeling extension package has been implemented to traditional 1D Noah LSM of WRF in a "coupled" or an "uncoupled" manner to provide surface overland flow, saturated subsurface flow, channel routing, and baseflow processes.
- WRF-Hydro, one major enhancement, can provide "infiltration capacity exceedance" to remain within the model domain as 'ponded water' which is subsequently available for lateral redistribution (Gochis et al. 2014 and Yucel et al. 2014).

■ Experimental Design

Model version	WRF Model 3.7 ver.		WRF-Hydro 3.0 ver.
Domain	1	2	1
Used period	00 UTC 21 Aug 2012 –12 UTC 25 Aug 2012	12 UTC 22 Aug 2012 – 12 UTC 25 Aug 2012	
Land Surface Model	Noah LSM		
Horizontal resolution	4.5 km	1.5 km	150 m
Number of grid points	221x291	70x70	690x690
Integral time	6		4
Source	KLAPS & NCEP reanalysis data		WRF output Domain 2
Micro physics	WRF Double-Monent 6-class		None
Long wave physics	Rapid Radiative Transfer Model for GCMs		
Short wave physics	Dudhia Scheme		
PBL Radiatoin	YSU		
Cumulus parameterization	Grell-Devenyi ensemble scheme	none	

■ Study Area and Flash Flood Case

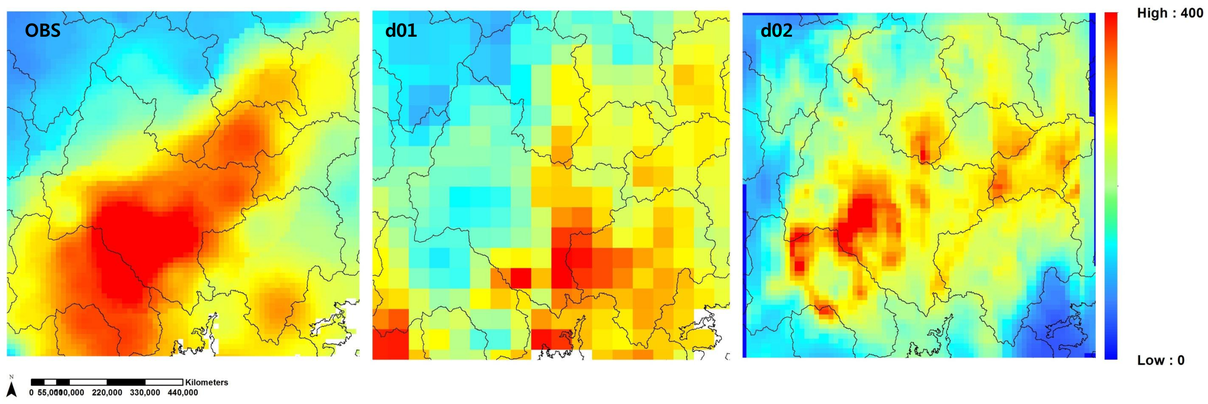


FLASH FLOOD CASE	lon	lat	year	date	time	location
	127.9416	35.331272	2012	2012-08-23	11:00	Sancheong-gun

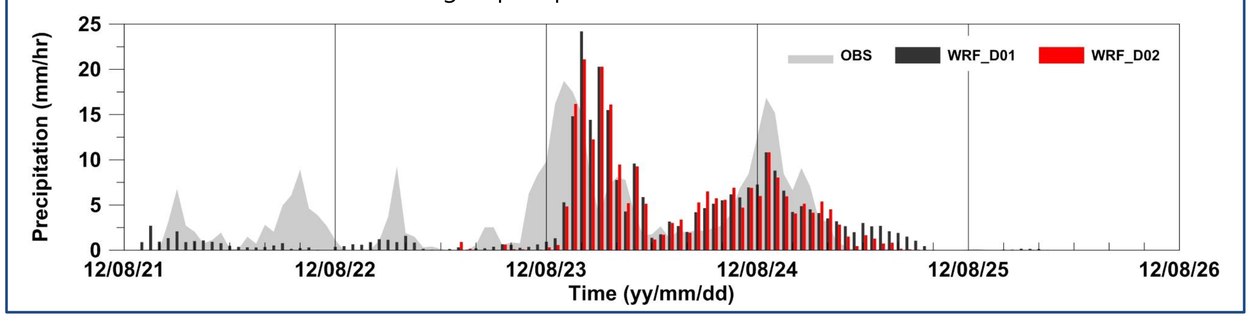
RESULTS

■ Evaluation of WRF Precipitation in flash flood case

- the accumulated precipitation (12 UTC 22 Aug 2012 – 12 UTC 25 Aug 2012, 72 hr)



- Time series of the basin averaged precipitation



RESULTS

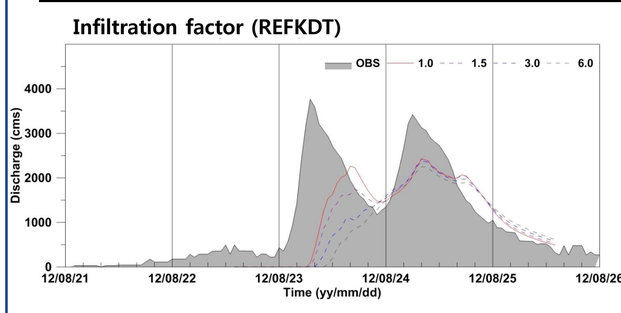
■ Calibration of the parameters

- The chosen parameters to calibrate is affecting the Hydrograph, specifically that can control the hydrograph volume and the shape.
- **Hydrograph Volume**
  - Infiltration factor (REFKDT)
  - Retetention depth (RETDEPRT)
- **Hydrograph Shape**
  - Surface roughness parameter (OVROUGHRT)
  - Channel manning coefficient (MannN)

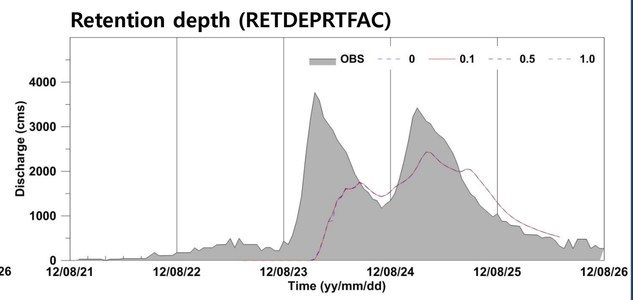
* A scaling factor has been used to find optimum parameters (except REFKDT).

Controlling the hydrograph volume

Infiltration factor (REFKDT)

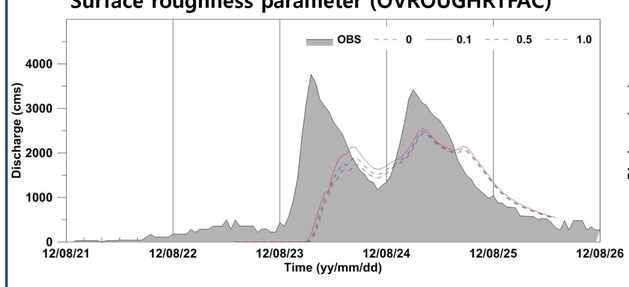


Retention depth (RETDEPRTFAC)

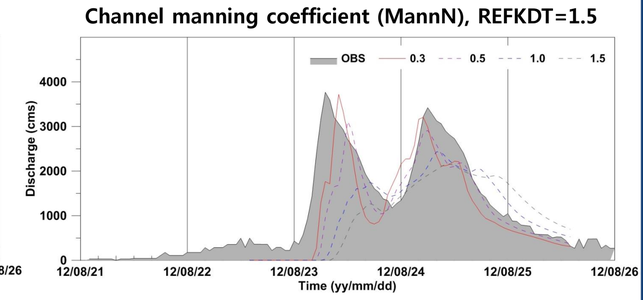


Controlling the hydrograph shape

Surface roughness parameter (OVROUGHRTFAC)



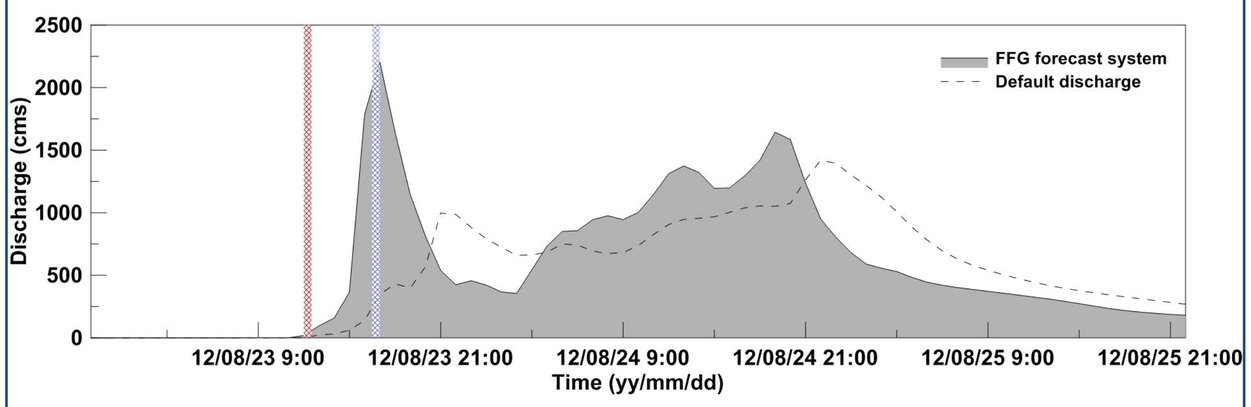
Channel manning coefficient (MannN), REFKDT=1.5



parameters	Value	RMSE	Nash-Sutcliffe
REFKDT	1.0	966.27	0.14
	1.5	1019.86	0.04
	3.0	1132.93	-0.18
	6.0	1213.76	-0.39
RETDEPRTFAC	0.0	1020.35	0.04
	0.1	1019.12	0.04
	0.5	1018.84	0.04
	1.0	1019.86	0.04

parameters		value	RMSE	Nash-Sutcliffe
OVROUGHRTFAC		0	1019.86	0.04
		0.1	965.12	0.14
		0.5	995.20	0.09
		1.0	1019.86	0.04
MannN	REFKDT=1.5	0.3	678.44	0.58
		0.5	751.84	0.48
		1.0	1019.86	0.04
		1.5	1178.13	-0.28

■ Application of WRF/WRF-Hydro to Flash Flood Forecast



- Note that the above mentioned precipitation simulation results happened 5 hour later compared to observation. The delay of peak discharge may be the consequence of 5 hour time lag in simulated precipitation.
- The discharge of the flash flood is not known, however, the optimized simulation discharge shows steep propagation at the flash flood timing compared to default simulation.

CONCULUSION

- This study investigated the use of the WRF-Hydro hydrometeorlogical modeling system that includes a numerical weather prediction model as well as fully distributed hydrologic and hydraulic models in simulating a flash flood event caused by heavy rainfall over mountainous basins in Korea.
- As a results of sensitivity test, the role of parameter controlling infiltration on temporal distribution is addressed for applying WRF-Hydro to flash flood forecasts in mountainous basin.
- The WRF-Hydro model simulation result reflecting on optimized parameters shows the possibility of the coupled atmospheric-hydrological model usage for heavy rain induced flash flood case over the Korean Peninsula.

REFERENCE

Gochis, D.J., W. Yu, D.N. Yates, 2015: The WRF-Hydro model technical description and user's guide, version 3.0. NCAR Technical Document. Available online at: WRFHydro 2.0 User Guide, 120 p.

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Yucel I., A. Onen, K.K. Yilmaz, and D.J. Gochis, 2015: Calibration and evaluation of a flood forecasting system: Utility of numerical weather predication model, data assimilation and satellite-based rainfall. *Journal of Hydrology*, **523**, 49-66.

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