Severe floods in Central Vietnam simulated by the WRF-TRIP coupling system

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The heavy rainfall event in Central of Vietnam from 10-13 November 2007

Central Vietnam: - population of ~60% of the whole country - vulnerable to disasters

In November 2007, 7 consecutive severe floods affected 18 provinces in Central Vietnam

- ✓ 117 deaths, 9 missing, 88 injured.
- \checkmark The total damage was estimated to be around 214 million USD.

Cause: heavy rainfall events



Quang Nam 2007 @AFP



Hue 2007 @AFP

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The heavy rainfall event in Central of Vietnam from 10-13 November 2007

The heaviest rainfall event: November 10th to November 13th
✓ The rainfall amount ~ 500-700mm from Hue to QuangNgai.
✓ At the NamDong rain-gauge station in Hue, value of 1789.9 mm was recorded



Weather Research Forecasting Model (WRF) version 3.0 **Resolution**: 18km x 6km **Time period**: 09/11/2007-15/11/2007 **Forcing**: Fẩ L (Final) Global Analyses on 1.0x1.0 degree global grids every six hours

Physics parameterizations:

- **Microphysics:** Goddard microphysics scheme<- ice, snow, graupel processes suitable for high-resolution simulations

- Longwave radiation: RRTM (Rapide Radiative Transfer Model) scheme
- Shortwave Radiation: Dudhia scheme
- Land surface: a OAH LSM
- Planetary boundary layer: Yonsei University scheme
- Cumulus Parameterization: Kain-Fritsch scheme

WRF – 2 domains of simulation

Mother domain 18 km

Inner domain 6 km



The heavy rainfall event in Central of Vietnam from 10-13 November 2007



Comparison with the observations?

The TamKy- doppler weather radar in Central of Vietnam





Radar reflectivity (dbZ) for 2007/11/10: product CAPPI *(Constant Altitude Plan Position Indicator)* - 2 km

The TamKy radar

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WRF rainfall & radar reflectivity



WRF rainfall can capture the spatial pattern detected by the radar
Don't have the "reflectivity to rainfall conversion " yet → rain gauges



CAPPI-2km Radar reflectivity (dbZ)

WRF rainfall & rain-gauge observation



Rain-gauge stations in Central Vietnam of the MAHASRI program (Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative)

WRF rainfall & rain-gauge observation



WRF rainfall & rain-gauge observation





- WRF generally underestimates extreme rainfall values
- WRF can capture somehow the daily fluctuations of rainfall at different stations

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WRF runoff



2007/11/10 - 00:00

- Surface runoff and sub-surface runoff are generated by the å OAH LSM.
- Route runoff to obtain river discharge → flood study & model validation
- → We use TRIP -Total Runoff Integrating Pathways model to route runoff simulated by WRFå OAH LSM

WRF-TRIP coupling

TRIP

- isolate the river basins, inter-basin water transport through river channels
- collect and route runoff to the river mouth for all the major rivers



Rivers in Asia on TRIP in 1°x1° mesh

Two versions of TRIP • constant river flow velocity approach (TRIP1) *(Oki and Sud, 1998)* • variable velocity approach (TRIP2) *(Ngo-Duc et al., 2008)*

TRIP2 had been successfully coupled with HTESSEL (Tiled ECMWF Scheme for Surface Exchange over Land). HTESSEL is used operationally in ECMWF's Integrated Forecast System.

(*Pappenberger et al.*, submitted to *International Journal of River Basin Management, 2009*).

WRF-TRIP coupling

✓ Created the river maps: based on the HydroSHEDs 30-sec data (http://hydrosheds.cr.usgs.gov/): flow direction, river sequence, elevation maps



\checkmark interpolated the WRF runoff to the new resolution

WRF-TRIP coupling



✓ underestimations of WRF rainfall lead to systematic underestimation of river discharge

✓ simulated discharge reaches its maximum value in the same time with the observed one

 ✓ if a good estimation of rainfall is obtained, river discharge can be well forecasted using TRIP.

Conclusions

- WRF can simulate the rainfall event from Nov 10th to Nov 13th
 - spatial pattern shown by radar reflectivity can be captured
 - daily fluctuations measured by the rain-gauges can be somehow captured
 - WRF generally underestimated extreme heavy rainfall values
- **TRIP is used to route WRF runoff**
 - 30-sec maps were made for the river in Central Vietnam
 - Runoff were interpolated to the new resolution
 - Underestimations of WRF rainfall lead to underestimation of discharge

Further studies

To improve the quality of the rainfall simulated by WRF:
 assimilate the radar information to the model
 use the near real-time data of the 30 rain-gauge stations which belong to the MAHASRI project.

✓ To use TRIP & other hydrological models to route WRF runoff and compare/calibrate with the observations; to obtain a good coupling system for the region.

→ To mitigate water-related disasters in Central Vietnam

Thank you for your attention!

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