Southwesterly Flow and Intense Orographic Rainfall Associated with Southwest and Ordinary Typhoons

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Central Mountain Range

Snow Mountain Range

Coastal Range

Animation of radar echoes for Herb (1996)
Distribution of maximum rainfall during the influence of typhoons (1897-1996)
Yu and Cheng (2014)
The best track of the six studied typhoons

**Objectives:**

To explore kinematics of southwesterly flow associated with SW and OR typhoons

SW (OR) typhoon defined as with (without) obvious combination of typhoon outer circulations with southwesterly monsoon flow
Typhoon locations and southwesterly monsoon

Vertical profiles of the mean winds over inset domain
Horizontal distribution of the accumulated rainfall for each of the studied typhoons
Study domain and data sources
Time-height section of Doppler-derived upstream oncoming flow
Vertical profiles of mean Doppler-derived wind speed averaged during strongest southwesterly flow (3-h period)
Radial ($u$) and tangential ($v$) flow averaged during strongest southwesterly flow (3-h period)
Vertical profiles of the ratio of $u$ and $v$ during the strongest period of WSW flow

\[ \text{Inflow angle}(\theta) = \tan^{-1}\left(\frac{u}{v}\right) \]

OR typhoon \( \sim 19^\circ \)
SW typhoon \( \sim 37^\circ \)
Hurricanes \( \sim 23^\circ \)
Schematic diagram for SW and OR typhoons

Plan view

SW typhoon

- Large inflow angle ($\theta$)
- Strong Southwestly monsoon

OR typhoon

- Small inflow angle ($\theta$)

Profile view

- SW typhoon
- OR typhoon

- Typhoon-Monsoon interaction layer
Table 2. The magnitudes of the upstream cross-barrier flow ($U$, m s$^{-1}$), typhoon background precipitation ($R_{bg}$, mm h$^{-1}$), orographic precipitation ($R_{mt}$, mm h$^{-1}$), precipitation enhancement ($\Delta R$, mm h$^{-1}$), and Froude number ($F_r$) for each of the studied typhoons.

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<tr>
<th></th>
<th>$U$</th>
<th>$R_{bg}$</th>
<th>$R_{mt}$</th>
<th>$\Delta R$</th>
<th>$R_{bg} \times U$</th>
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<th>$R_{bg}$</th>
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Evaluation of shear profiles via idealized orographic precipitation model

08/07 2100 UTC Typhoon Morakot (2009)

Rainfall intensity 57.9 mm h\(^{-1}\)

20% increase in rainfall intensity considering shear features like SW typhoon

Rainfall intensity 48.4 mm h\(^{-1}\)
Conclusions

• Differences in the kinematic nature of southwesterly flow between SW and OR typhoons were documented
  
  --- Intensity of the SW flow for SW typhoon decreased with height, with a maximum near the surface, in contrast to a minor vertical change in the intensity of the SW flow for OR typhoon.

  --- Larger ratio of the radial and tangential velocities (i.e., a larger inflow angle) was observed for the SW typhoon

  --- Typhoon-monsoon interaction was confined to the lowest 3 km

• For SW typhoon, shear type of wind profiles may represent an important kinematic signature favorable for orographic enhancement of precipitation

Reference: