NOAA RESEARCH • ESRL • PHYSICAL SCIENCES DIVISION

Budgetary Evaluation of Microphysics Schemes Used in Numerical Weather Prediction

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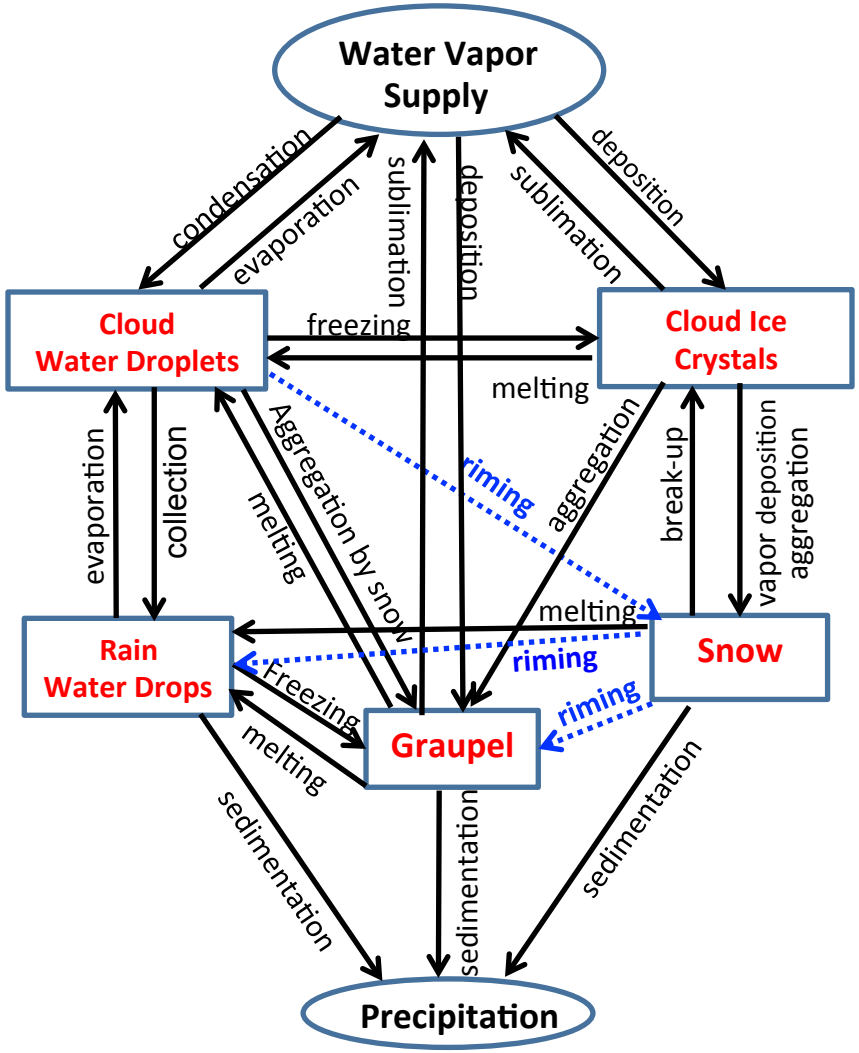
Basis for budgetary evaluation

- Gain and loss of a hydrometeor due to gravitational sedimentation
- Gain of a hydrometeor due to nucleation on aerosols
- Gain and loss of a hydrometeor due to collision and coalescence
- Gain and loss of a hydrometeor due to self-collection or breakup

What is the minimal complexity in microphysics schemes required in NWP model?



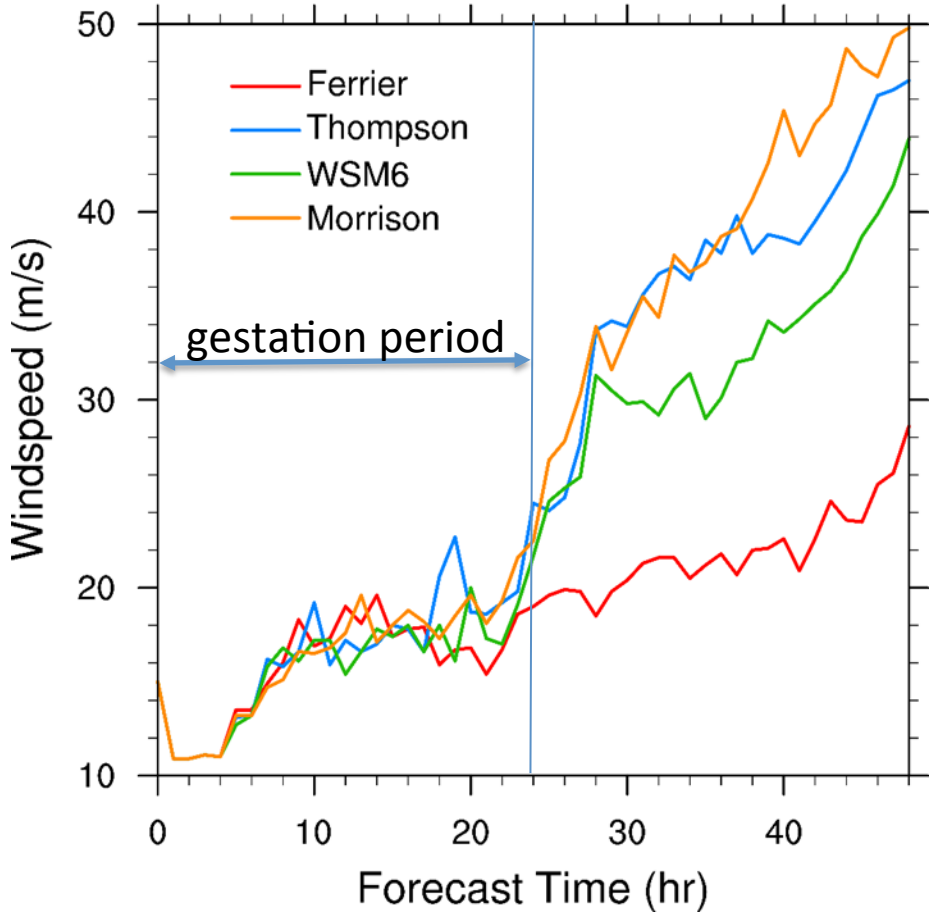
An idealized tropical cyclone intensification case

WRF-ARW (v3.5) is run nested 9km and 3km domains, 43 vertical levels, with the following 4 MP schemes.

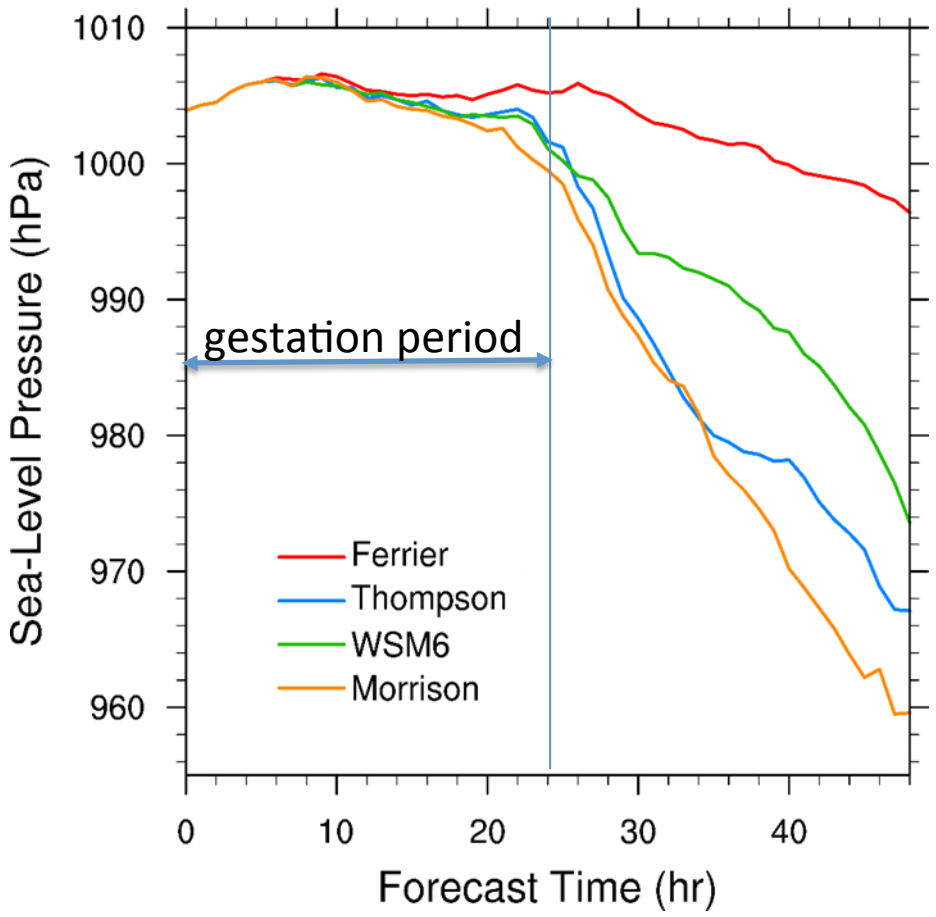
Microphysics Parameterization	Predicted Variables
Ferrier (a version of NOAA's operational scheme)	Mixing ratios of cloud water, rain water, snow; rime factor
WSM6	Mixing ratios of cloud water, rain water, cloud ice, snow and graupel
Thompson	Mixing ratios of cloud water, rain water, cloud ice, snow and graupel; number concentration of rain water and cloud ice
Morrison	Mixing ratios of cloud water, rain water, cloud ice, snow and graupel; number concentration of rain water, cloud ice, snow and graupel

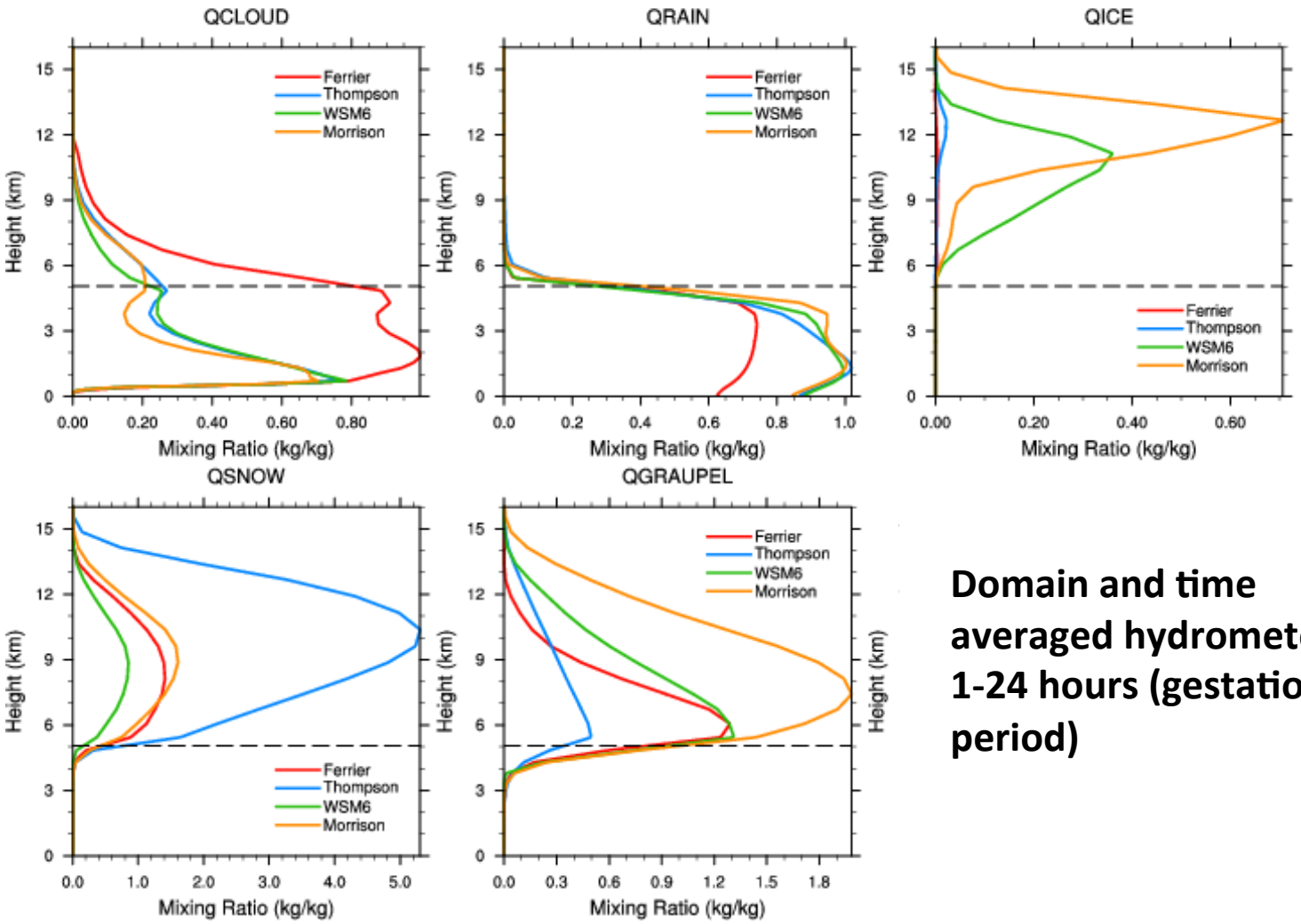
Sensitivity of intensification to microphysics parameterization

Maximum 10-m wind speed



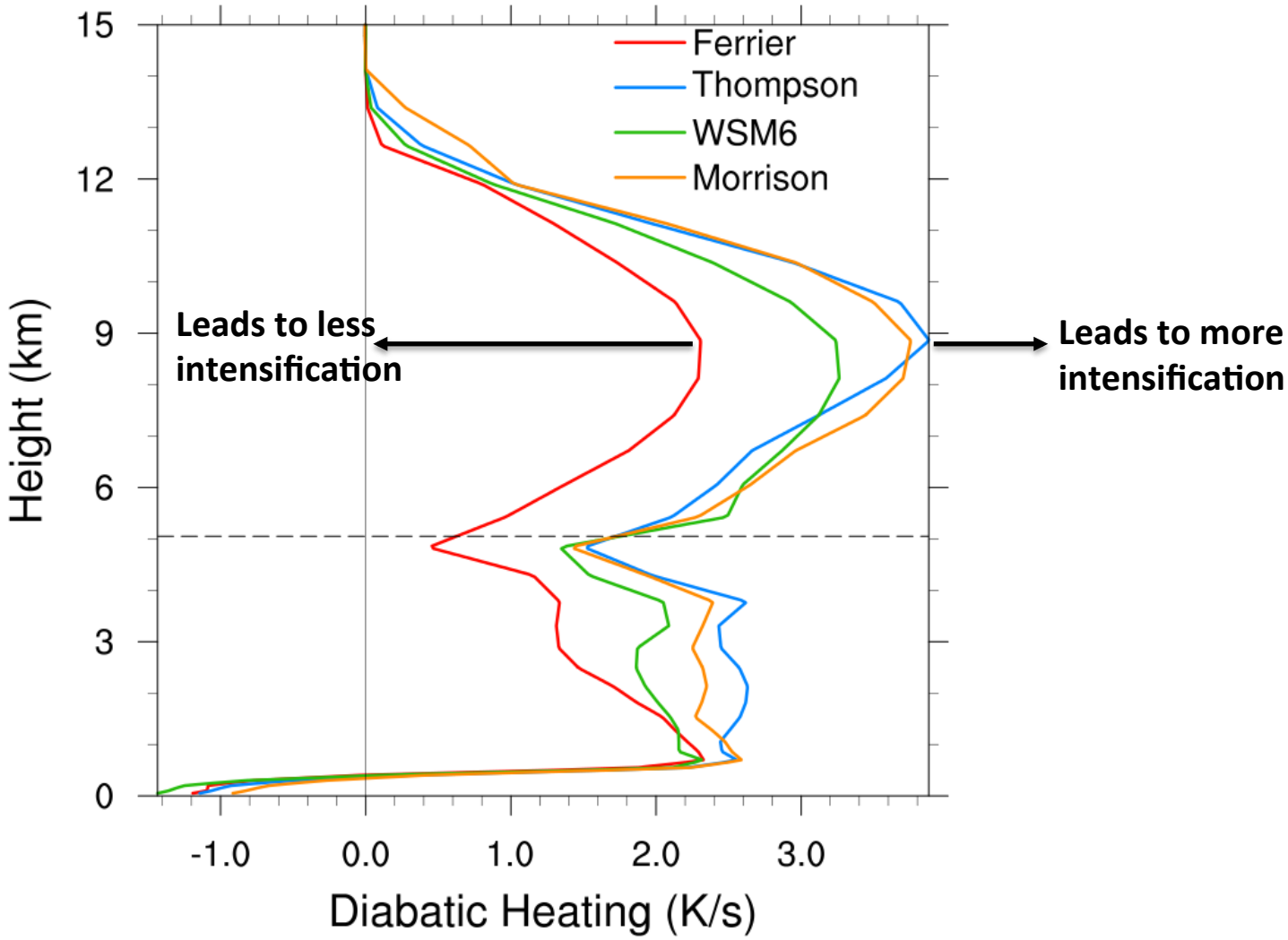
Minimum Sea Level Pressure



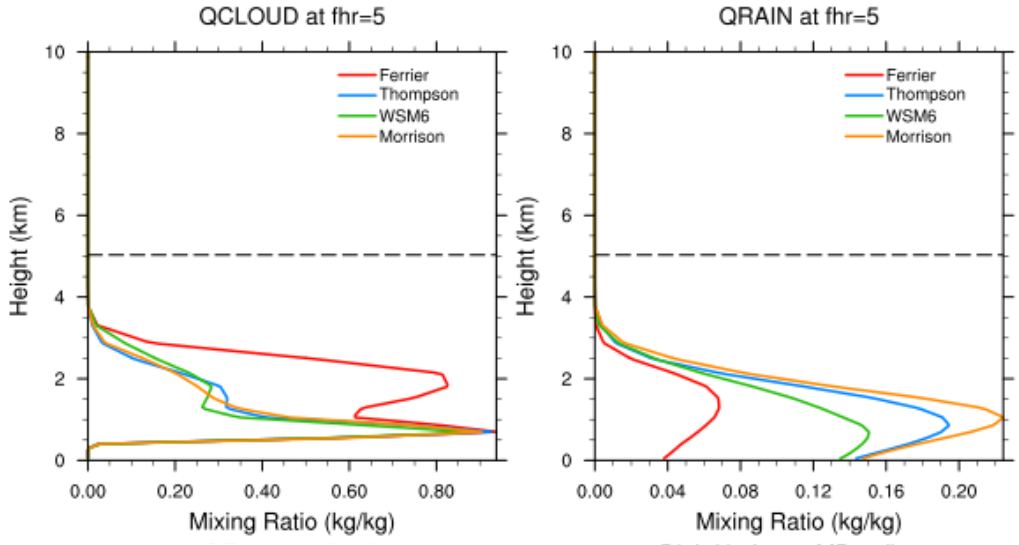


Domain and time averaged hydrometeors: 1-24 hours (gestation period)

Domain and time averaged MP diabatic heating: 1-24 Hours (gestation period)

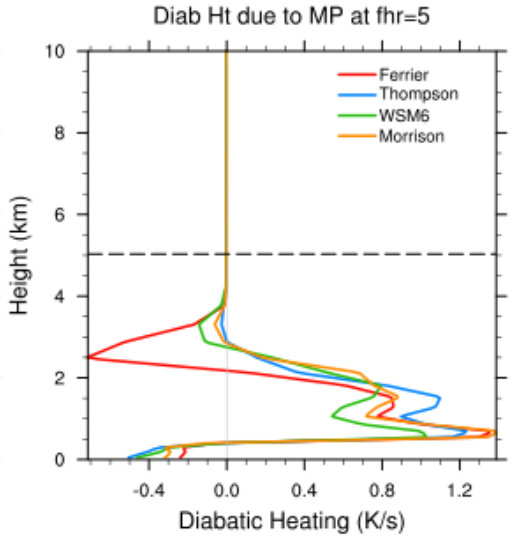


Mixing ratios of cloud and rain water and MP diabatic heating

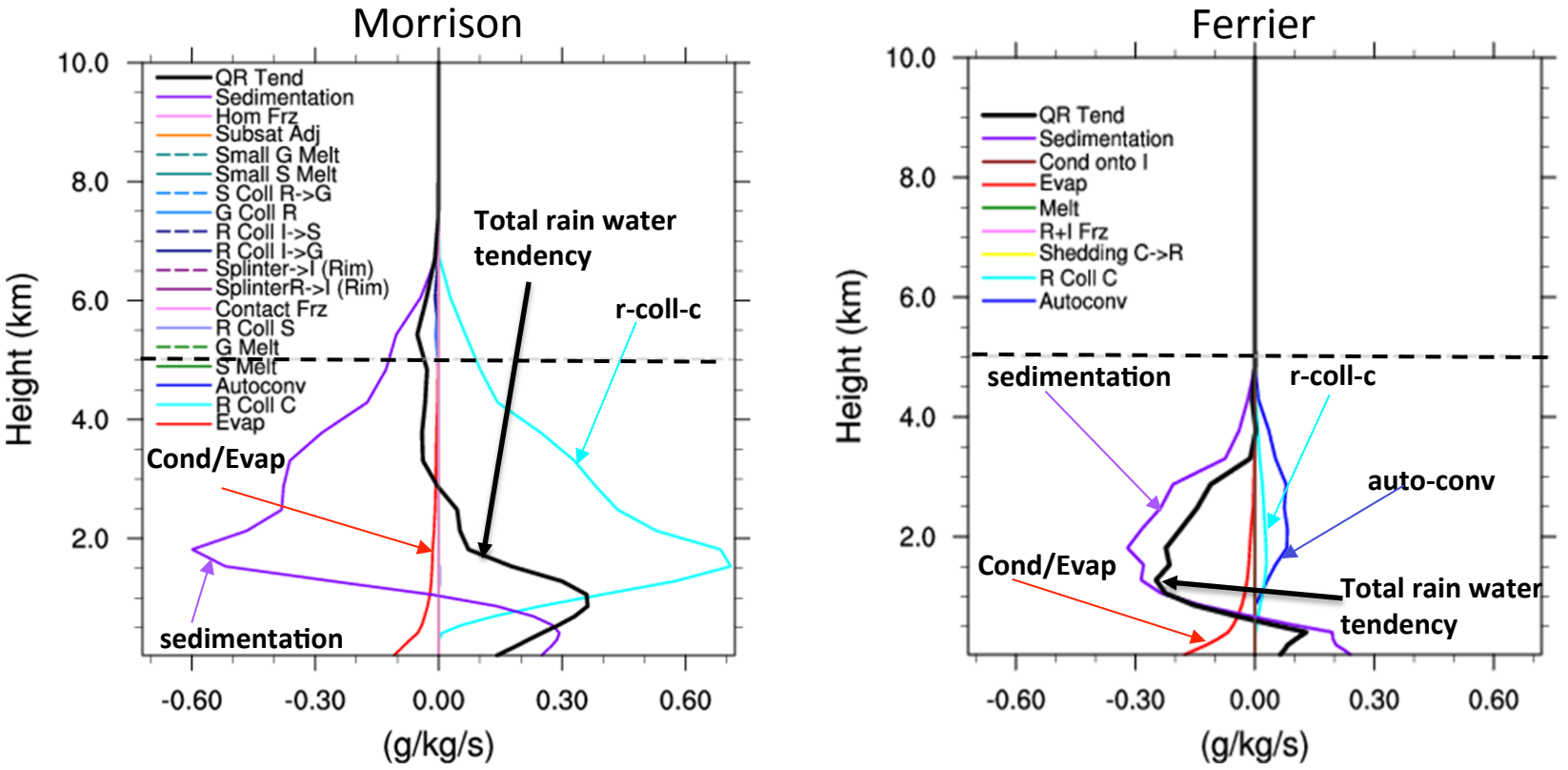


Different conversion rates for cloud to rain water, and different latent heating rates

Domain sum vertical profiles at t=5 h

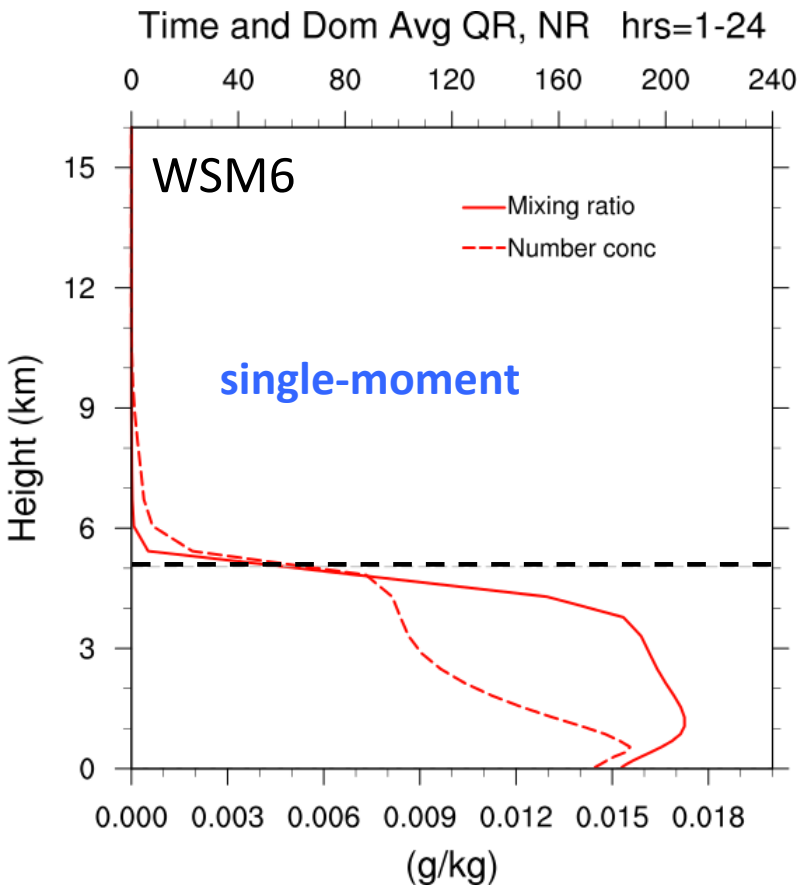


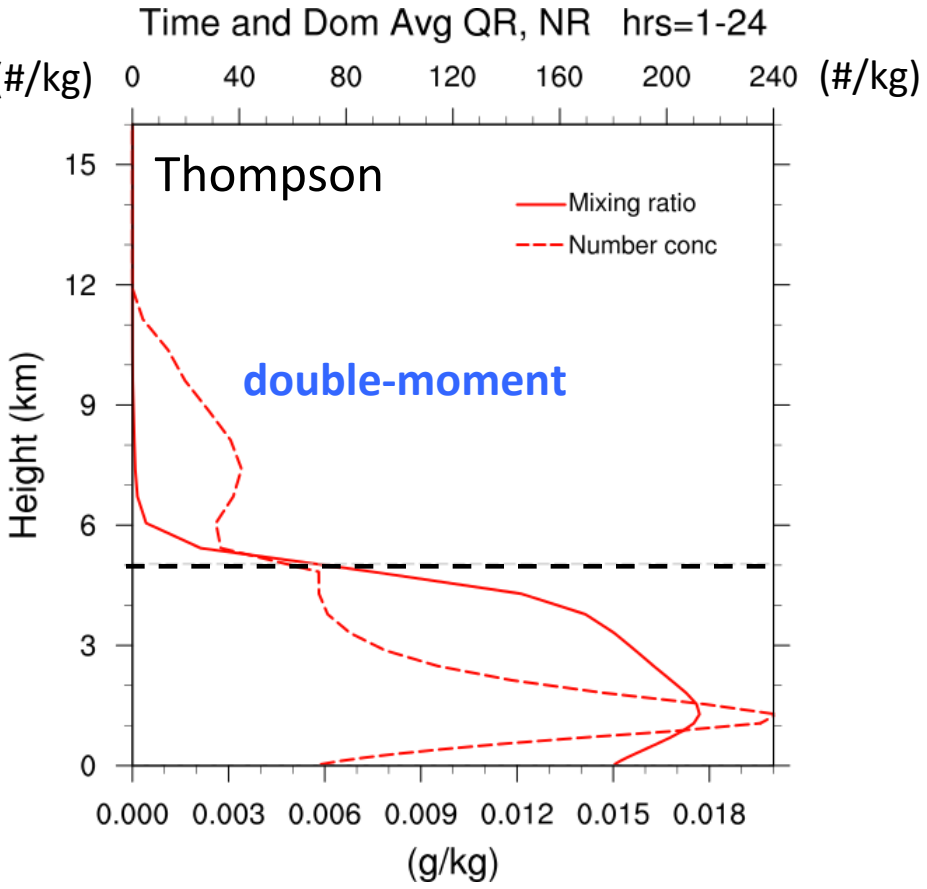
Budgets of rain water mixing ratio tendency at hour 6: Morrison vs Ferrier (a version of NOAA's operational scheme)



Different size assumptions embedded in all the sink/source terms

Single- vs double-moment formulation for rain water





Caution: it has been unclear so far if the differences are important or if they can be validated.

Summary and Conclusions

- **No significant differences in cloud water production between the four schemes are found in this idealized case study.**
- **Differences in the parameterized rain water production are in the size distribution assumption embedded in the calculations of autoconversion, collection growth, sedimentation and evaporation.**
- **Double-moment schemes *differ* from single-moment ones in the parameterizations of self-collection/breakup process and number concentration sorting.**
- **There is a tradeoff between the complexity needed to represent detailed microphysical processes and the uncertainties introduced by the added complexity.**