Evaluating the Influence of Microphysics On Orographic Precipitation





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Project Objectives

- Understand sensitivity to changes in ice microphysics during orographic precipitation events
 - Addition/modification of ice processes has been shown to impact surface precipitation (Colle and Zeng 2004, MWR; Stoelinga et al. 2003, BAMS)
- Using an idealized numerical framework to explore atmospheric river events
 - moist stable/neutral conditions are common in producing heavy rain during non-convective events

What is the sensitivity of dynamical structures, cloud development, and surface precipitation to changes in ice microphysics?

OLYMPEX Case: 13 November 2015



Model Configuration and Experiments

- Cloud Model 1, release 17 (Bryan and Fritsch 2002)
- Quasi-2D 10-hr simulation
- 2-km horizontal grid spacing
- 18-km domain height
- 55 stretched vertical levels
- Constant wind with height

Experiments	Microphysics Info
Warm-Rain Only	Kessler (1996)
lce	NASA-Goddard version of Lin, Farley, Orville (1983; LFO)
	Morrison (Morrison et al. 2005; 2009)
	Graupel vs Hail

Warm-rain Only (KESS)



Warm-rain Only (KESS)



Ice: LFO with graupel



Ice: MOR with graupel



Ice: Graupel vs Hail



MOR

NO SIGNIFICANT CHANGES IN DYNAMICS, CLOUD DEVELOPMENT – BOTH HAIL AND GRAUPEL DEVELOP SIMILARLY

Average precipitation rates at last hour



OLYMPEX 13 Nov 2015

Summary

- Warm-rain only simulation produces lee waves/ downslope windstorm and persistent upslope precipitation
- Addition of ice microphysics produces similar dynamical structures, but changes in microphysics and precipitation
- MOR vs LFO:
 - MOR has thicker cloud shield and no rain downstream; no snow upslope towards end of simulation
 - less precipitation with LFO, more with MOR: More cloud water may have been used for graupel than rain in LFO, not enough melting to compensate
- Sensitivity to choice of graupel/hail depends on scheme used
- Results show impact of ice microphysics schemes to surface precipitation and cloud development

What's next?: Embarking on ensemble sensitivity experiments...

- Exploring relative sensitivity of orographic rainfall to changes in microphysical and environmental parameters
 - Dig into the physical processes (riming, aggregation, etc.)
 - Change the settings inside the parameterization, then change these alongside modifications to the environment
- OLYMPEX data will help to anchor my simulations in reality and provide reasonable ranges for parameters
 - Compare simulations to observations

If you change the upstream conditions, will this impact the sensitivity to changes in ice microphysics? Objectives • Methods • Results • Summary • Future Work

Preliminary results of changes to upstream

