ARM/GCSS/SPARC TWP-ICE LAM Intercomparison Study

1. Motivation

To facilitate our understanding of the structure and evolution of tropical monsoonal deep convection, the resulting cirrus clouds, the induced convective transport, and their impact on the large-scale dynamics and thermodynamics, the ARM/GCSS/SPARC have decided to organize a joint model intercomparison study based on the Tropical Warm Pool – International Cloud Experiment (TWP-ICE). The case description and the scientific goal of the TWP-ICE intercomparison have been documented by Fridlind et al. (2009) in detail and can be found online at http://science.arm.gov/workinggroup/cpm/scm/scmic6/documentation.html. The limited area model (LAM) intercomparison described here is a unique component of this joint modeling study on tropical deep convective clouds. In addition to the scientific questions raised by Fridlind et al. (2009), the LAM intercomparison also focuses on issues that may not be appropriately addressed by the accompanying CRM, SCM, and NWP intercomparison studies. These include:

- Can LAM simulations capture the observed wide range of dynamical processes during the TWP-ICE experiment?

- How does surface heterogeneity, in particular the land/sea contrast, affect the cloud evolution during the active and suppressed monsoon periods?

- Can LAM simulations reproduce the observed diurnal cycle of the convective cloud systems initiated by the mainland and islands?

- Can LAMs realistically simulate the observed life cycle of mesoscale convective systems (MCSs)? And how do MCSs interact with the westerly monsoonal flow to regulate the cloud systems during different monsoon periods?

- Can LAMs statistically produce the similar cloud structure, anvil cirrus, and convective transport to those simulated by CRMs if LAMs are configured with a resolution compatible to that of CRMs? If not, what are the main reasons responsible for the difference?

2. Case Specification.

2.1 Time Period

- Monsoon trough ('landfoon'): 23-25 Jan 2006 (start on 12:00Z 22 Jan)
- Suppressed monsoon: 28-30 Jan 2006 (start on 12:00Z 27 Jan)
- CRM period, 0Z 18 Jan - 0Z 3 Feb (optional)

2.2 Forcing data

ECMWF analyses
NCEP reanalyses (if ECMWF is not available).

2.3 Model domain and resolution

- 128.891ºE – 132.891ºE, 13.923ºS-10.925ºS with model center at 130.891ºE, 12.425ºS
- Horizontal grid spacing: 1 km
- Vertical: 76 levels (model top at least 24 km)
  (Note: If nesting is available (optional), the area defined above should be the inner most domain. Model domain and resolutions are subject to change depending on computational ability.)

2.4 Nudging

For the run with CRM period (i.e., 0Z 18 Jan - 0Z 3 Feb), to keep the simulation as realistic as possible, the ECMWF grid-data is suggested to be nudged in simulations every 6 hr. Nudging coefficients are set to be the same as those suggested by Fridlind et al. (2009).

2.5 Tracer

- Mean tracer lifetime= 6 hours (exponential decay)
- Initialisation: tracer=1 in source layer; 0 elsewhere
- Source: tracer kept to 1 in source layer throughout the run

	TRACER1	TRACER2	TRACER3	TRACER4
Source layer	~0-250 m	~2-4km	~4-6km	~14-17km

2.6 Output

1 hourly and 3 hourly output in NETCDF format.

Table 1. 3-D fields at 3-hour intervals

Name	**Units**	**Description**
Variables (dimensions are time; x; y; z)		
P	hPa	Pressure
Z	m	Height
T	K	air temperature
U	m s^{-1}	eastward wind
V	m s^{-1}	northward wind
W	m s^{-1}	vertical wind (positive upward)
Qv	kg kg^{-1}	water vapor mass mixing ratio
Qc	kg kg^{-1}	cloud water mass mixing ratio
Qr	kg kg^{-1}	rain water mass mixing ratio
Qi	kg kg^{-1}	ice mass mixing ratio

Name	Units	Description
Tra1	kg kg^{-1}	boundary-layer tracer mixing ratio
Tra2	kg kg^{-1}	lower-troposphere tracer mixing ratio
Tra3	kg kg^{-1}	mid-troposphere tracer mixing ratio
Tra4	kg kg^{-1}	upper-troposphere tracer mixing ratio
Nc (optional)	L^{-1}	number concentration of cloud drops where cloud water mass mixing ratio > 10^{-6} kg kg^{-1}
Nr (optional)	L^{-1}	number concentration of rain drops where rain water mass mixing ratio > 10^{-6} kg kg^{-1}
Ni (optional)	L^{-1}	number concentration of ice particles where ice mass mixing ratio > 10^{-6} kg kg^{-1}
N_100 (optional)	L^{-1}	total number concentration of cloud, rain and ice particles with maximum dimension exceeding 100 µm where total condensate mass mixing ratio > 10^{-6} kg kg^{-1}

Table 2. 2-D fields at 1 hour interval

Name	Units	Description
Variables (dimensions are time; x; y)		
Lon	degree	Longitude
Lat	degree	Latitude
Psf	hPa	Surface pressure
Hgt	m	Terrain height
U10	m s^{-1}	10 m eastward wind
V10	m s^{-1}	10 m northward wind
T2	K	2 m temperature
Q2	Kg kg^{-1}	2 m moisture
SWdn	W m^{-2}	shortwave downwelling radiative flux
SWup	W m^{-2}	shortwave upwelling radiative flux
LWdn	W m^{-2}	longwave downwelling radiative flux
LWup	W m^{-2}	longwave upwelling radiative flux
Rainc	mm	Accumulated precipitation
Olr	W m^{-2}	TOA outgoing longwave radiation
Lwp	g m^{-2}	Accumulated liquid path
SHF	W m^{-2}	surface sensible heat flux
LHF	W m^{-2}	surface latent heat flux

Table 3. 1-D fields (domain averaged) at 1 hour interval

Name	Units	Description
Variables (dimensions are time; z)		
U1	m s^{-1}	eastward wind profile
V1	m s^{-1}	northward wind profile
Th	K	potential temperature
Tl	K	liquid water potential temperature
Qv1	kg kg^{-1}	mixing ratio
Qc1	kg kg^{-1}	cloud water mixing ratio
Qr1	kg kg^{-1}	rain water mixing ratio
Qi1	kg kg^{-1}	ice water mixing ratio
Cfr	%	cloud fraction

Name	Units	Description
Ratelw	K/day	longwave heating rate
Ratesw	K/day	shortwave heating rate
W2	$m^2\ s^{-2}$	vertical velocity variance
Tl2	K^2	variance of liquid water potential temperature
Qv2	$kg^2\ kg^{-2}$	variance of water vapor mixing ratio
Qc2	$kg^2\ kg^{-2}$	variance of cloud water
Qi2	$kg^2\ kg^{-2}$	variance of ice water
W3	$m^2\ s^{-2}$	third moment of vertical velocity
Tl3	K^3	third moment of liquid water potential temperature
Qv3	$kg^3\ kg^{-3}$	third moment of water vapor mixing ratio
Qc3	$kg^3\ kg^{-3}$	third moment of cloud water
Qi3	$kg^3\ kg^{-3}$	third moment of ice water
Tlc	K	in-cloud liquid water potential temperature
Qc1c	$kg\ kg^{-1}$	in-cloud cloud water mixing ratio
Qi1c	$kg\ kg^{-1}$	in-cloud ice water mixing ratio
W2c	$m^2\ s^{-2}$	in-cloud vertical velocity variance
Tl2c	K^2	in-cloud variance of liquid water potential temperature
Qc2c	$kg^2\ kg^{-2}$	in-cloud variance of cloud water
Qi2c	$kg^2\ kg^{-2}$	in-cloud variance of ice water
W3c	$m^2\ s^{-2}$	in-cloud third moment of vertical velocity
Tl3c	K^3	in-cloud third moment of liquid water potential temperature
Qc3c	$kg^3\ kg^{-3}$	in-cloud third moment of cloud water
Qi3c	$kg^3\ kg^{-3}$	in-cloud third moment of ice water
Wup	$m\ s^{-1}$	mean updraft core
Wdn	$m\ s^{-1}$	mean downdraft core

Note: clouds are defined whenever the total cloud water (liquid + ice) mixing ratio exceeds 10^{-6} $kg\ kg^{-1}$ **.** This threshold is used for all cloud related calculations including cloud base, cloud fraction, etc.

3. Schedule and Expected Outcomes.

3.1 Deadline

Results are required to submit by November 1st, 2009, but results provided before Aug 15th will be included in a preliminary comparison presented at the Fall ARM meeting

3.2 Publications

It is expected that at least one paper regarding LAM intercomparison will be submitted. Submitted model results will be included in the paper and participants included as co-authors.