Physics developments overview

Sander Tijm, Peter Clark,
Valery Masson, Federico Grazzini,
Neva Pristov

Overview

- Work of expert team
- Main topics research consortia
- Interesting topics NWP and climate modelling (mainly from ECMWF seminar on parameterization of subgrid physical processes)

Work of expert team

- Writing work plan, also overview of area
- Determining scope of expert team
- First meeting in Reading, 3 September 2008
- Actions for expert team

Work of expert team

- Work plan:
  - Overview of work in upper air physics
  - Many different aspects, many different resolutions with their own specific problems and solutions
  - Areas: Turbulent mixing (also 3D for high resolution), Radiation (also 3D for high resolution), Surface (other expert team, but closely related), Orographic drag, Convection and condensation (only condensation at very high resolution), Link with chemistry

Work of expert team

- Work plan:
  - Increase exchange of information between consortia via workplan and (hopefully) SRNWP website
  - Exchange information on methods for model development (academic cases, parameters to check, list of model output for easy intercomparison of model results)
  - Promote contribution to existing initiatives for model intercomparison and model development, e.g. Cloudnet, GABLS, GCSS
  - Stimulate exchange of model output at special observation sites like Sodankyla, Chilbolton, Lindenberg, Cabauw …

Work of expert team

- Work plan:
  - Organization of workshop or workshop sessions
  - NetFAM workshop on moist processes, organized by SMHI (June 2009)
  - Session on shallow to deep convection transition in NWP models with resolution 1-4 km. If possible based on model intercomparison for GCSS daily cycle of deep convection case

Main research topics COSMO

- Vertical diffusion
  - Improve daily cycle and extend to 3D
  - Higher resolution close to surface
- Testing of different convection schemes
  - Tiedtke, Kain-Fritsch Bechtold and Tiedtke-ECMWF
  - Too much grid scale precipitation at 7 km resolution
- Radiation scheme
  - Improve upon deficiencies in schemes (too little surface SW↓, too much TOA LW↑)

Main research topics UKMO

- Strategy 2 models, one global (10-20 km), one mesoscale (~1 km)
- NAE:
  - Aerosol: improved emission maps
  - Microphysics: improvements and coupling with aerosol
  - Radiation: bug fixes
- Mesoscale
  - Horizontal diffusion, impact on convection
  - Configuration of mesoscale model, variable resolution

Main research topics ALADIN/MF

- **<u>Goal</u>:**

  Development of common physics for NWP & Climate for ARPEGE and ALADIN-MF, having several parameterisations in common with AROME

- **<u>What we focus on</u>:**
  - **Interactions between Boundary Layer, Shallow convection, Deep convection and subgrid-cloud schemes**
  - **EDMF type mixing & shallow convection**
  - **Microphysics (Lopez, ICE3, 2moments $\mu\phi$)**
  - **3D turbulence (theory & LES, how to implement it in AROME)**
  - **Aerosols (dust, CCN) & interaction with radiation**

LACE developments in ALADIN

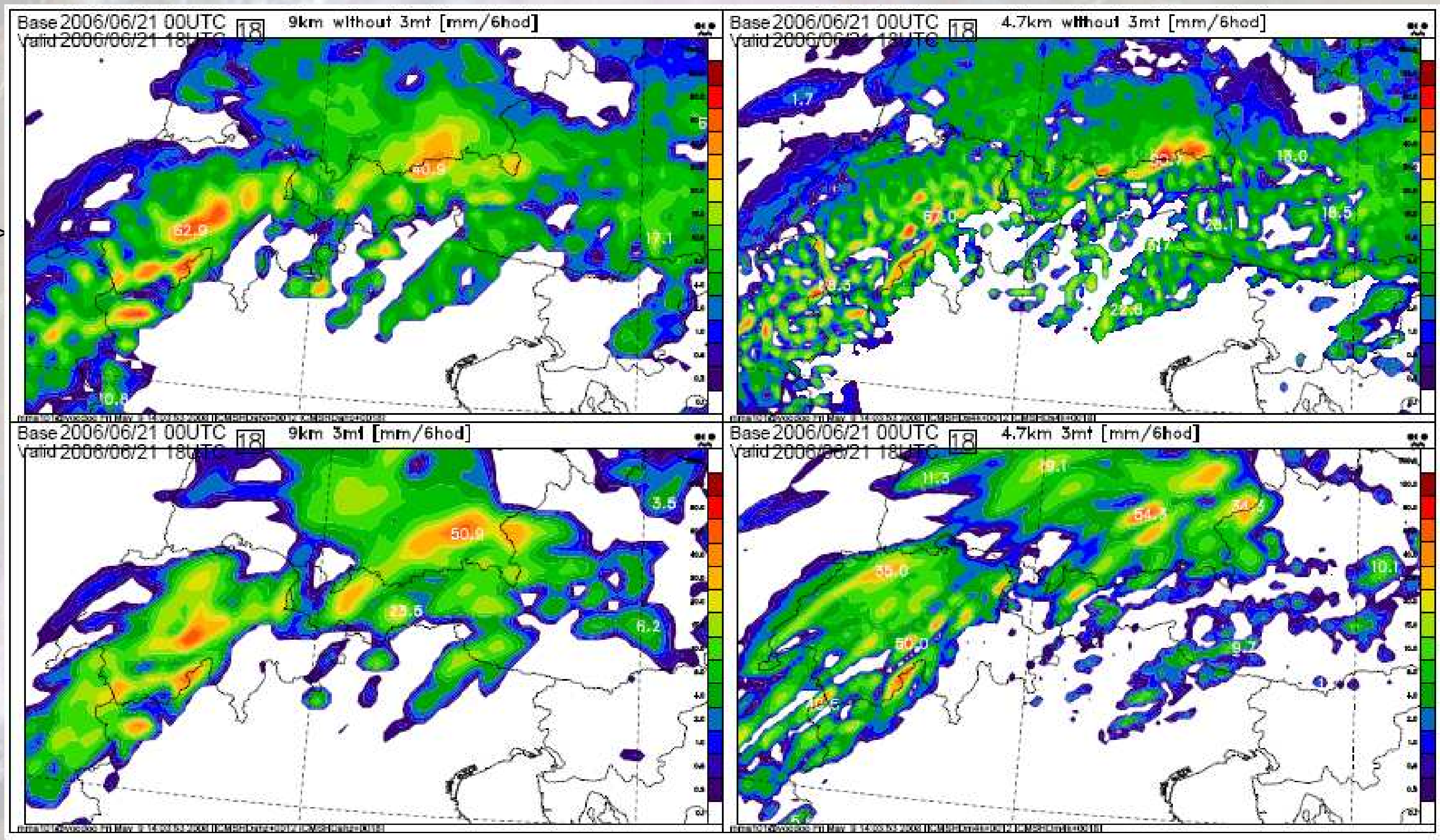
- Turbulence scheme
  - searching for the best mixing length formulation
  - to code consistently the full TKE scheme into the framework of the existing p-TKE scheme
- Radiation
  - new fits of gaseous broad band transmission
  - correction in the computation of the optical depths for the composite of gases
- 3MT (see presentation of Brozkova tomorrow)

Need of more than a ‘classical diagnostic’ convection scheme for true multiscale results (*18 h cumulated precipitation amounts*)

Δx=9.0 km Δx=4.7 km

Without 3MT =>

With 3MT =>



Main research topics HIRLAM

- EDMF scheme
    - first prototype is available
- New surface scheme
    - removal of last problems, cold dry bias in S Europe
- Study of deep convection problems in AROME
- Stable boundary layer improvements
    - Implement new tuning, removal of surface layer stress turning
- Coupling to chemistry
    - initial steps, improve output for offline coupling

Deep convection in AROME

L. Bengtsson

Clouds and radiation

- Currently cheap schemes called every time step or (much) more sophisticated schemes every n^{th} time step
- Inconsistency in interaction between clouds and radiation, impact of calling cloud scheme every time step?
- 3D cloud and radiation interaction

Interesting questions/developments

- Clouds and radiation
- Initiation of deep convection, are scales correct?
- Impact of aerosols on clouds
- Super parameterizations

Transition to deep convection

- Many factors impacting on transition from shallow to deep convection
  - Shallow convection scheme
  - Horizontal diffusion/mixing
  - Traditional vertical diffusion
- How different control mechanisms work is not clear yet

Transition to deep convection

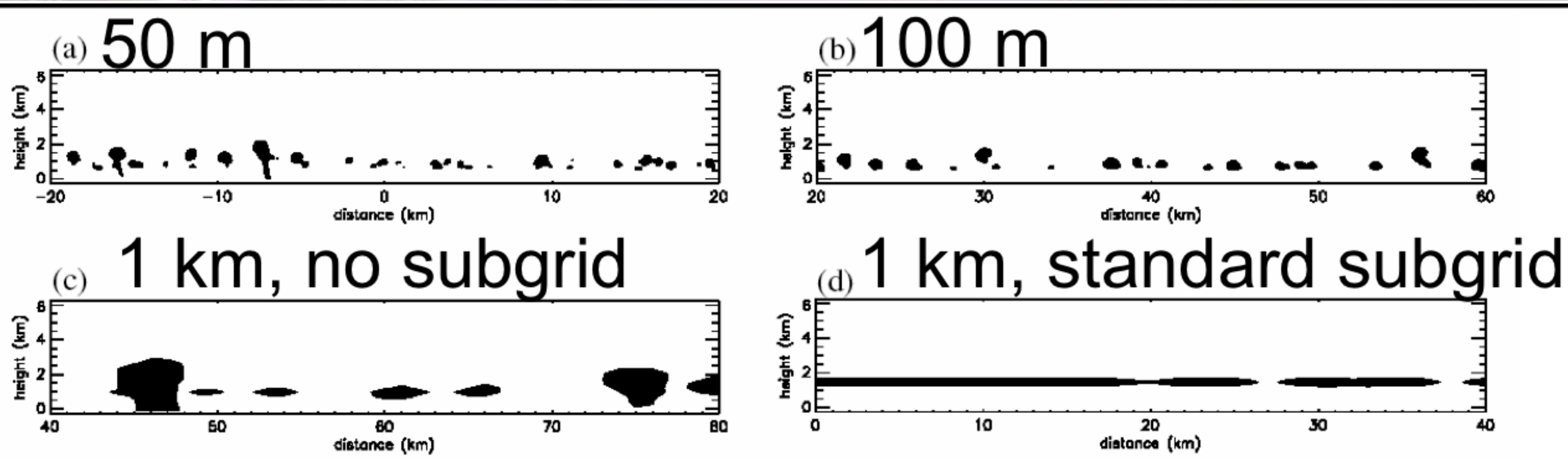


Figure 5. Shaded areas represent regions with a total hydrometeor mixing ratio greater than 0.05 g kg^{-1} at a time shortly after the first clouds have formed. Each run is focused on a 40 km region which is typical of the full domain. Results from 2D runs using a grid length of (a) 50 m, (b) 100 m, (c) 1 km and no subgrid mixing, and (d) 1 km and standard subgrid mixing.

Petch, 2006, Q.J.R.M.S 132, 345-358

P. Clark

Separate roles of horizontal and vertical mixing

Met Office

Vertical mixing in boundary layer promotes initiation

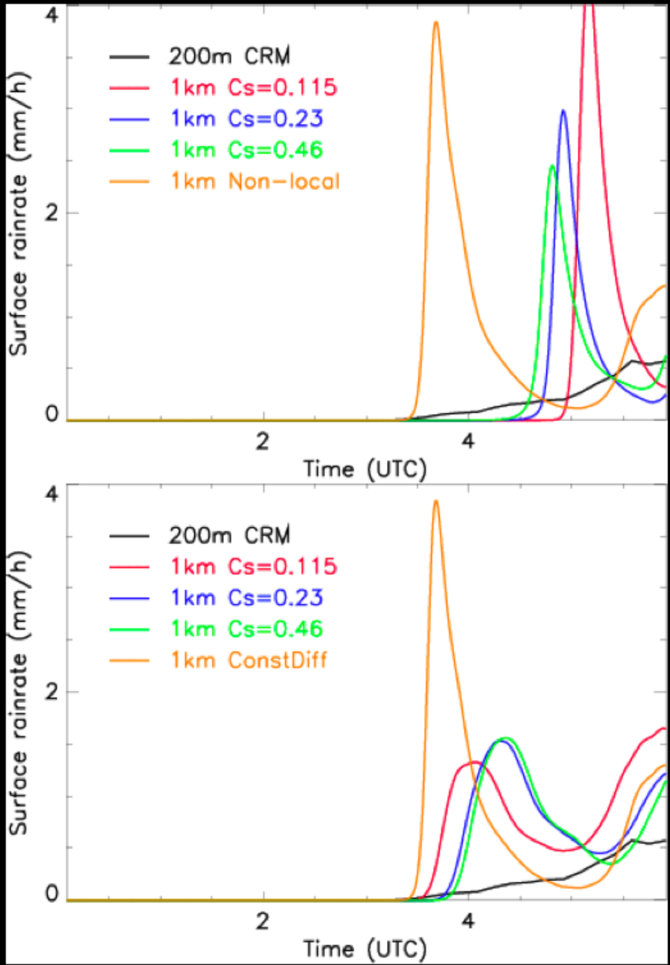
Horizontal mixing delays initiation but controls magnitude of deep clouds

Constant horizontal diffusion K=1430

Non-local boundary layer scheme in the vertical.

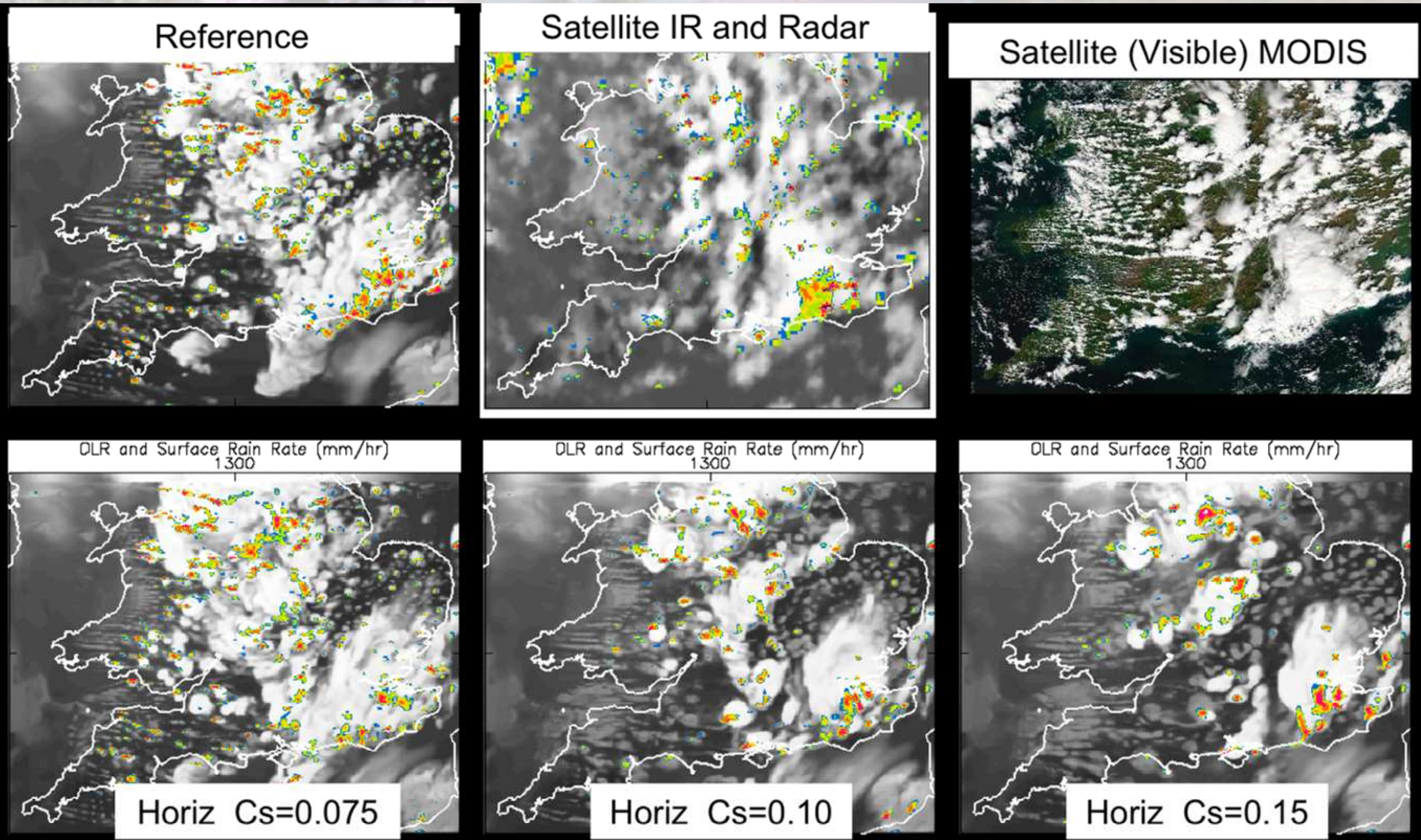
ConstDiff Coefficient: K=1430.

Max Diff for Cs runs: K=2086.



P. Clark

Transition to deep convection



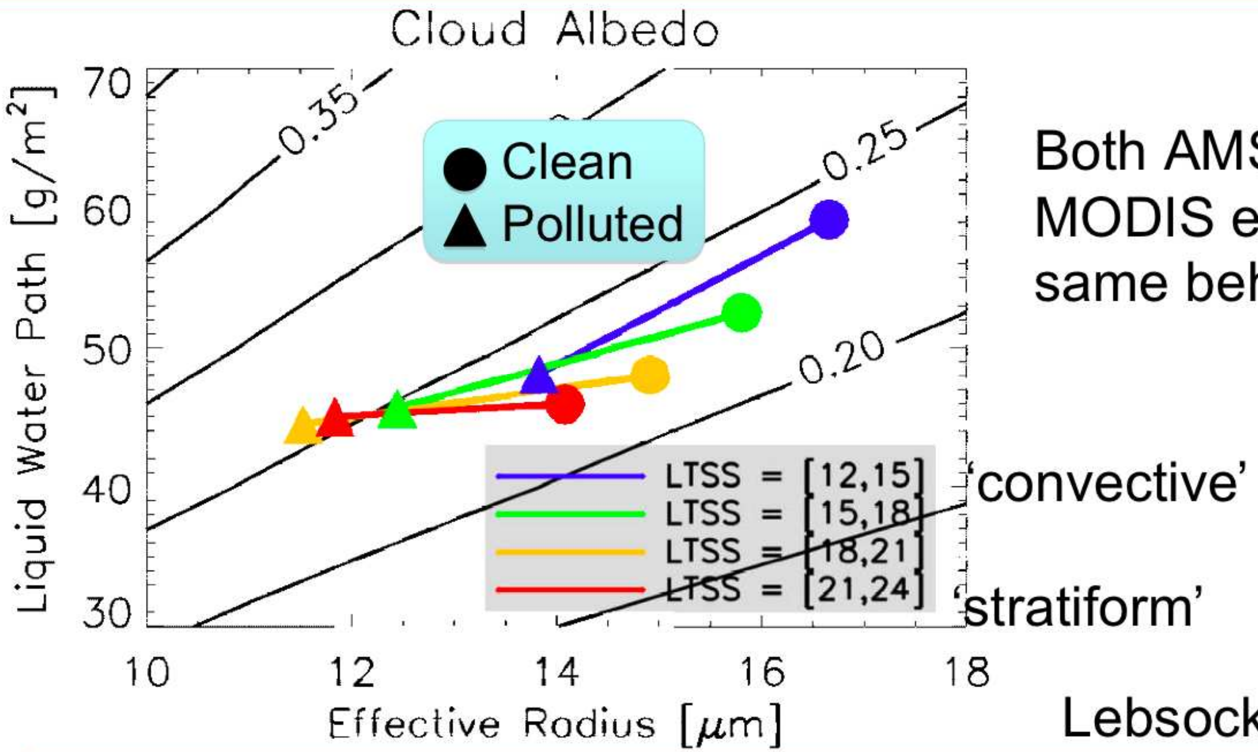
(Richard Forbes, Carol Halliwell) P Clark

Impact of aerosols

- How important is impact of aerosols on clouds and precipitation?
- Observation campaigns to try to estimate this impact (Longrex, Eucaari)
- Increasing aerosol number should decrease effective radius, increase number of droplets and albedo
- Satellite observations make validation possible

Impact of aerosols

Processes: aerosol effects on warm, non precipitating clouds



Both AMSR-E and MODIS exhibit the same behavior

G Stephens

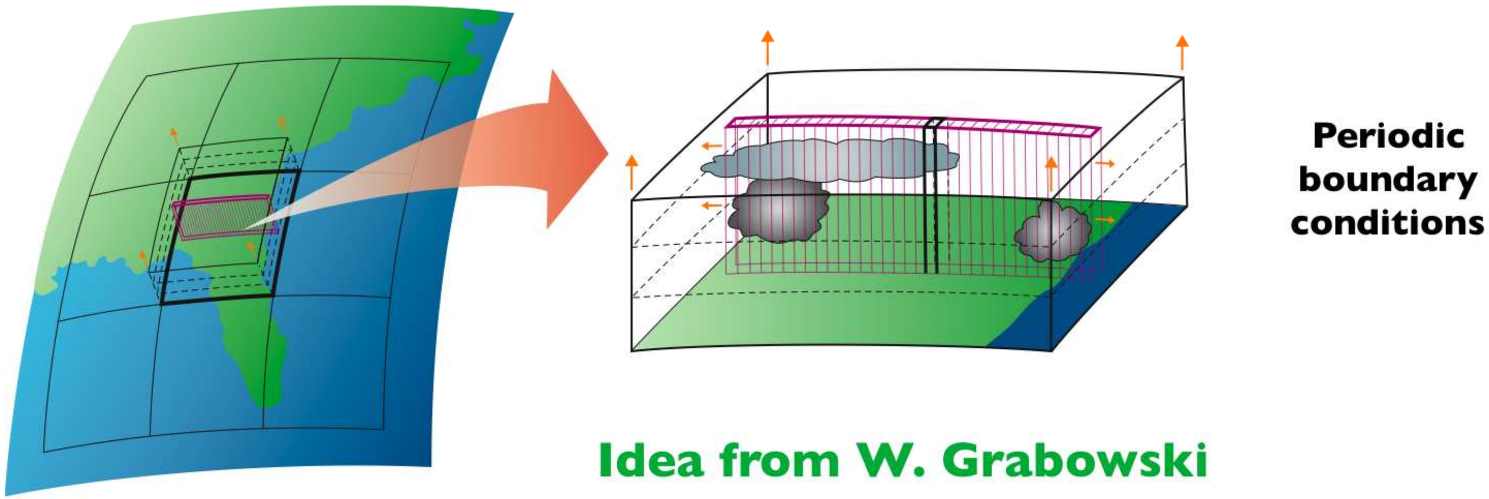
Lebsock et al., 2008

1. Stratiform clouds appear less susceptible to LWP reduction than are convective cloud

Super parameterization

- GCM, especially climate models, coarse resolution, depending heavily on param.
- GCRM 10^3 times more expensive than current models (e.g. ECMWF)
- Super parameterization runs high res. 2-D model in 3D grid box
- ‘Only’ 200 times more expensive than GCM, much cheaper than GCRM

The Multiscale Modeling Framework: A less costly alternative to GCRMs

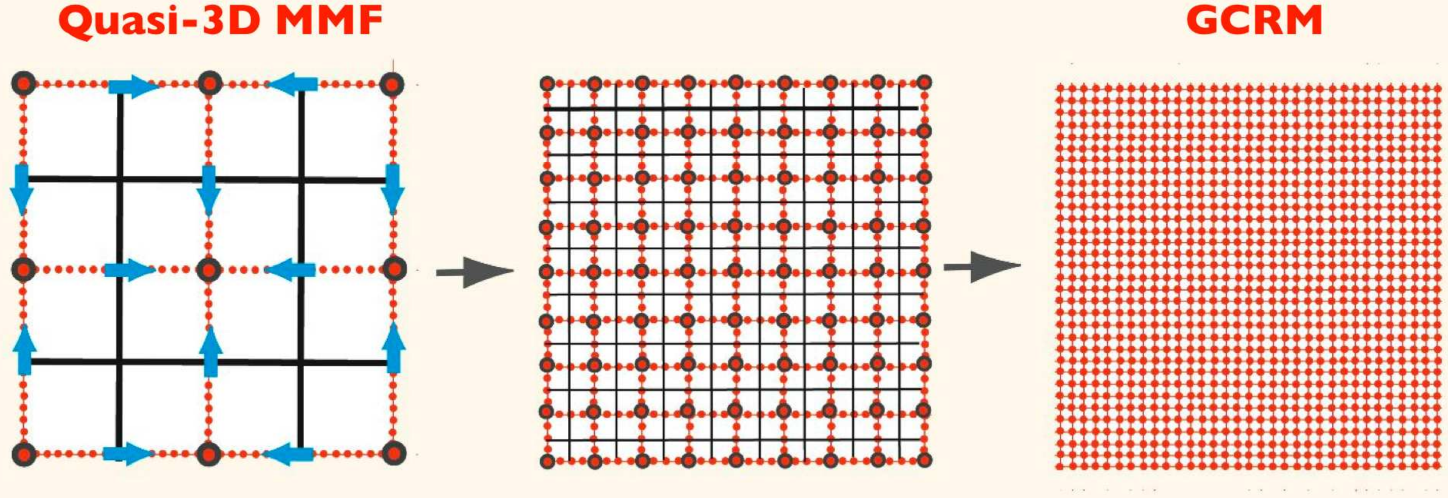


Idea from W. Grabowski

D. Randall

Super parameterization

Second-generation MMF



Convergence (in the mathematical sense):
Same equations, same code
Q3D MMF --> GCRM

D. Randall

Slide from Akio Arakawa

- Questions?

- Lunch!