



*ESRL Model development  
activities on Regional and  
Local-Scale*

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Jian-Wen Bao (PSD), Paul Schultz*



# *Outline*

- Physics developments for the Weather Research and Forecast (WRF) and the Rapid Update Cycle (RUC) modeling systems
- Coupled Modeling Systems
  - WRF/Chem
  - MM5/WRF and Ocean/Wave models
- Future Plans



# *Physics Development*

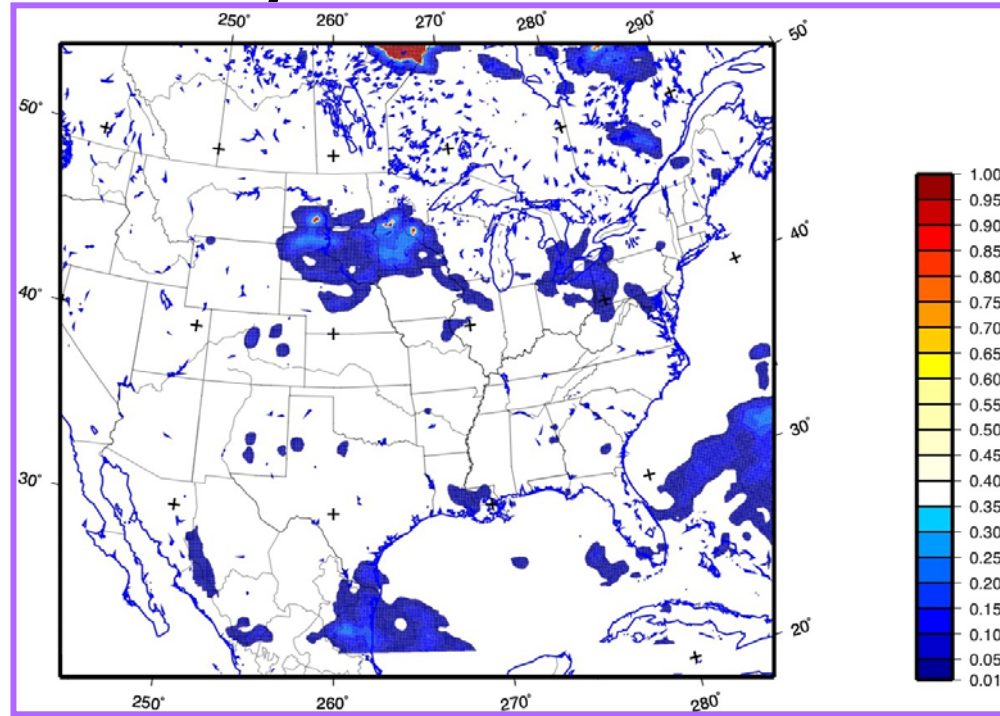
**Much of the physics development is related to the development of the RUC and Rapid Refresh (RR, will be using the WRF model), the backbone of high frequency aviation products – improving models for forecast applications**

**Physics development also plays a role for the research community – improving models for research applications**

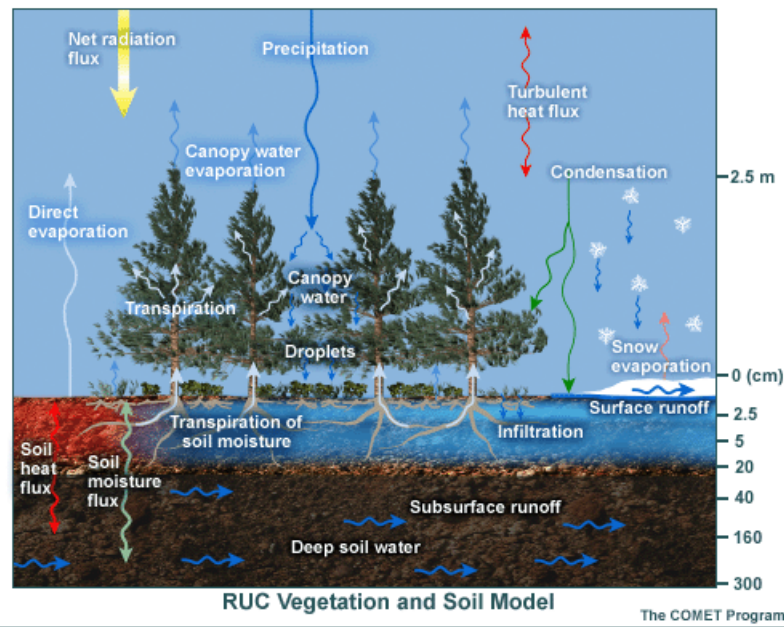


# Physics Development

Land Surface Modeling, (T. Smirnova)

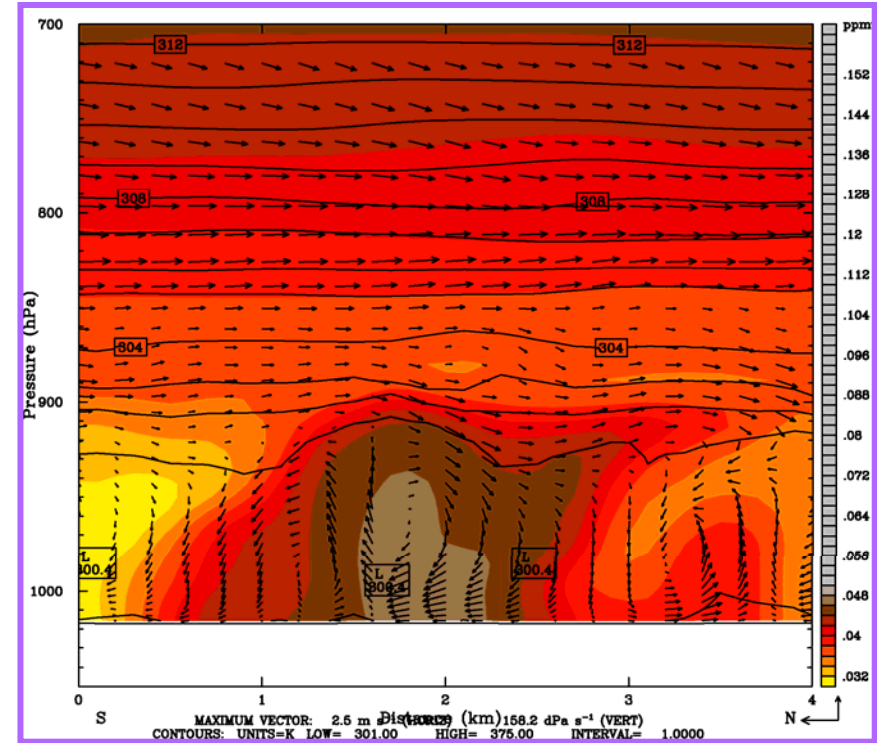


Probability distribution for heavy precipitation from Grell-Devenyi convective parameterization



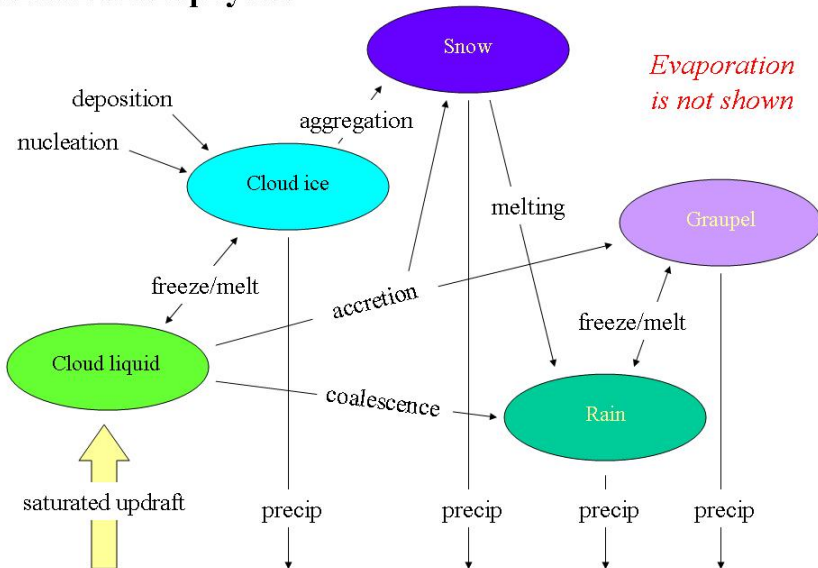
# Physics Development

Microphysics schemes (Paul Schultz, also work by Ami Solomon)



Boundary Layer parameterizations – Large Eddy simulation with WRF/Chem, (J-W. Bao and E. Grell, PSD)

## Schultz Microphysics



# *Physics Development: Posters*

- Poster on a comparison of different dynamic cores (different modeling approaches) using ESRL physics (Smirnova et al.)
- Poster on LES work (J-W Bao et al.)
- Poster on RR (Benjamin et al.)
- Poster on Schultz Microphysics (Schultz)

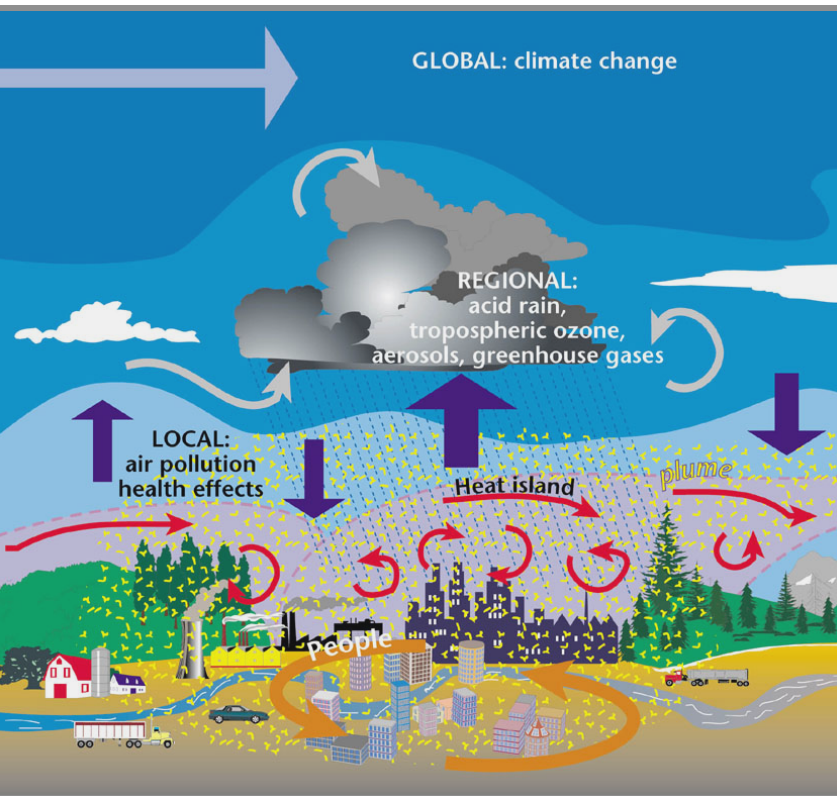
John Brown (GSD) leads WRF physics working group, W. Angevine (CSD) and J.-W. Bao (PSD) are members of Physics working group



*Coupled models: A modeling  
challenge with increasing  
importance*



# *Why do we couple models?*



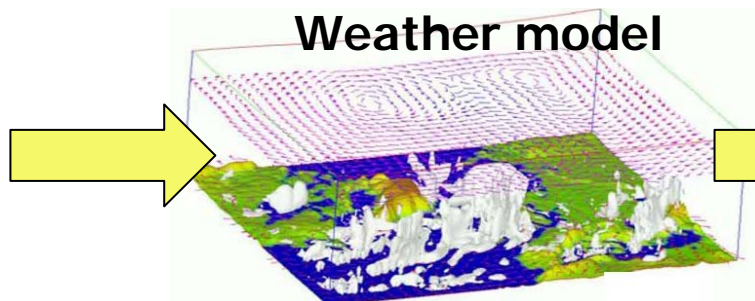
Many of today's environmental challenges depend on complex interactions of various processes. The modeling of these processes has evolved into separate disciplines, resulting in many different type of models that are only loosely related (the models! Not the real world!). Only recently has it become clear that the interactions of these processes are important : Couple different modeling system to develop ***Earth System Models***





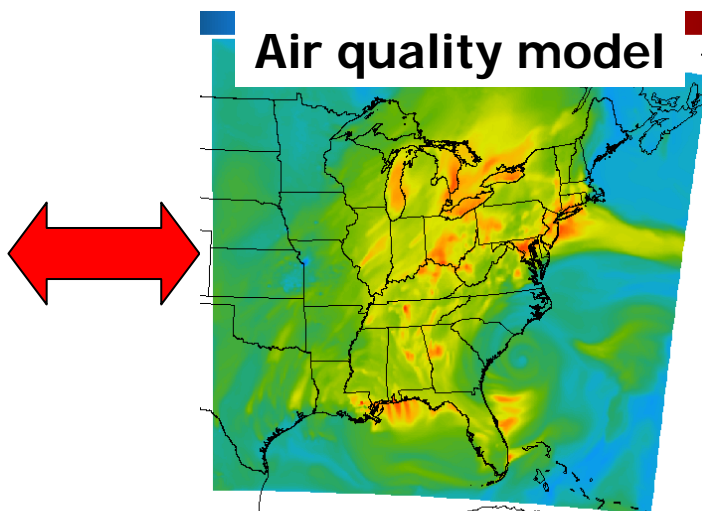
# Air Quality Forecasting: The commonly used approach ("offline")

Weather Data  
Analysis &  
Assimilation



Weather-Forecast

Biogenic and  
Anthropogenic  
emissions



AQ-Forecast

1Hr Avg Ozone Concentration(PPB) Ending Tue Sep 13 2005 4PM EDT  
(Tue Sep 13 2005 20Z)  
National Digital Guidance Database  
12z model run Graphic created-Sep 13 1:22PM EDT

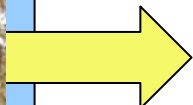
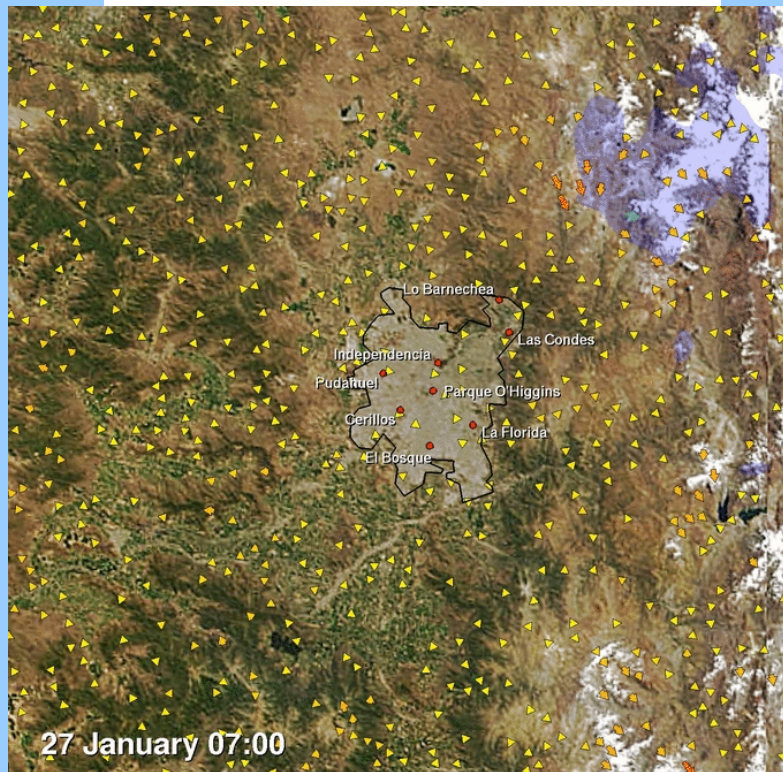
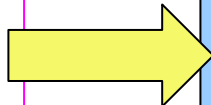
Removal modules



# *WRF/Chem: Online coupling of modeling systems*

Simultaneous forecast  
of weather and air  
quality

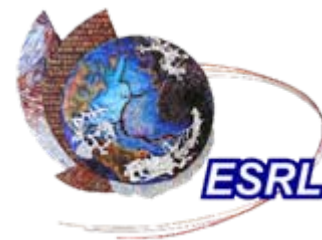
Weather Data  
Analysis &  
Assimilation &  
Emissions



Weather and  
AQ-Forecast

Chemistry, Aerosols,  
radiation, clouds,  
temperature, winds

Full interaction of meteorology and chemistry



# *WRF/Chem: widely used nationally and internationally, development led by ESRL*

- Includes aerosol direct and indirect effect,
- Multiple aerosol models
- Automatic generation of chemical mechanisms (the part of the model that treats the interactions of the chemical species with each other),
- **Global** to local scale (Large Eddy Simulation) applications, 1- and 2-way nesting capabilities,
- **Coupled with a sophisticated fire plume model**

See also poster, and <http://www.wrf-model.org/WG11>

Georg Grell leads WRF chemistry working group, Stuart McKeen (CSD) is a member

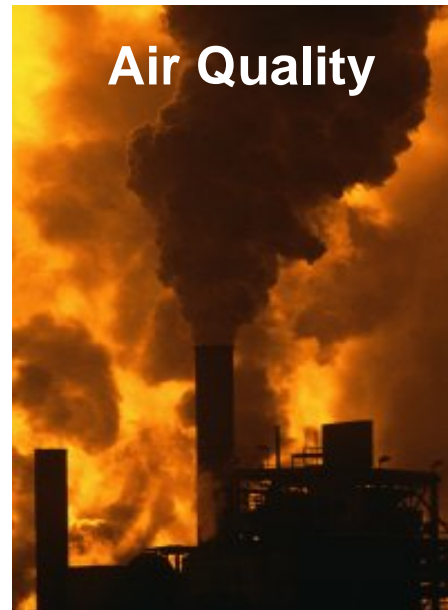


# *Current possible applications of WRF/Chem*

**Weather**



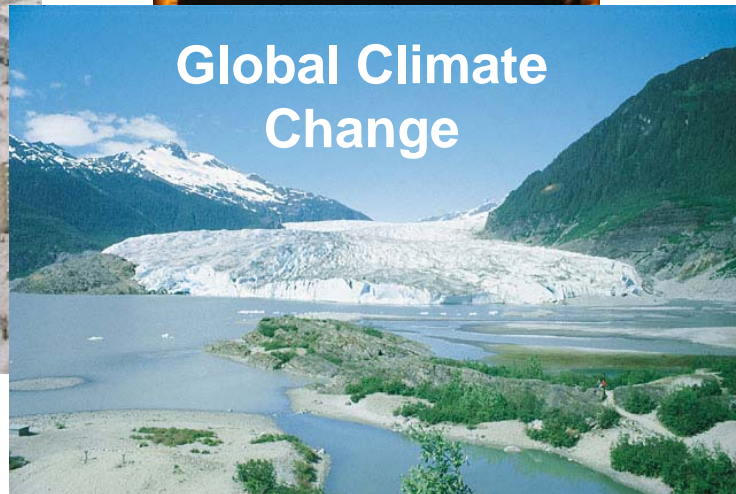
**Air Quality**



**Hazardous  
Release**



**Global Climate  
Change**



# *Coupled models: A modeling challenge with increasing importance*

- Other previous work related to Penn State NCAR Mesoscale Model Version 5 (MM5)
- Couple MM5 – Ocean model – Wave model (J.-W. Bao)
- Coupled MM5-Chemistry (Grell et al)



