Introducing the Multi-Scale Kain-Fritsch scheme to the Model for Prediction Across Scales

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Background

- Clouds are critical players in the earth’s climate system
  - Impact radiation balance, surface temperatures, and precipitation generation
  - Influence creation of stratospheric ozone
- Motivation:
  - Most mesoscale models neglect interaction between convective parameterization (CP) and radiation scheme
  - CP schemes have not been adapted for new variable-resolution model grids
- **Project Goal:** Test the performance of the scale-aware Multi-scale Kain-Fritsch (MSKF) CP scheme in the Model for Prediction Across Scales (MPAS)

Methods

- Multi-scale Kain-Fritsch (MSKF) CP scheme includes:
  - Dynamic adjustment timescale
  - Scale dependent entrainment effects
  - Sub-grid scale interactions between clouds and radiation, among other features
- Model for Prediction Across Scales (MPAS) v. 4.0
  - 15-60 km variable resolution mesh
  - Mesoscale reference physics suite:
    - WSM6 microphysics scheme
    - YSU planetary boundary layer scheme
    - RRTMG radiation schemes
    - Noah land-surface model
- CP scheme: MSKF and KF
- NCEP Climate Forecast System Reanalysis (CFSR)
  - 0.5° x 0.5° horizontal grid spacing
  - Used for initial conditions and surface update fields
- Simulation spanned 15 May 2006 – 14 August 2006
  - Conducted on DOE supercomputer Titan

Cloud Cover and Near-Surface Temperature

- Notable increases in cloud cover and using MSKF:
  - Along ITCZ
  - Over parts of southeast Asia
  - Along western coast of India
- General increase in cloud cover over CONUS with MSKF – especially in the NE
- Slight reductions in cloud cover over Gulf of Mexico and off northern CA coast
- Differences in near surface temperature consistent with differences in cloud cover

Precipitation

- Increases in precipitation with MSKF:
  - Along ITCZ
  - Over portions of SE Asia
  - Off west coast of India
- Differences in precipitation correlated with differences in cloud cover
  - Seasonal Average Precipitation (MSKF – KF)
  - Monthly Average Precipitation

Conclusions

- MSKF produces increased cloud cover and precipitation along ITCZ, south of China, and off west coast of India
- Structure of precipitation in MSKF more closely matches observations
- Over CONUS, MSKF results in more cloud cover and reduced 2-m temperature
- Discrepancy in precipitation patterns between KF and MSKF simulations needs to be investigated further

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