Recent Upgrades, Current Capabilities and Near-Term Plans of the NASA ARC Mars Climate Modeling Group

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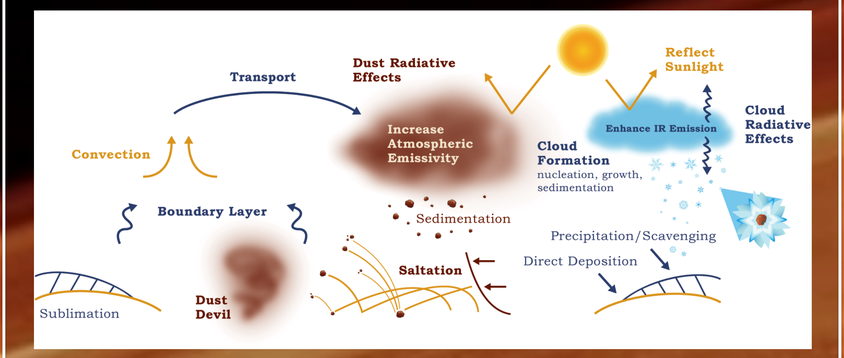
Recent Upgrades and Model Status

Modeling the Dust and Water Cycles on Mars

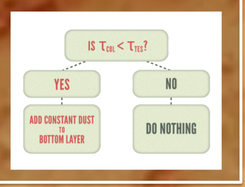


State-of-the-art Cloud Microphysics Scheme

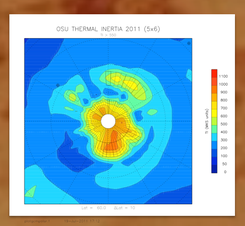
- 6 tracer moment scheme: log-normal distributions of dust & clouds
  - Dust mass, dust number, water vapor mass, water ice mass, water ice number, dust core mass
- Heterogeneous nucleation, growth, and sedimentation
- Scheme developed and implemented by Franck Montmessin (LATMOS)

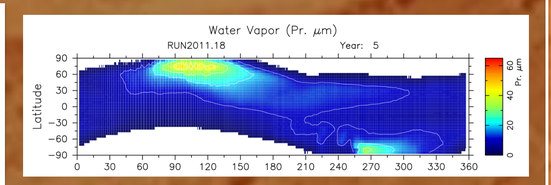
Dust Injection Schemes

1. Fully-Interactive Dust Cycle Modeling
   - Parameterized dust-lifting schemes in terms of surface stress and/or dust-devil flux (Kahre et al. [2006]; Kahre et al. [2008])
2. Dust Tracking (Assimilation)
   - MGS/TES opacity maps
   - Dust injected to "match" maps



Simulated Water Cycle

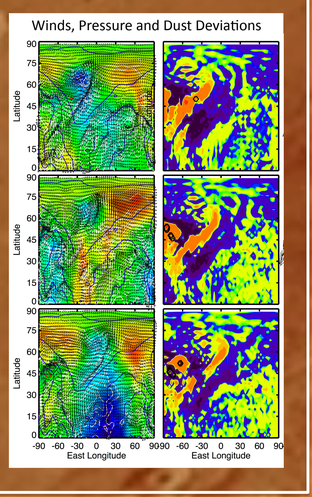




- Annual water cycle is well simulated with one source of water: the North Residual Cap
- Radiative effects of water ice clouds are significant
  - Warm low latitudes aloft
  - Cool polar regions down low
    - → Increases baroclinicity of the atmosphere and enhances eddy activity

Weather, Fronts, and the Simulated Dust Cycle

- A higher resolution version (2˚x3˚) of the Mars GCM can reasonably simulate key aspects of large-scale weather features observed on Mars
- Interactive dust lifting simulations suggest that dust is lifted by nocturnal down-slope flows on the Tharsis volcanoes, organized into the frontal convergence zone and transported eastward



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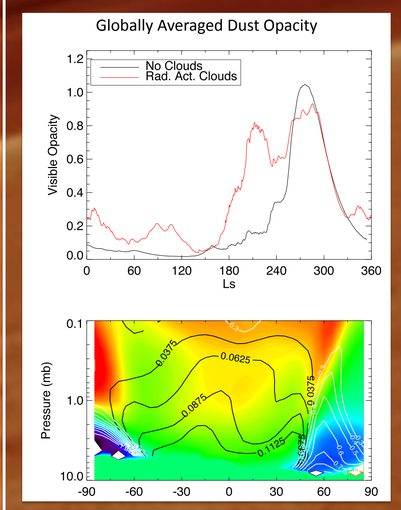
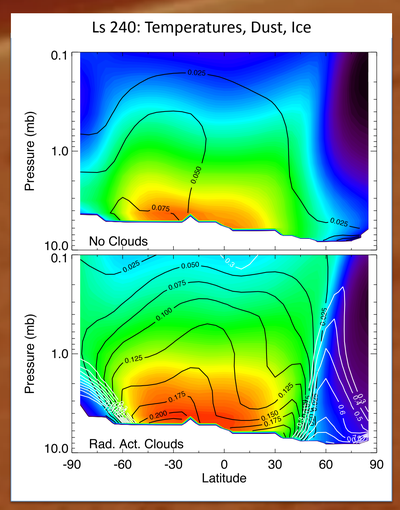
Recent Science Results

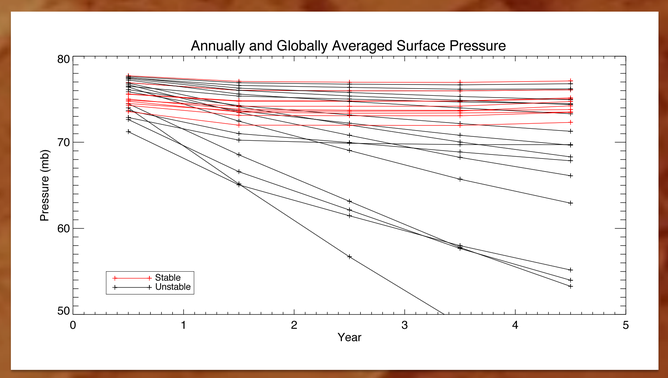
Present Mars: Coupling Dust and Water Cycles



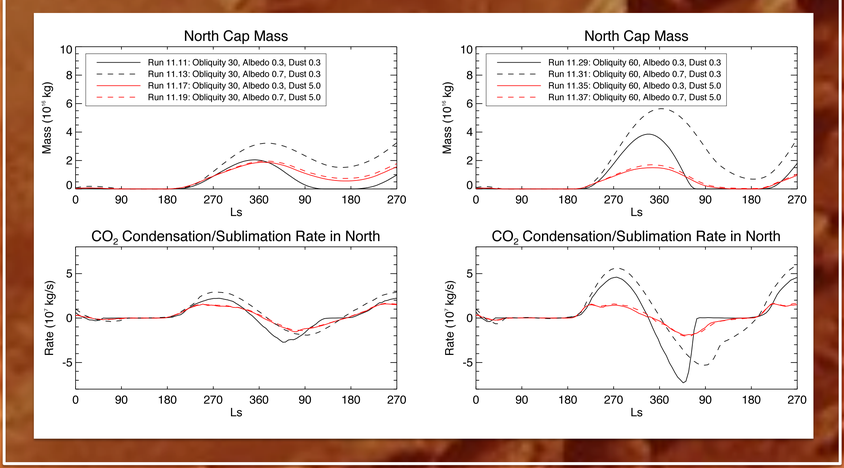


- Coupling dust and water cycles has a significant effect on the simulated dust cycle
- Increased lifting associated with transient eddies pre-solstice is more realistic
- A positive feedback loop is hypothesized between dust lifting, cloud formation and transient eddy amplification

Early Mars: Can an active dust cycle help stabilize 80 mb atmospheres?



- 80 mbar CO_2 atmospheres are difficult to maintain. Of the 36 simulations conducted, only 10 resulted in a stable atmosphere (i.e., permanent CO_2 ice caps did not form)
- Increasing the dust loading can either accelerate or decelerate atmospheric collapse, depending on the CO_2 ice cap albedo. Increased atmospheric dust only stabilizes the atmosphere at very high obliquity



Acknowledgements

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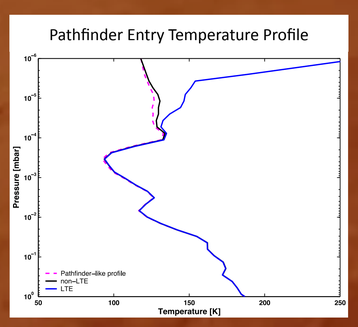
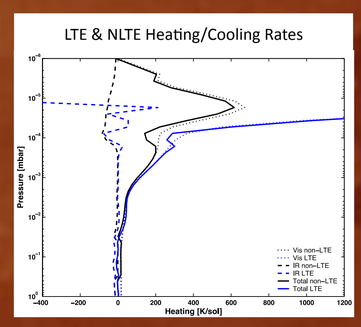
Near-Term Plans

Model Improvements in Progress

1. Raise model top and include NLTE
   (Amanda Brecht, NASA Postdoctoral Program at ARC)

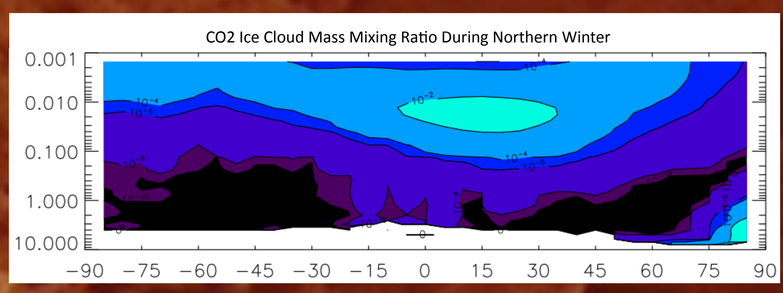
- Implement visible / IR corrections for non-LTE
  - Lopez-Valverde et al., 1998





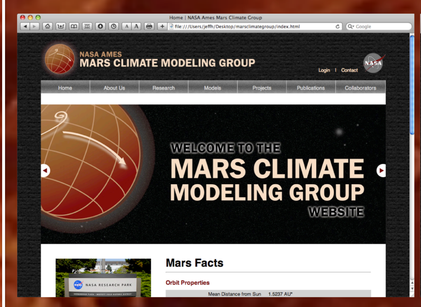
2. Adapt microphysics package for CO_2 ice clouds

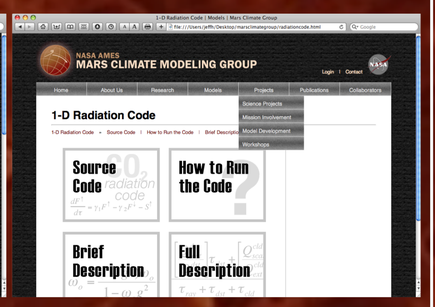
- Use H_20 microphysics code architecture
- Modify parameters for CO_2:
  - Diffusion Coefficient (Self Diffusion)
  - Constants
- Compare nucleation rates & growth rates to published values
- First results:



New Website Now Online!

http://spacescience.arc.nasa.gov/mars-climate-modeling-group





Physics package now available: Radiation Code

- Generalized 2-Stream Solution to RT Equation
- Gaseous Opacities for CO_2 and H_2O from Correlated-ks
- User Specified Dust and Cloud Optical Properties
- Flexible Spectral Bands