Cloud-Aerosol-Precipitation Interactions

Steven Ghan
Pacific Northwest National Laboratory
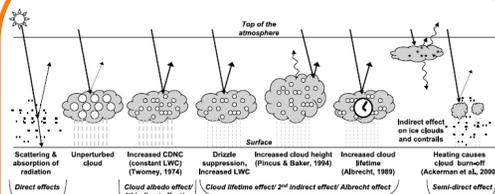
David Turner
University of Wisconsin

Robert Wood
University of Washington

Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by *Battelle* Since 1965
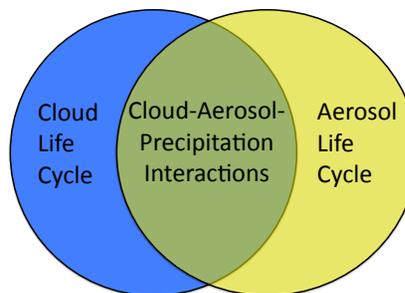
Aerosol Effects on Clouds

True-color image of northeastern Atlantic from MODIS Aqua on January 27, 2003
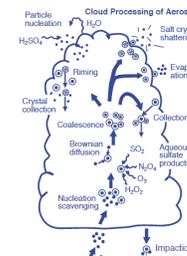
What needs to be done for aerosol effects on cloud?
- Use single particle composition measurements to determine dependence of activation on mixing state.
- Improve understanding of influence of entrainment on activation and liquid water content.
- Develop and test models of aerosol effects on shallow and deep cumulus clouds.
- Use field and modeling studies to determine conditions when aerosol influence on cloud can be distinguished from other factors
- Use laboratory and field studies to improve understanding and test physically-based models of anthropogenic aerosol effects on ice nucleation.
- Develop and evaluate models of ice supersaturation.
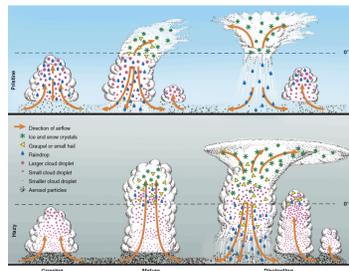
The Intersection of Cloud and Aerosol Life Cycles

Aerosol Effects on Precipitation

What needs to be done for aerosol effects on precipitation?
- Characterize aerosol, including absorption and giant CCN, below a variety of cloud systems in a variety of aerosol regimes.
- Measure updraft velocity and cloud droplet, drizzle and rain size distributions.
- Use the updraft and cloud and precipitation measurements to evaluate multiscale simulations given the measured aerosol properties.
- Use sensitivity experiments to separate effects of absorption from effects of activation on precipitation from the clouds.

Cloud and Precipitation Effects on Aerosol

What needs to be done for cloud effects on aerosol?
- Compare simulations of cloud-aerosol interactions with aerosol column budget measurements for deep convective cases.
- Evaluate global simulations with active remote sensing of aerosol.

Cloud-Aerosol-Precipitation Interactions

What needs to be done for cloud-aerosol-precipitation interactions?
- Analyze VOCALS *in situ* data and Azores AMF data to characterize breakup of stratocumulus.
- Use VOCALS and Azores data to evaluate cloud-resolving simulations with fully interactive clouds and aerosol.
- Perform sensitivity experiments to improve understanding of the breakup mechanism.