# Cloud Effects on Aerosols Breakout

GASS GEWEX WCRP Global Atmospheric System Studies

# 1st Pan-GASS Conference

**10-14 September 2012**
**Boulder, Colorado, USA**

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The **1st Pan-GASS Meeting** will take place 10-14 September 2012 in Boulder Colorado, USA. The meeting will focus on observing, understanding and modelling atmospheric physical processes. Topics will include:

- Progress in Representing Atmospheric Processes in Weather and Climate Models
- Stable Boundary Layers
- Radiation Modelling in Weather and Climate Models
- Land-Atmosphere Interactions
- High-Resolution Modeling, the Gray-Zone, and Stochastic Physics
- Boundary Layer Cloud Processes and Feedbacks (including CGILS)
- New Observations and Recent Field Campaigns
- Cloud Microphysics, Precipitation, and the Interactions of Clouds and Aerosols
- Polar Cloud Processes
- The Large-Scale Organization of Tropical Moist Convection.

The meeting will be held jointly with GEWEX Global Land/Atmosphere System Study (GLASS) Panel and the Madden-Julian Oscillation Task Force. Active projects will have specific break out sessions.

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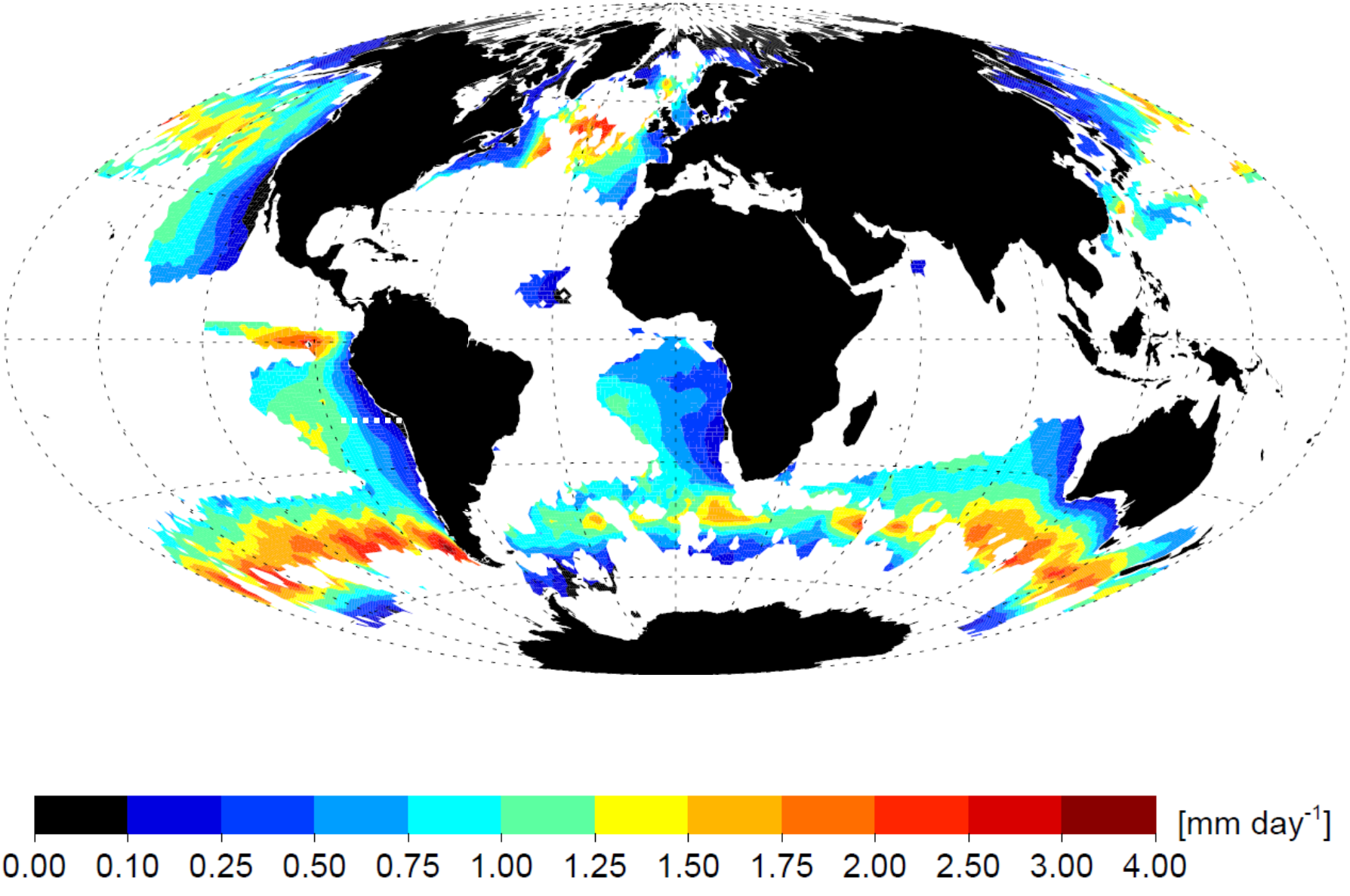
# Cloud effects on aerosol: The challenges

- Clouds exert major influences on the physical, chemical and optical properties of aerosols.
  - a large fraction of aerosol mass (including possibly SOA) is produced in clouds via aqueous phase processes. Many of these processes are not well understood and represented in models.
- Clouds, via precipitation formation, are the primary sink for cloud condensation nuclei and a major sink of nucleation mode aerosol
  - true even in environments with very low precipitation rates, e.g. marine stratocumulus. The effects on aerosols are not well quantified globally and obfuscate conclusions drawn from aerosol-cloud correlative studies
- The presence of clouds makes it challenging to learn about aerosol properties via remote sensing
  - clouds exist in anomalously humid microenvironments and aerosol radiative properties close to them will differ from those at far-field. Poses challenges for interpretation of aerosol-cloud property correlations.

# Mean precipitation rate (CloudSat, 2C-PRECIP-COLUMN, Stratocumulus regions)



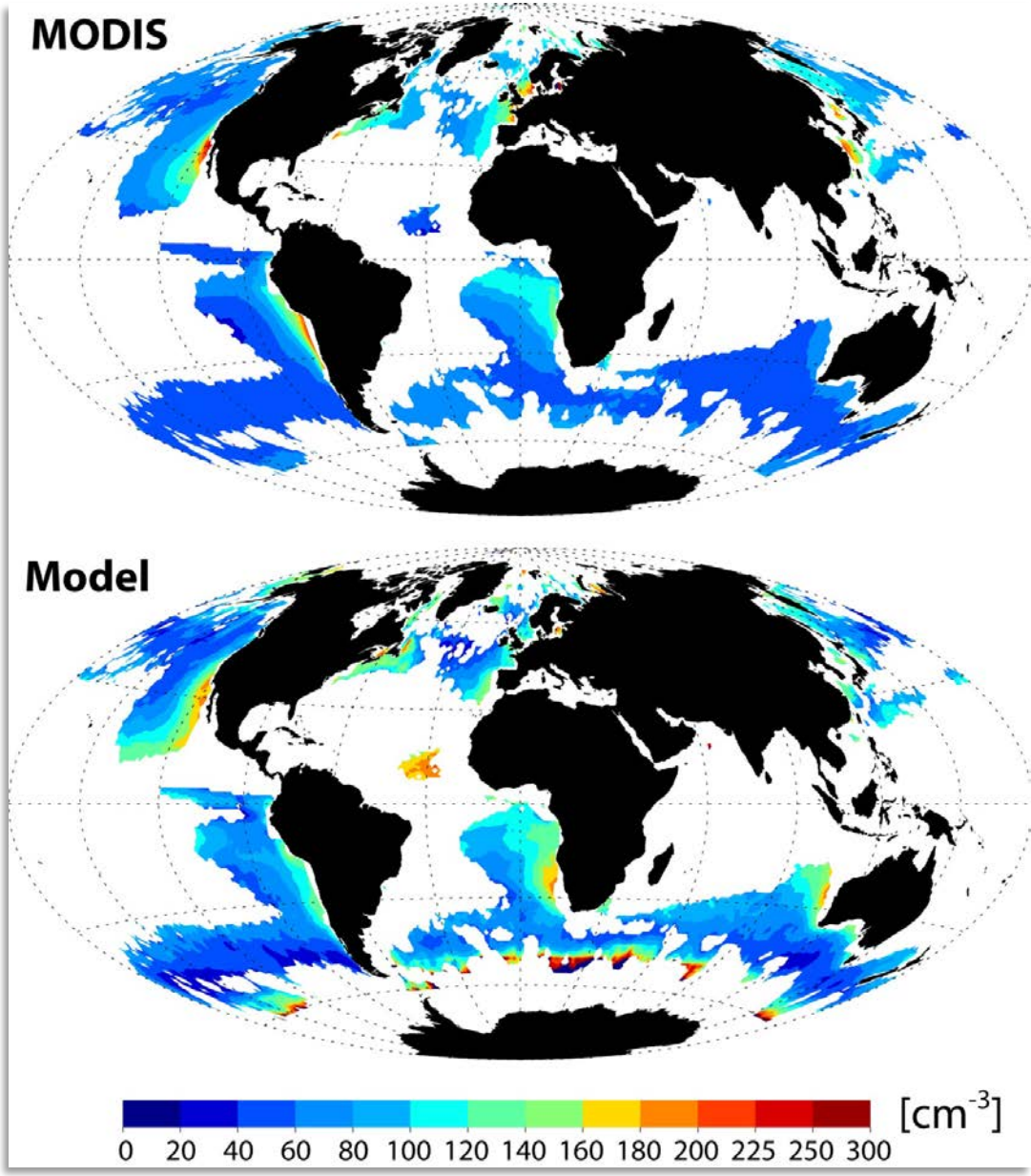
# What controls $N_d$?

• **Simple** budget model for CCN/$N_d$ in the MBL:

$$\dot{N} = [\dot{N}]_{ent} + [\dot{N}]_{sfc} + [\dot{N}]_{coal}$$

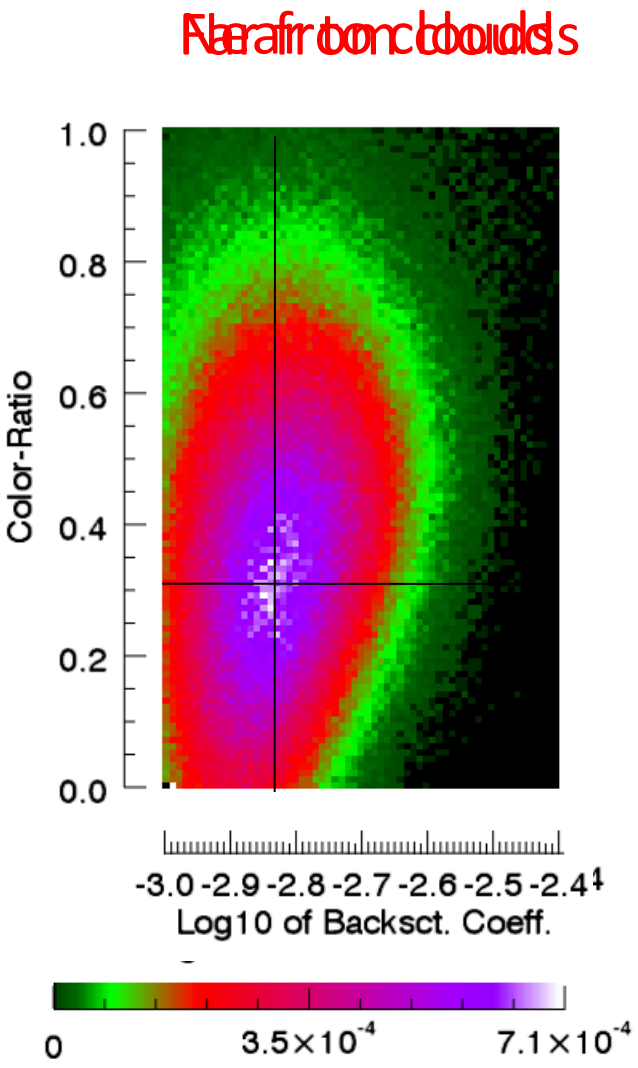
$$N_{eq} = \frac{\left(N_{FT} + \frac{\beta U_{10}^{3.41}}{Dz_i}\right)}{\left(1 + \frac{hkP_{CB}}{Dz_i}\right)}$$

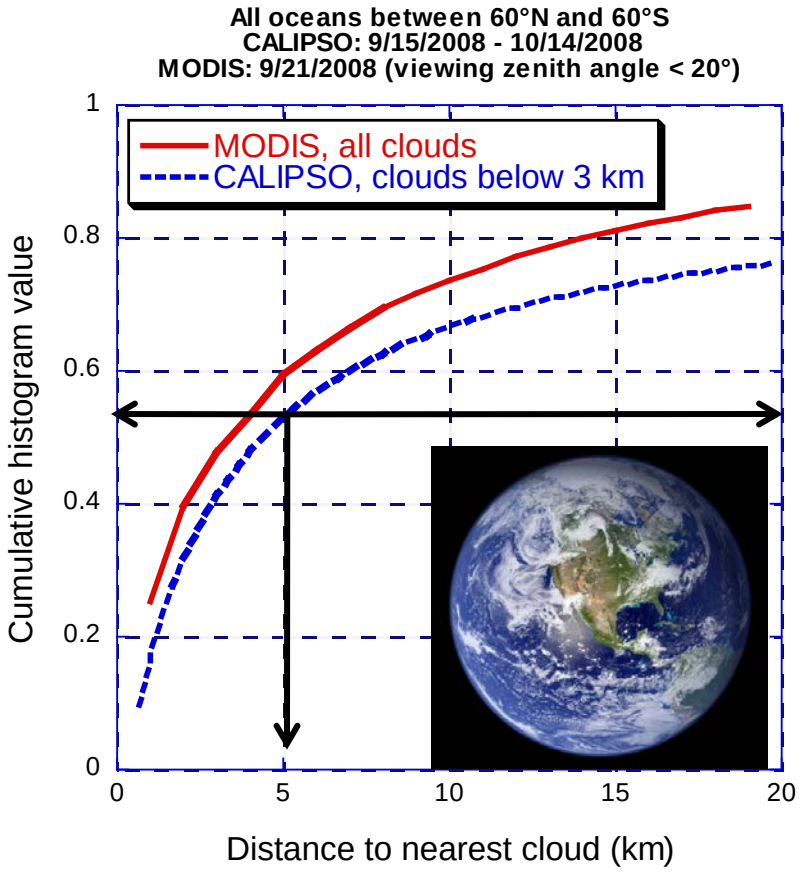
• Assume aerosol sources constant (here represented by FT concentration "buffer")
• Model pattern almost entirely driven by precipitation sinks
• Can reproduce significant amount of variance in $N_d$ over oceans ⇒ implications for significance of AOD vs $r_e$ relation ships




Wood et al. (2011)

# Cloud impacts on aerosol remote sensing




from **MODIS**: 60% of all clear sky pixels are located 5 km or less from all clouds

from **CALIPSO**: 50% of all clear sky pixels are located 5 km or less from low clouds

# Cloud effects on aerosol: ASR Opportunities

- In-situ observations
  - state-of-the-art physicochemical aerosol measurement technology within ASR program to examine chemical and physical signatures of cloud processing
  - Airborne platforms, new CVI on G-1.
- Remote sensing
  - ARM remote sensing Facilities (e.g. new HSRLs) provide remote sensing data on the cloud-clear sky boundary at much higher spatial resolution than is typically available from space
  - Precipitation radars can help quantify aerosol loss rates in a variety of environments
- Modeling
  - Process scale modeling to examine aerosol processing rates in clouds (e.g. explicit microphysics LES coupled with chemistry)
  - WRF-Chem, CAM, and MMF models for regional and global assessment

# Presentations

- **Hugh Morrison** – *Case #1 of the 8th WMO Cloud Modeling Workshop: CCN processing by a drizzling stratocumulus* (on behalf of Wojciech Grabowski and Lulin Xue)
- **Bruce Albrecht** – *Analysis of 2010 CIRPAS Twin Otter flights from Barbados to study clean air at cloud edges*
- **Mikhail Ovchinnikov** – *Modeling aerosol processing by clouds: goals, approaches, and challenges* (Ovchinnikov and Easter)
- **Larry Berg** – *TBD*.
- **Larry Berg** – *Aerosol and Cloud Predictions in WRF-Chem During VOCALS-REx* (paper by Qing Yang et al.)
- **Rob Wood** – *CALIPSO observations on aerosol properties near clouds* (on Behalf of Alexander Marshak)
- **Alexander Khain –** Role of in-cloud nucleation on cloud micro-structure