Convective-Stratiform-Anvil Transition (CStAT)

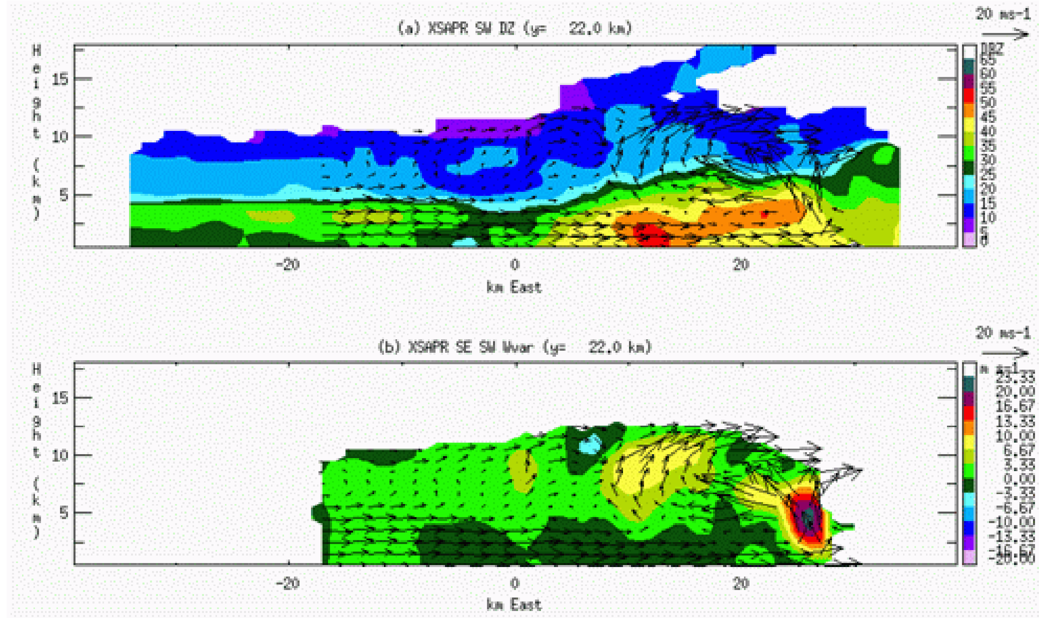
- Science questions
  - What are relative roles of LS conditions, aerosol, wind shear, small scale variability in determining structure morphological and microphysical properties?
  - What are most relevant properties models should reproduce to predict the convective lifecycle structure-wise? To what degree of accuracy?
  - How do errors in model microphysics, radiative and latent heating affect prediction of LS circulation?
- Objectives
  - Develop important observational targets for CRM, GCM, SCM
  - Identify (i) key differences in structural, microphysical properties of structures across models and observations, (ii) processes responsible for differences
  - Identify key measurements, retrievals, techniques (e.g., model simulators) needed to make progress

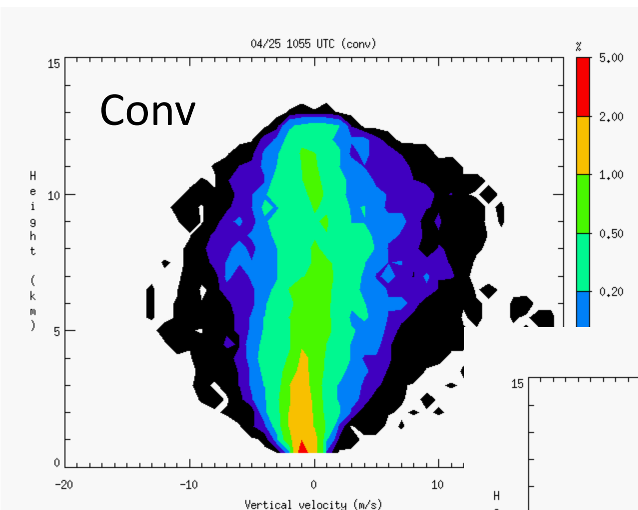
CStAT STM Breakout • 3/13/12

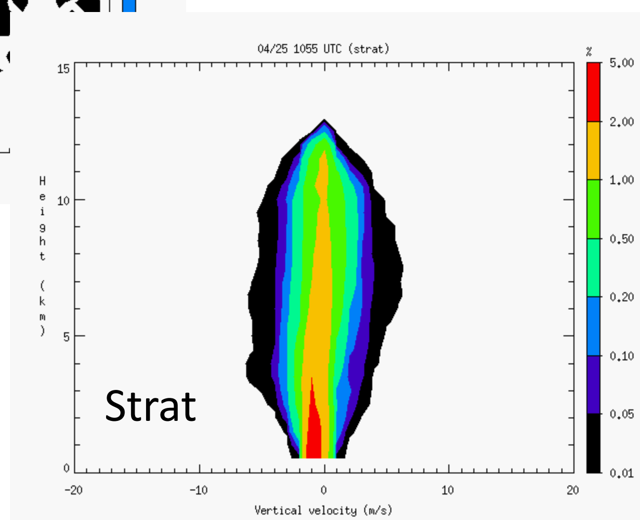
- Schumacher—Profiler observations of vertical velocity in convective, stratiform and anvil cloud over Darwin (demonstrate an elevated peak in convective vertical velocity at circa 8 km)
- Varble—The challenge of adequately representing deep convective dynamics, bulk microphysics, and their interaction in CRM and LAM simulations (includes simply identifying adequate spatial resolution)
- Rowe—Analysis of X-SAPR and C-SAPR data from MC3E
- Scott Collis—Forecast for MC3E and AMIE radar products

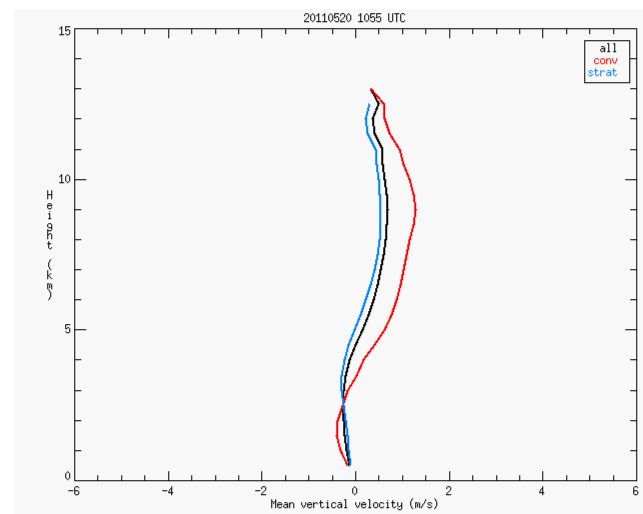
Vertical Velocity

- From dual-Doppler synthesis
  - XSAPRs – SW and SE
- Example from 20 May 2011 shows reasonable vertical velocities for both convective and trailing stratiform regions





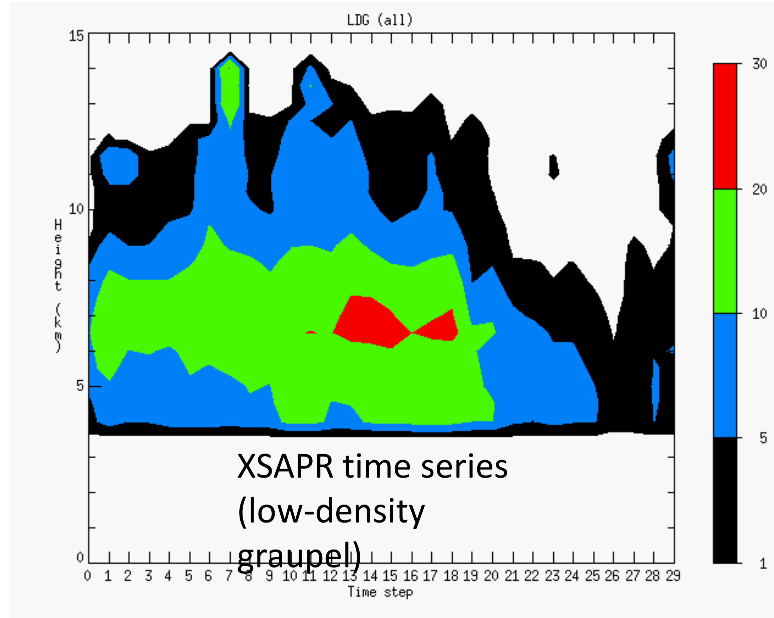


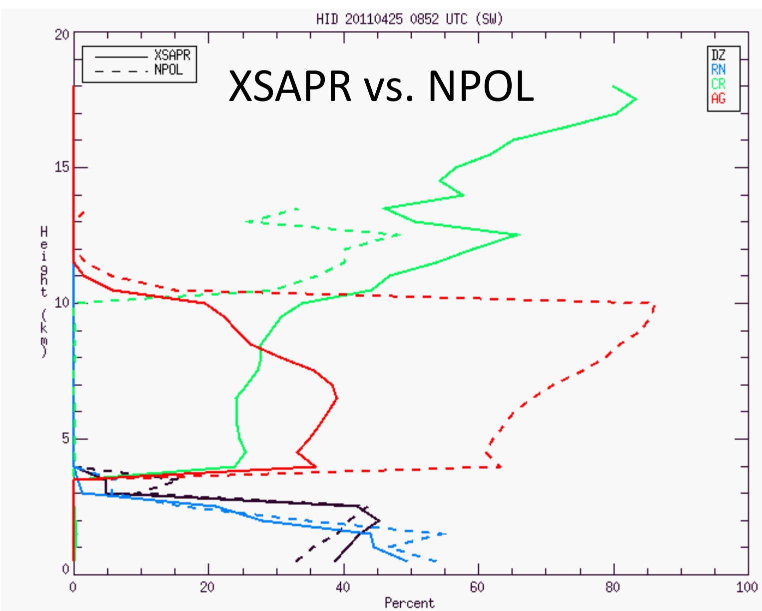


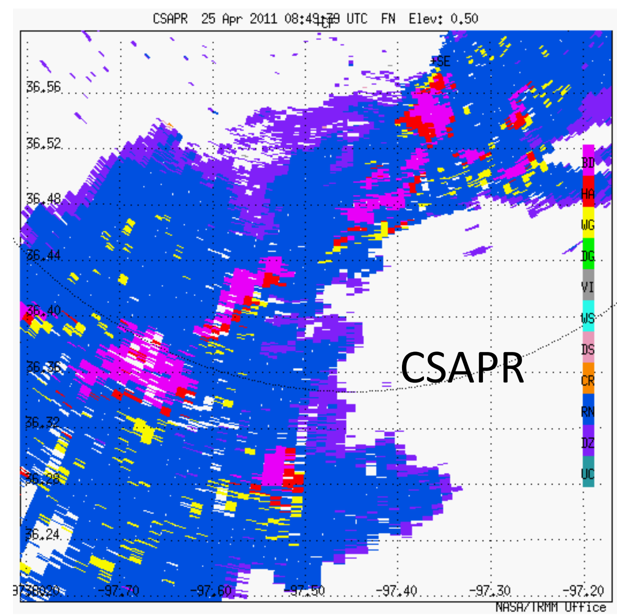
Source: Angela Rowe

Hydrometeor Identification

- Method for X-band based on Dolan and Rutledge (2009)
  - Modified to include hail, wet snow, and big drops
- Will use CSAPR data to create a dual-wavelength product
  - Greater sensitivity to phase shift at X-band (ice crystals, winter systems)

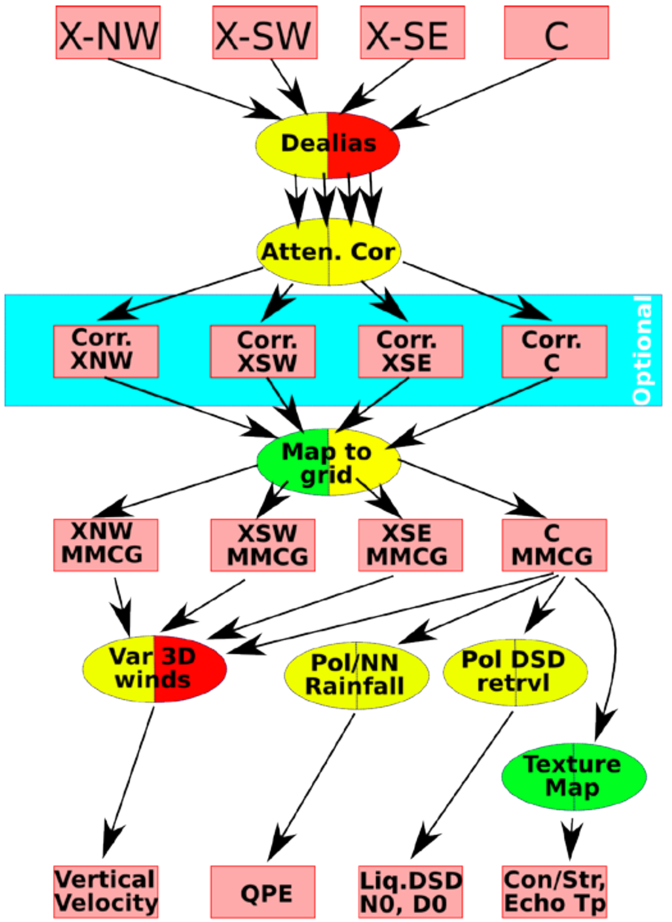


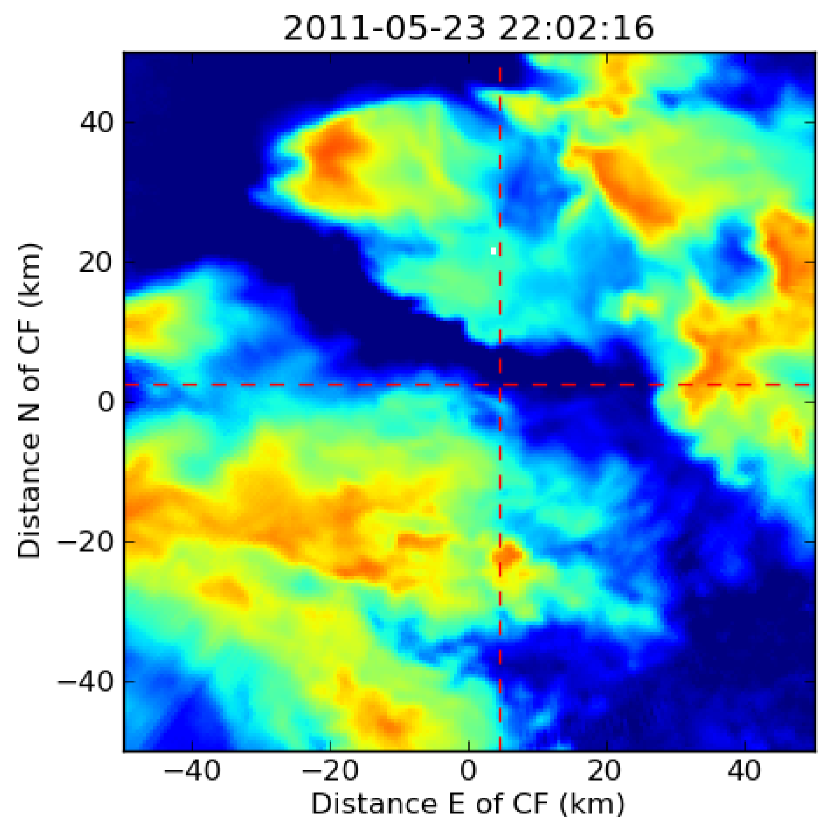




Source: Angela Rowe

State of precipitation radar VAPs related to CStAT





Var 3D winds: Variational 3D wind retrievals

Pol DSD retrvl: Polarimetric Drop size retrieval in warm rain

Pol/NN Rainfall: Polarimetric or Neural Network based rainfall retrieval

Texture Map: Stiener based convective stratiform classification. echo top detection

Map to grid: Balltree based Barnes filter

Dealias: U Washington 4DD velocity unfolding

Atten. Cor: PhiDP based attenuation and differential attenuation correction.

- Easy, Algorithm essentially done
- Moderate development work required
- Significant development work required, or further science needed.

CStAT STM Breakout • 3/13/12

- Tianle Yuan—Combining ASR obs and modeling: what can be done for CStAT?
- Christopher Williams—Developing an ARM simulator
- Alain Protat—What the BOM can contribute

Suggested approaches

1. Develop obs-based metrics for cloud life cycle and cloud macrophysical properties
2. Build statistics of these metrics and characterize meteorological regimes
3. Model-based simulator output and the same set of metric and environmental conditions
4. In-depth analysis of cases based on ground (esp. newly available radars) obs
5. Evaluate and identify critical processes and regimes from analyses of obs and model

Source: Tianle Yuan

CStAT: Develop a Single Column Model-to-Radar "Translator"

Method

Phase I – Generate a Library of Single Particle Electromagnetic (EM) Scattering Tables

- EM scattering table describes how EM wave interacts with a single particle
- Scattering depends on many factors:
  - Mie vs. T-Matrix code, operating freq., habit(liquid, mixed, solid), a/b ratio, view angle, etc.
- One EM scattering table is constructed for each combination of factors
  - 1. T-Matrix, liquid drops, Thurai & Bringi (2005) a/b ratio, 90° view angle, 5° canting, 20°C
  - 2. T-Matrix, liquid drops, Thurai & Bringi (2005) a/b ratio, 90° view angle, 5° canting, 15°C
  - 3. …
- Each row of the EM scattering table corresponds to an equivalent melted diameter
- Each column of the EM scattering corresponds to an output:
  - Radar backscattering cross section, σ_b (mm^2)
  - Scattering cross section, σ_s (mm^2)
  - Extinction cross section, σ_e (mm^2)
  - Asymmetry factor, g (dimensionless)
- CStAT does not generate EM scattering tables
  - Find experts already making these complicated calculations
- CStAT creates a library of EM scattering look-up tables
  - Anyone can contribute to this library

Phase II – Develop Modules that Translate Simulated Hydrometeor Distributions into an Integrated Radar Observables

- Uses individual particle EM scattering table to generate integrated radar observations

Source: Christopher Williams

Inputs from CAWCR

From scanning weather radars (CPOL, CSAPR)

Convective / Stratiform separation, area, fraction, rainfall
Large-scale atmospheric regime (for Darwin) to further bin the data
Hydrometeor classification in convective and stratiform
DSD properties (Nw, Do) and composite analysis of their variability
Convective cell volume, speed, lifetime, occurrence (for Darwin) in LS regimes
3D dynamics and mean advection speed of convective systems
(soon) 3D water content
Diurnal cycle of the above properties

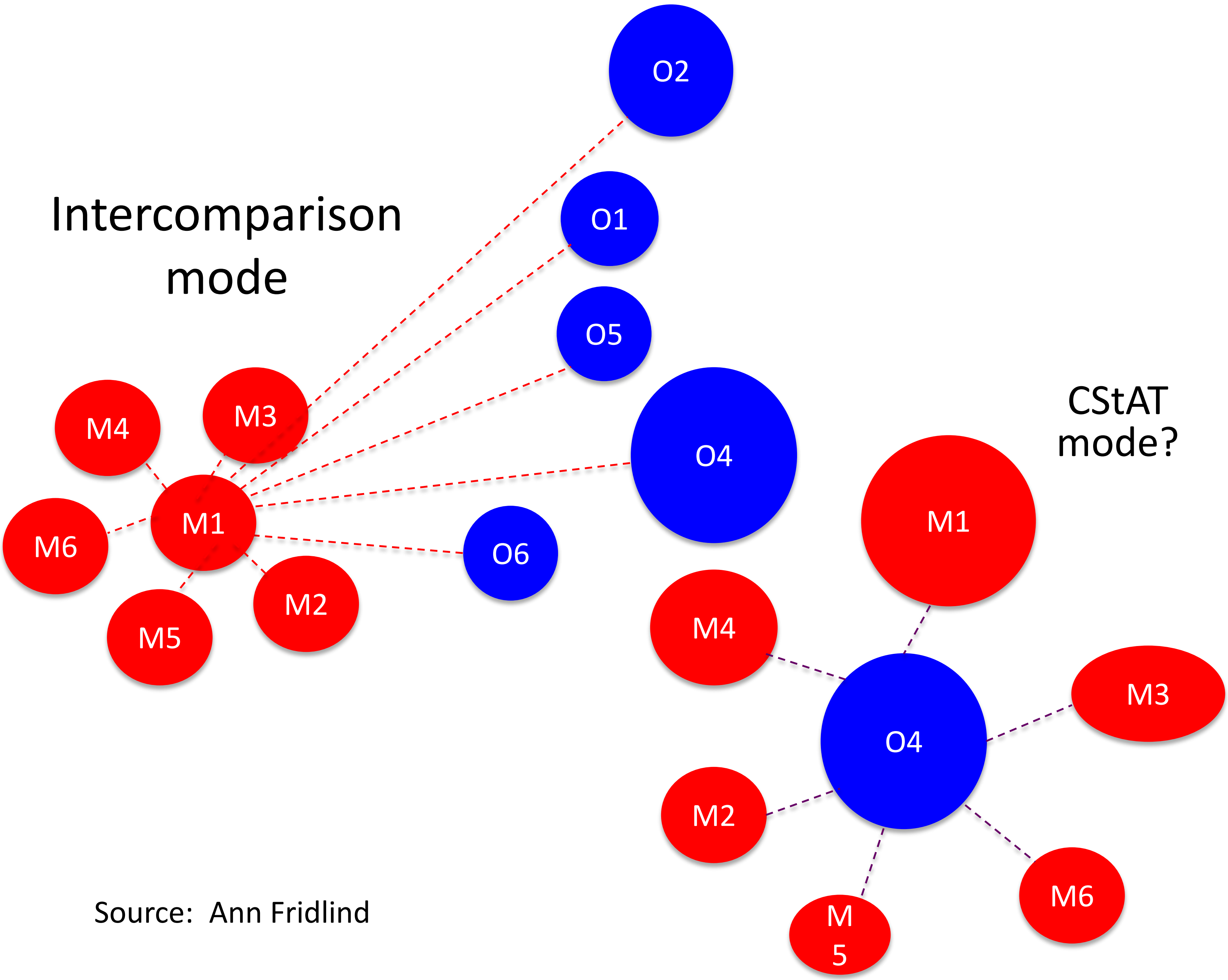
From scanning and vertically-pointing cloud radars (SACR, KAZR, MMCR) and lidars

Ice cloud macrophysical (cloud fraction in model grid, frequency of cloud occurrence)
Ice cloud microphysical properties (IWC, extinction, fall speed, optical depth, concentration)
In-cloud vertical air motions

Can relate variability of ice cloud properties to properties of parent convection within the coverage of CPOL (not fully exploited yet, but “cirrus age” methodology developed)

Geostationary satellite could play an important role in this ? (eg Mace et al. 2006 JAS)

Source: Alain Protat


Intercomparison mode
O2
O1
O5
O4
O6
M4
M3
M1
M6
M2
M5
CStAT mode?
M1
M4
O4
M3
M2
M6
M
5
Source: Ann Fridlind

State of the CStAT

- Ambitious problems
- Big ideas for collaboration
- Strong interest, contributions, attendance, discussion from observationalists and modelers (cloud-scale, global-scale)
- Strong interest in cross-campaign work (TWP-ICE, MC3E, AMIE)
- Way forward is not clear
- Keep meeting, communicating
- E-mail Sally.McFarlane@pnnl.gov or Ann.Fridlind@nasa.gov to be added to our e-mail discussion list