

# SPEC<sub>inc</sub>

## **In-situ Measurements of Microphysical Properties of Mid-latitude and Anvil Cirrus**



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# OUTLINE

- **CIRRUS CLOUDS:** Composite of 13 SPEC Learjet flights in Utah, Colorado and Oklahoma
  
- **ANVIL CLOUDS:** Examples of Data:
  - SPEC Learjet in Colorado
  - UND Citation near Cape Kennedy (ABFM Project)
  - ARA Egrett - Darwin, Australia
  - WB-57 and UND Citation (CRYTSTAL- FACE near Key West)
  - DC-8 in Central Pacific (KWAJEX)

# The Majority of the Mass in Mid-latitude Cirrus Clouds is found in Rosette Shaped Ice Particles

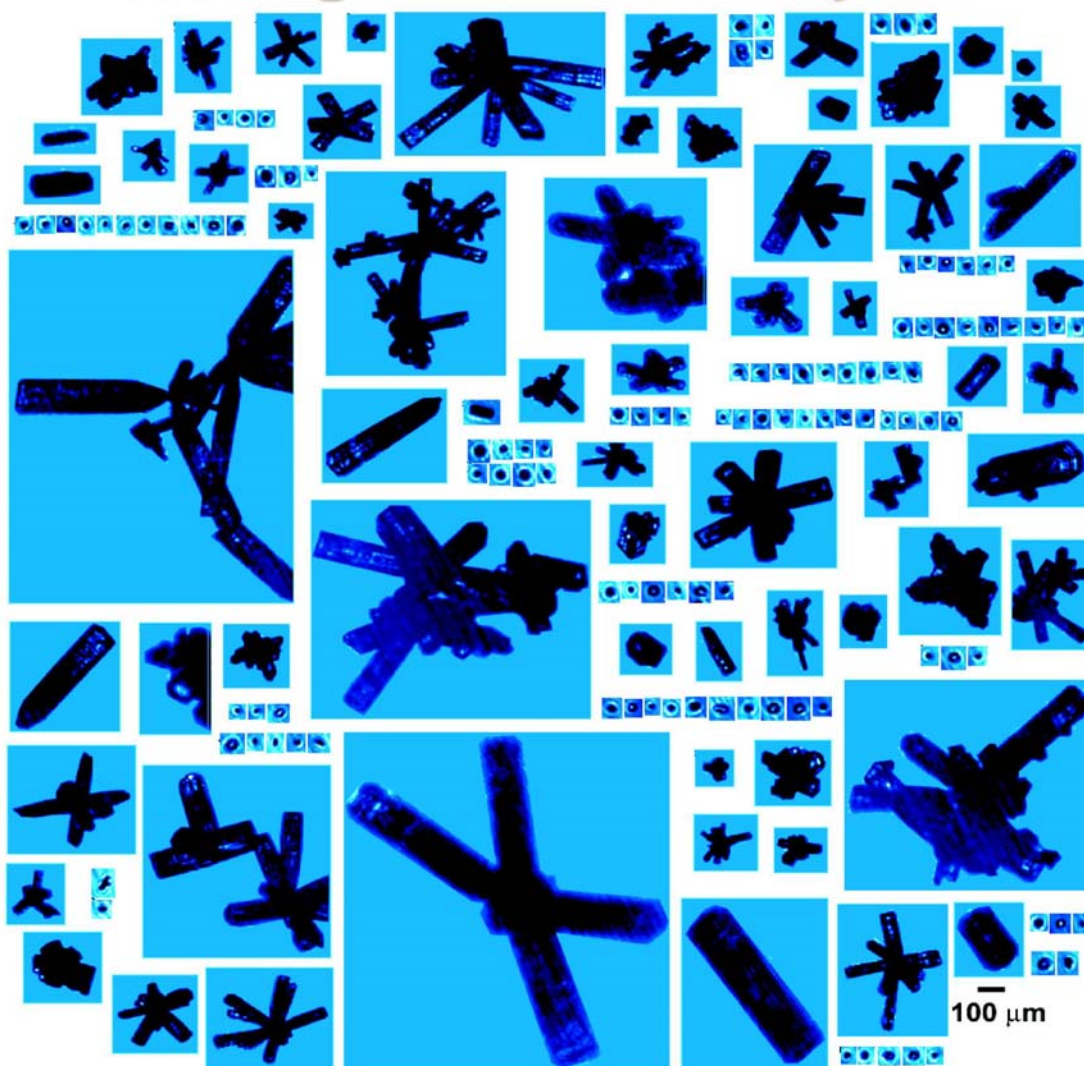
Volume 82

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## bulletin of the American Meteorological Society

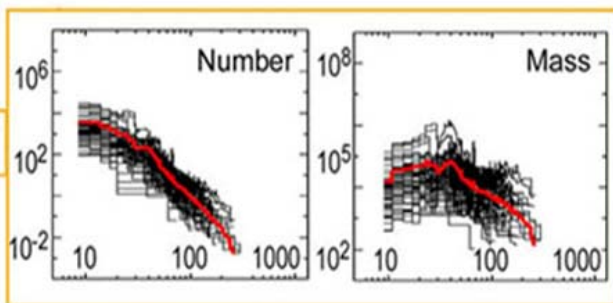
### CPI Images of Cirrus Ice Crystals



Data Collected on 1 June 1999 over the Facility  
for Atmospheric Remote Sensing in Utah

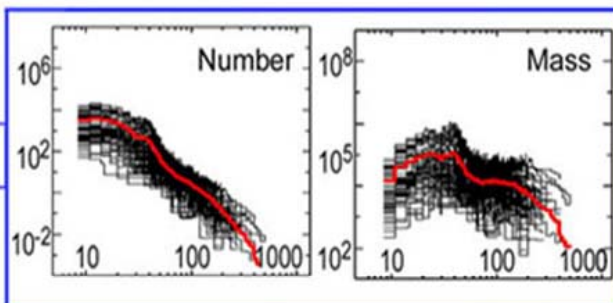
# Mid-latitude Cirrus

-55 C



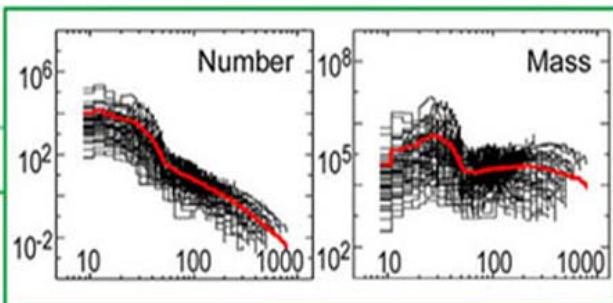
18% Rosettes  $R_{\text{eff}} = 18.4 \mu\text{m}$   
 $\text{IWC} = 0.003 \text{ g m}^{-3}$   $\beta_{\text{ext}} = 0.25 \text{ Km}^{-1}$

-45 C



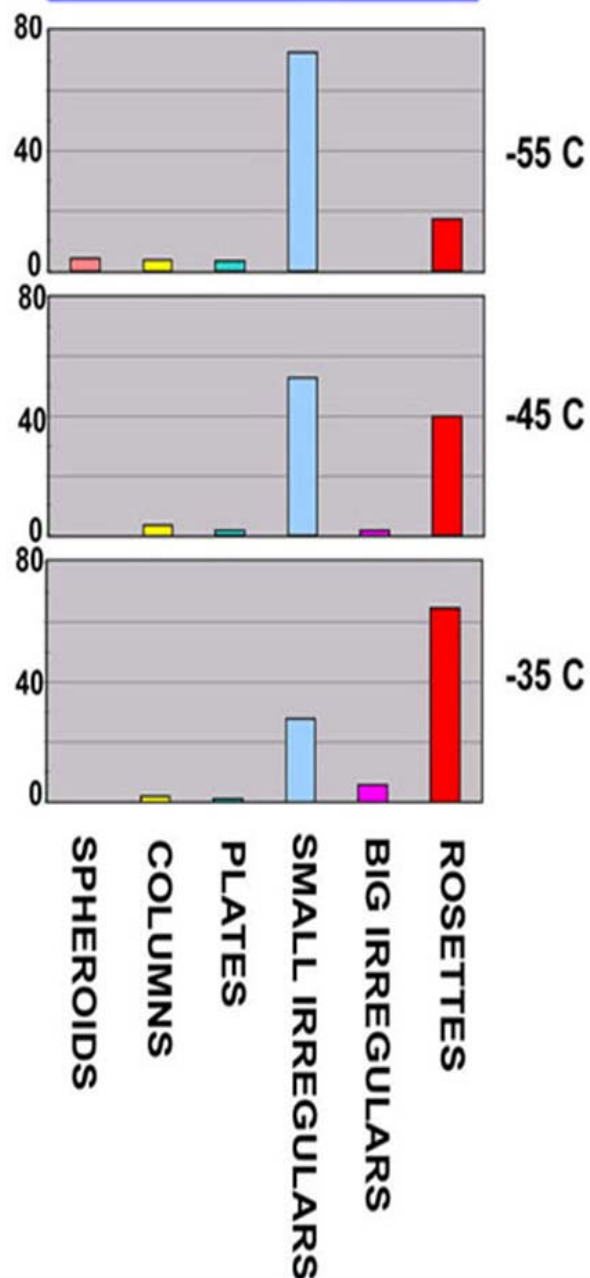
40% Rosettes  $r_{\text{eff}} = 25.0 \mu\text{m}$   
 $\text{IWC} = 0.006 \text{ g m}^{-3}$   $\beta_{\text{ext}} = 0.76 \text{ Km}^{-1}$

-35 C



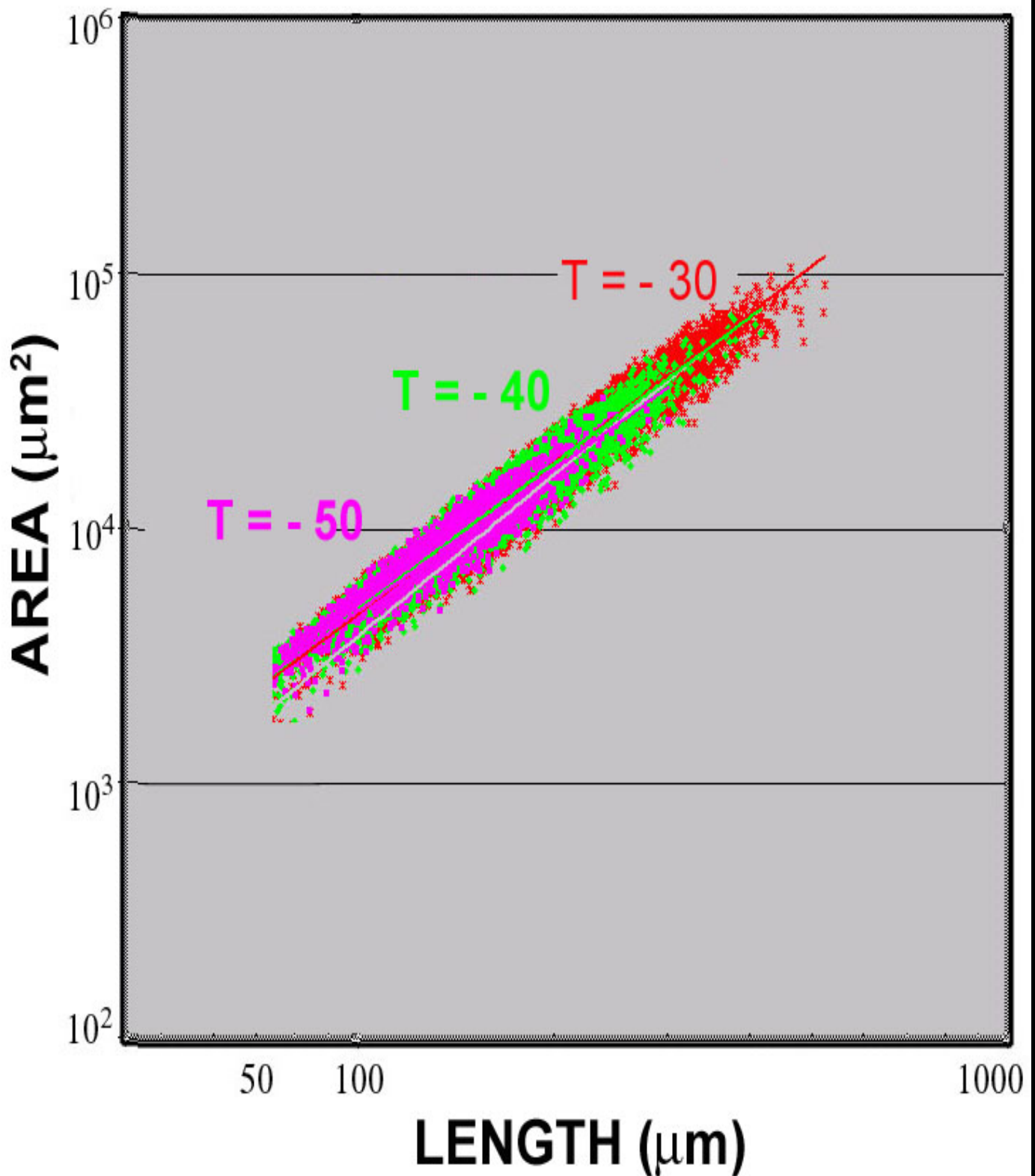
63% Rosettes  $r_{\text{eff}} = 36.7 \mu\text{m}$   
 $\text{IWC} = 0.022 \text{ g m}^{-3}$   $\beta_{\text{ext}} = 0.83 \text{ Km}^{-1}$

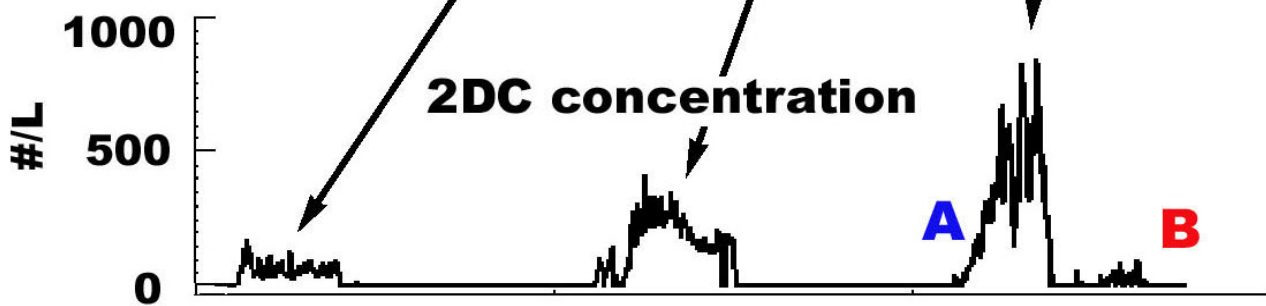
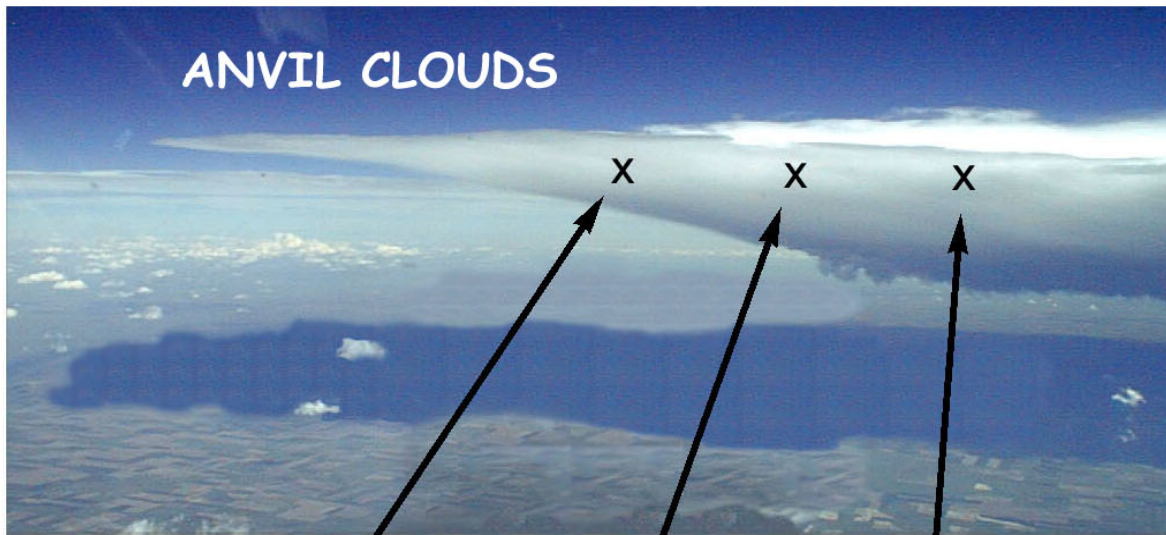
13 Flights  
 66 Extended Legs  
 256,559 Total Particles  
 % Habits by Mass





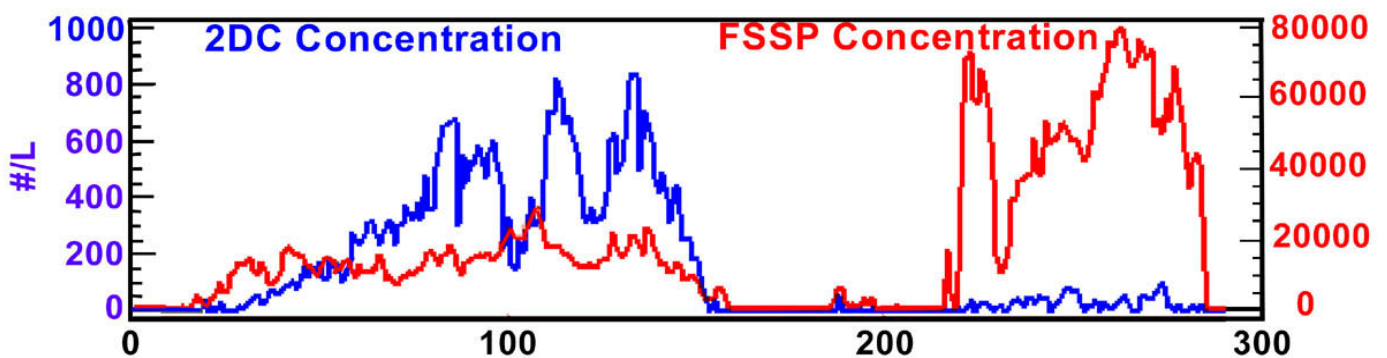
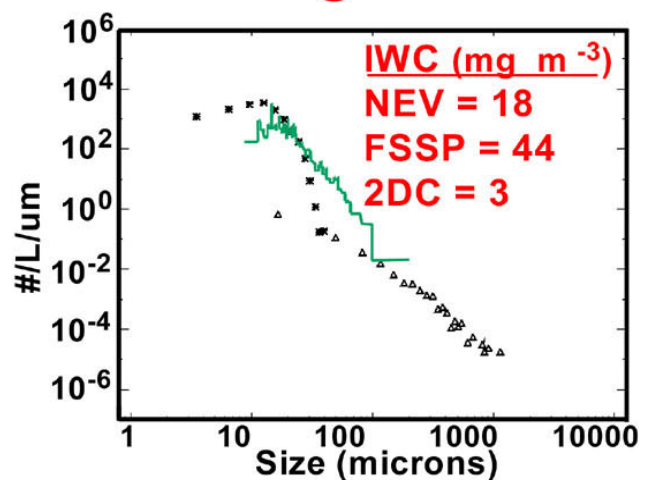
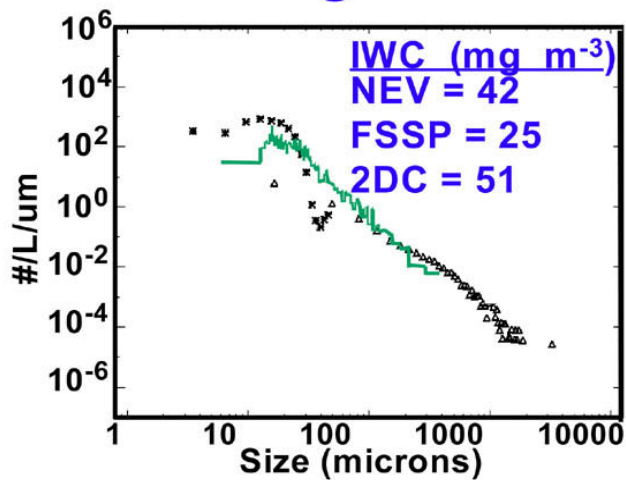
# Rosette Geometry as a $f(T)$





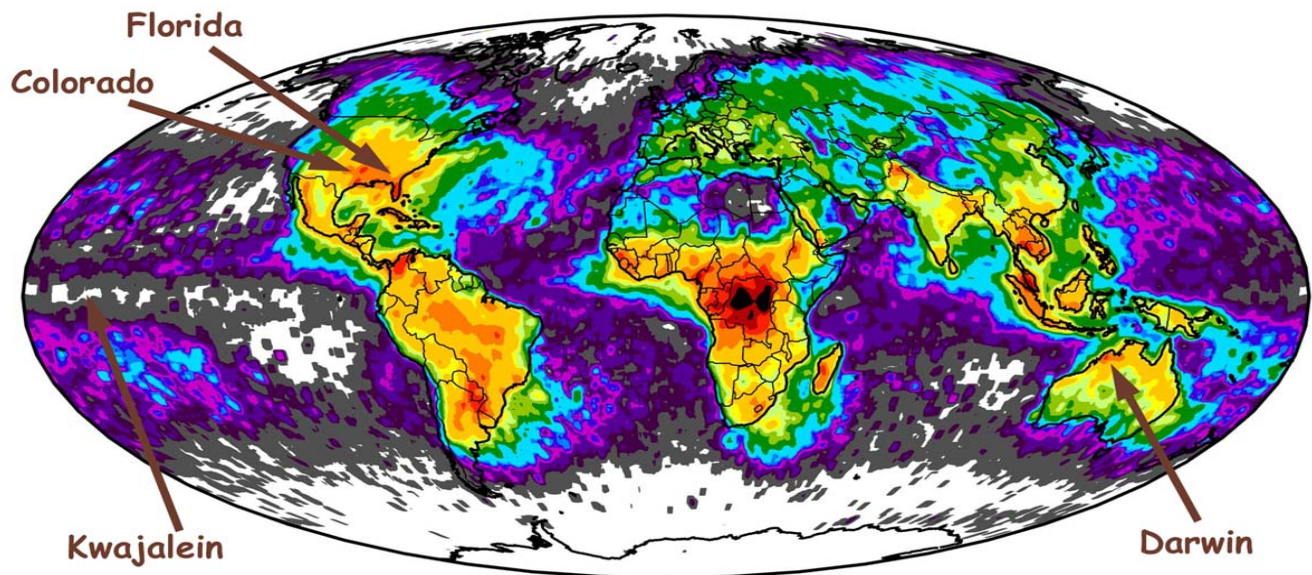
**Region A**

**Region B**



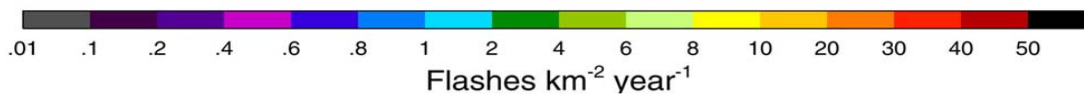


# The Frequency of Lightning Strikes (Indicator of Electric Field Strength) is Much Higher over Continental than it is over Maritime Regions



The Global Distribution of Lightning

Observations by the Optical Transient Detector (OTD) (April 1995 - March 2000)

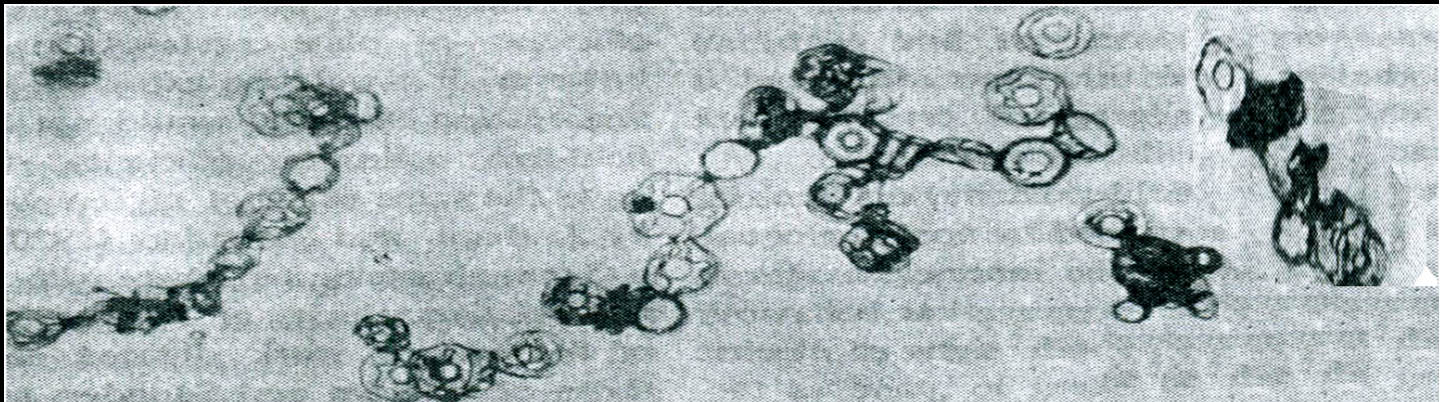


Flashes  $\text{km}^{-2} \text{ year}^{-1}$

Christian, H. J., et al., 2003: Global Frequency and distribution of lightning as observed from space by the Optical Transient Detector, *J. Geophys. Res.*, **108**(D1), 4005

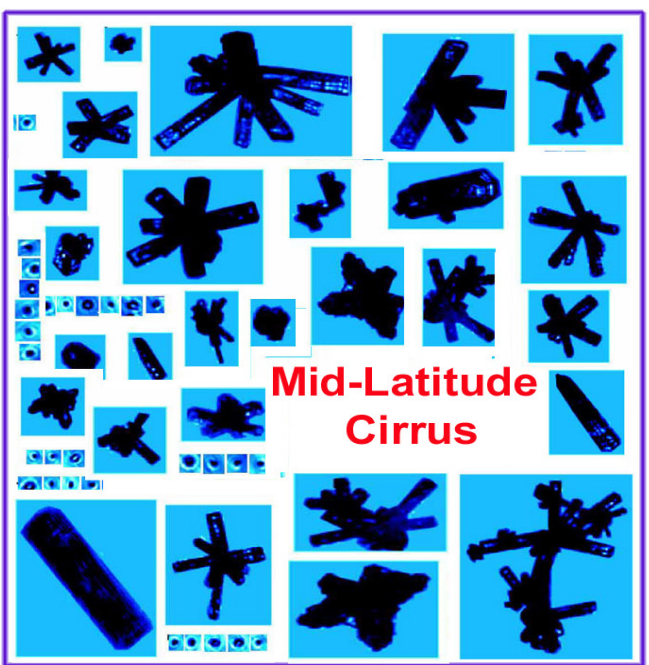
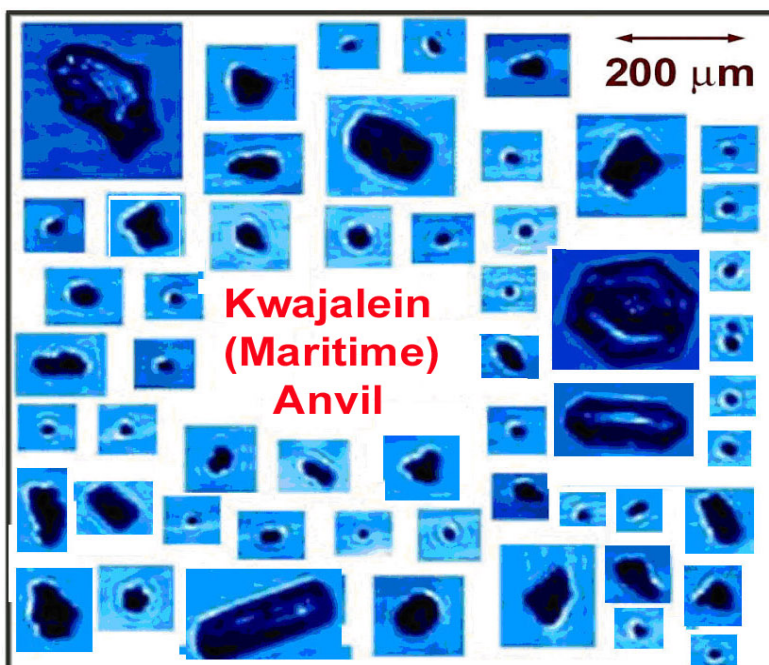
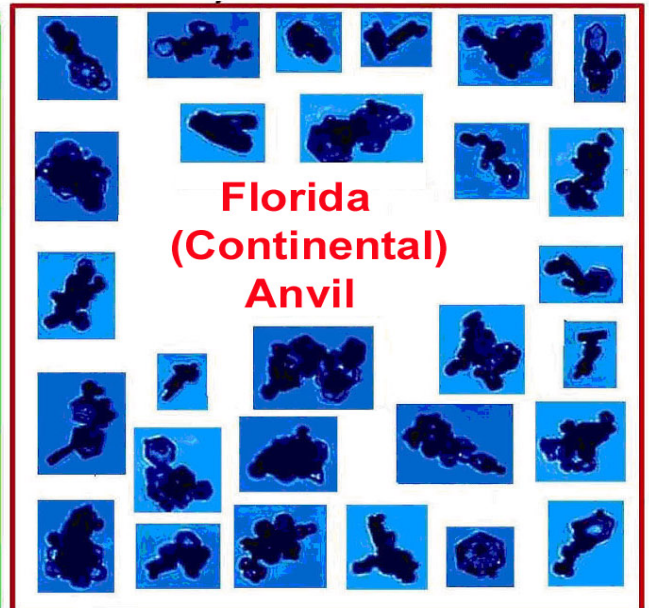
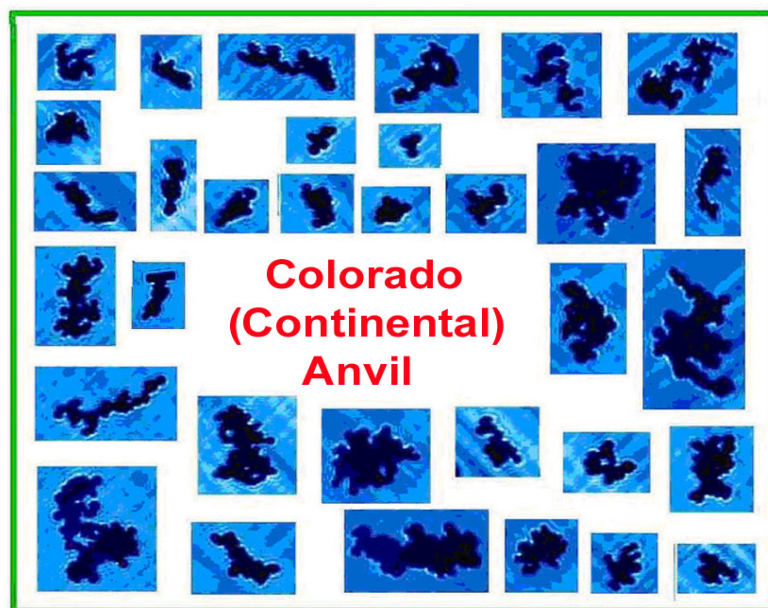
NASA/MSFC/NSSTC

# Examples of Chains of Ice Crystals formed in a High Electric Field in the Lab (Saunders and Wahab 1975)



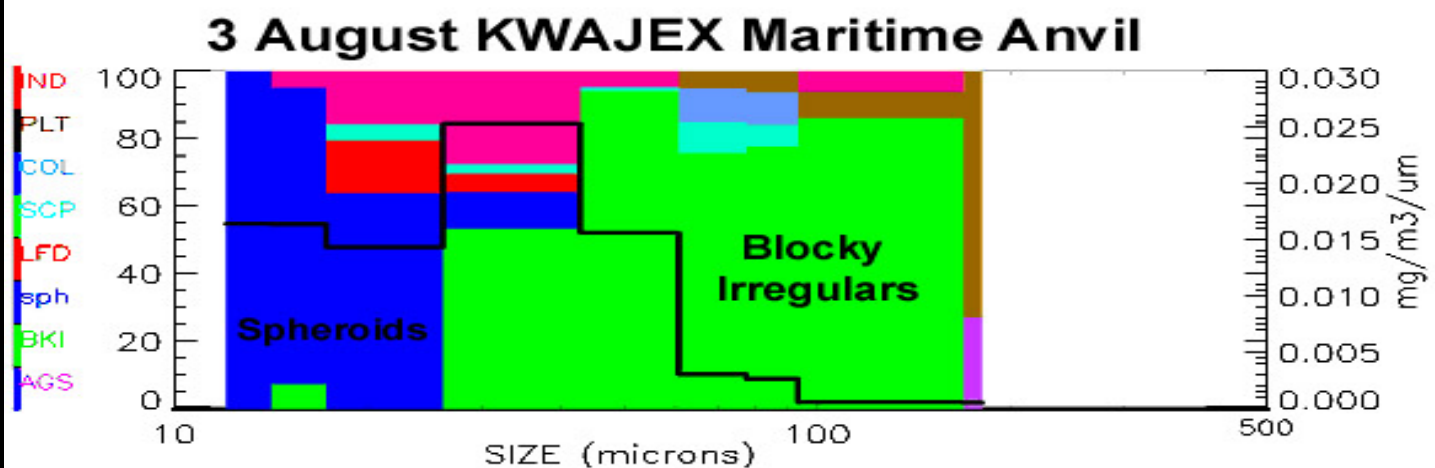
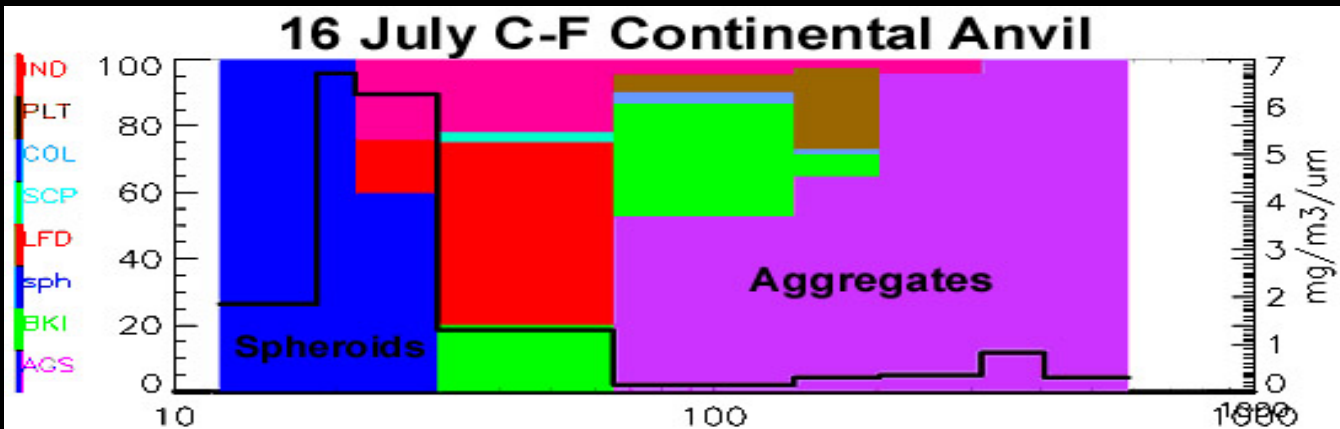


# Comparison of Ice Particle Shapes in Continental and Maritime Anvils, and Mid-Latitude Cirrus





# Ice Particle Types in Continental and Maritime Anvils



Airmass	Location	# Particles Counted	% Chains	% Doublets	% Other Aggregates	Temperature
Continental	Colorado 6-8-01a	3400	3	6	25	-47 C
Continental	Colorado 6-8-01b	1400	2	5	32	-47 C
Continental	Colorado 6-8-01c	3800	2	4	28	-47 C
Maritime	Kwajalein 8-3-98	3900	0	1	0.4	-40 to -60 C
Maritime	Kwajalein 8-25-98	1700	0	0.1	0.5	-55 C
Maritime	Kwajalein 9-2-98	11000	0	2.3	1.4	-5 to -40 C