GLOBE Workshop: Cloud Cover and Type

Dr. Lin Chambers

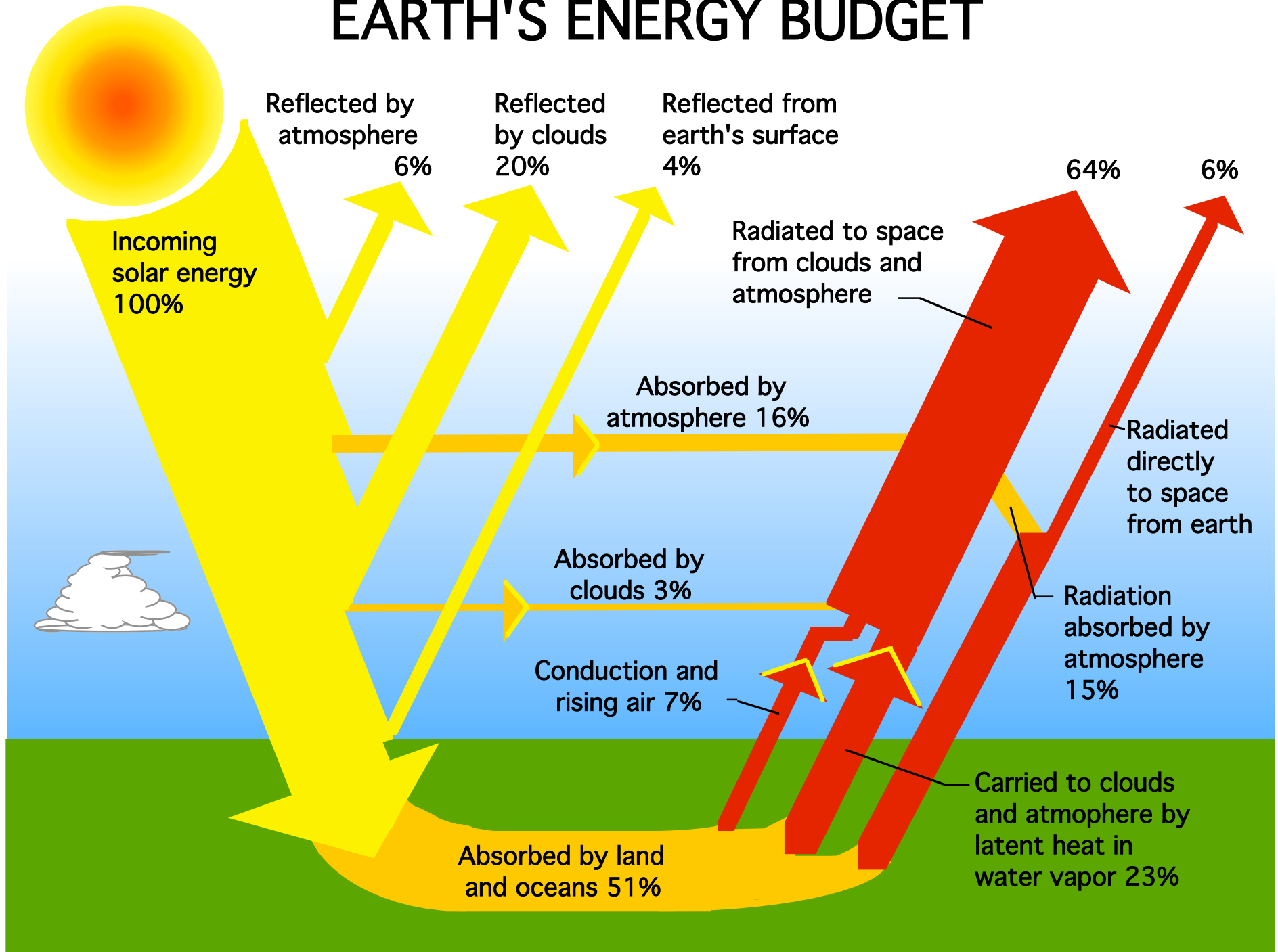NASA Langley Research Center

Hampton, VA

Outline

- Why do clouds matter
- Why are student observations of value
- Review of content
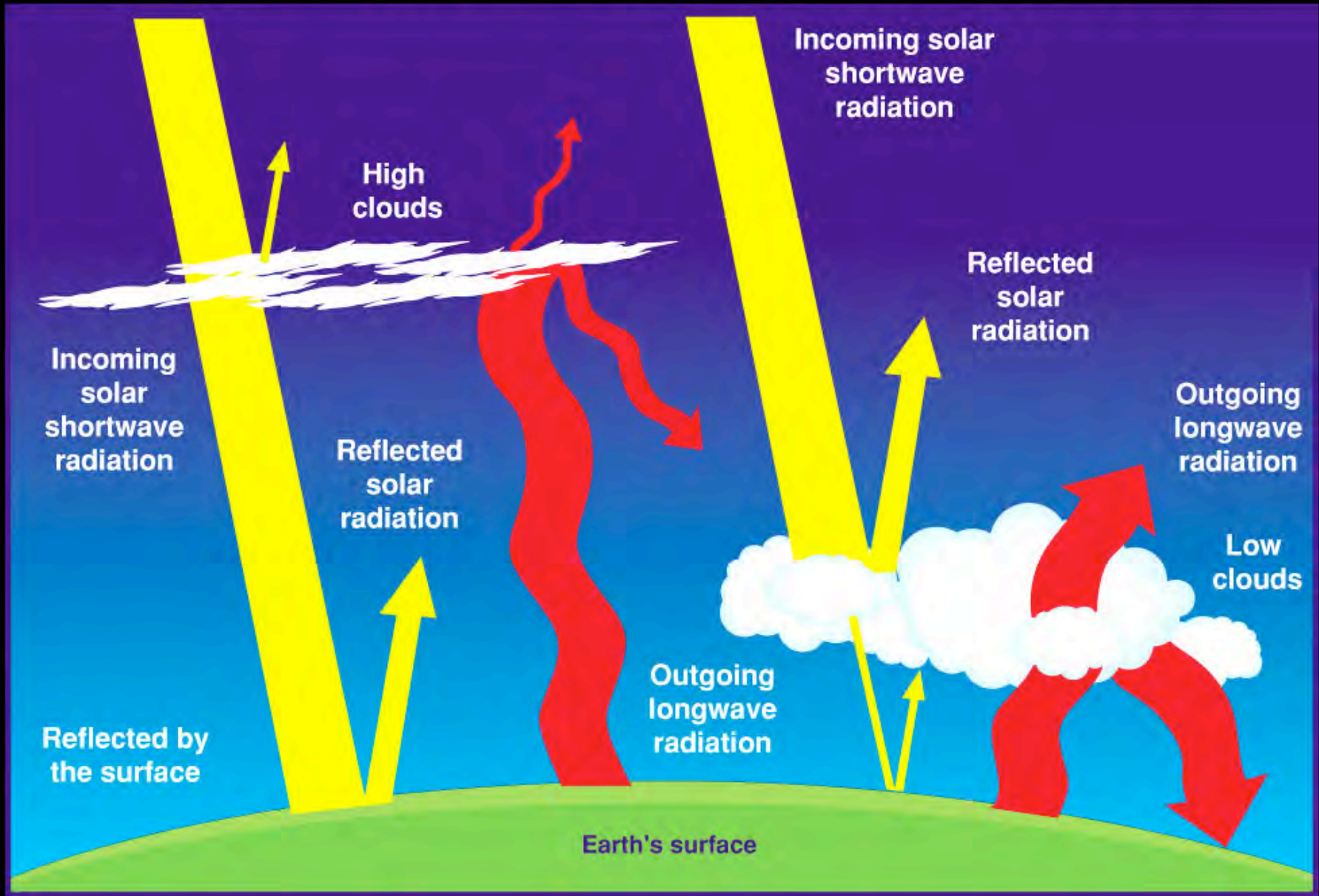- Practical matters of observation
- Uses of the data

Global Cloud Cover
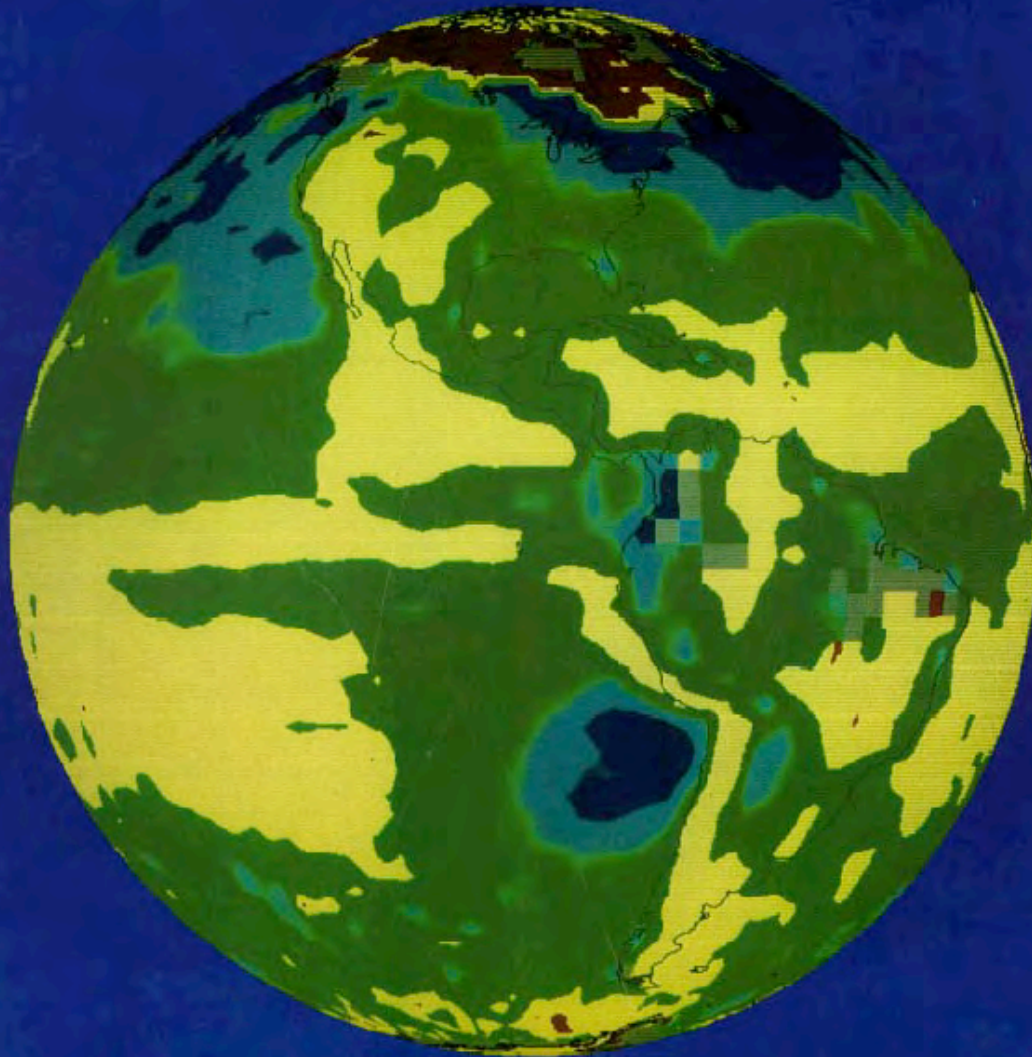## August 26, 1993

EARTH'S ENERGY BUDGET

Incoming solar energy 100%

Reflected by atmosphere 6%

Reflected by clouds 20%

Reflected from earth's surface 4%

Radiated to space from clouds and atmosphere

64%

6%

Absorbed by atmosphere 16%

Radiated directly to space from earth

Absorbed by clouds 3%

Radiation absorbed by atmosphere 15%

Conduction and rising air 7%

Carried to clouds and atmophere by latent heat in water vapor 23%

Absorbed by land and oceans 51%

Derived Product

Requires Cloud Detection and Cloud Property Retrieval
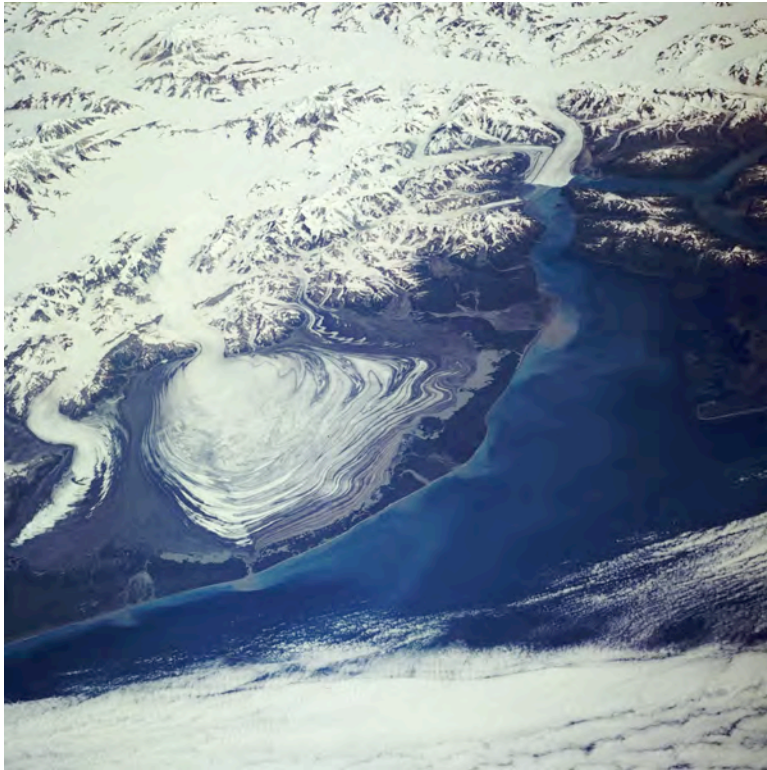
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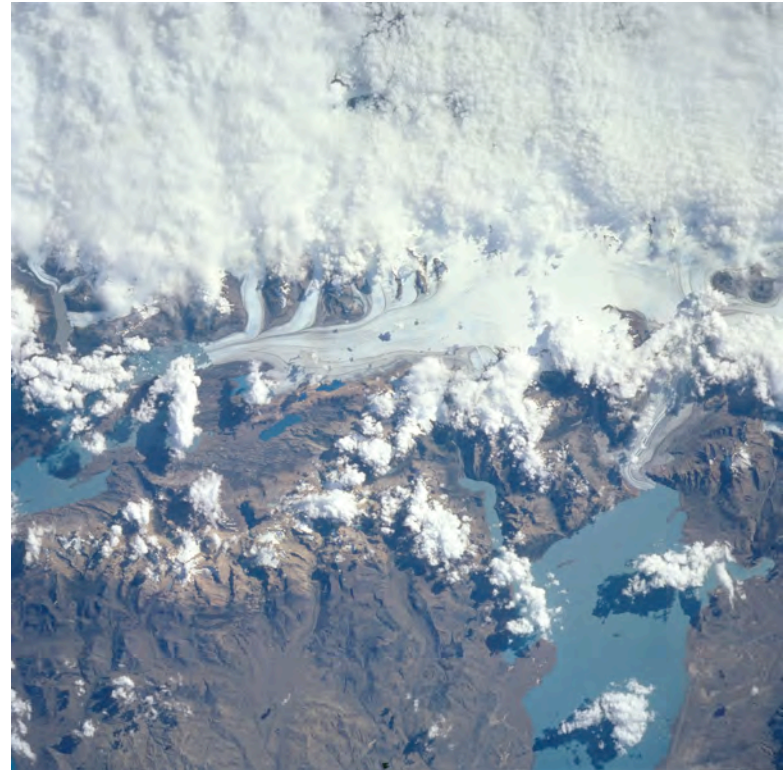- Practical matters of observation
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Clouds Looking Up

Clouds Looking Down

25 % Cloud Cover

70 % Cloud Cover

Outline

- Why do clouds matter
- Why are student observations of value
- Review of content
  - Cloud type
  - Cloud cover
  - Cloud height
- Practical matters of observation
- Uses of the data

Convective Clouds

Cumulus

Cumulonimbus

Low Level Clouds

Stratus

Nimbostratus

Stratocumulus

Fog – Caution!

Nimbostratus Clouds

Mid-Level Clouds

Altocumulus

Altostratus

High Level Clouds

Cirrus

Cirrocumulus

Cirrostratus

Contrails

What are Contrails?

- Contrails are **CLOUDS** that form in the wake of aircraft.

- Contrail is a shortened name for condensation trails.

- Also known as vapor trails, jet trails, "chemtrails"

Making A Cloud

Clouds form when water vapor condenses into visible water droplets or ice crystals.
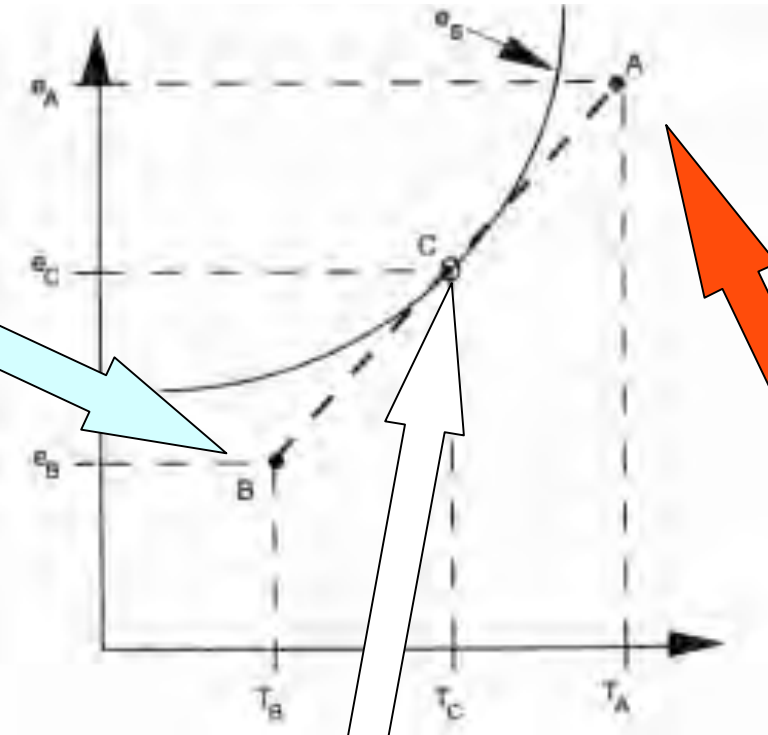
Condensation can occur in two ways:
1. Increase the water content in the air.
2. Cool the air to reach the dew point.

Nearly all contrails form by **mixing** of a colder, drier atmosphere with warmer, wetter jet exhaust *(mixing cloud).*
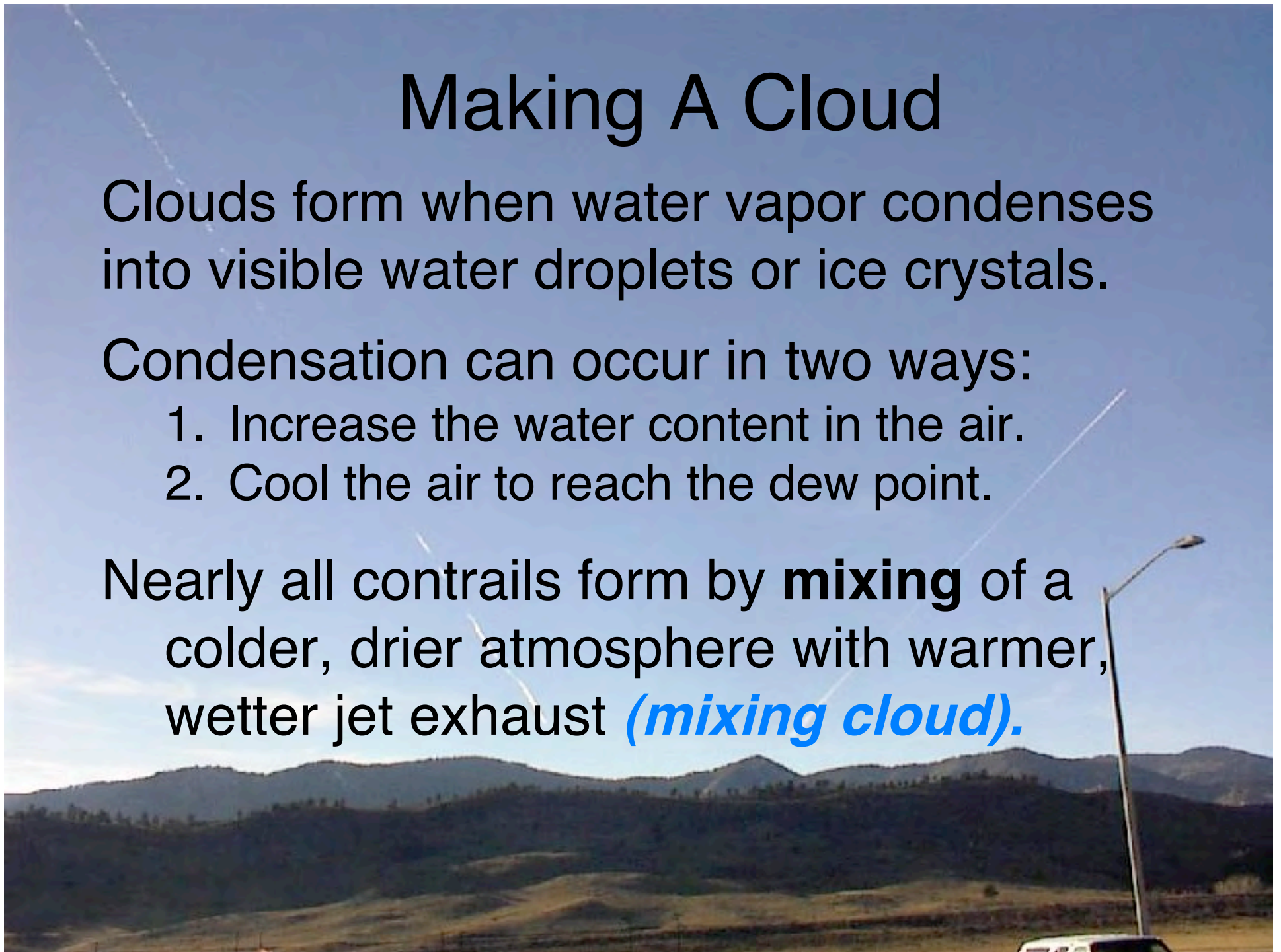
What is a Mixing Cloud?

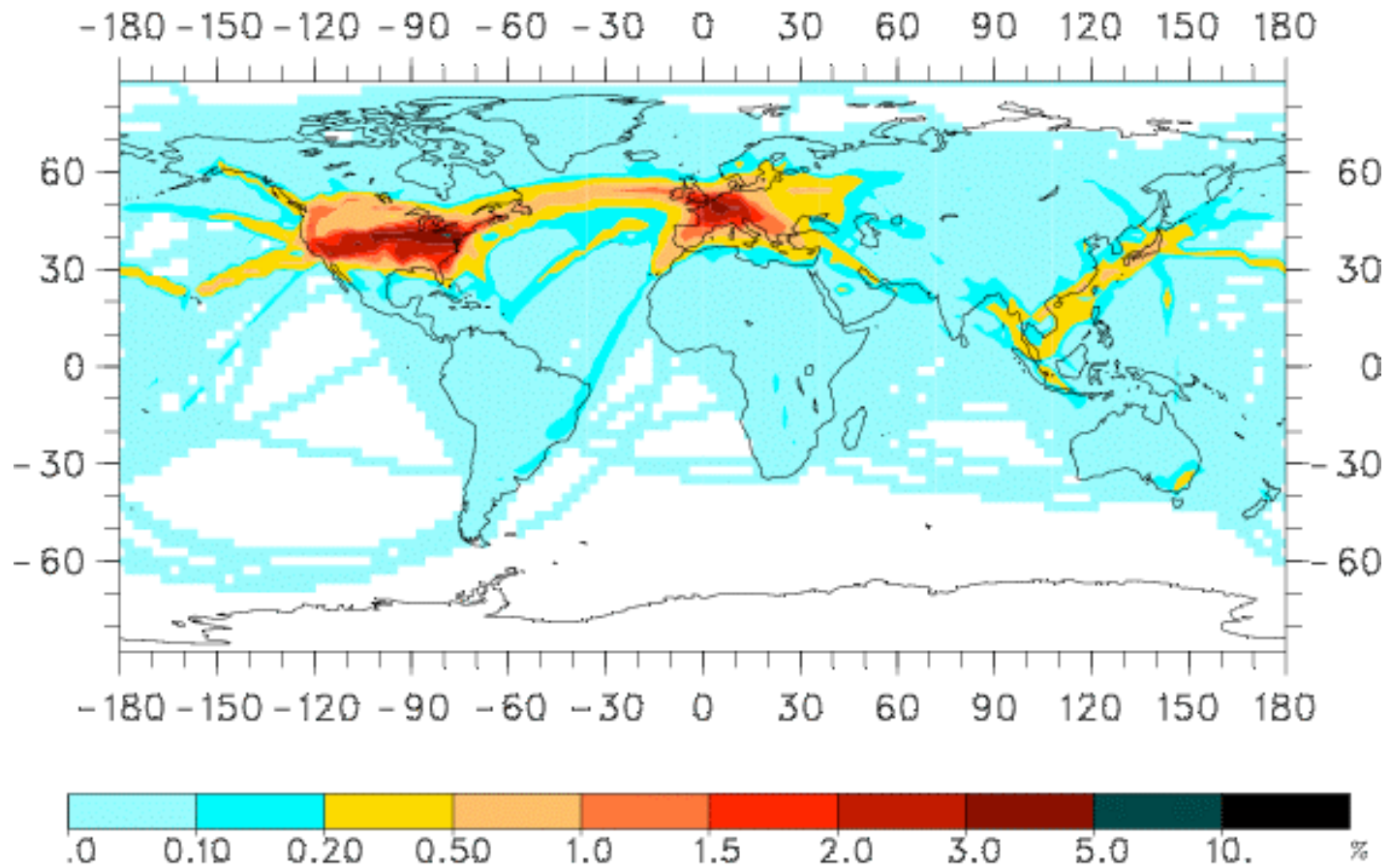B. Cold, dry air in upper atmosphere

The cloud that forms on your breath during a cold day is a mixing cloud

C. If you cross the line … contrail!

A. Hot, moist air from plane exhaust

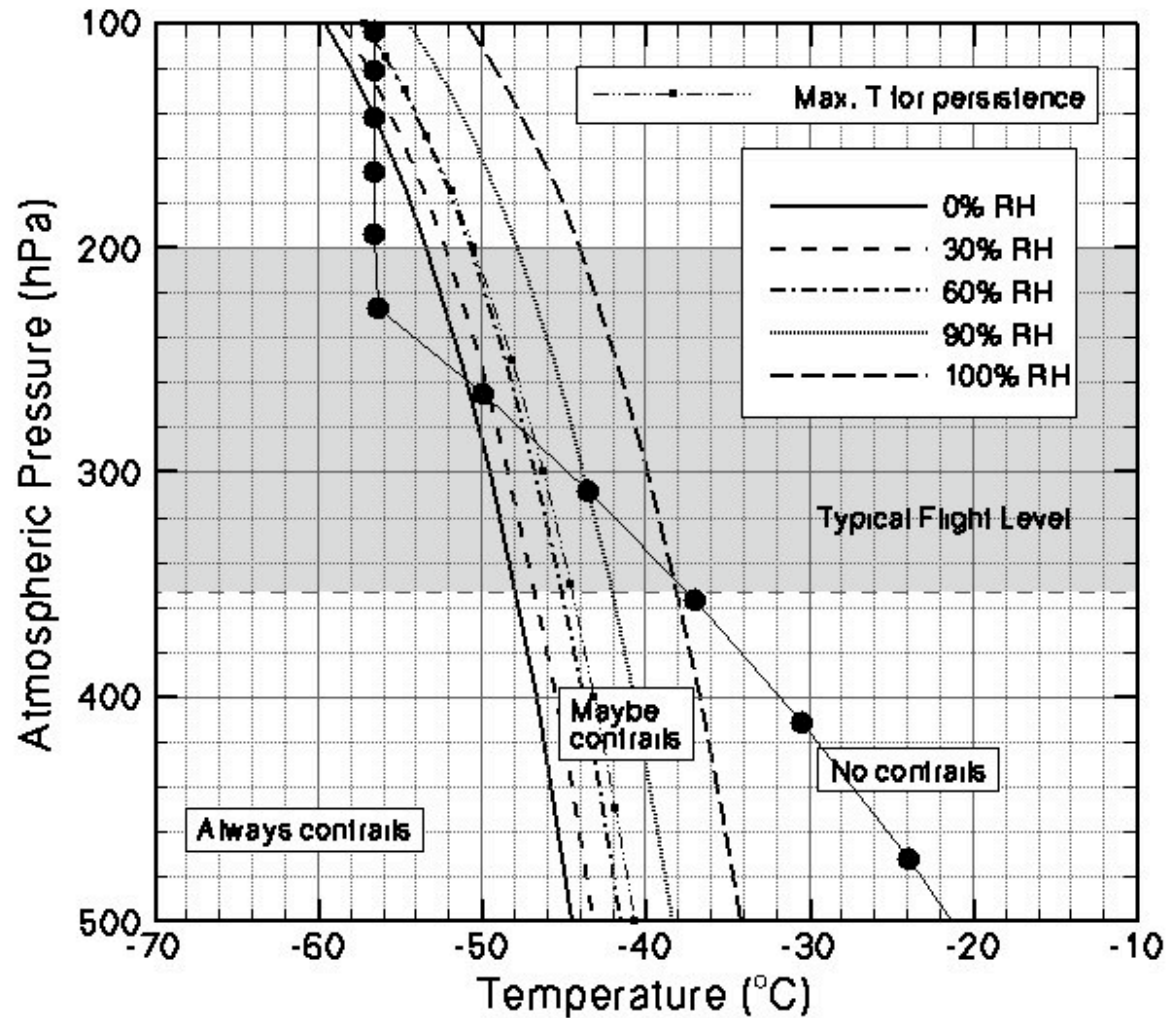persistent contrail coverage (1992), eta=0.3 linear weighting

Air traffic and persistent contrail coverage will continue to increase.

persistent contrail coverage (2050/1), eta=0.5
linear weighting
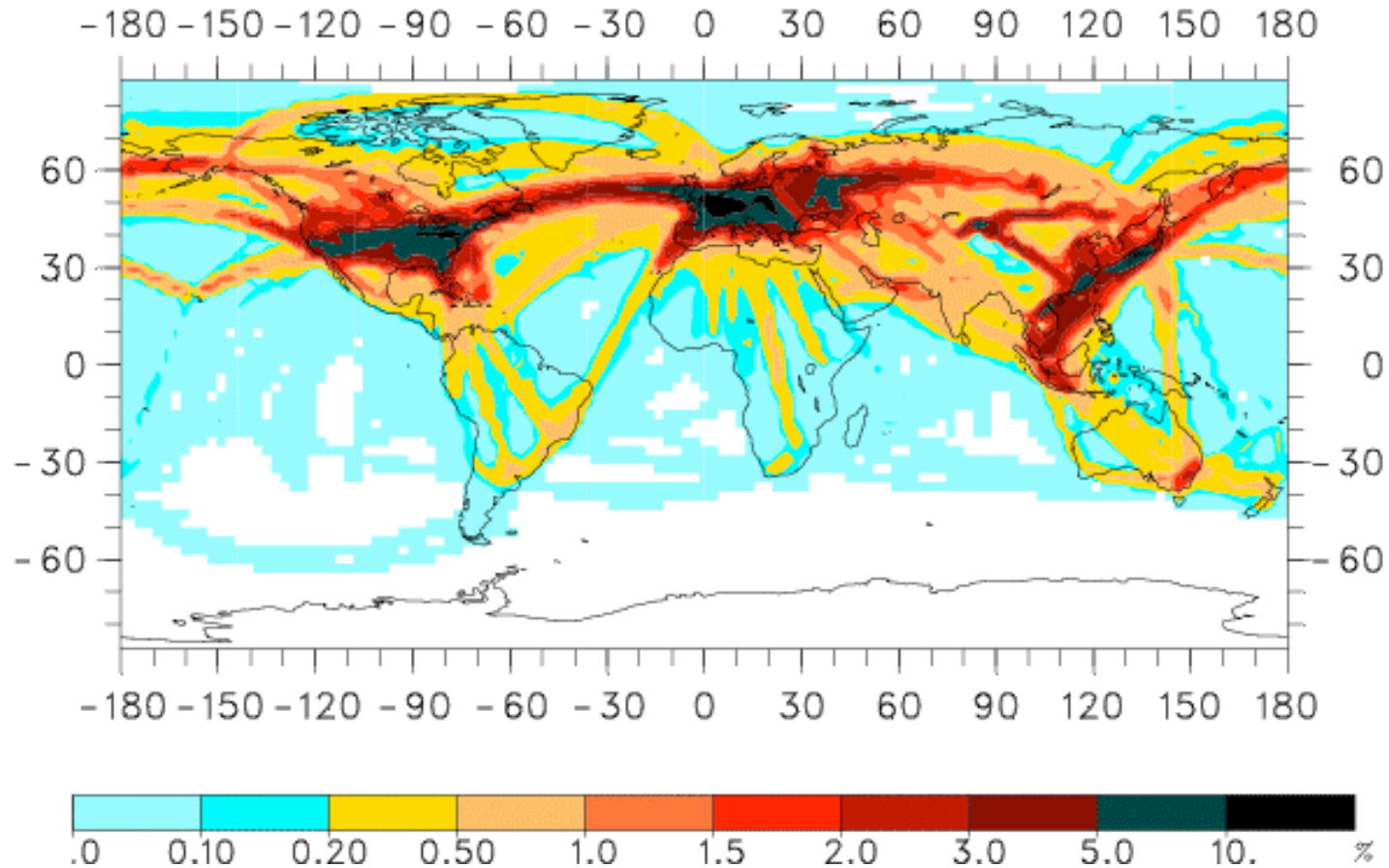
By 2050, warming due to contrails may be 2.5 to 25 % of the current greenhouse gas warming.

Website & Activities

http://asd-www.larc.nasa.gov/GLOBE/

Contrail Classification

Cloud Cover – Percentages

	Cloud Cover Classifications	Contrail Classifications
0	**No Clouds** The sky is cloudless; there are no clouds visible.	**None** There are no contrails visible.
0-10 %	**Clear** Clouds are present but cover less than one-tenth (or 10%) of the sky.	**0-10 %** Contrails are present but cover less than one-tenth (or 10%) of the sky.
10-25%	**Isolated Clouds** Clouds cover between one-tenth (10%) and one-fourth (25%) of the sky.	**10-25 %** Contrails cover between one-tenth (10%) and one-fourth (25%) of the sky.
25-50%	**Scattered Clouds** Clouds cover between one-fourth (25%) and one-half (50%) of the sky.	**25-50%** Contrails cover between one-fourth (25%) and one-half (50%) of the sky.
50-90%	**Broken Clouds** Clouds cover between one-half (50%) and nine-tenths (90%) of the sky.	**> 50%** Contrails cover more than one-half (50%) of the sky.
90-100%	**Overcast** Clouds cover more than nine-tenths (90%) of the sky.	
	Obscured Clouds and contrails cannot be observed because more than one-fourth (25%) of the sky cannot be seen clearly.	

Cloud Cover
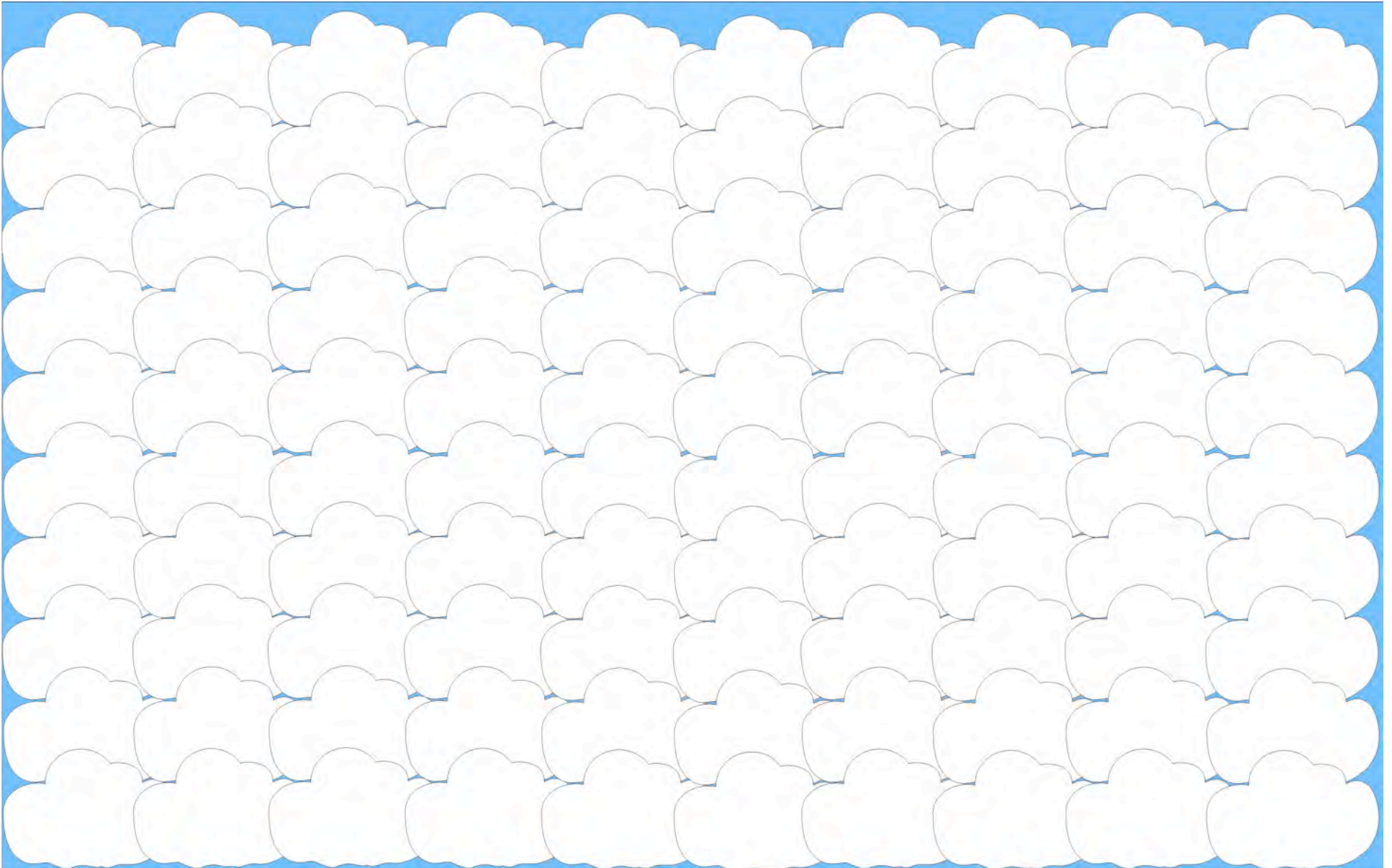
How Many Clouds?
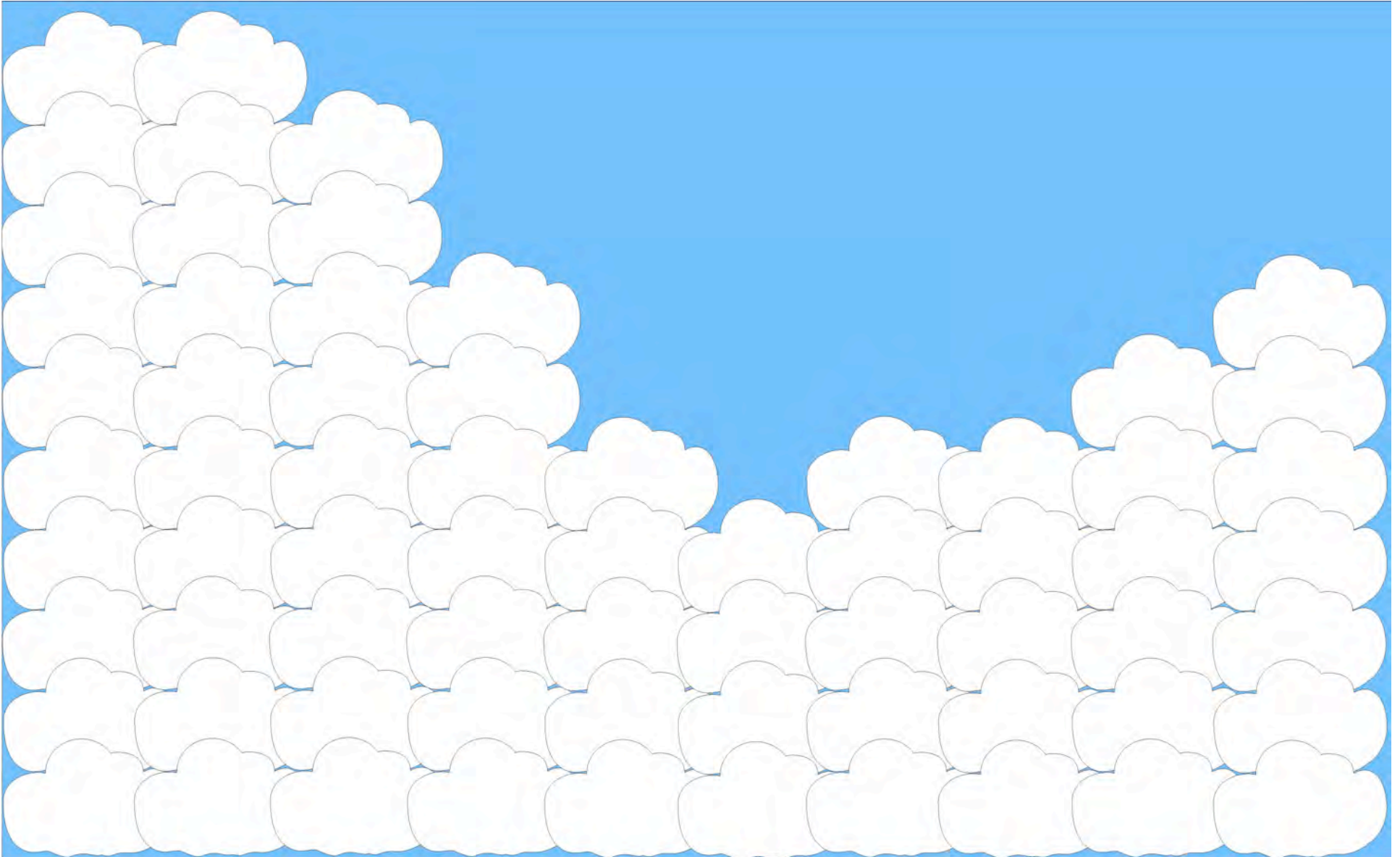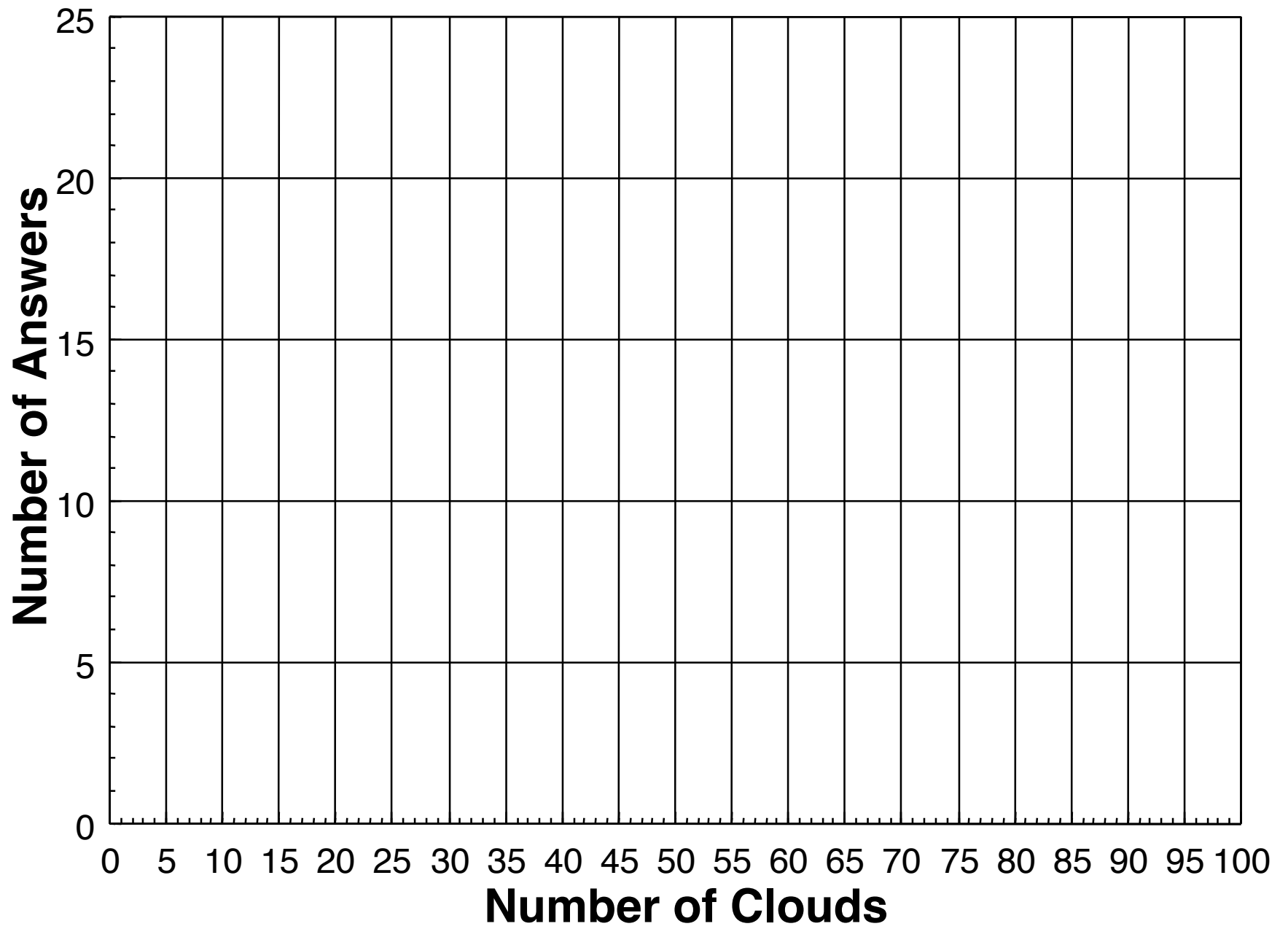
Results from "Guess the Cloud"
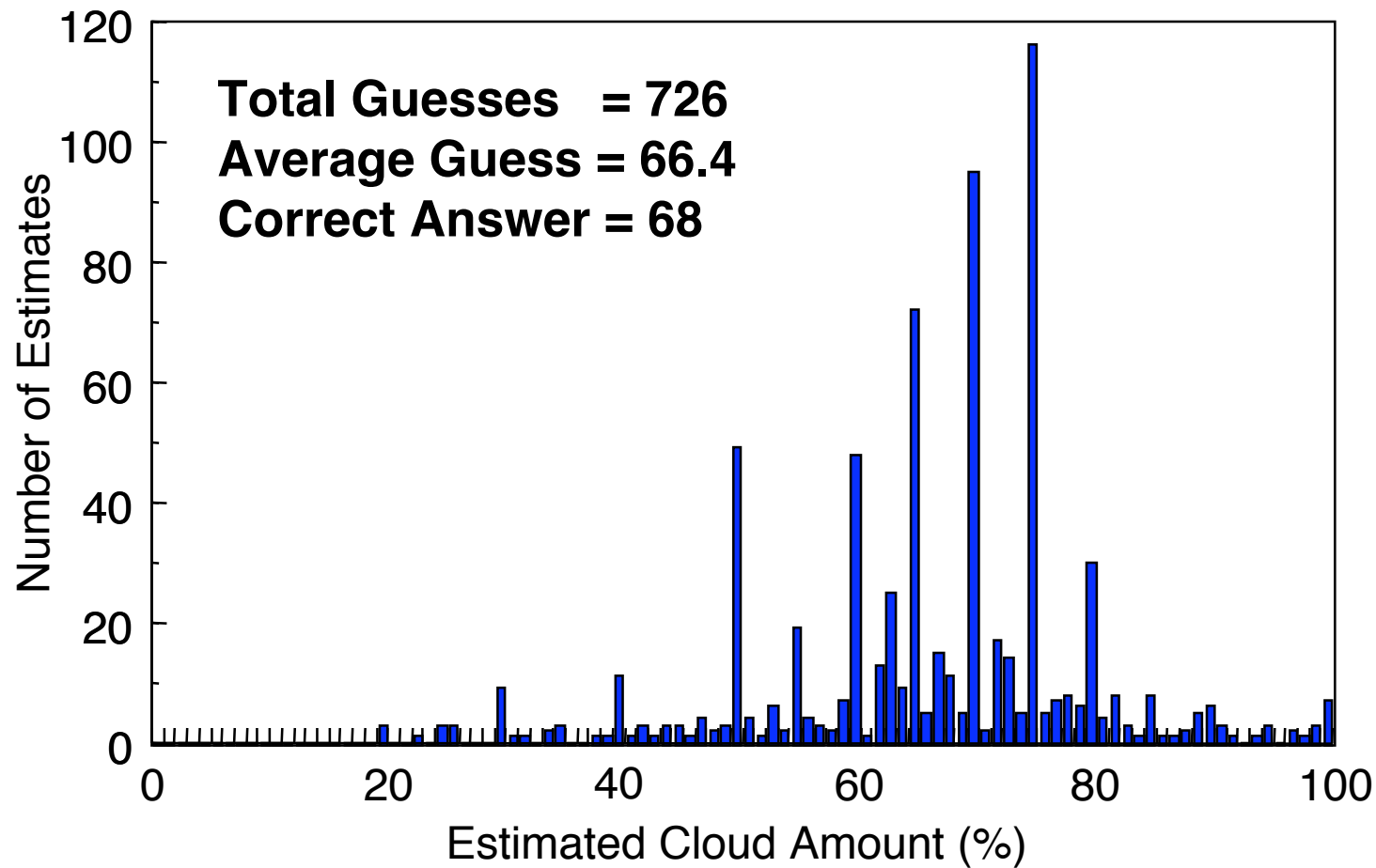
Do Contrails Affect Cloud Cover?

Photo by Louis Nguyen

1. 26. 2001

Determining Cloud Height

http://asd-www.larc.nasa.gov/SCOOL/lintips.html

Outline

- Why do clouds matter
- Why are student observations of value
- Review of content
- Practical matters of observation
  - Who, What, Where, When, Why, How?
- Uses of the data

What and Why?

- Science view already answered
- Any questions???

- Education view:
  - Your curriculum
  - See connection to Nat'l standards on pp. 14–19 of Atmosphere Introduction

Who?

- You and your students?
- Just your students?
- Your students and other students?
- Your students and community members?
- ???

Where?

- Atmosphere Study Site
- Do you need GPS?
- Do you need a clear area?

Atmosphere Investigation
Site Definition Sheet

School Name: _____ Class or Group Name: _____

Name(s) of student(s) filling in Site Definition Sheet: _____

_____

Date: _____ Check one: ☐ New Site ☐ Metadata Update

Site name (give your site a unique name): _____

Coordinates: Latitude: _____ ☐ N or ☐ S   Longitude: _____ ☐ E or ☐ W

Elevation: ____ meter

Source of Location Data (check one): ☐ GPS ☐ Other _____

Obstacles (Check one): ☐ No obstacles ☐ Obstacles (describe below)
(Obstacles are trees, buildings, etc. that appear above 14° elevation when viewed from the site.)

Description: _____

_____

_____

Buildings within 10 meters of your instrument shelter (Check one): ☐ No buildings ☐ Buildings
(describe below)

Description: _____

Photo Number and Orientation

14°

Height of Tree

4 Times Height of Tree
Distance to Instrument Shelter
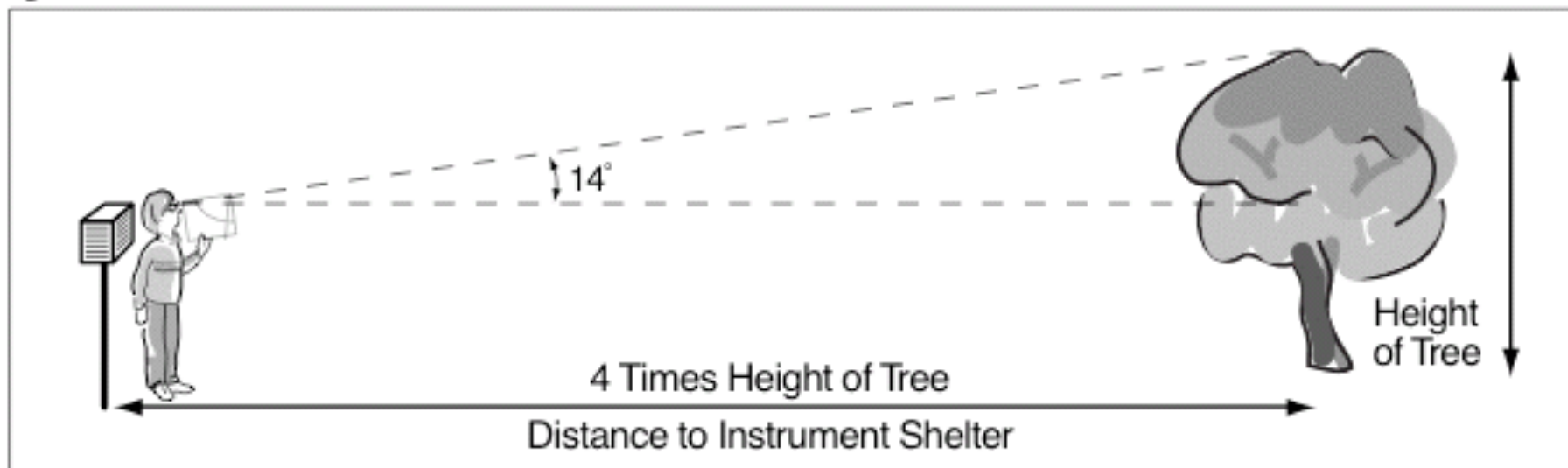
When?

Good

- ANY TIME!

Geostationary Times for Iowa		
UT	DST	EST
2:48	7:48	8:48
3:05	8:05	9:05
5:48	10:48	11:48
6:05	11:05	12:05
8:48	13:48	14:48
9:05	14:05	15:05

For Iowa

~8:00

~11:00

~14:00

Better

Best!

- Aqua/Terra overpass times

How?

- Suggested Sequence of Activities (p. 2 of Welcome in Atmosphere Protocol)
- Learning Activities
- Cloud and Contrail Charts

- Just do it!
- Let's do it now!

Data Sheet

Atmosphere Investigation

Clouds 1-Measurement Data Sheet

School Name: _____

Observer names: _____

_____

Date: Year_____ Month_____ Day_____ Study Site: ATM-_____

Local Time (hour:min):_____ Universal Time (hour:min):_____

Cloud Type

High (in the sky):
(Check all types seen)

❏ Cirrus ❏ Cirrocumulus ❏ Cirrostratus

Middle (of the sky):
(Check all types seen)

❏ Altostratus ❏ Altocumulus

Low (in the sky):
(Check all types seen)

❏ Stratus ❏ Stratocumulus ❏ Cumulus
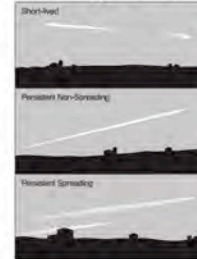
Rain or Snow Producing
Clouds:
(Check all types seen)

❏ Nimbostratus ❏ Cumulonimbus

GLOBE® 2003　　　Appendix - 3　　　Atmosphere

Atmosphere Investigation: Clouds 1-Measurement Data Sheet - Page 2

Contrail Type (Record the number of each type observed)

Short-lived

Short-lived Contrails
How many do you see? _____

Persistent Non-Spreading

Persistent Non-Spreading Contrails
How many do you see? _____

Persistent Spreading

Persistent Spreading Contrails
How many do you see? _____

Three-quarters or More of the Sky is Visible:
Cloud Cover (Check One)

No Clouds　Clear　Isolated　Scattered　Broken　Overcast
❏ 0%-No Clouds　❏ <10% Clouds　❏ 10-25% Clouds　❏ 25-50% Clouds　❏ 50-90% Clouds　❏ >90%

Contrail Cover (Check one)
❏ No Contrails (0%)　❏ 0-10%　❏ 10-25%　❏ 25-50%　❏ >50%

View of more than one-quarter or more of the sky is blocked: Obscured ❏ Check here

Why is the view of the sky blocked? (Check all that apply)

❏ Blowing Snow　❏ Heavy Snow　❏ Heavy Rain　❏ Fog　❏ Spray

❏ Volcanic Ash　❏ Smoke　❏ Dust　❏ Sand　❏ Haze
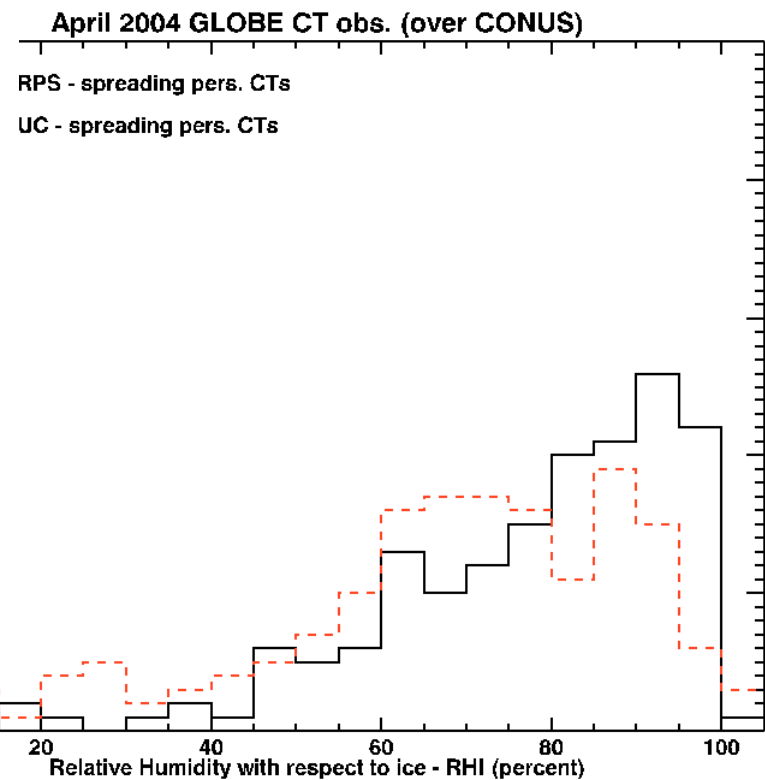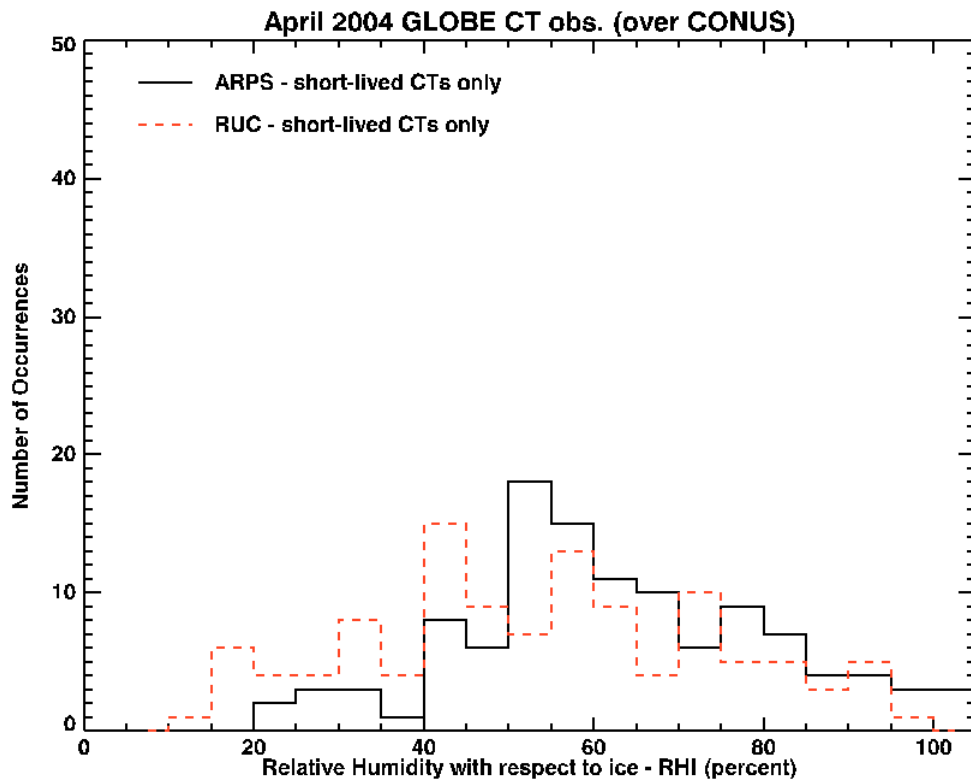
Comments:_____

_____

_____

GLOBE® 2003　　　Appendix - 4　　　Atmosphere

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- Why do clouds matter
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- Uses of the data

Initial GLOBE Contrail Data Analysis

Dr. Dave Duda, Hampton University

April 2004 GLOBE CT obs. (over CONUS)
ARPS - short-lived CTs only
RUC - short-lived CTs only

April 2004 GLOBE CT obs. (over CONUS)
RPS - spreading pers. CTs
UC - spreading pers. CTs

Method

- Compare GLOBE obs to:
    - RUC (Rapid Update Cycle; Benjamin et al.)
    - ARPS (Advanced Regional Prediction System; Xue et al.)
- Initial comparison for April 2004
- 1500 GLOBE observations of contrails

Comparing to Satellite

http://asd-www.larc.nasa.gov/usedata.html

- S'COOL Site Matched to 1 degree Satellite Region

- Observation Times Within 15 Minutes

Latitude	Longitude	City	State	Country
37.01	-76.30	Hampton	VA	USA

Surface Information				Satellite Information 83418				
Date: 2002-10-10	Universal Time: 17:29			Date: 2002-10-10	Universal Time: 17:28			
Satellite: Aqua				Satellite: Aqua				
Opacity	Cloud Cover	Type	Visualization		Altitude	Opacity	Cloud Cover	Phase Temp (C)
					7.39	Opaque 13.90	(95% to 100%) 99.86	mixed 253.68
Opaque	(95% to 100%)	Stratocumulus			3.15	Translucent 6.10	(0% to 5%) 0.14	water 277.90
Persistent Contrails: 00	Short-Lived Contrails: 00							
Surface Observations:	Snow/Ice: No Standing Water: No Muddy: No Dry Ground: Yes Leaves on Trees: Yes							
Temperature: C Barometric Pressure: hPa Relative Humidity: %								
Comments: Started sprinkling so nimbostratus								

Cloud Amount Comparison

		S'COOL Students			
		Clear	Partly Cloudy	Mostly Cloudy	Overcast
Satellite	Clear	1415	350	101	48
	Partly Cloudy	624	897	575	230
	Mostly Cloudy	193	553	695	680
	Overcast	143	187	489	1992

191 3-class errors (2%) - ~1/3 easily explainable

711 2-class errors (8%) - need more study

3271 1-class errors (36%) - may be near-matches

Students Overcast vs. Satellite Clear (48 cases)

- **Spatial Mismatch?:** >1/3 are schools located less than 0.1 degree from the edge of a lat/long grid box.
- **Universal Time?:** 3 cases with incorrect UT
- **Student/Satellite error?:** remaining cases have no clear explanation. Study needed.
- **Snow:** 10 cases, yet the satellite still reports clear sky.

		S'COOL Students			
		Clear	Partly Cloudy	Mostly Cloudy	Overcast
Satellite	Clear	1415	350	101	48
	Partly Cloudy	624	897	575	230
	Mostly Cloudy	193	553	695	680
	Overcast	143	187	489	1992

Snow Effect on Cloud Amount

All – scaled		Ground Observers			
		Clr	PC	MC	OV
S A T	Clr	163	40	12	6
	PC	72	103	66	27
	MC	22	64	80	78
	OV	16	22	56	230

Snow/Ice		Ground Observers			
		Clr	PC	MC	OV
S A T	Clr	*147*	*27*	8	10
	PC	67	*75*	*35*	19
	MC	**35**	59	*68*	**95**
	OV	18	**33**	52	**309**

Cloud Layer Comparison

Cloud Layers		Ground		
		No Cloud	Single	Multi
Sat	No Cloud	950	615[i]	100
	Single	306	2030	581
	Multi	249	3306[ii]	1035

[i] Conclusion: Satellite misses sparse clouds, esp. high

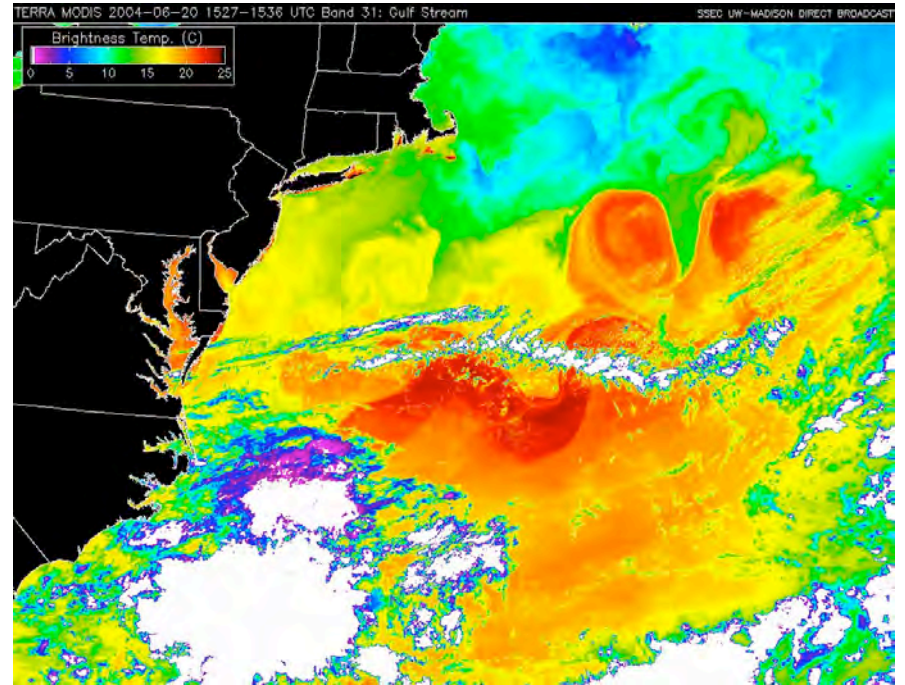[ii] Conclusion: Ground and satellite views are complementary. Cloud edge issue?

- Some other things you may see…

Inverse contrails (distrails)

Aircraft sometimes make holes in clouds!
You might also see contrail shadows on clouds

Contrail Cousins

Cloud "zippers" on Father's Day, 2004

Cloud/Contrail Protocol Summary

- No cost
- No equipment
- Simple
- Contrail website:

http://asd-www.larc.nasa.gov/GLOBE

- Do any time
- Takes 5–10 minutes
- WE WANT YOUR DATA!!!