

GLOBE Science: Clouds and Contrails

Dr. Lin Chambers, NASA Langley

1st NASA Langley GLOBE workshop

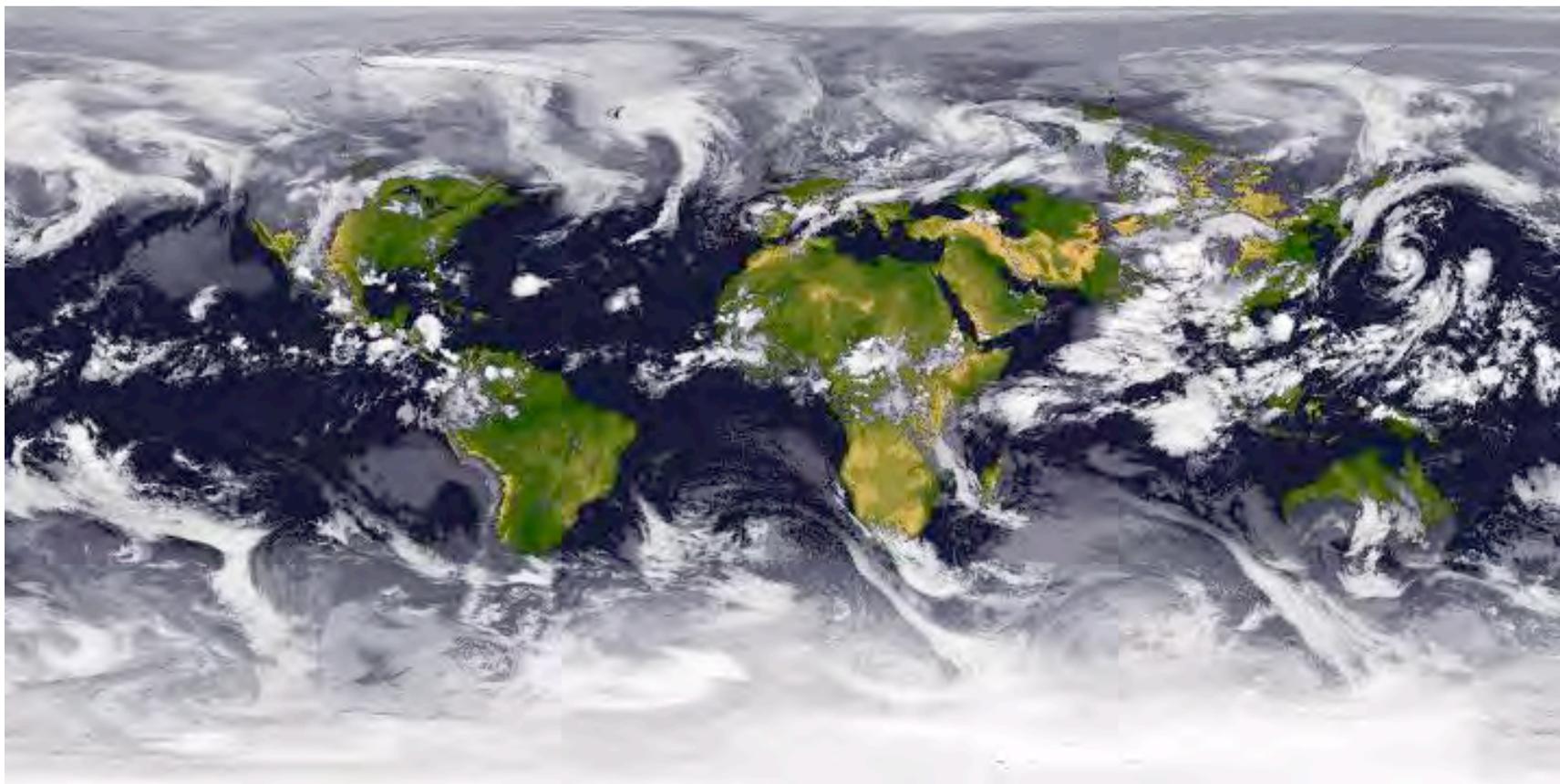
April 6, 2004

Objectives

- Obtain contrail (and other cloud) information from the largest possible network of ground observers
- Use to:
 - Validate satellite retrieval algorithms
 - Improve contrail prediction methods

Global Cloud Cover

August 26, 1993



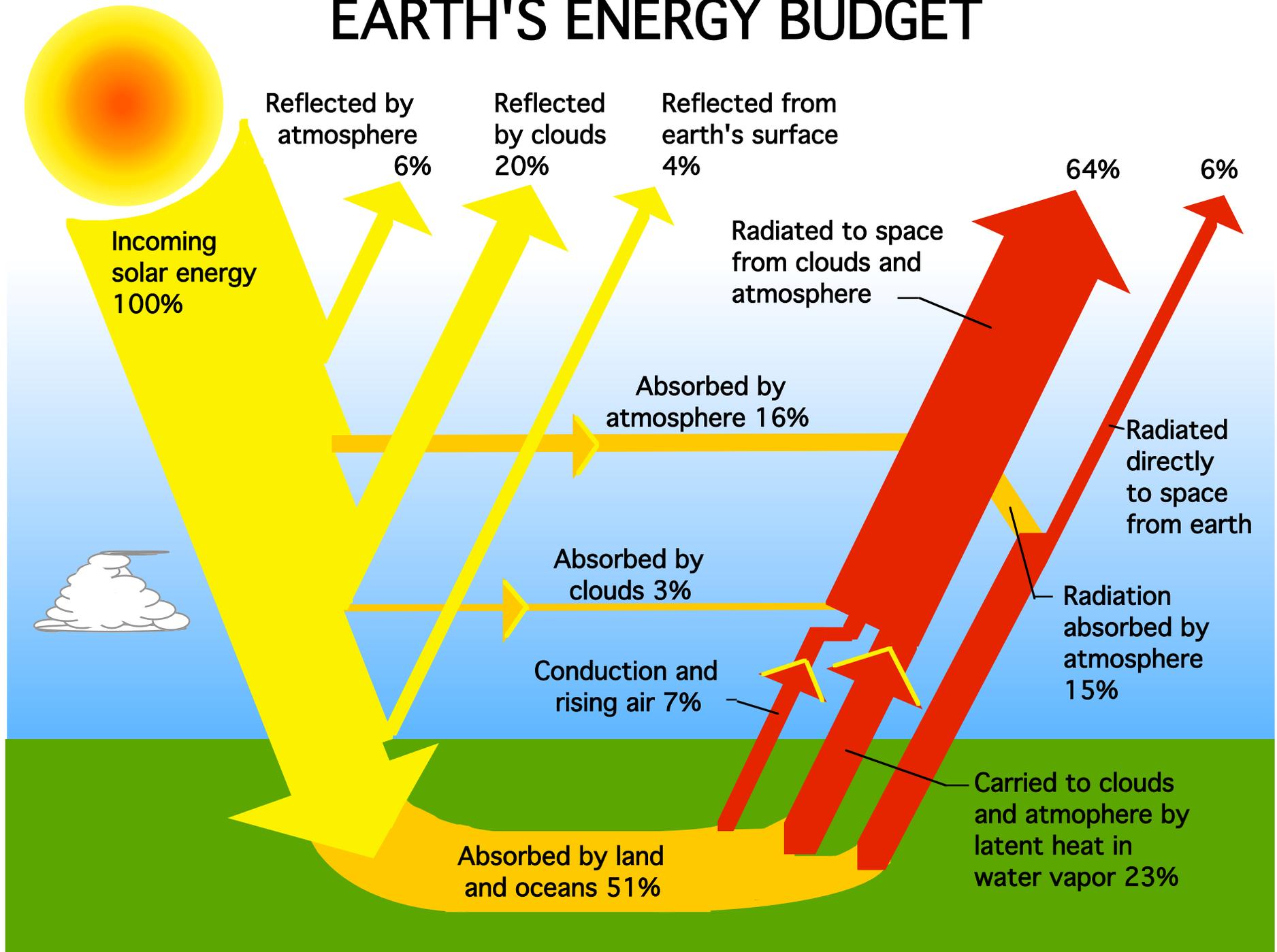
Do Humans Affect Cloud Cover?



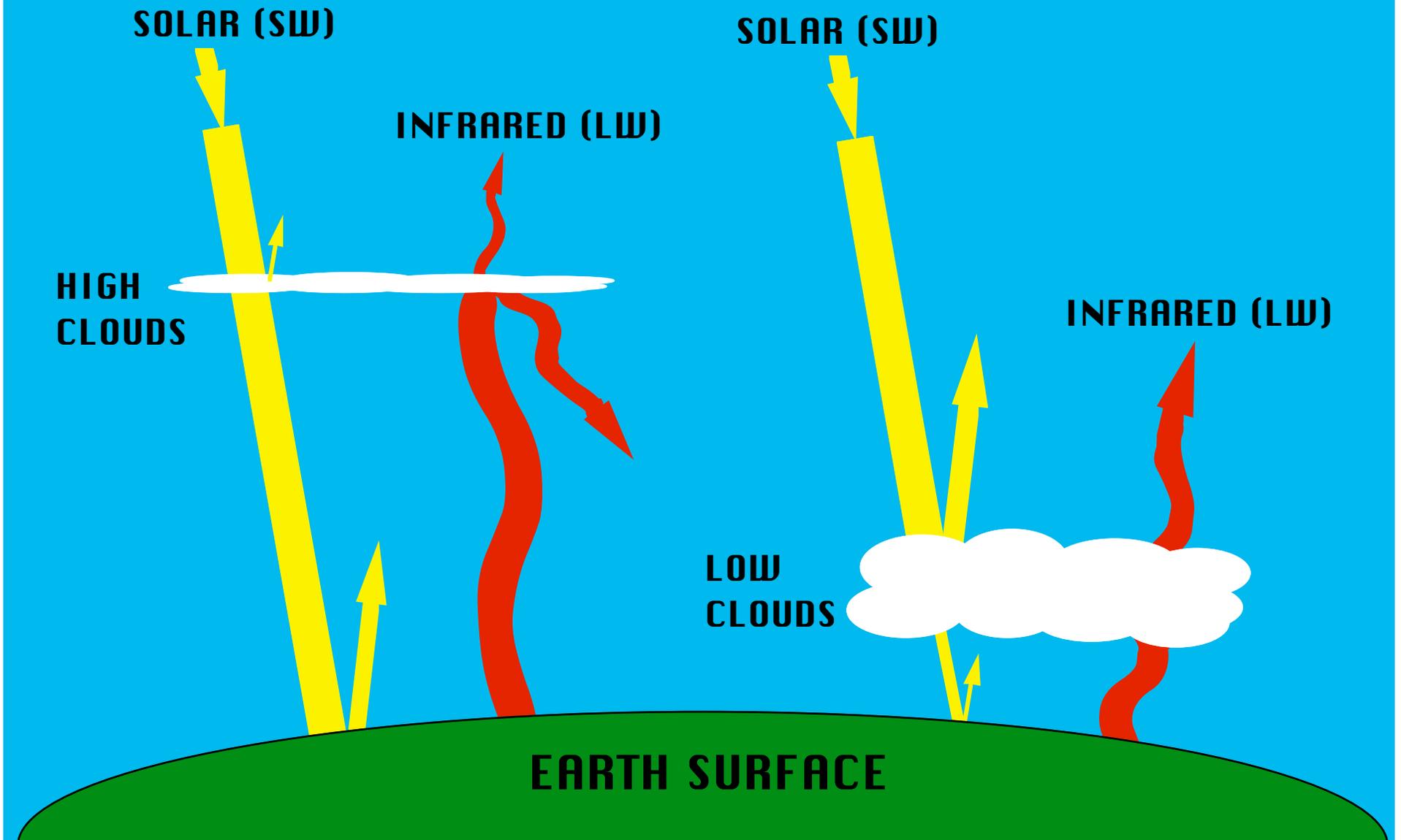
Photo by Louis Nguyen

1. 26. 2001

EARTH'S ENERGY BUDGET



CLOUD EFFECTS ON EARTH'S RADIATION

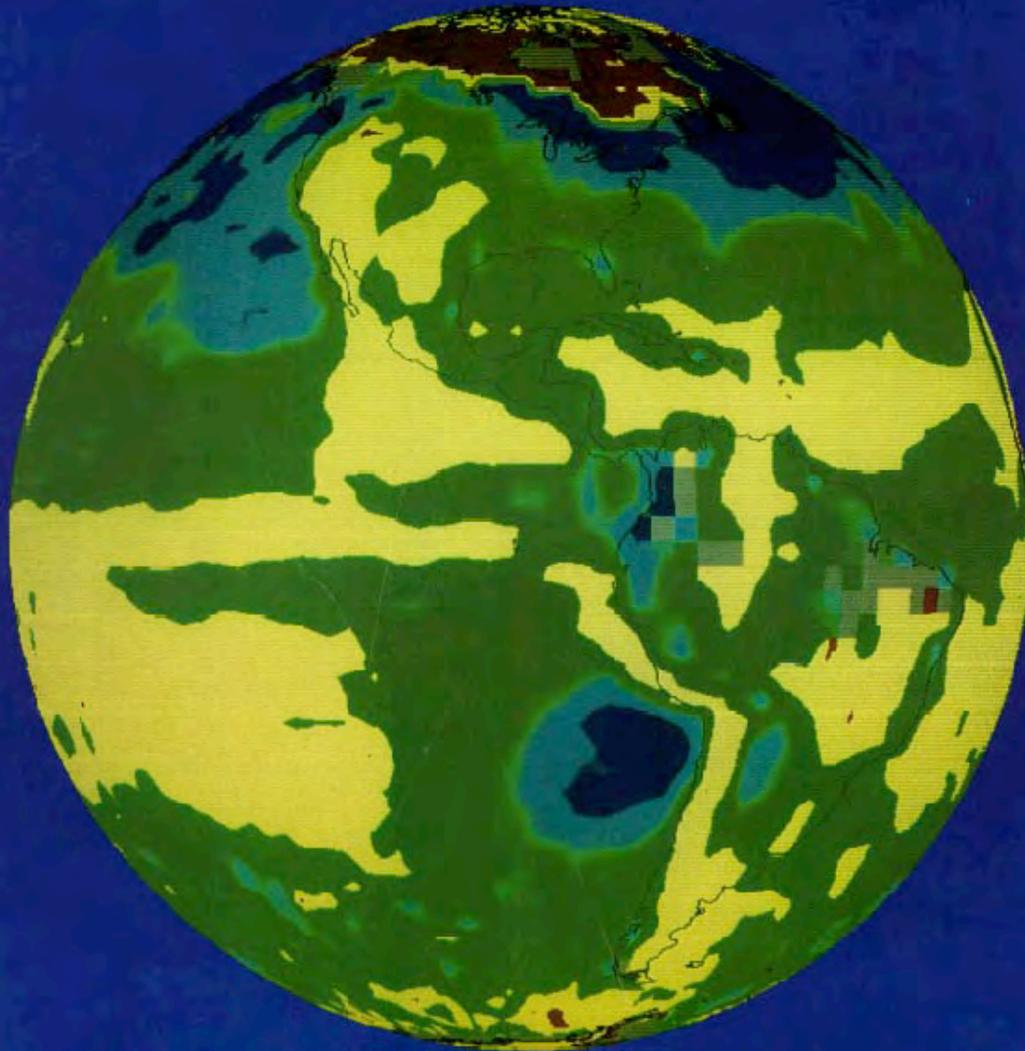


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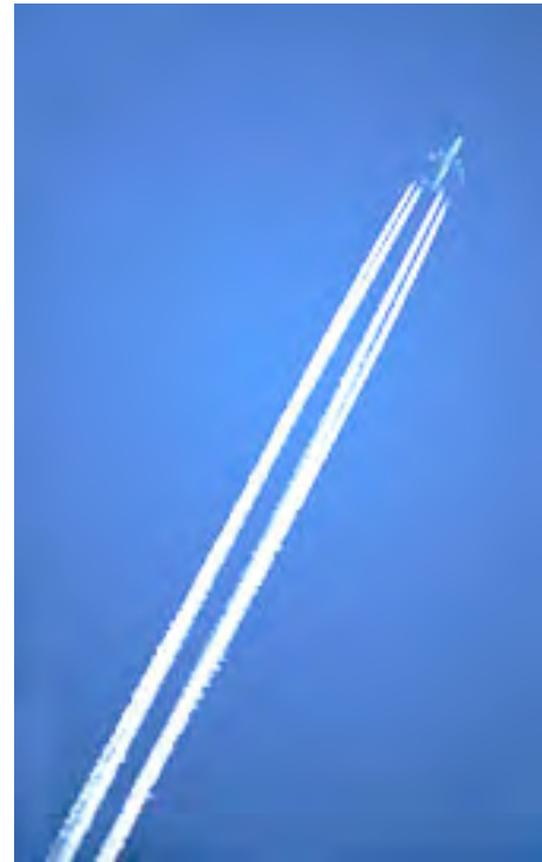


Derived Product

**Requires Cloud
Detection and
Cloud Property
Retrieval**

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”



Contrails have been around for a long time!



- They were first described in the scientific literature in 1919.
- During WWII, contrails sometimes littered the skies during aerial combat.

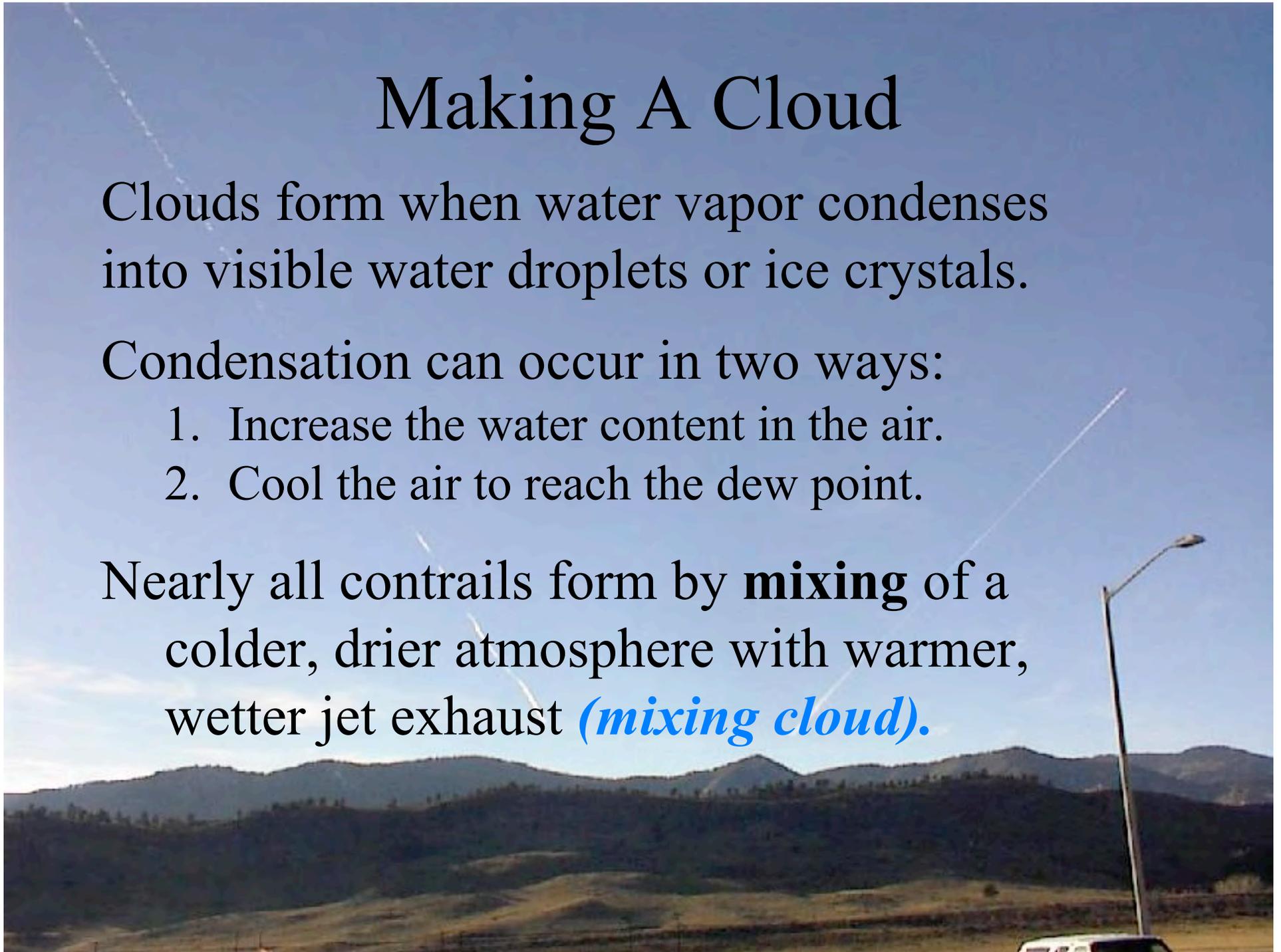
Making A Cloud

Clouds form when water vapor condenses into visible water droplets or ice crystals.

Condensation can occur in two ways:

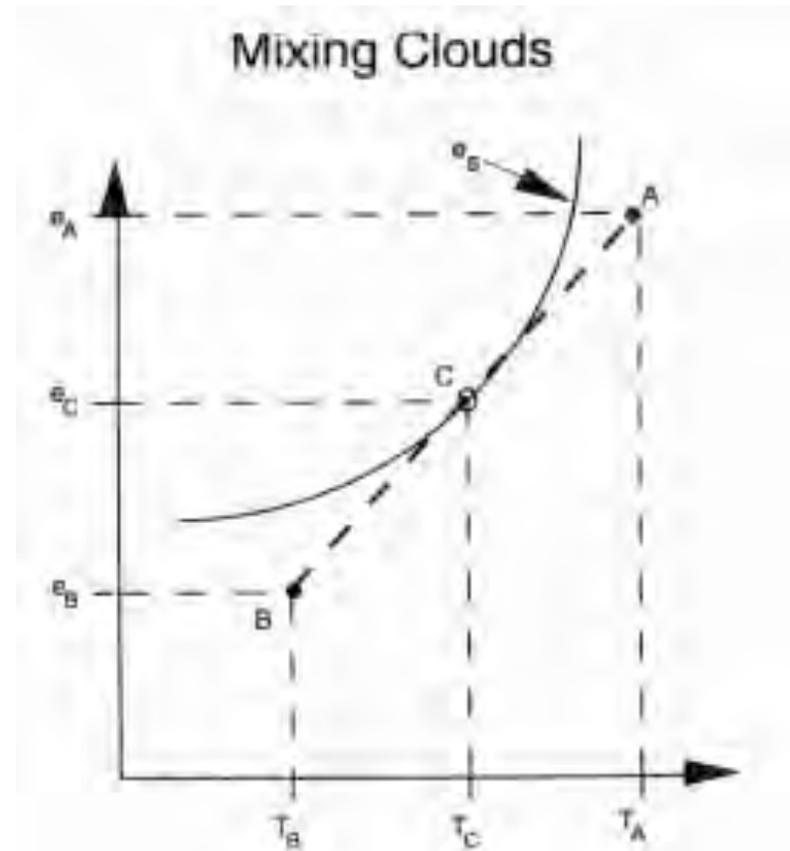
1. Increase the water content in the air.
2. Cool the air to reach the dew point.

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



Mixing clouds

- Mixing clouds form because the ability of air to 'hold' water vapor increases rapidly with temperature.
- Like contrails, the cloud that forms on your breath during a cold day is a mixing cloud.



Why Do We Study Contrails?



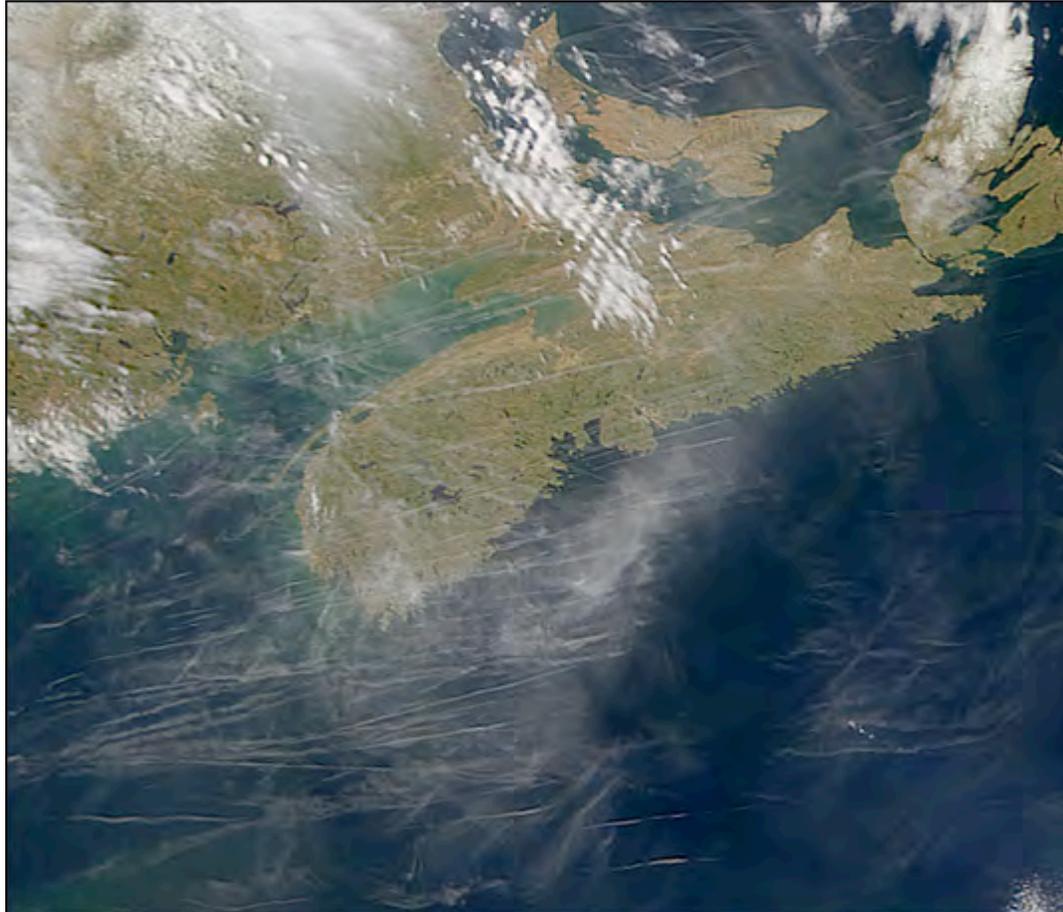
When the upper atmosphere is moist enough, the contrails continue to grow.



Under these conditions, the contrails become *persistent*.

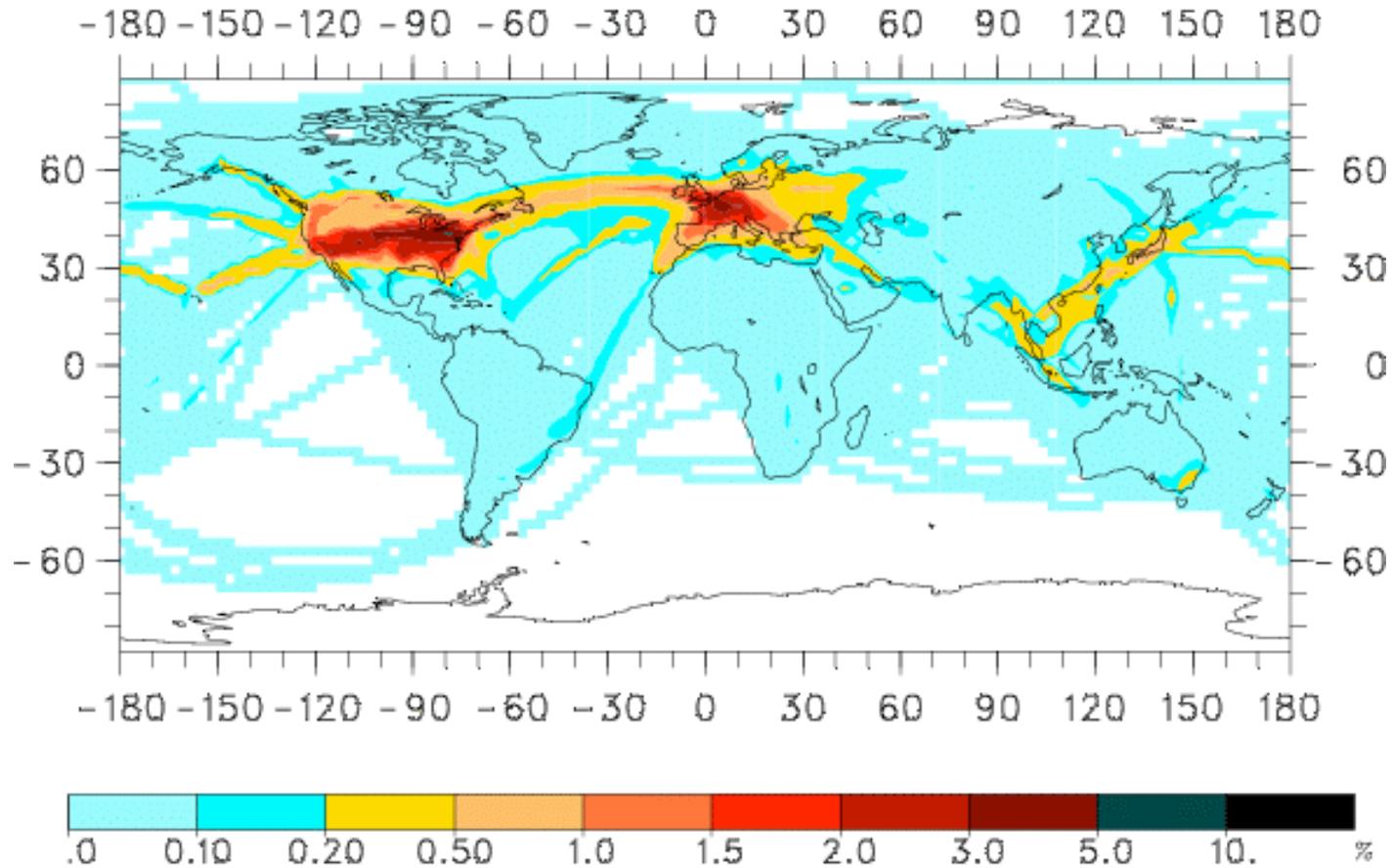
Persistent
contrails
occasionally
cover large
areas.

Like cirrus
clouds,
contrails
likely
contribute to
global
warming.



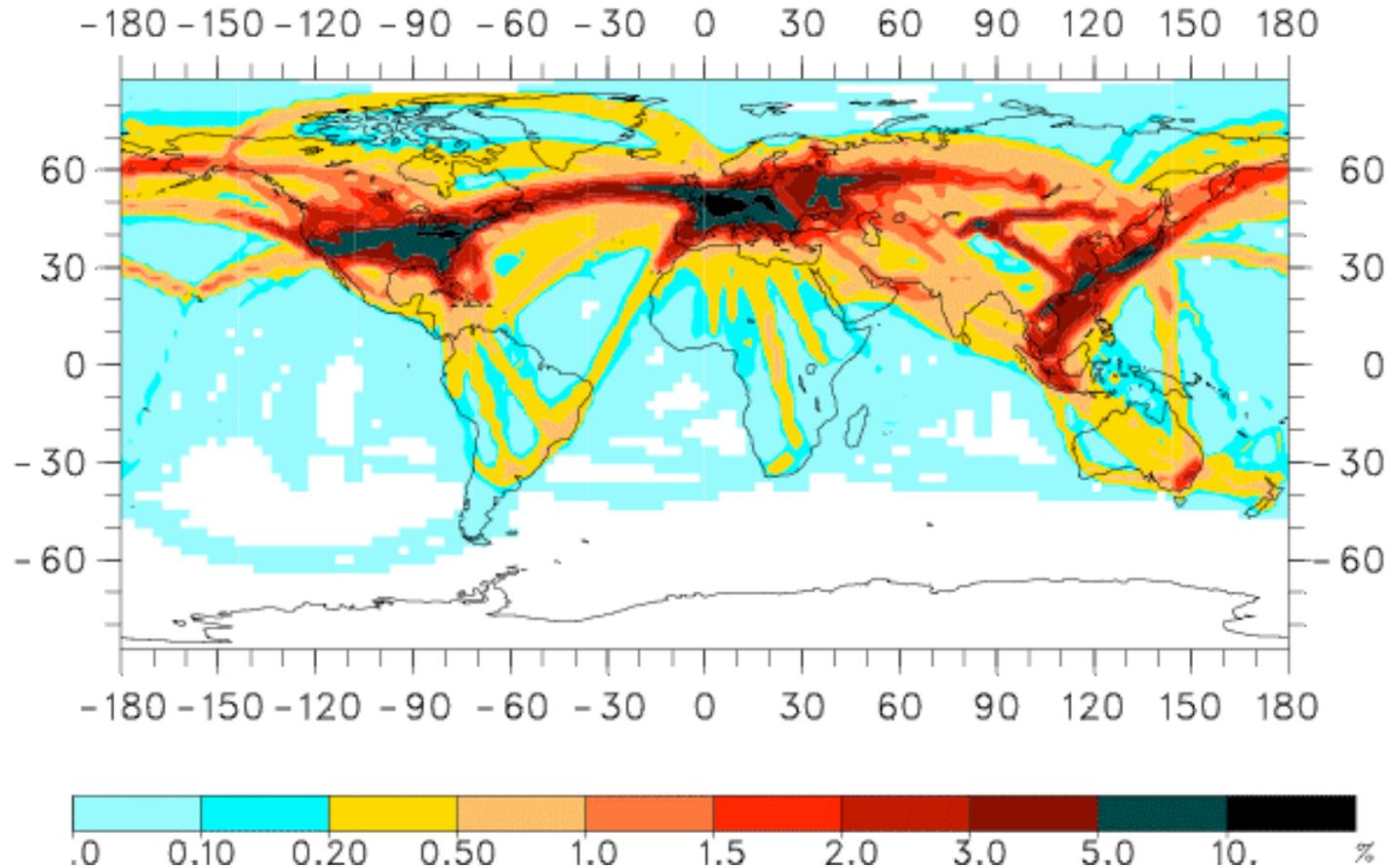
We currently
estimate that
contrails add
an additional
0.5 to 5
percent
warming to the
greenhouse gas
effect.

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, the warming due to contrails may be 2.5 to 25 percent of the current greenhouse gas warming.

A photograph of a sunset sky filled with numerous contrails. The sky transitions from a deep blue at the top to a bright orange and yellow near the horizon. Two tall, thin light poles are visible in the lower foreground. The text "GLOBE and Contrails" is centered in the middle of the image in a black serif font.

GLOBE and Contrails

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)



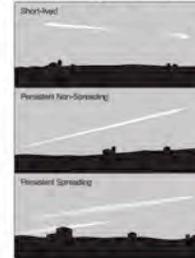
Nimbostratus



Cumulonimbus

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

Contrail Type (Record the number of each type observed)



Short-lived Contrails

How many do you see? _____

Persistent Non-Spreading Contrails

How many do you see? _____

Persistent Spreading Contrails

How many do you see? _____

Three-quarters or More of the Sky is Visible:

Cloud Cover (Check One)



No Clouds

0%-No Clouds



Clear

<10% Clouds



Isolated

10-25% Clouds



Scattered

25-50% Clouds



Broken

50-90% Clouds



Overcast

>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

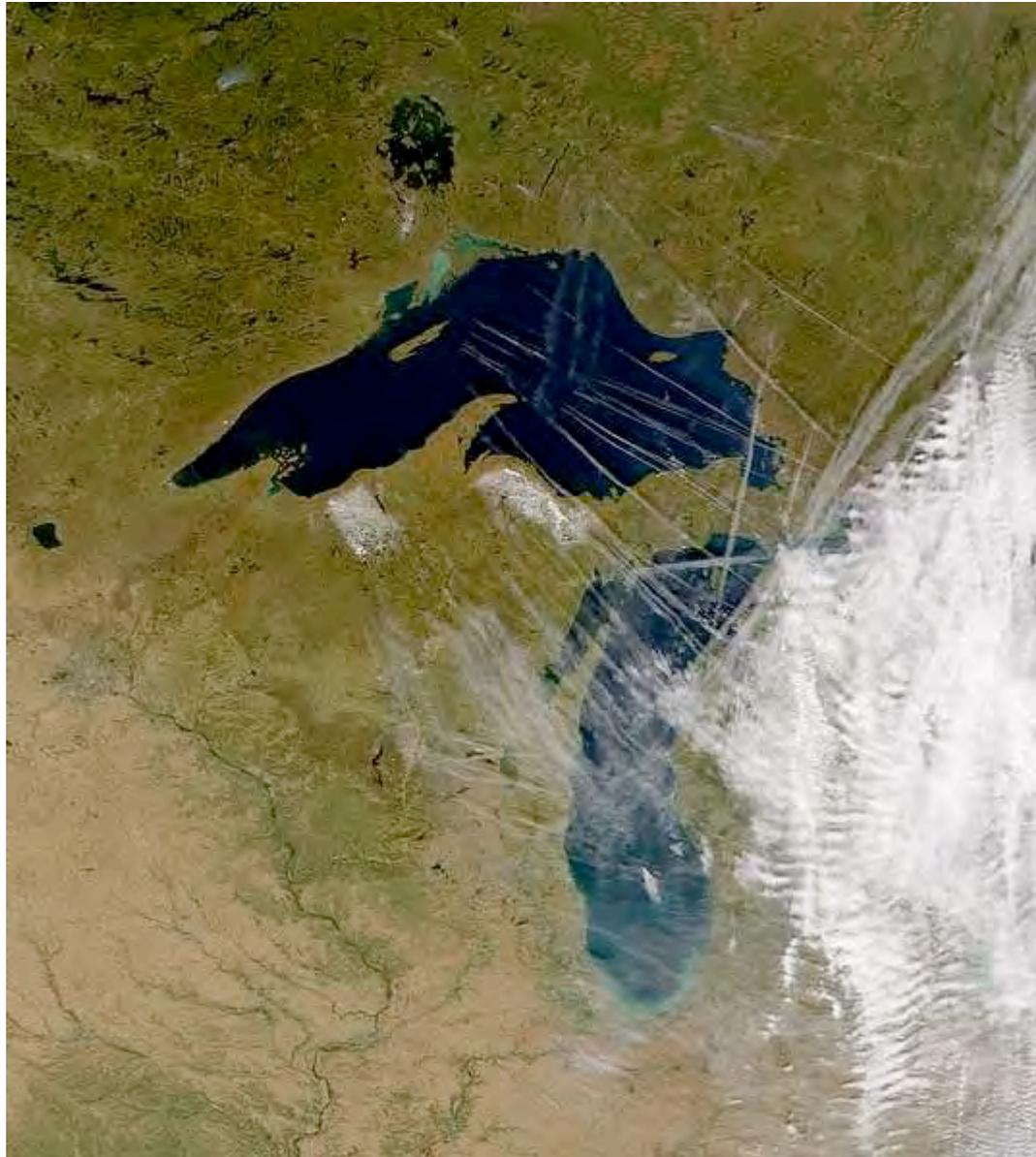


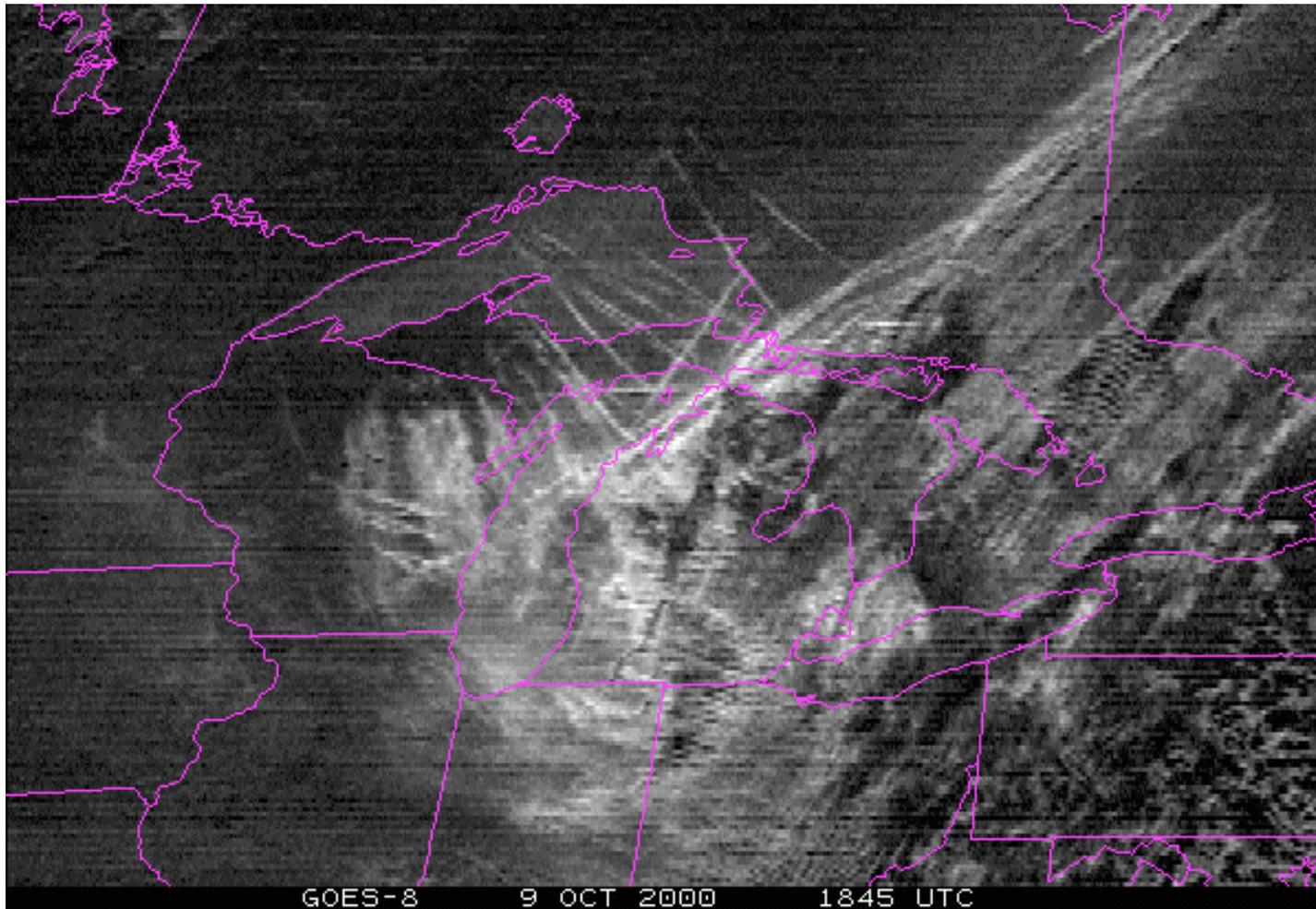
Haze

Comments: _____

Our estimates of the climatic effects of persistent contrails are still uncertain.

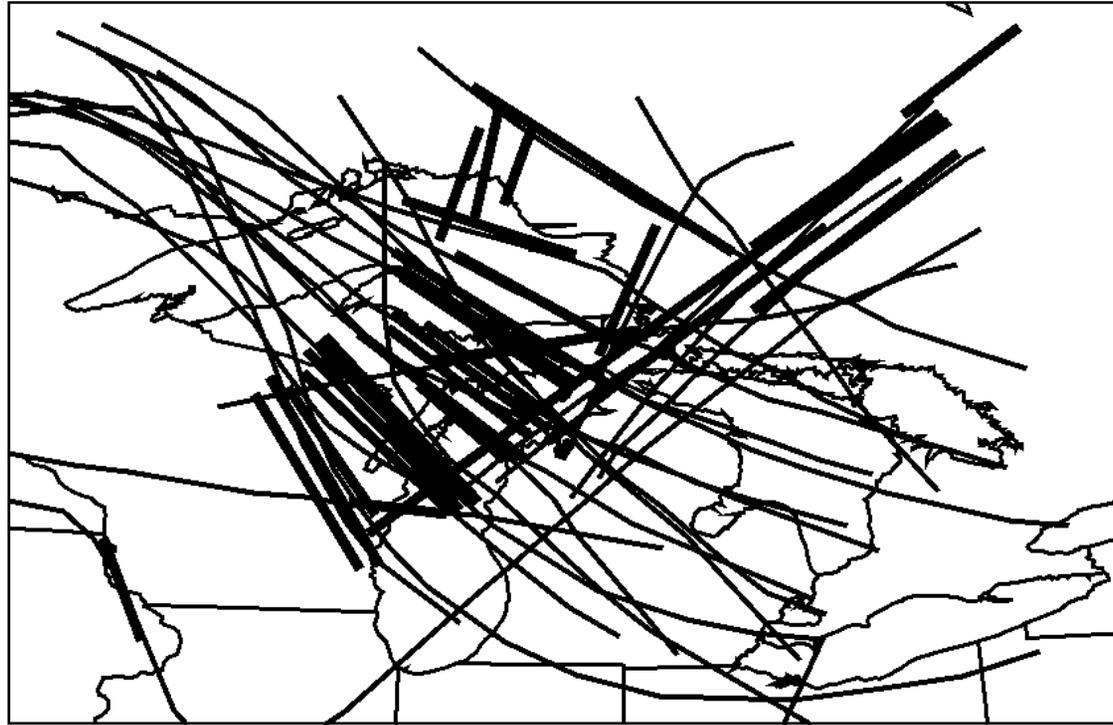
We still have trouble estimating contrail coverage.





Most contrails are still smaller than the resolution of most satellites.

17:45 UTC 9 October 2000



Using inventories of commercial aircraft flight data and satellite data, we are learning more about the growth and coverage of contrails under different atmospheric conditions. Surface observations from GLOBE would improve our studies.

Inverse contrails (distrails)



Aircraft sometimes make holes in clouds!

Cloud/Contrail Protocol Summary

- No cost
- No equipment
- Simple
- Website: <http://asd-www.larc.nasa.gov/GLOBE>
- Do any time
- Takes 5–10 minutes
- **WE WANT YOUR DATA!!!**