

The mysterious world of fog and dew

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*The Sun and Fog contested
The Government of Day —
The Sun took down his Yellow Whip
And drove the Fog away —
Emily Dickinson*

Definitions – NWS glossary

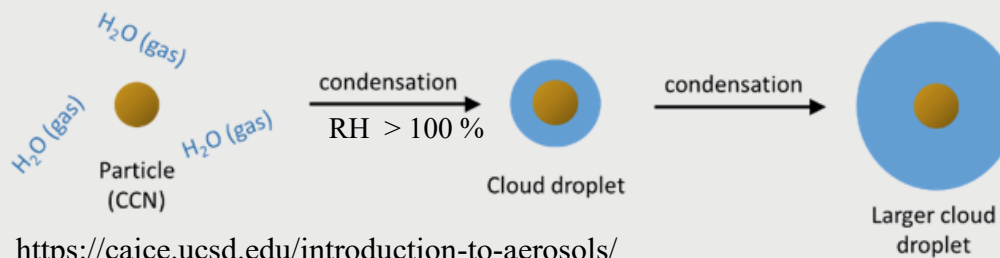
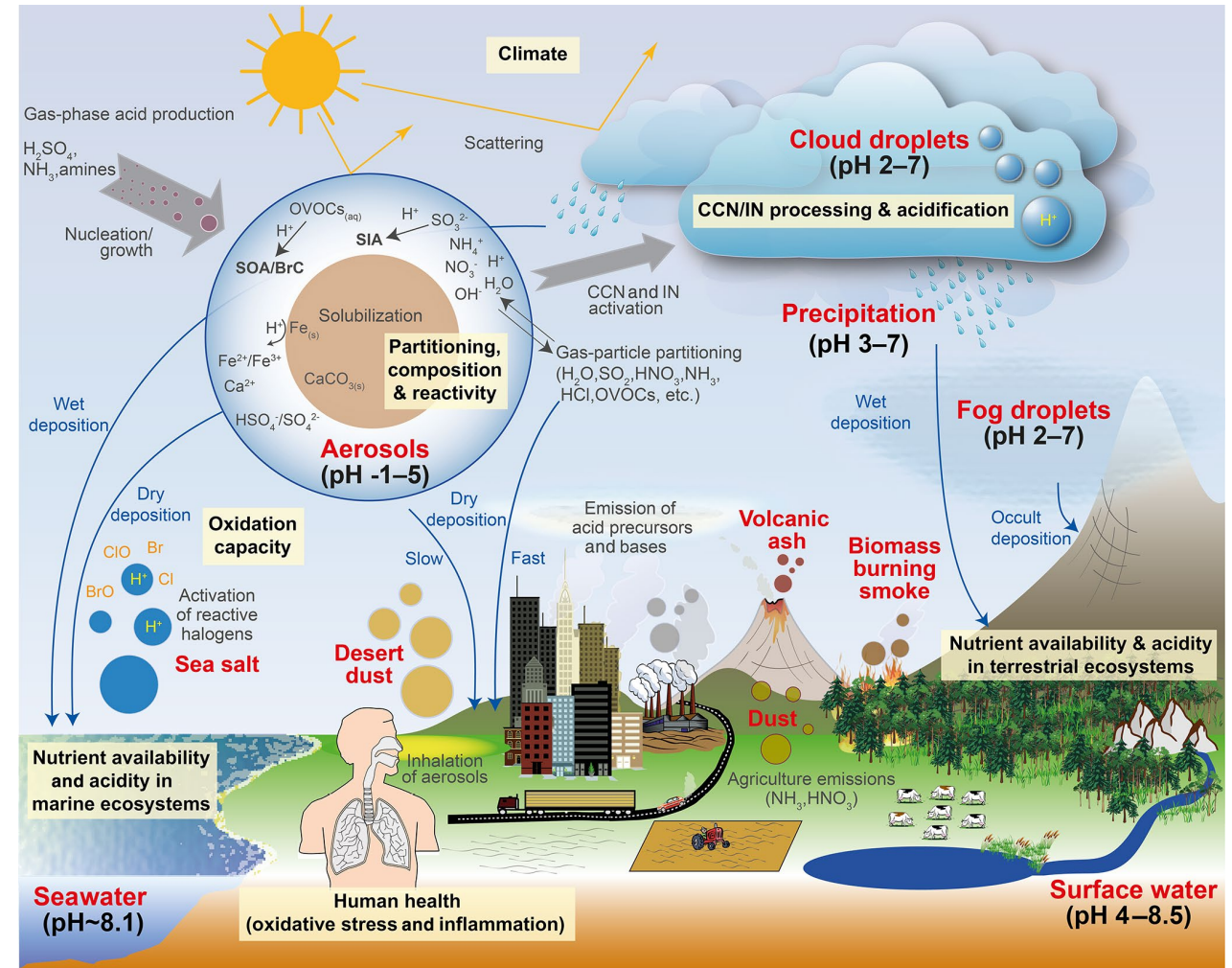
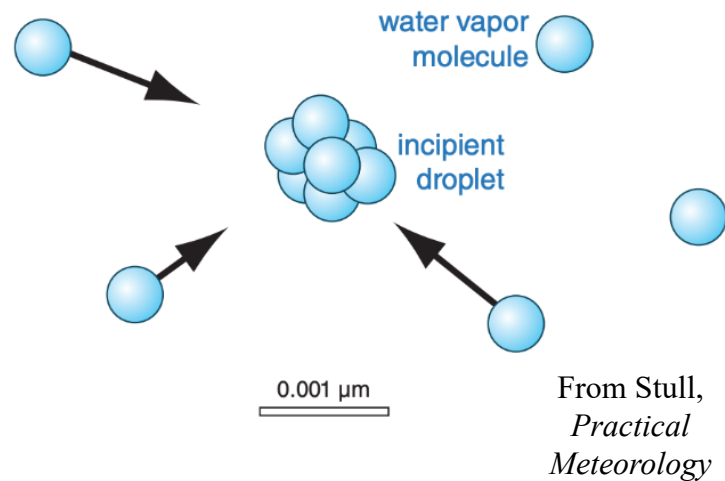
- Fog:
 - Water droplets suspended in the air at the Earth's surface. Fog is often hazardous when the visibility is reduced to $\frac{1}{4}$ mile or less.
- Dew:
 - Moisture that has condensed on objects near the ground, whose temperatures have fallen below the dewpoint temperature.



Fog drop formation

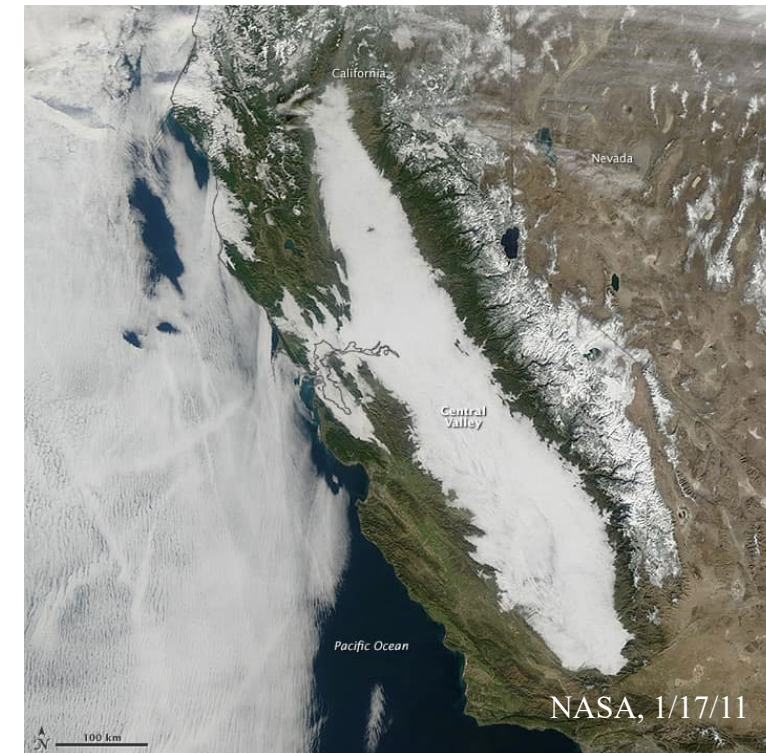
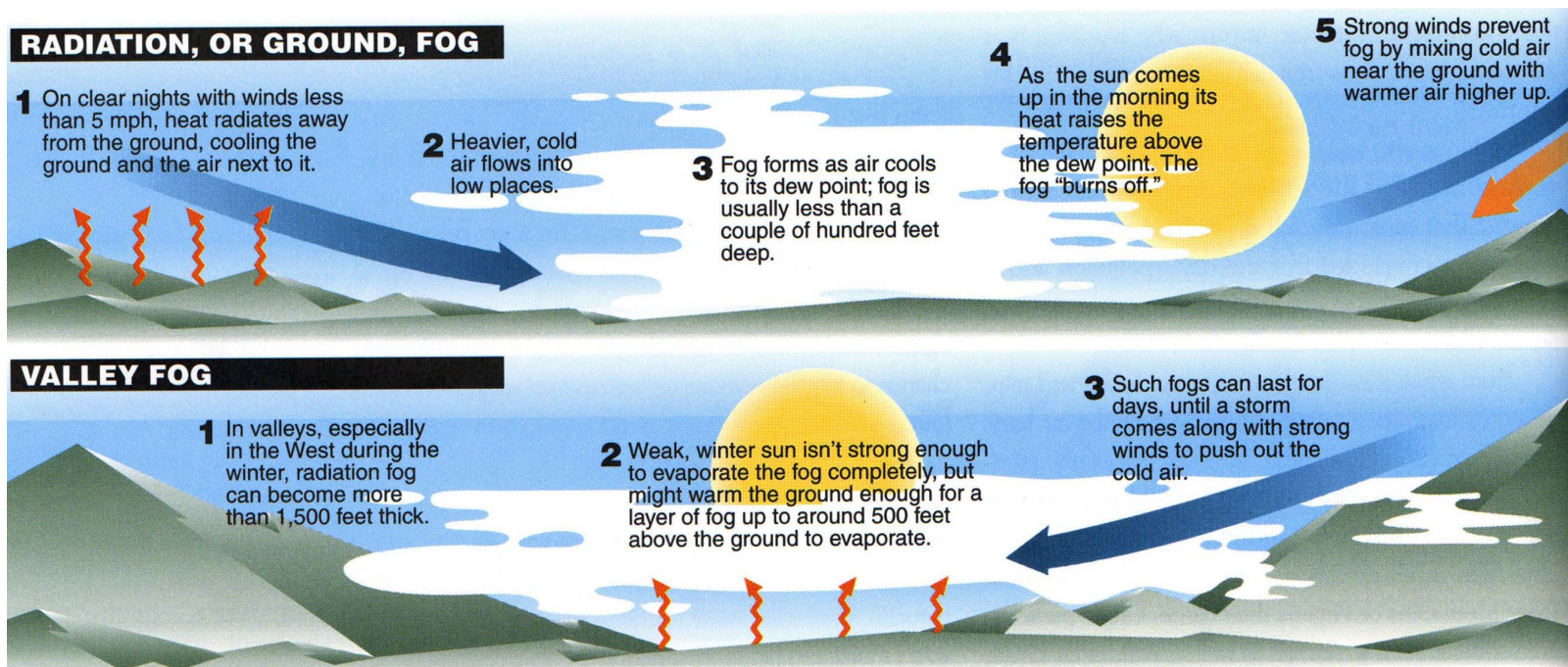
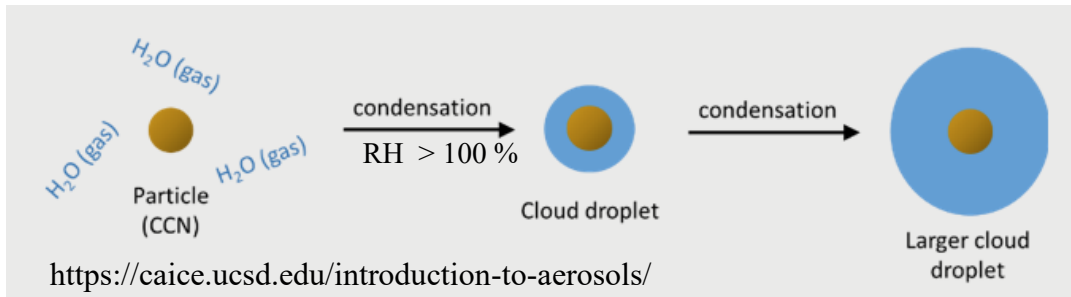
Pye et al. (2020)

a) Homogeneous nucleation

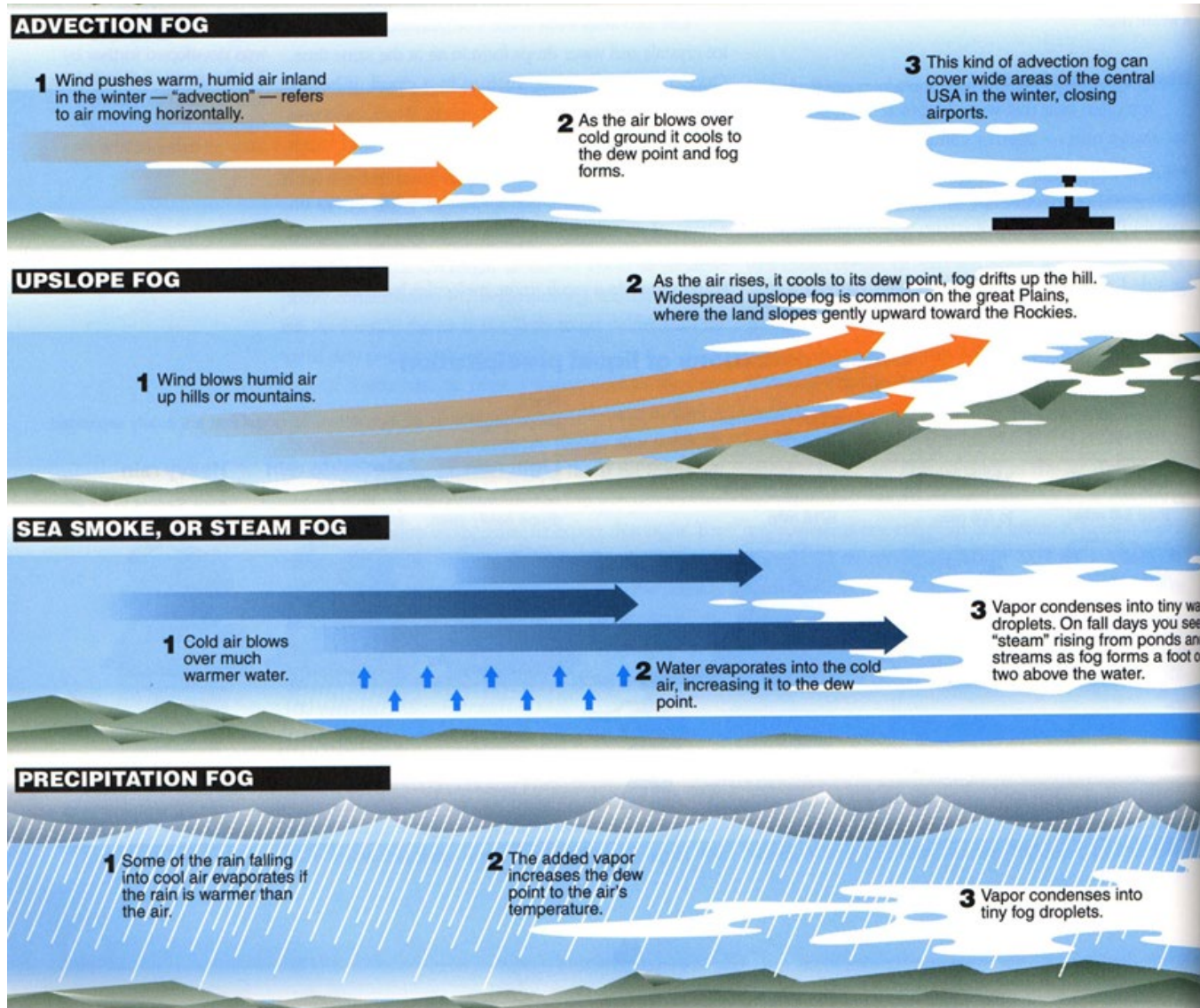


<https://caice.ucsd.edu/introduction-to-aerosols/>

Fog formation



More fog types



The USA Today Weather Book



<https://www.eoas.ubc.ca/courses/atsc113>

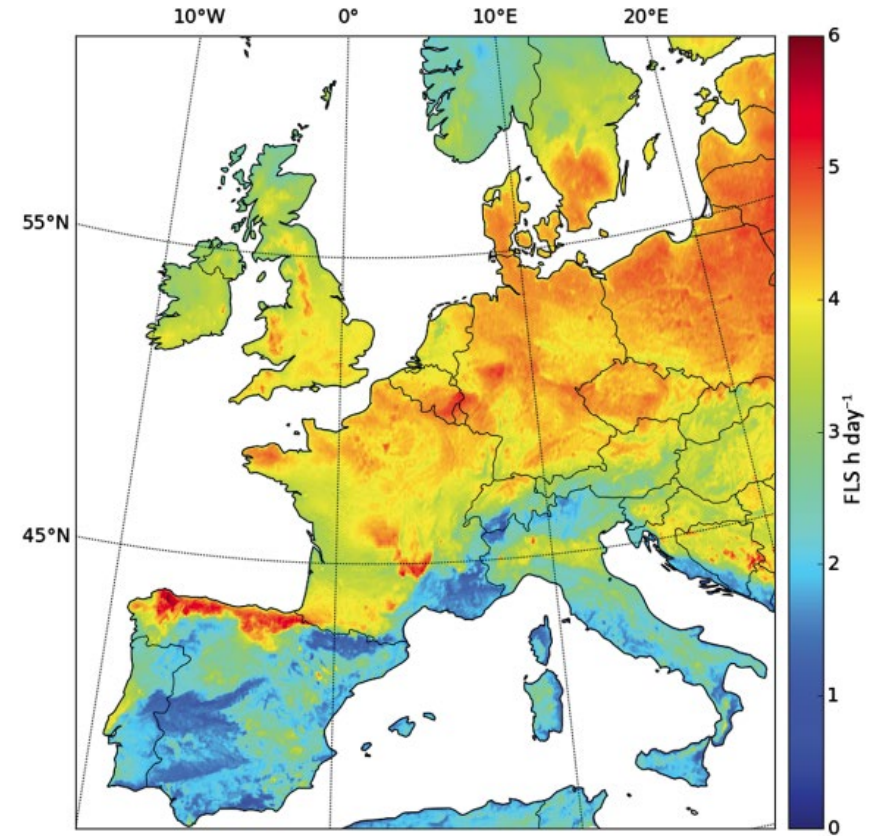
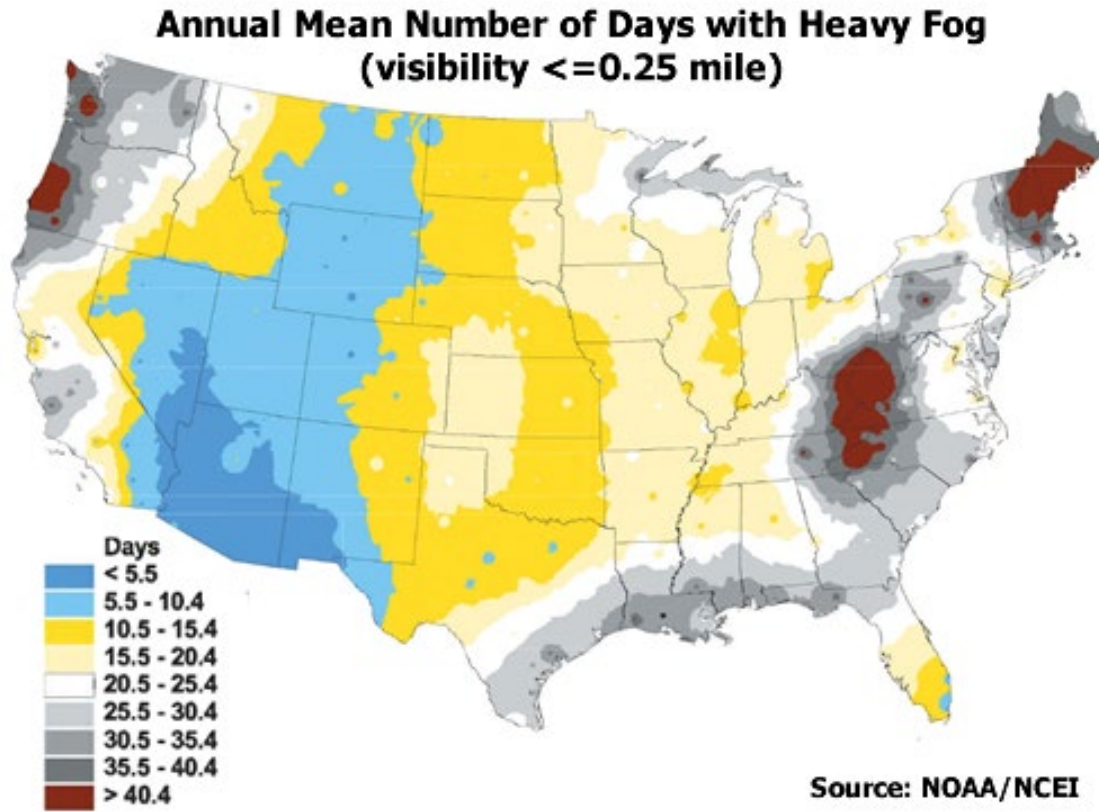


Figure 6. FLS h day⁻¹ averaged from 2006–2015 (342 328 scenes).

Egli et al. (2017) DOI:10.1002/qj.2941

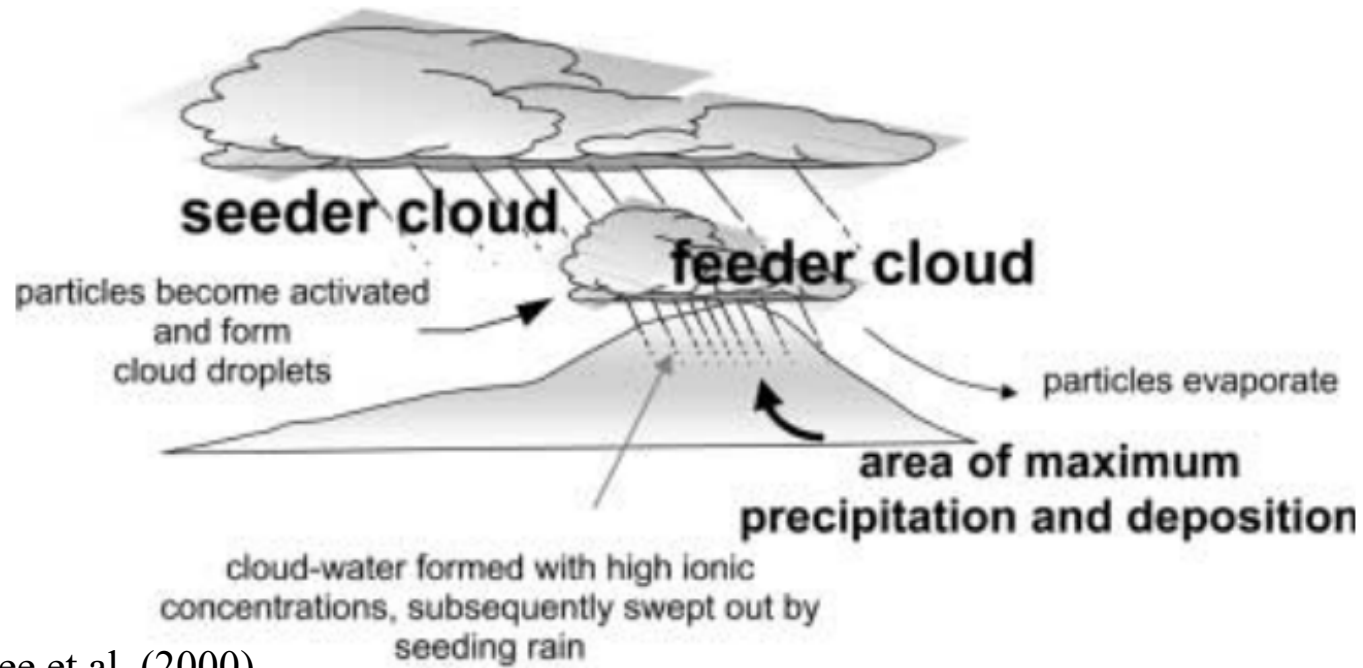
Fog frequency maps

Fog frequency can be determined by station observations and/or satellite



Supercooled fog and rime ice

Supercooled liquid fog drops instantly freeze on contact with surfaces below freezing



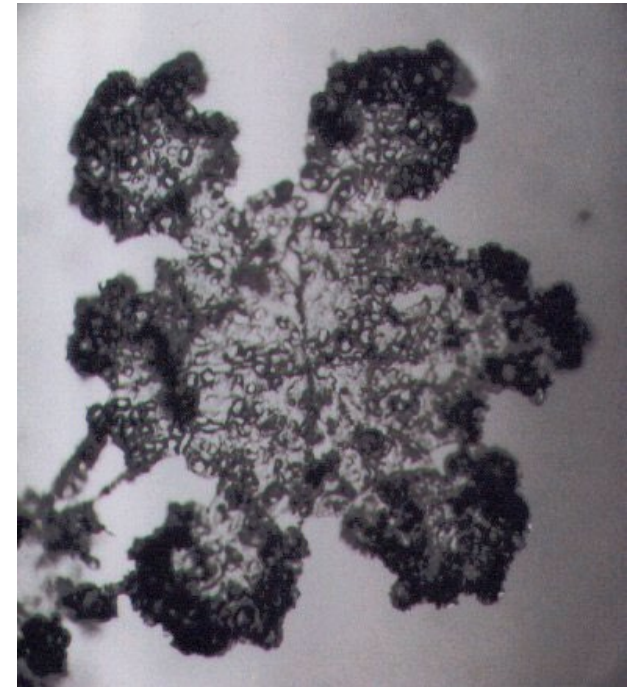
Lee et al. (2000)

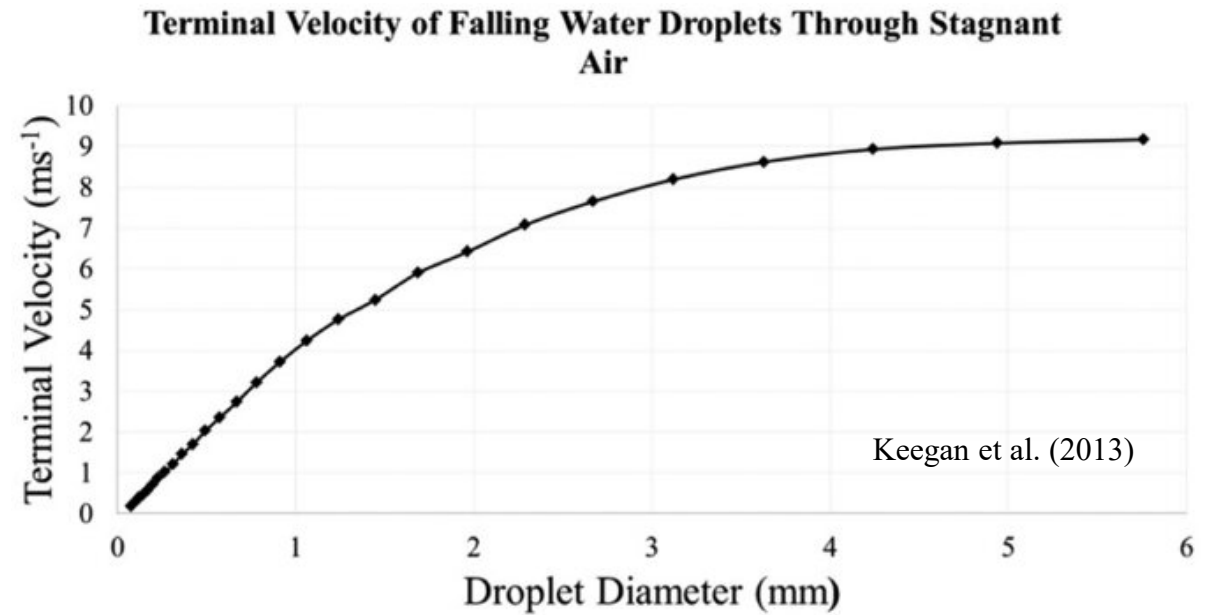
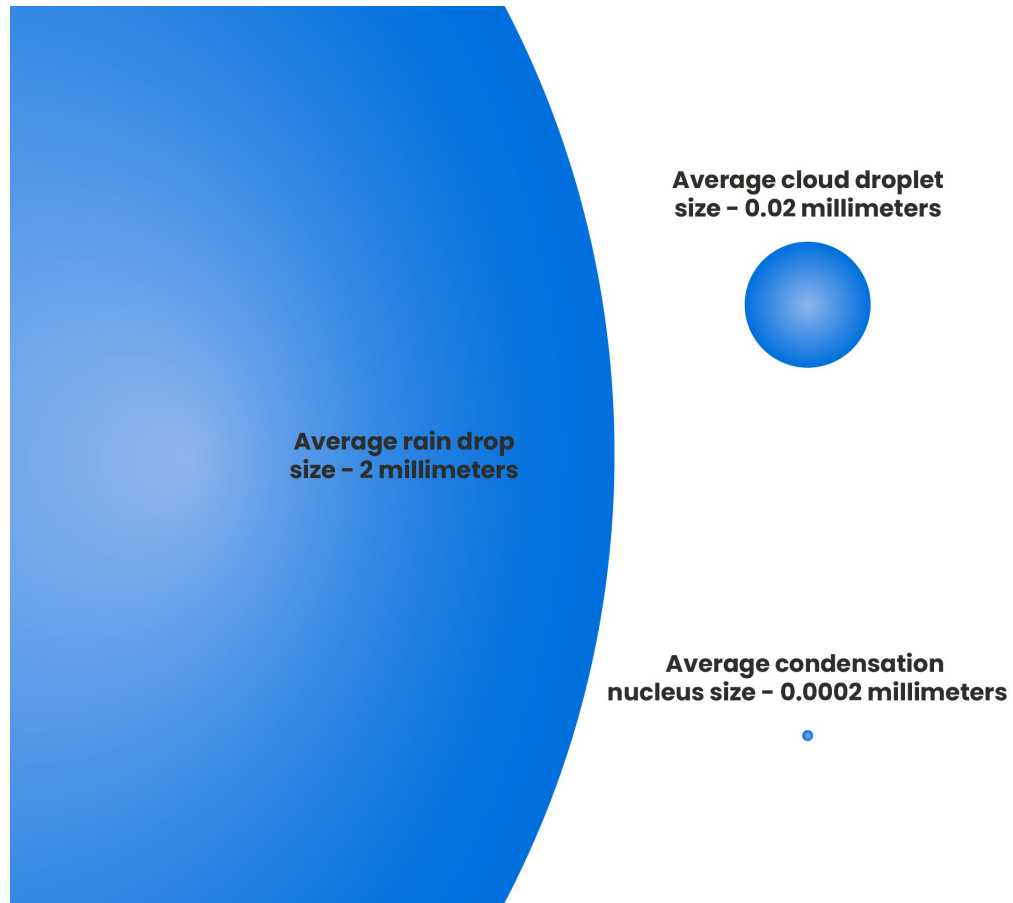
A brief aside: ice crystal riming

Falling snowflakes can capture supercooled cloud/fog drops



Formvar replica of rimed ice crystal from Mt. Rigi, Switzerland





Drop sizes

Fog drops stay in atmosphere MUCH longer than rain drops

Dew formation

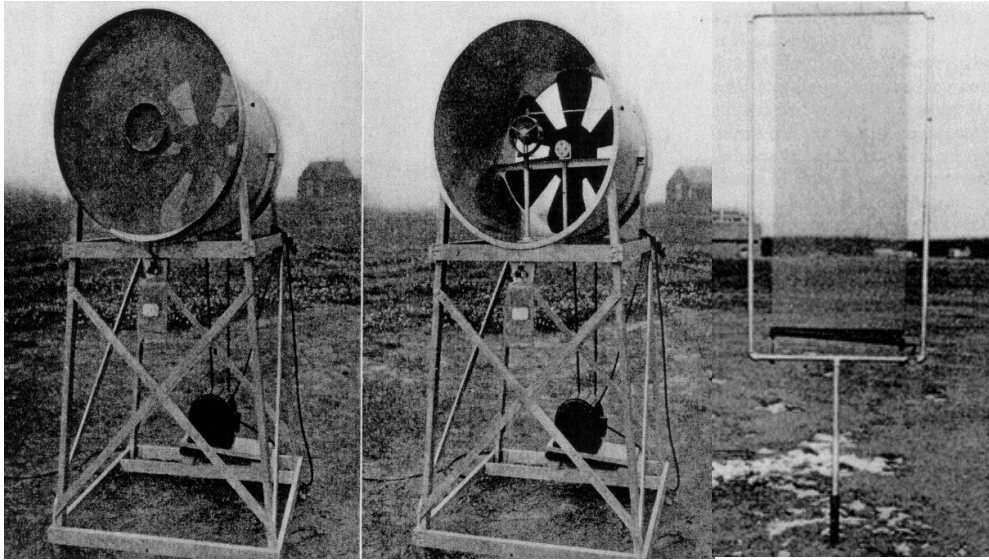


<https://www.flickr.com/photos/steve-wall/4680114666/in/photostream/>

Ersa, Greek goddess of dew



Radiative cooling of surfaces at night can drop their temperature below the air dewpoint leading to condensed water (dew) formation.



Houghton and Radford, 1938



History of fog research

- Round Hill Meteorological Station, 1928-38
- Houghton was MIT faculty, 1939-1970
 - Fog physical properties
 - visible and IR transmission through fog
 - fog dissipation
 - de-icing
 - military advisor



9th International Conference on Fog, Fog Collection, and Dew
Fort Collins, Colorado, July 2023

FOG EFFECTS





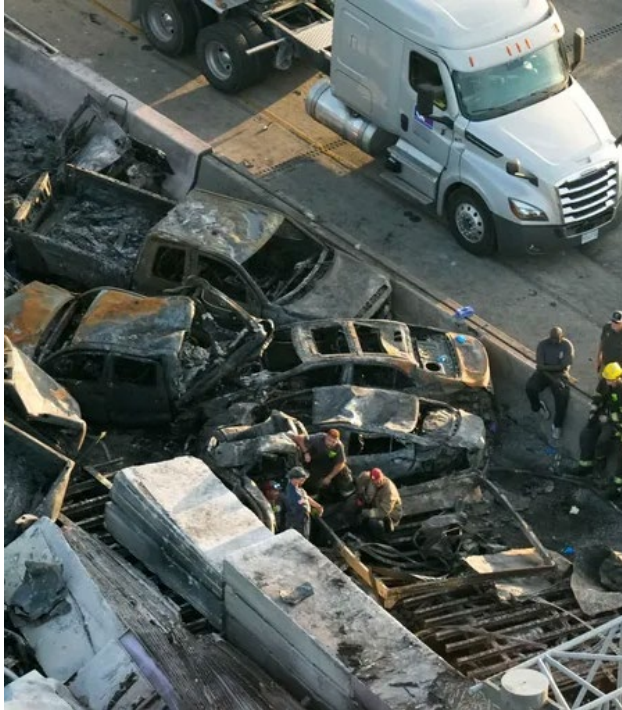
By Axel Hindemith - Axel Hindemith, Public Domain,
<https://commons.wikimedia.org/w/index.php?curid=902834>



By Brocken Inaglory, CC BY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=15799557>

The witches of Mt. Brocken

Brocken specter - shadow of an observer cast onto a cloud



Fog effects on infrastructure

- Transportation
 - Highways
 - Airports
- Structures
 - Ice/water loading
- Communications
 - Microwave interference

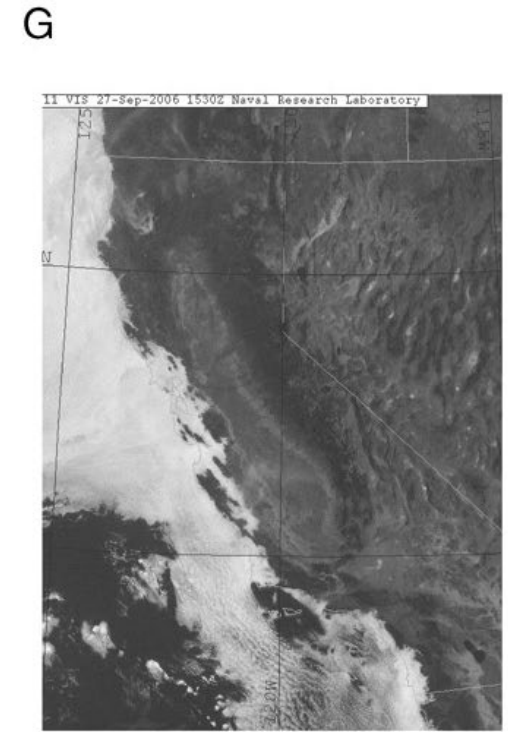
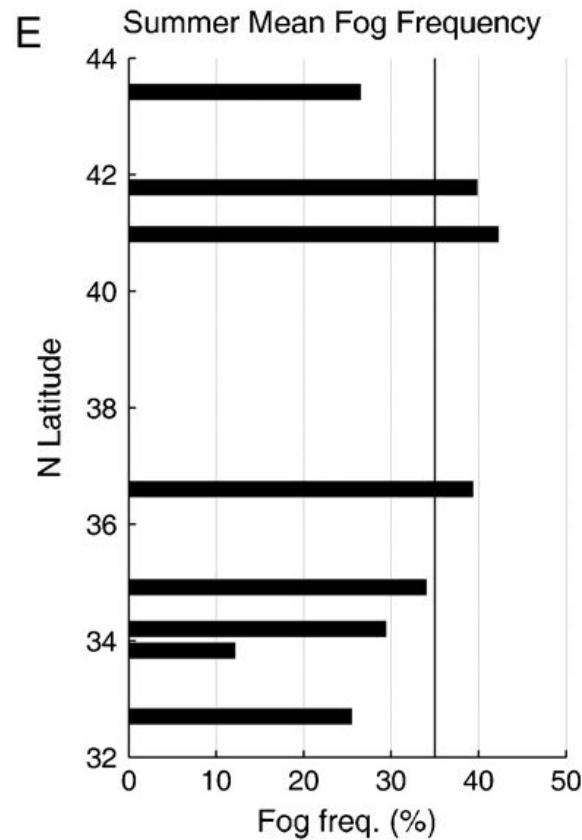


Fog and coastal redwoods

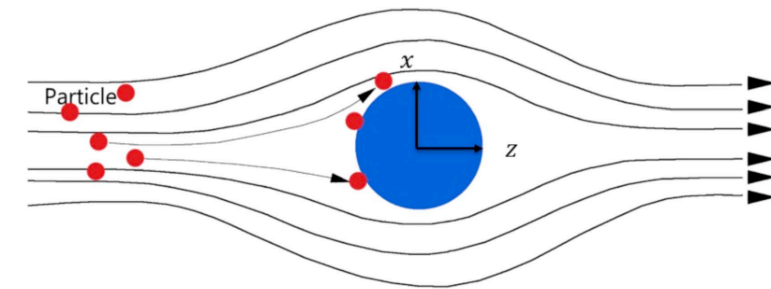


Fog and coastal redwoods

- Winter rains and dry summers
- Summer marine clouds formed over cool coastal upwelling zone
- Fogs: (1) reduce evapotranspiration from trees and (2) add water by drop capture & drip
- Decreasing coastal fog may increase summer drought stress



Johnstone and Dawson (2010)



Wang et al. (2016)



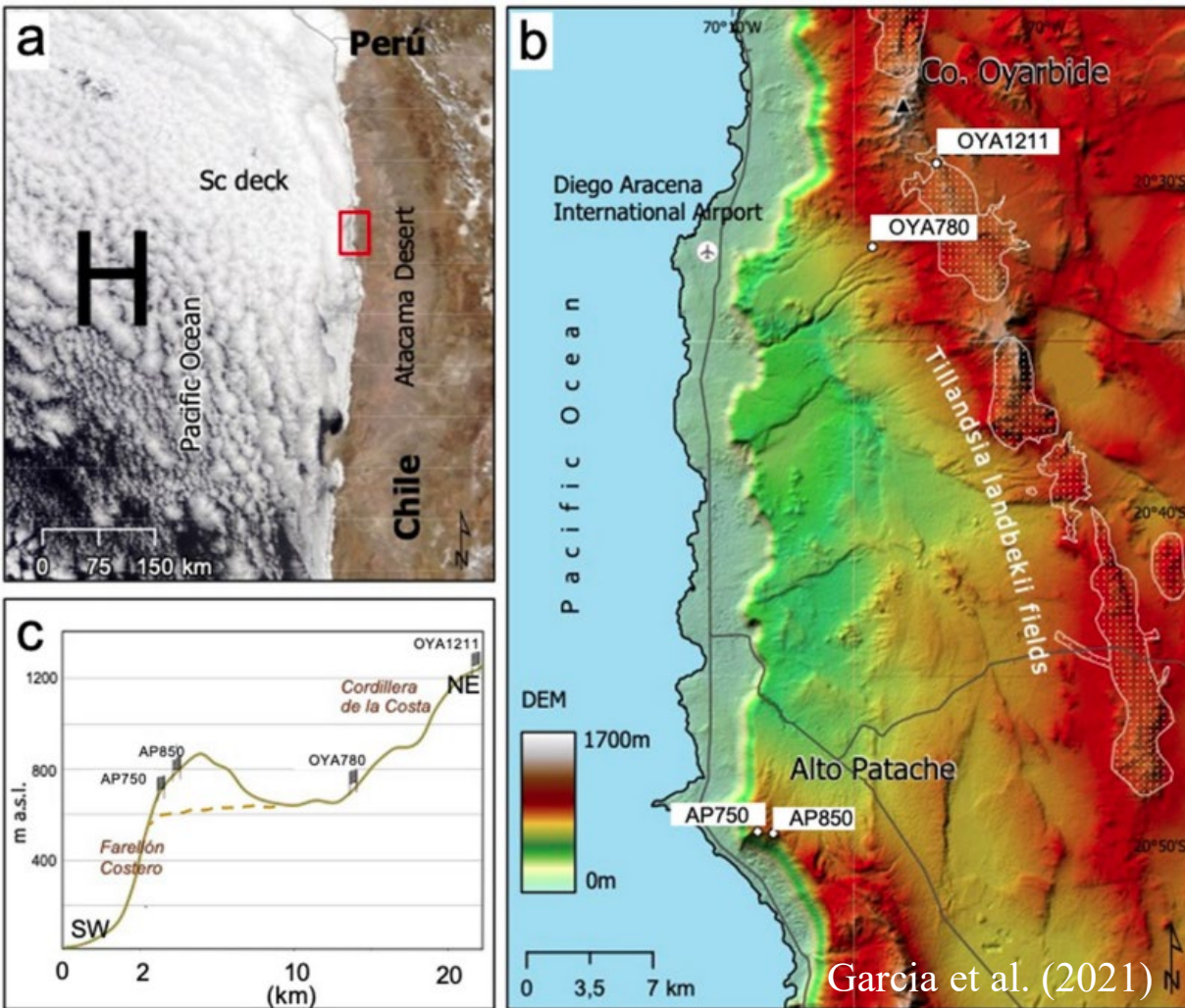
Photo: Forest and Kim Starr



<https://haleakalacrater.com/legends-of-haleakala-maui/>

HALEAKALACRATER.COM

Fog and the Haleakala Silversword



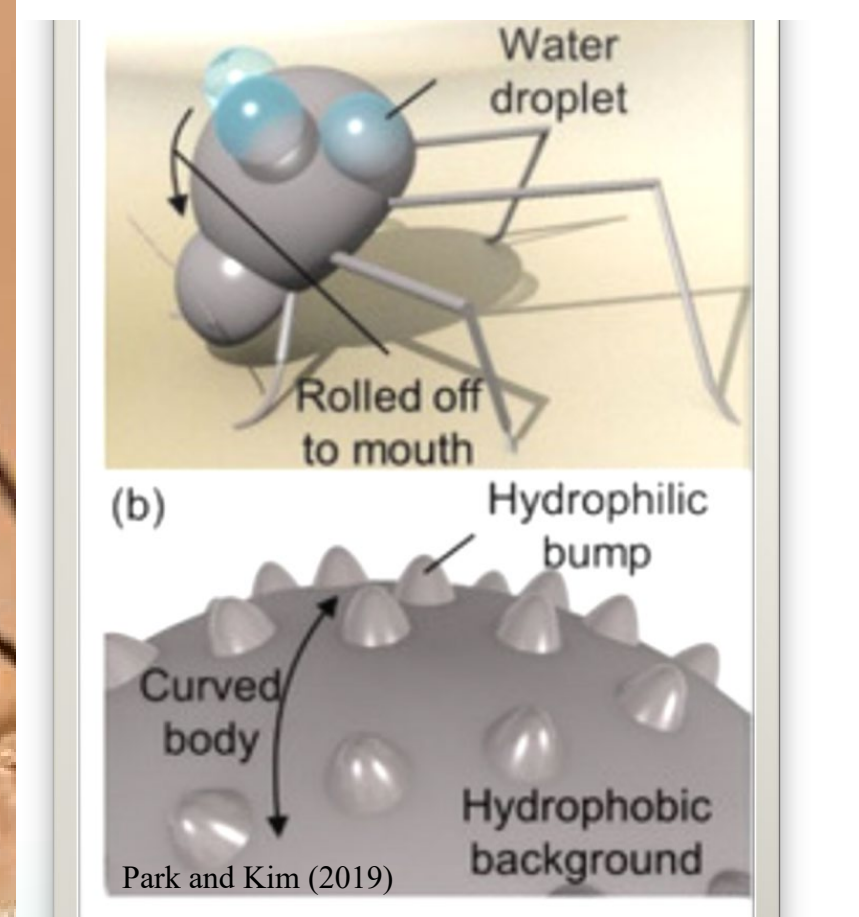
The Atacama desert is the driest nonpolar desert in the world – average annual rainfall is 0.6”

Fog and *Tillandsia landbeckii* in Chile’s Atacama Desert

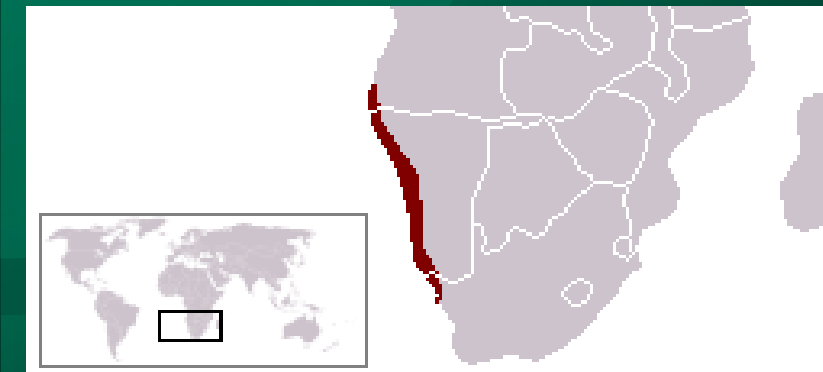


Fog and the Namib Dune Bushman Grass





Fog and the Namib desert beetle

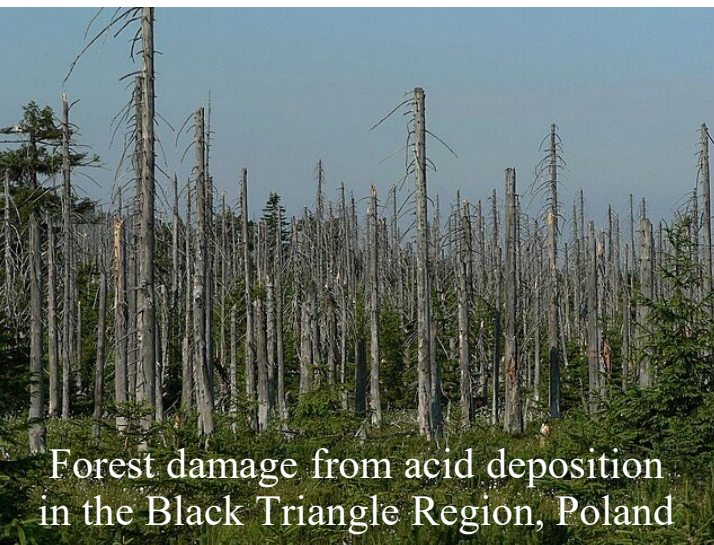




Forest damage from acid deposition – Mt. Mitchell, NC



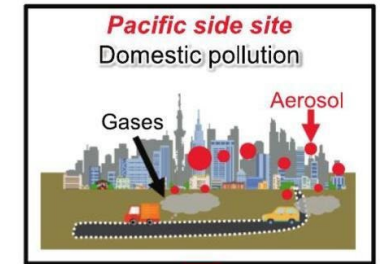
Fogs and intercepted clouds deliver pollutants to ecosystems through “occult” deposition



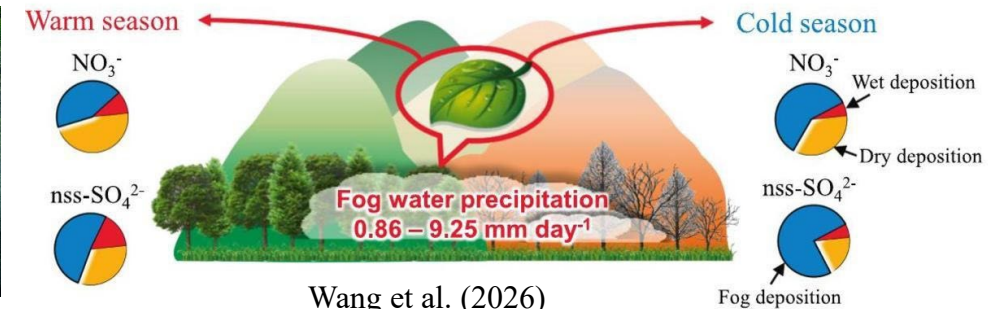
Forest damage from acid deposition in the Black Triangle Region, Poland



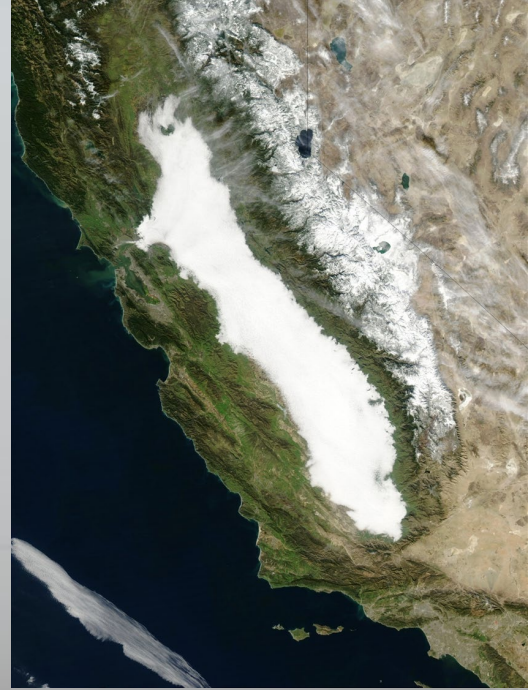
Deposition flux:
 nss-SO_4^{2-} **High**



Deposition flux:
 NO_3^- **High**



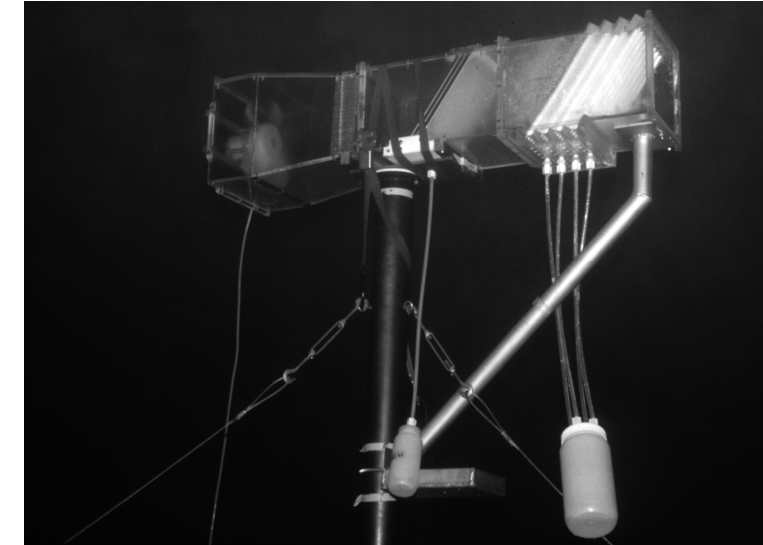
CSU fog studies



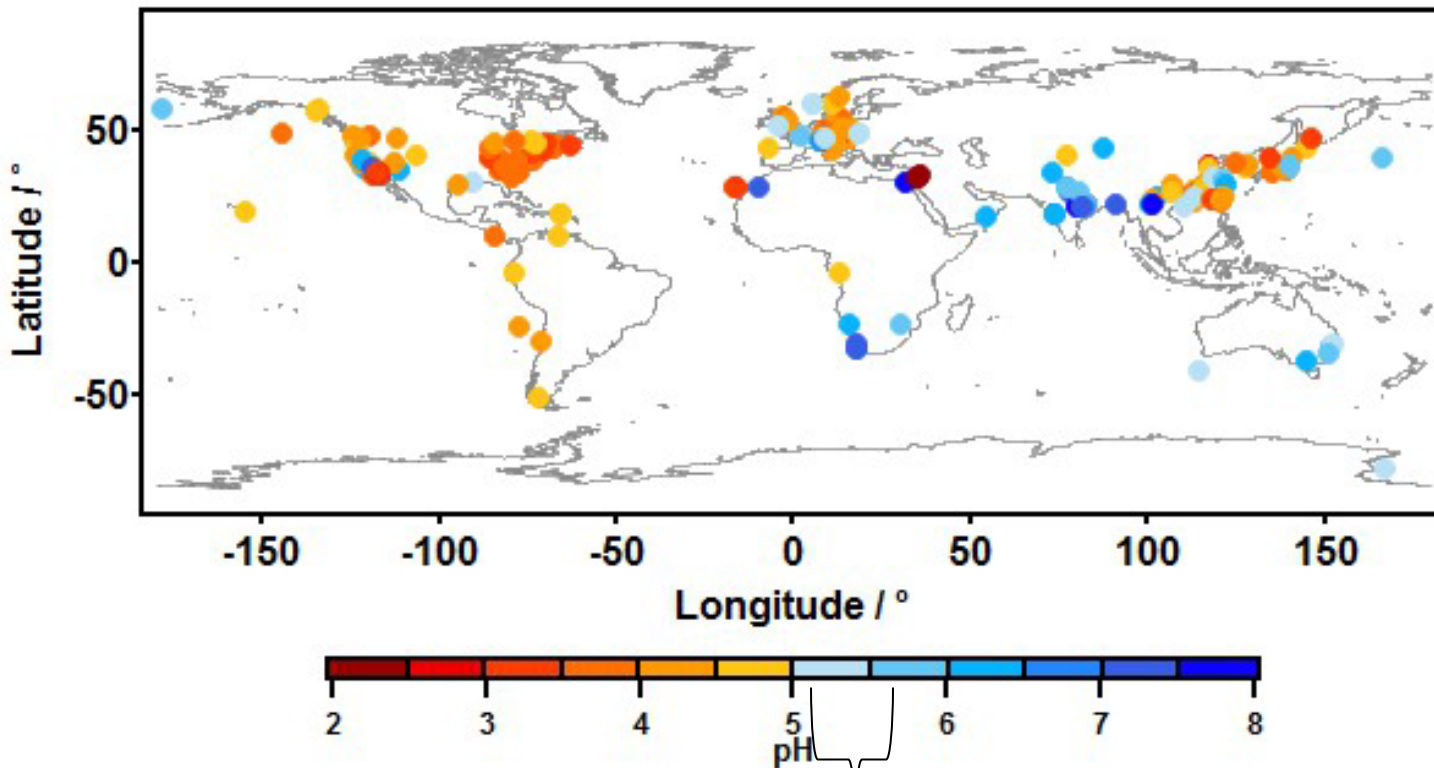
Time evolution

- pre-fog → fog → post fog
- Chemistry changes during fog
- Pollutant scavenging and removal

Fog and cloud collectors



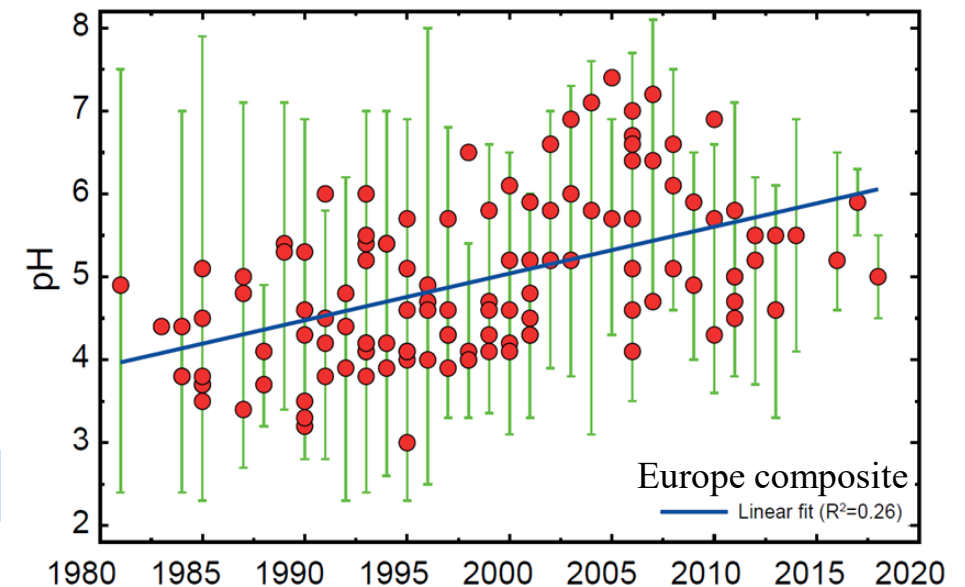
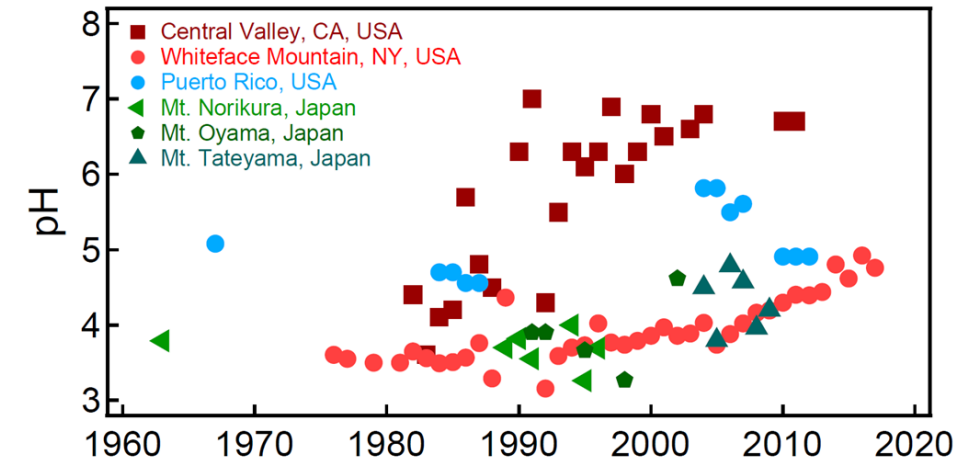
Global cloud/fog pH observations




Pye et al. (2020)

Typical pH
in clean
regions

$\text{CO}_2 + \text{water} \rightarrow \text{carbonic acid}$



A group of people are standing on a mountain peak, looking at a large, rectangular, dark-colored condensation collector net that is suspended by ropes and poles. The net is positioned vertically, and its surface appears to be covered in a fine layer of condensation. The people are dressed in outdoor gear, including hats and jackets. The background shows a clear blue sky with some wispy clouds, and the mountain's edge is visible in the foreground.

FOG AND DEW AS A WATER RESOURCE FOR PEOPLE

Water collection from fog and dew

- Fog:
 - Some of the driest places in the world experience intercepted clouds/fog
- Dew:
 - Clear skies in arid regions promote overnight surface cooling and dew formation
 - Increase cooling to increase water collection
- Remember that fog and dew can contain pollutants



Fog water collection projects by FogQuest.org

Current & past project locations:

Chile, Guatemala, Eritrea, Morocco,
Ethiopia, Nepal, Dominican Republic,
Haiti, Ecuador, Peru, Oman, Namibia,
Yemen, Israel



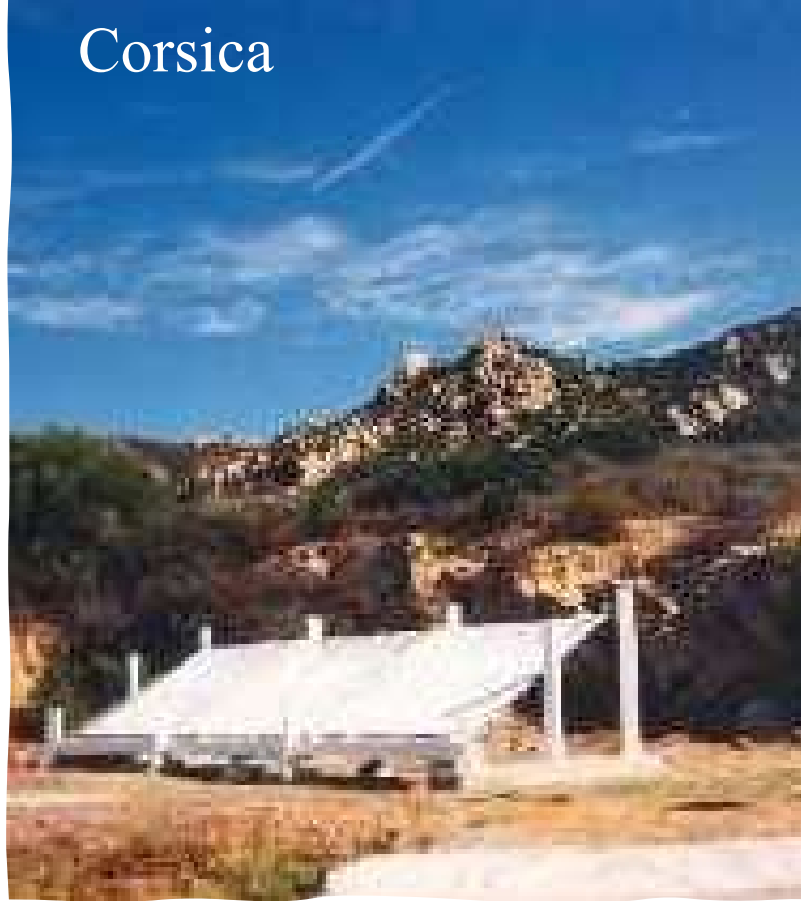
2 large fog collectors have been erected in, and near Tojquia.



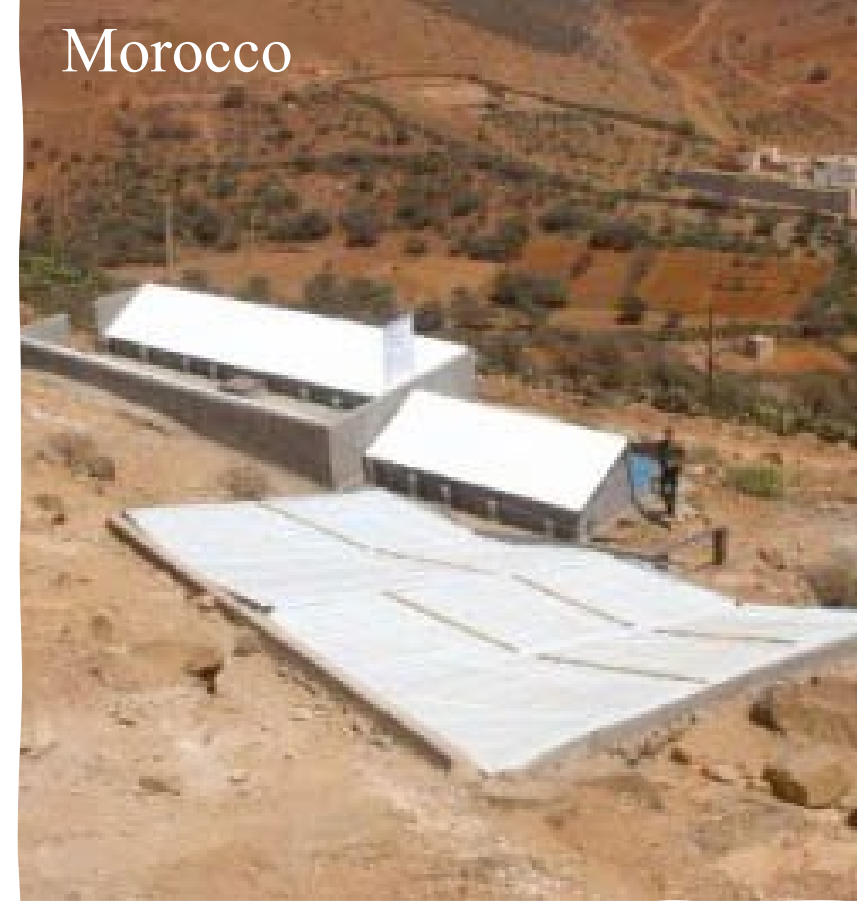
Croatia



Corsica



Morocco



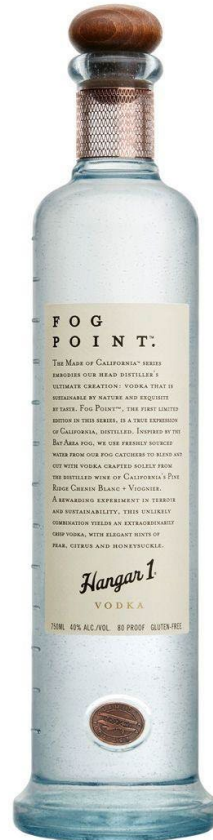
Dew collection

- OPUR – Intl. Organization for Dew Utilization
- Projects: France, Polynesia, Canary Islands, Croatia, Israel, Tunisia, Morocco, Mauritania, India, Australia, Chile

A FEW CULTURAL CONNECTIONS



Beverages



Literature, film and music

Rising with the Fog

*-From the last words of Emily
Dickinson*

She knew the end had come
when fog began to seep in
under her door
over the floor
like an ethereal sheet.
Her first guest in many years
silent and gentle, caressing every surface
with what she imagined
was a lover's touch.
It cocooned her, not warm
nor cold, but a comfortable pressure.
She floated deep within the sheet,
eyes closed, but still seeing
in this great, familiar darkness.
Then it rose,
and so did she
without fear, without grief
towards a pasture outside these walls
where her precious Gilbert ran
with immortality.
She let go of Lavinia's hand,
"I must go in; the fog is rising"

Fog

BY CARL SANDBURG

The fog comes
on little cat feet.

It sits looking
over harbor and city
on silent haunches
and then moves on.



"A thin grey fog hung over the city, and the streets were very cold; for summer was in England."

— Rudyard Kipling, *The Light That Failed* [Illustrated]



"Under the thinning fog the surf curled and creamed, almost without sound, like a thought trying to form in itself on the edge of consciousness."

— Raymond Chandler, *The Big Sleep*



"Mountain Dew" The Stanley Brothers



Questions?

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