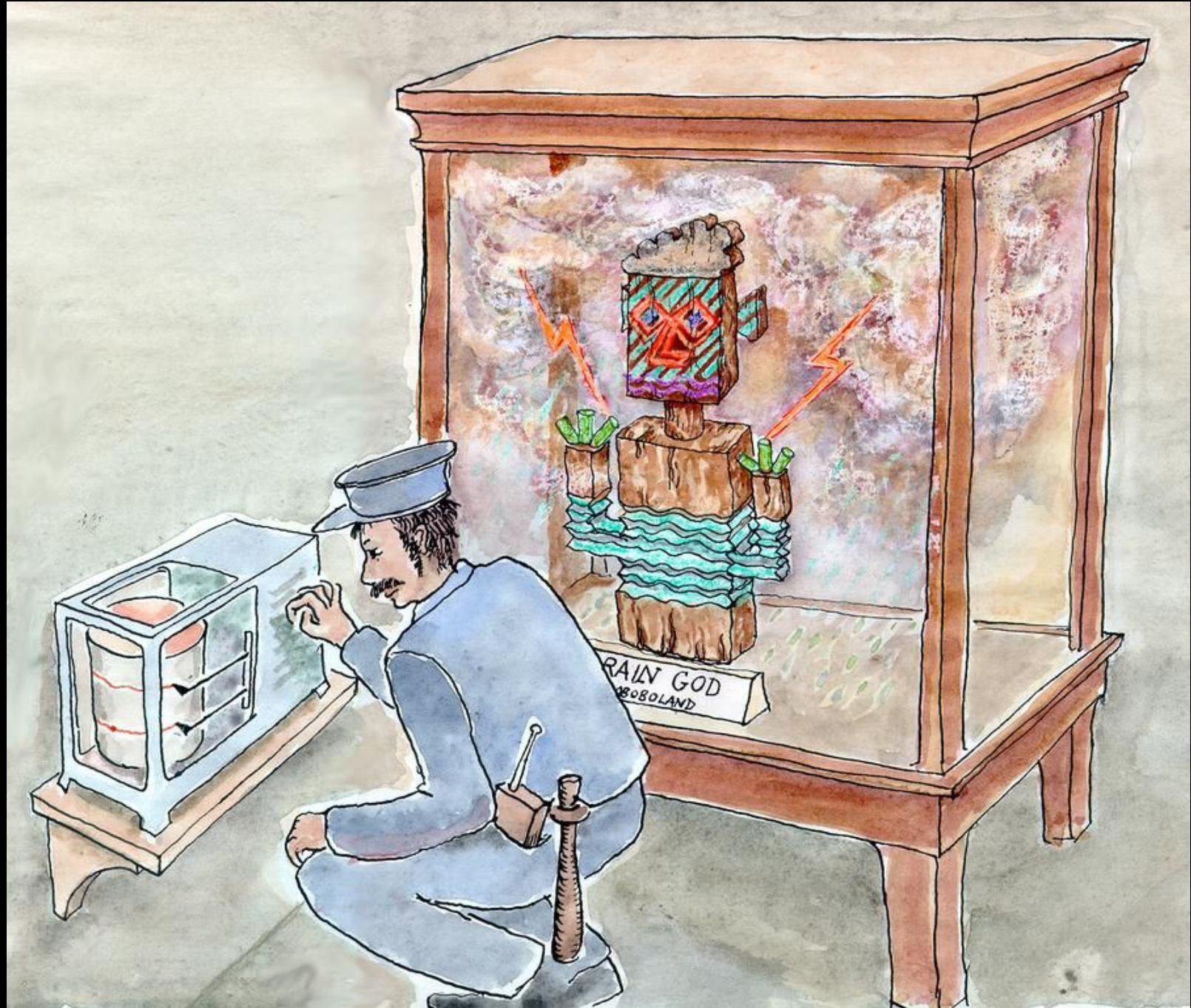


Enclosure as a substitute for air conditioning





The Royal Ontario Museum pipes conditioned air into showcases because the building cannot effectively be air conditioned



Influences on a showcase

Convective heat flow
Radiant energy flux
Thermal mass
Air exchange rate
Internal humidity buffer
Internal pollution rate
Pollutant reaction rate



Enclosures which contain both a humidity buffer and a temperature gradient are prone to condensation damage



Double glazed
window



Gilded bronze sculpture
Washington DC

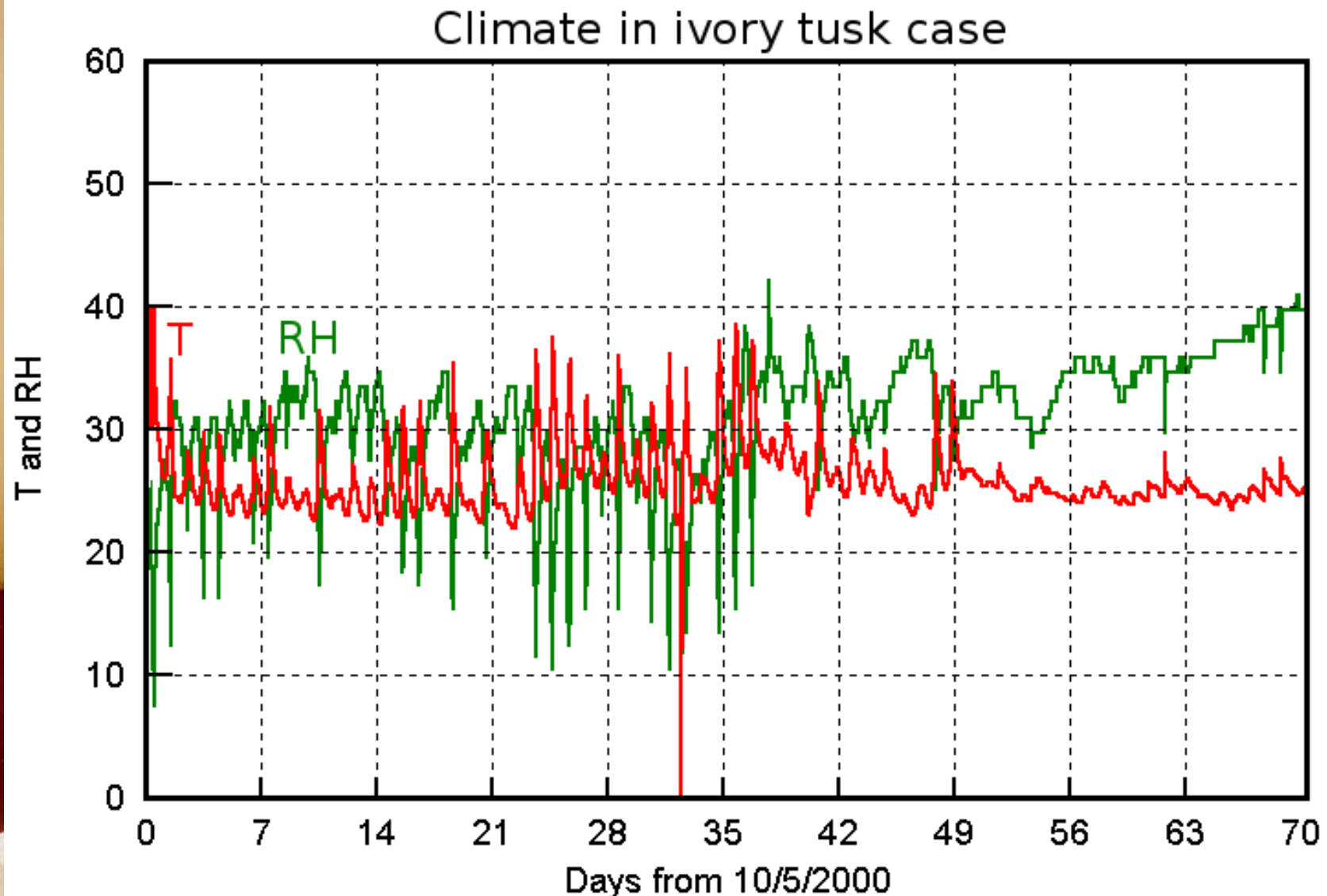


This applies even to enclosures apparently
without moisture buffers, exposed to a
temperature gradient

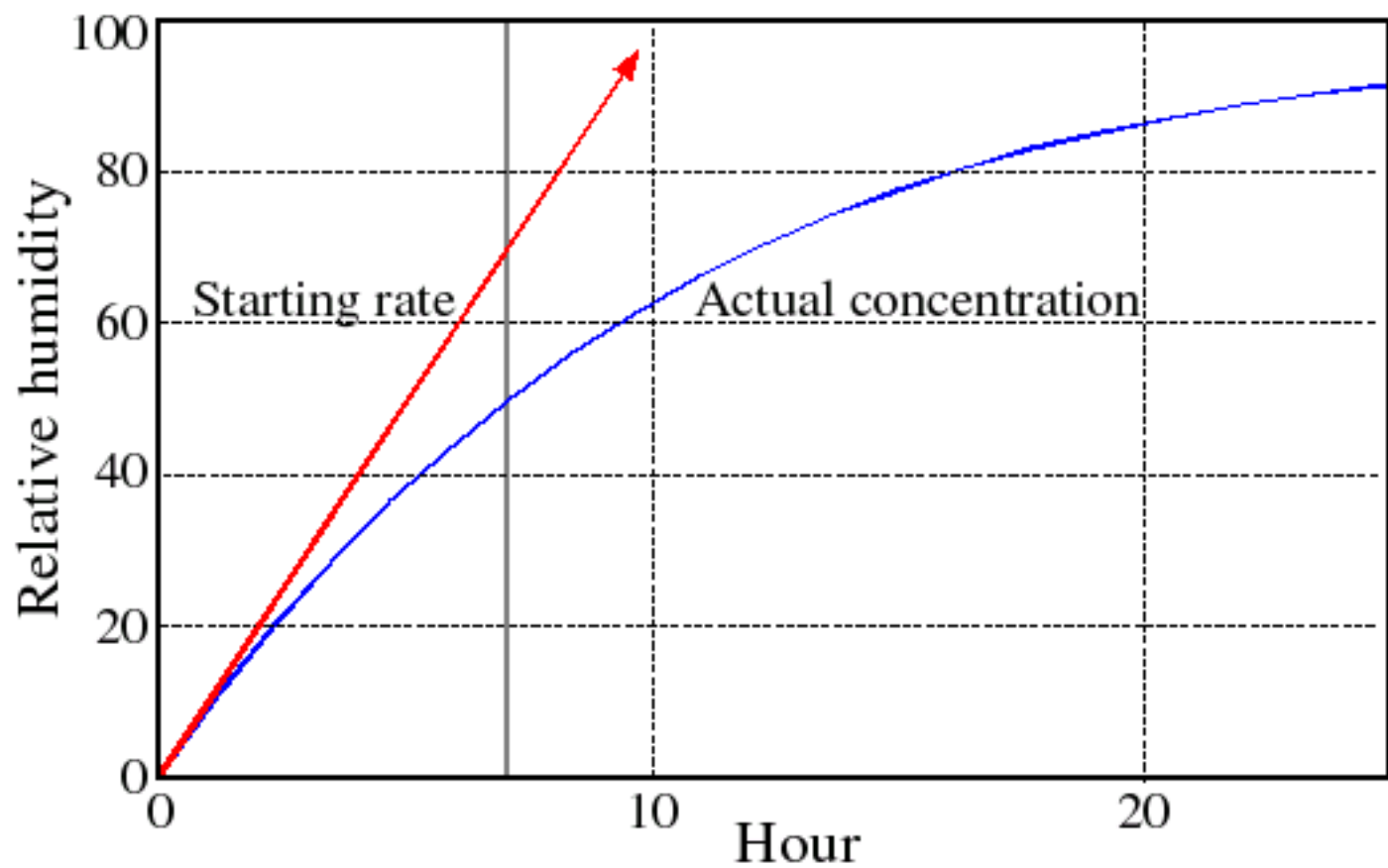


Unnoticed condensation is a particular threat to objects in containers moved in and out of cold storage

Ice forming within a film can shortly after putting it in a cold store



The effect of radiation at 60 klx on the temperature and RH within a showcase. Even 100 lx raises the temperature about 2°

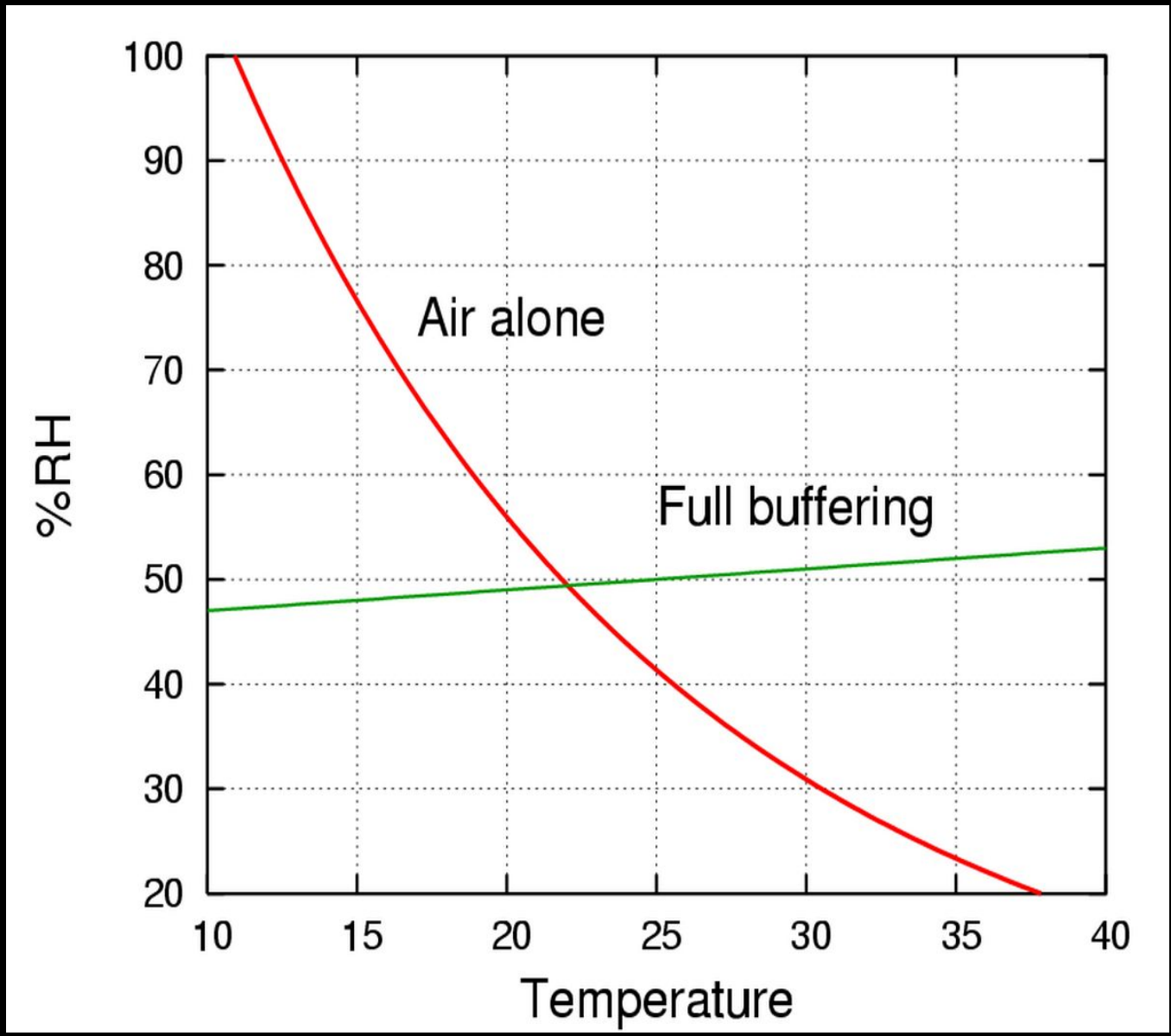


In a showcase, even in the dark, convective mixing is much faster than air leakage, so the exponential decay measure of air exchange rate applies

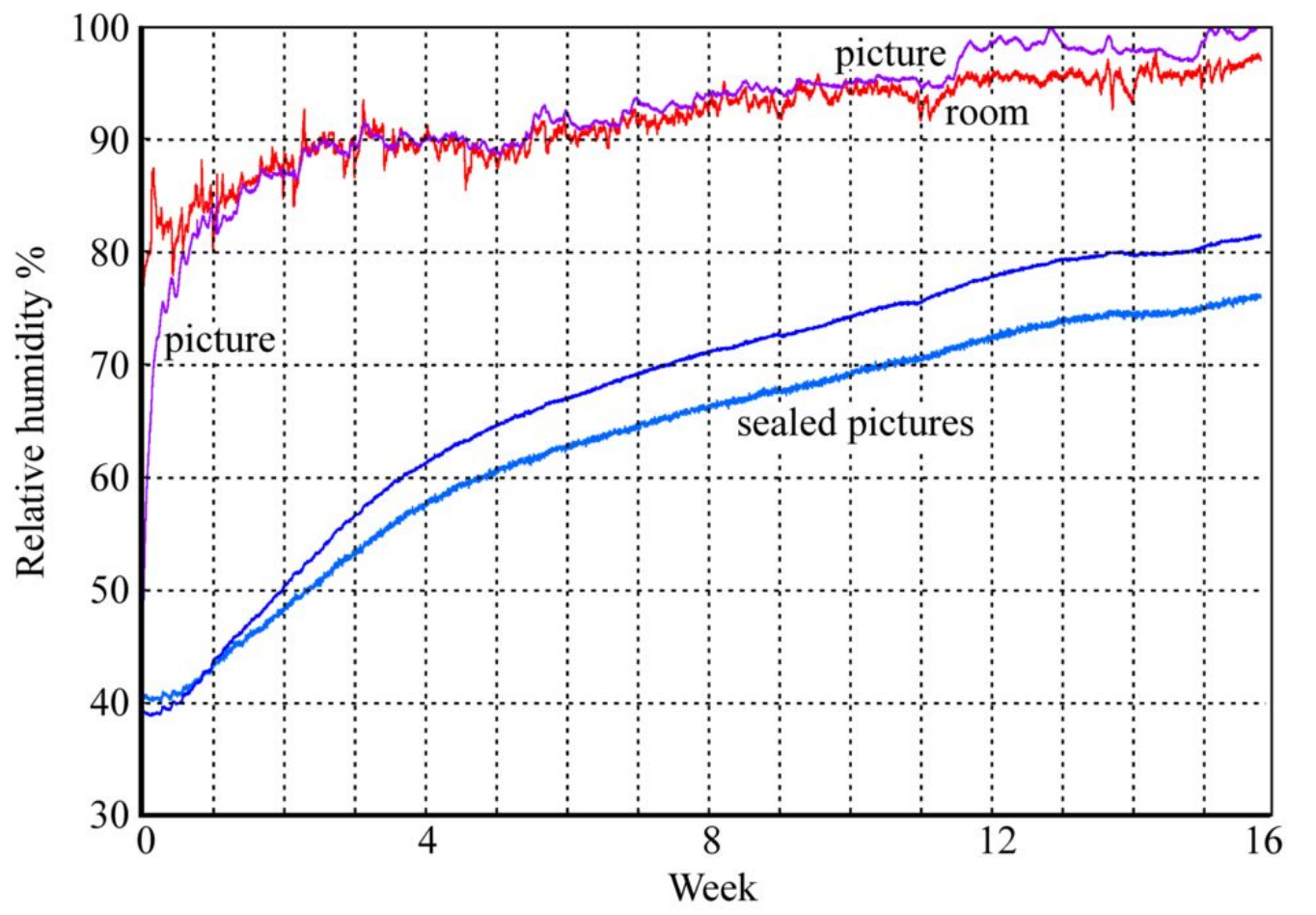


Humidity stabilisation is often the reason for enclosing objects

Often the objects themselves can effectively buffer their own microclimate



Enclosure stabilises the RH against variation caused by temperature change



Enclosure reduces the RH change caused by air leakage

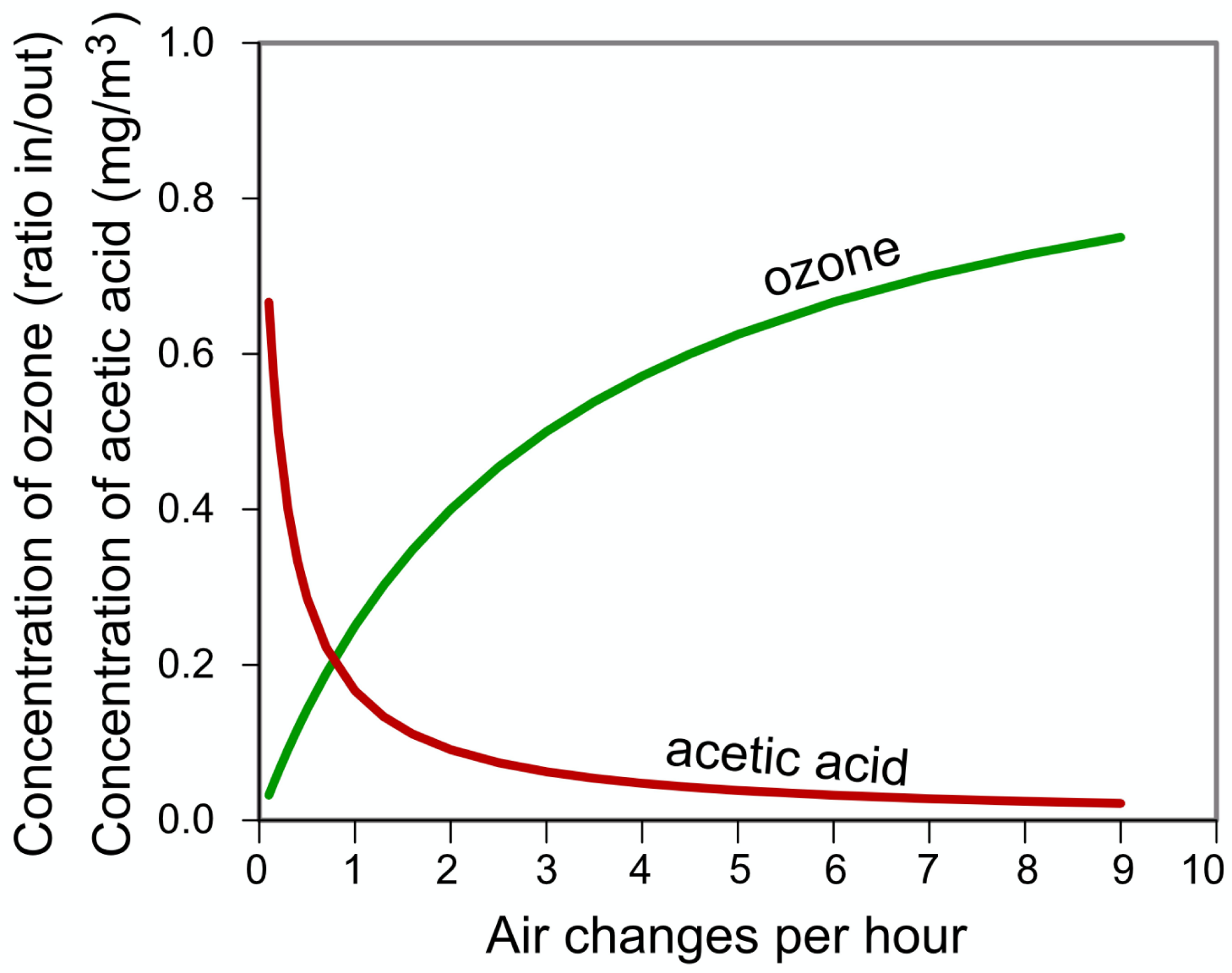
Rate of change of RH towards ambient of a glazed picture with card backboard and two pictures with aluminium sealed back



Internally generated pollution is a serious threat to artifacts, and can be generated from artifacts

Left: calcium acetate nitrate on coral brooch stored with celluloid jewellery.

Right: hydrogen sulfide reacts nearly instantaneously with silver



At least one air change per hour is needed to ventilate away internal pollution, but this will destroy the humidity stability



Treasures from the National Gallery moving from London to Wales on the outbreak of war

Transport of art requires only brief enclosure but exposes the container to extreme challenges

The solution is, from the outside in:
radiation shield - insulation - thermal buffer -
humidity buffer - artifact

(And a pump to reflate the truck tyres)