Increasing Carbon Dioxide Concentration in the Upper Atmosphere Observed by SABER

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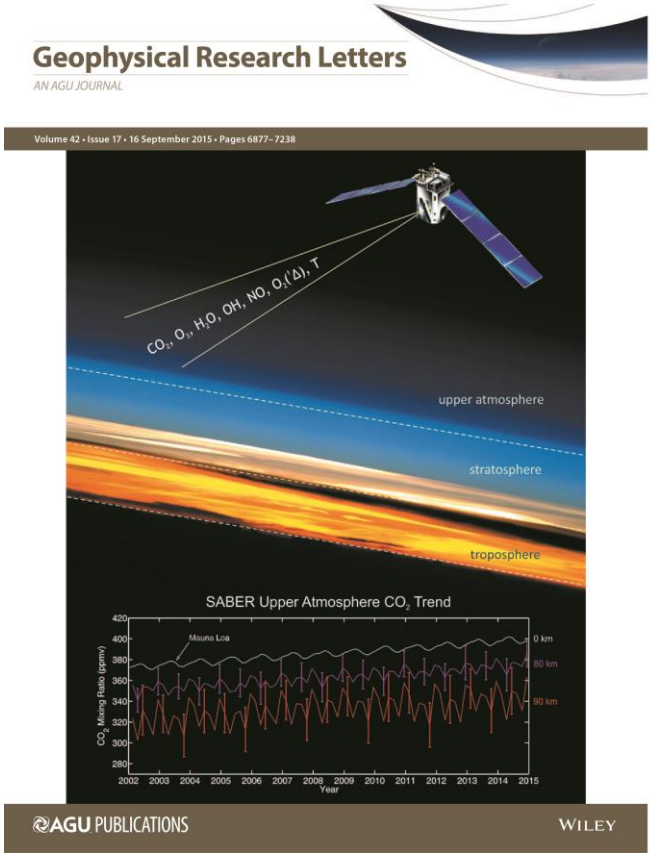
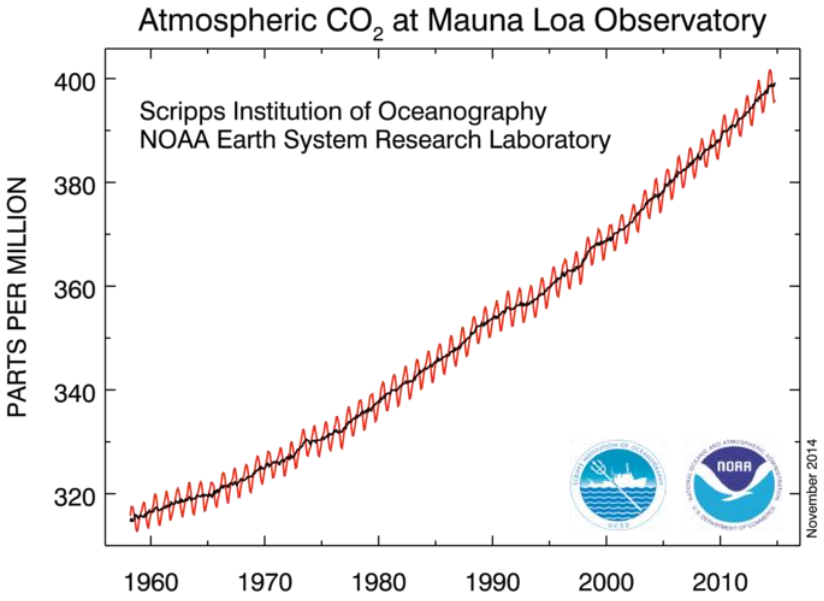
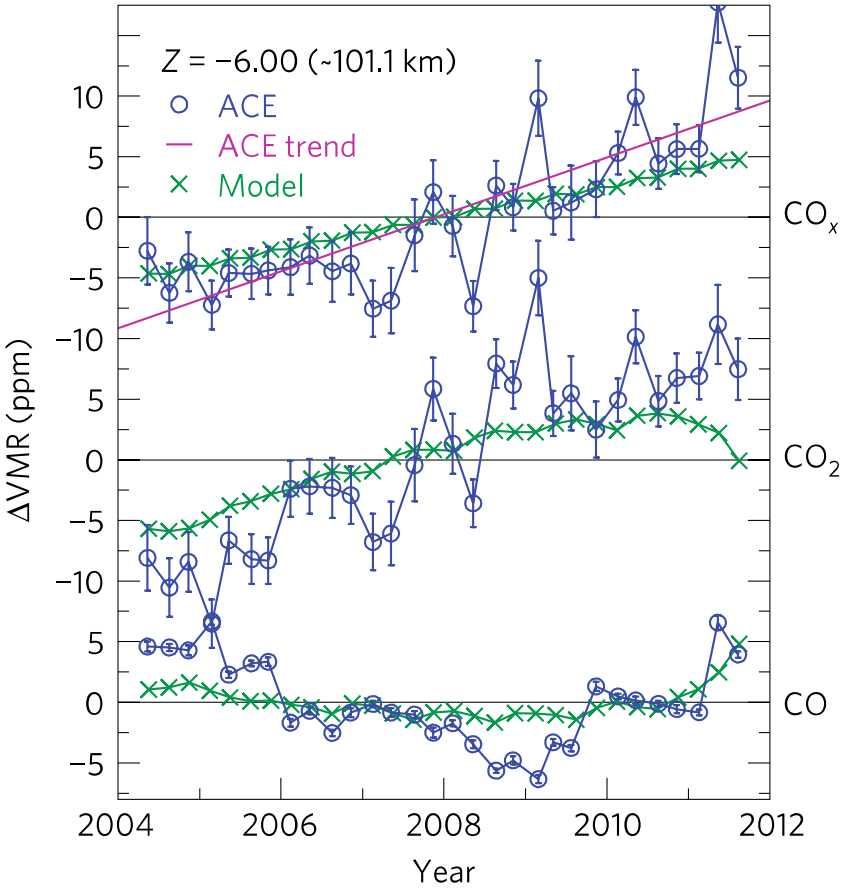


Savannah, Georgia, November 2015

Anthropogenic Long-term changes of CO2 abundance in the upper atmosphere

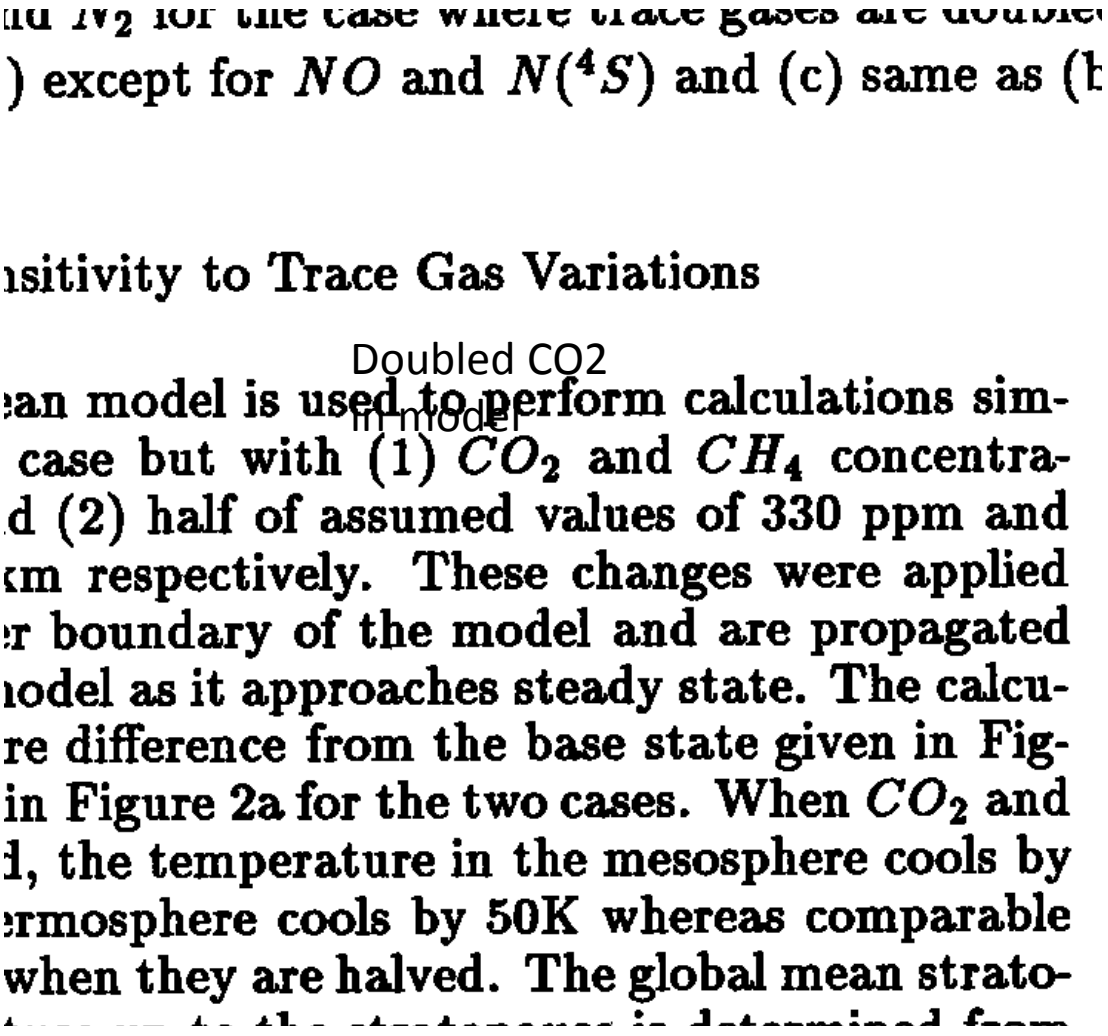
Keeling curve:
CO2 trend on the surface





Emmert et al., Nature Geo, 2012

Radiative Cooling of the upper atmosphere by rising anthropogenic CO2



ıd N_2 for the case where trace gases are double
) except for NO and $N(^4S)$ and (c) same as (b

ısitivity to Trace Gas Variations

Doubled CO2 in model

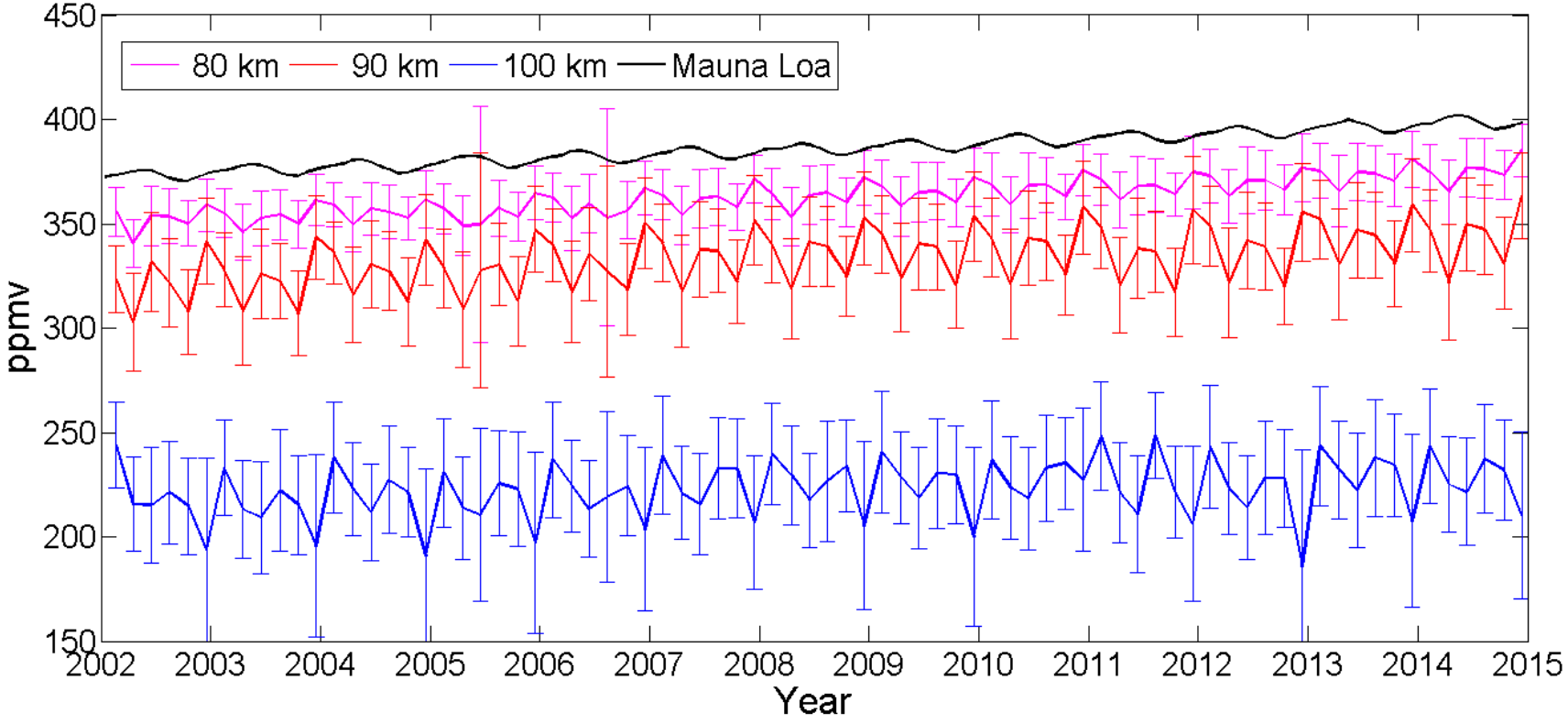
ean model is used to perform calculations sim-
case but with (1) CO_2 and CH_4 concentra-
d (2) half of assumed values of 330 ppm and
km respectively. These changes were applied
r boundary of the model and are propagated
ıodel as it approaches steady state. The calcu-
re difference from the base state given in Fig-
in Figure 2a for the two cases. When CO_2 and
l, the temperature in the mesosphere cools by
ermosphere cools by 50K whereas comparable
when they are halved. The global mean strato-

Roble and Dickinson, 1989

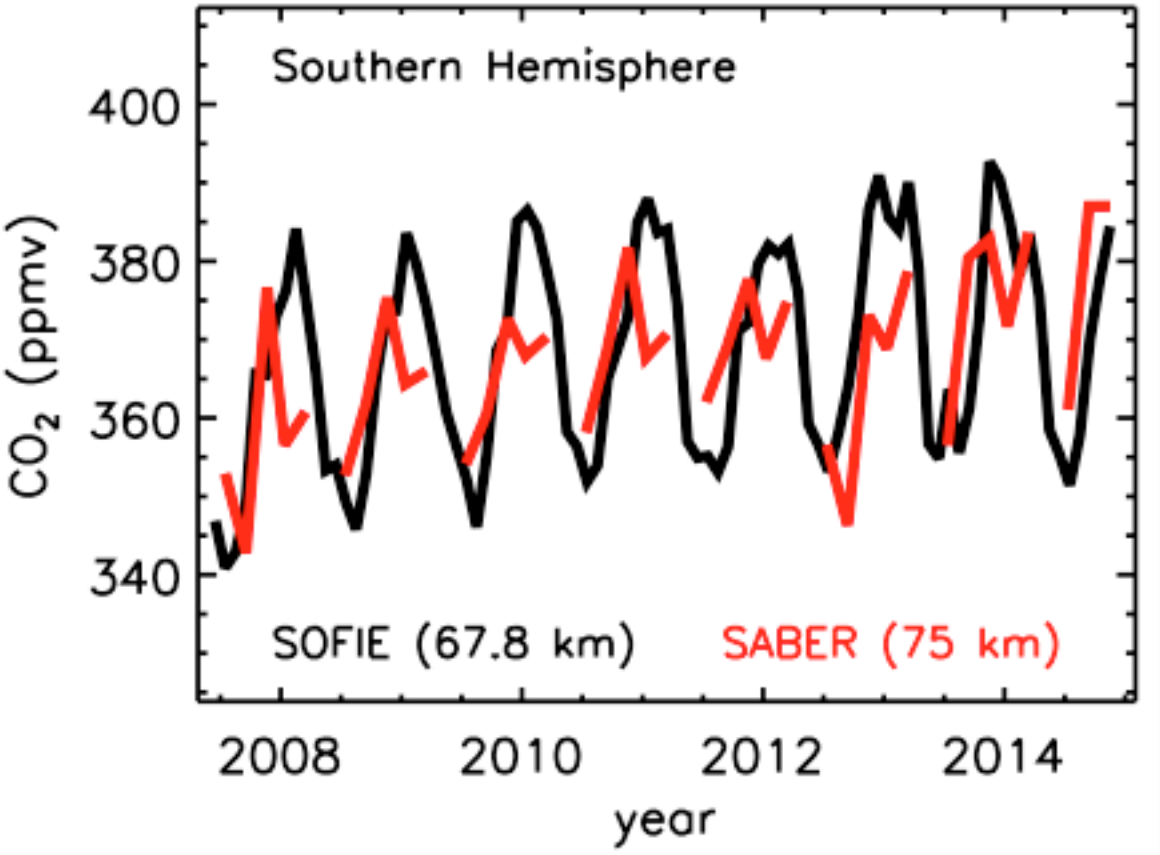
Trend in SABER CO2 (2002-2014)

~2 ppmv/year below 80 km or 5% per decade, the same as the trend on the ground

Yue et al., GRL, 2015



Cross-validation of CO2 trend in both SABER and AIM/SOFIE at high latitudes (2007-)



Courtesy of Mark Hervig

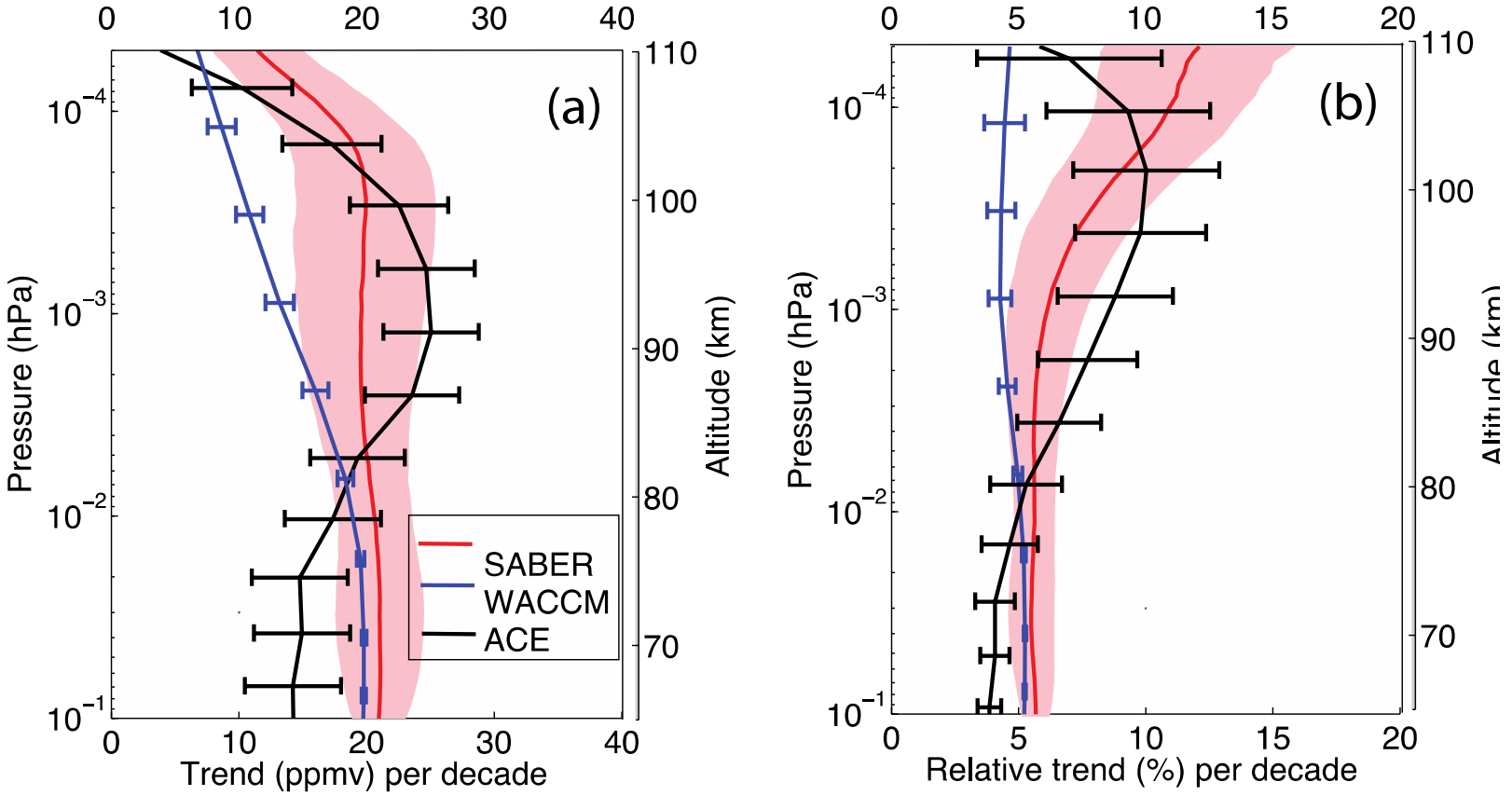
Multiple linear regression (MLR) of deseasonalized SABER CO2 (separating linear trend, QBO and solar cycle)

$$\mathrm{CO}_2(t) = \mu + \alpha \cdot t + \beta \cdot \mathrm{QBO}(t) + \gamma \cdot \mathrm{solar}(t)$$

- Linear trend
- 80 km: 20.6 ± 3.0 ppmv per decade
- 90 km: 19.5 ± 4.5 ppmv per decade
- 100 km: 19.9 ± 5.5 ppmv per decade
- 110 km: 12.8 ± 3.7 ppmv per decade

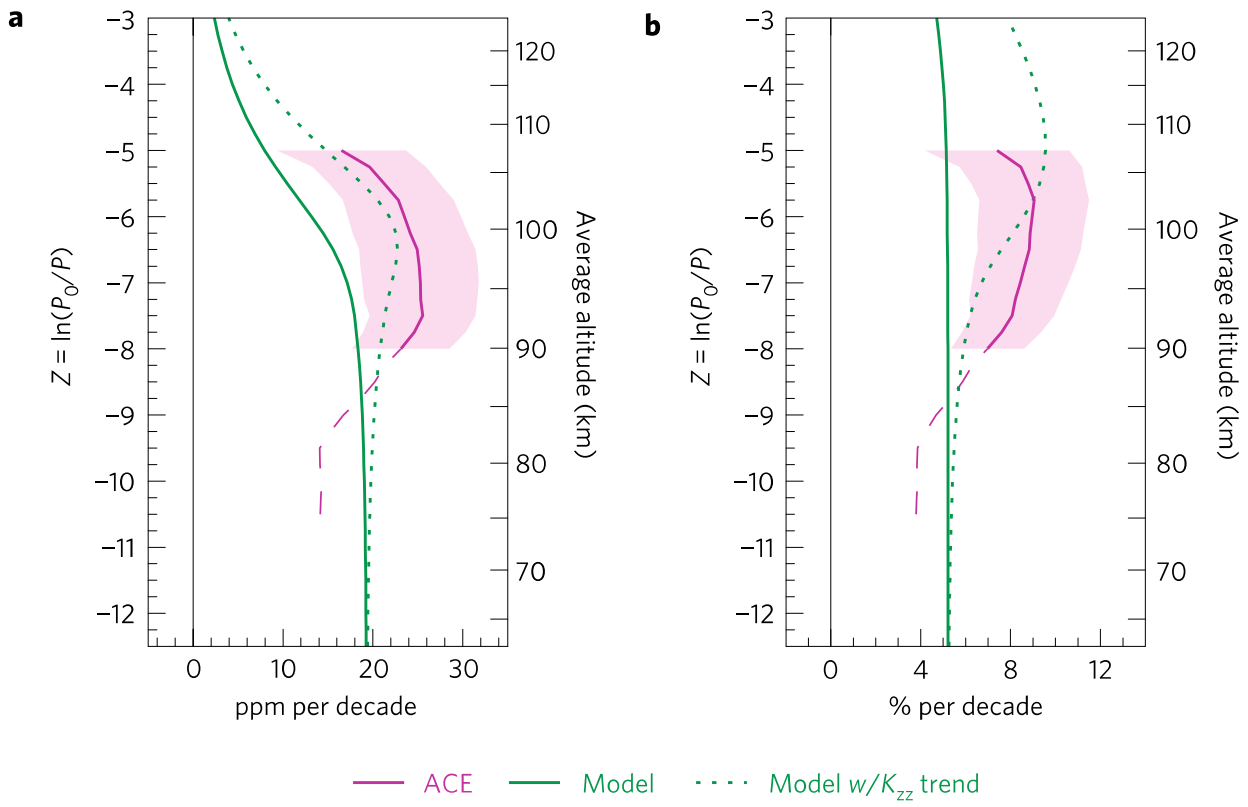
CO2 trend depends on altitude

faster than any model predictions, but WHY?



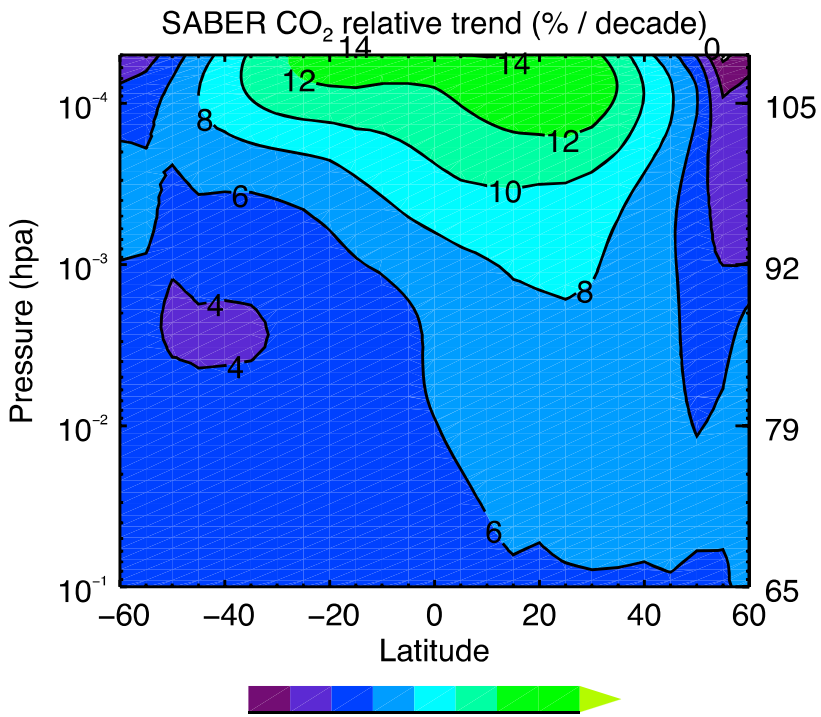
SABER: 2002-2014; ACE-FTS: 2004-2014; SD-WACCM: 2002-2012

If increase the eddy diffusion in the upper atmosphere by 30%, can achieve larger CO2 trend [Emmert et al., 2012; Garcia et al., in preparation]. But is it realistic?

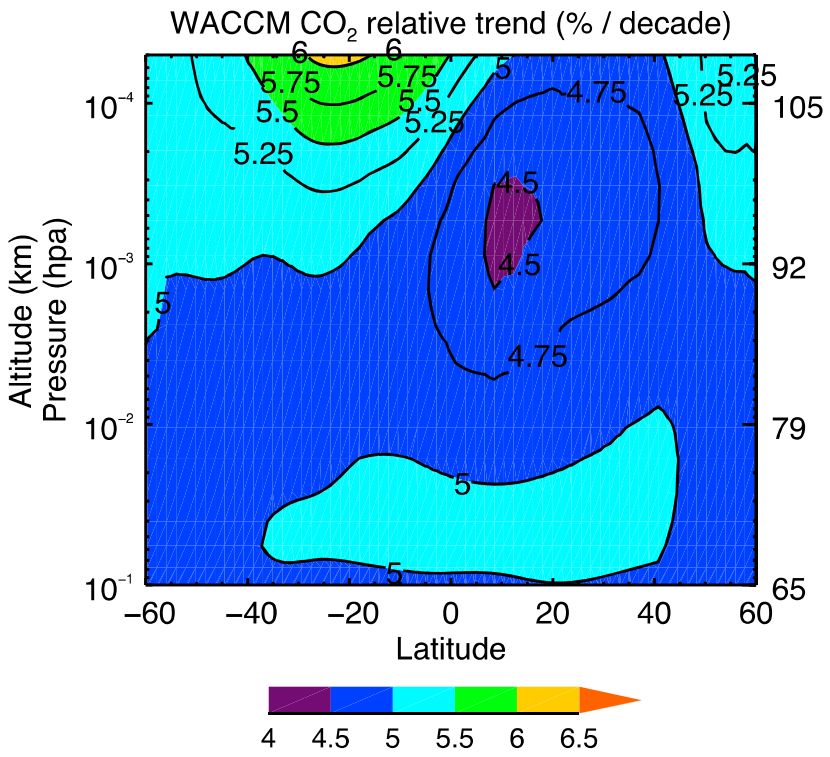


Emmert et al., Nature Geo, 2012

Hemispheric asymmetry of trend (trend in northern hemisphere about twice of southern hemisphere)

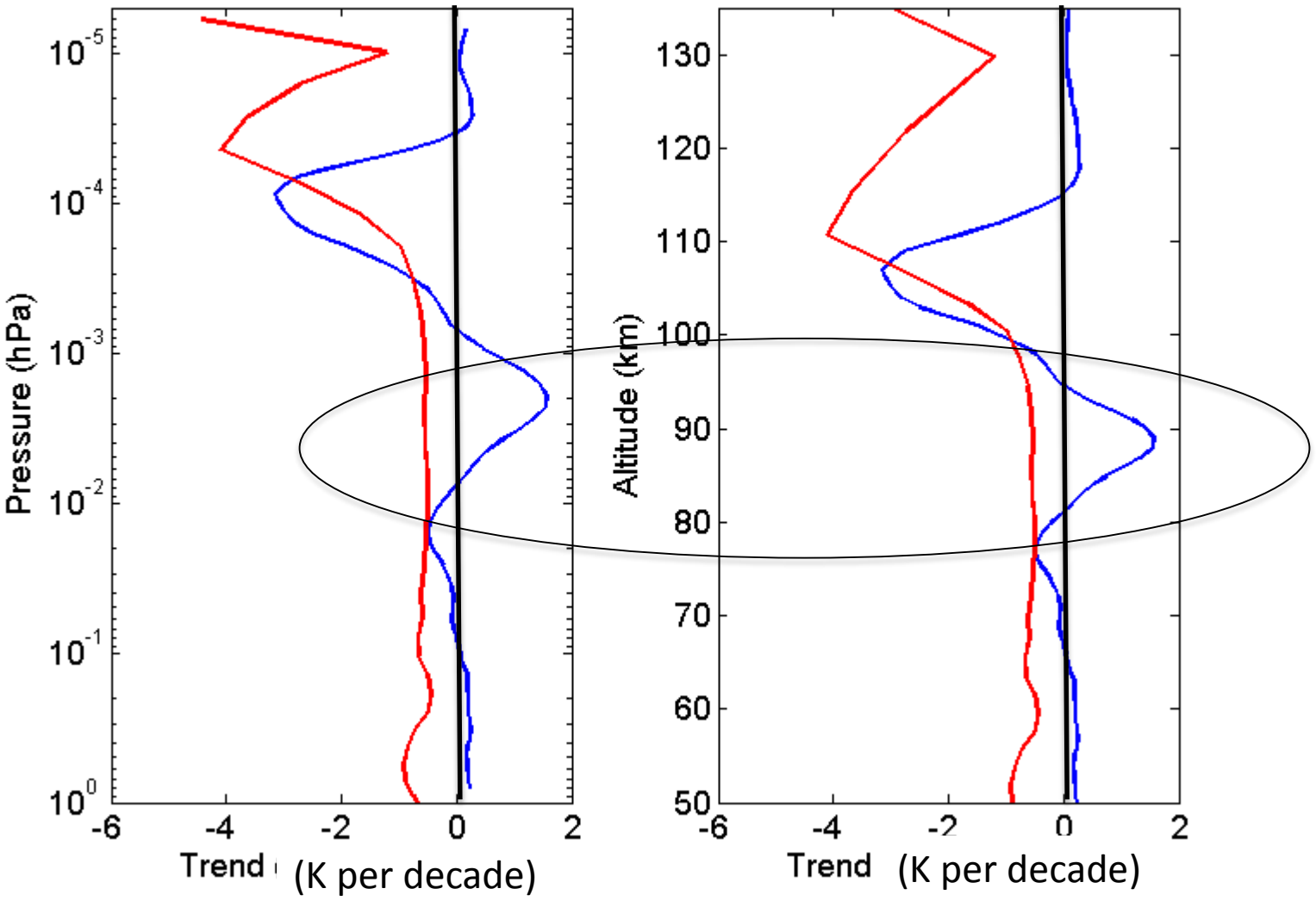


SABER



WACCM

Different SABER temperature trend in 2-channel retrieval and operational data (with WACCM CO2)



Operational SABER v2 T: cooling at all heights

2-channel retrieved T: cooling and warming at ~90 km

Featured in Nature

HUMAN EVOLUTION

Old finger with modern traits

A 1.84-million-year-old finger bone from Tanzania is the oldest known hominin hand bone with human-like features.

Ancient human relatives used stone tools 2 million to 3 million years ago, but had hands that were suited to living in trees. A team led by Manuel Domínguez-Rodrigo at Madrid's Institute of Evolution in Africa found a finger bone at a site in Olduvai Gorge, Tanzania, in 2013. The bone, named OH 86, is longer and straighter than those of earlier australopiths and similarly aged *Homo habilis* hand bones found nearby. Its closest match in size and shape in the fossil record is a finger bone from early *Homo sapiens*.

The finding suggests that some human-like traits emerged early in human evolution, and that a modern-looking hominin lived alongside more primitive-bodied creatures in East Africa some 2 million years ago.

Nature Commun. 6, 7987 (2015)

ATMOSPHERIC SCIENCE

Carbon dioxide levels peak up high

The carbon dioxide concentration in Earth's upper atmosphere is increasing at more than twice the average rate observed at the surface.

Jia Yue of Hampton University in Virginia and his colleagues analysed CO_2 measurements at different atmospheric heights and latitudes between 2002 and 2014 using a satellite-borne infrared radiometer. They found that CO_2 levels increased at a peak rate of 12% per decade at a height of 110 kilometres, with more pronounced rises in the Northern Hemisphere than in the Southern Hemisphere. The rate of CO_2 increase in the atmosphere below 80 kilometres is only about 5% per decade.

The fast build-up of CO_2 in the upper atmosphere, which climate models fail to reproduce, points to increased vertical mixing. This will probably not affect greenhouse warming at Earth's surface, but could eventually change the upper atmosphere's density and alter the altitude of satellites in orbit, the authors suggest.

Geophys. Res. Lett. http://doi.org/6x5 (2015)

MEDICAL MICROBIOLOGY

Lung pathogen evolves in isolation

Bacteria that infect the lungs of people with cystic fibrosis evolve into different forms in various parts of the lungs.

Pradeep Singh at the University of Washington in Seattle and his team dissected the infected lungs of ten people with the disease who were having lung transplants, and analysed the genomes of *Pseudomonas aeruginosa* bacteria sampled from different areas of the lung. Comparing areas that were mildly and severely diseased, the team found distinct lineages of the bacterium with variations in virulence, antibiotic resistance and other factors. They conclude that this diversity arose because bacterial cells became isolated in lung regions where they then evolved separately.

This regional diversification could enhance resistance to drugs and human defences, the authors say.

Cell Host Microbe http://doi.org/6zw (2015)

INFORMATION TECHNOLOGY

Suspended rods serve as bits

Rod-shaped nanoparticles suspended in water can store the zeroes and ones of digital computing on the basis of the rods' physical location.

Most digital memories are made of solid matter. But Madhavi Krishnan at the University of Zurich in Switzerland and her colleagues stored bits of information using the position and orientation of small silver rods suspended in solution between plates that were 150 nanometres apart. The rods levitate at the mouth of one of two holes in the plates that form a T shape. A short electrical pulse or a beam of light can move a nanoparticle from one hole to the other.

By adjusting the geometry of the T, the team could control the lifetime of the stored bit, which they calculate could be as much as 30 years for their arrangement.

Nature Nanotech. http://doi.org/6x2 (2015)

SOCIAL SELECTION

Popular topics on social media

Live-tweeting rule irks ecologists

To tweet or not to tweet? That was the question many ecologists struggled with at the annual meeting of the Ecological Society of America (ESA) earlier this month in Baltimore, Maryland. Last year, meeting attendees freely tweeted during researchers' presentations, but this year they received a surprising and confusing tweet from ESA on the eve of the conference. "Ask presenter before doing live tweets in sessions, posters. Presenters, let attendees know." The request rankled many. In a blog post, entomologist Terry Wheeler at McGill University in Canada said that ESA was "taking a step backward" from its open social-media policy of past years (go.nature.com/9knarg).

But Liza Lester, a communications officer at ESA, says that the society supports tweeting at conferences and did not intend to change its stance. "It was a misunderstanding," she says.

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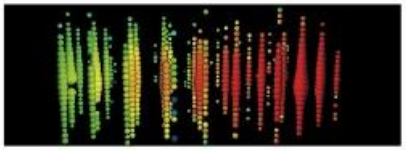

ASTROPHYSICS

Cosmic neutrinos abound

Super-high-energy neutrinos from outside the Milky Way pepper Earth from all directions.

Neutrinos are created in the Universe's most violent environments and travel through it almost unimpeded, providing a way to study distant astronomical objects. A team at the IceCube Neutrino Observatory at the South Pole reported the first evidence for neutrinos from outside the Galaxy in 2013, using observations of the Southern Hemisphere sky. Now the team has used a different method to detect more than ten super-high-energy neutrinos from the Northern Hemisphere. IceCube detects tracks of light (**pictured**) when neutrinos interact with particles in the ice that forms part of the detector.

As with the previous result, the neutrinos come from all over the sky rather than being concentrated in the Galactic plane, bolstering the claim that they come from farther afield, say the authors.

Phys. Rev. Lett. 115, 081102 (2015)

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Conclusions

- Long term trend in CO2 below 80 km is consistent with lower atmosphere (surface) measurements.
- Larger CO2 trend above 80 km in observations compared to climate models
- Faster CO2 trend in the NH than in the SH
- Long live SABER and TIMED