World Meteorological Organization
Working together in weather, climate and water

WMO OMM

Links between GRUAN and GAW

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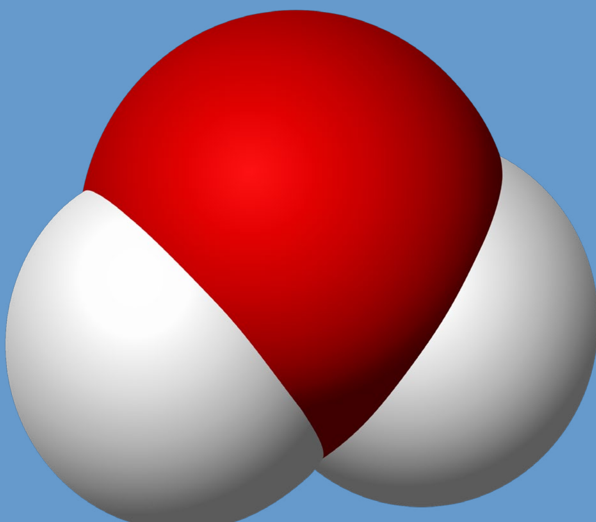
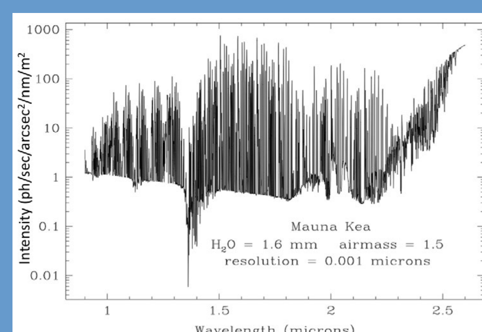
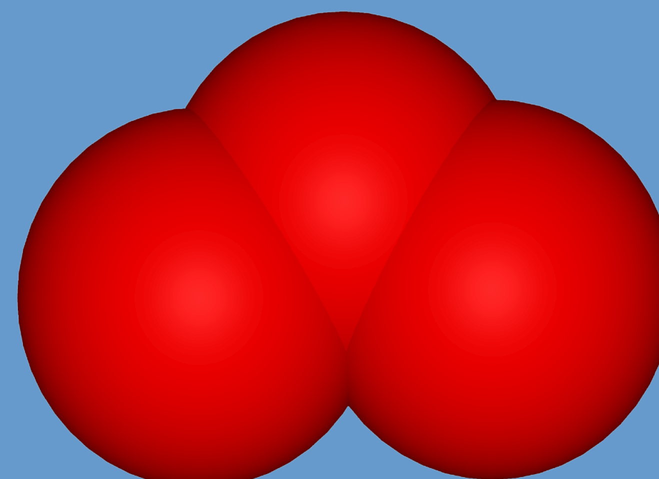






GAW observes six categories of parameters

- Stratospheric ozone (total, Umkehr, sondes)
- Greenhouse gases (CO_2, CH_4, N_2O)
- Reactive gases (O_3, CO, VOCs, NO_x, SO_2 etc.)
- Aerosols
- Total Atmospheric Deposition (formerly Precip. chem.)
- Solar UV radiation

SAGS

Ozone | UV

IGACO-Ozone-UV

Greenhouse Gases | Total atm. deposition

IG^3IS

Reactive gases | GURME | Aerosols

GAW Secretariat

WMO | GAW

CAS Open Programme Area Group

EPAC

Environmental Pollution & Atmospheric Chemistry

Scientific Steering Committee

Quality Assurance & Science Activity Centres

World & Regional Calibration Centres

GHG	N_2O VOC	CH_4	Precip. chem.	SF_6	Physical aerosol properties	In situ O_3, CO, CH_4	Optical depth	Total O_3	O_3 Sondes
NOAA ESRL/GMD (USA)	IMK-IFU (DE)	JMA (JP)	SUNY Albany (USA)	KMA (KR)	IFT (DE)	EMPA (CH)	WORCC (CH)	3 WCC (US, CA, RU) 6 Dobson RCC (JP, AU, ZA, AR, DE, CZ) 1 Brewer RCC (ES)	FZJülich (DE)

Central Calibration Laboratories

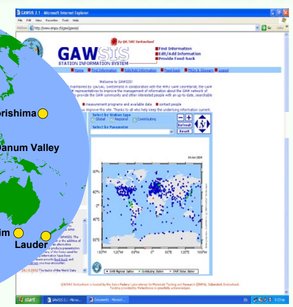
Host GAW World Reference Standards

CO_2, CH_4, N_2O CO, SF_6, Dobson O_3	Brewer total O_3	Ozone-sondes	In situ O_3
NOAA ESRL/GMD (USA)	Environment Canada	FZJülich (DE)	NIST (USA)

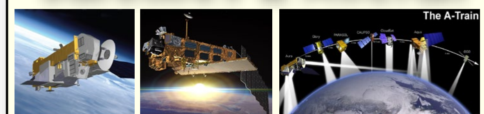
Contributing networks

TCCON, EANET, BSRN, emep, AERONET (AEROSOL ROBOTIC NETWORK), EARLINET, CAPMoN, NDACC, SHADOZ, AGAGE

GAW stations & GAWSIS



Satellites & Aircraft



GAW Products

GHG Bulletins

O_3 Bulletins

Assessments

Global fields

World Data Centres

WOUDC Ozone & UV	WDCGG Greenhouse gases	WDCA Aerosols	WRDC Radiation	WDCPC Total atm. dep.	WDC-RSAT Satellite data
Environment Canada (CA)	JMA (JP)	NILU (NO)	MGO (RU)	SUNY Albany (USA)	DLR (DE)

GAW Report no. 201: SOPs for ozonesondes

Water vapour, the "forgotten" molecule

- **Among all the compounds relevant for atmospheric chemistry, $H_2O(g)$ has been neglected**
- **The GAW Programme has the responsibility for Atmospheric Chemistry in the WMO Integrated Global Observing System (WIGOS)**
- **In the OSCAR (Observing Systems Capability Analysis and Review Tool) database, there is a line for H_2O (intended as a chemical species relevant for atmospheric chemistry)**
- **However, this line is essentially empty**
- **We need to determine the requirements for water vapour**

Next step

- **The Scientific Steering Committee for GAW (EPAC SSC) decided to adopt water vapour as a GAW parameter. By this we mean water vapour as a chemical species relevant for atmospheric chemistry and as a greenhouse gas**
- **The SSC also decided to establish a Task Team to review the current situation (capabilities) wrt water vapour meas-urements and to determine the requirements for such observations**

Water vapour as a greenhouse gas

- **The total greenhouse effect is 155 W/m^2 (Trenberth).**
- **H_2O is responsible for about 60% of this total greenhouse effect.**
- **Water vapour does not control the Earth's temperature, but is instead controlled by the temperature.**
- **The water vapour feedback doubles the warming effect of an increase in CO_2. If we add enough CO_2 to cause an increase of 1°C in the global mean temperature, the water vapour feedback will add another 1°C.**

Water vapour as a greenhouse gas

WMO OMM

Contributions of Stratospheric Water Vapor to Decadal Changes in the Rate of Global Warming

Susan Solomon,[1] Karen H. Rosenlof,[1] Robert W. Portmann,[1] John S. Daniel,[1] Sean M. Davis,[1,2] Todd J. Sanford,[1,2] Gian-Kasper Plattner[3]

Stratospheric water vapor concentrations decreased by about 10% after the year 2000. Here we show that this acted to slow the rate of increase in global surface temperature over 2000–2009 by about 25% compared to that which would have occurred due only to carbon dioxide and other greenhouse gases. More limited data suggest that stratospheric water vapor probably increased between 1980 and 2000, which would have enhanced the decadal rate of surface warming during the 1990s by about 30% as compared to estimates neglecting this change. These findings show that stratospheric water vapor is an important driver of decadal global surface climate change.

Over the past century, global average surface temperatures have warmed by about 0.75°C. Much of the warming occurred in the past half-century, over which the average decadal rate of change was about 0.13°C, largely due to anthropogenic increases in well-mixed greenhouse gases (*1*). However, the trend in global surface temperatures has been nearly flat since the late 1990s despite continuing increases in the forcing due to the sum of the well-mixed greenhouse gases (CO_2, CH_4, halocarbons, and N_2O), raising

poorly (*9*), and even up-to-date stratospheric chemistry-climate models do not consistently reproduce tropical tropopause minimum temperatures (*10*) or recently observed changes in stratospheric water vapor (*11*). Because of these limitations in prognostic climate model simulations, here we impose observed stratospheric water vapor changes diagnostically as a forcing for the purpose of evaluation and comparison to other climate change agents. However, in the real world, the contributions of changes in stratospheric water vapor to

Stratospheric water vapour increased between 1980 and 2000, but decreased by about 10% from 2000 to 2009.

This decrease in water vapour acted to slow the rate of increase in global surface temperature by 25% over 2000-2009

Water vapour as a chemical compound

Major source of HO_x in "clean" (hydrocarbon poor) air:

$O_3 + h\nu\ (\lambda<340nm) \rightarrow O_2 + O(^1D)$

$O(^1D) + H_2O \rightarrow 2OH$

=> OH depends mainly on ozone

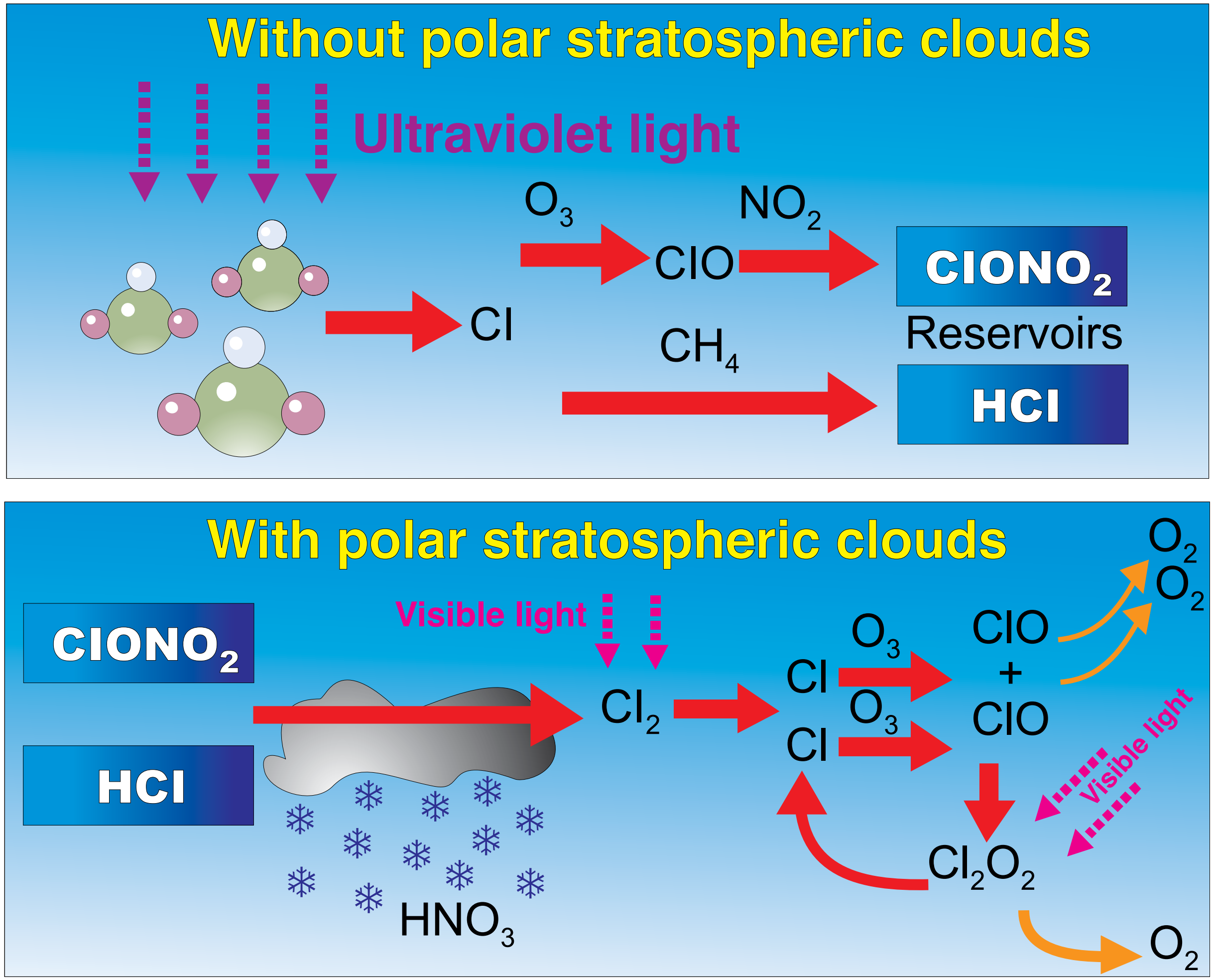
The same process is also the dominant loss process for ozone

This makes the ozone lifetime in the marine boundary layer dependent on:

a. absolute concentrations of water vapour (i.e. temperature)

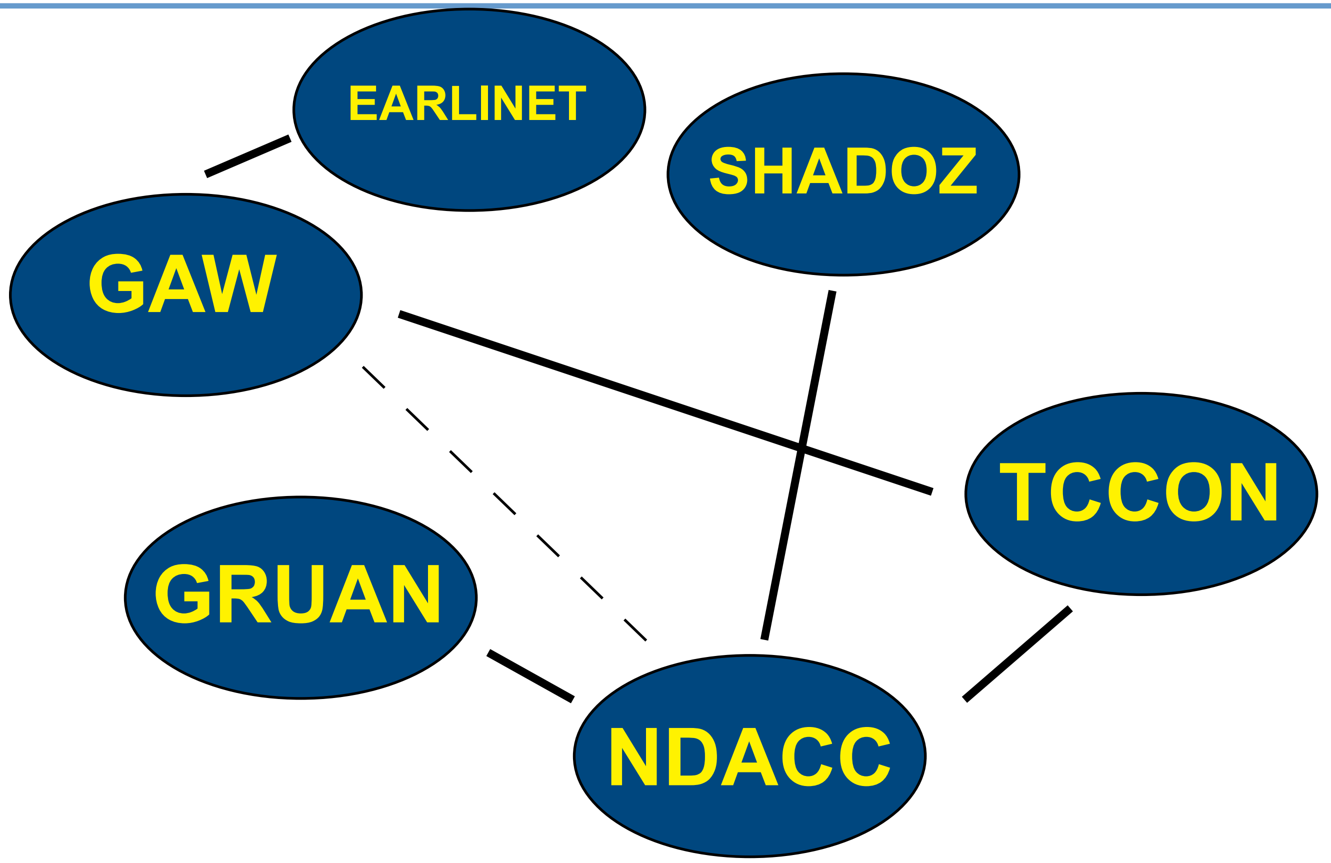
b. overhead ozone

The role of water in ozone depletion



Heterogeneous chemistry on the "ice" particles in polar stratospheric clouds (PSC). The critical temperature for formation of Type 1 PSCs depends on the concentration of water vapour and HNO_3. More water vapour in the stratosphere will lead to more PSCs and more ozone depletion as long as there are ODSs around.

Relationships between networks



Thank you for your attention!

GLOBAL
ATMOSPHERE
WATCH