On the role of HALO in UT/LS research

Overview and perspectives

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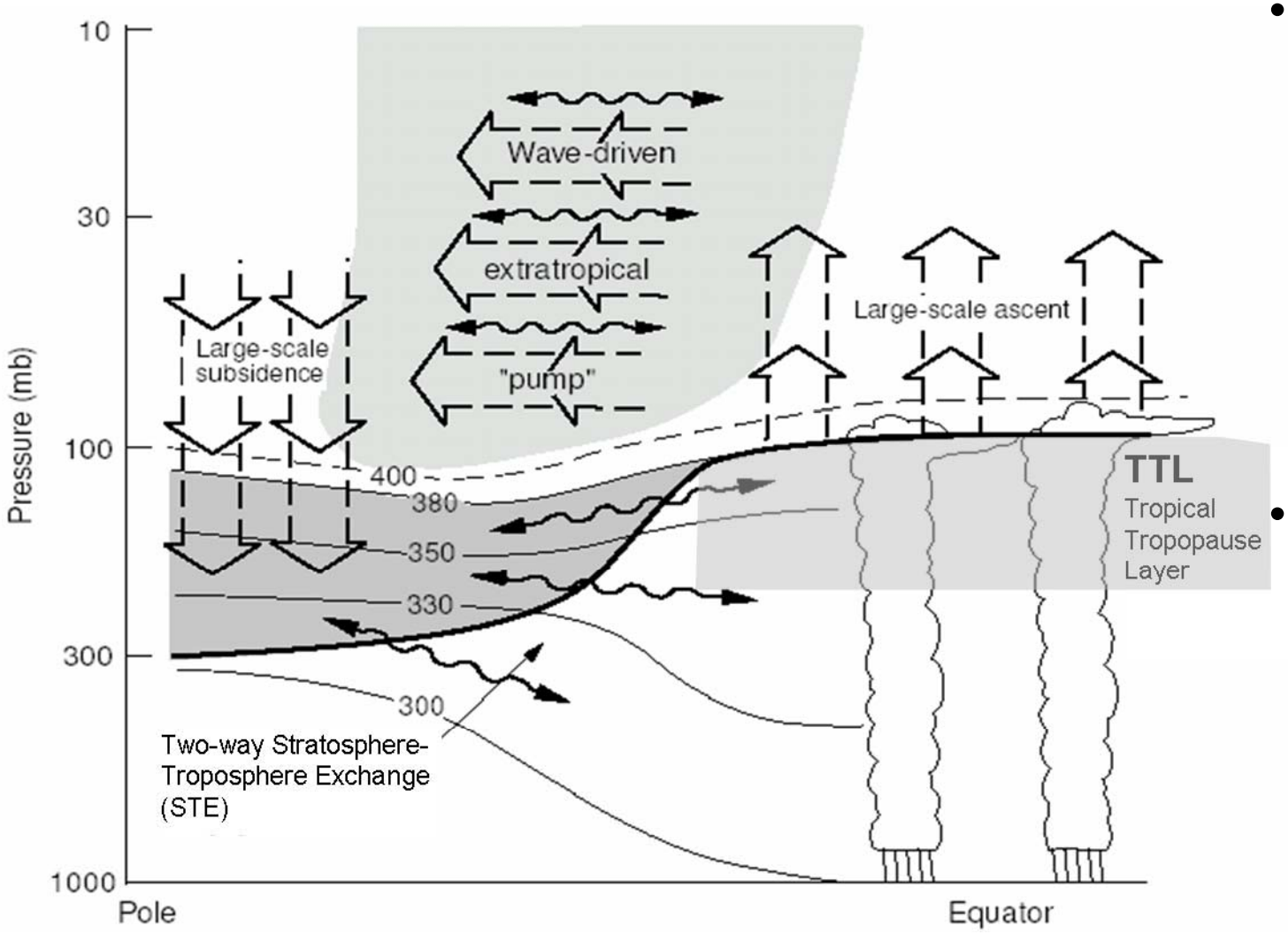
The UT/LS region and its global importance



adapted from Holton et al., 1995

- Input of tropospheric air and pollutants to the stratosphere
  - ***radiative balance***
  - ***ozone depletion***
- Input of stratospheric air with high NO_x and O_3 to the troposphere
  - ***oxidative capacity***

UT/LS science issues of relevance for HALO

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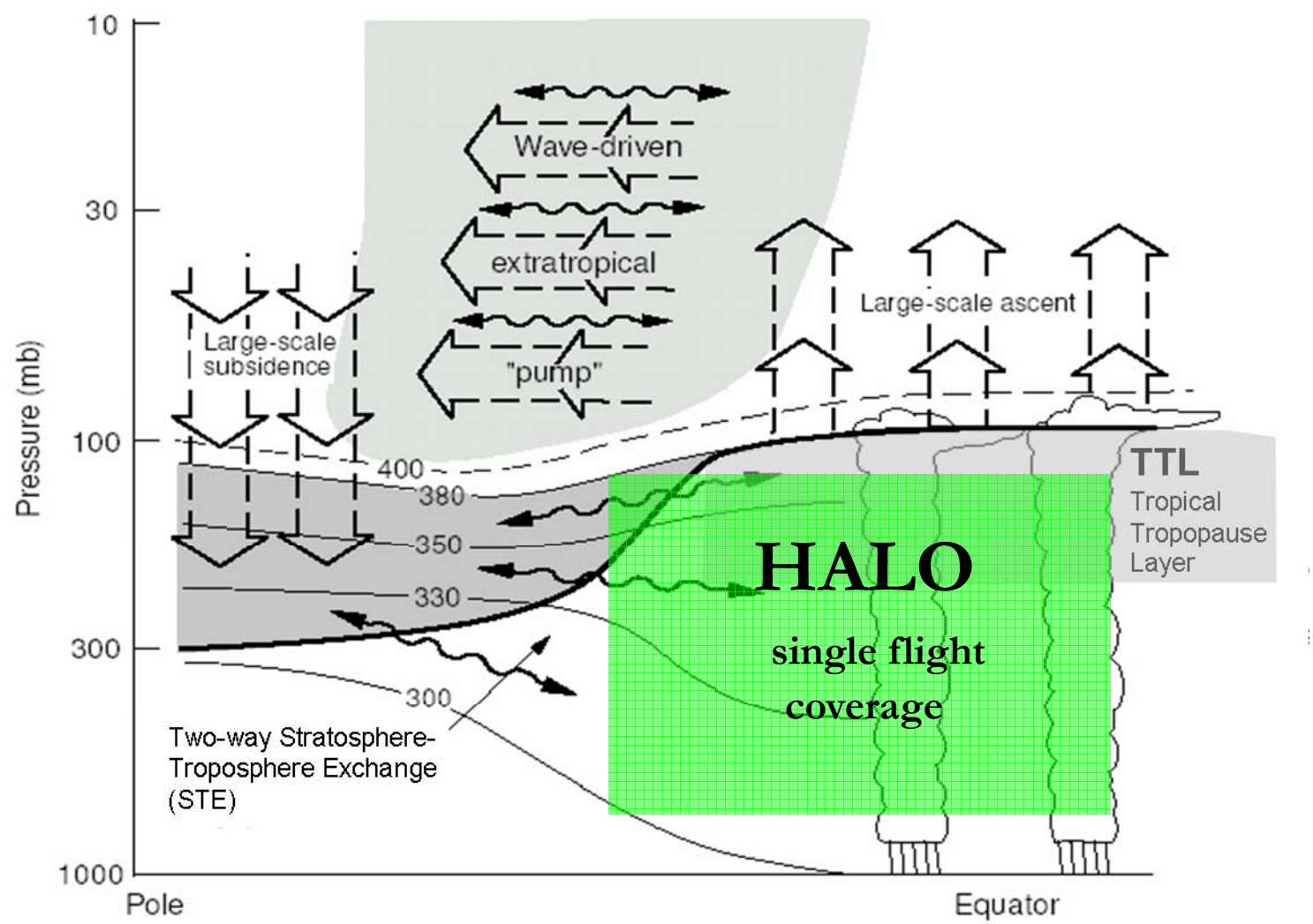
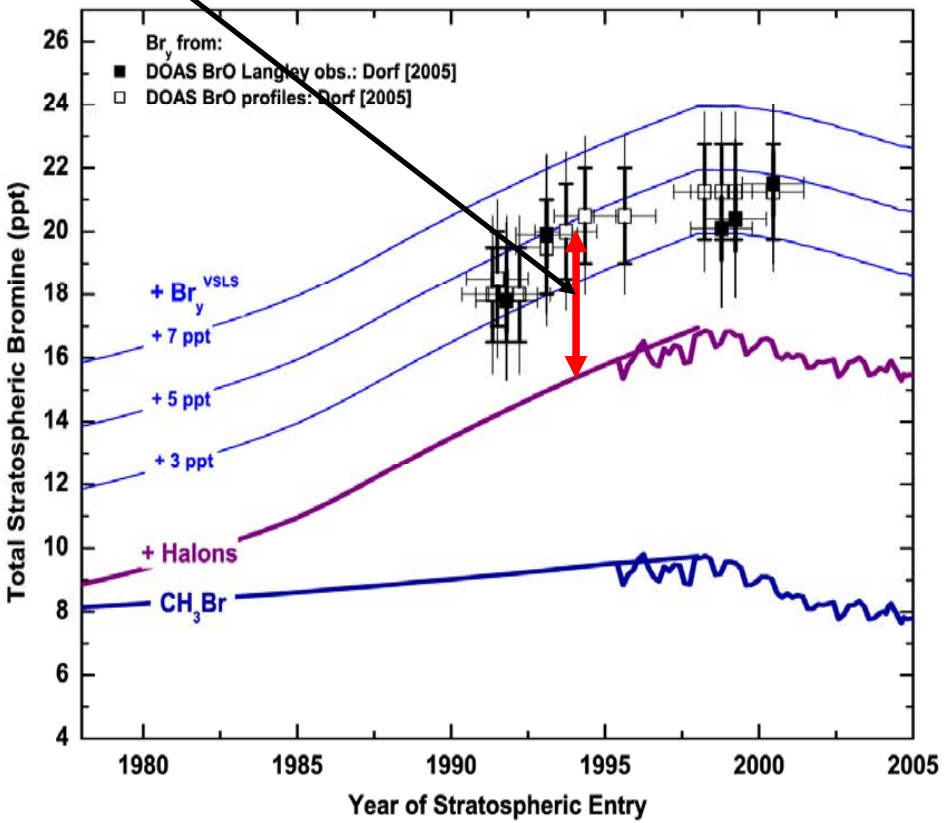
- **Tropical Tropopause layer (TTL) Issues**
  - How much halogen from short lived species is transported into the stratosphere?
  - What controls the seasonal cycle of ozone in the TTL - STJ and Asian Monsoon?
- **Extratropical UTLS (Ex-UTLS) issues**
  - Which dynamical processes control the chemical composition of the UT/LS (convection, mixing at PJ + STJ, intrusions)? Extratropical Tropopause layer (ExTL)?
  - What is the role of transport, mixing and radiation in maintaining the dynamical structure of UTLS? e.g. H_2O and N^2? Tropopause Inversion layer (TIL)?
  - What are the hemispheric differences ?

HALO in the Tropical Tropopause Layer (TTL)

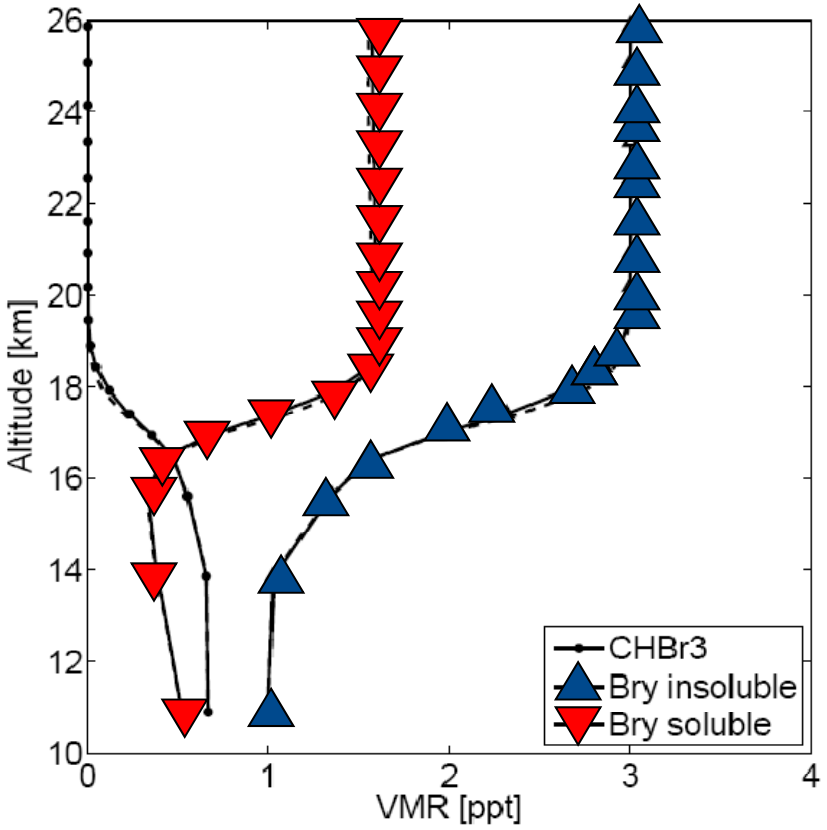


HALO in the TTL: Halogen input into the stratosphere

Additional bromine from short lived species
(Source gas and product gas injection)

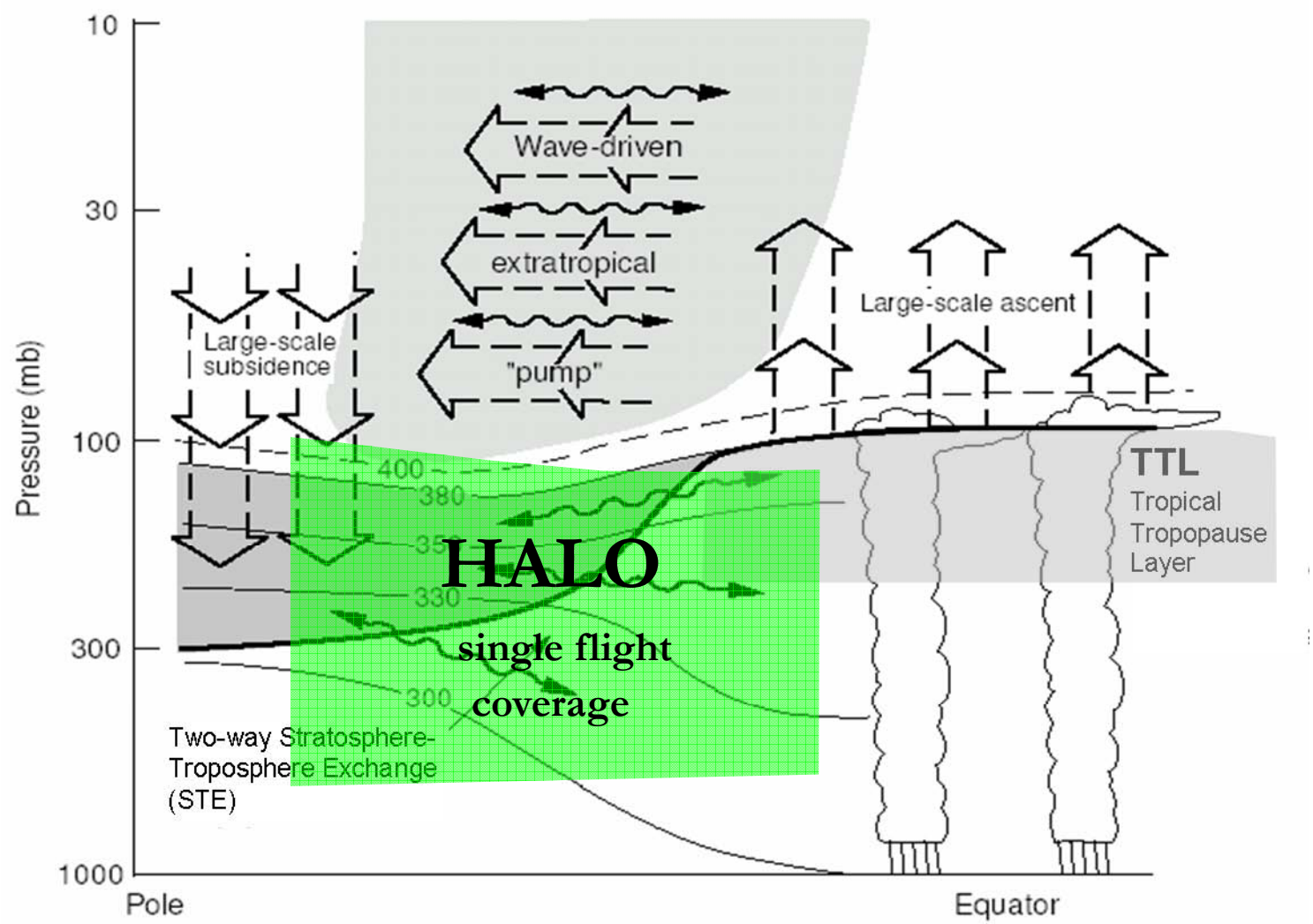


WMO 2006, Dorf et al., 2005

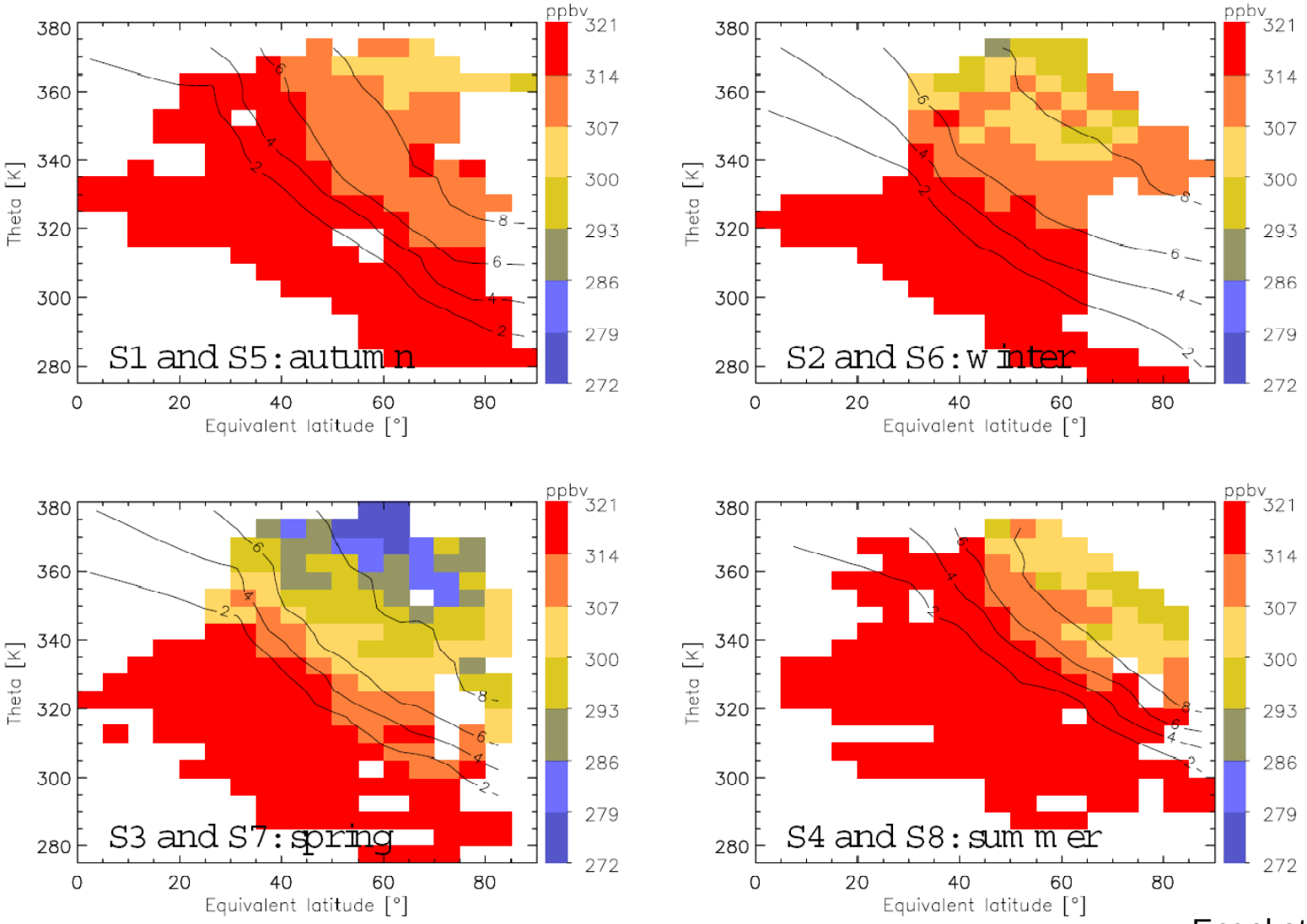


Aschmann et al., ACP, 2009

HALO in the Ex-UT/LS



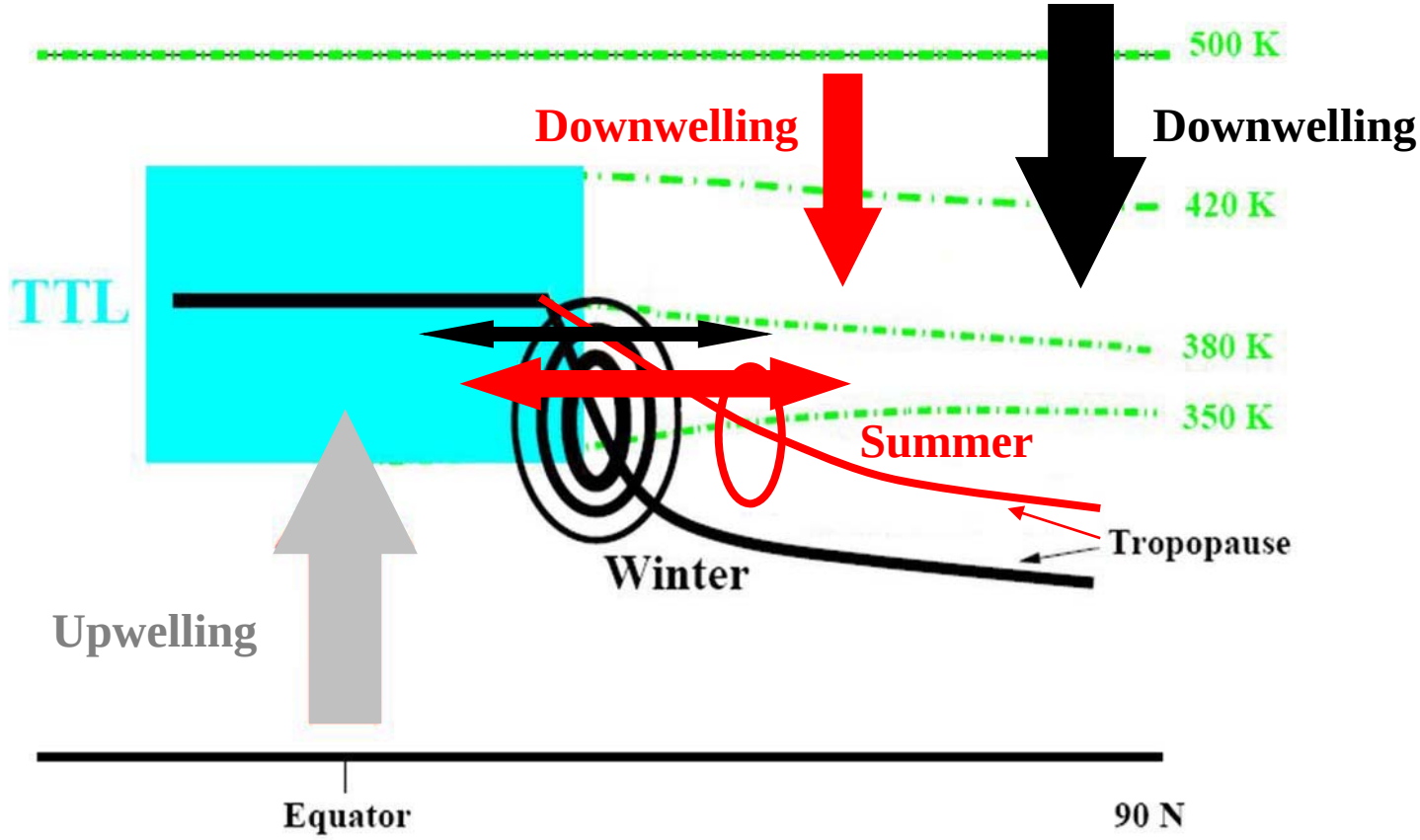
HALO in the Ex-UT/LS : Seasonality of trace gases in the LMS



Engel et al., 2006

HALO in the Ex-UT/LS and TTL: Seasonality of transport and mixing

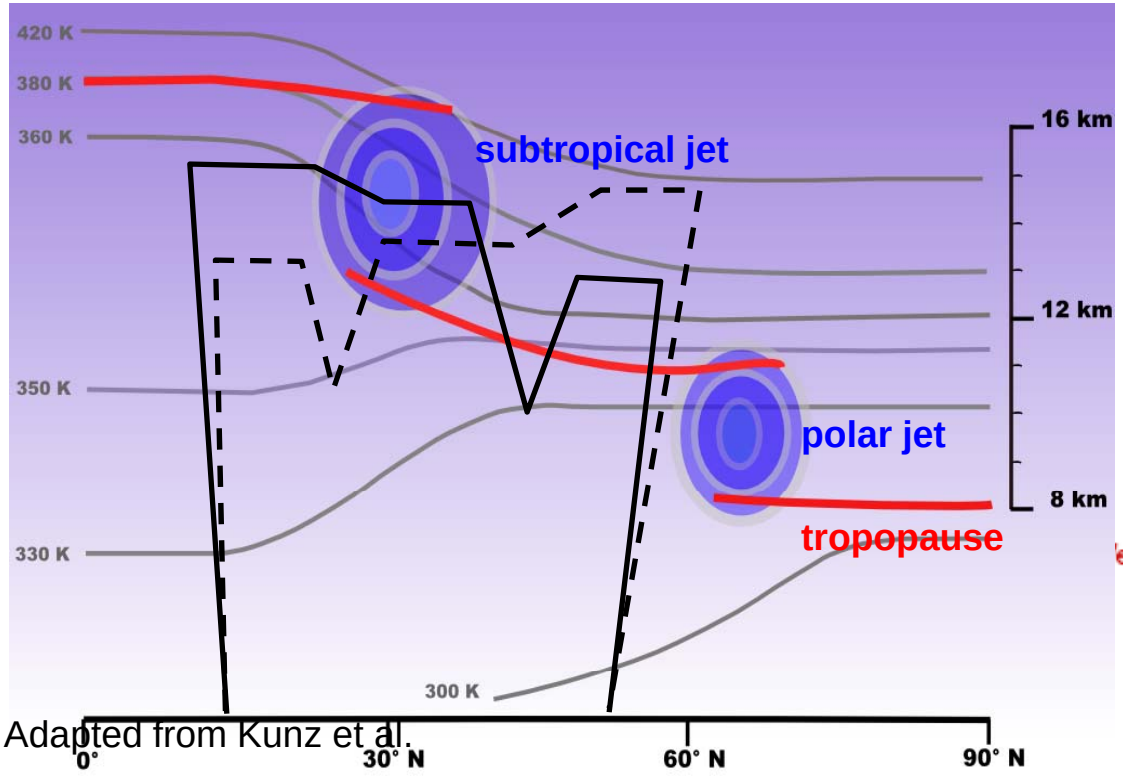
- **What is the role of the subtropical jet in modulating the coupling between the LMS into the TTL?**
- **What is the role of the Asian monsoon?**



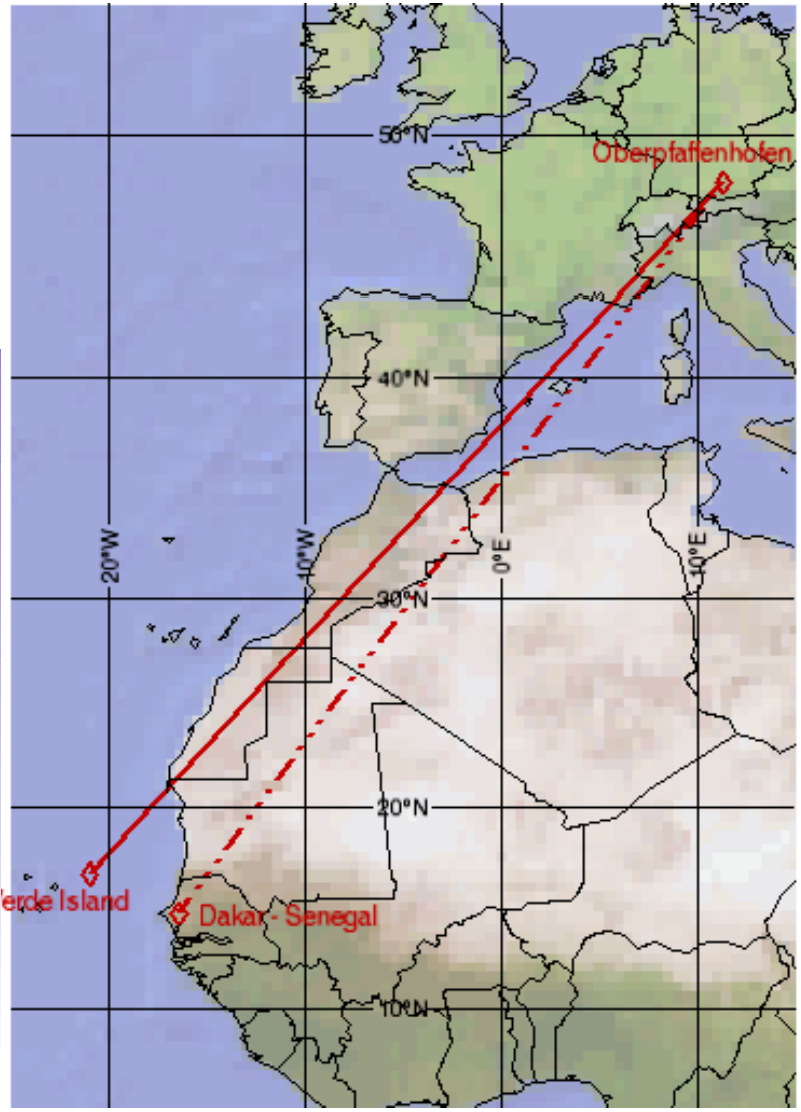
Adapted from Konopka et al. 2010

TACTS/SALSA with HALO

- **Sample both sides of the STJ**
- **Comprehensive tracer payload**
- **In-situ and remote sensing**
- **Seasonality**



Adapted from Kunz et al.



TACTS/SALSA methodology

- **High resolution and high precision observational fields of chemistry and transport tracers.**
  - Chemistry tracers: ozone, water vapour, NO_x, CO, halogenated source gases, halogenated product gases
  - Transport tracers: species with different source/sink characteristics, different lifetimes and different tropospheric trends

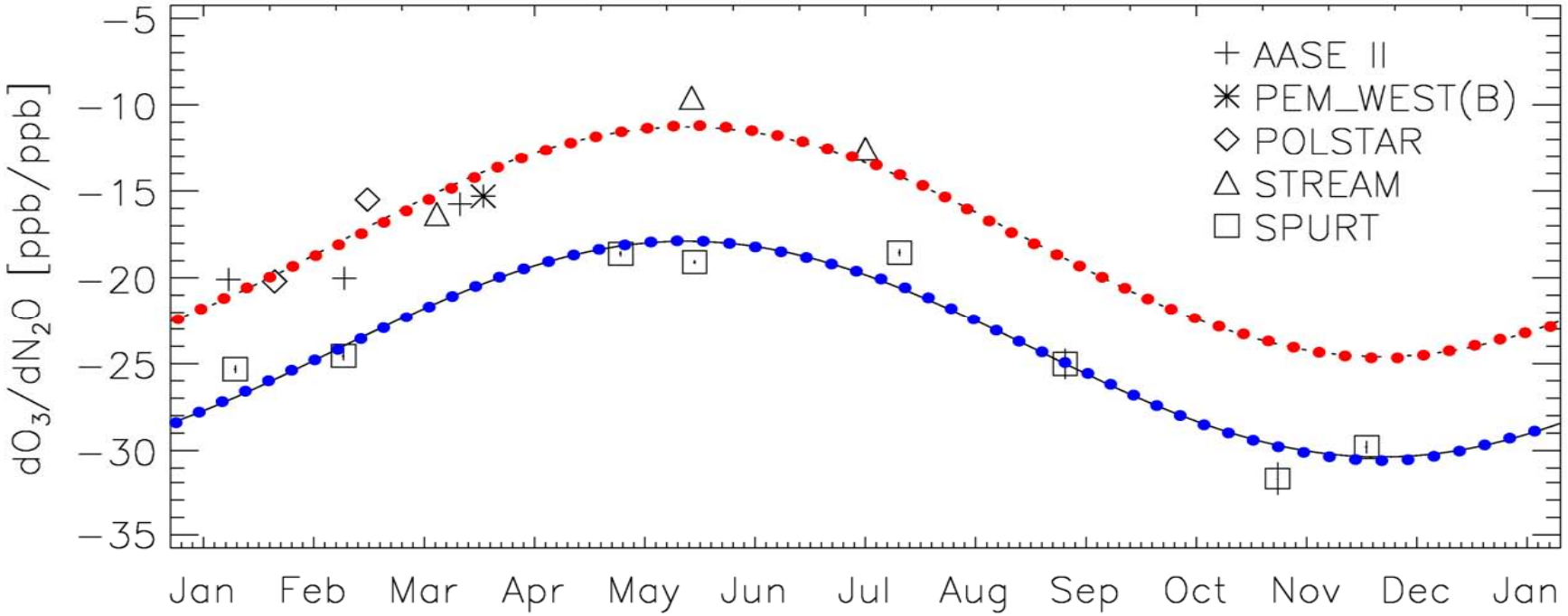
- **Bi-directional feedback with modelling work**
  - Better understanding of processes through combination of observations and models and improved representation of processes in models.

Long term perspectives - Climate Change

Projected increase of the stratospheric Brewer-Dobson circulation.

=> Impact on the UT/LS region

- Alter the chemical and dynamical characteristics
- Leading to feed-backs, e.g. on the radiative forcing



After stratospheric anomalies observed in 2001, Bönisch et al., in prep.

Summary of HALO UTLS perspectives

- **Observational data base is still sparse, although improving.**
- **Process understanding is limited, e.g.**
  - What controls the input of short lived halogen gases through the TTL into the stratosphere? (EU-Project SHIVA)
  - What controls transport, mixing and UTLS composition and seasonality? (TACTS/SALSA; CIRRUS-RS; POLSTRACC ..)
- **Observations (in-situ and remote sensing) are key to understanding chemical and dynamical characteristics and the underlying processes controlling these.**
- **Current satellites can provide climatological view, but miss details due to limited vertical resolution, strong vertical gradients and limited number of observed tracers.**
- **Coupling with climate change is a wide open field. Improved process understanding of today atmosphere is needed for projections of future atmospheres.**

THANK YOU FOR YOUR ATTENTION

- **Further research areas with relevance to the UTLS:**
  - **How does Stratosphere to Troposphere Transport (STT) influence the oxidative capacity of the troposphere**
  - **Cirrus clouds, Aerosols and radiation**
  - **High reaching convection**