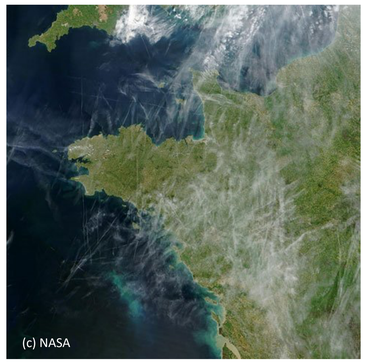
C01 Life Cycle of Ice Supersaturated Regions in the UTLS

Patrick Konjari (FZJ), Nils Brast (JGU), Philipp Reutter (JGU), Peter Spichtinger (JGU), Susanne Rohs (FZJ)

Motivation

- Ice supersaturated regions (ISSRs) are formation regions of natural and aircraft-induced contrail cirrus clouds and often found close to the tropopause.
- Transition from clear but ice supersaturated conditions to cloudy conditions change radiative feedback significantly.
- Lifecycle of ISSRs need to be better understood in order to improve their prediction in numerical weather models.
- Also the distinction between in-cloud and clear-sky ISSRs needs to be improved to asses their impact on radiation.



Collaborations within TPChange

A04 Use of A04 results for better distinction between cloudy and cloud-free ISSRs.

B02 Use of high-resolution radiosonde data for investigation of vertical structure of ISSRs.

B07 Work together on influence of turbulence and gravity waves on ISSR structure.

B08 Joint investigastion of ISSR formation in connection to warm conveyor belts.

C03 Conclusions and characteristics obtained from observations will be exchanged.

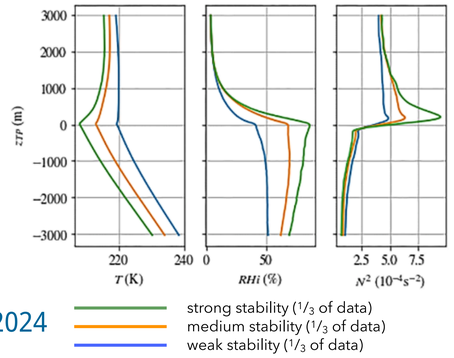
C05 Results regarding water vapor variability in observational and modeled data are exchanged.

Z01 Z02 Obtained ISSR climatology will be provided in a FAIR compliant way to be used in other projects.

Z03 Data from measurement campaigns from phase I and II are used for case studies on ISSRs and cirrus clouds.

Results from phase I

- Interaction between relative humidity w.r.t. ice (RHi) and tropopause structure
- Wetter profiles coincide with stronger tropopause inversion layer



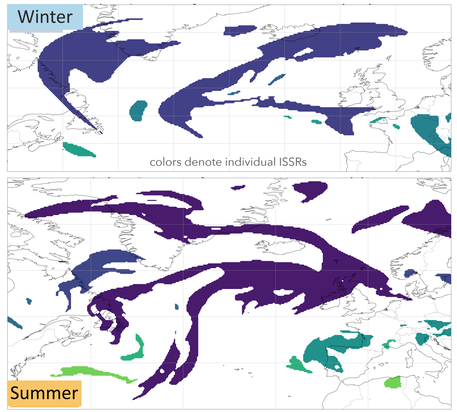
Köhler et al., 2024

- Gradient of RHi introduced as new tropopause definition

Reutter & Spichtinger, 2025

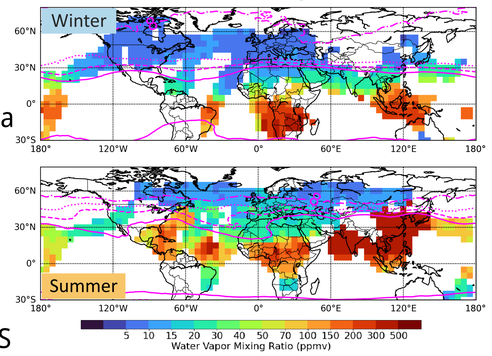
- Seasonal cycle of number and shape of ISSRs in the northern hemisphere
  - Less ISSRs in winter with compact geometry
  - More ISSRs in summer with more frayed geometry

Schuh et al., 2025



- Adjustment of IAGOS-CORE H_2O in the lower-most stratosphere (LMS)
  - Creation of new data base (IAGOS, JULIA, ERA5)
  - Production of high-resolution H_2O climatologies in LMS

Konjari et al., 2025



Research plan phase II

Main Goal: Build 2D and 3D ISSR climatology based on ERA5 and long-term in-situ measurements with the distinction of clear sky and cloudy conditions

- Work Package 1: Fractal properties and life cycle of ISSRs
  RHi values from ERA5 are used to detect ISSR fields in the UTLS region. These regions will then be tracked in time and their lifecycle is analyzed taking their fractal properties into account. Tracking algorithms including splitting and merging of objects need to be adapted for ISSRs.
- Work Package 2: Statistical patterns and scale-dependent formation processes of ISSRs
  Statistical analysis combining the IAGOS and JULIA data set. Here, the focus is on the differentiation of ISSRs in cloud-free and in-cloud areas using a newly developed classification system.
- Work Package 3: Synthesis of WP1 and WP2
  In this WP we bring the findings of WP1 and WP2 from modeling and observational analysis together to enhance the understanding of the formation of ISSRs and the embedded cirrus clouds. Additionally, the TPEx2 measurement campaign will be supported by contributing to the mission planning.

Objective:

- O1: Build ISSR climatology by use of fractal approach to obtain 2D and 3D structures of ISSRs (WP1) and by analysis of long term in situ observations (WP2).
- O2: Investigate life cycle of ISSRs using fractal objects through utilization of tracking algorithms including (WP1)
- O3: Classification of stage in life cycle and statistical investigation (WP1+2)
- O4: Identify relevant physical processes (WP1+2+3)