wege entstehen, indem wir sie gehen
paths emerge in that we walk them

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Monitoring sudden stratospheric warmings under climate change since 1980 based on reanalysis data verified by radio occultation

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A new SSWs monitoring approach – Intro & methodology

We developed and applied a new method for monitoring sudden stratospheric warmings (SSWs) that

- Can build on **any quality-assured reanalysis, model, and obs temperature** data over the polar region
- Is applicable at **different vertical resolutions** of data, from high-res profiles to 10 & 50 hPa levels only
- Employs the **concept of Threshold Exceedance Areas (TEAs) in temp anomalies** to monitor the SSWs
- Uses main-phase TEAs (middle-lower-strato warming) for three **key metrics - duration, area, strength**
- **Detects and classifies SSWs** into minor, major, extreme, and provides further characterization infos
- Enables a **long-term climatology** (1980-2021) and to **inspect statistics and multi-decadal changes**

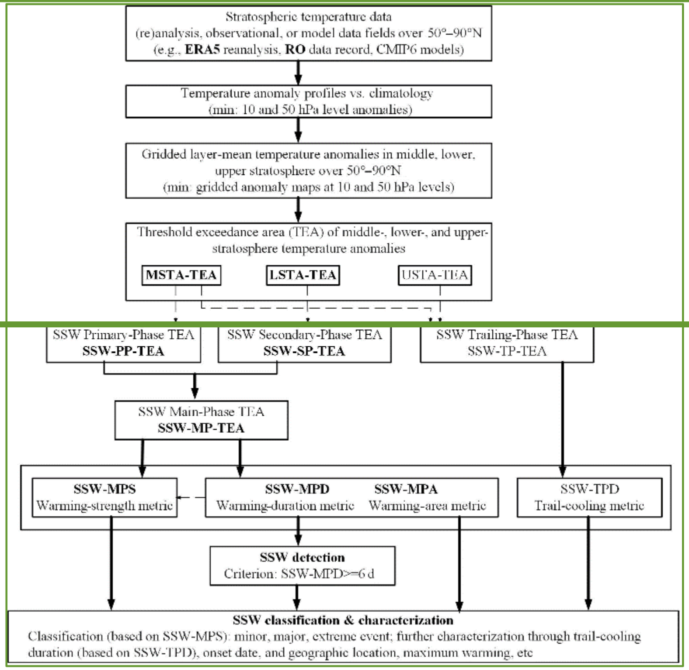
References – for reading up on the details

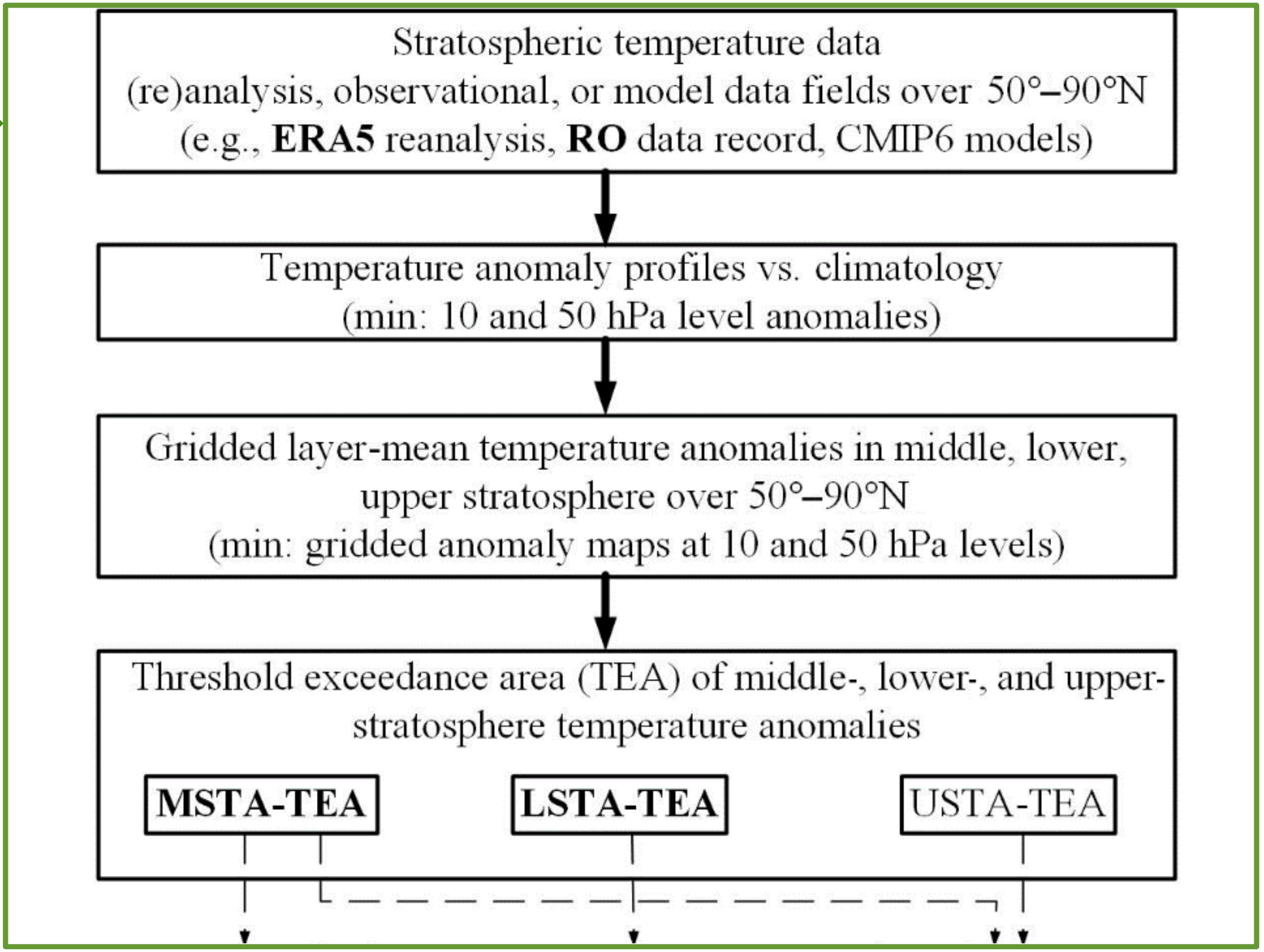
Li, Y., G. Kirchengast, M. Schwaerz, Y.-B. Yuan (2023): Monitoring sudden stratospheric warmings under climate change since 1980 based on reanalysis data verified by radio occultation, Atmos. Chem. Phys., 23, 1259-1284, https://doi.org/10.5194/acp-23-1259-2023

(initial explore-study) Li, Y., G. Kirchengast, M. Schwärz, F. Ladstädter, Y.-B. Yuan (2021): Monitoring Sudden Stratospheric Warmings using radio occultation: a new approach demonstrated based on the 2009 event, Atmos. Meas. Tech., 14, 2327-2343, https://doi.org/10.5194/amt-14-2327-2021

The new monitoring approach – Method overview (Part 1)

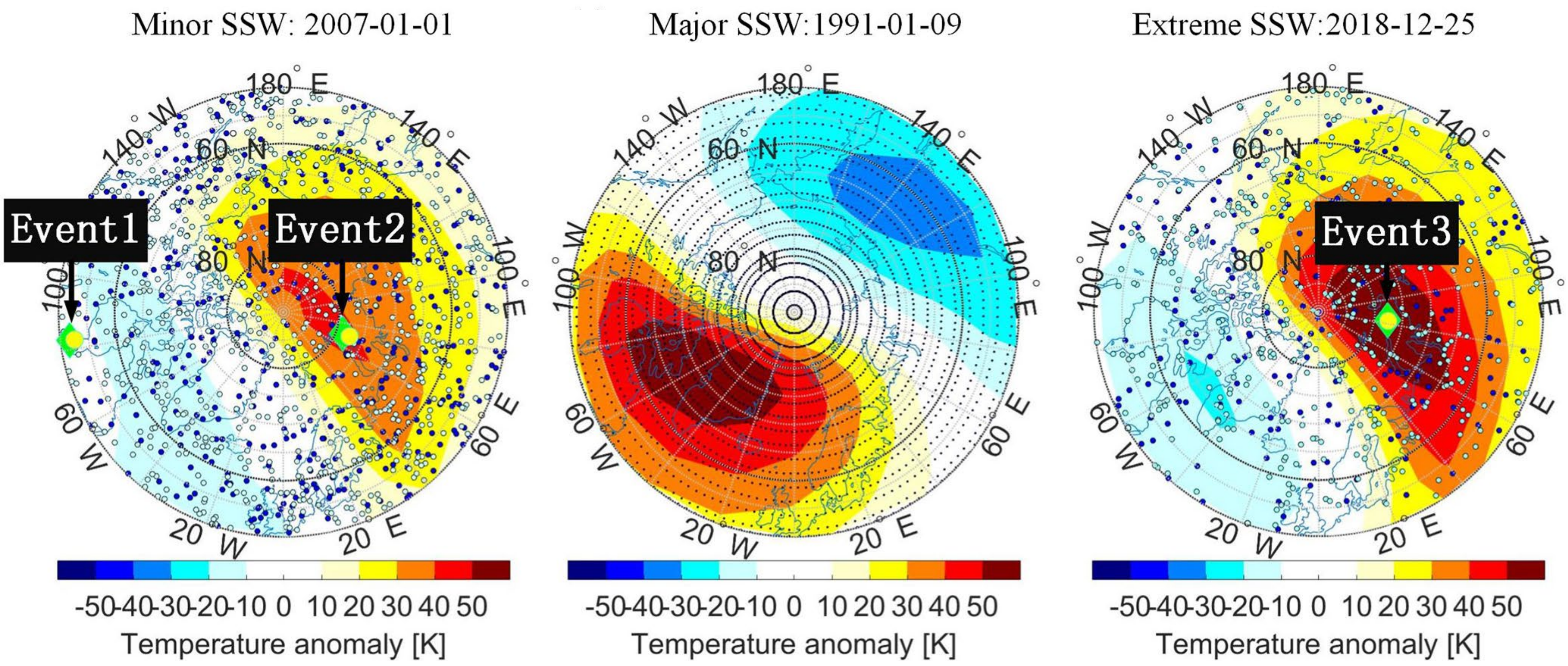
Schematic overview of the method and its main algorithmic steps, here “Part 1”, focusing on preparing the basic TEAs





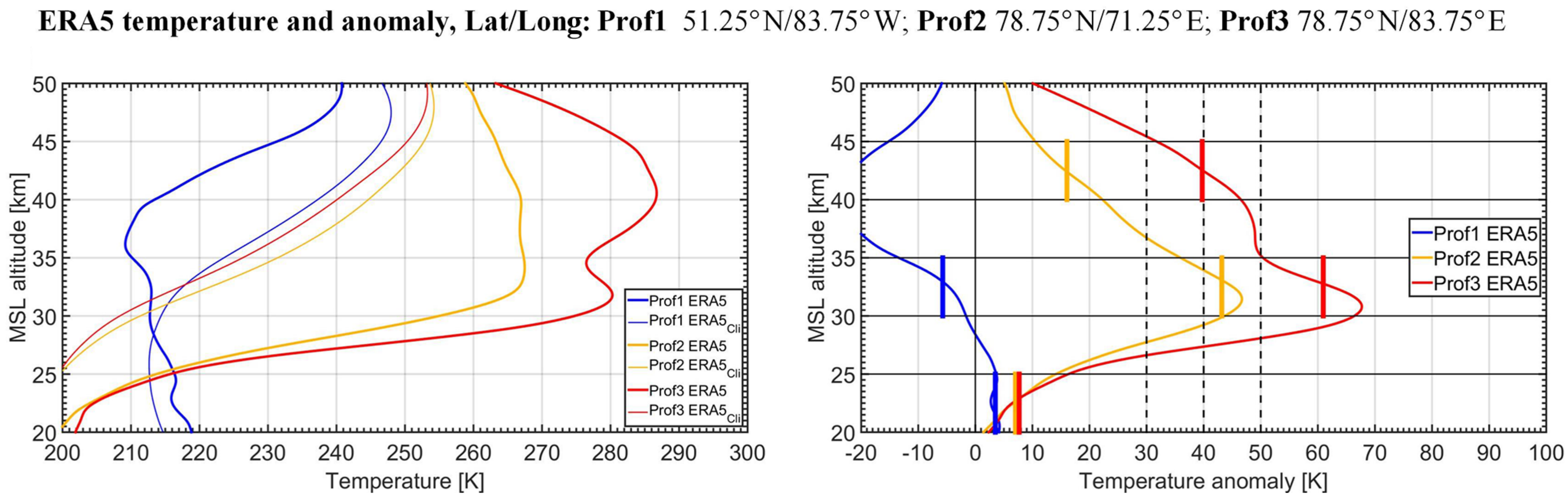
Tracking SSW-related temperature anomalies – Examples (1)

Polar-map view 50°N – 90°N of three daily middle-stratosphere ΔT anomalies, and three exemplary Event/Profile locations



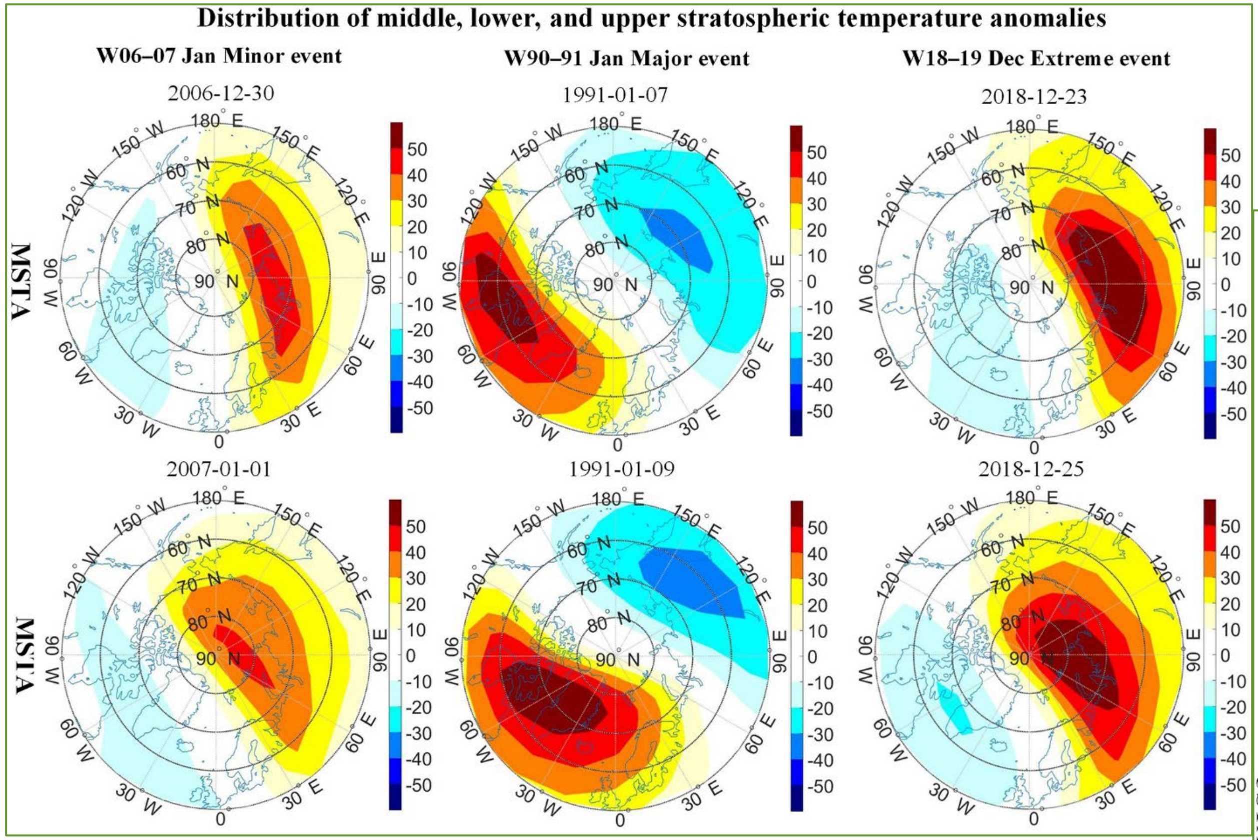
Tracking SSW-related temperature anomalies – Examples (2)

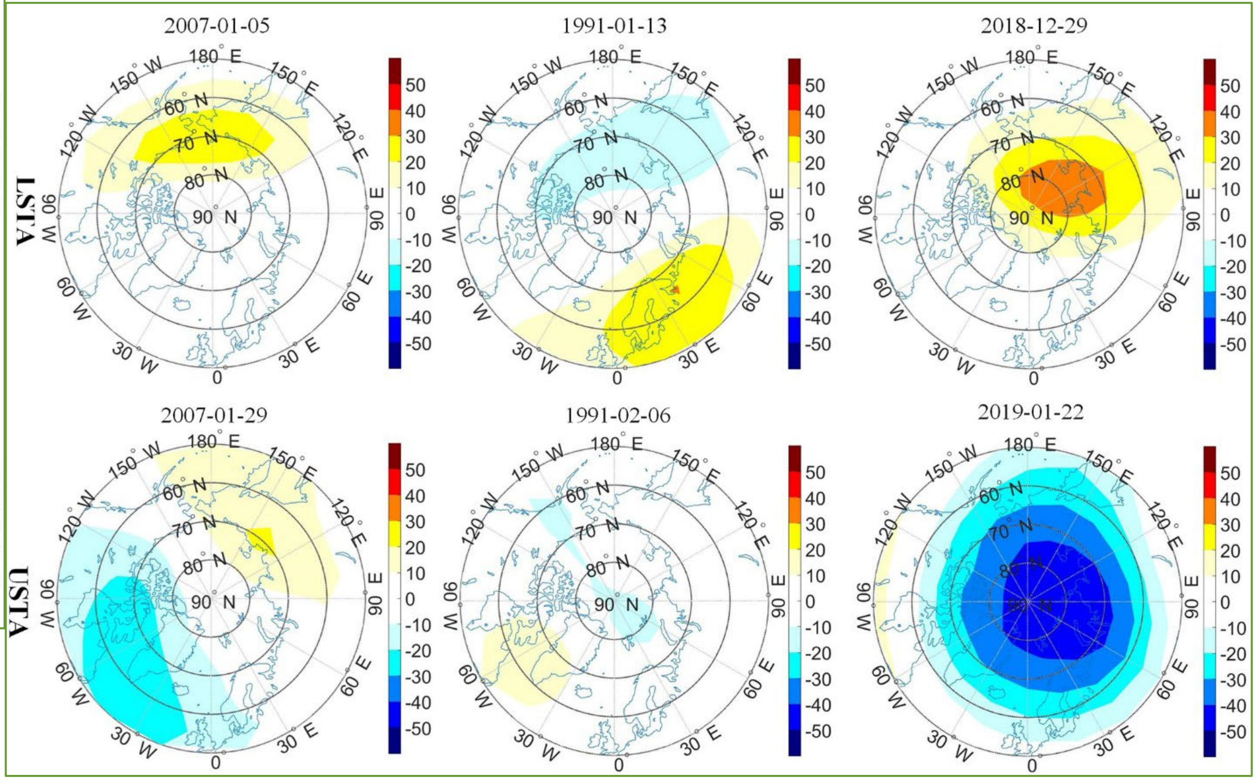
The three exemplary vertical temperature (left) and ΔT anomaly (right) profiles at the locations indicated in the map before



Tracking SSW-related temperature anomalies – Examples (3)

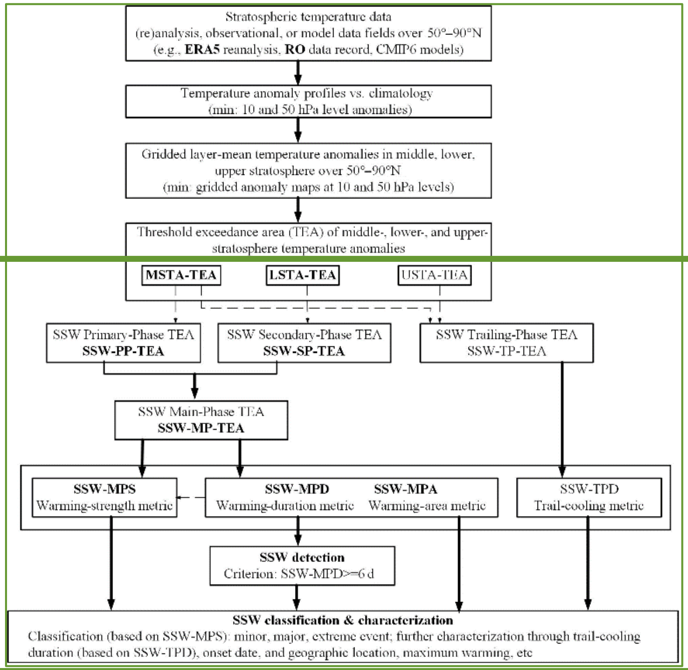
The exemplary ∆T anomalies before and at SSW onset date (left), and afterwards in lower and upper stratosphere (right)

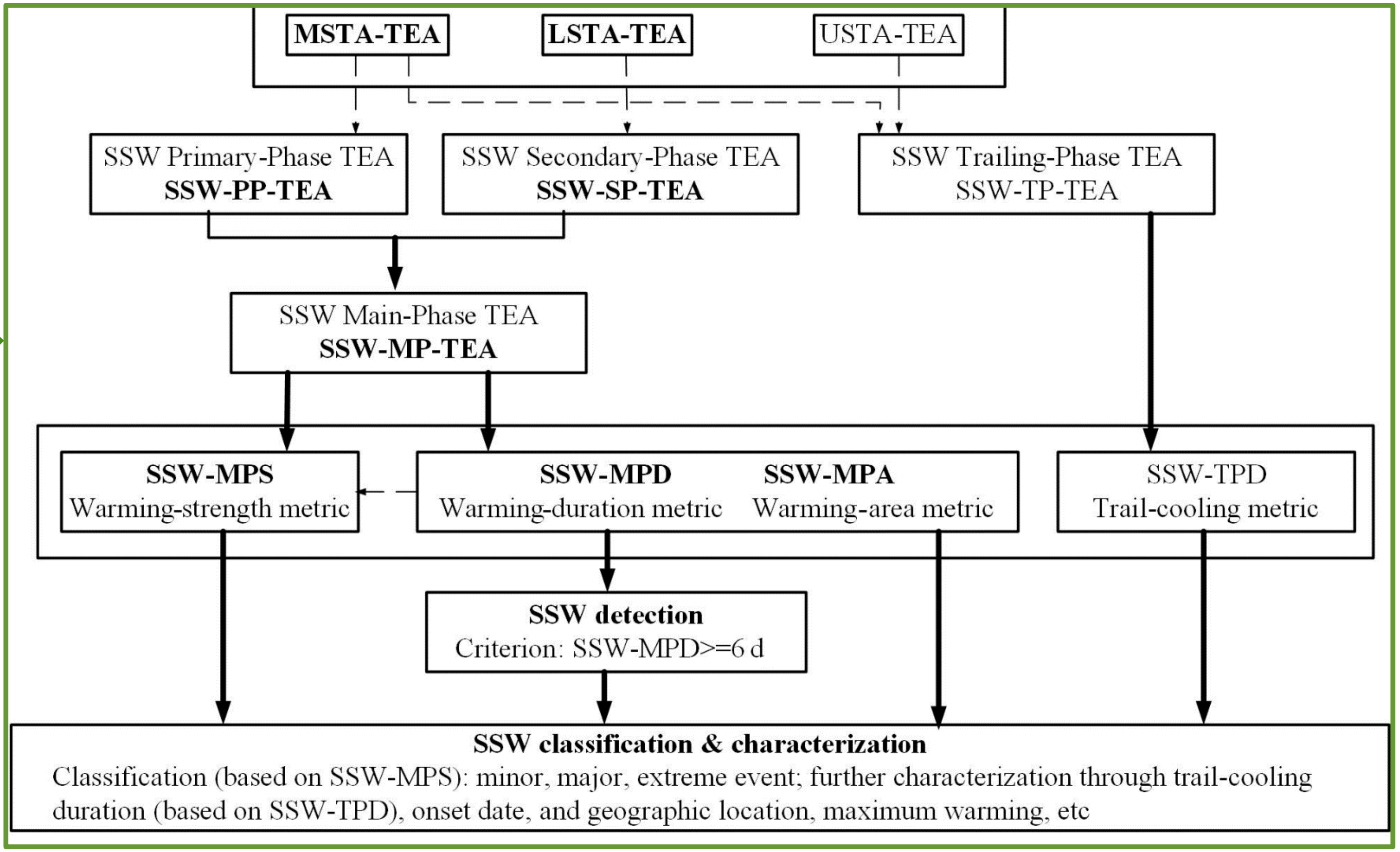




The new monitoring approach – Method overview (Part 2)

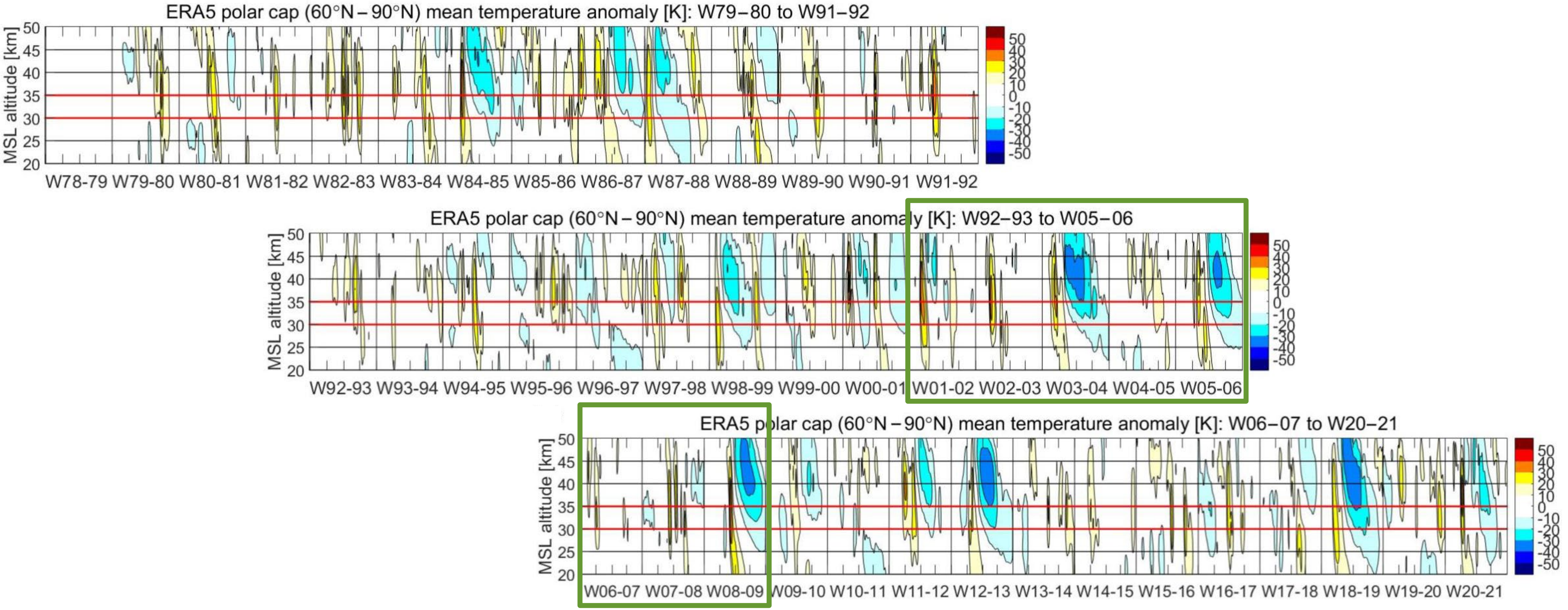
Schematic overview and its main algorithmic steps, here “Part 2”, from the TEAs to detection, classification, characterization





Tracking SSW-related temperature anomalies – 1980 to 2021

Polar-cap mean (60-90°N) time vs altitude (20-50 km) view of tracking the ΔT anomalies since 1980; 2001-2009 highlighted



TEAs & metrics-tracking results – Example winters 2001-2009

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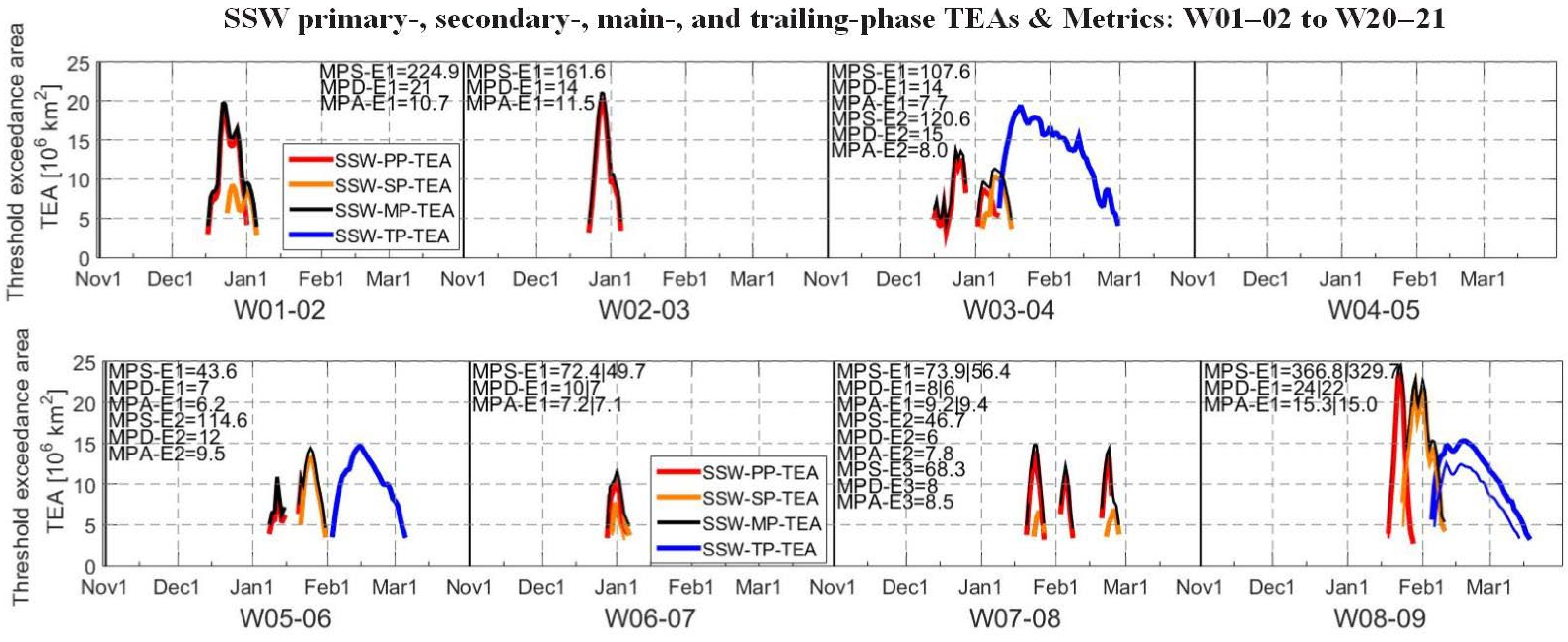
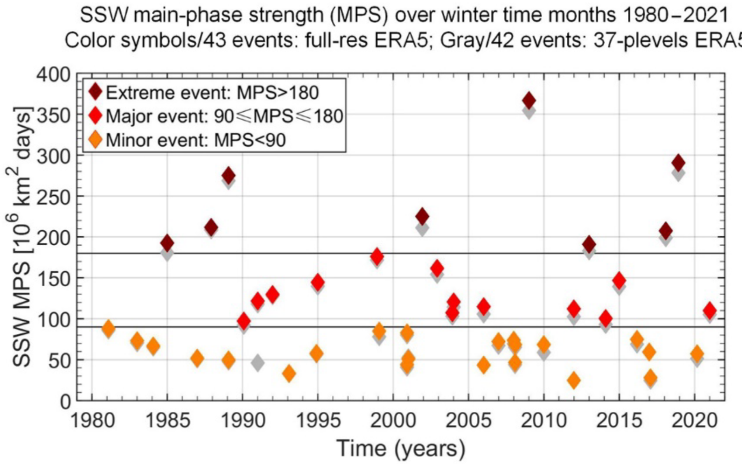
Threshold exceedance area (TEA) results and key metrics for exemplary minor, major, and extreme events in 2001 to 2009

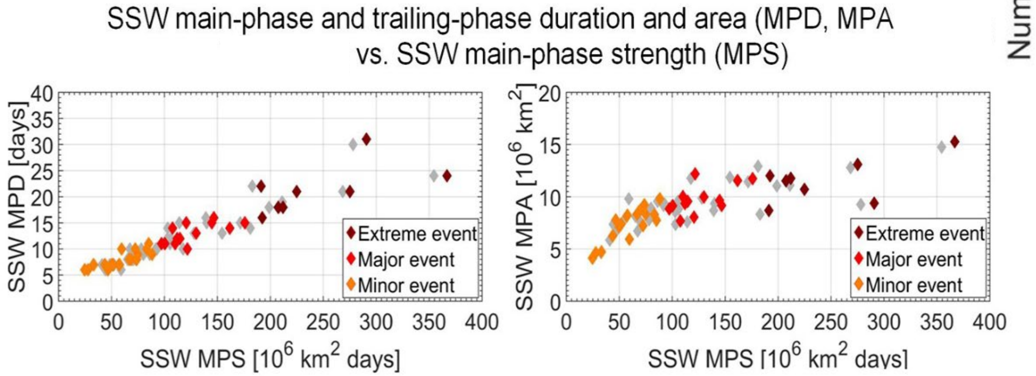


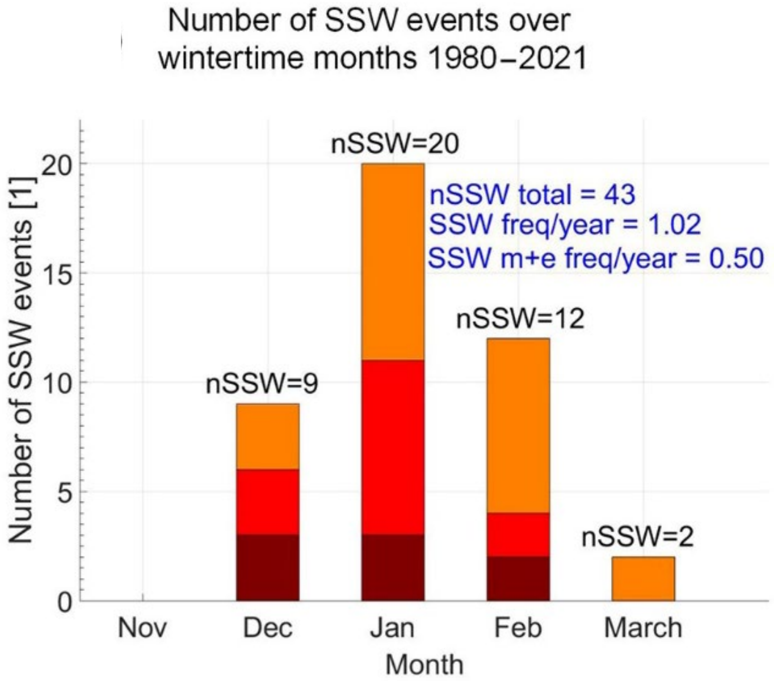
SSW climatology and statistics – results from 1980-2021 analysis

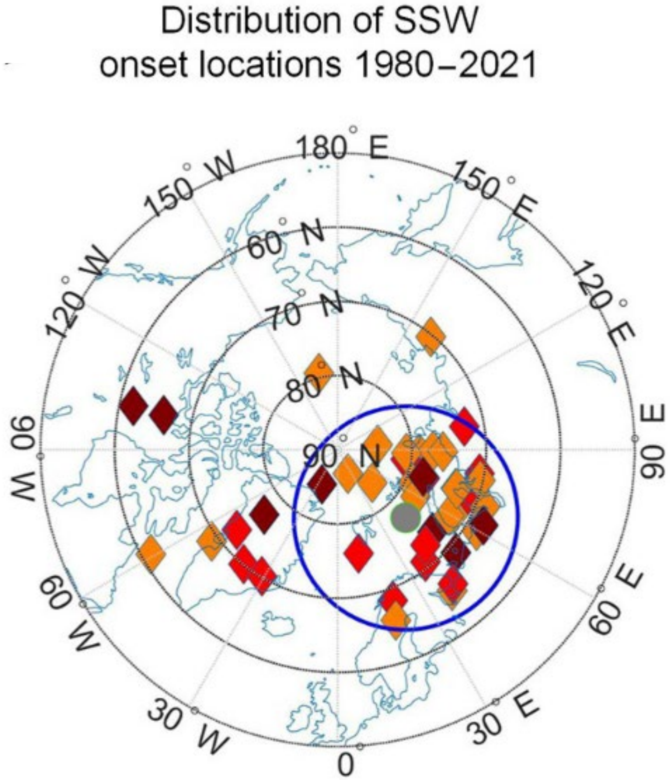
Long-term statistics from 42 winters 1980-2021 (with 43 events total), based on the key metrics and characterization infos

SSW long-term statistics from full-resolution and 37-plevels ERA5 data



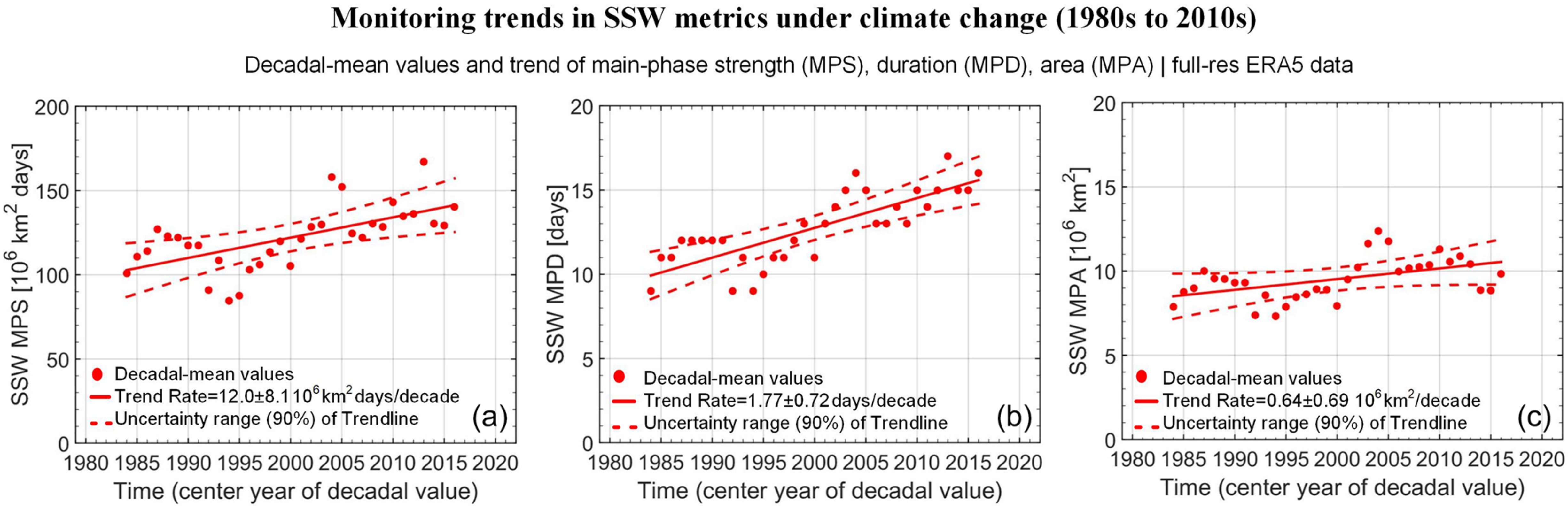






SSW multi-decadal change and trends – results from 1980-2021

Decadal-mean variability and change as well as long-term trend estimates in the three SSW monitoring key metrics



New monitoring of SSWs under climate change – Conclusions

The new TEA-based method for monitoring sudden stratospheric warmings (SSWs) was found to

- Be **robust for SSW detection, monitoring, and characterization** (from validation against previous studies)
- Be **applicable to different data sources and vertical resolutions**, from high-res to 10&50 hPa levels only
- Provide a **reliable SSW climatology** 1980-2021, enabling to inspect statistics and long-term changes

The results based on the long-term SSW climatology derived over 1980 to 2021 showed that

- Within the **42 winters, 43 SSW events** were detected, onset **95% in DJF**, 50% Jan, **75% in a location cluster**
- Long-term **1980s to 2010s** change showed **significant SSWs duration and strength increase** (by near 50%)
- They are a **valuable basis** for studying SSW links to changes in **polar-vortex dynamics and mid-lat extremes**

Key reference again – welcome to read up the details!

Li, Y., G. Kirchengast, M. Schwaerz, Y.-B. Yuan (2023): Monitoring sudden stratospheric warmings under climate change since 1980 based on reanalysis data verified by radio occultation, Atmos. Chem. Phys., 23, 1259-1284, https://doi.org/10.5194/acp-23-1259-2023

Thank you for your attention! ☺