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Using a machine learning and stochastics-founded model to provide near real-time stratospheric polar vortex diagnostics based on high-latitude infrasound data

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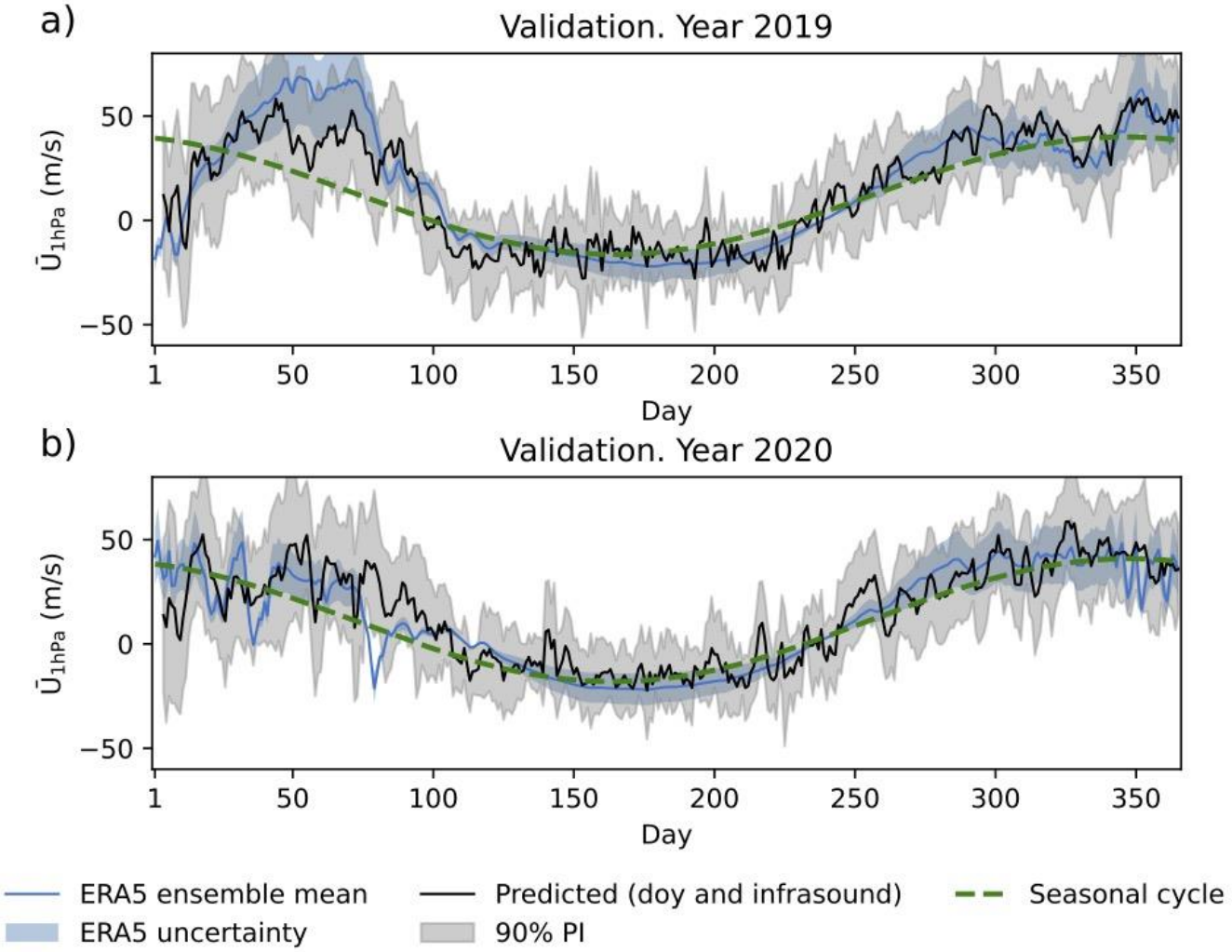
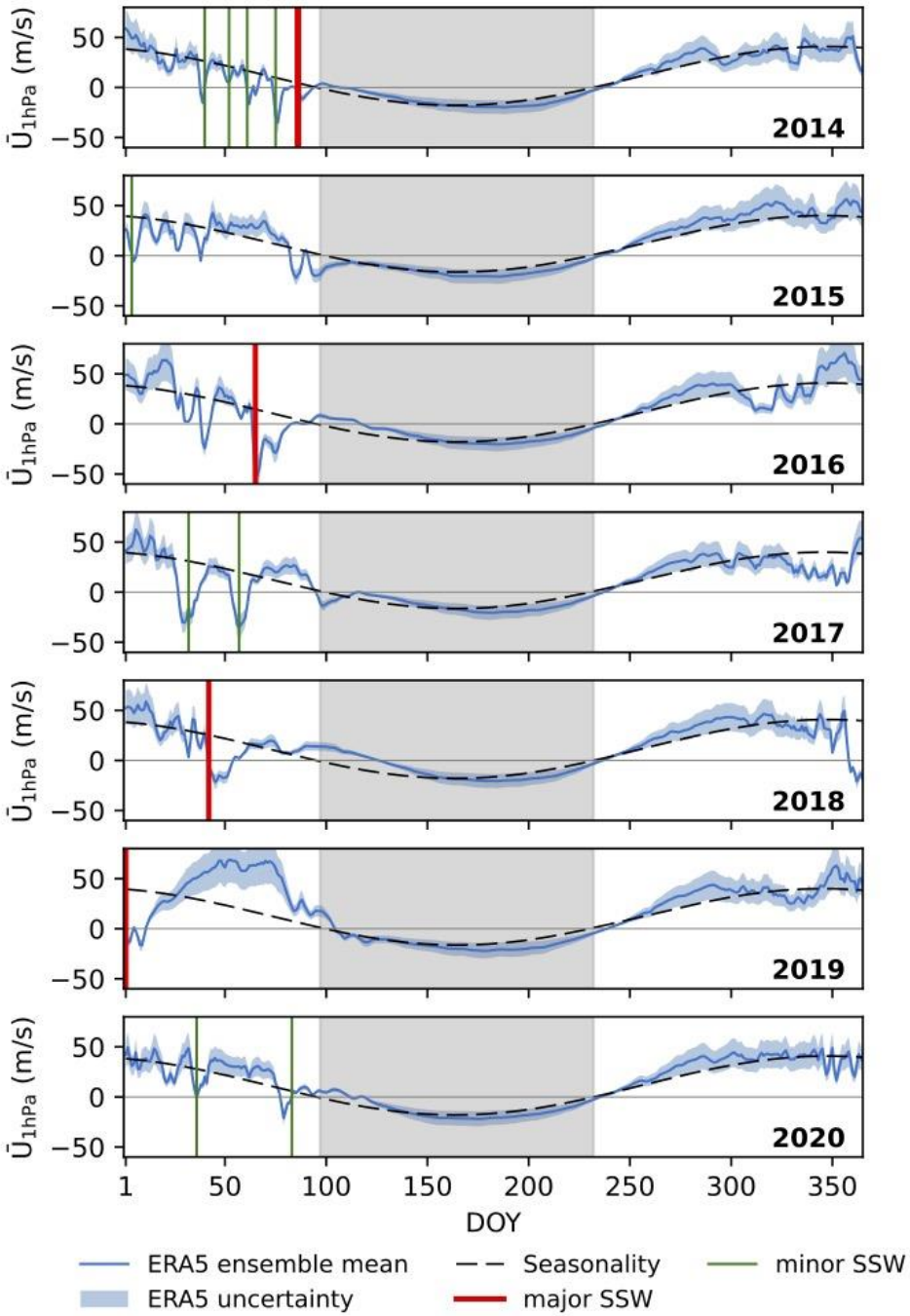
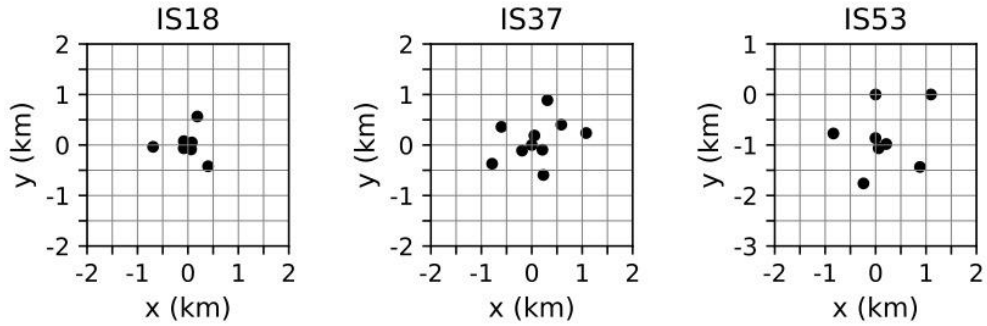
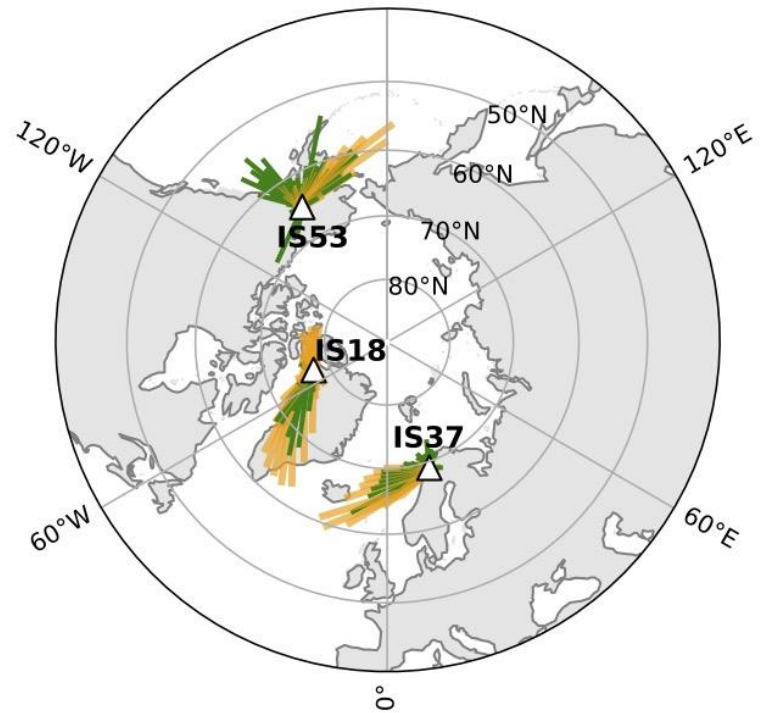
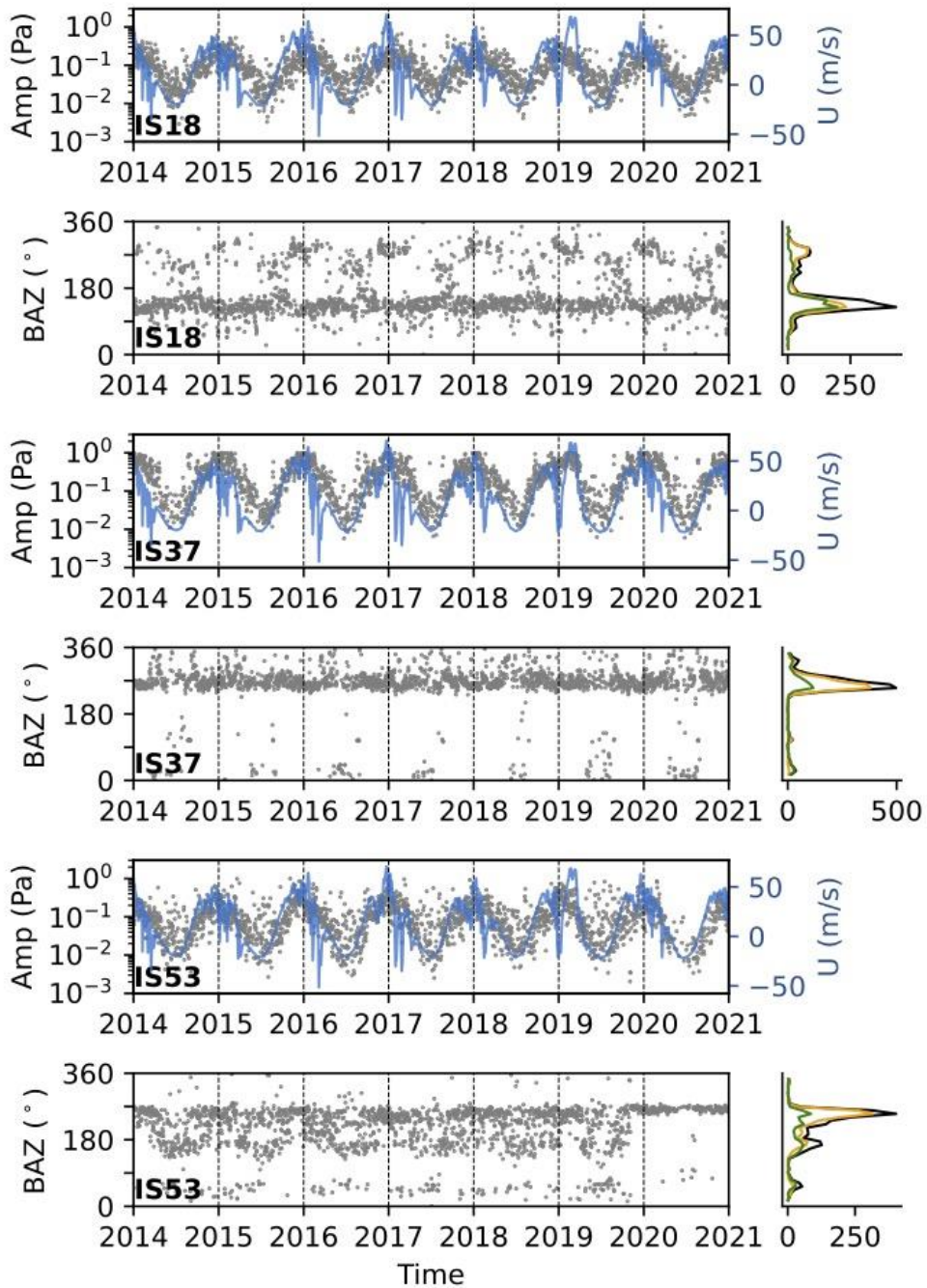
- Infrasound data is utilized along with a machine-learning supported stochastic model, the Delay-SDE-Net, to demonstrate how a near-real-time estimate of the polar cap zonal-mean zonal wind at the 1 hPa pressure level can be found solely from microbarom measurements and the day of year.
- The Delay-SDE-net was trained on five years (2014-2018) of microbarom data from three high-latitude stations in the IMS infrasound network to predict ERA5 re-analysis zonal-mean zonal wind.
- Two years (2019-2020) of validation data gives a root mean square error of around 12 m/s compared to the ERA5 model product.
- The Delay-SDE-net trained on microbarom data predicts negative zonal average zonal wind in the beginning of 2019 in contrast to when the model is solely trained on the day of year. This substantiates that information added from infrasound has potential to capture SSWs in near real-time.

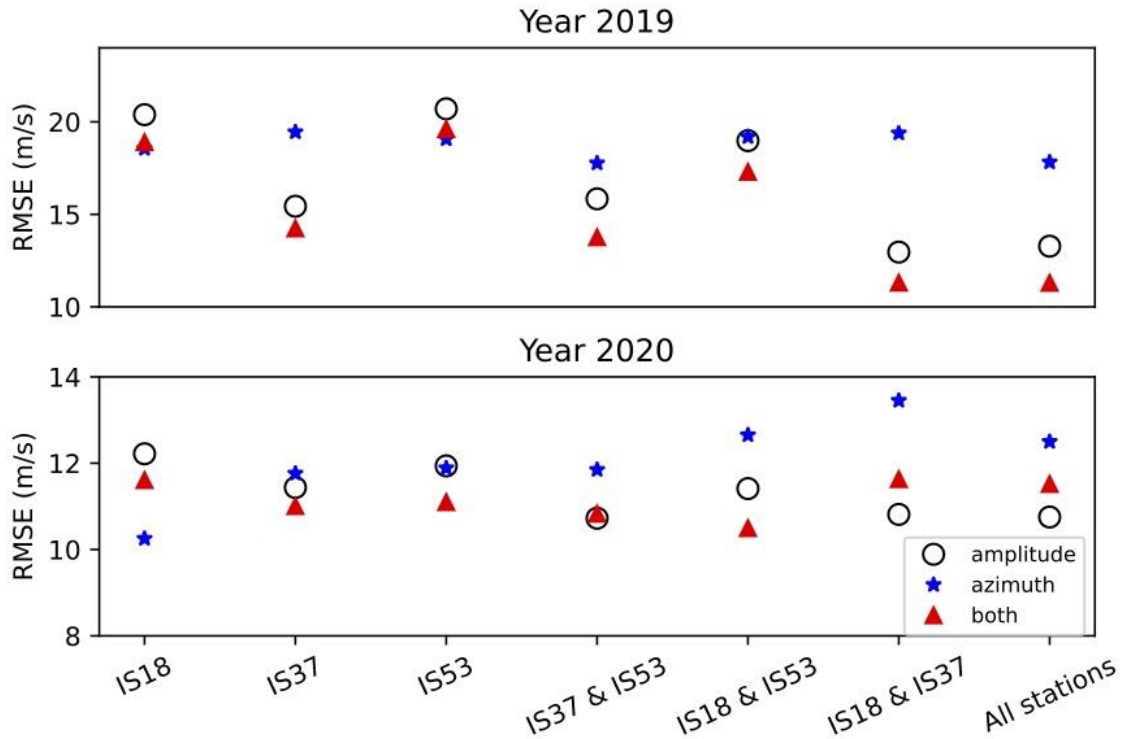



$\bar{U}_{1hPa}$ (m/s)
2014
2015
2016
2017
2018
2019
2020
DOY
ERA5 ensemble mean
ERA5 uncertainty
Seasonality
major SSW
minor SSW


IS18
IS37
IS53
y (km)
x (km)


120°W
120°E
60°W
60°E
0°
50°N
60°N
70°N
80°N
IS53
IS18
IS37
Cold season
Warm season


Amp (Pa)
U (m/s)
IS18
BAZ (°)
IS37
IS53
2014 2015 2016 2017 2018 2019 2020 2021
Time


Year 2019
Year 2020
RMSE (m/s)
amplitude
azimuth
both
IS18
IS37
IS53
IS37 & IS53
IS18 & IS53
IS18 & IS37
All stations