Group 4
Project Title: Atmospheric rivers and aerosol transport to the poles
Assistant: Rémy Lapere [remy.lapere@univ-grenoble-alpes.fr]

Background/motivation (short paragraph):
Atmospheric rivers (AR) are narrow, long, transient, water vapor-rich corridors of the atmosphere that greatly affect the hydrological budget in polar regions [Nash et al., 2018]. They are relatively rare (~12 per year in West Antarctica) but important contributors to snowfall accumulation in East Antarctica, sea ice decline in the Arctic and the decreasing ice mass on the Greenland ice sheet due to the enhanced downward longwave radiation and warm air advection [Wille et al., 2019]. The frequency and intensity of warm and moist air-mass intrusions (associated with AR) into the Arctic have increased over the past decades and have been related to sea ice melt [Caballero & Woods, 2016]. In the spring of 2020, a major warm air mass intrusion event was recorded in the high Arctic, associated with the transport of large quantities of aerosols originating from Europe, possibly affecting Arctic clouds properties [Dada et al., 2022]. This project aims at studying the transport of aerosols associated with such events and evaluating possible implications for polar climate.

Research question(s): [One research question (or several) per student]
- How much aerosols do AR transport toward the pole?
- Where do these aerosols come from? (source, species)
- How do they affect polar clouds?
- Do AR with larger aerosol content have a larger impact on polar climate?

These questions can be treated for the Arctic or Antarctic (or both) up to the students. The year of study is 2020 because we have the AR detection product for that year, but if the students are VERY motivated, they can try to use the algorithm from Wille et al., 2019 and MERRA2 data to recreate AR detection for other years.

Data:
- Reanalysis:
  - MERRA2 3-hourly (temperature, specific humidity, wind, pressure…)
  - CAMS atmospheric composition 3-hourly (aerosol optical depth with speciation, total column carbon monoxide)
- Atmospheric river detection product for the year 2020 based on Wille et al., 2019
- Observations at Zeppelin station (time series of carbon monoxide, vapor, aerosols, aod from aeronet…)
- EBAS platform for additional station data if needed

Reference(s): [Extra reading here, maybe also some textbooks with chapters]
Wille et al. West Antarctic surface melt triggered by atmospheric rivers. Nat. Geosci. 12, 911–916 (2019). https://doi.org/10.1038/s41561-019-0460-1

Nash et al., The Role of Atmospheric Rivers in Extratropical and Polar Hydroclimate, J. Geophys. Res., 123 (2018), 10.1029/2017JD028130

Caballero & Woods. The role of moist intrusions in Winter Arctic warming and sea ice decline. J. Clim. 29 (2016), doi.org/10.1175/JCLI-D-15-0773.1

Dada et al. A central arctic extreme aerosol event triggered by a warm air-mass intrusion, Nat. Comm., 13 (2022), 10.1038/s41467-022-32872-2