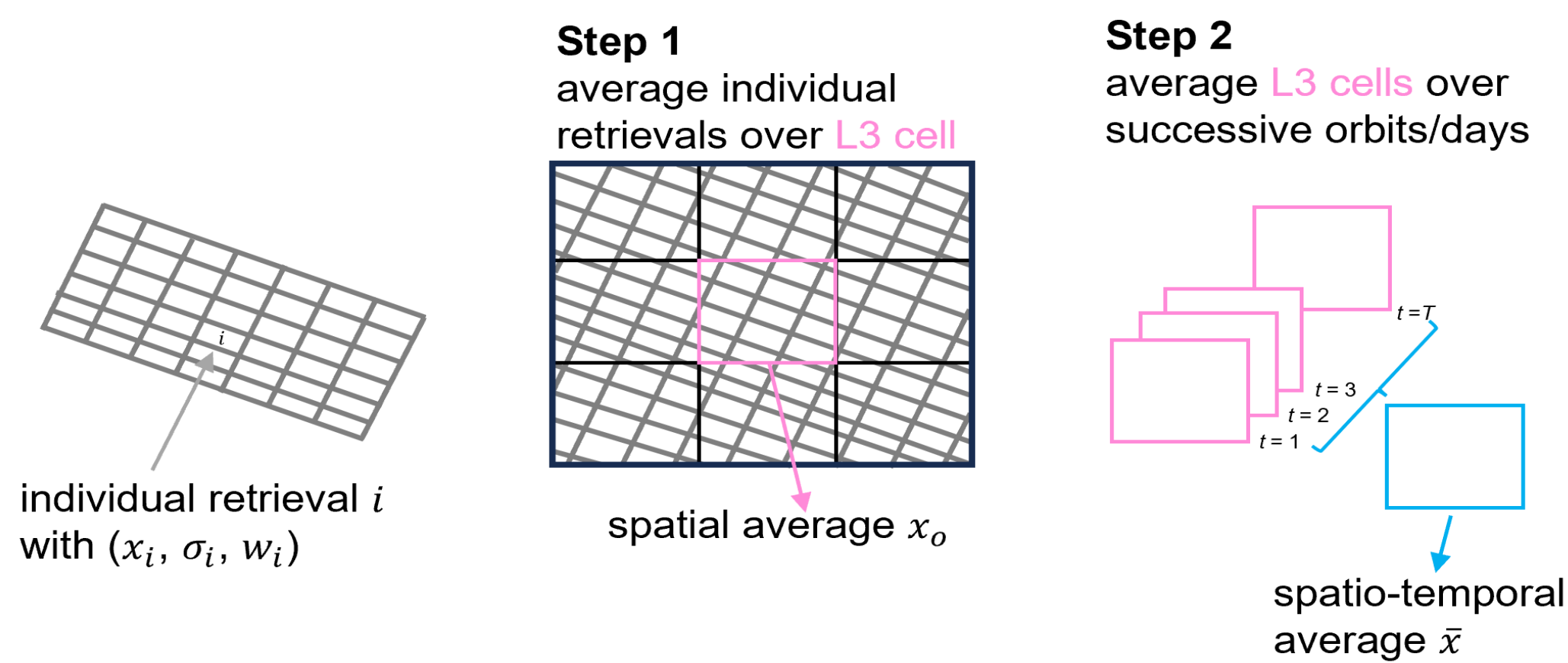


Monthly mean tropospheric NO₂

We have produced a NO₂ monthly mean data record for the ESA CCI+ project Precursors for Aerosols and Ozone.

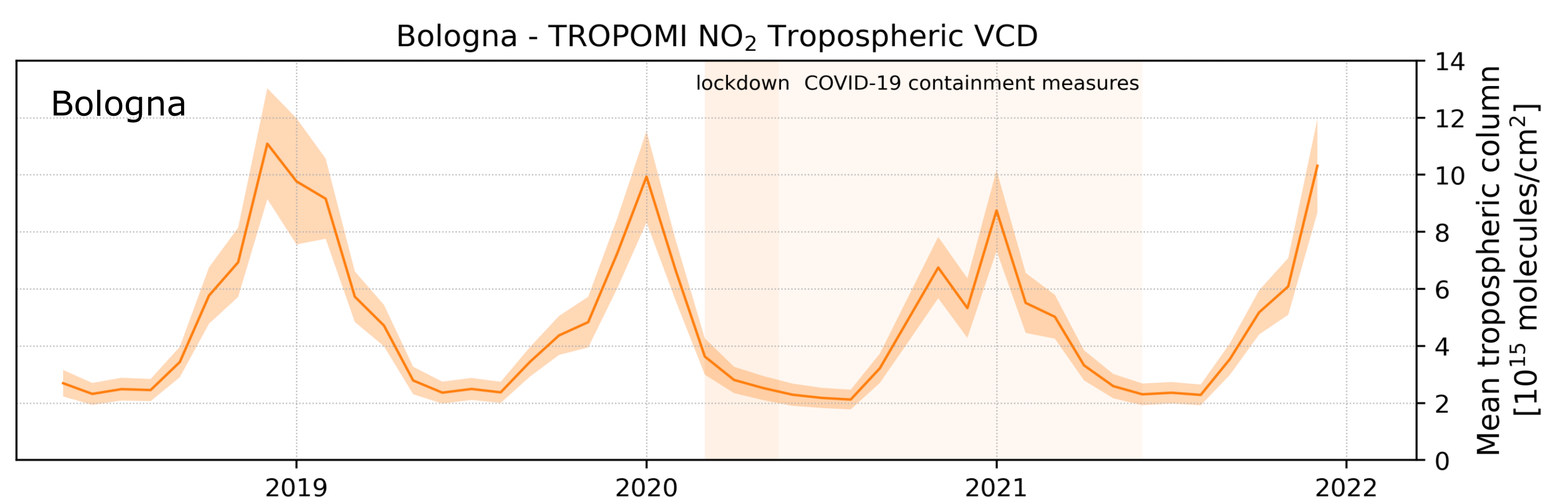
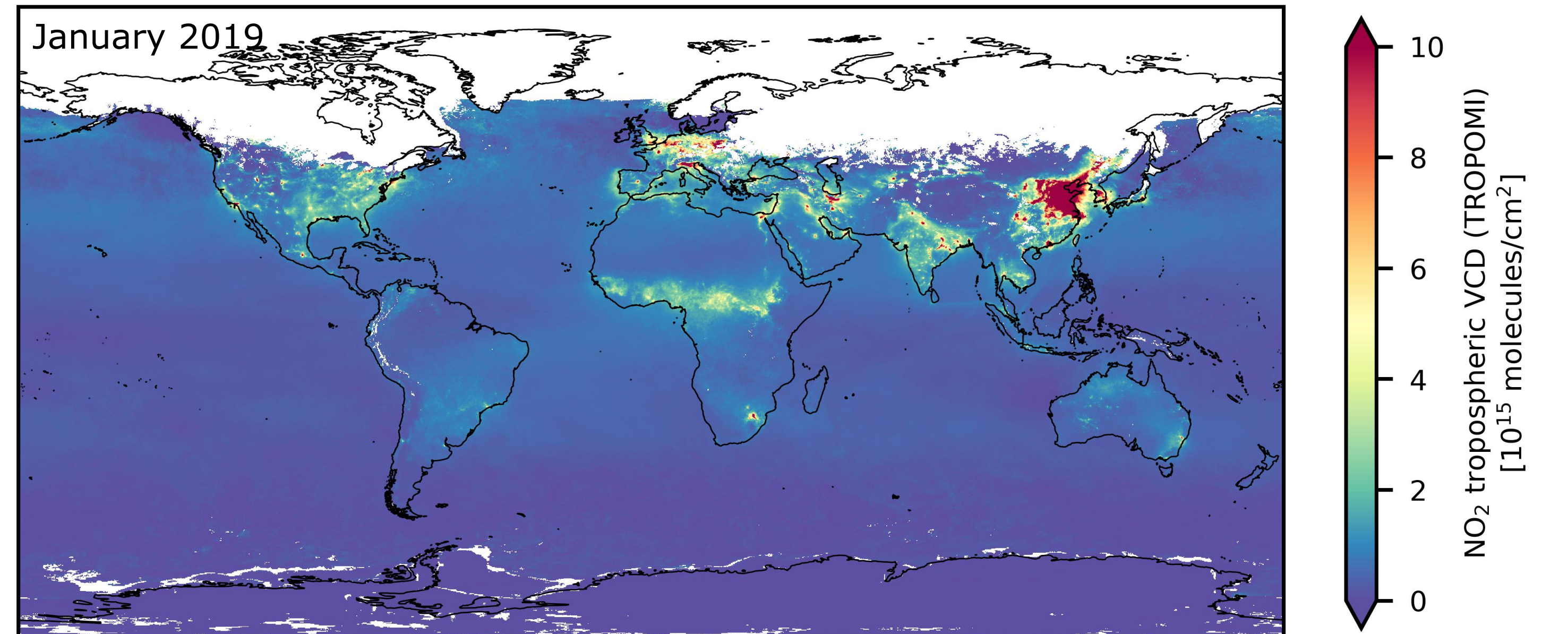
Two step procedure:

- Spatial averaging → superobservations by Rijsdijk et al. (2024), see poster P3.11
- Temporal averaging



Mean monthly tropospheric NO₂ is the weighted mean of the superobservations over time, weighted by the spatial representativity of these superobservations:

$$\bar{x} = \frac{\sum_{t=1}^T (w_{o,t} x_{o,t})}{\sum_{t=1}^T w_{o,t}}$$



Temporal averaging of uncertainties

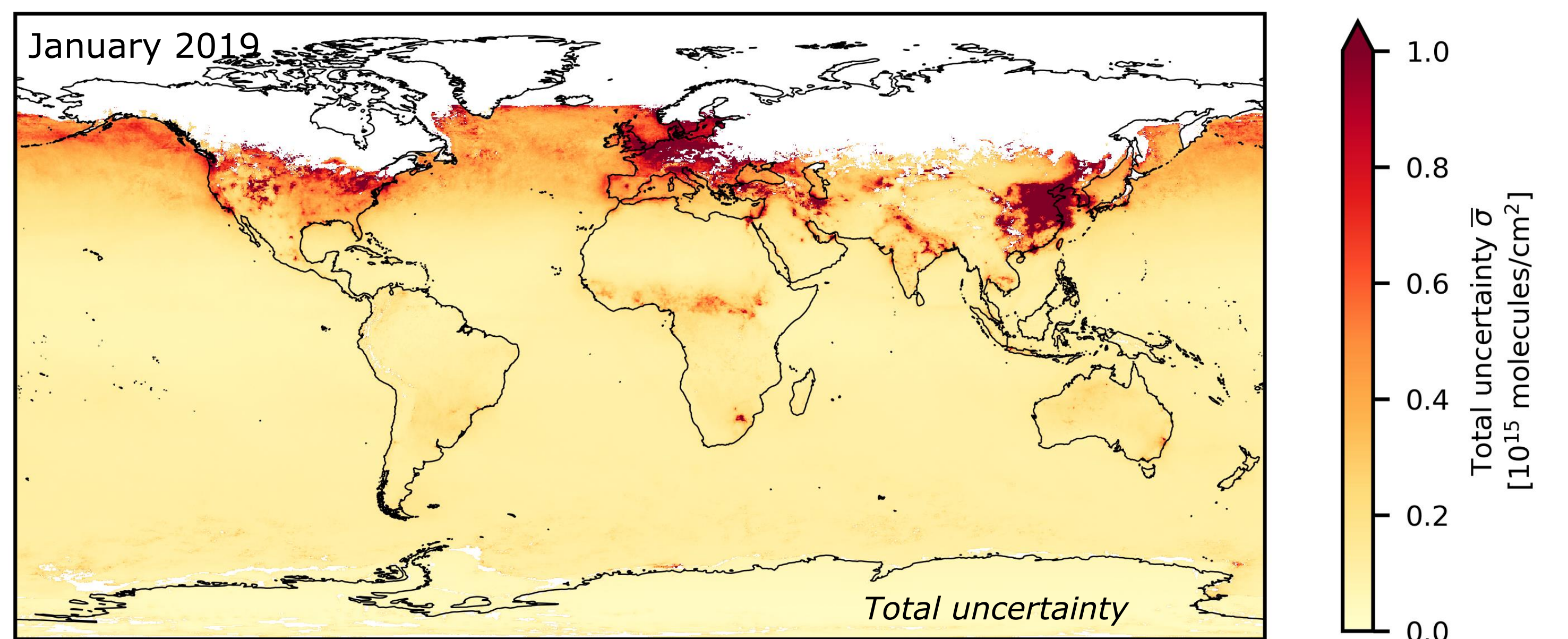
Level-3 uncertainty is the sum of the propagated measurement uncertainties and both spatial and temporal representativity uncertainty.

$$\bar{\sigma} = f(\bar{\sigma}_{SCD}, \bar{\sigma}_{strat}, \bar{\sigma}_{AMF}, \bar{\sigma}_{apriori}, \bar{\sigma}_{repr,t}, \bar{\sigma}_{repr,s})$$

When propagating the measurement uncertainty terms, rather than saying the uncertainties are fully correlated or fully uncorrelated through time, we empirically find a correlation coefficient which describes how correlated the uncertainties are and allow for a realistic uncertainty propagation.

Temporal correlation of AMF uncertainty

The largest source of uncertainty in the AMF is the climatological surface albedo. The largest difference between level-2 versions v2.3.1 and v2.4 is the use of a different climatological surface albedo dataset. The effect of this change on the NO₂ columns will be reflected in the difference in VCDtrop between v2.3.1 and v2.4 (see below). Thus, the difference between the versions should be representative of the uncertainty resulting from the climatological surface albedo. We calculate the correlations between these differences over different time lengths, to find how correlated the AMF uncertainty is through time.

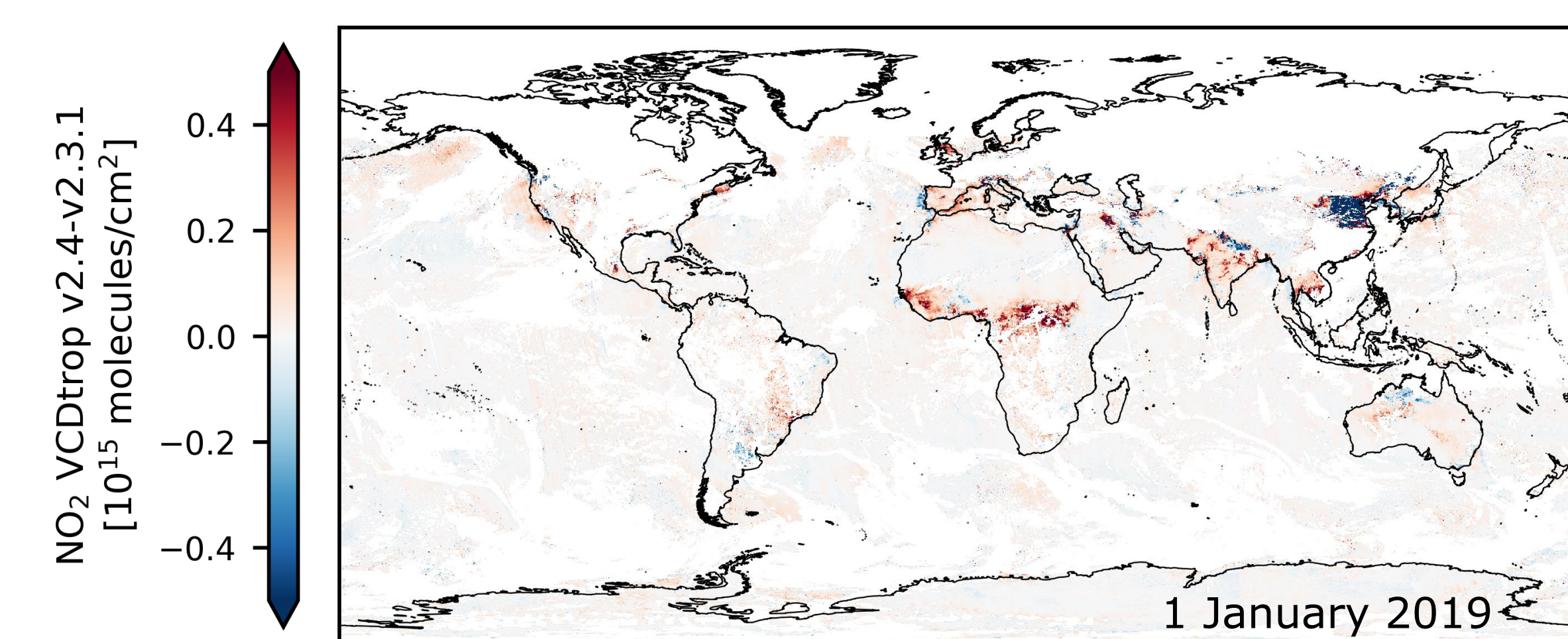
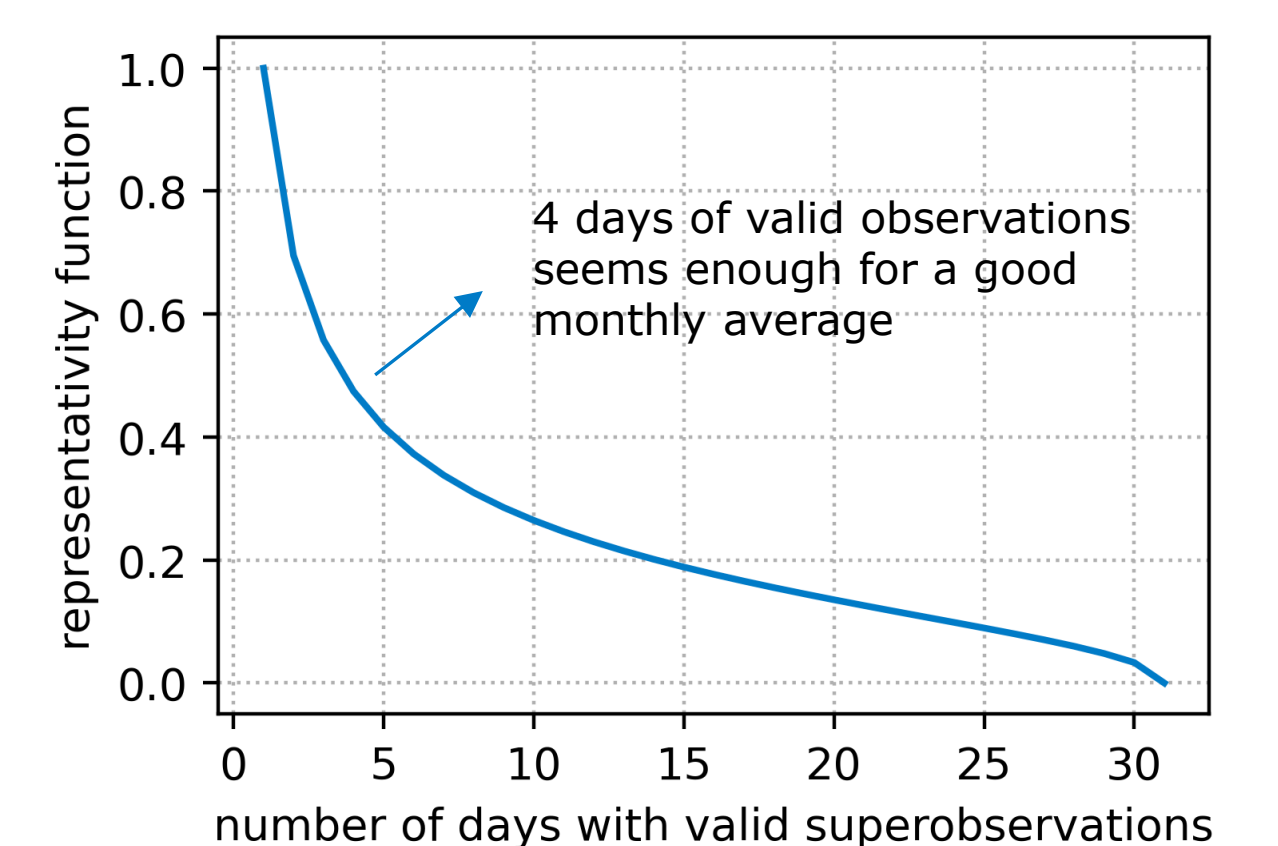


		Amsterdam	Beijing	Sub(tropical) Africa
Mean VCDtrop NO ₂	January 2019	5.45	32.28	7.20
	June 2019	4.58	11.04	14.63
Total uncertainty	January 2019	1.16 (21%)	5.51 (17%)	1.06 (15%)
	June 2019	0.78 (17%)	1.73 (16%)	2.10 (14%)

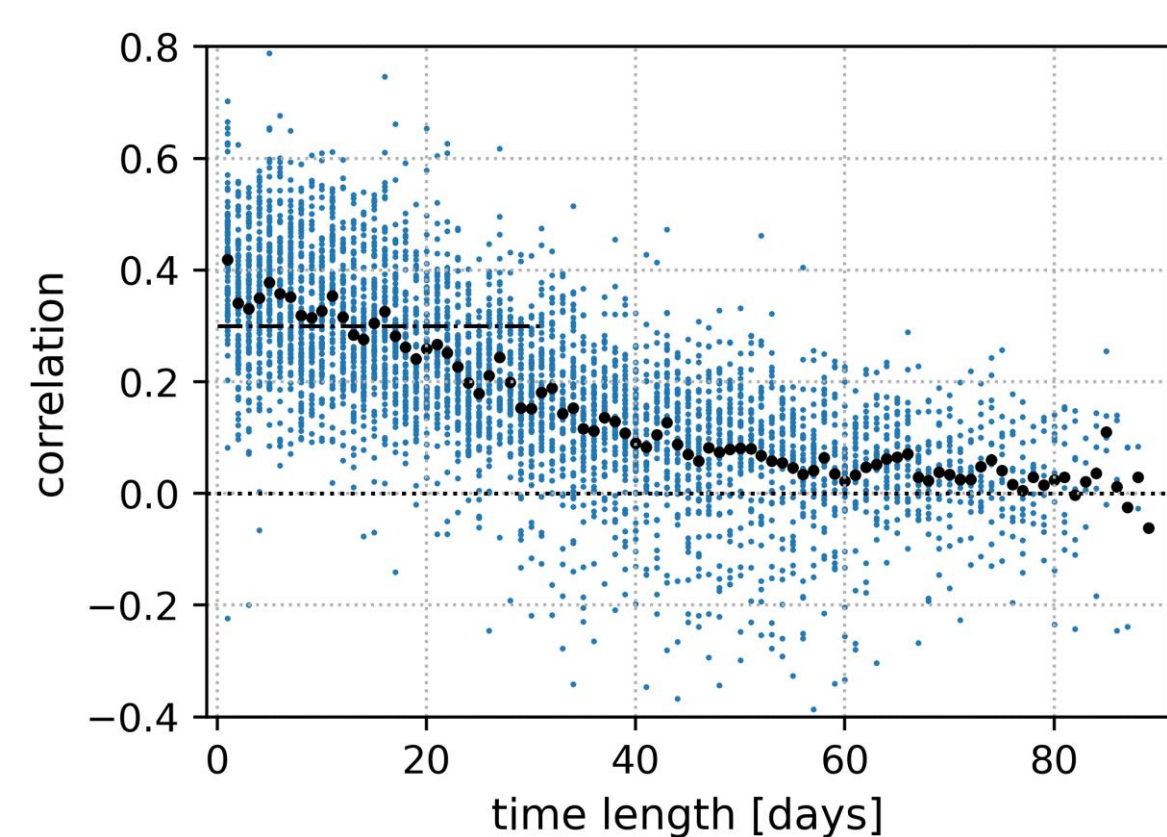
The uncertainty in polluted areas is only **15-20%** of the monthly mean tropospheric column. This is a substantial reduction from the relative uncertainty in the Level-2 product or the spatial means (superobservations).

Temporal representativity uncertainty

By only sampling days without cloud cover in the monthly means, we introduce a temporal representativity uncertainty. Persistent cloud cover can cause systematic sampling. However, it was shown that the distribution of NO₂ throughout the month is not sensitive to systematic sampling. Therefore, the temporal representativity uncertainty is modelled as the product of the uncorrelated representativity function on the right and the standard deviation of the individual gridded tropospheric column values.



- Determine difference v2.3.1 and v2.4 daily
- Find correlation between two days for different time lengths
- Find mean correlation for each time length
- Find mean correlation for a period of a month



→ $\bar{\sigma}_{AMF}$ is for 30% correlated within the timeframe of a month

Interested in using this dataset?

- Can be used for, e.g., model evaluation or trend analysis
- Also OMI NO₂ available (2004-2021) → see Isidora Anglou (P3.14)
- Available in different spatial and temporal resolutions
- Will be fully documented according to ESA CCI standards
- Other ozone-precursors (will be) available

Contact me at isolde.glissenaar@knmi.nl