ANNEX 4 to the OPERA PROGRAMME DECISION
SERVICE LEVEL AGREEMENTS

As approved by Joint STAC&PFAC-15, March 2019

Data flow in the new OPERA phase (2019-2023)

The legacy OPERA data centre ODC will be gradually replaced by three production lines.

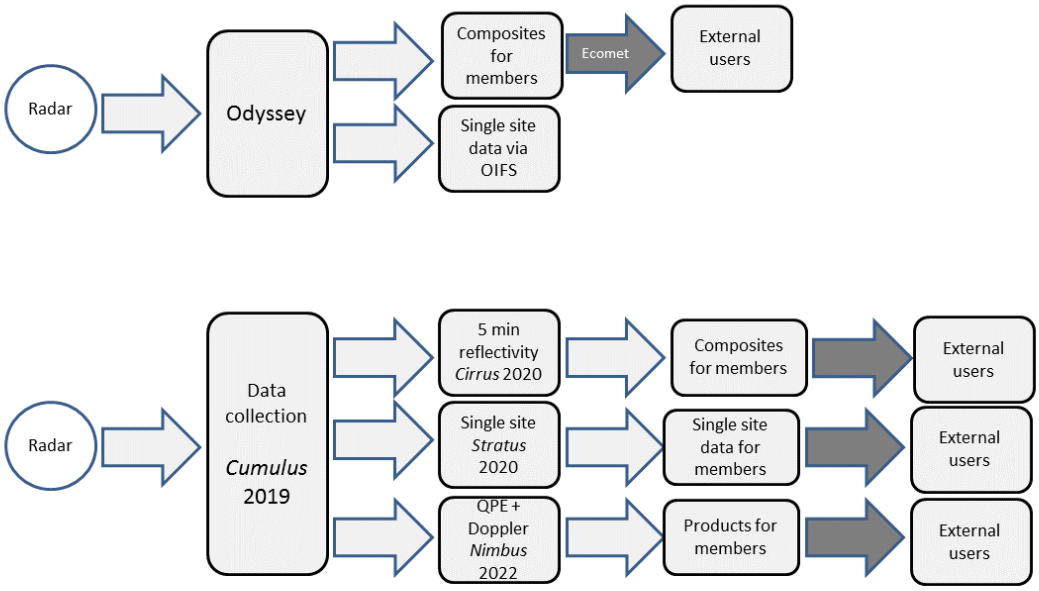


Figure 1: Schematics of the present system (upper panel) and the new three production lines (lower panel).

As new lines are being developed, their performance will be validated, and then the corresponding services in the current ODC can be switched off one by one.

It is important to note that this does not occur at the beginning of the new phase, but gradually when the new software is ready and validated.

Service levels of the production lines

The main reasons for separation of the production lines were the disparate requirements of users, and the opportunity to make full advantage of the increased quality of data provided by members' new or upgraded national networks. Of the production lines:

- *Cirrus* will be concentrating in creating 2D reflectivity composites, aiming in providing them at 5-minute interval within 5 minutes of data time.
- *Stratus* will act as a data hub distributing the members' single site data back to members, thus replacing bilateral exchange and supporting production of regional composites and input to some forecasters' workstations.
- *Nimbus* is the production line for centrally produced quality improved products, such as rain-rates and wind profiles. The foreseen application areas of Nimbus are the

hydrological models, verification of NWP models, assimilation with Latent Heat Nudging methods and flood warning services as well as a plethora of other applications such as forest fire risk assessment.

Important Points to Note:

Services for supporting NWP Data Assimilation: There is no dedicated channel for NWP data assimilation; it is likely that most of the assimilation groups will be using single site data from Stratus, but some of them (such as ECMWF) Nimbus, depending on their cut-off time and data assimilation method.

Services to support SESAR: This is covered by the permission table referred to in Annex 3 above.

Services to external users: The grey arrows in figure 1 above represent SLAs between external users and the Member providing this service on behalf of EUMETNET. The development of these SLAs is not the responsibility of OPERA given the external data policy issues that require consideration. The ECOMET (Economic interest grouping of the National Meteorological Services of the European Economic Area) license template provides an example for such SLAs.

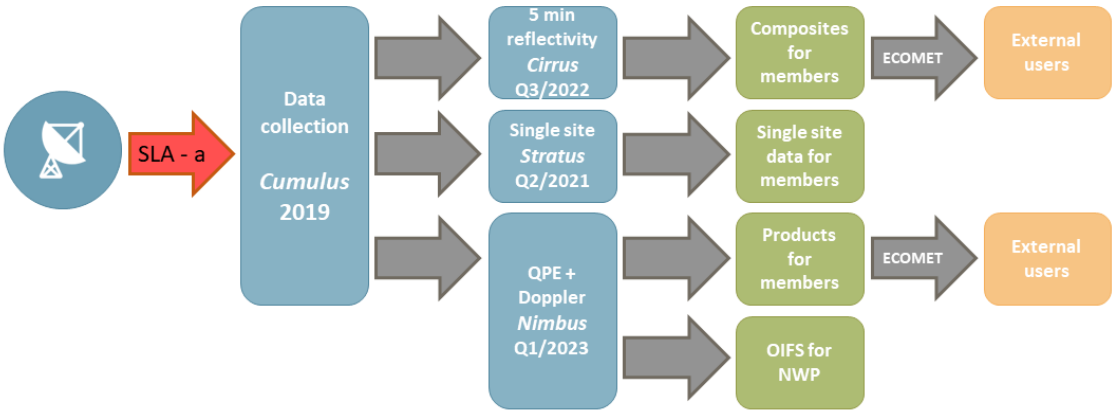
Performance Standards: The performance measures regarding timeliness for OPERA products have been defined and agreed as an element of the EUCOS Performance Standards

EUMETNET OPERA Data Centre Cumulus

Service Level Agreement-a between radar operators and DWD (as operator of Cumulus)

SLA Maturity Level: High

(endorsed by PFAC25)



1. Parameters	The main parameter submitted to Cumulus is DBZH, the (corrected) **radar reflectivity factor**. The DBZH field should be filtered with the processes available in the signal processor and/or in post-processing get the best quality, in terms of separating precipitation data from non-precipitating echoes (such as clutter and interference). All applied filtering methods and corrections shall be documented in the metadata fields and in the relevant internal OPERA wiki pages (e.g. https://agora.fmi.fi/display/OPERA/Cumulus+-+Data+supplier+information). The second parameter is TH, the **uncorrected radar reflectivity factor**. This is of interest for many quality applications. It should be filtered for thermal noise only (typically the applied filter is called LOG). The third parameter is the **Doppler velocity** VRAD(H). Unfolding can be applied if available. Again, all processing shall be documented in the metadata fields and in the relevant internal OPERA wiki pages. Other parameters, which are defined in the ODIM description, such as dual-polarization parameters, spectrum width or CSR (clutter-to-signal ratio on pixel level), are expected to be required by emerging applications during the Programme phase 2024 to 2028. Members should prepare to submit such additional data, where possible.

2. Destination and method of delivery	The data shall be delivered as files to the primary and the backup data servers at DWD. For delivery the sftp protocol should be used.
3. Availability	Input availability targets are set for all radars: >= 95% **Green** >= 85% and < 95% **Amber** < 85% **Red** Sites will not be rejected from the OPERA data system if they fall below target.
4. Timeliness	The expected timeliness target for all radars is defined as volumes (though faster sweep by sweep transfer mode is preferred) with a nominal time: On average over a monthly period the data arrived: >= 0 to <5 Minutes after the nominal time. (Within limits - **Green**) >= 5 to <=7 Minutes after the nominal time. (Marginal - **Amber**) > 7 Minutes or <0 Minutes after the nominal time (Outside limits - **Red**). These are set to ensure that data arrive in time for the start of compositing both inside OPERA production lines and by members' systems distributed via the Stratus data hub. A site falling outside of the limit (>5 minutes) will not appear or data is advected with previous observations, when possible, in composite products generated at the Cirrus as they will miss the compositing process start time.
5. File format	All data supplied to Cumulus must be fully compliant with ODIM HDF5 data format.
6. File structure	Data should preferably be submitted sweep by sweep. Full volumes will be accepted during the transition time to be agreed by the Expert Team. Each parameter can be either in the same file or in separate files. (Cartesian products, such as MAX or CAPPI are not accepted). It is recommended to provide collocated velocity and reflectivity data which are collected simultaneously, to allow the use of reflectivity for quality control of the velocity.
7. Poor data quality	The data provider must commit to reasonable endeavors to provide good quality data. In case the support team will receive notifications of poor quality from users, it will inform the radar operator.

	If a radar experiences long-term quality issues, the data from that radar will no longer be processed and distributed by the OPERA processing chain until the issue is resolved.
8. Monitoring	The timeliness and availability of incoming data will be monitored at Cumulus and performance statistics are available from the EUCOS Quality Monitoring Portal (QMP). Data providers and users can get access to the QMP by request to the Observations Capability Area Programme Management team.
9. Contact details	Up-to-date contact details must be made available to the OPERA team. These details will be used for notification of operational issues including: • Non-receipt of any incoming data from one particular member for more than 1 hour. • Non-receipt of incoming data from one particular radar site for more than 10 hours. • Reporting potential problem with the data from one or more of your radars.
10. Changes	Some changes in incoming data may cause problems either in Cumulus reception or in downstream processes using this data. This can lead to the changed radar being excluded from composites. Any changes applied to the data provided to Cumulus should be reported at least 1 month in advance by email to the Cumulus team, who will forward the information to all production lines. In general, the agreed testing and validation process, as described at https://agora.fmi.fi/display/OPERA/Introducing+a+new+radar+or+new+files, shall be followed. In brief the stages are: 1) NMHS to carry out self-check concerning ODIM compliance 2) SMHI to test ODIM compliance 3) Check NMHS-Cumulus transfer a. The NMHS continues to send their unchanged operational data files not to disturb or not to endanger the operational data flow to Cumulus and the subsequent production lines: Cirrus, Stratus, Nimbus. b. The NMHS sends the new tested data with a different file name. This filename shall consist of the standard file name according to the file naming convention and shall be preceded by the characters "test_".

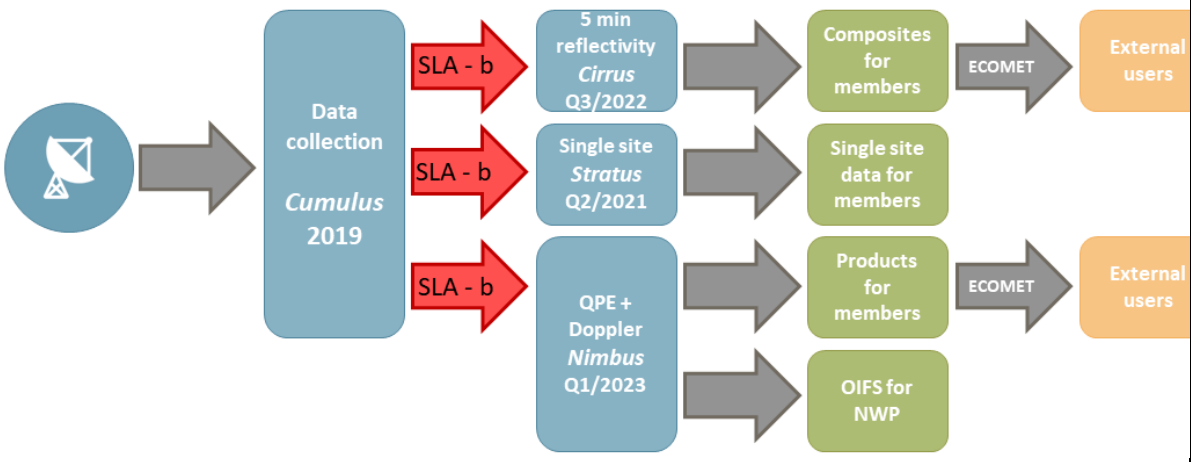
	4) Test Cumulus-Odyssey/Cirrus, Cumulus-Nimbus and Cumulus-ODE transfers and production processes (each production line is responsible for the check) 5) Start operational data provision (after the acceptance of all production lines)
11. New radars	As well as changes to existing radars, the OPERA production lines need at least 8 weeks' notice of any new radars being supplied to Cumulus. In general, the agreed testing and validation process, as described at https://agora.fmi.fi/display/OPERA/Introducing+a+new+radar+or+new+files, shall be followed.
12. Permitted use	The data submitted to the Cumulus data hub is delivered to EUMETNET members via Stratus with explicit agreement from each data owner and is used as input for composites and other products in Cirrus and Nimbus data centres. Details about the member authorization for use of radar data via Stratus can be found on the EUMETNET Portal on the page 'Procedures & technical regulations – OPERA'.

EUMETNET OPERA Data Centre Cumulus

Service Level Agreement-b between DWD, Météo France and ZAMG

SLA Maturity Level: High

(endorsed by PFAC25)



1. Quality and destinations	Cumulus forwards incoming single site radar data from members relying on the quality and availability of data from the members and passes on those data as they are in a timely manner to the production lines Cirrus, Stratus and Nimbus. For any data quality issues, the radar operator is contacted, and it is their responsibility to improve the incoming data.
2. Availability and timeliness	Sending of incoming data starts (T2) within 10 seconds after Cumulus gets the data from each country individually (T1). The goal is that the other OPERA production lines (Cirrus and Nimbus) should receive the data forwarded by Cumulus at the handover point (Cirrus and Nimbus incoming data server) no more than 10 seconds after Cumulus gets the data from each country individually. Availability: Loss L < 0.1% (A file is considered as lost if the recipient receives it 300s after transmission at Cumulus or ideally after the start of data acquisition.) Timeliness: T2 – T1 (mean) < 5s and T2 – T1 (99.87th percentile) < 10s
3. Performance measure	Incoming and outgoing data streams will be monitored by DWD.

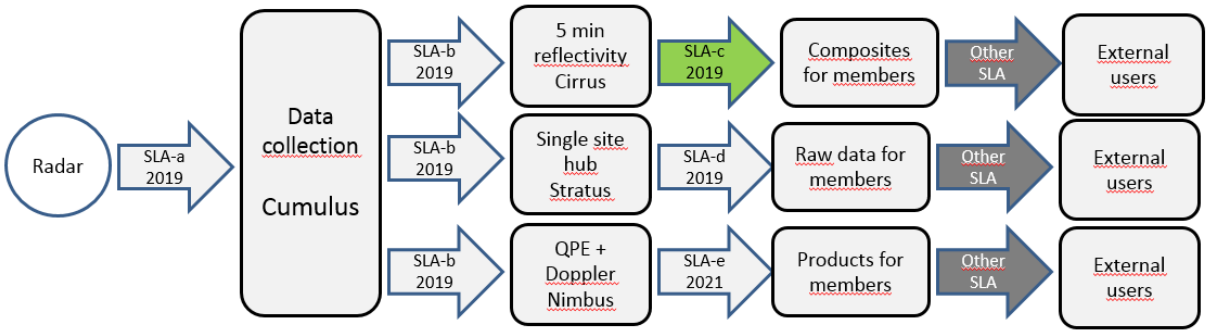
	The performance measure of the data hub will be later included in the OPERA quality monitoring functions in the EUCOS Quality Monitoring Portal (QMP).
4. Fault resolution	For system or hardware faults that affect availability, the target will be to respond and fix the fault on the primary server on the next business day in 98% of cases (calculated over a year). According to the contingency plan (see next item in this table) the second server will take over the tasks in the meantime.
5. Contingency	Cumulus is maintained at two identical implementations at DWD (primary and backup data servers). However, if data stream to DWD is not available, the data hub will notify the data providing Member from which data are missing about the break and ask for rectification.
6. Support cover	The user should report any observed irregularities in data availability to the DWD OPERA helpdesk (opera.data @dwd.de) at their earliest convenience. The goal is to provide the first answer to support enquiries in 75% of cases within three working days and 75% of the closing answers within two weeks.
7. Service failures	A tolerable level of service failure would be: one 'break' of up to 15 minutes in any 7-day period one 'break' of up to 60 minutes in any quarter of a year one 'break' of over 60 minutes in any one year, with service being restored within 4 hours. A 'break' denotes a reduction in service delivery, however the service will be deemed to be met if the agreed alternative output is being supplied.
8. Service description and delivery method	Redistribution of Members' single site radar data to production lines: sftp is recommended, in exceptional cases ftp can be used. Format HDF5 matching ODIM specification.
9. Permitted use	For the service defined for each of the OPERA production lines. Details about the member authorization for use of radar data via Stratus can be found on the EUMETNET Portal on the page 'Procedures & technical regulations – OPERA'.

	OPERA production lines shall ensure that the list of contributing NMHSs follows in the file header or other product documentation. EUMETNET must be acknowledged as the data provider in an appropriate way.
10. Consequences	If the conditions of this SLA are not met, the issue is raised via the Observations Capability Area Manager to the responsible Member STAC/PFAC delegates, then Assembly.

EUMETNET OPERA Data Centre Cirrus

Service Level Agreement-c between Météo France (as operator of Cirrus) and members receiving the composites

SLA Maturity Level: will be reviewed in PFAC27



1. Quality	Cirrus generates 2D composites of radar reflectivity relying in the quality and availability of incoming data from the members and the reliability of the data hubs (first Odyssey, later Cumulus) to pass that data in a timely manner. If the operator and OPERA PM see necessary, a satellite-based mask of non-precipitating area may be implemented temporarily. For any other quality issues, the radar operator is contacted and it is in their responsibility to improve the incoming data.
2. Performance Measure	• The performance measure of reflectivity composites will be included to the OPERA quality monitoring functions in the EUCOS Quality Monitoring Portal (QMP).
3. Fault resolution	• For system or hardware faults that affect availability, the target will be to respond and fix the fault within 2 hours of notification on 98% of cases (calculated over a year)
4. Contingency	• Cirrus is maintained at two identical implementations at Meteo France. However, if data stream to Meteo France is not available, the products will be empty.
5. Support Cover	The user should report any observed irregularities (such as suspected miscalibration of a radar) at OPERA Users helpdesk (support.opera@eumetnet.eu) at earliest convenience. • The goal is to provide the first answer to support enquiries in 75% of cases within three working days and 75% of the closing answers within two weeks.
6. Service Failures	A tolerable level of service failure would be: • one 'break' of up to 15 minutes in any 7-day period • one 'break' of up to 60 minutes in any quarter of a year

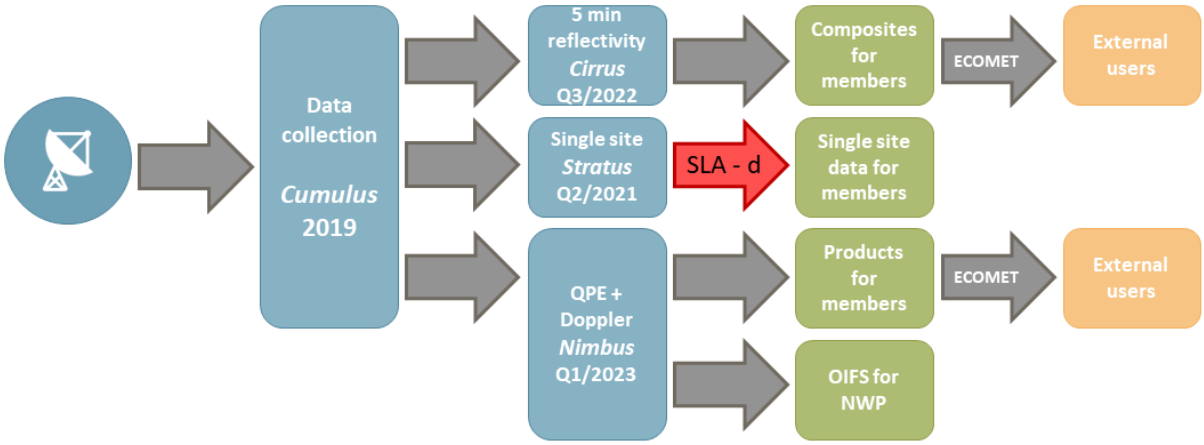
	● one ‘break’ over 60 minutes in any one year, with service being restored within 4 hours. A ‘break’ denotes a reduction in service delivery, however, the service will be deemed to be met if the agreed alternative output is being supplied.
7. Service description	The reflectivity composites will be generated every 5 minutes from incoming data of OPERA members. ● Format HDF5 matching ODIM specification
8. Permitted use	With explicit agreement from each data owners. ● The list of contributing NMSes shall follow in the file header or other product documentation. EUMETNET OPERA must be acknowledged as the data provider in an appropriate way.
9. Monitoring and Consequences	Timeliness and availability will be followed in the EUMETNET Quality Monitoring Portal. Summaries will be included in the OPERA annual reports. If the conditions of this SLA are not met, the issue is raised within EUMETNET according to the defined escalation procedure.

EUMETNET OPERA Data Centre Stratus

Service Level Agreement-d between DWD (as operator of Stratus) and members receiving the data

SLA Maturity Level: Medium

(endorsed by PFAC25)



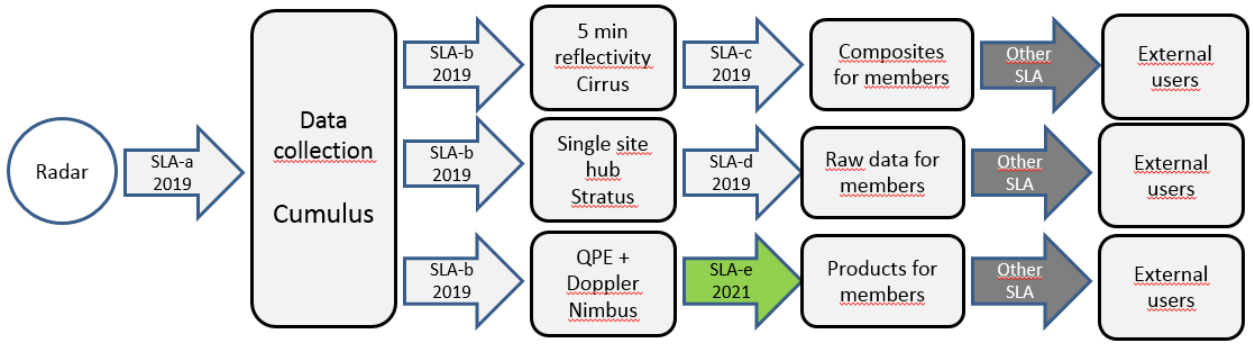
1. Quality	Stratus distributes radar data collected from OPERA members in the Cumulus. The data themselves are forwarded as are. Harmonization of the metadata is checked manually from time to time and the ill-defined metadata parameters are changed in Stratus, as agreed between the data provider and DWD.
2. Expected performance	Sending of incoming data starts (T2) within 10 seconds after Cumulus gets the data from each country individually (T1). Availability: Loss L < 0.1% (A file is considered as lost if the recipient receives it 300s after transmission at Cumulus or ideally after the start of data acquisition.) Timeliness: T2 – T1 (mean) < 5s and T2 – T1 (99.87th percentile) < 10s ● Downtime due to regular maintenance will be announced in advance.
3. Performance Measure	The performance measure of the data hub will be made available via the OPERA quality monitoring functions in the EUCOS Quality Monitoring Portal (QMP).
4. Fault resolution	For system or hardware faults that affect general availability, the target will be to respond within 2 hours of notification in 98% of cases (calculated over a year).

5. Contingency	There are redundant implementations of Stratus at two different DWD locations (primary and backup data servers).
6. Service Failures	A tolerable level of service failure would be: ● one 'break' of up to 15 minutes in any 7-day period ● one 'break' of up to 60 minutes in any quarter of a year ● one 'break' of over 60 minutes in any one year, with service being restored within 4 hours. A 'break' denotes a reduction in service delivery; however the service will be deemed to be met if the agreed alternative output is being supplied.
7. Service description	The Stratus data hub is distributing incoming data of OPERA members to other members and to other OPERA production lines: sftp is recommended, in exceptional cases ftp can be used ~~a~~ Format (HDF5 matching ODIM specification) as sent by members Status messages made available by NM(H)Ss will be made available in real time. The format for these will be developed in OPERA 5 task OD2 (not yet in place).
8. Permitted use	Details about the member authorization for use of radar data via Stratus can be found on the EUMETNET Portal on the page 'Procedures & technical regulations – OPERA'. Members using the OPERA data provided by Stratus shall ensure that the list of contributing NMHSs follows in the file header or other product documentation. EUMETNET must be acknowledged as the data provider in an appropriate way.
9. Monitoring and Consequences	Timeliness and availability will be followed in the EUMETNET Quality Monitoring Portal. Summaries will be included in the OPERA annual reports. If the conditions of this SLA are not met, the issue will be raised within EUMETNET via the Observations Capability Area manager to the responsible Member STAC/PFAC delegates, then Assembly.
10. Archive	Since 2022 incoming data archive has been stored at Stratus. Noting: ~~The old incoming data archive restored at Meteo-France is transferred to Stratus during OPERA 5~~. (This transfer is changed and postponed with the programme change request in JOINT23 to wait for the decision of final archive location in Autumn 2023.) No interface is implemented to Stratus (this is planned to be designed and implemented as part of the EU DEP RODEO project).

EUMETNET OPERA Data Centre Nimbus

Service Level Agreement-e between ZAMG (as operator of Nimbus) and members receiving the products

SLA Maturity Level: will be reviewed in PFAC27



1. Quality	Nimbus generates products of radar-based precipitation intensity and wind speed. It is relying on the quality and availability of incoming data from the members and the reliability of the data hub Cumulus to pass those data in a timely manner. It will implement the quality control methods developed within OPERA community. For any other quality issues, the radar operator is contacted and it is in their responsibility to improve the incoming data.
2. Performance Measure	● The performance measure of Nimbus products will be included to the OPERA quality monitoring functions in the EUCOS Quality Monitoring Portal (QMP).
3. Fault resolution	● For system or hardware faults that affect availability, the target will be to respond and fix the fault within 3 hours of notification on 98% of cases (calculated over a year)
4. Contingency	● Nimbus is operated using redundant implementations at ZAMG computing facilities. However, if the data stream to ZAMG is not available, the products will be empty.
5. Support Cover	The user should report any observed irregularities (such as suspected miscalibration of a radar) to the OPERA Users helpdesk (support.opera@eumetnet.eu) at earliest convenience. ● The goal is to provide the first answer to support enquiries in 75% of cases within three working days and 75% of the closing answers within two weeks.
6. Service Failures	A tolerable level of service failure would be: ● one 'break' of up to 15 minutes in any 7-day period ● one 'break' of up to 60 minutes in any quarter of a year

	● one ‘break’ over 60 minutes in any one year, with service being restored within 4 hours. A ‘break’ denotes a reduction in service delivery, however the service will be deemed to be met if the agreed alternative output is being supplied.
7. Service description & timeliness	The products will be generated every 15 minutes from incoming data of OPERA members. ● Format HDF5 matching ODIM specification
8. Permitted use	With explicit agreement from each data owner. ● The list of contributing NMSes shall follow in the file header or other product documentation. EUMETNET must be acknowledged as the data provider in an appropriate way.
9. Monitoring & Consequences	Timeliness and availability will be followed in the EUMETNET Quality Monitoring Portal. Summaries will be included in the OPERA annual reports. If the conditions of this SLA are not met, the issue is raised within EUMETNET according to the defined escalation procedure.