Dumb lidar guy tries to update WIGOS metadata

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- Initial motivation: Contributing networks are required to provide metadata to GAWSIS
  - MPLNET only has 5 stations in GAWSIS, but we have 73 in total
    - Original process to manually input station information too labor intensive and had issues (station ID, etc)
    - Also known issues with lidar related variables in OSCAR
  - ETWDC meeting in Oct: method to maintain metadata with M2M process introduced
    - I agreed to re-examine this issue
    - Combination of Drasko hire + COVID shutdown (available time) jump started this work
  - I will present my progress, report issues, and suggest methods to fix

- Secondary Motivation: Utilize OSCAR, rather than just put metadata into it
  - Could OSCAR provide metadata search & discovery for GALION data center
    - Not currently, but possible if suggested fixes are implemented
  - Tool for global network coordination across multiple programs: site gap planning, super sites, decision support
    - Over 20 years of running a network, and need to better coordinate with other networks is continual problem
    - Network heads have no capability to plan/coordinate our operations globally, even regionally in many areas
      - OSCAR could serve as tool to communicate and examine our assets
      - Requires fixes to OSCAR and addition of search capabilities for the online tool

Summary of results trying to update MPLNET metadata:

RRR process produces variable list and corresponding requirements, documented in OSCAR

- Variable table
- Requirements table (these are variables categorized by application area)
- There are issues with the variables (perhaps a mixture of RRR process and OSCAR structure)
    - NOTE: these issues are serious for lidar/GALION, and aerosol remote sensing in general

Somehow the variables are translated into the Code Registry used for online search tool

- Not all variables are in code registry
    - NOTE: key Lidar related variables missing
- Some variables in code registry were not found in OSCAR variable tables
    - NOTE: one important example related to lidar
- Code Registry for Observing Method (instrument) needs updating for lidar

There is no agreed upon method to update metadata in OSCAR using M2M

- Existing manual process is not feasible for large networks, only edit some info (not all)
- Existing process allows ANY user with account to edit station information (serious problem)
    - I can change the station name, lat, lon, regardless if the station supports multiple programs/networks
    - I can edit other program/network information
- Proposed method for M2M, with editing controls will be presented

Variable: Aerosol Extinction Coefficient

This is ID: 4 on variables table

Definition

Full name	Aerosol Extinction Coefficient		
Definition	3D field of spectral volumetric extinction cross-section of aerosol particles.		
Measuring Units	m^{-1}	**Uncertainty Units**	m^{-1}
Horizontal Res Units	km	**Vertical Res Units**	km
Stability Units	m^{-1} (Stability /decade)		

No wavelength information here

Comment:	The scattering and absorption components of aerosol extinction coefficient are called "aerosol scattering coefficient" and "aerosol absorption coefficient" May be specified as a size-dependent quantity.
Last modified:	

Classification

- **Domain:** Atmosphere
  - **Sub-domain:** Aerosols and radiation
    - **Variable:** Aerosol Extinction Coefficient
      - **Measured in Layers:**
        - MUS
        - UTLS
        - FT
        - PBL
        - M
- **Cross-cutting themes:**

- **Used in Application Areas:**
  - Climate-AOPC (deprecated)
  - Aeronautical Meteorology
  - Climate Monitoring (GCOS)

This level of detail is sufficient for the code registry

- Application Areas exist in code registry, but input of this information by site/program requires program contacts to wade thru LOTS of requirement tables to select appropriate app area (this is unlikely to happen)
- Layer assignments are missing in code registry. There is “Altitude/Depth”, but does not map to Layers.

Requirements defined for *Aerosol Extinction Coefficient* (3)

This information is from requirements table

This tables shows all related requirements. For more operations/filtering, please consult the full list of Requirements

Note: In reading the values, goal is marked blue, breakthrough green and threshold orange

Id	Variable	Layer	App Area	Uncertainty	Stability / decade	Hor Res	Ver Res	Obs Cyc	Timeliness	Coverage	Conf Level	Val Date	Source
55	Aerosol Extinction Coefficient	MUS UTLS FT PBL M	Climate-AOPC (deprecated)	0.00001 m^{-1} 0.000015 m^{-1} 0.00002 m^{-1}		10 km 20 km 100 km	0.5 km 0.65 km 1 km	24 h 2 d 7 d	7 d 14 d 60 d	Global	reasonable	2007-07-19	AOPC
735	Aerosol Extinction Coefficient	PBL	Aeronautical Meteorology							Global	firm	2013-12-05	J van der Meulen
810	Aerosol Extinction Coefficient	FT PBL	Climate Monitoring (GCOS)	0.1 m^{-1}	0.2 m^{-1}	200 km 500 km	1 km 2 km	7 d		Global	reasonable	2019-09-26	GCOS-200: The Global Observing System for Climate: Implementation Needs (Published 2016)

OSCAR Layers webpage table

Domain	Acronym	Full name
Atmosphere	TC	Total column
	TrC	Troposphere column
	MUS	Mid-upper stratosphere
	UTLS	Upper troposphere / lower stratosphere
	FT	Free troposphere
	PBL	Planetary boundary layer
	Near Surface	At the surface (in the air)
	Cloud-top	At the cloud top surface
	TOA	Top of the atmosphere
	LoThermo	Low Thermosphere (From 100 km to 200 km altitude)
	HiThermo	High Thermosphere (From 200 to about 500 km altitude)
	M	Mesosphere
Ocean	Sea surface	Surface of the ocean
	Bulk	Bulk layer (ocean sub-surface)
	Upper oc	Upper ocean
	Deep oc	Deep ocean
Terrestrial	Land surface	Land surface
	Root	Root region of the soil
	Deep soil	Deep soil layer
	Interior	Interior earth
Outer Space	Ionos	Ionosphere
	L1	At Lagrange point L1 (about 1,500,000 km from Earth)
	L4-L5	At Lagrange points L4, L5
	Geo	Around the geostationary orbit
	Leo	Low Earth Orbit altitude range
	Meo	Medium Earth Orbit altitude range
	Helio	In the whole heliosphere
	Sun	Solar surface and atmosphere
	Magnet	Magnetosphere
Cross-cutting	n/a (2D)	Not applicable. 2D field, no altitude dependence
	n/a	Not applicable. No altitude dependence

Altitude/Depth Code registry

Name	Notation	Description
inapplicable	inapplicable	None of the codes in the table are applicable in the context ...
of great depth	greatDepth	Between 1000 and 3000 m below mean sea level
of high altitude	highAltitude	Between 1000 and 3000 m above mean sea level
of low altitude	lowAltitude	Between 100 and 300 m above mean sea level
of middle altitude	middleAltitude	Between 300 and 1000 m above mean sea level
of middle depth	middleDepth	Between 300 and 1000 m below mean sea level
of shallow depth	shallowDepth	Between 100 and 300 m below mean sea level
of very great depth	veryGreatDepth	Deeper than 3000 m below mean sea level
of very high altitude	veryHighAltitude	Higher than 3000 m above mean sea level
of very low altitude	veryLowAltitude	Less than 100 m above mean sea level
of very shallow depth	veryShallowDepth	Less than 100 m below mean sea level
unknown	unknown	The elevation is unknown.

Code Registry should map to OSCAR requirements

Code Registry definitions are inaccurate. Can not use these:

”of middle altitude” is 300 – 1000 m?

“of high altitude” is only 1000 – 3000 m?

“of very high altitude” is 3 km to mesosphere

Lidar Related Variables*: From OSCAR Variables Table

ID	variable	domain	unit	App Area
4	Aerosol extinction coefficient	aerosols and radiation	m-1	Each variable has several different Application Areas listed, each with their own separate ID. What is this ID, and how does it map to the "primary" variable ID?
357	Aerosol Layer Height	Aerosols and Radiation	km	
6	Aerosol Optical Depth	Aerosols and Radiation		
26	Cloud Base Height	Clouds and Precipitation	km	
27	Cloud Cover	Clouds and Precipitation	%	
34	Cloud Optical Depth	Clouds and Precipitation		
35	Cloud Top Height	Clouds and Precipitation	km	
80	Height of the top of the PBL	Basic Atmospheric	km	
131	PSC occurrence	Atmospheric Chemistry		No app area

* Ignoring ozone, temperature, water vapor for now, all are retrieved from more advanced lidar

General Comments

Key variables missing in OSCAR (and thus code registry):

- Lidar signal, and/or attenuated backscatter
  - I think this is what was meant by “Vertical Distribution of Properties”?
  - This is closest to our “observable”
- No backscatter coefficients (total, aerosol, cloud, etc). Need to specify 180^{o} vs hemispheric.

Confusing variables (not shown in table above as a result)

- Cloud type: is this Cu or Cb? Or cloud phase? (water, ice, mixed)?
  - If not phase, then cloud phase variable is missing in OSCAR

Existing variables missing from code registry:

- Aerosol Layer Height
- Height of the top of the PBL

Lidar Related Variables: From Code Registry ObservedVariableAtmosphere (OSCAR Tool "Observed Variable")

Notation	Name*	OSCAR Tool "Category"	Note
315	Aerosol extinction coefficient	/atmosphere/aerosol/optical properties	
		/visibility/obscurations	Variable name is different in OSCAR Tool (Extinction Coefficient)
326	Vertical Distribution of Properties	/atmosphere/aerosol/optical properties	This is a meaningless variable. It is also only in this "category"? Why? Not in OSCAR variable tables.
325	Multiwavelength optical depth, total aerosol	/atmosphere/aerosol/optical properties	This is not the same as the OSCAR variable, multiwavelength now required here but in OSCAR variable its recommended. Name too odd and long.
321, 319, 320	Light backscattering coefficient, total aerosol (and PM1, PM10)	/atmosphere/aerosol/optical properties	This does NOT exist in OSCAR variables/requirements! Is this hemispheric? 180° backscatter? Why only aerosol? Lidar measures total atmospheric backscatter at 180° (molecular+aerosol+cloud+pollen+etc)
506	Cloud Optical Depth	/clouds/optical properties	Definition in OSCAR variables is contradictory. Definition says OD of "a cloud", but comments say "represents impact of the cloud water column". Is this column or cloud layer OD?
	Optical Depth within each layer	/clouds/optical properties	This does not exist in OSCAR variables, attempt to rectify above? Should be reconciled in OSCAR requirements first.
531	Height of cloud base	/clouds/position/	
532	Height of cloud top	/clouds/position/	
188	PSC Occurrence	/clouds	This should not be in clouds, OSCAR req domain is Atmos Chem
180	Cloud Cover	/clouds	Definition is vague in OSCAR. Is this cloud fraction? I think so…
179	Cloud Amount	/clouds	Not in OSCAR requirements, what is this?

* When notation ID provided, the name is from the code registry. If variable does not exist in registry, then using OSCAR online tool name.

General Comments: remote sensing variables are rather poorly spec'ed in OSCAR

- OSCAR online tool categorizes the variables, but code registry does not. Why?
  - categorization is wrong in some cases
- Wavelength of observation/variable seems to be completely missing in OSCAR variables & code registry
  - Not referring to "multiwavelength" in title of AOD, that is different issue.
  - How does one specify the wavelength associated with an observed variable?

Lidar Related Variables: From Code Registry ObservedMethodAtmosphere

There are 5 different LIDAR entries here
All appear to be generic, were these placeholders

I suggest redefining (and renaming) them as:

Register: Measurement/observing method (atmosphere)

Core meta
All proper
Download

URI: http://codes.wmo.int/wmdr/ObservingMethodAtmosphere

Measurement/observing method (atmosphere)

Contents

Show 20 entries Filter entries:

Name	Notation	Description	Types	Status
ICP-MS	134		Concept	stable
Impregnated filter	286		Concept	stable
inapplicable	inapplicable	None of the codes in the table are applicable in the context ...	Concept	stable
Indian Sonde	135		Concept	stable
Integrated cavity output spectroscopy (ICOS)	307		Concept	stable
Interferential method	136		Concept	stable
Ion Chromatography (IC) [general]	137		Concept	stable
IR absorption hygrometer	255		Concept	stable
IR spectrometry-radiometry [general]	314		Concept	stable
Klystron	326		Concept	stable
Lagranto (trajectory modeling)	249		Concept	stable
Laser induced fluorescence (LIF)	308		Concept	stable
Laser photoacoustic spectroscopy (LPAS)	309		Concept	stable
Laser spectroscopy [general]	310		Concept	stable
Light absorption photometry	315		Concept	stable
Light detection and ranging (Lidar)	143	Backscatter	Concept	stable
Light detection and ranging (Lidar)	324	Raman	Concept	stable
Light detection and ranging (LIDAR) profiler	142	HSRL	Concept	stable
Light detection and ranging (Lidar) profiler	243	Ozone	Concept	stable
Light detection and ranging (Lidar) profiler	269	DIAL	Concept	stable

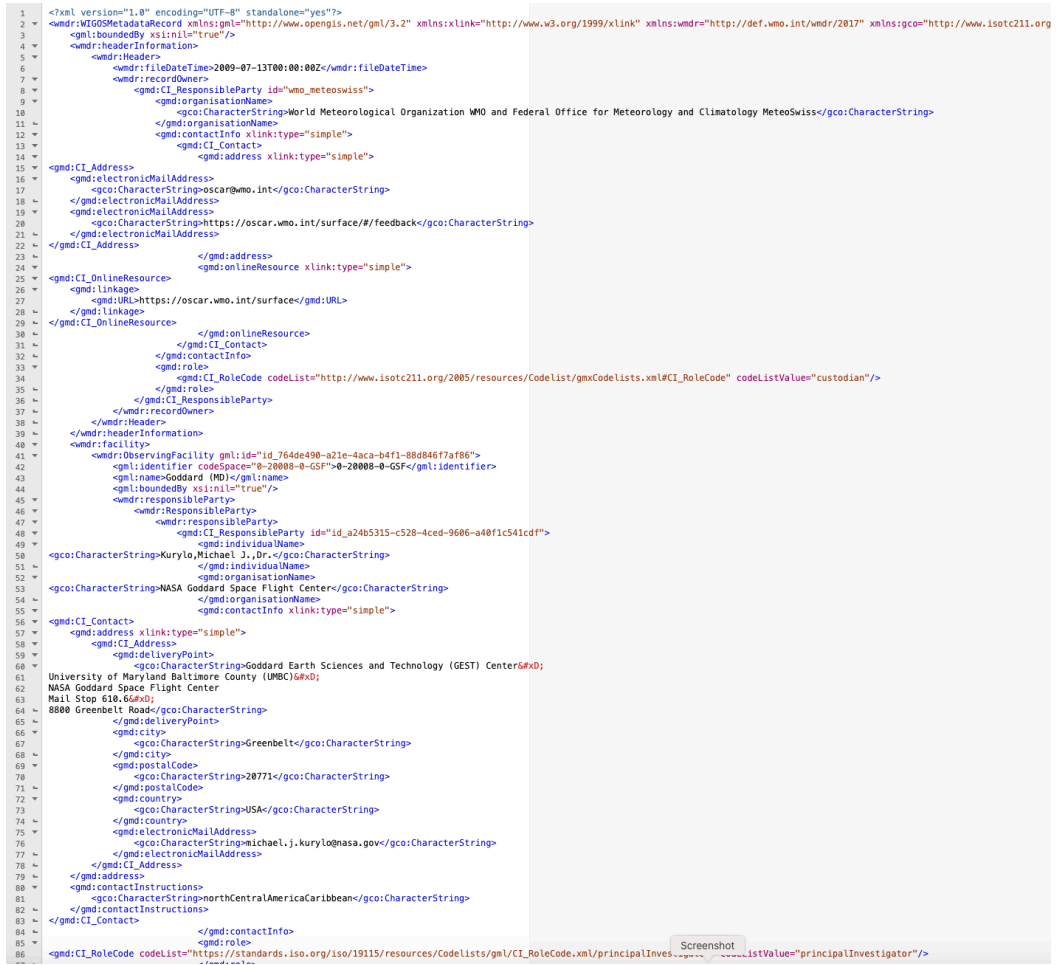
How to update metadata with M2M process?

What method were networks/users supposed to use to edit our information in OSCAR? Download XML file, edit it, and then resubmit somehow?

- WIGOS XML format is too complicated (gml & gmd codes throughout, no idea what they are, how do we issue/use these?)
- Program information spread across different XML elements, takes a lot of time to decode what is in here to then edit it
- No clear, easy to use tutorial for users (should be online with XML examples including comments)
- This process (like existing manual editor online) allows users to edit ALL the station information. Controls are needed.

Process to setup new station is unclear, we (user) cannot issue WIGOS station ID

The first 173 lines of the 563 line NASA Goddard XML file:



Proposed WMDR XML Template for Contributing Networks:

I tried to utilize existing WMDR XML syntax/names where possible

Included comments to help users!

Reformatted to be more simple and easy to complete

Station specific information would be left blank if only editing existing station

- If new station, user fills in station elements

Allows users to focus on their own program specific information

If this process is connected with a program-authorized M2M upload process, then will prevent users from editing operational OSCAR information that should be protected.

- Other programs should not be able to edit my program info
- Programs should not be able to edit station level information

```
<?xml version="1.0" encoding="UTF-8"?>
<!--    XML template for WMO programs/networks to interface with WIGOS Metadata (WMD) Standard
        This template is designed for one station per <wmd> element. Multiple <wmd> elements may be included in each file at discretion of WMO.
        To request creation of new station that does not exist in WIGOS:
            leave <id> empty
            fill in <station> element information, not all <station> sub-elements may be required
            fill in your <program_affiliation> element information, not all <program_affiliation> sub-elements may be required
        To request edit of station level information for an existing station:
            fill in the WIGOS station id in <id>
            update <station> element information
        If updating your program specific information for an existing WIGOS station:
            fill in the WIGOS station id in <id>
            leave <station> element empty
            update your <program_affiliation> element information
        Notes:
            XML tags are case sensitive, do not edit the tag names. If you add additional entries for elements that can accept multiple ones, be sure to keep the same syntax/case for the tags
            for elements associated with WMO code registries: use the "Notation Value", not "name" from the code table
        Judd Welton Comments:
            We should define miniumum required elements for integration with WIGOS. Certainly not all these elements are required.
            These elements do NOT map directly to the WMDR structure, but contain the information needed. I feel this format/structure is easier for program/network contributors to utilize
            To my knowledge there are no other WMDR templates like this (other than what Drasko sent me on May 27. If there are, we should harmonize somehow.
            This template should be paired with a simple on-line help/tutorial page. With XML examples like this template and with comments embedded.
-->
<wmd>
    <id></id><!-- WIGOS Station ID, obtain this from GAWSIS/OSCAR database for your station. If the station is new to WIGOS, leave wigosid empty -->
    <station><!-- this element is only utilized if requesting creation of new station, or to edit station level information for an existing station, otherwise leave empty -->
    </station>
    <program_affiliation><!-- program specific data goes here, ie MPLNET, EARLINET, TCON, SHADOZ -->
        <program></program><!-- must be from http://codes.wmo.int/wmdr/ProgramAffiliation/ -->
        <other_programs><!-- list any other WMO program affiliations associated with your program, e.g. GAWregional, etc -->
            <program></program><!-- must be from http://codes.wmo.int/wmdr/ProgramAffiliation/ -->
        </other_programs>
        <name></name><!-- program specific station name -->
        <responsible_party><!-- this element contains all the primary program contacts for this station, not necessarily the same as station contacts. Additional contacts can be added as <contact></contact> elements -->
            <contact><!-- this element should contain the overall program/network manager, successive contact elements could be the person responsible for managing the program at this station -->
                <name></name>
                <email></email>
                <organization></organization>
                <address>
                    <line1></line1>
                    <line2></line2>
                    <city></city>
                    <state_province></state_province>
                    <postal_code></postal_code>
                    <country></country>
                </address>
                <role></role><!-- suggest pointOfContact or principalInvestigator, but must be one from code registry https://standards.iso.org/iso/19115/resources/Codelists/gml/CI_RoleCode.xml -->
                <validperiod>
                    <timeperiod>
                        <begin></begin><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                        <end></end><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                    </timeperiod>
                </validperiod>
            </contact>
        </responsible_party>
        <reporting_status><!-- current and historical status of program affiliation with WIGOS station, multiple enteries added as <status></status> elements -->
            <status>
                <result></result><!-- must be from code registry http://codes.wmo.int/wmdr/ReportingStatus/ -->
                <timeperiod>
                    <begin></begin><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                    <end></end><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                </timeperiod>
            </status>
        </reporting_status>
        <observations><!-- the list of valid WMO observations provided by the program at this station, multiple enteries can be added as <observation></observation> elements -->
            <observation>
                <observed_variable></observed_variable><!-- must be from code registry http://codes.wmo.int/wmdr/ObservedVariableNAME/, where NAME is one of Atmosphere, Earth, Ocean, OuterSpace, Terrestrial -->
                <type></type><!-- must be from code registry http://codes.wmo.int/wmdr/Geometry/ -->
                <application_areas><!-- must be from code registry http://codes.wmo.int/wmdr/ApplicationArea , multiple entries added as <application_area></application_area> elements -->
                    <application_area></application_area>
                </application_areas>
                <optional><!-- optional information, these are additional OSCAR parameters that are important but optional for contributing networks -->
                </optional>
            </observation>
        </observations>
    </program_affiliation>
</wmd>
```

XML Template for Contributing Networks:

Optional Program Observation Information

This information is important, but currently not displayed on OSCAR tool. I'm interpreting that as "less" important than the basic observation information that would be required.

This is open for debate/edit, but I think we should definitely have a list of required information and optional. I doubt all stations have all information provided.

I added a non WMDR element called GALION here. The idea was to provide program specific observation info that is not currently available in the code registry (but should). This could removed, or just ignored for now on upload to OSCAR.

```
<optional><!-- optional information, these are additional OSCAR parameters that are important but optional for contributing networks -->
    <uom></uom><!-- unit of measure, must be from code registry http://codes.wmo.int/wmdr/unit/ -->
    <data_level></data_level><!-- must be from code registry http://codes.wmo.int/wmdr/LevelOfData/ -->
    <data_format></data_format><!-- must be from code registry http://codes.wmo.int/wmdr/DataFormat -->
    <data_policy></data_policy><!-- must be from code registry http://codes.wmo.int/wmdr/DataPolicy/ -->
    <instruments>
        <instrument>
            <type></type><!-- must be from code registry http://codes.wmo.int/wmdr/ObservingMethodAtmosphere/ or http://codes.wmo.int/wmdr/ObservingMethodTerrestrial/, need to expand this for GALION -->
            <locations><!-- element contains the exact location of program instrument (if significantly different from station location), if changes over time add additional <location></location> elements -->
                <location>
                    <geometry></geometry><!-- suggest point for most networks, but must be one from code registry http://codes.wmo.int/wmdr/Geometry -->
                    <position></position><!-- text string e.g , 8.9900016785 -76.8300018311 100.0. The format is  LAT(digitalDegrees) LON(digitalDegrees) ELEVATION(m) -->
                    <region></region><!-- must be from code registry http://codes.wmo.int/wmdr/WMORegion/ -->
                    <territory></territory><!-- must be from code registry http://codes.wmo.int/wmdr/TerritoryName/ -->
                    <climate_zone></climate_zone><!-- must be from code registry http://codes.wmo.int/wmdr/ClimateZone/ -->
                    <validperiod>
                        <timeperiod>
                            <begin></begin><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                            <end></end><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                        </timeperiod>
                    </validperiod>
                </location>
            </locations>
            <manufacturer></manufacturer><!-- open ended text -->
            <model></model><!-- open ended text -->
            <log></log><!-- open ended text -->
            <galion>
                <program_id></program_id><!-- program specific ID used for this instrument, e.g. serial number etc -->
                <lidar_type><!-- list the all lidar capabilities, one per <type></type> element. This could eventually be included in ObservingMethodAtmosphere code registry -->
                    <type></type><!-- one from list: ceilometer, backscatter, raman, hsrl, dial -->
                </lidar_type>
                <wavelengths><!-- lidar wavelengths in nm -->
                    <signal><!-- wavelengths for each signal channel -->
                        <wavelength></wavelength><!-- one wavelength per element -->
                    </signal>
                    <backscatter><!-- wavelengths for each backscatter profile reported -->
                        <wavelength></wavelength><!-- one wavelength per element -->
                    </backscatter>
                    <extinction><!-- wavelengths for each extinction profile reported -->
                        <wavelength></wavelength><!-- one wavelength per element -->
                    </extinction>
                    <depol><!-- wavelengths for each depolarization ratio profile reported -->
                        <wavelength></wavelength><!-- one wavelength per element -->
                    </depol>
                </wavelengths>
                <layers><!-- list all vertical layers that lidar profiles, one each for <layer></layer> element. From defined layers in OSCAR -->
                    <layer></layer><!-- one from list: near_surface, pbl, ft, utls, mus. These are from OSCAR Layers list https://www.wmo-sat.info/oscar/layers -->
                </layers>
                <nrt></nrt><!-- enter yes or no depending on capability to provide data in NRT -->
                <microphysics></microphysics><!-- enter yes or no depending on capability to meet the minimum 3B+2A condition for microphysical retrievals -->
            </galion>
        </instrument>
    </instruments>
    <validperiod><!-- availability of this program observation, may be different from overall program reporting status, multiple enteries added as <status></status> elements -->
        <timeperiod>
            <begin></begin><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
            <end></end><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
        </timeperiod>
    </validperiod>
    <temporal_information><!-- temporal information about the observation -->
        <reporting_interval></reporting_interval><!-- its unclear to me how this element is different than schedule, all these are under WMDR:Observation:Procedure:Deployment -->
        <schedule><!-- Judd: should provide users some guide to fill this in, its unclear to me. Why not use sampling strategy in code registry instead? -->
            <start_month></start_month>
            <end_month></end_month>
            <start_weekday></start_weekday>
            <end_weekday></end_weekday>
            <start_hour></start_hour>
            <end_hour></end_hour>
            <start_minute></start_minute>
            <end_minute></end_minute>
            <diurnal_basetime></diurnal_basetime>
        </schedule>
        <time_stamp_meaning></time_stamp_meaning><!-- must be from code registry  http://codes.wmo.int/wmdr/TimeStampMeaning  Judd Welton: I do not understand this -->
        <reference_time></reference_time><!-- must be from code registry http://codes.wmo.int/wmdr/ReferenceTime -->
    </temporal_information>
    <source_of_observation></source_of_observation><!-- must be from code registry http://codes.wmo.int/wmdr/SourceOfObservation/ -->
    <reference_surface></reference_surface><!-- must be from code registry http://codes.wmo.int/wmdr/ReferenceSurfaceType -->
    <feature_of_interest></feature_of_interest><!-- Judd Welton: I have no idea what this is -->
    <phenomenon_time></phenomenon_time><!-- Judd Welton: I have no idea what this is -->
    <result_time></result_time><!-- Judd Welton: I have no idea what this is -->
    <result></result><!-- Judd Welton: I have no idea what this is -->
</optional>
```

XML Template for Contributing Networks:

Station Element

This is only filled in to request creation of a new station in OSCAR, or to request edit of an existing station level information.

To create new station:
User provides all necessary information at station level, except the WIGOS ID (leave blank). User suggest station name, but that would have to be verified at WMO level to avoid conflict with potential existing station name.

To edit existing station level info:
User includes station element info, and WIGOS ID.

The upload of new station request would require a different series of actions than editing existing station info.

- WMO needs to control this process to avoid chaos

```
<station><!-- this element is only utilized if requesting creation of new station, or to edit station level information for an existing station, otherwise leave empty -->
    <name></name><!-- text name of station, not WIGSO id. This is the name that will be used within WIGOS -->
    <locations><!-- element contains station location information, if changes over time add additional <location></location> elements -->
        <location>
            <geometry></geometry><!-- suggest point for most networks, but must be one from code registry http://codes.wmo.int/wmdr/Geometry -->
            <position></position><!-- text string e.g , 8.9900016785 -76.8300018311 100.0. The format is  LAT(digitalDegrees) LON(digitalDegrees) ELEVATION(m) -->
            <region></region><!-- must be from code registry http://codes.wmo.int/wmdr/WMORegion/ -->
            <territory></territory><!-- must be from code registry http://codes.wmo.int/wmdr/TerritoryName/ -->
            <climate_zone></climate_zone><!-- must be from code registry http://codes.wmo.int/wmdr/ClimateZone/ -->
            <validperiod>
                <timeperiod>
                    <begin></begin><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                    <end></end><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                </timeperiod>
            </validperiod>
        </location>
    </locations>
    <date_established></date_established>
    <type></type><!-- suggest land for networks, but must be one from code registry http://codes.wmo.int/wmdr/FacilityType/ -->
    <responsible_party><!-- this element contains all the primary station contacts, not necessarily the same as program contacts. Additional contacts can be added as <contact></contact> elements -->
        <contact><!-- this element should contain the lead manager or main point of contact for the station, successive contact elements can be program affiliations etc... -->
            <name></name>
            <email></email>
            <organization></organization>
            <address>
                <line1></line1>
                <line2></line2>
                <city></city>
                <state_province></state_province>
                <postal_code></postal_code>
                <country></country>
            </address>
            <role></role><!-- suggest pointOfContact or principalInvestigator, but must be one from code registry https://standards.iso.org/iso/19115/resources/Codelists/gml/CI_RoleCode.xml -->
            <validperiod>
                <timeperiod>
                    <begin></begin><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                    <end></end><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                </timeperiod>
            </validperiod>
        </contact>
    </responsible_party>
    <online_resource><!-- website for station, may add additional URL links <url></url> elements -->
        <url></url>
    </online_resource>
    <description><!-- description information for the station, may add multiple descriptions as <info></info> elements -->
        <info>
            <text></text><!-- text description of the site -->
            <valid_period>
                <time_period>
                    <begin></begin><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                    <end></end><!-- ISO time string, YYYY-MM-DDTHH:MM:SSZ -->
                </time_period>
            </valid_period>
        </info>
    </description>
</station>
```

Conclusion:

Is RRR process required to add variables to OSCAR? If so, how to initiate consideration of new variables in next RRR?
What to do with variables in code registry that are missing from OSCAR? Backscatter, Vertical Distribution of Properties

What is process to add variables from OSCAR to code registry?
What does it mean if a variable is not in code registry?
Does that only impact content in OSCAR online tool (ie searching). Or does it mean that variable is not "operational"
Can a ceilometer site actually upload PBL height in BUFR to a forecast center (e.g. ECMWF)

OSCAR as a multi-program search and discovery tool: global network coordination etc

- Yes, if changes in prior slides are addressed
- Yes, if some search features could be added to the online tools
  - Search for stations based on multiple options (this AND that, not only this OR that)
    - Examples:
      - We can search for all GALION stations
      - We can search for all GALION OR BSRN stations
      - We cannot search for stations that only have GALION AND BSRN
    - Multiple search options based on following would be useful for decision planning:
      - program/network
      - observing type/instrument
      - Observed variable
      - Note: multiple options allows users ability to map super sites, look for gap coverages, etc…
  - Search by observed variable and method and proposed "layer" options
    - GALION: search for all stations that profile PBL, or stratosphere
      - Not all lidars profile through entire column
      - Ex: This is helpful for planning air quality applications and response to large volcanic eruption
- ~~Is it possible to extract OSCAR search results M2M? I see options to download various formats, but not sure how to engineer that in M2M~~
  - NOTE: Tom presented his pyoscar approach for this capability after my presentation, which looks great. So ignore this question.