ATMOSPHERE

National Aeronautics and Space Administration

NASA

EARTH SYSTEM OBSERVATORY

Open Source Science for ESO Mission Processing Study

Workshop #1
October 19-20, 2021

Atmosphere Observing System
Science Perspective

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AOS: One Observing System, Two Synergistic Segments

Constellation

- Incline orbit targets sub-daily variability, with unique measurements with Ku Doppler radar, tandem stereo cameras
- Polar orbit targets climate processes with enhanced W-band Doppler capability, HSRL lidar, radiation
- Additional contributions from JAXA, CSA, CNES under study

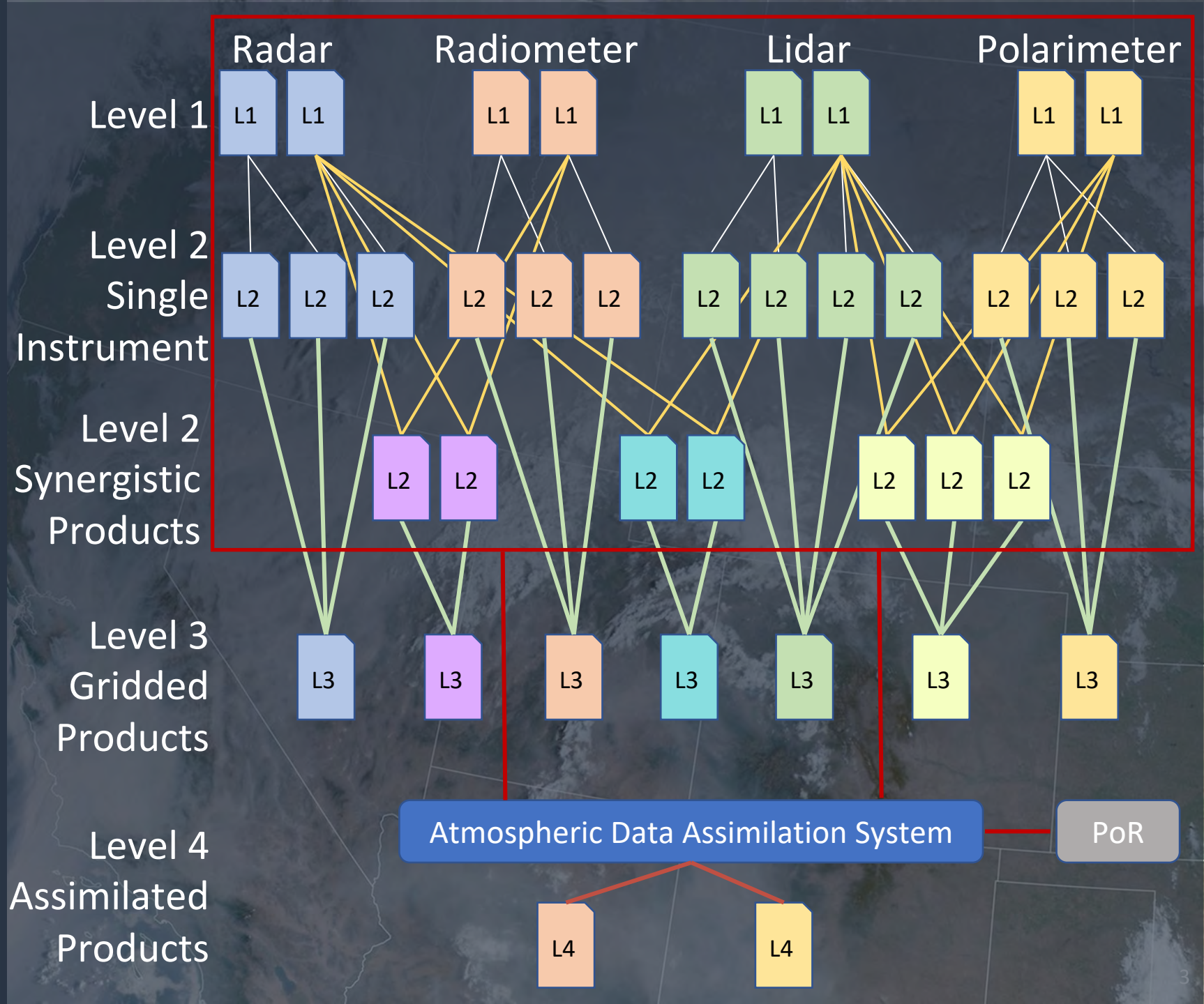
Pre-Decisional

Data Products & Algorithm Development

Science team currently working to identify list of single-instrument and multi-instrument (synergistic) products

At-launch standard products generally to be developed by project-funded science team

Experimental or enabled products and post-launch advancements likely funded, at least partly, through ROSES or open



Number of Products, Data Rates and Volumes

All estimates are **preliminary** and based on AOS Algorithm Team's current estimates

5.1 PB/year Total Volume (includes 0.7 PB/year L0 data)

Not all Synergistic Products have been included (may decrease individual instrument products)

	Num Prod	L0 Rate (Mbps)	L0 Vol (GB/day)	L1+ Vol (GB/day)	All Prod (GB/day)
Polar Orbit					
W-band Doppler, Ka-band Doppler Radars	15	3.5	35	11	47
HSRL Lidar	18	47	473	522	994
Passive Microwave Radiometer	11	0.1	1	189	190
Polarimeter	10	49	493	2,561	3,054
TICFIRE LWIR-TIR Spectrometer (contributed)	17	30	297	0	297
UV-VIS Spectrometer	24	37	372	19	391
Total	95	166	1,671	3,303	4,973
Inclined Orbit 1					
W-band, Ku-band Doppler Radar	15	3.6	36	9	45
Stereo Camera	4	5.0	50	2,263	2,313
Total	19	9	87	2,272	2,358
Inclined Orbit 2					
Backscatter Lidar	19	2.9	29	1,124	1,153
Passive Microwave Radiometer	8	0.2	2	160	162
Polarimeter	10	24	240	2,561	3,054
Stereo Camera	4	5.0	50	2,263	2,313
Total	14	29	321	6,108	6,682
Microwave Radiometer Merged	26			390	390
All Satellite Total	154	204	2,078	12,073	14,404

	L0 Vol (TB/year)	L1+ Vol (TB/year)	All Prod (TB/year)
All satellite total (per year)	741	4,306	5,138

	L0 Vol (PB/year)	L1+ Vol (PB/year)	All Prod (PB/year)
All satellite total (per year)	0.7	4.2	5.0

Applications Needs and Latency

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	Weather Forecasting	Disaster Modeling/Monitoring	Health & Air Quality
Long-term Decisions	**> 6 hour Latency** • Applied research studies • Improve algorithms • Model verification	**> 6 hour Latency** • Disaster relief & preparedness • Community planning • Developing models and studying past events	**> 6 hour Latency** • Exceptional event demonstrations and aerosol transport • Health studies/trends
Short-term Decisions	**3-6 hour Latency** • Operational hurricane forecasting • Operational weather forecasting • Operational model data assimilation	**3-6 hour Latency** • Volcanic disasters/warnings for aviation • Smoke/dust and air quality warnings for human health	**3-6 hour Latency** • Air quality model data assimilation • Air quality forecasting • Smoke modeling
Time-critical Decisions	**1 hour Latency** • Weather nowcasting/warnings • Fire weather/smoke forecasts • Dust storm warnings • Ingest in rapid update models	**1 hour Latency** • Disaster warning, evacuation, response, mobilization • Short-term flooding/landslide risk assessment	**1 hour Latency** • Air quality forecasting • Public health warnings (plume or catastrophic releases) • Chemical weather forecasting

3-6 hr **Spectrometer** measurement latency to deliver L1-L3 products >6 hrs

2 hr **Radar, Polarimeter & Lidar** measurement latency to deliver L1-L3 products within 3-6 hrs

<1 hr **Radiometer** measurement latency to deliver L1b radiances within 1h

Latency needs were determined from stakeholder engagement. Measurement latency refers to the baseline ground system latency, product latency refers to the near-real time data latency for products distributed to users.

Product Development & Data Availability

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- ROSES-funded science teams may not be formed until launch
- Mission algorithm teams responsible for standard at-launch products
  - Includes international partnerships (JAXA, CSA, CNES)
- Additional enabled or experimental products possible post launch from ROSES-funded algorithm team and potentially the wider community.
- Pre-launch *Analytic Collaborative Environment* for early engagement of modeling/scientific/applications user communities based on simulated data
- Open access after full instrument checkout, calibration activities
  - Initial release of Beta products, minimum level of scrutiny (~1–3 mo)
  - Promoted to Provisional after partial validation (3 mo – 1 yr)
  - Promoted to Validated after fully validated and quality checked (1 yr to NLT end of Phase E)

Applications

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The Applications Team is focused on ensuring that applications are considered to the greatest extent possible in mission design.

Plans for growth during Pre-Phase A

Stakeholder outreach: Engage applications communities through workshops and other means

Project Studies: focused on latency, inclination, instruments needs that impact applications value

Pre-Phase A Working Groups*:* Participate in instrument and algorithm working groups

Collaborate with other DO projects, particularly on the Community Assessment Report (CAR)

Plans for growth during Phase A and beyond

Product development and data/model access to support open sharing of data, information, and knowledge within the Applications community

Computational platforms and L3-L4 data product needs

Early Adopters Program *and Analytic Collaborative Environment*

Consideration of other avenues to increase synergistic data use across DO missions pre-launch

Cal/Val as part of science-driven suborbital program

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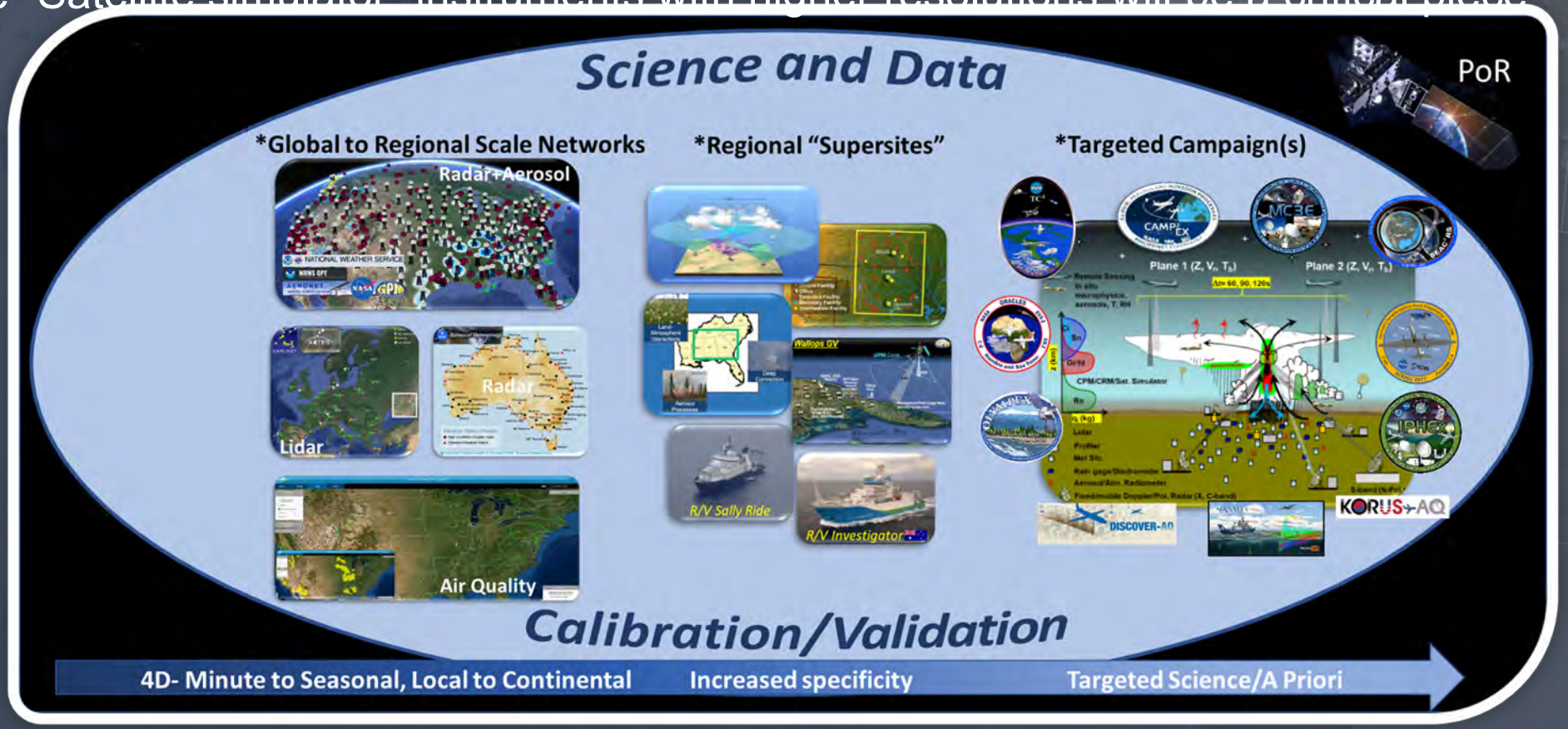
- Science-driven suborbital investigations will produce measurements relevant to cal/val
- Includes long-term regional networks, supersites, and targeted campaigns
- Airborne "Satellite simulator" instruments with higher resolutions will be a critical piece



Support for Open Science

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How will your project support open science through documentation, community development, open communications, and increasing accessibility to knowledge?

- May require a paradigm shift in how missions conduct post-launch algorithm activities
- Establishment of a pre-launch *Analytic Collaborative Environment*
- ATBDs for all products
- Sharing of documentation, holding community forums for users' groups, effective use of project website, provision of data production environment and algorithm code/libraries

How could a common framework, that provided easy access to another mission's algorithms and data, amplify your project's science objectives?

- A common framework may foster products that develop "organically" by users post launch (e.g., synergistic product databases, phenomenological or morphological feature databases, coincidences with PoR assets)

Are there any requirements, constraints, barriers, recommendations, or opportunities that you would like the study team to be aware of?

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How do we deal with proprietary or competition-sensitive code in open science?

Does open science mean unsolicited or outside-of-mission participation in at-launch algorithms?

Supporting Open Science could put burden on missions for user support. Who covers the cost of that burden?

Extra slides

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Product Development & Data Availability

- ROSES-funded teams may not be formed until launch
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  - Includes international partnerships (JAXA, CSA, CNES)
- Additional enabled or experimental products possible post launch from ROSES-funded team and potentially the wider community.
- Open access after full instrument checkout, calibration activities
  - Initial release of beta products, minimum level of scrutiny (~1–3 mo)
  - Promoted to provisional after adequate validation of successful performance (3 mo – 1 yr)
  - Promoted to mature after detailed assessment of performance (1 yr to NLT end of Phase E)

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Support for Open Science

How will your project support open science through documentation, community development, open communications, and increasing accessibility to knowledge?

- ATBDs for all products
- TBD: May require a paradigm shift in how missions conduct post-launch algorithm activities
- Sharing of documentation, holding community forums for users' groups, effective use of project website, provision of data production environment and algorithm code/libraries

How could a common framework, that provided easy access to another mission's algorithms and data, amplify your project's science objectives?

A common framework may foster products that develop "organically" by users post launch (single or synergistic product databases, phenomenological or morphological feature databases, coincidences with PoR assets)

Applications

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The Applications Team is focused on ensuring that applications are considered to the greatest extent possible in mission design. We do this by engaging stakeholder communities early in the mission development to provide feedback to the science and engineering teams, identify new application areas, and develop a community for early adopter activities. We will achieve this through several complementary approaches during

Plans for growth during Pre-Phase A

Project Studies: applications-oriented studies on latency, inclination, instruments needs that would impact applications value

Pre-Phase A Working Groups: Participate in instrument and algorithm working groups to articulate needs that impact L1-L4 products. Identify additional modeling, analysis and computational needs to address L3 / L4 product needs prioritized by stakeholders.

Stakeholder outreach: Engage applications communities through workshops (e.g. weather forecasting (2019), transportation (2020), air quality 2021), thematic discussions, focus groups leveraging existing mission stakeholder groups

Collaborate with other DO projects, particularly on the Community Assessment Report (CAR)

Plans for growth during Phase A and beyond

Product development and data/model access and availability: Participate in collaborative environment for integrated modeling and product development driven in part by applications to support open sharing of data, information, and knowledge within the Applications community

Computational platforms and data product needs: Engage with algorithm teams on L3-L4 product needs and computational options

Early Adopters Program: Develop an Early Adopter plan and implementation strategy leveraging past mission experiences to advance inter-agency and external partnerships, community engagement and data use

DO Collaboration: considering other avenues to increase synergistic data use across DO missions pre-launch (e.g., proxy data, data fusion, Early Adopter seed funding, ESO-wide applications ROSES solicitation)