National Aeronautics and Space Administration

Air Quality Architecture to Meet US National Needs for Forecasting, Management, and Assessment of Health Impacts

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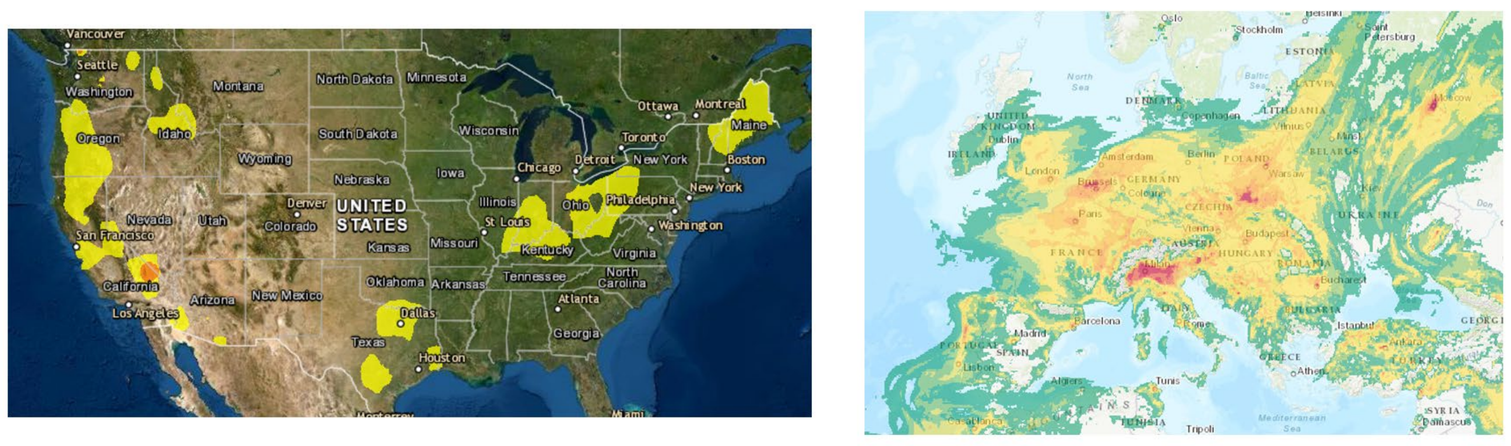
Program: FY22 R&TD Strategic Initiative
Strategic Focus Area: Earth System Science and Application Architecture Development - Strategic Initiative Leader: Jessica L Neu

Objective: To bring together a diverse set of stakeholders in the areas of air quality forecasting, research, and health studies to define potential architectures for the US air quality modeling and assimilation system of the future.



US: 1-day forecast of AQ Index based on local regression models and NOAA regional forecast model

Europe: 5-day forecast of 5 AQ species based on global model with assimilation of satellite data and full-physics regional models

Figure 1. Comparison of forecast capabilities in Europe, which has a coordinated set of air quality forecasting and attribution models (Figure 3) and those in the US, which rely heavily on local regression models.

Background:

There is a need for improved information on air quality in the US that cannot be met with the existing air quality measurement and information systems [1]. This task seeks to address the shortcomings of the current system (Figure 1) by engaging stakeholders from what have traditionally been three separate air quality disciplines - forecasting, attribution, and health impact studies - and mapping out a single national air quality architecture that can meet the needs of all three.

Approach and Results:

The keystone of our approach is a Community Workshop to bring together stakeholder agencies from all three air quality disciplines and discuss their Needs, Goals, and Objectives with respect to a national system of observations, modeling, and assimilation (Figure 2). In preparation for the workshop, we have been gathering information through both review of existing strategic documents for various air quality agencies and a series of conversations with representatives from these agencies. We have also reviewed current capabilities in the areas of observations, modeling, data assimilation, and information systems to identify gaps as well as opportunities for transition of capabilities from research to operations. Finally, we have worked to adapt the concept of a Science and Applications Traceability Matrix (SATM) to suit the needs of our project.

With respect to space-based observational gaps, we find that while NOAA's GEO-XO may provide geostationary measurements of some species in the UV (NO2, HCHO, SO2, column O3), the value of these measurements is limited without concurrent IR measurements of CO, CH4, Isoprene, NH3, and vertically-resolved O3. In terms of data assimilation, we learned that NOAA is committed to using code from the Joint Effort for Data assimilation Integration (JEDI) system developed at the Joint Center for Satellite Data Assimilation. Under the auspices of NASA HQ, Co-Is K. Bowman and K. Miyazaki have begun transferring NASA chemical data assimilation capabilities to JEDI. This lays the groundwork for NOAA (and others) to be able to use these capabilities for AQ forecasting and reanalyses. In terms of modeling, there are multiple approaches to go from global to local scales. These include using a global model to provide boundary conditions to regional models (European CAMS system, Figure 3) and using an adaptive grid that allows for smaller grid cells over the region(s) of interest (NCAR MUSICA, GEOS-Chem HP). NOAA is transitioning from its current NCEP production suite (NPS) that represents a heterogeneous set of models for different needs to a Unified Forecasting System (UFS) that represents a single, highly flexible modeling architecture that can be used for a wide variety of forecast needs. This represents an opportunity for this study to inform the development of the AQ forecasting system.

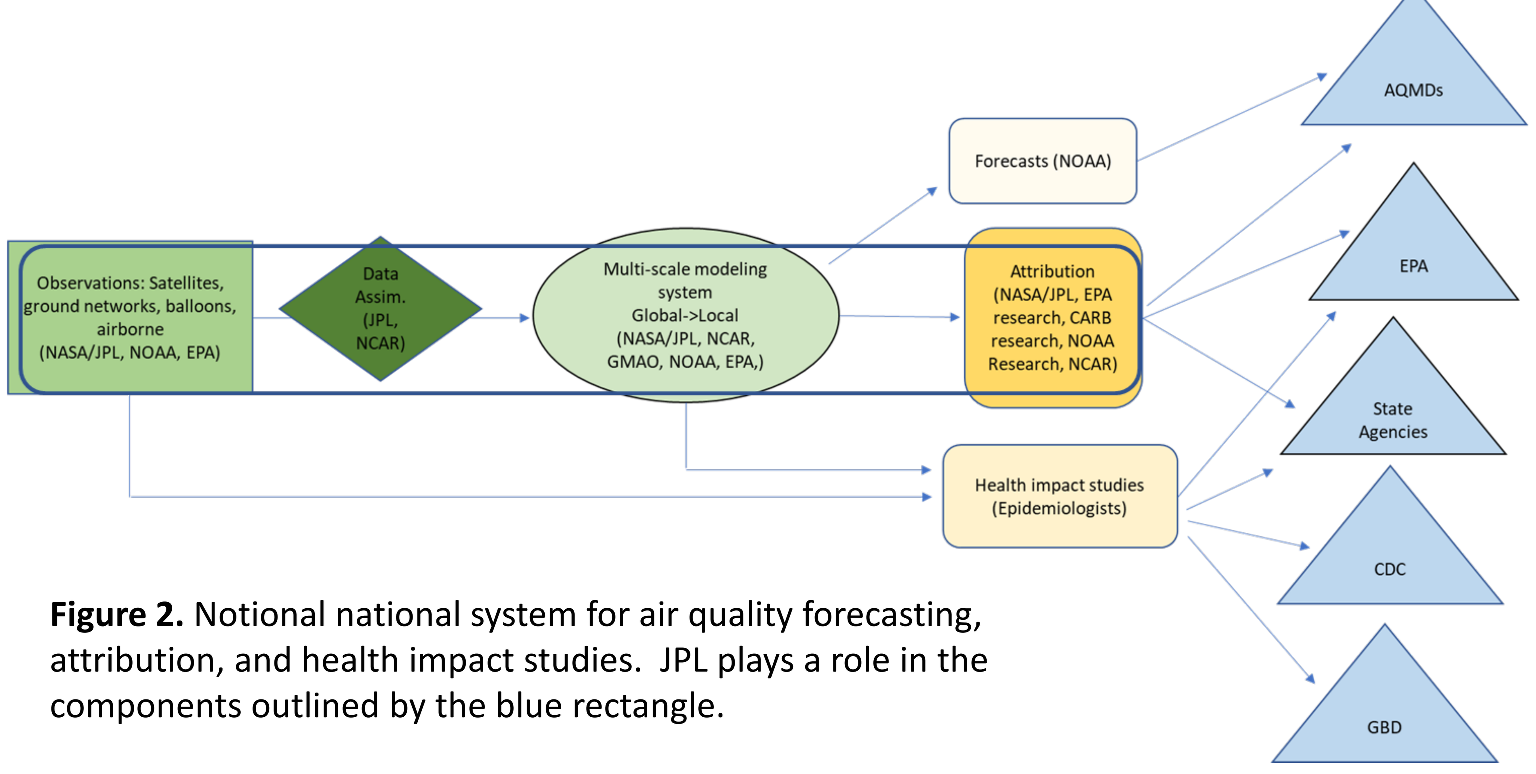


Figure 2. Notional national system for air quality forecasting, attribution, and health impact studies. JPL plays a role in the components outlined by the blue rectangle.

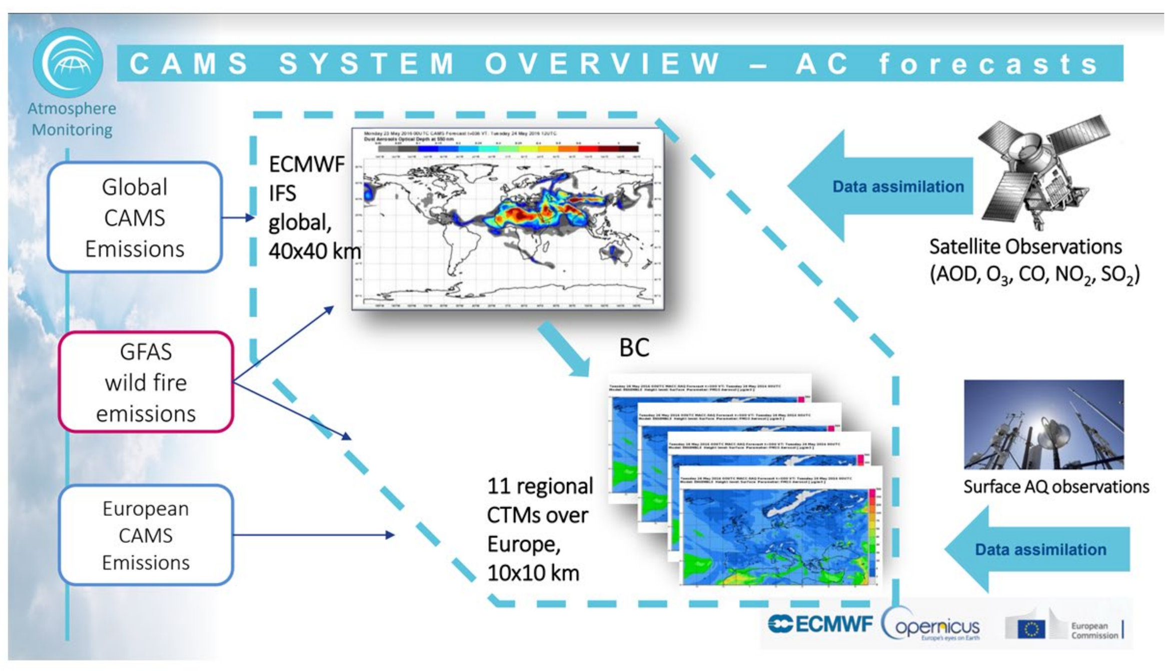


Figure 3. European Copernicus Atmosphere Modeling System structure. Satellite data is assimilated into the global model, which provides boundary conditions for regional models for each country. Surface observations are assimilated into these regional models.

Significance/Benefits to JPL and NASA:

Once conversations with all stakeholders are complete, we will have enough information to fill out the "left side" (Goals and Objectives) of our SATM in preparation for the Community Workshop. During the workshop, we will discuss the attributes of systems that are needed to meet these goals and objectives, laying the groundwork for developing system architecture requirements and comparing them to the capabilities we have identified. The workshop will represent the first time that the invited agencies will meet with the stated goal of developing a centralized air quality system for the nation. The final deliverable of the SRTD is a white paper to the next Earth Science Decadal Survey (ESDS) describing this system. If successful, JPL and NASA will be seen as contributing our system engineering skills to a problem of vital national importance and will become a well-known player in the world of air quality applications. We will also be in a position to propose new observations in support of the system and to integrate our state-of-the-art data assimilation capabilities into the architecture.

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Clearance Number: CL#
Poster Number: RPC#R22033

References:

[1] Thriving on Our Changing Planet A Decadal Strategy for Earth Observation from Space, National Academies Press, 2017**.**

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