Observations and Data Assimilation of Atmopsheric Constituents

White Paper Overview

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Outline

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  - Greenhouse gases
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  - Global Composition Modeling & Assimilation Systems
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      - Aerosols
      - Greenhouse gases
      - Reactive gases
    - Stratospheric Composition
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  - Regional Composition Modeling & Assimilation Systems
    - Air quality
    - Greenhouse gases
  - Integrated Earth System Analysis: Challenges
    - Composition coupling to atmospheric circulation and impact on NWP and seasonal forecasting
    - Composition coupling to ocean circulation & ecosystems
    - Composition coupling to terrestrial ecosystems
- Conclusions

Gaps & challenges in Atmospheric Composition Global Observing System -1

- Aerosols
  - Suborbital
    - Improve sparse ground based network
      - Sun photometry, PM 2.5
      - LIDAR
      - In particular, Africa, South America
      - Need for inter-calibration, homogenization
    - Routine ship-based measurements
    - Routine aircraft based measurements
  - Space-based
    - Lack of A/Q geostationary satellites covering Africa & South America
    - Need for next generation high-resolution, multi-angle, multi-spectral polarimetry
    - Need for multi-frequency LIDARS (HSRL)
    - Sustained monitoring of stratospheric aerosols

Gaps & challenges in Atmospheric Composition Global Observing System -2

- Greenhouse Gases
  - Suborbital
    - Consolidate and expand in-situ and ground-based remote-sensing infrastructures, including from aircraft: GAW, TCCON, ICOS, IAGOS, CONTRAIL …
    - Emerging needs for NRT
  - Space-based
    - Further exploitation of SCIA, GOSAT/TANSO
    - Take stock of OCO-2
    - Planned or proposed missions: GOSAT2, MERLIN, Carbonsat…
- Reactive Gases
  - Suborbital
    - NRT exchanges
    - Availability & sharing of regulatory air quality data worldwide
    - Aircraft measurements
    - ground-based profiles (in-situ and remote-sensing)
    - Supersites with comprehensive chemistry
  - Space-based
    - Profile information in the stratosphere (capabilities are phasing out)
    - Exploit data (hyperspectral, multi-instruments…) in order to achieve sensitivity in the mid- to low troposphere
    - Expectation from future GEO instruments (US, Asia, Europe)

Gaps & challenges in Atmospheric Composition Data Assimilation

(global and regional systems face similar challenges, though with slightly different flavors)

- Computational resources to enable ever demanding need for increased complexity
  - Handling of next generation high-resolution, hyper-spectral, multi-angle satellite data
  - More detailed process modeling to enable extraction of information content from new sensors
  - Increased ensemble sizes, resolution
- Algorithms for robust state & emission/parameter estimation.
- L2 or L1 (radiance) assimilation; impact of multi-instrument products vs assimilation of single instrument products
- (Balanced) approach for coupling across Earth-System components