Impact assessment of Aeolus-2 with the global NOAA OSSE system

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Objective

• Provide input for the workshop for EUMETSAT member states and ESA delegates regarding the selection of an Aeolus-2 mission.
• The workshop is scheduled for 8-9 September 2022.

• Run an Observing System Simulation Experiment (OSSE) using the NOAA system and simulated observations
• Assess the additional value of Aeolus-2, e.g., relative to Aeolus
NOAA OSSE system

- New OSSE system based on the ECMWF ECO1280 (~ 9km) nature run 14 months (00 UTC Sep 30, 2015 – Nov 30, 2016)
  - 137 levels in the vertical; up to 80km
  - 1 hour temporal resolution for the first month, 3-hour temporal resolution for the rest of the nature run
- Consolidated Observing Systems Simulator (COSS) package to simulate perfect observations; Explicit errors (biases and standard deviations) added to perfect observations
- Simulated observations based on the June/July 2020 observing system
  - Capability to simulate conventional, GNSS Radio Occultation profiles and MW/IR radiances under cloudy conditions – modifications to CRTM (Community Radiative Transfer Model)
- Working towards the simulation of 3D AMVs and DWL observations by LIPAS (KNMI)
- Calibration and experimentation done with NOAA FV3GFS v16.1 model

- OSSE time period: June 1 – July 30, 2020
The virtual June-July (2016) from the Nature Run was selected as the two-month period for the OSSE

- Observation simulation
  - All observing systems (minus Aeolus), including observation errors are available
  - Simulation of Aeolus and Aeolus-2

- OSSE calibration
  - Run OSE w/o Aeolus with the NOAA system
  - Run OSSE w/o Aeolus with the NOAA system
  - Impact of Aeolus in both setups should be similar
  - Some observation error tuning may be needed
Aeolus simulation

- Aeolus operational period: June/July 2020
- LIPAS = LiDar Performance Analysis Simulator
  - used in a number of scientific studies in preparation for Aeolus
- Simulates Mie and Rayleigh HLOS winds and errors, given
  - Instrument characteristics
  - Atmospheric conditions
    - ECMWF Nature Run (pressure, temperature, wind, humidity, clouds)
    - aerosol from CAMS (Copernicus Atmosphere Monitoring Service) database
  - Range Bin Setting scenario (RBS)
6 hours – 4 orbits
Nature Run truth – 1 orbit

HLOS Nature Run

Nature Run/CAMS backscatter
LIPAS simulated winds

Rayleigh wind

Mie wind
Wind statistics

**Rayleigh-clear**

LIPAS Rayleigh-clear wind statistics for t=Nature-Run
overall E<sub>0</sub>-t = 0.09
overall σ<sub>est</sub> = 4.01
overall 1.4826·MAD<sub>0</sub>-t = 5.32

Total obs count = 36674
QC reject: σ<sub>est</sub> > 8.0 (m/s)
Rejected: 2.6%

**Mie-cloudy**

LIPAS Mie-cloudy wind statistics for t=Nature-Run
overall E<sub>0</sub>-t = 0.07
overall σ<sub>est</sub> = 3.59
overall 1.4826·MAD<sub>0</sub>-t = 2.08

Total obs count = 2126
QC reject: σ<sub>est</sub> > 5.0 (m/s)
Rejected: 5.0%
Error statistics 2nd reprocessing Rayleigh-clear

Rayleigh, Clear

Count

Altitude (m)

Bias

SMAD

SDD (- - -)

Bias (m/s)

SMAD (m/s)

SDD (m/s)

0 0.1 0.2 0.3 0.4 0.5

Count

1 June - 31 July 2020

~16 m/s

Courtesy ECMWF
Error statistics 2nd reprocessing Mie-cloudy

Courtesy ECMWF
**Aeolus-2 simulation**

- Take EURD (End User Requirement Document) as starting point

- Similar sampling as Aeolus but with better quality winds

- Same vertical sampling (RBS scenario) as for Aeolus
  - Note. Aeolus-2 has more vertical bins than Aeolus

- LIPAS accumulation is fixed to 30 measurements (~87km along track) for both Rayleigh-clear and Mie-cloudy winds
  - Note. Operational Aeolus Mie-cloudy winds is the result of accumulating 4-5 measurements
Status and schedule

- LIPAS has been tuned on KNMI side and delivered to NOAA
- Run a short Control + Aeolus with preliminary errors (March 2022)
- Run a short real-data experiment with Aeolus to estimate realistic representativeness errors (March/April 2022)
- Estimate realistic observation errors for Aeolus and generate error-added Aeolus observations, 2-month period (April 2022)
- Run Aeolus experiment and quantify impact over Control (May 2022)
- Analysis of error sensitivity (June 2022)
- If analysis shows favorable results, run an additional OSSE with new error configuration (June/July 2022)

- Present results at the workshop for EUMETSAT member states and ESA delegates, 8-9 September 2022.