

Variability and Sources of Tropospheric Aerosols over the North Atlantic during NAAMES

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Introduction

➤ The North Atlantic Aerosols and Marine Ecosystems Study (**NAAMES**; <http://naames.larc.nasa.gov>) is a five-year NASA Earth-Venture Suborbital-2 Mission to characterize the plankton ecosystems and their influences on remote marine aerosols, boundary layer clouds, and their implications for climate in the North Atlantic.

While marine-sourced aerosols have been shown to make important contributions to surface aerosol loading, cloud condensation nuclei and ice nuclei concentrations over remote marine and coastal regions, it is still a challenge to differentiate the marine biogenic aerosol signal from the strong influence of continental pollution outflow.

➤ The objectives of this study are to determine the major transport pathways for North American pollution outflow to the North Atlantic, and to quantify the terrestrial and marine sources of aerosols during NAAMES using ground, ship, aircraft, and remote sensing observations in conjunction with a state-of-the-art global 3-D chemical transport model (GEOS-Chem).

➤ This poster presents an initial evaluation of GEOS-Chem for the periods of NAAMES campaigns #1 (Nov. 2015) and #2 (May 2016).

Research Questions

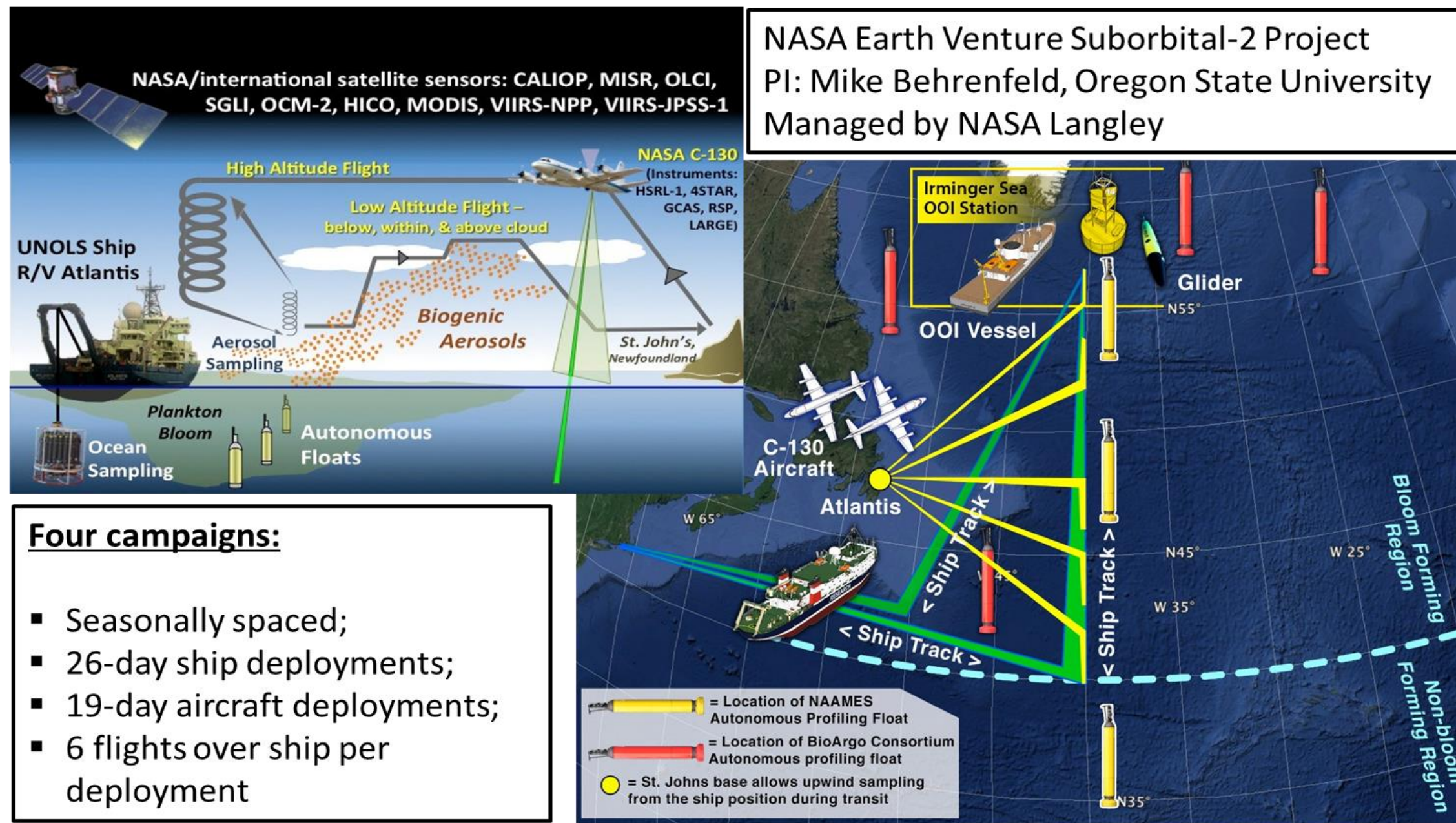
- What are the major outflow pathways and transport mechanisms for export of North American anthropogenic pollution to the North Atlantic during NAAMES?

➤ Can a state-of-the-art chemical transport model reproduce the distribution and variability of tropospheric aerosols over the North Atlantic as observed during NAAMES?

➤ What are the relative contributions of terrestrial and oceanic sources to the aerosol loading, aerosol optical depth, and their variability over the North Atlantic during NAAMES?

NAAMES Objectives and Concept of Operations

1. Define environmental and ecological controls on plankton communities
2. Define linkages between ocean ecosystem properties and biogenic aerosols



Model and Data

➤ GEOS-Chem: a global 3-D chemistry and transport model (v11-01)

- ✓ driven by the MERRA-2 assimilated meteorology (at $2^\circ \times 2.5^\circ$ horizontal resolution) from the NASA Global Modeling Assimilation Office (GMAO).

- ✓ includes sulfate-nitrate-ammonium aerosol thermodynamics coupled to ozone-NO_x-hydrocarbon-aerosol chemistry, mineral dust, sea salt [Jaegle et al., ACP 2011], elemental and organic carbon [Pye et al., ACP 2010] aerosols, especially a recently implemented parameterization for the marine primary organic aerosol emission [Gantt et al., GMD 2015].

➤ GEOS-Chem aerosol optical depth (AOD) calculated from the mass concentration, extinction efficiency, and particle mass density [Martin et al., JGR 2003].

- MODIS aerosol optical depths (AOD) data:

- ✓ Level 3 daily aerosol product (1°×1° resolution)
- ✓ Collection 6.1 (<https://ladsweb.nascom.nasa.gov/data/>)

- NASA GMAO MERRA-2 reanalysis

- ✓ <https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/>

- NAAMES aircraft & ship data

- ✓ <http://naames.larc.nasa.gov/>

Transport Pathways for N. American Pollution Outflow

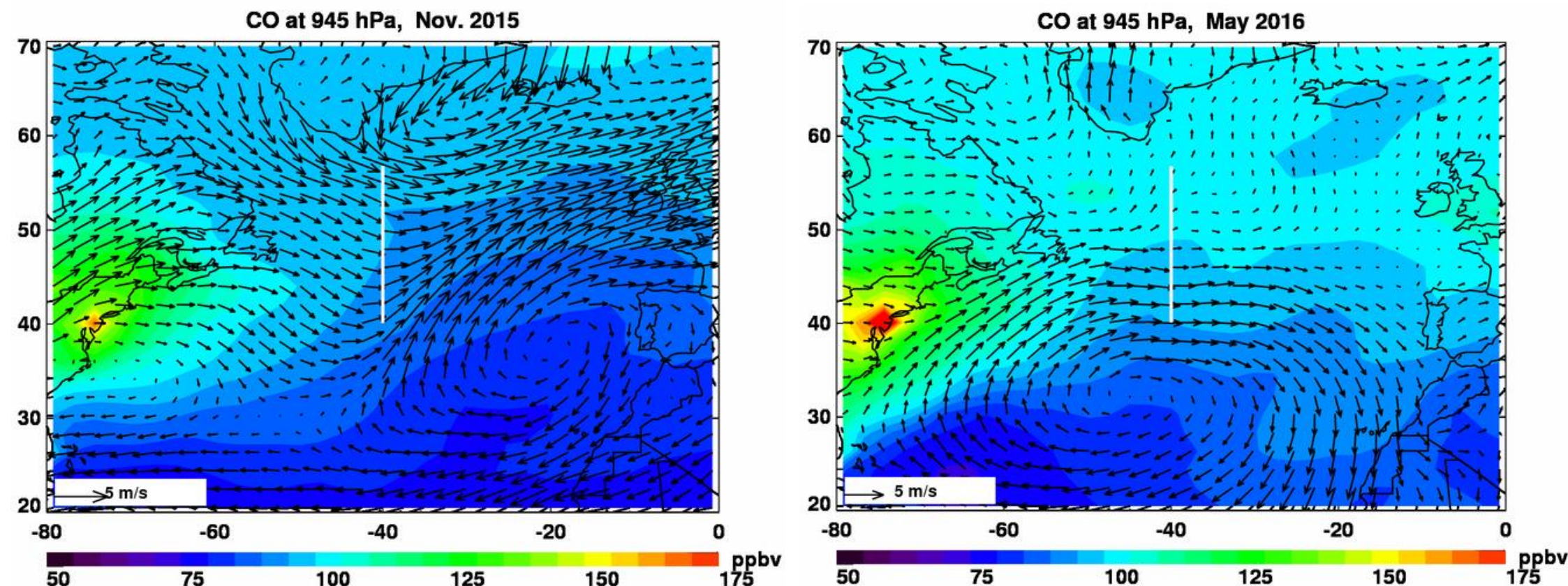


Fig. 1. GEOS-Chem monthly mean CO (ppbv) and winds near surface over the North Atlantic for Nov. 2015 (left) and May 2016 (right).

Along 40°W (nominal ship track 40-57°N), the ship has ample opportunities to sample marine air despite the influences of the North American continental outflow.

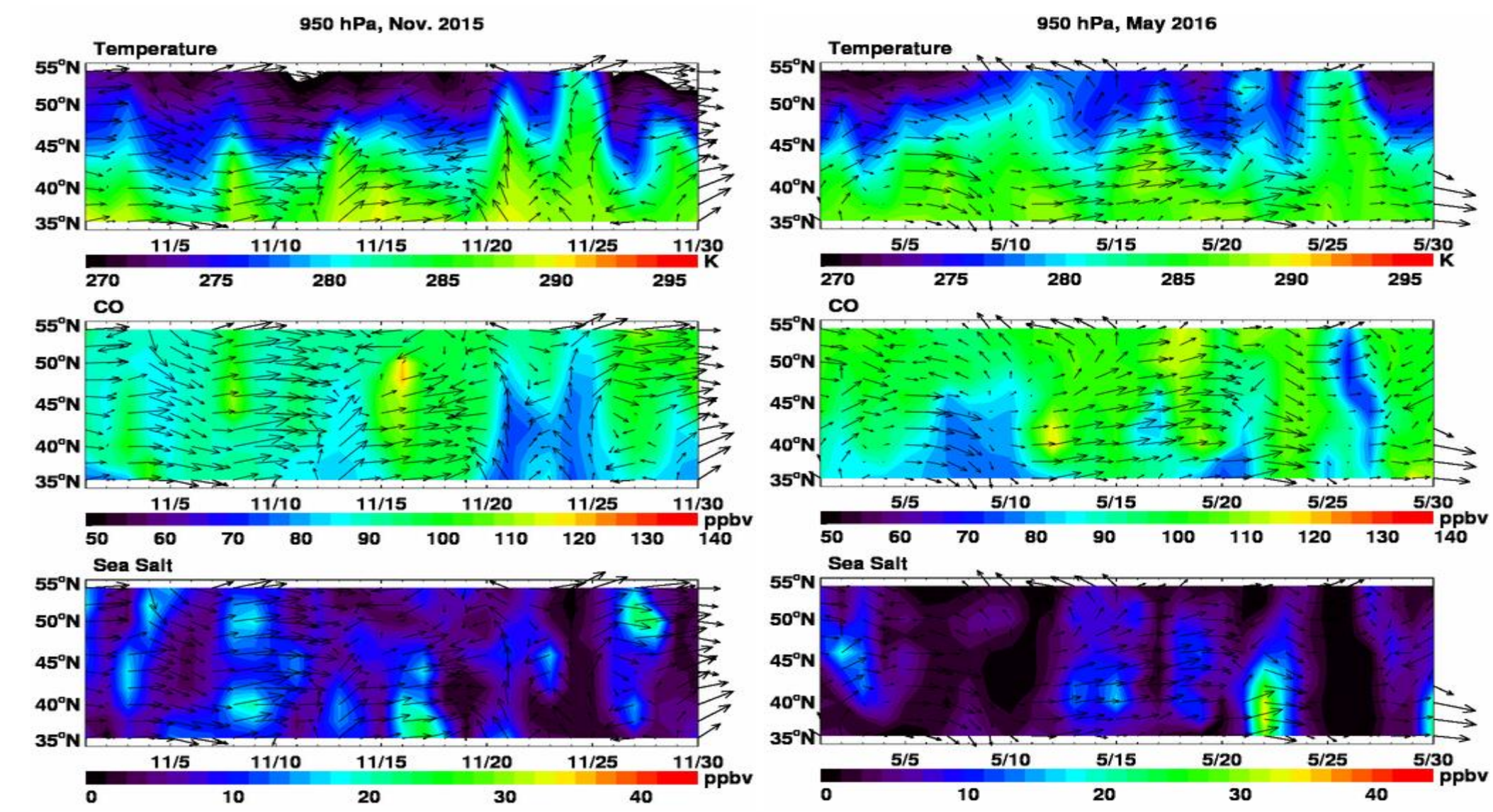


Fig. 2. Hovmöller diagram of model surface temperature, CO and sea salt concentrations along 40°W over the North Atlantic (Left: Nov. 2015; Right: May 2016)

Major transport pathways for N.A. pollution over the North Atlantic: boundary-layer outflow, frontal lifting, and convective outflow. Enhanced sea salt aerosols often associated with strong wind & warm air from south.

Aerosol Optical Depth (Global): MODIS vs. GEOS-Chem

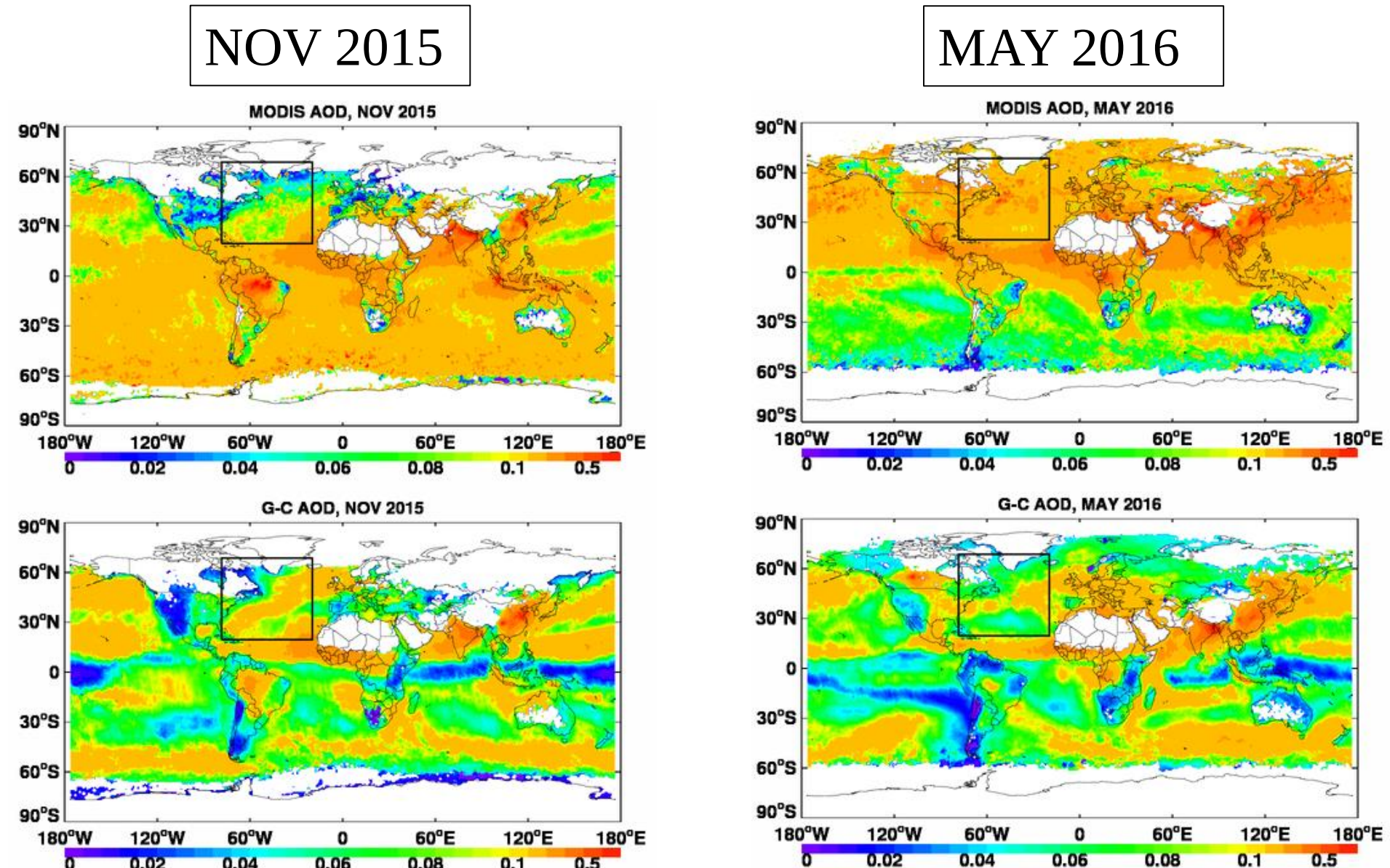


Fig. 3. Evaluation of GEOS-Chem global monthly mean AODs with MODIS / Aqua satellite retrievals for the NAAMES #1 and #2 months. Model output are sampled at 1:30pm LT along the satellite orbit track.

AOD (N. Atlantic): MODIS vs. GEOS-Chem

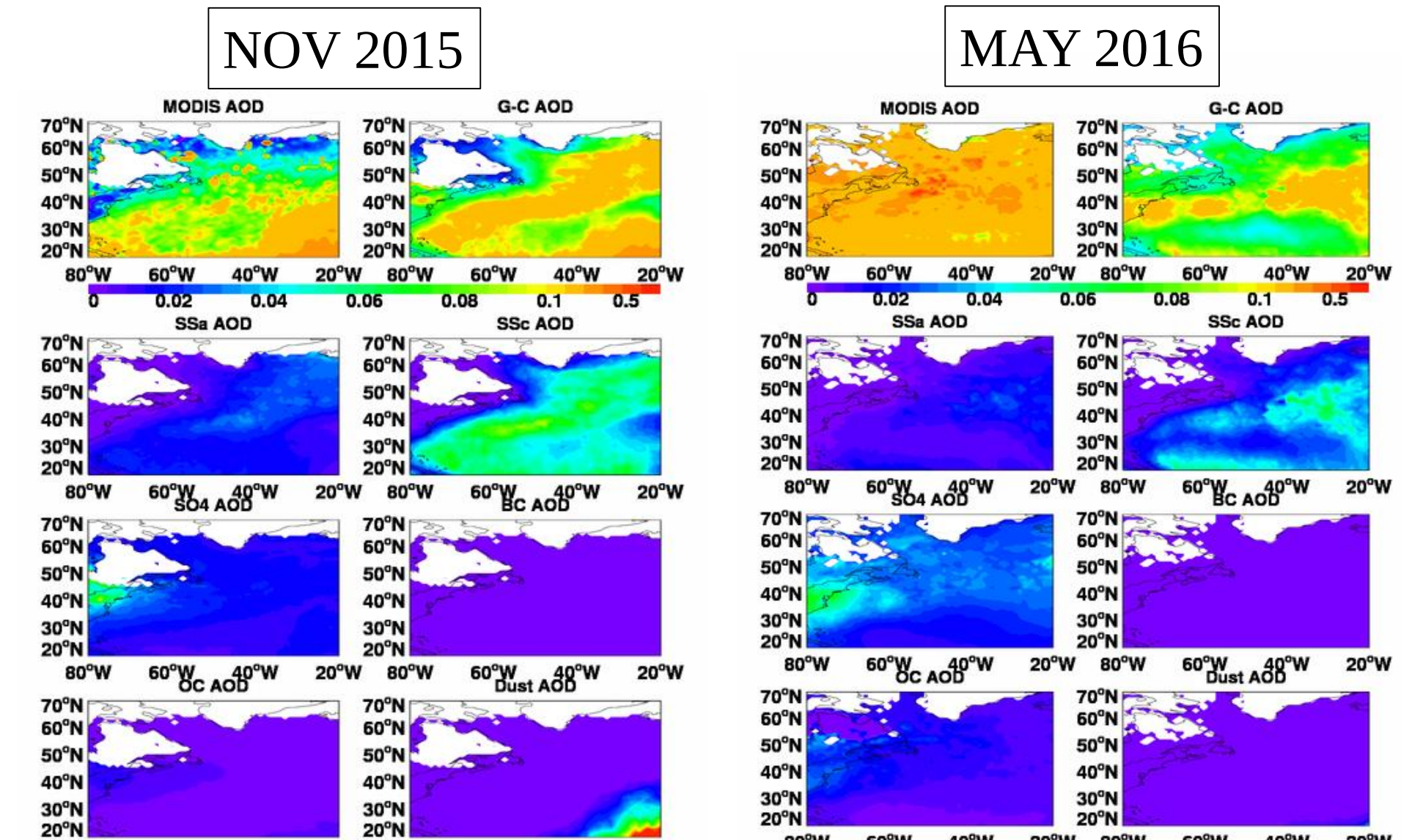
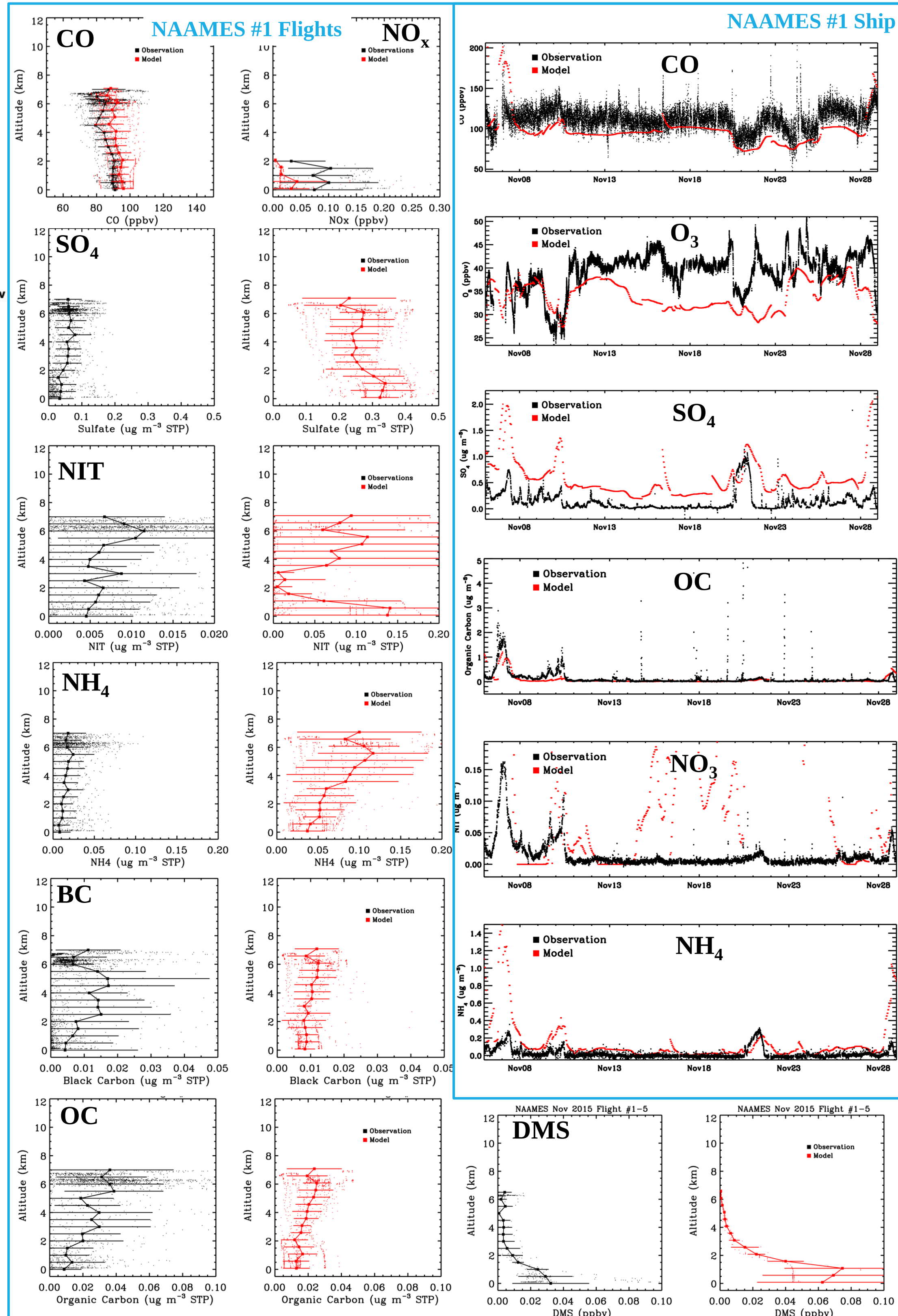


Fig. 4. Same as Fig.3, but for the N. Atlantic region. Also shown are contributions to the total AOD in the model from accumulation mode sea salt (SSa), coarse mode sea salt (SSc), sulfate (SO₄), black carbon (BC), organic carbon (OC), and dust.

Preliminary Comparisons: Observations vs. GEOS-Chem NAAMES #1 (NOV 2015)



NAAMES #2 (MAY 2016)

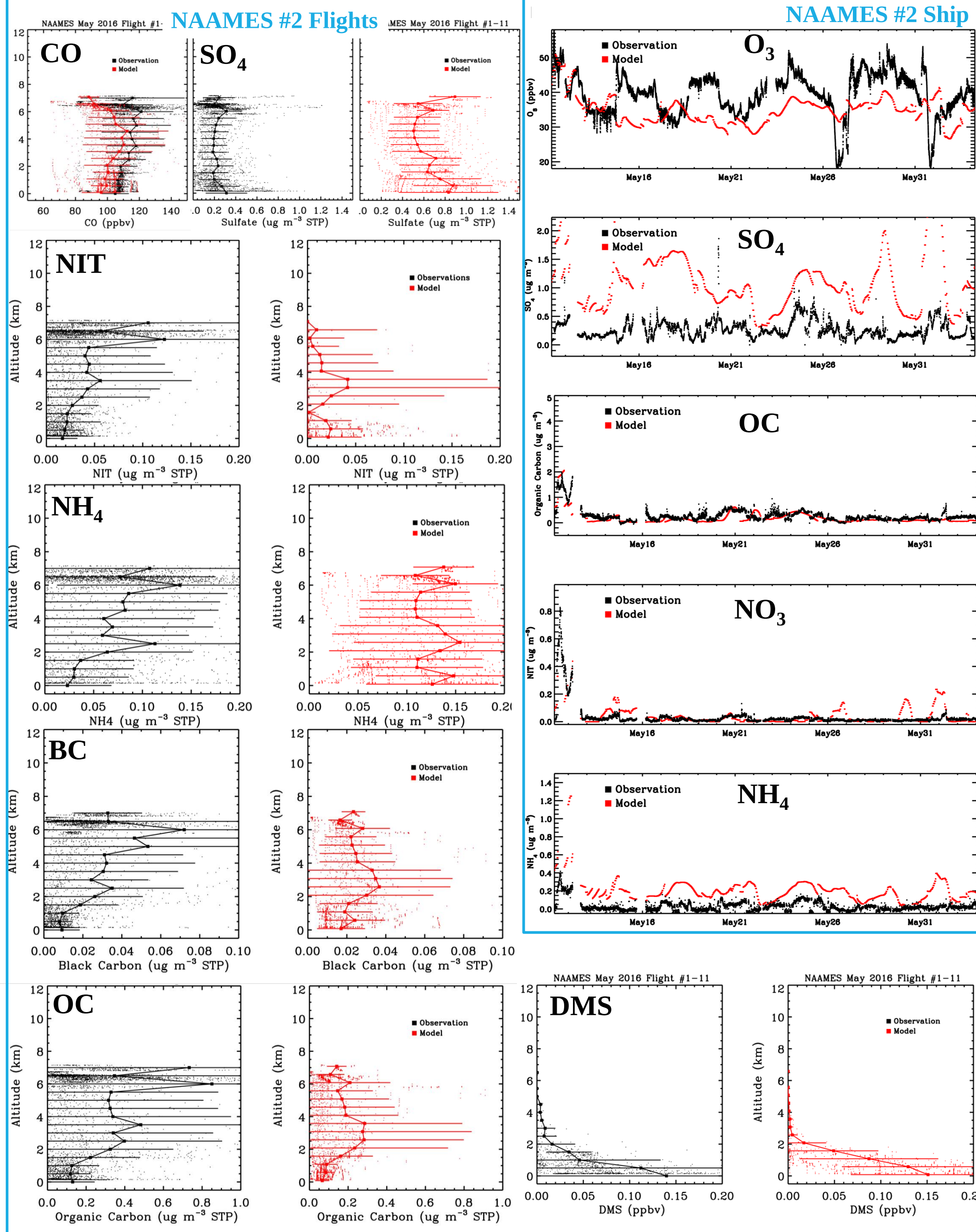


Fig. 5. Preliminary comparisons of GEOS-Chem simulated species concentrations with aircraft & ship measurements during NAAMES#1 (Nov. 2015) and #2 (May 2016).

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