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Supporting Information for

Atmospheric Research Over the Western North Atlantic Ocean Region and North American East Coast: A Review of Past Work and Challenges Ahead

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Introduction

The supporting information includes a sub-section of text, a table to complement the main manuscript file, in addition to references.

S1. Background on Air-Sea Interactions

The coupled atmosphere and ocean systems affect each other through exchanging sensible and latent heat, momentum, and trace gas fluxes across the air-sea interface. Such air-sea interactions affect atmospheric thermodynamics, clouds, precipitation, and circulation, which in turn impact ocean currents, temperature, and salinity. The spatial scale of air-sea interactions spans from local flux exchanges to oceanic wave generation, organization of MBL clouds, formation of storms/hurricanes, and global scale climate dynamics (e.g., ENSO). Large spatial variations in air-sea interaction on scales of km to tens of km can be driven by small-scale variability in SST and resultant variability in the MBL (e.g., Guymer et al., 1983). Understanding when, where, and how much air-sea flux exchange occurs is critically important for weather forecasting, climate modeling, assessment of environmental impacts, and management of natural resources (e.g., renewable energy applications).

The surface sensible heat flux F_{sh}, latent heat flux F_{lh}, and momentum flux (i.e., wind stress) F_{μ} are usually determined using the eddy correlation technique, based on temporally averaged eddy covariances $\overline{w'\theta'}$, $\overline{w'q'}$, $\overline{w'u'}$, and $\overline{w'v'}$ of fluctuating vertical velocity (w), potential temperature (θ), specific humidity (q), and horizontal wind components (u, v) (see Eqs. 1 – 3). The turbulent fluxes are challenging to measure directly, especially over remote oceans, without a stable platform. Thus, estimates of the fluxes are often parameterized with air-sea differences in potential temperature ($\Delta\theta$), specific humidity (Δq), and the horizontal wind components (Δu and Δv).

$$F_{sh} = \rho c_p \overline{w'\theta'} \approx \rho c_p C_{sh} S \Delta\theta \quad (1)$$

$$F_{lh} = \rho L_v \overline{w'q'} \approx \rho L_v C_{lh} S \Delta q \quad (2)$$

$$F_{\mu} = \rho \overline{w'u'} \approx \rho c_p C_{\mu} S[(\Delta u)^2 + (\Delta v)^2]^{1/2} \quad (3)$$

The calculation of fluxes involves air density (ρ), specific heat capacity at constant pressure (c_p), latent heat of evaporation (L_v), average wind speed (S) relative to the ocean surface currents, and the bulk transfer coefficients C_{sh}, C_{lh}, and C_{μ}. The treatments of these coefficients in various weather and climate models were reviewed in Zeng et al. (1998). These transfer coefficients can be treated differently for various purposes, either using constant values, separately, under stable, neutral, and unstable conditions (e.g., Weller et al., 1995) or further parameterized as a function of atmospheric stability and ocean surface roughness (e.g., Fairall et al., 1996). Primary state variables for calculating air-sea heat and momentum fluxes (more specifically, the air-sea differences), including ocean skin temperature, near-surface air temperature, humidity, and wind speed, can be measured directly. The eddy covariances can also be directly measured from a variety of platforms over oceans with some challenges and uncertainties (Cronin et al., 2019). Parameterized relationships in the bulk aerodynamic formulae (Eqs. 1 – 3) can then be used to estimate the transfer coefficients and/or surface roughness. Once the bulk algorithms are

evaluated and calibrated in field experiments, they are then broadly applied in satellite retrievals and numerical models (e.g., Fairall et al., 2003; Fairall et al., 1996; Zeng et al., 1998).

Table S1: Comprehensive summary of peer-reviewed publications related to atmospheric research over the North American East Coast and WNAO region, categorized by the following topics: Gas/Aerosol/Wet Dep = studies examining any aspect of gas-phase, aerosol, or wet deposition properties, respectively, such as composition; Clouds = studies examining cloud/storm characteristics; ACI = aerosol-cloud interactions; Air-Sea = air-sea interactions; Dev't/Validation = studies examining any aspect of a new method, model, or instrument and/or any validation studies between observations and models or retrievals; Met = studies with an extensive focus on meteorology and air flow analysis. Publications in alphabetical order by first author last name are grouped into campaigns/monitoring programs that are listed in alphabetical order. Rows showing multiple campaigns (e.g., "ICARTT/NEAQS 2002") indicate studies using data from each of the listed campaigns. "Bermuda" contains studies linked to other categories (i.e., AEROCE), while some AIRMAP studies fall into other campaigns (i.e., NEAQS 2002, ICARTT). IAGOS includes works from CARIBIC and MOZAIC. "Misc" includes studies not fitting under the other campaign names. Some publications addressed multiple topics and were therefore counted in multiple categories.

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
Aerosols99	Bates et al. (2001)		x						
Aerosols99	Bates et al. (2002)		x						
Aerosols99	Crimmins et al. (2004)		x						
Aerosols99	Hernandez et al. (2001)	x							
Aerosols99	Massling et al. (2003)		x						
Aerosols99	Quinn et al. (2001)		x						
Aerosols99	Thompson et al. (2000)	x							
Aerosols99	Voss et al. (2001)		x						
AIRMAP	Ambrose et al. (2010)	x						x	
AIRMAP	Ambrose et al. (2012)	x						x	
AIRMAP	DeBell et al. (2004a)	x	x						
AIRMAP	DeBell et al. (2004b)	x	x						
AIRMAP	Fischer et al. (2004)	x							x
AIRMAP	Hegarty et al. (2007)	x							x
AIRMAP	Mao and Talbot (2004a)	x							
AIRMAP	Mao and Talbot (2004b)	x							x
AIRMAP	Mao and Talbot (2012)	x	x						
AIRMAP	Mao et al. (2012)	x	x						
AIRMAP	Place et al. (2010)		x						
AIRMAP	Sigler et al. (2009)	x							
AIRMAP	Talbot et al. (2005)	x							
AIRMAP	Ziemba et al. (2006)		x						
AIRMAP	Ziemba et al. (2011)		x						
Bermuda	Ahmad et al. (2010)		x					x	
Bermuda	Allen et al. (1996)							x	
Bermuda	Altieri et al. (2013)			x					
Bermuda	Altieri et al. (2014)			x					
Bermuda	Altieri et al. (2016)		x	x		x			
Bermuda	Anderson et al. (1996)		x						
Bermuda	Arimoto et al. (1992)		x						
Bermuda	Arimoto et al. (1995)		x						
Bermuda	Arimoto et al. (1997)		x						
Bermuda	Arimoto et al. (1999)		x						
Bermuda	Arimoto (2001)		x						
Bermuda	Arimoto et al. (2002)		x					x	
Bermuda	Arimoto et al. (2003)		x						
Bermuda	Aryal et al. (2014)		x						
Bermuda	Babin et al. (2004)				x		x		
Bermuda	Baker and Hites (1999)	x							
Bermuda	Bates and Peters (2007)						x		
Bermuda	Benetti et al. (2017)	x							
Bermuda	Bergamaschi et al. (2009)							x	
Bermuda	Berkelhammer et al. (2016)	x							
Bermuda	Black and Dickey (2008)				x				
Bermuda	Bonne et al. (2015)								x
Bermuda	Boylan et al. (2015)	x							
Bermuda	Chen and Duce (1983)	x							
Bermuda	Chen et al. (2009)			x					
Bermuda	Chevallier et al. (2010)	x							
Bermuda	Church et al. (1982)			x					
Bermuda	Church et al. (1984)			x					

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
Bermuda	Colle et al. (1995)		x						
Bermuda	Conte and Weber (2002a)		x						
Bermuda	Conte and Weber (2002b)		x						
Bermuda	Cooper et al. (1998)	x							
Bermuda	Cornell et al. (1995)			x					
Bermuda	Cornell et al. (1998)			x					
Bermuda	Cutter (1993)			x					
Bermuda	Dickey et al. (1998)				x		x		
Bermuda	Ellis et al. (1993)		x						
Bermuda	Ennis and Sievering (1990)		x						
Bermuda	Fishwick et al. (2014)						x		
Bermuda	Galloway et al. (1982)			x					
Bermuda	Galloway et al. (1988a)			x					
Bermuda	Galloway et al. (1989)			x					
Bermuda	Galloway et al. (1993)		x	x		x			
Bermuda	Gawor et al. (2014)	x							
Bermuda	Genualdi et al. (2010)	x						x	
Bermuda	Gichuki and Mason (2014)	x	x						
Bermuda	Gobel et al. (2013)		x	x					
Bermuda	Guishard et al. (2007)				x				
Bermuda	Harner et al. (2006)	x						x	
Bermuda	Hastings et al. (2003)			x					
Bermuda	Hirsch et al. (2006)						x		
Bermuda	Hoffman and Duce (1976)		x				x		
Bermuda	Hoffman and Duce (1977)		x						
Bermuda	Hoffman et al. (1977)		x						
Bermuda	Holmes and Miller (2004)		x						
Bermuda	Huang et al. (1996)		x						
Bermuda	Huang et al. (1997)		x					x	
Bermuda	Huang et al. (1999)		x						
Bermuda	Hutter et al. (1995)		x						
Bermuda	Jickells et al. (1982)			x					
Bermuda	Jickells et al. (1990)						x		
Bermuda	Jickells et al. (1992)			x					
Bermuda	Jickells et al. (1994)		x	x			x		
Bermuda	Jickells et al. (1998)		x	x			x		
Bermuda	Kadko and Prospero (2011)			x			x		
Bermuda	Kadko et al. (2015)			x			x	x	
Bermuda	Keene and Savoie (1998)		x						
Bermuda	Keene et al. (1986)			x				x	
Bermuda	Keene et al. (2002a)		x						
Bermuda	Keene et al. (2007a)		x				x		
Bermuda	Keene et al. (2014)		x	x					
Bermuda	Keene et al. (2015)			x					
Bermuda	Kim et al. (1999)			x					
Bermuda	Kim et al. (2019)				x	x			
Bermuda	Knapp et al. (2010)			x			x		
Bermuda	Koblizkova et al. (2012a)	x						x	
Bermuda	Koblizkova et al. (2012b)	x						x	

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
Bermuda	Koch et al. (2009)				x		x		
Bermuda	Lee et al. (2007)	x							
Bermuda	Lim et al. (1994)			x					
Bermuda	Lin et al. (2012)		x						
Bermuda	Lomas et al. (2009)				x		x		
Bermuda	Lomas et al. (2013)						x		
Bermuda	Mackey et al. (2012a)		x				x		
Bermuda	Mackey et al. (2012b)		x				x		
Bermuda	MacLeod et al. (2013)	x							
Bermuda	Mahowald et al. (1997)		x					x	
Bermuda	Maring and Schwartze (1994)		x					x	
Bermuda	McInnes et al. (2013)						x		
Bermuda	Mead et al. (2013)		x						
Bermuda	Merrill (1994)								x
Bermuda	Merrill et al. (1996)	x							x
Bermuda	Michaels et al. (1993)			x			x		
Bermuda	Michaels and Knap (1996)						x		
Bermuda	Miller and Harris (1985)								x
Bermuda	Miller et al. (2013)				x				
Bermuda	Milne et al. (2000)	x							
Bermuda	Moody and Galloway (1988)			x					
Bermuda	Moody et al. (1995)	x							x
Bermuda	Moody et al. (2014)		x						x
Bermuda	Muhs et al. (2012)		x						
Bermuda	Nelson (1998)				x		x		
Bermuda	Oltmans and Levy (1992)	x							
Bermuda	Oltmans and Levy (1994)	x							
Bermuda	Oltmans et al. (2006)	x							
Bermuda	Oltmans et al. (2013)	x							
Bermuda	Orcutt et al. (2001)						x		
Bermuda	Panshin and Hites (1994)	x							
Bermuda	Parrish et al. (2016)	x							
Bermuda	Petron et al. (2002)	x						x	
Bermuda	Pozo et al. (2006)	x							
Bermuda	Pozo et al. (2009)	x							
Bermuda	Prados et al. (1999)	x							
Bermuda	Rigby et al. (2010)	x							
Bermuda	Robertson et al. (2005)	x						x	
Bermuda	Saikawa et al. (2014)	x						x	
Bermuda	Savoie et al. (2002)		x						
Bermuda	Sedwick et al. (2007)		x				x		
Bermuda	Shelley et al. (2012)		x				x		
Bermuda	Shoeib et al. (2010)	x							
Bermuda	Sholkovitz and Sedwick (2006)		x					x	
Bermuda	Sholkovitz et al. (1993)		x	x					
Bermuda	Sholkovitz et al. (2009)		x				x		
Bermuda	Sholkovitz et al. (2010)		x	x					
Bermuda	Sholkovitz et al. (2012)		x						
Bermuda	Shunthirasingham et al. 2010	x							
Bermuda	Smirnov et al. (2003)							x	

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
Bermuda	Steen-Larsen et al. (2014)	x						x	
Bermuda	Steinberg et al. (2001)						x		
Bermuda	Tarasova et al. (2007)	x							
Bermuda	Thompson et al. (2014)	x						x	
Bermuda	Tian et al. (2008)		x	x			x		
Bermuda	Todd et al. (2003)		x	x		x			
Bermuda	Tomza et al. (2001)		x					x	
Bermuda	Turekian et al. (2001)		x						
Bermuda	Turekian et al. (2003)		x						
Bermuda	Turner et al. (2016)	x							
Bermuda	Veron et al. (1992)		x	x					
Bermuda	Veron et al. (1993)			x			x		
Bermuda	Veron et al. (1998)			x			x		
Bermuda	Volpe and Spivack (1994)		x						
Bermuda	Waser and Bacon (1995)			x					
Bermuda	Witek et al. (2013)		x					x	
Bermuda	Wolff et al. (1986)	x	x						
Bermuda	Zedler et al. (2002)				x		x		
Bermuda	Zhou et al. (2008)		x				x		
CASP	Stewart 1991				x				
CITE 3	Anderson et al. (1993)	x	x						
CITE 3	Andreae et al. (1993)	x							
CITE 3	Cooper and Saltzman (1993)	x							
CITE 3	Ferek and Hegg (1993)	x							
CITE 3	Hoell et al. (1993)	x						x	
CITE 3	Matrai et al. (1993)	x							
CITE 3	Shipham et al. (1993)								x
CLAMS	Castanho et al. (2005)		x						
CLAMS	Chowdhary et al. (2005)		x					x	
CLAMS	Gatebe et al. (2005)		x					x	
CLAMS	Jin et al. (2005)							x	
CLAMS	Kahn et al. (2005)		x					x	
CLAMS	Levy et al. (2005)		x					x	
CLAMS	Magi et al. (2005)		x					x	
CLAMS	Redemann et al. (2005)		x					x	
CLAMS	Reidmiller et al. (2006)		x					x	
CLAMS	Remer et al. (2005)		x					x	
CLAMS	Smith et al. (2005a)		x					x	
CLAMS	Smith et al. (2005b)	x						x	
CLIMODE	Andersson et al. (2013)						x		
CONTRACE	Huntrieser et al. (2005)	x							
COVE	Jin et al. (2002)							x	
COVE	Jin et al. (2004)							x	
COVE	Kato et al. (2002)							x	
COVE	Kratz et al. (2010)							x	
COVE	Martins et al. (2009)							x	
COVE	Rutledge et al. (2006)							x	
COVE	Su et al. (2002)							x	
COVE	Zibordi et al. (2006)							x	
COVE	Zibordi et al. (2009)							x	

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
DISCOVER-AQ	Anderson et al. (2014)	x							
DISCOVER-AQ	Beyersdorf et al. (2016)		x						
DISCOVER-AQ	Brent et al. (2015)	x						x	
DISCOVER-AQ	Cheng et al. (2017)	x							
DISCOVER-AQ	Cheng et al. (2018)	x						x	
DISCOVER-AQ	Chu et al. (2015)		x					x	
DISCOVER-AQ	Compton et al. (2013)								x
DISCOVER-AQ	Crumeyrolle et al. (2014)		x						
DISCOVER-AQ	Follette-Cook et al. (2015)	x						x	
DISCOVER-AQ	Garner et al. (2015)	x						x	
DISCOVER-AQ	Goldberg et al. (2014)	x						x	
DISCOVER-AQ	Halliday et al. (2015)	x							
DISCOVER-AQ	He et al. (2014)	x							
DISCOVER-AQ	Hegarty et al. (2018)							x	x
DISCOVER-AQ	Knepp et al. (2015)	x						x	
DISCOVER-AQ	Lee et al. (2018)	x	x						
DISCOVER-AQ	Li et al. (2017)	x							
DISCOVER-AQ	Martins et al. (2015)	x						x	
DISCOVER-AQ	Mazzuca et al. (2017)	x							
DISCOVER-AQ	Munchak et al. (2013)		x					x	
DISCOVER-AQ	Reed et al. (2015)	x	x					x	
DISCOVER-AQ	Sawamura et al. (2014)		x					x	
DISCOVER-AQ	Simon et al. (2018)	x						x	
DISCOVER-AQ	Thompson et al. (2015)	x							
DISCOVER-AQ	Tzortziou et al. (2015)	x							
DISCOVER-AQ	Zhang et al. (2016)	x						x	
DISCOVER-AQ	Ziemba et al. (2013)		x					x	
EMEFS	MacDonald et al. (1993)	x						x	
EMEFS	McNaughton and Vet (1996)	x	x	x					
EOPACE	Reid et al. (2001)		x						
EOPACE	Zielinski and Piskozub (2005)		x						
ERICA	Hadlock and Kreitzberg (1988)				x				x
ERICA	Lackmann et al. (1997)								x
ERICA	Lackmann et al. (1999)								x
ERICA	Neiman and Shapiro (1993)				x		x		x
ERICA	Neiman et al. (1993)				x		x		x
ERICA	Schultz et al. (1998)				x		x		x
FAMS	Gill et al. (1995)	x							
FAMS	Guentzel et al. (1998)		x	x					
FAMS	Guentzel et al. (2001)		x	x					
FAMS	Landing et al. (1995)			x					
FAMS	Landing et al. (1998)		x	x				x	
FAMS	Pai et al. (1997)	x	x	x				x	
FAMS	Pollman et al. (1995)	x	x	x					
FAMS	Prospero and Landing (2009)		x	x					
FAMS	Prospero et al. (2010)		x	x					
FASINEX	Charnock and Businger (1991)				x		x		x
FASINEX	Stage and Weller (1985)				x		x		x
FASINEX	Stage and Weller (1986)				x		x		x
FASINEX	Weller (1991)				x		x		x

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
FASINEX	Weller et al. (1995)				x		x		x
GALE	Bane and Osgood (1989)						x		x
GALE	Blanton et al. (1989)						x		x
GALE	Boers et al. (1991)				x		x	x	x
GALE	Chang and Holt (1994)				x			x	x
GALE	Chou and Ferguson (1991)				x		x		x
GALE	Davis et al. (1991)						x		x
GALE	Dirks et al. (1988)				x		x		x
GALE	Grossman and Betts (1990)				x		x		x
GALE	Guishard et al. (1991)				x		x		x
GALE	Huang and Raman (1991)				x		x	x	x
GALE	Huang and Raman (1992)				x		x	x	x
GALE	Raman and Riordan (1988)				x		x		x
GALE	Vukovich et al. (1991)				x		x		x
GALE	Wayland and Raman (1989)				x		x		x
GCE/CASE/WATOX	Bardwell et al. (1990)	x	x					x	
GCE/CASE/WATOX	Church et al. (1990)		x	x					
GCE/CASE/WATOX	Gallagher et al. (1990)	x							
GCE/CASE/WATOX	Galloway et al. (1990)	x	x	x					
GCE/CASE/WATOX	Gorzelska and Galloway (1990)		x	x					
GCE/CASE/WATOX	Hansen et al. (1990)		x						
GCE/CASE/WATOX	Hastie et al. (1990)	x	x						
GCE/CASE/WATOX	Hitchcock et al. (1990)			x			x		
GCE/CASE/WATOX	Keene et al. (1990)	x	x						
GCE/CASE/WATOX	Kim et al. (1990)		x						
GCE/CASE/WATOX	Kopcewica et al. (1991)		x						
GCE/CASE/WATOX	Luria and Sievering (1991)	x						x	
GCE/CASE/WATOX	Luria et al. (1990)	x							
GCE/CASE/WATOX	Piotrowicz et al. (1990)	x							
GCE/CASE/WATOX	Pszenny et al. (1990a)	x	x	x			x		
GCE/CASE/WATOX	Pszenny et al. (1990b)	x	x	x					
GCE/CASE/WATOX	Ray et al. (1990a)	x							
GCE/CASE/WATOX	Ray et al. (1990b)	x							
GCE/CASE/WATOX	Reddy et al. (1990)		x						
GCE/CASE/WATOX	Sievering et al. (1990)		x						
GCE/CASE/WATOX	Sievering et al. (1991)	x	x						
GCE/CASE/WATOX	Stunder et al. (1990)								x
GCE/CASE/WATOX	Whelpdale et al. (1990)	x	x						
GOMECC	Helmig et al. (2012)	x					x		
GOMECC	Hu et al. (2010)	x					x		
GOMECC	Liu et al. (2011)	x					x		
GPCP	Galloway et al. (1983)			x					
IAGOS	Berkes et al. (2017)								x
IAGOS	Cohen et al. (2018)	x							
IAGOS	Fischbeck et al. (2017)	x							
IAGOS	Gaudel et al. (2018)	x						x	
IAGOS	Gressent et al. (2014)	x							
IAGOS	Heintzenberg et al. (2011)		x						
IAGOS	Hermann et al. (2008)		x						
IAGOS	Marenco et al. (1998)	x							
IAGOS	Petetin et al. (2018)	x							
IAGOS	Petzold et al. (2015)	x	x						
IAGOS	Petzold et al. (2017)				x				

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
IAGOS	Slemr et al. (2018)	x							
IAGOS	Stratmann et al. (2016)	x							
IAGOS	Trickl et al. (2003)	x							
IAGOS	Weigelt et al. (2009)					x			
IAGOS	Wisher et al. (2014)	x							
ICARTT	Ambrose et al. (2007)	x							
ICARTT	Angevine et al. (2006)								x
ICARTT	Avey et al. (2007)					x			
ICARTT	Bahadur et al. (2010)		x						
ICARTT	Bates et al. (2006)		x					x	
ICARTT	Brown et al. (2005)	x							
ICARTT	Brown et al. (2006a)	x	x						
ICARTT	Brown et al. (2006b)	x							
ICARTT	Cain et al. (2012)	x						x	
ICARTT	Chen et al. (2006)	x	x	x				x	
ICARTT	Clarke et al. (2007)		x						
ICARTT	Cook et al. (2007)	x	x					x	
ICARTT	Davis et al. (2014)	x							
ICARTT	de Gouw et al. (2006)	x	x			x			
ICARTT	Drury et al. (2010)		x					x	
ICARTT	Fairall et al. (2006)					x			x
ICARTT	Fehsenfeld et al. (2006)	x	x						
ICARTT	Fischer et al. (2006)	x	x						
ICARTT	Fried et al. (2008)		x					x	
ICARTT	Frost et al. (2006)	x							
ICARTT	Fuehlberg et al. (2007)								x
ICARTT	Garrett et al. (2006)	x	x			x			
ICARTT	Gilardoni et al. (2007)		x						
ICARTT	Griffin et al. (2007)	x							
ICARTT	Heald et al. (2006)		x					x	
ICARTT	Herndon et al. (2007)	x						x	
ICARTT	Hudman et al. (2007)	x						x	
ICARTT	Hudman et al. (2008)	x						x	
ICARTT	Jimenez et al. (2005)	x						x	
ICARTT	Keene et al. (2007b)	x	x						
ICARTT	Kim et al. (2008)	x							
ICARTT	Lee et al. (2011)	x						x	
ICARTT	Lewis et al. (2007)	x	x						
ICARTT	Mao et al. (2006)	x							
ICARTT	Martin et al. (2006)	x						x	
ICARTT	McKeen et al. (2005)	x						x	
ICARTT	McKeen et al. (2007)		x					x	
ICARTT	Medina et al. (2007)		x			x			
ICARTT	Methven et al. (2006)	x						x	
ICARTT	Millet et al. (2006)	x	x						
ICARTT	Murphy et al. (2006)		x						
ICARTT	Neuman et al. (2006)	x							
ICARTT	Nowak et al. (2007)	x						x	
ICARTT	Osthoff et al. (2006a)	x							
ICARTT	Osthoff et al. (2006b)	x						x	

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
ICARTT	Pagowski and Grell (2006)	x						x	
ICARTT	Pagowski et al. (2005)	x						x	
ICARTT	Pechtl and von Glasow (2007)	x							
ICARTT	Peltier et al. (2007)		x						
ICARTT	Pikelnaya et al. (2007)	x						x	
ICARTT	Pszenny et al. (2007)	x							
ICARTT	Quinn et al. (2006)		x						
ICARTT	Real et al. (2007)	x						x	
ICARTT	Reeves et al. (2007)	x						x	
ICARTT	Riddle et al. (2006)							x	x
ICARTT	Russell et al. (2007)		x						
ICARTT	Sierau et al. (2006)		x						
ICARTT	Singh et al. (2006)	x	x						
ICARTT	Sinreich et al. (2007)	x						x	
ICARTT	Sive et al. (2005)	x						x	
ICARTT	Smith et al. (2007)	x	x						
ICARTT	Snow et al. (2007)	x							
ICARTT	Sommariva et al. (2011)	x						x	
ICARTT	Stutz et al. (2007)	x							
ICARTT	Sullivan et al. (2006)		x					x	
ICARTT	Thompson et al. (2007a)	x							
ICARTT	Thompson et al. (2007b)	x							
ICARTT	Thornhill et al. (2008)		x						
ICARTT	Vandemark et al. (2016)		x						
ICARTT	Warneke et al. (2005)	x						x	
ICARTT	Warneke et al. (2006)	x						x	
ICARTT	White et al. (2006)							x	x
ICARTT	White et al. (2008)	x							
ICARTT	Wilczak et al. (2006)							x	
ICARTT	Williams et al. (2006a)		x					x	
ICARTT	Williams et al. (2006b)	x						x	
ICARTT	Williams et al. (2007)		x						
ICARTT	Wolfe et al. (2007)								x
ICARTT	Yu et al. (2007)	x						x	x
ICARTT	Yu et al. (2010)	x						x	
ICARTT	Ziemba et al. (2007)		x						
ICARTT/NEAQS 2002	Parrish et al. (2007)	x						x	
ICARTT/NEAQS 2002	White et al. (2007)	x							x
ICEALOT	Frossard et al. (2011)		x						
ICEALOT	Lapina et al. (2011)		x					x	
ICEALOT	Russell et al. (2010)		x						
ICEALOT/WACS/NAAMES	Quinn et al. (2017)		x						
MASEX	Bechtold et al. (1992)				x		x	x	x
MASEX	Boers and Melfi (1987)				x		x	x	x
MASEX	Melfi et al. (1985)				x			x	x
MASEX	Raasch (1990)				x			x	x
Misc	Alliss and Raman (1995a)				x				x
Misc	Alliss and Raman (1995b)				x				x
Misc	Appenzeller et al. (2000)	x							x
Misc	Atlas et al. (1983)				x				

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
Misc	Babin et al. (2003)				x				
Misc	Baker et al. (2017)		x					x	
Misc	Beattie and Whelpdale (1989)			x					x
Misc	Beaupré et al. (2019)		x				x		
Misc	Benitez-Nelson and Buesseler (1999)			x					
Misc	Bernhardt and DeGaetano (2012)				x				
Misc	Berresheim et al. (1991)	x	x	x					
Misc	Booth et al. (2012)					x			
Misc	Bosart (1981)				x				
Misc	Brennan and Lackmann (2005)				x				
Misc	Brice et al. (1988)	x							
Misc	Bulgin et al. (2008)					x			
Misc	Bunker (1976)						x		x
Misc	Bunker and Worthington (1976)						x		x
Misc	Businger (1995)								x
Misc	Carson (1950)				x		x		x
Misc	Cerveny and Balling (1998)					x			
Misc	Charles and Colle (2009a)				x			x	
Misc	Charles and Colle (2009b)				x			x	
Misc.	Chelton et al. (2004)						x		
Misc	Chou and Atlas (1982)				x		x		x
Misc	Christoudias et al. (2012)	x							x
Misc	Church et al. (1991)	x	x	x					
Misc	Cione et al. (1993)				x		x		x
Misc	Cogbill and Likens (1974)			x					
Misc	Colarco et al. (2014)		x						
Misc	Cooper et al. (1987)	x							
Misc	Creilson et al. (2003)	x							x
Misc	Crespo and Posselt (2016)				x				x
Misc	DeGaetano et al. (2002)				x				
Misc	De Mello et al. (1987)	x							
Misc	Dreessen et al. (2019)	x							
Misc	Driscoll et al. (2001)	x	x	x					
Misc	Eckhardt et al. (2003)	x							x
Misc	Engstrom et al. (2015)					x			
Misc	Evans and Jurewicz (2009)				x				
Misc	Feng et al. (2019)		x	x					
Misc	Fitzgerald et al. (1998)		x					x	
Misc	Fletcher et al. (2016a)				x		x		x
Misc	Fletcher et al. (2016b)				x		x		x
Misc	Frossard et al. (2019a)		x				x		
Misc	Frossard et al. (2019b)		x				x		
Misc	Gall and Johnson (1971)						x		x
Misc	Galloway et al. (1976)			x					
Misc	Ganetis and Colle (2015)				x				
Misc	Ganguly et al. (2009)		x					x	
Misc	Geerts and Hobbs (1991)				x			x	
Misc	Gettelman and Sherwood (2016)					x			
Misc	Greybush et al. (2017)					x		x	
Misc	Griffin et al. (2014)				x			x	

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
Misc	Hall and Booth (2017)				x		x	x	x
Misc	Harriss et al. (1984)	x	x					x	
Misc	Hegarty et al. (2010)	x							
Misc	Hirsch et al. (2001)				x				
Misc	Hoppel et al. (1984)		x						
Misc	Hoppel et al. (1985)		x						
Misc	Hurrell 1995								x
Misc	Husar et al. (1981)		x						
Misc	Husar et al. (1997)		x					x	
Misc	Ichiye and Zipser (1967)						x		x
Misc	Ignatov et al. (1995)		x					x	
Misc	Jones et al. (2009)					x			
Misc	Jongeward et al. (2016)		x						
Misc	Jordan et al. (2000)	x	x	x					
Misc	Kacenelenbogen et al. (2011)		x					x	
Misc	Kaufman et al. (2005)					x			
Misc	Keene et al. (1993)	x						x	
Misc	Keene et al. (2002b)			x				x	
Misc	Keim et al. (2005)		x						x
Misc	Kelleher and Feder (1978)	x	x					x	
Misc	Kessner et al. (2013)		x					x	
Misc	Kieber et al. (1999)			x					
Misc	Krabbenhoft et al. (1998)	x	x				x		
Misc	Kumjian and Lombardo (2017)				x			x	
Misc	Leibensperger et al. (2012a)		x						
Misc	Leibensperger et al. (2012b)		x						
Misc	Lewis et al. (2010)		x					x	
Misc	Li et al. (2002)	x							
Misc	Li et al. (2004a)				x		x		
Misc	Li et al. (2005)	x	x					x	
Misc	Likens and Bormann (1974)			x					
Misc	Likens et al. (1972)			x					
Misc	Lindner and Frysinger (2007)			x					
Misc	Liu et al. (2001)	x	x					x	
Misc	Liu et al. (2004)				x		x		
Misc	Lombardo et al. (2015)				x			x	
Misc	Long et al. (2009)				x			x	x
Misc	Loughner et al. (2016)		x						
Misc	Luan and Jaegle (2013)		x						x
Misc	Lukashin et al. (2000)		x						
Misc	Martin et al. (1990)				x				
Misc	McPherson et al. (2010)		x					x	
Misc	Meskhidze et al. (2019)		x						
Misc	Mesias et al. (2007)								x
Misc	Miller (1946)				x			x	x
Misc	Molthan et al. (2016)				x			x	
Misc	Moore et al. (2013)					x			
Misc	Muhs et al. (2007)		x	x					
Misc	Mullaugh et al. (2014)			x					
Misc	Nicosia and Grumm (1999)				x			x	
Misc	Novak and Colle (2012)				x			x	
Misc	Novak et al. (2004)				x				

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
Misc	Novak et al. (2006)				x			x	
Misc	Novak et al. (2008)				x			x	
Misc	Novak et al. (2010)				x				
Misc	Orton et al. (2016)				x				
Misc	Painemal et al. (2019)		x					x	
Misc	Park and Leovy (2004)				x		x		x
Misc	Peyridieu et al. (2010)		x					x	
Misc	Phillips et al. (2018)		x						
Misc	Picca et al. (2014)				x			x	
Misc	Plant et al. (2019)	x							
Misc	Powell et al. (2009)		x					x	
Misc	Pringle et al. (2010)		x						
Misc	Prospero (1999)		x	x					
Misc	Prospero and Carlson (1971)		x						
Misc	Prospero et al. (1987)			x					
Misc	Prospero et al. (2001)		x						
Misc	Pszenny et al. (1993)	x							
Misc	Raymond (2005)			x					
Misc	Reed et al. (1992)				x				
Misc	Richter et al. (1983)			x					
Misc	Robson et al. (2018)	x	x						x
Misc	Rogers et al. (2011)		x					x	
Misc	Rogers et al. (2014)		x					x	
Misc	Rogers et al. (2019)	x	x						
Misc	Root et al. (2007)				x			x	
Misc	Russell et al. (2003)	x	x						
Misc	Sanders (1986)				x				
Misc	Sanders and Bosart (1985)				x				
Misc	Sanders and Gyakum (1980)				x			x	
Misc	Savoie and Prospero (1977)		x						
Misc	Savoie et al. (1987)	x							
Misc	Scott et al. (2003)				x				
Misc	Scudlark et al. (1998)			x				x	
Misc	Serra et al. (2014)		x						x
Misc	Sethuraman et al. (1986)						x		x
Misc	Sharma et al. (1999)	x					x	x	
Misc	Siddique et al. (2015)				x			x	
Misc	Sienkiewicz et al. (1989)				x				
Misc	Smith et al. (2001)	x							
Misc	Song et al. (2011)	x							
Misc	Spicer (1982)	x							
Misc	Stauffer and Thompson (2015)	x							x
Misc	Sublette et al. (1996)						x		
Misc	Sweet et al. (1981)						x		x
Misc	Trapp et al. (2010)		x						
Misc	Uccellini et al. (1987)				x				
Misc	Warnecke et al. (1971)						x		
Misc	Wedam et al. (2009)								x
Misc	Wei et al. (2018)				x		x		x
Misc	Woods and Osborn (2001)		x						
Misc	Yoon et al. (2014)		x					x	
Misc	Young and Sikora (2003)				x				
Misc	Yu et al. (2004)						x	x	
Misc	Zamora et al. (2013)		x	x					
Misc	Zeller et al. (1977)	x							x

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
Misc	Zhang et al. (2002)				x			x	
Misc	Zhang et al. (2019)		x						
Misc	Zhao et al. (2008)		x					x	
Misc	Zhu and Kieber (2019)						x		
Misc	Zhu et al. (2019)	x							
Misc	Zuidema et al. (2019)		x						
NAAMES	Behrenfeld et al. (2019)	x	x			x	x		
NAAMES	Sanchez et al. (2018)		x			x			
NARE	Angevine et al. (1996)								x
NARE	Audiffren et al. (2004)	x	x			x			
NARE	Banic et al. (1996)	x	x						
NARE	Berkowitz et al. (1995)	x							
NARE	Buhr et al. (1996)	x	x						
NARE	Cooper et al. (2001)	x							x
NARE	Cooper et al. (2002a)	x							
NARE	Cooper et al. (2002b)	x							
NARE	Doran et al. (1996)	x							x
NARE	Fast and Berkowitz (1996)	x						x	x
NARE	Fast and Berkowitz (1997)	x						x	x
NARE	Fehsenfeld et al. (1996)	x	x						
NARE	Fried et al. (2002)	x						x	
NARE	Frost et al. (2002)	x						x	
NARE	Kleinman et al. (1998)	x						x	
NARE	Knapp et al. (1998a)	x							
NARE	Knapp et al. (1998b)	x						x	
NARE	Leaitch et al. (1996)					x			
NARE	Li et al. (2004b)	x						x	
NARE	Lin et al. (1998)	x						x	
NARE	McCaffery et al. (2004)	x						x	
NARE	Merrill and Moody (1996)							x	x
NARE	Moody et al. (1996)	x							x
NARE	Parrish et al. (1998)	x							
NARE	Parrish et al. (2000)	x							x
NARE	Ray et al. (1996)	x							
NARE	Roberts et al. (1996)	x							
NARE	Roberts et al. (1998)	x							
NARE	Spicer et al. (1996)	x						x	
NARE	Stohl et al. (2002)	x							
NARE	Stohl et al. (2004)							x	
NARE	Tanner et al. (1996)	x							
NARE	Wang et al. (1996)	x							
NARE	WeinsteinLloyd et al. (1996)	x							
NARE	Wild et al. (1996)	x							x
NARE	Zaucker al al. (1996)	x	x						
NARSTO-Northeast	Seaman and Michelson (2000)	x							x
NARSTO-Northeast	Zhang et al. (1998)	x							x
NEAQS 2002	Aldener et al. (2006)	x	x						
NEAQS 2002	Bates et al. (2005)		x						
NEAQS 2002	de Gouw et al. (2003)	x						x	
NEAQS 2002	de Gouw et al. (2005)	x	x						x

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
NEAQS 2002	Dibb et al. (2004)	x							
NEAQS 2002	Goldan et al. (2004)	x							
NEAQS 2002	Griffin et al. (2004)	x							
NEAQS 2002	Keene et al. (2004)	x	x						
NEAQS 2002	Quinn and Bates (2005)		x						
NEAQS 2002	Stark et al. (2007)	x							
NEAQS 2002	Yu et al. (2006)	x						x	
NEAQS 2002	Zhou et al. (2005)	x							
NODEM	Wadleigh (2004)		x						
OWLETS	Dacic et al. (2019)	x						x	
OWLETS	Farris et al. (2019)	x						x	
OWLETS	Gronoff et al. (2019)	x						x	
OWLETS	Sullivan et al. (2019)	x	x						
RAMMPP	Chen et al. (2001)	x	x						
RAMMPP	Chen et al. (2003)		x						
RAMMPP	Dickerson et al. (1995)	x							
RAMMPP	Hains et al. (2008)	x	x					x	
RAMMPP	Taubman et al. (2004)	x	x						
RAMMPP	Taubman et al. (2006)	x	x						x
RAMMPP	Vant-Hull et al. (2005)	x						x	
SABOR	Hair et al. (2016)		x					x	
SABOR	Ottaviani et al. (2018)							x	
SABOR	Stamnes et al. (2018)		x					x	
SCAR-A	Hegg et al. (1995)		x						
SCAR-A	Remer et al. (1997)		x					x	
SCAR-A/TARFOX	Soulen et al. (2000)							x	
SOLAS	Leaitch et al. (2010)					x			
SONEX/POLINAT 2	Dibb et al. (2000)	x	x						
SONEX/POLINAT 2	Fuehlberg et al. (2000)								x
SONEX/POLINAT 2	Grant et el. (2000)	x							x
SONEX/POLINAT 2	Jeker et al. (2000)	x							
SONEX/POLINAT 2	Paladino et al. (2000)		x						
SONEX/POLINAT 2	Schlager et al. (1997)	x	x						
SONEX/POLINAT 2	Singh et al. (1999)	x	x						
SONEX/POLINAT 2	Singh et al. (2000)	x							
SONEX/POLINAT 2	Singh et al. (2002)	x	x						
SONEX/POLINAT 2	Thompson et al. (1999)	x	x						
SONEX/POLINAT 2	Wang et al. (2000)		x						
SURE	Blumenthal et al. (1984)	x	x						
SURE	Perhac (1978)	x	x						
SURE	Shreffler and Barnes (1992)	x	x						
TARFOX	Bergstrom and Russell (1999)		x					x	
TARFOX	Durkee et al. (2000)		x						
TARFOX	Ferrare et al. (2000)	x	x						
TARFOX	Hartley and Hobbs (2001)	x						x	
TARFOX	Hartley et al. (2000)		x					x	
TARFOX	Hegg et al. (1997)		x					x	
TARFOX	Hignett et al. (1999)	x						x	
TARFOX	Hobbs (1999)		x						
TARFOX	Ismail et al. (2000)	x	x					x	
TARFOX	Kotchenruther et al. (1999)		x						

Campaign	Reference	Gas	Aerosol	Wet Dep	Clouds	ACI	Air-Sea	Dev't/Val	Met
TARFOX	Novakov et al. (1997)		x						
TARFOX	Redemann et al. (2000)		x					x	
TARFOX	Remer et al. (1999)		x						
TARFOX	Russell et al. (1999)		x						
TARFOX	Russell et al. (2002)		x					x	
TARFOX	Smirnov et al. (2000)		x					x	
TARFOX	Tanre et al.(1999)		x					x	
TARFOX	Veefkind et al. (1999)		x					x	
TCAP	Berg et al. (2016)		x						
TCAP	Fast et al. (2016)		x					x	x
TCAP	Kassianov et al. (2012)		x					x	
TCAP	Kassianov et al. (2014)		x					x	
TCAP	Kassianov et al. (2015)		x					x	
TCAP	Kassianov et al. (2018)		x					x	
TCAP	Lamer et al. (2014)				x			x	
TCAP	Liu and Li (2019)					x			
TCAP	Muller et al. (2014)		x					x	
TCAP	Niple et al. (2016)				x			x	
TCAP	Shinozuka et al. (2013)		x					x	
TCAP	Shinozuka et al. (2015)		x					x	
TCAP	Titos et al. (2014)		x						
WACS	Frossard et al. (2014)		x				x		
WACS	Kawamura et al. (2017)		x						
WACS	Keene et al. (2017)		x				x		
WACS	Kieber et al. (2016)		x				x		
WACS	Long et al. (2014)		x				x		
WACS	Quinn et al. (2014)		x						
WACS II	Aller et al. (2017)		x				x		
WATOX	Artz and Stunder (1987)								x
WATOX	Boatman et al. (1988)	x						x	
WATOX	Bottonheim and Gallant (1987)	x							
WATOX	Bridgman and Sievering (1988)		x						
WATOX	Bridgman et al. (1988)	x	x						
WATOX	Cahill (1988)		x						
WATOX	Galloway and Whelpdale (1987)	x	x						
WATOX	Galloway et al. (1988b)	x	x						
WATOX	Hansen and Novakov (1988)		x						
WATOX	Hastie et al. (1988a)	x	x					x	
WATOX	Hastie et al. (1988b)	x	x						
WATOX	Heikes et al. (1988)	x							
WATOX	Khalil and Rasmussen (1988)	x							
WATOX	Luke and Dickerson (1987)	x							
WATOX	Pueschel et al. (1988)		x						
WATOX	Schnell et al. (1987)	x	x						
WATOX	Stunder et al. (1987)								x
WATOX	Whelpdale et al. (1987)	x	x						
WINTER	Guo et al. (2016)		x						
WINTER	Haskins et al. (2019)	x	x						
WINTER	Salmon et al. (2018)	x						x	
WINTER	Schroder et al. (2018)	x	x					x	
WINTER	Shah et al. (2018)	x	x						
WINTER	Shah et al. (2019)		x						
WINTER	Sullivan et al. (2019)	x	x					x	
WINTER	Wang et al. (2019)	x							

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