

## Supplemental Material for Contrasting Local and Long-Range Transported Warm Ice-Nucleating Particles During an Atmospheric River in Coastal California, USA.

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### 1. Supplemental ATOFMS Analysis of Precipitation Methods

The size-resolved single particle mixing state of precipitation sample residues was measured using an ATOFMS (E. Gard et al., 1997). Samples were aerosolized using a collision-style nebulizer and dried using two silica diffusion driers. Samples were stirred using a magnetic stir bar to ensure that insoluble particles had not settled and were being aerosolized. Temporally adjacent precipitation samples were combined to obtain the requisite sample volume for use with the atomizer (75-100 mL), but samples were not combined across kinematic period boundaries. Single particle spectra and size data were imported into Matlab (The MathWorks, Inc.) and analyzed via the software toolkit FATES (Sultana, Cornwell, et al., 2017). Particles were divided into clusters based on their mass spectral features via an adaptive neural network and recombined based upon their characteristic mass spectra and size distributions (Rebotier & Prather, 2007; Song et al., 1999). Particles were separated into 4 different classes based upon previous ATOFMS lab and field studies: biomass burning (BB), organic carbon (OC), dust, and biological particles (Bio). Table SM1 below shows the representative peaks and literature references associated with each particle type.

Table SM1: Insoluble residue particle types identified using ATOFMS/FATES.

Particle type	Characteristic ion markers
Biomass burning (BB)	Intense $^{39}\text{K}^+$ and $^{97}\text{HSO}_4^-$ , minor contributions from $^{12}\text{C}^+$ , $^{26}\text{CN}^-$ , $^{46}\text{NO}_2^-$ , $^{62}\text{NO}_3^-$ , $^{125}\text{H}(\text{NO}_3)_2^-$ (P. J. Silva et al., 1999).
Organic carbon (OC)	$^{27}\text{C}_2\text{H}_3^+$ , $^{29}\text{C}_2\text{H}_5^+$ , $^{37}\text{C}_3\text{H}^+$ , $^{43}\text{CH}_3\text{CO}^+/\text{CHNO}^+$ (Qin et al., 2012; P. Silva & Prather, 2000; Spencer & Prather, 2006).
Dust	$^7\text{Li}^+$ , $^{27}\text{Al}^+$ , $^{39}\text{K}^+$ , $^{48,64}\text{Ti}$ , $\text{TiO}^+$ , $^{54,56}\text{Fe}^+$ , $^{60}\text{SiO}_2^-$ , $^{76}\text{SiO}_3^-$ , $^{79}\text{PO}_3^-$ (P. J. Silva et al., 2000).
Biological (Bio)	Strong $^{39}\text{K}^+$ and $^{79}\text{PO}_3^-$ , minor contributions from organic fragments (Fergenson et al., 2004; Sultana, Al-Mashat, et al., 2017).

### 2. Supplemental ATOFMS Analysis of Precipitation Results

See Discussion in Main Document, section 4.4.

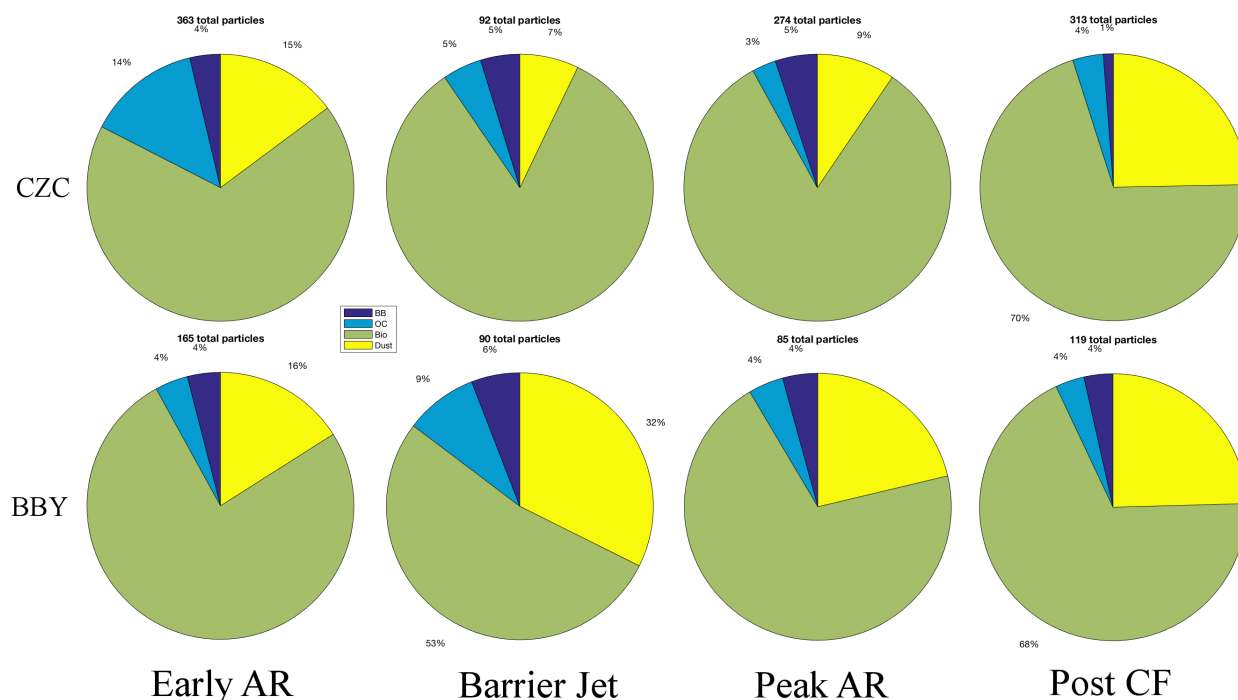


Figure SM1: Particle fraction by ATOFMS/FATES detected and classified type at CZC (top row) and BBY (bottom row) during precipitation collected during the kinematic periods: Early AR, Barrier Jet, Peak AR, and Post CF.

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