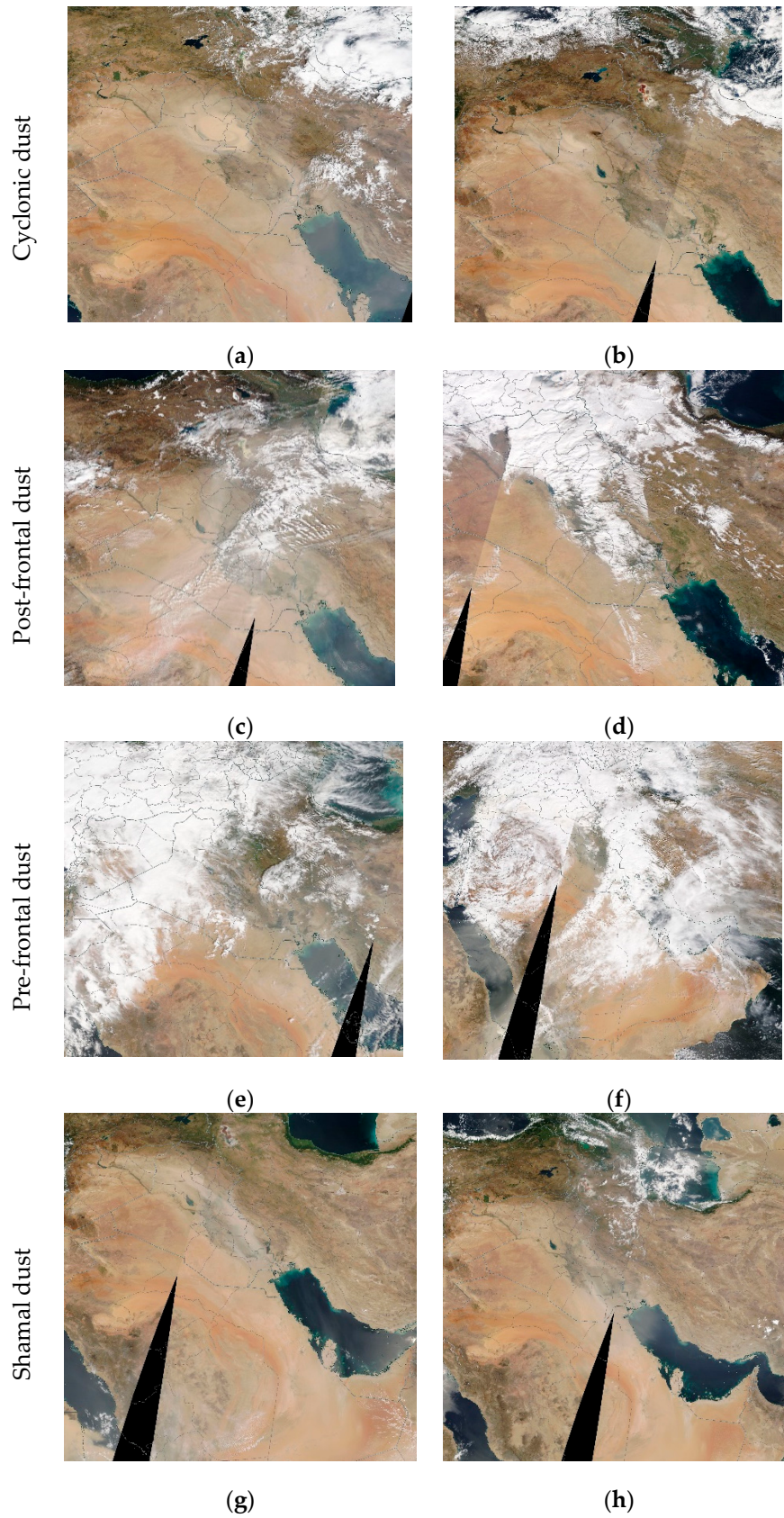
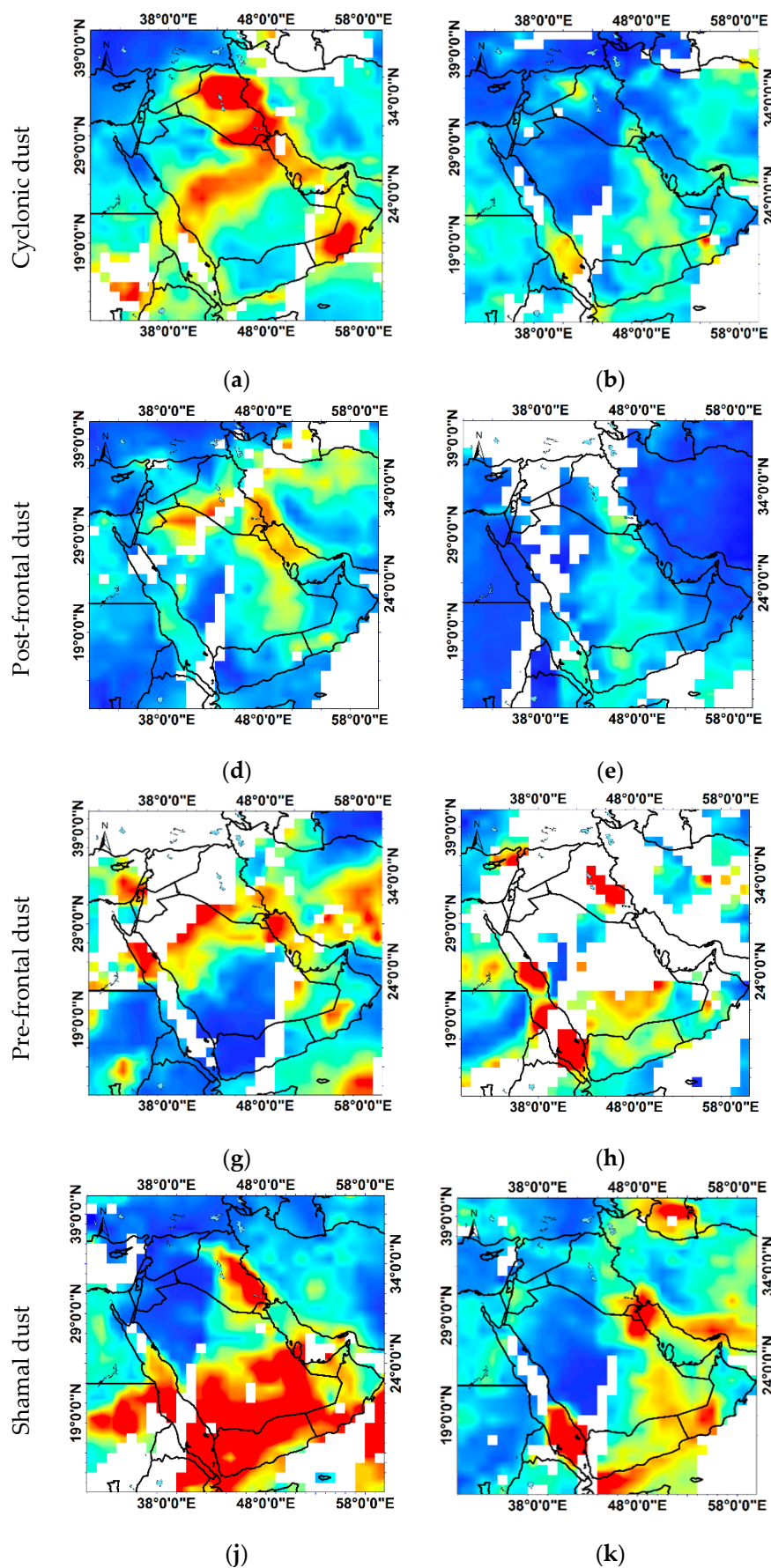


## Supplementary Material

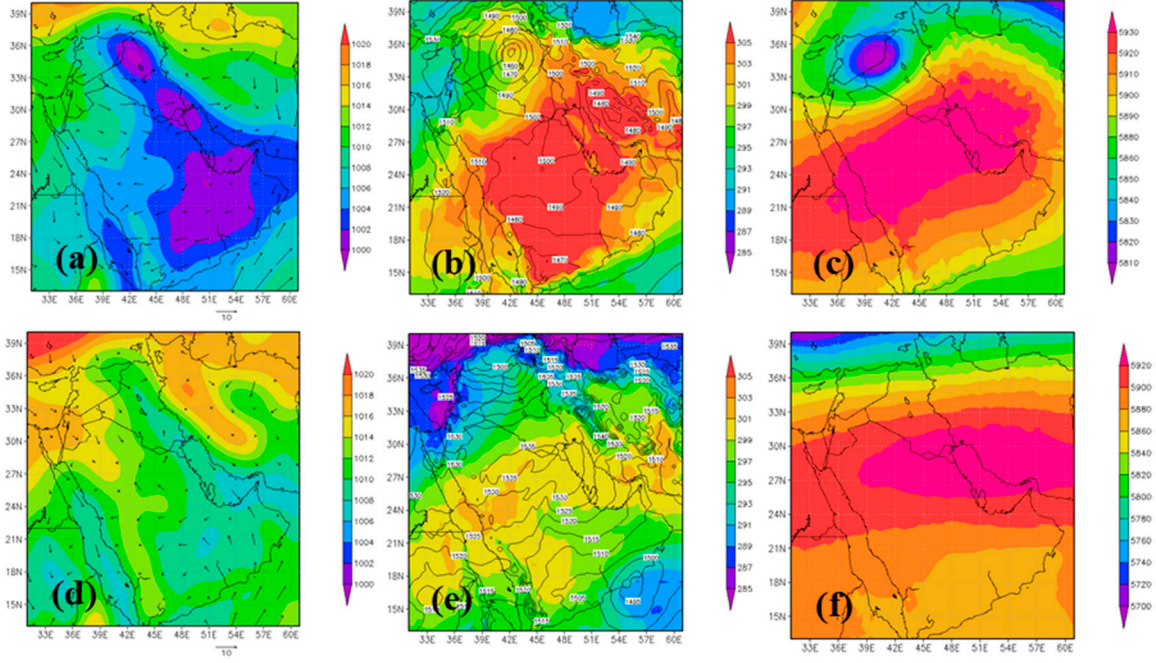


**Figure S1.** Terra-MODIS true color images on a) September 1, 2015 b) September 29, 2016, c) November 3, 2017, d) January 8, 2020, e) April 13, 2017, f) March 14, 2020, g) June 29, 2018, h) July 26, 2018.

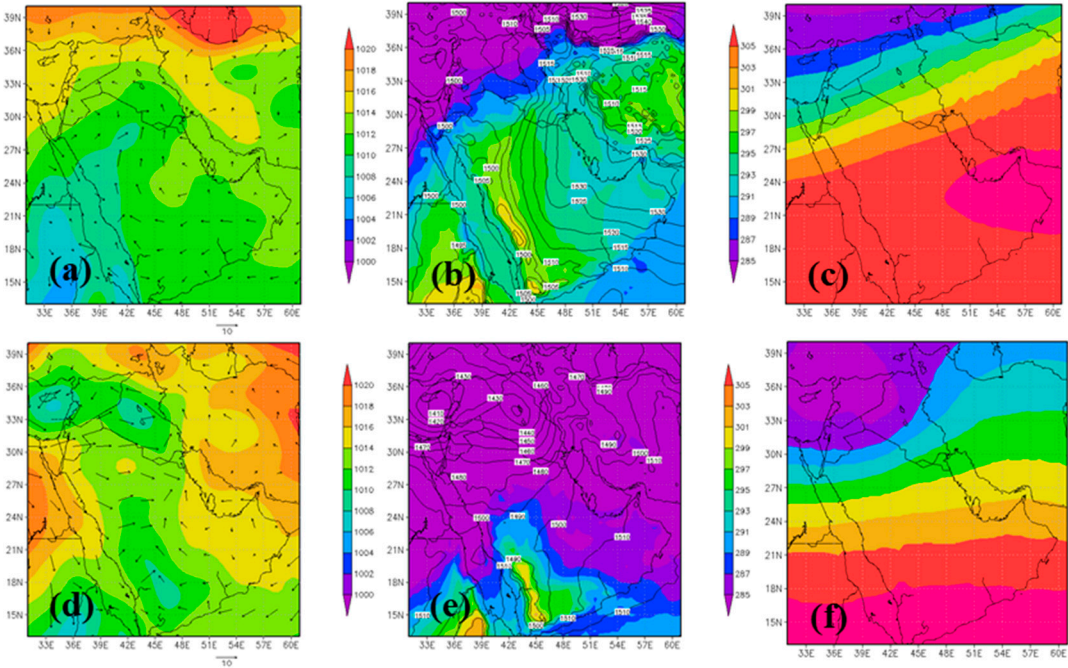


**Figure S2.** Terra-MODIS AOD<sub>550</sub> retrievals over the Middle East on a) September 1, 2015 b) September 29, 2016, c) November 3, 2017, d) January 8, 2020, e) April 13, 2017, f) March 14, 2020, g) June 29, 2018, h) July 26, 2018.

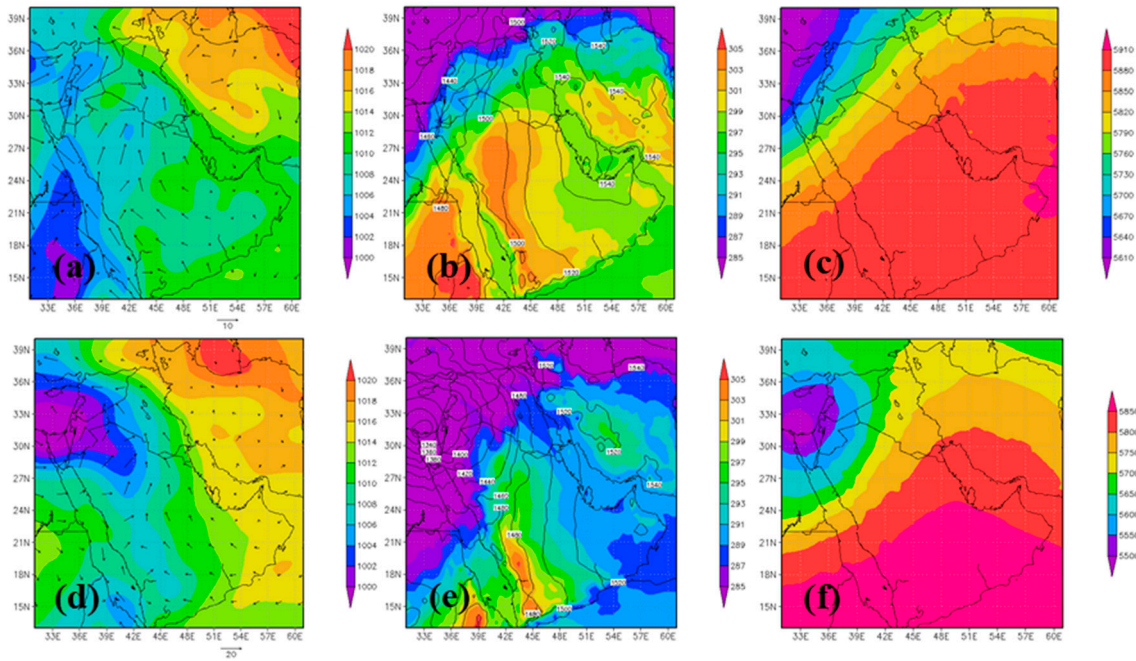




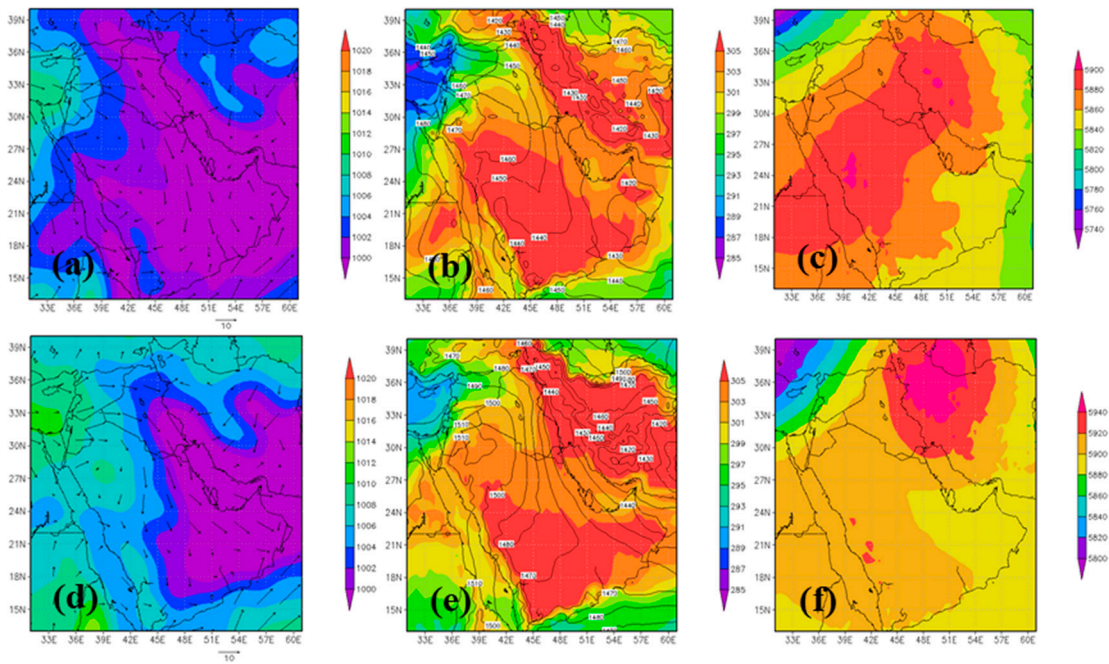
**Figure S3:** Mean sea level pressure (MSLP) with 10-m vector winds (a, d), geopotential heights and temperature at 850 hPa level (b, e) and geopotential heights at 500 hPa level (c, f) on August 31, 2015 at 00UTC (a-c) and September 28, 2016 at 00UTC (d-f).



**Figure S4:** Mean sea level pressure (MSLP) with 10-m vector winds (a, d), geopotential heights and temperature at 850 hPa level (b, e) and geopotential heights at 500 hPa level (c, f) on November 2, 2017 at 12UTC (a-c) and January 8, 2020 at 12UTC (d-f).



**Figure S5:** Mean sea level pressure (MSLP) with 10-m vector winds (a, d), geopotential heights and temperature at 850 hPa level (b, e) and geopotential heights at 500 hPa level (c, f) on April 13, 2017 at 12UTC (a-c) and March 13, 2020 at 12UTC (d-f).



**Figure S6:** Mean sea level pressure (MSLP) with 10-m vector winds (a, d), geopotential heights and temperature at 850 hPa level (b, e) and geopotential heights at 500 hPa level (c, f) on June 29, 2018 at 12UTC (a-c) and July 26, 2018 at 12UTC (d-f).



Model evaluation: a) dynamic dust storms

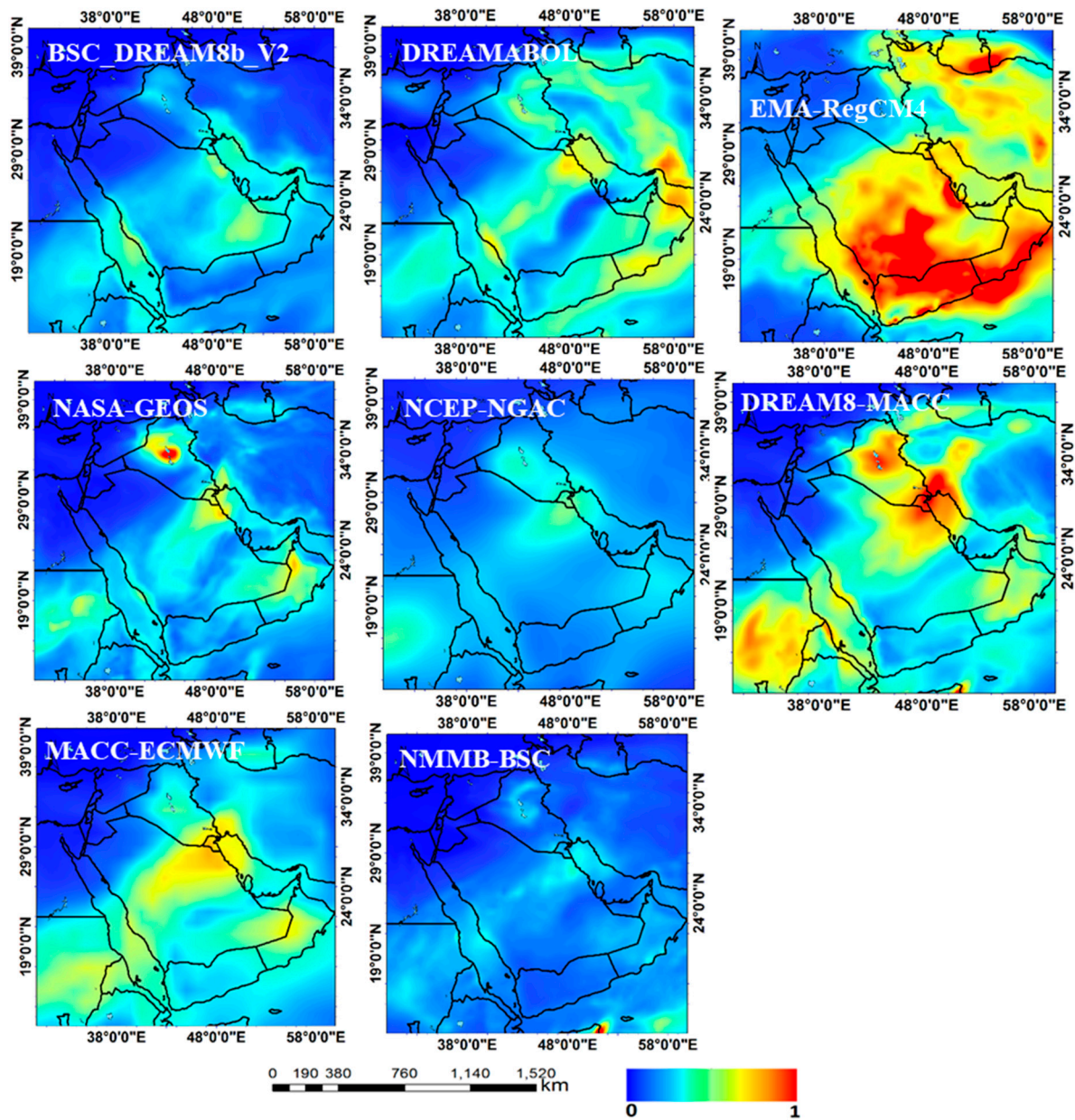


Figure S7: Spatial distribution of AOD retrieved from eight dust forecast models on November 1, 2015.

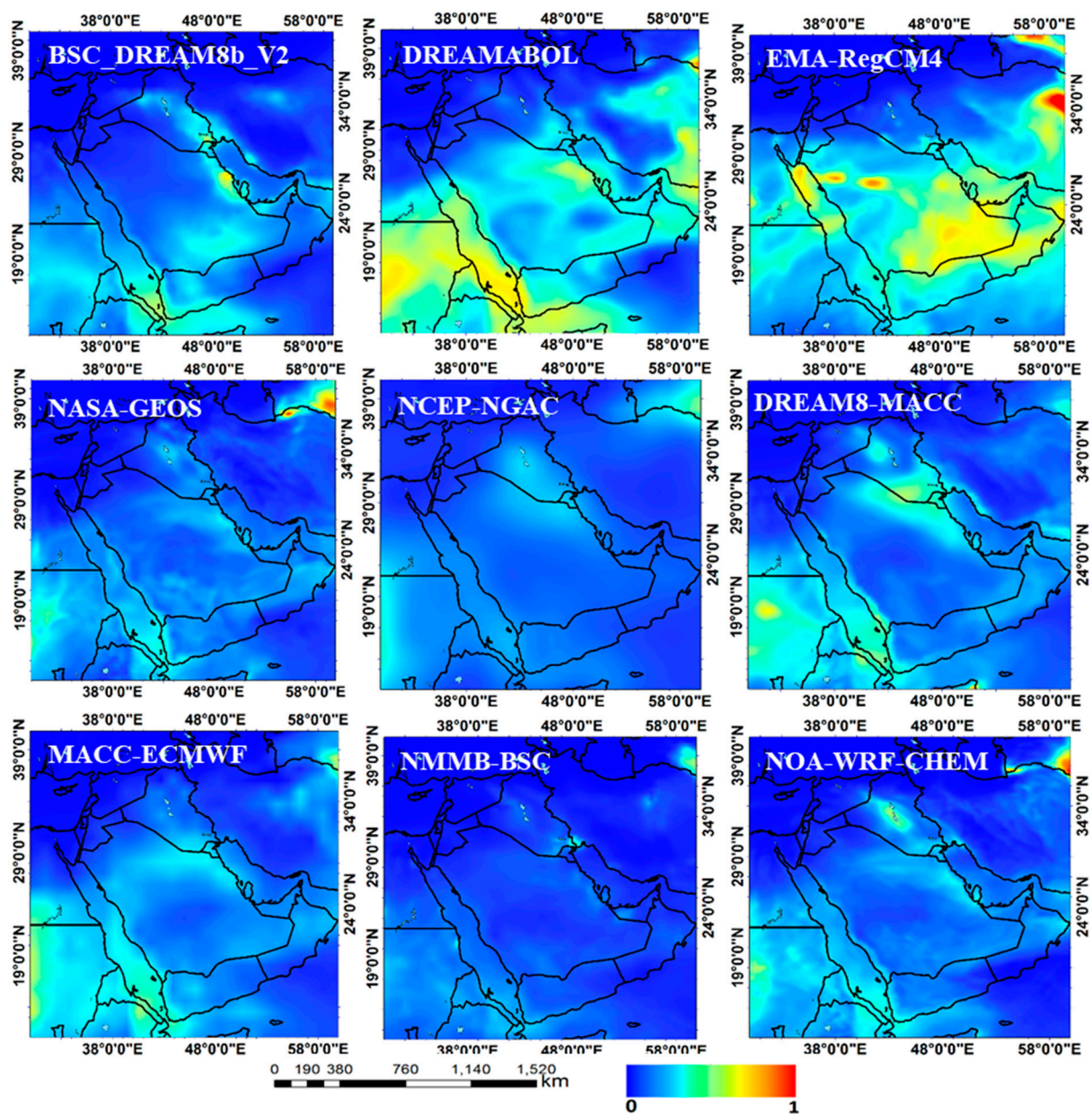


Figure S8: Spatial distribution of AOD retrieved from nine dust forecast models on September 29, 2016.



Model evaluation: b) post-frontal dust storms

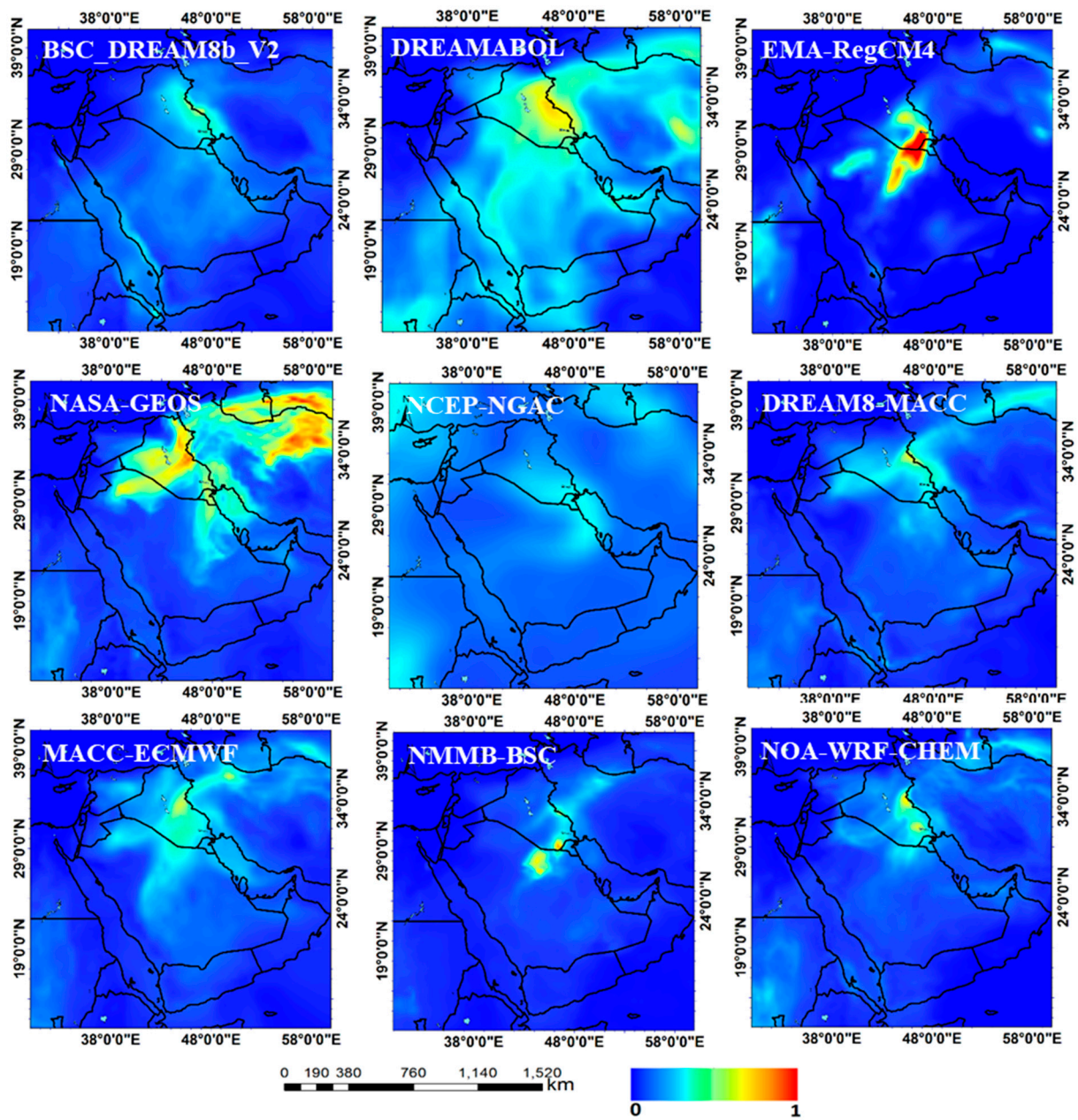


Figure S9: Spatial distribution of AOD retrieved from nine dust forecast models on November 3, 2017.

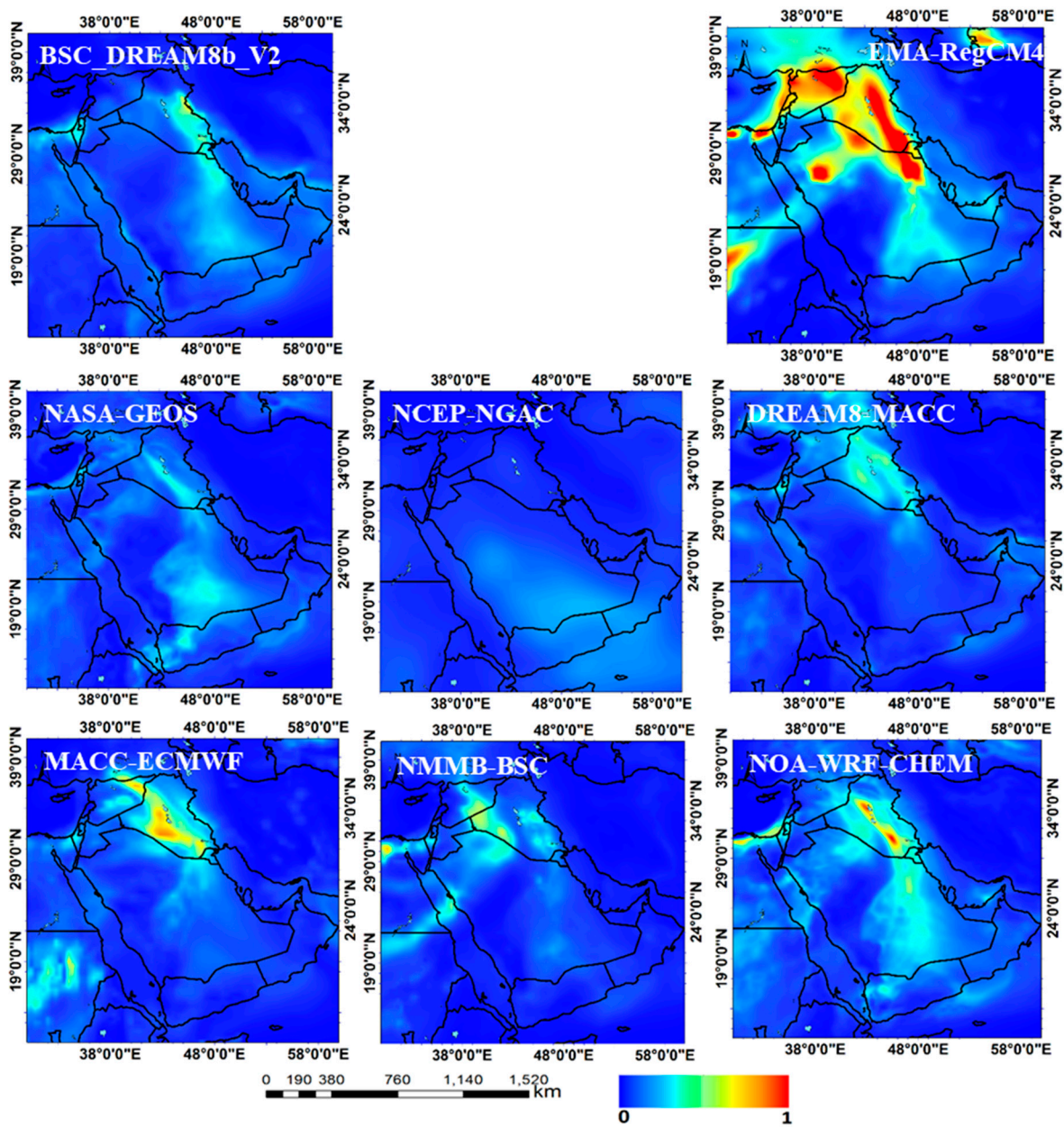


Figure S10: Spatial distribution of AOD retrieved from eight dust forecast models on January 8, 2020.



Model evaluation: c) pre-frontal dust storms

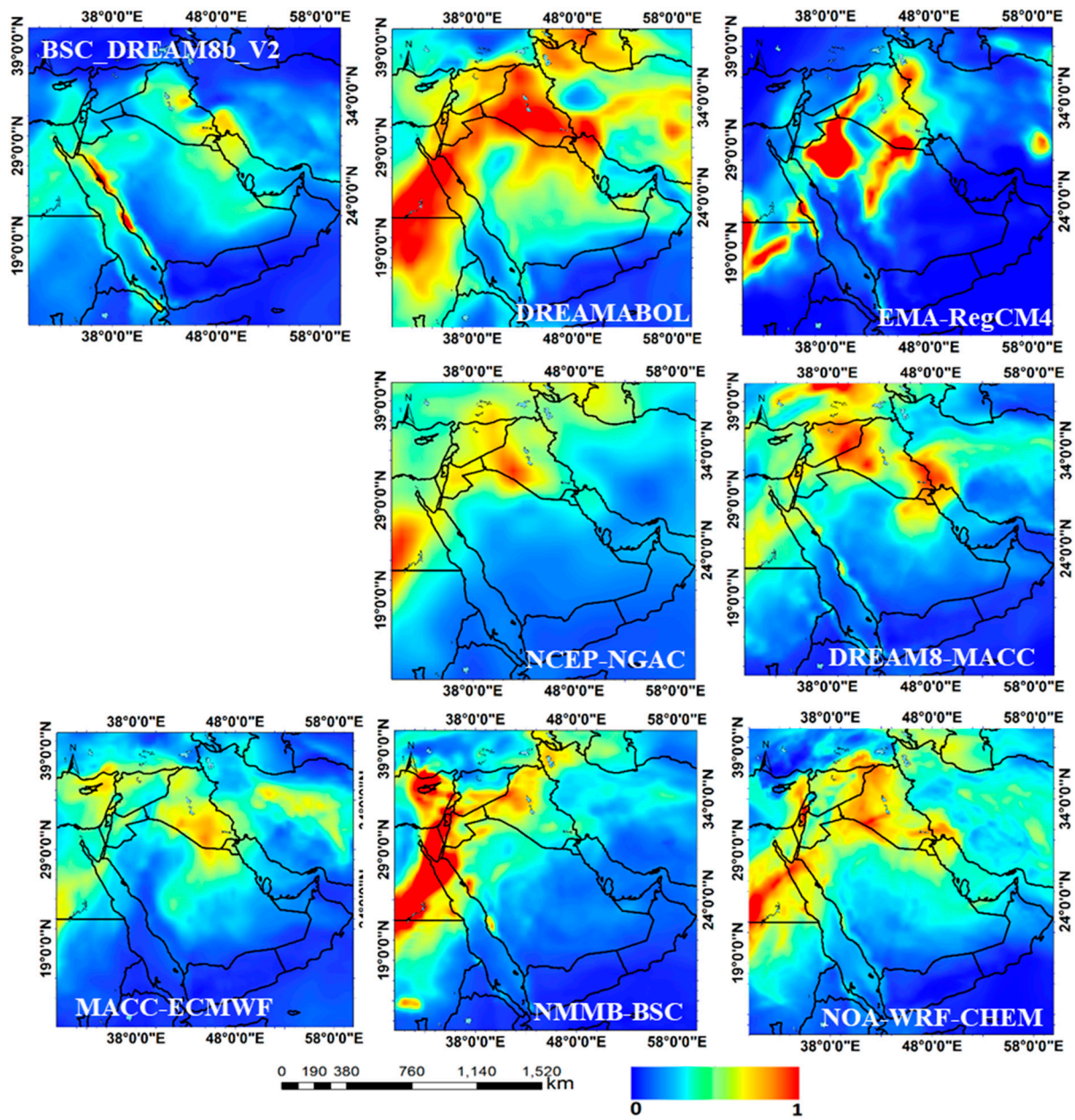
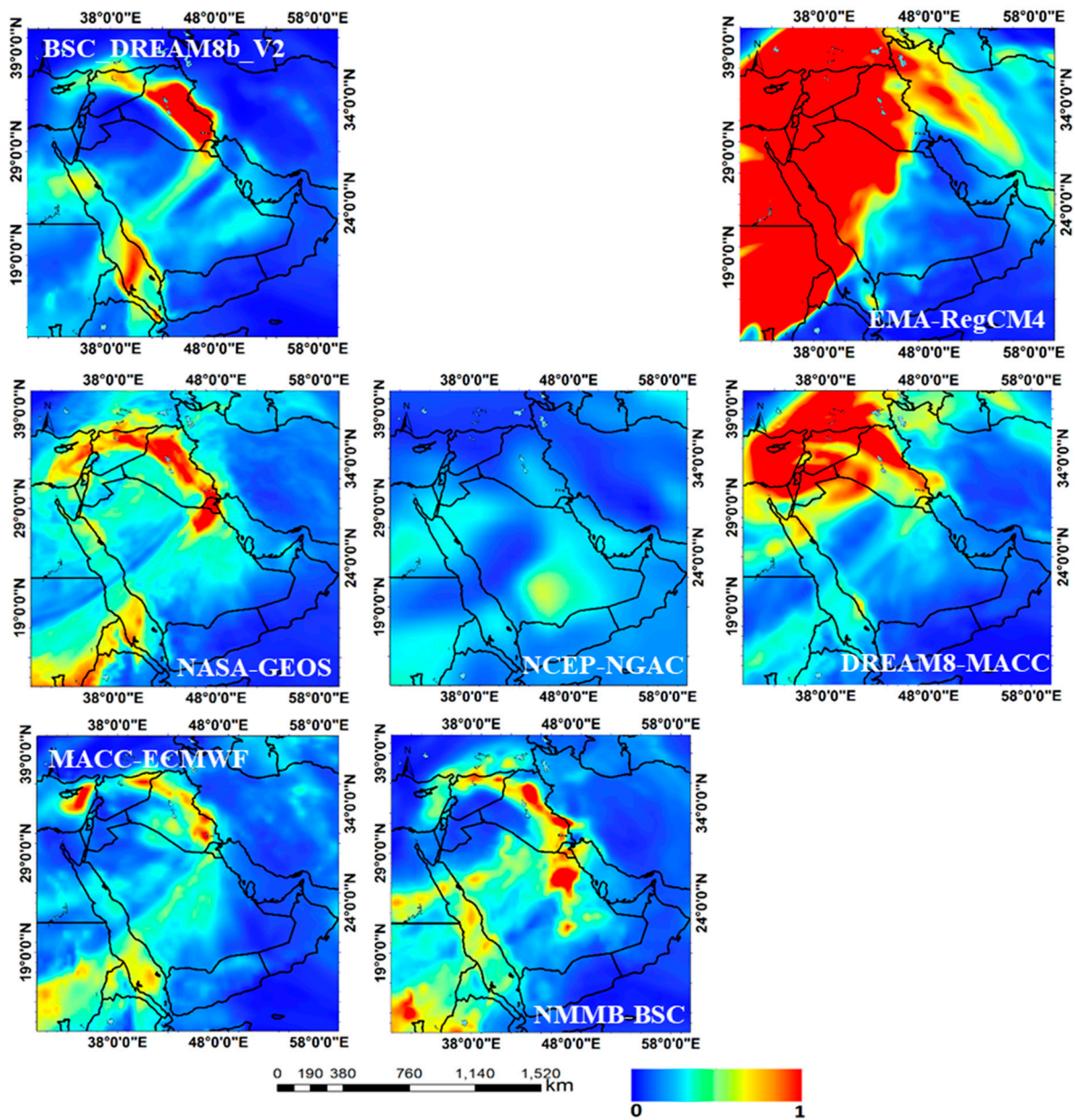


Figure S11: Spatial distribution of AOD retrieved from eight dust forecast models on April 13, 2017.



**Figure S12:** Spatial distribution of AOD retrieved from seven dust forecast models on March 14, 2020.



Synoptic meteorology: d) Shamal dust storms

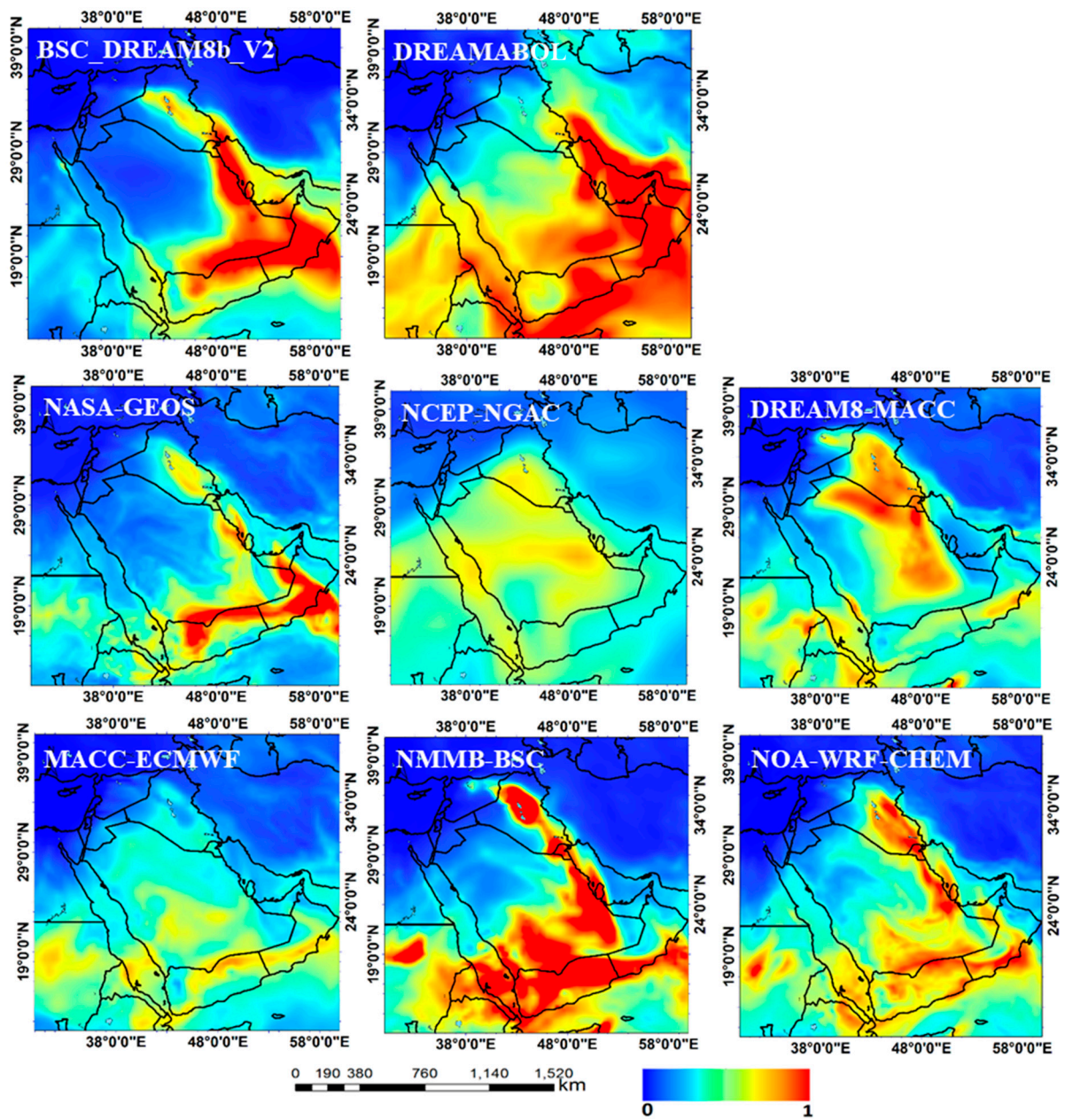


Figure S13: Spatial distribution of AOD retrieved from eight dust forecast models on June 29, 2018.

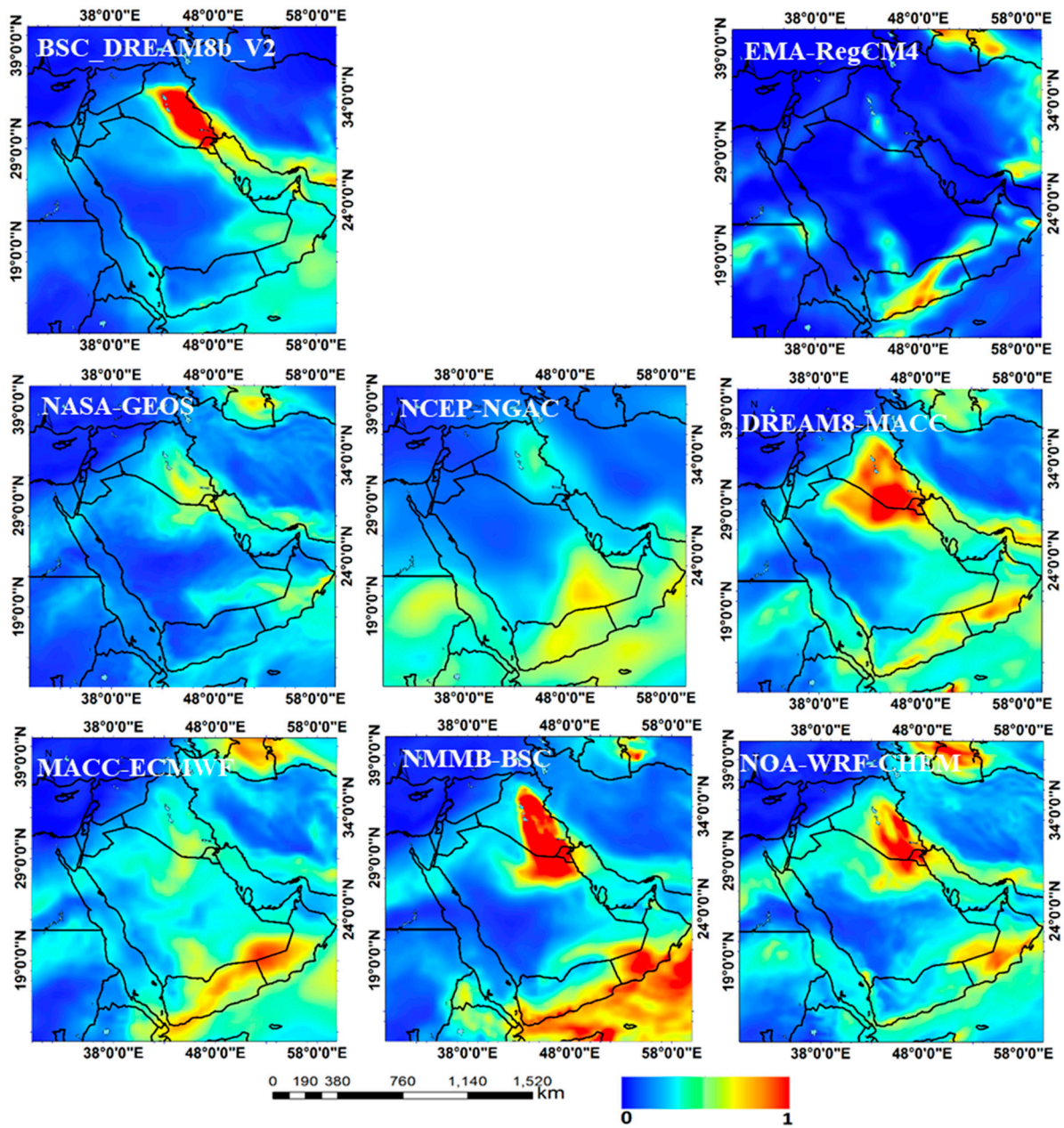


Figure S14: Spatial distribution of AOD retrieved from eight dust forecast models on July 26, 2018.