Supplementary Information.

S1.1 Analysis of AIRBUS in-service events

As a first step, the cases from the AIRBUS event database were evaluated, which in total covers 59 events. Of those events, about half fell outside the SEVIRI disc (29 of 59). Of the remaining 30 events, two were suspect, and for 19 events no daytime measurements were available, leaving nine (9) events for which MSG-CPP data was available.

A detailed meteorological and data analysis of all 30 events within the SEVIRI disc was then performed. The database contains a brief meteorological analysis of the event, images of all available MSG measurements surrounding the event (± 3 hours) for a ± 2° area around the event location of brightness temperatures and MSG-CPP parameters (if available). These images serve to identify and characterize the type of convection and convective activity of the event. Furthermore, time series of spatial average brightness temperatures and average MSG-CPP parameters (if available) were provided for ± 3 hours around the event, and averages were calculated for measurements within a radius of 10 km, 25 km, 50 km and 100 km. The purpose for the time series is to identify the stage of the convective activity (developing, mature, aging).

Figure S1a shows an example of the MSG-CPP measurements of event 31. This event clearly occurred right over a deep and strong convective event, with widespread iced cloud tops, high CWP values, high COT, high clouds, cold cloud tops and strong precipitation.

Figure S1b shows the time series of area average MSG-CPP parameters. Most parameters are fairly constant over the time period and independent of the area of averaging, indicative of mature large scale convection. When looking near the location of this event (radius < 10 km), we

do see that both the COT and CWP were increasing near the event, indicating that the convection was still active.

The nine events for which MSG-CPP data was available were further evaluated in detail to determine similarities between these nine events. Figure S2 shows a scatter plot of various MSG-CPP parameters falling within a 100 km radius of the event location. Panel (A) shows that the closer the measurements to the event, the higher the CWP. Typically MSG-CPP CWP is larger than 1000 g/m^2 near the events. Panel (B) shows that in general these clouds are cold clouds, with cloud top temperatures below -40°C (233 K), and cloud heights of 8 km or higher. Panel (C) shows that precipitation is directly related to the CWP, as expected [Roebeling et al., 2006; Meirink, 2013]. Precipitation thus is not an independent parameter in the MSG-CPP measurements. Finally, for all cases there the effective radius is > 10 μm.

S1.2 Construction of a provisional High IWC mask

Based on the analysis presented in the previous section, a first MSG-CPP High IWC mask was constructed. An MSG-CPP pixel is identified as potentially containing high IWC under the five conditions listed in table S2.

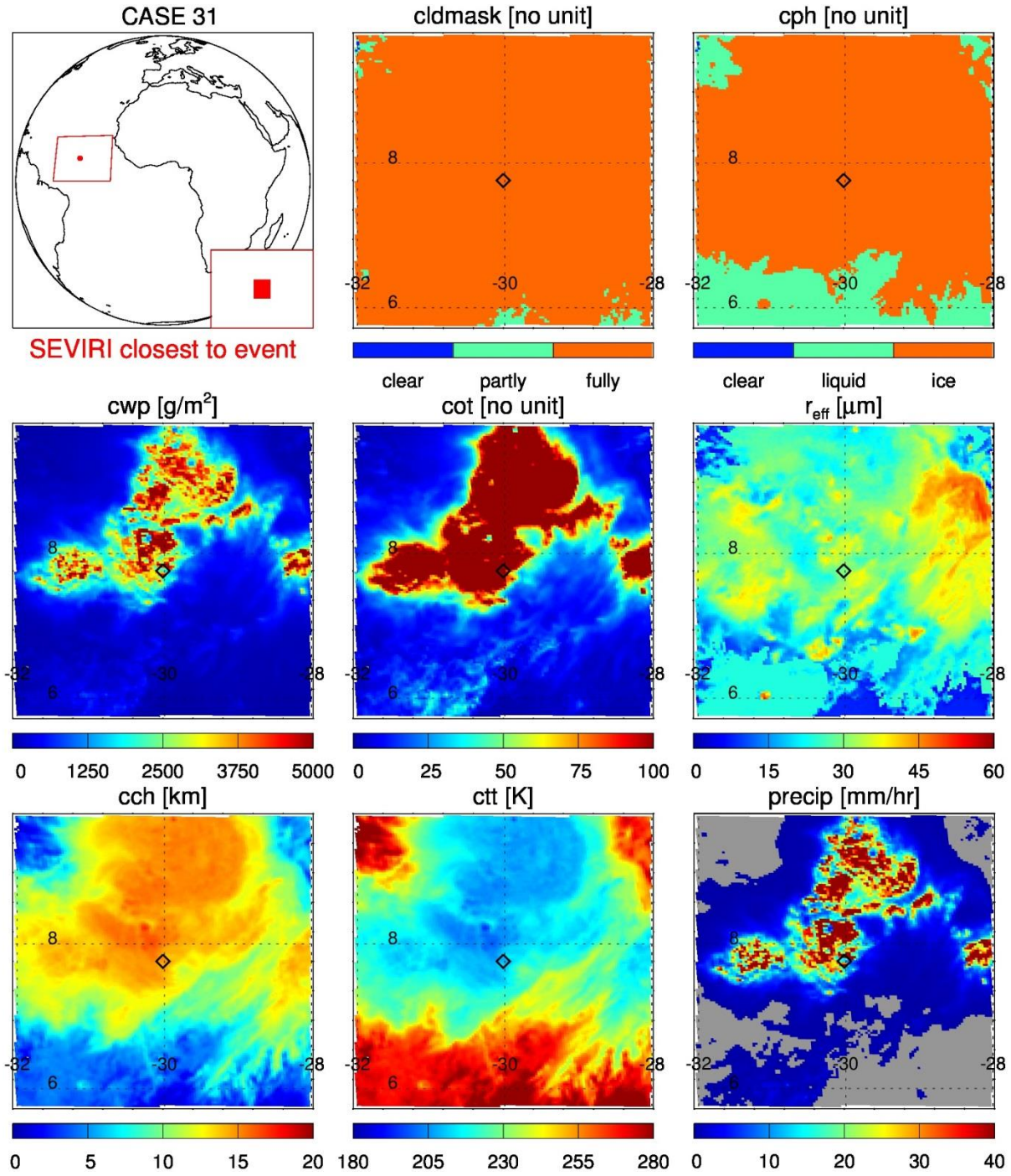
Figure S3 shows an example of how these criteria subsequently decrease the number of MSG-CPP measurements identified as high IWC events for AIRBUS event 31. Figure S4 shows the last panel of Figure 3 but then for the entire SEVIRI disc. Clearly the High IWC mask strongly reduces the number high IWC events. The strongest reductions in pixels are related to the requirement of cloud phase being ice, the cloud water path > 1000 g/m^2 and the cloud top height > 8 km and cloud top temperature < 225. Note that the cloud top height and cloud top temperature are locally interchangeable.

Finally, Figure S5 shows the High IWC mask as in Figures S3 and S4 for all nine AIRBUS events for which MSG-CPP is available. Unsurprisingly, all nine cases occur in areas identified by the High IWC mask.

Although the High IWC mask as defined here identifies potential high IWC events in a way that appears consistent with expectations, the limited number of AIRBUS events on which the High IWC mask is based means that there is room for further refinement, for which an alternative approach is needed as there are currently no other events available for analysis. Within the HAIC consortium it was decided that the 'next best thing' was to compare and evaluate the High IWC mask with radar and lidar observations from polar orbiting satellites.

YEAR	MONTH	DAY	HH:MM:SS
2008	01	02	09:18:01
2008	01	02	12:35:48
2008	01	03	13:19:04
2008	01	03	14:57:57
2008	01	03	16:36:50
2008	01	04	12:23:27
2008	01	05	16:24:30
2008	02	02	13:31:39
2008	02	02	16:49:25
2008	02	04	11:40:25
2008	02	05	10:44:47
2008	02	05	15:41:26
2008	03	02	13:00:45
2008	03	02	16:18:31
2008	04	01	09:55:30
2008	04	03	14:39:50
2008	04	03	16:18:43
2008	05	01	11:47:09
2008	05	02	14:09:18
2008	05	03	16:31:27
2008	05	04	13:56:57
2008	06	11	16:37:42
2008	09	02	15:31:07
2008	09	02	17:10:00
2008	10	04	10:34:40
2008	10	04	15:31:19
2008	10	04	17:10:12
2008	11	02	11:43:07
2008	12	01	11:12:50
2008	12	01	14:30:37
2008	12	03	12:39:24

Table S1. Dates of equator crossing time of DARDAR orbits used for detection of High IWC events in MSG-CPP.

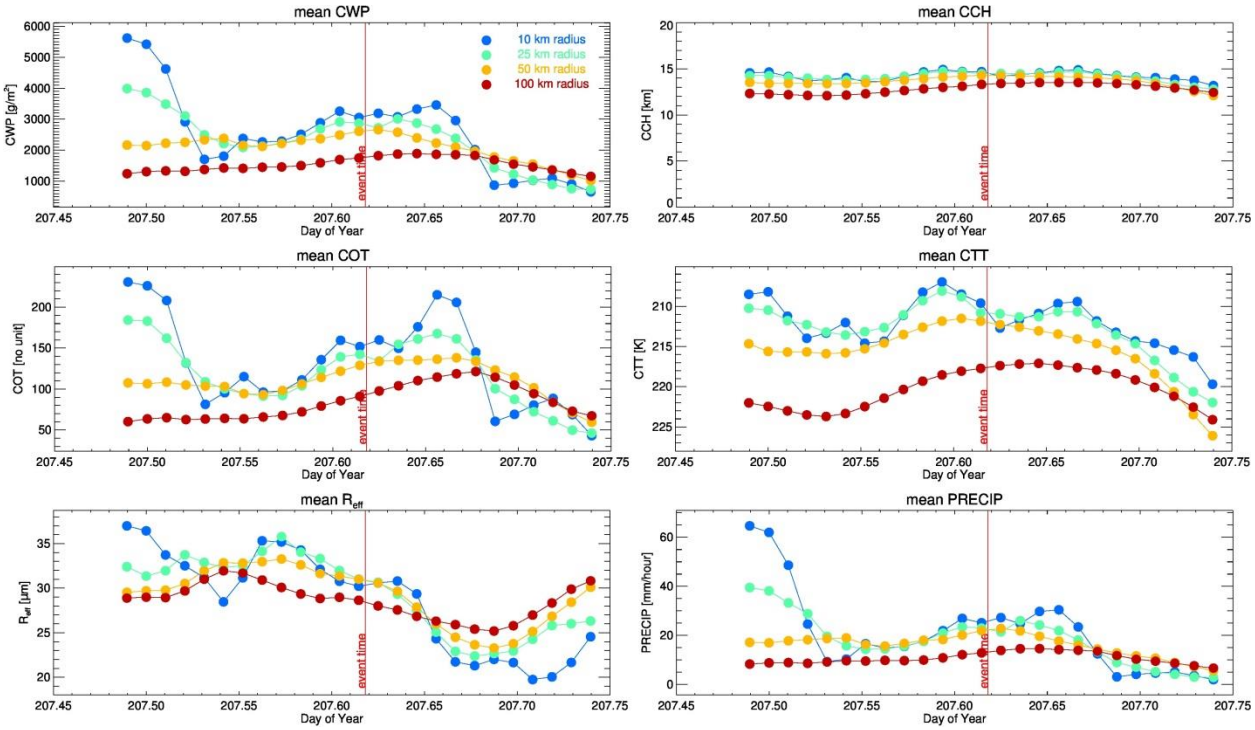


869

870 **Figure S1a. Nearest** MSG-CPP measurements for AIRBUS event 31. CWP = Cloud Water

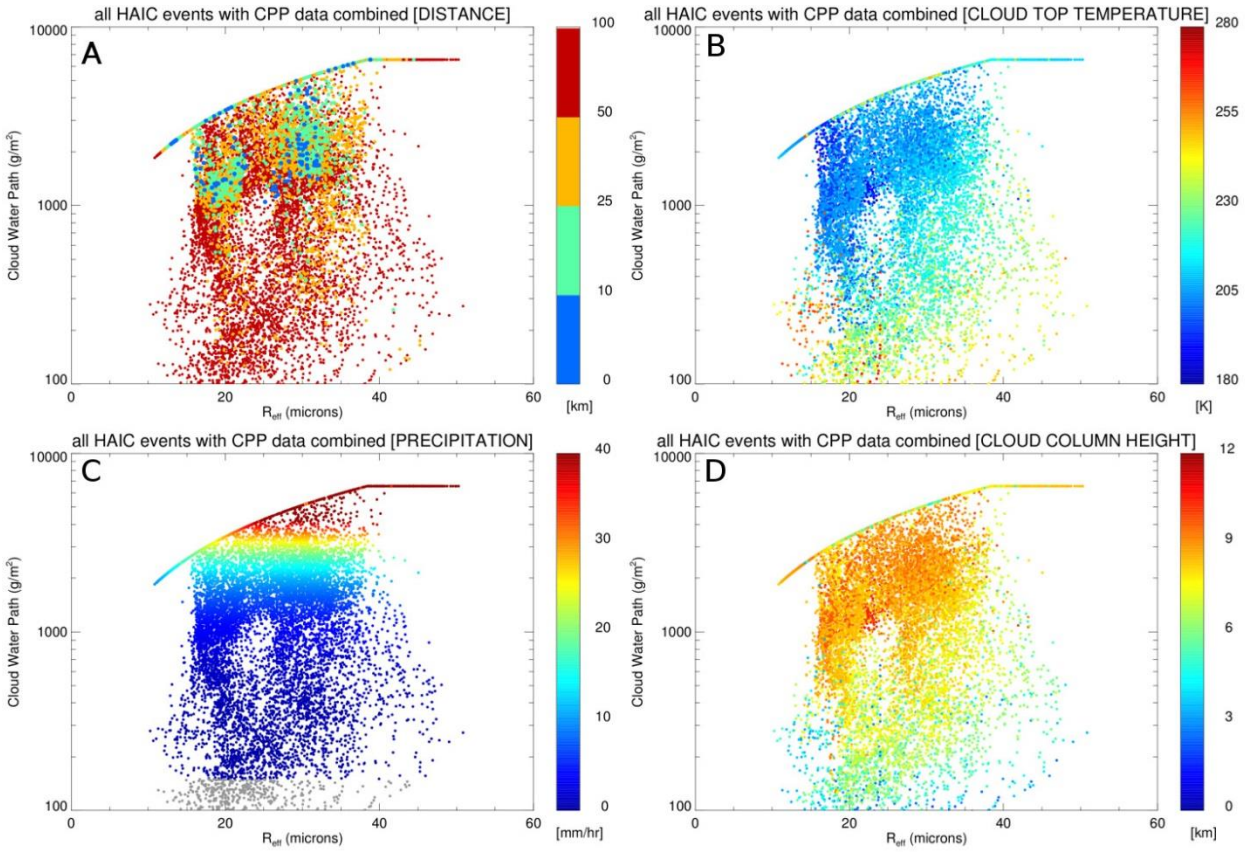
871 Path, COT = Cloud Optical Thickness, r_{eff} = effective radius, CCH = Cloud Column Height,

872 CTT = Clout Top Temperature, precip = precipiation.



873

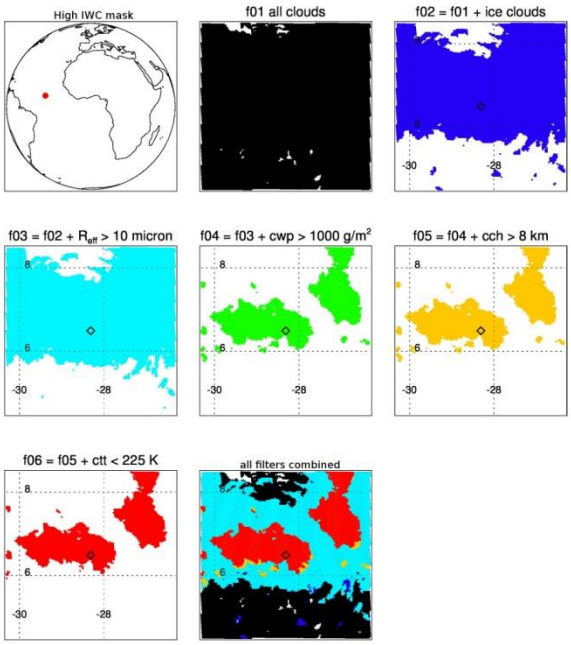
874 **Figure S1b**. Time series of area average MSG-CPP parameters for AIRBUS event 31 for the
875 period ± 3 hours around the event and the areas with radii of < 10 km, < 25 km, < 50 km and <
876 100 km.



877

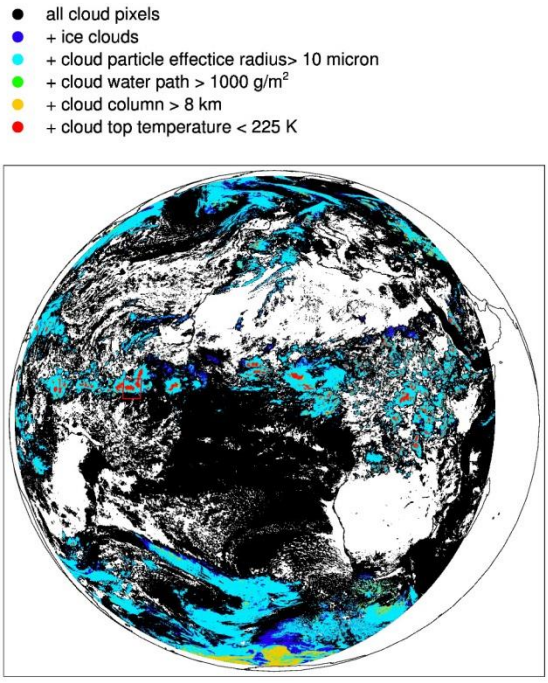
878 **Figure S2**. Scatterplots of MSG-CPP parameters for the nine AIRBUS events for which MSG-
879 CPP data is available. Only the MSG-CPP measurements closest to the event were taken. All
880 panels show the CWP (g/m^2) as function of the effective radius (μm). The color coding indicates
881 a third parameters: (A) radius within which MSG-CPP measurements were taken (km; distance
882 to event location), (B) cloud top temperature (K), (C) precipitation (mm/hr) and (D) cloud
883 column height (km). The upper line denotes a theoretical limit to the MSG-CPP relation between
884 CWP and the effective radius.

885



886

887 **Figure S3.** Filters applied for the of High IWC mask for AIRBUS event 31. Each panel indicates
888 the filter applied as in the title compared to the previous panel. The first panel shows the region
889 of interest, the last panel shows how each pixel is characterized.



890

Figure S4. As the last panel of Figure S3 but for the entire SEVIRI disc.

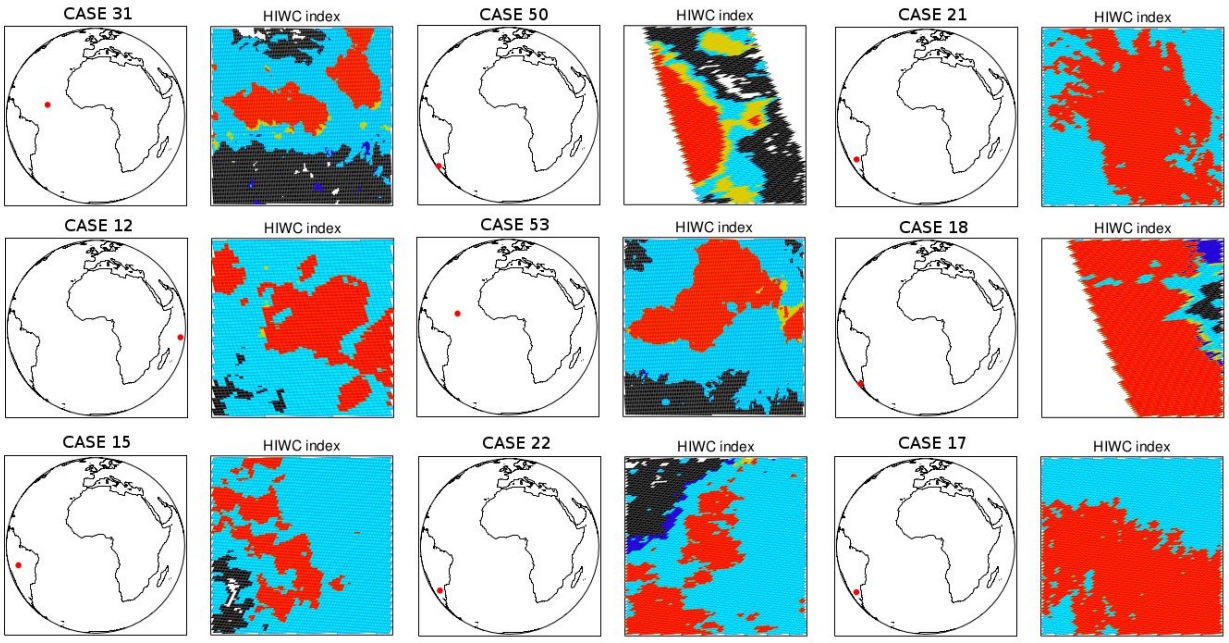


Figure S5. As Figure S3, first and last panels, but for all nine AIRBUS events for which MSG-CPP data is available (see table S1). Color coding as in Figures S3 and S4.