On the role of locally produced ultrafine aerosol for regional climate modification

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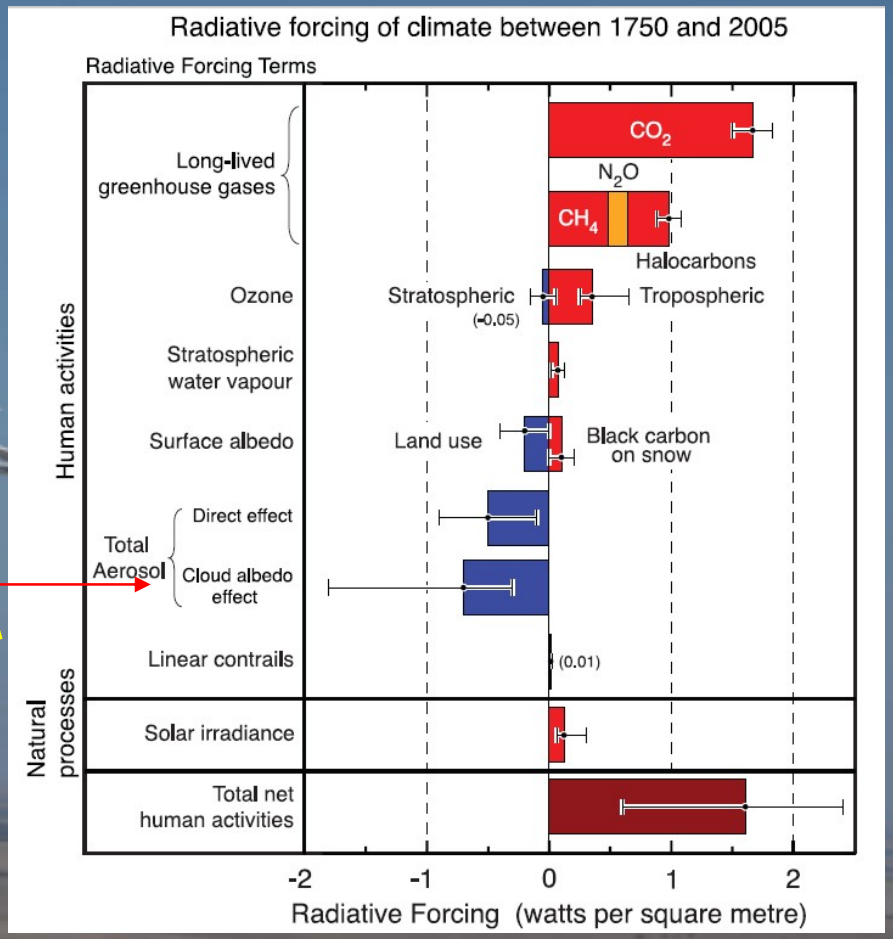
Why ultrafine:

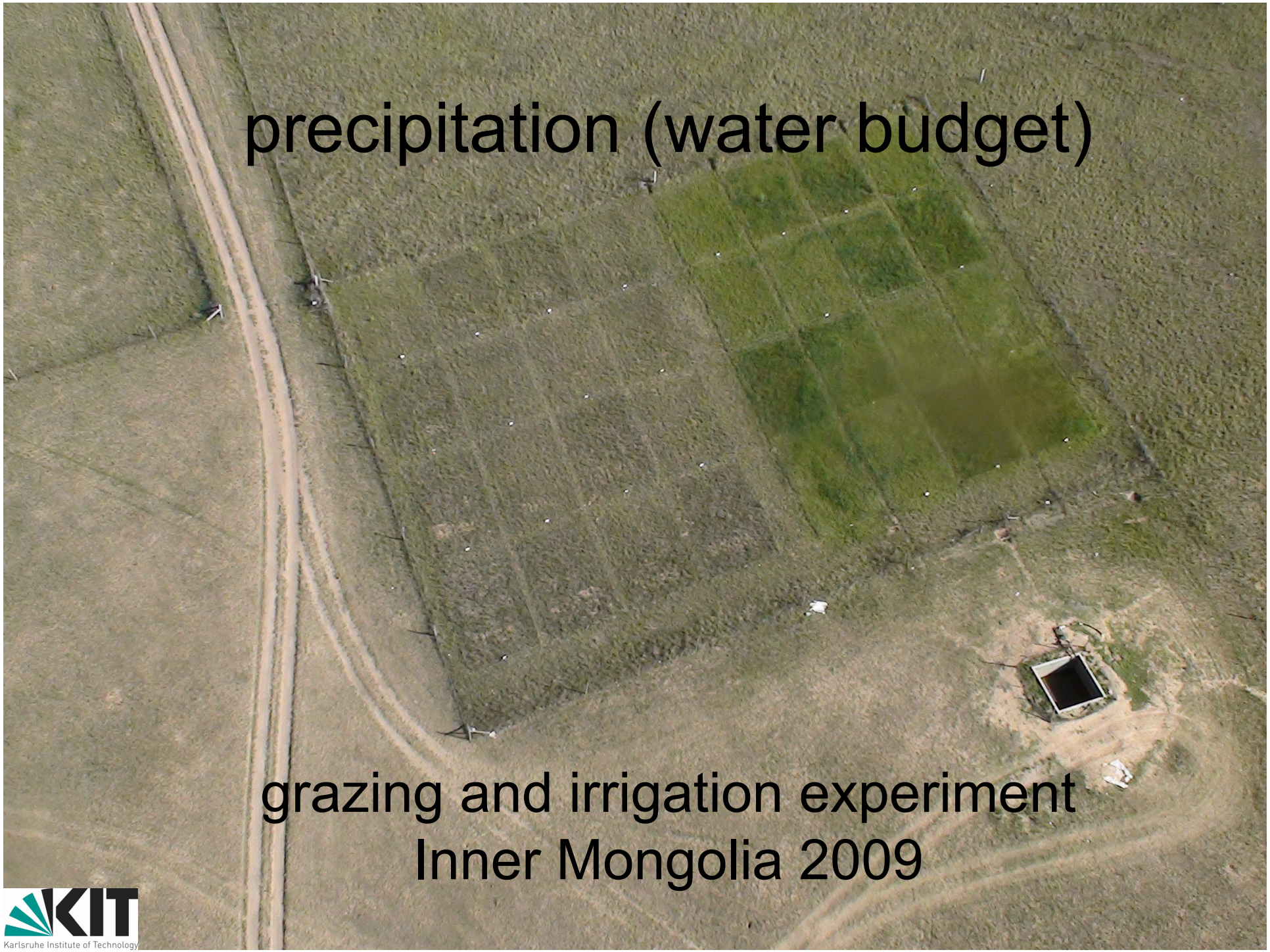
1) ~~direct~~ fine

2) indirect

cloud-
albedo
lifetime ?
precipitation ?

ultrafine
water related





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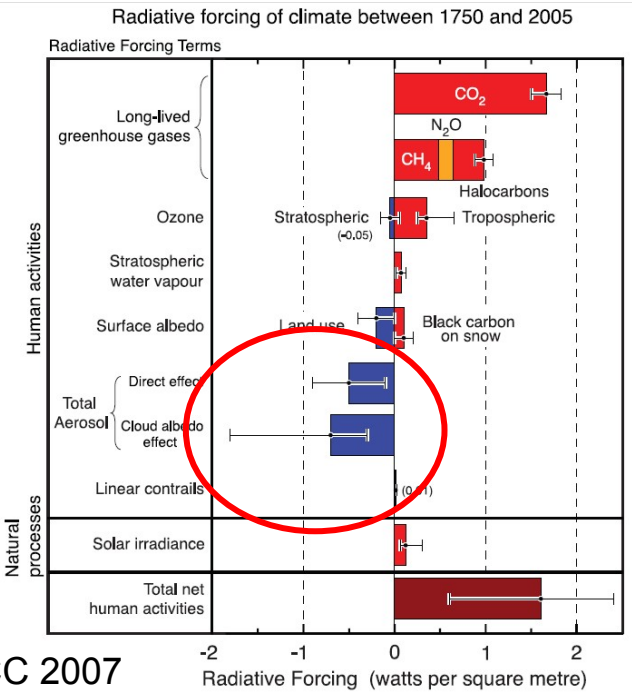
Reducing the uncertainties



IPCC 2007

models

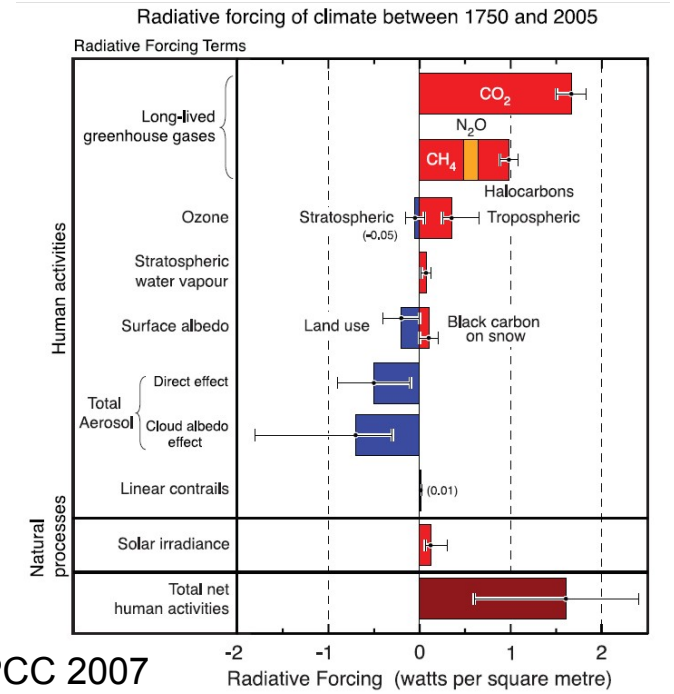
and

measurements

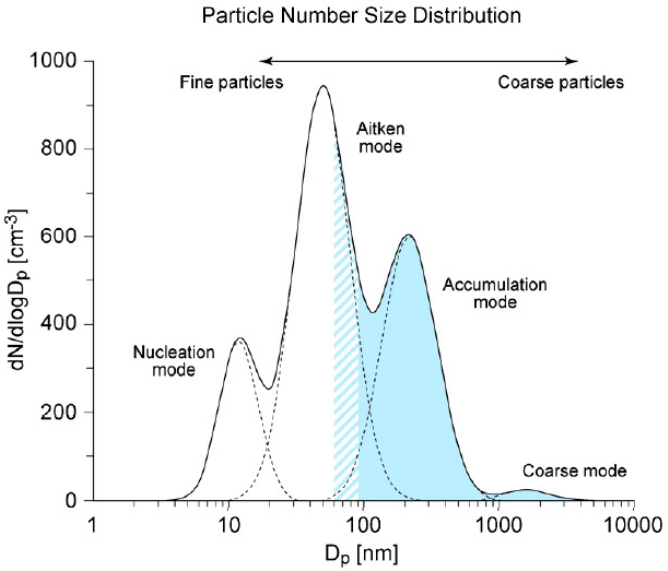
Reducing the uncertainties in model input parameters

⇩

measurement of cloud microphysics relevant aerosols +.....



IPCC 2007



Z.Levin, Aerosol Pollution Impact on Precipitation: A Scientific Review, 2007

Figure 3-1: *Typical particle number size distribution. The shaded band represents the range of sizes activated as CCN at 0.3% SS, a typical median SS in clouds.*

Measurements require both, well defined environmental conditions and long term data sets

two examples

Western Australian wheat belt

Steppe, Inner Mongolia (> 1000 km)

Western Australia

regional scale production of ultrafine aerosol following drastic land cover change and > rising ground water table

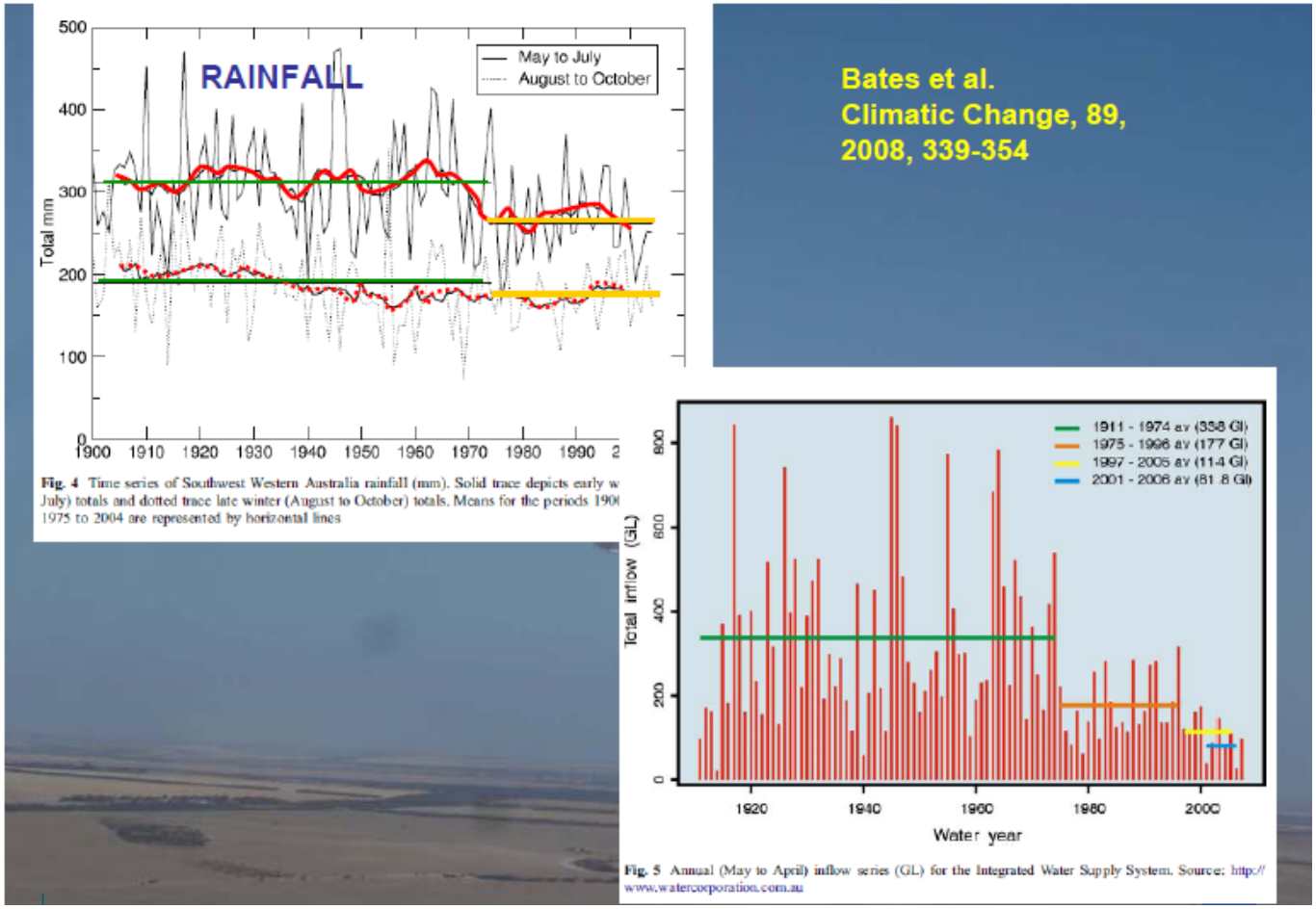


Fig. 4 Time series of Southwest Western Australia rainfall (mm). Solid trace depicts early w July) totals and dotted trace late winter (August to October) totals. Means for the periods 190 1975 to 2004 are represented by horizontal lines

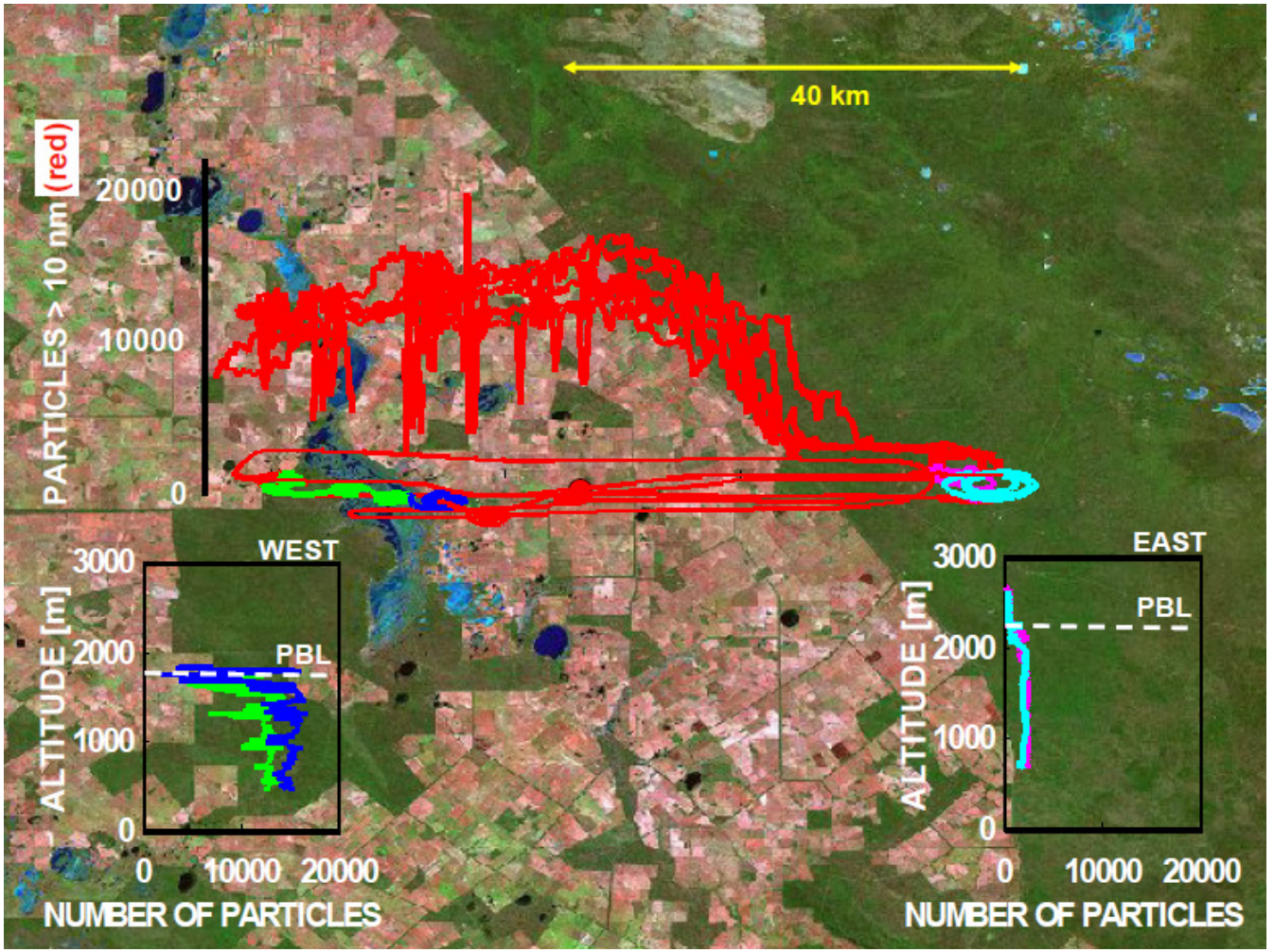
Fig. 5 Annual (May to April) inflow series (GL) for the Integrated Water Supply System. Source: http://www.watercorporation.com.au

Western Australia

regional scale production of ultrafine aerosol following drastic land cover change and > rising ground water table

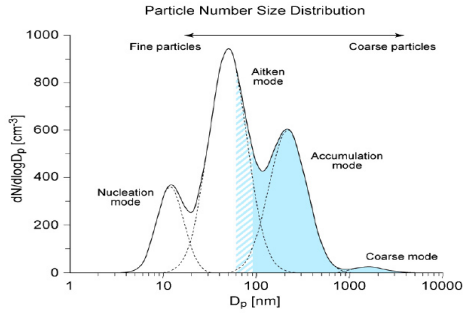
AEROSOL > 10 nm

 # / cm3



Western Australia

regional scale production of ultrafine aerosol following drastic land cover change and > rising ground water table



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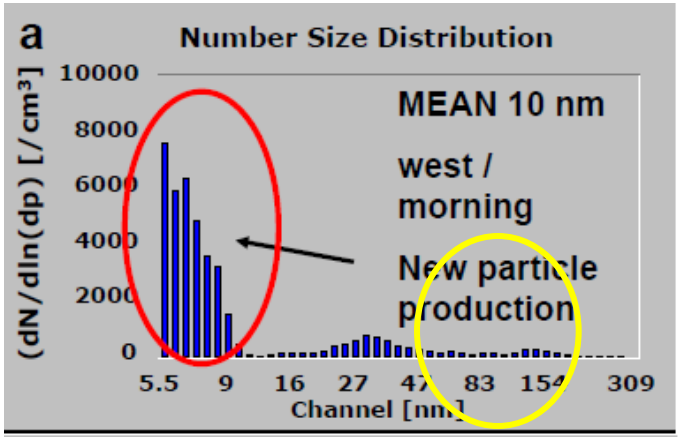
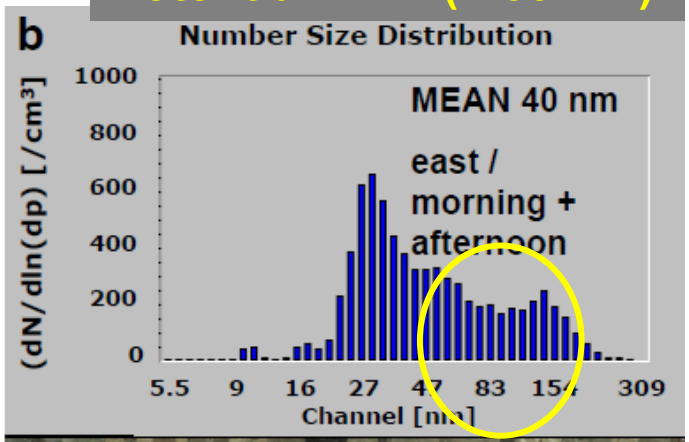
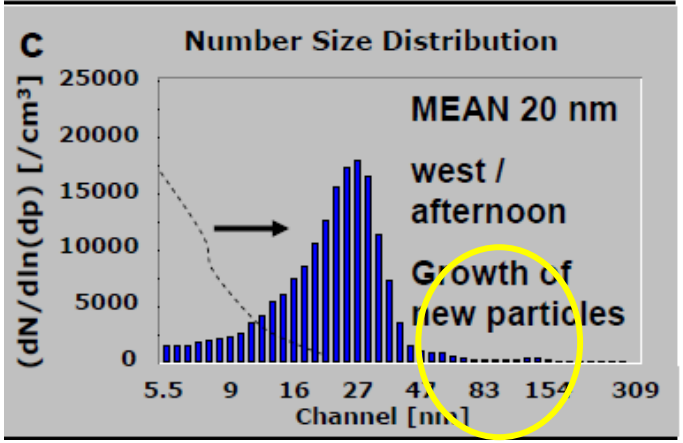
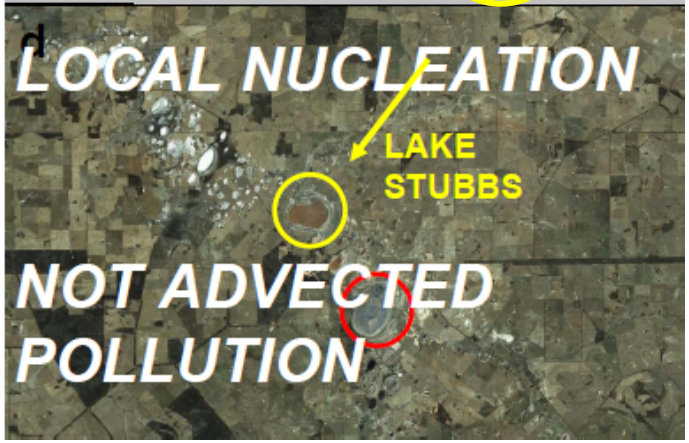


Potential CCN (> 60 nm)







Western Australia

regional scale production of ultrafine aerosol following drastic land cover change and > rising ground water table

Western Australia

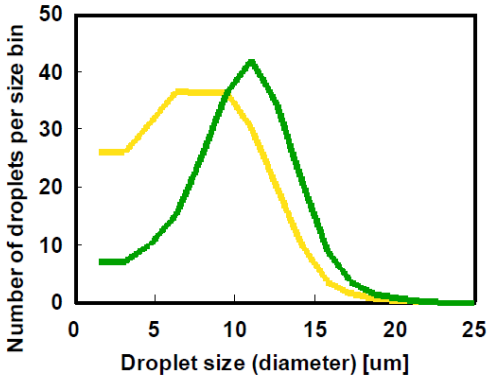
regional scale production of ultrafine aerosol following drastic land cover change and > rising ground water table

Parameter	West (agriculture) ground	West (agriculture) cloud base	East (natural vegetation) ground	East (natural vegetation) cloud base
Temperature [°C]	16	10	20	6
Pressure [hPa]	975	900	975	800
Dewpoint [°C]	11	9	6	3.5
Water [g/m3]	9.9	8.8	6.9	6.1
Potential CCN		~350		~250
Cloud droplets [/cm3]		247		198
Average diameter [um]		8.3		9.5
Liquid water content [g/m3]		0.10		0.15

Note the difference of water vapor converted into LWC

Western Australia

regional scale production of ultrafine aerosol following drastic land cover change and > rising ground water table



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$$R \sim LWP^{\alpha} N_d^{-\beta}$$

R = rain rate (cloud base)
LWP = liquid water path (macro)
N_d = drop conc (microphysical)

$\alpha \sim 1.50$
$\beta \sim 0.67$

Wang and Feingold, 2009a

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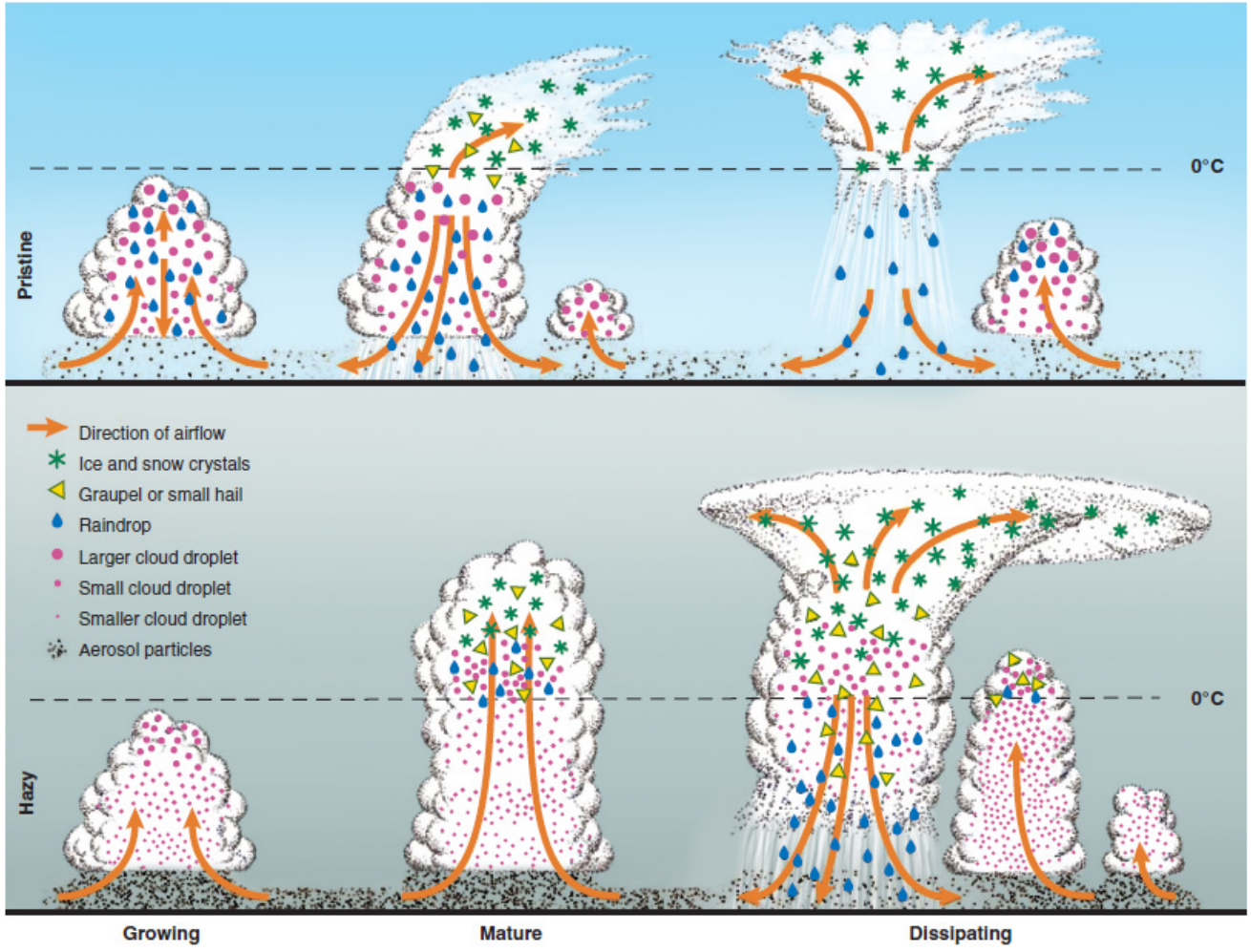
Flood or Drought: How Do Aerosols Affect Precipitation?

Daniel Rosenfeld, *et al.*
Science **321**, 1309 (2008);



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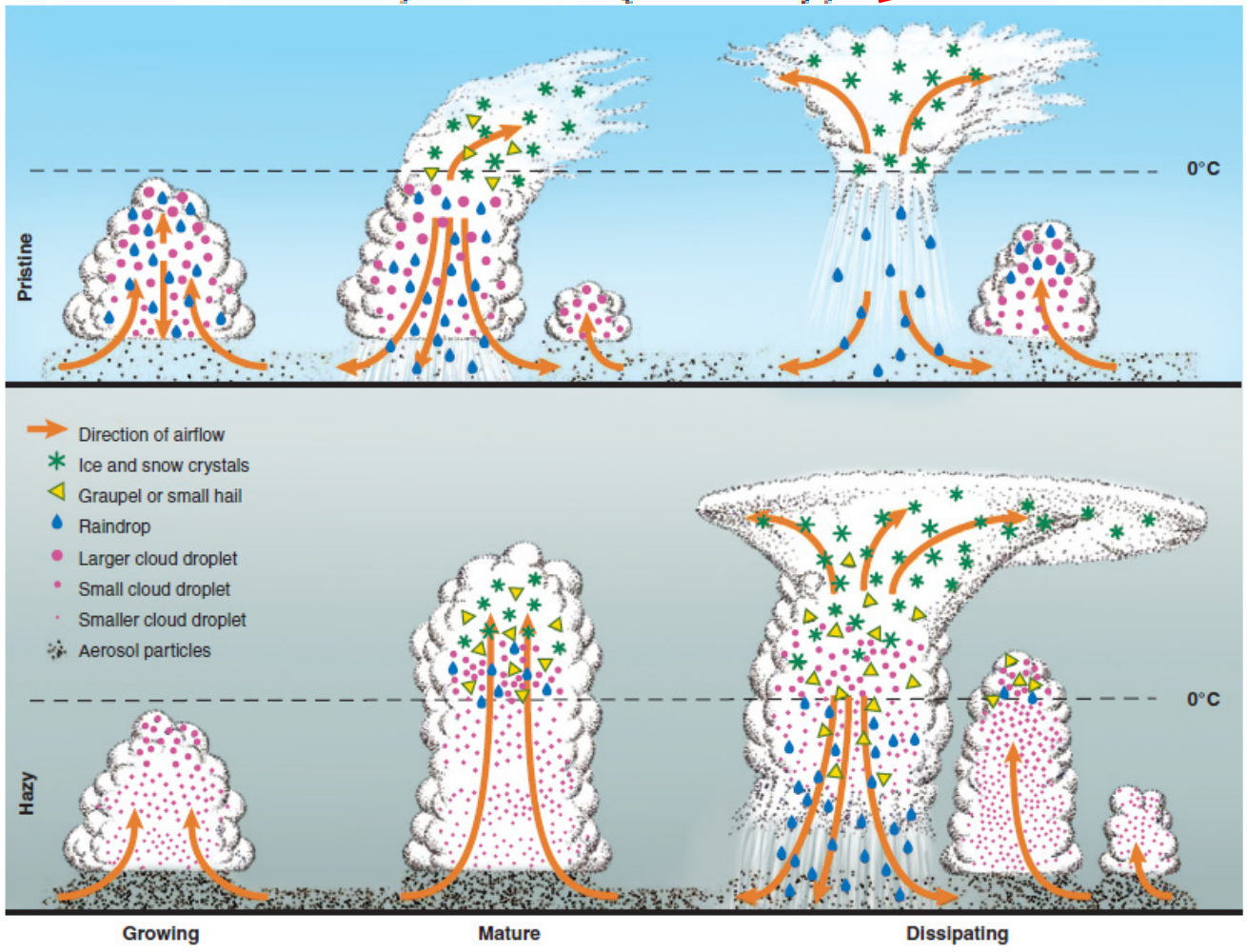
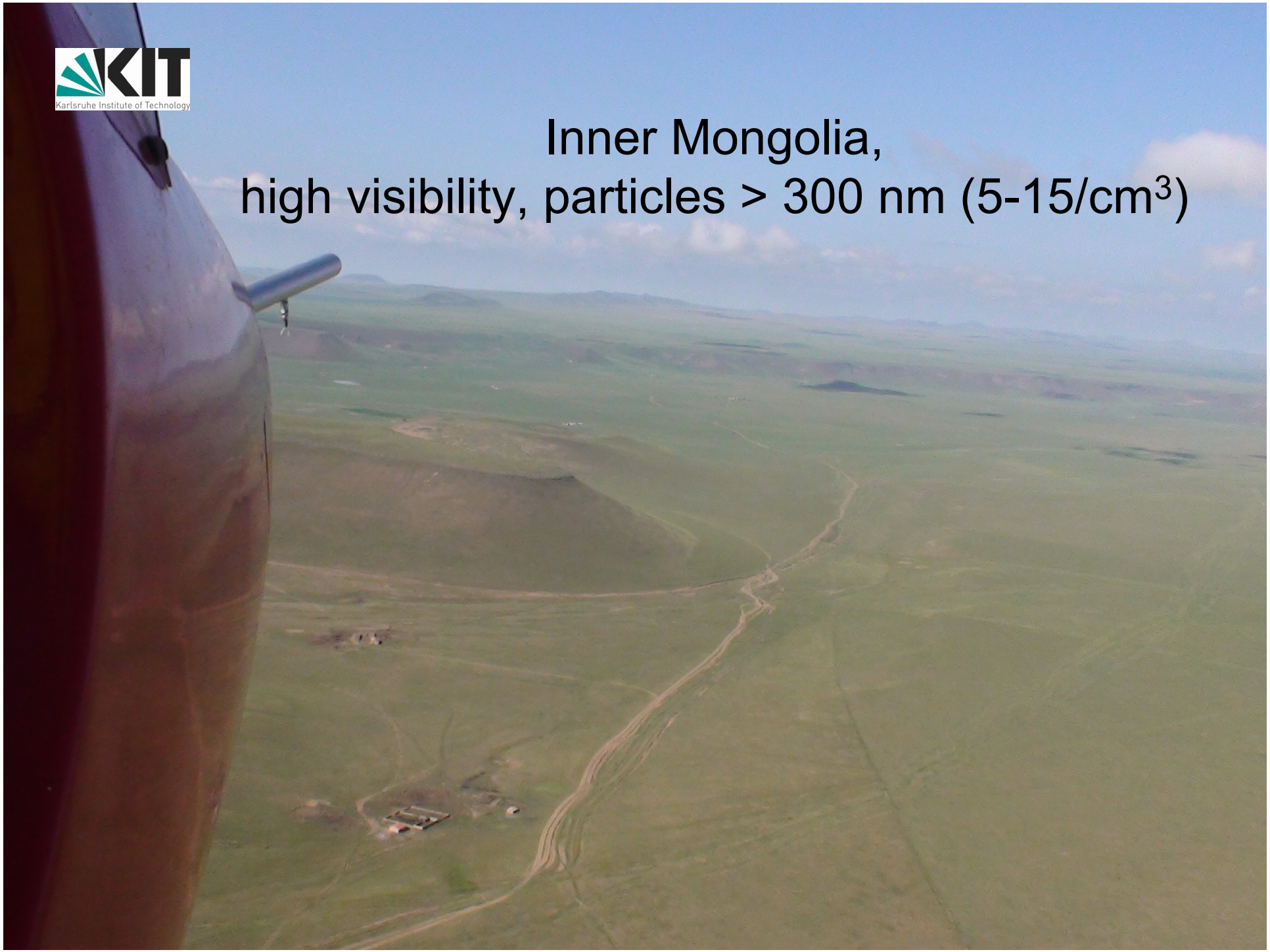
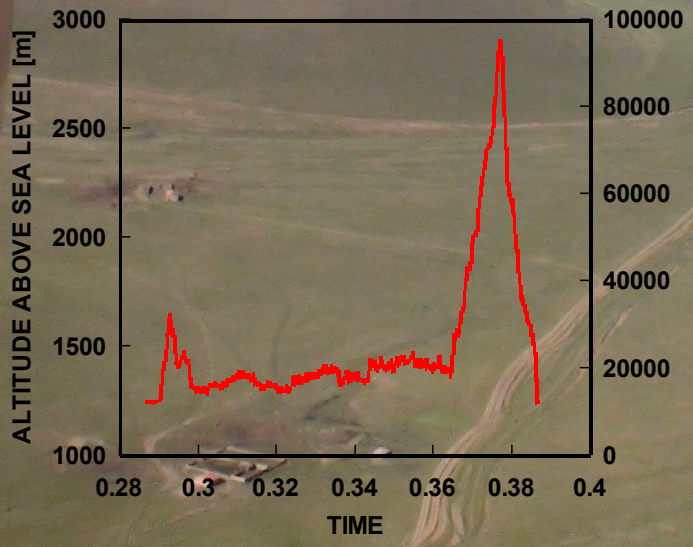
BOTH

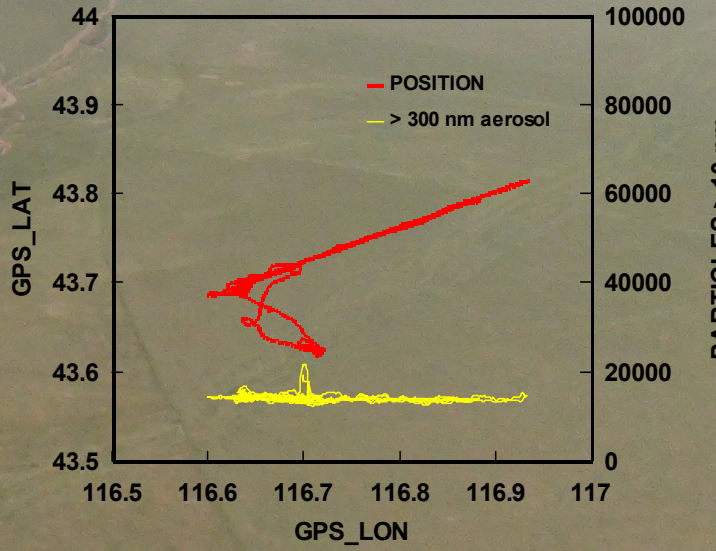



Inner Mongolia, summer 2009

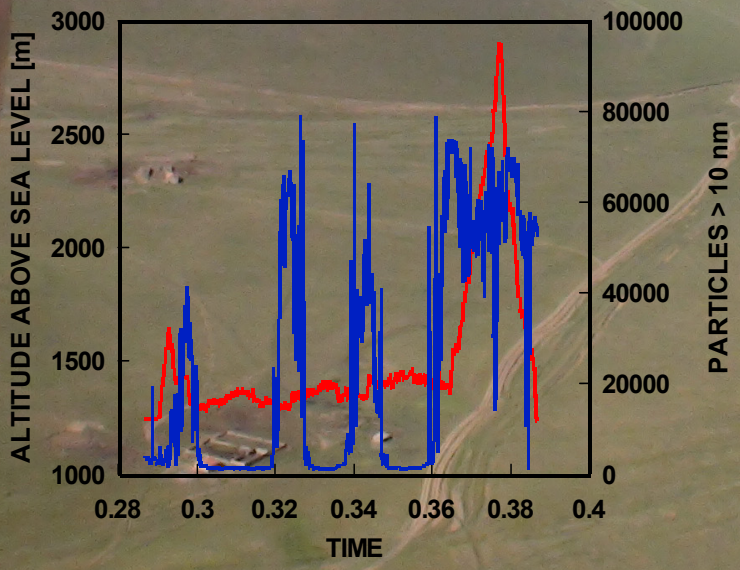

Inner Mongolia,
high visibility, particles > 300 nm (5-15/cm³)

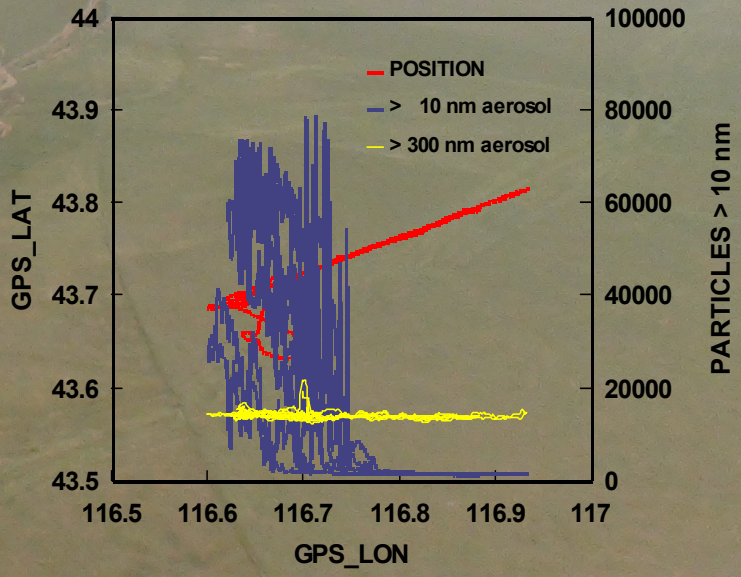
Inner Mongolia, ultrafine particle production?





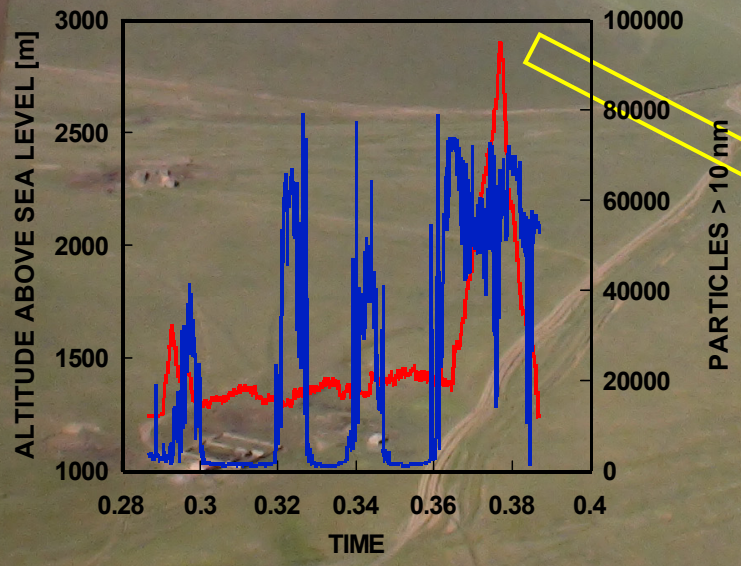
Inner Mongolia, ultrafine particle production?

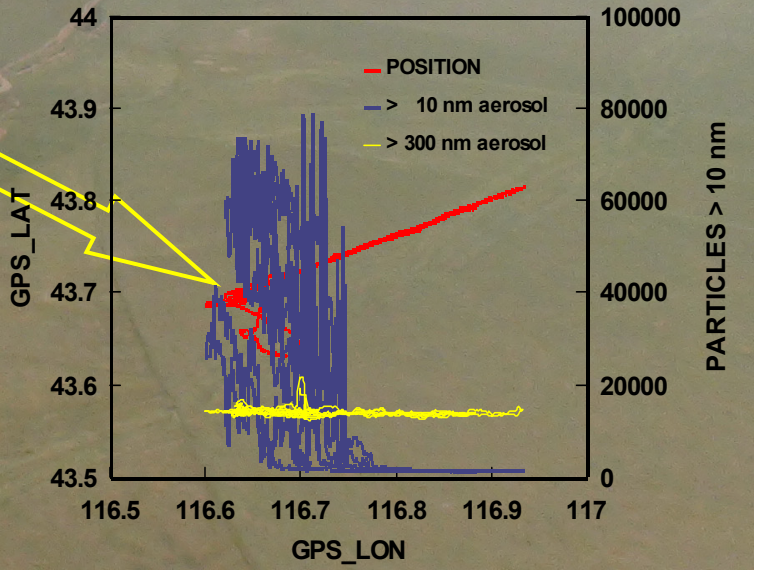




Inner Mongolia, ultrafine particle production?

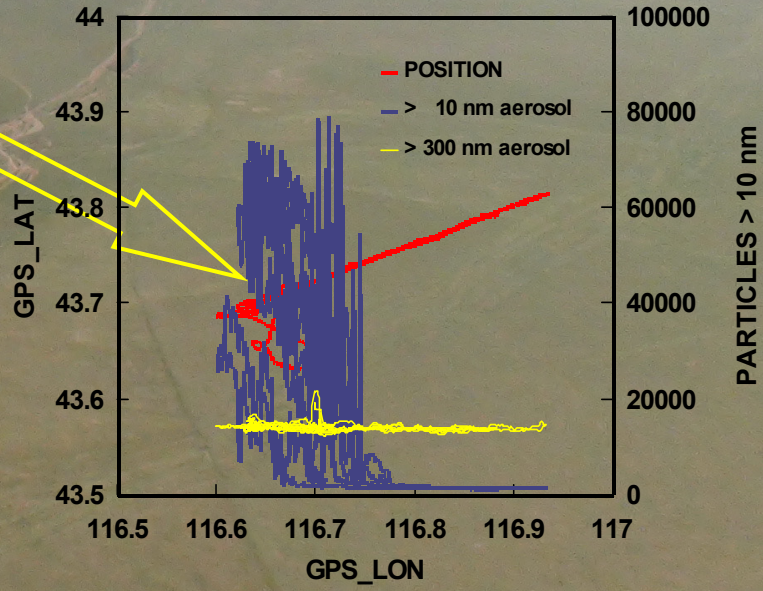
WIND 310 °, 8 m/sec, 55 km distance

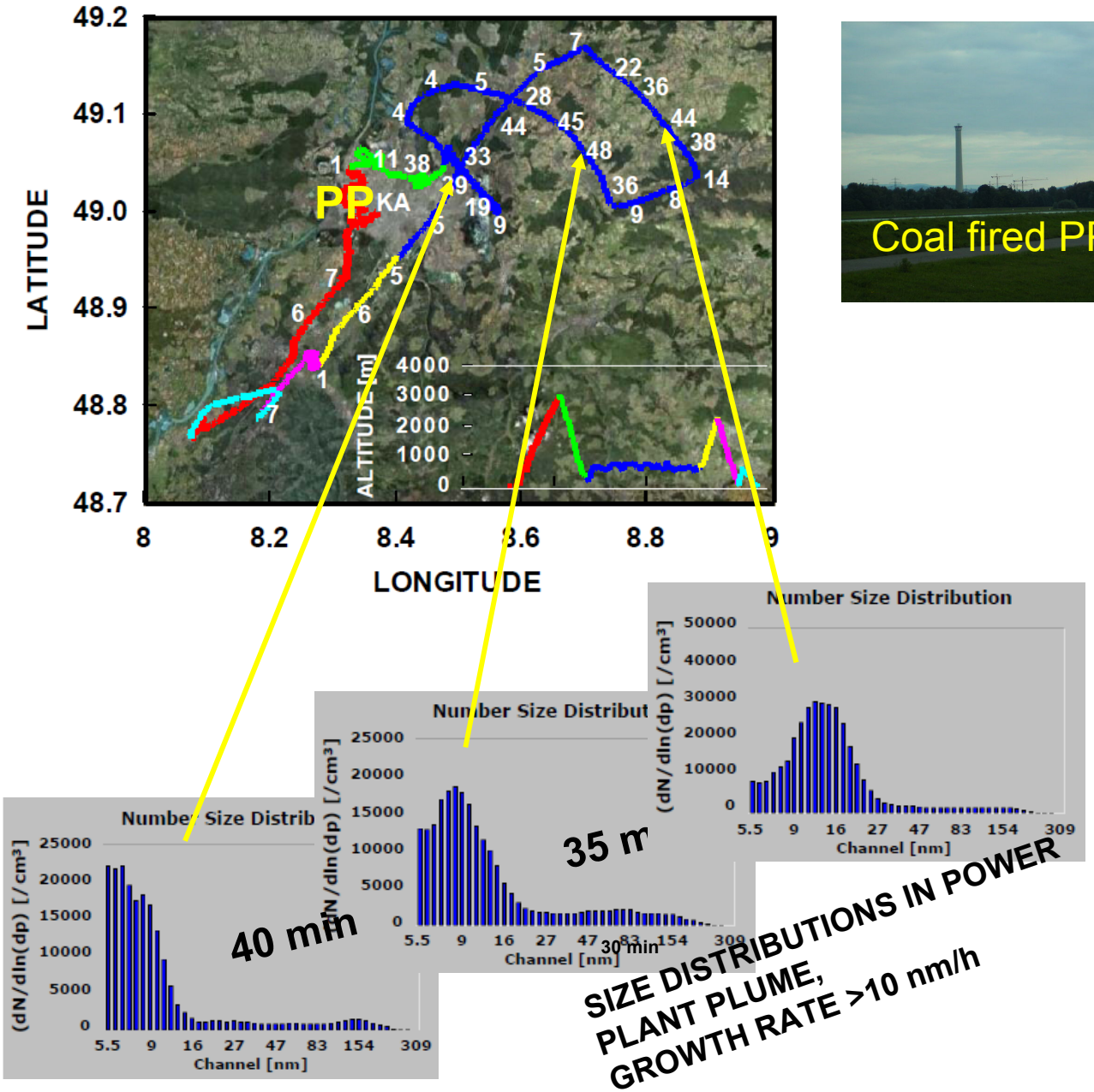




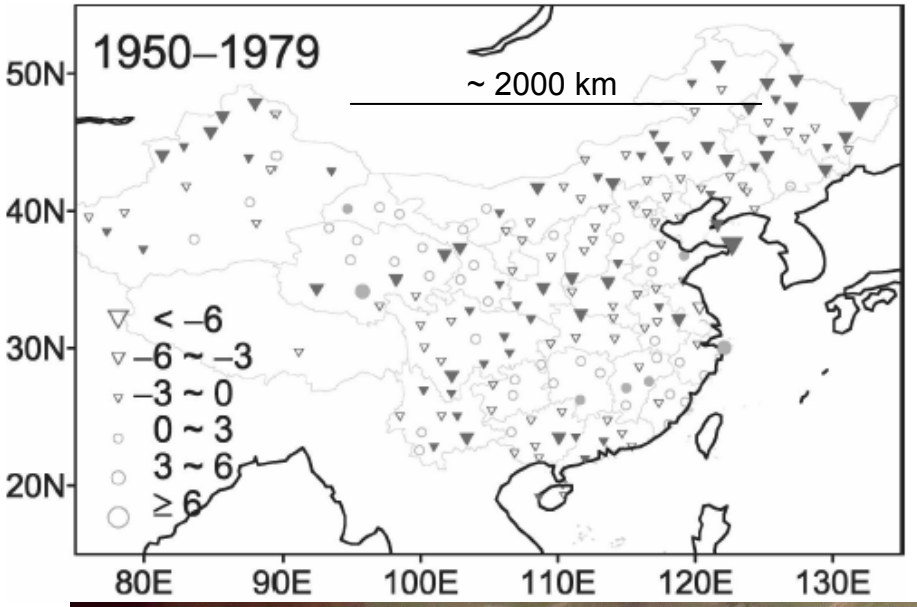
Inner Mongolia, ultrafine particle production?

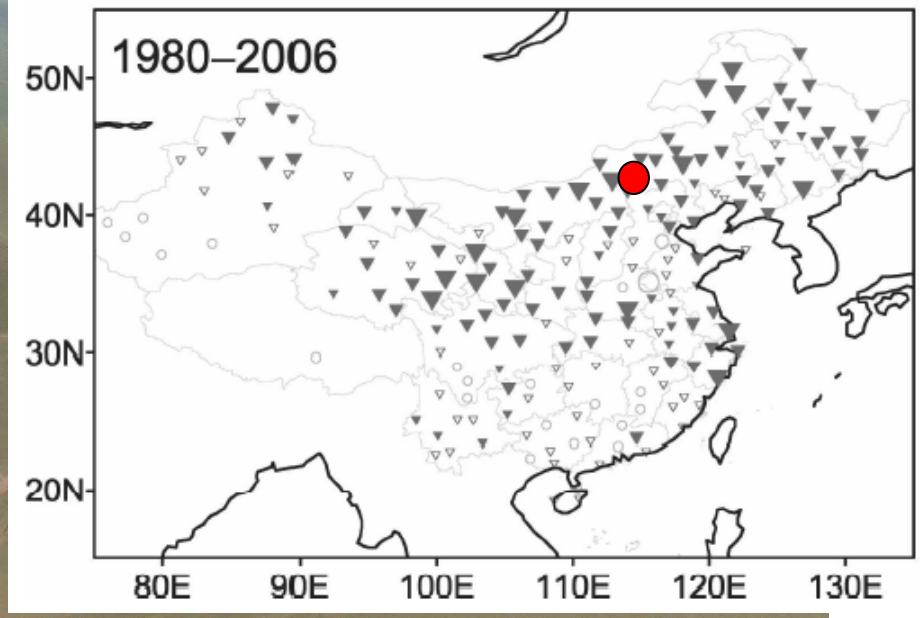
XILINHOT WIND 310 °, 8 m/sec, 55 km distance




49.2
49.1
49.0
48.9
48.8
48.7
LATITUDE
8
8.2
8.4
8.6
8.8
LONGITUDE
PP KA
ALTITUDE [m]
4000
3000
2000
1000
0
Coal fired PP KA
Number Size Distrib
(dN/dln(dp) [/cm³]
25000
20000
15000
10000
5000
0
5.5 9 16 27 47 83 154 309
Channel [nm]
40 min
Number Size Distribut
30 min
Number Size Distribution
50000
40000
30000
20000
10000
SIZE DISTRIBUTIONS IN POWER PLANT PLUME, GROWTH RATE >10 nm/h

Inner Mongolia, long term data sets frequency of rainy days in summer



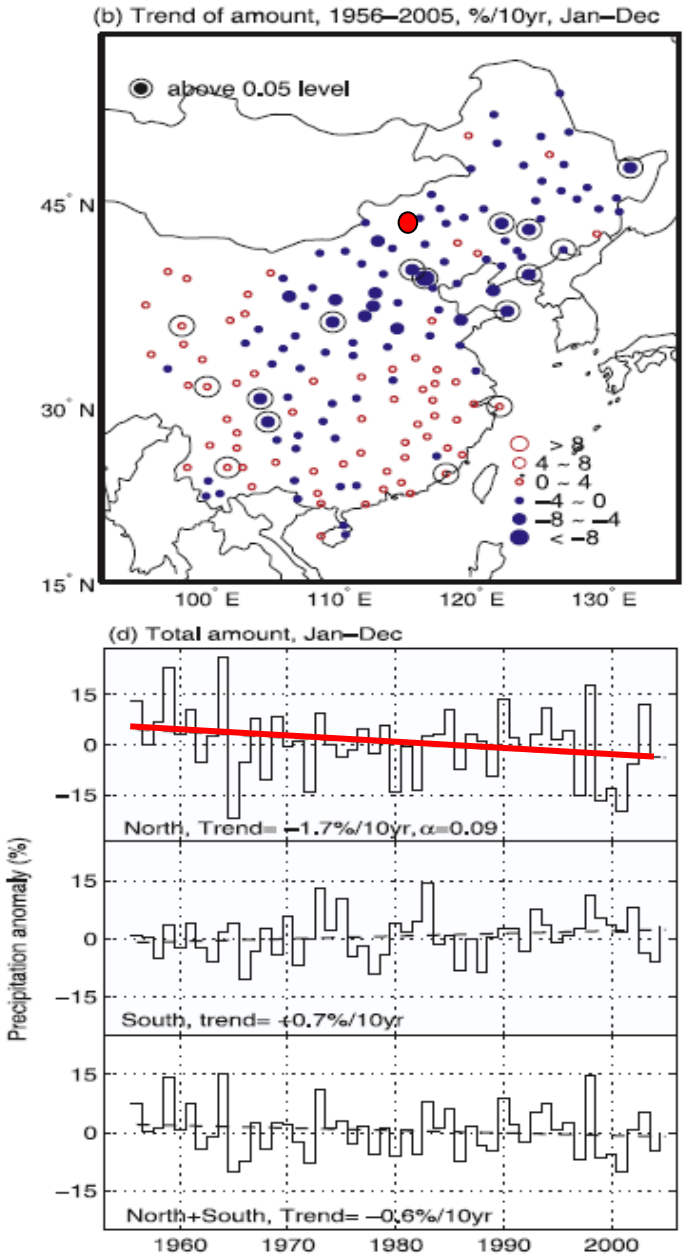


The Impact of Aerosols on the Summer Rainfall Frequency in China

YONG-SANG CHOI AND CHANG-HOI HO

JOURNAL OF APPLIED METEOROLOGY AND CLIMATOLOGY

Fig. 6. The trend of the rain frequency [days (10 yr)$^{-1}$] in summer for (top) 1955–79 and (bottom) 1980–2005. Stations significant at the 90% level are indicated by filled symbols. In contrast to the situation before 1979, the rain frequency has rapidly decreased since 1980.



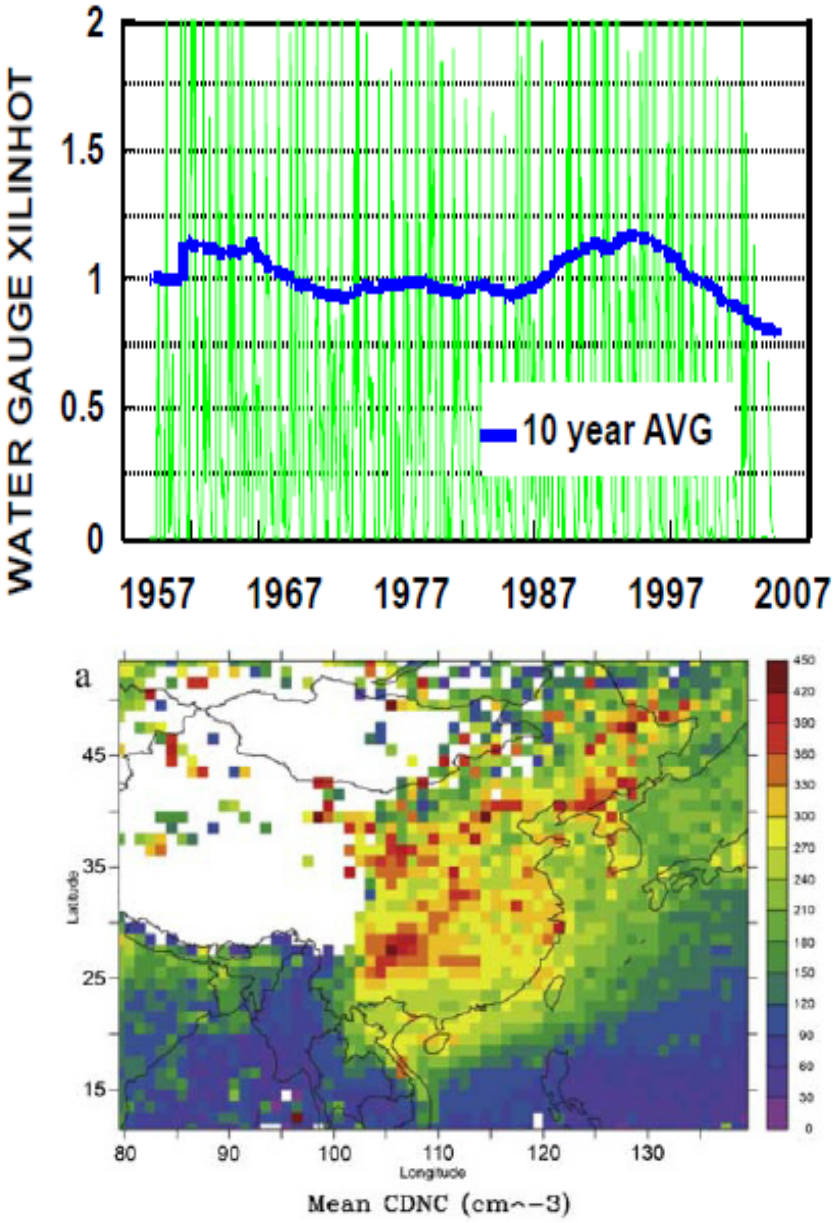
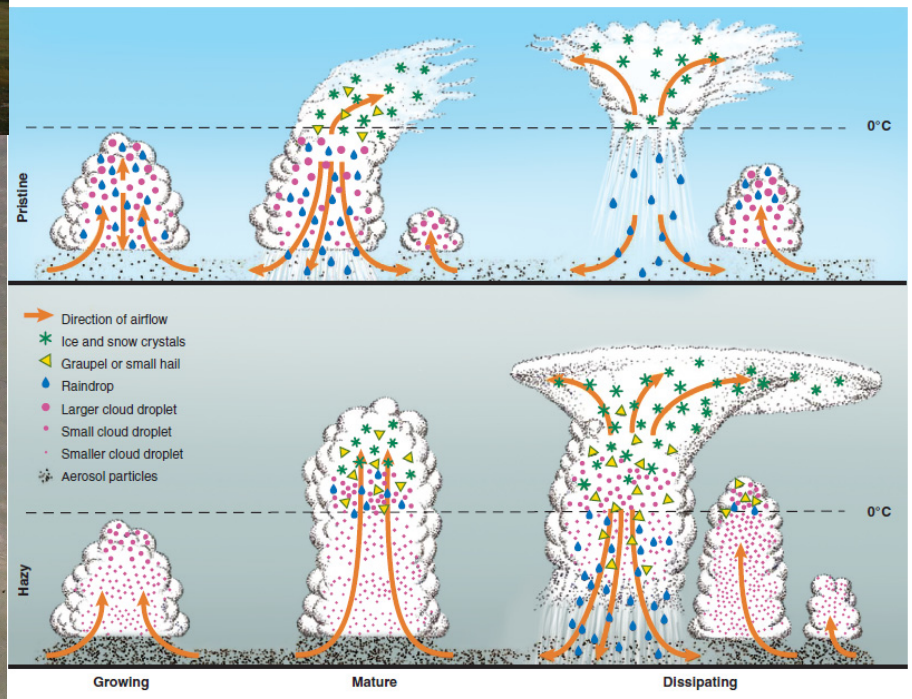


Figure 10. The spatial distribution for cloud droplet number concentration (CDNC, cm^3) and cloud effective radius for water clouds (CERW, μm) averaged for 2003–2006.

Inner Mongolia,
flood/drought,

erosion / desertification



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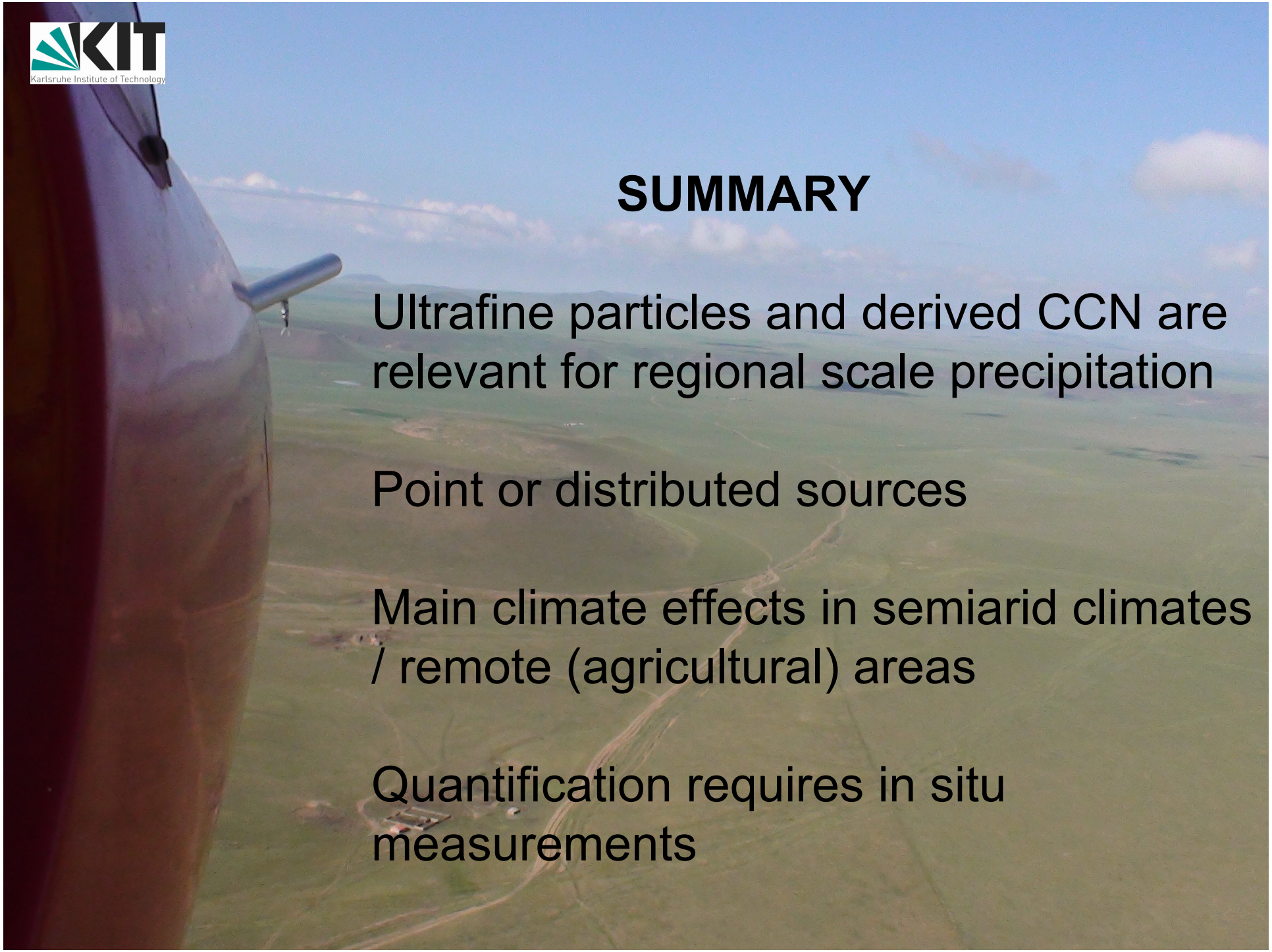

SUMMARY

Ultrafine particles and derived CCN are relevant for regional scale precipitation

Point or distributed sources

Main climate effects in semiarid climates / remote (agricultural) areas

Quantification requires in situ measurements