

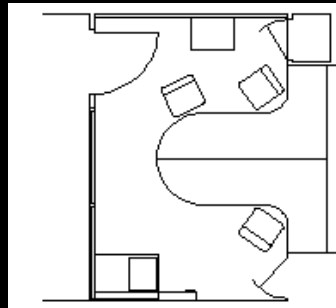
Imperial College
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INTERACTION OF CHARGED MOLECULES AND PARTICLES WITH ELECTROMAGNETIC FIELDS IN THE INDOOR ENVIRONMENT

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Electrical effects dominate aerosol removal in the 50-1000nm (0.05-1.0µm) size range (McMurry & Rader 1985)

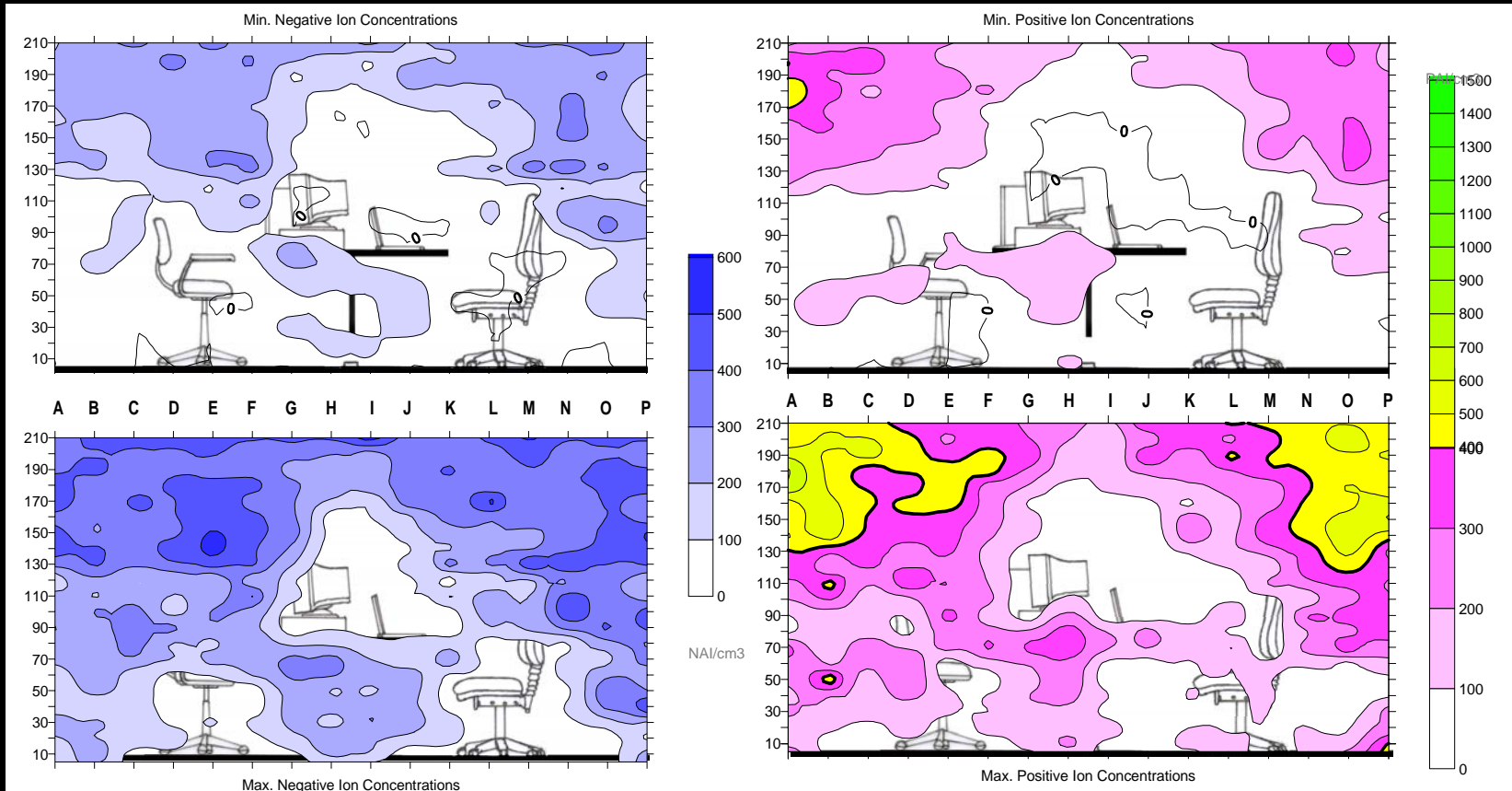
(This is a size range that contains many airborne contaminants)

Air Ion (AI) Mobilities

- Small AI (<1.6 nm dia.) (charged molecules) $>0.5 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$
- Intermediate AI (1.6-7.4 nm dia.) $0.1\text{-}0.5 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$
- Large AI (7.4-79 nm dia.) $<0.1 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$
(Intermediate and large air ions (LAI) are charged particles)
- High levels of Large AI found in areas with low SAI

BACTERIA (50-1000 nm DIA.) CAN BE HIGHLY CHARGED - THEY AND VIRUSES ARE OFTEN FOUND IN DROPLET NUCLEI (a type of airborne particle)

Small Air Ion levels can be location specific



Concentrations are reduced by some electrical items and synthetic finishes (Individuals can often spend long periods in areas with low SAI concentrations and high large AI concentrations)

Small Air Ions (SAI) are biologically essential

- Animals die in weeks if completely deprived of negative small air ions (NSAI) (Goldstein & Arshavskaya 1997) (Lapitsky 1947)
- Concentrations of 0-210 NSAI/cm³ measured at personal breathing zones in office (in previous slide)
concentrations of SAI may cause Hypoxia in humans (Chizhevskiy 1961)
- Both positive small air ions (PSAI) and NSAI are bactericidal when present in large numbers
- **BACTERIA AND VIRUSES THRIVE IN LOW LEVELS OF SAI**

LEGISLATION / GUIDELINES

The Russian Federation

(SanPiN (Sanitary and Epidemiological Norms) 2.2.4.1294-03)

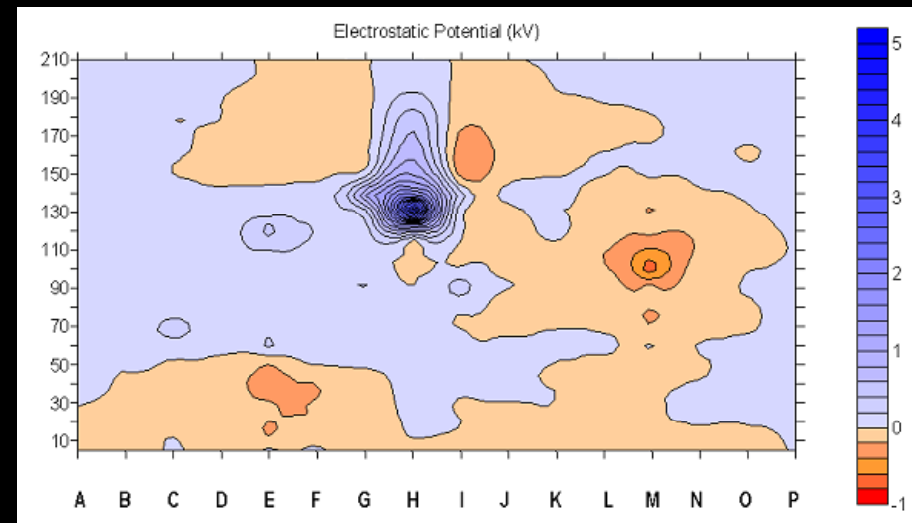
- Mandatory SAI levels per cm^3 whilst staying in enclosed space daily (should be introduced as standard)
- Minimum: 600 NSAI and 400 PSAI
- Optimum: 3000-5000 NSAI and 1500-3000 PSAI
- Maximum: 50000 NSAI and 50000 PSAI

The United States of America

- In 1972 the FAA acknowledged that very low SAI levels can produce detrimental effects (Rosenberg 1972)

Electrostatic Attraction (ESA), VOC and Bio-Aerosol Deposition

- Greatly effected by triboelectric nature of materials, electrical items and Relative Humidity (RH)
- Charges greatly increased when $RH \leq 20-30\%$ (Moss 1987)
- Deposition velocity increases with surface charge
- Deposition in the lung of $1\mu\text{m}$ particles with 100 elementary electric charges is ≈ 10 times larger than neutral particles (Bailey 1997) (High fields are often found where individuals spend long periods thereby increasing retention risk)



Section taken through office area
(shown in a previous slide)

A.C. Electric Fields (10-2000 Hz \pm 3dB)

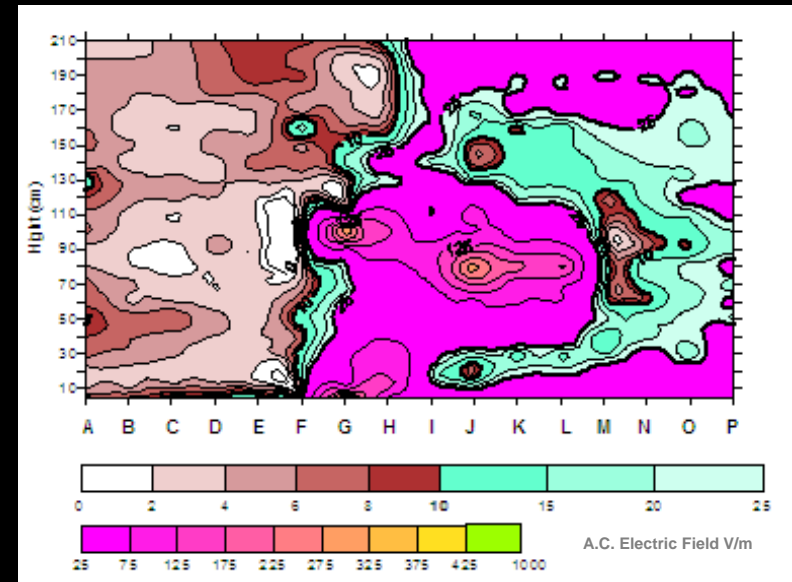
- Can influence deposition and possibly bacterial growth – higher microbial deposition linked with higher fields (deposition of other aerosol contaminants also increased)

International guidelines on permissible field levels vary greatly

ICNIRP and HPA (UK) suggest 5000 V/m (for 50 Hz fields to the public)

Russia and Sweden suggest ≤ 25 V/m (at 0.5m from VDUs)

(SanPiN, SWEDAC 1990:8)



Section taken through office area (shown in a previous slide)

Conclusions and Implications

- Excess charge plays a major role in contamination and deposition (and should be reduced whenever possible)
- Large charges can be highly localised and detrimentally reduce SAI (whilst detrimentally increasing LAI levels)
- Such regimes can negatively impact health and spread microbial infection (and should be discouraged, particularly in health-care environments)
- Buildings should be low EMF “SAI-friendly” environments (and adopt standards similar to those of Russia and Sweden)
- **SOLUTIONS CAN BE INEXPENSIVE AND GREATLY BENEFIT NATIONAL ECONOMIES**

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- All text shown in these slides typed with the colour presently used represent comments made by the author on the day of presentation.
- The full reference and author listing for the paper on which this presentation was originally based is: Jamieson, KS, ApSimon, HM, Bell, JNB and Yost, MG 2005. Interaction of Charged Molecules and Particles With Electromagnetic Fields in the Indoor Environment, *Indoor Air 2005: Proceedings of the 10th International Conference on Indoor Air Quality and Climate*, Indoor Air 4-9 September 2005, Beijing, China. CD-ROM 1 Disk, ISBN 7-89494-830-6.
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