#### High spatio-temporal resolution maps of atmospheric dry deposition velocities using the MÉRA dataset

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#### Concern about national emissions

- atmospheric emissions of gaseous compounds (e.g. ammonia from agriculture) are having an impact on natural ecosystems
- globally elevated inputs of nitrogen deposition have had a negative impact on plant species diversity
- nationally, they directly effect national commitments under the Habitats Directive



the National Emissions Ceiling Directive requires all member states establish a network of ecosystem sites to evaluate the impact of air pollutants on national ecosystems

ammonia emissions (perhaps) the most important national gaseous emissions

### Outline



#### Atmospheric deposition

- removal process, i.e., the transfer of trace chemicals in the atmosphere to the Earth's surface
- total deposition = wet deposition + dry deposition
- wet deposition is measured by the collection of precipitation samples and their chemical analysis
- Met Eireann have actively monitored precipitation ~60 years!) at a subset of stations, e.g., Valentia
- currently 5 stations in IE monitoring wet deposition.

#### dry deposition is not easily measured

Generally estimated from air concentration and deposition velocity



#### Atmospheric dry deposition

- dry deposition = air concentration × deposition velocity
- can make up a significant portion of total deposition (up to 50%)
- important in air pollution research (e.g., national emissions ceilings Directive)

#### Dry deposition velocity is:

- the rate at which dry deposition (abbreviated V<sub>dep</sub>) occurs
- varies with gaseous and particle species, receptor surface, and meteorological conditions
- accurate V<sub>dep</sub> -> accurate dry deposition estimation



## Why model?

- difficult to directly measure owing to very complex process ( aerosol physical and chemical properties, surface characteristics, micrometeorological conditions
- V<sub>dep</sub> can be inferred from deposition flux measurements and wind tunnel experiments
- results from theoretical estimations, wind tunnel experiments, and field observations don't often agree, particularly for the 0.1-1.0 µm particle sizes



Figure 5. A depiction of the processes contributing to the deposition of airborne particles and trace gases. Turbophoresis is a recent addition to the suite of mechanisms.

## Big leaf model



evergreen broadleaf shrub

water

sugar

### Model output



#### 31 gaseous species:

Sulphur dioxide, sulphuric acid, nitrogen dioxide, ozone, hydrogen peroxide, nitric acid, nitrous acid, pernitric acid, **ammonia**, peroxyacetylnitrate, aromatic acylnitrate, peroxymethacrylic nitric anhydride, formaldehyde, acetaldehyde, C3 carbonyls, C4-C5 carbonyls, C6-C8 carbonyls, aromatic carbonyls, methylvinyl-ketone, methacrolein, methylgloxal, methyl acohol, ethyl alcohol, C3 alcohol, cresol, formic acid, acetic acid, organic peroxides, organic nitrates, isoprene nitrate

3 particulate species classes: PM<sub>2.5</sub>, PM<sub>2.5-10</sub>, PM<sub>10+</sub>

#### Initial study

- big leaf model applied to hourly measured data from 23 Met Éireann monitoring stations (June 14, 2013 – July, 2014 to coincide with ammonia monitoring network)
- all landcover types relevant to Ireland were modelled



- results showed temporal (day/night, seasonal variation) and spatial variation in V<sub>dep</sub>
- publication of MERA daset provides meteorological data to map V<sub>dep</sub> on a national scale

## The MÉRA addition

- national application of big leaf model using MÉRA data
- resolution: 2.5 km<sup>2</sup>, 3-hourly
- overlaid with CORINE 2012 map, to allow landcover to be weighted per grid
- similar country wide studies have been conducted before (e.g. southern Belgium, de Vos & Zhang 2012), but not Ireland



## Results using MÉRA data



animated mapped model results for NH<sub>3</sub> for June 2013 to July 2014

### Mapping nitrogen deposition

V<sub>dep</sub> results allow us to improve dry and total deposition maps



 deposition > 10 kg N can impact plant species diversity (concern under the habitat directive)

# Thank you!

We gratefully acknowledge the funding from the EPA (project 2016-CCRP-MS.43) and collaboration from the NPWS

And of course thanks to MÉRA for the modelled data

## Further reading

#### References

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