Differences among atmospheric dispersion models applied to local scale

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Project Background: WP2.2 of the SAGEN project

- **Aim of the project:**
  - Reduce uncertainties in measurements and modelling of reactive nitrogen

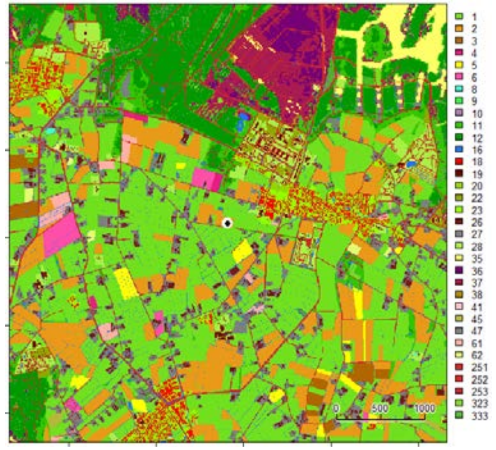
- **Focus of WP2.2:**
  - Modelling of nitrogen deposition from ‘hundred metres to a few kilometres’ (local scale)

- **Approach:**

1. Intercompare outcomes of operational dispersion models
   - identify spread in model outcomes
   - identify circumstances that give the largest spread

2. Compare model outcomes with observations (P1.1)

Intercomparison of concentrations and deposition



Study design:

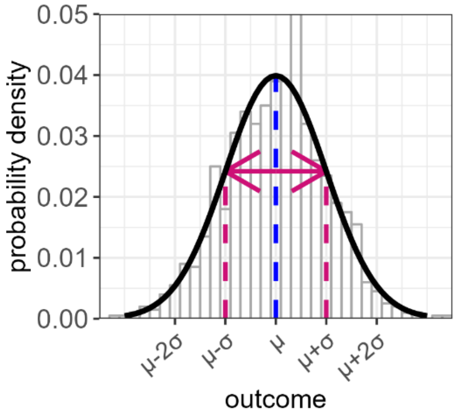
Eight operational atmospheric dispersion **models**
Four **cases**
Ten years hourly **meteorology**
Homogeneous (2×) and realistic **land cover**
Seven **distances** (from 50 m to 5 km) and 12 directions

Results:

Differences in annual **concentrations**
Differences in 10-year-average **deposition** fluxes
Most relevant meteorological conditions

Models:
ADMS, AERMOD, IFDM, OML,
OPS-ST, OPS-LT, SRM2, STACKS-D

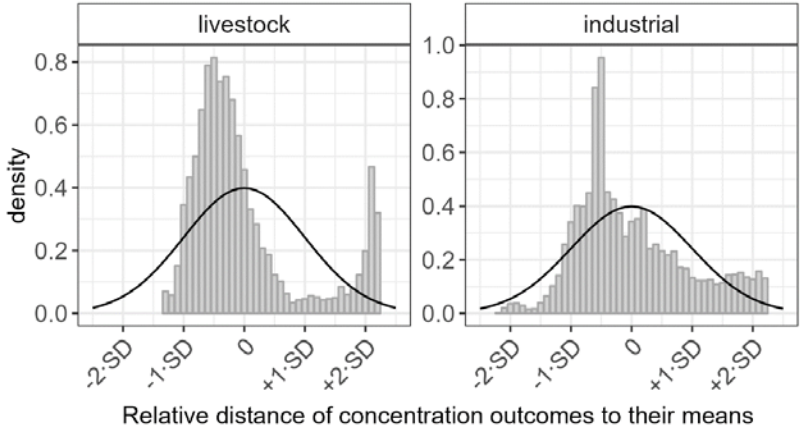
Measuring ‘differences among models’



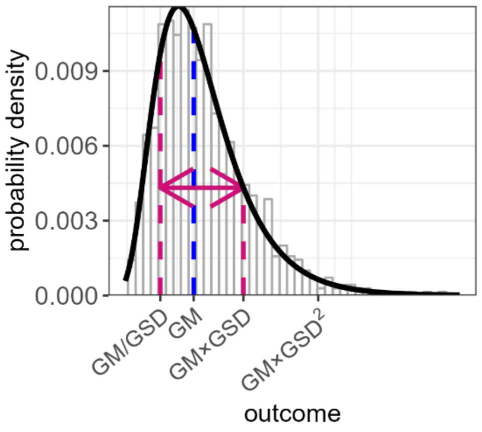
Normal distribution

average value (μ)
standard deviation (σ)

- typical <u>absolute</u> deviation (around μ)



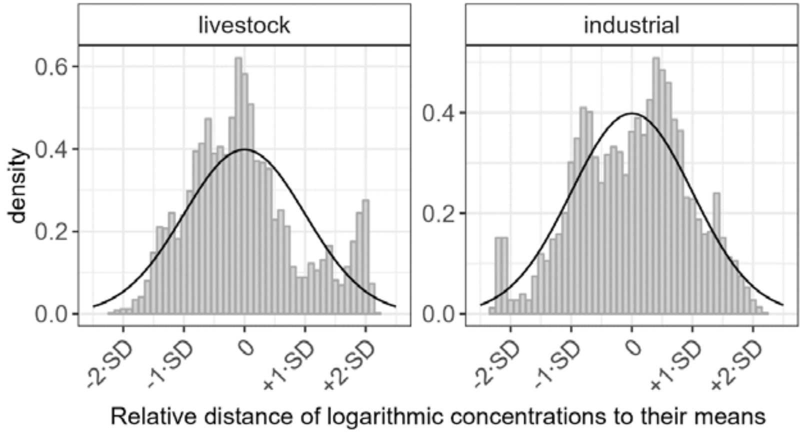
x



Lognormal distribution

Geometric Mean (~median)
Geometric Standard Deviation

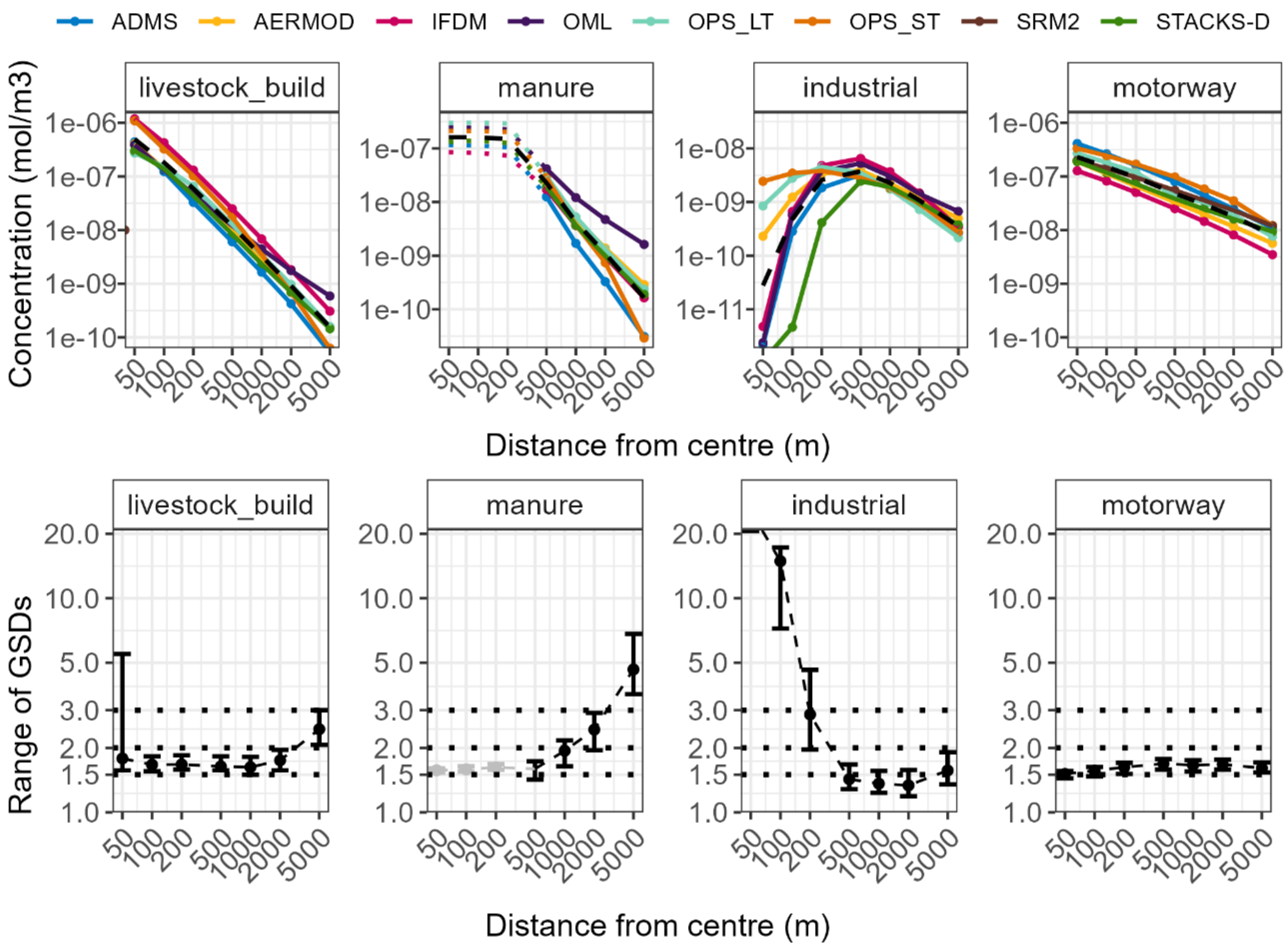
- typical <u>multiplicative factor</u> deviation (around GM)



log(x)

GSD=a: ~68% of data between GM/a and GM·a

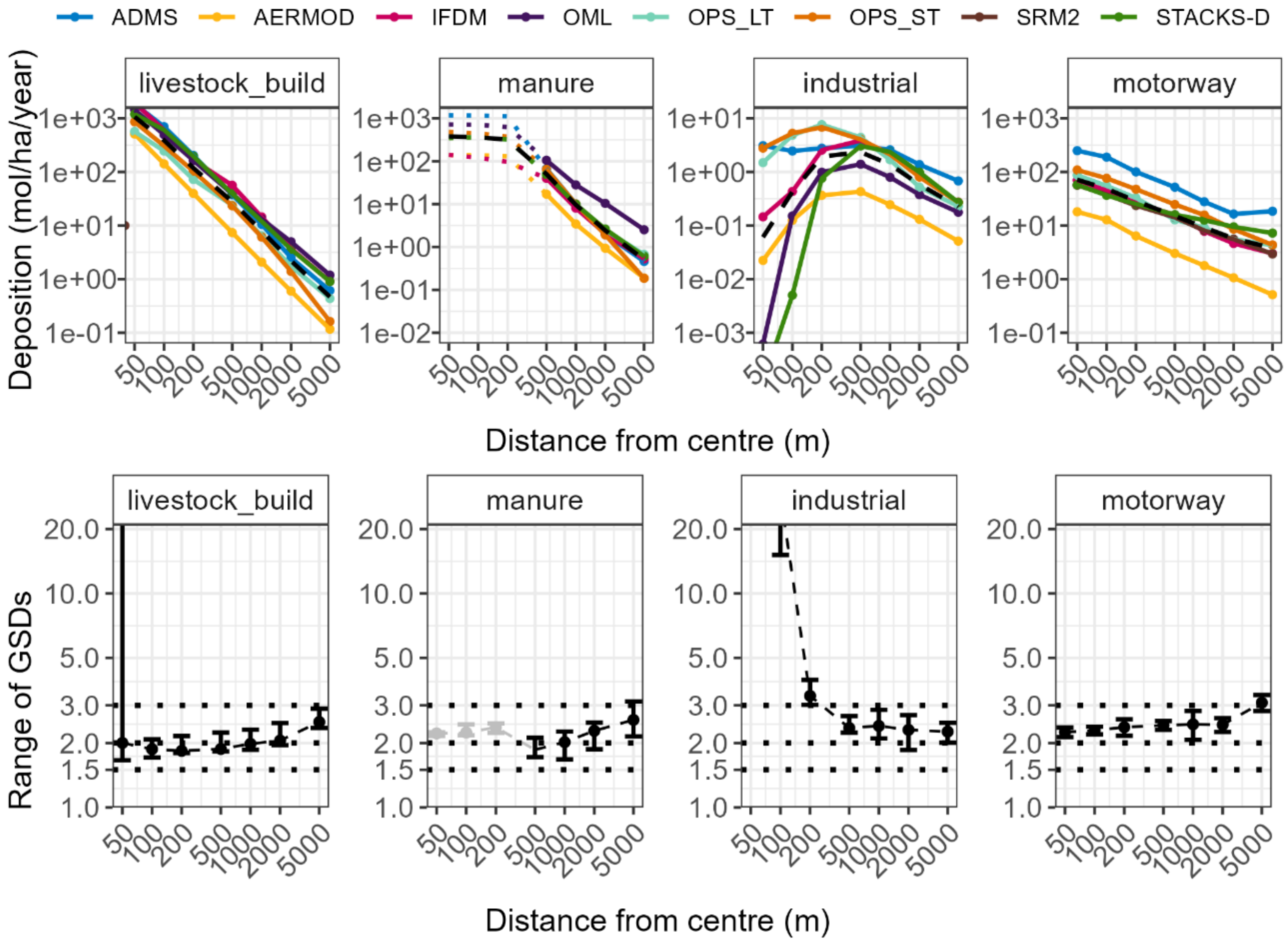
Differences in concentrations



- › different slopes for different cases
- › models differ mostly in magnitude
  - – much less in trend with distance

- › GSD mostly between 1.5 and 2
- › larger values:
  - – for manure (≥ 2000 m)
  - – close to industrial stack (≤ 200 m)
  - – very close to livestock housing

Differences in deposition fluxes



- similarity with concentration
- different order of models
- slightly larger spread

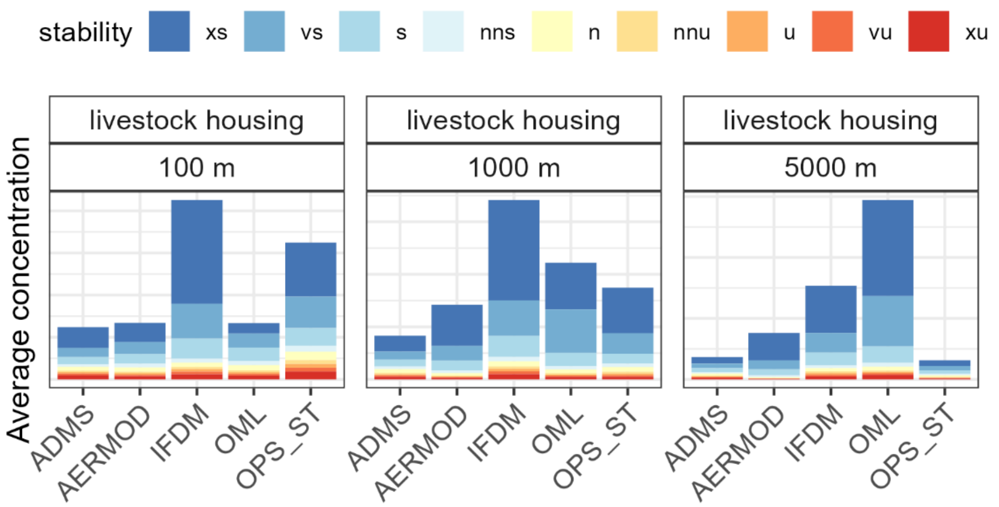
- GSD mostly between 2 and 3
- larger values:
  - close to industrial stack (≤ 200 m)
  - very close to livestock housing

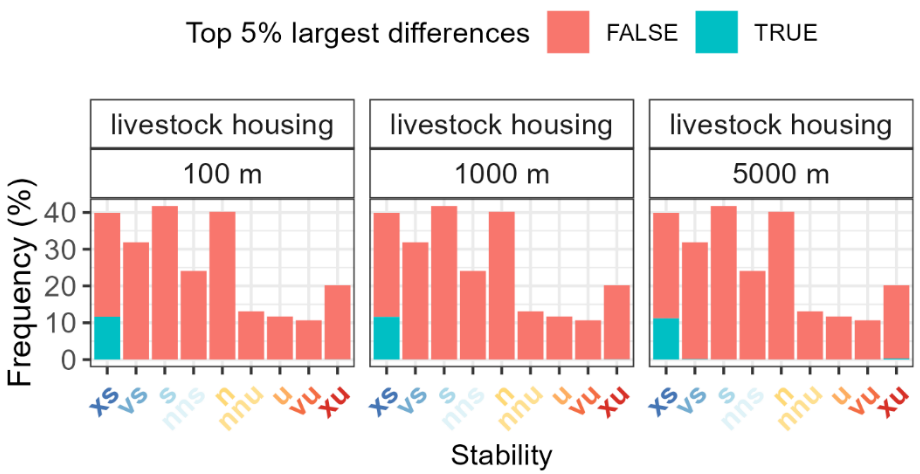
Relevance of atmospheric stability
for ground-level concentrations and **low sources**

- Using 5 models with hourly outcomes
- and 9 classes for stability

- Most important weather conditions:
  - extremely stable (xs)
  - very stable (vs)

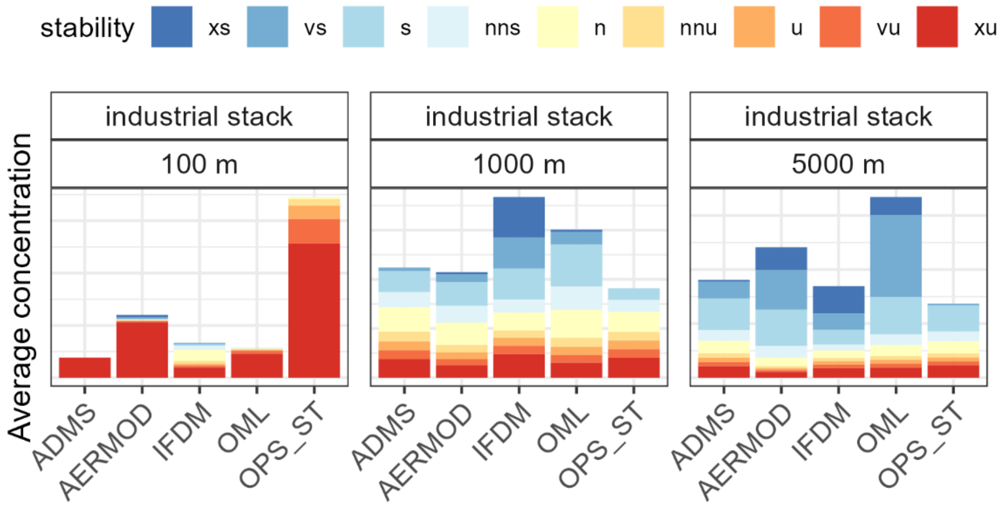
- Top 5% hours with largest differences:
  - extremely stable (xs)



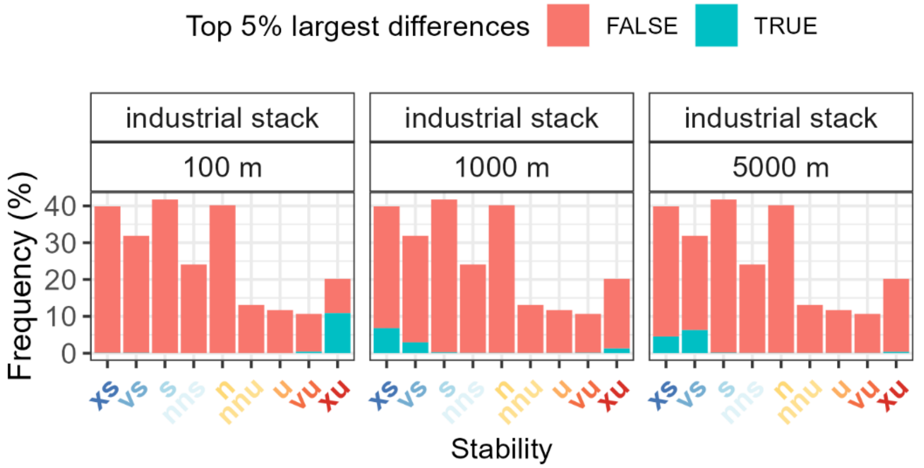


Relevance of atmospheric stability
for ground-level concentrations and **high sources**

- Most important weather conditions:
  - nearby: extremely unstable (xu)
  - further away: stable (s/vs/xs)



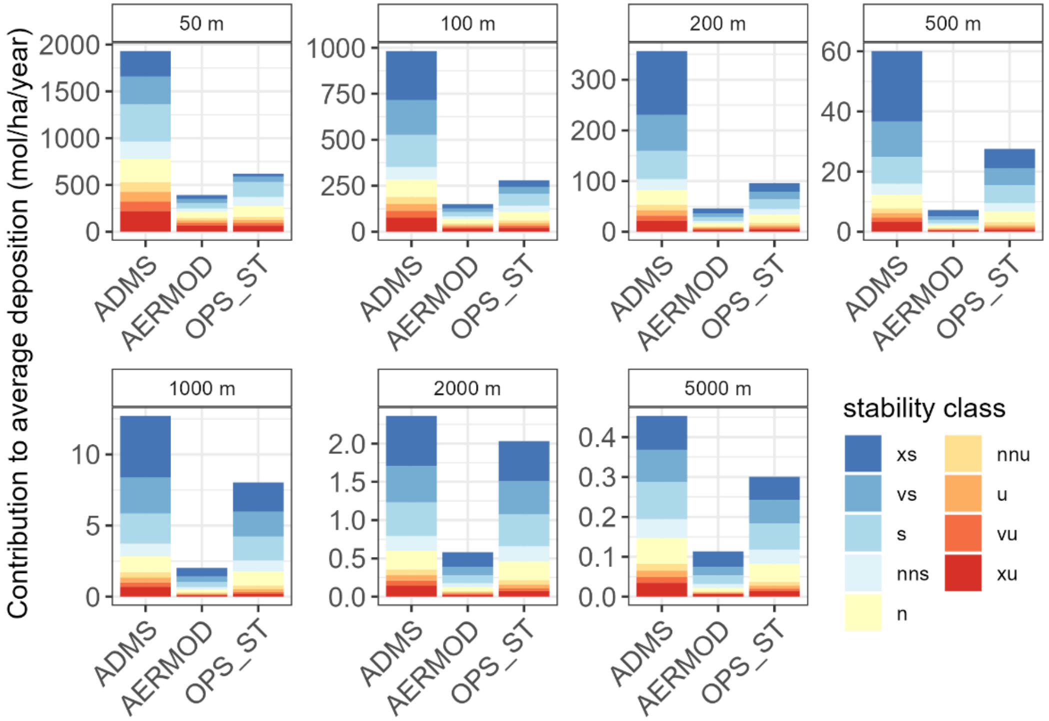
- Top 5% hours with largest differences:
  - nearby: extremely unstable (xu)
  - further away: extremely stable (xs) and very stable (vs)



Relevance of atmospheric stability for **deposition**

- Only **three models** with hourly output
- Some similarity with concentrations
  - relevance of xs slightly reduced
    - larger atmospheric resistance for xs

Results for livestock housing



Conclusions

1. Concentrations: GSD mostly between 1.5 and 2
   - some higher values close to sources (livestock_build and industrial) and for manure further away
2. Deposition: GSD mostly between 2 and 3
3. Extremely stable (xs) and very stable (vs) weather conditions most important
   - for calculated concentrations and deposition
   - for differences among models
4. Extremely unstable (xu) relevant close to industrial stack

Full report on the results of this intercomparison study is available online:
➔ [Differences in calculations of concentration and deposition of ammonia and nitrogen oxides at local scale]

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Thank you for your attention!

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Extra slides: Stability classes

Stability class	Monin-Obukhov length (L_b)
Extremely unstable (xu)	$-50 \leq L_b < 0$
Very unstable (vu)	$-100 \leq L_b < -50$
Unstable (u)	$-200 \leq L_b < -100$
Near-neutral unstable (nnu)	$-500 \leq L_b < -200$
Neutral (n)	$L_b < -500$ or $L_b > 500$
Near-neutral stable (nns)	$200 < L_b \leq 500$
Stable (s)	$50 < L_b \leq 200$
Very stable (vs)	$10 < L_b \leq 50$
Extremely stable (xs)	$0 < L_b \leq 10$