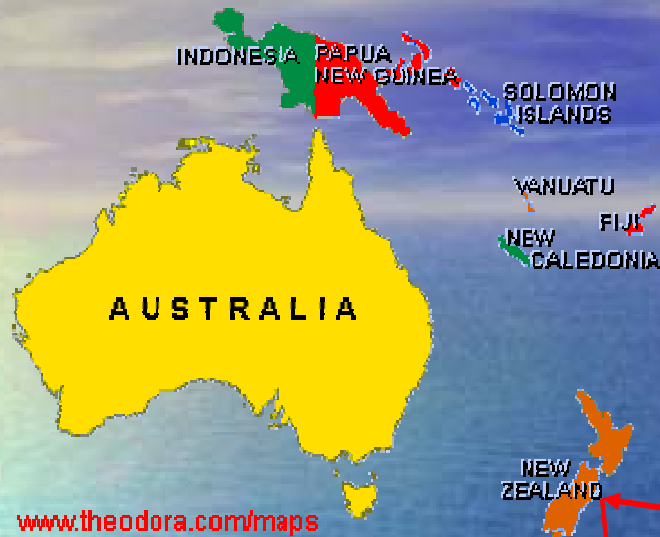


Application of MM5 to study of air pollution in Christchurch, New Zealand – some problems of using MM5 with global analysis data

Mikhail Titov, Andrew Sturman and Peyman Zawar-Reza

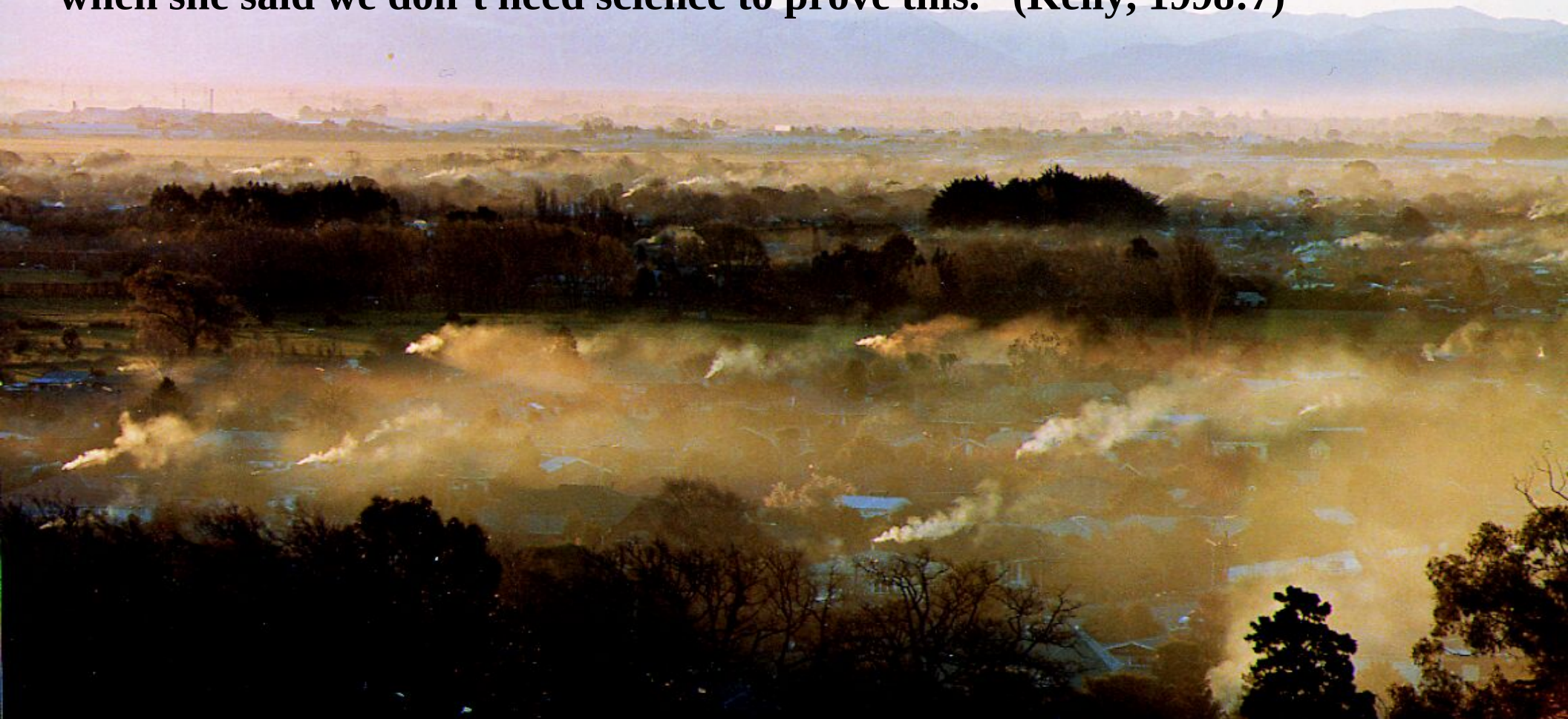
**Centre for Atmospheric Research and Department of
Geography, University of Canterbury
Christchurch, New Zealand**

Map of New Zealand and Christchurch region



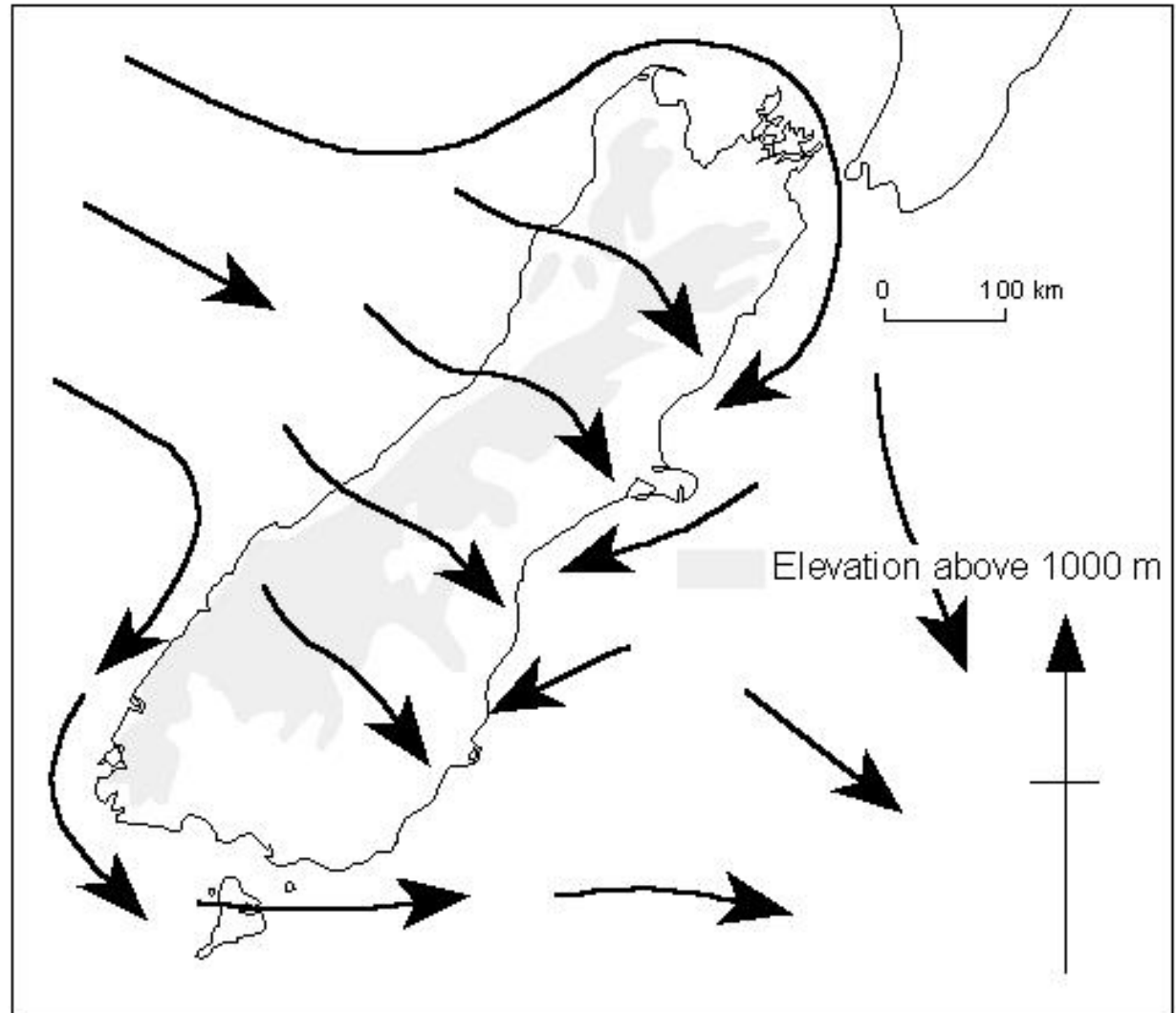
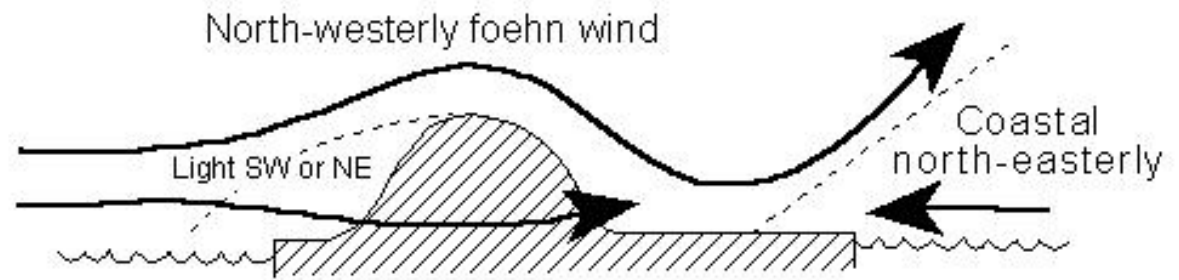
Winter time pollution – Christchurch

“Common sense shows that there is a smog problem in Christchurch - through winter you can both see and smell it. This is what Vicki Buck meant when she said we don’t need science to prove this.” (Kelly, 1998:7)

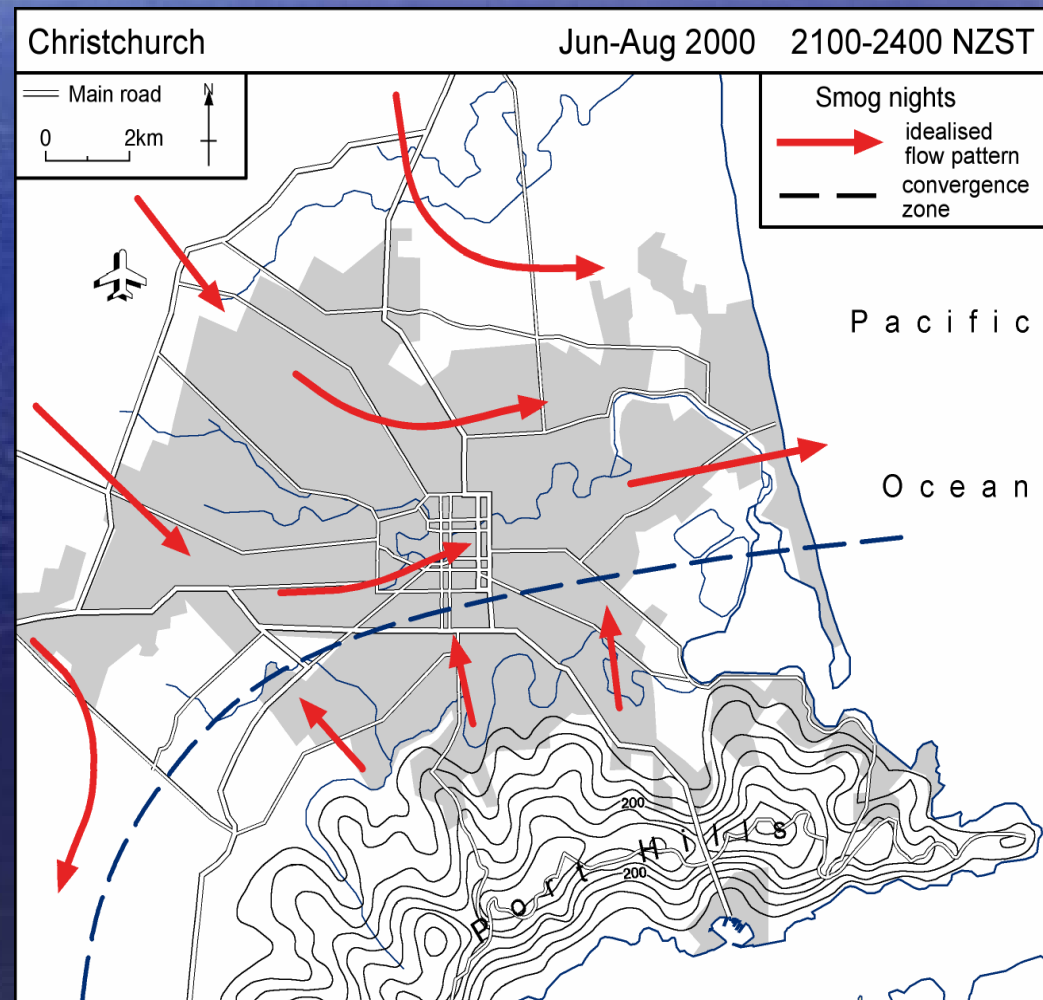
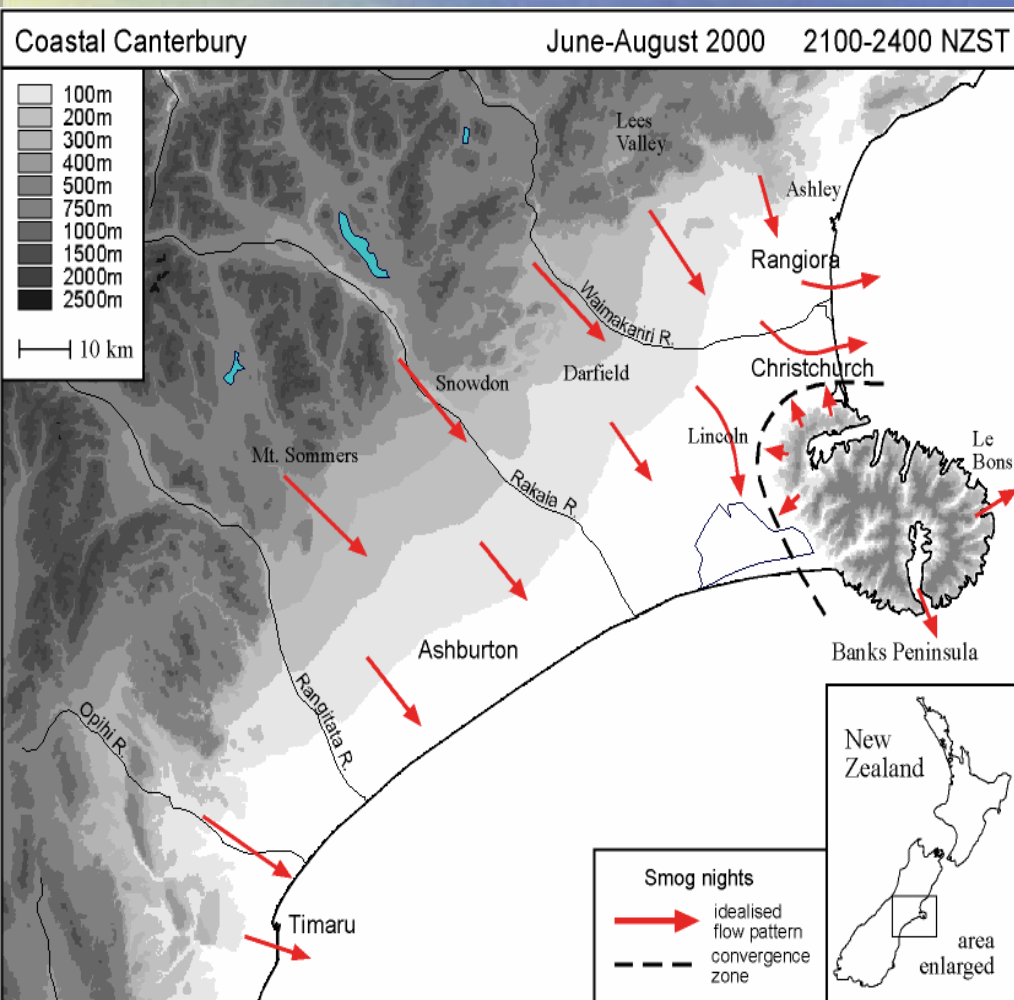


Flow over and around the South Island

Convergence of
Nor'easter and
Nor'wester over the
Canterbury Plains



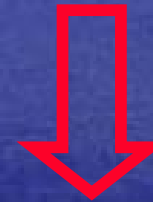
Topographic factors and a conceptual model of near-surface airflow during winter smog episodes over Christchurch



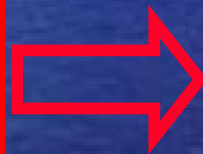
Local topographic influences on airflow

- ❏ Flow over and around the Southern Alps
- ❏ Flow over and around Banks Peninsula
- ❏ Land and sea breezes
- ❏ Drainage winds from the Port Hills and Canterbury Plains
- ❏ Wind and stability effects of urban and rural areas

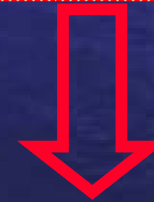
Input data:
NCEP Analysis
(Global meteorological
input fields)



Data Assimilation,
REGRID -> INTERPF

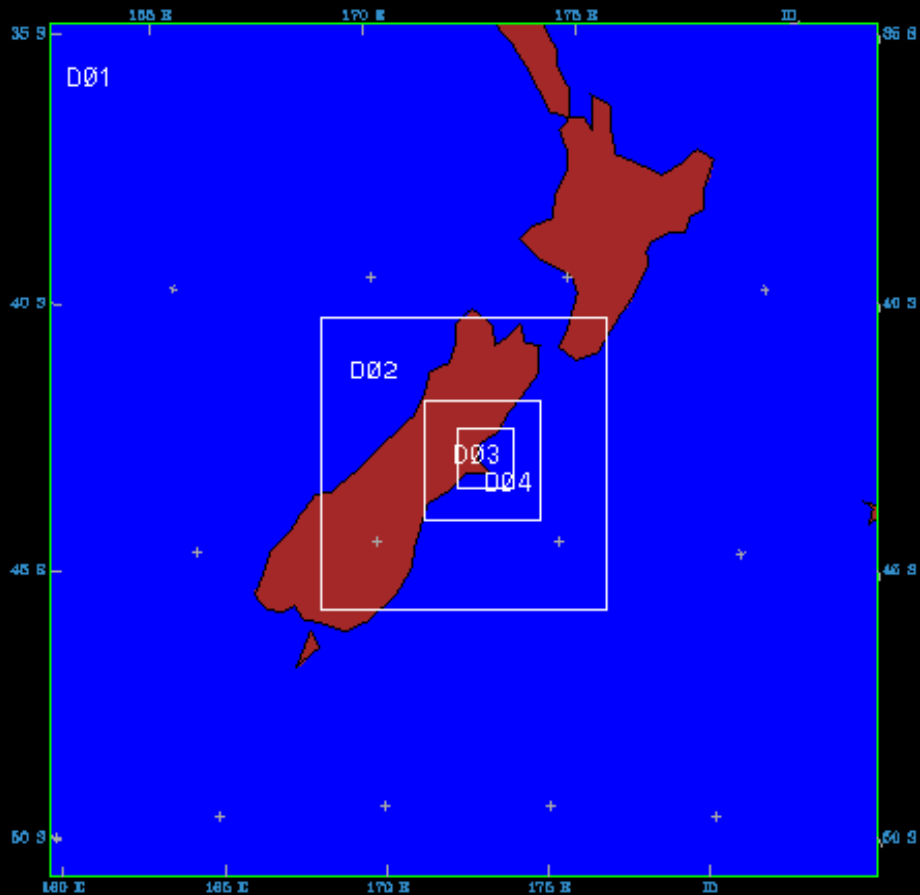


MM5 versions
3.5.3 & **3.6.1**

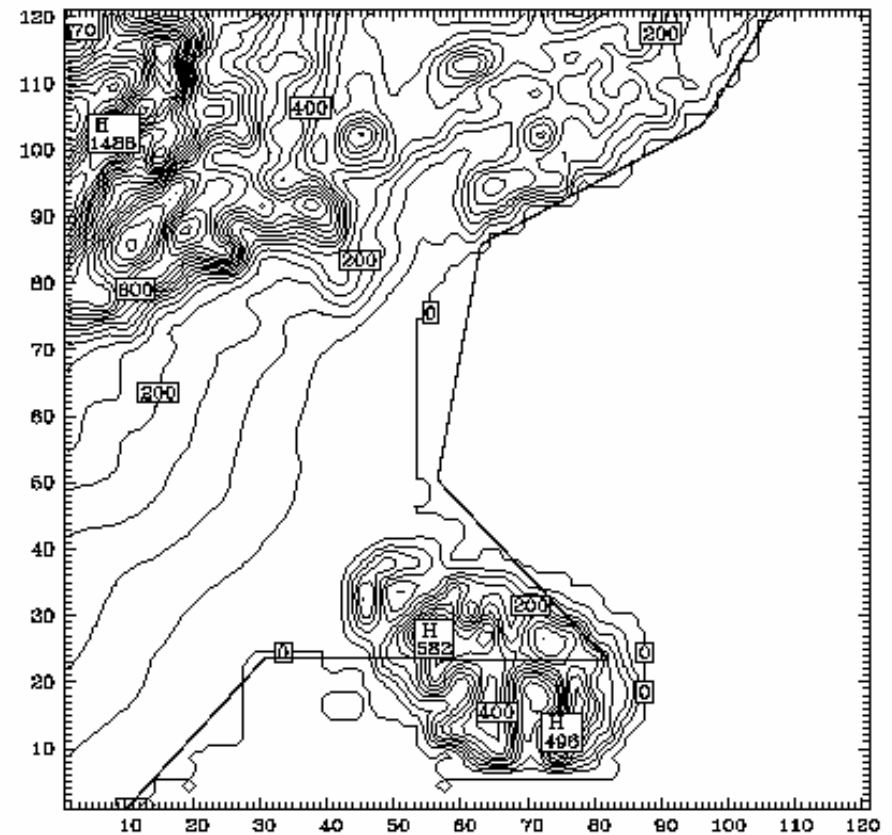


Eulerian dispersion
modules of **CAMx4**

Nested grids and orography (grid 4)



Dataset: MMOUT4 RIP: rip sample Init: 0000 UTC Tue 01 Aug 00
Fest: 0.00 Valid: 0000 UTC Tue 01 Aug 00 (1200 LST Tue 01 Aug 00)
Terrain height AMSL



CONTOURS: UNITS-m LFT- 0.0000 HGT- 1450.0 INTERVAL- 50.000
Model Info: V3.5.3 No Cumulus Backscatter Simple ice 1 km, 43 levels, 0 sec

MM5 BASIC PARAMETERISATION

- ✓ 4 grids with spatial resolution 27, 9, 3, 1 km
- ✓ 37 – 43 vertical levels (12 – 14 in lowest 500 m)
- ✓ Simple ice/graupel explicit moisture schemes –
Dudhia/Reisner1
- ✓ Grell cumulus parameterization (grids 1, 2)
- ✓ MRF (grid 1 & 2) and Blackadar (grids 3 & 4)
PBL parameterization
- ✓ Radiation cooling of atmosphere - RRTM
- ✓ Multi-layer soil temperature model –
bucket soil moisture scheme

Overview of the logical standing of the different methods of grid 4 initialization

Evaluation of the effects of Global Analysis data and FDDA analysis

Experiment 4x1

- ☑ 43 vertical levels
- ☑ Global Analysis
- ☑ grids 1-4 run: 72 h
- ☑ grid 4 run: 48 h
(24 h spin-up)

Experiment 4x2

- ☑ 43 vertical levels
- ☑ Global Analysis
- ☑ grids 1-3 run: 72 h
- ☑ grid 4 run: 48 h
(separately)

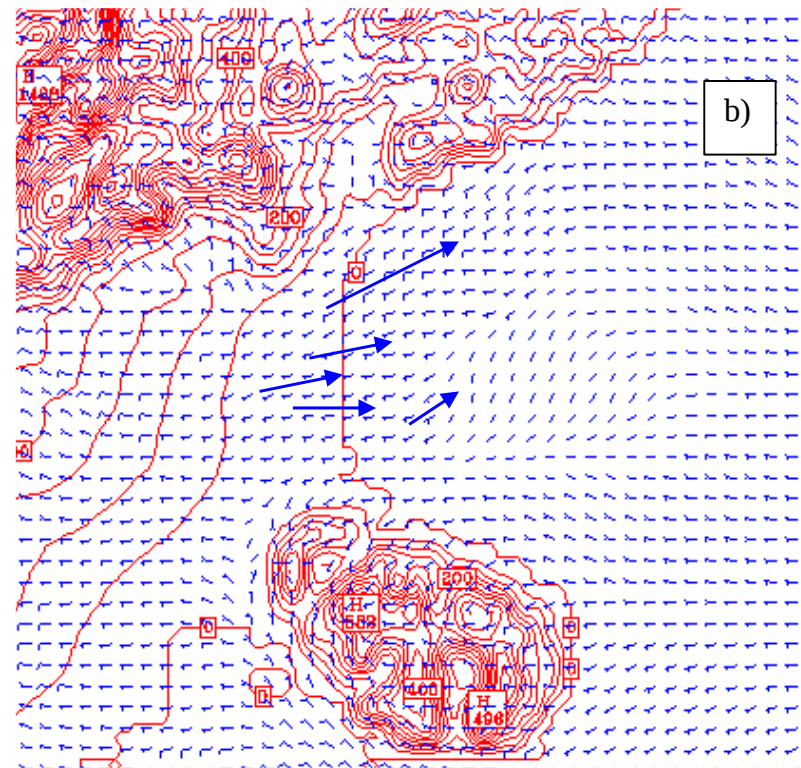
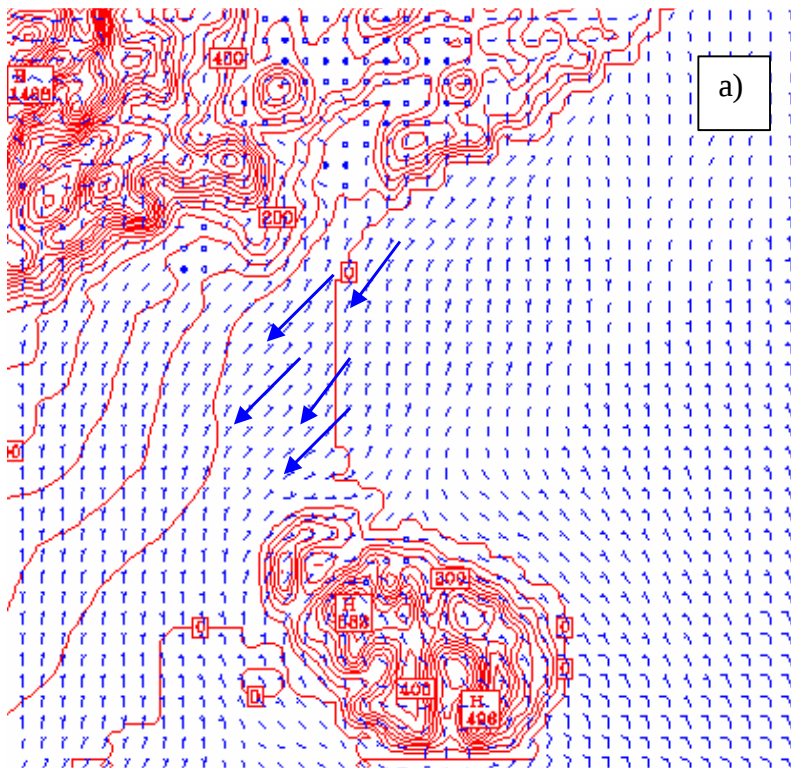
Experiment 4x3

- ☑ 43 vertical levels
- ☑ Global Analysis
- ☑ grid 1 run: 72 h
- ☑ grids 2-3 run: 72 h
(separately)
- ☑ grid 4 run: 48 h
(separately)

Modelled near-surface wind, experiment 4x1, grid 4:

a) 1700 NZST 4.08.2000 (41 h forecast)

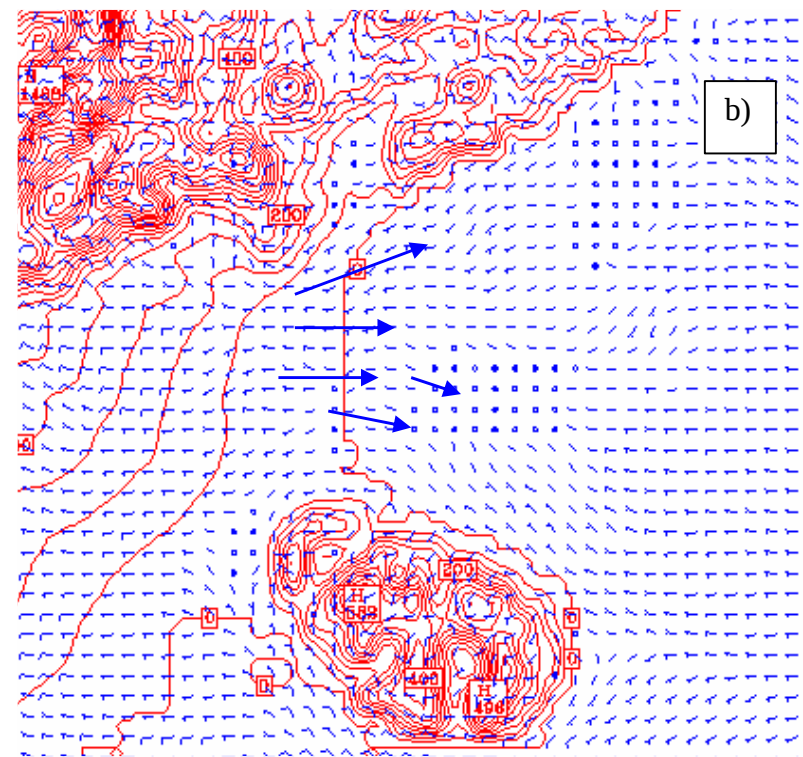
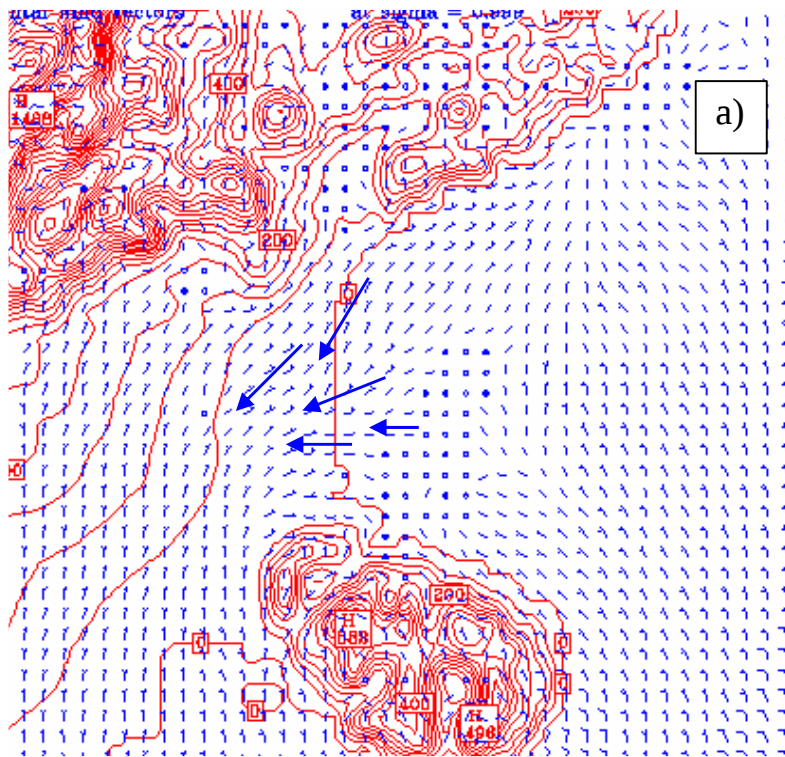
b) 0000 NZST 5.08.2000 (48 h forecast)



Modelled near-surface wind, experiment 4x2, grid 4:

a) 1700 NZST 4.08.2000 (41 h forecast)

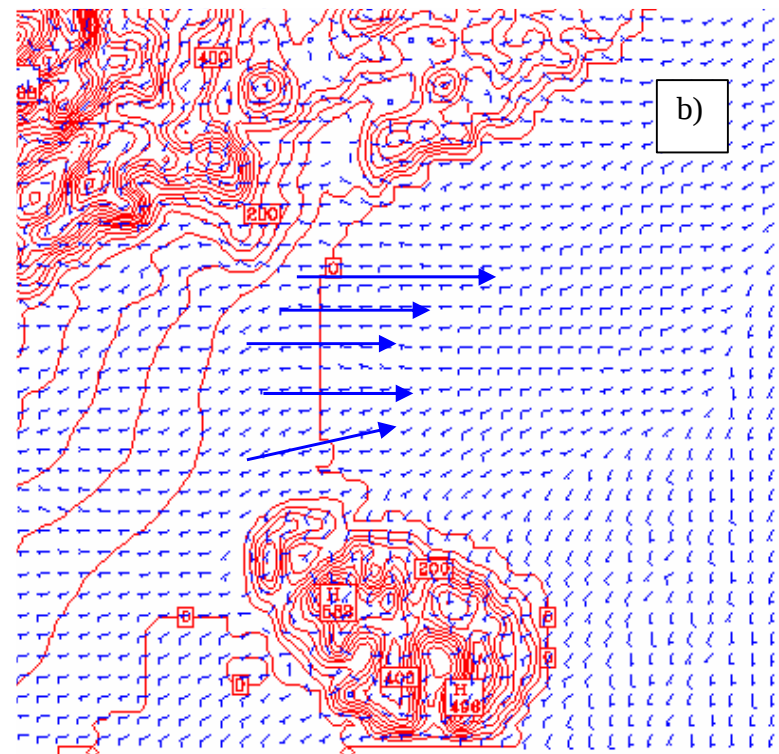
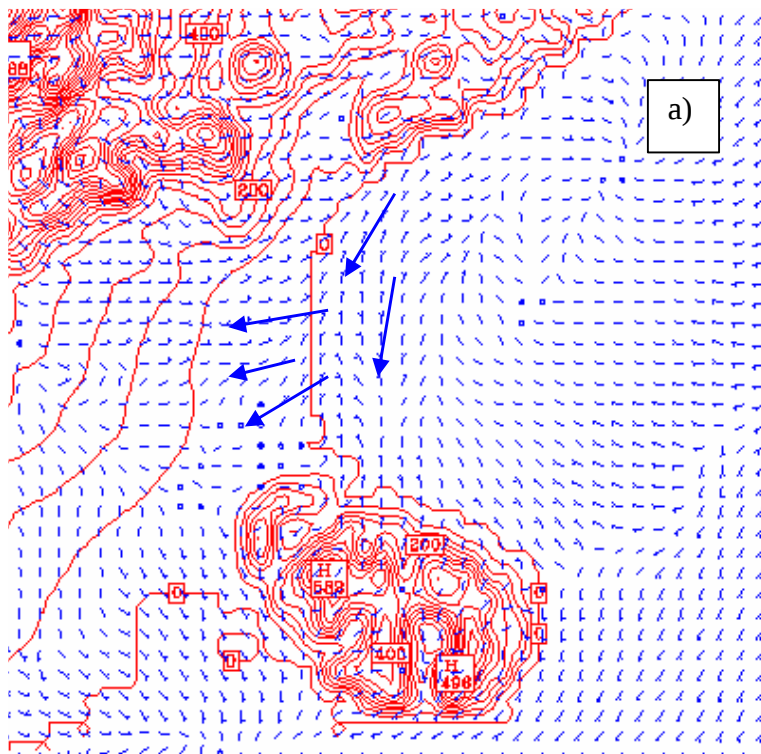
b) 0000 NZST 5.08.2000 (48 h forecast)



Modelled near-surface wind, experiment 4x3, grid 4:

a) 1700 NZST 4.08.2000 (41 h forecast)

b) 0000 NZST 5.08.2000 (48 h forecast)



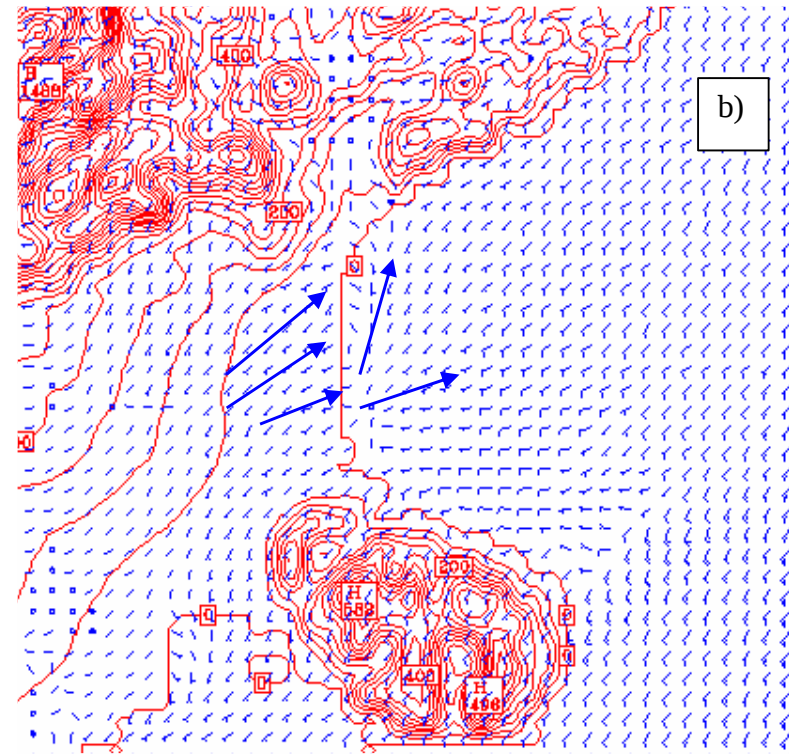
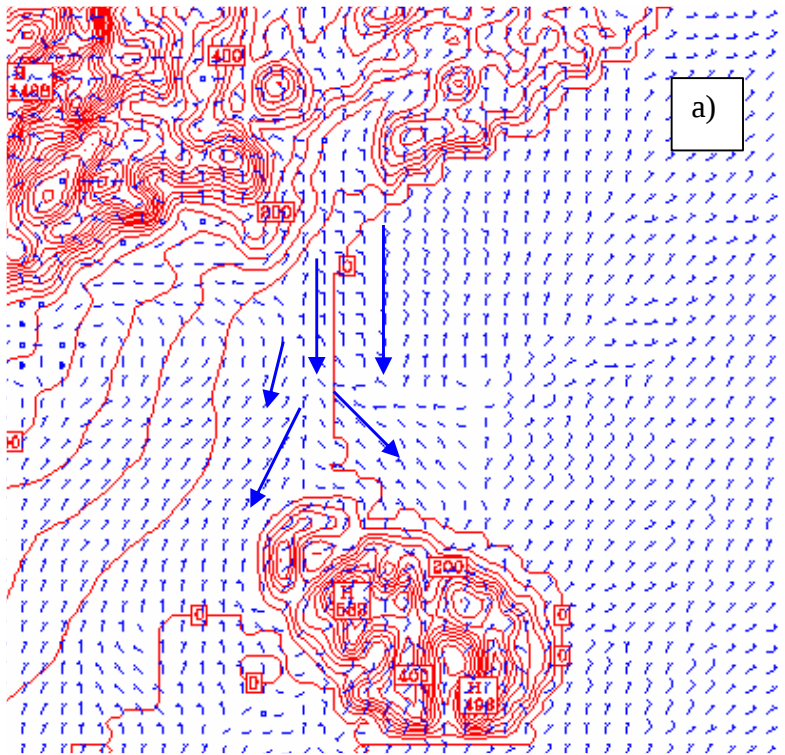
Model evaluation statistics: IOA, PCC, S-RMSE, U-RMSE, 1- 7 August 2000

EXPERIMENT	PCC	S-RMSE	U-RMSE	IOA
Wind Speed (m/s)				
Experiments 4x1	0.62	0.85	1.25	<u>0.71</u>
Experiments 4x2	0.65	0.67	0.88	<u>0.75</u>
Experiments 4x3	0.77	0.31	0.56	<u>0.87</u>
U-component (m/s)				
Experiments 4x1	0.69	0.85	1.46	<u>0.80</u>
Experiments 4x2	0.79	0.53	0.96	<u>0.86</u>
Experiments 4x3	0.91	0.25	0.61	<u>0.95</u>
V-component (m/s)				
Experiments 4x1	0.54	0.85	0.92	<u>0.60</u>
Experiments 4x2	0.53	0.73	0.76	<u>0.65</u>
Experiments 4x3	0.59	0.37	0.49	<u>0.76</u>
Temperature (°C)				
Experiments 4x1	0.92	1.49	1.52	<u>0.88</u>
Experiments 4x2	0.91	1.54	1.55	<u>0.90</u>
Experiments 4x3	0.94	1.37	1.90	<u>0.90</u>
Relative Humidity (%)				
Experiments 4x1	0.77	6.47	9.56	<u>0.81</u>
Experiments 4x2	0.86	6.10	6.68	<u>0.89</u>
Experiments 4x3	0.87	5.41	5.82	<u>0.91</u>

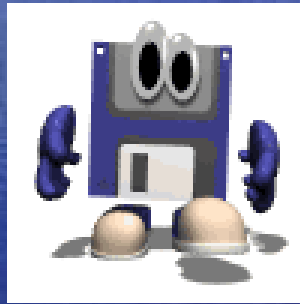
Modelled near-surface wind, grid 4 (14h forecast):

a) 1400 NZST 23.07.2000 (scheme 4x3)

b) 1400 NZST 23.07.2000 (scheme 4x1)



Problems of using WRF following our MM5 experience



✗ We need a new multi-parallel computer for proper WRF utilisation and application

Conclusion

- ✗ The research has shown the ability of MM5 to reproduce air circulation for the Christchurch area (during winter time)
- ✗ As expected, there was permanent conflict between synoptic scale processes imported via the global analysis and local scale processes: this factor was investigated for more accurate MM5 evaluation over Christchurch
- ✗ We are currently examining the issues involved in replacing MM5 by WRF